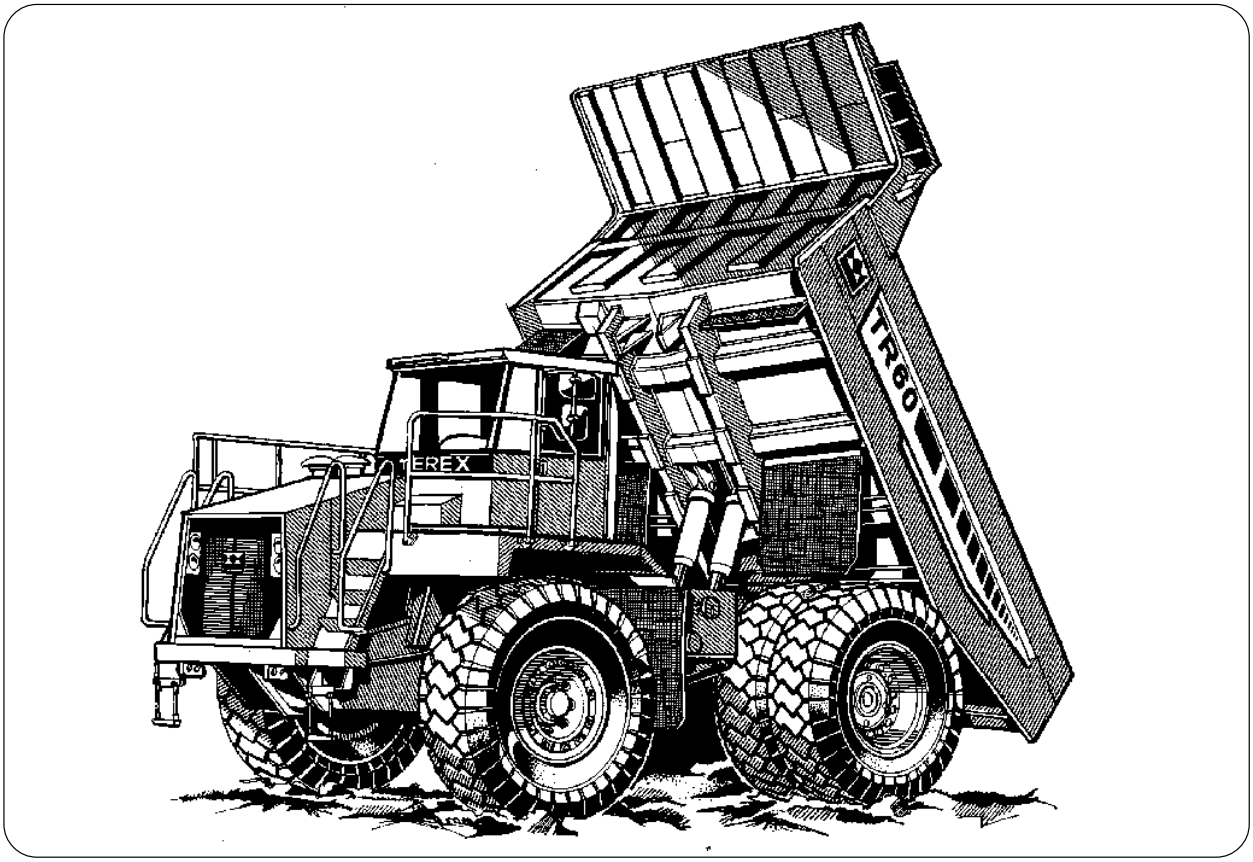
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TEREX

TR60
Off-Highway Truck Maintenance Manual



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TECHNICAL PUBLICATIONS DEPARTMENT
TEREX EQUIPMENT LIMITED,
MOTHERWELL, SCOTLAND, ML1 5RY
REF. NO. SM750/782

SM 1564 Rev 3 02-02

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The information contained within this Alert must not be made available to third parties not authorised to receive it.

Service Information Alert

DATE: April 1994 **B168**

MODEL: General

SUBJECT: VITON 'O' RINGS AND SEALS (FLUORO-ELASTOMERS) - SAFETY HAZARDS

PURPOSE:

To advise potentially hazardous condition.

DETAIL:

It has been brought to our attention that 'Viton' material used in manufacture of oil seals and 'O' rings, produces a highly corrosive acid (Hydrofluoric) when subjected to temperatures above 315° C.

The resulting contamination can have extreme consequences on human tissue since it is almost impossible to remove after contact.

We therefore recommend the following procedure when it is necessary to inspect any equipment that has been subjected to a high temperature i.e. fire.

a. Visually inspect for any gaskets or seals which have suffered from heat; they will appear black and sticky.

b. If this is affirmed - **Do Not Touch**

c. Make enquiries to ascertain the material composition. Any Fluoro-elastomer (Viton, Fluorel or Tecmoflon) should be considered dangerous but natural rubber and nitrile are non-hazardous.

d. If Fluoro-elastomer seals have been used, then the affected area MUST be decontaminated before undertaking further work.

e. Disposable Heavy Duty Gloves (Neoprene) MUST be worn and the affected area decontaminated by washing thoroughly with Limewater (Calcium Hydroxide solution).

f. Any cloths, residue and gloves used MUST be safely discarded after use.

Note: Burning of the discarded items is NOT RECOMMENDED, except in an approved incineration process where the gaseous products are treated by alkaline scrubbing.

TEREX SERVICE DEPARTMENT

TEREX Equipment Limited, Motherwell, Scotland ML1 5RY Tel. (0698) 732121 Tlx. 77141 Fax. (0698) 734046
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IMPORTANT SAFETY NOTICE

Proper service and repair is important to the safe, reliable operation of all motor vehicles. The service procedures recommended and described in this publication, are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the purpose. The special tools should be used when, and as recommended.

It is important to note that this publication contains various WARNINGS and NOTES which should be carefully read in order to minimize the risk of personal injury to personnel, or the possibility that improper service methods will be followed which may damage the vehicle or render it unsafe. It is also important to understand these WARNINGS and NOTES are not exhaustive. It is not possible to know, evaluate and advise the service trade of ALL conceivable ways in which service might be carried out, or, of the possible hazardous consequences of each way. Consequently, no such broad evaluation has been undertaken. Accordingly, anyone who uses a service procedure, or tool, which is not recommended, must first satisfy themselves thoroughly that neither their safety, nor vehicle safety, will be jeopardized by the service method he/she selects.

Two types of heading are used in this manual to attract your attention.

1. ⚠ **WARNING** - This symbol is used when an operating procedure, practice, etc., which, if not correctly followed could result in personal injury or loss of life. Look for this symbol to point out important safety precautions. It means - **ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!**

2. **Note -** This is used when an operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.

⚠ **WARNING**
Never use parts which are altered, modified, or weakened in operation. This can seriously jeopardize the integrity of the machine and could result in property damage or serious personal injury.

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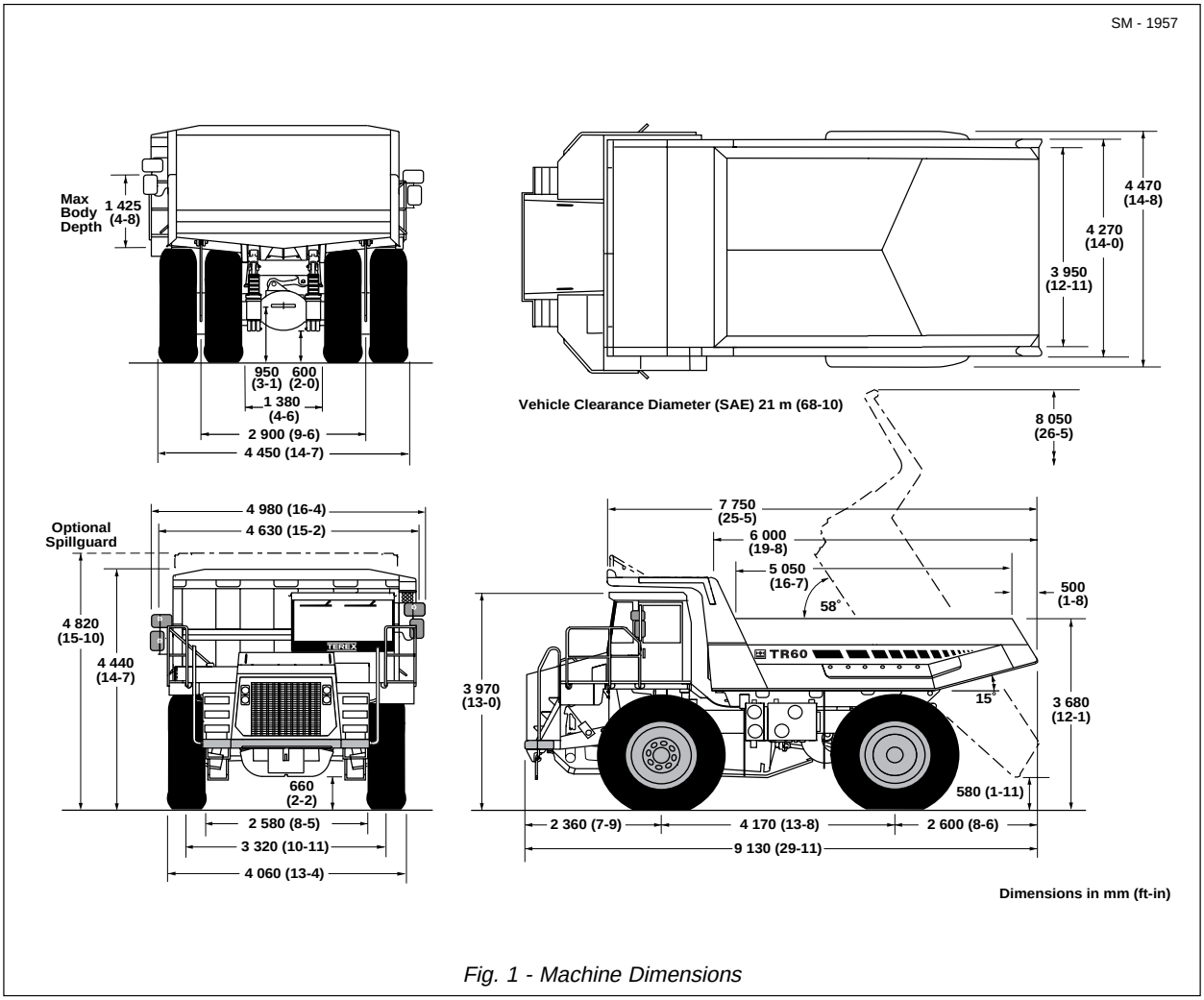


Fig. 1 - Machine Dimensions

ENGINE

Make/Model ..... Cummins QSK19-C650
Type ..... 4 Cycle, Turbocharged/Low Temperature Aftercooled. Electronic Management
Gross Power 1 500 through 2 100 rev/min ..... 485 kW (650 hp, 659 PS)
Net Power 1 500 through 2 100 rev/min ..... 462 kW (620 hp, 628 PS)

Note: Power ratings to SAE J1995 Jun 95. Engine emission meets USA EPA/CARB MOH 40 CFR 89 and EU NRMM (non-road mobile machinery directive).

Maximum Torque ..... 3 084 Nm (2 275 lbf ft) at 1 300 through 1 500 rev/min
Number of Cylinders/Configuration ..... 6, in line
Bore x Stroke ..... 159 x 159 mm (6.25 x 6.25 in)
Total Displacement ..... 18.9 litres (1 150 in³)
Starting ..... Electric
Maximum Speed, Full Load ..... 2 100 rev/min
Maximum Speed, No Load ..... 2 350 rev/min
Idle Speed ..... Self Adjusting
Safe Operating Angle ..... 30°/60% Grade

TRANSMISSION

Make/Model ..... Allison M6600AR automatic electronic control with soft shift feature. Remote mounted in the frame. Integral TC 682 torque converter and planetary gearing. Six speeds forward, two reverse. Automatic converter lockup action in all speed ranges. With body up, gear range is limited to 1st forward only. Downshift inhibitor. Intregal hydraulic retarder.

Speeds With 24.00 R 35 Tyres						
Forward						
Gear	1	2	3	4	5	6
Ratio	4.00	2.68	2.01	1.35	1.00	0.67
km/h	9.5	14.2	18.9	28.2	38.1	57.0
mile/h	5.9	8.8	11.8	17.5	23.7	35.5
Reverse						
Gear	1	2				
Ratio	5.12	3.46				
km/h	7.4	11.0				
mile/h	4.6	6.8				

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DRIVE AXLE

Heavy duty axle with single reduction spiral bevel gear differential, full floating axle shafts, and planetary reduction at each wheel.

Ratios:
Differential 3.73:1
Planetary 5.80:1
Total Reduction 21.63:1

SUSPENSION

Front: King pin strut type independent front wheel suspension by self-contained, variable rate, nitrogen/oil cylinders.

Rear: Variable rate nitrogen/oil cylinders with A-frame linkage and lateral stabilizer bar.

Maximum Strut Stroke
Front ..... 251 mm (9.9 in)
Rear ..... 182 mm (7.2 in)
Maximum Rear Axle Oscillation ..... ± 6.5 Degrees

WHEELS AND TYRES

Wheel Rim Width ..... 17 in
Standard Tyres (Front & Rear) .....24.00 R 35** Radial

Note: It is recommended that for tyres both listed and unlisted, the user should consult the tyre manufacturer and evaluate all job conditions in order to make the proper selection.

BRAKES

Service

All hydraulic brake system. Transmission mounted pressure compensating pump provides hydraulic pressure for brakes and steering. Independent circuits front and rear. Each circuit incorporates a nitrogen accumulator which stores energy to provide consistent braking response.

Front Brake Circuit Pressure ..... 159 bar (2 300 lbf/in²)
Rear Brake Circuit Pressure .....52 bar (750 lbf/in²)
Accumulators:
Nitrogen Precharge Pressure .....55 bar (800 lbf/in²)

Front:
Type .....Dry Disc with 1 calliper per wheel
Disc Diameter ..... 710 mm (28 in)
Pad Area, Total ..... 1 395 cm² (216 in²)

Rear:
Type .....Oil cooled, multiple friction discs, completely sealed from dirt and water.
Braking Surface, Total .....47 151 cm² (7 308 in²)

Parking

Application of rear brakes by springs in brake disc pack. Hydraulically released.
Hold-off Pressure .....83 bar (1 200 lbf/in²)

Retardation

Modulated lever control of rear disc pack. 510 kW (685 hp) continuous.
Retarder Actuation Pressure ..... up to 33 bar (480 lbf/in²)

Emergency

Push button solenoid control applies service and parking brakes. Automatically applies when engine is switched off. Parking brake applies should system pressure fall below a predetermined level.

Brakes conform to ISO 3450, SAE J1473 OCT 90.

STEERING SYSTEM

Independent hydrostatic steering with closed-centre steering valve, accumulator and pressure compensating piston pump.

Accumulator provides uniform steering regardless of engine speed. In the event of loss of engine power it provides steering of approximately two lock-to-lock turns.
A low pressure indicator light warns of system pressure below 83 bar (1 200 lbf/in²). Steering meets SAE J53.

System Pressure..... 159 bar (2 300 lbf/in²)
Relief Pressure .....207 bar (3 000 lbf/in²)
Steering Cylinders ..... Double Acting, Single Stage
Accumulator:
Oil Capacity ..... 14.0 litres (3.70 US gal)
Nitrogen Precharge Pressure .....55 bar (800 lbf/in²)
Steering Angle (Left and Right) .....39°
Pump:
Type ..... Piston
Capacity at 2 100 rev/min ..... 1.4 litres/s (22 US gal/min)

BODY HYDRAULICS

Two body hoist cylinders are mounted between the frame rails. Cylinders are two-stage with power down in the second stage.

System Relief Pressure ..... 190 bar (2 750 lbf/in²)
Pump:
Type ..... Gear
Capacity at 2 100 rev/min .....227 litres/min (60 US gal/min)
Control Valve ..... Servo Controlled, Open Centre
Body Raise Time..... 16 Seconds
Body Lower Time ..... 14 Seconds

ELECTRICAL

Type ..... 24 Volt, Negative Ground
Battery..... Two, 12 Volt, 165 Ah each, Maintenance Free
Accessories..... 24 Volt
Alternator .....70 Amp
Starter .....8.9 kW

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BODY

Longitudinal 'V' type floor with integral transverse box-section stiffeners. The body is exhaust heated and rests on resilient impact absorption pads.

Body wear surfaces are high hardness (360-440 BHN) abrasion resistant steel. Yield strength of plates 1 000 MPa (145 000 lbf/in²).

Plate Thicknesses:
- Floor ..... 19 mm (0.75 in)
- Side ..... 10 mm (0.39 in)
- Front, lower ..... 10 mm (0.39 in)

ROPS Cabguard SAE J1040 Feb 86. ISO 3471

Volumes:
- Struck (SAE) ..... 26 m³ (34 yd³)
- Heaped 2:1 (SAE) ..... 35 m³ (46 yd³)

SERVICE CAPACITIES

Engine Crankcase and Filters ..... 66 litres (17.5 US gal)
Transmission and Filters ..... 85 litres (22.5 US gal)
Cooling System ..... 157 litres (41.5 US gal)
Fuel Tank ..... 606 litres (160 US gal)
Steering Hydraulic Tank ..... 61 litres (16 US gal)
Steering System ..... 72 litres (19 US gal)
Body and Brake Cooling Tank ..... 216 litres (57 US gal)
Body and Brake Cooling System ..... 258 litres (68 US gal)
Planetaries (Total) ..... 43 litres (11.4 US gal)
Differential ..... 52 litres (13.7 US gal)
Front Ride Strut (Each) ..... 14 litres (3.7 US gal)
Rear Ride Strut (Each) ..... 17 litres (4.5 US gal)
Power Takeoff ..... 4 litres (1 US gal)

Typical Noise Levels

Operator Ear (ISO 6394) ..... 79 dbA

*Exterior Sound Rating (SAE J88 JUN 86) ..... 89 dbA
* - The above result is for the mode giving the highest exterior sound level when measured and operated as per the prescribed procedures of the standard. Results shown are for the vehicle in base configuration.

Note: Noise Level Exposure to the operator and bystander personnel may be higher depending upon proximity to buildings, rock piles, machinery etc.. The actual job site Noise Level Exposure must be measured and applicable regulations complied with in respect to Employee Hearing Protection.

Vehicle Weights (Mass)

	kg	lb
Chassis, with hoists	30 600	67 460
Body, standard	10 650	23 480
Net Weight	41 250	90 940
PAYLOAD, maximum	54 430	120 000
Maximum Gross Weight*	95 680	210 940
FOR UNIT EQIPPED WITH OPTIONAL HARD ROCK BODY:		
Chassis, with hoists	30 600	67 460
Body, with wear plates	13 200	29 100
Net Weight	43 800	96 560
PAYLOAD, maximum	51 880	114 380
Maximum Gross Weight*	95 680	210 940
* Maximum permissable gross vehicle weight with options, attachments, full tank and payload.		
WEIGHT DISTRIBUTION	Front Axle	Rear Axle
Empty %	48	52
Loaded %	34	66

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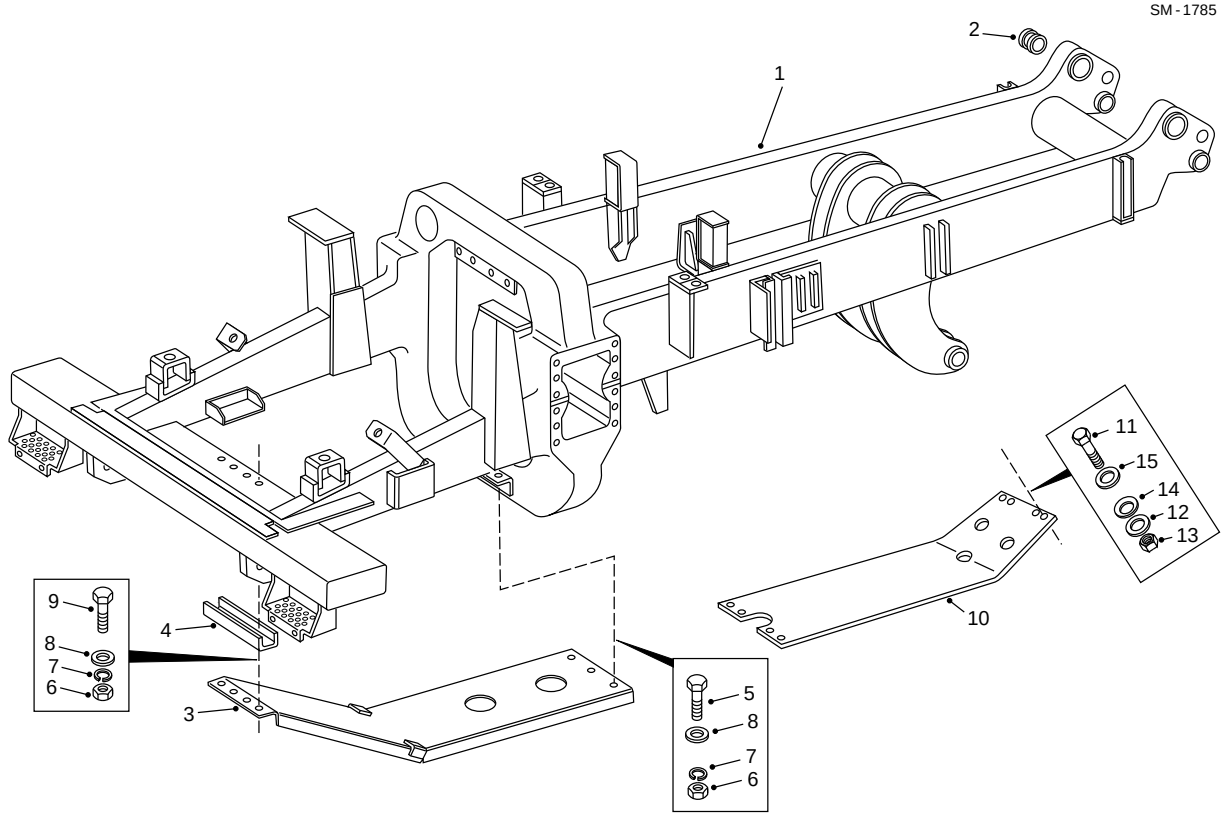
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1 - Frame Assembly
2 - Bushing
3 - Engine Guard
4 - Channel
5 - Bolt
6 - Nut
7 - Lockwasher
8 - Washer
9 - Bolt
10 - Transmission Guard
11 - Bolt
12 - Hardened Washer
13 - Locknut
14 - Spring Disc
15 - Washer

Fig. 1 - Exploded View of Chassis and Guards

REMOVAL

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

To remove any of the components shown in Figs. 1, 2, 3, 4 or 5 (or similar components) the following procedures should be carried out.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

3. Attach a suitable lifting device to the component and remove mounting hardware. Remove the component from the vehicle.

INSTALLATION

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Using a suitable lifting device, align the component to be installed in position on the chassis. Secure the component securely to the chassis with mounting hardware removed during removal.

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MAINTENANCE

Inspection

Inspect the frame and attached parts at intervals not exceeding 250 hours for cracked or broken welds and bending/twisting of the frame. Any defects found should be repaired before they progress into major failures. Contact your dealer for recommended weld and repair instructions.

Welding

Note: It is important that the electrical connections are disconnected in the following order to prevent damage to the electrical components:

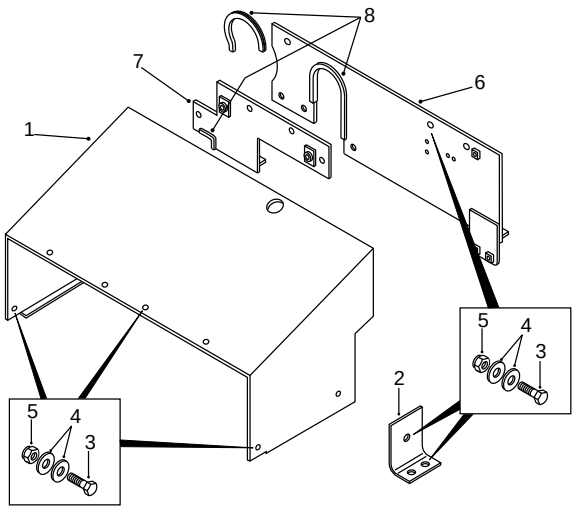
a. Disconnect battery equalizer ground cables.
b. Disconnect battery cables from terminal posts (ground cable first).
c. Disconnect battery equalizer positive cables.
d. Disconnect electrical connections at the ECU.

After welding, reconnect all of the above in the reverse order.

⚠ WARNING
Welding and flame cutting cadmium plated metals produce odourless fumes which are toxic. Recommended industrial hygiene practice for protection of the welding operator from the cadmium fumes and metallic oxides requires enclosure ventilation specifically designed for the welding process. A respiratory protective device such as the M.S.A. 'Gasfoe' respirator with G.M.A. cartridge will provide protection against cadmium, fumes and metallic oxides. The 'Gasfoe' respirator has been approved by the U.S. Bureau of Mines: Approval number 23B-10, and is designed to protect against gases, vapours, and/or metal fumes.

Electric arc welding is recommended for all chassis welding. Since the nature and extent of damage to the frame cannot be predetermined, no definite repair procedure can be established. As a general rule however, if parts are twisted, bent or pulled apart, or a frame is bent or twisted, no welding should be done until the parts are straightened or realigned.

Successfully welded repairs will depend to a great extent upon the use of the proper equipment, materials and the ability of the welder. The Service Department can be consulted regarding the feasibility of welding repairs.



1 - Hood Assembly
2 - Plate
3 - Bolt
4 - Hardened Washer
5 - Nut
6 - Baffle
7 - Baffle
8 - Beading

Fig. 2 - Exploded View of Hood and Mounting

Painting

A check of the condition of the paint should be made approximately twice a year and chassis repainted if necessary.

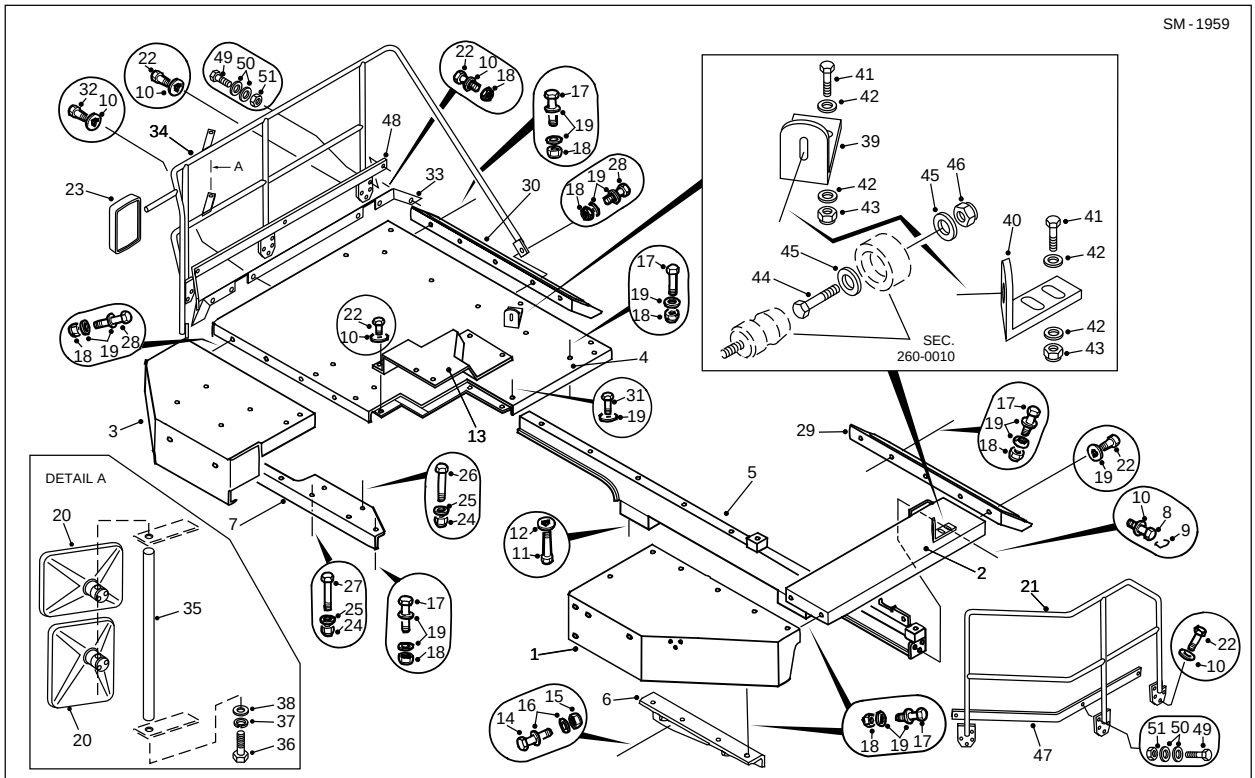
⚠ WARNING
Welding, burning, heating or dressing surfaces previously painted using polyurethane paint produces fumes which are toxic. Surfaces must be prepared using paint stripper prior to area being reworked. Recommended Industrial Hygiene and Safety Rules should be be followed for protection of the welding operator from fumes.

If painting of the actual frame of the unit is required, thoroughly clean the areas to be painted. Apply a primer coat of red oxide and then a finish coat of polyurethane enamel.

To keep rust and corrosion to a minimum, periodic painting of abrasions and other exposed metal areas on the frame is highly recommended.

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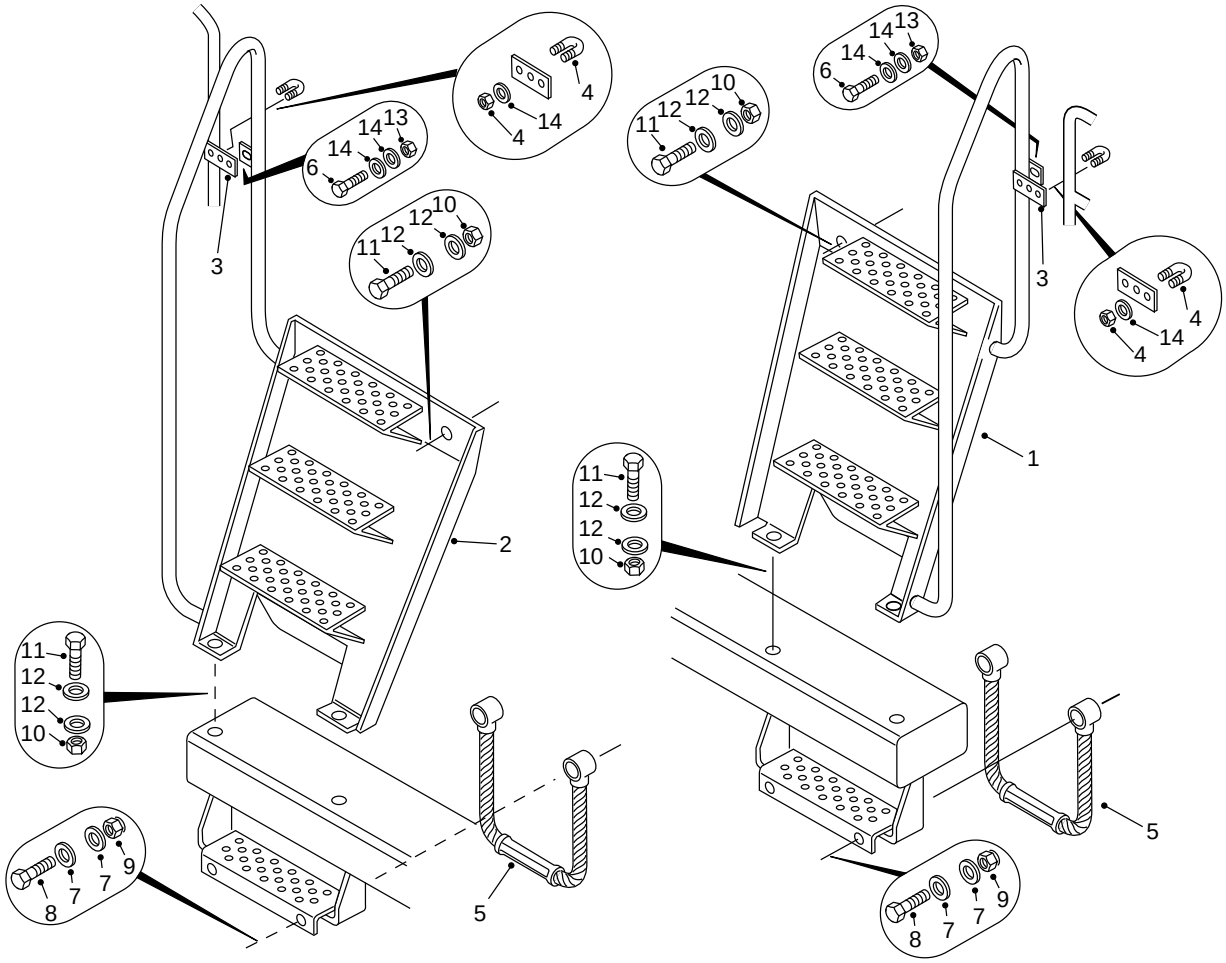
1 - LH Fender Assembly
2 - LH Platform Assembly
3 - RH Fender Assembly
4 - RH Platform Assembly
5 - Crossmember
6 - Support
7 - Support
8 - Bolt
9 - Lockwire
10 - Hardened Washer
11 - Bolt
12 - Washer
13 - Engine Access Cover
14 - Bolt
15 - Locknut
16 - Hardened Washer
17 - Bolt
18 - Locknut
19 - Hardened Washer
20 - Mirror
21 - LH Handrail
22 - Bolt
23 - Mirror Wide Angle
24 - Nut
25 - Washer
26 - Bolt
27 - Bolt
28 - Bolt
29 - Mudguard
30 - Mudguard
31 - Bolt
32 - Bolt
33 - Fender Extension RH
34 - RH Handrail
35 - Mirror Bracket
36 - Bolt
37 - Lockwasher
38 - Washer
39 - Plate Bent
40 - Plate bent
41 - Bolt
42 - Washer
43 - Nut
44 - Bolt
45 - Washer
46 - Nut
47 - Kick Plate
48 - Kick Plate
49 - Bolt
50 - Hardened Washer
51 - Nut

Fig. 3 - Exploded View of Fenders and Mounting

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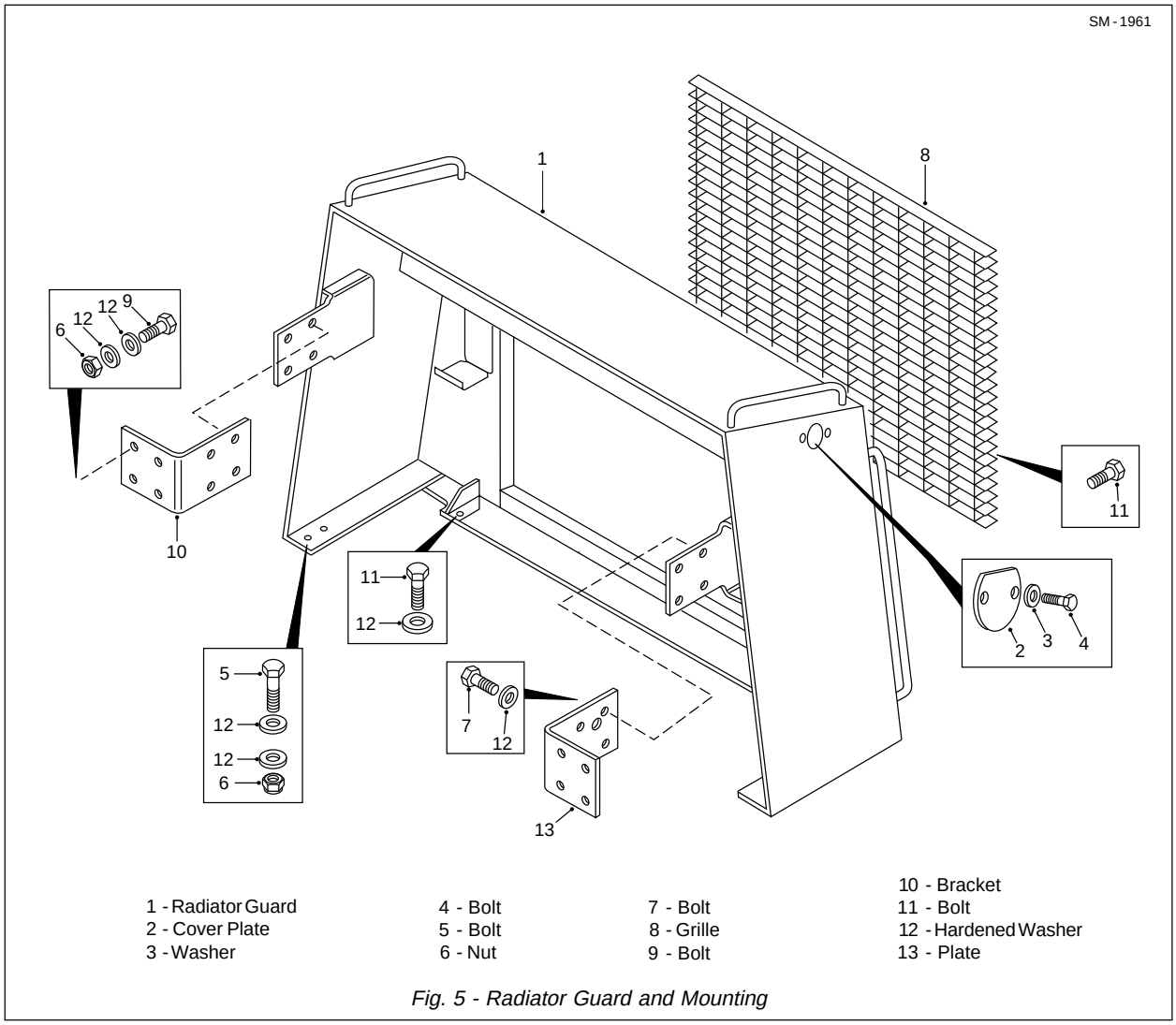


1 - LH Step Assembly
2 - RH Step Assembly
3 - Plate
4 - 'U' Bolt
5 - Step
6 - Bolt
7 - Washer
8 - Bolt
9 - Locknut
10 - Nut
11 - Bolt
12 - Hardened Washer
13 - Nut
14 - Hardened Washer

Fig. 4 - Exploded View of Ladders and Handrails

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1 - Radiator Guard
2 - Cover Plate
3 - Washer
4 - Bolt
5 - Bolt
6 - Nut
7 - Bolt
8 - Grille
9 - Bolt
10 - Bracket
11 - Bolt
12 - Hardened Washer
13 - Plate

Fig. 5 - Radiator Guard and Mounting

* * * *

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Welding

WARNINGS
Before any welding is done on a machine equipped with any electronic systems, disconnect the following (if applicable) in this order: Battery earth cable, battery supply cable, alternator earth cables, alternator supply cables and electrical connections at the engine ECM, transmission ECU, body control lever, hydraulics ECU and cab bulkhead to avoid damage to electrical components. Turn off battery master switch to isolate the batteries before disconnecting any components.
After welding connect all of the above in the reverse order.

Before any welding is done ensure all paint has been removed from the area to be welded. Failure to do so may result in hazardous fumes being given off from the paint.

Note: Always fasten the welding machines ground cable to the piece/frame being welded if possible.

Electric arc welding is recommended for all welded frame repairs. Since the nature and extent of damage to the frame cannot be predetermined, no definite repair procedure can be established. As a general rule however, if parts are twisted, bent or pulled apart, or a frame is bent or out of alignment, no welding should be done until the parts are straightened or realigned.

Successfully welded repairs will depend to a great extent upon the use of the proper equipment, materials and the ability of the welder. The Customer Support Department can be consulted regarding the feasibility of welding repairs.

WARNING
Welding and flame cutting cadmium plated metals produce odourless fumes which are toxic. Recommended industrial hygiene practice for protection of the welding operator from the cadmium fumes and metallic oxides requires enclosure ventilation specifically designed for the welding process. A respiratory protective device such as the M.S.A. 'Gasfoe' respirator with G.M.A. cartridge will provide protection against cadmium, fumes and metallic oxides. The 'Gasfoe' respirator has been approved by the U.S. Bureau of Mines: Approval number 23B-10, and is designed to protect against gases, vapours, and/or metal fumes.

Note: The current from the welding rod always follows the path of least resistance. If, for example, the ground clamp is attached to the rear frame when welding is performed on the front frame, the current must pass a frame connection to return to the welding machine. Since the pivot coupling offers the least resistance but not a sound electrical connection, small electric arcs may be set up across the moving parts which may cause welding blotches on their wearing surfaces and increase the wear rate of these components.

General Welding Procedure

The following general procedure should be used for the repair of defects outwith the vicinity of alloy steel castings.

1. Completely ARC-AIR gouge or grind out the crack until sound metal is reached. If ARC-AIR method is employed, pre-heat area to 100° C (212° F), measure 3 - 4" either side of repair prior to gouging. On completion of gouging grind to remove thin carbon layer.

2. Apply dye-penetrant check to ensure crack has been completely removed.

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3. Pre-heat area to 100° C (212° F), measured 3 - 4" either side of repair. Avoid local overheating.

4. Weld completely using E-7016 electrodes. Care must be taken to ensure electrodes are protected from moisture pick-ups at all times.

5. Allow repair weld to cool slowly.

6. Grind and blend repair to original contour. Paint heat damaged areas.

The following general procedure should be used for the repair of defects in alloy steel castings and in the welds joining steel castings.

1. Completely ARC-AIR gouge or grind out the crack until sound metal is reached. If ARC-AIR method is employed, pre-heat area to 200° C (392° F), measure 3 - 4" either side of repair prior to gouging. On completion of gouging grind to remove thin carbon layer.

2. Apply dye-penetrant check to ensure crack has been completely removed.

3. Pre-heat area to 200° C (392° F), measured 3 - 4" either side of repair. Avoid local overheating.

4. Weld completely using E-7016 electrodes. Care must be taken to ensure electrodes are protected from moisture pick-ups at all times.

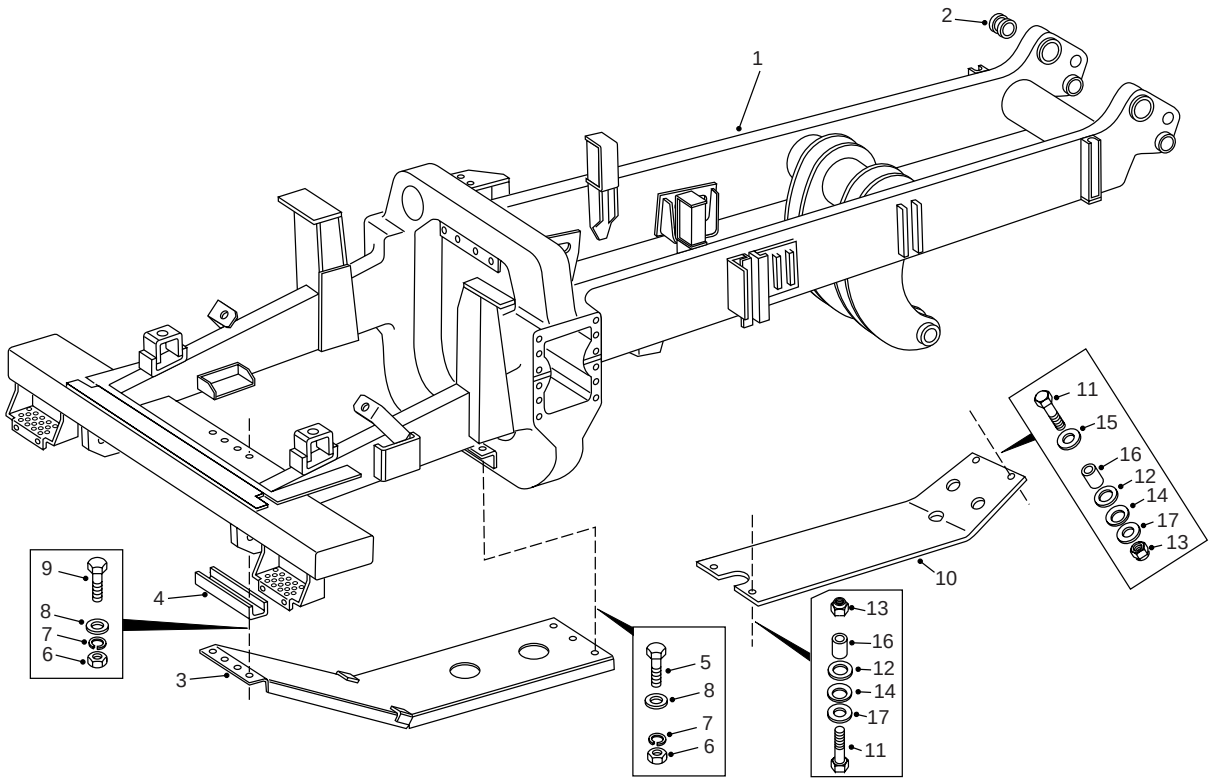
5. On completion of welding, post-heat repair area to 400° C (752° F), measure 3 - 4" either side of repair.

6. If welding has to be interrupted for any reason, e.g. overnight, post-heat immediately as in Step 5.

* * * *

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1 - Frame Assembly
2 - Bushing
3 - Engine Guard
4 - Channel
5 - Bolt
6 - Nut
7 - Lockwasher
8 - Washer
9 - Bolt
10 - Transmission Guard
11 - Bolt
12 - Hardened Washer
13 - Locknut
14 - Spring Disc
15 - Washer
16 - Spacer
17 - Washer

Fig. 1 - Exploded View of Chassis and Guards

REMOVAL

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

To remove any of the components shown in Figs. 1, 2, 3, 4 or 5 (or similar components) the following procedures should be carried out.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

3. Attach a suitable lifting device to the component and remove mounting hardware. Remove the component from the vehicle.

INSTALLATION

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Using a suitable lifting device, align the component to be installed in position on the chassis. Secure the component securely to the chassis with mounting hardware removed during removal.

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MAINTENANCE

Inspection

Inspect the frame and attached parts at intervals not exceeding 250 hours for cracked or broken welds and bending/twisting of the frame. Any defects found should be repaired before they progress into major failures. Contact your dealer for recommended weld and repair instructions.

Welding

Note: It is important that the electrical connections are disconnected in the following order to prevent damage to the electrical components:

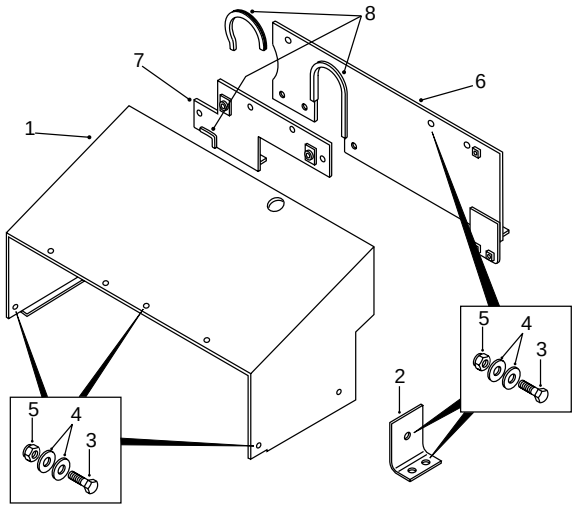
a. Disconnect battery equalizer ground cables.
b. Disconnect battery cables from terminal posts (ground cable first).
c. Disconnect battery equalizer positive cables.
d. Disconnect electrical connections at the ECU.

After welding, reconnect all of the above in the reverse order.

⚠ WARNING
Welding and flame cutting cadmium plated metals produce odourless fumes which are toxic. Recommended industrial hygiene practice for protection of the welding operator from the cadmium fumes and metallic oxides requires enclosure ventilation specifically designed for the welding process. A respiratory protective device such as the M.S.A. 'Gasfoe' respirator with G.M.A. cartridge will provide protection against cadmium, fumes and metallic oxides. The 'Gasfoe' respirator has been approved by the U.S. Bureau of Mines: Approval number 23B-10, and is designed to protect against gases, vapours, and/or metal fumes.

Electric arc welding is recommended for all chassis welding. Since the nature and extent of damage to the frame cannot be predetermined, no definite repair procedure can be established. As a general rule however, if parts are twisted, bent or pulled apart, or a frame is bent or twisted, no welding should be done until the parts are straightened or realigned.

Successfully welded repairs will depend to a great extent upon the use of the proper equipment, materials and the ability of the welder. The Service Department can be consulted regarding the feasibility of welding repairs.



1 - Hood Assembly
2 - Plate
3 - Bolt
4 - Hardened Washer
5 - Nut
6 - Baffle
7 - Baffle
8 - Beading

Fig. 2 - Exploded View of Hood and Mounting

Painting

A check of the condition of the paint should be made approximately twice a year and chassis repainted if necessary.

⚠ WARNING
Welding, burning, heating or dressing surfaces previously painted using polyurethane paint produces fumes which are toxic. Surfaces must be prepared using paint stripper prior to area being reworked. Recommended Industrial Hygiene and Safety Rules should be be followed for protection of the welding operator from fumes.

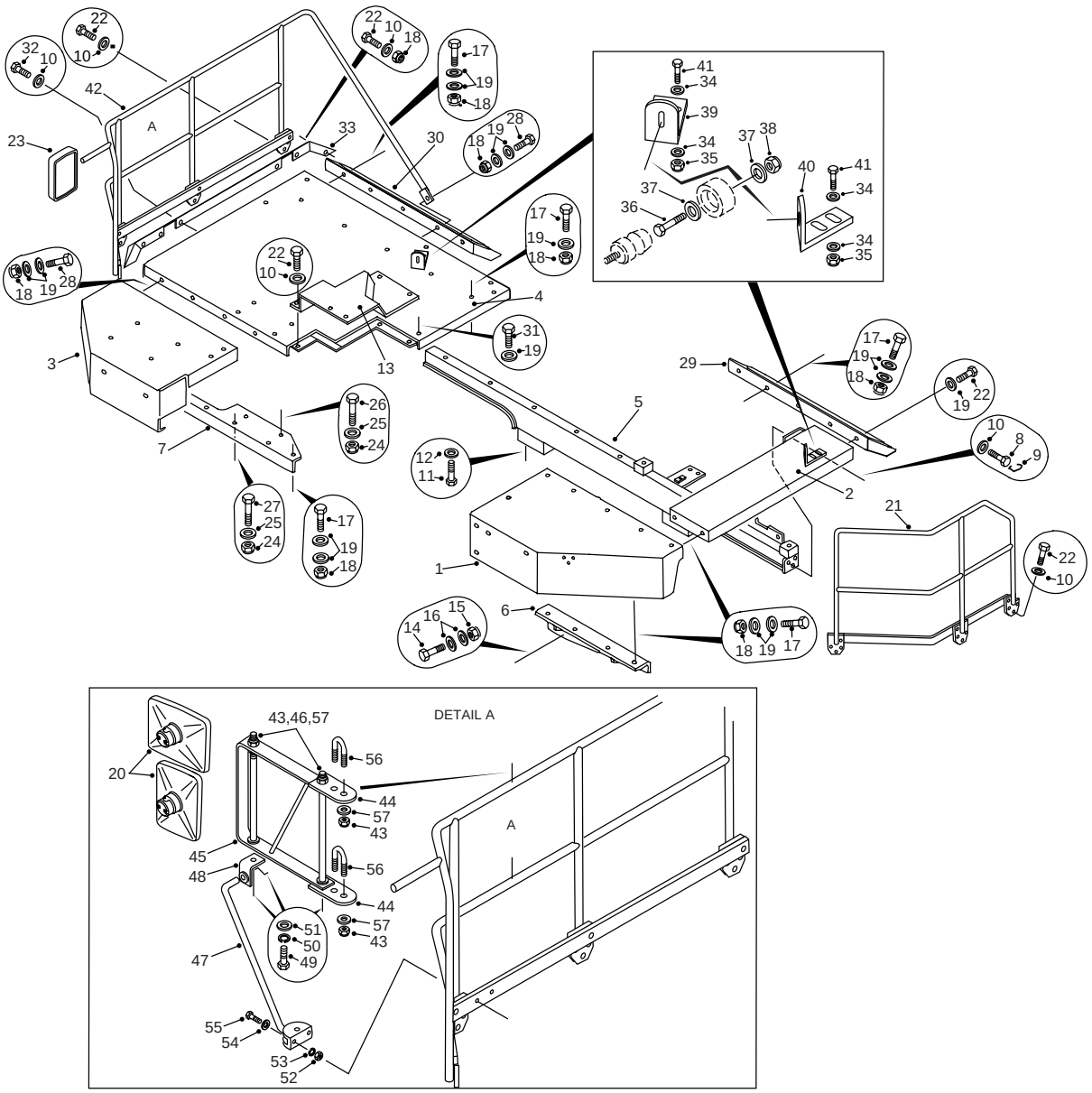
If painting of the actual frame of the unit is required, thoroughly clean the areas to be painted. Apply a primer coat of red oxide and then a finish coat of polyurethane enamel.

To keep rust and corrosion to a minimum, periodic painting of abrasions and other exposed metal areas on the frame is highly recommended.

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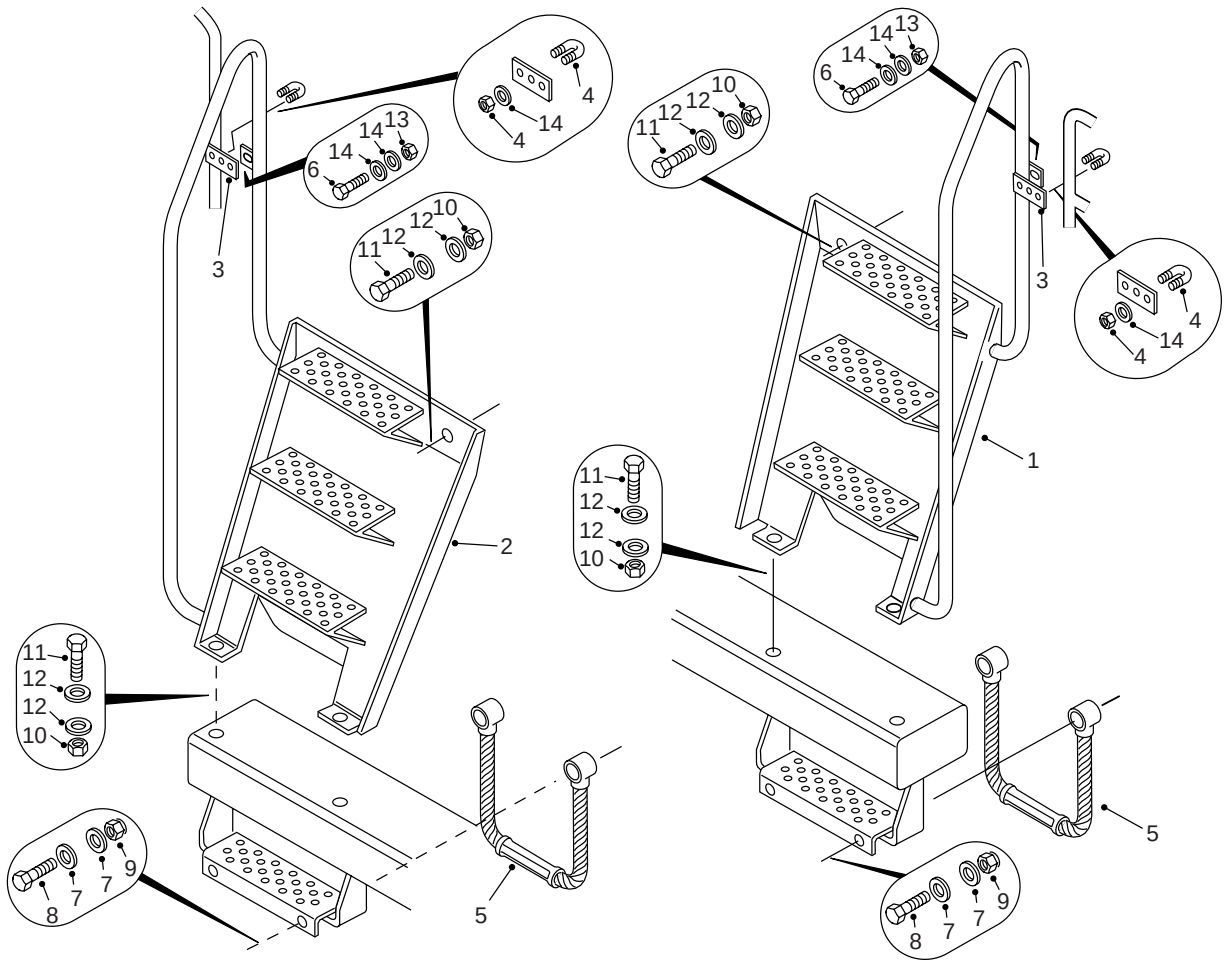
1 - LH Fender Assembly
2 - LH Platform Assembly
3 - RH Fender Assembly
4 - RH Platform Assembly
5 - Crossmember
6 - Support
7 - Support
8 - Bolt
9 - Lockwire
10 - Hardened Washer
11 - Bolt
12 - Washer
13 - Engine Access Cover
14 - Bolt
15 - Locknut
16 - Hardened Washer
17 - Bolt
18 - Locknut
19 - Hardened Washer
20 - Mirror
21 - LH Handrail
22 - Bolt
23 - Mirror Wide Angle
24 - Nut
25 - Washer
26 - Bolt
27 - Bolt
28 - Bolt
29 - Mudguard
30 - Mudguard
31 - Bolt
32 - Bolt
33 - Fender Extension RH
34 - Washer
35 - Nut
36 - Bolt
37 - Washer
38 - Nut
39 - Plate Bent
40 - Plate bent
41 - Bolt
42 - RH Handrail
43 - Nut
44 - Plate
45 - Mirror Arm Assembly
46 - Bar
47 - Rod Assembly
48 - Bracket Assembly
49 - Bolt
50 - Lockwasher
51 - Washer
52 - Nut
53 - Lockwasher
54 - Washer
55 - Bolt
56 - 'U' Bolt
57 - Hardened Washer

Fig. 3 - Exploded View of Fenders and Mounting

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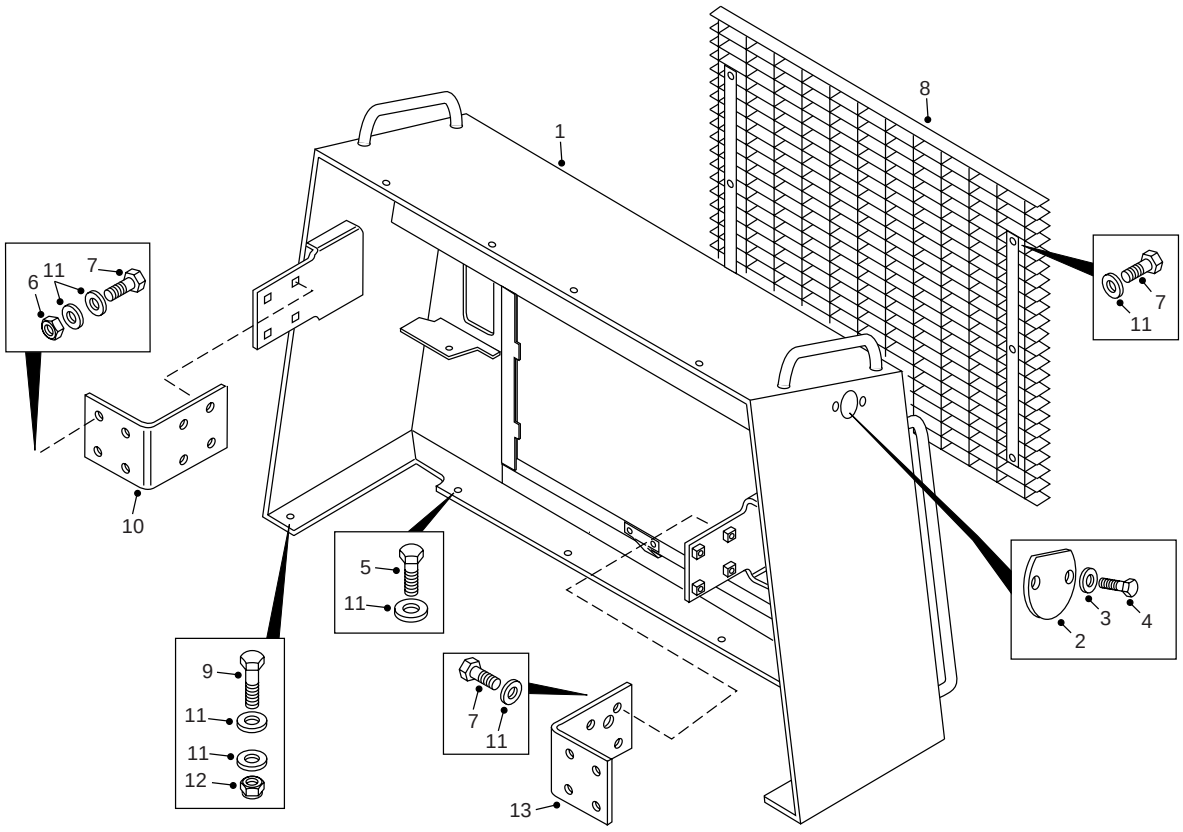


1 - LH Step Assembly
2 - RH Step Assembly
3 - Plate
4 - 'U' Bolt & Nut
5 - Step
6 - Bolt
7 - Washer
8 - Bolt
9 - Locknut
10 - Nut
11 - Bolt
12 - Hardened Washer
13 - Nut
14 - Hardened Washer

Fig. 4 - Exploded View of Ladders and Handrails

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1 - Radiator Guard
2 - Cover Plate
3 - Washer
4 - Bolt
5 - Bolt
6 - Nut
7 - Bolt
8 - Grille
9 - Bolt
10 - Bracket
11 - Hardened Washer
12 - Nut
13 - Bracket

Fig. 5 - Radiator Guard and Mounting

* * * *

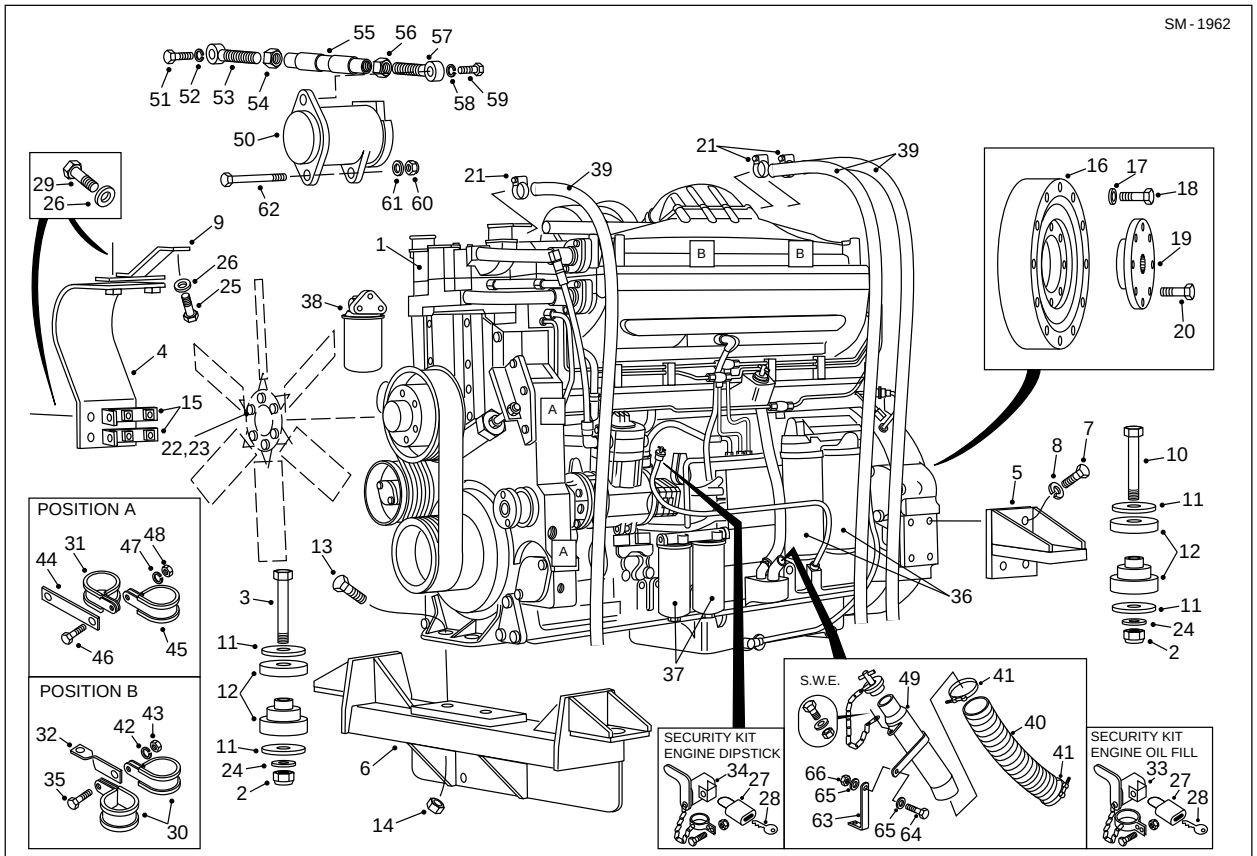
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1 - Engine
2 - Locknut
3 - Bolt
4 - Alternator Guard
5 - Rear Mount
6 - Front Mount
7 - Bolt
8 - Lockwasher
9 - Support Bracket
10 - Bolt
11 - Snubbing Washer
12 - Isolation Mount
13 - Bolt
14 - Locknut
15 - Plate Support
16 - Damper
17 - Lockwasher
18 - Bolt
19 - Flange Coupling
20 - Bolt
21 - Clamp
22 - Bolt
23 - Lockwasher
24 - Washer
25 - Bolt
26 - Washer
27 - Padlock
28 - Key
29 - Bolt
30 - P-Clip
31 - P-Clip
32 - Bracket
33 - Latch Assembly
34 - Latch Assembly
35 - Bolt
36 - Oil Filter
37 - Fuel Filter
38 - Coolant Filter
39 - Breather Line
40 - Filler Hose
41 - Clamp
42 - Lockwasher
43 - Locknut
44 - Plate
45 - P-Clip
46 - Bolt
47 - Lockwasher
48 - Locknut
49 - Filler Assembly
50 - Alternator
51 - Bolt
52 - Lockwasher
53 - Eye Bolt
54 - Jam Nut
55 - Link
56 - Nut
57 - Eye Bolt
58 - Lockwasher
59 - Bolt
60 - Locknut
61 - Lockwasher
62 - Bolt
63 - Bracket
64 - Bolt
65 - Washer
66 - Locknut

Fig. 1 - Engine and Mounting

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

For engine make, model and specification, refer to Section 000-0000, GENERAL INFORMATION. For engine servicing and repair data refer to the engine manufacturers service manual.

The engine is mounted to the frame at three points by a mounting bracket (6) at the front of engine (1) and two rear mounts (5). Rubber isolation mounts (12) through engine mounts provide sufficient flexibility to absorb varying engine vibration and torsional loads.

There are two full-flow oil filters (36) mounted on the left hand side of engine (1) in a downward position. The filters are of the throw away, spin-on type. Oil supplied by the engine oil pump passes through oil filters (36) before reaching the various moving parts of engine (1). The oil is forced by pump pressure through a passage in the filter adaptor and into the elements. Impurities are filtered out as the oil passes through the

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elements and out through another passage in the filter adaptor.

Engine coolant filter (38) and conditioner is a compact bypass type unit with a replaceable spin-on type element mounted on the gear case cover at the front right hand side of engine (1). Refer to Section 210-0000, COOLING SYSTEM.

There are two spin-on type fuel filters (37) mounted on the left hand side of engine (1). The primary fuel filter is in the fuel flow and acts as a strainer and the secondary fuel filter filters the fuel after having passed through the primary fuel filter.

QUANTUM ELECTRONIC FUEL CONTROL SYSTEM

Description

Refer to Fig. 2.

⚠ WARNING
Before any welding is done on a machine equipped with the Quantum Electronic Fuel System, disconnect the following in this order: Battery earth cable, battery supply cable, alternator earth cables, alternator supply cables, transmission black box connector, ECM interface harness connector (30 pin RHS), ECM power harness connector (5 pin RHS) and ECM sensor harness connector (30 pin LHS). Turn off ignition key switch to isolate the batteries before disconnecting any components.

After welding connect all of the above in the reverse order.

The engine is equipped with Quantum Electronic Fuel System which controls the timing and amount of fuel injection by the electronic fuel system injectors. The system also monitors several engine functions using electrical sensors which send electrical signals to the electronic control module (ECM). The ECM then computes the incoming data and determines the correct fuel output and timing for optimum power, fuel economy and emissions.

The Quantum Electronic Fuel System also takes action to prevent damage to the engine and, provides the serviceman with diagnostic capabilities so that problems can be corrected quickly and easily.

1. Electronic Control Module (ECM) - Receives electronic inputs from the driver as well as from mounted sensors that provide information electronically, such as oil pressure and temperature and intake manifold pressure. This information is used to control both the quantity of fuel injected and injection timing.

2. Programmable Read Only Memory (PROM) - Located in the ECM and encoded with the operating software. Additional information is programmed into the EEPROM. This information controls the horsepower rating, torque curve, maximum engine speed and engine protection devices. The ECM processes this information and sends electronic signals to the Electronic Fuel System Injectors where the precise amount of fuel is injected into the engine.

3. Electronic Fuel System Injectors - The injector is a lightweight, compact unit that injects diesel fuel directly into the combustion chamber. The amount of fuel injected and the beginning of injection timing is determined by the ECM. The ECM sends a command pulse which activates the injector solenoid.

The injector performs four functions:

a - Creates the high fuel pressure required for efficient injection.
b - Meters and injects the exact amount of fuel required to handle the load.
c - Atomizes the fuel for mixing with the air in the combustion chamber.
d - Permits continuous fuel flow for component cooling.

Electronic fuel system injectors are self compensating and virtually eliminate engine tune-ups.

Note: Never apply 12 V directly to terminals on the injector as it will burn out. Before removing injectors, the fuel passages must be blown out to prevent fuel flow from entering the cylinder head.

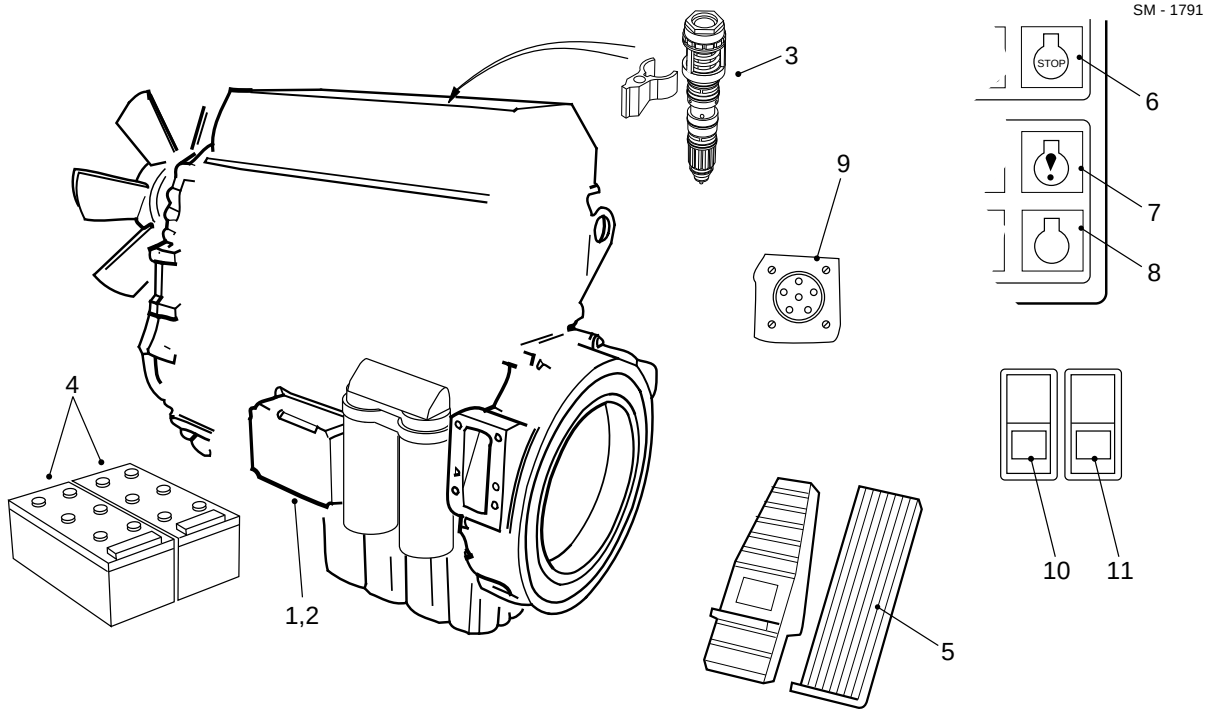
4. Batteries - Two 12 volt maintenance free batteries supply the machine with electrical power to operate all electrical components.

5. Electronic Foot Pedal - The electronic foot pedal provides an electrical signal to the engine's fuel control system in proportion to the degree of pedal actuation.

Note: The electronically controlled engine will override the electronic foot pedal position until the engine is

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1 - Electronic Control Module (ECM)
2 - Programmable Read Only Memory (PROM)
3 - Electronic Fuel System Injectors
4 - Batteries
5 - Electronic Foot Pedal
6 - Engine 'Stop' Light
7 - Engine 'Warning' Light
8 - Engine 'Fluid' Light
9 - Diagnostic Test Point
10 - Diagnostic Request Switch
11 - Diagnostic Search Switch

Fig. 2 - Quantum Electronic Fuel System Components

warmed up to the correct operating temperature. The engine MUST be started with foot 'OFF' the electronic foot pedal.

6. Engine Stop Light (Red) - When the engine 'Stop' light comes on, the computer has detected a major malfunction in the engine that requires immediate attention. It is the operators responsibility to shut down the engine to avoid serious damage.

7. Engine Warning Light (Yellow) - When the engine 'Warning' light comes on, the computer has detected a fault in the engine which may result in power loss. The fault should be diagnosed and corrected at the earliest opportunity.

8. Engine Protection Fluid Light (Amber) - When the engine 'Fluid' light comes on, the computer has detected a fault in the engine. The light will remain on as long as the fault is occuring. The fault should be diagnosed and corrected at the earliest opportunity. If the fault continues to get worse the light will flash. Stop the machine and do not operate until the fault is corrected.

9. Diagnostic Test Point - Plug in connector for diagnostic data reader (DDR).

10. Diagnostic Request Switch - To check for active codes:

a - turn the ignition key switch to the 'OFF' ('0') position.

b - press the diagnostic switch to the 'ON' position.

c - turn the ignition key switch to position '1'.

If no active codes are recorded the 'Stop', 'Warning' and 'Fluid' lights will illuminate and stay on.

If active codes are recorded the 'Stop', 'Warning' and 'Fluid' lights will illuminate momentarily. The yellow 'Warning' and red 'Stop' lights will begin to flash the code of the recorded fault.

11. Diagnostic Search Switch - When the engine is in diagnostic mode this switch is used to search through a list of fault codes, ie. pressing the top of the switch momentarily will advance to the next active

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fault code, pressing the bottom of the will go back to the previous code.

On machines which have a Low Idle Adjustment feature, this switch can also be used to increase or decrease (in increments of 25 RPM), the idle or intermediate speed of the engine.

Operation

Numbers in parentheses refer to Fig. 2.

The machine is equipped with the Quantum engine protection system which records fault codes in the ECM (1), when the engine malfunctions and when an out-of-range condition is found.

When the 'Stop' light (6) on the dash panel illuminates, the computer has detected a major malfunction in the engine that requires immediate attention. It is the operators responsibility to shut down the engine to avoid serious damage.

When an out-of-range conditions is found, the 'Fluid' light (8) illuminates and the engine protection system is initiated. The 'Fluid' light will start to flash if the out-of-range condition continues to get worse. The operator MUST shut down the engine to avoid serious damage.

The engine should not be restarted after it has been shut down after activation of the engine protection system unless the problem has been diagnosed and corrected.

Conditions that will cause the amber 'Fluid' light (8) to come on are; Low coolant level, High coolant temperature, Idle validation/throttle pedal switch mismatch, High intake manifold temperature, Low oil pressure and High fuel rail pressure.

Whenever the 'Stop' light (6), 'Warning' light (7) or 'Fluid' light (8) come on, the Electronic Fuel System computer will determine where the problem is and will store this information in its memory. If the malfunction is intermittent, the lights will come on and go off as the computer senses the changing engine condition.

A special diagnostic data reader (INSITE) is available that can be plugged into the engine computer memory via the onboard diagnostic test point (9). The reader is used to extract information related to the cause of the problem. Once the malfunction has been corrected, the Electronic Fuel System will return the engine to normal operation. The data reader can now distinguish between active codes and those stored in the historic code memory (inactive codes). Inactive codes can only be viewed using the data reader. The fault code recorded in the ECM memory will remain until it is erased by a technician.

⚠ WARNINGS
The operator of a Quantum-equipped vehicle must not attempt to use or read a data reader of any kind while the vehicle is operating. Doing so can result in loss of control, which may cause vehicle damage and may result in personal injury.

The operator can check for active faults by turning the ignition key switch to the 'OFF' position, switching the diagnostic switch 'ON' and then turning the ignition key switch to position '1'.

If no active fault codes are recorded, all three ('Stop', 'Warning' & 'Fluid') lights will come on and stay on. If active codes are recorded, all three lights will come on momentarily. The yellow ('Warning') and red ('Stop') lights will begin to flash the code of the recorded fault. The fault codes flash in the following sequence: the yellow light flashes once, then there is a pause where both lights are off. Then the numbers of the recorded fault code flash in red. There is a pause between each number. When the number is done, the yellow light flashes again. e.g. yellow flashes once - pause - red flashes twice - pause - red flashes three times - pause - red flashes five times - pause - yellow flashes once, indicates fault code 235. The number will repeat in the same sequence until the the system is advanced to the next active fault code or the diagnostic switch is switched to the 'OFF' position. Refer to 'Electronic Fuel System Diagnostic Codes' table for fault code descriptions.

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ELECTRONIC FUEL SYSTEM DIAGNOSTIC CODES		
Error Code	**Description**	**Fault Lamp**
111	ECM Hardware Internal Failure - Mission disabling	Red
112	Timing Actuator - Mechanically stuck	Red
113	Timing Actuator - Component shorted high	Yellow
114	Timing Actuator - Component shorted low	Yellow
115	Engine Speed Sensor - Both signals lost	Red
116	Fuel Timing Pressure Sensor - Component shorted high	Red
117	Fuel Timing Pressure Sensor - Component shorted low	Red
118	Fuel Pump Pressure Sensor - Component shorted high	Yellow
119	Fuel Pump Pressure Sensor - Component shorted low	Yellow
121	Engine Speed Sensor - One signal lost	Yellow
122	Boost Pressure Sensor - Component shorted high	Yellow
123	Boost Pressure Sensor - Component shorted low	Yellow
131	Throttle Position Sensor - Component shorted high	Red
132	Throttle Position Sensor - Component shorted low	Red
135	Oil Pressure Sensor - Component shorted high	Yellow
141	Oil Pressure Sensor - Component shorted low	Yellow
143	Oil Pressure Sensor - Data below normal range	Amber
144	Engine Coolant Temperature Sensor - Component shorted high	Yellow
145	Engine Coolant Temperature Sensor - Component shorted low	Yellow
151	Engine Coolant Temperature Sensor - Data above normal range	Amber
153	Intake Manifold Temperature Sensor - Component shorted high	Yellow
154	Intake Manifold Temperature Sensor - Component shorted low	Yellow
155	Intake Manifold Temperature Sensor - Data above normal range	Amber
221	Ambient Air Pressure Sensor - Component shorted high	Yellow
222	Ambient Air Pressure Sensor - Component shorted low	Yellow
231	Coolant Pressure Sensor - Component shorted high	Yellow
232	Coolant Pressure Sensor - Component shorted low	Yellow
233	Coolant Pressure, Engine Protection - Low coolant pressure	Amber
234	Engine Speed - Data above normal range	Red
235	Engine Coolant Level - Data below normal range	Amber
254	Fuel Shutoff Value - Component shorted low	Red
259	Fuel Shutoff Solenoid - Fuel shutoff valve stuck open	Red
261	Fuel Temperature, Engine Protection - Fuel temperature high	Amber
263	Fuel Temperature Sensor - Component shorted high	Yellow
265	Fuel Temperature Sensor - Component shorted low	Yellow
316	Fuel Pump Actuator - Component shorted high or low	Yellow
318	Fuel Pump Flow - Mismatch between estimated and desired pressures	Yellow
342	ECM Not Calibrated - ECM software mission disabling failure	Red
343	ECM Hardware Failure - Warning non mission disabling	Yellow
346	ECM Software - Read/write, checksum error - Non mission disabling	Yellow
415	Oil Pressure Sensor - Data indicates very low oil pressure	Amber
422	Engine Coolant Level Sensor Signals - Data invalid	Yellow
423	Fuel Timing Pressure Sensor - In-range failure	Yellow
431	Throttle Position Idle Validation Switch - Invalid	Yellow
432	Throttle Position Idle Validation Switch - Switch position & throttle percent mismatch	Amber
441	Battery Voltage, Unswitched - Data below normal engine range	Yellow
442	Battery Voltage, Unswitched - Data above normal engine range	Yellow
451	Fuel Pressure Sensor - Component shorted high	Red
452	Fuel Pressure Sensor - Component shorted low	Red
455	Fuel Control Valve - Component shorted high or open	Red
467	Timing Fueling Flow - Mismatch between estimated and desired timing	Yellow
468	Fueling Rail Flow - Mismatch between estimated and desired rail pressure	Yellow
511	Fuel Control Valve - Component shorted low	Red
514	Fuel Control Valve - Actuator mechanically stuck open	Red
524	Alternate Droop Switch Fault	Yellow
551	Idle Validation Circuit - No voltage detected on both off-idle and idle pins	Red
553	Engine Fueling Pressure Exceeded - Data above normal range	Red
554	Fuel Pressure Sensor - In-range failure	Yellow
555	Blowby Pressure, Engine Protection - Blowby pressure high	Amber
719	Blowby Pressure Sensor - Component shorted high	Yellow
729	Blowby Pressure Sensor - Component shorted low	Yellow
753	Engine Speed Sensor - Engine speed signals do not match	Off

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REMOVAL

Numbers in parentheses refer to Fig. 1.

Note: Tag all cables, harnesses, lines and pipes disconnected during removal to aid in installation.

WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

High electrical current can cause sparks and personal injury from burns. Turn ignition key switch to the 'Off' position before removing any components. Remove battery ground cable first, and reconnect last, to avoid damaging electrical components.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine.

2. Turn steering wheel several times to relieve pressure in the steering circuit. Block all road wheels.

3. Disconnect battery cables from battery terminal ports before starting removal procedures. Disconnect ground cable first.

4. Remove mounting hardware securing the hood on the vehicle. Remove hood assembly from the vehicle.

5. Disconnect electrical connections from the radiator guard and remove mounting hardware securing the radiator guard on the vehicle. Remove radiator guard from the vehicle.

6. Place a suitable container under the engine drain port, remove drain plug and drain the oil. After draining, reinstall drain plug in the engine sump and tighten securely.

WARNING
Harmful gas. Before disconnecting any air conditioner lines refer to Section 260-0130, AIR CONDITIONING. Refrigerant will rapidly freeze all objects with which it comes into contact, and it can cause serious damage to the skin and eyes.

7. If the truck is equipped with an air conditioning system, evacuate refrigerant from the system and disconnect lines at the compressor. Refer to Section 260-0130, AIR CONDITIONING.

8. With suitable containers in position, open drain cocks and drain coolant from the radiator and engine (1) assembly. Close all drain cocks after draining.

9. Identify cooling lines for ease of installation and with suitable containers in position, disconnect cooling lines from engine (1). Cap open line ends and fittings.

10. Using suitable lifting equipment, carefully remove the radiator assembly from the vehicle. Refer to Section 210-0040, RADIATOR AND MOUNTING.

11. Disconnect and remove air cleaner intake pipe from the engine turbocharger and air cleaner.

12. Disconnect and remove exhaust tube from the engine turbocharger.

13. Identify heater lines for ease of installation and, with a suitable container in position, disconnect heater lines from engine (1). Cap open line ends and fittings.

14. Close fuel shutoff valve at filter head, identify fuel lines for ease of installation and, with a suitable container in position, disconnect fuel lines from engine (1). Cap open line ends and fittings.

15. Identify all electrical harnesses and cables attached to engine (1) for ease of installation and disconnect from engine (1).

16. Disconnect driveline from engine coupling and secure clear of engine (1). Refer to Section 130-0010, FRONT DRIVELINE.

17. Remove tandem pump from the engine power takeoff. Refer to Section 230-0050, TANDEM PUMP.

Note: The hydraulic lines can be left attached to the tandem pump.

WARNING
Heavy assembly. To prevent personal injury and property damage, be sure lifting device is of adequate capacity and properly secured to do the job safely.

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18. Attach suitable lifting equipment to the lifting brackets on engine (1) assembly and raise lifting equipment to take up the slack.

19. Remove locknuts (14) and bolts (13) securing engine (1) assembly to front mounting (6). Remove locknuts (2), washers (24), snubbing washers (11) and bolts (10) securing rear mounting brackets (5) to the frame.

20. Check to make certain that all necessary line and electrical disconnections have been made before lifting engine (1).

21. Carefully lift engine (1) assembly clear of the frame and move to a clean work area. Securely mount engine (1) assembly to a work stand.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. If required, remove bolts (7) and lockwashers (8) securing rear mounts to engine (1). Remove rear mounts (5).

2. If required, remove rubber isolation mounts (12) from rear mounts (5).

3. Remove bolts (22) and lockwashers (23) securing fan to engine (1) then remove fan.

4. Loosen the fan hub mounting bolts and turn the adjusting rod anticlockwise enough to allow slack in poly 'V' belts. Remove poly 'V' belts.

5. If equipped with air conditioning, loosen compressor drive belt and remove compressor from engine (1). Refer to Section 260-0130, AIR CONDITIONING.

6. Remove bolts (25 & 29) and lockwashers (26) securing alternator guard (4) to engine (1). Remove alternator guard (4).

7. Loosen alternator mounting bolt (62) to allow slack in 'V' belts. Remove 'V' belts.

Note: Adjuster screw and link assembly (53 thru 57) will have been released when removing radiator assembly from the vehicle.

8. Remove bolt (51) and lockwasher (52) securing screw and link assembly (53 thru 57) to alternator (50). Support alternator (50) and remove locknut (60), lockwasher (61) and bolt (62). Remove alternator (50) from engine (1).

9. If necessary, damper (16) can be removed from the flywheel after the power takeoff assembly is removed. Refer to Section 110-0130, POWER TAKEOFF.

10. With power takeoff assembly removed, remove bolts (18) and washers (17). Remove damper (16) from engine (1). If necessary, remove bolts (20) from flange coupling (19). Remove flange coupling (19) from damper (15).

11. If required, remove bolt (64), washers (65) and locknut (66) securing filler assembly (49) to bracket (63). Loosen bottom clamp (41) and remove filler hose (40) and filler assembly (49) from engine (1).

12. Remove and discard filters (36, 37 & 38) from engine (1), as described in 'Maintenance'. Cover engine inlet ports to prevent entry of dirt.

13. Refer to 'Engine Manufacturers Service Manual' if engine service or repair is required.

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Inspect rubber isolation mounts (12) for damage and replace if required.

2. Check rear mounts (5), front mounting bracket (6) and mounting brackets on the front frame for cracks and/or damage. Repair or replace as necessary.

3. Inspect engine damper (16) and flange coupling (19) for damage and repair or replace as required.

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ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Remove covers from engine filter ports and install new filters (36, 37 & 38) on engine (1), as described in 'Maintenance'.

2. If removed, secure filler hose (40) and filler assembly (49) to engine (1) with bottom clamp (41). Secure filler assembly (49) to bracket (63) using bolt (64), washers (65) and locknut (66).

3. Install damper (16) to rear of engine (1) and secure with bolts (18) and washers (17). Install flange coupling (19) to damper (16) and secure with bolts (20).

4. Position alternator (50) on engine mounting bracket and align the holes in the alternator mounting flanges with the tube in the bracket. Secure alternator (50) in position with bolt (62), lockwasher (61) and locknut (60). Tighten bolt (62) finger tight at this stage.

5. Install adjuster screw and link assembly (53 thru 57) to alternator (50) and secure with bolt (51) and lockwasher (52). Tighten bolt (51) finger tight at this stage.

Note: Replace all belts in a set when one is broken or replaced.

6. Install 'V' belts in the grooves of alternator (50) and accessory drive pulley.

Note: Alternator belt tension adjustment is made after installation of engine (1) and the radiator assembly.

7. If equipped with air conditioning, install air conditioner compressor and drive belt to engine (1). Refer to Section 260-0130, AIR CONDITIONING.

8. Install poly 'V' belts to the fan pulley and crankshaft pulley.

9. Adjust poly 'V' belts by turning the adjusting screw clockwise until the correct tension is obtained. Refer to 'Drive Belt Adjustments'. When correct tension is obtained tighten fan hub mounting bolts to a torque of 101 - 126 Nm (75 - 93 lbf ft).

10. Position fan to fan pulley on engine (1) and secure with bolts (22) and lockwashers (23). Tighten bolts (22) in a star shaped pattern to a torque of 34 Nm (25 lbf ft).

11. If removed, install rubber isolation mounts (12) to front mounting bracket (6).

12. Secure rear mounts (5) to engine (1) with bolts (7) and lockwashers (8) as identified at disassembly. Tighten bolts (7) to a torque of 150 Nm (110 lbf ft). If removed, install rubber isolation mounts (12) in rear mounts (5).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

> ⚠ **WARNING**
> **To prevent personal injury and property damage, be sure lifting device is properly secured and of adequate capacity to do the job safely.**

1. Attach suitable lifting equipment to engine (1) lifting brackets and carefully position engine (1) assembly in the frame.

2. Secure engine (1) assembly to rear mounts on the frame with bolts (10), snubbing washers (11) washers (24) and locknuts (2). Secure engine (1) assembly to front mounting bracket (6) with bolts (13) and locknuts (14).

3. Connect driveline to the engine coupling. Refer to Section 130-0010, FRONT DRIVELINES.

4. Install tandem pump on power takeoff assembly and secure with mounting hardware. Refer to Section 230-0050, TANDEM PUMP.

5. Using suitable lifting equipment, install the radiator assembly to the frame and secure with mounting hardware. Refer to Section 210-0040, RADIATOR AND MOUNTING.

6. Adjust 'V' belts by loosening locknut (54) and turning screw assembly (55) clockwise until the correct tension is obtained (refer to 'Drive Belt Adjustments'). When correct tension is obtained tighten locknut (54).

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7. Tighten bolt (62) securing alternator (50) to engine mounting bracket and bolt (51) securing link (53) assembly to alternator (50) to a torque of 81 - 95 Nm (60 - 70 lbf ft).

8. Remove caps from all cooling lines and connect lines to the radiator assembly and engine (1) assembly as identified at removal.

9. Install air cleaner intake pipe and exhaust piping to engine turbocharger. Tighten mounting clamps securely.

10. Remove caps from heater lines and fittings and connect heater lines to engine (1) as identified at removal.

11. Remove caps from fuel lines and fittings and connect fuel lines to engine (1) as identified at removal.

12. Connect all electrical harnesses and cables to engine (1) (with the exception of battery connections) as identified at removal.

13. If the vehicle is equipped with air conditioning, connect the lines at the compressor as identified at removal. On completion of engine installation the air conditioning system will require to be charged. Refer to Section 260-0130, AIR CONDITIONING.

14. Using suitable lifting equipment, install radiator guard assembly to the frame. Secure with the required mounting hardware and connect electrical connections as identified at removal.

15. Using suitable lifting equipment, install hood assembly into position on the vehicle. Secure hood assembly with mounting hardware removed at removal.

16. Connect battery positive connections to battery terminal posts. Connect battery earth connections to battery terminal posts.

17. Ensure all lines, harnesses and cables are secured with clips and clamps as removed during removal. Ensure no lines are chaffing on sharp edges or resting against areas where heat will be evident. Ensure all drain plugs and cocks are secured tightly.

18. Fill the cooling system with coolant specified in Section 300-0020, LUBRICATION SYSTEM. Check the coolant level as described in Section 210-0000, COOLING SYSTEM.

19. Fill the engine with lube oil specified in Section 300-0020, LUBRICATION SYSTEM. Check oil level as described under 'Maintenance'.

20. Start up the engine and bring the engine oil to operating temperature. Check all lines and fittings for leaks and tighten as required.

21. Ensure parking brake is applied and remove wheel blocks from all road wheels.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

Note: Carry out the following maintenance procedures in conjunction with additional procedures listed in Section 300-0020, LUBRICATION SYSTEM.

Every 10 Hours (Daily)

Engine (1): Visually check engine for damage, loose or frayed belts and listen for any unusual noises. Check the turbocharger for leaks.

Engine (1) Oil Level: Check engine oil level and add oil if low. To allow checking before starting as well as immediately after shutting down the engine, the dipstick is provided with two types of marks:

1. Dot Marks - Before starting up after a major shut down period the oil level should be up to the top dot mark (cold level).

2. Dash Marks - Upon shutting down the engine at low idling (wait 1 to 2 minutes) the oil level should be up to, but not over, the top dash mark (hot level).

Every 250 Hours

Engine (1): Drain engine oil and refill. Refer to Section 300-0020, LUBRICATION SYSTEM for oil specification.

Engine Water Pump: Inspect water pump drain hole and clean if required.

Engine Oil Filters (36): Replace oil filters as follows:

1. Using filter wrench, remove and discard both oil filters (36) from engine (1). Inspect the sealing surface of the filter to ensure that the seal ring stayed with the filter. If not, remove it from the filter adaptor.

2. Clean the filter adaptor with a clean, lint free cloth.

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3. Lightly coat new oil filter (36) seal with clean engine oil as specified in Section 300-0020, LUBRICATION SYSTEM.

4. Start a new oil filter (36) on the filter adaptor and tighten it by hand until the seal touches the adaptor filter head. Tighten an additional 2/3 of a turn after contact.

Note: Mechanical tightening of oil filters (36) is not necessary and will distort or crack the adaptor. Tighten oil filters by hand only.

5. Repeat steps 3 and 4 for second oil filter (36).

6. Start and run the engine for a short period and check for oil leaks. If any leaks are noted, have them corrected.

7. After the engine has been stopped long enough (approximately 20 minutes) for the oil from various parts of engine (1) to drain back to the crankcase, check oil level and add oil to bring it to the proper level on the dipstick. Refer to Section 300-0020, LUBRICATION SYSTEM for oil specification.

Fuel Filters (37): Replace primary and secondary fuel filters as follows:

Note: There is a fuel system shut off valve on the discharge side of secondary fuel filter. Closing this valve will prevent loss of fuel prime at time of filter replacement.

1. Close shut off valve at secondary fuel filter and, using filter wrench, remove and discard both fuel filters from engine (1).

2. Fill the replacement filters and coat the gaskets slightly with clean fuel oil as specified in Section 300-0020, LUBRICATION SYSTEM.

3. Start a new fuel filter on the filter adaptor and tighten it by hand until the gasket contacts the adaptor fully with no side movement of the filter evident. Tighten an additional 1/2 of a turn.

Note: Mechanical tightening of fuel filters is not recommended, and may result in seal and/or cartridge damage. Tighten fuel filters by hand only.

4. Repeat step 3 for second fuel filter.

5. Start the engine and check for leaks. If any leaks are noted, have them corrected.

Coolant Filter (38): Check condition of coolant inhibitor as described in Section 210-0000, COOLING SYSTEM. Replace coolant filter (38) as follows:

Note: There is a shut off valve at the coolant inlet and outlet lines of coolant filter (38). Closing these valves will enable coolant filter (38) to be replaced without an excessive loss of coolant.

1. Close shut off valves at coolant filter (38) inlet and outlet lines and, using filter wrench, remove and discard coolant filter (38) from engine (1).

2. Clean the filter adaptor with a clean, lint free cloth.

3. Lightly coat new coolant filter (38) seal with clean engine oil as specified in Section 300-0020, LUBRICATION SYSTEM.

4. Start coolant filter (38) on the filter adaptor and tighten it by hand until the seal touches the adaptor filter head. Tighten an additional 2/3 of a turn after contact.

Note: Mechanical tightening of coolant filter (38) is not necessary and will distort or crack the adaptor. Tighten oil filters by hand only.

5. Open shut off valves at coolant filter (38) inlet and outlet lines.

6. Start the engine and check for leaks. If any leaks are noted, have them corrected. Add coolant as required. Refer to Section 210-0000, COOLING SYSTEM.

Drive Belt Adjustments

Every 50 Hours: Check all drive belt tensions and adjust if required. If vehicle is equipped with air conditioning, compressor belts should be checked and adjusted as described in Section 260-0130, AIR CONDITIONING.

Every 2 000 Hours: Replace all drive belts.

Note: Replace all belts in a set when one is worn. Single belts of similar size should not be used as a substitute for a matched belt set as premature belt wear can result due to belt length variation. All belts in a matched belt set are within 0.81 mm (0.032 in) of their specified centre distances.

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Using belt tension gauge, adjust the belt tension to the following values:

Fan - Poly 'V' Belt
Belt Tension 'New' - 3 340 N (750 lbf)
Belt Tension 'Used' - 2 450 - 3 340 N (550 - 750 lbf)

Alternator - 'V' Belt
Belt Tension 'New' - 556 N (125 lbf)
Belt Tension 'Used' - 445 N (100 lbf)

Note: A belt is considered 'Used' if it has been in service for 10 minutes or longer. If the used belt tension is less than the minimum value, tighten the belt to the maximum value.

Belts should be neither too tight nor too loose. Belts that are too tight impose excess loads on the crankshaft, fan and alternator bearings, shortening both belt and bearing life. Excessively overtightened belts can result in crankshaft breakage. A loose belt will slip and may cause damage to accessory components.

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of tools referenced in this section, general service tools required, and service tools which should be used in conjunction with procedures oulined in the engine manufacturers service manual. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

			TORQUE	
FIG. NO.	ITEM NO.	ITEM NAME	Nm	lbf ft
1	7	Bolt	150	110
1	22	Bolt	34	25
1	51	Bolt	81 - 95	60 - 70
1	62	Bolt	81 - 95	60 - 70
-	-	Fan Hub Mounting Bolts	101 - 126	75 - 93

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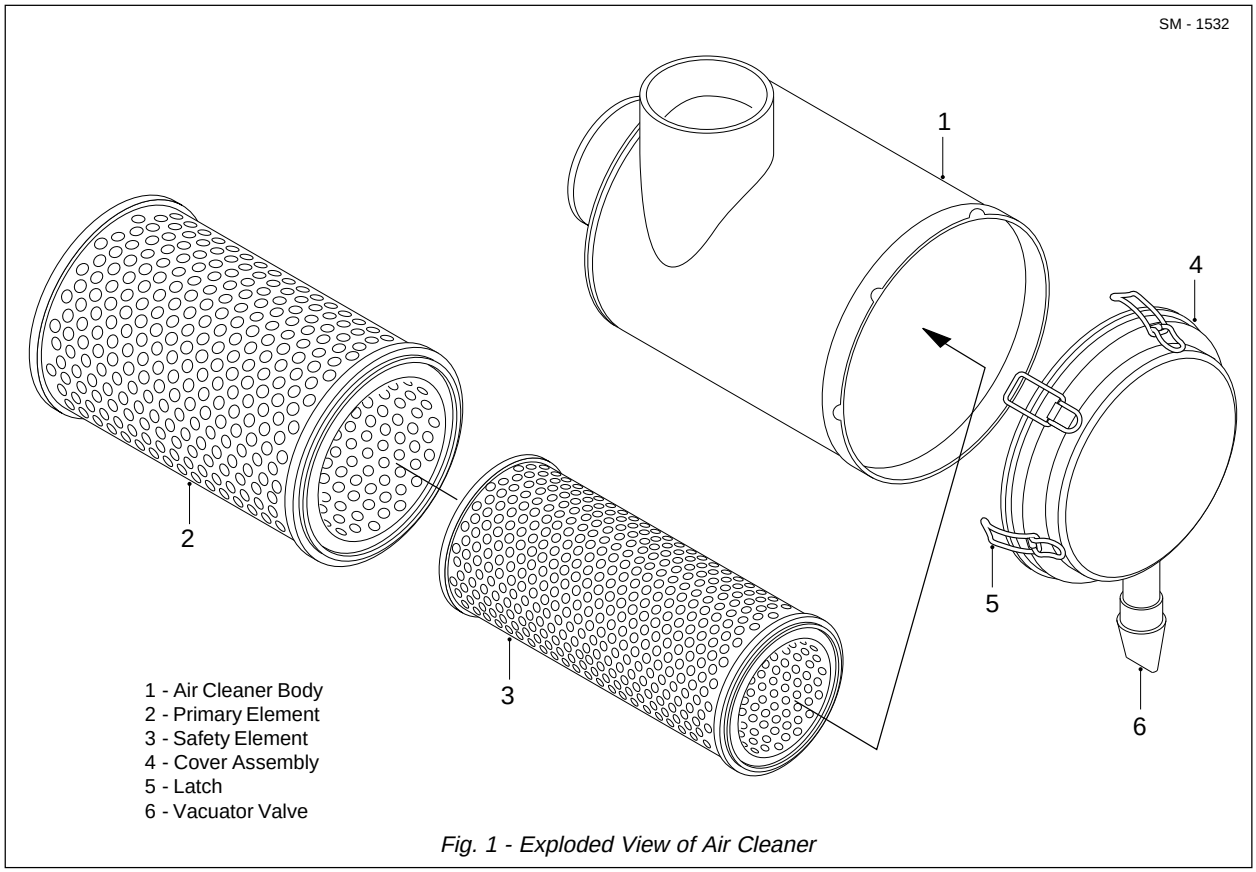


Fig. 1 - Exploded View of Air Cleaner

DESCRIPTION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

There are two, dual dry element type air cleaner assemblies mounted on the platform to the right hand side of the cab. Air cleaner assemblies prolong engine life by removing grit, dust and water from the air as it enters the engine. Grit and dust combined with engine oil, forms a highly abrasive compound which can destroy the engine in a comparatively short period of time.

A rubber vacuator valve (6) attached to cover assembly (4) in a downward position, ejects grit, dust and water while the engine is running. Vacuator valve (6) minimizes the need for daily servicing. Even though vacuator valve (6) is normally under a slight vacuum when the engine is running, pulsing of the vacuum opens and closes vacuator valve (6) expelling grit, dust and water as they collect. When the engine is stopped, vacuator valve (6) opens and expels any accumulated grit, dust or water.

An electrical air restriction gauge (14, Fig. 3) indicates when air restriction levels reach the maximum allowable limit. When air restriction levels are reached,

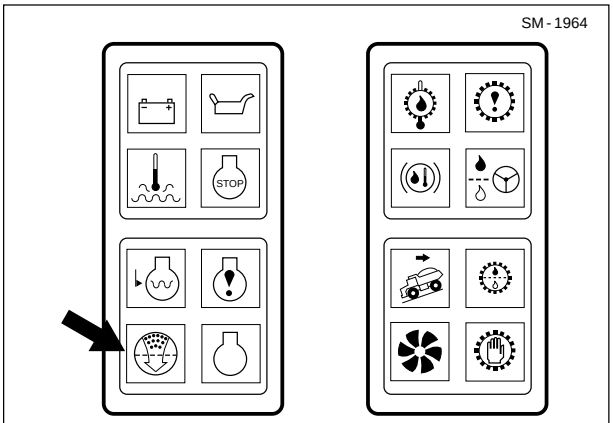


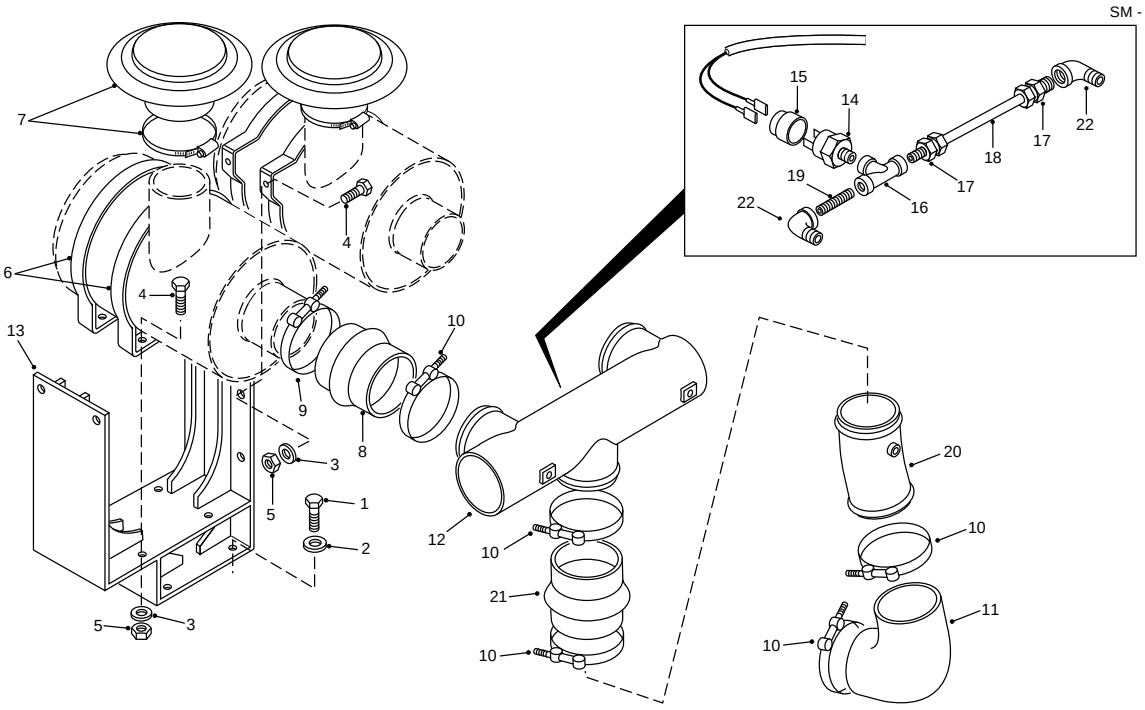
Fig. 2 - Air Cleaner Restriction Indicator Light

the circuit closes and a restriction indicator light in the dash panel (Fig. 2) illuminates. This light shows at a glance when the system air flow is being restricted indicating that primary element (2) should be serviced. Air restriction gauge (14, Fig. 3) automatically resets after each air cleaner assembly is serviced.

While the indicator light indicates the need for servicing, it does not give as precise a measurement as a water manometer or vacuum gauge. Refer to

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1 - Bolt
2 - Hardened Washer
3 - Hardened Washer
4 - Bolt
5 - Locknut
6 - Mounting Band
7 - Cap Assembly
8 - Hump Hose
9 - Clamp
10 - Clamp
11 - Elbow
12 - Tube Assembly
13 - Bracket Assembly
14 - Air Restriction Gauge
15 - Protective Cap
16 - Tee
17 - Adaptor
18 - Nylon Tube
19 - Nipple
20 - Tube
21 - Hump Hose
22 - Elbow

Fig. 3 - Exploded View of Air Cleaner Mounting

'Measuring Air Restriction'.

Safety element (3) is installed in each air cleaner assembly inside of primary element (2). This element increases the reliability of the air cleaner's protection of the engine from airborne dirt. It protects the engine from dirt admitted by a damaged primary element (2), or dirt that might be dropped into the air cleaner assembly while servicing primary element (2).

MAINTENANCE

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

⚠ WARNING
Always shutdown the engine before servicing air cleaner.

The air cleaner elements should be serviced only when the maximum allowable restriction has been reached, as indicated by air cleaner restriction indicator light. The elements should not be serviced on the basis of visual observation as this would lead to over service. When restriction readings finally indicate a change, remove primary element (2) carefully and clean/replace as required. Refer to 'Primary Element'.

Never attempt to clean safety element (3). Change safety element (3) after every third primary element (2) service.

Make sure vacuator valve (6) is not damaged or plugged and that the joint with cover assembly (4) is not broken. If vacuator valve (6) is lost or damaged, replace it to maintain pre-cleaner efficiency and normal filter element service life.

Check condition of clamps (9 & 10, Fig. 3), hump hoses (8 & 21, Fig. 3), elbow (11, Fig. 3), tube assembly (12, Fig. 3) and tube (20, Fig. 3). Tighten/ replace as necessary.

Air Cleaner Assembly

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Air cleaner body (1) should be thoroughly

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cleaned twice a year. Do not apply heat in any form to air cleaner body (1).

1. Release latches (5) on cover assembly (4) and remove cover assembly from air cleaner body (1).

2. Remove primary element (2) and safety element (3) from air cleaner body (1).

3. Slacken clamps (9, Fig. 3) and disconnect hump hose (8, Fig. 3) from air cleaner body (1).

4. Remove locknuts (5, Fig. 3), hardened washers (3, Fig. 3) and bolts (4, Fig. 3) securing the air cleaner assembly to the platform.

5. Remove the air cleaner assembly from the platform for cleaning.

6. Open clamps (6) and remove from air cleaner body (1). Open clamp on cap assembly (7) and remove cap assembly from air cleaner body (1).

7. Blank off air cleaner body (1) outlets with tape or cardboard. Reach inside body with a compressed air nozzle or brush and remove dust from the body.

8. Remove all loose dust from air cleaner body (1) and remove tape or cardboard from body outlets.

Note: Assembly and installation of the air cleaner assembly is the reverse of disassembly and removal.

Primary Element

Numbers in parentheses refer to Fig. 1.

Although a paper primary element (2) is used, it is possible to clean it so that it can be reused. The number of times one element can be reused depends on the type of dirt on the element and the care exercised in cleaning.

The life of a properly cleaned element will be approximately as long as that of a new element for the first one or two cleanings. After that, the life of the element will gradually decrease with each cleaning; however, it should perform satisfactorily through approximately six cleanings, providing it does not rupture.

Visually determine the condition of primary element (2) and choose either the compressed air or washing method.

1. Release latches (5) on cover assembly (4) and remove cover assembly from air cleaner body (1).

2. Remove primary element (2) from air cleaner body (1).

3. Using a damp cloth and a suitable solvent, wipe out all excess dust from air cleaner body (1) and allow to dry.

4. If the major contaminant on primary element (2) is light dust, direct a jet of compressed air, not exceeding 6.9 bar (100 lbf/in^2), against the pleats of the element. The air jet should be directed in the opposite direction of normal operating air flow. Move the air jet up and down the pleats, holding the air nozzle 25 mm (1.0 in) away from the pleats, to prevent rupturing the element with either the nozzle or air jet.

5. In cases where the dust cake on primary element (2) contains oil or carbon, air will not clean effectively. Using manufacturers recommended solution and warm water, not exceeding 48° C (120° F), soak primary element (2) for fifteen minutes. Element should be gently agitated to assist cleaning process.

Note: It is possible to modify an old agitator type washing machine for primary element (2) cleaning. Do not soak or agitate primary element (2) in the solution for more than fifteen minutes. Prolonged exposure softens vertical seams in the element.

6. Rinse washed element thoroughly with a low pressure stream of water, not exceeding 0.7 bar (10 lbf/in^2), opposite from the normal air flow, until rinse water runs clear.

7. Air dry primary element (2) thoroughly before returning it to service. Drying is a slow process which may be hastened by exposing element to slowly circulating heated air. Heated air temperature should not exceed 46°C (115°F). Drying time can be reduced to about three hours with heated air. DO NOT use a light bulb for drying. DO NOT use compressed air on a wet element.

Note: Replace paper elements after six cleanings or two years in service, whichever comes first. Mark each cleaned element to show total cleanings to date.

8. After primary element (2) is thoroughly dried, inspect for damage or ruptures, especially close to the end caps. To detect paper ruptures, place a bright light bulb inside the element and rotate element slowly. Inspection of element on the outside will disclose any holes where concentrated light shines through. Even the smallest hole will pass dust to the engine and may result in costly engine repairs.

9. Install primary element (2) in air cleaner body (1).

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10. Install cover assembly (4) on air cleaner body (1) and secure with latches (5).

Secondary Element

Numbers in parentheses refer to Fig. 1.

Since safety element (3) is protected from contamination by primary element (2), it needs no periodic cleaning and should be replaced only after every third primary element (2) service.

1. With primary element (2) removed from air cleaner body (1), remove safety element (3).

2. Remove any dust dislodged into air cleaner body (1) outlet and, using a damp cloth and a suitable solvent, wipe out all excess dust from air cleaner body (1) and allow to dry.

3. Install new safety element (3) followed by primary element (2) in air cleaner body (1)

4. Install cover assembly (4) on air cleaner body (1) and secure with latches (5).

Recommendations

Numbers in parentheses refer to Fig. 3.

1. Under no condition should the vehicle be operated without both filter elements in each air cleaner assembly.

2. It is very important that hump hoses (8 & 21), tube assembly (12), tube (20) and elbow (11) from the air cleaner assembly to the engine be airtight or the purpose of the air cleaner will be completely defeated. All clamps (9 & 10) should be checked frequently and tightened to prevent leaks.

3. Keep new or cleaned filter elements on hand for replacement to prevent unnecessary downtime of the vehicle.

MEASURING AIR RESTRICTION

Numbers in parentheses refer to Fig. 3.

As a dry air cleaner element becomes loaded with dust, the vacuum on the engine side of the air cleaner (air cleaner outlet) increases. This vacuum is generally measured as 'restriction in mm (inches) of water'.

The recommended maximum allowable intake restrictions at rated speed and load are as follows:

a. 380 mm-H_2O (15 in-H_2O) with clean filter elements.
b. 635 mm-H_2O (25 in-H_2O) with dirty filter elements.

While the air restriction gauge sends a signal to indicate the need for servicing, it does not give as precise a measurement as a water manometer or vacuum gauge.

Water Manometer

a. Remove protective cap (15) and disconnect harness at air restriction gauge (14). Remove air restriction gauge (14) from tee (16).

b. Hold water manometer vertically and fill both legs approximately half full of water. Connect one of the upper ends to tee (16) by means of a flexible hose.

c. With the manometer held vertically and the engine drawing maximum air, the difference in height of the water columns in the two legs is measured as the air cleaner restriction.

d. If the restriction exceeds the levels indicated, engine performance will be affected. Primary filter element should be cleaned or replaced.

Vacuum Gauge

a. Remove protective cap (15) and disconnect harness at air restriction gauge (14). Remove air restriction gauge (14) from tee (16).

b. Connect the hose from the vacuum gauge to tee (16) and, with the engine drawing maximum air, take a note of the reading on the gauge.

c. If the restriction exceeds the levels indicated, engine performance will be affected. Primary filter element should be cleaned or replaced.

SERVICE TOOLS

Refer to Section 300-0070, SERVICE TOOLS for part numbers of service tools referenced in this section and general service tools required. These tools are available from your dealer.

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DESCRIPTION AND OPERATION

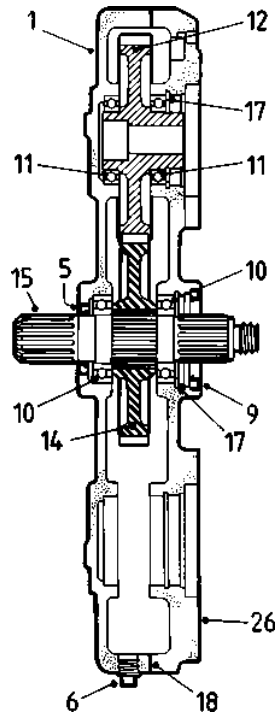
Numbers in parentheses refer to Fig. 1.

The function of the power takeoff (PTO), as the name implies, is to provide the means of mounting and driving an auxiliary component. The tandem pump for the body hoist system and disc brake cooling system is mounted to PTO cover (26) and its input shaft is meshed with the internal splines in the hub of driven gear (12). Refer to Section 230-0050, TANDEM PUMP.

The major components of the PTO assembly are; flywheel cover case (1), PTO cover (26), driveshaft (15), drive gear (14) and driven gear (12).

As driveshaft (15) is driven by the engine crankcase, drive gear (14) turns to drive driven gear (12). The tandem pump driveshaft, meshed in the hub of driven gear (12), turns with driven gear (12) to operate the tandem pump which, in turn, supplies hydraulic oil to the body hoist system and cooling oil to the disc brake assemblies. Refer to Section 230-0050, TANDEM PUMP.

SM - 1361



1 - Flywheel Cover Case
5 - Oil Seal
6 - Plug
9 - Oil Seal
10 - Bearing
11 - Bearing
12 - Driven Gear
14 - Drive Gear
15 - Driveshaft
17 - Snap Ring
18 - Gasket
26 - PTO Cover

Fig. 1 - Cutaway View of Power Takeoff Assembly

REMOVAL

Numbers in parentheses refer to Fig. 2.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions to relieve pressure in the steering system. Block all road wheels.

3. Disconnect driveline from yoke (22) at the PTO assembly. Refer to Section 130-0010, FRONT DRIVELINE.

4. Drain oil from power takeoff housing by removing drain plug (6) from flywheel cover case (1). Reinstall drain plug (6) securely.

5. Match mark tandem pump mounting flange and PTO cover (26) so that the pump can be installed in the same position at installation.

6. With suitable blocking or lifting equipment, support the pump before loosening attaching nuts. Remove nuts and lockwashers from pump mounting studs and secure pump clear of the PTO assembly.

7. Match mark engine flywheel housing and flywheel cover case (1) so that the PTO assembly can be installed in the same position at 'Installation'.

8. Attach a suitable lifting device to the PTO assembly and remove bolts (23 & 25) and lockwashers (24) securing PTO assembly to the engine flywheel housing. Carefully lower PTO assembly and spacer (27) from the flywheel housing and move to a clean work area for disassembly.

9. Remove spacer (27) from the PTO assembly.

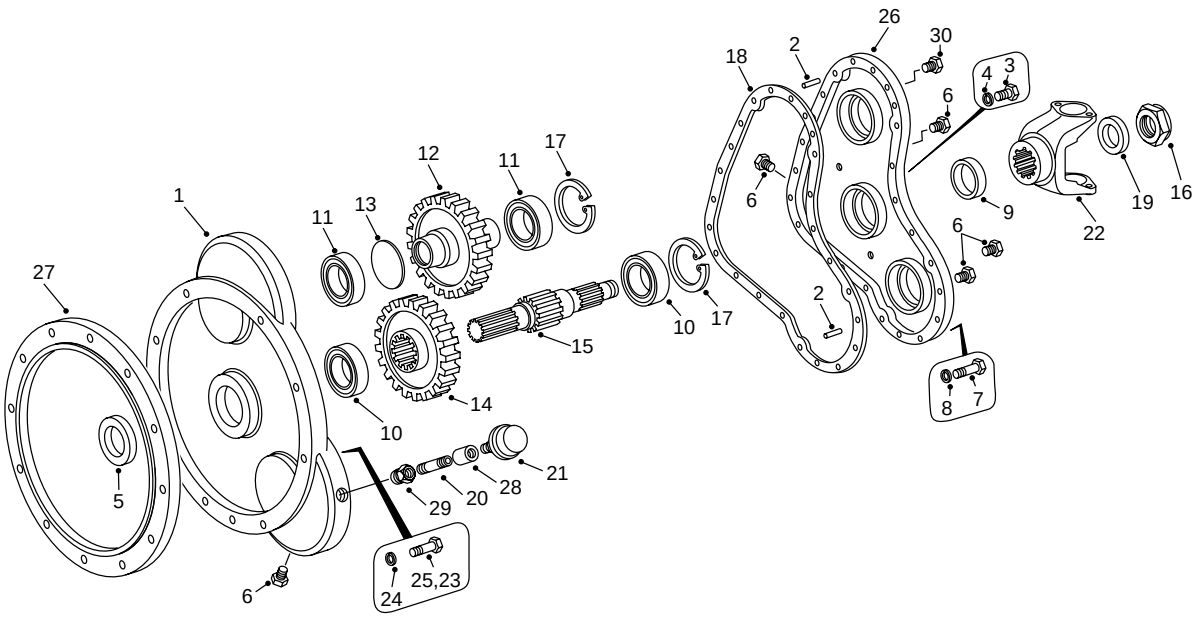
DISASSEMBLY

Numbers in parentheses refer to Fig. 2.

1. Remove locknut (16) and hardened washer (19) from driveshaft (15). Pull yoke (22) from driveshaft (15).

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1 - Flywheel Cover Case	8 - Lockwasher	15 - Driveshaft	23 - Bolt
2 - Dowel Pin	9 - Oil Seal	16 - Locknut	24 - Lockwasher
3 - Bolt	10 - Bearing	17 - Snap Ring	25 - Bolt
4 - Lockwasher	11 - Bearing	18 - Gasket	26 - PTO Cover
5 - Oil Seal	12 - Driven Gear	19 - Hardened Washer	27 - Spacer
6 - Plug	13 - Plug	20 - Breather	28 - Coupling
7 - Bolt	14 - Drive Gear	21 - Breather Cap	29 - Adaptor
		22 - Yoke	30 - Plug

Fig. 2 - Exploded View of Power Takeoff Assembly

2. Remove bolts (3 & 7) and lockwashers (4 & 8) from PTO cover (26). Pull PTO cover (26) and gasket (18) from flywheel cover case (1). Discard gasket (18).

3. Place PTO cover (26) yoke side up on a work bench. Pry oil seal (9) from PTO cover (26) and discard.

4. Remove snap rings (17) from pump and driveshaft bores. Drive bearings (10 & 11) from PTO cover (26) with a sleeve or soft steel drift. Drive on the outer race of bearings (10 & 11) taking care not to damage the bearings.

5. Slide drive gear (14) from driveshaft (15) and pull driven gear (12) from flywheel cover case (1).

6. Pull driveshaft (15) from flywheel cover case (1). Pry oil seal (5) from flywheel cover case (1).

7. Pull bearings (10 & 11) from flywheel cover case (1) with a suitable bearing puller.

8. If necessary, note locations and remove dowel pins (2) from flywheel cover case (1) and breather assembly (20, 21, 28 & 29) from PTO cover (26).

INSPECTION

Numbers in parentheses refer to Fig. 2.

1. Wash all parts thoroughly in a suitable solvent and dry all but bearings (10 & 11) with compressed air. Dry bearings (10 & 11) with a clean lint free cloth.

2. Check the condition of splines and teeth on gears (12 & 14), driveshaft (15) and yoke (22) for burrs or signs of wear.

3. Lubricate bearings (10 & 11) with oil and check operation by spinning bearings by hand. DO NOT spin bearings with compressed air. Inspect bearing bores for out of roundness. Replace bearings, if required.

4. Inspect flywheel cover case (1) and PTO cover (26) for cracks. If either flywheel cover case (1) or

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PTO cover (26) are damaged, both parts must be replaced as an assembly.

5. Visually check oil seal lip contact surfaces on driveshaft (15) and yoke (22) for nicks, dents, scratches, wear, or corrosion. Replace as necessary.

ASSEMBLY

Numbers in parentheses refer to Figs. 2.

Note: Prior to assembly, lubricate all seal lips and surfaces with lubricant specified in Section 300-0020, LUBRICATION SYSTEM.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

> **WARNING**
> **To prevent personal injury and property damage, be sure lifting device is properly secured and of adequate capacity to do the job safely.**

1. If removed, install dowel pins (2) in flywheel cover case (1) and breather assembly (20, 21, 28 & 29) in PTO cover (26), as noted at disassembly.

2. Install new oil seal (5) in centre bore of flywheel cover case (1) so that it is flush with flywheel cover case (1) face. See Fig. 1.

Note: When installing new oil seals, install them with the oil lip (larger of the two lips with the spring behind it) facing inward. Care should be taken to prevent damage to seal lips during assembly.

3. Press bearings (10 & 11) into their bores in flywheel cover case (1).

4. Press bearings (10 & 11) into their respective bores in PTO cover (26). Turn PTO cover (26) over and install snap rings (17).

5. Install new oil seal (9) into centre bore in PTO cover (26) so that it is flush with PTO cover (26) face. See Fig. 1.

6. Install driven gear (12) and driveshaft (15) into flywheel cover case (1). Slide drive gear (14) over driveshaft (15) to its proper location.

7. Install new gasket (18) on PTO cover (26) and assemble PTO cover (26) to flywheel cover case (1). Secure PTO cover (26) to flywheel cover case (1) with bolts (3 & 7) and lockwashers (4 & 8).

8. Install yoke (22), hardened washer (19) and locknut (16) on driveshaft (15) end. Tighten locknut (16) to a torque of 950 - 1 085 Nm (700 - 800 lbf ft).

INSTALLATION

Numbers in parentheses refer to Figs. 1 & 2.

Note: When reassembling PTO assembly to engine flywheel housing, and tandem pump to PTO assembly, be sure to align match marks inscribed during disassembly.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Install spacer (27) on PTO assembly and, using suitable lifting equipment, position PTO assembly on engine flywheel housing. Secure the PTO assembly and spacer (27) to the engine flywheel housing with bolts (23 & 25) and lockwashers (24).

2. Using suitable lifting equipment, position tandem pump over its mounting studs and secure with nuts and lockwashers removed during removal.

3. Reconnect driveline to yoke (22). Refer to Section 130-0010, FRONT DRIVELINE.

4. Remove oil level plug (6) from the front of PTO cover (26) and fill PTO assembly with lubricant specified in Section 300-0020, LUBRICATION SYSTEM, until oil flows from the oil level port. Install oil level plug (6) in PTO cover (26) and tighten securely.

5. Start the engine and bring oil to correct operating temperature. Check for leaks and correct as necessary.

6. Remove wheel blocks from all road wheels.

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Engine - Power Takeoff

Section 110-0130

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

Note: Refer to Section 300-0020, LUBRICATION SYSTEM for recommended check and drain intervals and lubricant specifications.

Oil Level Check

Remove oil level plug (6) from the front of PTO cover (6) and, if oil level is below the bottom of the filler hole, add lubricant until it flows from the filler hole. Reinstall oil level plug (6) and tighten securely.

Drain and Refill

To drain: Remove drain plug (6) from flywheel cover case (1) and drain oil into a suitable container. Reinstall drain plug (6) securely when draining is complete.

To refill: Remove oil level plug (6) from the front of PTO cover (26) and fill PTO assembly with lubricant specified in Section 300-0020, LUBRICATION SYSTEM, until oil flows from the oil level port. Install oil level plug (6) in PTO cover (26) and tighten securely.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

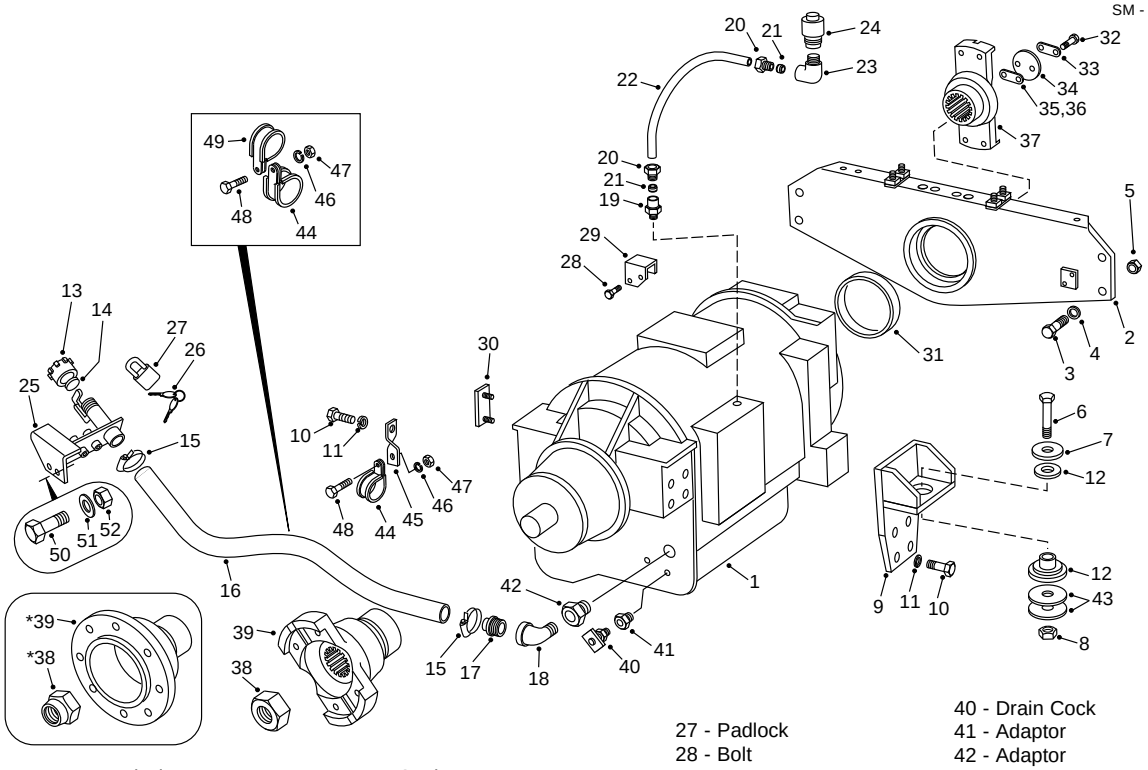
SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
2	16	Locknut	950 - 1 085	700 - 800

* * * *

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1 - Transmission
2 - Trunnion
3 - Bolt
4 - Washer
5 - Locknut
6 - Bolt
7 - Hardened Washer
8 - Nut
9 - Mounting Bracket
10 - Bolt
11 - Lockwasher
12 - Isolation Mount
13 - Filler Cap
14 - Gasket
15 - Clamp
16 - Filler Hose
17 - Filler Tube
18 - Elbow
19 - Connector
20 - Nut
21 - Sleeve
22 - Nylon Tube
23 - Elbow
24 - Breather
25 - Adaptor
26 - Key
27 - Padlock
28 - Bolt
29 - Cover Plate
30 - Level Gauge
31 - Ring
32 - Bolt
33 - Strip
34 - Retainer
35 - Shim
36 - Shim
37 - Input Yoke
38 - Nut
*38 - Locknut
39 - Output Yoke
*39 - Output Flange
40 - Drain Cock
41 - Adaptor
42 - Adaptor
43 - Snubbing Washer
44 - P-clip
45 - Bracket
46 - Lockwasher
47 - Nut
48 - Bolt
49 - P-clip
50 - Bolt
51 - Hardened Washer
52 - Nut

* - Pre June 1998 Production

Fig. 1 - Exploded View of Transmission and Mounting

DESCRIPTION

For transmission make, model and specification, refer to Section 000-0000, GENERAL INFORMATION. For transmission switches, sensors and instruments, refer to Section 190-0270, SWITCHES AND SENSORS. For transmission servicing and repair data, refer to the transmission manufacturers service manual.

The transmission is remote mounted in the frame and is supported by trunnion (2) assembly at the front and two mounting brackets (9) at the rear.

Integral with transmission (1) assembly are torque converter and planetary gearing. There are six forward gears and two reverse gears with automatic lockup in all speed ranges. Operation of the transmission is by the Commercial Electronic Control (CEC) Shift System, (previously known as ATEC).

A brief description and operation of the main transmission components are as follows:

CEC Shift System

Refer to Section 120-0070, CEC SHIFT SYSTEM for description and operation, wiring diagrams and electrical troubleshooting of the CEC System.

Torque Converter

The torque converter consists of three elements - pump, turbine, and stator. The pump is the input element and is driven directly by the engine. The turbine is the output element and is hydraulically driven by the pump. The stator is the reaction (torque multiplying) element.

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When the pump turns faster than the turbine, the torque converter is multiplying torque. When the turbine approaches the speed of the pump the stator starts to rotate with the pump and turbine. When this occurs, torque multiplication stops and the torque converter functions as a fluid coupling.

Lockup Clutch
The lockup clutch is located inside the torque converter and consists of three elements - piston, clutch plate, and backplate. The piston and backplate are driven by the engine and the clutch plate, located between the piston and backplate, is splined to the converter turbine.

The lockup clutch is hydraulically engaged and released in response to electronic signals from the ECU. It engages when the vehicle reaches a predetermined speed. Engagement of the lockup clutch provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage to provide maximum fuel economy. The lockup clutch releases at lower speeds (and momentarily during shifts). When the lockup clutch is released, drive from the engine is transmitted hydraulically through the converter to the transmission gearing. The lockup clutch also releases when the ECU detects certain undesirable conditions.

Planetary Gears and Clutches
A series of planetary gears and shafts provide the gear ratios and directions of travel for the vehicle. Power flow through the planetaries is controlled by multiple clutch packs. The clutches are applied and released hydraulically in response to electronic signals from the ECU.

Hydraulic Retarder
A vaned rotor and two vaned stators are the basic components of the retarder. Application of the retarder control valve fills the cavity around the rotor with oil when the vehicle must be slowed on steep downgrades. When the cavity is emptied, the rotor is free of drag. Refer to Section 250-0130, RETARDER CONTROL VALVE.

Maximum retarder effect occurs in the lowest gear range with foot off of the accelerator pedal. Long continuous use of the retarder will raise transmission oil temperature. Short periods of full release, to interrupt continuous application, will help prevent overheating.

During normal operation the dash mounted transmission oil temperature gauge should read in the green zone. However, during transmission retarder operation oil temperature can enter the yellow 'Retarder On' zone but should not enter the red zone.

Transmission Oil Cooler
The transmission oil is cooled by a separate oil cooler mounted between the radiator and transmission to maintain transmission oil within its required operating temperature range. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

Transmission Oil Filter
The transmission oil filter is mounted off the frame at the front right hand side of the transmission. It is installed in the transmission oil lines to remove dirt and other contaminants from the transmission oil to minimise wear and provide maximum service life for the transmission. Refer to Section 120-0100, TRANSMISSION OIL FILTER.

REMOVAL

Numbers in parentheses refer to Fig. 1.

Note: Tag all lines, pipes, electrical connections and mechanical linkages disconnected during removal to aid in installation.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ High electrical current can cause sparks and personal injury from burns. Switch circuit breakers to the 'Off' position before removing any electrical components. Remove battery ground cable first, and reconnect last, to prevent damaging electrical components.

⚠ Any time the battery equalizer is disconnected from the batteries, remove ground cable first, and reconnect last, to prevent damaging the component.

1. Position the vehicle in a level work area, raise the body and install the body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine. Turn steering wheel several times to relieve pressure in the steering circuit. Depress and release brake pedal continuously to relieve pressure in the braking system (pressure in accumulator hydraulic line should be zero).

3. Block all road wheels.

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Note: It is important that the electrical connections are removed in the order listed in step 4 to prevent damage to the electrical components.

4. Disconnect battery equalizer ground connection from the batteries. Disconnect battery cables from terminal posts (ground cable first). Disconnect battery equalizer positive connection. Disconnect electrical connections at the ECU.

5. Using suitable lifting equipment, support transmission guard and remove mounting hardware securing the guard to the frame. Remove transmission guard.

6. Disconnect driveline from input yoke (37) at the front of transmission (1). Refer to Section 130-0010, FRONT DRIVELINE.

7. Disconnect driveline from output yoke/flange (39) at the rear of transmission (1). Refer to Section 130-0020, REAR DRIVELINE.

8. Place a suitable container under drain cock (40), loosen drain cock and drain oil from transmission (1). After draining, tighten drain cock (40) securely.

9. Disconnect the transmission retarder linkage at transmission (1).

10. Place a suitable container under the steering tank drain plug, remove drain plug and drain the oil from the steering tank. After draining, reinstall drain plug.

11. Disconnect steering lines from the steering pump and remove mounting hardware securing steering lines to transmission (1). Cap all open line ends and steering pump fittings to prevent entry of dirt.

12. Disconnect transmission oil cooler lines and oil filter lines from transmission (1). Cap all open lines and fittings to prevent entry of dirt.

13. Disconnect hydraulic line from lockup drop out valve at the front right hand side of transmission (1).

14. Disconnect all remaining hydraulic lines attached to transmission (1). Cap all open lines and fittings to prevent entry of dirt.

15. Disconnect all electrical connections and cables attached to transmission (1).

16. Remove mounting hardware securing accumulator valve mounting bracket to the front left hand side of transmission (1) and move bracket and valve clear of the transmission (1).

17. Remove mounting hardware supporting mounting brackets for body hoist lines to the top of transmission (1).

18. Remove mounting hardware securing kick-over valve mounting bracket to the top of transmission (1).

19. Slacken nut (20) and move nut (20) and nylon tube (22) assembly free from connector (19) in the top of transmission (1).

20. Detach clamps (15) and remove filler hose (16) from filler tube (17) and adaptor (25).

21. Install suitable lifting eyes into the holes provided at the top of transmission (1) housing and secure a suitable lifting device to the eyes. Take up slack in the chain or cable.

22. Remove locknuts (5), bolts (3) and washers (4) securing trunnion (2) to the frame.

23. Remove bolts (6), hardened washers (7), snubbing washers (43) and nuts (8) securing mounting brackets (9) to frame.

24. Check to make certain that all hydraulic lines and electrical connections fitted to transmission (1) have been disconnected before moving transmission (1).

25. Carefully manoeuvre transmission (1) out of the frame mounting and lower onto a suitable dolly or pallet.

26. Move transmission (1) assembly to a suitable work area or onto a work stand for further disassembly, if necessary.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Refer to the transmission manufacturers Service Manual if transmission service or repair is required.

1. Remove bolts (32), strip (33), retainer (34) and shims (35 & 36) securing input yoke (37) on transmission (1). Pull input yoke (37) from transmission (1).

2. Pull trunnion (2) assembly from transmission (1) and remove ring (31) from trunnion (2), if required.

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3. Remove nut/locknut (38) securing output yoke/flange (39) on transmission (1). Pull output yoke/flange (39) from transmission (1).

4. Remove bolts (10) and lockwashers (11) securing mounting brackets (9) to transmission (1). Remove mounting brackets (9).

5. If necessary, remove isolation mounts (12) from mounting brackets (9).

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Secure mounting brackets (9) to transmission (1) assembly with bolts (10) and lockwashers (11). Tighten bolts (10) to a torque of 156 Nm (115 lbf ft). If removed, install isolation mounts (12) to mounting brackets (9).

2. If removed, fit new ring (31) to trunnion (2) and mount trunnion (2) to the front of transmission (1) with small leg to the top and facing away from transmission (1).

3. Make sure that transmission input shaft is in its most outward position and the bearing is seated against the shaft shoulder.

4. Coat input shaft splines and lip of oil seal with a thin layer of EP, NLGI molybdenum grease. Install input yoke (37) on input shaft by tapping lightly until the yoke is seated. If input yoke (37) is a tight fit, heat input flange (37) to 121° C (250° F) maximum prior to assembly. Two methods which may be employed are:

a. Heat in controlled temperature furnace for a minimum period of 45 minutes.

b. Submerge flange in heated oil for 15 minutes.

5. Use proper combination of shims (35 & 36) to obtain a 0.2 - 0.3 mm (0.008 - 0.012 in) gap between retainer face of input yoke (37) and end of input shaft. Fit retainer (34) and secure with bolts (32) and strip (33). Tighten bolts (32) to a torque of 130 - 156 Nm (96 - 115 lbf ft).

6. Coat output shaft splines and threads, and lip of oil seal with a thin layer of EP, NLGI molybdenum grease. Install output yoke/flange (39) on output shaft by tapping lightly until the yoke is seated. If output yoke/flange (39) is a tight fit, heat output yoke/flange (39) to 121° C (250° F) maximum prior to assembly, using either of the methods described in step 3.

7. Secure output yoke/flange (39) on output shaft with nut/locknut (38). Tighten nut (38) to a torque of 950 - 1 355 Nm (700 - 1 000 lbf ft).

8. After assembly has cooled, check torque of bolts (32) and nut/locknut (38) and retighten to their required torques.

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. Position transmission (1) assembly under the vehicle and attach a suitable lifting device to the eye bolts on top of transmission (1).

2. Carefully lift transmission (1) assembly into its mounting position and lightly secure trunnion (2) to the frame (mounting face to the front of the frame mounting brackets) with bolts (3), washers (4) and locknuts (5). Install bolts (3) from the rear of the assembly.

3. Install bolts (6), hardened washers (7), snubbing washers (43) and nuts (8) securing mounting brackets (9) to frame mounting brackets. Securely tighten bolts (6) to a torque of 278 Nm (205 lbf ft).

4. Securely tighten bolts (3), securing trunnion (2) to frame mounting brackets, to a torque of 156 Nm (115 lbf ft).

5. Remove lifting device and lifting eye bolts from top of transmission (1).

6. Install filler hose (16) to filler tube (17) and adaptor (25) and secure with clamps (15).

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7. Secure accumulator valve mounting bracket to the front left hand side of transmission (1) assembly with mounting hardware removed during removal.

8. Secure kick-over valve mounting bracket to top of transmission (1) assembly with mounting hardware removed during removal.

9. Secure body hoist lines mounting brackets to the top of transmission (1) assembly with mounting hardware removed during removal.

10. Connect all electrical connections and cables to transmission (1) as tagged at removal.

11. Connect transmission oil cooler lines to transmission (1) and oil filter lines to transmission oil filter as tagged at removal.

12. Connect steering pump hydraulic lines as tagged at removal and secure lines to transmission (1) with mounting hardware removed during removal.

13. Connect hydraulic line from lockup drop out valve to front right hand side of transmission (1).

14. Connect any remaining hydraulic lines which were removed during removal. Ensure all hydraulic lines are securely tightened.

15. Connect transmission retarder linkage at transmission (1).

16. Install rear driveline to output yoke/flange (39) at the rear of transmission (1) and secure with mounting hardware removed during removal. Refer to Section 130-0020, REAR DRIVELINE.

17. Install front driveline to input yoke (37) at the front of transmission (1) and secure with mounting hardware removed during removal. Refer to Section 130-0010, FRONT DRIVELINE.

18. Using suitable lifting equipment, support transmission guard and secure guard to the frame with mounting hardware removed during removal.

19. Fill transmission (1) assembly with oil specified in Section 300-0020, LUBRICATION SYSTEM, and check the oil level as described under 'Oil Level Check'.

20. Fill steering tank with oil specified in Section 300-0020, LUBRICATION SYSTEM, and check the oil level as described in Section 220-0040, STEERING AND BRAKE CONTROL TANK.

Note: It is important that the electrical connections are made in the order listed in step 21 to prevent damage to the electrical components.

21. Connect electrical connections at the ECU. Connect battery equalizer positive connection. Connect battery cables to battery terminal posts (ground cable last). Connect battery equalizer ground connection.

22. Start the engine and make an operational check while the engine is running of all lines and connections disconnected during removal of transmission (1). Check for leaks and tighten lines and fittings as required.

23. Ensure parking brake is applied, remove the body prop pins and lower the body. Refer to Section 270-0010, BODY AND MOUNTING. Remove wheel chocks from all road wheels.

MAINTENANCE

Periodic Inspections

For easier inspection, the transmission should be kept clean. Make periodic checks for loose bolts and leaking oil lines. Check the condition of electrical harnesses and connections regularly.

The transmission breather should be checked regularly and as frequently as necessary, depending on the operating conditions of the vehicle. A badly corroded or plugged breather restricts proper breathing and causes a buildup of condensation and subsequent oil deterioration.

Oil Level Check

⚠ WARNING
When checking the oil level, be sure that the parking brake is applied and all road wheels are securely blocked.

Check the transmission oil level and add oil if low, every 10 hours/daily. Use only oil of the type specified in Section 300-0020, LUBRICATION SYSTEM.

Because the transmission oil cools, lubricates and transmits hydraulic power it is important that the proper oil level be maintained at all times. If the oil level is too low, the converter and clutches will not receive an adequate supply of oil. If the oil level is too

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high, the oil will aerate and the transmission will overheat. It is absolutely necessary that the oil put into the transmission be clean.

Oil must be handled in clean containers to prevent foreign material from entering the system.

Note: Containers or fillers that have been used for antifreeze or engine coolant solution must not be used for transmission oil.

Visual Level Indicator
A visual level indicator is mounted on the lower left side of the transmission main housing and provides a method of checking the oil level. Refer to Fig. 2.

Cold Oil Level Check
Before starting the engine, check the visual level indicator or remove the ADD (lower) plug. If oil is present in the indicator or if oil flows from the plug opening, the transmission has sufficient oil to permit safe starting of the engine. If no oil is present, add sufficient oil to bring the level within the indicator or to cause a flow from the plug opening. Replace the plug.

Hot Oil Level Check
Note: Observe the condition of the oil in the visual level indicator or the type of flow from the plug opening. Foaming or spurting may indicate a false level.

A hot oil level check is made to determine if there is sufficient oil for working operation of the transmission. Select neutral on the transmission range selector and start the engine. Operate the vehicle until the transmission reaches a normal operating temperature of 82 - 103° C (180 - 220° F). Idle the engine, apply the parking brake and block all road wheels.

Check the visual level indicator or remove the FULL (upper) oil level check plug. The oil should be within the indicator limits shown in Fig. 2 or at or near the level of the plug opening. Add or drain oil as necessary to bring the oil level within these limits.

Note: The transmission may be operated safely as long as the oil level is above the ADD (lower) plug.

Oil and Filter Change

After the first 150 hours of operating a new or rebuilt transmission, the transmission oil and filters should be changed.

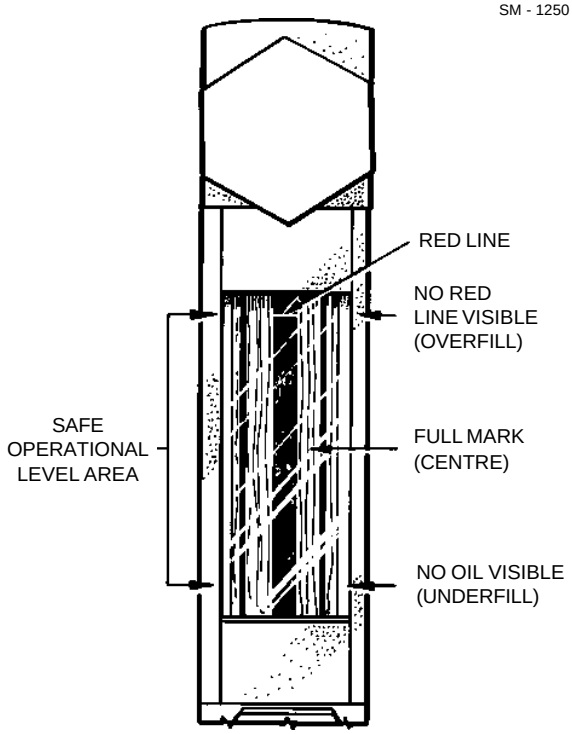


Fig. 2 - Visual Level Indicator

The transmission oil and filters should be changed at the intervals specified in Section 300-0020, LUBRICATION SYSTEM, or sooner, depending on operating conditions. Also, the oil must be changed whenever there are traces of dirt or evidence of high temperature indicated by discoloration or strong odour.

The screen and magnet assembly in the sump should be removed and cleaned with mineral spirits at each oil change. Metal particles in the oil (except for the minute particles normally trapped in the oil filters) indicate damage has occurred in the transmission When these particles are found in the filters, the cause must be established and rectified immediately to prevent damage to the transmission.

At each oil change, examine the used oil for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during operation of the transmission. However, if there is evidence of water or engine coolant in the oil, the cause must be established and rectified immediately to prevent damage to the transmission.

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Welding on Vehicles Equipped With CEC

WARNINGS
The ECU can be damaged by improper welding procedures.

Any time the battery equalizer is disconnected from the batteries, remove ground cable first, and reconnect last, to prevent damaging the component.

When frame or other welding is required, the following precautions are to be taken to protect the electronic components.

a. Disconnect battery equalizer ground connection from the batteries. Disconnect battery cables from terminal posts (ground cable first). Disconnect battery equalizer positive connection. Disconnect electrical connections at the ECU.

b. If additional system ground wires are connected to the frame, they must be disconnected also.

c. Cover electronic components and wiring to protect from damage.

d. Do not connect welding cables to electronic components. Do not weld on electronic components. If welding is to be done close to electronic components, the components should be removed prior to the welding process.

e. On completion of all welding reconnect electrical connections in the reverse order to step a.

TROUBLESHOOTING

Converter Stall Test

A stall test should be conducted when the power package (engine and transmission) is not performing satisfactorily. The purpose of the test is to determine the engine power output and establish if the transmission is the malfunctioning component.

WARNING
When conducting a stall test, the vehicle must be positively prevented from moving. The parking brake must be applied and the vehicle should be blocked to prevent movement forward or reverse. Keep people safely away from the vehicle path. Do not maintain the stalled condition longer than 30 seconds due to rapid heating of the transmission oil. With the transmission in neutral, run the engine at 1 200 - 1 500 rev/min for two minutes to cool the oil between tests. Do not allow the converter-out temperature to exceed 135° C (275° F). Keep a close check to prevent overheating of the engine cooling system.

1. Position the vehicle on a level area with room for movement all round.

2. Apply the parking brake and block all road wheels. Turn the manual mode key switch to the 'On' position and the mode selection switch to the 'Power' mode.

3. Apply the service brake, release the parking brake and select fifth gear on the transmission shift selector. The transmission will shift to fifth gear and deactivate the lockup clutch. Apply the parking brake and release the foot pedal.

4. Accelerate the engine to full throttle and, using a tachometer of known accuracy, note the maximum rev/min the engine will attain. Converter-out pressure should be 2 bar (30 lbf/in²).

Note: The stall speed of each vehicle is noted on the final inspection records prior to the vehicle leaving the factory. This can be used as a guide when checking the stall speed. It is recommended to keep a record of the stall speed after each major service and use the previous recorded value as a guide.

5. When the stall check is complete, return the accelerator to the idle position and move the shift selector to the neutral position.

Note: Engine power will decrease with an increase in elevation (altitude), becoming more pronounced at greater elevation. This will result in a lower engine speed under converter stall conditions.

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6. During the stall check the transmission oil temperature should rise while the engine is under load and drop when the transmission is returned to neutral. Should the temperature fail to drop it indicates that there is a problem with the converter.

7. After making allowances for elevation, a low engine speed may indicate the engine is not delivering full power. Refer to engine service manual for engine repair information.

Electronic Troubleshooting

Refer to Section 120-0070, CEC SHIFT SYSTEM for general electrical troubleshooting. For more detailed electrical troubleshooting refer to the Allison Transmission Commercial Electronic Control (CEC) Troubleshooting Manual SA2712A.

Mechanical Troubleshooting

It is recommended to follow the procedures laid down for mechanical troubleshooting, as outlined in the 'Mechanical Trouble Shooting' charts, before carrying out electrical troubleshooting procedures.

⚠ WARNING
Be sure to apply the parking brake, switch off the engine and block all road wheels before troubleshooting the vehicle. Should it be necessary to run the engine, it is imperative that an operator be present in the cab at all times, even at idle.

SPECIAL TOOLS

There are no special tools required for the procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS for part numbers of service tools which should be used in conjunction with procedures outlined in the transmission manufacturers service manual, and general service tools required. These tools are available from your dealer.

MECHANICAL TROUBLESHOOTING CHART

CONDITION	REASON	REMEDY
A - Transmission overheats	High or low oil level	Restore proper oil level
	Aerated (foaming) oil	Refer to condition 'B'
	Vehicle overloaded	Reduce load
	Engine coolant overheated	Correct engine overheating
	Transmission oil cooler or lines kinked or clogged	Clean or replace oil cooler or lines
	Low coolant level	Add coolant, check for leaks
	Oil leaking	Check transmission and lines for leaks
	Low main pressure	Refer to condition 'V'
	Low converter-out pressure	Refer to condition 'U'
	Vehicle brakes dragging	Check parking and service brakes
	Torque converter stator locked	Check for low top speed of vehicle. Check torque converter components.
	Clutch slipping seal rings or clutch plates.	Overhaul transmission. Replace worn piston
B - Oil is aerated (foaming)	Incorrect type of oil used	Change oil. Use only oil specified in Section 300-0020, LUBRICATION SYSTEM.
	High or low oil level	Restore proper oil level
	Air entering suction side of oil pump	Check oil pump bolts and gasket
	Water in oil	Check for source, clean system

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MECHANICAL TROUBLESHOOTING CHART		
CONDITION	REASON	REMEDY
C - Heavy metal debris found in oil	Transmission internal failure	Completely disassemble, clean and repair transmission. Replace filters and clean lines and oil cooler.
D - Coolant found in oil	Transmission oil cooler leaking	Completely disassemble and thoroughly clean transmission. Replace all friction faced clutch plates. Repair or replace oil cooler. Replace filters and clean external lines.
E - Transmission will not operate in any range regardless of selector position	Loss of electrical power	Refer to Electronic Troubleshooting
	Internal mechanical failure	Overhaul transmission
	Driveline failure	Check transmission input and output
	Low oil level	Restore proper oil level
	Low main pressure	Refer to condition 'V'
F - Transmission continues in the same forward gear regardless of selector position	Loss of electrical power	Refer to Electronic Troubleshooting
G - Shifting is erratic		Refer to Electronic Troubleshooting
H - Transmission operates only in first, neutral and reverse		Refer to Electronic Troubleshooting
I - Transmission shifts to neutral during reverse operation, but will operate normally in all other ranges		Refer to Electronic Troubleshooting
J - Vehicle operates in reverse and moves backwards in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	Reverse clutch has failed (won't release)	Overhaul transmission
K - Vehicle operates in first and second gears and moves forward in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	First and second gear clutch failed (won't release)	Overhaul transmission
L - Vehicle operates in third and fourth gears and moves forward in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	Third and fourth gear clutch failed (won't release)	Overhaul transmission

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MECHANICAL TROUBLESHOOTING CHART		
CONDITION	REASON	REMEDY
M - Vehicle operates in fifth and sixth gears and moves forward in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	Fifth and sixth gear clutch failed (won't release)	Overhaul transmission
N - No power is transmitted in any one range - Electronic Troubleshooting OK	Range clutch failed (won't apply, slipping)	Overhaul transmission. Check for worn piston seals, broken piston housing, or worn clutch plates in that range.
O - Vehicle will operate in second, fourth, sixth and reverse gears but will not operate in all other gears - Electronic Troubleshooting OK	Splitter-overdrive clutch won't release or splitter-direct clutch won't apply, slipping	Overhaul transmission. Check splitter clutches for worn components.
P - Vehicle will operate in first, third and fifth gears but will not operate in all other gears - Electronic Troubleshooting OK	Splitter-direct clutch won't release or splitter-overdrive clutch won't apply, slipping	Overhaul transmission. Check splitter clutches for worn components.
Q - Slow clutch engagement	Low oil level	Add oil to proper level
	Foaming oil	Refer to condition 'B'
	Worn piston seals	Overhaul transmission
	Low main pressure	Refer to condition 'V'
R - Vehicle lacks power and acceleration	Engine malfunction	Check engine. Refer to engine service manual.
	Aerated oil	Refer to condition 'B'
	Low engine speed at converter stall	Refer to condition 'T'
	High engine speed at converter stall	Refer to condition 'S'
	Hydraulic retarder partially applied	Check retarder linkage
	Vehicle brakes dragging	Check parking and service brakes
	Stator freewheel clutch failed	Overhaul transmission
S - High engine speed at converter stall	Low oil level	Add oil to proper level
	Low converter-out pressure	Refer to condition 'U'
	High oil temperature (above 135° C; 275° F)	Refer to condition 'A'
	Clutch slipping, main pressure normal	Overhaul transmission. Replace clutch piston seal rings or clutch plates.
	Foaming oil	Refer to condition 'B'

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MECHANICAL TROUBLESHOOTING CHART		
CONDITION	REASON	REMEDY
T - Low engine speed at converter stall	Low engine output torque	Tune engine and check output
	Converter element interference	Check for noise at stall; overhaul converter if necessary
	Transmission oil not up to operating temperature	Warm up transmission to 82 - 103° C (180 - 220° F)
U - Low converter-out pressure	Low oil level	Add oil to proper level
	Oil line leakage (oil cooler or filter)	Check for leaks, correct as required
	Plugged oil strainer	Clean oil strainer
	Defective oil pump	Rebuild/replace oil pump assembly
	High oil temperature	Refer to condition 'A'
	Foaming oil	Refer to condition 'B'
V - Low main pressure	Low oil level	Add oil to proper level
	Leaks in hydraulic system	Check all external points for leaks; check each range for localizing internal leaks
	Failure in pressure regulator	Overhaul valve assembly
	Worn input oil pump assembly	Rebuild/replace pump assembly
	Clogged oil strainer	Clean oil strainer
	Air leaks at suction side of input pump	Check input pump, correct as required
W - Downshift of transmission is permitted during lockup operation		Refer to Electronic Troubleshooting
X - Shift quadrant not illuminated	Failed light bulb	Replace the light bulb
Y - Reverse signal not energized		Refer to Electronic Troubleshooting

SPECIAL TORQUE SPECIFICATIONS				
			TORQUE	
FIG. NO.	ITEM NO.	ITEM NAME	Nm	lbf ft
1	3	Bolt	156	115
1	6	Bolt	278	205
1	10	Bolt	156	115
1	32	Bolt	130 - 156	96 - 115
1	38	Nut/Locknut	950 - 1 355	700 - 1 000

* * * *

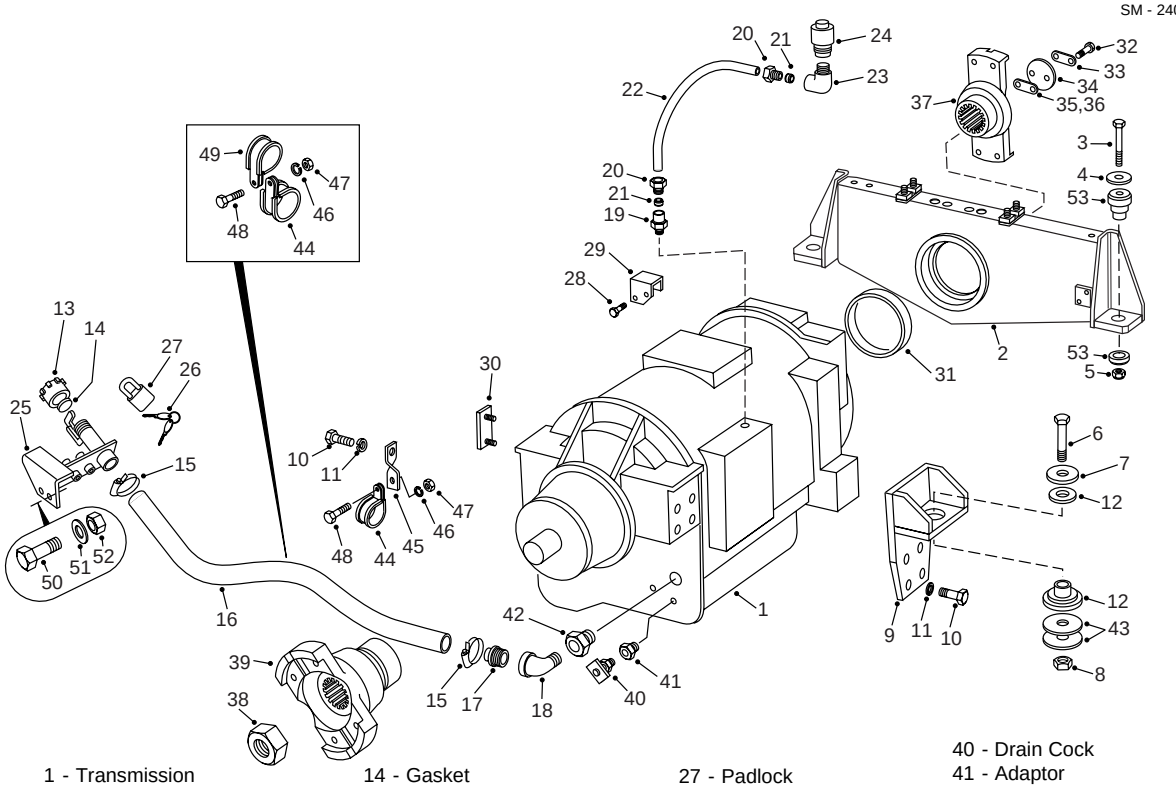
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1 - Transmission
2 - Trunnion
3 - Bolt
4 - Washer
5 - Locknut
6 - Bolt
7 - Hardened Washer
8 - Nut
9 - Mounting Bracket
10 - Bolt
11 - Lockwasher
12 - Isolation Mount
13 - Filler Cap
14 - Gasket
15 - Clamp
16 - Filler Hose
17 - Filler Tube
18 - Elbow
19 - Connector
20 - Nut
21 - Sleeve
22 - Nylon Tube
23 - Elbow
24 - Breather
25 - Adaptor
26 - Key
27 - Padlock
28 - Bolt
29 - Cover Plate
30 - Level Gauge
31 - Ring
32 - Bolt
33 - Strip
34 - Retainer
35 - Shim
36 - Shim
37 - Input Yoke
38 - Nut
39 - Output Yoke
40 - Drain Cock
41 - Adaptor
42 - Adaptor
43 - Snubbing Washer
44 - P-clip
45 - Bracket
46 - Lockwasher
47 - Nut
48 - Bolt
49 - P-clip
50 - Bolt
51 - Hardened Washer
52 - Nut
53 - Isolation Mount

Fig. 1 - Exploded View of Transmission and Mounting

DESCRIPTION

For transmission make, model and specification, refer to Section 000-0000, GENERAL INFORMATION. For transmission switches, sensors and instruments, refer to Section 190-0270, SWITCHES AND SENSORS. For transmission servicing and repair data, refer to the transmission manufacturers service manual.

The transmission is remote mounted in the frame and is supported by trunnion (2) assembly at the front and two mounting brackets (9) at the rear.

Integral with transmission (1) assembly are torque converter and planetary gearing. There are six forward gears and two reverse gears with automatic lockup in all speed ranges. Operation of the transmission is by the Commercial Electronic Control (CEC) Shift System, (previously known as ATEC).

A brief description and operation of the main transmission components are as follows:

CEC Shift System

Refer to Section 120-0070, CEC SHIFT SYSTEM for description and operation, wiring diagrams and electrical troubleshooting of the CEC System.

Torque Converter

The torque converter consists of three elements - pump, turbine, and stator. The pump is the input element and is driven directly by the engine. The turbine is the output element and is hydraulically driven by the pump. The stator is the reaction (torque multiplying) element.

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When the pump turns faster than the turbine, the torque converter is multiplying torque. When the turbine approaches the speed of the pump the stator starts to rotate with the pump and turbine. When this occurs, torque multiplication stops and the torque converter functions as a fluid coupling.

Lockup Clutch
The lockup clutch is located inside the torque converter and consists of three elements - piston, clutch plate, and backplate. The piston and backplate are driven by the engine and the clutch plate, located between the piston and backplate, is splined to the converter turbine.

The lockup clutch is hydraulically engaged and released in response to electronic signals from the ECU. It engages when the vehicle reaches a predetermined speed. Engagement of the lockup clutch provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage to provide maximum fuel economy. The lockup clutch releases at lower speeds (and momentarily during shifts). When the lockup clutch is released, drive from the engine is transmitted hydraulically through the converter to the transmission gearing. The lockup clutch also releases when the ECU detects certain undesirable conditions.

Planetary Gears and Clutches
A series of planetary gears and shafts provide the gear ratios and directions of travel for the vehicle. Power flow through the planetaries is controlled by multiple clutch packs. The clutches are applied and released hydraulically in response to electronic signals from the ECU.

Hydraulic Retarder
A vaned rotor and two vaned stators are the basic components of the retarder. Application of the retarder control valve fills the cavity around the rotor with oil when the vehicle must be slowed on steep downgrades. When the cavity is emptied, the rotor is free of drag. Refer to Section 250-0130, RETARDER CONTROL VALVE.

Maximum retarder effect occurs in the lowest gear range with foot off of the accelerator pedal. Long continuous use of the retarder will raise transmission oil temperature. Short periods of full release, to interrupt continuous application, will help prevent overheating.

During normal operation the dash mounted transmission oil temperature gauge should read in the green zone. However, during transmission retarder operation oil temperature can enter the yellow 'Retarder On' zone but should not enter the red zone.

Transmission Oil Cooler
The transmission oil is cooled by a separate oil cooler mounted between the radiator and transmission to maintain transmission oil within its required operating temperature range. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

Transmission Oil Filter
The transmission oil filter is mounted off the frame at the front right hand side of the transmission. It is installed in the transmission oil lines to remove dirt and other contaminants from the transmission oil to minimise wear and provide maximum service life for the transmission. Refer to Section 120-0100, TRANSMISSION OIL FILTER.

REMOVAL

Numbers in parentheses refer to Fig. 1.

Note: Tag all lines, pipes, electrical connections and mechanical linkages disconnected during removal to aid in installation.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ High electrical current can cause sparks and personal injury from burns. Switch circuit breakers to the 'Off' position before removing any electrical components. Remove battery ground cable first, and reconnect last, to prevent damaging electrical components.

⚠ Any time the battery equalizer is disconnected from the batteries, remove ground cable first, and reconnect last, to prevent damaging the component.

1. Position the vehicle in a level work area, raise the body and install the body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine. Turn steering wheel several times to relieve pressure in the steering circuit. Depress and release brake pedal continuously to relieve pressure in the braking system (pressure in accumulator hydraulic line should be zero).

3. Block all road wheels.

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Note: It is important that the electrical connections are removed in the order listed in step 4 to prevent damage to the electrical components.

4. Disconnect battery equalizer ground connection from the batteries. Disconnect battery cables from terminal posts (ground cable first). Disconnect battery equalizer positive connection. Disconnect electrical connections at the ECU.

5. Using suitable lifting equipment, support transmission guard and remove mounting hardware securing the guard to the frame. Remove transmission guard.

6. Disconnect driveline from input yoke (37) at the front of transmission (1). Refer to Section 130-0010, FRONT DRIVELINE.

7. Disconnect driveline from output yoke (39) at the rear of transmission (1). Refer to Section 130-0020, REAR DRIVELINE.

8. Place a suitable container under drain cock (40), loosen drain cock and drain oil from transmission (1). After draining, tighten drain cock (40) securely.

9. Disconnect the transmission retarder linkage at transmission (1).

10. Place a suitable container under the steering tank drain plug, remove drain plug and drain the oil from the steering tank. After draining, reinstall drain plug.

11. Disconnect steering lines from the steering pump and remove mounting hardware securing steering lines to transmission (1). Cap all open line ends and steering pump fittings to prevent entry of dirt.

12. Disconnect transmission oil cooler lines and oil filter lines from transmission (1). Cap all open lines and fittings to prevent entry of dirt.

13. Disconnect hydraulic line from lockup drop out valve at the front right hand side of transmission (1).

14. Disconnect all remaining hydraulic lines attached to transmission (1). Cap all open lines and fittings to prevent entry of dirt.

15. Disconnect all electrical connections and cables attached to transmission (1).

16. Remove mounting hardware securing accumulator valve mounting bracket to the front left hand side of transmission (1) and move bracket and valve clear of the transmission (1).

17. Remove mounting hardware supporting mounting brackets for body hoist lines to the top of transmission (1).

18. Remove mounting hardware securing kick-over valve mounting bracket to the top of transmission (1).

19. Slacken nut (20) and move nut (20) and nylon tube (22) assembly free from connector (19) in the top of transmission (1).

20. Detach clamps (15) and remove filler hose (16) from filler tube (17) and adaptor (25).

21. Install suitable lifting eyes into the holes provided at the top of transmission (1) housing and secure a suitable lifting device to the eyes. Take up slack in the chain or cable.

22. Remove locknuts (5), bolts (3) and washers (4) securing trunnion (2) to the frame.

23. Remove bolts (6), hardened washers (7), snubbing washers (43) and nuts (8) securing mounting brackets (9) to frame.

24. Check to make certain that all hydraulic lines and electrical connections fitted to transmission (1) have been disconnected before moving transmission (1).

25. Carefully manoeuvre transmission (1) out of the frame mounting and lower onto a suitable dolly or pallet.

26. Move transmission (1) assembly to a suitable work area or onto a work stand for further disassembly, if necessary.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Refer to the transmission manufacturers Service Manual if transmission service or repair is required.

1. Remove bolts (32), strip (33), retainer (34) and shims (35 & 36) securing input yoke (37) on transmission (1). Pull input yoke (37) from transmission (1).

2. Pull trunnion (2) assembly from transmission (1) and remove ring (31) from trunnion (2), if required. If necessary, remove isolation mounts (53) from

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trunnion (2).

3. Remove nut (38) securing output yoke (39) on transmission (1). Pull output yoke (39) from transmission (1).

4. Remove bolts (10) and lockwashers (11) securing mounting brackets (9) to transmission (1). Remove mounting brackets (9).

5. If necessary, remove isolation mounts (12) from mounting brackets (9).

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Secure mounting brackets (9) to transmission (1) assembly with bolts (10) and lockwashers (11). Tighten bolts (10) to a torque of 156 Nm (115 lbf ft). If removed, install isolation mounts (12) to mounting brackets (9).

2. If removed, install isolation mounts (53) to trunnion (2). If removed, fit new ring (31) to trunnion (2) and mount trunnion (2) to the front of transmission (1) with small leg to the top and facing away from transmission (1).

3. Make sure that transmission input shaft is in its most outward position and the bearing is seated against the shaft shoulder.

4. Coat input shaft splines and lip of oil seal with a thin layer of EP, NLGI molybdenum grease. Install input yoke (37) on input shaft by tapping lightly until the yoke is seated. If input yoke (37) is a tight fit, heat input flange (37) to 121° C (250° F) maximum prior to assembly. Two methods which may be employed are:

a. Heat in controlled temperature furnace for a minimum period of 45 minutes.

b. Submerge flange in heated oil for 15 minutes.

5. Use proper combination of shims (35 & 36) to obtain a 0.2 - 0.3 mm (0.008 - 0.012 in) gap between retainer face of input yoke (37) and end of input shaft. Fit retainer (34) and secure with bolts (32) and strip (33). Tighten bolts (32) to a torque of 130 - 156 Nm (96 - 115 lbf ft).

6. Coat output shaft splines and threads, and lip of oil seal with a thin layer of EP, NLGI molybdenum grease. Install output yoke (39) on output shaft by tapping lightly until the yoke is seated. If output yoke (39) is a tight fit, heat output yoke (39) to 121° C (250° F) maximum prior to assembly, using either of the methods described in step 3.

7. Secure output yoke (39) on output shaft with nut (38). Tighten nut (38) to a torque of 950 - 1 355 Nm (700 - 1 000 lbf ft).

8. After assembly has cooled, check torque of bolts (32) and nut (38) and retighten to their required torques.

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. Position transmission (1) assembly under the vehicle and attach a suitable lifting device to the eye bolts on top of transmission (1).

2. Carefully lift transmission (1) assembly into its mounting position and lightly secure trunnion (2) to the frame (mounting face to the front of the frame mounting brackets) with bolts (3), washers (4) and locknuts (5). Install bolts (3) from the rear of the assembly.

3. Install bolts (6), hardened washers (7), snubbing washers (43) and nuts (8) securing mounting brackets (9) to frame mounting brackets. Securely tighten bolts (6) to a torque of 278 Nm (205 lbf ft).

4. Securely tighten bolts (3), securing trunnion (2) to frame mounting brackets, to a torque of 156 Nm (115 lbf ft).

5. Remove lifting device and lifting eye bolts from top of transmission (1).

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6. Install filler hose (16) to filler tube (17) and adaptor (25) and secure with clamps (15).

7. Secure accumulator valve mounting bracket to the front left hand side of transmission (1) assembly with mounting hardware removed during removal.

8. Secure kick-over valve mounting bracket to top of transmission (1) assembly with mounting hardware removed during removal.

9. Secure body hoist lines mounting brackets to the top of transmission (1) assembly with mounting hardware removed during removal.

10. Connect all electrical connections and cables to transmission (1) as tagged at removal.

11. Connect transmission oil cooler lines to transmission (1) and oil filter lines to transmission oil filter as tagged at removal.

12. Connect steering pump hydraulic lines as tagged at removal and secure lines to transmission (1) with mounting hardware removed during removal.

13. Connect hydraulic line from lockup drop out valve to front right hand side of transmission (1).

14. Connect any remaining hydraulic lines which were removed during removal. Ensure all hydraulic lines are securely tightened.

15. Connect transmission retarder linkage at transmission (1).

16. Install rear driveline to output yoke (39) at the rear of transmission (1) and secure with mounting hardware removed during removal. Refer to Section 130-0020, REAR DRIVELINE.

17. Install front driveline to input yoke (37) at the front of transmission (1) and secure with mounting hardware removed during removal. Refer to Section 130-0010, FRONT DRIVELINE.

18. Using suitable lifting equipment, support transmission guard and secure guard to the frame with mounting hardware removed during removal.

19. Fill transmission (1) assembly with oil specified in Section 300-0020, LUBRICATION SYSTEM, and check the oil level as described under 'Oil Level Check'.

20. Fill steering tank with oil specified in Section 300-0020, LUBRICATION SYSTEM, and check the oil level as described in Section 220-0040, STEERING AND BRAKE CONTROL TANK.

Note: It is important that the electrical connections are made in the order listed in step 21 to prevent damage to the electrical components.

21. Connect electrical connections at the ECU. Connect battery equalizer positive connection. Connect battery cables to battery terminal posts (ground cable last). Connect battery equalizer ground connection.

22. Start the engine and make an operational check while the engine is running of all lines and connections disconnected during removal of transmission (1). Check for leaks and tighten lines and fittings as required.

23. Ensure parking brake is applied, remove the body prop pins and lower the body. Refer to Section 270-0010, BODY AND MOUNTING. Remove wheel chocks from all road wheels.

MAINTENANCE

Periodic Inspections

For easier inspection, the transmission should be kept clean. Make periodic checks for loose bolts and leaking oil lines. Check the condition of electrical harnesses and connections regularly.

The transmission breather should be checked regularly and as frequently as necessary, depending on the operating conditions of the vehicle. A badly corroded or plugged breather restricts proper breathing and causes a buildup of condensation and subsequent oil deterioration.

Oil Level Check

⚠ WARNING
When checking the oil level, be sure that the parking brake is applied and all road wheels are securely blocked.

Check the transmission oil level and add oil if low, every 10 hours/daily. Use only oil of the type specified in Section 300-0020, LUBRICATION SYSTEM.

Because the transmission oil cools, lubricates and transmits hydraulic power it is important that the proper oil level be maintained at all times. If the oil

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level is too low, the converter and clutches will not receive an adequate supply of oil. If the oil level is too high, the oil will aerate and the transmission will overheat. It is absolutely necessary that the oil put into the transmission be clean.

Oil must be handled in clean containers to prevent foreign material from entering the system.

Note: Containers or fillers that have been used for antifreeze or engine coolant solution must not be used for transmission oil.

Visual Level Indicator
A visual level indicator is mounted on the lower left side of the transmission main housing and provides a method of checking the oil level. Refer to Fig. 2.

Cold Oil Level Check
Before starting the engine, check the visual level indicator or remove the ADD (lower) plug. If oil is present in the indicator or if oil flows from the plug opening, the transmission has sufficient oil to permit safe starting of the engine. If no oil is present, add sufficient oil to bring the level within the indicator or to cause a flow from the plug opening. Replace the plug.

Hot Oil Level Check
Note: Observe the condition of the oil in the visual level indicator or the type of flow from the plug opening. Foaming or spurting may indicate a false level.

A hot oil level check is made to determine if there is sufficient oil for working operation of the transmission. Select neutral on the transmission range selector and start the engine. Operate the vehicle until the transmission reaches a normal operating temperature of 82 - 103° C (180 - 220° F). Idle the engine, apply the parking brake and block all road wheels.

Check the visual level indicator or remove the FULL (upper) oil level check plug. The oil should be within the indicator limits shown in Fig. 2 or at or near the level of the plug opening. Add or drain oil as necessary to bring the oil level within these limits.

Note: The transmission may be operated safely as long as the oil level is above the ADD (lower) plug.

Oil and Filter Change

After the first 150 hours of operating a new or rebuilt transmission, the transmission oil and filters should be changed.

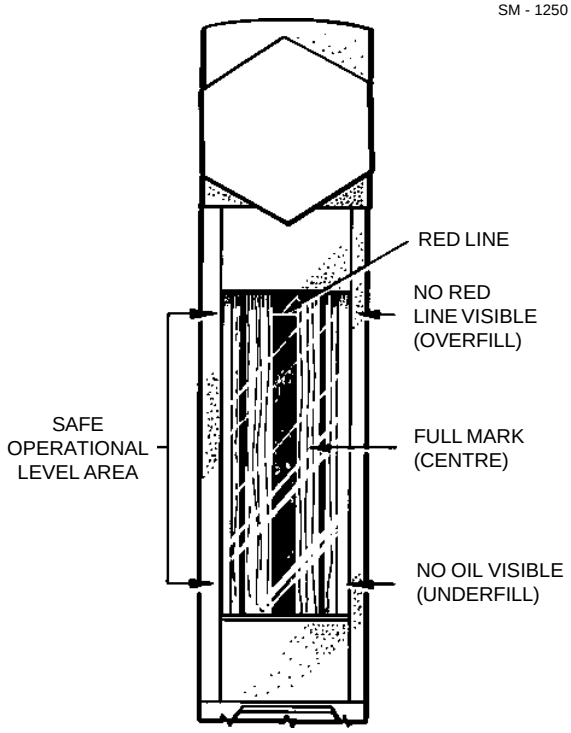


Fig. 2 - Visual Level Indicator

The transmission oil and filters should be changed at the intervals specified in Section 300-0020, LUBRICATION SYSTEM, or sooner, depending on operating conditions. Also, the oil must be changed whenever there are traces of dirt or evidence of high temperature indicated by discoloration or strong odour.

The screen and magnet assembly in the sump should be removed and cleaned with mineral spirits at each oil change. Metal particles in the oil (except for the minute particles normally trapped in the oil filters) indicate damage has occurred in the transmission When these particles are found in the filters, the cause must be established and rectified immediately to prevent damage to the transmission.

At each oil change, examine the used oil for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during operation of the transmission. However, if there is evidence of water or engine coolant in the oil, the cause must be established and rectified immediately to prevent damage to the transmission.

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Welding on Vehicles Equipped With CEC

WARNINGS
The ECU can be damaged by improper welding procedures.

Any time the battery equalizer is disconnected from the batteries, remove ground cable first, and reconnect last, to prevent damaging the component.

When frame or other welding is required, the following precautions are to be taken to protect the electronic components.

a. Disconnect battery equalizer ground connection from the batteries. Disconnect battery cables from terminal posts (ground cable first). Disconnect battery equalizer positive connection. Disconnect electrical connections at the ECU.

b. If additional system ground wires are connected to the frame, they must be disconnected also.

c. Cover electronic components and wiring to protect from damage.

d. Do not connect welding cables to electronic components. Do not weld on electronic components. If welding is to be done close to electronic components, the components should be removed prior to the welding process.

e. On completion of all welding reconnect electrical connections in the reverse order to step a.

TROUBLESHOOTING

Converter Stall Test

A stall test should be conducted when the power package (engine and transmission) is not performing satisfactorily. The purpose of the test is to determine the engine power output and establish if the transmission is the malfunctioning component.

WARNING
When conducting a stall test, the vehicle must be positively prevented from moving. The parking brake must be applied and the vehicle should be blocked to prevent movement forward or reverse. Keep people safely away from the vehicle path. Do not maintain the stalled condition longer than 30 seconds due to rapid heating of the transmission oil. With the transmission in neutral, run the engine at 1 200 - 1 500 rev/min for two minutes to cool the oil between tests. Do not allow the converter-out temperature to exceed 135° C (275° F). Keep a close check to prevent overheating of the engine cooling system.

1. Position the vehicle on a level area with room for movement all round.

2. Apply the parking brake and block all road wheels. Turn the manual mode key switch to the 'On' position and the mode selection switch to the 'Power' mode.

3. Apply the service brake, release the parking brake and select fifth gear on the transmission shift selector. The transmission will shift to fifth gear and deactivate the lockup clutch. Apply the parking brake and release the foot pedal.

4. Accelerate the engine to full throttle and, using a tachometer of known accuracy, note the maximum rev/min the engine will attain. Converter-out pressure should be 2 bar (30 lbf/in²).

Note: The stall speed of each vehicle is noted on the final inspection records prior to the vehicle leaving the factory. This can be used as a guide when checking the stall speed. It is recommended to keep a record of the stall speed after each major service and use the previous recorded value as a guide.

5. When the stall check is complete, return the accelerator to the idle position and move the shift selector to the neutral position.

Note: Engine power will decrease with an increase in elevation (altitude), becoming more pronounced at greater elevation. This will result in a lower engine speed under converter stall conditions.

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6. During the stall check the transmission oil temperature should rise while the engine is under load and drop when the transmission is returned to neutral. Should the temperature fail to drop it indicates that there is a problem with the converter.

7. After making allowances for elevation, a low engine speed may indicate the engine is not delivering full power. Refer to engine service manual for engine repair information.

Electronic Troubleshooting

Refer to Section 120-0070, CEC SHIFT SYSTEM for general electrical troubleshooting. For more detailed electrical troubleshooting refer to the Allison Transmission Commercial Electronic Control (CEC) Troubleshooting Manual SA2712A.

Mechanical Troubleshooting

It is recommended to follow the procedures laid down for mechanical troubleshooting, as outlined in the 'Mechanical Trouble Shooting' charts, before carrying out electrical troubleshooting procedures.

⚠ WARNING
Be sure to apply the parking brake, switch off the engine and block all road wheels before troubleshooting the vehicle. Should it be necessary to run the engine, it is imperative that an operator be present in the cab at all times, even at idle.

SPECIAL TOOLS

There are no special tools required for the procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS for part numbers of service tools which should be used in conjunction with procedures outlined in the transmission manufacturers service manual, and general service tools required. These tools are available from your dealer.

MECHANICAL TROUBLESHOOTING CHART

CONDITION	REASON	REMEDY
A - Transmission overheats	High or low oil level	Restore proper oil level
	Aerated (foaming) oil	Refer to condition 'B'
	Vehicle overloaded	Reduce load
	Engine coolant overheated	Correct engine overheating
	Transmission oil cooler or lines kinked or clogged	Clean or replace oil cooler or lines
	Low coolant level	Add coolant, check for leaks
	Oil leaking	Check transmission and lines for leaks
	Low main pressure	Refer to condition 'V'
	Low converter-out pressure	Refer to condition 'U'
	Vehicle brakes dragging	Check parking and service brakes
	Torque converter stator locked	Check for low top speed of vehicle. Check torque converter components.
	Clutch slipping seal rings or clutch plates.	Overhaul transmission. Replace worn piston
B - Oil is aerated (foaming)	Incorrect type of oil used	Change oil. Use only oil specified in Section 300-0020, LUBRICATION SYSTEM.
	High or low oil level	Restore proper oil level
	Air entering suction side of oil pump	Check oil pump bolts and gasket
	Water in oil	Check for source, clean system

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MECHANICAL TROUBLESHOOTING CHART		
CONDITION	REASON	REMEDY
C - Heavy metal debris found in oil	Transmission internal failure	Completely disassemble, clean and repair transmission. Replace filters and clean lines and oil cooler.
D - Coolant found in oil	Transmission oil cooler leaking	Completely disassemble and thoroughly clean transmission. Replace all friction faced clutch plates. Repair or replace oil cooler. Replace filters and clean external lines.
E - Transmission will not operate in any range regardless of selector position	Loss of electrical power	Refer to Electronic Troubleshooting
	Internal mechanical failure	Overhaul transmission
	Driveline failure	Check transmission input and output
	Low oil level	Restore proper oil level
	Low main pressure	Refer to condition 'V'
F - Transmission continues in the same forward gear regardless of selector position	Loss of electrical power	Refer to Electronic Troubleshooting
G - Shifting is erratic		Refer to Electronic Troubleshooting
H - Transmission operates only in first, neutral and reverse		Refer to Electronic Troubleshooting
I - Transmission shifts to neutral during reverse operation, but will operate normally in all other ranges		Refer to Electronic Troubleshooting
J - Vehicle operates in reverse and moves backwards in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	Reverse clutch has failed (won't release)	Overhaul transmission
K - Vehicle operates in first and second gears and moves forward in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	First and second gear clutch failed (won't release)	Overhaul transmission
L - Vehicle operates in third and fourth gears and moves forward in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	Third and fourth gear clutch failed (won't release)	Overhaul transmission

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MECHANICAL TROUBLESHOOTING CHART		
CONDITION	REASON	REMEDY
M - Vehicle operates in fifth and sixth gears and moves forward in neutral when engine is accelerated, but stalls in all other gears when engine is accelerated - Electronic Troubleshooting OK	Fifth and sixth gear clutch failed (won't release)	Overhaul transmission
N - No power is transmitted in any one range - Electronic Troubleshooting OK	Range clutch failed (won't apply, slipping)	Overhaul transmission. Check for worn piston seals, broken piston housing, or worn clutch plates in that range.
O - Vehicle will operate in second, fourth, sixth and reverse gears but will not operate in all other gears - Electronic Troubleshooting OK	Splitter-overdrive clutch won't release or splitter-direct clutch won't apply, slipping	Overhaul transmission. Check splitter clutches for worn components.
P - Vehicle will operate in first, third and fifth gears but will not operate in all other gears - Electronic Troubleshooting OK	Splitter-direct clutch won't release or splitter-overdrive clutch won't apply, slipping	Overhaul transmission. Check splitter clutches for worn components.
Q - Slow clutch engagement	Low oil level	Add oil to proper level
	Foaming oil	Refer to condition 'B'
	Worn piston seals	Overhaul transmission
	Low main pressure	Refer to condition 'V'
R - Vehicle lacks power and acceleration	Engine malfunction	Check engine. Refer to engine service manual.
	Aerated oil	Refer to condition 'B'
	Low engine speed at converter stall	Refer to condition 'T'
	High engine speed at converter stall	Refer to condition 'S'
	Hydraulic retarder partially applied	Check retarder linkage
	Vehicle brakes dragging	Check parking and service brakes
	Stator freewheel clutch failed	Overhaul transmission
S - High engine speed at converter stall	Low oil level	Add oil to proper level
	Low converter-out pressure	Refer to condition 'U'
	High oil temperature (above 135° C; 275° F)	Refer to condition 'A'
	Clutch slipping, main pressure normal	Overhaul transmission. Replace clutch piston seal rings or clutch plates.
	Foaming oil	Refer to condition 'B'

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MECHANICAL TROUBLESHOOTING CHART		
CONDITION	REASON	REMEDY
T - Low engine speed at converter stall	Low engine output torque	Tune engine and check output
	Converter element interference	Check for noise at stall; overhaul converter if necessary
	Transmission oil not up to operating temperature	Warm up transmission to 82 - 103° C (180 - 220° F)
U - Low converter-out pressure	Low oil level	Add oil to proper level
	Oil line leakage (oil cooler or filter)	Check for leaks, correct as required
	Plugged oil strainer	Clean oil strainer
	Defective oil pump	Rebuild/replace oil pump assembly
	High oil temperature	Refer to condition 'A'
	Foaming oil	Refer to condition 'B'
V - Low main pressure	Low oil level	Add oil to proper level
	Leaks in hydraulic system	Check all external points for leaks; check each range for localizing internal leaks
	Failure in pressure regulator	Overhaul valve assembly
	Worn input oil pump assembly	Rebuild/replace pump assembly
	Clogged oil strainer	Clean oil strainer
	Air leaks at suction side of input pump	Check input pump, correct as required
W - Downshift of transmission is permitted during lockup operation		Refer to Electronic Troubleshooting
X - Shift quadrant not illuminated	Failed light bulb	Replace the light bulb
Y - Reverse signal not energized		Refer to Electronic Troubleshooting

SPECIAL TORQUE SPECIFICATIONS				
			TORQUE	
FIG. NO.	ITEM NO.	ITEM NAME	Nm	lbf ft
1	3	Bolt	156	115
1	6	Bolt	278	205
1	10	Bolt	156	115
1	32	Bolt	130 - 156	96 - 115
1	38	Nut	950 - 1 355	700 - 1 000

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DESCRIPTION

The CEC (Commercial Electronic Control) shift system continually monitors the transmission and shift system electrical components and warns the operator when a problem develops. It also takes action to prevent damage to the transmission, and provides the serviceman with diagnostic capabilities so that problems can be corrected quickly and easily.

The CEC Plus II shift system used on this vehicle consists of a gear shift selector, an electronic control unit (ECU), throttle position sensor, transmission output shaft speed sensor (magnetic pick-up), oil temperature sensor, solenoids, switches, relays, circuit breakers, fuses, indicator lights and wiring harnesses.

In addition, CEC provides the following systems designed to protect the operator and mechanical components:

Reverse Inhibit - Prevents gear selection if engine is operating at more than 20% throttle.

Hoist Interlock Pressure Switch - The ECU will shift the transmission from reverse to neutral if the body control joystick is moved to the 'Raise' position. When this circuit has been activated, moving the transmission shift lever to neutral, then re-selecting reverse, will engage reverse gear whilst the body is held in the 'Raise' position. This feature is only operational in the normal automatic driving mode, either Power or Economy. It is not activated during the manual mode.

> ⚠ **WARNING**
> **The standard procedure for raising the body must still be adhered to.**

Body Up Interlock - When the body is raised, the CEC system will only allow the transmission to operate in first gear. This feature is only operational in the normal automatic driving mode, either Power or Economy. It is not activated during the manual mode.

Parking Brake Interlock - If the parking brake is applied while the transmission is in neutral, the CEC system will prevent a shift out of neutral to protect the brake components. If the parking brake is applied while the transmission is in gear, the parking brake interlock will not function and normal shifts will occur.

Lock-in-gear - The lock-in-gear feature is designed to protect the transmission from damage should wheel spinning or lockup occur due to poor traction or panic braking. The ECU will delay making a shift for several seconds and then, if the condition fails to correct itself, locks in gear and prevents any further shifting. The Check Trans and Do Not Shift lights will both come on. If this occurs, the ECU must be reset before normal operation may be resumed.

To reset the ECU if the transmission has locked in gear because of wheel spinning or a panic stop, stop the vehicle, select neutral 'N', apply the parking brake, and turn the ignition key switch to position '0' to shut down the engine. Wait ten seconds, then turn the ignition key switch to restart engine. Select reverse 'R', then neutral 'N'. The Check Trans and Do Not Shift lights should go off.

Cold Weather Starts - During cold weather, if the transmission temperature is below -24° C (-10° F) the Do Not Shift and Check Trans lights will illuminate and the ECU will prevent the transmission from being shifted out of Neutral. Between -24° C (-10° F) and -7° C (19° F) the lights will go out and the ECU will only permit operation in first or reverse gears. Above -7° C (19° F), normal operation will be permitted.

CEC PLUS II COMPONENTS

Description and Operation

Refer to Fig. 1.

1. Electronic Control Unit (ECU) - Contains an electronic microcomputer. The ECU receives information in the form of electronic signals from switches and sensors, processes the information according to shift schedule programs stored on a programmable read only memory (PROM) chip, and sends electronic signals to the appropriate solenoids which control the transmission.

The ECU is programmed to take corrective action to prevent damage to the transmission if a failure occurs in the CEC system and has diagnostic capabilities which allow the serviceman to quickly find and repair or replace a failed component.

2. Battery Equalizer - Since the ECU continually draws 12 volts from one of the vehicles batteries, the battery equalizer is provided to continually monitor and balance the charge on the batteries.

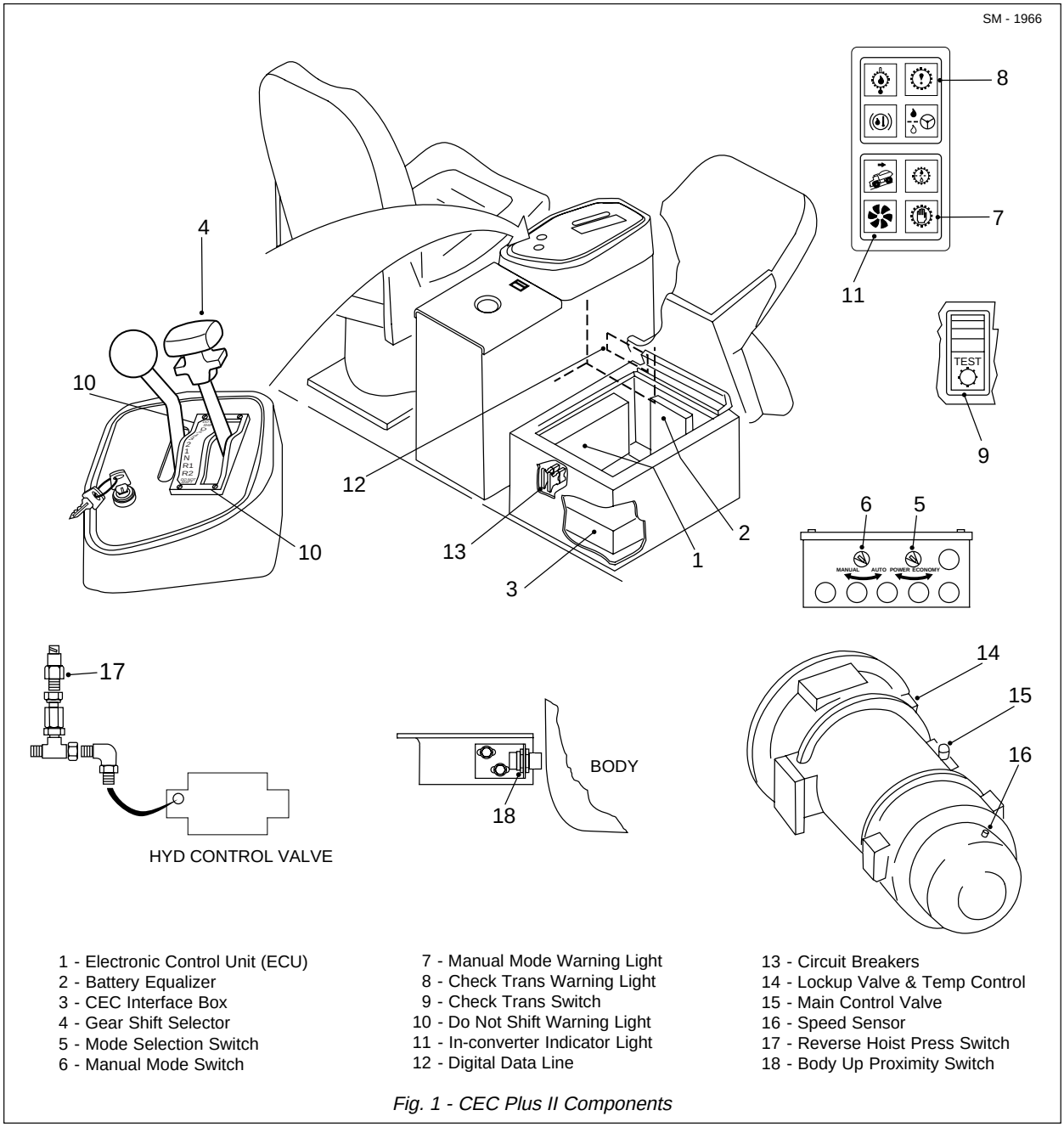
> ⚠ **WARNING**
> **Any time the battery equalizer is disconnected from batteries, remove ground wire first and reconnect last to avoid damaging component.**

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Transmission - CEC Plus II Shift System

Section 120-0070



1 - Electronic Control Unit (ECU)
2 - Battery Equalizer
3 - CEC Interface Box
4 - Gear Shift Selector
5 - Mode Selection Switch
6 - Manual Mode Switch
7 - Manual Mode Warning Light
8 - Check Trans Warning Light
9 - Check Trans Switch
10 - Do Not Shift Warning Light
11 - In-converter Indicator Light
12 - Digital Data Line
13 - Circuit Breakers
14 - Lockup Valve & Temp Control
15 - Main Control Valve
16 - Speed Sensor
17 - Reverse Hoist Press Switch
18 - Body Up Proximity Switch

Fig. 1 - CEC Plus II Components

3. CEC Interface Box - Provides the electrical link between the vehicle harnesses and the CEC harnesses. The interface box contains fuses and relays.

4. Gear Shift Selectors - When any one of the forward drive ranges is chosen, detents will hold the lever in the selected position. A two-finger latch release must be pulled up to permit movement of the lever into and out of neutral 'N' and reverse 'R'.

⚠ WARNING
Do not allow the vehicle to coast in Neutral. This practice can result in severe transmission damage.

The transmission provides six forward ranges, two reverse ranges and a neutral position. The transmission upshifts and downshifts automatically between first range and the highest range selected on

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the range selector in direct response to throttle position and transmission output speed.

When Reverse is selected the reverse alarm sounds and the reverse light illuminates at the rear of the vehicle. This feature warns personnel to the immediate rear of the vehicle that the operator has shifted to reverse.

When drive 'D' is selected, the transmission automatically upshifts and downshifts through all six forward ranges as required by loads and travel speeds. Selecting a lower range (4th, 3rd etc.) limits the highest range to which the transmission will automatically upshift.

If a lower range is selected while moving forward, the transmission automatically downshifts sequentially to the selected lower range at maximum controlled engine speeds. Downshifts will not occur until vehicle is slowed by use of the service brakes and/or retarder.

When shifting from neutral to start from a standstill, or to reverse direction, decelerate the engine to idle speed. To move forward, select drive 'D' and accelerate the engine to the vehicle load and speed requirements. The transmission will automatically upshift from 1st through 6th ranges as travel speed increases.

With the throttle fully depressed, and the mode selection switch in the Power position, the transmission upshifts to the next higher range when the engine attains maximum rated speed, since maximum power train output is needed under this condition. At lower throttle settings where minimum power train performance is required, the transmission will upshift to the next higher range at less than maximum rated engine speed.

Upgrades or soft spots might slow travel speed, even at full throttle, requiring transmission downshifts to maintain maximum powertrain performance. When this occurs, the transmission downshifts automatically.

Shift the transmission to the next lowest range if transmission 'Hunting' or 'Shift Cycling' occurs.

When temporarily stopped, such as for yielding the right-of-way to a loaded vehicle, the transmission can be left in the selected range and the vehicle held stationary with the service brakes.

However, when stopped for a more extended period with the engine left running, shift the transmission to neutral to avoid unnecessary heat buildup and apply the parking brake.

⚠ WARNING
Always select Neutral and apply the parking brake before leaving the operator's seat.

5. Mode Selection Switch - Gives the option to select between transmission Power and Economy shift schedules. The transmission must be in Neutral before the switch will function.

The transmission torque converter is equipped with a lockup clutch which, when engaged by the ECU, locks the converter pump and turbine together as a single unit and allows power to be transmitted mechanically from the engine directly to the transmission gearing on a 1:1 ratio. When the lockup clutch is disengaged, the torque converter acts as a fluid coupling, multiplying torque when engine speed is significantly higher than transmission output shaft speed.

When the mode selection switch is in the Power position, the ECU controls operation of the lockup clutch according to signals received by the throttle position sensor (giving engine speed as a percent of throttle), the transmission output shaft speed sensor, and range selector. The ECU may delay application of the lockup clutch and allow torque multiplication by the torque converter to take place until a balance is achieved between engine speed and transmission output shaft speed before activating the lockup clutch.

Power versus Economy Mode
The Power mode is designed for applications involving heavy loads and hilly duty cycles where performance rather than fuel economy is of prime importance.

The Economy mode is designed for applications involving lighter loads and level duty cycles or where fuel economy is more important than performance.

In the Economy mode, the ECU controls operation of the lockup clutch with a timed, preprogrammed schedule where in second through sixth gears the lockup clutch is disengaged only long enough to allow the torque converter's fluid coupling to absorb shift shock. Otherwise, the lockup clutch is engaged and no torque multiplication takes place in second through sixth gears.

6. Manual Mode Switch - The manual mode facility is designed as a Service Technician facility to allow stall checks and clutch pressure checks to be implemented by Service Personnel, and permit movement of the vehicle, if necessary, to a repair area. With the manual mode switch in the 'On' position, the body up interlock

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and hoist interlock pressure switch mechanisms are disengaged! This allows unauthorised selection of reverse or any forward gear with the body raised, constituting a safety hazard. Operators must not use the manual mode facility when working the vehicle! It is recommended that the mode selection key is removed from the unit and retained in a safe place until required by Service personnel.

Note: The manual mode can only be used if the mode selection switch is in the Power position and the transmission is in neutral.

⚠ WARNINGS

Do not operate the engine for more than 30 seconds at full throttle with transmission in gear and output stalled as this will result in severe overheat damage to the transmission.

⚠ The manual mode is not intended to be used for normal operations. The vehicle should only be driven at very low speeds in first or reverse gears if the manual mode is activated, or damage to the transmission may result.

7. Manual Mode Warning Light - Illuminates to alert the operator when the transmission has been switched to operate in the manual mode. The light should be 'Off' during normal operation.

8. Check Trans Warning Light - Illuminates to alert of a minor fault in the transmission shift system or abnormal transmission temperature. The light will come 'On' when the ignition key switch is turned to position '1' to provide a bulb and system check and should go 'Off' a few seconds after the engine is started and the transmission oil pressure rises.

The check trans warning light will come 'On' during operation, if the ECU has detected a minor fault in an electrical component or abnormal transmission oil temperature. If transmission oil temperature is too high, stop the vehicle, select neutral 'N', and increase engine speed to allow a greater flow of oil to the cooler until oil temperature drops to normal operating range. In most cases, a minor fault triggering the check trans warning light will not prevent normal operation from continuing but, depending on the nature of the problem, the ECU could take action to protect the transmission from damage, such as preventing operating in high gear ranges. If the check trans light comes 'On', have the problem diagnosed and corrected at the earliest opportunity.

9. Check Trans Switch - Is used in conjunction with the check trans warning light to obtain trouble codes which will indicate shift system malfunctions. Refer to 'Troubleshooting' covered in this section, or, Allison Commercial Electronic Control (CEC) Troubleshooting Manual SA2712A, for instructions on finding and clearing trouble codes and diagnostic procedures.

10. Do Not Shift Warning Light - This warning light is incorporated in the gear shift selector. The light will illuminate when the ignition key switch is turned to position '1' to provide a bulb and system check. It should go 'Off' a few seconds after the ignition is switched on.

If the do not shift warning light starts to flash and the buzzer sounds along with the Check Trans Warning Light, the ECU has detected a serious problem in the shift system and will disengage the lockup clutch, if applied, preventing a shift out of the gear the transmission is in (Lock-in gear). Any time the do not shift warning light starts flashing and the buzzer sounds, bring the vehicle to a stop at the first safe opportunity and shut down the engine until the problem is corrected.

11. In-convertor Indicator Light - Illuminates when the transmission is in torque converter drive. It goes 'Off' when Lockup is engaged. In order to avoid unnecessary waste of fuel, if traffic or other road conditions permit, the operator should modify throttle position, or gear held, to achieve a steady road speed with the torque converter lockup engaged (light 'Off').

12. Digital Data Line - Located in the right hand side of the transmission control tower. Plug in connector for diagnostic data reader (DDR).

CEC PLUS II ELECTRICAL CIRCUITS

Note: The following circuits refer to both colour coded wires (vehicle harnesses) and number coded wires (Allison harnesses). For ease of explanation, the number codes are used in the text.

Note: Where wire colours are indicated in the circuits followed by the Allison number in brackets, this indicates which Allison wire the vehicle harness wire will connect to.

Note: Refer to Section 190-0000, CIRCUIT DIAGRAMS, for vehicle electrical circuits. Refer to Section 190-0270, SWITCHES AND SENSORS, for location and description of transmission switches and sensors.

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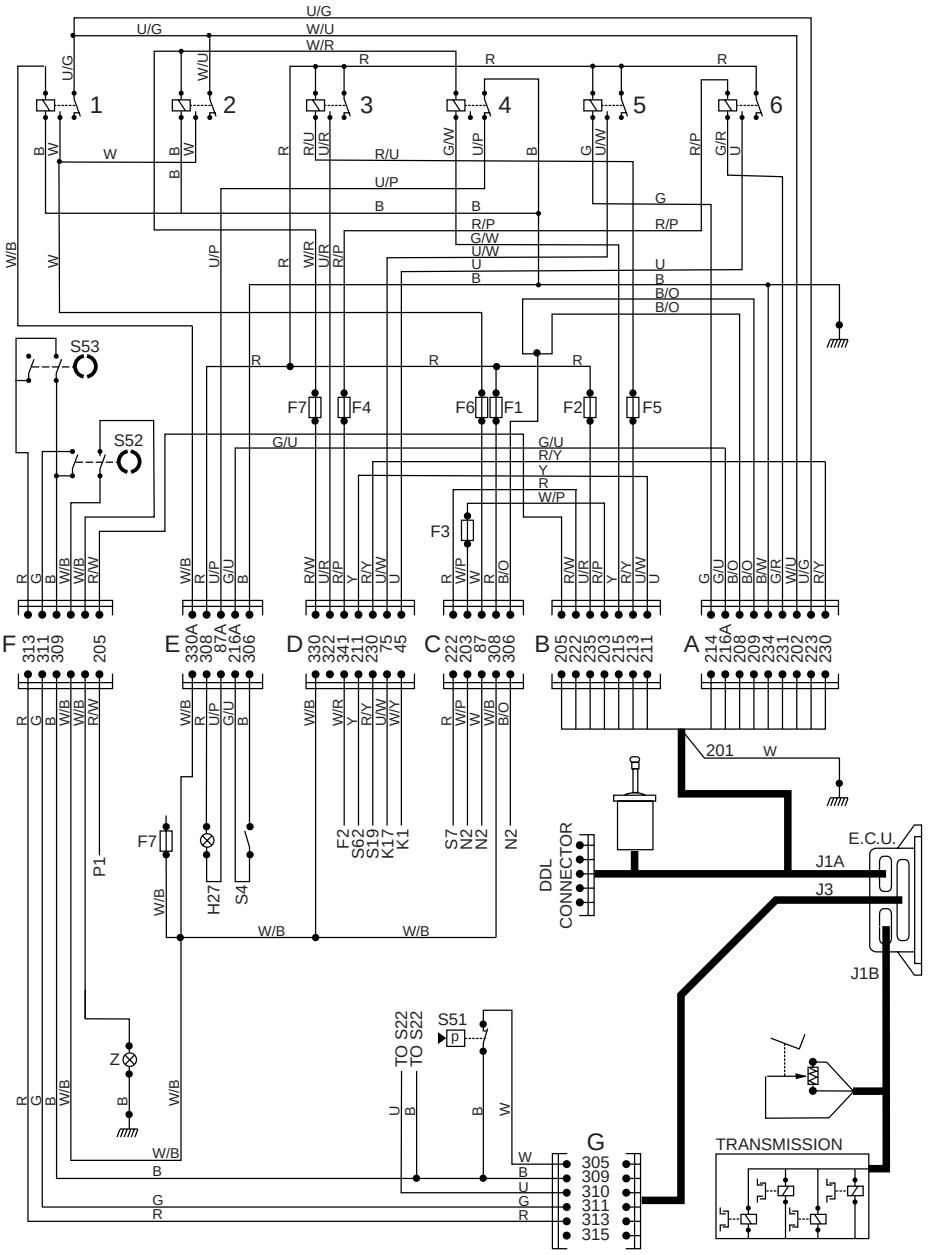


Fig. 2 - CEC Plus II and Interface Box Circuit Diagram

CEC COMPONENT DESIGNATIONS

F7 - 10 Amp Fuse - CEC (in fuse box)

H27 - Check Trans W/L

K1 - Starter Relay
K17 - Reverse Relay

N2 - Voltage Regulator

S4 - Test Switch
S7 - Park/Emergency Brake Switch
S19 - Dipswitch
S22 - Body Up W/light Switch
S51 - Reverse Hoist Pressure Switch
S52 - Manual Mode Keyswitch
S53 - Power/Economy Keyswitch
S62 - Retarder On Switch

INTERFACE BOX RELAYS

1 - ECU Initial Start
2 - ECU Supply
3 - Retarder (Not Used)
4 - Transmission Check
5 - Reverse Warning
6 - Neutral Start

INTERFACE BOX FUSES

1 - 8 Amp 5 - 5 Amp
2 - 5 Amp 6 - 8 Amp
3 - 8 Amp 7 - 5 Amp
4 - 5 Amp

WIRE COLOURS

B - Black O - Orange
N - Brown Y - Yellow
U - Blue P - Purple
R - Red W - White
G - Green S - Slate
L - Light Green

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⚠ WARNINGS

The ECU can be damaged by improper welding procedures.

⚠ Any time the battery equalizer is disconnected from the batteries, remove ground cable first, and reconnect last, to prevent damaging the component.

Note: When frame or other welding is required, the following procedure must be followed to protect the electronic components:

Turn ignition keyswitch to position '0' to shut down the engine and disconnect the batteries.

Disconnect battery equalizer ground connections from the batteries. Disconnect battery cables from terminal posts (ground cable first). Disconnect battery equalizer positive connections. Disconnect electrical connections at the ECU. On completion of all welding reconnect electrical connections in the reverse order to disconnections.

Note: Both 12 and 24 volt circuits are present in the CEC interface box. Extreme care must be taken, when making repairs to the system, to avoid damaging the ECU by introducing 24 volts into a 12 volt circuit.

Ecu Memory Power

The ECU draws 12 volts at a maximum of 10 milliamps (mA) continuously to store trouble codes and throttle position sensor calibration values. The ECU stores two trouble codes at a time in its memory. If the memory power is disconnected trouble codes and throttle position calibration values will be lost. Memory power must be reconnected, the engine started, and the vehicle may have to be put into operation, to restore trouble codes. Throttle position calibration values will be recalculated by the ECU when power is restored and engine started.

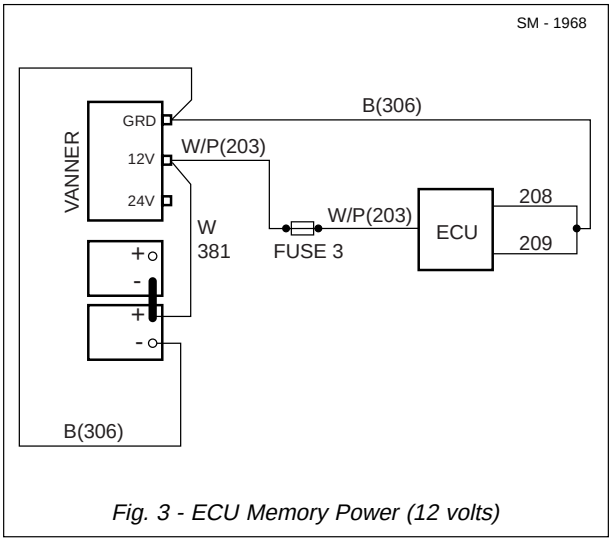


Fig. 3 - ECU Memory Power (12 volts)

Refer to Fig. 3. Current flows from the battery through lines 381, 203, Fuse 3 and line 203 to the ECU. The circuit is completed to ground through lines 208 or 209 and line 306.

Circuit Breakers

Refer to Fig. 4. When circuit breakers are switched 'ON' current (24 volts) flows through Fuse 1 and Line 308 to Relays 3, 5 & 6 and Check Trans indicator light. Current also flows through Fuse 2 and Line 235 to provide operating power for the shift selector. Circuits are completed to ground through ECU and Lines 208, 209 and 306.

Ignition Keyswitch

Refer to Fig. 5. When ignition keyswitch is turned to position '1', current (24 volts) flows through Cable 330A to Relay 1 and back to ground through Line 306, energising the solenoid. Solenoid in relay 1 closes switch, allowing current (12 volts) to flow through Line 87, Fuse 6, Switch and Lines 202A and 223A to the ECU. Circuit is completed to ground through Lines 208, 209 and 306.

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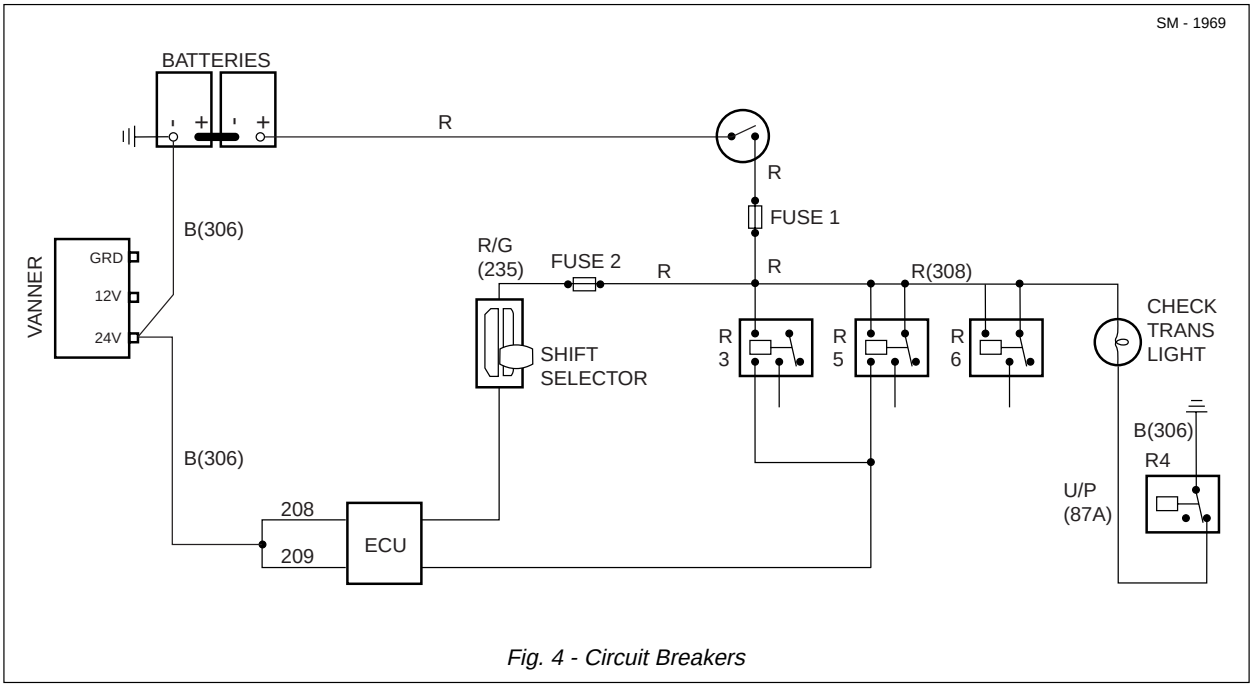


Fig. 4 - Circuit Breakers

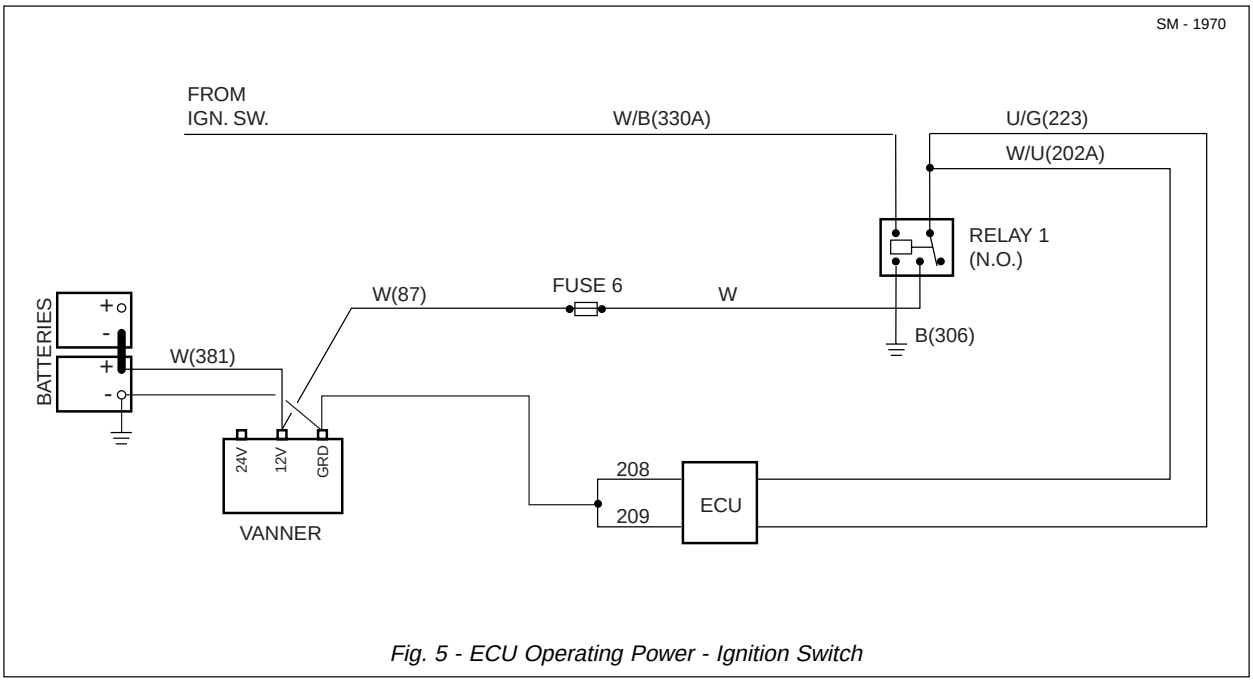


Fig. 5 - ECU Operating Power - Ignition Switch

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ECU Operating Power

Refer to Fig. 6. When the engine is started, current (24 volts) flows through Line 330 and Fuse 7 to Relay 2, energizing solenoid. Circuit is completed to ground through line 306. Solenoid in Relay 2 closes Switch allowing current (12 volts) to flow through Fuse 6, Line 87, Switch and Lines 202A or 223A to the ECU. Circuit is completed to ground through Lines 208 or 209 and Line 306.

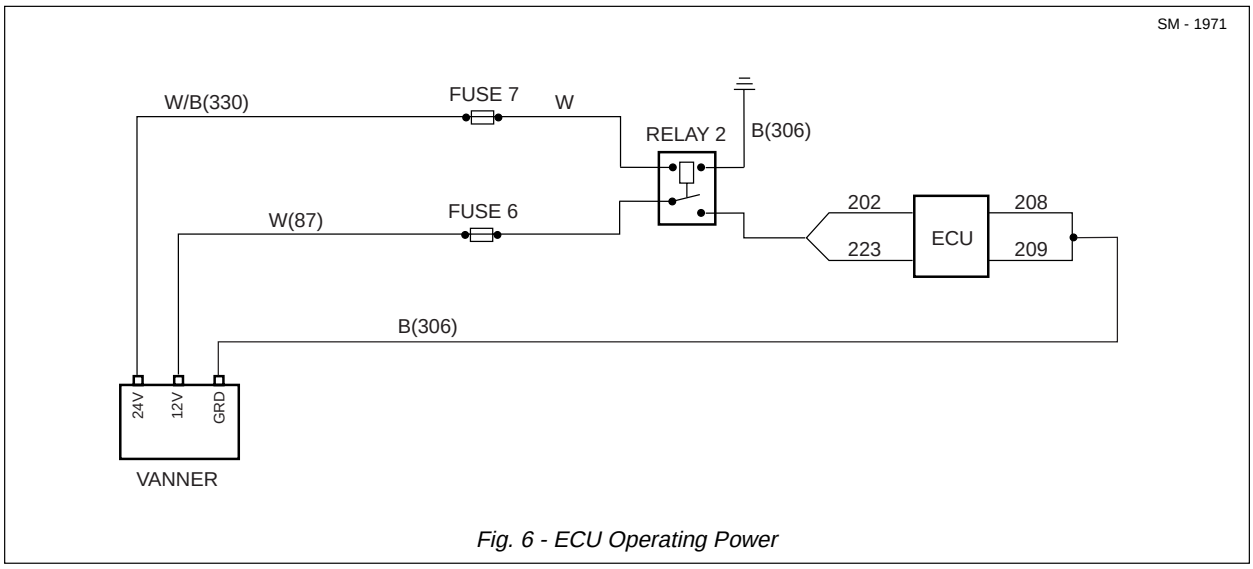


Fig. 6 - ECU Operating Power

Neutral Start Circuit

Refer to Fig. 7. The Neutral Start circuit prevents the engine from being started unless the shift selector is in Neutral position. When ignition keyswitch is turned to position '1', current (24 volts) flows through Line 341 and Fuse 4 to Relay 6, energizing solenoid. Current continues through Line 231 to shift selector, and goes to ground when selector is in Neutral through Line 210, ECU, Lines 208 or 209 and Line 306. Solenoid in Relay 6 closes Switch, allowing current (24 volts) to flow through Line 308, Switch and Line 45 to start solenoid. Refer to SECTION 190-0000, CIRCUIT DIAGRAMS for continuation of starter circuitry.

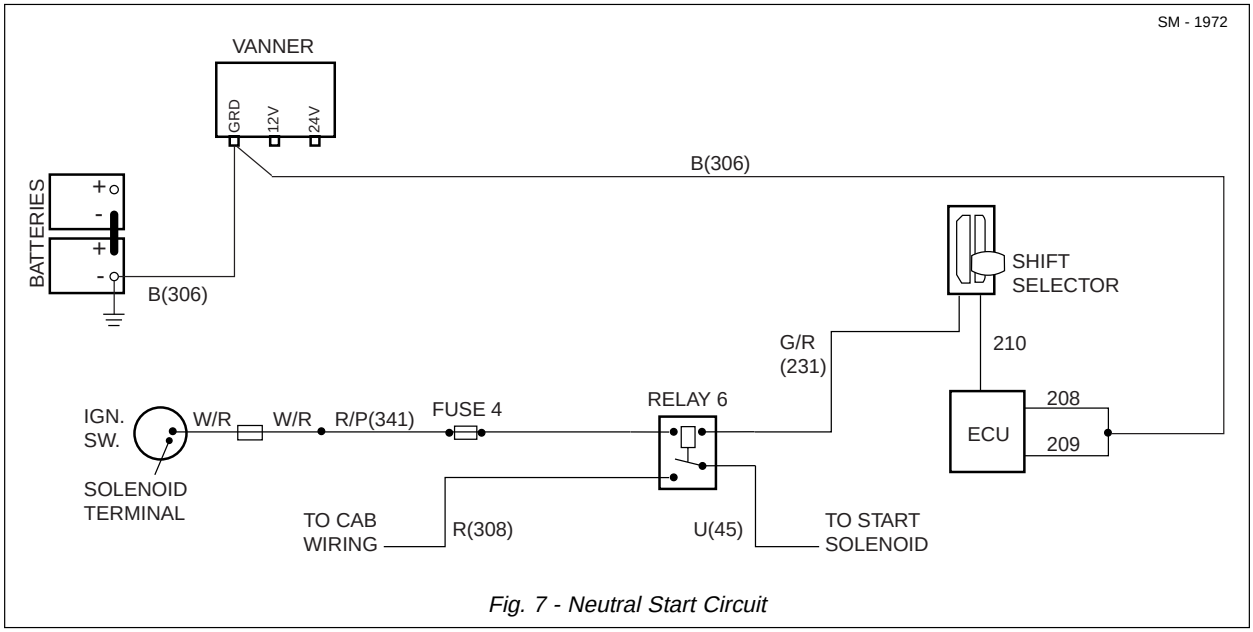


Fig. 7 - Neutral Start Circuit

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Check Trans Light

The Check Trans light has two functions: to warn the operator of a system failure and to flash trouble codes when the test switch is activated.

Normal Operation And Warning

Refer to Fig. 8. When the ignition keyswitch is turned to position '1', current (24 volts) flows through the circuit made by Fuse 1, Lines 308 and 87A, turning 'On' the Check Trans light.

When the engine is started, a switch in the ECU closes, allowing current (24 volts) to flow through the circuit made by Fuse 7, Lines 330, 215, 208 or 209 and 306. Relay 4 solenoid is energized, opening relay switch and turning 'Off' the Check Trans light.

Should the ECU detect a system failure, it will open internal switch, deactivating relay 4 solenoid. Relay switch closes, turning 'On' the Check Trans light to warn operator of failure.

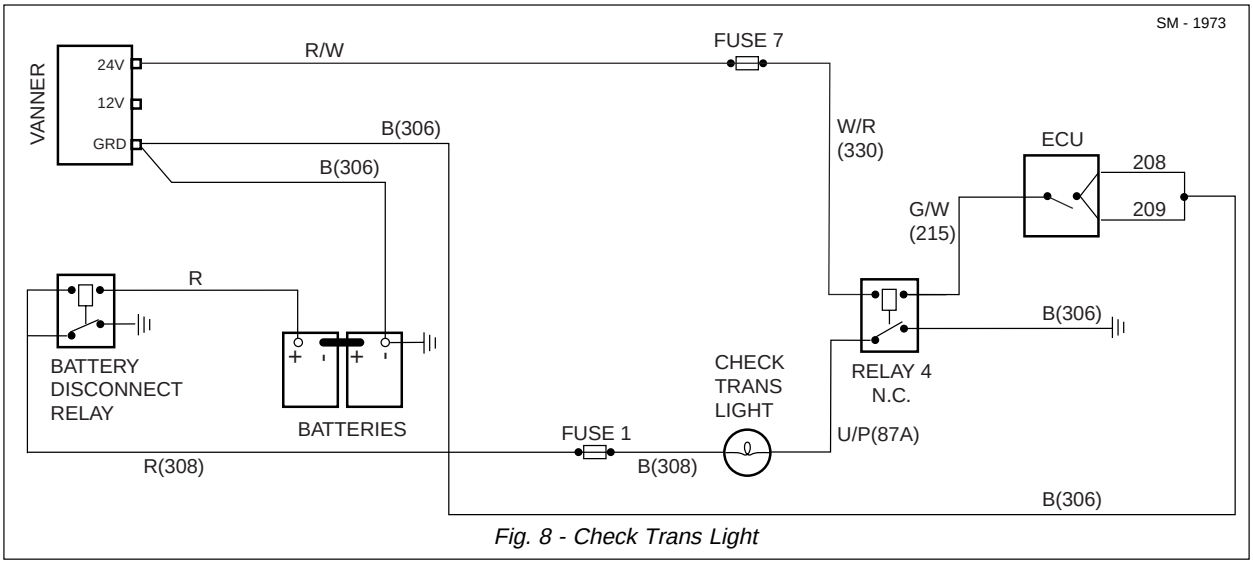


Fig. 8 - Check Trans Light

Obtaining Trouble Codes With Test Switch

Refer to Fig. 9. When the test switch is depressed, circuit to ground from ECU through line 216A and 306 is completed, signalling ECU to supply diagnostic codes to Check Trans light. When test switch is depressed, ECU closes internal switch, energizing relay solenoid which opens relay switch, turning Check Trans light off. ECU opens and closes internal switch to flash trouble codes with Check Trans light. The engine must be running.

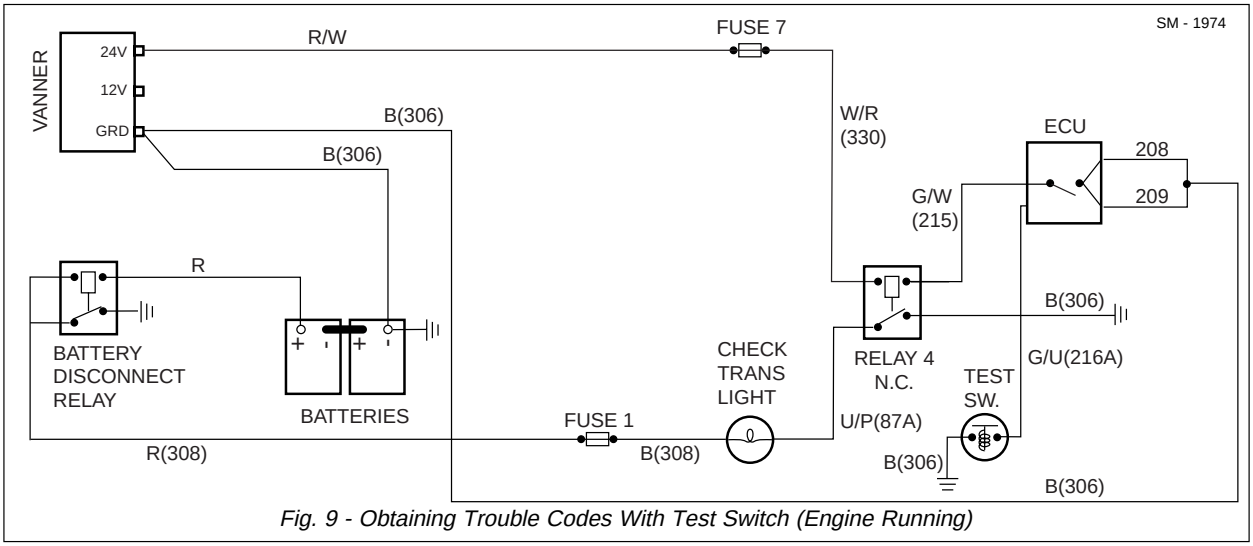


Fig. 9 - Obtaining Trouble Codes With Test Switch (Engine Running)

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Reverse Alarm

Refer to Fig. 10. When the shift selector is placed in Reverse, ECU closes circuit allowing current (24 volts) to flow through Line 308 and Fuse 1 to Relay 5, energizing solenoid. Current flows through Line 214 to ECU and back to ground through Lines 208 or 209 and Line 306. Solenoid closes Switch, allowing current to flow through Line 308, Switch and Line 75 to reverse alarm. Refer to SECTION 190-0000, CIRCUIT DIAGRAMS for continuation of Reverse Alarm circuitry.

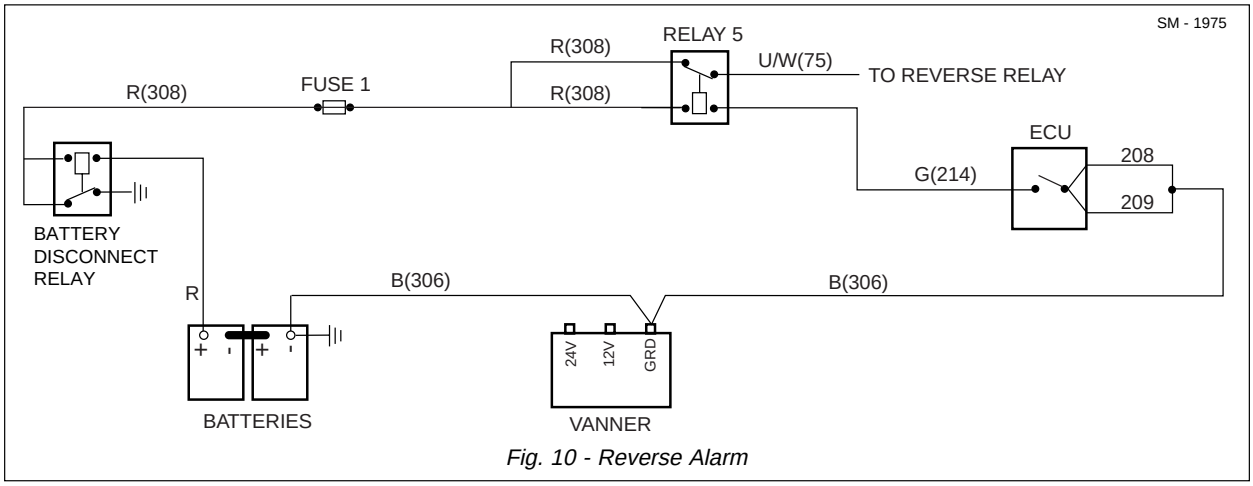


Fig. 10 - Reverse Alarm

Reverse Hoist Pressure Switch

Refer to Fig. 11. The Reverse Hoist Pressure switch is a safety feature to prevent the vehicle from backing up while the body is being raised. Current from the ECU flows through line 305, microswitch and line 309. If pressure switch is opened by the body control valve being moved to the 'Raise' position, current is interrupted and ECU will shift transmission to Neutral. To obtain Reverse again, switch must be opened and shift selector must first be placed in Neutral or a forward range. This interlock will not prohibit shifts to a forward range while body is being raised.

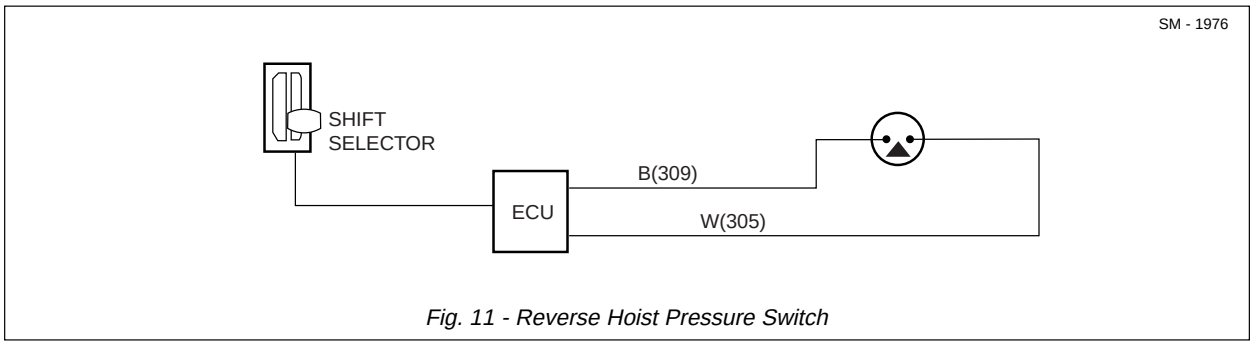


Fig. 11 - Reverse Hoist Pressure Switch

Parking Brake Interlock

Refer to Fig. 12. The Parking Brake Interlock prevents a shift out of Neutral when the parking brake is applied. When the parking brake is applied, switch opens, breaking the circuit to ground. The ECU then prevents a shift out of Neutral. This interlock will not inhibit shifting if the parking brake is applied while the transmission is operating in reverse or any forward range.

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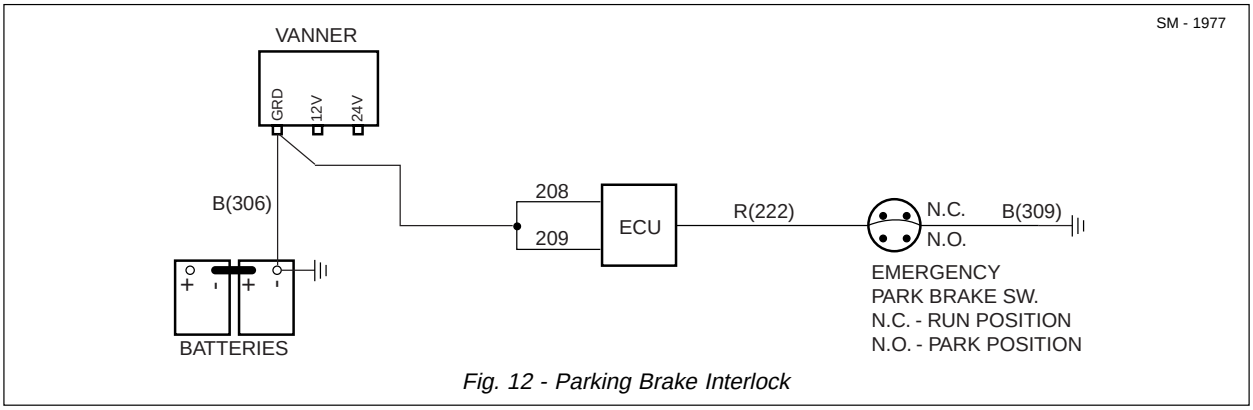


Fig. 12 - Parking Brake Interlock

Body Up Interlock

Refer to Fig. 13. When the body is raised off the chassis, the proximity switch opens to complete the circuit through Lines 309 and 310 to the ECU. The ECU then prevents the transmission from shifting above 1st gear until the body is lowered and the proximity switch closes.

Note: CEC wires B (309) and U (310) are 12 volt and P/G and P/R wires for the body up circuit are 24 V. Improper connection of wires could lead to CEC damage.

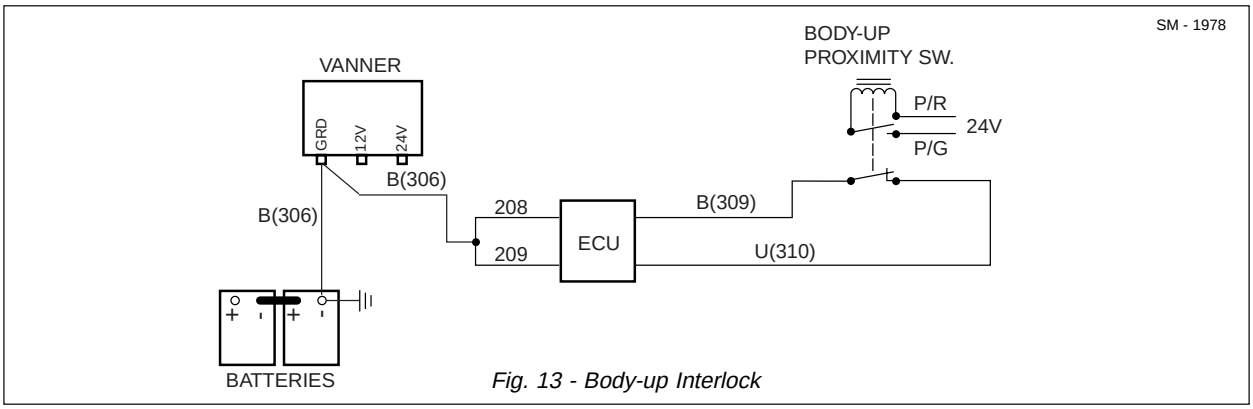


Fig. 13 - Body-up Interlock

Shift Selector Illumination

Refer to Fig. 14. When the panel light switch is closed, current (24 volts) flows through Line 230 to the shift selector. Lamps are 12 volts, wired in series, so that if one bulb burns out, both lamps will cease functioning. Circuit is completed to ground through lines 234 and 147 to the panel ground.

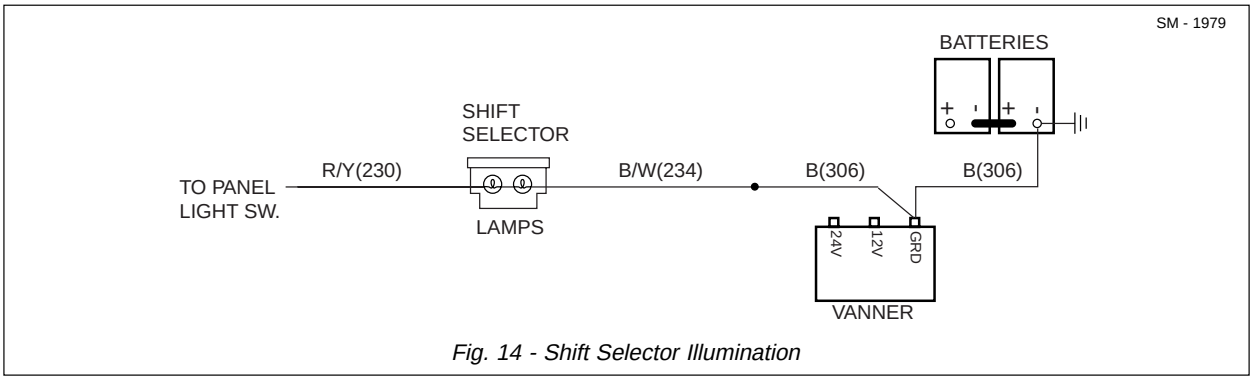


Fig. 14 - Shift Selector Illumination

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ECU Electromagnetic Shield - Ground

Refer to Fig. 15. Must be grounded to protect ECU.

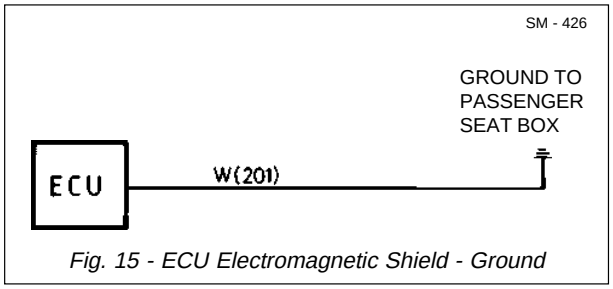


Fig. 15 - ECU Electromagnetic Shield - Ground

Mode Selection Switch

Refer to Fig. 16.

1. With mode selection switch in Economy (open) position, ECU will control transmission as per the Economy mode shift schedule.

2. With mode selection switch in Power (closed) position, Lines 313 and 315 are connected to Line 309 and the ECU will then control the transmission as per the Power mode shift schedule.

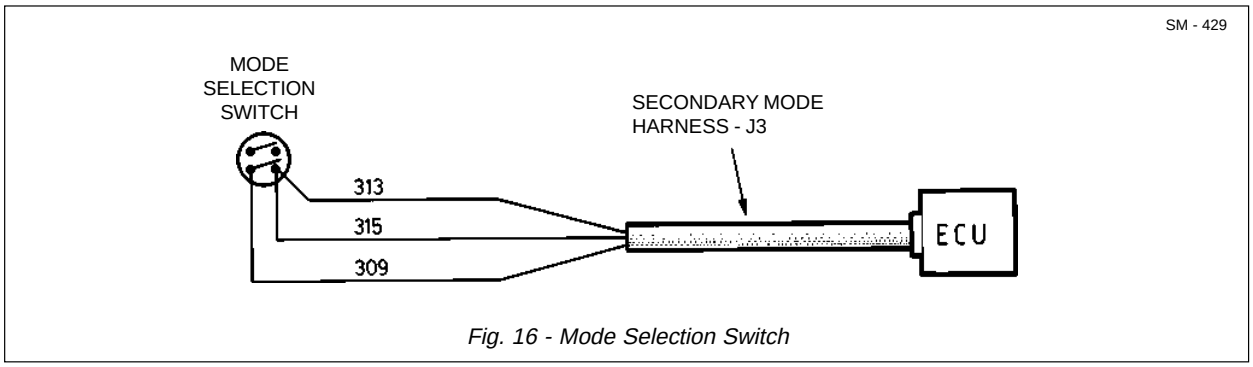


Fig. 16 - Mode Selection Switch

Manual Mode Switch

Refer to Fig. 17.

1. With ignition keyswitch at position '2' and manual mode switch 'On' (closed) indicator light on console will illuminate.

2. When mode selection switch is in the Power (closed) position and manual mode switch is in the 'On' (closed) position, Lines 311, 313 and 315 are all connected to Line 309 and ECU will change operation of transmission from automatic to manual.

Note: Both switches must be closed and transmission in neutral to obtain manual mode.

Note: CEC wires B (309) and 311 are 12 volt and W/B wires at manual mode switch are 24 V. Improper connection of wires could lead to CEC damage.

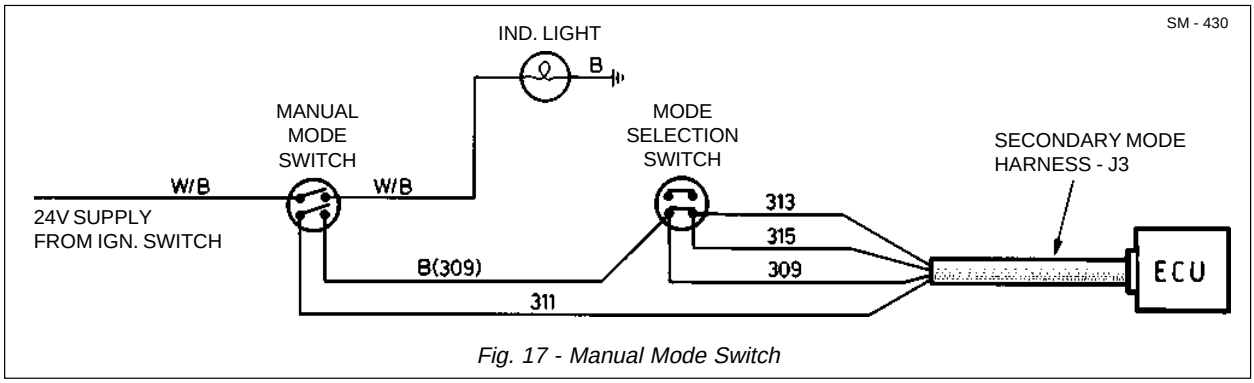


Fig. 17 - Manual Mode Switch

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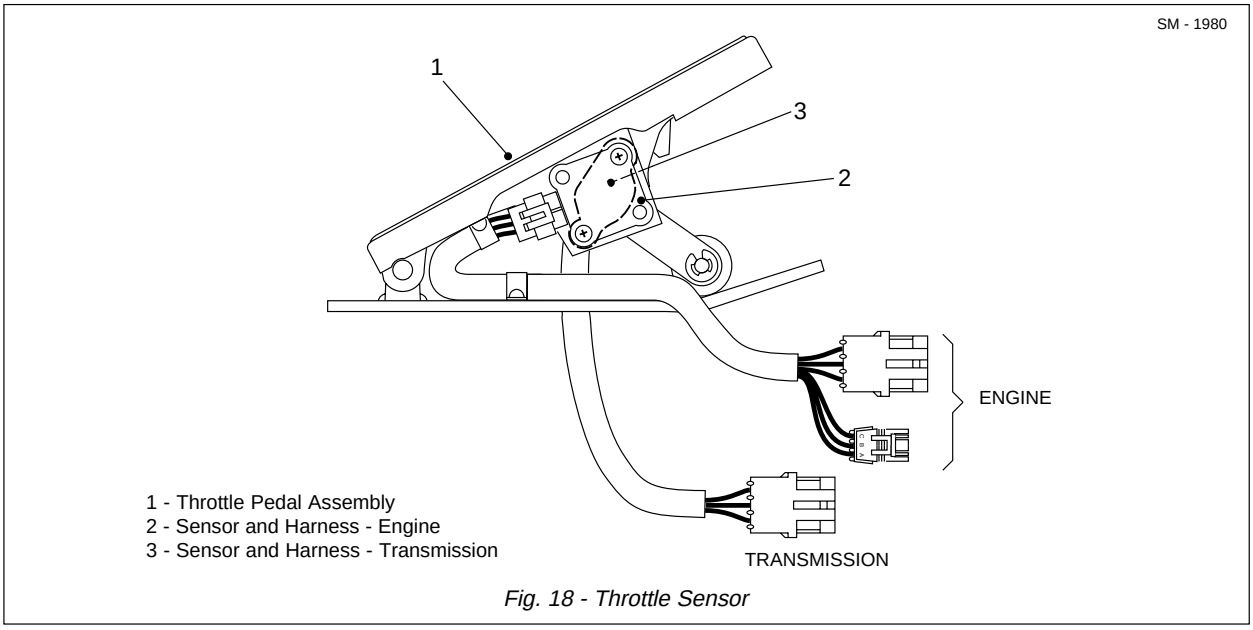


Fig. 18 - Throttle Sensor

VALVE BODY SOLENOIDS

The hydraulic circuits and valves within the electro-hydraulic valve bodies are controlled by continuous power solenoids. The solenoids are located in separate valve bodies and they shift the valve spools to direct hydraulic oil to the various clutch packs within the transmission.

TEMPERATURE SENSOR

Temperature Sensor is mounted in the lockup valve body cover. The ECU constantly monitors transmission oil temperature and will not permit shifts to occur when the oil temperature is -24° C (-10° F) or below. At this temperature, operation is restricted to Neutral and both the Do Not Shift and Check Trans lights will be on. From -22° C (-9° F) to -7° C (+19° F) operation will be restricted to Neutral, First and Reverse. Once transmission oil temperature reaches 121° C (250° F) the Check Trans light will come on and the ECU will restrict operation to Reverse, Neutral and First through Fourth gears. Temperatures can easily exceed 121° C (250° F) when the retarder is being used to help slow the vehicle while descending grades. When the oil temperature falls below 121° C (250° F) the Check Trans light will go off. Refer to Section 190-0270, SWITCHES AND SENSORS.

ELECTRONIC FOOT PEDAL

Refer to Fig. 18. The dual control electronic foot pedal provides an electronic signal to the engine's fuel control system in proportion to the degree of pedal actuation, an electronic signal is also sent to the transmission ECU.

Note: The electronic controlled engine will override the electronic foot pedal position until the engine is warmed up to the correct operating temperature. The engine MUST be started with the foot 'OFF' the electronic foot pedal.

The control system continually monitors the engine and warns the operator when a problem develops. The system also takes action to prevent damage to the engine and provides the serviceman with diagnostic capabilities. Refer to Section 110-0030, ENGINE AND MOUNTING.

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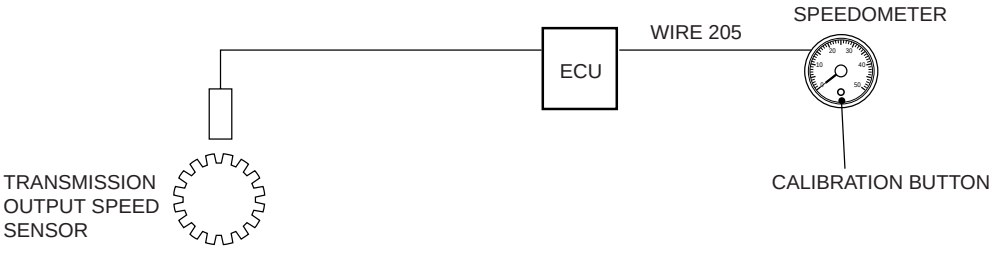


Fig. 19 - Electronic Speedometer Output

Speedometer/Odometer

Refer to Fig. 19. Driven by a signal from the CEC, the speedometer indicates travel speed in kilometers per hour and miles per hour. A digital odometer is incorporated in the speedometer to record the distance travelled by the vehicle at any given time.

Speedometer Calibration Table - All units with standard tyres		
Unit	Transmission	Pulses
TR35	CBLT-754	20200
TR40	M5600A	188600
TR45	M5600A	188600
TR60	M6600AR	208580
TR70	M6600AR	208580
TR100	DP-8963	249120

Speedometer Calibration

1. Determine the impulses/mile required. Reference speedometer calibration table.

2. Depress and hold calibration button on the speedometer and turn the ignition keyswitch to position '1'.

3. Release button when PULSE is displayed. The second digit will flash. Depress the button until the desired number is displayed the release the button for a few seconds until the next digit flashes.

4. Repeat step 3 to obtain the desired impulses/mile. After a few seconds only two digits will be displayed. The speedometer is now calibrated.

Transmission Output Speed Sensor

This is installed in the transmission rear cover. The sensor should be screwed in until it makes contact with the output gear and then backed out 3/4 turn and locked into place with the jam nut. Tighten the jam nut to 17 - 21 Nm (13 - 16 lbf ft). Refer to Section 190-0270, SWITCHES AND SENSORS.

Hoist Interlock Pressure Switch

Located in a tee installed in body hoist control valve. The hoist interlock is a safety feature to prevent the vehicle from backing up while the body is being raised. If the pressure switch is opened by the body control joystick being moved to the 'Raise' position, current is interrupted and the ECU will shift the transmission to Neutral. To obtain reverse gear whilst the body is held in the raise position, move the transmission shift lever to Neutral, then re-select reverse gear. This interlock will not prohibit shifts to a forward range while the body is being raised. Refer to Section 190-0270, SWITCHES AND SENSORS.

TROUBLESHOOTING

The ECU is a small computer with operating limits programmed into its memory. Whenever the ECU detects a condition which falls outside those limits, or a malfunctioning component, the Check Trans light, or Do Not Shift lights will be activated and a trouble code stored in the ECU's memory. Two soft codes (indicating problems which may inhibit but not prevent operation) or two hard codes (indicating problems which will limit or prevent operation), or one of each, can be stored in the memory at one time. The trouble codes identify which circuit the problem is in. The circuits consist of a component such as a solenoid, the applicable wiring harness and the ECU.

Both the Check Trans and Do Not Shift lights will come 'On' when the ignition keyswitch is turned to position '1'. The Check Trans light will stay on until the engine

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is started. The 'Do Not Shift' lights will go 'Off' when the ignition is switched on, unless the ECU has detected a failure in the system. Depressing the test button when the engine is running, will turn 'Off' the Check Trans light and call up a trouble code, if one is present. In the case of an intermittent problem, such as a line which shorts to ground occasionally due to vehicle movement, the lights may go on and off, but a trouble code will remain stored in the memory.

In an electronic system such as the CEC system, it is extremely important that connections at terminal blocks, grounds to vehicle frames, and all connectors be clean and secure. Connectors may be cleaned with a good quality solvent which does not conduct electricity and evaporates quickly (See Special Tools). Excess solvent should be shaken out or gently blown out with compressed air after cleaning.

FINDING TROUBLE CODES

Check Trans Light

Running the engine and depressing the test switch will cause the ECU to enter the diagnostic mode. The ECU will cause the Check Trans light to flash a trouble code, if present.

For example: FLASH - PAUSE - FLASH - FLASH - FLASH - LONG PAUSE denotes a Code 13.

If more than one trouble code is stored in the memory, the most important code will be flashed first. The problem indicated by the first code must be corrected and the code cleared from the memory before another code can be found.

Diagnostic Data Reader

Using a diagnostic data reader, both codes can be found at the same time. Plugging the diagnostic data reader into the Digital Data Line (DDL) connector (12, Fig. 1) under the dash panel, on the steering column mounting bracket, will automatically cause the ECU to enter the diagnostic mode. Ignition keyswitch must be turned to position '1'.

CLEARING TROUBLE CODES

Trouble codes should always be cleared from the ECU memory after repairs are made. To clear the trouble codes, make sure the ignition keyswitch is turned to position '1', depress the test switch, shift into Reverse and wait a few seconds, then shift back to Neutral. If the codes do not clear, turn the ignition keyswitch is turned to position '0', then back to position '1 and shift into Reverse and back to Neutral. If the codes are still present, the problem has not been corrected.

Note: After clearing a Code 21 (Throttle Position Sensor) the ignition keyswitch may have to be turned 'On' and 'Off' as many as five times to reset the self calibration feature of the throttle position sensor.

The following diagnostic procedures are a summary of troubleshooting procedures given in the Allison Commercial Electronic Control (CEC) Troubleshooting Manual SA 2712A. This manual contains detailed step by step procedures for diagnosing and correcting problems indicated by the trouble codes.

It is essential that the serviceman has an accurate Volt-Ohm Meter (VOM) in order to correctly diagnose problems in the CEC system.

Fig. 20 is an electrical circuit view showing the terminal numbers and wire numbers for the CEC J1A, J1B and J3 harnesses connecting the various components of the system.

Fig. 21 shows the locations of the terminals in Fig. 20 in their connectors. Check for intermittent shorts or open circuits by moving harnesses with VOM probes connected to the applicable terminals. For step-by-step procedures for finding shorts or open circuits in harnesses or components, refer to Allison Commercial Electronic Control (CEC) Troubleshooting Manual SA 2712A.

Note: Both 12 and 24 volt circuits are present in the control box interface. Extreme care must be taken, when making any repairs to the system, to avoid damaging the ECU by introducing 24 volts into a 12 volt circuit.

When troubleshooting leads to replacement of the ECU, always check for an over voltage condition. If too high a voltage damaged the ECU and the condition is not corrected the replacement ECU may also be damaged.

Voltage limits for the ECU are:

9 volts - minimum
16 volts - continuous
18 volts - 10 minutes
24 volts - 2 minutes

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⚠ WARNINGS

To prevent any unexpected shift during removal of wiring harnesses, shut down engine and switch 'OFF' both circuit breakers.

⚠ Be sure to apply the parking brake, shut off the engine and block all road wheels before any troubleshooting of the main valve body solenoids. Accidental activation of a solenoid while the engine is running could cause the vehicle to run away.

Code 13 - Low Battery Voltage

System Response:

1. If transmission is in neutral, Check Trans and Do Not Shift lights will come on. If forward or reverse is selected, shift will not occur.

2. If transmission is in forward or reverse and a shift is made, the code will be set in memory and no lights will come on. Shifts may be erratic or not made.

Probable Cause:

a. Insufficient voltage supplied to ECU.
b. Intermittent open circuit on power to ECU.
c. Intermittent or partial short to ground on power to ECU.

Remedy:

1. Check battery voltage with VOM. Fully charged batteries should measure 28 ± 1 volt.

2. Check vehicle charging system. With engine running, voltage regulator should put out 28 volts. Charge and recheck batteries.

3. Refer to Fig. 2. Check circuits supplying power to ECU through interface.

4. Input voltage to ECU can be checked with a digital analyser. Input voltage should be 10.5 - 16 volts. Place load on batteries by turning on all vehicle accessories and recheck input voltage. If input voltage is within limits and Code 13 recurs, replace ECU. If input voltage is not within limits check all connections between battery and ECU.

Code 21 - Throttle Position Sensor

System Response:

When sensor is stroked into error zone, the Check Trans light will come on. ECU will assume 100% throttle. Shift will occur at either closed throttle or full throttle points.

Probable Cause:

a. Throttle sensor failure.
b. Shorts or open circuits in harness wiring.

Remedy:

1. Check cable for binding.

2. Connect VOM probes to sensor terminals A & C (L, Fig. 21). If reading is not between 9 000 and 15 000 ohms replace sensor.

3. Connect VOM probes to sensor terminals A & B (L, Fig. 21). Stroke sensor slowly from closed to full throttle position and back. If VOM reading does not increase smoothly from at least 500 ohms to 15 000 ohms, replace sensor.

4. Connect one VOM probe to vehicle ground, other to sensor terminals A, B & C. VOM meter should not record continuity.

5. Check J1B harness wiring for shorts or open circuits.

6. If fault cannot be located, replace ECU.

Code 22 - Transmission Output Shaft Speed Sensor

System Response:

The Check Trans and Do Not Shift lights will come on. All shifts will be prevented and lockup clutch disengaged. If this happens due to wheel lockup (panic braking) or wheel spinning, the engine must be shut down, ignition keyswitch turned to position '0' and then back to position '1', engine restarted, and Neutral, Reverse and Neutral selected to reset ECU.

Probable Cause:

a. Sensor failure.
b. Open circuit or short in harness wiring.
c. Dirty or loose connections.
d. Sensor not adjusted properly in rear cover.
e. Unusually rapid deceleration, or wheel spinning.

Remedy:

1. Check speed sensor to ensure that it is properly threaded into rear cover, adjusted, and locked into place with jam nut.

2. Connect VOM probes to sensor terminals A & B (M, Fig. 21). If VOM reading is less than 50 ohms or greater than 200 ohms, replace sensor.

3. Connect one VOM probe to transmission housing, other to terminal A, then B. VOM meter should not record continuity.

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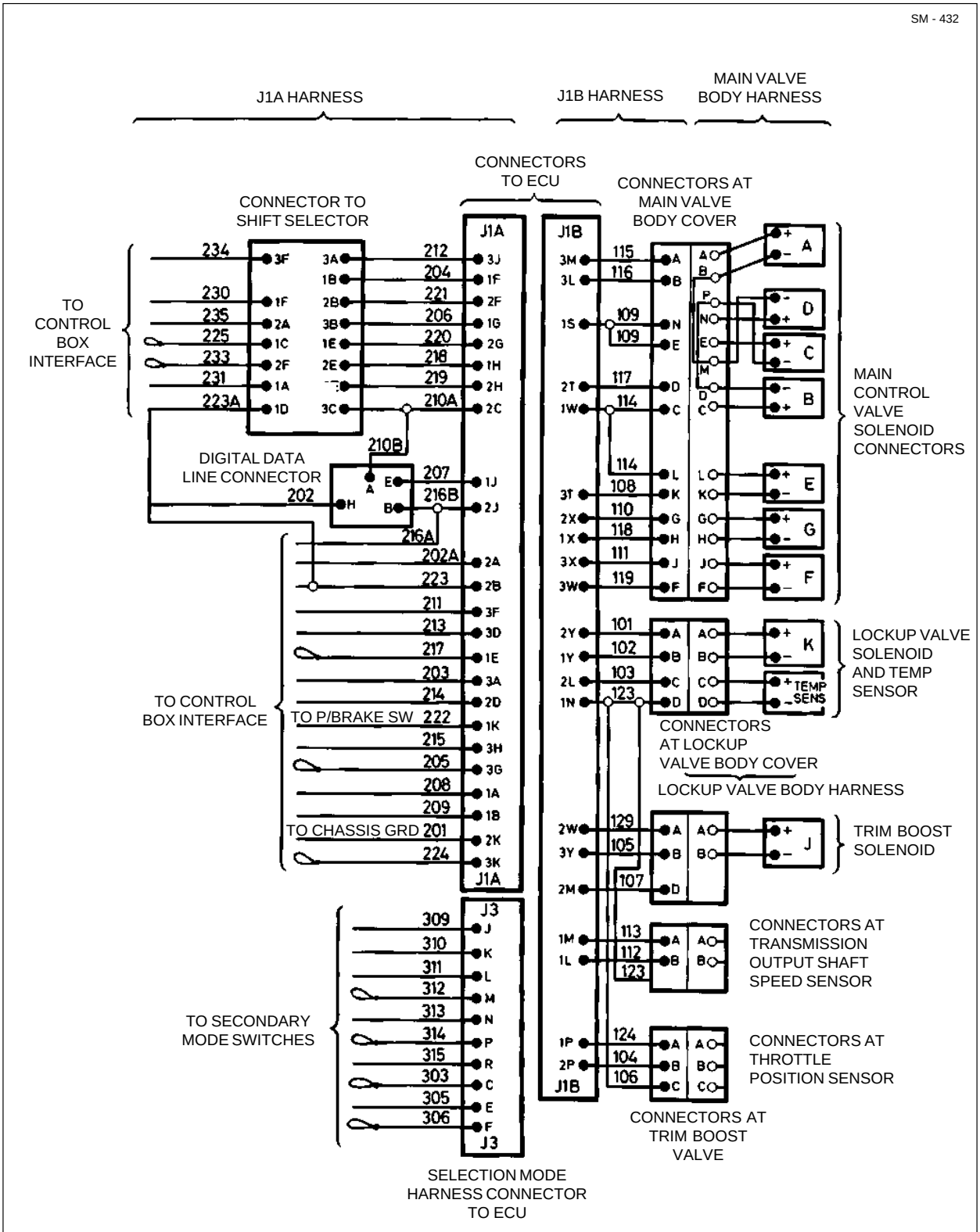
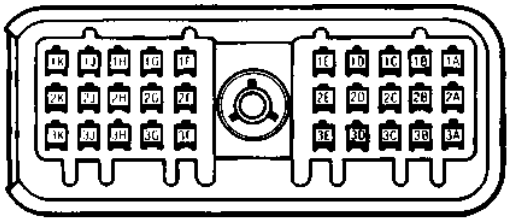


Fig. 20 - Electrical Circuit - J1A, J1B and J3 Harnesses

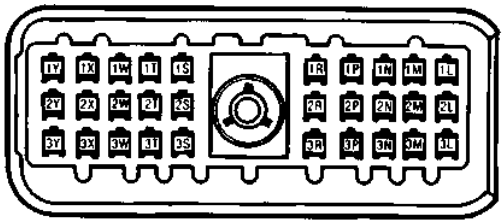
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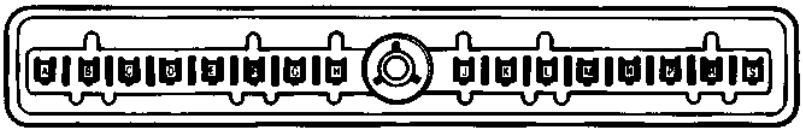
SM - 433



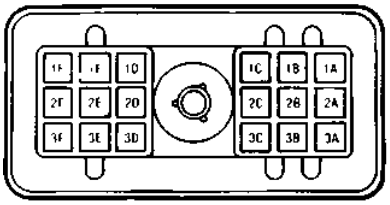
A - J1A HARNESS CONNECTOR TO ECU



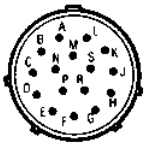
B - J1B HARNESS CONNECTOR TO ECU



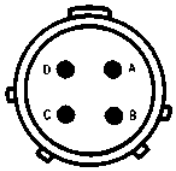
C - J3 HARNESS CONNECTOR TO ECU



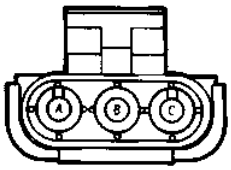
D - J1A HARNESS CONNECTOR TO SHIFT SELECTOR



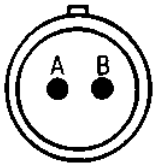
E - J1B HARNESS CONNECTOR TO MAIN VALVE BODY



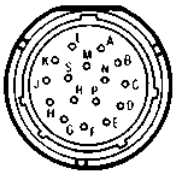
F - J1B HARNESS CONNECTOR TO LOCKUP VALVE BODY



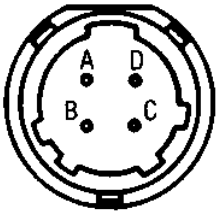
G - J1B HARNESS CONNECTOR TO THROTTLE POSITION SENSOR



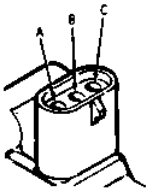
H - J1B HARNESS CONNECTOR TO TRANS OUTPUT SHAFT SPEED SENSOR



J - MAIN VALVE BODY HARNESS CONNECTOR



K - LOCKUP VALVE BODY CONNECTOR



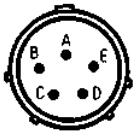
L - THROTTLE POSITION SENSOR CONNECTOR



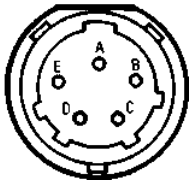
M - SPEED SENSOR CONNECTOR



N - DIGITAL DATA LINE CONNECTOR - J1A HARNESS



1/2 SHIFT/TRIM BOOST VALVE BODY CONNECTOR



J1B HARNESS CONNECTOR TO 1/2 SHIFT/TRIM BOOST VALVE

Fig. 21 - Harness Connectors

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4. Check J1B harness wiring for shorts or open circuits.

5. If fault cannot be located, replace ECU.

Code 23 - Shift Selector

System Response:
The Check Trans light will come on. Last good command from the shift selector will be used. Shifting may still occur up to and including the range selected.

Probable Cause:
a. Shift selector failure
b. Shorts or open circuits in harness wiring.

Remedy:
1. Check J1A harness connectors at the shift selector and ECU.

2. Check for shorts or open circuits in J1A harness wiring. Refer to Fig. 20 for applicable terminals and wire numbers.

3. If fault cannot be found using steps 1 & 2, install a new shift selector and reconnect all harness connectors. Test drive the vehicle and check for presence of trouble code. If trouble code recurs, replace new shift selector with old, check connectors and wiring again. If trouble code is still present, replace ECU.

Code 24 - Oil Temperature

System Response:
1. Below -23° C (-10° F), Check Trans and Do Not Shift lights will come on. Transmission will not shift out of Neutral. Code will NOT be set in memory. Warming oil to above -23° C (-10° F) will turn off lights.

2. Between -23° C (-10° F) and -7° C (20° F), operation is limited to Reverse, Neutral and First gears. No lights will come on. No code is set in memory. Warming oil above -7° C (20° F) will allow normal shifting.

3. Above 121° C (250° F), Check Trans light will come on and shifts to Fifth or Sixth gear will not be permitted. Code will be set in memory. Light will go off when oil temperature falls below 121° C (250° F).

Probable Cause:
a. Transmission oil temperature too high.

Remedy:
1. Check transmission oil level with engine at idle.

2. Check engine coolant temperature.

3. Check oil cooler and lines for blockage.

4. Stop vehicle, run engine at high idle until temperature drops.

Code 33 - Temperature Sensor

System Response:
If oil temperature is above 204° C (350° F) or below -73° C (-100° F), the Check Trans light will come on and code set in memory.

Probable Cause:
a. Sensor failure.
b. Oil temperature too hot or too cold.
c. Short or open circuit in harness wiring.

Note: A CODE 33 may erase a previously diagnosed CODE 24.

Remedy:
1. Check transmission oil level.

2. Check cooling system.

3. Connect VOM probes to pins C & D on lockup valve body connector (K, Fig. 21). VOM reading should be 5 000 to 130 000 ohms.

4. Connect one VOM probe to pin C, other to lockup valve body. VOM meter should not record continuity.

5. Check J1B and lockup valve body harness wiring for shorts or open circuits.

6. If fault cannot be located, replace ECU.

Code 34 - PROM Check

System Response:
If the ECU detects a CODE 34 condition, the Check Trans and Do Not Shift lights will come on, all shifts will be prevented, and the lockup clutch will be disengaged.

Probable Cause:
PROM not in socket, installed incorrectly, or wrong or faulty PROM installed.

> ⚠ **WARNING**
> **Only authorised warranty outlets are permitted to open the PROM access cover. Warranty may be void if opened by unauthorized personnel.**

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Remedy:
Install new ECU, send old ECU to authorized service centre for repair or replacement of PROM.

Codes 41 Thru 45 - Solenoids A Thru E

System Response:
1. If output shaft speed is over 500 rev/min, the Check Trans and Do Not Shift lights will come on, all shifts will be prevented and lockup clutch will be disengaged.

2. If output shaft speed is under 500 rev/min, the Check Trans light only will come on. Shifts will not be blocked unless speed is increased above 500 rev/min and condition is still present.

Probable Cause:
a. Failed solenoid.

b. Shorts or open circuits in J1B or main valve body harness.

Note: Solenoids in main valve body are lettered A, B, C, D, E, F and G from left to right.

Remedy:
1. Disconnect J1B harness from main valve body connector. Connect VOM probes to pins in main valve body connector corresponding to solenoid indicated by trouble code. Refer to Figs. 20 & 21. VOM should read 12 - 24 ohms.

2. Check J1B harness for shorts or open circuits in circuits corresponding to solenoids indicated by trouble code if correct reading was obtained in Step 1.

3. If in Step 1 VOM reading was not within limits, remove main valve body cover and disconnect harness from solenoid indicated by trouble code. Connect VOM probes to solenoid terminals. If VOM reading is not 12 - 24 ohms, replace solenoid.

4. If in Step 3 VOM reading was within limits, check main valve body harness for shorts or open circuits in circuits corresponding to solenoid indicated by trouble code.

Code 51 - Lockup (K) Solenoid and, Code 52 - 1-2 Shift Solenoid (H) or Trim Boost (J) Solenoid

System Response:
Either code will cause the Check Trans light to come on. When a CODE 51 is present the lockup clutch will either not function at all or only intermittently, depending on the problem.

When a CODE 52 is present, the trim boost solenoid will either not function at all or only intermittently, resulting in a loss of power in Reverse or lower forward gear range.

Probable Cause:
a. Failed solenoid.

b. Shorts or open circuits in J1B or main valve body harnesses.

Remedy:
1. Disconnect J1B harness from lockup valve body connector or trim boost valve body connector. Connect VOM probes to pins in valve body connector to which K or J solenoid is connected. Refer to Figs. 20 & 21. VOM should read 12 - 24 ohms.

2. Check J1B harness if correct reading was obtained in Step 1 for shorts or open circuits in circuits applicable to K solenoid.

3. If in Step 1 VOM reading was not within limits, remove lockup valve body cover or trim boost valve body cover and remove connector from solenoid. Connect VOM probes to solenoid terminals. If VOM probes to solenoid terminals reading is not 12 - 24 ohms, replace solenoid.

4. If in Step 3 VOM reading was within limits, check lockup valve body or trim boost valve body harnesses for shorts or open circuits.

Code 54 - Solenoid Chain (A, B, C, D & E))

System Response:
The Check Trans and Do Not Shift lights will come on, all shifts will be prevented and the lockup clutch will be disengaged.

Probable Cause:
a. Failed solenoid.

b. J1B harness not properly connected to main valve body harness connector.

c. Short or open circuit in J1B or main valve body harness.

Remedy:
1. Check to ensure J1B harness is properly connected to main valve body harness connector and that connectors are clean.

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2. Remove J1B harness from main valve body harness connector. Connect VOM probes to pins corresponding to Solenoids A thru E in turn. Refer to Figs. 20 & 21 for correct pins. VOM should read 12 - 24 ohms for each solenoid.

3. If correct reading was obtained from all solenoids in Step 2, check J1B harness circuits for shorts or open circuits.

4. If incorrect reading was obtained for one or more solenoids in Step 2, remove valve body cover and disconnect harness from solenoids in question. Connect VOM probes to solenoid terminals and check for correct reading of 12 - 24 ohms. If problem is not in solenoid check main valve body harness for shorts or open circuits.

Note: Solenoids in main valve body are lettered A, B, C, D, E, F and G from left to right.

Code 61/63 - Splitter High Solenoid (G)

System Response:
1. Below 500 rev/min, the Check Trans light only will come on. Shifts may not occur.

2. Above 500 rev/min, the Check Trans and Do Not Shift lights will come on, all shifts will be prevented and the lockup clutch will be disengaged.

Probable Cause:
a. Failed solenoid.

b. Short or open circuit in J1B or main valve body solenoid.

Remedy:
Use same procedure for checking 'G' solenoid as shown for Codes 41 thru 45 (A thru E Solenoids).

Code 62 - Splitter Low Solenoid (F)

System Response:
1. Below 500 rev/min, the Check Trans light only will come on. Shifts may not occur.

2. Above 500 rev/min, the Check Trans and Do Not Shift lights will come on and all shifts will be prevented.

Probable Cause:
a. Failed solenoid.

b. Short or open circuit in J1B or main valve body harness.

Remedy:
Use same procedure for checking 'F' solenoid as shown for Codes 41 thru 45 (A thru E Solenoids).

Code 69 - ECU Test (Software Error)

System Response:
ECU will turn itself off. The Check Trans and Do Not Shift lights will come on, all shifts will be prevented, and the lockup clutch disengaged.

Probable Cause:
Error in software (programming) inside ECU which prevents normal operation of shift system.

Remedy:
1. Replace ECU.

DETERMINING PROM PART NUMBER

The PROM is located inside the ECU and the part number is printed on the PROM itself. On the ECU is a label with the ECU/PROM assembly number. The ECU/PROM assembly number is also programmed into the PROM and can be read with the diagnostic data reader. A DDAD distributor or your dealer can use the ECU/PROM assembly number to determine the PROM part number.

> **⚠ WARNING**
> **Only authorized warranty outlets are permitted to open the PROM access cover. Warranty may be void if opened by unauthorized personnel.**

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ELECTRICAL TROUBLESHOOTING - No Codes		
CONDITION	REASON	REMEDY
No Check Trans light when ignition keyswitch is turned to position '1'	Faulty light bulb	Replace light bulb
	Faulty Relay 4	Replace Relay 4
	Incorrect power to Relay 4	Check circuit from batteries to Relay 4
	Faulty wiring to ECU	Check J1A harness wiring, interface in control box and wiring from circuit breakers and ignition keyswitch to ECU
	Faulty ECU	Replace ECU
Check Trans light will not go out when engine is started	Faulty Relay 4. Note 2.	Replace Relay 4
	Faulty wiring in cab. Note 2.	Check J1A harness and interface in control box
	Light wired incorrectly . Note 2.	Check wiring
	Oil temperature too low. Note 1.	Run engine until oil warms above -23° C (-10° F). Refer to Codes 24 and 33 troubleshooting procedures.
	Faulty ECU. Notes 1 and 2.	Replace ECU
Check Trans light goes out only when drive 'D' is selected	Percent throttle is incorrect	Refer to Code 21 troubleshooting procedure
Shift selector not illuminated	Light bulb burned out. Note 3.	Replace light bulbs
	Shift selector lamp power or ground wiring faulty	Check wiring from interface to panel
	Instrument panel circuit breaker open. Note 4.	Check reason for circuit breaker being open. Reset when corrected.
Transmission stays in Neutral (will not shift), or will not make a selected shift	Extremely low oil level	Check transmission oil level, add if low
	Oil temperature too low	Run engine until oil warms above -23° C (-10° F). Refer to Codes 24 and 33 troubleshooting procedures.
	Voltage to ECU too low	Refer to Code 13 troubleshooting procedure
	Throttle sensor not functioning properly	Refer to Code 21 troubleshooting procedure
	Shift selector not functioning properly	Refer to Code 23 troubleshooting procedure

Note 1 - Transmission will not shift.
Note 2 - Shift system operates normally.
Note 3 - Other instrument panel lights operate.
Note 4 - Other instrument panel lights do not operate.

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ELECTRICAL TROUBLESHOOTING - No Codes		
CONDITION	REASON	REMEDY
Transmission stays in Neutral (will not shift), or will not make a selected shift	Disconnected or dirty connectors	Check and clean harness connectors
	Faulty wiring harness	Check and repair harness
	Transmission output shaft speed sensor not functioning properly	Refer to Code 22 troubleshooting procedure
	Faulty F solenoid or circuitry	Refer to Code 62 troubleshooting procedure
	Faulty A, B or C solenoids or circuitry	Refer to Codes 41 - 45 troubleshooting procedures
	Internal hydraulic problem in transmission	Refer to Transmission Service Manual
	Faulty ECU	Replace ECU
	Faulty parking brake interlock switch or circuitry	Check wiring. Replace microswitch if necessary
	Faulty body up interlock switch or circuitry	Check wiring. Replace microswitch if necessary
Transmission will not shift into Reverse, but will shift into forward range	Faulty hoist interlock pressure switch or circuitry	Check wiring. Replace pressure switch if necessary
Vehicle will not start	Dead batteries	Charge batteries, replace if necessary
	Voltage to shift selector is too low	Refer to Code 23 troubleshooting procedure
	Faulty start circuit	Repair circuit
	Faulty Relay 6	Replace Relay 6
	Faulty neutral start circuit	Repair circuit
	Faulty shift selector	Refer to Code 23 troubleshooting procedure
Transmission does not shift properly (e.g. rough shifts, shifts at wrong speeds)	Faulty throttle position sensor or circuitry	Refer to Code 21 troubleshooting procedure
	Faulty transmission output shaft speed sensor or circuitry	Refer to Code 22 troubleshooting procedure
	Wrong PROM installed	Check PROM part number. Replace if necessary
	Intermittent shorts or open circuits in wiring	Check wiring and repair if necessary
	Crossed wires in harness	Check harness and repair
	Faulty temperature sensor circuitry	Refer to Code 22 troubleshooting procedure

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ELECTRICAL TROUBLESHOOTING - No Codes		
CONDITION	REASON	REMEDY
Transmission will not make a specific shift	Extremely low oil level	Check oil level and add if low
	Extreme oil temperature	Refer to Codes 24 and 33 troubleshooting procedures
	Faulty solenoid circuitry	Refer to Codes 41 - 45, 54, 61, 62 or 63 troubleshooting procedure
	Faulty transmission output shaft speed sensor or circuitry	Refer to Code 22 troubleshooting procedures
	Faulty shift selector	Refer to Code 23 troubleshooting procedures
	Internal hydraulic problem	Refer to Transmission Service Manual
	Faulty ECU	Replace ECU
Check Trans light flashes but no code present	Intermittent power to the ECU	Check power to ECU. Correct if necessary.
	Faulty Relay 4	Replace Relay 4
	Faulty wiring to 'Check Trans' light	Check wiring and repair if necessary
No reverse alarm signal	Reverse alarm not working	Repair or replace reverse alarm
	Faulty Relay 5	Replace Relay 5
	Faulty reverse alarm circuitry	Repair wiring and repair if necessary

SPECIAL TOOLS

The Special Tools listed in the following tables are required for servicing the CEC Plus II Shift System and are available from your dealer.

SPECIAL TOOLS	
TOOL NUMBER	TOOL NAME
15268971	PRO-LINK Diagnostic Data Reader (DDR)
15268973	CEC I and II Cartridge for DDR
15268975	DDR and CEC I and II Cartridge Assembly
15269231	CEC Off-Highway Diagnostic Service Kit
15269038	Portable Printer for use with DDR, complete with 110 V AC Adaptor
15269039	Portable Printer for use with DDR, complete with 220 V AC Adaptor
15269040	Printer Paper for use in above printer - 5 Rolls
15270344	NoFlash Electro Contact Cleaner

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SPECIAL TOOLS	
The following tools are contained in CEC Off-Highway Diagnostic Service Kit - 15269231	
TOOL NUMBER	TOOL NAME
15269232	Wire Cutter, Stripper and Terminal Crimper
15269233	Jumper Wire Set
15269234	Terminal Crimper
15269235	Terminal Remover - Metri Pack (J1A, J1B, J3 and Shift Selector Connector Terminals)
15269236	Terminal Remover - Speed Sensor and Throttle Position Sensor Terminals
15269237	Terminal Remover - Depress holding prong on ECU and DDL Connector Terminals
15269238	PROM Remover
15269239	High Impedance Digital Multimeter Kit
15269240	AMP Pin Remover - Remove terminal pins from Interface and Shift Selector Connectors
15269241	Terminal Crimper - Weatherpac

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DESCRIPTION

The CEC–2 (Commercial Electronic Control, Version 2) continually monitors the transmission and shift system electrical components and warns the operator when a problem develops. It also takes action to prevent damage to the transmission, and provides the serviceman with diagnostic capabilities so that problems can be corrected quickly and easily.

The CEC–2 system used on this vehicle consists of a gear shift selector, an electronic control unit (ECU), throttle position sensor, transmission speed sensors (3 off), oil temperature sensor, solenoids, switches, relays, circuit breakers, fuses, indicator lights and wiring harnesses.

CEC–2 COMPONENTS

Description and Operation

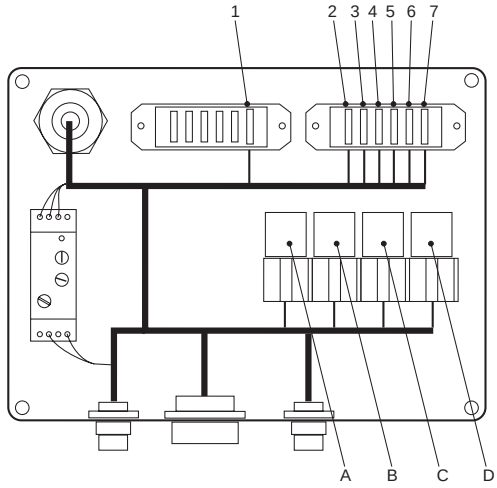
Electronic Control Unit (ECU) - Contains an electronic microcomputer. The ECU receives and processes information defining: shift selector position, throttle position, sump temperature, input speed, turbine speed and transmission output speed. The ECU uses this information to control the transmission solenoids and valves, supply system status and provide diagnostic information.

The ECU is programmed to take corrective action to prevent damage to the transmission if a failure occurs in the CEC–2 system and has diagnostic capabilities which allow the serviceman to quickly find and repair or replace a failed component. The ECU has 3 connectors; Blue - Transmission Connector, Gray - Vehicle Connector, Black - Selector Connector.

Power Module - The Power Module is located on the side of the battery box (Fig.1). The Power Module contains ignition run fuses and relays, and a timer relay for the shutdown function of the ECU. The ignition fuses and relays open power to the ECU. On power shut down the timer relay remains open for a 30 second period to allow the ECU to down load information and close down properly (Fig. 2).

CEC–2 Interface Box - Provides the electrical link between the vehicle harnesses and the CEC–2 harnesses. The interface box contains an ignition signal fuse and function relays.

Gear Shift Selector - The shift selector is a remote mounted lever type (Fig. 4). The gear shift selector is connected to the ECU by a wiring harness. The shift lever has 6 forward ranges and 2 reverse ranges, as well as a neutral position. The shift selector has a single digit LED display, that during normal operation will display the gear selected (*Not gear attained*). Diagnostic information can be displayed on the single digit LED display by pressing the diagnostic display button. There is a hold override button that must be pressed when shifting between R, N and D. The hold override button is released when desired selector position is reached. The selector lever can move freely between D and the number ranges without pressing the hold override button.



1. Control Fuse
2. Engine Master ECM Fuse
3. Engine Receiver ECM Fuse
4. Engine Master ECM Fuse
5. Engine Receiver ECM Fuse
6. Transmission ECU Fuse
7. Transmission ECU Fuse

A. Ignition Sense Relay
B. Engine ECM Power Relay 1
C. Engine ECM Power Relay 2
D. Trans. ECU Power Relay

Fig.1 - Power Module

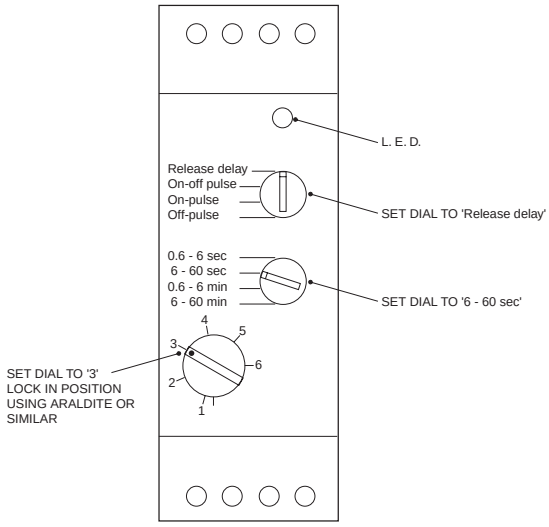


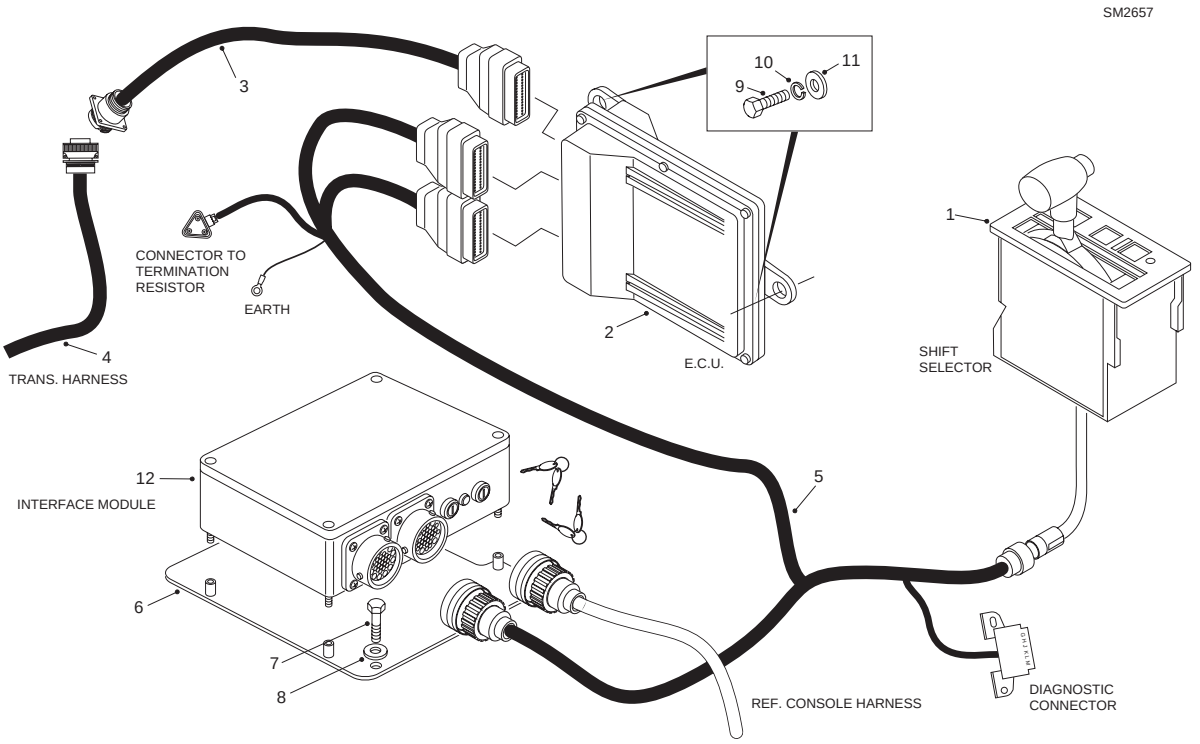
Fig.2 - Timer Relay Setting

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Transmission - C.E.C. 2

Section 120-0070



1. Gear Shift Selector
2. E.C.U.
3. Transmission Harness
4. Transmission Harness
5. Shift Control Harness
6. Mounting Plate
7. Bolt
8. Washer
9. Bolt
10. Lock Washer
11. Washer
12. Interface Box

Fig. 3 - C.E.C. 2 General Layout

⚠ WARNING
Do not allow the vehicle to coast in Neutral. This practice can result in severe transmission damage.

The transmission upshifts and downshifts automatically between first range and the highest range selected on the range selector in direct response to throttle position and transmission output speed.

When Reverse is selected the reverse alarm sounds and the reverse light illuminates at the rear of the vehicle. This feature warns personnel to the immediate rear of the vehicle that the operator has shifted to reverse.

When drive 'D' is selected, the transmission automatically upshifts and downshifts through all six forward ranges as required by loads and travel speeds. Selecting a lower range (4th, 3rd etc.) limits the highest range to which the transmission will automatically upshift.

If a lower range is selected while moving forward, the transmission automatically downshifts sequential to the selected lower range at maximum controlled engine speeds. Downshifts will not occur until vehicle is slowed by use of the service brakes and/or retarder.

When shifting from neutral to start from a standstill, or to reverse direction, decelerate the engine to idle speed. To move forward, select drive 'D' and accelerate the engine to the vehicle load and speed requirements. The transmission will automatically upshift from 1st through 6th ranges as travel speed increases.

With the throttle fully depressed, and the mode selection switch in the Power position, the transmission upshifts to the next higher range when the engine attains maximum rated speed, since maximum power train output is needed under this condition. At lower throttle settings where minimum power train performance is required, the transmission will upshift to the next higher range at less than maximum rated engine speed.

Upgrades or soft spots might slow travel speed, even at full throttle, requiring transmission downshifts to maintain maximum powertrain performance. When this occurs, the transmission downshifts automatically.

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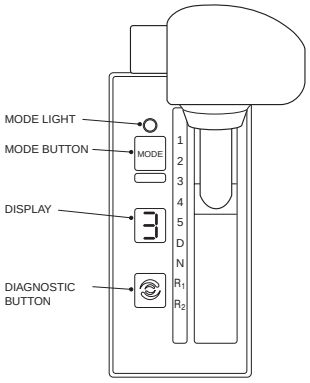


Fig. 4 - Gear Shift Selector

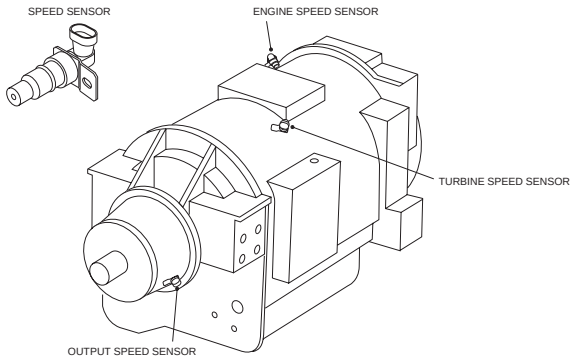


Fig. 5 - Speed Sensors Locations

Shift the transmission to the next lowest range if transmission 'Hunting' or 'Shift Cycling' occurs.

When temporarily stopped, such as for yielding the right-of-way to a loaded vehicle, the transmission can be left in the selected range and the vehicle held stationary with the service brakes.

However, when stopped for a more extended period with the engine left running, shift the transmission to neutral to avoid unnecessary heat buildup and apply the parking brake.

⚠ WARNING
Always select Neutral and apply the parking brake before leaving the operator's seat.

Speed Sensors - 3 off speed sensors (Fig. 5); Input, Turbine and Output Speed, provide information to the ECU. The input speed signal is generated by the gear teeth on the top PTO gear. The turbine speed signal is generated by the serrations on the tone wheel. The output speed sensor signal is generated by a toothed member attached to the output shaft. The speed ratios between the various speed sensors allow the ECU to determine if the transmission is in the selected range. Hydraulic problems are detected by comparing the speed sensor information for the current range to that ranges speed sensor information programmed in the ECU memory.

Mode Selection Switch - Gives the option to select between transmission Power and Economy shift schedules. The transmission must be in Neutral before the switch will function.

The transmission torque converter is equipped with a lockup clutch which, when engaged by the ECU, locks the converter pump and turbine together as a single unit and allows power to be transmitted mechanically from the engine directly to the transmission gearing on a 1:1 ratio. When the lockup clutch is disengaged, the torque converter acts as a fluid coupling, multiplying torque when engine speed is significantly higher than transmission output shaft speed.

When the mode selection switch is in the Power position, the ECU controls operation of the lockup clutch according to signals received by the throttle position sensor (giving engine speed as a percent of throttle), the transmission output shaft speed sensor, and range selector. The ECU may delay application of the lockup clutch and allow torque multiplication by the torque converter to take place until a balance is achieved between engine speed and transmission output shaft speed before activating the lockup clutch.

Power versus Economy Mode
The Power mode is designed for applications involving heavy loads and hilly duty cycles where performance rather than fuel economy is of prime importance.

The Economy mode is designed for applications involving lighter loads and level duty cycles or where fuel economy is more important than performance.

In the Economy mode, the ECU controls operation of the lockup clutch with a timed, preprogrammed schedule where in second through sixth gears the lockup clutch is disengaged only long enough to allow the torque converter's fluid coupling to absorb shift shock. Otherwise, the lockup clutch is engaged and no torque multiplication takes place in second through sixth gears.

Manual Mode Switch - The manual mode facility is designed as a Service Technician facility to allow stall checks and clutch pressure checks to be implemented

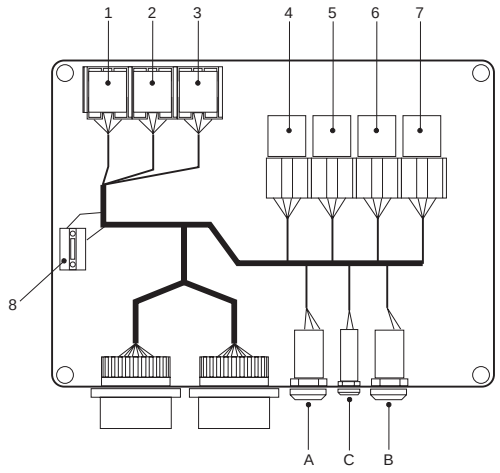
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by Service Personnel, and permit movement of the vehicle, if necessary, to a repair area. With the manual mode switch in the 'On' position, the body up interlock and hoist interlock pressure switch mechanisms are disengaged! This allows unauthorised selection of reverse or any forward gear with the body raised, constituting a safety hazard. Operators must not use the manual mode facility when working the vehicle! *It is recommended that the mode selection key is removed from the unit and retained in a safe place until required by Service personnel.*

Note: The manual mode can only be used if the mode selection switch is in the Power position and the transmission is in neutral.

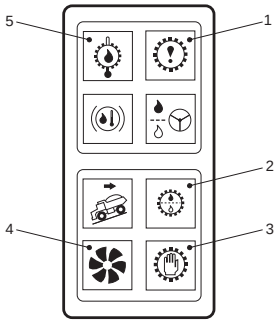
Manual Mode Warning Light - This light is located on the front face of the CEC–2 interface box. The Manual Mode Warning Light illuminates to alert the operator when the transmission has been switched to operate in the manual mode. The light should be 'Off' during normal operation.



1. Check Trans. Relay
2. Neutral Start Relay
3. Reverse Relay
4. Body Up Relay
5. Delta P Relay
6. Lock Up Off Relay
7. Converter Drive Relay
8. Ignition Sgnal Fuse
A. Manual/Automatic Key
B. Power/Economy Key
C. Manual Mode Light

Fig. 5- Interface Box

Check Trans Warning Light (Fig. 6) - Illuminates to alert of a minor fault in the transmission control system or abnormal transmission temperature. The light will come 'On' when the ignition key switch is turned to position '1' to provide a bulb and system check and should go 'Off' a few seconds after the engine is started and the transmission oil pressure rises. The check trans warning light will come 'On' during operation, if the ECU has detected a minor fault in an electrical component or abnormal transmission oil temperature. If transmission oil temperature is too high, stop the vehicle, select neutral 'N', and increase engine speed to allow a greater flow of oil to the cooler until oil temperature drops to normal operating range. In most cases, a minor fault triggering the check trans warning light will not prevent normal operation from continuing but, depending on the nature of the problem, the ECU could take action to protect the transmission from damage, such as preventing operating in high gear ranges. If the check trans light comes 'On', have the problem diagnosed and corrected at the earliest opportunity.



1. Transmission Check Light
2. Delta P Filter Restriction
3. Transmission Overspeed
4. Converter Mode Light
5. Transmission Oil Temperature

Fig. 6 - Warning Lights

Converter Mode Light - Illuminates when the transmission is in torque converter drive. It goes 'Off' when Lockup is engaged. In order to avoid unnecessary waste of fuel, if traffic or other road conditions permit, the operator should modify throttle position, or gear held, to achieve a steady road speed with the torque converter lockup engaged (light 'Off'). The Lockup relay in the interface box (Fig. 5) is also activated by the 20 bar (290 psi) pressure switch on the foot brake pedal. When this switch is activated the converter in light will be illuminated due to the transmission dropping out of converter lock up, avoiding engine stall.

Transmission Overspeed Light - Illuminates when the transmission ECU senses transmission RPM exceeds 2350 RPM.

Electro-Hydraulic Valve Components: The CEC–2 electro-hydraulic valve bodies contain various solenoids to control hydraulic pressure (Fig. 7). The solenoid pressure, or lack of pressure, positions shift valves that apply transmission clutches to produce the range selected by the ECU inputs (Fig. 8). The ECU is connected to the solenoids by a wiring harness, with multi-pin twist-lock connectors at the valve bodies (Fig.9).

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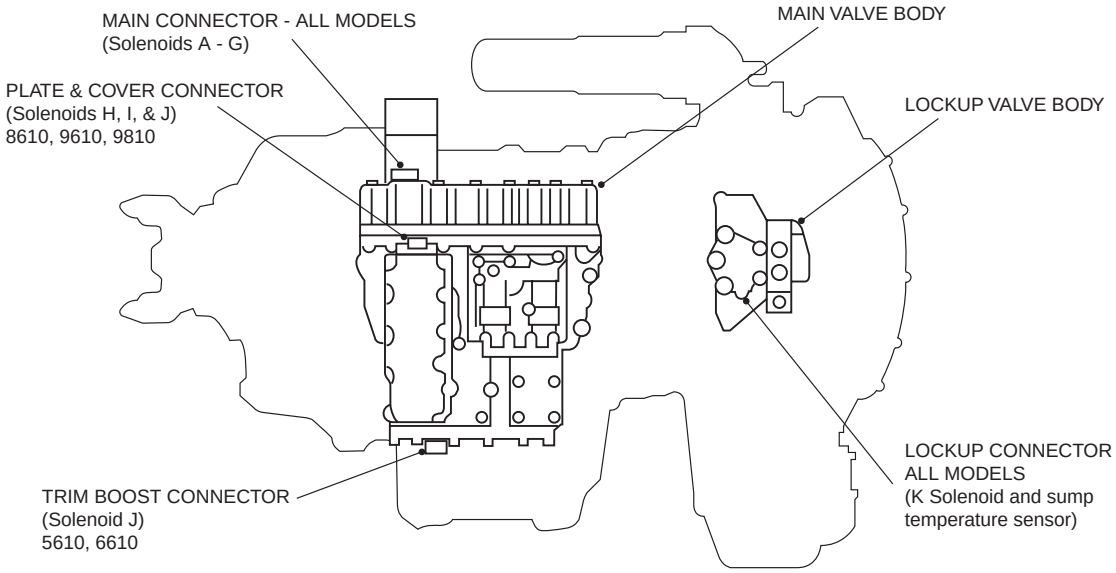


Fig. 7- Solenoid Positions

GEAR ATTAINED	SOLENOIDS ACTIVATED	CLUTCHES ENGAGED
6	E, G	5/6 - High Splitter
5	E, F	5/6 - Low Splitter
4	D, G	3/4 - High Splitter
3	D, F	3/4 - Low Splitter
2	C, G	1/2 - High Splitter
1	C, F	1/2 - Low Splitter
N	A, F	Low Splitter
R1	A, B, F	Reverse - Low Splitter
R2	A, B, G	Reverse - High Splitter

Fig. 8- Solenoid Activation (5010/6010 Series Only)

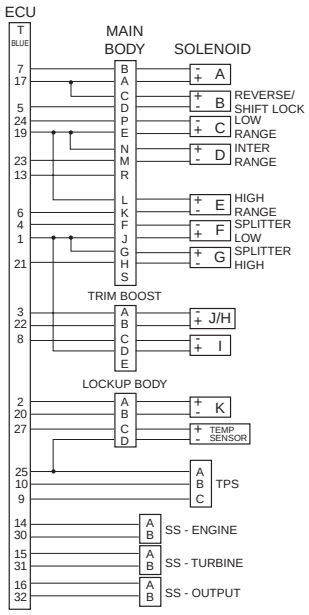


Fig. 9- Solenoid Wiring Harness to ECU

C.E.C.2 FUNCTIONS

1. **Check Transmission** - Relay within the Interface Box triggers the Transmission Check Light on the dash panel, when the transmission ECU senses a fault.

2. **Neutral Start** - Neutral start relay inside the interface box will not close unless the Transmission Shift Selector is in the neutral position, thus preventing the engine ignition circuit being energised.

3. **Hold in Range** - This is a body raise function. The ECU prevents any up-shifts when the body is raised while in a forward gear. The ECU receives a signal from the body up magnetic switch.

4. **Bed Hoist Interlock** (Reverse Hoist Interlock) - The ECU shifts the transmission to neutral (N) if the body is raised when the transmission is in a selected reverse gear (R). To over-ride this function, stop the truck, shift gear shift selector to neutral, than back to reverse. The ECU receives a signal from a pressure switch located on the raise circuit on the body control valve.

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5. **Delta P Hold** - The ECU prevents any up-shifts should the transmission filter switch sense a pressure differential of 2.5 bar (35 psi). This function is only active when oil temperature is >40°C (104°F).

6. **Lock in Gear** - The Lock in gear feature is designed to protect the transmission from damage should wheel spinning or lock-up occur due to poor traction or panic braking. The ECU will delay making a shift for several seconds and then, if the condition fails to correct itself, locks the gear to prevent any further shifting. The check transmission light will illuminate. If this occurs, the ECU must be reset before normal operation may be resumed.

To reset the ECU if the transmission is locked in gear, stop the truck, select neutral gear (N), apply the park brake and turn the ignition key to '0' position. Wait 10 seconds, then turn the ignition key to restart engine. Select Reverse gear (R) then neutral (N). The check transmission light should go off.

7. **Cold Weather Starts** - During cold weather, if the transmission temperature is below -24°C (-10°F) the Check Transmission light will illuminate and the ECU will prevent the transmission being shifted out of neutral (N). Between -24°C (-10°F) and -7°C (19°F) the light will go out and the ECU will only permit operation on first and reverse gear. Above -7°C (19°F) normal operation will be permitted.

TROUBLE-SHOOTING

Begin troubleshooting by checking the transmission fluid level and ECU input voltage. Remember that some problems may be temperature related. Do troubleshooting at the temperature level where the problem occurs. You can check diagnostic codes by;
1. Using gear shift selector display.
2. Pro-Link diagnostic tool.

Using Gear Shift Display

Reference Fig. 10

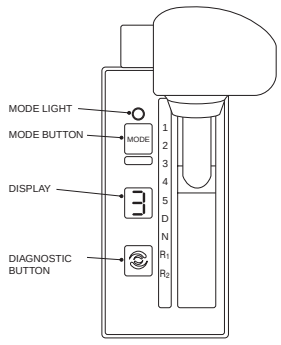


Fig. 10 - Gear Shift Display

Gear Shift Selector Procedure

1. Transmission check light will illuminate when the ECU detects a fault.
2. Stop the truck and shift gear selector to neutral (N).
3. Press the diagnostic button on the gear shift selector.
4. Display will flash one digit at a time.
5. Display starts with the code position, which will be d1, d2 etc. This is followed by the two digit main code, then the two digit sub-code.
6. To move to the next code, press the Mode Button to display the next diagnostic code. Up to 5 codes can be stored at one time.
7. Active codes are indicated by illumination of the Mode Light.

Clearing Codes

1. For Active Codes - Press and hold the mode button for 3 to 5 seconds.
2. For Inactive Codes - Press and hold the mode button for 8 to 10 seconds.

Exit Diagnostic Mode

1. Press diagnostic button.

Pro-Link Procedure

The Digital Data Line (DDL) is located on the right hand side of the centre console. The Pro-link should be connected at this point to access troubleshooting codes. Diagnostic codes are listed and stored in the ECU memory, listing the most recently occurring code first and logging upto 5 codes. The Pro-Link will display the code list position, main code, sub code and active indicator. The Pro-Link also has the capability of displaying an ignition signal counter and event counter. The following defines the different parts of the code list displayed by the Pro-Link;

(A) Code List Position - The position which the code occupies in the code list. Positions are displayed as 'd1' through to 'd5'.

(B) Main Code - The general condition or area of the fault detected by the ECU.

(C) Sub-Code - The specific area or condition related to the main code in which the fault is detected.

(D) Active Indicator - Indicates when a diagnostic code is active. The Pro-Link will indicate 'YES'.

(E) Ignition Cycle Counter - Determines the number of times the ignition has been cycled since the code was detected.

(F) Event Counter - Determines how many times the code has occurred without being cleared from the memory.

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TROUBLE-SHOOTING DIAGNOSTIC CODES

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
13	12	ECU input voltage, low	Yes	DNS
	23	ECU input voltage, high	Yes	DNS
21	12	Throttle position sensor, failed low	Yes	Use throttle default values
	23	Throttle position sensor, failed high	Yes	Use throttle default values
22	14	Engine speed sensor reasonableness test	Yes	Use default engine speed
	15	Turbine speed sensor reasonableness test	Yes	DNS, lock in current range
	16	Output speed sensor reasonableness test	Yes	DNS, lock in current range
23	12	Primary shift selector or RSI link fault	Yes	Hold in last valid direction. May cause "cateye" display.
	13	Primary shift selector mode function fault	No	Mode change not permitted
	14	Secondary shift selector or RSI link fault	Yes	Hold in last valid direction. May cause "cateye" display.
	15	Secondary shift selector mode function fault	No	Mode change not permitted
	16	Shift Selector display line fault	Yes	None. May cause "cateye" display.
24	12	Sump fluid temperature, cold	Yes	DNS, lock-to-range
	23	Sump fluid temperature, hot	Yes	No upshifts above a calibration range
25	11	Output speed sensor, detected at 0 output rpm, 1st	Yes	DNS, lock in current range (1st)
	22	Output speed sensor, detected at 0 output rpm, 2nd	Yes	DNS, lock in current range (2nd)
	33	Output speed sensor, detected at 0 output rpm, 3rd	Yes	DNS, lock in current range (3rd)
	44	Output speed sensor, detected at 0 output rpm, 4th	Yes	DNS, lock in current range (4th)
	55	Output speed sensor, detected at 0 output rpm, 5th	Yes	DNS, lock in current range (5th)
	66	Output speed sensor, detected at 0 output rpm, 6th	Yes	DNS, lock in current range (6th)
	77	Output speed sensor, detected at 0 output rpm, 7th	Yes	DNS, lock in current range (7th)
	88	Output speed sensor, detected at 0 output rpm, 8th	Yes	DNS, lock in current range (8th)

Abbreviations; DNS - Do Not Shift, Transmission will not respond to the shift selector when the transmission check light is illuminated.
SOL OFF - All Solenoids Off.
GPO - General Purpose Output, Output signal from ECU to control vehicle components to allow special operating mode.

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TROUBLE-SHOOTING DIAGNOSTIC CODES (CONT.)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
26	00	Throttle source not detected	No	Use throttle default values
33	12	Sump fluid temperature sensor failed low	Yes	Use default value of 93°C (200°F)
	23	Sump fluid temperature sensor failed high	Yes	Use default value of 93°C (200°F)
34	12	Factory calibration compatibility number wrong	Yes	DNS, SOL OFF
	13	Factory calibration fault	Yes	DNS, SOL OFF
	14	Power off fault	Yes	Use previous location, or factory calibration
	15	Diagnostic queue fault	Yes	Use previous location, or clear diagnostic queue
	16	Real time fault	Yes	DNS, SOL OFF
	17	Customer modifiable constants fault	Yes	DNS, SOL OFF
35	00	Power interruption (code set after power restored)	No	None (hydraulic default during interruption)
	16	Real time write interruption	Yes	DNS, SOL OFF
36	00	Hardware/software not compatible	Yes	DNS, SOL OFF
45	12	General solenoid failure — F	Yes	DNS
	13	General solenoid failure — K	Yes	DNS, Inhibit lockup
	14	General solenoid failure — B	Yes	DNS, Inhibit Reverse
	15	General solenoid failure — G	Yes	DNS
	16	General solenoid failure — E	Yes	DNS
	21	General solenoid failure — H/J	Yes	Turn off trim boost J, DNS H
	22	General solenoid failure — A	Yes	No action taken
	23	General solenoid failure — D	Yes	DNS
	24	General solenoid failure — I	Yes	No action taken
	26	General solenoid failure — C	Yes	DNS

Abbreviations; DNS - Do Not Shift, Transmission will not respond to the shift selector when the transmission check light is illuminated.
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TROUBLE-SHOOTING DIAGNOSTIC CODES (CONT.)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
46	21	Hi side overcurrent, H/J solenoid	Yes	Turn off H/J solenoid, DNS 8610, 9810
	26	Hi side overcurrent, C, D, E solenoid circuit	Yes	Turn off C, D, E solenoids
	27	Hi side overcurrent, A, B, F, G, I, K solenoid circuit	Yes	DNS. Turn off A, B, F, G, I, K solenoids.
56	11	Range verification ratio test, 1st	Yes	DNS
	22	Range verification ratio test, 2nd	Yes	DNS
	33	Range verification ratio test, 3rd	Yes	DNS
	44	Range verification ratio test, 4th	Yes	DNS
	55	Range verification ratio test, 5th	Yes	DNS
	66	Range verification ratio test, 6th	Yes	DNS
	77	Range verification ratio test, 7th or R1	Yes	DNS
	88	Range verification ratio test, 8th or R2	Yes	DNS
65	00	Engine rating too high	Yes	DNS, Lock-in-neutral
66	00	Serial communications interface fault	No	Use default throttle values
69	27	ECU, inoperative A, B, F, G, I, K solenoid	Yes	DNS, SOL OFF
	28	ECU, inoperative H/J solenoid	Yes	DNS, SOL OFF
	29	ECU, inoperative C, D, E solenoid	Yes	DNS, SOL OFF
	33	ECU, Computer Operating Properly (COP) fault	Yes	Reset ECU, shutdown ECU on 2nd occurrence (power loss; hydraulic defaults). May cause "cateye" display or all segments blank display
	34	ECU, EEPROM, fault	Yes	DNS, SOL OFF
	35	ECU, EEPROM, fault	Yes	Reset ECU
	39	Communication chip addressing error	Yes	Use defaults for J1939 data
	42	SPI output failure	No	GPO 1–8 and reverse warning inoperable
	43	SPI input failure	Yes	DNS, lock-in-range

Abbreviations; DNS - Do Not Shift, Transmission will not respond to the shift selector when the transmission check light is illuminated.
SOL OFF - All Solenoids Off.
GPO - General Purpose Output, Output signal from ECU to control vehicle components to allow special operating mode.

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GENERAL TROUBLESHOOTING

Performance Complaints

Make the following general checks before beginning specific troubleshooting.

- Are there active diagnostic codes?
- Is the shift lever in N to allow engine start?
- Is the battery properly connected and charged?
- Are all fluid levels correct?
- Is the voltage to the ECU correct?
- Is engine properly tuned?
- Is fuel flow to the engine correct?
- Is air flow to the cooler and radiator unrestricted?
- Is the driveline properly connected?
- Are there signs of fluid leakage under the vehicle?
- What is the origination point of this leak?
- Are all hydraulic connections leak free?
- Are all electrical connections correct?

After making these checks, Some complaints involve diagnostic codes, so all troubleshooting checks should involve checking the system for diagnostic codes.

Solenoid Ratings

Each pressure solenoid that controls the functions on the transmission via the CEC2 commands have electrical resistance ratings. (Ref. Fig 9) These electrical resistance ratings can be checked through the CEC2 harnesses and connectors to the ECU.

All solenoids should be checked at normal operating temperature.

A through G solenoid	12 to 24 ohms
K solenoid	12 to 24 ohms
J solenoid	10 to 13 ohms

Speed Sensor Ratings

The 3 speed sensors have electrical resistances and can be checked at various transmission temperatures. These resistances can be checked via the CEC2 harnesses and connectors to the ECU (Fig. 9).

Temperature	Resistance
-40°C (-40°F)	200 ohms
20°C (68°F)	300 ohms
110°C (230°F)	400 ohms

Speedometer/Odometer

Driven by a signal from the CEC, the speedometer indicates travel speed in kilometers per hour and miles per hour. A digital odometer is incorporated in the speedometer to record the distance travelled by the vehicle at any given time.

Speedometer Calibration Table - All units with standard tyres

Unit	Transmission	Pulses
TR40	M5610A	188600
TR45	M5610A	188600
TR60	M6610A	208580
TR70	M6610A	208580

Speedometer Calibration

1. Determine the impulses/mile required. Reference speedometer calibration table.

2. Depress and hold calibration button on the speedometer and turn the ignition keyswitch to position '1'.

3. Release button when PULSE is displayed. The second digit will flash. Depress the button until the desired number is displayed the release the button for a few seconds until the next digit flashes.

4. Repeat step 3 to obtain the desired impulses/mile. After a few seconds only two digits will be displayed. The speedometer is now calibrated.

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SPECIAL TOOLS

The Special Tools listed in the following tables are required for servicing the CEC 2 Shift System and are available from your dealer.

SPECIAL TOOLS	
TOOL NUMBER	TOOL NAME
15275098	Diagnostic Data Reader (DDR) Multikit (Includes Reader, Cartridge, Cables)
15275180	CEC 2 Diagnostic Card
15269038	Portable Printer for use with DDR, complete with 110 V AC Adaptor
15269039	Portable Printer for use with DDR, complete with 220 V AC Adaptor
15269040	Printer Paper for use in above printer - 5 Rolls
15270344	NoFlash Electro Contact Cleaner

SPECIAL TOOLS

The following list of tools are required to service CEC 2 wiring harnesses.

SPECIAL TOOLS	
TOOL NUMBER	TOOL NAME
15275719	Sealed Splice (14-16 AWG)
15275720	Sealed Splice (18-22 AWG)
15275721	Crimper - Deutsch Connector, Transmission Harness Bulkhead, J1939 Connector
15269234	Crimper (Alternate) - Delphi Packard (DDL connector)
15275722	Crimper (Alternate) - Throttle Position Sensor
15275723	Wire Stripper
15275724	Remover - Delphi Packard (DDL Connector), Sump Temperature Sensor
15275725	Remover - Throttle Position Sensor
15275726	Remover - Deutsch Connector
15275727	Crimper - Throttle Position Sensor, Delphi Packard (DDL Connector)
15275728	Crimper - Speed Sensors, Throttle Position Sensor,
15275729	Crimper - Repair of broken cable using appropriate Sealed Splice
15275730	Remover - Deutsch Connector (Optional DDL)
15269241	Crimper (Alternate) - Throttle Position Sensor
15275731	Remover - ECU Connectors, Shift Selector Connection
15275732	Connector Repair Kit - Transmission Harness Bulkhead Connector
15275733	Guide Pin - Transmission Harness Bulkhead Connector
15275734	Insertion Tool - Transmission Harness Bulkhead Connector
15275735	Terminal Remover - Transmission Harness Bulkhead Connector
15275736	Crimper - ECU Connectors, Shift Selector Connection

* * * *

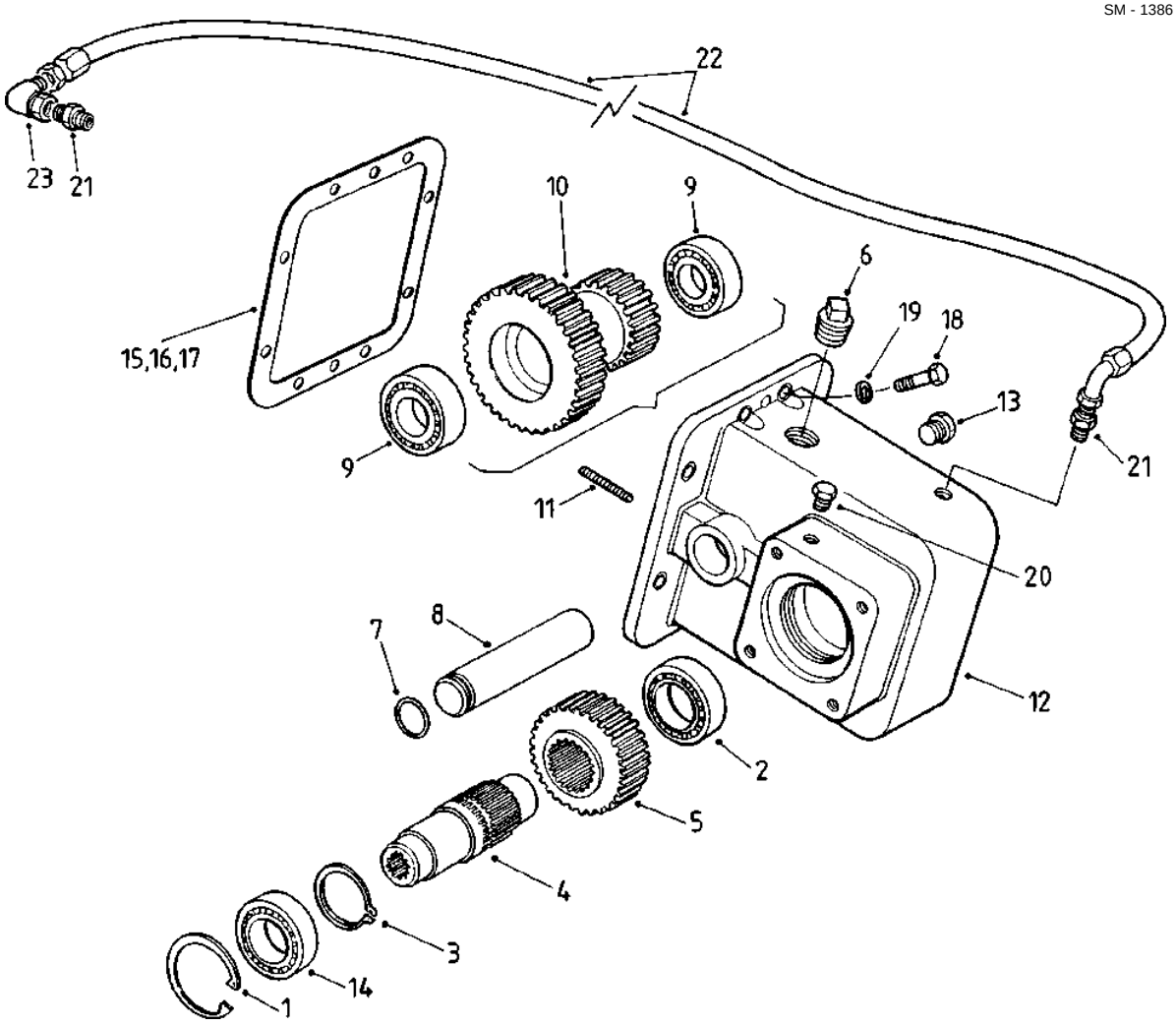
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1 - Snap Ring
2 - Bearing
3 - Snap Ring
4 - Output Shaft
5 - Driven Gear
6 - Pipe Plug
7 - 'O' Ring
8 - Pinion Shaft
9 - Bearing
10 - Pinion Gear
11 - Set Screw
12 - Housing
13 - Pipe Plug
14 - Bearing
15 - Shim 0.07 mm (0.003 in)
16 - Shim 0.20 mm (0.008 in)
17 - Shim 0.50 mm (0.020 in)
18 - Bolt
19 - Lockwasher
20 - Pipe Plug
21 - Adaptor
22 - Hose Assembly
23 - Elbow

Fig. 1 - Exploded View of Power Takeoff Assembly

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The power takeoff is mounted off a machined pad at the lower right hand side of the torque converter housing. Pinion gear (10) meshes with the oil pump drive gear and provides the drive through driven gear (5) to output shaft (4). Mounted off power takeoff housing (12) is the steering pump which is driven by output shaft (4). Refer to Section 220-0050, STEERING PUMP.

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the

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parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

3. Match mark the steering pump housing and power takeoff housing (12) to facilitate assembly. Remove steering pump from power takeoff housing (12) following procedures outlined in Section 220-0050, STEERING PUMP.

4. Disconnect hose assembly (22) from adaptor (21) and cap hose assembly and adaptor to prevent entry of dirt.

5. Attach suitable lifting equipment to the power takeoff assembly and remove bolts (18) and lockwashers (19). Lift the power takeoff assembly and shims (15, 16 & 17) from the torque converter housing. Keep shims (15, 16 & 17) with power takeoff housing (12) to assure correct installation. Cover torque converter housing to prevent entry of dirt.

Note: Identify or mark the number and thickness of shims (15, 16 & 17) removed. This procedure is necessary so as not to alter the backlash of the gears during assembly.

Note: The gasket used at the steering pump mounting face should be discarded and replaced at installation.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Remove the 'stake' mark from set screw (11), then remove set screw (11).

2. Place housing (12) on the bed of an arbor press with the steering pump mounting flange facing downward. Remove pipe plug (13) and press pinion shaft (8) out of housing (12).

Note: If an arbor press is unavailable, the pinion shaft can be driven out of the housing using a soft drift and hammer.

3. Remove and discard 'O' ring (7) from pinion shaft (8).

4. With housing (12) positioned mounting flange face up, lift out pinion gear (10) and bearings (9) as an assembly. Remove bearings (9) from pinion gear (10).

5. Remove snap ring (1) from housing (12). Insert a suitable puller tool into the internally splined output shaft (4) and pull output shaft, together with bearing (14) from driven gear (5).

6. Remove snap rings (1 & 3) and bearing (14) from output shaft (4) if necessary.

7. Remove driven gear (5) and bearing (2) from housing (12). Remove bearing (2) from driven gear (5).

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Clean all parts, except bearings (2, 9 & 14), in a suitable solvent and dry with compressed air.

2. Clean bearings (2, 9 & 14) in volatile mineral spirits, and wipe dry with clean, lint-free cloth. Lubricate with light oil, and spin by hand to check for wear and roughness. Replace with new bearings if excessively worn, or if operation is rough or noisy.

3. Check the condition of splines and teeth on all gears and shafts for burrs or signs of excessive wear.

4. Pinion shaft (8) and output shaft (4) should not be rough, worn, cracked or damaged. If either shaft is distorted, it should be replaced.

5. Check all threaded parts and tapped holes for stripped or battered condition.

6. Inspect housing (12) for cracks or bearing bores out-of-roundness.

7. Gear teeth should not be worn, cracked or broken.

8. Any small nicks, scratches or burrs should be smoothed up with a fine stone or crocus cloth, and part cleaned in solvent and dried with lint-free cloth.

ASSEMBLY

Numbers in parentheses refer to Fig. 1. Refer to Fig. 2 for location of parts within housing (12).

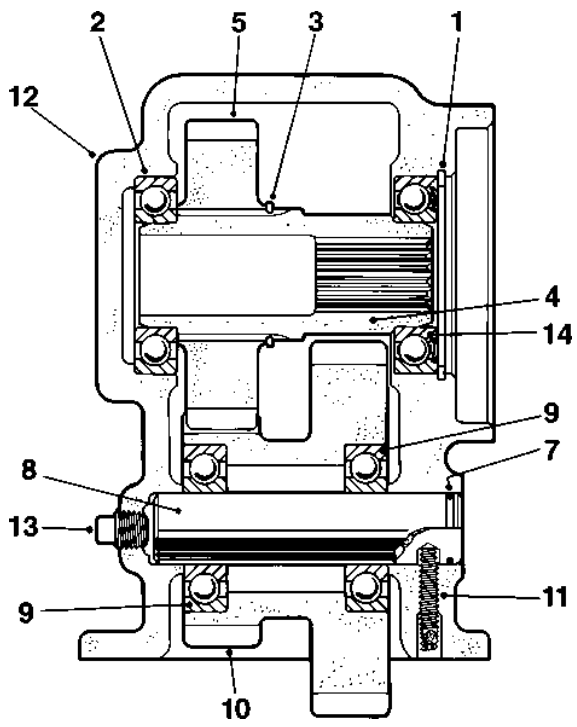
1. With housing (12) in position with steering pump mounting face up, press bearing (2) into bearing bore in housing (12).

Note: Be sure bearing is seated by tapping outer race with a soft drift and hammer.

2. Install snap ring (3) onto output shaft (4).

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1 - Snap Ring
2 - Bearing
3 - Snap Ring
4 - Output Shaft
5 - Driven Gear
7 - 'O' Ring
8 - Pinion Shaft
9 - Bearing
10 - Pinion Gear
11 - Set Screw
12 - Housing
13 - Pipe Plug
14 - Bearing

Fig. 2 - Cutaway View of Power Takeoff Assembly

3. Position driven gear (5) in housing (12) and slide output shaft (4) through driven gear (5). Press output shaft (4) into bearing (2), if necessary.

4. Press bearing (14) onto opposite end of output shaft (4) and install snap ring (1). Be sure bearing (14) is seated against output shaft (4) shoulder, with shielded side of bearing facing toward snap ring (1) (facing out).

5. Rotate driven gear (5) and check for any visible signs of drag.

6. Press bearings (9) into bearing bores of pinion gear (10). Be sure bearings are seated against shoulder in pinion gear.

7. Position pinion gear (10) and bearings (9) assembly in housing (12). Install a new 'O' ring (7) on pinion shaft (8). Insert pinion shaft (8) through pinion gear (10) and bearings (9), lining up set screw hole in pinion shaft (8) with set screw hole in housing (12).

8. Install and stake set screw (11) in housing (12).

9. Install pipe plug (13) in the end of pinion shaft (8).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Using suitable lifting equipment, position power takeoff assembly to torque converter housing and secure with bolts (18) and lockwashers (19), using the same quantity and thickness of shims (15, 16 & 17) removed during removal.

2. Remove pipe plug (6) from housing (12).

Note: Pipe plug (6) hole serves as an access for checking the backlash.

3. Position a dial indicator on housing (12) so that the plunger rests against a tooth of pinion gear (10).

4. Hold or block either the power takeoff drive gear, or the converter charging pump driven gear, whichever is the case, so that it cannot revolve.

5. Set the dial indicator to a zero reading then, with a screwdriver, turn pinion gear (10) back and forth as far as possible. The maximum allowable backlash is from 0.381 - 0.635 mm (0.015 - 0.025 in).

6. If the dial indicator reading is less than 0.381 mm (0.015 in) additional shims (15, 16 & 17) will have to be installed. A greater reading than 0.635 mm (0.025 in) means that some shims (15,16 & 17) will have to be removed.

7. After the correct backlash is obtained, remove the block preventing the gear from revolving. Install pipe plug (6) in housing (12) and secure the power takeoff

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assembly in position with bolts (18) and lockwashers (19).

8. Remove blanking caps from adaptor (21) and hose assembly (22) and install hose assembly (22).

9. Install steering pump on power takeoff assembly following procedures outlined in Section 220-0050, STEERING PUMP.

10. Start the engine and make an operational check while the engine is running. Check for leaks and tighten lines and fittings as required.

11. Ensure parking brake is applied and remove wheel chocks from all road wheels.

SERVICE TOOLS

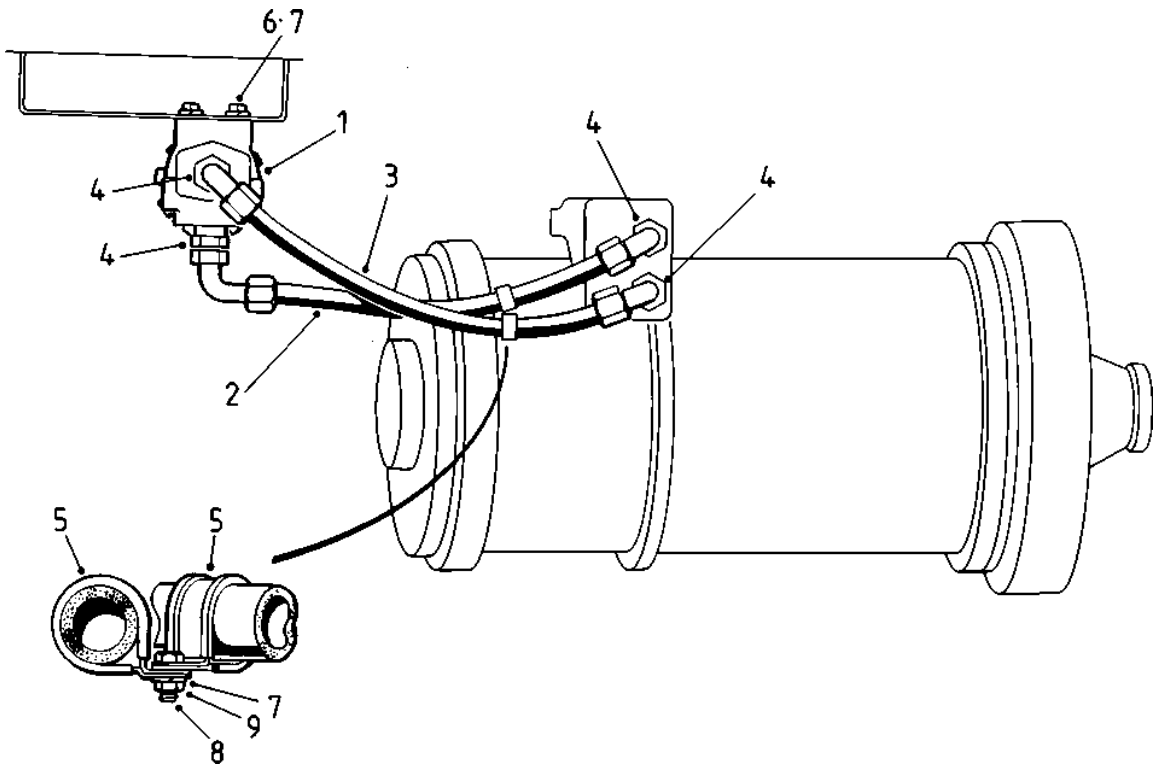
Refer to Section 300-0070, SERVICE TOOLS for part numbers of tools referenced in this section and general service tools required. These tools are available from your dealer.

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SM - 1385



1 - Filter Assembly
2 - Filter Inlet Line
3 - Filter Outlet Line
4 - Adaptor
5 - Clip
6 - Bolt
7 - Lockwasher
8 - Bolt
9 - Nut

Fig. 1 - Transmission Oil Filter and Lines

DESCRIPTION

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Transmission oil filter assembly (1, Fig. 1) is installed in the transmission oil lines to remove dirt and other contaminants from the transmission oil to minimise wear and provide maximum service life for the transmission.

A bypass valve in filter head (1) ensures an adequate flow of oil to the transmission if element (2) becomes clogged and cannot pass oil through quickly enough to satisfy demand. The bypass valve opens at 3.5 bar (50 lbf/in²).

Installed in filter head (1) is pressure switch (4) which sends a signal to a filter restriction indicator warning light (mounted on the dash panel) to warn the operator when element (2) becomes sufficiently clogged to restrict oil flow. This indicates that element (2) should be changed.

Oil flows from the transmission to the inlet side of filter head (1) where the oil will then take one of two paths:

a. If the oil is cold and thick, or element (2) is clogged, oil pressure increases and opens the bypass valve allowing the oil to bypass the filter and flow through filter head (1) and exit at the outlet port to the transmission.

b. If the oil is warm and element (2) is not clogged, oil will flow through element (2) before returning to the transmission.

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Transmission - Transmission Oil Filter

Section 120-0100

REMOVAL

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

> **WARNING**
> **To prevent personal injury and property damage, be sure wheel chocks are properly secured and of adequate capacity to do the job safely.**

1. Position the vehicle in a level work area, raise the body and install the body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine.

3. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

4. Tag filter inlet line (2) and filter outlet line (3) to aid in installation and disconnect from filter assembly (1). Cap open line ends and fittings to prevent entry of dirt.

5. Support filter assembly (1) and remove bolts (6) and lockwashers (7) securing filter assembly (1) to mounting bracket on the right hand frame rail. Remove filter assembly (1) and drain oil from assembly into a suitable container.

6. If filter assembly (1) is being replaced, remove adaptors (4) to use on new filter assembly (1).

7. If filter element (2, Fig. 2) is only being replaced, disassemble filter assembly (1) and replace element (2, Fig. 2) as described under 'Changing Filter Element'.

8. If required, remove filter inlet line (2) and filter outlet line (3) from the transmission. Cap open line ends and fittings to prevent entry of dirt.

9. If required, remove bolt (8), nut (9), lockwasher (7) and clips (5) securing filter inlet line (2) and filter outlet line (3) together.

INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. If new filter assembly (1) is being fitted, install adaptors (4) in filter head (1, Fig. 2).

2. Position filter assembly (1) to mounting bracket on the right hand frame rail and secure with bolts (6) and lockwashers (7).

3. If filter inlet line (2) and filter outlet line (3) were removed, remove blanking caps and install lines on adaptors (4) in the transmission, as tagged during removal.

4. Remove blanking caps and connect filter inlet line (2) and filter outlet line (3) to filter assembly (1), as tagged during removal.

5. If removed, secure filter inlet line (2) and filter outlet line (3) together with clips (5), bolt (8), lockwasher (7) and nut (9).

6. Start the engine and check for leaks. Tighten lines, fittings and filter locking collar as required.

7. Check transmission oil level and add oil if required. Refer to Section 120-0010, TRANSMISSION AND MOUNTING for correct fill level, and, use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

8. Ensure parking brake is applied, remove the body prop pins and lower the body. Refer to Section 270-0010, BODY AND MOUNTING.

9. Remove wheel chocks from all road wheels.

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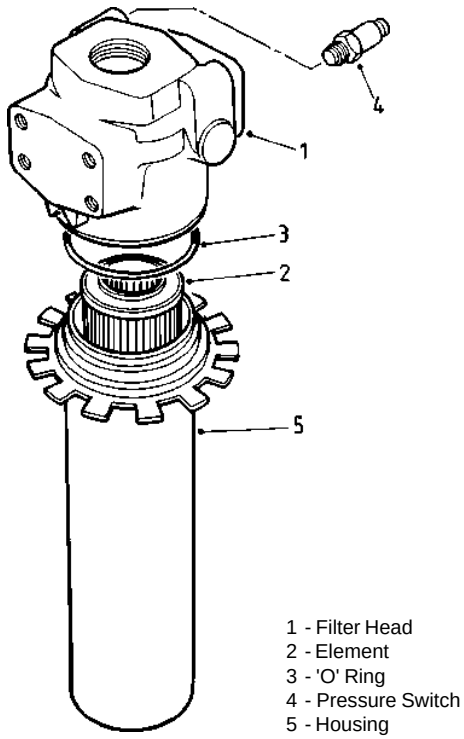


Fig. 2 - Exploded View of Transmission Oil Filter

CHANGING FILTER ELEMENT

Numbers in parentheses refer to Fig. 2.

Change filter element (2) at intervals specified in Section 300-0020, LUBRICATION SYSTEM. Element (2) should also be changed whenever a transmission overhaul is performed, or other internal servicing is carried out.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, raise the body and install the body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine.

3. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

4. With a suitable container under the filter assembly to catch draining oil, unscrew locking collar on housing (5) and remove housing (5) and element (2). Discard element (2).

5. Remove and discard 'O' ring (3) from filter head (1).

6. Clean housing (5) with clean fuel oil and dry with a clean lint free cloth. Lubricate new 'O' ring (3) and install on filter head (1).

7. Install new element (2) on filter head (1), making sure plastic insert in element centre contacts spiral snap ring on filter head (1).

8. Install housing (5) over element (2) and secure tightly with locking collar.

9. Start the engine and check the filter assembly for leaks. If leaks are present around locking collar on housing (5), tighten locking collar as required. If leaks persist, remove and install new 'O' ring (3) on filter head (1).

10. Check transmission oil level and add oil if required. Refer to Section 120-0010, TRANSMISSION AND MOUNTING for correct fill level, and, use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

11. Ensure parking brake is applied, remove the body prop pins and lower the body. Refer to Section 270-0010, BODY AND MOUNTING.

12. Remove wheel chocks from all road wheels.

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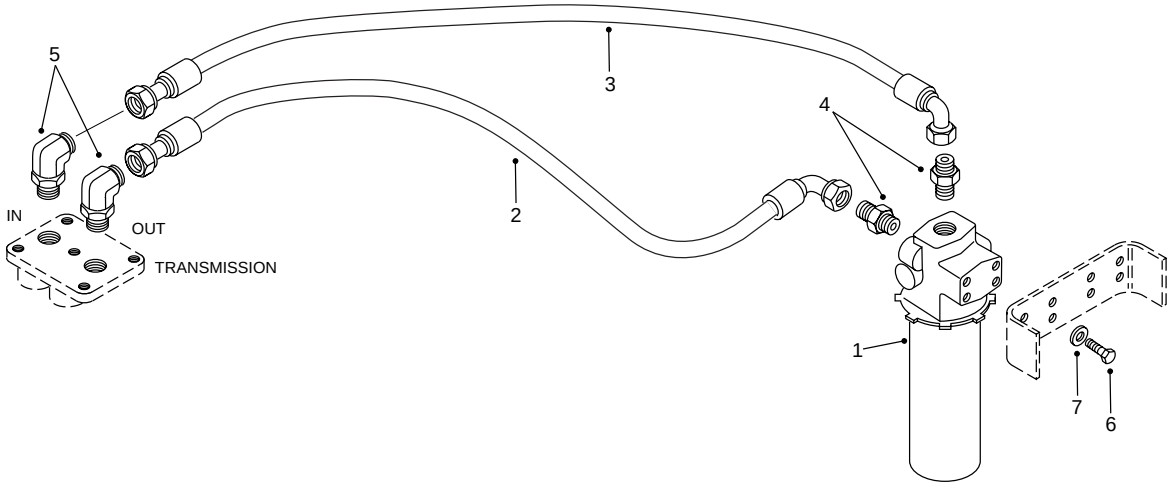
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1 - Filter Assembly
2 - Filter Inlet Line
3 - Filter Outlet Line
4 - Adaptor
5 - Elbow - 90°
6 - Bolt
7 - Washer

Fig. 1 - Transmission Oil Filter and Lines

DESCRIPTION

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Transmission oil filter assembly (1, Fig. 1) is installed in the transmission oil lines to remove dirt and other contaminants from the transmission oil to minimise wear and provide maximum service life for the transmission.

A bypass valve in filter head (1) ensures an adequate flow of oil to the transmission if element (2) becomes clogged and cannot pass oil through quickly enough to satisfy demand. The bypass valve opens at 3.5 bar (50 lbf/in²).

Installed in filter head (1) is pressure switch (4) which sends a signal to a filter restriction indicator warning light (mounted on the dash panel) to warn the operator when element (2) becomes sufficiently clogged to restrict oil flow. This indicates that element (2) should be changed.

Oil flows from the transmission to the inlet side of filter head (1) where the oil will then take one of two paths:

a. If the oil is cold and thick, or element (2) is clogged, oil pressure increases and opens the bypass valve allowing the oil to bypass the filter and flow through filter head (1) and exit at the outlet port to the transmission.

b. If the oil is warm and element (2) is not clogged, oil will flow through element (2) before returning to the transmission.

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Transmission - Transmission Oil Filter

Section 120-0100

REMOVAL

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

> **WARNING**
> **To prevent personal injury and property damage, be sure wheel chocks are properly secured and of adequate capacity to do the job safely.**

1. Position the vehicle in a level work area, raise the body and install the body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine.

3. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

4. Tag filter inlet line (2) and filter outlet line (3) to aid in installation and disconnect from filter assembly (1). Cap open line ends and fittings to prevent entry of dirt.

5. Support filter assembly (1) and remove bolts (6) and washers (7) securing filter assembly (1) to mounting bracket on the right hand frame rail. Remove filter assembly (1) and drain oil from assembly into a suitable container.

6. If filter assembly (1) is being replaced, remove adaptors (4) to use on new filter assembly (1).

7. If filter element (2, Fig. 2) is only being replaced, disassemble filter assembly (1) and replace element (2, Fig. 2) as described under 'Changing Filter Element'.

8. If required, remove filter inlet line (2) and filter outlet line (3) from the transmission. Cap open line ends and fittings to prevent entry of dirt.

INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. If new filter assembly (1) is being fitted, install adaptors (4) in filter head (1, Fig. 2).

2. Position filter assembly (1) to mounting bracket on the right hand frame rail and secure with bolts (6) and washers (7).

3. If filter inlet line (2) and filter outlet line (3) were removed, remove blanking caps and install lines on elbows (5) in the transmission, as tagged during removal.

4. Remove blanking caps and connect filter inlet line (2) and filter outlet line (3) on adaptors (4) on filter assembly (1), as tagged during removal.

5. Start the engine and check for leaks. Tighten lines, fittings and filter locking collar as required.

6. Check transmission oil level and add oil if required. Refer to Section 120-0010, TRANSMISSION AND MOUNTING for correct fill level, and, use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

7. Ensure parking brake is applied, remove the body prop pins and lower the body. Refer to Section 270-0010, BODY AND MOUNTING.

8. Remove wheel chocks from all road wheels.

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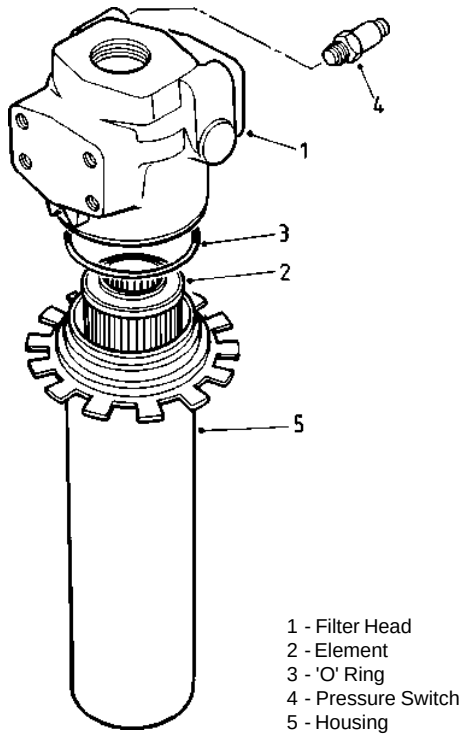


Fig. 2 - Exploded View of Transmission Oil Filter

CHANGING FILTER ELEMENT

Numbers in parentheses refer to Fig. 2.

Change filter element (2) at intervals specified in Section 300-0020, LUBRICATION SYSTEM. Element (2) should also be changed whenever a transmission overhaul is performed, or other internal servicing is carried out.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, raise the body and install the body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine.

3. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

4. With a suitable container under the filter assembly to catch draining oil, unscrew locking collar on housing (5) and remove housing (5) and element (2). Discard element (2).

5. Remove and discard 'O' ring (3) from filter head (1).

6. Clean housing (5) with clean fuel oil and dry with a clean lint free cloth. Lubricate new 'O' ring (3) and install on filter head (1).

7. Install new element (2) on filter head (1), making sure plastic insert in element centre contacts spiral snap ring on filter head (1).

8. Install housing (5) over element (2) and secure tightly with locking collar.

9. Start the engine and check the filter assembly for leaks. If leaks are present around locking collar on housing (5), tighten locking collar as required. If leaks persist, remove and install new 'O' ring (3) on filter head (1).

10. Check transmission oil level and add oil if required. Refer to Section 120-0010, TRANSMISSION AND MOUNTING for correct fill level, and, use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

11. Ensure parking brake is applied, remove the body prop pins and lower the body. Refer to Section 270-0010, BODY AND MOUNTING.

12. Remove wheel chocks from all road wheels.

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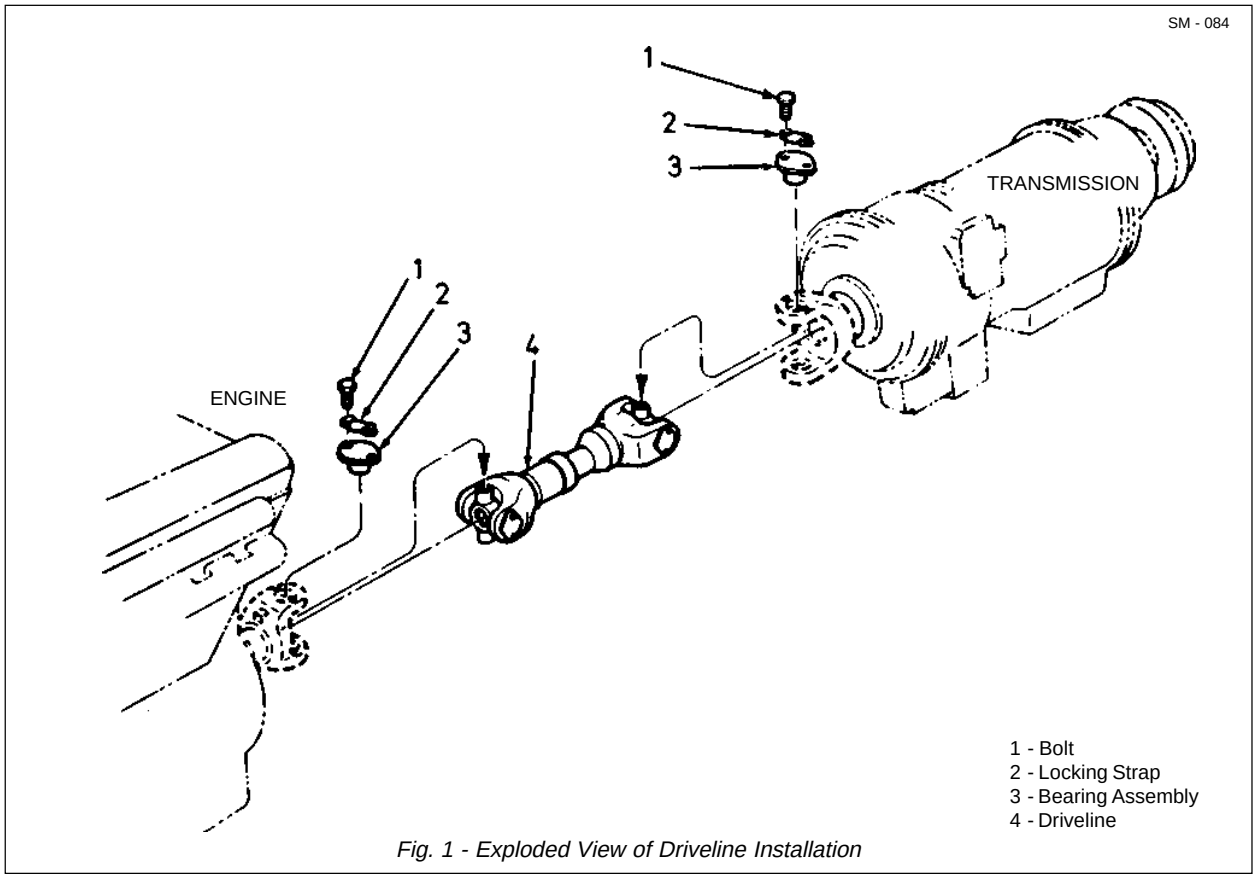


Fig. 1 - Exploded View of Driveline Installation

DESCRIPTION

The function of the driveline is to transmit rotating power from one point to another in a smooth and continuous action while allowing a degree of movement or misalignment of the components it connects.

The drivelines must operate through constantly changing relative angles between the components they are mounted to and must also be capable of changing length while transmitting torque.

A typical driveline consists of universal joints which allow some misalignment and permit the driveline to pivot in any direction, and, a light rigid hollow slip yoke and splined shaft assembly forming a slip joint.

The slip joint accommodates length variations generated during operation, preventing tension or compression loads from causing serious damage to the components.

Note: Extra care should be taken when handling the driveline since chips, dents, burrs or deformity on any rotating mass creates vibration and excessive wear during any operation.

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

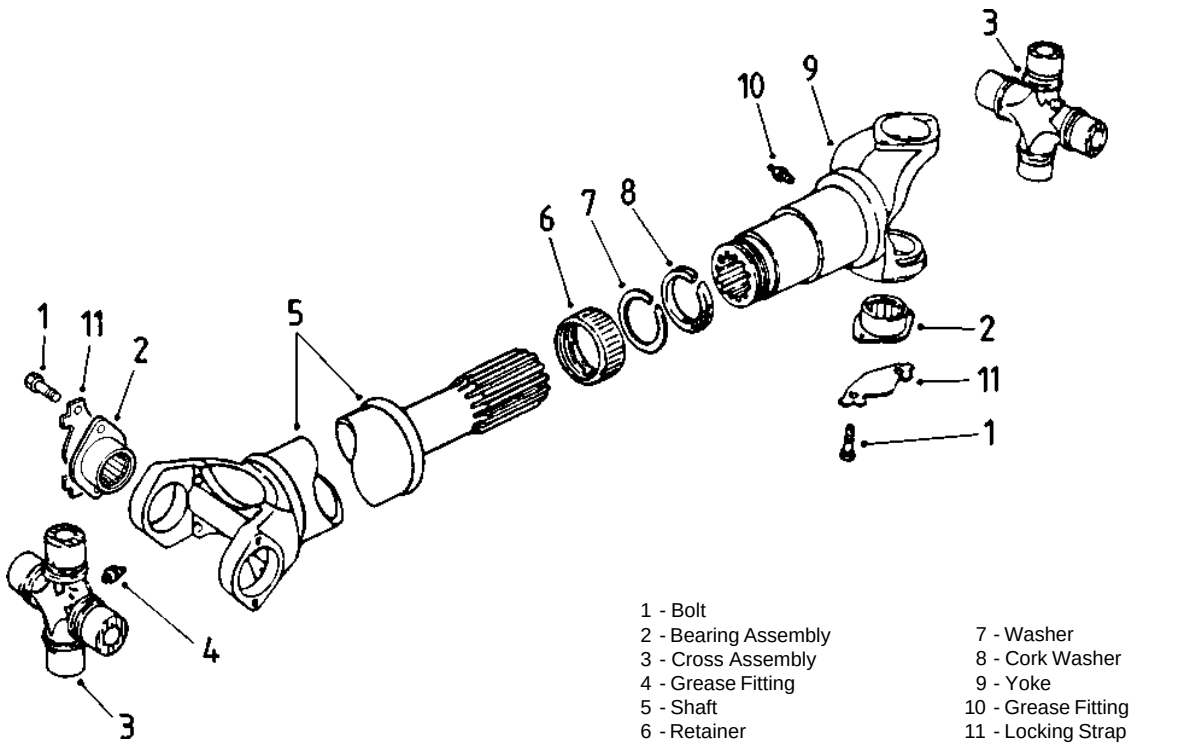
⚠ Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under a vehicle when the engine is running.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any other deformity of flanges will prevent accurate mating with the crosses and bearings. This will cause misalignment, which is accompanied by vibration and excessive wear.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

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1 - Bolt
2 - Bearing Assembly
3 - Cross Assembly
4 - Grease Fitting
5 - Shaft
6 - Retainer
7 - Washer
8 - Cork Washer
9 - Yoke
10 - Grease Fitting
11 - Locking Strap

Fig. 2 - Exploded View of Driveline

2. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

3. Using suitable lifting equipment, support driveline (4) assembly.

4. Straighten tabs of locking strap (2) and remove bolts (1) and locking strap (2) from bearing assemblies (3).

5. Using a soft faced hammer, tap bearing assembly (3) lightly clockwise, then anticlockwise. Pry up each end of bearing assembly (3) alternately until it is free from the flange yoke. Remove opposite bearing assembly (3) in the same manner.

6. Disconnect driveline (4) from flange yoke.

7. Repeat Steps 4 through 6 to disconnect opposite end of driveline (4).

8. Remove driveline (4) assembly from vehicle.

DISASSEMBLY

Numbers in parentheses refer to Fig. 2.

Slip Joint

1. If the slip joint is not properly marked, place identifying matching marks on shaft (5) and yoke (9) before disassembling driveline.

2. Remove retainer (6), from yoke (9) and pull yoke off shaft (5).

3. Remove cork washer (8), washer (7) and retainer (6) from shaft (5). Discard cork washer (8).

Universal Joint

1. Place the shaft (5) end of the driveline in a soft jawed vice. Bend down tabs of locking strap (11) and remove bolts (1) and locking strap.

2. Using a soft faced hammer, lightly tap bearing assembly (2) in a clockwise rotation, then counter-clockwise. Pry up each end of bearing assembly alternately until it is free from the yoke. Turn assembly over and remove opposite bearing assembly in the same manner.

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3. Remove cross assembly (3) from yoke by tilting slightly and lift out of yoke.

4. Repeat Steps 1 through 3 at opposite end of driveline.

INSPECTION

1. Clean all metal parts in a suitable solvent, except bearings. Clean bearings with a brush. Dry all parts, except bearings, with compressed air. Clean grease passages in slip yoke.

2. Clean bearings in volatile mineral spirits. Place bearings on a clean surface and allow to dry. Lubricate bearings with clean transmission oil, and check for wear and roughness by spinning by hand. If bearings show excessive wear, or if operation is rough or noisy, replace both bearings and cross assemblies. Never install new bearings on used crosses.

3. Inspect splines of shaft and yoke for nicks, burrs and excessive wear. Replace if wear is excessive or splines are nicked. Burrs may be removed with a fine file or medium India stone.

ASSEMBLY

Numbers in parentheses refer to Fig. 2.

Universal Joint

1. Place yoke (9) or shaft (5) in a soft jawed vice.

2. With grease fitting (4) on cross assembly (3) facing toward the tube end of the joint, insert one trunnion of the cross assembly into bearing assembly (2) hole in one of the yoke lugs. Be sure grease fitting in cross assembly is in line with grease fitting in slip yoke assembly. Tilt cross assembly until opposite trunnion will enter hole in the opposite yoke lug.

3. Insert bearing assembly (2) into yoke lug hole. Press bearing assembly into place with an arbor press or tap in place with a plastic hammer. Replace locking strap (11) and bolts (1).

4. Turn yoke assembly over and replace opposite bearing assembly (2) as described in Step 3. Tighten bolts (1) on both ends of yoke to a torque of 45 Nm (33 lbf ft), and bend tabs on locking straps (11) up against flat sides of bolts to prevent bolts loosening.

5. If joint appears to bind, tap bearing assembly (2) lightly to relieve any pressure on cross assembly (3).

6. Repeat Steps 1 through 5 for opposite end of driveline.

Slip Joint

1. Install retainer (6), washer (7) and new cork washer (8) over splines of shaft (5).

2. Lubricate the splines of the slip joint thoroughly with lubricant recommended in Section 300-0020, LUBRICATION SYSTEM.

3. Align splines of shaft (5) with yoke (9). Be sure that the arrow marks of yoke and shaft (or matching marks made in Step 1 during disassembly) are in line and slide the two together. These arrows line up the shaft for balance. Tighten retainer (6) on yoke (9) threads, and remove driveline assembly from the vice.

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any other deformity of flanges will prevent accurate mating with the crosses and bearings. This will cause misalignment, which is accompanied by vibration and excessive wear.

⚠ WARNINGS
To prevent personnel injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under a vehicle when the engine is running.

Note: Make sure driveline is assembled with alignment arrows and grease fittings properly aligned.

1. Using suitable lifting equipment, raise driveline (4) into position on the vehicle.

2. Install bearing assembly (3) in flange yoke over the end of the cross and secure with locking strap (2) and bolts (1). Tighten bolts (1) to a torque of 45 Nm (33 lbf ft), and bend tabs of locking strap (2) up against flat sides of bolts to prevent bolts loosening.

3. Repeat Step 2 on opposite side of flange yoke.

4. Repeat Steps 2 and 3 at opposite end of driveline.

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Driveline - Front Driveline

Section 130-0010

MAINTENANCE

Lubrication

Lubricate driveline with either a hand-operated or a pressure grease gun. Refer to Section 300-0020, LUBRICATION SYSTEM, for recommended lubricant and service intervals.

Periodic Inspection

Use a small pry bar to check companion flange yokes for looseness. If loose, drop one end of the driveline and twist the yoke to check backlash between splines and yokes. Replace any yoke that does not fit snugly.

Using a small pry bar, check the crosses for play. If loose, replace the cross and bearings. Check splines at slip joint and replace yoke, if excessively worn.

Note: In the event of a failed or worn bearing, a new cross with a new set of bearings must be installed.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

DRIVELINE DIAGNOSIS CHART

CONDITION	REASON	REMEDY
Vibration or Noise	Driveline bent or out of balance	Clean driveline in a suitable solvent. Inspect for contact with adjacent parts. If driveline is distorted or sprung, replace. If driveline does not run smoothly, and vibration is felt, remove driveline and dynamically balance the assembly.
	Driveline loose at yoke/flange	Check driveline mounting bolts for tightness. If loose, replace bolts and tighten to the proper torque specification.
	Worn or dry bearings	Test driveline by hand. If crosses are loose, replace cross and bearings as an assembly. Also, see below.
Excessive wear of cross and bearing assemblies	Lack of lubrication	Replace cross and bearings as an assembly. Lubricate cross assembly so that lubricant appears at ALL bearing and cross seals.
	Poor yoke/flange alignment run-outbalance.	Check yoke/flange for alignment, run-out and and/or Repair or replace as required.
	Driveline imbalance	Check to see if balance weights are missing or if driveline is distorted. If driveline is distorted, replace; if weights are missing, check balance of driveline dynamically and rebalance.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	1	Bolt	45	33
2	1	Bolt	45	33

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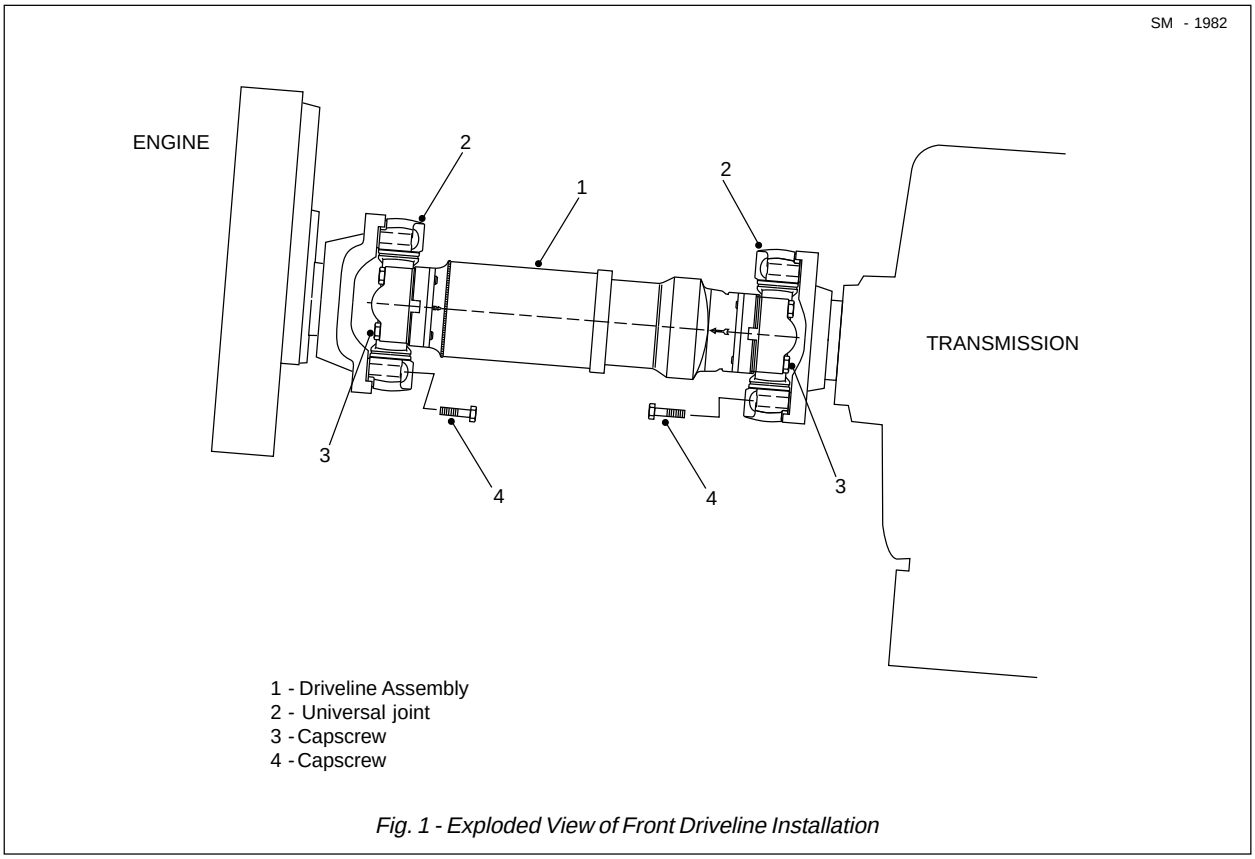


Fig. 1 - Exploded View of Front Driveline Installation

DESCRIPTION

The function of the driveline is to transmit rotating power from one point to another in a smooth and continuous action while allowing a degree of movement or misalignment of the components it connects.

The drivelines must operate through constantly changing relative angles between the components they are mounted to and must also be capable of changing length while transmitting torque.

A typical driveline consists of universal joints which allow some misalignment and permit the driveline to pivot in any direction, and, a light rigid hollow slip yoke and splined shaft assembly forming a slip joint.

The slip joint accommodates length variations generated during operation, preventing tension or compression loads from causing serious damage to the components.

Note: Extra care should be taken when handling the driveline since chips, dents, burrs or deformity on any rotating mass creates vibration and excessive wear during any operation.

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under a vehicle when the engine is running.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any other deformity of universal joints will prevent accurate mating. This will cause misalignment, which is accompanied by vibration and excessive wear.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

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2. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

3. Match mark universal joints (2) and their mating surfaces to ensure correct mating alignment when installing driveline assembly (1).

4. Support driveline (1) with suitable lifting equipment and remove capscrews (4) securing universal joints (2) to their mating components. Remove driveline assembly (1). If necessary tap driveline assembly (1) from its mating components with a soft faced hammer.

Note: Access to driveline assembly (1) can be obtained from underneath the vehicle.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

Universal Joint

1. Place the yoke end of driveline assembly (1) in a soft jawed vice, clamping on the tube of shaft.

Note: Do not distort the tube withn excessive grip.

2. Remove capscrews (3) and universal joints (2) from driveline assembly (1).

3. Place the shaft end of driveline assembly (1) in a soft jawed vice.

4. Remove capscrews (3) and universal joint (2) from driveline assembly (1).

INSPECTION

1. Clean all metal parts in a suitable solvent and dry all parts with compressed air.

2. Inspect splines of shaft and yoke for nicks, burrs and excessive wear. Replace if wear is excessive or splines are nicked. Burrs may be removed with a fine file or medium India stone.

3. Check the surfaces of the components that universal joints mate against for parallelism. Refer to Fig 2.

4. Check the condition of mounting capscrews and replace if required.

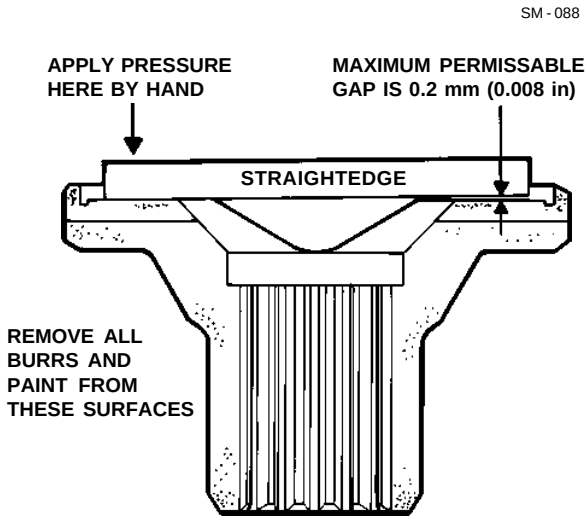


Fig. 2 - Checking Parallelism

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Universal Joint

1. Place the yoke end of driveline assembly (1) in a soft jawed vice, clamping on the tube of shaft.

Note: Do not distort the tube withn excessive grip.

2. Install universal joints (2) to yoke end of driveline assembly (1) and secure with capscrews (3). Tighten capscrews (3) to a torque of 128 - 142 Nm (95 - 105 lbf ft).

3. Place the shaft end of driveline assembly (1) in a soft jawed vice.

4. Install universal joint (2) to shaft end of driveline assembly (1) and secure with capscrews (3)

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any

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other deformity of universal joints will prevent accurate mating with the crosses and bearings. This will cause misalignment, which is accompanied by vibration and excessive wear.

⚠ WARNINGS
To prevent personnel injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ To prevent serious injury or death, DO NOT go under vehicle when the engine is running. Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc.

1. Using suitable lifting equipment, position driveline assembly (1) on the vehicle and align match marks on universal joints (2) with those on its mating surfaces.

2. Apply Loctite 242 to the threads of capscrews (4) and secure universal joints (2) to their mating surfaces with capscrews (4). Tighten capscrews (4) to a torque of 135 Nm (100 lbf ft).

3. Ensure the parking brake is applied and start the engine. Remove wheel blocks from all road wheels.

MAINTENANCE

Lubrication

Lubricate driveline with either a hand-operated or a pressure grease gun. Refer to Section 300-0020, LUBRICATION SYSTEM, for recommended lubricant and service intervals.

Periodic Inspection

Use a small pry bar to check companion flange yokes for looseness. If loose, drop one end of the driveline and twist the yoke to check backlash between splines and yokes. Replace any yoke that does not fit snugly.

Using a small pry bar, check the universal joints for play. If loose, replace the universal joints. Check splines at slip joint and replace universal joints, if excessively worn.

Note: In the event of a failed or worn bearing, a new universal joint with a new set of bearings must be installed.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

DRIVELINE DIAGNOSIS CHART

CONDITION	REASON	REMEDY
Vibration or Noise	Driveline bent or out of balance	Clean driveline in a suitable solvent. Inspect for contact with adjacent parts. If driveline is distorted or sprung, replace. If driveline does not run smoothly, and vibration is felt, remove driveline and dynamically balance the assembly.
	Driveline loose at yoke/flange	Check driveline mounting capscrews for tightness. If loose, replace capscrews and torque tighten to the proper specification.
Excessive wear of universal joints	Poor yoke/flange alignment and/or run-out	Check yoke/flange for alignment, run-out and balance. Repair or replace as required.
	Driveline imbalance	Check to see if balance weights are missing or if driveline is distorted. If driveline is distorted, replace; if weights are missing, check balance of driveline dynamically and rebalance.

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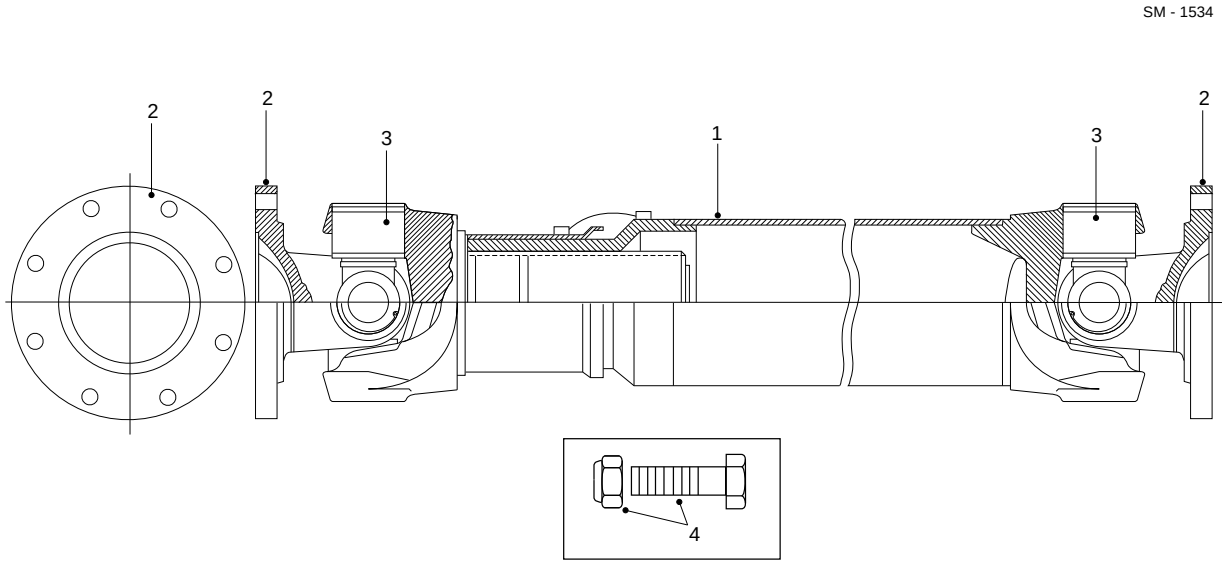
SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	3	Capscrew	128 - 142	95 - 105
1	4	Capscrew	135	100

* * * *

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1 - Driveline 2 - Flange Yoke 3 - Unit Package 4 - Bolt and Nut Set

Fig. 1 - Rear Driveline

DESCRIPTION

The function of the driveline is to transmit rotating power from one point to another in a smooth and continuous action while allowing a degree of movement or misalignment of the components it connects.

The drivelines must operate through constantly changing relative angles between the components they are mounted to and must also be capable of changing length while transmitting torque.

A typical driveline consists of universal joints which allow some misalignment and permit the driveline to pivot in any direction, and, a light rigid hollow slip yoke and splined shaft assembly forming a slip joint.

The slip joint accommodates length variations generated during operation, preventing tension or compression loads from causing serious damage to the components.

Note: Extra care should be taken when handling the driveline since chips, dents, burrs or deformity on any rotating mass creates vibration and excessive wear during any operation.

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under a vehicle when the engine is running.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any other deformity of flanges will prevent accurate mating with the crosses and bearings. This will cause misalignment, which is accompanied by vibration and excessive wear.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

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2. Turn steering wheel in both directions several times to relieve any pressure in the steering circuit. Block all road wheels.

3. Using suitable lifting equipment, support driveline (1) assembly.

4. Remove bolts and nuts (4) securing flange yoke (2) to transmission flange and differential flange.

5. Remove driveline (1) assembly from the vehicle.

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any other deformity of flanges will prevent accurate mating with the crosses and bearings. This will cause misalignment, which is accompanied by vibration and excessive wear.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ WARNING
Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under a vehicle when the engine is running.

1. Using suitable lifting equipment, raise driveline (1) assembly into position on the vehicle.

2. Connect flange yoke (2) to transmission flange with bolts and nuts (4). Tighten bolts (4) to a torque of 290 - 300 Nm (215 - 220 lbf ft).

3. Connect flange yoke (2) to differential flange with bolts and nuts (4). Tighten bolts (4) to a torque of 290 - 300 Nm (215 - 220 lbf ft).

MAINTENANCE

Lubricate driveline with either a hand-operated or a pressure grease gun. Refer to Section 300-0020, LUBRICATION SYSTEM, for recommended lubricant and service intervals.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	4	Bolt and Nut	290 - 300	210 - 220

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DRIVELINE DIAGNOSIS CHART		
CONDITION	REASON	REMEDY
Vibration or Noise	Driveline bent or out of balance	Clean driveline in a suitable solvent. Inspect for contact with adjacent parts. If driveline is distorted or sprung, replace. If driveline does not run smoothly, and vibration is felt, remove driveline and dynamically balance the assembly.
	Driveline loose at yoke/flange	Check driveline mounting bolts for tightness. If loose, replace bolts and tighten to the proper torque specification.
	Worn or dry bearings	Test driveline by hand. If crosses are loose, replace cross and bearings as an assembly. Also, see below.
Excessive wear of cross and bearing assemblies	Lack of lubrication	Replace cross and bearings as an assembly. Lubricate cross assembly so that lubricant appears at ALL bearing and cross seals.
	Poor yoke/flange alignment run-outbalance.	Check yoke/flange for alignment, run-out and and/or Repair or replace as required.
	Driveline imbalance	Check to see if balance weights are missing or if driveline is distorted. If driveline is distorted, replace; if weights are missing, check balance of driveline dynamically and rebalance.

* * * *

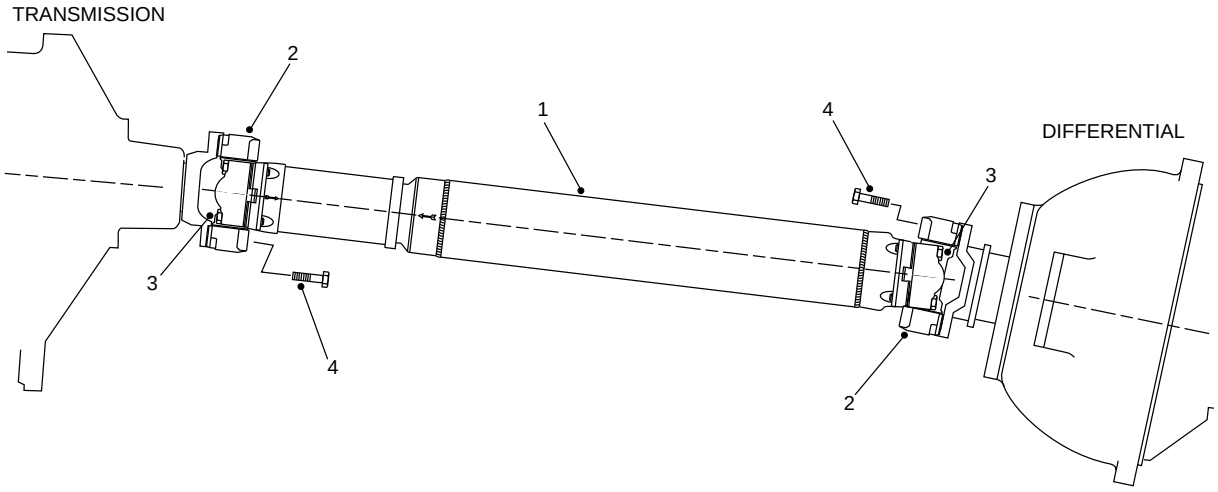
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1 - Driveline Assembly
2 - Universal joint
3 - Capscrew
4 - Capscrew

Fig. 1 - Exploded View of Rear Driveline Installation

DESCRIPTION

The function of the driveline is to transmit rotating power from one point to another in a smooth and continuous action while allowing a degree of movement or misalignment of the components it connects.

The drivelines must operate through constantly changing relative angles between the components they are mounted to and must also be capable of changing length while transmitting torque.

A typical driveline consists of universal joints which allow some misalignment and permit the driveline to pivot in any direction, and, a light rigid hollow slip yoke and splined shaft assembly forming a slip joint.

The slip joint accommodates length variations generated during operation, preventing tension or compression loads from causing serious damage to the components.

Note: Extra care should be taken when handling the driveline since chips, dents, burrs or deformity on any rotating mass creates vibration and excessive wear during any operation.

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under a vehicle when the engine is running.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any other deformity of universal joints will prevent accurate mating. This will cause misalignment, which is accompanied by vibration and excessive wear.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

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2. Turn steering wheel in both directions several times to relieve pressure in the steering circuit. Block all road wheels.

3. Match mark universal joints (2) and their mating surfaces to ensure correct mating alignment when installing driveline assembly (1).

4. Support driveline (1) with suitable lifting equipment and remove capscrews (4) securing universal joints (2) to their mating components. Remove driveline assembly (1). If necessary tap driveline assembly (1) from its mating components with a soft faced hammer.

Note: Access to driveline assembly (1) can be obtained from underneath the vehicle.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

Universal Joint

1. Place the yoke end of driveline assembly (1) in a soft jawed vice, clamping on the tube of shaft.

Note: Do not distort the tube withn excessive grip.

2. Remove capscrews (3) and universal joints (2) from driveline assembly (1).

3. Place the shaft end of driveline assembly (1) in a soft jawed vice.

4. Remove capscrews (3) and universal joint (2) from driveline assembly (1).

INSPECTION

1. Clean all metal parts in a suitable solvent and dry all parts with compressed air.

2. Inspect splines of shaft and yoke for nicks, burrs and excessive wear. Replace if wear is excessive or splines are nicked. Burrs may be removed with a fine file or medium India stone.

3. Check the surfaces of the components that universal joints mate against for parallelism. Refer to Fig 2.

4. Check the condition of mounting capscrews and replace if required.

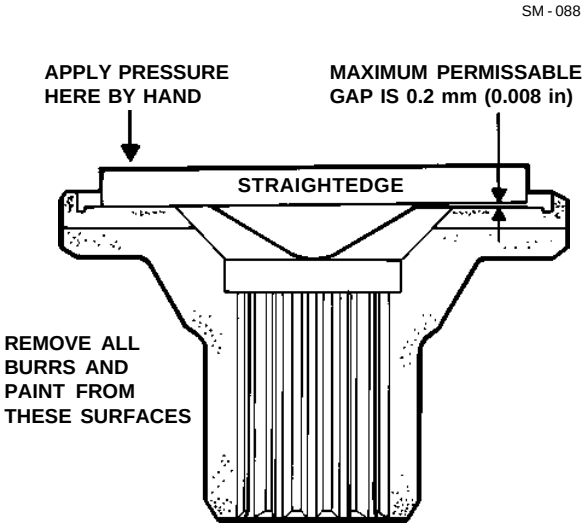


Fig. 2 - Checking Parallelism

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Universal Joint

1. Place the yoke end of driveline assembly (1) in a soft jawed vice, clamping on the tube of shaft.

Note: Do not distort the tube withn excessive grip.

2. Install universal joints (2) to yoke end of driveline assembly (1) and secure with capscrews (3). Tighten capscrews (3) to a torque of 312 - 325 Nm (230 - 240 lbf ft).

3. Place the shaft end of driveline assembly (1) in a soft jawed vice.

4. Install universal joint (2) to shaft end of driveline assembly (1) and secure with capscrews (3)

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any

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other deformity of universal joints will prevent accurate mating with the crosses and bearings. This will cause misalignment, which is accompanied by vibration and excessive wear.

⚠ WARNINGS
To prevent personnel injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ To prevent serious injury or death, DO NOT go under vehicle when the engine is running. Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc.

1. Using suitable lifting equipment, position driveline assembly (1) on the vehicle and align match marks on universal joints (2) with those on its mating surfaces.

2. Apply Loctite 242 to the threads of capscrews (4) and secure universal joints (2) to their mating surfaces with capscrews (4). Tighten capscrews (4) to a torque of 235 Nm (173 lbf ft).

3. Ensure the parking brake is applied and start the engine. Remove wheel blocks from all road wheels.

MAINTENANCE

Lubrication

Lubricate driveline with either a hand-operated or a pressure grease gun. Refer to Section 300-0020, LUBRICATION SYSTEM, for recommended lubricant and service intervals.

Periodic Inspection

Use a small pry bar to check companion flange yokes for looseness. If loose, drop one end of the driveline and twist the yoke to check backlash between splines and yokes. Replace any yoke that does not fit snugly.

Using a small pry bar, check the universal joints for play. If loose, replace the universal joints. Check splines at slip joint and replace universal joints, if excessively worn.

Note: In the event of a failed or worn bearing, a new universal joint with a new set of bearings must be installed.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

DRIVELINE DIAGNOSIS CHART

CONDITION	REASON	REMEDY
Vibration or Noise	Driveline bent or out of balance	Clean driveline in a suitable solvent. Inspect for contact with adjacent parts. If driveline is distorted or sprung, replace. If driveline does not run smoothly, and vibration is felt, remove driveline and dynamically balance the assembly.
	Driveline loose at yoke/flange	Check driveline mounting capscrews for tightness. If loose, replace capscrews and torque tighten to the proper specification.
Excessive wear of universal joints	Poor yoke/flange alignment and/or run-out	Check yoke/flange for alignment, run-out and balance. Repair or replace as required.
	Driveline imbalance	Check to see if balance weights are missing or if driveline is distorted. If driveline is distorted, replace; if weights are missing, check balance of driveline dynamically and rebalance.

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SPECIAL TORQUE SPECIFICATIONS

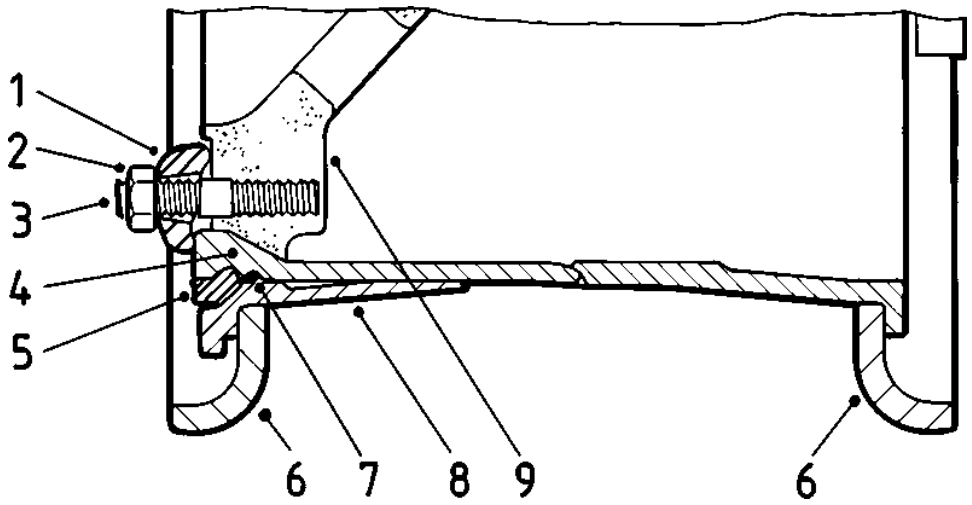
FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	3	Capscrew	312 - 325	230 - 240
1	4	Capscrew	235	173

* * * *

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1 - Clamp
2 - Wheel Nut
3 - Wheel Stud
4 - Rim
5 - Lock Ring
6 - Flange
7 - 'O' Ring
8 - Bead Seat Band
9 - Wheel

Fig. 1 - Sectional View of Typical Wheel Rim Assembly

DESCRIPTION

The wheel is mounted on the axle spindle with two tapered roller bearings mounted in the hub. The brake disc is bolted to the wheel. The tyre rim consisting of a base assembly, bead seat band and flanges is mounted on the wheel with clamps and nuts.

The wheel itself is a large cylindrical casting with the bearing bores and other finished surfaces machined after the wheel is cast.

The rim assembly consists of a rim base, inner and outer flanges, bead seat band, 'O' ring and lock ring.

The wheel rim assembly is designed to be replaced with a pre-assembled tyre and rim.

PREPARATION FOR SERVICING

⚠ WARNING
Before loosening rim clamps or performing any service on the tyre or rim components, to prevent personal injury and property damage, completely deflate tyre by removing the valve cap and core. Insert a thin wire through the valve to be sure the valve is not plugged. Even a flat tyre, in some cases, will retain sufficient air pressure to blow off a rim component with enough force to cause injury or death.

⚠ WARNING
Tyre explosion hazard. Gases that build up inside an air inflated tyre mounted on a rim during welding and/or heating of rim components can ignite, causing an explosion of the tyre and rim components. This warning also applies to Nitrogen gas inflated tyres. Ignition will not occur in a Nitrogen gas atmosphere; but the pressure build up from the applied heat may be sufficient to cause a blowout severe enough to injure or kill. Never weld or otherwise apply heat on rim components with the tyre mounted on the rim, whether the tyre is inflated or deflated, to prevent injury or property damage from the potential tyre explosion! Also, do not attempt to repair rims or rim components by welding or heating, even if the tyre is not mounted on the rim. It is recommended to scrap questionable rim parts unless specific permission and repair procedures are obtained in writing either from the company or the rim manufacturer.

REMOVING TYRE AND RIM ASSEMBLY

Numbers in parentheses refer to Fig. 1.

If the tyre and rim assembly is to be replaced with a pre-assembled tyre and rim assembly, it is not

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necessary to remove the tyre from the rim on the machine. The tyre and rim may be removed from the machine as an assembly, and transported to a more desirable location for removing the tyre from the rim.

> **WARNING**
> **To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of sufficient capacity to do the job safely.**

1. Apply parking brake and block the front and rear of all wheels, except the one to be raised. Use wooden blocks 100 mm x 100 mm (4 in x 4 in) or larger.

2. For tyre to be removed, set up jack to support machine weight, but do not raise machine.

3. Completely deflate tyre by removing valve cap and core. Check valve stem by running a piece of wire through the stem to make sure it is not plugged. See warning under 'Preparation For Servicing'.

4. Break wheel nuts (2) loose, but do not remove from wheel studs (3).

5. Jack the machine up only as high as necessary to remove wheel from machine, and place safety blocks under the frame.

6. Support the tyre with a chain or rope sling of sufficient strength attached to a suitable lifting device. Remove wheel nuts (2) and clamps (1) from wheel studs (3). Lift tyre and rim assembly clear.

DISMOUNTING TYRE FROM RIM

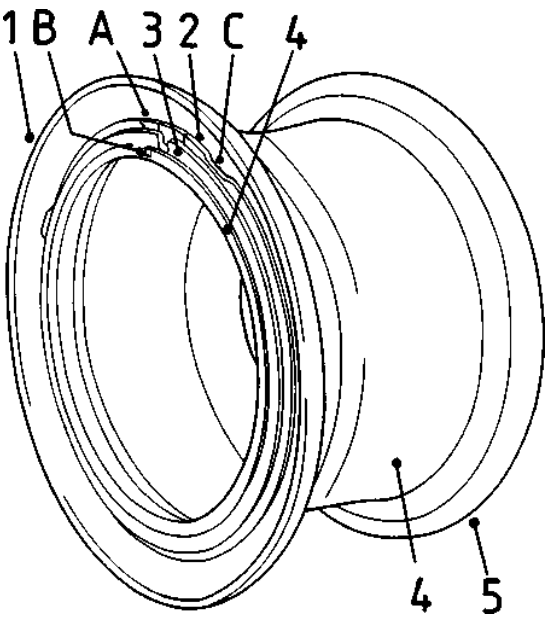
Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Note: The following instructions apply to use of hand tools. For procedures and tooling required to dismount the tyre from the rim, using hydraulic tools, contact the relevant tyre manufacturer.

> **WARNING**
> **When lifting tyre from rim, be sure the equipment is of sufficient capacity and properly secured to do the job safely.**

1. Completely deflate tyre if not done previously. See warning under 'Preparation For Servicing'. Tape valve threads to protect from damage, leaving valve end

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1 - Outer Flange
2 - Bead Seat Band
3 - Lock Ring
4 - Rim
5 - Inner Flange

Fig. 2 - Typical Rim Assembly

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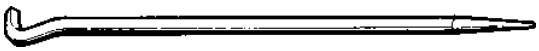


Fig. 3 - Pry Bar

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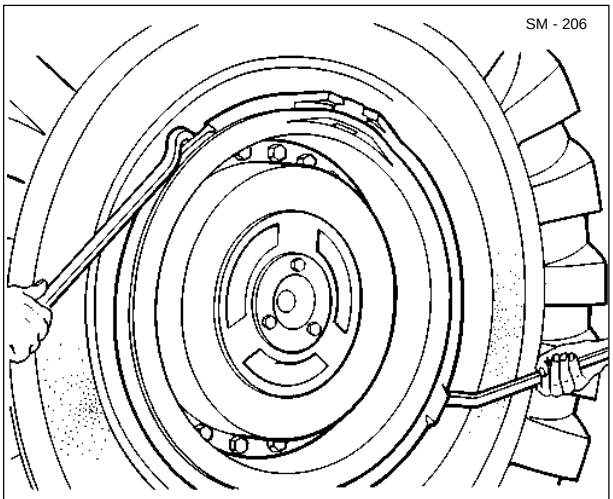


Fig. 4 - Breaking Typical Tyre Bead Loose

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open to avoid any possibility of trapping air inside the tyre.

2. Break outer tyre bead loose by placing the flat hooked end of a pry bar, see Fig. 3, into one of the breaking slots (C) between the bead seat band (2) and outer flange (1). A length of pipe slipped over straight end of bar will increase leverage. Twist straight end of bar around toward tyre to break this portion of bead. A second person may now insert another pry bar of the same type into the space between the bead seat band and flange, and with the same twisting action, hold the space gained with the first pry bar. Move first pry bar all the way around the wheel, twisting and following up with second pry bar, until inner tyre bead is loose.

3. Start bead seat band (2) in away from lock ring (3) by placing hooked end of pry bar in groove of rim (4), between ends of lock ring, and prying up with bar. Using two tools, as in Step 2, work completely around wheel.

4. Pry lock ring (3) out in same manner by starting at prying notch (B) in wheel, and work all the way around wheel with the two pry bars.

5. Remove and discard 'O' ring (7, Fig. 1).

6. After removing lock ring (3), pry out and remove bead seat band (2). Outer flange (1) may now be removed.

7. Similar breaking slots are provided on the inside of rims. The inner bead on the back side of the tyre may be broken by using the same method as in Step 2, for the outer bead. If the wheel assembly is still on the machine, another method which can be used is to place a small jack between the inner flange and some solid part of the machine frame. By extending the jack, pressure is exerted, which forces the tyre bead off the rim seat. Work around the wheel until the bead is broken at all points.

8. Using suitable lifting equipment, remove tyre from rim. This completes the removal of the tyre.

Note: If tyre and rim is on machine, and no tyre lifting equipment is available, 'walk' tyre off rim as follows: force bottom of tyre outward as far as possible; lower jack enough to allow weight of tyre to rest on ground; force top of tyre out as far as possible; raise jack to original height and repeat the above until tyre is off rim.

INSPECTION

Tyre

Check interior surface of the tyre to determine its condition. Inspect for cuts or fabric breaks that have penetrated the tyre body. The casing should be inspected closely for any sharp, pointed objects that may have penetrated the tyre body but is invisible from the outside. All dust, dirt, water or other foreign matter should be cleaned from the inside of the tyre.

Replace valve core assembly if condition is questionable.

Rim Assembly

Overloading, improper tyre inflation, rough terrain, high speed, accidents, dirt accumulation and corrosion all tend to reduce service life of rims and rim components. It is recommended that rims be inspected, as below, not less than at every tyre change and, as the warranty limit approaches, consideration be given to rim replacement.

> ⚠ **WARNING**
> **Never mix components of one manufacturer's rims with those of another. Using the rim base of one manufacturer with the lock ring of another or vice versa is dangerous. The lock ring of one may not fully engage with the lock ring groove of the other. Always consult the rim manufacturer for proper matching and assembly instructions. Also, use and servicing of damaged, worn out, or improperly assembled rim assemblies is a very dangerous practice. Failure to comply with the above warnings could result in explosions from tyre pressure causing serious personal injury and property damage.**

1. Clean all rust and dirt from rim parts and wheel.

2. Coat parts with primer paint. Allow thorough drying before assembling.

3. Inspect rim assemblies (Fig. 2) for bent, cracked, distorted, battered, and rusted parts which may have resulted from abusive practices outlined above. Replace any damaged parts with new parts.

4. Discard 'O' ring and replace with new one.

Note: Handle 'O' rings carefully, as damage will prevent an airtight seal for tyre inflation.

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MOUNTING TYRE ON RIM

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

> **⚠ WARNING**
> **When lifting tyre onto rim, be sure the equipment is of sufficient capacity and properly secured to do the job safely.**

1. If tubeless tyre valve assembly was removed from rim, install this assembly in the rim valve hole and tighten securely.

2. Tyre installations are performed in basically the same manner whether the rim (4) is on or off the machine. For off-machine installations, lay the rim on blocks or a mounting stand with 'O' ring groove up. The rim should be just off the floor enough so the tyre rests on the rim and does not touch the floor. The blocks should not extend more than 13 mm (0.5 in) beyond the rim base, so they won't interfere with inner flange (5).

3. Install inner flange (5) over rim (4).

4. Before assembly of tyre to rim, lubricate both tyre beads and new rubber 'O' ring (7, Fig. 1) with a thin solution of vegetable base soap and water. Make certain tyre valve assembly is securely in place. Lower the tyre onto the rim, seating tyre firmly against inner flange (5).

5. Install outer flange (1) on rim (4).

6. Install bead seat band (2) on rim (4).

7. Install lock ring (3) in groove of rim (4). Use pry bar for this operation, as illustrated in Fig. 5.

8. Force bead seat band (2) past 'O' ring groove in rim (4) by prying, or with lift truck forks. Use blocking between the forks and tyre to prevent tyre damage. Lubricate area of rim adjacent to 'O' ring groove with a thin solution of soap and water or another approved lubricant which is not harmful to rubber. Avoid using an excessive amount of lubricant. Insert a new 'O' ring (7, Fig. 1) in the groove of the rim behind the lock ring.

9. Lift tyre upwards to effect a seal between bead seat band (2) and 'O' ring (7, Fig. 1). In some cases

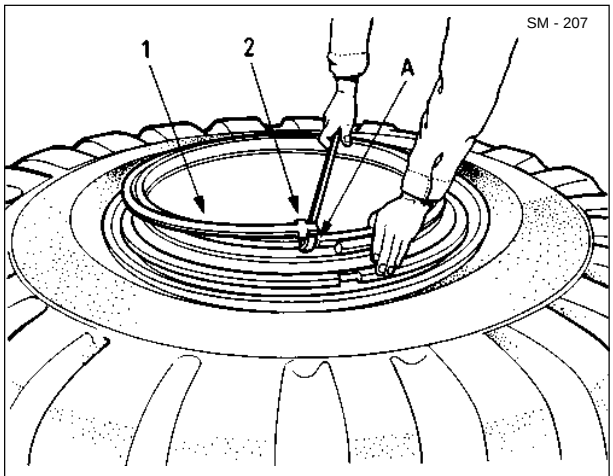


Fig. 5 - Installing Typical Lock Ring

the tyre will automatically spring out, making this step unnecessary.

MOUNTING TYRE AND RIM ASSEMBLY ON WHEEL

Numbers in parentheses refer to Fig. 1.

> **⚠ WARNING**
> **Be sure lifting equipment is of sufficient capacity and properly secured to do the job safely.**

1. Support tyre and rim assembly with a chain or rope sling attached to an overhead lifting device and slide onto wheel (9) of the machine. Side with lock ring (5) and bead seat band (8) should be facing outward.

2. Install clamps (1) and start wheel nuts (2) on wheel studs (3). Gradually tighten wheel nuts opposite each other, until all nuts are snug, torque tighten wheel nuts (2) to 690 Nm (510 lbf ft). Re-tighten nuts after a few hours operation.

Note: Wheel rim fastener torque should be checked regularly, particularly on new machines or newly-installed wheels, to maintain the required wheel rim-clamp load. A newly installed wheel or a new machine should be checked at 30 day intervals until rim fasteners show no significant torque loss from the previous check. After that, a 90 day torque check interval should be adequate.

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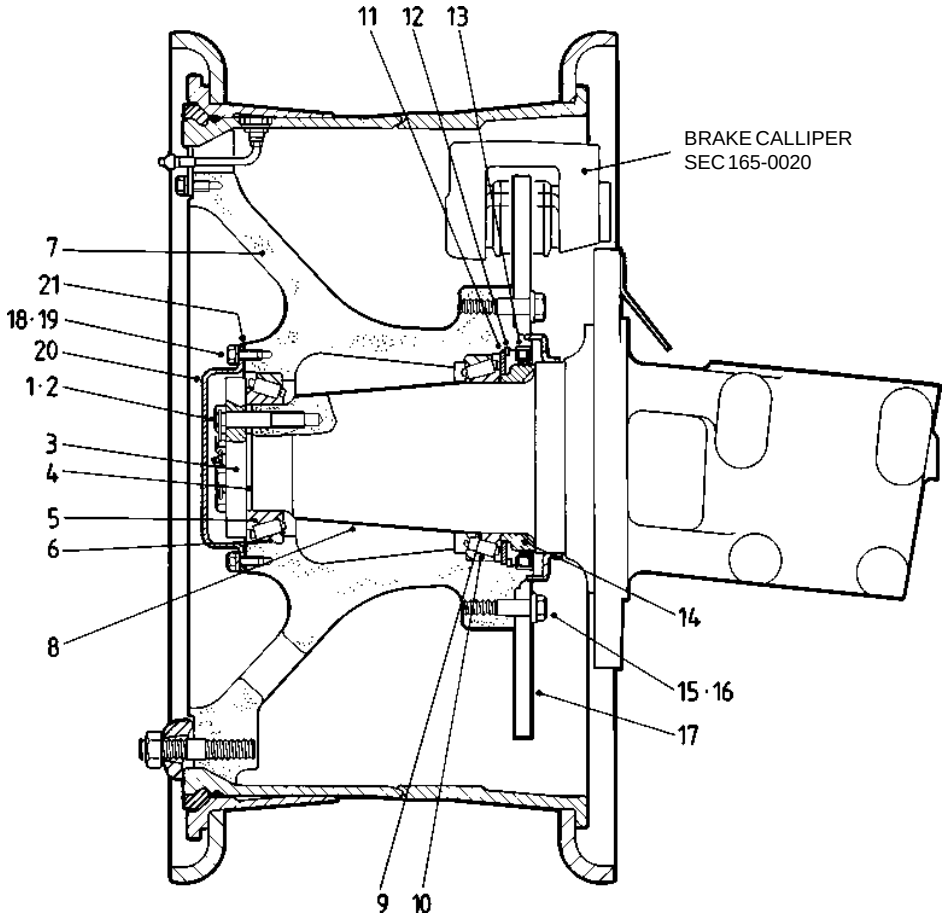


Fig. 6 - Sectional View of Front Wheel Assembly.

WHEEL

Removal and Disassembly

Numbers in parentheses refer to Fig. 6.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of sufficient capacity to do the job safely.

⚠ To prevent personal injury and property damage, completely deflate tyre by removing the valve cap and core. Insert a thin wire through valve to be sure valve is not plugged. Even a flat tyre, in some cases, will retain sufficient air pressure to blow off a rim component with enough force to cause injury or death.

1. Block the front and rear of all wheels, except the one to be raised. Jack up or lift machine so its weight is no longer on that wheel.

2. Deflate tyre completely, and remove the tyre and rim assembly from the wheel. Follow instructions under 'Removing Tyre and Rim Assembly'.

⚠ WARNING
To prevent possible personal injury, relieve the pressure in the braking system. The exact procedure must be followed as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

3. Relieve the pressure in the braking system. Refer to Section 250-0000, BRAKING SYSTEM SCHEMATIC. Disconnect brake hydraulic line at brake calliper.

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4. Remove brake calliper. Refer to Section 165-0020, BRAKE PARTS.

5. Remove bolts (18) and lockwashers (19) which secure cover (20) to wheel (7). Remove cover (20) and gasket (21).

6. Remove lockwire (1), bolts (2), plate (3) and shim pack (4) from spindle (8). Retain shim pack (4).

7. With suitable lifting equipment, pull wheel (7) off of spindle (8), being careful that outer bearing cone (5) does not fall.

8. If required, remove bolts (15) and lockwashers (16) securing brake disc (17) to wheel (7), and remove brake disc.

9. Remove seal (13), using hammer and soft drift.

10. Remove snap ring (12).

11. Tap out washer (11) and remove inner bearing cone (9) from spindle (8).

Note: Bearing cups and cones must always be replaced as a matched set, never separately.

⚠ WARNING
Be sure to use a soft drift and take care when driving out bearing cups with a drift, to avoid personal injury from chips or fragments.

12. If required, remove bearing cups (6 & 10) from wheel (7), by driving out with a soft drift.

13. During operation, seal (13) rides on bushing (14) which is shrunk on spindle (8) to provide a smooth contact surface for the seal. If the bushing is found to be rough or worn, remove bushing (14).

Inspection

1. Thoroughly clean all metal components, except bearing cones, in a suitable solvent. Dry with compressed air and coat all threaded components with light oil to facilitate assembly.

2. Using a suitable solvent, clean bearings and wipe dry with a lint free cloth. Lubricate lightly with light oil and spin by hand, to check for wear and roughness. Replace with new bearings if excessively worn, or if operation is rough or noisy.

3. Inspect all machined surfaces of all parts for scoring, pitting, corrosion and burring. Resurface or replace with new parts as necessary.

4. Inspect all threaded components, and repair or replace as necessary.

Assembly and Installation

Numbers in parentheses refer to Fig. 6.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of sufficient capacity to do the job safely.

⚠ Be sure to use a soft drift and take care when driving in bearing cups with a drift, to avoid personal injury from chips or fragments.

1. If removed, heat bushing (14) to 177 - 205° C (350 - 400° F) in oil to expand it for installation. If oil heating equipment is not available, heat the bushing evenly to 205° C (400° F). This takes about 1 minute, using a torch with a heating tip. Use a Tempilstik or other temperature gauge to make sure the bushing is

BEARING ADJUSTMENT

INITIAL SEATING BOLT TORQUE			GAUGING BOLT TORQUE			SHIM PACK THICKNESS		FINAL BOLT TORQUE		
No. of Bolts	Nm	lbf ft	No. of Bolts	Nm	lbf ft	mm	in	All Bolts	Nm	lbf ft
6	54	40	2	54	40	Ave. Gap + 0.025	Ave. Gap + 0.001	6	224	165

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hot enough. Slide heated bushing (14) on spindle (8) and tap lightly with a hammer to seat it.

Note: Do not apply flame directly to bushing. Place bushing on steel plate and apply flame to centre of plate, to evenly distribute heat.

2. If removed, install bearing cups (6 & 10) in their respective wheel (7) bearing bores with care to avoid damaging their raceways. Installation by press fit at ambient temperature is best. Note that the cups must seat fully against the shoulders of the cup bores in the wheel hub to assure retention of bearing adjustment. If carbon dioxide, or dry ice, freezing of the cup is used, remember to permit the cup and hub to warm to ambient temperature after insertion and then to tap them with a soft steel drift and hammer to seat.

3. Lubricate the bearings with lubricant specified in Section 300-0020, LUBRICATION SYSTEM. Do not pack bearings solidly with lubricant, as too much is harmful. Fill wheel cavity not less than one-third to not more than one-half full with lubricant.

4. If removed, install brake disc (17) on wheel (7) and secure with bolts (15) and lockwashers (16). Tighten bolts (15) to a torque of 420 Nm (310 lbf ft).

5. Install inner cone (9), washer (11), snap ring (12) and seal (13) in wheel end facing spindle. Seal lip must be facing out.

6. With suitable lifting equipment slide wheel (7) assembly onto spindle (8).

7. Install outer bearing cone (5) on spindle (8) and seat in outer bearing cup (6).

Note: Ensure all dirt, grease, and oil is completely removed from plate (3), shims (4) and end of spindle (8) to allow accurate setting of the bearing pre-load.

8. Install plate (3), without shims (4) on end of spindle (8), and secure with six bolts (2). Tighten bolts (2) evenly in equal increments to 'initial seating bolt torque' as specified in 'Bearing Adjustment Table', while rotating and bumping the wheel (7) assembly.

9. Remove bolts (2) and tap wheel (7) assembly to free bearings.

10. Reassemble plate (3) without shims (4) and using only two bolts (2) located 180° apart, adjacent to the gauging holes in plate (3). Tighten bolts (2) evenly in equal increments to 'Gauging Bolt Torque', as specified in 'Bearing Adjustment Table', while rotating and bumping wheel (7) assembly.

11. Determine gap between plate (3) and end of spindle (8) at both gauging holes. To determine gap, use a depth micrometer in both gauging holes to measure distance from outer face of plate (3) to end of spindle (8). Using a micrometer, measure thickness of plate (3). Subtract plate thickness reading from depth gauge readings.

12. Average the two readings, obtained at Step 11, in increments of 0.025 mm (0.001 in) and round off to the next higher 0.025 mm (0.001 in). This is the average gap. The required shim pack (4) thickness is equal to the average gap plus the tabulated constant as shown in the 'Bearing Adjustment Table'.

13. Install the required shim pack (4), plate (3) and bolts (2) on the end of spindle (8). Tighten bolts (2) evenly in equal increments to 'Final Bolt Torque', as specified in 'Bearing Adjustment Table', while rotating and bumping the wheel (7) assembly. Secure bolts (2) with lockwire (1).

14. Install gasket (21) and cover (20) and secure to wheel (7) with bolts (18) and lockwashers (19).

15. Install brake calliper, connect brake hydraulic line and bleed braking system. Refer to Section 165-0020, BRAKE PARTS.

16. Install tyre and rim assembly as described under 'Mounting Tyre and Rim Assembly on Machine'.

TYRE INFLATION

⚠ WARNINGS

To prevent personal injury and property damage, the tyre and rim assembly should be placed in a safety cage before inflating. If no safety cage is available or tyre is on the machine, the tyre and rim assembly should be wrapped with safety chains or with lash cables before inflating.

⚠ Even with these precautions remember that air-blast is a potential hazard. Tyre inflation should be carried out away from busy working areas.

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⚠ WARNING
To avoid personal injury and property damage, never stand or sit in front of a mounted tyre during tyre inflation. Use a clip-on air chuck with a long hose and stand to one side while the tyre is being inflated.

⚠ WARNING
To prevent personal injury and property damage, always prevent flammable vapours that could produce tyre explosions, from being pumped into tyres during inflation, by observing the following precautions:
A.
Use an air compressor and reservoir located inside a heated building, when available, so that alcohol, methanol, or other flammable antifreeze liquids are not needed in the air tanks to prevent moisture freezing in the tank and lines in subfreezing temperatures.
B.
Make sure that paints, lacquers, paint thinners, or similar materials that produce volatile, flammable vapours are not used or stored near the air intake of the compressor that supplies the air for inflating tyres. The compressor should be isolated from all such sources of flammable vapours.
C.
Be sure to thoroughly flush and blow off all flammable solvents used for cleaning the air compressor inlet screen before using the compressor for tyre inflation, or any other purpose.
D.
Do not charge batteries, either in or out of a machine, near the air inlet of a compressor used for inflating tyres. Charging batteries produces highly explosive hydrogen gas which can be readily drawn into a nearby compressor inlet and pumped into the tyre.
E.
Never exceed the specified concentration of alcohol when adjusting the alcohol vaporiser, or adding alcohol to the auxiliary air tank, used on machine air systems to prevent freezing or moisture condensate in below-freezing temperatures. Excessive alcohol, added to the machines air tanks in this manner can produce flammable vapours that will be pumped into a tyre when this air supply is used for tyre inflation if the tyre inflation kit is not equipped with a moisture filter. Alcohol added to machine air systems in

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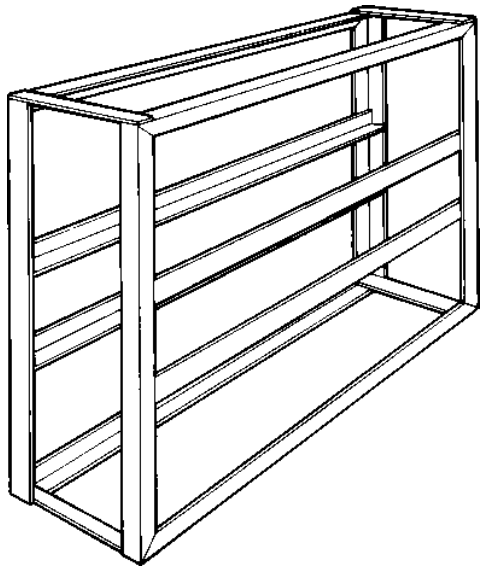


Fig. 7 - Typical Safety Cage

⚠ WARNING - Continued
recommended concentration to prevent condensate freezing are below hazardous levels for tyre inflation.
F.
Another source of hazardous flammable vapours in tyres is the tyre bead lubricant. Always use bead lubricants that do not introduce flammable vapours into the tyre.

Inflation

Note: Always use tyre inflation equipment with an air filter that removes moisture from the air supply, when available, to prevent moisture corrosion of internal rim parts.

1. If the tyre is off the machine, it should be placed in a safety cage before inflating. See Fig. 7.

2. Inflate all tyres with ratings of 16-ply and above to 5.2 bar (75 lbf/in²) to seat beads and seal 'O' ring, then adjust to the recommended pressure.

3. For recommended operating air pressure, refer to the chart under the heading, 'Tyre Inflation Pressures'.

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NITROGEN TYRE INFLATION

Note: All Warnings and procedures under 'Tyre Inflation' will apply, except for differences covered by this passage.

In certain environments it is recommended that tyres be inflated with dry nitrogen gas, and that the resulting oxygen content of the inflation does not exceed 5%. All machines whose tyres are factory inflated with dry nitrogen gas will be identified by a decal on the body or frame.

Nitrogen gas improves tyre pressure retention, increases tyre life by reducing carcass oxidation from within, minimizes rim rust and has no detrimental effects on the tyre. It also reduces the potential of a tyre explosion because it is an inert gas and will not support combustion inside the tyre.

The same tyre inflation pressure used for air inflation should be used for nitrogen inflation. Tyre valves formerly used with air inflation are entirely satisfactory for use with nitrogen gas.

Nitrogen Tyre Inflation Kit

⚠ WARNINGS
DO NOT USE charging assembly, Part No. 9359489, for tyre inflation because this assembly does not include a pressure regulator, safety relief valve, and adequate pressure gauging which is mandatory for tyre inflation purposes. Tyre volume is as much as 90 times greater than the average accumulator volume and hence it takes very much longer to inflate a tyre - up to 40 minutes or more for very large tyres.

⚠ Nitrogen gas cylinders used to inflate tyres are generally charged to approximately 152 bar (2 200 lbf/in²). A tyre blowout and/or rim failure could occur if inflation equipment is not properly used. Proper nitrogen charging equipment and personnel training for its use is a must to avoid over inflation.

1. A nitrogen tyre inflation kit is available from your dealer and consists of the following. Refer to Fig. 8.

a. Pressure regulator, 0 - 13 bar (0 - 200 lbf/in²), with two dual pressure gauges.

b. Safety relief valve, 8.6 bar (125 lbf/in²), that will assure an upper limit to the pressure available for tyre inflation.

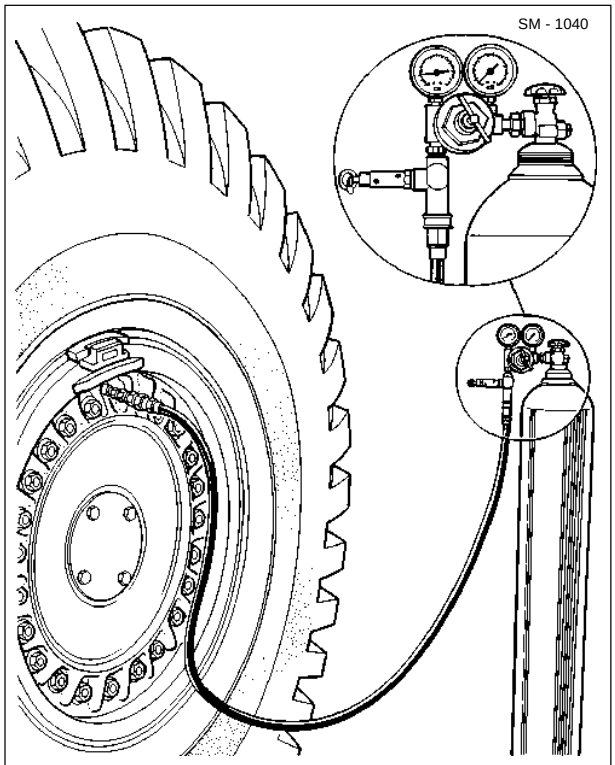


Fig. 8 - Nitrogen Tyre Inflation Kit

c. A 15.2 m (50 ft) length of flexible hose with interconnecting fittings. On the tyre end of the hose is a large bore quick connect/disconnect clip-on chuck.

2. The pressure regulator is connected to a nitrogen compressed gas cylinder available from local suppliers.

3. The usual procedure for using this type of equipment is as follows:

a. Connect nitrogen tyre inflation kit to nitrogen compressed gas supply. DO NOT connect clip-on chuck to the tyre valve at this time.

b. Open valve on nitrogen supply.

c. With flexible hose and clip-on chuck connected to nitrogen tyre inflation kit assembly but not connected to the tyre, adjust pressure regulator so that its output pressure is not more than 1.4 bar (20 lbf/in²) higher than the desired tyre inflation pressure.

d. Connect clip-on chuck to the tyre valve. The tyre will now inflate. Tyre pressure can be monitored by

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observing the gauge at the pressure regulator. STAY AWAY FROM THE TYRE.

e. When desired inflation pressure has been achieved, back off the regulator or close the valve on the compressed gas cylinder.

f. Remove the clip-on chuck and adjust the tyre pressure with the tyre gauge in the usual manner.

Re-inflation of a Mounted Tyre

To re-inflate a tyre with dry nitrogen gas which is now inflated with air, proceed as follows:

1. Exhaust the tyre until only air at atmospheric pressure remains in the tyre.

2. Re-inflate the tyre using only dry nitrogen gas to 4.15 bar (60 lbf/in²) gauge as a minimum, or to bead-seating pressure as a maximum.

3. Adjust to the service inflation pressure required:

a. If the required service inflation pressure is LESS than 4.1 bar (60 lbf/in²), remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.

b. If the required service inflation pressure is greater than 4.1 bar (60 lbf/in²), further inflate, with dry nitrogen gas only, to the pressure level required. Then remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.

New Tyre Mounts and Remounts

To newly mount or remount a tyre to its rim, use only dry nitrogen gas; this includes the pressure required to seat the beads. After seating the tyre beads, remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.

Note: Although a little more nitrogen gas is used to seat beads than that used for re-inflation of a mounted tyre, refer to 'Re-inflation of a Mounted Tyre', its cost is generally negligible in comparison to the time and labour saving and, longer tyre life achievable with the reduced oxygen content which results.

TYRE EXPLOSION HAZARD

⚠ WARNINGS

Whenever a machines tyre(s) is (are) exposed to excessive heat such as a machine fire or extremely hot brakes the hazard of a subsequent violent tyre explosion must be recognized. All persons must avoid approaching the machine so as not to be physically endangered in the event of an explosion of the tyre and rim parts. The machine should be moved to a remote area, but only when this can be done with complete safety to the operator operating or towing the machine. All other persons should stay clear of the machine. The fire or overheated brakes, wheel, etc. should be extinguished or cooled from a safe distance. Do not attempt to extinguish the fire or cool the machine by use of hand-held fire extinguishers.

⚠ If it is absolutely necessary to approach a machine with a suspect tyre, approach only from the front or the back. Stay at least 15 m (50 ft) from the tread area. Keep observers out of the area and at least 460 m (1 500 ft) from the tyre sidewall. Refer to Fig. 9. The tyre(s) should be allowed at least eight (8) hours cooling time after the machine is shut down or the fire extinguished before approaching closer.

⚠ DO NOT WELD ON OR HEAT RIM COMPONENTS. For several years the company and tyre and rim manufacturers have warned users never to weld rim components with the tyre mounted on the rim. The gases that build up inside the tyre during arc welding or heating on rim components can ignite, resulting in one of these explosive-like failures of the tyre and rim. This warning also applies to nitrogen inflated tyres. Ignition will not occur in the nitrogen atmosphere, but the pressure buildup from the heat of welding may be sufficient to cause a blowout severe enough to injure or kill. It is recommended to scrap the part if heat is necessary to repair any rim component.

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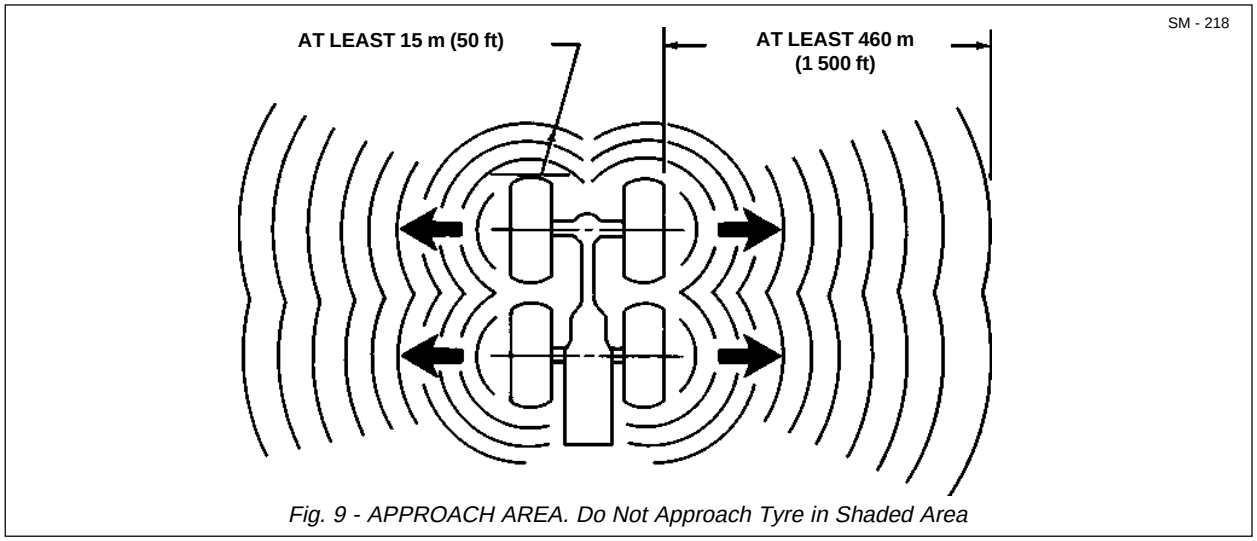


Fig. 9 - APPROACH AREA. Do Not Approach Tyre in Shaded Area

⚠ WARNING
There is always a possibility of a tyre explosion whenever the smell of burning rubber or excessively hot brakes is detected. The danger is also present when a fire on the machine reaches the tyre and wheel area. Under such conditions, all personnel must avoid approaching the machine in a manner that could result in injury should an explosion actually occur. Move the machine to a remote area only if it can be done without endangering the operator or other personnel in the area.

TYRE MAINTENANCE

Tyre Repairs

Prompt repair of tyre injuries will prevent small injuries from enlarging and causing tyre failure. Use the best tyre facilities available. If good repair facilities are not available, have the nearest dealer make the necessary repairs.

Minor cuts, snags, or punctures should be repaired upon discovery. Skive with a sharp pointed knife around any cut in the tyre tread area that is of sufficient depth or shape to hold pebbles or dirt. The angle of the skive should be no more than sufficient to expel all foreign material and should extend no deeper than the breaker. The skive should go to the bottom of the hole. Tyres with shallow cuts, if treated promptly, may be allowed to continue in service. If the cut extends deeper into the tyre carcass, the tyre should be removed for repair.

Ordinary tubeless tyre punctures can be repaired without removing the tyre from the rim. Use tyre repair plugs and follow the directions given by the manufacturer.

The tyre must be removed from the rim to repair larger punctures or cuts. Irregular shaped punctures or cuts less than 13 mm (0.5 in) in size can be repaired with a plug and hot patch. Insert a repair plug into the hole to keep out moisture and to back up the hot patch. Trim the plug off flush with the inside of the casing, buff, and apply the hot patch according to the instructions supplied with the hot-patch equipment.

Punctures 13 mm (0.5 in) or larger, large cuts, or bruise breaks require sectional or reinforced vulcanized repair. Cover the repair patch with a layer of cushion gum after application to the tubeless tyre to ensure an airtight repair. Any cords of the inside ply that are exposed in bugging and are not covered with repair patch must be coated with cushion gum to prevent air leakage into the carcass plies on tubeless tyres.

Recapping and Retreading

There are two general methods employed in restoring the tread surface of off-the-highway tyres: recapping, and retreading.

A recapped tyre has a new tread cured right over the old tread surface.

A retreaded tyre has the old tread removed entirely and a new tread cured directly onto the body of the tyre. A tyre can be recapped or retreaded if the cord

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body is free of cuts, bruises and separation, and is thoroughly sound, including previous repairs.

TYRE CARE

To obtain maximum service from off-the-highway tyres, a few common-sense precautions should be followed.

Maintain Correct Inflation

The most common cause of tyre damage is improper inflation. Both over-inflation and under-inflation are detrimental to tyre life. Tyre pressure should be checked daily, preferably before the machine is placed in operation. Refer to 'Tyre Inflation Pressures' for tyre pressure.

The valve cores should be checked for leaks. Keep in mind that valve cores are delicate mechanisms that wear out in service; therefore, they should be replaced when they become worn. Each tyre should be equipped with a valve cap to prevent dirt from damaging the valve core and causing air leakage.

Maintain Good Haul Roads

Because haul roads are considered temporary roads, they are frequently neglected. The better the haul road, the longer the tyre and machine life of off-the-highway equipment.

Although it takes time and effort to maintain good haul roads, delay and cost of tyre and machine breakdowns caused by poor haul roads is many times greater.

Inspect Tyres Regularly

A systematic plan for tyre inspection will more than pay for itself in lowered tyre costs per hour of operation. All tyres should be checked regularly for cuts, bruises, fabric breaks, excessive or uneven wear, embedded foreign matter, and any other damage which can be repaired. A considerable increase in tyre service can be realized if tyre injuries are repaired before they have progressed to the irreparable stage. The rim mounting nuts should be checked periodically and tightened to the recommended torque.

Prevent Overloading

Off-the-highway machines are designed to carry a maximum allowable payload. Excessive loading will overstress both the machine and tyres and shorten the life of both.

Prevent Tyre Contact With Oil

PREVENT TYRE CONTACT WITH PETROLEUM PRODUCTS. Rubber that is exposed to oil, petrol, or grease becomes soft and spongy and deteriorates rapidly. Always avoid driving machine equipped with rubber tyres through a puddle of petrol, fuel oil, lubricating oil, or grease. Never let a tyre stand in an oil or grease spot overnight.

Store Tyres Properly

The best of care given to tyres in service by operators and maintenance personnel can be completely nullified by careless storage. Time is not the only contributing factor to the deterioration of rubber products. Therefore, tyres that are to be stored must be protected from light, heat, oils, dirt, moisture and ozone. Stored tyres should be carefully covered with a tarpaulin or some other suitable material, such as opaque plastic sheets, to prevent contact with the contaminants listed.

Proper Handling of Tubeless Tyres and Rims
Tubeless tyres should be stored vertically. Horizontal stacking may compress the tyre walls making inflation difficult. If tyres are stored in racks, the lower supporting members should provide as broad a surface as possible to the tyre tread to avoid a concentration of load.

The beads of tubeless tyres must be protected from damage or a faulty air seal will result. Do not use hooks, cables, or chains in contact with the tyre beads when lifting these tyres. If forklift trucks are used for handling they should be equipped with broad, well rounded arms to distribute the load and prevent damage to the tyre bead. When handling tyres with the fork truck do not scrape the fork across the bead.

Tubeless tyre rims perform an important function as part of the assembly air seal. Proper care therefore must be taken not to distort or mutilate the rim parts because they must mate properly to form part of the basic air chamber. Since the rim base, bead seat bands, and flanges are endless, distortion may prevent easy assembly as well as possibly resulting in no seal.

Never drop, tumble, or roll rim parts.

If rim parts are stored outdoors they should be given a protective coat of a good commercial primer.

Similar parts should be stacked neatly to prevent distortion.

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Babbit or lead hammers, not sledge hammers, should be used in assembling rims.

'O' rings are seals and should be carefully stored in a cool, dry place where they will not be injured or damaged.

Valve cores also should be stored in a cool, dry and clean place.

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools outlined in this section and general service tools required. These tools are available from your dealer.

TUBELESS TYRE LEAK DIAGNOSIS

Occasionally a tubeless off highway tyre/rim assembly may leak in field service. To determine cause of leakage, the entire assembly including valve hardware, multi-piece rim assembly, 'O' ring and tyre should be checked using a soap solution.

This table lists various causes of air loss and possible remedy.

CAUSE	REMEDY
Defective valve	Tighten parts. Replace defective parts. Use valve caps.
Cracked rim or weld	Replace defective part ⚠ **WARNING** **Do not attempt repair of wheel components.**
Twisted or damaged 'O' ring	Replace 'O' ring (lubricate)
Tyre cuts and snags	Repair tyre damage
Bead area awl holes	Repair inner liner (preferred)
Leakage between tyre bead trim	With tyre removed from rim: Clean tyre beads in rim contact area Clean rim with wire brush Inspect 5 degree tapered bead seat band and the rim base in the bead seating area to determine if the transverse weld trims are flat or concave. Replace defective part(s). **Note:** Weld trim should follow rim contour. Mount tyre using a lubricant such as Murphy's Tyre and tube Mounting Compound, or equivalent, on tyre beads and rim bead seat area.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	2	Wheel Nut	690	510
6	2	Bolt	Refer to 'Bearing Adjustment Table'	
6	15	Bolt	420	310

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TYRE INFLATION PRESSURES

E3 tyres may be so roaded up to 48 km/h (30 mile/h), maximum, with a 30 minute cooling stop after each 80 km (50 miles) or 2 hours sustained operation - whichever occurs first - and a 60 minute cooling stop after each aggregate of 4 hours of operation.

E4 tyres may be so roaded up to 32 km/h (20 mile/h), maximum, with a 30 minute cooling stop after each 32 km (20 miles) or 1 hour of sustained operation - whichever occurs first - and a 60 minute cooling stop after each aggregate of 4 hours of operation.

The inflation pressures listed should be regarded as nominal only. Specific job conditions, terrain, haul road maintenance and length, maximum and workday average speed, job t-km/h (ton-mile/h) required and tyre t-km/h (ton-mile/h) capacity, etc., may require an increase in inflation pressure. It is recommended that for tyres both listed and unlisted the user consult the tyre manufacturer and evaluate all job conditions in order to make the proper selection.

TYRE INFLATION PRESSURES

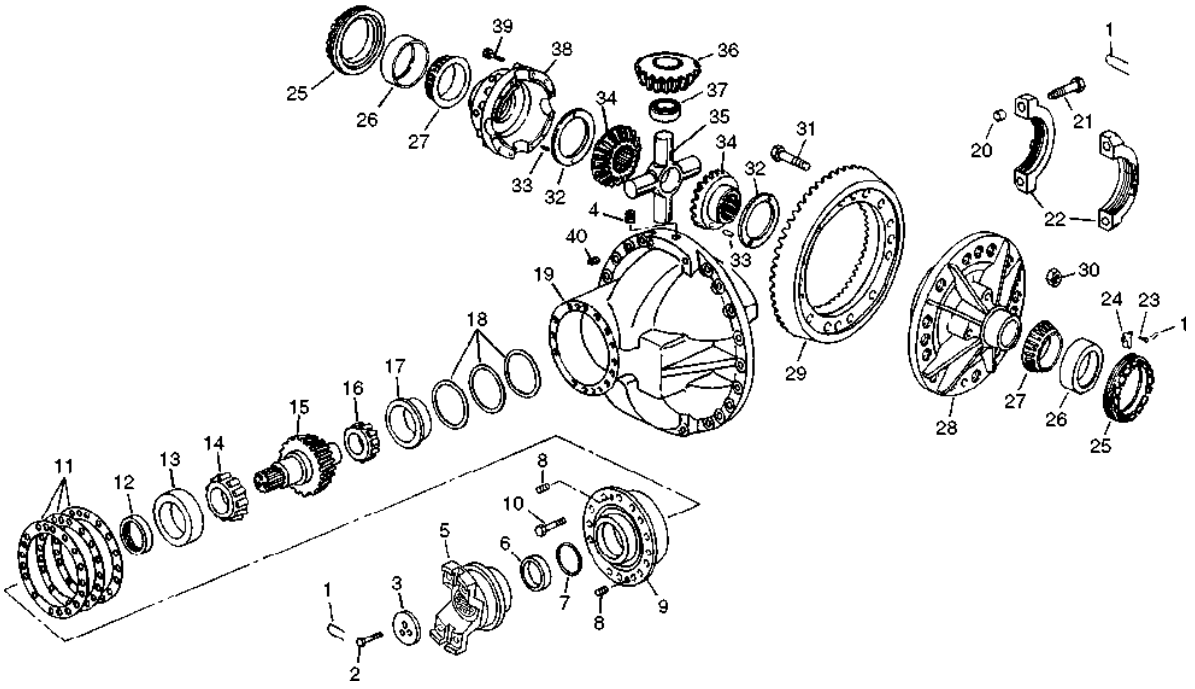
	PRESSURE	
BRIDGESTONE TYRE	bar	lbf/in²
24.00 R 35** Radial	5.9	87

* * * *

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SM - 1984



1 - Lockwire
2 - Bolt
3 - Plate
4 - Set Screw
5 - Yoke
6 - Sleeve
7 - 'O' Ring
8 - Set Screw
9 - Retainer
10 - Bolt
11 - Shim*
12 - Oil Seal
13 - Cup
14 - Cone
15 - Pinion Gear
16 - Cone
17 - Cup
18 - Shim*
19 - Carrier Housing
20 - Bushing
21 - Bolt
22 - Bearing Cap
23 - Bolt
24 - Lock
25 - Bearing Adjuster
26 - Cup
27 - Cone
28 - Flanged Case
29 - Ring Gear
30 - Nut
31 - Bolt
32 - Thrust Washer
33 - Dowel Pin
34 - Side Gear
35 - Spider
36 - Spider Pinion Gear
37 - Bearing
38 - Plain Case
39 - Bolt
40 - Plug

* - Shim Thickness - 0.08, 0.25, 0.76 mm (0.003, 0.010, 0.030 in)

Fig. 1 - Exploded View of Typical Differential

DESCRIPTION AND OPERATION

Numbers in parentheses refer to Fig. 1.

The differential performs three functions; it multiplies torque delivered by the driveline; it transmits this torque to the axle shafts; and it allows the drive wheels to rotate at different speeds.

When the truck is making a turn, one drive wheel must travel a greater distance than the other. If the wheels were connected by a single axle shaft, the wheel turning the larger radius of the turn circle would have to override the wheel making the shorter turn. Thus, one wheel would have to skip or hop causing tire scuffing and strain on the power train.

The differential eliminates wheel skip by allowing separate axle shafts inserted into side gears (34) to rotate at different speeds as the drive wheels rotate. The spider (35) and spider pinion gears (36) are meshed with side gears (34). This assembly is enclosed in plain case (38) and flanged case (28) which are bolted to ring gear (29). Thus, ring gear (29), plain case (38) and flanged case (28) rotate as an assembly when driven by input pinion gear (15). However, side gears (34), into which each axle shaft is inserted, are free to rotate independently about spider pinion gears (36) with which they are meshed. Therefore, as each drive wheel travels through a different arc as the truck makes a turn, side gears (34) rotate about spider pinion gears (36) to provide the required differential action.

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REMOVAL

Numbers in parentheses refer to Fig. 1.

> **WARNINGS**
> **To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.**
>
> **A come-a-long or chain fall with a minimum capacity of one ton is required for removal and installation of a differential assembly.**

1. Position the vehicle in a level work area, raise the body and install the body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine.

3. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels.

4. With suitable containers in position, drain the lubricant from the differential banjo housing and wheel planetary assemblies.

5. Remove the driving flange cover from each wheel and pull the axle shaft and sun pinion gear assembly of each driving wheel at least 150 mm (6 in) out of the wheel housing to disengage the inner axle shaft splines from the splines of side gears (34). Refer to Section 160-0030, AXLE GROUP.

6. Identify the relationship of pinion yoke (5) flange with that of the driveline companion flange using punch marks. Remove rear driveline connecting differential and transmission. Refer to Section 130-0020, REAR DRIVELINE.

7. Remove set screw (4) from differential housing and replace it with a lifting eye.

8. Install chain fall or come-a-long to the loop placed on the body just behind the hoist brackets. Attach the other end of the lifting device to eye previously installed in the differential assembly.

9. Support the weight of the differential assembly with the lifting device.

10. Remove the self locking nuts which secure the differential housing to the axle banjo housing. Each time a nut is removed, deeply scribe one of the flats on the nut. The nuts should not be reused more than five times.

11. Turn the four thread protectors in to break the seal between the differential assembly and banjo housing. If this does not move the differential assembly out enough, either remove the thread protectors and insert longer bolts in the four holes, or use a suitable bar to pry the differential assembly away from the banjo housing and studs. If a bar is used, caution should be exercised to prevent damaging the mounting surfaces.

12. Pull the differential assembly away from the banjo until it clears the studs of the axle banjo housing, then carefully lower the differential assembly.

13. Move differential assembly to a clean work area for disassembly.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

> **WARNING**
> **To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.**

Ring Gear Group

1. Remove lockwire (1) from bolts (2). Secure a ‘C' clamp over ring gear (29) to prevent it from turning. Loosen, do not remove, bolts (2).

2. Cut and remove lockwire (1), then loosen, but do not remove bolts (21) securing bearing caps (22) to carrier housing (19).

Note: Make identifying punch marks on both the bearing caps (22) and carrier housing (19), so that the bearing caps can be returned to their original position in assembly.

3. Scribe an identifying line on bearing adjusters (25) and carrier housing (19) bores which these adjusters screw into. If the differential assembly is disassembled for inspection purposes only, this line will be of assistance when readjusting the preload on the side

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bearing cups (26) and cones (27). If the differential is disassembled and parts replaced, do not rely on this line for determining the preload on the side bearings.

4. Cut and remove lockwires (1), then remove bolts (23) and locks (24).

5. Unscrew and remove bearing adjusters (25).

6. Remove bearing cap bolts (21), then remove bearing caps (22) from carrier housing (19). Salvage dowel bushings (20) that are seated in the bolt holes between the bearing caps and the differential housing.

7. With 'C' clamp still secured to ring gear (29), lift the differential assembly from carrier housing (19). See Fig. 2.

8. Remove side bearing cups (26) and cones (27), using a bearing puller. Wire the bearing races together for mating in assembly, and tag them for mating to plain case (38) and flanged case (28), from which they were removed.

Note: In conjunction with the bearing puller, use a round steel disc, approximately 95 mm (3.75 in) diameter and 10 mm (0.38 in) thick. This will serve as a centre for the puller screw to push against. Puller arms must not exert a force on the bearing roller separator cage.

9. Position the differential assembly vertically on a bench so that a portion of ring gear (29) can be clamped securely in a soft-jawed vice.

10. Loosen bolts (39) holding plain case (38) and flanged case (28) together.

11. Loosen bolts (31) and nuts (30) which hold ring gear (29) to flanged case (28). Remove all but two opposite nuts (30) and bolts (31).

12. Remove six of the bolts (39) which hold plain case (38) and flanged case (28) together.

Note: Before separating the cases, make identifying punch marks on plain case (38) and flanged case (28) to show their relationship for assembly purposes.

13. Place the assembly on a bench so that plain case (38) is facing upwards.

14. Remove remaining bolts (39), then lift plain case (38) off flanged case (28).

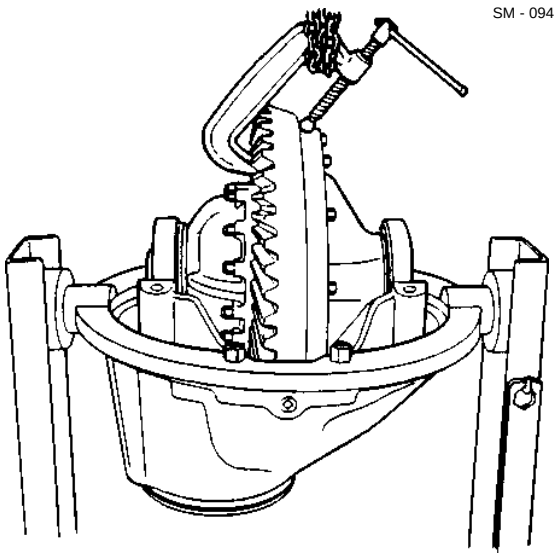


Fig. 2 - Removing Differential Assembly from Housing

15. Remove one thrust washer (32) and side gear (34), then lift spider (35) and spider pinion gears (36) out of flanged case (28).

16. Separate the four spider pinion gears (36) from spider (35) and bearings (37). Do not remove spider pinion gears (36) or bearings (37) unless worn or damaged.

17. Remove remaining side gear (34) and thrust washer (32) from flanged case (28).

18. Turn flanged case (28) and ring gear (29) assembly over on a suitable block of wood.

Note: Make sure that identifying marks are stamped on the side of ring gear (29) and flanged case (28) for assembly purposes.

19. Remove remaining bolts (31) and nuts (30), then separate flanged case (28) from ring gear (29) by tapping the edge of the ring gear with a soft-faced hammer as shown in Fig. 3.

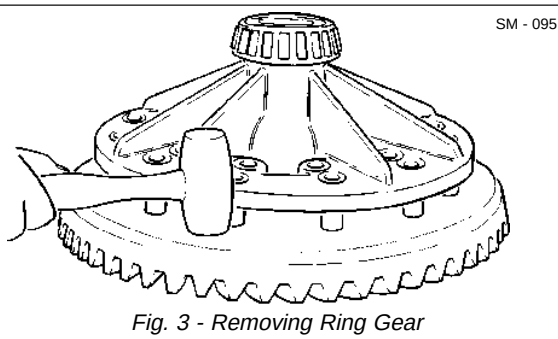


Fig. 3 - Removing Ring Gear

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20. Remove dowel pins (33) from plain case (38) and flanged case (28) only if they are damaged and have to be replaced.

Pinion Cage Group

Note: Before disassembling, punch identifying marks on retainer (9) and carrier housing (19) for assembly purposes.

1. Remove bolts (2) and plate (3). Pull yoke (5) assembly from pinion gear (15) shaft with care so as not to damage or distort the yoke flange.

2. Unscrew bolts (10) attaching retainer (9) and shims (11) to carrier housing (19).

3. Remove and discard 'O' ring (7) from groove in yoke (5).

4. Remove set screws (8) and screw in two 1/2"-13 UNC bolts in the tapped holes of retainer (9) flange, using these bolts as pullers to remove retainer (9) assembly.

Note: If the above retainer assembly removal procedure is not feasible, the following method may be used: Invert carrier housing (19), as shown in Fig. 4, then drive retainer (9) out of the housing. During this operation, be careful not to obliterate the etched dimension on the bottom of pinion gear (15) shaft.

5. Separate retainer (9), cup (13) and oil seal (12) from carrier housing (19), then remove shims (11). Wire shims (11) together to aid in assembly.

6. Using a soft-jawed vice with the jaws opened slightly wider than retainer (9) bore, place retainer (9) on top of the bars, with the flange facing downward. Tap out cup (13) and oil seal (12) with a soft-faced hammer. Be careful not to damage the inside machined surface of retainer (9) when removing cup (13).

Note: If the bearing races are still serviceable, wire the cups and corresponding cones together for mating in assembly. Bearing assembly (13 & 14) is replaceable as an assembly only. If any component is defective, the complete assembly must be replaced.

7. Remove pinion assembly (14, 15 & 16) from carrier housing (19).

8. Using a bearing puller similar to that shown in Fig. 5, remove cone (16) from pinion gear (15) shaft.

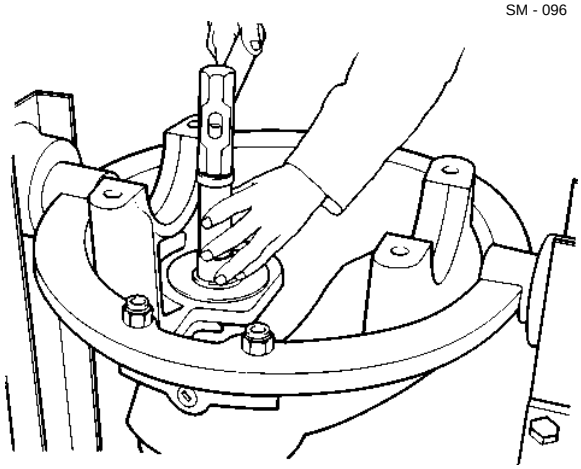


Fig. 4 - Driving Out Retainer Assembly

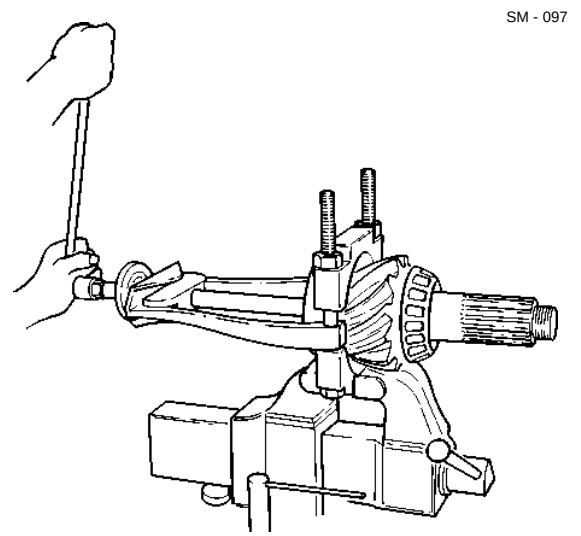


Fig. 5 - Removing End Bearing

9. Remove cones (14) from pinion gear (15) shaft using a suitable bearing puller.

10. Tap cup (17) and shims (18) from carrier housing (19).

INSPECTION

Numbers in parentheses refer to Fig. 1.

The importance of careful and thorough inspection cannot be over stressed. Thorough inspection and necessary replacement of parts now, may eliminate costly and avoidable trouble later.

1. Clean all parts in a suitable solvent.

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2. Immediately after cleaning, dry all parts, except bearings, with compressed air, or lint-free cloth. Bearings are better left to air dry, then inspected and oiled thoroughly with gear lubricant for protection from corrosion.

3. With the parts cleaned, coat parts immediately with light oil to prevent corrosion. If parts are not to be assembled immediately, treat them with a good rust preventative and wrap them with treated paper or other suitable material designed to prevent corrosion.

4. Replace all gaskets, 'O' rings and seals with new parts.

5. Before installing the differential assembly to the banjo, clean the inside and outside of the banjo housing to remove any foreign material.

6. Oil seal (12) rides on a special sleeve (6), which is on yoke (5) to provide a smooth contact surface. If the sleeve is rough or worn, pull it from the yoke and install a new one. Heat the new sleeve to 177 - 205° C (350 - 400° F) in oil to expand it for installation. If oil heating equipment is not available, heat the bushing evenly to 205° C (400° F). This takes about 1 minute using a torch with a heating tip. Use a Tempilstik or other temperature gauge to make sure sleeve (6) is hot enough. Slide heated sleeve on the yoke and tap lightly with a hammer to seat it.

7. Examine bearing cap bushings (20) for wear or damage. Replace as necessary.

8. Inspect all gears, pinions and splines for cracked or broken teeth, excessive wear, and pitted or scored surfaces. Repair or replace as necessary.

Note: If either ring gear (29) or pinion gear (15) is defective, both gears must be replaced, because they are serviced only as a matched set. This set is identified by a serial number on the OD of ring gear (29) and outer face of pinion gear (15). It is also advisable to replace side gears (34) or spider pinion gears (36) in matched sets only, because a newer gear installed to operate in conjunction with an older, worn gear tends to carry an uneven portion of the load. This creates an excessive amount of stress on the new gear.

9. Check for pitted, scored or worn thrust surfaces of differential case halves, spider trunnions and thrust washers. It is also advisable to replace thrust washers in sets, as the use of a combination of old and new washers may cause premature failure.

10. Inspect carrier housing (19), ring gear (29), plain case (38) and retainer (9) for bore damage, cracks and wear. Replace as necessary.

11. Check the amount of run-out on the machined surfaces of retainer (9). The outer machined surface on the hub of the bearing cage must be concentric with the bearing cup bore within 0.05 mm (0.002 in) total indicator reading (T.I.R.).

12. The outer machined surface (OD) on retainer (9) must be concentric within 0.05 mm (0.002 in) T.I.R. with the surface into which oil seal (12) fits.

13. The threads and bores of bearing caps (22) and carrier housing (19) must be concentric within 0.127 mm (0.005 in) T.I.R. and must be square with the pinion bore within 0.08 mm (0.003 in) when checked at points 254 mm (10 in) from the centre line of the pinion bore.

Note: Bearing caps (22) and carrier housing (19) can only be replaced as an assembly.

14. The machined mating surfaces of plain case (38) and flanged case (28) must be square with the axis of the cases within 0.08 mm (0.003 in) T.I.R.. The mating diameters of the cases must also be concentric within 0.08 mm (0.003 in) T.I.R..

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.**

Pinion Cage Group

Note: During assembly and installation, make sure that mated, punch-marked or otherwise identified parts are returned to their original positions, if still serviceable.

1. Determine the required shim pack (18) thickness so as to give the proper gauging distance within 0.08 mm (0.003 in) etched on pinion gear (15) tail shaft (see Fig. 6) as follows:

Note: The OD of a bearing cup (17) can be ground to 162 - 161 mm (6.372 - 6.371 in) to provide a slip fit

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special tool as an aid in determining the required thickness of shims (18).

a. Install a shim pack (18) of approximately 1.5 mm (0.060 in), measure and record the actual thickness as Dimension 'X', and the loosely fitting bearing cup (17) (see previous note) in the pinion gear shaft bore of carrier housing (19).

b. Install bearing cone (16) and bearing cone (14) on pinion gear (15). Install cup (13) into retainer (9) until it bottoms against the retainer shoulder. Install pinion gear assembly (14, 15 & 16) and retainer (9) into carrier housing (19). Secure retainer (9) with eight bolts (10) equally spaced.

c. Rotate pinion gear (15) and tighten bolts (10) until the pinion gear cannot be rotated by hand to seat the bearing rollers firmly.

d. Place a flat plate approximately 450 mm (18 in) long across the two bearing cap (22) mounting surfaces in carrier housing (19) as shown in Fig. 7. The plate must lie perfectly flat between the bearing cap mounting surfaces and must be clean and free of burrs.

e. Measure the distance from the end of pinion gear (15) shaft to the plate (axle centre line). See Fig. 7. Record this distance as Dimension 'A'.

f. Record the dimension etched on the end of pinion gear (15) as Dimension 'B'.

g. The correct thickness of shims (18) to be used is: Dimension 'X' + Dimension 'B' - Dimension 'A'.

2. Determine shim pack (11) thickness so as to allow pinion gear (15) 0.025 - 0.08 mm (0.001 - 0.003 in) axial end play as follows:

a. With pinion gear (15) installed as previously described in Steps 1a through 1f, rotate pinion gear (15) and tighten the eight bolts (10) evenly spaced, to 110 Nm (80 lbf ft) torque to seat the bearing rollers firmly.

b. Remove bolts (10) and reinstall two of them 180° apart. Tighten the two bolts alternately in 30 Nm (20 lbf ft) increments to a final torque of 110 Nm (80 lbf ft).

c. Measure the gap between retainer (9) and carrier housing (19) adjacent to the two installed bolts and record the average measurement as Dimension 'C'.

d. The correct thickness of shim pack (11) is:

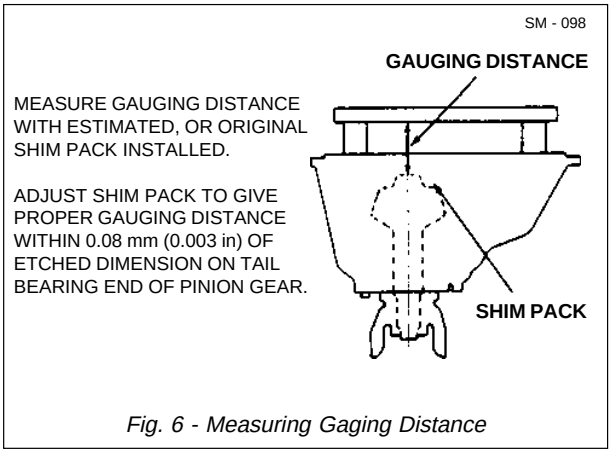


Fig. 6 - Measuring Gaging Distance

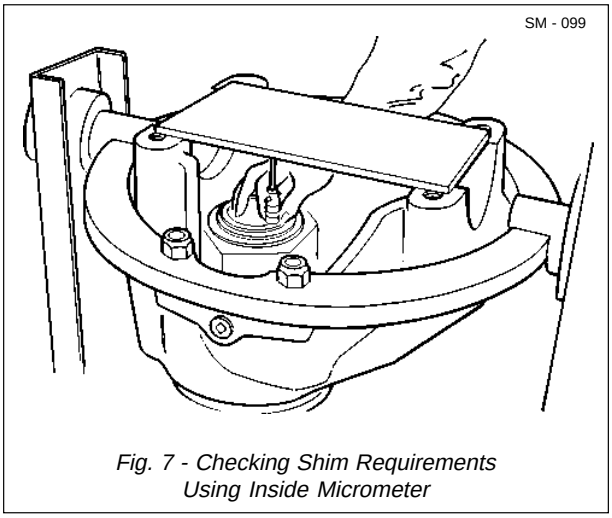


Fig. 7 - Checking Shim Requirements Using Inside Micrometer

0.48 mm (0.019 in) + Dimension 'C' - Dimension 'B' (Step 1f) - Dimension 'A' (Step 1e). This shim pack thickness should provide 0.05 mm (0.002 in) axial end play of pinion gear (15).

3. Remove bolts (10) and remove retainer (9) from carrier housing (19). Adjust shim pack (18) to the required thickness as calculated in Step 1g and replace the ground bearing cup (17) with bearing cup (17) to be installed permanently.

4. Install pinion gear assembly (14, 15 & 16) in carrier housing (19) as previously described in Steps 1 and 2.

5. Install oil seal (12) into retainer (9) flush with the retainer surface at the top of the seal bore.

6. Install measured shim pack (11) as calculated in Step 2d on retainer (9) and install the assembly on carrier housing (19). Align slot in retainer (9) with the lubrication holes in shims (11) and carrier housing (19) and install retainer assembly in carrier housing.

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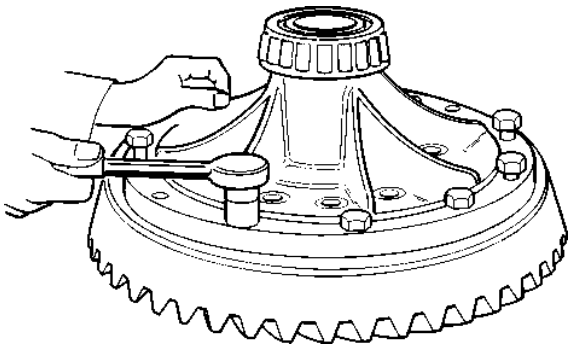


Fig. 8 - Installing Ring Gear

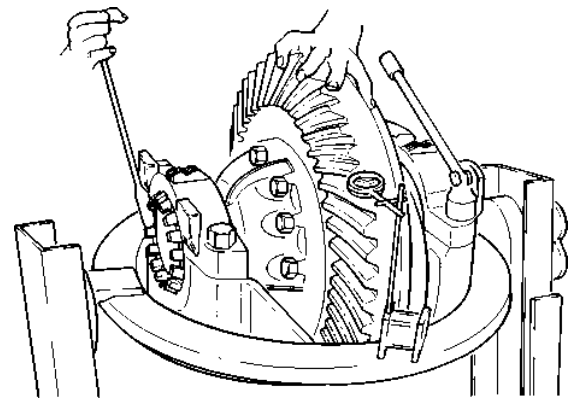


Fig. 9 - Turning Bearing Adjuster to Set Backlash

7. Install bolts (10) connecting retainer (9) to carrier housing (19) and tighten to a torque of 156 Nm (115 lbf ft). Install set screws (8) in retainer (9).

8. Lubricate the lip of sleeve (6) and spline of pinion gear (15) with multipurpose grease No. 2. Lubricant and insert 'O' ring (7) into yoke (5).

9. Install yoke (5) assembly to pinion gear (15) spline until it contacts cone (14). DO NOT POUND ON YOKE FLANGE.

10. Install plate (3) and secure to pinion gear (15) with bolts (2). Tighten bolts (2) to a torque of 290 Nm (213 lbf ft) and secure with lockwire (1).

Ring Gear Assembly

1. Align identification marks that were made during disassembly on ring gear (29) and flanged case (28).

2. Install bolts (31) and nuts (30) and tighten to a torque of 700 Nm (515 lbf ft). Refer to Fig. 8.

Spider and Component Parts Assembly

1. Press thrust washer dowel pins (33) into holes in plain case (38) and flanged case (28), if removed.

2. Lubricate inner walls of flanged case (28) and plain case (38) and all component parts with gear lubricant. Refer to Section 300-0020, LUBRICATION SYSTEM, for proper lubricant.

3. Position one thrust washer (32), grooved side facing towards side gear in bore of flanged case (28).

4. Install first side gear (34) machined surface against thrust washer (32) in flanged case (28).

5. Install bearings (37) in spider pinion gears (36) and install bearings and spider pinion gears on spider (35), if removed.

6. Lay complete spider assembly in pinion grooves in face of flanged case (28). Spread bearings (37) against shoulders of flanged case (28), using the bearing spreader tool which can be fabricated as shown in Fig. 19.

7. Install other side gear (34) and thrust washer (32), with grooved side of washer mating with machined surface of side gear, in plain case (38).

8. Assemble plain case (38) to ring gear (29) and flanged case (28) assembly, making certain that thrust washers (32) do not slip off dowel pins (33). Turn plain case (38) until the mating mark made during disassembly lines up with the mark made on flanged case (28).

9. Apply retaining compound to bolts (39) and install four bolts (39) equally spaced. Tighten bolts (39) to a torque of 271 Nm (200 lbf ft).

10. Check assembly for free gear rotation and correct if necessary. Install remaining bolts (39) and tighten to a torque of 271 Nm (200 lbf ft).

11. Press side bearing cones (16) squarely and firmly over machined cylinders of plain case (38) and flanged case (28).

Ring Gear Assembly to Carrier Housing

Bearing adjusters (25) have two basic functions: pre-loading cups (26) and cones (27); and positioning ring gear (29) to obtain the correct backlash between the ring gear and pinion gear (15). See Fig. 9. The bearing adjuster (25) located on the same side of pinion gear (15) as ring gear (29), pushes the ring gear

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toward the pinion gear. Bearing adjuster (25), located on the opposite side of pinion gear (15) than the ring gear, pushes the ring gear away from the pinion gear. The ring gear assembly must be installed onto carrier housing (19) so that cups (26) and cones (27) are properly pre-loaded; correct backlash exists between ring gear (29) and pinion gear (15), and satisfactory tooth pattern is established between ring gear and pinion gear.

These conditions can be obtained by using the following procedures:

1. Mount ring gear (29) and differential assembly on carrier housing (19). Make sure that side bearing cups (26) are properly positioned on side bearing cones (27). Install bearing caps (22) over cups (26) and cones (27), then secure bearing caps to the carrier housing with four dowel bushings (20) and bolts (21). Secure bolts snugly, but do not tighten them to torque specifications at this time.

Note: Each bearing cap (22) is mated to carrier housing (19), therefore, they must be returned to their original positions by aligning the identification marks made during disassembly.

2. Install a dial indicator to check the back side of ring gear (29) for true running. Rotate the assembly with an easy motion and note the back face runout. The runout is not to exceed 0.08 mm (0.003 in) with the dial indicator position as shown in Fig. 10.

3. Using a micrometer, take a measurement diagonally across bearing cap (22) lock pads and record it for reference later.

4. Install bearing adjusters (25) in their respective bearing caps (22).

5. Place a dial indicator in the position shown in Fig. 11, to check ring gear backlash. Tighten bearing adjuster (25) on the ring gear side until the backlash between ring gear (29) and pinion gear (15) reads 0.000 on the dial indicator.

6. Tighten the opposite bearing adjuster (25) until another measurement across bearing cap (22) lock pads indicates a 0.05 - 0.13 mm (0.002 - 0.005 in) expansion when compared to the measurement recorded in Step 3.

7. At this point the backlash tolerance between ring gear (29) and pinion gear (15) should be 0.30 - 0.46 mm (0.012 - 0.018 in) on gear sets with a 3.73:1 gear ratio. If this tolerance has not been obtained at this point, it

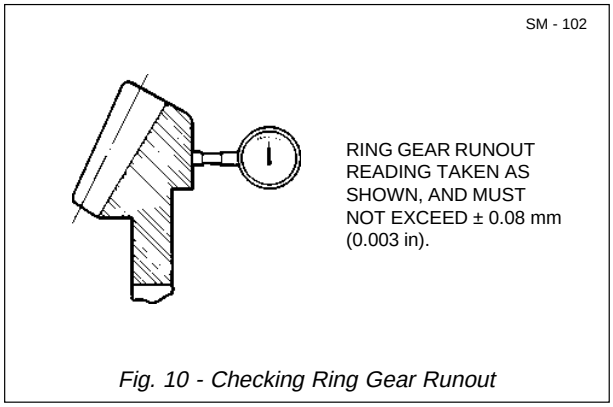


Fig. 10 - Checking Ring Gear Runout

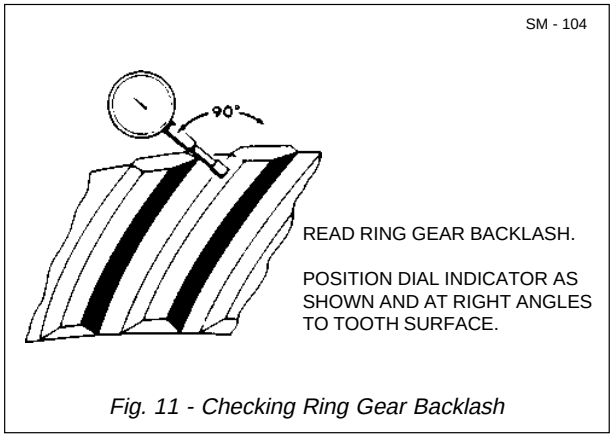


Fig. 11 - Checking Ring Gear Backlash

can be accomplished without changing the bearing preload by backing off one adjuster a certain number of notches and tightening up the opposite adjuster an equal number of notches.

8. When a satisfactory backlash tolerance has been established, check the gear tooth pattern as described under the heading 'Adjustments'.

9. If gear tooth pattern is not correct, some correction can be made by systematically loosening and tightening the bearing adjusters (25), as previously described, but in every instance re-check the backlash tolerance. If a favourable gear tooth pattern cannot be established within the backlash tolerance, it will be necessary to alter, add or remove, shims (18) between bearing cup (17) and carrier housing (19) and alter shims (11) by the same amount.

10. When altering these shims as described in 'Pinion Cage Group', disregard all procedures given for comparing the micrometer (measured) dimension and etched dimension on pinion gear (15) tail shaft end.

11. The procedures for keeping differential side bearing preload, backlash and favourable gear tooth

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pattern within specifications is strictly a 'try, check, and try again' method.

12. After a satisfactory preload, backlash and gear tooth pattern is obtained, make certain that the retainer bolts (10) are tightened to a torque of 156 Nm (115 lbf ft). Again check backlash tolerance and gear tooth pattern.

13. Tighten bearing cap bolts (21) to a torque of 644 Nm (475 lbf ft) and tie with lockwire (1). The lockwire passes over the top of bearing cap (22) and through the heads of the respective bolts. The same procedure is to be followed for both bearing caps.

14. A final measurement across bearing cap (22) pilot pads must indicate a 0.05 mm (0.002 in) to 0.13 mm (0.005 in) expansion, after ten ring gear revolutions under a light load, when compared to the original measurement recorded in Step 3. This ensures that the side bearings have the proper preload.

15. Install adjuster locks (24) and secure with bolts (23). Tighten bolts (23) to a torque of 33 Nm (24 lbf ft) and tie with lockwire (1).

ADJUSTMENTS

When adjusting a noisy differential that has been in service for some time, more harm than good can result. Changes in adjustment will frequently concentrate the bearing area on a small portion of the teeth which often results in failure. Therefore, it is advisable to know exactly what the end result will be before adjustments are made in an old differential.

Note: A rebuilt differential or one that has not worn excessively may be adjusted as previously described.

The following suggestions are offered to make gear tooth pattern analysis and identification easier.

1. Paint twelve ring gear teeth with Prussian Blue, oiled red lead, or some other easily removed paint or dye. When the pinion is rotated, the paint is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts.

2. Make this check by rotating the ring gear at least ten revolutions under light drive load. Another method for checking contact pattern is to turn the ring gear clockwise and anticlockwise several times. For sharper impressions apply a drag on the ring gear by forcing a wooden block against the edge of the ring gear while it is being turned.

3. Gear tooth patterns can be interpreted by referring to Figs. 12 through 17.

a. If a contact pattern similar to that shown in Fig. 12 is obtained, the adjustment is correct.

b. If the contact area is on the inner side of the ring gear teeth, see Fig. 13, move ring gear away from pinion by turning bearing adjusters equal amounts until the proper bearing pattern is obtained.

c. If the contact area is on the outer part of the ring gear teeth, see Fig. 14, move ring gear toward pinion by turning bearing adjuster.

d. If the contact area is along the root of the ring gear teeth, see Fig. 15, move the pinion out by adding shims.

e. If the contact area is along the top edge of the ring gear teeth, see Fig. 16, move the pinion in by removing shims.

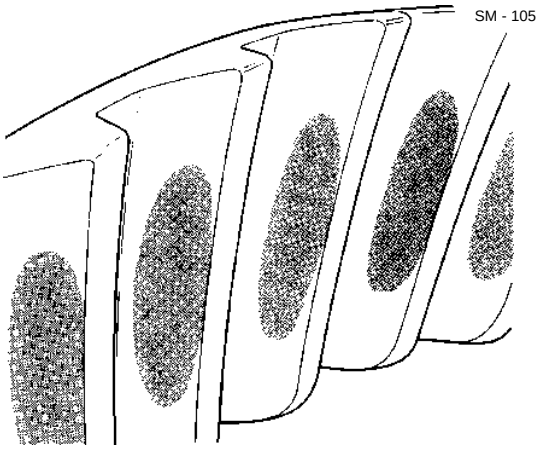


Fig. 12 - Proper Tooth Contact

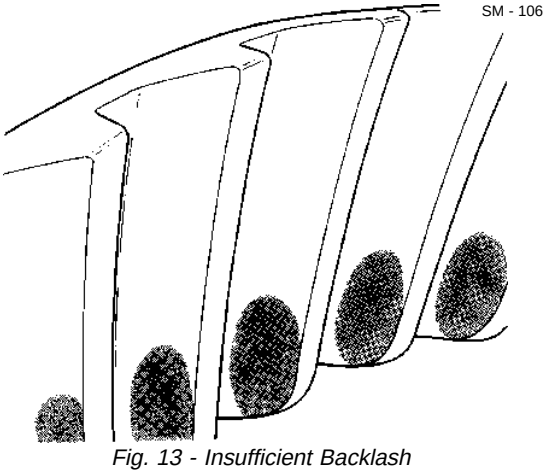


Fig. 13 - Insufficient Backlash

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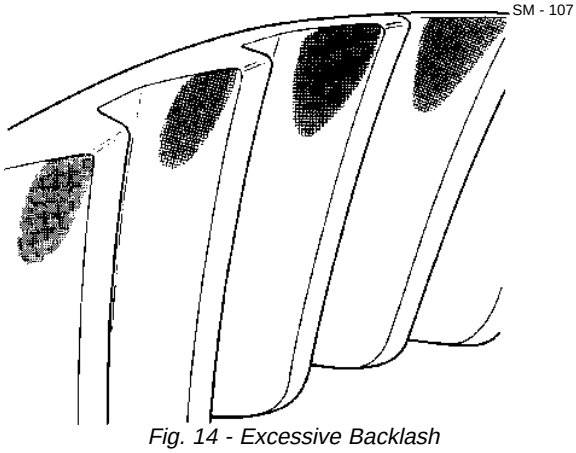


Fig. 14 - Excessive Backlash

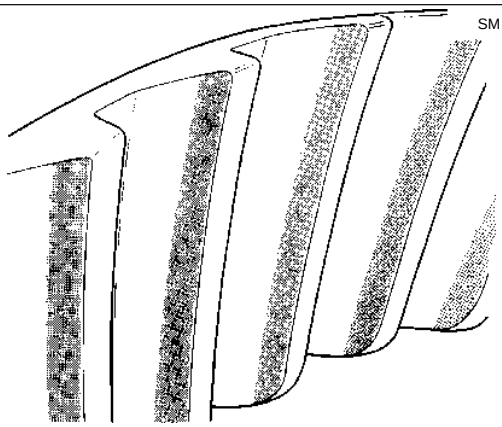


Fig. 16 - Pinion Out Too Far - Remove Shims

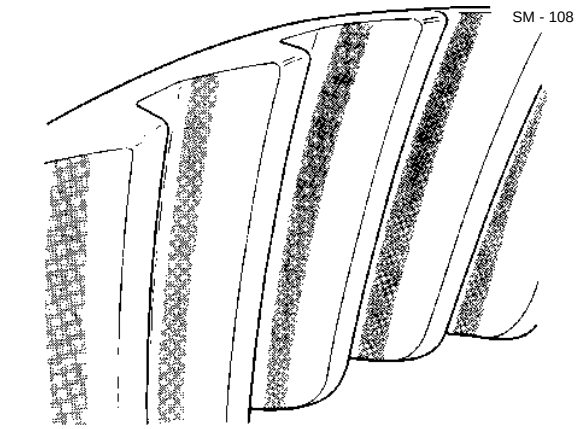


Fig. 15 - Pinion In Too Far - Add Shims

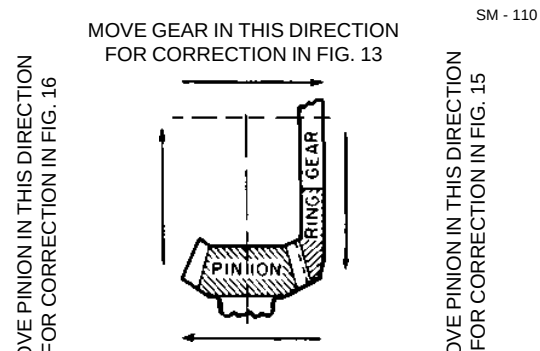


Fig. 17 - Correct Movement for Adjustment

INSTALLATION

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ A come-a-long or chain fall with a minimum capacity of one ton is required for removal and installation of a differential assembly.

1. Be sure truck wheels are chocked securely.

2. If the body is not already raised, raise body and install body prop pins. Refer to Section 270-0010, BODY AND MOUNTING.

3. Clean mating surfaces of the banjo and differential assembly with a Loctite 7063 cleaning agent to remove dirt, oil, grease, or other foreign matter. Leave cleaned surfaces to dry. Apply Loctite 5205 sealant to the banjo mounting face in a 3 to 5 mm (0.12 to 0.19 in) diameter bead, ensuring that all stud holes are encircled and each circle is connected to the one on either side (the loop between the studs will be on the inside of any extraction holes). Refer to Fig. 18.

Note: Install differential within 10 minutes before Loctite 5205 sealant cures.

4. Set screw (4) should already have been removed from the top of the differential housing and replaced with a lifting eye during removal. If not, remove set screw (4) from differential housing and replace it with a lifting eye.

5. Position the differential assembly under the truck in front of the banjo housing.

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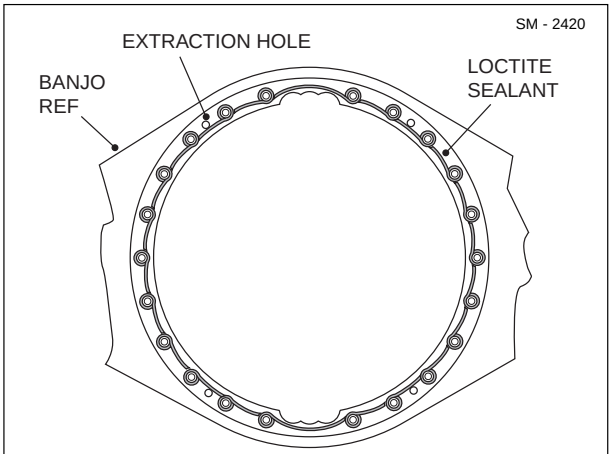


Fig. 18 - Applying Loctite 5205 Sealant

6. Install chain fall or come-a-long to the loop on the body just behind the hoist brackets. Attach the other end of the lifting device to the eye previously installed in the differential assembly.

7. Lift the differential assembly and carefully position it on the studs of the banjo housing.

8. Secure the differential assembly to the banjo with the self locking nuts removed at removal. Tighten the nuts evenly to a torque of 380 Nm (280 lbf ft).

9. Replace the rear driveline, aligning marks made during disassembly. Refer to Section 130-0020, REAR DRIVELINE.

10. Install the axle shafts, then replace and secure the driving flange cover to the wheels. Refer to Section 160-0030, AXLE GROUP.

11. Fill the drive axle, planetary reservoirs and differential with the proper grade and quantity of lubricant specified in Section 300-0020,LUBRICATION SYSTEM.

MAINTENANCE

Periodic Inspection

Inspect regularly the flange yoke mounting bolts, pinion shaft nut, pinion cage and seal retainer bolts, and differential stud nuts for tightness. Tighten the stud nuts and flange bolts weekly until they 'set' or show that they no longer need tightening. Keep the nuts tight to reduce the possibility of differential or driveline failure due to excessive vibration or wear.

Replace any mounting studs which have become stripped or broken.

Jack up the drive axle to 'test run' the differential and listen for noises which may indicate the need for adjustment or replacement of worn parts. When doing this, lift BOTH wheels off the ground. Both wheel brakes should be free to allow both wheels to rotate at approximately the same speed.

Note: Do not operate with only one wheel jacked up. Excessive operation in this manner will overheat the differential spider and cause galling or shearing of the spider trunnions and bearings.

If the differential is excessively noisy, it should be removed from the banjo and disassembled for inspection.

Lubrication

The differential is splash lubricated with an extreme pressure lubricant. The fill level plug is located in the centre rear of the banjo housing.

The differential should be checked and periodically drained and filled to the bottom of the fill-level hole, or to no more than 13 mm (0.5 in) below the fill level, with new lubricant as recommended. Refer to Section 300-0020, LUBRICATION SYSTEM. When the lubricant is drained, remove any chips of steel particles that may be attached to the magnetic drain plug located in the bottom of the banjo housing.

After draining and refilling an axle, the planetary gearing should be checked after 10 hours of operation.

1. Check the level in planetaries at oil level plug. If the oil level is low, add oil. This check point is a minimum check point only. If the oil level is above the check point, do not drain off oil.

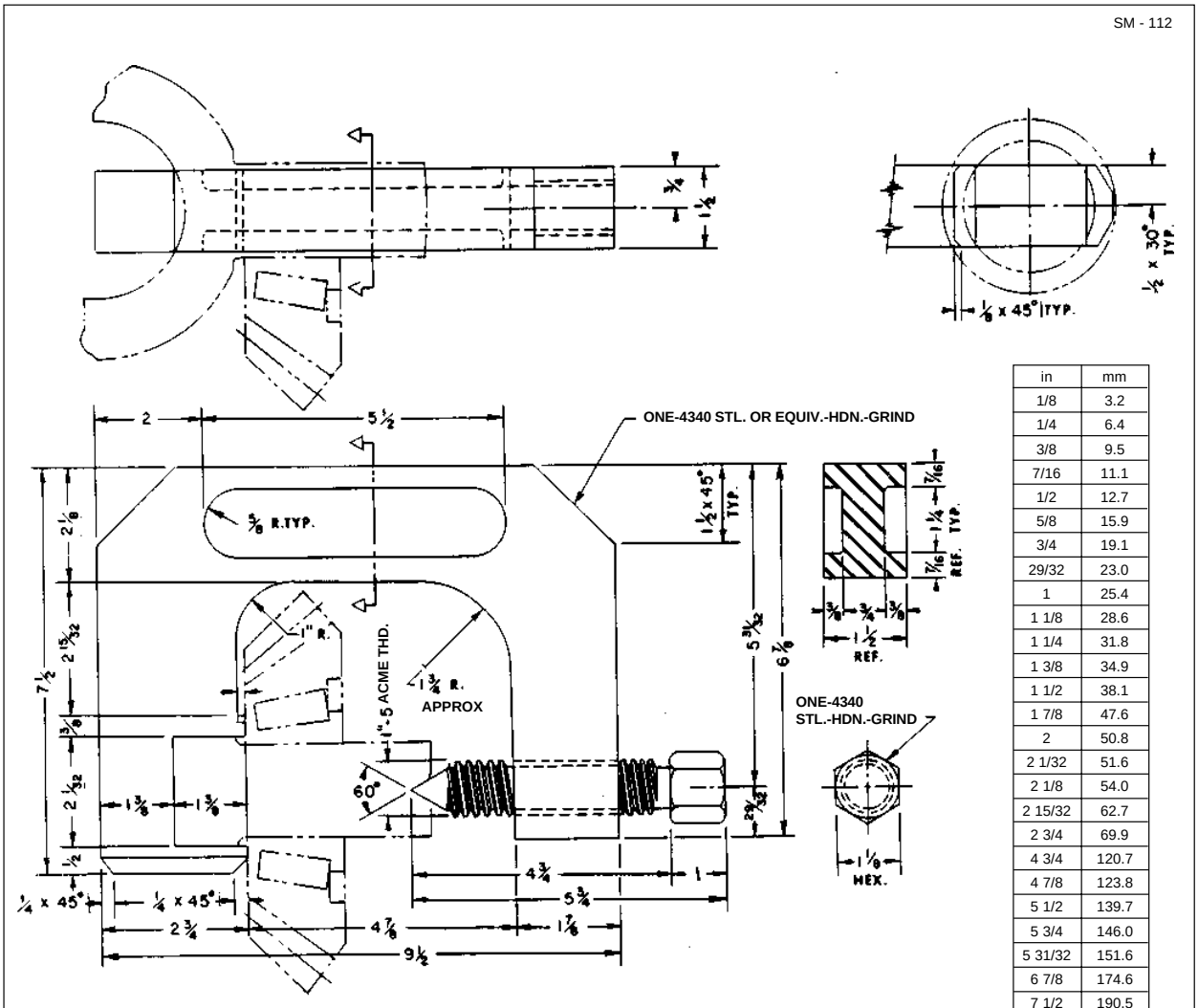
2. Add oil if needed. The oil level is correct when oil flows from the lube level check plug in the banjo. These checks should be made every 10 hours until oil level in the differential is maintained.

SPECIAL TOOLS

The spider bearing spreader tool can be fabricated as shown in Fig. 19. Refer to Section 300-0070, SERVICE TOOLS for part numbers of measuring tools referenced in this section and general service tools and adhesives required. These tools and adhesives are available from your dealer.

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in	mm
1/8	3.2
1/4	6.4
3/8	9.5
7/16	11.1
1/2	12.7
5/8	15.9
3/4	19.1
29/32	23.0
1	25.4
1 1/8	28.6
1 1/4	31.8
1 3/8	34.9
1 1/2	38.1
1 7/8	47.6
2	50.8
2 1/32	51.6
2 1/8	54.0
2 15/32	62.7
2 3/4	69.9
4 3/4	120.7
4 7/8	123.8
5 1/2	139.7
5 3/4	146.0
5 31/32	151.6
6 7/8	174.6
7 1/2	190.5
9 1/2	241.3

Fig. 19 - Spider Bearing Spreader Tool Dimensions

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	2	Bolt	290	213
1	10	Bolt	156	115
1	23	Bolt	33	24
1	21	Bolt	644	475
1	30	Nut	700	515
1	39	Bolt	271	200
-	-	Self Locking Nut	380	280

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DIAGNOSIS CHART		
CONDITION	REASON	REMEDY
Vibration.	Broken gear teeth.	Replace damaged gear.
	Excessive runout of pinion or flanged case.	Disassemble, correct or replace faulty part.
Continual noise.	Bearing worn.	Replace worn parts.
	Gears damaged or worn.	Replace gears.
Noise on drive.	Ring and pinion gear adjustment tight.	Adjust.
Noise on coast.	Bearing damaged.	Replace bearings.
	Loose ring and pinion gear adjustment.	Adjust gears.
	Excessive pinion gear end play.	Adjust.
Noise on turns.	Worn spider gears or side gears.	Replace gears.
	Worn or damaged spider bushings.	Replace bushings.
Loss of lubricant.	Oil seals worn.	Replace seal.
	Loose nuts.	Tighten nuts to correct torque.
	Cracked housing.	Repair or replace housing.

* * * *

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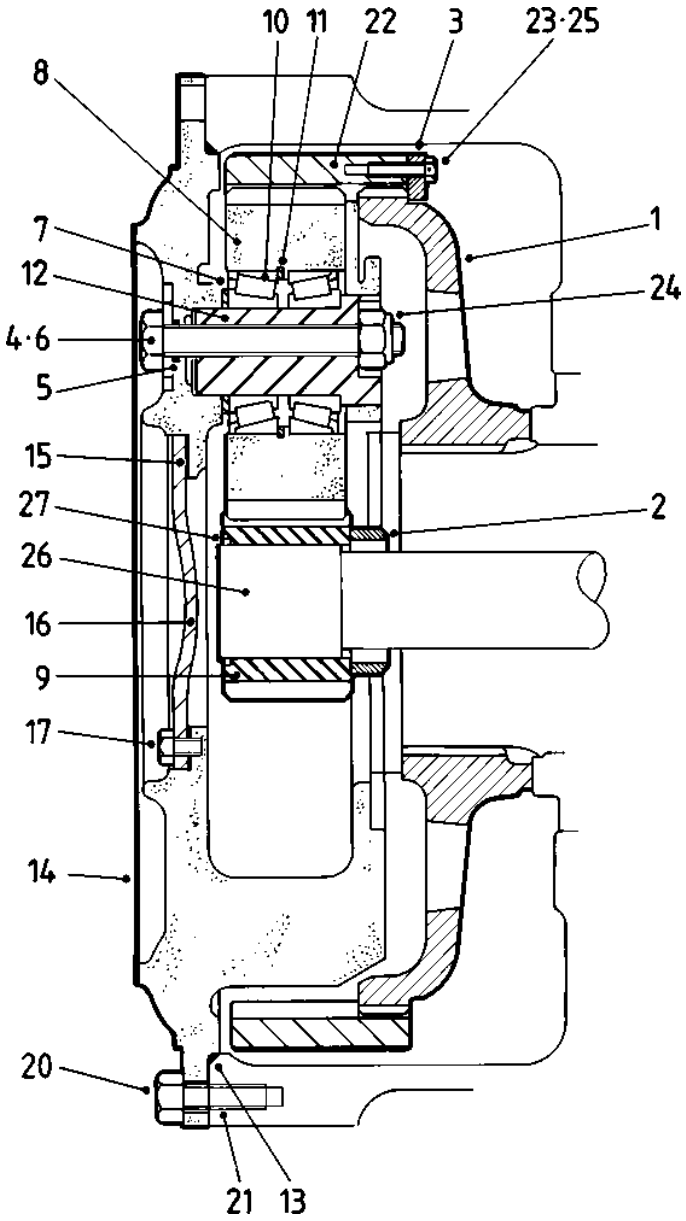
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SM - 235



1 - Ring Gear Carrier
2 - Ring
3 - Retainer Plate
4 - Bolt
5 - 'O' Ring
6 - Washer
7 - Spacer
8 - Planet Pinion
9 - Sun Gear
10 - Pinion Bearing
11 - Snap Ring
12 - Planet Pin
13 - 'O' Ring
14 - Planetary Carrier
15 - Gasket
16 - Cover
17 - Bolt
*18 - Magnetic Plug
*19 - Screw
20 - Nut
21 - Stud
22 - Ring Gear
23 - Bolt
24 - Nut
25 - Lockwire
26 - Axle Shaft
27 - Snap Ring

* Shown in Fig. 2.

Fig. 1 - Sectional View of Planetary Assembly

PLANETARY

Description and Operation

Numbers in parentheses refer to Fig. 1.

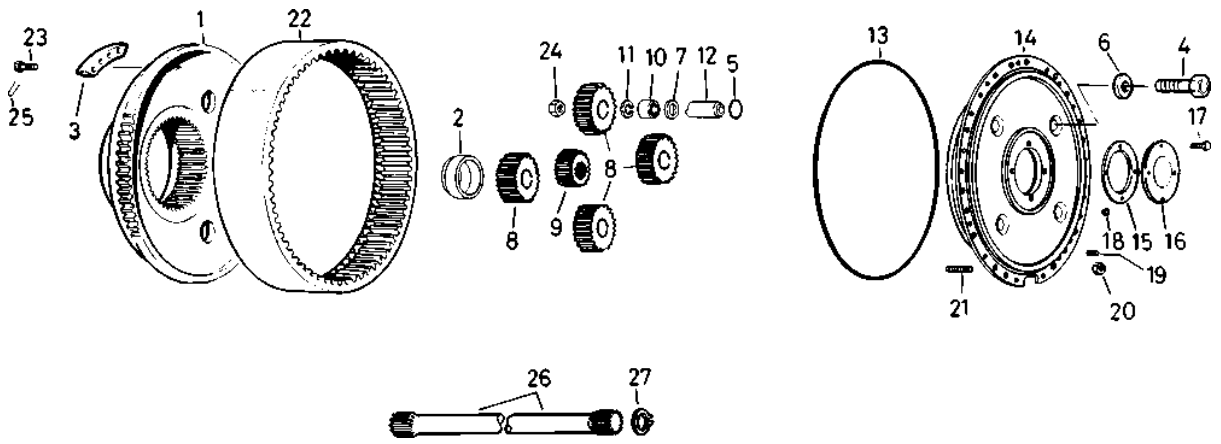
The planetary gearing is a single stage planetary gear assembly. This assembly contains sun gear (9), planetary carrier (14) with planet pinions (8) and ring gear (22), to provide gear ratio to the drive wheels.

Axle shaft (26) is driven by the differential and turns sun gear (9) to which it is splined. Sun gear (9) meshes with and rotates planetary pinions (8). Since ring gear (22) is splined to the wheel spindle it cannot turn and forces the planetary carrier (14) to rotate. This results in planetary carrier (14) being the output to the drive wheels.

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SM - 236



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16 - Cover
17 - Bolt
18 - Magnetic Plug
19 - Screw
20 - Nut
21 - Stud
22 - Ring Gear
23 - Bolt
24 - Nut
25 - Lockwire
26 - Axle Shaft
27 - Snap Ring

Fig. 2 - Exploded View of Typical Planetary

Planetary Gearing - Towing

Numbers in parentheses refer to Fig. 1.

> **WARNING**
> **Be sure adequate steering and braking pressure are available before towing to prevent injury or damage enroute.**

If the truck is to be towed, as in the case of a breakdown, the axle shaft (26) and sun gear (9) should be removed from the planetary assemblies.

The removal will prevent possible damage to the power train components during towing.

The axle shafts and sun gears can be removed easily by taking off driving flange cover (16) and simply sliding the axle shaft, together with the sun gear, out of each planetary assembly by hand. Be certain the driving flange covers are installed to protect the planetary assemblies from road dust and dirt while towing is in progress.

Removal and Disassembly

Numbers in parentheses refer to Fig. 2.

Note: The planetary assembly can be removed from the wheel without removing the tyre and rim assembly.

1. Position the vehicle in a level work area with magnetic plug (18) at its lowest point. Apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels.

3. With a suitable container in position, remove magnetic plug (18) and drain all lubricant from the planetary assembly.

4. Remove bolts (17), cover (16) and gasket (15) from planetary assembly.

5. Pull out sun gear (9), snap ring (27) and axle shaft (26) assembly from planetary housing. Remove snap ring (27) from axle shaft (26) and remove sun gear (9) from axle shaft (26).

> **WARNING**
> **To prevent personal injury and property damage, be sure lifting equipment is of adequate capacity and properly secured to do the job safely.**

6. The driving flange and planetary gear assembly can now be pulled from the wheel by removing the thread protectors and threading screws (19) into the

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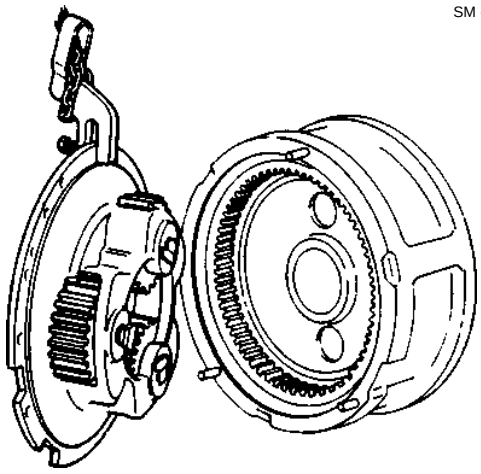


Fig. 3 - Removing Planetary Assembly

exposed holes. A hoist should be used, as shown in Fig. 3, to support the assembly during removal. Remove studs (21) if damaged.

7. Remove and discard 'O' ring (13) and place planetary assembly on a clean work surface with gear side up.

8. Remove nuts (24), bolts (4) and washers (6) from planet pinion (8) assemblies. Slide planet pinion (8) assemblies from planetary carrier (14).

9. Separate pinion bearing (10) sets and spacers (7) from planet pinions (8) and remove snap rings (11) from internal grooves of planet pinion (8).

10. Remove and discard 'O' rings (5) from planetary carrier (14).

INSPECTION

Numbers in parentheses refer to Fig. 2.

1. Clean all parts thoroughly in suitable solvent and dry with moisture-free compressed air or a clean, lint-free cloth. Allow bearings to air dry and dip in clean planetary lubricant.

2. Inspect all parts for damage. Repair or replace as necessary.

3. Inspect all pinions, gears and splines for excessive wear, cracked or broken teeth and pitted or scored surfaces. If replacing planet pinions or sun gear, be sure the new pinions or gear have the same number of teeth as the old ones so torque multiplication will remain the same.

4. Inspect bearings for damage or excessive wear. In addition, check for free fit in planet pinions and on the planet pins. Replace any parts which are in questionable condition.

5. Inspect for pitted, scored or worn thrust surfaces and burrs on planetary carrier (14).

6. Inspect ring gear (22) and planetary carrier (14) for cracks and wear.

Assembly and Installation

Numbers in parentheses refer to Fig. 2.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: If ring gear carrier (1) is replaced, the wheel bearing adjustment must be checked and corrected as required, as described in Section 160-0050, WHEEL, RIM AND TYRE.

1. Insert snap rings (11) in planet pinion (8) grooves. Oil bearing sets (10) and insert spacers (7) and bearings (10) in planet pinions (8).

2. Install new 'O' rings (5) in planetary carrier (14). Slide assembled planet pinions into their respective positions in planetary carrier (14).

3. Insert planet pins (12) through planet pinion (8) assemblies into planetary carrier (14) bores. Install washers (6) on bolts (4) and insert bolts (4) through planetary carrier (14) and planet pinions (8). Install nuts (24) on bolts (4) and tighten securely. Check planet pinions (8) for free rotation.

> ⚠ **WARNING**
> **To prevent personal injury and property damage, be sure lifting equipment is of adequate capacity and properly secured to do the job safely.**

4. Install new 'O' ring (13) in its groove in planetary carrier (14). Place the planetary assembly in position on the wheel. Mesh planet pinions (8) with ring gear (22) and push the planetary assembly into place. Install studs (21), if removed, and install nuts (20).

5. If sun gear (9) was removed during 'Disassembly', slide sun gear (9) over splines of axle shaft (26) and install snap ring (27). Install ring (2) on axle shaft (26) and insert axle shaft assembly into the spindle

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and banjo housing, pushing the axle shaft part way into the differential side gear. Mesh sun gear (9) with planet pinions (8).

6. Push axle shaft (26) and sun gear (9) inward as far as they will go. With a steel rule and straight edge, measure from cover mounting surface on planetary carrier (14) to the end of axle shaft (26). Note as dimension 'A'. See Fig. 4.

7. Next, lay cover (16) on flat surface and again use a straight edge and steel rule to measure the height of the inside raised surface of cover (16). Note as dimension 'B'. See Fig. 5. Subtract dimension 'B' from dimension 'A' and the clearance should be within 2.7 - 11.9 mm (0.106 - 0.469 in).

Note: If the end play is too small, the axle shaft is not pushed completely into the differential side gear. If the end play is greater than the allowable maximum, either the axle shaft end or the driving flange thrust cover, or both are excessively worn. To correct this, replace cover (16) first. If the end play is still too great, a new axle shaft must be installed.

8. Replace magnetic plug (18) and fill the planetary reservoir with lubricant specified in Section 300-0020, LUBRICATION SYSTEM, through the driving flange opening or fill plug until the correct level is reached.

9. Spread sealing compound on the surface of cover (16) which contacts the driving flange. Position gasket (15) and install cover (16) on driving flange using bolts (17). Be sure to replace any thread protectors which have been removed.

REAR AXLE

Description and Operation

Numbers in parentheses refer to Fig. 6.

The rear axle assembly consists of banjo (1) assembly and A-frame (39). The banjo provides the housing for the differential and axle shafts which drive the wheels, and spindles (2) to which the wheels are mounted. The banjo also connects the rear wheels to the chassis through A-frame (39), link (16), and the rear ride cylinders.

The rear axle is centrally mounted on the rear frame crossmember with a tapered pin (12) and component parts, which allows the axle to oscillate as the truck moves over uneven terrain.

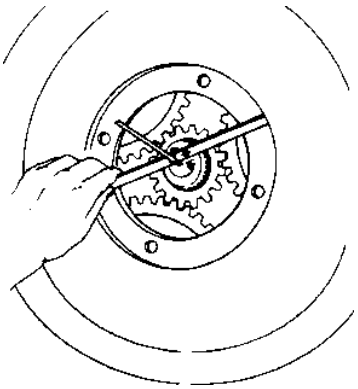


Fig. 4 - Measuring Dimension 'A'

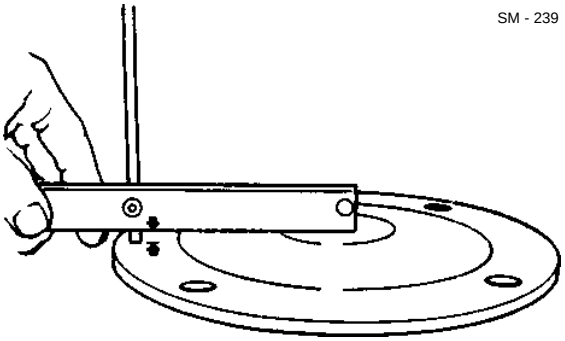


Fig. 5 - Measuring Dimension 'B'

Removal

Numbers in parentheses refer to Fig. 6.

Note: If differential only is to be removed, it can be done while axle is attached to the truck, as outlined in Section 160-0020, DIFFERENTIAL.

⚠ WARNINGS

Heavy machine. Make sure lifting device or jack has proper lifting capacity and is adequately secured to do the job safely. Personal injury and damage may result if machine falls or jack or lifting device collapses.

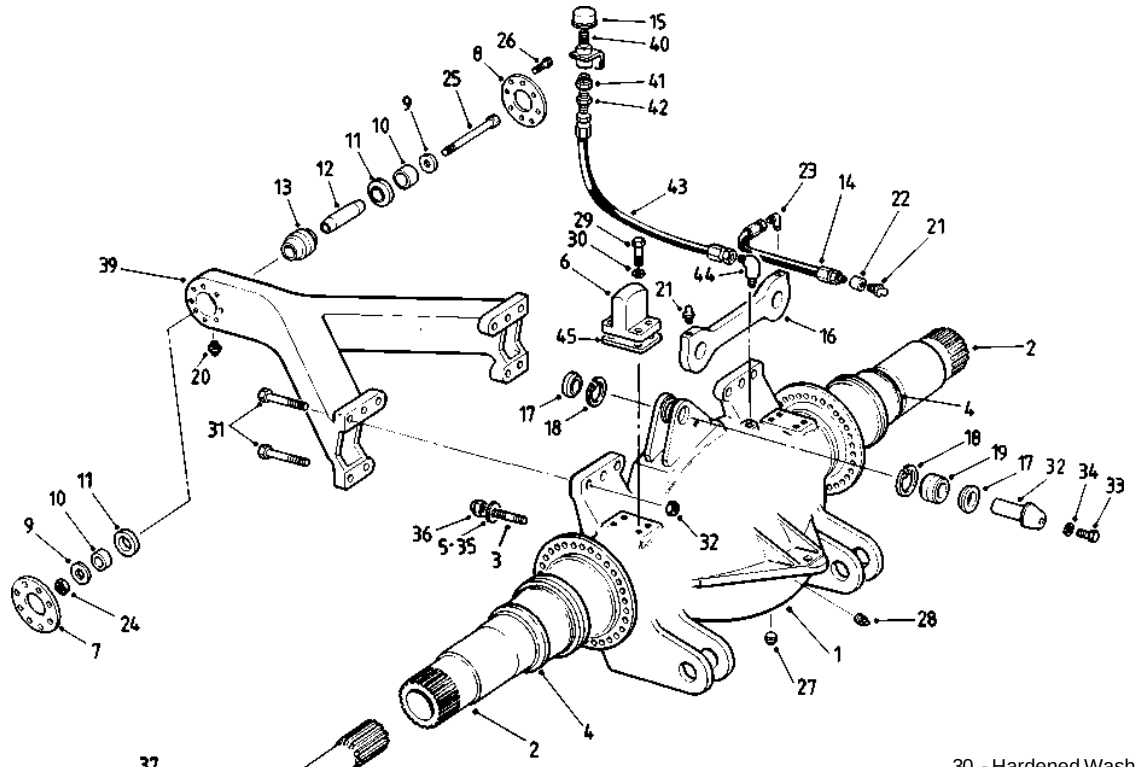
⚠ To prevent possible personal injury, relieve the pressure in the braking system. The exact procedure must be followed as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

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SM - 1380



1 - Banjo
2 - Spindle
3 - Stud
4 - Bearing Ring
5 - Hardened Spacer
6 - Oscillation Stop
7 - Tapped Retainer
8 - Retainer
9 - Washer
10 - Split Cup
11 - Spacer
12 - Tapered Pin
13 - Bearing
14 - Lube Line
15 - Breather
16 - Link
17 - Spacer
18 - Snap Ring
19 - Bearing
20 - Lube Fitting
21 - Lube Fitting
22 - Coupling
23 - Elbow
24 - Nut
25 - Bolt
26 - Bolt
27 - Magnetic Plug
28 - Plug
29 - Bolt
30 - Hardened Washer
31 - Bolt
32 - Pin
33 - Bolt
34 - Hardened Washer
35 - Hardened Washer
36 - Locknut
37 - Axle Shaft
38 - Snap Ring
39 - A-Frame
40 - Nipple
41 - Bushing
42 - Connector
43 - Breather Line
44 - Elbow
45 - Spacer

Fig. 6 - Exploded View of Axle Assembly and Mounting

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Operate the treadle valve continuously to relieve pressure in the braking system. Block all road wheels.

3. Disconnect brake, cooling, breather and lubrication lines. Drain all the lubricant from the axle, brake assemblies and planetary assemblies into suitable containers. Refer to Section 160-0020, DIFFERENTIAL, and, Section 165-0030, BRAKE PARTS. Cap all open lines and fittings to prevent entry of dirt.

Note: Avoid spilling lubricant on tyres, as it will deteriorate the rubber.

4. Jack up or lift the vehicle so its weight is no longer resting on the tyres of the axle assembly. Securely block the vehicle in this position.

5. Remove four bolts from the driveline flange and swing-driveline away from the differential. Punch mark both flanges to facilitate installation. Refer to Section 130-0020, REAR DRIVELINE.

6. If necessary remove the tyre and rim assemblies as described in Section 160-0050, WHEEL, RIM AND TYRE.

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7. Position a hydraulic jack under the axle at the differential housing, being sure jack is of suitable capacity and proportions to lift and balance the axle assembly. Place wheeled dollies at both ends of the axle for wheels to rest on when the axle is lowered. Raise axle just enough to take weight off centre tapered pin (12).

8. Remove lower ends of rear ride cylinders. Refer to Section 180-0050, RIDE CYLINDER.

9. Remove bolt (33), hardened washer (34) and pin (32) which mount link (16) to the chassis. Remove spacers (17).

10. Remove nut (24), washers (9) and bolt (25) attaching A-frame (39) to the chassis. Remove split cups (10) from tapered pin (12).

11. Drive tapered pin (12) out of the chassis using a soft drift. As tapered pin (12) moves out, remove spacers (11). Lower the axle assembly onto the wheeled dollies and roll out from beneath the vehicle.

Disassembly

Numbers in parentheses refer to Fig. 6.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure lifting equipment is of adequate capacity and properly secured to do the job safely.**

1. Remove bolts (26) from A-frame (39) and remove retainer (8) and tapped retainer (7). Drive bearing (13) from A-frame (39). If required, remove lube fitting (20) from A-frame (39).

2. Remove A-frame (39) from banjo (1) by removing bolts (31).

3. Remove bolts (29) and hardened washers (30) securing oscillation stop (6) to banjo (1). Remove oscillation stop (6) and spacer (45).

4. Remove bolt (33), hardened washer (34) and pin (32) which mount link (16) to banjo (1). Remove spacers (17).

5. Remove link (16) from banjo (1) brackets. Remove snap rings (18) and bearings (19) from link (16).

6. Remove lube line (14), elbow (23) and lube fitting (21) from link (16).

7. Remove breather line (43) and elbow (44) from banjo (1).

8. If differential is to be removed, remove nuts (36), hardened spacers (5) and hardened washers (35). Using suitable lifting equipment, remove differential assembly from banjo (1). Refer to Section 160-0020, DIFFERENTIAL.

9. If required, remove magnetic plug (27) and plug (28) from banjo (1).

10. If required, remove snap rings (38) and axle shafts (37) from spindles (2).

Inspection

1. Clean all metal parts in a suitable solvent, using a brush to clean bearings. Dry all parts on a clean surface and allow bearings to dry naturally. Make sure parts are free from dirt.

2. Check all inner and outer grooves for cleanliness. Check components for cracks, scores, blemishes or burrs. Use a fine stone to smooth out defective areas. Replace any parts that show excessive wear.

3. Inspect fittings, plugs, studs and their seating positions for thread wear. If threads in any of these parts are damaged, replace parts.

4. Check bushings, bearings and snap rings for wear or warped condition. Replace defective parts.

5. Replace old washers with new ones.

Assembly

Numbers in parentheses refer to Fig. 6.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: If heating of banjo (1) is required to assemble spindles (2) and banjo (1), banjo interference areas must cool to 66° C (150° F) maximum before welding. For welding spindles (2) to banjo (1) preheat spindles and banjo to 150° C (300° F) minimum in weld area and maintain during welding.

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WARNING
To prevent personal injury and property damage, be sure lifting equipment is of adequate capacity and properly secured to do the job safely.

1. If axle shafts (37) have been removed from spindles (2) install axle shafts in the spindles and secure with snap rings (38).

2. If removed, install magnetic plug (27) and plug (28) in banjo (1).

3. If differential was removed, position differential in banjo (1) and secure with nuts (36), hardened spacers (5) and hardened washers (35). Refer to Section 160-0020, DIFFERENTIAL.

4. Install elbow (44) in banjo (1) and connect breather line (43) to elbow (44).

5. Install lube fitting (21) and elbow (23) in link (16) and connect lube line (14) to elbow (23).

6. Install bearings (19) in link (16) and secure with snap rings (18). Position link (16) assembly in banjo (1) brackets and install spacers (17). Secure link (16) to banjo (1) with pin (32), hardened washer (34) and bolt (33).

7. Position spacer (45) and oscillation stop (6) on banjo (1) and secure with bolts (29) and hardened washers (30).

8. Install bearing (13) in A-frame (39). Fit retainer (8) and tapped retainer (7) to A-frame (39) and secure with bolts (26). If removed, install lube fitting (20) in A-frame (39).

9. Position A-frame (39) assembly to banjo (1) and secure with bolts (31). Tighten bolts (31) to a torque of 2 034 Nm (1 500 lbf ft).

Installation

Numbers in parentheses refer to Fig. 6.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

WARNING
To prevent personal injury and property damage, be sure lifting equipment is of adequate capacity and properly secured to do the job safely.

1. After banjo (1) and its components are reassembled, roll the assembly under the vehicle and align under the chassis.

2. Using a hydraulic jack of suitable capacity and proportions to lift and balance the axle assembly, raise the axle assembly into position in the chassis. Insert spacers (11) and, using a soft drift, drive in tapered pin (12).

3. Install split cups (10) and washers (9) on tapered pin (12) and secure with bolt (25) and nut (24).

Note: Since tapered pin (12) relies on bolt (25) clamping to spread out and seat split cups (10) against the pin for retention at initial assembly, the pin tends to loosen up after the vehicle is in operation. Positive seating is required and accomplished by re-tightening bolts (25) after the first few hours of operation, and thereafter, until bolts (25) retain their torque.

4. Align link (16) assembly and spacers (17) with the chassis and install pin (32). Secure pin (32) to the chassis with hardened washer (34) and bolt (33).

5. Install rear ride cylinders to the chassis and axle assembly as outlined in Section 180-0050, RIDE CYLINDER.

6. With the axle group securely fastened to the rear ride cylinders and the two sections of the chassis at link (16) and A-frame (39), release and remove the hydraulic jack.

7. Align the punch marks, as marked during removal, on the driveline and differential flanges, and secure with four bolts. Refer to Section 130-0020, REAR DRIVELINE.

8. If removed, replace tyre and rim assemblies as outlined in Section 160-0050, WHEEL, RIM AND TYRE.

9. Remove blanking caps and reconnect all brake, cooling, breather and lubrication lines. Refer to Section 160-0020, DIFFERENTIAL, and, Section 165-0030, BRAKE PARTS.

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10. Fill banjo, planetaries and disc brake assemblies with lubricant specified in Section 300-0020, LUBRICATION SYSTEM.

11. Lubricate the rear axle assembly through lube fittings (20 & 21) with lubricant specified in Section 300-0020, LUBRICATION SYSTEM.

12. Bleed the braking system as described in Section 165-0030, BRAKE PARTS.

MAINTENANCE

Proper lubrication of the axle group is essential if axles are to deliver the service intended. Refer to Section 300-0020, LUBRICATION SYSTEM for lubrication intervals and lubricant specifications.

AXLE DIAGNOSIS

Noises originating in the tyres, transmission or driveline might be attributed by mistake to the axle. Therefore, all possible sources of noise should be investigated before deciding the axle is at fault.

True axle noises may be located by lifting or jacking the truck until all driving wheels are clear of the floor or ground. Securely block the truck in this position. Run power train at moderate speed. Be certain all tyres are off the ground and, to prevent damage to the differential, see that neither rear brake drags.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and sealants required. These tools and sealants are available from your dealer.

AXLE DIAGNOSIS

CONDITION	REASON	REMEDY
Noise	Insufficient or incorrect lubricant	Check level; fill with proper type and grade lubricant
	Wheel bearings scored or rough	Replace bearings
	Gear teeth in planetary chipped	Replace gear
Loss of lubricant	Lubricant level too high	Drain and fill to proper level
	Lubricant foams excessively	Drain and fill with correct type and grade lubricant
	Worn or broken oil seal	Replace oil seal
	Restricted breather vent	Clean vents
	Loose nuts or bolts	Tighten nuts or bolts
Gain of lubricant	Restricted differential housing vent	Clean vent
Planetaries running hot	Insufficient or incorrect lubricant	Check level; fill with proper type and grade of lubricant
	Pinion bearings seized	Replace bearings

SPECIAL TORQUE SPECIFICATIONS

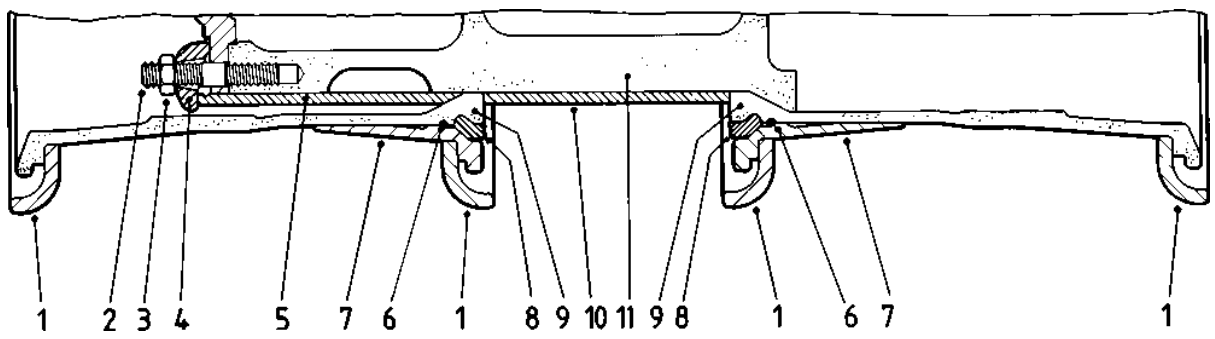
FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
6	31	Bolt	2 034	1 500

* * * *

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SM - 203



1 - Flange
2 - Wheel Stud
3 - Nut
4 - Clamp
5 - Wedge Band
6 - 'O' Ring
7 - Bead Seat Band
8 - Lock Ring
9 - Rim
10 - Spacer Band
11 - Wheel

Fig. 1 - Sectional View of Typical Dual Wheel Rim Assembly

DESCRIPTION

Each drive wheel is mounted on its spindle with two tapered roller bearings. All the weight of the truck resting on the drive axle is supported by the wheels and bearings; none of the weight is supported by, or transmitted through, the axle shafts. This type of construction is known as 'Full Floating'.

The wheel itself is a large cylindrical casting with the bearing bores and other finished surfaces machined after the wheel is cast.

The dual rim assembly consists of two rim bases, inner and outer flanges, bead seat bands, 'O' rings and lock rings.

The tyre and rim assembly is designed to be replaced with a pre-assembled tyre and rim.

PREPARATION FOR SERVICING

⚠ WARNING
Before loosening rim clamps or performing any service on the tyres or rim components, to prevent personal injury and property damage, completely deflate BOTH TYRES of dual assembly by removing the valve caps and cores. Insert a thin wire through valves to be sure valves are not plugged. Even a flat tyre, in some cases, will retain sufficient air pressure to blow off a rim component with enough force to cause bodily injury or death.

⚠ WARNING
Tyre explosion hazard. Gases that build up inside an air inflated tyre mounted on a rim during welding and/or heating of rim components can ignite, causing an explosion of the tyre and rim components. This warning also applies to Nitrogen gas inflated tyres. Ignition will not occur in a Nitrogen gas atmosphere; but the pressure build up from the applied heat may be sufficient to cause a blowout severe enough to injure or kill. Never weld or otherwise apply heat on rim components with the tyre mounted on the rim, whether the tyre is inflated or deflated, to prevent injury or property damage from the potential tyre explosion! Also, do not attempt to repair rims or rim components by welding or heating, even if the tyre is not mounted on the rim. It is recommended to scrap questionable rim parts unless specific permission and repair procedures are obtained in writing either from the company or the rim manufacturer.

REMOVING TYRE AND RIM ASSEMBLY

Numbers in parentheses refer to Fig. 1.

If the tyre and rim assembly is to be replaced with a pre-assembled tyre and rim assembly, it is not necessary to remove the tyre from the rim on the truck. The tyre and rim may be removed from the truck as an assembly, and transported to a more desirable location for removing the tyre from the rim.

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⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of sufficient capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Block all road wheels, except the ones to be raised. Use wooden blocks 100 x 100 mm (4 x 4 in) or larger.

3. For the tyre to be removed, set up jack to support truck weight, but do not raise truck.

4. Completely deflate both tyres by removing valve caps and cores. Check valve stems by running a piece of wire through the stems to make sure they are not plugged. See warning under 'Preparation For Servicing'.

5. Break wheel nuts (3) loose, but do not remove from wheel studs (2).

6. Jack the machine up only as high as necessary to remove the wheel from the truck, and place safety blocks under the axle.

7. Support the outer tyre with a chain or rope sling of sufficient strength attached to a suitable lifting device. Remove nuts (3) and clamps (4) from wheel studs (2). Remove wedge band (5) and lift tyre and rim assembly clear.

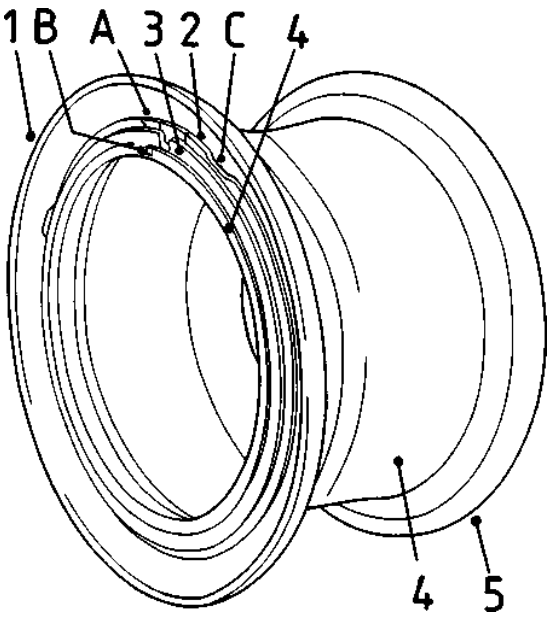
8. If inner rim assembly is being removed, remove spacer band (10), attach a lifting device to tyre and rim assembly, and remove from truck.

DISMOUNTING TYRE FROM RIM

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Note: The following instructions apply to use of hand tools. The procedure and tooling required to dismount the tyre from the rim using hydraulic tools is outlined under the heading 'Hydraulic Bead Breaking Tool'.

SM - 204



1 - Outer Flange
2 - Bead Seat Band
3 - Lock Ring
4 - Rim
5 - Inner Flange

Fig. 2 - Typical Rim Assembly

SM - 205



Fig. 3 - Pry Bar

SM - 206

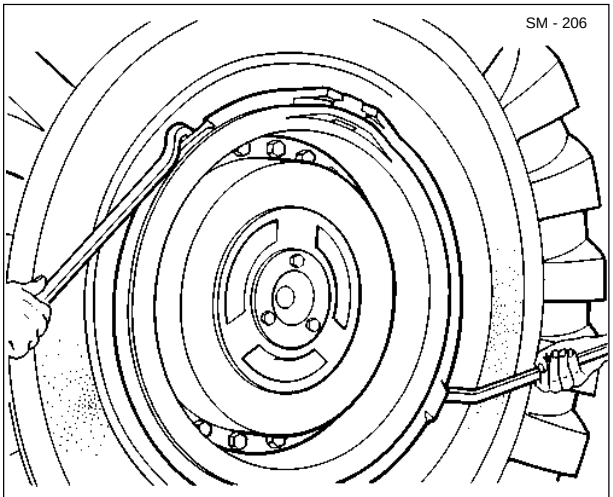


Fig. 4 - Breaking Typical Tyre Bead Loose

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⚠ WARNING
When lifting tyre from rim, be sure the equipment is of sufficient capacity and properly secured to do the job safely.

1. Completely deflate tyre if not done previously. See warning under 'Preparation For Servicing'. Tape valve threads to protect from damage, leaving valve end open to avoid any possibility of trapping air inside the tyre.

2. Break outer tyre bead loose by placing the flat hooked end of a pry bar, see Fig. 3, into one of the breaking slots 'C' between bead seat band (2) and flange (1). A length of pipe slipped over straight end of pry bar will increase leverage. Twist straight end of pry bar around toward tyre to break this portion of bead. A second person may now insert another bar of the same type into the space between the bead seat band and flange, and with the same twisting action, hold the space gained with first pry bar. Move first pry bar all the way around the wheel, twisting and following up with second pry bar, until inner tyre bead is loose.

3. Start bead seat band (2) in away from lock ring (3) by placing hooked end of pry bar in groove of rim (4), between ends of lock ring, and prying up with pry bar. Using two pry bars, as in Step 2, work completely around wheel.

4. Pry lock ring (3) out in same manner by starting at prying notch 'B' in wheel, and work all the way around wheel with the two pry bars.

5. Remove and discard 'O' ring (6, Fig. 1).

6. After removing lock ring (3), pry out and remove bead seat band (2). Outer flange (1) may now be removed.

7. Similar breaking slots are provided on the inside of rims. The inner bead on the back side of the tyre may be broken by using the same method as in Step 2, for the outer bead. If the wheel assembly is still on the truck, inner wheel only, another method which can be used is to place a small jack between the inner flange and some solid part of the truck frame. By extending the jack, pressure is exerted, which forces the tyre bead off the rim seat. Work around the wheel until the bead is broken at all points.

8. Using suitable lifting equipment, remove tyre from rim. This completes the removal of the tyre.

Note: If tyre and rim is on the truck, and no tyre lifting equipment is available, 'walk' tyre off rim as follows: force bottom of tyre outward as far as possible; lower jack enough to allow weight of tyre to rest on ground; force top of tyre out as far as possible; raise jack to original height and repeat above until tyre is off rim.

INSPECTION

Tyre

Check the interior surface of the tyre to determine its condition. Inspect for cuts or fabric breaks that have penetrated the tyre body. The casing should be inspected closely for any sharp, pointed objects that may have penetrated the tyre body but is invisible from the outside. All dust, dirt, water or other foreign matter should be cleaned from the inside of the tyre.

Replace valve core assembly if condition is questionable.

Rim Assembly

Overloading, improper tyre inflation, rough terrain, high speed, accidents, dirt accumulation and corrosion all tend to reduce the service life of rims and rim components. It is recommended that the rims be inspected, as below, not less than at every tyre change and as the warranty limit approaches, consideration be given to rim replacement.

⚠ WARNING
Never mix components of one manufacturer's rims with those of another. Using the rim base of one manufacturer with the lock ring of another or vice versa is dangerous. The lock ring of one may not fully engage with the lock ring groove of the other. Always consult the rim manufacturer for proper matching and assembly instructions. Also, use and servicing of damaged, worn out, or improperly assembled rim assemblies is a very dangerous practice. Failure to comply with the above warnings could result in explosions from tyre pressure causing serious personal injury and property damage.

1. Clean all rust and dirt from rim parts and wheel.

2. Coat parts with primer paint. Allow thorough drying before assembling.

3. Inspect rim assemblies (Fig. 2) for bent, cracked,

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distorted, battered, and rusted parts which may have resulted from abusive practices outlined above. Replace any damaged parts with new parts.

4. Discard 'O' rings and replace with new ones.

Note: Handle 'O' rings carefully, as damage will prevent an airtight seal for tyre inflation.

MOUNTING TYRE ON RIM

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

> ⚠ **WARNING**
> **When lifting tyre onto rim, be sure the equipment is of sufficient capacity and properly secured to do the job safely.**

1. If tubeless tyre valve assembly was removed from rim, install this assembly in the rim valve hole and tighten securely.

2. Tyre installations are performed in basically the same manner whether the rim (4) is on or off the truck. For off-truck installations, lay the rim on blocks or a mounting stand with 'O' ring groove up. The rim should be just off the floor enough so the tyre rests on the rim and does not touch the floor. Blocks should not extend more than 13 mm (0.5 in) beyond the rim base, so they won't interfere with inner flange (5).

3. Install inner flange (5) over rim (4).

4. Before assembly of the tyre to the rim, lubricate both tyre beads and new rubber 'O' rings (6, Fig. 1) with a thin solution of vegetable base soap and water. Make certain the tyre valve assembly is securely in place. Lower the tyre onto the rim, seating the tyre firmly against inner flange (5).

5. Install outer flange (1) on rim (4).

6. Install bead seat band (2) on rim (4).

7. Install lock ring (3) in groove of rim (4). Use pry bar for this operation, as illustrated in Fig. 5.

8. Force bead seat band (2) past 'O' ring groove in rim (4) by prying, or with lift truck forks. Use blocking between the forks and tyre to prevent tyre damage. Lubricate area of rim adjacent to 'O' ring groove with a

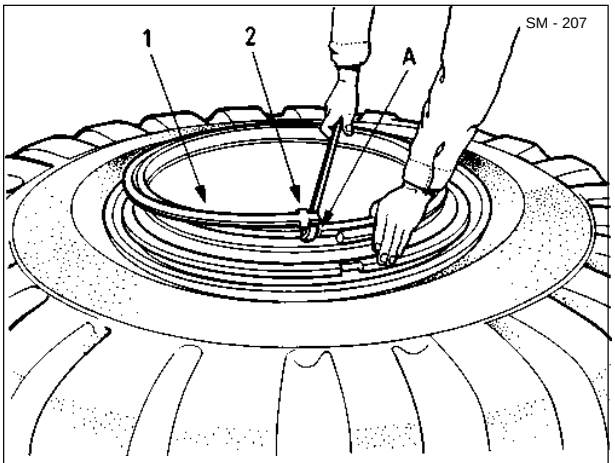


Fig. 5 - Installing Typical Lock Ring

thin solution of soap and water or another approved lubricant which is not harmful to rubber. Avoid using an excessive amount of lubricant. Insert new 'O' ring (6, Fig. 1) in groove of the rim behind lock ring.

9. Lift the tyre upwards to effect a seal between bead seat band (2) and 'O' ring (6, Fig. 1). In some cases the tyre will automatically spring out, making this step unnecessary.

MOUNTING TYRE AND RIM ASSEMBLY ON WHEEL

Numbers in parentheses refer to Fig. 1.

> ⚠ **WARNING**
> **Be sure lifting equipment is of sufficient capacity and properly secured to do the job safely.**

1. Support inner tyre and rim assembly, if removed, with a chain or rope sling attached to an overhead lifting device and slide onto wheel (11) of the truck. Side with lock ring (8) and bead seat band (7) should be facing outward. Install spacer band (10).

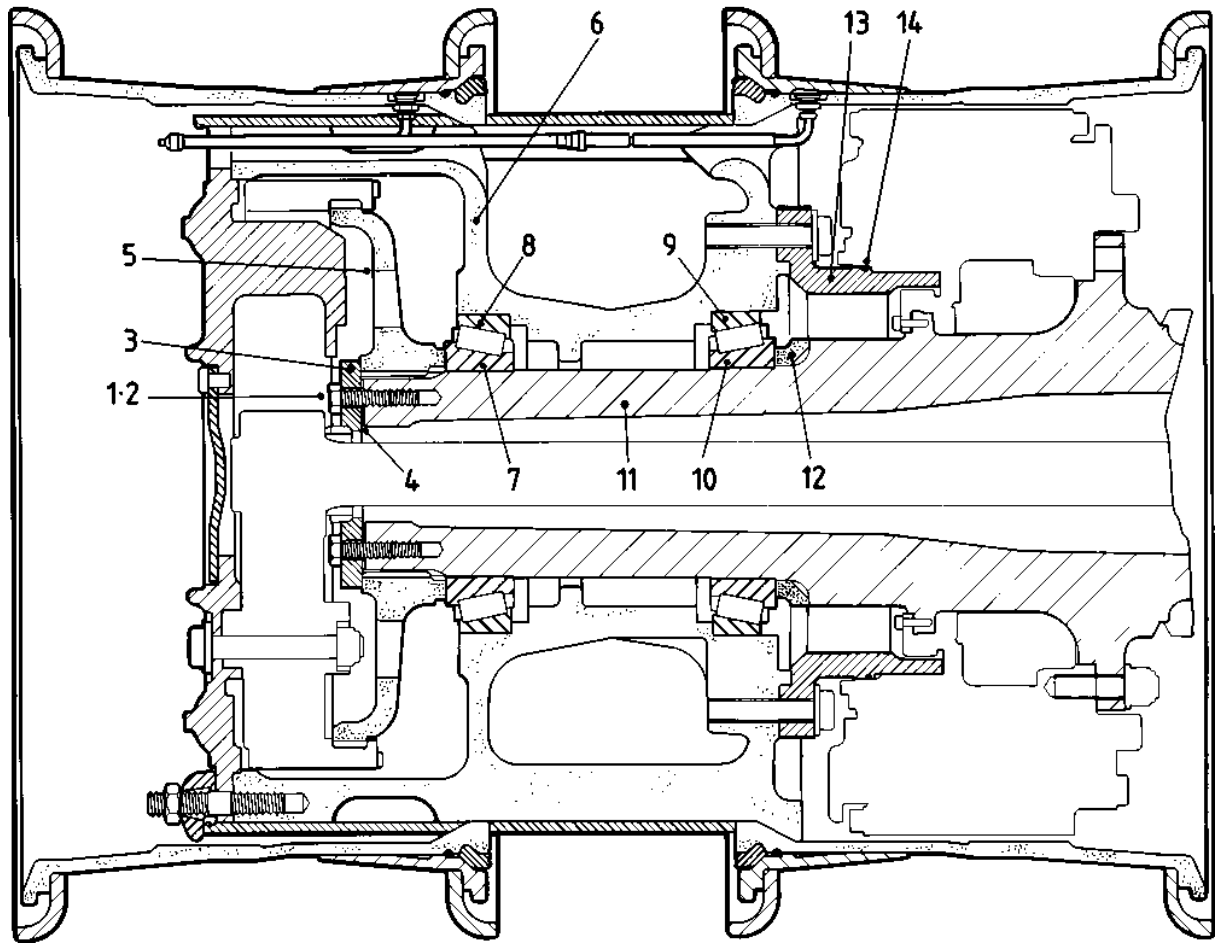
2. Install outer tyre and rim assembly in the same manner, except with bead seat band (7) and lock ring (8) facing inward, toward spacer band (10). Install wedge band (5).

3. Install clamps (4) and start nuts (3) on wheel studs (2). Gradually tighten nuts opposite each other, until all nuts are snug, and torque nuts (3) to 690 Nm

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SM - 202



1 - Lockwire
2 - Bolt
3 - Plate
4 - Shim Pack
5 - Ring Gear
6 - Wheel
7 - Outer Bearing Cone
8 - Outer Bearing Cup
9 - Inner Bearing Cup
10 - Inner Bearing Cone
11 - Spindle
12 - Spacer
13 - Wheel Driver
14 - 'O' Ring

Fig. 6 - Sectional View of Drive Wheel Assembly

(510 lbf ft). Re-tighten nuts after a few hours operation.

Note: Wheel rim fastener torque should be checked regularly, particularly on new trucks or newly-installed wheels, to maintain the required wheel rim-clamp load. A newly installed wheel or a new truck should be checked at 30 day intervals until the rim fasteners show no significant torque loss from the previous check. After that, a 90 day torque check interval should be adequate.

WHEEL

Removal and Disassembly

Numbers in parentheses refer to Fig. 6.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of sufficient capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

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2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels, except the ones to be raised.

3. Release parking brake.

> **⚠ WARNING**
> **To prevent personal injury and property damage, completely deflate BOTH TYRES of dual assembly by removing the valve caps and cores. Insert a thin wire through valves to be sure valves are not plugged. Even a flat tyre, in some cases, will retain sufficient air pressure to blow off a rim component with enough force to cause bodily injury or death.**

4. Deflate both tyres completely, and remove the tyre and rim assembly from the wheel. Follow instructions under 'Removing Tyre and Rim Assembly'.

5. Drain differential and planetary gear lubricant and remove planetary gear assembly from the wheel. Refer to Section 160-0030, AXLE GROUP.

6. Remove lockwire (1), bolts (2), plate (3) and shim pack (4) from spindle (11). Retain shim pack (4).

7. Pull ring gear (5) from end of spindle (11).

8. With suitable lifting equipment, pull wheel (6) off of spindle (11), being careful that outer bearing cone (7) does not fall.

9. Remove and discard 'O' ring (14) from wheel driver (13).

Note: The wheel driver (13) portion of the disc brake assembly is bolted to inner face of wheel (6), when the wheel is removed, the attached disc brake wheel driver (13) will also be removed. Refer to Section 165-0030, BRAKE PARTS, if necessary to remove wheel driver.

Note: Bearing cups and cones must always be replaced as a matched set, never separately.

10. Remove inner bearing cone (10) from spindle (11).

11. If required, remove bearing cups (8 & 9) from wheel.

Inspection

1. Thoroughly clean all metal components, except bearing cones, in a suitable solvent. Dry with compressed air and coat all threaded components with light oil to facilitate assembly.

2. Using a suitable solvent, clean bearings and wipe dry with a lint free cloth. Lubricate lightly with light oil and spin by hand, to check for wear and roughness. Replace with new bearings if excessively worn, or if operation is rough or noisy.

3. Inspect all machined surfaces of all parts for scoring, pitting, corrosion and burring. Resurface or replace with new parts as necessary.

4. Inspect all threaded components, and repair or replace as necessary.

Assembly and Installation

Numbers in parentheses refer to Fig. 6.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of sufficient capacity to do the job safely.**

1. Install bearing cups (8 & 9) in their respective wheel (6) bearing bores with care to avoid damaging their raceways. Installation by press fit at ambient temperature is best. Note that cups must seat fully against shoulders of cup bores in the wheel hub to assure retention of bearing adjustment. If carbon dioxide, or dry ice, freezing of the cup is used, remember to permit the cup and hub to warm to ambient temperature after insertion and then to tap them with a soft steel drift and hammer to seat.

2. If removed, install spacer (12), onto spindle (11).

3. Lubricate inner bearing cone (10) with lubricant specified in Section 300-0020, LUBRICATION SYSTEM. Install inner bearing cone (10) onto spindle (11), hard against spacer (12).

4. If removed, install wheel driver (13) on wheel (6). Refer to Section 165-0030 BRAKE PARTS.

5. Install new 'O' ring (14) on wheel driver (13). Refer to Section 165-0030, BRAKE PARTS.

6. With suitable lifting equipment slide wheel (6) assembly onto spindle (11), carefully mating splines of disc brake wheel driver (13) with splines of disc brake disc driver. Refer to Section 165-0030, BRAKE PARTS.

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BEARING ADJUSTMENT TABLE					
GAUGING BOLT TORQUE			FINAL BOLT TORQUE		
No. of Bolts	Nm	lbf ft	No. of Bolts	Nm	lbf ft
2	203	150	8	380	280

7. Lubricate outer bearing cone (7) with lubricant specified in Section 300-0020, LUBRICATION SYSTEM. Install outer bearing cone (7) on spindle (11) and seat in outer bearing cup (8).

8. Install ring gear (5) on end of spindle (11).

Note: Ensure all dirt, grease and oil is completely removed from plate (3), shim pack (4) and end of spindle (11) to allow accurate setting of the bearing pre-load.

9. Install plate (3), without shim pack (4) on end of spindle (11), and secure with eight bolts (2). Tighten bolts (2) evenly in equal increments to 'Gauging Bolt Torque', as specified in 'Bearing Adjustment Table', while rotating and bumping wheel (6) assembly.

10. Remove bolts (2) and tap the wheel (6) assembly to free bearings.

11. Reassemble plate (3) without shim pack (4) and using only two bolts (2) located 180° apart, adjacent to gauging holes in plate (3). Tighten bolts (2) evenly in equal increments to 'Gauging Bolt Torque' (ref. 'Bearing Adjustment Table'), while rotating and bumping wheel (6) assembly.

12. Determine gap between plate (3) and end of spindle (11) at both gauging holes. To determine gap, use a depth micrometer in both gauging holes to measure distance from outer face of plate (3) to end of spindle (11). Using a micrometer, measure thickness of plate (3). Subtract plate thickness reading from depth gauge readings.

13. Average the two readings, obtained at Step 12, in increments of 0.03 mm (0.001 in) and round off to the next higher 0.03 mm (0.001 in). This is the average gap. The required shim pack (4) thickness is equal to the average gap plus 0.18 mm (0.007 in).

14. Install required shim pack (4), plate (3) and bolts (2) on end of spindle (11). Tighten bolts (2) evenly in equal increments to 'Final Bolt Torque' (ref. 'Bearing Adjustment Table'), while rotating and bumping wheel (6) assembly. Secure bolts (2) with lockwire (1).

15. Install planetary gear assembly and fill planetary and differential assemblies with lubricant specified in Section 300-0020, LUBRICATION SYSTEM. Install tyre and rim assembly as described under 'Mounting Tyre and Rim Assembly on Machine'.

TYRE INFLATION

⚠ WARNING
To prevent personal injury and property damage, the tyre and rim assembly should be placed in a safety cage before inflating. If no safety cage is available or tyre is on the machine, the tyre and rim assembly should be wrapped with safety chains or with lash cables before inflating.

Even with these precautions remember that air-blast is a potential hazard. Tyre inflation should be carried out away from busy working areas.

⚠ WARNING
To avoid personal injury and property damage, never stand or sit in front of a mounted tyre during tyre inflation. Use a clip-on air chuck with a long hose and stand to one side while the tyre is being inflated.

⚠ WARNING
To prevent personal injury and property damage, always prevent flammable vapours that could produce tyre explosions, from being pumped into tyres during inflation, by observing the following precautions:

A.
Use an air compressor and reservoir located inside a heated building, when available, so that alcohol, methanol, or other flammable antifreeze liquids are not needed in the air tanks to prevent moisture freezing in the tank and lines in subfreezing temperatures.

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B.
Make sure that paints, lacquers, paint thinners, or similar materials that produce volatile, flammable vapours are not used or stored near the air intake of the compressor that supplies the air for inflating tyres. The compressor should be isolated from all such sources of flammable vapours.

C.
Be sure to thoroughly flush and blow off all flammable solvents used for cleaning the air compressor inlet screen before using the compressor for tyre inflation, or any other purpose.

D.
Do not charge batteries, either in or out of a machine, near the air inlet of a compressor used for inflating tyres. Charging batteries produces highly explosive hydrogen gas which can be readily drawn into a nearby compressor inlet and pumped into the tyre.

E.
Never exceed the specified concentration of alcohol when adjusting the alcohol vaporiser, or adding alcohol to the auxiliary air tank, used on machine air systems to prevent freezing or moisture condensate in below-freezing temperatures. Excessive alcohol, added to the machines air tanks in this manner can produce flammable vapours that will be pumped into a tyre when this air supply is used for tyre inflation if the tyre inflation kit is not equipped with a moisture filter. Alcohol added to machine air systems in recommended concentration to prevent condensate freezing are below hazardous levels for tyre inflation.

F.
Another source of hazardous flammable vapours in tyres is the tyre bead lubricant. Always use bead lubricants that do not introduce flammable vapours into the tyre.

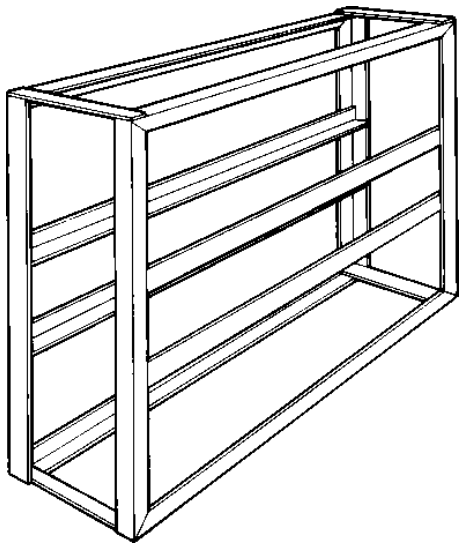


Fig. 7 - Typical Safety Cage

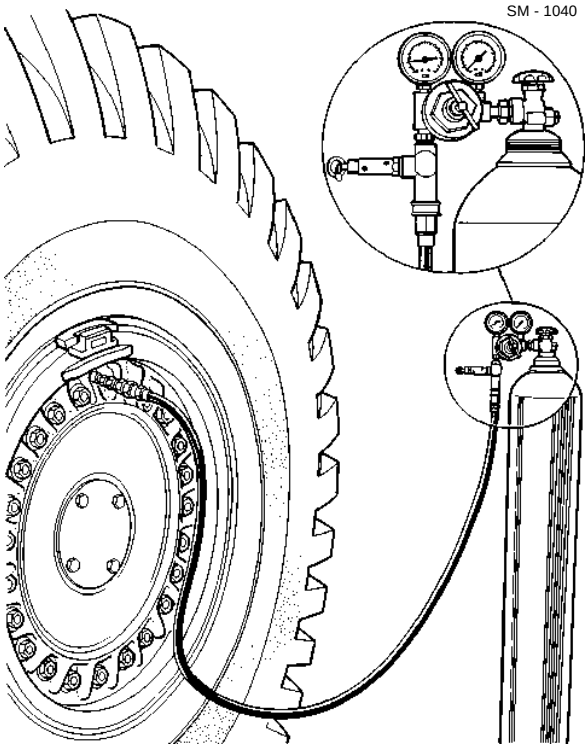


Fig. 8 - Nitrogen Tyre Inflation Kit

Inflation

Note: Always use tyre inflation equipment with an air filter that removes moisture from the air supply, when available, to prevent moisture corrosion of internal rim parts.

1. If the tyre is off the truck, it should be placed in a safety cage before inflating. See Fig. 7.

2. Inflate all tyres with ratings of 16-ply and above to 5.2 bar (75 lbf/in²) to seat beads and seal 'O' ring, then adjust to the recommended pressure.

3. For recommended operating air pressure, refer to the chart under the heading, 'Tyre Inflation Pressures'.

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NITROGEN TYRE INFLATION

Note: All Warnings and procedures under 'Tyre Inflation' will apply, except for differences covered by this passage.

In certain environments it is recommended that tyres be inflated with dry nitrogen gas, and that the resulting oxygen content of the inflation does not exceed 5%. All machines whose tyres are factory inflated with dry nitrogen gas will be identified by a decal on the body or frame.

Nitrogen gas improves tyre pressure retention, increases tyre life by reducing carcass oxidation from within, minimizes rim rust and has no detrimental effects on the tyre. It also reduces the potential of a tyre explosion because it is an inert gas and will not support combustion inside the tyre.

The same tyre inflation pressure used for air inflation should be used for nitrogen inflation. Tyre valves formerly used with air inflation are entirely satisfactory for use with nitrogen gas.

Nitrogen Tyre Inflation Kit

⚠ WARNINGS
DO NOT USE charging assembly, Part No. 9359489, for tyre inflation because this assembly does not include a pressure regulator, safety relief valve, and adequate pressure gauging which is mandatory for tyre inflation purposes. Tyre volume is as much as 90 times greater than the average accumulator volume and hence it takes very much longer to inflate a tyre - up to 40 minutes or more for very large tyres.

⚠ Nitrogen gas cylinders used to inflate tyres are generally charged to approximately 152 bar (2 200 lbf/in²). A tyre blowout and/or rim failure could occur if inflation equipment is not properly used. Proper nitrogen charging equipment and personnel training for its use is a must to avoid over inflation.

1. A nitrogen tyre inflation kit is available from your dealer and consists of the following. Refer to Fig. 8.

a. Pressure regulator, 0 - 13 bar (0 - 200 lbf/in²), with two dual pressure gauges.

b. Safety relief valve, 8.6 bar (125 lbf/in²), that will assure an upper limit to the pressure available for tyre inflation.

c. A 15.2 m (50 ft) length of flexible hose with interconnecting fittings. On the tyre end of the hose is a large bore quick connect/disconnect clip-on chuck.

2. The pressure regulator is connected to a nitrogen compressed gas cylinder available from local suppliers.

3. The usual procedure for using this type of equipment is as follows:

a. Connect nitrogen tyre inflation kit to nitrogen compressed gas supply. DO NOT connect clip-on chuck to the tyre valve at this time.

b. Open valve on nitrogen supply.

c. With flexible hose and clip-on chuck connected to nitrogen tyre inflation kit assembly but not connected to the tyre, adjust pressure regulator so that its output pressure is not more than 1.4 bar (20 lbf/in²) higher than the desired tyre inflation pressure.

d. Connect clip-on chuck to the tyre valve. The tyre will now inflate. Tyre pressure can be monitored by observing the gauge at the pressure regulator. STAY AWAY FROM THE TYRE.

e. When desired inflation pressure has been achieved, back off the regulator or close the valve on the compressed gas cylinder.

f. Remove the clip-on chuck and adjust the tyre pressure with the tyre gauge in the usual manner.

Re-inflation of a Mounted Tyre

To re-inflate a tyre with dry nitrogen gas which is now inflated with air, proceed as follows:

1. Exhaust the tyre until only air at atmospheric pressure remains in the tyre.

2. Re-inflate the tyre using only dry nitrogen gas to 4.15 bar (60 lbf/in²) gauge as a minimum, or to bead-seating pressure as a maximum.

3. Adjust to the service inflation pressure required:

a. If the required service inflation pressure is LESS than 4.1 bar (60 lbf/in²), remove the clip-on chuck

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and adjust the pressure with the tyre gauge in the usual manner.

b. If the required service inflation pressure is greater than 4.1 bar (60 lbf/in²), further inflate, with dry nitrogen gas only, to the pressure level required. Then remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.

New Tyre Mounts and Remounts

To newly mount or remount a tyre to its rim, use only dry nitrogen gas; this includes the pressure required to seat the beads. After seating the tyre beads, remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.

Note: Although a little more nitrogen gas is used to seat beads than that used for re-inflation of a mounted tyre, refer to 'Re-inflation of a Mounted Tyre', its cost is generally negligible in comparison to the time and labour saving and, longer tyre life achievable with the reduced oxygen content which results.

HYDRAULIC BEAD BREAKING TOOL

The hydraulic bead breaking tool illustrated in Fig. 9 is specifically designed to break tyre beads on rusted rims, and is available from your dealer. Refer to Special Tools. It can be used on rims having pry bar slots. The recommended procedure for using this tool is described below.

1. Prepare the vehicle for dismounting the tyre by following the necessary steps outlined under the headings 'Preparation for Servicing' and 'Dismounting Tyre from Rim'.

2. Before using the tool, make sure the tyre has been completely deflated by removing the valve core. Refer to the Warning under 'Preparation for Servicing'. Tape valve threads to protect from damage, leaving valve end open to avoid the possibility of trapping air inside the tyre.

3. Place the lip of the hydraulic tool in one of four breaking slots between the bead seat band and the rim flange.

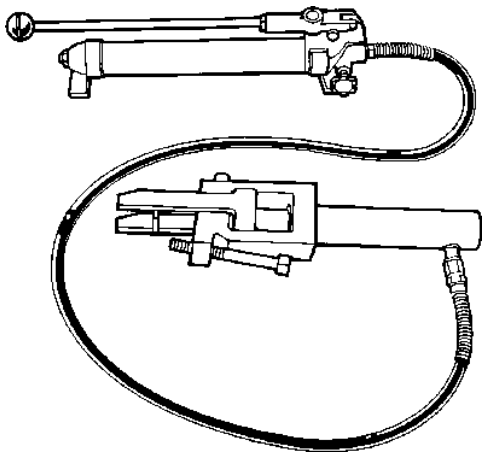


Fig. 9 - Typical Hydraulic Bead Breaking Tool

4. Adjust the locking screw to a position which will hold the tool in a line perpendicular to the face of the rim.

5. Close valve on the hydraulic pump and apply pressure to take up the slack in the tool and rim parts. This will cause the tool to tilt slightly downward. Release pressure and adjust the screw again so that the tool will be perpendicular to the rim when under pressure.

6. Apply enough pressure to move the flange back approximately 13 mm (0.5 in) and hold this distance by dropping a nut, or similar object, in the space between the flange and bead seat band.

7. Release pressure and move the tool about 300 mm (12 in) around the rim in either direction. Insert lip of tool between bead seat band and flange. Repeat cycle until 3/4 of the rim circumference has been covered. Apply pressure at this point until bead breaks loose.

8. Remove lock ring, bead seat band and rim flange as described previously in this section under 'Dismounting Tyre from Rim'.

9. After lock ring, bead seat band and rim flange have been removed, inner bead must be broken loose by following the procedure outlined for the outer bead, (steps 3 through 7).

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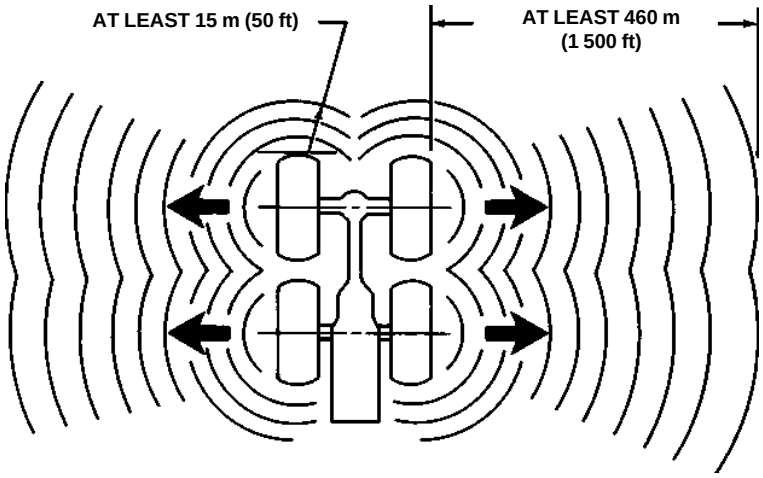


Fig. 10 - APPROACH AREA. Do Not Approach Tyre in Shaded Area

TYRE EXPLOSION HAZARD

⚠ WARNINGS

Whenever a machines tyre(s) is (are) exposed to excessive heat such as a machine fire or extremely hot brakes the hazard of a subsequent violent tyre explosion must be recognized. All persons must avoid approaching the machine so as not to be physically endangered in the event of an explosion of the tyre and rim parts. The machine should be moved to a remote area, but only when this can be done with complete safety to the operator operating or towing the machine. All other persons should stay clear of the machine. The fire or overheated brakes, wheel, etc. should be extinguished or cooled from a safe distance. Do not attempt to extinguish the fire or cool the machine by use of hand-held fire extinguishers.

⚠ If it is absolutely necessary to approach a machine with a suspect tyre, approach only from the front or the back. Stay at least 15 m (50 ft) from the tread area. Keep observers out of the area and at least 460 m (1 500 ft) from the tyre sidewall. Refer to Fig. 10. The tyre(s) should be allowed at least eight (8) hours cooling time after the machine is shut down or the fire extinguished before approaching closer.

⚠ There is always a possibility of a tyre explosion whenever the smell of burning rubber or excessively hot brakes is detected. The danger is also present when a fire on the machine reaches the tyre and wheel area. Under such conditions, all personnel must avoid approaching the machine in a manner that could result in injury should an explosion actually occur. Move the machine to a remote area only if it can be done without endangering the operator or other personnel in the area.

⚠ DO NOT WELD ON OR HEAT RIM COMPONENTS. For several years the company and tyre and rim manufacturers have warned users never to weld rim components with the tyre mounted on the rim. The gases that build up inside the tyre during arc welding or heating on rim components can ignite, resulting in one of these explosive-like failures of the tyre and rim. This warning also applies to nitrogen inflated tyres. Ignition will not occur in the nitrogen atmosphere, but the pressure buildup from the heat of welding may be sufficient to cause a blowout severe enough to injure or kill. It is recommended to scrap the part if heat is necessary to repair any rim component.

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TYRE MAINTENANCE

Tyre Repairs

Prompt repair of tyre injuries will prevent small injuries from enlarging and causing tyre failure. Use the best tyre facilities available. If good repair facilities are not available, have the nearest dealer make the necessary repairs.

Minor cuts, snags, or punctures should be repaired upon discovery. Skive with a sharp pointed knife around any cut in the tyre tread area that is of sufficient depth or shape to hold pebbles or dirt. The angle of the skive should be no more than sufficient to expel all foreign material and should extend no deeper than the breaker. The skive should go to the bottom of the hole. Tyres with shallow cuts, if treated promptly, may be allowed to continue in service. If the cut extends deeper into the tyre carcass, the tyre should be removed for repair.

Ordinary tubeless tyre punctures can be repaired without removing the tyre from the rim. Use tyre repair plugs and follow the directions given by the manufacturer.

The tyre must be removed from the rim to repair larger punctures or cuts. Irregular shaped punctures or cuts less than 13 mm (0.5 in) in size can be repaired with a plug and hot patch. Insert a repair plug into the hole to keep out moisture and to back up the hot patch. Trim the plug off flush with the inside of the casing, buff, and apply the hot patch according to the instructions supplied with the hot-patch equipment.

Punctures 13 mm (0.5 in) or larger, large cuts, or bruise breaks require sectional or reinforced vulcanized repair. Cover the repair patch with a layer of cushion gum after application to the tubeless tyre to ensure an airtight repair. Any cords of the inside ply that are exposed in bugging and are not covered with repair patch must be coated with cushion gum to prevent air leakage into the carcass plies on tubeless tyres.

Recapping and Retreading

There are two general methods employed in restoring the tread surface of off-the-highway tyres: recapping, and retreading.

A recapped tyre has a new tread cured right over the old tread surface.

A retreaded tyre has the old tread removed entirely and a new tread cured directly onto the body of the tyre. A tyre can be recapped or retreaded if the cord body is free of cuts, bruises and separation, and is thoroughly sound, including previous repairs.

TYRE CARE

To obtain maximum service from off-the-highway tyres, a few common-sense precautions should be followed.

Maintain Correct Inflation

The most common cause of tyre damage is improper inflation. Both over-inflation and under-inflation are detrimental to tyre life. Tyre pressure should be checked daily, preferably before the machine is placed in operation. Refer to 'Tyre Inflation Pressures' for tyre pressure.

The valve cores should be checked for leaks. Keep in mind that valve cores are delicate mechanisms that wear out in service; therefore, they should be replaced when they become worn. Each tyre should be equipped with a valve cap to prevent dirt from damaging the valve core and causing air leakage.

Maintain Good Haul Roads

Because haul roads are considered temporary roads, they are frequently neglected. The better the haul road, the longer the tyre and truck life of off-the-highway equipment.

Although it takes time and effort to maintain good haul
roads, the delay and cost of tyre and truck breakdowns caused by poor haul roads is many times greater.

Inspect Tyres Regularly

A systematic plan for tyre inspection will more than pay for itself in lowered tyre costs per hour of operation. All tyres should be checked regularly for cuts, bruises, fabric breaks, excessive or uneven wear, embedded foreign matter, and any other damage which can be repaired. A considerable increase in tyre service can be realized if tyre injuries are repaired before they have progressed to the irreparable stage. The rim mounting nuts should be checked periodically and tightened to the recommended torque.

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Prevent Overloading

Off-the-highway trucks are designed to carry a maximum allowable payload. Excessive loading will overstress both the truck and tyres and shorten the life of both.

Prevent Tyre Contact With Oil

PREVENT TYRE CONTACT WITH PETROLEUM PRODUCTS. Rubber that is exposed to oil, petrol, or grease becomes soft and spongy and deteriorates rapidly. Always avoid driving trucks equipped with rubber tyres through a puddle of petrol, fuel oil, lubricating oil, or grease. Never let a tyre stand in an oil or grease spot overnight.

Store Tyres Properly

The best of care given to tyres in service by operators and maintenance personnel can be completely nullified by careless storage. Time is not the only contributing factor to the deterioration of rubber products. Therefore, tyres that are to be stored must be protected from light, heat, oils, dirt, moisture, and ozone. Stored tyres should be carefully covered with a tarpaulin or some other suitable material, such as opaque plastic sheets, to prevent contact with the contaminants listed.

Proper Handling of Tubeless Tyres and Rims

Tubeless tyres should be stored vertically. Horizontal stacking may compress the tyre walls making inflation difficult. If tyres are stored in racks, the lower supporting members should provide as broad a surface as possible to the tyre tread to avoid a concentration of load.

The beads of tubeless tyres must be protected from damage or a faulty air seal will result. Do not use hooks, cables, or chains in contact with the tyre beads when lifting these tyres. If forklift trucks are used for handling they should be equipped with broad, well rounded arms to distribute the load and prevent damage to the tyre bead. When handling tyres with the fork truck do not scrape the fork across the bead.

Tubeless tyre rims perform an important function as part of the assembly air seal. Proper care therefore must be taken not to distort or mutilate the rim parts because they must mate properly to form part of the basic air chamber. Since the rim base, bead seat bands, and flanges are endless, distortion may prevent easy assembly as well as possibly resulting in no seal.

Never drop, tumble, or roll rim parts.

If rim parts are stored outdoors they should be given a protective coat of a good commercial primer.

Similar parts should be stacked neatly to prevent distortion.

Babbit or lead hammers, not sledge hammers, should be used in assembling rims.

'O' rings are seals and should be carefully stored in a cool, dry place where they will not be injured or damaged.

Valve cores also should be stored in a cool, dry and clean place.

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools outlined in this section and general service tools required. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	3	Nut	690	510
6	2	Bolt	Refer to 'Bearing Adjustment Table'	

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TUBELESS TYRE LEAK DIAGNOSIS

Occasionally a tubeless off highway tyre/rim assembly may leak in field service. To determine cause of leakage, the entire assembly including valve hardware, multi-piece rim assembly, 'O' ring and tyre should be checked using a soap solution.

This table lists various causes of air loss and possible remedy.

CAUSE	REMEDY
Defective valve	Tighten parts. Replace defective parts. Use valve caps.
Cracked rim or weld	Replace defective part ⚠ **WARNING** **Do not attempt repair of wheel components.**
Twisted or damaged 'O' ring	Replace 'O' ring (lubricate)
Tyre cuts and snags	Repair tyre damage
Bead area awl holes	Repair inner liner (preferred)
Leakage between tyre bead trim	With tyre removed from rim: Clean tyre beads in rim contact area Clean rim with wire brush Inspect 5 degree tapered bead seat band and the rim base in the bead seating area to determine if the transverse weld trims are flat or concave. Replace defective part(s). **Note:** Weld trim should follow rim contour. Mount tyre using a lubricant such as Murphy's Tyre and tube Mounting Compound, or equivalent, on tyre beads and rim bead seat area.

TYRE INFLATION PRESSURES

E3 tyres may be so roaded up to 48 km/h (30 mile/h), maximum, with a 30 minute cooling stop after each 80 km (50 miles) or 2 hours sustained operation - whichever occurs first - and a 60 minute cooling stop after each aggregate of 4 hours of operation.

E4 tyres may be so roaded up to 32 km/h (20 mile/h), maximum, with a 30 minute cooling stop after each 32 km (20 miles) or 1 hour of sustained operation - whichever occurs first - and a 60 minute cooling stop after each aggregate of 4 hours of operation.

The inflation pressures listed should be regarded as nominal only. Specific job conditions, terrain, haul road maintenance and length, maximum and workday average speed, job t-km/h (ton-mile/h) required and tyre t-km/h (ton-mile/h) capacity, etc., may require an increase in inflation pressure. It is recommended that for tyres both listed and unlisted the user consult the tyre manufacturer and evaluate all job conditions in order to make the proper selection.

TYRE INFLATION PRESSURES

	PRESSURE	
BRIDGESTONE TYRE	bar	lbf/in²
24.00 R 35** Radial	5.7	83

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DESCRIPTION AND OPERATION

⚠ WARNINGS
Use only hydraulic oils meeting specifications outlined in Section 300-0020, LUBRICATION SYSTEM. DO NOT use BRAKE FLUID (J1703). Use of improper fluids is destructive to rubber components of brakes resulting in loss of braking and possible catastrophic failure.

⚠ Exercise extreme caution while working on the braking system. The braking system operates at high pressure.

⚠ When servicing wheel brake parts, do not create dust by grinding or sanding brake pads or wheel brake parts with a dry brush or compressed air. A water dampened cloth should be used for cleaning wheel brake parts.

The service brakes are of the calliper disc-type. The calliper brake head is designed for use with hydraulic oils meeting the specifications outlined in Section 300-0020, LUBRICATION SYSTEM. **DO NOT use BRAKE FLUID (J1703).**

The head is bolted to a mounting plate on the spindle. The disc is bolted to the wheel. There is one brake head at each wheel.

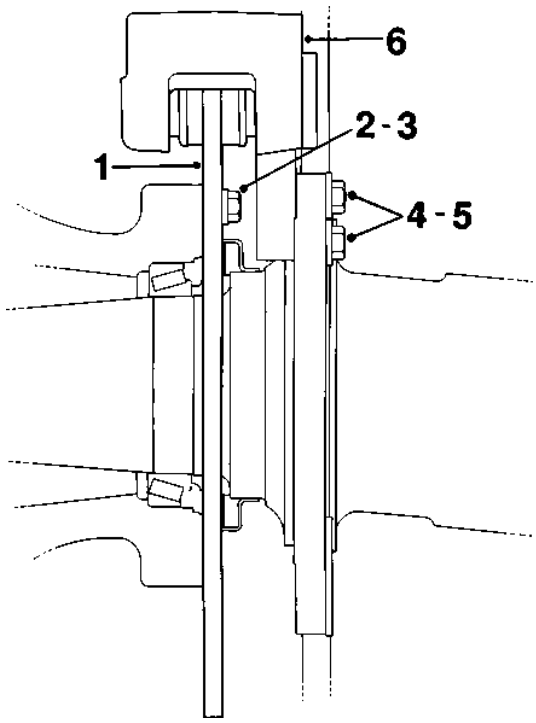
Each calliper brake head assembly consists of a torque plate, two brake pads; one on each side of the disc and six brake pistons; three on each side of the disc.

The brake is actuated by hydraulic oil entering the brake head through one of the bleeder ports. The piston bores on each side of the torque plate are interconnected by internal passages.

When the brake is actuated, the hydraulic pressure forces the pistons against the brake pads which are, in turn, forced against each side of the brake disc, slowing or stopping the disc and wheel rotation.

GENERAL INSPECTION

1. Inspect brake pads for wear. If the brake pad friction material is worn down to 3 mm (0.120 in) thickness, the pads must be replaced.



1 - Brake Disc
2 - Bolt
3 - Washer
4 - Bolt
5 - Washer
6 - Brake Head

Fig. 1 - Brake Head and Disc Mounting

⚠ WARNING
Failure to replace pads when worn to limits will result in loss of braking and possible catastrophic failure.

2. Inspect brake disc for wear. Measure thickness of brake disc at three points on the brake pad friction material contact circumference and determine the average disc thickness.

If the average disc thickness is 16 mm (0.63 in) or less, the disc must be replaced. Refer to Section 140-0040, WHEEL, RIM AND TYRE, for disc replacement instructions.

Disc Run Out

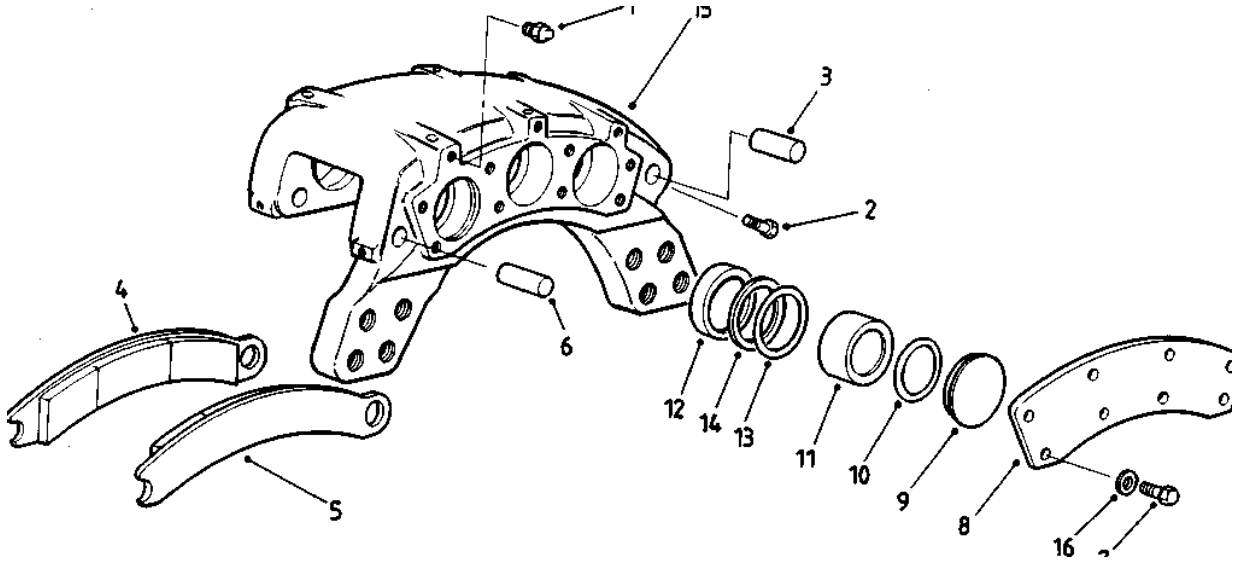
Maximum acceptable disc run out for disc speeds lower than 100 rev/min is 0.762 mm (0.030 in) total indicated reading (T.I.R.). Replace disc or repair hub If necessary to correct this condition. Refer to Section 140-0040, WHEEL, RIM AND TYRE.

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Brake Parts - Front Axle

Section 165-0020



1 - Bleeder
2 - Bolt
3 - Torque Pin
4 - Brake Pad
5 - Brake Pad
6 - Torque Pin
7 - Bolt
8 - Cover Plate
9 - Plug
10 - Seal
11 - Piston
12 - Boot
13 - Packing
14 - Backup Ring
15 - Torque Plate
16 - Washer

Fig. 2 - Exploded View of Typical Brake Head

BRAKE PAD REMOVAL AND INSTALLATION

Numbers in parentheses refer to Fig. 2.

Note: Tighten all fasteners without special torques specified, to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATION.

⚠ WARNINGS

To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

⚠ Use extreme caution to prevent personal injury when removing wheel. The exact procedure must be adhered to as described in Section 140-0040, WHEEL, RIM AND TYRE.

⚠ To prevent personal injury, keep hands and fingers etc. clear of the area between the brake disc and the brake head pistons.

1. Position the vehicle in a level work area, apply the parking brake and shutdown the engine.

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels. Remove tyre and rim, as described in Section 140-0040, WHEEL, RIM AND TYRE.

3. Loosen two bolts (2) securing large torque pins (3) at the end of the brake head. It is not necessary to loosen or remove the two smaller torque pins (6) at opposite end.

4. Move the two unlocked torque pins (3) away from the brake disc.

5. Attach a bleeder line and open bleeder valve (1). Use a screwdriver or pry bar inserted between the brake disc and brake pads to press pistons (11) back into torque plate (15) piston bores, as far as possible. Close bleeder valve.

6. Rotate brake pads (4 & 5) out of the opened end of the brake.

7. Install new brake pads (4 & 5) by placing friction material next to the brake disc and rotating into position in the brake head.

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8. Push the two unlocked pins (3) toward the brake disc.

9. Thread the two loosened bolts (2) in until bolts seat in grooves of pins (3). This can be checked by limited axial movement of pins as the bolts are being seated. Tighten bolts (2) to a torque of 30 - 38 Nm (22 - 28 lbf ft).

Note: Make sure torque pins (3 & 6) do not touch the brake disc. If they do, loosen bolts (2) and adjust pins to clear disc by 1.5 to 3.0 mm (0.060 to 0.120 in). Check to make sure that bolts (2) fully engage in pins and retighten bolts.

10. Depress the brake pedal until brake pads (4 & 5) contact the brake disc.

WARNING
Ensure the steering and brake control tank is maintained at the proper level at all times. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK.

11. When new brake pads are installed on a truck, the brake pad friction material should be burnished in accordance with the following procedure to achieve maximum braking performance:

a. Drive truck at 8 - 15 km/h (5 - 10 mile/h) with brakes applied at just enough pressure to produce a noticeable drag. Heavy smoke and foul odour from the brake pad friction material is normal during this procedure.

Note: An infrared thermometer pointed at the disc after stopping, can safely and easily determine the brake disc temperature. Refer to 'Special Tools'.

b. Continue cycle until the brake disc achieves a temperature of 315 - 370° C (600 - 700° F).

c. Permit the brake disc to cool to a temperature of less than 95° C (200° F).

d. Repeat Steps a and b.

e. Allow brake disc to cool to within 10° C (50° F) of ambient temperature.

f. Repeat Steps a and b until full braking performance (per applicable government regulations) is achieved.

BRAKE REMOVAL AND DISASSEMBLY

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

WARNINGS
To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

Use extreme caution to prevent personal injury when removing wheel. The exact procedure must be adhered to as described in Section 140-0040, WHEEL, RIM AND TYRE.

To prevent personal injury, follow the procedure given for relieving the pressure in the braking system and exercise extreme caution when loosening brake pipes or lines.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Operate the treadle valve continuously to relieve pressure in the brake accumulators. Block all road wheels. Remove tyre and rim, as described in Section 140-0040, WHEEL, RIM AND TYRE.

3. Carefully loosen brake pipes at base of both accumulators to check that pressure has released. Re-tighten brake pipes.

4. Remove hydraulic oil inlet line at brake head assembly. Plug the line and brake head to prevent entry of dirt.

5. Remove bolts (4, Fig. 1) and washers (5, Fig. 1) from mounting at spindle and remove brake head assembly to working area.

6. Disassemble brake head assembly in sequence of index numbers. Items (1, 2 & 3) may be left in torque plate (15) when servicing packings (13), seals (10), backup rings (14) and boots (12), if desired.

7. Repair kits are available which include new boots (12), backup rings (14), packings (13) and seals (10) in quantities sufficient to rebuild a calliper brake head. All parts included in a repair kit should be replaced each time a brake head is rebuilt.

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8. Inspect brake pads (4 & 5) per Step 1 in the 'General Inspection Procedure'.

9. Clean torque plate (15) making sure no solvent remains in the oil passages or grooves. Inspect dust boot and seal grooves, and, land areas between grooves for damage or cracks. Minor nicks and scratches may be blended with crocus cloth. Replace torque plate (15) if corrosion is excessive or dust boot and seal grooves are damaged, prohibiting proper rebuild of brake head.

10. Inspect pistons (11) for minor scratches and nicks and blend with crocus cloth. If piston is badly nicked or scratched or if the chrome plate is worn off, replace piston.

11. Torque pins (3 & 6) which are deeply grooved should be replaced.

ASSEMBLY

Numbers in parentheses refer to Fig. 2 unless specified otherwise.

Note: Tighten all fasteners without special torques specified, to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATION.

1. Lubricate packings (13), seals (10) and pistons (11) with petroleum base lubricating oil or vaseline.

> ⚠ **WARNING**
> **Do not use brake fluid (SAE J1703).**

2. Install backup rings (14), packings (13) and boots (12) into torque plate (15) piston bores. Lubricate per Step 1.

3. Install pistons (11) in torque plate (15) as follows: Position lubricated piston (11) into dust boot (12) and piston bore, holding piston at a slight angle. Insert forefinger between piston and dust boot and rotate forefinger around piston OD, lifting dust boot ID over OD of piston. Make sure OD lip of dust boot remains in the groove in the piston bore.

4. After piston (11) is through dust boot (12), centre piston by feel over packing (13). Apply, by hand, a turning thrusting pressure, working piston into and through packing.

5. When assured pistons (11) are through packings (13), pressure other than hand pressure may be used to press pistons the remainder of the way into piston bores. Snap open end of boot (12) into groove of piston.

6. Install seals (10) and piston plugs (9) into open end of piston bores of torque plate (15).

7. Attach cover plate (8) to torque plate with bolts (7) and washers (16). Tighten bolts (7) to a torque of 380 Nm (280 lbf ft).

8. When installing torque pins (3 & 6) and bolts (2) make sure the groove in the pin is directly under the bolt so that bolt (2) can perform its locking and retaining function.

Note: Lubricate torque pins (3 & 6) with a corrosion resistant lubricant prior to installation, to facilitate next pin removal.

9. Replace brake disc (1, Fig. 1) if worn per instructions under 'General Inspection' in this section. Refer to Section 140-0040, WHEEL, RIM AND TYRE, for replacement instructions.

INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATION.

> ⚠ **WARNINGS**
> **To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.**
>
> ⚠ **Use extreme caution to prevent personal injury when installing wheel. The exact procedure must be adhered to as described in Section 140-0040, WHEEL, RIM AND TYRE.**

1. Install washers (5) on bolts (4).

2. Position brake head over brake disc on brake mounting plate, aligning holes. Install assembled bolts (4) and washers (5) through mounting plate and into torque plate. Tighten bolts (4) to a torque of 610 Nm (450 lbf ft).

Note: Ensure torque pins (3 & 6, Fig. 2) do not touch

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the brake disc. If they do, loosen bolts (2) and adjust pins to clear disc by 1.5 - 3.0 mm (0.060 - 0.120 in). Check to make sure that bolts (2, Fig. 2) fully engage in pins and tighten bolts to a torque of 30 - 38 Nm (22 - 28 lbf ft).

3. Remove plugs from brake head and hydraulic inlet line and attach hydraulic inlet line at brake head.

4. Bleed the braking system as described under the heading 'Bleeding' in this section.

5. Install tyre and rim. Refer to Section 140-0040, WHEEL, RIM AND TYRE.

BLEEDING

Numbers in parentheses refer to Fig. 2.

In order to obtain satisfactory braking, the system should be bled as follows to eliminate any air in the hydraulic brake lines:

1. Check oil level in the steering and brake control tank and add oil if low. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK, for correct fill level and Section 300-0020, LUBRICATION SYSTEM, for oil specification.

2. Securely connect a bleeder line to bleeder valve (1), and place loose end of line in clean container.

⚠ WARNING
Loosen bleed nipples carefully. The braking system operates at high pressure.

3. Depress brake treadle valve and gradually open bleeder valve (1). Bleeder valve should remain open until oil exhausting from the bleeder valve is free from air bubbles. Close bleeder valve and release the brake treadle. Remove bleeder line.

Note: This system is equipped with accumulators which maintain pressure in the system even after engine shutdown. However, If the system pressure is zero, it will be necessary to start the engine to charge the system prior to bleeding. Always shutdown the engine before starting bleeding procedure.

4. Repeat Steps 1 through 3 at each brake head assembly.

MAINTENANCE

Every 10 Hours of Operation (Daily)
Inspect brake assembly to ensure that all bolts are tight and there are no leaks. Inspect for boot deterioration.

Check oil level in the steering and brake control tank and add oil if low. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK, for correct fill level and Section 300-0020, LUBRICATION SYSTEM, for oil specification.

Every 250 Hours of Operation
Check the brake pads and discs for wear and adjust or replace where necessary. Test for proper function.

Note: This service interval applies to normal driving. Check the pads more frequently under more severe conditions. Thickness of pad friction material should never be allowed to wear below 3 mm (0.12 in).

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the non-contact infrared thermometer and general service tools required. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	4	Bolt	610	450
2	2	Bolt	30 - 38	22 - 28
2	7	Bolt	380	280

* * * *

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DESCRIPTION AND OPERATION

Numbers in parentheses refer to Figs. 1 and 2.

Service Brakes

Note: The service brakes are of 'Upright Design', i.e. requiring pressure to hold the brakes on.

The rear service brakes are hydraulically actuated to slow or stop drive wheel rotation. When the service brake treadle in the operators' compartment is depressed, or when the retarder control lever on the centre console is actuated, with the retarder selection switch at the disc brake position, hydraulic pressure is transmitted to port 'D', Fig. 2, on the disc brake assembly. Hydraulic pressure entering port 'D', Fig. 2, forces service piston (31) against the brake disc pack consisting of damper assemblies (28), rotating friction discs (29) and splined plates (30).

The rotating friction discs, which are driven by the wheel, through wheel drivers (5) and disc drivers (27), are compressed between splined plates (30). This slows down and stops rotation of the driving wheels. The force applied against the disc pack is directly proportional to the degree of which the service brake treadle is depressed.

When the service brake treadle or retarder control lever is released, hydraulic pressure against service piston (31) is relieved, brake return springs (36) tension against heads of retaining pins (35) forces the pins to return service piston (31) to its original position, thus, relieving the pressure against the brake disc pack.

Parking Brakes

Note: The parking brake is of 'Inverted Design', i.e. requiring pressure to hold the brakes off.

The parking brakes are controlled by the park/ emergency brake control mounted on the instrument panel. The parking brakes are applied by spring tension and released by hydraulic pressure. With the control pulled 'OUT', hydraulic oil enters port 'F', Fig. 2, flows through a channel in disc housing (25) into a passage behind parking piston (23). Hydraulic oil pressure forces parking piston (23) against the tension of springs (20 & 21), keeping pressure off of the damper assemblies (28), thereby keeping pressure off the disc pack. With the control pushed 'IN', hydraulic pressure at port 'F', Fig. 2, is released, pressure against parking piston (23) is released. Spring (20 & 21) tension forces the parking piston against damper assembly (28) and disc pack consisting of rotating friction discs (29) and splined plates (30). The rotating discs are compressed between the splined plates and are held stationary, thus keeping the wheels from rotating. As long as there is no hydraulic pressure at port 'F', Fig. 2, parking brake will be applied. When hydraulic oil pressure is applied at port 'F', Fig. 2, parking brake will be released.

REMOVAL

Numbers in parentheses refer to Figs. 1 and 2.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of sufficient capacity to do the job safely.

⚠ Hydraulic fluid will remain within the braking system after engine shutdown. Operate the treadle valve continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

⚠ Use extreme caution to prevent personal injury when removing wheels. The exact procedure must be followed as described in Section 160-0050, WHEEL, RIM AND TYRE.

Note: Before removing and disassembling disc brake assemblies, measure and record the amount of wear of the brake disc and damper plates. Refer to 'Disc Assembly Wear Measurement Procedure', under 'Inspection' in this section, for the measurement procedure and the maximum allowable wear limits.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve any pressure in the steering circuit. Operate the treadle valve continuously to relieve any pressure in the braking system. Block all road wheels.

3. Remove plug (49) and drain cooling oil from disc brake assembly into a clean container. Reinstall plug.

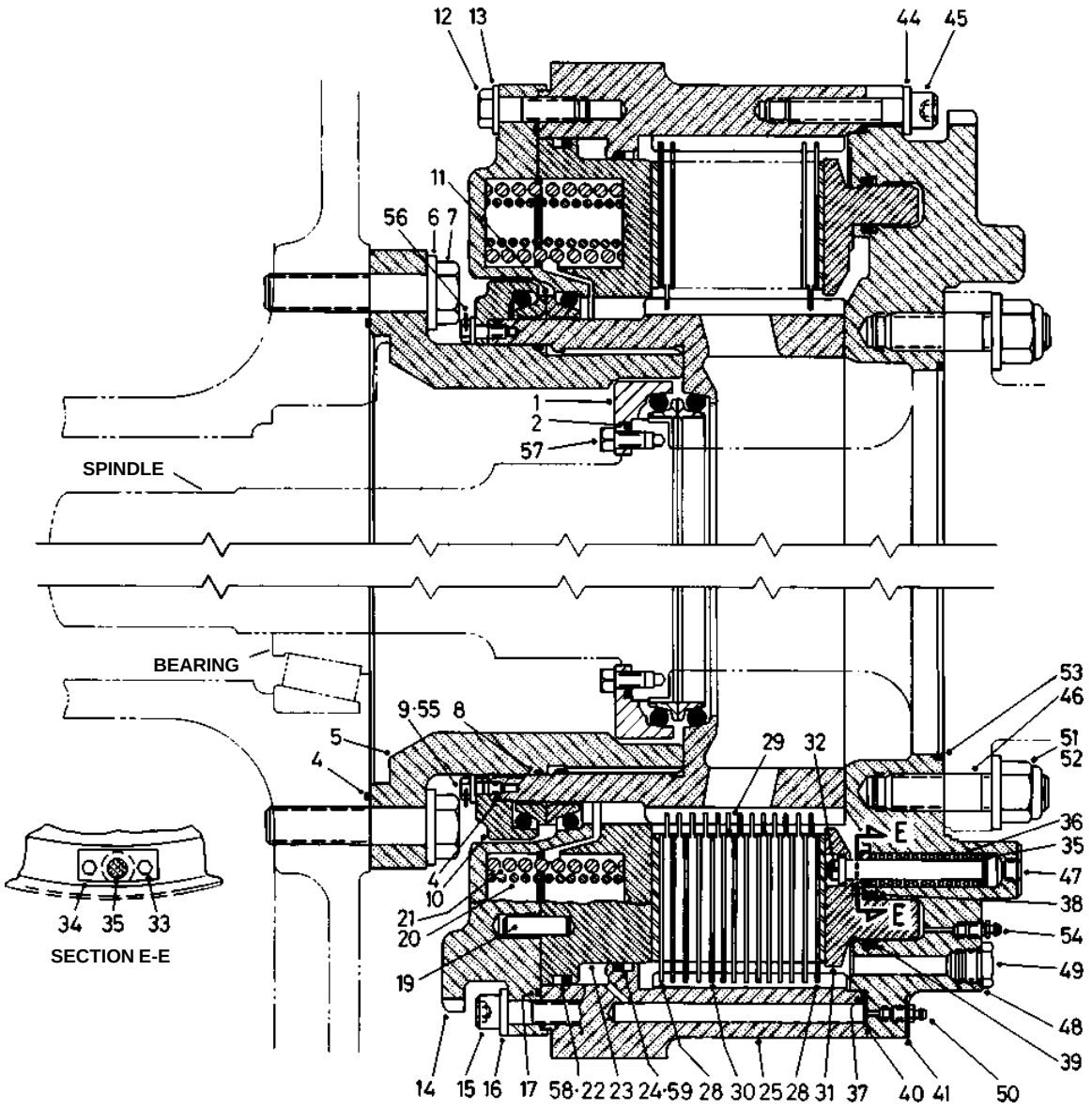
4. Open bottom bleeder valve (54) and drain brake hydraulic oil into a clean container. Close bleeder valve.

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Brake Parts - Rear Axle

Section 165-0030

SM - 1295



1 - Inner Seal Housing
2 - 'O' Ring
3 - Face Seal
4 - 'O' Ring
5 - Wheel Driver
6 - Hardened Washer
7 - Bolt
8 - 'O' Ring
9 - Bolt
10 - Seal Housing
11 - Face Seal
12 - Bolt
13 - Hardened Washer
14 - Spring Housing
15 - Socket Head Screw
16 - Hardened Washer
17 - 'O' Ring
*18 - Dowel
19 - Dowel
20 - Spring
21 - Spring
22 - Seal
23 - Parking Piston
24 - Seal
25 - Disc Housing
* 26 - Dowel
27 - Disc Driver
28 - Damper Assembly
29 - Friction Disc
30 - Splined Plate
31 - Service Piston
32 - Pin
33 - Bolt
34 - Retainer Plate
35 - Retaining Pin
36 - Return Spring
37 - 'O' Ring
38 - 'D' Section Seal
39 - 'D' Section Seal
40 - 'O' Ring
41 - Piston Housing Assembly
* 42 - Hardened Washer
* 43 - Bolt
44 - Hardened Washer
45 - Socket Head Screw
46 - Stud
47 - Pipe Plug
48 - 'O' Ring
49 - Plug
50 - Bleeder Valve
51 - Hardened Washer
52 - Nut
53 - 'O' Ring
54 - Bleeder Valve
55 - Hardened Washer
56 - Lockwire
57 - Bolt
58 - Spacer Ring
59 - Spacer Ring

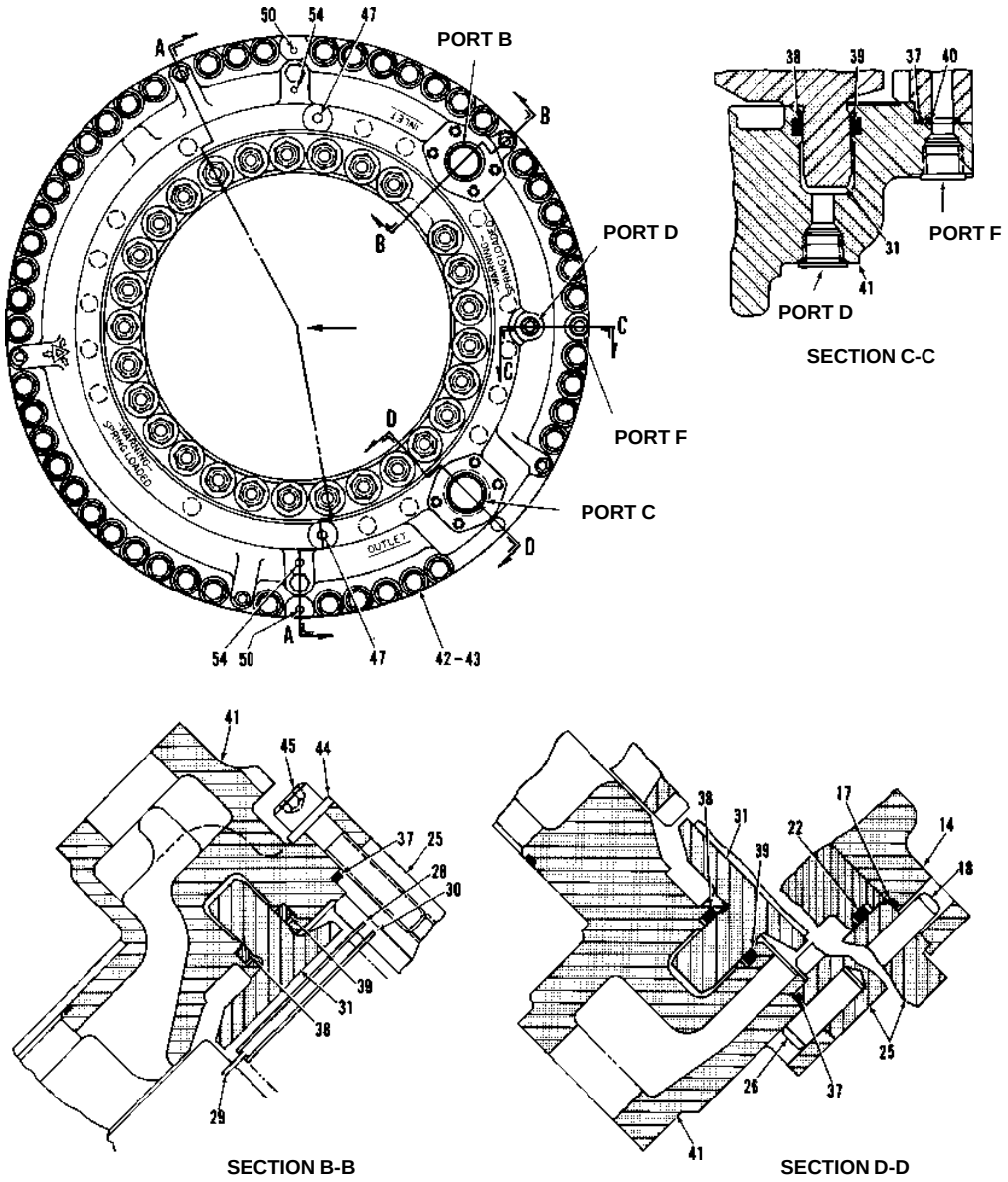
* Shown on Fig. 2.

Fig. 1 - Cutaway View of Typical Disc Brake Assembly (SECTION A-A - Fig. 2)

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NOTE: SECTION A-A Shown on Fig. 1.

14 - Spring Housing
17 - 'O' Ring
18 - Dowel
22 - Seal
25 - Disc Housing
26 - Dowel
28 - Damper Assemblies
29 - Friction Disc
30 - Splined Plates
31 - Service Piston
33 - Bolt
37 - 'O' Ring
38 - 'D' Section Seal
39 - 'D' Section Seal
40 - 'O' Ring
41 - Piston Housing Assembly
42 - Hardened Washer
43 - Bolt
44 - Hardened Washer
45 - Socket Head Screw
47 - Pipe Plug
50 - Bleeder Valve
54 - Bleeder Valve

Fig. 2 - Typical Disc Brake Assembly

Note: To minimize loss of brake hydraulic oil when the brake tubes are removed from the brake assemblies, remove the air breather from the steering and brake control tank and connect a vacuum pump to the breather port. Evacuate the air in the tank to a vacuum of 0.5 - 0.7 bar (15 - 20 inches of mercury).

5. Tag and disconnect brake cooling lines from ports 'B' and 'C' on piston housing assembly (41). See Fig. 2. Plug lines and ports to prevent ingress of dirt and hold oil in lines and tank.

6. Tag and disconnect service brake tube from port 'D'

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Brake Parts - Rear Axle

Section 165-0030

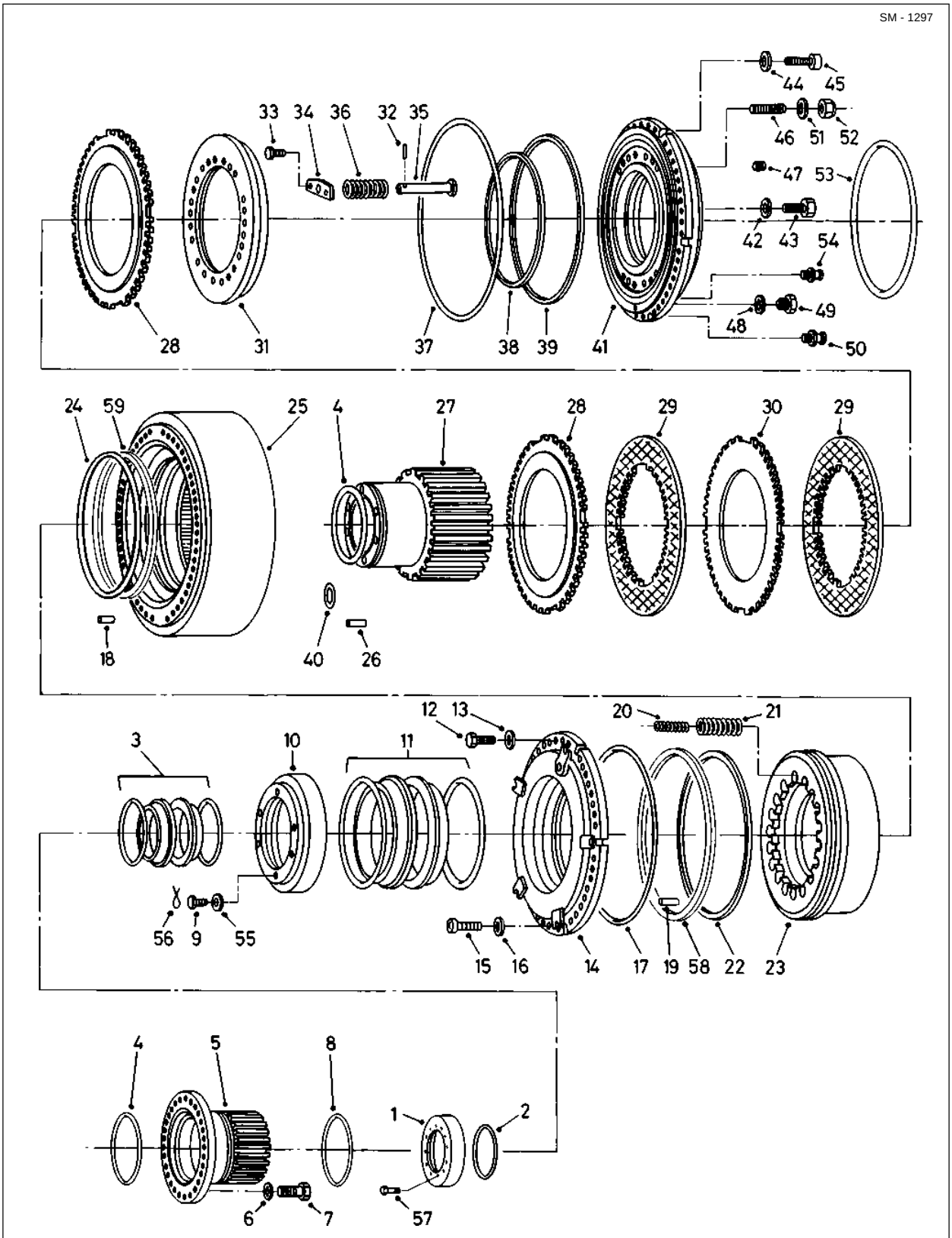


Fig. 3 - Exploded View of Typical Disc Brake Assembly

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1 - Inner Seal Housing	16 - Hardened Washers	31 - Service Piston	
2 - 'O' Ring	17 - 'O' Ring	32 - Pins	46 - Studs
3 - Face Seal	18 - Dowels	33 - Bolts	47 - Pipe Plugs
4 - 'O' Rings	19 - Dowel	34 - Retainer Plates	48 - 'O' Rings
5 - Wheel Driver	20 - Springs	35 - Retaining Pin	49 - Plugs
6 - Hardened Washers	21 - Springs	36 - Return Springs	50 - Bleeder Valves
7 - Bolts	22 - Seal	37 - 'O' Ring	51 - Hardened Washers
8 - 'O' Ring	23 - Parking Piston	38 - 'D' Section Seal	52 - Nut
9 - Bolts	24 - Seal	39 - 'D' Section Seal	53 - 'O' Ring
10 - Seal Housing	25 - Disc Housing	40 - 'O' Rings	54 - Bleeder Valves
11 - Face Seal	26 - Dowels	41 - Piston Housing Assembly	55 - Hardened Washers
12 - Bolts	27 - Disc Driver	42 - Hardened Washers	56 - Lockwire
13 - Hardened Washers	28 - Damper Assemblies	43 - Bolts	57 - Bolt
14 - Spring Housing	29 - Friction Discs	44 - Hardened Washers	58 - Spacer Ring
15 - Socket Head Screws	30 - Splined Plates	45 - Socket Head Screws	59 - Spacer Ring

Legend for Fig. 3

on piston housing assembly (41). See Fig. 2. Plug tube and port to keep out dirt and hold oil in tube.

7. Tag and disconnect parking brake tube from port 'F' on piston housing assembly (41). See Fig. 2. Plug tube and port to keep out dirt and hold oil in tube.

8. Remove wheel assembly from the truck as described in Section 160-0050, WHEEL, RIM AND TYRE.

9. Lay wheel down with wheel driver (5) up.

10. Remove and discard 'O' ring (8) from outer diameter of wheel driver (5).

11. Remove bolts (7) and hardened washers (6) securing wheel driver (5) to wheel. Using a suitable lifting device, lift wheel driver from wheel.

12. Remove and discard 'O' ring (4) from spindle.

13. Remove and discard bolts (57) securing inner seal housing (1). Remove seal housing from spindle. Remove and discard 'O' ring (2) from seal housing.

14. Remove face seal (3) from spindle and discard toric rings of face seal. Retain metallic seal elements and set aside for 'Inspection'.

15. Remove one bolt (12) and hardened washer (13) from spring housing (14) and one bolt (43) and hardened washer (42) from piston housing assembly (41), remove both bolts from as close to 12:00 o'clock position as possible. Install a lifting eye in each bolt hole.

16. Attach a suitable lifting device to disc brake assembly (at lifting eyes installed in Step 15) and take up slack. Remove nut (52) and hardened washer (51). Using lifting device, carefully remove disc brake assembly from spindle. Place disc brake assembly on a clean flat surface with spring housing (14) side up.

17. Repeat Steps 3 through 16 to remove the opposite disc brake assembly.

DISASSEMBLY

Numbers in parentheses refer to Fig. 3.

⚠ WARNING
To prevent personal injury and property damage, ensure lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Remove lockwire (56) from bolts (9). Remove bolts (9) and hardened washers (55) securing seal housing (10) to disc driver (27) and remove seal housing.

2. Remove and discard 'O' ring (4) from outer diameter of disc driver (27).

3. Remove face seal (11) from disc driver (27) and discard toric rings of face seal. Retain metallic elements unless scratched or damaged.

4. Using a suitable lifting device attached to disc driver (27), carefully lift disc driver from disc brake assembly.

5. Using a suitable lifting device, turn disc brake assembly over, with piston housing assembly (41) up.

6. Remove and discard 'O' ring (53) from piston housing assembly (41).

7. If necessary, remove bleeder valves (50 & 54) from piston housing assembly (41).

8. If necessary, remove plug (49) and 'O' ring (48)

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from piston housing assembly (41). Discard 'O' ring.

9. If necessary, remove studs (46) and pipe plug (47) from piston housing assembly (41).

10. Remove bolts (43) and hardened washers (42) from piston housing assembly (41).

> **⚠ WARNING**
> **Piston housing assembly (41) is under pressure from spring (20 & 21) compression. To prevent personal injury and property damage, use care when removing socket head screws (45) and hardened washers (44).**

11. Very carefully, remove socket head screws (45) and hardened washers (44), by turning screws out alternately, one turn at a time on each screw. Piston housing assembly (41) is under spring (20 & 21) compression. Using a suitable lifting device, lift piston housing assembly (41) from disc housing (25) and place on a flat surface, service piston (31) side up.

12. Remove and discard 'O' ring (37) from piston housing assembly (41).

13. Remove and discard 'O' rings (40) from piston housing assembly (41).

14. Using spring compression tool (shown in Fig. 4), screw the 'T' handle of the tool into the threaded hole in the end of one retaining pin (35), see Fig. 5.

Note: Spring compression tool may be fabricated as shown in Fig. 37.

15. With the base of the tool resting on the flat surface of service piston (31), press down on the tool handle to raise retaining pin (35) against the tension of spring (36). Raise retaining pin (35) enough to allow pin (32) to be removed from retaining pin. See Fig. 6. Remove spring compression tool from retaining pin (35).

16. Repeat Steps 14 and 15 to remove pin (32) from each retaining pin (35).

17. Install three 0.5 - 13 UNC bolts in three threaded holes in service piston (31). Alternately turn puller bolts in, gradually pulling service piston (31) from piston housing assembly (41). Remove the three puller bolts and remove service piston.

18. Remove and discard 'D' section seals (38 & 39) from piston housing assembly (41). See Fig. 7.

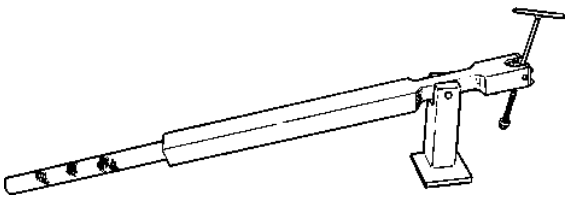


Fig. 4 - Spring Compression Tool

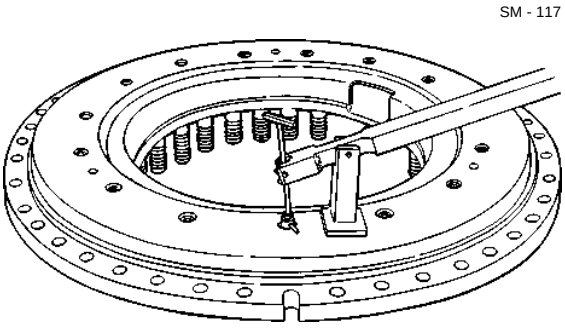


Fig. 5 - Using Spring Compression Tool on Typical Service Piston Assembly

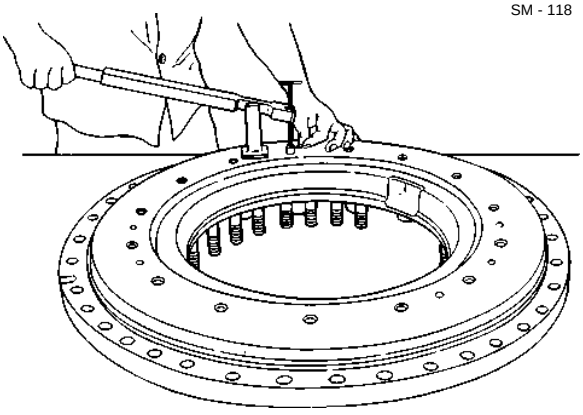


Fig. 6 - Removing Typical Pin

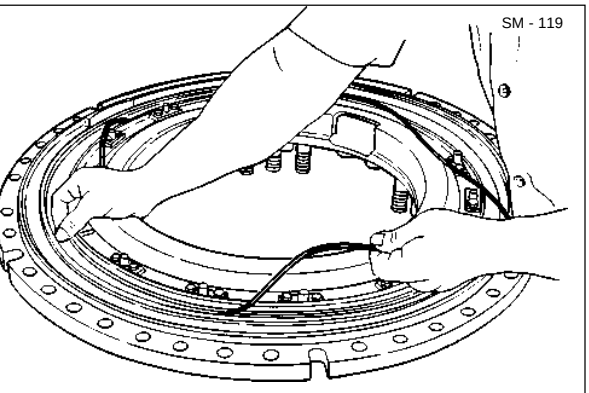


Fig. 7 - Removing/Installing 'D' Section Seal

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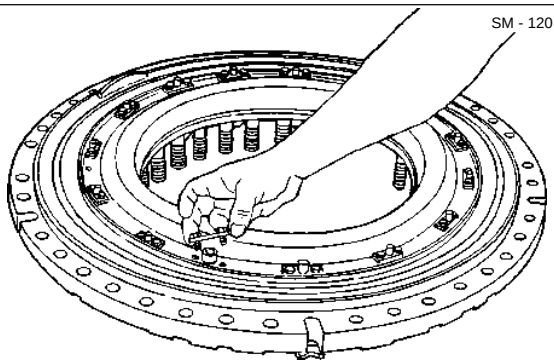


Fig. 8 - Removing/Installing Retainer Plate

⚠ WARNING
Return springs (36) are under compression. To prevent personal injury and property damage, use care when removing bolts (33) and retaining plates (34).

19. Very carefully, remove bolts (33) and retainer plates (34) securing return springs (36) in piston housing assembly (41). See Fig. 8.

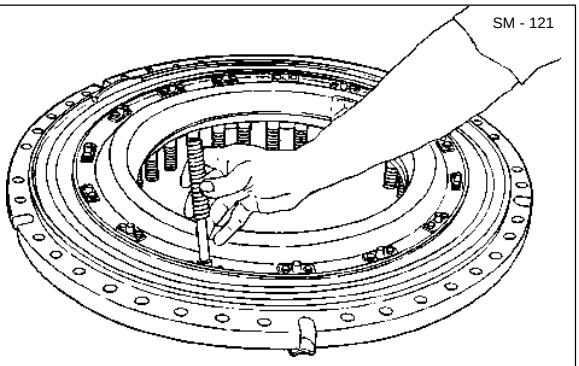


Fig. 9 - Removing/Installing Retaining Pin and Spring

20. Remove retaining pins (35) and return springs (36) from piston housing assembly (41). See Fig. 9.

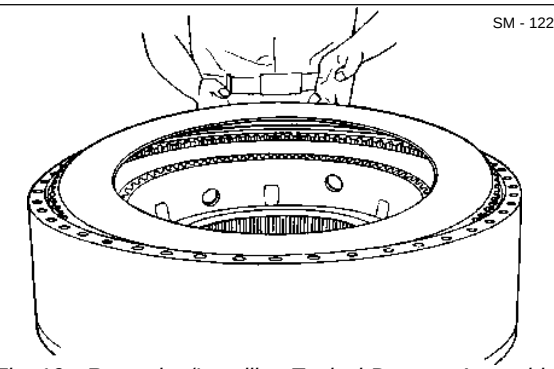


Fig. 10 - Removing/Installing Typical Damper Assembly

21. Remove damper assembly (28). Remove friction discs (29) and splined plates (30) alternately and final damper assembly (28) from disc housing (25). See Fig. 10.

22. If required, remove dowels (26) from disc housing (25).

23. With a suitable lifting device, lift disc housing (25) and turn over, with spring housing (14) side up.

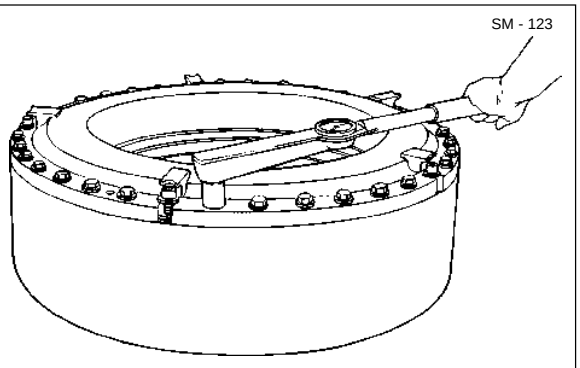


Fig. 11 - Removing/Installing Typical Spring Housing

24. Remove bolts (12) and hardened washers (13) from spring housing (14). See Fig. 11.

⚠ WARNING
Spring housing (14) is under pressure from spring (20 & 21) compression. To prevent personal injury and property damage, use care when removing socket head screws (15) and hardened washers (16).

25. Remove socket head screws (15) and hardened washers (16), by turning screws out alternately, one turn

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at a time. Using a suitable lifting device, lift spring housing (14) from disc housing (25). Refer to Fig. 12.

26. Remove and discard 'O' ring (17) from spring housing (14).

27. Remove springs (20 & 21) from parking piston (23). See Fig. 12.

28. Place lifting tool (shown in Fig. 13) over parking piston (23) with the legs resting on the edge of disc housing (25). Make sure the three holes of the tool are aligned with the three 0.5 - 13 UNC threaded holes in parking piston (23). Insert three 0.5 - 13 UNC lifting eyes into the three holes and thread into the three threaded holes in parking piston (23). The lifting eyes should be full threaded, with a 0.5 - 13 UNC nut on each lifting eye. Tighten the nuts down onto parking piston (23) until the parking piston is free of disc housing (25). Using a suitable lifting device attached to the lifting eyes of the lifting tool, raise and remove parking piston (23). See Fig. 14.

Note: The lifting tool shown in Fig. 13 may be fabricated as shown in Fig. 38.

29. Remove and discard seal (22) from parking piston (23). See Fig. 15. Remove spacer ring (58) from parking piston (23).

30. If required, remove dowels (19) from parking piston (23).

31. Remove and discard seal (24) from disc housing (25). See Fig. 16. Remove spacer ring (59) from disc housing (25).

32. If required, remove dowels (18) from disc housing (25).

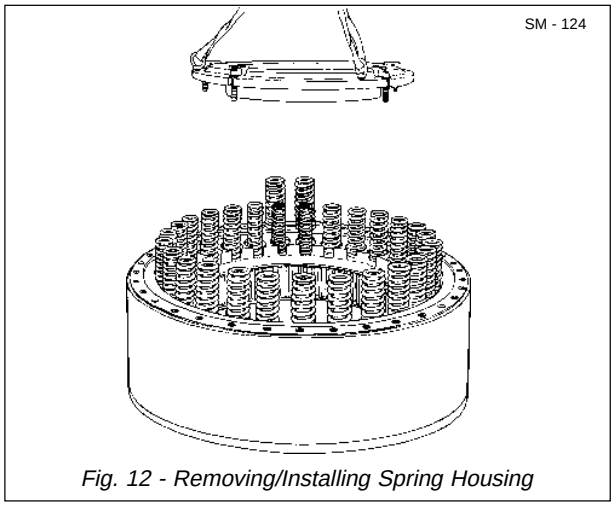


Fig. 12 - Removing/Installing Spring Housing

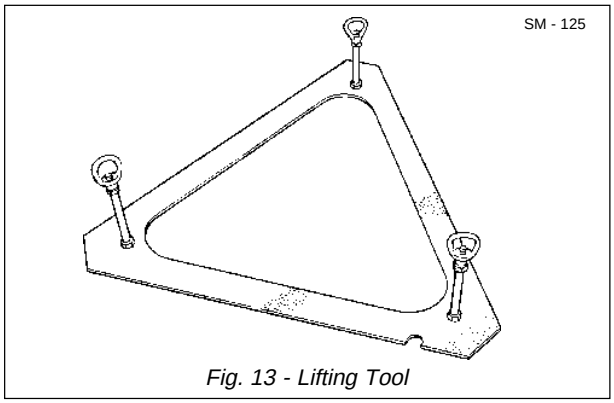


Fig. 13 - Lifting Tool

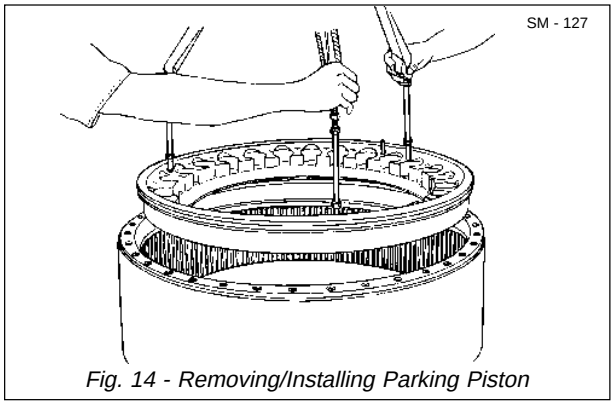


Fig. 14 - Removing/Installing Parking Piston

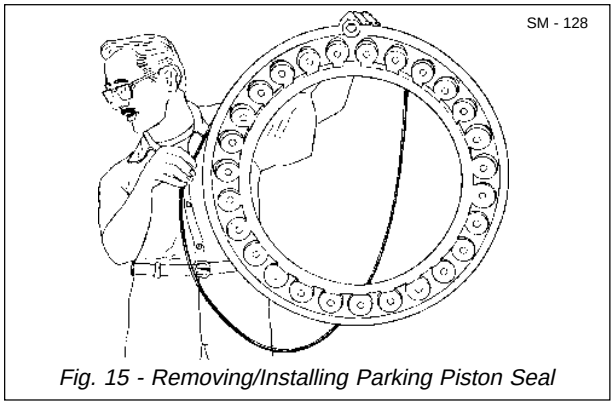


Fig. 15 - Removing/Installing Parking Piston Seal

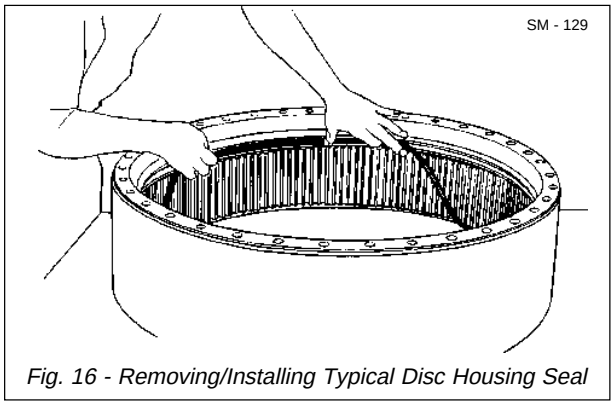
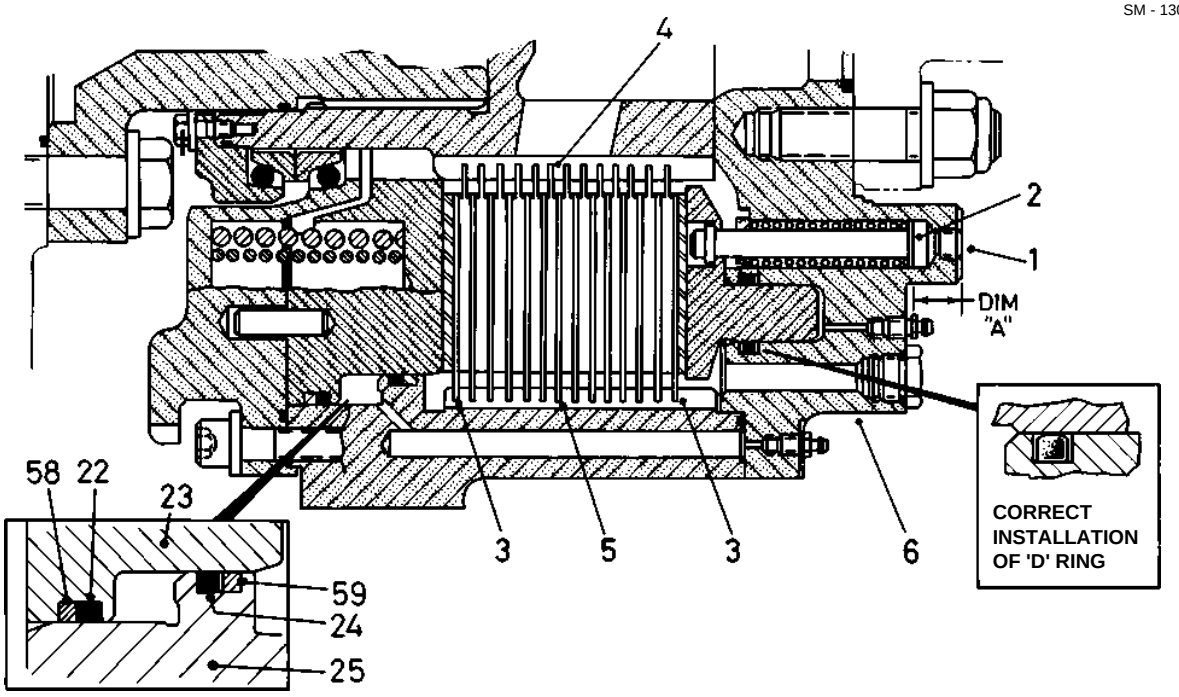


Fig. 16 - Removing/Installing Typical Disc Housing Seal

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1 - Pipe Plug
2 - Retainer Pin
3 - Damper Assembly
4 - Friction Disc
5 - Splined Plate
6 - Piston Housing
22 - Seal
23 - Parking Piston
24 - Seal
25 - Disc Housing
58 - Spacer Ring
59 - Spacer Ring

Fig. 17 - Typical Disc Assembly Wear Measurement

INSPECTION

Disc Assembly Wear Measurement Procedure

Note: This measurement should be made prior to removal and disassembly of the disc brake assemblies to determine the amount of wear on the brake discs.

Numbers in parentheses refer to Fig. 17, unless otherwise specified.

1. Pull out the parking - emergency brake control. This will pressurize parking brake cavity and compress parking brake springs (20 & 21, Fig. 1).

2. Depress service brake treadle or, with retarder selection mode switch in the disc brake position, place retarder control lever in the applied position. This will pressurize the service brake piston cavity.

3. Carefully remove pipe plug (1) from piston housing (6).

4. Insert a depth micrometer into the pipe plug hole and measure distance from end of retainer pin (2) to machined surface on piston housing (6). This is dimension 'A'. Record this dimension.

5. Record the dimension that is stamped on piston housing (6). Subtract the stamped dimension from dimension 'A' (Ref. Step 4). The difference is the amount of brake wear. Refer to 'Disc Brake Wear Limits' table for permissible wear limits.

New and Worn Disc Brake Wear Limits

Friction Disc Thickness
- New Disc ..... 5.08 ± 0.13 mm (0.200 ± 0.005 in)
- Worn Disc - Minimum Permissible Size ..... 4.57 mm (0.180 in)

Splined Plate Thickness
- New Plate ... 2.413 ± 0.064 mm (0.095 ± 0.0025 in)
- Worn Plate - Minimum Permissible Size ..... 2.29 mm (0.090 in)

Damper Plate Thickness
- New Damper Plate ..... 6.9 ± 0.051 mm (0.270 ± 0.020 in)
- Compression 'Set' after use ..... 5.84 mm (0.230 in)

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DISC BRAKE WEAR LIMITS TABLE761

	NUMBER OFF	THICKNESS	
		New	Worn
Friction Discs	7	35.56 mm (1.40 in)	32.00 mm (1.26 in)
Splined Plates	6	14.48 mm (0.57 in)	13.72 mm (0.54 in)
Damper Plates	2	13.72 mm (0.54 in)	11.68 mm (0.46 in)
Stack Thickness		63.75 mm (2.51 in)	57.40 mm (2.26 in)
Maximum Allowable Wear	6.35 mm (0.25 in)		

Disassembled Parts

Numbers in parentheses refer to Fig. 3.

1. Clean all parts in a suitable solvent.

2. Immediately after cleaning, dry all parts with compressed air.

3. After cleaning and drying, coat all parts with light oil to prevent corrosion.

4. The sealing face of face seals (3 & 11) metallic rings must be carefully inspected to determine if reuse is possible. The 'sealing band', which is a highly polished surface on the sealing face of each metallic ring, must be within the outer half of the total seal area, be concentric with the seal face diameters, of uniform width and free from wear marking. Refer to Fig. 18.

Note: Do not interchange metallic seal elements between assemblies. This can cause improper fit into seal housing (10) and prevent the correct metal to metal sealing contact.

Note: When using metallic rings which have satisfied inspection requirements, a slight 'overlap' condition, related to the original orientation of the seal faces, could occur and cause initial light leakage which will stop when the assembly has been 'run in'.

5. Before installing the disc brake assembly, clean all exterior surfaces to remove any foreign material.

6. Inspect all splines for cracked or broken teeth, excessive wear and pitted or scored surfaces. Repair or replace as necessary.

7. Check for pitted, scored or worn mating surfaces of housings.

8. Check all threaded holes and threaded parts for dirt or damaged threads. Repair or replace as necessary.

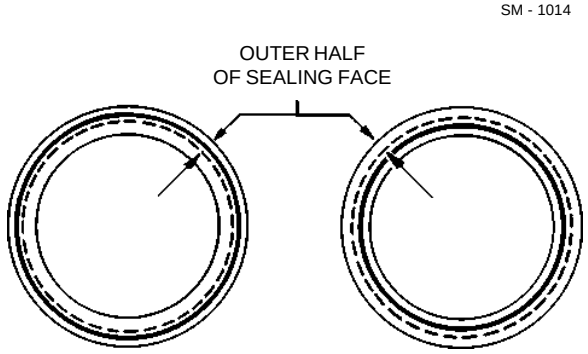


Fig. 18 - Metallic Ring Inspection

9. Check seal surfaces of service piston (31) for pitting, scoring or wear. Repair or replace as necessary.

10. Check springs (20, 21 & 36) for cracks or other damage and for spring tension.

11. Check all disc (29) and plate (30) contact surfaces for nicks, pits or corrosion. Check teeth of discs and plates for wear and damage.

12. Check finished surfaces of all other parts for scored or worn surfaces. Repair or replace as necessary.

ASSEMBLY

Numbers in parentheses refer to Fig. 3.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: All 'O' rings, seals and all contacting surfaces must be clean and lubricated at assembly.

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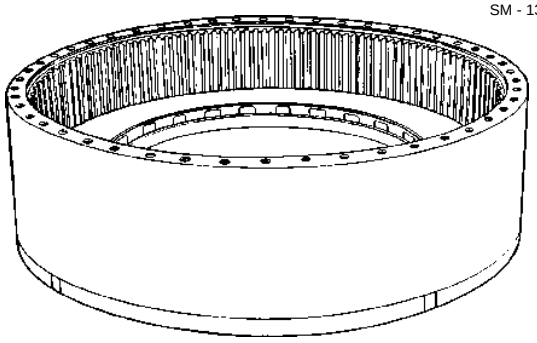


Fig. 19 - Typical Disc Housing

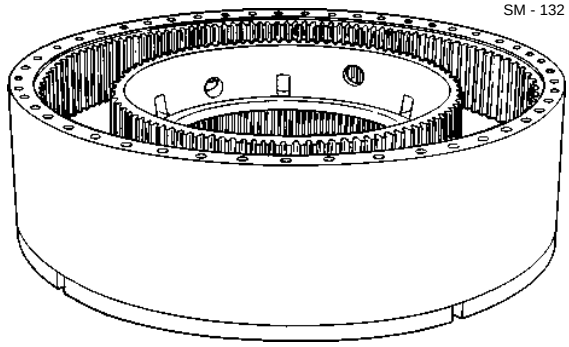


Fig. 20 - Disc Driver Installed in Typical Disc Housing

⚠ WARNING
To prevent personal injury and property damage, make sure lifting equipment is of adequate capacity and properly secured to do the job safely.

1. With a suitable lifting device, place disc housing (25) on a clean level surface, with spring housing (14) end up.

2. If removed, install dowels (18) in disc housing (25).

3. Stretch new seal (24) slightly. Lubricate seal groove in disc housing (25) and seal (24) with 'Wynns S.T.P.' to aid seal installation. Install seal (24). See Fig. 16.

4. Lubricate spacer ring (59) with 'Wynns S.T.P' and install in disc housing (25) as shown in Fig. 17.

5. If removed, install dowels (19) in parking piston (23).

6. Lubricate new seal (22) and groove in outer diameter of parking piston (23) with 'Wynns S.T.P.'. Install seal (22). See Fig. 15.

7. Lubricate spacer ring (58) with 'Wynns S.T.P' and install in parking piston (23) as shown in Fig. 17.

8. Lubricate disc housing seal (24) and area around the seal generously with 'Wynns S.T.P.'. Install parking piston (23) into disc housing (25).

9. Place spring housing (14) on parking piston (23) to align with dowel (19). Rotate spring housing (14) so that dowel (18) in disc housing (25) aligns with the hole in the spring housing. Seat parking piston (23) in disc housing with six bolts (12). Use care to prevent damage to seals (22 & 24). Remove bolts (12) and spring housing (14).

10. Install springs (20 & 21) in bores in parking piston (23). See Fig. 12.

11. Instal new 'O' ring (17) in groove in face of spring housing (14).

12. With a suitable lifting device, carefully install spring housing (14) over springs (20 & 21) on disc housing (25). Make sure springs are aligned with spring bores in spring housing and that dowels (19) are aligned with dowel holes in spring housing.

13. Install five socket head screws (15) and hardened washers (16) in holes under protruding ears on spring housing (14). Tighten socket head screws (15) alternately, one turn at a time, to draw spring housing (14), against the tension of springs (20 & 21), down to disc housing (25). Tighten socket head screws (15) to a torque of 260 - 280 Nm (190 - 210 lbf ft).

14. Install bolts (12) and hardened washers (13) in remaining holes in spring housing (14) and disc housing (25). Tighten bolts (12) to a torque of 260 - 280 Nm (190 - 210 lbf ft). See Fig. 11.

15. With a suitable lifting device, turn disc housing (25) over and place on a clean flat surface, spring housing (14) side down. See Fig. 19.

16. If removed, install dowels (26) in disc housing (25).

17. With a suitable lifting device attached to disc driver (27), position disc driver inside disc housing (25), with large splined end up. See Fig. 20. Block up disc driver with 50 mm x 100 mm (2 in x 4 in) blocks.

18. Install damper assembly (28) in disc housing (25), aligning teeth of damper with splines in disc housing. See Fig. 10. Ensure cork side of damper faces downward toward parking piston (23).

Note: Prior to installing friction discs (29), apply a

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coating of oil, of the type used in the system, to the discs.

19. Install friction disc (29) over disc driver (27), aligning teeth of friction disc with splines on disc driver.

20. Install splined plate (30) over friction disc (29) followed by another friction disc and a splined plate alternately until all are installed.

21. Install another damper assembly (28) over the last friction disc (29). See Fig. 21. Ensure cork side of damper assembly faces upward, toward service piston (31).

22. Install three new 'O' rings (40) in counterbore in three holes in mounting face of disc housing (25).

23. If removed, install studs (46) in piston housing assembly (41). See Fig. 22.

24. With a suitable lifting device, place piston housing assembly (41) on a clean flat surface, interior side up.

25. Install retaining pin (35) and return springs (36) in bores in piston housing assembly (41).

26. Install retainer plates (34) over retaining pins (35) and return springs (36) and secure with bolts (33). See Figs. 8 & 9.

27. Stretch new 'D' section seal (39) slightly. Install new 'D' section seals (38 & 39) in grooves in sides of channel in piston housing assembly (41). See Fig. 7.

Note: Install 'D' section seals in piston housing assembly as shown in the section in Fig. 17.

28. Install service piston (31), with flat surface up, into piston housing assembly (41). Ensure three 14 mm (0.56 in) drilled holes in service piston are aligned with three 0.5 - 13 UNC threaded holes in the piston housing. Be careful to prevent damaging the two 'D' section seals in piston housing assembly. Install three 0.5 - 13 UNC bolts, with flat washers through service piston to piston housing and draw service piston down gradually by turning bolts alternately, one turn at a time.

29. Using fabricated spring compression tool (shown in Fig. 4), screw the threaded end of the 'T' handle into the threaded hole of a retaining pin (35), as shown in Fig. 5.

30. With base of the tool resting on the flat surface of service piston (31), depress the handle of the tool to pull retaining pin (35) up far enough to insert pin (32) into hole in end of retaining pin. See Fig. 6. Release pressure on tool handle, making sure pin (32) is inserted far enough into retaining pin (35) to clear both sides of retaining pin hole in service piston (31). Remove spring compression tool.

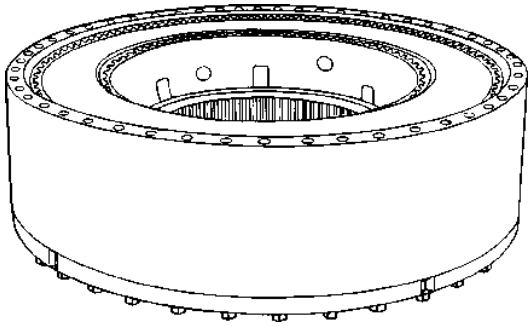


Fig. 21 - Final Damper Assembly Installed

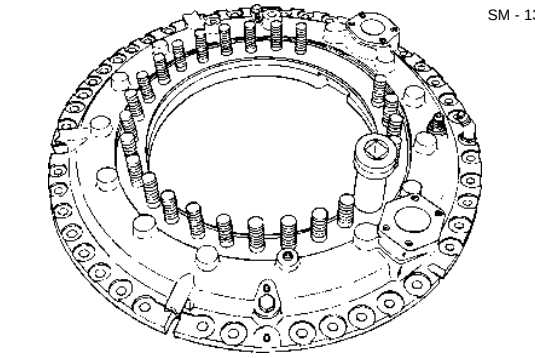


Fig. 22 - Installing Studs in Piston Housing

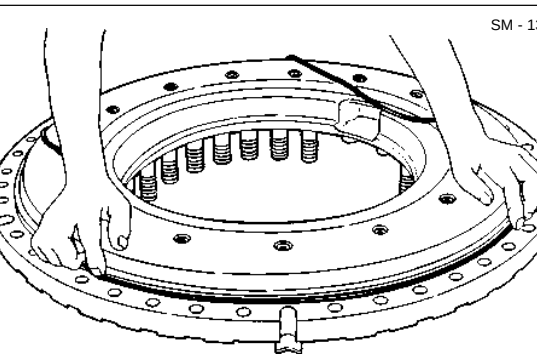


Fig. 23 - Installing 'O' Ring on Piston Housing

31. Repeat Step 28 to install pin (32) in each retaining pin (35).

32. Remove the three 0.5 - 13 UNC bolts and flat washers.

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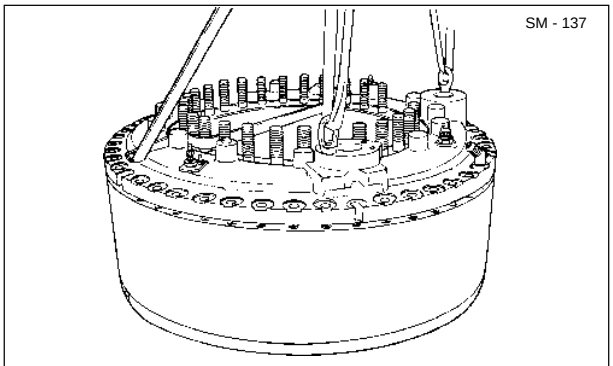


Fig. 24 - Installing Piston Housing on Disc Housing

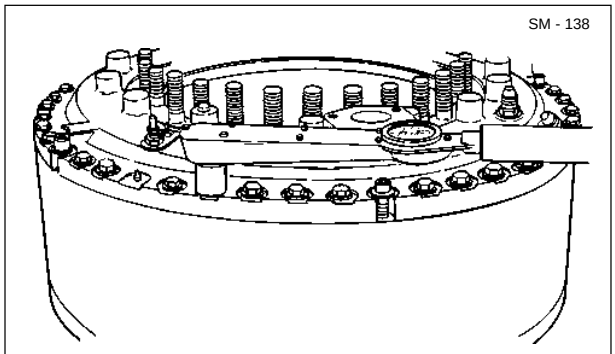


Fig. 25 - Tightening Piston Housing to Disc Housing

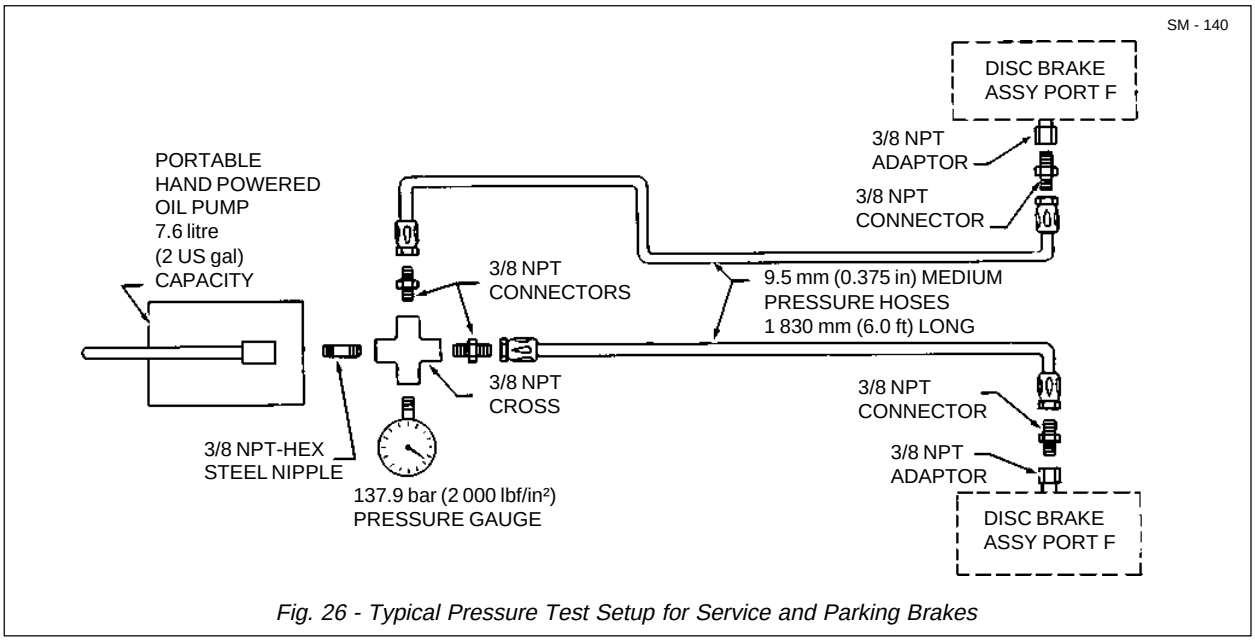


Fig. 26 - Typical Pressure Test Setup for Service and Parking Brakes

33. Install new 'O' ring (37) on piston housing assembly (41) as shown in Fig. 23.

34. With a suitable lifting device, turn piston housing assembly (41) over, with service piston (31) down.

35. If removed, install bleeder valves (50 & 54) in piston housing assembly (41).

36. If plug (49) was removed, install new 'O' ring (48) on plug and install plug in piston housing assembly (41).

37. Using a suitable lifting device attached to piston housing assembly (41), position piston housing assembly (41) on disc housing (25), making sure dowel pin holes in housing are aligned with dowels (26) on disc housing. Gradually lower piston housing onto disc housing. See Fig. 24.

38. Install five socket head screws (45), with hardened washers (44), in holes under protruding ears on piston housing assembly (41). Tighten socket head screws (45) alternately, one turn at a time, to draw piston housing assembly down snug on disc housing (25). Tighten socket head screws (45) to a torque of 260 - 280 Nm (190 - 210 lbf ft).

39. Install bolts (43) and hardened washers (42) in piston housing assembly (41). Tighten bolts (43) to a torque of 260 - 280 Nm (190 - 210 lbf ft). See Fig. 25.

Note: Be careful that disc driver (27) does not slide out of disc housing (25) when turning disc brake assembly over.

40. Refer to Fig. 26 for typical pressure test setup. Position brake assembly vertically with bleeder valves (50 & 54, Fig. 2) at the 12:00 o'clock position. Connect a portable hand pump filled with clean brake hydraulic oil to Port 'D', Fig. 2, and pressurize service

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brake piston cavity to 52 bar (750 lbf/in²). See Fig. 27.

Open bleeder valve (54, Fig. 2) slightly while pressurizing Port 'D' to release any trapped air. When hydraulic oil only, flows from bleeder valve (54), close the valve and pressurize piston cavity to 52 bar (750 lbf/in²). Apply and release the pressure ten times to seat the piston seals. After seating the piston seals, apply 52 bar (750 lbf/in²) pressure and close hand pump valve to hold the pressure. If service brake piston cavity does not lose more than 3.5 bar (50 lbf/in²) pressure in 15 minutes, service brake piston assembly is satisfactory.

Disconnect the pump hose from Port 'D', Fig. 2 and connect it to port 'F', Fig. 2 to seat and pressure test parking brake piston seals. Refer to Fig. 28. Pressurize parking brake piston cavity to 83 bar (1 200 lbf/in²) and open bleeder valve (50, Fig. 2) until all trapped air is released. When hydraulic oil only, flows, close the bleeder valve and pressurize parking brake cavity to 83 bar (1 200 lbf/in²). Apply and release the pressure ten times to seat parking piston seals. After seating seals, apply 83 bar (1 200 lbf/in²) pressure and close hand pump valve to hold the pressure. If parking brake cavity does not lose more than 7.0 bar (100 lbf/in²) pressure in 15 minutes, parking brake piston assembly is satisfactory.

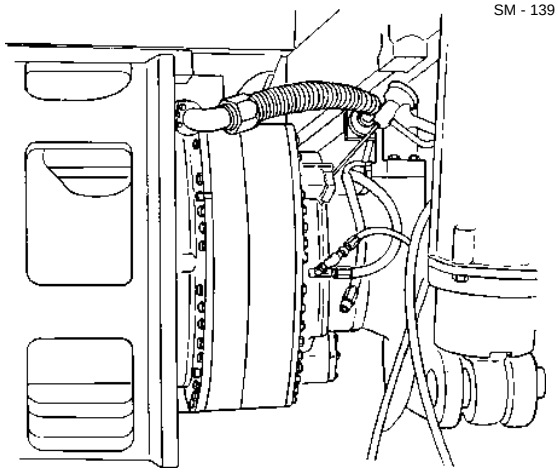


Fig. 27 - Charging Brake Pack With Oil

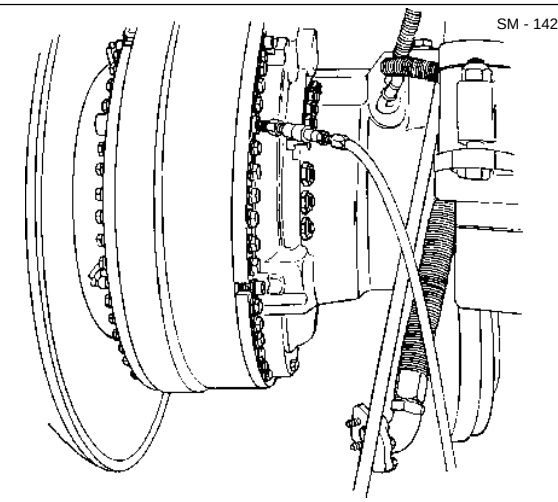


Fig. 28 - Pressurizing Parking Brake Assembly

INSTALLATION

Numbers in parentheses refer to Figs. 1 and 2.

> ⚠ **WARNING**
> **To prevent personal injury and property damage, ensure lifting equipment is of adequate capacity and properly secured to do the job safely.**

1. Install new 'O' ring (53) in counterbore on mounting face of piston housing assembly (41).

2. Remove one bolt (12) and hardened washer (13) from spring housing (14) and one bolt (43) and hardened washer (42) from piston housing assembly (41), both bolts from as close to 12:00 o'clock position as possible. Install a lifting eye in each bolt hole.

3. With a suitable lifting device attached to the disc brake assembly, at the lifting eyes installed in Step 2, position disc brake assembly on spindle. When installing right-hand brake assembly, 'INLET' port should be at the top. When installing left-hand brake assembly, 'INLET' port should be at the bottom. Insert studs (46) of disc brake assembly through holes in spindle flange, making sure 'O' ring (53) remains in counterbore on piston housing assembly.

4. Install nuts (52) and hardened washers (51) on studs (46). Tighten nuts (52) to a torque of 1 166 - 1 193 Nm (860 - 880 lbf ft). Remove lifting device and lifting eyes and reinstall bolts (12 & 43) and hardened washers (13 & 42) and tighten bolts to specified torque.

Note: Prior to installing face seal (11), clean face seal (11) and toric rings in '1.1.1. Trichlorethane' liquid.

Note: Seal installation kit (ref. Special Tools) comprises of seal sleeve, seal driver and a spring.

5. Insert seal sleeve tool (Fig. 29) in spring housing (14) until it is in as far as it can go.

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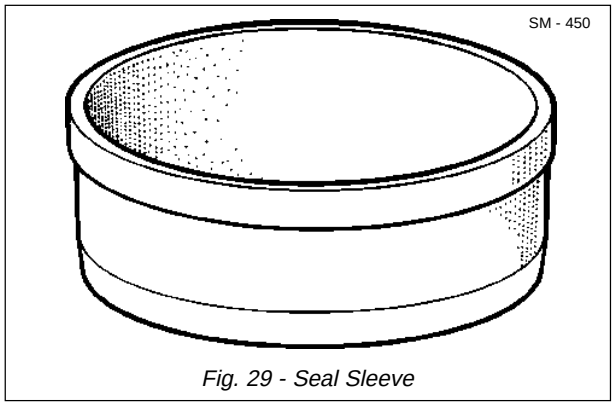


Fig. 29 - Seal Sleeve

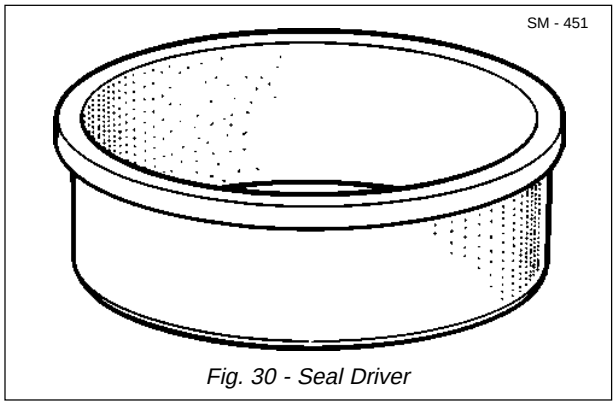


Fig. 30 - Seal Driver

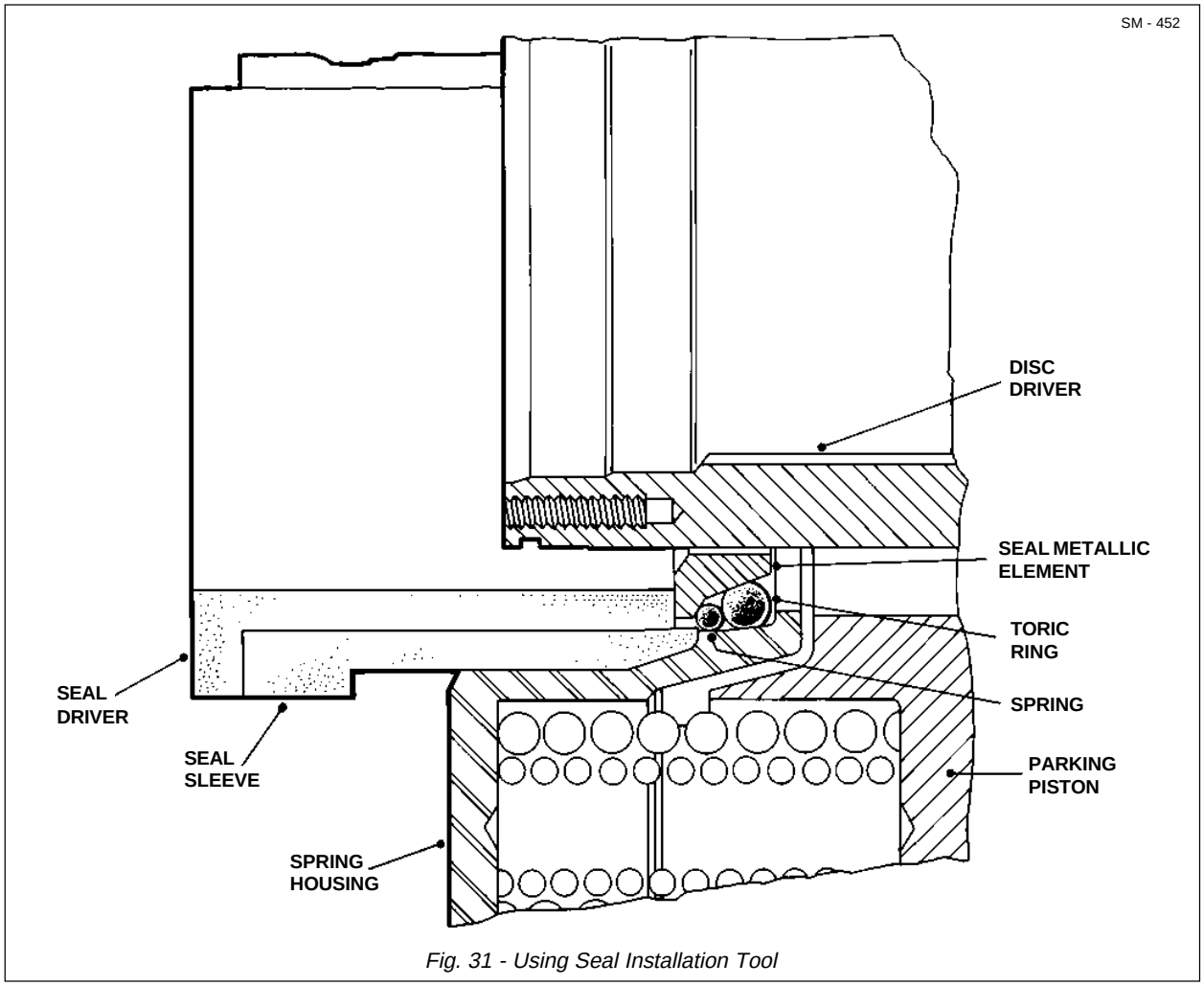


Fig. 31 - Using Seal Installation Tool

6. Insert seal installation kit spring on one half of face seal (11) and install toric ring on face seal. The spring prevents the toric ring from riding up the ramp on face seal (11) hence leading to easier installation.

7. Install one half of face seal (11) with 'O' ring and toric ring fitted, toric ring end first, inside seal sleeve and into spring housing (14).

8. Press home face seal (11) with seal driver (Fig. 30) until inside face of seal driver is flush with outside face of seal sleeve. See Fig. 31.

9. Remove seal driver from spring housing (14) and

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slowly remove seal sleeve. When seal driver and seal sleeve are removed, withdraw the spring from face seal (11). Apply a thin film of oil to metal contacting surface of face seal (11).

10. Install toric ring in other half of face seal and install in seal housing (10), toric ring side down. Refer to Figs. 32 & 33. Install seal installation tool (Fig. 34 'B') over face seal and press face seal into housing. See Fig. 35. Remove seal installation tool.

11. Coat 'O' ring (4) with grease and install in groove of disc driver (27). Apply a thin film of oil to metal contacting surface of face seal (11). Install seal housing (10), with half seal installed, over disc driver (27). Secure seal housing to disc driver with bolts (9) and hardened washers (55). Secure bolts (9) with lockwire (56).

Note: Prior to installing face seal (3), clean face seal (3) and toric rings in '1.1.1. Trichlorethane' liquid. Apply a thin film of oil to the metal contacting surfaces of the seal.

12. Install one half of new face seal (3), toric ring side inward, over spindle. Using seal installation tool (Fig. 34 'A'), press seal into disc driver (27) by tapping tool with a soft hammer. Remove seal installation tool.

13. Install other half of new face seal (3), toric ring side inward, into inner seal housing (1). Using seal installation tool (Fig. 34 'A'), press seal into seal housing. Remove seal installation tool.

14. Coat 'O' ring (2) with grease and install in groove on seal housing (1). Install seal housing (1), with face seal (3) installed, and secure with new bolts (57).

15. Install new 'O' ring (4) in groove on wheel.

16. Install wheel driver (5) on wheel and secure with bolts (7) and hardened washers (6). Make sure 'O' ring stays in groove on wheel. Tighten bolts (7) to a torque of 1 166 - 1 193 Nm (860 - 880 lbf ft).

17. Install new 'O' ring (8) on wheel driver (5).

> ⚠ **WARNING**
> **Use extreme caution to prevent personal injury when installing wheels. The exact procedure must be followed, as described in Section 160-0050, WHEEL, RIM AND TYRE.**

18. Install wheel on spindle as described in Section 160-0050, WHEEL, RIM AND TYRE. Be careful, when

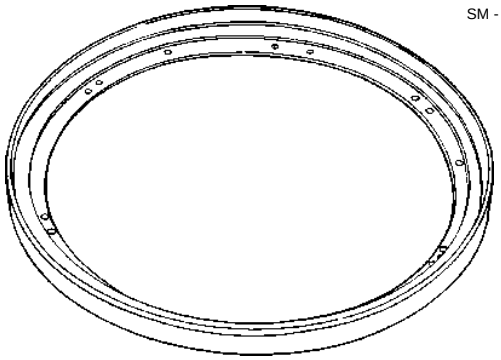


Fig. 32 - Seal Housing (10)



Fig. 33 - Half of Seal (11) Installed in Seal Housing

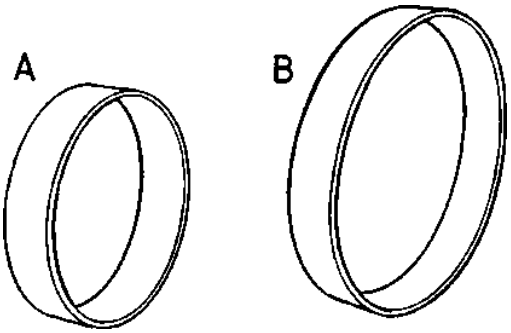


Fig. 34 - Seal Installation Tools

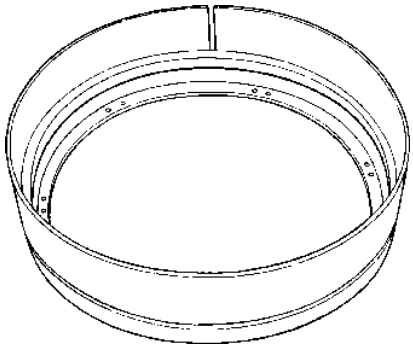
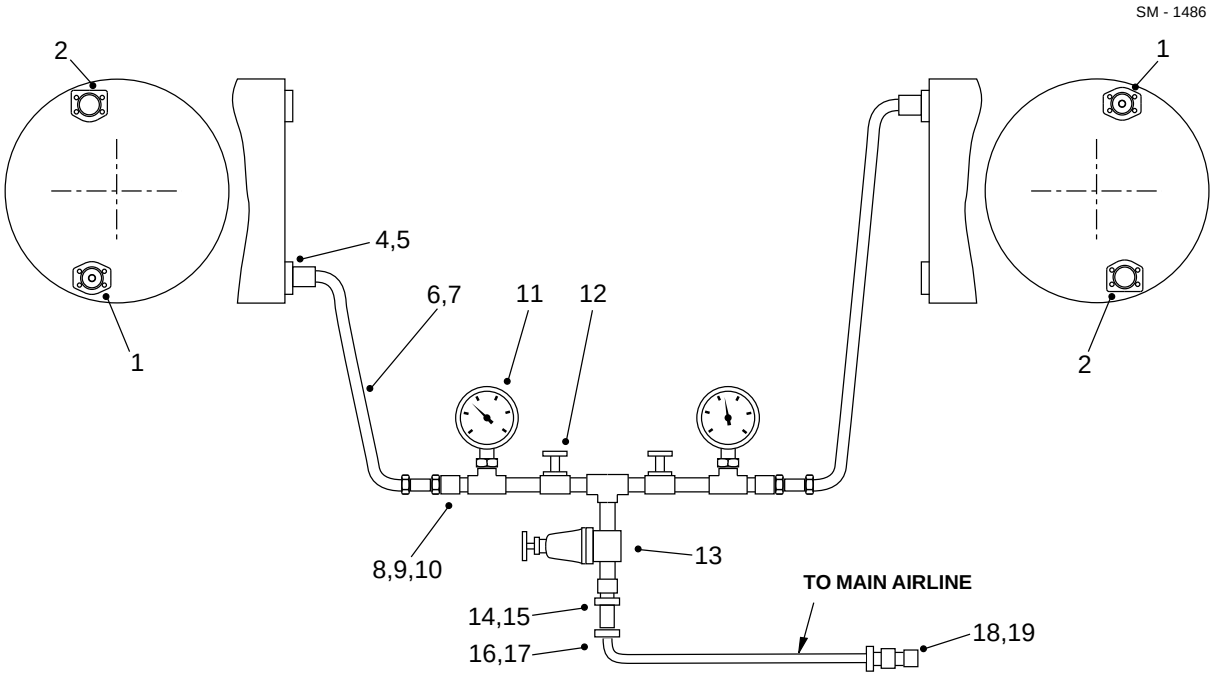


Fig. 35 - Installing Seal (11) in Seal Housing (10)

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1 - Blanking Plate (Port 'B')
2 - Blanking Plate (Port 'C')
3 - 'O' Ring
4 - Reducer Bush
5 - Connector
6 - Hose Assembly
7 - Female Swivel Connector
8 - Pipe Coupling
9 - Nipple
10 - Tee Piece
11 - Pressure Gauge
12 - Shutoff Valve
13 - Pressure Regulator
14 - Reducer Bush
15 - Connector
16 - Hose Assembly
17 - Female Swivel Connector
18 - Clip
19 - Adaptor

Fig. 36 - Typical Brake Pressure Test Setup

inserting wheel driver (5) on disc driver (27), not to damage 'O' ring (8) and to align wheel driver splines with splines on disc driver.

19. Fill service brake pack with 11 litres (3 US gal) of clean hydraulic oil, of the same type used in the brake cooling circuit. Pressurize the brake assembly with 2 bar (30 lbf/in^2) air pressure through Port 'B' (Inlet), Fig. 2, with the opposite Port 'C' (Outlet), Fig. 2, plugged.

Note: Refer to Fig. 36 for typical brake pressure test setup. Blanking plates for ports 'B' and 'C' may be fabricated as shown in Figs. 39 and 40.

While rotating the wheel, observe for air pressure loss on the air supply hose gauge. Less than 0.14 bar (2 lbf/in^2) air pressure loss in 15 minutes is satisfactory. If the air pressure loss is greater than 0.14 bar (2 lbf/in^2) in 15 minutes, rotate the wheel additionally to reseat all seals and pressurise the brake assembly to 2 bar (30 lbf/in^2). If the brake assembly again leaks more than 0.14 bar (2 lbf/in^2) air pressure in 15 minutes, loosen the wheel retainer bolts, rotate the wheel to reseat the seals, and tighten the bolts. Repeat the air pressure test to be sure the seals are properly seated, to prevent oil leaks.

Note: Be sure to uncap and install only one hydraulic line at a time to prevent loss of oil from brake hydraulic oil tank. The vacuum pump, installed during removal, cannot retain oil in tank if more than one line is uncapped at a time.

20. Remove plugs and install service brake hydraulic tube in port 'D', Fig. 2, as tagged at removal.

21. Remove plugs, and install parking brake hydraulic tube in port 'F', Fig. 2, as tagged at removal.

22. Remove plugs and install cooling lines in ports 'B' and 'C', Fig. 2, as tagged at removal.

23. Remove vacuum pump from brake hydraulic oil tank, installed during removal and reinstall air breather, in tank.

24. Fill steering and brake control tank with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Refer to SECTION 220-0040, STEERING AND BRAKE CONTROL TANK, for correct fill level.

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Note: If brake discs, service and/or parking pistons, piston housing, or the complete brake assembly have been replaced, a new brake-disc-stack-height measurement should be taken as described under 'Disc Assembly Wear Measurement Procedure', under 'Inspection' in this section. This dimension should then be stamped on the machined surface of pipe plug (47, Fig. 1) hole location for future reference.

BLEEDING

Numbers in parentheses refer to Fig. 1.

> **WARNING**
> **To prevent personal injury and property damage, be sure wheel blocks are properly secured and of sufficient capacity to do the job safely.**

In order to obtain satisfactory braking, the service brake and parking brake hydraulic systems must be bled to eliminate any air in the hydraulic lines, tubes and systems.

1. Make sure the steering and brake control tank is filled with oil specified in Section 300-0020, LUBRICATION SYSTEM.

2. Start engine, build up oil pressure in accumulators until accumulator pressure warning lights are extinguished, then shut down engine.

3. Block all road wheels. Pull out park/emergency brake control to release the brakes.

4. Securely connect a clean bleeder hose to upper bleeder valve (54) and place loose end of hose in a clean container.

> **WARNING**
> **Loosen bleeder valves carefully. The braking system operates at high pressure.**

5. Depress service brake pedal and gradually open bleeder valve (54). Bleeder valve should remain open until oil coming from bleeder valve is free of air bubbles. Close bleeder valve and release brake pedal.

Note: Recharge the system when necessary by repeating Step 2.

6. Securely connect bleeder hose to upper bleeder valve (50) and place loose end of hose in a clean container. Gradually open bleeder valve (50). Bleeder valve should remain open until oil coming from bleeder valve is free of air bubbles. Close bleeder valve.

7. Repeat entire process for opposite brake assembly.

Note: Steering and brake control tank must be kept at correct level at all times with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK, for correct fill level.

Note: If brake assembly has been serviced, repeat entire bleeding process to ensure all air is evacuated from the brake assemblies.

SPECIAL TOOLS

Refer to Figs. 37 through 40 for fabrication details of special tools and blanking plates referenced in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the seal installation tools outlined in this section and general service tools required. These tools are available from your dealer.

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INCHES	mm	INCHES	mm
0.03	0.76	0.72	18.2
0.06	1.52	0.75	19.0
0.12	3.0	0.81	20.5
0.130	3.3	1.00	25.4
0.139	3.5	1.12	28.4
0.177	4.5	1.68	42.7
0.18	4.6	2.00	50.8
0.19	4.8	2.50	63.5
0.22	5.6	2.56	65.0
0.25	6.3	3.00	76.2
0.26	6.6	4.00	101
0.38	9.6	5.50	140
0.47	11.9	6.00	152
0.50	12.7	20.00	508
0.62	15.7		

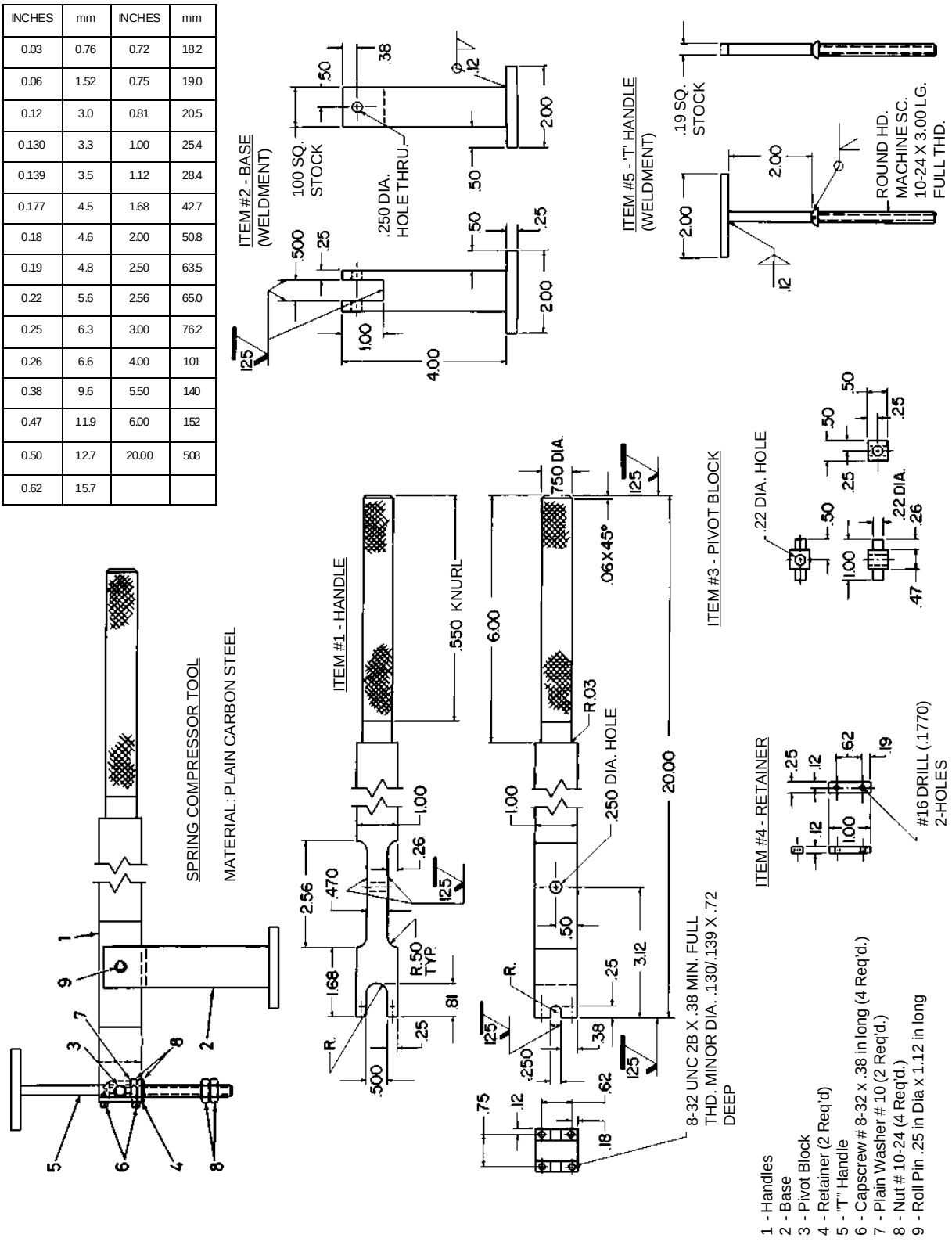
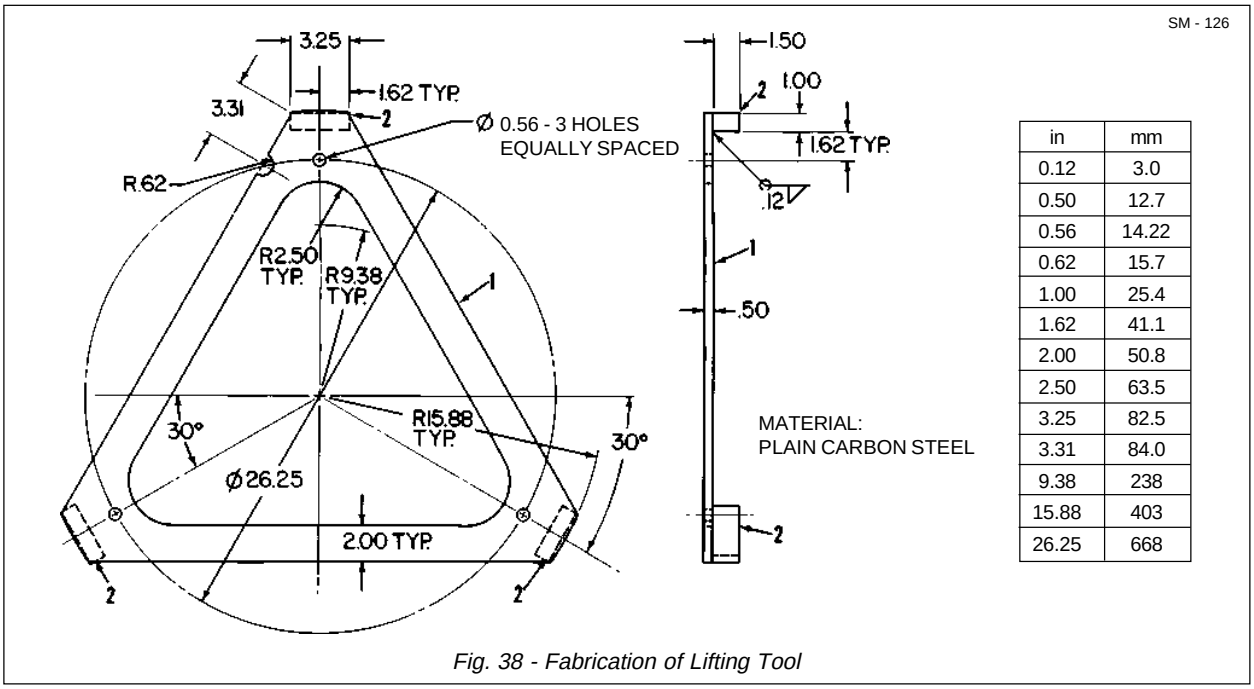


Fig. 37 - Fabrication of Spring Compressor Tool

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in	mm
0.12	3.0
0.50	12.7
0.56	14.22
0.62	15.7
1.00	25.4
1.62	41.1
2.00	50.8
2.50	63.5
3.25	82.5
3.31	84.0
9.38	238
15.88	403
26.25	668

Fig. 38 - Fabrication of Lifting Tool

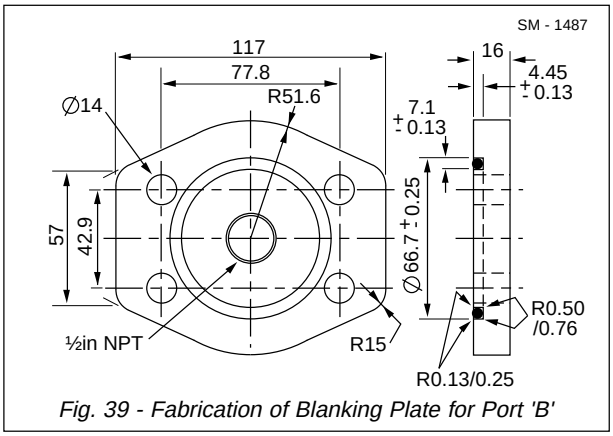


Fig. 39 - Fabrication of Blanking Plate for Port 'B'

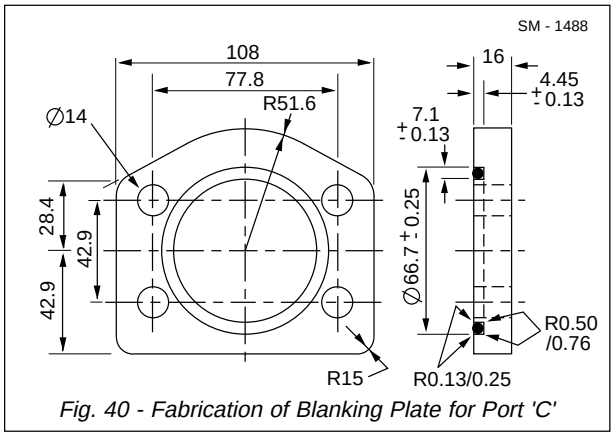


Fig. 40 - Fabrication of Blanking Plate for Port 'C'

SPECIAL TORQUE SPECIFICATIONS

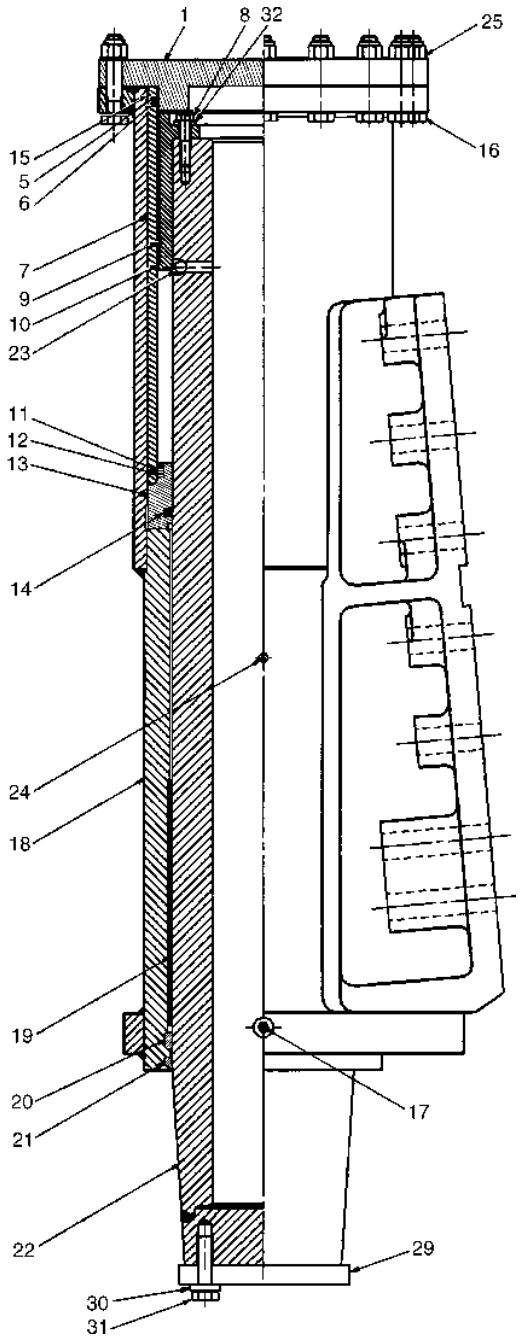
FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
3	7	Bolt	1 166 - 1 193	860 - 880
3	12	Bolt	260 - 280	260 - 280
3	15	Screw	260 - 280	260 - 280
3	43	Bolt	260 - 280	260 - 280
3	45	Screw	260 - 280	260 - 280
3	52	Nut	1 166 - 1 193	860 - 880

* * * *

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1 - End Cap
* 2 - Valve Assembly
* 3 - Check Valve
* 4 - Plug
5 - 'O' Ring
6 - Backup Ring
7 - Inner Tube
8 - Bolt
9 - Piston
10 - Wear Ring
11 - 'O' Ring
12 - Backup Ring
13 - Seal Retainer
14 - Seal
15 - 'O' Ring
16 - Bolt
17 - Lube Fitting
18 - Tube
19 - Wear Ring
20 - Seal
21 - Wiper
22 - Piston Rod
23 - Ball
24 - Relief Fitting
25 - Locknut
* 26 - Shear Key
* 27 - Hardened Washer
* 28 - Bolt
29 - Disc
30 - Hardened Washer
31 - Bolt
32 - Hardened Washer

* Shown on Fig. 4.

Fig. 1 - Cutaway View of Typical Ride Cylinder

DESCRIPTION AND OPERATION

Numbers in parentheses refer to Figs. 1 & 4.

The front ride cylinder suspends the front wheel and spindle from the chassis and absorbs road shock as the wheel travels over rough and uneven surfaces.

Oil and compressed nitrogen fill the inside of tube (18). When the wheel hits a road bump, piston rod (22) is forced into tube (18). Inward movement of piston rod (22) compresses the nitrogen within tube (18) thereby slowing piston rod travel speed. As piston rod (22) moves inward in tube (18), oil

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pressure unseats ball (23), allowing oil to fill the cavity between piston rod and tube (18). When the force of piston rod (22) is expended, the compressed nitrogen pushes the piston rod outward to its original position. The oil in the cavity between piston rod (22) and tube (18) slows and smooths the return travel of the piston rod.

REMOVAL

Numbers in parentheses refer to Fig. 2.

⚠ WARNINGS

Pressurized cylinders. Release pressure as described under 'Relieving Cylinder Pressure' before removing valves or fittings. Accidental release of pressure will result in personal injury and property damage.

⚠ To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels.

3. Relieve nitrogen pressure from BOTH front ride cylinders. Refer to 'Relieving Cylinder Pressure', in this section.

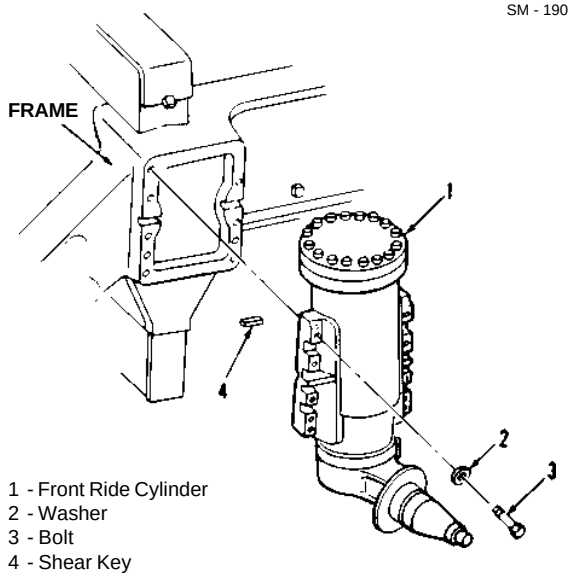
4. Jack frame up at 'horse collar' until front ride cylinder is fully extended.

5. Jack up ride cylinder until tyre is off ground and block steering arm in position.

6. Remove front tyre and rim. Refer to Section 140-0040, WHEEL, RIM, AND TYRE.

7. Remove cotter pins and castle nuts attaching tie rod and steering cylinder to steering arm. Secure both tie rod and steering cylinder away from the work area. Refer to Section 220-0120, STEERING CYLINDER AND LINKAGE.

8. Position lift truck forks under front ride cylinder and block up ride cylinder, spindle and wheel assembly as shown in Fig. 3.



1 - Front Ride Cylinder
2 - Washer
3 - Bolt
4 - Shear Key

Fig. 2 - Exploded View of Front Ride Cylinder Mounting

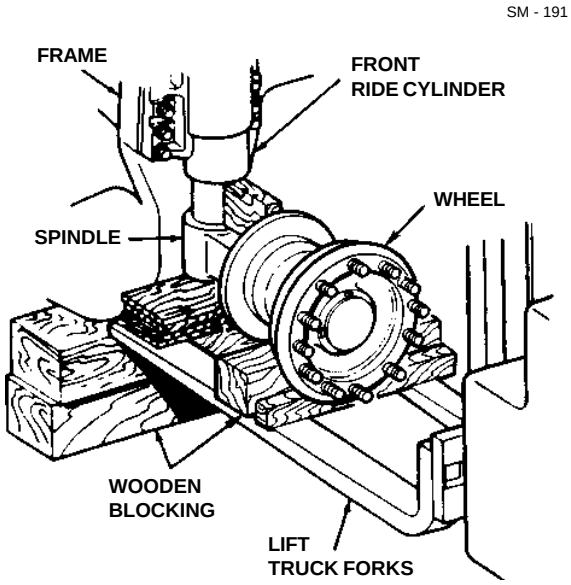


Fig. 3 - Front Ride Cylinder Removal and Installation

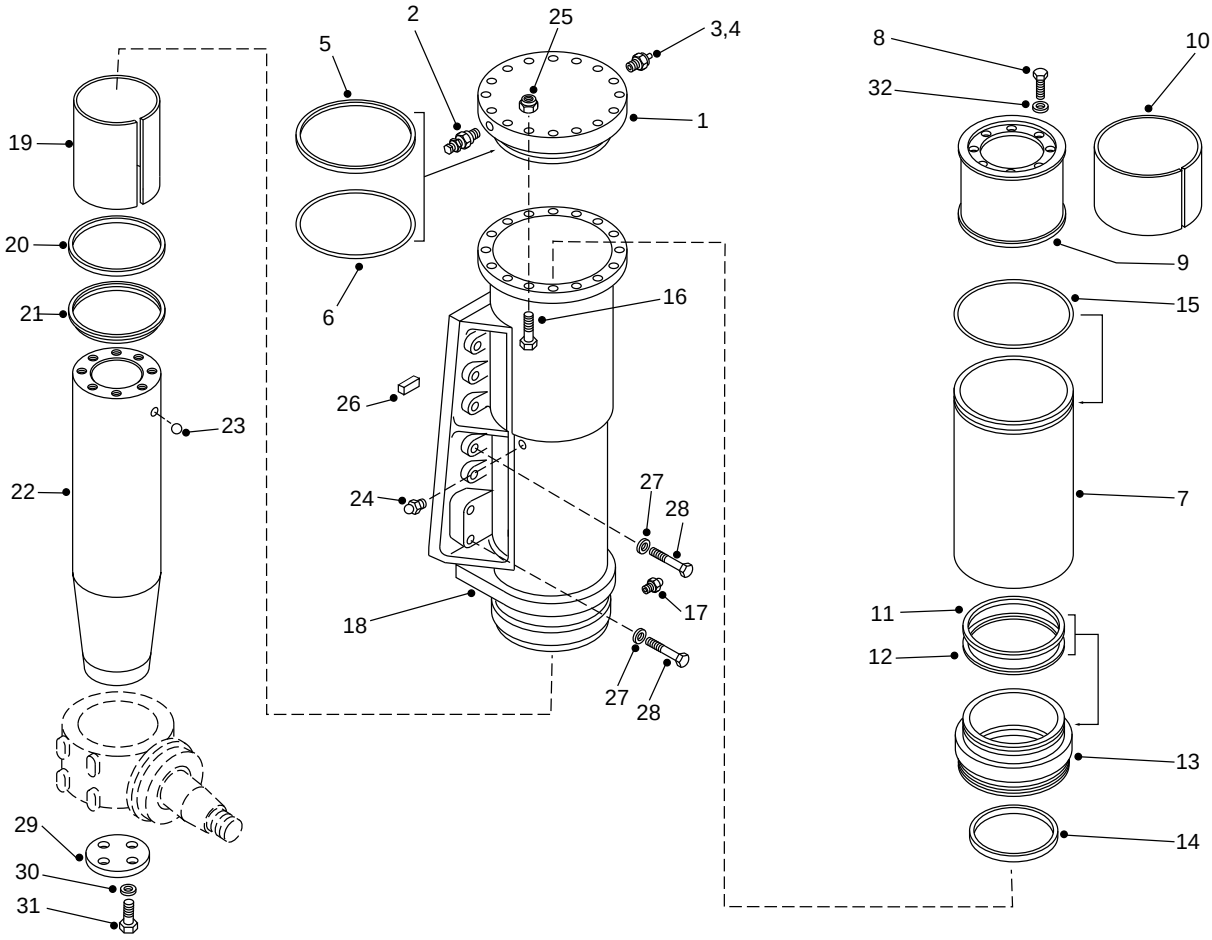
9. Remove bolts (3) and washers (2) attaching front ride cylinder (1) to the frame.

10. Carefully remove the front ride cylinder, spindle and wheel assembly to a suitable work area for further disassembly.

11. Follow procedures in Steps 4 through 10 above if the other front ride cylinder is to be removed.

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1 - End Cap
2 - Valve Assembly
3 - Check Valve
4 - Plug
5 - 'O' Ring
6 - Backup Ring
7 - Inner Tube
8 - Bolt
9 - Piston
10 - Wear Ring
11 - 'O' Ring
12 - Backup Ring
13 - Seal Retainer
14 - Seal
15 - 'O' Ring
16 - Bolt
17 - Lube Fitting
18 - Tube
19 - Wear Ring
20 - Seal
21 - Wiper
22 - Piston Rod
23 - Ball
24 - Relief Fitting
25 - Locknut
26 - Shear Key
27 - Hardened Washer
28 - Bolt
29 - Disc
30 - Hardened Washer
31 - Bolt
32 - Hardened Washer

Fig. 4 - Exploded View of Typical Front Ride Cylinder

DISASSEMBLY

Numbers in parentheses refer to Figs. 1 & 4.

⚠ WARNING
To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Remove locknuts (25) and bolts (16) securing end cap (1) to tube (18). Remove end cap.

2. Remove and discard 'O' rings (5 & 15) and backup ring (6) from end cap (1).

3. Drain oil from ride cylinder into a suitable container.

4. Remove bolts (31) and hardened washers (30) securing disc (29) and remove disc.

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Note: Piston rod (22) must be separated from the spindle for proper disassembly and assembly. It is best to disassemble and assemble piston rod from top of cylinder so holes in rod do not have to pass over seals.

5. The spindle can be removed from the rod by applying hydraulic pressure through the annular groove machined on the spindle taper. This can be done by removing the small plug from the spindle, and connecting a hand pump or high pressure grease gun. Refer to Fig. 5.

6. Remove bolts (8) and hardened washers (32) securing piston (9) to top of piston rod (22).

7. Install a lifting eye in the top of piston rod (22) and attach to an adequate lifting device. Slide piston rod (22) and piston (9) as an assembly out from top of tube (18).

Note: When removing piston rod (22), seal retainer (13) and inner tube (7) should come out as an assembly. If they do not come out intact after removing piston rod (22), remove inner tube (7) and seal retainer (13) individually from tube (18).

8. Slide piston (9) up piston rod (22) and remove ball (23).

Note: Take care not to misplace ball (23).

9. Remove piston (9) and remove wear ring (10) from piston.

10. Remove and discard 'O' ring (11), backup ring (12) and seal (14) from seal retainer (13).

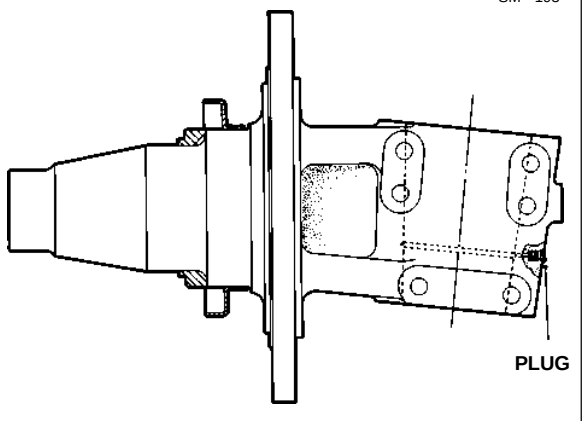


Fig. 5 - Spindle Annular Groove for Separating Tapers

11. Remove and discard seal (20) and wiper (21) from tube (18).

12. Remove wear ring (19).

INSPECTION

Numbers in parentheses refer to Fig. 4.

1. Wash all parts thoroughly in a suitable solvent. Dry all parts with compressed air. Check all inner and outer grooves in seal retainer (13) for cleanliness.

2. Inspect tube (18), piston rod (22) and piston (9) for scores, scuffing or small ridges in the walls. Use a fine stone to smooth out any defective areas. If damage is too extensive, replace with a new part.

3. Inspect all cylinder assembly components for signs of unusual distortion or excessive wear. Replace defective components.

4. Inspect plug (4), check valve (3), valve assembly (2) and lube fitting (17). Check their seating positions in end cap (1) and tube (18). If threads in any of these parts are damaged, restore the threads. Replace defective parts if necessary.

5. Inspect wear ring (19) for excessive wear or damage. Replace if damaged.

ASSEMBLY

Numbers in parentheses refer to Figs. 1 & 4.

⚠ WARNING
To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

Note: Apply a light coating of clean hydraulic oil to all components as they are assembled. This facilitates the assembly procedure. Make sure that all work is done in a clean area so that no contaminants can get into the oil.

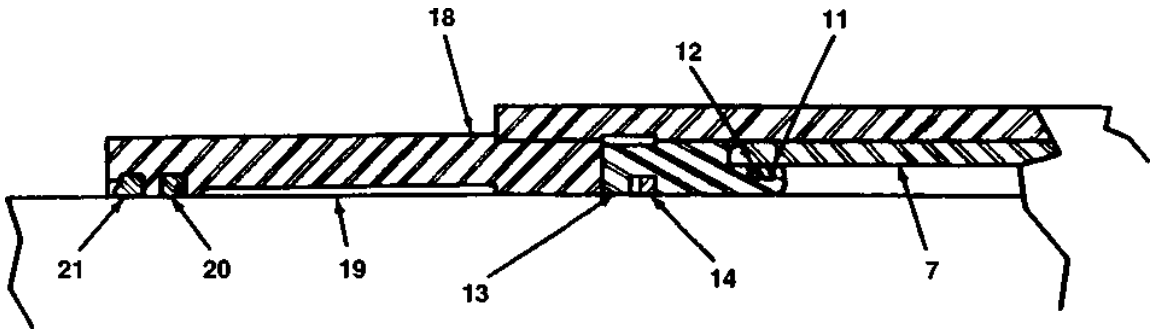
Note: For proper assembly procedure, seal (20) and wiper (21) should not pass over holes in piston rod (22).

1. Install new backup ring (12), seal (14) and 'O' ring (11) to seal retainer (13). Press seal retainer (13) assembly down into tube (18) until retainer bottoms at lower end of tube. Insert inner tube (7) into tube (18). Refer to Fig. 6.

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7 - Inner Tube
11 - 'O' Ring
12 - Backup Ring
13 - Seal Retainer
14 - Seal
18 - Outer Tube
19 - Wear Ring
20 - Seal
21 - Wiper

Fig. 6 - Cutaway View of Front Ride Cylinder Tube Assembly

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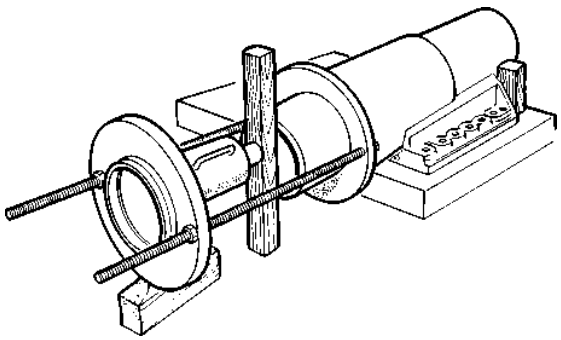


Fig. 7 - Installing Piston Rod in Outer Tube

2. Install wear ring (10) to piston (9) and install piston assembly to piston rod (22). Slide piston (9) assembly up piston rod (22) enough to install ball (23) in piston rod.

3. Apply Loctite 277 to threads of bolts (8) and secure piston (9) assembly to piston rod (22) with bolts (8) and hardened washers (32). Do not tighten bolts (8) at this time.

4. Install wear ring (19) in tube (18). Install with wear ring joint in line with lube fitting (17).

5. Install seal (20) and wiper (21) in tube (18).

6. Insert piston rod (22), piston (9) and wear ring (10) as an assembly, through the top of tube (18). Make sure check ball (23) is correctly positioned in piston rod (22).

Note: A convenient method for pressing piston rod (22) into outer tube (18) is illustrated in Fig. 7.

a) Using two 915 mm (36 in) long pieces of 12 mm (0.5 in) threaded rod stock, four washers and nuts, connect end cap (1) (outboard side facing inward) to outer tube (18).

b) Support one end of a hydraulic jack against end cap (1) and the other end against a block of wood long enough to extend beyond the circumference of piston rod (22). This will prevent a metal-to-metal contact between the jack and piston rod; avoiding possible piston rod/piston damage.

c) Extend the jack until piston rod (22) is flush with outer tube (18).

d) Remove jack, threaded rod stock, nuts, and washers. Remove any wood debris left from the wood block.

e) Move piston rod (22) and piston (9) assembly to full extended position and tighten bolts (8) to a torque of 105 Nm (78 lbf ft). This will help to centre parts and eliminate binding.

7. Install new 'O' rings (5 & 15) and backup ring (6) to end cap (1). Secure end cap (1) to the top of tube (18) with bolts (16) and locknuts (25). Tighten locknuts (25) evenly to a torque of 105 Nm (78 lbf ft).

8. Insert tapered end of piston rod (22) into the spindle and secure disc (29) to bottom of piston rod (22) with bolts (31) and hardened washers (30). Tighten bolts (31) to a torque of 280 Nm (205 lbf ft).

Note: A periodic inspection should be made to ensure proper torque is maintained on bolts (31).

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INSTALLATION

Numbers in parentheses refer to Fig. 2.

WARNING
To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Use lift truck forks with blocking placed as shown in Fig. 3 to position front ride cylinder to frame mounting surface.

Note: It may be helpful to use two guide studs approximately 25 mm (1 in) in diameter and 200 mm (8 in) long to guide the front ride cylinder into position on the frame's horse collar.

2. Secure front ride cylinder (1) to frame with washers (2) and bolts (3). Alternately tighten bolts (3) to a torque of 900 - 980 Nm (660 - 730 lbf ft).

3. Remove equipment used to position front ride cylinder to frame mounting surface.

4. Attach steering cylinder and tie rod to steering arm with castle nuts and cotter pins. Tighten tie rod nut to a torque of 1 150 - 1 290 Nm (850 - 950 lbf ft) and steering cylinder nut to a torque of 1 560 - 1 630 Nm (1 150 - 1 200 lbf ft).

Note: If necessary, refer to Section 220-0120, STEERING CYLINDER AND LINKAGE, for procedure in Step 4 above.

5. Connect brake hydraulic line to brake calliper and bleed braking system. Refer to Section 165-0020, BRAKE PARTS.

6. Install front tyre and rim assembly as described in Section 140-0040, WHEEL, RIM AND TYRE.

7. If the opposite ride cylinder was removed, follow steps 1 through 6 to install the cylinder.

8. Charge ride cylinders as described in 'Charging Instructions', in this section.

CHARGING RIDE CYLINDER

WARNING
To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

Relieving Cylinder Pressure

Numbers in parentheses refer to Fig. 8.

WARNING
Pressurized cylinders. Release pressure as described below before removing valves or fittings. Accidental release of pressure will result in personal injury and property damage.

Note: Vehicle must be empty and on a level surface prior to relieving ride cylinder pressure.

1. Support the frame near the ride cylinder with blocking and/or a hydraulic jack with adequate capacity.

2. Remove the cap from nitrogen charging valve (4) at the top of the cylinder. Turn the hex nut on the valve 1/4 to 1/2 turn counter-clockwise and depress the valve core. If no gas escapes, continue to turn the hex nut in 1/4 turn increments until the nitrogen releases as the valve core is depressed.

3. Remove blocking or release pressure on the hydraulic jack and allow the vehicles weight to fully retract the ride cylinder rod.

WARNING
Pressurised cylinders. Keep valve core depressed until all gas is bled from cylinder. Failure to release all pressure may result in personal injury or property damage.

4. Depress nitrogen charging valve (4) core again to be sure all pressure has been relieved.

Note: Nitrogen leaving the cylinder will often carry oil with it. This results from foaming of the oil in the cylinder. The foaming takes place as nitrogen which was dissolved in the oil at high pressure expands at atmospheric pressure. The oil lost in this operation must be replaced in the charging operation. The

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1 - Lube Relief Valve
2 - Pipe Plug
3 - Check Valve (Oil Fill Port)
4 - Nitrogen Charging Valve
5 - Lube Fitting

DIMENSION 'A' RIDE POSITION TRUCK EMPTY	
mm	in
165 - 171	6.5 - 6.75

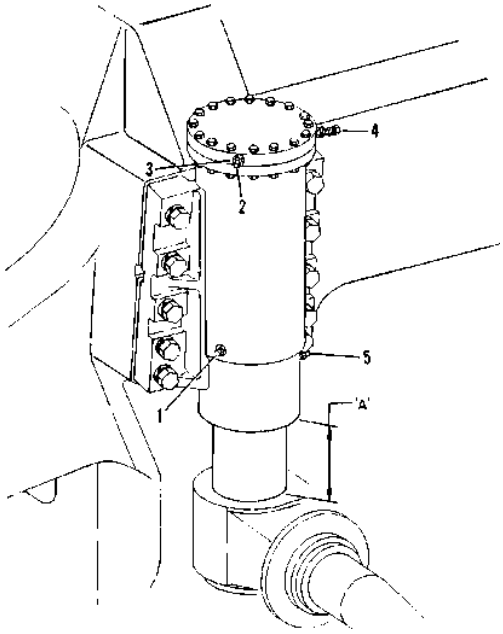


Fig. 8 - Typical Ride Cylinder Installation

longer the oil is allowed to stand at atmospheric pressure after discharging cylinder, the easier it will be to purge cylinder of bubbles in the oil when recharging.

Charging Instructions

Numbers in parentheses refer to Fig. 8, unless otherwise specified.

Note: To ensure that both ride cylinders will be equally charged to the required height specifications and equal pressures, both cylinders should be charged simultaneously.

Also when front ride cylinders are being charged, both rear ride cylinders should be extended equally. This can be accomplished by placing equal thickness blocks between axle and frame at the bump stops. It may be necessary to raise frame slightly to install spacers. Be sure to remove spacers when charging is complete.

Note: The pressure of a confined gas varies directly with its temperature. Hence, extreme changes in ride cylinder ambient temperature will change its nitrogen charge volume and, consequently, its operating height. It might be necessary, therefore, to add or remove nitrogen to maintain proper cylinder height as ambient temperature changes.

⚠ WARNINGS

Pressurized cylinders. Release pressure as described under 'Relieving Cylinder Pressure', before removing valves or fittings. Accidental release of pressure will result in personal injury and property damage.

⚠ A high pressure nitrogen pressure regulator must be used with the charging assembly. Failure to use a pressure regulator could cause property damage, personal injury, or death.

1. Remove pipe plug (2) from check valve (3). Attach hose from a pressure pump filled with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM, to check valve (3). Remove charging valve (4).

Note: Approximately 14 bar (200 lbf/in^2) pressure is required to open the check valve allowing oil to flow through the fitting into the cylinder. If a pump is not available to overcome this check valve cracking pressure:

a) Modify a spare check valve assembly by removing the internal valve and spring or,

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b) Make a fill-fitting by drilling through a 5/8 - 18 x 1.50 in bolt and tapping the head end of the hole 1/4 NPT.

Use either of these methods for filling the ride cylinder and reinstall the standard fitting for machine operation.

2. With cylinder rod in its retracted position, fill the cylinder until oil flows free of air bubbles from charging valve (4) port. It may be necessary to wait 30 or more minutes after nitrogen pressure has been released to clear the foam which has formed inside the cylinder.

3. Remove oil fill equipment, reinstall pipe plug (2) in check valve (3) or reinstall check valve (3) if it was removed at Step 1. Reinstall the nitrogen charging valve (4) in its port.

⚠ WARNING
Use dry nitrogen to charge cylinder. Do not use a gas such as oxygen which, if used by mistake for pressurizing, will explode violently when coming into contact with oil or grease, possibly causing personal injury and property damage.

To charge both cylinders simultaneously with nitrogen, a tee piece, coupling, two hoses (1, Fig. 9), valve chuck (2, Fig. 9) and valve extension (3, Fig. 9) can be added to the charging assembly (See Fig. 9). Assembly of this kit is described under 'Special Tools'.

4. Attach the charging assembly kit to the nitrogen bottle by turning down on gland nut (8, Fig. 9).

5. Install valve chucks (2, Fig. 9) to nitrogen charging valve (4) as follows:

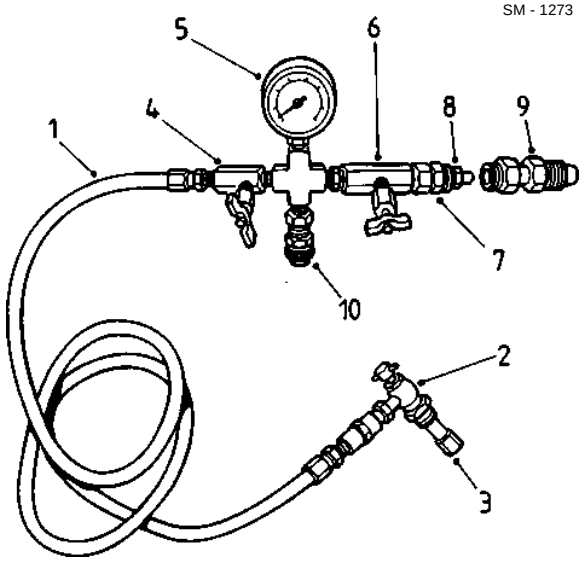
a. Rotate 'T' handle of valve chucks (12) anticlockwise until they stop.

b. Screw the swivel nuts down on nitrogen charging valves (4) until they seat.

c. Turn small hex on nitrogen charging valves (4) two to three turns anticlockwise to unseat the valves internally.

d. Rotate 'T' handles clockwise until they seat, opening check valves (valve cores) in nitrogen charging valves (4).

6. To check the amount of pressure in the nitrogen tank, close cylinder valve (4, Fig. 9) and open tank valve (6, Fig. 9). Open the valve on the nitrogen bottle slowly and note the reading on pressure gauge (5, Fig. 9). The available pressure in the nitrogen bottle must be over 31 bar (450 lbf/in^2).



1 - Line
2 - Valve Chuck
3 - Valve Extension
4 - Cylinder Valve
5 - Pressure Gauge
6 - Tank Valve
7 - Gland Fitting
8 - Gland Nut
9 - Cylinder Adaptor
10 - Bleeder Valve

Fig. 9 - Charging Assembly

7. Close tank valve (6, Fig. 9) and open cylinder valve (4, Fig. 9). Charge both cylinders to height 'A', shown in Fig. 8, by opening tank valve (6, Fig. 9) slowly and closing it occasionally. To check pressures in the cylinders, close tank valve (6, Fig. 9) and note the reading on pressure gauge (5, Fig. 9).

Note: If both cylinders do not extend evenly, check rear ride cylinders. Both rear ride cylinders should be extended equally (both can be fully collapsed). Also check that the truck is on a flat, level surface and empty.

Note: The cylinder should be charged to the height shown in Fig. 8 and MUST NOT be over charged above the recommended height. Overcharging can cause the cylinders to over extend, thus damaging the piston retaining bolts.

Note: The cylinder charging pressure shown in the following chart is for REFERENCE only. Cylinders should be charged according to the height specified in Fig. 8 and NOT solely on the basis of monitoring cylinder pressure.

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CYLINDER CHARGING PRESSURE	
bar	lbf/in²
13.8	200

Note: As the frame rises during the charging operations, follow the frame up with blocking and/or a hydraulic jack.

8. When height 'A' (Fig. 8) has been reached, close valve on the nitrogen bottle and tank valve (6, Fig. 9) securely. Turn small hex on nitrogen charging valves (4) clockwise to close valves internally. Rotate 'T' handles of valve chucks (2, Fig. 9) anticlockwise until they stop.

9. With cylinder valve (4, Fig. 9) open and tank valve (6, Fig. 9) closed, bleed pressure gauge (5, Fig. 9) and hoses (1, Fig. 9) through bleeder valve (10, Fig. 9). Loosen the swivel nuts and remove valve chucks (2, Fig. 9) and hoses (1, Fig. 9) from nitrogen charging valves (4).

Note: On new or rebuilt cylinders, the seals and wipers may grip the piston rods tighter and make it difficult to obtain the correct height shown in Fig. 8. If this happens, the cylinders should be charged as accurately as possible, the vehicle operated for several days, and then the cylinder checked.

10. Check nitrogen charging valves (4) for leakage with soapy water. If either core is leaking, depress it quickly once or twice to reseat the core. If leakage persists, replace core. Tighten charging valve lock nut and replace valve cap. Tighten valve cap so that it cannot be removed by hand.

11. If the cylinders bottom out when they are charged to the correct height and the truck is not being overloaded, the oil level may be incorrect. The ride cylinders should be discharged, refilled with oil, and recharged as described above.

MAINTENANCE

Check ride cylinder heights daily. Lubricate the ride cylinders at service intervals and with lubricant specified in Section 300-0020, LUBRICATION SYSTEM.

SPECIAL TOOLS

Numbers in parentheses refer to Fig. 9.

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the charging assembly shown in Fig. 9, additional parts required for simultaneous charging of both ride cylinders, general service tools and adhesives required. These parts, tools and adhesives are available from your dealer.

To simultaneously charge the ride cylinders, the charging assembly can be modified as follows:

a. Disconnect hose (1) assembly from cylinder valve (4) and install a tee piece in cylinder valve (4).

b. Connect hose (1) assembly to one branch of the tee piece and secure.

c. To make the second hose assembly, connect both additional hoses together with a coupling. Install a valve extension in a chuck valve and install the chuck valve assembly on the hose assembly.

d. Connect the second hose assembly to the remaining branch of the tee piece and secure.

SPECIAL TORQUE SPECIFICATIONS				
			TORQUE	
FIG. NO.	ITEM NO.	ITEM NAME	Nm	lbf ft
2	3	Bolt	900 - 980	660 - 730
1 & 4	8	Bolt	105	78
1 & 4	25	Locknut	105	78
1 & 4	31	Bolt	280	205
-	-	Tie Rod Nut	1 150 - 1 290	850 - 950
-	-	Steering Cylinder Nut	1 560 - 1 630	1 150 - 1 200

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Suspension System - Front Ride Cylinder

Section 180-0030

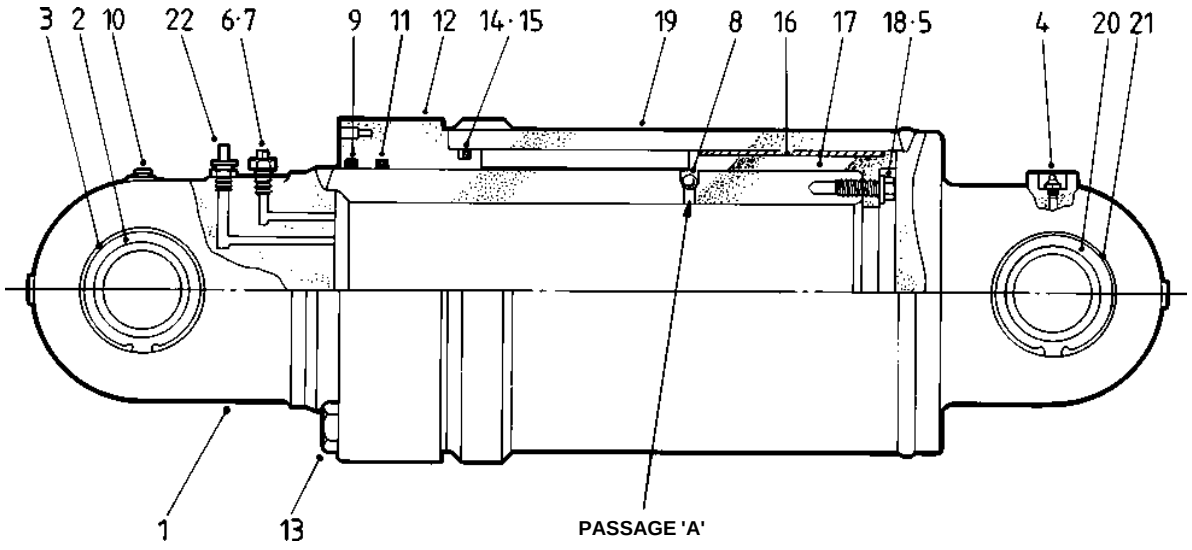
⚠ WARNING
This vehicle is equipped with precharged nitrogen gas cylinders of more than 2.8 bar (40 lbf/in²). Special permits may be required when transporting the vehicle or cylinders by any method while cylinders are charged. For shipment, contact the appropriate agency in the country involved. Consult your dealer for further permit information.

* * * *

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SM - 1369



1 - Piston Rod
2 - Spherical Bushing
3 - Snap Ring
4 - Lube Fitting
5 - Washer
6 - Check Valve
7 - Plug
8 - Ball
9 - Wiper
10 - Lube Fitting
11 - Seal
12 - Seal Retainer
13 - Bolt
14 - Backup Ring
15 - 'O' Ring
16 - Wear Ring
17 - Piston
18 - Bolt
19 - Tube
20 - Spherical Bearing
21 - Snap Ring
22 - Charging Valve Assembly

Fig. 1 - Cutaway View of Typical Rear Ride Cylinder

DESCRIPTION AND OPERATION

Numbers and letters in parentheses refer to Fig. 1.

The rear ride cylinders are used to absorb road shocks. The cylinder contains piston rod (1), tube (19) and piston (17). Oil and compressed nitrogen fill the inside of the cylinder.

When the wheel hits a bump on the ground, piston rod (1) is forced inward in the cylinder. The pressurized nitrogen compresses against the oil inside the cylinder. As the nitrogen pressure builds up in the cylinder, piston rod (1) slows down until it stops. Nitrogen pressure causes piston rod (1) to extend back to its original position. As piston rod (1) is compressing, ball (8) is forced off its seat, allowing the increased pressure to fill the cavity between tube (19) and piston rod (1) faster. As piston rod (1) returns to the normal ride position, the pressure in the cavity forces ball (8) against its seat. Pressure in the cavity is forced to return through passage 'A' thereby slowing the return of piston rod (1) to the normal ride position.

REMOVAL

Numbers in parentheses refer to Fig. 2.

⚠ WARNINGS

Pressurized cylinders. Release pressure as described under 'Relieving Cylinder Pressure' before removing valves or fittings. Accidental release of pressure will result in personal injury and property damage.

⚠ To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

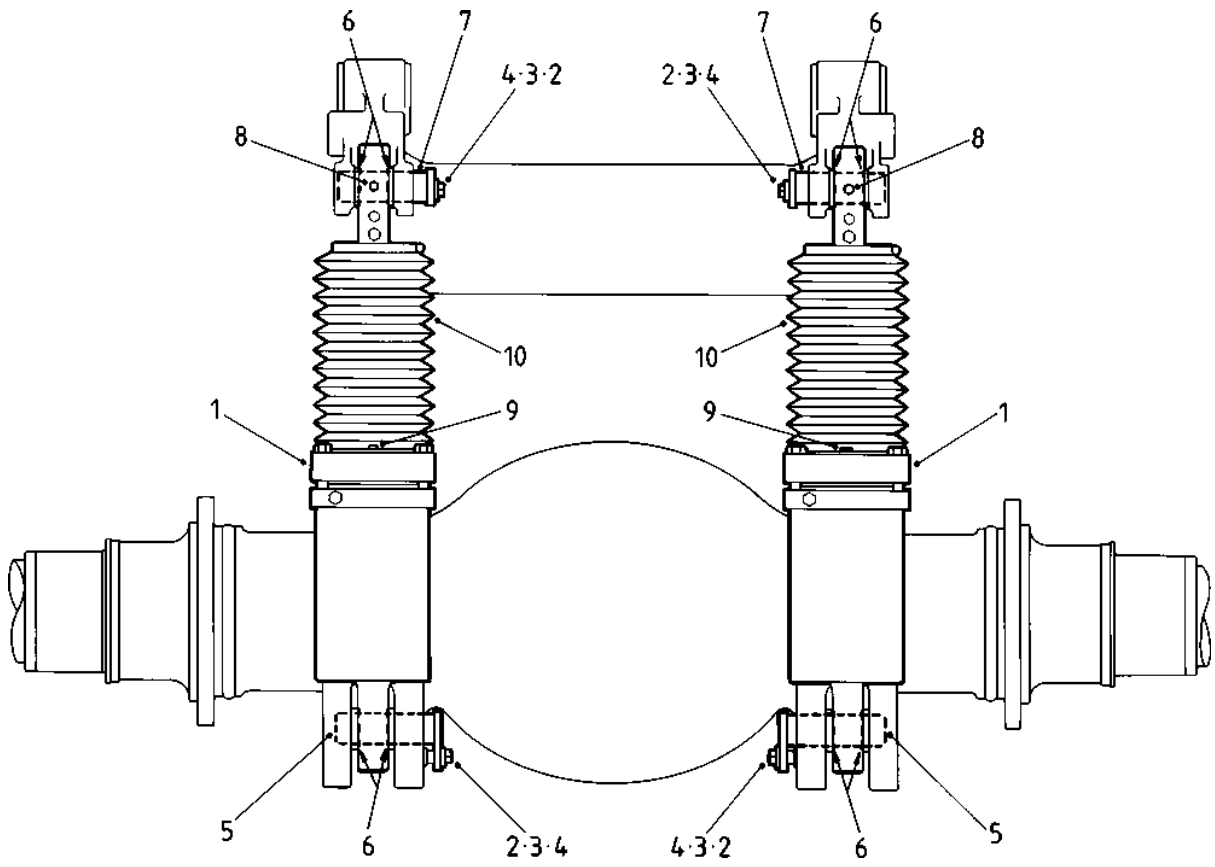
2. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Block all road wheels.

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Suspension System - Rear Ride Cylinder

Section 180-0050



1 - Ride Cylinder
2 - Bolt
3 - Lockwasher
4 - Washer
5 - Pin Assembly
6 - Spacer
7 - Pin Assembly
8 - Lube Fitting
9 - Bolt
10 - Boot Assembly

Fig. 2 - Typical Rear Ride Cylinder Mounting

3. Place a 35 mm (1.38 in) spacer between the frame and oscillation stop on both sides.

4. Relieve nitrogen pressure from BOTH rear ride cylinders. Refer to 'Relieving Cylinder Pressure', in this section.

5. Attach a suitable lifting device or 'come-along' to ride cylinder (1). If a 'come-along' is used, place a bar or heavy pipe through both body prop pin holes in the frame. Attach the 'come-along' to the bar or pipe. Place a suitable strap or chain around ride cylinder (1) and take up the slack.

Note: Lower end of ride cylinder (1) must be disconnected before upper end.

6. Remove bolt (2), lockwasher (3) and washer (4) securing pin assembly (5) through lower end of ride cylinder (1) and rear axle housing brackets. Drive pin assembly (5) out of ride cylinder (1) and bracket eyes. Remove spacers (6).

7. Remove bolt (2), lockwasher (3) and washer (4) securing pin assembly (7) through upper end of ride cylinder (1) and frame mounting. Drive pin assembly (7) out of frame and upper ride cylinder (1) eyes and remove spacers (6).

8. Lower ride cylinder (1) assembly and move to a clean work area for disassembly.

9. If required, repeat Steps 5 through 8 to remove second ride cylinder (1).

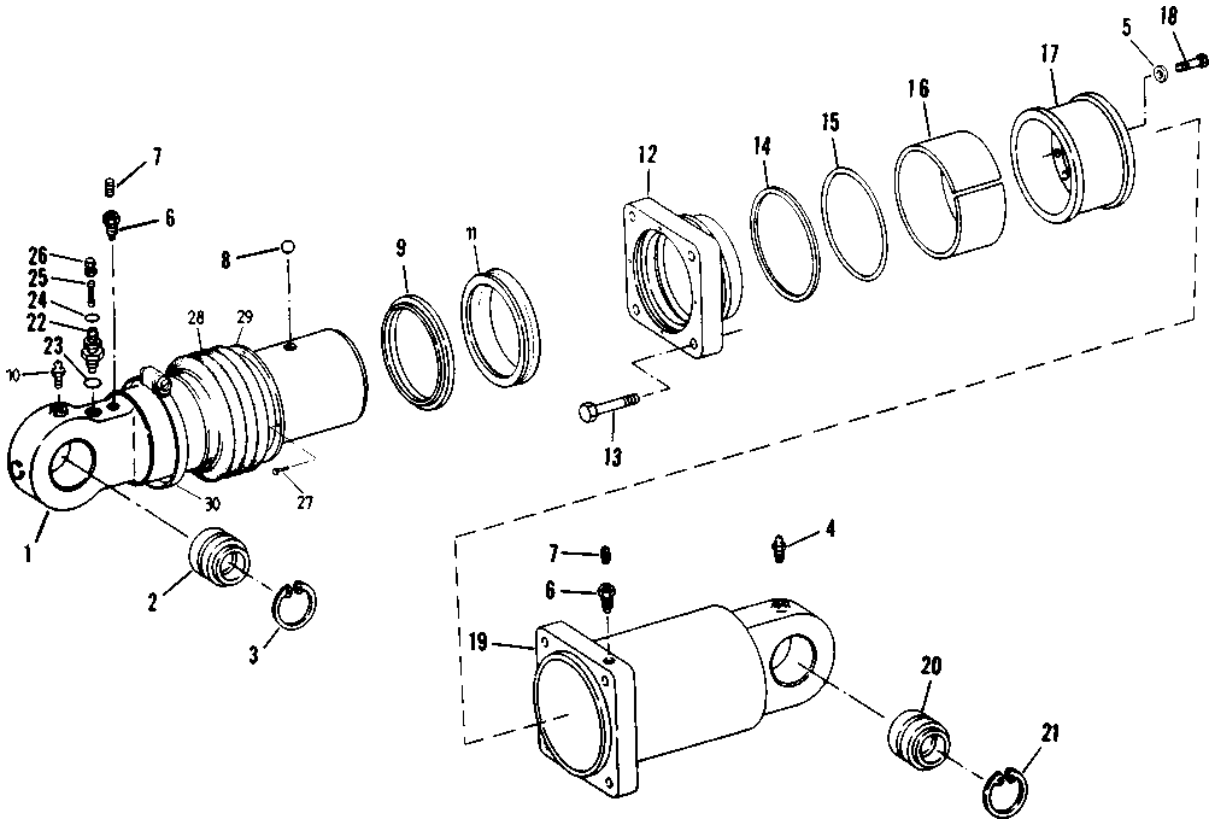
DISASSEMBLY

Numbers in parentheses refer to Fig. 3.

1. Remove clamp (30), bolts (27) and plate (29)

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1 - Piston Rod	9 - Wiper	17 - Piston	24 - Small Ring
2 - Spherical Bushing	10 - Lube Fitting	18 - Bolt	25 - Valve Core
3 - Snap Ring	11 - Seal	19 - Tube	26 - Cap
4 - Lube Fitting	12 - Seal Retainer	20 - Spherical Bearing	27 - Bolt
5 - Washer	13 - Bolt	21 - Snap Ring	28 - Boot
6 - Check Valve	14 - Backup Ring	22 - Charging Valve Assembly	29 - Plate
7 - Plug	15 - 'O' Ring	23 - Large Ring	30 - Clamp
8 - Ball	16 - Wear Ring		

Fig. 3 - Exploded View of Typical Ride Cylinder

securing boot (28) to piston rod (1) and seal retainer (12). Remove boot (28).

2. Remove check valve (6) and plug (7) assembly from tube (19) and loosen bolts (13). Drain oil from ride cylinder assembly into a suitable container.

3. Place ride cylinder assembly into a suitable position for disassembly and remove bolts (13) securing seal retainer (12) to tube (19).

4. Carefully remove tube (19) from piston rod (1) assembly.

5. Remove bolts (18) and washers (5) from piston (17) end of piston rod (1) assembly.

⚠ WARNING
Flying metal chips. Use a soft drift and drive to remove piston (17). Flying chips from a hard metal drift can cause serious personal injury.

6. Use a soft drift to tap piston (17) assembly off end of piston rod (1) assembly. This action frees ball (8) for removal from its seat in piston rod (1). Remove wear ring (16) from piston (17).

7. Place piston rod (1) assembly securely into position in a press bed with piston rod eye down. Press piston rod (1) out of seal retainer (12).

8. Remove and discard 'O' ring (15) and backup ring (14) from seal retainer (12) outer groove.

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9. Remove and discard seal (11) and wiper (9) from seal retainer (12) inner grooves.

10. Remove check valve (6) and plug (7) assembly from piston rod (1). If required, remove plug (7) from check valve (6).

11. Remove charging valve assembly (22) from piston rod (1). Do not disassemble charging valve assembly (22) unless required.

12. Remove lube fitting (10) from piston rod (1) and lube fitting (4) from tube (19).

13. Spherical bushings (2 & 20) can be removed by removing retainer snap rings (3 & 21) and pressing spherical bushings out of piston rod (1) and tube (19) eyes.

INSPECTION

Numbers in parentheses refer to Fig. 3.

1. Wash all parts thoroughly in a suitable solvent. Dry all parts with compressed air. Check all inner and outer grooves in seal retainer (12) for cleanliness.

2. Inspect tube (19), piston rod (1) and piston (17) for scores, scuffing or small ridges in the walls. Use a fine stone to smooth out any defective areas. If damage is too extensive, replace with a new part.

3. Check all cylinder assembly components for signs of unusual distortion or excessive wear. Replace defective components.

4. Inspect all plugs (7), check valves (6), charging valve assembly (22) and lube fittings (4 & 10). Check their seating positions in piston rod (1) and tube (19). If threads in any of these parts are damaged, restore the threads. If threads are not repairable, the defective part must be replaced.

5. Inspect both cylinder eye surfaces for scratches or signs of excessive wear. Check spherical bushings (2 & 20) and snap rings (3 & 21) for wear or warped condition. Replace defective parts.

6. Inspect wear ring (16) for excessive wear or damage. Replace if damaged.

ASSEMBLY

Numbers in parentheses refer to Fig. 3.

Note: Apply a light coating of clean hydraulic oil to all components to facilitate assembly procedure. Make certain that all work is carried out in a clean area so no dirt or other contaminants can get into the oil.

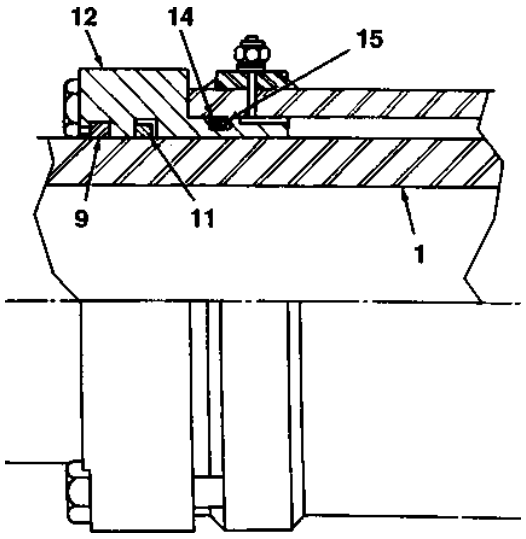
1. If removed, install snap ring (21) into tube (19) eye. Use a hand press to position spherical bushing (20) against snap ring (21) in eye of tube (19). Retain spherical bushing with remaining snap ring (21). Use similar procedure to install spherical bushing (2) and snap rings (3) in piston rod (1) eye end.

2. Install new seal (11) and wiper (9) into inner groove of seal retainer (12). See Fig. 4.

3. Install new backup ring (14) and 'O' ring (15) into outer groove of seal retainer (12). See Fig. 4.

4. Install seal retainer (12) on piston rod (1). Be careful not to damage wiper (9).

5. Place ball (8) into its seat in piston rod (1). Install wear ring (16) on piston (17) and press piston assembly into position on end of piston rod (1). Secure piston (17) assembly to piston rod (1) with bolts (18) and washers (5). Tighten bolts (18) evenly to a torque of 95 - 117 Nm (70 - 86 lbf ft).



1 - Piston Rod
9 - Wiper
11 - Seal
12 - Seal Retainer
14 - Backup Ring
15 - 'O' Ring

Fig. 4 - Cutaway View of Seal Retainer Assembly

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Note: Because of close tolerances, care will have to be taken when assembling piston rod (1) and piston (17) assembly into tube (19).

6. Install tube (19) over piston rod (1) assembly, pushing tube (19) in until piston (17) bottoms inside the tube.

7. Install bolts (13) in seal retainer (12) and tube (19). Tighten bolts (13) evenly to a torque of 576 - 644 Nm (425 - 475 lbf ft).

8. Install lube fittings (4 & 10), check valves (6), plugs (7) and charging valve assembly (22) in ride cylinder assembly as shown in Fig. 3.

9. Install boot (28) over piston rod (1) and secure to piston rod (1) and seal retainer (12) with clamp (30), plate (29) and bolts (27).

INSTALLATION

Numbers in parentheses refer to Fig. 2.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

WARNING
To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Attach a suitable lifting device or a 'come-along' to ride cylinder (1). If a 'come-along' is used, follow instructions in Step 5 under 'Removal' in this section.

Note: Lower end of ride cylinder (1) must be attached first.

2. Apply an anti-seize lubricant to pin assembly (5).

3. Install spacers (6) in place as pin assembly (5) is driven through banjo housing bracket and lower ride cylinder (1) mounting eyes. Secure pin assembly (5) in position to housing bracket with washer (4), lockwasher (3) and bolt (2).

4. Install upper end of ride cylinder (1) to frame by installing spacers (6) in place as pin assembly (7) is being driven through frame and upper ride cylinder (1) eyes. Secure pin assembly (7) to frame with washer (4), lockwasher (3) and bolt (2).

5. Remove lifting device or 'come-along' from ride cylinder (1).

6. If the opposite ride cylinder (1) was removed, follow Steps 1 through 5 to install the cylinder.

7. Charge ride cylinders as described in 'Charging Instructions', in this section.

CHARGING RIDE CYLINDER

WARNING
Lifting heavy parts or machines. To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

Relieving Cylinder Pressure

WARNING
Pressurized cylinders. Release pressure as described below before removing valves or fittings. Accidental release of pressure will result in personal injury and property damage.

Note: Vehicle must be empty and on a flat level surface prior to relieving ride cylinder pressure.

1. Support the frame near the ride cylinders with blocking and/or a hydraulic jack with adequate capacity.

2. Place a 35 mm (1.38 in) spacer on each oscillation stop to facilitate charging procedure, as shown in Fig. 5.

3. Remove cap from nitrogen charging valve (2) at top of ride cylinder. Turn hex nut on charging valve 1/4 to 1/2 turn anticlockwise and depress the valve core. If no gas escapes, continue to turn hex nut in 1/4 turn increments until nitrogen releases as the charging valve core is depressed.

4. Repeat step 3 for second ride cylinder.

5. Remove blocking or release pressure on the hydraulic jack and allow the vehicles weight to retract ride cylinder rods.

Note: Ride cylinders will not be fully retracted due to the spacers between the oscillation stops and frame rail.

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Suspension System - Rear Ride Cylinder

Section 180-0050

SM - 160

1 - Lube Fitting
2 - Nitrogen Charging Valve
3 - Plug
4 - Check Valve
5 - Check Valve

DIMENSION 'A' RIDE POSITION TRUCK EMPTY	
mm	in
505	19.88

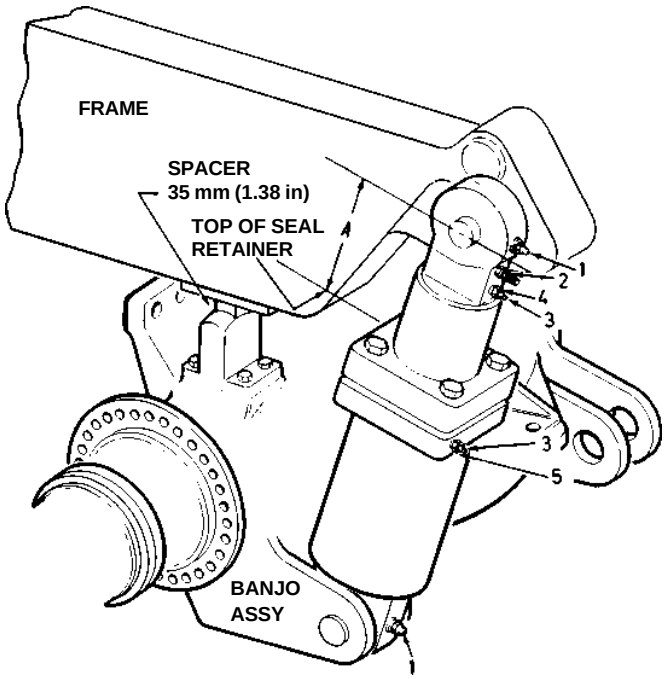


Fig. 5 - Typical Ride Cylinder Installation

⚠ WARNING
Pressurized cylinders. Keep valve core depressed until all gas is bled from cylinder. Failure to release all pressure may result in personal injury or property damage.

6. Depress nitrogen charging valve (2) core again to ensure all pressure has been relieved.

Charging Instructions

Numbers in parentheses refer to Fig. 6, unless otherwise specified.

Note: To ensure that both ride cylinders will be equally charged to the required height specifications and equal pressures, both cylinders should be charged simultaneously as shown in Fig. 6.

Note: The pressure of a confined gas varies directly with its temperature. Hence, extreme changes in ride cylinder ambient temperature will change its nitrogen charge volume and, consequently, its operating height. It might be necessary, therefore, to add or remove nitrogen to maintain proper cylinder height as ambient temperature changes.

⚠ WARNINGS
Pressurized cylinders. Release pressure as described under 'Relieving Cylinder Pressure', before removing valves or fittings. Accidental release of pressure will result in personal injury and property damage.

⚠ A high pressure nitrogen pressure regulator must be used with the charging assembly. Failure to use a pressure regulator could cause property damage, personal injury, or death.

1. Remove pipe plug (3) from check valve (5). Loosen check valve (4) slowly until groove in check valve thread is exposed. This opens a bleed path from the inside of the cylinder to the atmosphere. Attach hose from a pressure pump filled with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM, to check valve (5).

Note: Approximately 14 bar (200 lbf/in^2) pressure is required to open the check valve allowing oil to flow through the fitting into the cylinder.

Note: To readjust oil level, the truck must remain stationary for at least 10 hours to avoid, and release,

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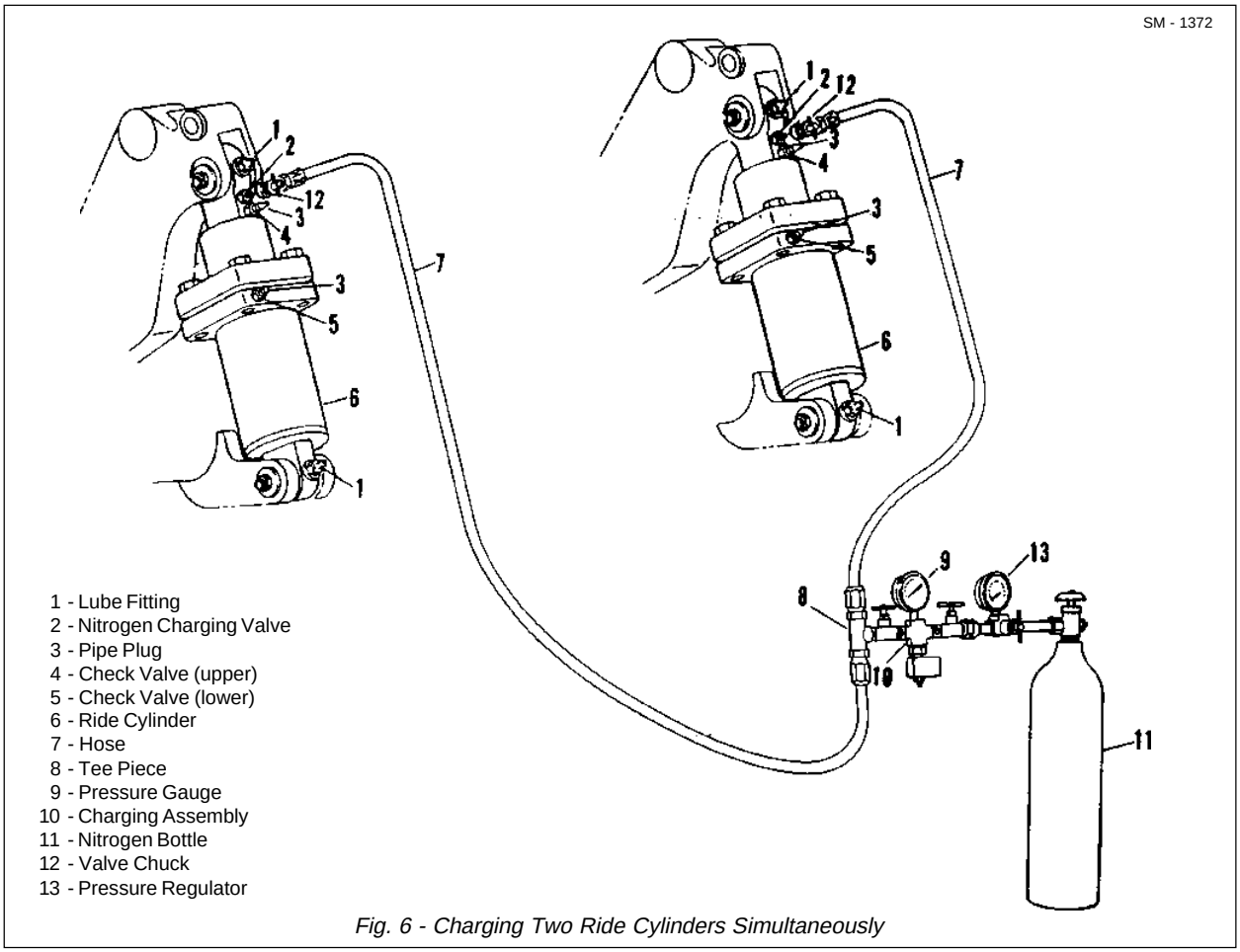


Fig. 6 - Charging Two Ride Cylinders Simultaneously

foaming of the oil. If the truck cannot be left idle for 10 hours, oil should be completely drained by removing top pin assembly (7, Fig. 2) and, using suitable lifting equipment, lower the cylinder until oil can be drained out of check valve (4 & 5) ports and nitrogen charging valve (2) port. Reinstall ride cylinder and secure with top pin assembly (7, Fig. 2).

2. With cylinder rod in its retracted position (except for the spacers on oscillation stops as shown in Fig. 5), fill the cylinder until oil flows free of air bubbles from check valve (4) port. It may be necessary to wait 30 or more minutes after nitrogen pressure has been released to clear the foam which has formed inside the cylinder. Screw in check valve (4) and close bleed valve with pipe plug (3). Remove nitrogen charging valve (2) from cylinder rod. Continue filling the cylinder with oil through check valve (5) port until it flows free of air bubbles, from nitrogen charging valve (2) port.

3. Remove oil fill equipment, reinstall plug (3) in check valve (5) and reinstall nitrogen charging valve (2) in its port.

⚠ WARNING

Use dry nitrogen to charge cylinder. Do not use a gas such as oxygen which, if used by mistake for pressurizing, will explode violently when coming into contact with oil or grease, possibly causing personal injury and property damage.

To charge both cylinders simultaneously with nitrogen, a tee piece (8), hose (1, Fig. 7), valve chuck (2, Fig. 7) and valve extension (3, Fig. 7) can be added to the charging assembly (See Fig. 7). Assembly of this kit is described under 'Special Tools'.

4. Attach the charging assembly kit to nitrogen bottle (11) by turning down on gland nut (8, Fig. 7).

5. Install valve chucks (12) to nitrogen charging valves (2) as follows:

a. Rotate 'T' handle of valve chucks (12) anticlockwise until they stop.

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b. Screw the swivel nuts down on nitrogen charging valves (2) until they seat.

c. Turn small hex on nitrogen charging valves (2) two to three turns anticlockwise to unseat the valves internally.

d. Rotate 'T' handles clockwise until they seat, opening check valves (valve cores) in nitrogen charging valves (2).

6. To check the amount of pressure in nitrogen bottle (11), close cylinder valve (4, Fig. 7) and open tank valve (6, Fig. 7). Open the valve on the nitrogen bottle slowly and note the reading on pressure gauge (9). The available pressure in nitrogen bottle (11) must be over 14 bar (200 lbf/in^2).

7. Close tank valve (6, Fig. 7) and open cylinder valve (4, Fig. 7). Charge both cylinders to height 'A', shown in Fig. 5, by opening tank valve (6, Fig. 7) slowly and closing it occasionally. To check pressures in the cylinders, close tank valve (6, Fig. 7) and note the reading on pressure gauge (9).

Note: If both cylinders do not extend evenly, check front ride struts. Both front struts should be extended equally (both can be fully collapsed). Also check that machine is on a flat, level surface and empty.

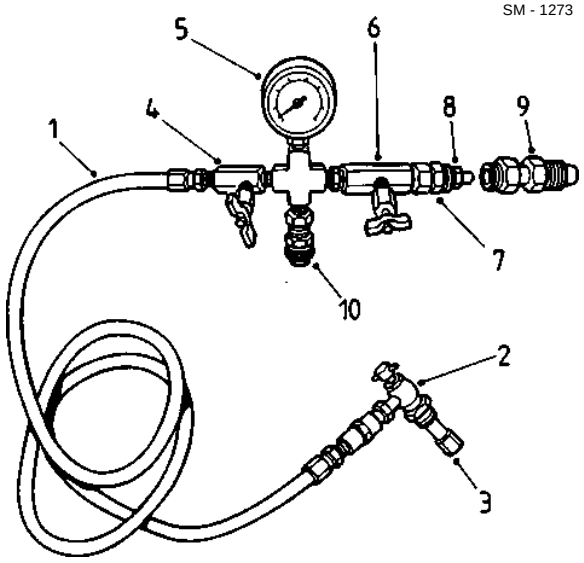
Note: The cylinders should be charged to the height shown in Fig. 5 and MUST NOT be overcharged above the recommended height. Overcharging can cause the cylinders to over extend, thus damaging the piston retaining bolts.

Note: Cylinder charging pressures shown in the chart below are intended to be for REFERENCE only. Cylinders should be charged according to the height specified in Fig. 5 and NOT solely on the basis of monitoring cylinder pressure.

Note: As the frame rises during charging operations, follow the frame up with suitable blocking and/or a hydraulic jack.

8. When height 'A' (Fig. 5) has been reached, close the valve on nitrogen bottle (11) and tank valve (6, Fig. 7) securely. Turn small hex on nitrogen charging valves (2) clockwise to close valves internally. Rotate 'T' handles of valve chucks (12) anticlockwise until they stop.

CYLINDER CHARGING PRESSURE		
	bar	lbf/in^2
Standard Body	8.3	120
Rock Body	9	130



1 - Line
2 - Valve Chuck
3 - Valve Extension
4 - Cylinder Valve
5 - Pressure Gauge
6 - Tank Valve
7 - Gland Fitting
8 - Gland Nut
9 - Cylinder Adaptor
10 - Bleeder Valve

Fig. 7 - Charging Assembly

9. With cylinder valve (4, Fig. 7) open and tank valve (6, Fig. 7) closed, bleed pressure gauge (9) and hoses (7) through bleeder valve (10, Fig. 7). Loosen the swivel nuts and remove valve chucks (12) and hoses (7) from nitrogen charging valves (2).

Note: On new or rebuilt cylinders, the seals and wipers may grip the piston rods tighter and make it difficult to obtain the correct height shown in Fig. 5. If this happens, the cylinders should be charged as accurately as possible, the vehicle operated for several days, and then the cylinder re-checked.

10. Check nitrogen charging valves (2) for leakage with soapy water. If either core is leaking, depress it quickly once or twice to reseat the core. If leakage persists, replace core. Tighten charging valve lock nut and replace valve cap. Tighten valve cap so that it cannot be removed by hand.

11. Remove spacers from oscillation stops.

12. After charging cylinders to the correct ride height the vehicle, with rated load, should have a 35 mm (1.38 in) gap or more, between the oscillation stops

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with the truck on a level surface. If there is less than 30 mm (1.25 in) between stops, check for machine overload. If the machine is not being overloaded, the ride cylinders should be discharged, filled with oil, and recharged with nitrogen as described above.

MAINTENANCE

Check ride cylinder heights daily. Lubricate the ride cylinders at service intervals and with lubricant specified in Section 300-0020, LUBRICATION SYSTEM.

SPECIAL TOOLS

Numbers in parentheses refer to Fig. 7.

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the charging assembly shown in Fig. 7, additional parts required for simultaneous charging of both ride cylinders and general service tools required. These parts and tools are available from your dealer.

To simultaneously charge the ride cylinders, the charging assembly can be modified as follows:

a. Disconnect hose (1) assembly from cylinder valve (4) and install a tee piece in cylinder valve (4).

b. Connect hose (1) assembly to one branch of the tee piece and secure.

c. To make the second hose assembly, install a valve extension in a chuck valve and install the chuck valve assembly on the hose assembly.

d. Connect the second hose assembly to the remaining branch of the tee piece and secure.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
3	13	Bolt	576 - 644	425 - 475
3	18	Bolt	95 - 117	70 - 86

⚠ WARNING
This vehicle is equipped with precharged nitrogen gas cylinders of more than 2.8 bar (40 lbf/in²). Special permits may be required when transporting the vehicle or cylinders by any method while cylinders are charged. For shipment, contact the appropriate agency in the country involved. Consult your dealer for further permit information.

* * * *

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COMPONENT DESIGNATIONS

A4 - Radio/Cassette Player
A5 - Speaker

B2 - Coolant Level Sender
B8 - Fuel Level Sender
B21 - Trans Oil Temp Sender
B22 - Engine Oil Press Sender
B23 - Trans Oil Press Sender

E3 - Interior Light
E5 - Reverse Light
E7 - Instrument Panel Lights
E11 - Side Marker Light, L
E12 - Tail Light, L
E13 - Side Marker Light, R
E14 - Tail Light, R
E26 - High Beam Haedlamp, L
E27 - High Beam Headlamp, R
E28 - Dipped Beam Headlamp, L
E29 - Dipped Beam Headlamp, R

F - Fuse (with number)

G1 - Generator
G2 - Battery

H6 - Direction Indicator F,L
H7 - Direction Indicator B,L
H8 - Direction Indicator F,R
H9 - Direction Indicator B,R
H10 - Brake Light, L
H11 - Brake Light, R
H13 - Retarder Light
H27 - Check Trans W/L

K1 - Starter Relay
K2 - Battery Disconnect Relay
K4 - Dir Inds Flasher Unit
K5 - Air Cond Comp Clutch
K15 - Headlamp Relay
K17 - Reverse Relay
K23 - Engine Run Relay
K32 - Retarder Select Solenoid
K41 - Brake Valve Timer (TR100)
K42 - Pre-lube Timer (TR100)

L3 - Reverse Alarm
L4 - Buzzer
L5 - Forward Horn

M1 - Starter Motor
M3 - Heater Blower Motor
M4 - Washer Motor
M5 - Wiper Motor
M13 - Air Seat Compressor

N2 - Voltage Regulator
N3 - Voltage Converter 12V

P1 - Speedometer
P2 - Tachometer
P3 - Coolant Temp Gauge
P4 - Fuel Level Gauge
P5 - Engine Oil Press Gauge
P8 - Trans Oil Temp Gauge
P14 - Trans Oil Press Gauge

R7 - Cigar Lighter
R9 - Panel Lights

S2 - Starter Keyswitch
S4 - Test Switch
S5 - Engine Oil Pressure Switch
S6 - Trans Oil Pressure Switch
S7 - Emergency Brake Switch*
S8 - Blower Switch
S10 - Wiper Switch
S13 - Horn Button
S14 - Hazard Lights Switch
S16 - Brake Pressure Switch
S18 - Lights Switch
S19 - Dipswitch
S22 - Body-up W/L Switch*
S24 - Low Fuel level Switch
S31 - Park Brake W/L Switch
S34 - Trans Oil Temp Switch
S36 - Trans Oil Filter Press Sw
S38 - Steering Filter Press Sw
S46 - Coolant Temp Switch
S47 - Coolant Level Switch
S48 - Accumulator Press Sw, F
S49 - Accumulator Press Sw, R
S50 - Brake Oil Temp Switch
S51 - Reverse Hoist Press Switch
S52 - Manual Mode Keyswitch
S53 - Power/Economy Keyswitch
S54 - Steering Tank Oil Level Sw
S56 - Air Cleaner Ret'n Switch
S57 - Low Steering Press Sw
S59 - Retarder Select Switch
S62 - Retarder On Switch

X1 - Handlamp Socket

Y1 - Fuel Solenoid
Y4 - Brake Oil Diverter Valve
Y16 - Lockup Drop-out Valve
Y21 - 50% Front Brake Valve
Y22 - Park Brake Valve (TR100)
Y25 - Quick-dump Brake Valve (TR100)

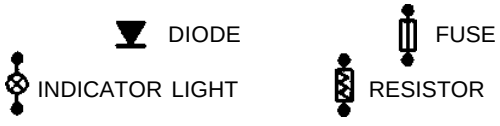
TERMINAL DESIGNATIONS IN ACCORDANCE WITH DIN 72 552

* NOTE: S22 SHOWN IN BODY-UP POSITION
S7 SHOWN IN PARK BRAKE APPLIED POSITION

L - LEFT R - RIGHT F - FRONT B - BACK

Wire Colours:

B - Black	O - Orange
N - Brown	Y - Yellow
U - Blue	P - Purple
R - Red	W - White
G - Green	S - Slate
L - Lt Green	K - Pink



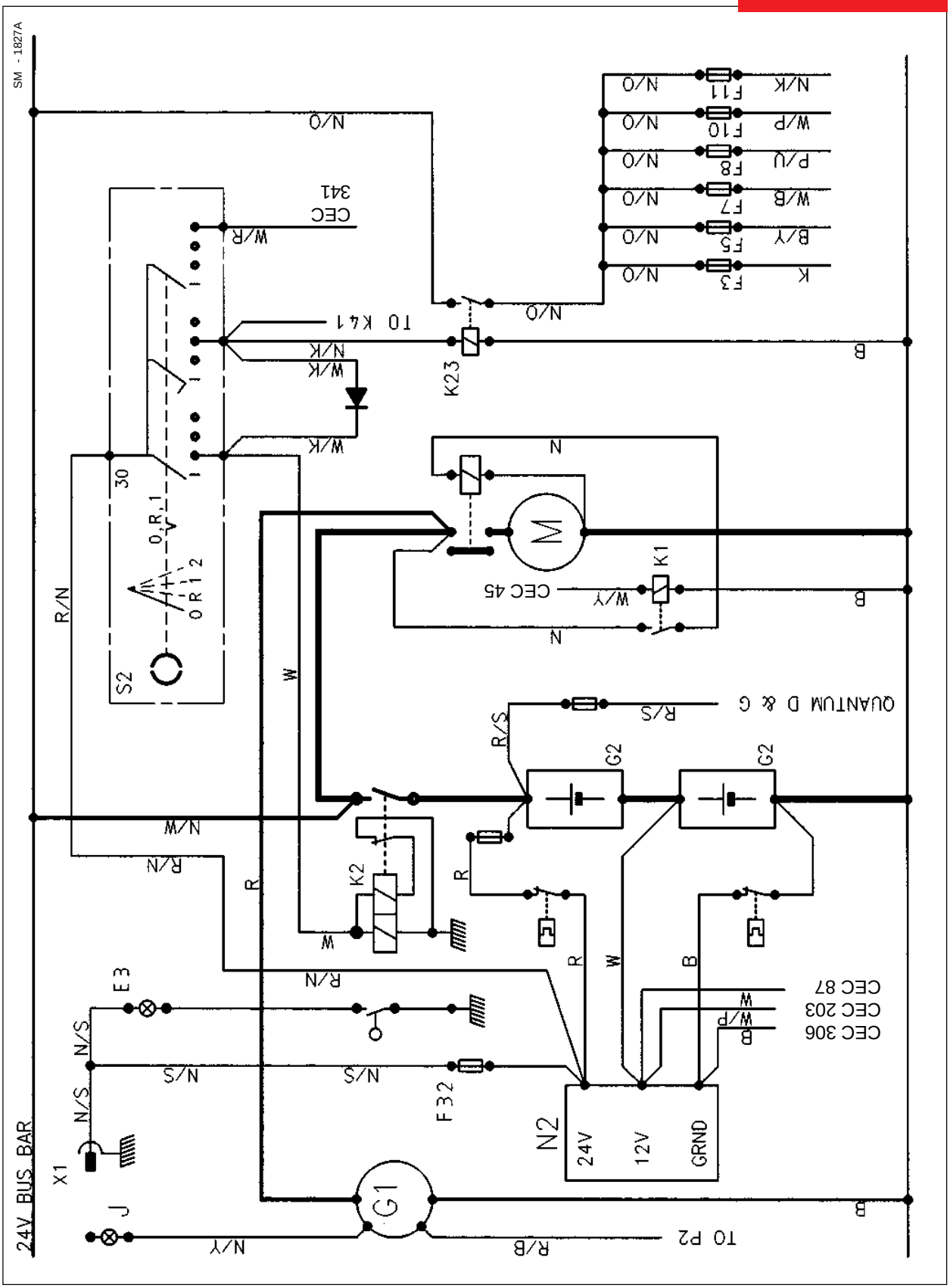
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Electrical System - Circuit Diagrams

Section 190-0000

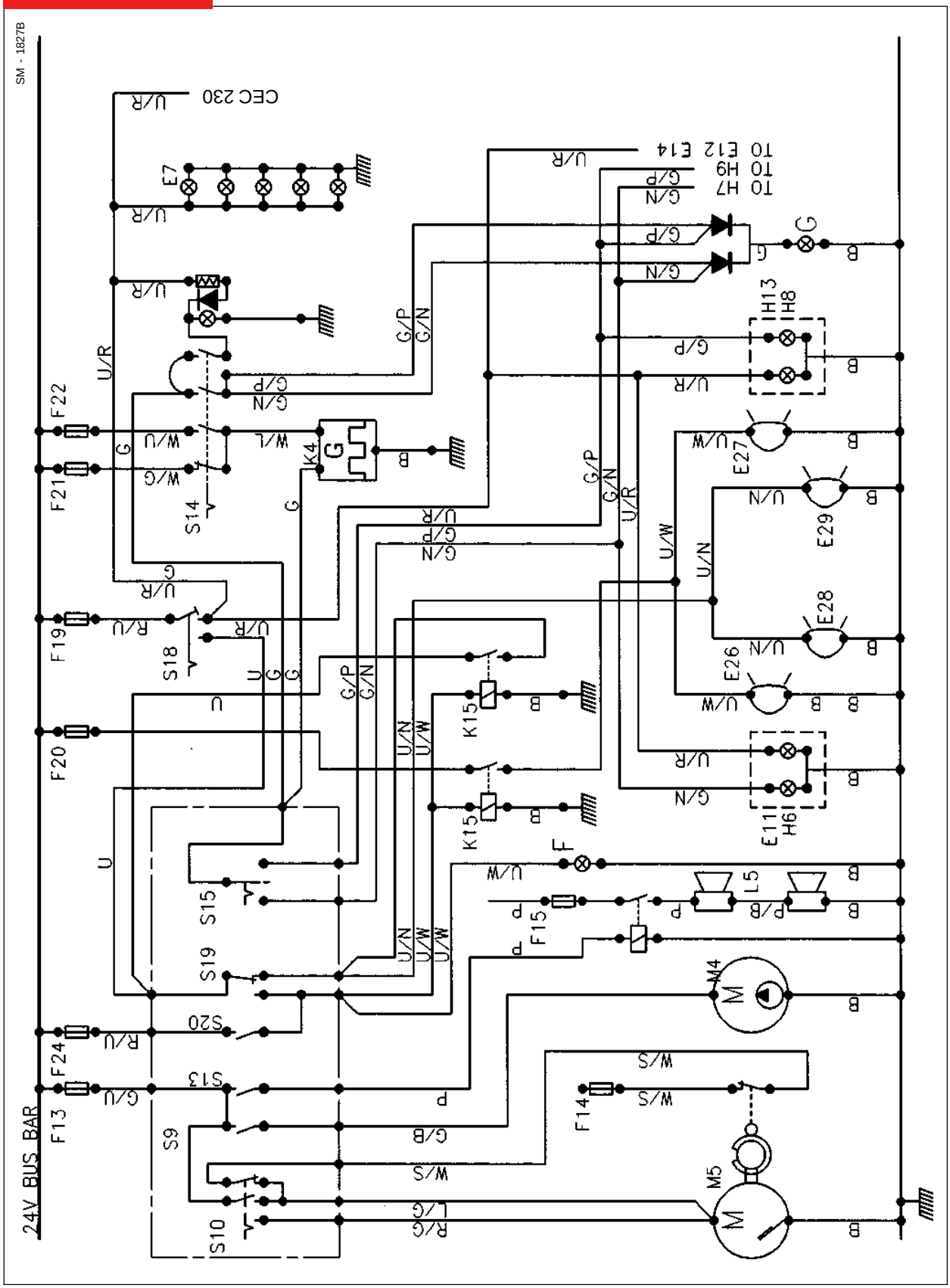
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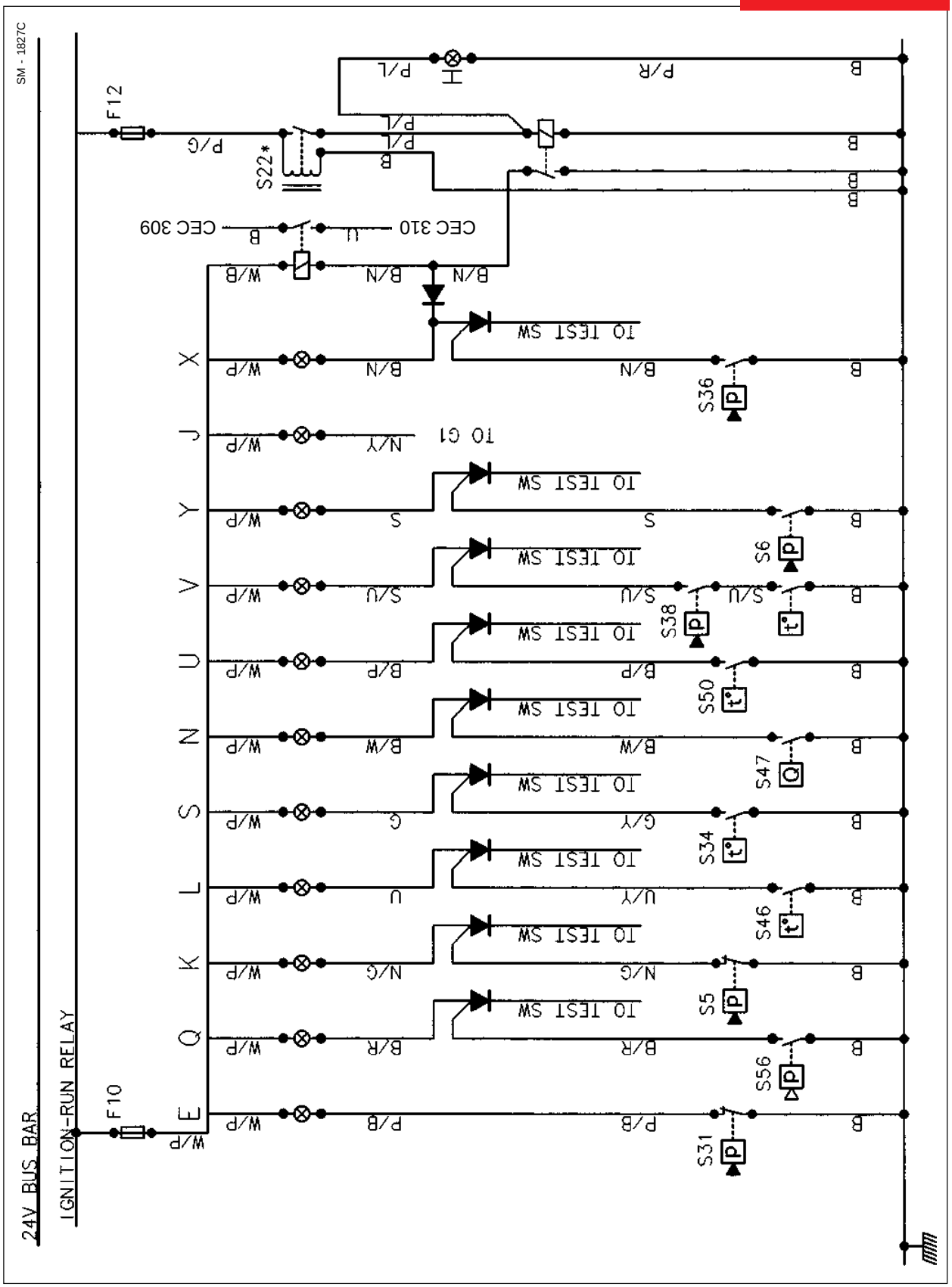
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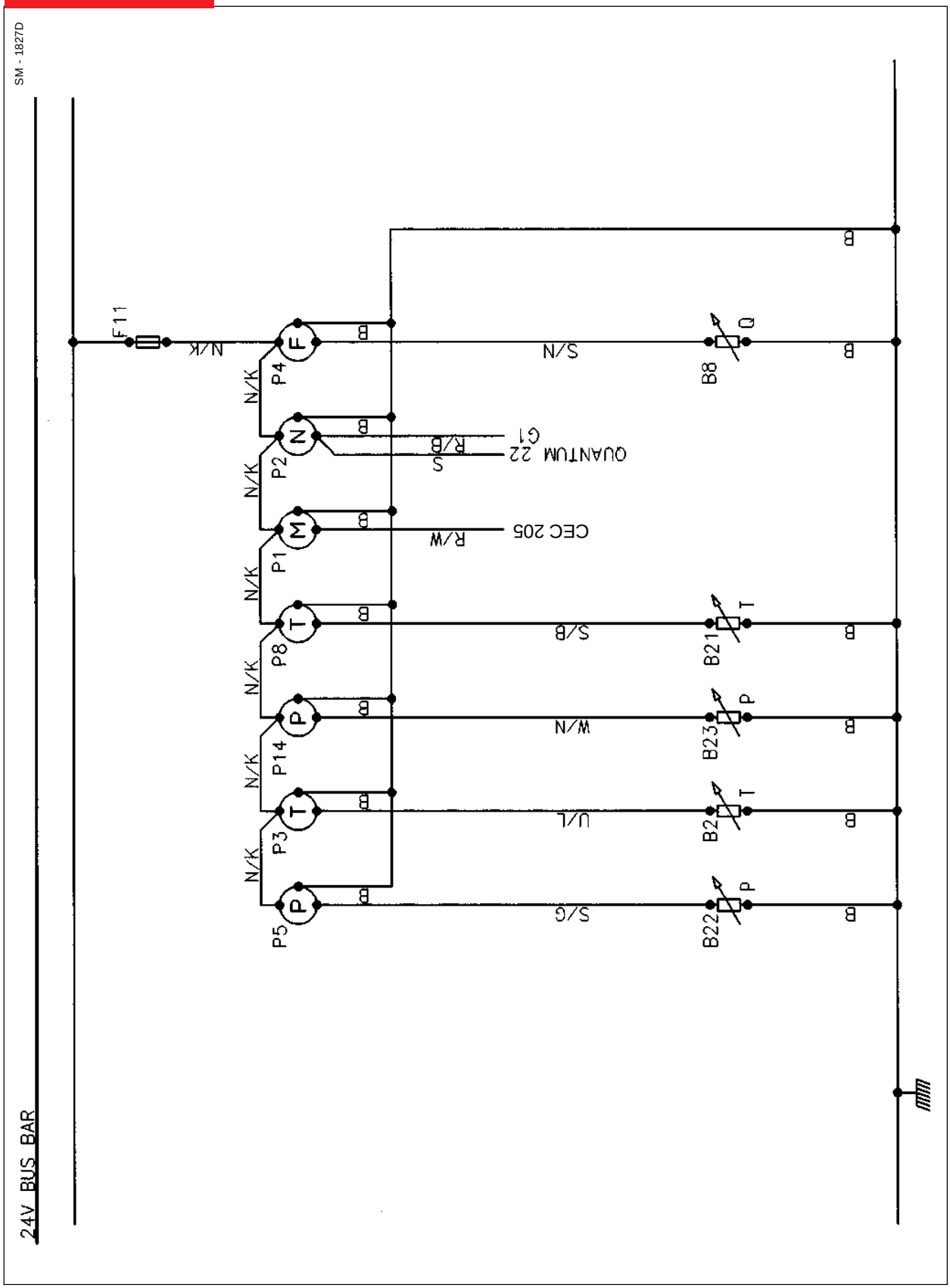
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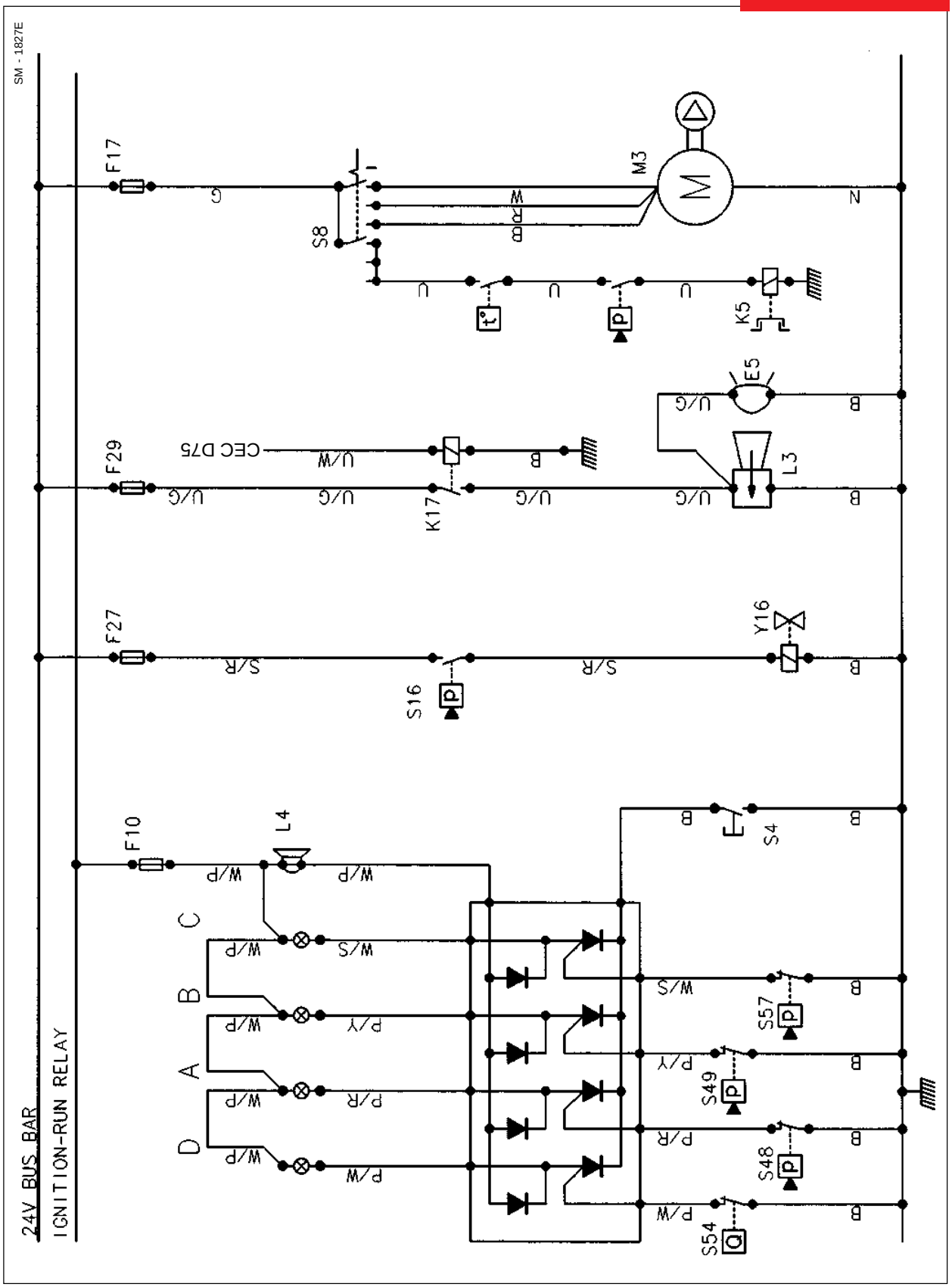
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Electrical System - Circuit Diagrams

Section 190-0000

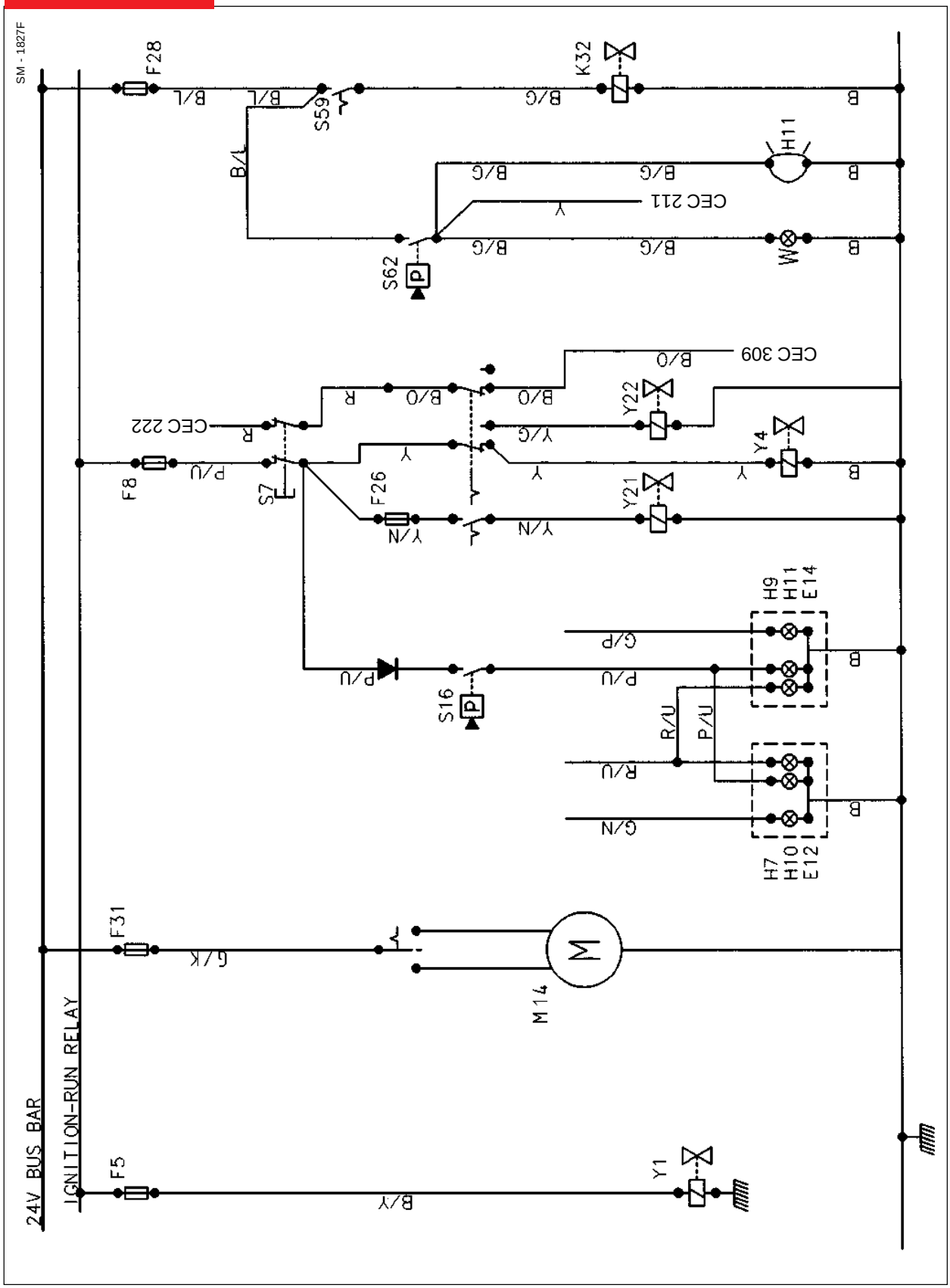
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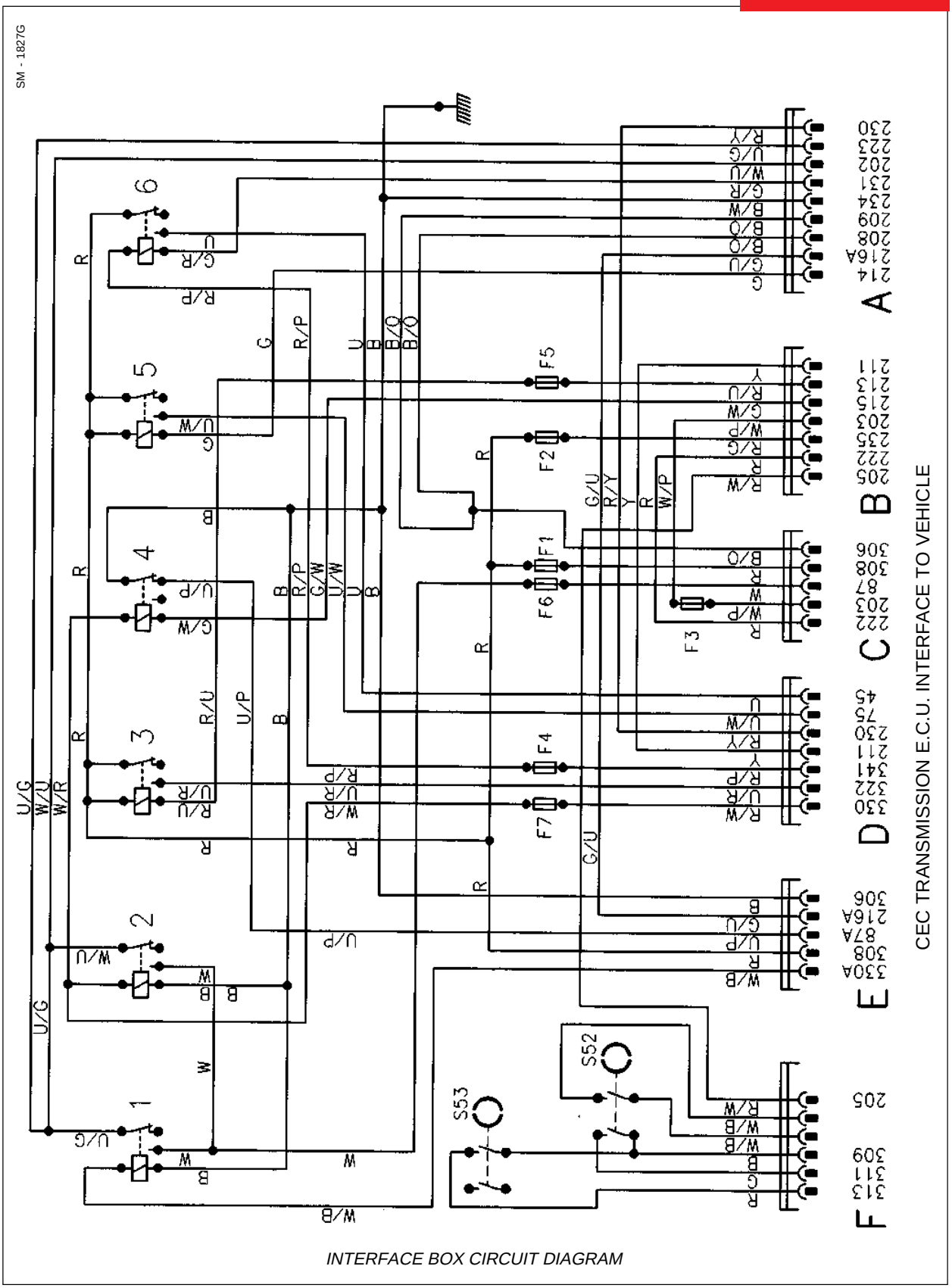
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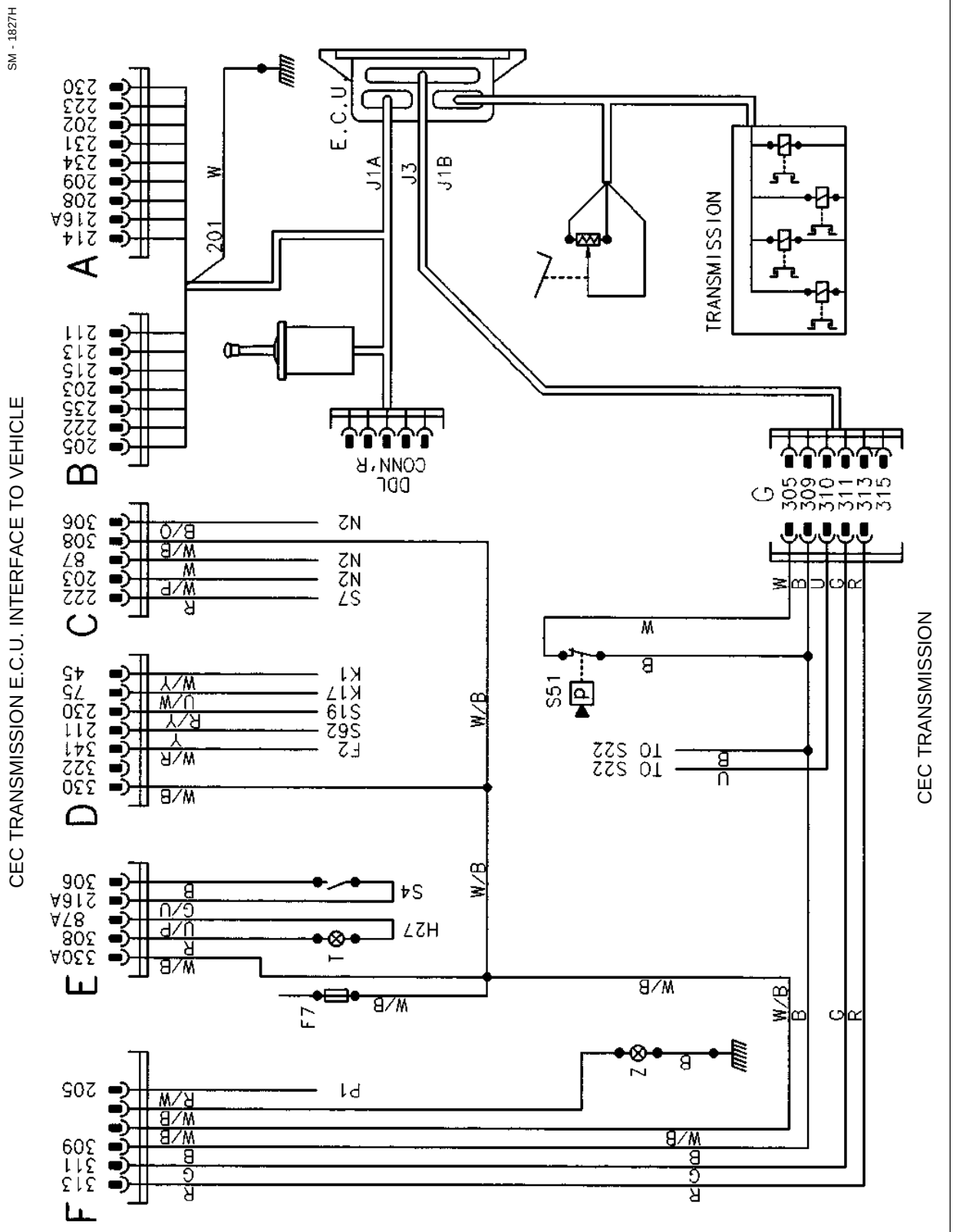


INTERFACE BOX CIRCUIT DIAGRAM

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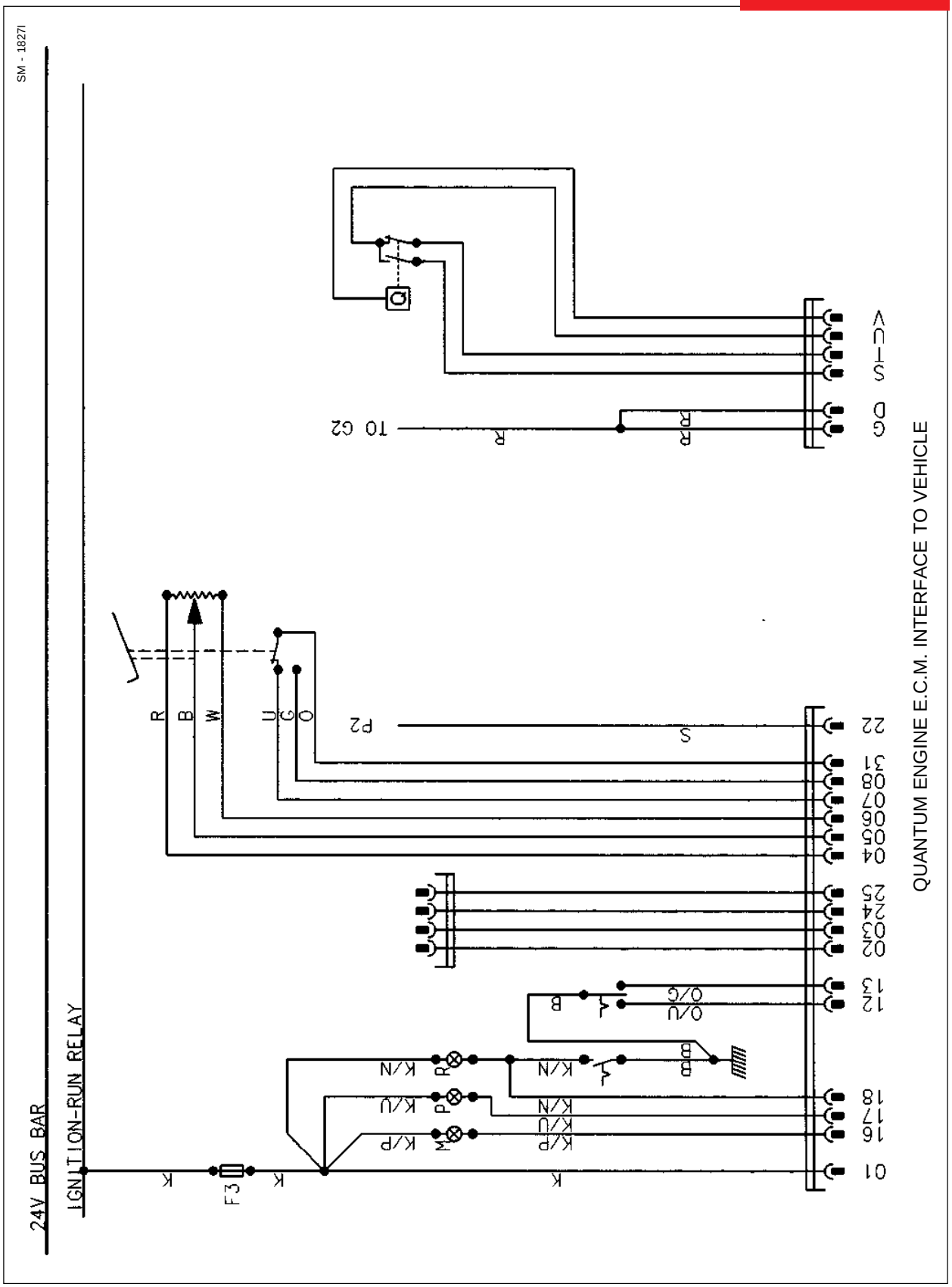


CEC TRANSMISSION CIRCUIT DIAGRAM

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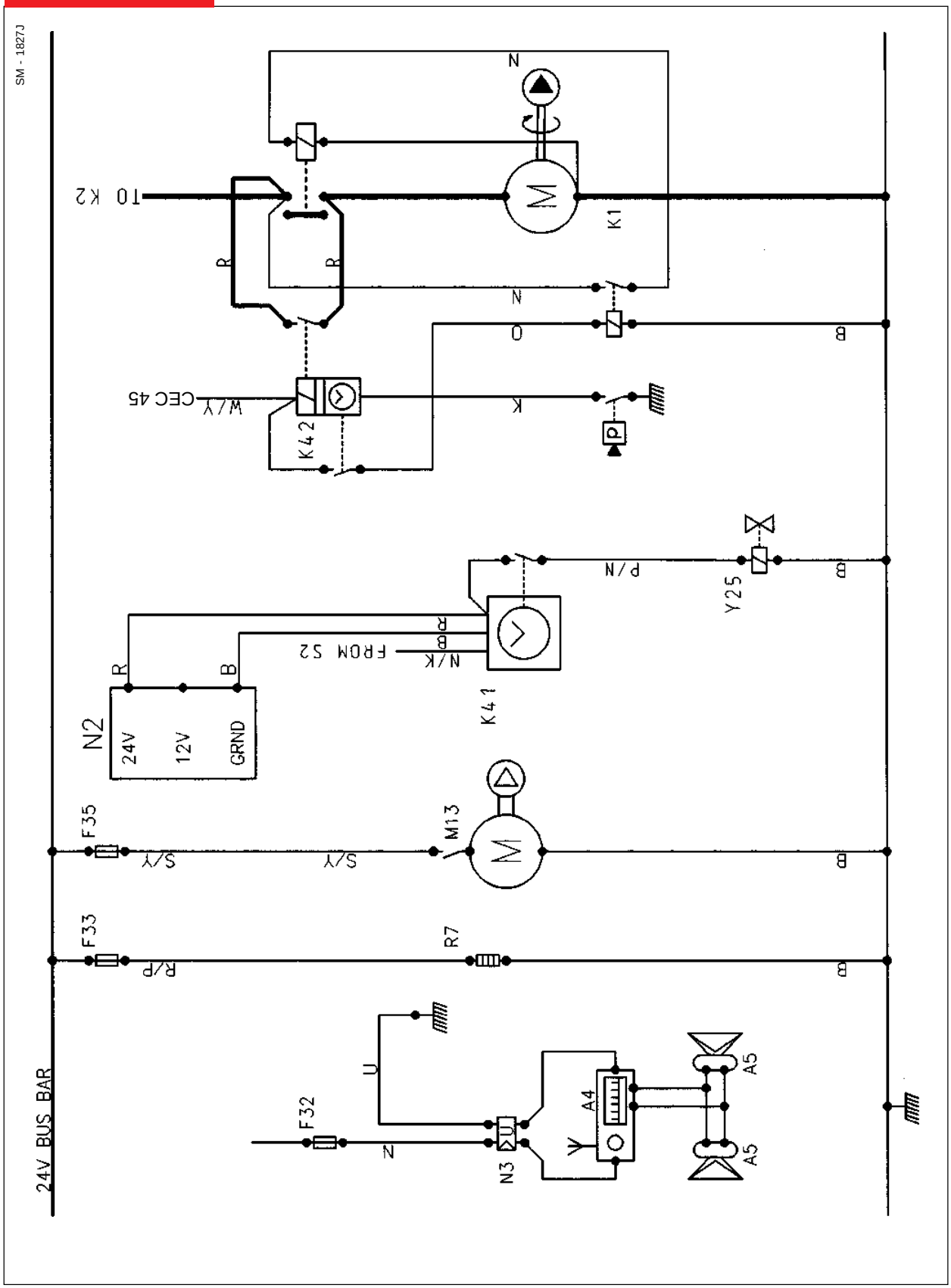
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Fuses, Relays and Warning Lights

Fuses, relays and warning lights which were not described under 'Component Designations' on the previous page, are identified in the following tables.

FUSES - Located in Fuse Box

Column	Fuse No.	Circuit	Current Rating
A	1	Spare	-
	2	Spare	-
	3	Engine ECM	5A
	4	Spare	-
	5	Fuel Solenoid	5A
	6	Spare	-
	7	CEC	10A
	8	Park Brake/Brake Lights	5A
	9	Spare	-
	10	Warning Lights	5A
	11	Instruments	5A
	12	Body-up W/L	5A
B	13	Wiper/Washer/Horn	10A
	14	Wiper Self Park	10A
	15	Horn	10A
	16	Spare	-
	17	Heater & Air Cond.	25A
	18	Spare	-
	19	Lights & Dipped Beam	10A
	20	Main Beam	10A
	21	Direction Indicators	5A
	22	Hazards	5A
	23	Spare	-
	24	Headlamp Flash	10A
C	25	Spare	-
	26	Front Brakes Press Red'n	5A
	27	Lockup Drop-out Solenoid	5A
	28	Retarder Controls	5A
	29	Reverse Alarm	5A
	30	Spare	-
	31	Electric Window	10A
	32	Worklamp/Cab Light/Radio	5A
	33	Cigarette Lighter	10A
	34	Heated Mirrors	15A
	35	Air Suspension Seat	15A
	36	Spare	-

Relays - Located in Fuse Box

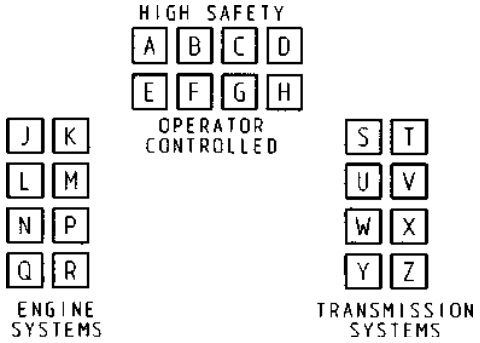
Engine Run	Reverse	Flasher
X	Body up	Trans Filter
Horn	X	X
Dipped Beam	Main Beam	X

CEC Fuses and Relays - Located in Interface Box

Fuses - Current Ratings	Relay Functions
1 - 8A	1 - ECU Initial Start
2 - 5A	2 - ECU Supply
3 - 8A	3 - Retarder (Not Used)
4 - 5A	4 - Transmission Check
5 - 5A	5 - Reverse Warning
6 - 8A	6 - Neutral Start
7 - 5A	

WARNING LIGHTS - Located in Dash Panel

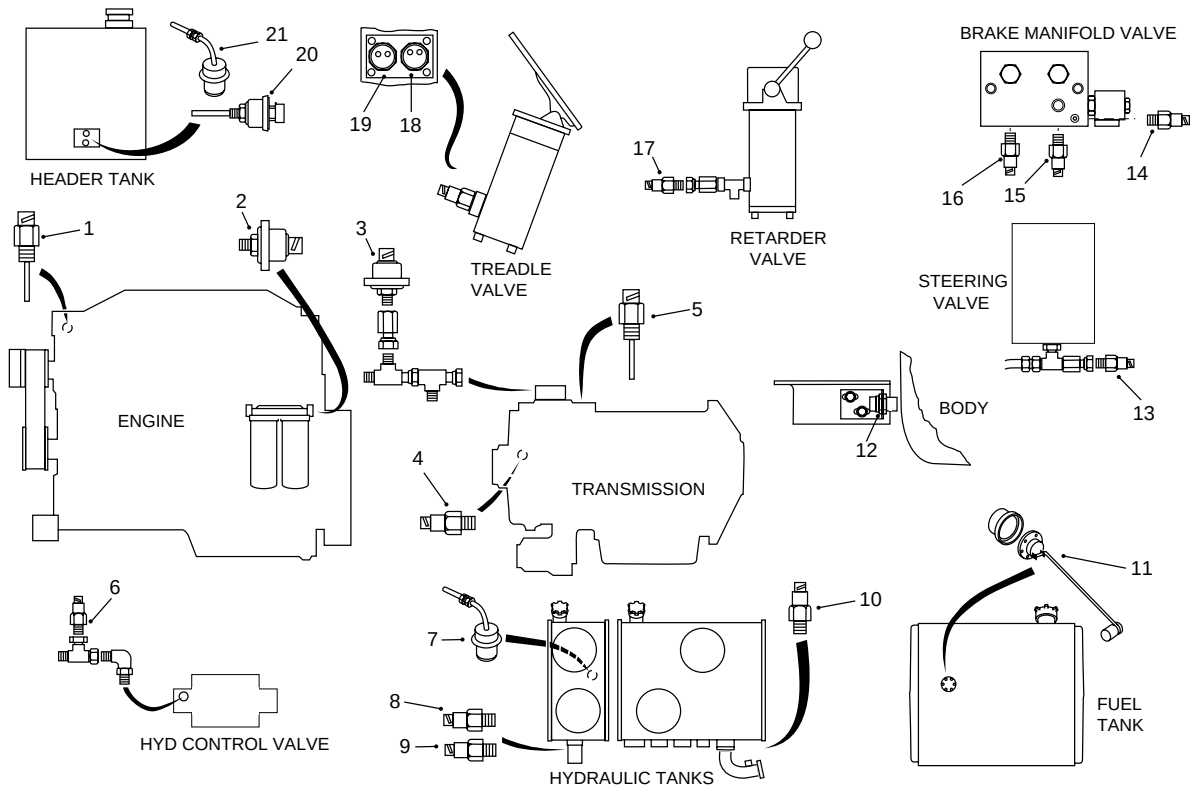
A	Front Brake Accumulator Pressure
B	Rear Brake Accumulator Pressure
C	Low Steering Accumulator Pressure
D	Low Steering and Brake Tank Oil Level
E	Parking Brake
F	Main Beam
G	Direction Indicators
H	Body-up
J	Alternator Charging
K	Engine Oil Pressure
L	Engine Coolant Temperature
M	Engine Diagnostic Light (Stop)
N	Engine Coolant Level
P	Engine Diagnostic Light (Warning)
Q	Air Cleaner Restriction
R	Engine Diagnostic Light (Fluid)
S	Transmission Oil Temperature
T	Check Transmission
U	Disc Brake Hydraulic Oil Temperature
V	Steering Filter Restriction
W	Retarder On
X	Transmission Oil Filter Restriction
Y	Converter Drive
Z	Manual Mode



* * * *

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1 - Engine Water Temperature Sender/Sw.
2 - Engine Oil Pressure Sender/Switch
3 - Transmission Oil Pressure Sender/Sw.
4 - Converter Drive Pressure Switch
5 - Transmission Oil Temp. Sender/Sw.
6 - Hoist Interlock Pressure Switch
7 - Hydraulic Oil Level Probe
8 - Steering Oil Temperature Switch
9 - Steering Filter Restriction Pressure Sw.
10 - Disc Brake Hydraulic Temp Switch
11 - Fuel Level Sender
12 - Body Up Proximity Switch
13 - Steering Pressure Switch
14 - Parking Brake Pressure Switch
15 - Rear Brake Accumulator Press Sw.
16 - Front Brake Accumulator Press Sw.
17 - Retarder Pressure Switch
18 - Stop Light Pressure Switch
19 - Lockup Drop Out Pressure Switch
20 - Engine Water Level Probe
21 - Engine Water Level Probe

Fig. 1 - Layout View of Switches and Sensors

DESCRIPTION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

This section describes the location and function of the various switches and sensors fitted to the vehicle to monitor all major components and systems. Gauges and indicator/warning lights mounted on the dash panel relay this information to the operator.

Note: Always make sure all gauges, indicator/warning lights and controls are working properly before operating the vehicle.

Engine

The Quantum electronic engine management system monitors the engine at all times and sends a signal to the engine stop light (6, Fig. 3), engine warning light (7, Fig. 3) and engine protection light (8, Fig. 3) to alert the operator of a fault in the engine circuit. Refer to Section 110-0030, ENGINE AND MOUNTING.

Engine Oil Pressure Sender/Switch (2) - Combined sender and switch unit, located in the lube oil filter housing at the rear left hand side of the engine.

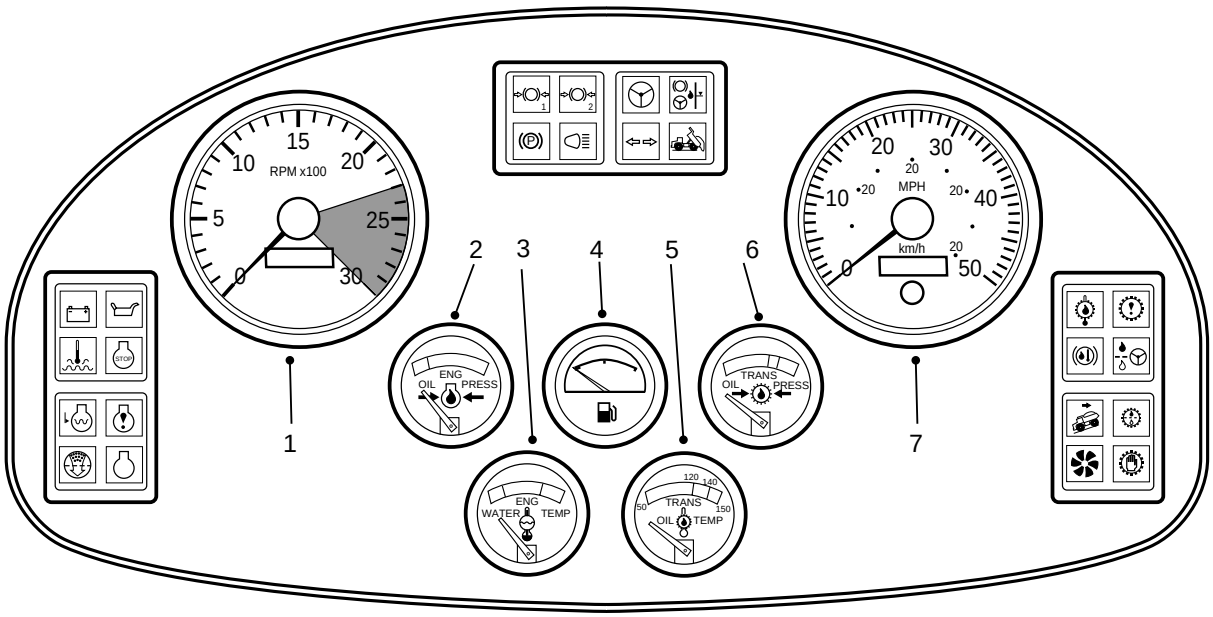
The pressure switch sends a signal to illuminate engine oil pressure warning light (5, Fig. 3) to indicate when the engine oil pressure drops below the safe operating pressure.

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Electrical System - Switches and Sensors

Section 190-0270



1 - Tachometer/Hourmeter Gauge
2 - Engine Oil Pressure Gauge
3 - Engine Water Temperature Gauge
4 - Fuel Gauge
5 - Transmission Oil Temperature Gauge
6 - Transmission Oil Pressure Gauge
7 - Speedometer/Odometer Gauge

Fig. 2 - Layout View of Gauges

The pressure sender sends a signal to the Engine Oil Pressure Gauge (4, Fig.2). The gauge should read in the lower end of the green zone at normal operating speeds and may fall to the lower end of the yellow zone at engine idle. Stop the engine if the gauge does not rise above the red zone until the fault is corrected.

Engine Water Temperature Sender/Switch (1) - Combined sender and switch unit, located in the thermostat housing.

The temperature switch sends a signal to illuminate engine water temperature warning light (2, Fig. 3) when engine water temperature rises above the safe operating temperature.

The temperature sender sends a signal to the Engine Water Temperature Gauge (3, Fig. 2). The gauge should read in the green zone after the engine has warmed. If the gauge reads in the red zone, stop the engine until the fault is corrected.

Engine Water Level Probe (21) - Located in the bottom of the coolant system header tank. Sends a signal to illuminate engine water level warning light (3, Fig. 3) when engine water level falls below the safe operating level.

Tachometer/Hourmeter (1, Fig. 2) - Driven from the engine ECM, the tachometer indicates the engine speed in revolutions per minute (rev/min). Never accelerate the engine to speeds indicated by the red zone on the dial face. A digital hourmeter is incorporated in the tachometer to record total hours of engine operation.

Tachometer Calibration Table - All units with standard tyres		
Unit	Engine	Pulses/revolution
TR35	Cummins M11	16.56
TR40	Cummins N14	16.80
TR45	Cummins QSK	12.00
TR60	Cummins QSK	12.00
TR70	DD Series 2000	12.00
TR100	Cummins KTA	15.72
TR100	DD Series 2000	12.00

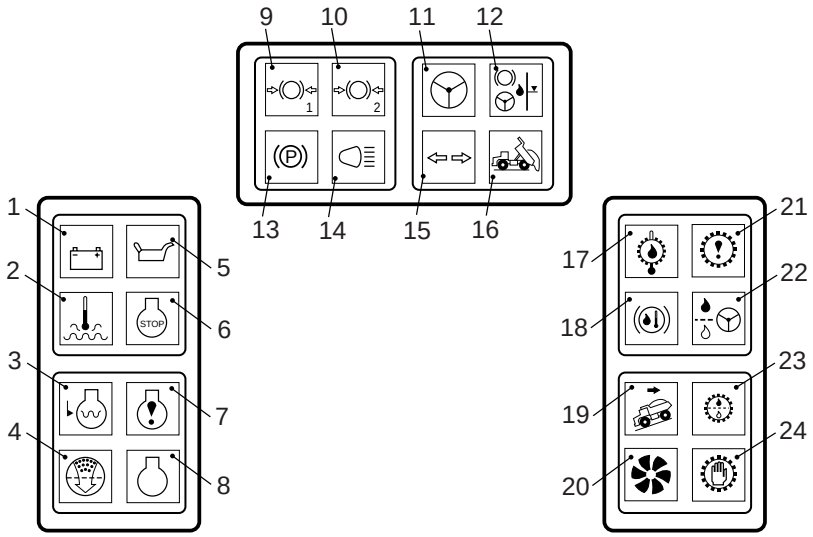
Tachometer Calibration

1. Determine the impulse setting required. Reference tachometer calibration table.

2. Turn the ignition keyswitch to position '1' and depress and hold calibration button on the tachometer. Release button when PULSE is displayed.

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1 - Alternator Charging
2 - Engine Water Temperature
3 - Engine Water Level
4 - Air Cleaner Restriction
5 - Engine Oil Pressure
6 - Engine Stop
7 - Engine Warning
8 - Engine Protection
9 - Front Brake Accumulator Pressure
10 - Rear Brake accumulator Pressure
11 - Low Steering Pressure
12 - Steering & Braking Tank Low Oil Level
13 - Parking Brake
14 - Headlight Main Beam
15 - Direction Indicator
16 - Body-up
17 - Transmission Oil Temperature
18 - Disc Brake Hydraulic Temperature
19 - Retarder Indicator
20 - In-converter Indicator
21 - Transmission Check
22 - Steering & Brake Filter Restriction
23 - Transmission Oil Filter Restriction
24 - Manual Mode Indicator

Fig. 3 - Layout View of Warning/Indicator Lights

3. After a few seconds, the digits will flash in sequence. Depress the button until the desired number is displayed the release the button for a few seconds until the next digit flashes.

4. Repeat step 3 to obtain the desired impulses/ revolution. The tachometer is now calibrated.

Transmission

Transmission Oil Pressure Sender (3) - Located at the top of the converter housing, the pressure sender sends a signal to the Transmission Oil Pressure Gauge (6, Fig.2) to indicate clutch application pressure. The reading will vary during shifts and with varying speeds and loads. The needle should remain in the green zone during normal operation but might rise into the upper red zone for short periods under heavy loading. When the load decreases, the needle should return to the green zone and may fall momentarily into the lower red zone. If the needle remains in either of the extreme zones for extended periods, stop the vehicle until the fault is corrected.

Converter Drive Pressure Switch (4) - Located on the right hand side of the transmission at the lockup valve body. Sends a signal to illuminate transmission in-converter indicator light (20, Fig. 3) to indicate when the transmission is in torque converter drive. The light goes out when transmission lockup is engaged.

Transmission Oil Filter Pressure Switch - Located in the transmission oil filter head. Sends a signal to transmission oil filter restriction indicator light (23, Fig. 3) to indicate that the filter is restricted and that the element requires to be changed. Refer to Section 120-0100, TRANSMISSION OIL FILTER.

Transmission Oil Temperature Sender/Switch (5) - Combined sender and switch unit, located at the outlet port for the transmission oil cooler.

The temperature switch sends a signal to illuminate transmission oil temperature warning light (17, Fig. 3) when the transmission oil temperature rises above the safe operating temperature.

The temperature sender sends a signal to the Transmission Oil Temperature Gauge (5, Fig. 2) to indicate converter-out oil temperature. The gauge should read in the green zone during normal operation.

Watch for wide deviations from normal readings on the gauge during vehicle operation. If the gauge, on vehicles which do not have a transmission retarder

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fitted, shows oil temperature consistently rising above the green zone (43 - 135° C; 100 - 275° F) under normal operating conditions; check for external causes. If none are evident shift to Neutral 'N' and operate the engine at 1 200 - 1 500 rev/min. If the transmission oil temperature does not decrease into the green zone within 2 or 3 minutes, the cause of overheating should be corrected before the vehicle is operated further.

Watch the gauge when operating on upgrades. If the oil temperature goes into the red zone (135 - 176° C; 275 - 350° F), select the range which will limit upshifts to the highest range in which the transmission will operate within the normal temperature range. If upshifting must be consistently limited to ranges lower than normal for the loads and the grades encountered to prevent overheating the transmission oil, the causes should be determined and corrected.

During transmission retarder operation (optional) oil temperature can enter the yellow 'Retarder On' zone but should not enter the red zone. Do not allow the temperature to stay at or near the top of the yellow zone for more than three minutes. Reduce downgrade travel speed to avoid the oil overheating and possible damage to the transmission.

Speedometer/Odometer (7, Fig. 2) - Driven by a signal from the CEC, the speedometer indicates vehicle travel speed in kilometres per hour (km/h) and miles per hour (mph). A digital odometer is incorporated in the speedometer to record the distance travelled by the vehicle at any given time. For speedometer calibration details, refer to Section 120-0070, CEC SHIFT SYSTEM.

Transmission Oil Temperature Sensor - The temperature sensor (thermistor) is mounted in the lockup control valve body cover at the front left hand side of the transmission. The transmission oil temperature is continuously monitored by the ECU. The ECU will only permit operation in a range best suited for the temperature condition and the 'Check Transmission' light will illuminate. Refer to Section 120-0070, CEC SHIFT SYSTEM.

Output Speed Sensor - The output speed sensor (magnetic pick-up) is installed in the rear cover of the transmission. The magnetic end of the sensor is positioned adjacent to the gear located on the transmission output shaft. Rotation of the output shaft causes the gear teeth to pass through the magnetic field at the end of the sensor. The passing of each gear tooth generates an electrical pulse which is directed to the ECU. The ECU recognises this signal as output speed. Refer to Section 120-0070, CEC SHIFT SYSTEM.

CEC Lockup Drop Out Pressure Switch (19) - The normally open (NO) pressure switch is located in the front plate of the treadle valve in the 'B2' circuit. As brake pressure increases to 20 bar (290 lbf/in²) and above, the circuit should close and send a signal to the lockup drop out solenoid, which in turn drops the transmission out of lockup. As pressure drops below 20 bar (290 lbf/in²) the circuit should open and lockup can be engaged. This will prevent the drive between the engine and transmission from locking up and subsequently stalling the engine.

Braking and Retardation

Front Brake Accumulator Pressure Switch (16) - The normally closed (NC) pressure switch, located in port 'PS1' of the brake manifold valve, senses the pressure in the front brake accumulator. The pressure switch sends a signal to illuminate front brake accumulator pressure warning light (9, Fig. 3) when pressure drops below 131 bar (1 900 lbf/in²). An audible alarm also sounds.

Rear Brake Accumulator Pressure Switch (15) - The normally closed (NC) pressure switch, located in port 'PS2' of the brake manifold valve, senses the pressure in the rear brake accumulator. The pressure switch sends a signal to illuminate rear brake accumulator pressure warning light (10, Fig. 3) when pressure drops below 131 bar (1 900 lbf/in²). An audible alarm also sounds.

Parking Brake Pressure Switch (14) - The normally closed (NC) pressure switch, located in port 'PS3' of the brake manifold valve, senses pressure in the parking brake line. The pressure switch sends a signal to illuminate parking brake indicator light (13, Fig. 3) when pressure drops below 65 bar (940 lbf/in²).

Stop Light Pressure Switch (18) - The normally open (NO) pressure switch is located in the front plate of the treadle valve in the 'B1' circuit. As brake pressure increases to 2.7 bar (39 lbf/in²) and above, the circuit should close and send a signal to illuminate the brake lights. As pressure drops below 2.7 bar (39 lbf/in²) the circuit should open and brake lights go out.

Retarder Pressure Switch (17) - The normally open (NO) pressure switch is located in the retarder control valve body. As retarder pressure increases to 2.7 bar (39 lbf/in²) and above, the circuit should close and

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send a signal to illuminate retarder indicator light (19, Fig. 3), and the retarder light at the rear of the vehicle. As pressure drops below 2.7 bar (39 lbf/in²) the circuit should open and the retarder lights should go out.

Steering

Steering Pressure Switch (13) - The normally closed (NC) pressure switch is located in a tee at accumulator valve mounted off the left hand side of the transmission. Sends a signal to illuminate low steering pressure warning light (11, Fig. 3) when steering pressure drops to 83 bar (1 200 lbf/in²) or lower. An audible alarm also sounds.

Steering Filter Restriction Pressure Switch (9) - The normally open (NO) oil pressure switch is located beside steering oil temperature switch (8) in the manifold block at the return port of the steering and brake control tank. The oil pressure switch will close and illuminate steering filter restriction indicator light (22, Fig. 3) when the restriction pressure exceeds 2.7 bar (39 lbf/in²), indicating a filter change is required.

Steering Oil Temperature Switch (8) - The normally open (NO) oil temperature switch closes when a temperature of 50° C (122° F) is reached. The oil temperature switch is connected in series with steering pressure switch (9), therefore, steering filter restriction indicator light (22, Fig. 3) will not illuminate until the oil reaches normal operating temperature.

Low Oil Level Switch (7) - Located in the steering and brake control tank, with electrical connection at the rear of the tank. Sends a signal to illuminate steering and braking tank low oil level warning light (12, Fig. 3) when the oil level in the tank falls below the safe operating level. An audible alarm also sounds. Refer to Section 220-0040 STEERING AND BRAKE CONTROL TANK.

Body and Disc Brake Cooling

Disc Brake Hydraulic Temperature Switch (10) - Located in the disc brake oil return tube to indicate if the disc brake cooling oil is overheating. The oil temperature switch sends a signal to illuminate disc brake hydraulic temperature warning light (16, Fig. 3) when a temperature of 121° C (250° F) is reached. If the light illuminates, reduce speed and shift transmission to the range that will maintain an engine speed as high as possible, without exceeding the maximum recommendation, to increase oil circulation and cooling. If trouble persists, stop the vehicle and have the fault corrected.

Body Up Proximity Switch (12) - Mounted off a bracket on the platform to the rear right hand side of the cab. When the body is raised off the chassis, the proximity switch opens and completes the electrical circuit to the ECU. The ECU then prevents the transmission from shifting above 1st gear until the body is fully lowered and the switch closes. Body-up warning light (16, Fig. 3) illuminates to indicate when the body is not resting on the chassis. Refer to Section 120-0070, CEC SHIFT SYSTEM.

Note: Never move the vehicle until body-up warning light (16, Fig. 3) goes out.

Hoist Interlock Pressure Switch - Located in a tee installed in body hoist control valve. The hoist interlock is a safety feature to prevent the vehicle from backing up while the body is being raised. If the pressure switch is opened by the body control joystick being moved to the raise position, current is interrupted and the ECU will shift the transmission to neutral. To obtain reverse gear whilst the body is held in the raise position, move the transmission shift lever to neutral, then re-select reverse gear. This interlock will not prohibit shifts to a forward range while the body is being raised. Refer to Section 120-0070, CEC SHIFT SYSTEM.

Fuel Tank

Fuel Level Sender (11) - Located in the rear of the fuel tank, the fuel level sender sends a signal to the fuel level gauge to indicate the amount of fuel left in the fuel tank.

Air Cleaner

Air Cleaner Restriction Gauge - Located in the air cleaner outlet pipe, the gauge sends a signal to illuminate air cleaner restriction indicator light (4, Fig. 3) to indicate that the air cleaner is restricted and that the element requires to be cleaned/changed.

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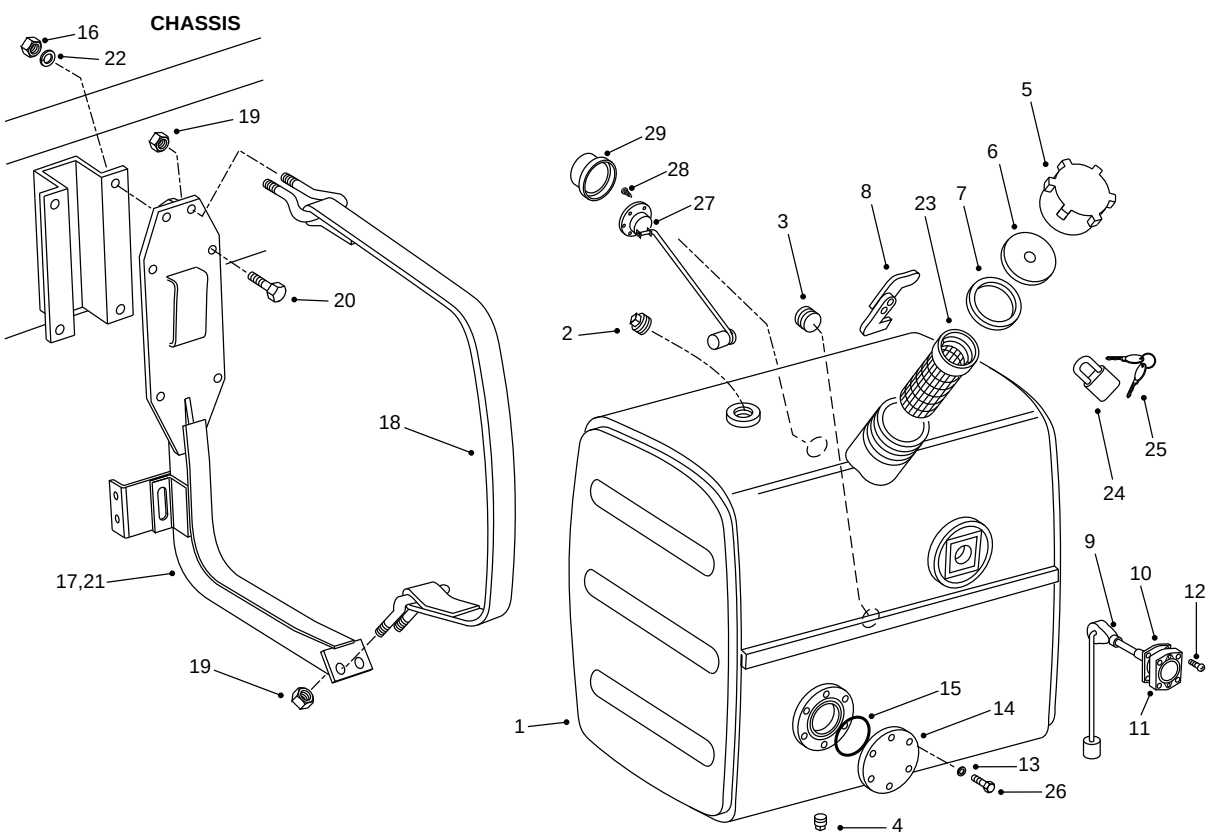
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1 - Fuel Tank
2 - Plug
3 - Plug
4 - Drain Plug
5 - Filler Cap
6 - Gasket
7 - Gasket
8 - Latch
9 - Gauge Fuel Level
10 - Gasket
11 - Dial
12 - Screw
13 - Lockwasher
14 - Cover Plate
15 - 'O' Ring
16 - Nut
17 - Mounting Bracket
18 - Heavy Duty Strap
19 - Nut
20 - Bolt
21 - Mounting Bracket
22 - Lockwasher
23 - Strainer
24 - Lock
25 - Key
26 - Bolt
27 - Fuel Level Sender
28 - Screw
29 - Cover

Fig. 1 - Exploded View of Fuel Tank and Mounting

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

Note: Refer to Section 300-0020, LUBRICATION SYSTEM, for fuel tank capacity and fuel specifications.

Fuel tank (1) is mounted off mounting brackets (17 & 21) secured to the right hand frame rail and is secured to mounting brackets (17 & 21) by heavy duty straps (18).

Integral with fuel tank (1) are fuel strainer (23) and fuel level sender (27). Fuel strainer (23) helps prevent foreign particles from entering fuel tank (1) when fuel tank (1) is being filled. Fuel level sender (27), located in the rear of fuel tank (1), sends a signal to the fuel level gauge in the dash panel to indicate the amount of fuel left in the fuel tank.

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Fuel System - Fuel Tank and Mounting

Section 200-0010

REMOVAL

Numbers in parentheses refer to Fig. 1.

> **WARNING**
> **To prevent personal injury and property damage, be sure wheel chocks and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. Position the vehicle in a level work area, raise the body and install the body safety pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine.

3. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Block all road wheels.

4. Close fuel shut off valve at the fuel filters to prevent loss of fuel prime at the engine.

5. Remove filler cap (5) from fuel tank (1). Discard gaskets (6 & 7) from filler cap (5) if damaged.

6. Remove cover (29) from fuel level sender (27) and disconnect electrical connections at fuel level sender (27).

7. With a suitable container in position, remove drain plug (4) and drain fuel from fuel tank (1). Reinstall drain plug (4) when fuel tank (1) is completely drained.

8. Identify and tag fuel lines connected to fuel tank (1) and, with a suitable container available to catch leakage, disconnect fuel lines from fuel tank (1). Cap open line ends to prevent entry of dirt.

9. Using a suitable lifting device, support fuel tank (1) and take up any slack. Remove nuts (19) securing heavy duty straps (18) to lower end of mounting brackets (17 & 21).

10. Swing heavy duty straps (18) clear of fuel tank (1) and remove fuel tank (1) from mounting brackets (17 & 21).

11. If required, remove nuts (19) securing heavy duty straps (18) to top end of mounting brackets (17 & 21) and remove heavy duty straps (18).

12. If required, remove nuts (16), lockwashers (22), bolts (20) and mounting brackets (17 & 21) from the chassis mounting brackets.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Remove fuel strainer (23) from fuel tank (1).

2. Remove screws (28) securing fuel level sender (27) to fuel tank (1) and remove fuel level sender (27). Check condition of rubber sealing ring on fuel level sender (27) and replace if required.

3. Remove screws (12) securing level gauge (9 &11) to fuel tank (1) and remove level gauge (9 & 11). Check condition of gasket (10) on level gauge (9 & 11) and replace if required.

4. Remove bolts (26), lockwashers (13), cover plate (14) and 'O' ring (15) from fuel tank (1). Discard 'O' ring (15).

CLEANING

Numbers in parentheses refer to Fig. 1.

1. Remove all dirt particles from fuel strainer (23) and clean fuel strainer (23) with clean diesel fuel.

2. Cover plate (14) port in fuel tank (1) can be used as an opening to remove dirt and sludge from the bottom of fuel tank (1) with a clean dry cloth. Remove drain plug (4) and flush fuel tank (1) with clean diesel fuel to remove any remaining dirt particles. Reinstall drain plug (4) and tighten securely.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Install new 'O' ring (15) in groove of fuel tank (1) boss and secure cover plate (14) to fuel tank (1) boss with lockwashers (13) and bolts (26).

2. Ensure rubber sealing ring is located on fuel level sender (27) and position fuel level sender (27) in fuel tank (1). Secure fuel level sender (27) to fuel tank (1) with screws (28).

3. Ensure gasket (10) is located on level gauge (9 & 11) and position level gauge (9 & 11) in fuel tank (1). Secure level gauge (9 & 11) to fuel tank (1) with screws (12).

4. Install fuel strainer (23) in fuel tank (1). If removed install new gaskets (6 & 7) in filler cap (5) and install filler cap assembly loosely to prevent entry of dirt.

5. Ensure that plugs (2 & 3) and drain plug (4) are securely tightened in fuel tank (1).

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INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

⚠ WARNING
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. If removed, install mounting brackets (17 & 21) to chassis mounting brackets and secure with bolts (20), lockwashers (22) and nuts (16).

2. If removed, install heavy duty straps (18) to top of mounting brackets (17 & 21) with overlap facils inside, as shown in Fig. 1, and secure with nuts (19). Swing heavy duty straps (18) clear of mounting area on mounting brackets (17 & 21).

3. Using suitable lifting equipment, position fuel tank (1) assembly on mounting brackets (17 & 21) and locate heavy duty straps (18) through mounting holes in lower end of mounting brackets (17 & 21). Secure heavy duty straps (18) to mounting brackets (17 & 21) with nuts (19).

4. Remove blanking caps from fuel lines and connect fuel lines to fuel tank (1) as identified at removal. Tighten fuel lines securely.

5. Connect electrical connections to fuel level sender (27) and install cover (29) over fuel level sender (27).

6. Remove filler cap (5) assembly from filler neck on fuel tank (1) and fill fuel tank (1) with fuel specified in Section 300-0020, LUBRICATION SYSTEM. Ensure vent hole in filler cap (5) is clear and install filler cap (5) assembly on filler neck. Tighten filler cap (5) securely.

7. Secure filler cap (5) on the filler neck with latch (8) and padlock (24).

8. Open fuel shut off valve at the fuel filters.

9. Start the engine and run for a few minutes to ensure fuel is being supplied to the engine. Check for leaks at fuel lines and tighten if required.

10. Remove body safety pins and lower the body. Remove wheel chocks from all road wheels.

FAST FUELLING - Optional

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

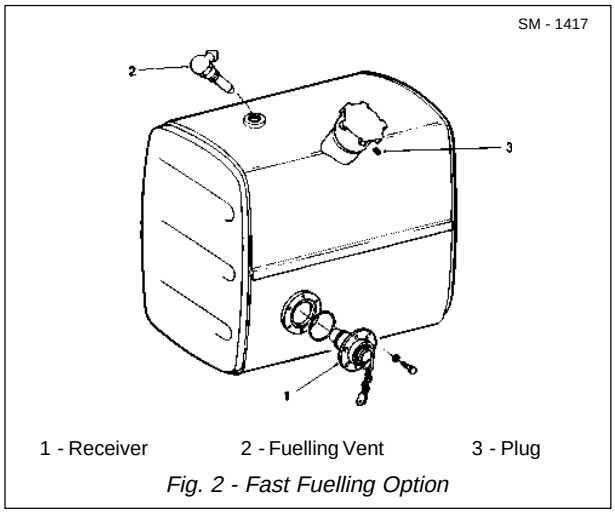
A fast fuel system can be installed in the fuel tank as an option. It involves replacing cover plate (14, Fig. 1) with a flange and nipple receiver (1) and plug (2, Fig. 1) with diesel fuelling vent (2). Receiver (1) is located near the bottom of the tank for bottom filling which helps eliminate foaming that occurs during the traditional 'splash fill' method at the top of the tank.

The advantages of fast fuelling are:
a. Reduces the fill time by around two thirds.
b. Reduces foaming which results in a full tank and more running time between fill-ups.
c. Reduces spillage because the nozzle automatically shuts off when the tank is full.
d. Reduces accidents because refuelling is done from ground level.

Operation

Numbers in parentheses refer to Fig. 2.

Attach the fast fuel nozzle to receiver (1) and turn the handle to the 'On' position. As fuel enters the tank, it forces the air inside the tank through the hollow stem in fuelling vent (2). When the fuel level in the tank nears the top, two hollow floating balls force the third ground ball against an 'O' ring seal and stops the flow of air from the tank. Fuel continues to flow into the tank and pressure begins to build. At approximately 0.4 bar (5.5 lbf/in^2), a diaphragm operated piston inside the nozzle starts to shut off the flow of fuel and system line pressure picks up and brings the nozzle to the 'Off' position. The nozzle is then disconnected from receiver (1).



1 - Receiver 2 - Fuelling Vent 3 - Plug

Fig. 2 - Fast Fuelling Option

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MAINTENANCE

Numbers in parentheses refer to Fig. 1.

Prior to starting the vehicle check the fuel level. Fuel tank (1) should be filled at the end of each shift to prevent condensation from gathering in the tank. Ensure vent hole in filler cap (5) is clear to prevent a vacuum from building up in fuel tank (1). Check condition of all fuel lines.

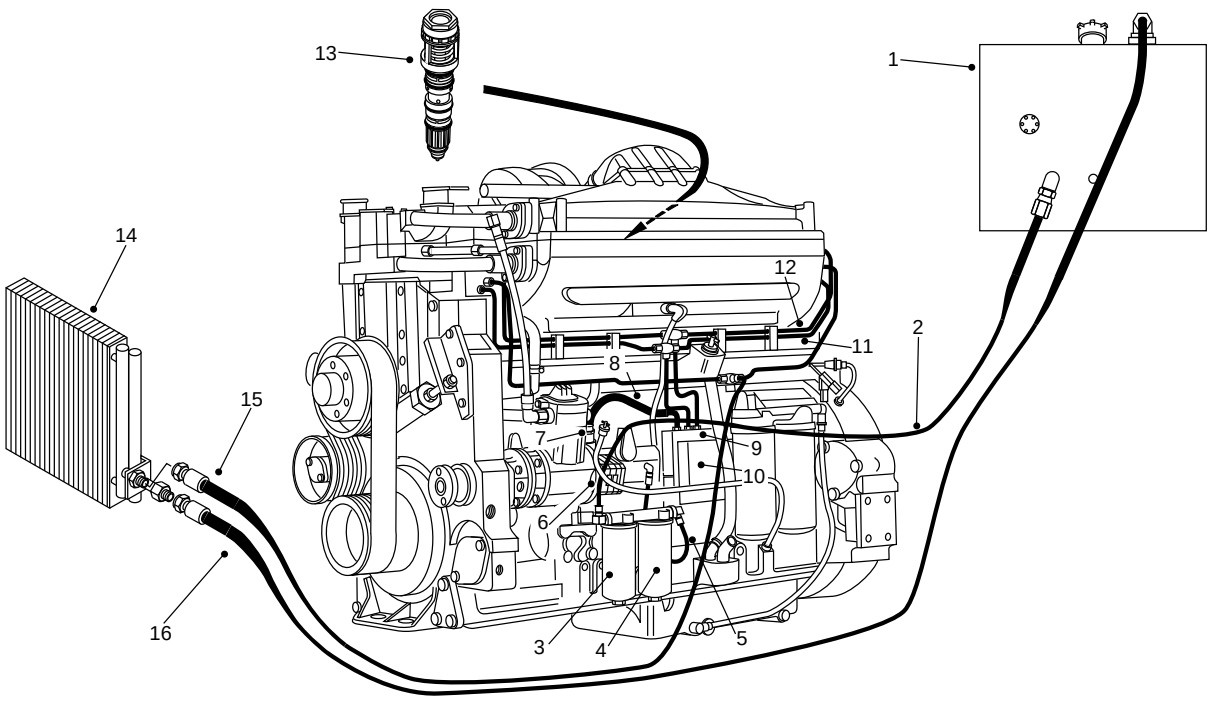
When filling fuel tank (1) check that there is no buildup of dirt and sludge at fuel strainer (23). Remove and clean fuel strainer (23) and filler cap (5) as required. From time to time make a visual check on the electrical connections at fuel level sender (27).

The condition of fuel tank (1) mounting should be checked carefully. Check heavy duty straps (18) and mounting brackets (17 & 21) for any sign of wear or damage and repair or replace as required. Check that nuts (16 & 19) and bolts (20) are securely tightened and that no wear on mounting holes is evident. Tighten nuts (16 & 19) and bolts (20) as required.

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1 - Fuel Tank
2 - Fuel Supply Line
3 - Primary Filter
4 - Secondary Filter
5 - Fuel Inlet Line
6 - Fuel Pump
7 - Fuel Supply Check Valve
8 - Fuel Control Valve Supply
9 - Fuel Control Valve Assembly
10 - ECM Cooling Plate
11 - Fuel Line
12 - Fuel Line
13 - Electronic Fuel Injector
14 - Fuel Cooler
15 - Fuel Line
16 - Fuel Return Line

Fig. 1 - Fuel Lines and Components

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The fuel system consists of the QUANTUM electronic fuel system controls, fuel manifolds (integral with the cylinder head), primary fuel filter (3), secondary fuel filter (4), fuel pump (6), electronic control module (ECM) cooling plate (10), electronic fuel injectors (13) fuel cooler (14), fuel tank (1) and the necessary connecting fuel lines.

There are two spin-on type fuel filters mounted on the left hand side of the engine. Primary fuel filter (3) is in the fuel flow and acts as a strainer and secondary fuel filter (4) filters the fuel after having passed through primary fuel filter (3).

Fuel pressure sensor is installed into the side of secondary fuel filter (4) and sends an electronic signal to the ECM telling it what the engine fuel pressure is at any given speed.

Fuel temperature sensor is installed into the top of secondary fuel filter (4) and sends an electrical signal to the ECM indicating fuel inlet temperature. The ECM uses this information to calculate fuel consumption.

Note: Both fuel pressure sensor and fuel temperature sensor are non-serviceable items and should be replaced as individual units. No adjustment is required.

Fuel pump (6) is attached to a drive assembly mounted on the rear side of the gear case at the front LH side of the engine and transfers fuel from fuel tank (1) to the electronic fuel injectors (13).

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The electronic fuel injector (13) is a lightweight, compact unit that injects diesel fuel directly into the combustion chamber. The amount of fuel injected and the beginning of injection timing is determined by the ECM. The ECM sends a command pulse which activates the injector solenoid.

The injector performs four functions:

a - Creates the high fuel pressure required for efficient injection.
b - Meters and injects the exact amount of fuel required to handle the load.
c - Atomizes the fuel for mixing with the air in the combustion chamber.
d - Permits continuous fuel flow for component cooling.

Electronic fuel injectors are self compensating and virtually eliminate engine tune-ups.

Note: Never apply 12 V directly to terminals on the injector as it will burn out. Before removing injectors, the fuel passages must be blown out to prevent fuel flow from entering the cylinder head.

ECM cooling plate (10) is mounted in front of the ECM on the LH side of the engine and absorbs heat generated by the ECM. Fuel from fuel pump (6) outlet line (8) flows through ECM cooling plate (10) to absorb this heat.

Fuel cooler (14) is mounted on the front RH side of the radiator and cools fuel returning to fuel tank (1).

Flexible fuel lines (2, 5, 8, 15 & 16) are used to facilitate connection of lines leading to and from fuel tank (1), and to minimize the effects of any vibration in the installation. A check valve is incorporated in the fuel supply line to maintain fuel pressure in the system. The restricting check valve is designed to provide the proper fuel system pressure under all conditions.

Note: Do not alter or substitute check valve since this may alter engine performance and emissions.

Note: Do not use restricted fittings or valves anywhere else in the fuel system.

When installing fuel lines, it is recommended that connections be tightened only sufficiently to prevent leakage of fuel; thus flared ends of the fuel lines will not become twisted or fractured because of excessive tightening.

OPERATION

Numbers in parentheses refer to Fig. 1.

Fuel is drawn from fuel tank (1) through primary and secondary fuel filters (3 & 4, respectively) and enters fuel pump (6). Leaving fuel pump (6) under pressure, the fuel flows through ECM cooling plate (10) to the engine cylinder head. The fuel flows to electronic fuel injectors (13) in the cylinder head through passages integral with the cylinder head. Surplus fuel exits at the rear of the cylinder head just above the inlet, flows through fuel cooler (14) and back to fuel tank (1).

MAINTENANCE

Every 10 Hours/Daily:
Make a visual check for fuel leaks at all engine mounted fuel lines and connections, fuel cooler, and at the fuel tank suction and return lines. Examine lines for leaks and check all fittings, clamps and ties carefully.

Make sure that fuel lines are not resting on or touching rotating components, heated surfaces including exhaust manifolds or sharp edges. If fittings have loosened or cracked, or if lines have ruptured or worn through, take corrective action immediately.

Refill the fuel tank at the end of each day's operation to prevent condensation from contaminating the fuel.

Every 250 Hours:
Replace the primary and secondary fuel filters as follows:

Note: There is a fuel system shut off cock on the discharge side of the secondary fuel filter. Closing this valve will prevent loss of fuel prime at time of filter replacement.

1. Close shut off valve at secondary fuel filter and, using a strap type filter wrench, remove and discard both the primary and secondary fuel filters from the engine.

2. Fill the replacement filters and coat the gaskets slightly with clean fuel oil as specified in Section 300-0020, LUBRICATION SYSTEM.

3. Start new primary fuel filter on the filter adaptor and tighten it by hand until the gasket contacts the adaptor fully with no side movement of the filter evident. Tighten an additional 1/2 of a turn.

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Note: Mechanical tightening of fuel filters is not recommended, and may result in seal and/or cartridge damage. Tighten fuel filters by hand only.

4. Repeat step 3 to install a new secondary fuel filter.

5. Start the engine and check for leaks. If any leaks are noted, have them corrected.

Every 500 Hours:
Open the drain at the bottom of the fuel tank to drain off any water and/or sediment. Check the seal in fuel tank filler neck cap and clean filler neck screen and cap. Check the condition of all fuel lines and replace if required. Clean and inspect fins on fuel cooler.

Diesel Fuel Oil

The sulphur content of diesel fuel oil should be as low as possible to avoid premature wear of piston rings and liner, excessive deposit formation, and minimise sulphur dioxide exhausted into the atmosphere. Limited amounts can be tolerated, but the amount of sulphur in the fuel and engine operating conditions can influence corrosion and deposit formation tendencies. The use of diesel fuel oil with a MAXIMUM sulphur content of 0.5% is recommended for use. Refer to Section 300-0020, LUBRICATION SYSTEM.

TROUBLESHOOTING

Locating Air Leaks in Fuel Lines

Air drawn into the fuel system may result in uneven running of the engine, black or white smoking and stalling when idling, or a loss of power. Poor operation is particularly noticeable at lower engine speeds. If air is found in the fuel, the source will normally be between the fuel tank and the fuel pump.

Check for loose, faulty or improper fuel line connectors. Presence of an air leak may be detected by following the procedures under 'Checking Fuel Flow'.

Checking Fuel Flow

1. Disconnect the fuel return line from the fitting at the fuel tank and hold the open end in a suitable container.

2. Start and run the engine at maximum rev/min and measure the fuel flow. Nominal fuel return spill with the check valve is 4.1 litres/min (65 US gal/min).

3. Immerse the end of the fuel return line in the fuel. Air bubbles rising to the surface of the fuel will indicate air being drawn into the fuel system on the suction side of the pump. If air is present, tighten all fuel lines connections between the fuel tank and fuel pump.

4. If the fuel flow is insufficient for satisfactory engine performance then proceed as follows:

a. Replace the primary and secondary fuel filters, as described under 'Maintenance'. Start the engine and run it at maximum rev/min and recheck the fuel flow. If fuel flow is still unsatisfactory, perform step 'b'.

b. Check the fuel lines for restrictions due to pinching, kinking or other damage. Be sure the correct restricted fitting is installed at the return port of the fuel tank. If no problem is found, substitute another fuel pump that is known to be operating correctly and recheck the fuel flow. When changing the fuel pump, inspect the fuel pump drive assembly, hubs and coupling. Clean all fuel lines with compressed air and be sure all fuel connections are tight.

c. Disconnect the fuel lines from the ECM cooling plate and, using a suitable connector, connect the two fuel lines, bypassing the cooling plate. Run the engine at maximum rev/min and recheck the fuel flow. If the fuel flow with the cooling plate bypassed is normal, the cooling plate should be replaced.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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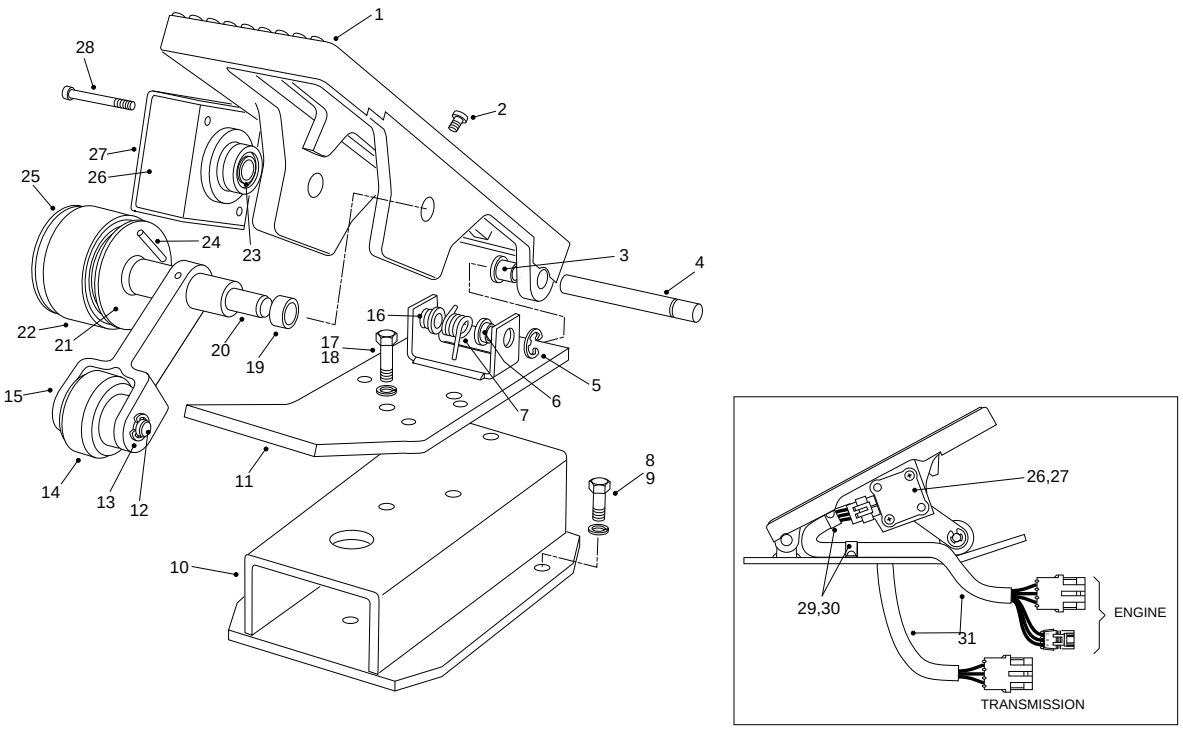
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1 - Pedal Assembly
2 - Screw
3 - Bushing
4 - Pin
5 - Snap Ring
6 - Bushing
7 - Spring
8 - Bolt
9 - Lockwasher
10 - Plate Assembly
11 - Plate
12 - Pin
13 - Snap Ring
14 - Roller
15 - Lever
16 - Bushing
17 - Bolt
18 - Lockwasher
19 - Bushing
20 - Shaft
21 - Thrust Washer
22 - Spring
23 - Bearing
24 - Pin
25 - Thrust Washer
26 - Cover
27 - Potentiometer
28 - Screw
29 - Screw
30 - Clamp
31 - Harness

Fig. 1 - Electronic Foot Pedal Assembly

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The electronic foot pedal assembly provides an electrical signal to the engine's fuel control system in proportion to the degree of pedal actuation. Maximum and minimum stops are built into the pedal assembly during manufacture. The pedal assembly comes preset and therefore no adjustment is necessary.

Note: The electronically controlled engine will override the electronic foot pedal position until the engine is warmed up to the correct operating temperature. The engine MUST be started with foot 'OFF' pedal assembly (1).

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine.

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2. Turn steering wheel in both directions several times to relieve any pressure in the steering circuit. Block all road wheels.

3. Disconnect electrical harness (31) from the mating engine and transmission harnesses.

4. Move cab floor mat back and clear from pedal assembly (1) and mounting plates.

5. Remove mounting bolts (8) and lockwashers (9) securing plate assembly (10) and pedal assembly (1) to cab floor plate. Remove plate assembly (10) and pedal assembly (1).

6. Remove bolts (17) and lockwashers (18) securing pedal assembly (1) to plate assembly (10). Remove pedal assembly (1) from plate assembly (10).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Position pedal assembly (1) on plate assembly (10) and secure with bolts (17) and lockwashers (18).

2. Secure plate assembly (10) and pedal assembly (1) to the cab floor plate with mounting bolts (8) and lockwashers (9) removed during removal.

3. Connect electrical harness (31) to the mating engine and transmission harnesses.

4. Position floor mat on cab floor and ensure that pedal assembly (1) is free to operate.

5. Remove wheel blocks and start the engine. Ensure that pedal assembly (1) operates correctly.

Note: The engine MUST be started with the foot 'OFF' pedal assembly (1).

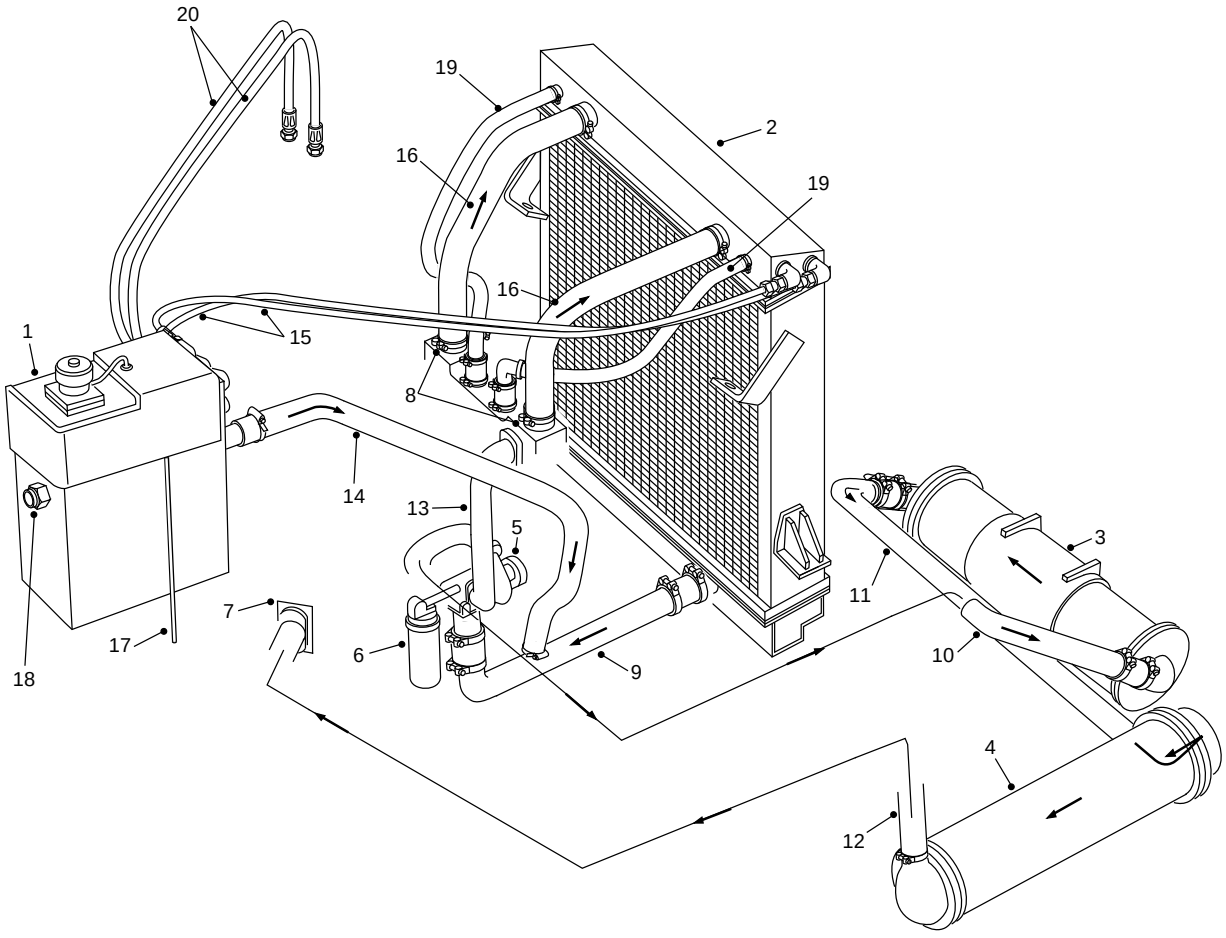
MAINTENANCE

Limited repair of the electronic foot pedal assembly is by replacement of parts only. Refer to vehicle Parts Book for part numbers of overhaul kits.

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1 - Header Tank
2 - Radiator
3 - Disc Brake Oil Cooler
4 - Transmission Oil Cooler
5 - Engine Water Pump
6 - DCA4 Coolant Filter
7 - Engine Oil Cooler
8 - Thermostat Housing
9 - Coolant Pipe
10 - Coolant Pipe
11 - Coolant Pipe
12 - Coolant Pipe
13 - Bypass Line
14 - Make-up Line
15 - Deaeration Line
16 - Coolant Pipe
17 - Overflow Tubing
18 - Window Nut
19 - Coolant Pipe
20 - Coolant Hose

Fig. 1 - Cooling System Diagram

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

A radiator and fan cooling system is used on the engines installed in these machines. This system has a centrifugal type water pump (5) to circulate coolant throughout the system. Two full blocking thermostats located in thermostat housing (8) control the flow of coolant throughout the system.

The main components of the cooling system are; header tank (1), radiator (2), engine water pump (5), DCA4 coolant filter (6), disc brake oil cooler (3), transmission oil cooler (4), engine oil cooler (7) and thermostat housing (8).

OPERATION

Numbers in parentheses refer to Fig. 1.

Upon starting a cold engine or when the coolant is below operating temperature, the coolant is restricted at thermostat housing (8) and bypass line (13) provides water circulation within the engine during the warm-up period.

Note: Engine coolant thermostats start to open at 80 ± 2° C (175 ± 3° F) and are fully open at 90 + 6° C (195 + 12° F).

Engine water pump (5) draws coolant from the radiator bottom tank through coolant pipe (9) and also

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from header tank (1) through make-up line (14). The coolant passes through DCA4 coolant filter (6) mounted at engine water pump (5). Engine water pump (5) then pumps coolant through coolant pipe (10) into disc brake oil cooler (3). Coolant flows through disc brake oil cooler (3), through coolant pipe (11) and into transmission oil cooler (4). The coolant draws heat from disc brake oil cooler (3) and transmission oil cooler (4) and then flows through coolant pipe (12) to engine oil cooler (7) and through the engine water jackets.

Aerated coolant is drawn off to header tank (1) from thermostat housing (8) and radiator (2) top tank through deaeration lines (15). Excess coolant at header tank (1) is discharged through overflow line (17) from the filler neck.

The upper portion of radiator (2) top tank is a deaeration chamber blocked off from the lower portion by a solid baffle and its only connection to the radiator core is through stand pipes which deaerate the radiator core.

When the coolant is below operating temperature, the engine thermostats remain closed and coolant flowing through the coolers and into thermostat housing (8), returns through bypass line (13) to engine water pump (5), and then back through the coolers.

When the coolant reaches operating temperature, the thermostats open allowing coolant to flow through coolant pipes (16) into the lower portion of radiator (2) top tank. Coolant then travels through the radiator core, where heat is drawn off by air circulating through the core, and into radiator (2) bottom tank, where it is recirculated back through the system.

The use of antifreeze is mandatory with the cooling system. The lack of coolant flow through the radiator with the thermostats closed allows the coolant in radiator (2) to freeze under low ambient temperature conditions.

PREVENTIVE MAINTENANCE

Numbers in parentheses refer to Fig. 1.

To ensure the continued efficient functioning of the cooling system, certain checks and operations should be performed at regular intervals.

⚠ WARNING

Do not remove the pressure control cap from the radiator header tank or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. Always release pressure from the system by depressing the pressure relief button on the cap. Remove cap slowly as the sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding) from the hot liquid.

As Required:

Tighten water manifold, water pump, oil coolers and radiator mounting bolts. Clean radiator core fins.

Note: Under extreme conditions it may be necessary to clean radiator core fins several times per shift.

Every 10 hours/Daily:

Check the coolant level. Fill radiator header tank (1) with coolant until coolant reaches the bottom of the filler neck and holds at that level. Window nut (18) should show full at all times.

Note: Any time a significant amount of coolant is added, the DCA4 concentration must be checked and the appropriate action taken. Refer to instructions under 'Coolant Recommendations' in this section.

Note: Removal of the filler cap when the system is hot vents the pressure in the system. If the filler cap is reinstalled while the system is hot, normal system build up to the rated pressure will not take place. This may result in a serious temporary reduction of coolant flow due to cavitation at the water pump inlet, particularly if the truck is being operated at high altitude.

Check cooling fan for cracks, loose rivets and bent or loose blades. Check fan mounting and tighten if required. Visually inspect the fan belt for wear and tension. Tighten/replace fan belt as required. Replace the cooling fan if required.

Check all cooling lines, pipes and components for leaks.

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Every 250 hours:

Check and replenish the DCA4 concentration as described under 'Coolant Recommendations' in this section.

Replace DCA4 coolant filter if required. When testing the DCA4 concentration, depending on the level of DCA4 , the coolant filter may not require to be changed. Refer to instructions under 'Coolant Recommendations' in this section.

Note: Under concentration of the DCA4 coolant additive can result in liner pitting and system corrosion. Over concentration can result in water pump seal leakage. Always maintain DCA4 concentration at recommended levels.

Every 250 hours:

Lubricate the fan idler pivot arm with grease as specified in Section 300-0020, LUBRICATION SYSTEM. Lubricate the pivot arm until grease appears from under the cap.

Every 1 500 hours:

Lubricate the fan hub with grease as specified in Section 300-0020, LUBRICATION SYSTEM. Remove vent plug from fan hub grease cavity and apply grease through grease fitting until grease comes out of the vent hole.

Every 6 000 hours:

Drain and flush the cooling system as described under the heading 'Draining and Flushing' in this section. Fill the cooling system with the correct mixture of antifreeze, water and DCA4 liquid as described under 'Coolant Recommendations' in this section.

Inspect the fan hub for wobble and grease leakage. Replace with a new or rebuilt unit as necessary.

Inspect the fan idler pulley assembly. Rebuild or replace the idler pulley as necessary.

Inspect the engine water pump for coolant or oil leakage at the water pump weep hole.

Note: A minor chemical buildup or streaking at the water pump weep hole is normal. Do not repair or replace the water pump unless an actual leak is confirmed.

DRAINING AND FLUSHING

Note: If the DCA4 coolant filter is properly maintained, the need for flushing the cooling system is greatly reduced.

The draining and flushing of the cooling system should be performed as follows:

⚠ WARNING
Do not remove the pressure control cap from the radiator header tank or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. Always release pressure from the system by depressing the pressure relief button on the cap. Remove cap slowly as the sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding) from the hot liquid.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Turn the steering wheel in both directions several times to relieve pressure in the steering system.

2. Drain the coolant from the engine and radiator into a suitable container.

3. Refill cooling system with clean soft water and a good radiator cleaning compound. If the engine is warm, fill slowly to prevent the rapid cooling and distortion of the metal castings.

4. Start the engine and operate the truck for fifteen (15) minutes to circulate the solution thoroughly.

5. Drain the cooling system completely.

6. Refill cooling system with clean, soft water and operate the truck for fifteen (15) minutes. Drain the cooling system completely to remove all cleaner residue from the system.

7. Refill cooling system with proper mix of antifreeze and water and install new precharge filter and correct concentration of DCA4 liquid. Refer to instructions under 'Coolant Recommendations'.

Note: If engine overheats and fan belt tension and water level are satisfactory, the entire cooling system may require cleaning with a descaling solvent and back flushing.

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In general, any flushing compound put out by a reputable manufacturer will do an acceptable job. Oxalic acid and sodium bisulphate type cleaners are the most generally used. Be certain to use the neutralizer compound after flushing radiator with an acid cleaner. The neutralizer is usually supplied with the acid cleaner.

Back Flushing Engine Jacket

Whenever the engine water jacket is rust clogged, pressure back flushing should be used after the draining of the cleaning compound. Be certain to remove both thermostats from thermostat housing before beginning back flushing operation.

1. Turn the shut-off valve at the coolant filter head to the 'Off' position.

2. Remove both thermostats from thermostat housing, reinstall thermostat housing, and clamp flushing gun to front neck of the water manifold.

3. Temporarily block engine water pump inlet opening and fill engine jacket with clean, soft water.

4. Unblock engine water pump inlet opening and blow water from the engine jacket with air from flushing gun clamped to neck of water manifold. Use full air pressure.

5. Repeat operation by alternately filling engine with clean, soft water and blowing out with air until flushing water runs out clean.

6. Turn the shut-off valve at the coolant filter head to the 'On' position.

Back Flushing Radiator

1. Disconnect both coolant tubes at the thermostat housing.

2. Disconnect coolant pipe from water pump inlet and block off make-up line connection at coolant pipe. Clamp the flushing gun to the coolant pipe end and fill the radiator with clean, soft water from the flushing gun.

3. Apply air pressure gradually increasing to a pressure of 0.7 bar (10 lbf/in^2). DO NOT EXCEED THIS PRESSURE.

4. Alternatively fill radiator with clean, soft water and flush with air until water runs out clear.

COOLANT RECOMMENDATIONS

Heavy duty diesel engines installed in these vehicles require a heavy duty coolant for optimum performance. Heavy duty coolant is defined as a correct mixture of good quality water, low silicate antifreeze and supplemental coolant additives (SCA's).

Water quality is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulphates cause cooling system corrosion.

It is recommended to use a low silicate antifreeze concentrate that meets ASTM D4985 specifications (less than 0.1% silicate). Low silicate antifreeze must be mixed with quality water at a 50/50 ratio (40 to 60% working range). A 50/50 mixture of antifreeze and water gives a -37° C (-34° F) freeze point and a boiling point of 109° C (228° F). The actual lowest freeze point of ethylene glycol antifreeze is at 68%. Using higher concentrations of antifreeze will raise the freeze point of the solution and increase the possibility of a silicate gel problem. A refractometer must be used to accurately measure the freeze point of the coolant. Refer to 'Special Tool and Test Kit'.

Supplemental coolant additives (DCA4), or equivalent, are used in conjunction with water and antifreeze to prevent liner pitting, corrosion and scale deposits in the cooling system. The cooling system must be precharged with the correct concentration of DCA4. Refer to the relevant 'Precharge Chart' in this section. When coolant is replaced in the field, it must be replaced with heavy duty coolant precharged with DCA4. In addition, a service coolant filter must be installed. Together, this will result in a total precharge of approximately 0.33 DCA4 units per litre of coolant.

Proper blending of heavy duty coolant is achieved as follows:

a. Pour water into a suitable clean container.

b. Add the same quantity of low silicate antifreeze to the water.

c. Add the correct quantity of DCA4 liquid for the cooling system capacity required. Refer to the relevant 'Precharge Chart' in this section for DCA4 quantities. Refer to Section 300-0020, LUBRICATION SYSTEM for cooling system capacity.

d. Thoroughly blend all components.

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Note: Following the correct order for mixing the heavy duty coolant will prevent additive dropout during the mixing process.

Note: The cooling system must be clean before adding DCA4 liquid.

Note: Do not use soluble oils in the cooling system. The use of soluble oils will lead to cylinder lining pitting, corrode brass and copper, damage heat transfer surfaces and damage seals and hoses.

DCA4 Test Kit

The test kit must be used:

a. When excessive coolant loss occurs.

b. After every 250 hours of operation

c. If the concentration is known to be above the high limit of 0.8 units per litre. Test at each subsequent oil change until the concentration decreases below the high limit.

Note: Do not use the test kit to omit or extend the service intervals unless the concentration is above 0.8 units per litre.

The test strip container is marked with an expiration date and the plastic container must be securely tightened to protect the moisture sensitive strips. Discard the strips if there is any doubt about the test strip quality.

Test Instructions

1. Collect coolant sample from the radiator or petcock. DO NOT collect from the coolant recovery or overflow system. Coolant must be between 10° C and 55° C when tested.

2. Remove one strip from bottle and replace cap immediately. DO NOT touch the pads on the end of the strip.

Note: Discard kit if unused strips have turned brown.

3. Dip strip in coolant sample for one second, remove, and shake strip briskly to remove excess liquid.

4. **45 seconds** after dipping strip compare and record results in the following order:

a. Compare **Freeze Point** (end pad) to colour chart and record the result.

b. Next, compare **Sodium Molybdate** (middle pad) to colour chart and record the result.

c. Finally, compare **Sodium Nitrate** test to colour chart and record the result.

5. All three readings must be completed **no later than 75 seconds** after dipping the strip.

6. It is okay to estimate a value between colour blocks, but if uncertain about the colour match, pick the lower numbered block.

7. Determine where the Sodium Molybdate level intersects the Sodium Nitrite level on the chart. The amount of SCA units per litre in the cooling system is given where the Sodium Molybdate row intersects the Sodium Nitrite column.

Note: For best results follow test times carefully. Use a stopwatch or clock with a sweep second hand. Comparing the test strip to the colour chart too soon before, or too late after, the required test time will result in incorrect readings and improper treatment, and could result in liner pitting and engine damage.

8. All readings should be recorded on the truck maintenance record for future reference.

Treatment Instructions

If the concentration is:

Above 0.8 units per litre - Do not replace the DCA4 filter or add liquid DCA4 until the concentration drops below 0.8 units per litre. The concentration must be tested at every subsequent 250 hour service interval until the concentration decreases below 0.8 units per litre.

Between 0.3 and 0.8 units per litre - Add the normal amount of DCA4 liquid as specified in the 'Service Chart'. Replace the DCA4 coolant filter, as per Engine Manufacturers coolant recommendations.

Below 0.3 units per litre - Add both the normal amount of DCA4 liquid specified in the 'Service Chart' and the amount specified in the 'Precharge Chart'. Replace the DCA4 coolant filter, as per Engine Manufacturers coolant recommendations.

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Cooling System - Cooling System

Section 210-0000

SPECIAL TOOL AND TEST KIT

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the refractometer and coolant test kit referenced in this section. These items are available from your Dealer.

Precharge Chart

Cooling System Capacity - Litres	Amount of DCA4 Liquid Required	
	Units	Litres
78 - 115	40	3.8
116 - 191	60	5.7
192 - 285	90	8.5
286 - 380	120	11.4
381 - 569	180	17.0

Service Chart

Cooling System Capacity - Litres	Amount of DCA4 Liquid Required	
	Units	Litres
78 - 115	10	1.0
116 - 191	15	1.4
192 - 285	20	1.9
286 - 380	25	2.4
381 - 569	40	3.8

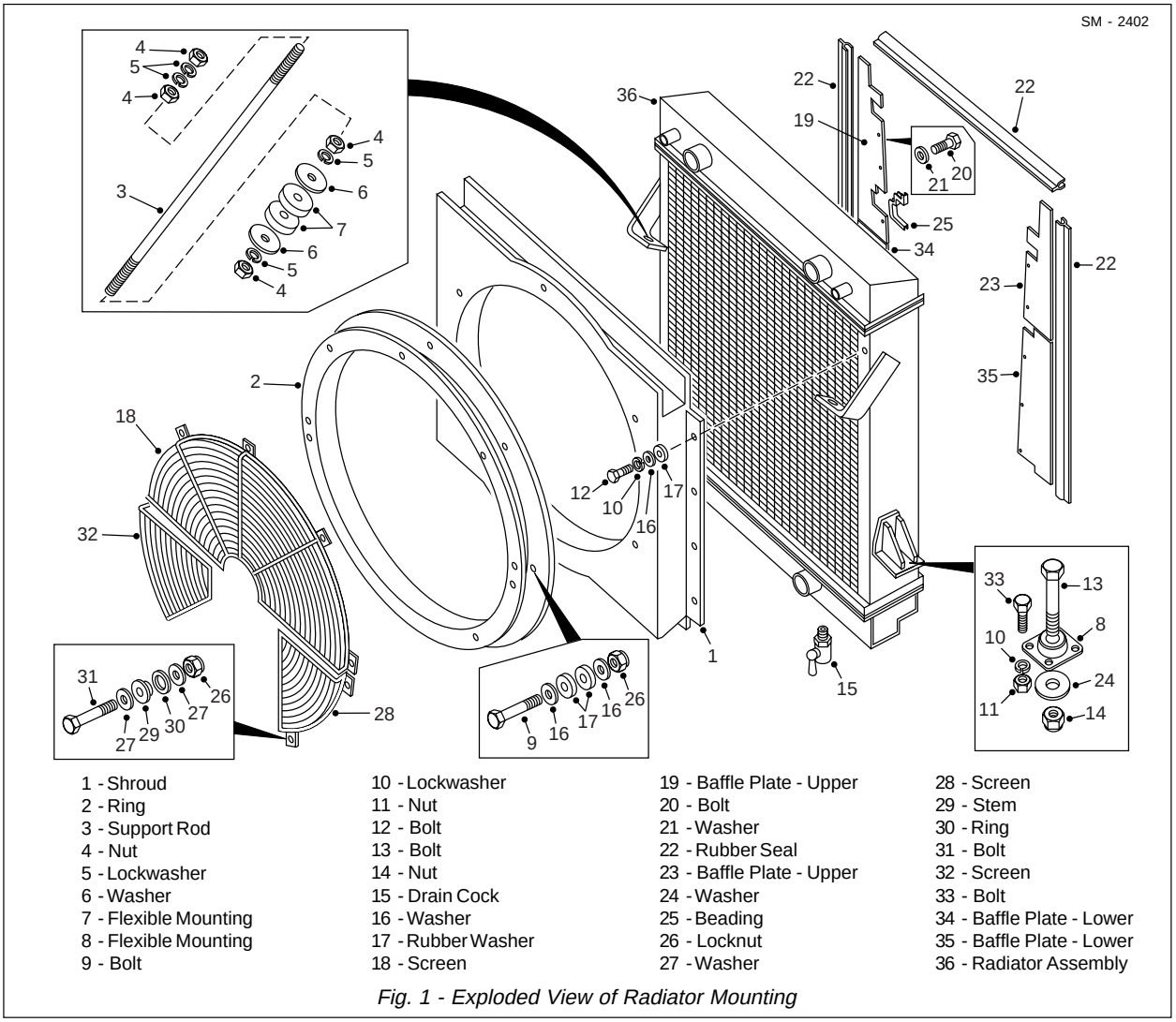
COOLING SYSTEM DIAGNOSIS CHART

CONDITION	REASON	REMEDY
Engine coolant temperature too high	Low coolant level	Fill cooling system to correct fill level
		Check for leaks and repair
	Faulty header tank pressure cap	Check pressure cap, replace if required
	Air in cooling system	Purge air from cooling system
	Front of radiator obstructed preventing free flow of air	Remove obstruction and clean radiator fins
	Fan drive belt broken or slipping	Check fan idler arm operation. Replace fan belt if broken.
	Thermostats not opening	Replace thermostats
	Restricted cooling system passages	Flush cooling system
	Faulty engine water pump	Repair or replace water pump
Engine coolant temperature	Thermostats remain open or open too low	Replace thermostats at too low a temperature
	Leakage around thermostat seals	Replace thermostat seals
	Extremely cold weather	Cover radiator or install radiator shutters
Sudden rise in engine coolant temperature	Lack of coolant	Check for coolant leaks
		Fill cooling system to correct fill level

* * * *

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1 - Shroud	10 - Lockwasher	19 - Baffle Plate - Upper	28 - Screen
2 - Ring	11 - Nut	20 - Bolt	29 - Stem
3 - Support Rod	12 - Bolt	21 - Washer	30 - Ring
4 - Nut	13 - Bolt	22 - Rubber Seal	31 - Bolt
5 - Lockwasher	14 - Nut	23 - Baffle Plate - Upper	32 - Screen
6 - Washer	15 - Drain Cock	24 - Washer	33 - Bolt
7 - Flexible Mounting	16 - Washer	25 - Beading	34 - Baffle Plate - Lower
8 - Flexible Mounting	17 - Rubber Washer	26 - Locknut	35 - Baffle Plate - Lower
9 - Bolt	18 - Screen	27 - Washer	36 - Radiator Assembly

Fig. 1 - Exploded View of Radiator Mounting

DESCRIPTION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Radiator assembly (36) is mounted at the front of the chassis in front of the engine cooling fan. It is fed from radiator header tank (1, Fig. 2) mounted on the platform to the right of the cab and air cleaners.

A fan shroud assembly comprising of shroud (1) and ring (2) improves the engine cooling fan efficiency, provides a more uniform distribution of air over the radiator core and helps restrict recirculation of air within the engine compartment.

Recirculation baffle plates (19, 23, 34 & 35) and rubber seals (22) around radiator assembly (36) prevent hot air from the engine cooling fan from being reintroduced into the cooling air circuit.

REMOVAL

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

⚠ WARNING

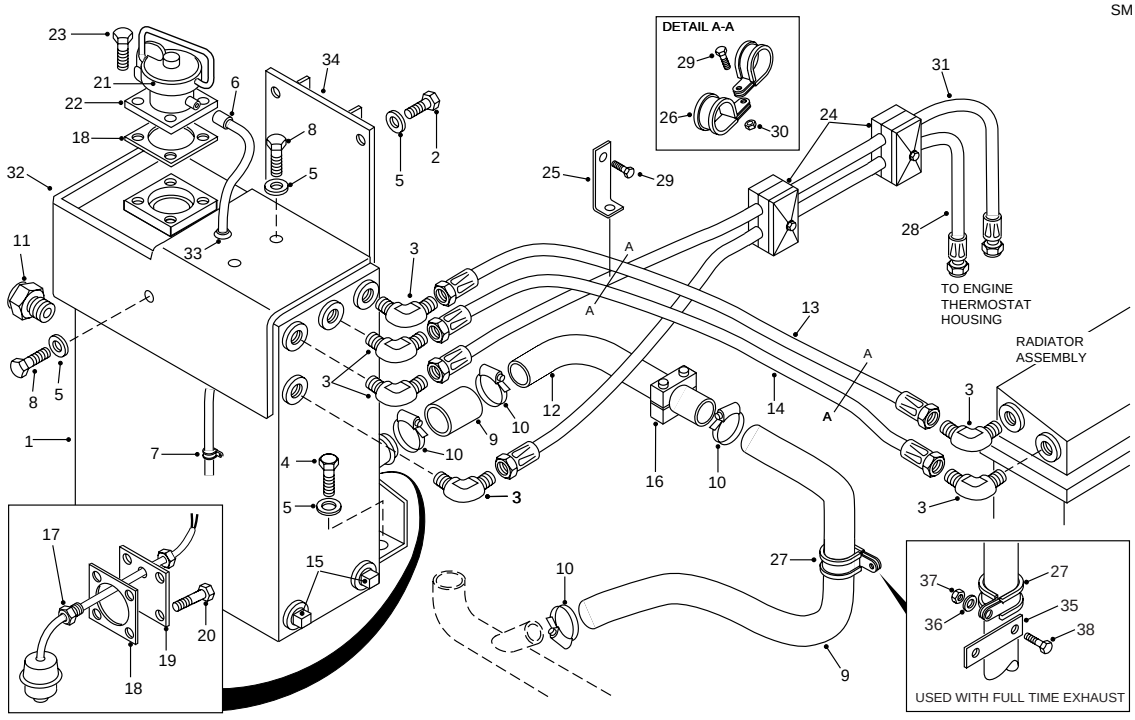
Do not remove the pressure control cap from the radiator header tank or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. Always release pressure from the system by depressing the pressure relief button on the cap. Remove cap slowly as the sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding) from the hot liquid.

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Cooling System - Radiator, Header Tank and Mounting

Section 210-0040



1 - Header Tank
2 - Bolt
3 - Elbow
4 - Bolt
5 - Hardened Washer
6 - Overflow Tubing
7 - P-Clip
8 - Bolt
9 - Hose
10 - Band Clamp
11 - Window Nut
12 - Coolant Pipe
13 - Deaeration Line
14 - Deaeration Line
15 - Plug
16 - Clamp
17 - Float Level Switch
18 - Gasket
19 - Adaptor Plate
20 - Bolt
21 - Filler Cap
22 - Filler Neck
23 - Bolt
24 - Clamp
25 - Bracket
26 - P-Clip
27 - P-Clip
28 - Hose Assembly
29 - Bolt
30 - Nut
31 - Hose Assembly
32 - Heat Shield
33 - Grommet
34 - Mounting Bracket
35 - Bracket
36 - Washer
37 - Nut
38 - Bolt

Fig. 2 - Radiator Header Tank Mounting and Lines

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels.

3. Remove mounting hardware securing the hood assembly to the vehicle and, using suitable lifting equipment, remove the hood assembly. Refer to Section 100-0010, CHASSIS, HOOD AND FENDERS.

4. Disconnect electrical connections to lights on the radiator guard and remove mounting hardware securing radiator guard to the vehicle. Using suitable lifting equipment, remove radiator guard assembly. Refer to Section 100-0010, CHASSIS, HOOD AND FENDERS.

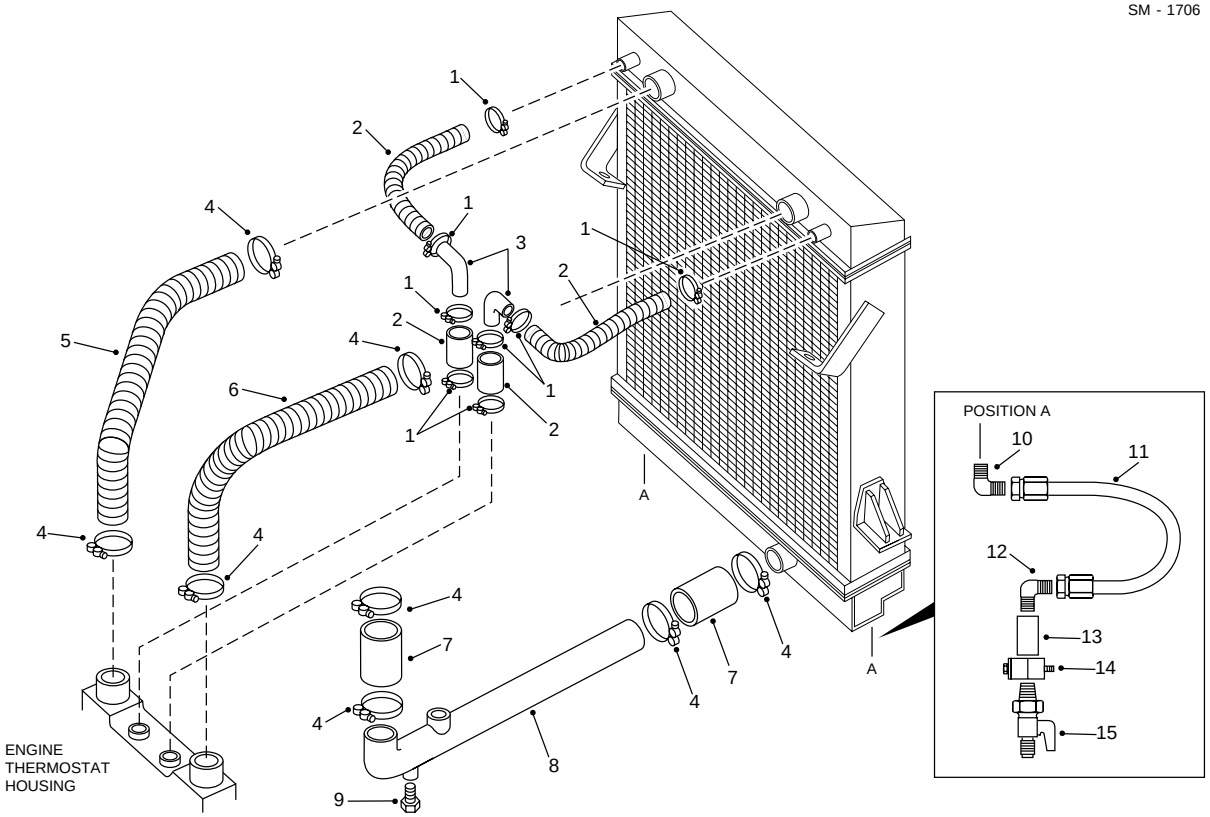
5. Depress pressure relief button on filler cap (21, Fig. 2) and remove filler cap from filler neck (22, Fig. 2).

6. With a suitable container in position, open drain cock (15) at the bottom of radiator assembly (36) and drain the cooling system. Close drain cock (15) securely when coolant is completely drained.

7. Remove locknuts (26), washers (27) and bolts (31) securing screens (18, 28 & 32) to ring (2). Remove screens (18, 28 & 32) from the vehicle. Remove stems (29) and rings (30) from screens (18, 28 & 32) if required.

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1 - Band Clamp
2 - Coolant Tube
3 - Elbow
4 - Band Clamp
5 - Silicone Hose
6 - Silicone Hose
7 - Silicone Hose
8 - Coolant Tube
9 - Plug
10 - Elbow
11 - Hose
12 - Elbow
13 - Coupling
14 - Pipe Clamp
15 - Drain Cock

Fig. 3 - Radiator Piping

8. Slacken band clamps (1, Fig. 3) and slide coolant tubes (2, Fig. 3) away from radiator top tank connections.

9. Slacken band clamps (4, Fig. 3) and slide hose (7, Fig. 3) back over coolant tube (8, Fig. 3) and away from radiator bottom tank connection.

10. Identify and disconnect deaeration lines (13 & 14, Fig. 2) from elbows (3, Fig. 2) in radiator top tank.

11. Ensure all coolant pipes and lines have been disconnected from radiator assembly (36).

12. Remove nuts (4) and lockwashers (5) securing support rods (3) to radiator side columns.

13. If necessary, remove nuts (4), lockwashers (5), washers (6) and flexible mountings (7) from bottom end of each support rod (3). Loosen inside nuts (4), lockwashers (5) and washers (6) securing support rods (3) to chassis brackets. Remove both support rods (3) from radiator side columns and chassis brackets.

14. Attach suitable lifting equipment to radiator assembly (36) and remove nuts (14), washers (24) and bolts (13) securing radiator assembly (36) on flexible mounting (8). Remove radiator assembly (36).

15. If necessary, remove nuts (11), lockwashers (10) and bolts (33) securing flexible mountings (8) to chassis mounting brackets.

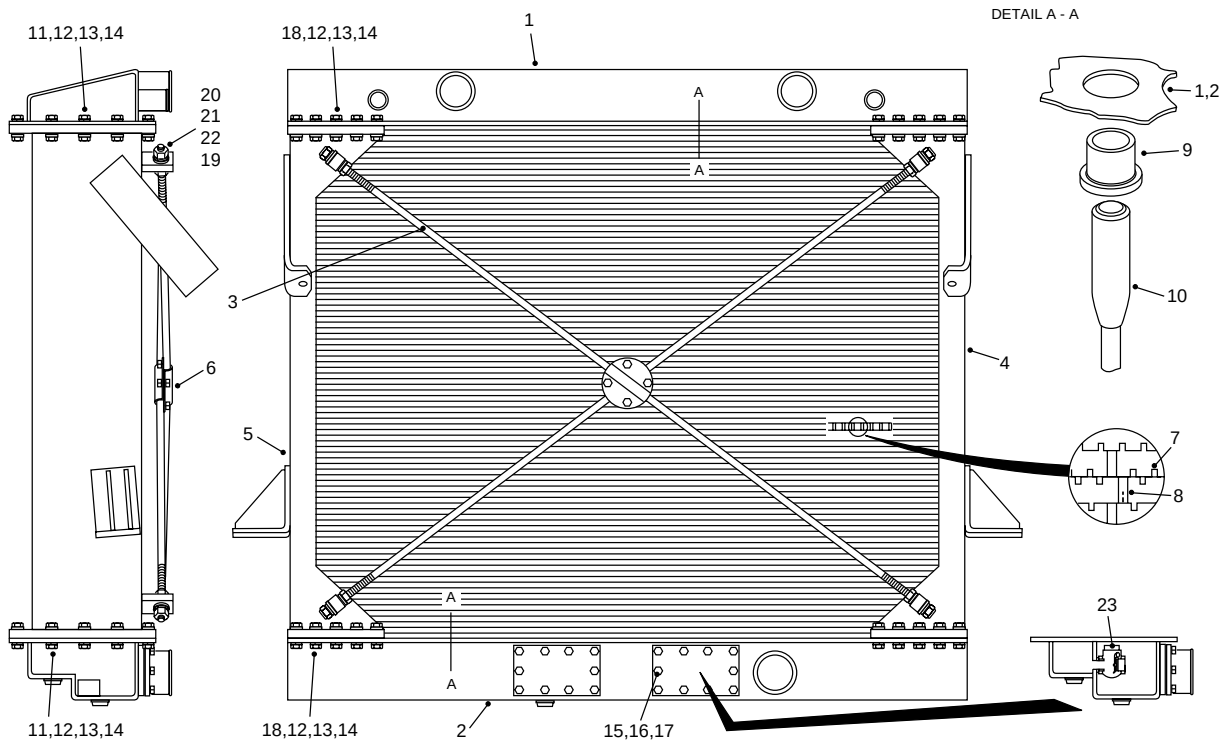
Header Tank

Numbers in parentheses refer to Fig. 2.

1. Slacken band clamps (10) and slide hose (9) over coolant pipe (12) and off of header tank (1) connection.

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1 - Top Tank
2 - Bottom Tank
3 - Crossbrace Rod
4 - Side Column - LH
5 - Side Column - RH
6 - Crossbrace Clamps
7 - Tube Stay Strip
8 - Spacer
9 - Rubber Ferrule
10 - Joule Tube
11 - Screw
12 - Nut
13 - Washer
14 - Lockwasher
15 - Screw
16 - Washer
17 - Lockwasher
18 - Screw
19 - Nut
20 - Locknut
21 - Washer
22 - Lockwasher
23 - Check Valve

Fig. 4 - Radiator Assembly

2. Disconnect deaeration lines (13, 14, 28 & 31) from elbows (3) in header tank (1).

3. Disconnect overflow tubing (6) from filler neck (22).

4. Disconnect electrical connection from float level switch (17).

5 Remove bolts (2) and washers (5) securing header tank (1) to mounting bracket (34). Remove bolts (4) and hardened washers (5) securing header tank (1) to the platform.

6. Attach suitable lifting equipment to header tank (1) and remove header tank assembly from the platform.

DISASSEMBLY/ASSEMBLY

Numbers in parentheses refer to Fig. 4, unless otherwise specified.

1. Remove bolts (12, Fig. 1), lockwashers (10, Fig. 1), washers (16, Fig. 1) and rubber washers (17, Fig. 1) securing shroud (1, Fig. 1) and ring (2, Fig. 1) assembly to radiator assembly (35, Fig. 1).

2. If required, remove bolts (20, Fig. 1) and washers (21, Fig. 1) securing baffle plates (19, 23, 34 & 35, Fig. 1) to radiator assembly (36, Fig. 1). Remove baffle plates (19, 23, 34 & 35, Fig. 1) and rubber seals (22, Fig. 1) from the radiator assembly (36, Fig. 1).

3. If required, remove screws (15), washers (16) and lockwashers (17) securing cover plates to bottom tank (2). Remove mounting hardware securing check valves (23) to bottom tank (2).

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Note: Joule tube (10) type radiators are designed in such a way that individual tubes can be replaced without the need to replace the entire radiator core.

Note: It may be necessary to remove several undamaged joule tubes (10) in order to gain access to the damaged tube.

Note: The top and bottom ends of joule tube (10) are distinguished by the top end of the tube having a long length of tube bare of grilling and the bottom end being fitted with a locating washer.

4. Removal of joule tube (10) and rubber ferrules (9) is as follows:

a. Push joule tube (10) upwards into the top tank (1) until the bottom of the tube is clear of the bottom tank (2).

b. Carefully pull joule tube (10) clear of bottom tank (2) and pull out from top tank (1).

c. Remove and discard rubber ferrules (9) from top tank (1) and bottom tank (2).

5. Replacement of joule tube (10) and rubber ferrules (9) is as follows:

a. Lightly coat outside diameter of new rubber ferrules (9) and tube holes in top tank (1) and bottom tank (2) with petroleum jelly.

b. Press rubber ferrules (9) by hand into the tube holes in the top and bottom tank (1 & 2), taking care that the flange of each rubber ferrule (9) fits flush on the respective tank plate face. It may be necessary to lightly tap the top of rubber ferrule (9) flange with a hammer to ensure a flush fit.

c. Lightly coat the bore of rubber ferrules (9) and each end of joule tube (10) with petroleum jelly.

d. Enter the top (longer) end of joule tube (10) into rubber ferrule (9) in top tank (1) and press upward until the short end of the tube is clear of rubber ferrule (9) flange in bottom tank (2).

e. Carefully enter the bottom of joule tube (10) into rubber ferrule (9) in bottom tank (2) taking care that the tube does not damage rubber ferrule (9) by scoring. Press down firmly until the locating washer rests on the flange of rubber ferrule (9).

6. If removed, clean and install check valves (23) to bottom tank (2). Install cover plates to bottom tank (2), secure with screws (15), washers (16) and lockwashers (17).

Note: Check valve (23) is a non-servicable item, replace if damaged.

7. If removed, install rubber seals (22, Fig. 1) and baffle plates (19, 23, 34 & 35, Fig. 1) to front of the radiator assembly (36, Fig. 1). Secure baffle plates (19, 23, 34 & 35, Fig. 1) to radiator assembly (36, Fig. 1) with bolts (20, Fig. 1) and washers (21, Fig. 1).

8. Secure shroud (1, Fig. 1) and ring (2, Fig. 1) assembly to radiator assembly (36, Fig. 1) with rubber washers (17, Fig. 1), washers (16, Fig. 1), lockwashers (10, Fig. 1) and bolts (12, Fig. 1).

Header Tank

Numbers in parentheses refer to Fig. 2.

1. Remove bolts (23) securing filler neck (22) assembly to header tank (1). Remove filler neck (22) assembly and discard gasket (18).

2. Remove bolts (20) securing adaptor plate (19) and float level switch (17) assembly to header tank (1). Remove adaptor plate (19), gasket (18) and float level switch (17) from header tank (1). Discard gasket (18).

3. If required, remove lock nut from float level switch (17) and remove float level switch from adaptor plate (19).

4. Remove window nut (11) from header tank (1).

5. Assembly of header tank (1) is the reverse of disassembly. Be sure to use new gaskets (18) when assembling filler neck (22) assembly and adaptor plate (19) assembly to header tank (1).

INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. If removed, position flexible mountings (8) on chassis mounting brackets and secure with bolts (33), lockwashers (10) and nuts (11).

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2. Using suitable lifting equipment, position radiator assembly (36) on flexible mountings (8) and secure with bolts (13), washers (24) and nuts (14).

3. Install nut (4), lockwasher (5), washer (6) and one half of flexible mounting (7) on the bottom end of each support rod (3). Install support rods (3) in chassis support brackets and secure with opposite half of flexible mountings (7), washers (6), lockwashers (5) and nuts (4).

Note: Before securing support rods (3) to mounting brackets on radiator side columns, align the radiator core assembly to be parallel with the leading end of the cooling fan. Adjust fan ring (2) to obtain adequate fan tip clearance.

4. Install nuts (4) and lockwashers (5) on top end of support rods (3) and secure support rods (3) to mounting brackets on radiator side columns with lockwashers (5) and nuts (4).

5. Connect deaeration line (13 & 14, Fig. 2) to elbows (3, Fig. 2) and tighten securely.

6. Slide coolant tubes (2, Fig. 3) over radiator top tank connections. Secure coolant tubes (2, Fig. 3) to radiator top tank connections with band clamps (1, Fig. 3).

7. Slide hose (7, Fig. 3) over radiator bottom tank connection. Secure hose (7, Fig. 3) to coolant tube (8, Fig. 3) and radiator bottom tank connection with band clamps (4, Fig. 3).

8. If removed, install stems (29) and rings (30) in screens (18, 28 & 32). Install screens (18, 28 & 32) on ring (2) and secure with bolts (31), washers (27) and locknuts (26).

9. Using suitable lifting equipment, position radiator guard assembly on the front of the chassis and secure with mounting hardware removed during removal. Refer to Section 100-0010, CHASSIS, HOOD AND FENDERS.

10. Connect all electrical connections to lights in radiator guard assembly.

Note: Do not secure hood assembly on the vehicle until vehicle has been started and checked for leaks. Refer to 'Initial Fill and Start-up'.

Header Tank

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

1. Using suitable lifting equipment, position header tank (1) on the platform and secure with bolts (4) and hardened washers (5).

2. Secure header tank (1) to mounting bracket (34) with bolts (2) and washers (5).

3. Slide hose (9) over bottom connection on header tank (1) and secure to header tank (1) and coolant pipe (12) with band clamps (10).

4. Connect deaeration lines (13, 14, 28 & 31) to elbows (3) and tighten lines securely.

5. Connect overflow tubing (6) to filler neck (22).

6. Connect electrical connection to float level switch (17).

Initial Fill and Start-up

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

1. Refer to Section 210-0000, COOLING SYSTEM for correct selection of heavy duty coolant.

2. Ensure drain cock (15, Fig. 1) is securely closed and fill the cooling system through filler neck (22) on header tank (1). Fill with coolant until coolant reaches the bottom of filler neck (22) and holds at that level.

3. Check all line and pipe connections for leaks prior to starting the vehicle. Tighten as required.

4. Start the engine and check for leaks. Tighten lines and fittings and top up coolant level as required. Window nut (11) should show full at all times. Fit filler cap (21).

5. Using suitable lifting equipment, position hood assembly on the vehicle and secure with mounting hardware removed during removal. Refer to Section 100-0010, CHASSIS, HOOD AND FENDERS.

6. Remove all wheel blocks.

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MAINTENANCE

Refer to Section 210-0000, COOLING SYSTEM for recommended preventive maintenance procedures, service intervals and coolant selection procedures.

Internal Cleaning - Water Tubes

If scale deposits are present inside the water tubes of the radiator, it is necessary to use a suitable scale remover such as 'Powdered Scale Solvent', or equivalent. This material is a free-flowing powder, inhibited to prevent attack on the cooling system materials.

WARNING
Take care to avoid contact of skin or eyes with the solvent. If contact is made it should be washed off immediately with clean water and medical advice should be taken.

For general cleaning use it is recommended to use a concentration of 50 - 100 kg/m³ of water at a temperature of up to 60° C. Rapid circulation or agitation with compressed air will reduce the time for cleaning.

Note: If scale deposits within the radiator are exceptionally heavy, concentrations up to 200 kg/m³ may be used.

The most convenient method of use is to prepare a concentrated solution by mixing the powder in hot water in a tank and then adding the concentrated solution to water contained in the radiator.

Note: The solvent must always be added carefully to water, not water to solvent.

External Cleaning

Note: If a build up of dirt is apparent during routine inspection, the following cleaning procedure should be adopted.

WARNING
To prevent possible injury when using compressed air or steam jet, wear adequate eye protection and do not exceed pressure values stated.

1. Direct a steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the faces of the radiator core assembly.

2. Liberally brush a liquid detergent on to those surfaces which were not satisfactorily cleaned at step 1. Leave to soak for at least 1 hour.

3. Apply a high pressure steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the treated surfaces, forcing the fouling material out from the radiator core assembly.

4. Leave radiator core assembly to dry before reinstalling the cooling equipment.

Note: In the case of grossly fouled surfaces which are not cleaned adequately in steps 1 through 4, the following procedure may be used.

5. Ensure that the radiator core assembly is dry.

6. Liberally brush on to both sides of the radiator core assembly an emulsifying cleaner such as 'Gunk', or equivalent, and leave to soak for at least 1 hour.

7. Apply a high pressure steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the treated surfaces, from several different angles, forcing the fouling material out from the radiator core assembly.

8. For surfaces with stubborn deposits, it may be necessary to repeat steps 5 through 7, brushing the surfaces between stages using a stiff bristle brush.

9. Leave radiator core assembly to dry before reinstalling the cooling equipment.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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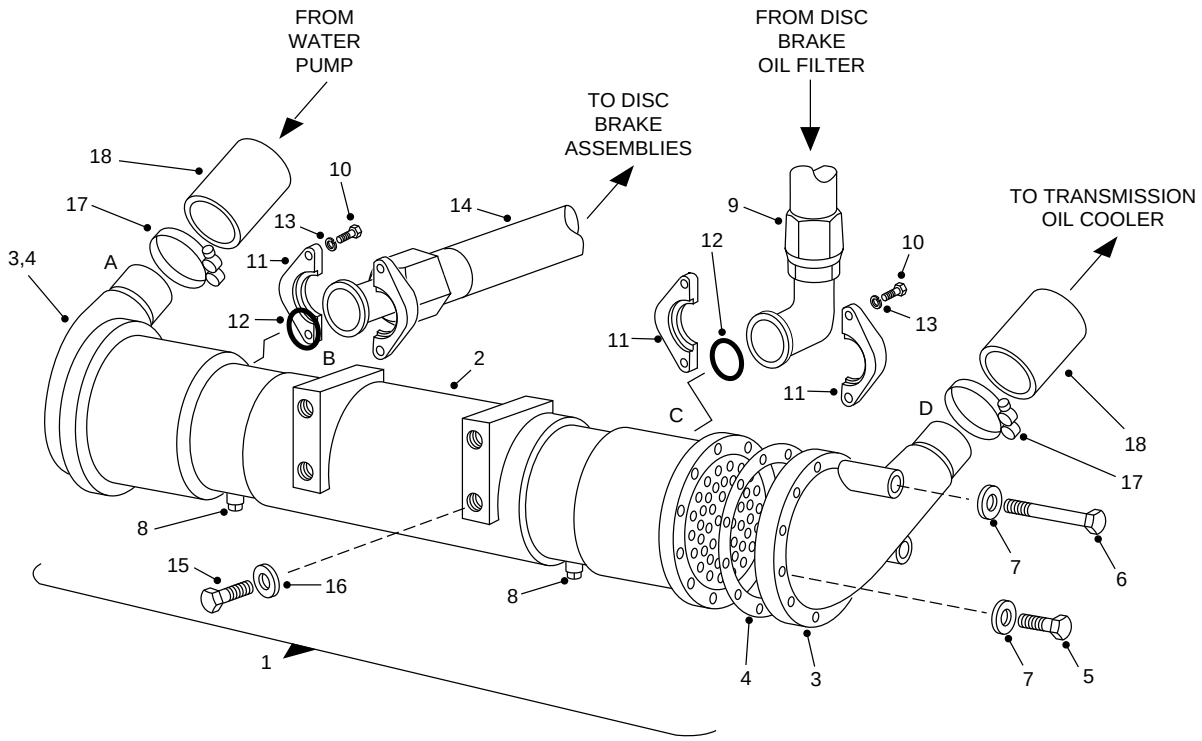
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1 - Disc Brake Oil Cooler
2 - Heat Exchanger
3 - Cooler Flange
4 - Gasket
5 - Bolt
6 - Bolt
7 - Lockwasher
8 - Drain Plugs
9 - Oil Line
10 - Bolt
11 - Split Flanges
12 - 'O' Ring
13 - Lockwasher
14 - Oil Line
15 - Bolt
16 - Washer
17 - Clamps
18 - Coolant Tubes

Fig. 1 - Exploded View of Disc Brake Oil Cooler

DESCRIPTION AND OPERATION

Numbers and letters in parentheses refer to Fig. 1.

The disc brake oil cooler is connected in the cooling system between the engine water pump outlet and transmission oil cooler. Refer to Section 210-0000, COOLING SYSTEM. The disc brake oil cooler is connected in the hydraulic system between disc brake filters and disc brake assemblies, and is used to cool disc brake cooling oil.

The disc brake oil cooler consists mainly of heat exchanger (2) and two cooler flanges (3), and is mounted at the engine front crossmember.

Coolant is pumped from the engine water pump to port 'A', circulates through cooler tubes in heat exchanger (2), and exits from port 'D' to the transmission oil cooler.

Disc brake cooling oil enters through port 'C' from the disc brake oil filter, circulates around cooler tubes in heat exchanger (2) and exits at port 'B' to the disc brakes.

Note: Oil flow must always flow in the opposite direction to coolant flow through the disc brake oil cooler.

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Cooling System - Disc Brake Oil Cooler

Section 210-0050

REMOVAL

Numbers in parentheses refer to Fig. 1.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure wheel blocks and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels.

3. Remove filler cap from body and disc brake cooling tank. With a suitable container in position, remove drain plug from the bottom of the body and disc brake cooling tank and drain the oil.

4. Using a suitable lifting device, support engine pan guard and remove attaching bolts, nuts, lockwashers and washers. Remove engine pan guard from truck.

5. Open drain cocks and drain cooling system. Refer to Section 210-0000, COOLING SYSTEM, for procedure.

6. Slacken bolts (5 & 6) securing cooler flanges (3) to heat exchanger (2) slowly, and drain coolant from disc brake oil cooler into a suitable container.

7. Remove drain plugs (8) on underside of disc brake oil cooler and drain oil into a suitable container.

8. Remove bolts (10), lockwashers (13) and split flanges (11) securing oil line (9) at port 'C'. Drain oil line (9) into a suitable container and discard 'O' ring (12). Cap oil line (9) end and port 'C' to prevent ingress of dirt.

9. Remove bolts (10), lockwashers (13) and split flanges (11) securing oil line (14) at port 'B'. Drain oil line (14) into a suitable container and discard 'O' ring (12). Cap oil line (14) end and port 'B' to prevent ingress of dirt.

10. Loosen clamps (17) and slide coolant tubes (18) off connections at ports 'A' and 'D'. Drain coolant tubes into a suitable container.

11. Support disc brake oil cooler with a suitable lifting device and remove bolts (15) and washers (16) securing disc brake oil cooler to mounting bracket on engine front crossmember. Lower disc brake oil cooler and remove to a clean work area for disassembly.

CLEANING AND DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: In the event of a major mechanical failure, transmission oil cooler assembly should be cleaned thoroughly or replaced. Do not attempt to clean cooler cores, after a transmission failure in which metal particles from worn or broken parts are released into the oil. Replace the cooler cores.

In many areas, raw water is extremely corrosive or scale forming and should be treated to prevent damage to the disc brake oil cooler. A properly maintained cooling system will significantly reduce cleaning intervals. Refer to Section 210-0000, COOLING SYSTEM.

Cleaning Oil Side

> **⚠ WARNING**
> **Dangerous fumes. To prevent personal injury, use trichloroethane only in the open or in a well ventilated room.**

1. Clean disc brake oil cooler before sludge hardens. After disc brake oil cooler is completely drained, circulate a solution of trichloroethane through the passages surrounding the cooler tubes in heat exchanger (2) to remove sludge.

2. If cooler tubes are badly clogged, circulate an oakite or alkaline solution through heat exchanger (2). Solution should be circulated through heat exchanger (2), in the reverse direction to normal flow, for approximately 15 minutes, after soaking for 10 minutes. The duration of circulation depends on how badly clogged the cooler tubes are. Flush thoroughly with clean hot water.

Cleaning Water Side

1. Match mark cooler flanges (3) and heat exchanger (2) to aid in assembly.

2. Remove bolts (5 & 6) and washers (7) securing cooler flanges (3) to heat exchanger (2). Remove cooler flanges (3) from heat exchanger (2) and discard gaskets (4).

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3. Make up a solution composed of 1/3 muriatic acid and 2/3 water. To each 9.5 litres (2.5 gal) of solution, add 227 g (0.5 lb) of oxalic acid.

4. Immerse heat exchanger (2) in the cleaning solution. Cleaning action is noticeable by bubbling and foaming. The process must be carefully observed and when bubbling stops, usually between 30 - 60 sec, remove heat exchanger (2) from cleaning solution and flush thoroughly with clean, hot water. After cleaning, dip disc brake oil cooler in light oil.

Note: Severely fouled cooler tubes can be cleaned by use of a rotary brush if normal cleaning is not sufficient.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Install new gaskets (4) to cooler flanges (3) and align cooler flanges (3) to heat exchanger (2) as match marked at disassembly. Secure with bolts (5 & 6) and washers (7) tightening alternately to give an even seal around cooler flange area.

2. Install drain plugs (8) in underside of heat exchanger (2).

INSTALLATION

Numbers and letters in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Using suitable lifting equipment, position disc brake oil cooler to mounting bracket on engine front crossmember and secure with bolts (15) and washers (16).

2. Install coolant tubes (18) on connections at ports 'A' and 'D' and secure with clamps (17).

3. Install new 'O' ring (12) on oil line (14) and secure oil line (14) to port 'B' with split flanges (11), bolts (10) and lockwashers (13).

4. Install new 'O' ring (12) on oil line (9) and secure oil line (9) to port 'C' with split flanges (11), bolts (10) and lockwashers (13).

5. Fill the body and disc brake cooling tank with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK for correct fill level. Install filler cap.

6. Ensure all drain cocks on the cooling system are securely locked and fill cooling system with coolant specified in Section 210-0000, COOLING SYSTEM.

7. Using suitable lifting equipment, install engine pan guard on the truck. Secure engine pan guard to the truck with bolts, lockwashers, washers and nuts.

8. Start the engine and check for leaks. Tighten lines and fittings as required.

9. Remove wheel blocks from all road wheels.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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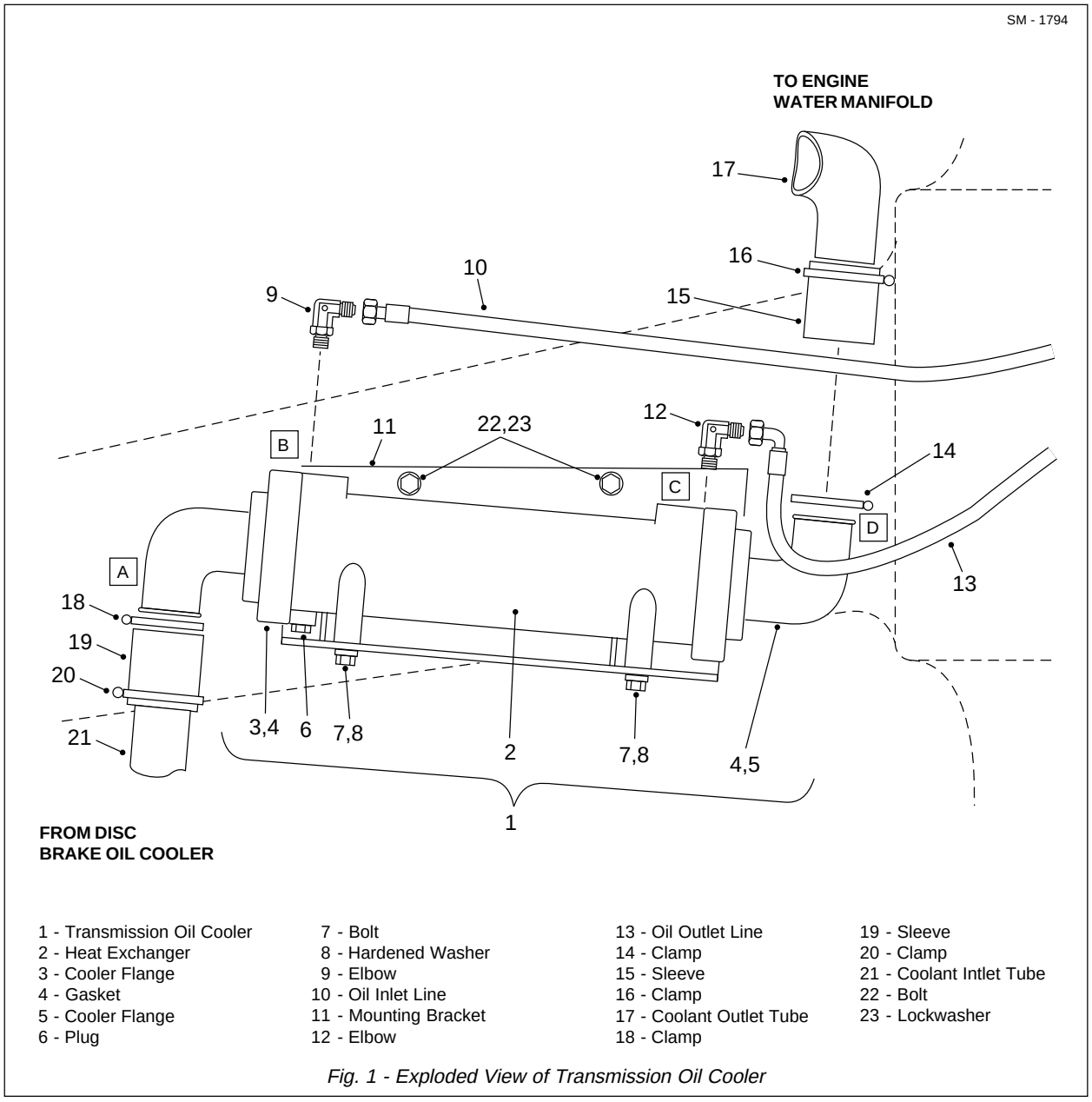
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1 - Transmission Oil Cooler
2 - Heat Exchanger
3 - Cooler Flange
4 - Gasket
5 - Cooler Flange
6 - Plug
7 - Bolt
8 - Hardened Washer
9 - Elbow
10 - Oil Inlet Line
11 - Mounting Bracket
12 - Elbow
13 - Oil Outlet Line
14 - Clamp
15 - Sleeve
16 - Clamp
17 - Coolant Outlet Tube
18 - Clamp
19 - Sleeve
20 - Clamp
21 - Coolant Intlet Tube
22 - Bolt
23 - Lockwasher

Fig. 1 - Exploded View of Transmission Oil Cooler

DESCRIPTION AND OPERATION

Numbers and letters in parentheses refer to Fig. 1.

The transmission oil cooler is connected between the radiator and transmission to maintain transmission oil within its required operating temperature range. Refer to Section 210-0000, COOLING SYSTEM.

Coolant enters port 'A' from the disc brake oil cooler, circulates through cooler tubes in heat exchanger (2), and exits at port 'D' to the engine water manifold.

Oil to be cooled enters port 'C' from the transmission convertor outlet port, circulates around cooler tubes in heat exchanger (2), and exits at port 'B' to the transmission convertor inlet port.

Note: Oil flow must always flow in the opposite direction to coolant flow through transmission oil cooler.

Transmission oil temperature switch, located on the left hand side of the transmission, sends a signal to illuminate the transmission oil temperature warning light (on the dash panel) when transmission oil temperature rises above the safe operating temperature.

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REMOVAL

Numbers in parentheses refer to Fig. 1.

> **WARNING**
> **To prevent personal injury and property damage, be sure wheel blocks and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. Position the vehicle in a level work area, apply the parking brake and shutdown the engine.

2. Turn the steering wheel in both directions several times to relieve pressure in the steering system. Block all road wheels.

3. Open drain cocks and drain the cooling system. Refer to Section 210-0000, COOLING SYSTEM, for procedure.

4. Remove drain plug from underside of the transmission and drain transmission oil into a suitable container.

5. Loosen clamps (18 & 20) and slide sleeve (19) over coolant inlet tube (21) from connection at port 'A'. Drain coolant from port 'A' and coolant inlet tube (21) into a suitable container.

6. Loosen clamps (14 & 16) and slide sleeve (15) over coolant outlet tube (17) from connection at port 'D'. Drain coolant from coolant outlet tube (17) into a suitable container.

7. Remove drain plugs (6) on underside of transmission oil cooler (1) and drain oil into a suitable container.

8. Remove oil inlet line (10) from elbow (9). Drain oil inlet line (10) into a suitable container. Cap oil inlet line (10) to prevent entry of dirt.

9. Remove elbow (9) from port 'B'. Plug port 'B' to prevent entry of dirt.

10. Remove oil outlet line (13) from elbow (12). Drain oil outlet line (13) into a suitable container. Cap oil outlet line (13) to prevent entry of dirt.

11. Remove elbow (12) from port 'C'. Plug port 'C' to prevent entry of dirt.

12. Support transmission oil cooler (1) with a suitable lifting device and remove bolts (7) and hardened washers (8) securing transmission oil cooler (1) to mounting bracket (11) located on right hand frame rail. Lower transmission oil cooler (1) and remove to a clean work area for disassembly.

CLEANING AND DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: In the event of a major mechanical failure, transmission oil cooler (1) assembly should be cleaned thoroughly or replaced. Do not attempt to clean cooler cores, after a transmission failure in which metal particles from worn or broken parts are released into the oil. Replace the cooler cores.

In many areas, raw water is extremely corrosive or scale forming and should be treated to prevent damage to transmission oil cooler (1). A properly maintained cooling system will significantly reduce cleaning intervals. Refer to Section 210-0000, COOLING SYSTEM.

Cleaning Oil Side

> **WARNING**
> **Dangerous fumes. To prevent personal injury, use trichloroethane only in the open or in a well ventilated room.**

1. Clean transmission oil cooler (1) before sludge hardens. After transmission oil cooler (1) is completely drained, circulate a solution of trichloroethane through the passages surrounding the cooler tubes in heat exchanger (2) to remove sludge.

2. If cooler tubes are badly clogged, circulate an oakite or alkaline solution through heat exchanger (2). Solution should be circulated through heat exchanger (2), in the reverse direction to normal flow, for approximately 15 minutes, after soaking for 10 minutes. The duration of circulation depends on how badly clogged the cooler tubes are. Flush thoroughly with clean hot water.

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Cleaning Water Side

1. Match mark cooler flanges (3 & 5) and heat exchanger (2) to aid in assembly.

2. Remove bolts securing cooler flanges (3 & 5) to heat exchanger (2). Remove cooler flanges (3 & 5) from heat exchanger (2) and discard gaskets.

3. Make up a solution composed of 1/3 muriatic acid and 2/3 water. To each 9.5 litres (2.5 gal) of solution, add 227 g (0.5 lb) of oxalic acid.

4. Immerse heat exchanger (2) in the cleaning solution. Cleaning action is noticeable by bubbling and foaming. The process must be carefully observed and when bubbling stops, usually between 30 - 60 sec., remove heat exchanger (2) from cleaning solution and flush thoroughly with clean, hot water. After cleaning, dip heat exchanger (2) in light oil.

Note: Severely fouled cooler tubes can be cleaned by use of a rotary brush if normal cleaning is not sufficient.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners, without special torques specified, to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Install new gaskets to cooler flanges (3 & 5) and align cooler flanges (3 & 5) to heat exchanger (2), as match marked at disassembly. Secure with bolts tightening alternately to give an even seal around cooler flange area.

2. Install drain plug (6) in underside of heat exchanger (2).

INSTALLATION

Numbers and letters in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Using suitable lifting equipment, position transmission oil cooler (1) to mounting bracket (11) on the right hand frame rail and secure with bolts (7) and hardened washers (8).

2. Install elbow (9) on port 'B'. Secure oil line (10) to elbow (9).

3. Install elbow (12) on port 'C'. Secure oil outlet line (13) to elbow (12).

4. Install coolant outlet tube (17) on connection at port 'D' and secure with sleeve (15) and clamps (14 & 16).

5. Install coolant inlet tube (21) on connection at port 'A' and secure with sleeve (19) and clamps (18 & 21).

6. Install drain plug in underside of transmission and fill transmission with transmission oil specified in Section 300-0020, LUBRICATION SYSTEM.

7. Ensure all drain cocks on the cooling system are securely locked and fill cooling system with coolant, specified in Section 210-0000, COOLING SYSTEM.

8. Start up engine and check for leaks. Tighten lines and fittings as required.

9. Remove wheel blocks from all road wheels.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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DESCRIPTION

Numbers in parentheses refer to Figs. 2 through 6.

The steering system is of the accumulator type which provides uniform steering, regardless of engine speed, and provides a limited amount of reserve steering pressure should the engine stall.

A brief description of the individual components used in the steering system are listed below. Detailed service and operating instructions for the individual components can be found in their relative component sections in this manual.

Steering and Brake Control Tank (1)

Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK.

The steering and brake control tank is the common oil reservoir for the steering system and the brake control system. It is mounted off the LH frame rail beside the main hydraulic tank.

An **Oil Level Switch (9)**, mounted at the rear of the tank, is used to indicate low oil level in the tank. The switch terminal is wired to a warning light on the right hand dash panel.

Steering Pump (2)

Refer to Section 220-0050, STEERING PUMP.

The steering pump is an axial piston, variable displacement (adjustable) pump, capable of high pressure operation. Mounted off the transmission power takeoff the steering pump is the common pressure supply to both the steering and brake control systems. Output is controlled to meet system requirements at any given time.

A compensator valve assembly regulates system pressure at 159 bar (2 300 lbf/in^2).

The steering pump is assembled for right hand (clockwise) rotation, as viewed from the driveshaft end.

Note: Never drive a pump in the wrong direction of rotation, as pump seizure may result.

Accumulator (3)

Refer to Section 220-0080, ACCUMULATOR.

The accumulator is of the piston type and is precharged with Nitrogen to 55 bar (800 lbf/in^2).

Mounted off the frame at the rear of the steering and brake control tank, the accumulator assembly consists of a charging valve, end cap, cylinder and piston.

The charging valve is equipped with a locking feature which, when opened, will allow the precharge to be checked or the accumulator charged. The piston acts as a separator dividing the cylinder into two sections.

The section nearest the charging valve contains the nitrogen precharge. The other section receives the hydraulic oil from the steering pump, via accumulator valve (4).

Accumulator Valve (4)

Refer to Section 220-0130, ACCUMULATOR VALVE.

Note: The relief valve cartridge can be replaced only as an assembly.

Incorporated in this assembly are three valves; a check valve, accumulator two-way valve and a system pressure protection valve.

An accumulator two-way valve is located in the centre portion of the assembly. In the operating position, engine running and two-way valve energized, this valve allows the accumulator to retain its pressure. In its non-operating position, engine shutdown and two-way valve de-energized, a controlled bleed-down of the accumulator pressure to the steering and brake control tank occurs. This bleed-down takes 3 to 5 minutes.

A relief valve cartridge, at the lower portion of the assembly, is preset to 207 bar (3 000 lbf/in^2) and seated. This valve acts as a backup in the event of a malfunction of the steering pump compensator valve. Should the compensator valve allow steering system pressure to exceed the preset pressure of the relief valve cartridge, valve will open and relieve excess oil pressure to the steering and brake control tank.

Steering Valve (5)

Refer to Section 220-0090, STEERING VALVE.

The steering valve is mounted to the cab firewall and is connected to the steering column, and controls hydraulic flow in the steering system. The steering valve is a closed centre orbitrol type valve. Closed centre means that the valve does not have any flow through it when it is in the neutral or no steering position.

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Double Relief Valve (6)

Refer to Section 220-0110, DOUBLE RELIEF VALVE.

The double relief valve is installed in the lines between the steering cylinders and the steering valve. Its purpose is to relieve shock loads on the steering cylinders by transferring the excessive pressure applied to the oil by the road shock, to the opposite end of the cylinders. This shock, if left unchecked, might damage steering linkage components.

The double relief valve pressure setting is 172 bar (2 500 lbf/in^2)

Steering Cylinder (7)

Refer to Section 220-0120, STEERING CYLINDER.

There are two single stage, double acting steering cylinders installed on the machine. These exert the necessary hydraulic force on the steering linkage to pivot the front wheels. Single stage, double acting means that the piston rod can have oil applied to either side, extending or retracting the piston rod.

Pressure Switch (8)

Refer to Section 220-0130, ACCUMULATOR VALVE.

The normally closed (NC) oil pressure switch is located in a tee at port 'G2' of the accumulator valve and illuminates a dash mounted indicator lamp when the steering pressure drops to 83 bar (1 200 lbf/in^2), or lower.

Oil Pressure Switch (10) and Oil Temperature Switch (11)

The normally open (NO) oil pressure switch is located beside the oil temperature switch in the manifold block at the return port of the steering and brake control tank. The oil pressure switch will close and illuminate an indicator lamp on the right hand dash panel when the restriction pressure exceeds 2.7 bar (39 lbf/in^2), indicating a filter change is required.

The normally open (NO) oil temperature switch closes when a temperature of 50° C (122° F) is reached. The oil temperature switch is connected in series with the oil pressure switch, therefore, the steering filter restriction indicator light will not illuminate until the oil reaches normal operating temperature.

Steering Filter (12)

Refer to Section 220-0150, STEERING FILTER.

The steering filter is mounted off the rear left hand side transmission mounting bracket. It is connected in the steering line between the accumulator valve and the steering valve.

There are two external ports ‘A’ and ‘B’ and an internal bypass port ‘C’ in the steering filter assembly.

Pressure Test Point

A diagnostic pressure test point at the rear left hand cab support provides a quick and easy method of checking the steering system pressure. The pressure is taken from a tee at port 'G2' of the accumulator valve and system pressure is 159 bar (2 300 lbf/in^2).

'O' RING FACE SEALS (ORFS)

Where hydraulic lines are fitted with ORFS connections, the following procedure should be carried out during 'Installation'. Refer to Fig. 1.

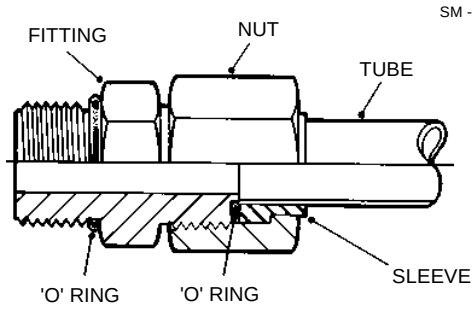


Fig. 1 - Assembly of Typical ORFS Connector

a. Ensure 'O' ring/seal is in place and that joining surfaces are clean. If necessary, retain 'O' ring/seal in place with a light coating of grease or vaseline.

b. Initially, the nuts should be tightened by hand.

c. Where a hose is fitted, ensure that it is not twisted or kinked when the nuts are tightened so that it is allowed to adopt a natural position.

d. Where a tube is fitted, ensure that the connection is aligned correctly.

e. Tighten the nut a further 1/4 to 1/2 a turn using the correct size spanner (wrench).

f. Check that a satisfactory hose or tube routing has been achieved.

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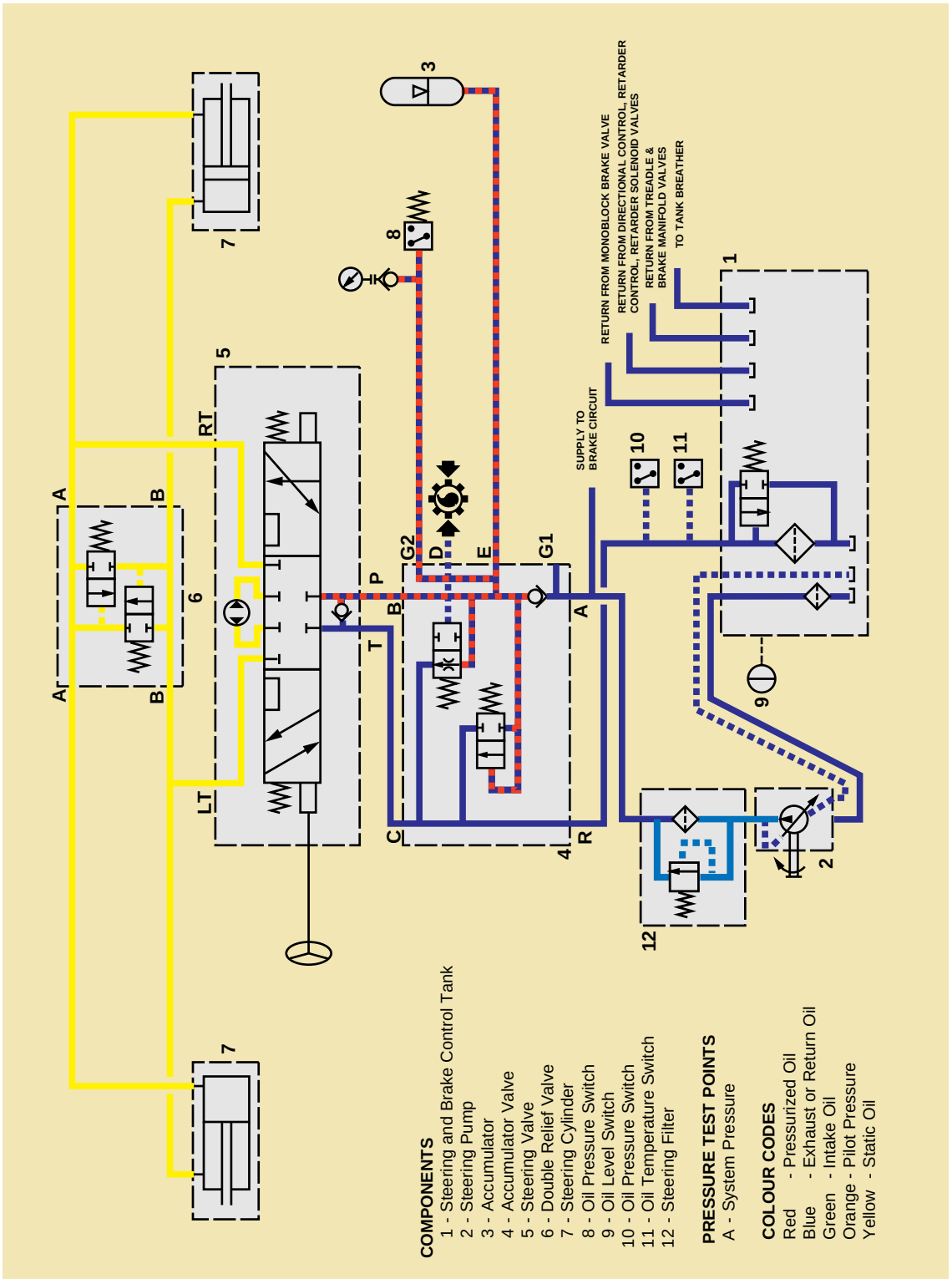


Fig. 2 - Steering System Schematic - Engine Shutdown

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Steering System - Steering System Schematic

Section 220-0000

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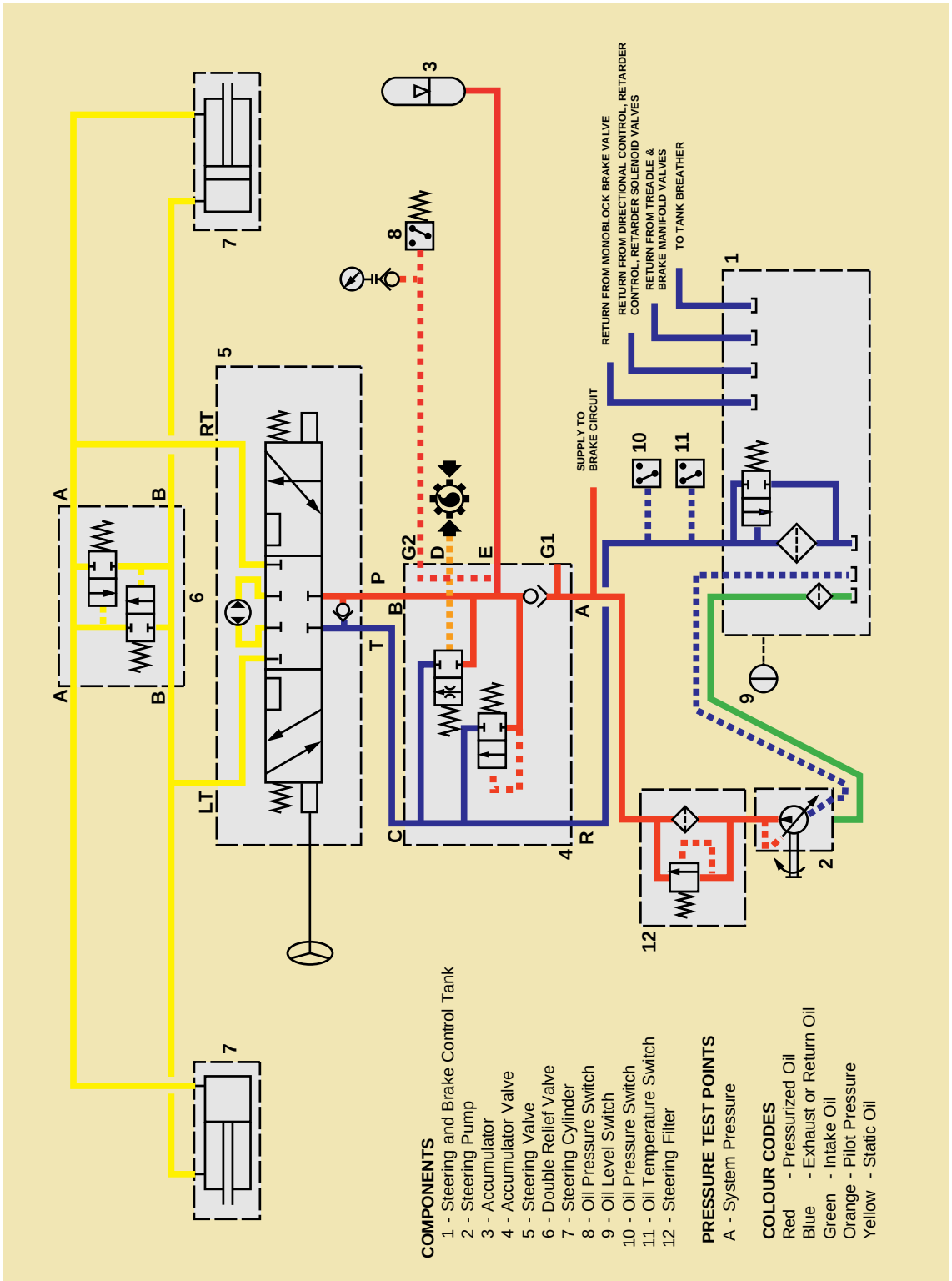


Fig. 3 - Steering System Schematic - Engine Running, Steering Valve Neutral

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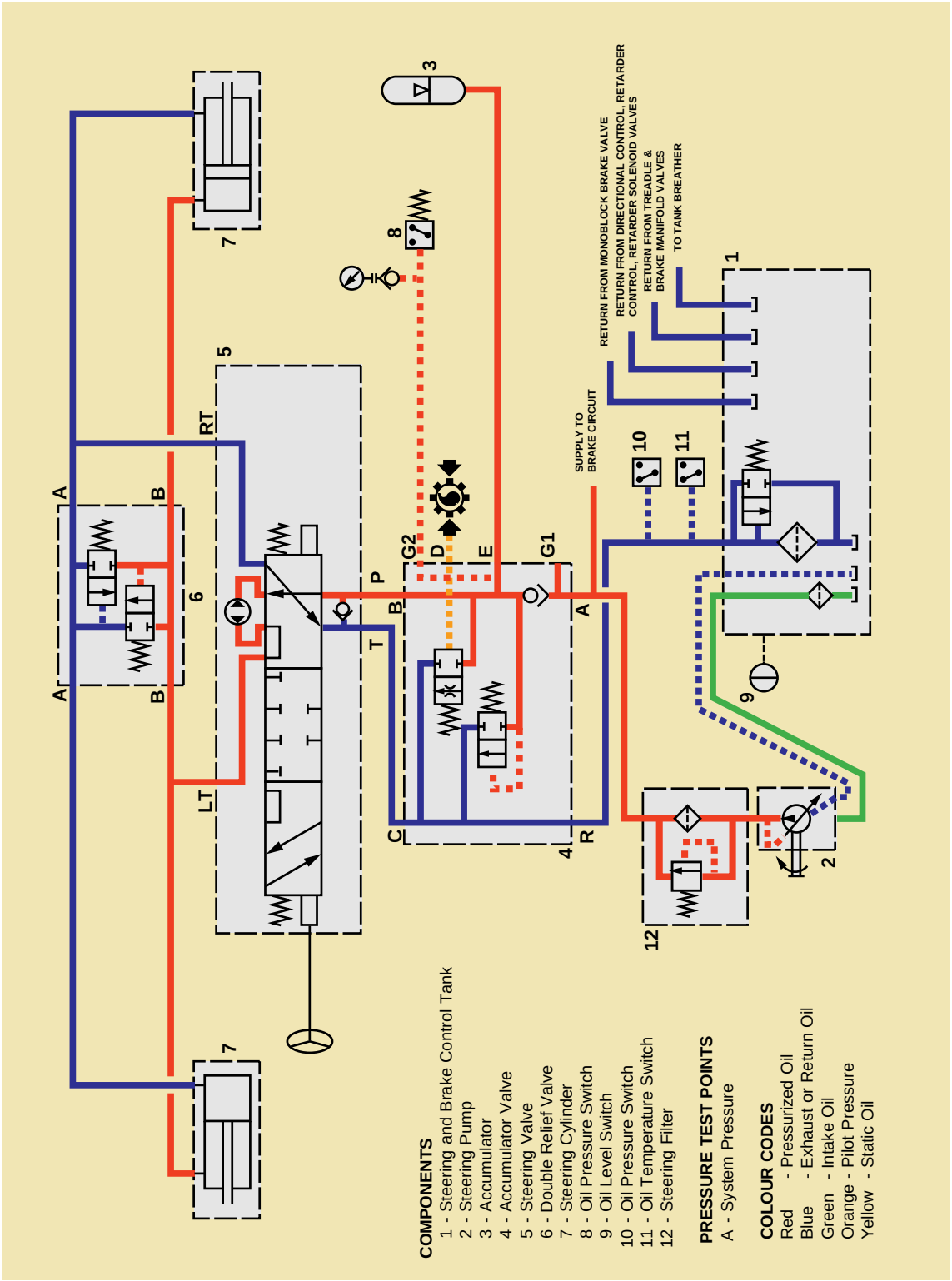


Fig. 4 - Steering System Schematic - Engine Running, Steering Valve Left Turn

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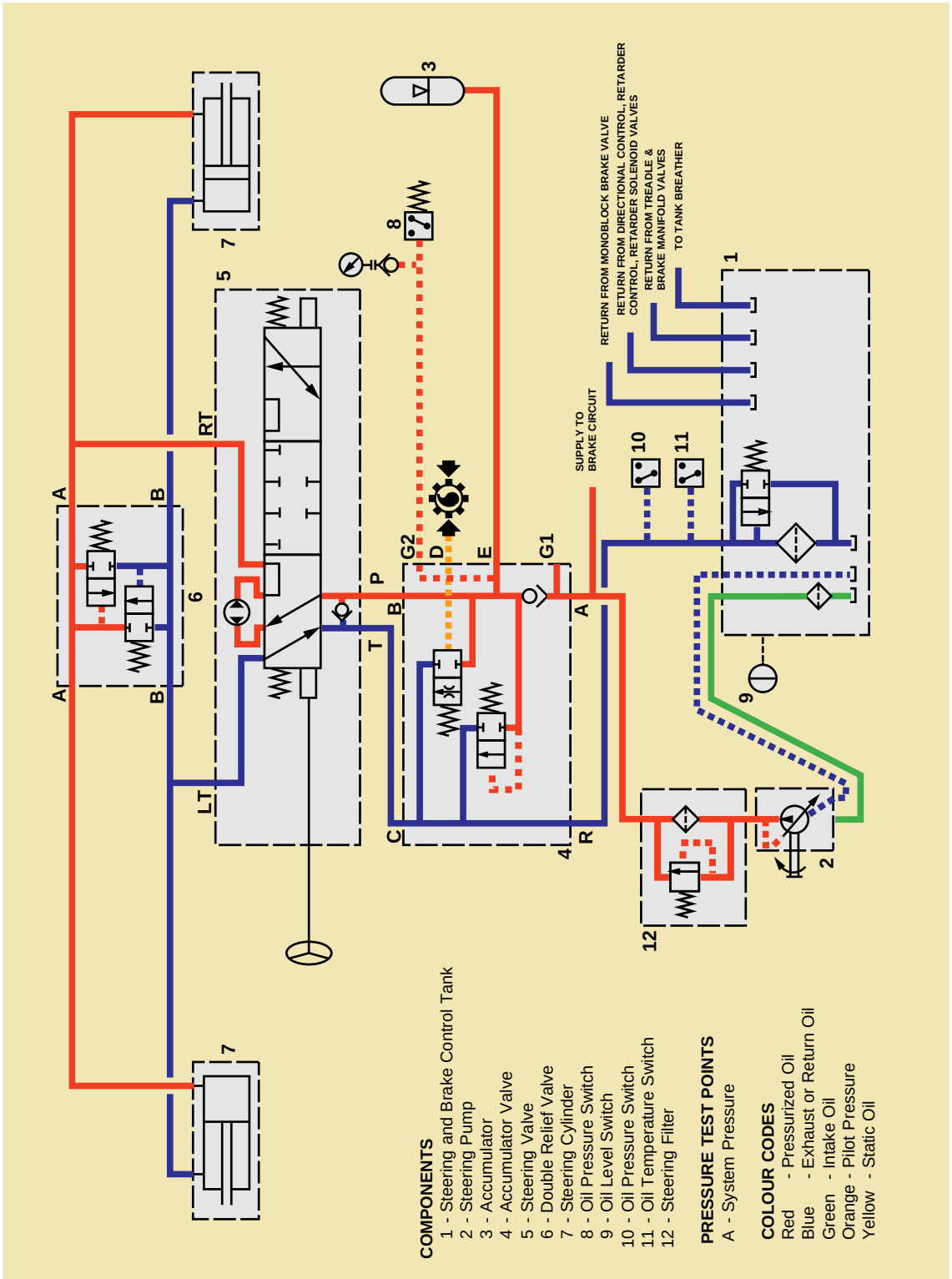


Fig. 5 - Steering System Schematic - Engine Running, Steering Valve Right Turn

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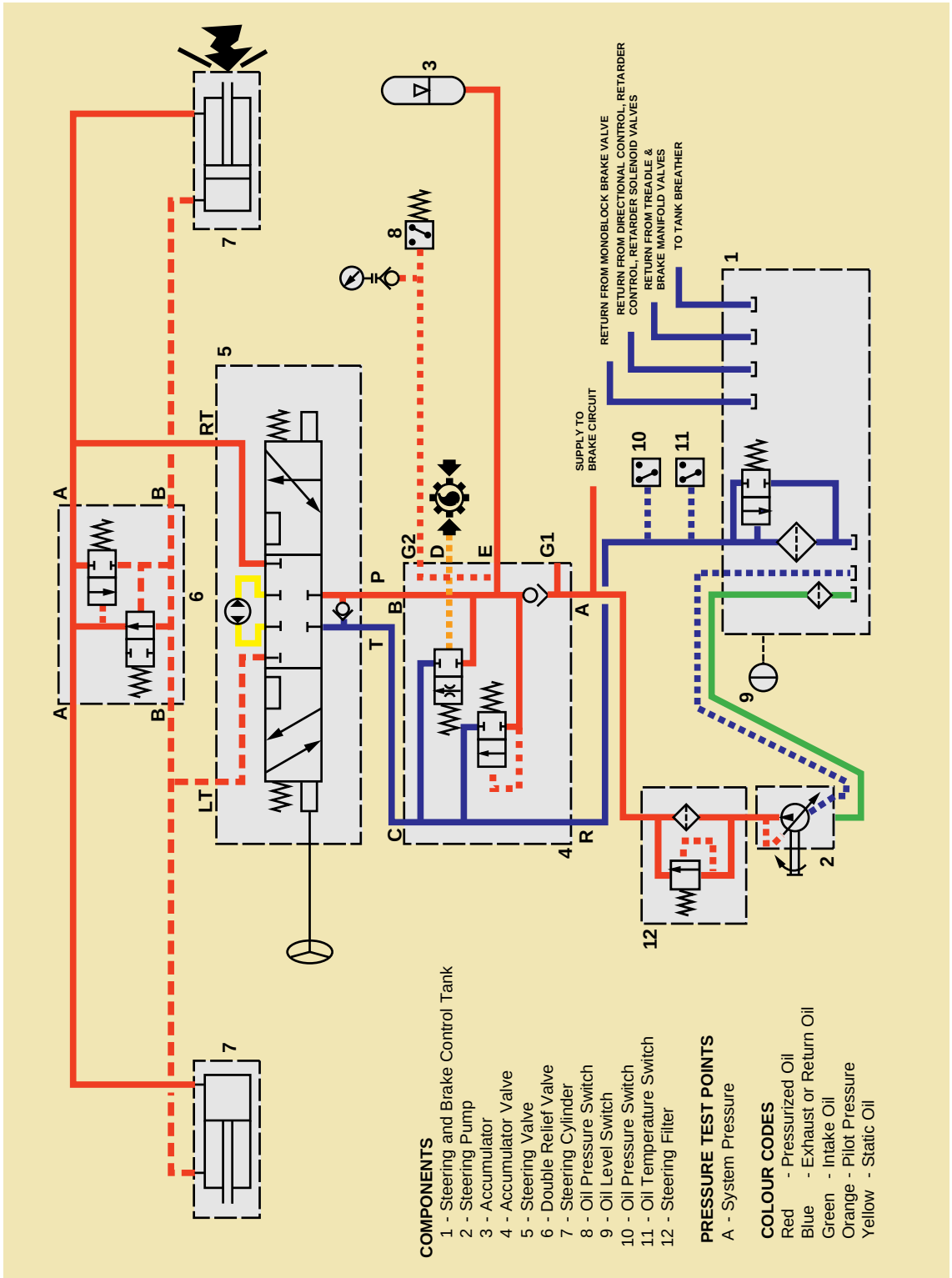


Fig. 6 - Steering System Schematic - Engine Running, Steering Cylinder Shock Load

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RELIEVING SYSTEM PRESSURE

⚠ WARNING
The steering system is equipped with an accumulator which maintains pressure in the system, even after engine shutdown. To prevent possible personal injury, follow the procedure for relieving the pressure and exercise extreme caution when loosening the steering lines.

1. Apply the parking brake and shut off the engine.

2. Turn steering wheel in both directions until the pressure is relieved in the steering system (pressure at the steering system diagnostic test point should be 0 bar (0 lbf/in^2)).

SERVICE TOOLS

It is recommended that the following tools are used when carrying out pressure or temperature checks during maintenance procedures. These tools, along with other general service tools, are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of these tools.

Multi-gauge

The multi-gauge is basically four pressure gauges in one. Continuous system pressure readings are indicated on one of three simultaneously reading gauges through a pressure range of 762 mm (30 in) of vacuum to 345 bar (5 000 lbf/in^2).

Non-contact Infrared Thermometer

The infrared thermometer can be used to spot heat problems early in electrical, mechanical and hydraulic systems. Hand held and easy to use, you simply aim, pull the trigger, and read the temperature. Since there is no need to touch what you are measuring, temperatures of hard-to-reach or moving components can be taken without getting burned or shocked.

STEERING SYSTEM DIAGNOSIS

CONDITION	REASON	REMEDY
Slow response or hard steering.	Wear or damage to front axle linkage.	Make necessary adjustment and/or replace defective parts. Refer to Section 220-0120, STEERING CYLINDER AND LINKAGE.
	Low steering oil level.	Fill steering and brake control tank to proper level. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK.
	Steering pump not delivering proper pressure.	Adjust pressure as described in Section 220-0050, STEERING PUMP.
	Defective steering cylinder.	Replace steering cylinder. Refer to Section 220-0120, STEERING CYLINDER AND LINKAGE.
	Defective line(s) in the steering system.	Repair or replace faulty line(s) or fitting(s).
	Contaminated filter in steering tank.	Replace oil filter. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK.
	Malfunctions in steering valve, accumulator valve or double relief valve.	Check out each of the valves. Refer to the appropriate Section for repair/replacement procedures.
	Incorrect tyre inflation.	Refer to Section 140-0040, WHEEL, RIM AND TYRE for inflation procedure and pressures.
	Low pressure in front ride cylinders.	Refer to Section 180-0030, RIDE CYLINDER for servicing procedure.
	Lack of lubrication.	Refer to Section 300-0020, LUBRICATION SYSTEM for lubrication points, lubricant specifications and service intervals.

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STEERING SYSTEM DIAGNOSIS (Continued)		
CONDITION	REASON	REMEDY
No steering response.	Completely failed steering pump.	Repair or replace steering pump and set at recommended pressure. Refer to Section 220-0050, STEERING PUMP.
	Burst hydraulic line in steering system.	Isolate defective line and replace with new one. Check steering and brake control tank oil level and add oil as necessary. Also, check for contamination in the system.
	Failed steering valve.	Repair or replace steering valve. Refer to Section 220-0090, STEERING VALVE.
	Completely contaminated steering system.	Drain and flush entire steering system. Check all component valves, cylinders, tank, etc.. Install new filters and refill system to correct level with fresh hydraulic fluid. Check new filter frequently.
Opposite steering.	Hydraulic lines connected incorrectly.	Reconnect lines as necessary. Refer to schematics.

* * * *

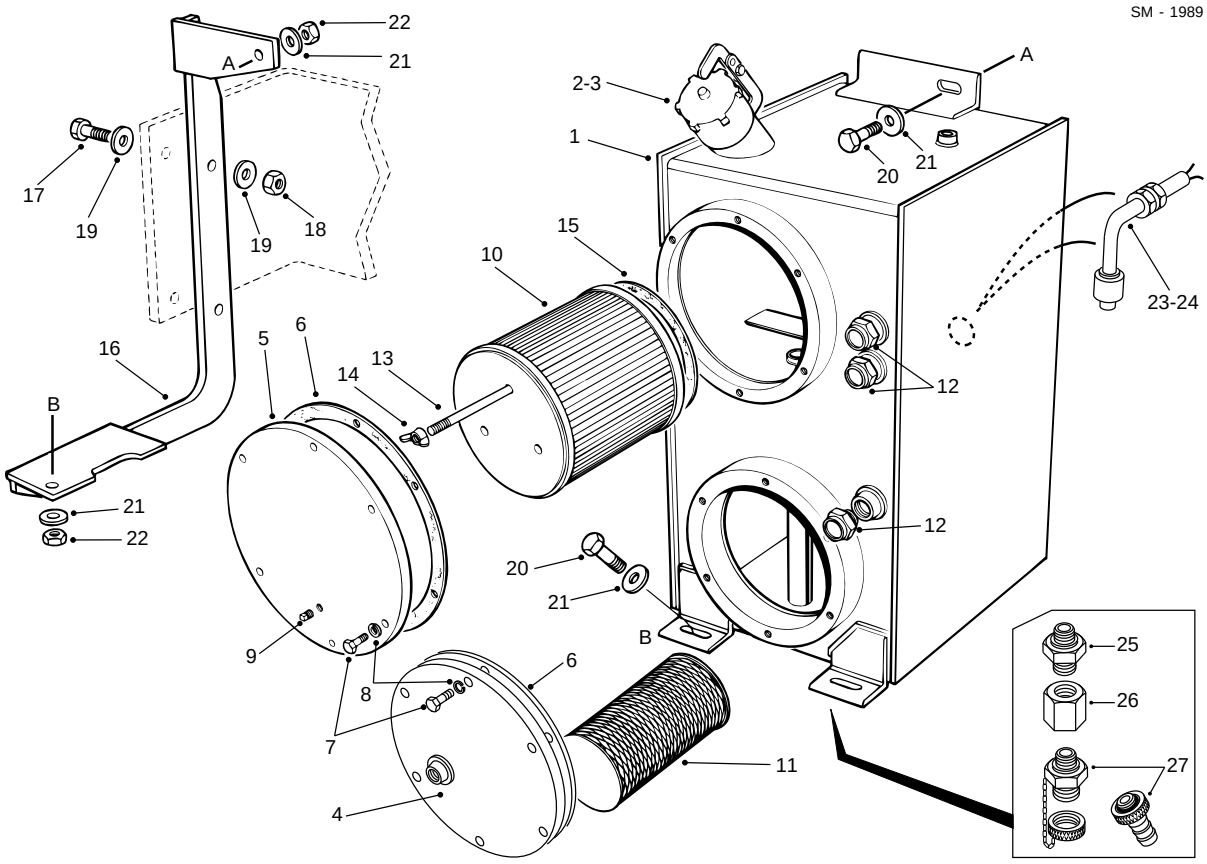
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1 - Tank	8 - Lockwasher	15 - Gasket	22 - Nut
2 - Filler Cap	9 - Plug	16 - Bracket	23 - Oil Level Switch
3 - Gasket	10 - Filter Assembly	17 - Bolt	24 - Seal
4 - Access Cover	11 - Suction Screen	18 - Nut	*25 - Adaptor
5 - Access Cover	12 - Window Nut	19 - Washer	*26 - Valve
6 - Gasket	13 - Rod	20 - Bolt	*27 - Drain Plug Kit
7 - Bolt	14 - Wing Nut	21 - Hardened Washer	

* - Optional

Fig. 1 - Exploded View of Steering and Brake Control Tank

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The Steering and Brake Control Tank can be identified as item 1 in Section 220-0000, STEERING SYSTEM SCHEMATIC, in this manual.

The steering and brake control tank (1) is the common oil reservoir for the steering and brake control systems. It is mounted off the left hand frame rail beside the main hydraulic tank.

Integral with tank (1) assembly are filter assembly (10), suction screen (11), window nuts (12) and oil level switch (23). Access covers (4 & 5) give easy access to replace filter assembly (10) and suction screen (11).

OPERATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified. Letters in parentheses refer to Fig. 3. Refer to Fig. 2 for hydraulic schematic of steering and brake control tank.

The steering and brake control oil flow is drawn from port 'A', through suction screen (11), by the steering pump mounted on the transmission power takeoff. Oil is then pumped to the accumulator valve in the steering circuit and the brake manifold valve in the brake control circuit. Internal pump leakage oil is returned to tank (1) at port 'B' from a line at the case drain port on the steering pump.

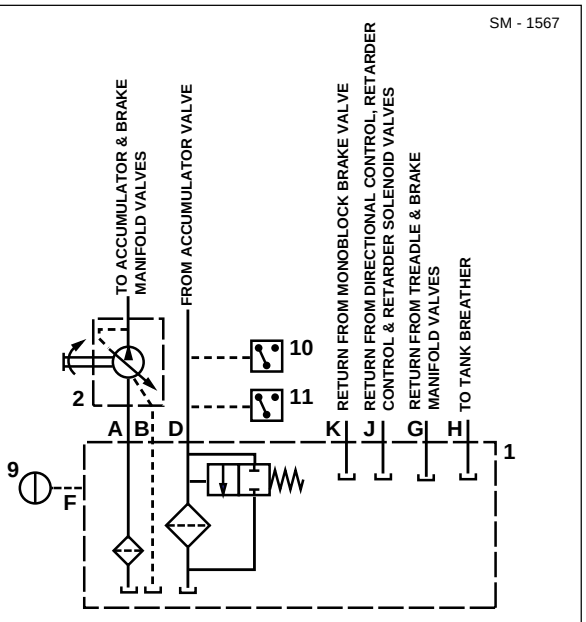
Port 'C' is plugged and provides a tank drain point.

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Steering System - Steering and Brake Control Tank

Section 220-0040



1 - Tank
2 - Steering Pump
9 - Oil Level Switch
10 - Oil Pressure Switch
11 - Oil Temperature Switch

Fig. 2 - Hydraulic Schematic

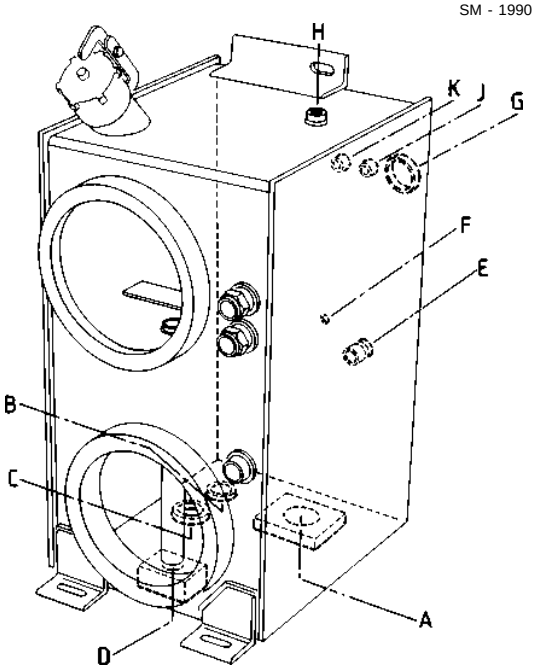


Fig. 3 - Port Locations

Return oil from the steering circuit enters the tank at port 'D' from the accumulator valve. The oil enters filter assembly (10) chamber and flows through a centre tube and filter element to tank (1) body.

Should filter assembly (10) become blocked, oil restriction pressure will increase and oil pressure switch (10, Fig. 2) will close sending a signal to the steering filter restriction warning light on the right hand dash panel, indicating that a filter change is required.

Note: Temperature switch (11, Fig. 2) opens when a temperature of 50° C (122° F) is reached. Temperature switch (11, Fig. 2) is connected in series with pressure switch (10, Fig. 2), therefore, steering filter restriction warning light will not illuminate until the oil reaches normal operating temperature.

Port 'E' is plugged.

A float oil level switch (23) is located in port 'F' and sends an electrical signal to a warning light on the RH dash panel to indicate when the oil level falls below the safe operating level.

Return oil from the brake treadle valve and brake manifold valve enters tank (1) at port 'G'.

A breather line at port 'H' is connected to a common tank breather mounted on top of the body and disc brake cooling tank. This allows any air entering tank (1) to be released to atmosphere, preventing a pressure build up in tank (1) assembly. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK.

Return oil from the directional control valve, retarder control valve and retarder solenoid valve enters tank (1) at port 'J'.

Return oil from the monoblock brake valve enters tank (1) at port 'K'.

An inter-connecting hose assembly (3, Fig. 4) links the steering and brake control tank and the body and disc brake cooling tank. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Checking Oil Level

Cold check: With the engine off, operate the steering left and right to discharge the steering accumulator.

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Operate treadle valve continuously to discharge braking accumulators. Oil should be showing in middle window nut (12).

If oil is required, remove filler cap (2) and fill tank (1) with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM, until oil shows in bottom window nut (12). Fit filler cap (2).

Hot check: With the engine running, oil at normal operating temperature and accumulators charged, oil must be between top and middle window nuts (12). Switch off the engine and operate the steering left and right to discharge the steering accumulator. Operate treadle valve continuously to discharge braking accumulators. Oil should show in top window nut (12).

If oil is required, remove filler cap (2) and fill tank (1) with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM, until oil shows in top window nut (12). Fit filler cap (2).

Replacing Hydraulic Oil

Tank (1) assembly should be drained, cleaned and refilled with clean hydraulic oil at the recommended service interval specified in Section 300-0020, LUBRICATION SYSTEM. Use only hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM.

Note: When oil in tank (1) is being replaced due to overheated oil, hydraulic component failure, or at recommended change interval, filter assembly (10) should be replaced.

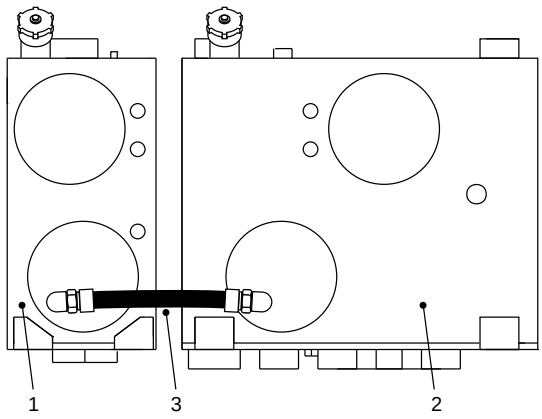
Changing Filter Assembly

Change filter assembly (10) at interval specified in Section 300-0020, LUBRICATION SYSTEM.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve any pressure in the steering system.



1 - Steering and Brake Control Tank
2 - Body and Disc Brake Cooling Tank
3 - Inter-Connecting Hose Assembly

Fig. 4 - Layout View of Hydraulic Tanks

Operate treadle valve continuously to discharge braking accumulators. Block all road wheels.

3. With suitable containers in position, remove drain plugs from tank (1) and body and disc brake cooling tank (2, Fig. 4) and drain the oil. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK. Reinstall drain plugs in tanks and tighten securely.

4. Remove bolts (7), lockwashers (8), access cover (5) and gasket (6) from tank (1). Discard gasket (6).

5. Remove wing nuts (14) from rods (13). Remove and discard filter assembly (10) and gasket (15) from tank (1).

6. Install new gasket (15) and filter assembly (10) in tank (1) and secure with wing nuts (14).

7. Install new gasket (6) and access cover (5) on tank (1) and secure with bolts (7) and lockwashers (8).

8. Fill tank (1) to correct level with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (2).

9. Remove wheel blocks, start the engine and charge the steering and brake control systems. Check oil level as described under 'Checking Oil Level'.

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Removing Suction Screen

Remove and clean suction screen (11) at interval specified in Section 300-0020, LUBRICATION SYSTEM.

WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Operate treadle valve continuously to discharge braking accumulators. Block all road wheels.

3. With suitable containers in position, remove drain plugs from tank (1) and body and disc brake cooling tank (2, Fig. 4) and drain the oil. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK. Reinstall drain plugs in tanks and tighten securely.

4. If required, remove inter-connecting hose (3, Fig. 4) from access cover (4). Fit blanking caps and plugs to hydraulic line and tank port. Remove bolts (7), lockwashers (8), access cover (4) and gasket (6) from tank (1). Discard gasket (6).

5. Reach inside tank (1) and unscrew suction screen (11) by turning hex head at the neck of suction screen (11).

WARNING
Splashing liquid. Wear a suitable face shield when using compressed air to dry tank and components.

6. Clean suction screen (11) and tank (1) with paraffin and dry with compressed air. Inspect for damage and renew if necessary.

7. Install suction screen (11) in tank (1) and secure by turning on hex head at the neck of suction screen (11).

8. Install new gasket (6) and access cover (4) on tank (1) and secure with bolts (7) and lockwashers (8). Remove blanking cap and plug and install inter-connecting hose (3, Fig. 4).

9. Fill tank (1) to correct level with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (2).

10. Remove wheel blocks, start the engine and charge the steering and brake control systems. Check oil level as described under 'Checking Oil Level'.

TANK ASSEMBLY

Removal

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Operate treadle valve continuously to discharge braking accumulators. Block all road wheels.

3. With suitable containers in position, remove drain plugs from tank (1) and body and disc brake cooling tank (2, Fig. 4) and drain the oil. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK. Reinstall drain plugs in tanks and tighten securely.

4. Ensure all hydraulic lines connected to tank (1) assembly are identified for ease of installation and, with suitable containers available to catch leakage, disconnect all hydraulic lines. Fit blanking caps and plugs to all hydraulic lines and tank ports.

5. Remove and tag electrical connections from oil level switch (23), oil temperature switch (12, Fig. 2) and oil pressure switch (11, Fig. 2).

WARNING
Heavy tank. Ensure lifting device is of adequate capacity and properly secured to avoid personal injury or property damage.

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6. Using suitable lifting equipment, support tank (1) assembly. Remove bolts (20), hardened washers (21) and nuts (22) securing tank (1) assembly to mounting brackets (16).

7. Remove tank (1) assembly to a suitable work area for disassembly.

Disassembly

Numbers in parentheses refer to Fig. 1.

1. Remove internal components from tank (1) assembly as described in 'Maintenance'.

2. If required, remove rods (13) and window nuts (12) from tank (1) assembly.

3. If required, remove oil level switch (23) from inside of tank (1) and discard seal (24).

Inspection

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
Splashing liquid. Wear a suitable face shield when using compressed air to dry tank and components.

1. Clean tank (1) and components with paraffin and dry with compressed air.

2. Inspect tank (1) for weld cracks and security of internal pipes and weld fitments.

3. Check suction screen (11) for damage and renew if necessary.

Assembly

Numbers in parentheses refer to Fig. 1.

1. If removed, install window nuts (12) and rods (13) in tank (1).

2. If removed, install new seal (24) on oil level switch (23) and install level switch assembly in tank (1).

3. Install all internal components as previously described in 'Maintenance'. Renew filter assembly (10) and gaskets (6 & 15).

Installation

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNING
Heavy tank. Ensure lifting device is of adequate capacity and properly secured to avoid personal injury or property damage.

1. Using suitable lifting equipment, position tank (1) assembly on mounting brackets (16) and secure with bolts (20), hardened washers (21) and nuts (22).

2. Remove blanking caps and plugs and install all hydraulic lines to tank (1) assembly, as tagged at 'Removal'.

3. Install electrical connections to oil level switch (23), oil temperature switch (12, Fig. 2) and oil pressure switch (11, Fig. 2).

4. Fill tank (1) with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (2).

5. Remove wheel blocks, start the engine and charge the steering and brake control systems. Check oil level as described under 'Checking Oil Level'.

5. Check all hydraulic line connections for leaks and tighten as required.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

* * * *

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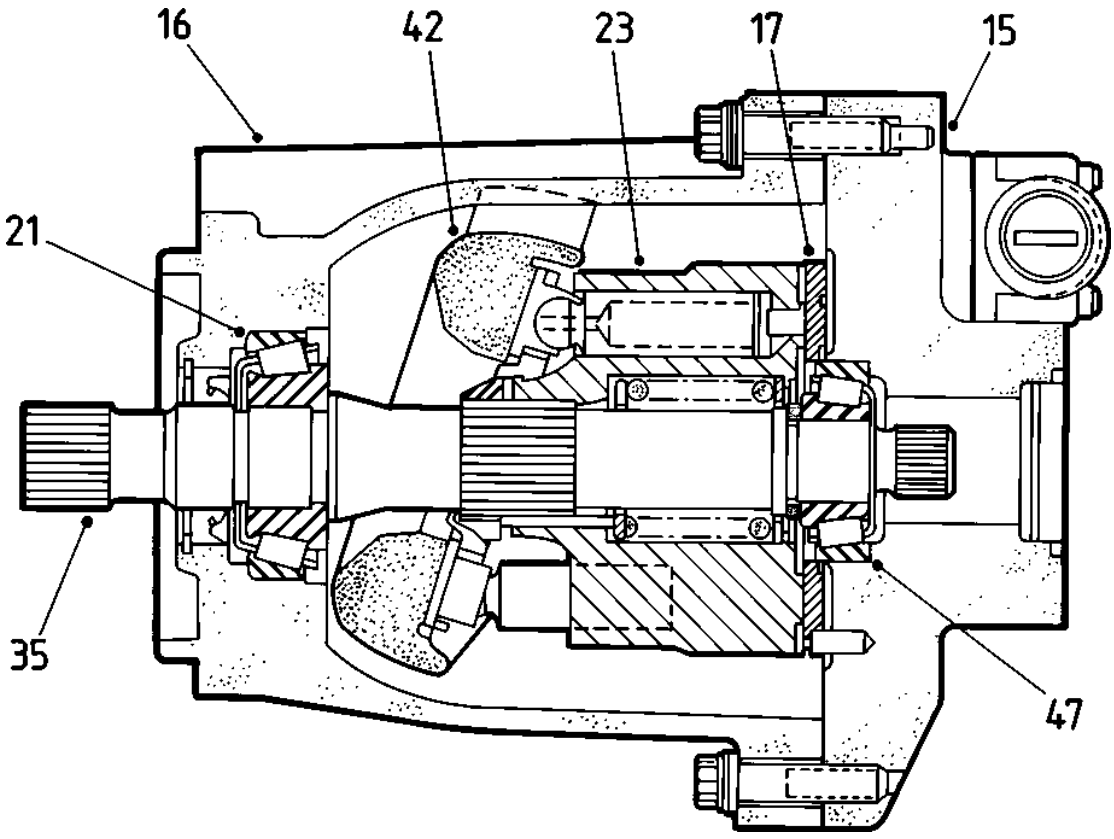
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1 thru 14 - Shown on Fig. 5
15 - Valve Block
16 - Pump Housing
17 - Valve Plate
18 thru 20 - Shown on Fig. 5
21 - Tapered Bearing
22 - Shown on Fig. 5
23 - Cylinder Block
24 thru 34 - Shown on Fig. 5
35 - Driveshaft
36 thru 41 - Shown on Fig. 5
42 - Yoke
43 thru 46 - Shown on Fig. 5
47 - Tapered Bearing
48 thru 57 - Shown on Fig. 5

Fig. 1 - Cutaway View Of Steering Pump

DESCRIPTION

Numbers in parentheses refer to Figs. 1 & 6.

The Steering Pump can be identified as item 2 in Section 220-0000, STEERING SYSTEM SCHEMATIC

The steering pump is an axial piston, variable displacement (adjustable) pump, capable of high pressure operation. Mounted off the transmission power takeoff it is the common pressure supply to both the steering and brake control systems. Output is controlled to meet system requirements at any given time. Compensator valve assembly (1 thru 14) regulates system pressure at 159 bar (2 300 lbf/in²).

The steering pump is assembled for right hand (clockwise) rotation, as viewed from driveshaft (35) end.

Note: Never drive a pump in the wrong direction of rotation as pump seizure may result.

The major pump components are; compensator valve assembly (1 thru 14), pump housing (16), driveshaft (35), rotating group (23 thru 32) and valve plate (17).

The variable displacement unit incorporates a mechanism which governs the angle of the yoke (42) which controls the stroke length of each piston as the cylinder block assembly (23) and driveshaft (35) rotate. The valve block (15) also serves as the back cover of the entire unit and includes the inlet and outlet ports. Tapered bearing (21) in valve block (15) and tapered bearing (47) in pump housing (16) support driveshaft (35).

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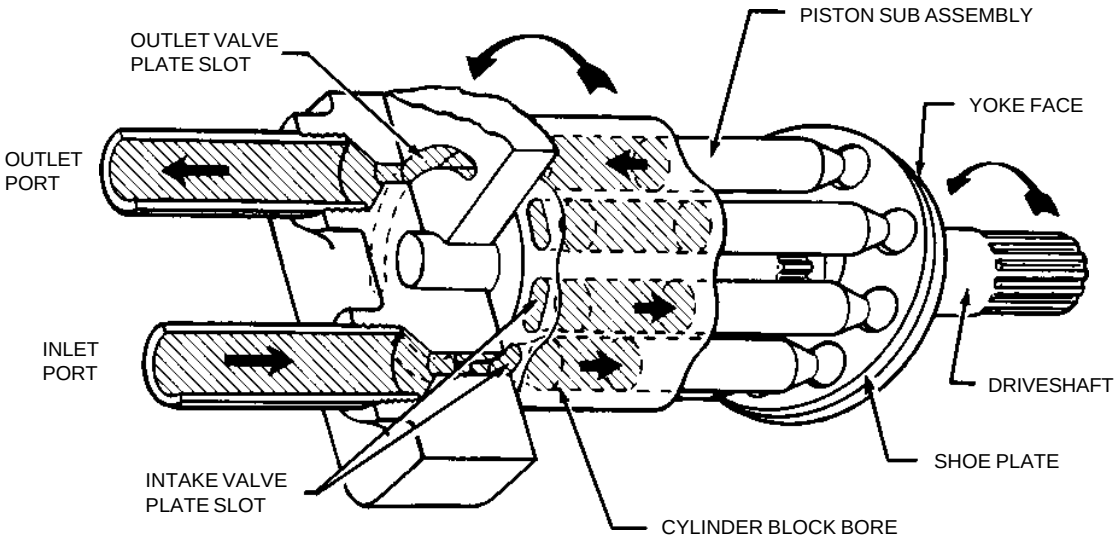


Fig. 2 - Pump Rotation and Oil Flow

OPERATION

Refer to Fig. 3 for hydraulic schematic of steering pump operation.

Rotation of the pump driveshaft causes the cylinder block, shoe plate and pistons to rotate. See Fig. 2. The piston shoes are held against the yoke face by the shoe plate. The angle of the yoke face imparts a reciprocating motion to each piston within the cylinder block. Inlet and outlet ports connect to a kidney slotted wafer plate. As the pistons move out of the cylinder block, a vacuum is created and fluid is forced into the void by atmospheric pressure. The fluid moves with the cylinder block, past the intake kidney slot, to the outlet (pressure) kidney slot. The motion of the piston reverses and fluid is pushed out of the cylinder block into the outlet port.

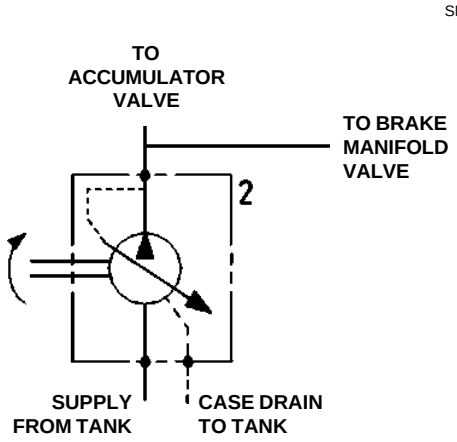


Fig. 3 - Hydraulic Schematic of Steering Pump Operation

Oil flows from the outlet (pressure) port to the accumulator valve which supplies steering circuit pressure. Pressure is tapped off from a tee in the accumulator valve to the brake manifold valve to supply brake circuit pressure.

Internal pump leakage oil is returned to tank through a line at the case drain port on the steering pump.

Variable Displacement

Variable displacement is effected by altering the angularity between the shoe plate and driveshaft axes, as shown by views ‘A’, ‘B’ and ‘C’ in Fig. 4.

During pump operation load or system pressure is continually fed to the bias piston and the compensator spool chamber.

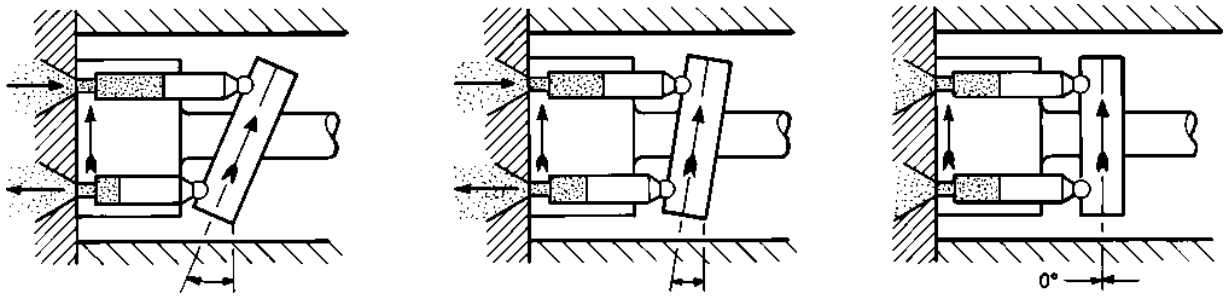
The operation of the compensator is such that when the system pressure (pump outlet) reaches the compensator spring setting the valve spool moves to meter fluid to the pump control piston.

As the force produced by the control piston overcomes the force of the bias piston the shoe plate

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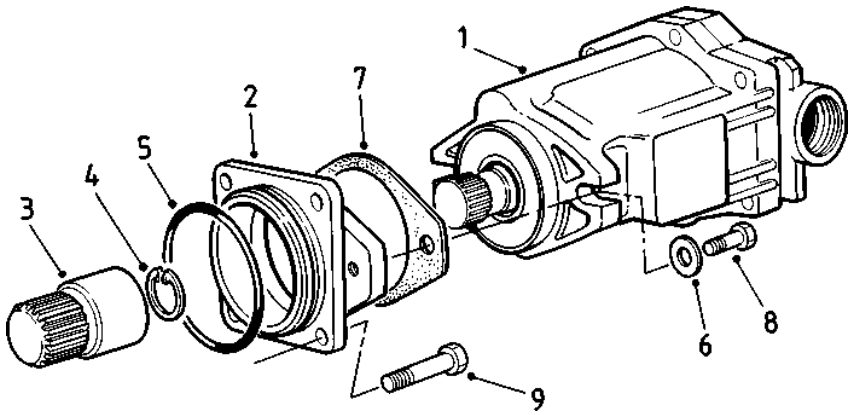
MAXIMUM SHOE PLATE ANGLE (MAXIMUM DISPLACEMENT)

DECREASED SHOE PLATE ANGLE (PARTIAL DISPLACEMENT)

ZERO SHOE PLATE ANGLE (MINIMUM DISPLACEMENT)

Fig. 4 - Variable Displacement Action

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1 - Pump
2 - Pump Adaptor
3 - Coupling
4 - Snap Ring
5 - 'O' Ring
6 - Hardened Washer
7 - Gasket
8 - Bolt
9 - Bolt

Fig. 5 - Pump Installation

angle moves toward the minimum displacement position. (View ‘C’ Fig. 4). The amount of angular movement of the shoe plate (i.e. displacement change) is determined by system flow demand and the resulting system pressure.

Equilibrium is achieved when the new displacement matches the system requirement.

REMOVAL

Numbers in parentheses refer to Fig. 5.

⚠ WARNING
To prevent personal injury and property damage, be sure blocking or lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Raise body and secure in place with body safety pins. Switch off the engine and turn steering wheel in both directions several times to release pressure in the steering system. Apply the parking brake and block all road wheels.

2. Remove drain plug from bottom of tank and drain oil into a suitable container. Reinstall drain plug.

3. Disconnect inlet line, outlet line and case drain line from the pump and drain any oil in the lines into a suitable container. Cap line ends and tag to facilitate 'Installation'.

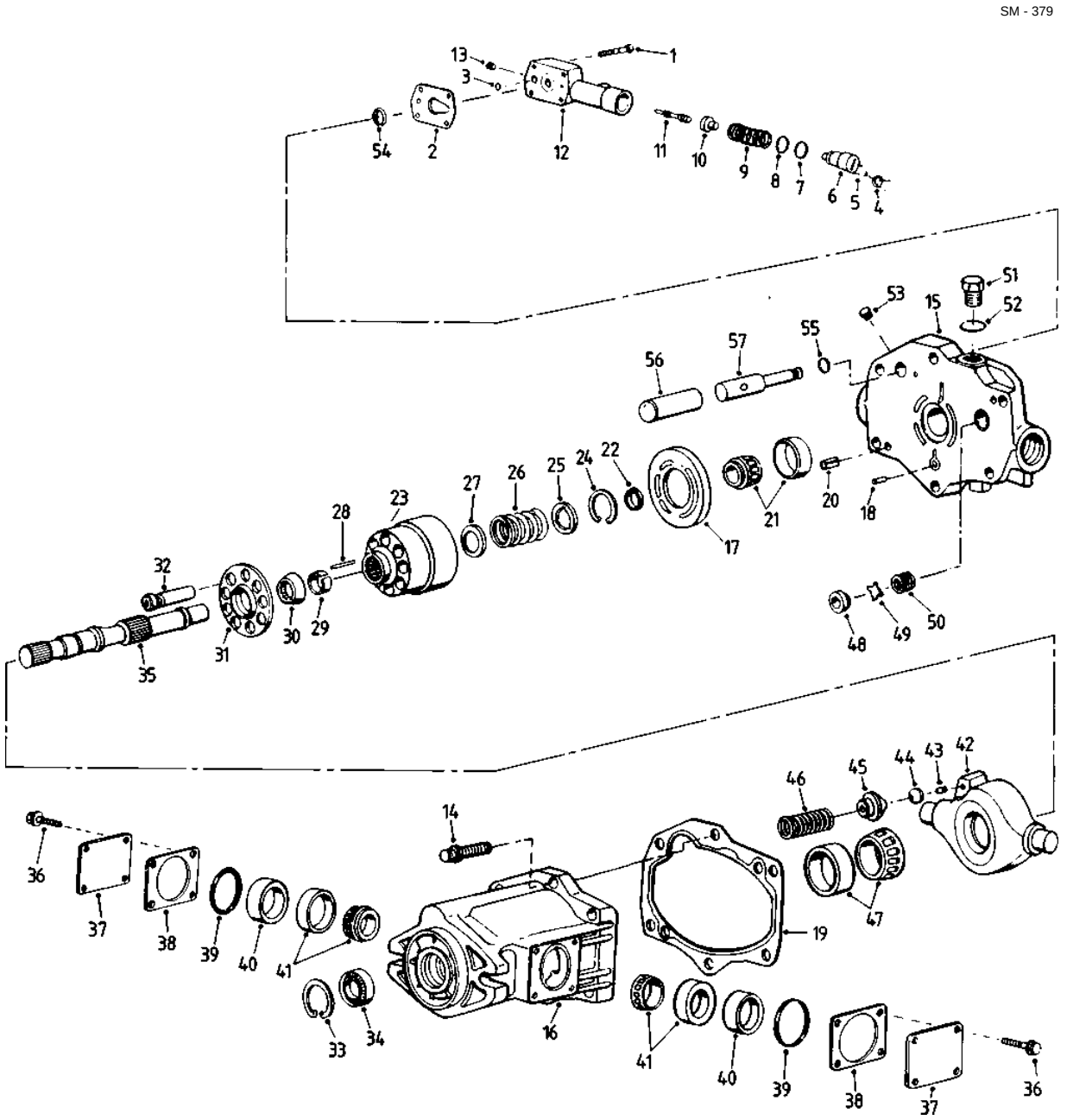
4. Support pump (1) with a suitable lifting device and remove two mounting bolts (8) and hardened washers (6). Pull pump (1) rearward to disengage pump driveshaft from drive coupling.

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Steering System - Steering Pump

Section 220-0050



1 - Screw
2 - Gasket
3 - 'O' Ring
4 - Seal
5 - Lockwire
6 - Plug
7 - Backup Ring
8 - 'O' Ring
9 - Spring
10 - Seat
11 - Spool
12 - Compensator Body
13 - Plug
14 - Screw
15 - Valve Block
16 - Pump Housing
17 - Valve Plate
18 - Dowel Pin
19 - Gasket
20 - Roll Pin
21 - Tapered Bearing
22 - Bearing Spacer
23 - Cylinder Block
24 - Retaining Ring
25 - Washer
26 - Spring
27 - Washer
28 - Pin
29 - Pin Retainer
30 - Spherical Washer
31 - Shoe Plate
32 - Piston and Shoe
33 - Retaining Ring
34 - Shaft Seal
35 - Driveshaft
36 - Screw
37 - Pintle Cover
38 - Shim Kit
39 - 'O' Ring
40 - Bearing Spacer
41 - Tapered Bearing
42 - Yoke
43 - Roll Pin
44 - Seat
45 - Seat
46 - Yoke Spring
47 - Tapered Bearing
48 - Valve Seat
49 - Valve
50 - Spring
51 - Plug
52 - 'O' Ring
53 - Plug
54 - Retainer
55 - 'O' Ring
56 - Compensator Piston
57 - Piston Rod

Fig. 6 - Exploded View Of Pump

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5. Pull pump (1) and gasket (7) straight out from the mounting flange of pump adaptor (2). Discard gasket (7). Do not remove pump adaptor from its mounting unless it is to be replaced.

6. Wash the outside of pump (1) thoroughly with a suitable solvent and move to a clean work area for 'Disassembly'.

OVERHAUL

In most cases, the pump will not require a complete overhaul as described within this section of the manual. In general, pump disassembly is accomplished according to the item number sequence as shown in Fig. 6. For pump assembly, reverse the item number sequence. The item number sequence can also be used as a guide for partial disassembly and assembly. If the pump needs a complete overhaul, obtain the necessary service tools listed on pages 12 & 13. Repair of this unit is intricate and should not be attempted without proper tools.

DISASSEMBLY

Numbers in parentheses refer to Figs. 1 & 6.

Note: Discard and replace all 'O' rings, gaskets and shaft seals removed during 'Disassembly'.

Removal and Disassembly of the Compensator Valve Assembly

1. Remove four screws (1) securing compensator valve assembly (1 thru 13) to valve block (15) and pull compensator valve assembly (1 thru 13) away from valve block (15).

2. Remove gasket (2) and 'O' ring (3) from compensator body (12).

3. Remove parts from compensator body (12) as follows:

a) Remove lockwire (5) and seal (4), plug (6), backup ring (7) and 'O' ring (8).

b) Remove spring (9), seat (10) and spool (11) from compensator body (12) and set aside for 'Inspection'.

c) Do not remove plug (13) unless it is necessary for inspection of the bore.

Inspection, Repair and Replacement

Note: All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Clean all removed parts using a commercial solvent that is compatible with system fluid. Compressed air may be used in cleaning, but, it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spool, compensator body and valve block passages.

Note: Replace all parts that do not meet the following specifications:

1. Inspect all components for excessive wear, erosion and/or seizure.

2. Inspect plugs (6 & 13, if removed) for damaged threads, burrs, etc.

3. Inspect spring (9) for wear and parallelism. Spring ends must be parallel. Replace if spring is warped or wear is evident.

4. Inspect seat (10) for wear in the area of spool (11) contact.

5. Inspect spool (11) for excessive wear, galling, scratches, etc. If scratches exist across the spool land, replace the spool and inspect the body bore. Rotate the spool while moving in and out of the bore to check for binding. NO BINDING CAN BE TOLERATED. If binding is evident, use an India stone to break sharp edges of the balancing grooves. Use 500 grit paper lightly on outer surface of the spool. Clean in solvent and lubricate then try bind test again. If binding still persists, replace the spool and/or body.

6. Inspect screw threads, replace if damaged.

Removal and Disassembly of Rotating Group

1. Remove six screws (14) which hold pump housing (16) to valve block (15).

2. Pull valve block (15) away from pump housing (16) then discard gasket (19).

3. Remove valve plate (17) and dowel pin (18) from valve block (15) and set aside for 'Inspection'.

4. Remove inner race of tapered bearing (21) and bearing spacer (22) from the end of driveshaft (35).

5. Slide the rotating group from pump housing (16), (hold shoe plate (31) with both hands during removal to prevent the group from separating).

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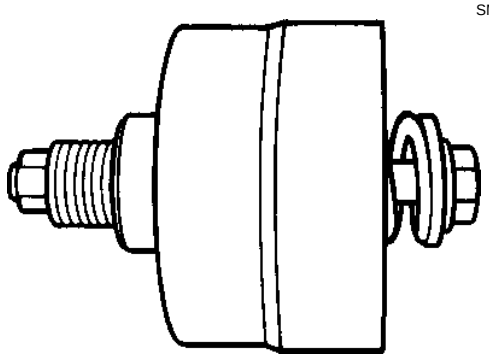


Fig. 7 - Cylinder Block Assembly/Disassembly Tool

Note: The rotating group consists of a cylinder block assembly (23 thru 27), nine piston and shoe assemblies (32), shoe plate (31), spherical washer (30), three pins (28) and pin retainer (29).

⚠ WARNING

The spring located within the cylinder block assembly is under high tension and can cause bodily harm if retaining ring (24) is removed without the use of disassembly tool. See Fig. 7.

6. Tighten nut and remove retaining ring (24) from cylinder block (23). Loosen nut and relieve spring (26) tension and remove washer (25), spring (26) and washer (27) from cylinder block (23). Set aside for 'Inspection'.

7. Separate shoe plate (31), spherical washer (30), pins (28) and pin retainer (29). Set aside for 'Inspection'.

Inspection, Repair and Replacement

1. Check inner race of tapered bearing (21) for scoring or brinelling of the rollers.

2. Check bearing spacer (22) for burrs.

3. Inspect cylinder block (23) face for wear, scratches and/or erosion between cylinders. Check spring (26), washers (25 & 27) and retaining ring (24), located within the cylinder block, for wear.

4. Check each cylinder block bore for excessive wear. Use piston and shoe (32) assemblies for this purpose. The piston should be a very close fit and slide easily in and out of the bore. No bind can be tolerated. If binding is evident, clean the cylinder block and piston, lubricate with clean hydraulic fluid and try again. Even minor contamination of the fluid could cause the piston to freeze up in the cylinder bore.

5. Inspect each piston and shoe (32) assembly for a maximum end play of 0.127 mm (0.005 in) between the piston and shoe.

6. The face thickness dimension of each shoe must be within 0.025 mm (0.001 in) of each other.

7. Inspect shoe plate (31) for excessive wear and cracking in the area of spherical washer (30). If heavy wear or cracks are found, replace the shoe plate and spherical washer at the same time.

8. Check spherical washer (30) for burrs, wear and possible scratches due to pin (28) breakage. Replace if wear is excessive.

9. Inspect pins (28) for equal length, excessive wear and possible bending. Replace all pins simultaneously if one is defective.

10. Pin retainer (29) may develop burrs. Remove all burrs with an India stone.

11. Inspect the face of valve plate (17) for excessive wear, scratches and possible fracture. If valve plate (17) is fractured, make sure new valve plate (17) rests flat against valve block (15) at assembly and that dowel pin (18) does not extend too far and hold the valve plate away from the valve block.

Note: Inspect yoke face and shaft bearing as follows: If either are defective, perform step 14 and remove yoke from the housing. If driveshaft is defective, follow procedure in step 21 to remove the driveshaft from the front bearing. If driveshaft, shaft bearing, pump housing or valve block are replaced, a 'Shaft Bearing Pre-load Adjustment' must be performed. See Page 10.

12. Inspect driveshaft (35) for wear, chipped splines and burrs; remove burrs with an India stone.

13. Inspect inner race of tapered bearing (47) for brinelling, pitting of the rollers and roughness when turned in outer race of tapered bearing (47) located in pump housing (16). If tapered bearing (47) is defective both the inner and outer races must be replaced. If the inner race shows no evidence of wear, do not remove the outer race from pump housing (16) or the inner race from driveshaft (35). If the bearing requires removal, perform the following steps 14 thru 18.

14. Inspect yoke (42) face for wear, roughness or

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scoring. If defective, remove yoke (42), yoke spring (46) and seat (45) as follows:

a) Remove four screws (36) that hold pintle covers (37) on each side of pump housing (16). Remove pintle covers (37). Be careful not to damage shims (38) which lie directly under pintle covers (37).

b) Retain shims (38), if possible, and use a micrometer to measure the total shim thickness. If the bearings are not defective, the same shims or a new shim of the same thickness will be needed to pre-load the bearings at installation. Remove 'O' rings (39) and bearing spacers (40) from each pintle on yoke (42).

Note: If shims (38) were destroyed during disassembly, a yoke bearing pre-load adjustment must be made at assembly.

c) Slide yoke (42) from side to side to loosen the outer race of tapered bearing (41) within pump housing (16). The outer races are a normal slip fit but may be tight. Use an open end wrench between the yoke and the pintle bearing to help slide out the races. Apply pressure to bearing rollers to gently press the inner race off of the yoke.

15. Remove yoke (42) and driveshaft (35) from pump housing (16) together. Turn the yoke at an angle and slide the two parts out of the housing. See Fig. 8.

16. After removal of yoke (42) from pump housing (16), remove seat (45) and yoke spring (46). Seat (44) and roll pin (43) will be attached to yoke (42). Do not disassemble further unless seat (44) is damaged.

Note: Normally a wear pattern will exist on seat (44). If the seat is damaged or shows heavy wear, replace seats (44 & 45) and roll pin (43).

Note: If driveshaft (35) is defective perform step 17. If front tapered bearing (47) was defective perform steps 17 & 18.

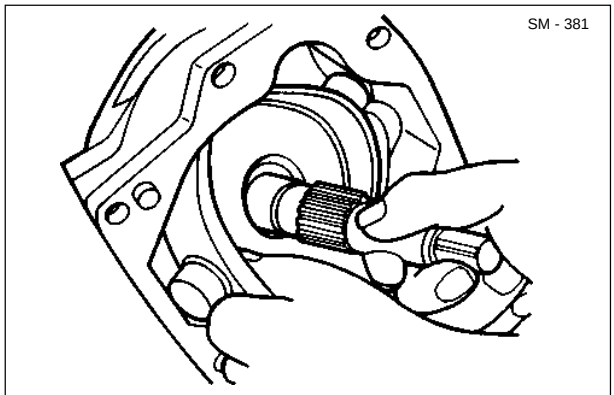


Fig. 8 - Removal Of Yoke and Driveshaft From Housing

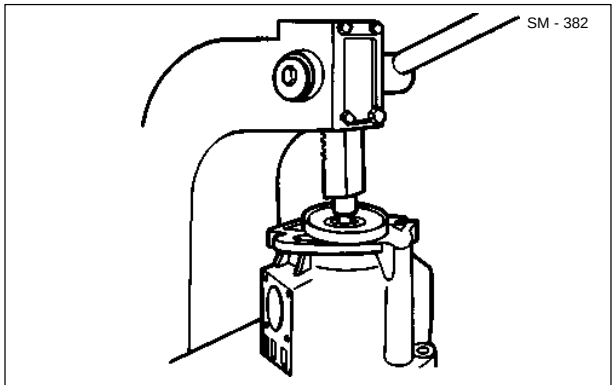


Fig. 9 - Removal Of Outer Race Of Tapered Bearing

17. Remove inner race of tapered bearing (47) from driveshaft (35) with the heavy wall tubing shown in Fig. 18. Press off with an arbor press.

18. Remove outer race of tapered bearing (47) from pump housing (16) as shown in Fig. 9.

19. Remove retaining ring (33) then press shaft seal (34) from pump housing (16).

Note: If yoke (42) and front tapered bearing (47) were not defective, perform the following step:

20. Remove and replace shaft seal (34) located within pump housing (16) as follows: Refer to Fig. 10.

a) Install heavy wall tubing over driveshaft (35) within pump housing (16). The end of the tubing will rest against the inner race of tapered bearing (47) and

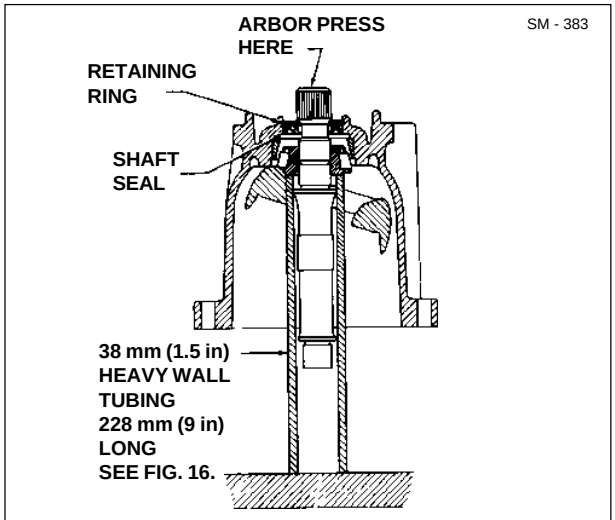


Fig. 10 - Removal Of Inner Race Of Tapered Bearing

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extend out beyond the end of pump housing (16). Place the complete unit with tubing into an arbor press with drive spline up. Press driveshaft (35) through the bearing and out of the unit. A 0.025 mm (0.001 in) press exists between the driveshaft and bearing so considerable force is required to remove the bearing. See Fig. 10.

b) Remove retaining ring (33) and pull shaft seal (34) from pump housing (16). Be careful not to damage the aluminium die cast housing in shaft seal (34) area.

Disassembly of Valve Block

1. Do not disassemble check valve parts (48 thru 50), unless action of the valve indicates a problem. Check the valve action with a pencil or a screwdriver. Press check valve in against the spring, it should return and hold firm against the seat. If the check valve is defective, remove and replace the complete assembly. Press new valve seat (48) flush with face of valve block (15). Do Not scratch the face of valve block (15).

2. Remove parts (51 thru 57) from valve block (15) and set aside for inspection.

Note: If tapered bearing (21) was defective, perform the following step.

3. Remove outer race of tapered bearing (21) from valve block (15). Refer to Fig. 11 and use special tool as shown in Fig. 19.

Note: Be careful not to scratch face of valve block (15) during removal of the bearing race.

Inspection, Repair and Replacement

1. Clean all parts and place them on a clean sheet of craft paper for inspection.

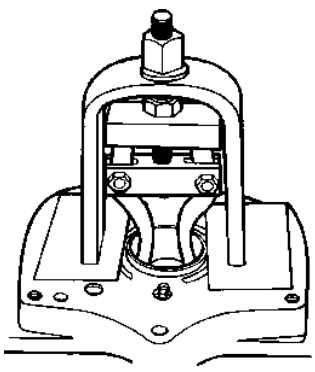


Fig. 11 - Removal Of Bearing Race From Valve Block

2. Inspect (51 & 53) for worn corners on the hex head, stripped threads and burrs in 'O' ring (52) groove. Use an India stone to remove burrs, if threads are defective replace the plugs.

3. Inspect piston rod (57) for nicks and burrs. Remove burrs and sharp edges with an India stone.

4. Inspect compensator piston (56) for wear at the area of yoke contact. Compensator piston (56) and piston rod (57) are a close tolerance fit and must assemble together without evidence of wear or bind. Rotate compensator piston (57) through 360° when checking for bind.

5. Inspect valve block (15) for burrs, nicks, plugged body passages, flatness of the pump valve plate area and porosity. Inspect check valve seat (48). Make sure valve seat (48) is tight within valve block (15) and does not protrude above valve block (15) face. Repair or replace valve block (15) if defective.

ASSEMBLY

Numbers in parentheses refer to Figs. 1 & 6.

This is largely the reverse numerical sequence to Disassembly, but note the following:-

Assembly of Compensator

Replace the gaskets and 'O' rings removed from the unit with those supplied in the seal kit. Do Not use grease to hold the seals in place. Use a viscosity improver (STP or equivalent). Flood all parts with system fluid to provide initial lubrication and prevent seizure.

Front Bearing Installation

a) Press driveshaft (35) into inner race of tapered bearing (47) as follows:
Use a short piece of 38 mm (1.5 in) heavy wall tubing (approximately 150 mm (6 in) long) over the drive spline of driveshaft (35). The tubing must be long enough to go through the shaft seal end of the pump and make contact with the inner race of the front bearing. Press driveshaft (35) through the bearing with an arbor press until the bearing bottoms against the shoulder of driveshaft (35). See Fig. 12.

b) Remove the short piece of tubing and turn tapered bearing (47) in its race with the end of the driveshaft. The bearing rollers must turn free and smooth.

c) Tape the spline end of driveshaft (35) with plastic tape to prevent cutting new shaft seal (34). Start

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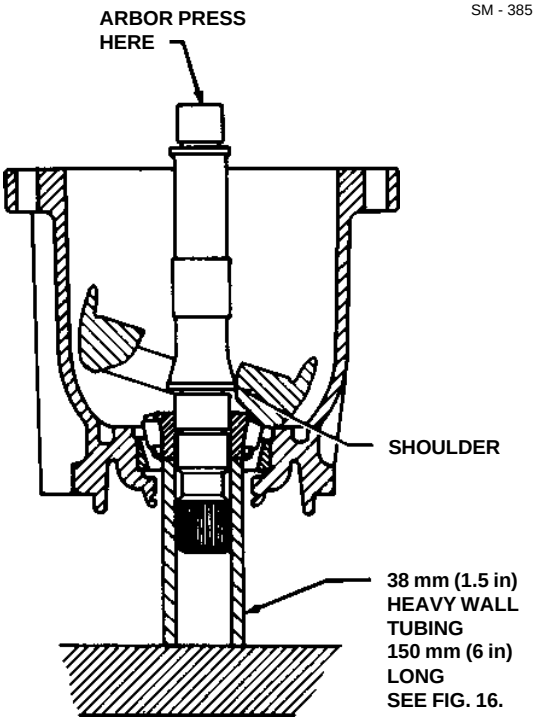


Fig. 12 - Tapered Bearing Installation

taping driveshaft (35) close to pump housing (16) and work toward the end of driveshaft (35). Install new shaft seal (34) in position over driveshaft (35) and press evenly into pump housing (16). Use shaft seal driver shown in Fig. 17. Shaft seal (34) must be positioned just below retaining ring (33) groove. Install retaining ring (33) into pump housing (16). Use internal circlip pliers to install retaining ring (33).

Assembly of Housing Parts

Note: If a new tapered bearing (47), driveshaft (35), valve block (15) or pump housing (16) is required, a complete pre-load adjustment must be performed. If the same parts are returned to service, the shaft bearing pre-load adjustment can be omitted. The same procedure applies to yoke (42) and its associated bearings.

1. If tapered bearing (47) requires replacement, install a new outer race into pump housing (16). Use tool shown in Fig. 20 to press bearing race in place. Make sure outer race is orientated properly to accept the inner race of bearing before pressing into pump housing (16). The outer race must be bottomed against the shoulder of pump housing (16) on completion of press.

2. Place pump housing (16) on a flat surface with shaft seal (34) end down. Lay inner race of tapered bearing (47) into the outer race. Install yoke spring (46) and seat (45) into pump housing (16).

3. Position the yoke pintles properly and install yoke (42) into pump housing (16). Assemble yoke bearings, races and spacers as follows:

a) Assemble inner race of tapered bearings (41) on each end of yoke (42) and insert outer race of tapered bearing (41).

b) Install bearing spacer (40) at one pintle end.

c) Install new 'O' ring (39) against bearing spacer (40) into the groove, then install a 0.025 mm (0.010 in) shim (38) under pintle cover (37). Install four screws (36) and torque to 20 - 21 Nm (15 - 16 lbf ft).

Note: Early designs used a screw and washer arrangement. These should be torque tightened to 13 - 14 Nm (9 - 10 lbf ft).

d) Set pump housing (16) on its side so the other pintle is up. Install bearing spacer (40) and rotate yoke (42) back and forth to seat inner races of tapered bearings (41) within the outer races. With bearing spacer (40) fully in against the outer race, measure the height of the spacer with respect to pump housing (16) pintle face in two places (180° apart). Use a depth micrometer to perform this measurement. See Fig. 13. Average the readings to obtain a nominal value. A 0.178 - 0.228 mm (0.007 - 0.009 in) pre-load is required on tapered bearings (41). Calculate the

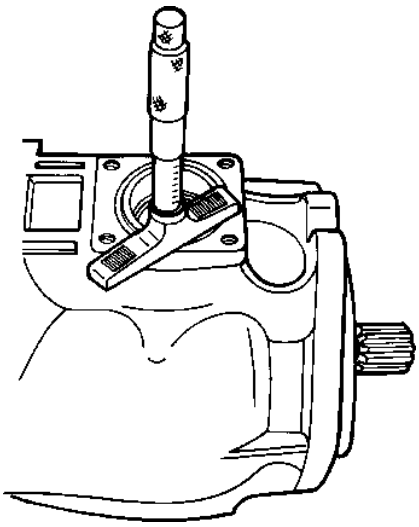


Fig. 13 - Measuring Height Of Bearing Spacer With Respect To The Housing Face

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necessary shims (38) to provide this pre-load as follows:

Assume the depth readings were 0.736 mm (0.029 in) and 0.685 mm (0.027 in). Add the two figures together and divide by two to obtain the average. In this case the calculated average is 0.710 mm (0.028 in). Subtract the nominal pre-load of 0.203 mm (0.008 in) from the calculated average to obtain the required shim thickness.

Note: If the calculated shim thickness is greater than 0.5 mm (0.02 in), another shim must be added to the opposite side of the yoke to reduce the total shim thickness to less than 0.5 mm (0.02 in). Shim thickness at either pintle must not exceed 0.5 mm (0.02 in). This is necessary to provide proper 'O' ring compression and prevent pintle seal leakage.

e) Install correct shims (38) and cross torque screws (36) to 20 - 22 Nm (15 - 16 lbf ft).

Note: Yoke (42) will be stiff but should be loose enough to be moved by hand, (approximately 27 Nm (20 lbf ft) torque. The tightness/drag indicates the bearings are pre-loaded. If the yoke cannot be moved by hand, the pre-load is too great, repeat the pre-load adjustment until correct.

4. Assemble the rotating group and install in pump housing (16) as follows:

a) Assemble spring (26), washers (25 & 27) and retaining ring (24) into cylinder block (23). Washer (25), with three notches, is assembled next to retaining ring (24). See Fig. 7 for assembly method. Set cylinder block (23) assembly face on a clean flat surface. Use craft paper between cylinder block and surface to prevent scratching cylinder block (23) face.

b) Install pin retainer (29) in cylinder block (23). Position pin retainer (29) approximately 6 mm (0.25 in) below the surface, and orientate the open end of pin retainer (29) to be away from the large spline openings.

c) Slide three pins (28) into cylinder block (23) assembly until they bottom against washer (27) within cylinder block (23).

d) Place spherical washer (30) on top of the three pins, then install shoe plate (31) with nine piston and shoe assemblies (32) over spherical washer (30) and into cylinder block (23). Wobble shoe plate (31) to make sure that each piston is free within its bore in cylinder block (23).

e) Set pump housing (16) on its side and hold driveshaft (35) horizontal. Slide rotating group into pump housing (16). Rotate driveshaft (35) to match shaft splines to cylinder block (23) and spherical washer (30).

5. If roll pins (20) were removed, install two roll pins (20) in pump housing (16). Place gasket (19) over roll pins (20), cover with craft paper and set aside for final assembly.

Assembly of Valve Block

1. If inner race of tapered bearing (21) was defective and outer race has been removed, a new outer race must be installed in valve block (15). Refer to Fig. 14 and press a new outer race in place with an arbor press. The outer race must bottom against the shoulder of valve block (15) on completion of press.

Note: Check flatness of valve block (15) face in the area around each roll pin (20) hole, and at bolt (14) openings. Use an India stone to remove burrs or raised metal in these areas.

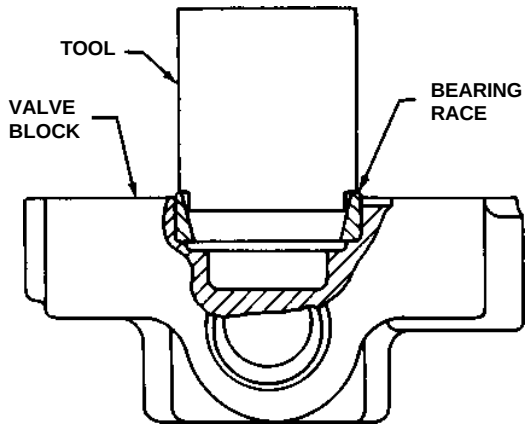


Fig. 14 - Installation Of Outer Race Of Tapered Bearing

2. Install plug (53) in valve block (15) and secure.

3. Install new 'O' ring (52) on plug (51) and thread plug (51) into place.

Shaft Bearing Pre-load Adjustment

Note: If the shaft bearings, driveshaft, valve block or pump housing were not replaced, use the bearing spacer removed during the disassembly procedure to pre-load the driveshaft and perform step 7. If pre-load adjustment is necessary, perform steps 1 thru 7.

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1. Install thickest bearing spacer (22) over driveshaft (35) with the chamfer facing pump housing (16) (toward the shoulder on driveshaft (35)).

2. Slide new inner race of tapered bearing (21) on driveshaft (35) and up against bearing spacer (22).

3. Install pump housing (16) to valve block (15) without gasket (19) and rotating group. Turn driveshaft (35) to seat the bearings then torque the six housing attaching screws (14) to 7 Nm (5 lbf ft). Check the opening between valve block (15) and pump housing (16) to be as even as possible after tightening.

4. Use a feeler gauge to measure the opening between valve block (15) and pump housing (16). Four measurements should be obtained equidistant around the unit. A tapered feeler gauge is especially useful for this purpose. Average the four readings by adding them together and dividing by four. Calculate thickness of bearing spacer (22) as follows:

Measured thickness of bearing spacer	3.81 mm (0.150 in)
Average gap (estimated)	0.685 mm (0.027 in)
Pre-load setting	0.076 ± 0.025 mm (0.003 ± 0.001 in)
Compressed thickness of gasket	0.508 mm (0.020 in)

Required bearing spacer thickness to provide a 0.076 ± 0.025 mm (0.003 ± 0.001 in) bearing pre-load 3.708 ± 0.025 mm (0.146 ± 0.001 in)

5. Remove six mounting screws (14) pump housing (16) from valve block (15).

6. Remove tapered bearing (21) and bearing spacer (22).

7. Locate a bearing spacer with calculated dimensions and place next to the new bearing on driveshaft (35). Chamfer must face shoulder on driveshaft (35). Use the original spacer and bearing if pre-load is not performed. Set aside for final assembly.

Final Assembly of Pump

Note: Lubricate all moving parts of the piston pump with system fluid to facilitate assembly and provide initial lubrication. Pour system fluid liberally over the rotating group and valve plate as these parts are without lubrication until the pump primes.

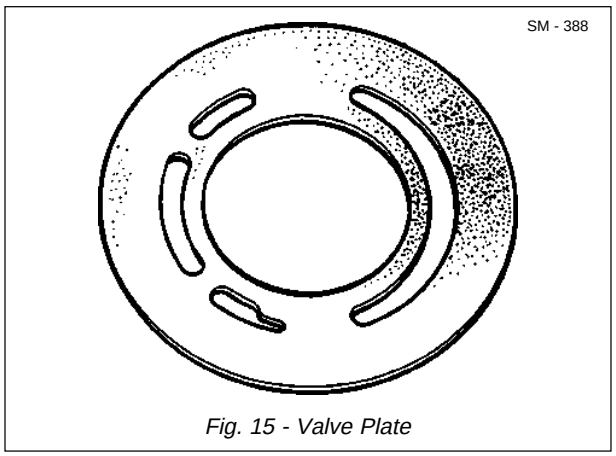


Fig. 15 - Valve Plate

1. Assemble valve plate dowel pin (18) into valve block (15).

2. Assemble valve plate (17) over the bearing race and dowel pin (18) with wear surface away from valve block (15). Refer to Fig. 15 for valve plate (17) identification.

Note: Valve plate (17) must be flat against valve block (15) face. Check to make sure it does not rock back and forth. If rocking of valve plate (17) occurs, check dowel pin (18), it may not be bottomed out in valve block (15). Rocking of valve plate (17) will induce high stress conditions across the valve plate and cause fractures to appear.

3. Place valve block (15) on its side.

4. Install piston rod (57) into valve block (15) and attach retainer (54).

5. Install new 'O' ring (55) in piston rod (57) 'O' ring groove.

6. Install compensator piston (56) over piston rod (57).

7. Secure pump housing (16) to valve block (15) with six screws (14), hand tight through the housing into the valve block. Cross torque screws (14) to bring valve block (15) and pump housing (16) together against gasket (19). Torque tighten screws (14) to 31 - 35 Nm (23 - 26 lbf ft).

8. Check the driveshaft torque to verify correct bearing pre-load. If the torque exceeds 8 Nm (6 lbf ft), perform a shaft bearing pre-load adjustment and repeat steps 7 & 8.

9. Mount the compensator assembly to pump housing (16) ensuring correct shaft rotation. Refer to Fig. 16.

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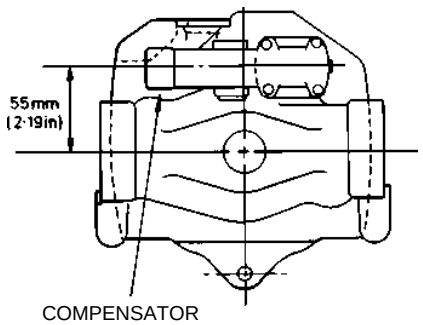


Fig. 16 - Compensator Position For RH Shaft Rotation

Thread four screws (1) through the compensator into valve block (15). Cross torque screws (1) to 7 - 8 Nm (5 - 6 lbf ft).

INSTALLATION

Numbers in parentheses refer to Fig. 5.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNING
To prevent personal injury and property damage, ensure lifting equipment is of sufficient capacity and properly secured to do the job safely.

1. Install snap ring (4) to coupling (3).

2. Coat coupling (3) spline with molybdenum disulphide grease and engage coupling in PTO drive.

3. Assemble 'O' ring (5) to pump adaptor (2) and secure pump adaptor (2) to PTO mounting face using four bolts (9). Torque tighten bolts (9) to 75 Nm (55 lbf ft).

4. Coat pump driveshaft spline with molybdenum disulphide grease and place pump (1) and gasket (7) on adaptor mounting flange.

5. Push pump inward to engage with coupling (3) and PTO drive. Install two mounting bolts (8) and hardened washers (6). Torque tighten bolts (8) to 105 Nm (78 lbfft).

6. Remove caps and connect outlet and inlet lines to the pump. Before connecting case drain line, fill the pump with oil specified in Section 300-0020, LUBRICATION SYSTEM. Connect the case drain line to pump. Fill steering and brake control tank with oil specified in Section 300-0020, LUBRICATION SYSTEM.

Note: It is very important that the pump cavity is completely filled with hydraulic oil. This will ensure proper lubrication of the internal parts of the pump when it is initially operated.

7. Refer to 'PUMP STARTING PROCEDURE' for proper pump priming and start-up procedure.

PUMP STARTING PROCEDURE

Numbers in parentheses refer to Figs. 1 & 6.

1. The pump must be started with less than 40% of normal system pressure. This is done by backing off the steering pressure relief valve so that the pump will start under no-load conditions.

2. Be sure the pump case drain line is free from obstructions that restrict the pump case drain flow back to tank and cause high case drain pressure which can lead to an early pump failure.

3. Before starting the engine after pump installation, remove the remaining case drain plug from the pump and an appropriate plug from the hydraulic tank and install 0 - 3.5 bar (0 - 50 lbf/in^2) gauges in both ports, as well as a gauge in the pressure circuit which can be read for setting the system steering pressure. Be sure to back out adjusting plug (6) until it is flush with compensator body.

4. Start the engine and monitor the system pressure gauge. The system should register pressure within 30 seconds. If not, re-check to assure that the system is properly filled with oil and that there is no restriction to the pump inlet. With the engine at Maximum No Load rev/min, read the pressures on both the tank and the pump case. At no time should the case pressure be more than 0.07 - 0.14 bar (1 - 2 lbf/in^2) above the tank pressure. If it is, there is either excessive restriction in the case drain line (obstructed or possibly a kinked hose), or the leakage rate in the pump is too high. In either case, the cause should be corrected. The system pressure can then be set by adjusting the compensator screw until a system pressure of 159 bar (2 300 lbf/in^2) is reached. The case to tank pressure differential should still not exceed 0.07 - 0.14 bar (1 - 2 lbf/in^2).

5. Shut off the engine, bleed off tank pressure, and remove the gauges. Check the steering system for proper operation.

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SPECIAL TOOLS

Special tools are shown in Figs. 17, 18, 19 & 20.

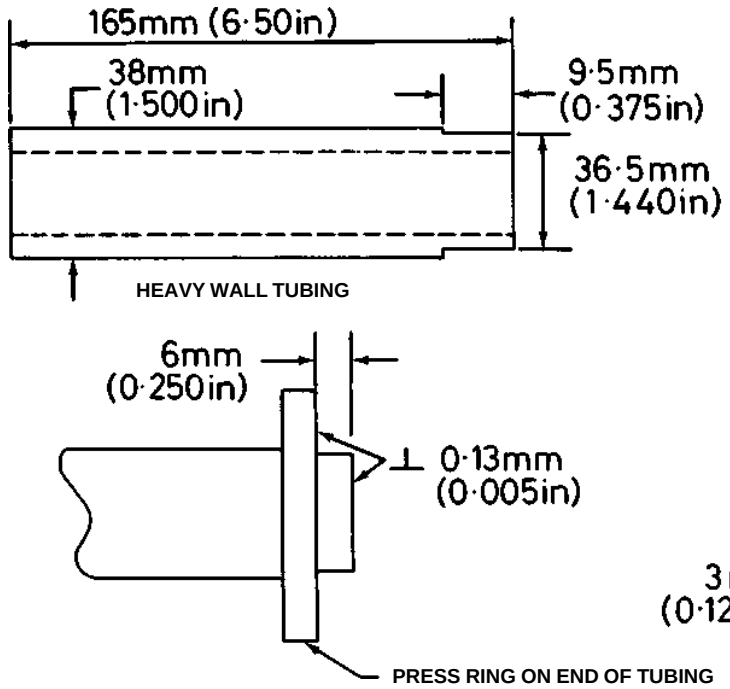
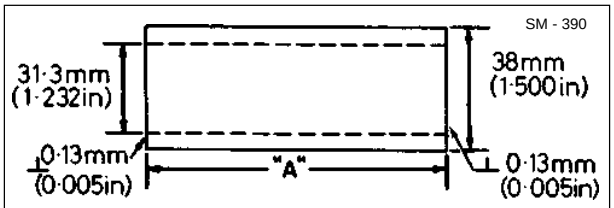


Fig. 17 - Shaft Seal Driver



USE FOR	"A"
Intermediate shaft bearing installation	100 mm (4 in)
Driveshaft bearing installation	150 mm (6 in)
Driveshaft bearing removal	228 mm (9 in)
38 mm (1.50 in) Heavy Wall Tubing	

Fig. 18 - Shaft Bearing Removal and Installation Tool

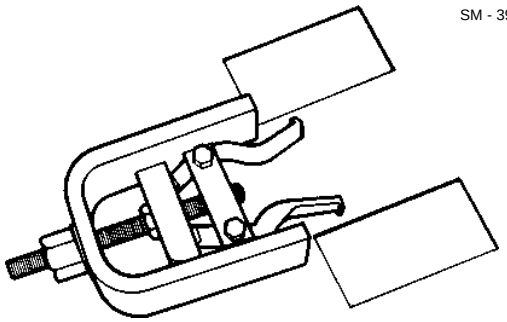
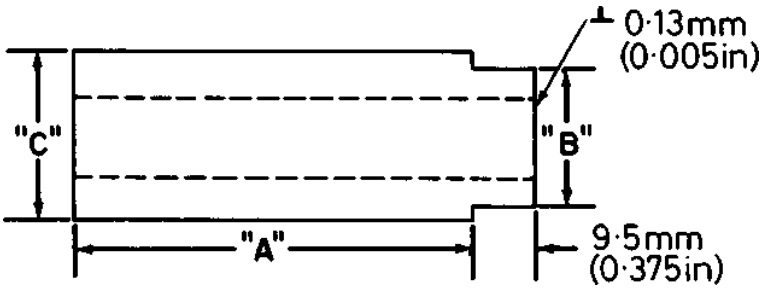


Fig. 19 - Valve Block Bearing Race Removal Tool And Shim Stock



NOMINAL PIPE BORE mm (in)	'A' mm (in)	'B' mm (in)	'C' mm (in)
38 (1.5)	100 (4.0)	41 (1.62)	48 (1.89)
50 (2.0)	100 (4.0)	54 (2.12)	60 (2.38)

Fig. 20 - Bearing Inner Race Installation Tools

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SPECIAL TORQUE SPECIFICATIONS TABLE046

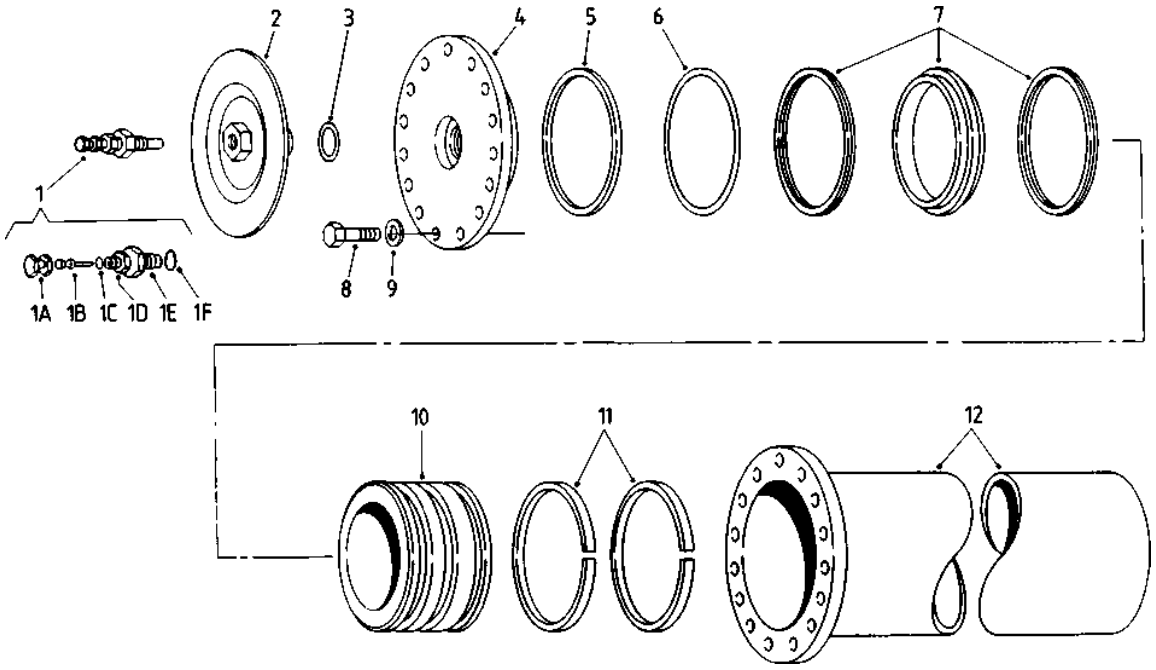
FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
6	1	Screw	7 - 8	5 - 6
5	8	Bolt	105	78
5	9	Bolt	75	55
6	14	Screw	31 - 35	23 - 26
6	36	Screw	20 - 22	15 - 16

* * * *

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SM - 171



1 - Charging Valve
1A - Cap
1B - Core
1C - 'O' Ring
1D - Locknut
1E - Body
1F - 'O' Ring
2 - Shield
3 - 'O' Ring
4 - End Cap
5 - Backup Ring
6 - 'O' Ring
7 - Seal Rings
8 - Bolt
9 - Hardened Washer
10 - Piston
11 - Wear Ring
12 - Cylinder

Fig. 1 - Exploded View of Accumulator

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The Steering Accumulator can be identified as item 3 in Section 220-0000, STEERING SYSTEM SCHEMATIC, in this manual.

The accumulator is of the piston type and is pre-charged with nitrogen to 55 bar (800 lbf/in^2). Mounted off the frame at the rear of the steering and brake control tank, the accumulator assembly consists of charging valve (1), end cap (4), cylinder (12) and piston (10). The charging valve (1) is equipped with a locking feature. Loosening the locknut (1D) will open the valve so that the pre-charge can be checked or the accumulator charged. The piston (10) acts as a separator dividing the cylinder (12) into two sections. The section nearest the charging valve (1) contains the nitrogen pre-charge. The other section receives the hydraulic oil from the steering pump.

TESTING

⚠ WARNING
Accumulators are charged with Nitrogen. The service pressure is 55 bar (800 lbf/in^2) at 21° C (70° F). Do not attempt to remove any valves or fittings until all nitrogen pressure is completely relieved to prevent personal injury and property damage.

Testing Charging Valve For Leakage

Numbers in parentheses refer to Fig. 1.

Remove valve cap (1A) from charging valve (1) and loosen locknut (1D). Coat open end of charging valve with soapy water. Bubbles indicate leaky valve core (1B). Attempt to reseat the valve core by depressing

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and releasing it quickly once or twice. Recheck for leakage, if leakage continues then discharge the accumulator as described under 'Discharging Nitrogen' in this section, then replace the valve core. Tighten locknut (1D) to 11 Nm (100 lbf in) and replace the valve cap (1A) finger tight.

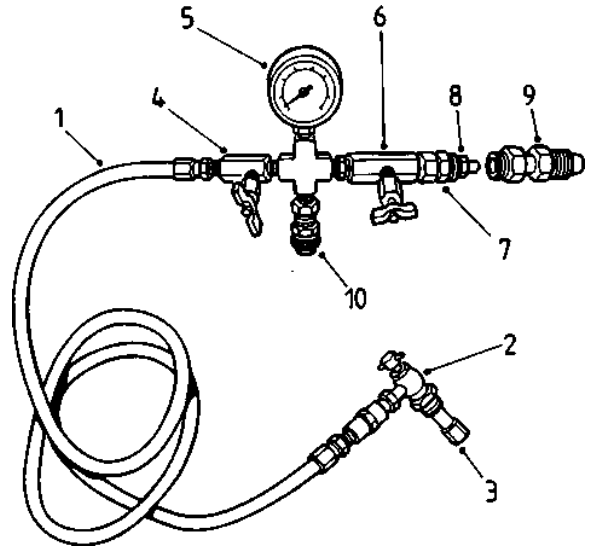
Testing Pre-charge Pressure

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Note: The nitrogen pressure in a steering accumulator is directly affected by changes in nitrogen temperature. The cylinder pressure will increase or decrease proportionally with temperature changes. An accumulator pressure reading taken on a steering system can vary about 4.3 bar (62 lbf/in²) with 22° C (72° F) temperature change. Such temperature changes could easily occur between noon and midnight of the same day. Refer to the table at the end of this section for Nitrogen pressures at ambient temperatures of other than 21° C (70° F).

To test accumulator pre-charge pressure or to charge the accumulator, a charging assembly tool can be used. Refer to Fig. 2.

1. Position the vehicle in a level work area, be sure the body is completely lowered, apply the parking brake and switch off the engine.



1 - Line
2 - Valve Chuck
3 - Valve Extension
4 - Accumulator Valve
5 - Pressure Gauge
6 - Tank Valve
7 - Gland Fitting
8 - Gland Nut
9 - Cylinder Adaptor
10 - Bleeder Valve

Fig. 2 - Charging Assembly

2. Turn steering wheel in both directions several times to relieve pressure in accumulator and steering system. Block all road wheels.

3. Check accumulator mountings to be sure the accumulator is held tightly in position.

4. Remove cap (1A, Fig. 1) from accumulator charging valve (1, Fig. 1). Attach charging line (1) to charging valve by rotating 'T' handle of valve chuck (2) counter-clockwise until it stops, then screw the swivel nut down on valve. Loosen charging valve locknut (1D, Fig. 1) by turning counter-clockwise one to two turns.

5. Turn 'T' handle clockwise until charging valve core is depressed. Be sure bleeder valve (10) is tight and does not leak, and valves (4 & 6) are closed.

6. To read accumulator pre-charge pressure, slowly open accumulator valve (4). Pressure gauge (5) will register pre-charge pressure, it should be 55 bar (800 lbf/in²) at 21° C (70° F) ambient temperature. Refer to the table at the end of this section for Nitrogen pressures at ambient temperatures of other than 21° C (70° F).

7. Close accumulator valve (4) and open bleeder valve (10) to dissipate gauge pressure. Close bleeder valve (10) after pressure is relieved. If the accumulator needs charged, leave line (1) and valve chuck (2) attached to charging valve and charge the accumulator as described under 'Charging The Accumulator'.

8. If pre-charge is 55 bar (800 lbf/in²) at 21° C (70° F), rotate 'T' handle counter-clockwise until it stops, then tighten locknut (1D, Fig. 1) on charging valve (1, Fig. 1) to 11 Nm (100 lbf in). Loosen the swivel nut and remove gauging head.

9. Install valve cap (1A, Fig. 1) on charging valve (1, Fig. 1) and tighten finger tight.

CHARGING THE ACCUMULATOR

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Either oil or water pumped nitrogen can be used to charge the accumulator. Both types are readily available from a local compressed gas dealer.

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⚠ WARNINGS
Do not use Oxygen or any gas other than Nitrogen to charge an accumulator. Oxygen under pressure coming into contact with oil or grease will cause a violent explosion. Always double check to make sure you are using Nitrogen to prevent personal injury and property damage.

⚠ A high pressure nitrogen pressure regulator must be used with the charging assembly. Failure to use pressure regulator could cause property damage, personal injury or death.

1. Attach line (1) and the swivel nut to charging valve (1, Fig. 1) as described in Steps 1 through 4 under the heading 'Testing Pre-Charge Pressure'. Be sure valves (4 & 6) are closed.

2. Attach gauging head to nitrogen bottle by screwing down on gland nut (8).

3. Open tank valve (6) slowly; pressure shown on pressure gauge (5) is tank pressure.

4. Open accumulator valve (4) slowly and charge accumulator to 55 bar (800 lbf/in²) at 21° C (70° F) ambient temperature, closing valve occasionally. Refer to the table at the end of this section for the Nitrogen pressures at ambient temperatures of other than 21° C (70° F).

5. To check accumulator charge, close tank valve (6), relieve pressure between tank and pressure gauge (5) by opening bleeder valve (10) momentarily. This will allow gauge needle to settle, thus giving correct pressure reading of accumulator charge.

6. When the correct pressure for the ambient temperature has been reached, close valves (4 & 6) tightly. Bleed pressure off pressure gauge (5) by opening bleeder valve (10). Close bleeder valve when oil pressure is bled from the gauge and unscrew gland nut (8) from nitrogen bottle.

7. Rotate 'T' handle of valve chuck (2) counter-clockwise until it stops, tighten charging valve locknut (1D, Fig. 1) to 11 Nm (100 lbf in), loosen the swivel nut and remove gauging head.

8. Check accumulator charging valve (1, Fig. 1) for leakage using soapy water. Reinstall valve cap (1A, Fig. 1) and tighten finger tight.

DISCHARGING NITROGEN

Numbers in parentheses refer to Fig. 1.

Make sure charging valve (1) is closed internally by turning locknut (1D) clockwise. Remove valve cap (1A) and valve core (1B) from charging valve assembly (1). Slowly turn locknut (1D) counter-clockwise to open charging valve assembly (1).

DO NOT remove charging valve (1) until all the gas has been completely evacuated.

⚠ WARNING
Do not try to discharge the accumulator by depressing charging valve core (1B).

REMOVAL

Numbers in parentheses refer to Fig. 3.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ Accumulators are charged with Nitrogen. Be sure all Nitrogen pressure has been relieved before removing accumulator from machine. Sudden release of pressure may cause personal injury.

1. Position the vehicle in a level work area, be sure the body is completely lowered, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve pressure in accumulator and steering system. Block all road wheels.

3. Discharge nitrogen from accumulator, as described under 'Discharging Nitrogen' in this section.

4. Disconnect hydraulic line from underside of accumulator. Cap the line and accumulator port to prevent ingress of dirt.

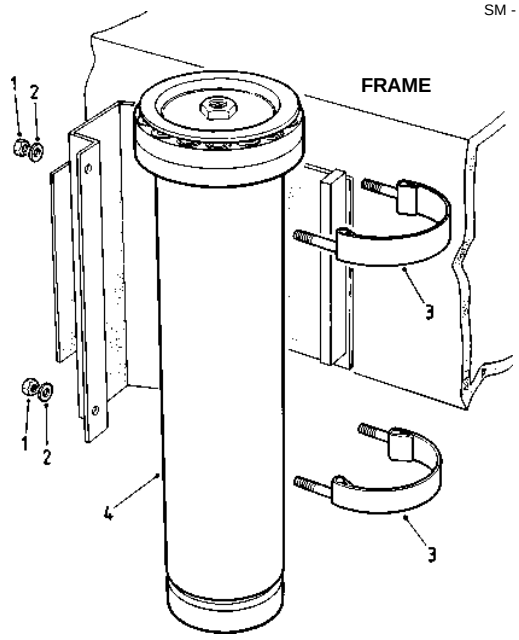
5. Support the accumulator using an adequate sling and lifting device. Remove nuts (1), washers (2) and mounting straps (3).

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Steering System - Accumulator

Section 220-0080



1 - Nut
2 - Washer
3 - Mounting Straps
4 - Accumulator

Fig. 3 - Accumulator Installation

6. Remove accumulator (4) from it's mounting bracket and move to a clean area for disassembly.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
Accumulators are charged with Nitrogen. The service pressure is 55 bar (800 lbf/in²) at 21° C (70° F). Do not attempt to remove any valves or fittings until all nitrogen pressure is completely relieved to prevent personal injury and property damage.

1. Make sure all nitrogen gas has been released before starting to disassemble the accumulator. Refer to section on 'Discharging Nitrogen'.

2. Remove charging valve (1) from shield (2).

3. Remove shield (2) from end cap (4) by using the hex head to unscrew the shield. Remove and discard ‘O’ ring (3) from end cap (4).

4. Remove bolts (8) and washers (9) from end cap (4). Remove end cap (4) from cylinder (12) and remove ‘O’ ring (6) and backup ring (5) from end cap (4). Discard 'O' ring and backup ring.

5. Insert a suitable wooden dowel through the port end of cylinder (12) to push out piston (10). Remove and discard seal rings (7) and wear rings (11) from piston (10).

INSPECTION

Numbers in parentheses refer to Fig. 1

1. Wash metal components with a suitable solvent and thoroughly air dry.

2. Inspect piston (10) for cracks or burrs. Replace piston (10), if excessively scored or worn.

3. Use an inspection lamp to check the bore of cylinder (12) for scratches or scoring. Minor nicks, scratches or light scoring of the bore can be removed by using crocus cloth. Dress the bore until all apparent imperfections have been removed. Replace complete accumulator assembly if inside of cylinder (12) is excessively scored or worn.

4. Inspect end cap (4) for damage and replace if necessary.

5. Inspect threads of bolts (8) and threads in cylinder (12) for damage. Replace all parts worn or damaged beyond repair.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Lubricate ‘O’ rings (3 & 6), backup ring (5), seal rings (7) and inside of cylinder (12) with hydraulic oil prior to assembly.

2. Install new seal rings (7) and wear rings (11) on piston (10). Insert piston (10) into cylinder (12) with seal rings (7) end toward open end of cylinder.

3. Place new backup ring (5) and ‘O’ ring (6) on end cap (4). Oil outside diameter of end cap and insert into cylinder (12).

4. Align bolt holes in flange of cylinder (12) with those of end cap (4) and insert bolts (8) and washers (9). Tighten bolts (8) to a torque of 271 - 298 Nm (200 - 220 lbf ft).

5. Place ‘O’ ring (3) on shield (2) and screw shield (2) into end cap (4). Tighten shield (2) to a torque of 102 - 135 Nm (75 - 100 lbf ft).

6. Install charging valve (1). Tighten locknut (1D)

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clockwise to 11 Nm (100 lbf in) to close charging valve. Insert valve core (1B), replace valve cap (1A) and tighten finger tight.

7. Test accumulator hydraulically for leakage or failure at 255 - 276 bar (3 700 - 4 000 lbf/in²). Discharge after testing.

INSTALLATION

Numbers in parentheses refer to Fig. 3.

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Using an adequate sling and lifting device, position the accumulator on its mounting bracket with oil inlet port downward and install mounting straps (3).

2. Attach mounting straps (3) securely with washers (2) and nuts (1).

3. Remove caps installed at 'Removal' to prevent dirt entering the hydraulic line and accumulator port.

4. Install hydraulic line securely to the oil inlet port at bottom of accumulator.

5. Charge accumulator with Nitrogen gas as described under the heading 'Charging the Accumulator' in this section.

6. Check oil level in the steering and brake control tank and add oil if necessary. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct oil level and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

7. Remove wheel blocks from all road wheels and start the engine. Operate the steering and check hydraulic lines for leaks. Tighten lines and fittings as required.

8. Recheck oil level in the steering and brake control tank and add oil if necessary.

MAINTENANCE

Inspect the accumulator regularly for any signs of leakage or damage.

Every 500 hours
Check the Nitrogen pre-charge pressure at the accumulator, prior to checking steering system pressure. Refer to 'Testing Pre-charge Pressure', in this section.

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools referenced in this section and general service tools required. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE		
			Nm	lbf ft	lbf in
1	1D	Locknut	11	-	100
1	2	Shield	271 - 298	200 - 220	-
1	8	Bolt	102 - 135	75 - 100	-

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AMBIENT TEMPERATURE - NITROGEN PRE-CHARGE PRESSURE			
AMBIENT TEMPERATURE		NITROGEN PRE-CHARGE PRESSURE	
°C	°F	bar	lbf/in²
-18	0	47.7	692
-12	10	48.8	708
-7	20	49.8	723
-1	30	50.9	738
5	40	52	754
10	50	53	769
16	60	54.1	785
21	70	55	800
27	80	56.2	815
32	90	57.3	831
38	100	58.3	846
43	110	59.4	862
49	120	60.5	877
54	130	61.5	892

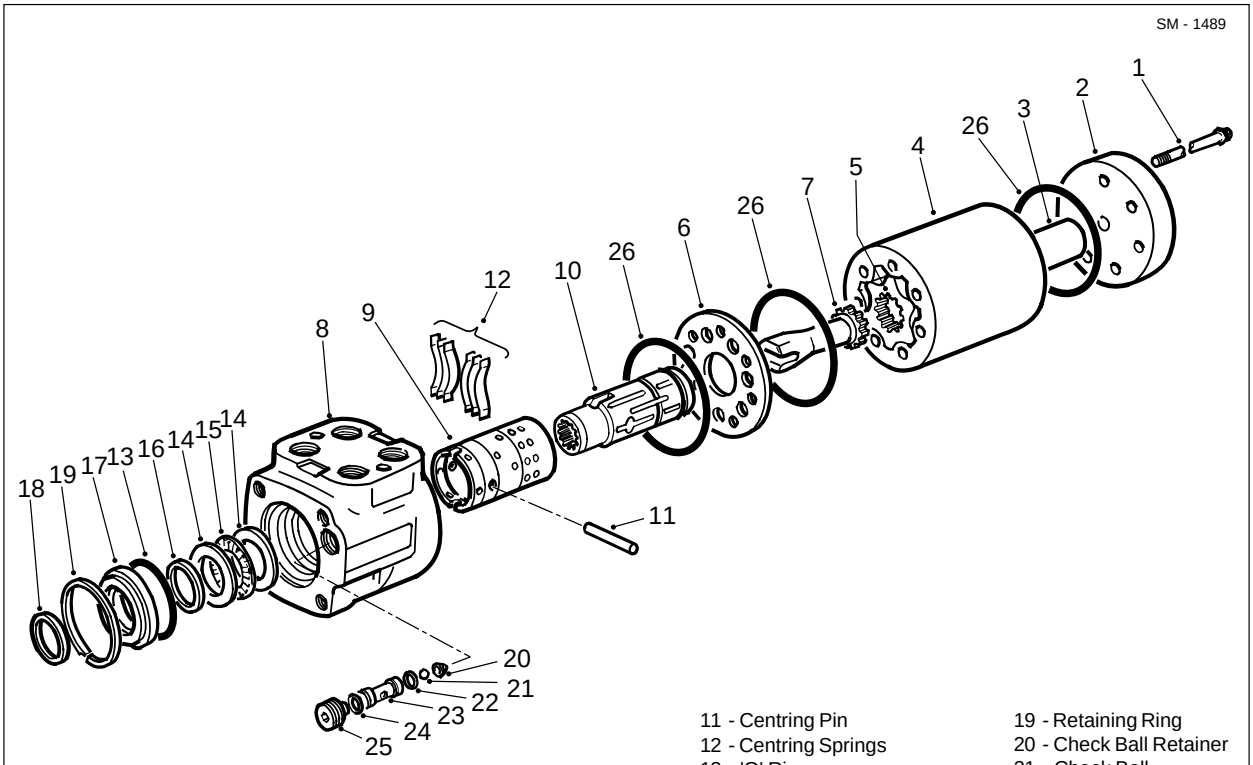
⚠ WARNING

This truck is equipped with pre-charged nitrogen gas cylinders of more than 2.8 bar (40 lbf/in²). Special permits may be required when transporting the truck or cylinders by any method while cylinders are charged. For shipment, contact the appropriate agency in the country involved. Consult your dealer for further permit information.

* * * *

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1 - Cap Screws
2 - End Cap
3 - Spacer
4 - Gerotor Housing
5 - Gerotor Gear
6 - Spacer Plate
7 - Driveshaft
8 - Valve Housing
9 - Sleeve
10 - Spool
11 - Centring Pin
12 - Centring Springs
13 - 'O' Ring
14 - Bearing Races
15 - Needle Bearing
16 - Quad Ring Seal
17 - Seal Gland Bushing
18 - Oil Seal
19 - Retaining Ring
20 - Check Ball Retainer
21 - Check Ball
22 - 'O' Ring
23 - Check Ball Seat
24 - 'O' Ring
25 - Set Screw
26 - 'O' Rings

Fig. 1 - Exploded View of Steering Valve

DESCRIPTION

Numbers in parentheses refer to Fig. 1. Letters in parentheses refer to Figs. 4 through 8.

Note: The Steering Valve can be identified as item 5 in Section 220-0000, STEERING SYSTEM SCHEMATIC, in this manual.

The steering valve is connected to the steering column and controls hydraulic flow in the steering system. The main components of the steering valve are valve housing (8), gerotor housing (4), gerotor gear (5), sleeve (9), spool (10) and driveshaft (7).

There are four ports on valve housing (8) as follows:

Port 'P' - Supply from accumulator valve
Port 'T' - Return to tank
Port 'R' - Cylinder supply for right-hand turn
Port 'L' - Cylinder supply for left-hand turn

Turning action of the steering wheel is transmitted through the steering column to sleeve (9) and driveshaft (7) which is fastened to the sleeve with centring pin (11). Rotation of driveshaft (7) causes gerotor gear (5), which is splined to driveshaft (7), to rotate in gerotor housing (4). When gerotor gear (5) rotates, oil in gerotor housing (4) pockets (see Fig. 2) is forced out and flows through spool (10) and sleeve (9) to the steering cylinder port.

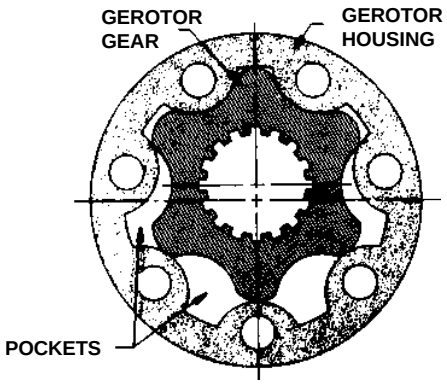


Fig. 2 - Gerotor Gear Set

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Spool (10) contains porting matched to sleeve (9) and rotates within sleeve (9) to provide directional control of the oil. See Fig. 3.

The steering valve has a rated flow of 1.0 litre/s (16 Us gal/min), measured at 70 bar (1 000 lbf/in²) pressure drop at full valve deflection.

OPERATION

Numbers in parentheses refer to Fig. 1. Letters in parentheses refer to Figs. 4 through 8.

When the operator turns the steering wheel a certain number of degrees for either a left or right-hand turn, the movement is transmitted through the steering column to spool (10). After a minimum rotation of 2.5 degrees, the ports in spool (10) start to align with ports in sleeve (9). When the steering wheel is rotated to a maximum of 10 degrees the ports are fully aligned, allowing full oil flow. After 10 degrees of travel in either direction the spool and sleeve rotate as an assembly through centring pin (11).

Oil from the accumulator valve flows into valve housing (8) at port 'P' and is channelled through sleeve (9) and spool (10) to gerotor housing (4). Porting in gerotor housing (4) permits oil to flow into pockets formed by gerotor housing (4) and gerotor gear (5). As spool (10) rotates, driveshaft (7) also rotates which, in turn, rotates gerotor gear (5) to which it is splined. When gerotor gear (5) rotates, it progressively forces oil out of the pockets (see Fig. 2), of gerotor housing (4). The oil is channelled through sleeve (9) and spool (10) and exits valve housing (8) through port 'R' for a right hand turn, or, port 'L' for a left hand turn. Oil then travels through steering lines to the steering cylinders.

As the steering cylinder pistons move, oil forced out of the steering cylinders returns to valve housing (8). The return oil passes through valve sleeve (9) and spool (10) and exits through port 'T' to tank.

When the steering effort is released, centring springs (12) which were put under tension by the rotation of spool (10), now force sleeve (9) to rotate back to its original position. This puts the ports out of alignment and stops pump oil flow to the steering cylinders. The truck stops turning further, but will hold the present turning radius until spool (10) is rotated past the 2.5 degree minimum.

Refer to Fig. 4, for left turn. As the steering column is turned, oil from the accumulator valve is directed through sleeve (9) and spool (10) to the metering section of the steering valve. Discharge from the metering section exits the steering valve at port 'L' to the base port of the right steering cylinder and rod port of the left steering cylinder. Exhaust oil from the opposite ends of steering cylinders flows through port 'R' in the steering valve and exits through port 'T' to tank.

Refer to Fig. 5, for right turn. As the steering column is turned, oil from the accumulator valve is directed through sleeve (9) and spool (10) to the metering section of the steering valve. Discharge from the metering section exits the steering valve at port 'R' to the base port of the left steering cylinder and rod port of the right steering cylinder. Exhaust oil from the opposite ends of steering cylinders flows through port 'L' in the steering valve and exits through port 'T' to tank.

Refer to Figs. 6 & 7, for manual steering operation. In the event of an engine or pump failure, the steering valve automatically reverts to a manual steering system. In this condition, the oil metering section becomes a rotary hand pump and directs oil under pressure through the normal porting configuration to the steering cylinders when the steering wheel is manually rotated in the desired direction. Check valve assembly (20 through 25) allows re-circulation of the oil between the steering cylinders and the valve. When power is returned the circuit pressure seats the valve and the system operates as described previously.

Refer to Fig. 8 for steering valve operating in the neutral position. In the neutral circuit, or non-steering position of the steering valve, spool (10) and sleeve (9) are held in the proper relative position by centring springs (12). These spring sets maintain a small preload force just adequate to re-centre the valve at any time it is brought against a travel limit and released. In this way the system is protected from becoming overheated when the truck is parked temporarily with the power steering circuit loaded.

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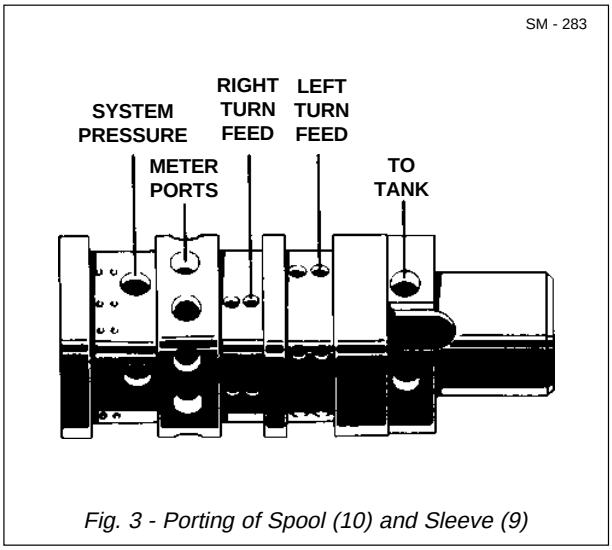


Fig. 3 - Porting of Spool (10) and Sleeve (9)

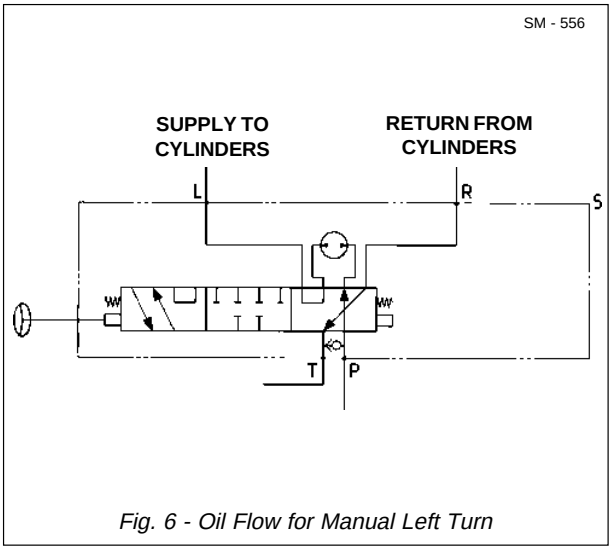


Fig. 6 - Oil Flow for Manual Left Turn

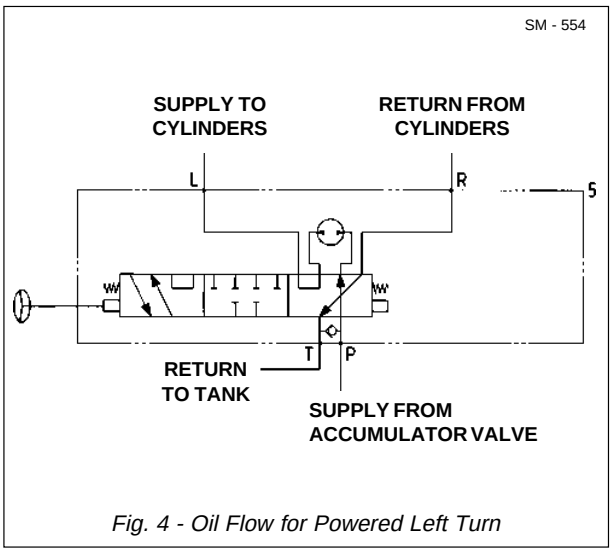


Fig. 4 - Oil Flow for Powered Left Turn

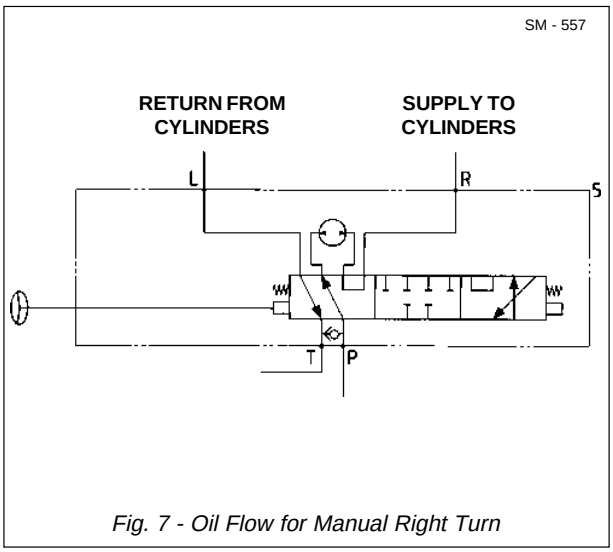


Fig. 7 - Oil Flow for Manual Right Turn

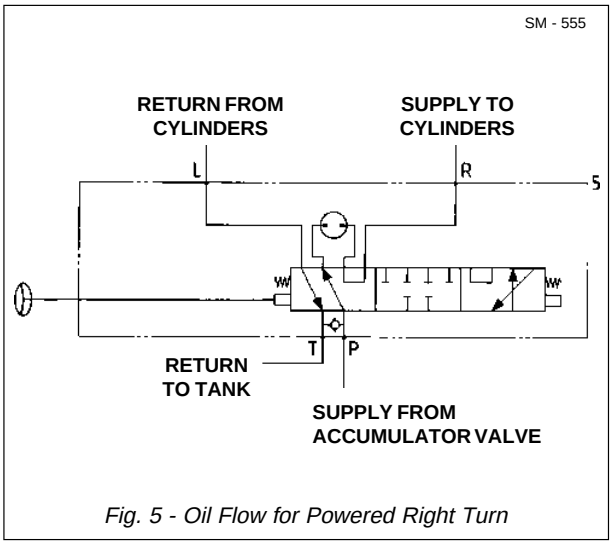


Fig. 5 - Oil Flow for Powered Right Turn

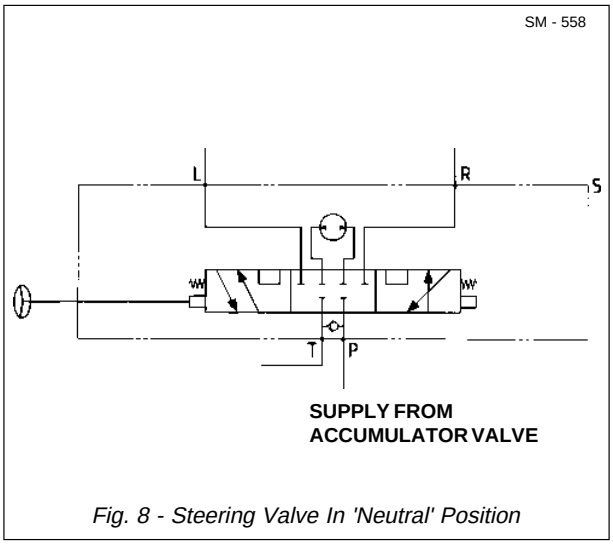


Fig. 8 - Steering Valve In 'Neutral' Position

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REMOVAL

Numbers in parentheses refer to Fig. 9.

⚠ WARNINGS
To prevent personal injury and property damage, turn steering wheel several times in each direction to relieve pressure in the steering accumulator.

⚠ To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is completely lowered, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve pressure in accumulator and steering system. Block all road wheels.

3. Remove bolts (5), washers (6) and lockwashers (7) securing cover (3) to the truck. Remove cover (3) from the truck.

4. Before removal of the steering valve, clean the valve and connecting lines around it to prevent ingress of dirt.

5. Ensure all hydraulic lines connected to steering valve (1) are identified for ease of installation and with suitable containers available to catch spillage, disconnect hydraulic lines. Cap all lines and plug all ports to prevent entry of dirt.

6. Support steering valve (1) and remove bolts (8) and lockwashers (4) securing steering column (2) to steering valve (1).

7. Carefully lower steering valve (1) until the splined shaft is free from steering column (2) and cab firewall. Move steering valve (1) to a clean area for disassembly.

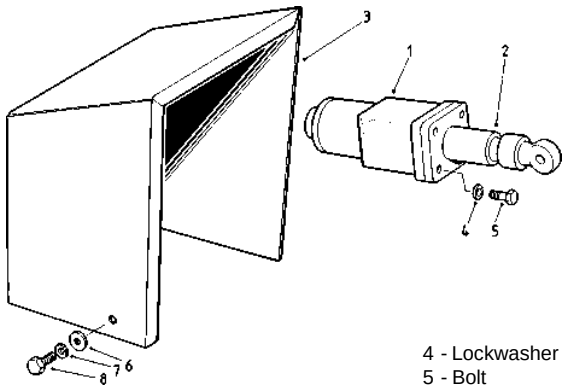


Fig. 9 - Exploded View of Steering Valve Installation

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Although all illustrations do not show steering valve in a vice, we recommend that you keep it in a vice during disassembly. Follow the clamping procedures explained throughout the text.

1. Clamp steering valve in vice, gerotor housing (4) end up. Clamp lightly on edges of mounting area. See Fig. 10. Use protective material on vice jaws. Do not overtighten jaws.

2. Remove cap screws (1) and end cap (2) from valve housing (8). See Fig. 11.

3. Remove gerotor assembly (3, 4 & 5) from valve housing (8). See Fig. 12. Be careful not to drop gerotor gear (5).

4. Remove drive spacer (3) and gerotor gear (5) from gerotor housing (4) Remove and discard 'O' ring (26) from gerotor housing (4). See Fig. 12.

5. Remove driveshaft (7) and spacer plate (6) from valve housing (8). Remove and discard 'O' rings (26) from spacer plate (6) and valve housing (8). See Fig. 13.

6. Remove valve housing (8) from vice. Place valve housing (8) on a clean, soft cloth to protect surface finish. Use a thin blade screwdriver to pry retaining ring (19) from valve housing (8), as shown in Fig. 14.

7. Push spool (10) and sleeve (9) assembly forward with your thumbs just far enough to free seal gland bushing (17) from valve housing (8). See Fig. 15. Remove seal gland bushing (17).

8. Remove and discard quad ring seal (16) from seal gland bushing (17). See Fig. 16.

9. Use a thin blade screwdriver to pry oil seal (18) from seal gland bushing (17). Do not damage seal gland bushing (17). Discard oil seal (18).

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SM - 288

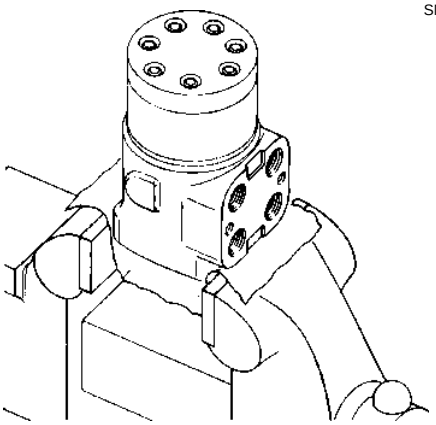
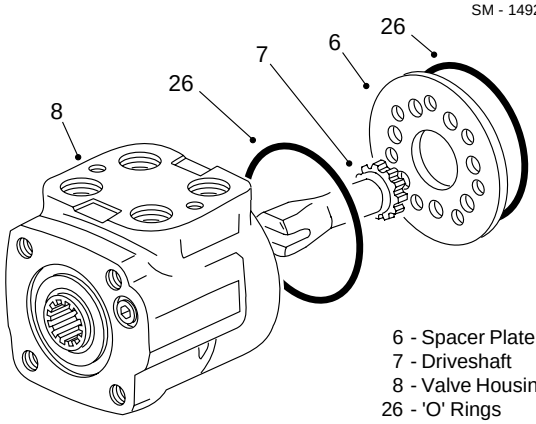


Fig. 10 - Valve Clamped in Vice

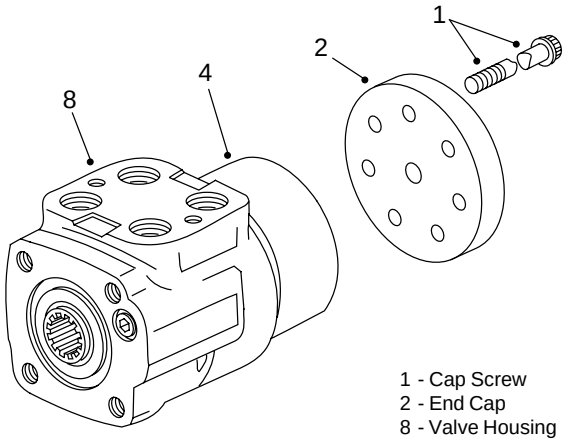
SM - 1492



6 - Spacer Plate
7 - Driveshaft
8 - Valve Housing
26 - 'O' Rings

Fig. 13 - Removing Driveshaft

SM - 1490



1 - Cap Screw
2 - End Cap
8 - Valve Housing

Fig. 11 - Removing End Cap

SM - 292

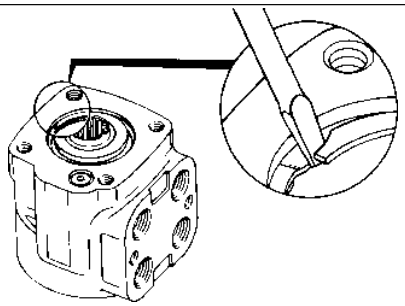
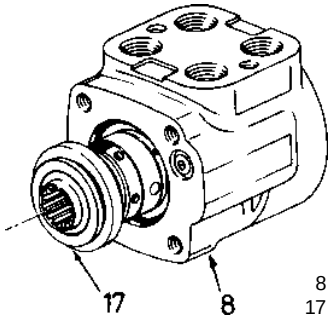


Fig. 14 - Removing Retaining Ring

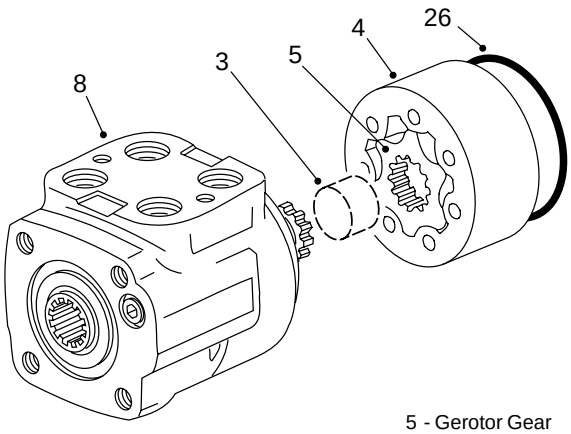
SM - 293



8 - Valve Housing
17 - Seal Gland Bushing

Fig. 15 - Removing Seal Gland Bushing

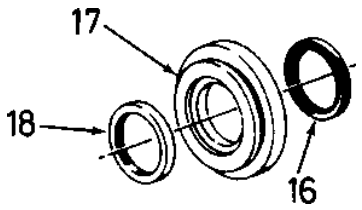
SM - 1491



5 - Gerotor Gear
3 - Spacer
8 - Valve Housing
4 - Gerotor Housing
26 - 'O' Ring

Fig. 12 - Removing Gerotor Assembly

SM - 294



16 - Quad Ring Seal
17 - Seal Gland Bushing
18 - Oil Seal

Fig. 16 - Removing Seals

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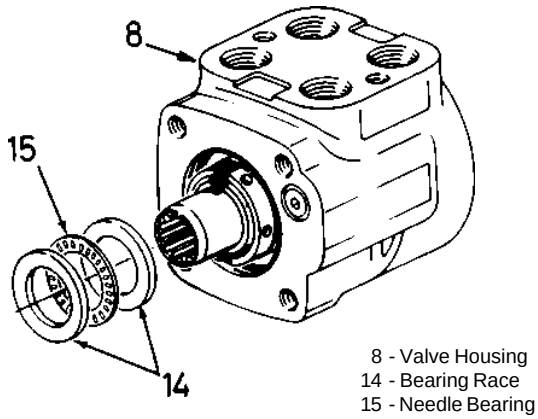


Fig. 17 - Removing Needle Bearing

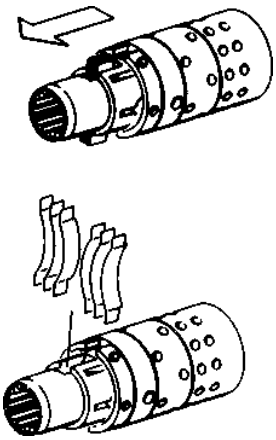


Fig. 19 - Separating Spool and Sleeve

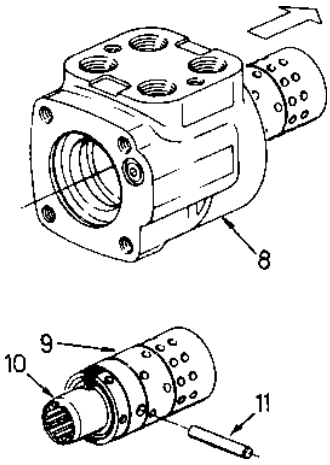


Fig. 18 - Removing Spool and Sleeve Assembly

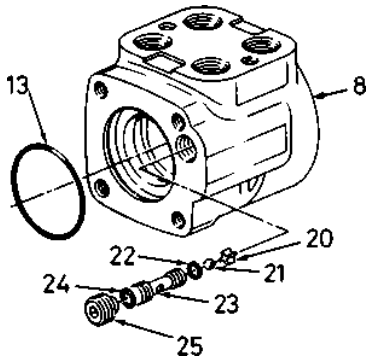


Fig. 20 - Removing 'O' Ring and Set Screw

10. Remove two bearing races (14) and needle bearing (15) from spool (10) and sleeve (9) assembly. See Fig. 17.

11. Remove spool (10) and sleeve (9) assembly from the 14 hole (meter) end of valve housing (8). See Fig. 18.

Note: Do not bind spool (10) and sleeve (9) assembly in valve housing (8). Rotate spool (10) and sleeve (9) assembly slowly when removing from valve housing (8).

12. Push centring pin (11) from spool (10) and sleeve (9) assembly. See Fig. 18.

13. Remove spool (10) from control end of sleeve (9). See Fig. 19. Rotate spool (10) slowly when removing from sleeve (9).

14. Remove six centring springs (12) from spool (10), by hand. See Fig. 19.

15. Remove and discard 'O' ring (13) from valve housing (8). See Fig. 20.

16. Remove set screw (25) from valve housing (8). See Fig. 20.

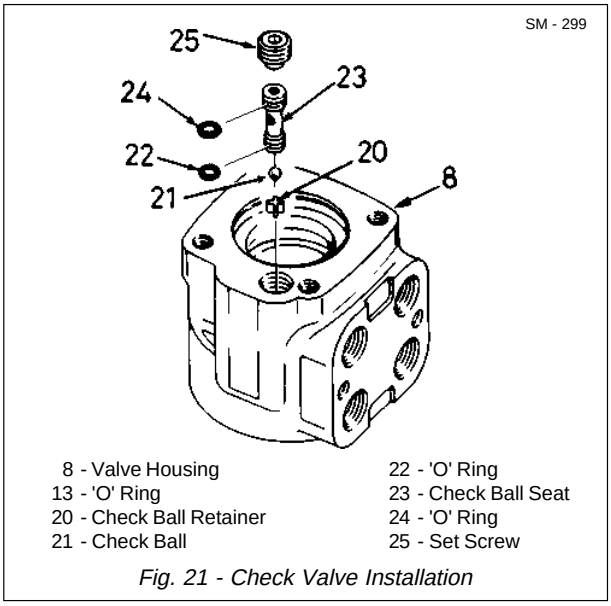
17. Screw an 1/8-24 machine screw into end of check ball seat (23) and, by pulling on screw with pliers, lift check ball seat (23) out of valve housing (8).

18. Remove and discard 'O' rings (22 & 24) from check ball seat (23).

19. Tip valve housing (8) to remove check ball (21) and check ball retainer (20).

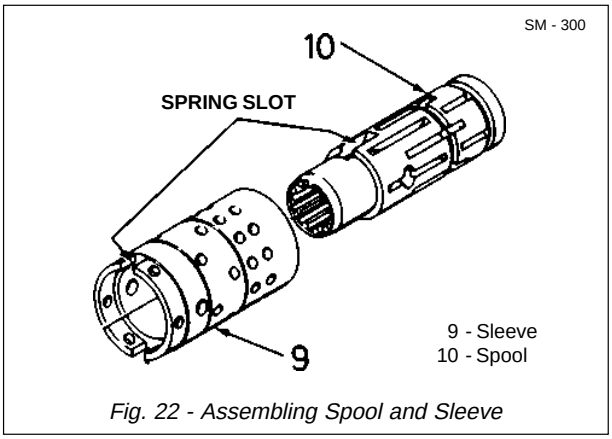
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8 - Valve Housing
13 - 'O' Ring
20 - Check Ball Retainer
21 - Check Ball
22 - 'O' Ring
23 - Check Ball Seat
24 - 'O' Ring
25 - Set Screw

Fig. 21 - Check Valve Installation



9 - Sleeve
10 - Spool

Fig. 22 - Assembling Spool and Sleeve

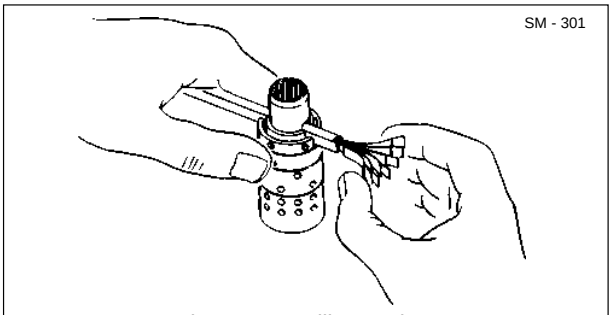


Fig. 23 - Installing Springs

INSPECTION

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in a clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind any parts.

Note: Lubricate all 'O' rings and seals (with exception of quad ring seal) with a petroleum jelly.

Replace all 'O' rings and oil seals with new 'O' rings and oil seals at assembly.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Use needle nose pliers to lower check ball retainer (20) into check valve hole of valve housing (8). See Fig. 21. Make sure check ball retainer (20) sits flat in valve housing (8).

2. Install check ball (21) in check ball retainer (20).

3. Install new 'O' ring (22) on large diameter end and new 'O' ring (24) on small diameter end of check ball seat (23).

4. Install check ball seat (23) assembly in valve housing (8), insert open end of check ball seat (23) first. See Fig. 21. Take care not to damage 'O' rings (22 & 24).

5. Install set screw (25) in valve housing (8) and tighten to a torque of 11 Nm (100 lbf in). Make sure set screw (25) is flush with, or slightly below, valve housing (8) surface.

6. Assemble spool (10) and sleeve (9) carefully so that the spring slots line up at the same end. See Fig. 22. Rotate spool (10) while sliding parts together. Test for free rotation. Spool (10) should rotate smoothly in sleeve (9) with finger tip force applied at splined end.

7. Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool (ref. 'Special Tools') through spring slots of both parts. Position three pairs of centring springs (12) (or two sets of three each) on bench so that extended edge is down and arched centre section is together. In this position, enter one end of entire spring set into spring installation tool, as shown in Fig. 23.

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8. Compress extended end of centring springs (12) and push into spool (10) and sleeve (9) assembly, withdrawing installation tool at the same time.

9. Centre centring springs (12) in the parts so that they push down evenly and are flush with upper surface of spool (10) and sleeve (9).

10. Install centring pin (11) through spool (10) and sleeve (9) assembly until centring pin (11) becomes flush at both sides of sleeve (9). See Fig. 24.

11. Position spool (10) and sleeve (9) assembly so that the splined end of spool (10) enters the 14 hole (meter) end of valve housing (8) first. See Fig. 25.

Note: Be extremely careful that the parts do not cock out of position while entering. Push parts gently into place with slight rotating action. Bring spool (10) and sleeve (9) assembly entirely within valve housing (8) bore until the parts are flush at the meter end of valve housing (8). Do not pull spool (10) and sleeve (9) assembly beyond this point to prevent centring pin (11) from dropping into the discharge groove of valve housing (8). With spool (10) and sleeve (9) assembly in this flush position, check for free rotation within valve housing (8) by turning with light finger force at the splined end.

12. Install new 'O' ring (13) in valve housing (8). See Fig. 26.

13. Install two bearing races (14) and needle bearing (15) in valve housing (8). See Fig. 26.

14. Install new oil seal (18) in seal gland bushing (17). Flat or smooth side of oil seal (18) must face down towards seal gland bushing (17). See Fig. 28.

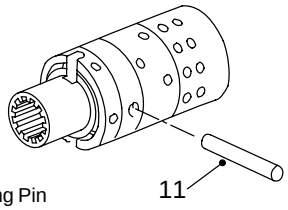
15. Install new dry quad ring seal (16) in seal gland bushing (17). See Fig. 28. Smooth quad ring seal (16) in place with your finger. Do not use any quad ring seal (16) that falls freely into pocket of seal gland bushing (17).

16. Install seal gland bushing (17) over spool (10) end with a twisting motion. Tap seal gland bushing (17) in place with a rubber hammer. Make sure seal gland bushing (17) is flush against bearing race (14).

17. Install retaining ring (19) in valve housing (8). See Figs. 27 and 28. Tap lightly on retaining ring (19) end to properly seat retaining ring (19) in its groove.

18. Carefully clamp valve housing (8) in vice as shown in Fig. 29. Clamp lightly on edges of mounting area.

SM - 616



11 - Centring Pin

Fig. 24 - Installing Centring Pin

SM - 303

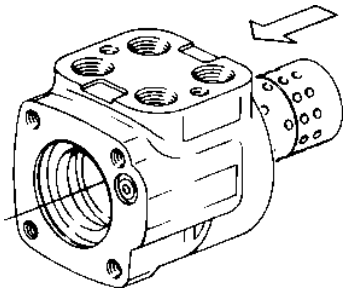
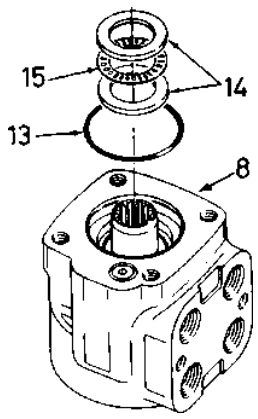


Fig. 25 - Installing Spool and Sleeve

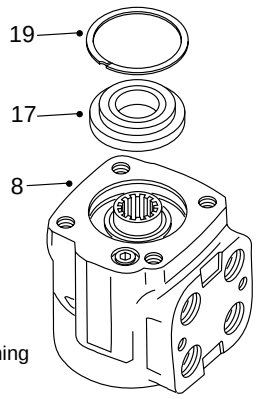
SM - 304



8 - Valve Housing
13 - 'O' Ring
14 - Bearing Race
15 - Needle Bearing

Fig. 26 - Needle Bearing Installation

SM - 305

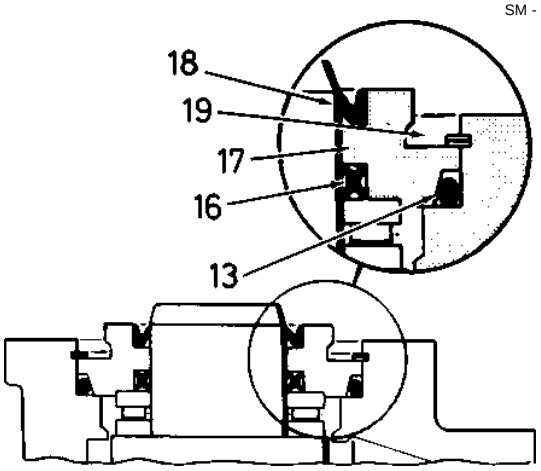


8 - Valve Housing
17 - Seal Gland Bushing
19 - Retaining Ring

Fig. 27 - Seal Bushing Installation

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13 - 'O' Ring
16 - Quad Ring Seal
17 - Seal Gland Bushing
18 - Oil Seal
19 - Retaining Ring

Fig. 28 - Seal and 'O' Ring Locations

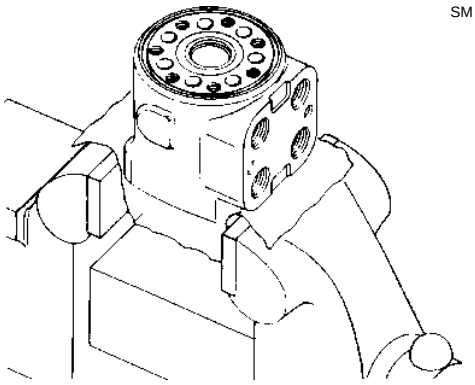
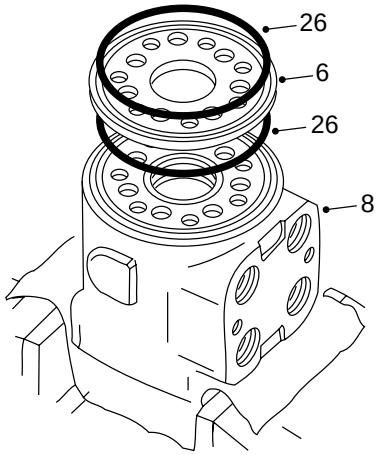


Fig. 29 - Valve Clamped in Vice



6 - Spacer Plate
8 - Valve Housing
26 - 'O' Rings

Fig. 30 - 'O' Ring and spacer Plate Installation

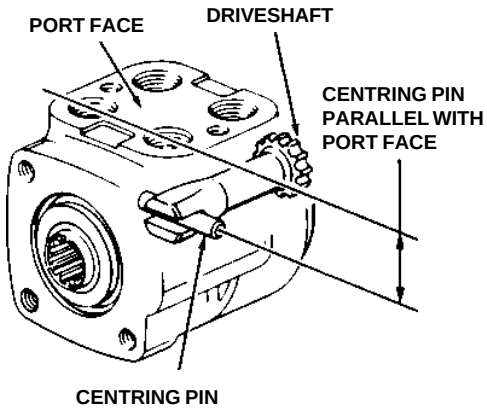
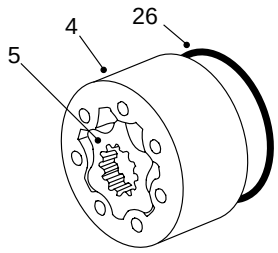


Fig. 31 - Aligning Spool and Sleeve



4 - Gerotor Housing
5 - Gerotor Gear
26 - 'O' Ring

Fig. 32 - Gerotor Gear Installation

Note: Check to ensure spool (10) and sleeve (9) are flush with, or slightly below, the meter end surface of valve housing (8). Clean the upper surface of valve housing (8) by wiping with the palm of clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for re-assembly. Do not use cloth or paper to clean surfaces.

19. Install new 'O' ring (26) in valve housing (8) and new 'O' ring (26) in spacer plate (6). Install spacer plate assembly on valve housing (8). See Fig. 30. Align bolt holes in spacer plate (6) with tapped holes in valve housing (8).

20. Rotate spool (10) and sleeve (9) assembly until centring pin (11) is parallel with port face. See Fig. 31. Install driveshaft (7) making sure you engage driveshaft (7) with centring pin (11). To assure proper alignment, mark driveshaft (7) as shown in Fig. 33.

21. Install gerotor gear (5) and new 'O' ring (26) in gerotor housing (4). See Fig. 32.

22. With seal side of gerotor housing (4) toward spacer plate (6), align gerotor gear (5) valleys on

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driveshaft (7), as shown in Fig. 33. Note the parallel relationship of reference lines A, B, C & D in Fig. 33. Align cap screw (1) holes without disengaging gerotor gear (5) from driveshaft (7).

23. Install spacer (3) in gerotor housing (4) and install end cap (2) on gerotor housing, as shown in Fig. 34.

24. Align cap screw (1) holes and install seven dry cap screws (1) in end cap (2). Pre-tighten cap screws (1) to 17 Nm (150 lbf in) then tighten to a torque of 31 Nm (275 lbf in) torque, in the sequence shown in Fig. 35.

INSTALLATION

Numbers in parentheses refer to Fig. 9.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Make certain, area of installation is clean.

2. Carefully raise steering valve (1) until the splined shaft is engaged in steering column (2) through the cab firewall.

3. Install bolts (5) and lockwashers (4) through steering column (2) and secure to cab firewall and steering valve (1).

4. Remove plugs from steering valve ports and caps from steering lines and install steering lines to steering valve (1), as identified at removal.

5. Check oil level in steering and brake control tank. Add oil, if necessary. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK, for correct oil levels. Refer to Section 300-0020, LUBRICATION SYSTEM, for the type of oil used.

6. Remove wheel blocks from all road wheels, start the engine and operate the steering system. Check steering valve assembly and all hydraulic lines for leaks. Tighten lines and fittings as required.

7. Secure cover (3) to the truck with washers (6), lockwashers (7) and bolts (8).

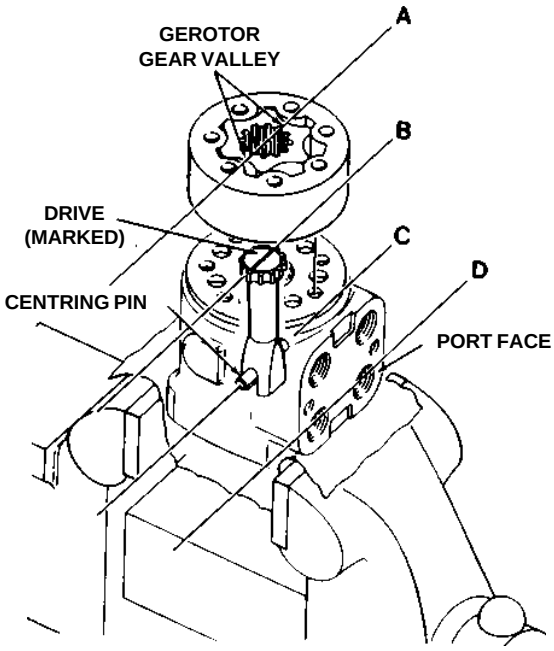


Fig. 33 - Aligning Housing and Gerotor

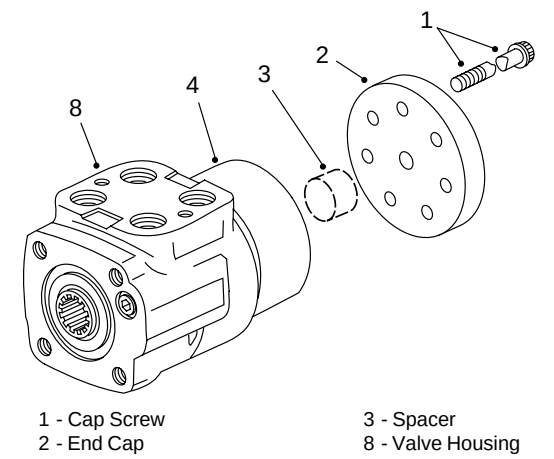


Fig. 34 - End Plate Installation

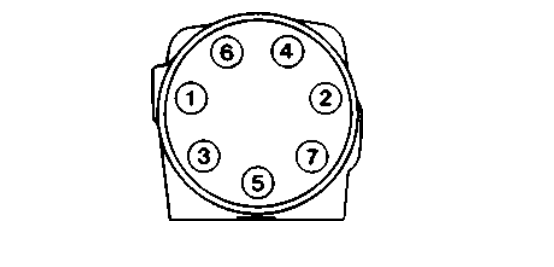


Fig. 35 - Cap Screw Tightening Sequence

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FILLING AND BLEEDING THE STEERING SYSTEM

1. Fill steering and brake control tank to Maximum level. Be ready to add oil when the engine is started. Do not let oil drop below the pump suction line to prevent air entering the system.

2. Start engine and let it idle. Immediately add oil to the steering and brake control tank as required. When no more oil can be added and oil is clear, proceed as follows:

a. Turn the steering wheel from lock to lock to bleed the air in the steering cylinders and lines.

Note: Immediately upon valve spool actuation oil must be added to the steering and brake control tank to replenish the oil moving into the circuit.

> ⚠ **WARNING**
> **Do not operate the vehicle until all air is bled from the oil.**

b. When the oil in the tank is clear (not cloudy or creamy), the system is free of air.

Note: Slight creep or drift of the steering wheel is normal.

c. Fill steering and brake control tank with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK, for correct fill level. Install filler cap an tank.

Hydraulic Oil

The steering system should be kept filled with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM.

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools referenced in this section and general service tools required. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	1	Cap Screw	31 (Dry)	275 (Dry)
1	25	Cap Screw	11	100

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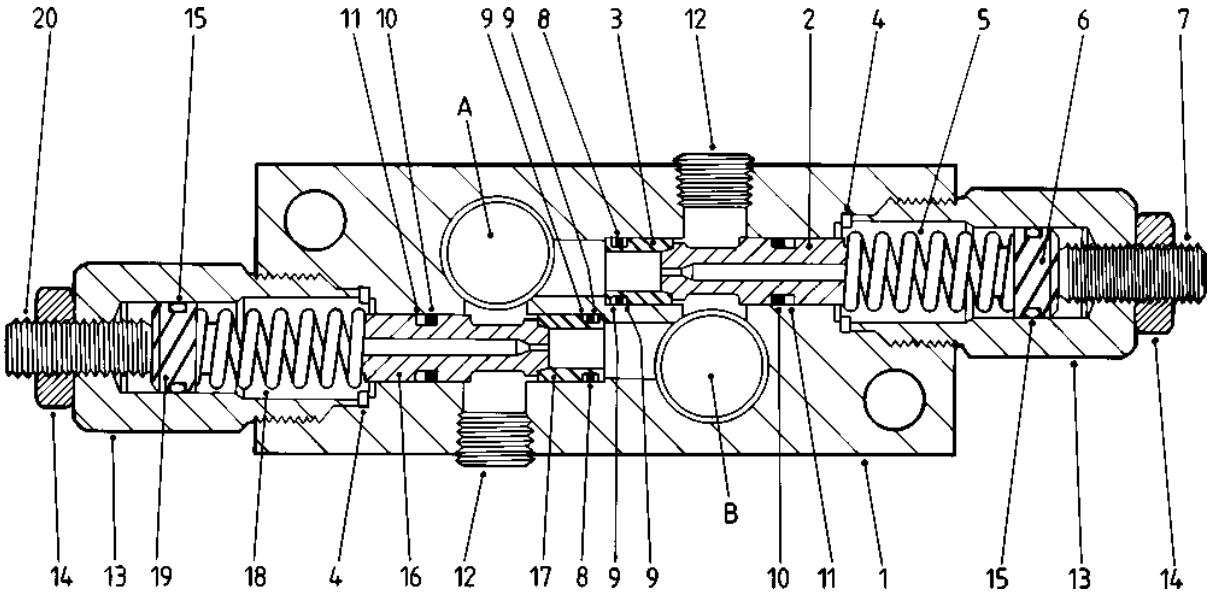
STEERING CONTROL DIAGNOSIS		
CONDITION	REASON	REMEDY
Steering wheel does not centre	Binding in steering linkage to valve	Align as required
	Worn gerotor	Replace parts
	Broken springs	Replace springs, drain and flush system
	Burrs on sleeve or spool	Disassemble and repair or replace parts
Apparent inability to steer when wheel is turned slowly	Dirt in system	Drain and flush system. Refill with clean oil
Slow steering	Excessive wear in sleeve and spool	Replace sleeve and spool
	Excessive wear in gerotor	Replace gerotor
Hard steering	See 'Slow Steering'	
Opposite steering	Lines hooked up incorrectly	Reconnect correctly
	Wrong orientation between gerotor and gerotor drive	Realign per instructions
Steering wheel rocking back and forth	See 'Opposite Steering'	
Steering wheel continues to turn	Input linkage binding	Align as required
	Burr on sleeve or spool	Disassemble and repair or replace
	Dirt in system	Drain and flush system. Refill with clean oil
	Broken springs	Replace springs, drain and flush system
No steering action	Sleeve and spool locked together	Disassemble and repair or replace

* * * *

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SM - 1326



1 - Valve Body
2 - Valve
3 - Valve Seat
4 - Washer
5 - Spring
6 - Spring End
7 - Adjustment Screw
8 - 'O' Ring
9 - Backup Ring
10 - 'O' Ring
11 - Backup Ring
12 - Plug
13 - Relief Body
14 - Jam Nut
15 - 'O' Ring
16 - Valve
17 - Valve Seat
18 - Spring
19 - Spring End
20 - Adjustment Screw

Fig. 1 - Cutaway View of Double Relief Valve

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The double relief valve can be identified as item 6 in Section 220-0000, STEERING SYSTEM SCHEMATIC, in this manual.

Installed in the lines between the steering cylinders and the steering valve, the double relief valve relieves shock loads on the steering cylinders by transferring the excessive pressure applied to the oil by the road shock, to the opposite end of the cylinders. This shock, if left unchecked, might damage steering linkage components.

Note: The relief valves are set to open at 172 bar (2 500 lbf/in²).

OPERATION

Numbers in parentheses refer to Fig. 1. Refer to Figs. 2, 3 and 4 for hydraulic schematics of double relief valve.

Note: Fig. 1 shows the double relief valve with both valves in the closed position.

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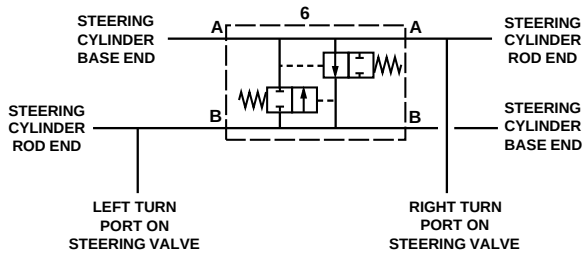


Fig. 2 - Double Relief Valve - Valve (16) Activated

When oil flowing through valve body (1) at port 'A', and out of the opposite side exceeds valve (16) setting, valve (16) is moved off valve seat (17) against the pressure of spring (18). See Fig. 2. As valve (16) moves off valve seat (17), oil flows out of port 'B' to the opposite end of steering cylinders. After the road shock has been dissipated, pressure is reduced and spring (18) seats valve (16) against valve seat (17). See Fig. 3.

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Steering System - Double Relief Valve

Section 220-0110

When oil flowing through valve body (1) at port 'B', and out of the opposite side exceeds valve (2) setting, valve (2) is moved off valve seat (3) against the pressure of spring (5). See Fig. 4. As valve (2) moves off valve seat (3), oil flows out of port 'A' to the opposite end of steering cylinders. After the road shock has been dissipated, pressure is reduced and spring (5) seats valve (2) against valve seat (3). See Fig. 3.

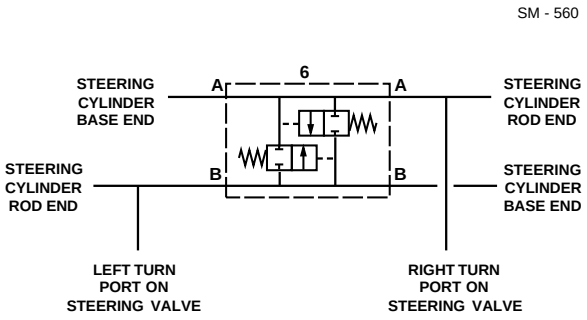


Fig. 3 - Double Relief Valve In Neutral Position

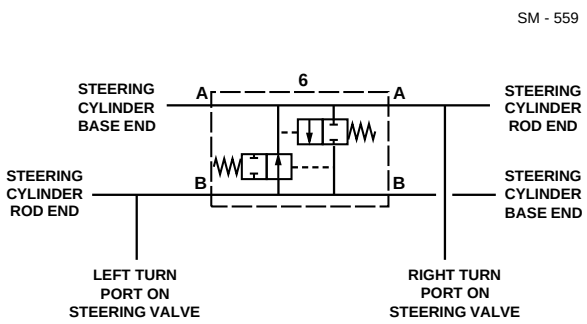


Fig. 4 - Double Relief Valve - Valve (2) Activated

REMOVAL

⚠ WARNINGS

Hydraulic fluid pressure will remain within the system after engine shutdown. To prevent personal injury and property damage, turn steering wheel several times in each direction to relieve pressure in the system.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, raise the body and secure in place with the body safety pins. Apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve any pressure in accumulator and steering system. Block all road wheels.

3. Before removal of double relief valve from the truck, clean exterior of the valve and hydraulic oil lines to prevent ingress of dirt.

4. Identify and tag all hydraulic oil lines to aid in installation and disconnect from double relief valve. Cap all lines and plug all ports of the double relief valve to prevent ingress of dirt.

5. Remove mounting hardware securing double relief valve to the truck and move to a clean area for disassembly.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. If required, remove elbows and tees from double relief valve and identify to aid in assembly.

2. Slacken jam nut (14) from adjustment screw (7) and carefully remove adjustment screw (7) from valve body (1).

⚠ WARNING

Compressed springs. Use care when removing relief body (13). Springs (5 & 18) are under compression and may spring out of valve body (1) bore, causing personal injury, if compression is not released carefully.

3. Carefully remove relief body (13) assembly from valve body (1). Remove washer (4) and spring end (6) assembly from relief body (13). Remove and discard 'O' Ring (15) from spring end (6).

4. Remove spring (5) from valve body (1).

Note: To remove valve (2) assembly and valve seat (3) assembly from valve body (1), it is necessary to turn valve body on its end and tap down on a work bench, or other suitable area, to release the parts.

5. Remove valve (2) assembly from valve body (1). Remove and discard 'O' Ring (10) and backup ring (11) from valve (2).

6. Remove valve seat (3) assembly from valve

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body (1). Remove and discard 'O' ring (8) and backup rings (9) from valve seat (3).

7. Follow steps 1 through 6 to disassemble the remaining valve (16) assembly.

8. If necessary, remove plugs (12) from valve body (1).

INSPECTION

Numbers in parentheses refer to Fig. 1.

Note: There is a seal kit available to replace all of the seals in the valve. However, if any of the other items are damaged the valve assembly should be replaced. Refer to the trucks Parts Book for part number of the seal kit.

1. Clean all parts with a suitable solvent and dry with compressed air.

2. Inspect all threaded parts for stripped or damaged threads.

3. Inspect valve body (1) bores, valves (2 & 16) and valve seats (3 & 17) for excessive wear, scratches or deep grooves. If either valve body (1), valves (2 & 16) or valve seats (3 & 17) are damaged beyond repair, the complete valve assembly must be replaced.

4. Inspect springs (5 & 18) for breaks, lack of tension or other damage. Replace if required.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Install new 'O' ring (8) and backup rings (9) on valve seat (3). Install new 'O' ring (10) and backup ring (11) on valve (2). Refer to Fig. 1.

2. Install valve seat (3) assembly in valve body (1) and lightly tap home with a pin punch. Install valve (2) assembly in valve body (1).

3. Install new 'O' ring (15) on spring end (6) and install spring end (6) assembly in relief body (13). Install spring (5) in relief body (13).

4. Install washer (4) on relief body (13) and thread relief body (13) assembly into valve body (1). Tighten relief body (13) to a torque of 60 - 65 Nm (44 - 48 lbf/in^2).

5. Thread adjustment screw (7) into valve body (1). Do not secure with jam nut (14) until after pressure setting adjustment is complete.

6. Repeat steps 1 through 5 to assemble remaining valve (16) assembly.

7. If removed, install plugs (12) in valve body (1).

8. Adjust valve as described under 'Adjustment'.

9. If removed, install elbows and tees on double relief valve as tagged at disassembly.

ADJUSTMENT

Numbers and letters in parentheses refer to Fig. 1.

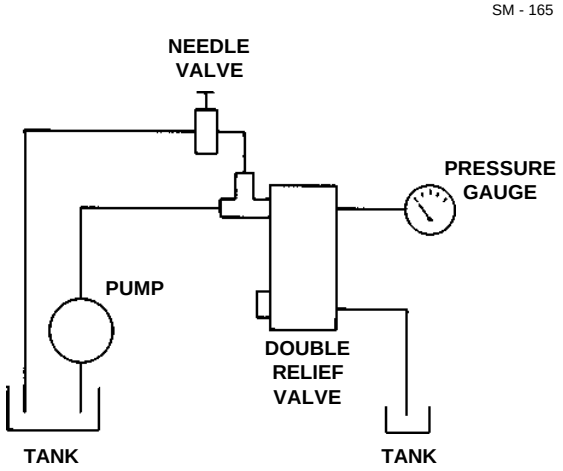


Fig. 5 - Setup for Adjusting Double Relief Valve

Note: Relief pressure setting is 172 bar (2 500 lbf/in^2).

1. Using adjusting setup as shown in Fig. 5, install a 0 - 207 bar (0 - 3 000 lbf/in^2) pressure gauge in one side of port 'B' and a tee in the opposite side of port 'B'.

2. Attach a controllable oil source to one leg of the tee.

3. Install a needle valve in the third leg of the tee, with a line returning from needle valve to oil reservoir.

4. Install a plug in one side of port 'A' and a line returning to oil reservoir in the opposite side of port 'A'.

5. Open the needle valve and start the pump. Gradually close the needle valve. If oil is discharged through port 'A' before relief pressure is reached, turn adjustment screw (7) in until discharge stops. Continue closing the needle valve and turning adjustment screw (7) until discharge through port 'A' occurs at relief pressure.

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If oil is discharged through port 'A' only when relief pressure is exceeded, turn adjustment screw (7) out and open needle valve slightly. Continue opening needle valve and turning adjustment screw (7) out until discharge through port 'A' occurs at relief pressure.

6. Repeat Steps 1 through 5 on opposite end of double relief valve. Adjust adjustment screw (20) so discharge through port 'B' occurs at relief pressure.

7. Re-check both relief settings before securing adjustment screws (7 & 20) with jam nuts (14).

8. Re-check both relief settings before installing double relief valve assembly on the truck.

INSTALLATION

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Make certain, area of installation is clean and position double relief valve on mounting bracket and secure in place with mounting hardware.

2. Remove blanking caps from hydraulic lines and install lines to double relief valve as identified during removal.

3. Check oil level in the steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

4. Start the engine and bring hydraulic oil to operating temperature.

5. Check double relief valve and hydraulic line connections for leaks and tighten as required.

6. Remove body safety pins and lower the body to the frame. Remove wheel blocks.

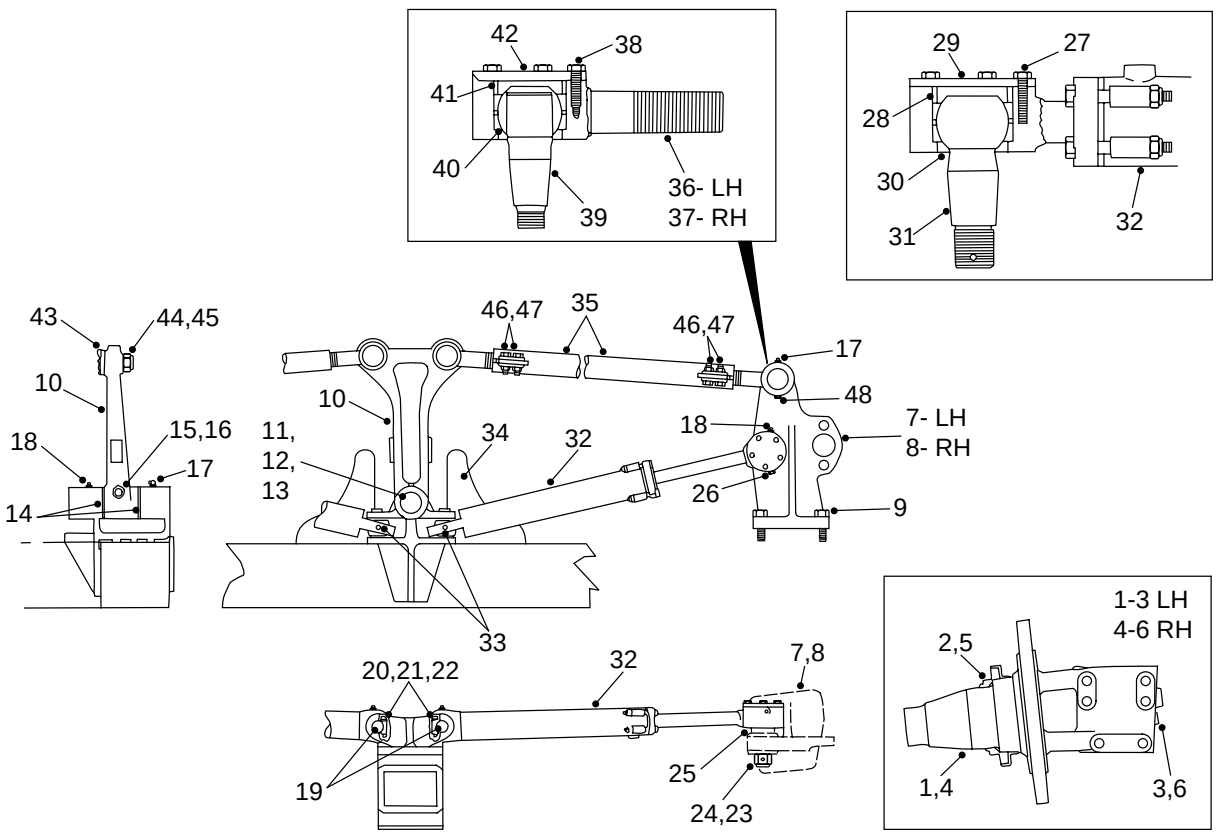
SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

* * * *

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1 - Spindle Assembly - LH	13 - Expansion Plug	25 - Seal	37 - Rod End
2 - Spacer	14 - Thrust Washer	26 - Plug	38 - Bolt
3 - Plug	15 - Locking Pin	27 - Bolt	39 - Stud
4 - Spindle Assembly - RH	16 - Nut	28 - Retainer Ring	40 - Bearing
5 - Spacer	17 - Lube Fitting	29 - Plate	41 - Retainer Ring
6 - Plug	18 - Lube Fitting	30 - Bushing	42 - Plate
7 - Steering Arm - LH	19 - Anchor Pin	31 - Ball Pin	43 - Seal
8 - Steering Arm - RH	20 - Bolt	32 - Steering Cylinder	44 - Castle Nut
9 - Bolt	21 - Lockwasher	33 - Lube Fitting	45 - Cotter Pin
10 - Bellcrank	22 - Plate	34 - Steering Stop	46 - Bolt
11 - Pin	23 - Cotter Pin	35 - Tie Rod	47 - Nut
12 - Bushing	24 - Castle Nut	36 - Rod End	48 - Plug

Fig. 1 - Layout of Steering Cylinder and Linkage

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The steering cylinders can be identified as item 7 in Section 220-0000, STEERING SYSTEM SCHEMATIC.

There are two single stage, double acting steering cylinders (32) installed on the machine. These exert the necessary hydraulic force on the steering linkage to pivot the front wheels. Single stage, double acting means that the piston rod can have oil applied to either side, extending or retracting the piston rod.

Steering cylinder (32) base ends are connected to the frame and piston rod ends are connected to steering arms (7 & 8). Cylinder mounting of the base end to the frame is by anchor pin (19) secured by plate (22), bolts (20) and lockwashers (21). Cylinder mounting of the piston rod end is by ball pin (31) secured in piston rod eye and secured to steering arms (7 & 8) by castle nuts (24) and cotter pins (23).

The mechanical steering linkage is adjustable to provide correct front end alignment and comprises of two tie rod assemblies (35) connected between bellcrank (10) and steering arms (7 & 8). Rod end assemblies (36 & 37) are secured to steering arms (7 & 8) by castle nuts (44) and cotter pins (45).

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REMOVAL

Numbers in parentheses refer to Fig. 1.

> ⚠ **WARNINGS**
> **To prevent personal injury and property damage, turn steering wheel several times in each direction to relieve pressure in the steering accumulator.**
>
> ⚠ **To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. Position the vehicle in a level work area, be sure the body is completely lowered, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve pressure in accumulator and steering system. Block all road wheels.

Steering Cylinder

1. Support steering cylinder (32) with suitable blocks or lifting device.

2. Ensure all hydraulic lines connected to steering cylinders (32) are identified for ease of installation and with suitable containers available to catch spillage, disconnect hydraulic lines. Cap all lines and ports to prevent entry of dirt.

3. Remove cotter pin (23) and castle nut (24) from ball pin (31) assembly at rod end of steering cylinder (32).

4. Remove bolts (20), lockwashers (21) and plate (22) from anchor pin (19) at base end of steering cylinder (32). Remove anchor pin (19) and carefully lift steering cylinder (32) from bellcrank (10) housing and steering arm (7). Remove seal (25) from steering arm (7) ball joint bore.

5. Drain hydraulic oil from steering cylinder (32) assembly and place in a clean work area for disassembly.

6. Repeat steps 3 through 5 to remove opposite steering cylinder (32) from bellcrank (10) and steering arm (8).

Steering Linkage

1. Remove cotter pins (45) from studs (39) and remove castle nuts (44).

2. With suitable lifting equipment, remove tie rod (35) assembly from steering arm (7) and bellcrank (10). Remove seals (43) and place tie rod (35) assembly in a clean work are for disassembly.

3. Using suitable lifting equipment, support steering arm (7) and remove bolts (9) securing steering arm (7) to the spindle. Remove steering arm (7).

4. Repeat steps 1 through 3 to remove the opposite tie rod (35) assembly and steering arm (8).

5. Break tack welds around expansion plugs (13) and remove expansion plugs from bellcrank housing.

6. Remove nut (16) from locking pin (15) and, using a mild steel drift, tap locking pin (15) out from bellcrank (10).

7. Using suitable lifting equipment, support bellcrank (10) and, using a mild steel drift (slightly less than 75 mm (3 in) in diameter), drive pin (11) from the bellcrank housing and bellcrank (10).

8. Remove bellcrank (10) and thrust washers (14) from the bellcrank housing.

9. If bushings (12) are to be replaced, use a mild steel drift (slightly more than 75 mm (3 in) in diameter) and drive bushings out of the bellcrank housing.

Note: If removing welds using an air arc, follow the procedures outlined for 'Welding' in Section 100-0010, CHASSIS, HOOD AND FENDERS.

10. If one or both steering stops (34) are damaged they can be removed by using an air arc to break the welds.

DISASSEMBLY

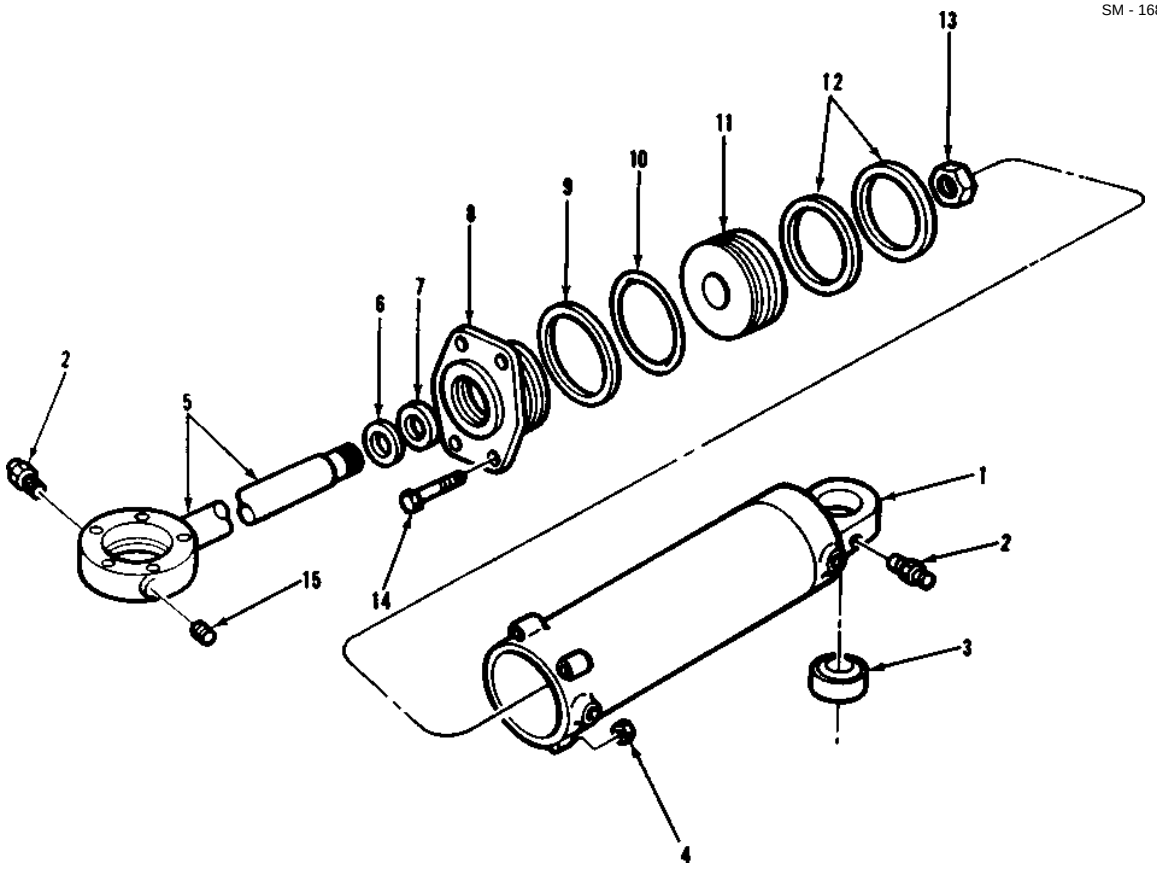
Tie Rod Assembly

Numbers in parentheses refer to Fig. 1.

Note: To aid in assembly and installation, record assembled length of tie rod (35) assembly for reference.

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1 - Tube
2 - Lube Fitting
3 - Bushing
4 - Nut
5 - Piston Rod
6 - Wiper
7 - Seal
8 - End Cap
9 - Backup Ring
10 - 'O' Ring
11 - Piston
12 - Piston Ring
13 - Nut
14 - Bolt
15 - Plug

Fig. 2 - Exploded View of Steering Cylinder

1. Remove lube fitting (17) and plug (48) from rod end (36).

2. Place tie rod (35) assembly in a vice, or similar holding device, and remove bolts (38) securing plate (42) to rod end (36). Remove plate (42).

3. Pry retainer ring (41) out of rod end (36).

4. Turn tie rod (35) in vice so that the threaded end of stud (39) points upwards. Using a soft faced hammer, tap stud (39) out of rod end (36) and remove bearing (40).

5. Repeat steps 2 through 4 to disassemble rod end (37) of tie rod (35).

6. Loosen nuts (47) and bolts (46) and unscrew rod ends (36 & 37) from tie rod (35).

Steering Cylinder - Piston Rod End

Numbers in parentheses refer to Fig. 1.

1. Remove lube fitting (18) and plug (26) from piston rod end of steering cylinder (32).

2. Place steering cylinder (32) assembly in a vice, or similar holding device, and remove bolts (27) securing plate (29) to piston rod end. Remove plate (29).

3. Pry retainer ring (28) out of the piston rod eye.

4. Turn steering cylinder (32) in vice so that the threaded end of ball pin (31) points upwards. Using a soft faced hammer, tap ball pin (31) out of piston rod eye and remove bushing (30).

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Steering Cylinder

Numbers in parentheses refer to Fig. 2.

1. Clean outer surfaces of steering cylinder assembly with a suitable cleaning solvent to remove dirt and grease.

2. Remove bolts (14) and nuts (4) securing end cap (8) to tube (1).

3. Pull end cap (8), piston rod (5) and piston (11) out of tube (1) as an assembly.

4. Position eye end of piston rod (5) in a soft-jawed vice and remove nut (13).

5. Pull piston (11) assembly off piston rod (5) and remove and discard piston rings (12) from piston (11).

6. Remove and discard backup ring (9) and 'O' ring (10) from outer groove of end cap (8).

7. Press piston rod (5) out of end cap (8).

8. Remove and discard wiper (6) and seal (7) from inside groove of end cap (8).

9. If necessary, press bushing (3) out of tube (1) eye.

10. Remove lube fitting (2) from base end of tube (1).

INSPECTION

1. Clean all metal parts of the steering cylinder in a suitable solvent and dry with clean, lint-free cloths. Make certain all cylinder ports are free of dirt or contamination.

2. Check cylinder tube and outer diameter of piston for scratches, cracks, or other signs of damage. Use a fine stone to remove scratches or ridges. Replace these components, if defects cannot be corrected.

3. Inspect piston rod for distortion, cracks or other defects. Replace piston rod if defective area is irreparable.

4. Check bushings for wear and replace if required.

ASSEMBLY

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Steering Cylinder

Numbers in parentheses refer to Fig. 2.

Note: To facilitate assembly procedure, apply a light coating of hydraulic oil to all components as they are assembled. Make sure that all work is carried out in a clean area.

1. Insert a new seal (7) and new wiper (6) to inner grooves of end cap (8). Position a new backup ring (9) and 'O' ring (10) into outer groove of end cap (8).

2. Press end cap (8) assembly into position on piston rod (5).

3. Position two new piston rings (12) on piston (11) and slide the piston assembly onto piston rod (5) until it bottoms against the shoulder. Screw nut (13) onto threaded end of piston rod (5) and tighten to a torque of 350 - 393 Nm (260 - 290 lbf ft).

Note: Nut (13) should not be used more than three times. Check nut locking collar condition and replace if it does not produce a firm locking action on piston rod threads.

4. If removed, press bushing (3) into tube (1) eye.

5. Slide tube (1) onto piston rod (5) assembly and press tightly into position to end cap (8). Secure end cap (8) to tube (1) with bolts (14) and nuts (4). Tighten nuts (4) to a torque of 75 - 81 Nm (55 - 60 lbf ft).

6. Install lube fitting (2) at base end of tube (1).

Steering Cylinder - Piston Rod End

Numbers in parentheses refer to Fig. 1.

1. Place steering cylinder (32) assembly in a vice, or similar holding device, with tapped holes in piston rod eye facing up.

2. Lubricate bushing (30) and ball pin (31) with grease and tap bushing and ball pin as an assembly into piston rod eye end of steering cylinder (32).

3. Secure ball pin (31) in place with retainer ring (28). Make sure retainer ring seats properly in piston rod eye.

4. Position plate (29) on piston rod end and secure with bolts (27).

5. If removed, install lube fitting (18) and plug (26) in piston rod end of steering cylinder (32).

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Tie Rod Assembly

Numbers in parentheses refer to Fig. 1.

1. Place tie rod (35) in a vice, or similar holding device, and screw rod ends (36 & 37) onto tie rod (35) until assembled length recorded at disassembly is obtained.

Note: The assembled length of tie rod (35) is for reference only. Do not tighten bolts (46) and nuts (47) until front end alignment is checked and corrected, after installation is complete.

2. With tapped holes in rod end (36) facing up, lubricate bearing (40) and stud (39) with grease and tap bearing and stud as an assembly into rod end (36).

3. Secure stud (39) in place with retainer ring (41). Make sure retainer ring seats properly in rod end (36).

4. Position plate (42) on rod end (36) and secure with bolts (38).

5. Repeat steps 1 through 4 for to assemble rod end (37) assembly to opposite end of tie rod (35).

6. Install lube fitting (17) and plug (48) in rod end (36).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Steering Linkage

1. If removed, press or drive new bushings (12) into upper and lower bores of the bellcrank housing. Be sure the 13 mm (0.5 in) diameter hole in each bushing is in line with lube fittings (17 & 18) in bellcrank housing.

2. Using suitable lifting equipment, install bellcrank (10) between upper and lower bores of the bellcrank housing with a thrust washer (14) on both sides of bellcrank hub. Align pin (11) bores of bellcrank (10) and thrust washers (14) with those of the bellcrank housing.

3. Install pin (11) through bellcrank housing and bellcrank (10), aligning the slot in pin (11) with locking pin (15) hole in bellcrank (10).

4. Drive locking pin (15) into bellcrank (10), making sure it seats solidly in its bore. Secure locking pin (15) in bellcrank (10) with nut (16). Tighten nut (16) to a torque of 245 - 300 Nm (180 - 220 lbf ft).

Note: Prior to welding on the vehicle, follow the procedures outlined for 'Welding' in Section 100-0010, CHASSIS, HOOD AND FENDERS.

5. Place expansion plugs (13) into upper and lower bores of bellcrank housing (10) and tack weld each expansion plug in three places.

6. Using suitable lifting equipment, position steering arm (7) to spindle assembly (1) and secure with bolts (9).

7. Install seals (43) on studs (39) and, using suitable lifting equipment, install tie rod (35) assembly on bellcrank (10) and steering arm (7) and secure with castle nuts (44). Tighten castle nuts (44) to a torque of 1 150 - 1 290 Nm (850 - 950 lbf ft).

8. Secure castle nuts (44) to studs (39) with new cotter pins (45).

9. Repeat steps 6 through 8 to install steering arm (8) and opposite tie rod (35) assembly.

10. Adjust tie rod (35) assembly length as described under 'Adjustment', with bellcrank (10) centred and the vehicle unladen.

Note: Prior to welding on the vehicle, follow the procedures outlined for 'Welding' in Section 100-0010, CHASSIS, HOOD AND FENDERS.

11. If either steering stop (34) was removed, position a new steering stop on the chassis and weld in place. Use an E-70 welding rod and build 9 mm (3/8 in) fillet all around steering stop (34).

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Steering Cylinder

1. Position seal (25) on steering arm (7) ball joint bore.

2. Insert base end of steering cylinder (32) into clevis on bellcrank housing and ball pin (31) in steering arm (7) bore.

3. Secure ball pin (31) to steering arm (7) with castle nut (24). Tighten castle nut (24) to a torque of 1 560 - 1 630 Nm (1 150 - 1 200 lbf ft) and secure to ball pin (31) with new cotter pin (23).

4. Install anchor pin (19) and plate (22) at base end of steering cylinder (32) assembly and secure with bolts (20) and lockwashers (21).

Note: Plate (22) fits into the slot at the end of anchor pin (19).

5. Repeat steps 1 through 4 to install the opposite steering cylinder (32) to steering arm (8) and bellcrank housing.

6. Remove blanking caps from hydraulic lines and cylinder ports and connect hydraulic lines to cylinder ports, as identified at removal.

7. Check oil level in the steering and brake control tank and add oil if necessary. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct oil level and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

8. Remove wheel blocks from all road wheels and start the engine. Operate the steering and check hydraulic lines for leaks. Tighten lines and fittings as required.

9. Re-check oil level in the steering and brake control tank and add oil if necessary.

ALIGNMENT

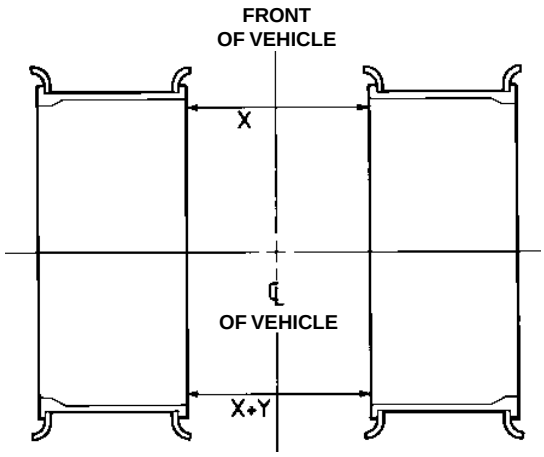
Numbers in parentheses refer to Fig. 1.

Correct front end alignment is dependent on three basic fundamentals:

a. Caster - Forward and rearward tilt of the axle assembly.

b. Camber - Outward tilt of the top of the front wheels.

c. Toe-in - Inward turning of the front wheels.



Wheel Alignment (Toe-in) Dimensions	
TYRE TYPE	DIMENSION 'Y'
Cross-ply	10 - 16 mm (0.38 - 0.62 in)
Radial	0 - 10 mm (0 - 0.38 in)

Fig. 3 - Plan View of Wheel Alignment

Note: Caster and camber are built into the vehicle and are not adjustable.

Check for toe-in only when the truck is empty and bellcrank (10) is centred. Use a slide bar attached to the wheel rim edge to make this check.

If adjustment is necessary, loosen nuts (47) and bolts (46) at each end of tie rod (35) assemblies. Turn tie rods (35) with a pipe wrench until correct toe-in dimension is obtained. Refer to Fig. 3.

When tie rod (35) lengths have been established, secure rod ends (36 & 37) to tie rods (35) with bolts (46) and nuts (47).

MAINTENANCE

Every 50 Hours - Lubricate steering cylinders and steering pivot pin with grease specified in Section 300-0020, LUBRICATION SYSTEM.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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SPECIAL TORQUE SPECIFICATIONS				
			TORQUE	
FIG. NO.	ITEM NO.	ITEM NAME	Nm	lbf ft
1	16	Nut	245 - 300	180 - 220
1	24	Castle Nut	1 560 - 1 630	1 150 - 1 200
1	44	Castle Nut	1 150 - 1 290	850 - 950
2	4	Nut	75 - 81	55 - 60
2	13	Nut	350 - 393	260 - 290

* * * *

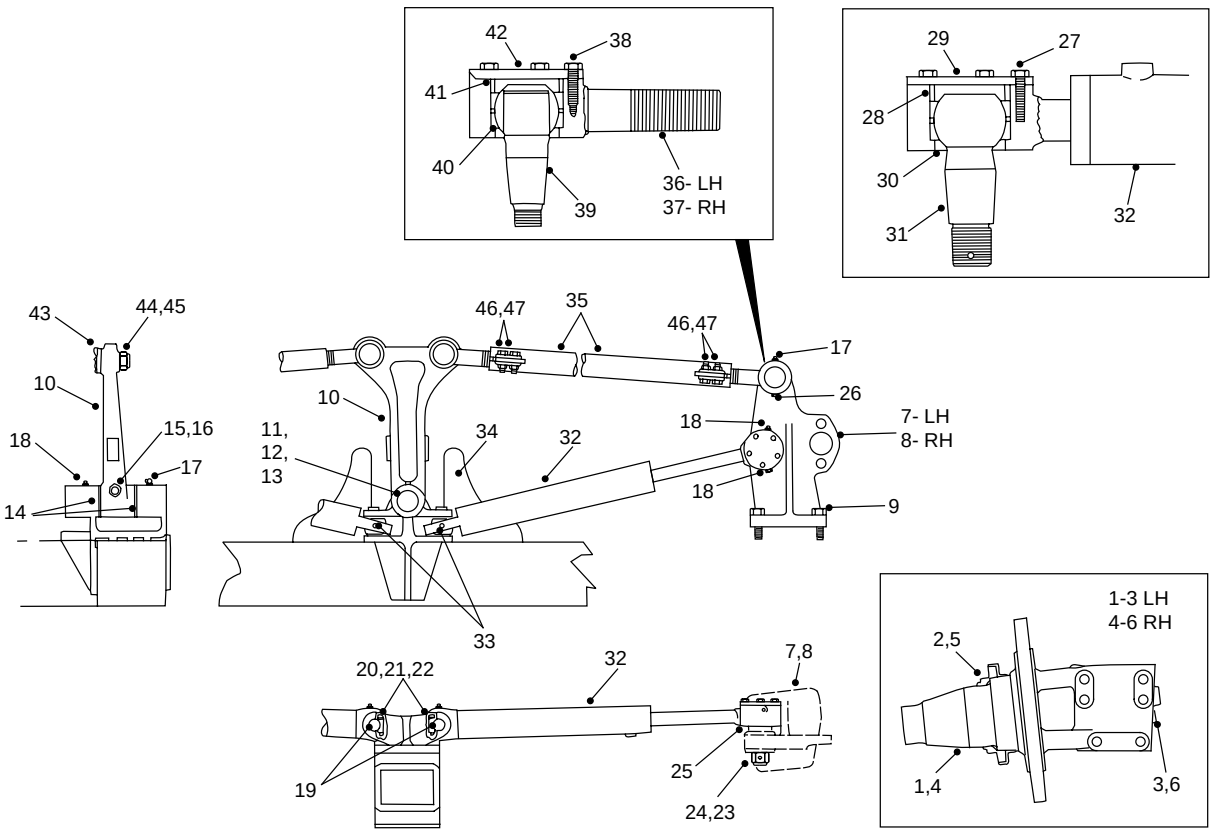
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1 - Spindle Assembly - LH
2 - Spacer
3 - Plug
4 - Spindle Assembly - RH
5 - Spacer
6 - Plug
7 - Steering Arm - LH
8 - Steering Arm - RH
9 - Bolt
10 - Bellcrank
11 - Pin
12 - Bushing
13 - Expansion Plug
14 - Thrust Washer
15 - Locking Pin
16 - Nut
17 - Lube Fitting
18 - Lube Fitting
19 - Anchor Pin
20 - Bolt
21 - Lockwasher
22 - Plate
23 - Cotter Pin
24 - Castle Nut
25 - Seal
26 - Plug
27 - Bolt
28 - Retainer Ring
29 - Plate
30 - Bushing
31 - Ball Pin
32 - Steering Cylinder
33 - Lube Fitting
34 - Steering Stop
35 - Tie Rod
36 - Rod End
37 - Rod End
38 - Bolt
39 - Stud
40 - Bearing
41 - Retainer Ring
42 - Plate
43 - Seal
44 - Castle Nut
45 - Cotter Pin
46 - Bolt
47 - Nut

Fig. 1 - Layout of Steering Cylinder and Linkage

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The steering cylinders can be identified as item 7 in Section 220-0000, STEERING SYSTEM SCHEMATIC.

There are two single stage, double acting steering cylinders (32) installed on the machine. These exert the necessary hydraulic force on the steering linkage to pivot the front wheels. Single stage, double acting means that the piston rod can have oil applied to either side, extending or retracting the piston rod.

Steering cylinder (32) base ends are connected to the frame and piston rod ends are connected to steering arms (7 & 8). Cylinder mounting of the base end to the frame is by anchor pin (19) secured by plate (22), bolts (20) and lockwashers (21). Cylinder mounting of the piston rod end is by ball pin (31) secured in piston rod eye and secured to steering arms (7 & 8) by castle nuts (24) and cotter pins (23).

The mechanical steering linkage is adjustable to provide correct front end alignment and comprises of two tie rod assemblies (35) connected between bellcrank (10) and steering arms (7 & 8). Rod end assemblies (36 & 37) are secured to steering arms (7 & 8) by castle nuts (44) and cotter pins (45).

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REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS

To prevent personal injury and property damage, turn steering wheel several times in each direction to relieve pressure in the steering accumulator.

⚠ To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is completely lowered, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve pressure in accumulator and steering system. Block all road wheels.

Steering Cylinder

1. Support steering cylinder (32) with suitable blocks or lifting device.

2. Ensure all hydraulic lines connected to steering cylinders (32) are identified for ease of installation and with suitable containers available to catch spillage, disconnect hydraulic lines. Cap all lines and ports to prevent entry of dirt.

3. Remove cotter pin (23) and castle nut (24) from ball pin (31) assembly at rod end of steering cylinder (32).

4. Remove bolts (20), lockwashers (21) and plate (22) from anchor pin (19) at base end of steering cylinder (32). Remove anchor pin (19) and carefully lift steering cylinder (32) from bellcrank (10) housing and steering arm (7). Remove seal (25) from steering arm (7) ball joint bore.

5. Drain hydraulic oil from steering cylinder (32) assembly and place in a clean work area for disassembly.

6. Repeat steps 3 through 5 to remove opposite steering cylinder (32) from bellcrank (10) and steering arm (8).

Steering Linkage

1. Remove cotter pins (45) from studs (39) and remove castle nuts (44).

2. With suitable lifting equipment, remove tie rod (35) assembly from steering arm (7) and bellcrank (10). Remove seals (43) and place tie rod (35) assembly in a clean work are for disassembly.

3. Using suitable lifting equipment, support steering arm (7) and remove bolts (9) securing steering arm (7) to the spindle. Remove steering arm (7).

4. Repeat steps 1 through 3 to remove the opposite tie rod (35) assembly and steering arm (8).

5. Break tack welds around expansion plugs (13) and remove expansion plugs from bellcrank housing.

6. Remove nut (16) from locking pin (15) and, using a mild steel drift, tap locking pin (15) out from bellcrank (10).

7. Using suitable lifting equipment, support bellcrank (10) and, using a mild steel drift (slightly less than 75 mm (3 in) in diameter), drive pin (11) from the bellcrank housing and bellcrank (10).

8. Remove bellcrank (10) and thrust washers (14) from the bellcrank housing.

9. If bushings (12) are to be replaced, use a mild steel drift (slightly more than 75 mm (3 in) in diameter) and drive bushings out of the bellcrank housing.

Note: If removing welds using an air arc, follow the procedures outlined for 'Welding' in Section 100-0010, CHASSIS, HOOD AND FENDERS.

10. If one or both steering stops (34) are damaged they can be removed by using an air arc to break the welds.

DISASSEMBLY

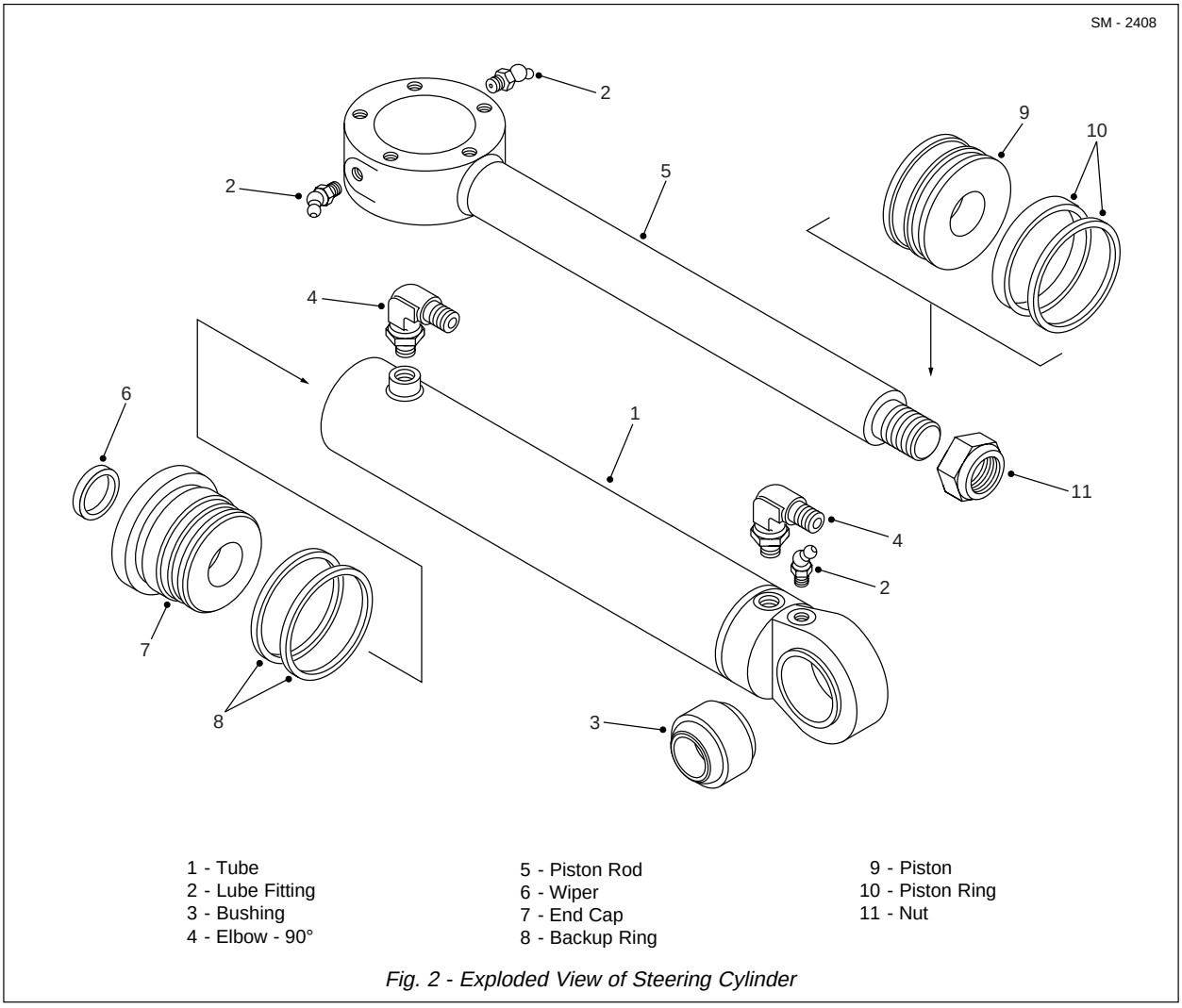
Tie Rod Assembly

Numbers in parentheses refer to Fig. 1.

Note: To aid in assembly and installation, record assembled length of tie rod (35) assembly for reference.

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1 - Tube
2 - Lube Fitting
3 - Bushing
4 - Elbow - 90°
5 - Piston Rod
6 - Wiper
7 - End Cap
8 - Backup Ring
9 - Piston
10 - Piston Ring
11 - Nut

Fig. 2 - Exploded View of Steering Cylinder

1. Remove lube fitting (17) and plug (26) from rod end (36).

2. Place tie rod (35) assembly in a vice, or similar holding device, and remove bolts (38) securing plate (42) to rod end (36). Remove plate (42).

3. Pry retainer ring (41) out of rod end (36).

4. Turn tie rod (35) in vice so that the threaded end of stud (39) points upwards. Using a soft faced hammer, tap stud (39) out of rod end (36) and remove bearing (40).

5. Repeat steps 2 through 4 to disassemble rod end (37) of tie rod (35).

6. Loosen nuts (47) and bolts (46) and unscrew rod ends (36 & 37) from tie rod (35).

Steering Cylinder - Piston Rod End

Numbers in parentheses refer to Fig. 1.

1. Remove lube fitting (18) and plug (26) from piston rod end of steering cylinder (32).

2. Place steering cylinder (32) assembly in a vice, or similar holding device, and remove bolts (27) securing plate (29) to piston rod end. Remove plate (29).

3. Pry retainer ring (28) out of the piston rod eye.

4. Turn steering cylinder (32) in vice so that the threaded end of ball pin (31) points upwards. Using a soft faced hammer, tap ball pin (31) out of piston rod eye and remove bushing (30).

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Steering Cylinder

Numbers in parentheses refer to Fig. 2.

1. Clean outer surfaces of steering cylinder assembly with a suitable cleaning solvent to remove dirt and grease.

2. Unscrew retainer end cap (7) from cylinder tube (1).

3. Pull end cap (7), piston rod (5) and piston (9) out of tube (1) as an assembly.

4. Position eye end of piston rod (5) in a soft-jawed vice and remove nut (11).

5. Pull piston (9) assembly off piston rod (5) and remove and discard piston rings (10) from piston (9).

6. Remove and discard backup ring (8) from outer groove of end cap (7).

7. Press piston rod (5) out of end cap (7).

8. Remove and discard wiper (6) from inside groove of end cap (7).

9. If necessary, press bushing (3) out of tube (1) eye.

10. Remove lube fitting (2) from base end of tube (1).

INSPECTION

1. Clean all metal parts of the steering cylinder in a suitable solvent and dry with clean, lint-free cloths. Make certain all cylinder ports are free of dirt or contamination.

2. Check cylinder tube and outer diameter of piston for scratches, cracks, or other signs of damage. Use a fine stone to remove scratches or ridges. Replace these components, if defects cannot be corrected.

3. Inspect piston rod for distortion, cracks or other defects. Replace piston rod if defective area is irreparable.

4. Check bushings for wear and replace if required.

ASSEMBLY

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Steering Cylinder

Numbers in parentheses refer to Fig. 2.

Note: To facilitate assembly procedure, apply a light coating of hydraulic oil to all components as they are assembled. Make sure that all work is carried out in a clean area.

1. Insert a new wiper (6) to inner grooves of end cap (7). Position new backup rings (8) into outer groove of end cap (7).

2. Press end cap (7) assembly into position on piston rod (5).

3. Position two new piston rings (10) on piston (9) and slide the piston assembly onto piston rod (5) until it bottoms against the shoulder. Screw nut (11) onto threaded end of piston rod (5) and tighten to a torque of 475 - 508 Nm (350 - 375 lbf ft).

Note: Nut (11) should not be used more than three times. Check nut locking collar condition and replace if it does not produce a firm locking action on piston rod threads.

4. If removed, press bushing (3) into tube (1) eye.

5. Slide tube (1) onto piston rod (5) assembly and press tightly into position to end cap (7). Secure end cap (7) to tube (1) and tighten to a torque of 508 - 542 Nm (375 - 400 lbf ft).

6. Install lube fitting (2) at base end of tube (1).

Steering Cylinder - Piston Rod End

Numbers in parentheses refer to Fig. 1.

1. Place steering cylinder (32) assembly in a vice, or similar holding device, with tapped holes in piston rod eye facing up.

2. Lubricate bushing (30) and ball pin (31) with grease and tap bushing and ball pin as an assembly into piston rod eye end of steering cylinder (32).

3. Secure ball pin (31) in place with retainer ring (28). Make sure retainer ring seats properly in piston rod eye.

4. Position plate (29) on piston rod end and secure with bolts (27).

5. If removed, install lube fitting (18) and plug (26) in piston rod end of steering cylinder (32).

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Tie Rod Assembly

Numbers in parentheses refer to Fig. 1.

1. Place tie rod (35) in a vice, or similar holding device, and screw rod ends (36 & 37) onto tie rod (35) until assembled length recorded at disassembly is obtained.

Note: The assembled length of tie rod (35) is for reference only. Do not tighten bolts (46) and nuts (47) until front end alignment is checked and corrected, after installation is complete.

2. With tapped holes in rod end (36) facing up, lubricate bearing (40) and stud (39) with grease and tap bearing and stud as an assembly into rod end (36).

3. Secure stud (39) in place with retainer ring (41). Make sure retainer ring seats properly in rod end (36).

4. Position plate (42) on rod end (36) and secure with bolts (38).

5. Repeat steps 1 through 4 for to assemble rod end (37) assembly to opposite end of tie rod (35).

6. Install lube fitting (17) and plug (26) in rod end (36).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Steering Linkage

1. If removed, press or drive new bushings (12) into upper and lower bores of the bellcrank housing. Be sure the 13 mm (0.5 in) diameter hole in each bushing is in line with lube fittings (17 & 18) in bellcrank housing.

2. Using suitable lifting equipment, install bellcrank (10) between upper and lower bores of the bellcrank housing with a thrust washer (14) on both sides of bellcrank hub. Align pin (11) bores of bellcrank (10) and thrust washers (14) with those of the bellcrank housing.

3. Install pin (11) through bellcrank housing and bellcrank (10), aligning the slot in pin (11) with locking pin (15) hole in bellcrank (10).

4. Drive locking pin (15) into bellcrank (10), making sure it seats solidly in its bore. Secure locking pin (15) in bellcrank (10) with nut (16). Tighten nut (16) to a torque of 245 - 300 Nm (180 - 220 lbf ft).

Note: Prior to welding on the vehicle, follow the procedures outlined for 'Welding' in Section 100-0010, CHASSIS, HOOD AND FENDERS.

5. Place expansion plugs (13) into upper and lower bores of bellcrank housing (10) and tack weld each expansion plug in three places.

6. Using suitable lifting equipment, position steering arm (7) to spindle assembly (1) and secure with bolts (9).

7. Install seals (43) on studs (39) and, using suitable lifting equipment, install tie rod (35) assembly on bellcrank (10) and steering arm (7) and secure with castle nuts (44). Tighten castle nuts (44) to a torque of 1 150 - 1 290 Nm (850 - 950 lbf ft).

8. Secure castle nuts (44) to studs (39) with new cotter pins (45).

9. Repeat steps 6 through 8 to install steering arm (8) and opposite tie rod (35) assembly.

10. Adjust tie rod (35) assembly length as described under 'Adjustment', with bellcrank (10) centred and the vehicle unladen.

Note: Prior to welding on the vehicle, follow the procedures outlined for 'Welding' in Section 100-0010, CHASSIS, HOOD AND FENDERS.

11. If either steering stop (34) was removed, position a new steering stop on the chassis and weld in place. Use an E-70 welding rod and build 9 mm (3/8 in) fillet all around steering stop (34).

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Steering Cylinder

1. Position seal (25) on steering arm (7) ball joint bore.

2. Insert base end of steering cylinder (32) into clevis on bellcrank housing and ball pin (31) in steering arm (7) bore.

3. Secure ball pin (31) to steering arm (7) with castle nut (24). Tighten castle nut (24) to a torque of 1 560 - 1 630 Nm (1 150 - 1 200 lbf ft) and secure to ball pin (31) with new cotter pin (23).

4. Install anchor pin (19) and plate (22) at base end of steering cylinder (32) assembly and secure with bolts (20) and lockwashers (21).

Note: Plate (22) fits into the slot at the end of anchor pin (19).

5. Repeat steps 1 through 4 to install the opposite steering cylinder (32) to steering arm (8) and bellcrank housing.

6. Remove blanking caps from hydraulic lines and cylinder ports and connect hydraulic lines to cylinder ports, as identified at removal.

7. Check oil level in the steering and brake control tank and add oil if necessary. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct oil level and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

8. Remove wheel blocks from all road wheels and start the engine. Operate the steering and check hydraulic lines for leaks. Tighten lines and fittings as required.

9. Re-check oil level in the steering and brake control tank and add oil if necessary.

ALIGNMENT

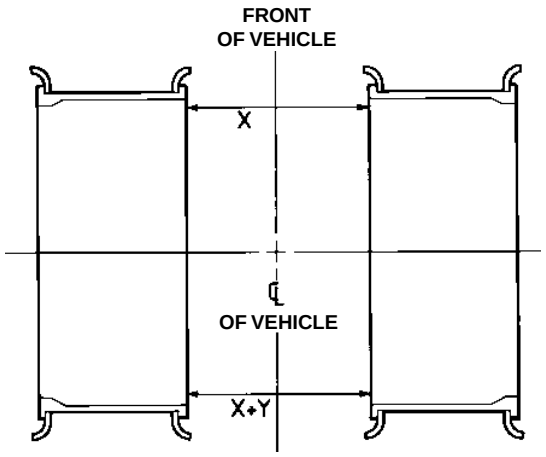
Numbers in parentheses refer to Fig. 1.

Correct front end alignment is dependent on three basic fundamentals:

a. Caster - Forward and rearward tilt of the axle assembly.

b. Camber - Outward tilt of the top of the front wheels.

c. Toe-in - Inward turning of the front wheels.



Wheel Alignment (Toe-in) Dimensions	
TYRE TYPE	DIMENSION 'Y'
Cross-ply	10 - 16 mm (0.38 - 0.62 in)
Radial	0 - 10 mm (0 - 0.38 in)

Fig. 3 - Plan View of Wheel Alignment

Note: Caster and camber are built into the vehicle and are not adjustable.

Check for toe-in only when the truck is empty and bellcrank (10) is centred. Use a slide bar attached to the wheel rim edge to make this check.

If adjustment is necessary, loosen nuts (47) and bolts (46) at each end of tie rod (35) assemblies. Turn tie rods (35) with a pipe wrench until correct toe-in dimension is obtained. Refer to Fig. 3.

When tie rod (35) lengths have been established, secure rod ends (36 & 37) to tie rods (35) with bolts (46) and nuts (47).

MAINTENANCE

Every 50 Hours - Lubricate steering cylinders and steering pivot pin with grease specified in Section 300-0020, LUBRICATION SYSTEM.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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SPECIAL TORQUE SPECIFICATIONS				
			TORQUE	
FIG. NO.	ITEM NO.	ITEM NAME	Nm	lbf ft
1	16	Nut	245 - 300	180 - 220
1	24	Castle Nut	1 560 - 1 630	1 150 - 1 200
1	44	Castle Nut	1 150 - 1 290	850 - 950
2	7	End Cap	508 - 542	375 - 400
2	11	Nut	475 - 508	350 - 375

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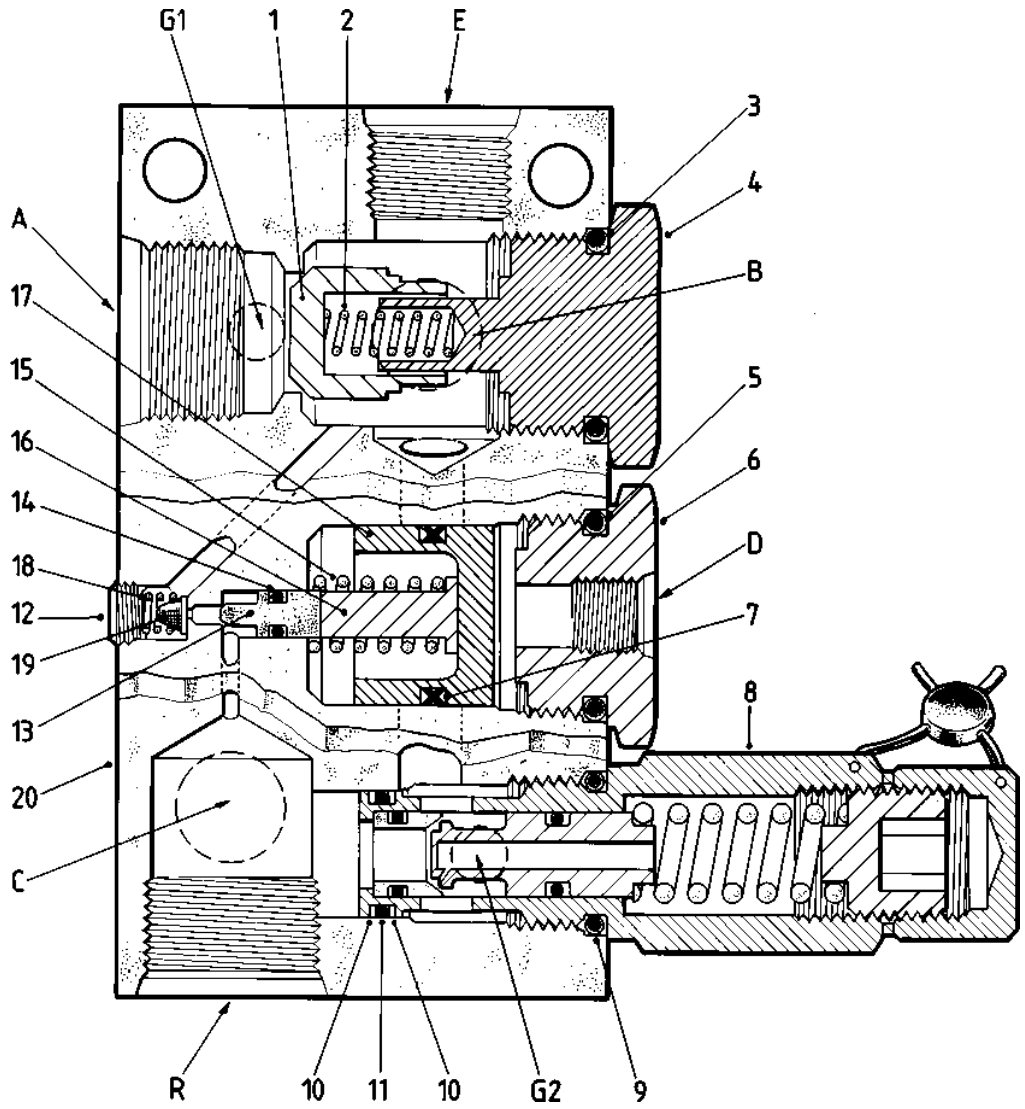
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SM - 169



1 - Poppet
2 - Spring
3 - 'O' Ring
4 - Plug
5 - 'O' Ring
6 - Plug
7 - Quad Ring
8 - Relief Valve Cartridge
9 - 'O' Ring
10 - Backup Ring
11 - 'O' Ring
12 - Plug
13 - Piston
14 - 'O' Ring
15 - Spring
16 - Pin
17 - Piston
18 - Spring
19 - Filter
20 - Valve Body

Fig. 1 - Cutaway View of Accumulator Valve

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The Accumulator Valve can be identified as item 4 in Section 220-0000, STEERING SYSTEM SCHEMATIC, in this manual.

Note: Relief valve cartridge (8) can be replaced only as an assembly.

Incorporated in this assembly are three valves; a check valve, accumulator two-way valve and a system pressure protection valve.

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Steering System - Accumulator Valve

Section 220-0130

An accumulator two-way valve (13 thru 17) is located in the centre portion of the assembly. In the operating position, engine running and two-way valve energized (refer to Fig. 2), this valve allows the accumulator to retain its pressure. In its non-operating position, engine shutdown and two-way valve de-energized (refer to Fig. 3), a controlled bleed-down of the accumulator pressure to the steering and brake control tank occurs. This bleed-down takes 3 to 5 minutes.

Relief valve cartridge (8), at the lower portion of the assembly, is preset to 207 bar (3 000 lbf/in²) and seated. This valve acts as a backup in the event of a malfunction of the steering pump compensator valve. Should the compensator valve allow steering system pressure to exceed the preset pressure of relief valve cartridge (8), valve will open and relieve excess oil pressure to the steering and brake control tank. Refer to Fig. 4.

OPERATION

Numbers and letters in parentheses refer to Fig. 1, unless otherwise specified.

Oil from the steering pump enters the accumulator valve at port 'A'. This pressure unseats poppet (1) and oil flows to the steering valve through port 'B' and to the accumulator through port 'E'. Pressure is supplied to pressure switch (8, Figs. 2, 3 & 4) and remote diagnostic test point through a tee piece in port 'G2'. Refer to Fig. 2.

During operation of the machine, transmission pilot pressure through port 'D' keeps the two-way valve (13 thru 17) energized (closed). This traps a supply of oil in the accumulator.

Return oil from the steering valve enters port 'C' and exits through port 'R' to tank.

Port 'G1' is plugged.

Should pressure in any of these circuit lines exceed the preset pressure setting on relief valve cartridge (8), the relief valve will open and oil will exit through port 'R' to tank. Refer to Fig. 4.

When engine is shut off, transmission pilot pressure dissipates, and spring (15) shifts the two-way valve (13 thru 17) to the de-energised (open) position. This allows oil to flow back from the accumulator through port 'E' into an internal passage, past piston (13) and exits through port 'R' to tank. Refer to Fig. 3.

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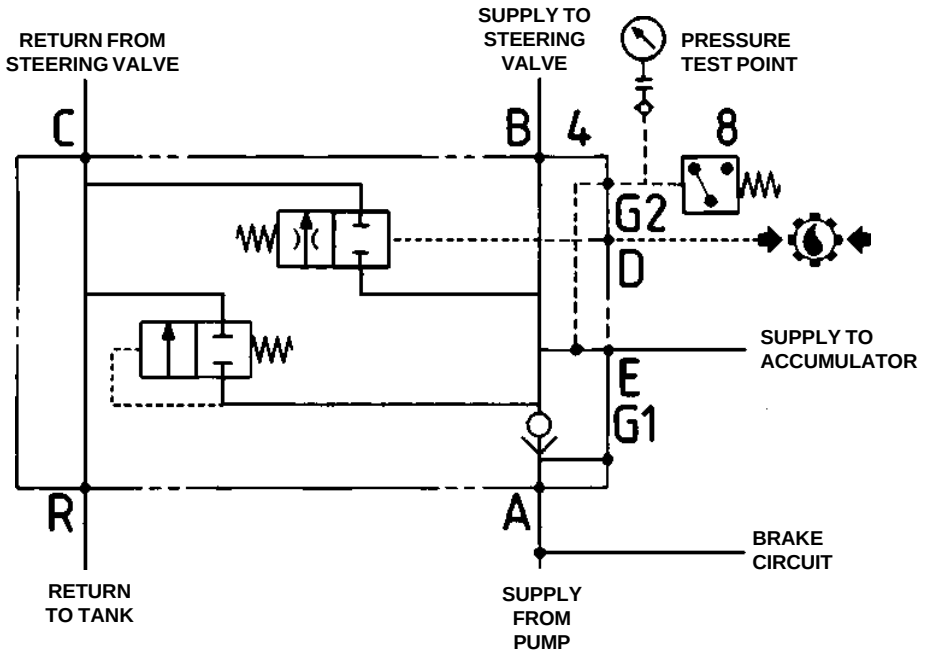


Fig. 2 - Two-way Valve Energized

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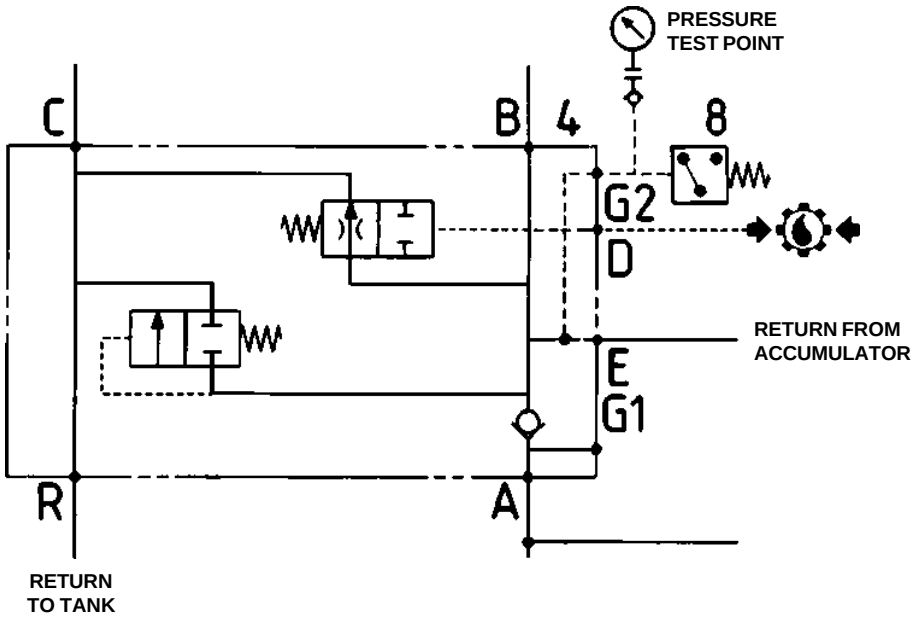


Fig. 3 - Two-way Valve De-energized

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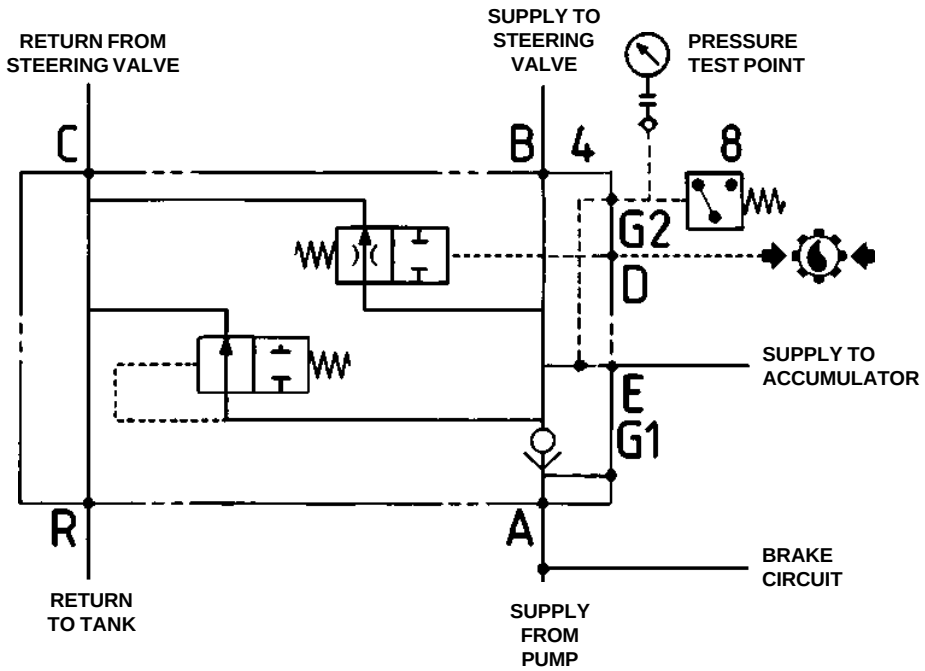


Fig. 4 - Relief Valve Open

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Steering System - Accumulator Valve

Section 220-0130

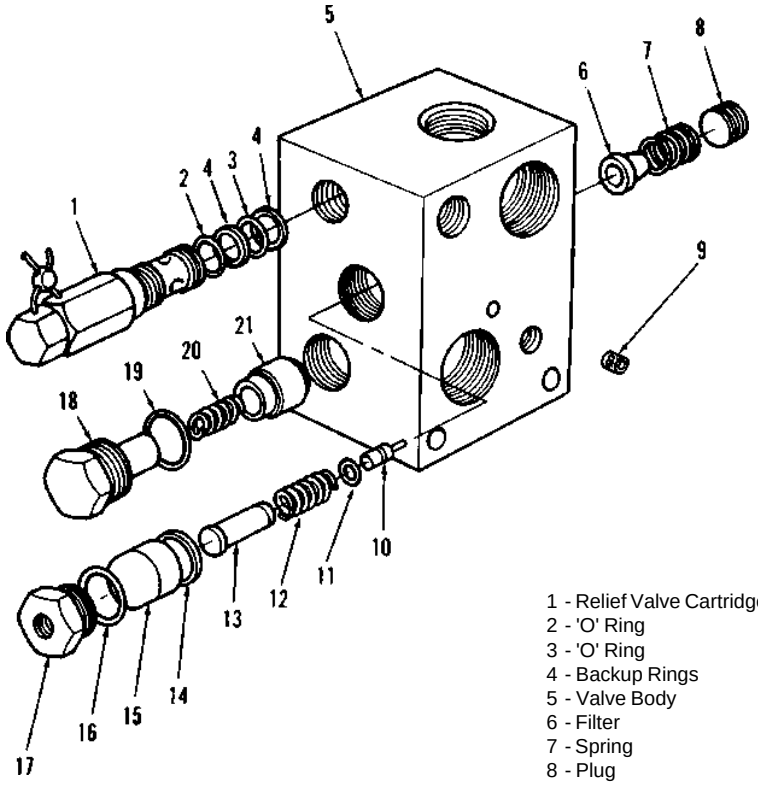


Fig. 5 - Exploded View of Accumulator Valve

REMOVAL

⚠ WARNINGS

Dangerous pressure. Turn steering wheel several times in each direction to relieve pressure in the system. Failure to release pressure as stated can result in personal injury and property damage.

⚠ To prevent personal injury and property damage, be sure wheel chocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to release any pressure in accumulator and steering system. Block all road wheels.

3. Clean the accumulator valve and surrounding area. Identify and tag all hydraulic lines at accumulator valve.

4. Disconnect all hydraulic lines from the accumulator valve and drain oil into a suitable container. Plug all hydraulic lines and ports of the accumulator valve to prevent ingress of dirt.

5. Remove mounting hardware securing accumulator valve to the machine. Clean external surface of accumulator valve assembly with a suitable solvent and move to a clean area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Fig. 5.

1. Remove plug (17) and piston (15) from valve body (5). Remove quad ring (14) from piston (15) and 'O' ring (16) from plug (17). Discard quad ring (14) and 'O' ring (16).

2. Remove pin (13), spring (12) and piston (10) from valve body (5). Remove and discard 'O' ring (11) from pin (13). Discard spring (12).

3. Remove plug (18), spring (20) and poppet (21) from valve body (5). Remove and discard 'O' ring

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(19) from plug (18). Discard spring (20).

4. Clamp valve body (5) in a soft-jawed vice and remove relief valve cartridge (1) from valve body (5). Remove and discard backup rings (4), 'O' ring (3) and 'O' ring (2) from relief valve cartridge (1).

Note: Do NOT disassemble relief valve cartridge (1) assembly; it is pressure set and sealed at assembly. If relief valve cartridge (1) is defective, it must be replaced with a new one.

5. Remove plug (8), spring (7) and filter (6) from valve body (5). Remove breather (9) from valve body (5). Discard filter (6), breather (9) and spring (7).

INSPECTION

Numbers in parentheses refer to Fig. 5.

1. Clean all parts with a suitable solvent and dry with compressed air.

2. Check port threads and make sure they are not damaged or stripped.

3. Check poppet (21) and seats in valve body (5). Ensure they are not worn, nicked, cracked or scored.

4. Check condition of relief valve cartridge (1). Insert a blunt-nosed drift or punch into relief valve cartridge (1) end and depress the piston. If piston does not move freely, or hangs up, replace relief valve cartridge (1) assembly. Relief valve cartridge (1) assembly should also be replaced if lead seal has been removed, as the relief valve cartridge (1) adjustment may not be accurate.

ASSEMBLY

Numbers in parentheses refer to Fig. 5.

1. Install new filter (6), new spring (7) and plug (8) in valve body (5). Install new breather (9) in valve body (5).

2. Place valve body (5) in a soft-jawed vice. Install new 'O' rings (2 & 3) and backup rings (4) on relief valve cartridge (1). Install relief valve cartridge (1) assembly in valve body (5).

3. Install new 'O' ring (11) on piston (10). Press piston (10) into its bore in valve body (5).

4. Install new spring (12) on pin (13) and install pin (13) assembly in valve body (5). Install new quad ring (14) on piston (15) and install piston (15) assembly in valve body (5).

5. Install new 'O' ring (16) on plug (17) and install plug (17) in valve body (5).

6. Install new 'O' ring (19) on plug (18) and install poppet (21), new spring (20) and plug (18) in valve body (5).

INSTALLATION

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Install accumulator valve assembly on its mounting bracket and secure with mounting hardware as removed at 'Removal'.

2. Connect all hydraulic lines securely to accumulator valve as tagged at 'Removal'.

3. Check the level of oil in the steering and brake control tank. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK. Add oil if low. Use oils meeting the specifications outlined in Section 300-0020, LUBRICATION SYSTEM.

4. Remove wheel chocks, start the engine and slowly operate steering system. Check for correct steering operation and leaks. Tighten lines and fittings if necessary and re-check oil level.

MAINTENANCE

Numbers in parentheses refer to Fig. 5.

1. Check breather (9) regularly for plugging, due to accumulation of dirt, painting over or plugged with tape or other material. Check filter (6) for plugging.

2. Clean filter (6) and breather (9) with a suitable cleaning solvent, or if required, replace.

3. If painting in the area of the accumulator valve is necessary, be sure to mask breather (9). Be sure to remove all masking tape from breather (9) after painting.

* * * *

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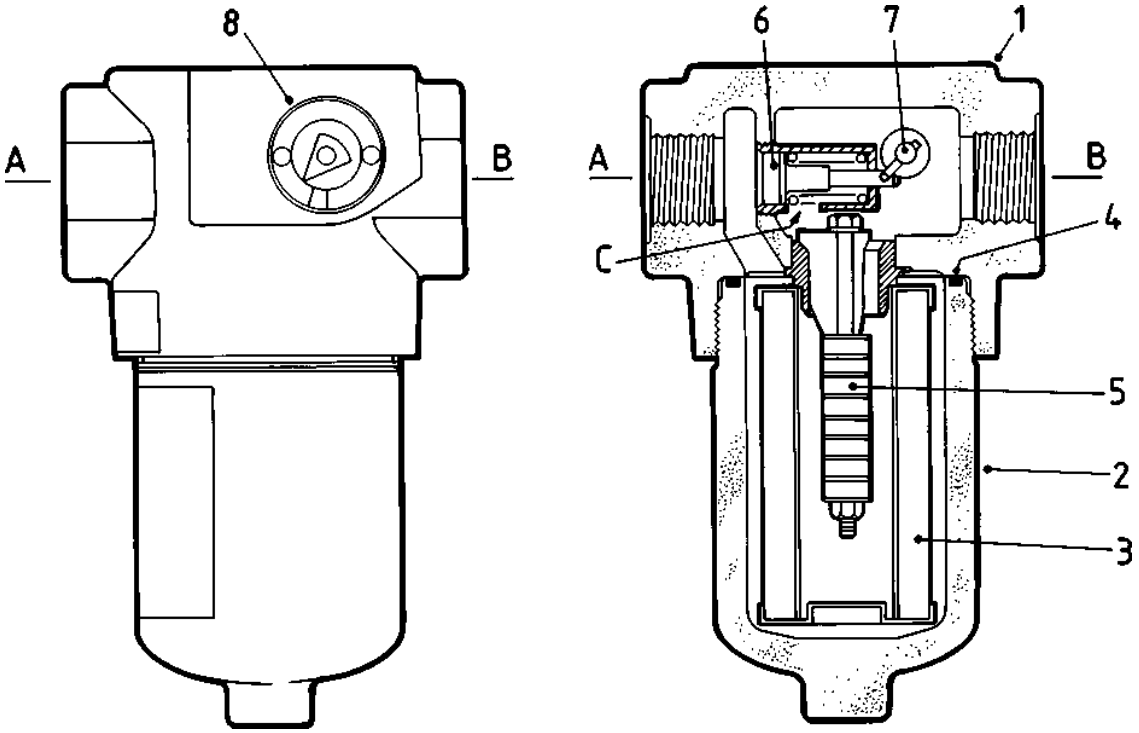
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SM - 627



1 - Housing
2 - Bowl
3 - Element
4 - 'O' Ring
5 - Magnets
6 - Bypass Valve
7 - Indicator Link
8 - Visual Indicator
'A' - Inlet Port
'B' - Outlet Port
'C' - Bypass Port

Fig. 1 - Elevation and Sectional View of Steering Filter

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The steering filter is mounted off the rear left hand transmission mounting bracket. It is connected in the steering line between the accumulator valve and the steering valve.

The main components of the steering filter are; housing (1), bowl (2), element (3), magnets (5), bypass valve (6) and visual indicator (8). There are two external ports 'A and 'B' and an internal bypass port 'C' in the steering filter assembly.

OPERATION

Numbers in parentheses refer to Fig. 1.

Hydraulic oil enters inlet port 'A' from the accumulator valve and passes to the annular area of bowl (2) outside element (3) and then through element (3) to outlet port 'B'.

The pressure drop across the filter is minimal when element (3) is clean. Contaminants (dirt) build up across element (3) as hydraulic oil passes through the filter. Pressure drop across the filter increases, as dirt build up increases, and is felt across spring loaded piston bypass valve (6). Bypass valve (6) is mechanically linked to visual indicator (8), see Fig. 2. Movement of the piston in bypass valve (6) is reflected on visual indicator (8). As dirt build up increases, indicator link (7) will move from the green area into the yellow area on visual indicator (8).

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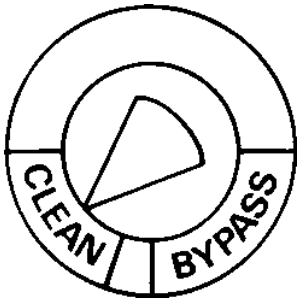


Fig. 2 - Steering Filter Visual Indicator

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Steering System - Steering Filter

Section 220-0150

Element (3) should be changed immediately visual indicator registers in the yellow 'Needs Cleaning' area.

Note: Bypass valve (6) is still not open at this point.

Bypass valve (6) starts to open when indicator link (7) passes from the yellow area into the red area on visual indicator (8). If visual indicator (8) is in the red 'Bypass' area, bypass valve (6) is open and this allows a certain amount of hydraulic oil to bypass clogged element (3).

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

The steering filter visual indicator (8) should be checked daily. Element (3) should be changed immediately visual indicator (8) registers in the yellow area, or every 1 000 hours, whichever comes first.

Changing Filter Element

Numbers in parentheses refer to Fig. 1.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNINGS

Dangerous pressure. Turn steering wheel several times in each direction to relieve pressure in the system. Failure to release pressure as stated can result in personal injury and property damage.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Turn steering wheel in both directions several times to relieve any pressure in accumulator and steering system. Block all road wheels.

3. Remove hydraulic lines at inlet port 'A' and outlet port 'B' and drain oil into a suitable container.

4. Drain hydraulic oil from filter assembly into a suitable container by unscrewing bowl (2) from housing (1). Lower bowl (2) vertically to clear element (3), which will remain in housing (1), and discard 'O' ring (4).

5. Dislodge element (3) from its push fit in housing (1) and remove carefully.

6. Remove magnet (5) assembly from element (3) and discard element (3). If necessary, remove hex nut securing magnets (5) on the post. Clean magnets (5) and secure on post with hex nut.

7. Clean housing (1) and bowl (2) thoroughly with a suitable solvent, for installation of new element (3).

8. Install magnet (5) assembly in new element (3) and push element (3) into housing (1).

9. Install new 'O' ring (4) on bowl (2) and lubricate bowl (2) and housing (1).

10. Screw bowl (2) into housing (1) and torque tighten to 20 Nm (15 lbf ft).

11. Connect inlet and outlet lines to steering filter and fill hydraulic tank with oil as specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK, for correct fill level.

12. Remove wheel blocks and disconnect shipping bar and place in the stowed position. Start engine, check for correct steering operation and check for leaks. Tighten lines and fittings, as required.

Note: If there is air in the steering system the system must be bled, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC.

SPECIAL TORQUE SPECIFICATIONS TABLE184

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	2	Bowl	20	15

* * * *

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DESCRIPTION

Numbers in parentheses refer to Figs. 2 through 5.

The body system schematic primarily covers operation of the body hoist system. However, as the hydraulic tank is common to the body hoist and the disc brake cooling circuit, several components of the cooling system are also covered in the schematic.

A brief description of the individual components shown in the body system schematic are listed below. Detailed service and operating instructions for the individual components can be found in their relevant component sections in this manual.

Body and Disc Brake Cooling Tank (1)

Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK.

The body and disc brake cooling tank is the common reservoir for the body hoist system and oil cooled disc brakes (OCDB) cooling oil. It is mounted off the left hand frame rail rearwards of the steering and brake control tank.

Tandem Pump (2)

Refer to Section 230-0050, TANDEM PUMP.

The tandem gear pump, mounted off the engine power takeoff, supplies hydraulic oil for operating the body and cooling the rear disc brake assemblies.

This is a multiple gear type pump consisting of two separate sections connected together as one assembly.

The front section draws oil from the body and disc brake cooling tank, then pumps the oil to body control valve (3) where, depending on spool position, oil flows to the body hoist circuit or, with spool in the float position, flows through manifold block (4) to supplement the disc brake cooling oil.

The rear section draws oil from the body and disc brake cooling tank, then pumps the oil through manifold block (4) to supply the disc brake cooling circuit.

Body Control Valve (3)

Refer to Section 230-0060, BODY CONTROL VALVE. Also referenced in this section is **Manifold Block (4).**

Mounted off the left hand frame rail to the rear of the horse collar, the body control valve is used to direct oil to the body cylinders for raising or lowering the body.

Integral of the body control valve body is a four position spool and a relief valve assembly. The four positions of the control spool are; 'Raise', 'Hold', 'Float' and 'Lower' (power down). The spool is detented in the 'Hold' position.

Note: The control joystick should be kept in the 'Float' position at all times, except when raising or lowering the body.

A relief valve assembly next to the pressure inlet port, opens and allows oil to flow back to the body and disc brake cooling tank when pressure in the hydraulic system exceeds 190 bar (2 750 lbf/in²).

The system relief pressure can be checked at the diagnostic test point on the rear left hand cab support.

Body Cylinder (5)

Refer to Section 230-0130, BODY CYLINDER.

There are two body hoist cylinders mounted between the frame rails. The cylinders are two-stage with power down in the second stage.

Kick-over Valve (6)

Refer to Section 230-0090, KICK-OVER VALVE.

The kick-over valve, mounted off a bracket at the rear of the transmission, is installed in the hydraulic system to prevent the body from pulling a void in body cylinders (5) when dumping unbalanced loads. The kick-over valve also provides a means of return oil from the body lower circuit to return, through body control valve (3), to body and disc brake cooling tank (1).

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Disc Brake Oil Filter (7)

There is one full flow oil filter installed in the hydraulic line between manifold block (4) and disc brake oil cooler (8). Internal of the filter housing is a relief valve which opens at 1 bar (15 lbf/in²) and allows oil to bypass the filter element when it becomes blocked. The filter indicator should be checked daily, and the element changed when the indicator shows oil at the replace element level.

Disc Brake Oil Cooler (8)

Refer to Section 210-0050, DISC BRAKE OIL COOLER.

The disc brake oil cooler is connected in the hydraulic system between disc brake oil filter (7) and disc brake assemblies and is used to cool disc brake cooling oil. The disc brake oil cooler is connected in the cooling system between the engine water pump outlet and the transmission oil cooler. Refer to Section 210-0000, COOLING SYSTEM.

Note: Oil flow must always flow in the opposite direction to coolant flow through disc brake oil cooler.

Body Control Joystick (9)

Refer to Section 230-0081, BODY CONTROL JOYSTICK.

The body control joystick is located in the hydraulic lines between the pilot supply valve and the body control valve. The body control joystick directs the oil to either side of the body control valve to move the control spool position. Body control joystick sequence, starting from the rear most position and working forward are; ‘Raise’, ‘Hold’, ‘Float’ and ‘Lower’ (Power down).

Note: The body control joystick should be kept in the ‘Float’ position at all times, except when raising or lowering the body.

Relief Valve (10)

Located in the body and disc brake cooling tank, the relief valve controls oil pressure in the disc brake cooling circuit. The relief valve is set to open at 3 bar (45 lbf/in²).

Relief Valve (11)

The relief valve (safety valve) is installed in the hydraulic lines between the kick-over valve and the lower ports on the body cylinders. Should pressure in these lines exceed 207 bar (3 000 lbf/in²) the valve will open and excess oil will return to the body and disc brake cooling tank.

Tank Breather (12)

Located in the top of body and disc brake cooling tank (1), the breather is common to both the body and disc brake cooling tank and the steering and brake control tank. The breather allows any air entering the tanks to be released to atmosphere, preventing a pressure build up in the tank assemblies.

Disc Brake Oil Temperature Switch (13)

The disc brake oil temperature switch is installed in the disc brake oil return tube to indicate if the disc brake cooling oil is overheating. The oil temperature switch sends a signal to illuminate the warning light on the dash panel when a temperature of 121° C (250° F) is reached.

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Pilot Supply Valve (14)

Refer to Section 230-0121, PILOT SUPPLY VALVE.

The pilot supply valve, mounted off the accumulator mounting bracket on the right hand platform, is located in the hydraulic lines between the steering pump and the body control joystick. Intregal of the pilot supply valve is a restriction valve which steps down the supply pressure of 159 bar (2 300 lbf/in²) from the steering pump to between 30 bar (435 lbf/in²) and 35 bar (500 lbf/in²). The pilot supply valve is fitted with an accumulator, pre-charged with nitrogen, to a pressure of 13 bar (188 lbf/in²).

Pressure Test Points

There are five diagnostic pressure test points in the body hoist system, as shown in Figs. 2 through 5.

Note: When checking hydraulic pressures the vehicle should be positioned on a level surface and all road wheels securely blocked.

Test Point A
System Relief Pressure - 190 bar (2 750 lbf/in²)

Test Point B
Kick-over Pressure - 172 bar (2 500 lbf/in²)

Test Point C
Accumulator Pressure - 13 bar (188 lbf/in²)

Test Point D
Spool Actuation Pressure - Raise Side - Install a tee into servo line, raise side.

Spool in Raise position - Pressure should be 15.9 - 17.8 bar (230 - 258 lbf/in²).

Spool in Hold position - Pressure should be 0 bar (0 lbf/in²).

Test Point E
Spool Actuation Pressure - Lower Side - Install a tee into servo line, lower side.

Spool in Lower position - Pressure should be 22.6 - 25.6 bar (328 - 371 lbf/in²).

Spool in Float position - Pressure should be 13 ± 0.5 bar (188 ± 7 lbf/in²).

'O' RING FACE SEALS (ORFS)

Where hydraulic lines are fitted with ORFS connections, the following procedure should be carried out during 'Installation'. Refer to Fig. 1.

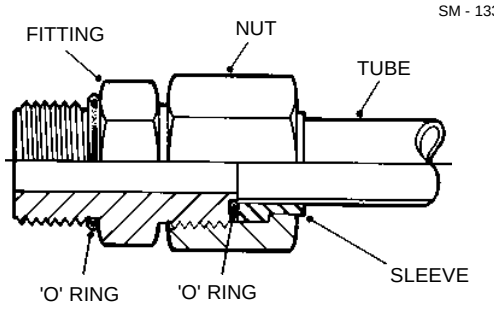


Fig. 1 - Assembly of Typical ORFS Connector

a. Ensure 'O' ring/seal is in place and that joining surfaces are clean. If necessary, retain 'O' ring/seal in place with a light coating of grease or vaseline.

b. Initially, the nuts should be tightened by hand.

c. Where a hose is fitted, ensure that it is not twisted or kinked when the nuts are tightened so that it is allowed to adopt a natural position.

d. Where a tube is fitted, ensure that the connection is aligned correctly.

e. Tighten the nut a further 1/4 to 1/2 a turn using the correct size spanner (wrench).

f. Check that a satisfactory routing has been achieved.

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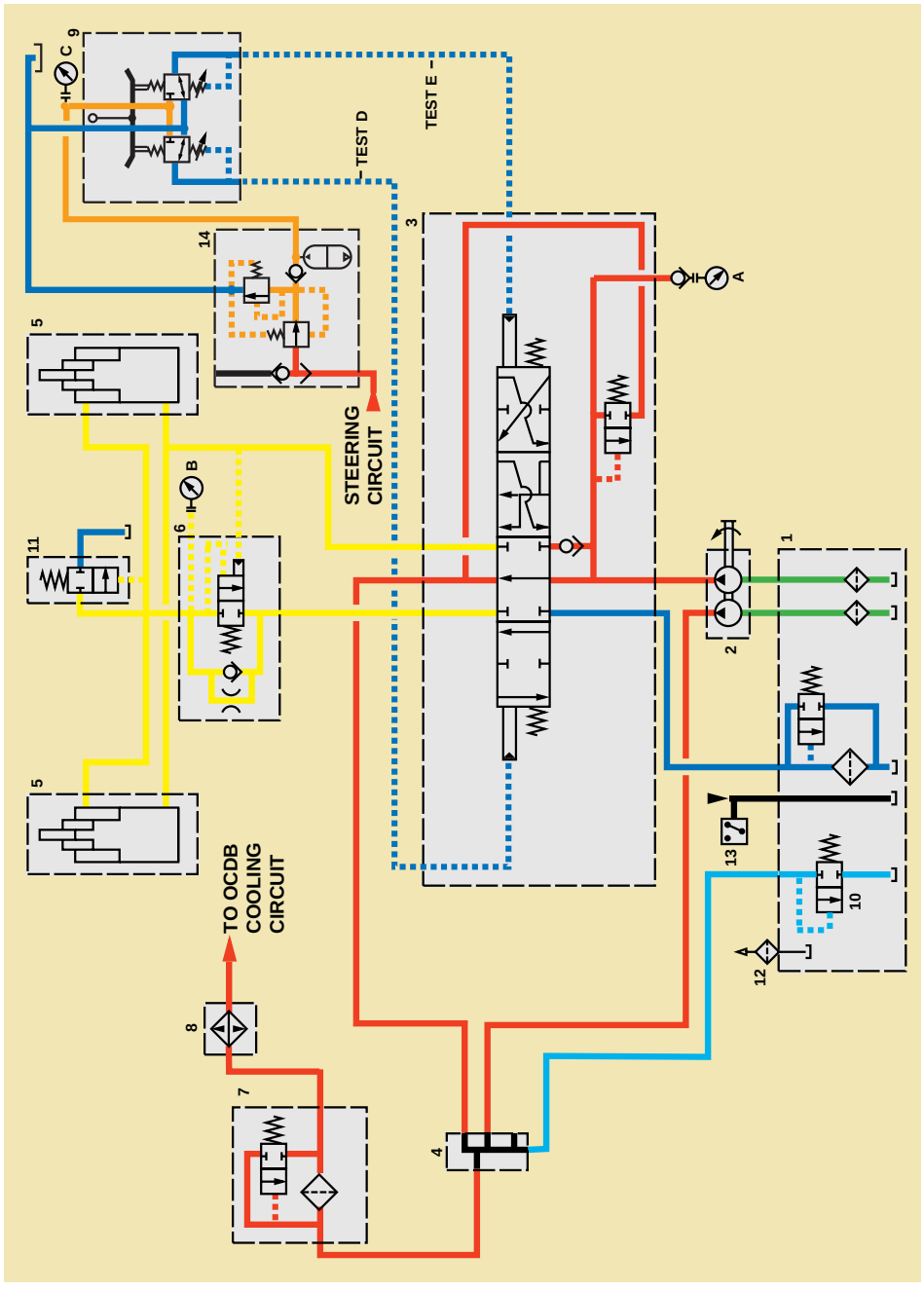
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Body System - Body System Schematic

Section 230-0000

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COMPONENTS

1 - Body and Disc Brake Cooling Tank
2 - Tandem Pump
3 - Body Control Valve
4 - Manifold Block
5 - Body Cylinder
6 - Kick-over Valve
7 - Disc Brake Oil Filter
8 - Disc Brake Oil Cooler
9 - Remote Control Valve
10 - Relief Valve
11 - Relief Valve
12 - Tank Breather
13 - Disc Brake Oil Temp Switch
14 - Pilot Supply Valve

PRESSURE TEST POINTS

A - System Relief Pressure
B - Kick-over Pressure
C - Accumulator Pressure

COLOUR CODES

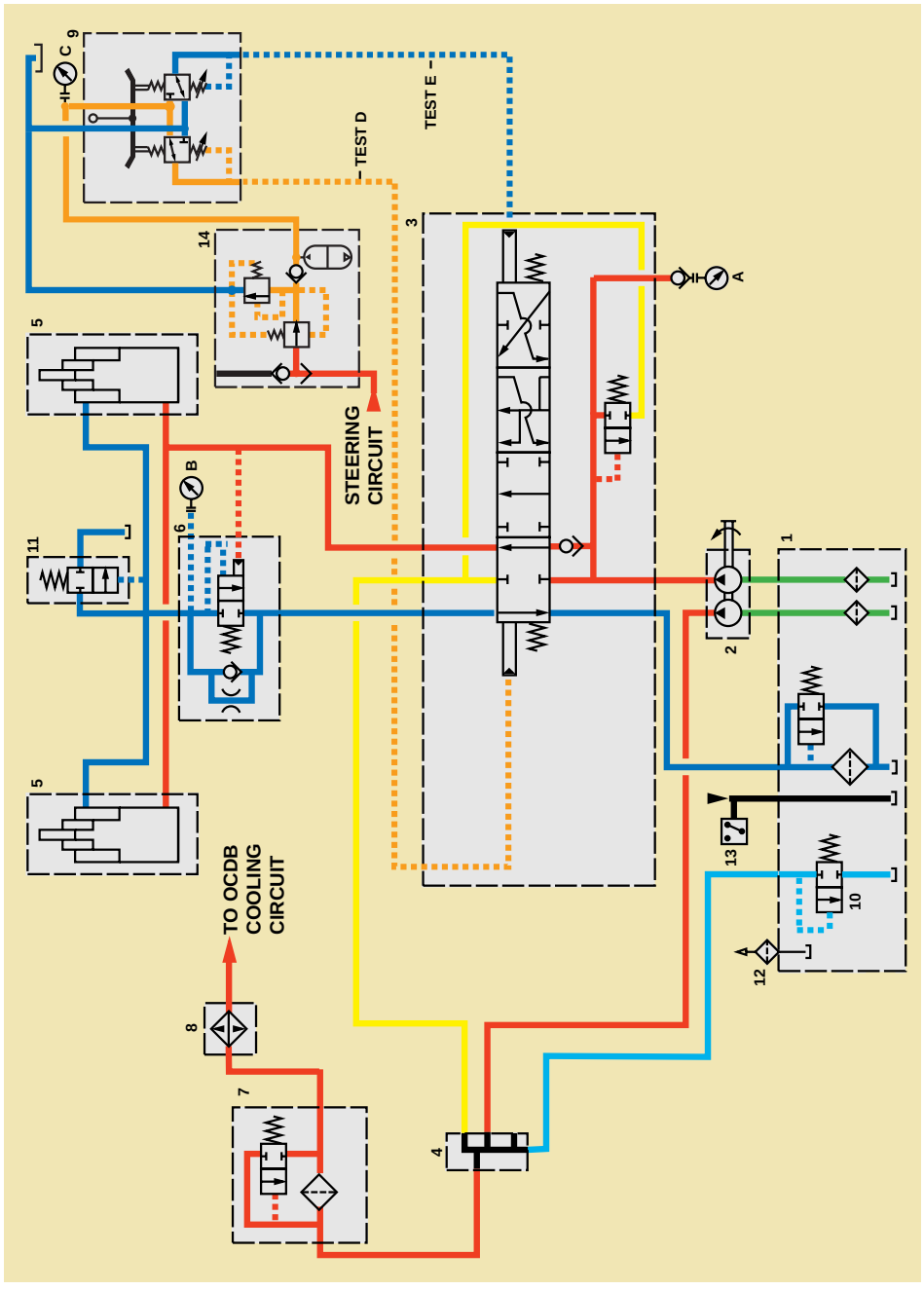
Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

Fig. 2 - Body Hoist System Schematic - Body Control Valve in the 'Hold' Position

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SM - 2270B



COMPONENTS
1 - Body and Disc Brake Cooling Tank
2 - Tandem Pump
3 - Body Control Valve
4 - Manifold Block
5 - Body Cylinder
6 - Kick-over Valve
7 - Disc Brake Oil Filter
8 - Disc Brake Oil Cooler
9 - Remote Control Valve
10 - Relief Valve
11 - Relief Valve
12 - Tank Breather
13 - Disc Brake Oil Temp Switch
14 - Pilot Supply Valve

PRESSURE TEST POINTS
A - System Relief Pressure
B - Kick-over Pressure
C - Accumulator Pressure

COLOUR CODES
Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

Fig. 3 - Body Hoist System Schematic - Body Control Valve in the 'Raise' Position

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Body System - Body System Schematic

Section 230-0000

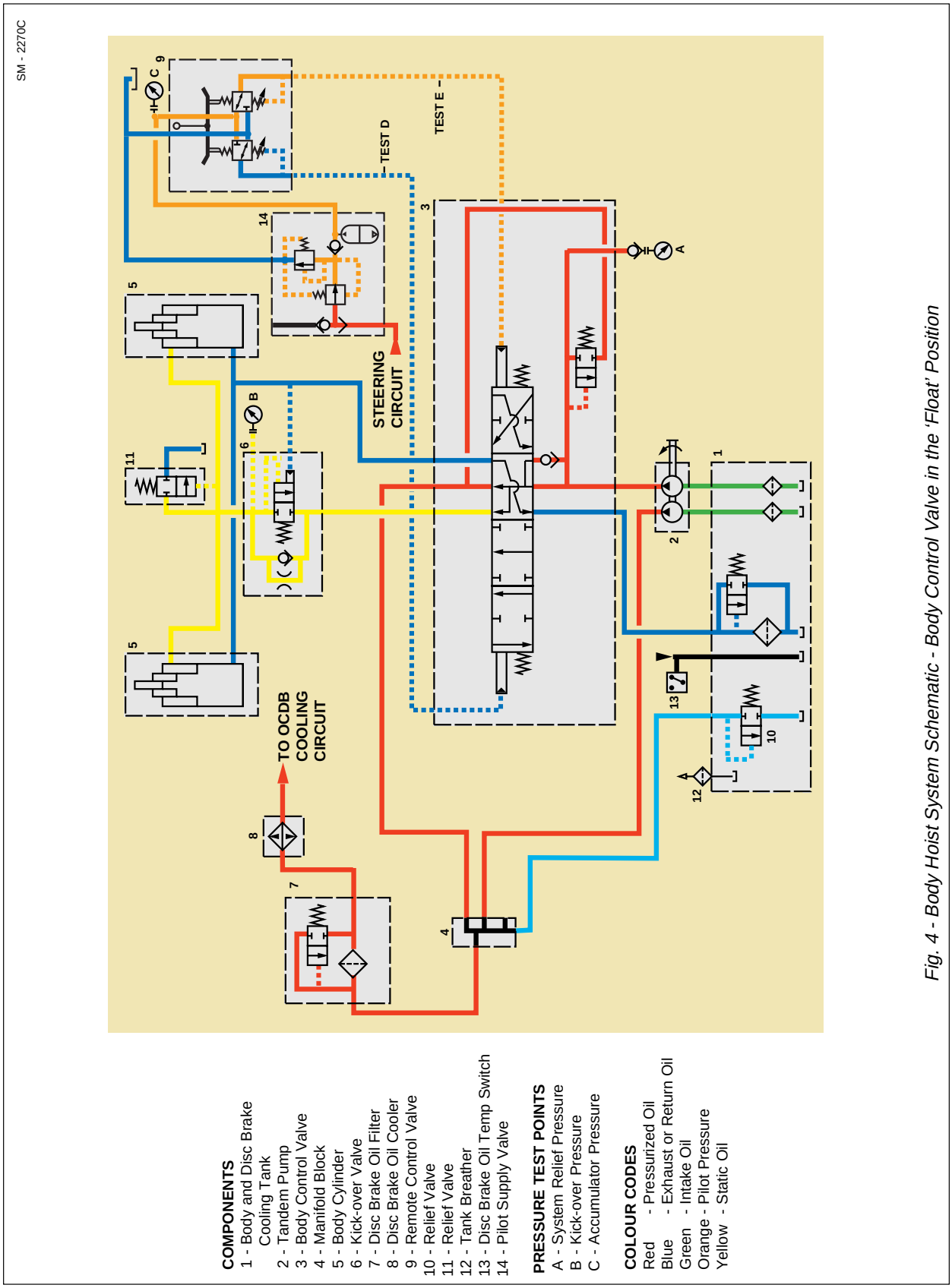


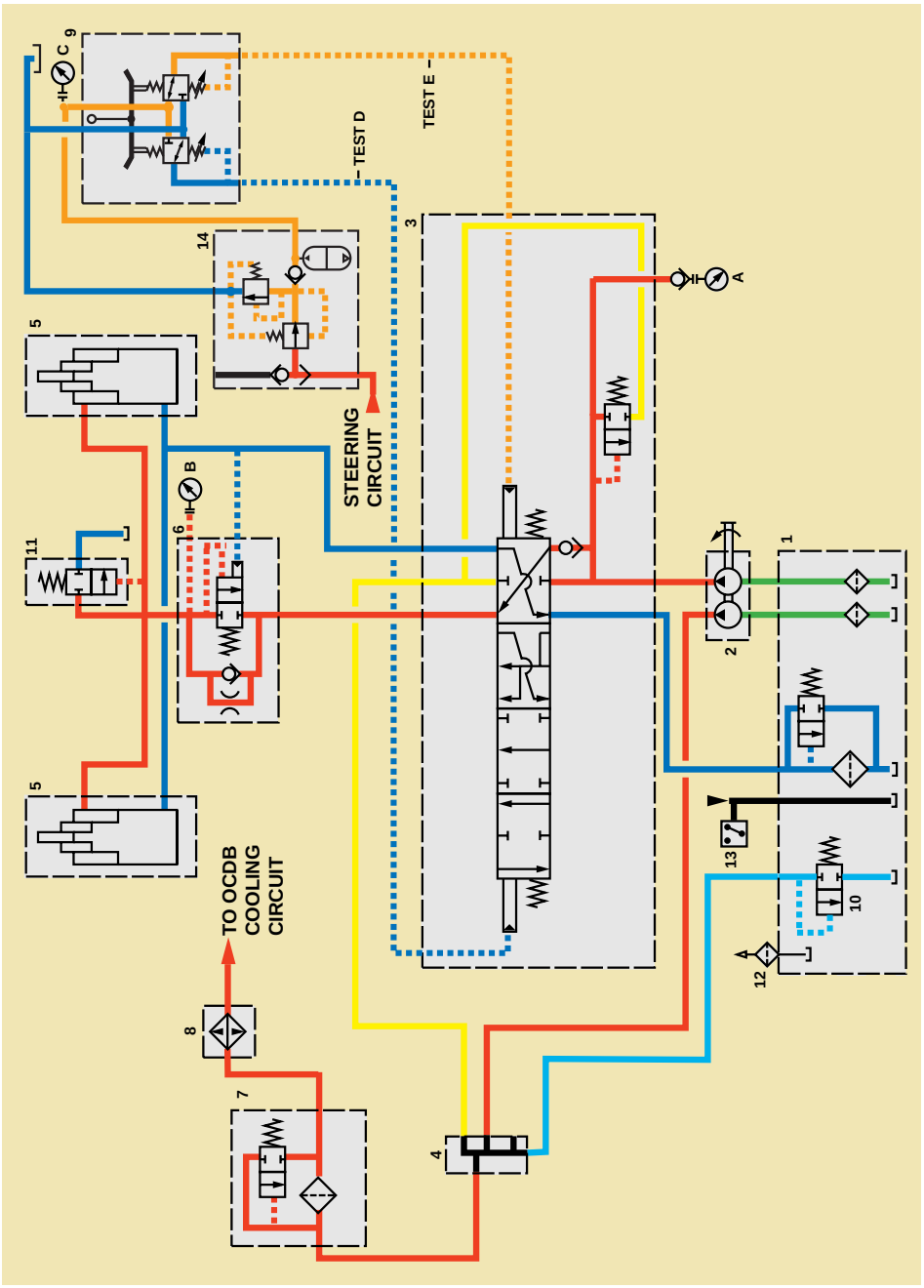
Fig. 4 - Body Hoist System Schematic - Body Control Valve in the 'Float' Position

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SM - 2270D



COMPONENTS
1 - Body and Disc Brake Cooling Tank
2 - Tandem Pump
3 - Body Control Valve
4 - Manifold Block
5 - Body Cylinder
6 - Kick-over Valve
7 - Disc Brake Oil Filter
8 - Disc Brake Oil Cooler
9 - Remote Control Valve
10 - Relief Valve
11 - Relief Valve
12 - Tank Breather
13 - Disc Brake Oil Temp Switch
14 - Pilot Supply Valve

PRESSURE TEST POINTS
A - System Relief Pressure
B - Kick-over Pressure
C - Accumulator Pressure

COLOUR CODES
Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

Fig. 5 - Body Hoist System Schematic - Body Control Valve in the 'Lower' Position

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SERVICE TOOLS

It is recommended that the following tools are used when carrying out pressure or temperature checks during maintenance procedures. These tools, along with other general service tools, are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of these tools.

Multi-gauge

The multi-gauge is basically four pressure gauges in one. Continuous system pressure readings are indicated on one of three simultaneously reading gauges through a pressure range of 762 mm (30 in) of vacuum to 345 bar (5 000 lbf/in^2).

Non-contact Infrared Thermometer

The infrared thermometer can be used to spot heat problems early in electrical, mechanical and hydraulic systems. Hand held and easy to use, you simply aim, pull the trigger, and read the temperature. Since there is no need to touch what you are measuring, temperatures of hard-to-reach or moving components can be taken without getting burned or shocked.

BODY HOIST SYSTEM DIAGNOSIS

CONDITION	REASON	REMEDY
Body raise time too slow or system pressure is low.	Worn pump.	Rebuild or replace pump.
	Pump cavitation.	Check oil level, add if low.
		Check for obstruction in pump inlet hose. Clear or replace hose as required.
		Drain tank, clean strainers, replace filter elements and refill tank.
		Remove pump and check driveshaft.
	Dirt lodged between relief valve poppet and seat.	Remove relief cartridge and clean to seat poppet or replace cartridge.
	Relief valve not set to correct pressure.	Remove and replace relief cartridge assembly.
	Body cylinder binding, obstructed or leaking.	Rebuild or replace cylinder. Check for, and remove obstruction.
	Pilot valve in kick-over valve stuck shut or pilot line plugged.	Remove, disassemble and free pilot valve. Remove and check pilot line.
	Clogged breather.	Clean or replace breather.
Body lower time too slow in float.	Return oil from body cylinders being restricted in hoses or control valve.	Check hoses for kinks or restrictions.
		Check control valve spool for proper float position.
	Clogged breather.	Clean or replace breather.
	Kick-over valve malfunction.	Check and adjust.
Body drift while in the hold position.	Control valve spool not in detent position.	Check for worn detent, weak or broken centring spring.
	Oil bypass at spool in control valve.	Replace worn oil seals.

* * * *

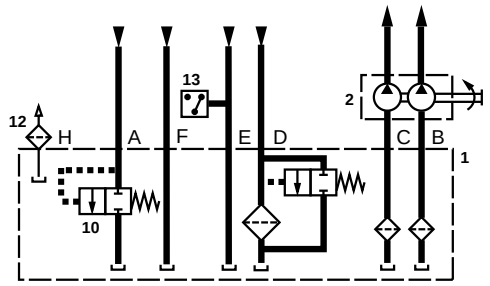
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Body System - Body and Disc Brake Cooling Tank

Section 230-0040

SM - 1685



1 - Hydraulic Tank
2 - Tandem Pump
10 - Relief Valve
12 - Breather
13 - Oil Temperature Switch

Fig. 2 - Hydraulic Schematic

SM - 1330

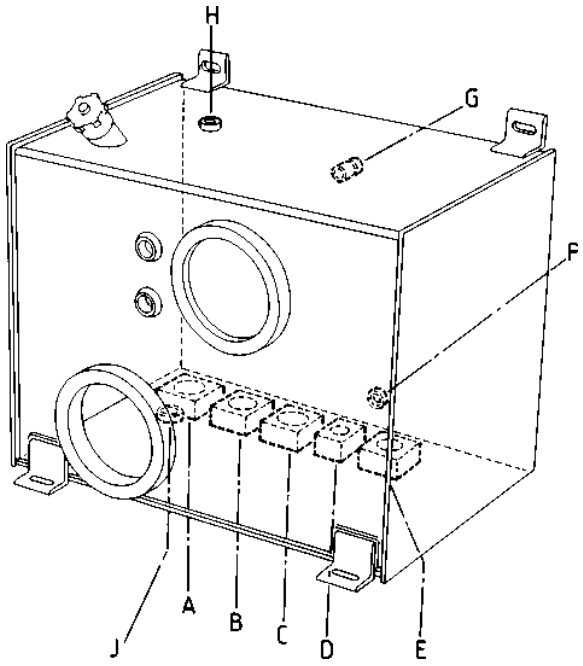


Fig. 3 - Port Locations

OPERATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified. Refer to Fig. 2 for hydraulic schematic and Fig. 3 for port locations.

The body hoist oil flow is drawn from port 'B', through suction screen (18), by the front section of the tandem gear pump mounted off the engine power takeoff. Oil is then pumped to the body control valve where, depending on spool position, oil flows to the body hoist circuit or, with spool in the float position, flows through the manifold block at the rear of the control valve to supplement the disc brake cooling oil.

The disc brake cooling oil flow is drawn from port 'C', through suction screen (18), by the rear section of the tandem gear pump. Oil is then pumped through the manifold block at the rear of the body control valve to the disc brake cooling circuit.

Excess disc brake cooling oil at the manifold block, returns to tank at port 'A' and flows through pressure relief valve (19) to the tank body.

Return oil from the body hoist circuit enters the tank at port 'D' from the body control valve. The oil enters filter element (13) chamber and flows through a centre tube and filter elements (13) to the tank body, thus ensuring return oil is filtered before entering the tank.

Return oil from the disc brake cooling circuit enters the tank at port 'E'. A disc brake oil temperature switch (13, Fig. 2) is installed in the return tube to indicate if disc brake cooling oil is overheating. The oil temperature switch sends a signal to illuminate the warning light on the dash panel when a temperature of 121° C (250° F) is reached.

Return oil from the kick-over valve enters the tank at port 'F' via a second safety relief valve installed in the hydraulic lines between the kick-over valve and the lower ports on the body cylinders.

Port 'G' is plugged.

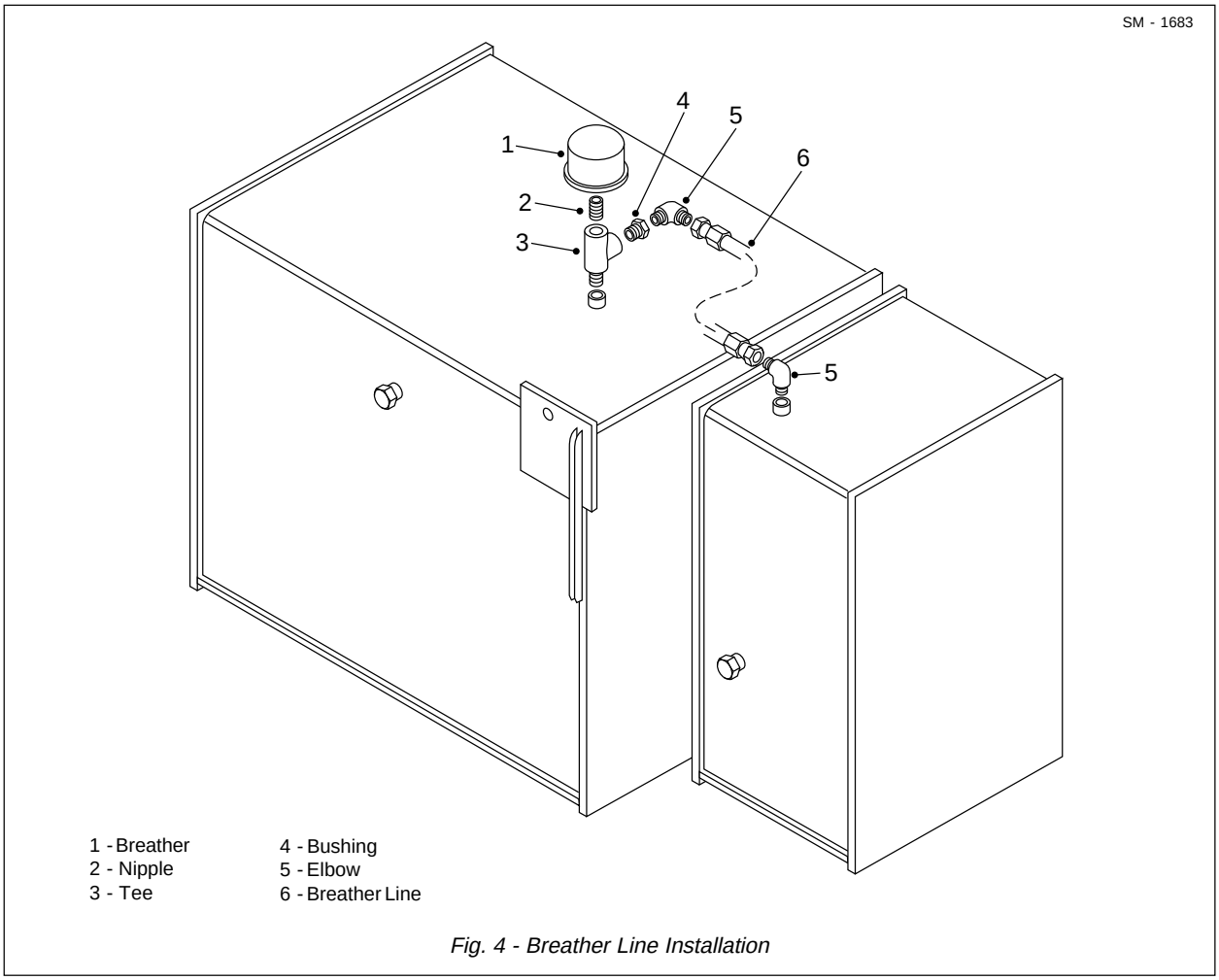
A breather installed in a tee at port 'H' is the common breather to both the body and disc brake cooling tank and the steering and brake control tank. This allows any air entering the tanks to be released to atmosphere, preventing a pressure build up in the tank assemblies. See Fig. 4.

Port 'J' is plugged and provides a tank drain port.

An inter-connecting hose assembly (3, Fig. 5) links the body and disc brake cooling tank and the steering and brake control tank. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK.

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1 - Breather
2 - Nipple
3 - Tee
4 - Bushing
5 - Elbow
6 - Breather Line

Fig. 4 - Breather Line Installation

MAINTENANCE

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Checking Oil Level

Cold Check: With the engine off and the body fully lowered, the bottom window nut (16) should show full.

If oil is required, remove filler cap (5) and fill hydraulic tank (1) with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM, until oil shows in bottom window nut (16). Fit filler cap (5).

Hot Check: Operate the body hoist cylinders to their fully extended positions to charge both cylinders and all hoist lines then lower the body. With the engine running, oil at normal operating temperature and body fully lowered, the oil level should show in top window nut (16). Under all conditions bottom window nut (16) should show full.

If oil is required, remove filler cap (5) and fill hydraulic tank (1) with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM, until oil shows in top window nut (16). Fit filler cap (5).

Replacing Hydraulic Oil

Hydraulic tank (1) should be drained, cleaned, and hydraulic oil changed, at interval specified in Section 300-0020, LUBRICATION SYSTEM. Use only hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM.

Note: When oil in hydraulic tank (1) is being replaced due to overheated oil, hydraulic component failure, or at recommended change interval, filter elements (13) should be replaced.

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Changing Filter Elements

Change filter elements (13) at interval specified in Section 300-0020, LUBRICATION SYSTEM.

WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Block all road wheels.

3. With suitable containers in position, remove drain plug (17) from hydraulic tank (1) and drain the oil. Reinstall drain plug (17) in hydraulic tank (1) and tighten securely. Remove drain plug from steering and brake control tank and drain the oil. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK. Reinstall drain plug in hydraulic tank and tighten securely.

4. Remove bolts (7), lockwashers (8), access cover (2) and gasket (15) from hydraulic tank (1). Discard gasket (15).

5. Remove wing nuts (12), bypass valve (9) and plate (10) from rods (11). Remove and discard filter elements (13) and gaskets (14) from hydraulic tank (1).

Note: Bypass valve (9) is set at 1.7 bar (25 lbf/in^2).

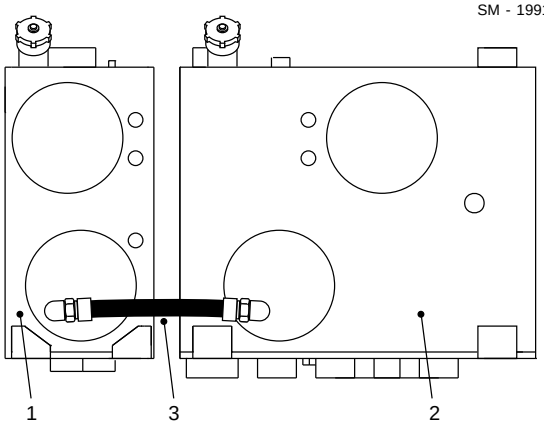
6. Install new gaskets (14) and filter elements (13) in oil filter chamber in hydraulic tank (1).

7. Install bypass valve (9) in plate (10) and secure plate (10) assembly on rods (11) with wing nuts (12).

8. Install new gasket (15) and cover (2) on hydraulic tank (1) and secure with bolts (7) and lockwashers (8).

9. Fill hydraulic tank (1) and steering and brake control tank to correct level with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (5).

10. Start the engine and raise and lower the body to charge the system. Switch off the engine and check oil level as described under 'Checking Oil Level'. Remove wheel blocks.



1 - Steering and Brake Control Tank
2 - Body and Disc Brake Cooling Tank
3 - Inter-Connecting Hose Assembly

Fig. 5 - Layout View of Hydraulic Tanks

Suction Screens and Relief Valve

Remove and clean suction screens (18) at interval specified in Section 300-0020, LUBRICATION SYSTEM.

Note: Relief Valve (19) is set at 3 bar (45 lbf/in^2).

WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Block all road wheels.

3. With suitable containers in position, remove drain plug (17) from hydraulic tank (1) and drain the oil. Reinstall drain plug (17) in hydraulic tank (1) and tighten securely. Remove drain plug from steering

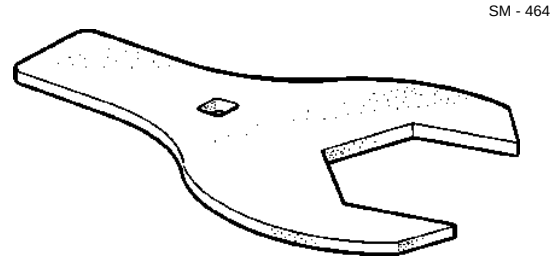


Fig. 6 - Suction Screen Removal/Installation Tool

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and brake control tank and drain the oil. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK. Reinstall drain plug in hydraulic tank and tighten securely.

4. If required, remove inter-connecting hose assembly (3, Fig. 5) from access cover (3). Fit blanking cap and plug to hydraulic line and tank port. Remove bolts (7), lockwashers (8), access cover (3) and gasket (15) from hydraulic tank (1). Discard gasket (15).

5. Remove lockwire (31) securing suction screens (18) in hydraulic tank (1).

6. Using a suitable tool, as shown in Fig. 6, unscrew suction screens (18) by turning hexagon head at neck of each suction screen.

7. Remove relief valve (19) assembly. Disassemble relief valve (19) assembly by removing, cap (21), shim (23), spring (22) and poppet (20).

⚠ WARNING
Splashing liquid. Wear a suitable face shield when using compressed air to dry tank and components.

8. Clean suction screens (18) and hydraulic tank (1) with paraffin and dry with compressed air. Inspect for damage and renew if necessary.

9. Assemble relief valve (19) in reverse order to disassembly. Thoroughly clean and dry threads on relief valve (19) and tank port and apply Loctite Activator 'T' to threads. Apply Loctite 242 to threads of relief valve (19) and install relief valve assembly in hydraulic tank (1).

10. Insert lockwire (31) in suction screens (18) and install suction screens in hydraulic tank (1). Secure suction screens (18) in hydraulic tank (1) using a suitable tool, as shown in Fig. 6.

11. Join ends of lockwire (31) and secure suction screens (18) together with lockwire (31).

Note: Do not grip the body of suction screens (18). Use a suitable tool, as shown in Fig. 6, to grip the hexagon head at the neck of each suction screen.

12. Install new gasket (15) and access cover (3) on hydraulic tank (1) and secure with bolts (7) and lockwashers (8). Remove blanking cap and plug from hydraulic line and tank port and install inter-connecting hose assembly (3, Fig. 5) to access cover (3).

13. Fill hydraulic tank (1) and steering and brake control tank to correct level with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (5).

14. Start the engine and raise and lower the body to charge the system. Switch off the engine and check oil level as described under 'Checking Oil Level'. Remove wheel blocks.

Breather

Remove and clean breather (1, Fig. 4) at the interval specified in Section 300-0020, LUBRICATION SYSTEM. Replace breather if cleaning is not sufficient.

TANK ASSEMBLY

Removal

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Block all road wheels.

3. With suitable containers in position, remove drain plug (17) from hydraulic tank (1) and drain the oil. Reinstall drain plug (17) in hydraulic tank (1) and tighten securely. Remove drain plug from steering and brake control tank and drain the oil. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK. Reinstall drain plug in hydraulic tank and tighten securely.

4. Ensure all hydraulic lines connected to hydraulic tank (1) assembly are identified for ease of installation and, with suitable containers available to catch leakage, disconnect all hydraulic lines. Fit blanking caps and plugs to all hydraulic lines and tank ports.

5. Disconnect breather line (6, Fig. 4) from elbow (5, Fig. 4). Fit blanking caps to line.

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6. Disconnect inter-connecting hose assembly (3, Fig. 5) from access cover (3). Fit blanking caps to line.

⚠ WARNING
Heavy Tank. Ensure lifting device is of adequate capacity and properly secured to avoid personal injury or property damage.

7. Support hydraulic tank (1) assembly with suitable lifting equipment.

8. Remove bolts (26), hardened washers (28) and nuts (27) securing hydraulic tank (1) assembly to mounting brackets (24 & 25).

9. Remove hydraulic tank (1) assembly to a suitable work area for disassembly.

Disassembly

Numbers in parentheses refer to Fig. 4, unless otherwise specified.

1. Remove internal components from hydraulic tank (1) as previously described under 'MAINTENANCE'.

2. If required, remove rods (11, Fig. 1) and window nuts (16, Fig. 1) from hydraulic tank (1, Fig. 1).

3. If required, remove breather (1), nipple (2), tee (3), bushing (4) and elbow (5) from hydraulic tank (1, Fig. 1).

Inspection

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

⚠ WARNING
Splashing liquid. Wear a suitable face shield when using compressed air to dry tank and components.

1. Clean hydraulic tank (1) and components with paraffin and dry with compressed air.

2. Inspect tank for weld cracks and security of internal pipes and weld fitments.

3. Check suction screens (18) for damage and renew if required.

4. Check pressure relief valve (19) assembly is free of contaminants and that poppet (20) is free.

5. Check bypass valve (9) for damage or wear and replace if required.

6. Check breather (1, Fig. 4) for damage and replace if required.

Assembly

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

1. Install all internal components as previously described under 'MAINTENANCE'. Renew filter elements (13) and gaskets (14 & 15).

2. If removed, install window nuts (16) and rods (11) in hydraulic tank (1).

3. If removed, install tee (3, Fig. 4), bushing (4, Fig. 4), elbow (5, Fig. 4), nipple (2, Fig. 4) and breather (1, Fig. 4) on hydraulic tank (1).

INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Using suitable lifting equipment, position hydraulic tank (1) assembly on mounting brackets (24 & 25) and secure with bolts (26), hardened washers (28) and nuts (27).

2. Remove blanking cap from breather line (6, Fig. 4) and connect breather line to elbow (5, Fig. 4). Tighten breather line securely.

3. Remove blanking cap from inter-connecting hose assembly (3, Fig. 5) and connect hose to access cover (3). Tighten hose assembly securely.

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4. Remove blanking caps and plugs and install all lines to hydraulic tank (1) , as tagged at removal.

5. Fill hydraulic tank (1) to correct level with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (5).

6. Start the engine and raise and lower the body to charge the system. Switch off the engine and check oil level as described under 'Checking Oil Level'.

7. Check all lines and fittings for leaks and tighten as required. Remove wheel blocks.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools and adhesives are available from your dealer.

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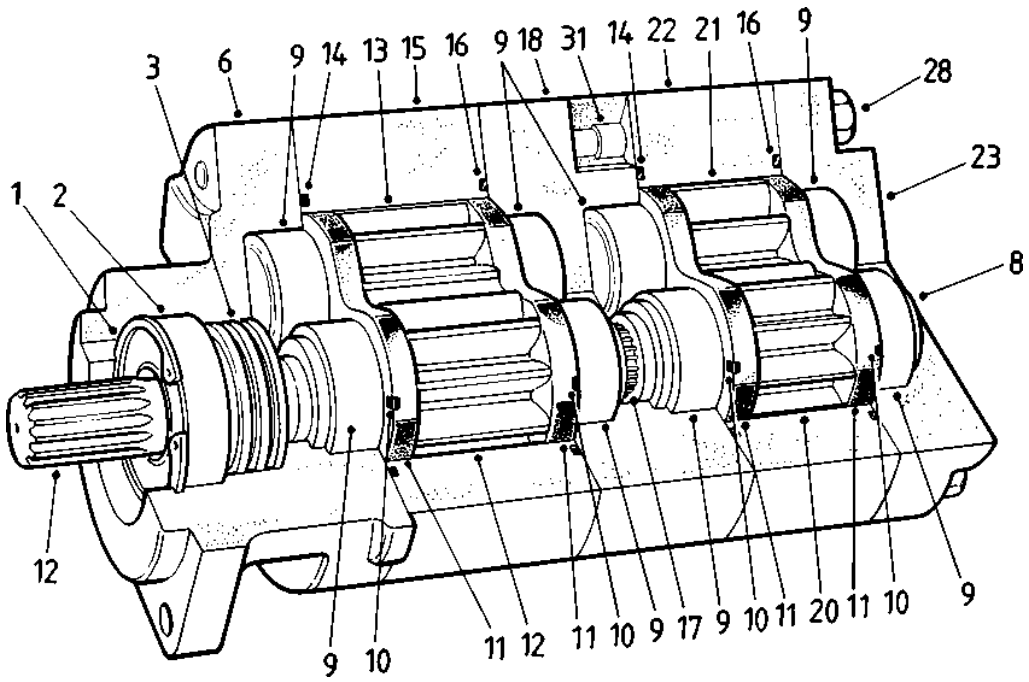
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1 - Snap Ring	8 - Ring Seals	16 - Seals	24 - Name Plate *
2 - Spacer	9 - Bearings	17 - Connecting Shaft	25 - Drive Screws *
3 - Seal Retainer	10 - Pocket Seals	18 - Bearing Carrier	26 - Washers *
4 - 'O' Ring *	11 - Thrust Plates	19 - Plug *	27 - Studs *
5 - Seal *	12 - Driveshaft & Gear	20 - Drive Gear	28 - Nuts
6 - Shaft End Cover	13 - Driven Gear	21 - Driven Gear	29 - Pins (if used) *
7 - Plug *	14 - Seals	22 - Gear Housing	30 - Seals (if used)
	15 - Gear Housing	23 - End Cover	31 - Anti-Vibration Rings

* Shown on Fig. 6.

Fig. 1 - Cutaway View of Tandem Pump

DESCRIPTION

Numbers in parentheses refer to Figs. 1 & 6.

The Tandem Pump can be identified as item 2 in Section 230-0000, BODY SYSTEM SCHEMATIC, in this manual.

The tandem gear pump, mounted off the engine power takeoff, supplies hydraulic oil for operating the body and cooling the rear disc brake assemblies.

This is a multiple gear type pump consisting of two separate sections connected together as one assembly. The front section consists of driveshaft & gear (12), driven gear (13) and gear housing (15). Drive gear (20), driven gear (21) and gear housing (22) make up the rear section. Connecting shaft (17) connects the rear section to driveshaft and gear (12).

OPERATION

Numbers in parentheses refer to Figs. 1 & 6. Refer to Fig. 2 for the operation of a typical gear type hydraulic pump. Refer to Fig. 3 for hydraulic schematic of the tandem pump operation.

As the drive gear rotates, the driven gear rotates in the opposite direction. The pockets between the gear teeth carry oil from the inlet port around the gear housing ID to the pump outlet port. As the gear teeth re-mesh, this oil is forced out of the outlet port of the gear housing. The maximum oil delivery rate of each section of the tandem pump is fixed by the width of its respective gear set and the speed at which driveshaft (12) is turned.

The front section of the tandem pump draws oil from the body and disc brake cooling tank, then pumps the

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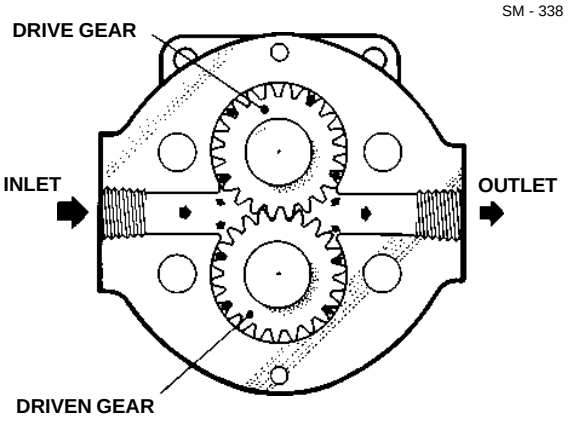


Fig. 2 - Typical Pump Operation

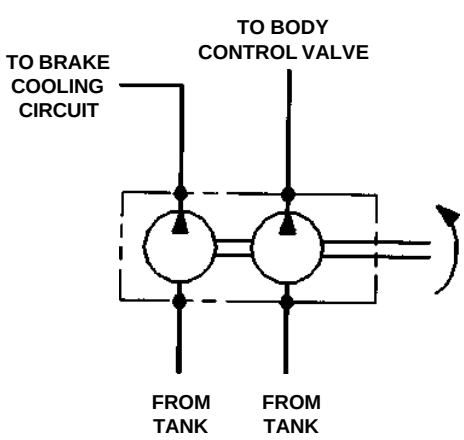


Fig. 3 - Hydraulic Schematic of Tandem Pump Operation

oil to the body control valve where, depending on spool position, oil flows to the body hoist circuit or, with spool in the float position, flows through the manifold block at the rear of the control valve to supplement the disc brake cooling oil.

The rear section of the tandem pump draws oil from the body and disc brake cooling tank, then pumps the oil through the manifold block at the rear of the body control valve to supply the disc brake cooling circuit.

REMOVAL

⚠ WARNING
To prevent personal injury and property damage, make sure blocking or lifting equipment is of adequate capacity and properly secured to do the job safely.

1. Position the vehicle in a level work area and apply the parking brake. Switch off the engine and block all road wheels.

2. Drain oil from hydraulic oil tank into a suitable container.

3. Clean pump housing and tag and disconnect inlet and outlet lines from the pump. Drain oil in lines into a suitable container. Cap lines and pump ports to prevent ingress of dirt.

4. With suitable blocking or lifting equipment, support pump before loosening attaching nuts. Remove nuts and lockwashers from pump mounting studs. Move pump to a suitable work area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Figs. 1 & 6.

1. Place pump in a soft-jawed vice, driveshaft (12) down. Match mark all pump sections with a punch to aid assembly. See Fig. 4.

Note: Do not clamp vice on pump machined surfaces at any time.

2. Remove nuts (28) and washers (26) from studs (27). See Fig. 5. Remove studs (27) from pump assembly.

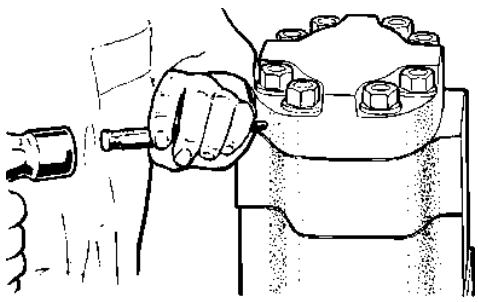


Fig. 4 - Marking Typical Pump Sections

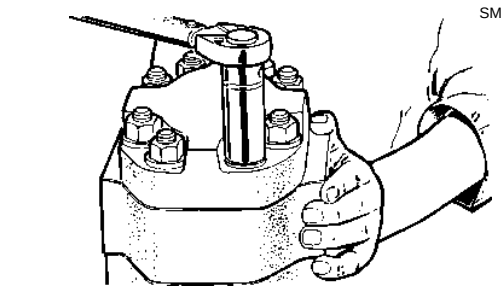
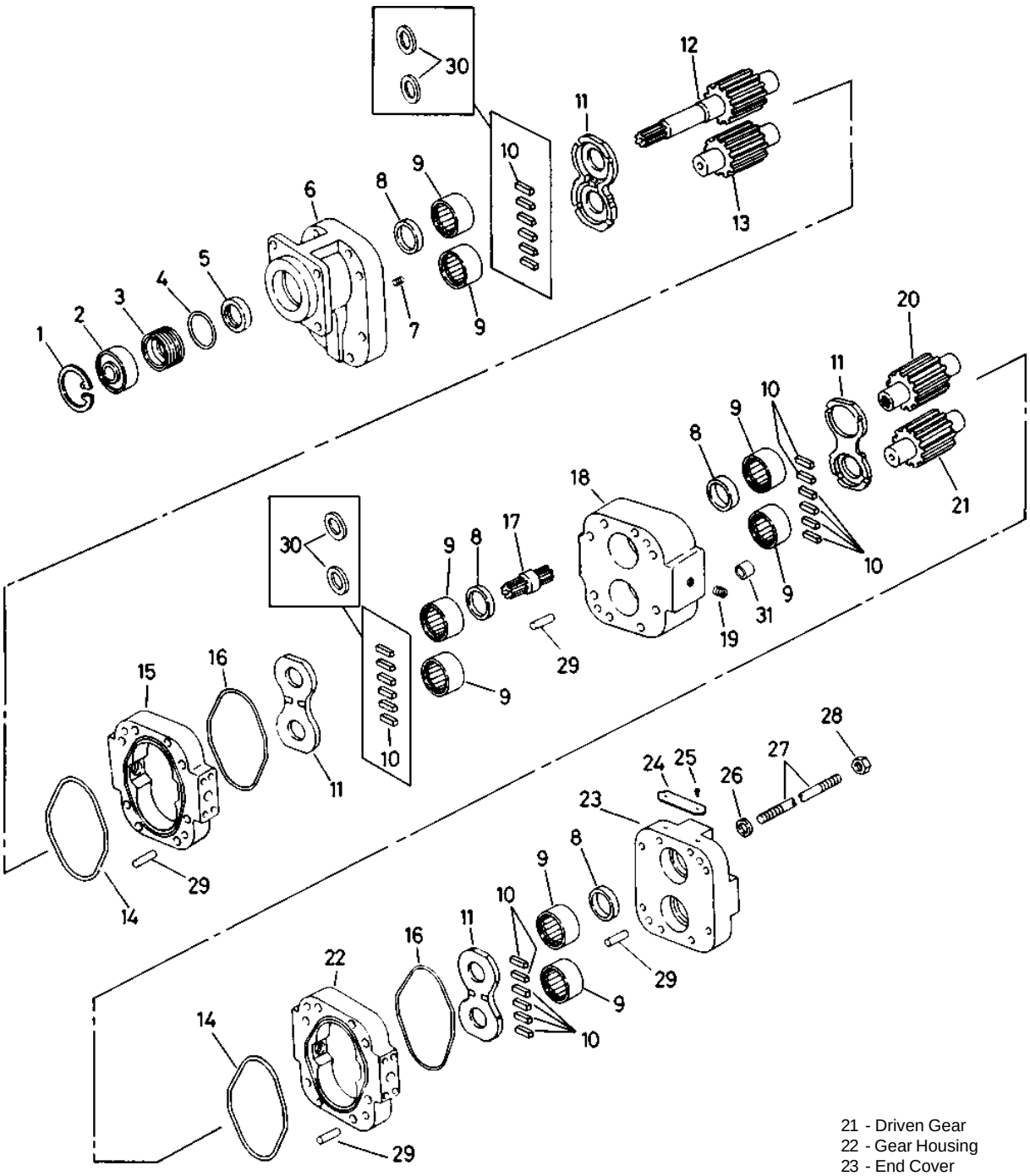


Fig. 5 - Removing Nuts

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1 - Snap Ring
2 - Spacer
3 - Seal Retainer
4 - 'O' Ring
5 - Seal
6 - Shaft End Cover
7 - Plug
8 - Ring Seals
9 - Bearings
10 - Pocket Seals
11 - Thrust Plates
12 - Driveshaft & Gear
13 - Driven Gear
14 - Seals
15 - Gear Housing
16 - Seals
17 - Connecting Shaft
18 - Bearing Carrier
19 - Plug
20 - Drive Gear
21 - Driven Gear
22 - Gear Housing
23 - End Cover
24 - Name Plate
25 - Drive Screws
26 - Washers
27 - Studs
28 - Nuts
29 - Pins (if used)
30 - Seals (if used)
31 - Anti-Vibration Rings

Fig. 6 - Exploded View Of Tandem Pump

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3. Tap end cover (23) with a soft hammer and separate from gear housing (22). If end cover (23) must be pried off, use care to avoid damaging machined surfaces of the cover and housing. See Fig. 7. If thrust plate (11) stays with gear housing (22), it can be tapped out later. Do not damage or distort the thrust plate.

4. Separate gear housing (22) from bearing carrier (18) and lift off. See Fig. 8. If it must be pried loose, use care to prevent damage to machined surfaces. Tap or pry out thrust plate (11) carefully, if it remained with gear housing (22).

5. Mark three meshed gear teeth with a dab of Prussian blue, or similar dye, and lift out matched gears (20 & 21). See Fig. 9. Keep these gears together. Do not interchange with other gear sets.

6. Loosen bearing carrier (18) with a plastic hammer and lift or pry off with care to avoid damaging machined surfaces. Separate thrust plate (11) from bearing carrier (18) carefully to avoid distortion. See Fig. 10.

7. Remove connecting shaft (17) from driveshaft and gear (12). See Fig. 11.

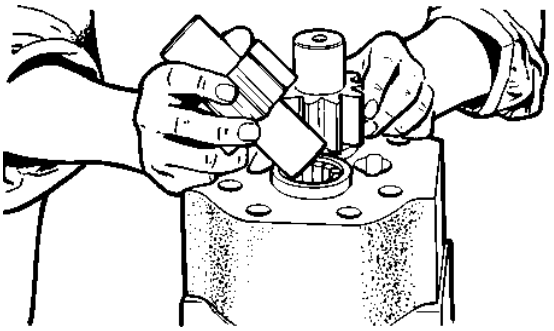


Fig. 9 - Removing Gears

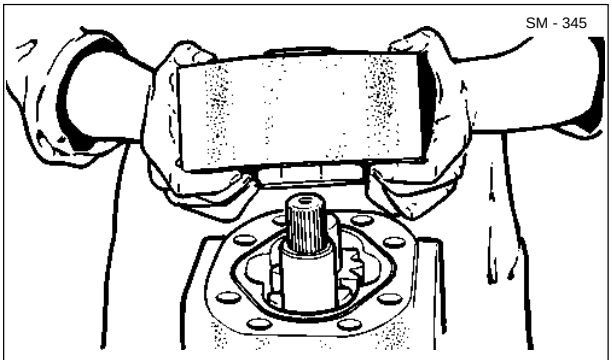


Fig. 10 - Removing Bearing Carrier

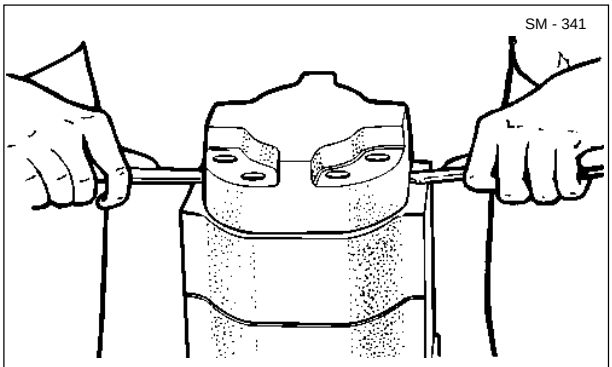


Fig. 7 - Removing End Cover

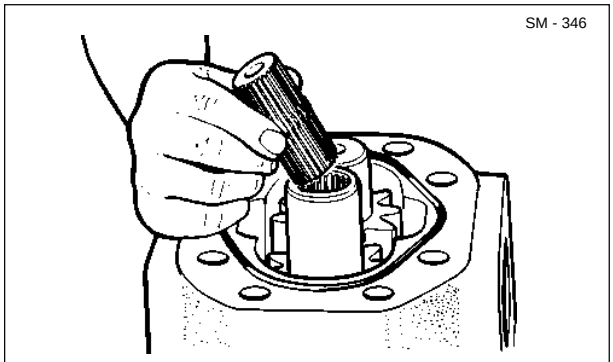


Fig. 11 - Removing Connecting Shaft

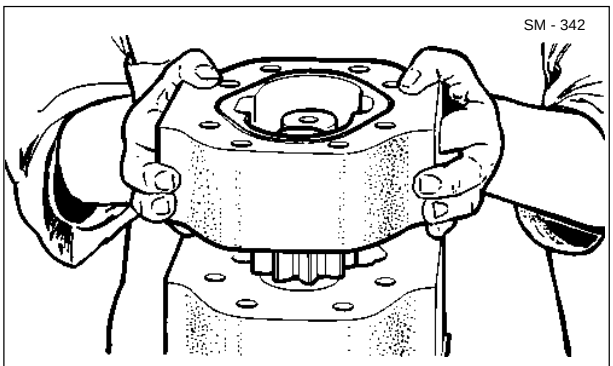


Fig. 8 - Removing Gear Housing

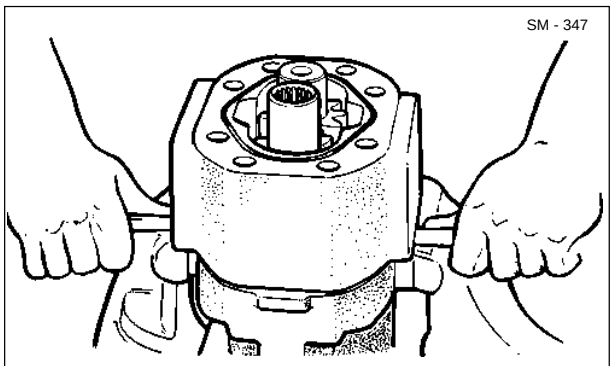


Fig. 12 - Removing Gear Housing

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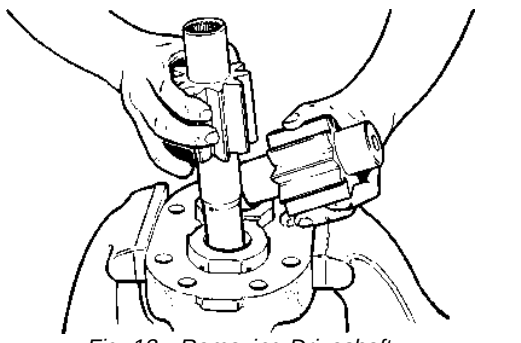


Fig. 13 - Removing Driveshaft

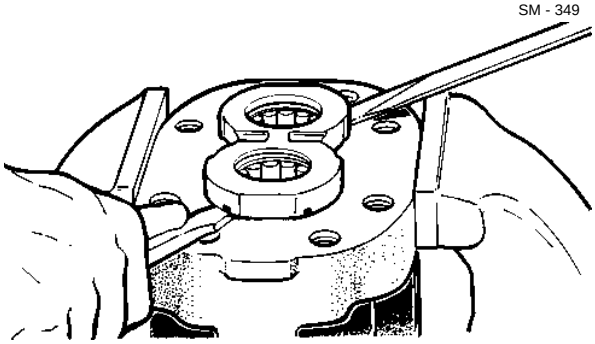


Fig. 14 - Removing Thrust Plate

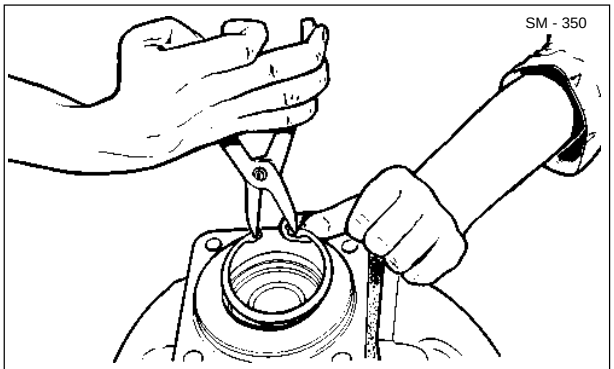


Fig. 15 - Removing Snap Ring

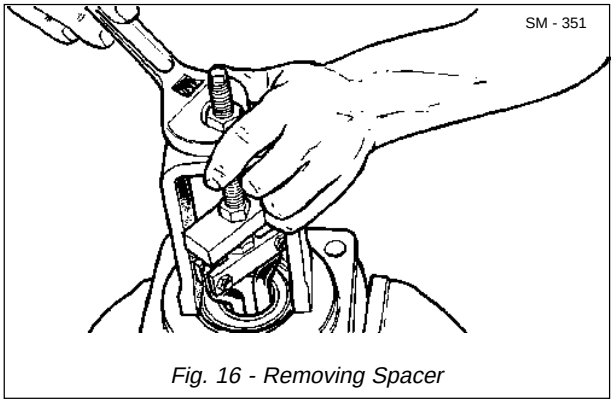


Fig. 16 - Removing Spacer

8. Separate and lift off gear housing (15) with care. See Fig. 12. Remove thrust plate (11) as in Step 4.

9. Mark three meshed gear teeth with a dab of Prussian blue or similar dye and remove the matched driveshaft and gear (12) and driven gear (13) set. See Fig. 13.

10. Pry thrust plate (11) from shaft end cover (6) carefully to avoid distortion. See Fig. 14.

11. Clamp shaft end cover (6) in vice, mounting face up. Remove snap ring (1) with snap ring pliers. See Fig. 15.

12. Pull spacer (2) from shaft end cover (6) with a bearing puller. See Fig. 16.

13. Remove seal retainer (3) and seal (5) from shaft end cover (6). See Fig. 17. The seal retainer removal tool shown in Fig. 37 can be easily made for this purpose. Remove and discard 'O' ring (4).

14. Tap seal (5) from seal retainer (3). See Fig. 18. The tool shown in Fig. 37 can be fashioned to separate these parts.

15. If necessary, remove bearings (9) and ring seals (8) from shaft end cover (6), bearing carrier (18) and

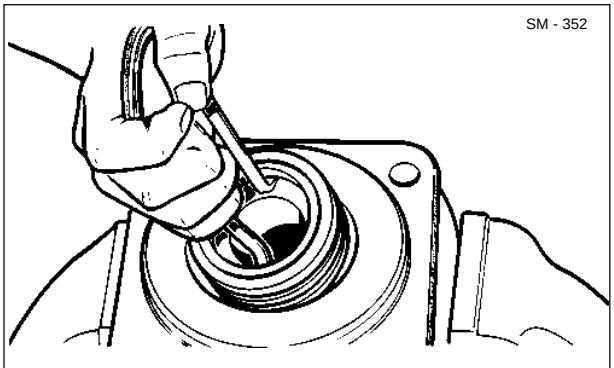


Fig. 17 - Removing Seal Retainer

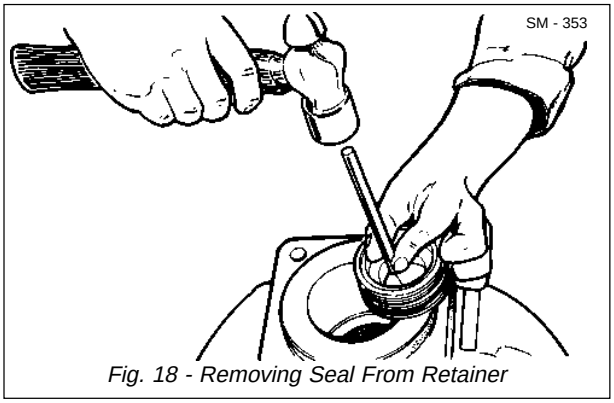


Fig. 18 - Removing Seal From Retainer

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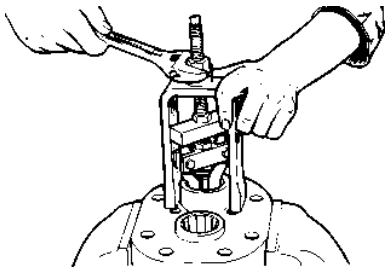


Fig. 19 - Removing Bearings

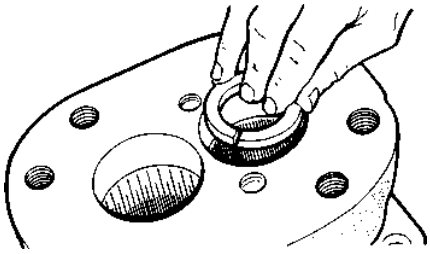


Fig. 20 - Removing and Installing Seals

end cover (23). See Figs. 19 & 20.

16. Remove and discard all seals (30), if used, and pocket seals (10) from thrust plates (11), and seals (14 & 16) from gear housings (15 & 22).

17. Remove plug (7) only if damaged.

18. Remove anti-vibration rings (31) from bearing carrier (18) only if damaged.

INSPECTION

Numbers in parentheses refer to Figs. 1 & 6.

1. Clean all parts in suitable solvent and dry all but bearings with compressed air.

2. Dry bearings with a clean, lint-free cloth.

3. Examine all bearings (9) carefully for scoring, spalling or pitting. Lightly oil the bearings and spin by hand to check for roughness of operation. Replace bearings if necessary.

4. Check ring seals (8) for wear or damage and replace if necessary.

5. Check gear housings (15 & 22) carefully for wear. Hydraulic pressure forces the gears against the low pressure side of the housing. As the bearings and gear hubs wear, the housing gear bores wear. Excessive bore cutout, particularly in a short period, indicates excessive pump loading or dirty oil. Place a straight edge across the cutout area of the gear bore. If a 0.13 mm (0.005 in) feeler gauge can be slipped between the straight edge and the worn area of the gear bore, replace the gear housing.

6. Check gears carefully for wear. Scoring, grooving or burring of the gear teeth OD requires gear replacement. Nicked, grooved or fretted gear tooth mating surfaces also require gear replacement. Any wear of gear hubs in excess of 0.05 mm (0.002 in), or detectable by touch, requires gear replacement. Since both drive and driven gears of a set are matched, both gears must be replaced if one is worn or damaged.

7. Check the centre of thrust plates (11) at the point of meshing of gears (12 & 13) and (20 & 21). Erosion indicates contaminated oil. Pitted thrust plates indicate cavitation or aeration of the oil supply. Discoloured thrust plates are a sign of pump overheating.

Thrust plate side wear permits oil to bypass gears and allows internal oil slippage and reduced pump efficiency. Check thrust plate surface wear against the size of new thrust plates. If worn more than 0.05 mm (0.002 in), replace the thrust plates.

8. Bearings (9) should fit into their bores with a light press fit. A tight hand fit is allowable. If the bearings can fall out of their bores, the bores might be distorted or oversize. When gears are replaced, their bearings must also be replaced.

9. Check driveshaft and gear (12) for wear or damage to splines, and seal areas. Replace the driveshaft and driven gear matched set if wear is detectable by touch or measures in excess of 0.05 mm (0.002 in) at the seal or drive areas. Excessive spline wear requires driveshaft and matching gear replacement.

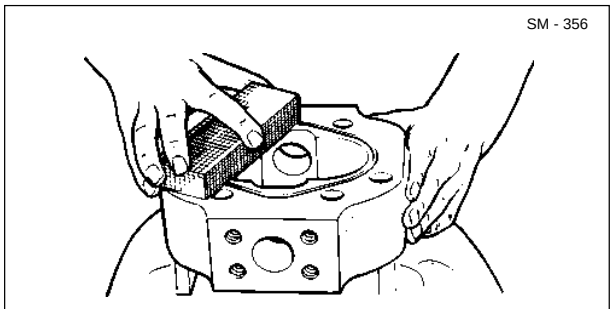


Fig. 21 Cleaning Gear Housing

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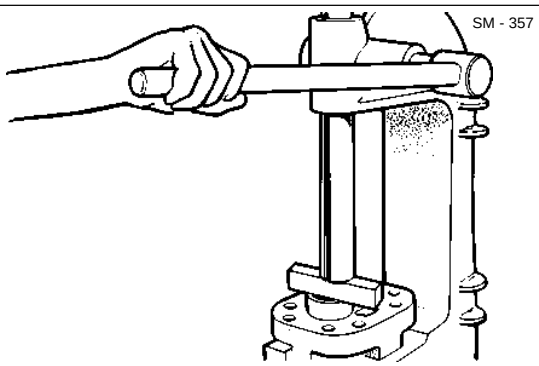


Fig. 22 - Installing Bearings

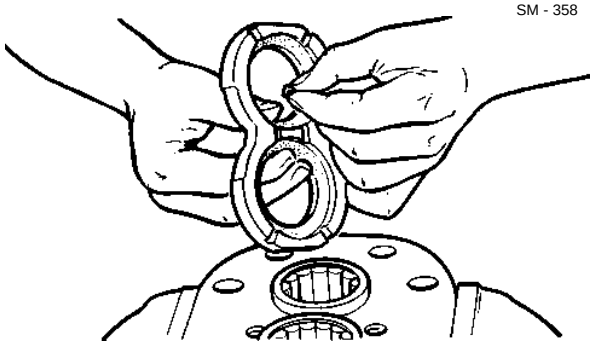


Fig. 23 - Installing Centre Pocket Seals

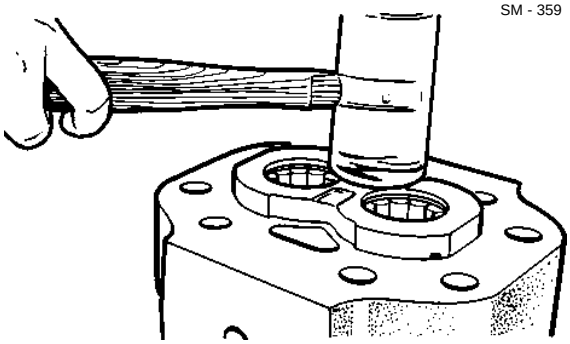


Fig. 24 - Seating Thrust Plate

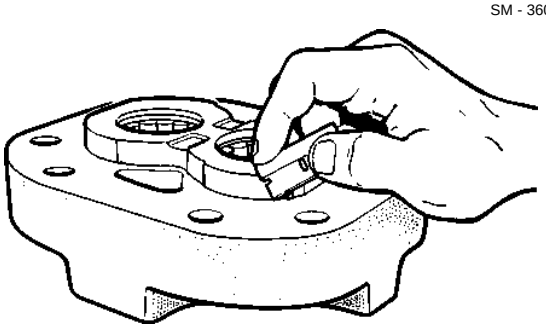


Fig. 25 - Trimming Pocket Seals

10. Smooth all machined surfaces with a medium-grit stone. See Fig. 21. Deburr all bearing bores if required.

11. Clean parts in a suitable solvent and dry with compressed air after smoothing surfaces.

ASSEMBLY

Numbers in parentheses refer to Figs. 1 & 6.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. If removed, install new plug (7) in shaft end cover (6). Be sure to install plug in the outlet side of shaft end cover (6). The unplugged drain hole must be on the inlet side of shaft end cover (6). Turn plug (7) in until one thread of the hole is visible. Secure plug (7) by staking around the hole with a punch.

2. If removed, install ring seals (8) into the bearing bores in shaft end cover (6), bearing carrier (18) and end cover (23). The notch in the ring seal must be visible. See Fig. 20.

3. If removed, press new bearings (9) into the bearing bores of shaft end cover (6), bearing carrier (18) and end cover (23) with an arbor press. See Fig. 22. If removed, install new anti-vibration rings (31) in bearing carrier (18).

4. For each thrust plate (11) using pocket seals (10), cut two pocket seals 9 mm (0.34 in) long from a new seal strip. Coat with grease and insert seals into the centre slots of thrust plates (11). See Fig. 23. Coat new seals (30), if used, with grease and install in remaining thrust plates (11).

5. Place thrust plate (11) over bearings (9) in shaft end cover (6), bearing carrier (18) and end cover (23). With seals facing bearings, tap thrust plate with a soft hammer to about 0.8 mm (0.031 in) from machined surface. See Fig. 24.

6. For each thrust plate (11) using pocket seals (10), cut four pocket seals 11 mm (0.44 in) long from a new seal strip. Insert one pocket seal into each of the outer slots in the thrust plates. Push each seal into the thrust plate slot so that it touches bearing (9). Tap thrust plate (11) down against the machined surface with a soft hammer. Trim the exposed ends of pocket seals (10) square and flush with thrust plate (11) using a razor blade or sharp knife. See Fig. 25.

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7. With shaft end cover (6) clamped in a soft-jawed vice, insert driveshaft and gear (12) into the shaft end cover bore and push down until the gear is snug against thrust plate (11). Install matched driven gear (13) hub into its bearing (9) so that the three teeth marked at 'Disassembly' will mesh. See Fig. 26.

8. Coat new seals (14 & 16) with grease and insert them into their grooves in both sides of gear housings (15 & 22). See Fig. 27.

9. Slide gear housing (15) over gears (12 & 13) and, with match marks made at 'Disassembly' aligned, tap gear housing (15) with a soft hammer until it rests snugly against shaft end cover (6). See Fig. 28. If a new gear housing is used, make sure the large oil port will be toward the inlet, and the small port toward the outlet side of the pump assembly. Be sure seal (14) is not pinched or dislodged. Coat gears (12 & 13) with hydraulic fluid for initial lubrication when the pump is started.

10. With match marks aligned, position bearing carrier (18) on gear housing (15) so that bearings (9) will receive the journals of the drive and driven gears (12 & 13). Tap bearing carrier (18) down tight with a soft hammer. See Fig. 29.

Note: The drain hole plug (19) must be on the inlet side of the pump.

11. Insert connecting shaft (17) into the spline of driveshaft and gear (12). See Fig. 30.

12. Insert the matched set of drive and driven gears (20 & 21) into their respective bores of bearings (9) in bearing carrier (18) so that the three teeth marked at 'Disassembly' will mesh. See Fig. 31. Push the gears down tightly against thrust plate (11).

13. Slide gear housing (22) over gears (20 & 21) and, with match marks made at 'Disassembly' aligned, tap

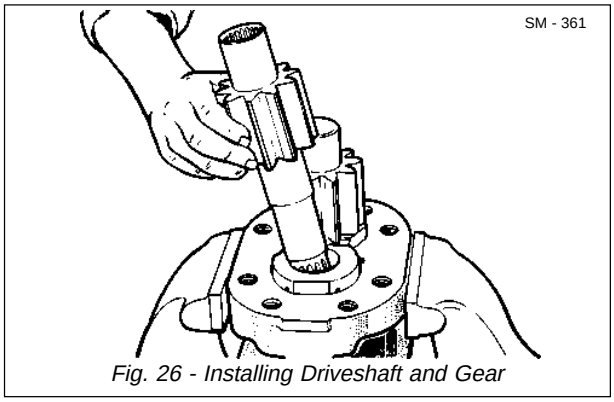


Fig. 26 - Installing Driveshaft and Gear

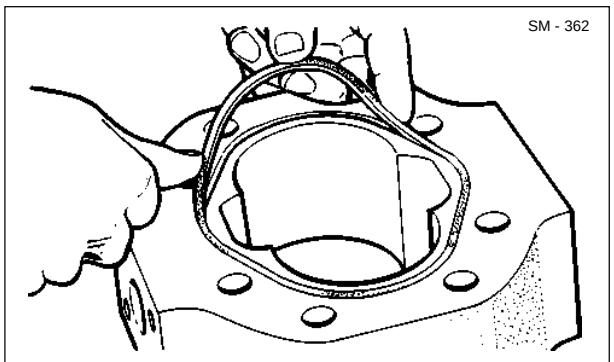


Fig. 27 - Installing Seals

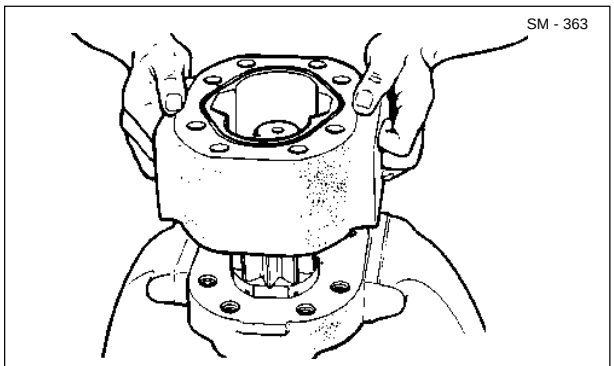


Fig. 28 - Installing Gear Housing

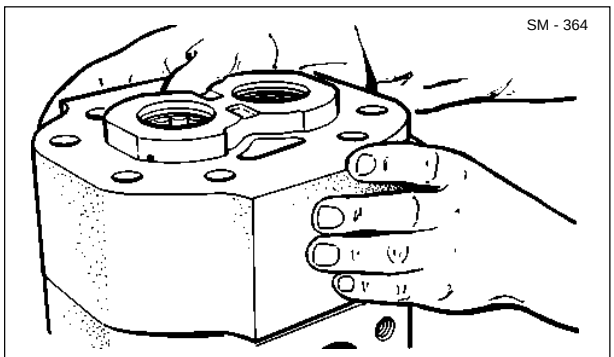


Fig. 29 - Installing Bearing Carrier

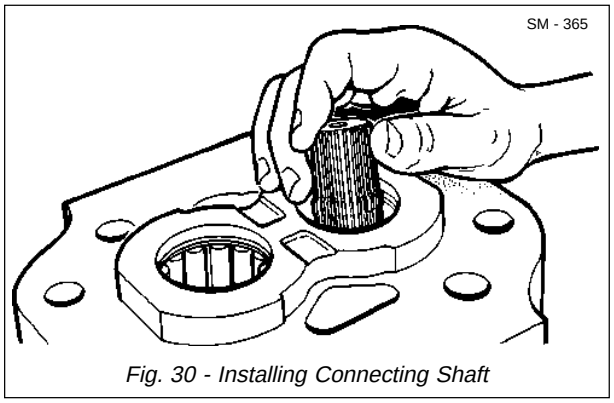


Fig. 30 - Installing Connecting Shaft

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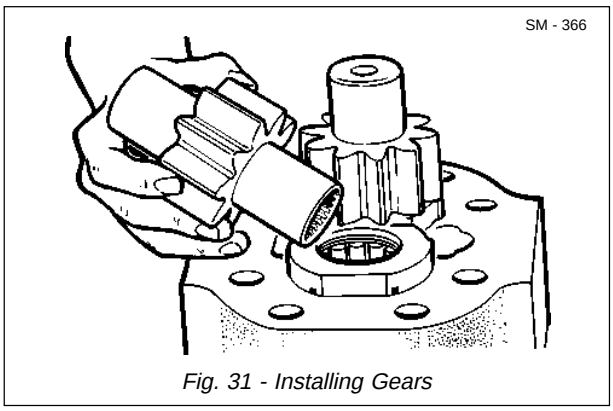


Fig. 31 - Installing Gears

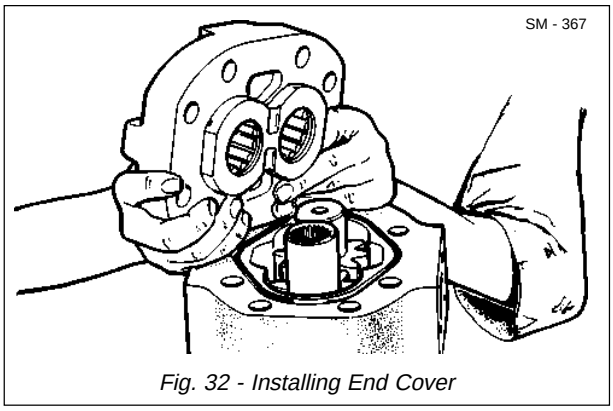


Fig. 32 - Installing End Cover

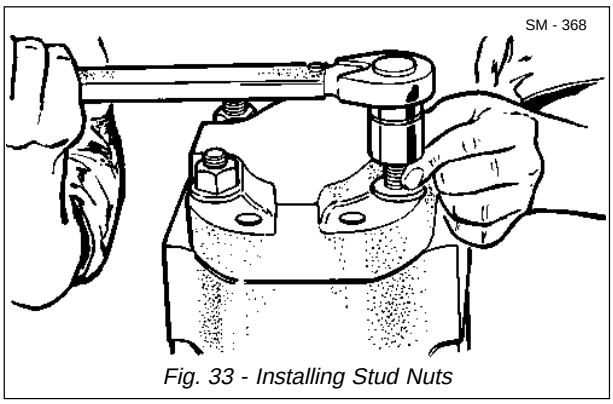


Fig. 33 - Installing Stud Nuts

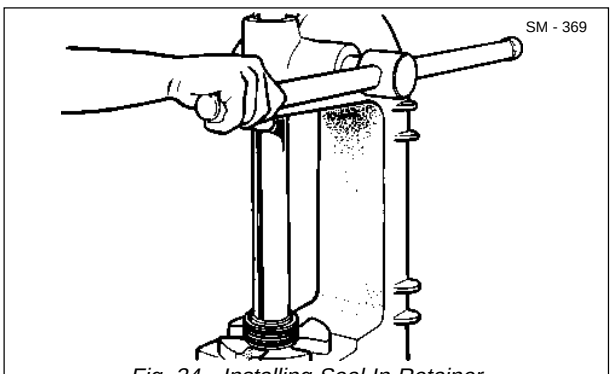


Fig. 34 - Installing Seal In Retainer

gear housing (22) with a soft hammer until it rests snugly against bearing carrier (18). Refer to Fig. 28. If a new housing is used, make sure the large oil port will be toward the inlet, and the small port toward the outlet side of the pump assembly. Be sure seal (14) is not pinched or dislodged. Coat gears (20 & 21) with hydraulic fluid for initial lubrication when pump is started.

14. With match marks aligned, position end cover (23) over gear (20 & 21) journals. Tap end cover (23) lightly with a soft hammer to seat on gear housing (22). See Fig. 32. Be careful not to pinch seal (16).

15. Insert eight studs (27) through the pump assembly and thread into shaft end cover (6). Install washers (26) and nuts (28). Tighten opposite nuts alternately until snug. See Fig. 33. Rotate driveshaft (12) with a 150 mm (6 in) wrench and check carefully for pump binding. If the pump rotates freely, torque tighten alternate nuts (28) to 271 Nm (200 lbf ft). If the pump binds, the cause should be determined and corrected before completing the assembly. Check for burrs on shafts, housings, bearings, etc., or similar causes.

16. Coat the OD of seal (5) with Loctite Seal retainer or equivalent. Press seal (5), metal side down, into seal retainer (3) on an arbor press using a 70 mm (2.75 in) diameter bar. See Fig. 34. Be careful not to damage the lip of seal (5).

17. Clamp pump assembly in a soft-jawed vice, driveshaft (12) up.

18. Coat a new 'O' ring (4) with grease and install on seal retainer (3). Oil a seal installation sleeve and twist into the seal ID carefully. Slide the sleeve and seal over driveshaft (12) and seat seal (5) and seal retainer (3) assembly firmly in shaft end cover (6) bore. Remove seal installation sleeve. See Fig. 35.

19. Insert spacer (2) over driveshaft (12) and install

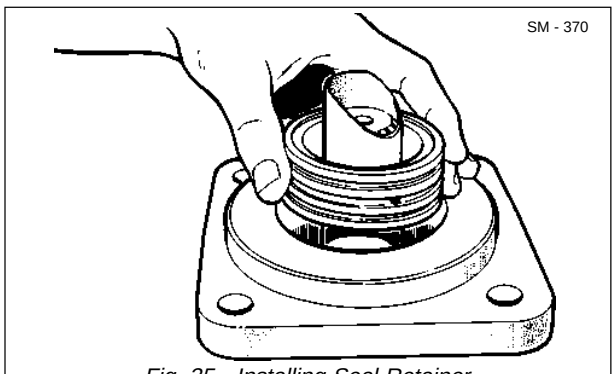


Fig. 35 - Installing Seal Retainer

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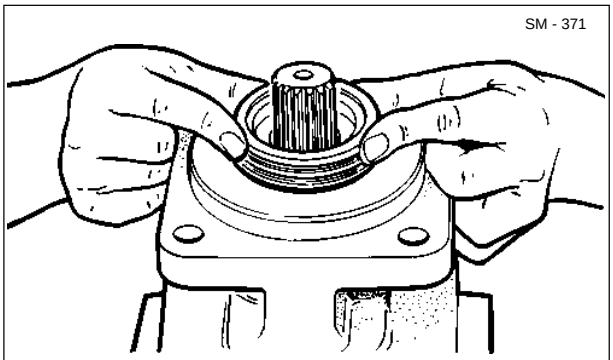


Fig. 36 - Installing Spacer In Retainer

into shaft end cover (6) against seal retainer (3). See Fig. 36.

20. Install snap ring (1) in shaft end cover (6) snap ring groove.

INSTALLATION AND RUN-IN

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNING
To prevent personal injury and property damage, make sure blocking or lifting equipment is of adequate capacity and properly secured to do the job safely.

1. Coat the pump driveshaft spline with high grade plating-type molybdenum disulphide grease 15% minimum (typical).

2. With suitable lifting equipment position pump on mounting studs. Secure with lockwashers and nuts.

3. Fill all pump ports with clean hydraulic oil and connect lines to pump, as tagged during 'Removal.

4. Fill body and disc brake cooling tank to the proper level. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK. Refer to Section 300-0020, LUBRICATION SYSTEM, for correct oil specifications.

5. Operate the pump at least two minutes at zero pressure at engine idle speed. During this break-in period, it should run free and not develop excessive heat. If the pump becomes hot to touch, it is binding and might seize. The pump will then have to be rebuilt with extra care to avoid binding. If the pump runs properly, speed and pressure can be increased to normal operating values.

6. Check pump mounting and line connections for leaks.

LUBRICATION

All pump parts are lubricated by the hydraulic oil. The oil, therefore, must be kept clean to minimize pump wear. Whenever there is a hydraulic system failure, the oil should be drained, the entire system flushed, oil filters replaced, oil screens thoroughly cleaned and fresh hydraulic oil installed to eliminate all metal particles or foreign matter.

Refer to Section 300-0020, LUBRICATION SYSTEM, for recommended periodic oil drain periods and oil specifications.

SPECIAL TOOLS

The special tools shown in use in Figs. 17 & 18 can be fabricated as shown in Fig. 37.

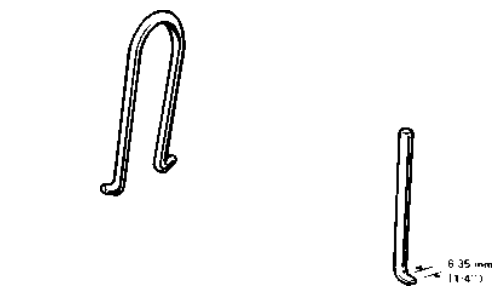


Fig. 37 - Special Tools

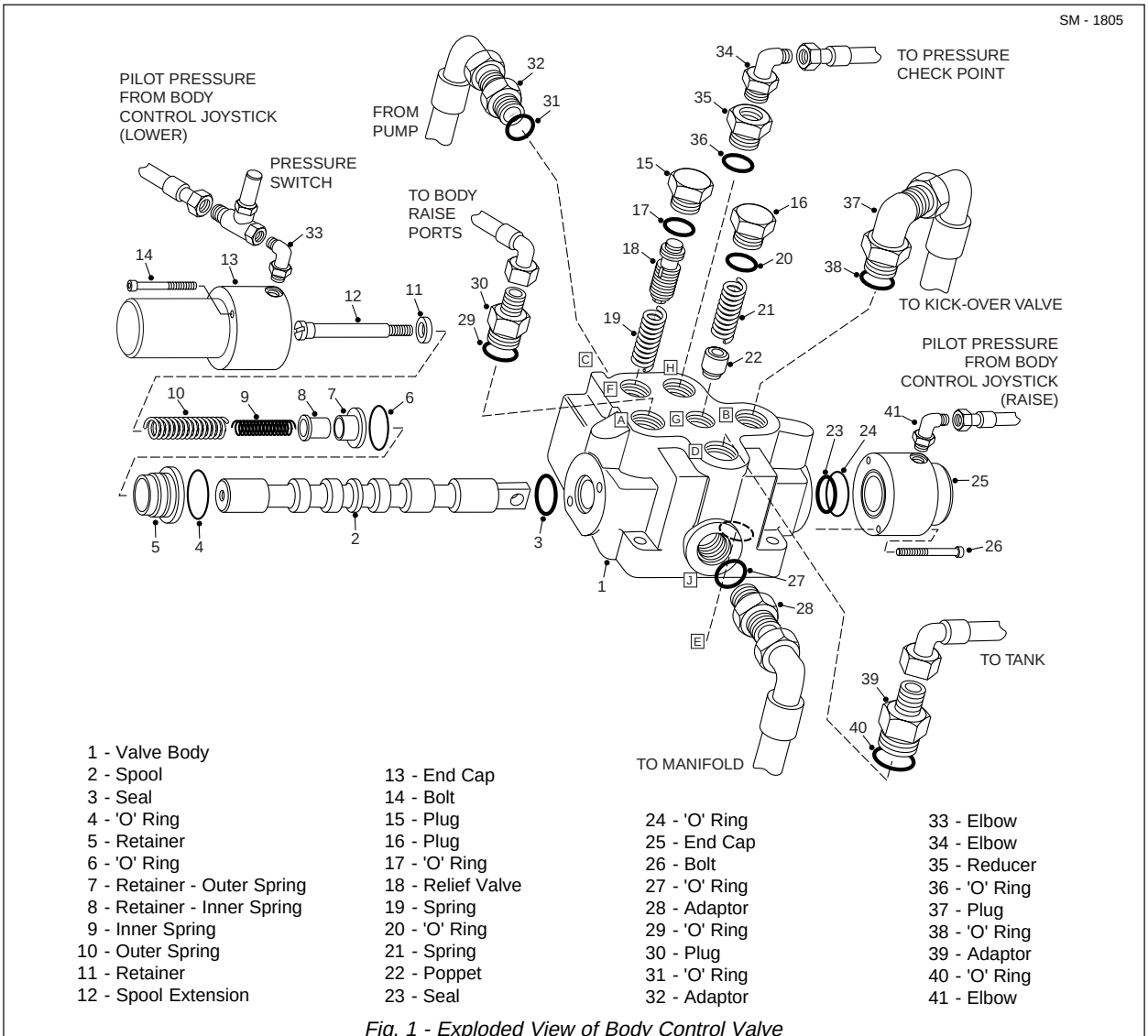
SPECIAL TORQUE SPECIFICATIONS TABLE047

FIG. NO.	ITEM NO.	NAME	TORQUE	
			Nm	lbf ft
1 & 6	28	Nut	271	200

* * * *

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1 - Valve Body
2 - Spool
3 - Seal
4 - 'O' Ring
5 - Retainer
6 - 'O' Ring
7 - Retainer - Outer Spring
8 - Retainer - Inner Spring
9 - Inner Spring
10 - Outer Spring
11 - Retainer
12 - Spool Extension
13 - End Cap
14 - Bolt
15 - Plug
16 - Plug
17 - 'O' Ring
18 - Relief Valve
19 - Spring
20 - 'O' Ring
21 - Spring
22 - Poppet
23 - Seal
24 - 'O' Ring
25 - End Cap
26 - Bolt
27 - 'O' Ring
28 - Adaptor
29 - 'O' Ring
30 - Plug
31 - 'O' Ring
32 - Adaptor
33 - Elbow
34 - Elbow
35 - Reducer
36 - 'O' Ring
37 - Plug
38 - 'O' Ring
39 - Adaptor
40 - 'O' Ring
41 - Elbow

Fig. 1 - Exploded View of Body Control Valve

DESCRIPTION

Numbers letters in parentheses refer to Fig. 1.

The body control valve can be identified as item 3, and the OCDB manifold block as item 4, in Section 230-0000, BODY SYSTEM SCHEMATIC.

Mounted off the left hand frame rail to the rear of the horse collar, the body control valve is used to direct hydraulic oil to the body hoist cylinders for raising or lowering the body, and, depending on spool (2) position, is directed through the OCDB manifold block to supplement the OCDB cooling oil.

Hydraulic oil is pumped to the body control valve from the front section of the tandem gear pump mounted on the engine power takeoff.

Integral of body control valve body (1) is a four position spool (2) and relief valve (18) assembly. The four positions of control spool (1) are; 'Raise', 'Hold', 'Float' and 'Lower' (power down). Spool (2) is detented in the 'Hold' position and contains an inner and outer spring (9 & 10) which returns spool (2) from the 'Raise' to 'Hold' position. The control lever should be kept in the 'Float' position at all times, except when raising or lowering the body.

Movement of spool (2) is by hydraulic pressure from the pilot accumulator valve connected to the body control joystick at the left hand side of the drivers' seat. Refer to Section 230-0081, BODY CONTROL JOYSTICK.

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Body System - Body Control Valve

Section 230-0060

Relief valve (18) assembly, installed in port 'F', opens and allows oil to flow back to the body and disc brake cooling tank when pressure in the hydraulic system exceeds 190 bar (2 750 lbf/in^2).

The system relief pressure is taken from port 'H' and can be checked at the diagnostic test point on the rear left hand cab support.

The port identifications are as follows:
Port 'A' - Body cylinder 'Raise' circuit
Port 'B' - Body cylinder 'Lower' circuit
Port 'C' - Inlet supply from tandem pump
Port 'D' - Return to Tank
Port 'E' - Blanked off
Port 'F' - Pressure relief valve assembly
Port 'G' - Check valve assembly
Port 'H' - System pressure check port
Port 'J' - Supply to OCDB manifold block & HPCO

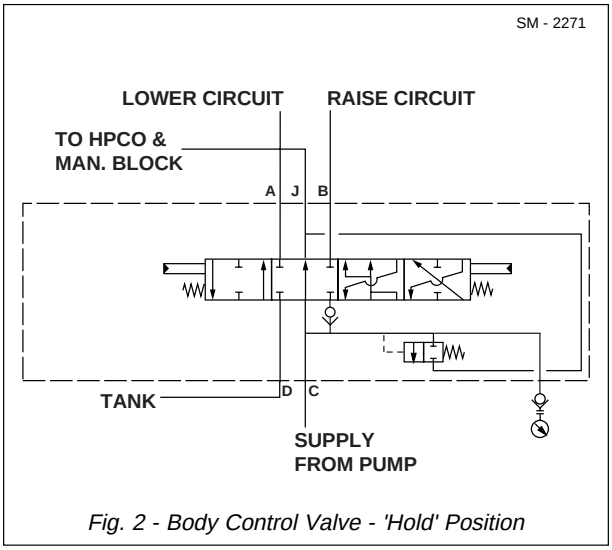


Fig. 2 - Body Control Valve - 'Hold' Position

OPERATION

Body 'Hold' Position

Numbers and letters in parentheses refer to Fig. 1. Refer to Fig. 2 for hydraulic schematic of the body control valve operating in the 'Hold' position.

With the hydraulic control joystick and spool (2) in the 'Hold' position, oil enters control valve body (1) at port 'C', flows through the valve and exits at port 'J' to the OCDB manifold block. The oil flow is directed through the OCDB manifold block to supplement the OCDB cooling oil.

Spool (2) blocks the flow of oil to and from the body hoist cylinders, holding the cylinder pistons in place.

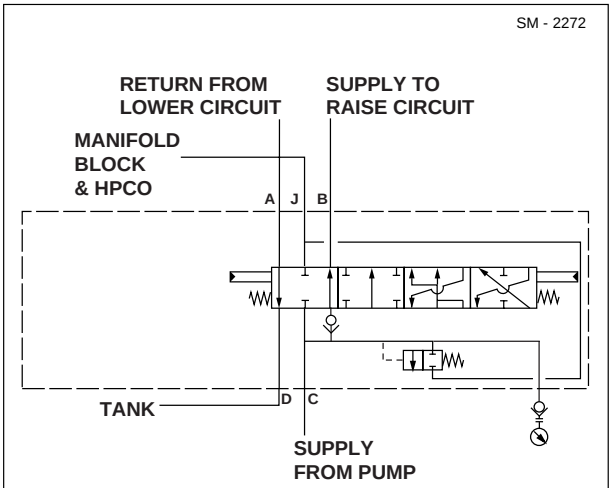


Fig. 3 - Body Control Valve - 'Raise' Position

Body 'Raise' Position

Numbers and letters in parentheses refer to Fig. 1. Refer to Fig. 3 for hydraulic schematic of the body control valve operating in the 'Raise' position.

Moving the hydraulic control joystick to the 'Raise' position moves spool (2) position within valve body (1). Hydraulic oil enters control valve body (1) at port 'C'. Oil pressure opens poppet (22) and oil flows through the passage opened by spool (2) and exits at port 'B' to the 'Raise' ports on the body hoist cylinders.

Return oil from the body hoist cylinders enters control valve body (1) at port 'A', via the kick-over valve, flows through the passage opened by spool (2) and exits at port 'D' to the body and disc brake cooling tank. Refer

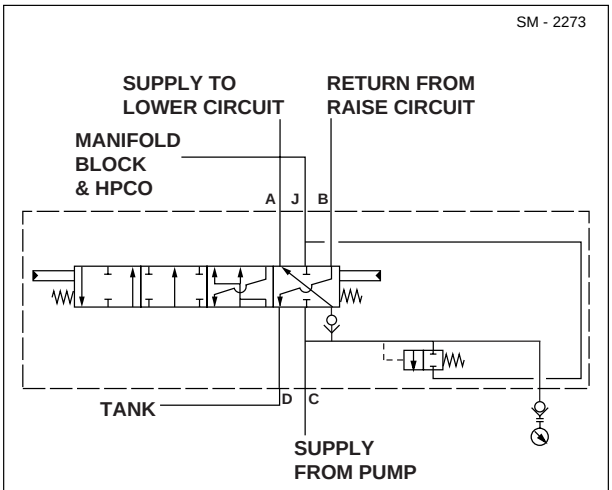


Fig. 4 - Body Control Valve - 'Lower' Position

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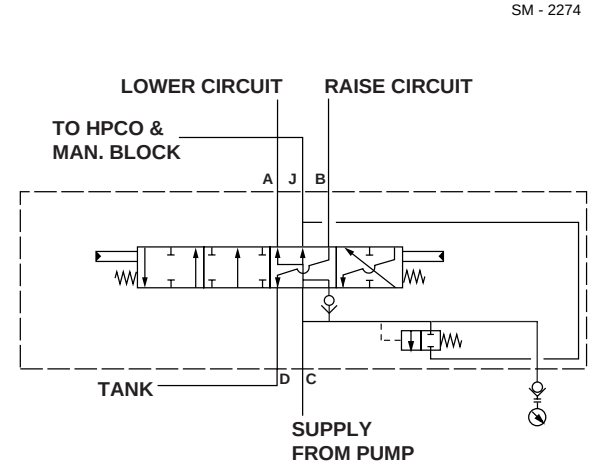


Fig. 5 - Body Control Valve - 'Float' Position

to Section 230-0090, KICK-OVER VALVE, for oil flow through the kick-over valve.

Body 'Lower' (Power Down) Position

Numbers and letters in parentheses refer to Fig. 1. Refer to Fig. 4 for hydraulic schematic of the body control valve operating in the 'Lower' position.

Moving the hydraulic control joystick to the 'LOWER' position moves spool (2) position within valve body (1). Hydraulic oil enters control valve body (1) at port 'C'. Oil pressure opens poppet (22) and oil flows through the passage opened by spool (2) and exits at port 'A' to the kick-over valve.

Oil travels through the kick-over valve, to the 'Lower' ports on the body hoist cylinders. Refer to Section 230-0090, KICK-OVER VALVE, for oil flow through the kick-over valve.

Return oil from the body hoist cylinders enters control valve body at port 'B', flows through the passage opened by spool (2) and exits at port 'D' to the body and disc brake cooling tank.

Body 'Float' Position

Numbers and letters in parentheses refer to Fig. 1. Refer to Fig. 5 for hydraulic schematic of the body control valve operating in the 'Float' position.

Note: The control joystick should be kept in the 'Float' position at all times, except when raising or lowering the body.

Moving the hydraulic control joystick to the 'Float' position, moves the spool to a position within valve body (1) which allows the body to lower by its own weight.

Hydraulic oil enters control valve body (1) at port 'C'. Oil which is not required to replenish the oil in the hoist cylinders, as the body is lowered, passes through valve body (1) and exits at port 'J' to the OCDB manifold block. The oil flow is directed through the OCDB manifold block to supplement the OCDB cooling oil.

Oil forced out of the hoist cylinders as the body lowers, enters control valve body (1) at port 'B', flows through the passage opened by spool (2) and exits at port 'D' to the body and disc brake cooling tank. Make-up oil flows around spool (2) and exits at port 'A' to replenish oil in the hoist cylinders as the body lowers.

Relief Valve

Numbers and letters in parentheses refer to Fig. 1.

Relief valve (18) assembly, in port 'F' of valve body (1), is set to relieve oil pressure in excess of 190 bar (2 750 lbf/in^2). Should oil pressure at inlet port 'C' exceed 190 bar (2 750 lbf/in^2), relief valve (18) will open and oil will flow through an internal passage in valve body (1) and exit at port 'J' to the OCDB manifold block. When excess oil pressure is relieved, relief valve (18) will re-seat allowing normal oil flow through the body control valve.

REMOVAL

Numbers in parentheses refer to Fig. 6, unless otherwise specified.

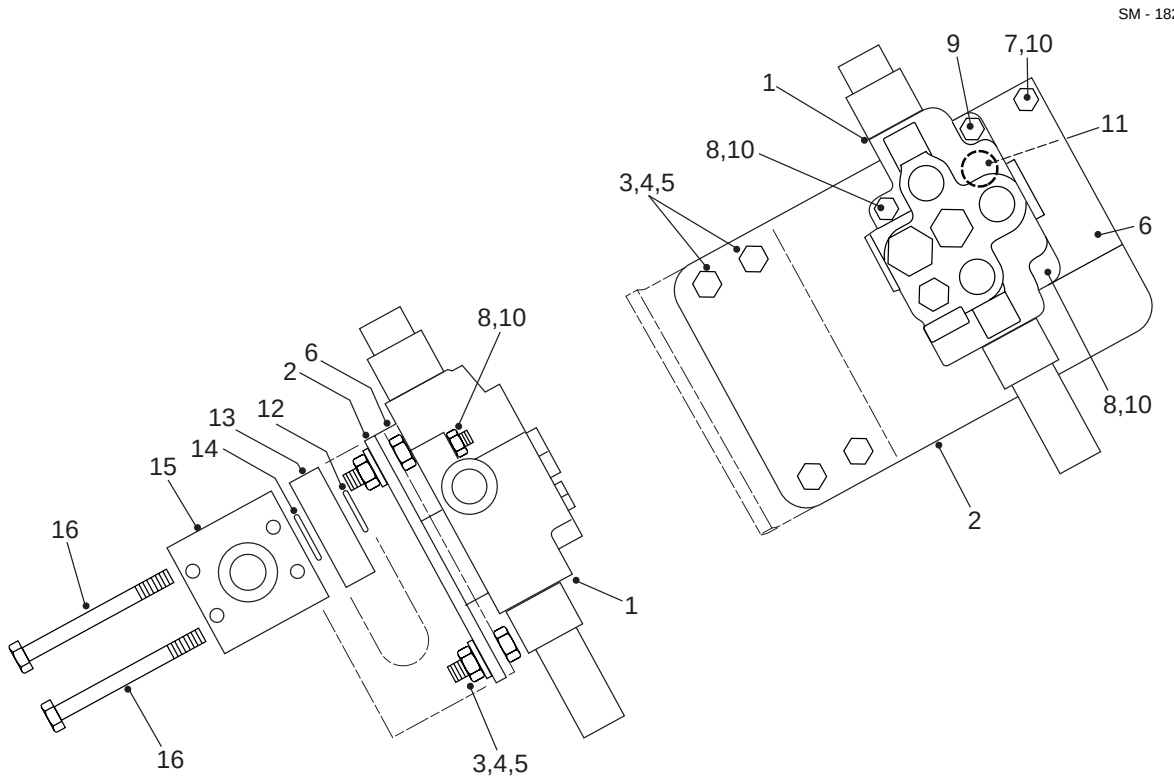
⚠ WARNING
Hydraulic fluid pressure will remain within the system after engine shut down. Operate the body control joystick in both directions approximately 15 times to ensure the pressure has dissipated from the pilot supply valve accumulator before carrying out any work on the body control system or serious injury could result.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

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Body System - Body Control Valve

Section 230-0060



1 - Body Control Valve	5 - Nut	9 - Bolt	13 - Block
2 - Mounting Plate	6 - Block	10 - Nut	14 - 'O' Ring
3 - Bolt	7 - Bolt	11 - 'O' Ring	15 - Manifold Block
4 - Hardened Washer	8 - Bolt	12 - 'O' Ring	16 - Bolt

Fig. 6 - Body Control Valve and OCDB Manifold Block Installation

1. Position the vehicle in a level work place, raise the body and secure in place with the body safety pins. Apply the parking brake, switch off the engine.

2. Operate steering left and right several times to discharge the steering accumulator. Block all road wheels.

3. Remove drain plug from body and disc brake cooling tank and drain oil into a suitable container. Reinstall drain plug in the tank and secure.

4. Clean body control valve (1) and surrounding area with a suitable solvent. Identify and tag all hydraulic lines connected to body control valve (1) and manifold block (15), to aid in 'Installation'.

5. With suitable containers available to catch spillage, disconnect all hydraulic lines from body control valve (1) and manifold block (15). Cap all hydraulic lines and ports to prevent ingress of dirt.

6. Support body control valve (1), mounting plate (2), blocks (6 & 13) and manifold block (15) assembly with a suitable lifting device and remove nuts (5), bolts (3) and hardened washers (4). Remove assembly from mounting bracket and move clear of the vehicle.

7. Remove bolts (16) securing manifold block (15) and block (12) to block (6). Remove manifold block (15) and block (12). Discard 'O' rings (12 & 14).

8. Remove bolts (7 & 8) and nuts (10) securing body control valve (1) and block (6) to mounting plate (2). Remove mounting plate (2).

9. Remove bolt (9) securing block (6) to body control valve (1). Remove block (6).

10. Remove and discard 'O' ring (11) from body control valve (1).

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DISASSEMBLY

Numbers and letters in parentheses refer to Fig. 1.

> **WARNING**
> **Spring loaded parts. Use care when removing end cap, retainers and plugs to prevent sudden release of spring tension behind these parts. Personal injury or property damage could result if care is not taken.**

Note: Clean entire control valve assembly with a suitable solvent and dry thoroughly prior to disassembly.

Relief Valve

1. Carefully remove plug (15) and 'O' ring (17) from port 'F' in valve body (1). Discard 'O' ring (17).

2. Remove relief valve (18) and spring (19) from port 'F' in valve body (1).

Check Valve

1. Carefully remove plug (16) and 'O' ring (20) from port 'G' in valve body (1). Discard 'O' ring (20).

2. Remove spring (21) and poppet (22) from port 'G' in valve body (1).

Valve Spool

1. Carefully remove bolts (14) and end cap (13) from valve body (1). If required, remove elbow (33) from end cap (13).

2. Unscrew spool extension (12) and remove retainer (11), outer spring (10) and inner spring (9) from valve spool (2).

3. Carefully remove inner and outer spring retainers (8 &7) from valve spool (2).

4. Carefully remove 'O' ring (6), retainer (5) and 'O' ring (4) from valve spool (2). Discard 'O' rings (4 & 6).

5. Remove spool (2) and seal (3) from valve body (1). Discard 'O' rings (4 & 6).

6. Remove bolts (26), end cap (25), seal (23) and 'O' ring (24) from valve body (1). Discard 'O' ring (24). If required, remove elbow (41) from end cap (25).

Valve Body

1. If required, remove adaptor (28) and 'O' ring (27) from port 'J' in valve body (1). Discard 'O' ring (27).

2. If required, remove elbow (34), reducer (35) and 'O' ring (36) from port 'H' in valve body (1). Discard 'O' ring (36).

3. If required, remove adaptors (30 & 39) and elbow (37) from ports 'D', 'B' and 'A' respectively. Discard all 'O' rings.

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Wash all parts thoroughly in a suitable solvent and dry with compressed air.

2. Inspect valve body (1) bores and spool (2) for grooves, deep scratches or excessive wear. Ensure that spool (2) fits its respective valve body bore with a slight hand pressure and without perceptible side clearance.

Note: If condition of valve body (1) bores or spool (2) indicates that they require to be replaced, the body control valve should be replaced as an assembly.

3. Inspect check valve poppet (22) for grooves or defects which may cause leakage. Replace poppet (22) if it appears to be damaged. Small nicks and grooves can be removed from poppet (22) seat by using a fine grain grinding compound and lapping seat.

4. Replace relief valve (18) assembly if defective.

Note: If a new check valve poppet (22) or relief valve (18) is used, the respective seat should be lapped to conform to the new part.

ASSEMBLY

Numbers and letters in parentheses refer to Fig. 1.

Note: Lubricate all components with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM, prior to assembly.

Valve Body

1. If removed, install new 'O' rings on adaptors (30 & 39) and elbow (37) and secure in ports 'D', 'B' and 'A' of valve body (1) respectively.

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2. If removed, install new 'O' ring on elbow (34) and secure in reducer (35). Install new 'O' ring (36) on reducer (35) and secure adaptor assembly in port 'H' of valve body (1).

3. If removed, install new 'O' ring (27) on adaptor (28) and secure in port 'J' of valve body (1).

Valve Spool

1. Install new 'O' ring (24) and seal (23) in valve body (1). Position end cap (25) on valve body (1) and secure with bolts (26). Tighten bolts (26) to a torque of 14 - 20 Nm (10 - 15 lbf ft). If removed, install elbow (41) in end cap (25).

2. Install seal (3) and 'O' ring (4) over the eye end of spool (2) and install in valve body (1).

3. Assemble retainer (5), 'O' ring (6), outer spring retainer (7), inner spring retainer (8), inner spring (9), outer spring (10) and retainer (11) and install in valve body (1) as an assembly.

4. Install spool extension (12) and tighten to a torque of 14 - 20 Nm (10 - 15 lbf ft).

5. Position end cap (13) on valve body (1) and secure with bolts (14). Tighten bolts (14) to a torque of 14 - 20 Nm (10 - 15 lbf ft). If removed, install elbow (33) in end cap (13).

Check Valve

1. Install poppet (22) and spring (21) in port 'G' of valve body (1).

2. Install new 'O' ring (20) on plug (16) and secure in port 'G' of valve body (1). Tighten plug (16) to a torque of 81 - 100 Nm (60 - 70 lbf ft).

Relief Valve

1. Install spring (19) and relief valve (18) in port 'F' of valve body (1).

2. Install new 'O' ring (17) on plug (15) and secure in port 'F' of valve body (1).

INSTALLATION

Numbers in parentheses refer to Fig. 6, unless otherwise specified.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

> **⚠ WARNING**
> **To prevent personal injury and property damage, make sure lifting equipment is of adequate capacity and properly secured to do the job safely.**

1. Install new 'O' ring (11) in groove of port 'E' in valve body (1, Fig. 1).

2. Position body control valve (1) on block (6) and install bolt (9). Do not fully tighten bolt (9) at this stage.

3. Position body control valve (1) and block (6) assembly on mounting plate (2) and secure with bolts (7 & 8) and nuts (10). Tighten bolts (7, 8 & 9) securely. Turn assembly over.

Note: Install bolt (8) from mounting plate (10) end of the assembly.

4. Install new 'O' ring (12) in block (13) and new 'O' ring (14) in manifold block (15). Secure block (13) assembly and manifold block (15) assembly to plate (6) with bolts (16).

5. Using suitable lifting equipment, position body control valve (1), mounting plate (2), blocks (6 & 13) and manifold block (15) assembly to mounting bracket on the frame.

Note: Mounting plate (2) is positioned below mounting bracket on the frame.

6. Secure mounting plate (2) assembly to frame mounting bracket with bolts (3), hardened washers (4) and nuts (5).

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7. Reconnect hoses, as identified at removal, to elbows (33 & 41, Fig. 1).

8. Remove all blanking caps from hydraulic lines and install all hydraulic lines to body control valve (1, Fig. 1) and manifold block (15), as tagged at 'Removal'.

Note: Be sure to use new 'O' rings where used.

9. Fill body and disc brake cooling tank with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK for fill level procedure.

10. Start the engine, remove body safety pins and operate the body. Check body control valve (1, Fig. 1), manifold block (15) and hydraulic lines for leaks. Correct as required.

11. Check body control valve for correct operation in all four positions.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

Note: Limited repair of the body control valve is by replacement of parts only.

Relief Valve Pressure Check

Relief valve (18) pressure should be checked at the interval specified in Section 300-0020, LUBRICATION SYSTEM, as follows:

a. Connect a hydraulic gauge capable of reading 0 - 207 bar (0 - 3 000 lbf/in^2) to remote diagnostic pressure point on the rear left hand cab support.

b. Start the engine and raise the body completely.

c. Increase engine speed to maximum rev/min and check gauge reading. Pressure gauge should read 190 bar (2 750 lbf/in^2).

d. If pressure reading is incorrect, relief valve (18) and spring (19) should be replaced and pressure checked again.

e. Remove pressure gauge from remote diagnostic pressure point.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	3	Plug	81 - 100	60 - 70
1	20	Spool Extension	14 - 20	10 - 15
1	22	Bolt	14 - 20	10 - 15

* * * *

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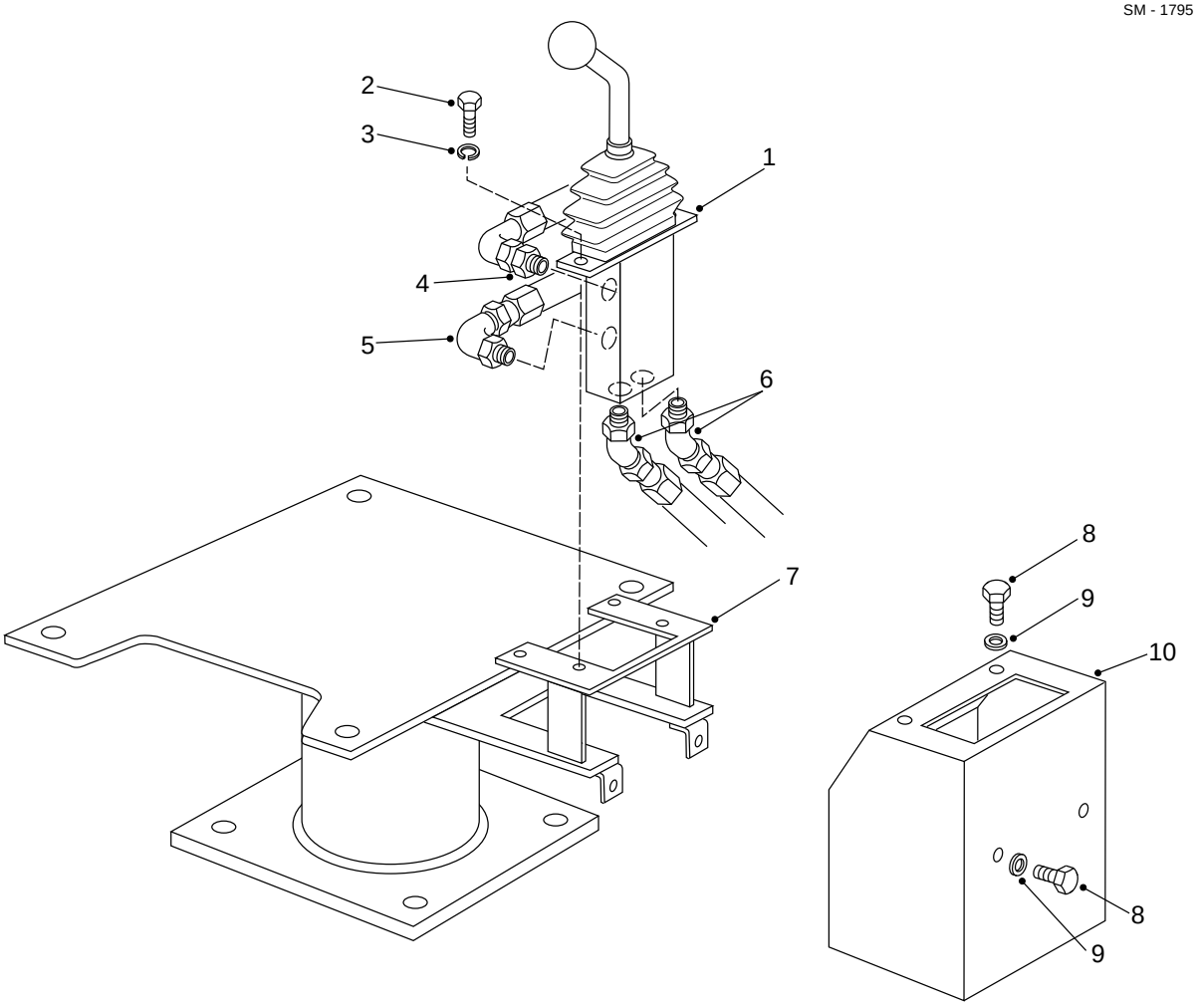
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1 - Body Control Joystick
2 - Bolt
3 - Lockwasher
4 - Connector
5 - Elbow
6 - Elbow
7 - Mounting Bracket
8 - Screw
9 - Lockwasher
10 - Cover Plate

Fig 1. - Body Control Joystick Installation

DESCRIPTION

The body control joystick can be identified as item 9 in Section 230-0000, BODY SYSTEM SCHEMATIC.

Mounted on the left hand side of the operator's seat, the body control joystick is located in the hydraulic body circuit between the body control valve and the pilot accumulator valve. See Fig. 2 for schematic symbol.

OPERATION

The body control joystick controls the hydraulic valve which operates the body hoist cylinders. The four

SM - 1798

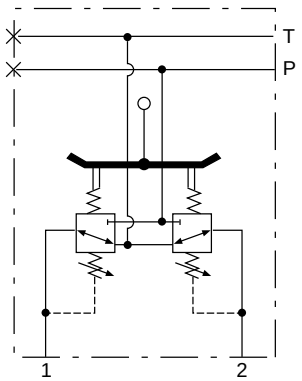


Fig. 2 - Body Control Joystick Schematic Symbol

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operating positions of the joystick from front to rear are as follows:

'LOWER' - This position provides hydraulic force to power-down the body. It is needed when the body cannot be started downward from the fully raised position by gravity. When the body starts lowering by gravity, the joystick should be moved to the 'FLOAT' position.

'FLOAT' - The joystick should be moved to this position while the body is lowering by gravity and should remain in this position until the body must be operated again. The control joystick should always be kept in 'FLOAT' while the machine is in motion.

'HOLD' - Moving the joystick to this position while the body is being raised or lowered traps the oil in the body hoists to stop and hold the body at any desired height. The joystick will remain in the detented 'HOLD' position when released.

'RAISE' - This position directs oil to extend the body hoists and raise the body. When released, the joystick will be spring-returned to the 'HOLD' position.

REMOVAL AND INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNINGS

Hydraulic fluid pressure will remain within the system after engine shut down. Operate the body control joystick in both directions approximately 15 times to ensure the pressure has dissipated from the pilot supply valve accumulator before carrying out any work on the body control system or serious injury could result.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Operate the body control joystick (1) continuously to discharge the pilot valve accumulator. Block all road wheels.

3. Remove screws (8) and lockwashers (9) securing cover plate (10) to mounting bracket (7) on the operator's seat. Remove cover plate (10).

4. Ensure all hydraulic lines connected to body control joystick (1) are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines.

5. Remove bolts (2) and lockwashers (3) securing body control joystick (1) to mounting bracket (7). Remove body control joystick (1).

6. Note location of elbows (5 & 6) and connector (4) and remove from body control joystick (1) for use on the new joystick.

7. Install elbows (5 & 6) and connector (4) in new body control joystick (1) ports as removed from the old joystick.

8. Secure body control joystick (1) to mounting bracket (7) on the operator's seat with bolts (2) and lockwashers (3).

9. Remove blanking caps from hydraulic lines and install lines to body control joystick (1) as identified during removal.

10. Check oil level in the body and disc brake cooling tank and add oil if required. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK for correct fill level, and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

11. Remove wheel blocks, start the engine and bring hydraulic oil to operating temperature. Operate body control joystick (1) and check hydraulic line connections for leaks and tighten as required.

MAINTENANCE

Limited repair of the body control joystick is by replacement of parts only. Refer to vehicle Parts Book for part numbers of kits.

SPECIAL TOOLS

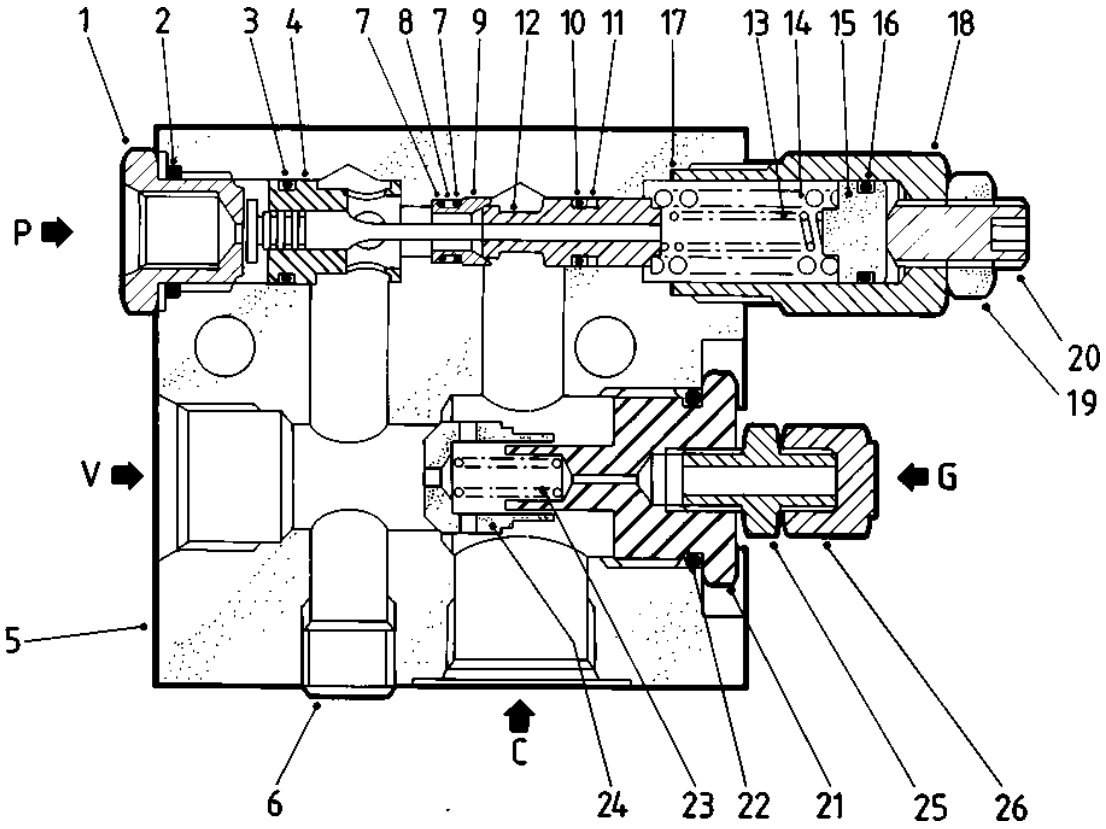
There are no special tools required for procedures outlined in this section. Refer to Section 300-0020, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

* * * *

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SM - 585



1 - Plug
2 - 'O' Ring
3 - 'O' Ring
4 - Pin Assembly
5 - Valve Body
6 - Plug
7 - Backup Rings
8 - 'O' Ring
9 - Spool Seat
10 - 'O' Ring
11 - Backup Ring
12 - Relief Spool
13 - Spring
14 - Spring
15 - Spring End
16 - 'O' Ring
17 - Gasket
18 - Plug
19 - Nut
20 - Screw
21 - Guide
22 - 'O' Ring
23 - Spring
24 - Poppet
25 - Connector
26 - Cap

Fig. 1 - Sectional View of Kick-over Valve

DESCRIPTION

The Kick-over Valve can be identified as item 6 in Section 230-0000, BODY SYSTEM SCHEMATIC.

The kick-over valve, mounted off a bracket at the rear of the transmission, is installed in the hydraulic system to prevent the body from pulling a void in the cylinders when dumping unbalanced loads. The kick-over valve also provides a means of return oil from the body lower circuit to return, through the body control valve, to the body and disc brake cooling tank.

OPERATION

Numbers in parentheses refer to Fig. 1.

Refer to Fig. 2. As the body is raised, return oil from the body cylinders enters port 'C'. A pilot line connected to port 'P' and the body raise lines, supplies pilot pressure which causes pin assembly (4) to raise relief spool (12) off its seat. As long as oil pressure in the raise lines remains at 10 bar (150 lbf/in^2) or more, relief spool (12) remains off its seat and return oil is free to pass around relief spool (12), through a passage in the kick-over valve, to exit at port 'V', and return to tank via the body control valve.

If the pressure required to raise the body becomes less than 10 bar (150 lbf/in^2), which would indicate the body is running ahead of the pump, springs (13 & 14) seat relief spool (12) and return oil is blocked, preventing body runaway. When the pressure within the kick-over valve reaches 172 bar (2 500 lbf/in^2) relief spool (12) is again raised off its

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Body System - Kick-over Valve

Section 230-0090

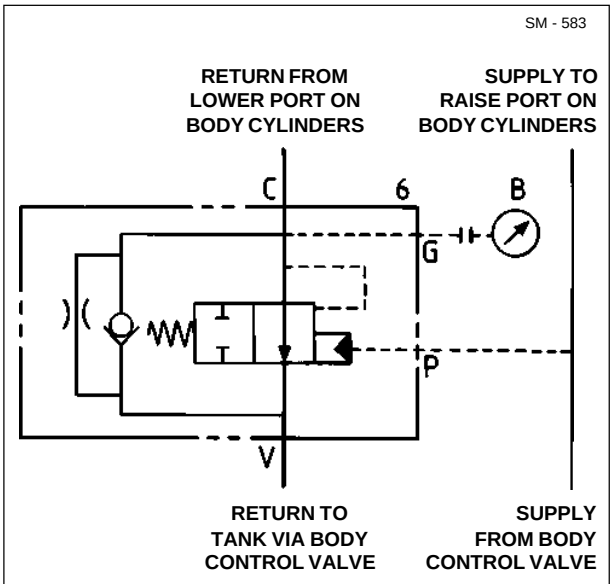


Fig. 2 - Kick-over Valve Operating in Body 'Raise' Position

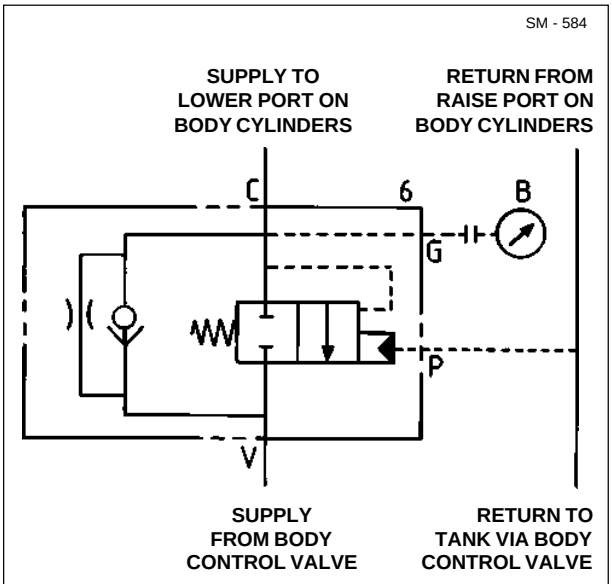


Fig. 3 - Kick-over Valve Operating in Body 'Lower' Position

seat, due to oil travelling through internal porting, and return oil is free to pass around relief spool (12), through a passage in the kick-over valve, to exit at port 'V', and return to tank via the body control valve.

Refer to Fig. 3. When the body control valve is used to lower the body, oil is directed to port 'V' of the kick-over valve. Oil pressure forces poppet (24) off its seat, oil exits at port 'C', and flows to the body cylinders to power down the body. Return oil from the raise port on the body cylinders returns to tank via the body control valve.

Note: A second safety relief valve, set at 207 bar (3 000 lbf/in^2), is incorporated in the hydraulic lines between the kick-over valve and the lower ports on the body cylinders. This relief valve can be identified as item 12 in Section 230-0000, BODY SYSTEM SCHEMATIC.

REMOVAL

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Make sure body is completely lowered, or, raise body and secure in place with the body safety pins. Apply the parking brake, switch off the engine and block all road wheels.

2. Clean kick-over valve housing with a suitable solvent and tag hydraulic lines to aid in 'Installation'.

3. Disconnect all hydraulic lines from kick-over valve and drain oil into a suitable container. Cap all lines and plug kick-over valve ports to prevent ingress of dirt.

4. Remove mounting hardware securing kick-over valve to mounting bracket. Move kick-over valve to a clean work area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Fig 1.

1. Remove plug (1) from valve body (5). Remove and discard 'O' ring (2) from plug (1). Remove pin assembly (4) from valve body (5). Remove and discard 'O' ring (3) from pin assembly (4).

2. Remove plug (6) from valve body (5).

3. Remove guide (21) assembly from valve body (5). Remove 'O' ring (22) and spring (23) from guide (21). Discard 'O' ring (22). Remove poppet (24) from valve body (5). If required, remove connector (25) and cap (26) from guide (21).

4. Remove screw (20) and nut (19) from plug (18).

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5. Remove plug (18) from valve body (5).

6. Remove gasket (17), spring end (15), 'O' ring (16), springs (13 & 14), relief spool (12), backup ring (11) and 'O' ring (10) from plug (18). Remove spool seat (9), backup rings (7) and 'O' ring (8) from valve body (5). Discard backup rings (7 & 11) and 'O' rings (8, 10 & 16).

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Clean all metal parts thoroughly in suitable solvent and dry with compressed air. Inspect valve body (5) bores, plugs (1, 6, 18 & 25), guide (21) and relief spool (12) for grooves, deep scratches or excessive wear.

2. Inspect poppet (24) for grooves or defects which may cause leakage. If poppet (24) appears to be faulty, replace with a new one.

3. Inspect all parts for ridges, nicks, burrs or scoring which may cause leakage. Replace parts if worn or damaged.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Install new 'O' ring (8), and new backup rings (7) on spool seat (9). Install spool seat in valve body (5). Install new 'O' ring (10) and new backup ring (11) on relief spool (12). Install relief spool (12) assembly in valve body (5).

2. Install new 'O' ring (16) on spring end (15) and install in plug (18). Install springs (13 & 14) in plug (18) and install plug (18) in valve body (5).

3. Install nut (19) and screw (20) in plug (18).

4. Install poppet (24) in valve body (5). Install spring (23) and new 'O' ring (22) in guide (21). Align with poppet (24) and install guide (21) assembly in valve body (5). If removed, install connector (25) and cap (26) in guide (21).

5. Install plug (6) in valve body (5).

6. Install new 'O' ring (3) on pin assembly (4) and install in valve body (5). Install new 'O' ring (2) on plug (1) and install into valve body (5).

ADJUSTMENT

Numbers in parentheses refer to Fig. 1.

1. Install kick-over valve onto a test bench.

2. Remove cap (26) from connector (25) in port 'G' of valve body (5) and install a 0 - 207 bar (0 - 3 000 lbf/in²) pressure gauge.

3. Install a suitable return to tank line at port 'V'.

4. Slacken nut (19) and set kick-over pressure by supplying oil to port 'C', at 1.26 litres/s (20 GPM), and adjusting screw (20) until pressure at port 'C' is 172 bar (2 500 lbf/in²). Lock nut (19) and re-check pressure setting.

5. Turn off hydraulic oil supply and bleed off pressure from hydraulic lines. Remove hydraulic oil lines from kick-over valve.

> ⚠ **WARNING**
> **Make sure pressure in the testing circuit has dissipated before removing any lines or personal injury could occur.**

6. Remove pressure gauge from gauge port and install plug (25). Remove kick-over valve from test bench and set aside for 'Installation'.

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Position spacer, if used, and kick-over valve on mounting bracket and secure with mounting hardware.

2. Connect hydraulic lines as marked at 'Removal'.

3. Raise body and check kick-over valve and hydraulic lines for leaks.

4. Remove cap (26) and install a pressure gauge in port 'G'. Check kick-over pressure is 172 bar (2 500 lbf/in²), at maximum rev/min, and with body

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cylinder extending through second stage and pilot line removed.

5. Remove pressure gauge from port 'G' and install cap (26) on connector (25).

6. Check the level of oil in the body and disc brake cooling tank. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK. Add oil if low. Use oils meeting specifications outlined in Section 300-0020, LUBRICATION SYSTEM.

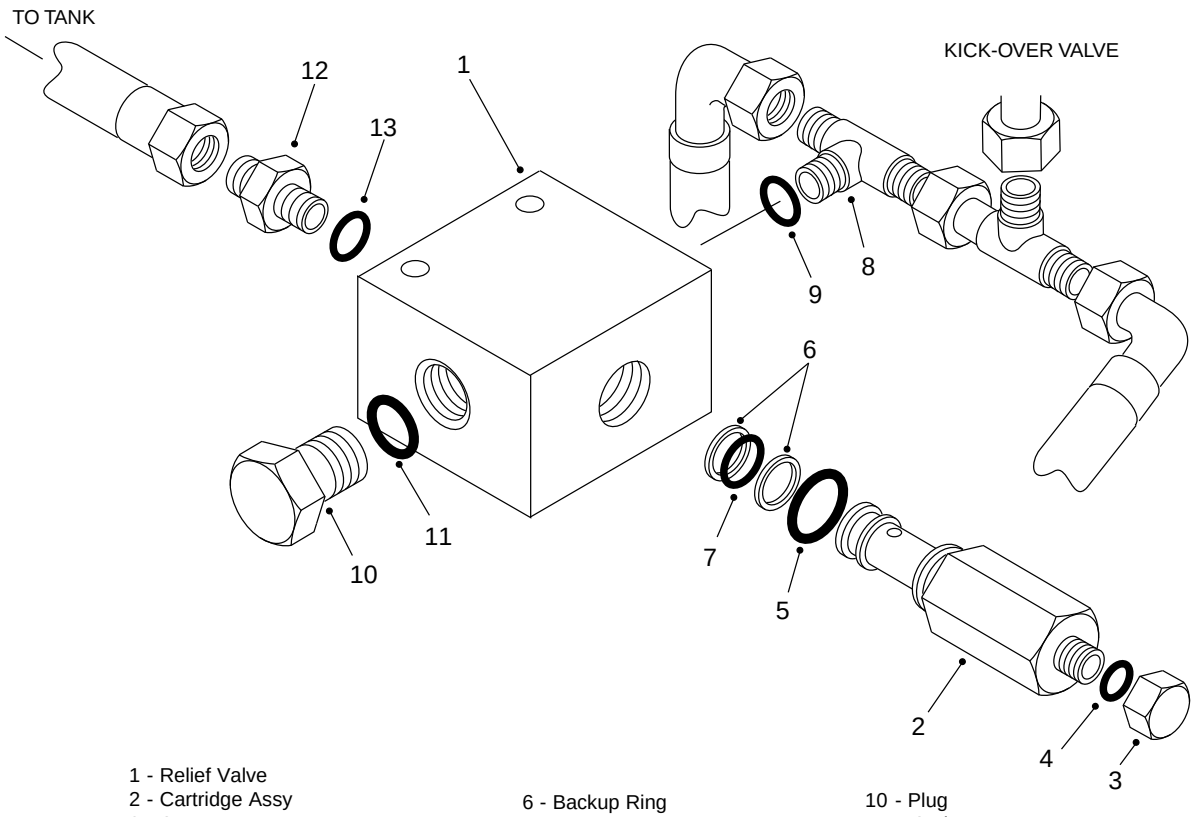
MAINTENANCE

Inspect the kick-over valve regularly for any signs of leaks or damage. When carrying out pressure checks on the truck, check kick-over pressure as described in 'Installation'.

* * * *

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1 - Relief Valve
2 - Cartridge Assy
3 - Cap
4 - 'O' ring
5 - 'O' ring
6 - Backup Ring
7 - 'O' ring
8 - Tee Piece
9 - 'O' ring
10 - Plug
11 - 'O' ring
12 - Adaptor
13 - 'O' ring

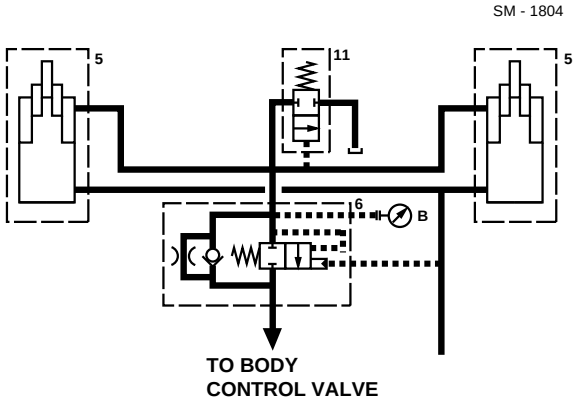
Fig 1. - Relief Valve Installation

DESCRIPTION

The relief valve can be identified as item 11 in Section 230-0000, BODY SYSTEM SCHEMATIC.

Mounted off the kick-over valve at the rear of the transmission, the relief valve is located in the hydraulic body circuit between the body cylinders and the kick-over valve (See Fig. 2).

The relief valve (safety valve) is installed in the hydraulic lines between the kick-over valve and the lower ports on the body cylinders. Should pressure in these lines exceed 207 bar (3 000 lbf/in²) the valve will open and excess oil will return to the body and disc brake cooling tank.



5 - Body Cylinders 6 - Kick-over Valve 11- Relief Valve

Fig. 2 - Relief Valve Schematic Symbol

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Body System - Relief Valve

Section 230-0120

REMOVAL

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.**

1. Raise body and secure in place with the body safety pins. Apply the parking brake, switch off the engine and block all road wheels.

2. Clean relief valve housing with a suitable solvent and tag hydraulic lines to aid in 'Installation'.

3. Support relief valve and disconnect all hydraulic lines and drain oil into a suitable container. Cap all lines and plug relief valve ports to prevent ingress of dirt.

4. Move relief valve to a clean work area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Fig 1.

1. Remove plug (10) from valve body (1). Remove and discard 'O' ring (11) from plug (10).

2. Remove tee piece (8) from valve body (1). Remove and discard 'O' ring (9) from tee piece (8).

3. Remove adaptor (12) from valve body (1). Remove and discard 'O' ring (13) from adaptor (12).

4. Remove cartridge assembly (2) from valve body (1). Remove 'O' rings (5 & 7) and backup rings (6) from cartridge assembly (2). Discard 'O' rings (5 &7). If required, remove cap (3) and 'O' ring (4) from cartridge assembly (2).

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Clean all metal parts thoroughly in suitable solvent and dry with compressed air. Inspect valve body (1) bores, plug (10), adaptor (12) and cartridge assembly (2) for grooves, deep scratches or excessive wear.

2. Inspect all parts for ridges, nicks, burrs or scoring which may cause leakage. Replace parts if worn or damaged.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Install new 'O' rings (5 &7), new backup rings (6) on cartridge assembly (2). If removed, install new 'O' ring (4) and cap (3) on cartridge assembly (2).

2. Install cartridge assembly (2) in valve body (1).

3. Install new 'O' ring (13) on adaptor (12). Install adaptor (12) in valve body (1).

4. Install new 'O' ring (9) on tee piece (8).Install tee piece (8) in valve body (1).

5. Install new 'O' ring (11) on plug (10).Install plug (10) in valve body (1).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Position relief valve and connect hydraulic lines as marked at 'Removal'.

2. Remove body safety pins, operate body and check relief valve and hydraulic lines for leaks.

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3. Remove cap (3) and install a pressure gauge in port. Check kick-over pressure is 172 bar (2 500 lbf/in²), at maximum rev/min, and with body cylinder extending through second stage and pilot line removed.

4. Remove pressure gauge from port and install cap (3) on cartridge assembly (2).

5. Check the level of oil in the body and disc brake cooling tank. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK. Add oil if low. Use oils meeting specifications outlined in Section 300-0020, LUBRICATION SYSTEM.

MAINTENANCE

Inspect the relief valve regularly for any signs of leaks or damage. When carrying out pressure checks on the truck, check relief pressure as described in 'Installation'.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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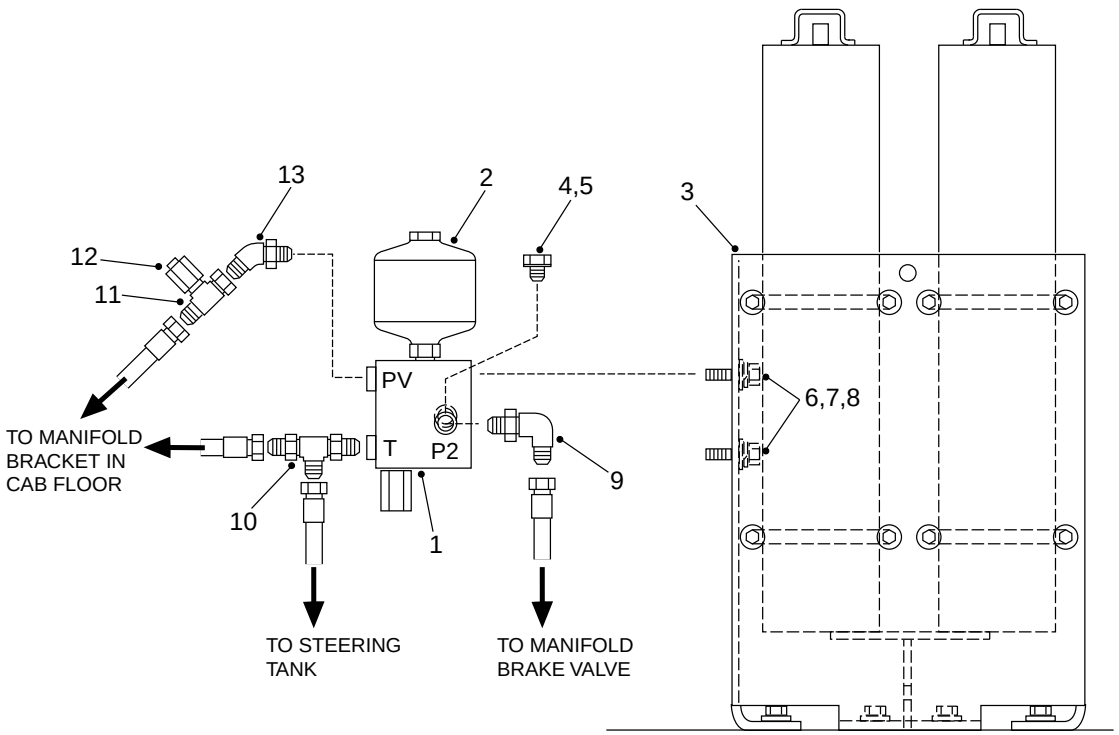
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SM - 1799



1 - Valve Body
2 - Accumulator
3 - Mounting Bracket
4 - Plug
5 - Seal
6 - Bolt
7 - Lockwasher
8 - Washer
9 - Elbow - 90°
10 - Tee Piece
11 - Diagnostic Fitting
12 - Cap
13 - Elbow - 45°

Fig 1. - Pilot Supply Valve Installation

DESCRIPTION

The pilot supply valve can be identified as item 14 in Section 230-0000, BODY SYSTEM SCHEMATIC.

Mounted off the accumulator mounting bracket on the right hand platform, the pilot supply valve is located in the hydraulic lines between the steering pump and the body control joystick. See Fig. 2 for schematic symbol.

Intregal of the pilot supply valve is a restriction valve which steps down the supply pressure of 159 bar (2 300 lbf/in²) from the steering pump to between 30 bar (435 lbf/in²) and 35 bar (500 lbf/in²). The pilot supply valve is fitted with an accumulator, pre-charged with nitrogen, to a pressure of 13 bar (188 lbf/in²).

SM - 1800

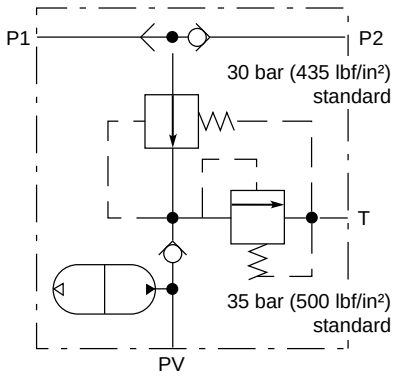


Fig. 2 - Pilot Supply Valve Schematic Symbol

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Body System - Pilot Supply Valve

Section 230-0121

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

The pilot supply valve is a non-serviceable item and should be replaced completely, if damaged, as follows:

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNINGS
Hydraulic fluid pressure will remain within the system after engine shut down. Operate the body control joystick in both directions approximately 15 times to ensure the pressure has dissipated from the pilot supply valve accumulator before carrying out any work on the body control system or serious injury could result.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, be sure the body is fully lowered, apply the parking brake and switch off the engine.

2. Operate the body control joystick continuously to discharge the pilot supply valve accumulator. Block all road wheels.

3. Ensure all hydraulic lines connected to pilot supply valve (1) are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines.

4. Remove bolts (6), lockwashers (7), washers (8) and pilot supply valve (1) from mounting bracket (3).

5. Note location of elbows (9 & 13) and tee piece (10) and remove from pilot supply valve (1) for use on the new valve. If necessary, disconnect diagnostic fitting (11) and cap (12) from elbow (13).

6. Install elbows (9 & 13) and tee piece (10) in new pilot supply valve (1) ports as removed from the old valve. If necessary, install diagnostic fitting (11) and cap (12) to elbow (13).

7. Secure pilot supply valve (1) to mounting bracket (3) with bolts (6), washers (8) and lockwashers (7).

8. Remove blanking caps from hydraulic lines and install lines to pilot supply valve (1) as identified during removal.

9. Check oil level in the body and disc brake cooling tank and add oil if required. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK for correct fill level, and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

10. Remove wheel blocks, start the engine and bring hydraulic oil to operating temperature.

11. Operate body control joystick (1) and check hydraulic line connections for leaks and tighten as required.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0020, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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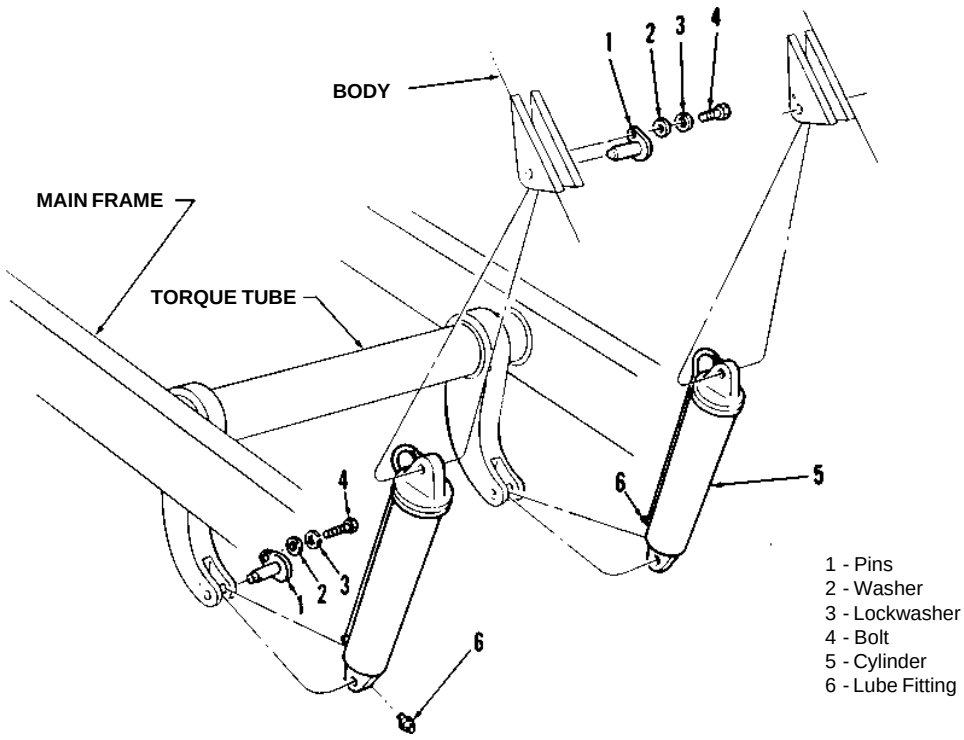


Fig. 1 - Exploded View of Body Cylinder Mounting

DESCRIPTION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

The body cylinders can be identified as item 5 in Section 230-0000, BODY SYSTEM SCHEMATIC.

There are two body hoist cylinders mounted between the frame rails. Cylinder base ends (3, Fig. 2) are connected to the body and retractable ends (26, Fig. 2) are connected to the frame. The cylinders are two-stage with power down in the second stage. Cylinder mounting is by pins (1) secured by washers (2), lockwashers (3) and bolts (4).

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Raise body and install body prop pins at rear of unit. Apply the parking brake, shut off the engine and chock all road wheels.

2. Install a suitable strap around the cylinder and attach to a lifting device.

3. Position oil pan beneath cylinder (5). Place body control valve lever in 'Float' position. Identify and remove the hydraulic lines. Cap lines to keep out dirt.

4. Remove bolt (4), lockwasher (3), washer (2) and upper pin (1) from cylinder (5) connecting it to the body.

5. Collapse the cylinder. Wire cylinder to prevent it from extending during removal.

6. Remove bolt (4), lockwasher (3), washer (2) and pin (1) from lower end of cylinder.

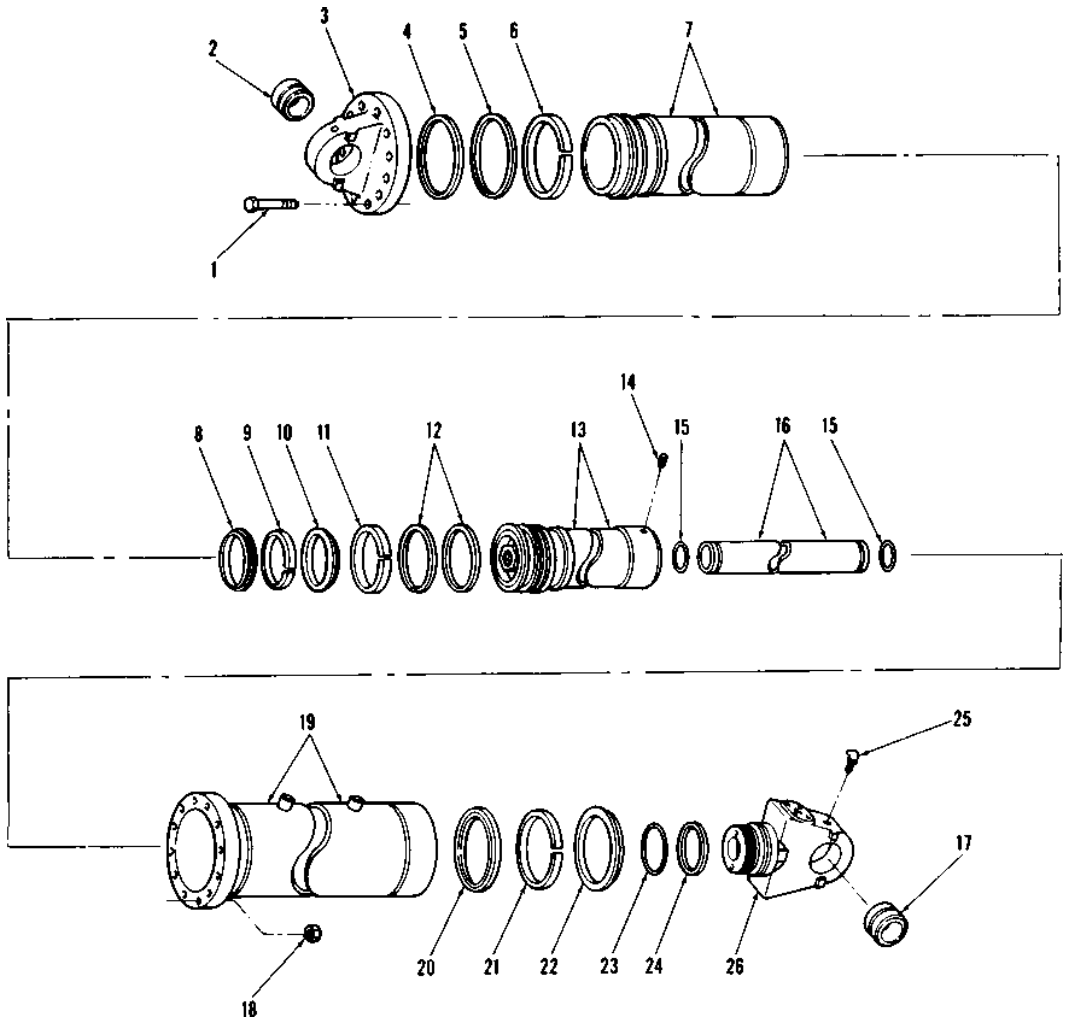
7. Remove cylinder to a clean area for 'Disassembly'.

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Body System - Body Cylinder

Section 230-0130



1 - Bolt	8 - Seal	15 - Seal	21 - Wear Ring
2 - Bushing	9 - Wear Ring	16 - Tube	22 - Wiper
3 - Base	10 - Wiper	17 - Bushing	23 - 'O' Ring
4 - Backup Ring	11 - Wear Ring	18 - Nut	24 - Backup Ring
5 - 'O' Ring	12 - Piston Ring	19 - Tube	25 - Fitting
6 - Wear Ring	13 - Tube	20 - Seal	26 - End
7 - Tube	14 - Set Screw		

Fig. 2 - Exploded View of Body Cylinder

DISASSEMBLY

Numbers in parentheses refer to Fig. 2.

⚠ WARNING
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Remove bolts (1) and nuts (18) securing base (3) to cylinder tube (19). Remove base.

2. Remove and discard backup ring (4) and 'O' ring (5) from base (3).

3. Extend end (26) assembly about 150 mm (6 in) and remove set screw (14).

4. Unscrew end (26) and remove.

5. Remove and discard 'O' ring (23) and backup ring (24) from end (26).

6. Push inner tube (7) from outer tube (19) and

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remove. Remove wear ring (6) from tube (7).

7. Remove and discard wiper (10), wear ring (9) and seal (8) from tube (7).

8. Push tube (13) from outer tube (19) and remove. Remove wear ring (11) and piston rings (12) from tube (13). Discard piston rings.

9. Remove tube (16) from tube (13). Remove and discard seals (15) from tube (19).

10. Remove and discard seal (20), wear ring (21) and wiper (22) from tube (16).

11. Press bushings (2 & 17) from base (3) and end (26), respectively, if bushings show signs of excessive wear.

12. Remove grease fitting (25) from end (26), if damaged.

INSPECTION

1. Wash all parts thoroughly in a suitable solvent and dry with clean, lint-free cloths. Clean all grooves carefully to remove any foreign material.

2. Blow out the passages in the tubes and piston rod with compressed air to remove any foreign material.

3. Inspect the tubes, for broken welds or deep grooves. Shine a light through components to inspect for damage.

4. Remove ridges, nicks and scratches with a fine stone and clean. Replace any components which cannot be repaired.

5. Inspect all bolts and nuts for thread damage and replace as necessary.

6. Inspect bushings and wear rings for excessive wear, and replace as necessary.

7. Replace all seals, 'O' rings and wipers.

ASSEMBLY

Numbers in parentheses refer to Fig. 2.

⚠ WARNING
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Replace grease fitting (25) in end and replace bushings (2 & 17) in base (3) and end (26), respectively, if removed.

2. Install seal (20), wear ring (21) and wiper (22) into tube (19).

3. Replace seals (15) on tube (16) and place tube in tube (13).

4. Place wear ring (11) and piston rings (12) on tube (13), and install in tube (19).

5. Install seal (8), wear ring (9) and wiper (10) in tube (7).

6. Install wear ring (6) on tube (7) and place inner tube (7) in outer tube (19).

7. Place backup ring (24) and 'O' ring (23) on end (26).

8. Install end (26) assembly into tube (13) and tighten to a torque of 1 900 - 2 300 Nm (1 400 - 1 700 lbf ft).

9. Install set screw (14) into tube (13).

10. Replace 'O' ring (5) and wiper (4) on base (3).

11. Align base (3) and tube (19) as shown in Fig. 3.

12. Secure base (3) to tube (19) with bolts (1) and nuts (18). Tighten bolts (1) to a torque of 142 - 156 Nm (105 - 115 lbf ft).

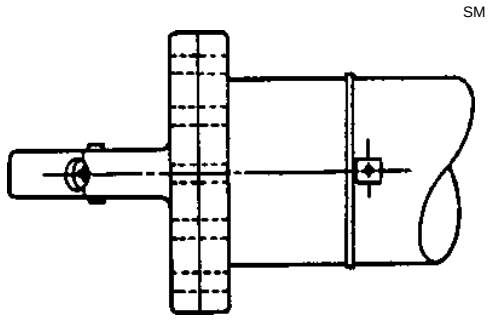


Fig. 3 - Aligning Base

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Body System - Body Cylinder

Section 230-0130

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

> ⚠ **WARNING**
> **To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.**

1. Install a suitable strap around the cylinder and position cylinder on unit so that bottom lube fitting (6) is toward the rear of the truck.

2. Install bottom pin (1) first and secure with washer (2), lockwasher (3) and bolt (4).

3. Install hydraulic lines to proper cylinder ports.

4. Start engine and extend cylinder until top mounting hole is aligned. Install top pin (1) and secure with washer (2), lockwasher (3) and bolt (4).

5. Lubricate pins at lube fittings (6) with lubricant as specified in Section 300-0020, LUBRICATION SYSTEM. Check hydraulic oil tank level. Refer to Section 230-0040, BODY AND DISC BRAKE COOLING TANK.

6. Remove body prop pins and operate body. Check cylinder lines for leaks. Tighten fittings as required to stop leaks.

MAINTENANCE

Every 50 Hours:
Lubricate body hinge pins and body hoist bushings with grease, as specified in Section 300-0020, LUBRICATION SYSTEM.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
2	1	Bolt	142 - 156	105 - 115
2	26	End	1 900 - 2 300	1 400 - 1 700

* * * *

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DESCRIPTION

Numbers in parentheses refer to Figs. 2 through 7.

The hydraulic braking system is of closed centre design wherein constant pressure is stored in accumulators and is regulated, as required, to retard or stop the machine.

A brief description of the individual components used in the braking system are listed below. Detailed service and operating instructions for the individual components can be found in their relative component sections in this manual.

Steering and Brake Control Tank

Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK.

The steering and brake control tank is the common oil reservoir for the steering system and the brake control system. It is mounted off the left hand frame rail beside the body and disc brake cooling tank.

Steering Pump (1)

Refer to Section 220-0050, STEERING PUMP.

The steering pump is an axial piston, variable displacement (adjustable) pump, capable of high pressure operation. It is the common pressure supply to both the steering and brake control systems. Output is controlled to meet system requirements at any given time.

A compensator valve assembly regulates system pressure at 159 bar (2 300 lbf/in^2).

The steering pump is assembled for right hand (clockwise) rotation, as viewed from the driveshaft end.

Note: Never drive a pump in the wrong direction of rotation, as pump seizure may result.

Accumulator (2)

Refer to Section 220-0130, ACCUMULATOR.

There are two brake accumulators mounted at the rear of the cab. One for the rear brake circuit and the other for the front brake circuit. The rear brake circuit accumulator also maintains a constant pressure in the parking brake circuit, to hold the parking brake off, when the truck is operating.

The accumulator is of the piston type and is precharged with nitrogen to 55 bar (800 lbf/in^2). It consists of a charging valve assembly, cylinder assembly and a piston. The charging valve is equipped with a locking feature which, when opened, will allow the precharge to be checked or the accumulator charged. The piston acts as a separator dividing the cylinder assembly into two sections. The section nearest the charging valve contains the nitrogen precharge. The other section receives the hydraulic oil from the pump, via the brake manifold valve.

Brake Manifold Valve (3)

Refer to Section 250-0050, BRAKE MANIFOLD VALVE.

The brake manifold valve is mounted off the cab mounting crossmember and distributes hydraulic oil flow from the pump, to the treadle valve, front and rear brake circuit accumulators and parking brake at the rear wheels. It also provides appropriate returns to tank for the hydraulic oil.

Rear Brake Accumulator Pressure Switch (14) - The normally closed (NC) pressure switch, located in port 'PS2', senses the pressure in the rear brake accumulator. The pressure switch sends a signal to a warning light on the dash panel when pressure drops below 131 bar (1 900 lbf/in^2).

Front Brake Accumulator Pressure Switch (15) - The normally closed (NC) pressure switch, located in port 'PS1', senses the pressure in the front brake accumulator, and sends a signal to a warning light on the dash panel when pressure drops below 131 bar (1 900 lbf/in^2).

Parking Brake Pressure Switch (16) - The normally closed (NC) pressure switch, located in port 'PS3', senses pressure in the parking brake line, and sends a signal to a warning light on the dash panel when pressure drops below 65 bar (940 lbf/in^2).

Treadle Valve (4)

Refer to Section 250-0070, TREADLE VALVE.

The treadle valve controls the level of hydraulic oil pressure applied to front and rear brakes and the maximum pressure available to these circuits. It is operated by a foot pedal in the operators cab and, with the engine running, is automatically applied by the brake manifold valve.

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The differing maximum operating pressures required for the front and rear brakes are achieved within the treadle valve. These can be adjusted, BUT, only together, i.e. adjustments are made to both circuits simultaneously.

Stop Light Pressure Switch (13) - The normally open (NO) pressure switch is located in the front plate of the treadle valve in the 'B1' circuit. As brake pressure increases to 2.7 bar (39 lbf/in²) and above, the circuit should close and send a signal to illuminate the brake lights. As pressure drops below 2.7 bar (39 lbf/in²) the circuit should open and brake lights go out.

Lockup Drop Out Pressure Switch (17) - The normally open (NO) pressure switch is located in the front plate of the treadle valve in the 'B2' circuit. As brake pressure increases to 20 bar (290 lbf/in²) and above, the circuit should close and send a signal to the lockup drop out solenoid, which in turn drops the transmission out of lockup. As pressure drops below 20 bar (290 lbf/in²) the circuit should open and lockup can be engaged.

Front Brake Callipers (5)

Refer to Section 165-0020, BRAKE PARTS.

The service brakes are of the calliper disc type. The calliper brake head is designed for use with hydraulic oils meeting the specifications outlined in Section 300-0020, LUBRICATION SYSTEM. DO NOT USE BRAKE FLUID (J1703).

The calliper head is bolted to a mounting plate on the spindle and the disc is bolted to the wheel. There is one brake head at each wheel. Each calliper brake head assembly consists of a torque plate, two brake pads; one on each side of the disc, and six brake pistons; three on each side of the disc.

The brake is actuated by hydraulic oil entering the brake head through one of the bleeder ports. The piston bores on each side of the torque plate are interconnected by internal passages. When the brake is actuated, the hydraulic pressure forces the pistons against the brake pads which are in turn forced against each side of the brake disc, slowing or stopping the disc and wheel rotation.

Shuttle Valve (6)

Refer to Section 250-0140, SHUTTLE VALVE.

The shuttle valve allows the distribution of pressure from either the treadle valve, to activate the rear service brakes, or, the retarder control valve, to utilise the rear service brakes as a retarder.

The shuttle valve consists of a well fitting spool which is pushed under pressure, depending on flow direction, to one end position, where it seals against an 'O' ring seal. The 'O' ring is protected by a metal housing.

Oil Cooled Disc Brakes (7)

Refer to Section 165-0030, BRAKE PARTS.

Service Brakes
The service brakes are of 'Upright Design', i.e. requiring pressure to hold the brakes on.

The rear service brakes are hydraulically actuated to slow or stop drive wheel rotation. When the treadle valve in the operators' compartment is depressed, or when the retarder control lever on the centre console is actuated, with the retarder selection switch (if fitted) at the disc brake position, hydraulic pressure is transmitted to the disc brake assembly. Hydraulic pressure entering the disc brake assembly forces the service piston against the brake disc pack consisting of damper assemblies, rotating friction discs and splined plates.

The rotating friction discs, which are driven by the wheel through wheel drivers and disc drivers, are compressed between the splined plates. This slows down and stops rotation of the driving wheels. The force applied against the disc pack is directly proportional to the degree of which the service brake treadle valve is depressed, or, retarder control lever is moved.

When the service brake treadle valve, or retarder control lever, is released, hydraulic pressure against the service piston is relieved allowing the service piston to return to its original position, thus, relieving the pressure against the brake disc pack.

Parking Brakes
The parking brake is of 'Inverted Design', i.e. requiring pressure to hold the brakes off.

The parking brakes are controlled by the park/emergency brake control mounted on the right hand side of the dash panel. The parking brakes are applied by spring tension and released by hydraulic pressure. With the park/emergency control 'Out', the parking brakes are held off. With the park/emergency control 'In' the parking brakes are held on.

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Monoblock Brake Valve (8)

Refer to Section 250-0100, MONOBLOCK BRAKE VALVE.

Mounted off the left hand frame rail, the monoblock brake valve incorporates three valves; a pressure reducing valve, pressure relief valve and a shuttle valve.

The pressure reducing valve reduces the available hydraulic oil pressure from the rear brake accumulator to a pressure of 83 bar (1 200 lbf/in^2).

The pressure relief valve regulates pressure, after pressure the reducing valve, to provide a residual pressure of 3.5 bar (50 lbf/in^2) in the rear brake lines. A filter system, comprising of a disc filter and a conical filter, helps protect an orifice plate at the pressure relief valve.

The shuttle valve, depending on spool position, provides a residual pressure of 3.5 bar (50 lbf/in^2) in the rear brake lines, or, upon actuation of the treadle or retarder valve, the brake actuation pressure overcomes the residual pressure to give a brake application at the rear brake packs.

Directional Control Valve (9)

Refer to Section 250-0090, DIRECTIONAL CONTROL VALVE.

The directional control valve is located in the 'Px' hydraulic circuit between the brake manifold valve and the treadle valve. The 'Px' circuit hydraulically actuates the treadle valve when the park/emergency control switch is activated. The directional control valve also controls automatic service brake, applied pressure bleed down, with engine shutdown.

Retarder Control Valve (10)

Refer to Section 250-0130, RETARDER CONTROL VALVE.

The retarder control valve, mounted in the centre console to the right hand side of the operator, is a closed centre controller which is used to apply a continuous braking force to hold the vehicle at a safe steady speed when descending grades.

The valve applies reduced pressure to either the oil cooled disc brakes (OCDB) or the optional transmission retarder. Selection of either the OCDB retarder or transmission retarder is made by a separate retarder selection switch on the dash panel. Pressing the switch at the top will select the OCDB retarder and pressing the bottom will select the transmission retarder.

Note: The transmission retarder circuit is made up of **Directional Control Valve (11)** and **Transmission Retarder Cylinder (12)**.

Retarder Light Pressure Switch (18)

The retarder light pressure switch is a normally open (NO) switch. As retarder pressure increases to 2.7 bar (39 lbf/in^2) and above, the circuit should close and send a signal to illuminate the retarder indicator light in the dash panel, and the retarder light at the rear of the truck. As pressure drops below 2.7 bar (39 lbf/in^2) the circuit should open and the retarder lights should go out.

Pressure Reducing Valve (19)

Refer to Section 250-0110, PRESSURE REDUCING VALVE.

Mounted on the inside of the left hand frame rail in front of the body guide, the pressure reducing valve is located in the hydraulic brake circuit between the treadle valve and the front brake callipers.

The pressure reducing valve, on application of the 50% brake reduction switch, mounted on the dash panel in the cab, allows the operator to limit the braking pressure to 50% at the front brakes.

Pressure Test Points

There are four diagnostic pressure test points in the braking system, as shown in Figs. 2 through 7.

Note: When checking hydraulic pressures the vehicle should be positioned on a level surface and all road wheels securely blocked.

Test Point A
Park Brake Pressure - Taken from port 'TP1' on the monoblock brake valve, this pressure can be checked at diagnostic test point (rear) mounted off rear mounting bracket for the body and disc brake cooling tank.

Pressure reading should be 83 bar (1 200 lbf/in^2) with the engine running and the parking emergency brake control applied (pressed in).

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Test Point B
Transmission Pilot Pressure - Taken from a tee in the transmission pilot pressure line to the directional control valve, this pressure can be checked at diagnostic test point at the rear left hand cab support.

Pressure should be 11.7 - 12.7 bar (170 - 180 lbf/in^2) with the engine operating at 1 500 rev/min, output stalled, in all ranges and lockup.

Test Point C
Front Service Brakes Pressure - Taken from a tee in the 'B1' line from the treadle valve to the front brake callipers, this pressure can be checked at diagnostic test point at the rear left hand cab support.

Pressure reading should be 159 bar (2 300 lbf/in^2) with the engine running and the treadle valve applied.

Test Point D
This test point is used to record the Rear Service Brake Pressure, Residual Brake Pressure and the Retarder Pressure - Taken from port 'TP2' on the monoblock brake valve, these pressures can be checked at diagnostic test point (front) mounted off rear mounting bracket for the body and disc brake cooling tank. Pressure readings should be as follows:

Rear Service Brakes Pressure - 52 bar (750 lbf/in^2), with the engine running and treadle valve applied.

Residual Brake Pressure - 3.5 bar (50 lbf/in^2), with the engine running and both the service brakes and the parking brakes released.

Retarder Pressure - 33 bar (480 lbf/in^2), with the engine running and the retarder control lever fully applied.

'O' RING FACE SEALS (ORFS)

Where hydraulic lines are fitted with ORFS connections, the following procedure should be carried out during installation. Refer to Fig. 1.

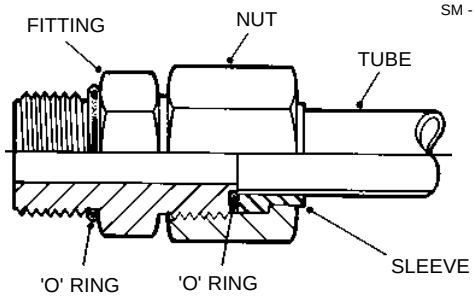


Fig. 1 - Assembly of Typical ORFS Connector

a. Ensure 'O' ring/seal is in place and that joining surfaces are clean. If necessary, retain 'O' ring/seal in place with a light coating of grease or vaseline.

b. Initially, the nuts should be tightened by hand.

c. Where a hose is fitted, ensure that it is not twisted or kinked when the nuts are tightened so that it is allowed to adopt a natural position.

d. Where a tube is fitted, ensure that the connection is aligned correctly.

e. Tighten the nut a further 1/4 to 1/2 a turn using the correct size spanner (wrench).

f. Check that a satisfactory hose or tube routing has been achieved.

RELIEVING PRESSURE

⚠ WARNINGS
The braking system is equipped with accumulators which maintain pressure in the system even after engine shutdown. Operate the treadle valve continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators (pressure in accumulator hydraulic lines should be 0 bar (0 lbf/in^2)). Block all road wheels.

3. Carefully loosen brake pipes at base of both the front and rear accumulators to check that all pressure has been released. Tighten brake pipes.

BLEEDING THE BRAKES

If either the front or rear brake assemblies have been serviced, the brakes must be bled to ensure that no air remains in the braking system.

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In the interests of safety, it is important that the exact procedure for bleeding the brakes is carried out as outlined in Section 165-0030, BRAKE PARTS (rear brakes) and Section 165-0020, BRAKE PARTS (front brakes).

SERVICE TOOLS

It is recommended that the following tools are used when carrying out pressure or temperature checks during maintenance procedures. These tools, along with other general service tools, are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of these tools.

Multi-gauge

The multi-gauge is basically four pressure gauges in one. Continuous system pressure readings are indicated on one of three simultaneously reading gauges through a pressure range of 762 mm (30 in) of vacuum to 345 bar (5 000 lbf/in^2).

Non-contact Infrared Thermometer

The infrared thermometer can be used to spot heat problems early in electrical, mechanical and hydraulic systems. Hand held and easy to use, you simply aim, pull the trigger, and read the temperature. Since there is no need to touch what you are measuring, temperatures of hard-to-reach or moving components can be taken without getting burned or shocked.

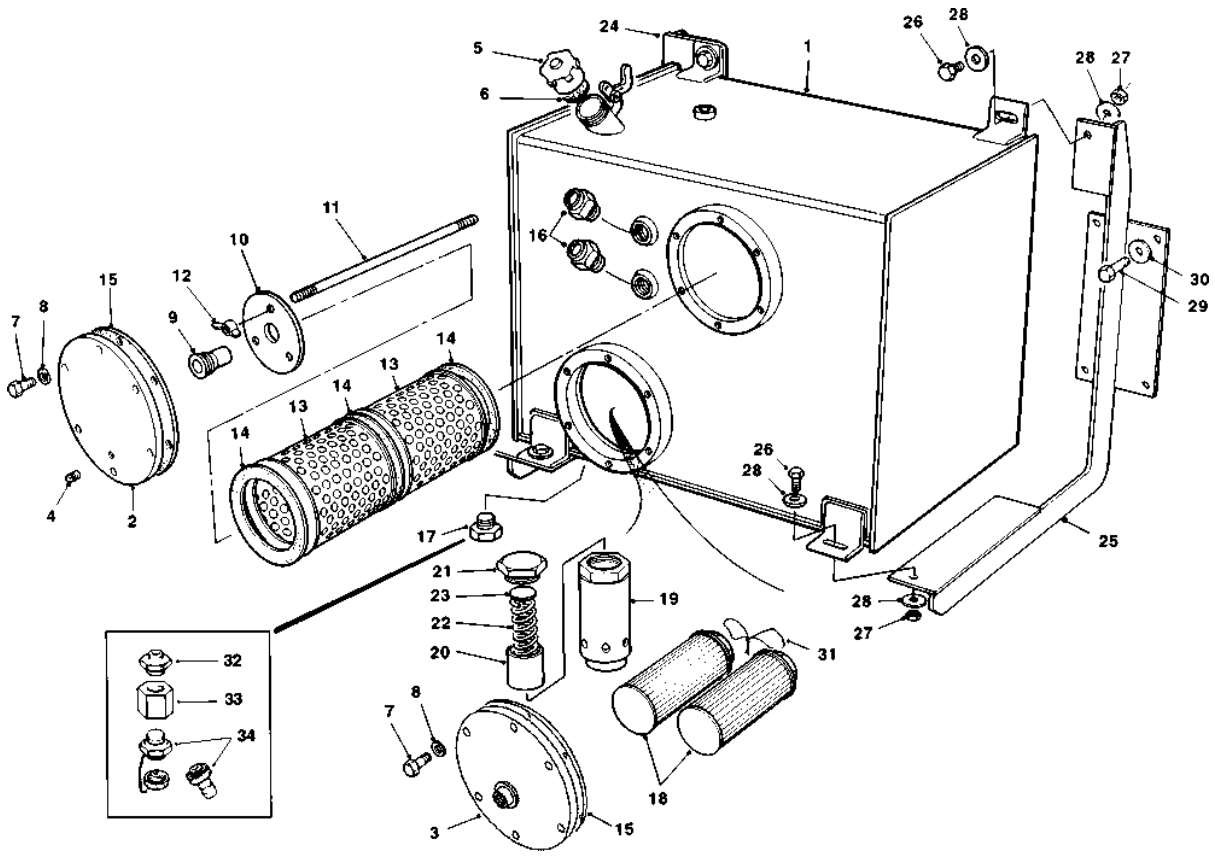
BRAKING SYSTEM DIAGNOSIS

CONDITION	REASON	REMEDY
Inadequate braking	Low System Pressure	Check oil level
		Check oil condition
		Check for leakage
		Check system pressure and adjust as required
	Treadle valve delivery pressure below normal	Check front and rear brake circuits
		Check treadle valve operation
		Check for leakage (modular assembly)
	Brake surfaces inefficient	Check brake linings and discs
		Check callipers for leakage
		Replace seals or components as required
Brakes do not release	Defective treadle valve	Repair or replace defective component. Check adjustments (pedal return).
	Loose or broken wire in the brake manifold valve solenoid circuit	Repair circuit as required
	Faulty solenoid	Replace defective component
	Faulty park/emergency switch	Repair or replace as required
	Restriction in tank return line	Clear restriction
	Seal bypass condition - parking brake assembly	Replace seals or component as required
Emergency brakes do not apply	Faulty park/emergency switch	Repair or replace as required
	Faulty solenoid	Replace defective component
	No transmission pilot pressure at directional control valve	Check transmission pressure
		Check for restriction in pilot line
	Faulty directional control valve	Check spool operation. Repair or replace component.
	Oil leakage - service brakes	Check and repair
	Faulty park brake assembly	Replace seals or component as required
	Faulty brake manifold solenoid cartridge	Check valve operation. Replace solenoid cartridge if required.

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1 - Hydraulic Tank	10 - Plate	19 - Relief Valve	28 - Hardened Washer
2 - Access Cover	11 - Rod	20 - Poppet	29 - Bolt
3 - Access Cover	12 - Wing Nut	21 - Cap	30 - Washer
4 - Plug	13 - Filter Element	22 - Spring	31 - Lockwire
5 - Filler Cap	14 - Gasket	23 - Shim	*32 - Adaptor
6 - Gasket	15 - Gasket	24 - Mounting Bracket	*33 - Valve
7 - Bolt	16 - Window Nut	25 - Mounting Bracket	*34 - Drain Plug Kit
8 - Lockwasher	17 - Drain Plug	26 - Bolt	
9 - Bypass Valve	18 - Suction Screen	27 - Nut	* - Optional

Fig. 1 - Exploded View of Body and Disc Brake Cooling Tank

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The Body and Disc Brake Cooling Tank can be identified as item 1 in Section 230-0000, BODY SYSTEM SCHEMATIC, in this manual.

The hydraulic tank (1) is the common reservoir for the body hoist system and oil cooled disc brakes (OCDB) cooling oil. It is mounted off the LH frame rail rearwards of the steering and brake control tank.

Integral with hydraulic tank (1) assembly are filter elements (13) with bypass valve (9), suction screens (18) and window nuts (16). Access covers (2 & 3) give easy access to replace filter elements (13) and clean suction screens (18).

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Braking System - Braking System Schematic

Section 250-0000

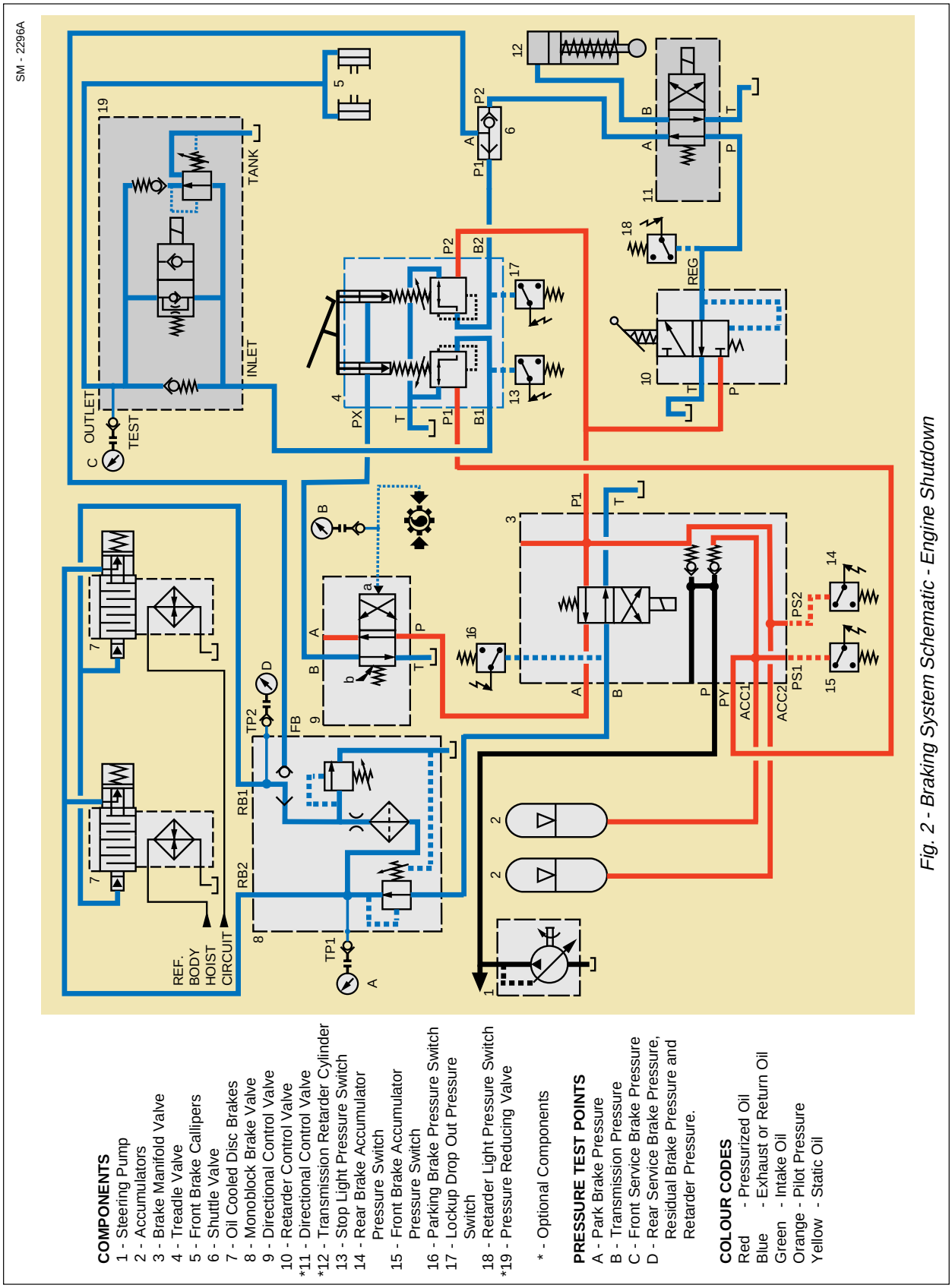


Fig. 2 - Braking System Schematic - Engine Shutdown

COMPONENTS

1 - Steering Pump
2 - Accumulators
3 - Brake Manifold Valve
4 - Treadle Valve
5 - Front Brake Callipers
6 - Shuttle Valve
7 - Oil Cooled Disc Brakes
8 - Monoblock Brake Valve
9 - Directional Control Valve
10 - Retarder Control Valve
*11 - Directional Control Valve
*12 - Transmission Retarder Cylinder
13 - Stop Light Pressure Switch
14 - Rear Brake Accumulator Pressure Switch
15 - Front Brake Accumulator Pressure Switch
16 - Parking Brake Pressure Switch
17 - Lockup Drop Out Pressure Switch
18 - Retarder Light Pressure Switch
*19 - Pressure Reducing Valve

* - Optional Components

PRESSURE TEST POINTS

A - Park Brake Pressure
B - Transmission Pressure
C - Front Service Brake Pressure
D - Rear Service Brake Pressure, Residual Brake Pressure and Retarder Pressure.

COLOUR CODES

Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

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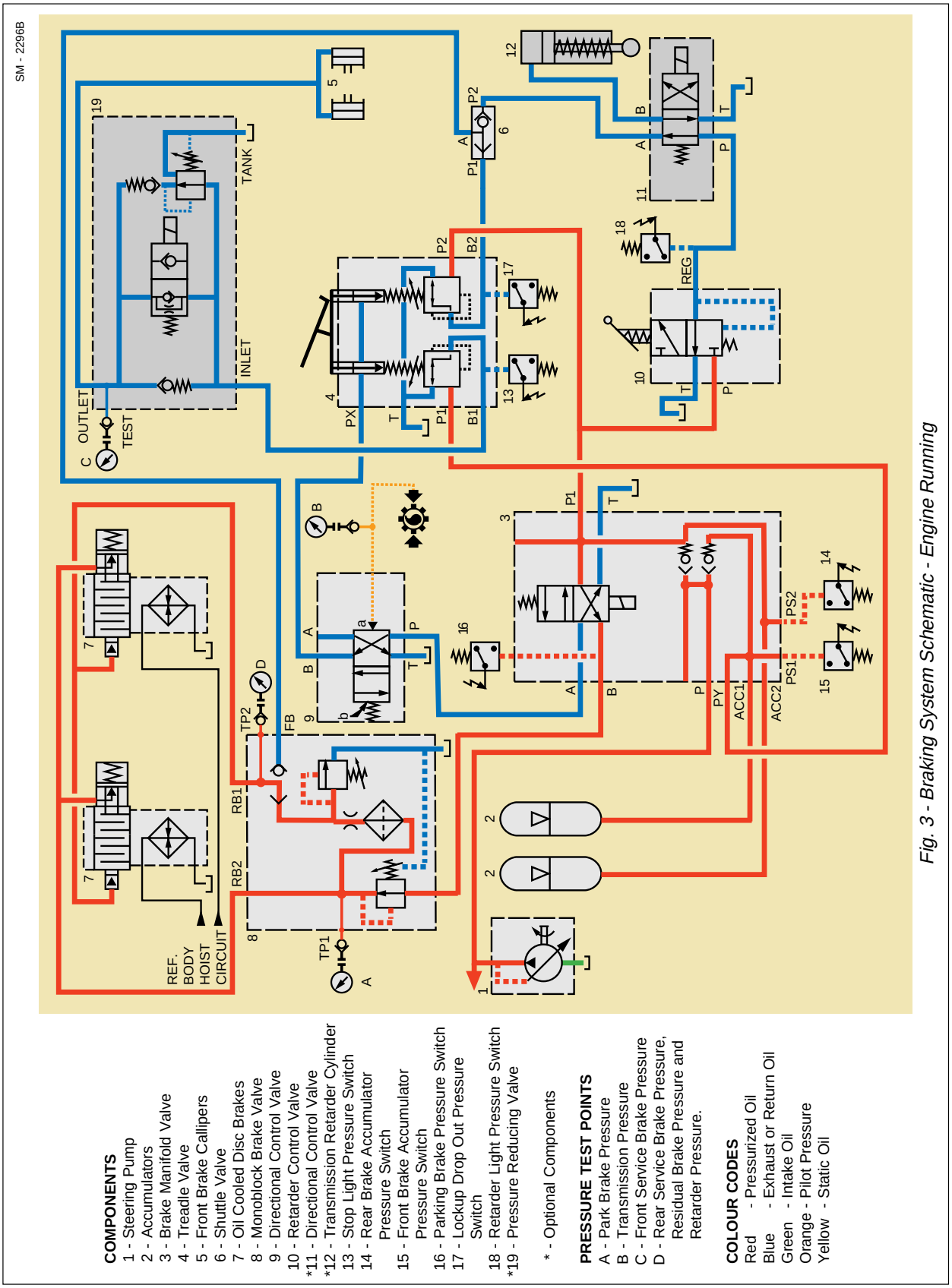


Fig. 3 - Braking System Schematic - Engine Running

COMPONENTS

1 - Steering Pump
2 - Accumulators
3 - Brake Manifold Valve
4 - Treadle Valve
5 - Front Brake Callipers
6 - Shuttle Valve
7 - Oil Cooled Disc Brakes
8 - Monoblock Brake Valve
9 - Directional Control Valve
10 - Retarder Control Valve
*11 - Directional Control Valve
*12 - Transmission Retarder Cylinder
13 - Stop Light Pressure Switch
14 - Rear Brake Accumulator Pressure Switch
15 - Front Brake Accumulator Pressure Switch
16 - Parking Brake Pressure Switch
17 - Lockup Drop Out Pressure Switch
18 - Retarder Light Pressure Switch
*19 - Pressure Reducing Valve

* - Optional Components

PRESSURE TEST POINTS

A - Park Brake Pressure
B - Transmission Pressure
C - Front Service Brake Pressure
D - Rear Service Brake Pressure, Residual Brake Pressure and Retarder Pressure.

COLOUR CODES

Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

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Braking System - Braking System Schematic

Section 250-0000

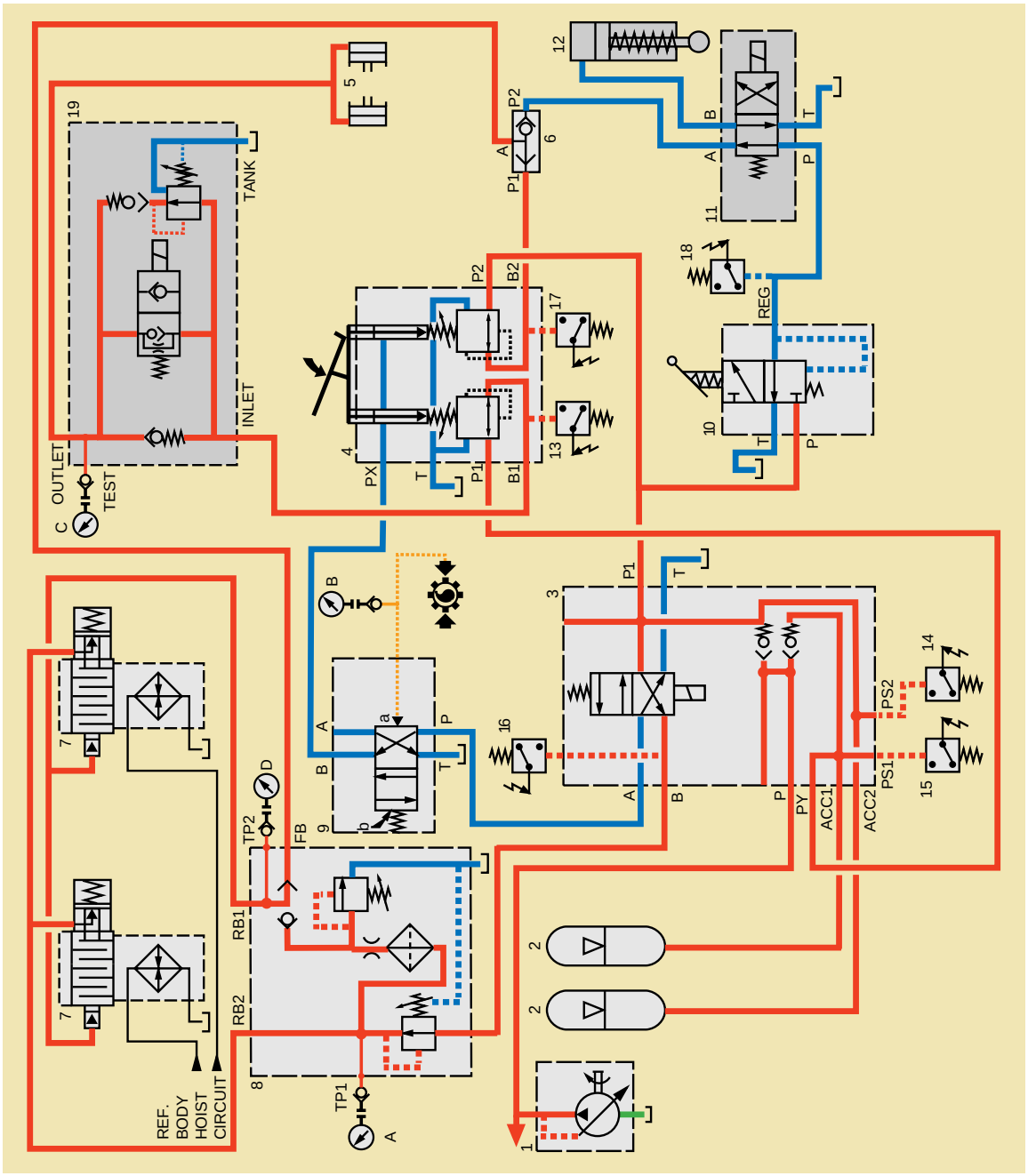


Fig. 4 - Braking System Schematic - Engine Running, Service Brake Applied

COMPONENTS

1 - Steering Pump
2 - Accumulators
3 - Brake Manifold Valve
4 - Treadle Valve
5 - Front Brake Callipers
6 - Shuttle Valve
7 - Oil Cooled Disc Brakes
8 - Monoblock Brake Valve
9 - Directional Control Valve
10 - Retarder Control Valve
*11 - Directional Control Valve
*12 - Transmission Retarder Cylinder
13 - Stop Light Pressure Switch
14 - Rear Brake Accumulator Pressure Switch
15 - Front Brake Accumulator Pressure Switch
16 - Parking Brake Pressure Switch
17 - Lockup Drop Out Pressure Switch
18 - Retarder Light Pressure Switch
*19 - Pressure Reducing Valve

* - Optional Components

PRESSURE TEST POINTS

A - Park Brake Pressure
B - Transmission Pressure
C - Front Service Brake Pressure
D - Rear Service Brake Pressure, Residual Brake Pressure and Retarder Pressure.

COLOUR CODES

Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

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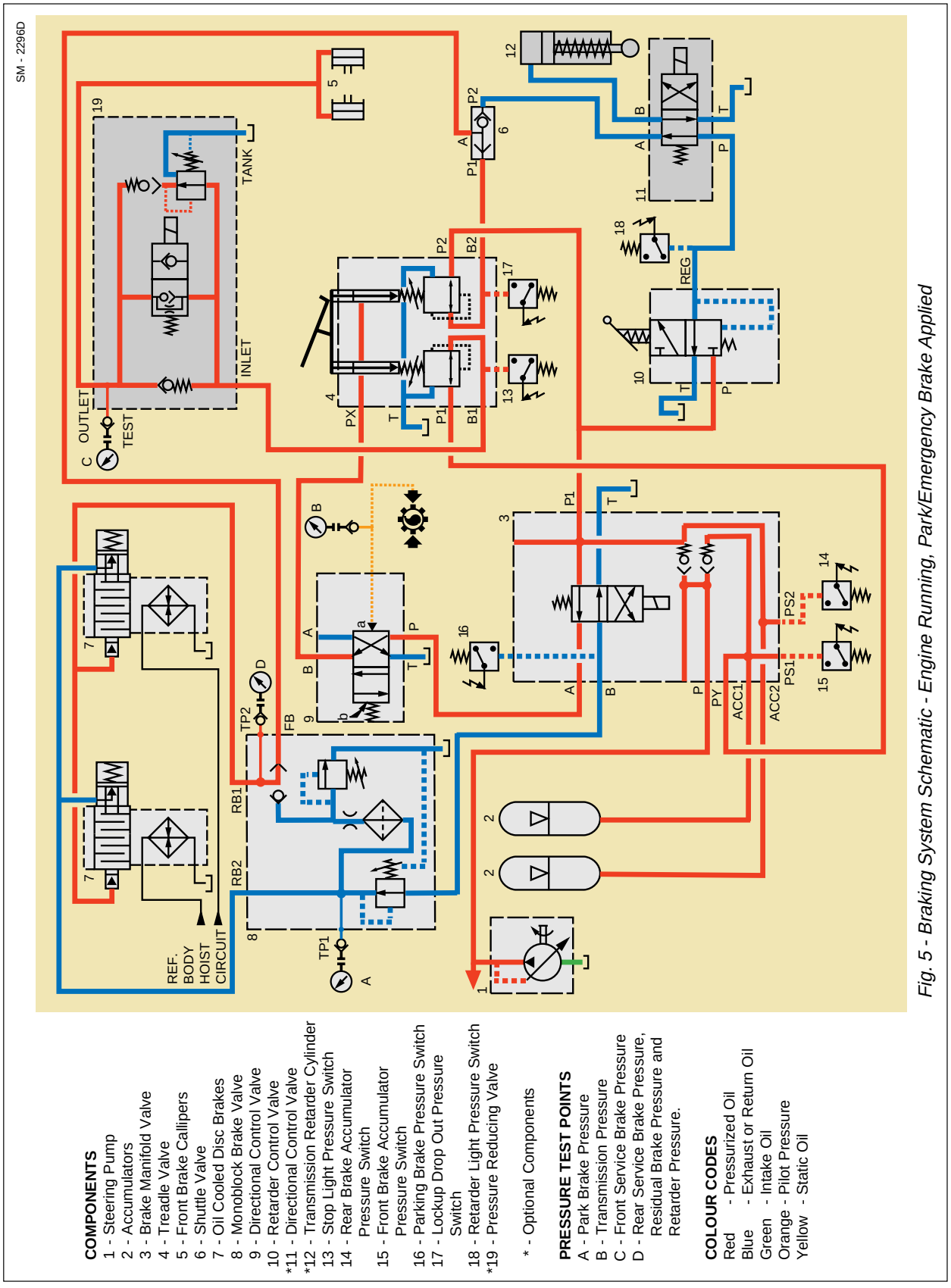


Fig. 5 - Braking System Schematic - Engine Running, Park/Emergency Brake Applied

COMPONENTS

1 - Steering Pump
2 - Accumulators
3 - Brake Manifold Valve
4 - Treadle Valve
5 - Front Brake Callipers
6 - Shuttle Valve
7 - Oil Cooled Disc Brakes
8 - Monoblock Brake Valve
9 - Directional Control Valve
10 - Retarder Control Valve
*11 - Directional Control Valve
*12 - Transmission Retarder Cylinder
13 - Stop Light Pressure Switch
14 - Rear Brake Accumulator Pressure Switch
15 - Front Brake Accumulator Pressure Switch
16 - Parking Brake Pressure Switch
17 - Lockup Drop Out Pressure Switch
18 - Retarder Light Pressure Switch
*19 - Pressure Reducing Valve

* - Optional Components

PRESSURE TEST POINTS

A - Park Brake Pressure
B - Transmission Pressure
C - Front Service Brake Pressure
D - Rear Service Brake Pressure, Residual Brake Pressure and Retarder Pressure.

COLOUR CODES

Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

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Braking System - Braking System Schematic

Section 250-0000

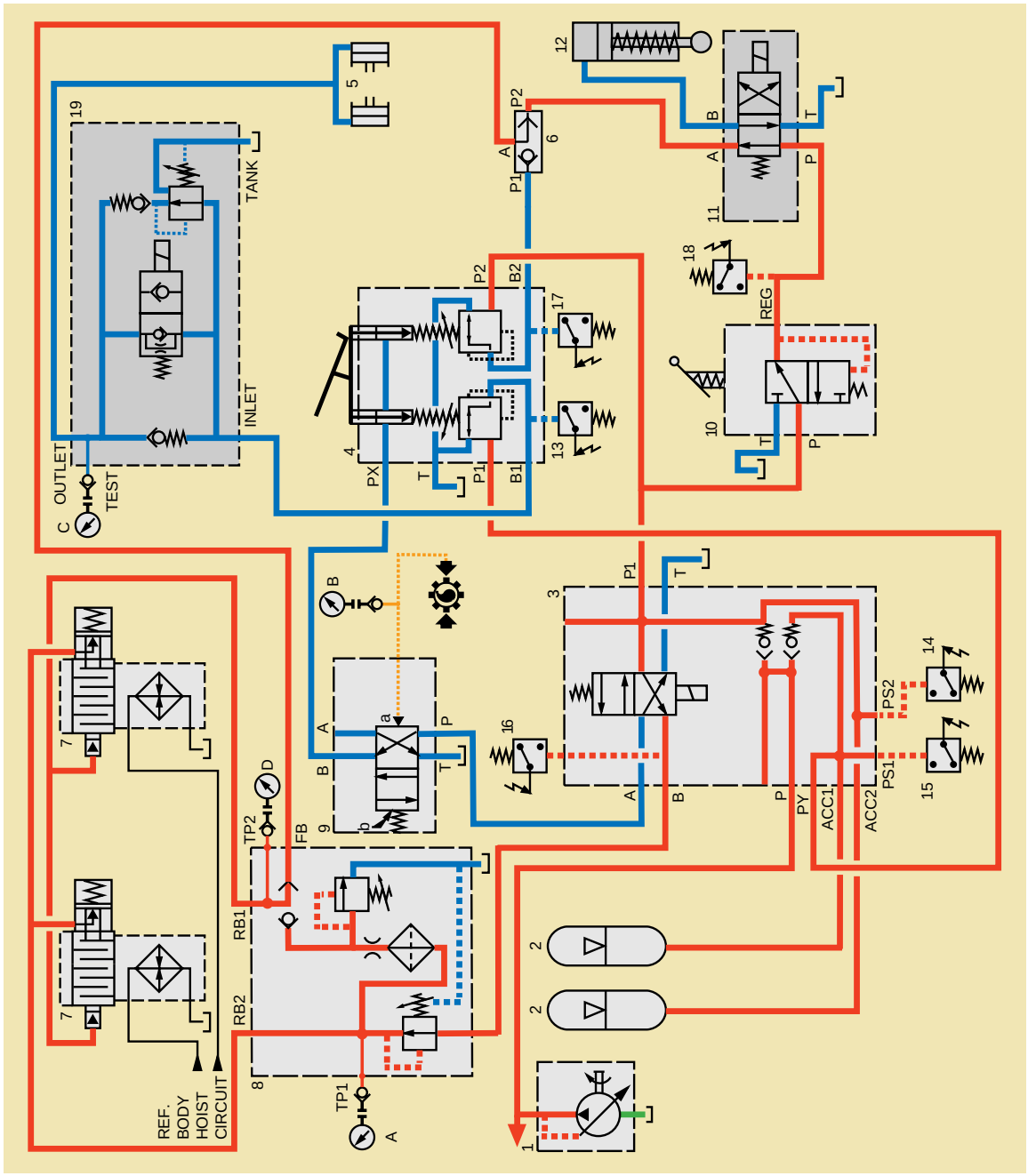


Fig. 6 - Braking System Schematic - Engine Running, OCDB Retarder Applied

COMPONENTS

1 - Steering Pump
2 - Accumulators
3 - Brake Manifold Valve
4 - Treadle Valve
5 - Front Brake Callipers
6 - Shuttle Valve
7 - Oil Cooled Disc Brakes
8 - Monoblock Brake Valve
9 - Directional Control Valve
10 - Retarder Control Valve
*11 - Directional Control Valve
*12 - Transmission Retarder Cylinder
13 - Stop Light Pressure Switch
14 - Rear Brake Accumulator Pressure Switch
15 - Front Brake Accumulator Pressure Switch
16 - Parking Brake Pressure Switch
17 - Lockup Drop Out Pressure Switch
18 - Retarder Light Pressure Switch
*19 - Pressure Reducing Valve

* - Optional Components

PRESSURE TEST POINTS

A - Park Brake Pressure
B - Transmission Pressure
C - Front Service Brake Pressure
D - Rear Service Brake Pressure, Residual Brake Pressure and Retarder Pressure.

COLOUR CODES

Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

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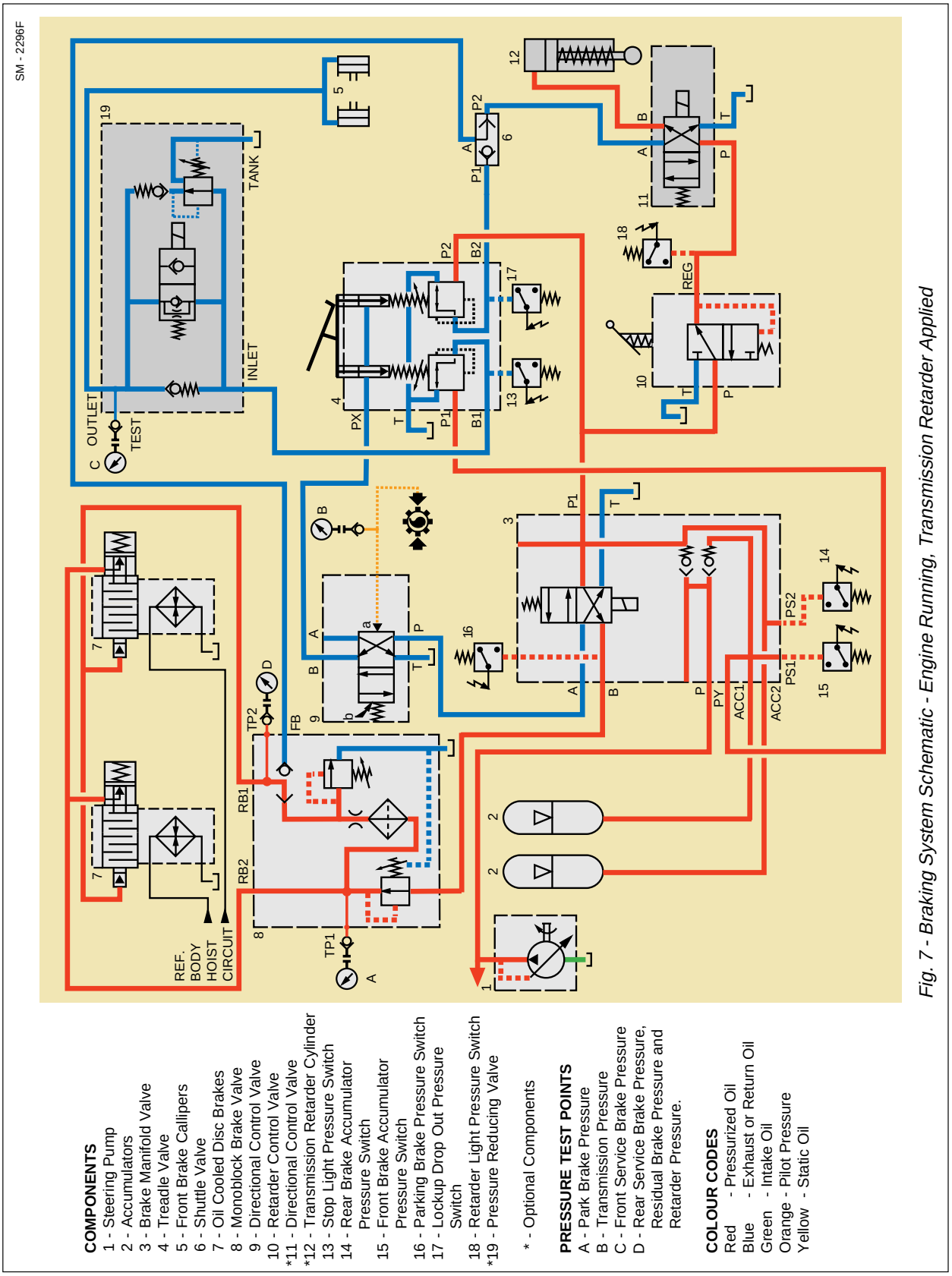


Fig. 7 - Braking System Schematic - Engine Running, Transmission Retarder Applied

COMPONENTS

1 - Steering Pump
2 - Accumulators
3 - Brake Manifold Valve
4 - Treadle Valve
5 - Front Brake Callipers
6 - Shuttle Valve
7 - Oil Cooled Disc Brakes
8 - Monoblock Brake Valve
9 - Directional Control Valve
10 - Retarder Control Valve
*11 - Directional Control Valve
*12 - Transmission Retarder Cylinder
13 - Stop Light Pressure Switch
14 - Rear Brake Accumulator Pressure Switch
15 - Front Brake Accumulator Pressure Switch
16 - Parking Brake Pressure Switch
17 - Lockup Drop Out Pressure Switch
18 - Retarder Light Pressure Switch
*19 - Pressure Reducing Valve

* - Optional Components

PRESSURE TEST POINTS

A - Park Brake Pressure
B - Transmission Pressure
C - Front Service Brake Pressure
D - Rear Service Brake Pressure, Residual Brake Pressure and Retarder Pressure.

COLOUR CODES

Red - Pressurized Oil
Blue - Exhaust or Return Oil
Green - Intake Oil
Orange - Pilot Pressure
Yellow - Static Oil

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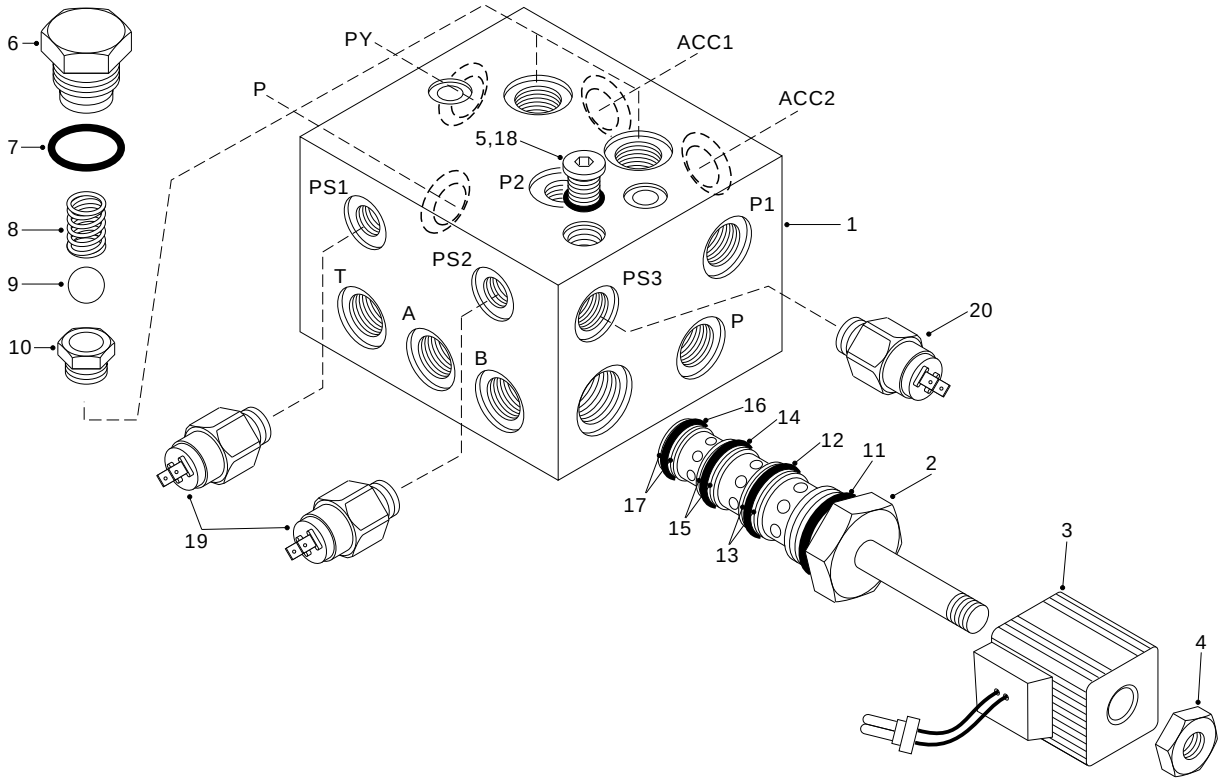
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1 - Valve Body
2 - Solenoid Cartridge
3 - Solenoid Coil
4 - Locknut
5 - Plug
6 - Retainer
7 - 'O' Ring
8 - Spring
9 - Check Ball
10 - Seat
11 - 'O' Ring
12 - 'O' Ring
13 - Backup Rings
14 - 'O' Ring
15 - Backup Rings
16 - 'O' Ring
17 - Backup Rings
18 - 'O' Ring
19 - Accumulator Pressure Switches
20 - Park Brake Pressure Switch

Fig. 1 - Exploded View of Brake Manifold Valve

DESCRIPTION

The brake manifold valve can be identified as item 3 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

Mounted off the cab mounting crossmember, the brake manifold valve distributes hydraulic oil flow from the steering pump, to the treadle valve, front and rear brake circuit accumulators and parking brake at the rear wheels. The valve also provides appropriate returns to the steering and brake control tank for the hydraulic oil.

OPERATION

Numbers in parentheses refer to Fig. 1. Refer to Figs. 2 and 3 for hydraulic schematics.

Hydraulic oil from the steering pump enters the brake manifold valve at port 'P'. Oil pressure moves check balls (9) from their seats (10) and allows oil to flow through port 'ACC1' to the front brake accumulator and through port 'ACC2' to the rear brake accumulator.

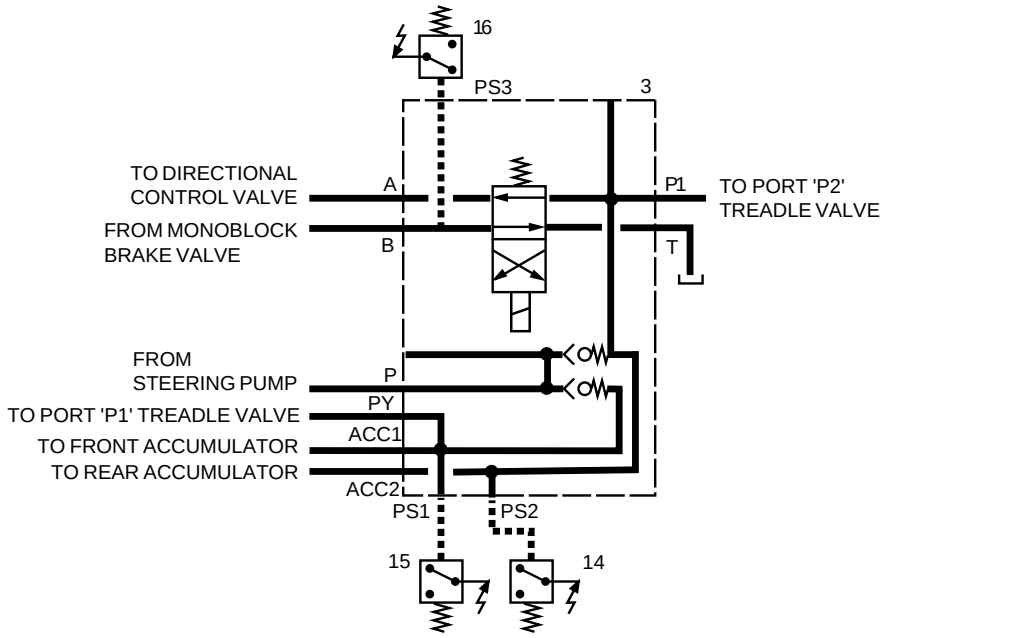
Pressurised oil exits the brake manifold valve through port 'PY' and flows to port 'P1' on the treadle valve, and, through port 'P1' on the brake manifold valve to port 'P2' on the treadle valve.

Solenoid Cartridge - De-energized

When the park/emergency brake switch is activated (pushed in), the electrical signal between the switch and solenoid coil (3) is opened, de-energizing solenoid cartridge (2). Oil flows through solenoid cartridge (2) and exits the brake manifold valve through port 'A' to

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3 - Brake Manifold Valve
14 - Rear Brake Accumulator Pressure Switch
15 - Front Brake Accumulator Pressure Switch
16 - Parking Brake Pressure Switch

Fig. 2 - Park/Emergency Brake Switch Activated - Solenoid Cartridge De-energized

the directional control valve. The oil travels through the directional control valve and into the 'Px' port in the treadle valve for an emergency brake application.

Return oil from the parking brake circuit flows through the monoblock brake valve and enters the brake manifold valve at port 'B'. The oil flows through solenoid cartridge (2) and exits the brake manifold valve at port 'T' to the steering and brake control tank. With no pressure in the parking brake circuit to hold the parking brake off, the parking brake is applied.

Solenoid Cartridge - Energized

When the park/emergency brake switch is deactivated (pulled out), the electrical signal between the switch and solenoid coil (3) is closed, energizing solenoid cartridge (2). Oil flows through solenoid cartridge (2) and exits the brake manifold valve at port 'B' to the monoblock brake valve. The oil flows through the pressure reducing valve in the monoblock brake valve and exits the valve to release the parking brakes. Refer to Section 250-0100, MONOBLOCK BRAKE VALVE.

Return oil from the 'Px' port on the treadle valve flows through the directional control valve and into the brake manifold valve at port 'A'. The oil travels through solenoid cartridge (2) and exits the brake manifold valve at port 'T' to the steering and brake control tank.

Pressure Switches

Accumulator pressure switches (19) in ports 'PS1' and 'PS2' send a signal to illuminate warning lights in the right hand dash panel when the pressure drops below 131 bar (1 900 lbf/in²).

Parking brake pressure switch (20) sends a signal to illuminate the parking brake light in the right hand dash panel when the pressure in the parking brake circuit drops below 65 bar (940 lbf/in²).

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS

Hydraulic fluid pressure will remain within the system after engine shut down. Operate the treadle valve continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

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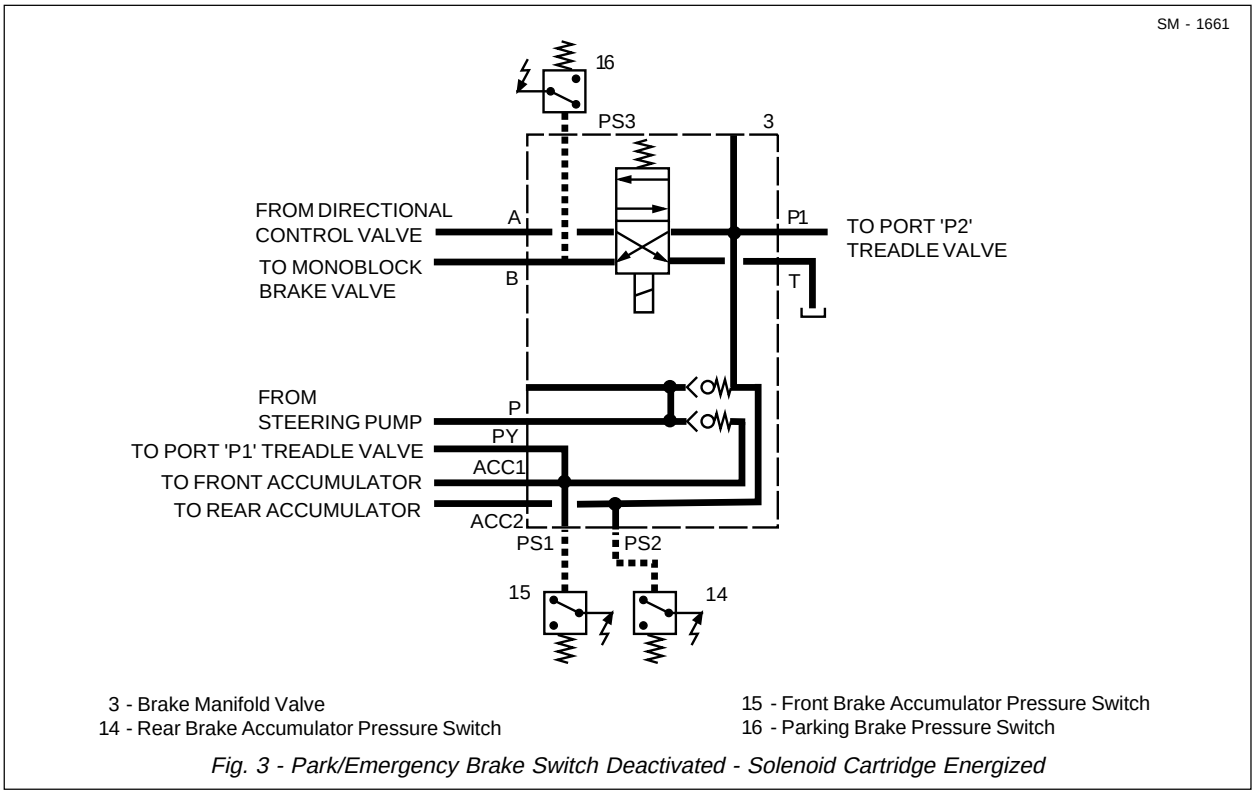


Fig. 3 - Park/Emergency Brake Switch Deactivated - Solenoid Cartridge Energized

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators. Block all road wheels.

3. Remove and tag electrical connections to solenoid coil (3) and pressure switches (19 & 20).

4. Clean brake manifold valve assembly and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to the brake manifold valve are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines.

5. Release and remove mounting hardware securing brake manifold valve to the cab mounting crossmember and remove assembly from the truck.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Clamp valve body (1) lightly in a soft jawed vice, retainers (6) face up. Do not overtighten jaws. Remove retainers (6) from valve body (1) and discard 'O' rings (7).

2. Remove plug (5) from valve body (1) and discard 'O' ring (18).

3. Carefully remove valve body (1) assembly from the vice and remove springs (8) and check balls (9) from valve body (1).

4. If required, clamp valve body (1) lightly in soft jawed vice and remove check ball seats (10).

5. Rotate valve body (1) in vice until solenoid coil (3) is facing up. Lightly clamp valve body (1) in vice and remove locknut (4) and solenoid coil (3) from solenoid cartridge (2).

6. Remove solenoid cartridge (2) assembly from valve body (1) and discard 'O' rings (11, 12, 14 & 16) and backup rings (13, 15 & 17).

7. Mark valve body (1) port identification on each of the pressure switches (19 & 20) and remove from valve body (1).

Note: It is important that the pressure switches are clearly identified as the pressure settings between pressure switches (19) and pressure switch (20) are different.

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8. If required, note orientation and remove hydraulic line connectors from ports in valve body (1).

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Install new 'O' rings (11, 12, 14 & 16) and backup rings (13, 15 & 17) on solenoid cartridge (2) as shown in Fig. 1.

2. Install solenoid cartridge (2) assembly in valve body (1) and tighten securely. Install solenoid coil (3) on solenoid cartridge (2) and secure with locknut (4).

3. Rotate valve body (1) in vice until retainer (6) face is up. Install new 'O' ring (18) on plug (5) and install plug (5) assembly in valve body (1).

4. If removed, apply Loctite 603 to threads of seats (10) and install seats (10) in valve body (1). Tighten seats (10) to a torque of 20 Nm (15 lbf ft). See Fig. 4.

5. Install one check ball (9) on seat (10) and spring (8) on check ball (9). Install new 'O' ring (7) on retainer (6) and carefully place retainer (6) assembly over spring (8) in valve body (1). Tighten retainer (6) securely in valve body (1). See Fig. 4.

6. Repeat step 5 for second check ball, spring and retainer assembly.

7. Install pressure switches (19 & 20) in valve body (1) as noted during disassembly.

8. If removed, install hydraulic line connectors in valve body (1) as noted during disassembly.

INSTALLATION

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Position brake manifold valve assembly to the cab mounting crossmember and secure with mounting hardware.

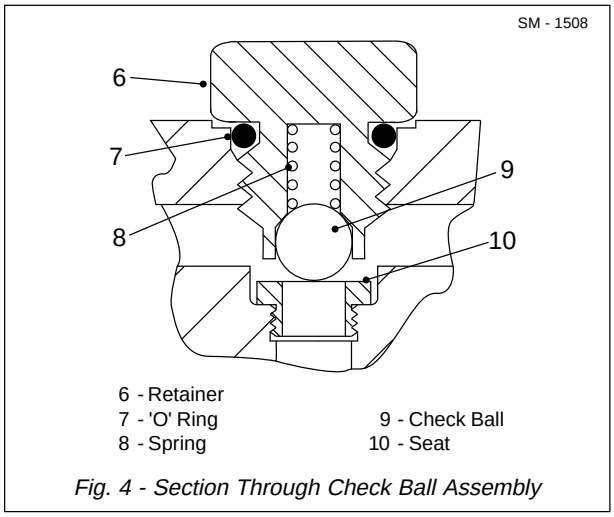


Fig. 4 - Section Through Check Ball Assembly

2. Remove blanking caps from hydraulic lines and connect to brake manifold valve as noted during removal.

3. Connect electrical connections to solenoid coil (3) and pressure switches (19 & 20) as noted during removal.

4. Check oil level in the steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

5. Remove wheel blocks, start the engine and bring hydraulic oil to operating temperature.

6. Check brake manifold valve and hydraulic line connections for leaks and tighten as required.

7. Shut off engine and make sure a full service brake application is made followed by a parking brake application.

8. Repeat all braking and engine shut down cycles several times and check for appropriate application/ release cycle several times.

9. Check all connections again for leaks and tighten as required.

10. Remove body safety pins and lower the body to the frame.

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MAINTENANCE

Inspect the brake manifold valve regularly for any signs of leakage or damage and repair/replace as required.

Note: Limited repair of the brake manifold valve is by replacement of parts only.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools, and adhesives are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	10	Seat	20	15

* * * *

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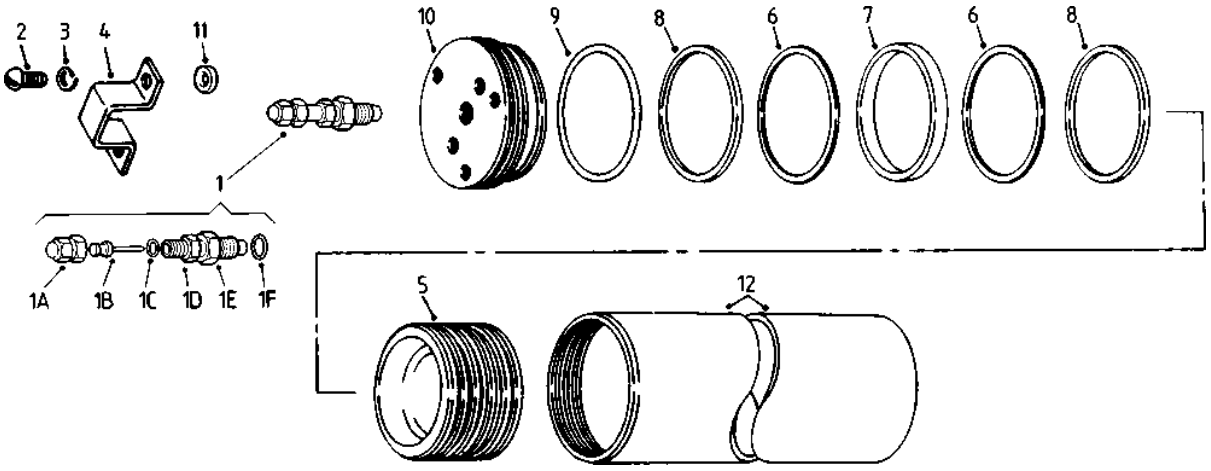
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1 - Charging Valve
1A - Cap
1B - Core
1C - 'O' Ring
1D - Locknut
1E - Body
1F - 'O' Ring
2 - Screw
3 - Lockwasher
4 - Protector
5 - Piston
6 - Backup Rings
7 - 'V' Section Ring
8 - Wear Rings
9 - 'O' Ring
10 - End Cap
11 - Pad
12 - Cylinder

Fig. 1 - Exploded View of Accumulator

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The Brake Accumulators can be identified as items 2 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

There are two brake accumulators mounted off the platform at the rear right hand side of the cab. One for the rear brake circuit and the other for the front brake circuit. The rear brake circuit accumulator also maintains a constant pressure in the parking brake circuit, to hold the parking brake off, when the truck is operating.

The accumulator is of the piston type and is precharged with nitrogen to 55 bar (800 lbf/in^2). It consists of charging valve (1), end cap (10), cylinder (12) and piston (5). Charging valve (1) is equipped with a locking feature. Loosening locknut (1D) will open the valve so that the precharge can be checked or the accumulator charged.

OPERATION

Numbers in parentheses refer to Fig. 1.

Piston (5) acts as a separator dividing cylinder (12) into two sections. The section nearest charging valve (1) contains the nitrogen pre-charge. Hydraulic oil from the steering pump flows through accumulator check valves in the brake manifold valve and into the lower section of the accumulators. Accumulator pressure is monitored by pressure switches in the brake manifold valve. Refer to Section 250-0050, BRAKE MANIFOLD VALVE.

TESTING

⚠ WARNING
Accumulators are charged with Nitrogen. The service pressure is 55 bar (800 lbf/in^2) at 21°C (70°F). Do not attempt to remove any valves or fittings until all nitrogen pressure is completely relieved to prevent personal injury and property damage.

Testing Charging Valve For Leakage

Numbers in parentheses refer to Fig. 1.

1. Remove screws (2), lockwashers (3), protector (4) and pads (11) from accumulator.

2. Remove valve cap (1A) from charging valve (1) and loosen locknut (1D). Coat open end of charging valve with soapy water. Bubbles indicate leaky valve

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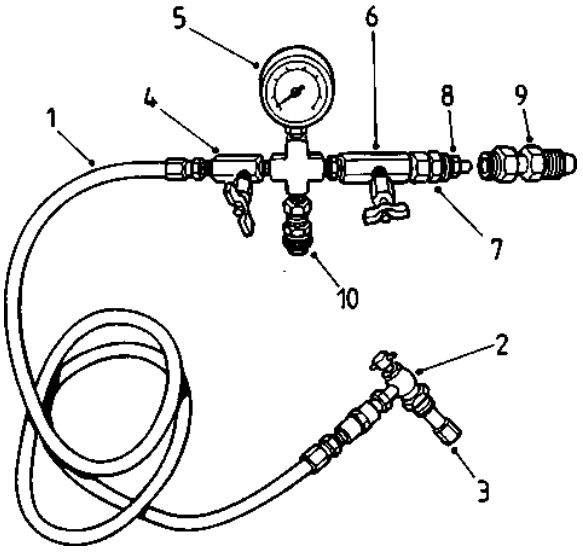
core (1B). Attempt to reseat the valve core by depressing and releasing it quickly once or twice. Recheck for leakage, if leakage continues then discharge the accumulator as described under 'Discharging Nitrogen' in this section, then replace the valve core. Torque tighten locknut (1D) to 11 Nm (100 lbf in) and replace valve cap (1A) finger tight.

Testing Pre-charge Pressure

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Note: The nitrogen pressure in an accumulator is directly affected by changes in nitrogen temperature. The cylinder pressure will increase or decrease proportionally with temperature changes. An accumulator pressure reading can vary about 4.3 bar (62 lbf/in^2) with 22° C (72° F) temperature change. Such temperature changes could easily occur between noon and midnight of the same day. Refer to the table at the end of this section for Nitrogen pressures at ambient temperatures of other than 21° C (70°F).

To test accumulator pre-charge pressure or to charge the accumulator, a charging assembly tool can be used. See Fig. 2.



1 - Line
2 - Valve Chuck
3 - Valve Extension
4 - Accumulator Valve
5 - Pressure Gauge
6 - Tank Valve
7 - Gland Fitting
8 - Gland Nut
9 - Cylinder Adaptor
10 - Bleeder Valve

Fig. 2 - Charging Assembly

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators. Block all road wheels.

3. Check accumulator mountings to be sure the accumulator is held tightly in position.

4. Remove cap (1A, Fig. 1) from accumulator charging valve (1, Fig. 1). Attach charging line (1) to charging valve by rotating 'T' handle of valve chuck (2) anticlockwise until it stops. Screw the swivel nut down on the valve until it seats. Loosen charging valve locknut (1D, Fig. 1) by turning anticlockwise one to two turns.

5. Turn 'T' handle clockwise until charging valve core is depressed. Be sure bleeder valve (10) is tight and does not leak, and valves (4 & 6) are closed.

6. To read accumulator precharge pressure, slowly open accumulator valve (4). Pressure gauge (5) will register pre-charge pressure, it should be 55 bar (800 lbf/in^2) at 21° C (70° F) ambient temperature. Refer to the table at the end of this section for Nitrogen pressures at ambient temperatures of other than 21° C (70° F).

7. Close accumulator valve (4) and open bleeder valve (10) to dissipate gauge pressure. Close bleeder valve (10) after pressure is relieved. If accumulator needs charged, leave line and chuck attached to charging valve and charge the accumulator as described under 'Charging The Accumulator'.

8. If precharge is 55 bar (800 lbf/in^2) at 21° C (70° F), rotate 'T' handle anticlockwise until it stops, then torque tighten locknut (1D, Fig. 1) on charging valve (1, Fig. 1) to 11 Nm (100 lbf in). Loosen the swivel nut and remove the gauging head.

9. Install valve cap (1A, Fig. 1) on charging valve (1, Fig. 1) and tighten finger tight.

CHARGING THE ACCUMULATOR

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Either oil or water pumped nitrogen can be used to charge the accumulator. Both types are readily available from a local compressed gas dealer.

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⚠ WARNINGS
Do not use Oxygen or any gas other than Nitrogen to charge an accumulator. Oxygen under pressure coming into contact with oil or grease will cause a violent explosion. Always double check to make sure you are using Nitrogen to prevent personal injury and property damage.

⚠ A high pressure nitrogen pressure regulator must be used with the charging assembly. Failure to use pressure regulator could cause property damage, personal injury or death.

1. Attach line (1) and the swivel nut to charging valve (1, Fig. 1) as described in Steps 1 through 4 under the heading 'Testing Pre-charge Pressure'. Be sure valves (4 & 6) are closed.

2. Attach gauging head to nitrogen bottle by screwing down on gland nut (8).

3. Open tank valve (6) slowly; pressure shown on gauge (5) is tank pressure.

4. Open accumulator valve (4) slowly and charge accumulator to 55 bar (800 lbf/in^2) at 21° C (70° F) ambient temperature, closing valve occasionally. Refer to the table at the end of this section for the Nitrogen pressures at ambient temperatures of other than 21° C (70° F).

5. To check accumulator charge, close tank valve (6), relieve pressure between tank and gauge by opening bleeder valve (10) momentarily. This will allow gauge needle to settle, thus giving correct pressure reading of accumulator charge.

6. When the correct pressure for the ambient temperature has been reached, close valves (4 & 6) tightly. Bleed pressure off pressure gauge (5) by opening bleeder valve (10). Close bleeder valve when all pressure is bled off the gauge.

7. Unscrew gland nut (8) from nitrogen bottle.

8. Rotate 'T' handle of valve chuck (2) anticlockwise until it stops, torque tighten charging valve locknut (1D, Fig. 1) to 11 Nm (100 lbf in), loosen the swivel nut and remove gauging head.

9. Check accumulator charging valve (1, Fig. 1) for leakage using soapy water. Reinstall valve cap (1A, Fig. 1) and tighten finger tight.

DISCHARGING NITROGEN

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Make sure charging valve (1) is closed internally by turning locknut (1D) clockwise. Remove valve cap (1A) and valve core (1B) from charging valve assembly (1). Slowly turn the locknut (1D) anticlockwise to open the charging valve assembly (1).

DO NOT remove charging valve (1) until all the gas has been completely evacuated.

⚠ WARNING
Do not try to discharge the accumulator by depressing the charging valve core (1B, Fig. 1).

REMOVAL

Numbers in parentheses refer to Fig. 3.

⚠ WARNINGS
Make sure that lifting equipment, blocking materials and wheel blocks are properly secured and of adequate capacity to prevent personal injury and property damage.

⚠ Accumulators are charged with Nitrogen. The service pressure is 55 bar (800 lbf/in^2) at 21° C (70° F). Be sure all Nitrogen pressure has been relieved before removing accumulator from the truck. Sudden release of pressure may cause personal injury.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators. Block all road wheels.

3. Remove screws (2, Fig. 1), lockwashers (3, Fig. 1) and protector (4, Fig. 1).

4. Discharge nitrogen from accumulators. Refer to previous section on 'Discharging Nitrogen' for correct procedure.

5. Disconnect hydraulic lines from bottom of accumulators. Drain oil and cap the lines and accumulator ports to prevent ingress of dirt.

6. Support the accumulators using an adequate sling and lifting device. Remove bolts (1 & 2), washers (3) and clamps (4). Remove accumulators.

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Braking System - Accumulator

Section 250-0060

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
Accumulators are charged with Nitrogen. The service pressure is 55 bar (800 lbf/in²) at 21° C (70° F). Do not attempt to remove any valves or fittings until all nitrogen pressure is completely relieved to prevent personal injury and property damage.

1. Make sure all nitrogen gas has been released before starting to disassemble the accumulator. Refer to section on 'Discharging Nitrogen'.

2. Remove charging valve (1) from end cap (10).

3. With accumulator lying horizontal, hold accumulator cylinder (12) with a strap wrench.

4. Install pins in three equally spaced holes in end cap (10), then use a long bar working against the pins to remove end cap from cylinder (12). Remove and discard 'O' ring (9).

5. Grip cast web of piston (5) with pliers and while rotating, pull piston from cylinder (12). Remove and discard wear rings (8), backup rings (6) and 'V' section ring (7).

INSPECTION

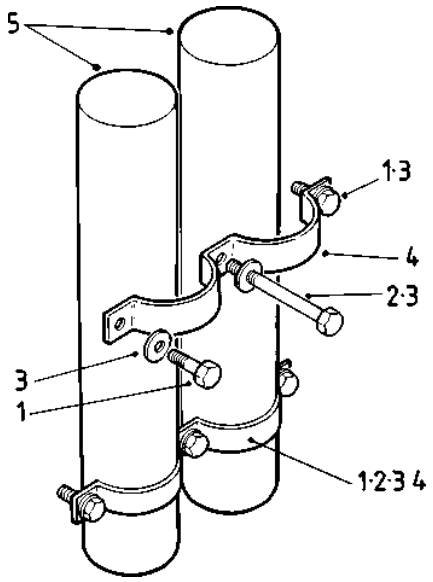
Numbers in parentheses refer to Fig. 1.

1. Wash metal components with a suitable solvent and thoroughly air dry.

2. Inspect piston (5) for cracks or burrs. Replace piston (5) if excessively scored or worn.

3. Use an inspection lamp to check the bore of accumulator cylinder (12) for scratches or scoring. Minor nicks, scratches or light scoring of the bore can be removed by using crocus cloth. Dress the bore until all apparent imperfections have been removed. Replace complete accumulator assembly if the inside of cylinder (12) is excessively scored or worn.

4. Inspect threads in end cap (10) and threads in cylinder (12) for damage. Replace all parts worn or damaged beyond repair.



1 - Bolt
2 - Bolt
3 - Washer
4 - Clamp
5 - Accumulator

Fig. 3 - Accumulator Installation

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Lubricate ‘O’ ring (9), wear rings (8), backup rings (6), 'V' section ring (7) and inside of cylinder (12) with hydraulic oil prior to assembly.

2. Install new 'V' section ring (7), backup rings (6) and wear rings (8) on piston (5).

3. Insert piston (5) into cylinder (12) with cupped end facing the open end of the cylinder. Do not let 'V' section ring (7) drag on cylinder threads. Use a hammer and wood block to tap piston into place until all of piston is 50 mm (2.0 in) below beginning of honed bore. Keep pressure against piston while tapping 'V' section ring (7) through the bore chamfer, otherwise piston will bounce back, damaging the 'V' section ring.

4. Install new 'O' ring (9) on end cap (10) and install end cap (10) in cylinder (12). Tighten cap so that it is flush with the end of cylinder (12) within 1.6 - 2.4 mm (0.062 - 0.094 in) above or below.

5. Install charging valve (1). Torque tighten locknut (1D) clockwise to 11 Nm (100 lbf in) to close charging valve, insert valve core (1B), replace valve cap (1A) and tighten finger tight.

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6. Test accumulator hydraulically for leakage or failure at 255 - 276 bar (3 700 - 4 000 lbf/in^2). Discharge after testing.

INSTALLATION

Numbers in parentheses refer to Fig. 3.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

> ⚠ **WARNING**
> **Make sure that lifting equipment, blocking materials and wheel chocks are properly secured and of adequate capacity to prevent personal injury and property damage.**

1. Position accumulators on mounting bracket with the oil inlet ports downward.

2. Attach clamps (4) securely with washers (3) and bolts (1 & 2).

3. Remove caps installed at 'Removal' to prevent dirt entering the hydraulic lines and accumulator ports.

4. Install hydraulic lines securely to the oil inlet port at the bottom of the accumulators.

5. Charge the accumulator with Nitrogen gas as described under the heading 'Charging the Accumulator' in this section.

6. Check oil level in steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and, use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

7. Remove wheel chocks, start the engine and bring hydraulic oil to operating temperature.

8. Check for oil leaks as the oil pressure increases. Tighten line connections and fittings as necessary.

MAINTENANCE

Inspect the accumulators regularly for any signs of leakage or damage.

Every 500 hours
Check the Nitrogen precharge pressure at the accumulators, prior to checking braking system pressure. Refer to 'Testing Pre-charge Pressure', in this section.

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools referenced in this section and general service tools required. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf in
1	1D	Locknut	11	100

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AMBIENT TEMPERATURE - NITROGEN PRE-CHARGE PRESSURE			
AMBIENT TEMPERATURE		NITROGEN PRE-CHARGE PRESSURE	
°C	°F	bar	lbf/in²
-18	0	47.7	692
-12	10	48.8	708
-7	20	49.8	723
-1	30	50.9	738
5	40	52	754
10	50	53	769
16	60	54.1	785
21	70	55	800
27	80	56.2	815
32	90	57.3	831
38	100	58.3	846
43	110	59.4	862
49	120	60.5	877
54	130	61.5	892

⚠ WARNING

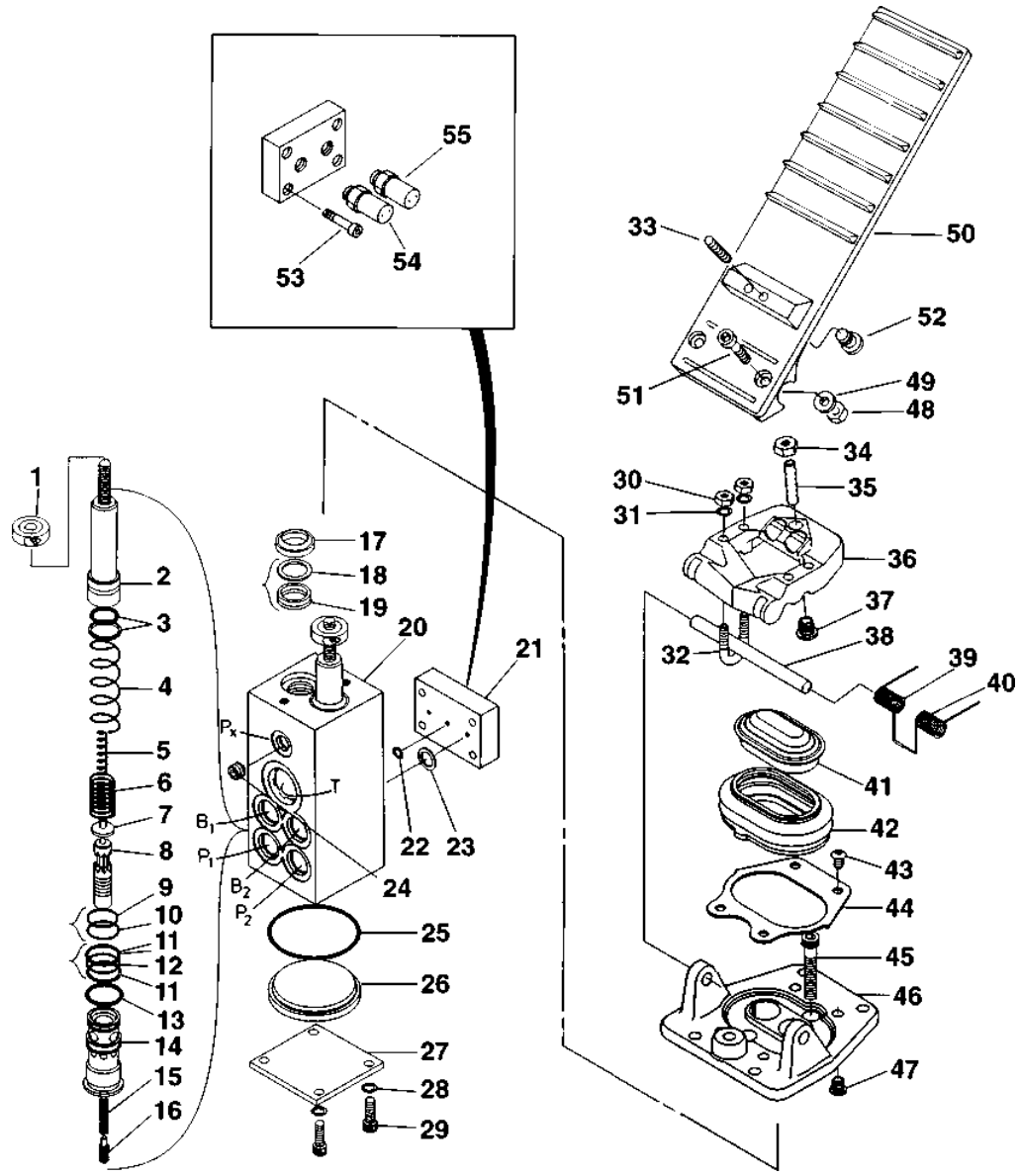
This truck is equipped with precharged nitrogen gas cylinders of more than 2.8 bar (40 lbf/in²). Special permits may be required when transporting the truck or cylinders by any method while cylinders are charged. For shipment, contact the appropriate agency in the country involved. Consult your dealer for further permit information.

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1 - Adjustment Collar
2 - Actuator Plunger
3 - Glyde Ring Assembly
4 - Plunger Return Spring
5 - Regulator Spring
6 - Regulator Spring
7 - Spring Seat
8 - Regulator Spool
9 - Backup Ring
10 - 'O' Ring
11 - Backup Ring
12 - 'O' Ring
13 - 'O' Ring
14 - Regulator Sleeve
15 - Spool Return Spring
16 - Reaction Plunger
17 - Wiper Seal
18 - Backup Ring
19 - Seal
20 - Valve Body
21 - Plate
22 - 'O' Ring
23 - Face Seal
24 - Screw
25 - 'O' Ring
26 - Retaining Plug
27 - Base Plate
28 - Washer
29 - Capscrew
30 - Nut
31 - Washer
32 - U Bolt
33 - Screw
34 - Nut
35 - Adjustment Screw
36 - Actuator Cam
37 - Insert
38 - Pivot Pin
39 - Return Spring
40 - Return Spring
41 - Cap
42 - Boot
43 - Screw
44 - Retainer Plate
45 - Capscrew
46 - Actuator Base
47 - Insert
48 - Nut
49 - Washer
50 - Pedal
51 - Capscrew
52 - Insert
53 - Capscrew
54 - Lockup Drop Out Pressure Switch
55 - Stop Light Pressure Switch

Fig. 1 - Exploded View of Treadle Valve Assembly

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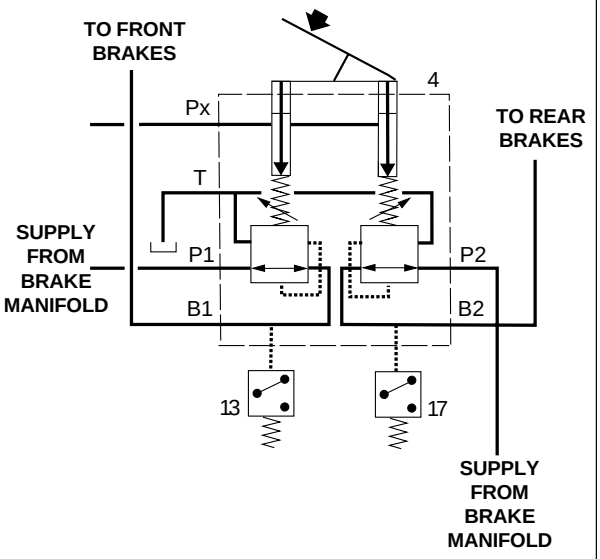


Fig. 2 - Normal Service Brake Application

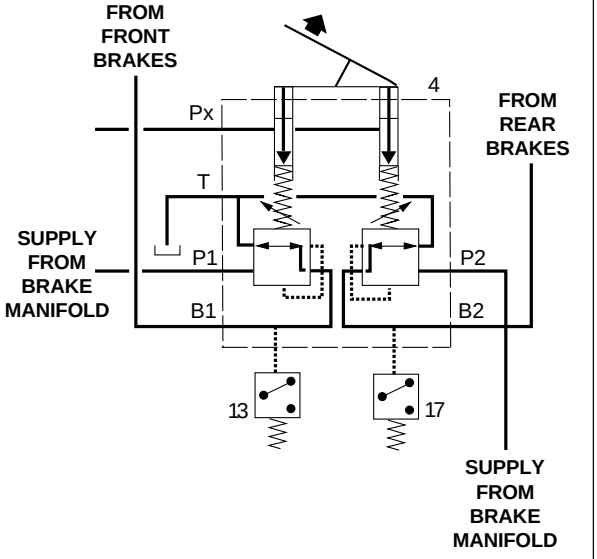


Fig. 3 - Normal Service Brake Release

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

Note: The treadle valve can be identified as item 4 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

The treadle valve is a closed centre controller which controls the level of hydraulic oil pressure applied to the front and rear brakes and the maximum pressure available to these circuits. It is operated by a foot pedal in the operators cab and with the engine running, is automatically applied by the brake manifold valve. Refer to Section 250-0050, BRAKE MANIFOLD VALVE.

The differing maximum operating pressures required for the front and rear brakes are achieved within the treadle valve. These pressures can be adjusted as described under 'Testing and Adjustments'.

In the normal position, brake pedal (50) and regulator spools (8) are in the up position. In this condition the notched area near the top of regulator spools (8) is exposed to the tank cavity in valve body (20), the lower portion of the notched area is exposed to the regulated pressure outlet ports of the valve. This effects a direct link between the tank port 'T' and the regulated outlet ports 'B1' and 'B2'. While regulator spools (8) are in this position the brakes are released.

Stop light pressure switch (55) sends a signal to illuminate the brake lights at the rear of the vehicle on actuation of the treadle valve.

Lockup drop out pressure switch (54) sends a signal to actuate the lockup drop out solenoid, which in turn drops the transmission out of lockup on actuation of the treadle valve.

OPERATION

Numbers in parentheses refer to Fig. 1.

Normal Service Brake Application

Refer to Fig. 2. When the operator depresses pedal (50), actuator plungers (2) are moved down and push on regulator springs (5 & 6) which in turn, push regulator spools (8) down. As regulator spools (8) move down, the metering notches move out of the tank cavity and close outlet ports 'B1' and 'B2' off to tank port 'T'. Regulator spools (8) continue to move downward until the lower edge of the metering notches become exposed to the inlet pressure ports. This movement opens inlet ports 'P1' and 'P2' to outlet ports 'B1' and 'B2' respectively.

As hydraulic pressure builds in the brake, oil flows through the small orifice in the side of regulator spools (8) and into the cavities below the spools. As pressure rises in the brake it also rises in the cavities below the spools forcing regulator spools (8) upwards closing outlet ports 'B1' and 'B2'. Regulator spools (8) are now balanced between the brake pressure and the pressure of regulator springs (5 & 6) generated by the

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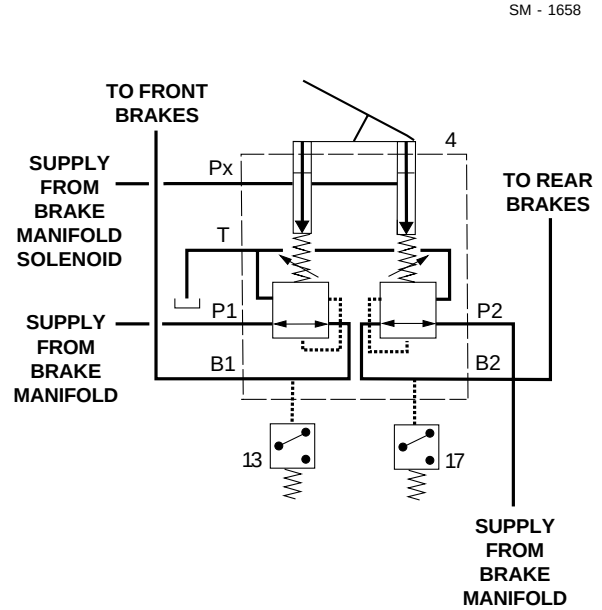


Fig. 4 - Park/Emergency Brake Application

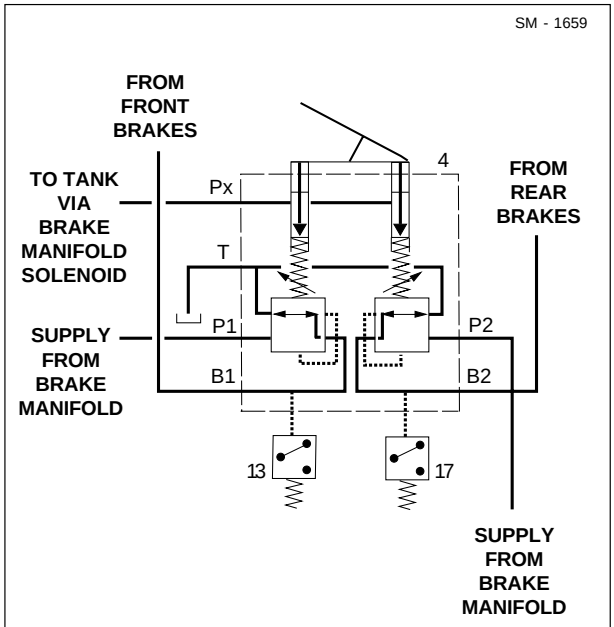


Fig. 5 - Park/Emergency Brake Release

operators force on pedal (50). Regulator spools (8) have closed off the inlet ports, outlet ports and the tank port and will remain in this position as long as pedal (50) is not moved. If the operator further depresses pedal (50), regulator spools (8) will move down and build more pressure in the brake until it balances the pedal force.

Normal Service Brake Release

Refer to Fig. 3. When the operator releases pedal (50), regulator spool (8) will become unbalanced and move upwards, opening outlet ports 'B1' and 'B2' to tank. At this point, oil in the 'B1' and 'B2' lines is released to tank through tank port 'T', releasing the brakes.

Emergency Stop Brake Application/ Release

Refer to Fig. 4. Pressing/pushing of the emergency control knob results in the de-energization of the brake manifold valve solenoid. This allows full pressure to enter the 'Px' port in the treadle valve simulating a full and immediate depression of pedal (50), i.e. pushing regulator spools (8) downwards and thereby applying maximum braking action.

Refer to Fig. 5. Releasing the emergency control knob will energize the brake manifold valve solenoid, allowing the pressure in the 'Px' line to fall via the return to tank port opened within the valve. Outlet ports 'B1' and 'B2' are opened to tank port 'T' allowing oil in the 'B1' and 'B2' lines to return to tank, releasing the brakes.

Note: Outlet ports 'B1' and 'B2' will give output pressure 5% higher when activated by an emergency stop ('Px' circuit) than a brake pedal actuation.

REBUILD CRITERIA

Inspect the valve regularly for any signs of leakage or damage. Check the actuator for excessive cam rock and replace components if necessary.

The controller should be rebuilt if one or more of the following conditions exist:

1. Any sign of external leakage.

Note: Check all hydraulic lines and fittings to ensure leakage is not coming from there.

2. Failure of the pedal to return to full upright position.

3. Treadle valve holds pressure when in the neutral position.

4. Varying output pressure with the pedal fully depressed.

5. Output pressure should remain constant between circuits within ± 5.2 bar (± 75 lbf/in²).

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Braking System - Treadle Valve

Section 250-0070

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

⚠ Hydraulic oil pressure will remain within the system after engine shut down. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the braking accumulators. Block all road wheels.

3. Clean treadle valve assembly and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to the treadle valve are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines and treadle valve ports.

4. Remove and tag electrical connections to stop light pressure switch (55) and lockup drop out pressure switch (54).

5. Release and remove mounting hardware securing the treadle valve to the cab floor. Remove treadle valve assembly to a clean area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Remove blanking caps from treadle valve ports and drain oil from valve body (20) ports by rotating the valve over a suitable container.

2. Secure the controller upright in a table vice.

3. Remove pedal (50) from actuator cam (36) by loosening two capscrews (51) at the pedal heel. Note that capscrews (51) need not be removed.

4. Loosen but do not remove nuts (30) from 'U' bolts (32) securing actuator pivot pin (38).

5. Remove pivot pin (38) from actuator base (46) with a punch and hammer. Remove actuator cam (36) assembly and inspect for any abnormal wear or cracks. Set aside for assembly.

6. Remove screws (43) securing retainer plate (44) to actuator base (46).

7. Remove retainer plate (44), boot (42) and cap (41) as an assembly by grasping boot (42) and gently lifting from actuator base (46).

8. Loosen the socket head capscrews from adjustment collars (1) and unscrew adjustment collars (1).

9. Remove capscrews (45) securing actuator base (46) to valve body (20). Remove actuator base (46) from valve body (20).

10. Remove stop light pressure switch (55) and lockup drop out pressure switch (54) from plate (21).

11. Remove capscrews (53) securing plate (21) on valve body (20). Remove plate (21) and discard 'O' ring (22) and face seals (23).

12. Remove controller from the vice.

13. Remove capscrews (29) and washers (28) from the base of valve body (20). Remove base plate (27).

14. With valve body (20) upright, retaining plug (26) should fall out. If retaining plug (26) does not fall out, lightly tap the plug to dislodge.

15. Remove and discard 'O' ring (25) from counterbore in the base of valve body (20).

Note: Throughout the following steps it is important to keep the circuits and circuit components identified as to which side of the unit they came from. For a given circuit, all the components have a tolerance stack which could vary. Keep the 'B1' and 'B2' components separate.

16. With the controller upright on the work bench, hold valve body (20) with one hand and push the 'B1' actuator plunger (2) down with the other hand until regulator sleeve (14) pops loose.

17. Repeat the above procedure to loosen the 'B2' regulator sleeve (14).

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18. Turn valve body (20) on its side on the work bench and remove regulator sleeves (14) from valve body (20).

19. Remove regulator spools (8), reaction plungers (16) and spool return springs (15) from regulator sleeves (14).

20. Remove plunger return springs (4), regulator springs (5 & 6) and spring seats (7) from valve body (20).

21. Remove actuator plungers (2) by pushing down by hand (toward the bottom of valve body (20)) on the actuator plunger until actuator plunger (2) slides out.

22. Remove glyde ring assembly (3) from actuator plunger (2).

23. Remove 'O' rings (10, 12 & 13) and teflon backup rings (9 & 11) from regulator sleeves (14) and discard.

24. Remove wiper seals (17), seals (19) and backup rings (18) from the actuator section of the valve and discard.

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Clean all parts with a suitable cleaning solvent.

2. Inspect actuator plunger (2) for wear on the sides where it moves through the seals. If axial grooves are seen or if any wear is evident, replace actuator plunger (2). Actuator plungers (2) with diameter worn below 18.97 mm (0.747 in) must be replaced.

3. Place regulator spool (8) into regulator sleeve (14) and push the spool lightly through the sleeve. Regulator spool (8) must be able to move freely and smoothly the entire length of regulator sleeve (14). If it cannot, regulator spool (8) and regulator sleeve (14) must be replaced as a matched set.

Note: Never replace just the spool or sleeve. They must be replaced as a matched set.

4. Inspect each spring carefully for cracks or breaks. Any spring with a crack or break must be replaced. Also, if the treadle valve was not reaching proper regulated pressure, replace all regulator springs.

5. Inspect threaded inserts (37, 47 & 52) in actuator cam (36), actuator base (46) and pedal (50). If any of the threads are damaged, the inserts must be replaced.

SUB-ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: All metal parts should be thoroughly cleaned with a suitable solvent, dried, and lubricated with a light weight oil before assembly. This valve is built to extremely close manufacturing tolerances. Great care should be taken to keep components protected from contamination prior to and during assembly.

Boot and Cap

1. Inspect boot (42) for any cracks, tears, or other damage. If damage is evident, replace boot (42). To replace boot (42), follow the procedure below.

2. Remove and discard boot (42) from cap (41). Using a knife or suitable scraper, thoroughly clean the sides of cap (41) by scraping the lip where the cap contacts the boot. Clean thoroughly to remove all residual adhesive or particles of boot (42).

3. Apply a thin bead of Loctite Prism 410 onto the upper side of cap (41). Apply the bead to the two long sides only. Do not apply it to the rounded ends, these must not be sealed to allow the boot to 'breathe'.

4. Carefully position cap (41) into the groove of new boot (42) wiping off excess Loctite.

5. Position boot (42) such that it conforms to the contour of cap (41), then set aside. Loctite Prism 410 requires about 30 minutes to cure.

Threaded Inserts

1. Position actuator base (46) upside down on the work bench and support directly under each of the four floor mounting holes. Install threaded inserts (47) into actuator base (46) by tapping lightly with a small hammer until insert (47) flanges become flush with actuator base (46). Be sure actuator base (46) is supported to prevent braking. Thoroughly clean actuator base (46) assembly and set aside.

2. Position actuator cam (36) upside down on the work bench and support it at the centre hole. Insert threaded insert (37) by tapping lightly with a small hammer until its flange becomes flush with actuator cam (36) surface. Be sure actuator cam (36) is supported to prevent breaking. Thoroughly clean actuator cam (36) assembly and set aside.

3. Position pedal (50) upside down on the work bench and support it directly above the two holes near its

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centre. Install threaded inserts (52) by tapping lightly with a small hammer until their flanges become flush with pedal (50) surface. Be sure pedal (50) is supported to prevent breaking.

4. Install oval point screws (33) into inserts (52) and screw down until 12.7 mm (0.5 in) of screws (33) protrude below insert (52) flanges. Make sure that both screws (33) are adjusted to the same dimension.

5. If removed, install capscrews (51) into pedal (50) and install washers (49) and nuts (48) onto capscrews (51). Screw nuts (48) on flush with the ends of capscrews (51) and set the assembly aside.

Valve Body Seals

1. Install seal (19) in seal groove of valve body (20) first. Position seal (19) in the groove so that internal 'O' ring is facing down toward the bottom of valve body (20). See Fig. 6.

2. Make sure the internal 'O' ring is still seated inside seal (19) and did not get dislodged during installation. Position seal (19) to the bottom of the groove.

3. Install backup ring (18) on top of seal (19). Start by hand and then continue to work into the groove either by hand or by using an 'O' ring installation tool.

4. Install wiper seal (17) in the top counterbore. Position wiper seal (17) in the groove so that the register lip is facing up toward the actuator.

5. Repeat steps 1 through 4 for the second circuit.

Regulator Sleeve

1. Install 'O' ring (10) onto the smallest groove (on the top) of regulator sleeve (14). Install 'O' ring (12) onto the middle groove of regulator sleeve (14). Install 'O' ring (13) onto the largest groove (on the bottom) of regulator sleeve (14). See Fig. 7.

2. Install backup ring (11) onto each side of 'O' ring (12) located in the middle of regulator sleeve (14). See Fig. 7.

3. Install backup ring (9) behind 'O' ring (10) located at the top end of regulator sleeve (14). 'O' ring (10) is the smallest of the three 'O' rings. Position backup ring (9) so that it is next to the top of regulator sleeve (14). The top of regulator sleeve (14) is the end with the smallest OD. See Fig. 7.

4. Repeat steps 1 through 3 for the second circuit.

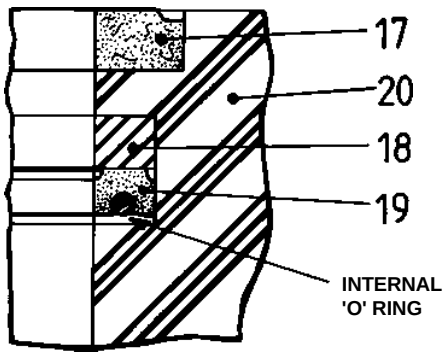


Fig. 6 - Valve Body Seal Installation

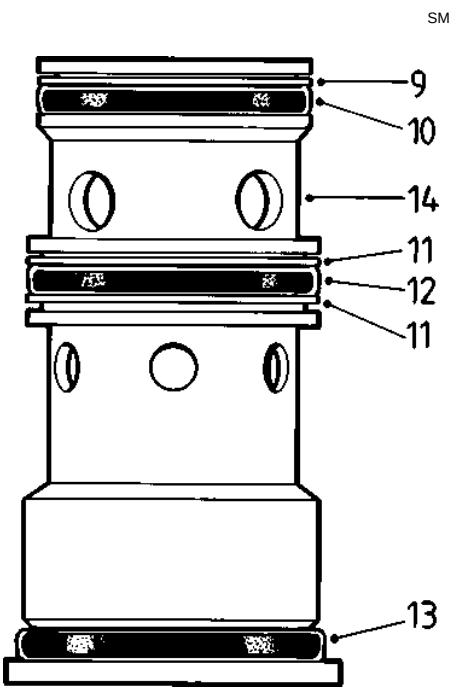


Fig. 7 - Regulator Sleeve Seal Installation

Actuator Plunger

Note: Glyde ring (3) assembly consists of an 'O' ring and a split glyde ring.

1. Install 'O' ring into the 'O' ring groove located at the large diameter end of actuator plunger (2).

2. Install split glyde ring over the 'O' ring. Twist and squeeze the split glyde ring into a small circle before installing to ensure a tight fit over the 'O' ring.

3. Repeat steps 1 and 2 for the second circuit.

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ASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Lightly lubricate glyde ring assembly (3) and install the 'B1' actuator plunger (2) into the 'B1' circuit. Be careful not to damage or cut the glyde ring during installation. Observe glyde ring assembly (3) through tank port 'T' as actuator plunger (2) is being installed.

Note: It may be necessary to work the glyde rings past the sharp edge in valve body (20) to prevent damage to the seal. Make sure actuator plunger (2) is completely seated and bottomed. See Fig. 8.

2. Repeat step 1 for the 'B2' actuator plunger.

Note: Start with either side (circuit) of the valve and build that side up complete before starting on the other circuit. Be careful to assemble components into the circuit from which they were removed.

3. Install plunger return spring (4), regulator springs (5 & 6) and spring seat (7) into the appropriate circuit. If spring seat (7) does not seat correctly on top of regulator spring (6), lightly shake valve body (20) to correctly position spring seat (7).

4. Lightly lubricate regulator spool (8) assembly and install into regulator sleeve (14). The spherical end of regulator spool (8) should be at the top of regulator sleeve (14). The top of regulator sleeve (14) is the end with the smallest OD.

Note: Check to ensure that regulator spool (8) will slide smoothly and freely in regulator sleeve (14). Replace the entire spool and sleeve assembly if the spool does not slide smoothly and freely.

5. Remove regulator spool (8) from regulator sleeve (14) before installing sleeve into valve body (20).

6. Lightly lubricate 'O' rings (10, 12 & 13) on regulator sleeve (14).

7. Install regulator sleeve (14) assembly into the correct circuit of valve body (20). Make sure spring seat (7) is correctly seated in regulator spring (6) before installing regulator sleeve (14). Push regulator sleeve (14) into bore until retaining flange at the base contacts valve body (20).

8. Install spool return spring (15) into regulator spool (8). Install reaction plunger (16) into regulator spool (8). Reinstall regulator spool (8) into regulator sleeve (14).

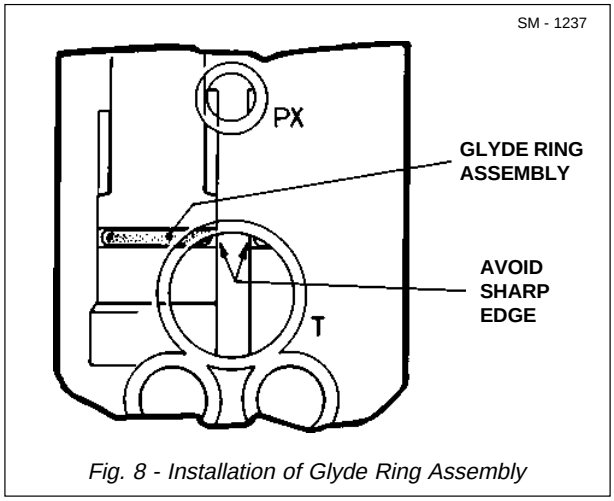


Fig. 8 - Installation of Glyde Ring Assembly

9. Repeat steps 3 through 8 for the second circuit.

10. Lightly lubricate 'O' ring (25) and install into the counter bore in the bottom end of valve body (20).

11. Install retaining plug (26) into the counter bore on the bottom of valve body (20). Make sure steps on retaining plug (26) are facing the counter bore (toward the top of valve body (20)).

12. Install base plate (27) on top of retaining plug (26) and secure with capscrews (29) and washers (28). Tighten capscrews (29) evenly to a torque of 16 - 17 Nm (140 - 150 lbf in), alternating diagonally to evenly seat regulator sleeve (14) assembly.

13. Install actuator base (46) on top of valve body (20) and secure with capscrews (45). Make sure to position properly for correct port direction. Tighten capscrews (45) to a torque of 20 - 21 Nm (180 - 190 lbf in).

14. Screw adjustment collars (1) onto the top of actuator plungers (2). Screw all the way down until they bottom on the threads.

Note: It is extremely important to bottom-out adjustment collars (1) to prevent over-stressing and breaking the springs during the adjustment process.

15. Lightly lubricate and install new 'O' ring (22) and face seals (23) in grooves of plate (21).

16. Install valve body (20) in a vice with tank port 'T' facing down. Carefully place plate (21) assembly on valve body (20) and secure with capscrews (53). Tighten capscrews (53) to a torque of 16 - 17 Nm (140 - 150 lbf in).

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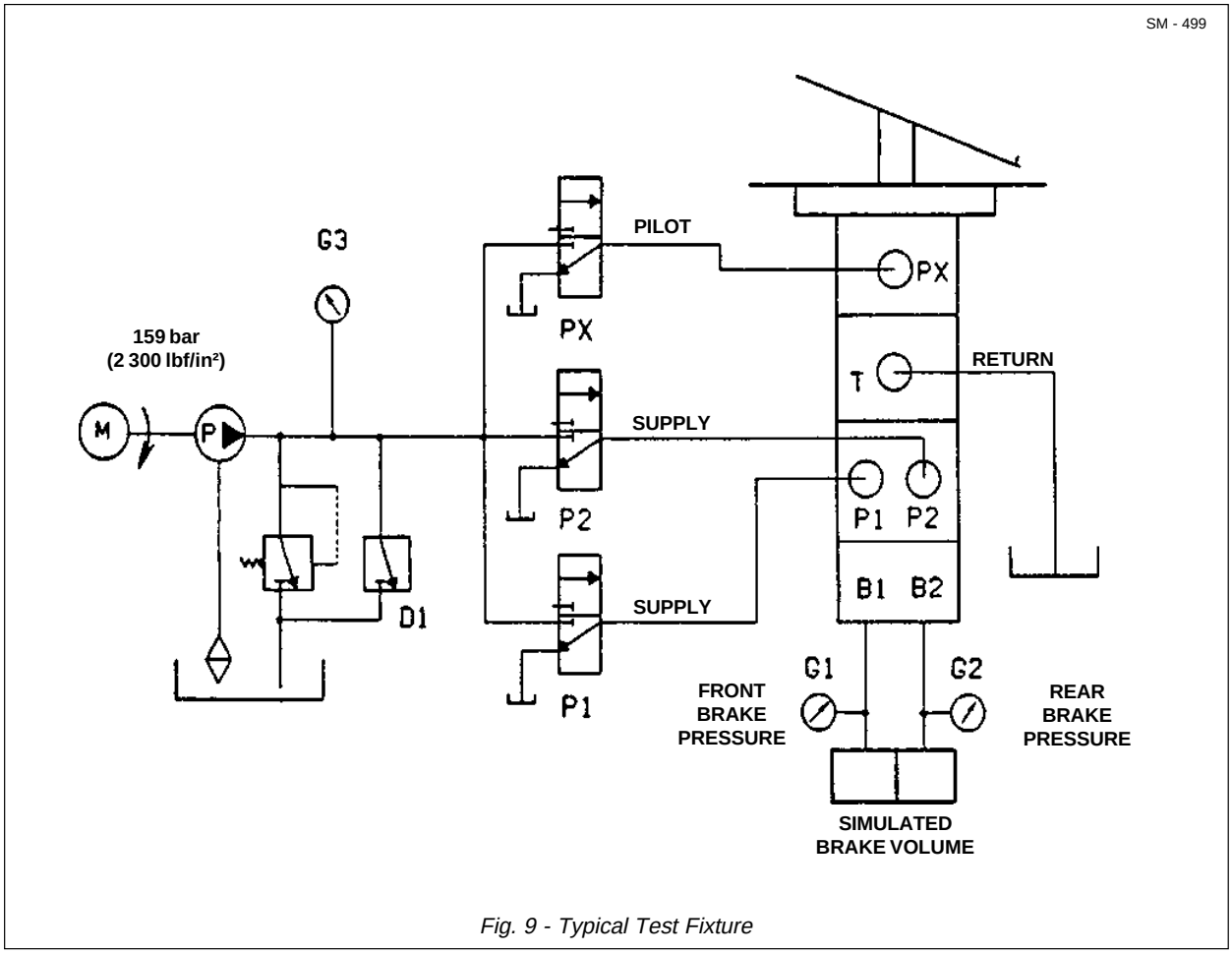


Fig. 9 - Typical Test Fixture

17. Install stop light pressure switch (55) and lockup drop out pressure switch (54) in plate (21) and tighten securely.

Note: The valve assembly must be connected to a hydraulic supply and pressures set before further assembly can be done.

TESTING AND ADJUSTMENTS

Numbers in parentheses refer to Fig. 1.

Note: A hydraulic test fixture with capabilities similar to the one shown in Fig. 9 is required.

1. Position the valve in the test fixture to allow plungers to be activated by hand using a lever. See Fig. 10.

2. Attach pilot supply line to 'Px' port of valve body (20).

3. Attach main supply lines to 'P1' and 'P2' ports of valve body (20).

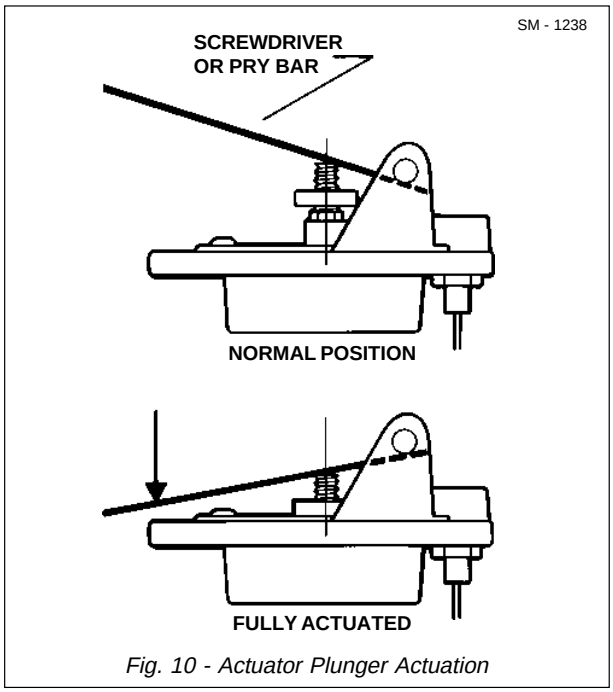


Fig. 10 - Actuator Plunger Actuation

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4. Attach tank return line to 'T' port of valve body (20).

5. Attach output ports 'B1' and 'B2' to test lines. Check that all ports are used.

6. Set supply line pressure to 159 bar (2 300 lbf/in²).

7. Set pilot supply pressure to 159 bar (2 300 lbf/in²).

8. Return line pressure during this test is not to exceed 0.34 bar (5 lbf/in²).

9. Test valve with 10W hydraulic oil at 50° + 6° C (120° + 10° F).

Setting Manual and Pilot Pressure

1. Install pivot pin (38) in actuator base (46) by itself without installing pedal (50) assembly.

2. By taking a screw driver or pry bar and placing it under pivot pin (38) and on top of actuator plunger (2) assembly, you will be able to actuate each circuit individually. See Fig. 10.

3. Gradually apply pressure on each circuit to check for leaks. Make sure adjustment collar (1) is screwed all the way down on the threads.

4. Adjust adjustment collar (1) up (anticlockwise) starting with one turn increments until the output pressure is 159 bar (2 300 lbf/in²) at port 'B1' with adjustment collar (1) contacting actuator base (46) (fully actuated). See Fig. 10. Fine adjustment will require only turning the collar in 1/8 turn increments.

5. Adjust adjustment collar (1) up (anticlockwise) starting with one turn increments until the output pressure is 52 bar (750 lbf/in²) at port 'B2' with adjustment collar (1) contacting actuator base (46) (fully actuated). See Fig. 10. Fine adjustment will require only turning the collar in 1/8 turn increments.

6. Cycle each circuit 50 times using pilot apply.

7. Recheck pressures after cycling. If they have changed, readjust.

8. Tighten the capscrews in adjustment collars (1) to 3 - 3.5 Nm (25 - 30 lbf in). You may have to rotate entire actuator plunger (2) to get to the capscrews.

9. Check pressures again after tightening the capscrews. If the pressures have altered, loosen the appropriate capscrew and readjust.

FINAL ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Remove pivot pin (38) from actuator base (46).

2. Assemble actuator cap (41), boot (42) and retainer plate (44) to actuator base (46) and secure with screws (43).

3. Insert pivot pin (38) through the hole in actuator base (46), through the holes in 'U' bolts (32), and through the pivot pin hole in the other side of actuator base (46). As pivot pin (38) is being inserted, install pedal return springs (39 & 40).

4. Centre pivot pin (38) and secure with nuts (30) and washers (31) on 'U' bolts (32). Tighten nuts (30) to a torque of 16 - 17 Nm (140 - 150 lbf in).

5. Install pedal (50) assembly on actuator cam (36) and secure with capscrews (51), washers (49) and nuts (48).

ADDITIONAL TESTING AND ADJUSTMENT

Numbers in parentheses refer to Fig. 1.

1. Depress pedal (50) as quickly as possible. The output pressure on the circuits must reach 159 bar (2 300 lbf/in²) at port 'B1' and 52 bar (750 lbf/in²) at port 'B2' within 10 seconds. Measurement of time begins the moment force is applied to move pedal (50).

2. Back-off deadband adjustment screw (35) (anticlockwise) so that adjustment screw (35) is not touching actuator cap (41). Apply Loctite 243 to adjustment screw (35) prior to setting the deadband.

3. Set the deadband by placing a 0.64 mm (0.025 in) shim between the pedal return stop and the boss on the actuator base return stop. See Fig. 11.

4. Turn adjustment screw (35) down (clockwise) until it is touching actuator cap (41).

5. Continue turning adjustment screw (35) clockwise until you start to see a pressure reading on the pressure gauge then back-off adjustment screw (35) 1/8 turn (anticlockwise).

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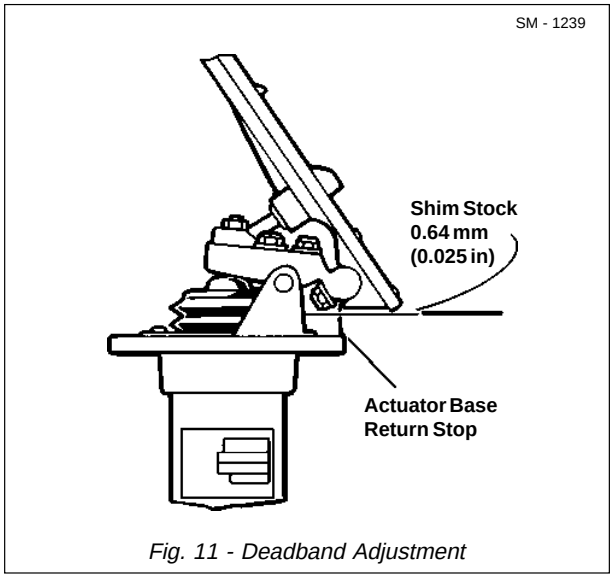


Fig. 11 - Deadband Adjustment

6. Tighten nut (34) and remove the shim stock. Apply a few drops of Loctite 243 to nut (34).

Pedal Angle Adjustment

1. Loosen nuts (48) at the rear of actuator cam (36). Do not loosen nuts (30) on 'U' bolts (32).

2. Adjust pedal (50) angle by turning screws (33) located in the top face or ribbed side of pedal (50). Clockwise will raise the angle and anticlockwise will lower the angle.

3. Adjust the two screws (33) evenly. When the desired pedal angle is achieved, apply Loctite 243 on screws (33).

4. While holding the pedal down, retighten the rear capscrews (51) and nuts (48).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Position treadle valve assembly on cab floor and secure with mounting hardware. Remove blanking caps from ports.

2. Remove blanking caps and connect hydraulic lines to the treadle valve assembly as noted at removal.

3. Connect electrical connections to stop light pressure switch (55) and lockup drop out pressure switch (54) as noted at removal.

4. Check oil level in steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

5. Remove wheel blocks, start the engine and bring hydraulic oil to operating temperature.

6. Apply the brakes and check for oil leaks. Tighten line connections and fittings as necessary.

Note: When performing Step 7, make sure that parking brake applies and releases appropriately.

7. Check brake operations by actuating pedal and park/emergency control.

8. Switch off engine and check oil level in steering and brake control tank. See Step 4.

SERVICE

Numbers in parentheses refer to Fig. 1.

Brake Actuating Pressure

Note: Test front 'B1' and rear 'B2' brake circuit actuating pressures at diagnostic test points and adjust if necessary. Refer to Section 250-0000, BRAKING SYSTEM SCHEMATIC for location of test points.

1. Connect a hydraulic gauge capable of recording a pressure of 0 - 207 bar (0 - 3 000 lbf/in²) to diagnostic pressure point for front 'B1' brake pressure.

2. Start engine and bring hydraulic oil temperature to operating temperature.

3. Actuate treadle valve fully and check reading on pressure gauge. Pressure reading should be 159 bar (2 300 lbf/in²).

4. Repeat steps 1 through 3 at diagnostic pressure point for rear 'B2' brake pressure. Pressure reading should be 52 bar (750 lbf/in²).

Note: If the pressures to the brake circuits have been determined as low or high, the pressures can be raised or lowered by an in service (in situ) adjustment.

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5. Remove pedal (50) from actuator cam (36) by loosening two capscrews (51) at the pedal heel. Note that capscrews (51) need not be removed.

6. Loosen but do not remove nuts (30) from U bolts (32) securing actuator pivot pin (38).

7. Remove pivot pin (38) from actuator base (46) with a punch and hammer. Remove actuator cam (36) assembly.

8. Remove screws (43) securing retainer plate (44) to actuator base (46).

9. Remove retainer plate (44), boot (42) and cap (41) as an assembly by grasping boot (42) and gently lifting from actuator base (46).

10. Slacken capscrews in adjustment collars (1).

11. Install pivot pin (38) in actuator base (46) and by taking a screw driver or pry bar and placing it under pivot pin (38) and on top of actuator plunger (2), you will be able to actuate each circuit individually.

12. Start engine to ensure full hydraulic pressure.

13. Test front 'B1' and rear 'B2' brake circuit actuating pressures at diagnostic test points and adjust if necessary. Pressures should be 159 bar (2 300 lbf/in²) for front 'B1' circuit and, 52 bar (750 lbf/in²) for rear 'B2' circuit.

Note: Turning adjustment collar (1) up (anticlockwise) will increase the pressure while turning it down (clockwise) will decrease the pressure. Fine adjustment will require only turning the collar in 1/8 turn increments.

14. When pressure is set correctly, tighten the capscrews in adjustment collars (1) to 3 - 3.5 Nm (25 - 30 lbf in).

15. Check pressures again after tightening the capscrews. If the pressures have altered, loosen the appropriate capscrew and readjust. Shut down the engine.

16. Remove pivot pin (38) from actuator base (46).

17. Assemble actuator cap (41), boot (42) and retainer plate (44) to actuator base (46) and secure with capscrews (43).

18. Insert pivot pin (38) through the hole in actuator base (46), through the holes in 'U' bolts (32), and through the pivot pin hole in the other side of actuator base (46). As pivot pin (38) is being inserted, install pedal return springs (39 & 40).

19. Centre pivot pin (38) and secure with nuts (30) and washers (31) on 'U' bolts (32). Tighten nuts (30) to a torque of 16 - 17 Nm (140 - 150 lbf in).

20. Install pedal (50) assembly on actuator cam (36) and secure with capscrews (51), washers (49) and nuts (48).

Stop Light Pressure Switch

Stop light pressure switch (55) is a normally open switch. Attach a continuity tester to terminals on stop light pressure switch (55). The circuit should be open.

As brake pressure increases to 2.7 bar (39 lbf/in²) and above, the circuit should close and send a signal to illuminate the brake lights. As pressure drops below 2.7 bar (39 lbf/in²) the circuit should open and brake lights go out.

Lockup Drop Out Pressure Switch

Lockup drop out pressure switch (54) is a normally open switch. Attach a continuity tester to terminals on lockup drop out pressure switch (54). The circuit should be open.

As brake pressure increases to 20 bar (290 lbf/in²) and above, the circuit should close and send a signal to the lockup drop out solenoid, which in turn drops the transmission out of lockup. As pressure drops below 20 bar (290 lbf/in²) the circuit should open and lockup can be engaged.

MAINTENANCE

General

Check all hydraulic brake lines and fittings at treadle valve for leaks and damage. Tighten/replace as required.

Every 1 000 Hours

Check front and rear brake pressures at diagnostic test points. If the pressures are outwith the specified pressure range, inspect the valve and take relevant action (adjust pressures, strip down and repair or replace valve).

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Braking System - Treadle Valve

Section 250-0070

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools, sealants and adhesives required. These tools, sealants and adhesives are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

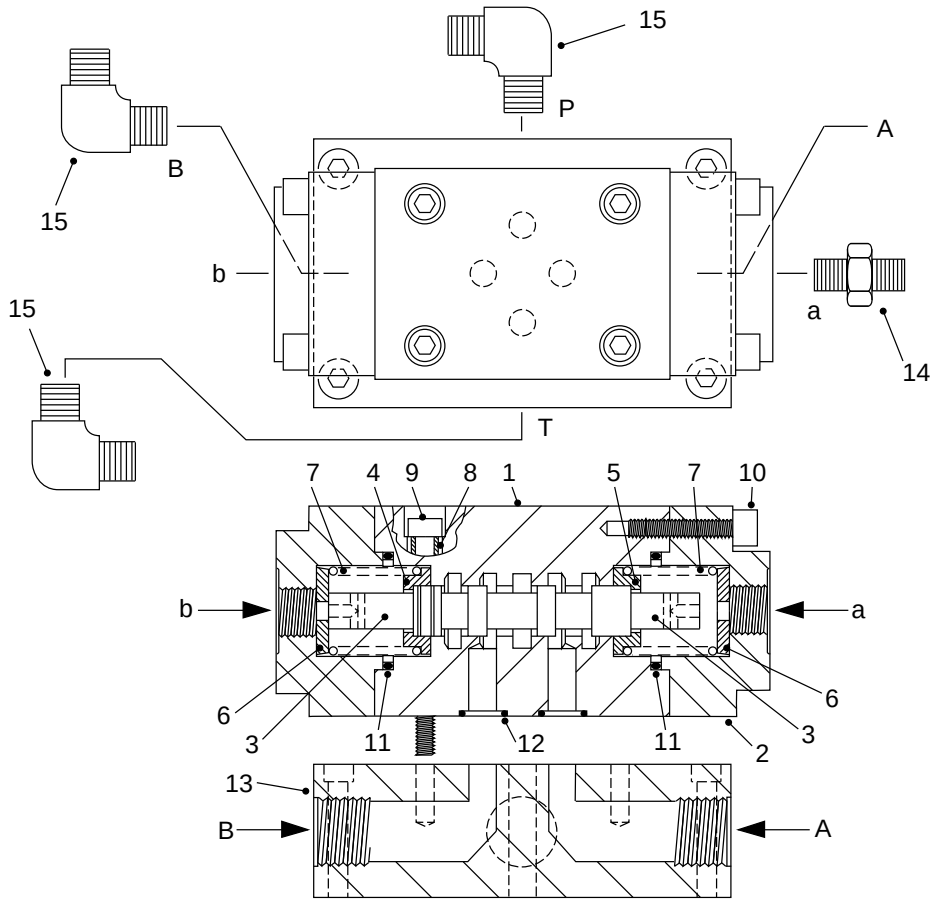
FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf in
1	29	Capscrew	16 - 17	140 - 150
1	30	Nut	16 - 17	140 - 150
1	45	Capscrew	20 - 21	180 - 190
1	53	Capscrew	16 - 17	140 - 150
-	-	Adjustment Collar Capscrews	3 - 3.5	25 - 30

* * * *

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SM - 1509



1 - Valve Body
2 - End Cover
3 - Spool
4 - Spring End Cap
5 - Spring End Cap
6 - Slide Washer
7 - Spring
8 - Spacer
9 - Allen Bolt
10 - Allen Bolt
11 - 'O' Ring
12 - 'O' Ring
13 - Sub Plate
14 - Connector
15 - Elbow

Fig. 1 - Directional Control Valve

DESCRIPTION

The directional control valve can be identified as item 9 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

Mounted off the underside of the cab floor, the directional control valve is located in the 'Px' hydraulic circuit between the brake manifold valve and the treadle valve. The 'Px' circuit hydraulically actuates the treadle valve when the park/emergency brake switch is activated (pushed in). The directional control valve also controls automatic service brake applied pressure bleed down, with engine shutdown.

The directional control valve assembly comprises of a sub plate and valve body assembly. Hydraulic connections to the directional control valve assembly are made as follows:

Valve Body Assembly
Port 'a' - Transmission control pressure.
Port 'b' - Plugged.

Note: Transmission control pressure is taken from a tee in the transmission control pressure line and can be recorded at a remote diagnostic point on the rear left hand cab support. Refer to Figs. 2 and 3.

Sub Plate
Port 'A' - Plugged.
Port 'B' - 'Px' port on treadle valve.
Port 'P' - Brake Manifold Valve.
Port 'T' - Steering and Brake Control Tank.

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Braking System - Directional Control Valve

Section 250-0090

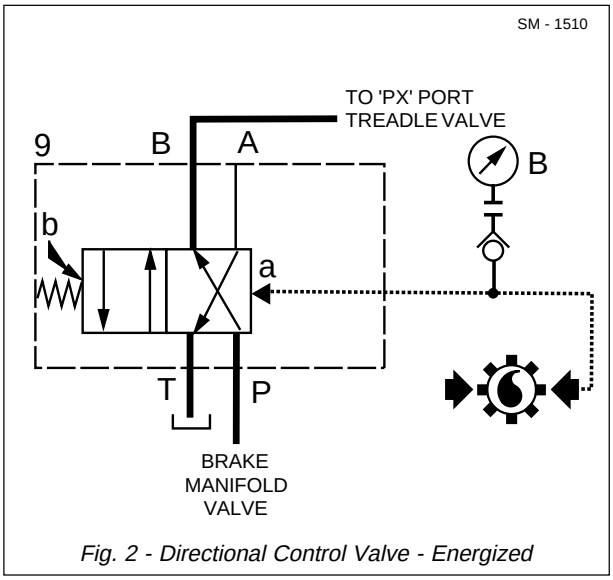


Fig. 2 - Directional Control Valve - Energized

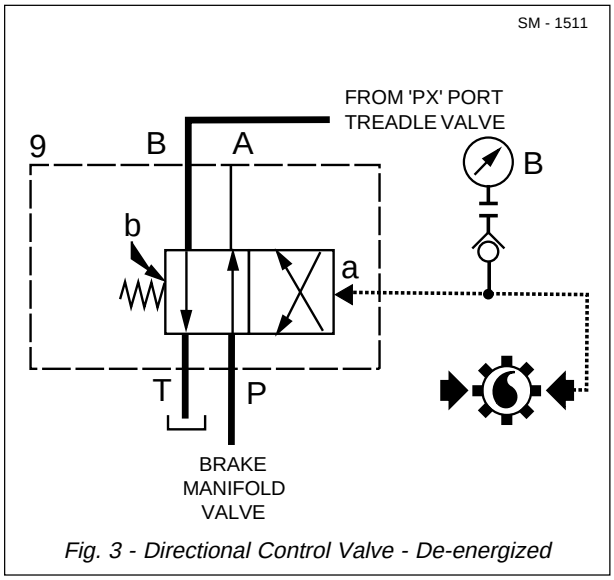


Fig. 3 - Directional Control Valve - De-energized

OPERATION

Numbers in parentheses refer to Fig. 1.

Refer to Fig. 2. When the engine is running, transmission control pressure enters the directional control valve at port 'a'. Oil pressure forces spool (3) against spring (7) pressure, at port 'b' side of valve body (1), internally linking port 'P' to port 'B' in sub plate (13). This results in an open circuit between the brake manifold valve and port 'Px' in the treadle valve.

Depending on the condition of the park/emergency brake switch, oil flows through the directional control valve to energise or exhaust the 'Px' port on the treadle valve as follows:

Park/emergency brake switch activated (pushed in) - Oil flows through the directional control valve to the 'Px' port in the treadle valve.

Park/emergency brake switch deactivated (pulled out) - Return oil from the 'Px' port in the treadle valve flows through the directional control valve, through manifold brake valve solenoid to the steering and brake control tank.

Refer to Fig. 3. When the engine is shutdown, the park/emergency brake switch is automatically applied and transmission control pressure is relieved from port 'a'. Spring (7) pressure, at port 'b' side of valve body (1), forces spool (3) back, internally linking port 'B' to port 'T'. This results in an open circuit between the brake manifold valve and port 'Px' in the treadle valve.

A controlled bleed down of the applied service brakes to the steering and brake control tank occurs through the directional control valve. This controlled bleed down permits a synchronised service brake release/ mechanical park brake application. Refer to Section 250-0000, BRAKING SYSTEM SCHEMATIC.

Note: On engine shutdown, brake accumulator pressure is dead headed at ports 'P' and 'A' in the directional control valve.

REMOVAL

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS

Hydraulic fluid pressure will remain within the system after engine shut down. Operate the treadle valve continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators. Block all road wheels.

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3. Clean directional control valve assembly and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to the directional control valve are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines.

4. Release and remove mounting hardware securing directional control valve to the mounting plate on the underside of the cab floor and remove assembly from the truck.

DISASSEMBLY/ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: With the exception of replacing 'O' rings (11 & 12), the directional control valve is a non serviceable item and should be replaced as a complete assembly. The 'O' rings can be replaced as follows:

1. Note orientation of valve body (1) to sub plate (13) to facilitate assembly.

2. Clamp sub plate (13) lightly in a soft jawed vice and remove allen bolts (9) and spacers (8).

3. Separate valve body (1) from sub plate (13) and discard 'O' rings (12).

4. Install new 'O' rings (12) in valve body (1) and fit valve body (1) to sub plate (13) as noted prior to disassembly. Install spacers (8) in valve body (1) and secure valve body (1) to sub plate (13) with allen bolts (9).

5. Remove allen bolts (10) and end covers (2) from valve body (1) and discard 'O' rings (11).

6. Install new 'O' rings (11) in end covers (2) and secure to valve body (1) with allen bolts (10).

BENCH TEST

Letters in parentheses refer to Fig. 1.

1. Install directional control valve on a test bench and connect as follows:

a. Install hydraulic supply capable of 0 - 159 bar (0 - 2 300 lbf/in²) to port 'P'.

b. Install hydraulic supply capable of 0 - 21 bar (0 - 300 lbf/in²) to port 'a'.

c. Install a suitable return line to port 'T'.

d. Install a pressure gauge suitable for 0 - 207 bar (0 - 3 000 lbf/in²) to port 'B'.

2. Make sure all control valves to supply lines are closed.

3. Turn on hydraulic power supplies and make sure hydraulic oil is at normal operating temperature.

4. Open control valve for port 'P' supply and adjust to give a supply reading of 159 bar (2 300 lbf/in²). Reading on pressure gauge at port 'B' should be zero.

Note: The directional control valve starts to de-energise (close) when transmission pilot pressure falls below 7 bar (100 lbf/in²) and is fully de-energised when transmission pilot pressure falls to 5.5 bar (80 lbf/in²).

5. Open control valve for port 'a' supply and slowly increase this supply pressure from 0 to 21 bar (0 to 300 lbf/in²) thus energising (opening) the directional control valve. Pressure reading at port 'B' should now read 159 ± 7 bar (2 300 ± 100 lbf/in²). Reading on pressure gauge at port 'D' should begin to fall when supply pressure at port 'a' drops to 7 bar (100 lbf/in²). This rate of fall should reach a maximum rate when supply pressure at port 'a' drops to 5.5 bar (80 lbf/in²) or below. With supply pressure at port 'a' at 5.5 bar (80 lbf/in²) or less, pressure on gauge at port 'B' should quickly drop to almost zero, by exhausting to tank via port 'T'.

6. Slowly energise (open) control valve for port 'a' supply. Pressure reading at port 'B' should start to rise when pressure at port 'a' reaches 5.5 bar (80 lbf/in²). Rate of pressure increase at port 'B', should reach a maximum level, when supply pressure at port 'a' reaches 7 bar (100 lbf/in²) or above.

7. Close all control valves and turn off hydraulic supply pressures. Bleed off hydraulic supply lines and remove directional control valve from the test bed for installation.

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INSTALLATION

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Position the directional control valve assembly to the mounting plate on the underside of the cab floor and secure with mounting hardware.

2. Remove blanking caps from hydraulic lines and connect to directional control valve as noted during removal.

3. Check oil level in the steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

4. Remove wheel blocks, start the engine and bring hydraulic oil to operating temperature.

5. Check directional control valve and hydraulic line connections for leaks and tighten as required.

6. Shut off engine and make sure a full service brake application is made followed by a parking brake application.

7. Repeat all braking and engine shut down cycles several times and check for appropriate application/ release cycle several times.

8. Check all connections again for leaks and tighten as required.

MAINTENANCE

Inspect the directional control valve regularly for any signs of leakage or damage and replace 'O' rings or complete assembly as required.

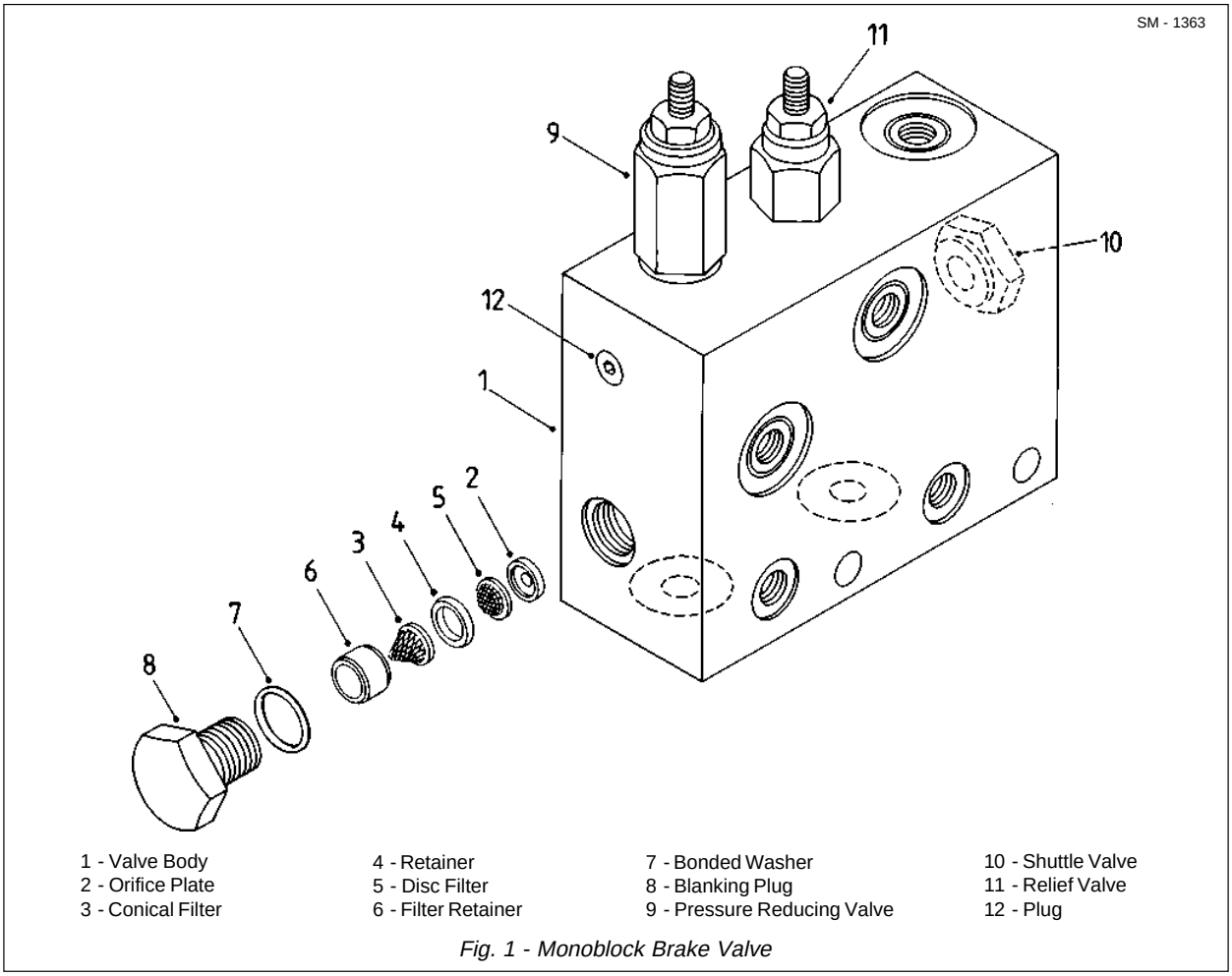
SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

* * * *

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1 - Valve Body
2 - Orifice Plate
3 - Conical Filter
4 - Retainer
5 - Disc Filter
6 - Filter Retainer
7 - Bonded Washer
8 - Blanking Plug
9 - Pressure Reducing Valve
10 - Shuttle Valve
11 - Relief Valve
12 - Plug

Fig. 1 - Monoblock Brake Valve

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The monoblock brake valve can be identified as item 8 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

Mounted off the left hand frame rail, the monoblock brake valve incorporates three valves; pressure reducing valve (9), pressure relief valve (11) and shuttle valve (10).

Pressure reducing valve (9) reduces the available hydraulic oil pressure from the rear brake accumulator to a pressure of 83 bar (1 200 lbf/in^2).

Pressure relief valve (11) regulates pressure, after pressure reducing valve (9), to provide a residual pressure of 3.1 ± 0.35 bar (45 ± 5 lbf/in^2) in the rear brake lines. A filter system, comprising of disc filter (5) and conical filter (3), helps protect orifice plate (2) at pressure relief valve (11).

Shuttle valve (10), depending on spool position, provides a residual pressure of 3.1 ± 0.35 bar (45 ± 5 lbf/in^2) in the rear brake lines, or, upon actuation of the treadle or retarder valve, the brake actuation pressure overcomes the residual pressure to give a brake application at the rear brake packs.

OPERATION

Numbers in parentheses refer to Fig. 1.

Refer to Fig. 2. With the engine running and the brake manifold valve energized, (park/emergency brake switch deactivated - pulled out) hydraulic oil from the rear brake accumulator flows through the brake manifold valve and enters valve body (1) at port 'P'. Oil flows through pressure reducing valve (9) and exits valve body (1) at port 'RB2' to release the parking brake. Oil pressure is reduced to 83 bar (1 200 lbf/in^2) before leaving valve body (1) at port 'RB2'. Excess oil at pressure reducing valve (9) is diverted back to tank through port 'T' in valve body (1).

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At the same time, oil enters pressure relief valve (11) circuit, passing through conical filter (3), disc filter (5) and orifice plate (2) to shuttle valve (10). Oil pressure pushes shuttle valve (10) spool across and oil exits valve body (1) from port 'RB1' to the rear brake lines. Oil pressure is regulated to 3.1 ± 0.35 bar (45 ± 5 lbf/in^2) before leaving valve body (1) at port 'RB1'. Excess oil at pressure relief valve (11) is diverted back to tank through port 'T' in valve body (1).

Brake Application

Refer to Fig. 3. On application of the treadle valve, oil pressure, up to a maximum of 52 bar (750 lbf/in^2), flows through a shuttle valve in the front brake lines and enters valve body (1) at port 'FB'. Oil pressure acts on shuttle valve (10) spool, overcomes residual pressure, and pushes shuttle valve (10) spool across to open port 'FB' to port 'RB1'. Oil pressure then leaves port 'RB1' to apply the rear brakes.

Refer to Fig. 2. When the treadle valve is released and the pressure in the rear brakes fall below 3.1 ± 0.35 bar (45 ± 5 lbf/in^2), residual pressure pushes shuttle valve (10) spool back across to close off port 'FB' to the rear brake lines. Residual pressure is present in the rear brake lines.

Retarder Application

Refer to Fig. 3. On application of the retarder valve, oil pressure, up to a maximum of 33 bar (480 lbf/in^2), flows through a shuttle valve in the front brake lines and enters valve body (1) at port 'FB'. Oil pressure acts on shuttle valve (10) spool, overcomes residual pressure, and pushes shuttle valve (10) spool across to open port 'FB' to port 'RB1'. Oil pressure then leaves port 'RB1' to apply the rear brakes.

On application of the treadle valve during retarder operation, treadle valve pressure takes priority at the shuttle valve in the rear brake lines when it exceeds retarder applied pressure. This operation cancels the retarder input and the rear brakes are applied by the treadle valve pressure.

Refer to Fig. 2. In either condition (treadle/retarder valve application), when the pressure in the rear brakes fall below 3.1 ± 0.35 bar (45 ± 5 lbf/in^2), residual pressure pushes shuttle valve (10) spool back across to close off port 'FB' to the rear brake lines. Residual pressure is present in the rear brake lines.

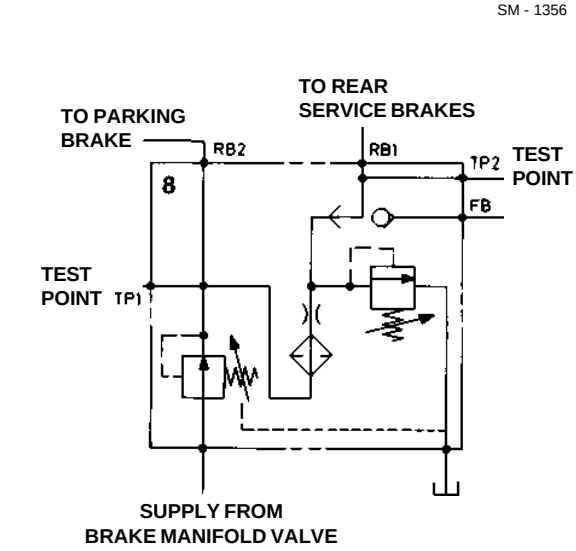


Fig. 2 - Residual Pressure at Rear Service Brakes

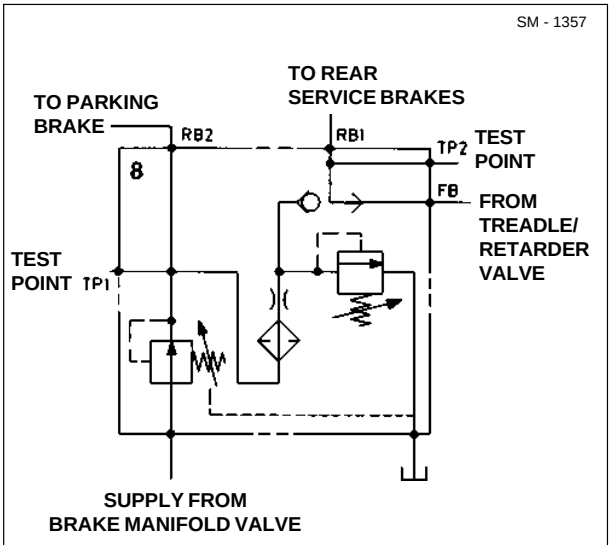


Fig. 3 - Treadle/Retarder Valve Actuated

Pressure Test Points

Port 'TP1' provides a tapping point for parking brake pressure. This pressure can be checked at diagnostic test point (rear) mounted off rear mounting bracket for body and disc brake cooling tank.

Port 'TP2' provides a tapping point for rear brake/ retarder application pressure. This pressure can be checked at diagnostic test point (front) mounted off rear mounting bracket for body and disc brake cooling tank.

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REMOVAL

⚠ WARNINGS
Hydraulic fluid pressure will remain within the system after engine shut down. Operate the treadle valve continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

⚠ To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, raise the body and secure in place with the body safety pins. Apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators. Block all road wheels.

3. Clean monoblock brake valve and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to the valve are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open line ends and valve ports.

4. Remove mounting hardware securing monoblock brake valve to left hand frame rail and remove valve to a clean work area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Other than the outer seals on pressure reducing valve (9), shuttle valve (10) and relief valve (11), it is not recommended that anything else is changed.

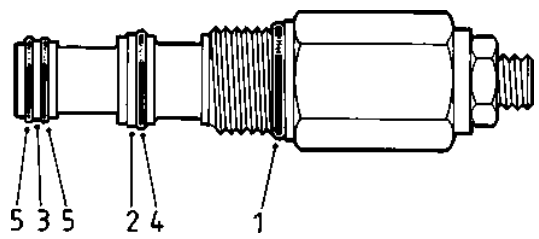
1. Remove pressure reducing valve (9) assembly from valve body (1). Remove and discard 'O' rings (1, 2 & 3, Fig. 4) and backup rings (4 & 5) from pressure reducing valve (9).

2. Remove shuttle valve (10) assembly from valve body (1). Remove and discard 'O' rings (3, 4 & 6, Fig. 5) and backup rings (5 & 7, Fig. 5) from shuttle valve (10).

3. Remove relief valve (11) assembly from valve body (1). Remove and discard 'O' rings (8 & 9, Fig. 6) and backup ring (11, Fig. 6) from relief valve (11).

4. If required, remove blanking plug (8) from valve body (1). Remove and discard 'O' ring (7) from blanking plug (8).

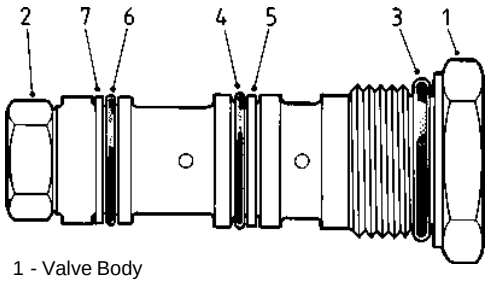
SM - 1353



1 - 'O' Ring
2 - 'O' Ring
3 - 'O' Ring
4 - Backup Ring
5 - Backup Ring

Fig. 4 - Pressure Reducing Cartridge Seals

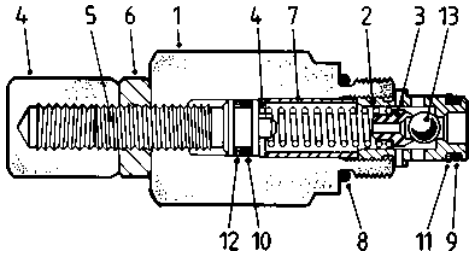
SM - 1354



1 - Valve Body
2 - Shuttle Ball Retainer
3 - 'O' Ring
4 - 'O' Ring
5 - Backup Ring
6 - 'O' Ring
7 - Backup Ring

Fig. 5 - Shuttle Valve Cartridge Seals

SM - 1355



1 - Body
2 - Sleeve
3 - Guide
4 - Spring
5 - Adjustment Screw
6 - Nut
7 - Spacer
8 - 'O' Ring
9 - 'O' Ring
10 - 'O' Ring
11 - Backup Ring
12 - Backup Ring
13 - Ball
14 - Cap Nut

Fig. 6 - Pressure Relief Cartridge

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ASSEMBLY

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

1. Install new 'O' ring (7) on blanking plug (8) and install blanking plug in valve body (1). Tighten blanking plug (8) securely.

2. Install new 'O' rings (8 & 9, Fig. 6) and backup ring (11, Fig. 6) on relief valve (11) as shown in Fig. 6. Install relief valve (11) assembly in valve body (1) and tighten securely.

3. Install new 'O' rings (3, 4 & 6, Fig. 5) and backup rings (5 & 7, Fig. 5) on shuttle valve (10) as shown in Fig. 5. Install shuttle valve (10) assembly in valve body (1) and tighten securely.

4. Install new 'O' rings (1, 2 & 3, Fig. 4) and backup rings (4 & 5) on pressure reducing valve (0) as shown in Fig. 4. Install pressure reducing valve (9) assembly in valve body (1) and tighten securely.

INSTALLATION

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Position monoblock brake valve assembly to mounting brackets on the left hand frame rail and secure with mounting hardware.

2. Remove blanking caps from hydraulic lines and connect to monoblock brake valve as recorded at 'Removal'.

3. Check oil level in steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and, use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

4. Remove wheel chocks, start the engine and bring hydraulic oil to operating temperature.

5. Check monoblock brake valve for leaks and tighten connections as required.

6. Shut off engine and make sure a full service brake application is made followed by a parking brake application.

7. Repeat all braking and engine shut down cycles several times and check for appropriate application/ release cycle several times.

8. Check all connections again for leaks and tighten as required.

9. Remove body safety pins and lower the body to the frame.

MAINTENANCE

Inspect the monoblock brake valve regularly for any signs of leakage or damage.

Note: Limited repair of the monoblock brake valve is by replacement of parts only.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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DESCRIPTION

The pressure reducing valve can be identified as item 19 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

Mounted on the inside of the left hand frame rail in front of the body guide, the pressure reducing valve is located in the hydraulic brake circuit between the treadle valve and the front brake callipers.

The pressure reducing valve, on application of the 50% brake reduction switch, mounted on the dash panel in the cab, allows the operator to limit the braking pressure to 50% at the front brakes.

OPERATION

Numbers in parenthesis refer to Fig. 1.

Refer to Fig. 2. Pressing the 50% brake reduction switch to the 'On' position sends a signal to energize the solenoid in pressure reducing valve (1). Oil cannot pass through the check valve and is directed through the relief valve. The relief valve limits the maximum braking pressure to the front brake callipers to 79.5 bar (1 150 lbf/in²).

Refer to Fig. 3. Pressing the 50% brake reduction switch to the 'Off' position sends a signal to de-energize the solenoid in pressure reducing valve (1). In this condition full braking pressure 159 bar (2 300 lbf/in²) is applied to the front brake callipers when the treadle valve is operated.

REMOVAL/INSTALLATION

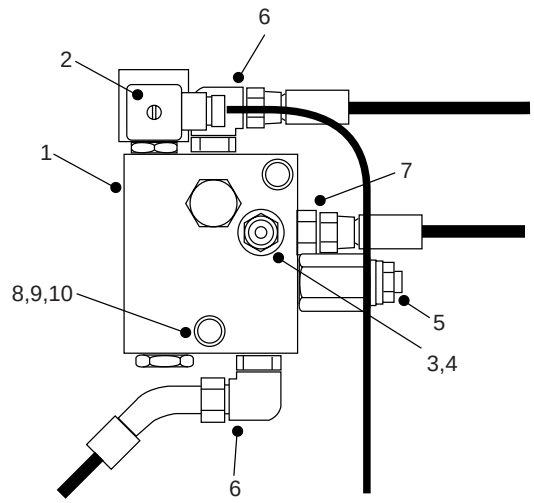
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNING
Hydraulic fluid pressure will remain within the system after engine shut down. Operate the treadle valve continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

SM - 2297



1 - Pressure Reducing Valve
2 - Solenoid
3 - Diagnostic Nipple
4 - Dust Cap
5 - Cartridge
6 - Elbow - 90°
7 - Adapter
8 - Bolt
9 - Washer
10 - Pad

Fig. 1 - Pressure Reducing Valve Installation

SM - 2298

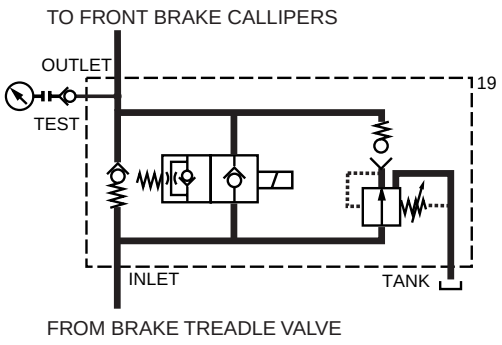


Fig. 2 - Pressure Reducing Valve - Solenoid Energized

SM - 2299

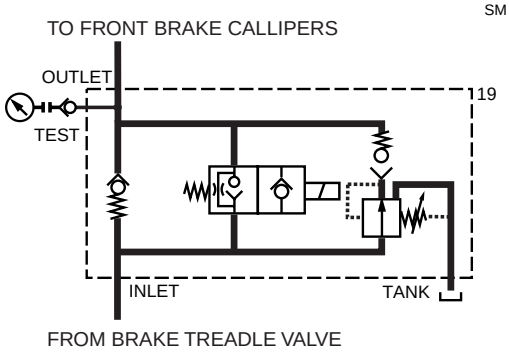


Fig. 3 - Pressure Reducing Valve - Solenoid De-Energized

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Braking System - Pressure Reducing Valve

⚠ WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, raise the body and secure in place with the body safety pins. Apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators. Block all road wheels.

3. Clean pressure reducing valve (1) and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to pressure reducing valve (1) are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines.

4. Support valve body and remove bolts (8) and washers (9) securing pressure reducing valve (1) to its mounting. Remove pressure reducing valve (1) from vehicle.

5. Note location and orientation of elbows (6) and adaptor (7) and remove from pressure reducing valve (1).

6. Replace all 'O' rings and install elbows (6) and adaptor (7) in pressure reducing brake valve (1) ports as identified.

7. Secure pressure reducing valve (1) to mounting with bolts (8) and washers (9).

8. Remove blanking caps from hydraulic lines and install lines to pressure reducing valve (1) as identified during removal.

9. Check oil level in the steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and, Section 300-0020, LUBRICATION SYSTEM for oil specification.

10. Remove wheel blocks, start the engine and bring hydraulic oil to operating temperature.

11. Check pressure reducing valve (1) and hydraulic line connections for leaks and tighten as required.

12. Remove body safety pins and lower the body to the frame.

MAINTENANCE

Limited repair of the pressure reducing valve is with replacement of parts only. Refer to vehicle parts book for lists of kits available.

SPECIAL TOOLS

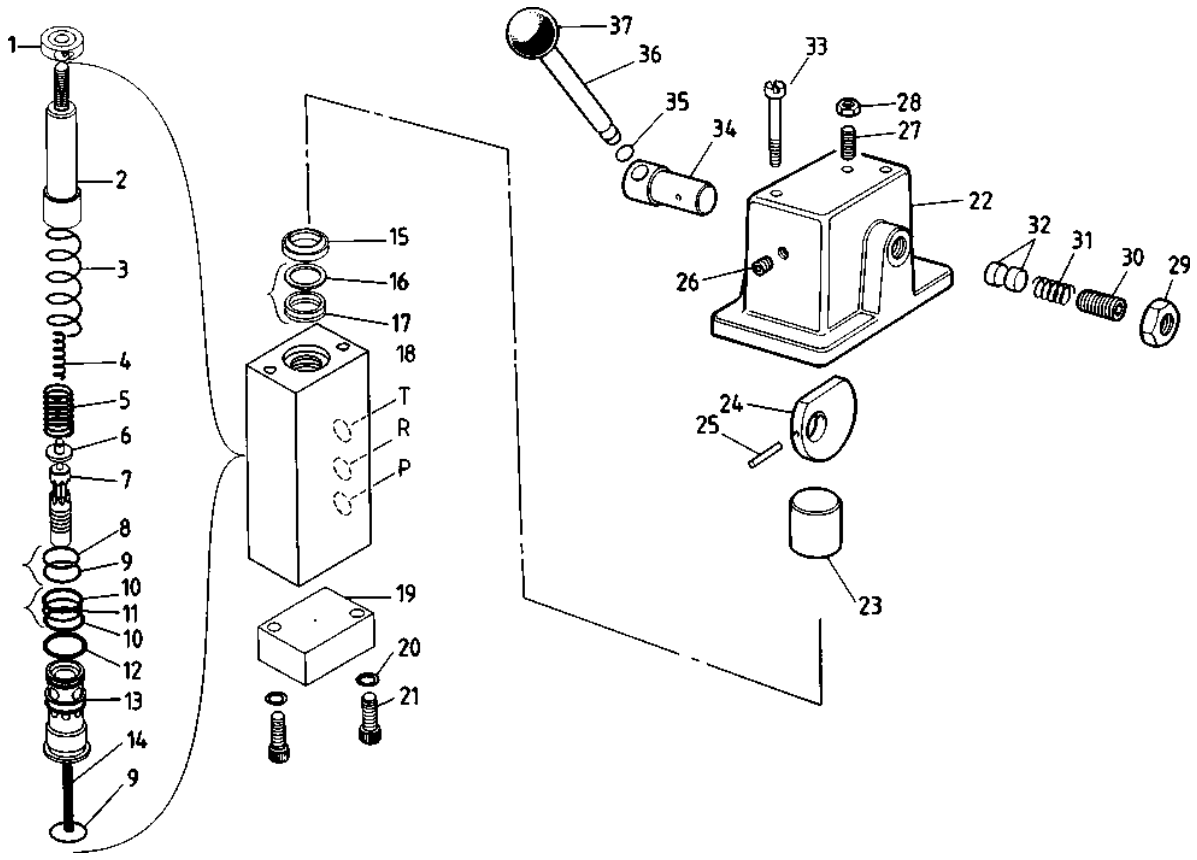
There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

* * * *

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SM - 1272



1 - Adjustment Collar
2 - Actuator Plunger
3 - Plunger Return Spring
4 - Regulator Spring
5 - Regulator Spring
6 - Spring Seat
7 - Regulator Spool
8 - Backup Ring
9 - 'O' Ring
10 - Backup Ring
11 - 'O' Ring
12 - 'O' Ring
13 - Regulator Sleeve
14 - Spool Return Spring
15 - Wiper Seal
16 - Backup Ring
17 - Seal
18 - Valve Body
19 - Retainer
20 - Washer
21 - Capscrew
22 - Housing
23 - Cap
24 - Cam
25 - Spring Pin
26 - Plug
27 - Set Screw
28 - Jam Nut
29 - Jam Nut
30 - Set Screw
31 - Spring
32 - Friction Puck
33 - Capscrew
34 - Shaft
35 - Ring
36 - Lever
37 - Knob

Fig. 1 - Exploded View of Retarder Control Valve

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

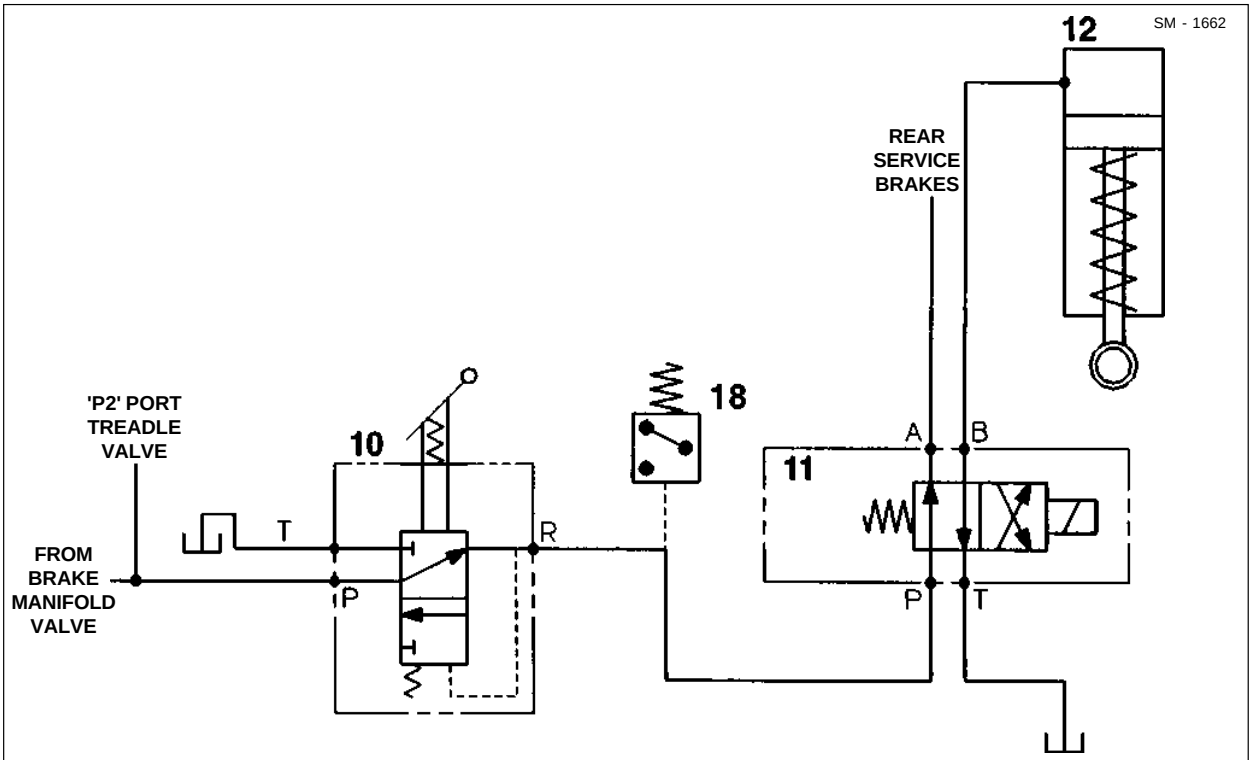
The retarder control valve can be identified as item 10 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

Also referenced in this section is a transmission retarder circuit consisting of a directional control valve, transmission retarder cylinder and a pressure switch. Refer to Figs. 2 through 5.

The retarder control valve, mounted in the centre console to the right hand side of the operator, is a closed centre controller which is used to apply a continuous braking force to hold the vehicle at a safe steady speed when descending grades. The valve applies reduced pressure to either the oil cooled disc brakes (OCDB) or the transmission retarder. Selection of either the OCDB retarder or transmission retarder is made by a separate retarder selection switch on the left hand switch panel. Pressing the switch at the top will select the OCDB retarder and pressing the bottom will select the transmission retarder.

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10 - Retarder Control Valve
11 - Directional Control Valve
12 - Transmission Retarder Cylinder
18 - Pressure Switch

Fig. 2 - OCDB Retarder Applied

In the normal position, lever (36) is in the forward position and regulator spool (7) is in the up position. In this condition the notched area near the top of regulator spool (7) is exposed to the tank cavity in valve body (18), the lower portion of the notched area is exposed to the regulated pressure outlet port of the valve. This effects a direct link between tank port 'T' and regulated outlet port 'R'. While regulator spool (7) is in this position the retarder is released.

OPERATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

> **WARNING**
> **The retarder is used for slowing the vehicle, not for parking. When parking the vehicle, the park/emergency control should be applied.**

OCDB Retarder Application

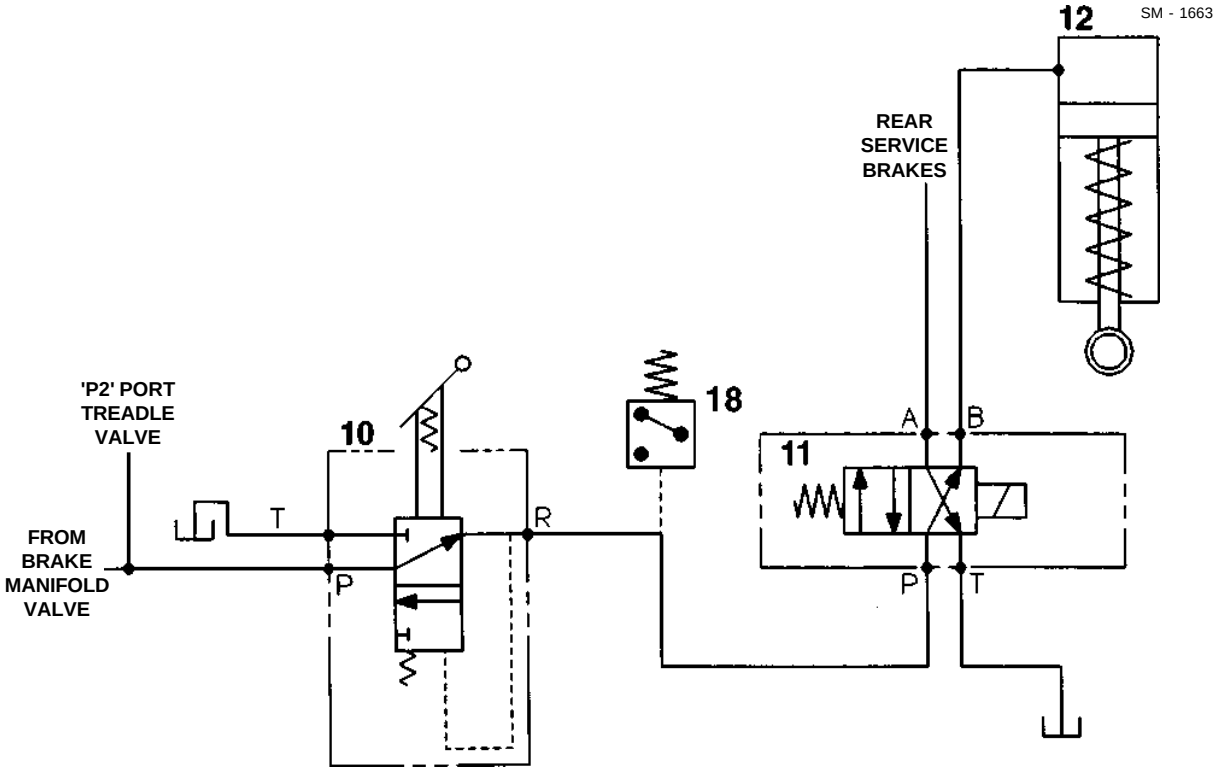
Refer to Fig. 2. In this condition the directional control valve (if fitted) is de-energized.

When the operator activates lever (36), actuator plunger (2) is moved down and pushes on regulator springs (4 & 5) which in turn, push regulator spool (7) down. As regulator spool (7) moves down, the metering notches move out of the tank cavity and close outlet port 'R' off to tank port 'T'. Regulator spool (7) continues to move downward until the lower edge of the metering notches become exposed to the inlet pressure port 'P'. This movement opens inlet port 'P' to outlet port 'R'.

Reduced pressure travels through directional control valve (11, Fig. 2) to the shuttle valve in the rear brake lines. A spool in the shuttle valve is moved under the influence of this pressure to close off the treadle valve circuit and open the retarder valve circuit to the monoblock brake valve. When the pressure applied by the retarder control valve is greater than the residual pressure of 3.1 ± 0.35 bar (45 ± 5 lbf/in^2) acting on the shuttle valve in the monoblock brake valve, the spool in the shuttle valve will move across, opening the retarder circuit to the rear service brakes. The result

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10 - Retarder Control Valve
11 - Directional Control Valve
12 - Transmission Retarder Cylinder
18 - Pressure Switch

Fig. 3 - Transmission Retarder Applied

of this operation is a reduced pressure application of the rear service brakes.

As hydraulic pressure builds in the brake, oil flows through the small orifice in the side of regulator spool (7) and into the cavity below the spool. As pressure rises in the brake it also rises in the cavity below the spool forcing regulator spool (7) upwards closing outlet port 'R'. Regulator spool (7) is now balanced between the brake pressure and the pressure of regulator springs (4 & 5) generated by lever (36) position. Regulator spool (7) has closed off inlet port 'P', outlet port 'R' and tank port 'T' and will remain in this position until lever (36) is moved. This maintains the applied pressure within the brake circuit and provides infinitely variable application of the braking force. If the operator further actuates lever (36), regulator spool (7) will move down and build more pressure in the brake until it balances the lever force.

The maximum pressure applied by the retarder control valve is governed by the stroke of regulator spool (7) within the valve. This stroke can be adjusted during maintenance operations.

Note: Should the operator depress the treadle valve to obtain a full service brake application, when the retarder is applied, treadle valve pressure takes priority at the shuttle valve in the brake lines when it exceeds retarder applied pressure. A full service brake application occurs.

A retarder applied pressure switch (18, Fig. 2) (installed in a tee at port 'R') will close, sending a signal to illuminate an indicator light in the dash panel, and a retarder light at the rear of the truck, to indicate that the retarder is applied.

Transmission Retarder Application

Refer to Fig. 3. In this condition the directional control valve is energized.

⚠ WARNING
Great care should be used if applying the retarder when road surfaces are slippery. The retarder braking effect will occur only at the driving axle and could make the truck difficult to control.

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Braking System - Retarder Control Valve

Section 250-0130

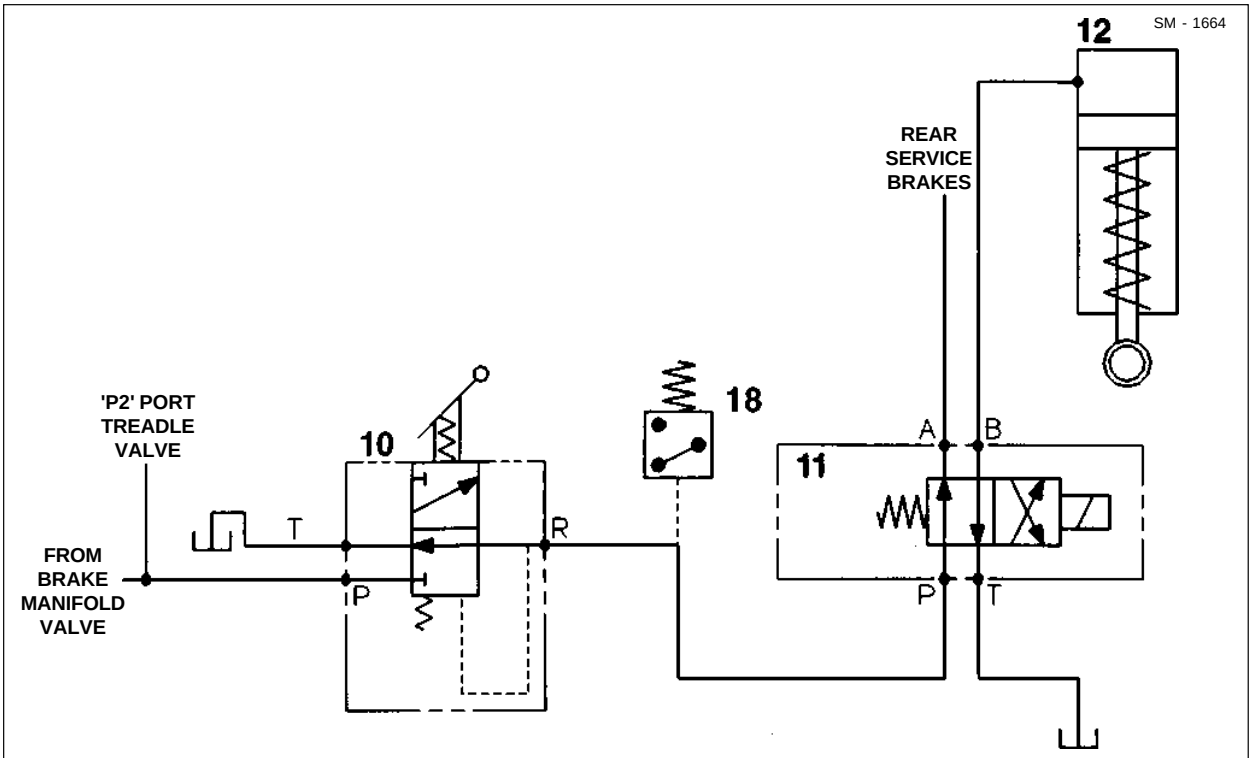


Fig. 4 - OCDB Retarder Released

When the operator activates lever (36), actuator plunger (2) is moved down and pushes on regulator springs (4 & 5) which in turn, push regulator spool (7) down. As regulator spool (7) moves down, the metering notches move out of the tank cavity and close outlet port 'R' off to tank port 'T'. Regulator spool (7) continues to move downward until the lower edge of the metering notches become exposed to the inlet pressure port 'P'. This movement opens inlet port 'P' to outlet port 'R'.

This permits reduced pressure to travel through directional control valve (11, Fig. 3) to transmission retarder cylinder (12, Fig. 3) on the transmission. Oil fills the cavity around the rotor within the retarder and creates drag, which in turn, slows the truck down. When the cavity is emptied, the rotor is free of drag.

As hydraulic pressure builds in the retarder, oil flows through the small orifice in the side of regulator spool (7) and into the cavity below the spool. As pressure rises in the retarder it also rises in the cavity below the spool forcing regulator spool (7) upwards closing outlet port 'R'. Regulator spool (7) is now balanced between the retarder pressure and the pressure of regulator springs (4 & 5) generated by lever (36) position. Regulator spool (7) has closed off inlet port 'P', outlet port 'R' and tank port 'T' and will remain in this position until lever (36) is moved. This maintains the applied pressure within the transmission retarder circuit and provides infinitely variable application of the retarder. If the operator further actuates lever (36), regulator spool (7) will move down and build more pressure in the retarder until it balances the lever force.

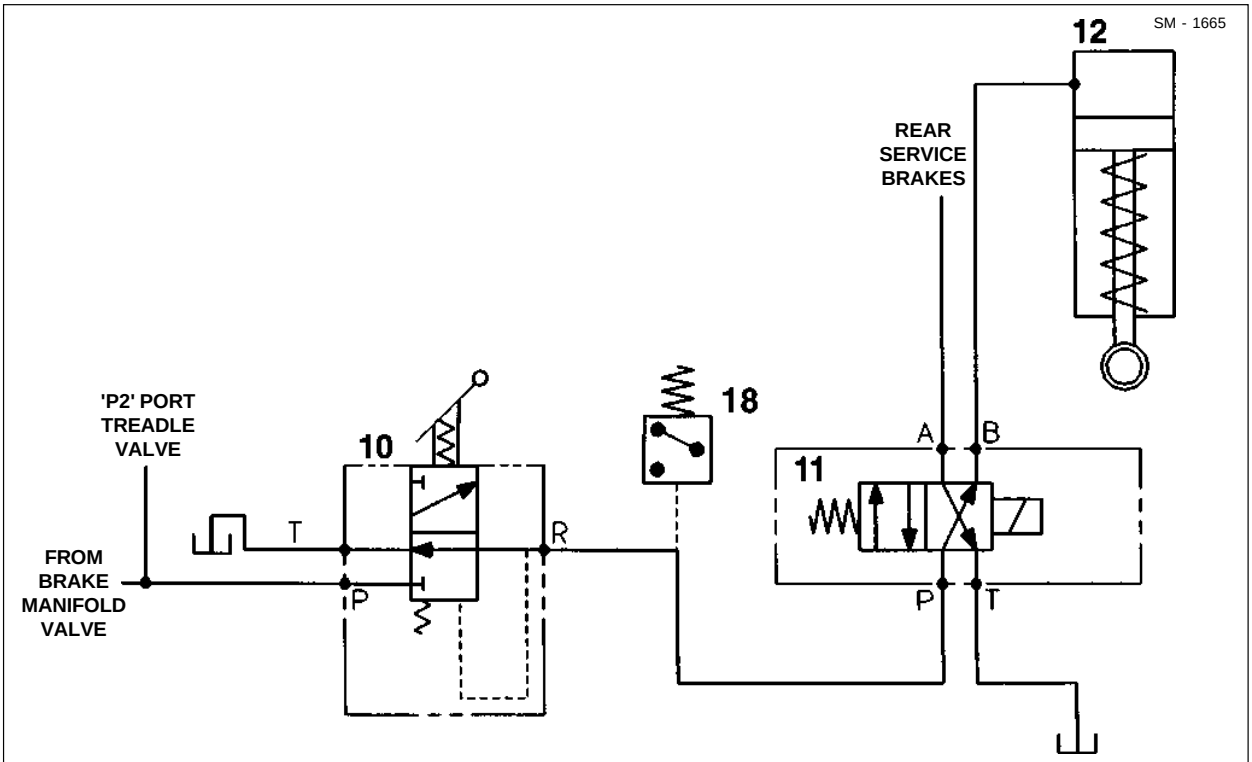
The maximum pressure applied by the retarder control valve is governed by the stroke of regulator spool (7) within the valve. This stroke can be adjusted during maintenance operations.

Note: Should the operator depress the treadle valve to obtain a full service brake application, when the retarder is applied, treadle valve pressure takes priority at the shuttle valve in the brake lines when it exceeds retarder applied pressure. A full service brake application occurs.

A retarder applied pressure switch (18, Fig. 3) (installed in a tee at port 'R') will close, sending a signal to illuminate an indicator light in the dash panel, and a retarder light at the rear of the truck, to indicate that the retarder is applied.

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10 - Retarder Control Valve
11 - Directional Control Valve
12 - Transmission Retarder Cylinder
18 - Pressure Switch

Fig. 5 - Transmission Retarder Released

OCDB Retarder Release

Refer to Fig. 4. In this condition the directional control valve (if fitted) is de-energized.

When the operator releases lever (36), regulator spool (7) will become unbalanced and move upwards under the influence of the rear brake circuit pressure and spool return spring (14). As a result, regulator spool (7) moves to open outlet port 'R' to tank port 'T', closing inlet pressure port 'P'. The pressure will fall and retarder applied pressure switch (18, Fig. 4) will open, switching off the retarder indicator light on the dash panel and retarder light at rear of the truck.

Transmission Retarder Release

Refer to Fig. 5. In this condition the directional control valve is in energized.

When the operator releases lever (36), regulator spool (7) will become unbalanced and move upwards under the influence of the transmission retarder circuit pressure and spool return spring (14). As a result, regulator spool (7) moves to open outlet port 'R' to tank port 'T', closing inlet pressure port 'P'. The pressure will fall and retarder applied pressure switch (18, Fig. 5) will open, switching off the retarder indicator light on the dash panel and retarder light at rear of the truck.

REBUILD CRITERIA

Inspect the valve regularly for any signs of leakage or damage. The controller should be rebuilt if one or more of the following conditions exist:

1. Any sign of external leakage.

Note: Check all hydraulic lines and fittings to ensure leakage is not coming from there.

2. Retarder valve holds pressure when in the neutral position.

3. Varying output pressure with the lever fully actuated.

4. Spring pin securing shaft to actuator cam has failed.

5. Excessively worn friction pucks. This will be evident through mechanical interference of actuator cam (24),

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or, the inability to compress spring (31) enough to hold lever (36) in the fully applied position during normal operation.

REMOVAL

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

⚠ Hydraulic oil pressure will remain within the braking system after engine shut down. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the braking accumulators. Block all road wheels.

3. Remove and tag electrical connections to retarder pressure switch.

4. Ensure all hydraulic lines connected to the retarder valve are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines and retarder valve ports.

5. Release and remove mounting hardware securing the retarder control valve in the centre console. Remove retarder control valve assembly to a clean area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Remove blanking caps from valve body (18) ports and drain oil by rotating the valve over a suitable container.

2. Secure the valve upright in a table vice.

3. Remove capscrews (33) securing housing (22) assembly to valve body (18). Remove housing assembly.

Valve Body

1. Remove cap (23) from the top of valve body (18).

2. Loosen the socket head capscrew from adjustment collar (1) and unscrew adjustment collar (1). Remove controller from the vice.

3. Remove capscrews (21) and washers (20) securing retainer (19) to valve body (18). Remove retainer (19).

4. Remove and discard 'O' ring (9) from counterbore in the base of valve body (18).

5. With the controller upright on the work bench, hold valve body (18) with one hand and push actuator plunger (2) down with the other hand until regulator sleeve (13) pops loose.

6. Turn valve body (18) on its side on the work bench and remove regulator sleeve (13).

7. Remove regulator spool (7) and spool return spring (14) from regulator sleeve (13).

8. Remove plunger return spring (3), regulator springs (4 & 5) and spring seat (6) from valve body (18).

9. Remove actuator plunger (2) by pushing down (toward the bottom of valve body (18)) on actuator plunger (2) by hand, until the plunger slides out.

10. Remove and discard 'O' rings (9, 11 & 12) and teflon backup rings (8 & 10) from regulator sleeve (13).

11. Remove and discard wiper seal (15), seal (17) and backup ring (16) from the actuator section of valve body (18).

Actuator

1. Loosen jam nut (29) and remove set screw (30) from housing (22).

2. Remove spring (31) from housing (22). Inspect spring (31) carefully for cracks or breaks and replace if required.

3. Remove plug (26) from housing (22). Spring pin (25) may have already sheared off. If not, use a 2.3 mm (0.09 in) pin punch to press spring pin (25) past shaft (34).

4. Rotate lever (36) and shaft (34) sub-assembly to release it from cam (24). Pull lever (36) and shaft (34) sub-assembly from housing (22).

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Note: Do not try to disassemble lever (36) from shaft (34). If shaft (34) or lever (36) are damaged, replace shaft (34), lever (36), ring (35) and spring pin (25).

5. Remove cam (24) from housing (22). Inspect cam (24) surfaces and replace if worn.

6. Remove spring pin (25) from cam (24), and also from shaft (34) if it has sheared off during operation.

7. Remove friction pucks (32) from housing (22).

8. Loosen jam nut (28) and set screw (27).

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Clean all parts with a suitable cleaning solvent.

2. Inspect actuator plunger (2) for wear on the sides where it moves through the seals. If axial grooves are seen or if any wear is evident, replace actuator plunger (2). Actuator plunger (2) must be replaced if the diameter is worn below 18.97 mm (0.747 in).

3. Place regulator spool (7) into regulator sleeve (13) and push the spool lightly through the sleeve. Regulator spool (7) must be able to move freely and smoothly the entire length of regulator sleeve (13). If it cannot, regulator spool (7) and regulator sleeve (13) must be replaced as a matched set.

Note: Never replace just the spool or sleeve. They must be replaced as a matched set.

4. Inspect each spring carefully for cracks or breaks. Any spring with a crack or break must be replaced. Also, if the retarder valve was not reaching proper regulated pressure, replace all regulator springs.

SUB-ASSEMBLY

Numbers in parentheses refer to Fig. 1.

Note: All metal parts should be thoroughly cleaned with a suitable solvent, dried, and lubricated with a light weight oil before assembly. This valve is built to extremely close manufacturing tolerances. Great care should be taken to keep components protected from contamination prior to and during assembly.

Actuator

1. If new lever (36) and shaft (34) are being fitted proceed as follows:

a. Attach lever (36) to shaft (34) and compress ring (35) into the groove on lever (36).

b. Slide lever (36) and ring (35) into shaft (34) while maintaining ring (35) in a compressed state. As lever (36) and shaft (34) are assembled, ring (35) will disappear and spring into shaft (34) as it passes the shaft groove.

c. Move lever (36) back and forth to ensure ring (35) was allowed to spring out completely. Attach knob (37) to lever (36) and secure.

2. Place friction puck (32) located furthest from spring (31) into cavity in housing (22). Tap puck (32) lightly with a rod and mallet to ensure puck (32) protrudes from housing (22).

3. Measure the distance friction puck (32) protrudes from housing (22). This distance should be approximately 2.3 mm (0.09 in). If this distance varies more than 0.5 mm (0.02 in), replace the actuator assembly.

4. Insert cam (24) in housing (22).

5. Align shaft (34) and lever (36) assembly with housing (22) and cam (24) bore. Insert shaft (34) into housing (22) and cam (24) bore.

6. Align 3 mm (0.12 in) diameter holes in shaft (34) and cam (24). Install spring pin (25) until pin is recessed approximately 2.3 mm (0.09 in) below cam (24) surface.

7. Place second friction puck (32) in housing (22) and place spring (31) behind friction puck (32).

8. Install set screw (30) in housing (22).

Note: Set screw (30) will be adjusted later to provide the proper spring compression.

9. Install jam nut (29) on set screw (30) and tighten finger tight.

10. Install set screw (27) in housing (22) and jam nut (28) on set screw (27). Finger tighten jam nut (28).

11. Turn sub-assembly with the bottom side up and fill the actuation cavity with EP, NLGI grease until cam (24) is covered. Refer to Section 300-0020, LUBRICATION SYSTEM for grease specification.

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Valve Body Seals

1. Install seal (17) in seal groove of valve body (18) first. Position seal (17) in the groove so that 'O' ring inside the seal is facing down toward the bottom of valve body (18). See Fig. 6.

2. Make sure the internal 'O' ring is still seated inside seal (17) and did not get dislodged during installation. Position seal (17) to the bottom of the groove.

3. Install backup ring (16) on top of seal (17). Start by hand and then continue to work into the groove either by hand or by using an 'O' ring installation tool.

4. Install wiper seal (15) in the top counterbore. Position wiper seal (15) in the groove so that the register lip is facing up toward the actuator.

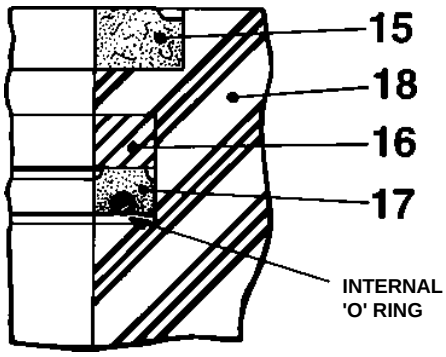


Fig. 6 - Valve Body Seal Installation

Regulator Sleeve

1. Install 'O' ring (9) onto the smallest groove (on the top) of regulator sleeve (13). Install 'O' ring (11) onto the middle groove of regulator sleeve (13). Install 'O' ring (12) onto the largest groove (on the bottom) of regulator sleeve (13). See Fig. 7.

2. Install backup ring (10) onto each side of 'O' ring (11) located in the middle of regulator sleeve (13). See Fig. 7.

3. Install backup ring (8) behind 'O' ring (9) located at the top end of regulator sleeve (13). 'O' ring (9) is the smallest of the three 'O' rings. Position backup ring (8) so that it is next to the top of regulator sleeve (13). The top of regulator sleeve (13) is the end with the smallest OD. See Fig. 7.

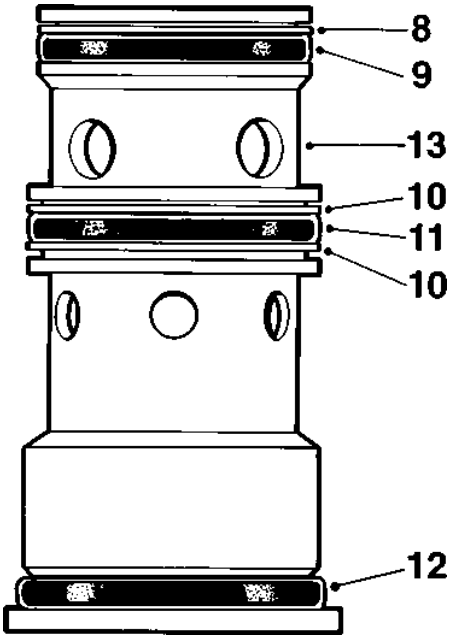


Fig. 7 - Regulator Sleeve Seal Installation

Valve Body Assembly

Numbers in parentheses refer to Fig. 1.

1. Install actuator plunger (2) in valve body (18).

2. Install plunger return spring (3), regulator springs (4 & 5) and spring seat (6) in valve body (18). If spring seat (6) does not seat correctly on top of regulator spring (5), lightly shake valve body (18) to correctly position spring seat (6).

3. Lightly lubricate regulator spool (7) assembly and install into regulator sleeve (13). The spherical end of regulator spool (7) should be at the top of regulator sleeve (13). The top of regulator sleeve (13) is the end with the smallest OD.

Note: Check to ensure that regulator spool (7) will slide smoothly and freely in regulator sleeve (13). Replace the entire spool and sleeve assembly if the spool does not slide smoothly and freely.

4. Remove regulator spool (7) from regulator sleeve (13) before installing sleeve into valve body (18).

5. Lightly lubricate 'O' rings (9, 11 & 12) on regulator sleeve (13).

6. Install regulator sleeve (13) assembly in valve body (18). Make sure spring seat (6) is correctly

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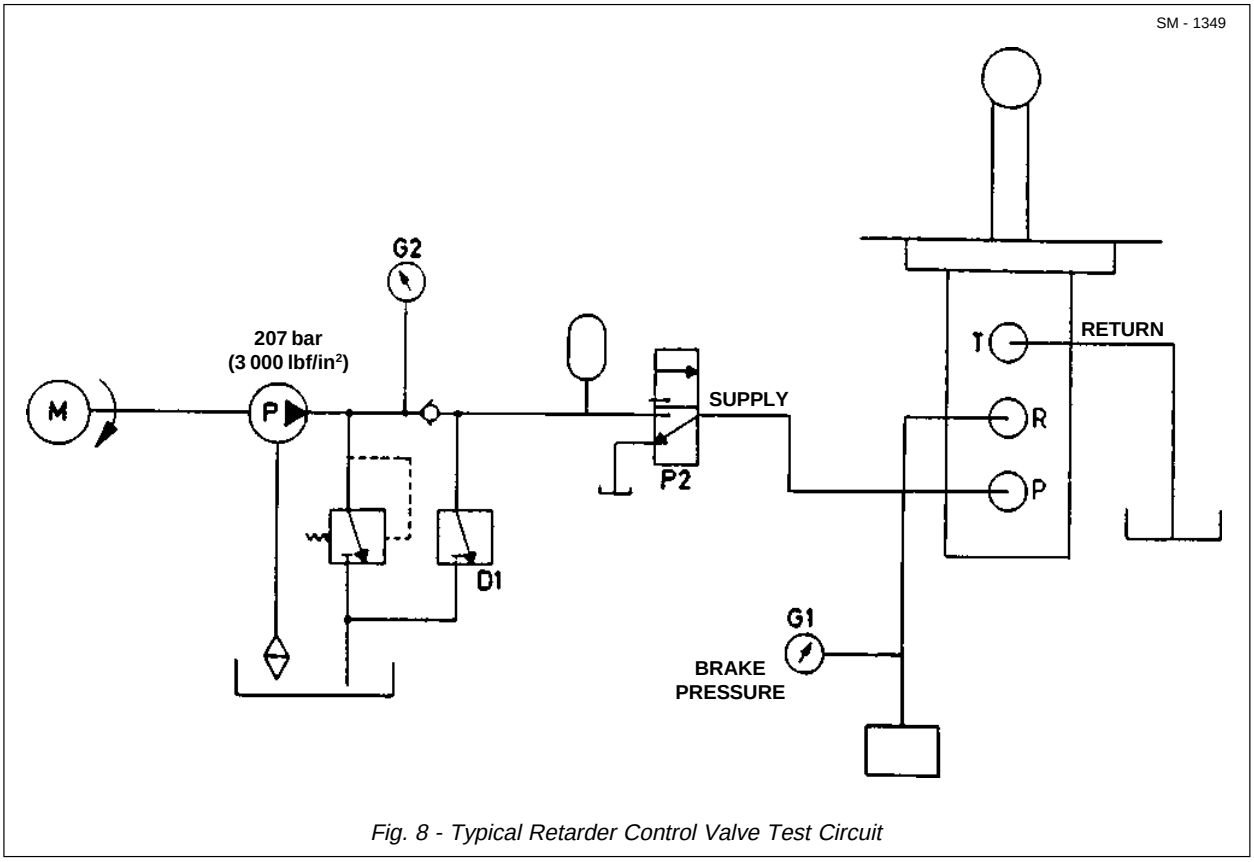


Fig. 8 - Typical Retarder Control Valve Test Circuit

seated in regulator spring (5) before installing regulator sleeve (13). Push regulator sleeve (13) into bore until retaining flange at the base contacts valve body (18).

7. Install spool return spring (14) into regulator spool (7). Reinstall regulator spool (7) into regulator sleeve (13).

8. Lightly lubricate 'O' ring (9) and install into counter bore in the bottom end of valve body (18).

9. Install retainer (19) to valve body (18) and secure with capscrews (21) and washers (20). Tighten capscrews (21) evenly to a torque of 20 - 21 Nm (180 - 190 lbf in), alternating diagonally to evenly seat regulator sleeve (13) assembly.

10. Screw adjustment collars (1) onto the top of actuator plunger (2). Screw all the way down until it bottoms on the thread.

Note: It is extremely important to bottom-out adjustment collar (1) to prevent over-stressing and breaking the springs during the adjustment process.

TESTING AND ADJUSTMENTS

Numbers in parentheses refer to Fig. 1.

Note: A hydraulic test fixture with capabilities similar to the one shown in Fig. 8 is required.

1. Position the valve in the test fixture to allow actuator plunger (2) to be activated by hand using a lever.

2. Attach main supply input pressure line to port 'P'.

3. Attach tank return line to port 'T'.

4. Attach regulated output test line to port 'R'. Check that all ports are used.

5. Set supply line pressure to 159 bar (2 300 lbf/in²).

6. Return line pressure during this test is not to exceed 0.34 bar (5 lbf/in²).

7. Test valve with 10W hydraulic oil at 50° + 6° C (120° + 10° F).

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Setting Apply Pressure

Note: Before actuating the valve, be sure adjustment collar (1) is bottomed to prevent excessive pressure from damaging regulator springs (4 & 5).

1. Gradually increase pressure in order to check for leaks. Make sure adjustment collar (1) is screwed all the way down on the threads and cap (23) is installed on valve body (18).

2. Actuate plunger (2) until cap (23) contacts valve body (18). The pressure reading should be below regulated pressure of 33 ± 1.7 bar (480 ± 25 lbf/in^2).

3. To raise the regulated pressure, back adjustment collar (1) up (anticlockwise) in small increments until the output pressure is 33 ± 1.7 bar (480 ± 25 lbf/in^2) at port 'R'. Fine adjustment will require only turning the collar in 1/8 turn increments.

Note: Adjust adjustment collar (1) in small increments to prevent the valve from being over pressurised during the adjustment procedure. Excessive pressure could cause premature regulator spring failure.

4. Once regulated pressure has been set, tighten the capscrew on adjustment collar (1). Check the pressure again after tightening the capscrew. If the pressure has moved out of the specified range, loosen the capscrew and readjust.

5. Cycle the valve for a minimum of 50 times, then recheck the pressure. If the pressure setting has moved out of the specified range, repeat the adjustment procedure.

6. Apply Loctite 290, or equivalent, to actuator plunger (2) threads and adjustment collar (1) locking screw.

Final Assembly and Adjustments

Numbers in parentheses refer to Fig. 1.

1. Apply a small bead of Loctite 518 gasket compound, or equivalent, to the top of valve body (18) sub-assembly.

2. Install actuator sub-assembly on top of valve body (18) sub-assembly with the valve porting facing as shown in Fig. 1.

3. Secure actuator sub-assembly to valve body sub-assembly with capscrews (33). Tighten capscrews (33) to a torque of 20 - 21 Nm (180 - 190 lbf in).

4. Adjust set screw (27) on top of housing (22) inward until the pressure begins to rise. Measure lever (36) angle and back set screw (27) out until a lever angle of 6° is achieved.

Note: Failure to comply with this specification may result in the regulated pressure not being released to tank.

5. Secure jam nut (28) on set screw (27) to lock the initial lever angle.

6. Fully apply lever (36) to check the maximum regulated output pressure and readjust if required.

Note: The approximate total lever (36) travel is 60° and this value may be used for reference purposes only.

7. Apply and hold lever (36) to maintain maximum regulated output pressure. Adjust set screw (30) until sufficient spring (31) force is generated to hold lever (36) in the full apply position.

8. Turn set screw inward until friction pucks (32) hold lever (36) while generating the maximum regulated pressure (approximately 1.5 turns).

9. Secure set screw (30) in position with jam nut (29) to lock spring (31) compression.

INSTALLATION

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATION.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Position retarder control valve assembly in the centre console and secure with mounting hardware.

2. Remove blanking caps from hydraulic lines and connect to retarder valve assembly as noted on removal.

3. Connect electrical connections to retarder pressure switch as noted at 'Removal'.

4. Check the level of oil in the steering and brake control tank. Refer to Section 220-0040, STEERING

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AND BRAKE CONTROL TANK. Add oil if low. Use oils meeting the specifications outlined in Section 300-0020, LUBRICATION SYSTEM.

5. Start engine and bring hydraulic fluid to operating temperature and apply all brakes in sequence.

6. Check for oil leaks and tighten connections as necessary.

7. Engage retarder. Make sure of a full service brake application and that retarder light illuminates. Release retarder.

8. Check all connections again for leaks and tighten as necessary.

MAINTENANCE

General

Check all hydraulic brake lines and fittings at retarder control valve for leaks and damage. Tighten/replace as required.

Every 1 000 Hours

Check retarder pressure at diagnostic test point as follows:

a. Connect a hydraulic gauge capable of recording a pressure of 0 - 70 bar (0 - 1 000 lbf/in^2) to diagnostic pressure point for rear brake/retarder pressure.

b. Start engine and bring hydraulic oil temperature to operating temperature.

c. Actuate retarder control valve fully and check reading on pressure gauge. Pressure reading should be 33 ± 1.7 bar (480 ± 25 lbf/in^2).

If the pressure is outwith the specified pressure range, inspect the valve and take relevant action (adjust pressures, strip down and repair or replace valve).

Retarder Light Pressure Switch

The retarder light pressure switch is a normally open switch. Attach a continuity tester to terminals on the pressure switch. The circuit should be open.

As retarder pressure increases to 2.7 bar (39 lbf/in^2) and above, the circuit should close and send a signal to illuminate the retarder indicator light in the dash panel, and the retarder light at the rear of the truck. As pressure drops below 2.7 bar (39 lbf/in^2) the circuit should open and the retarder lights should go out.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools, and adhesives are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf in
1	21	Capscrew	20 - 21	180 - 190
1	33	Capscrew	20 - 21	180 - 190

* * * *

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DESCRIPTION

Letters in parentheses refer to Fig. 1.

The Shuttle Valve can be identified as item 6 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

The shuttle valve allows the distribution of pressure from either the treadle valve, to activate the rear service brakes, or, the retarder control valve, to utilise the rear service brakes as a retarder.

The shuttle valve consists of a well fitting spool which is pushed under pressure, depending on flow direction ('P1' to 'A' or 'P2' to 'A') to one end position, where it seals against an 'O' ring seal. The 'O' ring is protected by a metal housing. Flow from 'P1' to 'A', or 'P2' to 'A' can only occur with the valve open.

OPERATION

Refer to Fig. 1. On application of the treadle valve, hydraulic oil, up to a maximum pressure of 52 bar (750 lbf/in²), acts on port 'P1'. This pressure pushes the spool across to close port 'P2'. Oil pressure flows through port 'A' to the monoblock brake valve mounted off the left hand frame rail. Refer to Section 250-0100, MONOBLOCK BRAKE VALVE.

Refer to Fig. 2. On application of the retarder control valve, hydraulic oil, up to a maximum pressure of 33 bar (480 lbf/in²), acts on port 'P2'. This pressure pushes the spool across to close port 'P1'. Oil pressure flows through port 'A' to the monoblock brake valve mounted off the left hand frame rail. Refer to Section 250-0100, MONOBLOCK BRAKE VALVE.

On application of the treadle valve during retarder operation, treadle valve pressure takes priority at the shuttle valve when it exceeds retarder applied pressure. This operation cancels the retarder input and the rear brakes are applied by the treadle valve.

TESTING

Letters in parentheses refer to Fig. 1.

Remove shuttle valve from the truck (as described under 'Maintenance') and plug outlet port 'A'. Apply hydraulic oil pressure of 110 bar (1 600 lbf/in²) through inlet port 'P1' and visually inspect inlet port 'P2' for leaks. Repeat this test for inlet port 'P2'. If any leakage of hydraulic oil occurs, replace shuttle valve.

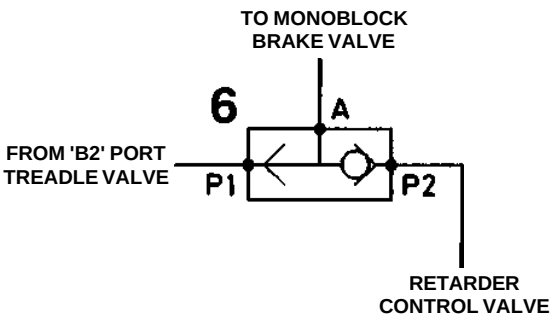


Fig. 1 - Treadle Valve Activated

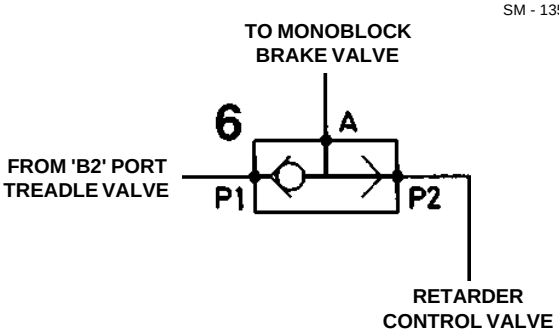


Fig. 2 - Retarder Control Valve Activated

MAINTENANCE

The shuttle valve is a non-serviceable item and should be replaced completely, if damaged, as follows:

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

⚠ WARNINGS

To prevent personal injury and property damage, ensure wheel blocks are of sufficient capacity and properly secured to do the job safely.

⚠ To prevent personal injury, relieve the pressure in the braking system. The exact procedure must be followed as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

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Braking System - Shuttle Valve

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the treadle valve continuously to discharge the brake accumulators. Block all road wheels.

3. Clean shuttle valve assembly and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to the shuttle valve are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines.

4. Remove mounting hardware securing the shuttle valve to mounting bracket on the underside of the cab. Remove shuttle valve and disconnect all fittings for use on the new valve.

5. Install all fittings on the new shuttle valve and secure shuttle valve assembly to mounting bracket with mounting hardware.

6. Remove blanking caps from hydraulic lines and install lines to shuttle valve as identified during removal.

7. Check oil level in steering and brake control tank and add oil if required. Refer to Section 220-0040, STEERING AND BRAKE CONTROL TANK for correct fill level, and, use only oil as specified in Section 300-0020, LUBRICATION SYSTEM.

8. Remove wheel blocks, start the engine and bring hydraulic oil to operating temperature.

9. Apply the brakes and check for oil leaks and correct operation of the shuttle valve. Tighten line connections and fittings as necessary.

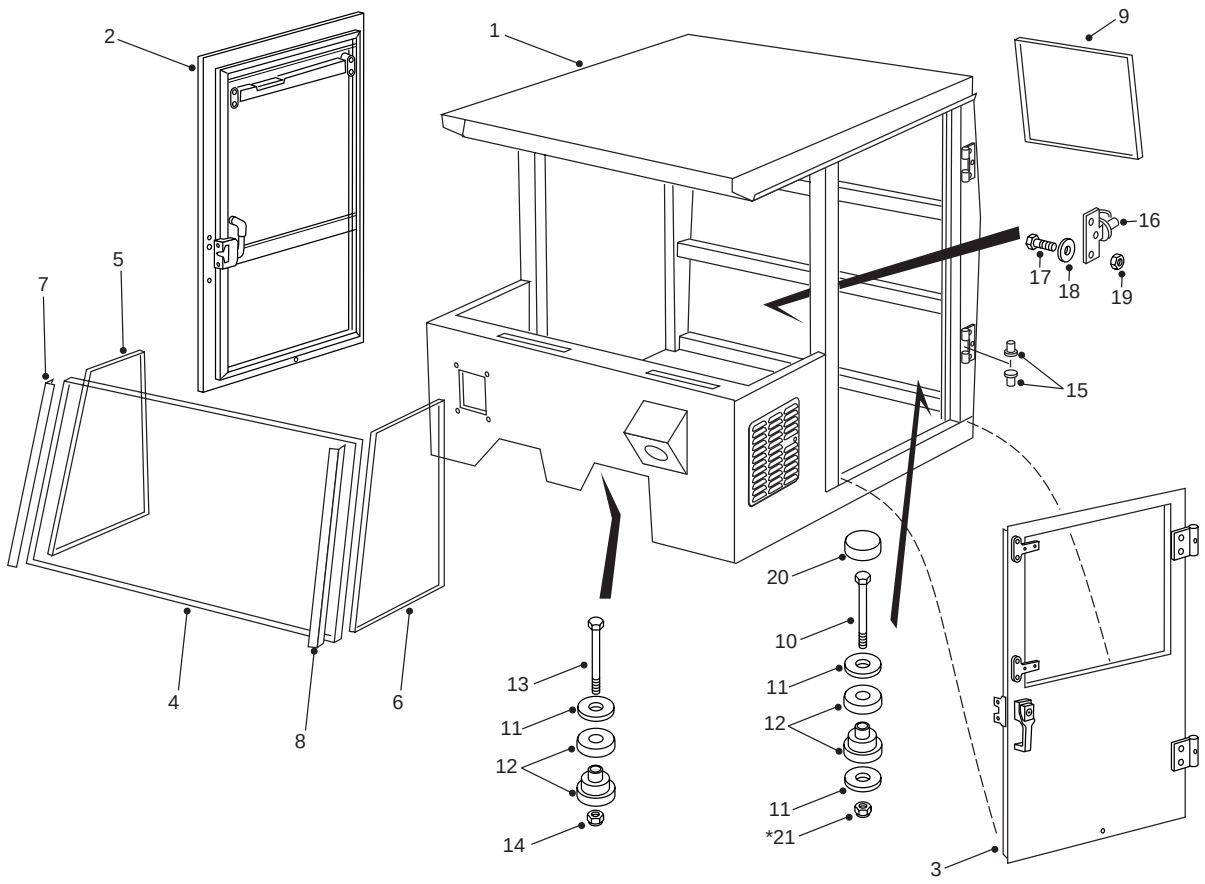
SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

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1 - Cab Assembly
2 - RH Door Assembly
3 - LH Door Assembly
4 - Front Glass
5 - RH Side Glass
6 - LH Side Glass
7 - RH Cover
8 - LH Cover
9 - Rear Glass
10 - Bolt
11 - Snubbing Washer
12 - Rubber Mount
13 - Bolt
14 - Locknut
15 - Insert
16 - Catch Assembly
17 - Screw
18 - Washer
19 - Nut
20 - Cap
*21 - Locknut

* - From January 2000 Production

Fig. 1 - Exploded View of Cab Assembly

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

Cab assembly (1) is mounted through rubber mounts (12) which damp structure borne noise and vibration. The cab conforms with ISO/SAE, FOPS (Falling Object Protective Structure) safety legislation, with ROPS (Roll Over Protective Structure provided by the cab guard.

FOPS - ISO 3449, SAE J231

⚠ WARNING
The protection offered by the FOPS protective structure may be impaired if it has been subjected to any modification or damage. Unauthorized modification will void certification.

Access to cab assembly (1) is from either side and visibility is unrestricted through tinted glass. A heater/filter/pressurizer and demisting unit in front of

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the passengers seat keeps the cab interior air fresh and dust free. A sliding window in RH door assembly (2) and an electric window in LH door assembly (3) provide additional ventilation. An air conditioner is also fitted to cab assembly (1) as standard. Refer to Section 260-0130, AIR CONDITIONING.

REMOVAL

Numbers in parentheses refer to Fig. 1.

Note: Identify and tag all cables, harnesses, lines and pipes disconnected from cab assembly (1) during removal to aid in installation.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ Hydraulic oil pressure will remain within the braking system after engine shutdown. Operate the treadle valve continuously until the pressure has dissipated before removing any brake lines or serious injury could result.

⚠ Hydraulic oil pressure will remain within the body control system after engine shutdown. Operate the body control joystick in both directions approximately 15 times to discharge the pilot valve accumulator before disconnecting any hoses.

⚠ High electrical current. Turn the ignition key switch 'Off' before disconnecting any electrical components. Disconnect electrical connections in the correct order given to prevent damage to the electrical components.

1. Position the vehicle in a level work area, raise the body and install the body safety pins. Refer to Section 270-0010, BODY AND MOUNTING.

2. Apply the parking brake and switch off the engine.

3. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Operate the treadle valve continuously to discharge the braking accumulators. Operate the body control joystick continuously to discharge the pilot valve accumulator. Block all road wheels.

4. Disconnect the electrical cables in the following order to prevent damage to the electrical components.

a. Disconnect battery equalizer ground cables.
b. Disconnect battery cables from terminal posts (ground cables first).
c. Disconnect battery equalizer positive cables.
d. Disconnect electrical connections at the ECU.

5. Disconnect all remaining electrical connections attached to cab assembly (1).

6. Carefully loosen brake pipes at the base of both brake accumulators to check that brake pressure has been discharged. Re-tighten brake pipes.

7. Ensure all steering and braking lines connected to the cab are identified for ease of installation, and with suitable containers available to catch leakage, disconnect all lines. Fit blanking caps to all open lines and fittings.

⚠ WARNING
Before disconnecting any air conditioner lines, refer to Section 260-0130, AIR CONDITIONING. Refrigerant will rapidly freeze all objects with which it comes into contact. It can cause serious and permanent damage to the eyes and skin.

8. Evacuate the air conditioning system and disconnect air conditioning lines. Refer to Section 260-0130, AIR CONDITIONING. Fit blanking caps to all open lines and fittings.

9. Ensure heater lines are identified for ease of installation, and with suitable containers available to catch leakage, disconnect heater lines. Fit blanking caps to open lines and fittings.

10. Ensure body control joystick lines are identified for ease of installation, and with suitable containers available to catch leakage, disconnect hoses at manifold plate in cab floor. Fit blanking caps to open lines and fittings.

11. Ensure all connections to cab assembly (1) have been removed, prior to removal.

12. Attach suitable lifting equipment to cab assembly (1) and take up the slack. Remove cap (20) from bolt head. Remove locknut (14) securing bolt (13) to front cab support. Remove locknut (21), if fitted and slacken off bolts (10) from rear cab supports.

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Note: Use padded spreader bars when removing cab assembly (1) with overhead lifting equipment to prevent damage from concentrated loads at cab lifting points with hooks, chains, cables etc..

13. Lift cab assembly (1) carefully from the cab supports and remove to suitable stands. Remove bolts (13 & 10), snubbing washers (11) and rubber mounts (12) from cab assembly (1).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM. Renew all 'O' rings where used.

> ⚠ **WARNING**
> **To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. Inspect rubber mounts (12) for damage and replace if necessary. If installing new rubber mounts (12), lubricate them with water or a suitable rubber lubricant and install in cab assembly (1). Use a driver of the same diameter as the internal metal sleeve in rubber mount (12) to drive the mounts fully home.

2. Attach suitable lifting equipment (with padded spreader bars) and position cab assembly (1) to cab supports. Take care when positioning cab assembly (1) to prevent snagging of lines and components on the underside of cab assembly (1).

3. Secure cab assembly (1) to front cab support with bolt (13), snubbing washer (11) and locknut (14) and, to rear cab support with bolts (10), snubbing washers (11) and locknuts (21), if fitted. Fit cap (20) over head of rear mounting bolts (10).

4. Remove blanking caps from all body control joystick lines and connect lines as identified at removal. Tighten all lines securely.

5. Remove blanking caps from all braking and steering lines and connect lines as identified at removal. Tighten all lines securely.

6. Connect all electrical connections with the exception of battery cables, battery equalizer cables and CEC connections, as identified at removal.

7. Remove blanking caps from heater lines and fittings and connect lines as identified at removal. Tighten heater lines securely.

> ⚠ **WARNING**
> **Before connecting any air conditioner lines, refer to Section 260-0130, AIR CONDITIONING. Refrigerant will rapidly freeze all objects with which it comes into contact. It can cause serious and permanent damage to the eyes and skin.**

8. Connect the air conditioning lines to the evaporator and charge the system. Refer to Section 260-0130, AIR CONDITIONING.

9. Connect electrical cables in the following order.

a. Connect all electrical connections removed at the ECU.
b. Connect battery equalizer positive connections.
c. Connect battery cables to terminal posts (positive cables first).
d. Connect battery equalizer ground cables.

10. Check cab assembly (1) and be sure that all lines, cables and harnesses removed at removal have been reconnected.

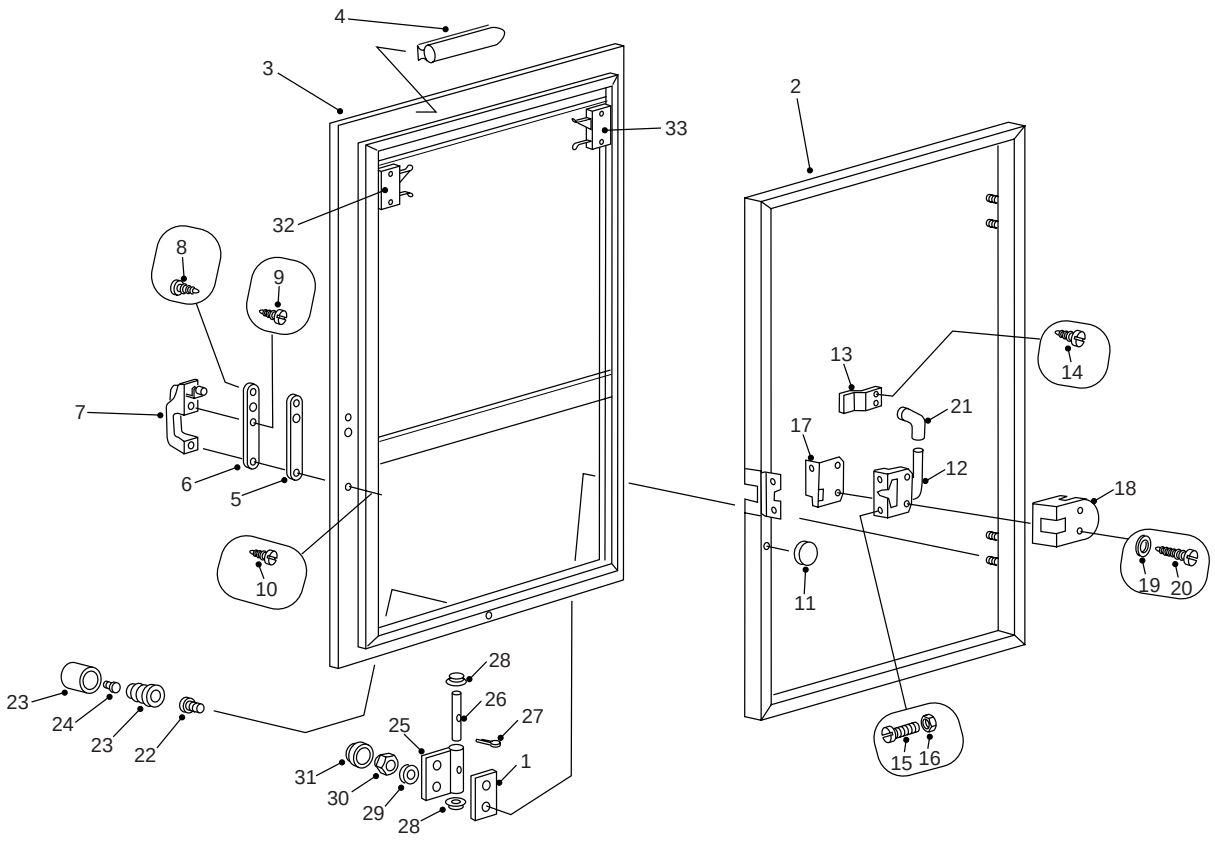
11. Fill both hydraulic tanks with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Check coolant level at radiator header tank and add coolant if low. Refer to Section 300-0020, LUBRICATION SYSTEM.

12. Start the engine and check for leaks. Tighten lines and fittings as required. Allow the vehicle to warm to normal operating temperatures and check all connections for leaks.

13. Check all instruments and controls for proper operation. Remove body safety pins and lower the body to the frame.

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1 - Gasket
2 - RH Door Frame
3 - Sliding Frame
4 - Seal
5 - Gasket
6 - Spacer
7 - Door Handle
8 - Screw
9 - Screw
10 - Screw
11 - Grommet
12 - Lock
13 - Locking Plate
14 - Screw
15 - Screw
16 - Nut
17 - Fixing Plate
18 - Lock Cover
19 - Washer
20 - Screw
21 - Cover
22 - Nut
23 - Retainer
24 - Screw
25 - Hinge
26 - Pin
27 - Split Pin
28 - Clip
29 - Washer
30 - Nut
31 - Cap
32 - Catch - LH
33 - Catch - RH

Fig. 2 - Exploded View of Right Hand Door Assembly

RIGHT HAND DOOR

Description

The right hand door assembly is of welded steel construction, hinged at the rear. It has a two section glass window. The lower section is stationary while the upper section slides up and down, with a multi-position lock and stop rack arrangement on each side to hold the window in the selected position. A retainer assembly mounted on the platform prevents the door from swinging all the way open, and holds the door in the open position.

The door assembly can be removed from the cab as a complete assembly, however, components such as the lock, handle and glass assembly can be removed with the door attached to the cab.

Removal and Installation

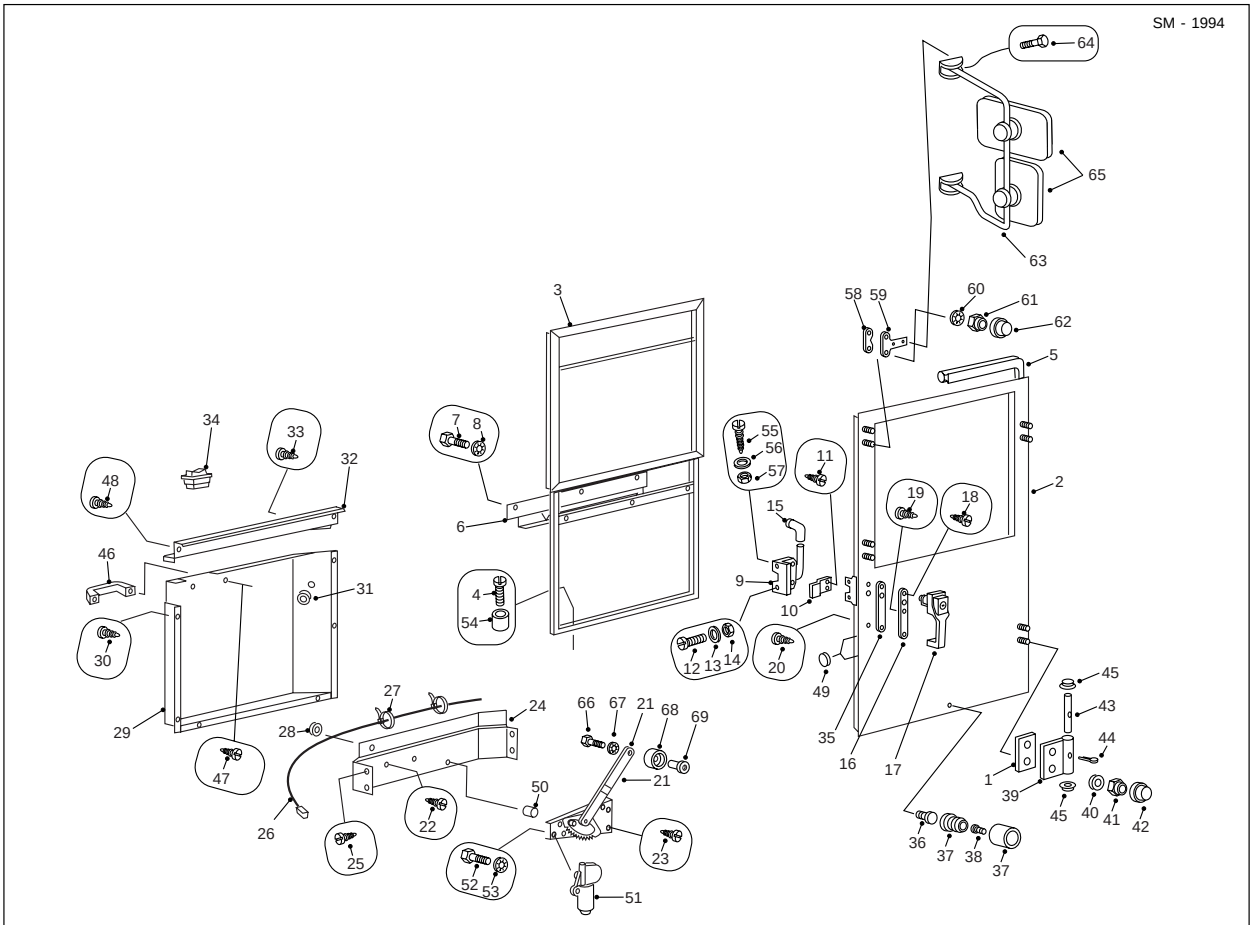
Numbers in parentheses refer to Fig. 2.

⚠ WARNING
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Open RH door assembly (2, Fig. 1) and attach a suitable lifting device. Remove caps (28) and splitpins (27) from hinges (25). Using a suitable driver, chap pin (26) out from hinge (25). Remove RH door assembly (2, Fig. 1) from cab assembly (1, Fig. 1).

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1 - Grommet	15 - Cover	29 - Inner Door	42 - Cap	56 - Washer
2 - LH Door	16 - Spacer	30 - Screw	43 - Pin	57 - Nut
3 - Window assembly	17 - Door Handle	31 - Grommet	44 - Split Pin	58 - Spacer
4 - Screw	18 - Screw	32 - Switch Support	45 - Clip	59 - Mirror Support
5 - Seal	19 - Screw	33 - Screw	46 - Handle	60 - Washer
6 - Glass Support	20 - Screw	34 - Switch	47 - Screw	61 - Nut
7 - Screw	21 - Slide	35 - Seal	48 - Screw	62 - Cap
8 - Washer	22 - Screw	36 - Nut	49 - Grommet	63 - Mirror Arm
9 - Lock Assembly	23 - Screw	37 - Door Retainer	50 - Spacer	64 - Bolt
10 - Latch Bracket	24 - Support	38 - Screw	51 - Motor	65 - Mirror
11 - Screw	25 - Screw	39 - Hinge	52 - Screw	66 - Screw
12 - Screw	26 - Electric Cable	40 - Washer	53 - Washer	67 - Washer
13 - Washer	27 - Clip	41 - Locknut	54 - Spacer	68 - Nylon Roller
14 - Nut	28 - Grommet		55 - Screw	69 - Bush

Fig. 3 - Exploded View of Left Hand Door Assembly

2. If required, fit new inserts (15, Fig. 1) to hinges.

3. Attach a suitable lifting device to RH door assembly (2, Fig. 1) and align the door assembly to hinges on cab. Install pin (26), aligning holes and secure using split pin (27). Replace caps (28).

4. Check RH door assembly (2, Fig. 1) for correct operation and also that the locks are operating correctly.

LEFT HAND DOOR

Description

The left hand door assembly is of welded steel construction, hinged at the rear. It has an electric roll down glass window which provides the operator with additional ventilation. A retainer assembly mounted on the platform prevents the door from swinging all the way open, and holds the door in the open position.

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The door assembly can be removed from the cab as a complete assembly, however, components such as the lock, handle and glass assembly can be removed with the door attached to the cab.

Removal and Installation

Numbers in parentheses refer to Fig. 3.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.**

1. Open LH door assembly (3, Fig.1) fully and attach a suitable lifting device. Remove caps (45) and splitpins (44) from hinges (39). Using a suitable driver, chap pin (43) out from hinge (39). Remove LH door assembly (3, Fig. 1) from cab assembly (1, Fig. 1).

2. If required, fit new inserts (15, Fig. 1) to hinges.

3. Attach a suitable lifting device to LH door assembly (3, Fig. 1) and align the door assembly to hinges on cab. Install pin (43), aligning holes and secure using split pin (44). Replace caps (45).

4. Check LH door assembly (3, Fig. 1) for correct operation and also that the locks are operating correctly.

REPLACING GLASS

Numbers in parentheses refer to Fig. 1.

Note: When replacing broken glass, it is the user's responsibility to ensure that replacement glass meets the required specifications.

Front glass (4), side glasses (5 & 6) and rear glass (9) panels are held in place by a bonding adhesive. The front and side glasses (4, 5 & 6) also have corner covers (7 & 8).

To replace a glass assembly, proceed as follows:

Note: Ensure the glass is supported adequately before starting to cut the adhesive seal.

1. If necessary, remove corner covers (7 & 8).

2. Using a pointed tool, pierce a hole in the adhesive seal, it is advisable to start at the top edge of the glass. Unscrew one handle of the special tool and feed the wire through the opening. Pierce a second hole in the adhesive on the side directly opposite the first.

3. From inside the cab pull the wire through and feed it back out through the second hole.

4. Re-fit the handle on the special tool. Pull both handles outwards until wire is taut.

5. Manouver the special tool around the edge of the glass, keeping the wire taut, to cut the adhesive seal. Ensure the glass is supported adequately before completing the cut. Remove glass from window aperture.

6. Clean the remains of the adhesive from the edge of the panel opening using a suitable solvent.

7. Coat the edge of the replacement glass with primer and apply adhesive around the lip of the window aperture, as per the manufacturers recommendations.

8. Position glass onto panel opening, pressing firmly so that adhesive bonds sufficiently to allow the glass to be moved or straightened up as required.

9. Ensuring the glass is adequately supported, allow the sealing adhesive to set properly.

10. Clean off any excess adhesive using a suitable solvent.

11. If removed, re-fit corner covers (7 & 8).

Water Leaks

Test for leaks by directing a stream of water along the adhesive seal, while an assistant marks the spot of leakage inside the cab. Care should be taken to note whether the leak is between adhesive and glass. Then apply a sealing compound from the outside. Start from a point near the leak and continue applying the sealer until well beyond the suspected point of entry.

This should stop the leak immediately, but since some sealing compounds should be allowed to set before getting wet, wait a few minutes before testing.

SPECIAL TOOLS

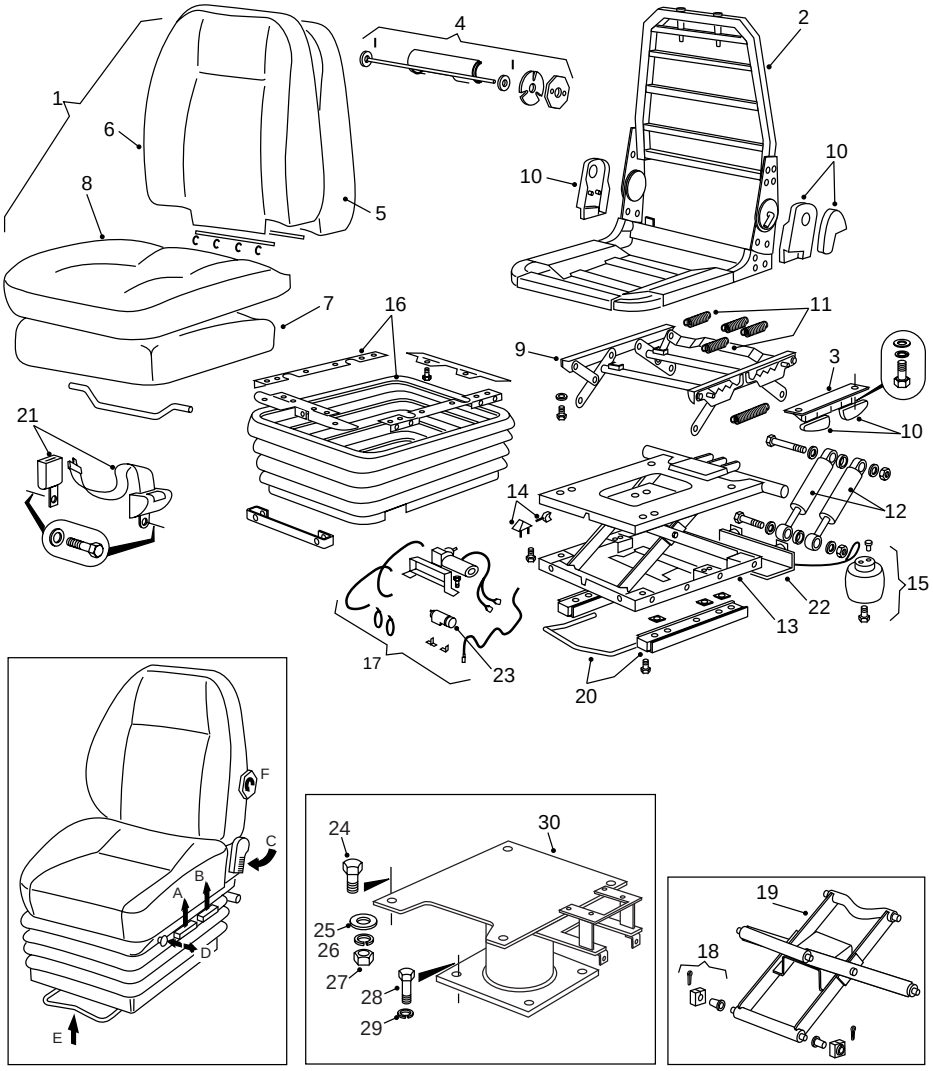
Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools referenced in this section and general service tools required. These tools are available from your dealer.

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SM - 2352



1 - Seat Assembly
2 - Seat Frame
3 - Latch Height Riser
4 - Lumbar Support
5 - Back Cushion
6 - Back Cover
7 - Seat Cushion
8 - Seat Cover
9 - Height Riser Assembly
10 - Handles
11 - Height Riser Spring
12 - Damper
13 - Suspension Assembly
14 - Upstop/Bumpstop
15 - Air Spring
16 - Suspension Cover
17 - Manual Valve
18 - Bearing
19 - Lever
20 - Slide Adjuster
21 - Lap Belt
22 - Tether
23 - Switch
24 - Bolt
25 - Washer
26 - Lockwasher
27 - Nut
28 - Bolt
29 - Lockwasher
30 - Seat Base

Fig. 1 - Exploded View of Driver Seat

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
By Law, seat belts must be provided. Always wear seat belts when travelling in the vehicle.

The driver seat is secured to the cab floor with bolts (28) and lockwashers (29). The seat assembly (1) consists of a seat cushion (7) and back cushion (5) mounted to seat frame (2). Seat frame (2) is attached to seat base (30) by means of a suspension assembly. The air seat only reacts when the driver sits on the seat. When unoccupied, the seat sinks to

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the lowest position to allow easier access. The incorporated block out maintains the seat in position for driving.

A retractable lap belt (21) is secured to the seat assembly using bolts and lockwashers. A lift lever buckle allows quick release of lap belt (21).

The following is the list of controls to adjust the seat:
A. Height and slope adjustment, front.
B. Height and slope adjustment, rear.
C. Backrest angle adjustment.
D. Weight adjustment.
E. Horizontal adjustment (sliderails).
F. Lumber support adjustment (5 positions).

⚠ WARNING
Do not attempt to adjust the seat or seat belt while the machine is moving. Loss of control may result. Stop the machine; apply the brakes; then adjust.

REMOVAL AND DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the steering in both directions several times to relieve any pressure in the steering system. Block all road wheels.

3. Disconnect compressor connector at the rear of the seat.

4. Push the control valve button (D) in to release the air from the seat air suspension system.

5. Using suitable lifting equipment, support seat and remove bolts (28) and lockwashers (29) securing complete seat assembly to the cab floor. Remove seat assembly from vehicle.

6. Remove bolts and lockwashers securing lap belt (21) to seat assembly. Remove lap belt (21).

7. Remove bolts (24), washers (25), lockwashers (26) and nuts (27) securing seat base (30) to seat assembly. Remove seat base (30) from seat assembly.

8. If required, remove pop-out button and pull back suspension cover (16) to allow access to suspension assembly (13).

9. If required, remove mounting hardware securing dampers (12) to suspension assembly (13). Remove dampers (12).

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Inspect air lines, control valve (D), dampers (12) and air spring (15) for leaks and damage and replace if required.

2. Check all brackets and frame for cracks and/or damage. Repair or replace as necessary.

3. Check springs (11) for fatigue or damage and replace as required.

ASSEMBLY AND INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. If removed, secure dampers (12) to suspension assembly (13) using mounting hardware as removed at Removal.

2. If required, install suspension cover (16) over suspension assembly (13) and refit pop-out button.

3. Install seat base (30) to seat assembly and secure using bolts (24), washers (25), lockwashers (26) and nuts (27).

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4. Position lap belt (21) to seat assembly and secure using bolts and lockwashers as removed at Removal.

5. Using suitable lifting equipment, position seat assembly on the cab floor and secure with bolts (28) and lockwashers (29).

6. Reconnect compressor connector at the rear of the seat.

7. Start the engine and charge the air system. Pull out control valve button (D) to allow air into seat suspension system and check seat for proper operation.

8. Remove wheel chocks from road wheels.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

The care of the upholstery on seat cover (8) and back cover (6) is a relatively simple, but important matter. Accumulation of dirt on the surface eventually turns into a hard gritty substance which cuts into the surface of the upholstery.

To clean seat cover (8) and back cover (6), use warm water and a mild soap, such as Castile. Work up thin soap suds on a piece of soft cloth and rub the upholstery briskly. Remove the suds with a damp cloth, using no soap, and finish by wiping the upholstery dry with a soft, dry cloth.

Lap belt (21) assembly should be inspected by the user on a regular basis. Replace lap belt (21) immediately if hardware is worn or damage, straps are nicked or frayed, buckle is not functioning correctly, loose stitching is found, or if the strap material has lost strength due to the effects of ultraviolet rays.

Note: Regardless of appearance, lap belt (21) must be removed and replaced at least once every three years.

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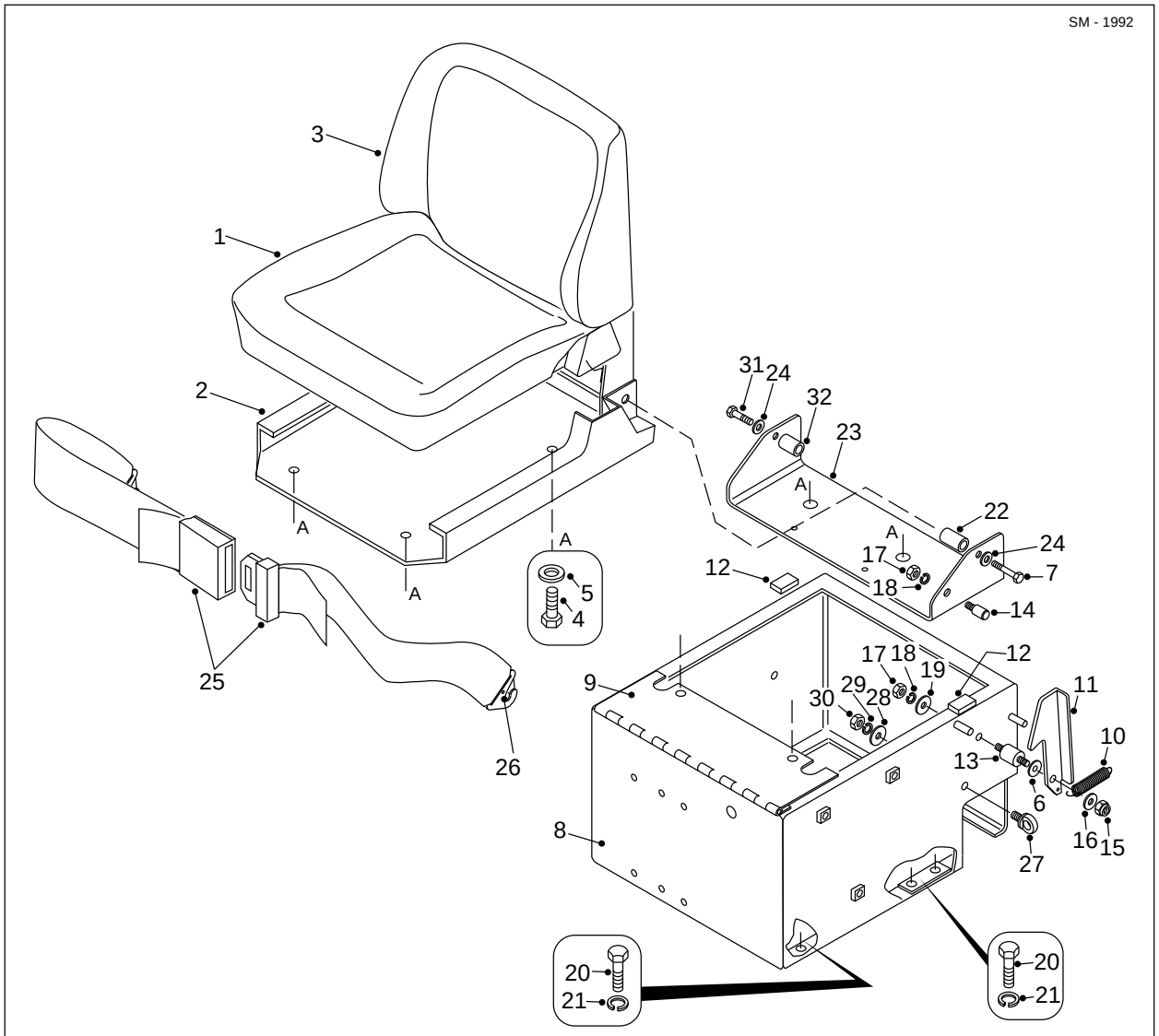
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1 - Seat Cushion	9 - Hinge	17 - Nut	25 - Lap Belt
2 - Seat Frame	10 - Spring	18 - Lockwasher	26 - Cotter Pin
3 - Back Cushion	11 - Latch	19 - Washer	27 - Eye Bolt
4 - Bolt	12 - Pad	20 - Bolt	28 - Washer
5 - Lockwasher	13 - Pivot Pin	21 - Lockwasher	29 - Lockwasher
6 - Washer	14 - Latch Pin	22 - Spacer	30 - Nut
7 - Bolt	15 - Locknut	23 - Bracket	31 - Bolt
8 - Seat Base	16 - Hardened Washer	24 - Washer	32 - Spacer

Fig. 1 - Exploded View of Passenger Seat

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
By Law, seat belts must be provided. Always wear seat belts when travelling in the vehicle.

The passenger seat is located to the right of the control console and secured to the cab floor with bolts (20) and lockwashers (21). The seat assembly consists of a seat cushion (1) and back cushion (3) mounted to seat frame (2). Seat frame (2) is attached to seat base (8) by means of a hinge (9) at the front end and locked at the rear by a spring loaded latch

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arrangement. Located within seat base (8) are the major CEC components; battery equalizer box, electronic control unit (ECU) and CEC interface box.

An adjustable lap belt (25) is secured with snap hooks to eye bolts (27) on seat base (8). A lift lever buckle allows quick release of lap belt (25).

REMOVAL AND DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ WARNINGS
High electrical current. Turn the ignition key switch 'Off' before disconnecting any electrical components. Disconnect electrical connections in the correct order given to prevent damage to the electrical components.

1. Position the vehicle in a level work area, apply the parking brake and shutdown the engine.

2. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Block all road wheels.

3. Move seat latch (11) to the release position and tilt seat assembly forward. Support or block the seat assembly and remove bolts (4) and lockwashers (5). Remove seat assembly from seat base (8).

4. Remove mounting hardware, back and seat cushions (1 & 3) from seat frame (2).

5. Remove bolts (7 & 31), washers (24) and spacers (22 & 32) securing bracket (23) to seat frame (2). Remove bracket (23).

6. Remove nut (17), lockwasher (18) and latch pin (14) from seat base (8).

7. Remove spring (10) from latch (11) and seat base (8). Remove locknut (15), hardened washer (16) and latch (11) from pivot pin (13). Remove nut (17), lockwasher (18), washer (19) and pivot pin (13) from seat base (8).

8. Remove cotter pins (26), release the snap hooks on lap belt (25) and remove lap belt (25) halves from eye bolts (27). Remove nuts (30), lockwashers (29), washers (28) and eye bolts (27) from seat base (8).

9. If seat base (8) requires to be removed, disconnect the electrical cables in the following order to prevent damage to the electrical components.

a. Disconnect battery equalizer ground cables.
b. Disconnect battery cables from terminal posts (ground cables first).
c. Disconnect battery equalizer positive cables.
d. Disconnect electrical connections at the ECU.

10. Disconnect electrical connections from switch breakers. If required, remove switch breakers from seat base (8).

11. Remove mounting hardware securing the CEC components to seat base (8). Remove lockwashers (21) and bolts (20) securing seat base (8) to the cab floor. Remove seat base (8) from the cab.

ASSEMBLY AND INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. If removed, position seat base (8) on cab floor and secure with bolts (20) and lockwashers (21).

2. If removed, install switch breakers on seat base (8) and connect electrical cables to switch breakers.

3. Connect the electrical cables in the following order to prevent damage to the electrical components.

a. Connect electrical connections at the ECU.
b. Connect battery equalizer positive connections.
c. Connect battery cables to terminal posts (positive cables first).
d. Connect battery equalizer ground cables.

4. Position eye bolts (27) through mounting holes in seat base (8) and secure with washers (28), lockwashers (29) and nuts (30). Tighten nuts (30) to a torque of 70 Nm (52 lbf ft). Position snap hooks of lap belt (25) halves through eye bolts (27) and secure with cotter pins (26).

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5. Install pivot pin (13) through mounting hole in seat base (8) and secure with washer (19), lockwasher (18) and nut (17).

6. Install latch (11) on pivot pin (13) and secure with hardened washer (16) and locknut (15). Tighten locknut (15) enough to allow latch (11) to pivot freely. Install spring (10) to latch (11) and seat base (8).

7. Install latch pin (14) in seat frame (2) and secure with lockwasher (18) and nut (17).

8. Position bracket (23) on seat frame (2) and secure with bolts (7 & 31), washers (24) and spacers (22 & 32).

9. Position back and seat cushions (1 & 3) on seat frame (2) and secure with mounting hardware.

10. Position the seat assembly to hinge (9) of seat base (8) and secure with bolts (4), lockwashers (5) and nuts (6). Tighten nuts (6) to a torque of 18 Nm (13 lbf ft). Lower seat assembly on seat base (8) and ensure latch arrangement is operating correctly.

11. Remove wheel chocks from road wheels.

LAP BELT ADJUSTMENT

Always check that the lap belt is properly adjusted and secured prior to moving off. To adjust the lap belt, close the lift-lever buckle and release the adjustable latch. Lengthen or shorten the belt halves until the desired length is obtained.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

The care of the upholstery on seat cushion (1) and back cushion (3) is a relatively simple, but important matter. Accumulation of dirt on the surface eventually turns into a hard gritty substance which cuts into the surface of the upholstery.

To clean seat cushion (1) and back cushion (3), use warm water and a mild soap, such as Castile. Work up thin soap suds on a piece of soft cloth and rub the upholstery briskly. Remove the suds with a damp cloth, using no soap, and finish by wiping the upholstery dry with a soft, dry cloth.

Lap belt (25) assembly should be inspected by the user on a regular basis. Replace lap belt (25) immediately if hardware is worn or damage, straps are nicked or frayed, buckle is not functioning correctly, loose stitching is found, or if the strap material has lost strength due to the effects of ultraviolet rays.

Note: Regardless of appearance, lap belt (25) must be removed and replaced at least once every three years.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	15	Nut	To allow latch to pivot	
1	30	Nut	70	52

* * * *

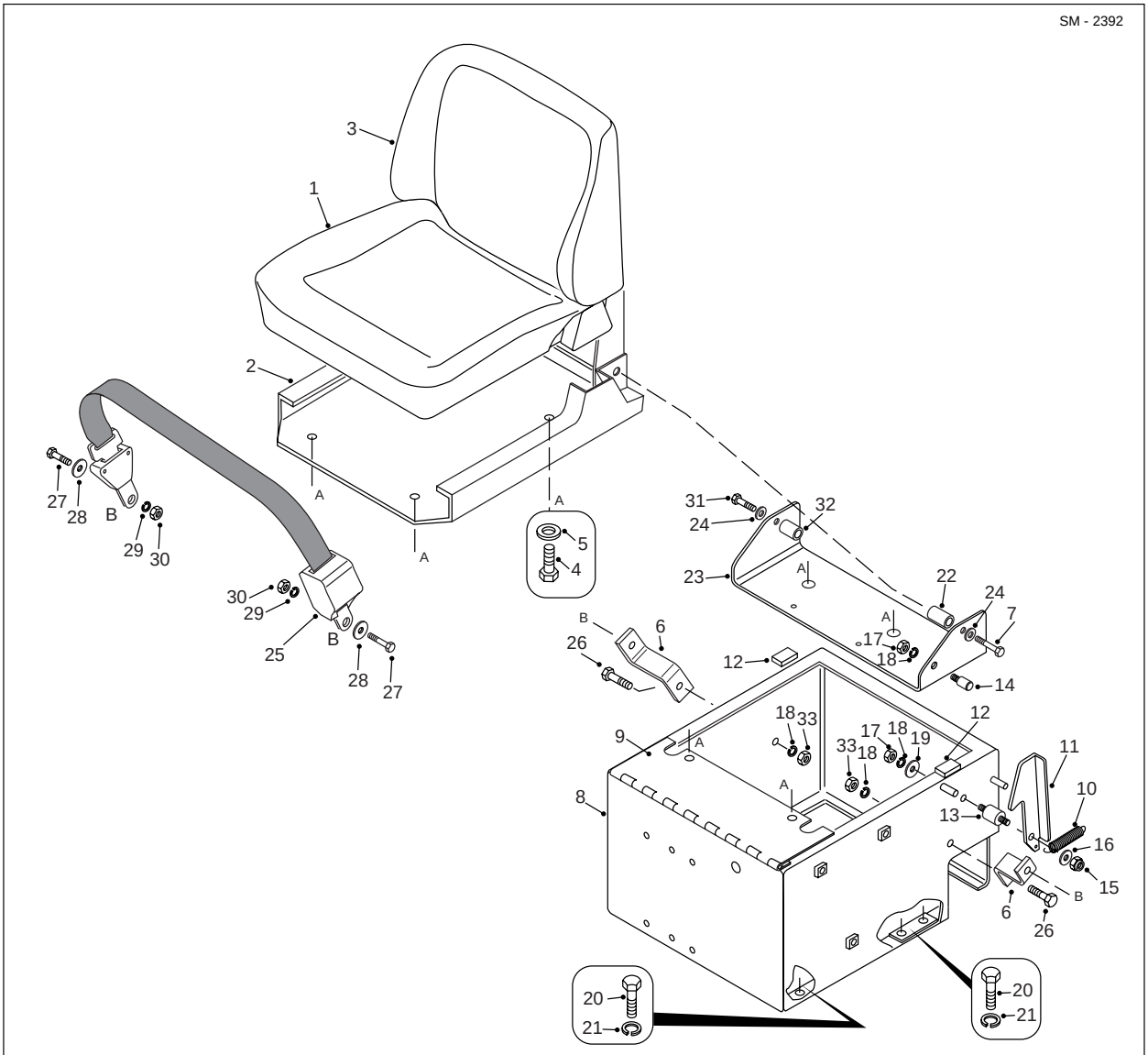
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1 - Seat Cushion
2 - Seat Frame
3 - Back Cushion
4 - Bolt
5 - Lockwasher
6 - Bracket
7 - Bolt
8 - Seat Base
9 - Hinge
10 - Spring
11 - Latch
12 - Pad
13 - Pivot Pin
14 - Latch Pin
15 - Locknut
16 - Hardened Washer
17 - Nut
18 - Lockwasher
19 - Washer
20 - Bolt
21 - Lockwasher
22 - Spacer
23 - Bracket
24 - Washer
25 - Lap Belt
26 - Bolt
27 - Bolt
28 - Washer
29 - Lockwasher
30 - Nut
31 - Bolt
32 - Spacer
33 - Nut

Fig. 1 - Exploded View of Passenger Seat

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

⚠ WARNING
By Law, seat belts must be provided. Always wear seat belts when travelling in the vehicle.

The passenger seat is located to the right of the control console and secured to the cab floor with bolts (20) and lockwashers (21). The seat assembly consists of a seat cushion (1) and back cushion (3) mounted to seat frame (2). Seat frame (2) is attached to seat base (8) by means of a hinge (9) at the front end and locked at the rear by a spring loaded latch

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arrangement. Located within seat base (8) are the major CEC components; battery equalizer box, electronic control unit (ECU) and CEC interface box.

A retractable lap belt (25) is secured to seat base (8) using bolts (27), washers (28), lockwashers (29) and nuts (30). A release button allows quick release of lap belt (25).

REMOVAL AND DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

⚠ WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠ WARNINGS
High electrical current. Turn the ignition key switch 'Off' before disconnecting any electrical components. Disconnect electrical connections in the correct order given to prevent damage to the electrical components.

1. Position the vehicle in a level work area, apply the parking brake and shutdown the engine.

2. Turn the steering wheel in both directions several times to relieve any pressure in the steering system. Block all road wheels.

3. Move seat latch (11) to the release position and tilt seat assembly forward. Support or block the seat assembly and remove bolts (4) and lockwashers (5). Remove seat assembly from seat base (8).

4. Remove mounting hardware, back and seat cushions (1 & 3) from seat frame (2).

5. Remove bolts (7 & 31), washers (24) and spacers (22 & 32) securing bracket (23) to seat frame (2). Remove bracket (23).

6. Remove nut (17), lockwasher (18) and latch pin (14) from bracket (23).

7. Remove spring (10) from latch (11) and seat base (8). Remove locknut (15), hardened washer (16) and latch (11) from pivot pin (13). Remove nut (17), lockwasher (18), washer (19) and pivot pin (13) from seat base (8).

8. Remove bolts (27), washers (28), lockwashers (29) and nuts (30) securing lap belt (25) to seat base (8) and remove lap belt (25). Remove bolts (26), lockwashers (18), nuts (33) and brackets (6) from seat base (8).

9. If seat base (8) requires to be removed, disconnect the electrical cables in the following order to prevent damage to the electrical components.

a. Disconnect battery equalizer ground cables.
b. Disconnect battery cables from terminal posts (ground cables first).
c. Disconnect battery equalizer positive cables.
d. Disconnect electrical connections at the ECU.

10. Disconnect electrical connections from switch breakers. If required, remove switch breakers from seat base (8).

11. Remove mounting hardware securing the CEC components to seat base (8). Remove bolts (20) and lockwashers (21) securing seat base (8) to the cab floor. Remove seat base (8) from the cab.

ASSEMBLY AND INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. If removed, position seat base (8) on cab floor and secure with bolts (20) and lockwashers (21).

2. If removed, install switch breakers on seat base (8) and connect electrical cables to switch breakers.

3. Connect the electrical cables in the following order to prevent damage to the electrical components.

a. Connect electrical connections at the ECU.
b. Connect battery equalizer positive connections.
c. Connect battery cables to terminal posts (positive cables first).
d. Connect battery equalizer ground cables.

4. Position brackets (6) on seat base (8) and secure with bolts (26), lockwashers (18) and nuts (33). Position lap belt (25) on mounting brackets (6) and secure with bolts (27), washers (28), lockwashers (29) and nuts (30).

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5. Install pivot pin (13) through mounting hole in seat base (8) and secure with washer (19), lockwasher (18) and nut (17).

6. Install latch (11) on pivot pin (13) and secure with hardened washer (16) and locknut (15). Tighten locknut (15) enough to allow latch (11) to pivot freely. Install spring (10) to latch (11) and seat base (8).

7. Install latch pin (14) in bracket (23) and secure with lockwasher (18) and nut (17).

8. Position bracket (23) on seat frame (2) and secure with bolts (7 & 31), washers (24) and spacers (22 & 32).

9. Position back and seat cushions (1 & 3) on seat frame (2) and secure with mounting hardware.

10. Position the seat assembly to hinge (9) of seat base (8) and secure with bolts (4) and lockwashers (5). Tighten bolts (4) to a torque of 18 Nm (13 lbf ft) lubed. Lower seat assembly on seat base (8) and ensure latch arrangement is operating correctly.

11. Remove wheel chocks from road wheels.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

The care of the upholstery on seat cushion (1) and back cushion (3) is a relatively simple, but important matter. Accumulation of dirt on the surface eventually turns into a hard gritty substance which cuts into the surface of the upholstery.

To clean seat cushion (1) and back cushion (3), use warm water and a mild soap, such as Castile. Work up thin soap suds on a piece of soft cloth and rub the upholstery briskly. Remove the suds with a damp cloth, using no soap, and finish by wiping the upholstery dry with a soft, dry cloth.

Lap belt (25) assembly should be inspected by the user on a regular basis. Replace lap belt (25) immediately if hardware is worn or damage, straps are nicked or frayed, release mechanism is not functioning correctly, loose stitching is found, or if the strap material has lost strength due to the effects of ultraviolet rays.

Note: Regardless of appearance, lap belt (25) must be removed and replaced at least once every three years.

SPECIAL TORQUE SPECIFICATIONS

FIG. NO.	ITEM NO.	ITEM NAME	TORQUE	
			Nm	lbf ft
1	4	Bolt	18	13
1	15	Nut	To allow latch to pivot	

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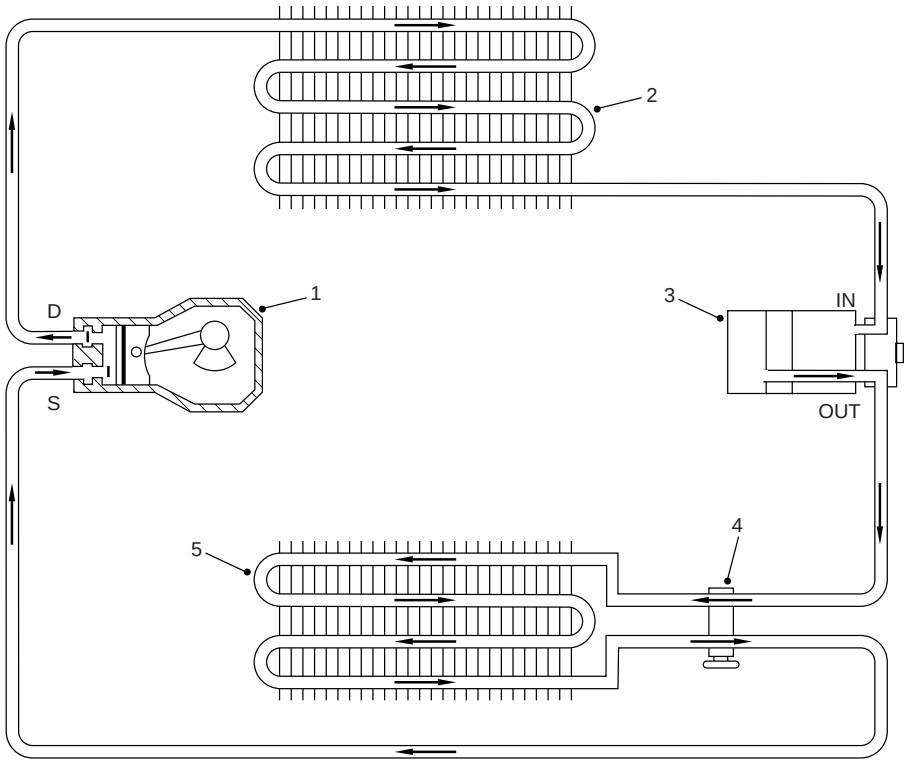
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SM - 2430



1 - Compressor
2 - Condenser
3 - Receiver Drier
4 - Expansion Valve
5 - Evaporator

Fig. 1 - Typical Air Conditioning Flow Diagram

DESCRIPTION

Temperature Control Switch

A thermostat switch senses the temperature of the evaporator and engages or disengages the compressor clutch. The control for this switch is located in the cab.

Compressor

The compressor is designed to compress vapour and can be damaged by non-compressibles such as dirt, moisture, liquid refrigerant (R-134a), etc. The compressor draws vaporized R-134a from the evaporator (which maintains the low pressure necessary for proper evaporation) and compresses the vapour to a high pressure, which is necessary for condensation. The high pressure vapour then moves into the condenser where heat can be radiated to change the R-134a back to liquid.

Note: R-134a designates the type of refrigerant used in heavy duty vehicle air conditioning systems.

Compressor Drive Clutch

The R-134a compressor systems use an electronically actuated clutch to engage and disengage drive to the compressor. The 'V' belt pulley is mounted on a bearing and is free to rotate without turning the compressor crankshaft any time electrical power is disconnected. The compressor is not operating when the pulley is freewheeling. The field coil is energized by supplying electrical current to the exposed wire. The other end of the coil winding is grounded to the compressor and equipment frame. Energizing the coil creates a magnetic force that locks the driven disk to the pulley and drives the compressor.

Condenser

The purpose of the condenser is to radiate enough heat energy from the compressed high pressure vaporized R-134a so that the R-134a changes from vapour to liquid. During normal operation all the high pressure section of the system will be warm or hot, but large quantities of heat should be radiating from the condenser. Nothing should be permitted to stop or

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slow down this radiation of heat. Cooling fins are located on the condenser tubes and fans are used to circulate cool air around the condenser tubes. Keep all leaves, paper, dirt, etc. clear from the condenser and condenser filter. The cooling fins should be straight to permit free flow of air. The condenser is sometimes located ahead of the engine radiator and blockage of air flow through the radiator also affects the condenser. Bent fan blades, slipping fan drive, inoperable condenser fan motors, or any other fault that lessens the amount of cool air circulated through the condenser, should be corrected. The oil, dirt, or antifreeze will act as an insulator that will inhibit the radiation of heat.

Since the purpose of the condenser is to radiate heat energy, anything that prevents or inhibits this action may affect cooling, but the temperature and pressure of the R-134a raise and lower together. Heat energy that has not been radiated will remain in the R-134a and the result will be pressure that is too high. The condenser, hoses, connections and seals can be damaged by the high pressure. Pressure sensing safety switches may be activated by the high pressure caused by the condenser not radiating enough heat.

Receiver Drier

The high pressure liquid R-134a moves from the condenser to the receiver drier, where the R-134a is stored and filtered. Moisture is the major enemy of the air conditioning system and the desiccant inside the receiver drier will absorb only a small amount. The container of desiccant inside the receiver drier may break open and contaminate the system if any attempt is made to dry the desiccant, or, if more moisture is inside the system than the desiccant can absorb.

Every effort should be made to remove all moisture from the system and install a new receiver drier if its condition is questionable. Installation of a new receiver drier is recommended each time any part of the R-134a system is open to the atmosphere. Bubbles are observed in the sight glass on top of the receiver drier during the charging procedure.

A filter screen is located in the receiver drier to stop solid contaminates circulating round the system. Blockage of the filter will result in a drop in pressure that will be indicated by a drop in system performance. Connections of the new receiver drier should be securely capped before installation to prevent the entrance of moisture (air) while in storage.

Thermostatic Expansion Valve

An expansion valve is installed in the system to lower the pressure before the R-134a enters the evaporator. The reduction in pressure is done by passing the R-134a through a small hole (orifice). The size of the orifice must be controlled to compensate for changes in pressure and temperature. The temperature of R-134a leaving the evaporator is sensed by a thermostatic sensor that moves the valve seat via a diaphragm and actuating pin.

Evaporator - Heat/Cool

The evaporator is the low pressure, low temperature component where liquid R-134a absorbs heat from surrounding air. The expansion valve bleeds high pressure R-134a into the low pressure evaporator. The R-134a expands rapidly in the evaporator and its temperature is quickly reduced. The R-134a absorbs heat from the air when the blower fan circulates air over the evaporator coil fins. The exchange of heat from the air to the R-134a depends upon the difference in temperature. During high heat load, such as usually encountered when the system is first turned on, the temperature difference is great and the R-134a will absorb heat quickly. The blower fan can be set at its highest setting to circulate large quantities of warm air around the evaporator. After the cab has cooled, the fan speed should be reduced so that the already cool air will have a longer time to yield heat to the R-134a as it passes the evaporator coils. The heater circuits utilize engine coolant at approximately 82° C (180° F).

High Pressure and Low Pressure Switches

The pressure switches are electric switches that monitor air conditioner operation. The high pressure and low pressure switches are activated at preset pressures and engage and disengage the compressor clutch.

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REMOVAL

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

⚠ WARNINGS
Always wear goggles or glasses to protect your eyes when working around R-134a. R-134a boils at sea level temperatures of -29.8° C (-21.6° F), which means that direct contact with your skin will produce frostbite. Exercise extreme care when handling R-134a.

⚠ If you get the slightest trace of R-134a in your eye, flood the eye immediately with cool water; then treat with mineral oil or clear petroleum jelly followed by boric acid rinse. Report to a hospital or doctor as soon as possible.

⚠ The chemicals of R-134a change when burned and become a poison phosgene gas that will damage the respiratory system if inhaled. NEVER SMOKE in an area where R-134a is used or stored. Use hot water or an approved heated charge cylinder as a heat source if required to force R-134a into the system. If using water, do not exceed 52° C (125° F). Never use direct flame or electric heaters in direct contact with the R-134a container. High temperatures may result in raising the pressure to a dangerous level.

⚠ NEVER discharge or vent refrigerant gases into the atmoshere. All possible steps should be taken to ensure refrigerant gases are recovered under strict control.

⚠ To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate steering right and left several times to relieve pressure in the steering system. Block all road wheels.

3. If required, remove mounting hardware securing hoodsides to vehicle. Remove hoodsides.

4. Discharge the air conditioning system as described under 'Discharging The System'.

5. When satisfied that the system is completely discharged, tag refrigerant hoses (1 & 2) to aid in installation and carefully disconnect hoses from adaptors at cab firewall. Cap adaptor fittings and refrigerant hoses (1 & 2) to prevent foreign matter from entering the system.

6. If necessary to gain access to components inside air conditioning unit (43, Fig. 3) (located in the right hand side of the cab), disengage quarter-turn screws securing front cover (44, Fig. 3) and filter element (46, Fig. 3) on air conditioning unit (43, Fig. 3). Remove front cover (44, Fig. 3).

7. Tag and disconnect harness connector at the right hand side of air conditioner.

8. Tag refrigerant hoses (2 & 4) to aid in installation and carefully disconnect hoses from receiver/drier (9). Cap receiver/drier (9) fittings and refrigerant hoses (2 & 4) to prevent foreign matter from entering the system. Disconnect switch (10) from receiver/drier (9).

9. Support receiver/drier (9) and slacken clamps (11) securing receiver/drier (9) to mounting bracket (12). Remove receiver/drier (9) from vehicle. If necessary, remove mounting hardware and bracket (12) from vehicle.

10. Tag refrigerant hoses (3 & 4) to aid in installation and carefully disconnect hoses at condenser (5). Cap condenser (5) fittings and refrigerant hoses (3 & 4) to prevent ingress of foreign matter.

11. If required, support air conditioner condenser (5) and remove mounting hardware and condenser (5) from vehicle.

12. Tag refrigerant hoses (1 & 3) to aid in installation and carefully disconnect hoses from compressor (13). Cap compressor (13) fittings and refrigerant hoses (1 & 3) to prevent foreign matter from entering the system.

13. Disconnect electrical connection from compressor (13) clutch.

14. Remove mounting hardware and drive belt guards (15 & 16) from vehicle.

15. Slacken nuts (33) and washers (34) on adjuster rod (29) to release tension on drive belt (14).

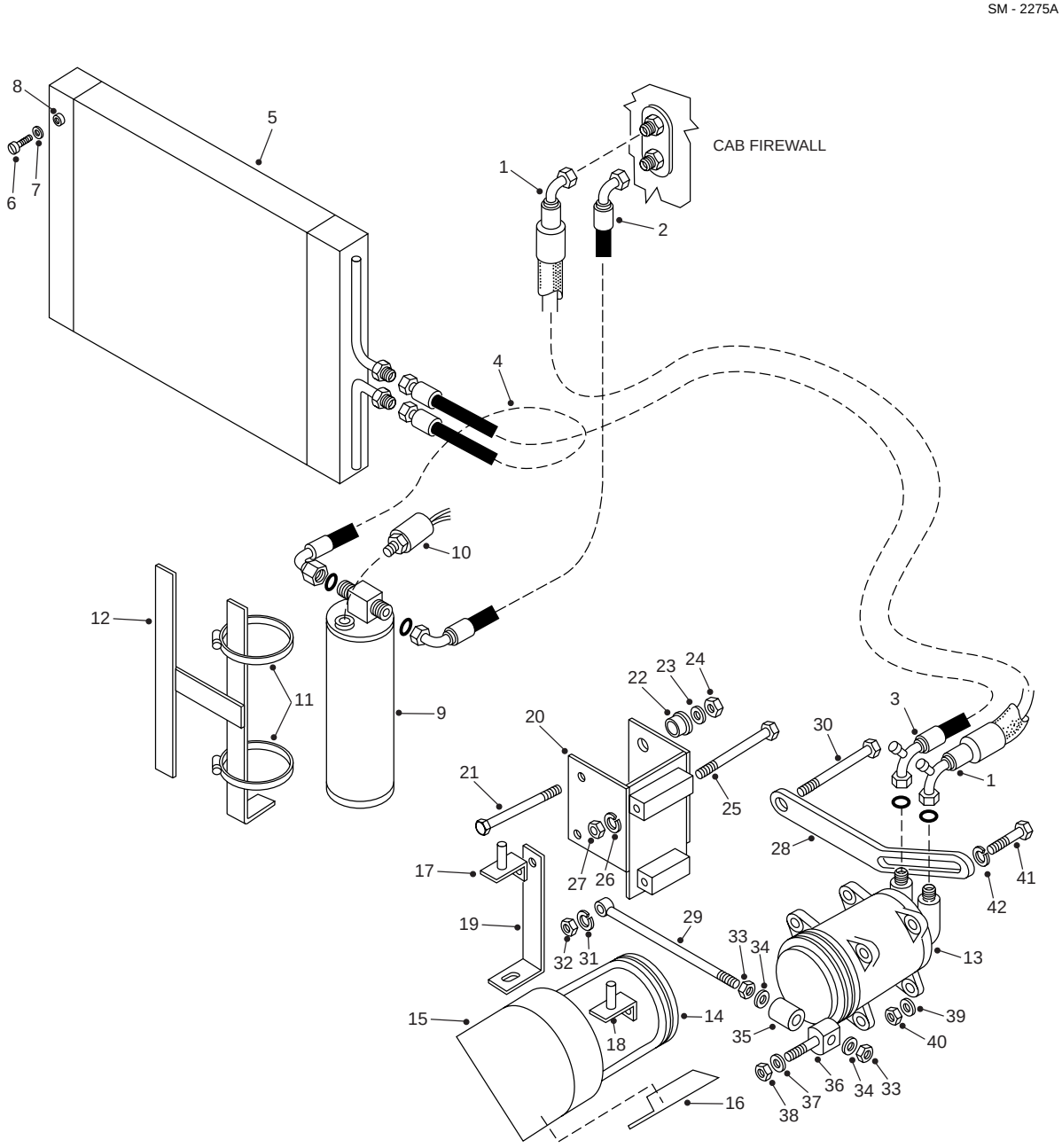
16. Slacken nut (40), bolt (41), lockwasher (42), washer (39) and adjustor bracket (28). Drive belt (14)

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Operators Compartment - Air Conditioning

Section 260-0130

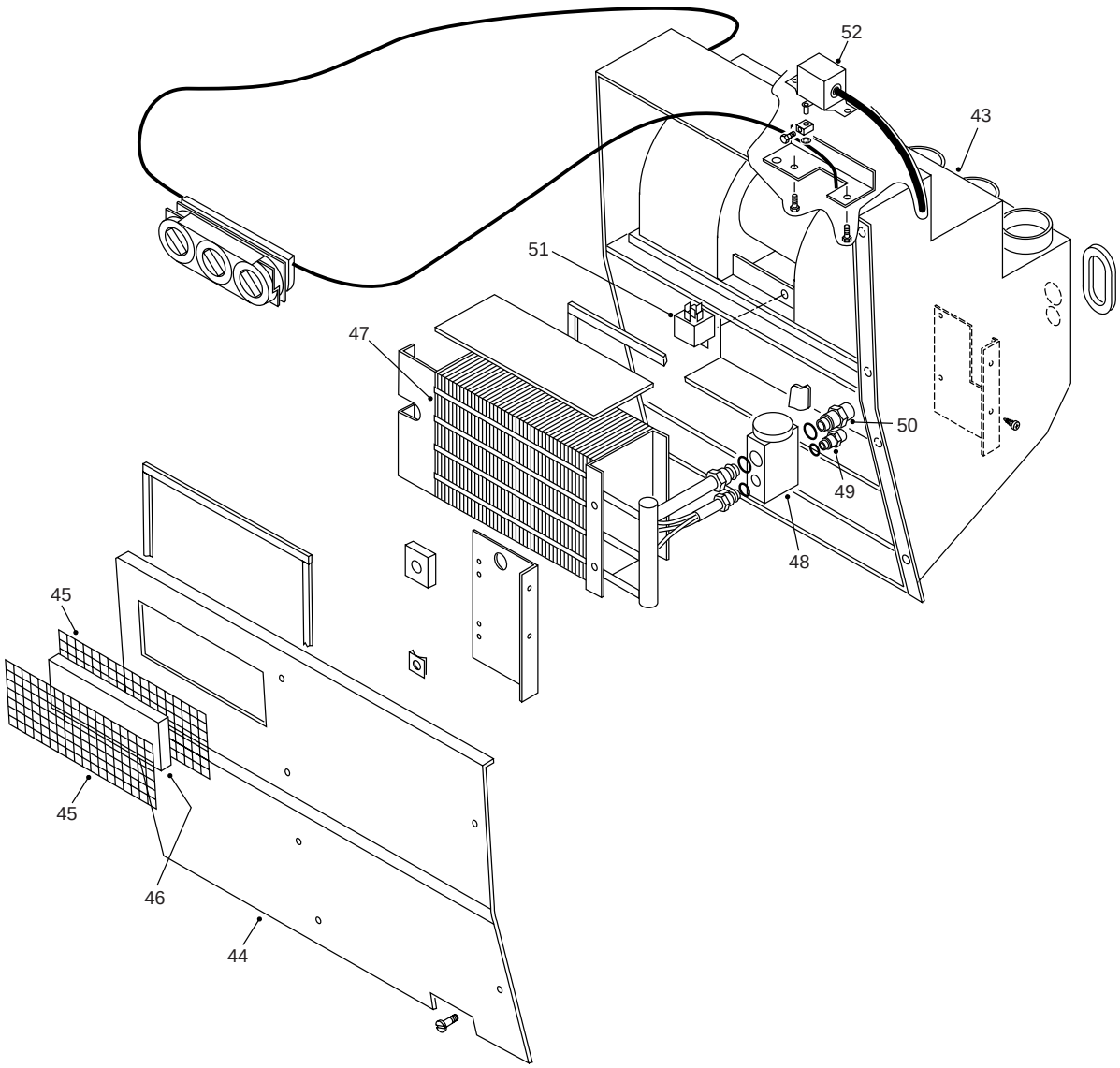


1 - Refrigerant Hose
2 - Refrigerant Hose
3 - Refrigerant Hose
4 - Refrigerant Hose
5 - Condenser
6 - Bolt
7 - Lockwasher
8 - Nut
9 - Receiver/Drier
10 - Switch - Trinery
11 - Clamp
12 - Bracket
13 - Compressor
14 - Drive Belt
15 - Belt Guard
16 - Belt Guard Cover
17 - Bracket Belt Guard
18 - Bracket Belt Guard
19 - Bracket Belt Guard
20 - Mounting Bracket
21 - Bolt
22 - Bush
23 - Washer
24 - Nut
25 - Bolt
26 - Lockwasher
27 - Nut
28 - Adjuster Bracket
29 - Adjuster Rod
30 - Bolt
31 - Lockwasher
32 - Nut
33 - Nut
34 - Washer
35 - Spacer
36 - Pivot Block
37 - Washer
38 - Nut
39 - Washer
40 - Nut
41 - Bolt
42 - Lockwasher

Fig. 2 - Air Conditioner Lines and Mounting

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43 - Air Conditioning Unit
44 - Cover
45 - Grille
46 - Filter Element
47 - Evaporator Matrix
48 - Expansion Valve
49 - Adaptor
50 - Adaptor
51 - Relay
52 - Thermostat

Fig. 3 - Air Conditioner Lines and Mounting

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should now be free to slide off of groove in compressor (13).

17. Remove bolt (30), lockwasher (31), nut (32), adjuster bracket (28) and adjuster rod (29) from mounting bracket (20). Remove nuts (33 & 38), washers (34 & 37) and slide pivot block (36) clear of compressor (13).

18. Support compressor (13) and remove bolt (25), lockwasher (26) and nut (27) securing compressor (13) to mounting bracket (20). Remove compressor (13) from the vehicle.

Note: If drive belt (14) does not require replacement do not remove from engine fan pulley. If drive belt (14) requires replacement, proceed with steps 19 and 20.

19. If required, remove mounting hardware securing drive belt guard assembly to radiator shroud assembly.

20. Release tension on Poly 'V' fan belt and remove from fan pulley. Remove compressor drive belt (14) from the rear groove of the fan pulley. Refer to Section 110-0030, ENGINE AND MOUNTING.

21. If required, remove bolts (21), nuts (24), washers (23), bushes (22) and mounting bracket (20) from vehicle. Replace bushes (22) if worn.

22. If required, disconnect all clamps and clips securing refrigerant hoses and harnesses to the vehicle. Remove hoses and harnesses from the vehicle.

INSTALLATION

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

Note: Tighten all fasteners to standard torques specified in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

> **⚠ WARNING**
> **To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.**

1. If removed, position front cover (44, Fig. 3) and filter assembly (46, Fig. 3) on air conditioner unit (43, Fig. 3) and secure using quarter-turn screws.

2. Remove caps from end of refrigerant hoses (1 & 2) and adaptors on cab firewall and connect hoses to ports as tagged at Removal.

3. Route refrigerant hoses (1 & 2) and secure with clamps removed during Removal.

4. Install receiver/drier (9) to mounting bracket (12) and secure with clamps (11). If removed, secure mounting bracket (12) assembly to vehicle with mounting hardware removed during Removal.

5. Remove caps from end of refrigerant hoses (2 & 4) and ports on receiver/drier (9) and connect hoses to ports as tagged at Removal. Connect switch (10) to receiver/drier (9).

6. If removed, install condenser unit (5) to vehicle and secure with mounting hardware removed during Removal.

7. Remove caps and connect refridgerant hoses (3 & 4) to condenser unit (5) ports as tagged at Removal.

8. If removed, install mounting bracket (20) to vehicle and secure using bolts (21), bushes (22), washers (23) and nuts (24).

9. Fit compressor (13) to mounting bracket (20) and secure with bolt (25), lockwasher (26) and nut (27). Do not fully tighten at this stage.

Note: If fan guard, Poly 'V' fan belt and compressor drive belt (14) were removed, proceed with steps 10 & 11.

10. Install new drive belt (14) onto rear groove on engine fan pulley and fit to rear groove on compressor (13).

11. Refit Poly 'V' fan belt and adjust tension. Refer to Section 110-0030, ENGINE AND MOUNTING. Refit fan guard and secure with mounting hardware as removed during removal. Refer to Section 210-0040, RADIATOR AND MOUNTING.

12. Locate pivot block (36) through compressor mounting hole and secure in place with washer (37) and nut (38). Do not tighten at this stage.

13. Install nut (33), washer (34) and spacer (30) on adjuster rod (29), locate in pivot block (36) and secure in place with washer (34) and nut (33). Do not tighten at this stage.

14. Locate adjuster bracket (28) through compressor

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mounting hole and secure in place with bolt (41), lockwasher (42), washer (39) and nut (40). Do not tighten at this stage.Install spacer (30) on adjuster block (25).

15. Support compressor (13) and position eyelets on adjuster rod (29) and adjuster bracket (28) adjacent to lug on mounting bracket (20) and secure with bolt (30), lockwasher (31) and nut (32).

16. Adjust tension of compressor drive belt (14) with nuts (33) on adjuster rod (29) until there is approximately an inward deflection of 10 mm (0.4 in) at the centre of drive belt (14). Fully tighten all mounting hardware.

17. Install drive belt guards (15 & 16) and secure using mounting hardware as removed at Removal.

18. Remove caps from end of refrigerant hoses (1 & 3) and ports on compressor (13) and connect hoses to ports as tagged at Removal.

19. Connect electrical connection to compressor (13) clutch.

20. Secure all lines with clips and clamps as removed during removal. Ensure no lines are chaffing on sharp edges or resting against areas where heat will be evident.

21. Charge the air conditioning system as described under 'Charging Procedure'.

22. Start up the engine and check for correct operation of the air conditioning system.

23. Secure hood sides to vehicle and remove wheel blocks.

MAINTENANCE

⚠ WARNING
Always wear goggles or glasses to protect your eyes when working around R-134a. R-134a boils at sea level temperatures of -29.8° C (-21.6° F), which means that direct contact with your skin will produce frostbite. Exercise extreme care when handling R-134a.

⚠ WARNINGS
If you get the slightest trace of R-134a in your eye, flood the eye immediately with cool water; then treat with mineral oil or clear petroleum jelly followed by boric acid rinse. Report to a hospital or doctor as soon as possible.

⚠ The chemicals of R-134a change when burned and become a poison phosgene gas that will damage the respiratory system if inhaled. NEVER SMOKE in an area where R-134a is used or stored. Use hot water or an approved heated charge cylinder as a heat source if required to force R-134a into the system. If using water, do not exceed 52° C (125° F). Never use direct flame or electric heaters in direct contact with the R-134a container. High temperatures may result in raising the pressure to a dangerous level.

1. Periodically clean the condenser coil of debris and dirt using water or air pressure. A partially blocked condenser coil can reduce the life of the compressor belt and/or clutch.

2. If the system has a heater in the same location as the air conditioning evaporator core, heater valves should be closed.

3. To check the refrigerant level, run the engine at 1 200 rev/min with fans on high speed and thermostat fully open for a minimum of five minutes. If the clutch is engaged in this situation, there should be very few bubbles visible in the receiver-drier sight glass.

Note: Unit can operate with some bubbles visible, but not milky looking.

4. Ensure all hoses and hose clamps are free from contact with sharp metal, moving parts or near to manifolds.

5. Inspect condensation drain lines for debris, sharp bends or breaks.

6. Inspect the clutch wire from the thermostat for bare spots.

7. Inspect bolts and nuts on the compressor and mounting bracket for proper tightness.

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8. Inspect and clean outside and inside cab air filters periodically, depending on dust conditions. Replace the outside filter when it becomes saturated to the point it won't come clean.

Maintenance of 'V' belt Drives

1. Listen for 'ticking' sound - they mean interference with the belts. Visually inspect for bent or damaged belt guards.

2. Replace all belts in a mismatched set at one time to ensure even load distribution.

3. Periodically check tension and keep belts tight.

- The ideal tension is the lowest tension at which the belt will not slip under peak load conditions.
- Check belt tension frequently during the first 24 - 48 hours of run-in operation.
- Initial belt tension should be 445 N (100 lbf) dropping to 334 N (75 lbf) after the first 48 hours.
- There should be a freeplay of 10 mm in the 'V' belt.
- Do not over tension belts.
- Keep belts free from foreign material that may cause slippage.
- Inspect the V-drive periodically. Re-tension belts if they are slipping.
- Maintain sheave alignment with a strong straight edge tool while tensioning belts.

4. Never attempt to correct belt slippage by using a belt dressing. The dressing may cause softening and deterioration.

5. If belt slips, even when properly tensioned, check for overload, worn sheave grooves or oil or grease on the belts.

6. Never pry a 'V' belt or force it into the sheave groove. Loosen the 'V' belt tightener prior to installation.

7. A belt that has operated while rolled over in the sheave groove may be damaged - replace it.

8. Store belts in a cool, dry place. If stored on a machine, relieve all belt tension by loosening the 'V' belt tightener.

9. Never attempt to check or adjust belts while they are running.

Refrigerant Oil

⚠ WARNINGS
To prevent personal injury always wear rubber gloves when handling refrigerant oils.

⚠ Too much refrigerant oil will dampen the cooling effect and too little refrigerant oil may lead to compressor failure. If in doubt flush the system.

Oil is required to lubricate the compressor. The oil mixes with the refrigerant and is carried around the system. The compressor and receiver drier are supplied with an oil charge.

Compressor	4.75 fl oz (135 ml)
Receiver Drier	2 fl oz (60 ml)

However, if any component is replaced the following amount of oil should be added to the system;

Condenser	add 1 fl oz (30 ml)
Evaporator	add 1.5 fl oz (40 ml)

The oil should be added to the oil filling port of the compressor before the recovery procedure is started or by using an oil injector when the system is being charged, observing the following good practises:

a. Only pour the amount required from the container straight into a CLEAN measuring jug and immediately pour the oil into the compressor.
b. Re-cap container tightly as soon as the required amount has been taken (never leave an oil container open).
c. Do not mix different oils.

Only new oil should be used, because oil that has been exposed to the air will have absorbed water (hygroscopic).

Use only refrigerant oil as specified in Section 300-0020, LUBRICATION SYSTEM.

System Leak Testing

Recommended Equipment Required:
Electronic Leak Detector

Switch off the engine and check all connections

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throughout the system for leaks. A large leak point will have an oily or greasy appearance. The refrigerant carries compressor oil with it and deposits it around the leak area. Check all such points for loose connections and tighten.

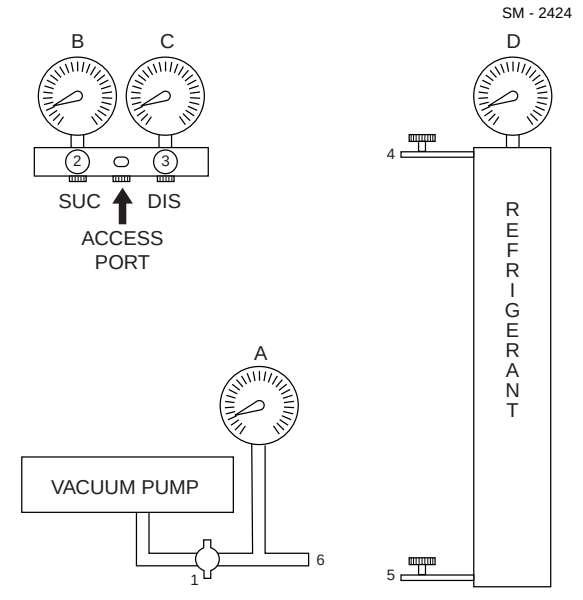
Using a suitable leak detector, search for leaks around all joints, connections, seals and control devices. If a leak is located, recover the refrigerant from the system and repair. Fully evacuate and charge the system to make it operational.

DISCHARGING THE SYSTEM

Note: Refer to all WARNINGS listed under 'Maintenance' prior to discharging the system.

Recommended Equipment Required:
Portable High Vacuum Charging Station
Suitable Canister
or Standard Service Manifold (Refer to Fig. 4)

To eliminate system contaminants from an air conditioning system requires discharging the entire system. This means recovering all of the refrigerant and cleansing all contamination (air and moisture) from the system components. If any of the major system components are to be repaired or replaced, the system must also be completely discharged.



Gauges:
A - Vacuum Gauge
B - Low Pressure Gauge
C - High Pressure Gauge
D - Charging Cylinder Pressure Gauge

Valves:
1 - Vacuum Pressure
2 - Suction Line
3 - Discharge Line
4 - Refrigerant Gas
5 - Refrigerant Liquid

Port:
6 - Vacuum Connection

Fig. 4 - Standard Service Manifold

⚠ WARNINGS
The vehicle must not be running during this procedure. Be sure to have adequate ventilation during this operation. Do not discharge refrigerant near an open flame.

⚠ NEVER discharge or vent refrigerant gases into the atmoshere. All possible steps should be taken to ensure refrigerant gases are recovered under strict control.

Numbers and letters in parentheses refer to Fig. 4.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate steering right and left several times to relieve pressure in the steering system. Block all road wheels.

3. If required, remove mounting hardware securing hoodsides to vehicle. Remove hoodsides.

4. Connect the service hose (yellow) to the centre access port on the manifold gauge and to the vacuum connection (6) on vacuum pump. Ensure that the system is empty before connecting the vacuum so that refrigerant does not enter the pump.

5. Tighten down (turn clockwise) both high and low side valves on the gauge manifold to the closed position. Remove protective caps from the service ports on the compressor.

6. Connect both service hoses from the two fittings (2 & 3) in the bottom of the manifold to the two service ports on the compressor. High side (red) to compressor discharge valve, low side (blue) to compressor suction valve.

7. Switch vacuum pump on, open vacuum pressure valve (1) until less than 6 mb is reached on vacuum gauge (A). The vacuum gauge (A) should remain at this value when vacuum pressure valve (1) is closed to indicate that there are no leaks.

Note: Minimum evacuation time = 1 hour.

8. Open the low side hand valve on the manifold and vacuum pressure valve (1) and watch that the gauges

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start to register that a vacuum is being drawn. If the gauges do not register the vacuum then a blockage or leak is present. Open the high side and pump down until a vacuum of 10 mb is achieved.

9. After 10 - 15 minutes close vacuum pressure valve (1) and allow the system to settle, vacuum gauge (A) should not alter. If the vacuum is held, no leaks or refrigerant contaminated oil is present. If not, open the vacuum pressure valve (1) and continue pumping, checking at regular intervals. If there is a leak, check all fittings and tighten if necessary.

10. Tighten down (turn clockwise) both high and low side valves on the gauge manifold to the closed position, remove the service hose (yellow) from the vacuum connection (6) on vacuum pump and switch the pump 'Off'.

11. Connect the service hose (yellow) to the R-134a cylinder. Open the cylinder valve and then purge air from the hose at the manifold connection.

12. Open the low side hand valve on the manifold slowly, until low pressure gauge (B) is at bottle pressure. Watch the high side manifold gauge (C) rise to ensure that no blockage is present. Close the manifold valve and cylinder, then disconnect the hose from the cylinder.

13. Connect the service hose (yellow) to the Nitrogen cylinder. Open the neck valve on the cylinder and set the regulator pressure such that it is higher than the system pressure then purge the hose. Open the low side hand valve on the manifold, as the pressure rises open the high side hand valve on the manifold and allow a system pressure of 10 bar (150 psig) to be reached. Close all the valves. Using a suitable electronic leak detector, check all joints in the air conditioning system for leaks. Tighten any loose joints and re-test if necessary.

14. If removed, secure hood sides to vehicle and remove wheel blocks.

CHARGING THE SYSTEM

Note: Refer to all WARNINGS listed under 'Maintenance' prior to charging the system.

Recommended Equipment Required:
Portable High Vacuum Charging Station
Electronic Leak Detector
or Standard Service Manifold (Refer to Fig. 4)

For New Or Completely Empty System

Note: The charging procedure must be done in ambient temperatures above 15.5° C (60° F) with the R-134a canister temperature equal to the outside ambient temperature.

1. Shut off engine and block all road wheels.

2. If required, remove mounting hardware securing hoodsides to vehicle. Remove hoodsides.

3. Remove protective caps from 'quick coupler' valves on rear of compressor.

4. Connect low pressure gauge hose (blue hose and gauge) to suction side or low side fitting on compressor. The suction side can be identified by the size of the hose connected to the fitting. This will be the largest diameter hose of the system.

5. Connect the high pressure gauge hose (red hose and gauge) to discharge or high side fitting on compressor.

6. Connect yellow supply hose to suction port on vacuum pump.

7. Open both sides of gauges, low and high, completely.

8. Start vacuum pump to evacuate the complete air conditioning system.

9. Run vacuum pump for approximately 30 minutes. Ideal gauge readings should be 29.92 inches of mercury. The pressure will vary with altitude; it will be approximately 0.03 bar (0.5 lbf/in²) less for each 305 m (1 000 ft) of elevation.

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10. Before disconnecting power supply from vacuum pump, close both high and low side gauges. Remove yellow hose from vacuum pump and connect to R-134a source.

11. Open R-134a source. Loosen, but do not remove, yellow supply hose at manifold on gauges to remove all air in the yellow supply hose, replacing the air with R-134a. This is done in a few seconds. Tighten yellow supply hose.

12. Open low side of R-134a gauges slowly. When gauge reads zero open both sides completely. Vacuum in the system will draw R-134a gas into the system. Hold until both gauge readings equalize.

Note: Never charge with liquid R-134a. Charge on the low pressure side only.

Final Charging Of The System

1. Start the engine and run at engine idle speed.

2. Turn the air conditioning system on with the thermostat set on maximum cooling and fan on high speed.

3. At this point a visual inspection must be made of the sight glass on top of the receiver-drier. As charging continues, the sight glass will appear milky coloured as the bubbles in the system circulate. As the system continues the charging process, the regularity of the bubbles in the sight glass will gradually diminish. When no bubbles are seen in the sight glass, close the low pressure valve (blue side) completely.

4. Increase the engine idle speed while observing the sight glass. If many bubbles are seen resulting from the increased engine speed, open the low pressure side valve. Allow the system to continue the charging procedure until the sight glass is clear. If the sight glass remains clear, with the increased engine speed, do not add any more R-134a.

Note: Occasionally bubbles are noticed during clutch cycling or system start-up. This is a normal condition.

5. With the system completely charged, shut off the engine. Close the valve on the R-134a canister and remove the yellow supply hose. Remove both the low pressure (blue) hose and high pressure (red) hose from the filling ports on the compressor.

Note: Some R-134a will escape as the hoses are being removed. Replace protective caps on hoses.

The system is completely charged when;

a. the sight glass is free from bubbles.
b. the suction pressure on the gauge is approx. 20 - 30 psig at 25° C ambient.
c. the correct weight of refrigerant has been added (typically 0.95 - 1.0 kg).
d. the correct superheat can be measured at the evaporator, approx. 3 - 6° C.
e. the correct sub-cooling can be measured at the condenser, approx. 5 - 7° C.

6. Replace protective caps on hoses and valve fittings.

7. Secure hood sides to vehicle and remove wheel blocks.

SPECIAL TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools referenced in this section and general service tools and sealants required. These tools and sealants are available from your dealer.

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AIR CONDITIONING DIAGNOSIS		TABLE158
CONDITION	PROBLEM	REMEDY
1. Belt Trouble		
Slipping	Loose	Adjust belt to 12 mm (0.5 in) depression
	Overcharge	Correct the charge
	Air in system	Evacuate and re-charge
Excessive wear	Pulley not aligned	Align Pulley
	Belt too tight	Adjust or replace
	Bad idler bearing	Replace idler bearing
	Belt wrong width	Replace with correct belt
2. Vibration/Noise in Compressor area		
Vibration/noise	Stuck compressor or clutch	Replace
Vibration	Overcharge	Correct the charge
	Air in system	Evacuate system and re-charge
	Compressor mounting or belts loose	Tighten
	Drive pulley loose	Tighten
	Belt tension incorrect	Correct tension
	Faulty compressor	Replace compressor
Noise with clutch engaged	Faulty clutch bearing	Replace bearing
Noise with clutch engaged or disengaged	Clutch loose	Tighten
Noise	Clutch rubbing field coil	Align clutch
	Faulty belt	Replace belt
	Compressor oil level low	Add oil
Chatter/Knock	Valve plate broken	Repair or replace

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AIR CONDITIONING DIAGNOSIS (CONT.)		
CONDITION	PROBLEM	REMEDY
3. Noise - Evaporator		
Rubbing/scraping	Fan blade or blower	Repair or replace
Hissing	Low charge/leak	Correct charge/repair leak
Chatter/knocking	Expansion valve	Replace
Noisy case	Loose brackets/screws	Tighten
Motor squeal	Dry bearings	Replace
4. Air Conditioning Inadequate After Short Period of Operation		
Cooling quits	Loss of refrigerant	Charge system/check for leaks
	Moisture in system	Replace drier
	Thermostat	Replace thermostat
	Clutch	Check pull-in of clutch or replace
Cooling intermittent	Moisture in system	Replace drier
5. Electrical Trouble		
Blower motor or condenser fan motor inoperable	Defective circuit breaker or bad wiring connections	Replace. Clean and tighten connections
	Tight motor bearing	Repair or replace motor
	Switch open or shorted	Repair or replace switch
Slow running blower	Shaft binding	Replace motor - worn bearings
	Wheel misaligned	Replace
	Bad blower switch	Replace blower
	Insufficient current	Install larger alternator
Clutch inoperable	Defective circuit breaker	Replace
	Loose connection	Clean and tighten connection
	Broken wire - ground	Repair wire
	Shorted or open field	Replace field

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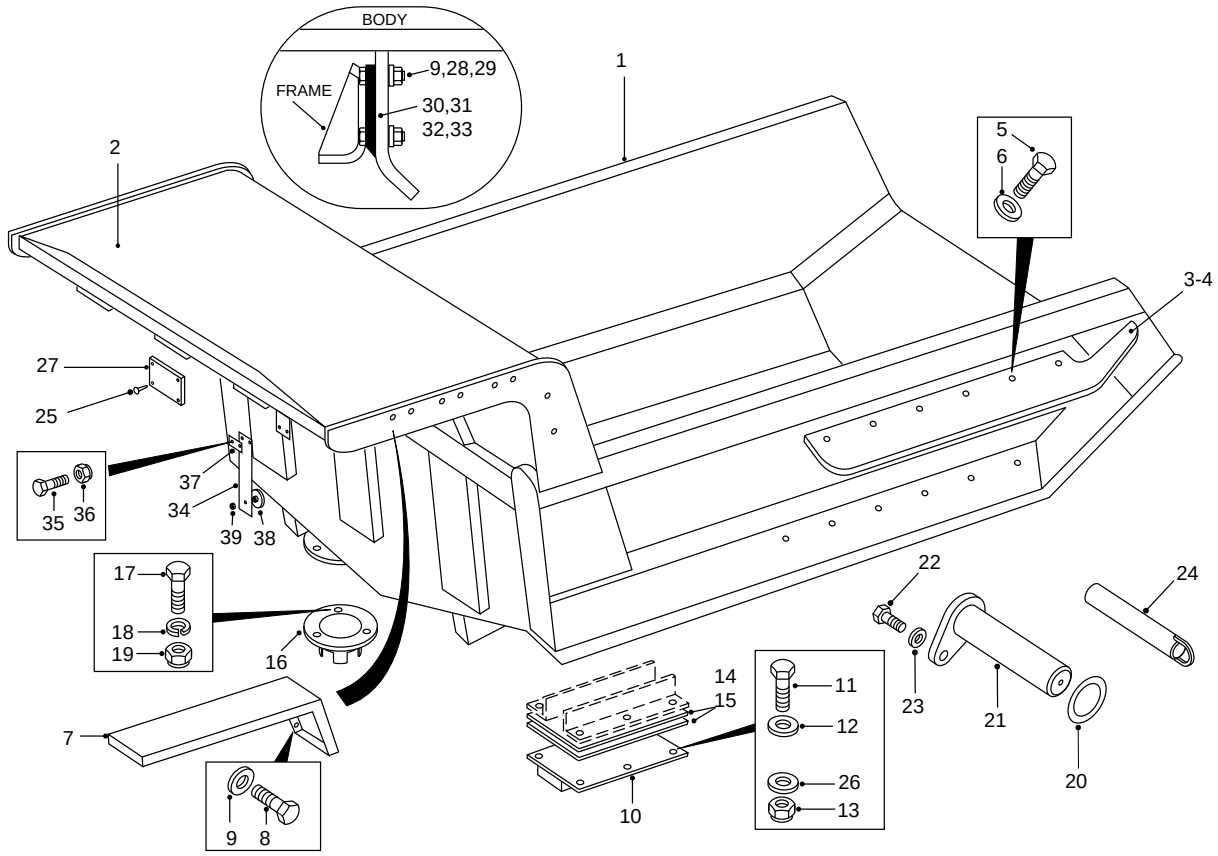
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AIR CONDITIONING DIAGNOSIS (CONT.)		
CONDITION	PROBLEM	REMEDY
6. Air Conditioning System Trouble - Gauges must be connected		
High head pressure	Overcharge of refrigerant	Purge system as necessary
	Air in system	Evacuate and re-charge
	Condenser clogged	Clean condenser
Low head pressure	Undercharge of refrigerant	Complete charge
	Bad compressor valve plate or gasket	Repair or replace
	Restriction in drier	Replace drier
Low suction pressure	Restriction in lines	Clean lines
	Restriction in expansion valve	Replace expansion valve and drier
	Improper expansion valve in charge	Replace expansion valve
	Refrigerant leak	Inspect lines and fittings. Tighten, repair or replace

* * * *

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1 - Body Assembly	10 - Body Pad	20 - Shim	30 - Shim
2 - Cab Guard Assembly	11 - Bolt	21 - Body Hinge Pin	31 - Shim
3 - Shedder Plate - LH	12 - Washer	22 - Bolt	32 - Shim
4 - Shedder Plate - RH	13 - Locknut	23 - Hardened Washer	33 - Shim
5 - Bolt	14 - Shim	24 - Body Safety Pin	34 - Body Down Indicator
6 - Washer	15 - Shim	25 - Screw	35 - Bolt
7 - Guard	16 - Cover Plate	26 - Hardened Washer	36 - Locknut
8 - Bolt	17 - Bolt	27 - ROPS/FOPS Decal	37 - Plate
9 - Washer	18 - Lockwasher	28 - Bolt	38 - Reflector
	19 - Nut	29 - Nut	39 - Locknut

Fig. 1 - Exploded View of Body and Mounting

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

Note: Refer to Section 000-0000, GENERAL INFORMATION, for body volumes, plate thicknesses, material specifications and dimensions.

Body assembly (1) is constructed from a one piece, longitudinal 'V' floor which gives the body rigidity and a low centre of gravity. Bottom, side and front plates are of high yield abrasion-resistant steel reinforced by wide channel-section stiffeners. A long 15° sloping tail chute gives good load retention and permits controlled dumping into hoppers or crushers.

The body is pivoted at body hinge pins (21) at the rear of the frame and is operated by two, two stage hoist cylinders mounted between the frame rails. The hoist cylinders raise the body to a tipping angle of 58° in 13 seconds and power down the body in 9 seconds.

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OPERATION

The body control joystick, mounted at the left hand side of the drivers' seat, controls the body control valve which supplies hydraulic oil to operate the body hoist cylinders.

The four operating positions of the body control joystick from front to rear are; Lower, Float, Hold and Raise. Refer to Section 230-0060, BODY CONTROL VALVE and, Section 230-0081, BODY CONTROL JOYSTICK.

Raising the Body

Before raising the body, allow the engine to slow to idle, make sure the rear wheels are on firm level ground, shift the transmission to Neutral and hold the vehicle stationary by applying the brakes with the Parking-Emergency brake control.

Move the body control joystick all the way back to the 'Raise' position and accelerate the engine. The body can be stopped at any point by moving the joystick to 'Hold'. Decelerate the engine as the last stages of the body hoists begin to extend to slow the raising speed as the hoists approach their maximum extensions.

When the body has been raised to the desired height, move the control joystick to the 'Hold' position until the body is to be lowered.

Lowering the Body

To lower the body, move the control joystick to the 'Float' position to allow the body's weight to lower it to the frame. Body descent can be stopped at any position by moving the joystick back to the 'Hold' position. If the body does not begin to lower by its own weight, such as after dumping downgrade, move the control joystick all the way forward to the 'Lower' position and power the body downward until it begins lowering by gravity. Then move the joystick to 'Float' to allow the body to lower the rest of the way to the chassis.

Make sure that the body is completely lowered and the control lever is in 'Float' before releasing the brakes and moving the vehicle.

REMOVAL

Numbers in parentheses refer to Fig. 1.

Note: Approximate weight of body assembly (1) is 10 650 kg (23 480 lb).

⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and block all road wheels.

2. Raise body assembly (1) and install body safety pins (24).

3. Remove mounting hardware securing hoist cylinder mounting pins to body assembly (1). Do not remove cylinder mounting pins at this stage.

4. Remove body safety pins (24) and lower body assembly (1) to rest on the frame rails.

5. Support body hoist cylinders from the rear of the vehicle to prevent them swinging back on removal of cylinder mounting pins. Remove cylinder mounting pins and allow body hoist cylinders to rest against the chassis.

6. Remove bolts (22) and hardened washers (23) securing body hinge pins (21) through body assembly (1) and pin mounting bores.

7. Remove body hinge pins (21) and shims (20) from body assembly (1) and pin mounting bores. Using suitable lifting equipment, sling body assembly (1) and remove from the vehicle.

Note: Do not remove body pads (10) and shims (14 & 15) unless body pads (10) are being replaced.

8. If required, remove locknuts (13), hardened washers (26), washers (12) and bolts (11) securing body pads (10) and shims (14 & 15) to body assembly (1). Remove and discard body pads (10) and shims (14 & 15).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Approximate weight of body assembly (1) is 10 650 kg (23 480 lb).

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⚠ WARNING
To prevent personal injury and property damage, be sure wheel chocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Ensure body hinge pins (21) and bores in body assembly (1) are thoroughly cleaned with a suitable solvent. Coat body hinge pins (21) and bores in body assembly (1) with a suitable anti-seize compound.

2. Using suitable lifting equipment, sling body assembly (1) and centralise over the frame.

3. Align body hinge pin (21) bores in body assembly (1) with mounting bores in the frame. Install body hinge pins (21) and secure with bolts (22) and hardened washers (23).

4. Remove lifting equipment from rear lifting points on body assembly (1) and raise the front end of body assembly (1) to provide access to install body hoist cylinders. Position wooden blocks (or suitable stands) on the frame rails and lower body assembly (1) to rest on the blocks. Remove lifting equipment from body assembly (1).

5. Start the engine and using the body control lever, extend the body hoist cylinders until mounting holes are aligned with mounting bores on body assembly (1). Secure both body hoist cylinders to body assembly (1). Refer to Section 230-0130, BODY CYLINDER.

6. Raise body assembly (1), remove blocks and lower body assembly (1).

7. If removed, install body pads (10) and shims (14 & 15) as described under 'Body Shimming Procedure'.

8. Centralise body assembly (1) on the frame rails, remove body hinge pins (21) and shim body hinge pins (21) with shims (20) as described under 'Body Shimming Procedure'.

9. If removed, shim the body guides with shims (30, 31, 32 or 33) as described under 'Body Shimming Procedure'.

10. Raise and lower body assembly (1) and check for correct clearance at body hinge pins (21) and body guides.

Body Shimming Procedure

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: When it becomes necessary, body pads (10) should be replaced as a set to maintain load distribution along the chassis. Existing body pads will have taken a compression 'set' and a new pad shimmed to match existing pads will not carry its share of the load, resulting in uneven load distribution along the chassis.

Note: The body guides should also be inspected and rebuilt with shims (29, 30, 31 or 32) as necessary at this time.

1. Raise body assembly (1) clear of the frame and position body pads (10) roughly in position on the frame rails. Lower body assembly (1) onto body pads (10).

2. Shim the two rear body pads (10) with shims (14 & 15) until body hinge pins (21) are just touching at the top of body assembly (1) bores.

3. Shim remaining body pads (10) with shims (14 & 15) to ensure body assembly (1) is resting parallel on the frame.

4. Secure body pads (10) and shims (14 & 15) to body assembly (1) with bolts (11), washers (12), hardened washers (26) and locknuts (13).

5. Centralise body assembly (1) on the frame rails, remove body hinge pins (21) and reinstall with shims (20) to obtain a maximum gap of 1.5 mm (0.060 in) between inner leg and body pivot. Secure body hinge pins (21) with bolts (22) and hardened washers (23).

6. Ensure body assembly (1) is centralised on the frame rails and measure gap between body guides on the frame and the body guides. Secure shims (30, 31, 32 or 33) to body guides on body assembly (1) using bolts (28), washers (9) and nuts (29) as shown in Figure 1. Leave a gap of 3.3 mm (0.13 in) between body and frame guides.

Note: Only one shim (30, 31, 32 or 33) to be used on each side.

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7. Raise and lower body assembly (1) and check for correct clearance at body hinge pins (21) and body guides.

CLEANING HEATED BODY

Note: Optional exhaust heating of the body is available for dumping of sticky or frozen materials.

> ⚠ **WARNINGS**
> **To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.**
>
> ⚠ **Oxygen and oil should never be blown into the body passages in an attempt to burn out the carbon deposits, as the combination of oxygen and oil forms a highly explosive mixture.**

It is necessary to periodically clean out the carbon deposits in the body heating passages which restrict the flow of exhaust gases. This reduces the engine efficiency and prevents the body from being heated.

Occasionally the carbon deposits are ignited by spontaneous combustion or by heat from the exhaust gases. The resulting fire in the heating passages is helpful in that it burns away some of the carbon and helps keep the body passages open. However, the fire should be allowed to burn itself out and should not be encouraged by pouring fuel into the passages.

If excessive exhaust back pressure develops, another method of cleaning out the body passages is to remove the heat channel plates and scrape the carbon from the heating passages.

To remove the heat channel plates, burn out the weld around them and lift out from the body assembly with suitable lifting equipment.

Note: Prior to welding on the vehicle, follow the procedures outlined for 'Welding' in Section 100-0010, CHASSIS, HOOD AND FENDERS.

After the heating passages are thoroughly cleaned, replace the heat channel plates and weld to sides and bottom of the body assembly.

MAINTENANCE

Lubricate body hinge pins and body hoist cylinder pins at the intervals stated and with lubricant specified in Section 300-0020, LUBRICATION SYSTEM.

* * * *

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SAFETY PRECAUTIONS

Do not allow unauthorized personnel to service or maintain this vehicle. Study the Operator's Handbook and Service Manual before starting, operating or servicing this vehicle. Always follow procedures and safety precautions detailed throughout this manual.

Always attach a 'DO NOT OPERATE' or similar warning sign to the ignition switch or a prominent control before cleaning, lubricating or servicing the vehicle.

Never allow anyone to work on the vehicle while it is moving. Make sure there is no one on the vehicle before working on it.

Do not work under or near an unblocked or unsupported body. Always use the body safety pins.

Do not work under or near any unblocked or unsupported linkage, part or vehicle.

Always relieve pressure before servicing any pressurized system. Follow the procedures and safety precautions detailed in the relevant Service Manual section.

Always deflate the tyre before attempting to remove any embedded objects or removing the tyre and rim assembly from the vehicle.

Always use a self-attaching chuck with a long airline, and, stand to one side while the tyre is inflating. Refer to Section 160-0050, WHEEL RIM AND TYRE.

LUBRICATION AND SERVICE

WARNING

These vehicles are equipped with engine and transmission oil pans which permit operation on longitudinal slopes up to 30° (60%). For operation on steeper slopes, the factory should be consulted.

Lubrication is an essential part of preventive maintenance. It is important that the instructions, regarding types of lubricants and the frequency of their application, be followed to prolong the useful life of the vehicle. Periodic lubrication of moving parts reduces to a minimum the possibility of mechanical failures.

All change and service periods are recommendations based on average operating conditions. Lubricants showing evidence of excessive heat, oxidation or dirt should be changed more frequently to prevent these conditions.

Lubricant change and service periods must be established on the basis of individual job conditions utilizing oil sampling and recommendations from lubricant suppliers.

Thoroughly clean all fittings, caps, plugs etc., to prevent dirt from entering any system while carrying out servicing procedures. Lubricants must be at operating temperature when draining.

Note: Do not operate any system unless oil level is within the recommended operating levels as indicated on oil level dipstick, sight gauge or level plug.

Lubrication and Service Chart

Small circles on the following illustration represent points at which lubrication and/or servicing must take place, at the intervals indicated on the left hand side of the lubrication and service chart. The numbered circles on the illustration contain reference numbers which correspond to the reference numbers in the 'Ref. Points' column of the lubrication and service chart.

Note: At each scheduled maintenance interval, perform all previous checks in addition to the ones specified.

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Miscellaneous - Lubrication System

Section 300-0020

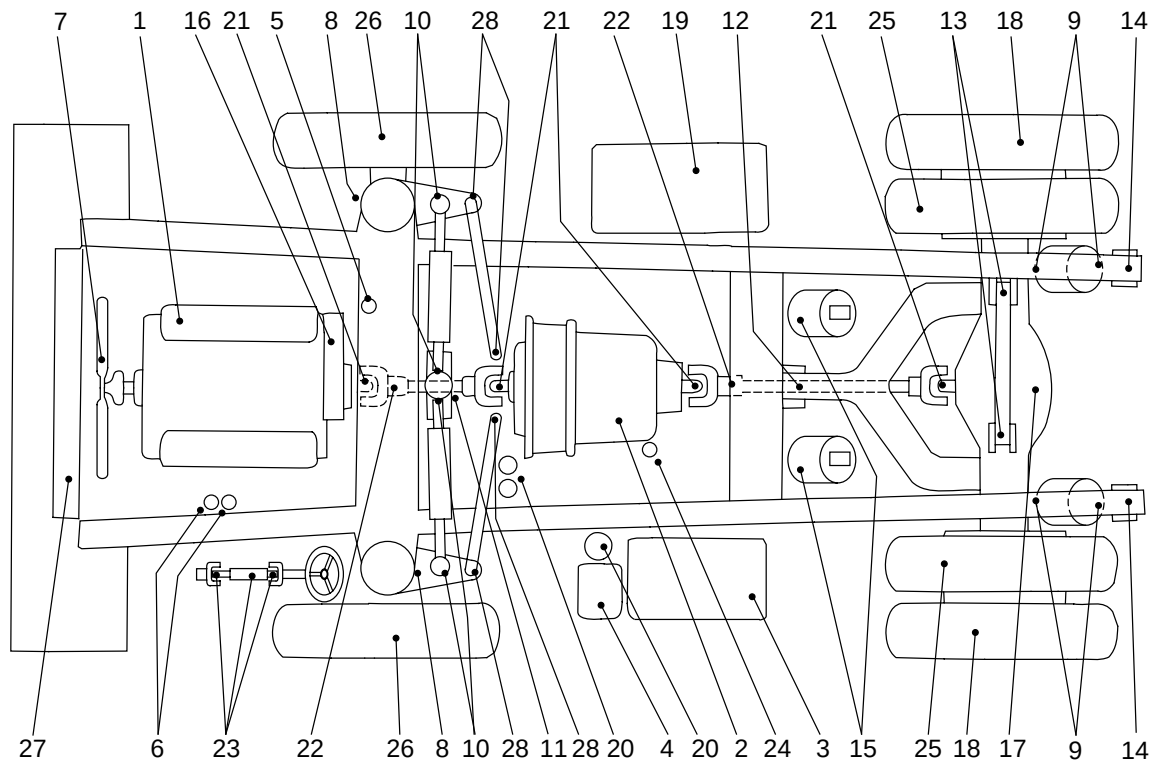


Fig. 1 - Lubrication and Service Points

LUBRICATION AND SERVICE CHART

Interval Hours	Ref. Points	Identification	Service Instructions	No. of Points	Lubricant	Service/Quantities
	1	Engine	Check oil level. Add if low.	1	EO	As Required
	2	Transmission	Check oil level. Add if low.	1	HTF	As Required
	3	Main Hydraulic Tank	Check oil level. Add if low.	1	HO	As Required
	4	Steering Hydraulic Tank	Check oil level. Add if low.	1	HO	As Required
	5	Radiator Header Tank	Check coolant level. Add if low.	1	Antifreeze	See Page 4
	-	Steering Hydraulic Tank Filter	Check W/Light. Replace element if reqd.	1	-	See Page 4
	6	Rear Disc Brake Filter	Check indicator. Replace element if reqd.	1	-	See Page 4
	-	Fuel Filter/Water Separator	Drain water and sediment	2	-	-
10	7	Cooling Fan	Visually inspect for debris and damage	1	-	-
	-	Drive Belts	Visually inspect all belts	-	-	Ref. Engine Manual
	8 & 9	Front and Rear Ride Cylinders	Visually inspect heights	4	-	Ref. Sec. 180-0030/ 180-0050
	-	Air Cleaner Restriction W/Light	Check. Replace element if reqd.	1	-	-
	-	Air Cleaner Vacuator Valve	Check for proper operation	1	-	-
	-	Tyres	Check condition. Check pressures when tyres are cold.	6	-	Ref. Sec. 140-0040/ 160-0050
	-	Controls, Instruments and W/Lights	Check for proper operation	-	-	-
	-	General Inspection	Check for leaks and worn/damaged parts. Repair/replace as required.	-	-	-
	8	Front Ride Cylinders	Lube	2	EP, NLGI	20 Strokes
	9	Rear Ride Cylinder Spherical Bushing	Lube	4	EP, NLGI	See Note
50	10	Steering Cylinders	Lube	4	EP, NLGI	See Note
	28	Steering Linkage	Lube	4	EP, NLGI	See Note
	11	Steering Pivot Pin	Lube	2	EP, NLGI	See Note

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LUBRICATION AND SERVICE CHART

Interval Hours	Ref. Points	Identification	Service Instructions	No. of Points	Lubricant	Service/Quantities
50	12	A-Frame Nose Spherical Bushing	Lube	1	EP, NLGI	See Note
	13	Banjo Stabilizer Spherical Bushing	Lube	2	EP, NLGI	See Note
	14	Body Hinge Pins	Lube	2	EP, NLGI	See Note
	15	Body Hoist Bushings	Lube	4	EP, NLGI	See Note
250	1	Engine	Drain and refill	1	EO	See Page 5
	-	Engine Oil Filters	Replace filters	3	-	Ref Engine Manual
	-	Engine Fuel Filters	Replace filters	2	-	Ref Engine Manual
	-	Engine Coolant Additive	Check DCA concentration and replenish	-	DCA4	Ref Engine Manual
	-	Engine Coolant Filter(s)	Replace filter(s) if required	1	-	See Page 4
	-	Engine Crankcase Breather	Clean	1	-	Ref Engine Manual
	7	Engine Cooling Fan	Check condition	1	-	-
	16	Engine Power Takeoff	Check oil level. Add if low.	1	EPL	-
	17	Differential	Check oil level. Add if low.	1	EPL	-
	18	Wheel Planetaries	Check oil level. Add if low.	2	EPL	-
	-	Differential Breather	Clean	1	-	-
	-	Transmission Breather	Clean	1	-	-
	-	Alternator Drive Belt	Check belt tension. Adjust if required.	1	-	Ref Engine Manual
	-	Accessory Drive Belts (if fitted)	Check belt tension. Adjust if required.	2	-	Ref Engine Manual
	-	Front Brake Pads	Check wear. Replace if required.	4	-	See Page 4
500	19	Fuel Tank	Clean filler neck screen and cap	-	-	-
	-	Air Cleaner	Clean primary tubes and inlet screens	-	-	-
	20	Accumulators	Check nitrogen pressures	3	-	-
	21	Driveline Universal Joints	Lube (if grease nipple fitted)	-	*EP, NLGI	See Note
	22	Driveline Slip Joints	Lube	2	*EP, NLGI	See Note
	23	Steering Column Universal Joints	Lube	3	*EP, NLGI	See Note
	-	Hydraulic & Steering Tank Breather	Clean	1	-	-
1 000	-	Hydraulic System Pressure Checks	Check pressures at check points	-	-	See Page 5
	-	Main Hydraulic Filter	Replace element	2	-	See Page 5
	6	Rear Disc Brake Filter(s)	Replace element(s)	1	-	See Page 5
	2	Transmission	Drain and refill	1	HTF	See Page 5
	-	Transmission Oil Filter	Replace element	1	-	-
	24	Steering In-line Filter	Replace element	1	-	See Page 5
1 500	-	Engine Crankcase Breather	Clean/Replace	1	-	Ref Engine Manual
	16	Engine Power Takeoff	Drain and refill	1	EPL	See Page 5
	17	Differential	Drain and refill	1	EPL	See Page 5
	18	Wheel Planetaries	Drain and refill	2	EPL	See Page 5
	-	Fan Idler Pivot Arm	Lube	1	EP, NLGI	See Note
2 000	3	Main Hydraulic Tank	Drain and refill	1	HO	See Page 5
	-	Main Hydraulic Tank Suction Screens	Remove and clean	2	-	-
	4	Steering Tank	Drain and refill	1	HO	See Page 5
	-	Steering Hydraulic Tank Filter	Replace element	1	-	See Page 5
	-	Steering Tank Suction Screen	Remove and clean	1	-	-
	19	Fuel Tank	Drain and refill	1	Diesel	See Page 5
	25	Rear Brake Packs	Drain and refill	2	HO	-
4 000	27	Cooling System	Drain, flush and refill	1	Antifreeze	See Page 5
	-	Air Conditioning Compressor	Drain, flush and refill	1	PAG Oil	See Page 5
5 000	26	Front Wheel Bearings	Repack	2	*EP, NLGI	*

* - Fill compartment one half full.

Note - Lubricate slowly until excess lube is seen.

EO - Engine Oil. Refer to chart under 'Recommended Lubricants'.

EPL - Extreme Pressure Gear Lubricant meeting specification MIL-L-2105C.

HTF - Hydraulic Transmission Oil Type C-4. Refer to chart under 'Recommended Lubricants'.

HO - Hydraulic Transmission Oil meeting Specification EMS19058 Refer to chart under 'Recommended Lubricants'.

EP, NLGI - Extreme Pressure Lithium No. 2 Grease. Refer to chart under 'Recommended Lubricants'.

*EP, NLGI - Extreme Pressure Lithium No. 2 Grease (without 'Molybdenum'). Refer to chart Under 'Recommended Lubricants'.

PAG Oil - Polyalklene Glycol (PAG) Compressor Lubricating Oil - Low Viscosity (ISO46).

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MISCELLANEOUS SERVICING

WHEN REQUIRED

Seat Belts - Inspect seat belts and replace if damaged.
Note: Replace seat belts at least once every three years, regardless of appearance.

Windscreen Wipers and Washers - Inspect wiper blades and replace if damaged. Top up washer reservoir.

Wheel Rim Nuts - After first 10 hours of operation re-torque nuts to 690 Nm (510 lbf ft). Check torque every 50 hours (weekly) thereafter.

EVERY 10 HOURS OF OPERATION

Walk Around Inspection - Inspect the machine as described in Section 4 of the Operators Handbook.

Engine - Visually check engine for damage, loose or frayed belts and listen for any unusual noises.

Engine Air Cleaners - Check air cleaner piping, hoses and clamps. Change air cleaner element only when air cleaner flow restriction warning light illuminates. Service vacuator valve daily. Inspect and remove any obstructions from the vacuator valve lips. Valve lips should be open and pliable with engine stopped.
Note: Service air cleaners more often under extremely dusty operating conditions.

Radiator Header Tank - Check coolant level and add if low. Fill radiator header tank with coolant until coolant reaches the bottom of the filler neck and holds at that level.
Note: Any time a significant amount of coolant is added, the DCA4 concentration MUST be checked. If the concentration is low, engine damage will result. Conversely, over-inhibiting antifreeze solutions can cause silicate dropout. Refer to Section 210-0000, COOLING SYSTEM.

Steering, Braking and Body Hoist Systems - Check for correct operation of all systems before operating the truck.

Steering Hydraulic Tank Filter - Check steering filter restriction warning light with the truck empty, brakes released, oil at normal operating temperature, engine operating at 1 500 rev/min and while turning the steering wheel at one turn/sec. If the warning light illuminates, the filter element should be replaced.

Rear Disc Brake Oil Filter(s) - Replace element(s) when indicator shows oil at the replace element level.

AFTER FIRST 150 HOURS OF OPERATING NEW OR REBUILT COMPONENTS

Transmission - Drain oil, replace filters and refill.

Differential - Drain oil and refill.

Planetaries - Drain oil and refill.

EVERY 250 HOURS OF OPERATION

Coolant Additive - Check and replenish DCA4 concentration as described in Section 210-0000, COOLING SYSTEM.

Coolant Filter(s) - Replace coolant filter(s) if required. When testing the DCA4 concentration, depending on the level of DCA4, the coolant filter(s) may not necessarily have to be changed. Refer to Section 210-0000, COOLING SYSTEM.

Cooling Fan - Visually check the fan for cracks, loose rivets, and bent or loose blades. Check fan mounting and tighten if required. Replace any fan that is damaged.
Note: The fan belt is maintained to the correct belt tension by a spring loaded idler arm, therefore, there is no need to check or adjust belt tension.

Drive Belts - Visually check the belts and replace if they are cracked or frayed. Adjust belts that have a glazed or shiny surface which indicates belt slippage. Correctly installed and tensioned belts will show even pulley and belt wear. Refer to Section 110-0030, ENGINE AND MOUNTING for drive belt tension and adjustment of new and used drive belts.

Front Brakes - Check pads and discs for wear and replace where necessary.
Note: This service interval applies to normal driving. Check more frequently under more severe conditions. Thickness of pad friction material should never be allowed to wear below 3 mm (0.12 in).

Oil Can Points - Oil hinges, and other working parts with engine oil.

EVERY 1 000 HOURS OF OPERATION

Hydraulic System Pressure Checks - Check all steering, body and braking system pressures.

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Note: Instructions for checking pressure, and locations of pressure check points, are contained in the relevant service manual section. If the pressures are outwith the specified settings then components in the relevant system should be inspected, repaired or replaced to ensure the correct operation of the system. All safety instructions in the relevant sections should be strictly adhered to.

Main Hydraulic Tank Filter - Clean filter housing and install new element.

Rear Disc Brake Filter(s) - Replace filter element(s) when indicator sight gauge shows replacement is necessary, or after 1 000 hours of operation, whichever comes first.

Steering In-line Filter - Clean filter housing and install new element when indicated, or after 1 000 hours of operation, whichever comes first.

EVERY 2 000 HOURS OF OPERATION

Steering Hydraulic Tank Filter - Clean filter housing and install new element when indicated, or after 2 000 hours of operation, whichever comes first.

ENGINES AND TRANSMISSIONS

All information contained in the 'Lubrication and Service Chart' was extracted from the relevant manufacturers 'Operation and Maintenance Manual', and was correct at time of publication.

User should ensure that information contained in this chart reflects the information shown in the relevant manufacturers 'Operation and Maintenance Manual' supplied with the Truck.

Maintenance procedures should be carried out in conjunction with any additional procedures contained in the relevant manufacturers 'Operation and Maintenance Manual', at the intervals specified.

SERVICE CAPACITIES

Ref. Points	Identification	Lubricant	Service Capacities	
			litres	US gal
1	Engine Crankcase and Filters	EO	66	17.4
2	Transmission and Filters	HTF	85	22.5
3	Main Hydraulic Tank	HO	216	57
-	Main Hydraulic System	HO	258	68
4	Steering Hydraulic Tank	HO	61	16
-	Steering Hydraulic System	HO	72	19
27	Cooling System	Coolant	157	41.5
19	Fuel Tank	Diesel	606	160
8	Front Ride Cylinders (Each)	HO	14	3.7
9	Rear Ride Cylinders (Each)	HO	17	4.5
16	Engine Power Takeoff	EPL	4	1.1
17	Differential	EPL	52	13.7
18	Wheel Planetaries (Total)	EPL	43	11.4
-	Air Conditioning Compressor	PAG Oil	0.125	0.033

Note: Capacities given are approximate. Work to dipstick, sight gauges or level plugs. Use table in conjunction with 'Recommended Lubricants' table.

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Miscellaneous - Lubrication System

Section 300-0020

RECOMMENDED LUBRICANTS			
COMPONENT	LUBRICANT	VISCOSITY (See Note 1)	
Engine	Engine oil with 1.00 % sulphated ash is recommended. Sulphated ash must not exceed 1.85 % limit. API code CE or CF-4. See Note 2.	**Ambient Temp** 0° C and above -10° C and above -25° to 35° C	**Recommendation** SAE 20W-40 SAE 15W-40 SAE 10W-30
Transmission	Hydraulic Transmission Oil, Type C-4. Preheat is required below minimum temperatures shown. See Note 3.	**Ambient Temp** -30° to 25° C -27° to 25° C -20° to 15° C -15° to 45° C 0° to 35° C 10° to 45° C	**Recommendation** SAE 0W-20 (Arctic) DEXRON-III SAE 10W SAE 15W-40 SAE 30 SAE 40
Hydraulic System	Hydraulic Transmission Oil meeting Specification EMS19058. See Note 4.	SAE 10W at ambient temperatures of -18° to 32° C SAE 30W at ambient temps of 32° C and above	
Cooling System	Heavy Duty Coolant. Refer to Section 210-0000, COOLING SYSTEM.		
Fuel Tank	Diesel Fuel Oil with maximum Sulphur 0.5%.	DIN EN590	
Differential Planetary Gears Power Takeoff	Multipurpose Extreme Pressure type gear oil meeting MIL-L-2105C Specifications (No Zinc Additive). See Note 5.	SAE 80W-90 at ambient temperatures of -18° to 32° C	
Grease Fittings	Multipurpose Extreme Pressure Lithium Grease (which may, or may not contain 'Molybdenum'), with a typical melting point of 190° C.	No. 2 Consistency	
Drivelines Steering Column Wheel Bearings	Multipurpose Extreme Pressure Lithium Grease (without 'Molybdenum'), with a typical melting point of 190° C.	No. 2 Consistency	
Ride Cylinders (Nitrogen/Oil)	Hydraulic oil meeting MIL-L-2104C Specifications or API Service code CC or CD/SC.	SAE 10W at ambient temperatures of -18° to 32° C	

Temperature Conversions																		
° Celsius	-32	-30	-27	-25	-20	-18	-15	-10	0	10	15	25	32	35	38	45	93	190
° Fahrenheit	-26	-22	-17	-13	-4	0	5	14	32	50	59	77	90	95	100	113	200	375

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Note 1 - Consult your lubricant supplier for the correct viscosity of lubricant to use when ambient temperatures are consistently above or below those listed.

Note 2 - Cummins Engine Co., does not recommend any specific brand of engine oil but the use of oils that meet API categories. Cummins recommends use of only the multi-graded viscosity oils shown for the various ambient temperatures listed.

Note 3 - Operation below the minimum temperatures listed for the oil used without proper preheat or warm-up results in greatly reduced transmission life. If auxiliary heating is available, preheat the oil to the minimum temperature limit. If not available, run the engine at part throttle with the transmission in neutral to raise the fluid temperature.

Hydraulic Transmission Oil meeting Specification EMS19058 may also conform to the Allison C-4 requirements. Consult your lubricant supplier for confirmation.

Note 4 - Typical SAE 10W oils complying with Specification EMS19058 are:

KUWAIT TO4
SHELL DONAX TC
ESSO TORQUE FLUID
TEXACO TEXTRAN
TOTAL TRANSMISSION AC
MOBILTRANS HD
CASTROL TFC
BP AUTRAN 4

Other lubricant suppliers may have comparable products and should be consulted for confirmation.

Note 5 - If rear axle has limited slip differential, an EP oil with limited slip additives should be used because using standard SAE 90 oil may result in very loud noise and jerking of the wheels when driving slowly round sharp corners.

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INTRODUCTION

Contained in this section are recommended service tools and equipment required for maintenance, overhaul and troubleshooting. In certain instances, both Metric and Imperial equivalents of the same tools are listed. These tools are available from your dealer.

Note: The Company reserves the right to make changes in the design or construction of tools and equipment without obligation to incorporate such changes in tools and equipment previously sold.

Note: A tool may be of one piece construction or consist of a number of parts.

General

*15269784 - Multi-Gauge - Pressure range of 30 in of vacuum to 5 000 lbf/in²
15269785 - Non-contact Infrared Thermometer
15268968 - Strap Type Filter Wrench
15268969 - Socket Type Filter Wrench
15268970 - Universal Belt Tension Gauge
15269858 - Digital Tachometer
15269859 - Multimeter
15269813 - Water Manometer
15269802 - Dial Indicator Gauge - Metric
15269803 - Dial Indicator Gauge - Imperial
15269804 - Magnetic Base for Dial Indicator Gauge
15269805 - Micrometer - 0 to 25 mm
15269806 - Micrometer - 0 to 1 in
15269807 - Micrometer - 400 to 500 mm
15269808 - Micrometer - 16 to 20 in
15269809 - Internal Micrometer - 50 to 210 mm
15269810 - Internal Micrometer - 2 to 8 in
15269860 - 92 Piece Heavy Equipment Tool Kit
15269861 - Torque Wrench - 3/8 in drive, 20 - 100 Nm (15 - 80 lbf ft) range
15269862 - Torque Wrench - 1/2 in drive, 60 - 330 Nm (45 - 250 lbf ft) range
15269863 - Torque Wrench - 3/8 in drive, 4 - 20 Nm (40 - 180 lbf in) range
15269864 - Torque Wrench - 3/4 in drive, 300 - 1 000 Nm (200 - 750 lbf ft) range
15269865 - Torque Wrench - 3/4 in drive, 700 - 1 500 Nm (500 - 1 000 lbf ft) range
15269866 - Torque Multiplier - 1/2 in to 1 in drive, 25:1 Ratio, 3 000 Nm (2 200 lbf ft) range

* - The following items should be added to the multi-gauge to enable the gauge to be used on diagnostic test points:
15018226 - Diagnostic Coupling
00118748 - Connector (2 off)
15004085 - Hose Assembly (-4 HP, 84 in long)

Engine

The following tools are recommended for Engine Maintenance Procedures and should be used in conjunction with procedures outlined in the engine manufacturers service manual.

15270022 - Valve Seat Inserter Tool
15270024 - Valve Spring Compressor
15270075 - Dial Depth Gauge
15269956 - Standard Puller
15270056 - Water Pump Bearing Mandrel
15269957 - Torque Wrench Adaptor
15272177 - Compressor, Piston Ring
15270031 - Fuel Passage Cleaning Brush
15270431 - Hydrostatic Tester
15270078 - Manometer
15270972 - Main Bearing Cap Puller
15270007 - Dowel Pin Extractor
15272204 - Mandrel, Air compressor Bushing
15269959 - Main Bearing Cap Puller
15272178 - Concentricity Gauge
15270436 - Crosshead Guide Spacer
15270437 - Piston Ring Expander
15272179 - Gauge, Belt Tension
15270440 - Water Tube Driver
15270441 - Valve Seat Extractor
15269960 - Dial Gauge Attachment
15272180 - Compressor, Valve Spring
15272205 - Torque Wrench (0-150 in lbs)
15272206 - Wrench, Oil Filter
15270443 - Pressure Regulator Removal Tool
15270446 - Head Water Testing Kit
15269962 - Dial Bore Gauge Kit
15270448 - Connecting Rod Guide Pins
15270040 - Valve Spring Tester
15272207 - Set, Fillet Ball Gauges
15272208 - Puller, Water Pump Impeller
15272209 - Puller, Idler Shaft
15270060 - Water Pump Bearing Mandrel
15270061 - Water Pump Bearing Separator
15272210 - Tube, Fuel Line Sight #12
15272181 - Kit, Valve Seat Grooving (check voltage)
15270452 - Liner Installation Tool
15270010 - Crack Detection Kit
15270458 - Gear Puller Assembly
15269969 - Universal Cylinder Liner Puller
15269961 - Dial Indicator Gauge
15269975 - Pulley Installation Tool
15272183 - Cutter, Oil Filter
15272211 - Wrench, Injector Preload Torque
15270047 - Slide Hammer Assembly
15270070 - Coupling Puller
15269993 - Driver Handle
15270480 - Valve Seat Extractor
15272184 - Dolly,Valve Insert Staking

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15272182 - Fixture, Cylinder Head Water Test
15270481 - Cup Plug Driver
15270482 - Cup Plug Driver
15270483 - Cup Plug Driver
15272185 - Dolly, Valve Seat Staking
15272186 - Driver, Compressor Seat Installation
15272187 - Driver, Compressor Seat Remover
15269992 - Expansion Plug Driver
15270982 - Set, Cylinder Liner Clamp
15272188 - Blowby Check Tool (0.406")
15272189 - Kit, Digital Thermometer
15272190 - Fixture, Rod Bolt Checking
15272191 - Kit, Air Compressor Valve Seat
15272192 - Compressor, Piston Ring
15269999 - Gauge Block
15270068 - Pump Seal Driver
15272193 - Kit, Cylinder Head Leak Test
15272194 - Kit, Guide Stud
15272195 - Handle, T Lift Stud
15272196 - Kit, Pulley Installation Adapter
15271475 - Insite Data Reader
15272197 - Driver Low Temperature Thermostat Seal
15272198 - Gauge, Piston Ring Groove
15272199 - Gauge, Valve Head Thickness Check
15272211 - Kit, Rail Line Pressure
15272200 - Gauge, Valve Clearance
15272201 - Driver Oil Seal
15272202 - Fixture, Injector Timing
15272203 - Gauge, Head Bolts
15272204 - Mandrel, Air compressor Bushing
15272205 - Torque Wrench (0-150 in lbs)
15272206 - Wrench, Oil Filter
15272207 - Set, Fillet Ball Gauges
15272208 - Puller, Water Pump Impeller
15272209 - Puller, Idler Shaft
15272210 - Tube, Fuel Line Sight #12
15272211 - Kit, Rail Line Pressure

Transmission

CEC Electronic Diagnostic

15268971 - PRO-LINK Diagnostic Data Reader (DDR)
15268973 - CEC I and II Cartridge For DDR
15268975 - DDR and CEC I and II Cartridge Assembly
15269231 - CEC Off-Highway Diagnostic Service Kit
15270344 - LPS NoFlash Electro Contact Cleaner
15269038 - Portable Printer for use with DDR, complete with 110 V AC Adaptor
15269039 - Portable Printer for use with DDR, complete with 220 V AC Adaptor
15269040 - Printer Paper for use in above printers - 5 rolls

The following tools are contained in CEC Off-Highway Diagnostic Service Kit - 15269231:
15269232 - Wire Cutter, Stripper and Terminal Crimper
15269233 - Jumper Wire Set
15269234 - Terminal Crimper
15269235 - Terminal Remover - Metri Pack (J1A, J1B, J3 and Shift Selector Connector Terminals)
15269236 - Terminal Remover - Speed Sensor and Throttle Position Sensor Terminals
15269237 - Terminal Remover - Depress holding prong on ECU and DDL Connector Terminals
15269238 - PROM Remover
15269239 - High Impedance Digital Multimeter Kit
15269240 - AMP Pin Remover - Remove terminal pins from interface and shift selector Terminals
15269241 - Terminal Crimper - Weatherpac

The following tools are recommended for Transmission Maintenance Procedures and should be used in conjunction with procedures outlined in the transmission manufacturers service manual.

15270422 - Stator Assembly Installing Tool
15270423 - Support Legs
15270424 - Switch Sequence Gauge
15270425 - Shift Inhibitor Clutch Drilling Feature
15270426 - Harness Adaptor
15270427 - Torque Converter Spanner Wrench
15270428 - Belville Assembly Spring Compressor

Wheel, Rim and Tyre

09202013 - Fishtail Wrench
15251192 - Tyre Inflation Kit (Air)
15269121 - Tyre Inflation Kit (Nitrogen)
15270392 - Hydraulic Bead Breaking Kit

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Accumulators/Ride Cylinder Charging

09359489 - Charging Assembly

The following parts can be assembled for simultaneously charging the rear ride cylinders:
09359489 - Charging Assembly
00454145 - Tee Piece
15269788 - Hose
15269789 - Chuck Valve
15269790 - Valve Extension

The following parts can be assembled for simultaneously charging the front ride cylinders:
09359489 - Charging Assembly
00454145 - Tee Piece
00444355 - Coupling
15269788 - Hose - 2 required
15269789 - Chuck Valve
15269790 - Valve Extension

Steering Valve

15270489 - Spring Installation Tool

Cooling and Air Conditioning

15269814 - DCA4 Test Kit - Metric
15269816 - Refractometer - °C Scale
15269817 - Refractometer - °F Scale
15269844 - Portable High Vacuum Charging Station - R-134a Gas
15269845 - Halogen Leak Tester

Cab

15271016 - Glass Removal Tool
15271017 - Bonding Kit (Quick Dry)

OCDB Brake Packs

15267573 - Seal Installation Kit
15265300 - Seal Installation Tool
15265301 - Seal Installation Tool

Lubrication

09122784 - Grease Gun Assembly
09175662 - High Pressure Bucket Pump Lube Kit

Adhesives and Sealants

15269103 - Loctite 221
09362529 - Loctite 225
09029849 - Loctite 243
09244598 - Loctite 270
09985300 - Loctite 271
15269104 - Loctite 275
15269245 - Loctite 277
15233715 - Loctite Prism 406
15269111 - Loctite Prism 410
15269105 - Loctite 515
09007209 - Loctite 574 (50 ml)
09379518 - Loctite 574 (160 ml)
15269106 - Loctite 577 (Superflex)
15270244 - Loctite 592 Pipe Sealer with Teflon
15023696 - Loctite 635
09371048 - Loctite 638
15269107 - Loctite 641
15304830 - Loctite 5205 (Ref. Sec. 160-0020)
15305445 - Loctite 7063 Cleaning Agent
15269108 - Loctite Superclean Safety Solvent 706
15229541 - Loctite Activator 'N'
09243825 - Loctite Activator 'T'
09175039 - General Adhesive
15269114 - Tectyl 280 Wax Based Rust Preventive
09380475 - Hylosil RTV Silicone Compound
15270516 - Wynn's STP
15303808 - Silicon Grease (Dielectric)

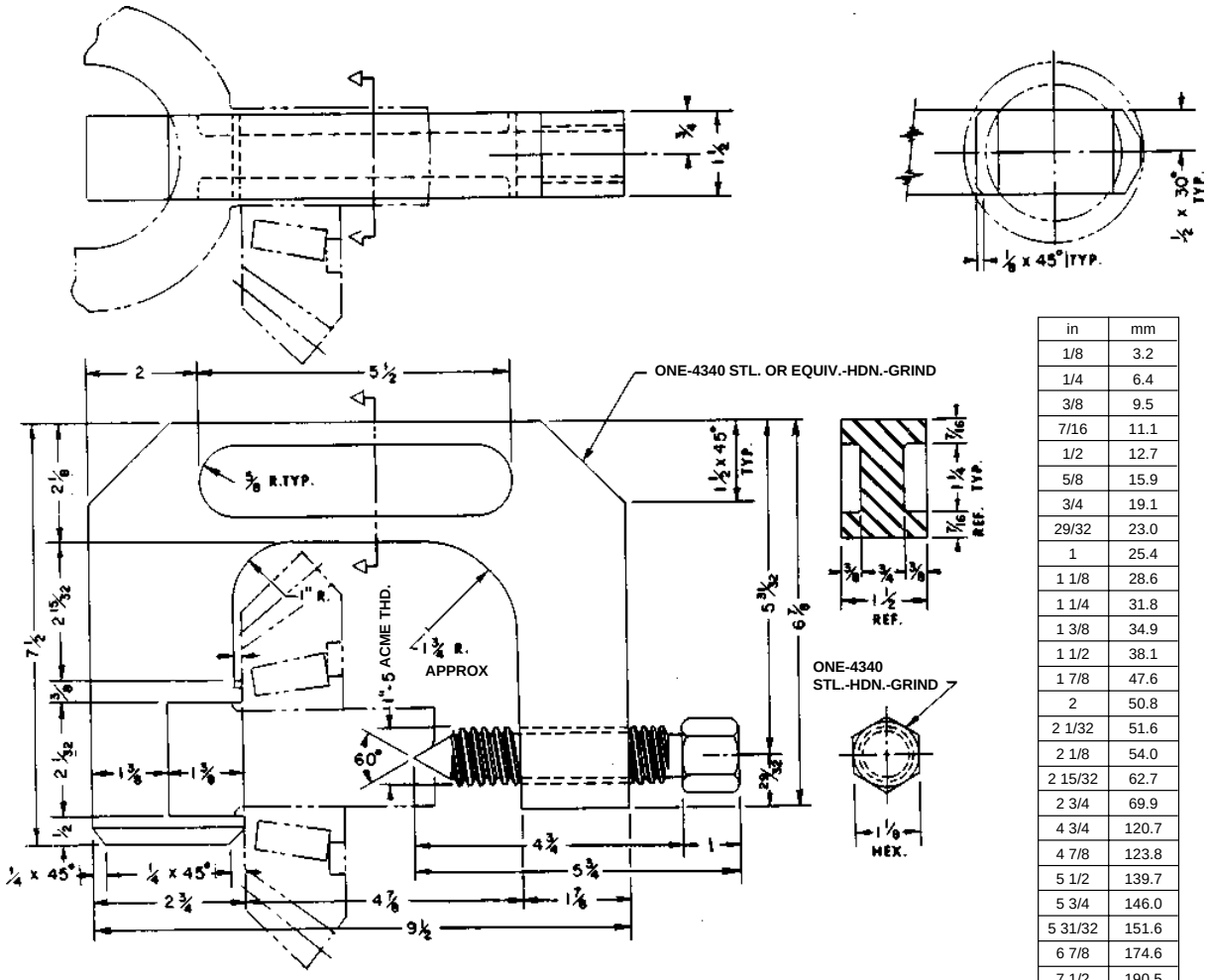
Fabricated Tools

The service tools shown in Figs. 1 through 8 can be fabricated as shown.

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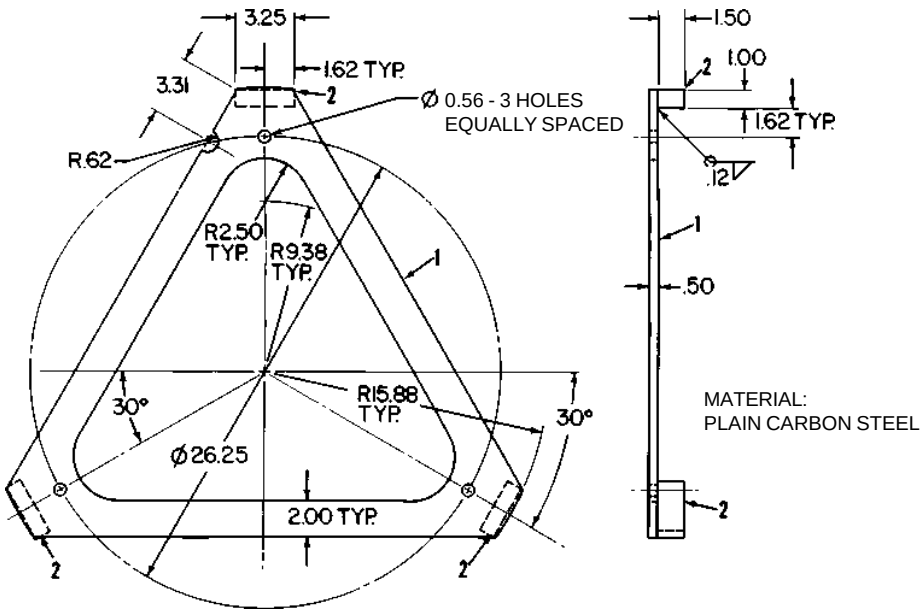
in	mm
1/8	3.2
1/4	6.4
3/8	9.5
7/16	11.1
1/2	12.7
5/8	15.9
3/4	19.1
29/32	23.0
1	25.4
1 1/8	28.6
1 1/4	31.8
1 3/8	34.9
1 1/2	38.1
1 7/8	47.6
2	50.8
2 1/32	51.6
2 1/8	54.0
2 15/32	62.7
2 3/4	69.9
4 3/4	120.7
4 7/8	123.8
5 1/2	139.7
5 3/4	146.0
5 31/32	151.6
6 7/8	174.6
7 1/2	190.5
9 1/2	241.3

Fig. 1 - Spider Bearing Spreader Tool Dimensions (Section 160-0020, DIFFERENTIAL)

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in	mm
0.12	3.0
0.50	12.7
0.56	14.22
0.62	15.7
1.00	25.4
1.62	41.1
2.00	50.8
2.50	63.5
3.25	82.5
3.31	84.0
9.38	238
15.88	403
26.25	668

Fig. 2 - Fabrication of Lifting Tool (Section 165-0030, BRAKE PARTS)

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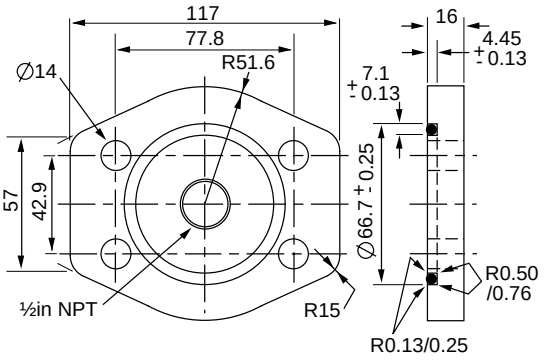


Fig. 3 - Fabrication of Blanking Plate for Port 'B' (Section 165-0030, BRAKE PARTS)

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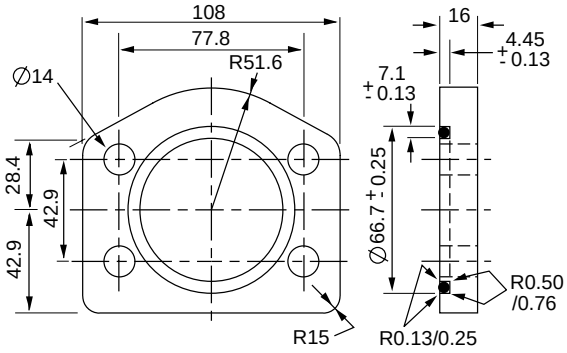


Fig. 4 - Fabrication of Blanking Plate for Port 'C' (Section 165-0030, BRAKE PARTS)

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CLICK HERE FOR HORIZONTAL DRAWING

INCHES	mm	INCHES	mm
0.03	0.76	0.72	18.2
0.06	1.52	0.75	19.0
0.12	3.0	0.81	20.5
0.130	3.3	1.00	25.4
0.139	3.5	1.12	28.4
0.177	4.5	1.68	42.7
0.18	4.6	2.00	50.8
0.19	4.8	2.50	63.5
0.22	5.6	2.56	65.0
0.25	6.3	3.00	76.2
0.26	6.6	4.00	101
0.38	9.6	5.50	140
0.47	11.9	6.00	152
0.50	12.7	20.00	508
0.62	15.7		

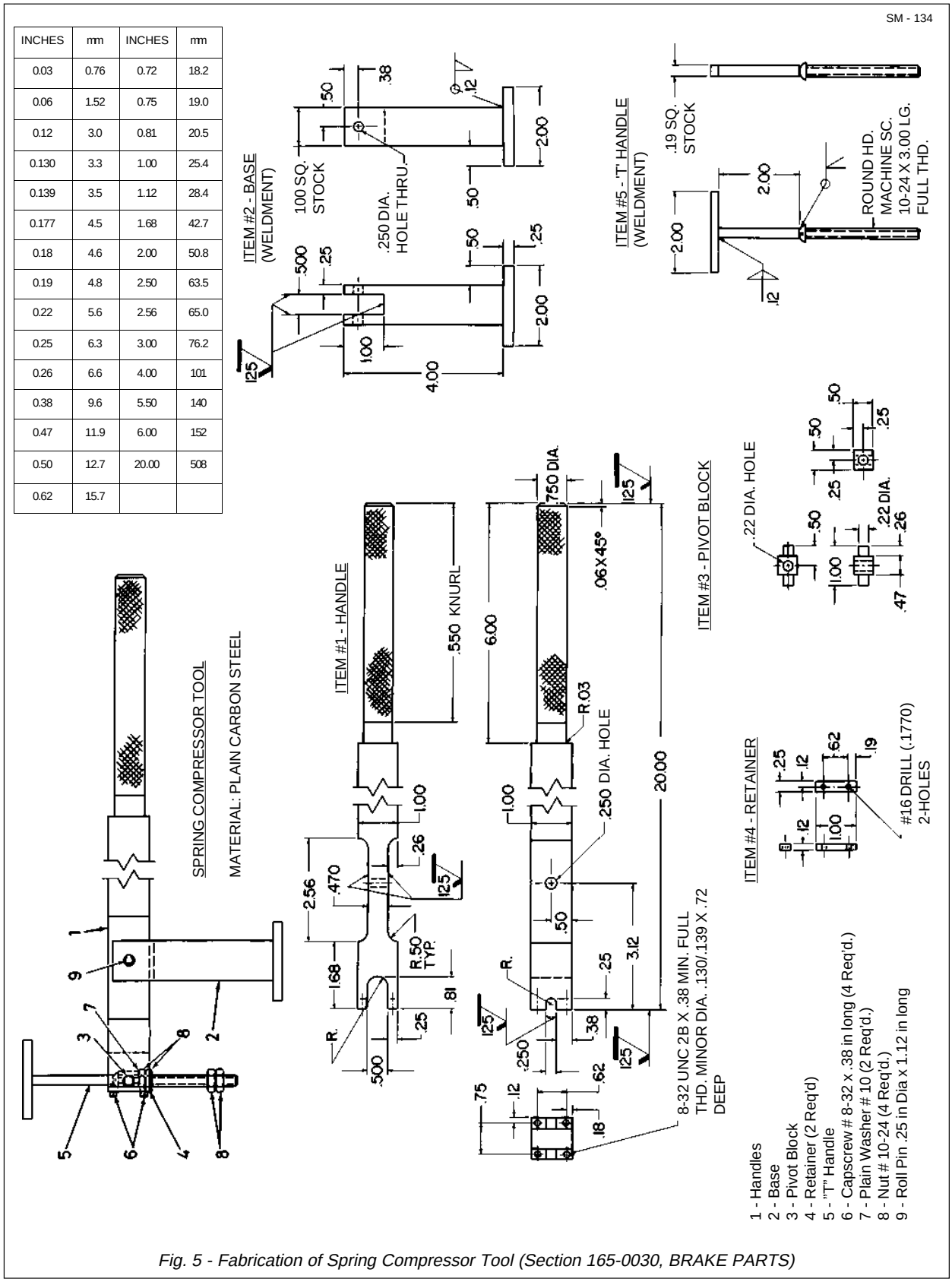


Fig. 5 - Fabrication of Spring Compressor Tool (Section 165-0030, BRAKE PARTS)

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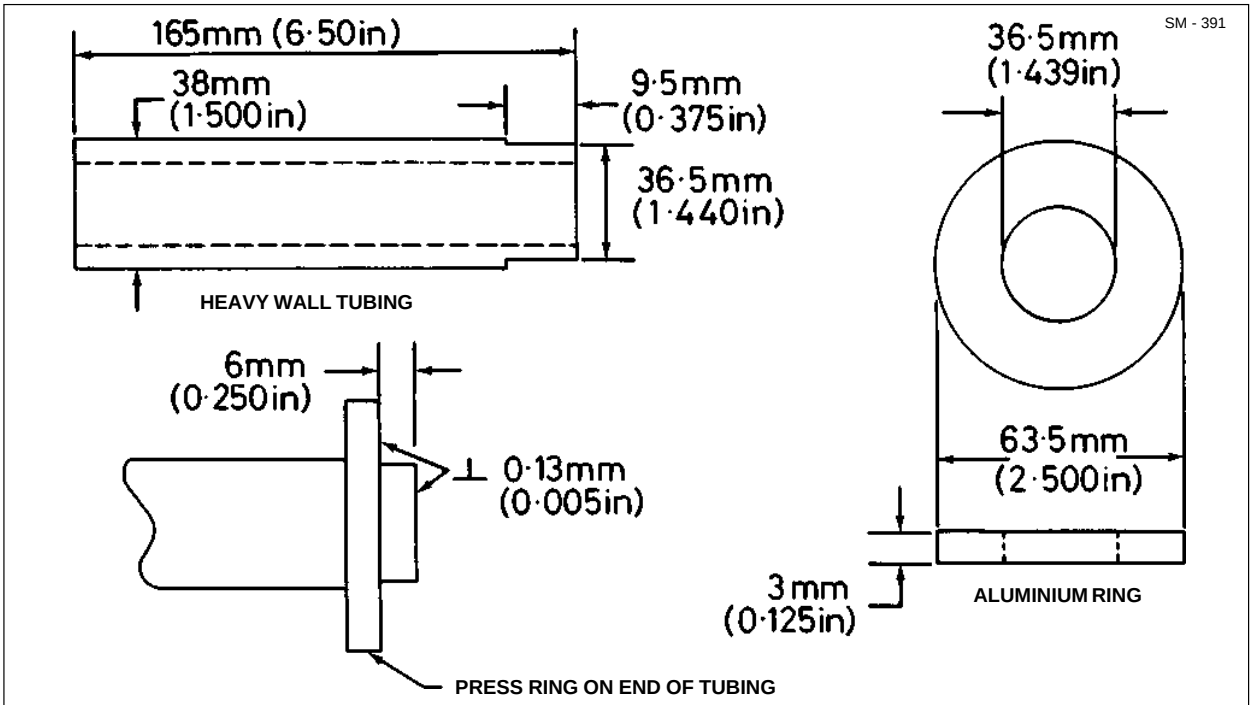
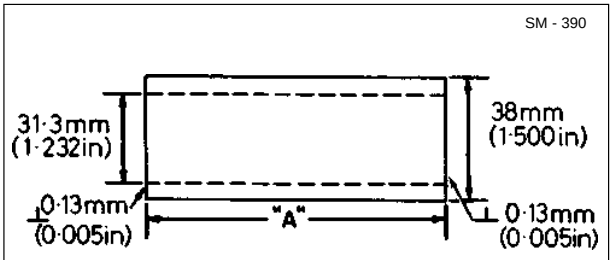
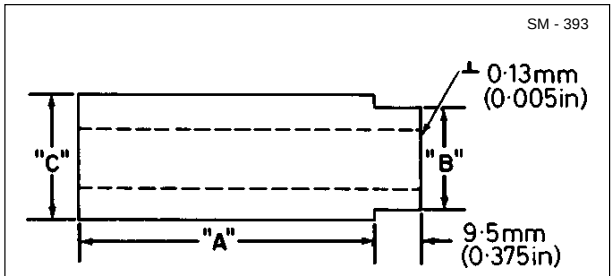


Fig. 6 - Shaft Seal Driver (Section 220-0050, STEERING PUMP)



USE FOR	"A"
Intermediate shaft bearing installation	100 mm (4 in)
Driveshaft bearing installation	150 mm (6 in)
Driveshaft bearing removal	228 mm (9 in)
38 mm (1.50 in) Heavy Wall Tubing	

Fig. 7 - Shaft Bearing Removal and Installation Tool (Section 220-0050, STEERING PUMP)



NOMINAL PIPE BORE mm (in)	'A' mm (in)	'B' mm (in)	'C' mm (in)
38 (1.5)	100 (4.0)	41 (1.62)	48 (1.89)
50 (2.0)	100 (4.0)	54 (2.12)	60 (2.38)

Fig. 8 - Bearing Inner Race Installation Tools (Section 220-0050, STEERING PUMP)

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WARNING
Some fasteners are important attaching parts which could affect the performance of vital components and systems, and/or, could result in major repair expense. Fasteners should be replaced with parts of the same part number, or with equivalent parts, if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. The torque values shown in the following tables should be used in all cases, unless otherwise specified elsewhere in this manual, in order to avoid possible personal injury or property damage.

The following torque specification tables are based on GM Standard Materials for bolts, nuts, studs and self-locking fasteners based on SAE bolt steel classifications, or, prevailing torque specifications for self-locking fasteners.

To prevent the threaded bolts and nuts used on this equipment from being overstressed during assembly, and to establish a uniform value to which these fasteners can be safely tightened, the following torque tables have been compiled.

The torque values listed in the tables have been established over a period of years and cover all conditions of assembly. The maximum torque values for standard bolts and nuts are based on 75% of the specified minimum proof strength of the bolt steel in order to provide a safety factor to compensate for the variation in the accuracy of torque wrenches, skill of the assembler, and variance in fractional conditions. **All torque values are for lubricated threads**. The term 'lubricated' includes the application of thread lubricants, cadmium plating or the use of hardened washers.

To provide a quick method for determining the GM material classification of a particular standard bolt or nut, compare the bolt head markings to those in the appropriate tables, then locate the maximum torque value for that bolt size in the column under that marking.

RECOMMENDED MAXIMUM TORQUES (IMPERIAL) ± 10% TABLE144

	SAE Symbol GM 260-M Steel (SAE GR 2)		SAE Symbol GM 280-M Steel (SAE GR 5)		SAE Symbol GM 290-M Steel (SAE GR 7)		SAE Symbol GM 300-M Steel (SAE GR 8)		12 Point Cap Screws	
Size	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft
0.25 - 20	5	4	8	6	11	8	12	9	14	10
0.25 - 28	7	5	10	7	12	9	14	10	15	11
0.31 - 18	11	8	18	13	22	16	24	18	27	20
0.31 - 24	12	9	19	14	24	18	27	20	30	22
0.38 - 16	20	15	31	23	38	28	43	32	49	36
0.38 - 24	23	17	34	25	43	32	49	36	56	41
0.44 - 14	33	24	47	35	59	43	68	50	75	55
0.44 - 20	37	27	54	40	68	50	79	58	87	64
0.50 - 13	50	37	75	55	94	69	106	78	119	88
0.50 - 20	56	41	88	65	106	78	122	90	134	99
0.56 - 12	75	55	108	80	136	100	156	115	171	126
0.56 - 18	81	60	122	90	149	110	176	130	191	141
0.62 - 11	102	75	149	110	190	140	217	160	237	175
0.62 - 18	115	85	169	125	210	155	244	180	270	199
0.75 - 10	176	130	271	200	332	245	380	280	420	310
0.75 - 16	203	150	298	220	366	270	420	310	472	348
0.88 - 9	169	125	434	320	536	395	610	450	679	501
0.88 - 14	190	140	488	360	590	435	678	500	751	554
1.00 - 8	258	190	651	480	800	590	915	675	1 021	753
1.00 - 12	285	210	719	530	881	650	1 003	740	1 119	825
1.00 - 14	285	210	732	540	902	665	1 030	760	1 148	847

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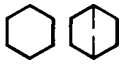
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Miscellaneous - Standard Bolt and Nut Torque Specifications

Section 300-0080

RECOMMENDED MAXIMUM TORQUES (IMPERIAL) ± 10%										TABLE145
	SAE Symbol GM 260-M Steel (SAE GR 2)		SAE Symbol GM 280-M Steel (SAE GR 5)		SAE Symbol GM 290-M Steel (SAE GR 7)		SAE Symbol GM 300-M Steel (SAE GR 8)		12 Point Cap Screws	
Size	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft
1.12 - 7	366	270	800	590	1 132	835	1 302	960	1 447	1 067
1.12 - 12	407	300	902	665	1 274	940	1 451	1 075	1 624	1 198
1.25 - 7	515	380	1 132	835	1 600	1 180	1 830	1 350	2 043	1 507
1.25 - 12	569	420	1 254	925	1 776	1 310	2 034	1 500	2 267	1 672
1.38 - 6	664	490	1 478	1 090	2 095	1 545	2 400	1 770	2 676	1 974
1.38 - 12	759	560	1 688	1 245	2 393	1 765	2 739	2 020	3 056	2 254
1.50 - 6	881	650	1 966	1 450	2 786	2 055	3 186	2 350	3 556	2 623
1.50 - 8	936	690	2 088	1 540	2 962	2 185	3 390	2 500	3 781	2 789
1.50 - 12	990	730	2 217	1 635	3 145	2 320	3 593	2 650	4 010	2 958
1.75 - 5	-	-	-	-	4 393	3 240	5 016	3 700	5 604	4 133
1.75 - 12	-	-	-	-	5 091	3 755	5 830	4 300	6 497	4 792
1.88 - 8	-	-	-	-	6 006	4 430	6 874	5 070	7 664	5 653
1.88 - 12	-	-	-	-	6 304	4 650	7 213	5 320	8 048	5 936
2.00 - 4.5	-	-	-	-	6 623	4 885	7 565	5 580	8 448	6 231
2.00 - 8	-	-	-	-	7 342	5 415	8 406	6 200	9 367	6 909
2.00 - 12	-	-	-	-	7 687	5 670	8 786	6 480	9 811	7 236
2.25 - 4.5	-	-	-	-	9 701	7 155	11 090	8 180	12 377	9 129
2.25 - 8	-	-	-	-	10 629	7 840	12 148	8 960	13 566	10 006
2.25 - 12	-	-	-	-	11 050	8 150	12 636	9 320	14 102	10 401
2.50 - 12	-	-	-	-	15 280	11 270	17 463	12 880	19 500	14 383

Note: Where materials other than GM Standards are used, refer to the conversion table below.

Types of Steel	Rockwell Hardness Range	Applicable Torque Values	SAE Bolt Head Symbols
Plain Low Carbon (eg. SAE 1018 or 1020)	Rockwell "B" 85-100	GM 260-M	
Plain Medium Carbon (eg. SAE 1035, 1038 & 1045)	Rockwell "C" 19-30	GM 280-M	
Medium Carbon Alloy (eg. SAE 4140, 8642 & 5157)	Rockwell "C" 28-34	GM 290-M	
Medium Carbon Alloy (eg. SAE 4140, 8642 & 5147)	Rockwell "C" 32-38	GM 300-M	

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RECOMMENDED MAXIMUM TORQUES (METRIC) ± 10% TABLE146

Size	Class 8.8		Class 9.8		Class 10.9		Class 12.9	
	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft
M 1.6 - 0.35	-	-	0.20	0.15	-	-	0.20	0.15
M 1.6 - 0.20	-	-	0.25	0.20	-	-	0.40	0.30
M 2.0 - 0.40	-	-	0.25	0.20	-	-	0.45	0.30
M 2.0 - 0.25	-	-	0.45	0.30	-	-	0.45	0.30
M 2.0 - 0.45	-	-	0.25	0.20	-	-	0.45	0.30
M 2.5 - 0.35	-	-	1	0.75	-	-	1	0.75
M 3.0 - 0.50	-	-	1	0.75	-	-	2	1.5
M 3.0 - 0.35	-	-	1	0.75	-	-	2	1.5
M 3.5 - 0.60	-	-	2	1.5	-	-	3	2
M 4.0 - 0.70	-	-	3	2	-	-	4	3
M 4.0 - 0.35	-	-	3	2	-	-	5	3
M 5.0 - 0.80	-	-	5	4	-	-	8	6
M 5.0 - 0.50	-	-	6	4	-	-	9	6
M 6.0 - 1.00	-	-	9	6	-	-	13	10
M 6.3 - 1.00	-	-	10	8	13	10	16	11
M 6.0 - 0.75	-	-	10	7	12	9	14	10
M 8.0 - 1.25	-	-	21	15	27	20	32	23
M 8.0 - 1.00	-	-	23	17	29	21	34	25
M 10.0 - 1.50	-	-	42	31	54	39	63	46
M 10.0 - 1.25	-	-	45	32	57	41	67	48
M 12.0 - 1.75	-	-	74	53	94	68	110	80
M 12.0 - 1.25	-	-	81	58	103	74	121	87
M 14.0 - 2.00	-	-	118	85	151	109	176	127
M 14.0 - 1.50	-	-	128	92	163	118	190	137
M 16.0 - 2.00	169	122	-	-	234	169	274	197
M 16.0 - 1.50	181	130	-	-	250	180	292	211
M 18.0 - 2.50	234	169	-	-	323	234	378	273
M 18.0 - 1.50	263	190	-	-	363	262	425	307
M 20.0 - 2.50	330	239	-	-	457	330	531	386
M 20.0 - 1.50	367	265	-	-	507	366	593	423
M 22.0 - 2.50	451	325	-	-	623	450	728	526
M 22.0 - 1.50	495	357	-	-	684	494	800	577
M 24.0 - 3.00	571	412	-	-	790	570	923	667
M 24.0 - 2.00	623	450	-	-	861	622	1 007	727
M 27.0 - 3.00	837	605	-	-	1 158	836	1 354	977
M 27.0 - 2.00	903	652	-	-	1 250	902	1 461	1 055
M 30.0 - 3.00	1 135	820	-	-	1 570	1 134	1 835	1 325
M 30.0 - 2.00	1 258	908	-	-	1 740	1 256	2 034	1 468
M 30.0 - 1.50	1 300	939	-	-	1 799	1 299	2 102	1 516
M 36.0 - 4.00	1 985	1 433	-	-	2 745	1 982	3 208	2 317
M 36.0 - 3.00	2 102	1 517	-	-	2 907	2 099	3 398	2 453

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Miscellaneous - Standard Bolt and Nut Torque Specifications

SELF-LOCKING FASTENERS

Self-locking fasteners develop a measured gripping action or torque and provide a renewed locking action after being removed and reinstalled to their original mating part. The self-locking fasteners used on this equipment meet specifications necessary to allow the fasteners to be reused up to five times. Whenever a self-locking fastener is removed, the head of the fastener should be deeply scribed or otherwise marked to record the number of times the fastener has been used. Do not use a self-locking fastener more than five times.

The following table shows the minimum torque specifications allowed to remove self-locking fasteners after the initial break-away torque has been achieved. Any self locking fastener that can be removed with less than the prevailing torque value shown in the table should be discarded, even if the fastener has not yet been reused five times.

MINIMUM PREVAILING TORQUE - REMOVAL TABLE537

	Lockscrews		Locknuts			
	SAE Grade 5 & 8 and ASTM A-574		SAE Grade 5		SAE Grade 8	
Size	Nm	lbf in	Nm	lbf in	Nm	lbf in
0.25 - 20	0.3	3	0.4	3.5	0.5	4.5
0.25 - 28	0.3	3	0.4	3.5	0.5	4.5
0.31 - 18	0.6	5	0.6	5.5	0.9	7.5
0.31 - 24	0.6	5	0.6	5.5	0.9	7.5
0.38 - 16	1.0	9	1.0	8.5	1.3	11.5
0.38 - 24	1.0	9	1.0	8.5	1.3	11.5
0.44 - 14	1.4	12	1.4	12	1.8	16
0.44 - 20	1.4	12	1.4	12	1.8	16
0.50 - 13	1.8	16	1.7	15	2.3	20
0.50 - 20	1.8	16	1.7	15	2.3	20
0.56 - 12	2.5	22	2.4	21	3.2	28
0.56 - 18	2.5	22	2.4	21	3.2	28
0.62 - 11	3.4	30	3.1	27	4.1	36
0.62 - 18	3.4	30	3.1	27	4.1	36
0.75 - 10	5.1	45	4.6	41	6.1	54
0.75 - 16	5.1	45	4.6	41	6.1	54
0.88 - 9	7.3	65	7.0	62	9.3	82
0.88 - 14	7.3	65	7.0	62	9.3	82
1.00 - 8	9.6	85	9.5	84	12.7	112
1.00 - 12	9.6	85	9.5	84	12.7	112
1.00 - 14	-	-	9.5	84	12.7	112

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GENERAL

The storage of machines for short periods of time or during the off-season is an important item if major damage to components is to be avoided. Failure to take the necessary steps to protect the various assemblies while the machine is being stored can result in an expensive overhaul job and delay in returning the machine to work.

TEMPORARY STORAGE

When storing a machine for a period of 30 days or less, the following precautions must be taken:

1. INSPECTION AND REPAIR - Thoroughly inspect and test the machine and make any necessary repairs or adjustments which may be necessary to prepare the machine for service. This will enable you to put the machine back into use immediately at the end of the storage period.

2. LUBRICATION - Lubricate the machine completely according to the instructions given in Section 300-0020, LUBRICATION SYSTEM of this manual.

3. PARKING - After thoroughly cleaning the entire machine, park it on a hard, dry, level surface that is free from grease and oil. The oil and grease would cause tyre deterioration. Apply the parking brake.

4. BATTERIES - Where moderate temperatures are expected, the batteries may be left in the machine. Up to 30 days, the batteries may require a boost at the end of the storage period. Preferably place the batteries in the shop where they can be inspected, brought up to full charge and placed on a trickle charge to keep them at full charge. In very cold or hot climates, store the batteries where they will be protected from temperature extremes.

5. RUST PREVENTION - Remove all evidence of rust from the machine and repaint. In addition, cover all exposed machine surfaces with a good rust preventive.

6. SUPPLY TANKS - Fill fuel and hydraulic tanks to prevent moisture condensation within the tanks.

7. TYRES - Inflate all tyres to correct pressure. During storage, check inflation pressure approximately once every two weeks.

8. ENGINE - Consult the relevant Engine Maintenance Manual for complete information on storing the engine for periods shorter than 30 days.

9. TRANSMISSION - Fill transmission sumps to the proper level.

EXTENDED STORAGE - Under Six Months

When storing a machine for periods of longer than 30 days, but under six months, the following procedure must be followed:

1. INSPECTION AND REPAIR - Same as Step 1 given under 'Temporary Storage'.

2. LUBRICATION - Same as Step 2 given under 'Temporary Storage'.

3. PARKING - Same as Step 3 given under 'Temporary Storage'. Machines should be blocked up so the tyres are off the ground or floor.

4. BATTERIES - Remove batteries from the machine and store them in a suitable place where they can be inspected and charged at least every 30 days or placed on a trickle charger.

5. RUST PREVENTION - Same as Step 5 given under 'Temporary Storage'.

6. SUPPLY TANKS - Same as Step 6 given under 'Temporary Storage'.

7. TYRES - With the machine on blocks, as called for in Step 3, deflate the tyres to 0.7 bar (10 lbf/in^2) pressure. Remove all traces of grease and oil and protect the tyres from direct sunlight and water with a suitable cover.

8. TRANSMISSION - Consult the relevant Transmission Maintenance Manual for storage data involving periods longer than 30 days.

9. ENGINE - Consult the relevant Engine Maintenance Manual for storage data involving periods longer than 30 days.

10. VENTS AND BREATHERS - Remove all vents and breathers and plug openings with pipe plugs. If it is not possible to do this, seal vents and breathers with waterproof tape.

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Miscellaneous - Unit Storage

Section 300-0090

EXTENDED STORAGE - Over Six Months

When a machine is to be stored for a period over SIX MONTHS, the following procedure must be followed:

Note: These steps are in addition to those given previously under 'Extended Storage - Under Six Months'.

1. LUBRICATION - Completely lubricate the machine according to the instructions contained in Section 300-0020, LUBRICATION SYSTEM of this manual.

2. WHEEL BEARING - Remove, clean, inspect and repack all wheel bearings.

Note: The above steps must be repeated for every Six Month period the machine is in storage.

REMOVAL FROM EXTENDED STORAGE

General

1. LUBRICATION - Completely lubricate the machine according to the instructions in Section 300-0020, LUBRICATION SYSTEM of this manual.

2. BATTERIES - Install batteries and check for a full charge. Charge batteries as required.

3. TYRES - Inflate tyres to the proper pressures. Refer to Section 140-0040, WHEEL RIM AND TYRE, of this manual.

4. FUEL AND HYDRAULIC TANKS - Drain off condensation and fill tanks to proper level, remove breather covers and install air breathers. Be sure breathers are clean before installation.

5. VENTS AND BREATHERS - Remove seals and plugs from all breather openings, then install all breathers and vents.

6. ENGINES - Consult the relevant Engine Maintenance Manual for instructions on removing an engine from storage.

7. PAINT - Check machine for rust. Remove all rust spots and repaint rusted areas.

8. TRANSMISSION - Consult the relevant Transmission Maintenance Manual for instructions on removing from storage.

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