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GRADALL®

COMBINED SERVICE MANUAL

XL4210II

3 1 2 0 0 0 5 7

November 2006

Upperstructure
Starting S/N 0210017506

GRADALL
406 Mill Avenue S.W.
New Philadelphia, OH, 44663, USA
Telephone: (330) 339-2211
Fax: (330) 339-3579

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GRADALL®

OPERATOR & SAFETY MANUAL

Keep this manual with machine at all times.

Model (s)
XL4210 II

31200056
Original Issue
December, 2004

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IMPORTANT SAFETY NOTICES

IT MUST REMAIN THE RESPONSIBILITY OF MACHINE OWNER to ensure that any assigned operator be fully trained and experienced, and has a full understanding of Operator/ Safety Manual provided, and that operator has had sufficient, supervised, opportunity to practice in a safe area to become familiar with machine before operating machine at a work site.

Safe operation depends upon reliable equipment and proper operating procedures. Performing the checks and services described in this manual will help keep your Gradall® Excavator in reliable condition and use of the recommended operating procedures can help you avoid accidents. Because some procedures may be new to even the experienced operator we recommend that this manual be read, understood and followed by all who operate the unit.

Strict attention to, and compliance with, instructions provided in this manual as well as the EMI & Gradall Hydraulic Excavator Safety Manuals and all instructional decals and plates affixed to the machine, will help you avoid personal injury and damage to the equipment. The information provided is not intended to cover all situations; it would be impossible to anticipate and evaluate all possible applications and methods of operation for this unit.

Any procedure not specifically recommended by The Gradall Company must be thoroughly evaluated from the standpoint of safety before it is placed in practice. If you aren't sure, contact your Gradall Excavator Distributor before operating.

Do not modify this machine without written permission from The Gradall Company.
Use only genuine Gradall replacement parts.

The Gradall Company retains all proprietary rights to the information contained in this manual.

The company also reserves the right to change specifications without notice.

Gradall is a registered trademark for hydraulic excavators, hydraulic material handlers and attachments manufactured by The Gradall Company.

It is Gradall Policy to continually improve its products. Therefore designs, materials and specifications are subject to change without notice and without incurring any liability on units already sold. Units shown may have optional equipment.

Though no offense or discrimination is intended, only the masculine pronouns will be used throughout this manual.

The Gradall Company
406 Mill Ave. S.W., New Philadelphia, Ohio 44663

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REVISIONS

This page is provided so you may determine that this Manual is complete and current with respect to Gradall Engineering Specifications.

Page	Date	Revision
N/A	12/2004	Original Release of Manual

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INTRODUCTION

General
This manual provides important information to familiarize you with required lubrication and maintenance by operator and with proper operating procedures for the Gradall Hydraulic Excavator.

Related Manuals & Decals
Separate publications are furnished with the excavator to provide information concerning safety, replacement parts, maintenance procedures, theory of operation and vendor components. All decals and additional manuals for your machine are available from your Gradall Distributor.

Operator Qualifications
This excavator has been designed for operators weighing from 104 to 216 pounds (47 to 98.5 kg) and from 61 to 74 inches (155 to 188 cm) tall. Potential operators beyond these limits should be observed while operating and driving the unit in an open area to determine their ability for safe, efficient operation.

The operator must hold a valid, applicable driver's license which requires acceptable age, vision, hearing, manual dexterity and response. He must also be in acceptable physical and mental condition, not undergoing medical treatment or using drugs or alcohol.

Before operating the excavator at a work site, the operator must familiarize himself with the machine by practicing in an open area not hazardous to persons or property. Because many operational features of the XL 4210 II are different from previous Gradall excavators extensive practice is required for proper operation.

The operator must read, understand and comply with instructions contained in the following material furnished with the excavator:
- This Operator/Safety Manual
- Gradall Hydraulic Excavator Safety Manual
- EMI Hydraulic Excavator Safety Manual
- All Instructional decals and plates
- Any optional equipment instructions furnished

Orientation
When used to indicate direction or location, the terms front, rear, left and right relate to the orientation of a person sitting in the operator's seat (figure I-1).

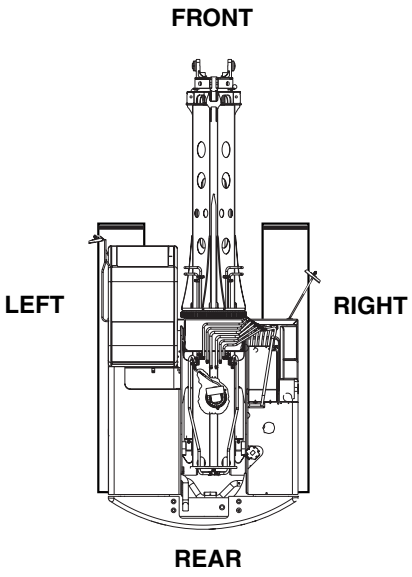


Figure I-1

Serial Number Location (Product Identification No.)
Specify Serial Number and lot number when ordering parts and when discussing specific applications and procedures with your distributor. The PIN plate (figure I-2) is located on front, center portion of upperstructure frame.

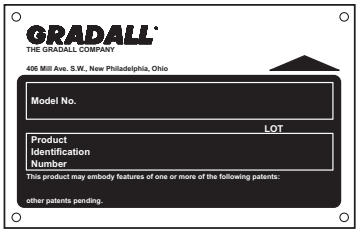
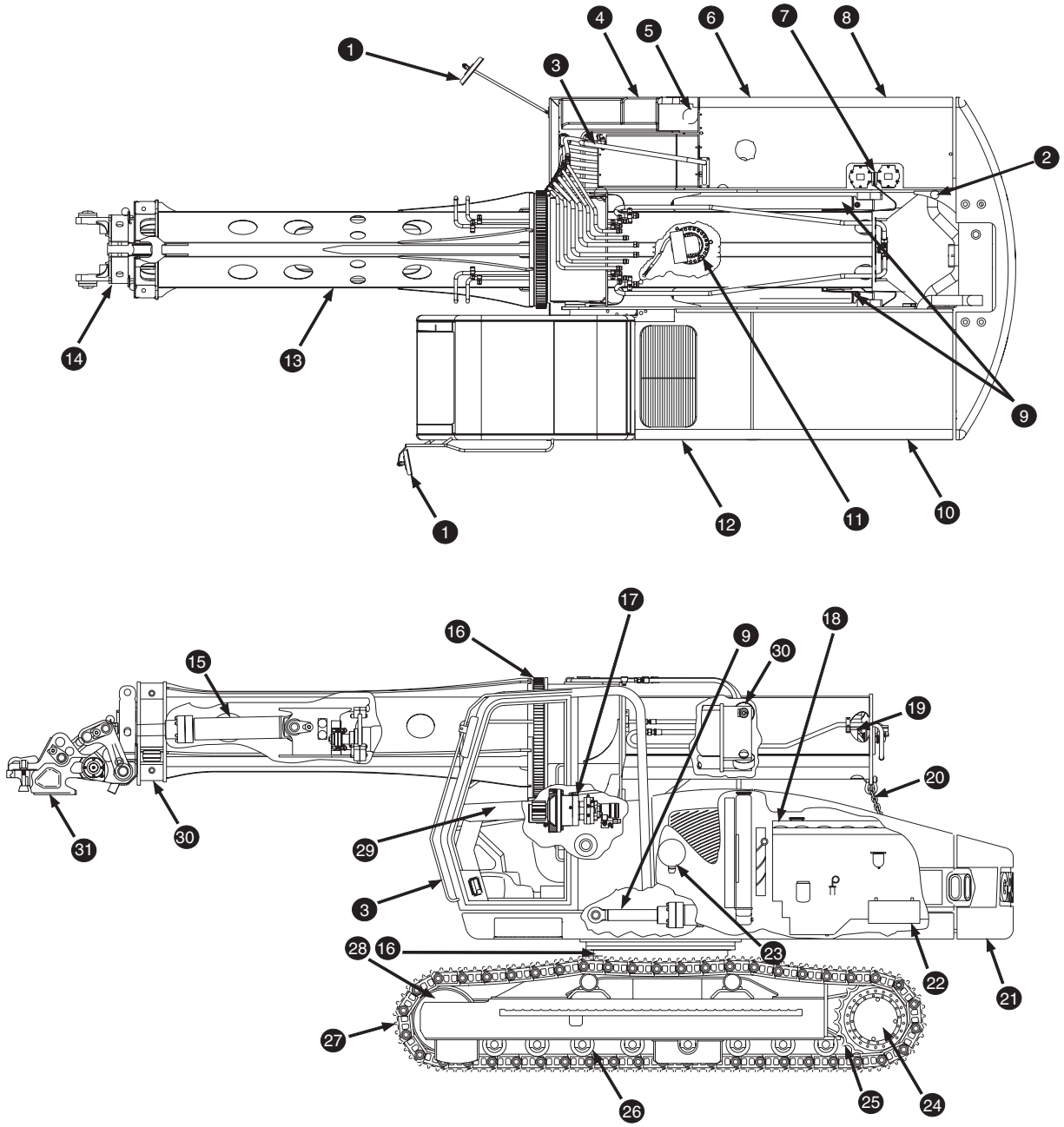


Figure I-2

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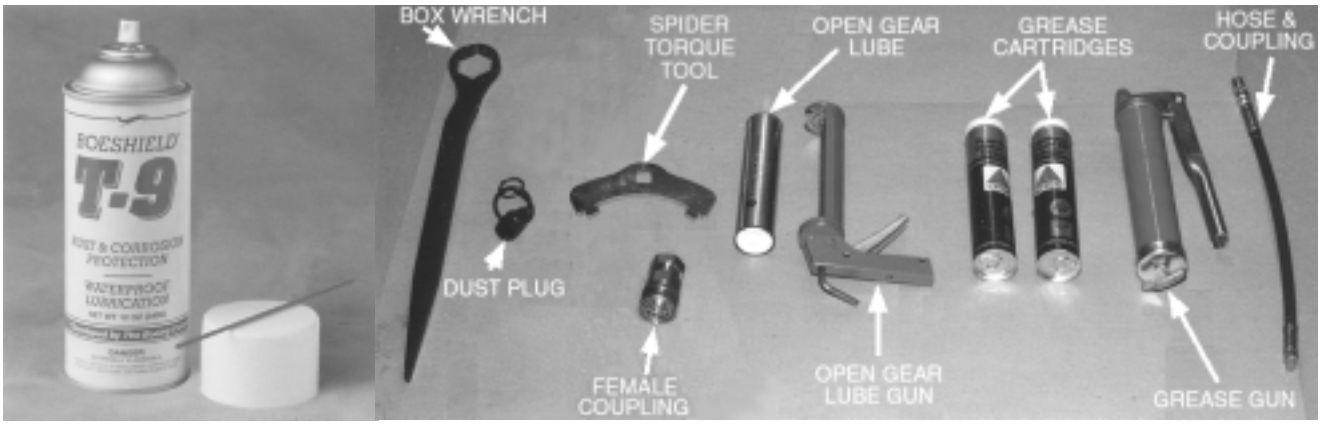
NOMENCLATURE



1	Mirror
2	Hydraulic Reservoir Pressure Release Valve
3	Hand Rail
4	Valve Compartment
5	Fuel tank Fill
6	Fuel Tank
7	Hydraulic filters
8	Hydraulic Reservoir
9	Hoist Cylinder (2)
10	Engine/pump compartment
11	Swing Transmission
12	Air Cleaner/Oil Cooler Compartment
13	Main Boom
14	Telescoping Boom
15	Tool Cylinder

16	Swing/Tilt Bearing
17	Tilt Transmission
18	Engine
19	Telescoping Boom Cylinder
20	Boom Tie Down Chain
21	Counterweight
22	Battery
23	Air Cleaner
24	Planetary Track Drive
25	Track Drive Sprocket
26	Track Roller
27	Track
28	Track Idler
29	Operator Cab
30	Boom Rollers
31	Bucket Adapter

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XL 4210 II Tool Kit

(Kit can be ordered under part number 8031-5004)

QTY	PART NO.	DESCRIPTION	USE
1	1440-4645	12 Oz. Can Boeshield	Cylinder Rod Protectant
1	8345-1128	Female Coupling	Pressure fill hydraulic reservoir
1	8362-3027	Dust Plug	Protect female coupling
1	8381-3109	Button Hd Coupling	Adapt grease gun to adjust tracks
1	8504-1300	Grease Gun	Apply grease to fittings
1	8504-1301	Hose and Coupling	Adapt grease gun to fittings
2	8504-1302	Grease Cartridges	Initial supply for grease gun
1	8504-1356	Box Wrench (1-7/8”)	Install and remove attachment
1	8042-1115	Spider Nut Wrench	Adjust Spider on Boom Cylinder
1	8664-1304	Open Gear Lubricant	Lubricate swing & tilt gears
1	8664-1305	Open Gear Lubricant Gun	Apply open gear lubricant to gears

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Read and understand all manuals and instructional material listed on cover, inside front cover and introduction page of this Manual before starting, operating or performing maintenance procedures on this equipment.

Safe operation depends on reliable equipment and proper operating procedures. Performing the adjustments and repairs described in this Manual will help to keep your Hydraulic Excavator in reliable condition. Use of the recommended operating procedures can help you avoid accidents. This Manual must be read, understood and followed by all who operate and service this machine.

Regardless of previous experience operating similar equipment, the operator must be given sufficient opportunity to practice with the excavator in a safe, open area (not hazardous to people or property) to gain operating skills and the proper "feel" for controls and operating clearances required for safe, efficient operation.

Complying with the DANGER, WARNING and CAUTION notes in this Manual will help you avoid injury and damage to the equipment. These notes are not intended to cover all eventualities; it would be impossible to anticipate and evaluate all possible applications and methods of operation for this equipment.

Any procedure not specifically recommended by GRADALL must be thoroughly evaluated from the standpoint of safety before it is placed in practice. If you are not sure, contact your GRADALL Distributor before operating.

Do not modify this machine without written permission from GRADALL.

BASIC SAFETY ISSUES

Always **check to be sure all controls are in neutral position before starting engine.** Although controls are designed to return to neutral when released, a foreign object could hold a control in an activated position.

Always maintain **3-point contact** with grab handles and steps when climbing on and off the machine. Never jump from the machine. Repair or replace any damaged steps and grab handles.

Perform all **"Checks and Services Before Starting the Engine"** and all **"Warm-Up and Operational Checks"** at the beginning of each work shift. Complete all required maintenance before operating the equipment.

Learn and **follow your employer's safety rules**.

Keep everyone off the machine while it is operating. Be alert for bystanders or anyone who may be working nearby. **Do not lift people with this machine.**

Never carry a water can, equipment, or other worker's tools or personal items on the machine. Such items can cause other workers to approach the machine without your knowledge and result in serious injury or death.

WATCH FOR THESE SYMBOLS ; THEY CALL YOUR ATTENTION TO SAFETY NOTICES.

⚠ DANGER

This symbol indicates an extreme hazard which will result in high probability of death or serious injury if proper precautions are not taken.

⚠ WARNING

This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.

⚠ CAUTION

This symbol indicates a hazard which may result in injury or damage to equipment or property if proper precautions are not taken.

⚠ WARNING

Failure to comply with safety precautions listed in this Manual and detailed on the machine could result in machine damage, personal injury or death.

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Stay clear of moving fan, belts, pulleys, meshing gears, drive shafts and other moving parts. Do not operate this equipment without doors, covers, and guards in place and secured.

Be particularly careful if this is not the machine you usually operate. **Read the manuals** listed in the introduction and then **practice operating the machine in a safe, open area** to become familiar with the controls.

Always sound the horn to warn others of unexpected machine movements.

Be certain boom or attachment is resting firmly on ground and that **engine is stopped with key removed** before performing lubrication or maintenance procedures inside boom. Place a "DO NOT OPERATE" tag on the controls. **Always lower boom to rest and stop engine** before leaving cab.

Check operation of lights and flashing swing warning lights. Lights on each side of counterweight flash when upperstructure is swinging.

Mark all hoses before servicing to assure proper re-assembly.

Keep grab handles, steps, and walkways free of mud, oil, grease, and other foreign material. Replace non-skid surface material as required.

Be sure windows and door are securely latched in open or closed position when operating. Replace damaged latches and weak access cover support struts immediately.

Always stop engine before leaving cab.

Check to be sure windows and mirrors are clean and that mirrors are properly adjusted for your position and machine configuration. **Ensure adequate visibility for safe travel.**

Know overall height of your unit before traveling. Approach unknown clearances slowly (measure from ground to tallest point of machine/attachment.

Don't get too close to unstable ground or the edge of an excavation, getting too close can cause the unit to tip.

Always be especially careful when using mirrors; distances are distorted and field of view is limited, especially when swinging. **Always use a signal person when operating in tight quarters.**

Stay away from hot exhaust.

Do not use this machine in an explosive environment. This machine is not designed to protect the operator from external fire or blast.

Be aware of the potential hazards related to batteries **(Figure 1-1 & Figure 1-2).**

⚠ WARNING

Operator must be seated with seat belt fastened, before traveling.

⚠ WARNING

Welding could damage electrical wires, engine electronics.

Turn off engine, disconnect both the positive (+) and negative (-) battery cables and disconnect the 23-pin Deutsch connector located toward the rear L.H. side of engine before welding to prevent damage to electronic components.

Damaged electronic components could lead to an accident due to loss of vehicle control, resulting in severe injury.

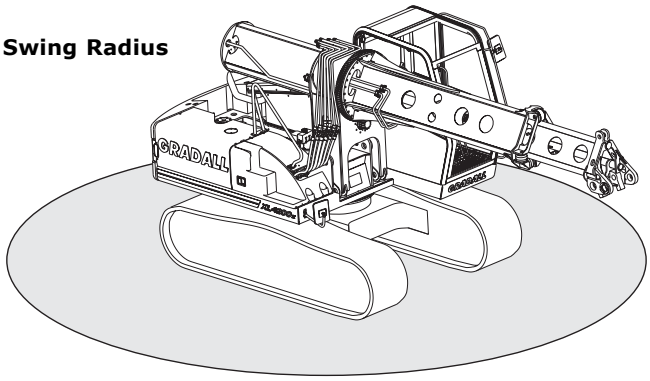


Figure 1-1



Figure 1-2

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The **XL4210II Excavator is designed as a one-person machine.** There is no safe place for another person on the unit other than the operator. Do not allow anyone inside the swing radius of the boom/attachment (other than the operator) while the machine is in operation. Failure to keep all people clear could cause an accident resulting in serious injury or death.

Pressure can be maintained in hydraulic circuits long after the engine has been shut down. This pressure can cause oil (or items such as pipe plugs) to **"shoot out"** at high speed **if pressure is not released** correctly (figure 1-3). **Refer to service manual for procedure to relieve hydraulic pressure trapped in circuits**.

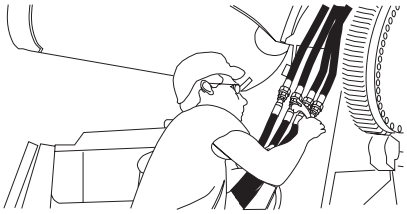


Figure 1-3

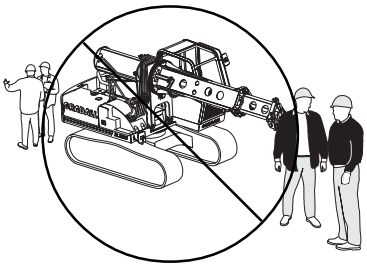


Figure 1-4

Do not operate with bystanders or other workers near machine (figure 1-4).

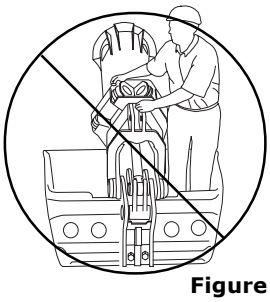


Figure 1-5

Keep everyone off of machine while it is operating. Do not lift people with this machine (figure 1-5).

⚠ WARNING

Travel on off-highway grades is recommended only under the following conditions:

Boom and attachment are positioned for maximum visibility and adequate clearances.

Surface is firm enough to support unit.

Surface provides adequate traction to prevent slipping.

Surface is not rough enough or steep enough to cause tipping.

Low travel speed is selected.

There is no load in bucket, attached to boom, or any other part of machine.

⚠ WARNING

Avoid injury! Always relieve pressure trapped in circuits before disconnecting, removing or installing hydraulic components.

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Additional Precautions

- **Before traveling, adjust boom elevation to ensure clear view of right mirror. Adjust these positions as necessary to clear overhead obstructions. Return to initial positions after clearing overhead obstructions. If these instructions do not resolve all visibility problems, use a signal person.**
- **The excavator is equipped with a travel alarm to warn others in area of machine travel, either forward or reverse. If alarm fails to sound when traveling, STOP. Contact maintenance personnel to have condition repaired before traveling.**
- **Before stopping engine always be certain to position upperstructure to permit an easy, safe climb to ground and then back to cab. Always remove key from ignition before leaving cab.**
- **Before operating at a worksite, check location of all utility, phone and cable lines. Have your supervisor determine how close you can safely permit attachment to approach utility lines. Stay clear of phone and cable lines.**
- **Always fasten seat belt before operating.**

⚠ WARNING

Whenever rotating equipment (such as a mower or mixer) is installed on machine, adequate shielding must be installed to deflect flying debris.

Never operate such equipment with other persons within range of possible flying debris. Be certain that mower discharge is never aimed at persons, equipment, structures, or thoroughfares.

As an additional precaution, safety glass and appropriate window guards must be installed on machine.

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"PINCH POINTS"

Save lives and prevent injuries: Learn to recognize and avoid "Pinch Points"!

It must remain the **RESPONSIBILITY OF OWNER** to be certain **OPERATOR** is aware of **PINCH POINTS. PINCH POINTS** can cause **SERIOUS INJURY OR DEATH.**

It is the **OPERATOR'S** responsibility to **KEEP OTHERS CLEAR OF PINCH POINTS.** Never allow others to be on or near machine while operating or traveling.

Boom Holes & Rollers (Figure 1-10)
Always rest boom or attachment firmly on ground and stop engine before performing any procedure thru a boom hole or before servicing boom rollers.



Figure 1-10

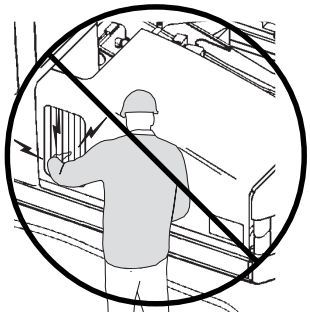


Figure 1-11

Access Covers (Figure 1-11)
Be sure all access covers are in the fully open position before performing any procedures inside compartments. Additional measures may be required to keep covers open in high wind environments.

Counterweight and Another Object (Figure 1-12)
Position machine to prevent possibility of a person being injured in a pinch point between counterweight and another object. Avoid working too close to other objects.

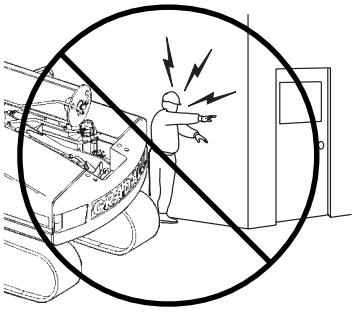


Figure 1-12

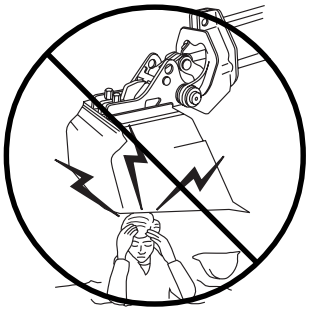


Figure 1-13

Boom and Attachment (Figure 1-13)
Never permit anyone under boom, attachment or load.

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Bucket & Linkage (Figure 1-14)

Be certain that attachment is resting firmly on ground and engine is stopped before performing any procedure on bucket, linkage or boom rollers.

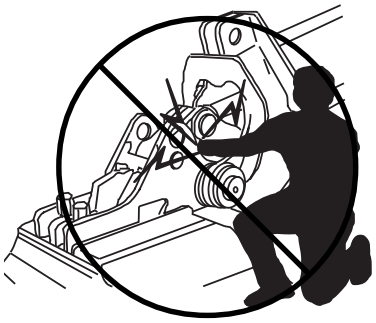


Figure 1-14

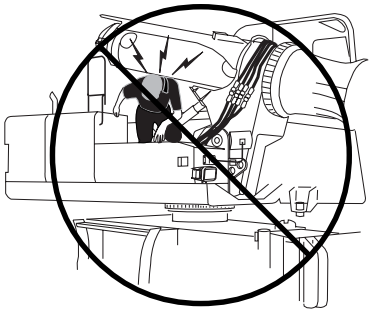


Figure 1-15

Boom Cradle & Deck (Figure 1-15)

Rest boom or attachment on ground and stop engine before permitting anyone to work beneath boom cradle.

Upperstructure & Crawler (Figure 1-16)

Never permit anyone to approach the machine while upperstructure is swinging.

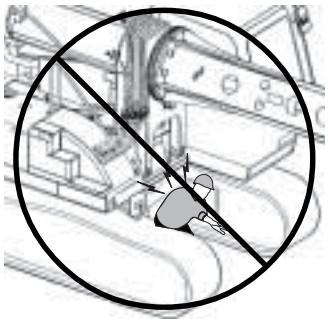
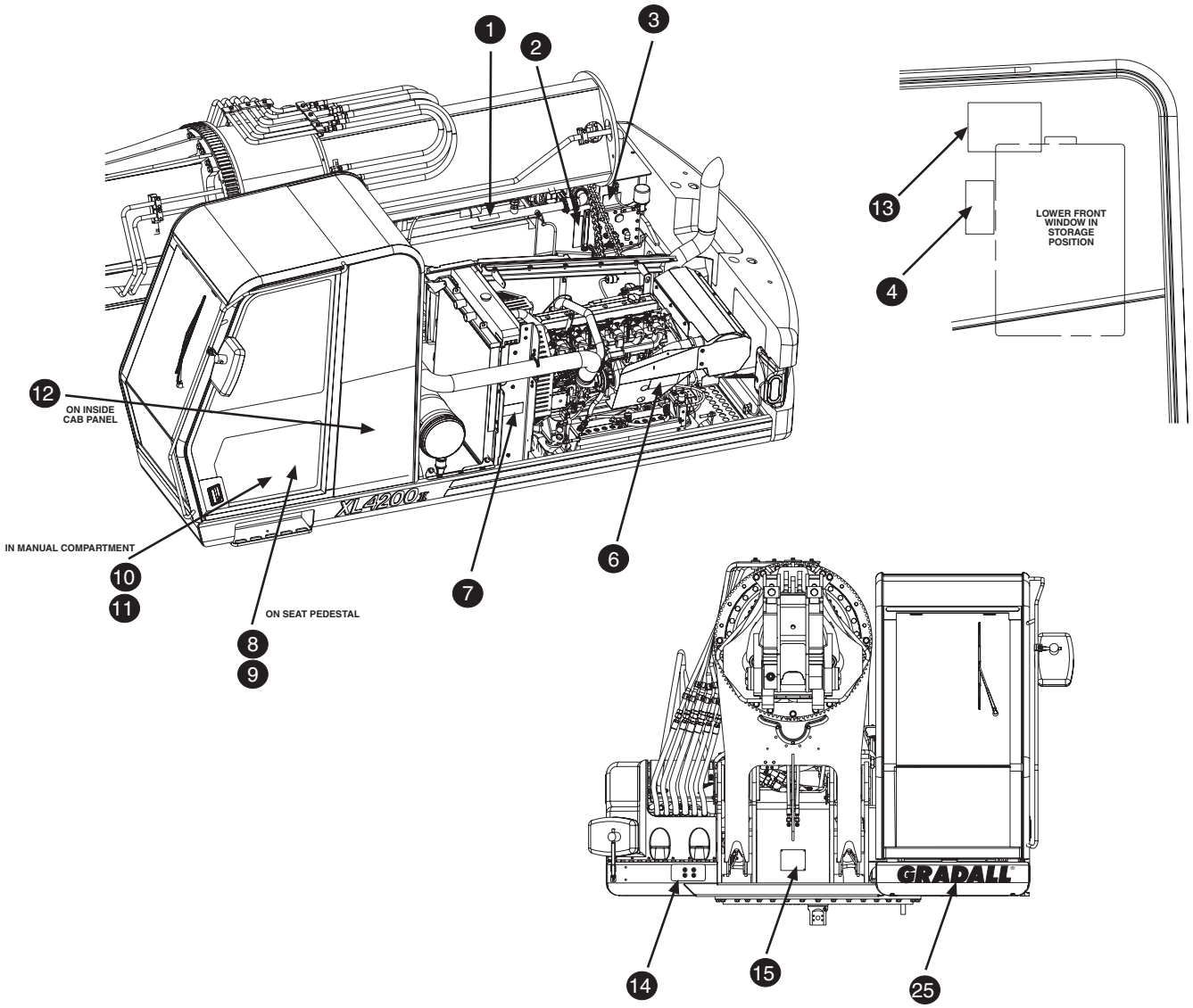


Figure 1-16

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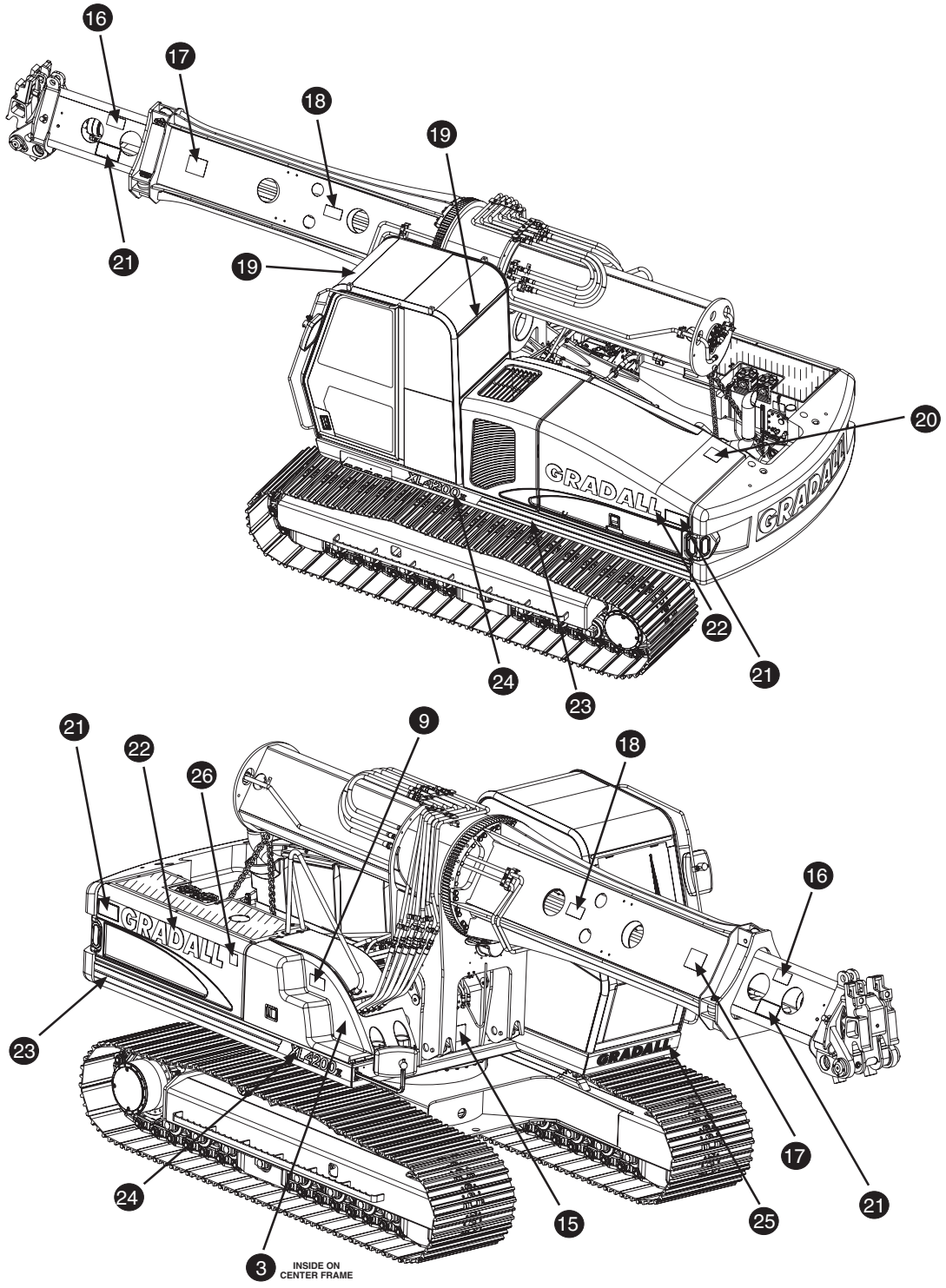
DECAL LOCATIONS



1	9114-3288	HYDRAULIC DECAL
2	8031-3019	RESERVOIR FILL DECAL
3	8090-3012	HYDRAULIC WARNING DECAL
4	8091-3074	WARNING DECAL
6	7736-3358	BATTERY WARNING DECAL
7	8060-3038	WARNING DECAL
8	7733-3027	MADE IN USA DECAL
	8036-3155	MANUAL DECAL

9	8060-3036	WARNING DECAL - CLIMBING
10	8046-3028	OPERATING DECAL - DEERE
11	8046-3027	OPERATING DECAL - GRADALL
12	8036-3181	ESCAPE HAMMER
13	8046-3064	OPERATING DECAL - SAE
14	8046-3039	LUBRICATING DECAL - UPPER
15	7733-3047	SERIAL NUMBER PLATE

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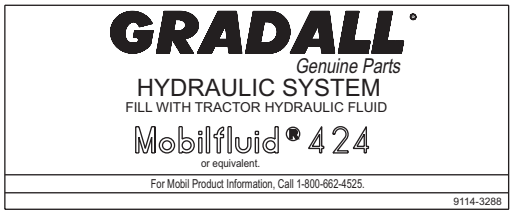


16	8090-3017	WARNING DECAL - NO RIDERS
17	8033-3235	DANGER DECAL
18	8060-3037	WARNING DECAL - PINCH POINT
19	8037-3066	REFLECTIVE STRIPE
20	8037-3077	NO STEP DECAL
21	8060-3039	WARNING DECAL - SWING
22	8037-3065	LARGE GRADALL DECAL

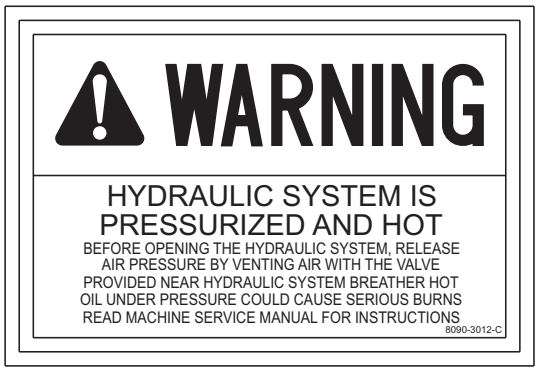
23	8037-3104	SIDE STRIPE DECAL
24	8041-3021	XL4210II DECAL
25	8037-3061	SMALL GRADALL DECAL
26	8021-3104	DIESEL FUEL DECAL
27	8036-3088	QUICK DISCONNECT DECAL - (not shown)
28	8046-3006	FUSE DECAL -(not shown)

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DECALS



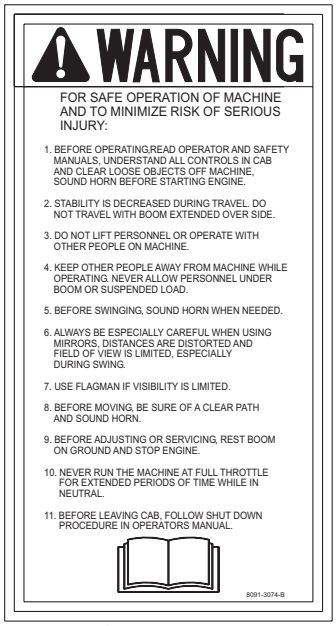
Located on tube beside pressure fill port
Part No. 9114-3288



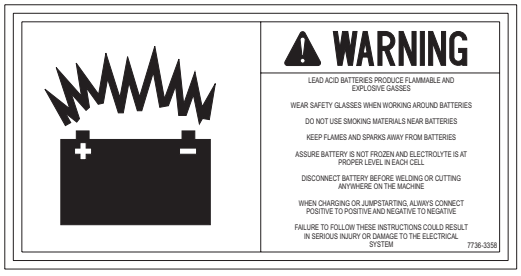
Located on inside frame by reservoir
Part No. 8090-3012



Located on reservoir by pressure fill port
Part No. 8031-3019



Located on inside cab window
Part No. 8091-3074



Located above battery in engine compartment
Part No. 7736-3358

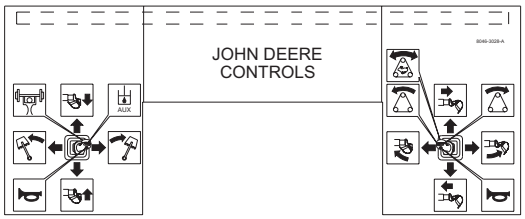


Located on side of oil cooler
Part No. 8060-3038

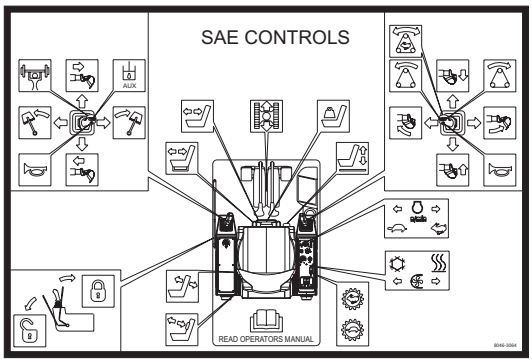
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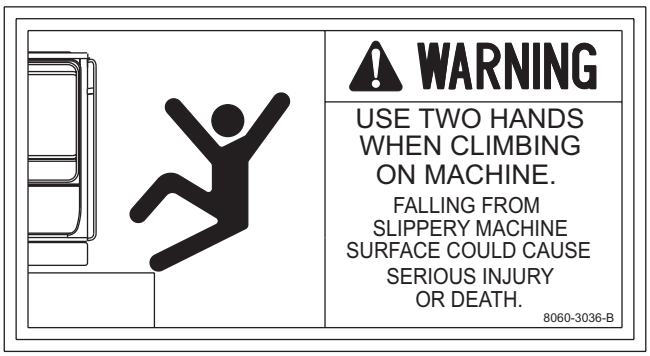
Located in manual drawer
Part No. 8046-3027



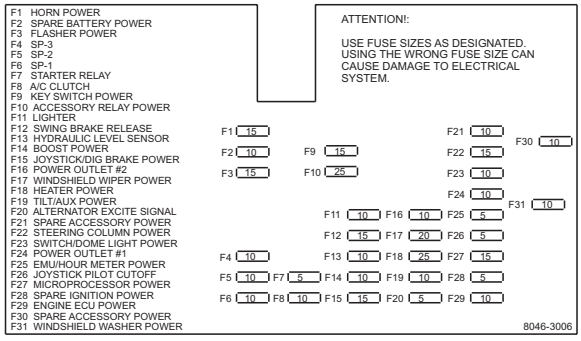
Located in manual drawer
Part No. 8046-3028



Located on inside cab window
Part No. 8046-3064



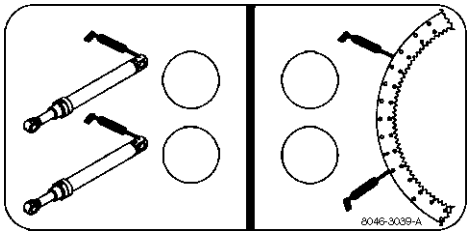
Located on seat pedestal, valve access cover
Part No. 8060-3036



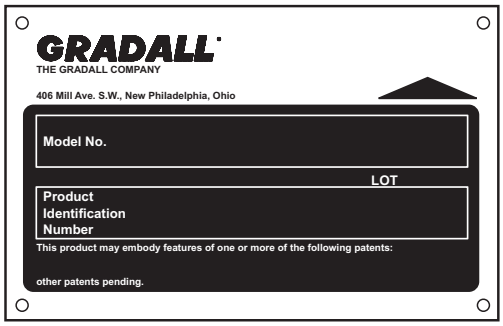
Located inside fuse cover
Part No. 8046-3006

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DECALS



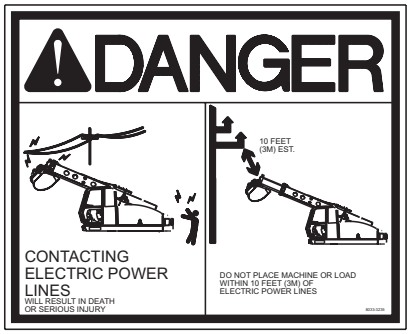
Located on front of upper frame
Part No. 8046-3039



Located on front center upper frame
Part No. 7733-3047



Located on both sides of boom
Part No. 8090-3017



Located on both sides of boom
Part No. 8033-3235

Located above front and rear cab windows
Part No. 8037-3066



Located on both sides of boom
Part No. 8060-3037



Located on top of engine cover
Part No. 8037-3077



Located on both sides of boom
and front of engine cover
Part No. 8060-3039

GRADALL

Located on engine cover
and reservoir cover
Part No. 8037-3065

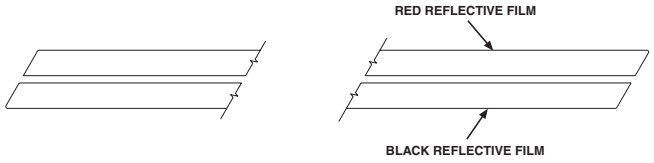
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GRADALL®

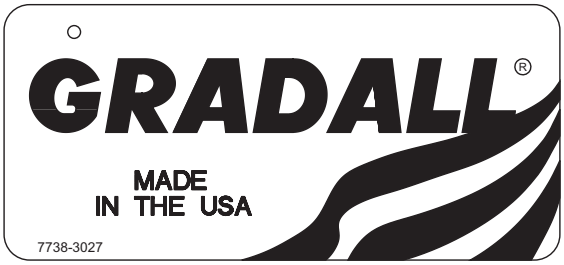
Located on front of cab
Part No. 8037-3061

MANUALS
8036-3155

Located on seat pedestal
Part No. 8036-3155



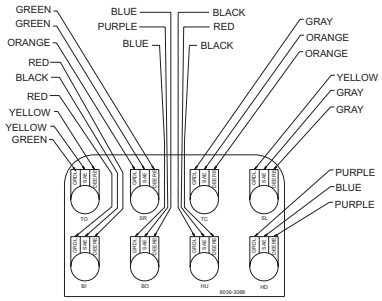
Located on both sides of upper frame
Part No. 8037-3104



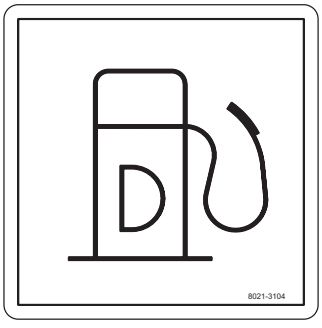
Located on seat pedestal
Part No. 7733-3027

XL4210 II

Located on both sides of upper frame
Part No. 8041-3021



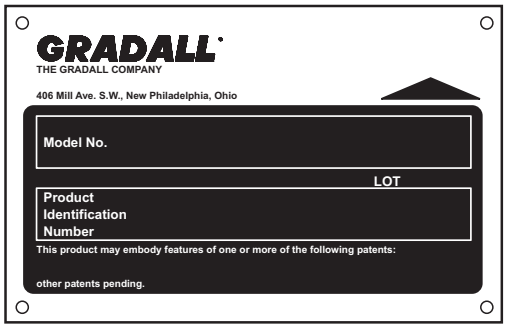
Located on bulkhead
in Pilot Valve tray
Part No. 8036-3088



Located on reservoir cover
Part No. 8021-3104

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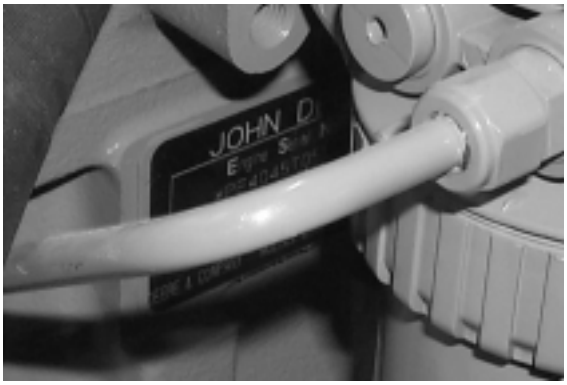
SERIAL NUMBER PLATES



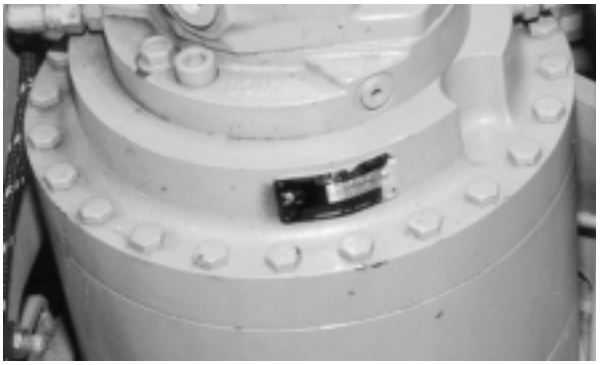
Machine Product Identification No. Plate
Located on Front Upperstructure Frame



Swing Motor
Located on Swing Transmission



Engine
Located in Engine Compartment

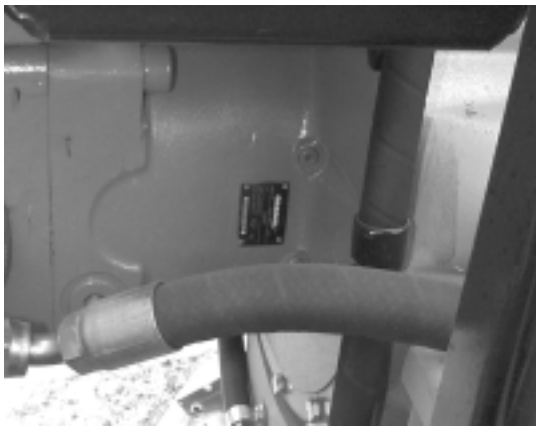


Swing Transmission
Located Beneath Boom Cradle

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Photo Not Available
At Time of Publication

Track Drive Motor
Located on Undercarriage



Hydraulic Pump
Located in Engine/Pump
Compartment



Tilt Motor
Located on
tilt transmission



Tilt Transmission
Located within boom cradle

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Heater

The cab is equipped with a heater located behind operator's seat. Rotate knob located on right arm pod clockwise for maximum heat or rotate knob counter-clockwise for no heat. The three-speed heater fan must be operated to circulate heated air.

Air Conditioner (optional)

The air conditioner is controlled by a rocker switch located on right arm pod. Air conditioner will operate only when heater/air conditioner fan switch is positioned for operation (high, medium, or low). Turn rotary heat control knob to full counter-clockwise position for maximum cooling.

Defrosting

Window defrosting can be accomplished by aiming air vents to direct air toward windows as appropriate. Maximum defrosting is accomplished by operating both heater and optional air conditioner to provide warm dry air.

Heater/Air Conditioner Fan

The heater fan is controlled by a rotary switch located on right arm pod.

Fresh air is supplied to fan thru a filtered vent in cab floor.

An air filter element is provided to clean outside air flowing to fan. Service element as indicated in the Service Manual. Operating conditions may require more frequent element cleaning or replacement.

Ventilation

In addition to heating, defrosting and optional air conditioning, the cab is equipped for varying degrees of natural ventilation.

Door and upper front window must be latched in open or closed position during operation. Lever to release door from latched-open position is located above lower door hinge.

Main (upper) front window can be latched in fully open position. Be certain window is secured firmly in position selected (including closed) using both latches. Lower front window can be removed and stored to the right of operator's seat.

Wiper/Washer

A wiper/washer is furnished as standard equipment (figure 4-1). The washer reservoir bottle is located along the frame rail. Fill as required.

Cigarette Lighter

A cigarette lighter is provided on right hand console. With lighter element removed, the receptacle can be used to power an auxiliary 12 VDC device equipped with an appropriate adapter.

⚠ WARNING

Always be certain to position boom or attachment on ground and stop engine before opening or closing door or front windows. Accidental actuation of controls could cause serious injury or death.

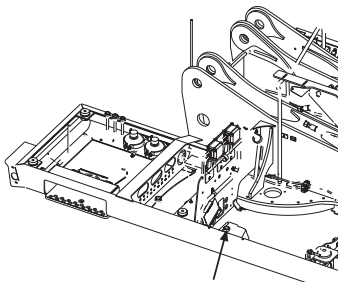


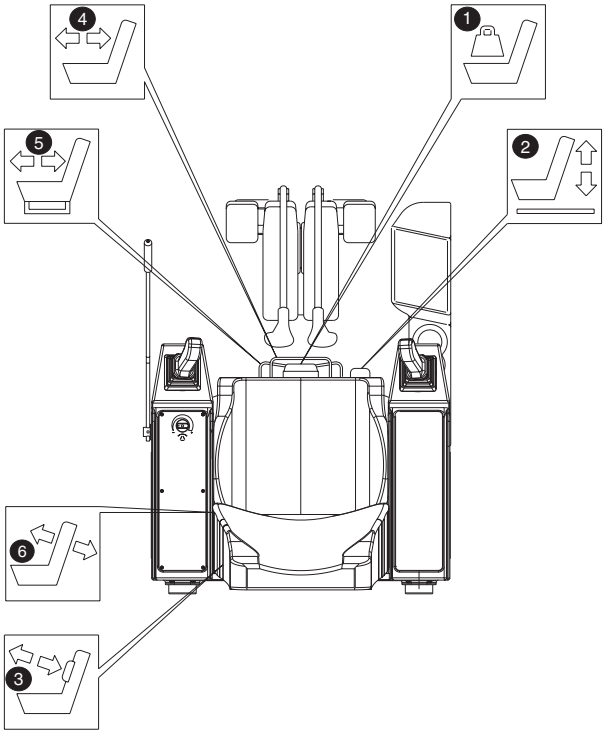
Figure 4-1

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Seat Adjustment

WARNING

Perform all seat adjustments with engine stopped. Accidental actuation of controls could cause serious injury or death.



1	WEIGHT ADJUSTMENT
2	HEIGHT ADJUSTMENT
3	LUMBAR ADJUSTMENT
4	UPPER FORE AND AFT ADJUSTMENT
5	LOWER FORE AND AFT ADJUSTMENT
6	SEAT BACK ADJUSTMENT

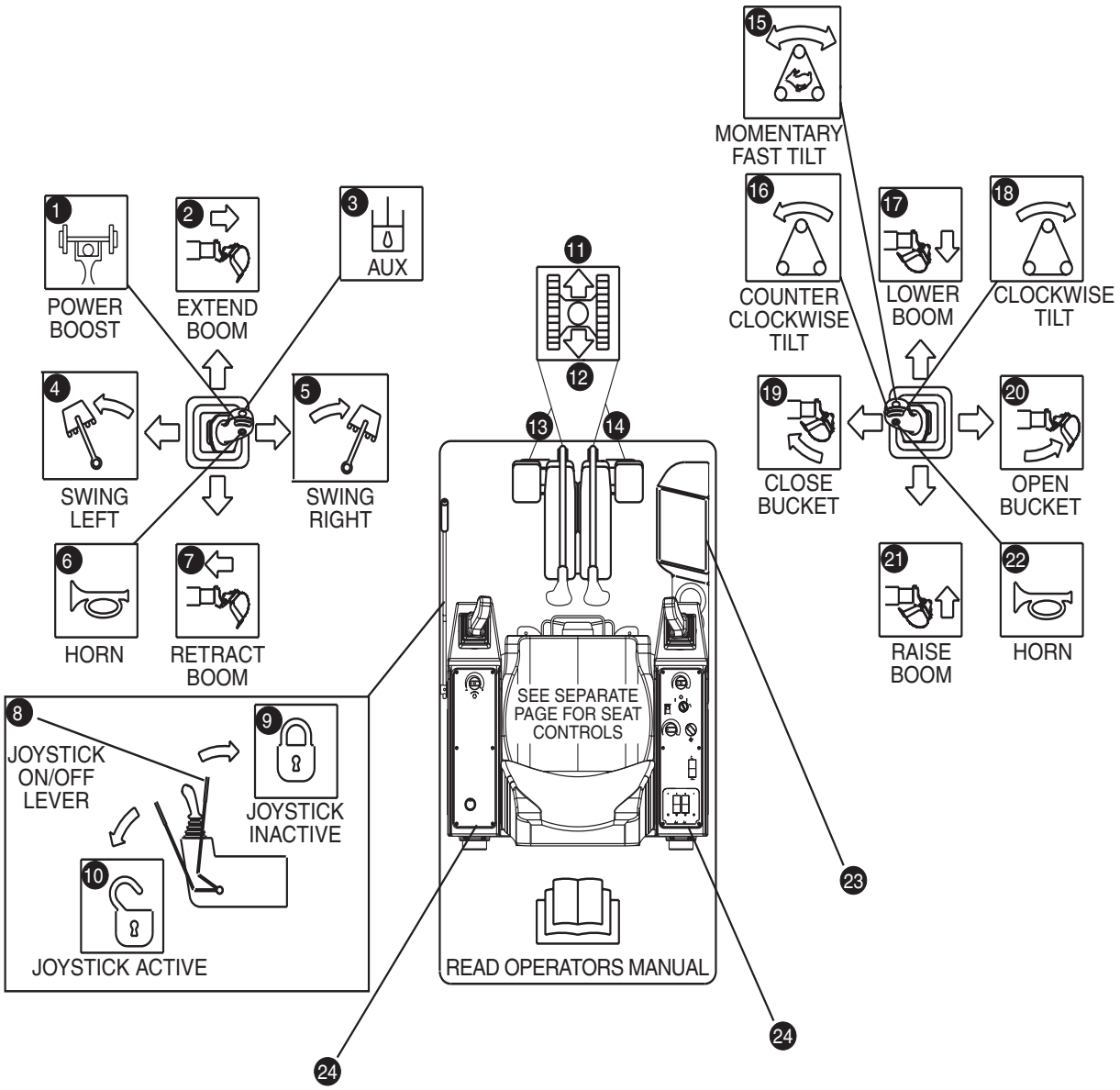
NOTE!

Pilot control lever must be in down position and engaged for joystick controls and pedals to function.

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Control & Instrument Identification

(Standard SAE Pattern shown, see page 8.2 for alternate patterns)

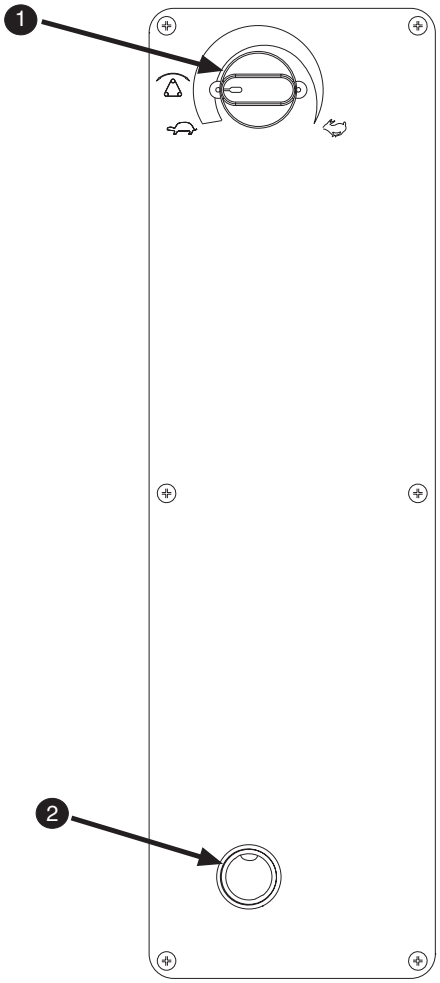


1	POWER BOOST
2	EXTEND BOOM
3	AUXILIARY HYDRAULICS FUNCTION
4	SWING LEFT
5	SWING RIGHT
6	HORN
7	RETRACT BOOM
8	JOYSTICK ON/OFF LEVER
9	JOYSTICK INACTIVE
10	JOYSTICK ACTIVE
11	FORWARD TRAVEL
12	REVERSE TRAVEL

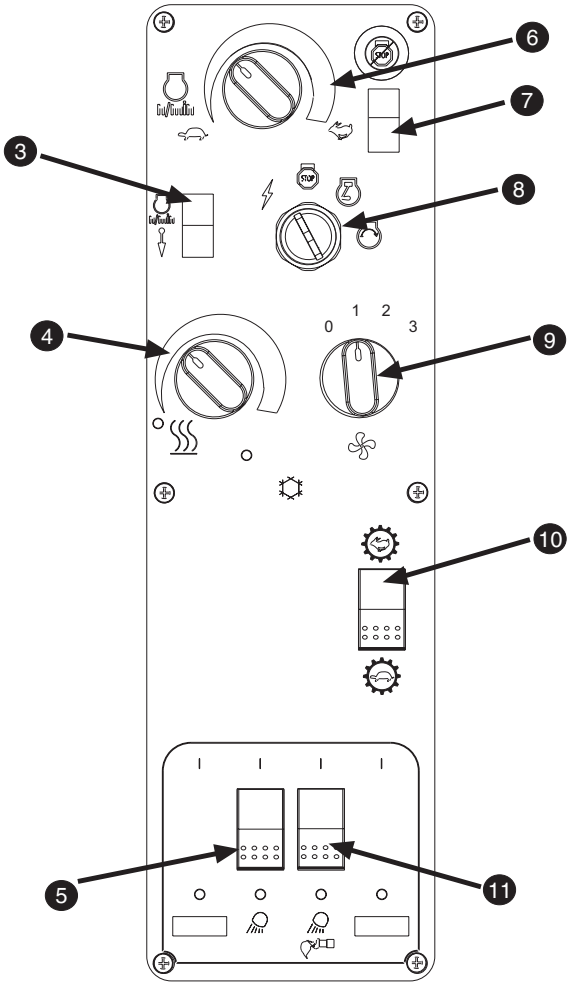
13	LEFT TRACK
14	RIGHT TRACK
15	MOMENTARY FAST TILT
16	COUNTER CLOCKWISE TILT
17	LOWER BOOM
18	CLOCKWISE TILT
19	CLOSE BUCKET
20	OPEN BUCKET
21	RAISE BOOM
22	HORN
23	SEE PAGE 4.4, ELECTRONIC MONITOR
24	SEE PAGE 4.3, ARM POD

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Control & Instrument Identification (continued)



LEFT ARM POD



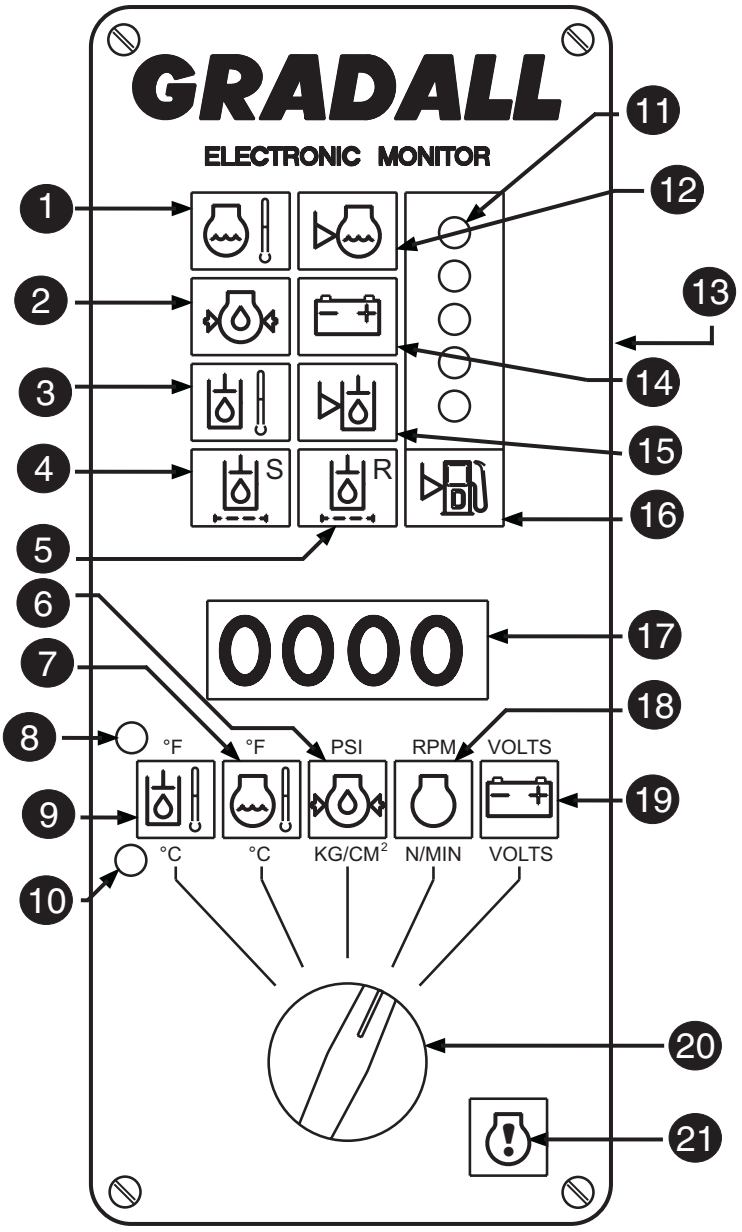
RIGHT ARM POD

1	TILT SPEED CONTROL
2	WIPER SWITCH
3	AUTO IDLE OVERRIDE SWITCH
4	TEMPERATURE CONTROL
5	WORK LIGHTS

6	ENGINE SPEED
7	ENGINE DIAGNOSTIC SWITCH
8	IGNITION SWITCH
9	FAN SPEED CONTROL
10	CRAWLER SPEED
11	BOOM LIGHTS

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Electronic Monitor



⚠ CAUTION

An electronic monitor caution signal indicates a condition which may cause serious damage to your machine. Correct cause of signal before continuing operation.

1	ENGINE COOLANT TEMPERATURE
2	ENGINE OIL PRESSURE
3	HYDRAULIC OIL TEMPERATURE
4	HYDRAULIC OIL SUCTION
5	HYDRAULIC OIL RETURN FILTER
6	ENGINE OIL PRESSURE
7	ENGINE COOLANT TEMPERATURE
8	ENGLISH UNITS INDICATOR
9	HYDRAULIC OIL TEMPERATURE
10	METRIC UNITS INDICATOR
11	FUEL LEVEL

12	ENGINE COOLANT LEVEL
13	U.S./METRIC SELECTION SWITCH (back of monitor)
14	BATTERY CHARGE
15	HYDRAULIC OIL LEVEL
16	FUEL LEVEL LOW
17	DIGITAL DISPLAY WINDOW
18	ENGINE SPEED
19	BATTERY CHARGE
20	DIGITAL DISPLAY SELECTOR SWITCH
21	ENGINE FAULT LIGHT

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Digital Display Selector Switch & Symbols (item 20): This switch permits operator to choose which operating value will be shown in digital display window: battery charge, engine speed, engine oil pressure, engine coolant temperature or hydraulic oil temperature.

Appropriate symbol will glow (green) to indicate which value has been selected.

If value displayed flashes on and off, value is outside normal operating range.

U.S./Metric Unit Indicators (item 13): The operator may choose to have engine oil pressure, engine coolant temperature and hydraulic oil temperature shown in U.S. or metric units as defined beside symbols.

Selection of units to be shown is made by a switch (not shown) located on back surface of monitor. Move switch as appropriate for U.S. units or for metric units.

U.S. or Metric mode must be selected with ignition switch in OFF position. Indicator light will glow (green) to show which mode has been selected.

CAUTION SYMBOLS & ALARM

Battery Charge (item 14): Symbol glows (red) in response to low battery charge (below 11.6 VDC)

Engine Coolant Level (item 12): Symbol glows (red) and alarm sounds if coolant level falls below acceptable operating level.

Engine Coolant Temperature (item 1): Symbol glows (red) if coolant temperature exceeds 230°F (110°C). Alarm sounds if temperature reaches 234°F (112°C).

Engine Fault Light (item 21): Symbol glows (yellow) if engine shutdown is pending or various conditions pertaining to engine problems occur.

Engine Oil Pressure (item 2): Symbol glows (red) if oil pressure falls below 10 psi (68.9 kPa). Alarm sounds if pressure remains below 10 psi (68.9 kPa) for 10 seconds or longer.

Fuel Level (item 11): These lights glow (green) to indicate approximate fuel level. For example, if all five are glowing, tank is full; if only the bottom three are glowing tank is approximately half full. With no lights glowing, tank is less than 10% full.

Fuel Level Low (item 16): Symbol glows (red) if fuel level falls below 15% full.

Hydraulic Oil Level (item 15): Symbol glows (red) and alarm sounds if oil level falls below acceptable operating level.

Hydraulic Oil Return Filter (item 5): Symbol glows (yellow) in response to excessive resistance to flow. Cold oil can cause symbol to glow. Refer to Warm-Up & Operational Checks for details.

Hydraulic Oil Suction (item 4): Symbol glows (yellow) and alarm sounds in response to a few conditions. Refer to Warm-Up & Operational Checks for details. Alarm not active until 2.5 minutes after start.

Hydraulic Oil Temperature (item 3): Symbol glows (yellow) in response to excessive hydraulic temperature (200°F/93°C).

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CHECKS & SERVICES BEFORE STARTING ENGINE
(To be performed at beginning of each work shift.)

Do not step or stand on engine cover.

Before removing filler caps or fill plugs, wipe all dirt and grease away from the ports. If dirt is allowed to enter these ports, it can shorten the life of major hydraulic components along with o-rings, seals, packing and bearings.

When adding fluids or lubricants, refer to lubrication section of this manual to determine proper type, specification and grade to be used.

If spark arrestors are required, be sure they are in place and in good working order.

Inspect unit for obvious damage, vandalism and needed maintenance (figure 5-1). Check for signs of fuel, lubricant, coolant and hydraulic leaks. Open all access doors and look for loose fittings, clamps, components and attaching hardware. Replace hydraulic lines that are cracked, brittle, cut or show signs of abrasion. Also look for signs of tampering.



Figure 5-1



Figure 5-2

Check to be sure **windows, lights and mirrors are clean** and **undamaged (figure 5-2).** Also be certain **mirrors are properly adjusted** for operator's position.

Service the unit in accordance with the lubrication and maintenance diagram and schedule (figure 5-3).

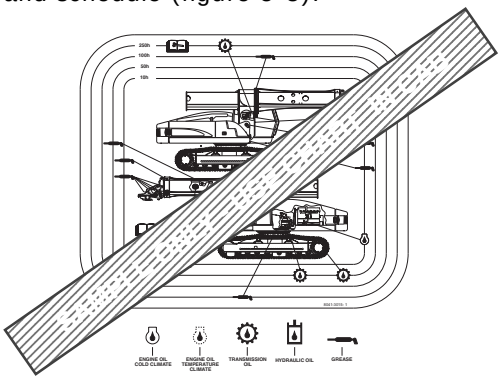


Figure 5-3



Figure 5-4

Check hydraulic fluid level in reservoir with boom extended half way and bottom of bucket flat on ground (figure 5-4). Refill reservoir as necessary using proper fluid.

NOTE!
Complete required maintenance before operating machine.

⚠ WARNING

Use extreme caution when checking items beyond your normal reach. Use an approved safety ladder.

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Check fuel level symbol on electronic monitor and replenish as necessary. Refuel at the end of work shift to minimize condensation. Over tightening cap on plastic tank will cause difficulty in removal **Do not over tighten (see figure 5-5).**



Figure 5-5

WARNING

Always stop engine when refueling. Be sure area is free of open flame, sparks or any condition which could cause fuel or fuel vapor to ignite.

Check engine coolant level symbol on electronic monitor and replenish as necessary (figure 5-6). **Be sure antifreeze solution is adequate** (50/50 mixture of water and antifreeze plus 1oz of conditioner per liter of coolant) for expected temperatures. **Be sure radiator and oil cooler fins are clean.** Oil cooler is hinged to facilitate cleaning.



Figure 5-6

WARNING

If it becomes necessary to replenish coolant in a hot radiator, stop engine and relieve pressure before removing the radiator cap. Relieve pressure by holding cap with heavy rags and turning cap slowly counterclockwise until sound of escaping pressure is heard. Wait a few minutes until sound of escaping pressure stops. Then remove cap cautiously.

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Starting John Deere Engine

Note: If engine and hydraulic systems are cold perform all steps in the following procedure. If engine and hydraulic systems are warm, warm-up steps may be eliminated.

Insert ignition key and turn clockwise to RUN position while observing electronic monitor.

All monitor symbols should glow briefly and alarm should sound momentarily as a bulb check.

If any symbol continues to glow, correct cause before starting engine.

Sound horn as a warning before starting engine.

Turn ignition switch key clockwise to START position to engage starter motor. Release key immediately when engine starts. If engine fails to start within 30 seconds, release key and allow starter motor to cool before trying again.

After engine starts, reduce speed to low idle and observe **engine oil pressure** caution symbol on electronic monitor. If symbol continues to glow for more than fifteen seconds, stop engine and determine cause of low oil pressure. Correct cause of malfunction before restarting engine.

To assure **proper lubrication,** operate engine at or below 1200 rpm with no load for 1-2 minutes. Extend this period 2-4 minutes when temperatures are below freezing.

Observe **battery charge** caution symbol. Symbol should go out to indicate that charging system is functioning properly.

Observe **hydraulic oil suction** caution symbol. Symbol may go out in a few seconds to indicate hydraulic reservoir is pressurized. Cold hydraulic oil may cause suction symbol to continue to glow and alarm to sound.

Adjust engine speed to approximately 1500 RPM and perform warm up and operational checks shown on page 5.4.

Cold Weather Starting Aids

It must remain the **responsibility of the owner** to determine proper use of starting aid with regard to engine and starting aid manufacturer's instructions.

NOTE!

When starting engine at the beginning of work shift, be sure to perform all "CHECKS AND SERVICES BEFORE STARTING ENGINE".

⚠ CAUTION

Turning ignition switch to START position while engine flywheel is rotating may cause serious damage to engine and/or starting motor.

⚠ CAUTION

Improper use of a starting aid may cause severe engine damage. Be sure you understand how to use your starting aid, pay particular attention to manufacturer's warnings.

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Normal Engine Operation

Engine Oil Pressure:
Low Idle (950 RPM) - 15 psi (105 kPa)
Max RPM (2400 RPM) - 50 psi (345 kPa)

Engine Operating Temperature:
John Deere - 180°F. to 202°F. (82° to 94°C)

Battery charge indication of alternator output: Approximately 14 volts with engine running at 2000 RPM.

Be alert for unusual noises or vibration. When an unusual condition is noticed, stop machine in a safe position and shut off engine. Determine cause and correct problem before continuing.

Avoid prolonged idling. If the engine is not being used, turn it off.

NOTE!

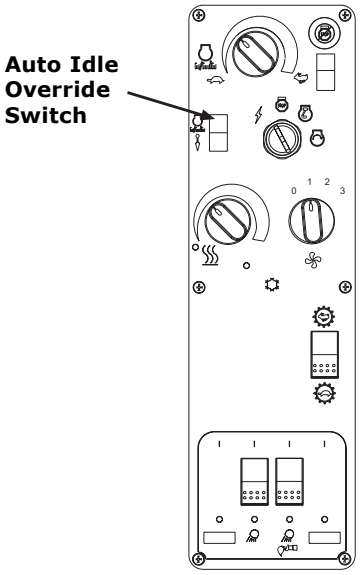
Observe electronic monitor frequently to be sure all engine systems are functioning properly.

CAUTION

Always keep engine covers closed while engine is running.

Auto Idle Override Switch (fuel saving)

- With switch in off position, engine speed will remain as set by operator.
- With switch in on position, engine speed will return to low idle (depending on hydraulic system conditions) after 7 seconds of inactivity. Once hydraulic controls are activated, the engine resumes speed setting.



RIGHT ARM POD

Stopping the Engine

- To stop engine, perform shut-down procedure shown below.
- Operate engine at idle speed for 3 to 5 minutes before turning it off. This allows engine coolant and lubricating oil to carry excessive heat away from critical engine areas. Without a reasonable cooling period, turbocharger can be seriously damaged.
- Do not “gun” engine before shut down.

Shut-Down Procedure

Park the Excavator in a safe location away from other equipment and/or traffic lanes. Park on flat, level ground.

1. Remove feet from foot pedals.
2. Position boom/bucket on ground.
3. Position joystick on/off lever to inactive position as shown on page 4.2.
4. Shut off engine and remove ignition key.
5. Exit excavator properly.

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WARM UP & OPERATIONAL CHECKS (To be performed at beginning of each work shift)

The safety, efficiency and service life of your excavator can be increased by performing the following operational checks while the engine and hydraulic oil are warming to operating temperature.

1. Observe electronic monitor digital display for appropriate values while switching to each position. Leave switch positioned for hydraulic oil temperature display.

2. Observe hydraulic oil suction caution symbol. If symbol continues to glow after two minutes of engine operation, perform the following procedure:

   a. Increase engine speed to approximately half throttle.

   b. Slowly raise and extend boom fully.

   c. Retract and lower boom fully and return engine speed to low idle. These boom movements should have created sufficient positive pressure in reservoir to cause suction filter light to go out.

NOTE: Step 3 requires that hydraulic oil be at least 60° F (15.6° C.). If necessary, increase engine speed to full throttle and **stall boom extend function** to speed warming of hydraulic system.

3. Observe **hydraulic oil return** caution symbol. If symbol is still glowing, observe hydraulic oil temperature value on digital display. Normally, symbol light will not glow when hydraulic oil reaches approximately 60° F. (15.6° C.).

4. Check operation of all **excavator functions** in both directions.

5. Check operation of **travel functions** in both directions and be certain that **travel alarm sounds** when traveling. Travel alarm and horn must be audible from inside operators cab with engine running.

6. Stop engine and **service all items** which could not be serviced with machine in original position.

NOTE!

Complete required maintenance before operating machine.

NOTE!

A small residual flow from the pump flushes thru the main valve until there is a demand *from any circuit. With hydraulic oil temperature within operating range, and all functions at rest,* ***it is unlikely that return filter indicator light will glow even if the filter is clogged.***

However, if this symbol flashes on and off during operation of these circuits, it can be assumed that return filter element is clogged and must be replaced.

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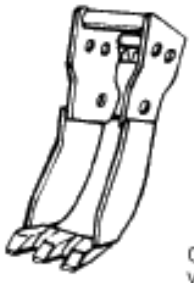
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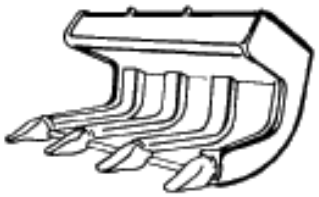
ATTACHMENTS



	Cu. yd.	m3
8045-6020 24" (610 mm) Excavating bucket	3/8	.31
8045-6021 30" (762 mm) Excavating bucket	1/2	.41
8045-6022 36" (914 mm) Excavating bucket	5/8	.54
8045-6023 42" (1.07 m) Excavating bucket	3/4	.64
8045-6024 48" (1.22 m) Excavating bucket	1	.76



	Cu. yd.	m3
8065-6104 15" (381 mm) Trenching bucket	1/5	.15
8065-6012 21" (533 mm) Trenching bucket	1/4	.19



8065-6102 40" (1.02 m) Pavement removal bucket



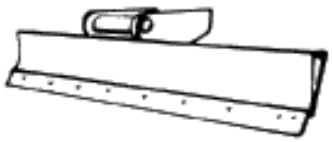
	Cu. yd.	m3
8065-6007 60" (1.52 m) Ditching bucket	7/8	.73
8065-6006 66" (1.68 m) Ditching bucket	1	.76
8065-6002 72" (1.83 m) Ditching bucket	1 1/8	.87



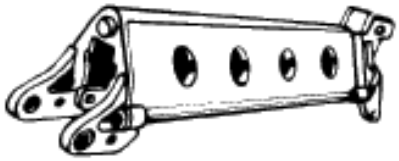
	Cu. yd.	m3
8065-6013 72" (1.83 m) Dredging bucket	1 1/8	.87



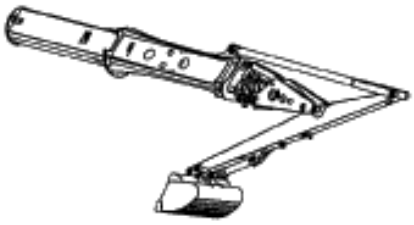
8065-6009 Single-tooth ripper



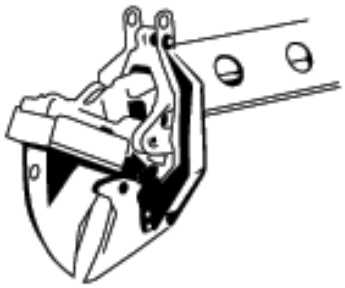
8065-6024 8' (2.4 m) Grading blade



8045-5002 4' (1.2 m) Boom extension
8045-5003 6' (1.8 m) Boom extension
8045-5004 8' (2.4 m) Boom extension
8045-5005 12' (3.7 m) Tubular Boom extension



8045-5007 Telestick attachment



8045-5008 Tree Limb Shear Attachment

NOTE!

Capacities shown are in heaped cu. yd.

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ADAPTER ATTACHMENT INSTALLATION



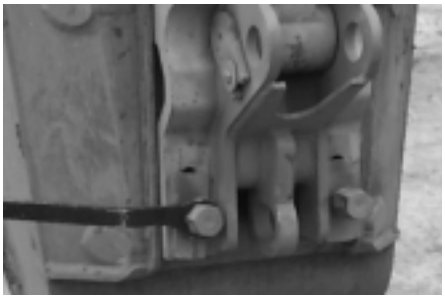
1. Be sure wedge bolts are secured in storage position (toward rear) and position bucket adapter above bucket bar as shown.



2. Lower boom until concave section of adapter contacts bucket bar.



3. Move adapter toward “bucket close” position until outer end of adapter contacts bucket. Ensure proper alignment and continue to close until adapter contact stops.



4. Move wedge bolts forward and position wedge between adapter and bucket bar. Be certain wedge surfaces are flush between adapter and bar and tighten fully. Jog tool control a few times and retighten. Check often to be sure bolts remain tight.



5. Position bucket linkage as desired.

⚠ CAUTION

Digging with a loose or improperly fitted bucket may cause excessive wear, shear adapter bolts or cause loss of bucket.

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Use your crawler properly

Travel in forward direction whenever possible (with track drive motors at rear). Traveling in reverse increases wear on sprockets and rollers.

Plan your work to equalize left and right turns. Constantly turning in one direction will cause track components to wear unevenly.

Apply power to both tracks when turning. When power is applied to only one track it becomes necessary for the driving track to overcome the drag of the other track.

Hard digging in one spot can cause as much track wear as frequent moves. Do not neglect service to tracks and sprockets because of infrequent moves.

Rough operation and operation on uneven ground can cause unnecessary wear and damage to track components. Reasonable operation and regular maintenance will extend track life significantly.

Mud, frozen mud and debris can prevent rollers from turning and cause flat spots. Clean track components as often as necessary.

Never park crawler units on a steep incline or on the side of a hill. This can distort roller seals and cause a loss of lubricant which could ruin the rollers.

Always raise boom to horizontal position when traveling to permit view of right hand mirror.

Always install the boom tie down chain (Fig. 8-1) for long travel, transport and loading or unloading unit.

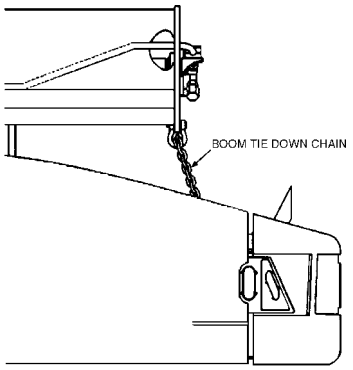


Fig. 8-1

Crawler Controls

TRACK DRIVE PEDALS/LEVERS: Track drive pedals/levers permit independent control of each track and its brake(Fig. 8-2). Brake is released when pedal or lever is actuated and applied when pedal or lever is released. Use of controls is illustrated on next page.

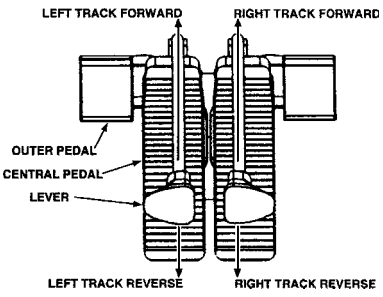


Fig. 8-2

SPEED CONTROL: Your crawler is equipped with a rocker switch to select crawler speed range (Fig. 8-3).

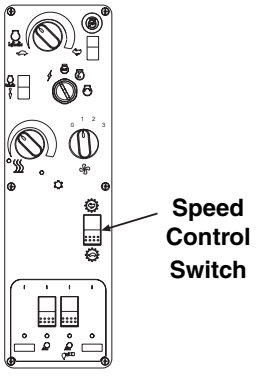
HIGH SPEED: Depress front portion of rocker switch. This is an automatic speed control. High will shift to low as terrain and turning requires, then return to high automatically.

LOW SPEED: Depress rear portion of rocker switch for maximum tractive effort and maneuverability in tight quarters. **Use low speed when loading or unloading machine.**

Speed changes can be made while traveling or when stopped. Engine speed will also adjust travel speed.

NOTE!

Lever, central pedal and outer pedal move as one for either track.



Speed control switch is located on right arm pod.

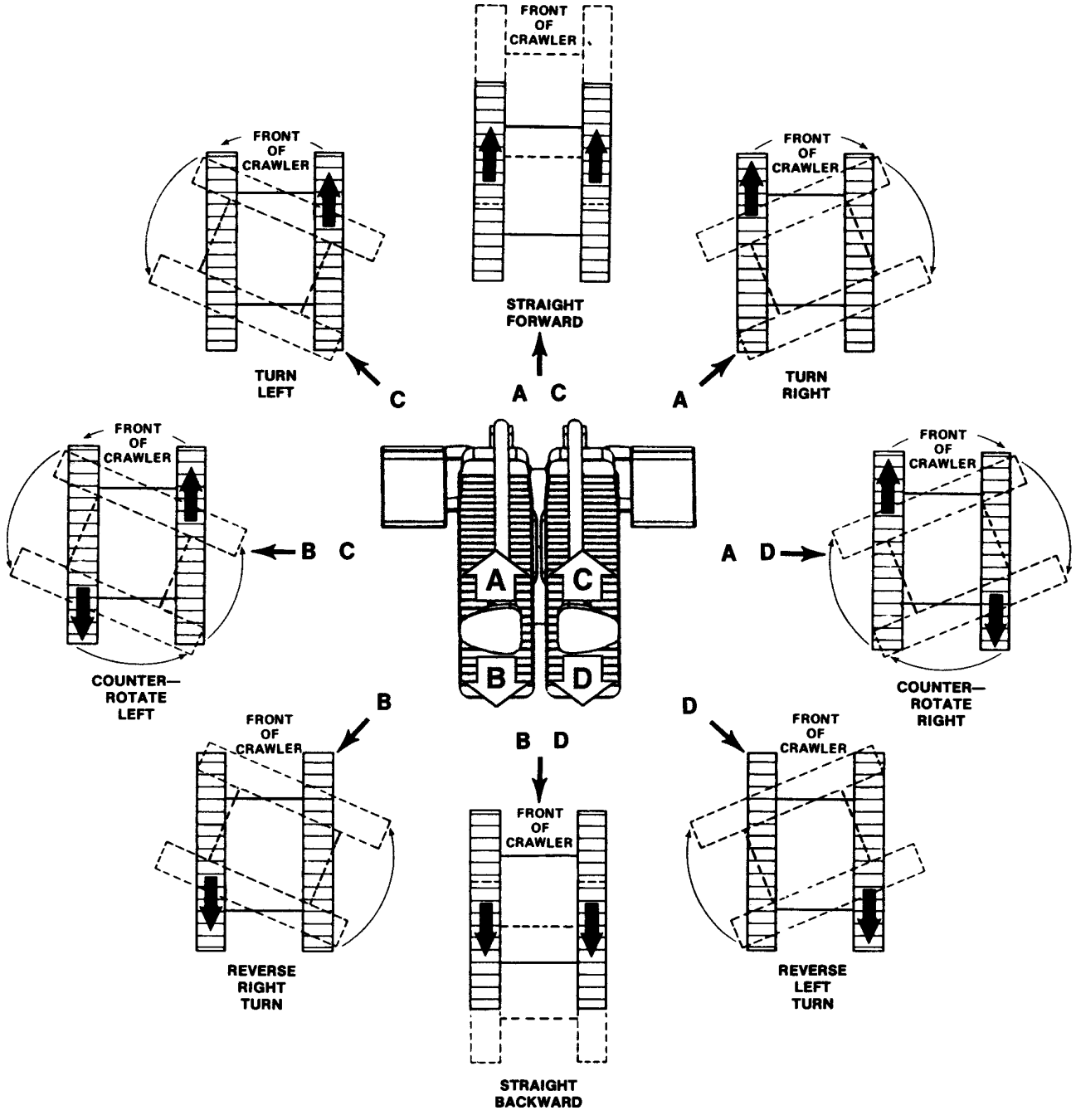
Fig. 8-3

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Practice with travel controls in a safe, open area.

WARNING

Avoid confusion! Before actuating track drive pedals, think about the direction you are facing with respect to the direction the crawler is facing. (Drive sprockets are at rear of crawler). Confusion could cause you to travel in the direction opposite of that which is expected.



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CHANGING CONTROL PATTERNS

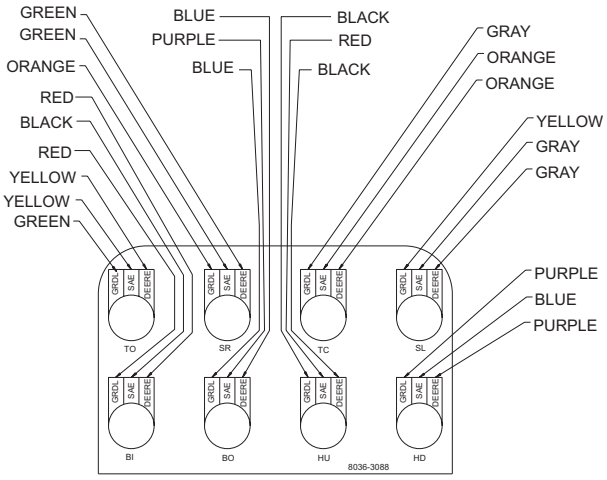


Figure 10-1.

This excavator, unless specified differently, is assembled and shipped with the operating controls in the standard SAE control configuration. The controls can be very easily changed to GRADALL or JOHN DEERE patterns. Located under the valve cover is a bulkhead with a decal **(figure 10-1)** showing different positions for the pilot control lines. There are eight pilot lines that are individually coded by different color bands with a quick-disconnect fitting on the end of each hose. There are eight different positions (two rows) on the bulkhead. In order to change the control pattern, **TURN OFF ENGINE, REMOVE KEY,** and select the desired pattern (SAE, GRDL, DEERE). To complete the change, the hoses are disconnected and positioned such that the hose band color is matched with the color corresponding to the desired control pattern color. For example, to change the "tool open" function from SAE to Gradall (GRDL), the yellow pilot hose would be removed from the bulkhead and moved to the position that currently has the gray pilot hose. **Note that the hose colors and the pattern identifying colors must match for all control configurations.** In all cases, hoses in the top row always stay in the top row, while hoses in the bottom row will always stay on the bottom. After changing the control pattern in the valve compartment, ALWAYS change the operating decal in the operator's cab. CAREFULLY check the pattern change before the start of any machine operation to make certain all controls are functioning as expected.

Control Patterns

SAE CONTROL PATTERN (permanent decal)

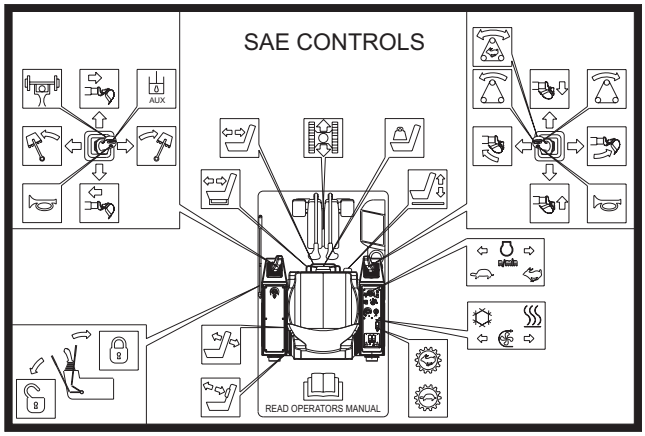


Figure 10-2.

WARNING

Always change cab control decal when changing control pattern. Alternate pattern decals are located in drawer under seat.

WARNING

Test your controls before operating. If controls have been modified to another pattern, be sure you are familiar with functions and ensure that diagram in cab shows actual pattern. Alternate patterns are located under seat. If you do not have the proper control pattern decal, do not change the control pattern.

NOTE!

SAE, Gradall, and John Deere controls relate only to boom, swing, and bucket (tool) functions. ***Do not alter other control operations.***

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Control Patterns

GRADALL CONTROL PATTERN
Overlay
(to be placed over permanent decal)



Figure 10-3.

JOHN DEERE CONTROL PATTERN
Overlay
(to be placed over permanent decal)

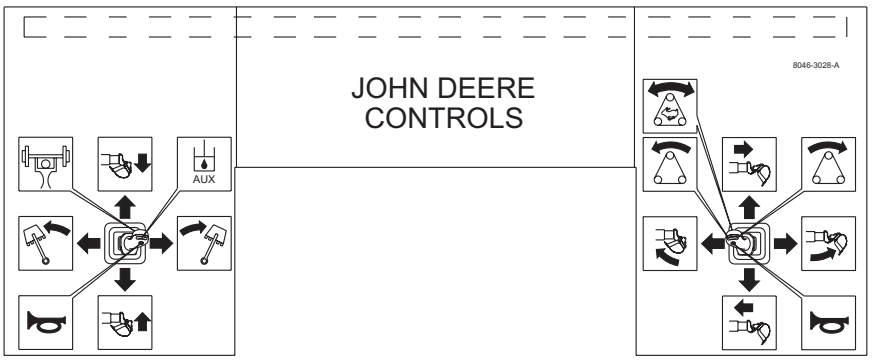


Figure 10-4.

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Prepare for Digging

1. Position unit for efficient digging cycle and check for appropriate clearances.

2. Stop engine and secure door and windows in desired position for ventilation. Remove boom tie down chain from boom.

3. Warm up engine and hydraulic oil and then set engine to full throttle position.

4. Be certain pilot control lever is in down position to energize joysticks and pedals.

Joystick Controls and digging cycle shown with standard SAE pattern

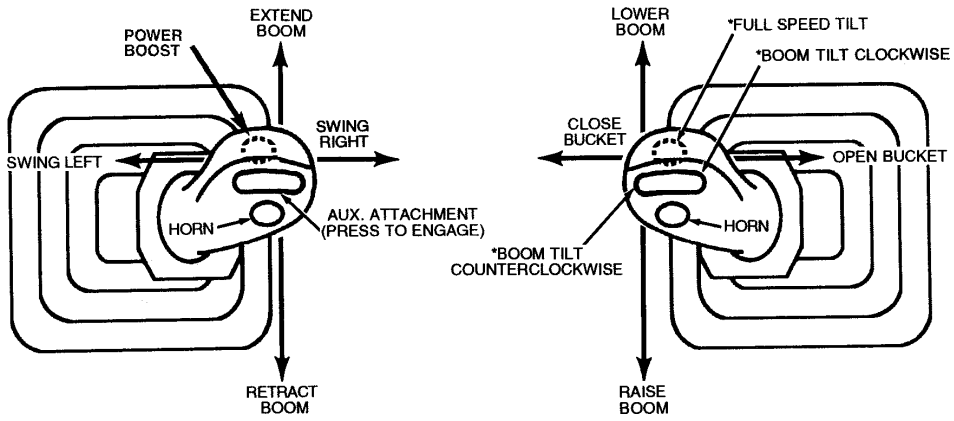


Figure 10-5

* If tilt speed has been reduced for conditions speed can be temporarily increased to maximum by depressing FULL SPEED TILT button.

CAUTION

While digging, pay close attention to the degree of boom angle in relation to machine position. In certain instances it is possible for the boom to come into contact with the undercarriage.

WARNING

Test your controls before operating. The control pattern shown in figure 10-5 is the standard SAE pattern. If controls have been modified to another pattern, be sure you are familiar with functions and ensure that diagram in cab shows actual pattern. Alternate patterns are located under the seat. If you do not have the proper control pattern decal, do not change the control pattern.

NOTE!

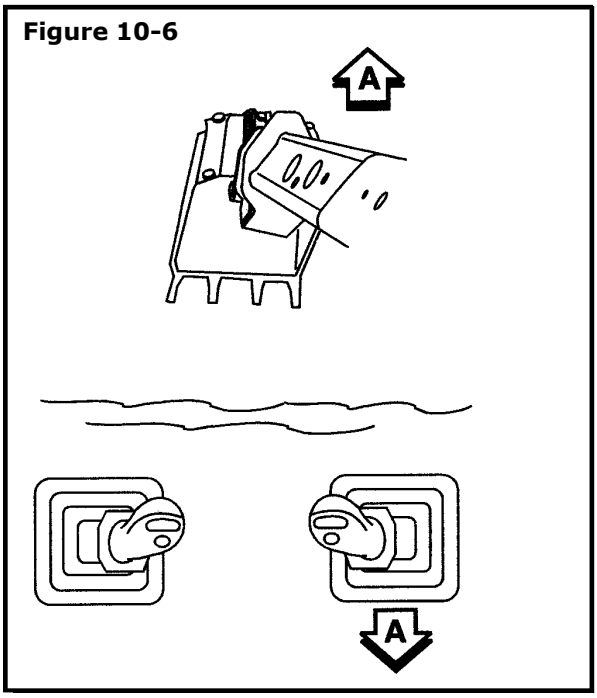
Practice with controls in a safe, open area.

Joysticks & pedals return to neutral position when released.

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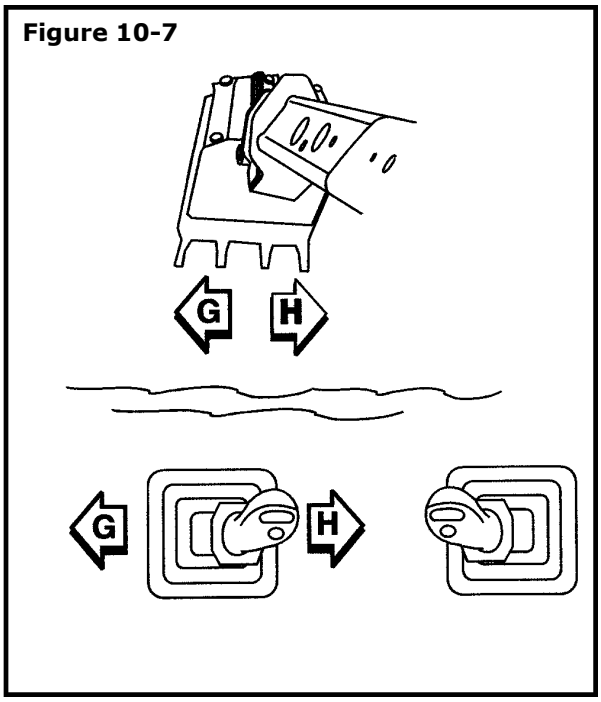
SAE DIGGING CYCLE

Figure 10-6



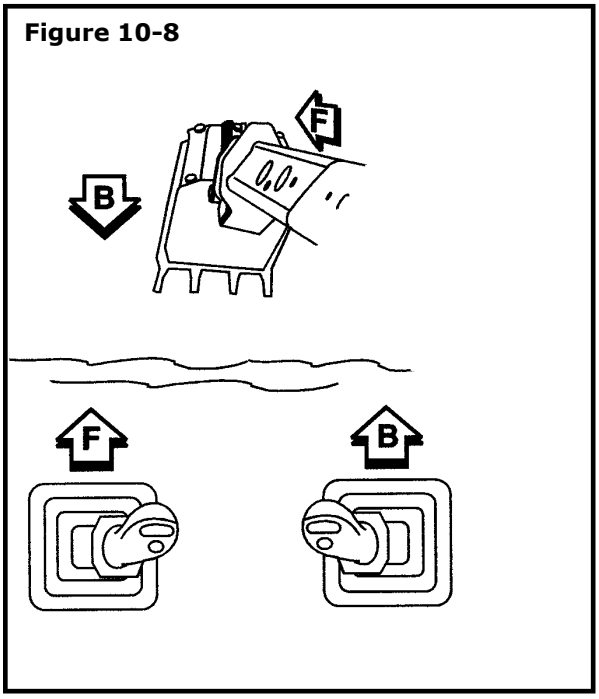
5. Pull back on right joystick **(A)** to raise boom far enough to clear all obstructions. **See Figure 10-6.**

Figure 10-7



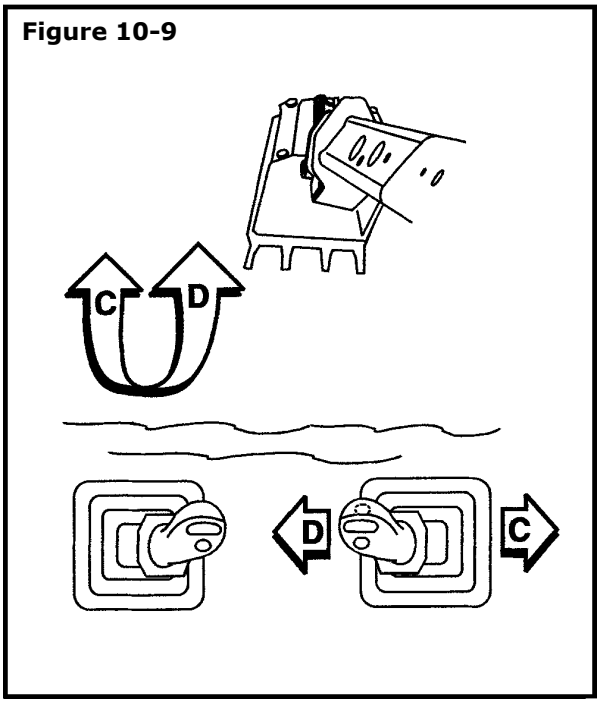
6. Move left joystick to left **(G)** to swing left or to right **(H)** to swing right to digging site. **See Figure 10-7.**

Figure 10-8



7. While pushing left joystick forward **(F)** to extend boom, push right joystick forward **(B)** to lower boom into position for start of cut. **See Figure 10-8.**

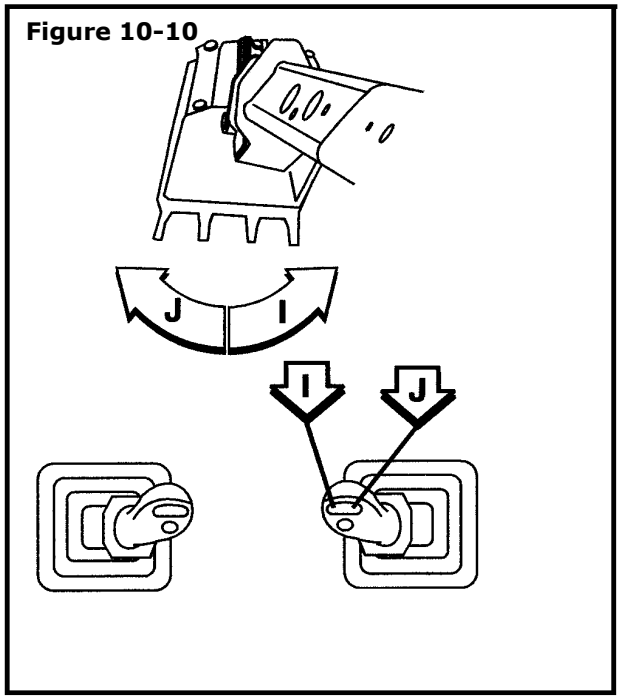
Figure 10-9



8. Move right joystick to right **(C)** to open bucket or to left **(D)** to close bucket for correct penetration. Teeth should angle downward slightly (about 5 degrees). Angle may be greater for soft digging. **See Figure 10-9.**

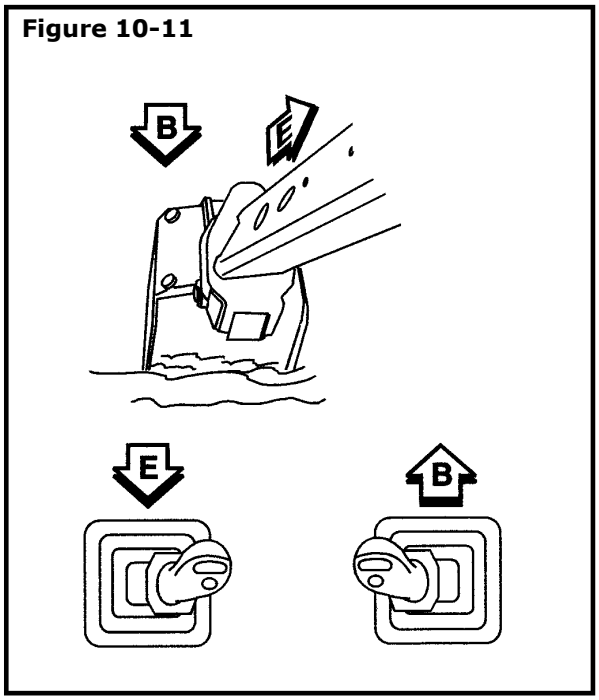
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Figure 10-10



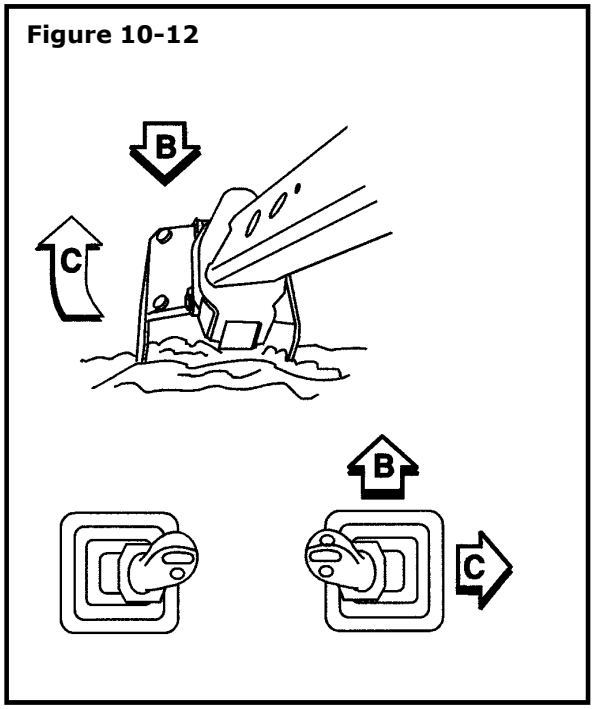
9. If required, press left side of tilt switch **(I)** to tilt counterclockwise or right side of switch **(J)** to tilt clockwise. If necessary, use full speed tilt button to return to full speed tilt. **See Figure 10-10.**

Figure 10-11



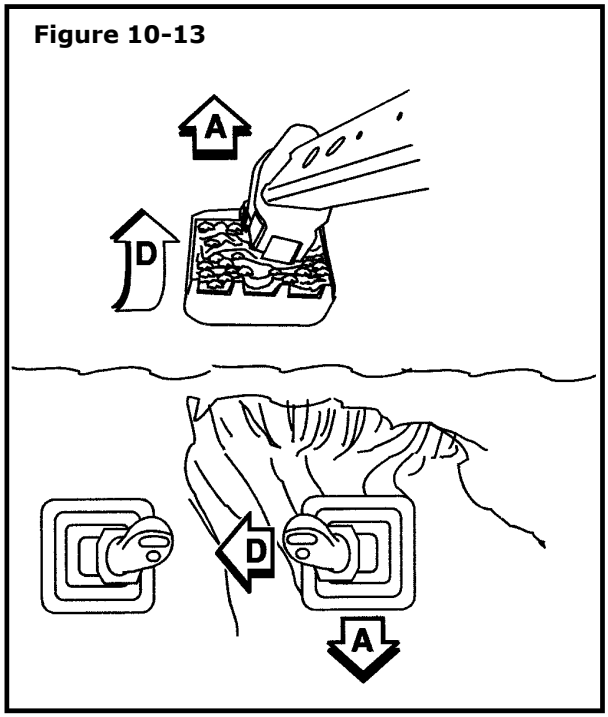
10. While pushing forward on right joystick **(B)** to lower boom and force bucket into ground, pull back on left joystick **(E)** to retract boom and fill bucket. **See Figure 10-11.**

Figure 10-12



11. As bucket is filling, jog right joystick forward **(B)** to lower boom and maintain depth of cut. At same time jog right joystick to right **(C)** to open bucket and maintain proper bucket angle. **See Figure 10-12.**

Figure 10-13



12. When bucket is full, or when boom is fully retracted, move right joystick to left **(D)** to close bucket. At same time pull right joystick back **(A)** to raise boom far enough to clear obstructions. **See Figure 10-13.**

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SAE DIGGING CYCLE

Figure 10-14

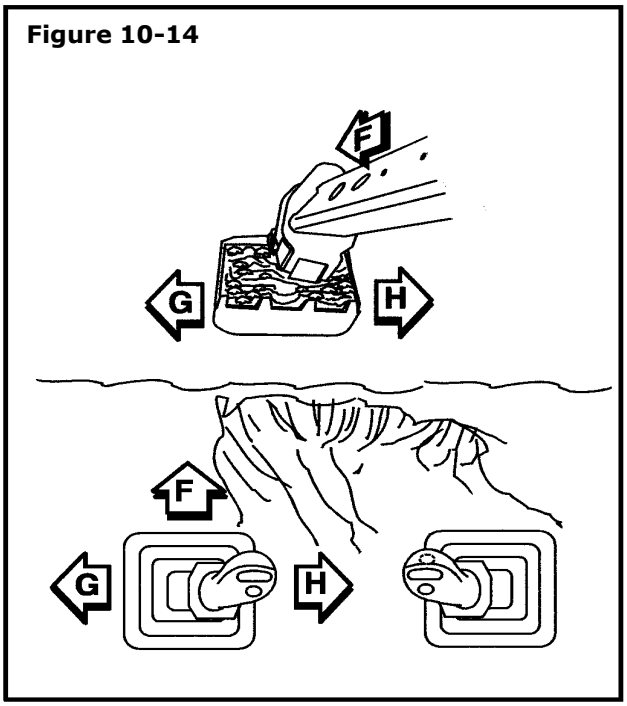
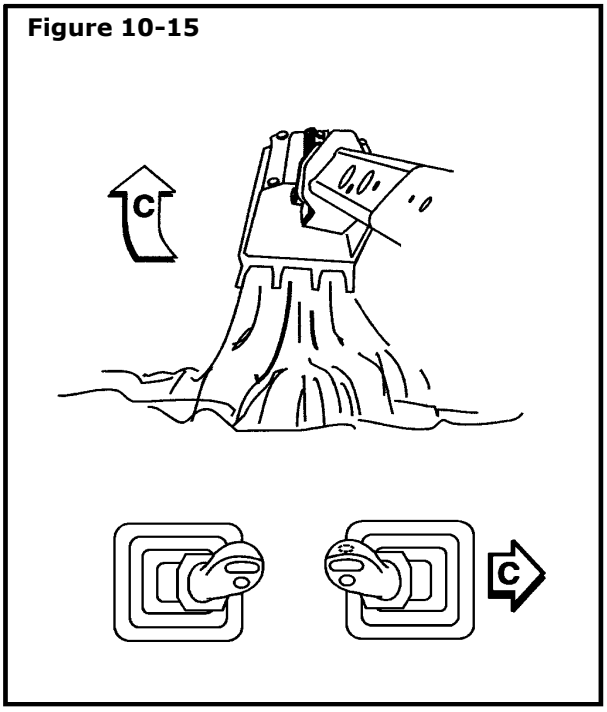


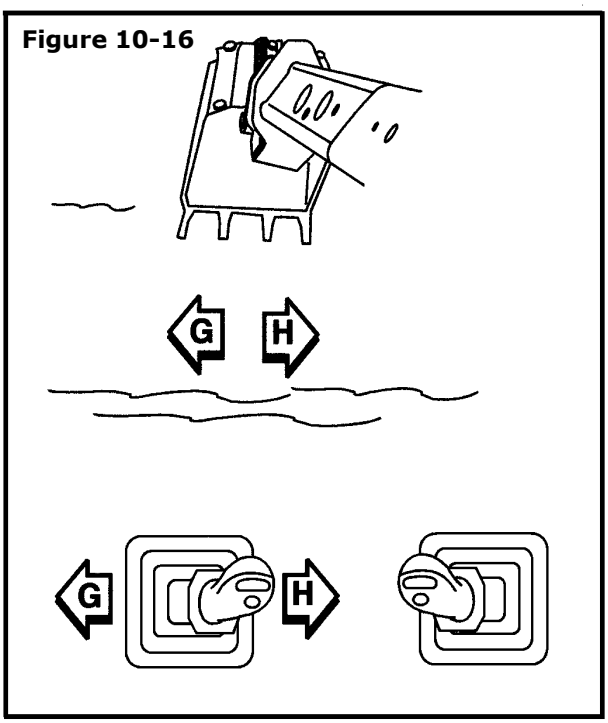
Figure 10-15



13. Move left joystick to right **(H)** to swing right or to left **(G)** to swing left to dump site. If necessary, extend boom by pushing left joystick forward **(F)**. **See Figure 10-14.**

14. Move right joystick to right (C) to open bucket and dump load. **See Figure 10-15.**

Figure 10-16



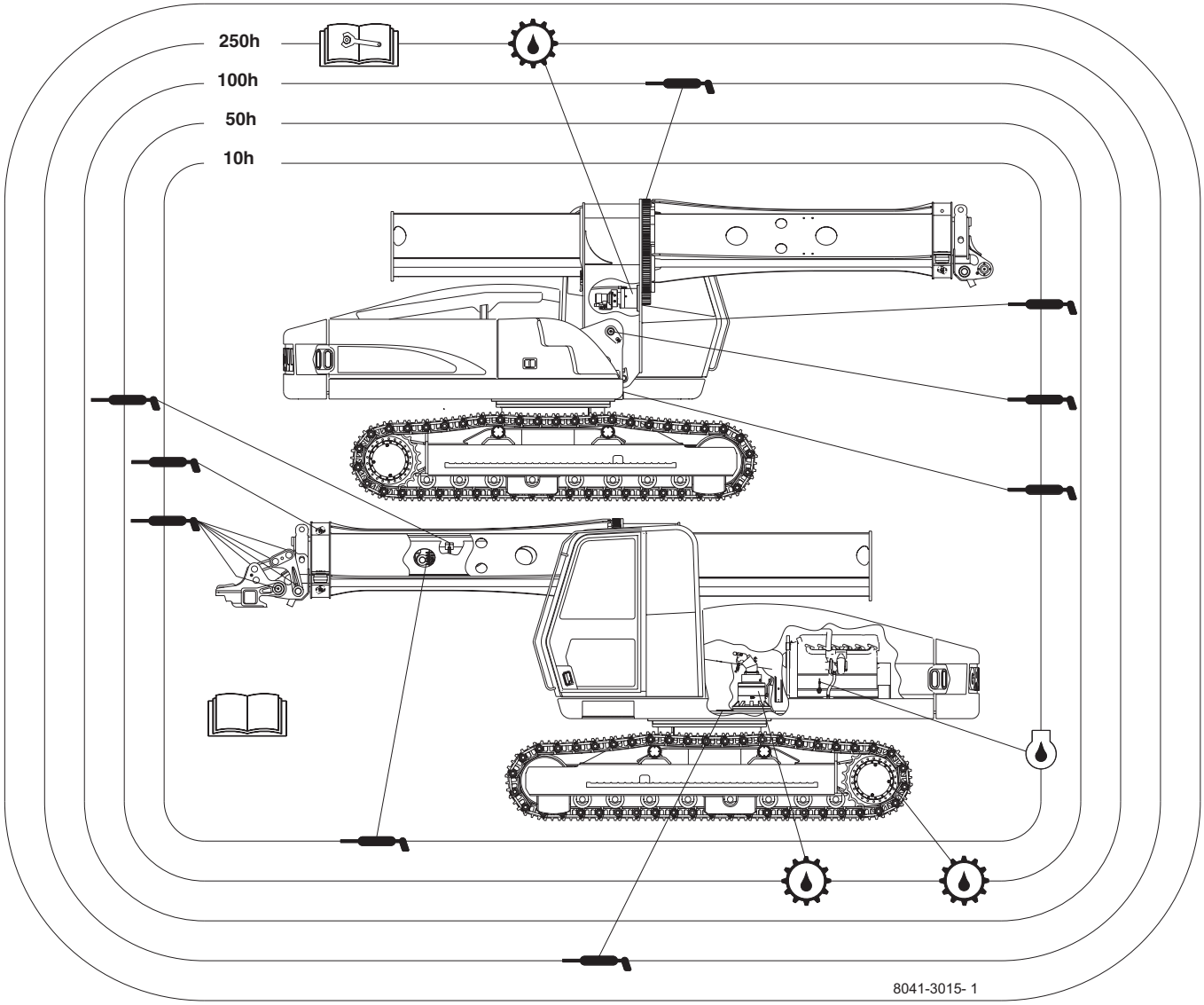
15. Move left joystick to left **(G)** or right **(H)** to align boom for next cut. Repeat steps 7 thru 15. **See Figure 10-16.**

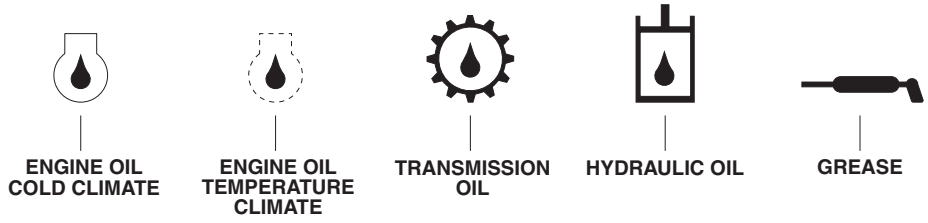
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MAINTENANCE AND LUBRICATION DIAGRAM





See service manual for additional lubrication and maintenance information.

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RECOMMENDED LUBRICANTS & CAPACITIES

Lubrication chart

XL 4210 II			SPECIFICATIONS		CAPACITIES*	
APPLICATION	**SYMBOL**	**GRADE****	**GENERAL**	**ISO**	**ENGLISH**	**LITERS**
Crawler Planetary	GO (multi-purpose lube)	EP 80/90	MIL-L-2105D		6.3 quarts	6
Engine Cooling System	AF/CC (anti-freeze/water)****	50/50 mix	Permanent		26 quarts	24.6
Engine Crankcase	EO (engine oil)	15W-40	MIL-L-2104E		17 quarts	16
Grease Fittings	CG (extreme pressure lube)	No.2				
Hydraulic System	HF (hydraulic fluid)	***	***		50 gallons	189.2
Swing Brake	HF (hydraulic fluid)	***	***		6.75 ounces	0.2
Swing Bull Gear	CG (extreme pressure lube)	No.2				
Swing Transmission	GO (multi-purpose lube)	EP 90	MIL-L-2105D		5 quarts	4.73
Tilt Bull Gear	GL (open gear lubricant)		P/N 8664-1304			
Tilt Transmission	GO (multi-purpose lube)	80W90	P/N 1440-3126		32-34 ounces	0.9-1
Track Idler	EO (engine oil)	SAE 30-40	MIL-L-2104E		0.71 pints	0.34
Track Rollers	EO (engine oil)	SAE 30-40	MIL-L-2104E		1.1 pints	0.52

* Capacities are approximate; check level to be sure.

** May vary; check vendor literature in service manual for ambient temperature limits.

*** Hydraulic Fluid Specifications:
Pour Point -46°F., SSU @ 100°F. 275; Flash point 442°F.
Approved Supplier & Type: Mobile Mobilfluid 424

**** Add 19 ounces of John Deere Cooling System Conditioner (P/N 1440-5267) when refilling cooling system.

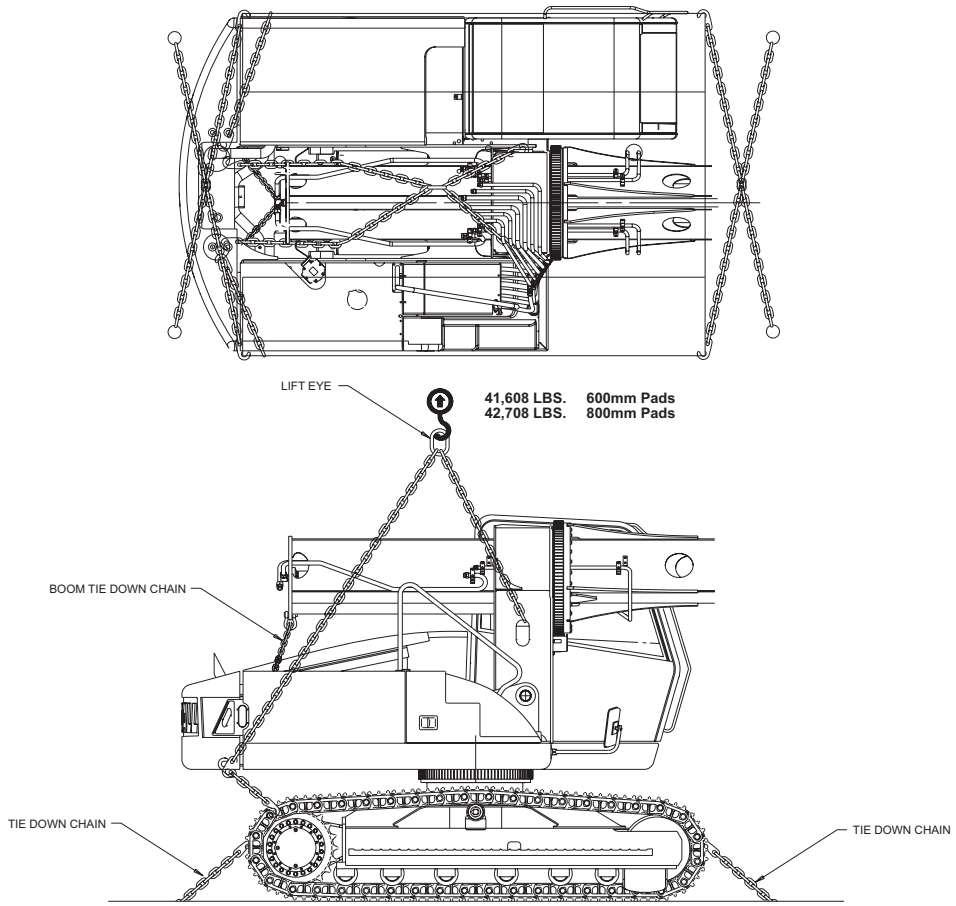
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RECOMMENDED TORQUE SPECS

SPECIFICATIONS FOR XL4210II UPPER ASSEMBLY TORQUE NOTES	
DESCRIPTION	TORQUE (WET) TO
BOOM & CRADLE ASSEMBLY (COMMON)	
-BOOM CYLINDER MOUNTING BOLTS	200 +15 -0 FT-LBS.
-TILT RING MOUNTING BOLTS	340 +25 -0 FT-LBS.
-TILT DRIVE MOUNTING BOLTS	200 +15 -0 FT-LBS.
-PIN CAP BOLTS	40 +5 -0 FT-LBS.
-SPIDER NUT RETAINER	55 +5 -0 FT-LBS.
-SPIDER RETAINER BOLTS	30 +5 -0 FT-LBS.
-SPIDER PADS	55 +5 -0 FT-LBS.
SWING TRANSMISSION (COMMON)	
-MOTOR ASSEMBLY CAPSCREWS	68 +10 -0 FT-LBS.
XL4210II BEFORE PAINT ASSEMBLY	
-SWING BEARING CAPSCREWS (UPPER ASS'Y. TO UNDERCARRIAGE)	200 +15 -0 FT-LBS.
-SWING BEARING CAPSCREWS	200 +15 -0 FT-LBS.
-SWING TRANSMISSION MOUNTING BOLTS	340 +25 -0 FT-LBS.
-POWER UNIT MOUNT BOLTS (2) FRONT & (2) REAR	225 +25 -0 FT-LBS.
-FUEL & HYD TANK OUTSIDE BOLTS	140 +15 -0 FT-LBS.
-COUNTERWEIGHT	545 +50 -0 FT-LBS.
-ENGINE COVER SUPPORT BOLTS TO CENTER FRAME	68 +10 -0 FT-LBS.
-CENTERPIN STABILIZER BOLTS (XL4200II)	68 +10 -0 FT-LBS.
-CENTERPIN STABILIZER BOLTS (XL4100II & XL4300II)	240 +25 -0 FT-LBS.
-CAB MOUNT BOLTS	200 +15 -0 FT-LBS.
XL4210II POWER UNIT ASSEMBLY	
-ENGINE SIDE MOUNT BOLTS	66 +10 -0 FT-LBS.
-ENGINE FRONT MOUNT BOLTS	166 +15 -0 FT-LBS.
-TOP ALTERNATOR MOUNTING BOLT	32 +5 -0 FT-LBS.
-BOTTOM ALTERNATOR MOUNTING BOLT	38 +5 -0 FT-LBS.
-PUMP FLANGE MOUNTING BOLTS	38 +10 -0 FT-LBS.
-FLYWHEEL MOUNTING BOLTS	40 +5 -0 FT-LBS.
-STARTER MOUNTING SCREWS	38 +10 -0 FT-LBS.
-HEATSHIELD	30 +15 -0 FT-LBS.

SPECIFICATIONS FOR XL4210II CRAWLER UNDERCARRIAGE ASSEMBLY TORQUE NOTES	
DESCRIPTION	TORQUE (WET) TO
XL4210II CRAWLER UNDERCARRIAGE ASSEMBLY	
-PAD BOLTS OVER MASTER LINK	120 +12 -12 FT-LBS. PLUS 1/3 TURN (120°)
-CARRIER ROLLER	200 +15 -0 FT-LBS.
-BOTTOM ROLLERS	200 +15 -0 FT-LBS.
-SPROCKET MOUNTING BOLTS	230 +15 -0 FT-LBS.
-DRIVE MOUNTING BOLTS	230 +15 -0 FT-LBS.
-CENTER PIN MOUNTING BOLTS	68 +10 -0 FT-LBS.

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For Transporting:

Retract horizontal boom fully, install boom tie-down chain and secure with hitch pins. Chain is stored in engine compartment.

Align upperstructure with tracks (drive sprockets at rear). Install two chains from holes near rear of frame to tracks as shown.

Position excavator as required and secure to transport using four cross chains as shown.

Do not tie down front of boom.

For Lifting:

Retract horizontal boom fully, install transport chain and secure with hitch pins. Chain is stored in engine compartment.

Attach four legged chain as shown. Using crane of adequate capacity, take most of slack from chains.

Pad chains as necessary to prevent damage to components and paint. Be certain right rear chain is clear of hydraulic filter.

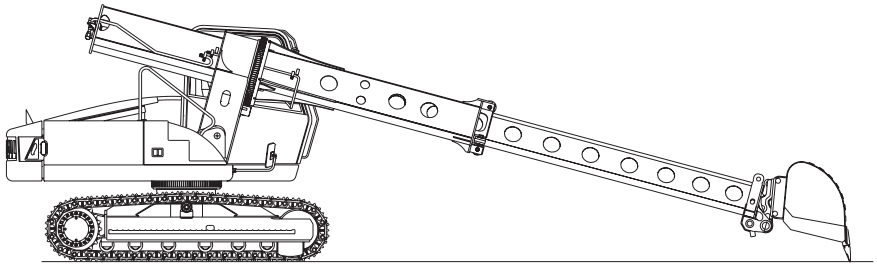
Take all slack from chains and inspect rigging for safety. Use tag lines to control load during lift.

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LOADING & SECURING FOR TRANSPORT

Towing:

Refer to service manual for instructions for towing crawler.



If you get stuck:

- If unit becomes stuck in soft ground you can use the boom to help free it.
- Position upperstructure parallel with tracks placing boom to the front or rear as appropriate for boom to help push or pull unit free. Pushing works best.
- While actuating travel pedals/levers in appropriate direction extend or retract boom as required to push or pull unit to solid ground.
- Whether pushing or pulling, be sure to adjust boom angle as required to keep bucket imbedded in ground.

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General

Because Gradall cannot anticipate all storage situations, we do not provide step-by-step procedures for short term storage. However, we do require that you review the following points and implement those appropriate to your situation:

For All Situations:

This may be a good opportunity to take a sample of hydraulic fluid for analysis.

Lubricate all grease gun points until fresh lube is expelled from lube point.

Check the hourmeter and the lubrication and maintenance schedule. If you are close to any lubricant change period, make the change before storage.

Check level of anti-freeze protection, drain and refill if necessary to obtain proper protection.

- Always select a site providing a firm, level surface, free of natural hazards: salt or corrosive spray, mud slides, flooding, fire, etc.
- If machine must remain on an unpaved surface, be sure tracks are resting on sturdy boards to prevent them from being frozen in soft ground.
- Whenever possible, select a site that will minimize the threat of theft, damage or vandalism.
- The site should afford sufficient space to allow the unit to be exercised periodically.
- Apply Boeshield *T9 (Gradall Part No. 1440-4645) to exposed cylinder rods.

Thoroughly clean all mud and debris from the machine to help protect surfaces from corrosion.

Be sure all doors, windows, and covers, are closed and locked. Install vandal covers if available.

Activate all excavator functions periodically, preferably on a weekly basis. The period of use should last until engine and hydraulic oil have reached normal operating temperature.

If it is impractical to activate functions regularly, and if freezing temperatures are expected, remove batteries and store in a warm location.

Tape a note inside cab window indicating the person to be called in an emergency.

Always be certain to remove ignition key before leaving machine.

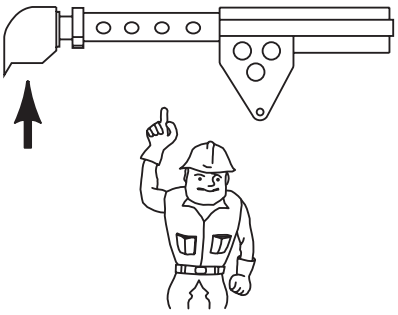
https://truckmanualshub.com/

EXCAVATOR HAND SIGNALS

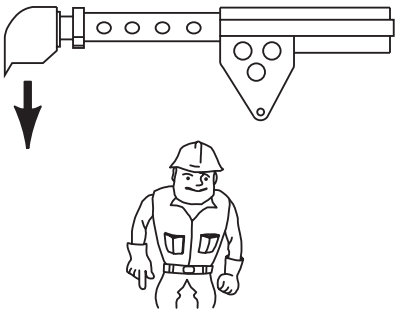
Standard Signals - When excavator work conditions require hand signals, they shall be provided or posted conspicuously for the use of both signalman and operator. No excavator motions shall be made unless signals are clearly understood by both signalman and operator.

Special Signals - When signals for auxiliary equipment functions or conditions not covered are required, they shall be agreed upon in advance by the operator and signalman.

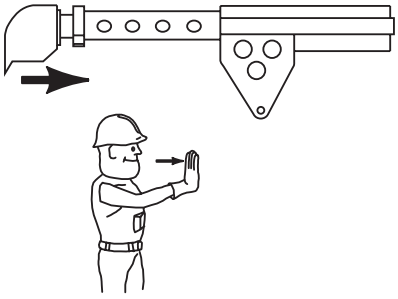
Instructions - When it is desired to give instructions to the operator other than provided by the established signal system, all excavator motions shall first be stopped.



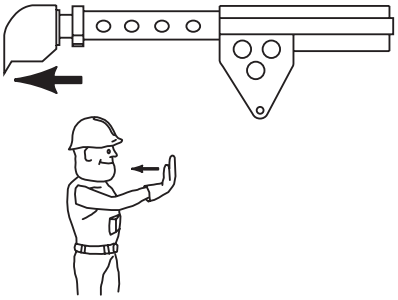
RAISE LOAD VERTICALLY - With either forearm vertical, forefinger pointing up, move hand in small horizontal circle.



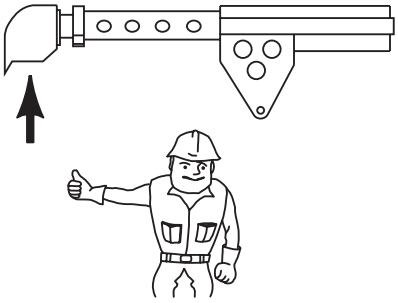
LOWER LOAD VERTICALLY - With either arm extended downward , forefinger pointing down, move hand in small horizontal circle.



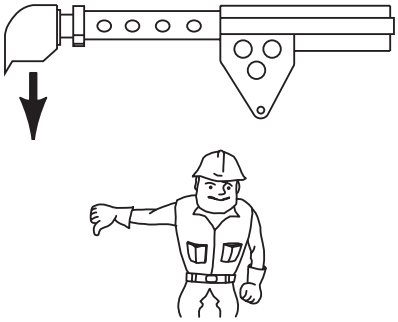
MOVE LOAD IN HORIZONTALLY - With either arm extended, hand raised and open toward direction of movement, move hand in direction of required movement.



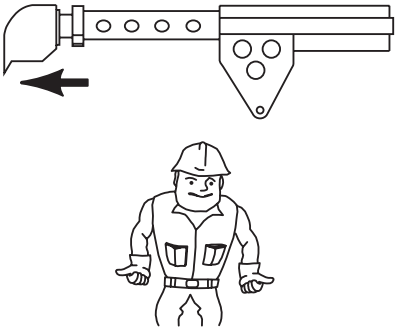
MOVE LOAD OUT HORIZONTALLY - With either arm extended, hand raised and open toward direction of movement, move hand in direction of required movement.



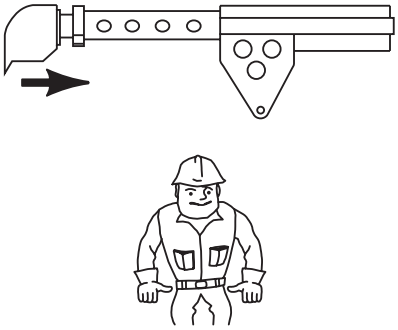
RAISE BOOM - With either arm extended horizontally, fingers closed, point thumb upward.



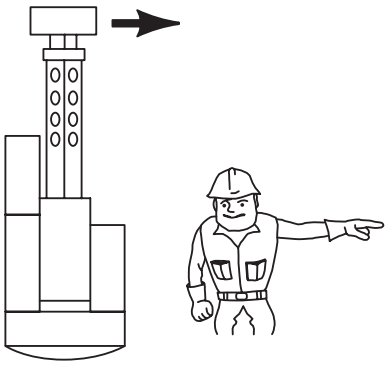
LOWER BOOM - With either arm extended horizontally, fingers closed, point thumb downward.



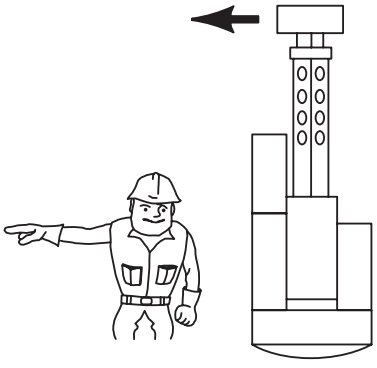
EXTEND TELESCOPIC BOOM - With both hands clenched, point thumbs outward.



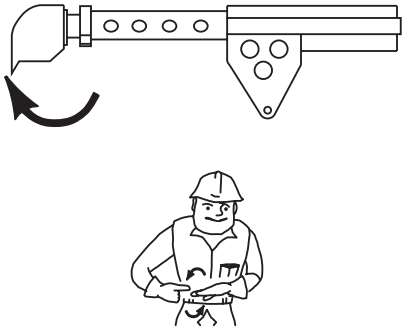
RETRACT TELESCOPIC BOOM - With both hands clenched, point thumbs inward.



SWING - With either arm extended horizontally, point with forefinger to direction of swing rotation.



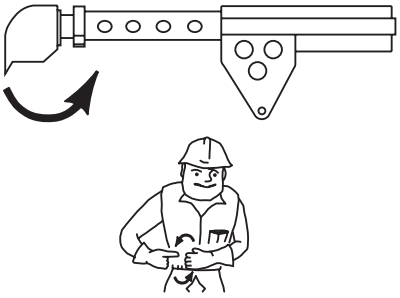
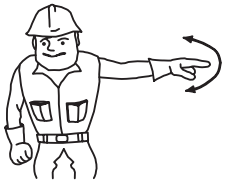
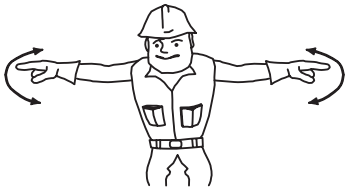
SWING - With either arm extended horizontally, point with forefinger to direction of swing rotation.



OPEN BUCKET - Hold one hand open and stationary. Rotate other hand in small vertical circle with forefinger pointing horizontally at open hand.

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EXCAVATOR HAND SIGNALS

 CLOSE BUCKET - Hold one hand closed and stationary. Rotate other hand in small vertical circle with forefinger pointing horizontally at closed hand.	 MOVE SLOWLY - Place one hand motionless in front of hand giving motion signal. (Raise load slowly is shown.)	 THIS FAR TO GO - With hands raised and open inward , move hands laterally, indicating distance to go.
 STOP - With either arm extended laterally, hand open downward, move arm back and forth.	 EMERGENCY STOP - With both arms extended laterally, hands open downward, move arms back and forth.	 STOP ENGINE - Draw thumb or forefinger across throat.

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GRADALL®

Gradall Industries, Inc.
New Philadelphia Operations
406 Mill Avenue, S.W.
New Philadelphia, Ohio 44663
USA

PHONE: (330) 339-2211
FAX: (330) 339-8468
www.gradall.com

https://truckmanualshub.com/

Revision
11-15-95

The Gradall® Company
XL Series Upper Critical Item Check Sheet

Model _____ **Serial** _____

Item	Assembler	Value
Swing Transmission Torqued		
Pinion Gear Backlash		
Swing Bearing Ring Torqued		
Molybdenum Grease On Pinion Splines		
Pinion Gear Torqued		
Molybdenum Grease On Swing Brake Splines		
Molybdenum Grease On All Motor Splines		
Swing Brake Fluid		
Swing Transmission Fluid		
Swing Motor To Swing Transmission Torque		
Counterweight Hardware Installation		
Battery Cables Connected Properly		
Upper Structure To Chassis/Undercarriage Torqued		
Radiator Coolant Level		
Engine Oil Level		
Hydraulic Oil Level		
Hose Routings		
Wire Routings		
All Grease Points Greased		
All Controls Operate Properly		

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The Gradall Company, New Philadelphia Ohio

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DRAWING NUMBER: **8041-9016**
REVISION:
ORIG. REL. DATE: **10-11-04**
BY: **JDB**

REV	DESCRIPTION			CHECKED	APPROVED
-	ES 875254	JBURTON	10-11-04	JDB	JDB

FINAL TEST REPORT

SERIAL # _____

Model XL4210-II Light Duty

DATE _____

PRESSURE TEST			GAGE LOCATION	(P.S.I.) MIN. - MAX.	ACTUAL
I.	**Flushing** Pressure (No Functions Moving, High Idle)		P	650 - 850	
II.	**Pump Differential** (Pump - Loadsense, Boom out Bottomed)		P - LS	275 - 295	
III.	**Joystick Pilot** Pressure (With Tool Moving @ Pilot Manifold)		P2	500 - 620	
IV.	Deere 6068TF150 **Engine Speed** (RPM) (2100 RPM Rated)				
	A.	High Idle	Monitor	2250 - 2350	
	B.	Low Idle	Monitor	800-950	
V.	**Travel**				
	A.	Left Track (top valve [forward = in , rev. = out])	P	4825-4975	
	B.	Right Track (bottom [forward = in , rev. = out])	P	4825-4975	
VI.	**Boom**				
	A.	Cyl. Bottomed - Retracted, (Inside Relief Valve)	X @ Valve	5000-5150***	(Not Factory Checked)
	B.	Cyl. Bottomed - Extended, (Outside Relief Valve)	X @ Valve	2500 - 2700	
	C.	"Pump" Setting (LS Setting, Cylinder Retracted)	X @ Valve	4450 – 4550**	
VII.	**Tilt**				
	A.	Tilt Motor CCW, (Inside Relief Valve)	LS	2125-2325	
	B.	Tilt Motor CW, (Outside Relief Valve)	LS	2125-2325	
VIII.	**Hoist**				
	A.	Cyl. Bottomed - Retracted (Inside Relief Valve)	X @ Valve	3000 - 3200	
	B.	Cyl. Bottomed - Extended (Loadsense Relief Setting W/ Pressure Boost Actuated)	X @ Valve	4850 – 4950**	
	C.	Lock Valve Setting (Boom Starts To Drift W/ Load)	X @ Valve	5125 - 5175	
	D.	Hoist Up Port Relief (Boom Starts To Fall W/ Load)	X @ Valve	5225 - 5300***	
IX.	**Tool**	(Can Over-Power Tool Cyl. With Boom Function)			
	A.	Tool Cyl. Extended, Inside Hose Port	X @ Valve	5000 - 5150***	(Not Factory Checked)
	B.	Tool Cyl. Retracted, Outside Hose Port	X @ Valve	5000 - 5150***	(Not Factory Checked)
X.	**Swing**				
	A.	Swing Regulator Pressure	MA port on motor	4150 - 4250**	
	B.	Dynamic Braking (Joystick in Neutral) Right (Inside valve)	MA port on motor	3000 - 3300	
	C.	Dynamic Braking (Joystick in Neutral) Left (Outside valve)	MB port on motor	3000 - 3300	
XI..	**System Dump** Pressure (Hoist Down, Boom Retract)		MA port on motor	290-500****	
XII.	**Auxiliary** (Optional Equipment)				
	A.	Inside Relief	X @ Valve	1900-2100	
	B.	Outside Relief	X @ Valve	1900-2100	
XIII.	**Pump Power Setting** (Main pump): Drawdown when combining swing,, Tool bottomed, Hoist up, and Boom out. (Machine moving with full 60" ditching bucket, swinging 90°). Confirm with full speed 1st gear, stall outrigger up, and apply brake pedal to max drawdown.		Monitor	2000 RPM to 2150 RPM	

NOTES: See hydraulic system set-up procedure for detailed system adjustment if required.
*Pressure test to be performed with oil at operating temp (120 - 160 deg F). and engine running full throttle
**Pressures correspond to regulator compensator setting or loadsense line relief
***Specified pressures of these reliefs correspond to 1/2 GPM flow.
****To be tested after operating time test is conducted

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8041-9016 GRADALL TEST REPORT SERIAL # _____

Model XL4210-II Light Duty

DATE _____

OPERATING TIME TEST		SECONDS MIN. - MAX.	ACTUAL
I.	Run Boom Out - level	8.0 – 8.6	
II.	Run Boom In - Level	8.0 - 8.6	
III.	Hoist		
	A. Boom In - Raise from Ground to 30° (*12.5*" Stroke)	2.5 – 3.1	
	B. Boom In - Lower from 30° to Ground (With Bucket)	1.5 - 2.3	
	C. Bounce Limited to 3 (With empty bucket @ full ext... Hoist up and stop @ boom level)		
IV.	Tool Open	1.8 – 2.2	
V.	Tool Close	3.3 – 3.9	
VI.	Swing Right 360° Boom In and Boom Out	7.4 – 7.9	
VII.	Swing Left 360° Boom in and Boom Out	7.4 – 7.9	
VIII.	Swing Brake Sets (time delay relay)	3.0 – 3.2	
IX.	Tilt 360°		
	A. Max. CW	13.4-15.3	
	B. Max. CCW	13.4-15.3	
X.	Travel Speed (3.42 MPH)		
	1. Time for 100 Ft. (High Speed) Forward	19.0 – 21.5	
	2. Time for 100 Ft. (High Speed) Reverse	19.0 – 21.5	
XI.	Straight Travel (Deflection to be less than 3 Ft. in 100 Ft.)		
	1. Forward		FT
	2. Reverse		FT

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8041-9016
Model XL4210-II Light Duty

GRADALL TEST REPORT
INSPECTION CHECKLIST

_____ Oil in Power Unit
_____ Coolant in Power Unit
_____ Reservoir Oil Level
_____ Gear Lube in Swing Tran.
_____ Upperstructure Greased
_____ Hyd. Oil in Swing Brake
_____ Gear Lube in Tilt Trans And Tilt Brake
_____ Oil in all gearboxes
_____ Tracks Adjusted
_____ Engine Oil in Transmission
_____ Two speed functions
_____ Cab Glass & Rubber OK
_____ Heater/Defroster and Controls function
_____ Oil Pressure, Engine At Operating Temp (No Load)
_____Auto idle function works
_____ Center Pin Dry
_____ Control Orientation & Operation Correct

_____ Boom Rollers Adjusted
_____ Cont. Levers & Switches Funct.
_____ Control Valves Free
_____ Hoses Clear of Interference
_____ All Cylinder Pins Locked
_____ Air Cleaner Connections Tight
_____. Electronic Monitor Functions Work With No Intermittent Operation
_____ Window Moves Freely
_____ Window Latches Work Both Up and Down
_____ Windshield Wiper & Washer OK
_____ Cab Door Latches Hold
_____ Access Doors Aligned, Latches Working Correctly
_____ Tilt Speed Override Switch Works
_____ Start/Stop Engine
_____ Alternator System Charging Voltage At Battery (Acceptable Range 13.3 - 14.7 Volts)
_____ Pilot On/Off & Starter Lockout Function

_____ No Leaks-Fuel Tank & Reservoir
_____ Tool Cylinder Rod Not Damaged
_____ Swing Brake (Bleed)
_____ Satisfactory Welds
_____ All Hose Clamps Tight
_____ Reservoir Oil Filter Clean
_____ Door Lock
_____ Boom Drift _____"in 5 minutes (max. spec. is 2" in 5 min @ 120°F oil with 36" bucket)
_____ Swing lights work
_____ Throttle Functions Properly
_____ Attachments Fit
_____ Horn Functions
Travel Alarm Functions:(4 modes)
_____ Left Forward
_____ Left Reverse
_____ Right Forward
_____ Right Reverse
_____ No Delay in Joystick Controls
_____ Engine Alarms
_____ Install Tamper Proof Cap on pump Adjustment Screw (9114-3222 Use 9114-3224 For service only

Tested By: _____ Date: _____

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The Gradall Company, New Philadelphia Ohio

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SHIPPING INSPECTION CHECKLIST

GRADALL UPPER

_____ Machine Conforms to Order

_____ All Name Plates Applied
_____ All Inst. Plates Applied

_____ Tool Kit on Machine
_____ Reservoir Oil Level

_____ No Paint on Cylinder Rods
_____ Swing Gears Lubed
_____ Keys

GENERAL

_____ Nonstandard Controls Identified
_____ Paint & Appearance OK

_____ All Decals Installed
_____ Masking Removed

_____ Gear Covers in Place
_____ Belly Pans in Place
_____ Swing Lights Work

MANUALS

_____ 1 Complete Manual Pkg. (As listed on Order)
_____ Serial No. Information Added to Manual
_____ Additional Operator's Manual
_____ Safety Manuals (As listed on Order)

_____ Machine Controls Set to SAE or Other Pattern Per Order.

_____ Proper Control Decal Installed On Operators Window

ENGINE

_____ Coolant Level
_____ Fuel
_____ Engine Oil

Special Items (List) _____

_____

_____

_____

Inspected By: _____ Date: _____

_____

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DRAWING NUMBER: **8041-9015**
REVISION:
ORIG. REL. DATE: **9-28-04**
BY: **JDB**

REV	DESCRIPTION			CHECKED	APPROVED
A	ES 941987	JBURTON	02-11-05	JDB	JDB

FINAL TEST REPORT

TRACKING #_____
SERIAL # _____
DATE _____

Model XL4210-II

PRESSURE TEST			GAGE LOCATION	(P.S.I.) MIN. - MAX.	ACTUAL
I.	**Flushing** Pressure (No Functions Moving, High Idle)		P	650 - 850	
II.	**Pump Differential** (Pump - Loadsense, Boom out Bottomed)		P - LS	275 - 295	
III.	**Joystick Pilot** Pressure (With Tool Moving @ Pilot Manifold)		P2	500 - 620	
IV.	Deere 6068TF150 **Engine Speed** (RPM) (2100 RPM Rated)				
	A.	High Idle	Monitor	2250 - 2350	
	B.	Low Idle	Monitor	800-950	
V.	**Travel**				
	A.	Left Track (top valve [forward = in , rev. = out])	P	4825-4975	
	B.	Right Track (bottom [forward = in , rev. = out])	P	4825-4975	
VI.	**Boom**				
	A.	Cyl. Bottomed - Retracted, (Inside Relief Valve)	X @ Valve	5000-5150***	(Not Factory Checked)
	B.	Cyl. Bottomed - Extended, (Outside Relief Valve)	X @ Valve	2500 - 2700	
	C.	"Pump" Setting (LS Setting, Cylinder Retracted)	X @ Valve	4450 – 4550**	
VII.	**Tilt**				
	A.	Tilt Motor CCW, (Inside Relief Valve)	LS	4000-4200	
	B.	Tilt Motor CW, (Outside Relief Valve)	LS	4000-4200	
VIII.	**Hoist**				
	A.	Cyl. Bottomed - Retracted (Inside Relief Valve)	X @ Valve	3000 - 3200	
	B.	Cyl. Bottomed - Extended (Loadsense Relief Setting W/ Pressure Boost Actuated)	X @ Valve	4850 – 4950**	
	C.	Lock Valve Setting (Boom Starts To Drift W/ Load)	X @ Valve	5125 - 5175	
	D.	Hoist Up Port Relief (Boom Starts To Fall W/ Load)	X @ Valve	5225 - 5300***	
IX.	**Tool**	(Can Over-Power Tool Cyl. With Boom Function)			
	A.	Tool Cyl. Extended, Inside Hose Port	X @ Valve	5000 - 5150***	(Not Factory Checked)
	B.	Tool Cyl. Retracted, Outside Hose Port	X @ Valve	5000 - 5150***	(Not Factory Checked)
X.	**Swing**				
	A.	Swing Regulator Pressure	MA port on motor	4150 - 4250**	
	B.	Dynamic Braking (Joystick in Neutral) Right (Inside valve)	MA port on motor	3000 - 3300	
	C.	Dynamic Braking (Joystick in Neutral) Left (Outside valve)	MB port on motor	3000 - 3300	
XI..	**System Dump** Pressure (Hoist Down, Boom Retract)		MA port on motor	290-500****	
XII.	**Auxiliary** (Optional Equipment)				
	A.	Inside Relief	X @ Valve	1900-2100	
	B.	Outside Relief	X @ Valve	1900-2100	
XIII.	**Pump Power Setting** (Main pump): Drawdown when combining swing,, Tool bottomed, Hoist up, and Boom out. (Machine moving with full 60" ditching bucket, swinging 90°).		Monitor	2000 RPM to 2150 RPM	

NOTES: See hydraulic system set-up procedure for detailed system adjustment if required.
*Pressure test to be performed with oil at operating temp (120 - 160 deg F). and engine running full throttle
**Pressures correspond to regulator compensator setting or loadsense line relief
***Specified pressures of these reliefs correspond to 1/2 GPM flow.
****To be tested after operating time test is conducted

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TRACKING# _____

8041-9015 GRADALL TEST REPORT SERIAL # _____

Model XL4210-II

DATE _____

OPERATING TIME TEST		SECONDS MIN. - MAX.	ACTUAL
I.	Run Boom Out - level	8.0 – 8.6	
II.	Run Boom In - Level	8.0 - 8.6	
III.	Hoist		
	A. Boom In - Raise from Ground to 30° (*12.5*" Stroke)	2.5 – 3.1	
	B. Boom In - Lower from 30° to Ground (With Bucket)	1.5 - 2.3	
	C. Bounce Limited to 3 (With empty bucket @ full ext... Hoist up and stop @ boom level)		
IV.	Tool Open	1.8 – 2.2	
V.	Tool Close	3.3 – 3.9	
VI.	Swing Right 360° Boom In and Boom Out	15.3 – 15.8	
VII.	Swing Left 360° Boom in and Boom Out	15.3 – 15.8	
VIII.	Swing Brake Sets (time delay relay)	0.8 – 1.2	
IX.	Tilt 360°		
	A. Max. CW	6.9-8.8	
	B. Max. CCW	6.9-8.8	
X.	Travel Speed (3.42 MPH)		
	1. Time for 100 Ft. (High Speed) Forward	19.0 – 21.5	
	2. Time for 100 Ft. (High Speed) Reverse	19.0 – 21.5	
XI.	Straight Travel (Deflection to be less than 3 Ft. in 100 Ft.)		
	1. Forward		FT
	2. Reverse		FT

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8041-9015
Model XL4210-II

GRADALL TEST REPORT
INSPECTION CHECKLIST

TRACKING #_____
SERIAL #_____

_____ Oil in Power Unit
_____ Coolant Level and Protection Level to -30°F
_____ Reservoir Oil Level
_____ Gear Lube in Swing Tran.
_____ Upperstructure Greased
_____ Hyd. Oil in Swing Brake
_____ Gear Lube in Tilt Trans And Tilt Brake
_____ Oil in all gearboxes
_____ Tracks Adjusted

_____ Two speed functions

_____ Heater/Defroster and Controls function

_____ Oil Pressure, Engine At Operating Temp (No Load)

_____Auto idle function works
_____ Center Pin Dry
_____ Control Orientation & Operation Correct

_____ Hoses In Boom Not Twisted
_____ Boom Rollers Adjusted

_____ Cont. Levers & Switches Funct.
_____ Control Valves Free
_____ Hoses Clear of Interference
_____ All Cylinder Pins Locked

_____. Electronic Monitor Functions

_____ Window Moves Freely
_____ Window Latches Work Both Up and Down

_____ Cab Door Latches Hold
_____ Access Doors Aligned

_____ Tilt Speed Override Switch Works

_____ Alternator System Charging Voltage At Battery (Acceptable Range 13.3 - 14.7 Volts)
_____ Pilot On/Off & Starter Lockout Function

_____ No Leaks-Fuel Tank & Reservoir
_____ Tool Cylinder Rod Not Damaged
_____ Swing Brake (Bleed)
_____ Satisfactory Welds

_____ Reservoir Oil Filter Clean
_____ Door Lock
_____ Boom Drift _____"in 5 minutes (max. spec. is 2" in 5 min @ 120°F oil with 36" bucket)
_____ Swing lights work
_____ Throttle Functions Properly
_____ Attachments Fit
_____ Horn Functions
Travel Alarm Functions:(4 modes)
_____ Left Forward
_____ Left Reverse
_____ Right Forward
_____ Right Reverse
_____ No Delay in Joystick Controls
_____ Engine Alarms
_____ Install Tamper Proof Cap on pump Adjustment Screw (9114-3222) Use 9114-3224 For service only

Tested By: _____ Date: _____

_____

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The Gradall Company, New Philadelphia Ohio

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SHIPPING INSPECTION CHECKLIST

TRACKING #_____
SERIAL #_____

GRADALL UPPER

_____ All Name Plates Applied
_____ All Inst. Plates Applied

_____ Tool Kit on Machine
_____ Reservoir Oil Level

_____ No Paint on Cylinder Rods
_____ Swing Gear Lubed
_____ Keys

GENERAL

_____ Nonstandard Controls Identified
_____ Paint & Appearance OK

_____ All Decals Installed
_____ Masking Removed

_____ Gear Covers in Place
_____ Belly Pans in Place
_____ Swing Lights Work

MANUALS

_____ OPERATORS
_____ PARTS
_____ SERVICE

REVISION

_____
_____
_____

_____ Machine Controls Set to SAE or Other Pattern Per Order.

_____ Proper Control Decal Installed On Operators Window

ENGINE

_____ Coolant Level Correct
_____ Engine Oil Level Correct

Special Items (List) _____

Inspected By: _____ Date: _____

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REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	1	W/R 8040-029 JAM 10-9-03 PROTOTYPE RELEASE	CES	RDM

8093-3366
ø0.8mm
34 GPM
FOOTPEDAL
8033-3094
8043-3220
125 PSI
N.O.
RH JOYSTICK
8043-3208
LH JOYSTICK
8043-3207
QUICK DISCONNECT
BULKHEAD
SAE PATTERN SHOWN
SWING MOTOR
8044-3003
TILT MOTOR
8032-3026
SEQUENCE VALVE M1 M2
8032-3027
30 GPM
30 GPM
OPTION
3100 PSI
3100 PSI
TILT
2225 PSI
2225 PSI
PstDR
SWING
30 GPM
30 GPM
SHIFT:
1500 PSI
UP
4000 PSI
DOWN
PROPEL
42 GPM
PROPEL
42 GPM
8033-3100
100 PSI
N.O.
HOIST
8 GPM
3100 PSI
27 GPM
30 GPM
TOOL
5250 PSI
5100 PSI
33 GPM
42 GPM
BOOM
5100 PSI
2600 PSI
44 PSI
4200 PSI
ø0.7mm
ø1.5mmx
5350 PSI
8GPM
4900 PSI
18 GPM
ø0.4mm
ø1.2mm
44 PSI
MAIN VALVE
8043-3010 ST'D.
8043-3011 W/AUX
8043-3221
400 PSI
N.O.
8033-3100
100 PSI
N.O.
PILOT MANIFOLD
8043-3037
AUXb
AUXa
TILT R
TILT L
2-SPD
.8mm
SWING
BRAKE
PILOT
CUT-OFF
VALVE
650 PSI
ø1.5mm
PSI
500
8043-3213
.8mm
COLD START
VALVE
8047-3050
8043-3106
45 PSI 140°F
8043-3106
45 PSI 140°F
OIL COOLER
8037-3004
FILL
10 PSIG
10 MICRON
.3 PSIG
8093-3068
BREATHER
(2) FILTERS
8047-3029
10u
35 PSI BYPASS
35 PSI SWITCH
RESERVOIR ASSEMBLY
8047-5002
30.5 GAL LOW LEVEL (COLD)
50.7 GAL HIGH LEVEL (HOT)
19.6 GAL MIN HEAD SPACE
8093-3061
8096-3220
MAIN PUMP
8043-3014
Vg max Vg min
8043-3209
.045"
8043-3206
200 PSI
(2) DRIVE ASSEMBLY
8041-3006
CENTER PIN
8093-3333
LEFT
RIGHT
PS
Pm1
Pm2

NOTE
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TOLERANCES UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM QT'Y	PART NUMBER	DESCRIPTION
,		

PAINT ,
APPROVED BY RDM
CHECKED BY CES
DRAWN BY JAM
DATE 10-9-03

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO
SOLIDWORKS 3D

TITLE: HYDRAULIC SCHEMATIC
MATERIAL: XL4200II
SIZE 4 | CAGE CODE 10086 | 8041-9001 | REV. 1
SCALE NTS | WGT N/A | SHEET 1 OF 1

SUPERSEDED BY ,

ORIGINAL RELEASE: W/R 8040-029

SUPERSEDES , | SIMILAR TO , | M- 8041-0000

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

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The Gradall Company, New Philadelphia Ohio

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DRAWING NUMBER: **8041-9003**
REVISION: **-**
ORIG. REL. DATE: **9-11-03**
BY: **CES**

REV	DESCRIPTION	CHECKED	APPROVED
-	WR 8040-027 CES RELEASE TO JED		

START-UP PROCEDURE: XL4200-II

Before starting the engine: All assemblies complete with all motor cases and gearbox cases filled per specification. Radiator filled with coolant. Boom installed level with transport pin in place.

1 _____ Fill reservoir to full level with **Mobilfluid** 424 (1440-4825) tractor fluid and charge reservoir to 10 PSI with breather installed.

Bleed air from the following:

2 _____ Swing brake - attach drain hose and loosen special bleed port (On backside).

3 _____ Main pump – Loosen hose connection at main pump case drain port. Tighten fitting when oil runs clear.

4 _____ Disconnect wire connector at rear of engine injector pump (wire labels are ECU INJECT A and ECU INJECT B) to prohibit engine from starting.

5 _____ Main pump – install test lead hose on mini-check at “G” port on main pump. Turn engine over (Do Not Start) until all air is purged.

6 _____ Engine fuel – prime by actuating manual lift pump on engine until resistance is increased.

Start the engine at idle speed (950 RPM)

7 _____ Calibrate speed dial and governor actuator with BB-3 Microprocessor Control unit (8036-3119).

8 _____ Lower Pilot Lever to turn on pilot circuit. Then move each pilot control (including foot pedals) back and forth 3 times quickly to vent remaining air. (Do Not Actuate Valves).

9 _____ With boom level, actuate boom out 2” then in 2”. Repeat 3 times. Do not hit boom in end of stroke until the last stroke.

10 _____ Extend hoist cylinders 12” then retract without bottoming cylinder (repeat 3 times).

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11 _____ Attach hoist cylinder rods to the cradle.

Increase engine speed to 1000 RPM

12 _____ Raise boom to slightly above level. Slowly extend and retract boom cylinder 10 times without hitting end of stroke in either direction. Bottom cylinder on in stroke first then bottom on out stroke.

13 _____ Jog tilt CCW until boom motion occurs. Slowly tilt boom to 90° CCW. Close and open tool cylinder 5 times without hitting end of stroke. Tilt boom to 90°CW. Close and open tool cylinder 5 times allowing the cylinder to bottom on the last cycle.

14 _____ Acuate propel forward (low) and reverse slowly 5 times. Select high range and repeat.

15 _____ Top off hydraulic reservoir.

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MANNESMANN REXROTH

Hydromatik
Brueninghaus Hydraulik

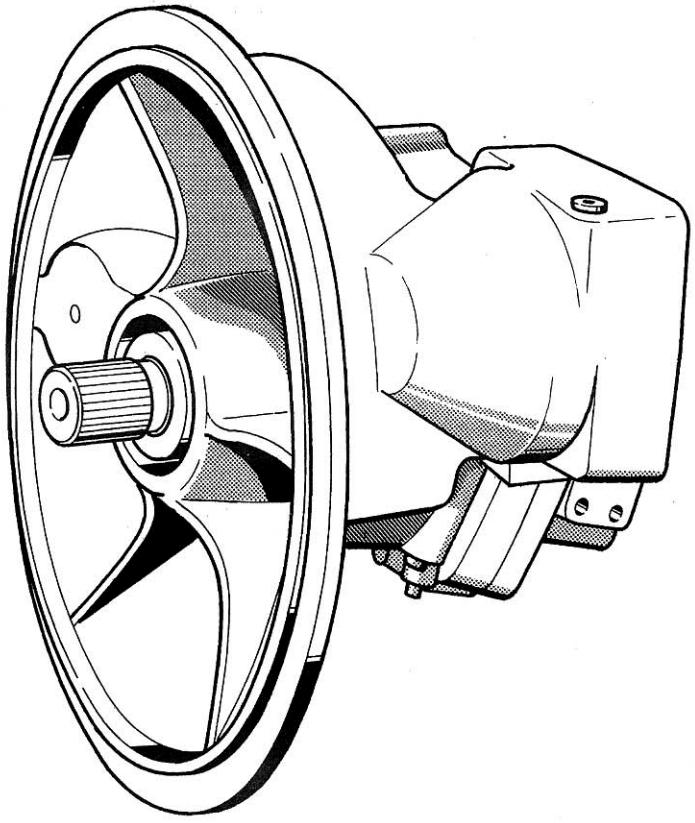
Verstelldoppelpumpe A8VO - SRH/60
Variable Displacement Double Pump A8VO - SRH/60

RDE 93010-02-R 05.85

Reparaturanleitung Nenngrößen 28–107
Repair Instructions Sizes 28–107

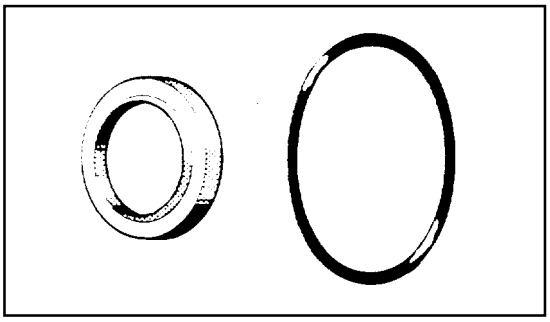
R

Mit Nebenabtrieb und Dreikreis-Regelventil
With Auxiliary drive and Three-Circuit Control Valve



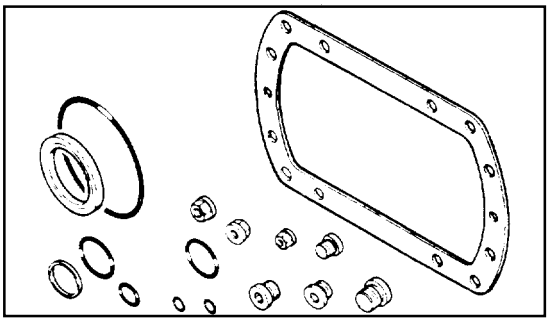
INHALT	Seite/Page	CONTENTS
Dichtsätze	2	Seal kits
Hinweis/Schnittbild	3	Note/Section
Baugruppen	2– 5	Subassemblies
Triebwelle abdichten	6– 7	Sealing drive shaft
Zwischenlagerdeckel abdichten	8	Sealing intermediate bearing cap
Verhältnisdruckregelventil abdichten/zerlegen	9–11	Sealing/stripping pressure averaging valve
Hubverstellung abdichten/zerlegen	12–13	Sealing/stripping piston stroke adjustment
Dreikreis-Regelventil abdichten/zerlegen	14–16	Sealing/stripping three-circuit control valve
Reglergehäuse abdichten	17–19	Sealing control housing
Regler zerlegen/reinigen	20–21	Stripping/cleaning control
Reglerteile überprüfen	22	Checking control parts
Regler montieren	23–24	Refitting control
Triebwerke ausbauen	25–26	Dismantling rotary groups
Nebenabtrieb ausbauen	27–29	Dismantling auxiliary drive
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Nebenabtrieb einbauen	32–33	Refitting auxiliary drive
Triebwerke montieren	33–35	Refitting rotary groups
Nebenabtrieb einbauen	35–36	Refitting auxiliary drive
Dichtmuttern austauschen	37	Replacing seal nuts
Anziehdrehmomente	37	Tightening torques
Vorrichtungen	38	Tools and devices

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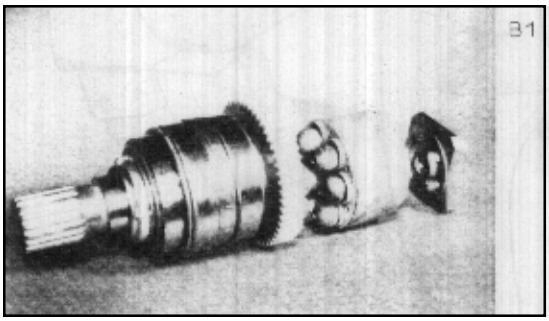
D1 Dichtsatz für Triebwelle.

Seal kit for drive shaft.



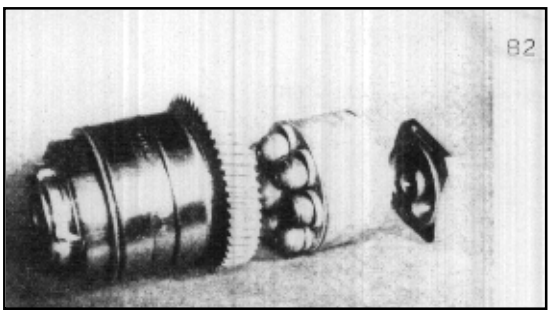
D2 ÄuÜerer Dichtsatz (mit D1).

Outer seal kit (includes D1).



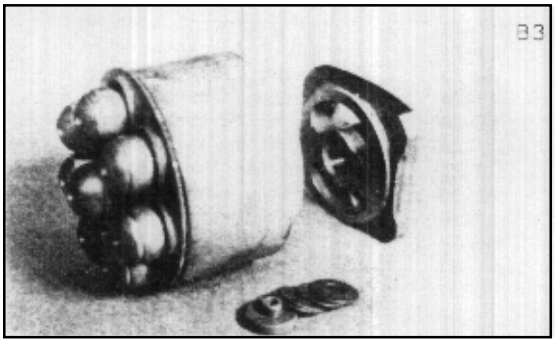
B1 Triebwerk 1, einbaufertig abgestimmt.

Rotary group 1, ready to install.



B2 Triebwerk 2, einbaufertig abgestimmt.

Rotary group 2, ready to install.



B3 Triebwerk, hydraulischer Teil (für Triebwerk 1 und 2 getrennt bestellen - siehe Bild 65-67).

Rotary group, hydraulic section (order Separately for rotary groups 1 and 2 - see Figs. 65-67.

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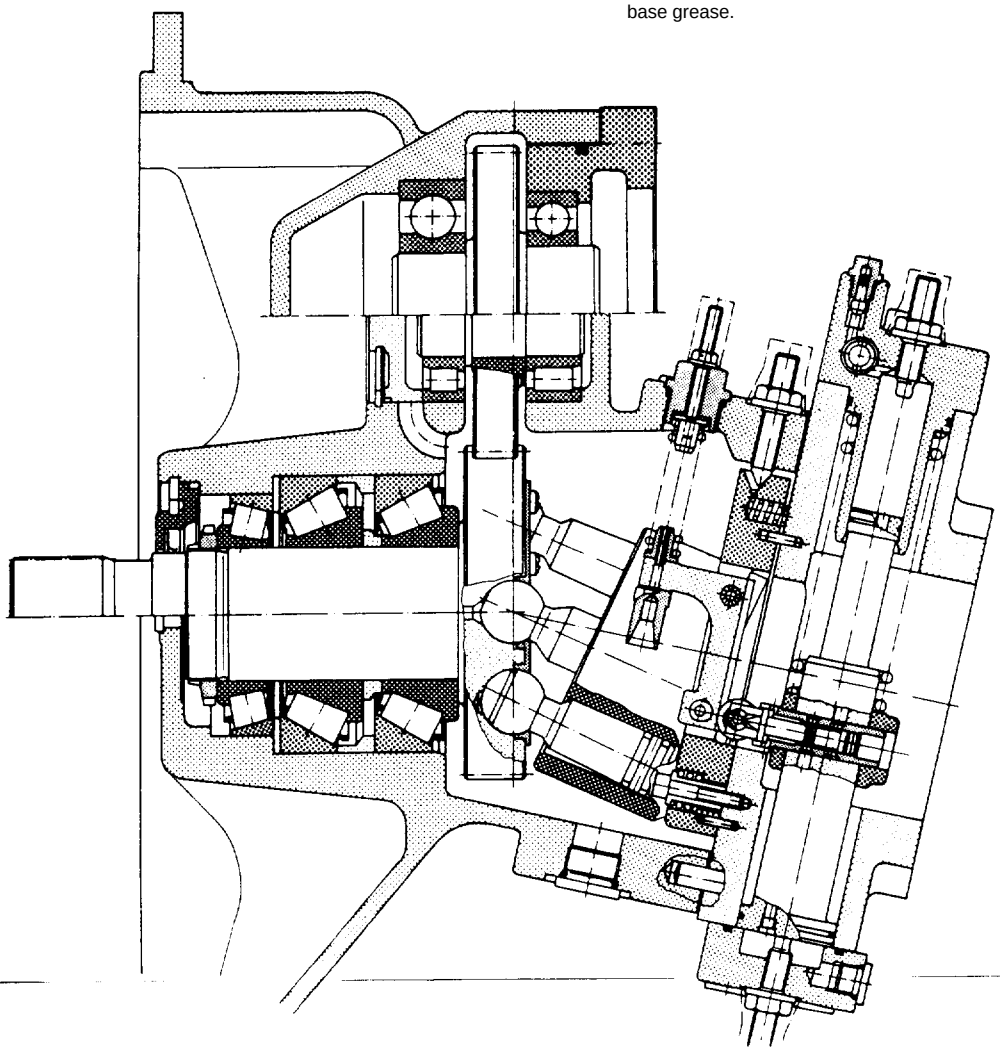
HINWEIS

Tellgeprufte and vormontierte Original-Hydromatik Baugruppen armöglichen bei kürzentem Zeitaufwand erfolgenreiche Reparaturen.
Soil trotzdemm mit Einzelteilen nepariert werden, dann haben Sie Teil an unserer Erfahrung, indem Sie hun meue Original-Hydromatik-dichtungen - Sicherungselemerte und -lager verbauen. Es sing auch die Teile, die Sie grungsatzlich bei jeder Demontage wenchseln sollten, denn den noch vorhandenen Gebrauchswert dieser Teile kann man nicht durch eihe Sichtprüfung

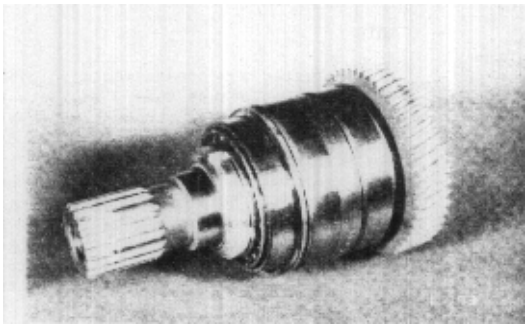
bestimmen, Zudem wäre es doon schade, wenn der erfolg Ihrer Arbeit durch ein, vergleichsweise billiges Bauteil, in frage gestellt wäre.
Besonders rasch erhalten Sie die richtigen Ersatzteile, wenn Sie uns bei der Bestellung Typ- und Fabriknummer mit angeben.
Die Reparaturarbeiten sind einfach, trotzdem sollten Sie unser An gebot zur Schulung nutzen und sich bei uns das notwendige spezialwissen aneignen. Dies gilt auch für den Spezialisten, den wir gerne wiewickelten Producte einweisen wollen.
Bei den Montageschritten, bei denen wir die Verwendung von Fett empfehlen, verwanden Sie bitte ein mit der späteren Druckflüssigkeit verträgliches zänes Fett. Für Mineralöl z.B. Fett auf Kalziumbasis.

NOTE

The pretested and preassembled original Hydromatik subassemblies ensure speedy an successful repairs.
Should it nevertheless become necessary for you to carry out repairs on individual components, avail yourself of our experience and make it a rule to only us original hydromatik seals, retaining rings and bearings. These should be replaced whenever a unit is stripped down, since the service life that may still be left over cannot be determined by visual check. And, wouldn't it be a shame to goof up on otherwise excellent repair job by trying to save on relatively inexpensive components.
Please always give us both unit type and serial number when ordering spares. This will help us speed your order on its way to you.
Repair on hydromatik units are easy to make. You should still make use of our training program to acquire the necessary background. By the way, this offer is also good for the specialist. We will be only too glad to tutor him whenever our products have been updated.
For assembly steps where we recommend the use of grease, only viscous type grease compatible with the pressurized medium for running the unit should be used; if the medium is mineral oil, use a calciumbase grease.

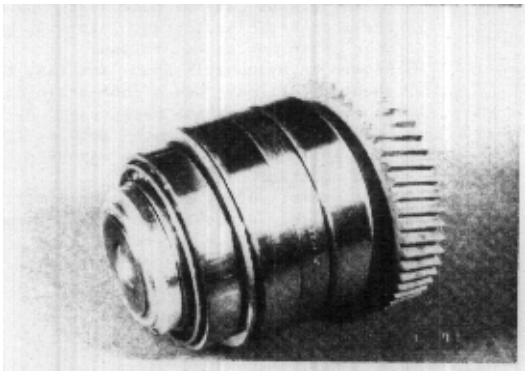


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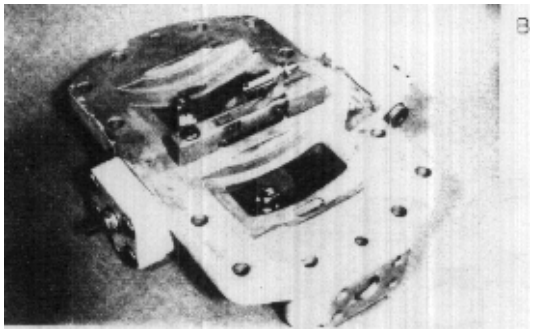
B4 Triebwerk 1, mechanischer Teil, einbaufertig abgestimmt.

Rotary group 1, mechanical section, ready to install.



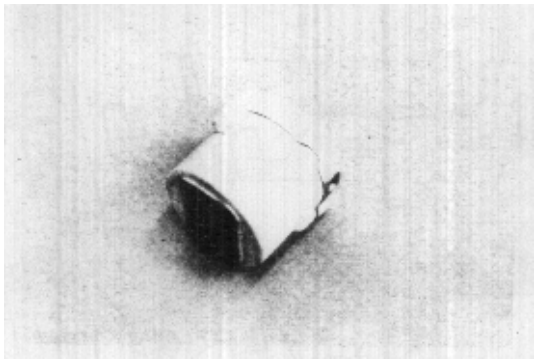
B5 Triebwerk 2, mechanischer Teil, einbaufertig abgestimmt.

Rotary group 2, mechanical section ready to install.



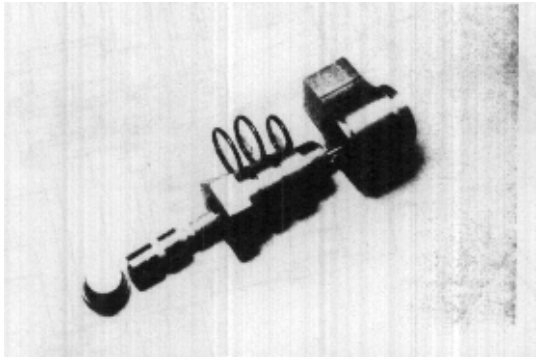
B6 Regler, vorgeprüft.

Control, pretested.



B7 Hubbergrenzung, hydraulisch.

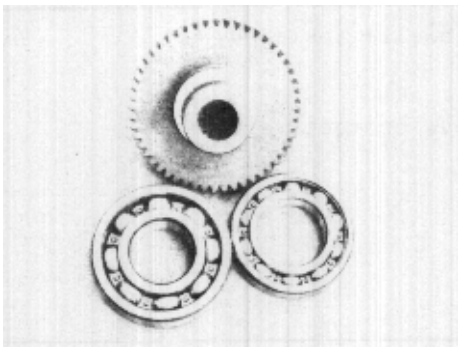
Stroke limiter, hydraulic.



B8 Dreikreis-Regelventil.

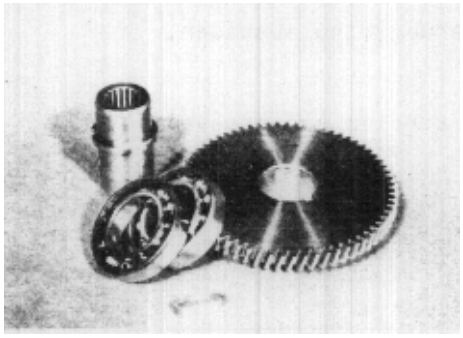
Three-circuit control valve.

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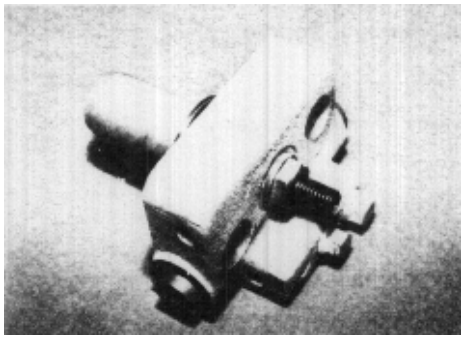
B9 Zwischenrad mit lagersatz.

Intermediate gear and bearing kit.



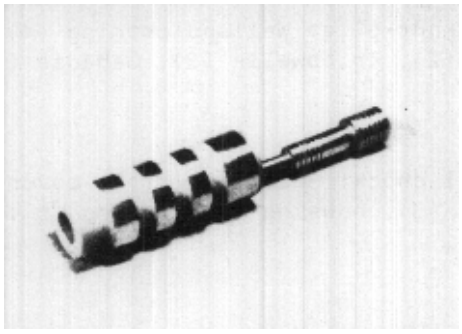
B10 Nebenabrieb.

Auxiliary drive.



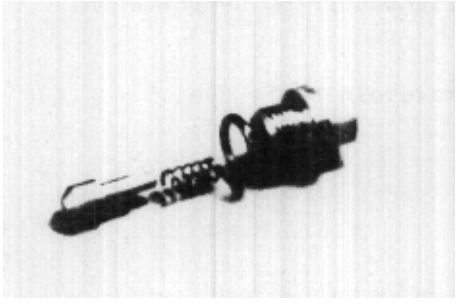
B11 Verhältnisdruckregelventil vorgeprüft.

Pressure averaging valve pretested.



B12 Steuerbüchse und kolben für Verhältnishdruckregelventil.

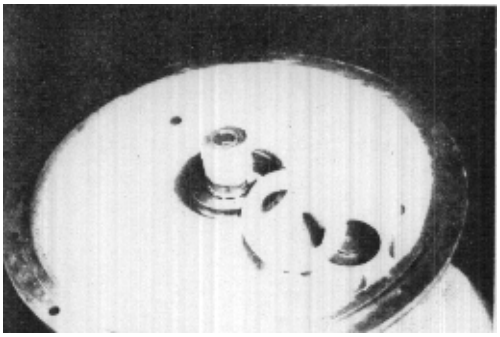
Control bush and control piston for pressure averaging valve.



B13 Rückshlagventil für Verhältnisdruckregegelventil

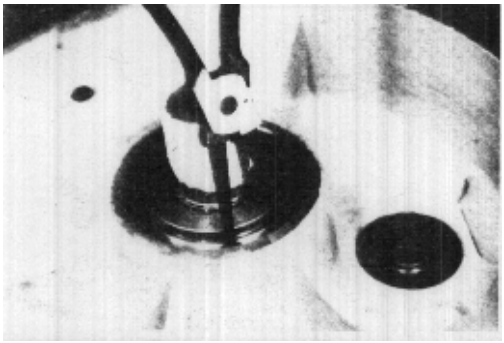
Check valve for pressure averaging valve.

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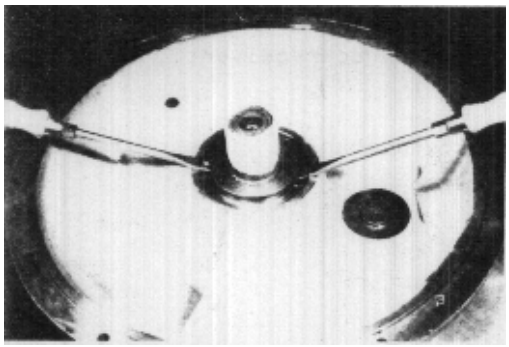
1 Triebwelle abkleben.

Remove protective cover.



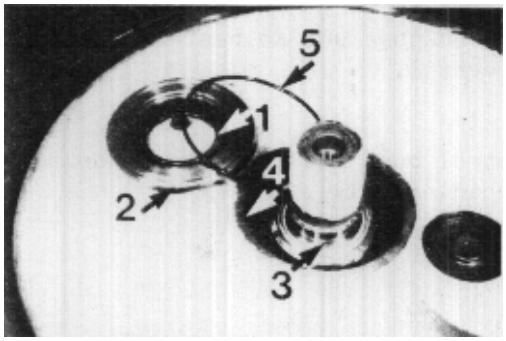
2 Sicherungsring ausbauen.

Free circlip and remove.



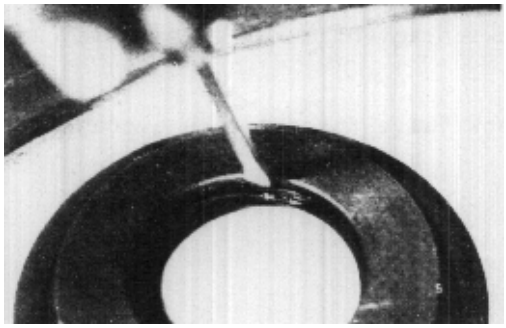
3 Verschlußring abdrücken.

Prize off front cover



4 Sichtkontrollef: Wellendichtring (1), Verschluß-ring (2), Triebwelle (3) Gehäuse (4), O-Ring (5).

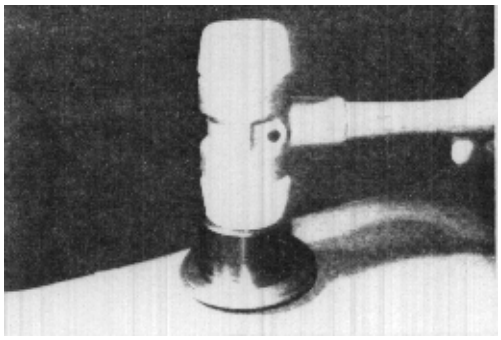
Visual check: Shaft seal (1), cover (2), drive shaft (3), housing (4), O-ring (5).



5 Wellendichtring demontieren.

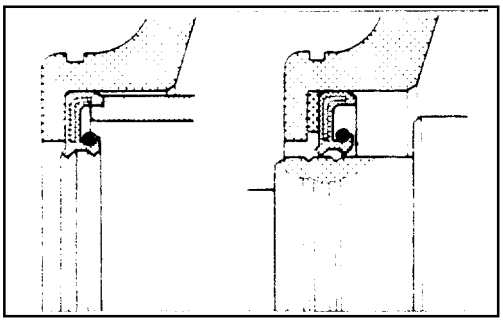
Remove old shaft seal.

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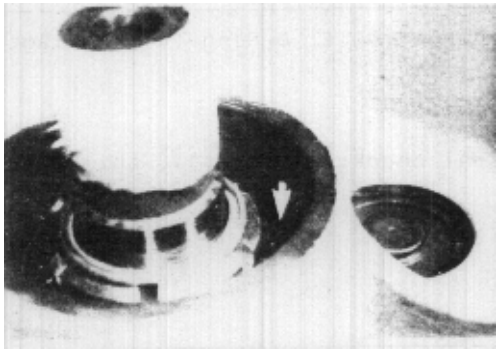
6 Radialwellendichtring einpressen, Montagering im dichtsatz. Den Verschlußring am bearbeiteter Bund auflegen.

Press in shaft seal, supporting cover on outer machined surface.



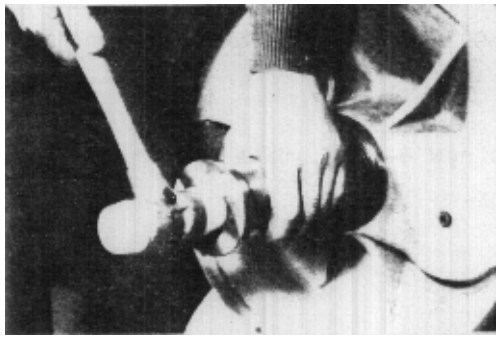
7 Bei tiefer Laufrille beiliegende Scheibe vor den Wellendichtring einlegen.

If the shaft is deeply grooved, insert shim behind seal.



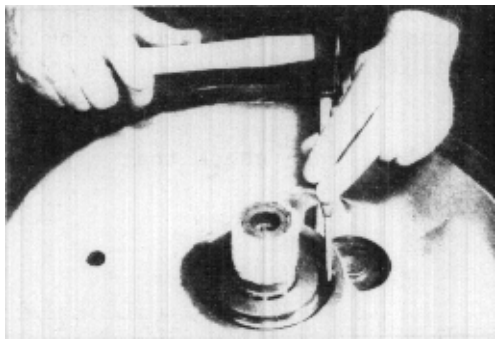
8 Neuen O-Ring einlegen, uaf bündiges Anliegen achten. O-Ring sowie Dicht - und Staublippe des Wellendichtringes einfetten.

Fit new O-Ring, make sure there is a snug fit. Grease O-Ring and lips of shaft seal.



9 Verschlußring montieren, nachsetzen.

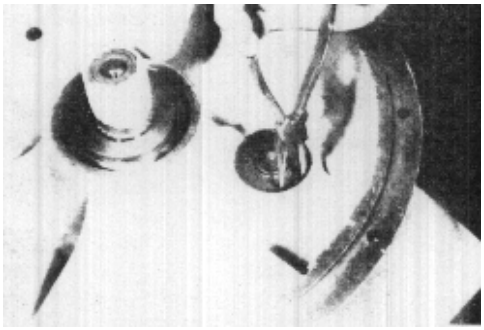
Fit front cover.



10 Sicherungsring mit Durchschlag einsprenger, anschließend Stizkontrolle!

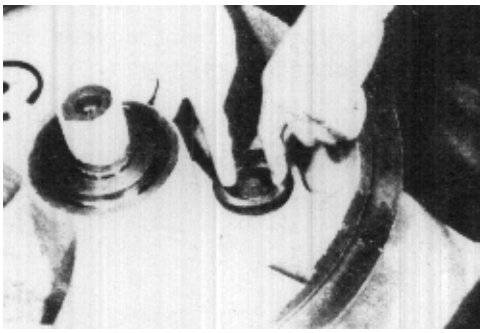
Fit circlip using a punch, then check that circlip is well seated!

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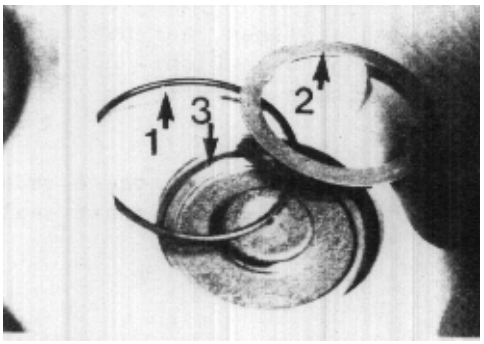
11 Sicherungsring ausbauen.

Remove circlip



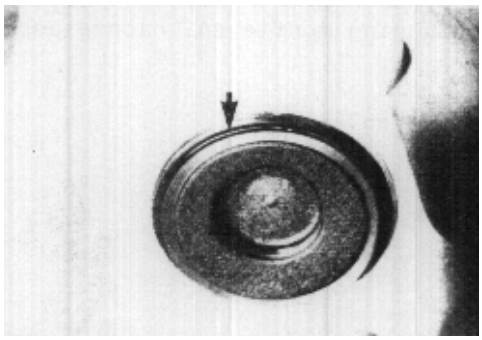
12 Beilagscheiben und O-Ring entnehmen.

Take out shim and O-ring.



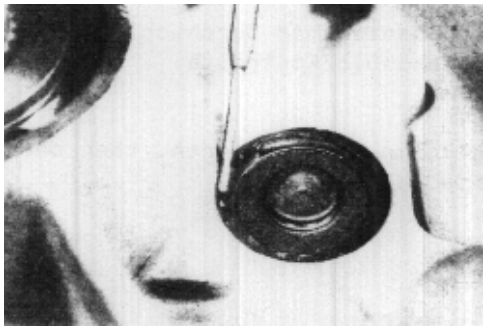
13 Sichtkontrolle: O-Ring (1), Beilagscheibe (2), Nut (3).

Visual check: o-ring (1), shim (2), groove (3).



14 Neuen O-Ring einlegen, auf bündiges Anliegen achten.

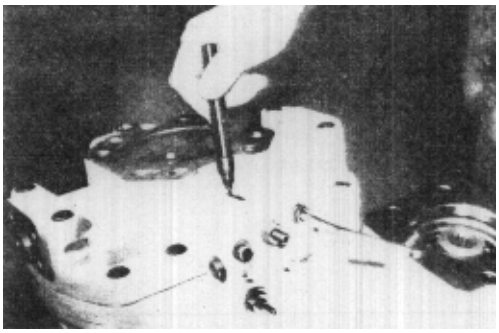
Fit new O-ring, make sure there is a snug fit.



15 Sicherungsring einsprengen, anschließnd Sitz-kontrolle!

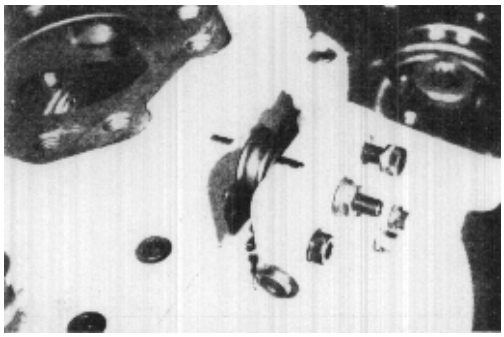
Fit circlip, then check that circlip is well seated!.

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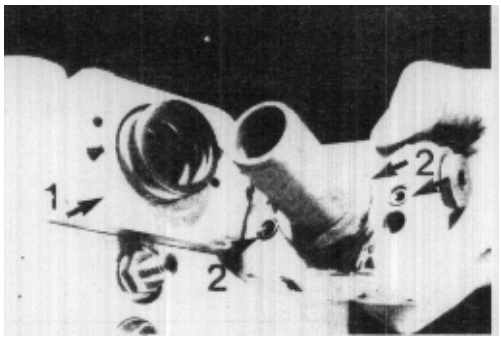
16 Verhältnishdruckregelti zum Genäuse kenn-zeichnen. Befestigungsschrauben ausbauen.

Provide mark or averaging valve and housing. Remove fastening screws.



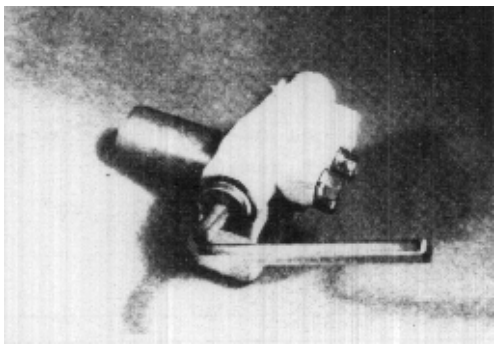
17 Rückstellfeder drückt von innen. Gegenhalten oder mit längerer Schraube entspannen.

Return spring tension from inside. Counterhold or release tension with long screw.



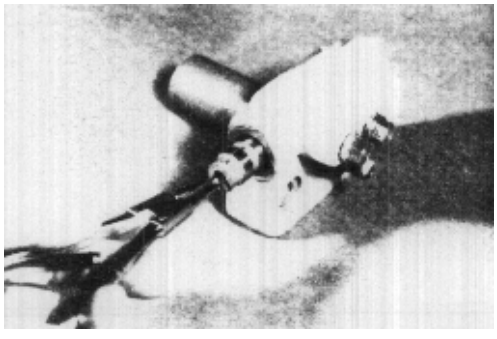
18 Sichtkontrolle: Dichtfläche (1), O-ring und groove (2).

Visual check: Sealing face (1), O-ring and groove (2).



19 Verschlußschraube ausbauen (siehe hierzu auch Bild 30).

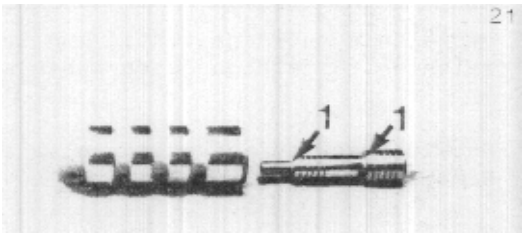
Remove plug (see also Fig. 30).



20 Büchse mit kolben ziehen.

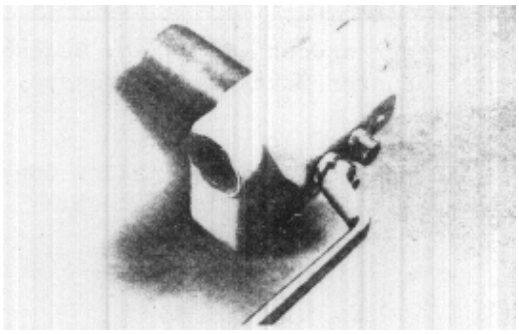
Pull out control bush and piston.

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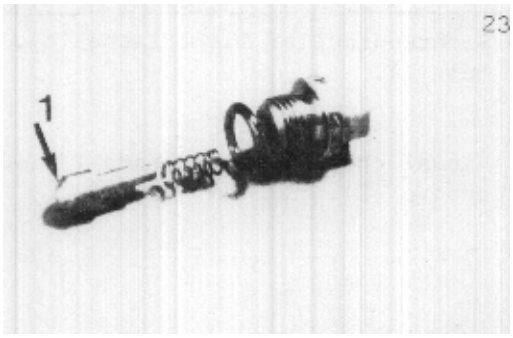
21 Sichtkontrolle: Steuerkanten (1) scharfkantig, Kolben in Büchse leichtgäangig.

Visual check: Control lands (1) should have sharp edges, piston run freely in bush.



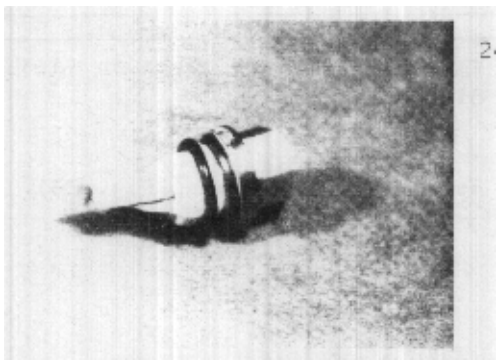
22 Rückschlagventile ausbauen.

Remove check valves.



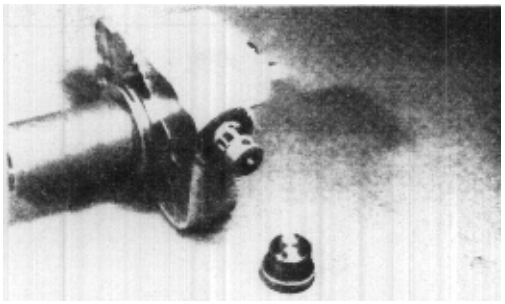
23 Sichtkontrolle: Sitz (1) bucgt eubgescgkagen.

Visual check: Make sure that seat is not grooved.



24 Bei Montage des neuen O-Ringes Gewinde abkleben (Beschädigungsschutz).

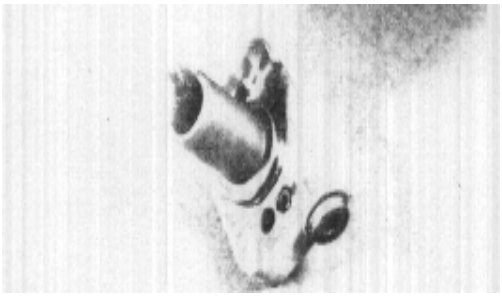
When fiitng new O-Ring, tape up threads to protect against damage.



25 Montage in umgekehrter Folge.

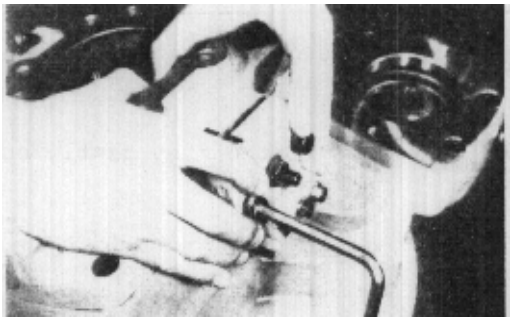
Reassemble in reverse order.

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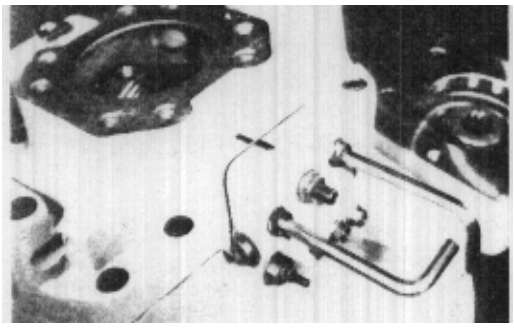
26 O-Ring mit winig Fett ankleben. Eiführungsfase für den kolbenrign des Stellkolbens mit reicnlich Fett bestreichen.

Lightly grease O-rings and place in position. Appy generous amount of grease to control piston ring entry chamfer.



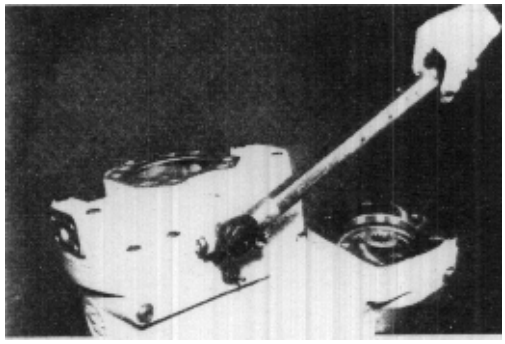
27 Verhältnisdruckregelventil-Genhäause gegen Federkraft aufarücken, mit einer Befestigungsschraube halten. Nicht mit überlangen Schrauben aufziehen, sonst Gefahr der Beschädigung des Kolbenringes.

Push on pressure averaging valve housing against spring force and hold in place with fastening screw. Do not tighten with oversize screws - otherwise piston ring may be damaged.



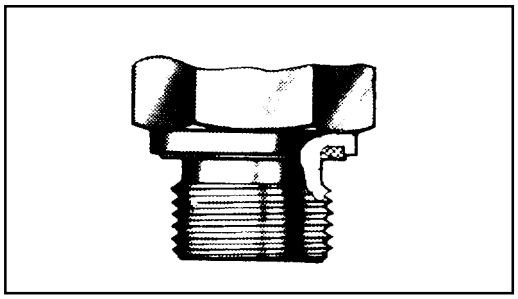
28 Fertigmontage durch gleichmäßiges Eindrehen beider Befestigungsschrauben.

Final assembly by evenly turning both fastening screws.



29 Anziehdrehmomente beachten -siehe Seite 37.

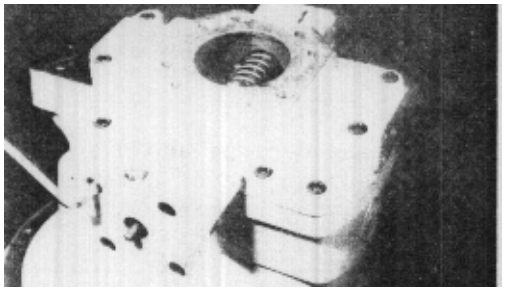
Observe tightening torques - see page 37.



30 Hinweis: Verschlußschrauben und dichtstopfen haben elastische Dichtungen, die nicht gewechselt werden können; deshalb komplett austauschen.

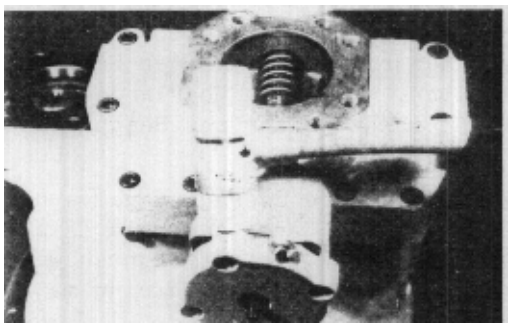
Note: Plugs have flexible seals which cannot be replaced, these must therefore be exchanged complete.

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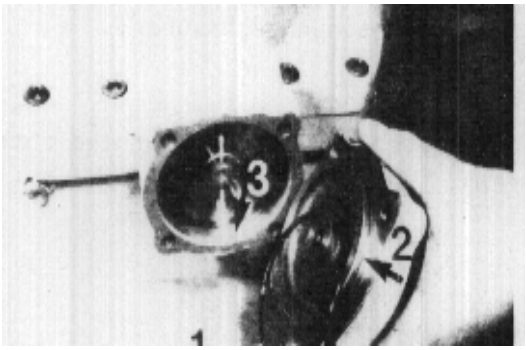
31 Deckelschrauben ausbauen.

Remove cover screws.



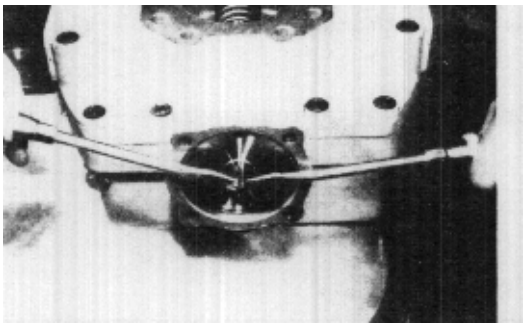
32 Deckel drehen und mit leichten Schlagen abheben.

Turn cover and lift off by gently punching.



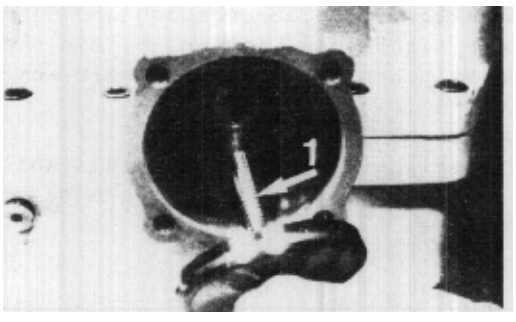
33 Sichtkontrolle: O-Ring (1), Nut (2), Gehäuse (3).

Visual check: O-ring (1), groove (2), housing (3).



34 Kolben ziehen, dazu Schraube als Montagehilfe eindrehen.

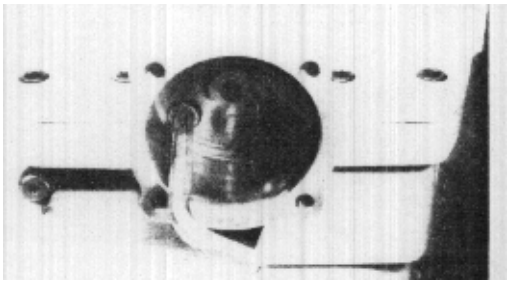
Pull out piston, turning screw for easier removal.



35 Sichtkontrolle: Riefenfrei und keine Einlaufspuren. Auf der kolbenstange (1) können, je nach Anwendung, Scheiben zur Hubbegrenzung beigelegt sein.

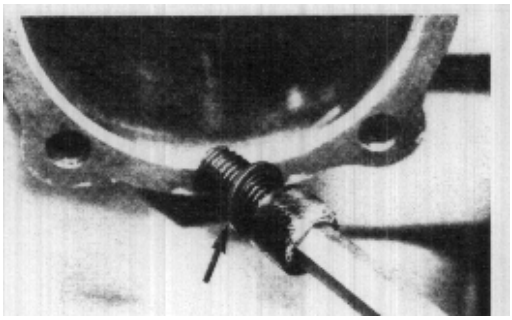
Visual check: Free of scoring and no evidence of wear, the piston rod may be provided with piston stroke limiting washers, depending on

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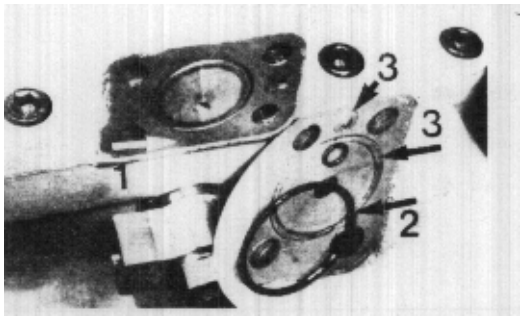
36 Innere Befestigung sschrauben ausbauen.

Remove inner fastening screws.



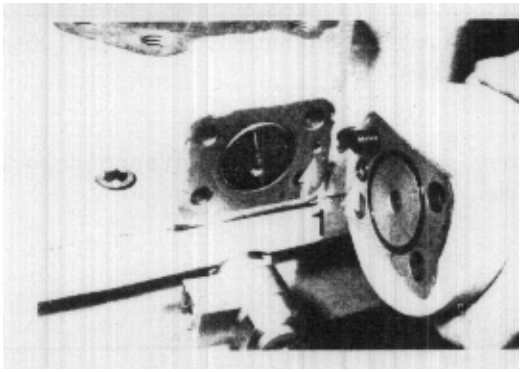
37 Dichtringe auf den Schrauben Uberprufen/aus-wechseln. Gehause abheben.

Check/replace screw seal rings. Lift housing.



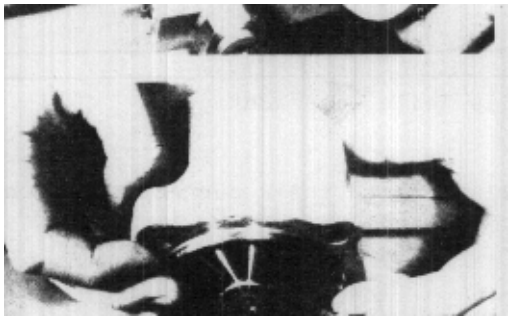
38 Sichtkontrolle: dichtfläche (1) ohne Schaden, O-Ring (2), Nuten (3).

Visual check: Sealing face (1) ohne Schaden, O-rings (2), Nuten (3).



39 Gehäuse montagerichtig (Leckölbohrung (1) aufsetzen.

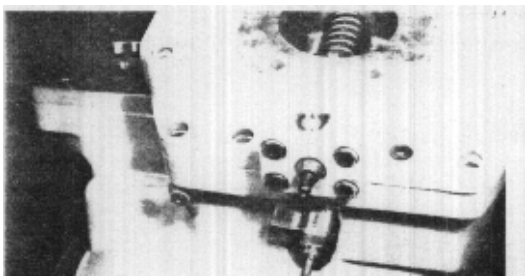
Correctly position housing (oil leakage bore (1).



40 Kolbenring mit reichlich Fett einsetzen, weitere Montage in umgekehrter Folge.

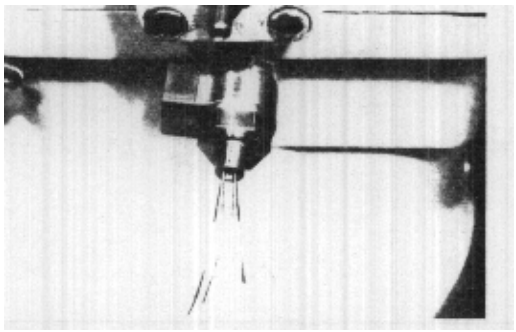
Fit piston ring generously greasing; further reassembly in reverse order.

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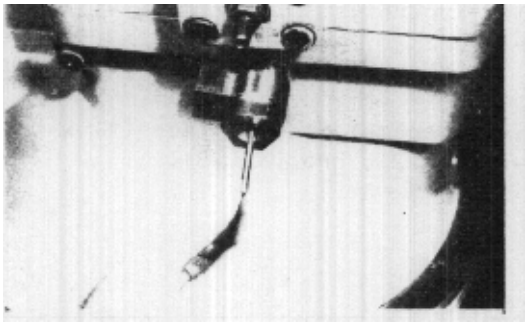
41 Vershlußschraube uasbauen.

Remove sealing plug.



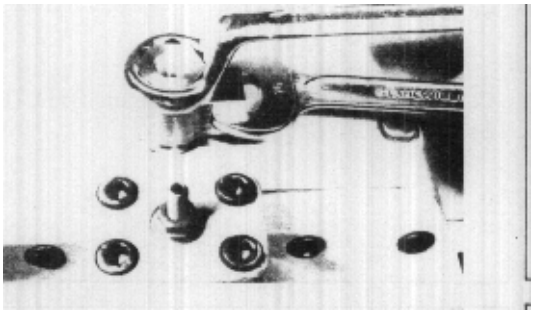
42 Kolben ziehen.

Pull out pistion.



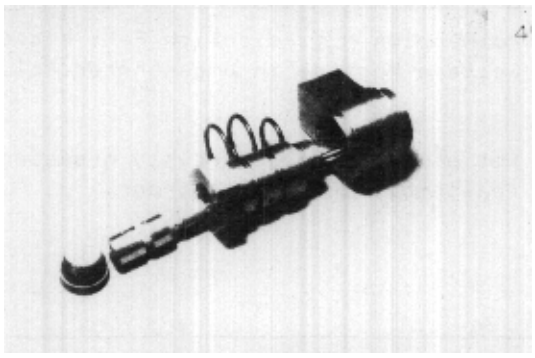
43 Reglerstange entnehmen.

Remove control rod.



44 Einschraubteil ausbauen, am Anschlußstück gegenhalten.

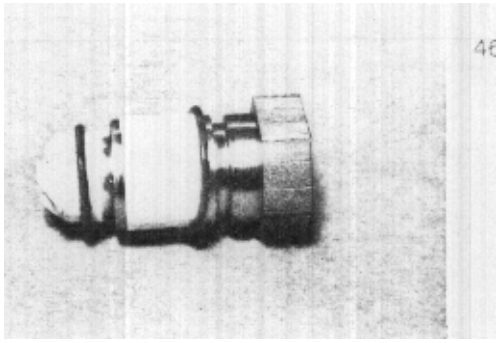
Remove screw-in part, counterhold on connecting piece.



45 Alle Teile lagerichtig.

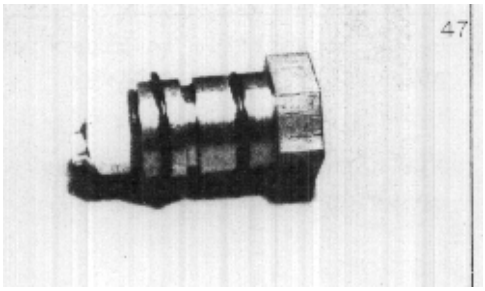
All parts in their correct position.

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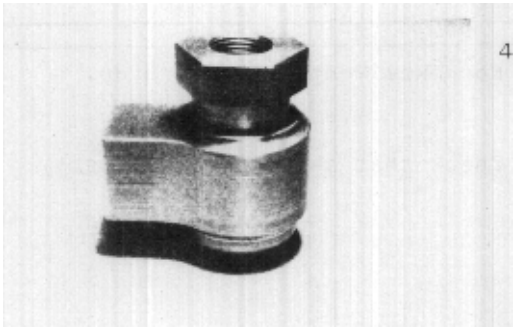
46 Montage des äußeren und inneren O-Ring, Beschädigungsschutz durch klebeband.

Fit outer and inner O-rings. Tape up to prevent damage.



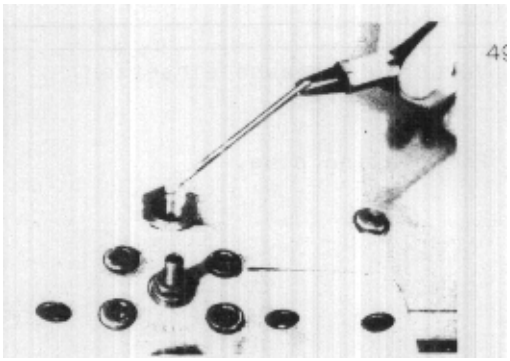
47 Montage des mittleren O-Ringes, nach Montage der O-Renge Einschraubteil einfetten.

Fit center O-ring. After fitting O-rings, grease screw-in part.



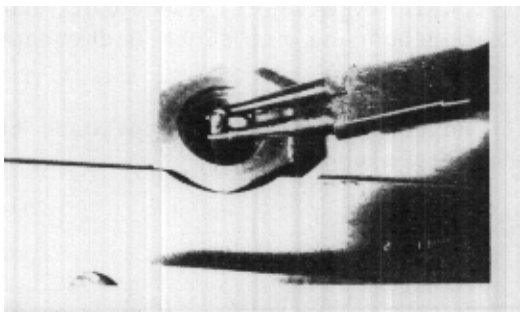
48 Zusammenbau von Einschraubteil und Anschlußatück.

Assemble screw-in part and conneting piece



49 Reglerstange an einem Ende mit reichlich zähem Fett einstreichen.

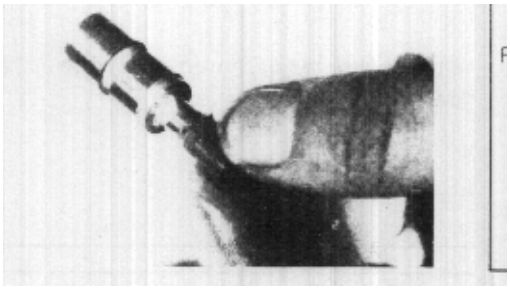
Generously apply viscous grease to one end of control rod.



50 Reglerstange einsetzen; vormontierte Baugruppe: Einschraubteil/Anschlußtück in Pumpengehäuse montieren.

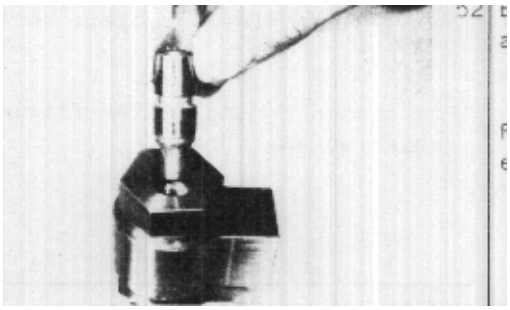
Insert control rod; mount prefitted screw-in part/connecting piece subassembly into pump housing.

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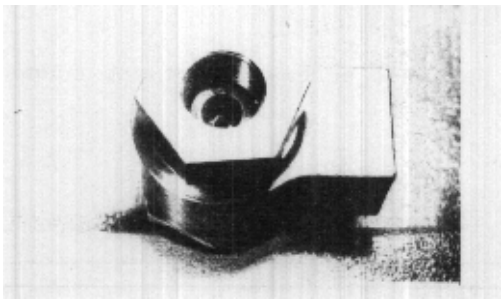
51 Steuerkolben mit Fett in Steuerb•chse einsetzen.

Fit greased control piston into control bush.



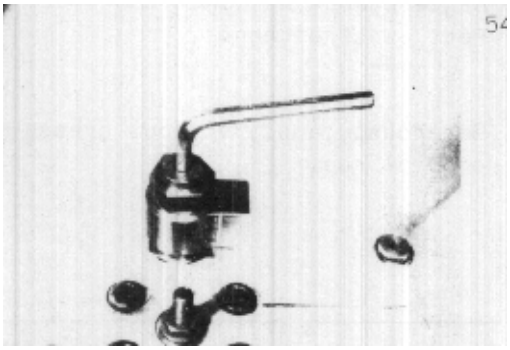
52 Beide Steuerteile in Einschraubteil einbauen.
auf richtige Lage achten.

Fit both control components into screw-in part,
ensuring correct position.



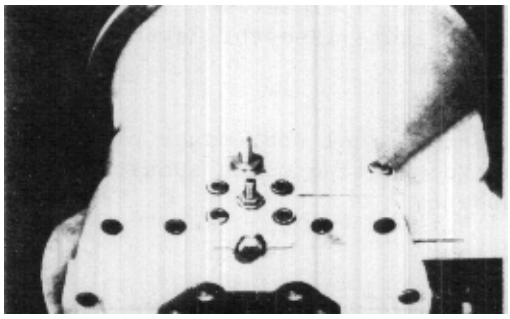
53 Korrekte Montage •berpr•fen.

Check that assembly is correct.



54 Verschluáschraube einsetzen.

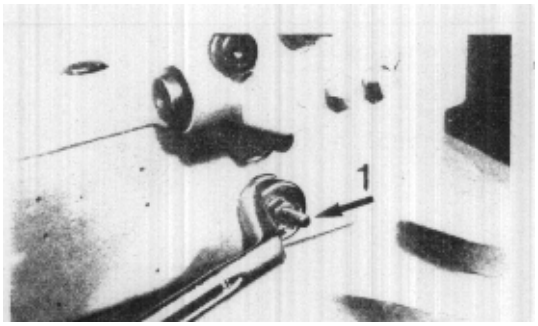
Fit Sealing plug.



55 Ist kein Regelventil eingebaut, dann ist die Gewindebohrung mit einem Dichtstopfen verschlossen.

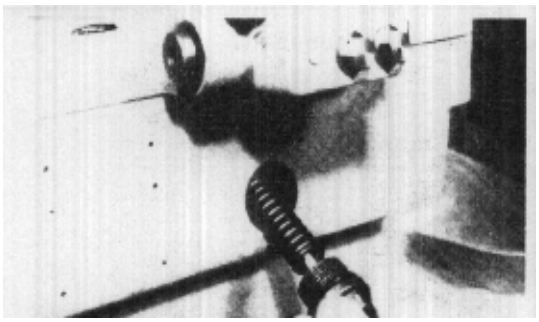
IIf no control valve is provided, the tapped hole is plugged.

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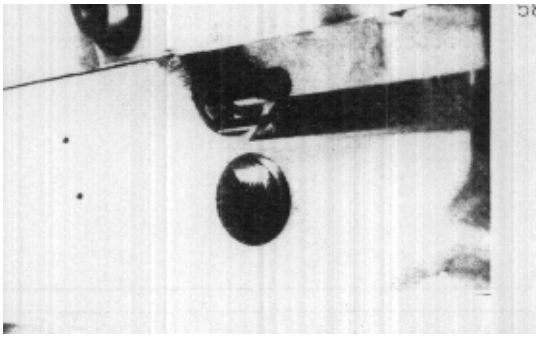
56 Gewindeh•lse f•r Leistungseinstellung ausbauen. Einstellschraube (1) nicht l”sen!

Remove threaded sleeves for power setting. Do not loosen setting screww (1)!



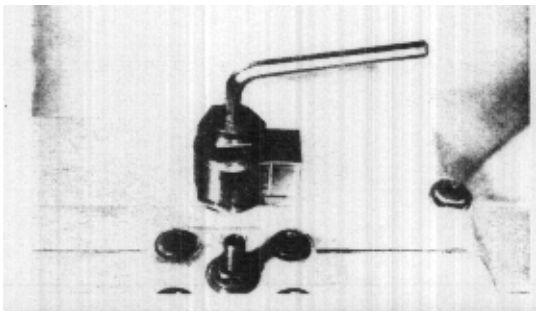
57 Auf Meáfeder achten.

Watch out for measuring spring.



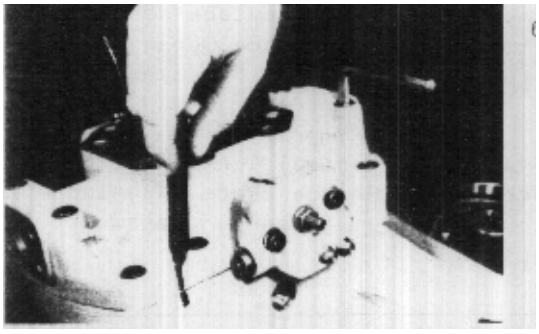
58 Einstellschraube für Feineinstellung ausbauen. Vorher Einstellmaá festhalten (siehe Bild 156 bis 158).

Remove fine adjusment setting screw, after recording setting dimension beforehand (see Figs. 156-158).



59 Dreikreis-Regelventil ausbauen. (Siehe Bild 41 bis 44).

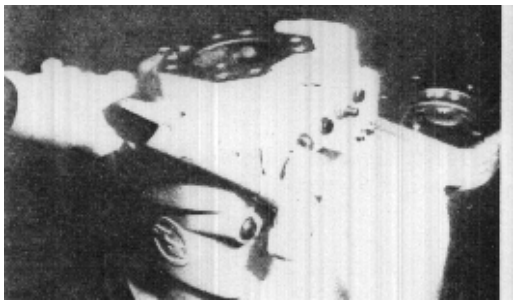
Remove three-circuit control valve (see Figs. 41-44).



60 Gehäuse kennzeichnen, Befestigungsschrauben ausbauen.

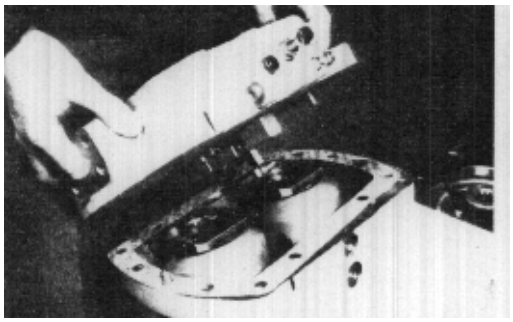
Provide mark on housing, remove fastening screws.

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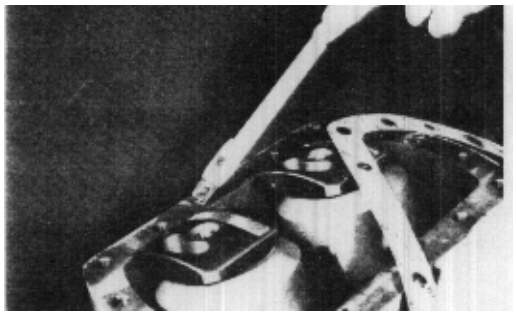
61 Reglergeh„use l”sen.

Free control housing.



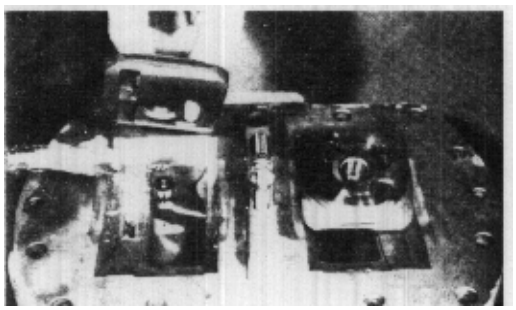
62 Reglergeh„use adheben.

Lift off control housing.



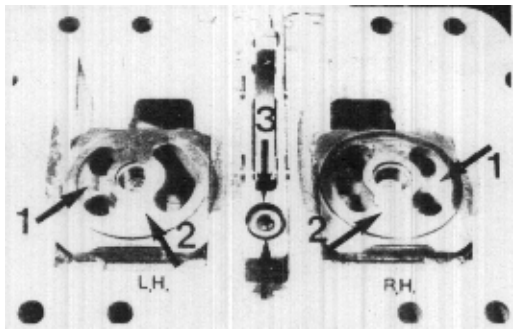
63 Papierdichtung entfernen, Dichtfl„chen s„ubern.

Remove gasket, clean sealing faces.



64 Steuerlinsen mit Fett in Gleitbahn kleben.

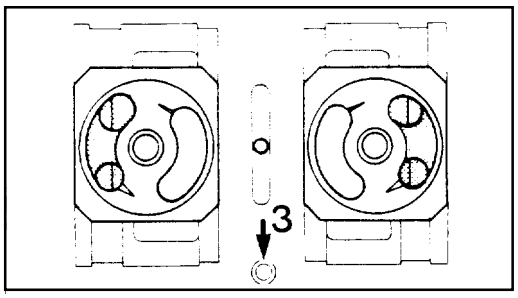
Fit control lenses in sliding surface with grease.



65 Auf richtige Einbaulage der Steuerlinsen achten. Steg (1) groáe Ger„uschkerben (2), Befestigungsschraube f•r lagerbock (3).

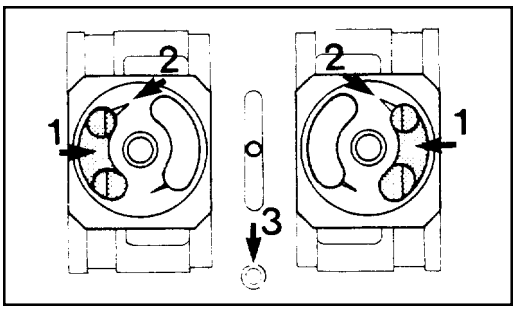
Make sure control lensses are fitted in correct position. Bridge piece (1), large noise damping notches (2), fastening screw for lever support block (3).

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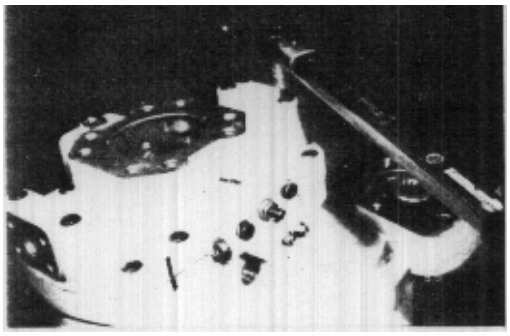
66 Falschmontage
Steg richtig, groáe Ger„uschkerbe falsch. Befestigungsschraube f•r Lagerbock (3).

Wrong
Bridge piece correct, large noise damping notch wrong. Fastening screw for lever support block (3).



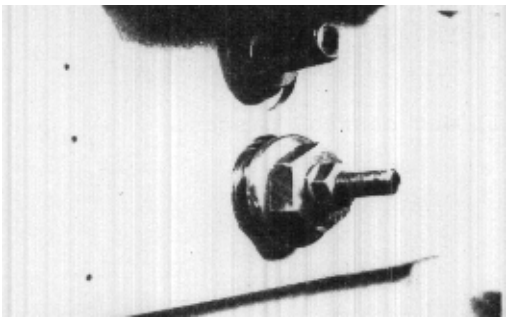
67 Steuerlinsen richtig eingelegt. Steg (1), groáe Ger„uschkerbe (2), Befestigungsschraube f•r lagerbock (3).

Control lenses fitted correctly. Bridge piece (1), large nois damping notch (2), fastening screw for lever support block (3).



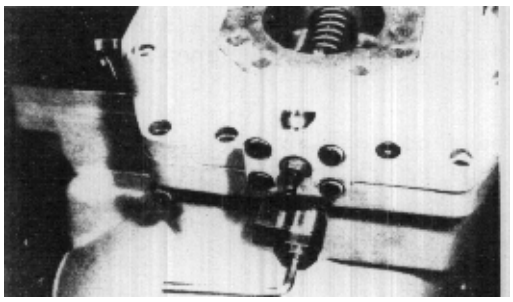
68 Neue Papierdichtung auflegen, Reglergeh„use mon tieren, Befestigungsschrauben mit Drehmomentenschl•ssel anziehen (Momente siehe Seite 37).

Place new gasket, mount control housing, tighten fastening scres by means of a torque wrench. (For torques refer to page 37).



69 Feineinstellung maáhaltig einbauen (Bild 58). Gewindeh•lse f•r Leistungseinstellung montieren.

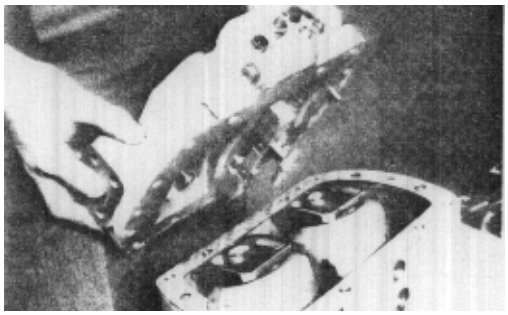
Accurately mount fine adjunstment (Fig. 58). Fit threaded sleeve for power setting.



70 Dreikreis-Regelventil einsetzen (Bild 46-55).

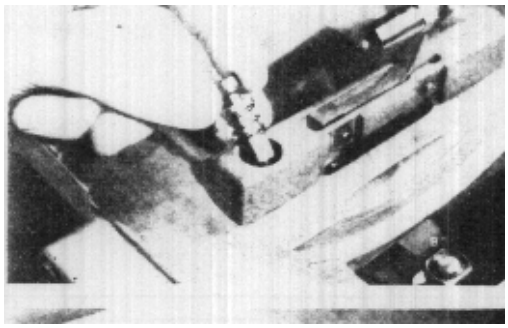
Fit three-circuit control valve (Figs. 46-55).

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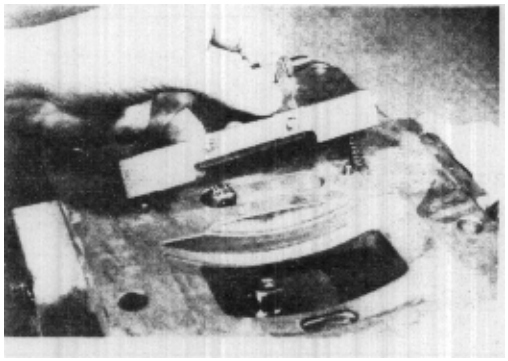
71 Regrlergeh„use abnehmen (Bild 56-62).

Remove control housing (Figs. 56-62).



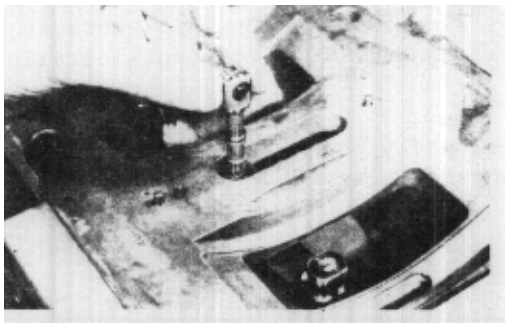
72 Schraube im Lagerbock mit Distanzhülse und Druckfeder entnehmen.

Remove lever support block screw together with spacer and compression spring.



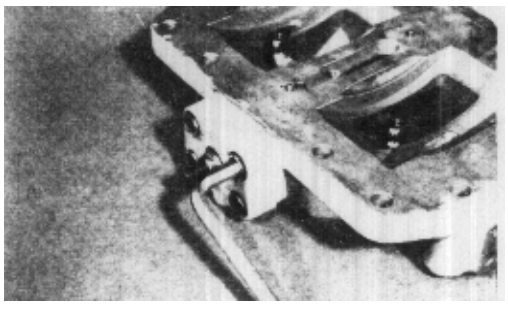
73 Lagerbock abheben.

Lift off lever support block.



74 Steuerkolben Ziehen.

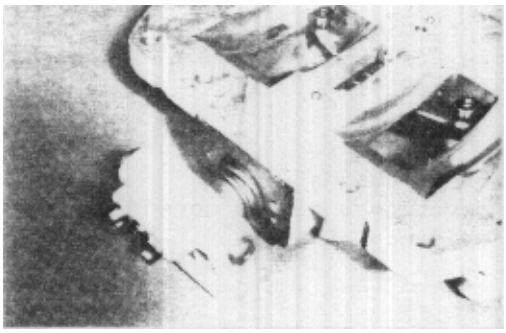
Pull out control piston.



75 Deckel mit Omax-Anschlagschraube abbauen (Einstellung nicht ver„nderb).

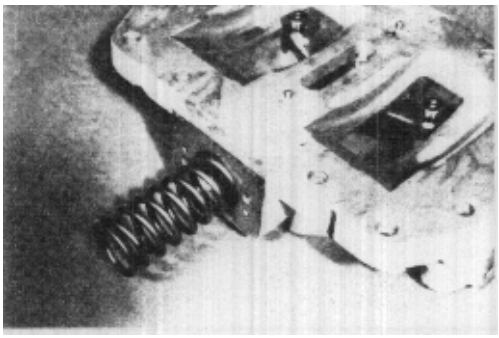
Remove cover with Omax stop screw (do not change position of stop).

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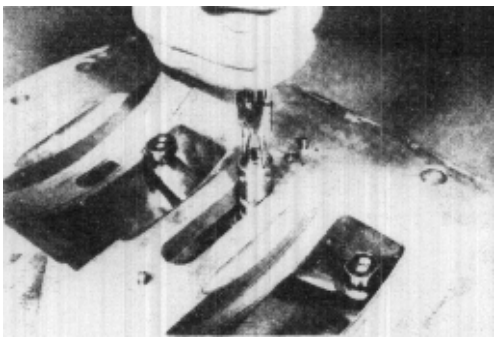
76 Druckmittler demontieren. (Bild 16-23).

Remove pressure sensing head (Figs. 16-23)



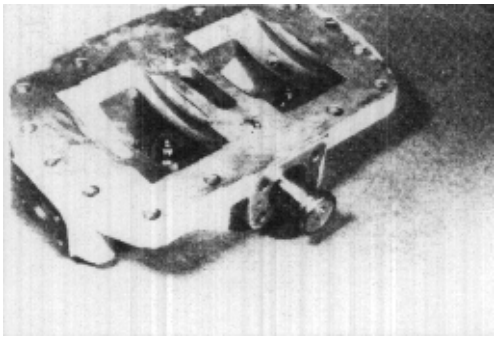
77 Druckfeder entnehmen.

Remove spring.



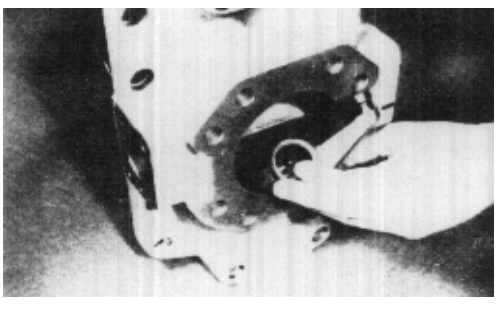
78 Steuerb•chse zeihen.

Pull out control bush.



79 Stellkolben ausschieben.

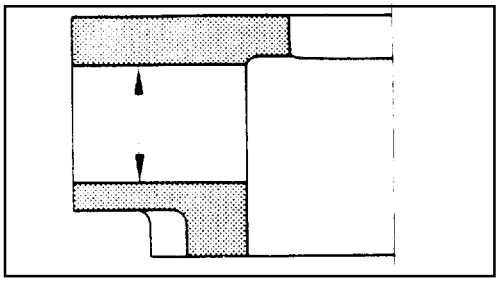
Push out control piston.



80 Schwenkgabel •ber Sauganschluá entnehmen.

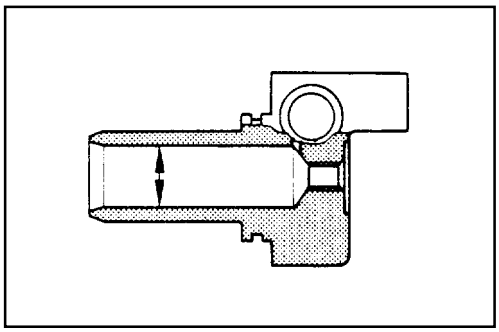
Remove swivel fork via suction port. Check/fit control parts.

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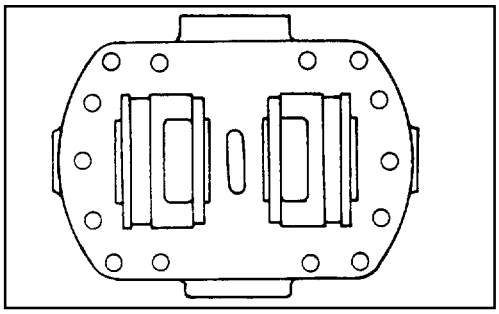
81 Reglergeh„use
Groáe Stellkolbenbohrung riefenfrei und micht ausgelaufen

Control housing
large control piston bore free of scoring and no evidence of wear.



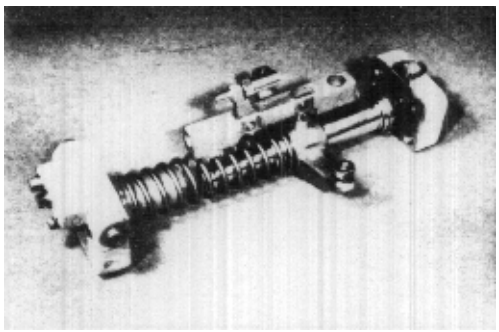
82 Verh„ltnisdruckregelventil-Geh„use
Kleine Stellkolbenbohrung riefenfrei und nicht ausgelafen.

Pressure averaging valve housing
Small control piston bore free of scoring and no evidence of wear.



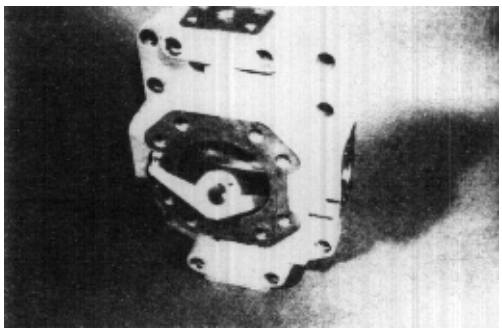
83 Reglergeh„use
Gleitbahn und Seitenf•hrung der Steuerlinser riefenfrei, nicht ausgelaufen.

Control housing
Sliding surface and side guides of control lenses free of scoring and no evidence of wear.



84 Die Innenteile lagerichtig.

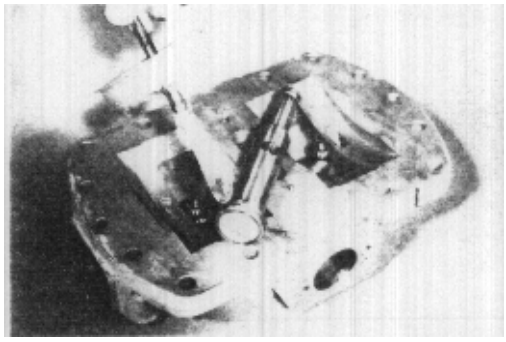
Inner parts in correct position.



85 Schwenkgabel lagerichtig einlegen. Bearbeiteter Bund ist Anlage f•r die Druckfeder.

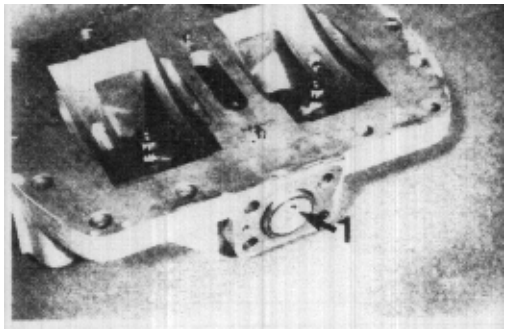
Correctly fit swivel fork. Apply compression spring to machined shoulder.

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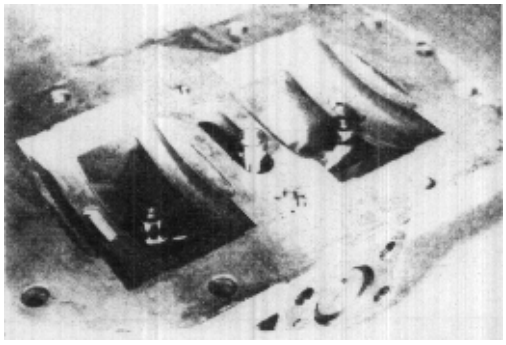
86 Kolbenring ainfetten.

Grease piston rings.



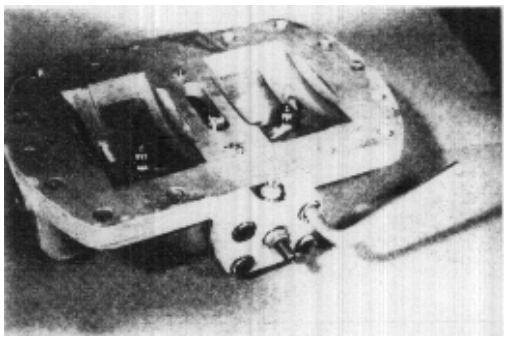
87 Stellkolben einsetzen. Auf die richtige Lage der exzentrischen Steuer”lbohrung (1) in der roáen Stellkolbenstirnfl„che achten.

Insert control piston. Make sure the eccentric pilot oil bore (1) in the large control piston front face is in the correct position.



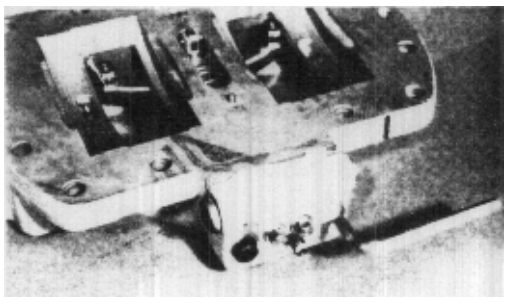
88 Steuerb•chse einsetzen.

Insert control bush.



89 Decke mit Omax-Anschlag Montieren.

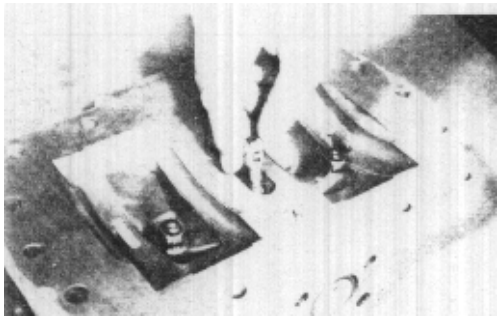
Fit cover with Omax stop.



90 Druckmittler montieren (Bild 24-30).

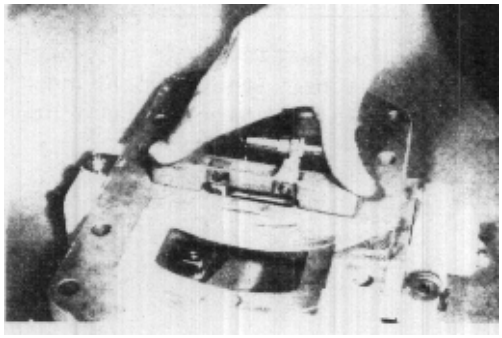
Mount pressure sensing head (Figs. 24-30).

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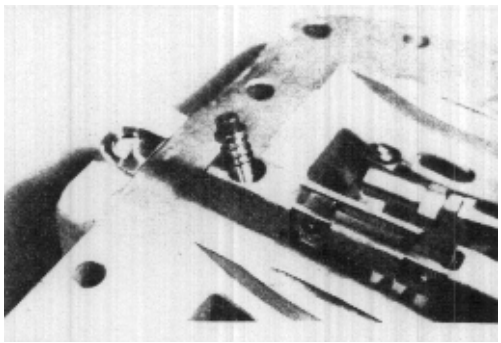
91 Steuerkolben einsetzen.

Insert control piston.



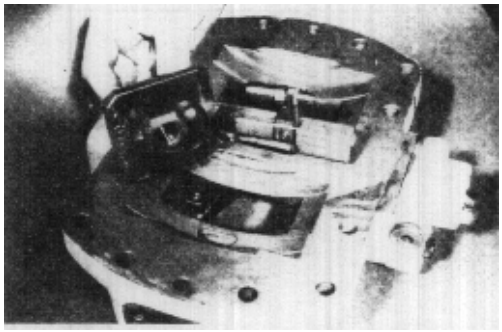
92 Lagerbock montieren (kr„ftig andr•cken).

Fit lever support block - press firmly into position.



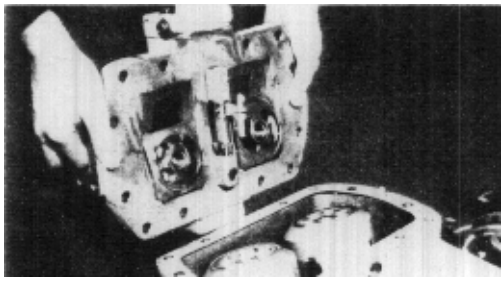
93 Befestigungsschraube mit Distanzh•lse und Druck feder einsetzen.

Insert fastening screw with spacer and spring.



94 Steuerlinsen lagerichtig ankleben, vergl. Bild 65 bis 67.

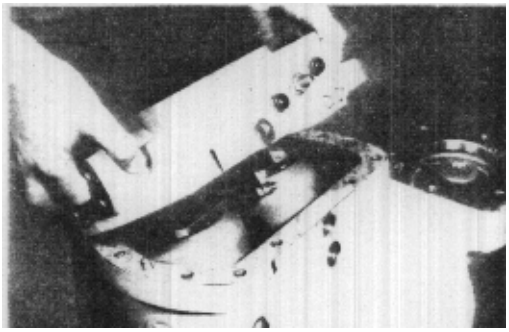
Fit control lenses, making sure they are in correct position, see Figs. 65-67.



95 Reglergeh„use Auflegen und Pumpe komplettieren, (Bild 63-70).

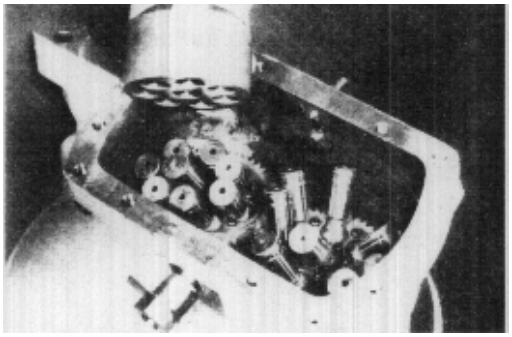
Fit control housing and complete pump assembly (see Figs. 63-70).

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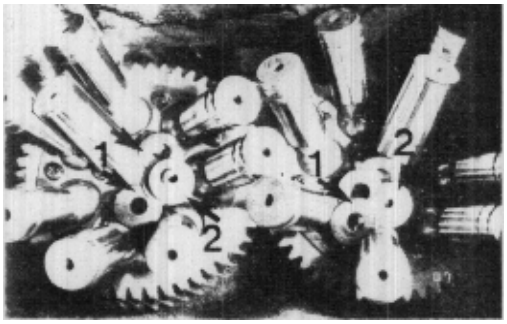
96 Reglergeh„use demontieren, (Bild 56-62).

Remove control housing (Figs. 56-62).



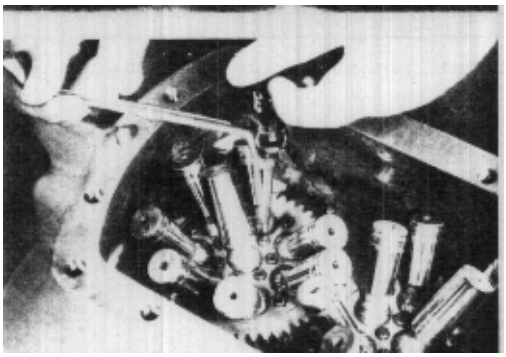
97 Zylinder abziehen.

Remove cylinder block.



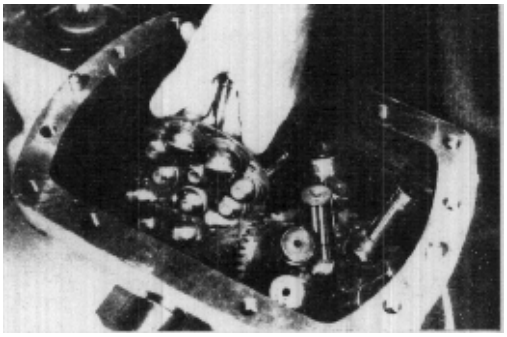
98 Tellerfedern (1) Federteller (2) entnehmen.

Remove cup spring (1) and spring plates (2).



99 Befestigungsschrauben der R•ckzugplatte ausbauen (eingeklebt).

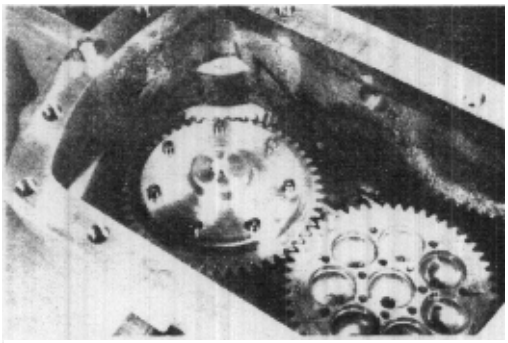
Remove fastening screws fo retaining plate (loctited).



100 Kolbensatz mit Schrauben, R•ckzugplatte und Mittelzapfen ausheben.

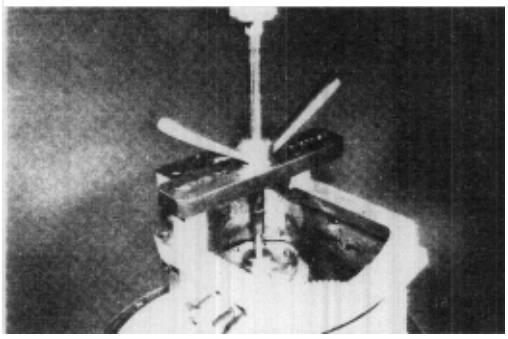
Lift out piston assembly with screws, retaining plate and center pin.

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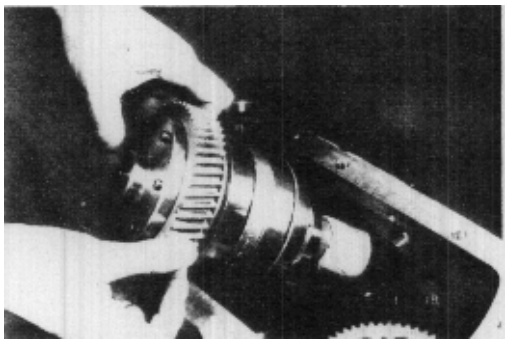
101 Platte der Ausziehvorrichtung auf Triebflansch montieren.

Fit plate of extractor device on drive flanges.



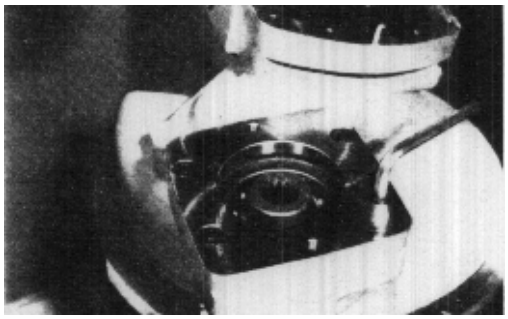
102 Vorrichtung komplett aufbauen, Triebwelle ziehen.

Assemble rest of extractor and pull out drive shaft.



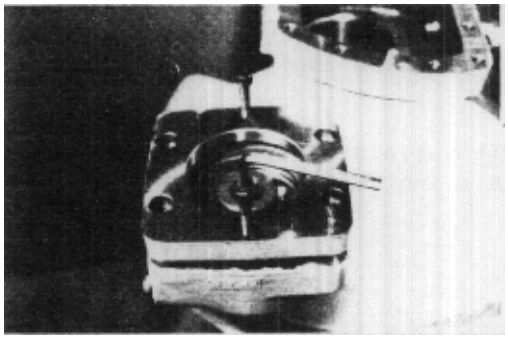
103 Triebwelle ausheben.

Lift outj drive shaft.



104 Befestigungsschrauben ausbauen.

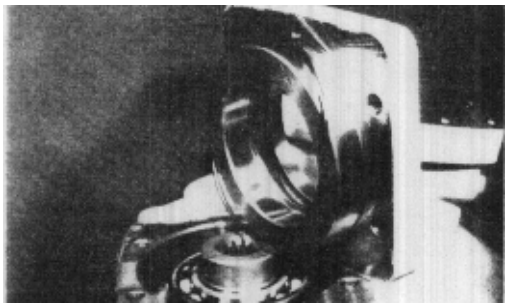
Remove fastening screws.



105 Lagerdeckel adbrücken.

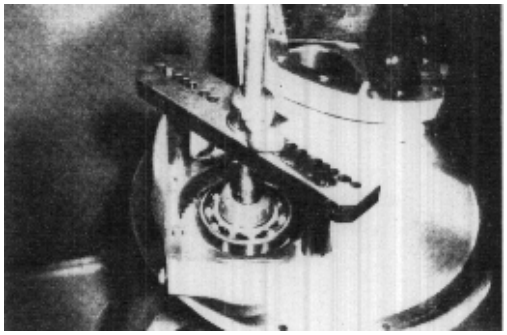
Prize off bearing cap.

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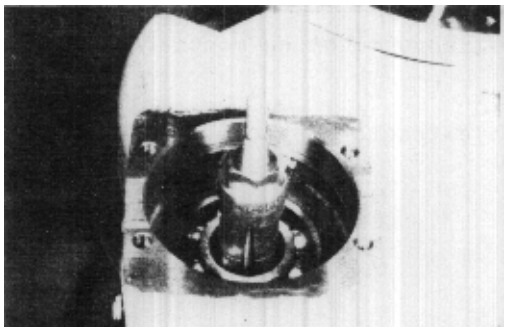
106 Bei Undechtheit Sichtkontrolle von O-Ring, Gehuse und Nut.

In the event of leakage, visual check of O-ring, housing and groove.



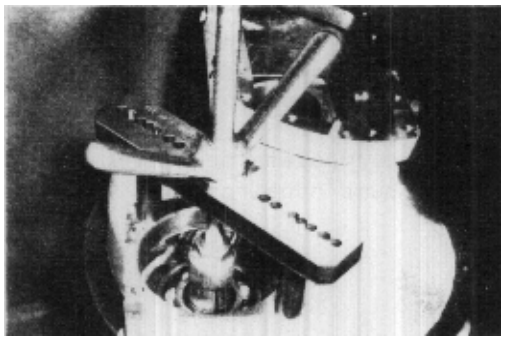
107 Abziehvorrichtung montieren. Abtriebsritzel ziehen.

Fit extractor device. Pull out output pinion.



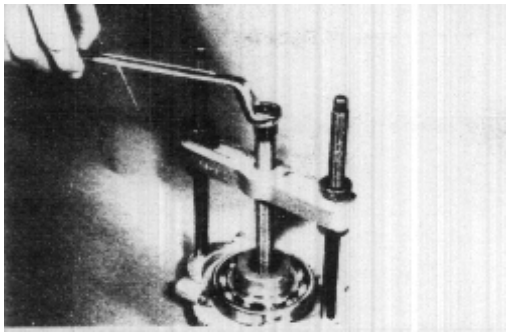
108 Lagerabziehvorrichtung einsetzen.

Fit bearing extractor device



109 Vorrichtung komplett aufbauen und Lager ziehen.

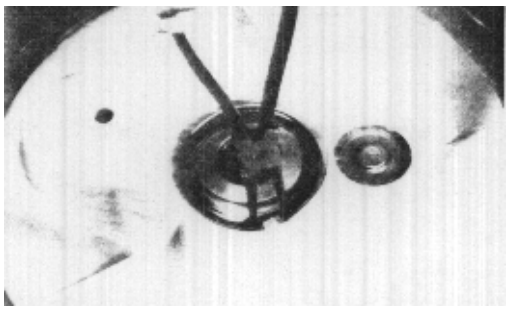
Completely mount device and pull bearing.



110 Ritzellager abziehen.

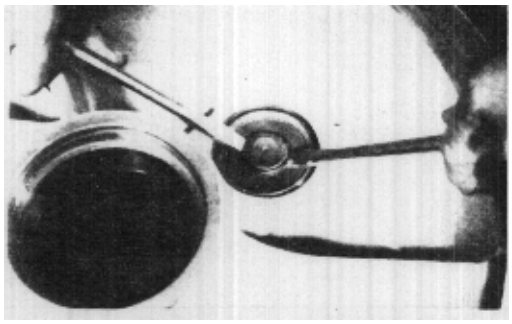
Pull out pinion bearing.

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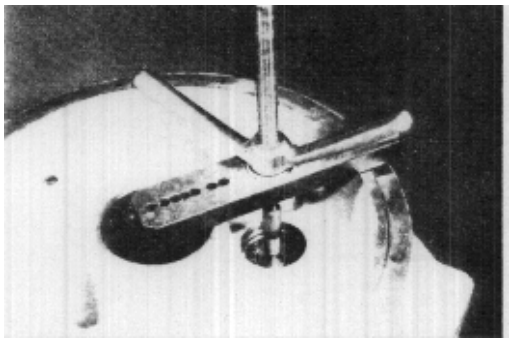
111 Verschluáring demontieren (Bild 2 und 3).

Remove front cover (Figs. 2 and 3).



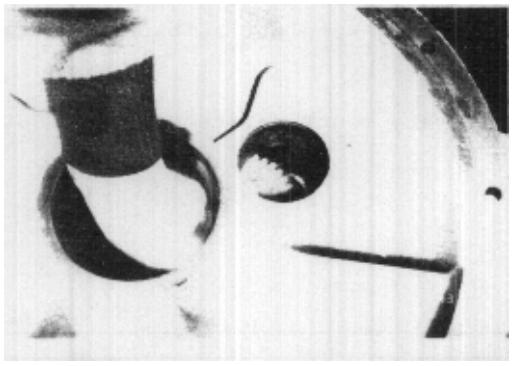
112 Zwischenraddeckel demontieren, vorher Ausbau des Sicherungsringes (Bild 11) und der Beilagscheiben (Bild 12).

Remove intermediate gear cap, take out circlip (Fig. 11) and shims (Figs. 12) beforehand.



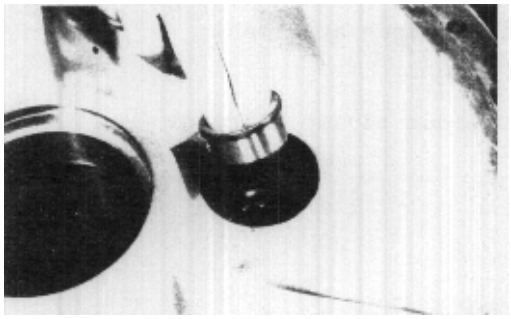
113 Ausziehvorrichtung montieren, Ritzel ziehen,

Fit extractor device, pull out pinion.



114 Zwischenrad vom Einbauort entnehmen und in das Pumpengeh„use legen.

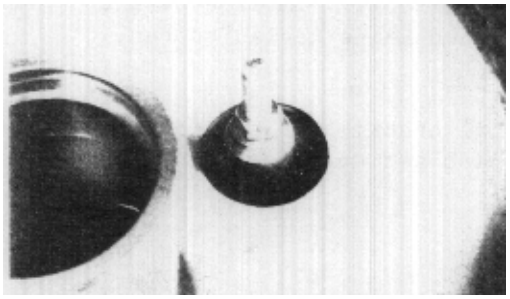
Remove intermediate gear from its position and place in pump housing.



115 Innenring des hinteren lagers entnehmen.

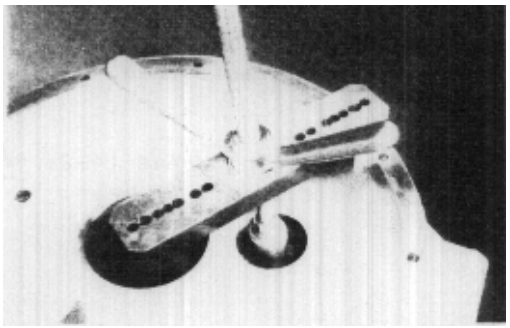
Remove inner raceway of bearing at the back.

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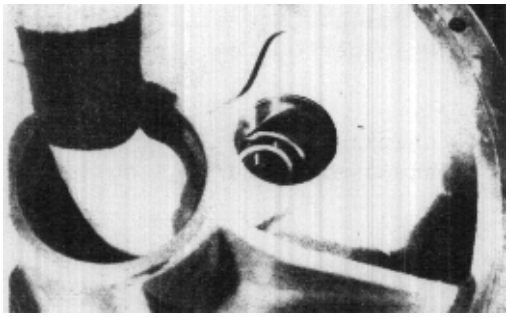
116 Lagerabziehvorrichtung einsetzen.

Fit bearing extractor device.



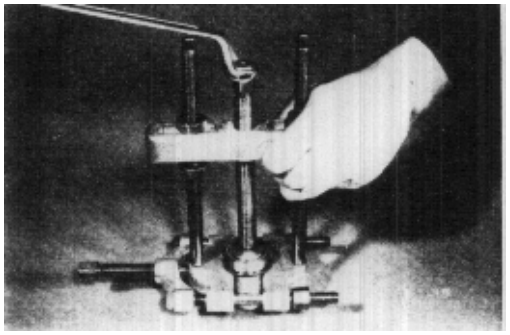
117 Abziehvorrichtung komplettieren, Lager ausziehen.

Complete extractor device, pull out bearing.



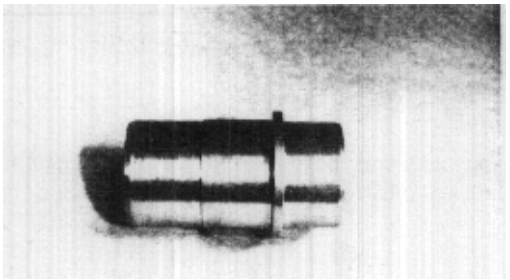
118 Lager •ber Triebwellenbohrung entnehmen.

Pull out bearing via drive shaft bore.



119 Lagerinnenring vom Ritzel abziehen.

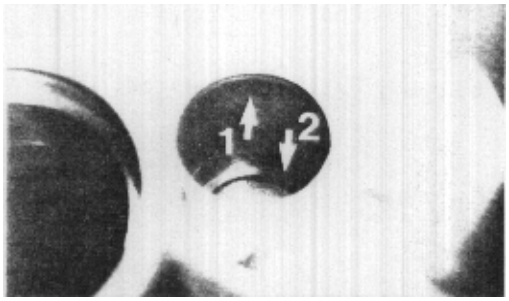
Pull inner raceway off pinion.



120 Sichtkontrolle: lagersitze riefenfrei, Innenringe der Lager d•rfen sich nicht gecrent haben Paáfedersitz nicht ausgeschlagen.

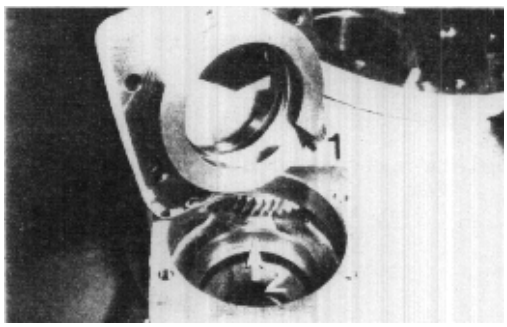
Visual check: Bearing seats free of scoring, inner raceways of bearings must not have turned. Key seat must show no evidence of wear.

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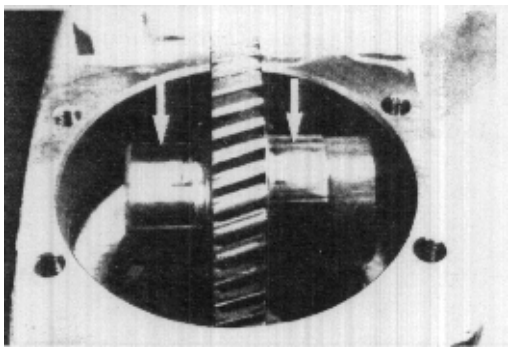
121 Sichtkontrolle: Im lagerbereich (1+2) riefen-frei und keine Einlaufspuren.

Visual check: bearing areas (1+2) free of scoring and no evidence of wear.



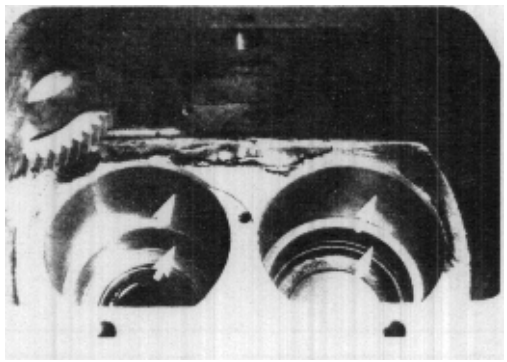
122 Sichtkontrolle: Im Lagerbereiche (1+2) riefen-frei und keine Einlaufspuren.

Visual check: bearing areas (1+2) free of scoring and no evidence of wear.



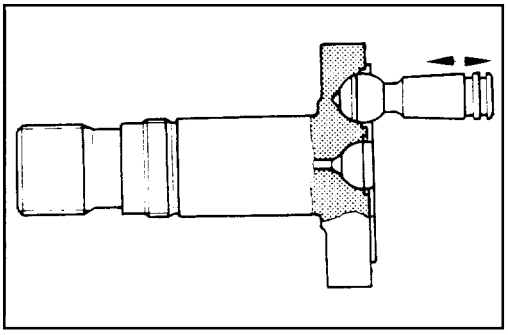
123 Sichtkontrolle: Lagersitze riefenfrei, Inner-ringe der Lager d•rfen sich nicht gedrent haben.

Visual check: bearing seats free of scoring, inner raceways of bearings must not have turned.



124 Sichtkontrolle: Im lagerbereich (1+2) riefen-frei und keine Einlaufspuren.

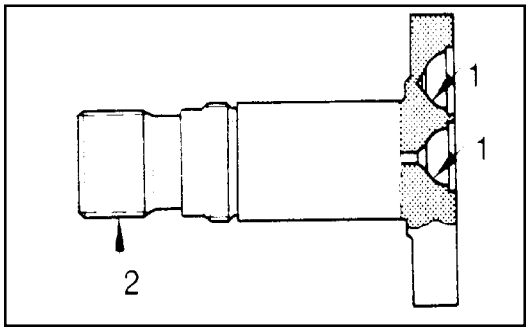
Visual check: bearing areas (1+2) free of coring and no evidence of wear.



125 Axiales Kolbenspiel. (šberpr•fung mit montier-ter Rückzugplate).

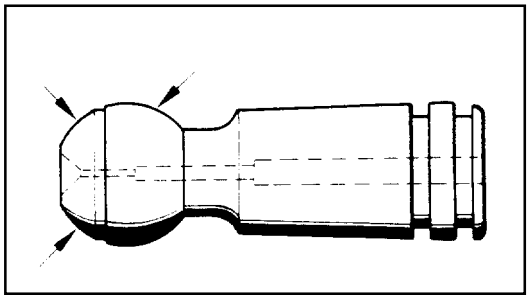
Axial piston play. (Inspection with the re-taining plate mounted).

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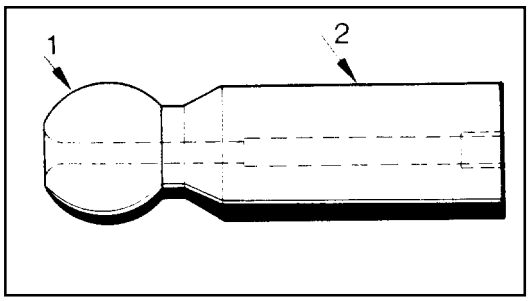
126 Triebwellen
1) Kalotten riefenfrei und keine Pittings.
2) Kein Passungsrost, nicht ausgeschlagen.

Drive shafts
1) Cups free of scratches and no pitting.
2) Free of corrosion, erosion or fretting; no damage to splines or keyways.



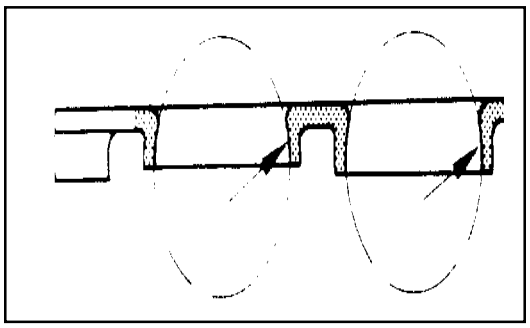
127 Kolben
Riefenfrei und keine Pittings.

Piston
No scoring and no pitting.



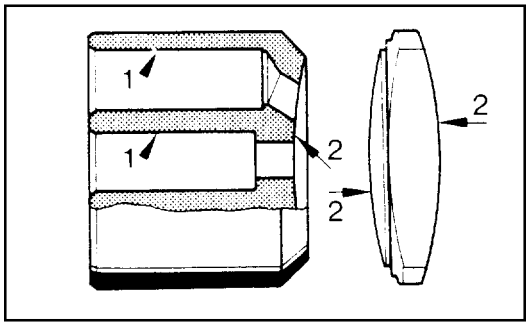
128 Mittelzapfen
Riefenfrei und keine Pittings.

Center pin
No scoring and no pitting.



129 Rükzugplatte
Riefenfrei und keine Ausbrüche.

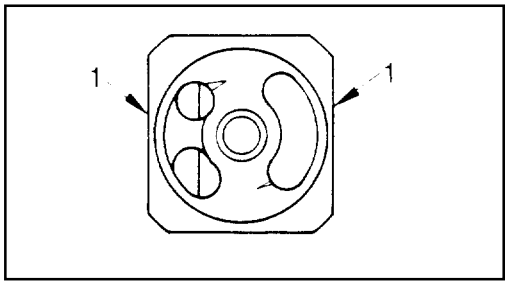
Retaining plate
Free of scoring and no evidence of wear.



130 Zylinder/Steuerlinse
1) Bogrungen riefenfrei, nicht ausgelaufen.
2) Gleichm„áiges Tragbila, riá-und riefenfrei.

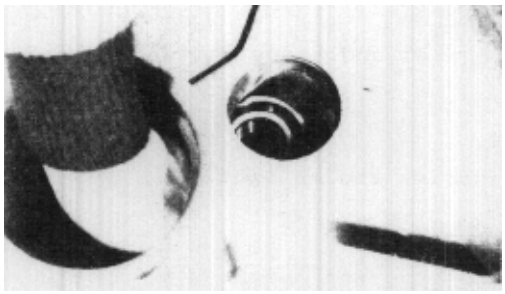
Cylinder block/control len
1) Bores free of scoring, no evidence of wear.
2) Faces smooth and even, free of cracks and scoring.

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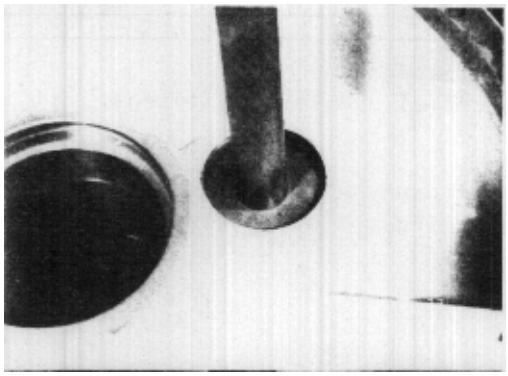
131 Steuerlinse
Seitenf•hrung nicht eingelaufen und riefenfrei.

Control lens
Side guide shows no evidence of wear and is free of scoring.



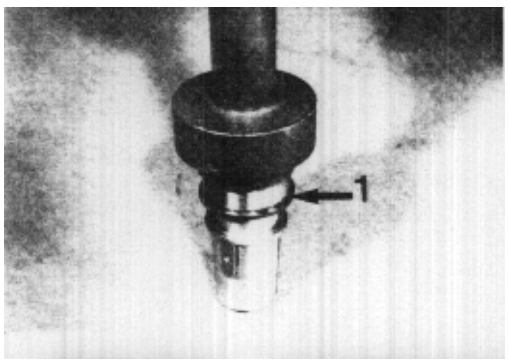
132 Groáes Zwischenradlager, seitenrichtig •ber Montageort legen.

Large intermediate gear bearing, apply to mounting site true to side.



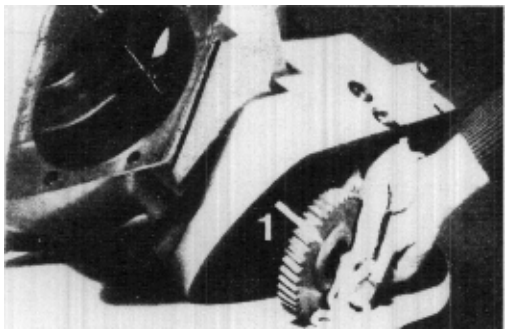
133 Lager einpressen. Preákraft nur auf den Auáenring des Lagers.

Press bearing into position. Take care to put pressure only on the outer rings of bearing.



134 Innenring des neuen Lagers seitenrichtig aupressen. (Bord 1).

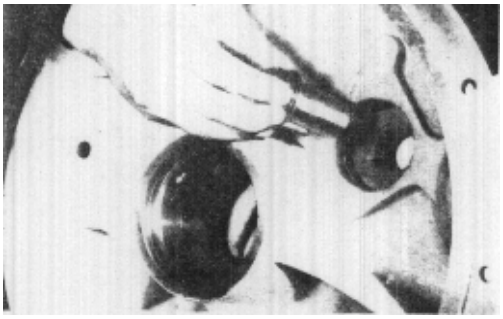
Press inner raceway of new bearing into position true to side (rim 1).



135 Zwischenrad auf 90ø C erw rmen und am Montageort ablegen. Einbaulage (=Bund 1) beachten.

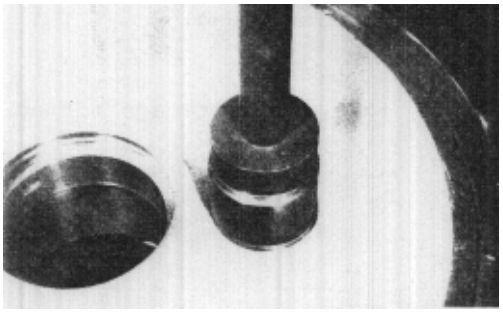
Pre-warm intermediate gear to 90ø C and place in mounting site. Observe position for inserting (shoulder 1).

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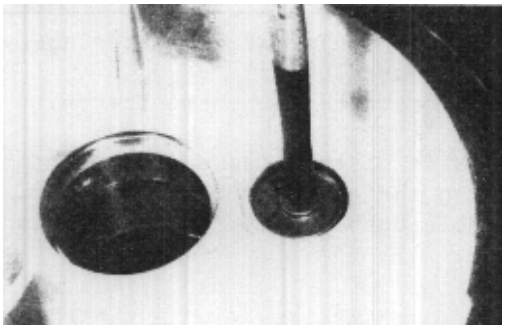
136 Paßfeder (1) zur Paáfedernut im Zahnrad ausrichten, z•gig einpressen.

Align key (1) with keyway in gear, press in swiftly.



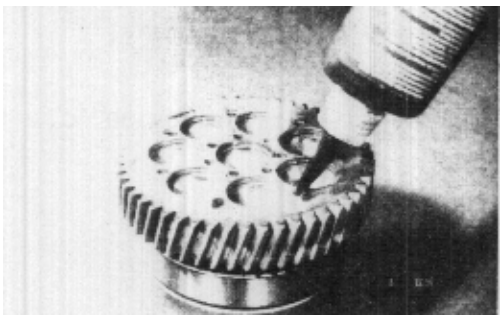
137 Äuáeres Zwischenradlager einpressen. Preákraft nur auf Auánning.

Press in outer intermediate gear bearing. Make sure to put pressure only on outer ring.



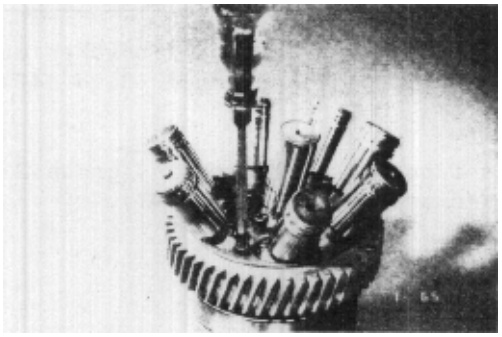
138 Deckel einsetzen. Weitere Fertigmontage siehe Bild 13-15.

Insert cap. For further assembly refer to figs. 13-15.



139 Schraubensicherungs eintr„feln (Loctite 242). Die Gewindebohrungen m•ssen absolut frei sein von ™l, Fett, Staub oder anderen Verschmutzungen, welche die Schraubensicherung gef„hrden.

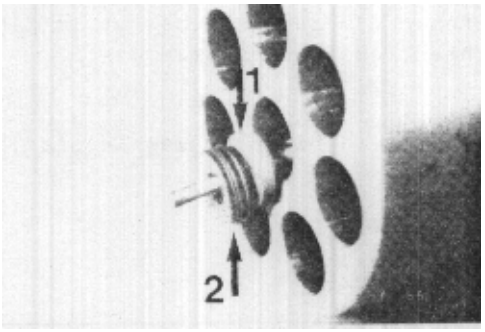
Apply Loctite 242 to screw lock. Tapped holes must be absolutely free of oil, grease, dirt and other contaminations which may impair screw lock.



140 Kolbensatz, Mittelzapfen und R•ckzugplatte aufsetzen. Befestigungsschrauben montiere.

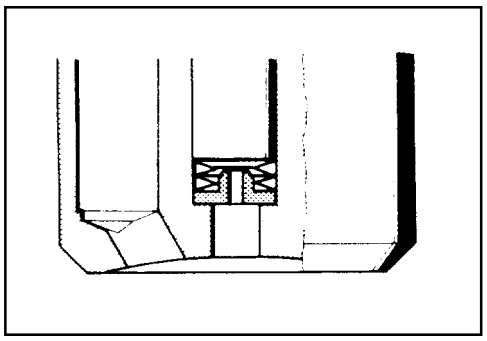
Place piston assembly, center pin and retaining plate into position, fit fastening screws.

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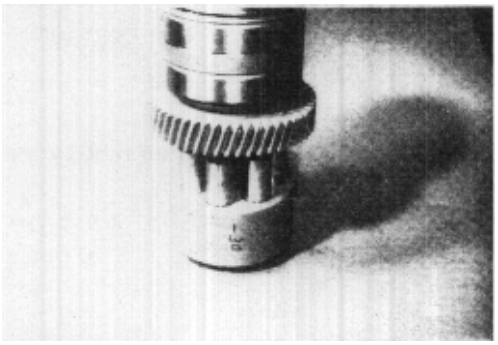
141 Federteller (1) und Tellerfederr (2) mit Fett lagerichtig einkleben.

Fit spring plate (1) and cup springs (2) in correct position with grease.



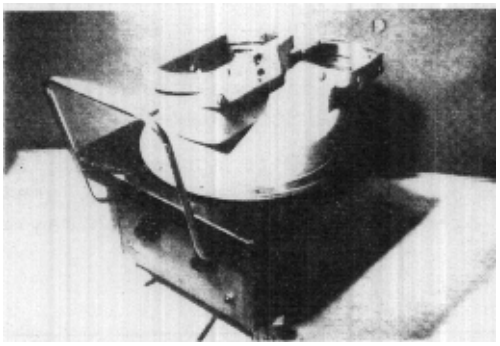
142 Die richtige Schichtung.

Make sure that all parts are fitted correctly.



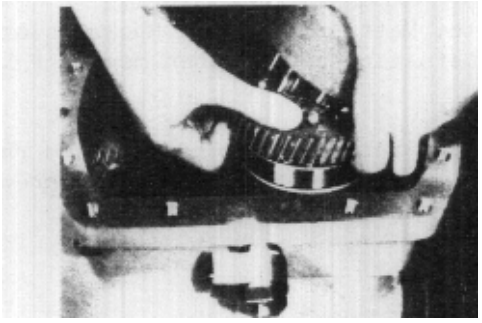
143 Kolben einf„deln. Weiche Unterlage verwenden - Besch„digungsschutz!
Beide Triebwerke so vormontieren.

Trhead in piston. Use soft support to prevent sliding surface from being damaged. Pre-assemble both rotary groups in this way.



144 Gehäuse auf 80 C erwärmen.

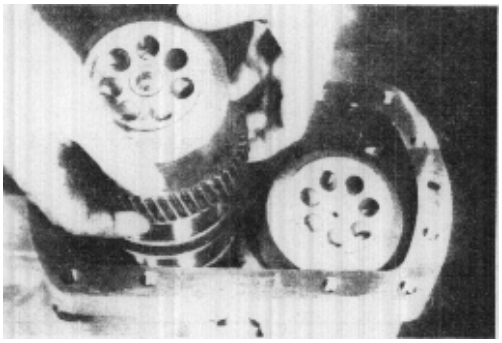
Pre-warm housing to approx 80 C.



145 Vormontiertes Triebwerk 2 trocken einsetzen. Zahnmarkierung ausrichten (Bild 147).

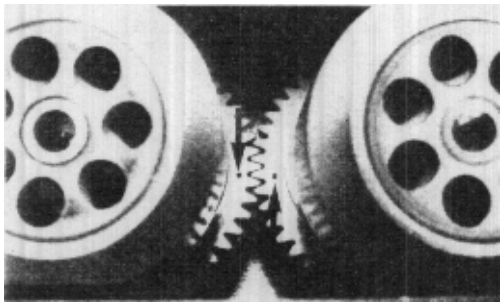
Insert pre-assembled rotary group 2 dry. Align marked gear teeth (Fig. 147).

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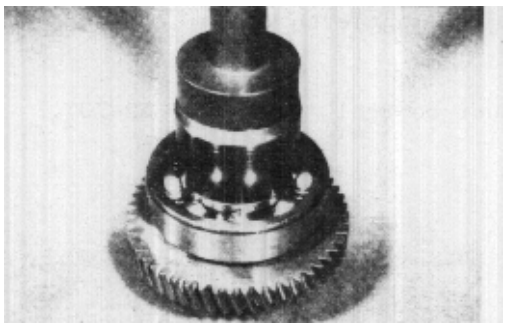
146 Triebwerd 1 einsetzen, auf Zafnmarkienung achten (Bild 147).

Insert rotary group 1, observing marked gear teeth. (Fig. 147).



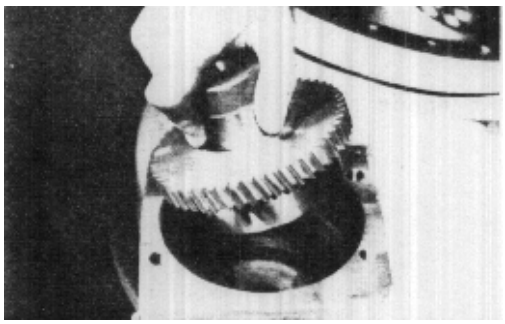
147 Zahnmarkierungen stehen sich gegenüber.

Marked teeth must mate.



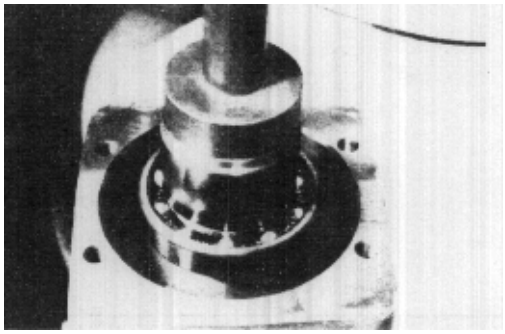
148 Inneres (großes) Rillenkugellager aufpressen. Preákraft nur aut Innenring.

Press inner (large) grooved ball bearing into position. Make sure to put pressure only on inner raceway.



149 149 Ritzel mit Lager einsetzen (bei noch warmen Geh„use!).

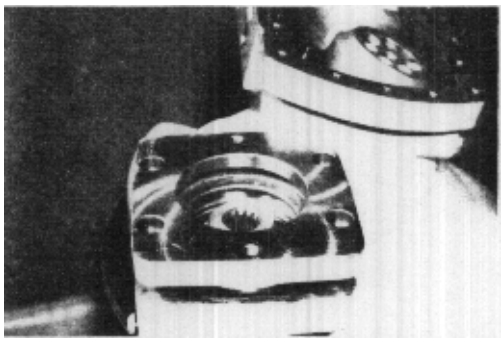
Insert pinion together with bearing, with the housing still warm.



150 Äuáeres (kleines) Rillenkugellager auf ca. 80 C erw„rmen und aufschieben.

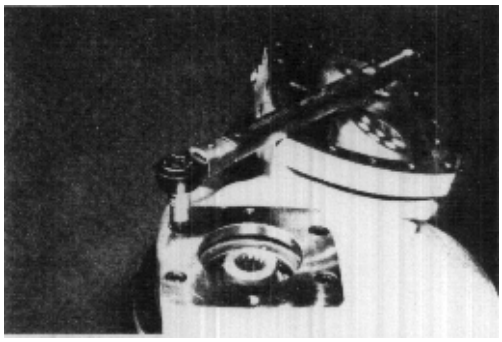
Pre-warm outer (small) grooved ball bearing to approx 80 C and push on.

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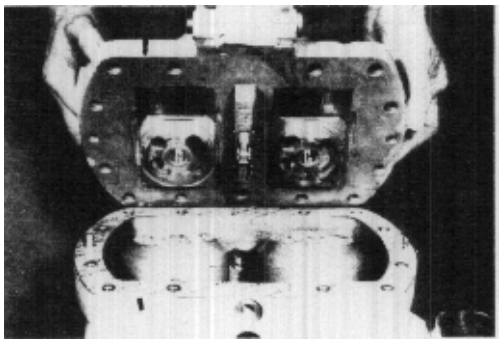
151 Flansch des nebenabtriebes mit neuem O-Ring aufsetzen.

Place secondary power take-off flange with new O-ring in position.



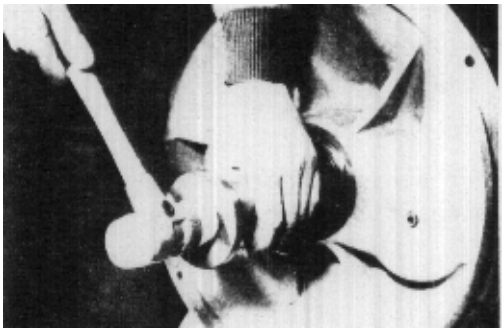
152 Mit den Befestigungsschrauben Lager gleichm„áig einziehen.

Evenly secure bearing with fastening screws.



153 Regler montieren (siehe Bild 63-70).

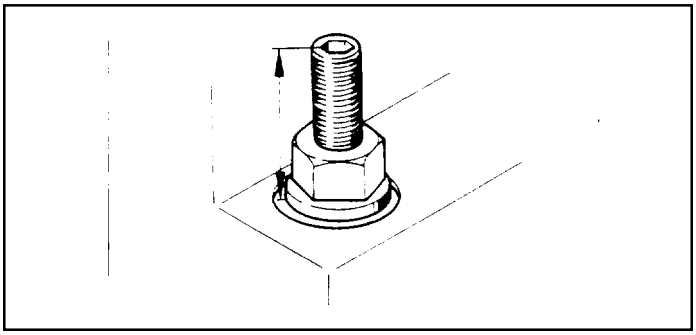
Mount control (see Figs. 63-70).



154 Verschluáring montieren (siehe Bild 4-10).

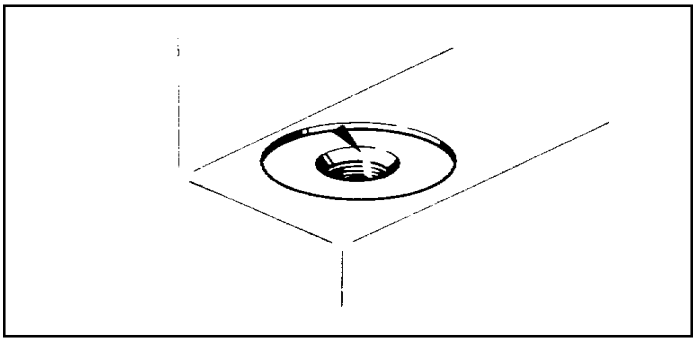
Mount front cover (see Figs. 4-10).

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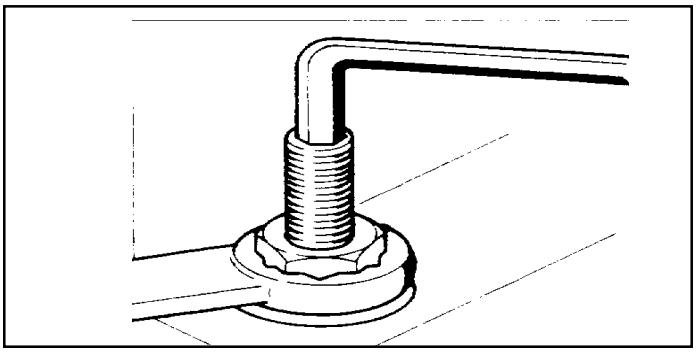
156 Überstand der Einstellschraube zur bearbeitetgn Dischtfläche messen und festhalten.

Measure and record setting screw height above machined sealing face.



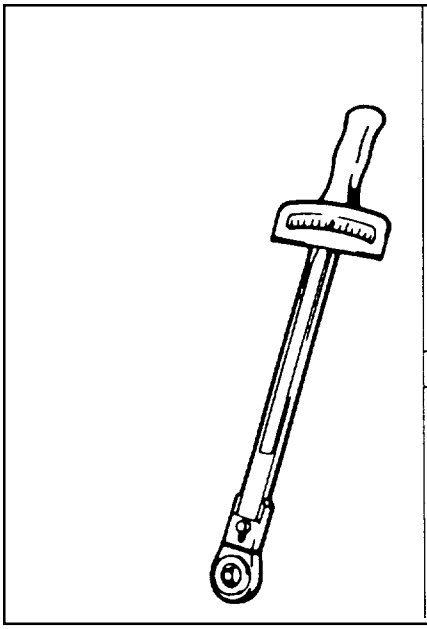
157 Kontrolle der Dichtfläche (Fase) auf Unversehrtheit.

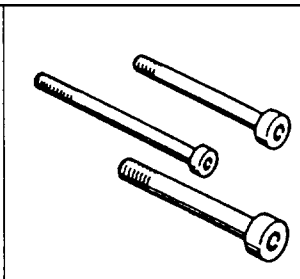
Check sealing face for evenness.



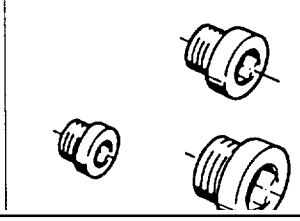
158 Neue Dichtmutter einbauen. Auf genaue Überstandshöhe der Einstellschraube achten.

Fit new seal nut. Make sure setting screw is exactly at recorded height.



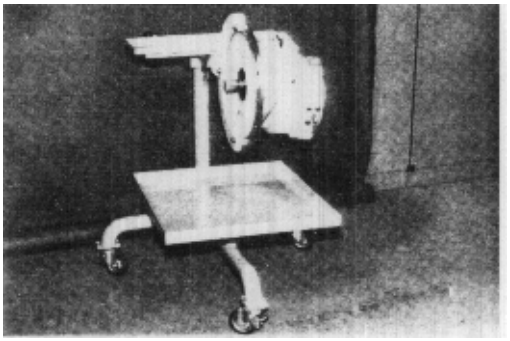


Gewinde Thread	Festigkeitsklassen Stability Classification		
	8,8	10,9	12,9
	Nm / ftlb		
M 3	1,08 / 0,78	1,6 / 1,15	1,9 / 1,37
M 4	2,84 / 2,05	4,0 / 2,89	4,8 / 3,47
M 5	5,90 / 4,26	8,3 / 6,00	9,8 / 7,09
M 6	9,80 / 7,09	14 / 10,1	17 / 12,2
M 20	402 / 290	569 / 411	677 / 489
M 22	540 / 390	765 / 553	912 / 659



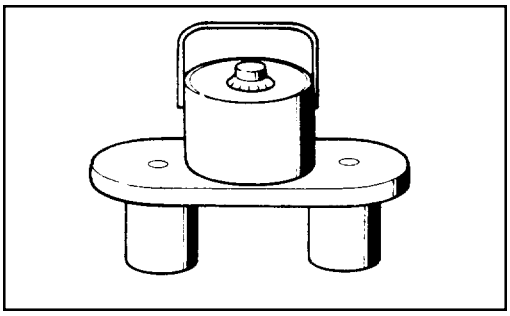
Gewinde Thread	Nm	ftlb
M 12 x 1,5	20	14,5
M 22 x 1,5	60	43,4
M 26 x 1,5	70	50,6
M 33 x 2	120	86,8

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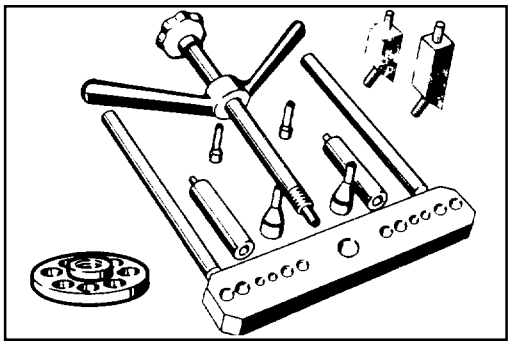
V1 Montagebock mit verschiedenen Einsätzen.

Assembly stand with various accessories.



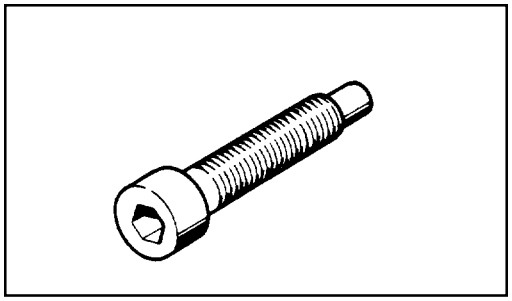
V2 Anwärmvorrichtung oder Heizplatte, entsprechend Bild 144.

Pre-warning device or heating plate (see Fig. 144).



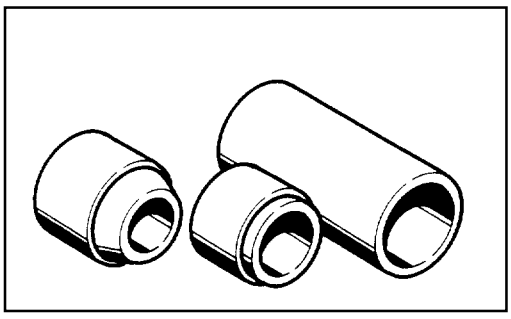
V3 Ausziehvorrichtung.

Extractor device.



V4 Abdrückschraube (ergl. Bild 105).

Pulling screw (of. Fig. 105).



V5 Verschiedene Einpresshülsen (vergl. Bild 150/148 ect.).

Various press-fit bushes (of. Fig. 150/140 etc.).

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For your own notes

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MANNESMANN REXROTH

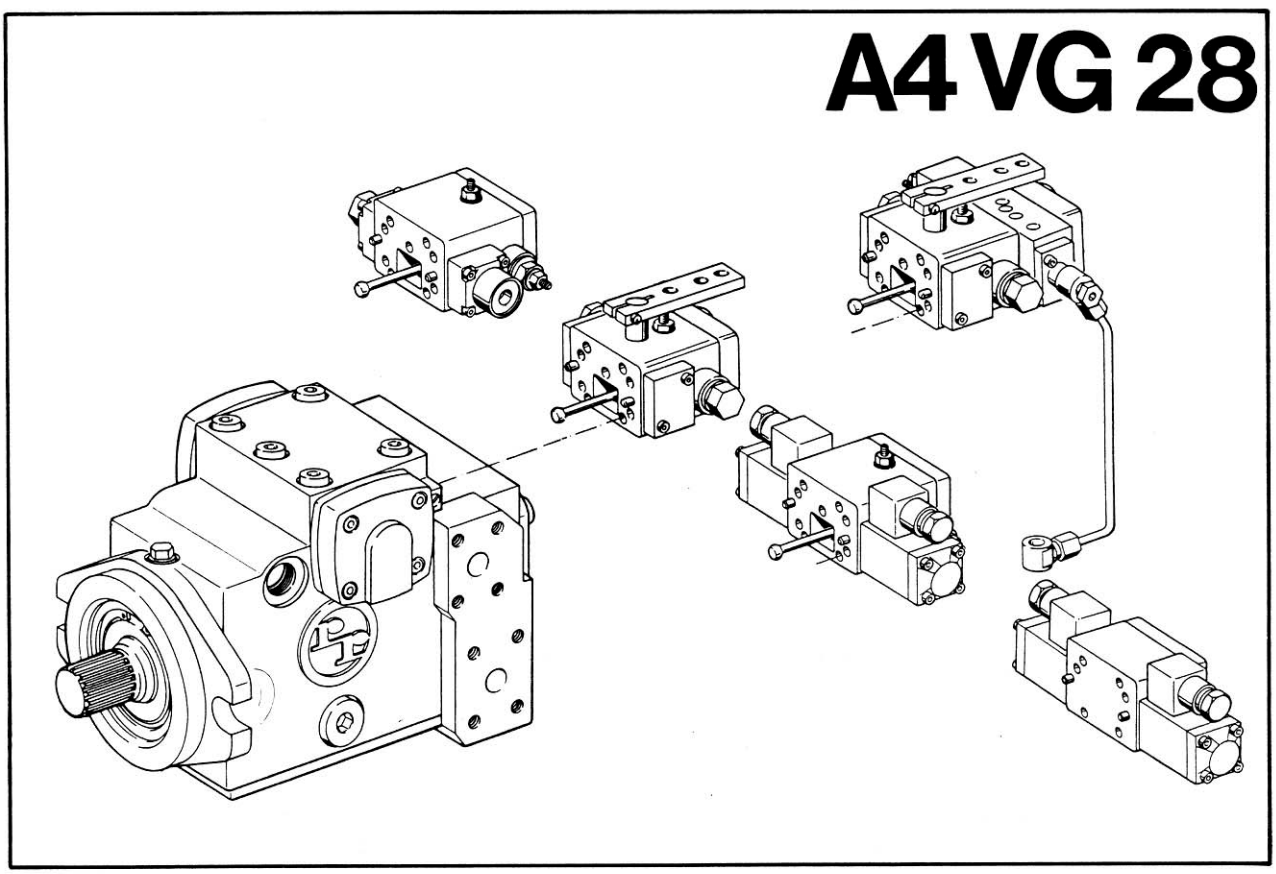
Hydromatik GmbH

R/E

Reparaturanleitung
Ersatzteilliste
Verstellpumpe A4V
Baureihe 3

Repair Instructions
Spare Parts List
Variable Displacement
Pump A4V Series 3

A4VG 28



RDE 92 002-30-R/E
03.86

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HINWEIS

Teilgeprüfte und vormontierte Original-Hydromatik-Baugruppen ermöglichen bei kürzestem Zeitaufwand erfolgreiche Reparaturen.

Besonders rasch erhalten Sie die richtigen Ersatzteile, wenn Sie uns bei der Bestellung Typ- und Fabriknummer mit angeben.

Die Reparaturarbeiten sind einfach, trotzdem sollten Sie unser Angebot zur Schulung nutzen und sich bei uns das notwendige Spezialwissen aneignen.

ACHTUNG

Alle Einstell- und Prüfarbeiten sind bei betriebswarmer Anlage durchzuführen. Beide Fahr- und Drehrichtungen sind Gefahrenzonen; deshalb kein Aufenthalt in diesen Bereichen bei Prüf- und Einstellarbeiten!

NOTES

Part-tested and pre-assembled original Hydromatik component groups enable successful repairs to be carried out in the shortest possible time.

Especially fast delivery of the correct spare parts is ensured if you quote type and serial number of the unit when ordering.

Repairs are simple, but we nevertheless recommend that you take up our offer of training in order to familiarise yourself with the necessary specialised knowledge.

IMPORTANT

All setting and test procedures should be carried out with the system at operating temperature. Both directions of travel or rotation are danger zones; do not therefore remain in these areas during test and setting procedures!

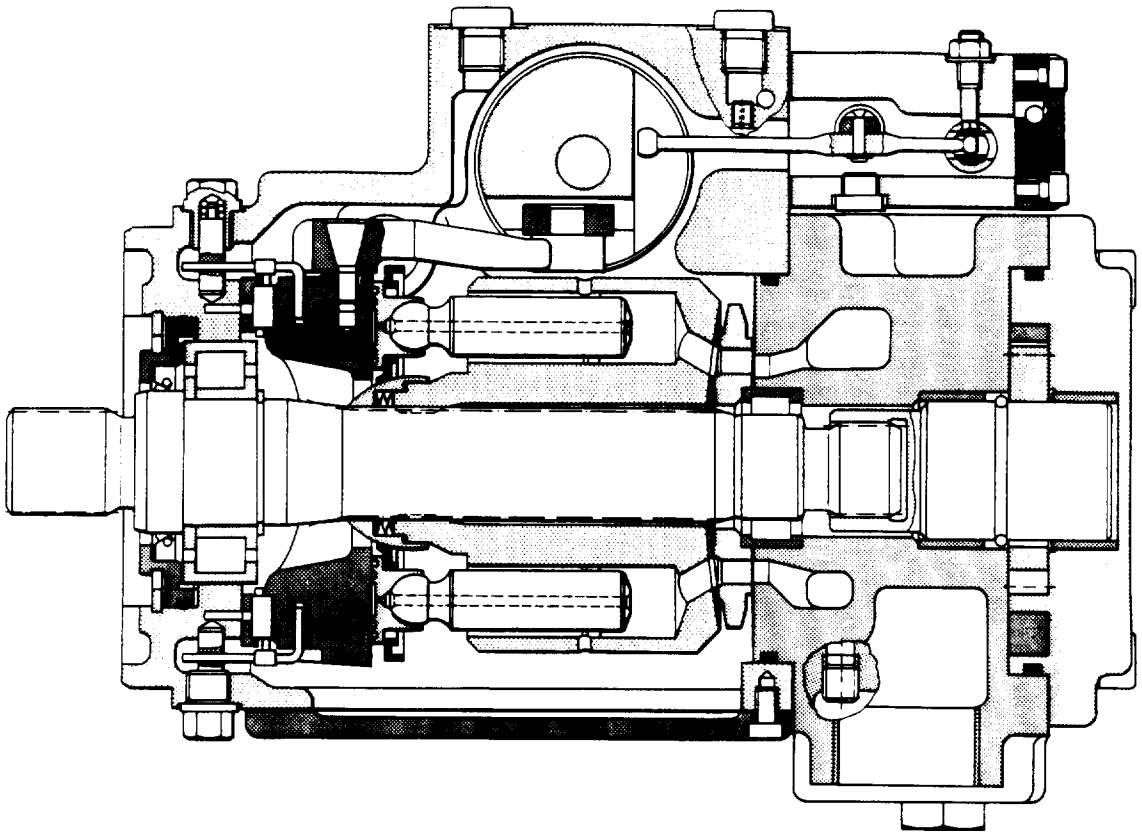
INHALT

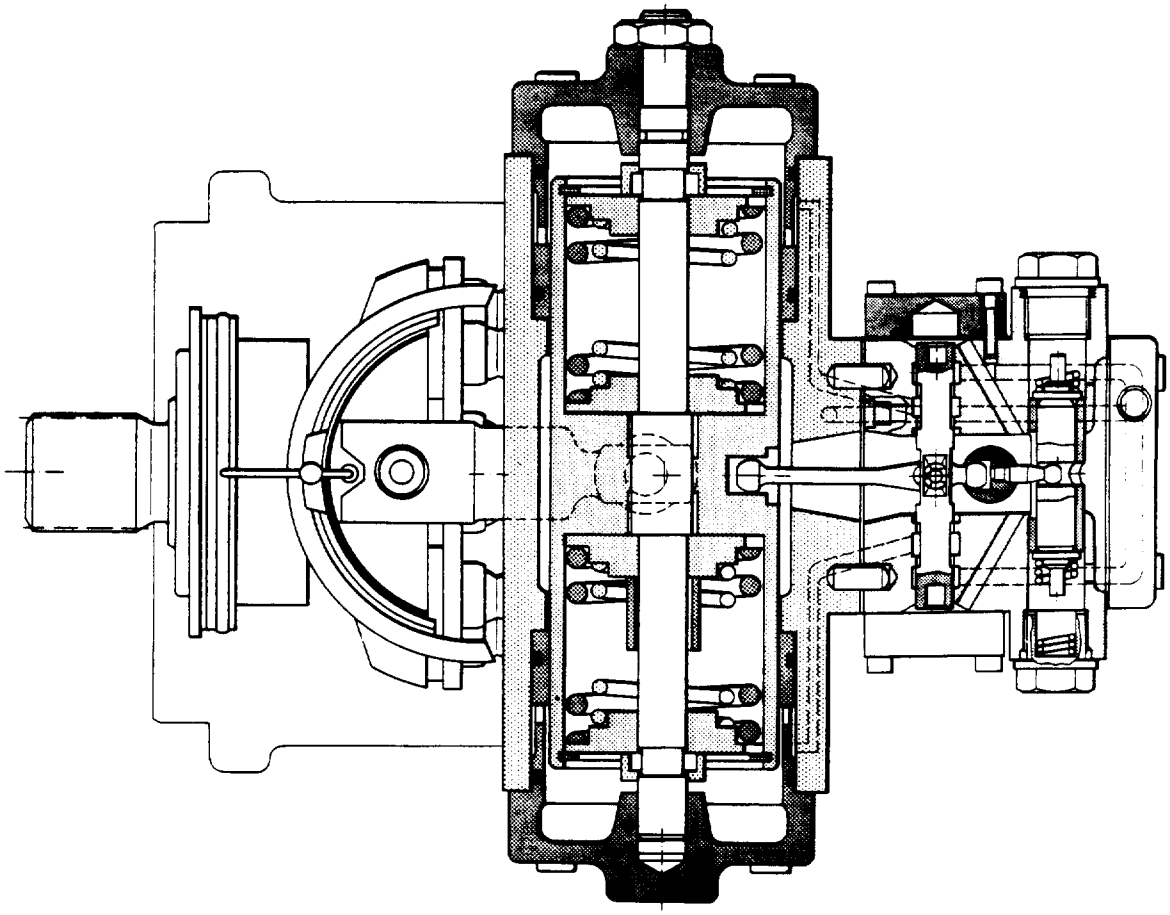
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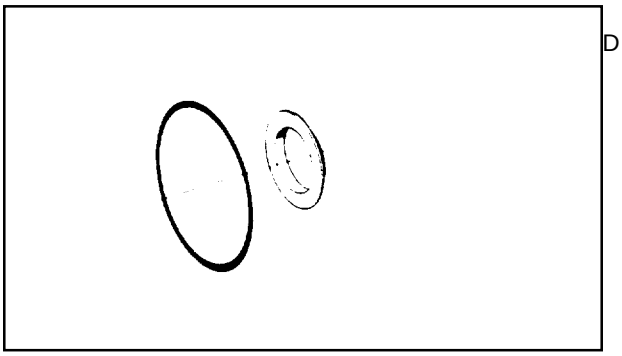
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Drive shaft
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Safety/boost valve
Boost pressure and control valve
Auxiliary pump
Control devices
Flushing valve
Sealing nut
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Setting instructions for
zero position
DA control valve
Valves
Safety valve
Pressure cut-off
Qmax stop

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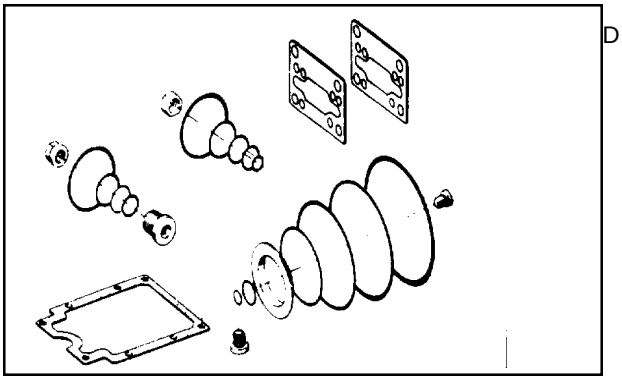
D1

Dichtsatz für Triebwelle.

Seal kit for drive shaft.

Best.-Nr./Part no.

270 627/VKSU 1167.



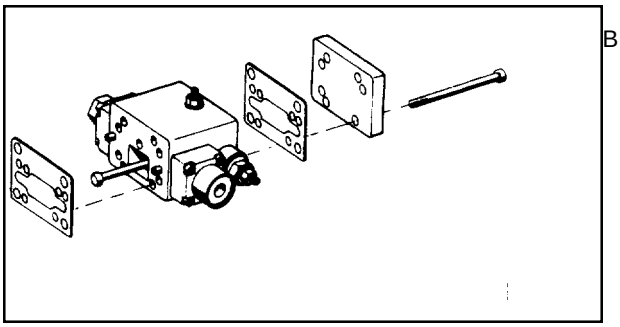
D2

ÄouBerer Dichtsatz.

External seal kit.

Best.-Nr./Part no.

270 628/VKSU 1168.



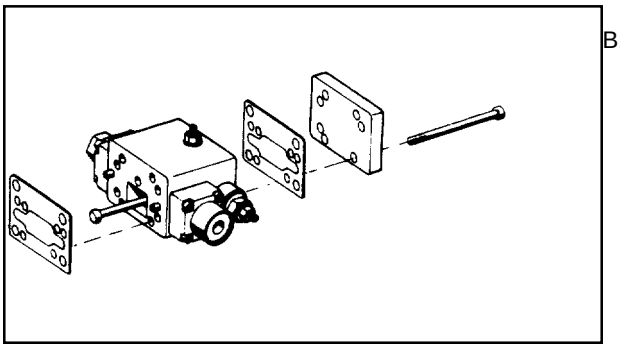
B1

HD-Ansteuerger„t (Hydraulisch-Druckabh„ngig).

HD control device (hydraulic,pressure related).

Best.-Nr./Part no.

416 222/427.13.01.02.



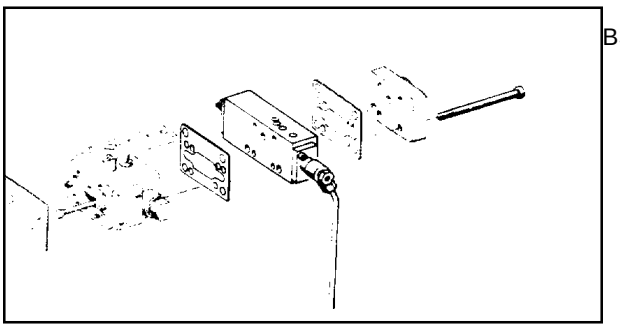
B2

HW-Ansteuerger„t (**H**ydraulisch-**W**eg„bhangig).

HW control device (hydraulic, servo stem).

Best.-Nr./Part no.

416 030/426.13.01.02.



B3

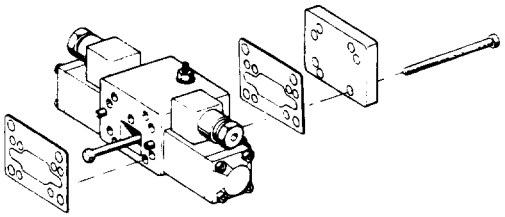
D-Regelventil (Druckabschneidung).

D control valve (pressure cut-off).

Best.-Nr./Part no.

420 953/525.08.03.50.

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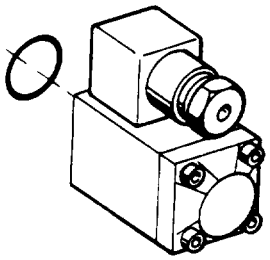


B4

EP-Ansteuerger„t (Elektrisch—Proportional).

EP control device (electrical, proportional).

Best.-Nr./Part no.
12 V: 416 521/428.13.01.01.
24 V: 415 225/428.13.01.02.



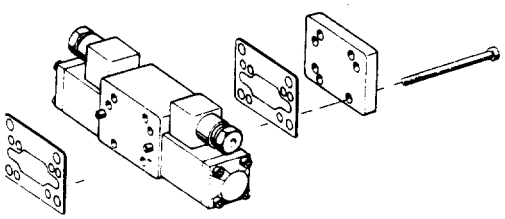
B5

Proportional magnet mit Stecker und O-Ring.

Proportional solenoid with plug an O-ring.

Best.-Nr./Part no.
12 V: 154730 + 152503 + 85290 + 83736
24 V: 154731 + 152503 + 85290 + 83736

12 V: 154730
24 V: 152503+85290 + 83736.

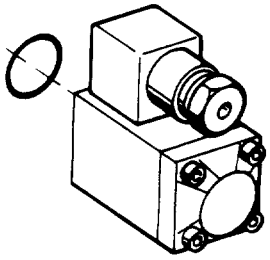


B6

DA-Fahrrichtungsventil (Drehzahl-Abh„ngig).

DA directional valve (speed related).

Best.-Nr./Part no.
12 V: 416 374/515.10.01.50
24 V: 416 375/515.10.01.51.

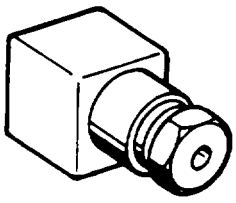


B7

Schaltmagnet für Farrichtungsventilmit Stekker und O-ring

Solenoid for directional valve with plug and O-ring.

Best.-Nr./Part no.
12 V: 153 519
24 V: 154 229. + 152 503 + 85290 + 86478



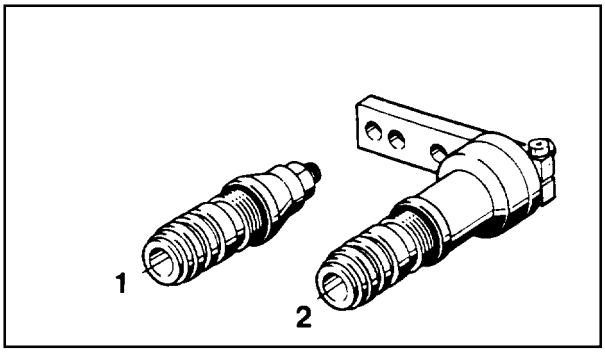
B8

B8 Stecker fur Magnete.

Plug for solenoide.

Best.-Nr./Part no.
152 503 + 85290.

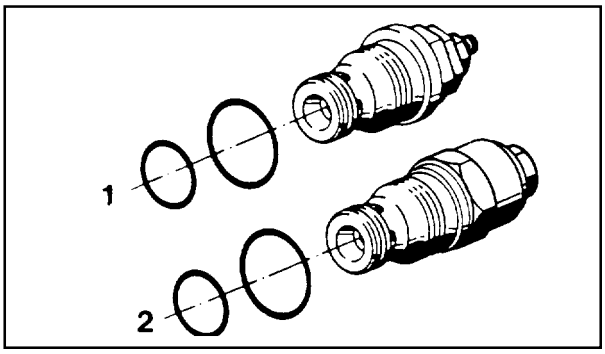
https://truckmanualshub.com/



B9

DA-Regelventil (**D**rehzah-**A**bhangig)
1.verstellbar - Best.-Nr. 416 283.
2.fest eingestellt - Best.-Nr. 416 389.
Meálende und Feder vom ausgebauten Ventil übernehmen.

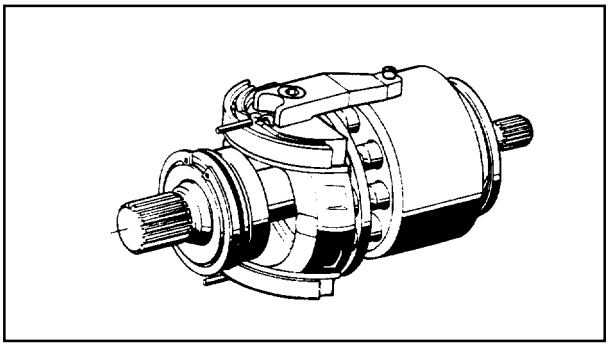
DA control valve (speed related).
1. variable - part no. 416 283.
2. fixed setting - part no. 416 389.
Metering orifice and spring to be taken from disassembled valve.



B10

Sicherheits- und Einspeiseventil.
1. vorgesteuert - Best.-Nr. 419 675.
2. direkt gesteuert - Best.-Nr. 417 534.

Safety and boost valve.
1. pilot operated - part no. 419 675.
2. direct operated - part no. 417 534.

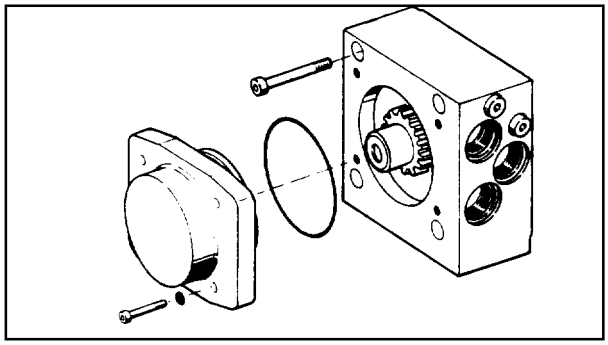


B11

Triebwerk, einbaufertig.

Rotary group, ready for installation.

Best.-Nr./Part no.
415 489/215.13.02.20/DIN-Welle
415 490/215.13.02.30/SAE-BB-Welle.

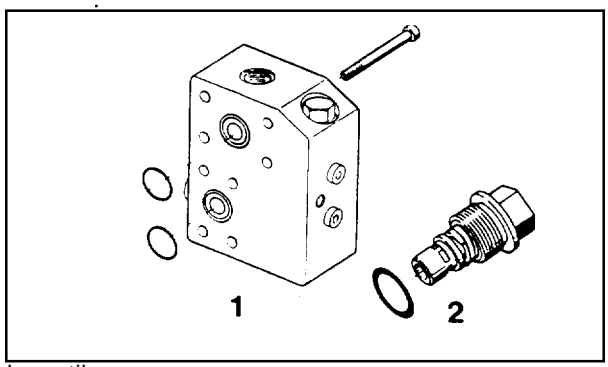


B12

Hilfspumpe.

Auxiliary pump.

Best.-Nr./Part no.
422 134/296.13.30.11.

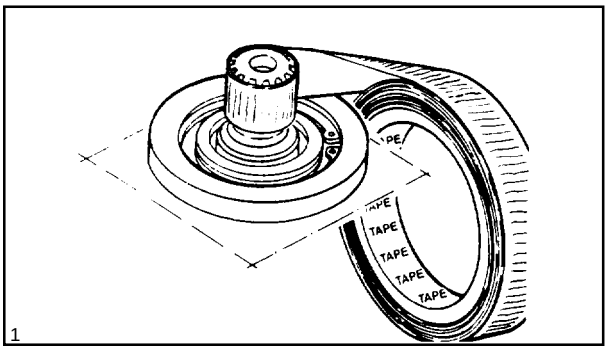


B13

1. Spülventil
Best.-Nr. 424 278/503.28.02.03.
2. Speisedruck-Begrenzungsventil
Best.-Nr. 415 829/521.08.01.10

1. Flushing valve
Part no. 424 278/503.28.02.03.
2. Boost pressure relief valve
Part no. 415 829/521.08.01.10.

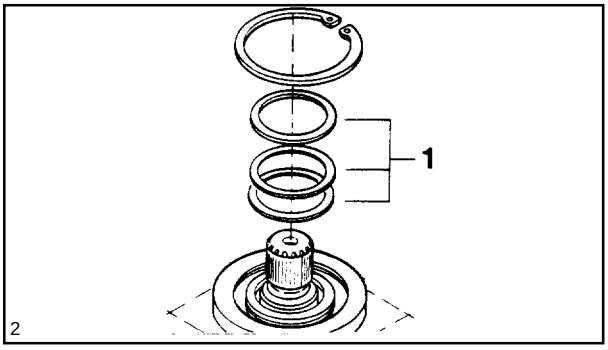
https://truckmanualshub.com/



1

1 Triebwelle abkleben.

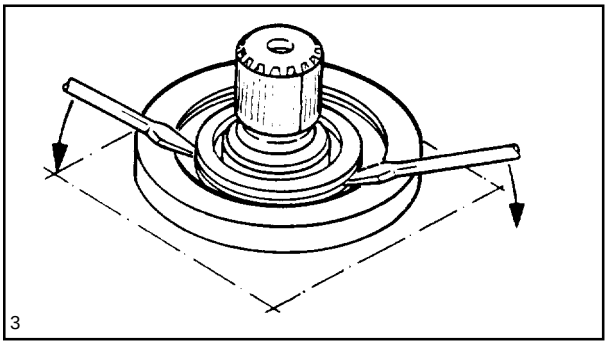
Tape up drive shaft.



2

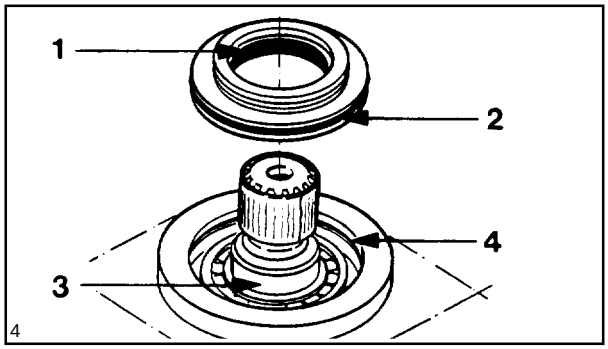
2 Paßscheiben 1.
Die dicke Paáscheibe zum Sicherungscing hin.

Shims 1.
The thick shim should be nearest to retaining ring.


3

3 Verschlußring ausheben.

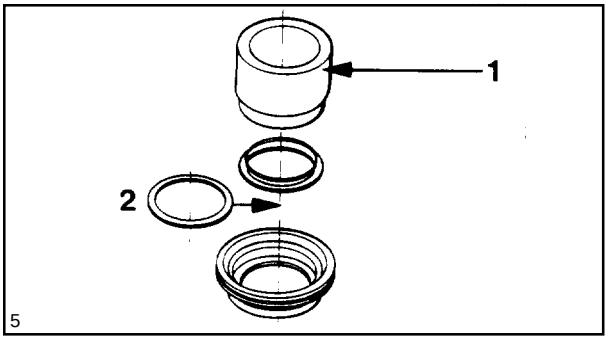
Lift out end ring.



4

4 Kontrolle
Dichtlippe 1; O-ring/O-ringnut 2; Laufstelle 3 (Rille); Gehäuse 4 (O-Ringanlage).

Inspect
Sealing lip 1; O-ring/O-ring groove 2; running area (groove) 3; housing (O-ring contact face) 4.

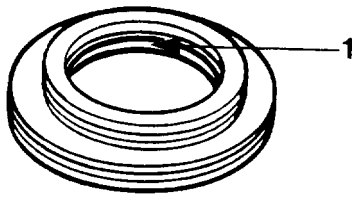


5

5 Vormontage
Wellendichtring (trocken) mit Einpresshülse 1 montieren. Beilagescheibe 2 nur wenn Laufrille tief ist.

Pre-assembly
Fit shaft seal (dry) with press-in device 1.
Fit washer 2 only if running groove is deep.

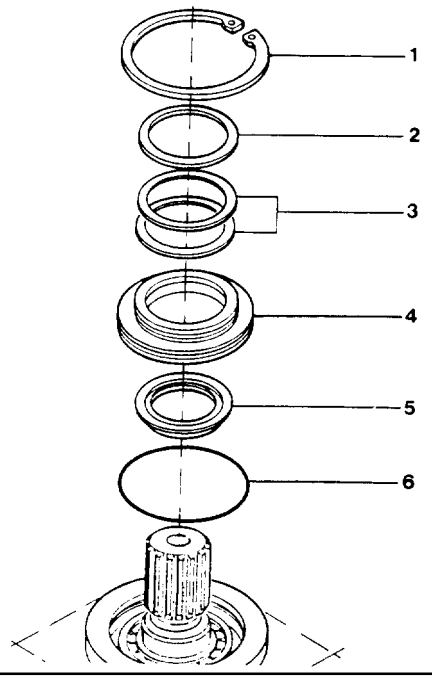
https://truckmanualshub.com/



6

Vormontage
Raum 1 zwischen Staub- und Dichtlippe mit Fett füllen.

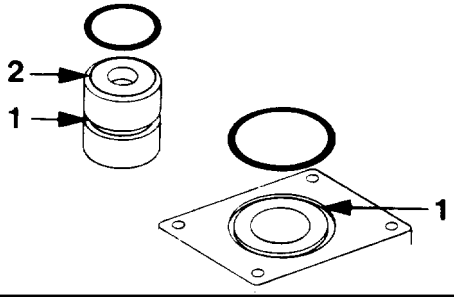
Pre-assembly
Fill space 1 between outer and inner sealing lips with grease.



7

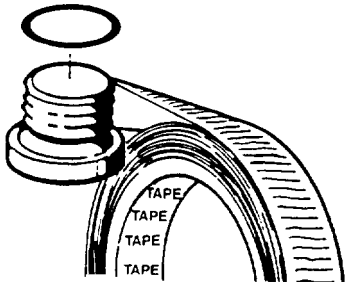
Triebwelle abdichten
Sicherungsring 1
Paßscheibe dick 2
Paßscheiben 3
Verschlußring 4
Wellendichtring 5
O-Ring 6.

Seal drive shaft
Retaining ring 1
thick shim 2
end ring 4
shaft seal 5
O-ring 6



8

Einbau von O-Ring in Nut.
Nut nicht mit Fett füllen 1, O-Ring mit Fett einreiben. Montage über die Seite mit Fase, 2.
Fitting O-ring in groove.
Do not fill groove with grease 1, apply grease to O-ring. Fit via chamfered side, 2.

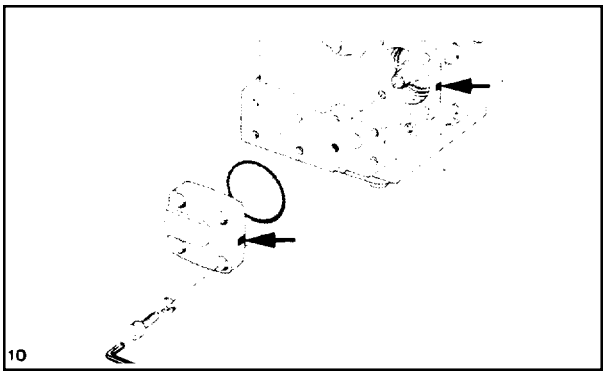


9

Einbau von O-Ring hinter Gewinde oder Einstich
Gewinde 1 oder Einstich abkleben.

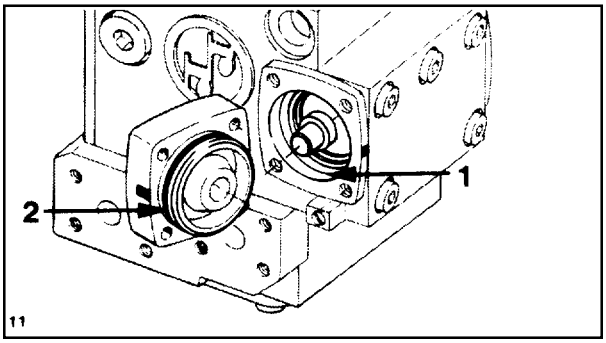
Fitting O-ring behind thread or recess. Tape up thread or recess, 1.

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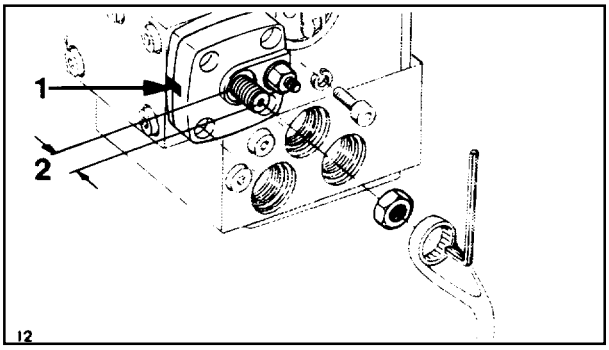
10 Einbaulage zum Gehäuse kennzeichnen.

Mark the installation position in relation to housing.



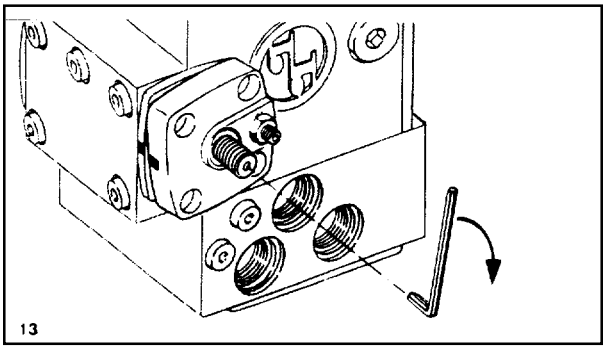
11 Kontrolle
Dichtfläche im Gehäuse 1, O-Ring/O-Ringnut 2.

Inspect
Sealing face in housing 1, O-ring/O-ring groove 2.



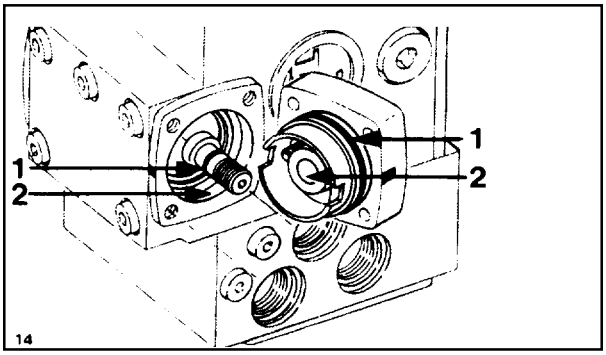
12 Einbaulage kennzeichnen 1. Höhe vor Demontage messen 2 (=Voreinstellung bei Montage siehe Nn).

Mark installation position 1. Measure height before dismantling 2 (=pre-setting before assembly, see No.).



13 Abheben durch Drehen der Einstellschraube.

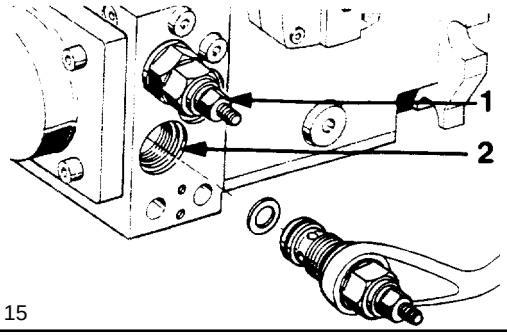
Lift off by turning the setting screw.



14 Kontrolle
O-Ring/O-Ringnut 1, Dichtflächen im Deckel und Gehäuse 2.

Inspect
O-ring/O-ring groove 1, sealing faces in cover and housing 2.

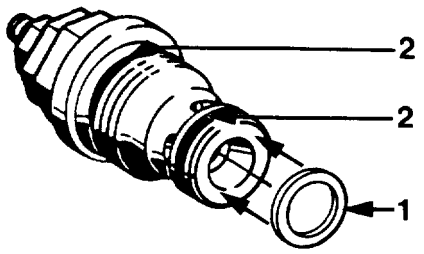
https://truckmanualshub.com/



15

15 Ausbau der Ventile ohne Veränderung des Einstellwertes.
1. Druckseite B, 2 Druckseite A.

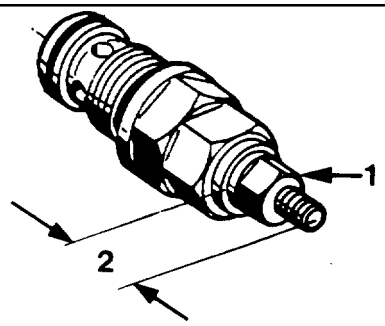
Remove the valves without altering their settings.
1. Pressure side B, 2 pressure side A.



16

16 Montagehilfe
Scheibe mit Fett ankelben 1, O-Ringe entsprechend Nr. 9 montieren, 2.

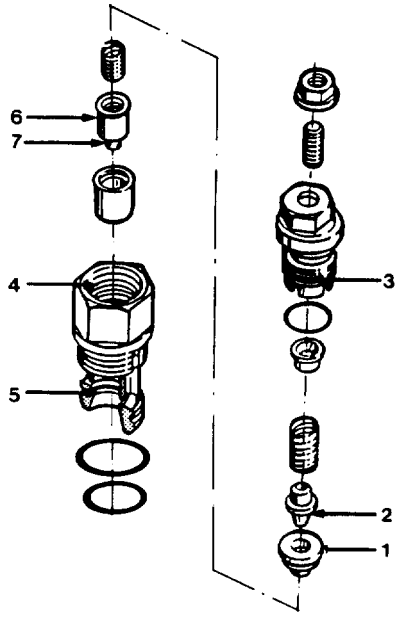
Assembly aid
Fit washer with grease 1, fit O-rings as indicated in No. 9, 2.



17

17 1 vor Ausbau der Dichtmutter 1, Höhe 2 messen (=Voreinstellung bei Montage).

1 before removing sealing nut 1, measure height 2 (pre-setting before assembly).



18

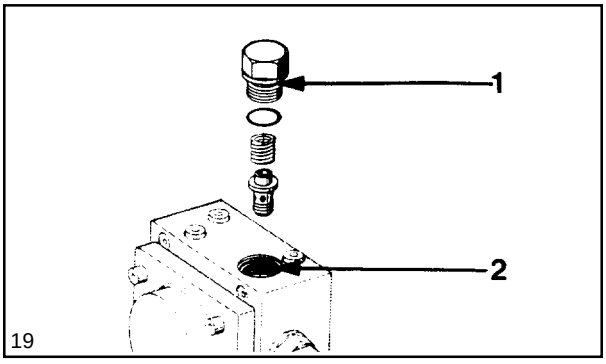
18 Kontrolle
1 Sitz Vorsteuerventil
2 Sitz Vorsteuerkegel
3 O-Ringnut
4 O-Ring Dichtfläche
5 Hauptkolbensitzfläche
6 Hauptkolben
7 Vorsteuerdüsen

Montagehilfe: Teile mit Fett ankleben.

IInspect
1 Pilot valve seat
2 Pilot poppet seat
3 O-ring groove
4 O-ring sealing face
5 Main spool seating area
6 Main spool
7 Pilot jets.

Assembly aid: fit parts with grease.

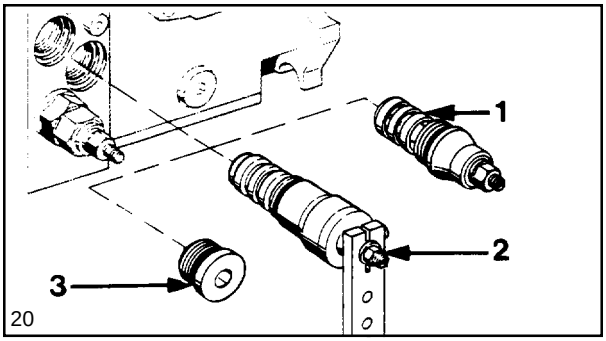
https://truckmanualshub.com/



19

19 Kontrolle/Speisedruckventil
1 Einstich in Verschlußschraube.
2 Dichtfläche in Anschlußplatte.

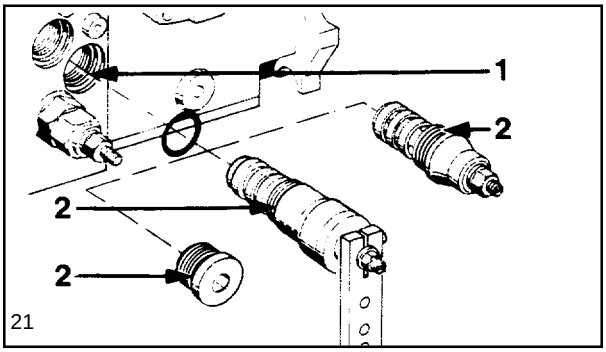
Boost pressure valve - inspect:
1 recess in screwed plug.
2 sealing face in subplate.



20

20 Regelventil
1 Regelventil, fest eingestellt
2 Regelventil, verstellbar
3 ohne Regelventil - Verschlußschraube.

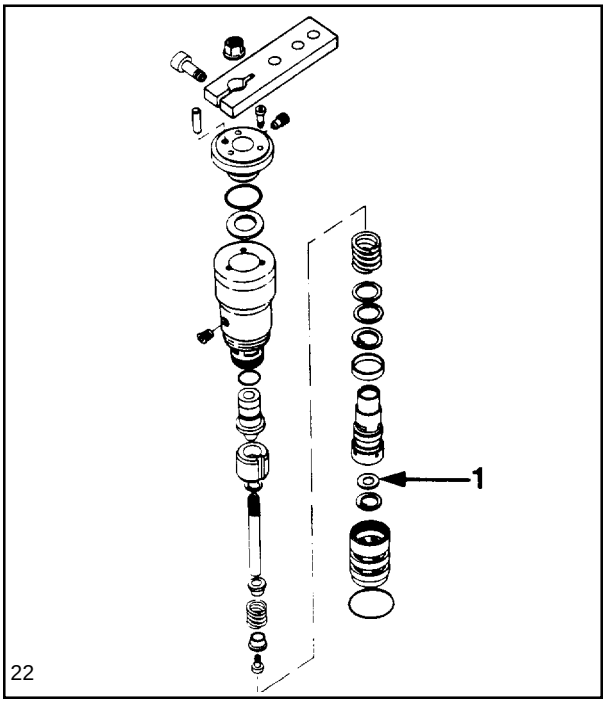
Control valve
1 control valve - fixed setting
2 control valve, variable
3 without control valve, screwed plug.



21

21 Kontrolle
1 Dichtfläche im Gehäuse.
2 Einstich im Ventilgehäuse.

Inspect
1 sealing area in housing.
2 recess in valve housing.

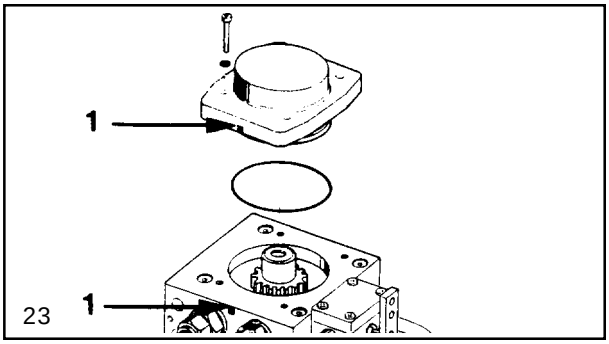


22

22 Regelventil
Bei Ventiltausch Meßblende und Feder aus dem getauschten Regelventil entnehmen (siehe B 9).

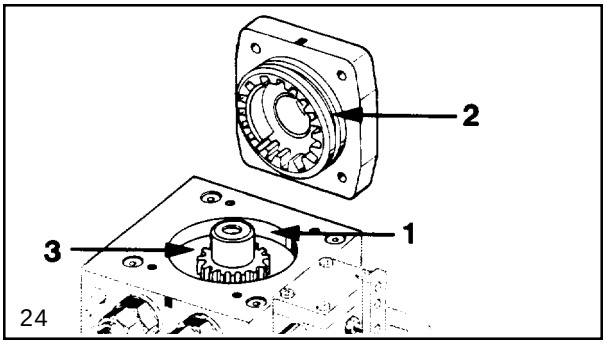
Control valve
In case of interchange of valve to take metering orifice and sprang from control valve (see B 9).

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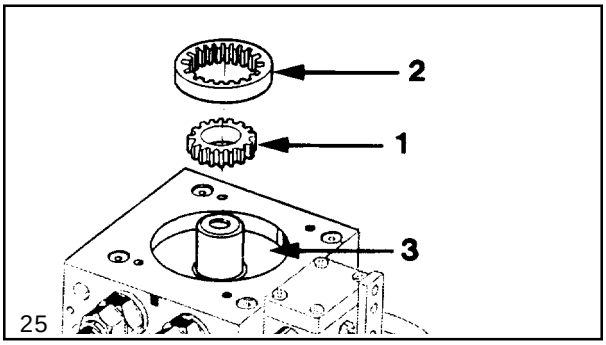
23 Deckellage markieren 1.

Mark position of cover 1.



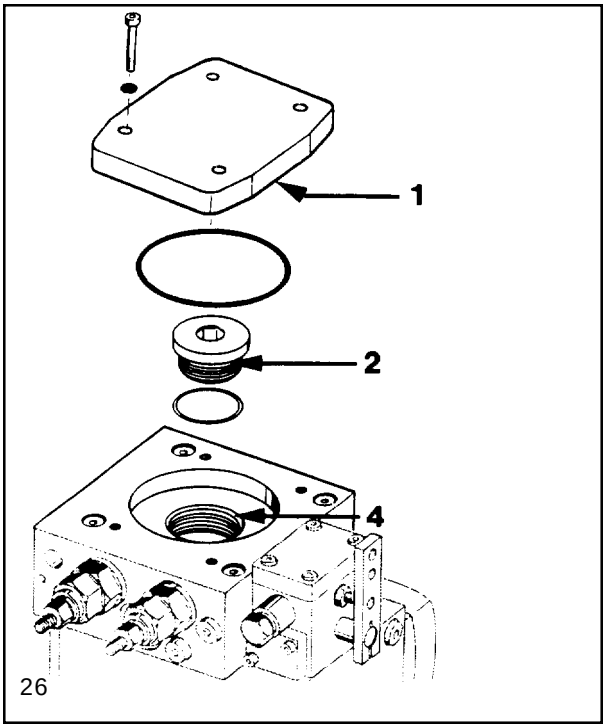
24 Kontrolle
1 O-Ring Dichfläche.
2 O-Ringnut.
3 Verschleiß durch Schmutz.

Inspect
1 O-ring sealing face.
2 O-ring groove.
3 wear caused by dirt.



25 Kontrolle auf Verschleiß.
1 Ritzel.
2 Laufrad.
3 Gehäuse.

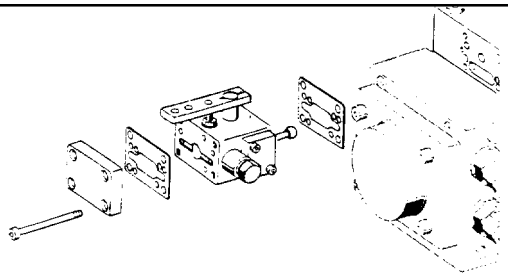
Inspect for wear.
1 pinion.
2 gear wheel.
3 housing.



26 Ohne Hilfspumpe, Kontrolle.
1 Dichtfläche.
2 Einstich in Verschlußschraube.
3 Nut im Gehäuse (außen).
4 Nut im Gehäuse (innen).

Without auxiliary pump, inspect.
1 sealing face.
2 recess in screwed plug.
3 groove in housing (external).
4 groove in hsouing (innen).

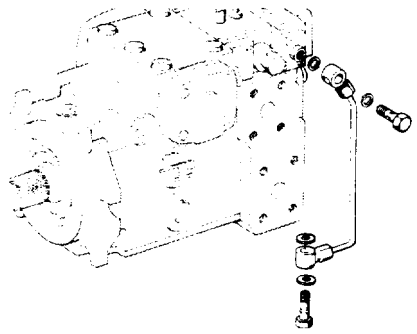
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27

27 Ansteuergerät ohne Druckabschneidung. Bei Demontage Dichtflächen nicht beschädigen.

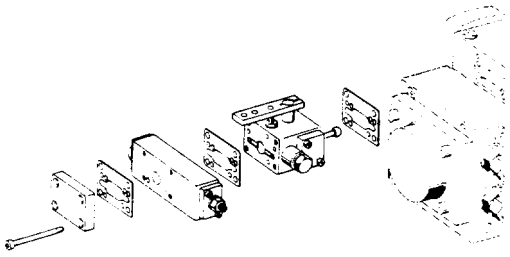
Control device without pressure cut-off. Take care not to damage sealing faces when dismantling.



28

28 Hochdruckleitung zur Druckkabschneidung.

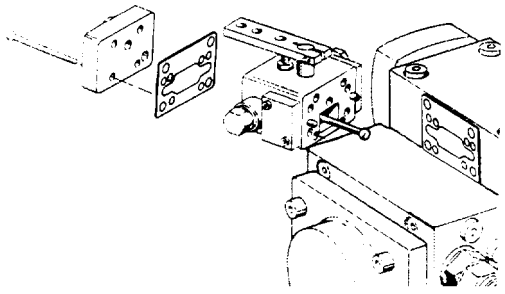
High pressure line to pressure cut-off.



29

29 Ansteuergerät mit Druckabschneidung.

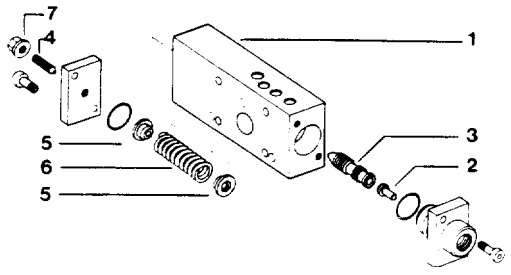
Control device with pressure cut-off.



30

30 Kontrolle aller Dichtflächen. Nach Wiederanbau der O-Lage einstellen!

Inspect all sealing faces. After re-fitting set the O-position!

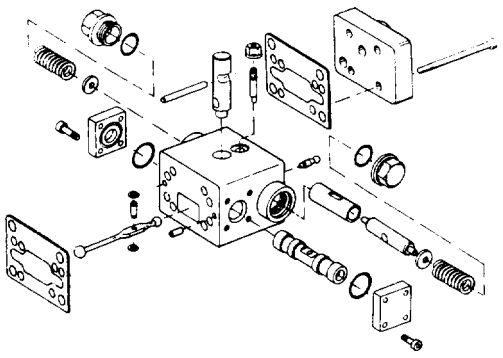


31

31

Druckabschneidung	/	Pressure cut off
Anschluß 1		connection 1
Meßkolben 2		measuring spool 2
Steuerkolben 3		control spool 3
Einstellschraube 4		setting screw 4
Federteller 5		spring washer 5
Meßfeder 6		measuring spring 5
Dichtmutter 7		sealing nut 7.

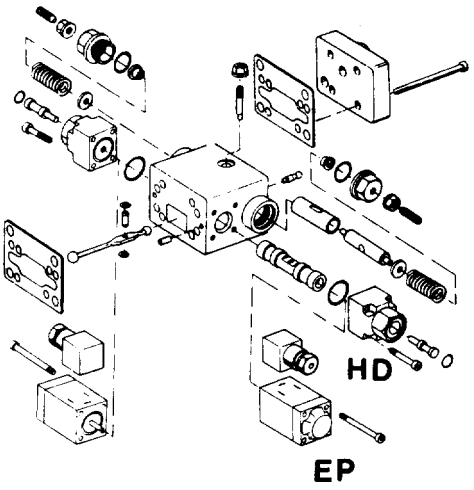
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32

32 HW-Ansteuergerät.

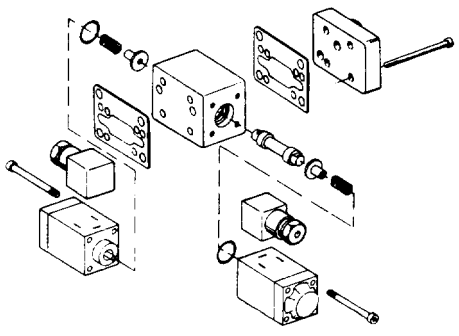
HW control device.



33

33 HD/EP-Ansteuergerät.

HD/EP control device.

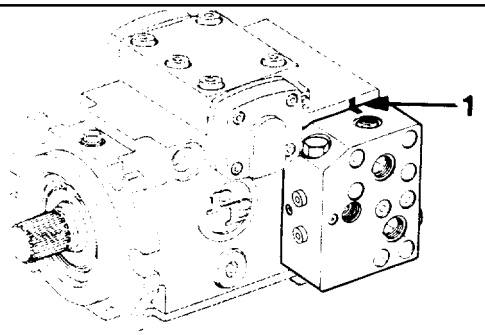


34

34 DA-Ansteuergerät

DA control device.

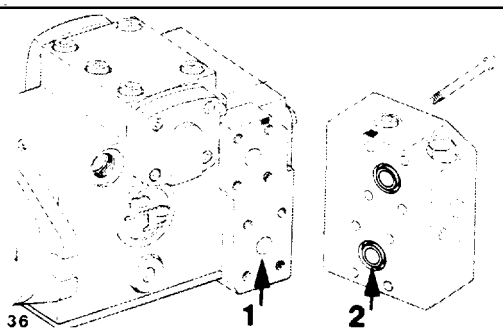
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35

35 Einbaulage kennzeichnen.

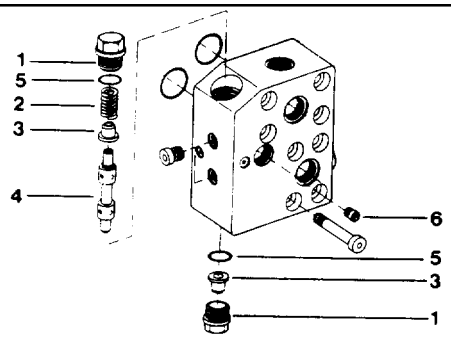
Mark installation position.



36

36 Kontrolle
Dichtfläche 1,
Nut 2.

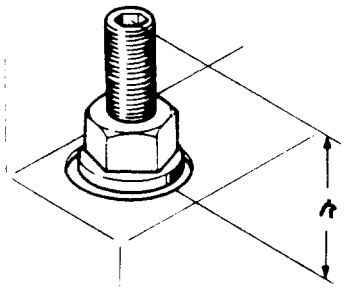
Inspect
Sealing face 1,
Groove 2.



37

37 Spülventil
Verschlußschraube 1, Feder 2, Scheibe 3, Steuerkolben 4, O-Ring 5, Drossel 6.

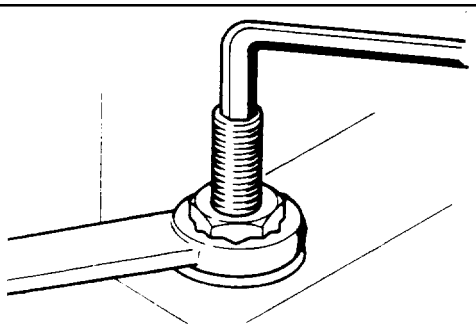
Flushing valve
Screwed plug 1, spring 2, washer 3, control spool 4, O-ring 5, throttle 6.



38

38 Dichtmutter austauschen. Zuerst Einstellhöhe messen und festhalten.

Replace sealing nut. First measure and record setting height.

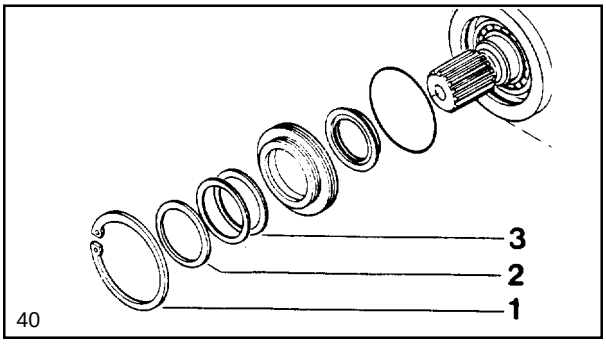


39

39 Beim Anziehen Einstellschraube gegenhalten, anschließen Einstellhöhe kontrollieren.

When tightening, lock setting screw, then check setting height.

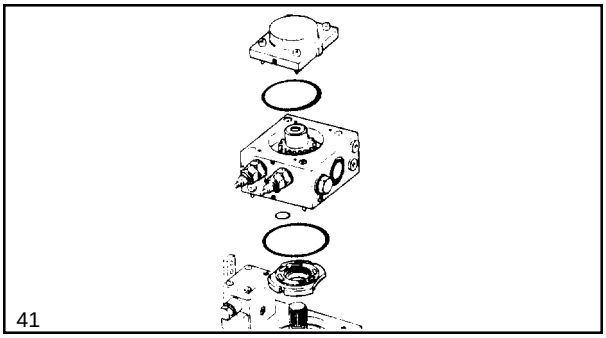
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40

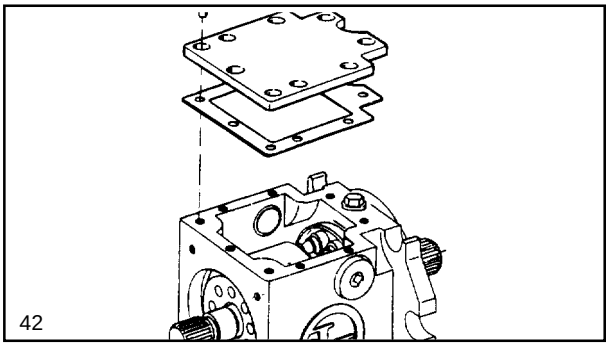
40 Triebwellenabdichtung ausbauen (NR. 1-3). Wenn vorhanden HD-Leitung der Druckabschneidung abbauen (Nr. 28).

Remove drive shaft seal (No. 1-3). If fitted, remove high pressure line to pressure cut-off (No. 28).


41

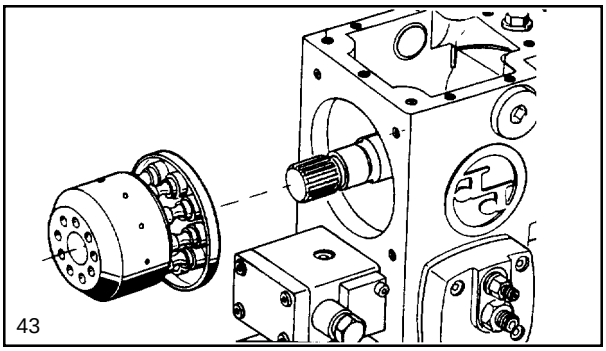
41 Anschlußplatte mit Ventilen abheben - Steuerplatte entnehmen. Vorher Lage der Teile markieren.

Lift off subplate with valves - remove portplate, but first mark position of parts.


42

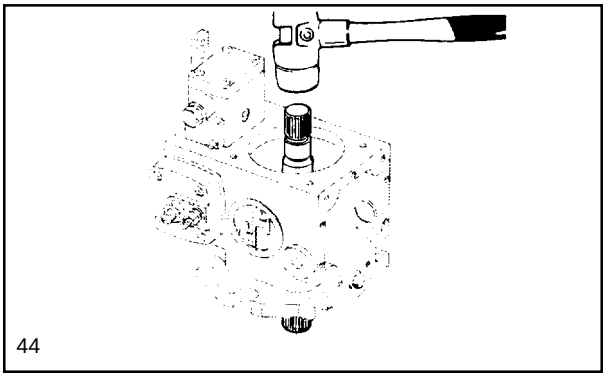
42 Seitendeckel abnehmen.

Remove side cover.


43

43 Hydraulisches Triebwerksteil komplett abschieben.

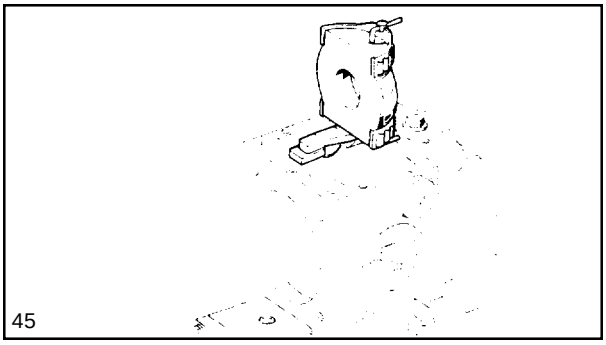
Push off hydraulic section of rotary group complete.


44

44 Triebwelle mit groBem Larger austreiben.

Push out drive shaft with large bearing.

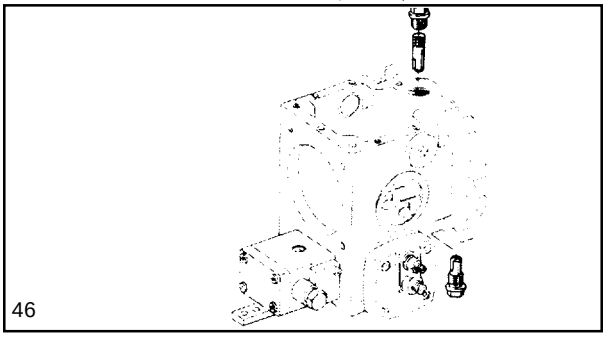
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45

45 Schwenkwiege mit Lager, Lagerschalen und Gleitstein (auf Verstellhebel) entnehmen.

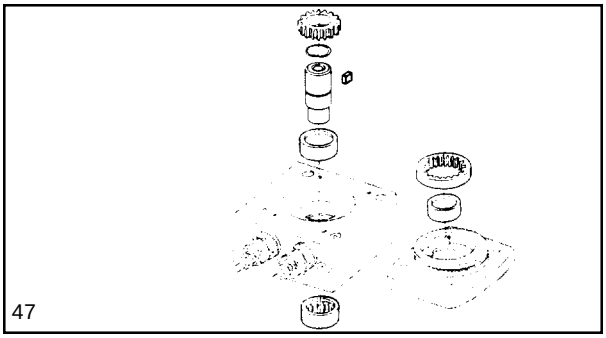
Remove rocker arm with bearing, bearing boxes and slide ring (on adjusting lever).



46

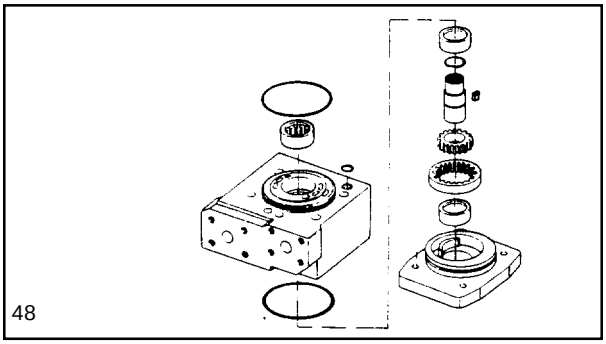
46 Käfigführung ausbauen. Nach Abnahme des Ansteuergerates kann jetzt auch der Stelizylinder zur Inspektion abgezogen werden - nur Dekkelschrauben lösen.

Remove guide cage. Once the control device has been removed, the positioning cylinder can also be pulled off for inspection - just loosen cover screws.



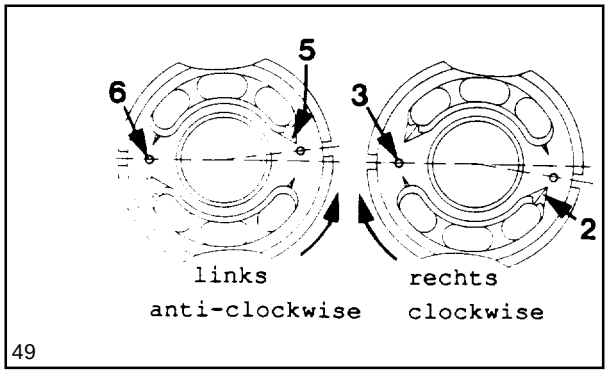
47

47 Hiltspumpenteile ausbauen, Kleines Triebwerklager mit Dorn austreiben.
Remove auxiliary pump parts, drive out small rotary group bearing with punch.



48

48 Neues Lager und neue Dichtungen montieren. Hilfspumpenteile kräftig mit Öl benetzen und einsetzen.
Fit new bearings and new seals. Lubricate auxiliary pump parts liberally with oil and place in position.

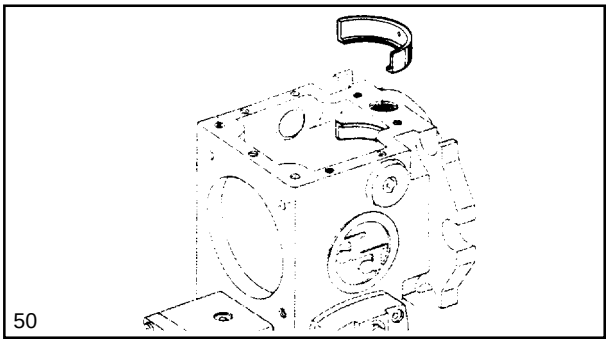


49

49 Steuerplatte mit Fett aufkleben, Drehrichtung
rechts, große Kerbe (2), Verdrillstift (3),
links, große Kerbe (5), Verdrillstift (6).

Affix port plate with grease, direction of rotation.
clockwise, large groove (2), torsion pin (3),
anti-clockwise, large groove (5), torsion pin(6).

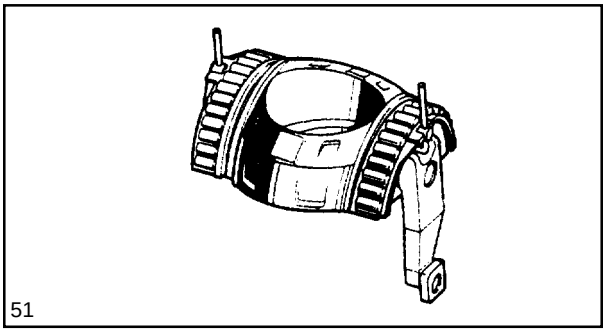
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50

50 Neue Lagerschalen einsetzen.

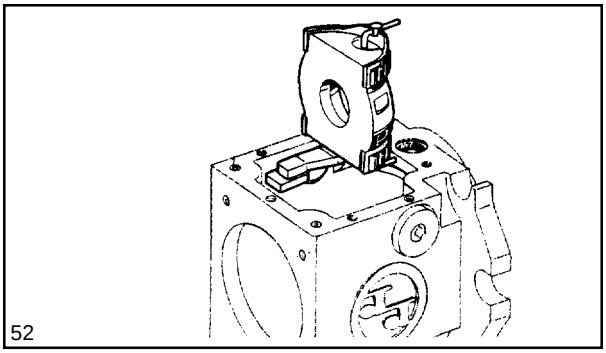
Insert new bearing boxes.



51

51 Käfig mit Rollen, Führungsstiften und Gleitstein mit Fett auf Schwenkwiege kleben.

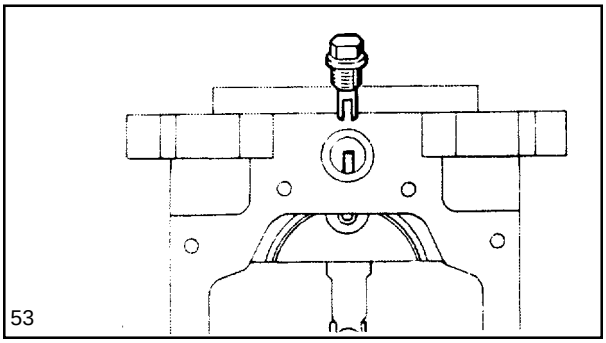
Attach cage with rollers, guide pins and slide ring to rocker arm with grease.



52

52 Vormontierte Schwenkwiege einsetzen.

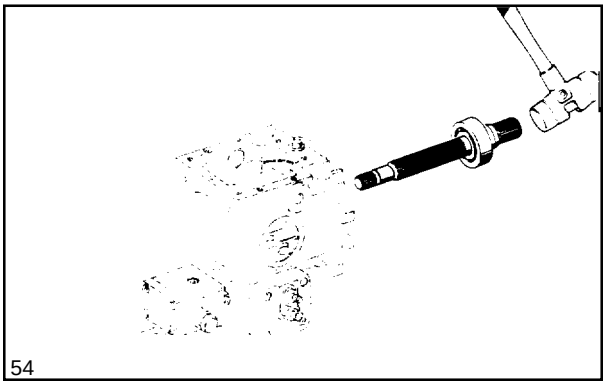
Insert pre-assembled rocker arm.



53

53 Käfig-Führungsstift und Käfigführung ausrichten und montieren.

Align and fit cage guide pin and guides.

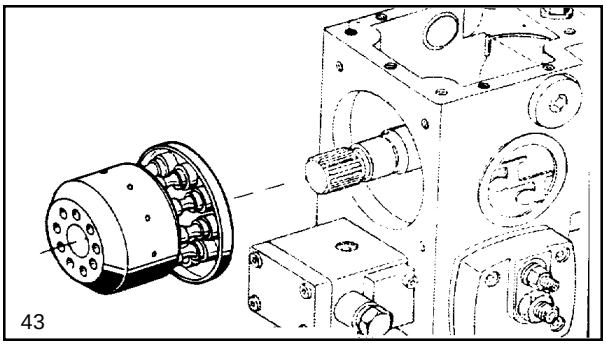


54

54 Triebwelle mit großem Lager mit leichten Hammerschlägen eintreiben. Schwenkwiege gegenhalten.

Drive in drive shaft with large bearing using light hammer blows. Counterhold rocker arm.
Hydromatik

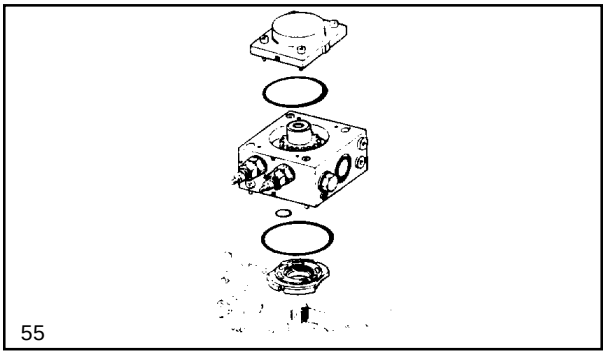
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43

55 Hydraulischen Triebwerksteil aufschieben.

Push on hydraulic rotary group section.



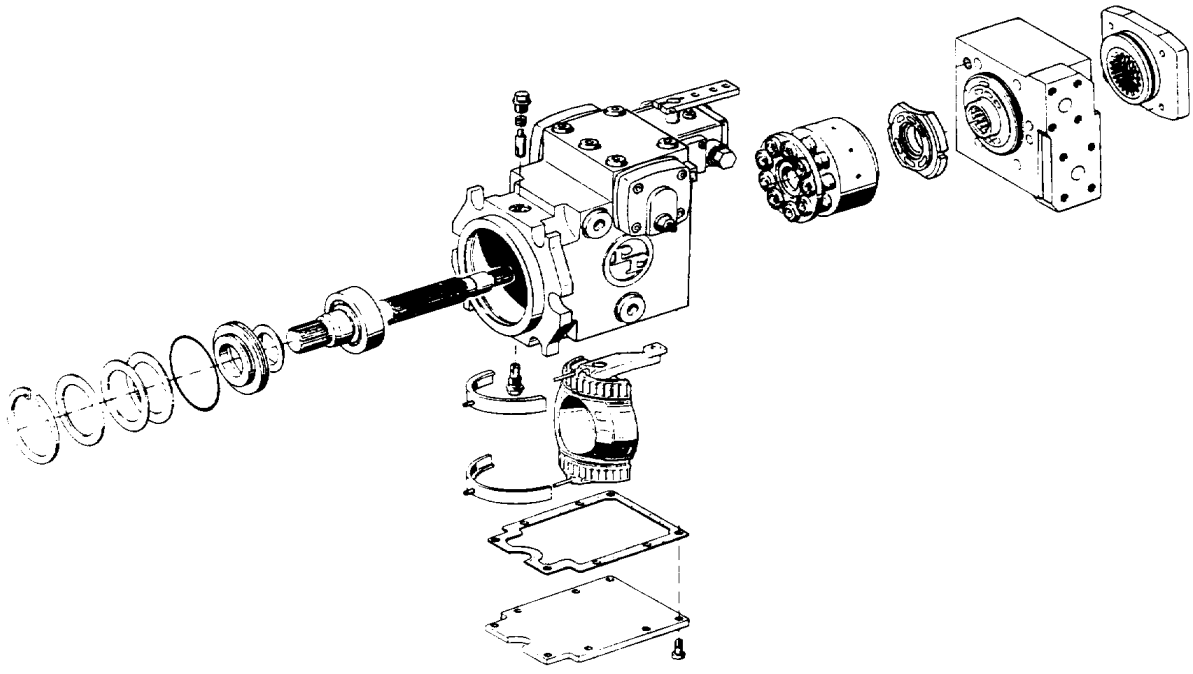
55

56 Anschlußplatte mit Ventilen und Hilfspumpe lagerichtig aufsetzen.

Place subplate with valves and auxiliary pump in correct position.

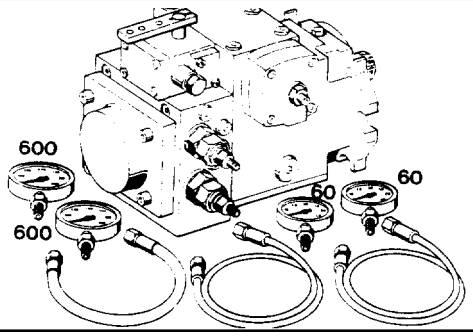
57 ↓ Seitendeckel, Hilfspumpendeckel sowie Triebwellenabdichtung mit neuen Dichtringen montieren, ebenso HD-Leitung soweit vorhanden.

Fit side cover, auxiliary pump cover and drive shaft seal using new seal rings, also high pressure line if fitted.
Hydromatik



56

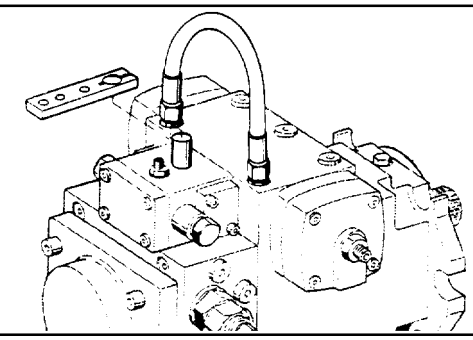
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59

59 Schlauch NW 12, 2 Meßschlauche, 2 Manometer bar, 2 pressure gauges 60 bar. Set when machine is mit Nenndrehzahl. Vorsicht: Maschine gut in beiden Richtungen blokkieren.

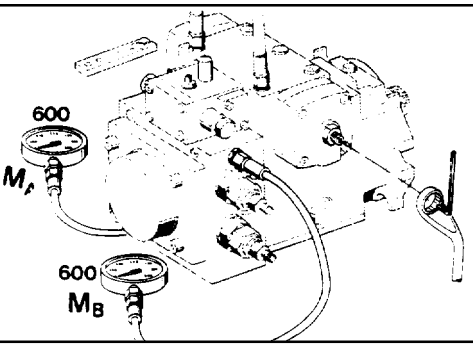
size 12 hose, 2 measuring hoses, 2 pressure gauges 600 bar, 2 pressure gauges 60 bar, Set when machine is up to operating temperature and nominal speed. Warning: Block machine well in both directions.



60

60 Mit Schlauch NW 12 beide Stelikammern verbinden. Stelihebel lösen, oder Stecker abziehen, oder Steuerdruckleitungen abziehen (Vermeidung von Restsignal).

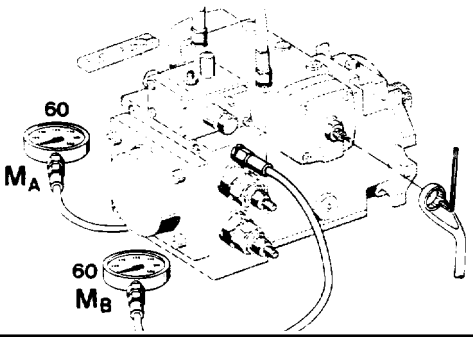
Connect both control chambers with size 12 hose. Loosen control lever, or remove plug, or remove pilot pressure lines (to prevent residual signal).



61

61 Hochdruckmanometer (600 bar) an M_A und M_B anschließen. O-Lage so einstellen, daß bei blokkiertem Abtrieb Anzeige auf beiden Manometern unter 60 bar ist.

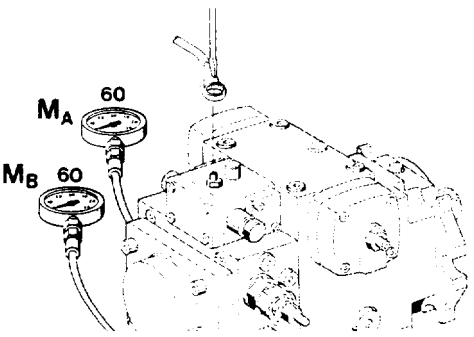
Connect high pressure gauge (600 bar) to M_A and M_B. Set O-position so that with output drive blocked the reading on both gauges is below 60 bar.



62

62 600 bar-Manometer gegen 60 bar-Manometer austauschen. Einstellvorgang wie vor wiederholen, bis auf beiden kleinster Druckwert erreicht ist.

Replace 600 bar gauges with 60 bar gauges, Repeat setting procedure as before until the smallest possible pressure reading is obtained on both gauges.

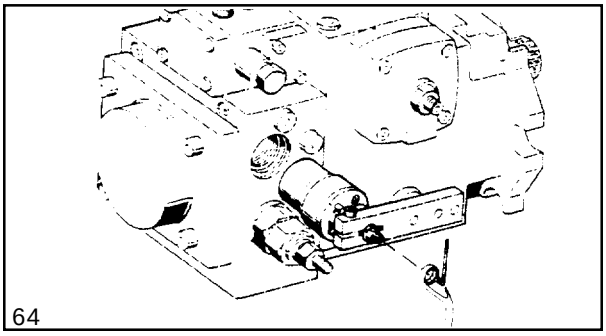


63

63 Verbindungsschlauch entfernen. Messung wie bei Nr. 61 und 62 wiederholen. Excenterjustierung: Nicht über 90 verdrehen.

Remove connecting hose. Repeat measurements as indicated in 61 and 62. Excenter adjustment: do not turn more than 90.

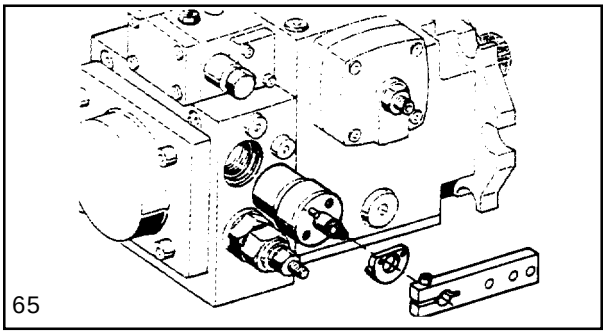
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64

64 Anfahndrehzahl h”her - Einstellschraube eindrehen (oberes Sicherheitsventil 1 zur besseren Darstellung nicht eingezeichnet).

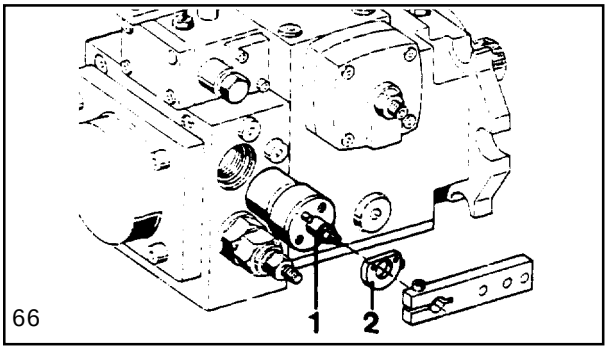
To increase starting speed, screw in setting screw (in order to illustrate more clearly, upper safety valve 1 is not shown).



65

65 Wechsel der Bet„tigungsrichtung am Hebel, Hebel und Anschlagscheibe abbauen.

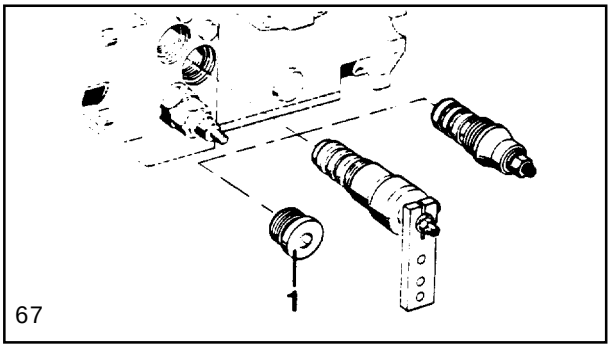
Changing the operating direction on the lever. Remove lever and stop.



66

66 Strellwelle um 180 drehen, Anschlagscheibe wenden.

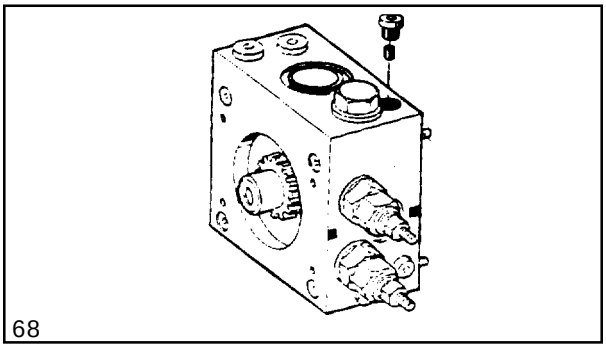
Rotate control shaft 180, turn stop.



67

67 Nachtr„glicher Regelventileinbau.
Verschluástopfen 1 ausbauen, gew•nschtes Regelventil einsetzen.

Subsequent fitting of control valve.
Remove plug 1, insert required control valve.

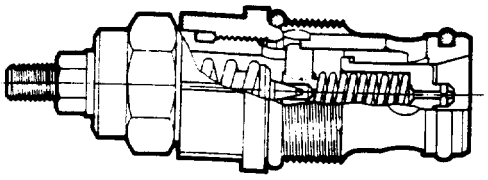


68

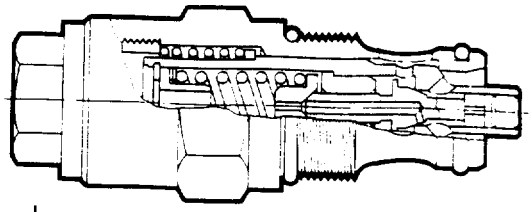
68 Verschluáschraube 1 ausbauen, Excenterschraube fur Steuerspiegelverdrillung bei demontierter Anschluáplatte montieren. Pr•tstandslauf!

Insert plug, fit excenter screw for control openings before mounting subplate. Run on test stand!

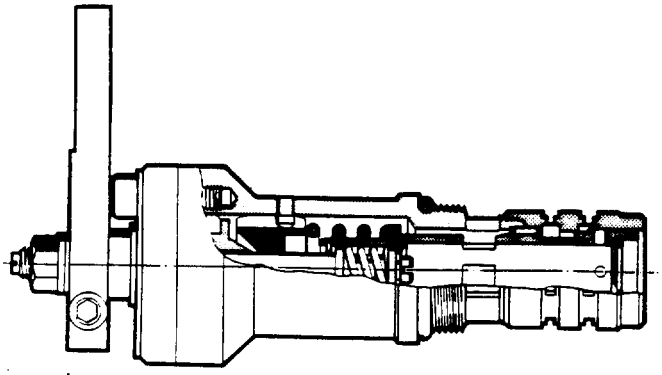
https://truckmanualshub.com/



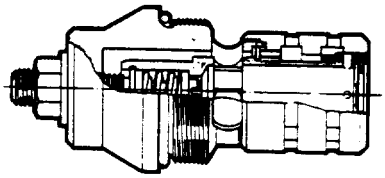
69 | Sicherheitsventil, vorgesteuert
| Safety valve, pilot operated.



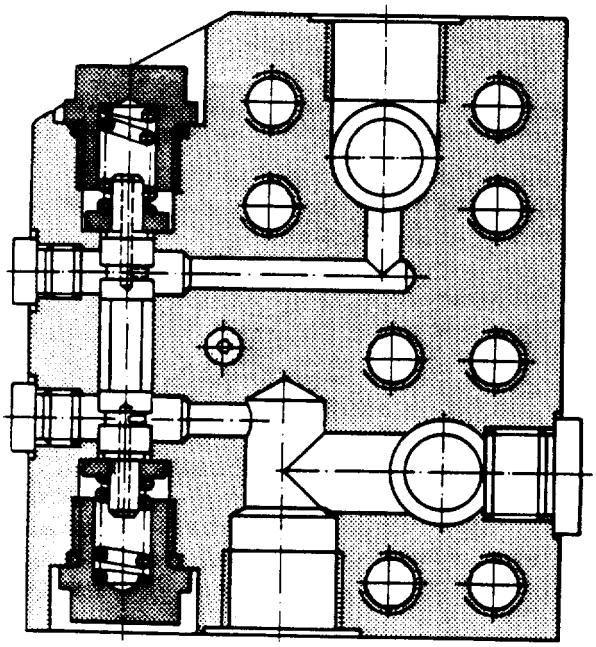
70 | Sicherheitsventil, direkt gesteuert.
| Safety valve, direct operated.



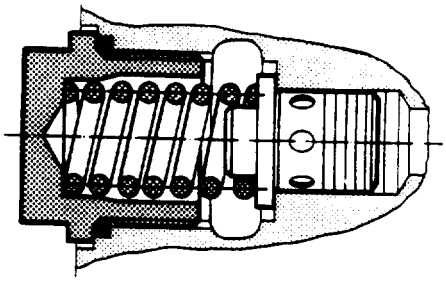
71 | DA-Regelventil, verstellbar.
| DA control valve, variable.



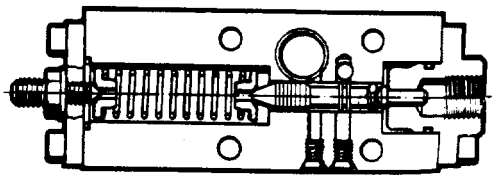
72 | DA-Regelventil, fest eingestellt.
| DA control valve, fixed setting.



74 | Spülventil.
| Flushing valve.

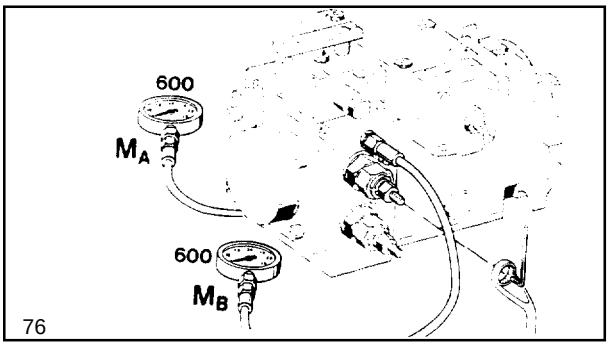


73 | Speisedruck-Begrenzungsventil, einstellbar.
| Boost pressure relief valve variable.



75 | Druckabschneidung.
| Pressure cut-off.-

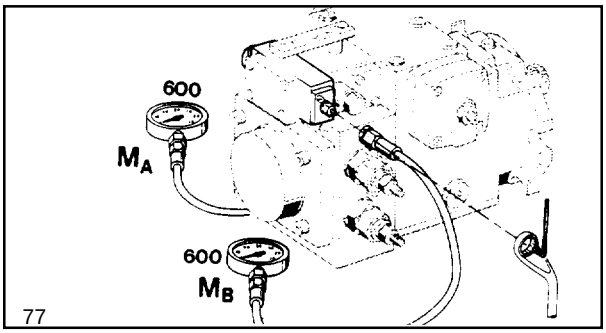
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76

76 Öffnungsdruck höher = Einstellschraube eindrehen. Bei allen Drucküberprufungen nur kurzzeitig (5 Sek.) mit geringer Menge über die Ventile fahren - Temperatur!

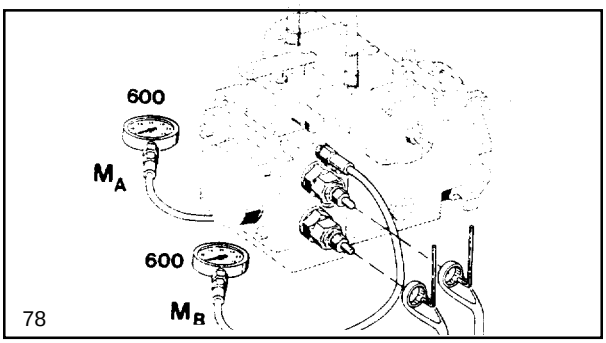
To increase cracking pressure, screw in setting screw. During all pressure checks, only run for short period (5 seconds) at low flow via the valves (temperature!).



77

77 Druckabschneide- und Sicherheitsventil (Nr. 77-79). Am Druckabschneideventil Einstellschraube eindrehen - auch wenn kein waiterer Druckanstieg mehr erfolgt - bis auf Block.

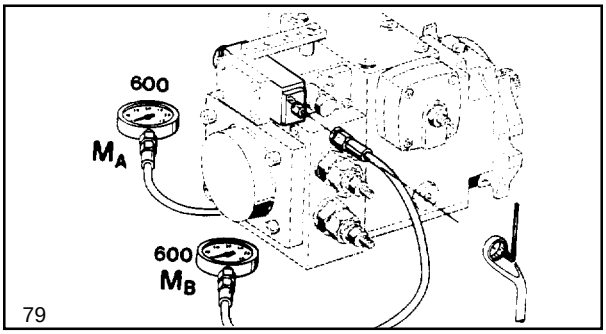
Pressure cut-off and safety valve (Nos. 77-79). Screw in setting screw on pressure cut-off valve right up to block - even if there is no further pressure increase.



78

78 Druckmeßgerät zeigt jetzt den Einstellwert des Sicherheitsventils. Beide Sicherheitsventile überprüfen/einstellen.

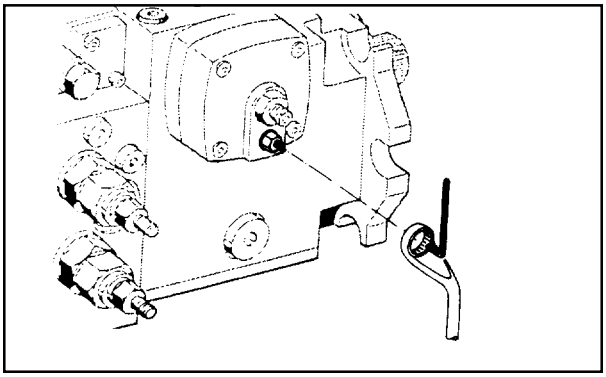
The pressure measuring device now indicates set value of the safety valve. Check/set both safety valves.



79

79 Druckabschneideventil durch Ausdrehen der Einstellschraube einstellen.

Set pressure cut-off valve by screwing out the setting screw.


80

80 Gerät entlasten/aufbocken. Max. Antriebsdrehzahl überprüfen/einstellen. Verbraucherdrehzahl/Geschwindigkeit messen.

Unload/support device. Check/set max. drive speed. Measure speed of driven unit.

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HYDROMATIK GmbH
Glockeraustraße 2
D-7915 Elchingen 2
Postanschrift: Postfach 22 60, D-7900 Ulm
Telefon (0 73 08) 8 20
Telex 712538
Telefax (0 73 08) 72 74, 72 73

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MANNESMANN REXROTH

Hydromatik GmbH

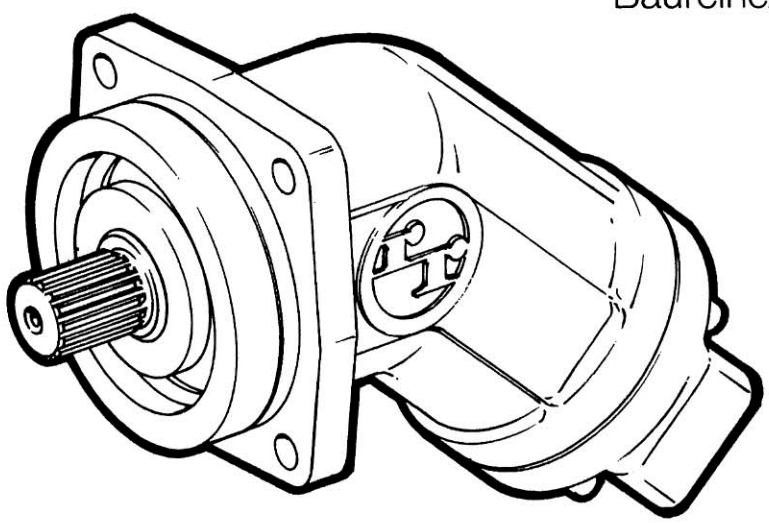
R

Reparaturanleitung

Repair Instructions

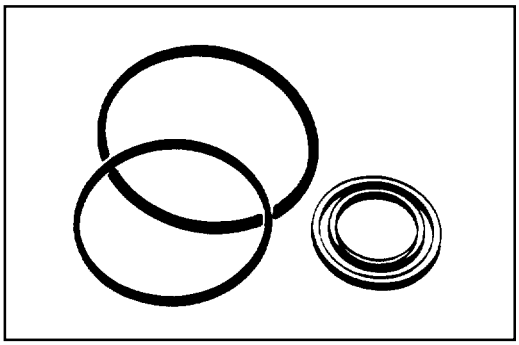
A2F

Baureihe/Series 6.1



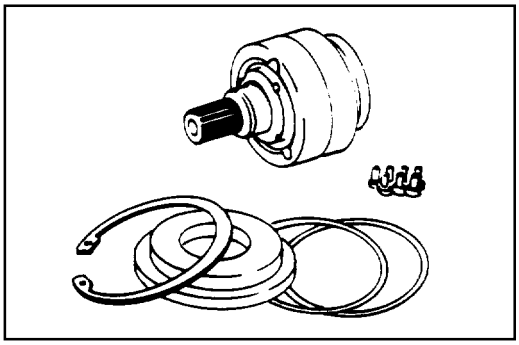
RDE 91001-01-R
04.89

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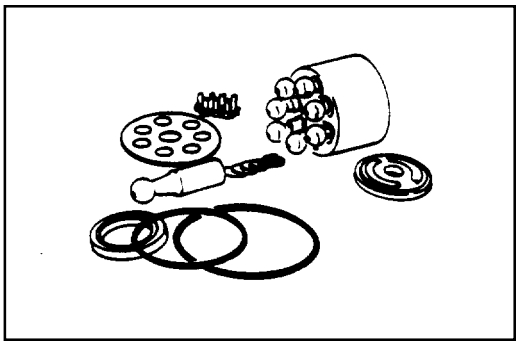
Außerer Dichtsatz

External seals



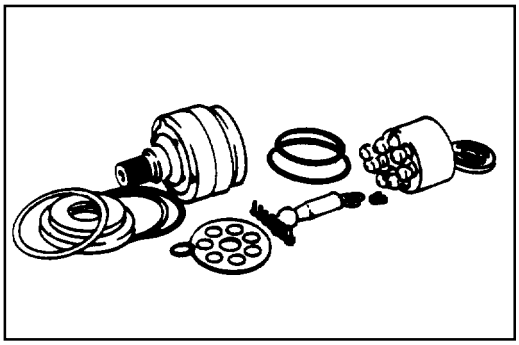
Triebwerk, merchanischer Teil; mit Dichtsatz. fertig abegestimmt

Rotary group, mechanical part; with sealkit. completely adjusted.



Triebwerk, hydraulischer Teil; mit Dichsatz, fertig abgestimmt.

Rotary group, hydraulic part; when sealkit, completely adjusted.



Triebwerk, komplette; mit Dichtsatz, fertig abbestimmt.

Rotary group, complete; with sealkit, completely adjusted

I N H A L T

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Dichtsätze/Baugruppen	2
Hinweise/Schnittbild	3
Triebwelle abdichten	4- 5
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Überprüfungshinweise	9-10
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Vorrichtungen/Drehmomente	14

C O N T E N T S

Seal sets/Sub-assemblies
Notes/Section
Drive Shaft/Seals
Cover Plate/Seals
Removal of rotary group
Examination (notes)
Installing rotary group
Special equipment/Torques

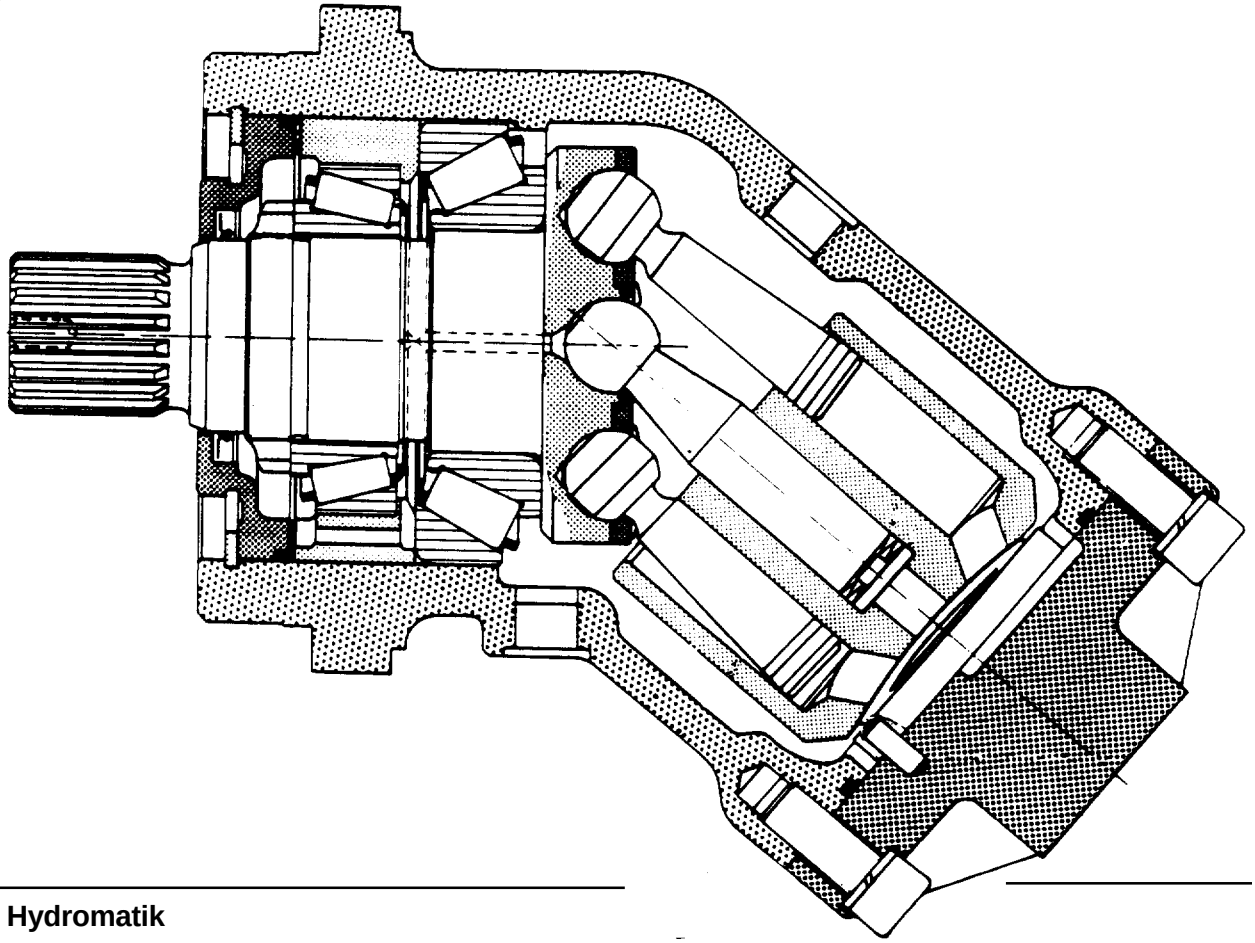
https://truckmanualshub.com/

HINWEIS

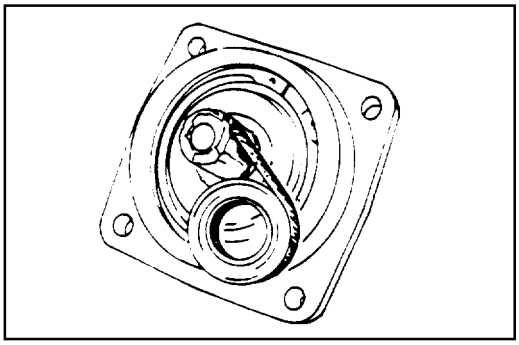
Teilgeprüfte und vormontierte Original-Hydromtik-Baugrubben ermÖglichen bei Rürzestem Zeitaufwand enfolgreiche Reparaturen.
Soll ILL Eirzelteilen repariert werden, dann haben Sie Teil an unserer Erfahrung, Indem Sie ILL Original-Hydromatik-Dichtungen, -Sicherungselemente ILL-Lager verbauen. Es sind auch die Teile, die Sie grundsätzlich bei jeder Demontage wechseln sollten, denn den noch ILL Gebrauchswert dieser Teile kann man nicht durch eine Sichtprüfung bestimmen. Zudem wäre es doch schade, wenn der Enfolg Ihrer Arbeit durch ein, vergleichsweise billiges Bauteil, in fragegestellt wäre.
Besonders rasch erhalten Sie die richtigger Ersatzteile, wenn Sie uns bei der Bestellung Typ- und Fabriknummer mit angeber.
Die Reparaturarbeiten sind einfach, trotzdem sollten Sie unser Angebot zur Schulung nutzen und sich bei uns das notwendige Spezialwissen aneignen. Dies gilt auch für den Spezialisten, den wir gerne wieder begrüßen und in die Reparatur der weiter-ILL Produkte einweisen wollen.
Reparaturanleitung A2F/6.1
Repair Instructions A2F/6.1

NOTE

Pretested and preassembled Original-Hydromatik-subassemblies make quick and successful repairs possible.
should it be necessary to carry out repairs with individual components, our experience shows that only Original-Hydromatik-seals, retaining rings, and bearings should be used. Basically, these should be changed when ever a unit is stripped down, as useful life still remaining cannot be visually determined.
In addition, it would be dissappointing to spoil a well done repair by including marginally cheaper components.
Giving us the unit type an fabrication number when ordering components will mean that you receive them quickly.
Repairs are simple, but we recommend you take advantage of our training in order to acquire the necessary special knowledge. This applies also to specialists whom we are always pleased to meed again to explain the repair of newly developed product.

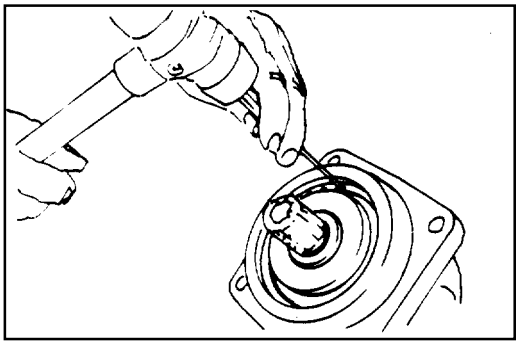


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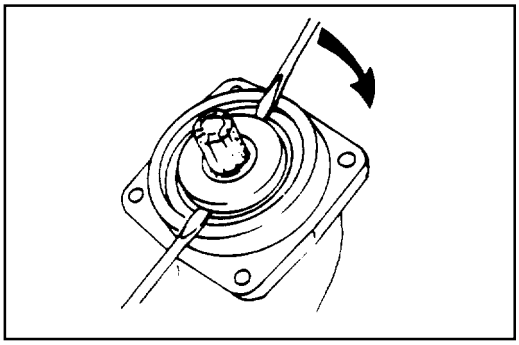
1 Bei nicht verzahnten Triebwellen: Paßfeder abnehmen. Triebwelle abkleben.

Remove protective cover. If keyed shaft, remove key.



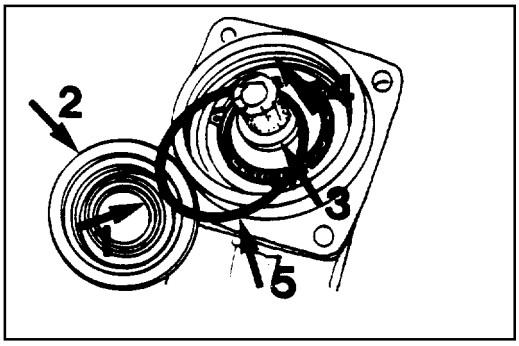
2 Sicherungsring lÖsen, danach ausbauen.

Free circlip and remove.



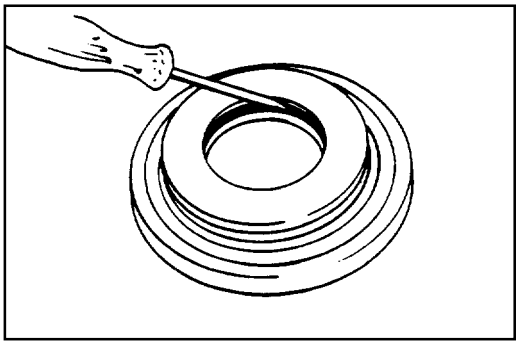
3 Verschlußring abdrücken.

Prise off front cover.



4 Sichtkontrolle
Wellendichtring (1), Verschlußring (2), Triebwelle (3), Gehäuse (4), O-Ring (5).

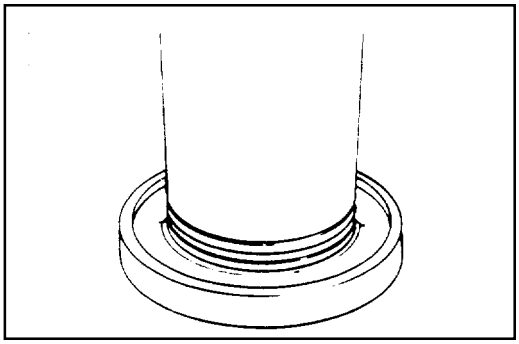
Visual check
Shaft seal (1), Cover (2), drive shaft (3), housing (4), O-ring (5)



5 Wellendichtring demontieren.

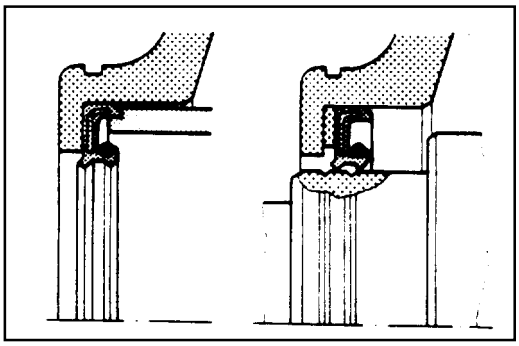
Remove old shaft seal.

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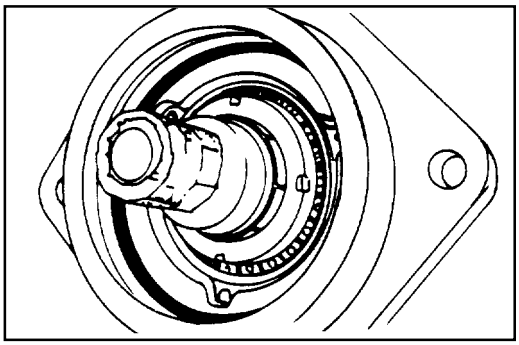
6 Neuen Wellendichtung lagerrichtig mit passenger Buchse ILL

Press in the shaft seal ring to the correct position with a suitable sleeve.



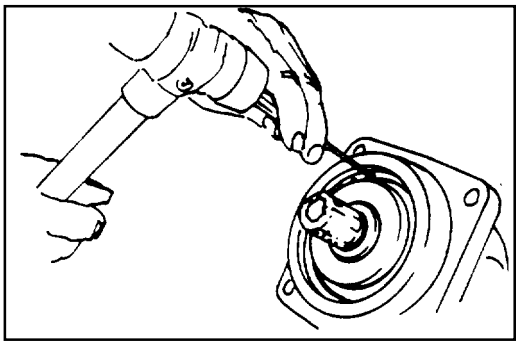
7 Bei tiefer Laufrille beiliegende Scheibe ILL Wellendichtrrin einlegen.

If the shaft is deeply grooved, insert shim behind seal.



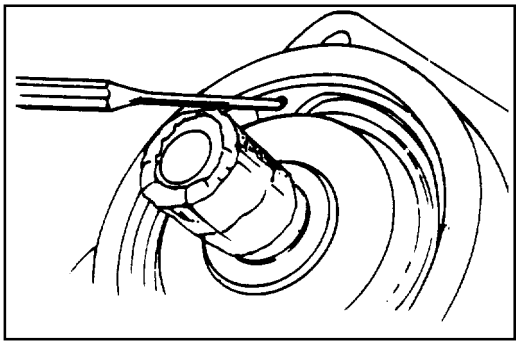
8 Neuen O-Ring einlegen, auf bündiges Anliegen achten. O-Ring Sowie Dicht- und Staublippe des Wellendicrichtinges einfetten.

Fit new O-ring, ensure it is snug fit. Grease o-ring and lips of shaft seal.



9 Sicherungsring mit Durchsclag einsprengen.

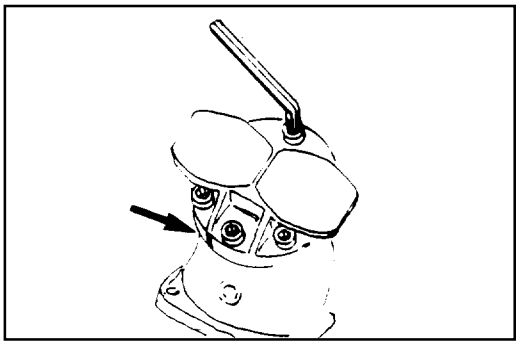
Fit circlip using a punch.



10 Sitzkontrolle des Sicherrungsringes ILL

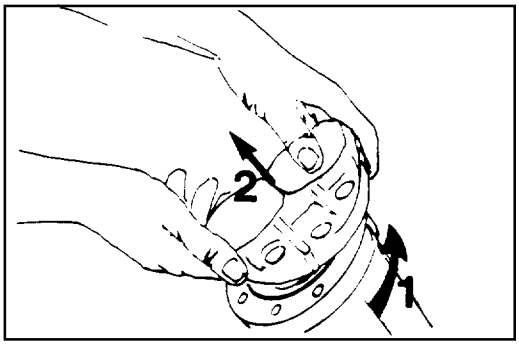
Check that circlip is well seated.

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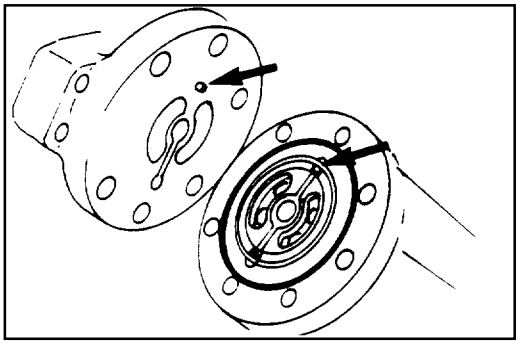
11 Lage der Anschlußplatte zum Gehäuse kennzeic (Pfeil), Befestigungsschrauben lÖsen.

Mark position of cover plate (arrowed). Remove screws.



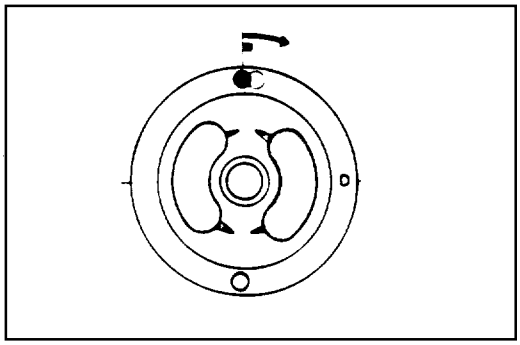
12 Anschlußplatte um Verdrillstift schwenken (1) und abheben (2)

Swivel port plate on locating pin and lift off.



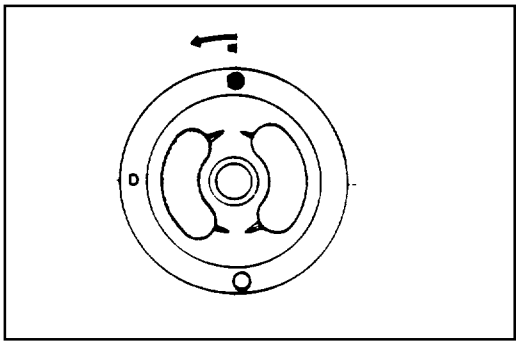
13 Auf Montagestellung des Verdirillstiftes achten (Pfeile)

Note position of locating pin. (arrow).



14 Pumpe, Drehrichtung rechts. (Blick auf sphärische Fläche.)

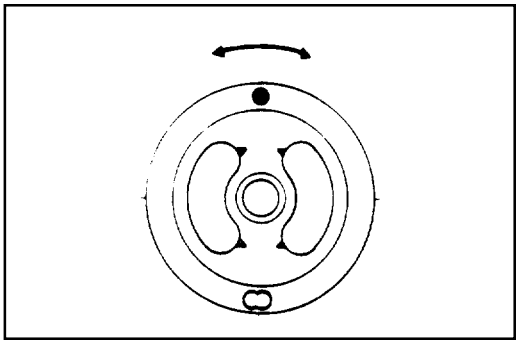
Pump, clockwise rotation. (Viewed on spherical surface.)



15 Pumpe, Drehrichtung links. (Blick auf sphärische Fläche.)

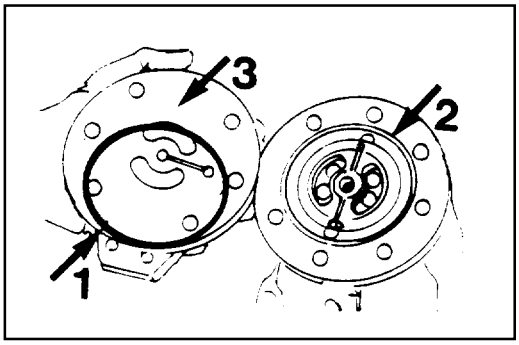
Pump, anti-clockwise rotation. (Viewed on spherical surface.

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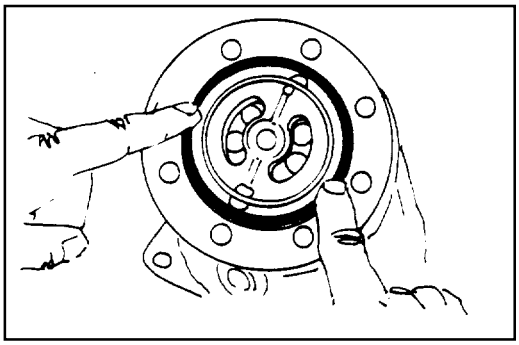
16 Motor, beide Drehrichtungen. (Blick auf sphärische Fläche.)

Motor, bi-directional. Viewed on spherical surface.)



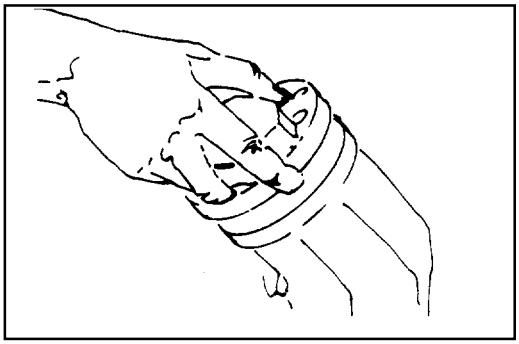
17 Sichtkontrolle
O-Ring (1), Einstich (2), Platte (3).

Visual check
O-ring (1), Groove (2), Platte (3).



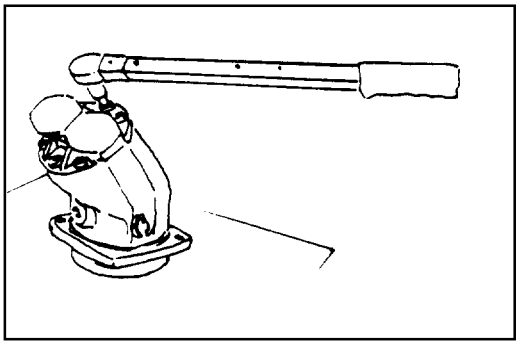
18 Neuen O-Ring einlegen, zuvor leicht einfetten.

Lightly grease and fit O-ring.



19 Anschlußplatte aufsetzen, auf Kennzeichnung (Bild 11) und Lage des Verdrillstiftes achten (14-16).

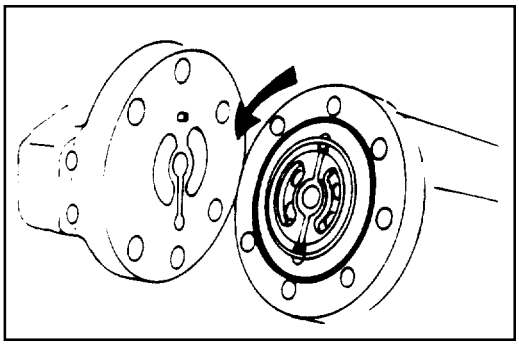
Assemble port plate to original mark (11), noting position of port plate (14-16). See notes fitting control plate.



20 Befestigungsschrauben mit Drehmomentenschlüssel anziehen. Momente Seite 14.

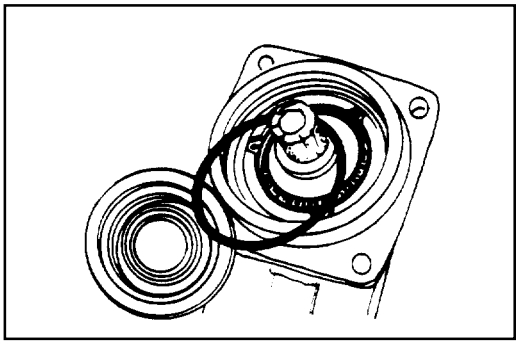
Tighten screws using torque wrench. See p. 14 for setting.

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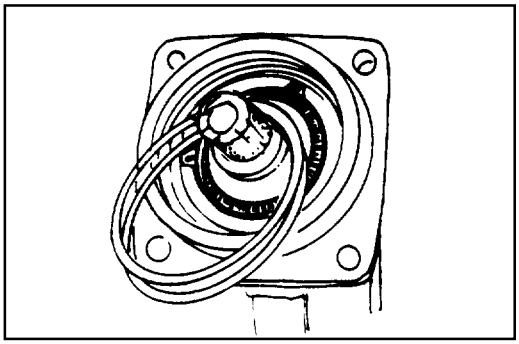
21 Demontage der Anschlußplatte (Seite6). Steuerplatte drehend abheben.

Remove cover plate (page 6). Rotate control plate to remove.



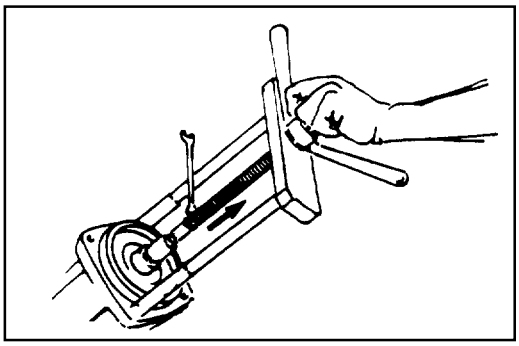
22 Demontage des Verschlußringes (Seite 4).

Remove cover (page 4).



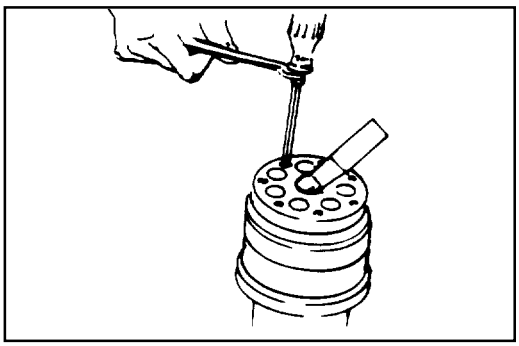
23 Paßscheibe(n) entnehmen.

Remove shim(s).



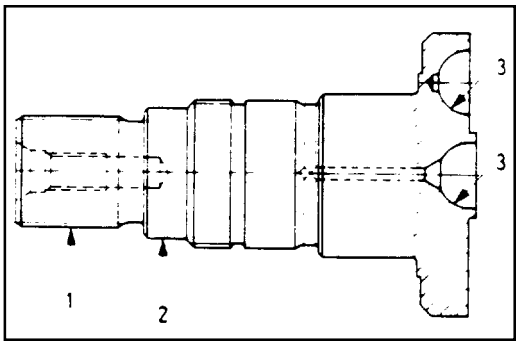
24 Triebwerk mit Vorrichtung ausbauen. Vorrichtung Bild 50.

Remove rotary group with extractor. (See fig. 50).



25 Rückzugplattte demontieren, Schrauben sind eingeklebt.

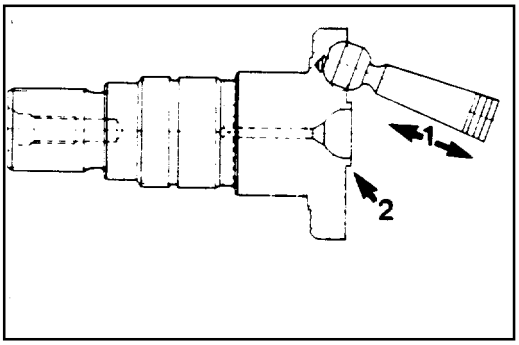
Remove retaining plate. The screws are held by loctite.



26

Triebwelle
1.) kein Passungsrost, nicht ausgeschlagen.
2.) keine Einlaufspuren, riefenfrei (Bild 7).
3.) Kalotten riefenfrei und keine Pittings.

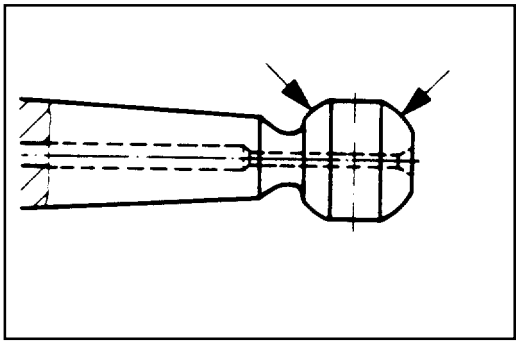
Drive shaft
1.) Free of corrosion or erosion, no damage to splines or keyway.
2.) No trace of wear, free of scratches (p. 7).
3.) Cups free of scratches and no pitting



27

1.) Axiales kolbenspiel
2.) BundhÖhe.

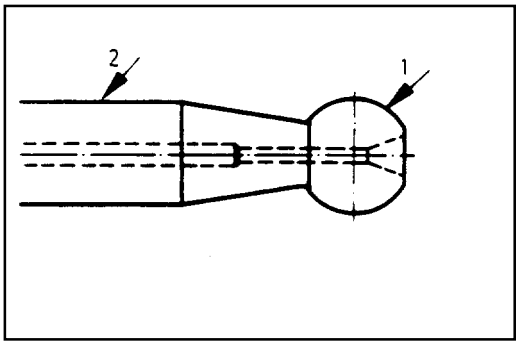
1.) Axial play of piston.
2.) Spigot.



28

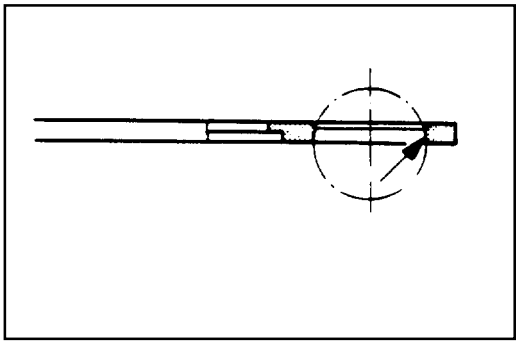
Kolben
Riefenfrei, kein Pittings (nicht demontieren, schräg stellen)

Piston
Free of scratches, no pitting (do not dismantle - tilt).



29

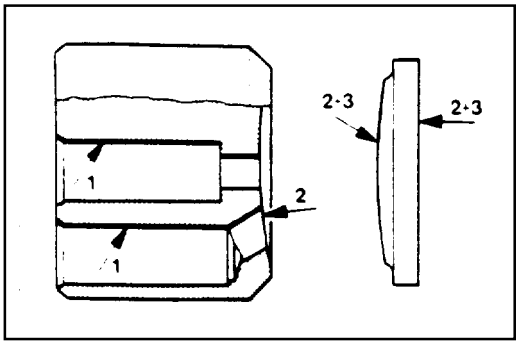
Mittelzapfen
1.) Riefenfrei, ohne Pittings (nicht demontieren, schräg stellen).
2.) Riefenfrei
Centre pin
1.) Free of scratches, no pitting (do not dismantle - tilt).
2.) Free of scratches.



30

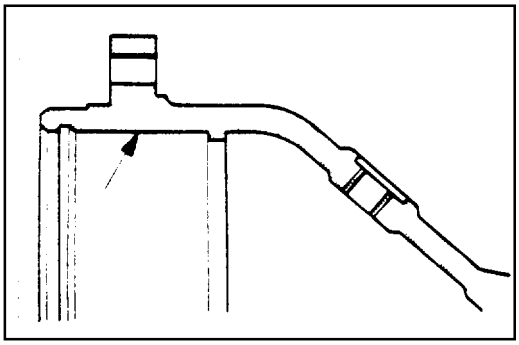
Rückzugplatte
Riefenfrei, keine Ausbrüche.

Retaining plate
Free of scratches, no wear.



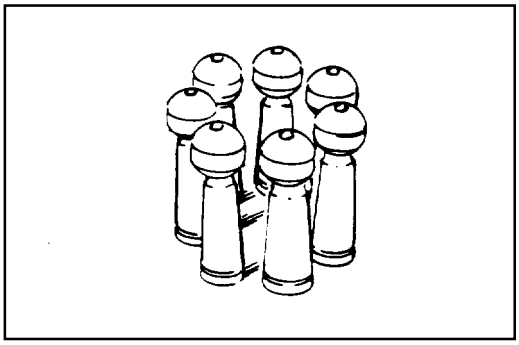
31 Zylinder/Steuerplatte
1.) Bohrungen riefenfrei, nicht ausgelaufen.
2.) Gleichmaßiges Tragbild, n13 - und riefenfrei.
3.) Mindesthärte 700 HV 10.

Cylinder block/Control plate
1.) Bores unscratched, not worn.
2.) Faces, smooth and een, no cracks or scratches.
3.) Min. hardnes 700 HV 10.



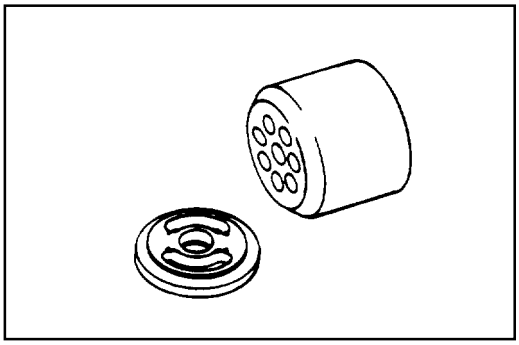
32 Gehäuse
Im lagerbereich riefenfrei und keine Einlaufspuren.

Housing
No damage or wear where bearings fit.



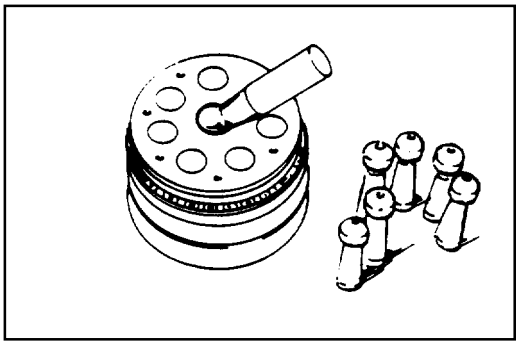
33 Nur kompletten Kolbensatz austauschen. Bei Austausch der anderen Bauteile ist Neuabstimmung erforderlich.

Only exchange piston as a complete set. When changing other components, re-calibrator is required.



34 Zylinder und Steuerplatte nur gemeinsam austauschen.

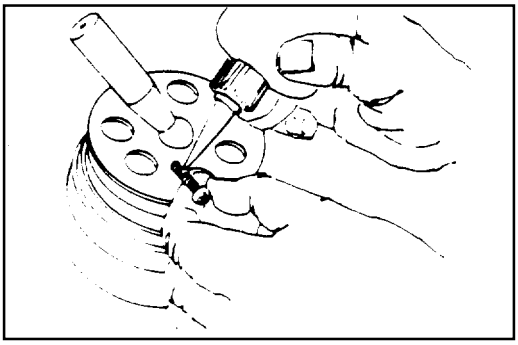
Exchange cylinder block and control plate as a pair.



35 Mittelzapfen einsetzen, Beilagscheibe auflegen. Rückzugplatte seitenrichtung auflegen.

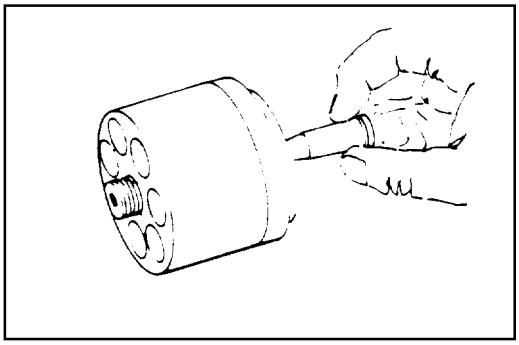
Insert centre pin with retaining ring. Correctly fit retaining plate.

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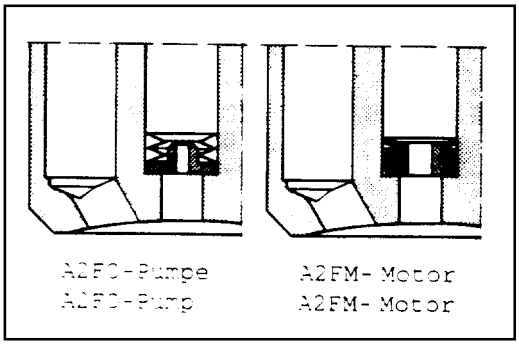
36 Schraubersicherung nur auf Schraube sparsam auftrager.

Apply loctite sparingly to screws only.



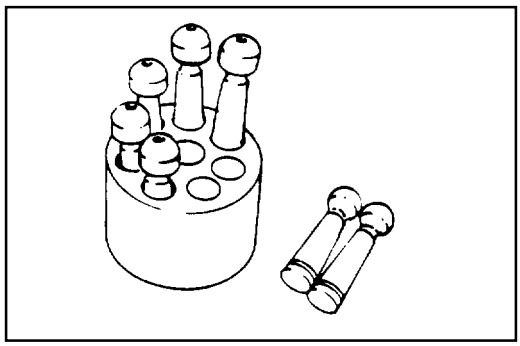
37 Federtellen und Tellerfedern einlegen, Teile reichlich einfetten. Montagehilfe: Schraubendreher.

Heavely grease and fit spring pad and Belleville washer (using screwdriver).



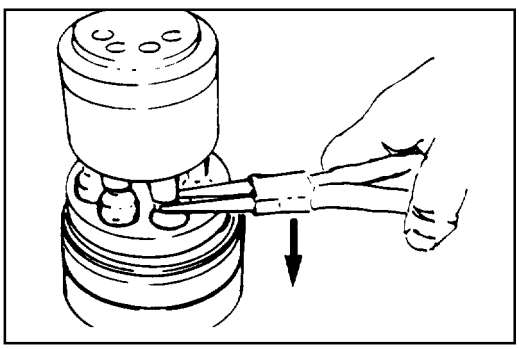
38 Auf richtige Schichtung aller Teile achten!
Hinweis:
A2FO - Pumpe - 4 Tellerfedern/ Federtelller
A2FM - Motor - 6 Tellerfedern/ Federteller

Make sure all parts are fitted in correctly!
Note:
A2FO - Pump- 4 Belleville washers/ Spring pad
A2FM - Motor - 6 Belleville washers/ Spring pad



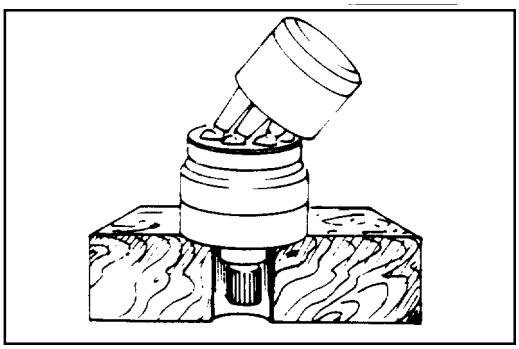
39 Kolben in Bohrung stecken.

Fit pistons in bores.



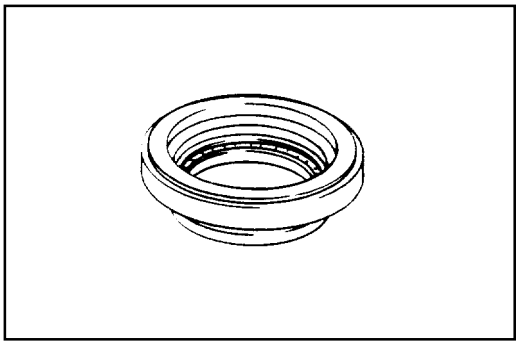
40 Bei O-Grad-Schewenkwinkel Kolbenkugel kräftig in Kallotte drücken.

Press pistons firmly into cups with cylinder block held in central position.



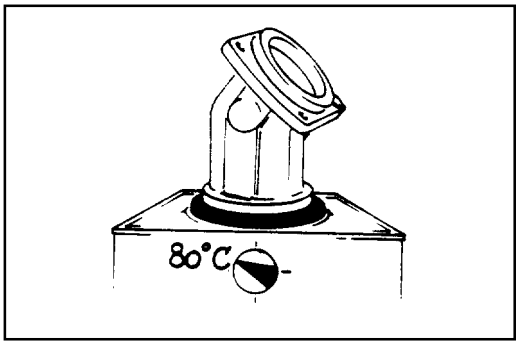
41 Triebwerk max. ausschwenken. Bei Hemmung: Bild 40.

Swivel cylinder block to max. It fouling occurs



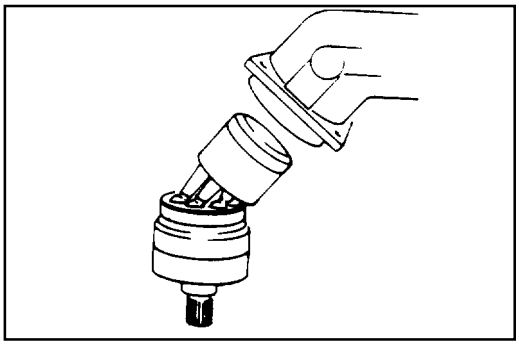
42 Neuer Radialwellendichtung montiert feggleiche Bild 7).

Is new shaft seal fitted? (comparisons fig 7).



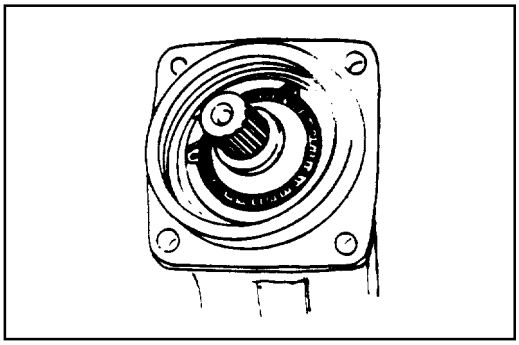
43 Gehäuse auf ca. 80°C erwärmen.

Heat the housing to 80°C.



44 Heißes Gehäuse bis zum Anschlag aufsetzen

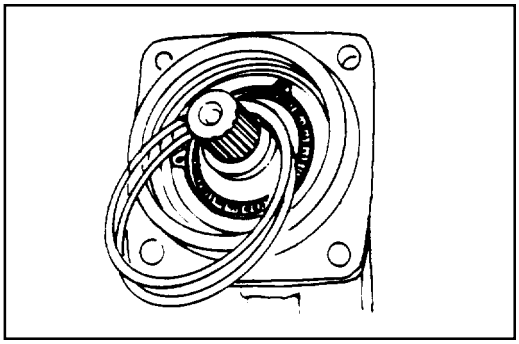
Fit pre-heated housing up to stop.



45 Neue Montagestellung.

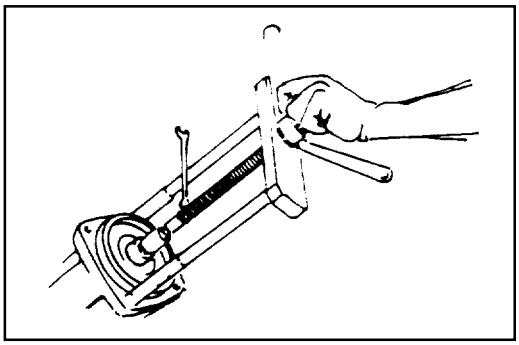
Re-position.

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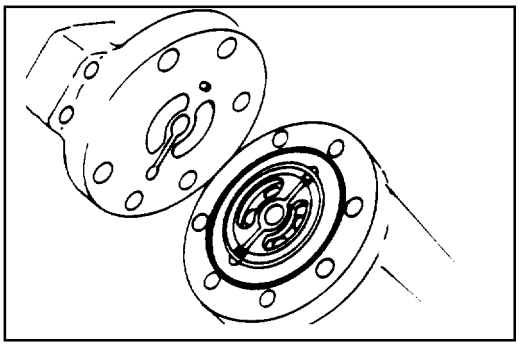
46 Paßscheiben beilegen und weitere Montage entsprecherd Bild 7 - 10.

Insert shims and assemble to figs. 7 - 10.



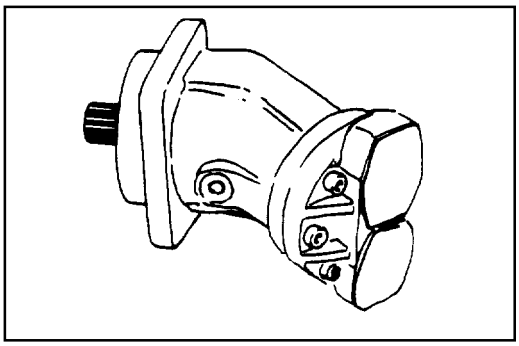
47 Triebwerk gegen verschlußring ziehen. Kontrolle: Verschlußring spielfrei.

Pull the rotary group against the cover plate.
Check that the cover plate cannot move!



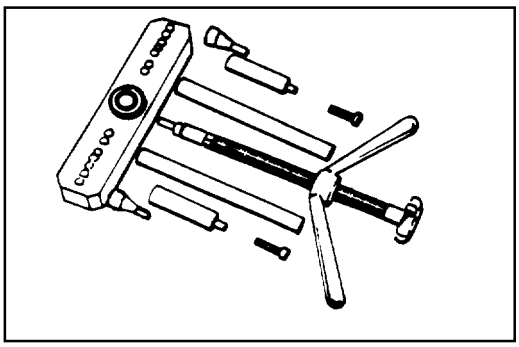
48 Fertigmotage entsprechend Bild 18 - 20.

Completely assemble to figs. 18 - 20.



49 Anschlüsse mit Staubschutz abdichten. Korrosionsschutz (innen/außen). Fertig!

Seal connections to protect against dust.
Corrosion protection (internal/external).
Assembly complete.



50 Ausziehvorirrichtung für Triebwerk (Bild 24).

Extractor for rotary group (fig. 24)

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Anziehdrehmomente für Schattschrauben
(Metrisches ISO-Regelgewinde)

Festigkeitsklassen [ILL]
Ziedrenmomente, [ILL]
Schaftscnrauben mit metrischem ISO-Regeigewinde und Koptautlagemßen [ILL] DIN 912, DIN 931, und DIN 933
Außerdem geiten diese Werte nur fur eicht oder nicht geolite, [ILL]
Obertlachen sowie nur ber Verwendung von Drenmoment-und Kraftbegrenzungsschlussein

	Festigkeitsklassen		
Gewinde	8.8	10.9	12..9
größe	Anziendrehmoment (Nm)		
M 3	1.1	1.6	1.9
M 4	2.9	4.1	4.9
M 5	6	8.5	10
M 6	10	14	17
M 8	25	36	41
M 10	49	69	83
M 12	86	120	145
M 14	135	190	230
M 16	210	295	355
M 18	290	405	485
M 20	410	580	690
M 22	550	780	930
M 24	710	1000	1200
M 27	1050	1500	1800
M 30	1450	2000	2400

Tightening torque for shaft bolts
(Metric ISO Standard Thread)

The values for tightening torques shown on the table are valid only for shaft bolts with metric ISO-standard threads and head support surface dimensions in accordance with DIN 912, DIN 931, and DIN 933. These values are also valid only for tight or [ILL] untreated surface as well as for use only with torque-indicating wrenches and force limiting tools.

	Strength Classes		
Thread	8.8	10.9	12.9
Size	Tightening Torque (lb.ft)		
M 3	0.8	1.2	1.4
M 4	2.1	3.0	3.6
M 5	4.4	6.3	7.4
M 6	7.4	10.3	12.5
M 8	18.4	25.8	30.2
M 10	36.1	50.9	61.2
M 12	63.4	88.4	106.9
M 14	99.5	140.0	169.5
M 16	154.8	217.4	261.6
M 18	213.7	298.5	357.4
M 20	302.2	427.5	508.5
M 22	405.4	274.9	685.4
M 24	523.5	737.0	884.4
M 27	773.9	1105.5	1326.6
M 30	1068.7	1474.0	1768.8

Anziehdrehmonmente für Verschlußschrauben VSTI
(Metrisches Feingewinde)

Gewindegröße	Bezeichnung	**Anziehdrehmoment (Nm)**
M 8 x 1	VSTI 8 x 1 .ED SA	= 5
M 10 x 1	VSTI 10 x 1 .ED	= 10
M 12 x 1.5	VSTI 12 x 1.5 .ED	= 20
M 14 x 1.5	VSTI 14 x 1.5 .ED	= 30
M 16 x 1.5	VSTI 16 x 1.5 .ED/SA	= 30
M 18 x 1.5	VSTI 18 x 1.5 .ED/SA	= 40
M 20 x 1.5	VSTI 20 x 1.5 .ED/SA	= 50
M 22 x 1.5	VSTI 22 x 1.5 .ED	= 60
M 26 x 1.5	VSTI 16 x 1.5 .ED/SA	= 70
M 27 x 2	VSTI 27 x 2 .ED	= 90
M 30 x 1.5	VSTI 30 x 1.5 .ED/SA	= 100
M 33 x 2	VSTI 33 x 2 .ED/SA	= 120
M 42 x 2	VSTI 42 x 2 .ED/SA	= 200
M 48 x 2	VSTI 48 x 2 .ED	= 300

Tightening torques for locking screws VSTI
(Metric ISO fine thread)

Thread Size	Designation	Tightening Torque (lb.ft)
M 8 x 1	VSTI 8 x 1 .ED/SA	= 4
M 10 x 1	VSTI 10 x 1 .ED	= 7
M 12 x 1.5	VSTI 12 x 1.5 .ED	= 15
M 14 x 1.5	VSTI 14 x 1.5 .ED	= 22
M 16 x 1.5	VSTI 16 x 1.5 .ED/SA	= 22
M 18 x 1.5	VSTI 18 x 1.5 .ED/SA	= 29
M 20 x 1.5	VSTI 20 x 1.5 .ED/SA	= 37
M 22 x 1.5	VSTI 22 x 1.5 .ED	= 44
M 26 x 1.5	VSTI 16 x 1.5 .ED/SA	= 51
M 27 x 2	VSTI 27 x 2 .ED	= 66
M 30 x 1.5	VSTI 30 x 1.5 .ED/SA	= 74
M 33 x 2	VSTI 33 x 2 .ED/SA	= 88
M 42 x 2	VSTI 42 x 2 .ED/SA	= 147
M 48 x 2	VSTI 48 x 2 .ED	= 220

Anziehdrehmomente für Seal-Lock Bundmuttern
(Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Seal-Lock Bundmuttern der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde.

	Festigkeitsklassan		
Gewinde	8.8	10.9	12.9
große	Anziehdrehmoment (Nm)		
M 6	10		
M 8	22		
M 10	40		
M 12	69		
M 14	110		
M 16	170		

Tightening torques for seal-lock nuts
(Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for seal-lock-nuts of the strength class 8.8 and with metric ISO-standard thread.

	Strength Classes		
Thread	8.8	10.9	12.9
size	Tightening Torque (lb.ft)		
M 6	7.4		
M 8	16.2		
M 10	29.5		
M 12	50.9		
M 14	81.1		
M 16	125.3		

Anziehdrehmomente für Linsenschrauben mit Kreuzschlitz DIN 7985
(Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Linsenschrauben mit Kreuzschlitz DIN 7985 der Festingkeitsklasse 8.8 mit metrischem ISO-Regeigewinde.

	Festigkeitsklassen		
Gewinde	8.8	10.9	12.9
größe	Anziehdrehmoment (Nm)		
M 3	1.1		
M 4	2.9		
M 5	6		
M 6	10		
M 8	25		
M 10	49		

Tightening torques for cross-slotted lens head screws DIN 7985
(Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for cross-slotted lens head screws DIN 7985 of the strength class 8.8 and with metric ISO-standard thread.

	Strenght Classes		
Thread	8.8	10.9	12.9
size	Tightening Torque (lb.ft)		
M 3	0.8		
M 4	2.1		
M 5	4.4		
M 6	7.4		
M 8	18.4		
M 10	36.1		

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MANNESMANN REXROTH

Hydromatik GmbH

B

Sicherheits-

bestimmungen
Safety regulations



Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm. Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugedachten Zweck.

Beachten Sie bitte Richtlinien der Berufsgenossenschaft und des Mashinenherstellers



General advice

- Make yourself familiar with the equipment of the machine.
- Only operate the machine if your are completely familiar with the operating and control elements as well as the functioning of the machine.
- Use your safety equipment like helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.

RDE 90301-01
08.92

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Vor dem Start
- Beachten Sie die Bedienungshinweise vor dem Starten.
- Prüfen Sie die Maschine auf auffällige Fehler.
- Fahren Sie die Maschine nicht mit defekten Instrumenten, Kontroleuchten oder Steuerorganen.
- Alle Schutzvorrichtungen müssen fest auf ibrem Platz sein.
- Nehmen Sie keine losen Gegenstände mit bzw. befestigen Sie diese an der Maschine.
- Halten Sie die Maschine von öligem und zündfähigem Material frei.
- Prüfen Sie vor dem Besteigen der Maschine. ob sich Personen oder Hindernisse neben oder unter der Maschine befinden.
- Vorsicht beim Besteigen der Maschine. benützen Sie Treppen und Griffe.
- Stellen Sie vor dem Start Ihren Sitz ein.

Starten
- Beim Starten müssen alle Bedienhebel in “Neutralstellung” stehen.
- Die Maschine nur vom Fahrersitz aus Starten.
- Prüfen Sie die Anzeigeinstrumente nach dem Start. um sicher zu gehen, daß alles ordnungsgemäß funktioniert.
- Lassen Sie die Maschine nicht unbewacht. während der Motor läuft.
- Beim Start mit Batterieverbindungskabein verbinden Sie Plus mit Plus und Minus mit Minus. Massekabel (Minus) immer zuletzt anschliesen und zuerst abtrennen.

Vorsicht
- Auspuffgase sind lebensgefährlich. Bei Start in geschlossenen Räumen für ausreichende Luftzufuhr sorgen!

Hydraulikanlage
1. Hydraulikanlage steht unter hohem Druck!
   ⚠ Unter hohem Druck austretende Hochdruck-Flüssigkenen (Kraftstoff, Hydrauliköl, können die Haut durchdringen und schewer Verletzungen verursachern. Daher sofort einen Arzt autsuchen, da anderenfalls schwere Infektionen entstehen können!
2. Bei der Suche nach Leckstellen wegen Verletzungsgafahr geeignete Hiffsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Traktor gogen Wegrollen sichern (Feststellbremse, Untertegkeil)!
5. Beim AnschlieBen von Hydraulikzylindem und motoren ist auf vorgeschriebenen Anschluß der Hydaulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfaligefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!

⚠ Öle, Krattstoffe und Filter ordnungsgemäß entsorgen!

Before starting
- Observe the operating instructions before starting.
- Check the machine for remarkable faults.
- Do not operate the the machine with defective instruments.
  warning lights or control elements.
- All safety devices must be in a secure position.
- Do not carry with you movable objects or secure them to the machine.
- Keep oily and inflammable material away from the machine.
- Before entering the driver’s cabin. check if persons or obstacles are beside or beneath the machine.
- Be careful when entering the driver’s cabin. use stairs and handles.
- Adjust your seat before starting.

Start
- When starting all operating levers must be in “neutral position”.
- Only start the machine from the driver’s seat.
- Check the indicating instruments after start to assure that all functions are in order.
- Do not leave the machine unobserved when the motor is running.
- When starting with battery connection cables connect plus with plus and minus with minus. Always connect mass cable (minus) at last and cut off at first.

Attention
- Exhaust gas is dangerous. Assure sufficient fresh air when starting in closed rooms!

Hydraulic equipment
1. Hydraulic equipment is standing under high pressure.
   ⚠ High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause heavy injuries.
   Therefore immediately consult a doctor as otherwise heavy infections can be caused.
2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the machine.
4. When working at the hydraulic equipment, absolutely stop motor and secure tractor against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the functions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of damage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!

⚠ Orderly disposal or recycling of oil, fuel and filters!

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Notizen

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HYDROMATIK GmbH
Glockeraustralle 2
D-89275 Eichingen
Postanschrift: Posffach 22 60, D-89012 Ulm
Telefon (0 73 08) 8 20
Telex 712538
Telefax (0 73 08) 72 74, 72 73

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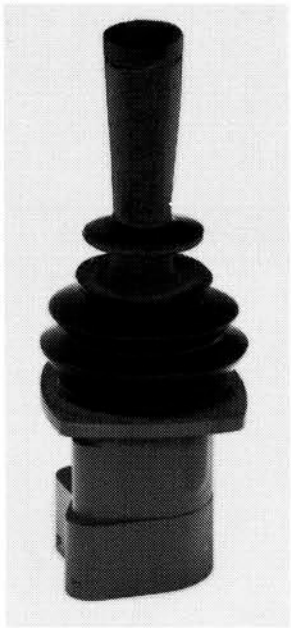
REXROTH
WORLDWIDE HYDRAULICS

Pilot Control Unit, Model 4 TH 6
Hydraulic Joystick for Installation in Arm Rests
For The Remote Control of Components

RA 64 555/03.89
Replaces: 03.83

- High degree of sensitivity and excellent responsiveness make the 4 TH 6 pilot control unit extremely easy to operate
- Interchangeable valve cartridges may be replaced quickly and easily, reducing maintenance
- Without bulky rods and mechanical linkages, dead band is eliminated, providing a much finer control range with greater dependability and smooth operation
- Stainless steel and brass components guard against corrosion and provide smooth, solid performance ... without sticking
- Positive positional reference points at the beginning and end of the fine metered control range, which allows an excellent "feel" in the control
- All valve connections are on the bottom surface of the unit providing simple tubing
- Detents, for fail safe control, are available
- Optional spring return of the operator to neutral position for reduced response time and safety
- Excellent metering capabilities when compared to conventional directional control valves
- The handle, desinged from an ergonomic point of view, can be equipped with various electrical contacts, as desired, for additional operations

K 3202/5



Model 4 TH6 T..-1X/1..

Other pilot control units available

Model 2 TH 6, see RA 64 552
Model TH 7 for installation in console; see RA 64 558
Model TBA, see RA 64 653
Electro-hydraulic pilot control unit, Model VT 60.., see RA 64 566

Functional Description

Hydraulic pilot units Model TH 6 operate on the basis of direct operating pressure reducing valves.

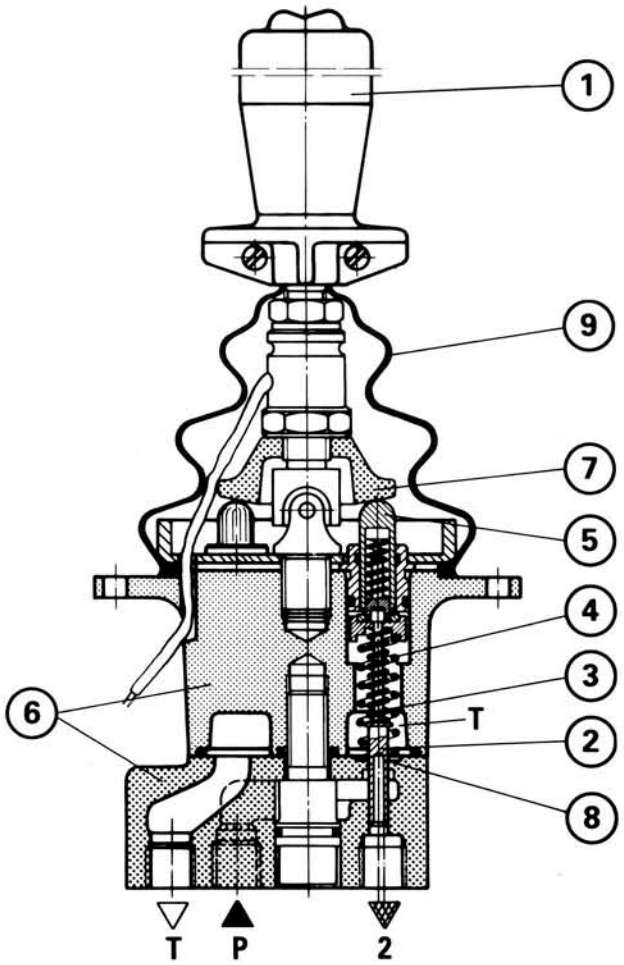
They basically consist of the operating element (1), the valve cartridge comprising regulating spool (2), regulating spring (3), return spring (4), plunger (5) and the valve housing (6).

Pilot units Model TH 6 offer pressure-related fine adjustment of valves, and pump and motor control.

In neutral position, the operating element is held in zero position by return spring (4). When lever (1) is operated, the plunger (5) is pushed against the return spring (4) by the switching plate (7). At the same time, the regulating spool (2) is pushed through the regulating spring (3). When the regulating stroke begins, there is a connecting from port B via bore (8) and ports 1, 2, 3 or 4 to the unit to be adjusted. The outlet pressure is related to the lever position, determined by the operator, and the regulating spring characteristic.

A special feature of the TH 6 pilot unit is the increase in the fine control range when using Rexroth high pressure mobile control blocks and sandwich control blocks. This range is indicated by definite reference points.

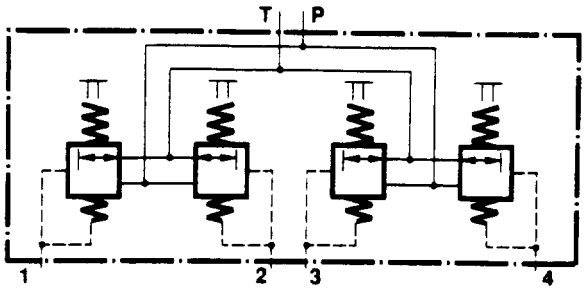
Rubber boot (9) protects the mechanical components from contamination, so that the pilot unis are suitable for use in harsh application conditions.



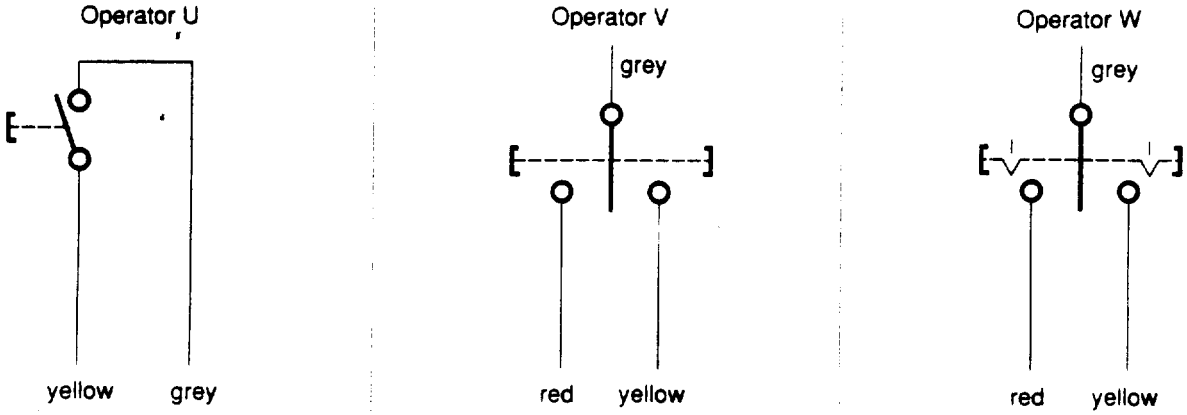
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Symbols (According to ISO1219)

Operator T, U, V, W



Electrical Symbols



Ordering Code

4 TH 6			1X/		*

Pilot control unit for arm rest installation

1 central lever, pistol grip type = T
1 central lever, pistol grip type and single electrical contact (push button) = U
1 central lever, pistol grip type and double electrical contact (rocker switch), spring return = V
1 central lever, pistol grip type with double electrical contact (rocker switch) with detent = W

Control curve number 06 or 11
see characteristics page 3

1X = Series 10 - 1
(10 to 19 = installation and connection dimensions remain unchange

V = Viton seals, suitable f
Phosphate ester fluids (HFD-I

M = Buna-N seals, suitable f
Petroleum oils (HM, HL, HLI

01 = BSP Por
05 = SAE-6; 9/16-18 Por

Further details to be written in clear te
For round flange mount, please order "SO

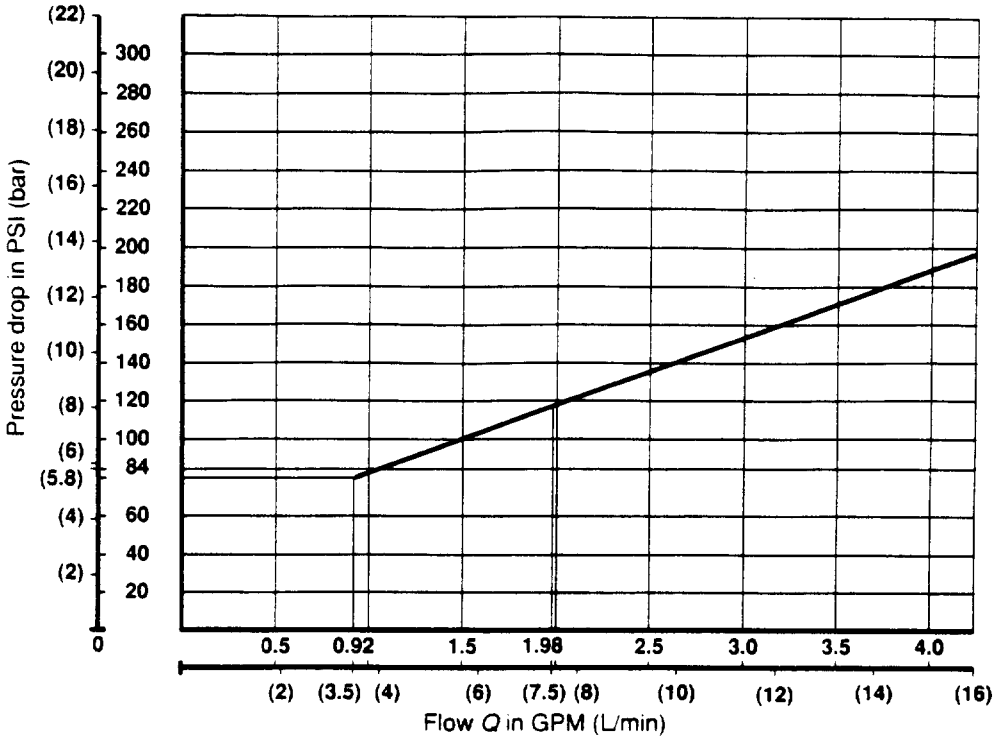
Technical Data (For applications outside these parameters please count us!)

Hydraulic fluid			Petroleum oils (HM, HL, HLP) Phosphate ester fluids (HFD-R)
Maximum degree of fluid contamination			Class 18/15 according to ISO 4406. Therefore, we recommend a filter with a retention rate of $\beta_{10} \geq 75$.
Fluid temperature range		°F (°C)	Buna-N seals; - 22 ... 158 (- 30 ... 70), Viton seals; – 4 ... 158 (– 20 ... 70)
Viscosity range		SUS (mm²/s)	60 ... 1760 (10 ... 380)
Electrical			
Contact loading	– DC		30 V 5 A
	– AC		125 V 10 A or 250 V 10 A
Weight (approx.)		lbs (kg)	6.7 (2.6)
Note: When selecting pilot lines			For tubing 3/8" (10 mm OD x 1 mm wall); for hose corresponding bore size

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Performance Curves, measured at v = 190 SUS and t = ° F (41 mm²/ s and 50 °C)

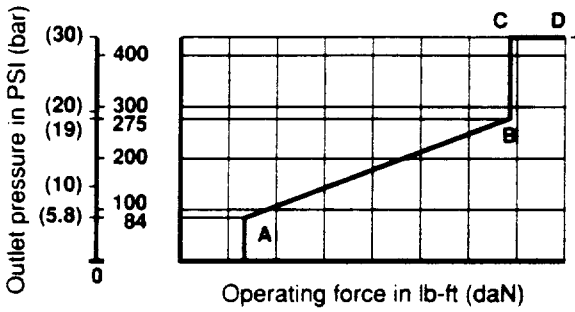
Δp = Q – curve 1 → T, 2 → T, 3 → T, 4 → T



only valid for the standard control range code 06

Performance curves: Control Ranges, Operating Forces

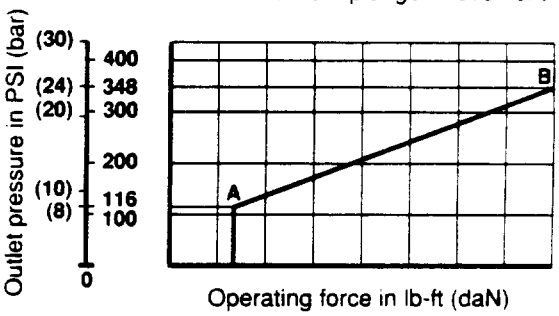
Control curve, number 06
Lever deflection/ plunger movement



Max pilot pressure required

Note (for curve 06): This curve represents applications of remote control with sandwich mobile control blocks and those with high pressure circuits.

Control curve, number 11
Lever deflection/ plunger movement



Operation of 1 lever

Intersection point		A	B	C	D
Lever deflection	°	2°20'	17°20'	17°20'	20°
Operating force on lever	lb-ft (daN)	2.95 (0.4)	12.5 (1.7)	18.4 (2.5)	20.0 (2.7)

Operation of 1 lever

Intersection point		A	B
Lever deflection	°	2°20'	20°
Operating force on lever	lb-ft (daN)	6.6 (0.4)	18.4 (2.5)

Operation of 2 levers

Intersection point		A	B	C	D
Lever deflection	°	2°30'	19°	19°	22°
Operating force on lever	lb-ft (daN)	4.4 (0.6)	17.7 (2.4)	26 (3.5)	28 (3.8)

Operation of 2 levers

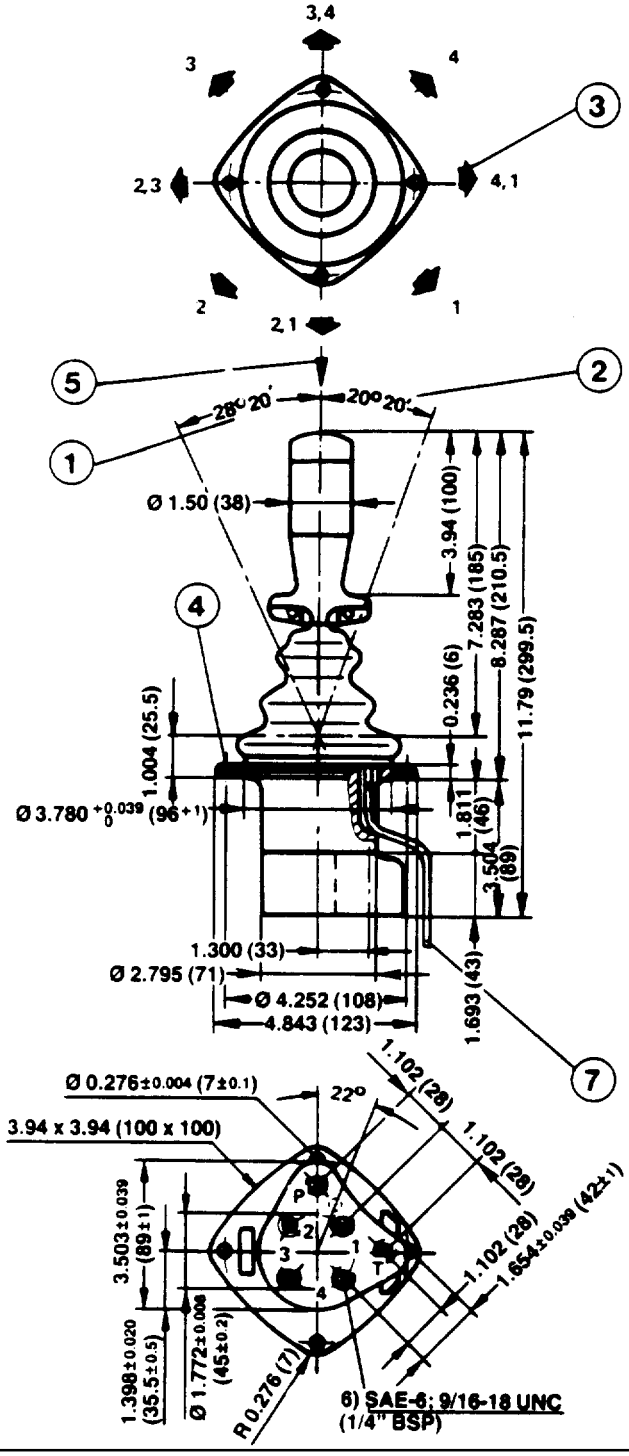
Intersection point		A	B
Lever deflection	°	2°30'	22°
Operating force on lever	lb-ft (daN)	4.4 (0.6)	25 (3.5)

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Unit Dimensions

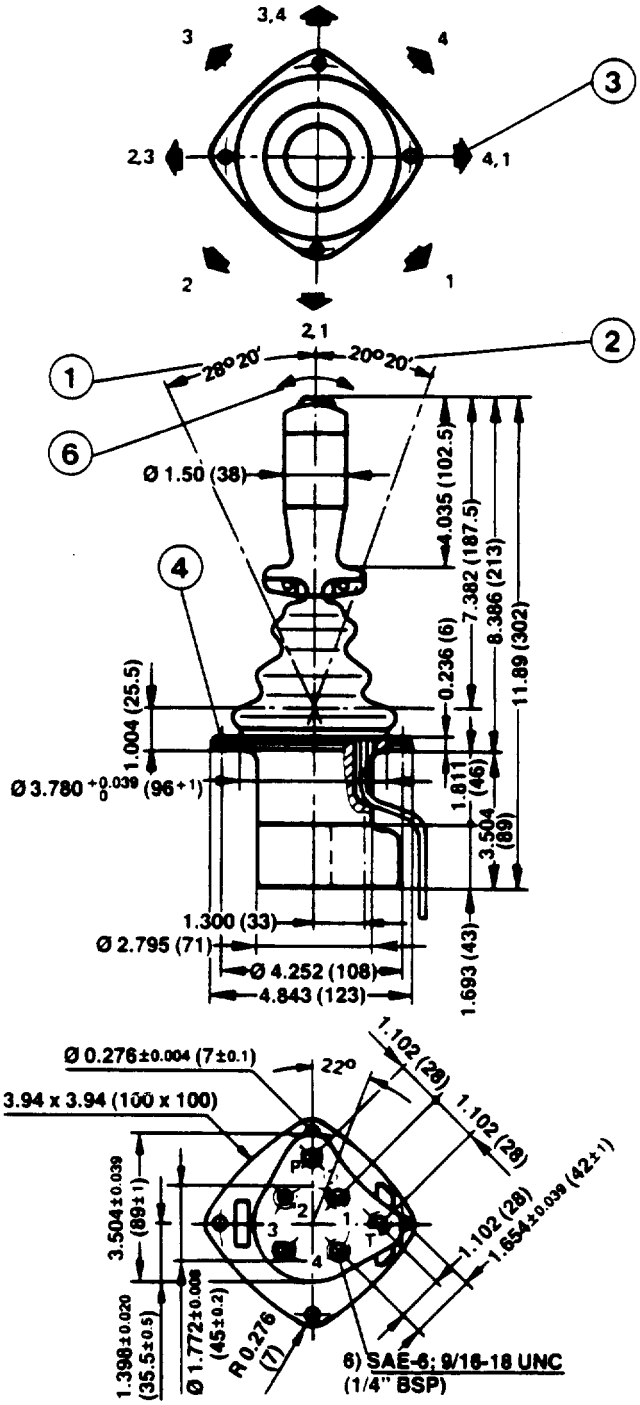
(Dimensions in inches and millimeters)

Model T, I central lever, pistol grip type
Model U, I central lever. pistol grip type and single electrical contact (push button)



Model V, 1 central lever, pistol grip type and double electrical contact (rocker switch) , spring return

Model W, 1 central lever, pistol grip type and double electrical contact (rocker switch), with detent



1 Lever deflection when both operators are shifted simultaneously
2 Lever deflection when operator is shifted
3 Shifted position for pressurization of pilot valve
4 Through holes for valve mounting
5 Shifted position for energizing electrical contact (Model U)
6 Shifting position for energizing electrical contact (Model V, W)
7 Not for Model T

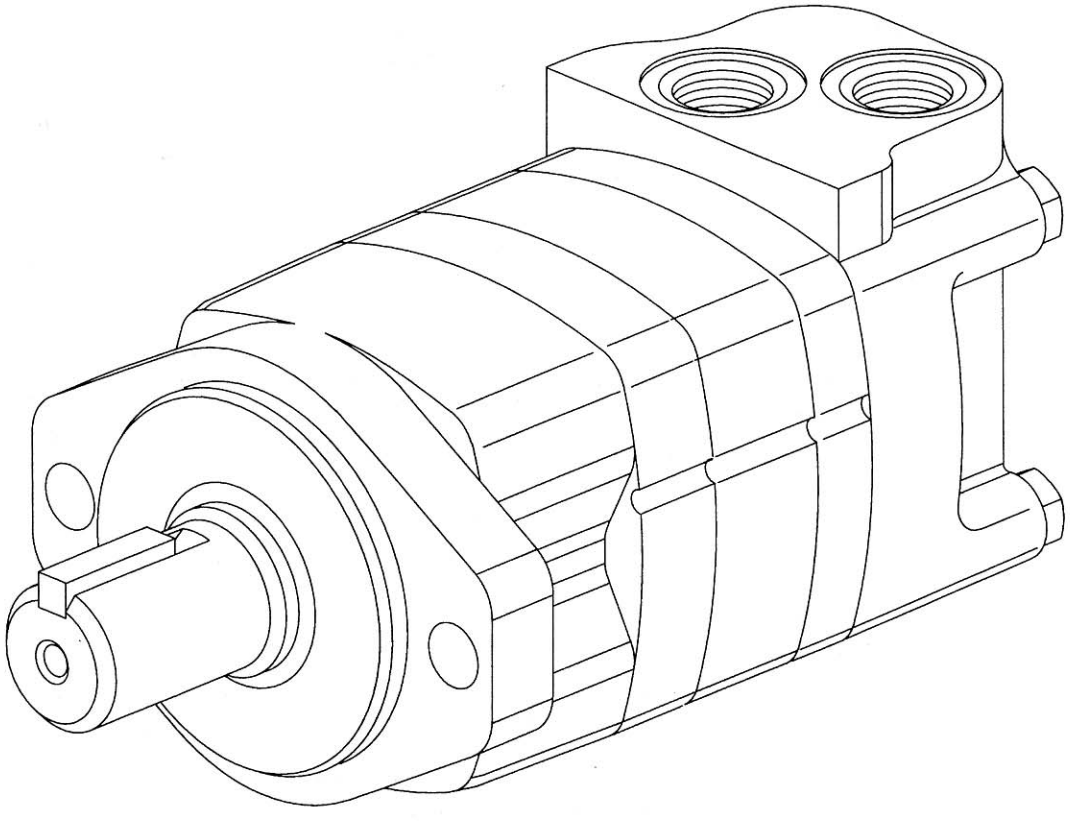
THE REXROTH CORPORATION
MOBILE HYDRAULICS DIVISION P.O.Box 394,1700 Old Mansfield Road, Wooster, OH 44691-0394 phone (216) 263-3400 Telex: 98-6335
INDUSTRIAL HYDRAULICS DIVISION P.O Box 2407,2315 City Line Road, Bethlehem, PA 1807-2131 Phone (215) 694-8300 Telex: 84-7498

Char-Lynn®
Hydraulic Motor

No. 7-124
March, 1996

EATON

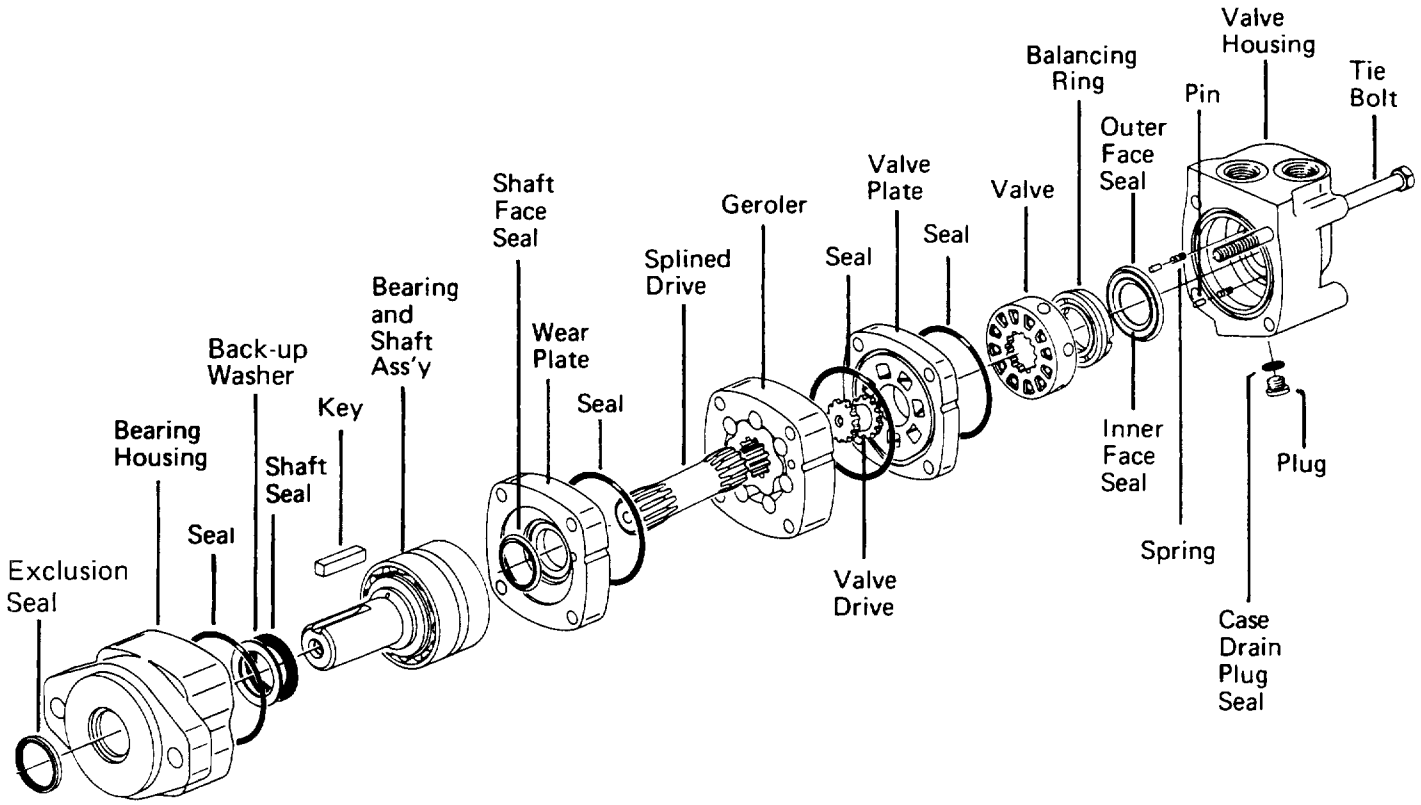
Repair Information



2000 Series
Disc Valve Geroler Motor

006

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Tools required for disassembly and reassembly.

Torque wrench 500 lb-in[57Nm] capacity
12-16 [300-450] breaker bar
9/16 socket
Small screwdriver 6-8x1/4[150-200x6,5] blade
3/16 allen wrench
Press

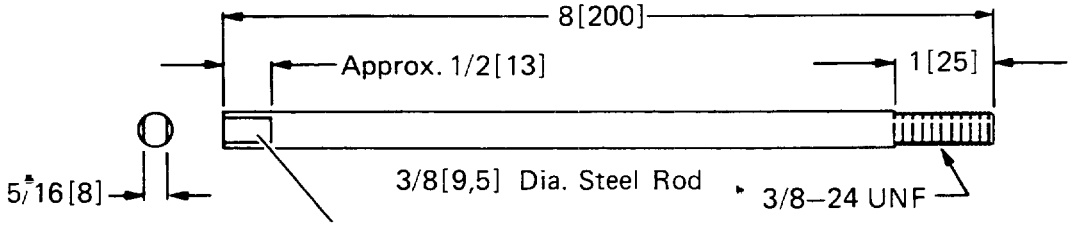
* Unless indicated otherwise, measurements are given in inches[mm]

** Shaft seal installation tool (600496)

** Bullet (600465) for 1 diameter shafts

The following tools are not necessary for disassembly and reassembly, but are extremely helpful.

Alignment studs (2)



Grind Flat Spots on Each Side

**** Available--by special order**

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Disassembly

Cleanliness is extremely important when repairing a hydraulic motor. York in a clean area. Before disconnecting the lines, clean the port area of the motor thoroughly. Use a wire to remove foreign material and debris from around the exterior joints of the motor. Check the shaft and keyslot, remove all nicks, burrs or sharp edges that might damage the bearing housing seals when installing the shaft and bearing assembly. Before starting the disassembly procedures, drain the oil from the motor.

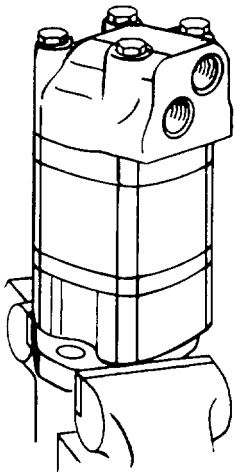


Figure 1

1 Place the motor in a vise with the output shaft down. Clamp across the mounting flange of the motor not the housing. Excessive clamping pressure will cause distortion. When clamping, use some protective device on the vise, such as special soft jaws, pieces of hard rubber or board

Although not all drawings show the motor in a vise, we recommend that you keep the motor in the vise during disassembly and reassembly. Follow the clamping procedures explained throughout the manual.

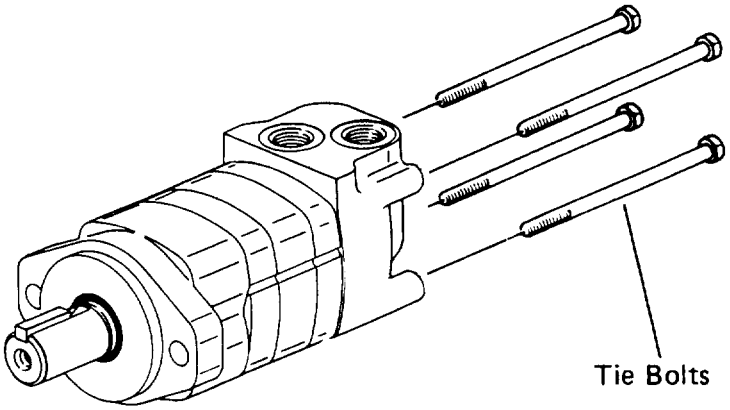


Figure 2

2 Remove 4 bolts from motor.

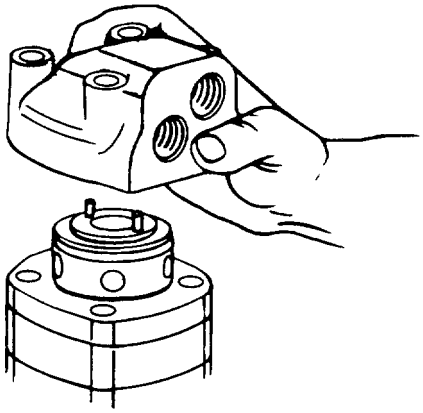


Figure 3

3 Lift valve housing straight up. If done carefully the pins, springs, balance ring assembly, and valve will remain on the valve plate.

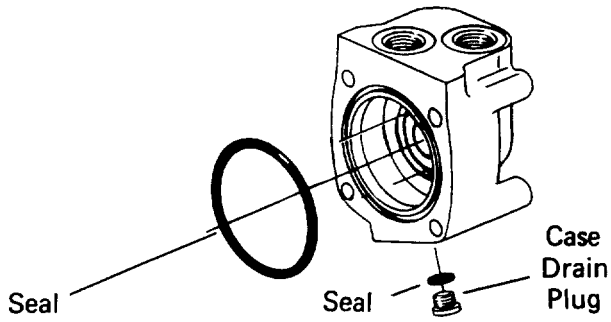


Figure 4

4 Carefully remove 3[76] diameter seal from valve housing.

5 Remove case drain plug-with seal, from valve housing.

6 Remove 2 pins and 2 springs from balance ring assembly, see Fig. 5.

Disassembly

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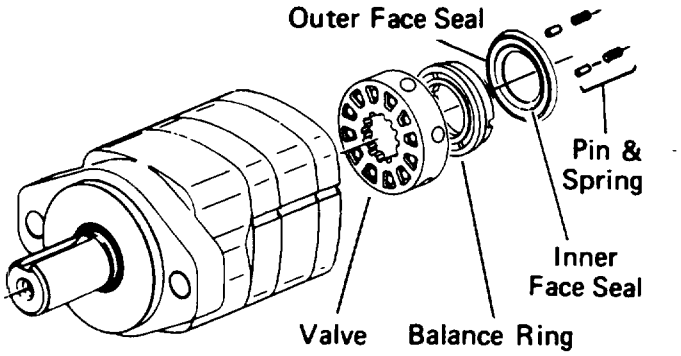


Figure 5

7 Remove balance ring assembly.

8 Remove inner and outer face seals from balance ring.

9 Remove the valve.

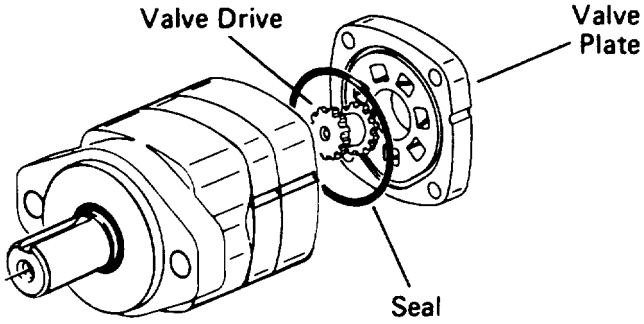


Figure 6

10 Remove the valve plate.

11 Remove the 3[76] diameter seal from valve plate.

12 Remove the valve drive.

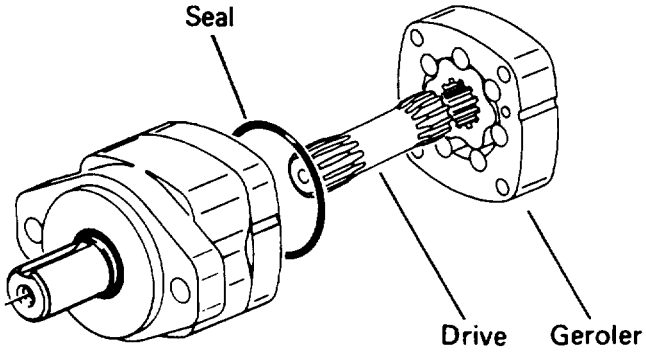


Figure 7

13 Remove the Geroler. Be sure to retain the rollers in the outer ring if they are loose.

14 Remove the drive.

15 Remove the 3[76] diameter seal from wear plate, see Fig. 7.

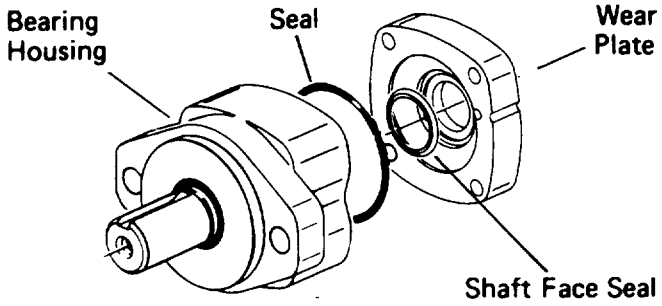


Figure 8

16 Remove the wear plate.

17 Remove the shaft face seal from the wear plate.

18 Remove the 3[76] diameter seal from bearing housing.

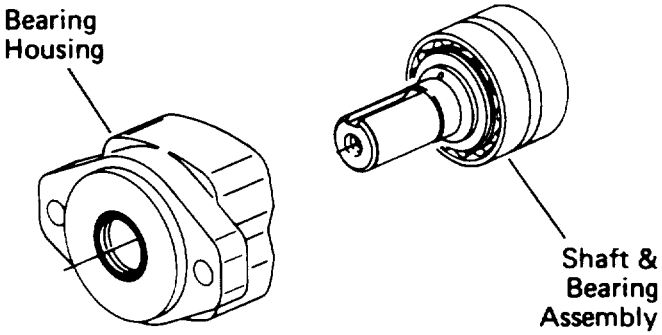


Figure 9

19 You may need a press to remove shaft and bearing assembly from bearing housing. (Key must be removed before removing shaft.)

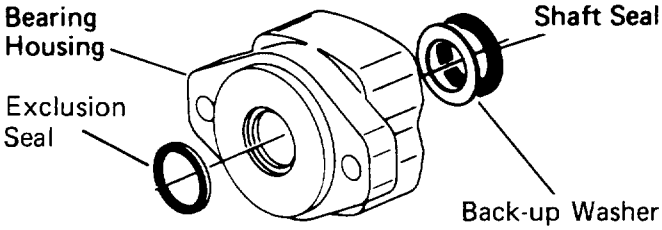


Figure 10

20 Use a small screwdriver to remove shaft seal, back-up washer and exclusion seal from bearing housing, see Fig. 10. Do not damage bore of housing.

Note: Individual parts of shaft and bearing assembly are not sold separately. Replace as a unit.

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get in the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts. Check around the keyway and chamfered area of the shaft for burrs, nicks or sharp edges that can damage the seals when reassembling the bearing housing.

Note: Lubricate all seals (prior to installation) with petroleum jelly such as Vaseline. Use new seals when reassembling this motor. Refer to parts list (6-129) for proper seal kit number

21 Use a press to install exclusion seal in outer bore of bearing housing. Lip of seal must face outward. See Fig. 11. If a press is not available use a plastic or rubber hammer, being careful not to damage or cock seal in the bore.

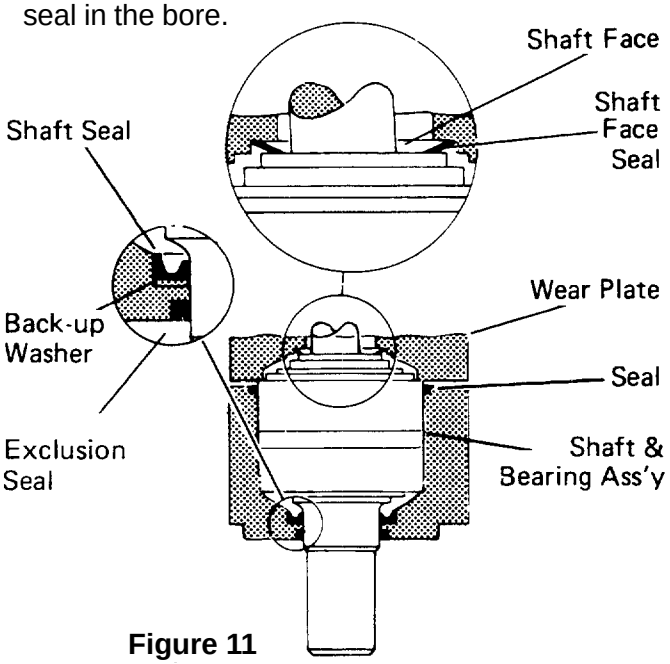


Figure 11

22 Place back-up washer into seal bore. Place shaft seal onto installation tool (600496) and press seal into seal bore of the housing.

23 Clamp housing in vise, see Fig. 1.

24 Place protective bullet (see note below) over shaft. Apply petroleum jelly to inside diameter of dust and shaft seal. You may need a press to install shaft and bearing assembly. Do not distort shaft seal. Damage to this seal will cause leakage.

Note: Bullet (600465), for 1" shafts, available—by special order. Use tape over other shafts to prevent cutting the seals.

25 Apply petroleum jelly to the 3[76] diameter seal. Install seal into the bearing housing.

26 Alignment studs can be very helpful in reassembly of the motor. See special tool listing page 2. If you use studs, install 2 studs diagonally opposed in the bearing housing

27 Install the shaft face seal in the wear plate as shown in Fig. 11. Do not distort seal.

28 Install the wear plate, see Fig. 11.

29 Apply a light film of petroleum jelly to the 3[76] diameter seal and install seal in the wear plate.

30 Install the drive into the output shaft.

31 Align the notch on the outside of the Geroler with the notch on the wear plate. Install the Geroler against the wear plate. Be sure to retain the rollers in the outer ring if they are loose.

32 Install the valve drive in the Geroler.

Note: Installation at this time involves 3 steps in the timing of the motor. Timing determines the direction of rotation of the output shaft. Timing parts include:
1. Geroler
2. Valve Drive
3. Valve Plate
4. Valve

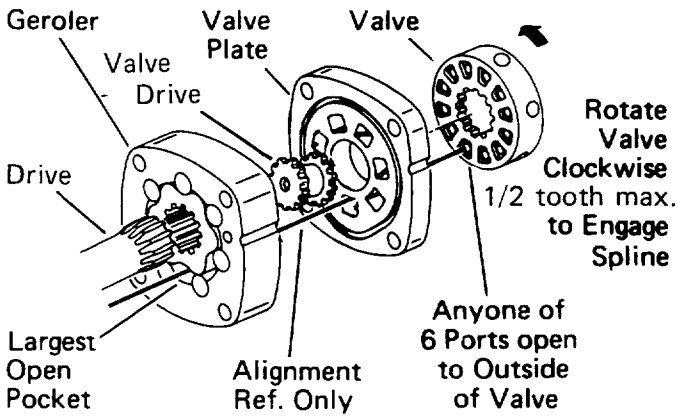


Figure 12 Timing Alignment

Timing Step # 1– Locate the largest open pocket in the Geroler and mark it on the outside edge of the Geroler.

33 Apply a light film of petroleum jelly to the 3[76] diameter seal. Install seal in groove of valve plate.

Reassembly

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34 Align the notch on the outside of the valve plate with the notch on the Geroler as shown in Fig. 12.

Timing Step # 2 – Locate the slot opening in the valve plate which is in line with the largest open pocket of the Geroler.
Timing Step # 3 – Locate any one of the side openings of the valve and align this opening with the open slot of the valve plate that is in line with the largest open pocket of the Geroler. Install the valve by rotating it clockwise until the spline teeth engage (1/2 spline tooth max.). This will provide the proper rotation when pressurized as shown in Fig. 13.

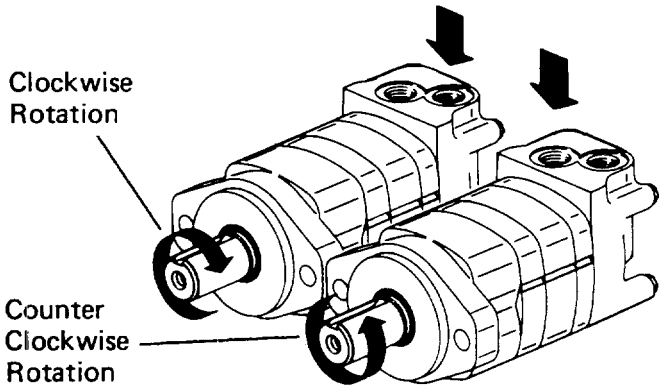


Figure 13

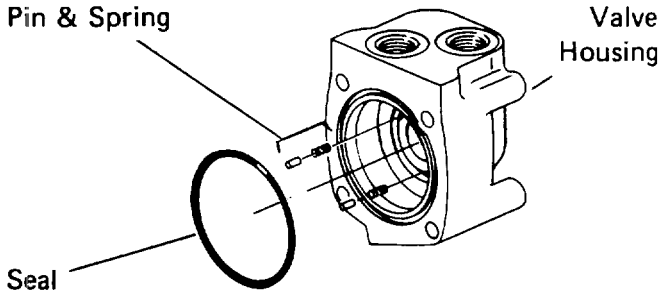


Figure 14

35 Install 2 springs and 2 pins in the holes located in the bore of the valve housing, as shown in Fig. 14.

36 Apply a light film of petroleum jelly to the 3[76] diameter seal. Install seal in the valve housing.

37 Apply petroleum jelly to inner and outer face seals. Install seals on balance ring as shown in Fig. 15.

<u>Important:</u> Install face seals in the positions shown in Fig. 15. or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.

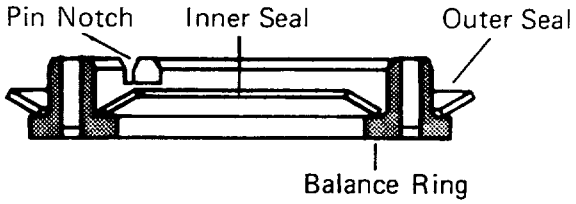


Figure 15

38 Align pin notches in balance ring with pins in bore of valve housing. Install balance ring assembly in valve housing.

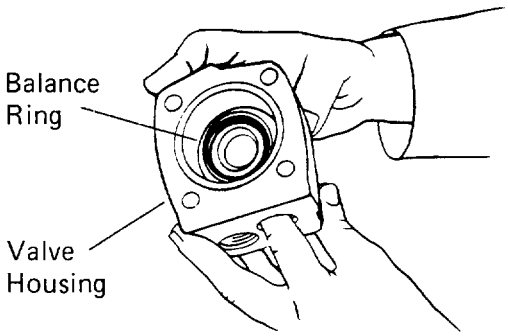


Figure 16

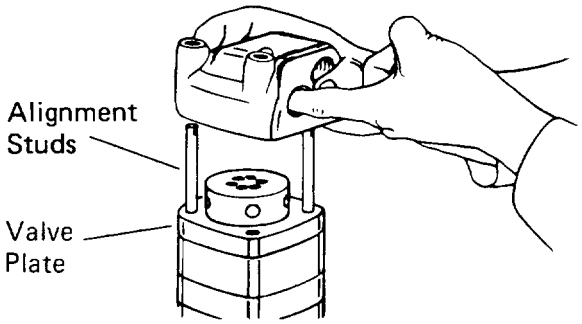


Figure 17

39 Insert your finger through port of valve housing. Apply pressure to side of balance ring as shown in Fig. 16. Hold ring in position until valve housing is in place against valve plate. See Fig. 17

Note: After installing the valve housing on the valve plate check for proper placement. Push down on the valve housing. You should get a slight spring action.

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Reassembly

40 Install tie bolts. If you use alignment Studs, install 2 bolts opposite the studs. Finger tighten the bolts. Remove the alignment studs and replace with the two remaining bolts. Torque all four bolts alternately to 50 Nm [450 lb-in].

41 Install seal on case drain plug then install in valve housing. torque to 6 Nm [50 lb-in.

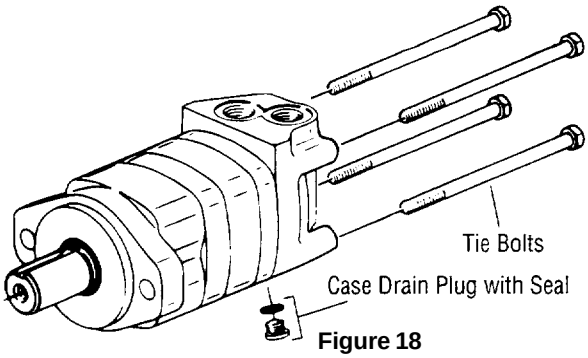


Figure 18

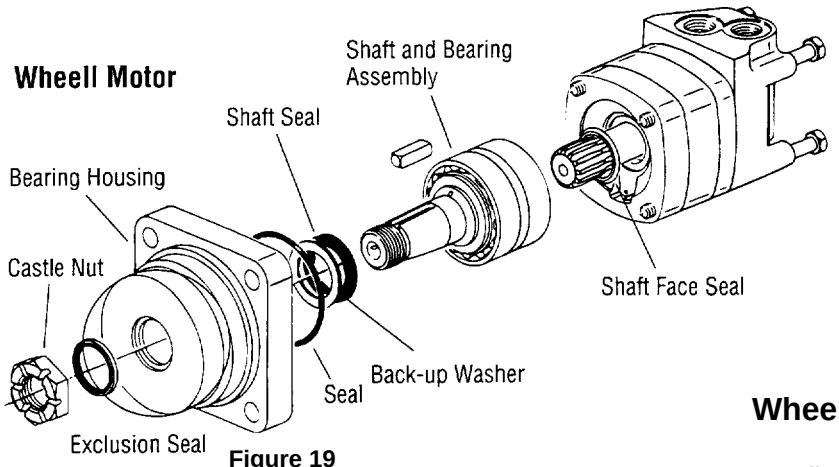
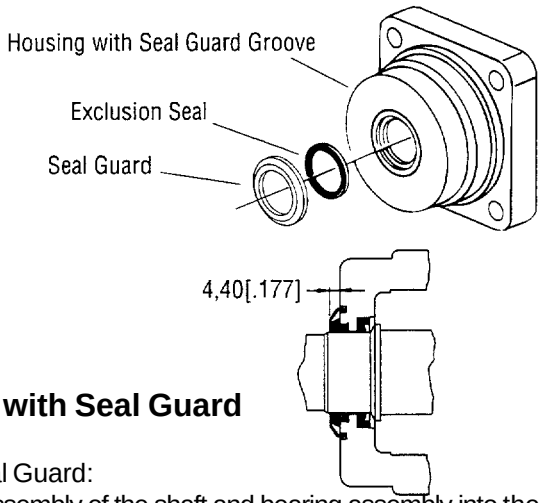


Figure 19

On wheel motors, a different bearing housing is used, see Fig. 19. Other than this the same parts are the same as the standard motor and the same disassembly and reassembly procedures apply.



Wheell Motor with Seal Guard

Installation of Seal Guard:
After completing assembly of the shaft and bearing assembly into the bearing housing, press the seal guard onto the shaft with a tool that will provide an even push over the seal. This tool must bottom out against the bearing housing and provide a 4,5 mm [.177 inch] stop for the seal guard.

Bearingless Motor

This motor is the same as the standard motor without the shaft/bearing assembly, and bearing housing. The mounting flange replaces the bearing housing, see Fig. 20 Follow same disassembly and reassembly procedures as rear section of standard motor.

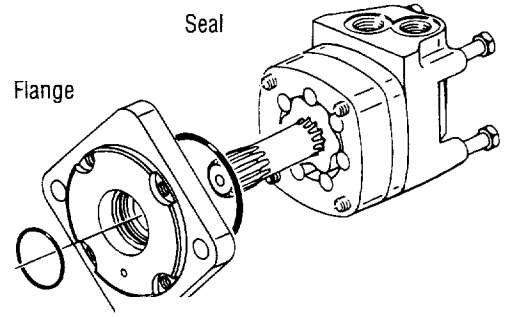
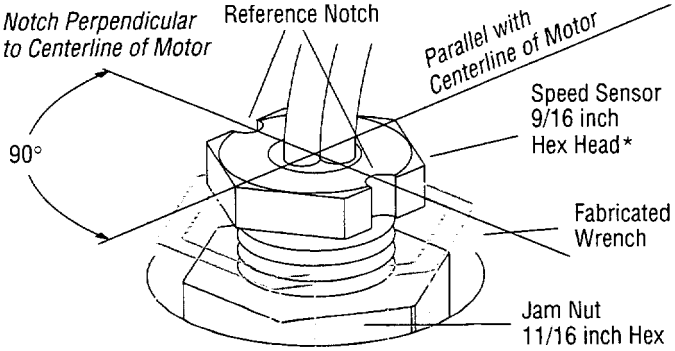


Figure 20

Speed Sensor Installation

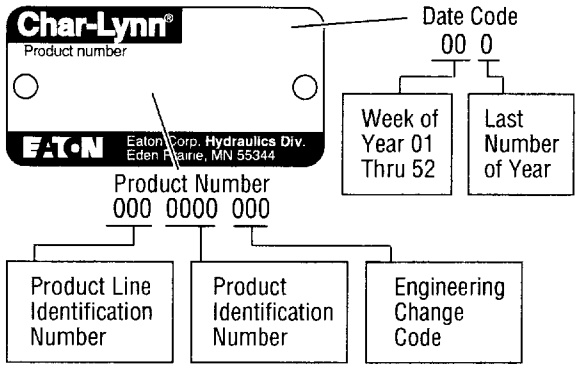


*Turn Speed Sensor in to bottom (making sure jam nut is backed off sufficiently), back off 1/4 turn (CCW) and if reference notch(s) is not positioned as shown above continue turning (CCW) to align refer ence notch 90 off of center line of motor or perpendicular to motor shaft Hold speed sensor in this position and tighten jam nut to 8,5 — 14 Nm [75 — 125 lb-in].

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For Additional Literature Contact Eaton Corp. Hydraulics Division 15151 Highway 5 Eden Prairie, MN 55344.

- Specifications and performance data, Catalog No.11 -878 O
- Replacement part numbers and kit information-Parts Information No. 6-129



How to Order Replacement Parts

Each Order Must Include the Following:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts

Product Numbers — 2000 Series

Use digit prefix—**104**-,**105**-, or **106**- plus four digit number from charts for complete product number—Example **106**-1039.

Mounting	Shaft	Ports	Displacement cm³/r [in³/r] and Product Number								
			80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
2 Bolt SAE A Flange	1 inch Straight	7/8-14 O-ring Staggered	**104**-1001	-1002	-1003	-1004	-1005	-1006	-1007	-1143	—
		1-1/16—12 O-ring 180° Apart	**104**-1037	-1038	-1039	-1040	-1041	-1042	-1043	-1044	—
	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**104**-1022	-1023	-1024	-1025	-1026	-1027	-1028	-1228	-1420
		1-1/16—12 O-ring 180° Apart	**104**-1061	-1062	-1063	-1064	-1065	-1066	-1067	-1068	-1421
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**104**-1029	-1030	-1031	-1032	-1033	-1034	-1035	-1229	-1422
		1-1/16—12 O-ring 180° Apart	**104**-1087	-1088	-1089	-1090	-1091	-1092	-1093	-1094	-1423
2 Bolt SAE B Flange	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**104**-1200	-1201	-1202	-1203	-1204	-1205	-1206	-1207	—
	1-1/4 In. Involute SAE C Splined	7/8-14 O-ring Staggered	**104**-1208	-1209	-1210	-1211	-1212	-1213	-1214	-1215	—
	1 Inch SAE 6B Splined	7/8-14 O-ring Staggered	**104**-1193	-1194	-1195	-1196	-1197	-1198	-1199	—	—
	7/8 Inch SAE B Splined	7/8-14 O-ring Staggered	**104**-1216	-1217	-1218	-1219	-1220	—	—	—	—
Standard with 4 Bolt Square Flange	32 mm Straight	G 1/2 (BSP)	**104**-1384	-1385	-1386	-1387	-1388	-1389	-1390	-1391	—
	1-1/4 Inch 14 T Splined	G 1/2 (BSP)	**104**-1376	-1377	-1378	-1379	-1380	-1381	-1382	-1383	—
Wheel Motor	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**105**- —	—	—	—	—	—	—	—	-1148
		1-1/16—12 O-ring 180° Apart	**105**- —	—	—	—	—	—	—	—	-1149
	32 mm Straight	G 1/2 (BSP)	**105**-1134	-1135	-1136	-1137	-1138	-1139	-1140	-1141	—
	1-1/4 Inch Tapered	7/8-14 O-ring Staggered	**105**-1001	-1002	-1003	-1004	-1005	-1006	-1007	-1060	-1152
		1-1/16—12 O-ring 180° Apart	**105**-1071	-1072	-1073	-1074	-1075	-1076	-1077	-1078	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**105**-1029	-1030	-1031	-1032	-1033	-1034	-1035	-1096	—
		1-1/16—12 O-ring 180° Apart	**105**-1079	-1080	-1081	-1082	-1083	-1084	-1085	-1086	—
Bearingless		7/8-14 O-ring Staggered	**106**-1008	-1009	-1010	-1011	-1012	-1013	-1014	-1015	-1047
		G 1/2 (BSP)	**106**-1038	-1039	-1040	-1041	-1042	-1043	-1044	-1045	—

106-1039

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ACCREDITED BY THE DUTCH COUNCIL FOR CERTIFICATION Reg. No. 24

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Eaton Ltd.
Hydraulics Division
15151 Hwy. 5
Eden Prairie, MN 55344
Telephone 612/937-9800
Fax 612/937-7130

Eaton Corporation
Hydraulics Division
Glenrothes, Fife
Scotland, KY7 4NW
Telephone 01 -592-771 -771
Fax 01 -592-773-184

Eaton GmbH
Hydraulics Products
Am Schimmersfeld 7
40880 Ratingen, Germany
Telephone 02102-406-830
Fax 02102-406-800

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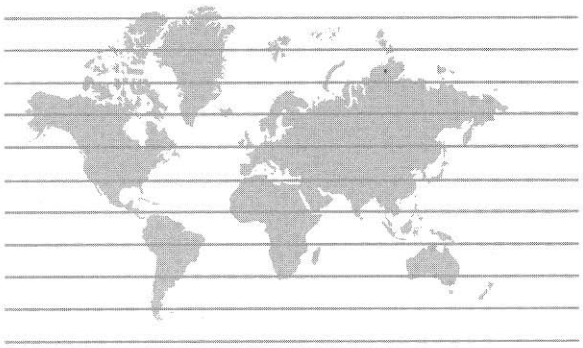
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Parker Hydraulics

Bulletin 1512-003-M1/USA

Torqlink™ Service Procedure

Effective: May 31, 2000



TB, TE, TJ, TF, TG, TH Series

Low Speed, High Torque Hydraulic Motors

https://truckmanuals.info/

⚠ WARNING

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

This document and other information from Parker Hannifin Corporation, its subsidiaries and authorized distributors provide product and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

The products described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by Parker Hannifin Corporation and its subsidiaries at any time without notice.

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Definitions

NOTE: A NOTE provides key information to make a procedure easier or quicker to complete.

CAUTION: A CAUTION refers to procedure that must be followed to avoid damaging the Torqlink™ or other system components.

WARNING: A WARNING REFERS TO PROCEDURE THAT MUST BE FOLLOWED FOR THE SAFETY OF THE EQUIPMENT OPERATOR AND THE PERSON INSPECTING OR REPAIRING THE TORQLINK™.

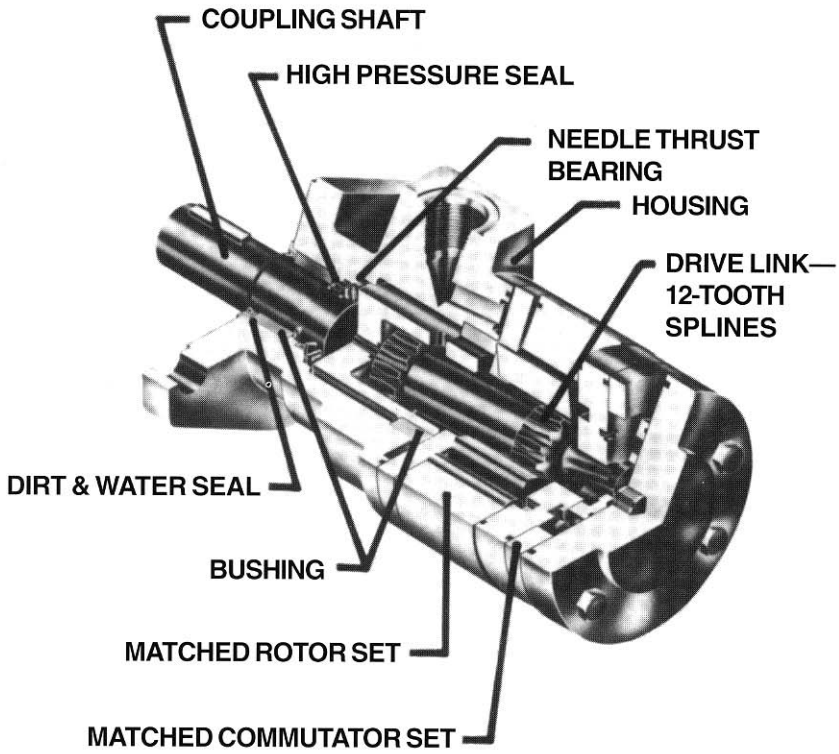
Disclaimer

This Service Manual has been prepared by Parker Hannifin for reference and use by mechanics who have been trained to repair and service hydraulic motors and systems on commercial and non-commercial equipment applications. Parker Hannifin has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the techniques and tools required for maintaining, repairing and servicing the complete line of Parker TB, TE, TJ, TF, TG, & TH Torqlink™ Units. However, despite the care and effort taken in preparing this general Service Manual, Parker **makes no warranties** that (a) the Service Manual or any explanations, illustrations, information, techniques or tools described herein are either accurate, complete or correct as applied to a specific Torqlink™ unit, or (b) any repairs or service of a particular Torqlink™ unit will result in a properly functioning Torqlink™ unit.

If inspection or testing reveals evidence of abnormal wear or damage to the Torqlink™ unit or if you encounter circumstances not covered in the Manual, STOP – CONSULT THE EQUIPMENT MANUFACTURER'S SERVICE MANUAL AND WARRANTY. DO NOT TRY TO REPAIR OR SERVICE A TORQLINK™ UNIT WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL PARKER REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO PARKER SPECIFICATIONS FOR THE TORQLINK™ UNIT.

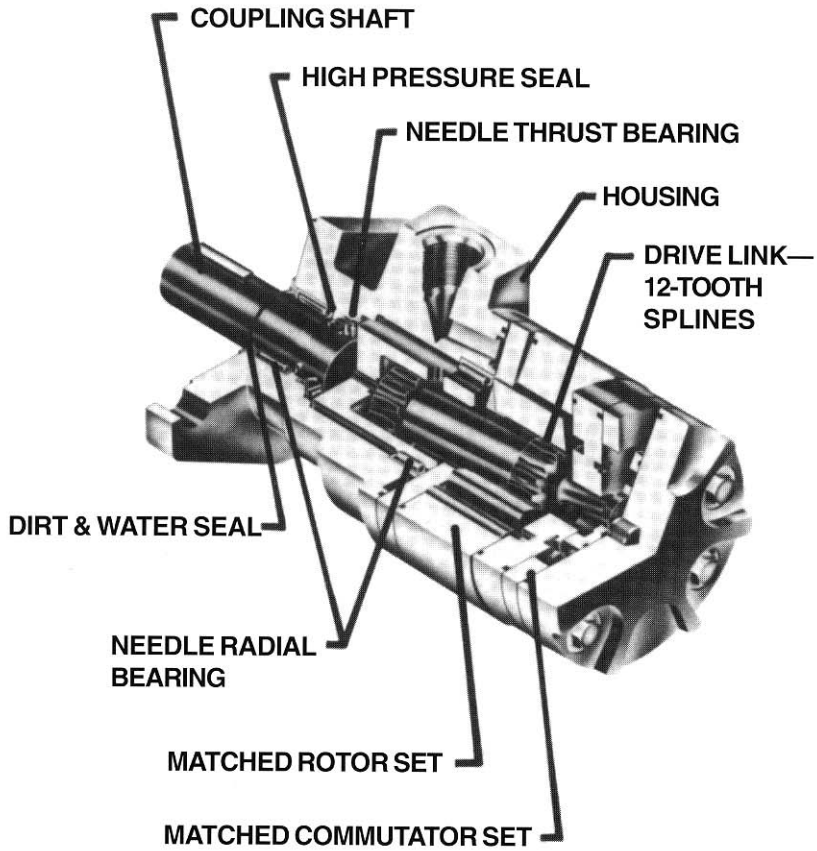
It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular Torqlink™ unit to (a) inspect the unit for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the equipment, or the safe operation of the Torqlink™, and (c) fully inspect and test the Torqlink™ unit and the hydraulic system to insure that the repair or service of the Torqlink™ unit has been properly performed and that the Torqlink™ and hydraulic system will function properly.

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Torqlink™ TB Series features include:

- The roller vane rotor set design offers a low-friction, wear compensation which maximizes the useful performance life of the motor.
- Zero leak **commutation valve provides greater, more consistent volumetric efficiency.**
- Design flexibility - TB offers the widest selection of shaft options, displacements and mounting flanges in the industry.
- Patented 60-40 spline member arrangement transmits more torque with less weight.
- Full flow lubrication maximizes cooling and may provide up to 50% longer life than motors not having this feature.
- Higher pressure rating provide greater torque than competitive brands.
- Full interchangeability with other motors which are designed according to industry standards.
- Compatible with most hydraulic systems with regard to pressure, torque and speed.
- A unique high-pressure shaft seal that eliminates the need for case drains.
- Up to 13 horsepower output.

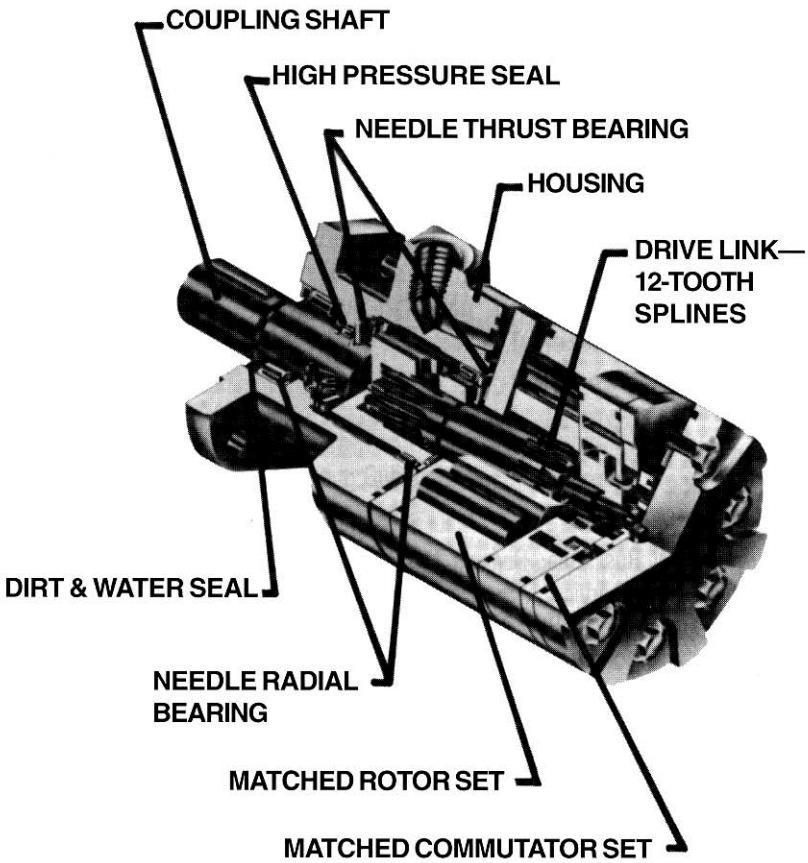


Torqlink™ TE Series features include:

- Roller vanes to reduce friction and internal leakage and to maintain efficiency.
- Zero leak **commutation valve provides greater, more consistent volumetric efficiency.**
- Wheel mount version available.
- More starting torque than competitive motors in applications where the shaft is side loaded. (Competitive brands require more pressure to start the motor.)
- A needle-roller mounted coupling shaft and steel-caged thrust bearing which can withstand 1000-pound thrust loads.
- Side load capacity is 1600 lbs. (727.3 kg) maximum at center of output shaft.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- Up to 17 horsepower output.
- Greater durability due to superior lubrication and minimum drive spline wear.
- Patented 60-40 spline member arrangement transmits more torque with less weight.

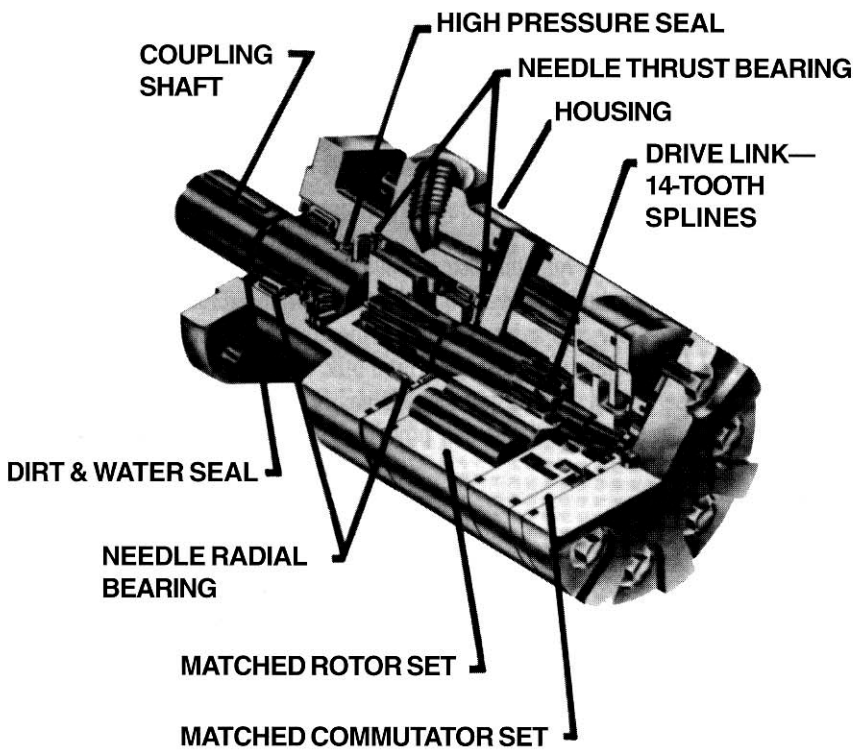
Parker Hannifin Corporation
Hydraulic Pump/Motor Division
Greeneville, TN 37745 USA

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Torqlink™ TF Series features include:

- Heavy-duty thrust and roller bearings for up to twice side-load capacity to the previous motor.
- Roller vanes to reduce friction and internal leakage, and to maintain efficiency.
- A patented orbiting commutation system for less wear and longer life.
- A patented 60:40 arrangement of internal and external spline members to transmit more torque with less weight.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- A unique manifold designed to improve operating efficiency.
- Up to 1000 lbs. (453.6 kg) end-thrust capacity in either direction.
- A design that is less sensitive to contamination than competitive motors.
- Up to 36 horsepower output.
- Greater durability because of superior lubrication and minimum drive spline wear.
- Superior low speed performance.
- Zero leak **commutation valve provides greater, more consistent volumetric efficiency.**



Torqlink™ TG & TH Series features include:

- Roller vanes to reduce friction and internal leakage and to maintain efficiency.
- A patented orbiting commutation system for less wear and longer life.
- A patented 60:40 arrangement of internal and external spline members to transmit more torque with less weight.
- A unique high-pressure shaft seal that eliminates the need for case drains, check valves and extra plumbing.
- A manifold designed to improve operating efficiency.
- Heavy-duty thrust and roller bearings for up to twice the side-load capacity to the previous motor.
- Up to 1000 lbs. (453.6 kg) end-thrust capacity in either direction.
- A design that is less sensitive to contamination than competitive motors.
- Up to 49 horsepower output.
- Greater durability because of superior lubrication and minimum drive spline wear.
- Zero leak **commutation valve provides greater, more consistent volumetric efficiency.**

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This service manual has one purpose: to guide you in maintaining, troubleshooting, and servicing the TB, TE, TJ, TF, TG, & TH Torqlink™ (low-speed, high-torque hydraulic motor).

Material in this manual is organized so you can work on the Torqlink™ and get results without wasting time or being confused. To get these results, you should read this entire manual before you begin any work on the Torqlink™.

This manual also contains troubleshooting information and checklist. If you must service the Torqlink™, the checklist will help you to determine where the problem may be.

The three-column format of the Disassembly and Inspection, and Assembly sections will make it easier for you to conduct major work on the Torqlink™. Column 1 gives a brief key for each procedure. Column 2 explains in detail the procedure you should follow. Column 3 illustrates this procedure with photographs. Read all material carefully and pay special attention to the notes, cautions, and warnings.

A page with the Torqlink™ exploded assembly view is provided several places in this manual. The component part names and item numbers assigned on this exploded assembly view correspond with names and item numbers (in parentheses) used in the disassembly and assembly procedures set forth in this manual.

Service part list charts are also provided in this manual with the part names and exploded view item numbers cross referenced to Parker service part numbers.

Service parts are available through the Original Equipment Manufacturer or Parker approved TB, TE, TJ, TF, TG, & TH Distributors.

As you gain experience in servicing the Torqlink™, you may find that some information in this manual could be clearer or more complete. If so, let us know about it. Do not try to second guess the manual. If you are stuck, contact us. Servicing the Torqlink™ should be a safe and productive procedure, in order for the unit to deliver the reliable, long-life operation engineered into it.

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NOTE: Before troubleshooting any system problem, check service literature published by the equipment and/or component manufacturers. Follow their instructions, if given, for checking any component other than the Torqlink™ unit.

Preparation

Make your troubleshooting easier by preparing as follows:

- work in a clean, well-lighted place;
- have proper tools and materials nearby;
- have an adequate supply of clean petroleum-based solvent.

WARNING: SINCE SOLVENTS ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT, EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA AND OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

Preliminary Checks

Hydraulic systems are often trouble-free. Hence, the problem an operator complains of could be cause by something other than the hydraulic components.

Thus, once you have determined that a problem exists, start with the easy-to-check items, such as:

- parts damaged from impact that were not properly repaired, or that should have been replaced; and
- improper replacement parts used in previous servicing
- mechanical linkage problems such as binding, broken, or loose parts or slipping belts

Hydraulic Components

If you think the problem is caused by a hydraulic component, start by checking the easy-to-reach items.

Check all hoses and lines for cracks, hardening, or other signs of wear. Reroute any usable hoses that are kinked, severely bent, or that rest against hot engine parts. Look for leaks, especially at couplings and fittings. Replace any hoses or lines that don't meet system flow and pressure ratings.

Next, go to the reservoir and filter or filters. Check fluid level and look for air bubbles. Check the filter(s). A filter with a maximum 50 micron filtration is recommended for the Torqlink system.

Visually check other components to see if they are loosely mounted, show signs of leaks, or other damage or wear.

Excessive heat in a hydraulic system can create problems that can easily be overlooked. Every system has its limitation for the maximum amount of temperature. After the temperature is attained and passed, the following can occur:

- oil seal leaks
- loss of efficiency such as speed and torque
- pump loss of efficiency
- pump failure
- hoses become hard and brittle
- hose failure

A normal temperature range means an efficient hydraulic system. Consult the manuals published by equipment and/or component manufacturers for maximum allowable temperature and hydraulic tests that may be necessary to run on the performance of the hydraulic components. The Torqlink™ is not recommended for hydraulic systems with maximum temperatures above 200°F (93.3°C).

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Trouble	Cause	Remedy
Oil Leakage	1. Hose fittings loose, worn or damaged.	Check & replace damaged fittings or "O" Rings. Torque to manufacturers specifications.
	2. Oil seal rings (4) deteriorated by excess heat.	Replace oil seal rings by disassembling Torqlink™ unit.
	3. Special bolt (1, 1A, 1B or 1C) loose or its sealing area deteriorated by corrosion.	(a) Loosen then tighten single bolt to torque specification. (b) Replace bolt.
	4. Internal shaft seal (16) worn or damaged.	Replace seal. Disassembly of Torqlink™ unit necessary.
	5. Worn coupling shaft (12) and internal seal (16).	Replace coupling shaft and seal by disassembling Torqlink™ unit.
Significant loss of speed under load	1. Lack of sufficient oil supply	(a) Check for faulty relief valve and adjust or replace as required. (b) Check for and repair worn pump. (c) Check for and use correct oil for temperature of operation.
	2. High internal motor leakage	Replace worn rotor set by disassembling Torqlink™ unit.
	3. Severely worn or damaged internal splines.	Replace rotor set, drive link and coupling shaft by disassembling Torqlink™ unit.
	4. Excessive heat.	Locate excessive heat source (usually a restriction) in the system and correct the condition.
Low mechanical efficiency or undue high pressure required to operate Torqlink™ unit	1. Line blockage	Locate blockage source and repair or replace.
	2. Internal interference	Disassemble Torqlink™ unit, identify and remedy cause and repair, replacing parts as necessary.
	3. Lack of pumping pressure	Check for and repair worn pump.
	4. Excessive binding or loading in system external to Torqlink™ unit.	Locate source and eliminate cause.

CAUTION: If the hydraulic system fluid becomes overheated [in excess of 200°F (93.3°C)], seals in the system can shrink, harden or crack, thus losing their sealing ability.

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- Clean, petroleum-based solvent
- Emery paper
- Vise with soft jaws
- Air pressure source
- Arbor press
- Screw driver
- Masking tape
- Breaker bar
- Torque wrench-ft. lbs. (N m)
- Sockets: 1/2 or 9/16 inch thin wall, 1 inch
- Allen Sockets: 3/16, 3/8 inch
- Adjustable crescent wrench or hose fitting wrenches
- SAE 10W40 SE or SF oil
- Special bearing mandrel for TB & TE Torqlinks (SEE FIGURE 1)
- Special bearing mandrel for TH Torqlinks (consult factory)
- Special bearing mandrel for TF, TG & TJ Torqlinks (SEE FIGURE 2)
- Feeler gage .005 inch (.13 mm)
- TB & TE Torqlinks require blind hole bearing puller for 1.06 inch (26.9) mm) and 1.62 inch (41.1 mm) diameter bearing/bushing.
- TH Torqlinks require blind hole bearing puller for a 1.575 inch dia. (40.0 mm) and 2.130 inch dia. (54.1 mm) bearings.
- TF, TG & TJ Torqlinks require blind hole bearing puller for 1.400 inch dia. (35.6 mm) and 2.130 inch dia. (54.1 mm) bearings.
- Clean corrosion resistant grease. Part #406018 is included in each seal kit. Recommended grease is Parker Specification #045236 or Mobil Mobilith SHC® 460

NOTE: The available service seal kits include the recommended grease as a grease pack #406018

CAUTION: Mixing greases that have different bases can be detrimental to bearing life.

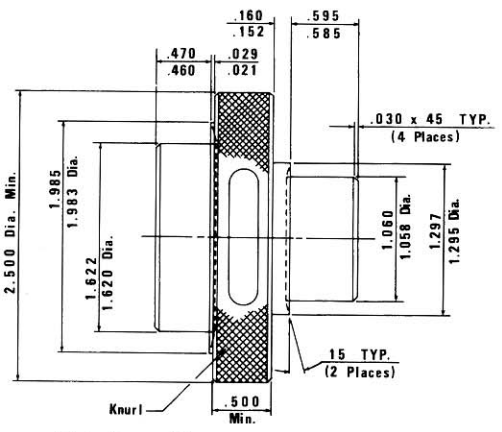
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CONVERSIONS

INCHES	mm	INCHES	mm
.020	.51	1.060	26.92
.021	.53	1.295	32.89
.029	.74	1.297	32.94
.030	.76	1.396	35.46
.111	2.81	1.398	35.51
.119	3.02	1.620	41.15
.152	3.86	1.622	41.20
.160	4.06	1.983	50.37
.296	7.52	1.985	50.42
.304	7.72	2.120	53.85
.460	11.68	2.122	53.90
.470	11.94	2.233	56.72
.500	12.70	2.235	56.77
.585	14.86	2.483	63.07
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.675	17.15	2.88	73.2
1.058	26.87		

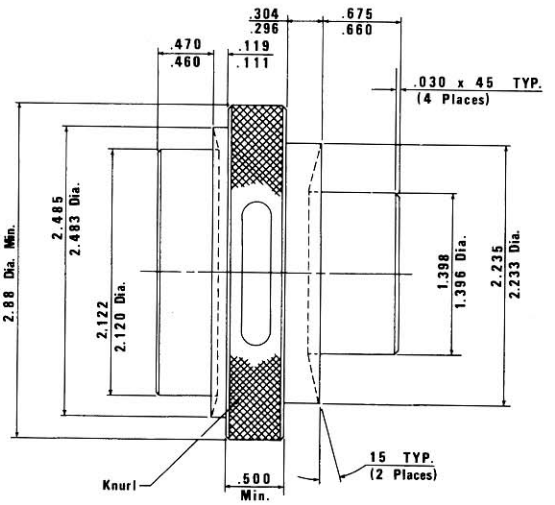
Torque Chart

Part Name	Item Number	Torque
bolt 5/16 24 UNF 2A	1, 1A, 1B or 1C	22-26 ft. lbs. (30-35 N m)
bolt 3/8 24 UNF 2A	1, 1A, 1B or 1C	45-55 ft. lbs. (60-76 N m)
bolt 5/8 18 UNF 2A	12D	140-180 ft. lbs. (190-244 N m)
nut 3/4 16 UNF 2B	12B (TB, TE)	175-255 ft. lbs. (237-305 N m)
nut 1-20 UNEF 2B	12B (TF, TG)	300-400 ft. lbs. (407-542 N m)
nut 1-1/8 18 UNEF 2B	12B (TG)	300-400 ft. lbs. (407-542 N m)



(Fabricate if considered necessary)

Figure 1 – TB & TE

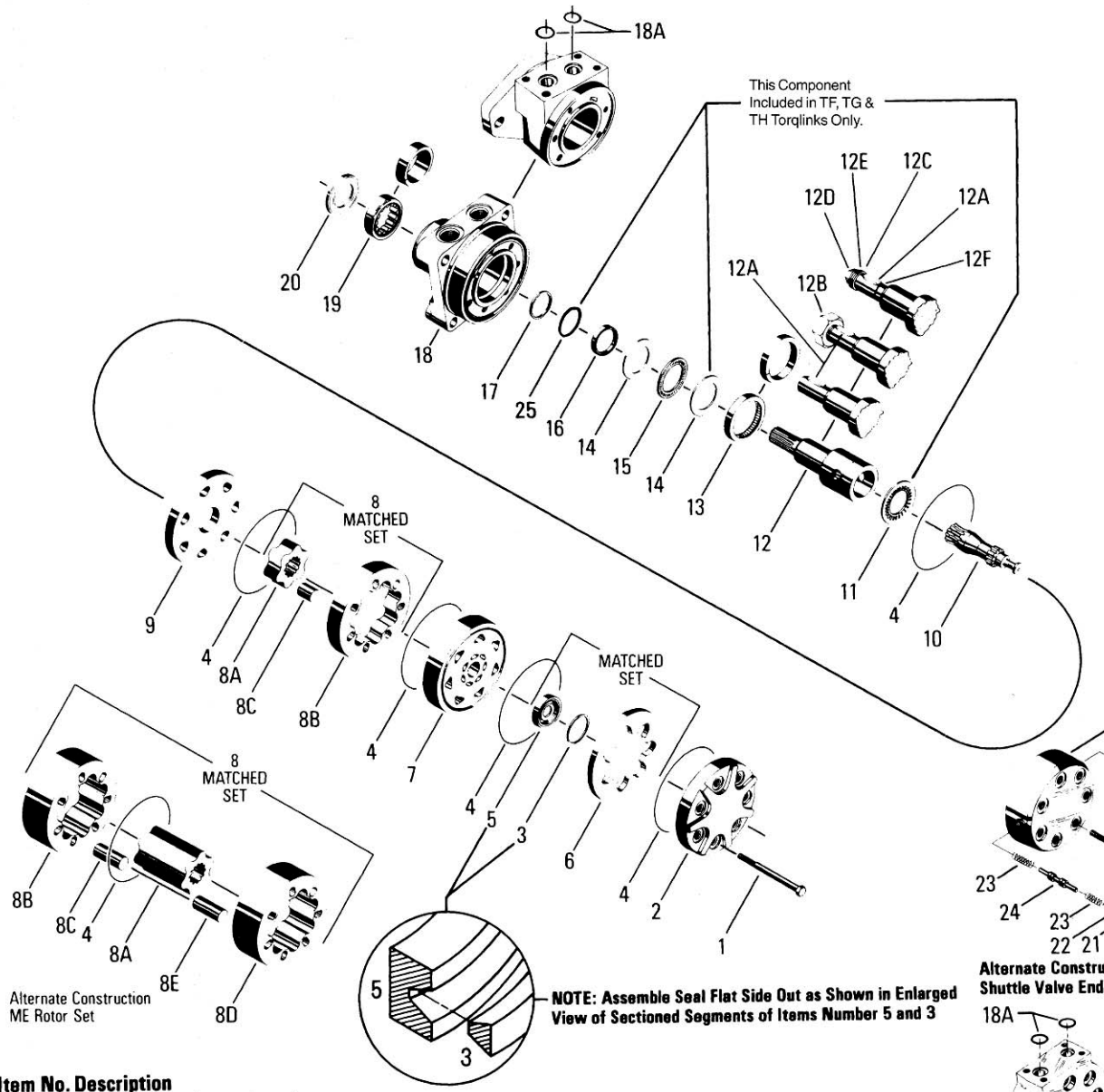


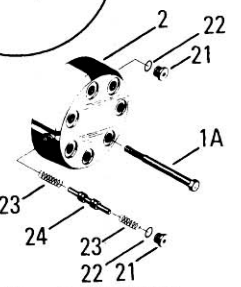
(Fabricate if considered necessary)

Figure 2 – TF & TG

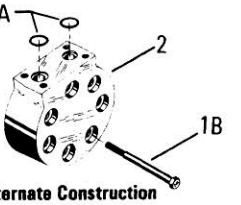
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Typical Assembly

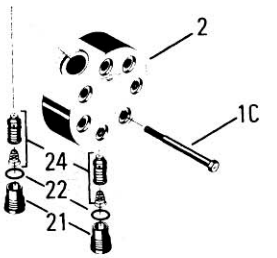




Alternate Construction Shuttle Valve End Cover



Alternate Construction Manifold Port End Cover

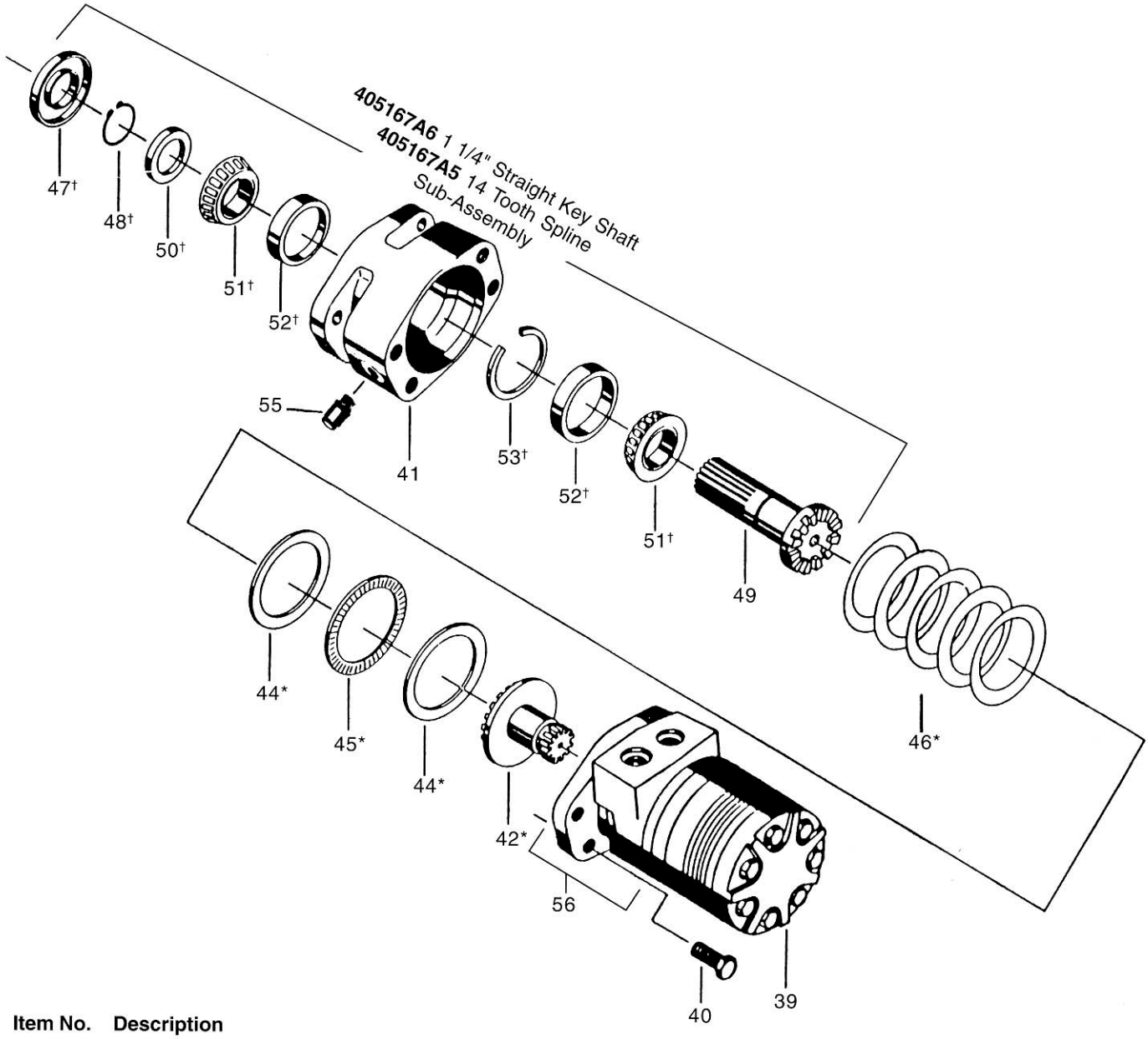


Alternate Construction Relief Valve End Cover

Item No.	Description
1.	Special Bolts (5, 6, or 7)
1A.	Special Bolts (7)
1B.	Special Bolts (7)
1C.	Special Bolts (7)
2.	End Cover
3.	Seal Ring-Commutator
4.	Seal Ring (5)
5.	Commutator
6.	Commutator Ring
7.	Manifold
8.	Rotor Set
8A.	Rotor
8B.	Stator or Stator Half
8C.	Vane (7)
8D.	Stator Half
8E.	Vane (7)
9.	Wear Plate
10.	Drive Link
11.	Thrust Bearing
12.	Coupling Shaft
12A.	Key
12B.	Nut
12C.	Washer
12D.	Bolt
12E.	Lockwasher
12F.	Retaining Ring
13.	Bearing/Bushing, Inner
14.	Thrust Washer
15	Thrust Bearing
16.	Seal
17.	Backup Washer
18	Housing
18A.	O-Ring (2)
19.	Bearing/Bushing, Outer
20.	Dirt & Water Seal
21.	Plug (2)
22.	O-Ring (2)
23.	Spring
24.	Valve (Shuttle or Relief)
25.	Backup Washer

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Typical Assembly



Item No.	Description	
39	Torqlink Sub-Assembly	
40	Bolt 1/2-13 (UNC-2A) (4 Req'd.)	G179885
41	Clutch Housing	405167
42*	Splined Gear Drive	490102
44*	Thrust Washer (2)	400142
45*	Thrust Bearing	073005
46*	Disc Spring (5)	028511
47†	Seal - Dirt and Water	478030
48†	Snap Ring	401622
49	Drive Shaft 14 Tooth Spline	093043
49	Straight Key Shaft 1 1/4"	093044
50†	Thrust Washer	400141
51†	Bearing and Cone Assembly (2)	067033
52†	Bearing Cup (2)	400140
53†	Retaining Ring	401623
55	Plug	G444571
56	Housing	ME012013A1

NOTE: Apply .06 in. (1.5 mm) Bead of Loctite #51514 Around Full Circumference of Pilot

* Items sold separately: not included in Seal Kit

† 3649 for Clutch Assembly only

3221 Seal Kit for Hydraulic Motor only Item #39.

Clutch Motor applies to TF Series only (Not available in 22, 25, 29 cu in.)

SHC Oil 90 WT 45± 5CC

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Chart Use Example:
TB0045AS010AAAB Torqlink™ includes part numbers listed to the right of TB (SERIES), 0045 (DISP.), AS (MOUNTING/PORTING), 01(SHAFT), 0 (ROTATION), and AAAB (OPTION) shown in the left hand column of the chart.

Caution:
The charted component service information is for the Torqlinks listed only. Refer to the original equipment manufacturer of the equipment using the Torqlink for assembly numbers not listed below.

SERIES	EXPLODED VIEW ITEM #	5 & 6	7	9	[A]13	14	15	17	[A]19	20
	DESCRIPTION	COMMUTATOR & RING ASSY	MANIFOLD (SEE NOTE)	WEAR PLATE	BRONZE BUSHING	THRUST WASHER	THRUST BEARING	BACKUP WASHER	"DU" BEARING	DIRT & WATER SEAL
TB-	Service Part #	MF018000A1	MF015000	477341	069511	028483	065066	028516	065505	478036

DISPLACEMENT GROUP	EXPLODED VIEW ITEM # 1 or 1A or 1C				ROTOR THICKNESS	8A	8B	10
	DISPLACEMENT (in³/rev)	BOLT (5)†	BOLT (5)	BOLT (5)	"L" DIM OF ROTOR THICKNESS	ROTOR SET	FREE RUNNING ROTOR SET††	DRIVE LINK
0045-	2.7	021311	021433	021308	**.3169**	MF027003	MF027005	MF023000
0050-	3.0	021311	021444	021308	**.3751**	MF037003	MF037005	MF033000
0065-	4.0	021306	021358	021435	**.5001**	MF047003	MF047005	MF043000
0080-	5.0	021382	021438	021359	**.6258**	MF057003	MF057005	MF053000
0100-	6.0	021357	021308	021445	**.7508**	MF067003	MF067005	MF063000
0130-	8.0	021307	021359	021439	**1.0008**	MF087003	MF087005	MF083000
0165-	9.9	021358	021310	*	**1.2508**	MF107003	MF107005	MF103000
0195-	11.9	021308	021383	021465	**1.5008**	MF127003	MF127005	MF123000
0230-	13.9	021359	021384	021460	**1.7508**	MF147003	MF147005	MF143000
0260-	15.9	021310	021466	021467	**2.0008**	MF167003	MF167005	MF163000
0295-	17.9	021383	021414	*	**2.2508**	MF187003	MF187005	MF183000
0330-	20.0	021384	021459	021448	**2.5008**	MF207003	MF207005	MF203000
0365-	22.6	021460	021448	*	**2.8406**	MF227003	N/A	MF223000
0390-	24.0	021414	021449	021464	**3.0030**	MF247003	N/A	MF243000

† Bolts for TB Series front ported units are the same as rear ported units.
†† Free running rotorset is not available in 0365 or 0390 Displacements.
* Not released.

HOUSING GROUP	Mounting Code Porting Code	EXPLODED VIEW ITEM #		2	[1,2]18	[A]18A
		DESCRIPTION MOUNTING	PORTING	END COVER	HOUSING SERVICE PART #	O-RING (2)
FRONT PORTING	MS-	Standard (4 Bolt)	7/8" O-Ring	MF016000	MF012014A2	
	AS-	SAE A (2 Bolt)	7/8" O-Ring	MF016000	MF012001A2	
	FS-	4 Bolt	7/8" O-Ring	MF016000	MF012003A2	
	AM-	SAE A (2 Bolt)	Manifold	MF016000	MF012004A2	032790
	FM-	4 Bolt	Manifold	MF016000	MF012005A2	032790
	MM-	Standard (4 Bolt)	Manifold	MF016000	MF012049A2	032790
	AP-	SAE A (2 Bolt)	1/2" NPTF	MF016000	MF012006A2	
	FP-	4 Bolt	1/2" NPTF	MF016000	MF012007A2	
REAR PORTING	Mounting Code Porting Code	EXPLODED VIEW ITEM #		2	[1,B]18	[A]18A
		DESCRIPTION MOUNTING	PORTING	END COVER	HOUSING SERVICE PART #	O-RING (2)
	AR-	SAE A (2 Bolt)	Rear (3/4"-16 SAE O-Ring)	MF016001	MF012008A2	
	FR-	4 Bolt	Rear (3/4"-16 SAE O-Ring)	MF016001	MF012010A2	

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	EXPLODED VIEW ITEM #		12	12A	12B
		DESCRIPTION	COUPLING SHAFT	WOODRUFF KEY	NUT
COUPLING SHAFT GROUP	01-	Long 6B Snapwire Groove	MF019007		
	09-	1" Ø, 0.38 Pinhole, 0.55" from end	MF019000		
	10-	1" Short Woodruff Key 1/4" Tap	MF019006	G124553	
	11-	1" Short 6B Spline, 1/4" Snapwire Groove	MF019003		
	12-	1" Tapered (Short)	MF019004	G124553	025136
	13-	1" Long Woodruff Snapwire Groove	MF019005	G124553	
	14-	1" Ø, Double Pinhole	MF019001		
	15-	1" Ø, 0.32 Pinhole 0.4" from end	MF019002		
	21-	"-10 Code" plus Corrosion Resistant	MF019008		
	25-	1" Tapered SAE	MF019011	G124553	025136
	26-	25 mm Straight with 8 mm Keyway	MF019012	039042	
	28-	13 Tooth Spline	MF019014		

	EXPLODED VIEW ITEM #		2	3	4	16	21	22	23	24
		DESCRIPTION	BOLTS (5)	END COVER	COMMUTATOR SEAL	SEAL RING (5)	INNER SEAL	PLUG & O-RING ASSY	O-RING	SPRING	VALVE W/SPRING
OPTION GROUP	AAAB	No Paint	Item #1		032435	032821	032377	036297	032750	401674	
	AAAC	Corrosion Resistant Paint	Item #1		032435	032821	032377	036297	032750	401674	
	AAAH	Fluorocarbon Seals	Item #1		032435	032822	032809	036297	032750	401674	
	BBCK	1740 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A7	032435	032821	032377	036297	032750	401674	4100107
	BBCM	1200 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A31	032435	032821	032377	036297	032750	401674	41001031
	BBCN	2030 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A5	032435	032821	032377	036297	032750	401674	4100105
	BBCP	1450 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A10	032435	032821	032377	036297	032750	401674	41001010
	BBCT	1560 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A2	032435	032821	032377	036297	032750	401674	4100101
	BBCP	1450 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A10	032435	032821	032377	036297	032750	401674	41001010
	AAJV	Bidirectional Shuttle Valve (3:30), Black Paint	Item #1A	MF016003A1	032435	032821	032377	036297	032750	401674	415603

[1] Service housing ass'y ITEM #18 with part number suffix-A2 includes ITEM #13 and #19.

[2] Order (2) #032790 ITEM #18A for service housing assembly where manifold ports are used.

Standard seal kit #3219 includes six #032821 seal rings, #032435 commutator seal, #032377 inner seal, #028516 back up washer, #478036 dirt & water seal, #406018 grease pack, bulletin #050015.

Special seal kit #3220 for units that use fire retardant fluids include six #032822 seal rings, #032435 commutator seal, #032809 inner seal, #028516 back up washer, #478036 dirt & water seal, #406018 grease pack, bulletin #050015.

For reverse timed manifold, use MF015001.

* Speed sensor not available in TB Series.

Commutator set for rear ported units MF018001A1

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Chart Use Example:
TE0045AS010AAAB Torqlink™ includes part numbers listed to the right of TE (SERIES), 0045 (DISP.), AS (MOUNTING/PORTING), 01(SHAFT), 0 (ROTATION), and AAAB (OPTION) shown in the left hand column of the chart.

Caution:
The charted component service information is for the Torqlinks listed only. Refer to the original equipment manufacturer of the equipment using the Torqlink for assembly numbers not listed below.

SERIES	EXPLODED VIEW ITEM #	5 & 6	7	9	[1]13	14	15	17	[1]19	20
	DESCRIPTION	COMMUTATOR & RING ASSY	MANIFOLD (SEE NOTE)	WEAR PLATE	INNER BEARING	THRUST WASHER	THRUST BEARING	BACKUP WASHER	OUTER BEARING	DIRT & WATER SEAL
TE-	Service Part #	MF018000A1	MF015000	477341	069512	028483	065066	028516	065506	478036

DISPLACEMENT GROUP	EXPLODED VIEW ITEM #	1 or 1A or 1C			ROTOR THICKNESS	8A	8B	10
	DISPLACEMENT (in³/rev)	BOLT (6)†	BOLT (6)	BOLT (5)	"L" DIM. OF ROTOR THICKNESS	ROTOR SET	FREE RUNNING ROTOR SET††	DRIVE LINK
0045-	2.7	021311	021433	021308	**.3169**	MF027003	MF027005	MF023000
0050-	3.0	021311	021444	021308	**.3751**	MF037003	MF037005	MF033000
0065-	4.0	021306	021358	021435	**.5001**	MF047003	MF047005	MF043000
0080-	5.0	021382	021438	021359	**.6258**	MF057003	MF057005	MF053000
0100-	6.0	021357	021308	021445	**.7508**	MF067003	MF067005	MF063000
0130-	8.0	021307	021359	021439	**1.0008**	MF087003	MF087005	MF083000
0165-	9.9	021358	021310	*	**1.2508**	MF107003	MF107005	MF103000
0195-	11.9	021308	021383	021465	**1.5008**	MF127003	MF127005	MF123000
0230-	13.9	021359	021384	021460	**1.7508**	MF147003	MF147005	MF143000
0260-	15.9	021310	021446	021467	**2.0008**	MF167003	MF167005	MF163000
0295-	17.9	021383	021414	*	**2.2508**	MF187003	MF187005	MF183000
0330-	20.0	021384	021459	021448	**2.5008**	MF207003	MF207005	MF203000
0365-	22.6	021460	021448	*	**2.8406**	MF227003	N/A	MF223000
0390-	24.0	021414	021449	021464	**3.0030**	MF247003	N/A	MF243000

† Bolts for TE Series front ported units are the same as rear ported units.
†† Free running rotorset is not available in 0365 or 0390 displacements.
* Not released.

HOUSING GROUP	Mounting Code Porting Code	EXPLODED VIEW ITEM #		2	[1,4]18	18	[1,2]18A	SPEED SENSOR 18	SPEED SENSOR 18
		DESCRIPTION MOUNTING	PORTING	6 BOLT END COVER	5 BOLT HSG SERVICE PART #	6 BOLT HSG SERVICE PART #	O-RING (2)	6 BOLT HSG SERVICE PART #	SENSOR
FRONT PORTING	MS-	Standard (4 Bolt)	7/8" O-Ring	MF016007	MF012014A1	MF012214A1		MF012314A1	455069
	AS-	SAE A (2 Bolt)	7/8" O-Ring	MF016007	MF012001A1	MF012201A1		MF012301A1	455069
	US-	Wheel Mount	7/8" O-Ring	MF016007	MF012002A1	MF012202A1		MF012302A1	455069
	FS-	4 Bolt	7/8" O-Ring	MF016007	MF012003A1	MF012203A1		MF012303A1	455069
	AM-	SAE A (2 Bolt)	Manifold	MF016007	MF012004A1	MF012204A1	032790	MF012304A1	455069
	FM-	4 Bolt	Manifold	MF016007	MF012005A1	MF012205A1	032790		
	MM-	Standard (4 Bolt)	Manifold	MF016007	MF012049A1	MF012249A1	032790		
	AP-	SAE A (2 Bolt)	1/2" NPTF	MF016007	MF012006A1	MF012206A1		MF012306A1	455069
	FP-	4 Bolt	1/2" NPTF	MF016007	MF012007A1	MF012207A1		MF012307A1	455069
	AT-	SAE A (2 Bolt)	1/2" BSPF	MF016007	MF012011A1	MF012211A1			

HOUSING GROUP	Mounting Code Porting Code	EXPLODED VIEW ITEM #		2	[1,4]18	SPEED SENSOR 18	SPEED SENSOR 18
		DESCRIPTION MOUNTING	PORTING	5 BOLT END COVER	5 BOLT HSG SERVICE PART #	5 BOLT HSG SERVICE PART #	SENSOR
REAR PORTING	MR-	Standard (4 Bolt)	Rear Port (3/4"-16 SAE O-Ring)	MF016001	MF012021A1		
	UR-	Small Wheel Mount	Rear Port (3/4"-16 SAE O-Ring)	MF016001	MF012009A1	N/A	455069
	FR-	4 Bolt Mount	Rear Port (3/4"-16 SAE O-Ring)	MF016001	MF012010A1		
	AR-	SAE A (2 Bolt)	Rear Port (3/4"-16 SAE O-Ring)	MF016001	MF012008A1	N/A	455069

NOTE: Rear ported TE motors always have 5 bolts at the back end cover.

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	EXPLODED VIEW ITEM #	12	12A	12B	SPEED SENSOR 12
	DESCRIPTION	COUPLING SHAFT	WOODRUFF KEY	NUT	COUPLING SHAFT
COUPLING SHAFT GROUP	01- Long 6B Snapwire Groove	MF019007			MF019307
	09- 1" Ø, 0.38 "Pinhole, 0.55" from end	MF019000			
	10- 1" Short Woodruff Key 1/4" Tap	MF019006	G124553		MF019306
	11- 1" Short 6B Spline, 1/4" Snapwire Groove	MF019003			MF019303
	12- 1" Tapered (Short)	MF019004	G124553	025136	MF019304
	13- 1" Long Woodruff Snapwire Groove	MF019005	G124553		MF019305
	14- 1" Ø, Double Pinhole	MF019001			
	15- 1" Ø, 0.32 "Pinhole 0.4" from end	MF019002			
	21- "-10 Code" plus Corrosion Resistant	MF019008			MF019308
	22- 25 mm Straight Shaft with 7 mm Keyway	MF019009	039041		
	25- 1" Tapered SAE	MF019011	G124553	025136	MF019311
	26- 25 mm Straight with 8 mm Keyway	MF019012	039042		MF019312
	28- 13 Tooth Spline	MF019014			MF019314

	EXPLODED VIEW ITEM #	[4]1, 1A, 1C	2	2	3	4	16
	DESCRIPTION	BOLT	5 BOLT END COVER	6 BOLT END COVER	COMMUTATOR SEAL	SEAL RING (5)	INNER SEAL
OPTION GROUP	AAAA Standard Black Paint	Item #1		MF016007	032435	032821	032377
	AAAB No Paint	Item #1		MF016007	032435	032821	032377
	AAAC Corrosion Resistant Paint	Item #1		MF016007	032435	032821	032377
	AAAG Fluorocarbon Seals	Item #1		MF016007	032435	032822	032809
	BBCK 1740 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A7	N/A			
	BBCM 1200 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A31	N/A			
	BBCN 2030 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A5	N/A			
	BBCP 1450 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A10	N/A			
	BBCT 1560 PSI Internal Bidirectional Relief, No Paint	Item #1C	MF016006A2	N/A			
	AAJV Bidirectional Shuttle Valve (3:30), Black Paint	Item #1A	MF016003A1	MF016009A1	032435	032821	032377
	FSAA Speed Sensor, Black Paint	Item #1		MF016007	032435	032821	032377
	FSAB Speed Sensor, No Paint	Item #1		MF016007	032435	032821	032377
	FSAH Speed Sensor, Castle Nut, No Paint	Item #1		MF016007	032435	032821	032377
	FSAJ Speed Sensor, Castle Nut, Black Paint	Item #1		MF016007	032435	032821	032377

[1] Service housing ass'y ITEM #18 with part number suffix-A1 includes ITEM #13, #14, #15 and #19.

[2] Select the required bolt number in designated "DISPLACEMENT GROUP" under bolt ITEM #1, 1A, 1B or 1C shown in designated "OPTION GROUP"

[3] Castle Nut #025156 is required if the designated "OPTION GROUP" is AAAF, AAAN, or AAAU.

[4] Order (2) #032790 ITEM #18A for service housing assembly where manifold ports are used.

Standard seal kit #3219 includes six #032821 seal rings, #032435 commutator seal, #032377 inner seal, #028516 back up washer, #478036 dirt & water seal, #406018 grease pack, bulletin #887.

Special seal kit #3220 for units that use fire retardant fluids include six #032822 seal rings, #032435 commutator seal, #032809 inner seal, #028516 back up washer, #478036 dirt & water seal, #406018 grease pack, bulletin #887.

For reverse timed manifold, use MF015001.

Commutator set for rear ported unit MF018001A1

* TD Series motors were (5) five bolt end cover with (5) five bolt housing. The newly released TE Series motors are (6) six bolt end cover with (6) bolt housing.

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Chart Use Example:
TJ0045US080AAAB Torqlink™ includes part numbers listed to the right of TJ (SERIES), 0045 (DISP.), US (MOUNTING/ PORTING), 08(SHAFT), 0 (ROTATION), and AAAB (OPTION) shown in the left hand column of the chart.

Caution:
The charted component service information is for the Torqlinks listed only. Refer to the original equipment manufacturer of the equipment using the Torqlink for assembly numbers not listed below.

SERIES	EXPLODED VIEW ITEM #	[1]5 & 6	7	9	[1]13	[1]14	[1]15	17	[1]19	20	25
	DESCRIPTION	COMMUTATOR ASSEMBLY	MANIFOLD (SEE NOTE)	WEAR PLATE	INNER BEARING	THRUST WASHER(2)	THRUST BEARING	BACKUP WASHER	OUTER BEARING	DIRT & WATER SEAL	BACKUP WASHER
TJ-	Service Part #	MF018000A1	MF015000	477341	069513	028348	069030	028515	068027	478035	029118

DISPLACEMENT GROUP	EXPLODED VIEW ITEM #	1 or 1A or 1C	ROTOR THICKNESS	8A	8B	10
	DISPLACEMENT (in³/rev)	BOLT (6)	"L" DIM. OF ROTOR THICKNESS	ROTOR SET	FREE RUNNING ROTOR SET[††]	DRIVE LINK
0045-	2.7	021311	021433	021308	**.3169**	MF027003	MF027005	MF023000
0050-	3.0	021311	021444	021308	**.3751**	MF037003	MF037005	MF033000
0065-	4.0	021306	021358	021435	**.5001**	MF047003	MF047005	MF043000
0080-	5.0	021382	021438	021359	**.6258**	MF057003	MF057005	MF053000
0100-	6.0	021357	021308	021445	**.7508**	MF067003	MF067005	MF063000
0130-	8.0	021307	021359	021439	**1.0008**	MF087003	MF087005	MF083000
0165-	10.0	021358	021310	*	**1.2508**	MF107003	MF107005	MF103000
0195-	12.0	021308	021383	021465	**1.5008**	MF127003	MF127005	MF123000
0230-	14.0	021359	021384	021460	**1.7508**	MF147003	MF147005	MF143000
0260-	16.0	021310	021446	021467	**2.0008**	MF167003	MF167005	MF163000
0295-	18.0	021383	021414	*	**2.2508**	MF187003	MF187005	MF183000
0330-	20.0	021384	021459	021448	**2.5008**	MF207003	MF207005	MF203000
0365-	22.6	021460	021448	*	**2.8406**	MF227003	N/A	MF223000
0390-	24.0	021414	021449	021464	**3.0030**	MF247003	N/A	MF243000

[††] Free running rotorset is not available in 0365 or 0390 displacements.
* Not released.

HOUSING GROUP Mounting Code / Porting Code	EXPLODED VIEW ITEM #		[1]18
	DESCRIPTION MOUNTING	PORTING	SERVICE HOUSING ASS'Y
US-	Wheel Mount (4 Bolt)	7/8"-14 SAE O-Ring	MP012002A1

COUPLING SHAFT GROUP	EXPLODED VIEW ITEM #	12	12A	12B
	DESCRIPTION	COUPLING SHAFT	KEY	NUT
08-	1 1/4" Tapered	MP019000	G124554	025126

OPTION GROUP	EXPLODED VIEW ITEM #	[2]1, 1A, 1C	2	3	4	16
	DESCRIPTION	BOLT	END COVER	COMMUTATOR SEAL	SEAL RING (5)	INNER SEAL
AAAB	No Paint	ITEM #1	MF016007	032435	032821	032817
AAAC	Corrosion Resistant Paint	ITEM #1	MF016007	032435	032821	032817
AAAG	Fluorocarbon Seals	ITEM #1	MF016007	032435	032822	032818
AABJ	Free Running Rotor Set	ITEM #1	MF016007	032435	032821	032817
BBCK	1740 PSI Internal Bidirectional Relief, No Paint	ITEM #1C	MF016006A7			
BBCM	1200 PSI Internal Bidirectional Relief, No Paint	ITEM #1C	MF016006A31			
BBCN	2030 PSI Internal Bidirectional Relief, No Paint	ITEM #1C	MF016006A5			
BBCP	1450 PSI Internal Bidirectional Relief, No Paint	ITEM #1C	MF016006A10			
BBCT	1560 PSI Internal Bidirectional Relief, No Paint	ITEM #1C	MF016006A2			
AAJV	Bidirectional Shuttle Valve (3:30), Black Paint	ITEM #1A	MF016009A1	032435	032821	032817

[1] Service housing ass'y ITEM #18 with part number suffix-A1 includes ITEM #13, #14, #15 and #19.

[2] Order (2) #032790 ITEM #18A for service housing assembly where manifold ports are used.

[3] Nut #025113 is required if the designated "OPTION GROUP" is AAAF, AAAN, or AAAU.

Standard seal kit #3647 includes five #032821 seal rings, #032435 commutator seal, #032817 inner seal, #028515 and #029118 back washers, #478035 dirt & water, #406018 grease pack, bulletin #687.

Special seal kit #3648 for units that use fire retardant fluids or higher temperature oil includes five #032822 seal rings, #032435 commutator seal, #032818 shaft seal, #028515 back up washer, #478035 dirt & water seal, #406018 grease pack, #029118 thrust washer, #687 bulletin.

For reverse timedmanifold, use MF015001.

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Parker Hannifin Corporation
Hydraulic Pump/Motor Division
Greeneville, TN 37745 USA

TF Service Parts List Chart

Chart Use Example:
TF0080AS010AAAB Torqlink™ includes part numbers listed to the right of TF (SERIES), 0080 (DISP.), AS (MOUNTING/PORTING), 01(SHAFT), 0 (ROTATION), and AAAA (OPTION) shown in the left hand column of the chart.

Caution:
The charted component service information is for the Torqlinks listed only. Refer to the original equipment manufacturer of the equipment using the Torqlink for assembly numbers not listed below.

SERIES	EXPLODED VIEW ITEM #	[7]5 & 6	7	9	11	[1]13	[1]14	[1]15	17	[1]19	20	25
	DESCRIPTION	COMMUTATOR ASSEMBLY	MANIFOLD (SEE NOTE)	WEAR PLATE	THRUST BEARING	INNER BEARING	THRUST WASHER(2)	THRUST BEARING	BACKUP WASHER	OUTER BEARING	DIRT & WATER SEAL	BACKUP WASHER
TF-	Service Part #	ME018000A1	ME015000	477340	068024	071019	400136	069017	028515	068027	478035	029118

DISPLACEMENT GROUP	EXPLODED VIEW ITEM #	[2](SELECT ITEM # BOLT PER OPTION GROUP) 1 OR 1A OR 1B OR 1C					8A	8B	10		
	DISPLACEMENT (in³/rev)	BOLT (7)	BOLT (7)	BOLT (7)	BOLT (7)	ROTOR THICKNESS	ROTOR SET	FREE RUNNING ROTOR SET	DRIVE LINK	"L DIM" 12 TOOTH	"L DIM" 14 TOOTH
0080-	4.9	021326	021340	021273	021413	.4393	MB057003	MB057005	MB063000	4.262"	
0100-	6.1	021326	021340	021273	021413	.4393	MB067003	MB067005	MB063000	4.262"	
0130-	7.8	021271	021386	021273	021279	.5643	MB087003	MB087005	MB083000	4.388"	
0140-	8.6	021390	021273	021273	021379	.6268	MB097003	MB097005	MB093000	4.451"	
0170-	10.3	021376	021387	021387	021392	.7518	MB107003	MB107005	MB103000	4.577"	
0195-	12.0	021352	021379	021379	021291	.8768	MB127003	MB127005	MB123000	4.703"	
0240-	14.5	021272	021291	021291	021412	1.0643	MB157003	MB157005	MB153000	4.892"	
0280-	17.1	021340	021392	021392	021385	1.2518	MB187003	MB187005	MB183000	5.081"	
0360-[†]	22.2	021387	021378	021378	021415	1.5018	ME237003	ME237007	MB233002		5.458"
0365-	22.2	021387	021378	021378	021415	1.6268	MB237003	MB237005	MB233000	5.458"	
0405-[†]	24.7	021379	021366	021415	021374	1.7923	ME247003	ME247007	MB253002		5.604"
0475-[†]	29.1	021392	021394	021394	021393	2.1268	ME297003	ME297007	MB293002		5.947"

[†] (Not available in clutch motor)

FRONT PORTING	Mounting Code Porting Code	EXPLODED VIEW ITEM #		2	[1]18	SPEED SENSOR 18	SPEED SENSOR 18
		DESCRIPTION MOUNTING	[8]PORTING	END COVER	SERVICE HOUSING ASS'Y	SERVICE HOUSING ASS'Y	SENSOR
	MS-	Standard (4 Bolt)	7/8" O-Ring	ME016000	ME012001A1	ME012301A1	455069
	US-	Wheel Mt. (4 Bolt)	7/8" O-Ring	ME016000	ME012002A1	ME012301A1	455069
	AS-	SAE A (2 Bolt)	7/8" O-Ring	ME016000	ME012006A1	ME012306A1	455069
	HS-	Whl. (US) w/Machined Pilot Nose	7/8" O-Ring	ME016000	ME012008A1		
	LS-	Whl. w/Brake Mt. (4 Bolt)	7/8" O-Ring	ME016000	ME012009A1		
	BS-	SAE B (2 Bolt)	7/8" O-Ring	ME016000	ME012019A1	ME012319A1	455069
	GS-	**Clutch Motor**	**7/8" O-Ring**	**ME016000**	**ME012013A1**		
	AM-	SAE A (2 Bolt)	Manifold	ME016000	ME012028A1	ME012328A1	455069
	MM-	Standard (4 Bolt)	Manifold	ME016000	ME012018A1		
	AT-	SAE A (2 Bolt)	1/2" BSPF	ME016000	ME012027A1		
	MT-	Standard (4 Bolt)	1/2" BSPF	ME016000	ME012010A1	ME012310A1	455069

HOUSING GROUP	REAR PORTING	EXPLODED VIEW ITEM #		1, 1A, 1B, 1C	2	[1]18	SPEED SENSOR 18	SPEED SENSOR 18
		DESCRIPTION MOUNTING	[8]PORTING	BOLT	END COVER	SERVICE HOUSING ASS'Y	SERVICE HOUSING ASS'Y	SENSOR
	MA-	Standard (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012004A1		
	UA-	Wheel Mt. (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012005A1		
	AA-	SAE A (2 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012007A1	ME012307A1	455069
	WA-	Wheel, Optional (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012011A1		
	VA-	SAE A (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012049A1		
	MB-	Standard (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012004A1		
	UB-	Wheel Mt. (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012005A1		
	AB-	SAE A (2 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012007A1	ME012307A1	455069
	WB-	Wheel, Optional (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012011A1		
	VB-	SAE A (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012049A1		
	ME-	Standard (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012004A1		
	UE-	Wheel Mt. (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012005A1		
	AE-	SAE A (2 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012007A1	ME012307A1	455069
	WE-	Wheel, Optional (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012011A1		
	VE-	SAE A (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012049A1		

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Greeneville, TN 37745 USA

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	EXPLODED VIEW ITEM #	12	SPEED SENSOR 12	CLUTCH MOTOR 12	12A	12B	12C	12D	12E	12F
	DESCRIPTION	COUPLING SHAFT	COUPLING SHAFT	COUPLING SHAFT	KEY	NUT	WASHER	5/8-18 BOLT	LOCK WASHER	RETAINING RING
COUPLING SHAFT GROUP 01-	Long 6B Snapwire Groove	MB019001	MB019301							
02-	Long Woodruff, 1/4" Tap Snapwire Groove	MB019002	MB019302		G124553					
03-	1.25" Straight Keyed 5/8-18 Int. Thd.	MB019003	MB019303	**093044**	039028		028413	G223734	028992	401333
04-	10B Spline	MB019004								
05-	14 Tooth Spline 5/8-18 Int. Thd.	MB019005	MB019305	**093043**			028413	G223734	028992	
06-	19 Tooth Spline	MB019006								
07-	15 Tooth Spline	MB019007								
08-	1.25" Tapered Shaft	MB019000	MB019300		G124554	[3]025126				
28-	13 Tooth Spline (16/32)	MB019023	MB019323							

	EXPLODED VIEW ITEM #	12	SPEED SENSOR 12	
	DESCRIPTION	COUPLING SHAFT	COUPLING SHAFT	SENSOR
COUPLING SHAFT GROUP FOR DISP.-0360, -0405, -0475 ONLY[†] 01-	Long 6B Snapwire Groove	ME019001	ME019301	455069
02-	Long Woodruff, 1/4" Tap Snapwire Groove	ME019002	ME019302	455069
03-	1.25" Straight Keyed 5/8-18 Int. Thd.	ME019003	ME019303	455069
04-	10B Spline	ME019004		
05-	14 Tooth Spline 5/8-18 Int. Thd.	ME019005	ME019305	455069
06-	19 Tooth Spline	ME019006		
07-	15 Tooth Spline	ME019007		
08-	1.25" Tapered Shaft	ME019000	ME019300	455069
19-	1.38" Tapered 1.125-18 Thd.	ME019010		
20-	1.38" Straight Key 5/8 Tap	ME019011		

[†] (Not available in clutch motor)

	EXPLODED VIEW ITEM #	[2]1, 1A, 1B, 1C	2	3	4	16	[6]21 & 22	[4,6]22	[6]23	[6]24	12B	
	DESCRIPTION	BOLT (7)	END COVER	COMMUTATOR SEAL	SEAL RING (5)	INNER SEAL	PLUG & O-RING ASSEMBLY	O-RING	SPRING (2)	VALVE	CASTLE NUT	SENSOR
OPTION GROUP AAAA	Black Paint	Item #1		032435	032819	032817						
AAAC	Corrosion Resistant Paint	Item #1		032435	032819	032817						
AAAF	Castle Nut Replacing Patch Lock Nut	Item #1		032435	032819	032817					025113	
AAAG	Fluorocarbon Seals, Black Paint	Item #1		032435	032820	032818						
AAAH	Fluorocarbon Seals, No Paint	Item #1		032435	032820	032818						
AAAT	Bidirectional Shuttle Valve 11:00	Item #1A	[6]ME016003A1	032435	032819	032817	036297	032791	401642	415569		
AAAU	Bidirectional Shuttle Valve 11:00 & Castle Nut	Item #1A	[6]ME016003A1	032435	032819	032817	036297	032791	401642	415569	025113	
BBBA	1000 PSI Cross Port Relief Endcover, Black Paint	Item #1C	[6]ME016004A1	032435	032819	032817	411063A1	032424		41001210	(2), 1000 PSI	
BBBG	1500 PSI Cross Port Relief Endcover, Black Paint	Item #1C	ME016004A5	032435	032819	032817	411063A1	032424		41000976	(2), 1500 PSI	
BBBB	2000 PSI Cross Port Relief Endcover, Black Paint	Item #1C	[6]ME016004A2	032435	032819	032817	411063A1	032424		41001220	(2), 2000 PSI	
BBCG	2500 PSI Int. Bidirectional Relief Endcover, No Paint	Item # 1C	ME016004A6	032435	032819	032817	411063A1	032424		41001225	(2), 2500 PSI	
BBCX	2500 PSI Int. Bidirectional Relief Endcover, No Nut, Black Paint	Item # 1C	ME016004A6	032435	032819	032817	411063A1	032424		41001225	(2), 2500 PSI	
BBCW	3000 PSI Int. Bidirectional Relief Endcover, No Nut, No Paint	Item # 1C	ME016004A3	032435	032819	032817	411063A1	032424		41001230	(2), 3000 PSI	
BBBC	3000 PSI Cross Port Relief Endcover, Black Paint	Item #1C	[6]ME016004A3	032435	032819	032817	411063A1	032424		41001230	(2), 3000 PSI	
BBBD	4000 PSI Cross Port Relief Endcover, Black Paint	Item #1C	[6]ME016004A4	032435	032819	032817	411063A1	032424		41001240	(2), 4000 PSI	
DDDA	Clutch Motor	Item #1	ME016000	032435	032819	032817						
FSAA	Speed Sensor Option	Item #1	ME016000	032435	032819	032817						455069

For reverse timed manifold, use ME015001.

[1] Service housing ass'y ITEM #18 with part number suffix-A1 includes ITEM #13, #14 two req'd, #15 and #19.

[2] Select the required bolt number in designated "DISPLACEMENT GROUP" under bolt ITEM #1, 1A, 1B or 1C shown in designated "OPTION GROUP."

[3] 1-20 UNEF slotted nut #025113 is required on 1-1/4" tapered shaft if the designated "OPTION GROUP" is AAAF, AAAN, or AAAU.

[4] ITEM #22 is part of plug & o-ring assy's but can be serviced separately.

[5] Service endcover ME016001J1 includes two #032790 o-rings, ITEM 18A on the exploded ass'y view that can also be serviced separately.

[6] End cover assembly item #2 also includes item #21, #22, #24 and if required item #23. All but item #21 can be serviced separately.

[7] ME018001A1 commutator ass'y. is required if the designated "OPTION GROUP" is AAAM, AAAN, or AAAP.

[8] Order (2) #032790 seals for parts when ordering manifold-style porting.

Standard seal kit #3221 includes six #032819 seal rings, #032435 commutator seal, #032817 inner seal, #028515 and #029118 back washers, #478035 dirt & water, #406018 grease pack, bulletin #687.

Special seal kit #3222 for units that use fire retardant fluids includes six #032435 commutator seal, #032818 inner seal, #028515 and #029118 back up washers, #478035 dirt & water seal, #406018 grease pack, bulletin #687.

Vespel commutator seal AADJ #032751. High temperature seal black in color.

* Standard seal kit #3221 for motor only. If repairing clutch, need #3649. Kit includes two #067033 bearing and cone assemblies, two #400740 bearing cups, one #400141 thrust washer, one #401622 snap ring, one #401632 retaining ring, and one #478030 dirt and water seal.

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Chart Use Example:
TG0140AS010AAAB Torqlink™ includes part numbers listed to the right of TG (SERIES), 0140 (DISP.), AS (MOUNTING/ PORTING), 01(SHAFT), 0 (ROTATION), and AAAB (OPTION) shown in the left hand column of the chart.

Caution:
The charted component service information is for the Torqlinks listed only. Refer to the original equipment manufacturer of the equipment using the Torqlink for assembly numbers not listed below.

SERIES	EXPLODED VIEW ITEM #	[7]5 & 6	7	9	11	[1]13	[1]14	[1]15	17	[1]19	20	25
	DESCRIPTION	COMMUTATOR ASSEMBLY	MANIFOLD (see note)	WEAR PLATE	THRUST BEARING	INNER BEARING	THRUST WASHER(2)	THRUST BEARING	BACKUP WASHER	OUTER BEARING	DIRT & WATER SEAL	BACKUP WASHER
TG-	Service Part #	ME018000A1	ME015000	477342	068024	071019	400136	069017	028515	068027	478035	029118

DISPLACEMENT GROUP		EXPLODED VIEW ITEM # [2](SELECT ITEM # BOLT PER OPTION GROUP) 1 or 1A or 1B or 1C					8A	8B	10	
	DISPLACEMENT (in³/rev)	BOLT (7)	BOLT (7)	BOLT (7)	BOLT (7)	ROTOR THICKNESS	ROTOR SET	FREE RUNNING ROTOR SET	DRIVE LINK	DRIVE LINK "L DIM"
0140-	8.6	021390	021273	021273	021379	**.6286**	ME097003	ME097007	ME093000	**4.4385**
0170-	10.3	021376	021387	021387	021392	**.7518**	ME107003	ME107007	ME103000	**4.5650**
0195-	12.0	021352	021379	021379	021291	**.8768**	ME127003	ME127007	ME123000	**4.6905**
0240-	14.5	021272	021291	021291	021412	**1.0643**	ME157003	ME157007	ME153000	**4.8795**
0280-	17.1	021340	021392	021392	021385	**1.2518**	ME187003	ME187007	ME183000	**5.0685**
0335-	20.6	021273	021385	021385	021366	**1.5018**	ME217003	ME217007	ME213000	**5.3195**
0405-	24.7	021379	021366	021415	021374	**1.7923**	ME247003	ME247007	ME243000	**5.6045**
0475-	29.1	021392	021394	021394	021393	**2.1268**	ME297003	ME297007	ME293000	**5.9475**
0530-	32.3	021385	021393	021393	021395	**2.3768**	ME337003	ME337007	ME333000	**6.1985**
0625-	38.0	021366	021329	021329	021458	**2.7536**	ME377003	N/A	ME373000	**6.5745**
0785-	48.0	021395	021388	021388	021416	**3.5036**	ME487003	N/A	ME483000	**7.3285**
0960-	58.5	021396	021389	021389	021399	**4.2536**	ME587003	N/A	ME583000	**8.0815**

	Mounting Code Porting Code	EXPLODED VIEW ITEM #		[1]18	[1]18A	SPEED SENSOR 18	18
		DESCRIPTION MOUNTING	[8]PORTING	SERVICE HOUSING ASS'Y	O-RING (2)	SERVICE HOUSING ASS'Y	SENSOR
FRONT PORTING	MS-	Standard (4 Bolt)	7/8" O-Ring	ME012001A1		ME012301A1	455069
	US-	Wheel Mt. (4 Bolt)	7/8" O-Ring	ME012002A1		ME012302A1	455069
	AS-	SAE A (2 Bolt)	7/8" O-Ring	ME012006A1		ME012306A1	455069
	BS-	SAE B (2 Bolt)	7/8" O-Ring	ME012019A1		ME012319A1	455069
	HS-	Wheel (US) with Machined Pilot Nose	7/8" O-Ring	ME012008A1			
	AM-	SAE A (2 Bolt)	Manifold	ME012028A1	032790	ME012328A1	455069
	MM-	Standard (4 Bolt)	Manifold	ME012018A1	032790		
	AT-	SAE A (2 Bolt)	1/2" BSPF	ME012027A1			
	MT-	Standard (4 Bolt)	1/2" BSPF	ME012010A1		ME012310A1	455069

HOUSING GROUP	Mounting Code Porting Code	EXPLODED VIEW ITEM #		1, 1A, 1B, 1C	2	[1]18	SPEED SENSOR 18	18
		DESCRIPTION MOUNTING	[8]PORTING	BOLT	END COVER	SERVICE HOUSING ASS'Y	SERVICE HOUSING ASS'Y	SENSOR
REAR PORTING	MA-	Standard (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012004A1		
	UA-	Wheel Mt. (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012005A1		
	AA-	SAE A (2 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012007A1	ME012307A1	455069
	WA-	Wheel, Optional (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012011A1		
	VA-	SAE A (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	ME012049A1		
	MB-	Standard (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012004A1		
	UB-	Wheel Mt. (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012005A1		
	AB-	SAE A (2 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012007A1	ME012307A1	455069
	WB-	Wheel, Optional (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012011A1		
	VB-	SAE A (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	ME012049A1		
	ME-	Standard (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012004A1		
	UE-	Wheel Mt. (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012005A1		
	AE-	SAE A (2 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012007A1	ME012307A1	455069
	WE-	Wheel, Optional (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012011A1		
	VE-	SAE A (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	ME012049A1		

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	EXPLODED VIEW ITEM #	12	SPEED SENSOR 12	12A	12B	12C	12D	12E	12F
	DESCRIPTION	COUPLING SHAFT	COUPLING SHAFT	KEY	NUT	WASHER	5/8-18 BOLT	LOCK WASHER	RETAINING RING
COUPLING SHAFT GROUP	01- Long 6B Snapwire Groove	ME019001	ME019301						
	02- Long Woodruff, 1/4" Tap Snapwire Groove	ME019002	ME019302	G124553*					
	03- 1.25" Straight Keyed 5/8-18 Int. Thd.	ME019003	ME019303	039028		028413	G223734	028992	401333
	04- 10B Spline	ME019004							
	05- 14 Tooth Spline 5/8-18 Int. Thd.	ME019005	ME019305			028413	G223734	028992	
	06- 19 Tooth Spline	ME019006							
	07- 15 Tooth Spline	ME019007							
	08- 1.25" Tapered Shaft	ME019000	ME019300	G124554	[3]025126				
	19- 1.38" Tapered 1.125-18 Thd.	ME019010		G124554	[7]025138				
	20- 1.38" Straight Key 5/8 Tap	ME019011		039028		028518	G223734	028992	401658

*(1/4 x 1.00)

	EXPLODED VIEW ITEM #	[2]1, 1A, 1B, 1C	2	3	4	16/8A	[6]21 & 22	[4,6]22	[6]23	[6]24	
	DESCRIPTION	BOLT (7)	END COVER	COMMUTATOR SEAL	SEAL RING (5)	INNER SEAL	PLUG & O-RING ASSEMBLY	O-RING	SPRING	(2) VALVE	SENSOR
OPTION GROUP	AAAA Black Paint	Item #1	ME016000	032435	032819	032817					
	AAAC Corrosion Resistant Paint	Item #1	ME016000	032435	032819	032817					
	AAAF Castle Nut Replacing Patch Lock Nut	Item #1	ME016000	032435	032819	032817					
	AAAG Fluorocarbon Seals	Item #1	ME016000	032435	032820	032818					
	AAAT Bidirectional Shuttle Valve Endcover 11:00	Item #1A	[6]ME016003A1	032435	032819	032817	036297	032791	401642	415569	
	AAAU Bidirectional Shuttle Valve Endcover 11:00 & Castle Nut	Item #1A	[6]ME016003A1	032435	032819	032817	036297	032791	401642	415569	
	BBBA 1000 PSI Cross Port Relief Endcover	Item #1C	[6]ME016004A1	032435	032819	032817	411063A1	032424		41001210(2), 1000 PSI	
	BBBG 1500 PSI Cross Port Relief Endcover	Item #1C	ME016004A5	032435	032819	032817	411063A1	032424		41000976(2), 1500 PSI	
	BBBB 2000 PSI Cross Port Relief Endcover	Item #1C	[6]ME016004A2	032435	032819	032817	411063A1	032424		41001220(2), 2000 PSI	
	BBCG 2500 PSI Cross Port Relief Endcover	Item #1C	ME016004A6	032435	032819	032817	411063A1	032424		41001225(2), 2500 PSI	
	BBBC 3000 PSI Cross Port Relief Endcover	Item #1C	[6]ME016004A3	032435	032819	032817	411063A1	032424		41001230(2), 3000 PSI	
	BBBD 4000 PSI Cross Port Relief Endcover	Item #1C	[6]ME01604A4	032435	032819	032817	411063A1	032424		41001240(2), 4000 PSI	
	FSAA Speed Sensor Option	Item #1	ME016000	032435	032819	032817					455069

For reverse timed manifold, use ME015001.

[1] Service housing ass'y ITEM #18 with part number suffix-A1 includes ITEM #13, #14 two req'd, #15 and #19.

[2] Select the required bolt number in designated "DISPLACEMENT GROUP" under bolt ITEM #1, 1A, 1B or 1C shown in designated "OPTION GROUP."

[3] 1-20 UNEF slotted nut #025113 is required on 1-1/4" tapered shaft if the designated "OPTION GROUP" is AAAF, AAAN, or AAAU.

[4] ITEM #22 is part of plug & o-ring assy's but can be serviced separately.

[5] Service end cover ME016001J1 includes two #032790 o-rings, ITEM 18A on the exploded ass'y view that can also be serviced separately.

[6] End cover assembly item #2 also includes item #21, #22, #24 and if required item #23. All but item #21 can be serviced separately.

[7] ME018001A1 commutator ass'y. is required if the designated "OPTION GROUP" is AAAM, AAAN, or AAAP.

[8] Order (2) #032790 seals for parts when ordering manifold-style porting.

Standard seal kit #3221 includes six #032819 seal rings, #032435 commutator seal, #032817 inner seal, #028515 and #029118 back washers, #478035 dirt & water seal, #406018 grease pack, bulletin #687.

Special seal kit #3222 for units that use fire retardant fluids includes six #032820 seal rings, #032435 commutator seal, #032818 inner seal, #028515 and #029118 back up washers, #478035 dirt & water seal, #406018 grease pack, bulletin #687.

Vespel commutator seal AAAJ #032751. High temp seal black in color.

(08) 1-1/4 Shaft zinc di chromate Castle Nut 1-20 #025139

(08) 1-1/4 Shaft Castle Nut 1-20 #025113

(19) 1-3/8 Shaft Castle Nut 1-1/4-18 #025139

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Chart Use Example:
TH0140AS010AAAB Torqlink™ includes part numbers listed to the right of TH (SERIES), 0140 (DISP.), A (MOUNTING), S (PORTING), 31 (SHAFT), 0 (ROTATION), and AAAB (OPTION) shown in the left hand column of the chart.

Caution:
The charted component service information is for the Torqlinks listed only. Refer to the original equipment manufacturer of the equipment using the Torqlink for assembly numbers not listed below.

SERIES	EXPLODED VIEW ITEM #	[8]5 & 6	7	9	11	[1]13	[1]14	[1]15	17	[1]19	20	25
	DESCRIPTION	COMMUTATOR ASSEMBLY	MANIFOLD (SEE NOTE)	WEAR PLATE	THRUST BEARING	INNER BEARING	THRUST WASHER(2)	THRUST BEARING	BACKUP WASHER	OUTER BEARING	DIRT & WATER SEAL	BACKUP WASHER
TH-	Service Part #	ME018000A1	ME015000	477342	068024	071031	069023 (2)	069022	028537	069021	487063	028538

DISPLACEMENT GROUP	EXPLODED VIEW ITEM #	[2](SELECT ITEM # BOLT PER OPTION GROUP) 1 OR 1A OR 1B OR 1C				8A	8B	10	
	DISPLACEMENT (in³/rev)	BOLT (7)	BOLT (7)	BOLT (7)	BOLT (7)	ROTOR THICKNESS	ROTOR SET	FREE RUNNING ROTOR SET	DRIVE LINK	DRIVE LINK "L DIM"
0140-	8.6	021390	021273	021273	021379	.6286	ME097003	ME097005	ME093000	4.4385
0170-	10.3	021376	021387	021387	021392	.7518	ME107003	ME107007	ME103000	4.5650
0195-	12.0	021352	021379	021379	021291	.8768	ME127003	ME127005	ME123000	4.6905
0240-	14.5	021272	021291	021291	021412	1.0643	ME157003	ME157005	ME153000	4.8795
0280-	17.1	021340	021392	021392	021385	1.2518	ME187003	ME187005	ME183000	5.0685
0335-	20.6	021273	021385	021385	021366	1.5018	ME217003	ME217005	ME213000	5.3195
0405-	24.7	021379	021366	021415	021374	1.7923	ME247003	ME247005	ME243000	5.6045
0475-	29.1	021392	021394	021394	021393	2.1268	ME297003	ME297005	ME293000	5.9475
0530-	32.3	021385	021393	021393	021395	2.3768	ME337003	ME337005	ME333000	6.1985
0625-	38.0	021366	021329	021329	021458	2.7536	ME377003	N/A	ME373000	6.5745
0785-	48.0	021395	021388	021388	021416	3.5036	ME487003	N/A	ME483000	7.3285
0960-	58.5	021396	021389	021389	021399	4.2536	ME587003	N/A	ME583000	8.0815

HOUSING GROUP		Mounting Code Porting Code	EXPLODED VIEW ITEM #				[1]18
			DESCRIPTION MOUNTING	PORTING			SERVICE HOUSING ASS'Y
	FRONT PORTING	MS-	SAE A (4 Bolt)	7/8" O-Ring			MJ012002A1
		US-	Wheel Mt. (4 Bolt)	7/8" O-Ring			MJ012001A1

HOUSING GROUP		Mounting Code Porting Code	EXPLODED VIEW ITEM #		1, 1A, 1B, 1C	2	[1]18
			DESCRIPTION MOUNTING	PORTING	BOLT	END COVER	SERVICE HOUSING ASS'Y
	REAR PORTING	MA-	Standard Mount (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	MJ012004A1
		UA-	Wheel Mt. (4 Bolt)	Rear Port (7/8" O-Ring; Axial)	Item #1B	ME016009	MJ012003A1
		MB-	Standard Mount (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	MJ012004A1
		UB-	Wheel Mt. (4 Bolt)	Rear Port (7/8" O-Ring; Radial)	Item #1B	ME016002	MJ012003A1
		ME-	Standard Mount (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	MJ012004A1
		UE-	Wheel Mt. (4 Bolt)	Rear Port (Manifold; Radial)	Item #1B	ME016001J1	MJ012003A1

COUPLING SHAFT GROUP	EXPLODED VIEW ITEM #	12	12A	12B	12C	12D	12E	12F
	DESCRIPTION	COUPLING SHAFT	KEY	NUT	WASHER	7/8-14 BOLT	LOCK WASHER	RETAINING RING
31-	1-1/2" Tapered Shaft	MJ019000	039046	025131				
32-	1-1/2" Straight Key	MJ019001	039040		028492	G426477	G103327	401464
36-	17 Tooth Spline	MJ019002						

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OPTION GROUP	EXPLODED VIEW ITEM #	[2]1, 1A, 1B, 1C	2	3	4	16	[6]21 & 22	[4,6]22	[6]23	[6]24
	DESCRIPTION	BOLT (7)	END COVER	COMMUTATOR SEAL	SEAL RING (5)	INNER SEAL	PLUG & O-RING ASSEMBLY	O-RING	SPRING (2)	VALVE
AAAA	Black Paint	Item #1	ME016000	032435	032819	032836				
AAAC	Corrosion Resistant Paint	Item #1	ME016000	032435	032819	032836				
AAAF	Castle Nut Replacing Patch Lock Nut	Item #1	ME016000	032435	032819	032836				
AAAG	Viton Seals Black Paint	Item #1	ME016000	032435	032820	032836				
AAAH	Viton Seals No Paint	Item #1	ME016000	032435	032820	032836				
AAAT	Hot Oil Shuttle Endcover 11:00	Item #1A	[6]ME016003A1	032435	032819	032836	036297	032790	401642	415569
AAAU	Hot Oil Shuttle Endcover 11:00 & Castle Nut	Item #1A	[6]ME016003A1	032435	032819	032836	036297	032790	401642	415569
BBBA	1000 PSI Cross Port Relief Endcover	Item #1C	[6]ME016004A1	032435	032819	032836	411063A1	032424		41001210 (2), 1000PSI
BBBB	2000 PSI Cross Port Relief Endcover	Item #1C	[6]ME016004A2	032435	032819	032836	411063A1	032424		41001220 (2), 2000PSI
BBBC	3000 PSI Cross Port Relief Endcover	Item #1C	[6]ME016004A3	032435	032819	032836	411063A1	032424		41001230 (2), 3000PSI
BBBD	4000 PSI Cross Port Relief Endcover	Item #1C	[6]ME016004A4	032435	032819	032836	411063A1	032424		41001240 (2), 4000PSI
BBBG	1500 PSI Cross Port Relief Endcover	Item #1C	ME016004A5	032435	032819	032836	411063A1	032424		41000976 (2), 1500PSI
BBCG	2500 PSI Cross Port Relief Endcover	Item #1C	ME016004A6	032435	032819	032836	411063A1	032424		41001225 (2), 2500PSI

For reverse timed manifold, use MF015001.

[1] Service housing ass'y ITEM #18 with part number suffix-A1 includes ITEM #13, #14 two req'd, #15 and #19.

[2] Select the required bolt number in designated "DISPLACEMENT GROUP" under bolt ITEM #1, 1A, 1B or 1C shown in designated "OPTION GROUP."

[3] 1-20 UNEF slotted nut #025133 is required if the designated "OPTION GROUP" is AAAF, AAAN, or AAAU.

[4] ITEM #22 is part of plug & o-ring assy's but can be serviced separately.

[5] Service and cover ME016001J1 includes two #032790 o-rings, ITEM 18A on the exploded ass'y view that can also be serviced separately.

[6] End cover assembly item #2 also includes item #21, #22, #24 and if required item #23. All but item #21 can be serviced separately.

[7] ME018001A1 commutator ass'y. is required if the designated "OPTION GROUP" is AAAM, AAAN, or AAAP.

Standard seal kit #3224 includes six #032819 seal rings, #032435 commutator seal, #032836 inner seal, #028537 and #028538 back washers, #478063 dirt & water, #406018 grease pack, bulletin #687.

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Preparation Before Disassembly

- Before you disassemble the Torqlink™ unit or any of its components read this entire manual. It provides important information on parts and procedures you will need to know to service the Torqlink™.

- Determine whether the Torqlink™ you are about to disassemble is the Small Frame Series TB, TE or TJ or the Large Frame Series TF, TG, or TH so you can follow those procedures that pertain to that Series Torqlink™. The first two letters of the "spec" number on the Torqlink™ identification tag is the Series designation. Also determine the type of end construction from the alternate views shown on the exploded view.

- The Small Frame Series TB & TE Torqlinks™ will have a 3.66 inch (92.9 mm) main body outside diameter and five or six 5/16-24 UNF 2A cover bolts. The Medium Frame Series TJ Torqlinks™ will have a 3.66 inch (92.9 mm) main body outside diameter and six 5/16-24 UNF 2A cover bolts. The Large Frame Series TF, TG, & TH Torqlinks™ will have a 5 inch (127.9 mm) main body outside diameter and seven 3/8 24 UNF 2A cover bolts.

- Refer to "Tools and Materials Required for Services" section for tools and other items required to service the Torqlink™ and have them available.

- Thoroughly clean off all outside dirt, especially from around fittings and hose connections, before disconnecting and removing the Torqlink™. Remove rust or corrosion from coupling shaft.

- Remove coupling shaft connections and hose fittings and immediately plug port holes and fluid lines.

- Remove the Torqlink™ from system, drain it of fluid and take it to a clean work surface.

- Clean and dry the Torqlink™ before you start to disassemble the unit.

- As you disassemble the Torqlink™ clean all parts, except seals, in clean petroleum-based solvent, and blow them dry.

WARNING: petroleum-base solvents are flammable. Be extremely careful when using any solvent. Even a small explosion or fire could cause injury or death.

WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

CAUTION: Never steam or high pressure wash hydraulic components. Do not force or abuse closely fitted parts.

- Keep parts separate to avoid nicks and burrs.

- Discard all seals and seal rings as they are removed from the Torqlink™. Replace all seals, seal rings and any damaged or worn parts with genuine Parker or OEM approved service parts.

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Reference Exploded Assembly View

Place Torqlink in a vise

1. Place the Torqlink™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

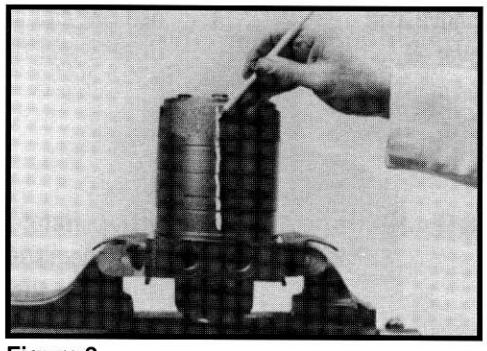


Figure 3

WARNING

WARNING: IF THE TORQLINK™ IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DISLODGED DURING THE SERVICE PROCEDURES, CAUSING INJURY.

Scribe alignment mark & loose valve plugs

2. Scribe an alignment mark down and across the Torqlink™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 inch Allen wrench or 1 inch hex socket required. SEE FIGURES 3 & 4.

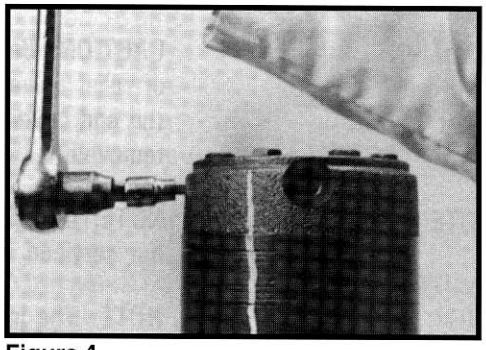


Figure 4

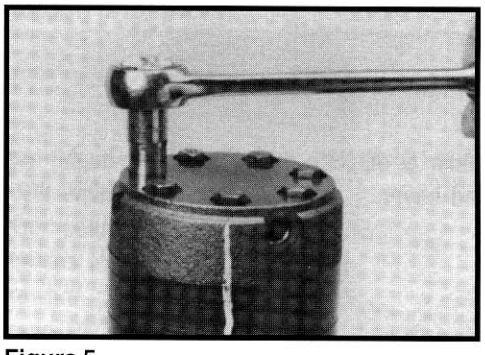


Figure 5

Remove special bolts & inspect bolts

3. Remove the five, six, or seven special ring head bolts (1, 1A, 1B, or 1C) using an appropriate 1/2 or 9/16 inch size socket. SEE FIGURE 5. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts. SEE FIGURE 6.

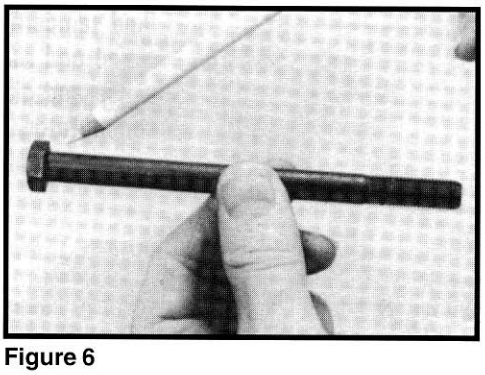


Figure 6

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Remove end cover & inspect bolts

4. Remove end cover assembly (2) and seal ring (4). Discard seal ring. SEE FIGURE 7.

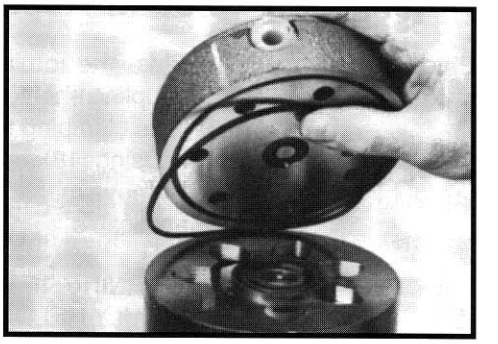


Figure 7

NOTE

NOTE: Refer to the appropriate "alternate cover construction" on the exploded view to determine the end cover construction being serviced.

Remove plugs and valves

5. If the end cover (2) is equipped with shuttle valve or relief valve (24) components, remove the two previously loosened plugs (21) and o-rings (22). SEE FIGURE 8.

CAUTION

CAUTION: Be ready to catch the shuttle valve or relief valve components that will fall out of the end cover valve cavity when the plugs are removed.

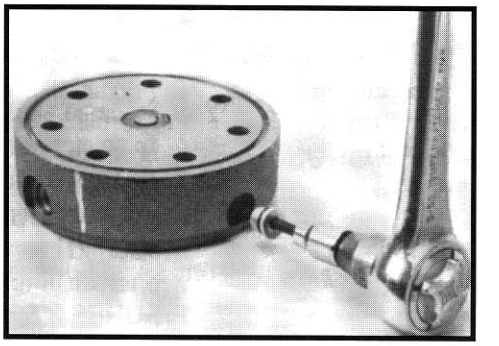


Figure 8

NOTE

NOTE: O-ring (22) is not included in seal kits but serviced separately if required.

NOTE

NOTE: The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.

Wash & inspect end cover

6. Thoroughly wash end cover (2) in proper solvent and blow dry. Be sure the end cover valve apertures, including the internal orifice plug, are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary. SEE FIGURE 9.

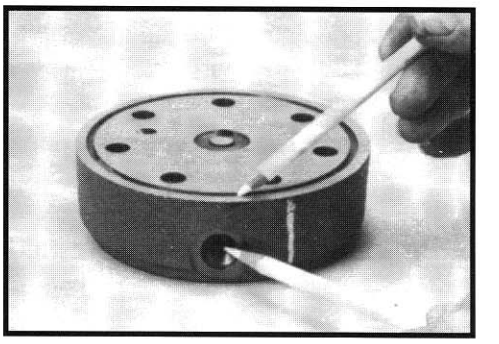


Figure 9

NOTE

NOTE: A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.

Remove & inspect commutator ring

7. Remove commutator ring (6). SEE FIGURE 10. Inspect commutator ring for cracks, or burrs.

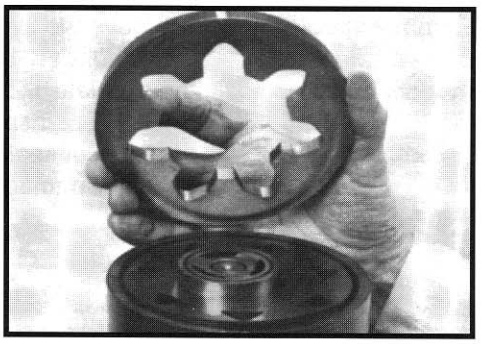


Figure 10

Parker Hydraulics
Parker Hannifin Corporation
Hydraulic Pump/Motor Division
Greeneville, TN 37745 USA

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Remove & inspect commutator

8. Remove commutator (5) and seal ring (3) Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator and commutator ring as a matched set. SEE FIGURE 11 & 12.

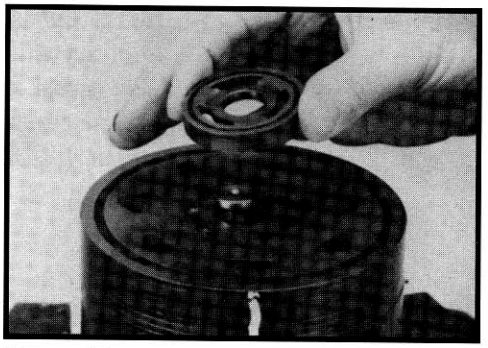


Figure 11

Remove manifold

9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. SEE FIGURE 13. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.

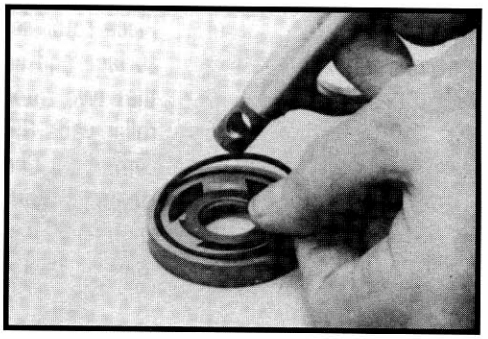


Figure 12

NOTE

NOTE: The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of the manifold to ensure that same surface is reassembled against the rotor set.

Remove & inspect rotor set & wearplate

10. Remove rotor set (8) and wearplate (9), together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. SEE FIGURE 14. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wearplate. You may have to shift the rotor set on the wearplate to work the drive link out of the rotor (8A) and wearplate. SEE FIGURE 15. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the wearplate for cracks, brinelling, or scoring. Discard seal ring (4) that is between the rotor set and wearplate.

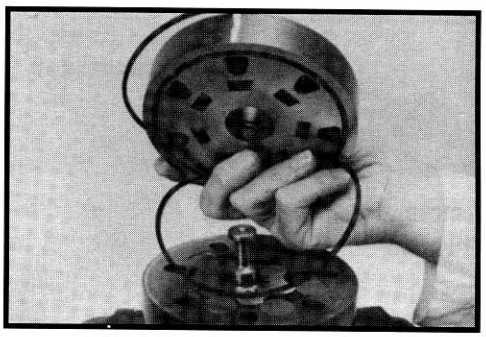


Figure 13

NOTE

NOTE: The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqlink™ will ensure correct reassembly of rotor into stator and rotor set into Torqlink™. Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set and Torqlink™.

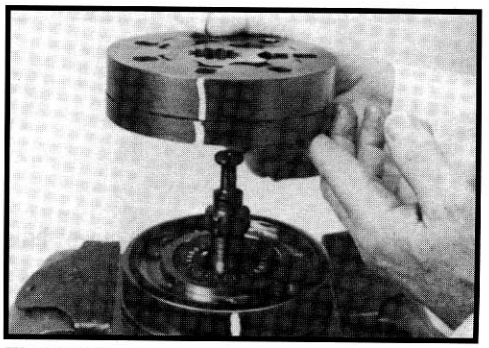


Figure 14

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NOTE

NOTE: Series TG Torqlinks™ may have a rotor set with two stator halves (8B & 8D) with a seal ring (4) between them and two sets of seven vanes (8C & 8E). Discard seal ring only if stator halves become disassembled during the service procedures.

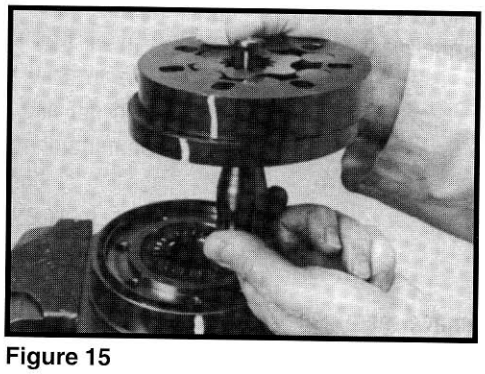


Figure 15

NOTE

NOTE: A polished pattern on the wear plate from rotor rotation is normal.

Check rotor, vance clearance

11. Place rotor set (8) and wear plate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180 degrees apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is more than .005 inches (0.13 mm) of clearance, replace rotor set. SEE FIGURE 16.

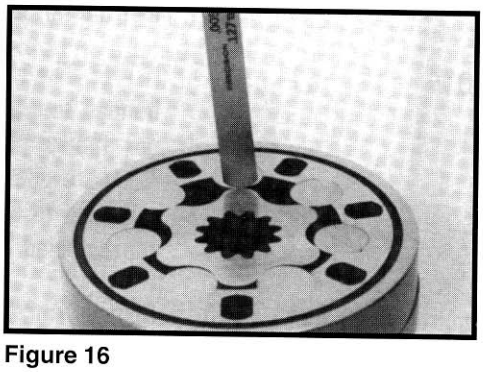


Figure 16

NOTE

NOTE: If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.

Remove & inspect drive link

12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. SEE FIGURE 17. Remove and discard seal ring (4) from housing (18).

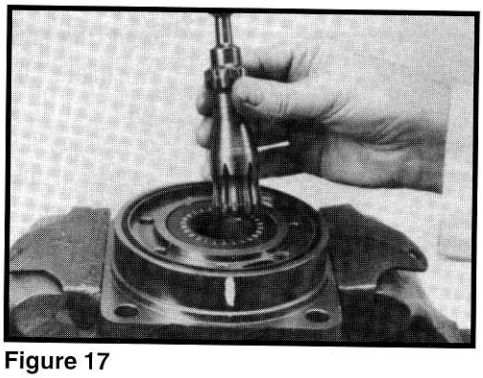


Figure 17

Remove thrust bearing

13. Remove thrust bearing (11) from top of coupling shaft (12) if Torqlink is a Series TF, TG, or TH. Inspect for wear, brinelling, corrosion and a full complement of retained rollers. SEE FIGURE 18.



Figure 18

https://truckmanualshub.com/

Check coupling shaft for rust or corrosion

14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used. SEE FIGURE 19. Remove any key (12A), nut (12B), washer (12C), bolt (12D), lock washer (12E), or retaining ring (12F).

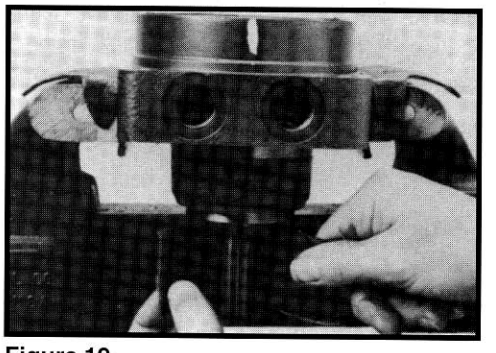


Figure 19

Remove & inspect coupling shaft

15. Remove coupling shaft (12), by pushing on the output end of shaft. SEE FIGURE 20. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. SEE FIGURE 21. Replace coupling shaft if any of these conditions exist.

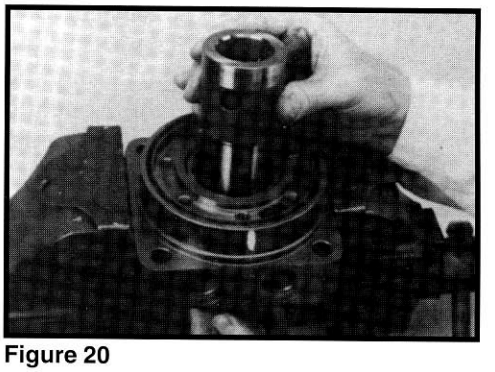


Figure 20

NOTE

NOTE: Minor shaft wear in seal area is permissible. If wear exceeds .020 inches (0.51 mm) diametrically, replace coupling shaft.

NOTE

NOTE: A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.

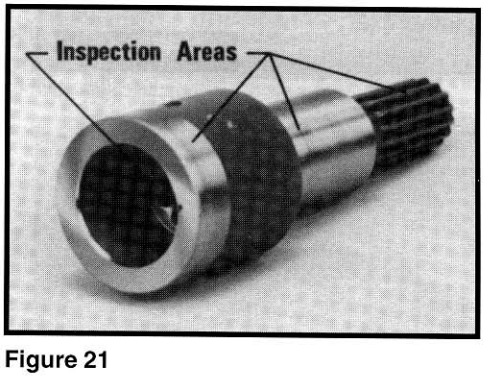


Figure 21

Remove seal ring from housing

16. Remove and discard seal ring (4) from housing (18).

Remove & inspect thrust washer & thrust bearing

17. Remove thrust bearing (15) and thrust washer (14) if the unit is a Series TB or TE. Inspect for wear, brinelling, corrosion and a full complement of retained rollers. SEE FIGURE 22.

NOTE

NOTE: Large Frame Series TF, TG & TJ Torqlinks have a thrust bearing (15) sandwiched between two thrust washers (14) that cannot be removed from housing (18) unless bearing (13) is removed for replacement.

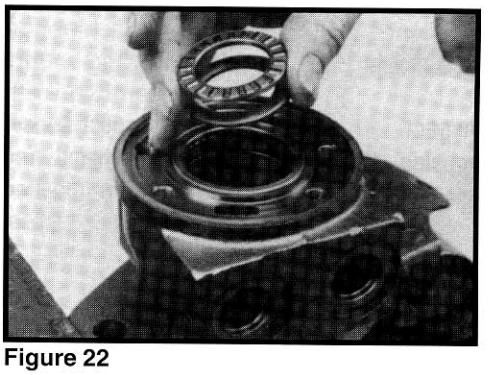


Figure 22

https://truckmanualshub.com/

Remove seal & washer or washers

18. Remove seal (16) and back up washer (17) from Small Frame, TB & TE housing (18). Discard both. SEE FIGURE 23.

    Remove seal (16), backup washer (17), and backup washer (25) from Large Frame, Series TF, TG & TJ Torqlink™ housing by working them around unseated thrust washers (14) and thrust bearing (15) and out of the housing. Discard seal and washers. SEE FIGURE 24.



Figure 23

NOTE

NOTE: The original design units of Large Frame, Series TF & TG Torqlinks™ did not include backup washer (25), but must include backup washer (25) when reassembled for service.

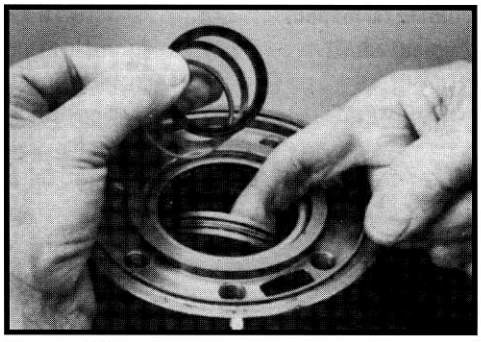


Figure 24

Remove seal

19. Remove housing (18) from vise, invert it and remove and discard seal (20). A blind hole bearing or seal puller is required. SEE FIGURE 25.

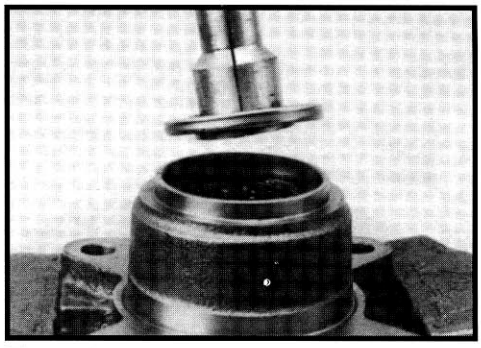


Figure 25

Inspect housing assembly

20. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. SEE FIGURE 26. If the housing is defective in these areas, discard the housing assembly.

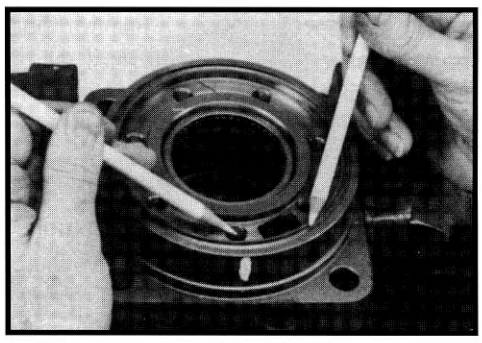


Figure 26

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Parker Hannifin Corporation
Hydraulic Pump/Motor Division
Greeneville, TN 37745 USA

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Inspect housing bearing/bushing

21. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion. SEE FIGURE 27. The TB Series bushing (19) or (13) to coupling shaft diameter clearance must not exceed .010 inch (.025 mm). A bearing, bushing, or thrust washer that does not pass inspection must be replaced. SEE FIGURE 28. If the housing has passed this inspection the disassembly of the Torqlink™ is completed.

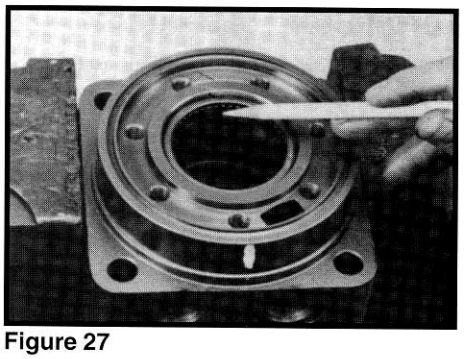


Figure 27

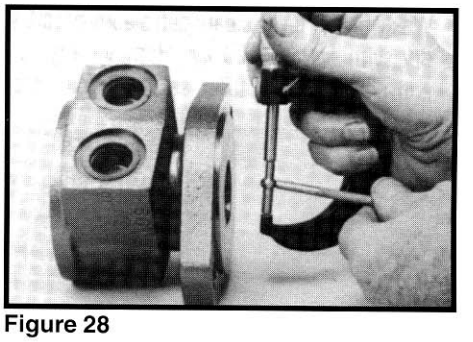


Figure 28

NOTE

NOTE: The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counter bore should be measured and noted before removing the bearings/bushings. This will facilitate the correct reassembly of new bearings/bushings. SEE FIGURE 29.

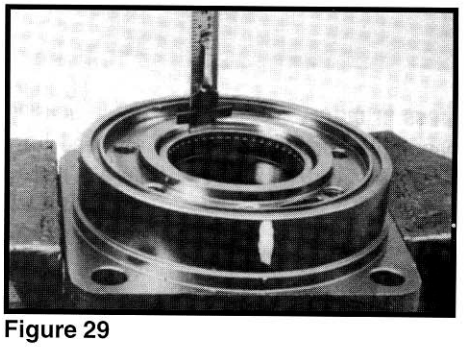


Figure 29

Remove bearings or bushings & thrust washers

22. If the bearings, bushing or thrust washers must be replaced use a suitable size bearing puller to remove bearing/bushings (19) and (13) from housing (18) without damaging the housing. Remove thrust washers (14) and thrust bearing (15) if they were previously retained in the housing by bearing (13). SEE FIGURES 30 & 31.

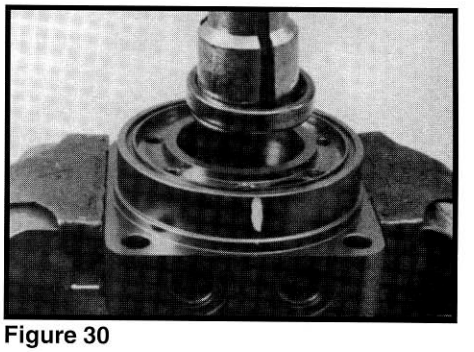


Figure 30

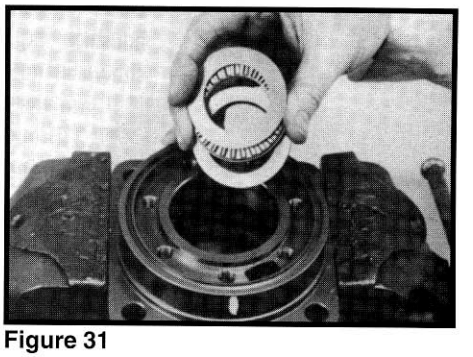


Figure 31

THE DISASSEMBLY OF TORQLINK™ IS COMPLETED.

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- Replace all seals and seal rings with new ones each time you reassemble the Torqlink™ unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly.
- **NOTE: Individual seals and seal rings as well as a complete seal kit are available. SEE FIGURE 32. The parts should be available through most OEM parts distributors or Parker approved Torqlink™ distributors. (Contact your local dealer for availability).**
- **NOTE: Unless otherwise indicated, do not oil or grease parts before assembly.**
- Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing areas.

WARNING

WARNING: SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

WARNING

WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

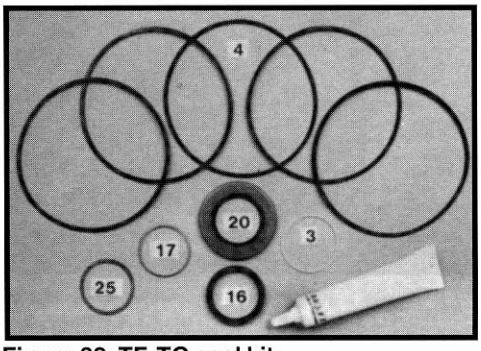
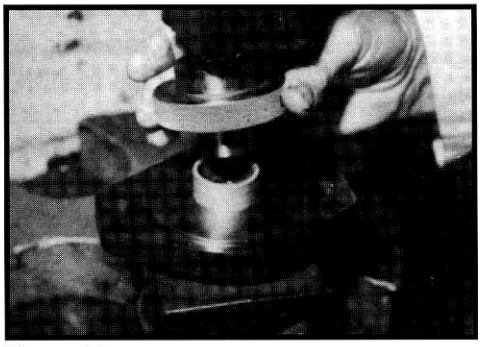


Figure 32, TF, TG seal kit

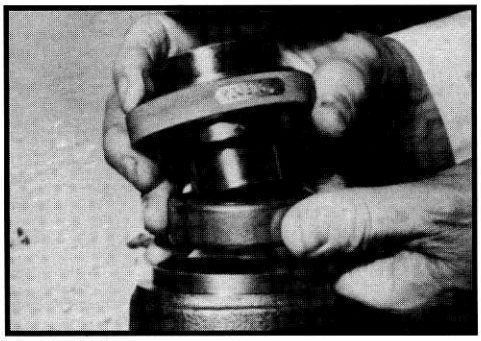
Press in outer bearing/bushing

1. If the housing (18) bearing components were removed for replacement, thoroughly coat and pack a **new** outer bearing/bushing (19) with clean corrosion resistant grease recommended in the material section. Press the new bearing/ bushing into the counterbore at the mounting flange end of the housing, using the appropriate sized bearing mandrel such as described in figure 1 or figure 2 which will control the bearing/ bushing depth.

   Small Frame Series TB and TE Torqlink™ housings require the use of bearing mandrel shown in figure 1 to press bearing/ bushing (19) into the housing to a required depth of .151/.161 inches (3.84/4.09 mm) from the end of the bearing counterbore. SEE FIGURE 33.


Figure 33

   Large Frame Series TF, TG & TJ Torqlink™ housings require the use of the bearing mandrel shown in figure 2 to press bearing (19) into the housing to a required depth of .290/ .310 inches (7.37/7,87 mm) from the outside end of the bearing counterbore. SEE FIGURE 34.


Figure 34

   Large Frame Series TH Torqlink housings require the use of a bearing mandrel. Consult factory for specifications.

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NOTE

NOTE: Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/ bushing is not cocked when pressing a bearing/bushing into the housing.

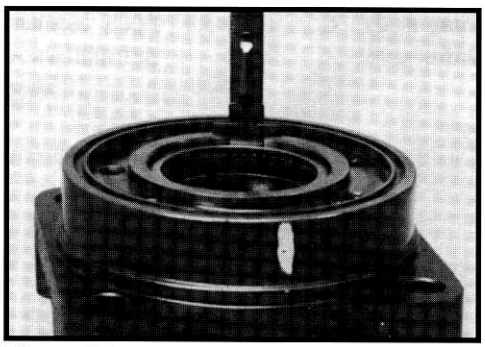


Figure 35

CAUTION

CAUTION: If the bearing mandrel specified in the "Tools and Materials Required for Servicing" section is not available and alternate methods are used to press in bearing/bushing (13) and (19) the bearing/ bushing depths specified must be achieved to insure adequate bearing support and correct relationship to adjacent components when assembled. SEE FIGURE 35.

CAUTION

CAUTION: Because the bearing/bushings (13) and (19) have a press fit into the housing they must be discarded when removed. They must not be reused.

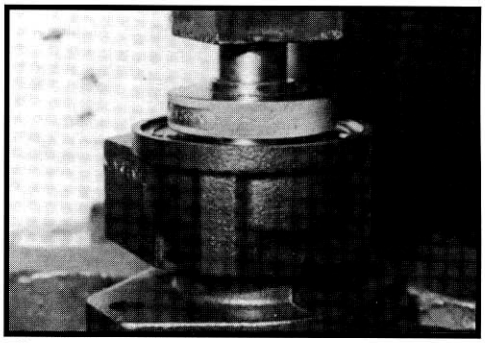


Figure 36

Press in inner bearing/bushing

2. The Small Frame Series TB and TE Torqlink™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to .03 inch (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing (19). Reference figure 1, "Tools and Materials Required for Servicing" section. SEE FIGURE 36.

   The Large Frame Series TF, TG & TJ Torqlink™ housing (18) requires that you assemble a **new** backup washer (25), **new** seal (16), with the lip facing to the inside of Torqlink (see figure 69A), **new** thrust washer (14), **new** thrust bearing (15) and a **new** second thrust washer (14) in that order before pressing in the inner housing bearing (13). SEE FIGURE 37 & 38. When these components are in place, press **new** bearing (13) into the housing (18) to a depth of .105/.125 inches (2.67/3.18), .03 inches max for TJ (.76) below the housing wear plate contact face. Use the opposite end of the bearing mandrel used to press in outer bearing (19). Reference figure 2, in the "Tools and Materials Required for Servicing" section. SEE FIGURE 39.

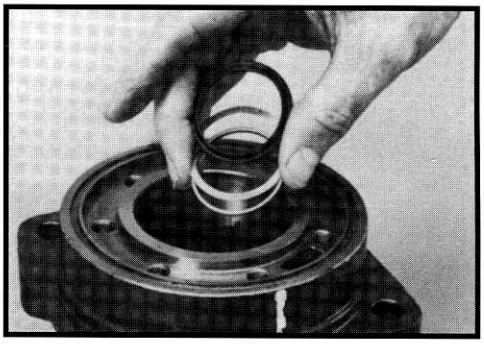


Figure 37

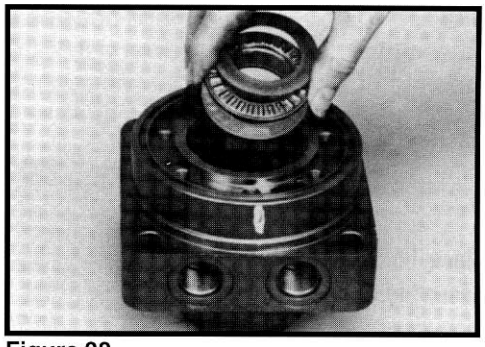


Figure 38

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Press in dirt & water seal

3. Press a **new** dirt and water seal (20) into the housing (18) outer bearing counterbore.

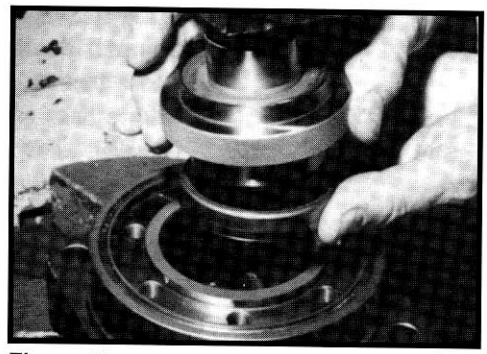


Figure 39

The Small Frame Series TB and TE Torqlink™ dirt and water seal (20) must be pressed in until its' flange is flush against the housing. SEE FIGURE 40.

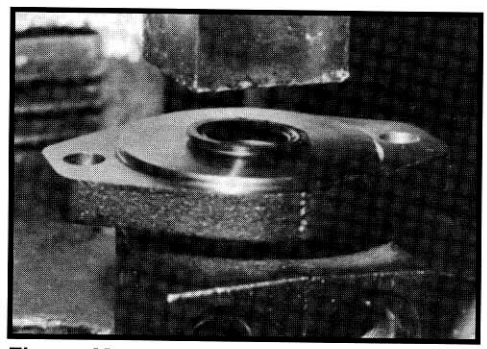


Figure 40

The Large Frame Series TF, TG & TJ Torqlink™ dirt and water seal (20) must be pressed in with the lip facing out and until the seal is flush to .020 inches (.51 mm) below the end of housing. SEE FIGURE 41.

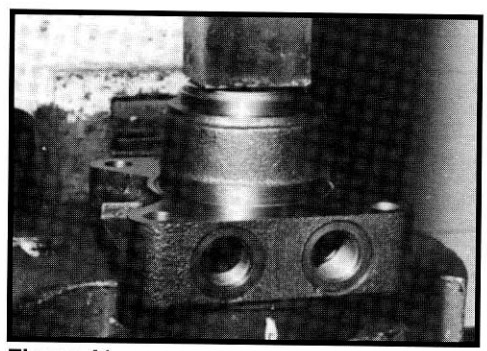


Figure 41

Place housing assembly into vice

4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange. SEE FIGURE 42.

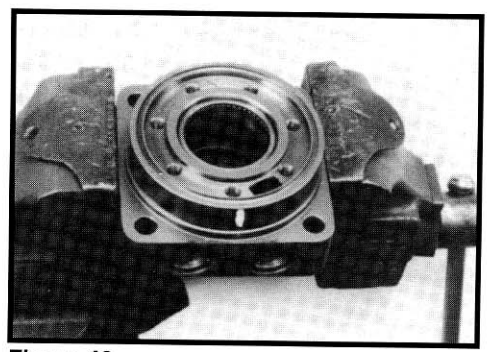


Figure 42

https://truckmanualshub.com/

Assemble backup washer & seal

5. On Small Frame, Series TB & TE Torqlinks™ assemble a **new** backup washer (17) and **new** seal (16) with the seal lip facing toward the inside of Torqlink™ (see Figure 69B), into their respective counterbores in housing (18) if they were not assembled in procedure 2.

   Large Frame, Series TF, TG & TJ Torqlink™ housing (18) that did not require replacement of the bearing package will require that the two "captured" thrust washers (14) and thrust bearing (15) be unseated and vertical to the counterbore and the **new** backup washer (17), **new** backup washer (25), and **new** seal (16) be worked around the thrust bearing package and placed into their respective counterbores. The seal lip must face out of the seal counterbore and toward the inside of Torqlink™ (see figure 69A). Be sure the thrust bearing package is reseated correctly after assembly of the seal and backup washer. SEE FIGURES 43 & 44.

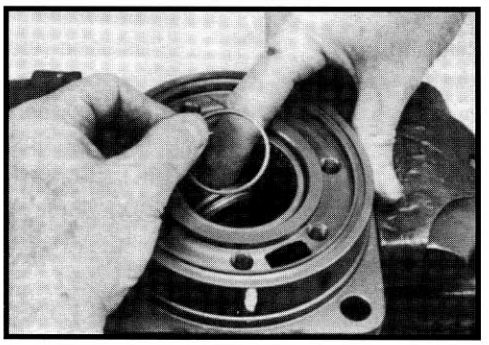


Figure 43

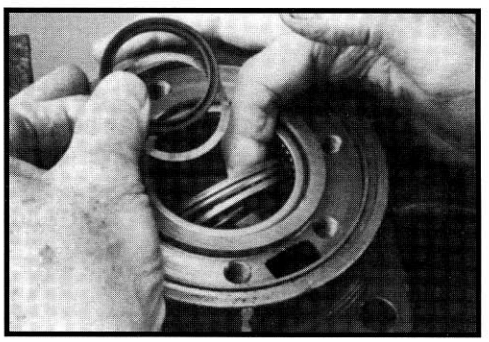


Figure 44

CAUTION

CAUTION: Original design Large Frame, TF & TG Torqlinks™ that do not have backup washer (25) when disassembled must be assembled with a new backup washer (17), new backup washer (25), and new seal (16).

Assemble thrust washer & bearing

6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Series TB or TE Torqlink™. SEE FIGURE 45.

NOTE

NOTE: Small Frame Series TB and TE Torqlinks™ require one thrust washer (14) with thrust bearing (15). The coupling shaft will be seated directly against the thrust bearing.

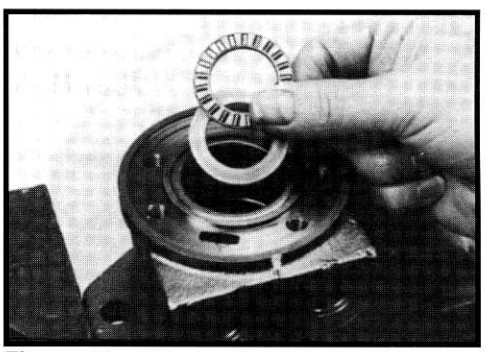


Figure 45

Apply masking tape to shaft

7. Apply masking tape around splines or keyway on shaft (12) to prevent damage to seal. SEE FIGURE 46.

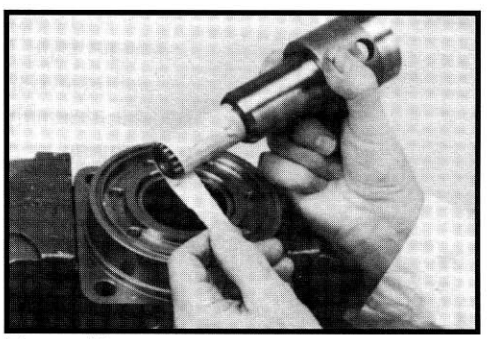


Figure 46

Parker Hydraulics

Parker Hannifin Corporation
Hydraulic Pump/Motor Division
Greeneville, TN 37745 USA

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Install coupling shaft

8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in TB and TE Series housings and against the second thrust washer (14) in TF and TG Series housings. SEE FIGURE 47.

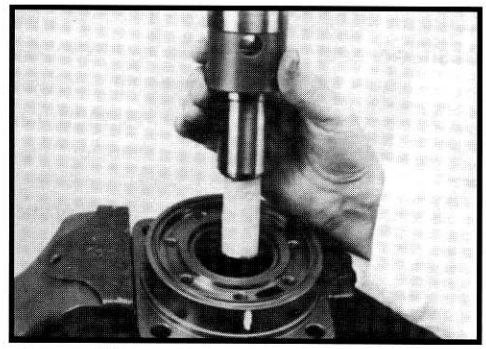


Figure 47

CAUTION

CAUTION: The outer bearing (19) is not lubricated by the system's hydraulic fluid. Be sure it is thoroughly packed with the recommended grease, Parker Gear grease specification #045236, E/M Lubricant #K-70M.

NOTE

NOTE: Mobil Mobilith SHC ® 460
NOTE: A 102 Tube (P/N 406010) is included in each seal kit.

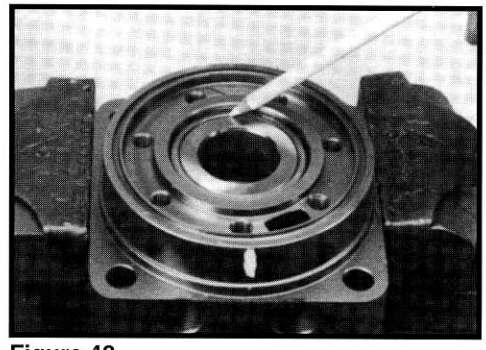


Figure 48

NOTE

NOTE: The coupling shaft (12) will be flush or just below the housing wear plate surface on Small Frame, Series TB, TE & TJ Torqlinks™ when properly seated while the coupling shaft (12) on Large Frame, Series TF, TG, or TH Torqlinks™ will be approximately .10 inch (2.54 mm) below the housing wear plate surface to allow the assembly of thrust bearing (11). The coupling shaft must rotate smoothly on the thrust bearing package. SEE FIGURE 48.

Install thrust bearing

9. Install thrust bearing (11) onto the end of coupling shaft (12) only if you are servicing an TF, TG, or TH Series Torqlink™. SEE FIGURE 49.



Figure 49

Insert seal ring

10. Apply a small amount of clean grease to a **new** seal ring (4) and insert it into the housing (18) seal ring groove. SEE FIGURE 50.

NOTE

NOTE: One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over .5 inch (12.7 mm) longer than the bolts (1, 1A, 1B, or 1C) used in the Torqlink™.

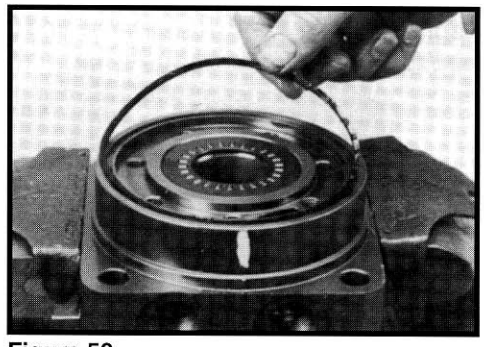


Figure 50

https://truckmanualshub.com/

Install drive link

11. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines. SEE FIGURE 51.

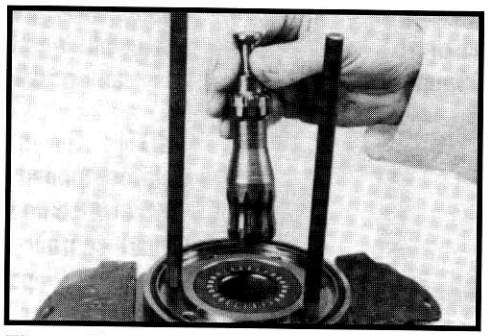


Figure 51

NOTE

NOTE: Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.

Assemble wear plate

12. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18). SEE FIGURE 52.

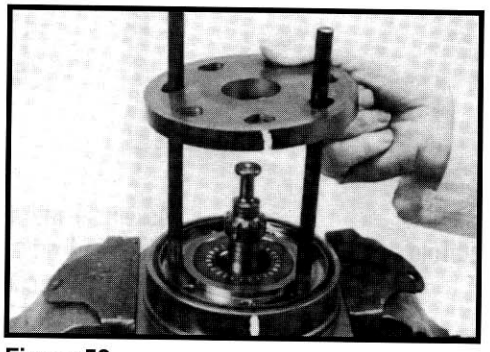


Figure 52

Assemble seal ring

13. Apply a small amount of clean grease to a new seal ring (4) and assemble it into the seal ring groove on the wear plate side of the rotor set stator (8B). SEE FIGURE 53.

Install the assembled rotor set

14. Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines. SEE FIGURE 54.

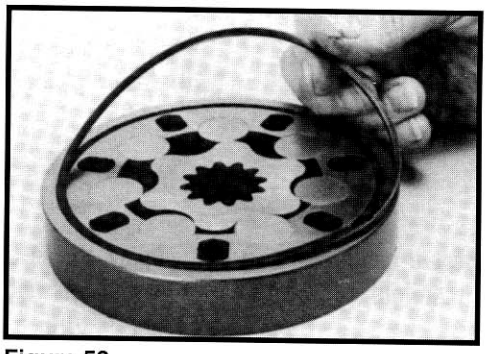


Figure 53

NOTE

NOTE: It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.

NOTE

NOTE: If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure."

NOTE

NOTE: The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down. The rotor set seal ring groove faces toward the wear plate (9).

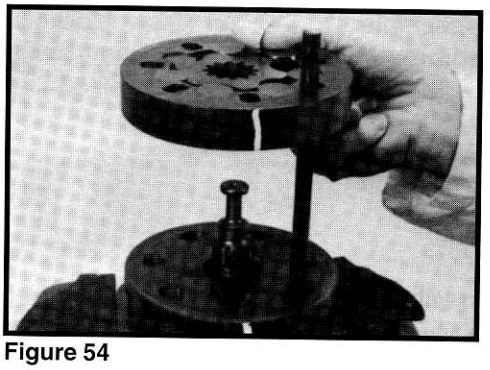


Figure 54

https://truckmanualshub.com/

Assemble seal ring in manifold

15. Apply clean grease to a **new** seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7). SEE FIGURE 55.

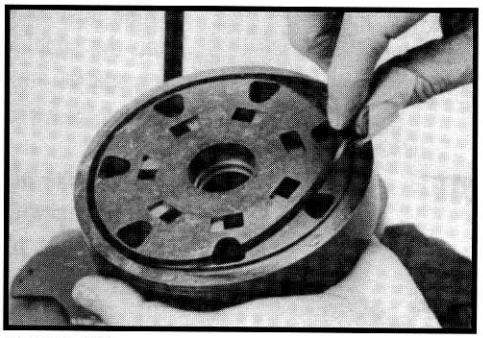


Figure 55

NOTE

NOTE: The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.

Assemble manifold

16. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set. SEE FIGURE 56.

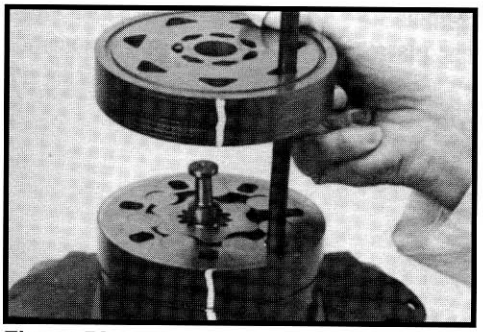


Figure 56

Insert a seal in manifold

17. Apply grease to a **new** seal ring (4) and insert it in the seal ring groove exposed on the manifold. SEE FIGURE 57.

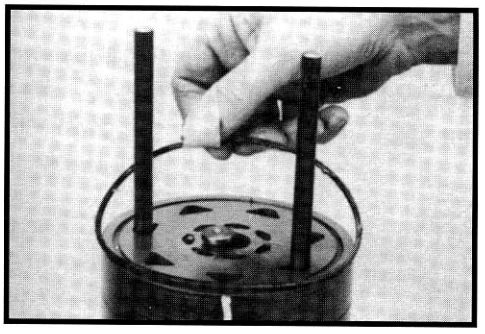


Figure 57

Assemble commutator ring

18. Assemble the commutator ring (6) over alignment studs onto the manifold. SEE FIGURE 58.

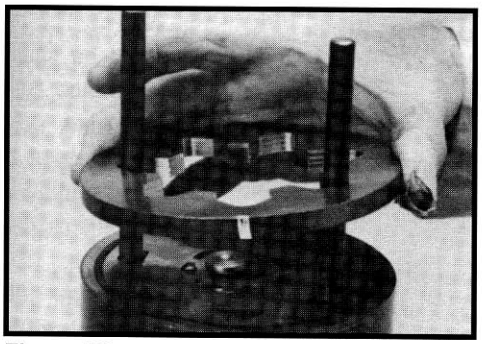


Figure 58

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Assemble seal & commutator

19. Assemble a **new** seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up. SEE FIGURE 59, 60.

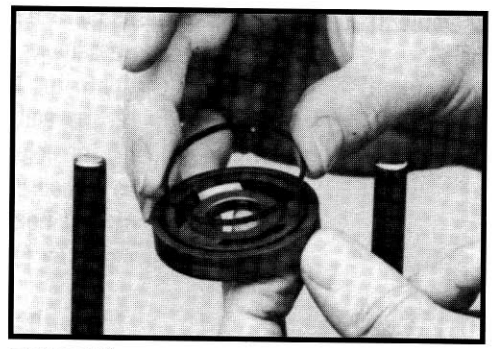


Figure 59

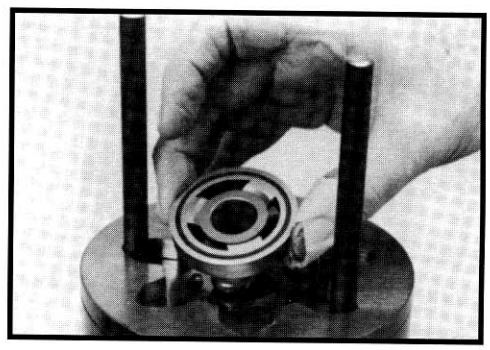


Figure 60

Assemble shuttle valve parts into end cover

20. If shuttle valve components items #21, #22, #23, #24 were removed from the end cover (2) turn a plug (21) with a **new** o-ring (22), loosely into one end of the valve cavity in the end cover. Insert a spring (23) the valve (24) and the second spring (23) into the other end of the valve cavity. Turn the second plug (21) with a **new** o-ring (22) loosely into the end cover valve cavity. 3/16 inch Allen wrench required. SEE FIGURE 61.

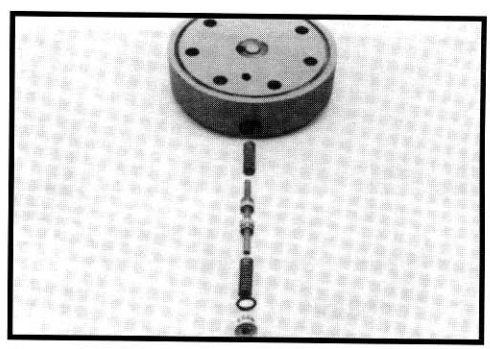


Figure 61

Assemble relief valve parts in end cover

21. If relief valve components items #21, #22, #24 were removed from the end cover (2) assemble a **new** o-ring (22) on the two plugs (21). Assemble a two piece relief valve (24) in each of the plugs, with the large end of the conical spring into the plug first and the small nut of the other valve piece in the small end of the conical spring. Turn each of the plug and relief valve assemblies into the end cover loosely to be torqued later. 3/8 inch Allen or 1 inch Hex socket required. SEE FIGURE 62.

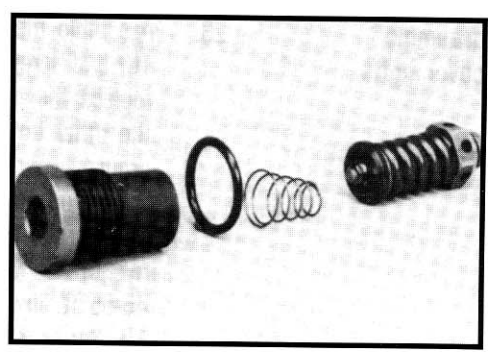


Figure 62

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Assemble seal ring & end cover

22. Assemble a **new** seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. SEE FIGURE 63, 64. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18). The correct 5 bolt end cover bolt hole relationship to housing port bosses is shown in FIGURE 65.

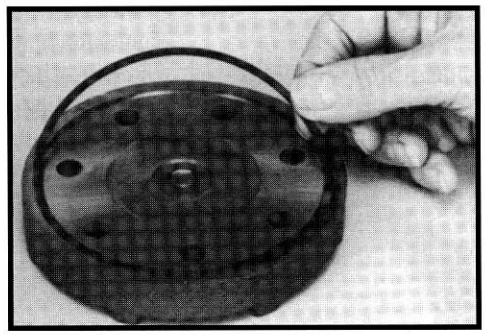


Figure 63

NOTE

NOTE: If the end cover has a valve (24) or has five bolt holes, use the line you previously scribed on the cover to radially align the end cover into its original position.

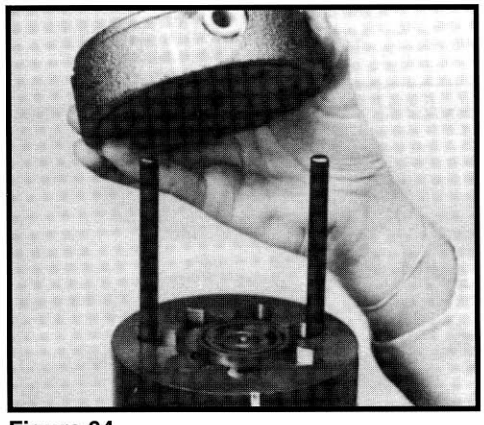


Figure 64

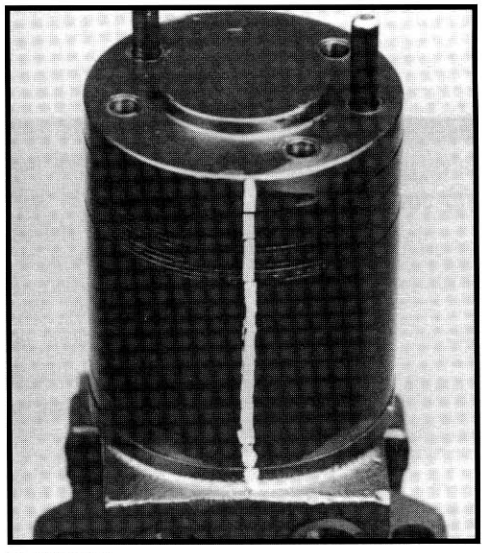


Figure 65

Assemble cover bolts

23. Assemble the 5 or 7 special bolts (1, 1A, 1B or 1C) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 22-26 ft. lbs. (30-35 N m) for the five TB or six TE Series 5/16 24 threaded bolts or six TJ bolts or 45-55 ft. lbs. (61-75 N m) for the seven TF & TG Series 3/8-24 threaded bolts. SEE FIGURE 66, 67, 68.

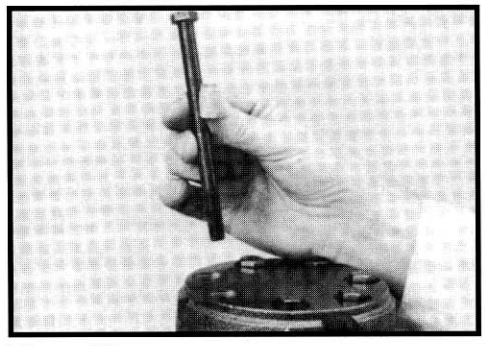


Figure 66

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NOTE

NOTE: The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.

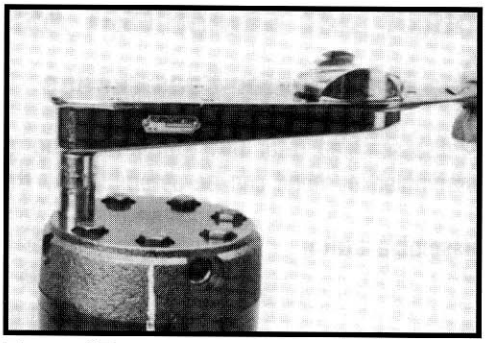


Figure 67

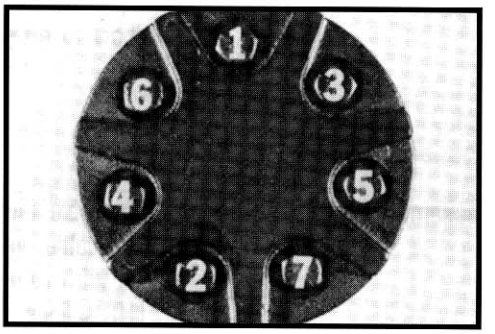


Figure 68

Torque the valve plugs

24. Torque the two shuttle valve plug assemblies (21) in end cover assembly to 9-12 ft. lbs. (12-16 N m) if cover is so equipped. SEE FIGURE 69.

    Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs. (61-75 N m) if cover is so equipped.

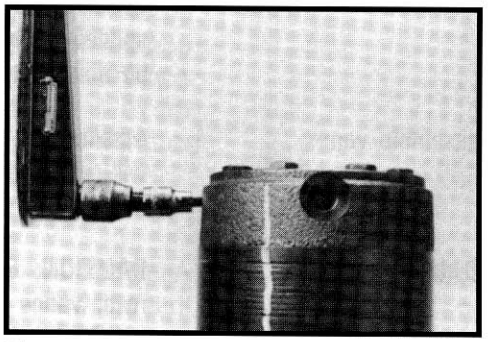


Figure 69

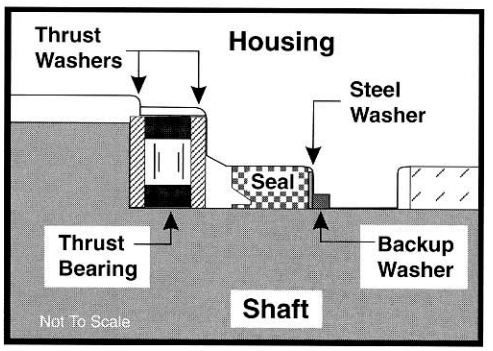


Figure 69A Large Frame

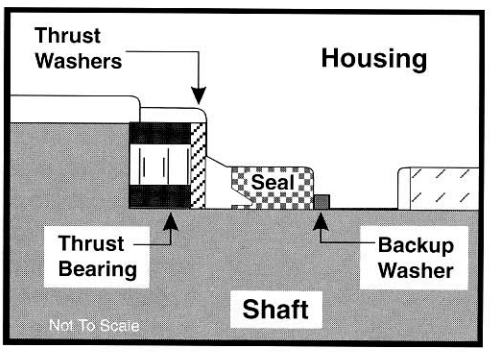


Figure 69B Small Frame

THE ASSEMBLY OF THE TORQLINK™ IS NOW COMPLETE EXCEPT FOR WOODRUFF KEY (12A), NUT (12B), WASHER (12C), BOLT (12D), LOCKWASHER (12E), RETAINER RING (12F) or PORT O-RINGS (18A) AT INSTALLATION IF APPLICABLE. PROCEED TO FINAL CHECKS SECTION.

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One Piece Stator Construction

A disassembled rotor (8A) stator (8B) and vanes (8C) that cannot be readily assembled by hand can be assembled by the following procedures.

Assemble stator

1. Place stator (8B) onto wear plate (9) with seal ring (4) side down, after following Torqlink™ assembly procedures 1 through 13. Be sure the seal ring is in place. SEE FIGURE 70.

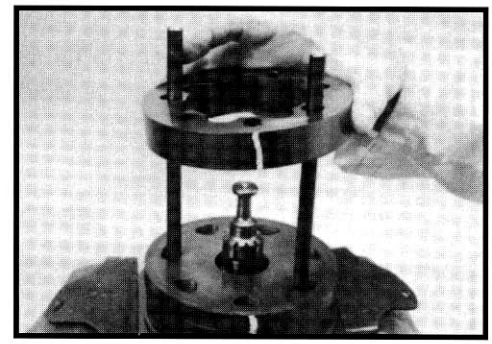


Figure 70

Insert two bolts

2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

Assemble rotor

3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines. SEE FIGURE 71.

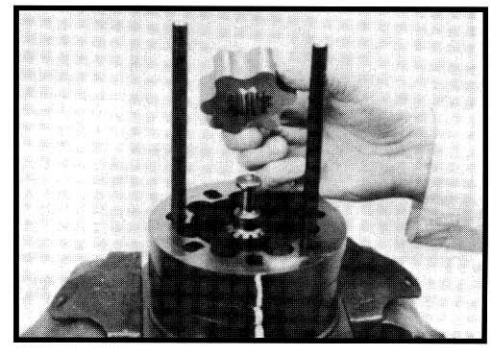


Figure 71

NOTE

NOTE: If the manifold side of the rotor was etched during Torqlink disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.

Assemble vanes

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets. SEE FIGURE 72.

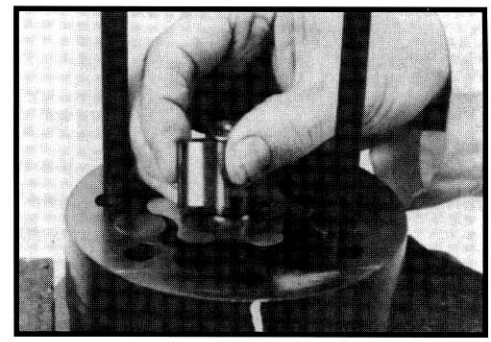


Figure 72

CAUTION

CAUTION: Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

Assemble full complement of vanes

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force. SEE FIGURE 73.

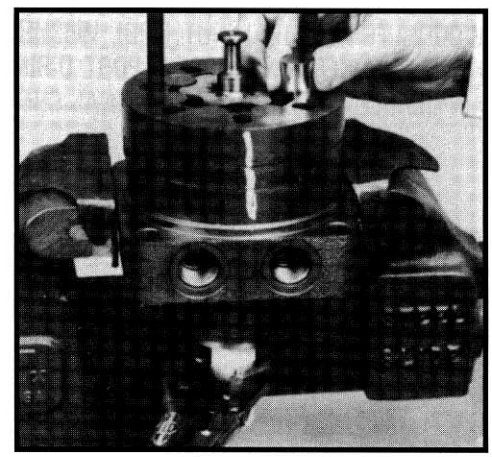


Figure 73

Remove two assembled bolts

6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

Go to Torqlink™ assembly procedure #15, to continue Torqlink™ assembly.

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Two Piece Stator Construction

A disassembled rotor set (8) that cannot be readily assembled by hand and has a two piece stator can be assembled by the following procedures.

Assemble stator halves

1. Place stator half (8B) onto wear plate (9) with seal ring (4) side down, after following Torqlink™ assembly procedures 1 through 13. Be sure the seal ring is in place.

Insert two alignment studs

2. Align stator bolt holes with wear plate and housing bolts and turn two alignment studs finger tight into bolt holes approximately 180 degrees apart to retain stator half and wear plate stationary.

Assemble rotor

3. Assemble rotor (8A), counterbore down if applicable, into stator half (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.

NOTE

NOTE: Use any marking you applied to rotor set components to reassemble the components in their original relationship to ensure ultimate wear life and performance.

Assemble vanes

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.

CAUTION

CAUTION: Excessive force used to push the rotor vanes into place could shear off the coating applied to the stator vane pockets.

Assemble full complement of vanes

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator half (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.

Assemble seal ring in stator half

6. Place second stator half (8D) on a flat surface with seal ring groove up. Apply a small amount of grease to a **new** seal ring (4) and assemble it into stator half ring groove.

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Assemble second stator half

7. Assemble the second stator half (8D) over the two alignment studs and rotor (8A) with seal ring side down onto the first stator half (8B) aligning any timing marks applied for this purpose.

CAUTION

CAUTION: If the stator half (8B) is a different height (thickness) than stator half (8D) the stator vanes (8C) or (8E) of the same length (height) as the stator half must be reassembled in their respective stator half for the rotor set to function properly.

Assemble vanes

8. Assemble six vanes (8E), or as many vanes that will readily assemble into the stator vane pockets.

Assemble full complement of vanes

9. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8E) into stator (8D), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.

   Go to Torqlink™ assembly procedure #15, to continue Torqlink™ assembly.

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Final Checks

- Pressurize the Torqlink™ with 100 p.s.i. dry air or nitrogen and submerge in solvent to check for external leaks.
- Check Torqlink™ for rotation. Torque required to rotate coupling shaft should not be more than 50 ft. lbs. (68 N m)
- On TB, TE & TJ Series Torqlinks, pressure port with "A" cast under it on housing (18) is for clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "B" cast under it is for counter clockwise coupling shaft rotation.
- On TF, TG, & TH Series Torqlinks, pressure port with "B" cast under it on housing (18) is for clockwise coupling shaft rotation as viewed from the output end of coupling shaft. Pressure port with "A" case under it is for counter clockwise coupling shaft rotation.
- Use test stand if available, to check operation of the Torqlink™.

Hydraulic Fluid

Keep the hydraulic system filled with one of the following:

- 10W40 SE or SF manufacturers suggested oil.
- Hydraulic fluid as recommended by equipment manufacturer, but the viscosity should not drop below 50 SSU or contain less than .125% zinc anti-wear additives.

  CAUTION: Do not mix oil types. Any mixture, or an unapproved oil, could deteriorate the seals. Maintain the proper fluid level in the reservoir. When changing fluid, completely drain old oil from the system. It is suggested also that you flush the system with clean oil.

Filtration

Recommended filtration 20-50 micron.

Oil Temperature

Maximum operating temperature 200°F (93.3° C).

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Tips for Maintaining the Torqlink™ Hydraulic System

- Adjust fluid level in reservoir as necessary.
- Encourage all operators to report any malfunction or accident that may have damaged the hydraulic system or component.
- Do not attempt to weld any broken Torqlink™ component. Replace the component with original equipment only.
- Do not cold straighten, hot straighten, or bend any Torqlink™ part.
- Prevent dirt or other foreign matter from entering the hydraulic system. Clean the area around and the filler caps before checking oil level.
- Investigate and correct any external leak in the hydraulic system, no matter how minor the leak.
- Comply with manufacturer's specifications for cleaning or replacing the filter.

CAUTION: Do not weld, braze, solder or any way alter any Torqlink™ component.

CAUTION: Maximum operating pressure must not exceed recommended Torqlink™ pressure capacity.

CAUTION: Always carefully inspect any system component that may have been struck or damaged during operation or in an accident. Replace any component that is damaged or that is questionable.

CAUTION: Do not force any coupling onto the Torqlink™ coupling shaft as this could damage the unit internally.

Parker extends close technical cooperation and assistance. If problems occur which you cannot solve, please contact your local Parker approved Distributor or Parker Technical Support. Our phone number and fax number and address are on the back cover of this manual.

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3. Delivery: Unless otherwise provided on the face hereof, delivery shall be made F.O.B. Seller's plant. Regardless of the method of delivery, however, risk of loss shall pass to Buyer upon Seller's delivery to a carrier. Any delivery dates shown are approximate only and Seller shall have no liability for any delays in delivery.

4. Warranty: Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 18 months from date of shipment from Parker Hannifin Corporation. **THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED. NOTWITHSTANDING THE FOREGOING, THERE ARE NO WARRANTIES WHATSOEVER ON ITEMS BUILT OR ACQUIRED WHOLLY OR PARTIALLY, TO BUYER'S DESIGNS OR SPECIFICATIONS.**

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7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

8. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property, Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

9. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. Patents, U.S. Trademarks, copyrights, trade dress and trade secrets (hereinafter 'Intellectual Property Rights'). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, replace or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights. If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter 'Events of Force Majeure'). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of action accrues.

9/91-P

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Greeneville, TN 37745 USA
Tel: (423) 639-8151
FAX: (423) 787-2418
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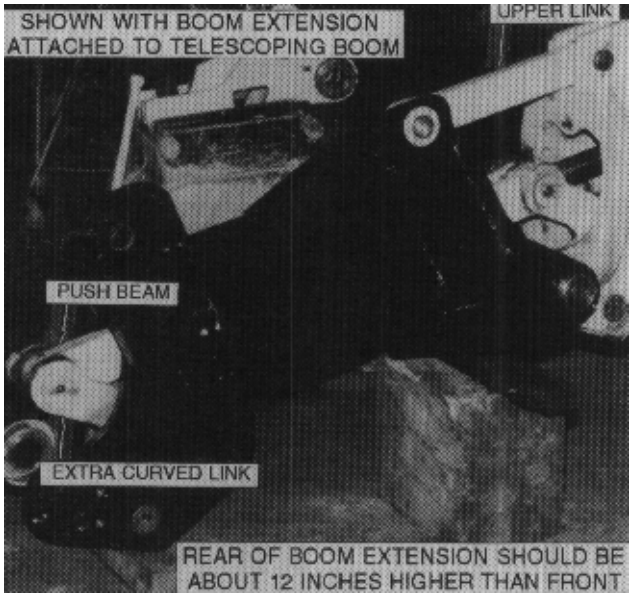
TB, TE, TJ, TF, TG, TH 1/2000

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BOOM EXTENSION INSTALLATION

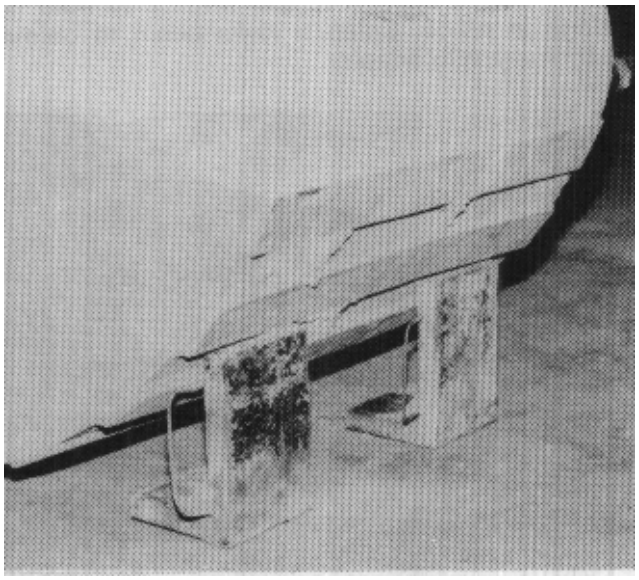
This procedure is to be performed only by experienced field maintenance personnel.

Installation:

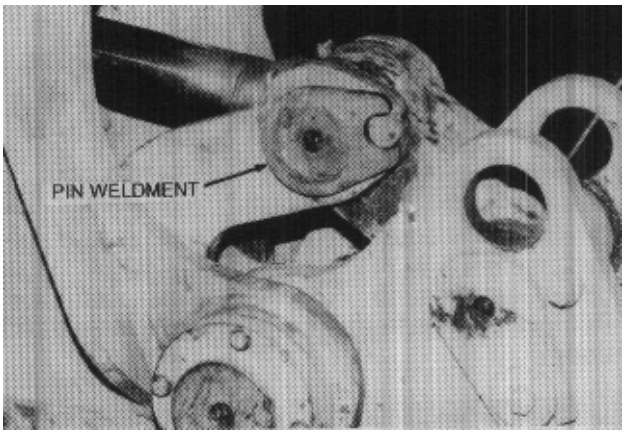


NOTE: It is assumed that excavator is equipped with appropriate bucket attached to telescoping boom and that boom extension is supported on blocks as shown above. It is also assumed that upper link, push beam and extra curved link have been loosely assembled to boom extension.

1. Position machine in a manner that will permit boom to be extended fully and parallel with blocked boom extension. Outer end of boom (not bucket) should be approximately even with rear of blocked boom extension.



2. Rest bucket lip flat on ground and block bucket as shown to prevent bucket from rolling.

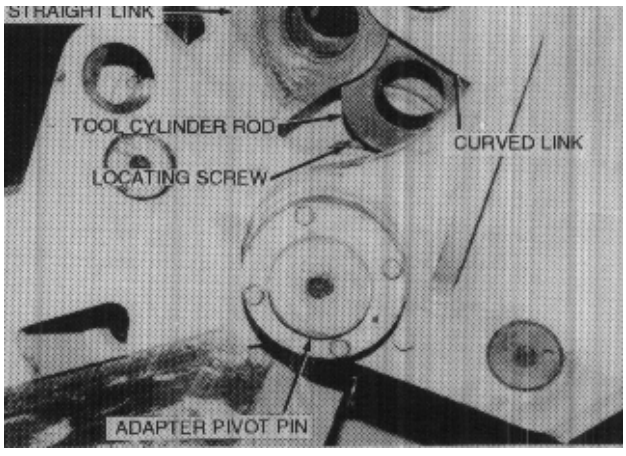


3. Remove pin weldment to disconnect tool cylinder rod, curved link and straight link.

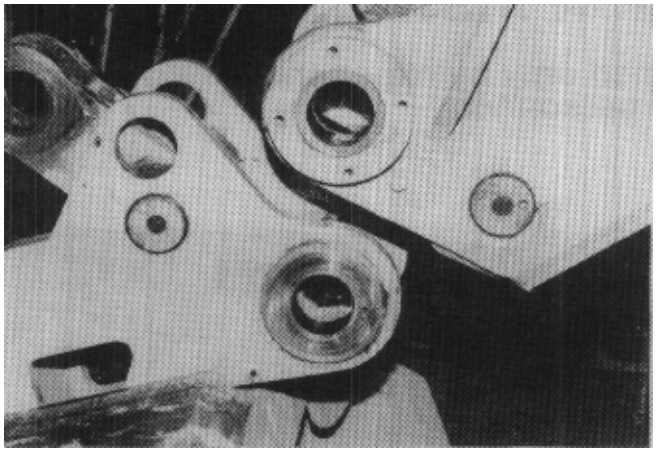
⚠ WARNING

Step 4 requires that adapter pivot pin be removed. Depending on length of time machine has been at rest, some hydraulic fluid may have leaked past valve spool in hoist control valve. This condition could allow boom to fall some distance when pivot pin is removed. KEEP ALL BODY PARTS CLEAR.

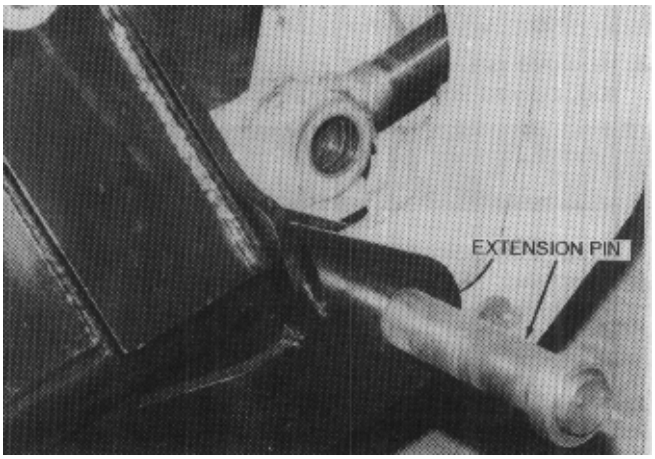
NOTE: If excessive force is required to remove pivot pin in step 4, raise boom slightly and then lower boom gently to rest. Be certain bucket remains properly blocked.



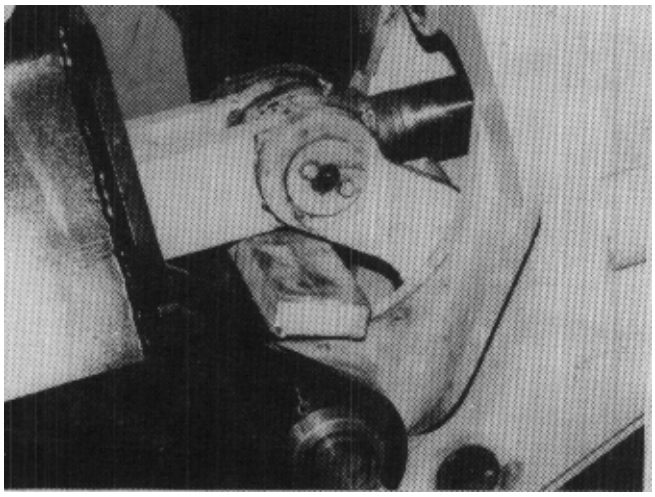
4. Read WARNING and NOTE above and then remove adapter pivot pin carefully. Note the locating screw, lock washer and nut at center of pin.



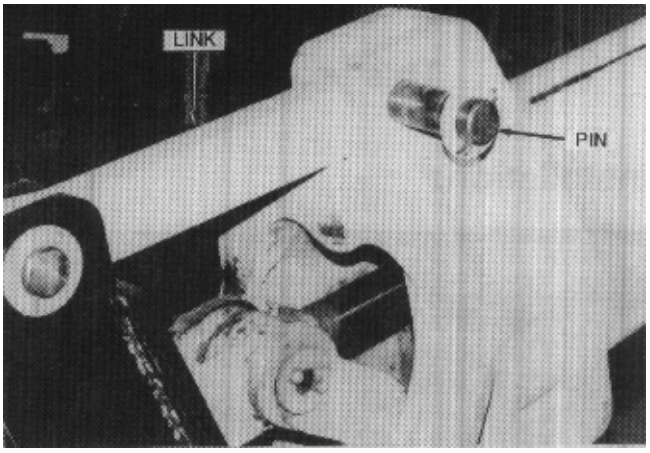
5. Check to be sure tool cylinder rod, curved link and straight link are clear of each other. Raise boom far enough to clear bucket adapter. Retrieve O-rings from area between adapter and boom.



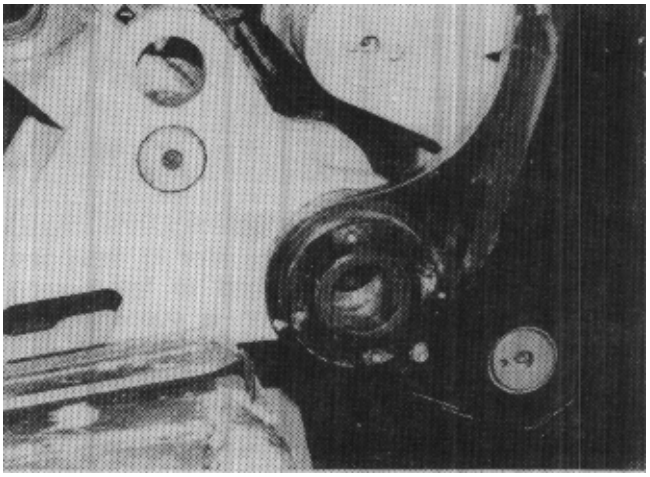
6. Align telescoping boom and boom extension with boom directly above extension. Lower boom carefully to align holes and install extension pin. Secure using collars, screws and lock nuts. Align push beam and tool cylinder rod.



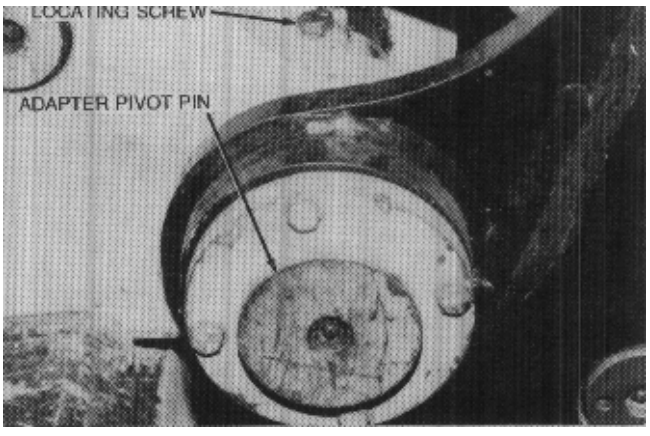
7. With curved link aligned with cylinder rod and push beam, secure using pin weldment, washer, lock washers and screws.



8. Align link at top of telescoping boom. It may be necessary to raise or lower boom slightly to accomplish this. Secure using pin, washers and cotter pins.

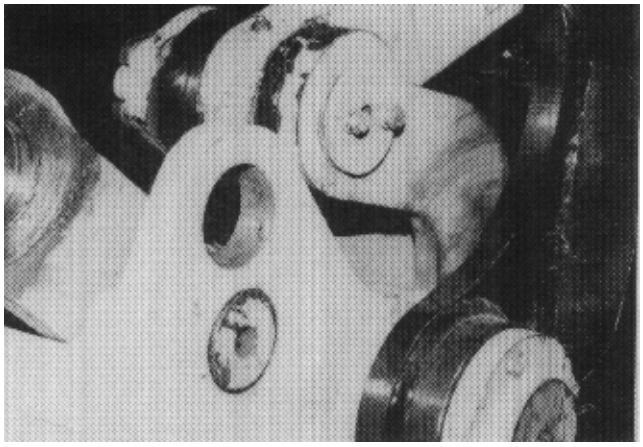


9. Align boom extension directly above bucket and bucket adapter combination. Clean all grease from adapter bosses. Inspect o-rings (removed in step 5) and replace if necessary. Secure o-rings in position on adapter bosses using masking tape. **Do not attempt to use fingers to hold o-rings in place.** Carefully lower boom to obtain alignment with adapter.

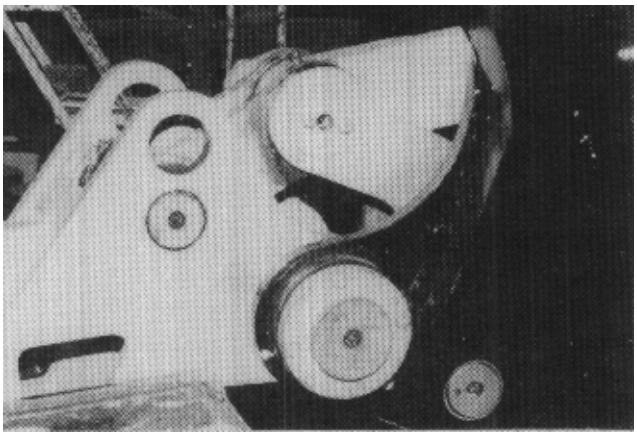


10. Check to be sure o-rings are positioned properly and then install adapter pivot pin. Secure using collars, lock washers, screws and nut.

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11. Remove screws, lock washers, washer and pin weldment from stored position in push beam and curved link. Keep hands and fingers clear.



12. Align straight link and curved link and install pin weldment part way to maintain alignment. Now align push beam with links. It may be necessary to extend or retract tool cylinder slightly to obtain alignment. Complete pin installation and secure using washer, screws and lock washers.

Removal:

Removal of boom extension and installing bucket and adapter on telescoping boom is essentially the reverse of installation procedure. However, keep the following points in mind when removing extension boom from telescoping boom:

Block boom extension as shown in first photo of installation procedure.

Be especially careful when removing boom extension pin. Read WARNING and NOTE aboye step 4, comply and then remove pin carefully.

Be sure to use adapter pivot pin when attaching adapter and bucket to telescoping boom.

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406 Mill Avenue, S.W., New Philadelphia, Ohio 44663
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Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

CALIFORNIA

Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Wash hands after handling.

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TORQUE-HUB®

Final Drives

ASSEMBLY-DISASSEMBLY MANUAL

FOR THE

S6A

UNIT

FAIRFIELD

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INTRODUCTION

This manual is a step-by-step guide to assembly and disassembly of torque-hub units. It is designed for the customer or shop mechanic who is repairing a particular model of torque-hub final drive. Users of this manual should note that each part mentioned is followed by an indentification number enclosed in parentheses. These part numbers may be referred to in the Parts List section of this manual and on the cross-sectional view of this unit. A print of each tool discussed in this manual is shown in the Tooling section. Users should familiarize themselves with the procedures for roll and leak testing and bolt tightening and torquing found on the following two pages before getting started.

This manual includes the following sections.

1. Roll and Leak Testing Procedures

2. Bolt Tightening and Torquing Procedures

3. Disassembly Procedures

4. Sub-Assembly Procedures

5. Main Assembly Procedure

6. Drawings of all Essential Tools

7. Parts List

8. Cross-Sectional View of the Unit

SAFETY

Standard safety practices should be followed during the disassembly and assembly procedures described. Safety glasses and safety shoes should be worn. Heavy, heat resistant gloves should be used when heated components are handled. Be especially alert when you see the word CAUTION. This indicates that a particular operation could cause personal injury if not performed properly or if certain safety procedures are not followed.

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ROLL and LEAK TESTING

Torque-hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

THE ROLL TEST

The purpose of a roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying a constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for proper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

THE LEAK TEST

The purpose of a leak test is to make sure that the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at the main seal or wherever "O" rings or gaskits are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where "O" rings or gaskits meet the exterior of the unit then checking for air bubbles. If a leak is detected in a seal, "O" ring, or gaskit, the part must be replaced.

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TIGHTENING and TORQUING BOLTS

If an air impact wrench is used to tighten bolts, extreme care should be taken to insure that bolts are not tightened beyond their indicated torque specification. Never use an impact wrench to tighten shoulder bolts, all shoulder bolts should be tightened by hand.

The following steps describe the proper procedure for tightening and torquing bolts or socket head cap screws in a bolt circle.

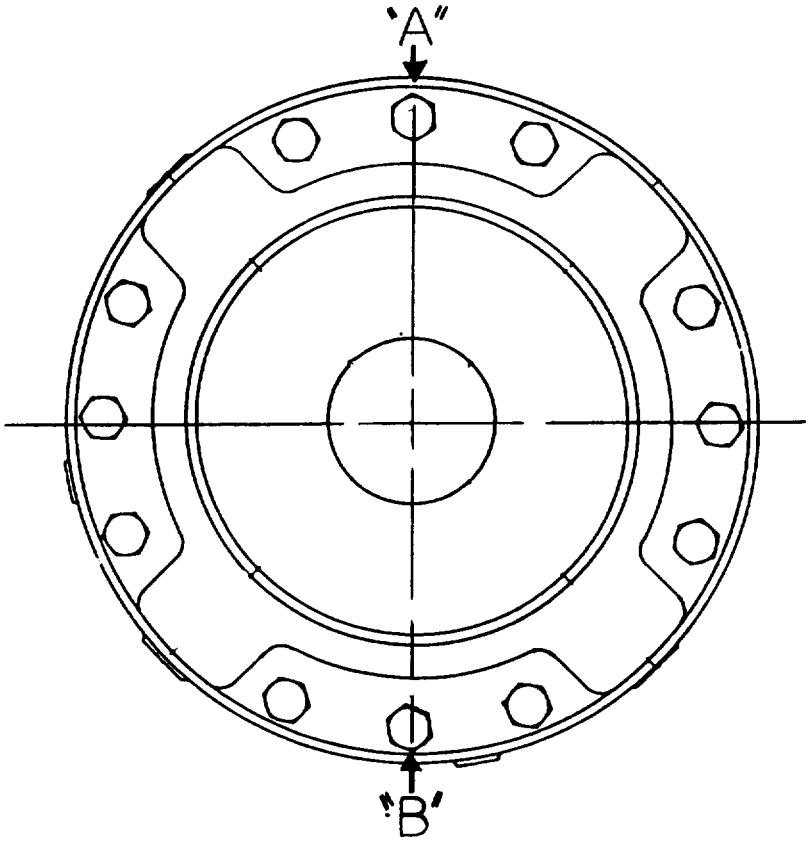
1. Tighten (but do not torque) bolt "A" until snug.

2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.

3. Continue around the bolt circle and tighten the remaining bolts.

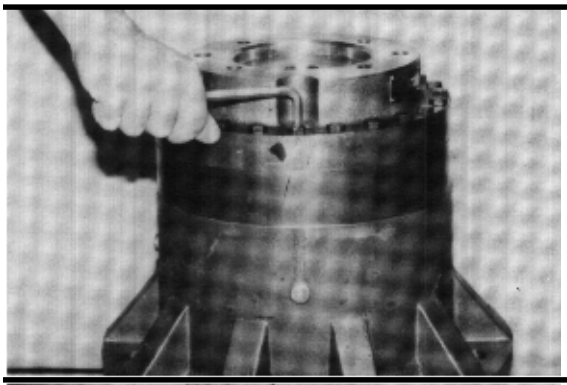
4. Now use a torque wrench to apply the specified torque to bolt "A"

5. Continue around the bolt circle and apply an equal torque to the remaining bolts.



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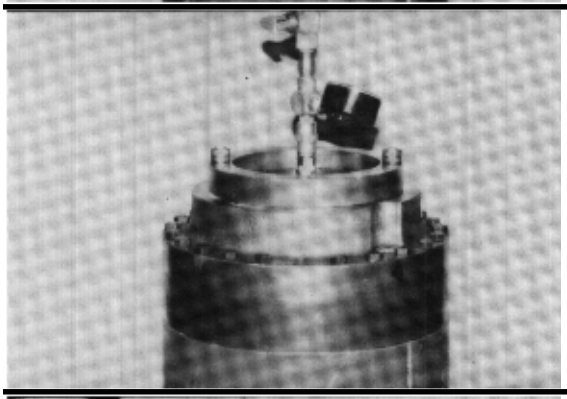
MAIN DISASSEMBLY



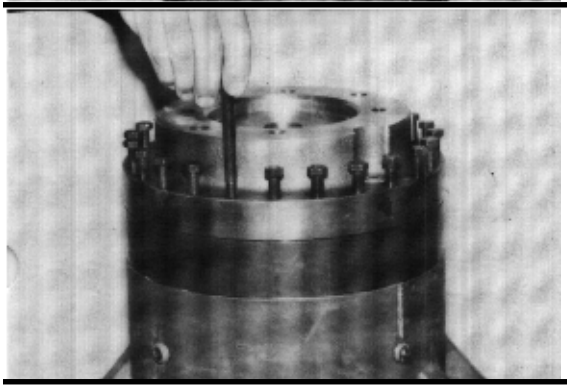
1. Remove **pipe plug (15)** from **cover(6)** and drain the oil from the unit.



2. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. The ratio number is the same as the last two digits in the model number found on the ID tag of the unit.

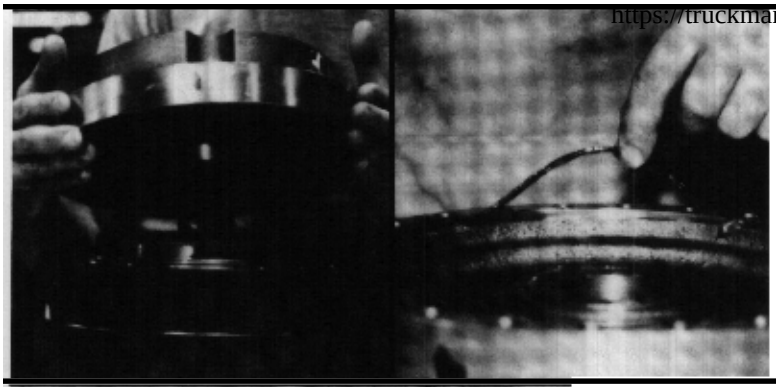


3. Leak test the unit at a pressure of 5 psi for 2-3 minutes.



4. Remove all **24 grade 8 bolts(16)** from **cover(6).**

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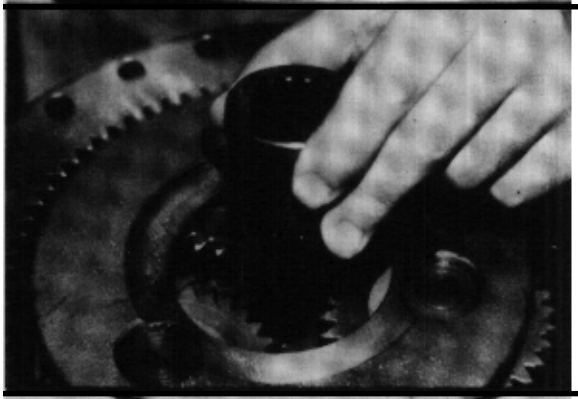
5. Lift **cover(6)** off of **hub(1G)** and remove **“O” ring(5)** from the counterbore in the cover. Discard the “O” ring.



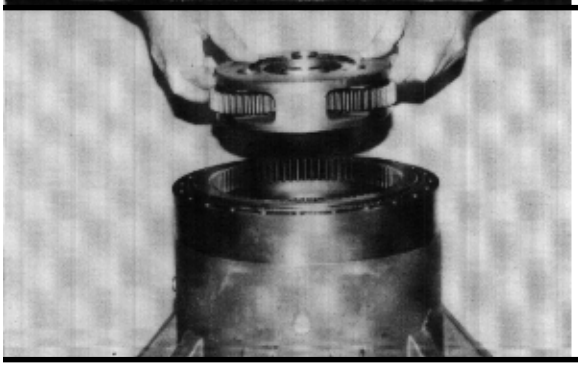
6. Remove small **thrustwasher(7)** from the counterbore in the center hole in **cover(6).**



7. Remove large **thrust washer(14), thrust bearing(13),** and large thrust **washer(12)** from the raised inside circular edge of **cover(6).**

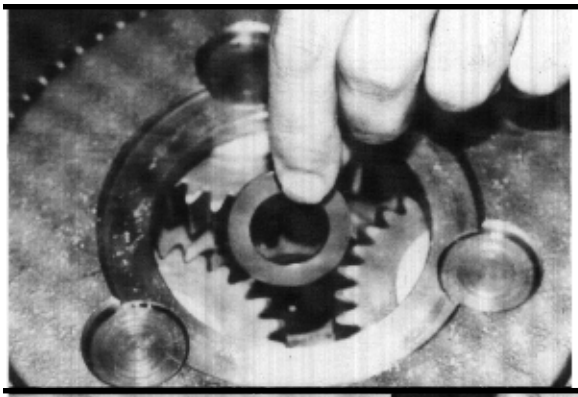


8. Remove **input gear(8)** from mesh with the planet gears in **first stage carrier assembly(3).**

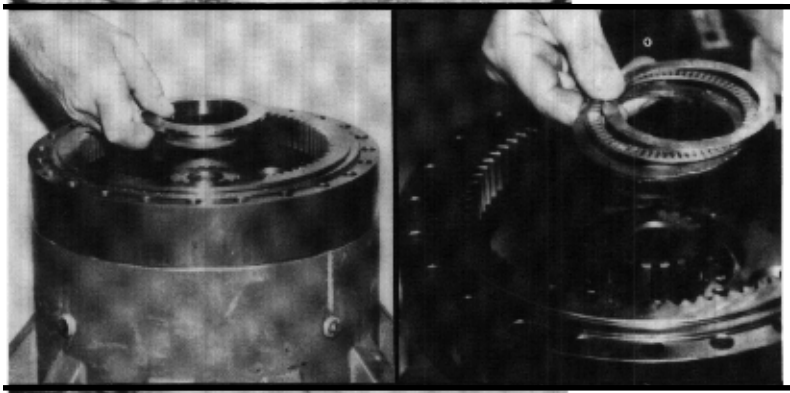


9. Lift out **first stage carrier assembly(3).**

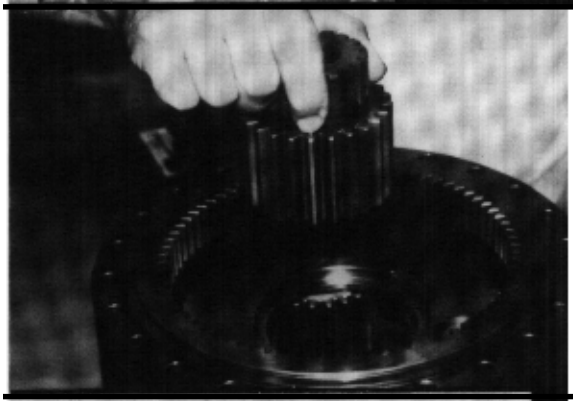
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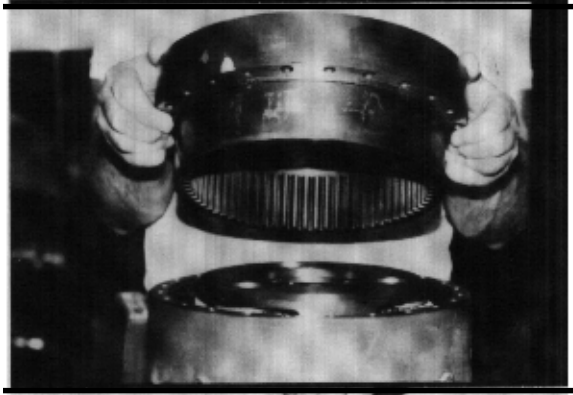
10. Remove small **thrust washer(9)** from the top of **second stage sun gear(11).**



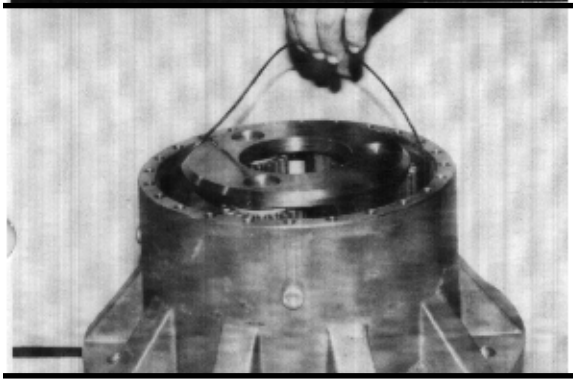
11. Remove **thrust bearing carrier(10),** large **thrust washer(14), thrust bearing(13),** and large **thrust washer(12)** from the counterbore of **second stage carrier assembly(2).**



12. Remove **second stage sun gear(11)** from mesh with **second stage carrier assembly(2).**

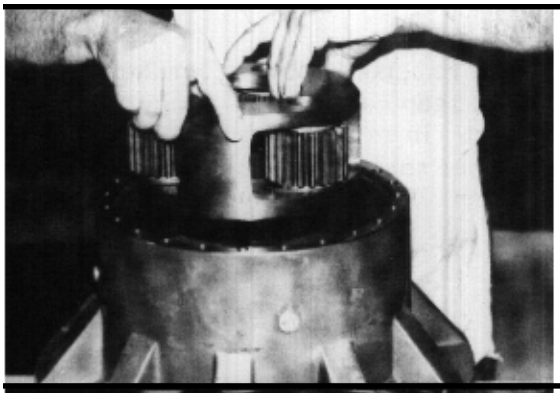


13. Lift out **ring gear(4).**



14. Remove **"O" ring(5)** from the counterbore in **hub(1G)** and discard.

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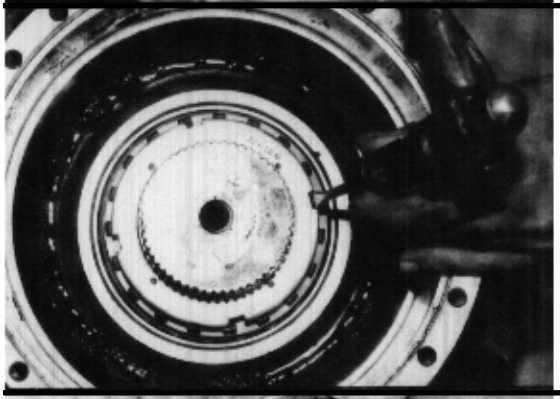


15. Lift out **second stage carrier assembly(2)** from mesh with **output shaft(1A).**

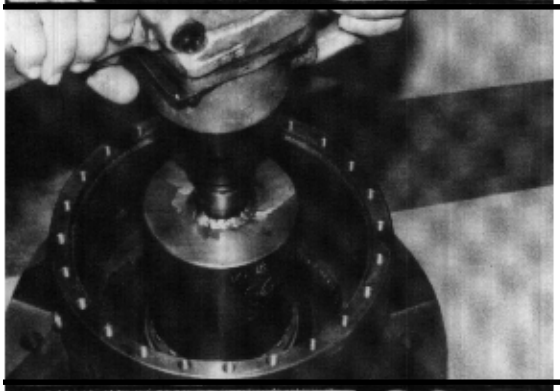


16. Using retaining ring pliers, remove **retaining ring(1L)** from groove around the outside of **output shaft (1A).**

CAUTION: Safety glasses should be worn during this procedure.

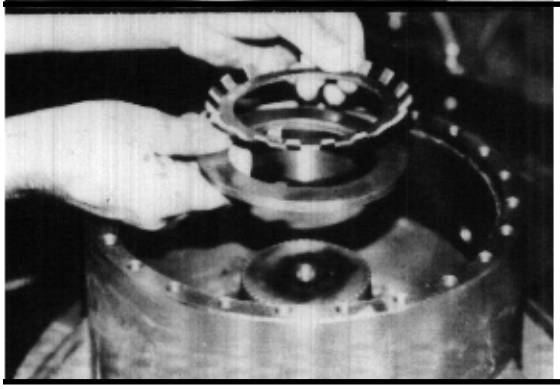


17. With a screwdriver or chisel and hammer, straighten out the tang on **lockwasher(1J)** which has been bent into the notch on **locknut(1K).**



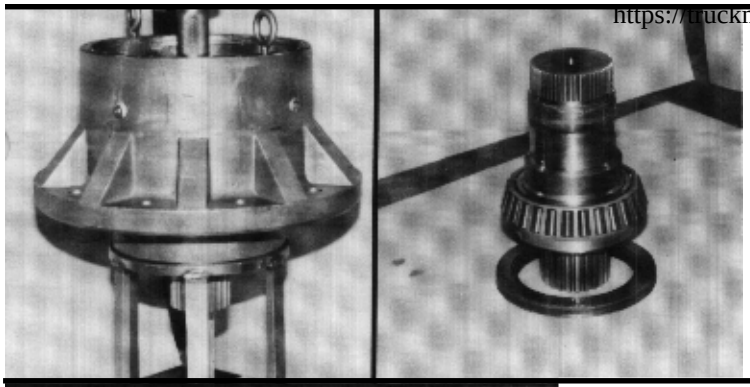
18. Using an AN-18 locknut wrench (tool no T-156766), loosen **locknuts (1K).** Remove the locknut from **output shaft(lA)** and discard.

NOTE: The output shaft must be held securely enough to resist turning when the locknut is loosened.

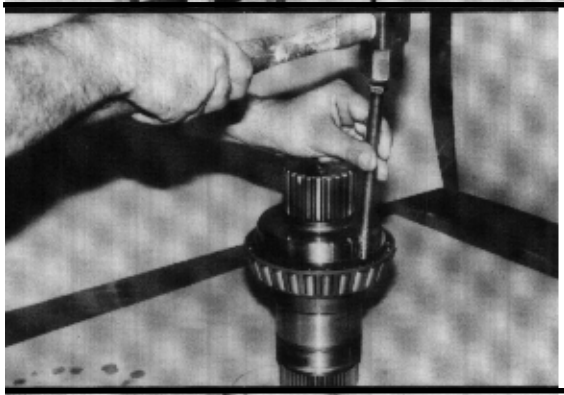


19. Remove **lockwasher(1J)** and **tanged washer(1H)** from **output shaft(1A).** Discard the lockwasher.

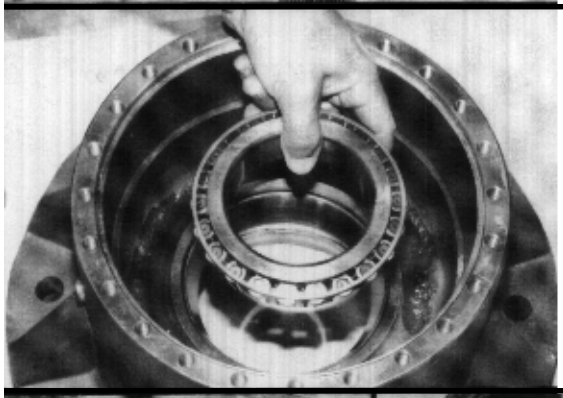
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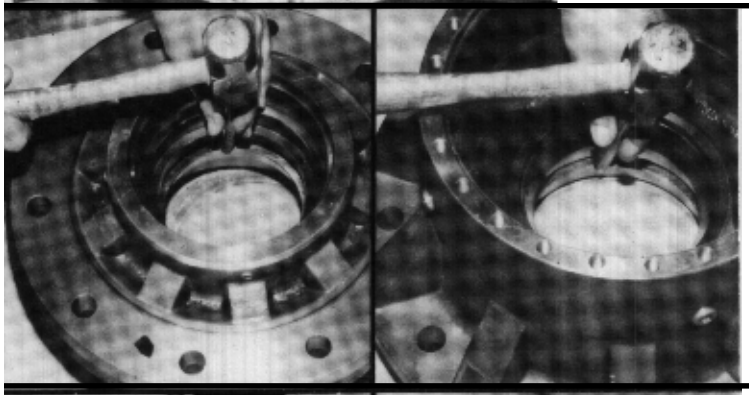
20. Raise **hub(1G)** above your work surface and support it from underneath in a manner that will allow **output shaft(1A)** to fall through the bottom. Press the output shaft out of the hub. The output shaft will come out with **bearing cone (1D)** attached and **seal(1B).** Discard the seal.



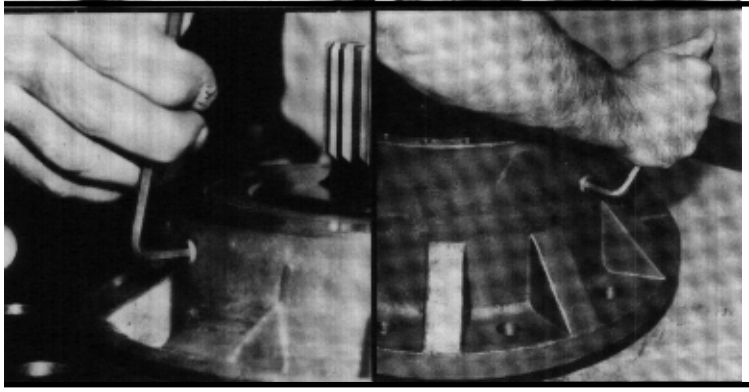
21. Remove **bearing cone (1D)** from **output shaft(lA).**



22. Lift bearing **cone(1F)** out of **hub(1G).**



23. Using a soft punch and hammer, remove **bearing cups (1E) and (1C)** from **hub(1G).** Be very careful not to strike the counterbores of the hub where these cups are located when using the punch.

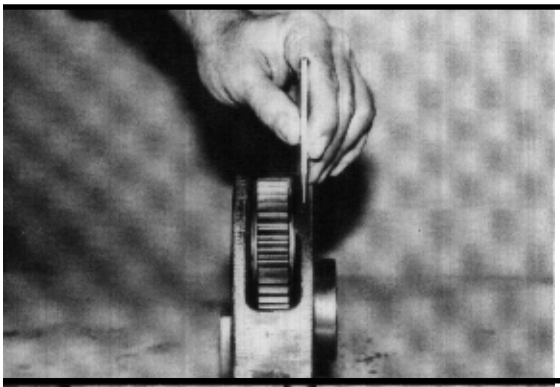


24. Remove all four **pipe plugs (1M), (1N), and (1P)** from **hub(1G).**

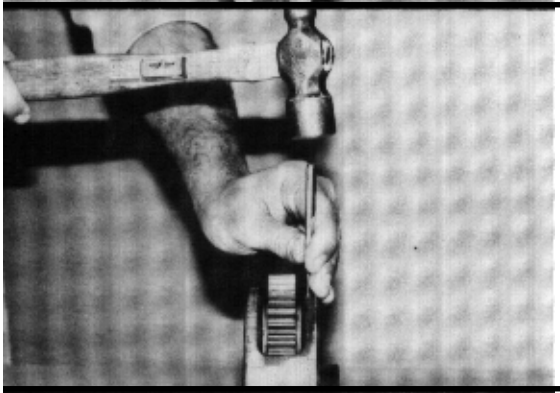
25. At this point the main disassembly is complete.

https://truckmanualshub.com/

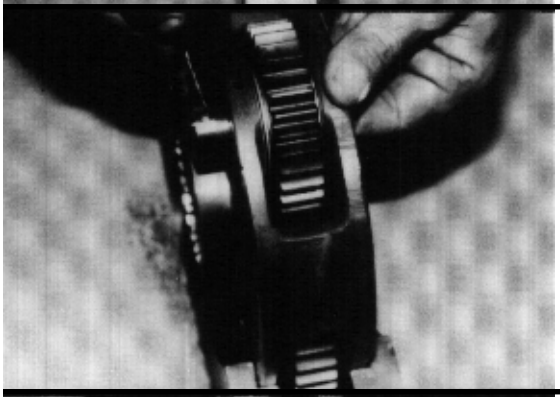
FIRST STAGE CARRIER DISASSEMBLY



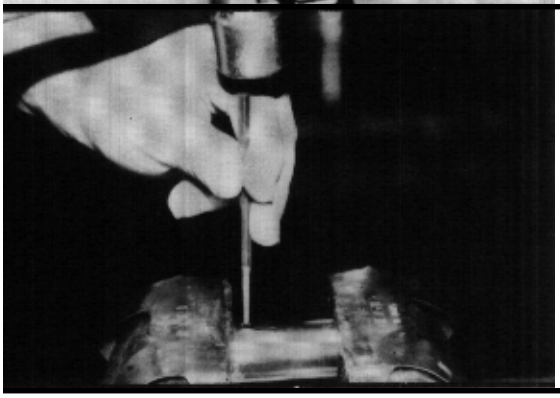
1. Locate **dowel pin(3D)** which holds **planes shaft(3E)** in **carrier housing (3A).**



2. Drive the **dowel pin(3D)** down into **planes shaft(3E)** until it bottoms against the carrier housing. If the dowel pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.

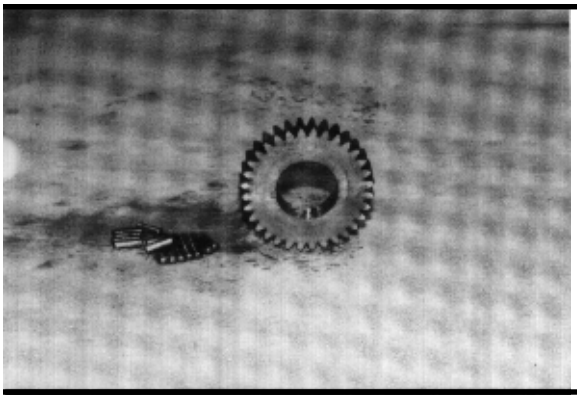


3. Remove **planet shaft(3E)** from carrier housing(3A). The four **thrust washers(3B)** and **planet gear(3F)** will slide off.



4. Using an alignment punch and hammer, drive **dowel pin(3D)** out through the end of the dowel pin hole in **planet shaft(3E)** that it originally went into.

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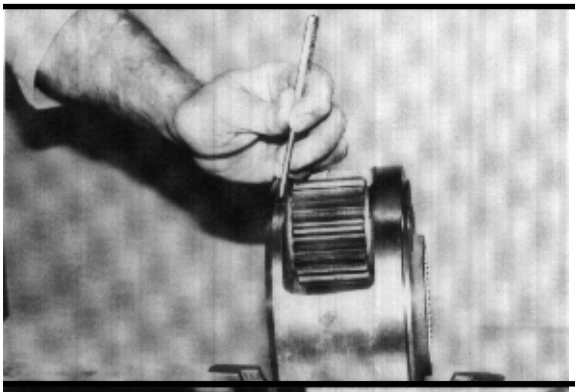
5. Remove **needle rollers(3C)** from inside **planet gear(3F).**

6. Repeat steps 1-5 to remove the two remaining planet gears.

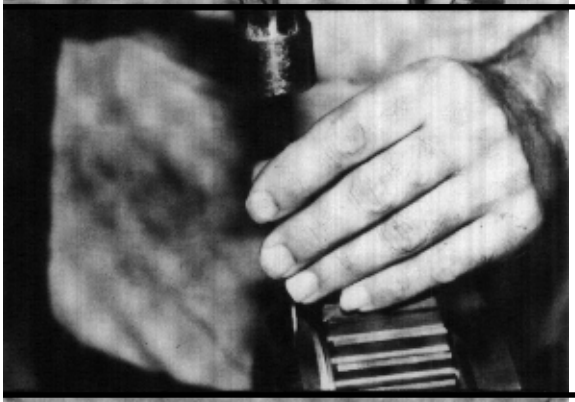
7. At this point the first stage carrier disassembly is complete.

https://truckmanualshub.com/

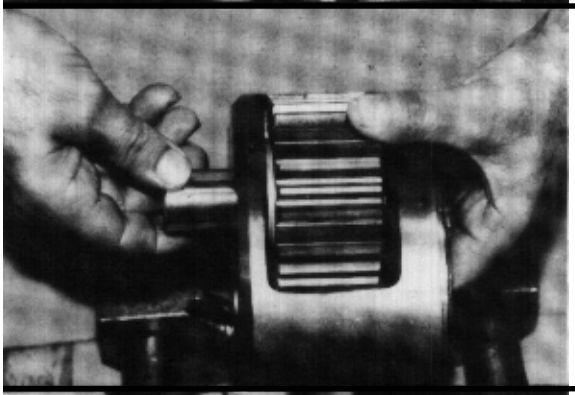
SECOND STAGE CARRIER DISASSEMBLY



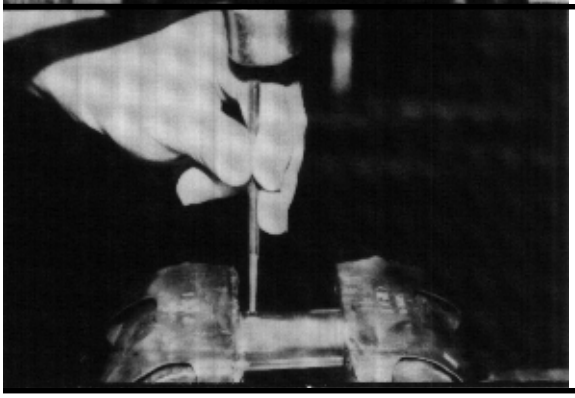
1. Locate **dowel pin(2G)** which holds **planet shaft(2E)** in **carrier housing (2A).**



2. Drive **dowel pin(2G)** down into **planets shaft(2E)** until it bottoms against the carrier housing. If the dowel pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.

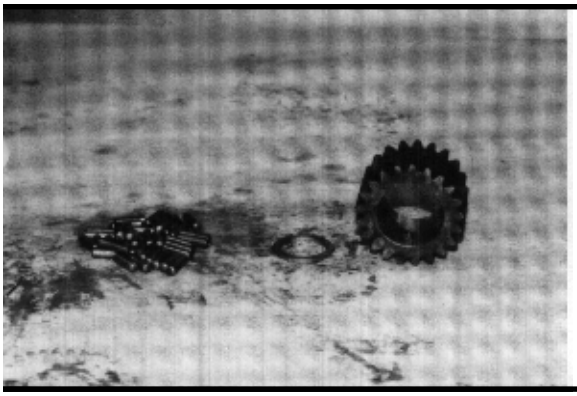


3. Remove **planet shaft(2E)** from **carrier housing(2A).** The four **thrust washers(2B)** and **planet gear(2F)** will slide off.



4. Using an alignment punch and hammer, drive **dowel pin(2G)** out through the end of the dowel pin hole in **planet shaft(2E)** that it originally went into.

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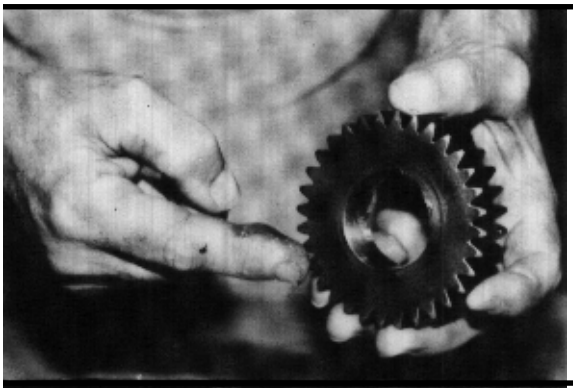
5. Remove **needle rollers(2C)** and **spacer(2D)** from inside **planes gear(2f)**

6. Repeat steps 1-5 to remove the two remaining planets gears.

7. At this point the second stage carrier disassembly is complete.

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FIRST STAGE CARRIER SUB-ASSEMBLY

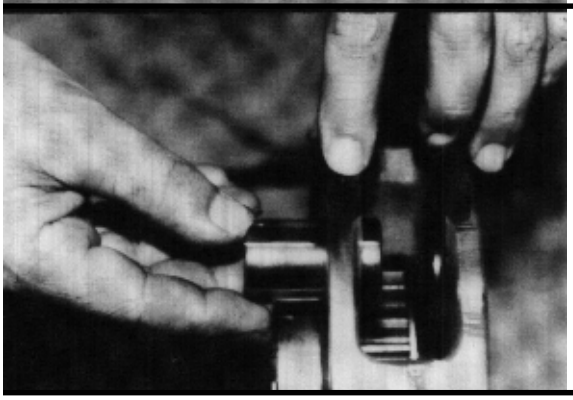


1. Apply grease to the inside of one **first stage carrier planes gear(3F).**



2. Line the inside of **planet gear (3F)** with **19 needle rollers(3C).**

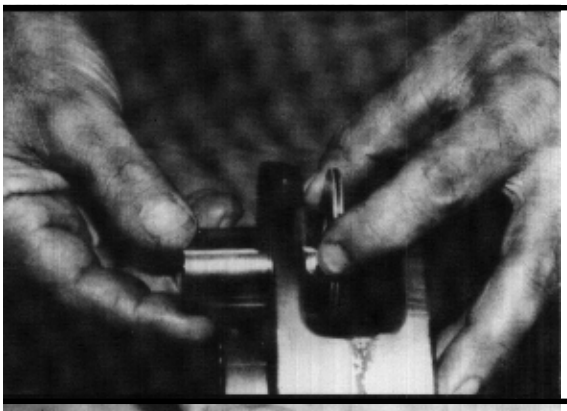
3.Stand **first stage carrier housing(3A)** in an upright position.



4. Insert a **planet shaft(3E)** into one of the planet shaft roles which has a dowel pin hole on **carrier housing(3A).** The end of the planet shaft that does not have the dowel pin hole should be inserted into the carrier housing first.

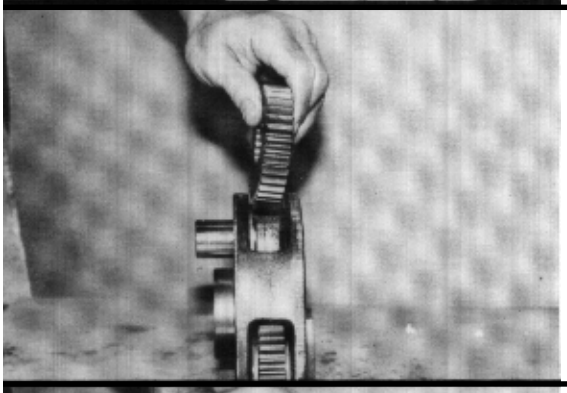
NOTE: One end of the dowel pin hole on the planet shaft has a chamfer or gradual slope. This end should be up to allow easy alignment.

https://truckmanualshub.com/

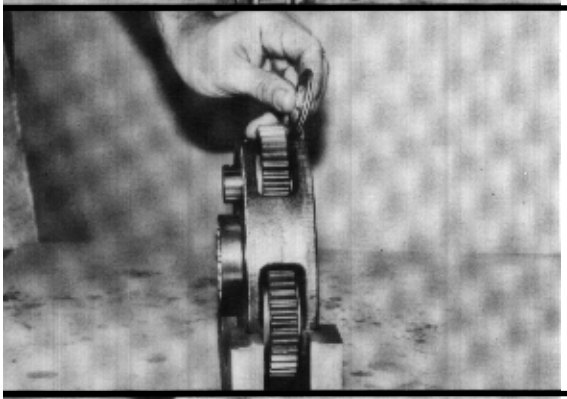


5. Place two **thrust washers(3B)** onto the end of **planet shaft(3E)** which has been inserted through the planet shaft hole in **carrier housing(3A).**

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.

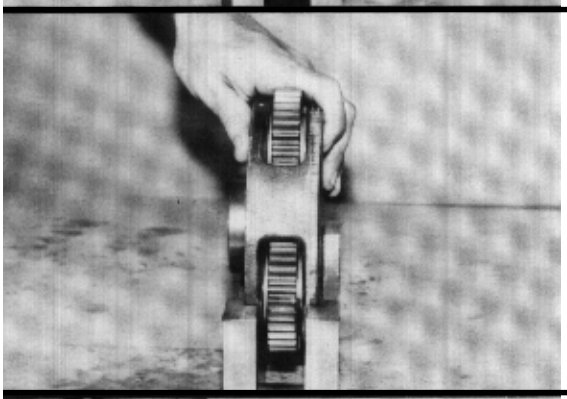


6. Following the thrust washers place **planet gear (3F),** with needle rollers, onto **planet shaft (3E).**

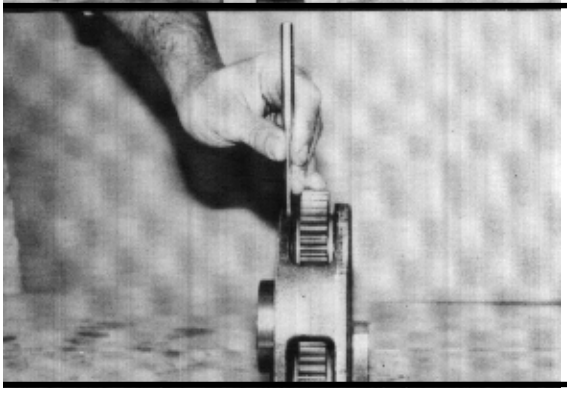


7. Following the planet gear, place two more **thrust washers(3B)** onto **planet shaft(3E).**

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.

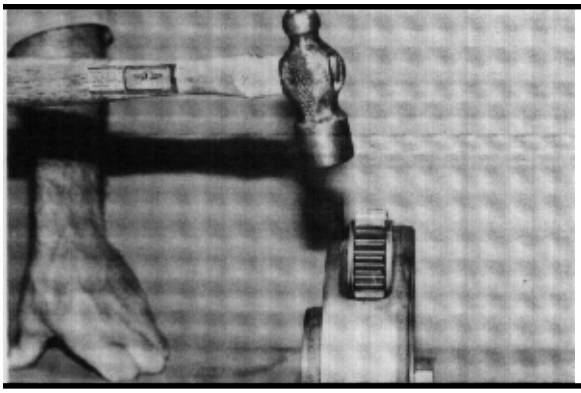


8. Now insert **planet shaft(3E)** through the opposite planet shaft hole on **carrier housing(3A).**



9. Using an alignment puch or similar tool, align the dowel pin holes on **carrier housing(3A)** and **planet shaft (3E).**

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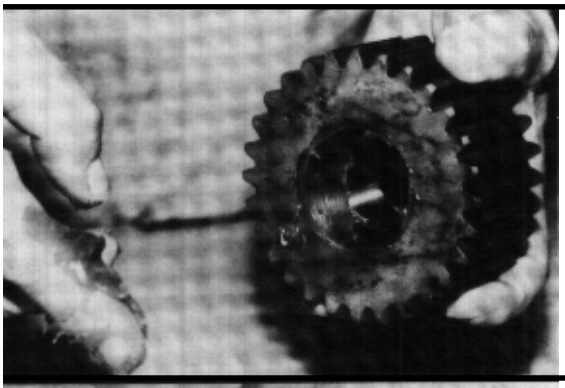
10. If you examine a **dowel pin (3D)** carefully, you will notice that one end is smaller than the other. Drive this end of the **dowel pin (3D)** down into the aligned dowel pin holes. It should be driven to just below (1/10 in.) the surface of the carrier housing.

ll. Repeat the procedure in steps 1-10 for installation of the two remaining first stage planes gears(3F).

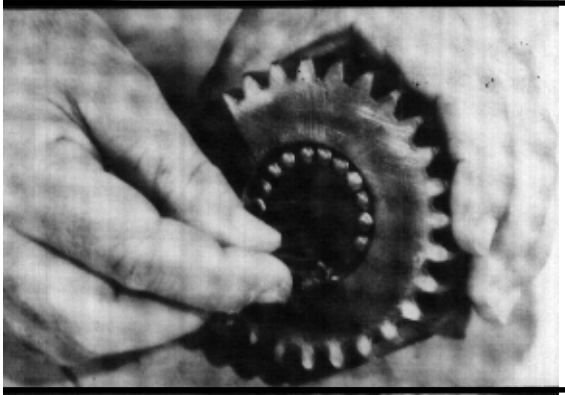
l2. At this point the first stage carrier sub-assembly is complete.

https://truckmanualshub.com/

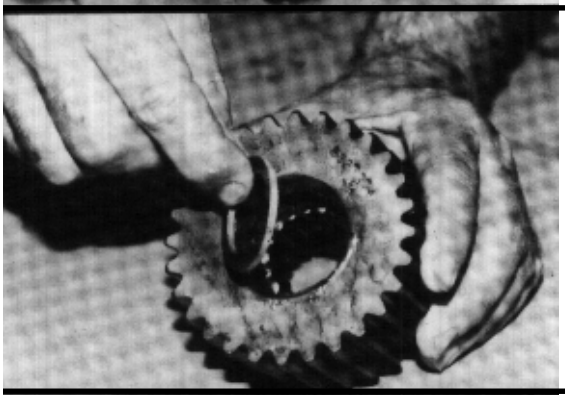
SECOND STAGE CARRIER SUB-ASSEMBLY



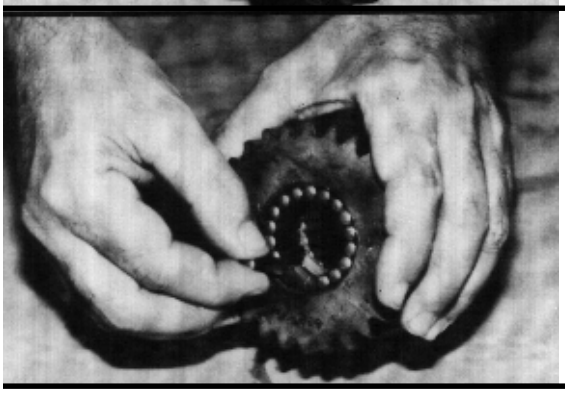
1. Apply grease to the inside of one **second stage planet gear(2F).**



2. Line one half of **planet gear(2F)** with 18 **needle rollers(2C).**



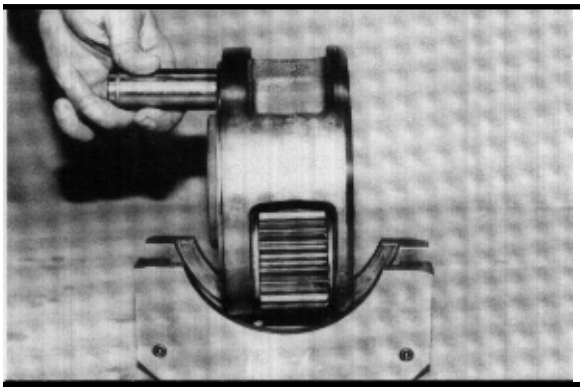
3. Place one **spacer(2D)** inside **planet gear(2F)** so that it rests on top of the **needle rollers (2C).**



4. Line the remaining half of **planet gear(2F)** with 18 **needle rollers(2C).**

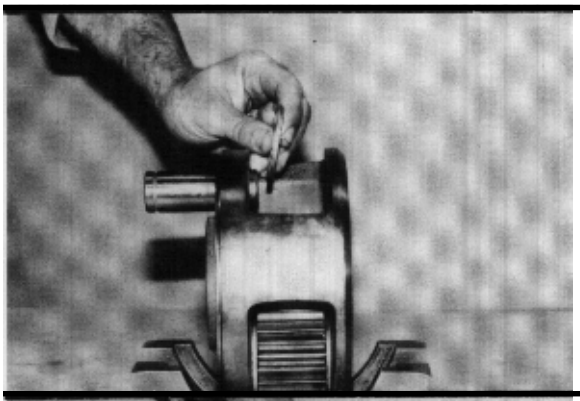
https://truckmanualshub.com/

5. Stand second stage carrier housing(2A) in an upright position.



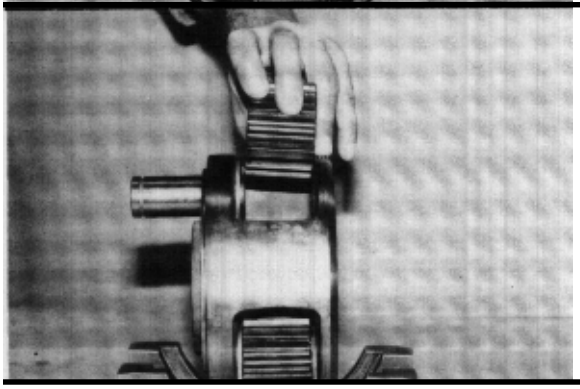
6. Insert **planet shaft(2E)** into a planet shaft hole that does not have a dowel pin hole on **carrier housing** (2A). The end of the planet shaft with the dowel pin hole should be inserted into the carrier housing first.

NOTE: One end of the dowel pin hole on the planet shaft has a chamfer or gradual slope. This end should be up to allow easy alignment.



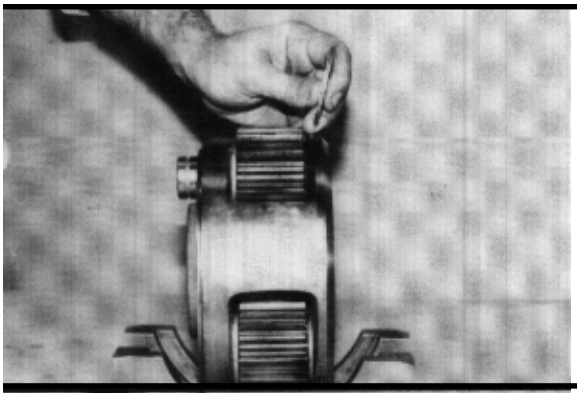
7. Place two **thrust washers(2B)** onto the end of the planet shaft which has been inserted through the planet shaft hole.

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.



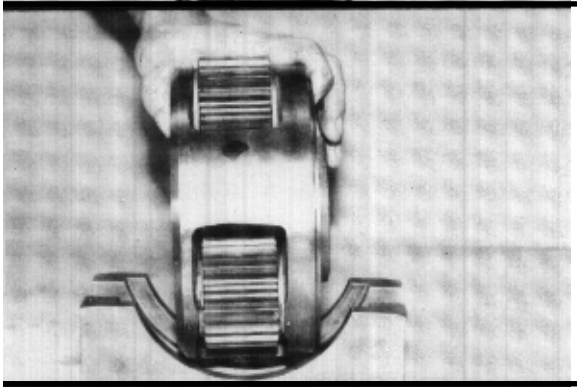
8. Following the thrust washers, place **planet gear(2F),** with needle rollers, onto **planes shaft(2E).**

https://truckmanualshub.com/

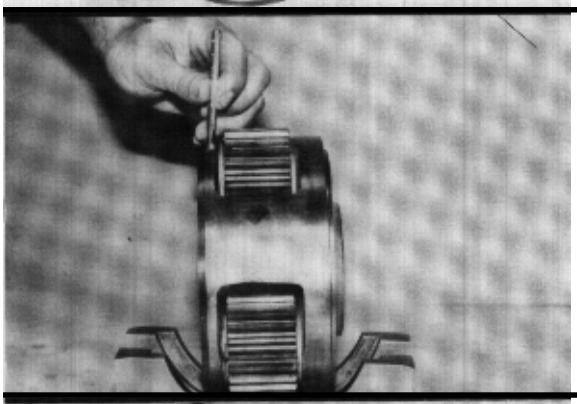


9. Following the planet gear, place two more **thrust washers(2b)** unto **planet shaft(2E).**

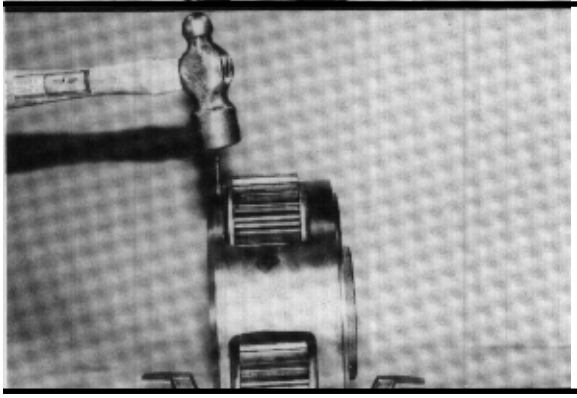
NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.



10. Now insert **planet shaft(2E)** through the opposite planet shaft hole on **carrier housing(2A).**



11. Using an alignment punch or similar tool, align the dowel pin holes on the carrier housing and planet shaft.



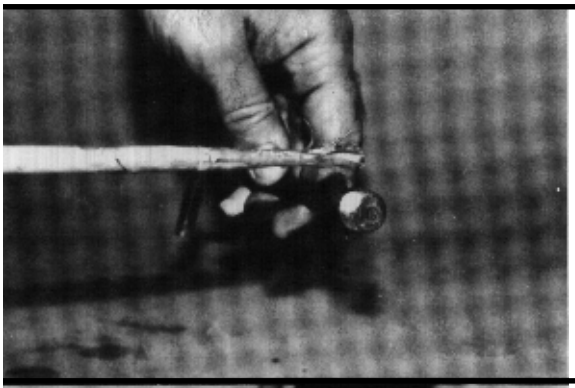
12. If you examine a **dowel pin(2G)** carefully, you will notice that one end is smaller than the other. Drive this end of **dowel pin(2G)** down into the aligned dowel pin holes. It should be driven to just below (1/10 in.) the surface of the carrier housing.

13. Repeat the procedure in steps 1-12 for installation of the two remaining second stage planet gears(2F).

14. At this point the second stage carrier sub-assembly is complete.

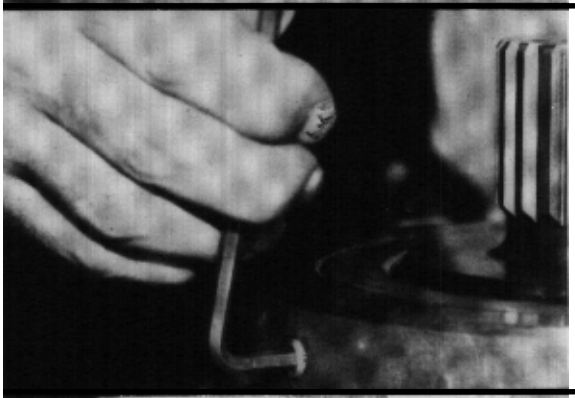
https://truckmanualshub.com/

HUB-SHAFT SUB-ASSEMBLY



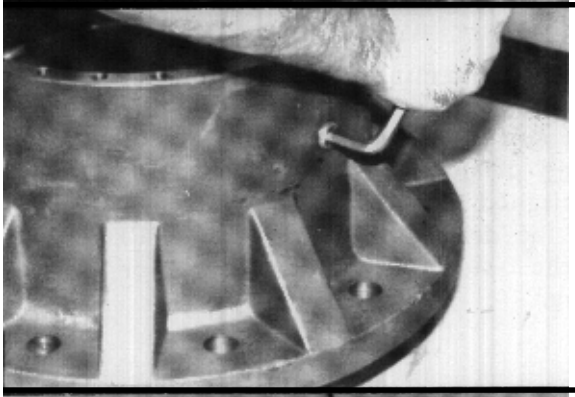
1. Apply a light coat of "Never-Seize" to the four hub **pipe plugs (1M), (1N), and (1P).**

Note: **Pipe plug(1P)** is a magnetic plug.

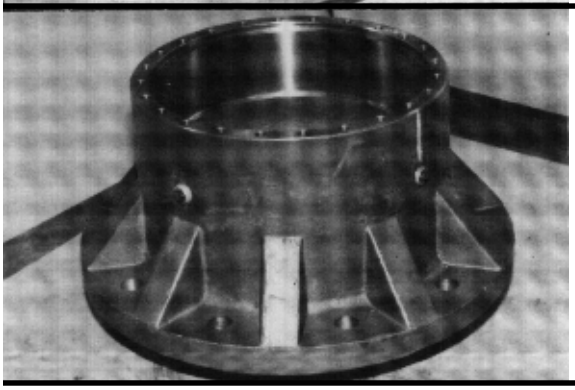


2. With **hub(lG)** standing on its large diameter end, tighten **pipe plugs(1M)** into the two pipe plug holes nearest the small diameter end of **hub(1g).**

NOTE: Notice that **pipe plugs(lM)** are much smaller than **pipe plugs (1N)** and **(1P).**



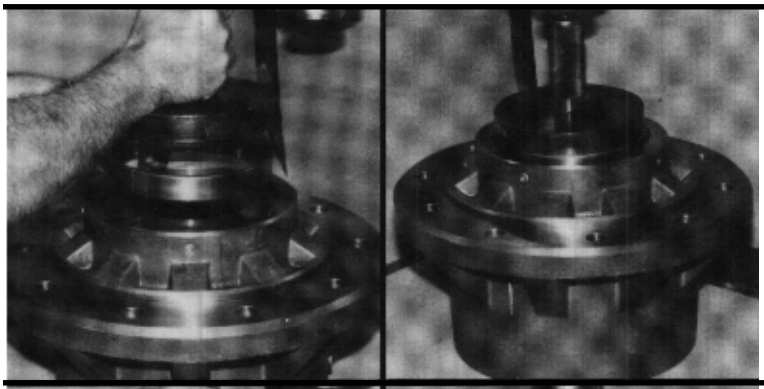
3. Turn **hub(1G)** over so that it rests on its small diameter end and the two pipe plug holes nearest the hub's large diameter and are facing you. Tighten **magnetic pipe plug(1P)** into the right-hand pipe plug hole.



4. Mark the location of magnetic pipe **plug(1P)** so that it may be aligned with the pipe plug hole in **cover(6)** in a later step.

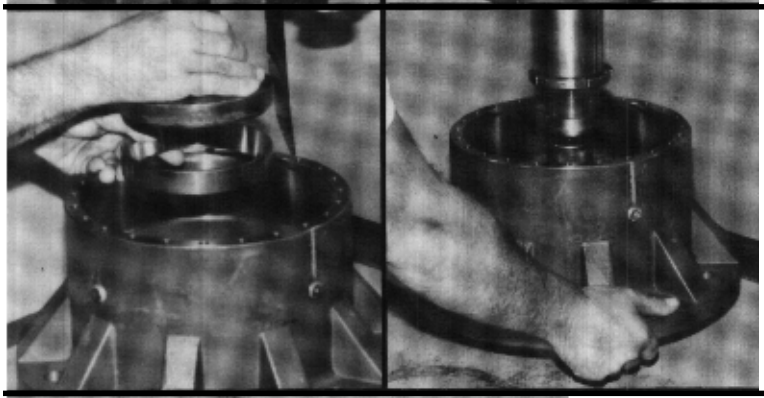
https://truckmanualshub.com/

5. Install **pipe plug(1N)** into the left-hand pipe plug hole nearest the large diameter end of **hub (1G).**



6. With **hub(1G)** still standing on its large diameter end, press **bearing cup(1C)** into the small diameter end of **hub(1G)** usina a bearing cup pressing fixture (tool no.T- 156792).

NOTE: Make sure that the cup sits square with the counterbore of the hub before pressing.

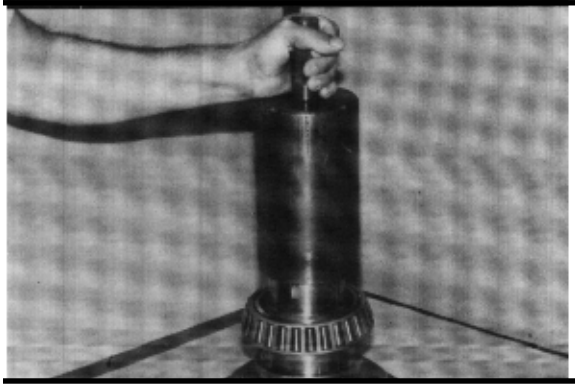


7. Turn **hub(1G)** over so that it rests on its small diameter end. Press **bearing cup(1E)** down into **hub(lG)** using a bearing cup pressing fixture (tool no. T-130717).

NOTE: Make sure that the cup sits square with the counterbore of the hub before pressing.

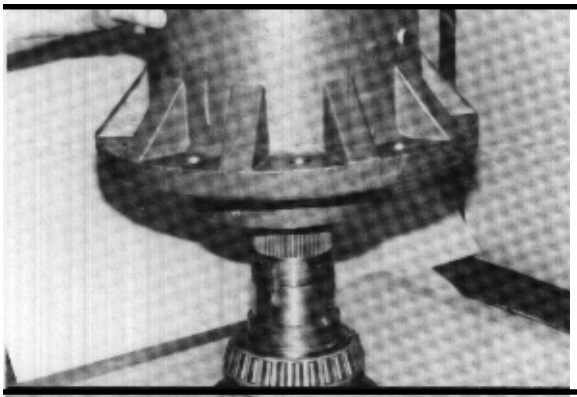


8. Spray the inside of **bearing cone(1D)** with oil.



9. Press **bearing cone(1D)** onto **output shaft(1A)** using a bearing cone pressing fixture (tool no.T-158049).

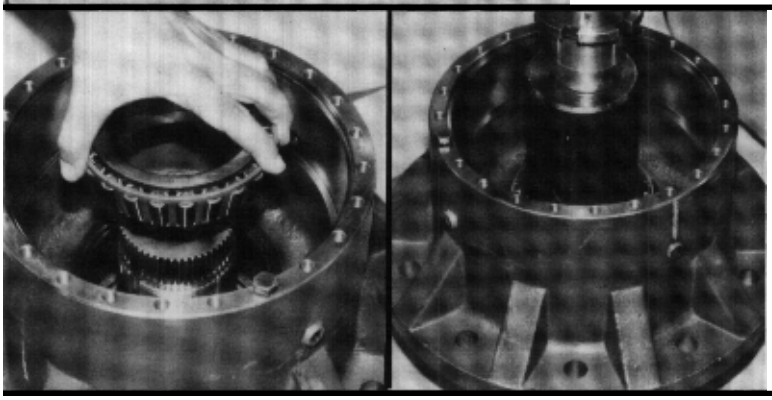
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10. With small diameter end down, lower **hub(1G)** onto **output shaft(1A).**

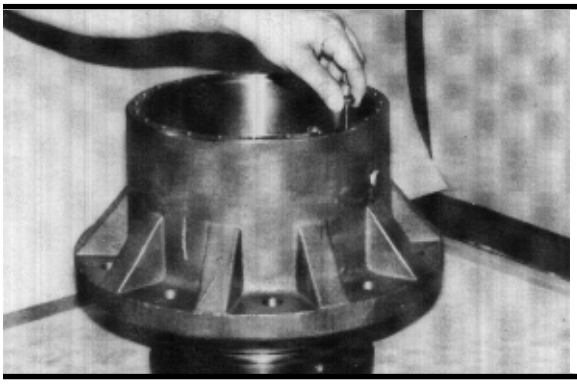


11. Spray the inside of **bearing cone(1F)** with oil.



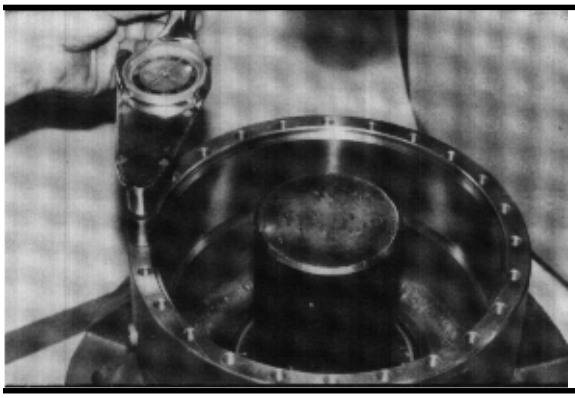
12. Press **bearing cone(1F)** onto **output shaft(1A)** using a bearing cone pressing fixture (tool no. T-146588). Reduce the pressure applied to the bearing cone and press the cone again. This time rotate the hub in both clockwise and counter-clockwise directions while pressing. Stop pressing when the hub starts to resist the rotation.

13. Now measure the initial rolling torque of **hub(1G).** To do this, follow steps a-d.



a) Tighten a bolt into one of the bolt holes on the hub. The bolt used should be one that fits the hole.

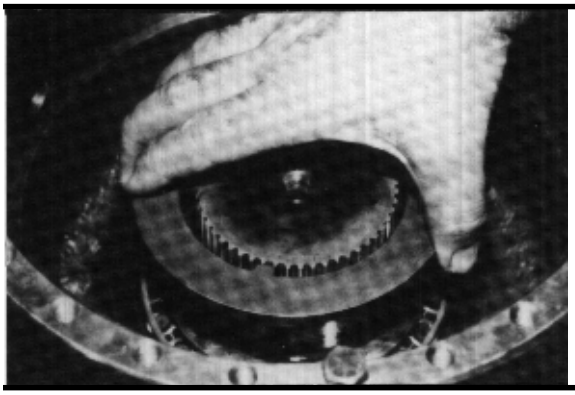
b) Place a torque wrench on the bolt so that the arm of the wrench lines up on a tangent to the circumference of the hub as shown in figure 1.



c) Keeping the wrench in this position at all times, use the arm of the wrench to guide the hub around in one rotation.

d) Read the gauge on the torque wrench. The initial rolling torque should be 25-30 in.-lbs. Measure the rolling torque several times to insure an accurate reading.

NOTE: If the initial rolling torque is less than 25 in.-lbs., apply more pressure to **bearing cone(1F).** If the initial rolling torque is higher than 30 in.-lbs., strike the top of **output shaft(1A)** with a soft face hammer to release the load on the shaft, then repeat steps 13b - 13d.



14. Place **tanged Fwasher(1H)** onto **output shaft(1A).**

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THE CORRECT READING CAN ONLY BE MADE IF THE TORQUE WRENCH IS PULLED SLOWLY (APPROX. 3.5 R.P.M.) AND SMOOTHLY TOWARDS YOU.

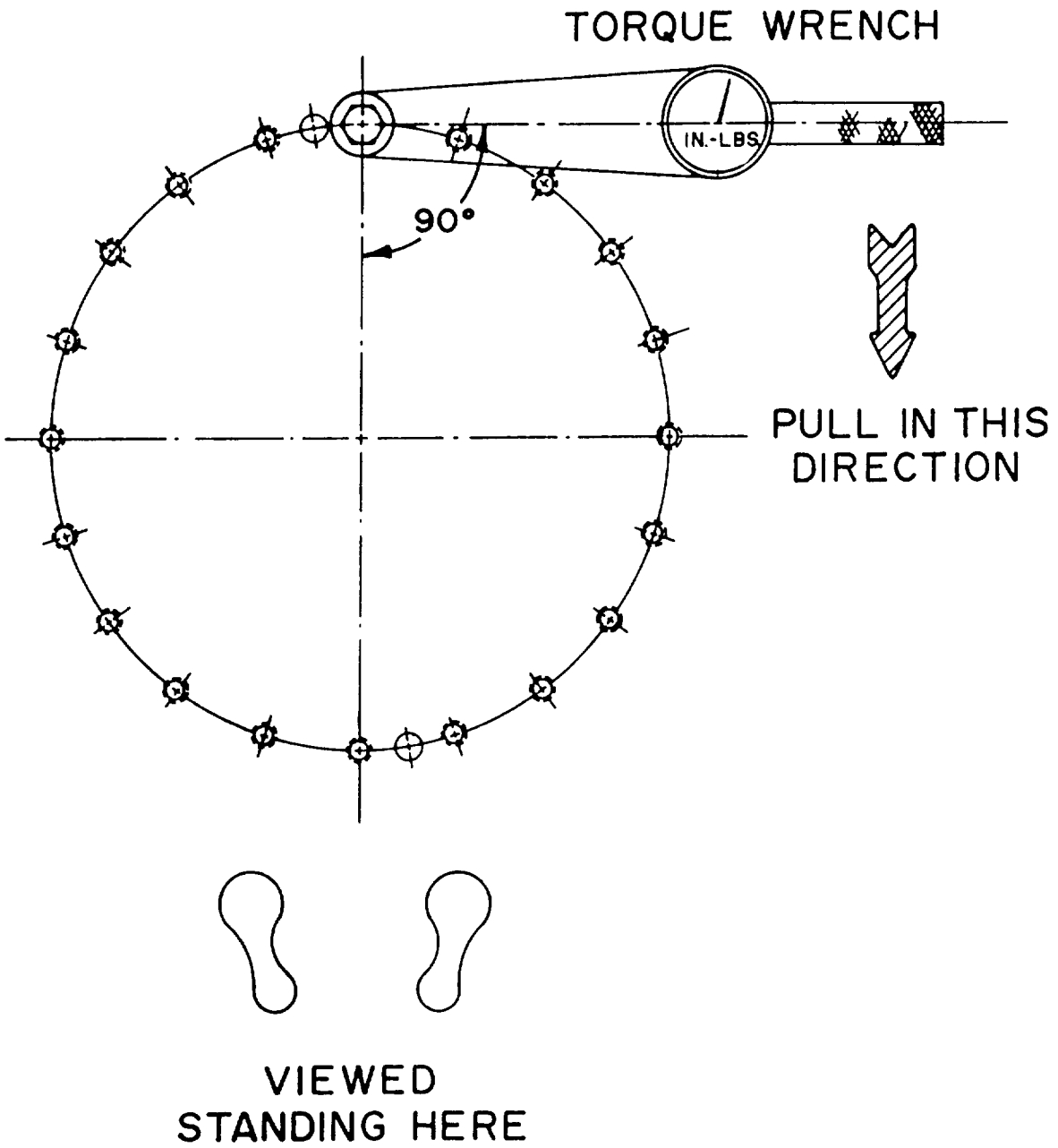
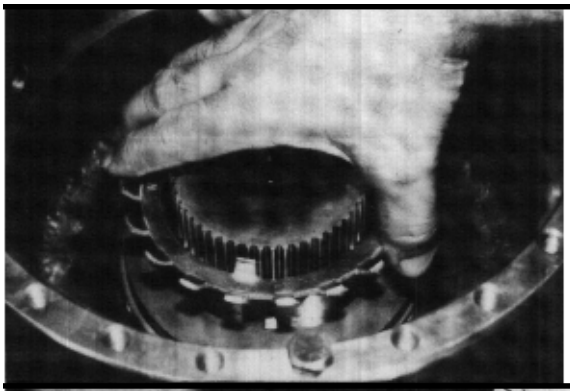


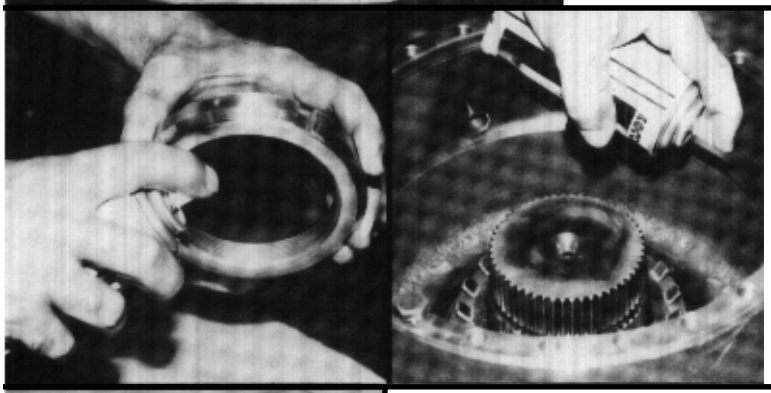
Figure 1.

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15. Place **lockwasher(1J)** onto **output shaft(1A).**

NOTE: Notice that **lockwasher(1J)** has tangs and **tanged washer(1H)** does not.



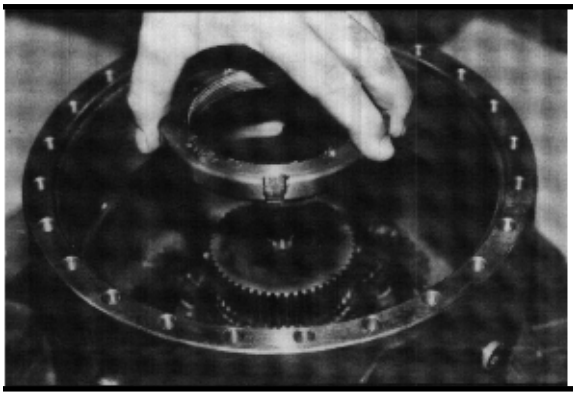
16. Spray the inside of **locknut(1K)** and the exposed sides of **output shaft(1A)** with Locquic Primer T. Allow two minutes drying time.



17. Apply Loctite 277 Adhesive/ Sealant to the second screwthread from the bottom of **locknut(1K).**

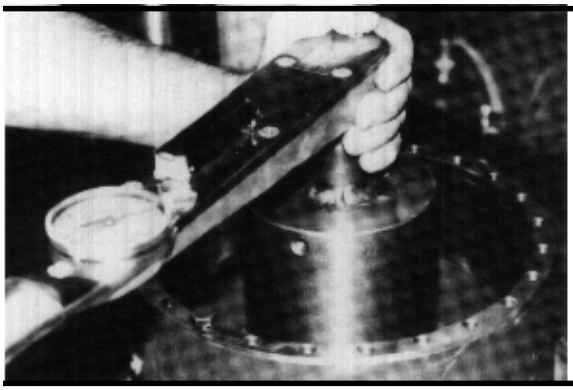
NOTE: The bottom of **locknut(1K)** has a chamfered or inward sloping edge.

NOTE: Loctite 277 is an anaerobic adhesive. Once it has been removed from air, it sets. Therefore, once the locknut has been placed on the output shaft, it must be torqued immediately or the adhesive will make it difficult to turn.



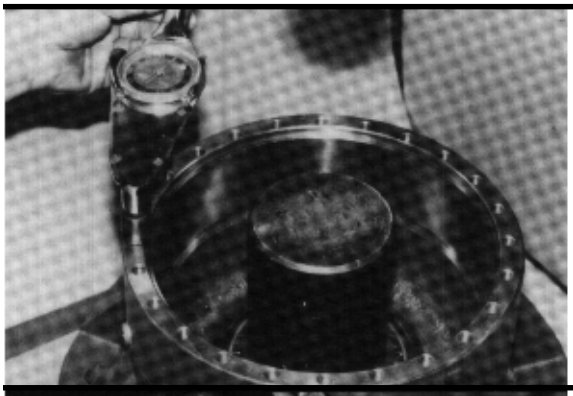
18. Place **locknut(1K)** onto **output shaft(1A)** and screw into place.

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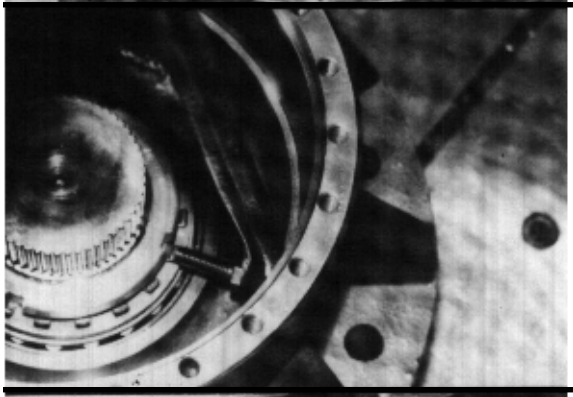
19. Using an AN-18 locknut wrench (tool no. T-156766) and a torque wrench, apply 225 ft.-lbs. of torque to **locknut(1K).**

NOTE: One tang on **lockwasher(1J)** must line up directly with one notch on **locknut(1K).** If one tang does not line up with a locknut notch, apply sufficient increased torque to the locknut until it does. Never loosen the locknut.

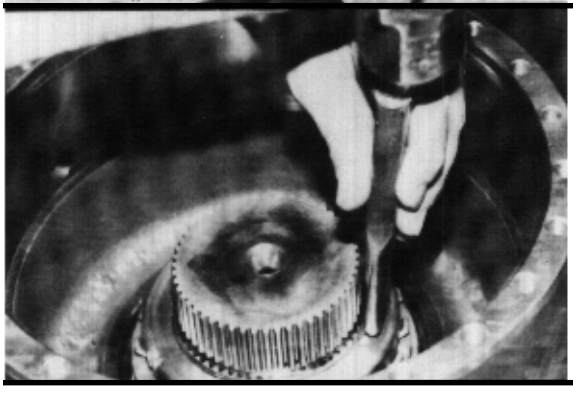


20. Measure the final rolling torque of **hub(1G)** using the same manner described in steps 13a - 13d. The final rolling torque should measure 35-60 in.-lbs.

NOTE: Remove the bolt from the hub.



21. Bend the aligned tang on **lockwasher(1J)** up into the notch on **locknut(1K).**



22. Using a center punch and hammer, stake **locknut(1K)** in four equally spaced positions around the circumference of the locknut and at a distance of 1/8 in. from the inside edge of the locknut.

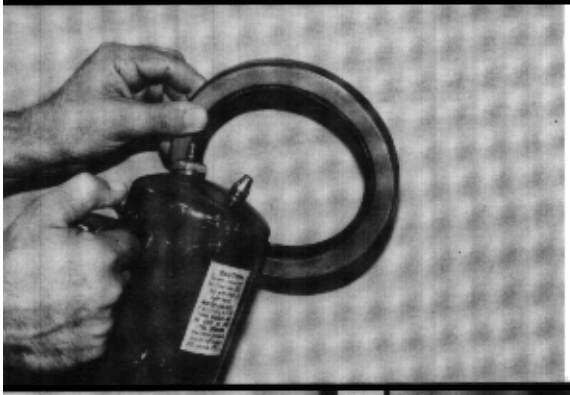
23. At this point the hub-shaft subassembly is complete.

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MAIN ASSEMBLY

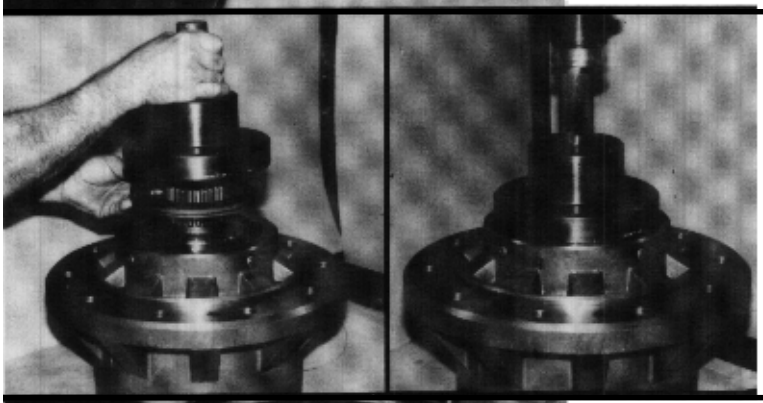


1. Turn **hub(1G)** over so that it rests on its large diameter end. Spray oil on all exposed surfaces inside the hub while turning **output shaft(1A).**



2. Spray the inside of **seal(1B)** with oil.

NOTE: The open face of the seal may have a waved surface. This is an intentional design used to keep dirt out.



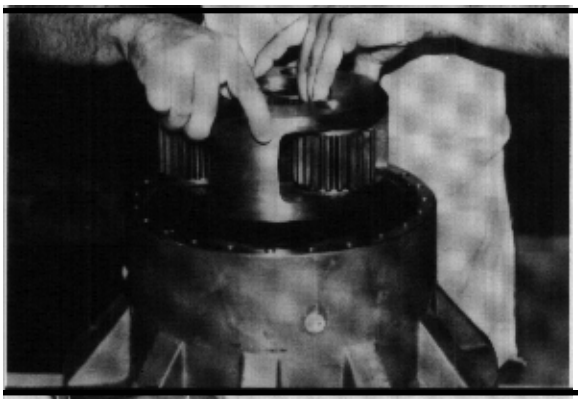
3. Press **seal(1B)** into the small diameter end of **hub (1G)** using a seal pressing fixture (tool no.T-156799).



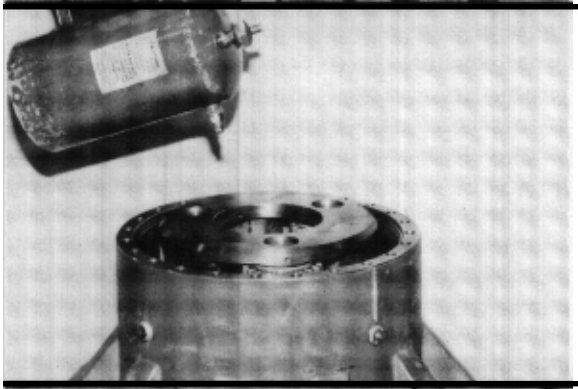
4. Turn **hub(1G)** over once again so that it rests on its small diameter end. Using retaining ring pliers, insert **retaining ring(1L)** into the groove on **output shaft(1A).**

CAUTION: Saftey glasses should be worn during this procedure.

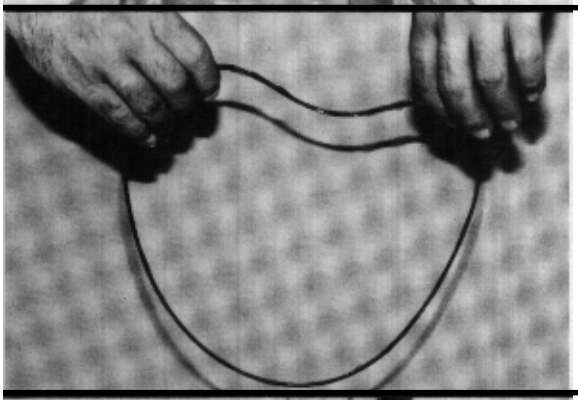
https://truckmanualshub.com/



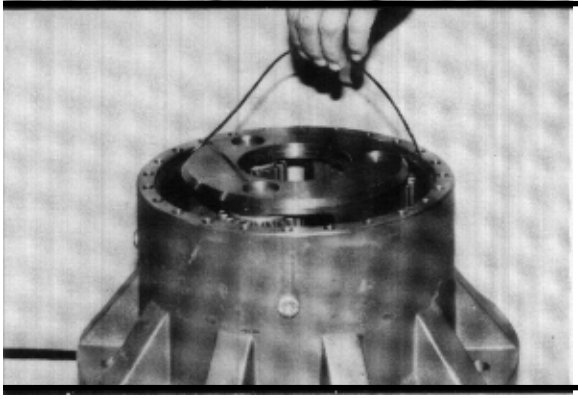
5. Place second **stage carrier assembly(2)**, with spline connections down, into **hub(1G)** so that the carrier's spline connections mesh with the spline connections on **output shaft (1A).**



6. Spray oil on all exposed surfaces inside **hub(1G).**



7. Grease **"O" ring(5).**



8. Place **"O" ring(5)** into the counterbore of **hub(1G).** Make sure that the counterbore is oil free before installing "O" ring.

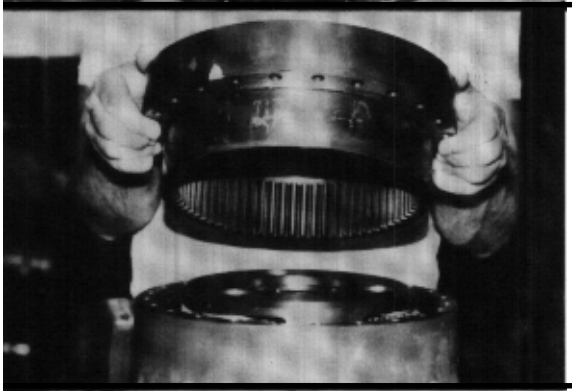
CAUTION: Beware of sharp edges and burrs in the counterbore while installing the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.

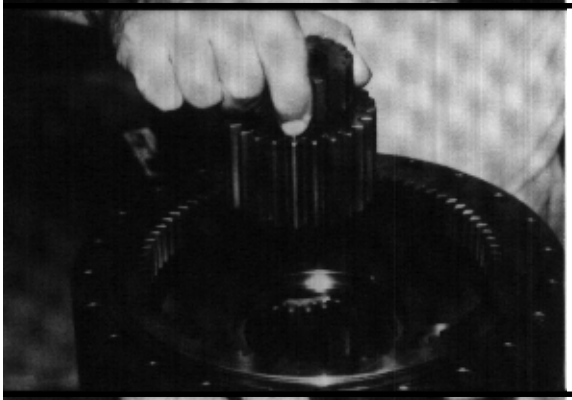
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9. Spary oil on the inside of **ring gear(4).**



10. Place **ring gear(4)** with small diameter end down, into **hub(lG)** so that it fits over **second stage carrier assembly(2).**

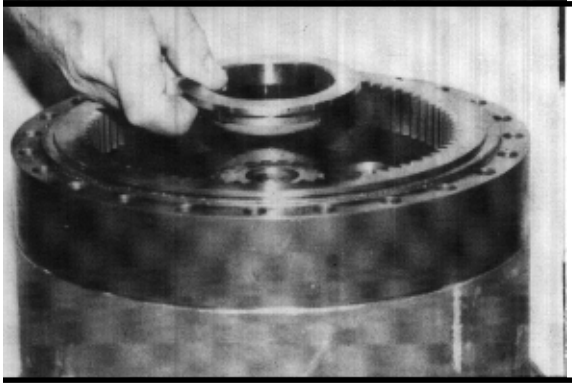


11. Place **second stage sun gear(11),** with large diameter end down, into mesh with the planet gears of the **second stage carrier assembly(2).**



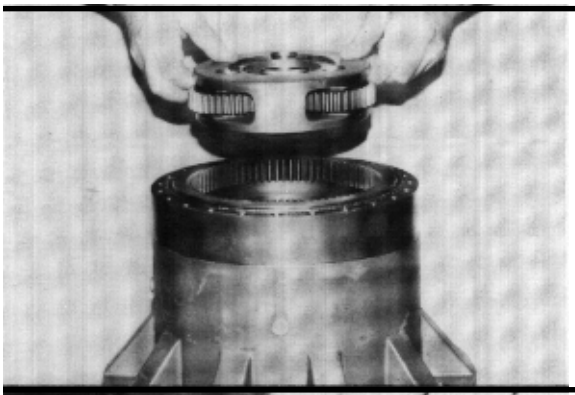
l2. Place large **thrust washer(14), thrust bearing(13)**, and large **thrust washer(12)** in that order into the counterbore of **second stage carrier assembly(2).**

NOTE: Notice that **thrust washer(14)** is much thicker than **thrust washer(12).**

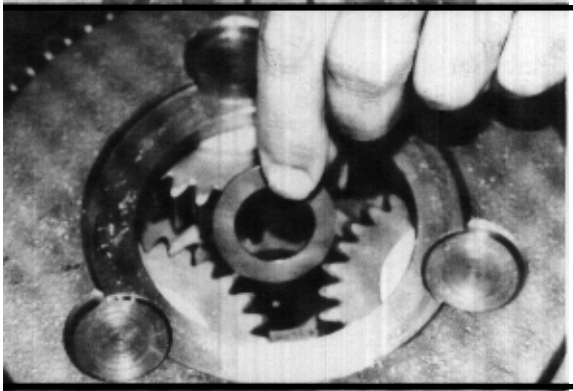


13. Place thrust bearing carrier (10), with small diameter end down, into the counterbore of **second stage carrier assembly(2).** It should fit over the thrust bearing set(12, 13, 14) described in step 12.

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14. Place **first stage carrier assembly(3)**, with spline connections down, into mesh with the **second stage sun gear(ll)** and the **ring gear(4).**



15. Place small **thrust washer(9)** on top of **second stage sun gear(ll).**



16. Place **input gear(8)**, with small diameter end down, into mesh with the planet gears of **first stage carrier assembly(3).** The input gear should be centered on the small **thrust washer(9).**

17. Set **cover(6)** down on its small diameter end.



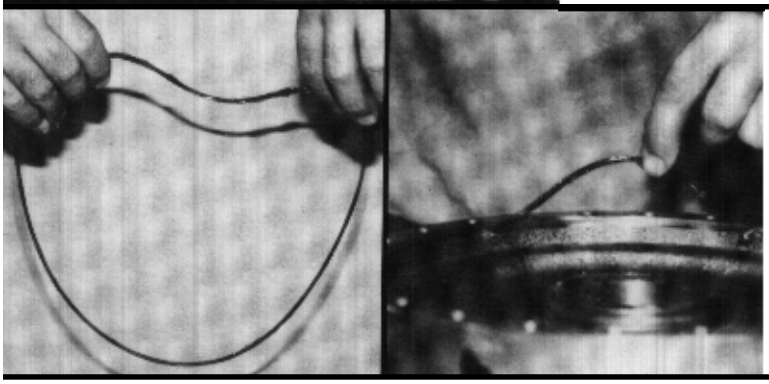
18. Grease one side of large **thrust washer(12), thrust bearing(13)**, and large **thrust washer(14)** and place them greased side down in that order over the raised inside circular edge of **cover(6).**

NOTE: Notice that **thrust washer(14)** is much thicker that **thrust washer (12).**

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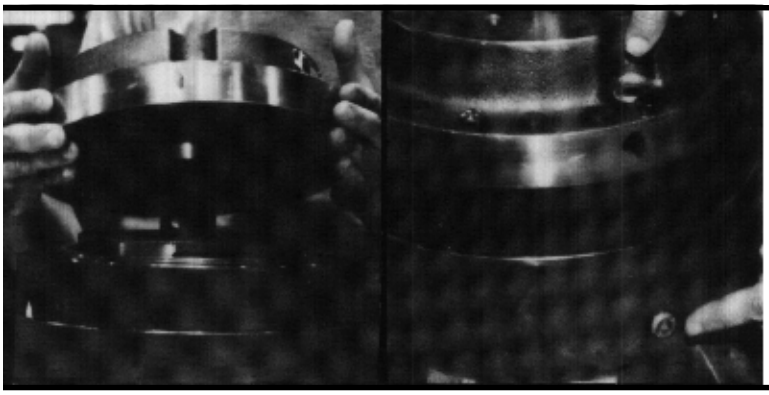
19. Grease small **thrust washer(7)** and place it in the counterbore of the center hole in **cover(6).**



20. Grease **"O" ring(5)** and place it around the counterbore in **cover(6).**

CAUTION: Beware of sharp edges and stalling the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



21. Place **cover(6)**, with large diameter end down, on top of **ring gear(4)** so that the cover's pipe plug hole aligns with the magnetic pipe plug hole in **hub(lG)** according to figure 2.

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This figure shows the most common pipe plug timing for this series. Pipe plug timings may vary among units with different model numbers. Refer to an original assembly print for your particular unit to determine its correct pipe plug timing.

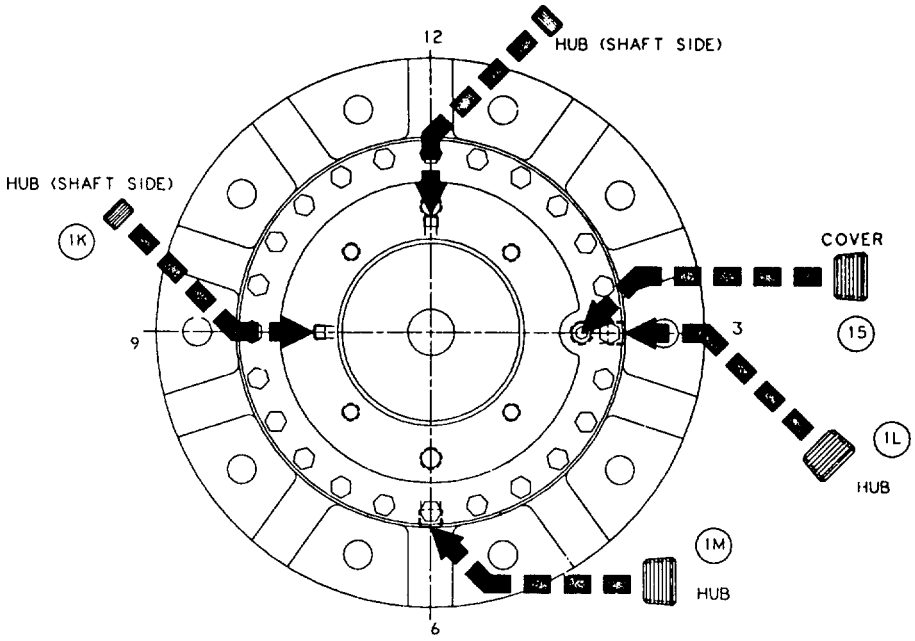
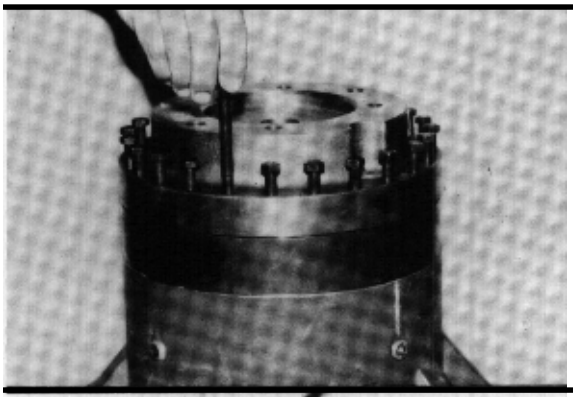
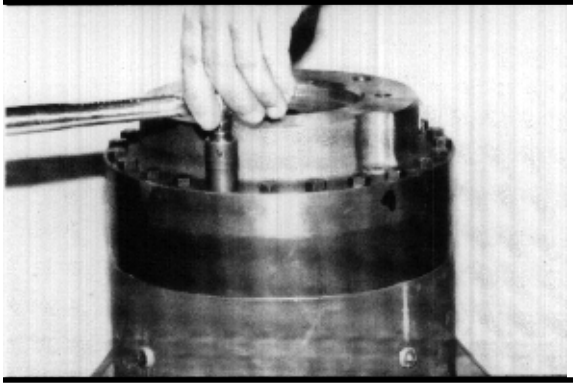


Figure 2.

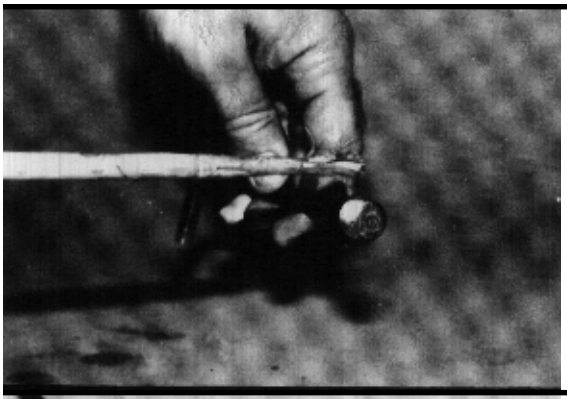


22. Place the 24 **grade 8 bolts(16)** into **cover(6)** and tighten.

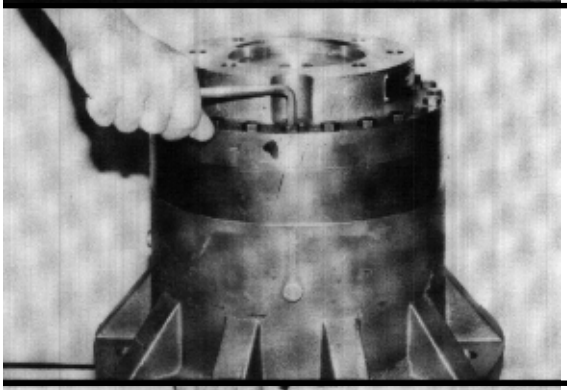


23. Using a torque wrench, apply 35-45 ft.-lbs of torque to each **grade 8 bolt (16).**

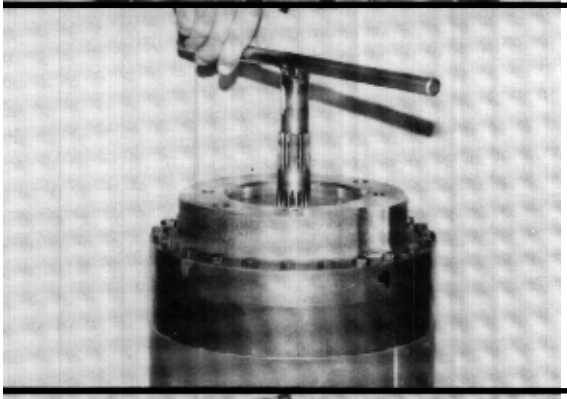
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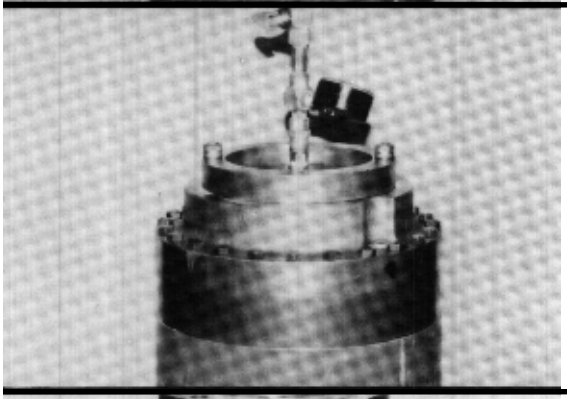
24. Apply a light coat of “Never-Seize” to **pipe plug(15).**



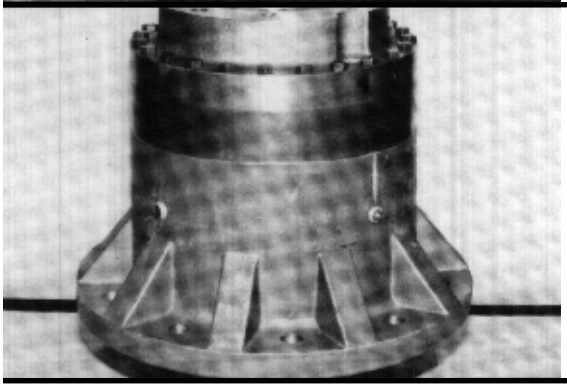
25. Tighthen **pipe plug(15)** into the pipe plug hole in **cover(6).**



26. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. The ratio number is the same as the last two digits in the model number found on the **ID** tag of the unit.



27. Leak test the unit at a pressure of 5 psi for 2-3 minutes.



28. At this point the main assembly complete.

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The following specialized tools are used in the assembly of this unit. The tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools must be made from mild steel. All dimensions are given in inches.

OPTIONAL: In order to improve tool life, tools may be carborized and hardened. If this is done, however, the tools must be ground on all surfaces labeled with a “G” on the tool diagram.

1. TOOL NO. T-130717
   BEARING CUP PRESSING FIXTURE for CUP(1E)

2. TOOL NO. T-156792
   BEARING CUP PRESSING FIXTURE for CUP(1C)

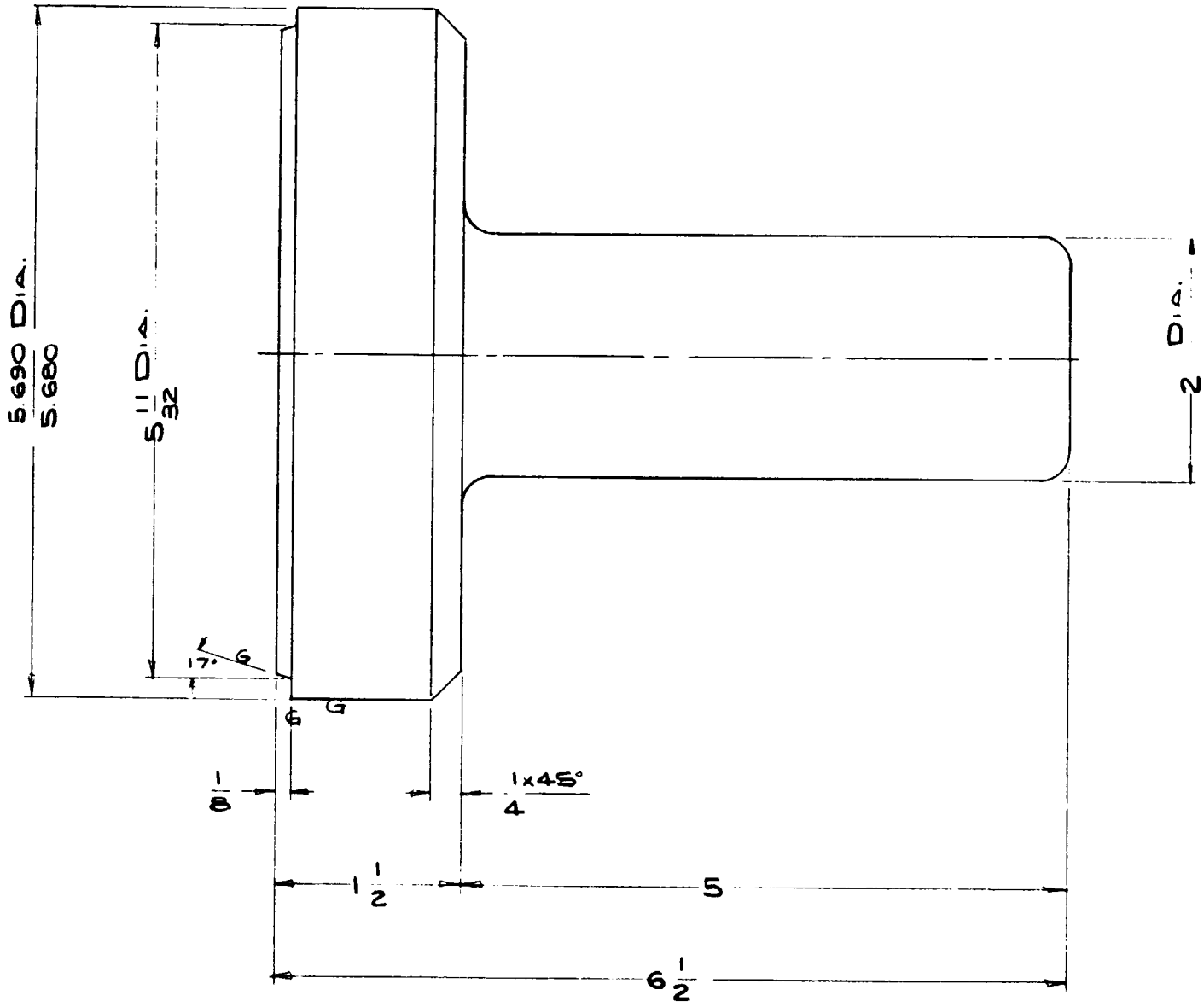
3. TOOL NO. T-158049
   BEARING CONE PRESSING FIXTURE for CONE(1D)

4. TOOL NO. T-146588
   BEARING CONE PRESSING FIXTURE for CONE(1F)

5. TOOL NO. T-156766
   AN-18 LOCKNUT WRENCH

6. TOOL NO. T-156799
   SEAL PRESSING FIXTURE

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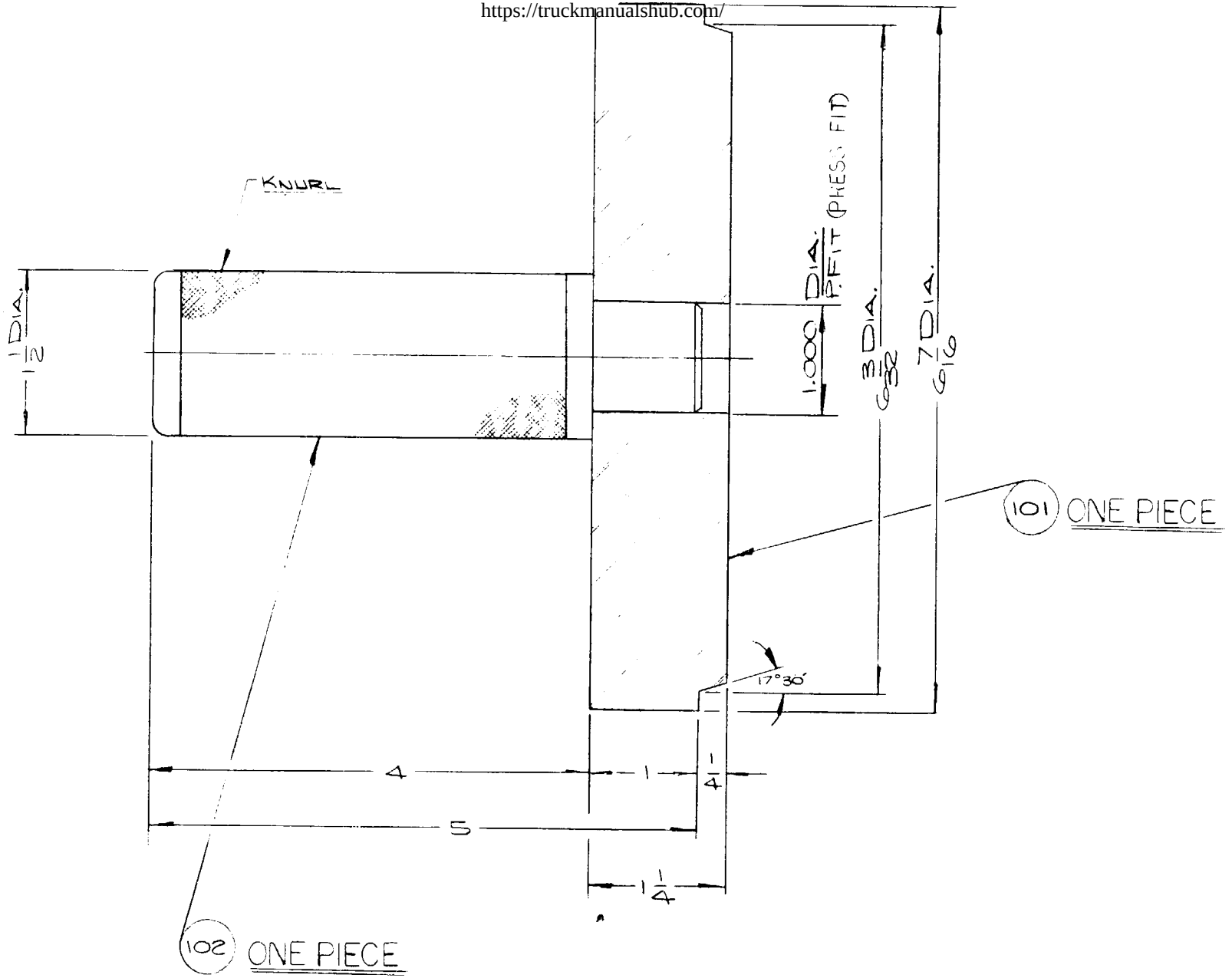


T-130717

SCALE: 3/4 ONE PIECE

BEARING CUP PRESSING FIXTURE
for CUP(1E)

https://truckmanualshub.com/

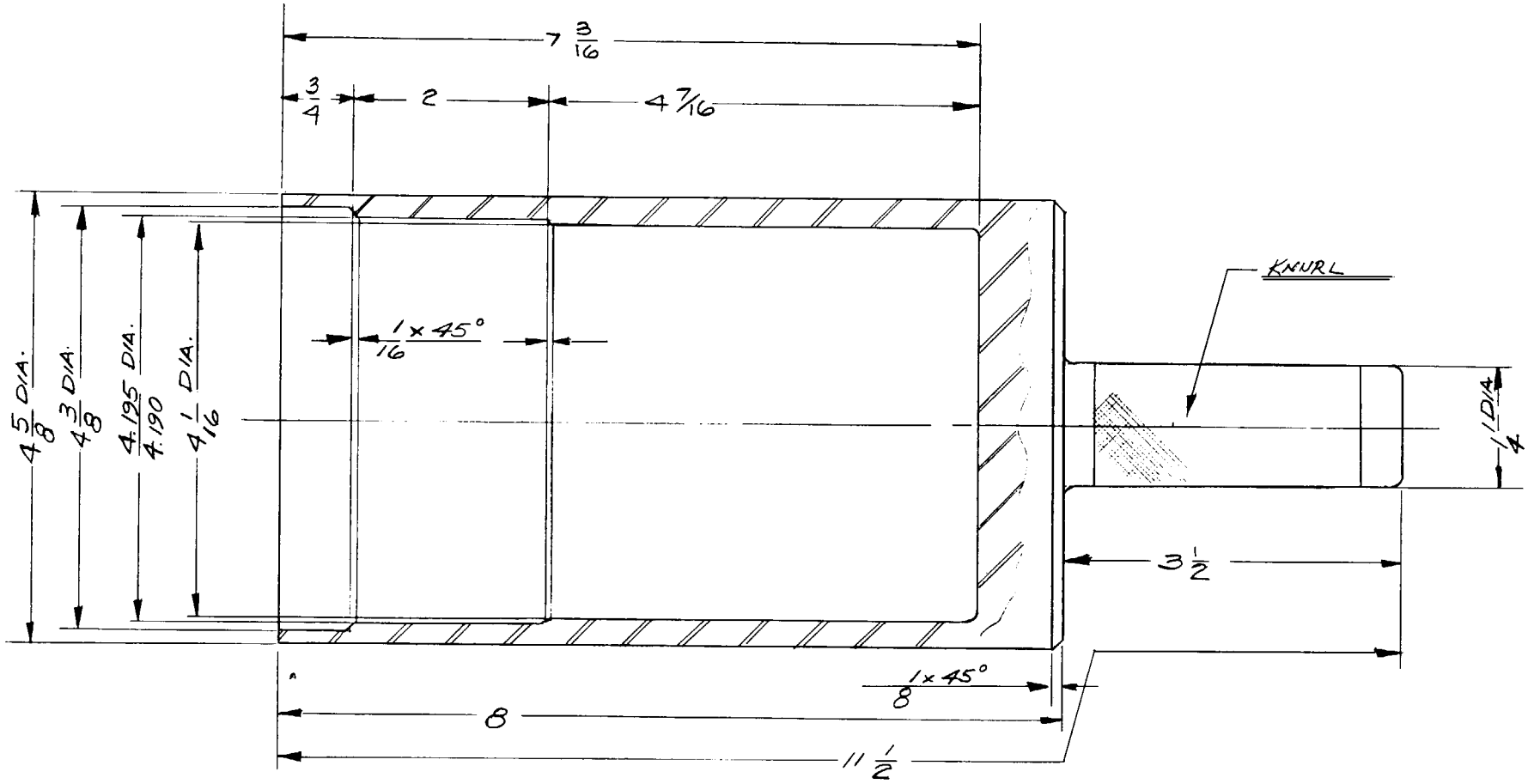


T-156792

SCALE: 3/4

BEARING CUP PRESSING FIXTURE
for CUP(1C)

https://truckmanualshub.com/

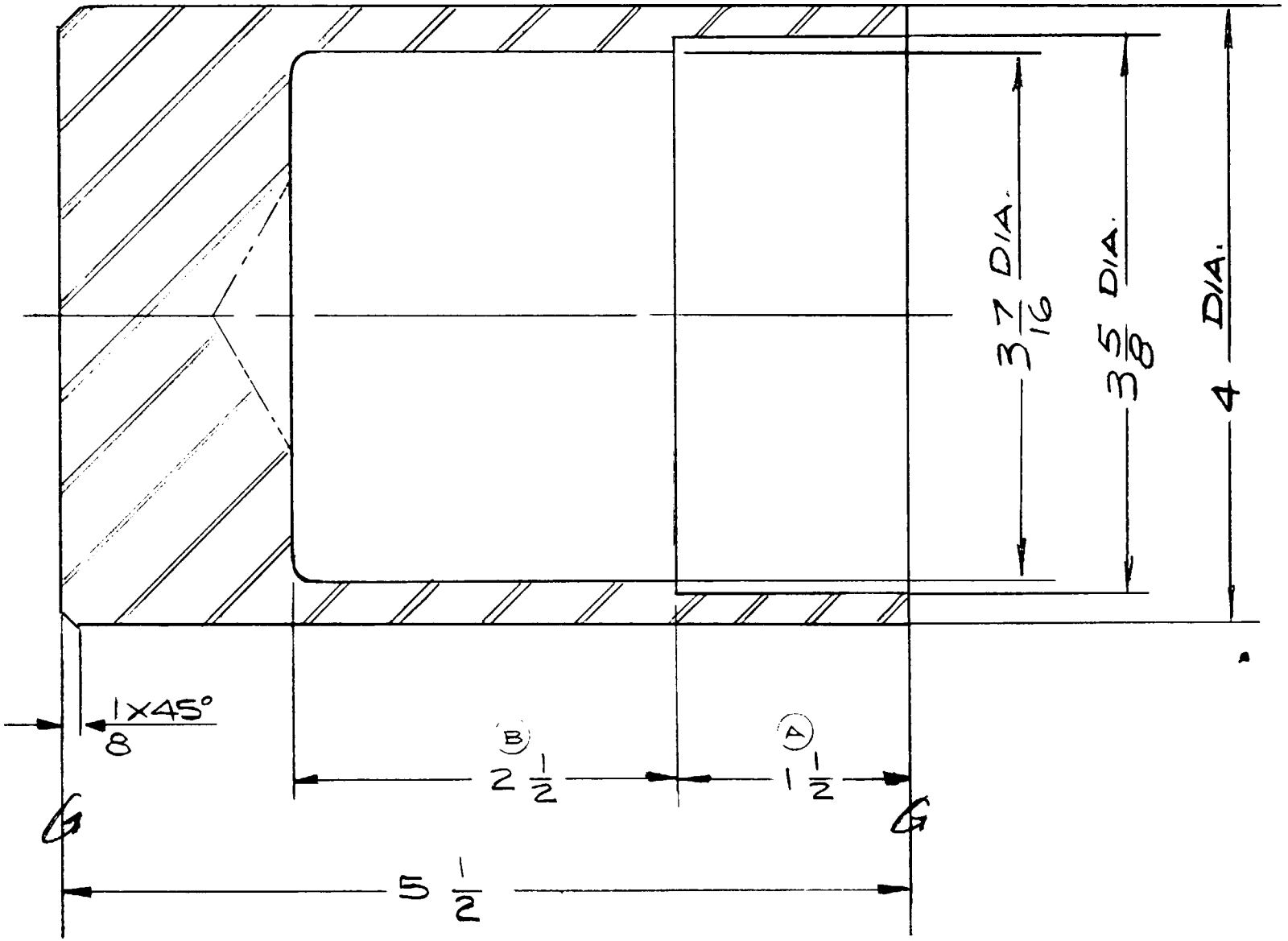


T-158049

SCALE: 3/4 ONE PIECE

BEARING CONE PRESSING FIXTURE
for CONE(1D)

https://truckmanualshub.com/

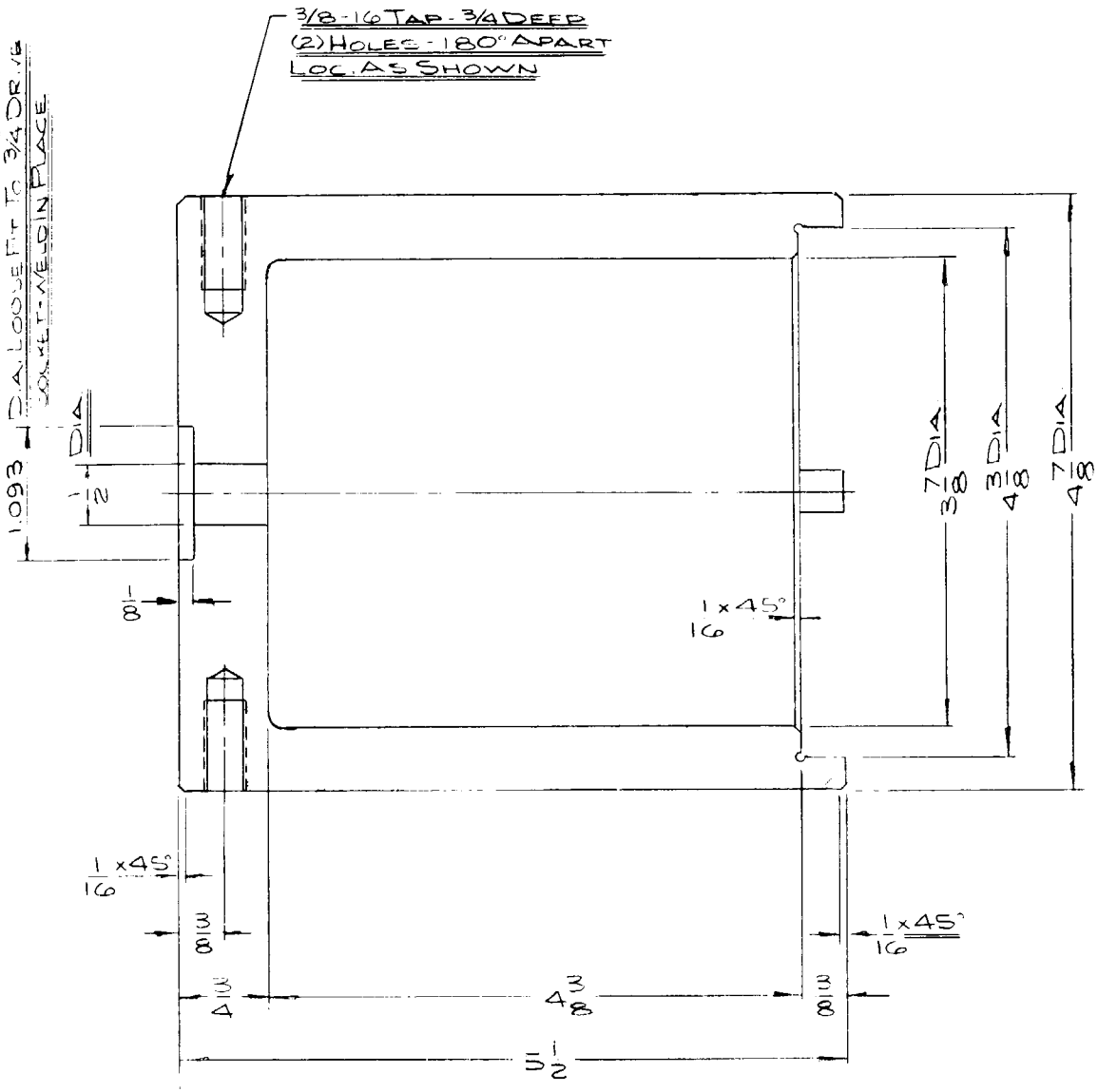


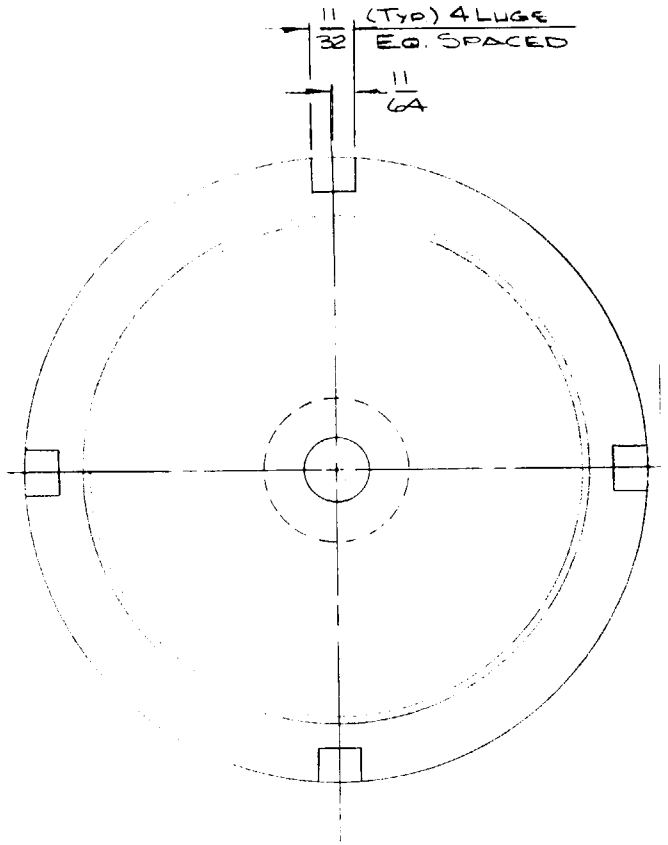
T-146588

SCALE: full ONE PIECE

BEARING CONE PRESSING FIXTURE
for CONE(1F)

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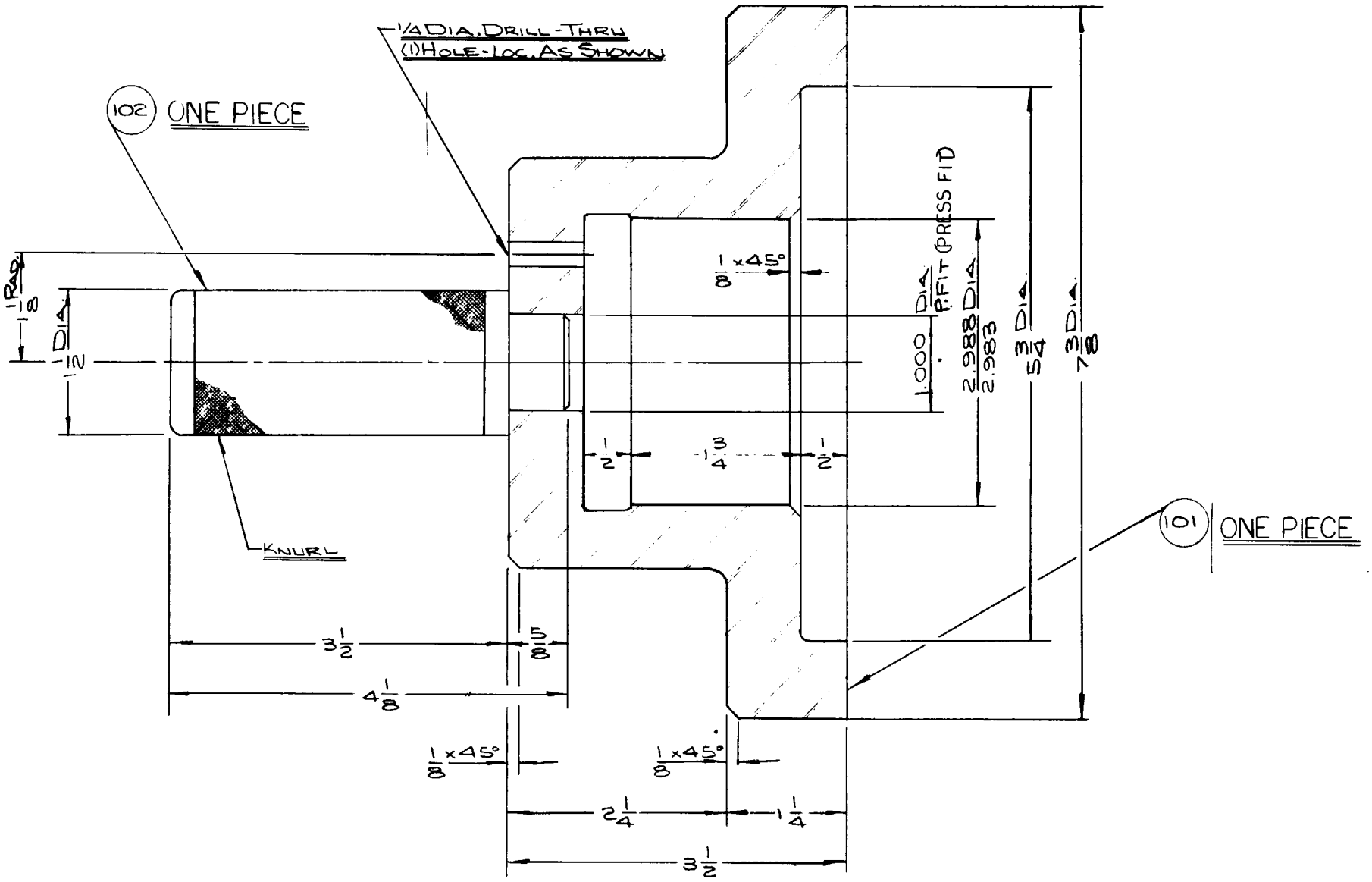
T-156766

AN-18 LOCKNUT WRENCH

SCALE: 2/3 ONE PIECE

USE 3/4 in. DRIVE SOCKET

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T-156799 **SCALE: 2/3**

SEAL PRESSING FIXTURE

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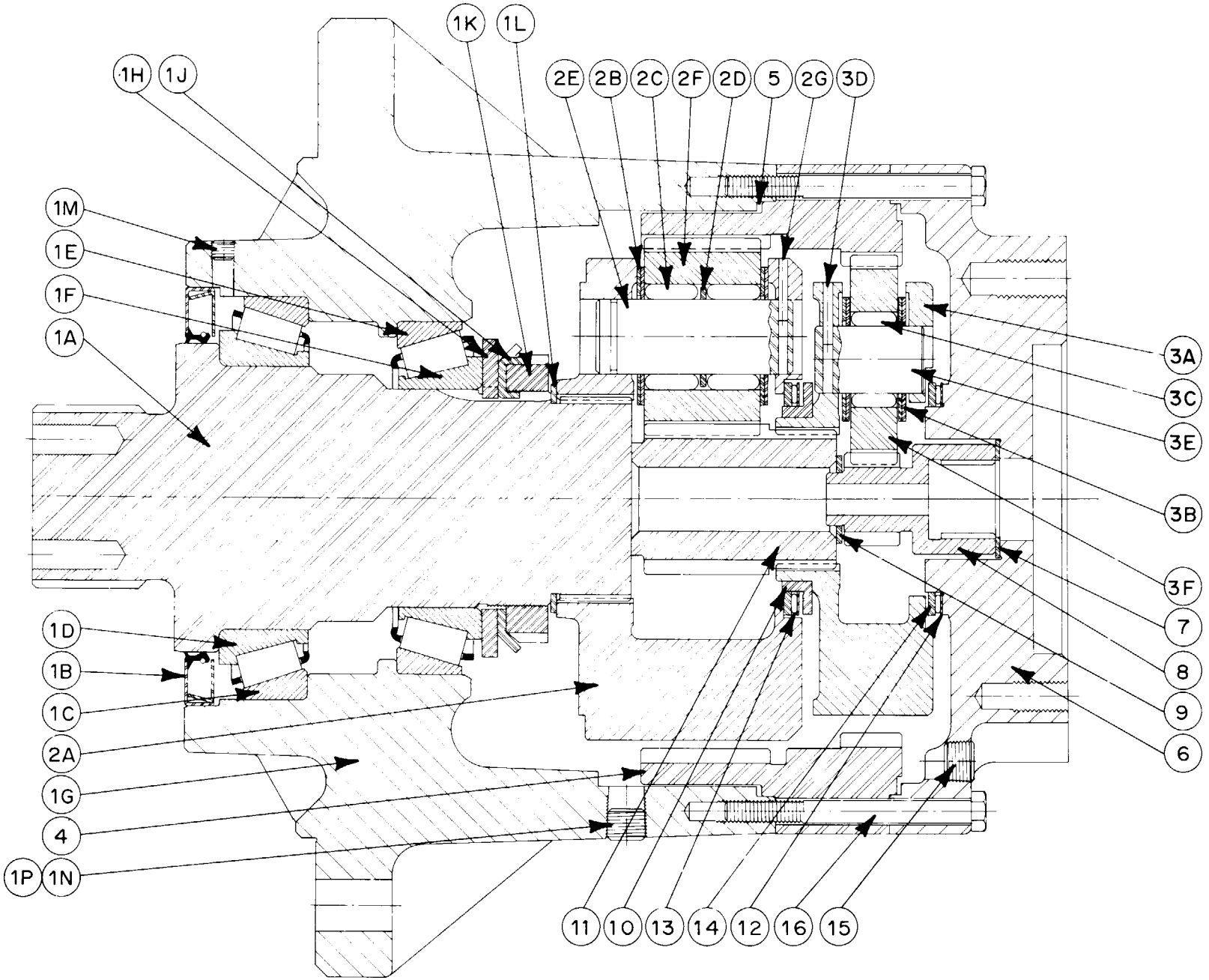
PARTS LIST

ITEM	QUANTITY	DESCRIPTION
1	1	hub-spindle sub-assembly
1A	1	output shaft
1B	1	seal
1C	1	bearing cup
1D	1	bearing cone
1E	1	bearing cup
1F	1	bearing cone
1G	1	hub
1H	1	tanged washer
1J	1	lockwasher
1K	1	locknut
1L	1	retaining ring
1M	2	pipe plug
1N	1	pipe plug
1P	1	magnetic pipe plug
2	1	second stage carrier sub-assembly
2A	1	second stage carrier
2B	12	thrust washer
2C	108	needle roller
2D	3	spacer
2E	3	planet shaft
2F	3	planet gear
2G	3	dowel pin
3	1	first stage carrier sub-assembly
3A	1	1 first stage carrier
3B	12	thrust washer
3C	57	needle roller
3D	3	dowel pin
3E	3	planet shaft
3F	3	planet gear
4	1	ring gear
5	2	“O” ring
6	1	cover
7	1	thrust washer
8	1	input gear
9	1	thrust washer

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ITEM	QUANTITY	DESCRIPTION
10	1	thrust bearing carrier
11	1	second stage sun gear
12	2	thrust washer
13	2	thrust bearing
14	2	thrust washer
15	1	pipe plug
16	24	bolt
17	4	drive screw
18	1	ID plate

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CROSS-SECTIONAL VIEW of S6A

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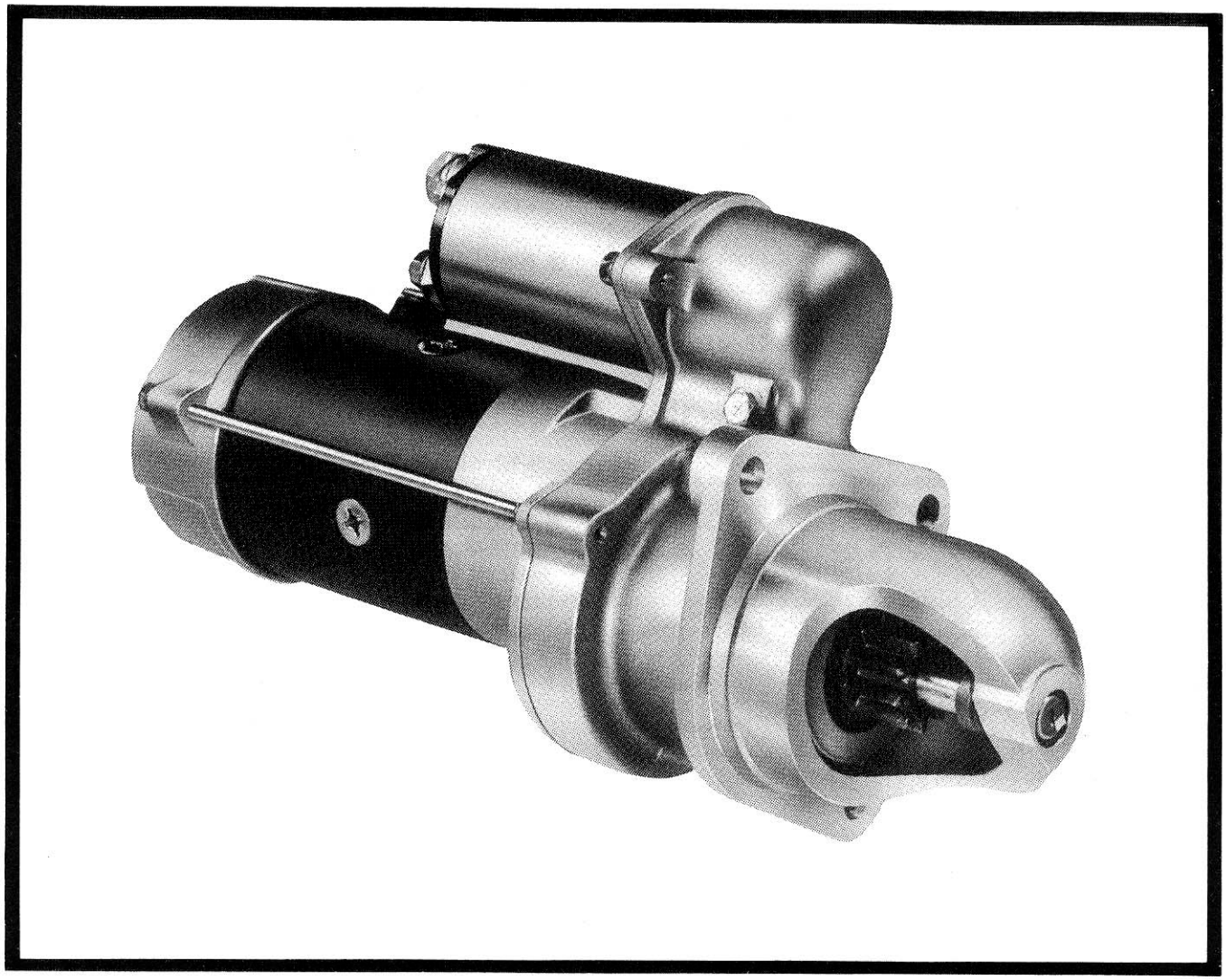
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Delco Remy

PRODUCT INFORMATION

1M-128
9/15/91



28-MT CRANKING MOTOR SERVICE MANUAL

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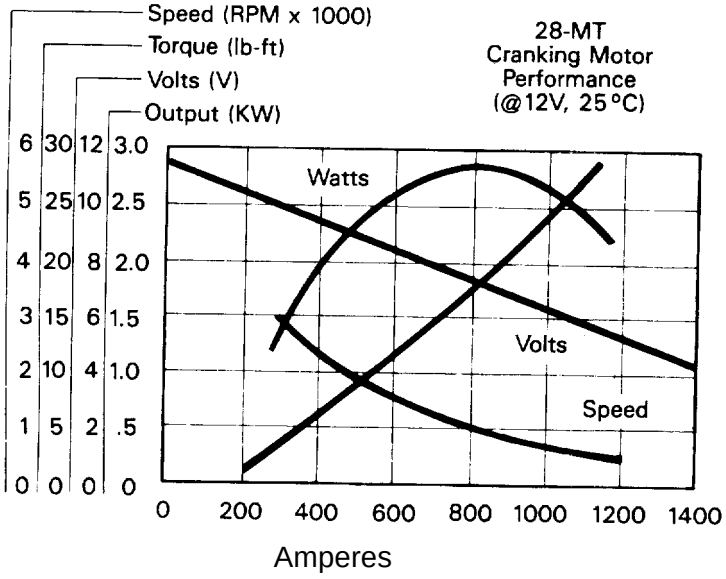
FEATURES

■ Totally-Enclosed Shift Mechanism
- Solenoid-Operated Shift Lever
- "O" Ring Seals
- Solenoid Sealing Boot

■ Sealed Solenoid
- Layer Wound Coil
- Waffle Design Contact Face

■ Bearing Lubrication and Sealing
- Ball Bearing at Commutator End
- Bronze Sleeve Bushing in Drive Housing
- Sealing for Wet Clutch Applications Available

■ Medium-Duty Drive
- Positive-Shift Overrunning Clutch
- Five Roll



■ Gear Reduction
- Gear Ratio: 3.875/1
- Two Ball Bearings

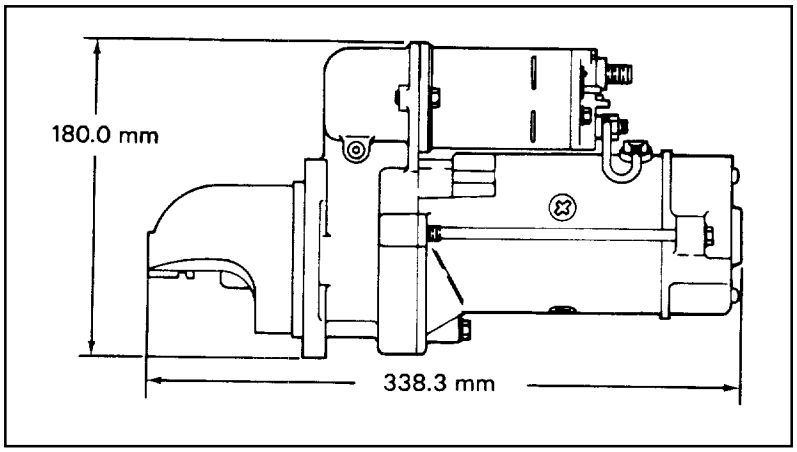
■ Long-Life Brushes
- Four One-Piece Brushes
- Constant Pressure Brush Springs
- Radialine Brush Holders
- Heavy Brush Leads

■ High-Reliability Armature
- Molded Bar Commutator
- Steel Banded
- Varnish Impregnated
- Dynamically Balanced

■ Field Coils
- Nomex Covered Conductors
- Insulation Between Coils and Pole Shoes

■ Medium-Duty Applications
- Diesel Powered Light Trucks
- Diesel Passenger Cars
- Low-Range Diesel Engines

■ Specifications
- Diesel Engine Size:
  —Up to 6.5 liters
- System Voltage: 12-V or 24-V
- Rotation: Clockwise or Counter-Clockwise
- Mounting:
  —S.A.E. #1, #2, #3, #4
  —Automotive Type: Pad Mount
- Pinion Data
  —S.A.E.: No. Teeth/Pinion Blank: (Pitch 10/11 (10-12); 10/11 (8-10); 12/13 (8-10)
- Weight: 8.0 kg (17.6 lbs.



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INTRODUCTION AND DESCRIPTION

INTRODUCTION

This publication covers the Delco Remy 28-MT Cranking Motor (see figure 1). As listed in the CONTENTS, descriptive information and instructions for testing, troubleshooting, removal, unit repair and installation are provided. For parts information, refer to the Delco Remy Service Parts Catalog.

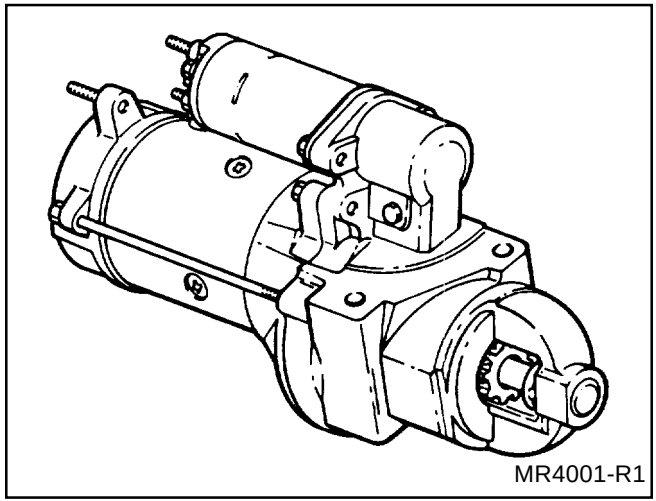


Figure 1 — 28-MT Cranking Motor

GENERAL DESCRIPTION

Figures 1 and 2

The 28-MT Cranking Motor provides high starting torque in a compact, lightweight package by using a high speed motor through an offset gear reduction unit. The 28-MT is suitable for medium duty applications such as diesel-powered light trucks and passenger cars, and other low-range diesel engines. Weighing just 8 kg (17.6 lb), the 28-MT produces up to 3 kilowatts of output. Models are available for either 12- or 24-volt systems, and with either clockwise or counterclockwise rotation.

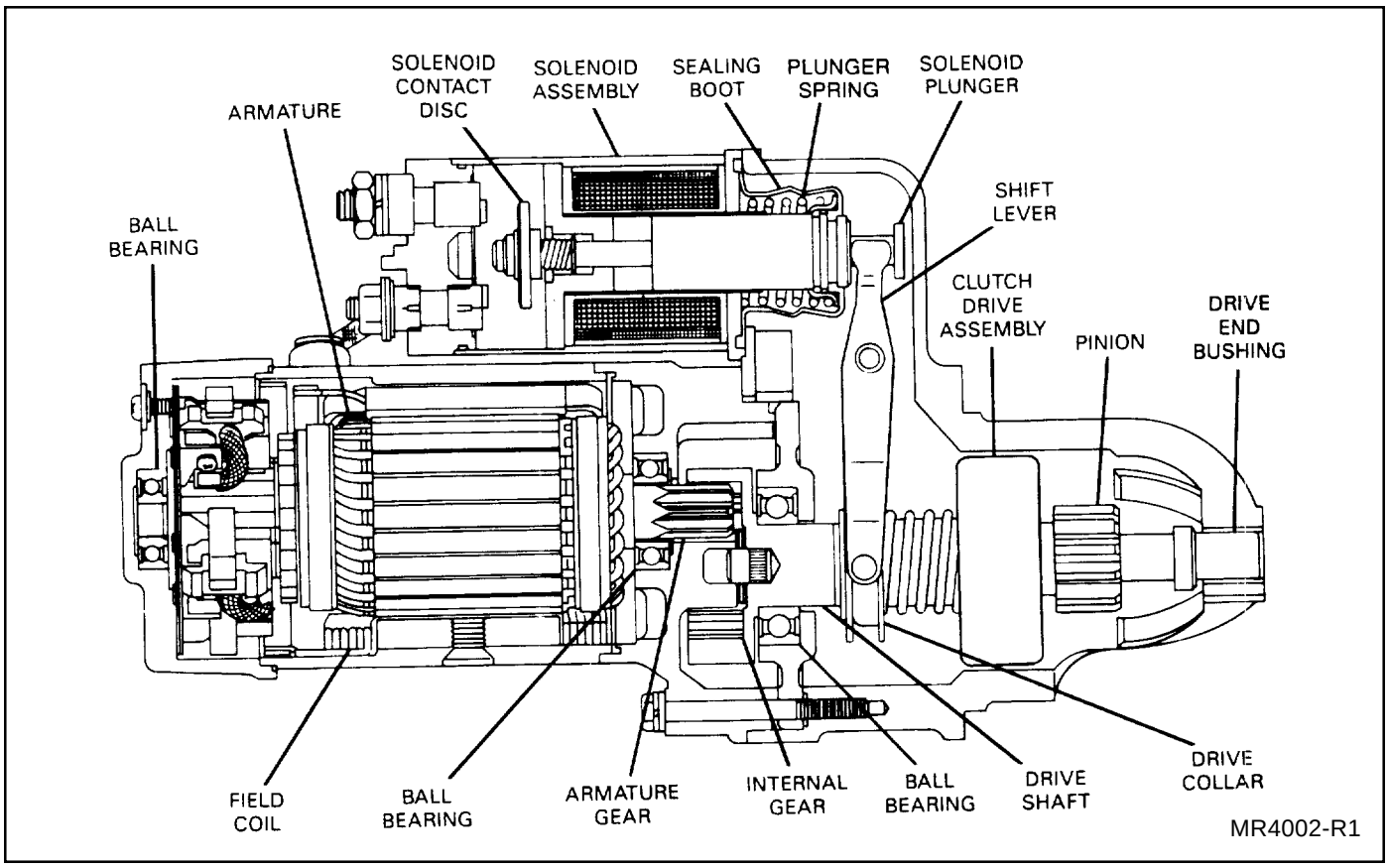


Figure 2 – Cranking Motor Cross Section

The 28-MT has a totally enclosed, solenoid operated mechanism for positive shift of the pinion into engagement. The solenoid is sealed to prevent entry of foreign material. Within the solenoid, waffle-type contact faces and a solid link between the contact disc assembly and the solenoid plunger help prevent contact sticking. The shift lever is attached to the plunger on one end and mates with a collar on the drive assembly at the other end. The action of the lever forces the drive pinion into engagement with the engine flywheel when the magnetic pull of the solenoid draws the plunger in.

A medium-duty, 5-roll overrunning drive is used for low overrun friction and long operating life. The drive shaft is supported by a ball bearing at the gear reduction end by a sleeve bushing at the drive end. An external helical spline on the drive shaft turns the pinion as it moves into engagement with the engine flywheel. An internal gear at the gear reduction end of the drive shaft is driven by the armature shaft gear at a speed of one drive shaft revolution for each 3.875 revolutions of the armature.

The 28-MT armature is dynamically balanced and rides in sealed ball bearings at each end. Steel banding and varnish impregnation are used for added armature strength. The molded-bar commutator receives electrical power through radially positioned, one-piece brushes. Constant-pressure brush springs are used for even brush wear and long brush life.

OPERATING PRINCIPLES

Figures 2, 3 and 4

Figure 3 shows an electrical schematic for the cranking motor when it is at rest and when it is cranking the engine. The cranking motor is at rest when the engine is off and also when the engine is running normally after starting.

When the start switch is closed, a small current flows through the solenoid pull-in coil, field coil, and armature windings to ground. A small current also flows through the hold-in coil to ground. With both solenoid coils energized, the plunger is pulled magnetically into the solenoid. This action moves the shift lever and engages the pinion with the engine ring gear, and moves the contact disc to close the solenoid switch contacts. When the switch contacts close, a large current flows through the field coils and armature, causing the armature to turn and crank the engine. This large current heats up the current carrying conductors in the motor.

When the engine starts and picks up speed, the overrunning clutch allows the pinion to spin freely on the cranking motor drive shaft, preventing the engine from "driving" the cranking motor. When the start switch is current momentarily flows from the solenoid contacts through the pull-in coil and hold-in coil to ground. The current flow through the pull-in coil is in the opposite direction to that in the hold-in coil. This creates opposing magnetic fields that cancel each other out. With the magnetic pull of the solenoid canceled, the plunger is released and the plunger spring pushes it out of the solenoid, opening the solenoid contacts. The shift lever pulls the pinion out of engagement with the flywheel.

Figure 4 shows a typical wiring circuit with the cranking motor installed on the vehicle. One or more control switches may be used in series with the start switch to prevent cranking the engine unless certain system conditions are met. Refer to the specific vehicle wiring diagram to see what other cranking controls may be used. A typical example of a control switch is a neutral safety switch that prevents cranking unless the transmission in is neutral. In 12-volt systems, the relatively low current in the "S" terminal circuit may be handled directly by the start switch. However, higher current levels in 24-volt systems always require that the start switch operate a separate magnetic switch in the "S" terminal circuit.

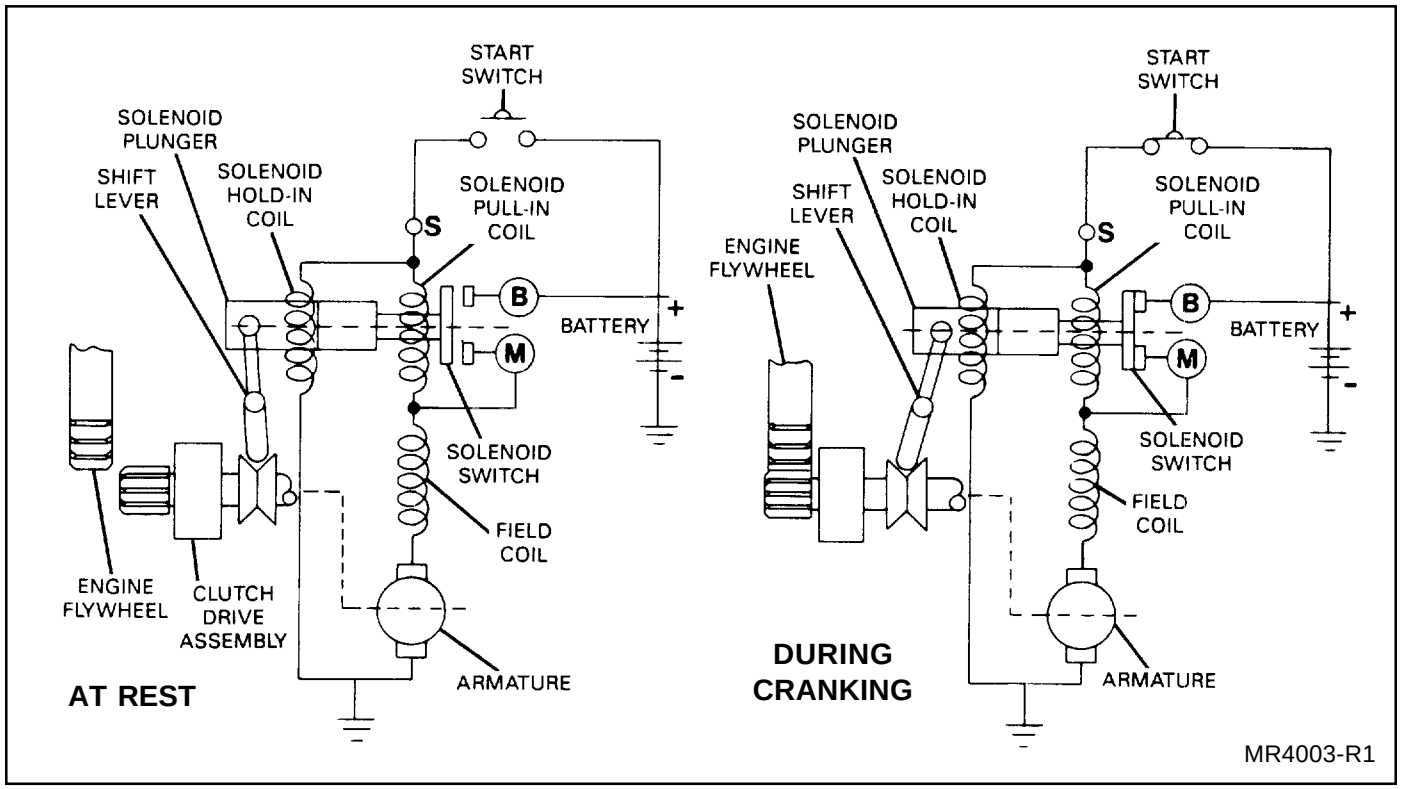


Figure 3 – Cranking Motor Electrical Schematic

NOTICE: To avoid damage to the motor due to overheating, do not crank the engine continuously for more than 30 seconds at a time. If the engine has not started within 30 seconds, allow the cranking motor to cool for at least 2 minutes before trying again.

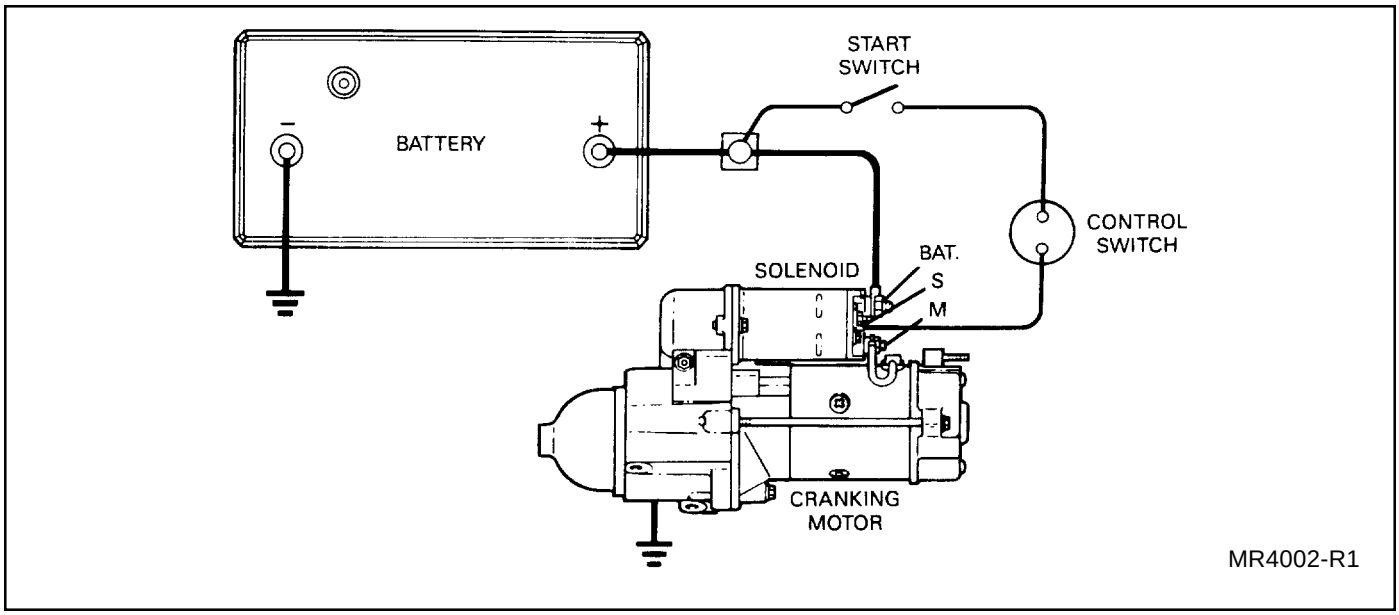


Figure 4 - Cranking Motor Wiring Circuit

TROUBLESHOOTING

ON-VEHICLE SERVICE

To independently test the cranking motor it is necessary to remove it from the engine. However, before doing this, checks should be made to ensure that the problem is with the cranking motor and not with the engine, battery, wiring or switches. When the other possible problem sources have been eliminated, then remove and test the cranking motor. Comparison of test results with the Troubleshooting Chart, Table 1, will aid in isolating the problem within the cranking motor to specific components. This will determine the repair or repairs needed to restore the cranking motor to serviceability.

BATTERY TESTS

Realistic testing, as well as successful operation, requires a fully charged battery capable of supplying the current needs of the starting system. Step one in troubleshooting the starting system is to test the battery. Follow vehicle or battery manufacturer's instructions, such as Delco Remy bulletins 1B-115 and 1B-116.

WIRING AND SWITCHES

VISUAL INSPECTION

Visually inspect all wiring and switches in the starting circuit for damage and loose or corroded connections. This includes all ground connections. Clean and tighten connections as required. Replace damaged wiring or components.

CONTINUITY CHECK

Set parking brake and/or block wheels to prevent movement of vehicle during checks. Disconnect field lead on cranking motor from solenoid "M" terminal and insulate carefully to prevent accidental contact. Set manual transmission to neutral and depress clutch, or place automatic transmission in "Park." Use voltmeter to check for voltage at solenoid "S" terminal while start switch is held in "Start" position. If voltage is not present at "S" terminal, use voltmeter and vehicle manufacturer's wiring diagram to trace control circuit and locate point of voltage loss and correct as necessary. For further information on general diagnosis of the starter control circuit, refer to Delco Remy publication DR-9O33.

CRANKING MOTOR REMOVAL

If the battery, wiring and switches are in satisfactory condition and the engine is known to be functioning properly, remove the cranking motor for further testing. Refer to the vehicle or engine manufacturer's instructions for the proper removal procedure.

CRANKING MOTOR NO-LOAD TEST

GENERAL INFORMATION

With the cranking motor removed from the engine, the no-load test can reveal damage that can be corrected by repair or it may indicate the need for component testing after the cranking motor is disassembled. Repair and component test procedures are described in the UNIT REPAIR section. The no-load test is also used to test units for normal operation after repair or overhaul. Comparison of test results with the Troubleshooting Chart, Table 1, will indicate what corrective action, if any, is required.

TEST HOOK-UP

Figure 5

Connect the cranking motor for the no-load test as shown in figure 5 using suitable instruments, battery cables and connecting wiring. Note the following.

1. Secure cranking motor in suitable test stand to check operation.
2. Use a momentary contact, pushbutton switch in the test circuit for quick release if very high current surges are encountered.
3. Make all connections or disconnections with the switch open and the carbon pile load turned off.
4. If sparking or current flow in the battery circuit is noted when making connections, the cranking motor solenoid switch contacts may be frozen shut (refer to Table 1, Troubleshooting).
5. As the last step in making the test connection, ground the negative battery cable securely to a clean metal ground on the cranking motor frame.
6. The carbon pile load is used to adjust operating voltage for comparison with specifications. It may not be necessary in all cases but should be used to eliminate the need for interpolation of test data.

TEST PROCEDURE

CAUTION: Keep fingers and tools away from opening in D.E. (drive end) housing while testing. The strong shifting action of the solenoid could cause personal injury or damage as the drive pinion moves into the cranking position and spins.

NOTICE: During no-load test, close switch and operate cranking motor for cycles of 30 seconds maximum. Between cycles, allow cranking motor to cool for at least two minutes. Otherwise, overheating and damage to the cranking motor may result.

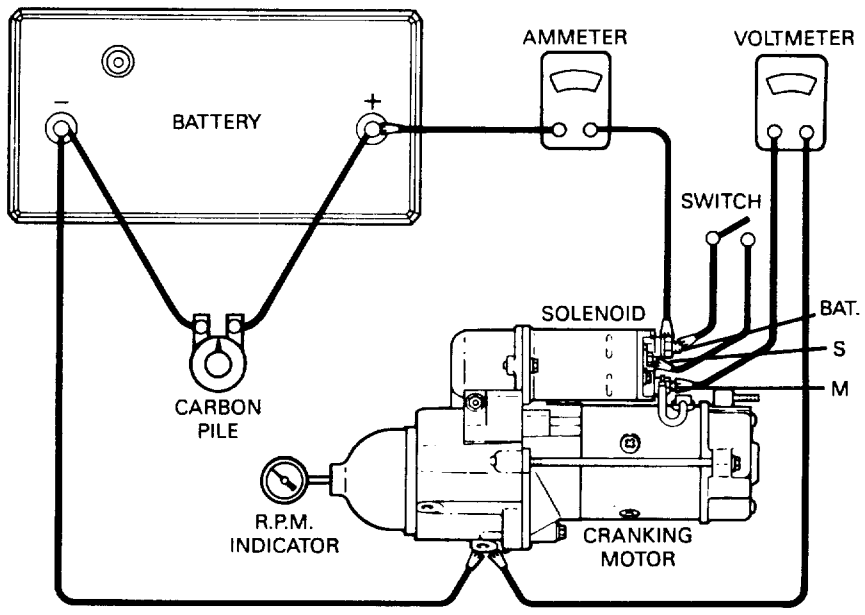


Figure 5 - Cranking Motor No-Load Test Hook-Up

1. Momentarily close switch.
   - If there is high current flow and cranking motor fails to operate (zero rpm), release switch immediately. Internal mechanical damage is indicated. Discontinue test and refer to Table 1, Troubleshooting.
   - If there is no current flow and cranking motor fails to operate (zero rpm), release switch immediately. An open circuit is indicated. Discontinue test and refer to Table 1, Troubleshooting.
   - If there is current flow and cranking motor operates, release switch and proceed with the next step of the no-load test.
2. Close switch and observe voltmeter. Adjust carbon pile load to obtain 10 volt reading (20 volts on 24-volt cranking motor). Observe and record ammeter and RPM readings. Release switch.

Compare ammeter and RPM readings to those listed under "Specifications" at the end of this manual. If the readings are outside the limits shown, refer to Table 1 to determine the most likely causes. If the readings are within the limits, the cranking motor is operating normally.

TROUBLESHOOTING

If results of the no-load test are outside limits, refer to Table 1, Troubleshooting for probable cause and correction. The conditions listed in the table apply specifically to the no-load test and do not necessarily apply to operation under other circumstances.

Table 1. Troubleshooting

CONDITION	PROBABLE CAUSE	CORRECTION*
Normal current and speed	a. Cranking motor OK	a. Recheck battery, switches and wiring, including battery cable loss check if cranking motor operation on engine is slow or sluggish
Current flow with test circuit switch open	a. Solenoid switch contacts stuck closed	a. Test and, necessary, replace solenoid assembly
Failure to operate with very low or no current	a. Open solenoid winding	a. Inspect and test solenoid assembly
	b. Open field circuit	b. Inspect and test frame & field assembly
	c. Open armature coil(s) or high insulation between commutator bars	c. Inspect armature
	d. Broken brush spring(s) or worn brushes	d. Inspect brushes and brush springs
Failure to operate with high current	a. Frozen bearing or other damage to drive train	a. Inspect bearings, armature, drive shaft and related drive parts
	b. Direct ground in terminals or fields	b. Inspect and test frame and field assembly, solenoid assembly, armature and brush installations for shorts
Low speed with high current	a. Excessive friction in bearing(s) or gear reduction unit, bent armature shaft or loose pole shoe, bent drive shaft	a. Inspect bearings, armature, drive shaft, and gear reduction gears
	b. Shorted armature	b. Inspect and test armature
	c. Grounded armature or fields	c. Inspect and test frame and field coil assembly and armature.
Low speed with normal (or low) current	a. High internal electrical resistance caused by poor connections, defective leads or dirty commutator	a. Inspect internal wiring, electrical connections and armature commutator
	b. Causes listed under “Failure to operate with no current”	b. Corrections listed under “Failure to operate with no current”
High speed with high current	a. Shorted fields	a. Inspect and test field and frame assembly

*Refer to UNIT REPAIR section for required disassembly, inspection, test and, if necessary repair or replacement instructions.

UNIT REPAIR

NOTICE: Always install fasteners at original location. If necessary to replace fasteners, use only correct part number or equivalent. If correct part number is not available use only a fastener of equal size and strength (refer to Delco Remy Standard Hardware Fasteners section in Service Parts Catalog). Use a torque wrench to tighten fasteners when a torque value is specified in these instructions or in the vehicle or engine manufacturer's instructions. Torques specified are for dry, unlubricated fasteners unless otherwise specified.

INTRODUCTION

Figure 6

Figure 6 illustrates the cranking motor broken down into component parts and assemblies. Index numbers on figure 6 correspond to those used in the Delco Remy Service Parts Catalog. Do not attempt to disassemble the following components which are serviced as assemblies:

solenoid assembly (1)
clutch drive assembly (2)
brush holder assembly (3)
armature assembly (13)
frame and field assembly (19)

This section provides instructions for complete disassembly of the cranking motor as would be the case for overhaul. If the cranking motor is not due for overhaul, and repair affecting specific parts only is required, the cranking motor may be disassembled only to the extent necessary to gain access to these parts. Parts removed from the cranking motor as subassemblies or groups need not be disassembled for such limited repair unless they contain the affected parts. Total disassembly is recommended however, to ensure that all parts can be thoroughly cleaned and inspected.

In this section the cranking motor is broken down by main groups. These groups are then disassembled into individual parts and assemblies. Illustrations accompany the text to show specific operations. To see the parts relationship of the complete cranking motor, refer back to figure 6.

DISASSEMBLY

Make a mark completely down one side of the cranking motor to ensure proper alignment of all components at assembly. Use a colored pencil or marker that will show on all parts. Disassemble as follows:

UNIT DISASSEMBLY

Figure 7

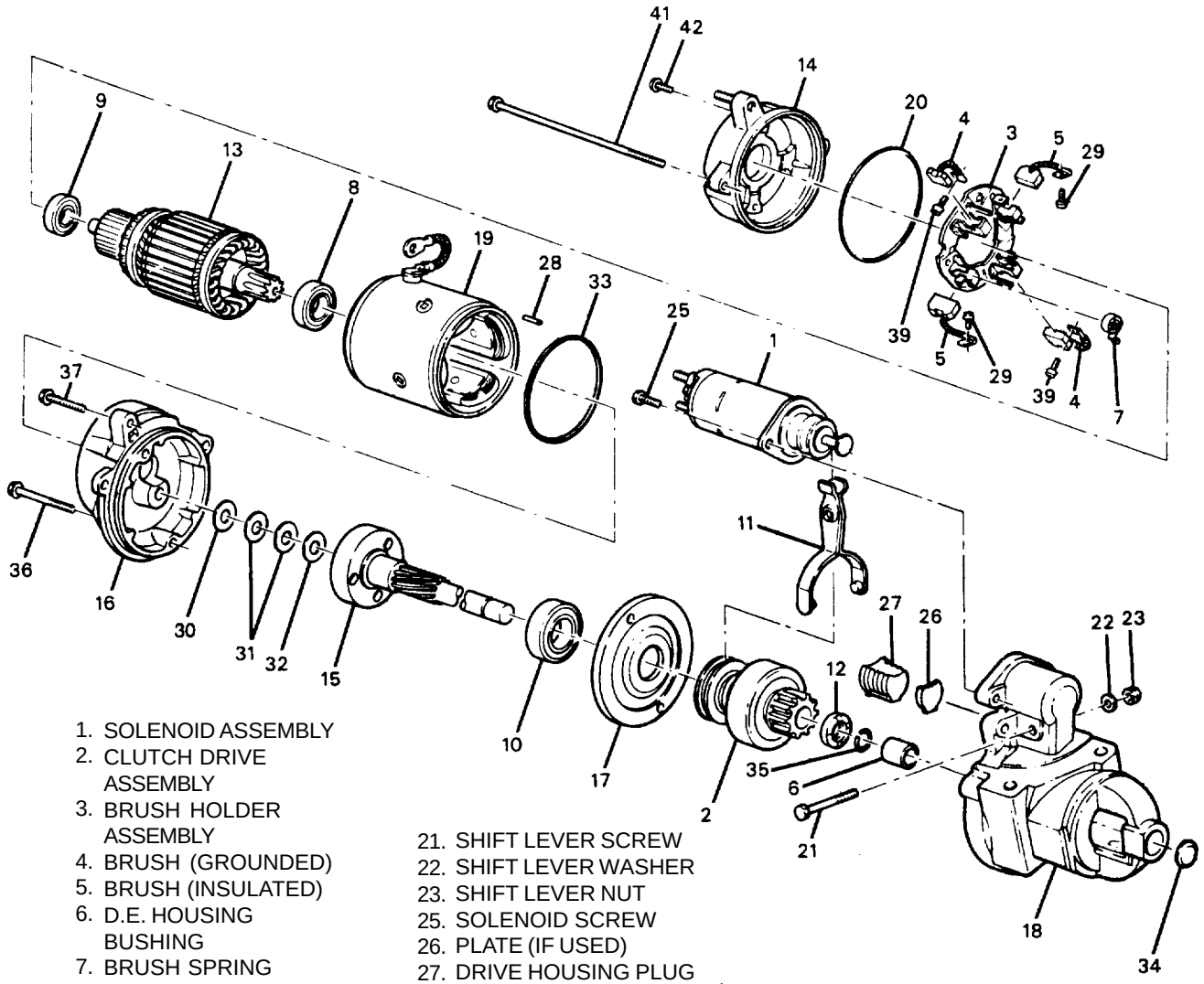
Remove or Disconnect

1. Motor lead on frame, field and brush holder group (A) from solenoid assembly (1). Reinstall nut on solenoid terminal.
   - Remove nut on solenoid, slip off motor lead and reinstall nut
2. Thru bolts (41).
3. Brush plate screws (42).
4. C.E. frame (14) AND O-ring (20).

Important

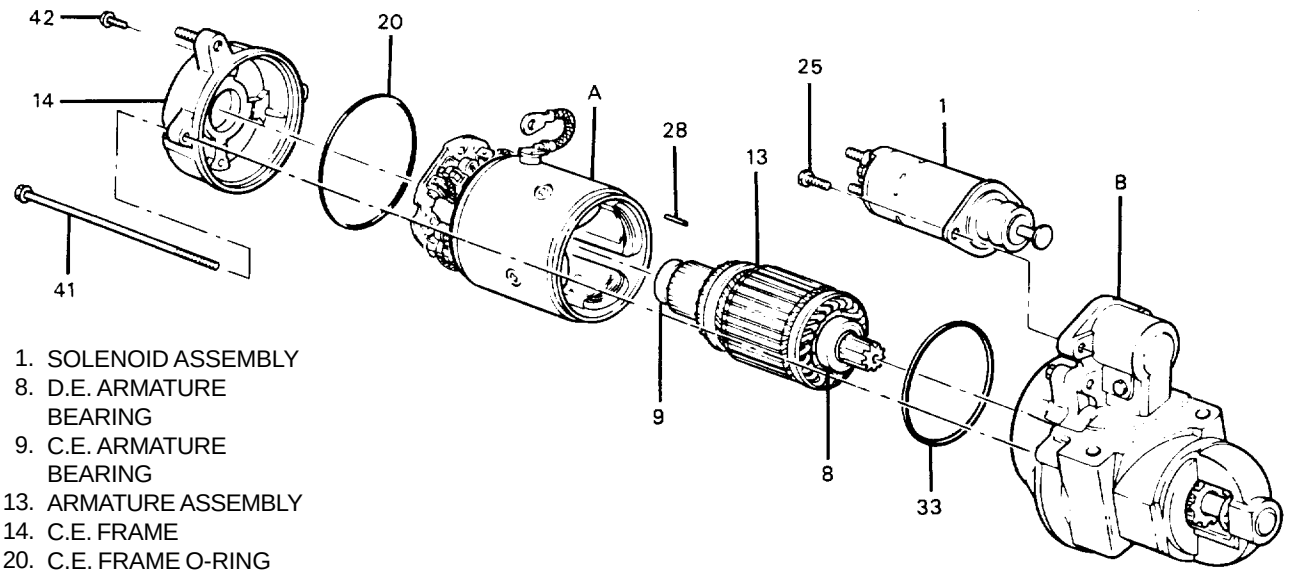
- In the following step, use care not to loose the small dowel pin (28) installed between frame, field and brush holder group (A) and gear reduction and drive group (B). Dowel pin is required for assembly and must be saved. If dowel pin should be lost, it must be replaced with 2 mm (0.079 in.) dia x 10 mm (0.394) in. long pin procured or manufactured locally.

5. Frame, field and brush holder group (A), dowel pin (28) and frame seal (33).
   - Armature assembly (13) may come off with frame, field and brush holder group (A) or may be retained by gear reduction and drive group (B).
6. Armature assembly (13) with bearings (8 and 9).
   - Do not remove bearings from armature assembly unless replacement is required (refer to *CLEANING, INSPECTION AND REPAIR).*
7. Solenoid screws (25).
8. Solenoid assembly (1).
   - Pivot inside end of solenoid assembly (1) out of engagement with shift lever in gear reduction and drive group (B) and withdraw solenoid assembly.



1. SOLENOID ASSEMBLY
2. CLUTCH DRIVE ASSEMBLY
3. BRUSH HOLDER ASSEMBLY
4. BRUSH (GROUNDED)
5. BRUSH (INSULATED)
6. D.E. HOUSING BUSHING
7. BRUSH SPRING
8. D.E. ARMATURE BEARING
9. C.E. ARMATURE BEARING
10. CENTER SUPPORT BEARING
11. SHIFT LEVER
12. PINION STOP
13. ARMATURE
14. C.E. FRAME
15. DRIVE SHAFT
16. ARMATURE SUPPORT BRACKET
17. DRIVE SHAFT SUPPORT
18. DRIVE HOUSING
19. FRAME & FIELD ASSEMBLY
20. C.E. FRAME O-RING
21. SHIFT LEVER SCREW
22. SHIFT LEVER WASHER
23. SHIFT LEVER NUT
25. SOLENOID SCREW
26. PLATE (IF USED)
27. DRIVE HOUSING PLUG
28. DOWEL PIN
29. INSULATED BRUSH SCREW
30. WASHER (FIBER)
31. WASHER (THIN; ONE OR TWO MAY BE USED)
32. WASHER (THICK)
33. FRAME SEAL
34. BUSHING PLUG (IF USED)
35. STOP RING
36. DRIVE HOUSING BOLT (LONG)
37. DRIVE HOUSING BOLT (SHORTER ON SOME MODELS)
39. GROUNDED BRUSH SCREW
41. THRU BOLT
42. BRUSH PLATE SCREW

Figure 6 - Cranking Motor Assembly



1. SOLENOID ASSEMBLY
8. D.E. ARMATURE BEARING
9. C.E. ARMATURE BEARING
13. ARMATURE ASSEMBLY
14. C.E. FRAME
20. C.E. FRAME O-RING
25. SOLENOID SCREW
28. DOWEL PIN
33. FRAME SEAL
41. THRU BOLT
42. BRUSH, PLATE SCREW
A. FRAME, FIELD & BRUSH HOLDER GROUP
B. GEAR REDUCTION & DRIVE GROUP

MR4007-R1

Figure 7 - Electrical Group

DISASSEMBLY OF FRAME, FIELD AND BRUSH HOLDER GROUP

Figure 8

Remove or Disconnect

Insulated brush screws (29).

Move brush holder assembly (3) [with brushes (4 and 5)] away from frame and field assembly (19) slightly to reach across with screwdriver and remove screws (29).

Frame and field assembly (19).

Grounded brush screws (39).

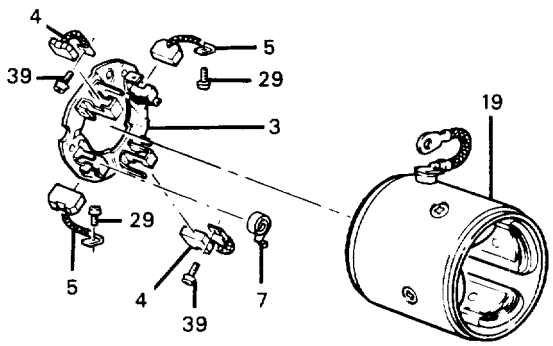
Brushes (4 and 5), if replacement is required.

Grasp brush end of each brush spring (7) with needle nose pliers, twist spring end away from brush (4 or 5) and withdraw brush.

Brush springs (7), if replacement is required.

Grasp brush end of each brush spring (7) with needle nose pliers, twist spring end away from brush socket on brush holder assembly (3) and remove spring.

NOTICE: At this stage of disassembly, all electrical component can be inspected and, if required, independently tested as specified in CLEANING, INSPECTION AND REPAIR.



3. BRUSH HOLDER ASSEMBLY
4. BRUSH (GROUNDED)
5. BRUSH (INSULATED)
7. BRUSH SPRING
19. FRAME & FIELD ASSEMBLY
29. INSULATED BRUSH SCREW
39. GROUNDED BRUSH SCREW

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Figure 8 - Frame, Field and Brush Holder Group

DISASSEMBLY OF GEAR REDUCTION AND DRIVE GROUP

Figure 9

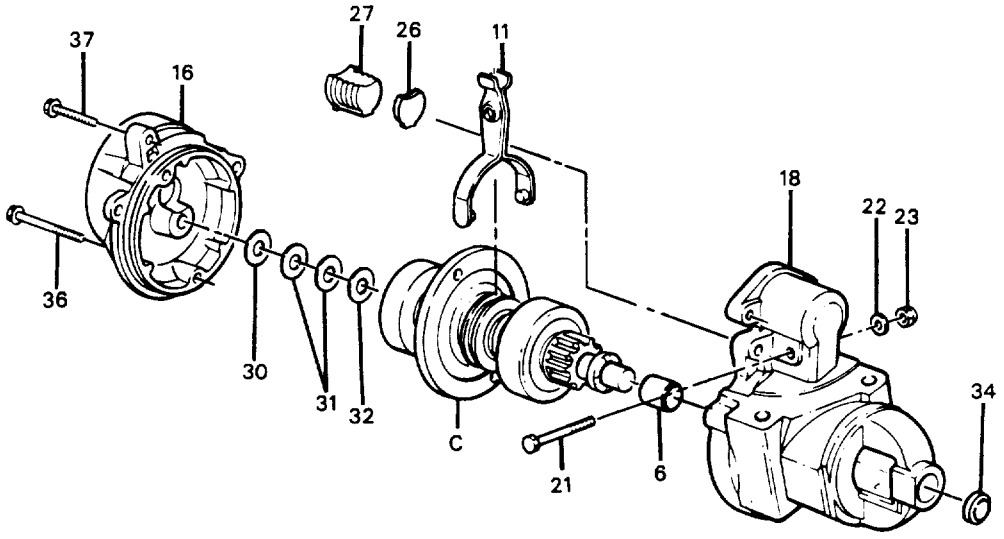
Remove or Disconnect

1. Housing bolts (36 and 37).
2. Armature support bracket (16).

Important

- Washers (30 through 32) may stick to armature support bracket or to drive shaft and clutch group (C) as armature support bracket is removed. In either case, note the position and number of each of these washers.

3. Washers (30 through 32)
   - Save washers to be installed in the same position and number at assembly.
4. Drive housing plug (27) and plate (26).
   - Pry out drive housing plug using a large screwdriver.
5. Shift lever nut (23), washer (22) and screw (21).
6. Shift lever (11) and drive shaft and clutch group (C) from drive housing (18) together, then separate.
   - Do not remove bushing plug (34) or bushing (6) from drive housing (18) unless replacement is required (refer to *CLEANING, INSPECTION AND REPAIR).*



6. D.E. HOUSING BUSHING
11. SHIFT LEVER
16. ARMATURE SUPPORT BRACKET
18. DRIVE HOUSING
21. SHIFT LEVER SCREW
22. SHIFT LEVER WASHER
23. SHIFT LEVER NUT
26. PLATE (IF USED)
27. DRIVE HOUSING PLUG
30. WASHER (FIBER)
31. WASHER (THIN; ONE OR TWO MAY BE USED)
32. WASHER (THICK)
34. BUSHING PLUG (IF USED)
36. DRIVE HOUSING BOLT (LONG)
37. DRIVE HOUSING BOLT (SHORTER ON SOME MODELS)
C. DRIVE SHAFT & CLUTCH GROUP

MR4009-R1

Figure 9 - Gear Reduction and Drive Group

DRIVE SHAFT AND CLUTCH GROUP

Figures 10 and 11

Disassembly of the drive shaft and clutch group is not required unless it is necessary to clean, inspect or replace one or more parts of the group separately. Then, proceed as follows:

Remove or Disconnect

1. Stop rings (35) and pinion stop (12).
   - Position drive shaft and clutch group on work bench with internal gear end down.
   - Using open tube slightly larger than shaft (see figure 11), drive pinion stop (12) toward clutch drive assembly (2) until it clears stop rings (35).
   - Using care not to scratch drive shaft (15) pry stop rings out of shaft groove and slide off end of shaft.
   - Inspect edges of shaft groove for burrs that may have been formed through repeated cranking cycles. Such burrs may make removal of pinion stop and clutch drive assembly (2) difficult. If burrs are found, use a suitable file to carefully remove burrs only -not base metal. Thoroughly clean away metal filings.
   - Slide pinion stop (12) off drive shaft (15). Discard old pinion stop (12) and stop rings (35). New parts must be used at assembly.
2. Clutch drive assembly (2) from drive shaft (15).
3. Drive shaft support (17) from drive shaft (15).
   - Do not remove bearing (1O) from drive shaft (15) unless replacement is required (refer to *CLEANING, INSPECTION AND REPAIR).*

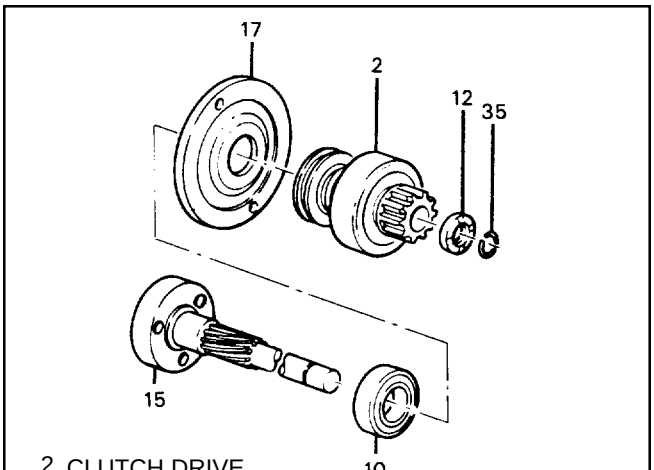


Figure 10 - Drive Shaft and Clutch Group

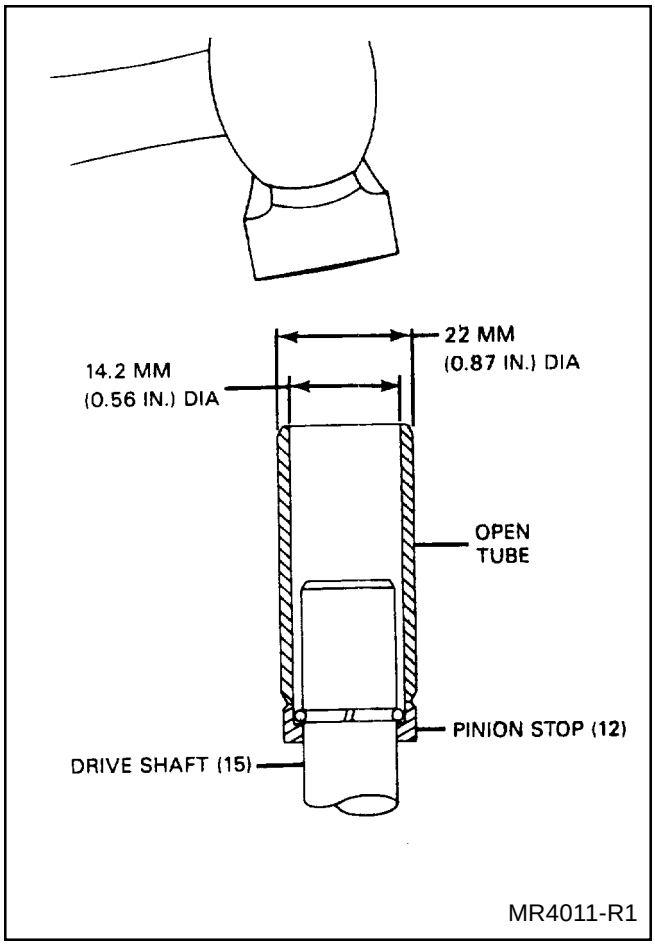


Figure 11 - Removing Pinion Stop

CLEANING, INSPECTION AND REPAIR

CLEANING

NOTICE: Do not clean or immerse cranking motor parts in grease dissolving solvents. Solvents will dissolve grease packed in drive assembly and may damage armature or field coil insulation.

Clean

All cranking motor parts with a soft cloth prior to testing.

INSPECTION

Figure 6

Inspection in the following steps refers to visual inspection of cranking motor parts and assemblies to determine their serviceability. Electrical tests for certain assemblies are described in COMPONENT ELECTRICAL TESTING.

Inspect

1. All parts for cracks, distortion or other structural damage. Replace parts or assemblies which are cracked, bent or otherwise damaged.
2. Threaded parts for stripped, crossed or otherwise damaged threads. Replace parts with thread damage that cannot be cleaned up using a suitable tap or die. Replace any hardware items that have damaged threads.
3. Solenoid assembly (1) for cut or torn boot. If boot is damaged, replace solenoid assembly.
4. Clutch drive assembly (2) for the following. Replace clutch drive assembly if damaged:
   - Pinion gear turns roughly or turns in both directions.
   - Pinion gear teeth broken or showing evidence of step wear.
   - Deep scoring or other damage to shift lever collar.
5. Brush holder assembly (3) for the following. Replace brush holder if damaged:
   - Loose riveted joints.
   - Cracked or broken insulation.
6. Brushes (4 and 5) for excessive wear.
   - Minimum allowable brush length is 12 mm (0.472 in.). Replace excessively worn brushes in sets.
7. D.E. Housing bushing (6) for scoring or other damage. Replace damaged bushing (refer to *REPAIR*, following).
8. Ball bearings (8, 9 and 10) as follows:
   - Hold armature (13) or drive shaft (15) and slowly rotate outer bearing race by hand.
   - Check that bearing turns freely without binding or the feel of flat spots.
   - Replace damaged bearings (refer to *REPAIR*, following).
9. Armature assembly (13) for the following:
   - Gear teeth that are broken, or that show evidence of step wear or root interference.
   - Rough commutator surface. Polish with No. 400 grit polishing cloth if necessary. Thoroughly clean metal dust from between commutator bars. If commutator surface cannot be repaired in this manner, replace armature assembly. Do not turn commutator in a lathe.
   - Worn commutator. Replace armature assembly commutator OD is less than 35 mm (1.378 in.) or if undercut depth at any point is less than 0.2 mm (0.008 in.). Do not undercut insulation.
10. Drive shaft (15) for the following. Replace drive shaft if damaged:
    - Scored or damaged shaft where it turns in bushing (6).
    - Internal gear with teeth broken or showing evidence of step wear.
    - Damaged spline. Clutch drive assembly must slide smoothly and easily over full length of spline.

COMPONENT ELECTRICAL TESTING

Figures 12 and 13

Perform the following electrical tests on the solenoid assembly (1), armature assembly (13) and frame and field assembly (19) to determine their serviceability:

1. Using a suitable ohmmeter, check windings of solenoid assembly (1) for continuity as follows:
   - Check resistance of solenoid pull-in and hold-in windings in series by measuring resistance between motor terminal (see figure 12) and solenoid case. Resistance should be approximately 0.95 ohms for 12 volt cranking motors and approximately 1.75 ohms for 24 volt cranking motors.
   - An extremely high resistance reading indicates a break or fault in winding continuity. A very low resistance reading indicates a short or ground in the winding circuit. Either condition is cause for replacement of the solenoid assembly.
2. Check armature (13) as follows for shorts, opens or grounds using suitable test equipment and instruments (test lamp must be 110 volts or lees):
   - Rotate armature in a growler holding a steel strip such as a hacksaw blade against the armature. If a short circuit is present, the steel strip will vibrate in that area.
   - Check the armature for grounds using a test lamp or ohmmeter. There shall be no continuity between the armature shaft and any point on the commutator.
   - Check for opens by visually inspecting the points where the armature conductors join the commutator. A poor connection often will be indicated by signs of arcing or burning of the commutator.
   - Replace armatures which are shorted, grounded or show evidence of opens.
3. Check frame and filed assembly (19) for grounds or opens using test lamp (110 volts max.) or ohmmeter, as follows:
   - Check that there is continuity (no opens) between the field terminal that connects to the solenoid, and the connection points for insulated brushes on the field coil straps.
   - Check that there is no continuity (no grounds) between the frame and the field terminal that connects to the solenoid.
   - Replace frame and field assemblies that have grounds or opens.

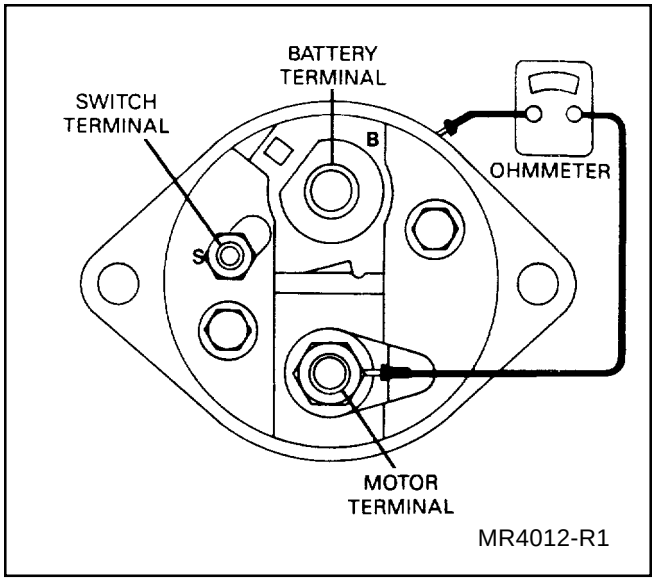


Figure 12 - Solenoid Terminals

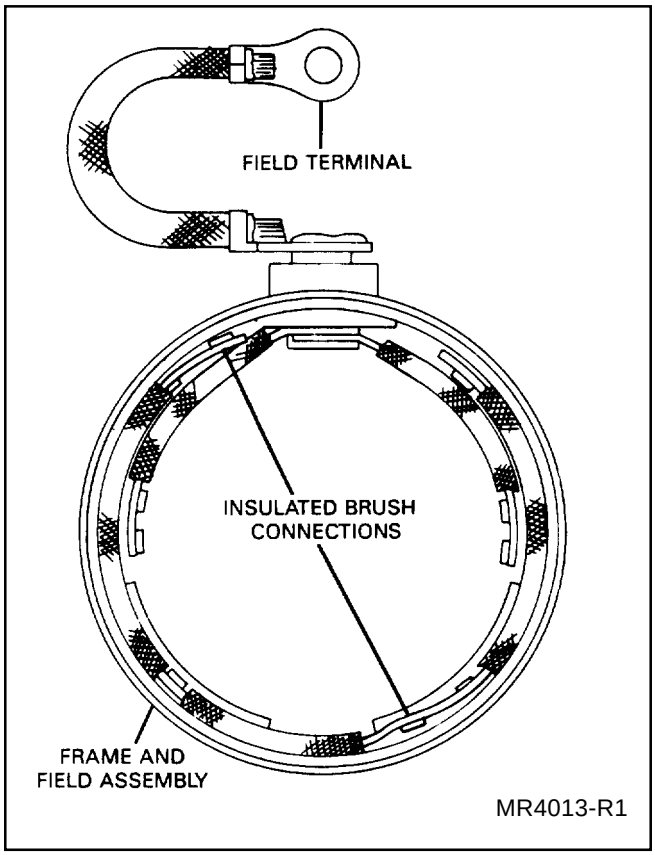


Figure 13 - Frame and Field Assembly

REPAIR PROCEDURES

Figures 6 and 14

1. If necessary, replace bearings (8 and 9, figure 6) on armature (13) as follows:

   NOTICE: Ball bearings which are removed from armature must be replaced with new bearings. Removal procedure causes internal damage to bearings.

Remove or Disconnect

- C.E. and/or D.E. bearings (8 and/or 9) from shaft of armature (13) using suitable bearing puller.

Install or Connect

- New C.E. and/or D.E. bearings (8 and/or 9) to armature assembly (13) using tube that bears on bearing inner race only. Press on bearing until inner race bottoms out against shoulder on armature shaft.

2. If necessary, replace center support bearing (10, figure 6) on drive shaft (15) as follows:

   NOTICE: Ball bearings which are removed from drive shaft must be replaced with new bearings. Removal procedure causes internal damage to bearings.

Remove or Disconnect

- Center support bearing (10) from drive shaft (15) using locally fabricated tool as shown in (figure 14).

Install or Connect

- Center support bearing (10) from drive shaft (15) using locally fabricated tool (figure 14). With drive shaft in suitable support fixture, place tool bolt ends through access holes in wide end of drive shaft and squarely press bearing off of surface on center shaft.

3. If necessary, replace bushing (6, figure 6) in drive housing (18) as follows:
   - From inside drive housing (18), drive out plug (34) if present. Use file to clean away remnants of old stake to allow installation of new plug. Clean away any metal shavings.
   - Using suitable open tube, press out bushing (6).
   - Using suitable open tube, press new bushing (6) into drive housing (18) until end of bushing is flush with inside of housing.
   - Install new plug (34), if used, to drive housing. Stake housing material over plug at three places, equally spaced.

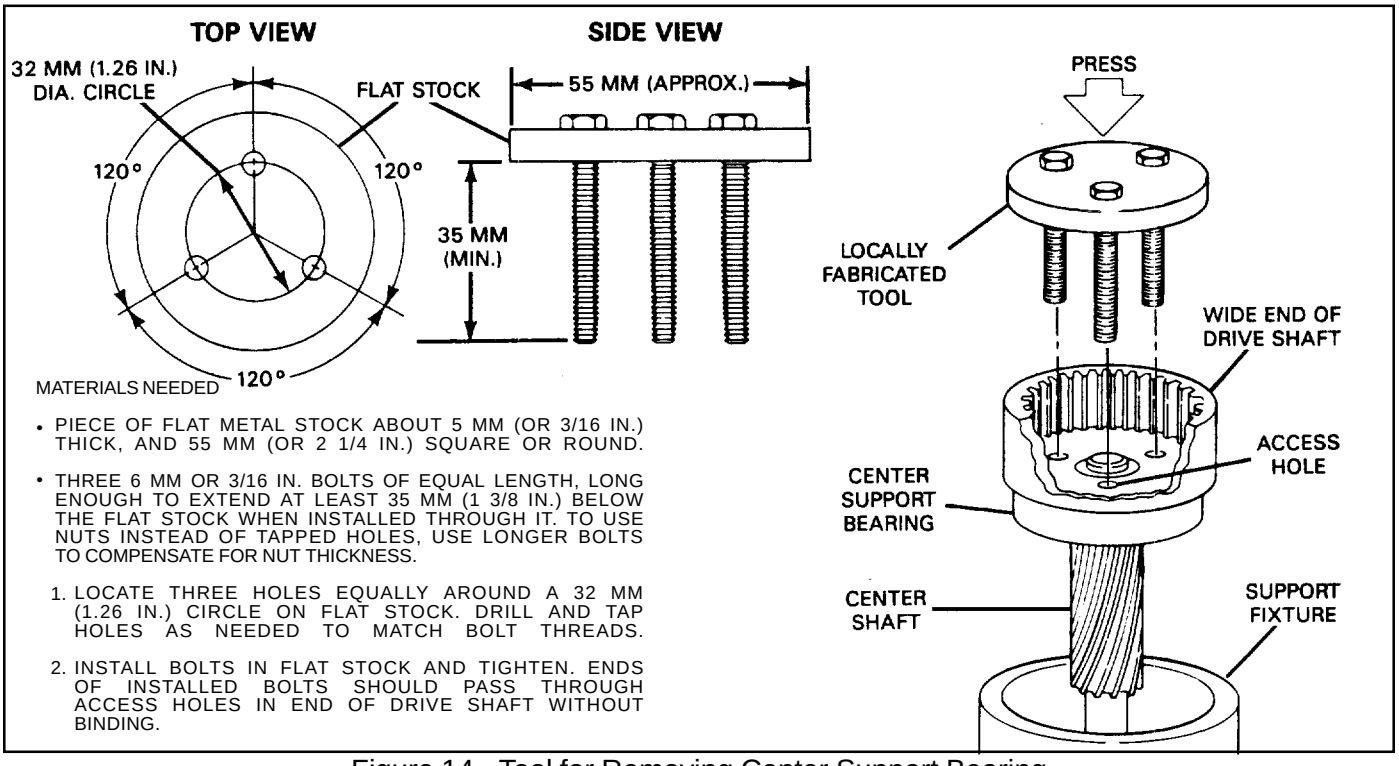


Figure 14 - Tool for Removing Center Support Bearing

ASSEMBLY

LUBRICATION DURING ASSEMBLY

Armature bearings (8 and 9, figure 6) and drive shaft support bearing (10) are permanently lubricated. Do not add lubricant to these bearings. Using Delco Remy Lubricant No. 196094, lubricate the following just before or during assembly (avoid excessive grease):

- D.E. housing bushing (6) (in drive housing).
- Pivot hole and working surface on ends of shift lever (11).
- Internal gear, shaft and spline on drive shaft (15).

DRIVE SHAFT AND CLUTCH GROUP

Figures 10 and 15

If disassembled, position drive shaft on work surface with internal gear end down and assemble drive shaft and clutch group as follows:

Important

- If center support bearing (10) is being replaced, install on drive shaft (15) as specified in REPAIR PROCEDURES, step 2 before proceeding with assembly.

Install or Connect

1. Drive shaft support (17) to drive shaft (15), seating bearing (10) in support.
2. Clutch drive assembly (2) to drive shaft (15).
3. New pinion stop (12) and stop rings (35).
   - Slide pinion stop (12) onto drive shaft (15), end with recess for stop rings (35) up.
   - Install stop rings (35) in groove in drive shaft (15).
   - Pick up and support assembly under pinion stop (12). A metal block, with a U-shaped cutout that will slide over shaft between pinion gear and stop, can be clamped in a vise to provide support (see figure 15).
   - Make sure stop rings (35) (in drive shaft groove) are fully seated in pinion stop recess and stake upper edge of pinion stop (12) over stop ring (35) at four places, equally spaced. Do not allow staked metal to contact drive shaft (15).

ASSEMBLY OF GEAR REDUCTION AND DRIVE GROUP

Figure 9

Important

- D.E. bushing (6) and plug (34) are being replaced, install in drive housing (18) as specified in REPAIR PROCEDURES, step 3 before proceeding with assembly.

1. Lubricate D.E. housing bushing, shift rever, and drive shaft as described under LUBRICATION DURING ASSEMBLY

Install or Connect

2. Arms on shift rever (11) with shift collar on drive shaft and clutch group (C).
3. Assembled shift lever (11) and drive shaft and clutch group (C) into drive housing (18), aligning holes in drive shaft support (17, figure 10) with those in drive housing.
   - Make sure that drive shaft support is fully seated in drive housing and that drive shaft bearing (10, figure 10) remains fully seated in drive shaft support.
4. Shift lever screw (21), washer (22) and (23).

Tighten

Nut to 4.5 N-m (40 lb-in.).

5. Plate (26), if used, and drive housing plug (27) to drive housing (18).
6. Washers (30 through 32) in same number and position as noted at disassembly.
7. Armature support bracket (16) to drive housing (18), aligning mark made prior to disassembly with that on drive housing.
8. Drive housing bolts (36 and 37).

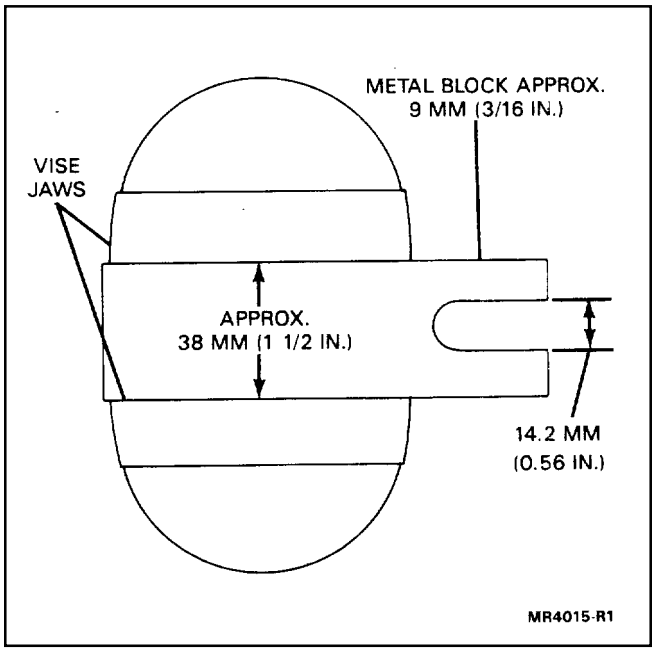


Figure 15 - Pinion Stop Support Block

Tighten

- Bolts (36 and 37) to 8.5 Nm (75 lb.-in.).

ASSEMBLY OF FRAME, FIELD AND BRUSH HOLDER GROUP

Figures 8, 16 and 17

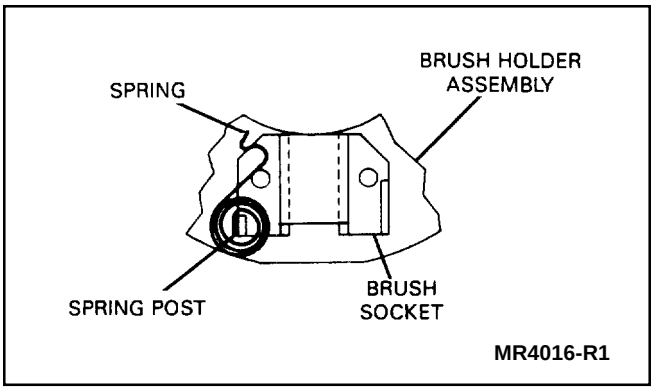


Figure 16 - Brush Spring on Post

Install or Connect

1. Brush springs (7), if removed.
   - Start each brush spring onto post on brush holder assembly (3) as shown in figure 16, just enough to hold inside end of spring from turning.
   - Grasp free end of spring with needle nose pliers and twist clockwise over top of brush socket.
   - Push spring fully onto post and release free end to engage notch in brush socket.
2. **NOTICE:** Brush leads may be damaged by excessive handling. Do not over-flex leads near clip welds or clips may break off.

   Brushes (4 and 5), if removed.
   - See figure 17 for proper installed position of all brushes. Make sure insulated brushes (5) go into brush sockets of brush holder assembly (3) that are mounted on insulation.
   - To install each brush, grasp free end of brush spring with needle nose pliers, twist clockwise to clear brush socket and insert brush partly into brush socket.
   - Gradually release spring so that its end contacts side (not end) of brush (see figure 17). This will hold brushes retracted until after brush holder is installed over armature commutator.
3. Grounded brush screws (39).
   - Position terminals of grounded brush leads behind terminal tabs on brush holder (3) (see figure 17).
   - Insert brush screws (39) through terminal tabs on brush holder and thread into brush lead terminals.

Tighten

- Grounded brush screws to 1.5 N-m (13 lb-in.).

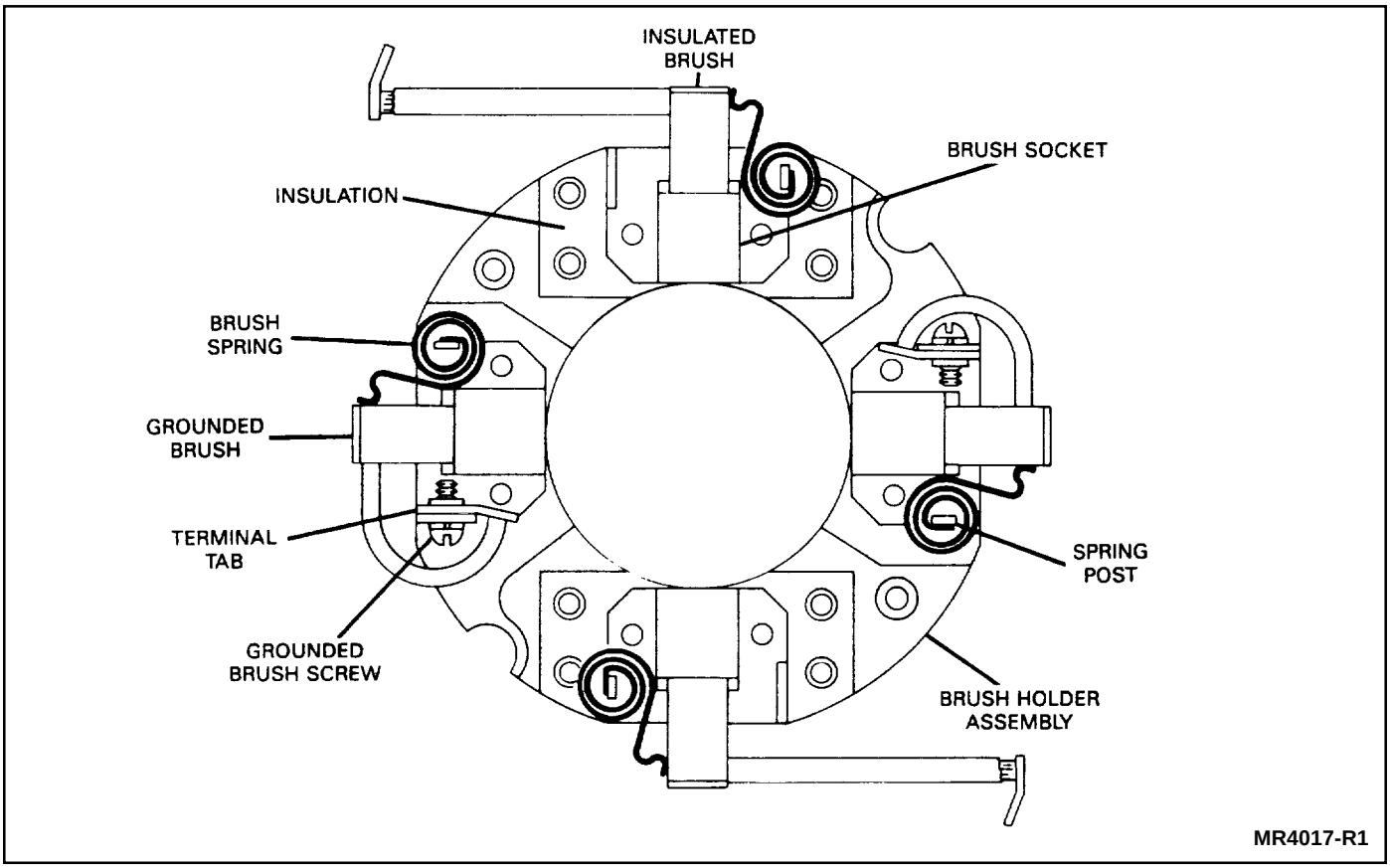


Figure 17 - Springs and Brushes on Brush Holder

4. Frame and field assembly (19) to brush holder assembly.
   - Position brush holder assembly (3) (with installed brushes) over terminal end of frame and field assembly (19).
   - Attach terminals of insulated brush leads to conductors in frame and field assembly with insulated brush screws (29).

Tighten

- Insulated brush screws to 1.5 N-m (13 lb-in.).

UNIT ASSEMBLY

Figures 7 and 18

Support gear reduction and drive group (B) with pinion gear end down and proceed as follows:

Important

- If armature bearings (8 and 9) are being replaced install on armature (13) as specified in REPAIR PROCEDURES, step 1 before proceeding with assembly.

Install or Connect

1. Solenoid assembly (1).
   - Pivot plunger of solenoid assembly into engagement with shift lever in gear reduction and drive group (B).
   - Position solenoid assembly mounting flange and install solenoid mounting screws (25).

Tighten

- Solenoid screws to 2.8 N-m (25 lb.-in.).

2. Frame seal (33).
3. Armature assembly (13) with bearings (8 and 9) into gear reduction and drive group (B).
   - Make sure gear teeth are aligned, then seat bearing (8) on armature shaft fully into housing recess.
4. Frame, field and brush holder group (A).
   - Place dowel pin (28) in hole in armature support bracket of gear reduction and drive group (B).
   - Position frame, field and brush holder group over armature assembly (13), align hole for dowel pin (28) and marks made prior to disassembly and seat in gear reduction and dove group (B).
   - Twist brush springs (7, figure 8) away from brushes (4 and 5, figure 8) slide brushes in to contact commutator on armature (13) and release brush springs to contact ends of brushes.
5. O-ring (20).

Important

- O-ring can easily be damaged during installation of the C.E. frame (14). To prevent such damage, install O-ring as described in the following steps.
- Install O-ring on frame, field and brush holder group (A) so that it is against the shoulder on the field frame that will abut the C.E. frame when installed. This is the normal installed position for the O-ring.
- Carefully roll the O-ring out of its normal installed position up onto the major OD of the field frame. Allow O-ring to remain in this position until C.E. frame is partially installed.

6. C.E. frame (14).
   - Align marks on C.E. frame and frame and field assembly (19, figure 8) made prior to disassembly.
   - Start C.E. frame onto frame and field assembly, leaving a gap just slightly larger than the thickness of O-ring (20).
7. Brush plate screws (42).
   - Use a scribe or similar tool to align tapped holes in brush holder assembly (3, figure 8) with screw holes in C.E. frame 14).

Tighten

- Brush plate screws to 2.8 N-m (25 lb-in.).

8. Thru bolts (41).
   - Install thru bolts and tighten by hand but do not close gap between C.E. frame and field assembly where O-ring (20) goes.
   - Roll O-ring (20) back down into its installed position between C.E. frame and frame and field assembly.
   - Align timing ribs on edge of C.E. frame (14) with timing spots on frame and field assembly (A) to assure proper brush alignment. Refer to figure 18. Marks are located in 2 places on motor but will only match one way.

Tighten

- Thru bolts (41) to 8.5 NM (75 lb-in.).

9. Motor lead on frame and field assembly (19), figure 8).
   - Remove nut from terminal on solenoid, install motor lead terminal and reinstall nut.

Tighten

- Nut on terminal of solenoid assembly to 11 N-m (100 lb.-in.).

CRANKING MOTOR INSTALLATION

TESTING AFTER REPAIR OR OVERHAUL

After repair or overhaul, the cranking motor can be tested as specified in the *Cranking Motor No-Load Test* found in the *TROUBLESHOOTING* section.

After repair, overhaul, testing or replacement of the cranking motor, refer to the vehicle or engine manufacturer's instructions for the proper installation procedure. Use the following torques when making electrical connections to cranking motor:

CAUTION: Make sure negative battery cable is disconnected at battery when making electrical connections to cranking motor. Otherwise, injury may result. If a tool is shorted at the solenoid battery terminal, the tool will heat enough to cause a skin burn.

Tighten

- Solenoid battery (B) terminal nut to 18 N-m (13 lb-ft).
- Solenoid switch (S) terminal nut to 1.8 N-m (16 lb-in.).

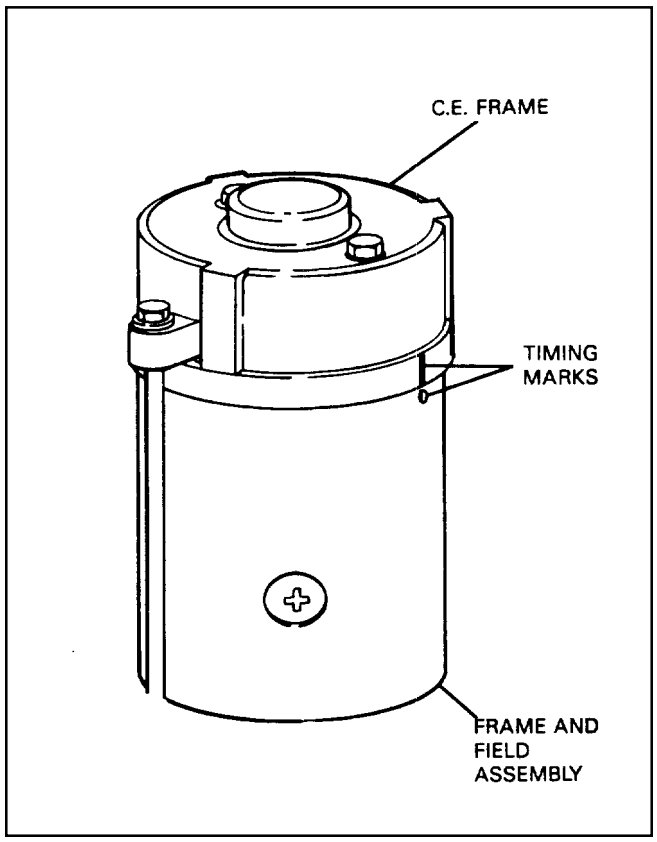


Figure 18 - Aligning Timing Marks

NOTES

SPECIFICATIONS
CRANKING MOTOR

MOTOR MODEL	SERIES	TYPE	ROTATION VIEWING D.E.	SPEC. NO.	NO LOAD TEST (INCLUDES SOLENOID CURRENT) VOLTS	MIN. AMPS	MAX. AMPS	MIN. RPM	MAX. RPM
1113266	28MT	171	CW	7136	10	125	190	3000	5600
1113267	28MT	171	CW	7136	10	125	190	3000	5600
1113268	28MT	171	CW	7137	20	75	90	3600	5400
1113269	28MT	171	CW	7136	10	125	190	3000	5600
1113270	28MT	171	CW	7136	10	125	190	3000	5600
1113271	28MT	171	CW	7136	10	125	190	3000	5600
1113272	28MT	171	CW	7137	20	75	90	3600	5400
1113273	28MT	171	CW	7136	10	125	190	3000	5600
1113274	28MT	171	CW	7136	10	125	190	3000	5600
1113275	28MT	171	CW	7136	10	125	190	3000	5600
1113276	28MT	171	CW	7136	10	125	190	3000	5600
1113277	28MT	171	CW	7137	20	75	90	3600	5400
1113278	28MT	171	CW	7136	10	125	190	3000	5600
1113279	28MT	171	CW	7136	10	125	190	3000	5600
1113280	28MT	171	CW	7136	10	125	190	3000	5600
1113281	28MT	171	CW	7136	10	125	190	3000	5600
1113282	28MT	171	CW	7136	10	125	190	3000	5600
1113283	28MT	171	CW	7136	10	125	190	3000	5600
1113284	28MT	171	CW	7136	10	125	190	3000	5600
1113285	28MT	171	CW	7136	10	125	190	3000	5600
1113286	28MT	171	CW	7136	10	125	190	3000	5600
1113287	28MT	171	CW	7136	10	125	190	3000	5600
1113288	28MT	171	CW	7136	10	125	190	3000	5600
1113289	28MT	171	CW	7136	10	125	190	3000	5600
1113290	28MT	171	CW	7136	10	125	190	3000	5600
1113291	28MT	171	CW	7137	20	75	90	3600	5400
1113292	28MT	171	CW	7136	10	125	190	3000	5600
1113293	28MT	171	CW	7136	10	125	190	3000	5600
1113294	28MT	171	CW	7136	10	125	190	3000	5600
1113295	28MT	171	CW	7136	10	125	190	3000	5600
1113296	28MT	171	CW	7136	10	125	190	3000	5600
1113297	28MT	171	CW	7136	10	125	190	3000	5600
1113298	28MT	171	CW	7136	10	125	190	3000	5600
1113299	28MT	171	CW	7136	10	125	190	3000	5600

SOLENOID

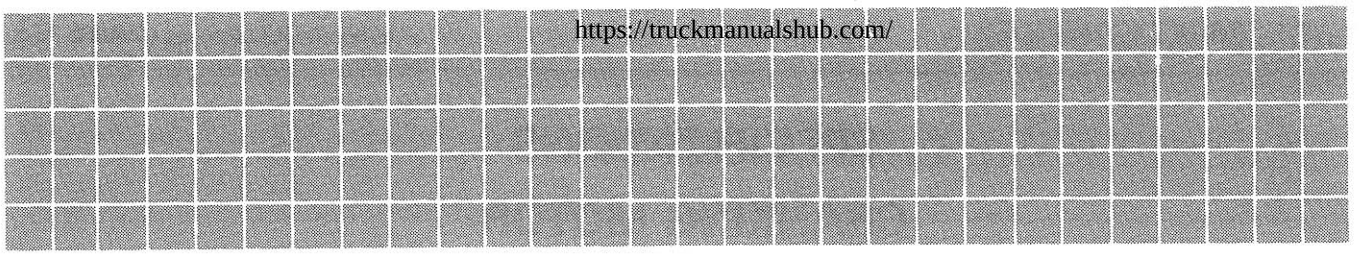
SWITCH MODEL	RATED VOLTAGE	CURRENT CONSUMPTION PULL-IN WINDING AMPS	VOLTS	OHMS	HOLD-IN WINDING AMPS	VOLTS	OHMS
10456454	12	52- 59	10	0.17-0.19	12-14	10	0.76-0.81
10457055	12	52- 59	10	0.17-0.19	12-14	10	0.76-0.81
10457061	12	52- 59	10	0.17-0.19	12-14	10	0.76-0.81
10457115	24	100-125	20	0.16-0.20	12-14	20	1.45-1.65
10457116	24	100-125	20	0.16-0.20	12-14	20	1.45-1.65

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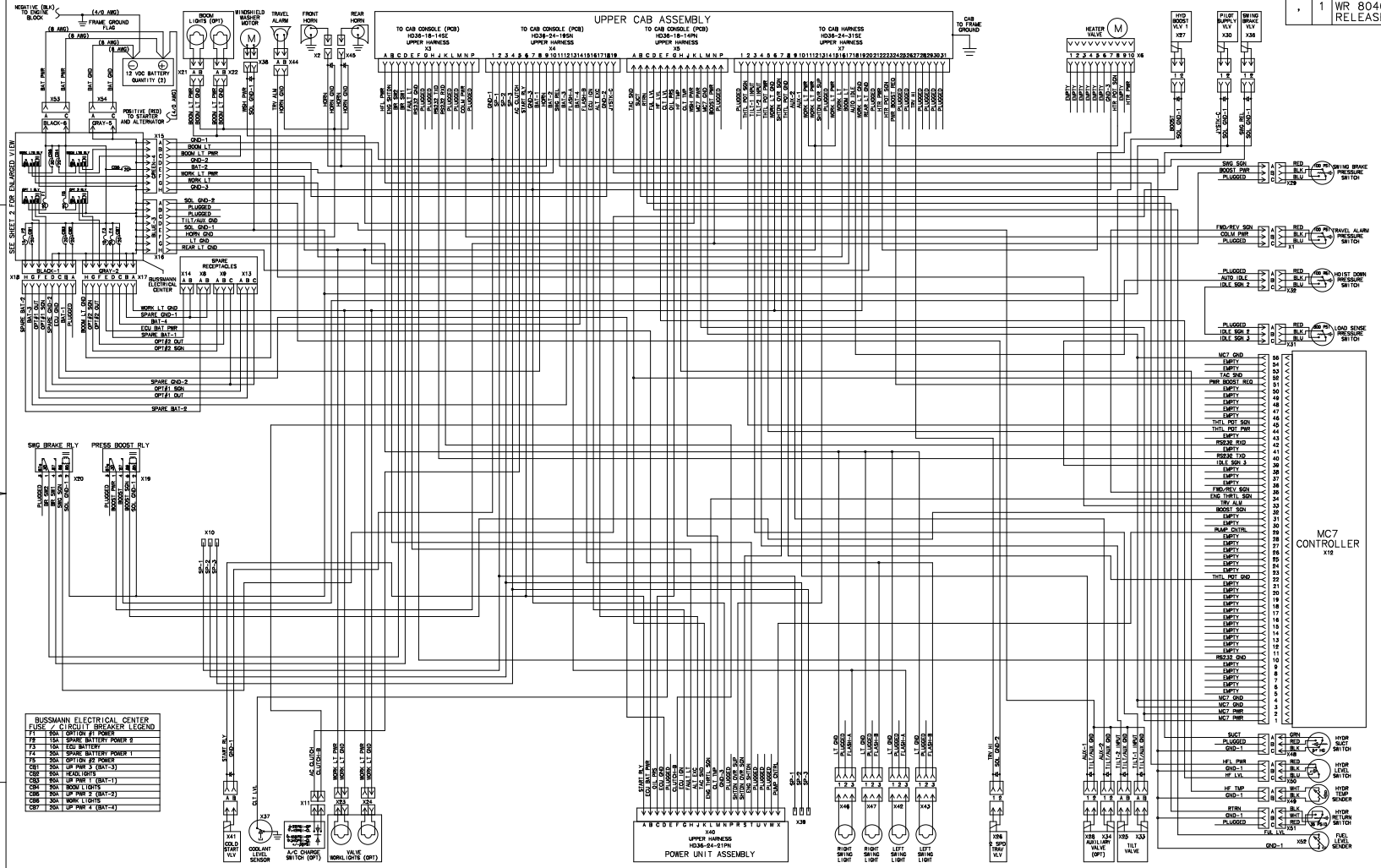
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,	1	WR 8040-029 JAM 10-8-03 RELEASE FOR PROTOTYPE	BEB	RDM



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1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

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DRAWN BY JAM
DATE 10-8-03

THE GRADALL COMPANY
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TITLE: ELECTRICAL SCHEMATIC
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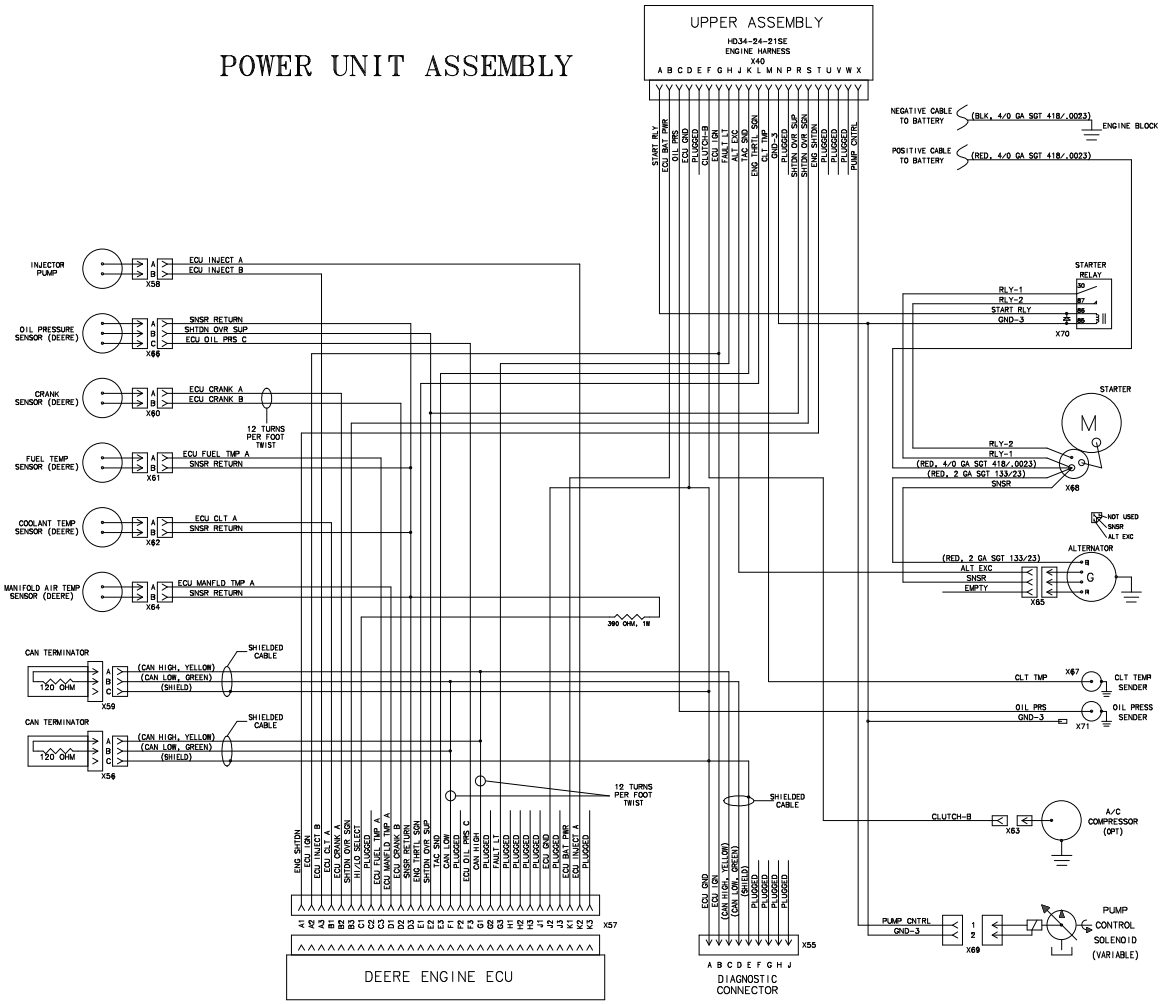
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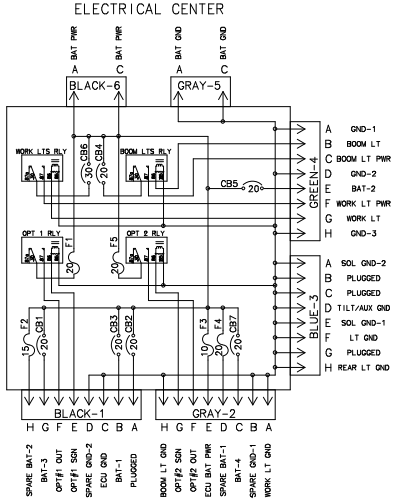
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REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	A	EC 060134 JGK 10/16/06 REV LEVEL UPDATE ONLY	JGK	GTB
,	1	WR 8040-029 JAM 10-8-03 RELEASE FOR PROTOTYPE	BEB	RDM

POWER UNIT ASSEMBLY



ENLARGED BUSSMANN VIEW FROM SHEET 1



BUSSMANN ELECTRICAL CENTER FUSE / CIRCUIT BREAKER LEGEND		
F1	20A	OPTION #1 POWER
F2	15A	SPARE BATTERY POWER 2
F3	10A	ECU BATTERY
F4	20A	SPARE BATTERY POWER 1
F5	20A	OPTION #2 POWER
CB1	20A	UP PWR 3 (BAT-3)
CB2	20A	HEADLIGHTS
CB3	20A	UP PWR 1 (BAT-1)
CB4	20A	BOOM LIGHTS
CB5	20A	UP PWR 2 (BAT-2)
CB6	30A	WORK LIGHTS
CB7	20A	UP PWR 4 (BAT-4)

NOTE

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TOLERANCES
UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060°
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
		,	

PAINT ,
APPROVED BY RDM
CHECKED BY BEB
DRAWN BY JAM
DATE 10-8-03

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO
SDRC 3D

TITLE ELECTRICAL SCHEMATIC
MATERIAL XL4200II
SIZE 4 | CAGE CODE 10086 | 8041-9011 | REV. A
SCALE NTS | WGT N/A | SHEET 2 OF 4

SUPERSEDES ,
SIMILAR TO ,
M-8041
ORIGINAL RELEASE: WR 8040-029
FORMAT_3D_SIZE4.dwg REV. D 07-08-02

SUPERSEDED BY ,

https://truckmanualshub.com/

XL4200II CAB CONSOLE (PCB)

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
C-2 D-8	A	EC 060134 JGK 10/16/06 AT END *A*: 8036-3244 12V POWER SUPPLY WAS 8036-3123 CIGARETTE LIGHTER, REVISED SYMBOL: 12V POWER SUPPLY WAS CIGARETTE LIGHTER AT FUSE F11.	JGK	GTB
,	1	WR 8040-029 JAM 10-8-03 RELEASE FOR PROTOTYPE	BEB	RDM

FUSE LEGEND		
F1	15A	HORN POWER
F2	10A	SPARE BATTERY POWER
F3	15A	FLASHER POWER
F4	10A	SP-3 (SPARE 3)
F5	10A	SP-2 (SPARE 2)
F6	10A	SP-1 (SPARE 1)
F7	5A	STARTER RELAY
F8	10A	AC CLUTCH
F9	15A	KEY SWITCH POWER
F10	25A	ACCESSORY RELAY PWR
F11	10A	12V POWER SUPPLY
F12	15A	SWING BRAKE RELEASE
F13	10A	HYD LEVEL SENDER
F14	10A	BOOST POWER
F15	15A	JOYSTICK/DIGBRAKE PWR
F16	10A	POWER OUTLET #2
F17	20A	WIPER POWER
F18	25A	HEATER POWER
F19	10A	TILT/AUX POWER
F20	5A	ALTERNATOR EXCITE
F21	10A	SPARE ACCESSORY PWR
F22	15A	STEER COLUMN POWER
F23	10A	SWITCH/DOME LT PWR
F24	10A	POWER OUTLET #1
F25	5A	EMU/HOURMETER POWER
F26	5A	JOYSTICK PILOT CUTOFF
F27	15A	MC7 CONTROLLER POWER
F28	5A	SPARE IGNITION POWER
F29	10A	ECU IGNITION POWER
F30	10A	SPARE ACCESSORY PWR
F31	10A	W/WASHER POWER

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,	,	,	,

PAINT ,
APPROVED BY RDM
CHECKED BY BEB
DRAWN BY JAM
DATE 10-8-03

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: ELECTRICAL SCHEMATIC
MATERIAL: XL4200II
SIZE: 4 | CAGE CODE: 10086 | 8041-9011 | REV: A
SCALE NTS | WGT N/A | SHEET 3 OF 4

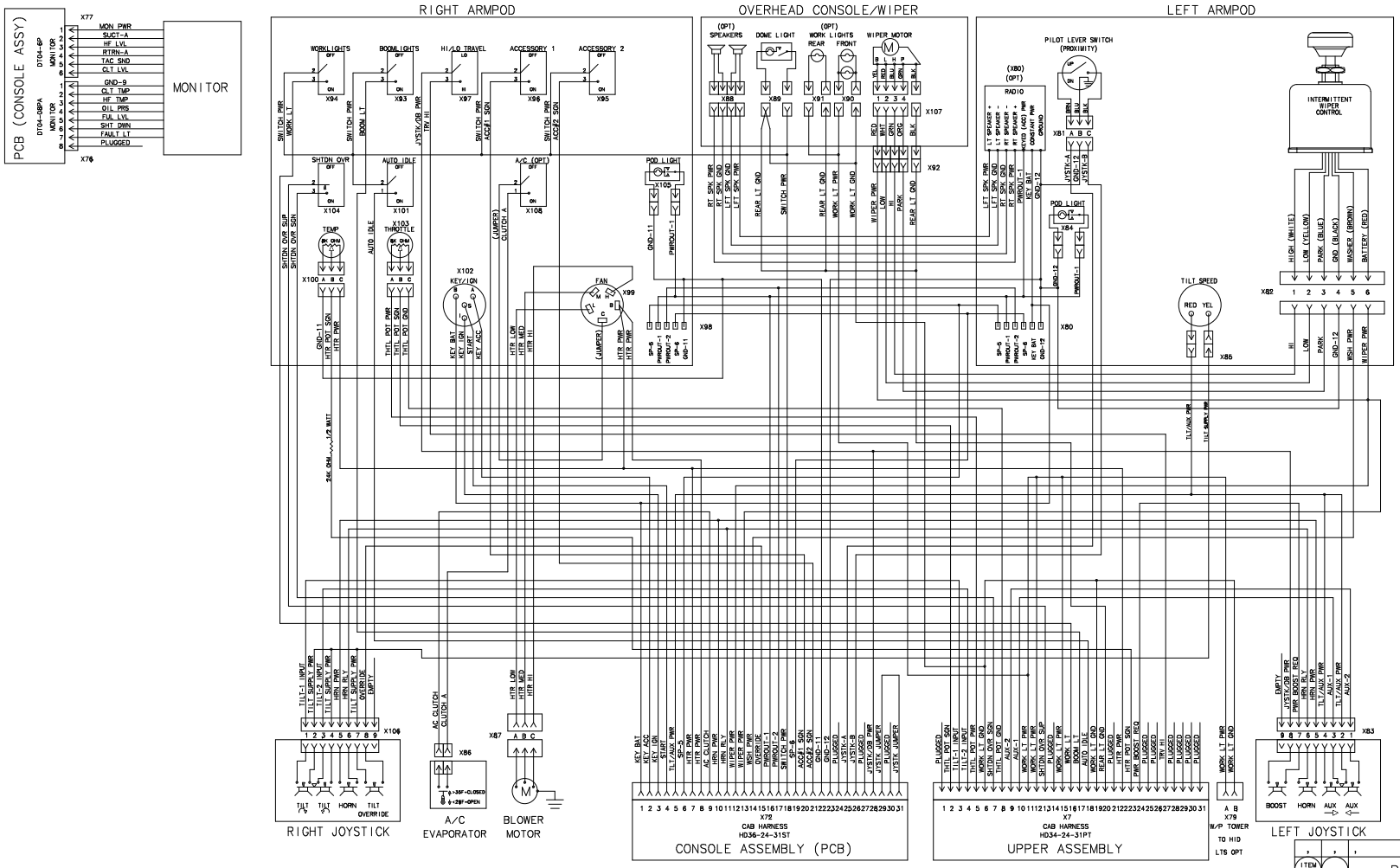
SUPERSEDES ,
SIMILAR TO ,
M-8041
ORIGINAL RELEASE: WR 8040-029
FORMAT_3D_SIZE4.dwg REV. D 07-08-08

SUPERSEDED BY ,

https://truckmanualshub.com/

XL420011 CAB

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
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,	1	WR 8040-029 JAM 10-8-03 RELEASE FOR PROTOTYPE	BEB	RDM



ITEM	QTY	PART NUMBER	DESCRIPTION
,	,	,	,

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PAINT ,

APPROVED BY RDM

CHECKED BY BEB

DRAWN BY JAM

DATE 10-8-03

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL420011

SIZE 4 | CAGE CODE 10086 | 8041-9011 | REV. A

SCALE NTS | WGT N/A | SHEET 4 OF 4

SUPERSEDED BY ,

SUPERSEDES , | SIMILAR TO , | M-8041

ORIGINAL RELEASE: WR 8040-029

FORMAT_3D_SIZE4.dwg REV. D 07-08-08

https://truckmanualshub.com/

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
.	A	EC 070254 GTB 12/5/07 RELEASE TO PRODUCTION	GTB	JAB

PACKARD CONN 12010996
PACKARD TERMINAL 12124582
PACKARD SEAL 12015359

ALT EXC | 16 GA SXL

ALT EXC | 16 GA | TO *S*
ALT EXC | 16 GA | TO *O*
ALT EXC | 16 GA | TO *C*

(CAN HIGH) | 18 GA | TO 'K'
(CAN HIGH) | 18 GA | TO *A* | 12 TURN/FT TWIST
(CAN HIGH) | 18 GA | TO SPLICE AT *B*

(CAN LOW) | 18 GA | TO 'K'
(CAN LOW) | 18 GA | TO *A* | 12 TURN/FT TWIST
(CAN LOW) | 18 GA | TO SPLICE AT *B*

(SHIELD) | 18 GA | TO SPLICE AT *B*
ECU GND | 18 GA | TO | ECU GND | SPLICE NEAR *B*

ECU GND | 16 GA | TO *A*
ECU GND | 18 GA | TO | SHIELD | SPLICE AT 'K'
ECU GND | 12 GA | TO *C*
ECU GND | 18 GA | TO *D*
ECU BAT PWR | 18 GA | TO *A*
ECU BAT PWR | 12 GA | TO *C*

PACKARD CONN 02965164
PACKARD TERMINAL 12124517

EMPTY

TAPE OFF LEG 'S' TO THIS SIDE OF HARNESS

SNSR | 16 GA SXL
ALT EXC | 16 GA SXL

CLUTCH-B | 16 GA SXL | .157 FEMALE BULLET

CLT TMP | 16 GA SXL | #10 RING

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	ECU MANFLD TMP A	18 GXL
B	SNSR RETURN	18 GXL
	PACKARD ASSY 12162193 PACKARD TERMINAL 12124075	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	ECU CLT A	18 GXL
B	SNSR RETURN	18 GXL
	PACKARD ASSY 12162193 PACKARD TERMINAL 12124075	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	ECU FUEL TMP A	18 GXL
B	SNSR RETURN	18 GXL
	PACKARD ASSY 12162193 PACKARD TERMINAL 12124075	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	ECU INJECT A	16 TXL
B	ECU INJECT B	16 TXL
	PACKARD ASSY 12124813 PACKARD TERMINAL 12176389 PACKARD SEAL 12015323 PACKARD SECONDARY LOCK 12020807	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	(CAN HIGH)	18 GXL
B	(CAN LOW)	18 GXL
C	PLUGGED	--
	DEUTSCH DT06-3S DEUTSCH LOCK W3S-1939 DEUTSCH CONTACTS 0462-201-1631 DEUTSCH PLUG 114017 -USE CHAMPLAIN SAE J1939/11-18 CABLE OR EQUIVALENT IN THIS CONNECTOR. -INSTALL DEUTSCH DT04-3P-P006 TERMINATOR WITH DEUTSCH LOCK W3P-1939 ON THIS CONNECTOR. -WIRE LABELS NOT NECESSARY AT THIS CONNECTOR.	

(CAN HIGH) | 18 GA | TO *B*
(CAN HIGH) | 18 GA | TO SPLICE AT *K*
(CAN HIGH) | 18 GA | TO *D*
(CAN LOW) | 18 GA | TO *B*
(CAN LOW) | 18 GA | TO SPLICE AT *K*
(CAN LOW) | 18 GA | TO *D*
(SHIELD) | TO SPLICE AT *K*
(SHIELD) | TO *D*

TAPE-OFF LEG 'K' TO THIS SIDE OF HARNESS

TIE WRAP LEG B TO BODY OF HARNESS

SNSR RETURN | 18 GA | TO 'F'
SNSR RETURN | 18 GA | TO 'A'
SNSR RETURN | 18 GA | TO 'N'
HI/LO SELECT | 18 GA | TO 'A'
390Ω, 1W RESISTOR
SEAL RESISTOR/WIRE SPLICE WITH HEAT SHRINK

RLY-1 | 10 GA SXL | SNSR | 16 GA SXL | M12 RING
RLY-2 | 10 GA SXL | M5 SPADE
2X 4.000

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
1	PUMP CNTRL	16 SXL
2	GND-3	16 SXL
	DEUTSCH DT06-2S DEUTSCH LOCK W2S DEUTSCH CONTACTS 0462-201-16141	

GND-3 | 16 GA SXL | 1/4 FEMALE SPADE
START RLY | 16 GA SXL | 1/4 FEMALE SPADE
RLY-2 | 10 GA SXL | #10 RING
RLY-1 | 10 GA SXL | #10 RING
GND-3 | 16 GA SXL | SEALED END
OIL PRS | 16 GA SXL | # 10 RING

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	SNSR RETURN	18 GXL
B	SHTDN OVR SUP	18 GXL
C	ECU OIL PRS C	18 GXL
	PACKARD ASSY 12065287 PACKARD TERMINAL 12103881	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	ECU CRANK A	18 GXL
B	ECU CRANK B	18 GXL
	PACKARD ASSY 12162193 PACKARD TERMINAL 12124075 -WIRES IN THIS CONNECTOR TO BE TWISTED 12 TURNS/FOOT	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	ECU GND	18 GXL
B	ECU IGN	18 GXL
C	(CAN HIGH)	18 GXL
D	(CAN LOW)	18 GXL
E	(SHIELD)	SHIELD
F	PLUGGED	--
G	PLUGGED	--
H	PLUGGED	--
J	PLUGGED	--
	DEUTSCH CONN HD10-9-1939PE DEUTSCH CONTACT 0460-202-1631 DEUTSCH PLUG 114017 DEUTSCH DUST CAP HDC16-6-9 -USE CHAMPLAIN SAE J1939/11-18 CABLE OR EQUIVALENT IN POSITIONS C, D, & E. -COVER EXPOSED SHIELD WIRE WITH CLEAR SHRINK TUBING. -WIRE LABELS NOT NECESSARY AT POSITIONS C, D, & E. -USE 12" DOUBLE END TIE WRAP TO SECURE DUST CAP TO HARNESS APPROXIMATELY 3" BEHIND CONNECTOR. APPLY DUST CAP TO CONNECTOR.	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A1	ENG SHTDN	18 GXL
A2	ECU IGN	16 TXL
A3	ECU INJECT B	16 TXL
B1	ECU CLT A	18 GXL
B2	ECU CRANK A	18 GXL
B3	SHTDN OVR SGN	18 GXL
C1	HI/LO SELECT	18 GXL
C2	PLUGGED	--
C3	ECU FUEL TMP A	18 GXL
D1	ECU MANFLD TMP A	18 GXL
D2	ECU CRANK B	18 GXL
D3	SNSR RETURN	18 GXL
E1	ENG THRTL SGN	18 GXL
E2	SHTDN OVR SUP	18 GXL
E3	TAC SND	18 GXL
F1	CAN LOW	18 GXL
F2	PLUGGED	--
F3	ECU OIL PRS C	18 GXL
G1	CAN HIGH	18 GXL
G2	PLUGGED	--
G3	FAULT LT	18 GXL
H1	PLUGGED	--
H2	PLUGGED	--
H3	PLUGGED	--
J1	PLUGGED	--
J2	ECU GND	16 TXL
J3	PLUGGED	--
K1	ECU BAT PWR	16 TXL
K2	ECU INJECT A	16 TXL
K3	PLUGGED	--
	PACKARD ASSY 12034398 PACKARD TERMINAL 12103881 PACKARD PLUG 12034413 -WIRES ECU CRANK A AND ECU CRANK B TO BE TWISTED 12 TURNS/FOOT. -WIRES CAN HIGH AND CAN LOW TO BE TWISTED 12 TURNS/FOOT	

CONN POS	WIRE DESIGNATION	WIRE GA & TYPE
A	START RLY	16 SXL
B	ECU BAT PWR	12 GXL
C	OIL PRS	16 SXL
D	ECU GND	12 GXL
E	PLUGGED	--
F	CLUTCH-B	16 SXL
G	ECU IGN	12 GXL
H	FAUL LT	18 GXL
J	ALT EXC	16 SXL
K	TAC SND	18 GXL
L	ENG THRTL SGN	18 GXL
M	CLT TMP	16 SXL
N	GND-3	16 SXL
P	PLUGGED	--
R	SHTDN OVR SUP	18 GXL
S	SHTDN OVR SGN	18 GXL
T	ENG SHTDN	18 GXL
U	PLUGGED	--
V	PLUGGED	--
W	PLUGGED	--
X	PUMP CNTRL	16 SXL
	DEUTSCH PLUG HD34-24-21SE DEUTSCH NUT 112263-90 DEUTSCH WASHER 112264 DEUTSCH CONTACTS 0462-201-16141 DEUTSCH CONTACTS 0462-203-12141 DEUTSCH PLUG 114017	

ECU IGN | 16 GA | TO *A*
ECU IGN | 12 GA | TO *C*
ECU IGN | 18 GA | TO *D*

TIEWRAP
GND-3
MOLDED DIODE JULIAN P/N: 08HA0004
START RLY

DIODE INSTALLATION AT END H

NOTES:
1. ALL DIMENSIONS ARE FROM THE CENTER OF WIRES
2. WRAP HARNESS WITH WOVEN NYLON LOOM.
3. WIRE DESIGNATIONS TO BE VISIBLY HOT-STAMPED ON WIRE ENDS AND COVERED BY CLEAR HEAT SHRINK.
4. ALL TERMINALS AND CONNECTORS TO BE SEALED.
5. HARNESS MUST BE MANUFACTURED TO GRADALL ELECTRICAL SPECIFICATION 7731-9050 UNLESS OTHERWISE SPECIFIED.
6. ALL UNDERLINED DIMENSIONS ARE OUT OF SCALE.
7. 18 GA. WIRE TO BE 19/.0092 (19/.23 mm) STRANDING.
8. 16 GA. WIRE TO BE 19/29 STRANDING.
9. 12 GA. WIRE TO BE 19/25 STRANDING.
10. 10 GA. WIRE TO BE 19/23 STRANDING.

SUPERSEDES . | SIMILAR TO 8046-3081 | M-8047-5001, 8047-5008, 8047-5013

ORIGINAL RELEASE:.

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3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
.	.	.	.

PURCHASE COMPLETE
PAINT .
APPROVED BY JAB
CHECKED BY GTB
DRAWN BY GTB
DATE 12/5/07

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: HARNESS-ENGINE
MATERIAL: XL4200II, XL4200II CE XL4300II, XL4300II CE

SIZE 5 | CAGE CODE 10086 | 8046-3113 | REV. A

SCALE N/A | WGT . | SHEET 1 OF 2

SUPERSEDED BY .

FORMAT_3D_SIZE5.dwg REV. B 03/07/01

https://truckmanualshub.com/

NOTE:
ALL BULLET TERMINALS TO BE .157 SIZE

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
.	A	EC 070254 GTB 12/5/07 RELEASE TO PRODUCTION	GTB	JAB

WIRE DESIGNATION	WIRE COLOR/STRIPE	WIRE GAGE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	REMARKS
ENG SHTDN	BROWN	18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES									SHUTDOWN FROM EMU
ECU IGN	DK GREEN/DK BLUE	12/16/18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES	D	DEUTSCH HD10 SERIES							ECU IGNITION POWER
ECU INJECT B	LT GREEN/GRAY	16	A	PACKARD CONNECTOR	J	PACKARD CONNECTOR									FUEL INJECTION CONTROL
ECU CLT A	LT BLUE/LT GREEN	18	A	PACKARD CONNECTOR	M	PACKARD CONNECTOR									COOLANT LEVEL TO ECU
ECU CRANK A	LT GREEN/LT BLUE	18	A	PACKARD CONNECTOR	R	PACKARD CONNECTOR									CRANK POSITION TO ECU
SHTDN OVR SGN	VIOLET/DK BLUE	18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES									ENGINE SHUTDOWN OVERRIDE SIGNAL
HI/LO SELECT	TAN/LT BLUE	18	A	PACKARD CONNECTOR		390Ω , 1W RESISTOR									HI/LO SELECT
ECU FUEL TMP A	LT GREEN/TAN	18	A	PACKARD CONNECTOR	L	PACKARD CONNECTOR									FUEL TEMP. INPUT TO ECU
ECU MANFLD TMP A	LT BLUE	18	A	PACKARD CONNECTOR	N	PACKARD CONNECTOR									MANIFOLD TEMP. INPUT TO ECU
ECU CRANK B	PINK/LT BLUE	18	A	PACKARD CONNECTOR	R	PACKARD CONNECTOR									CRANK POSITION TO ECU
SNSR RETURN	LT BLUE/DK GREEN	18	A	PACKARD CONNECTOR	F	PACKARD CONNECTOR	N	PACKARD CONNECTOR		390Ω, 1W RESISTOR	L	PACKARD CONN	M	PACKARD CONN	COMMON ECU SIGNAL TO SENSORS
ENG THRTL SGN	DK GREEN/YELLOW	18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES									ENGINE SPEED REQUEST
SHTDN OVR SUP	WHITE TAN	18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES	F	PACKARD CONNECTOR							ENGINE SHUTDOWN OVERRIDE POWER
TAC SND	DK BLUE/RED	18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES									TACHOMETER PICK-UP
CAN LOW	GREEN	18	A	PACKARD CONNECTOR	B	DEUTSCH DT06	D	DEUTSCH HD10 SERIES	K	DEUTSCH DT06					CAN-BUSS (LOW)
ECU OIL PRS C	LT BLUE/GRAY	18	A	PACKARD CONNECTOR	F	PACKARD CONNECTOR									OIL PRESSURE SIGNAL TO ECU
CAN HIGH	YELLOW	18	A	PACKARD CONNECTOR	B	DEUTSCH DT06	D	DEUTSCH HD10 SERIES	K	DEUTSCH DT06					CAN-BUSS (HIGH)
FAULT LT	YELLOW/BROWN	18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES									ENGINE ECU FAULT INDICATOR
ECU GND	BLACK	12/16/18	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES	D	DEUTSCH HD10 SERIES		SPLICE TO "SHIELD"					ECU GROUND
ECU INJECT A	LT GREEN/DK BLUE	16	A	PACKARD CONNECTOR	J	PACKARD CONNECTOR									FUEL INJECTION CONTROL
ECU BAT PWR	PINK/WHITE	12/16	A	PACKARD CONNECTOR	C	DEUTSCH HD30 SERIES									ECU BATTERY POWER
SHIELD	(NONE)	N/A	D	DEUTSCH HD10 SERIES		SPLICE TO "ECU GND"									CAN-BUSS SHIELDING
START RLY	VIOLET	16	C	DEUTSCH HD30 SERIES	H	1/4 FEMALE SPADE									START SIGNAL TO START RELAY
OIL PRS	DK BLUE/BROWN	16	C	DEUTSCH HD30 SERIES	E	#10 RING TERMINAL									OIL PRESSURE SIGNAL TO EMU
CLUTCH-B	GRAY/YELLOW	16	C	DEUTSCH HD30 SERIES	Q	FEMALE BULLET									A/C CLUTCH POWER
ALT EXC	PINK/BROWN	16	C	DEUTSCH HD30 SERIES	O	PACKARD CONNECTOR	S	PACKARD ALT. CONN.							ALTERNATOR EXCITATION
CLT TMP	DK BLUE/TAN	16	C	DEUTSCH HD30 SERIES	P	#10 RING TERMINAL									COOLANT TEMP. SIGNAL TO EMU
GND-3	BLACK	16	C	DEUTSCH HD30 SERIES	E	SEALED END	G	DEUTSCH DT06	H	1/4 FEMALE SPADE					GROUND #3
PUMP CNTRL	WHITE/BROWN	16	C	DEUTSCH HD30 SERIES	G	DEUTSCH DT06									PUMP HORSEPOWER CONTROL
RLY-1	RED/YELLOW	10	H	#10 RING TERMINAL	I	M12 RING TERMINAL									BATTERY POWER TO START RELAY
RLY-2	PINK/GRAY	10	H	#10 RING TERMINAL	I	M5 SPADE TERMINAL									POWER TO STARTER SOENOID
SNSR	PINK/TAN	16	I	M12 RING TERMINAL	S	PACKARD ALT. CONN.									ALTERNATOR SENSE WIRE

SUPERSEDES .
SIMILAR TO 8046-3081
M-8047-5001, 8047-5008, 8047-5013

ORIGINAL RELEASE: .

FORMAT_3D_9-17-29.dwg REV. 9 03/07/07

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PURCHASE COMPLETE
PAINT .
APPROVED BY JAB
CHECKED BY GTB
DRAWN BY GTB
DATE 12/5/07

ITEM	QTY	PART NUMBER	DESCRIPTION
.	.	.	.

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: HARNESS-ENGINE

MATERIAL: XL4200II, XL4200II CE
XL4300II, XL4300II CE

SIZE 5 | CAGE CODE 10086 | 8046-3113 | REV. A

SCALE N/A | WGT . | SHEET 2 OF 2

SUPERSEDED BY: .

https://truckmanualshub.com/

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
C4	A	EC 050149 JGK 11/4/05 32.000 WAS 20.000	JGK	GTB
.	2	WR #8043-033 JAM 9/9/03 CHANGED END W; ADDED BREAKOUT FOR WIPER PWR 14GA SPLIT TO (3) WIPER PWR 16GA; END E WIPER PWR WAS MOTOR PWR.	BEB	RDM
.	1	WR #8043-033 SEG 03/14/03 PROTOTYPE RELEASE.	BEB	RDM

CONNECTOR KEY
TYP AT D & F
(VIEW FROM MATING SIDE)

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	AUX-2	16
2	TLT/AUX PWR	16
3	AUX-1	16
4	TLT/AUX PWR	16
5	HRN PWR	16
6	HRN RLY	16
7	PWR BOOST REQ	16
8	JYSTK/DB PWR	16
9	EMPTY	--

AMP CONN 350720-1
AMP TERMINAL 350874-1

D

16 GA. GND-12 — 2X 3.000 — 18.000 — **V** 16 GA. PWROUT-1
16 GA. TLT/AUX PWR — 2X 4.000 — 18.000 — **U** 16 GA. TILT SUPPLY PWR

3.000 / 9.000 / 4.000 / 1.000 / 1.000 / 13.000 / 12.000 / 2.000 / 3.000

W

CONN POS	WIRE DESIGNATION	WIRE GA.
1	HIGH	16
2	LOW	16
3	PARK	16
4	GND-12	16
5	WSH PWR	16
6	WIPER PWR	14

DEUTSCH DT06-6S
DEUTSCH LOCK W6S
DEUTSCH CONTACTS 0462-209-16141
DEUTSCH CONTACTS 0462-201-16141

3" — 6.000

X

CONN POS	WIRE DESIGNATION	WIRE GAUGE
A	JYSTK-A	16
B	GND-12	16
C	JYSTK-B	16

PACKARD ASSY 12015793
PACKARD TERMINAL 12124580
PACKARD SEAL 12010293

3.000 — 9.000

R ALL 16 GA. IN END R
KEY BAT
PWROUT-1
GND-12
SP-5
SP-6
PWROUT-2

6X 12.000

Z ALL 18 GA. IN END Z
RT SPK PWR
RT SPK GND
LFT SPK PWR
LFT SPK GND

4X 10.000

TO END "C" — WORK LT PWR 16 GA.
TO END "E" — WORK LT PWR 10 GA.
10 GA. — 12 GA. WORK LT PWR TO END "Y"
16 GA. WORK LT PWR TO END "A"
16 GA. WORK LT PWR TO END "A"
WORK LT PWR TO END "A" 16 GA.

WORK LT GND TO END "AC" 16 GA.
WORK LT GND TO END "E" 10 GA.
16 GA. WORK LT GND TO END "A"
16 GA. WORK LT GND TO END "A"
12 GA. WORK LT GND TO END "Y"

WIPER PWR 14 GA. — 16 GA. WIPER PWR
16 GA. WIPER PWR
16 GA. WIPER PWR

3.000

Y

CONN POS	WIRE DESIGNATION	WIRE GAUGE
A	WORK LT PWR	12
B	WORK LT GND	12

PACKARD ASSY 12015792
PACKARD TERMINAL 12124581
PACKARD SEAL 12015193

A

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	PLUGGED	--
2	THTL POT SGN	16
3	TILT-1 INPUT	16
4	TILT-2 INPUT	16
5	THLT POT PWR	16
6	WORK LT GND	16
7	SHTDN OVR SGN	16
8	THTL POT GND	16
9	AUX-2	16
10	AUX-1	16
11	WORK LT PWR	16
12	WORK LT PWR	16
13	SHTDN OVR SUP	16
14	PLUGGED	--
15	WORK LT PWR	16
16	WORK LT	16
17	BOOM LT	16
18	AUTO IDLE	16
19	WORK LT GND	16
20	REAR LT GND	16
21	PLUGGED	--
22	HTR PWR	16
23	HTR POT SGN	16
24	PWR BOOST REQ	16
25	PLUGGED	--
26	PLUGGED	--
27	TRV HI	16
28	PLUGGED	--
29	PLUGGED	--
30	PLUGGED	--
31	PLUGGED	--

DEUTSCH CONN HD34-24-31 PT
DEUTSCH NUT 112263-90
DEUTSCH LOCKWASHER 112264
DEUTSCH CONTACT 0460-202-16141
DEUTSCH PLUG 114017

NOTES:

1. WRAP HARNESS WITH WOVEN NYLON LOOM.
2. WIRE DESIGNATIONS TO BE VISIBLY HOT-STAMPED ON WIRE ENDS (CLEAR HEAT SHRINK NOT REQUIRED).
3. HARNESS MUST BE MANUFACTURED TO GRADALL ELECTRICAL SPECIFICATION 7731-9050 UNLESS OTHERWISE SPECIFIED.
4. ALL UNDERLINED DIMENSIONS ARE OUT OF SCALE.
5. 10 GAUGE WIRE TO BE TYPE SXL, 19/23 STRANDING.
   12 GAUGE WIRE TO BE TYPE SXL, 19/25 STRANDING.
   16 GAUGE WIRE TO BE TYPE SXL, 19/29 STRANDING.
   18 GAUGE WIRE TO BE TYPE SXL, 16/30 STRANDING.
6. DO NOT MOLD FEMALE SPADES. THOROUGHLY COVER EXPOSED AREA OF FEMALE SPADES WITH HS101 HEAT SHRINK TUBING

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	TILT-1 INPUT	16
2	TILT SUPPLY PWR	16
3	TILT-2 INPUT	16
4	TILT SUPPLY PWR	16
5	HRN PWR	16
6	HRN RLY	16
7	TILT SUPPLY PWR	16
8	OVERRIDE	16
9	EMPTY	--

AMP CONN 350720-1
AMP TERMINAL 350874-1

F

16 GA. GND-11 — 2X 3.000 — 18.000 — **H** 16 GA. PWROUT-1

3.000 / 9.000 / 2.000 / 1.000 / 1.000 / 13.000 / 3.000

T

ALL 16 GA. IN END T
KEY IGN
KEY ACC
KEY BAT
START
4X 4.000 — 9.000

AQ

SHTDN OVR SGN 16 GA.
SHTDN OVR SUP 16 GA.
2X 3.000 — 18.000 — **I**
3X 4.000 — 18.000

S

ALL 16 GA. IN END S
HTR LOW
HTR HI
HTR MED
2X HTR PWR
CLUTCH A
4X 4.000 — 9.000 — 6.000

CONN POS	WIRE DESIGNATION	WIRE GAUGE
A	GND-11	16
B	HTR POT SGN	16
C	HTR PWR	16

PACKARD ASSY 12015793
PACKARD TERMINAL 12124580
PACKARD SEAL 12010293

16 GA. AUTO IDLE — 2X 3.000 — 18.000 — **J** 16 GA. SWITCH PWR
9.000 — 4.000 — **K**

24KΩ, 1/2 WATT RESISTOR
SONIC BOND OR SLEEVE & CRIMP AND SOLDER
SELF SEALING HEAT SHRINKABLE TUBING (3/8")
.500 / .500 / .250 / .250 / .375 / .375 / 1.750
NOTE: ASSEMBLE RESISTOR PER SECTION 5 (SPLICES) OF GENERAL SPECS.

L ALL 16 GA. IN END L
PWROUT-1
GND-11
SP-5
SP-6
PWROUT-2

5X 12.000

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	EMPTY	-
2	JYSTK/DB PWR	16
3	TRV HI	16
4	EMPTY	-
5	EMPTY	-
6	EMPTY	-
7	EMPTY	-
8	EMPTY	-

CARLINGSWITCH VCH CONN HOUSING
PACKARD TERMINAL 12015870

Q

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	EMPTY	-
2	SWITCH PWR	16
3	ACC #2 SGN	16
4	EMPTY	-
5	EMPTY	-
6	EMPTY	-
7	EMPTY	-
8	EMPTY	-

CARLINGSWITCH VCH CONN HOUSING
PACKARD TERMINAL 12015870

P

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	EMPTY	-
2	SWITCH PWR	16
3	BOOM LT	16
4	EMPTY	-
5	EMPTY	-
6	EMPTY	-
7	EMPTY	-
8	EMPTY	-

CARLINGSWITCH VCH CONN HOUSING
PACKARD TERMINAL 12015870

O

M

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	EMPTY	-
2	SWITCH PWR	16
3	ACC #1 SGN	16
4	EMPTY	-
5	EMPTY	-
6	EMPTY	-
7	EMPTY	-
8	EMPTY	-

CARLINGSWITCH VCH CONN HOUSING
PACKARD TERMINAL 12015870

N

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	EMPTY	-
2	SWITCH PWR	16
3	WORK LT	16
4	EMPTY	-
5	EMPTY	-
6	EMPTY	-
7	EMPTY	-
8	EMPTY	-

CARLINGSWITCH VCH CONN HOUSING
PACKARD TERMINAL 12015870

5X 3.000 — 5X 9.000

28.250

CONN POS	WIRE DESIGNATION	WIRE GAUGE
A	HTR LOW	16
B	HTR MED	16
C	HTR HI	16

PACKARD ASSY 12015793
PACKARD TERMINAL 12124580
PACKARD SEAL 12010293

3X 3.000
16 GA. AC CLUTCH
CLUTCH A 16 GA.

G

CONN POS	WIRE DESIGNATION	WIRE GAUGE
1	KEY BAT	16
2	KEY ACC	16
3	KEY IGN	16
4	START	16
5	TLT/AUX PWR	16
6	SP-5	16
7	HTR PWR	16
8	HTR PWR	16
9	AC CLUTCH	16
10	HRN PWR	16
11	HRN RLY	16
12	WIPER PWR	16
13	WIPER PWR	16
14	WSH PWR	16
15	OVERRIDE	16
16	PWROUT-1	16
17	PWROUT-2	16
18	SWITCH PWR	16
19	SP-6	16
20	ACC #1 SGN	16
21	ACC #2 SGN	16
22	GND-11	16
23	GND-12	16
24	PLUGGED	--
25	JYSTK-A	16
26	JYSTK-B	16
27	PLUGGED	--
28	JYSTK/DB PWR	16
29	JYSTK JUMPER	16
30	PLUGGED	--
31	JYSTK JUMPER	16

DEUTSCH CONN HD36-24-31 ST
DEUTSCH CONTACT 0462-201-16141
DEUTSCH PLUG 114017

B

32.000 / 3.000

AC

16 GA. REAR LT GND — 16 GA. WORK LT GND
SWITCH PWR 16 GA.
6.000 / 18.000

C

REAR LT GND 16 GA.
WORK LT PWR 16 GA.
5.000

E

87.000 — 10.000
30.000 — 30.000 — 10.000
2X 4.000 — 2X 4.000
2.000 — 7X 3.000

WORK LT PWR 10 GA.
WORK LT GND 10 GA.
WIPER PWR 16 GA.
REAR LT GND 16 GA.
LOW 16 GA.
HI 16 GA.
PARK 16 GA.

18 GA. RT SPK PWR .187 FEMALE SPADE
18 GA. RT SPK GND .110 FEMALE SPADE
LFT SPK GND 18 GA. .110 FEMALE SPADE
LFT SPK PWR 18 GA. .187 FEMALE SPADE

AA **AB**

ORIGINAL RELEASE: WR #8040-033

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TOLERANCES
UNLESS OTHERWISE SPECIFIED
1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
		PURCHASE COMPLETE	
		PAINT .	
		APPROVED BY RDM	
		CHECKED BY BEB	
		DRAWN BY SE GREEN	
		DATE 03/14/03	

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO
TITLE: CAB HARNESS
MATERIAL: XL4200 II
SIZE 5 | CAGE CODE 10086 | 8046-3043 | REV. A
SCALE NONE | WGT . | SHEET 1 OF 2

SUPERSEDES . | SIMILAR TO 8046-3003 | M- 8046-5005

FORMAT_30_SIZE5.dwg REV. B 03/07/01

SUPERSEDED BY .

https://truckmanualshub.com/

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
.	A	EC 050149 JGK 11/4/05 REV LEVEL UPDATE ONLY	JGK	GTB
.	2	WR #8040-033 JAM 9/9/03 REMOVED 'MOTOR PWR'; W WIRE ENDS WERE FEMALE SPADES; ADDED E TO 'WIPER PWR'; 'WIPER PWR' WAS 12 GA.; ADDED END W TO 'GND -12'.	BEB	RDM
.	1	WR #8040-033 SEG 03/14/03 PROTOTYPE RELEASE.	BEB	RDM

WIRE DESIGNATION	WIRE COLOR/STRIPE	WIRE GAGE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	WIRE END	TERMINAL TYPE	REMARKS
SHTDN OVR SUP	WHITE/TAN	16	A	DEUTSCH HD 30 SERIES	AQ	1/4" FEMALE SPADE							SHUTDOWN OVERRIDE SUPPLY
SHTDN OVR SGN	VIOLET/DARK BLUE	16	A	DEUTSCH HD 30 SERIES	AQ	1/4" FEMALE SPADE							SHUTDOWN OVERRIDE SIGNAL
THTL POT SGN	WHITE/LT GREEN	16	A	DEUTSCH HD 30 SERIES	I	3 WIRE W/P TOWER							THROTTLE SELECTOR
TILT-1 INPUT	BROWN/VIOLET	16	A	DEUTSCH HD 30 SERIES	F	AMP MATE-N-LOK PLUG							TILT VALVE-1 INPUT
TILT-2 INPUT	BROWN/WHITE	16	A	DEUTSCH HD 30 SERIES	F	AMP MATE-N-LOK PLUG							TILT VALVE-2 INPUT
THTL POT PWR	ORANGE/BLACK	16	A	DEUTSCH HD 30 SERIES	I	3 WIRE W/P TOWER							THROTTLE SELECTOR POWER
THTL POT GND	BLACK	16	A	DEUTSCH HD 30 SERIES	I	3 WIRE W/P TOWER							THROTTLE SELECTOR GROUND
AUX-2	BROWN/LT GREEN	16	A	DEUTSCH HD 30 SERIES	D	AMP MATE-N-LOK PLUG							AUXILIARY VALVE-2 POWER
AUX-1	BROWN/DK GREEN	16	A	DEUTSCH HD 30 SERIES	D	AMP MATE-N-LOK PLUG							AUXILIARY VALVE-1 POWER
WORK LT PWR	YELLOW/VIOLET	16/12/10	A	3X DEUTSCH HD 30 SERIES	E	FEMALE BULLET	Y	2-WIRE W/P TOWER	C	FEMALE BULLET			WORK LIGHT POWER (OPTIONAL)
WORK LT	YELLOW/WHITE	16	A	DEUTSCH HD 30 SERIES	N	PACKARD CONNECTOR							WORK LIGHTS (OPTIONAL)
BOOM LT	YELLOW/LT GREEN	16	A	DEUTSCH HD 30 SERIES	O	PACKARD CONNECTOR							BOOM LIGHTS (OPTIONAL)
AUTO IDLE	WHITE/DK GREEN	16	A	DEUTSCH HD 30 SERIES	J	1/4 FEMALE SPADE							STELMOTOR AUTOMATIC IDLE
WORK LT GND	BLACK	16/12/10	A	2X DEUTSCH HD 30 SERIES	E	MALE BULLET	Y	2-WIRE W/P TOWER	AC	1/4 FEMALE SPADE			WORK LIGHT GROUND (OPTIONAL)
REAR LT GND	BLACK	16	A	DEUTSCH HD 30 SERIES	C	MALE BULLET	E	FEMALE BULLET	AC	1/4 FEMALE SPADE			REAR LIGHT GROUND (OPTIONAL)
HTR POT SGN	GRAY/BROWN	16	A	DEUTSCH HD 30 SERIES	K	24KΩ RESISTOR/3 WIRE W/P TOWER							HEATER POSITION SWITCH
PWR BOOST REQ	WHITE/ORANGE	16	A	DEUTSCH HD 30 SERIES	D	AMP MATE-N-LOK PLUG							POWER BOOST
KEY BAT	RED/DK GREEN	16	B	DEUTSCH HD 30 SERIES	T	#10 RING SCREW	R	SEALED END					BATTERY POWER TO KEY SWITCH
KEY ACC	ORANGE/YELLOW	16	B	DEUTSCH HD 30 SERIES	T	#10 RING SCREW							ACCESSORY SIGNAL FROM KEY SWITCH
KEY IGN	ORANGE/BLUE	16	B	DEUTSCH HD 30 SERIES	T	#10 RING SCREW							IGNITION SIGNAL FROM KEY SWITCH
START	VIOLET/ORANGE	16	B	DEUTSCH HD 30 SERIES	T	#10 RING SCREW							STARTER RELAY
TLT/AUX PWR	ORANGE/PINK	16	B	DEUTSCH HD 30 SERIES	D	2X AMP MATE-N-LOK PLUG	U	FEMALE BULLET					TILT/AUXILIARY VALVE POWER
SP-5	GRAY/BLACK	16	B	DEUTSCH HD 30 SERIES	L	SEALED END	R	SEALED END					WIRE-5 (OPTIONAL)
HTR PWR	ORANGE/RED	16	B	2X DEUTSCH HD 30 SERIES	K	3 WIRE W/P TOWER	A	DEUTSCH HD 30 SERIES	S	2X 1/4 FEMALE SPADE			HEATER POWER
HRN PWR	RED/BROWN	16	B	DEUTSCH HD 30 SERIES	D	AMP MATE-N-LOK PLUG	F	AMP MATE-N-LOK PLUG					HORN POWER
HRN RLY	VIOLET/BLACK	16	B	DEUTSCH HD 30 SERIES	D	AMP MATE-N-LOK PLUG	F	AMP MATE-N-LOK PLUG					HORN RELAY
WIPER PWR	ORANGE/VIOLET	16	B	2X DEUTSCH HD 30 SERIES	W	DEUTSCH DT06-6S	E	FEMALE BULLET					WINDSHIELD WIPER POWER (OPTIONAL)
WSH PWR	VIOLET/TAN	16	B	DEUTSCH HD 30 SERIES	W	DEUTSCH DT06-6S							WINDSHIELD WASHER POWER (OPTIONAL)
OVERRIDE	WHITE/GRAY	16	B	DEUTSCH HD 30 SERIES	F	AMP MATE-N-LOK PLUG							TILT SPEED OVERRIDE
PWROUT-1	ORANGE/WHITE	16	B	DEUTSCH HD 30 SERIES	R,L	SEALED END	V,H	1/4 FEMALE SPADE					OUTLET-1 POWER
PWROUT-2	ORANGE/LT GREEN	16	B	DEUTSCH HD 30 SERIES	R	SEALED END	L	SEALED END					OUTLET-2 POWER
SWITCH PWR	ORANGE/DK GREEN	16	B	DEUTSCH HD 30 SERIES	N	PACKARD CONNECTOR							SWITCH POWER
			J	1/4 FEMALE SPADE	O	PACKARD CONNECTOR	AC	1/4 FEMALE SPADE					
			M	PACKARD CONNECTOR	P	PACKARD CONNECTOR							
SP-6	GRAY/TAN	16	B	DEUTSCH HD 30 SERIES	R	SEALED END	L	SEALED END					WIRE-6 (OPTIONAL)
ACC#1 SGN	WHITE/YELLOW	16	B	DEUTSCH HD 30 SERIES	M	PACKARD CONNECTOR							ACCESSORY-1 SIGNAL
ACC#2 SGN	WHITE/BLUE	16	B	DEUTSCH HD 30 SERIES	P	PACKARD CONNECTOR							ACCESSORY-2 SIGNAL
GND -11	BLACK	16	B	DEUTSCH HD 30 SERIES	K	3 WIRE W/P TOWER	H	3/16 FEMALE SPADE	L	SEALED END			GROUND-11
GND -12	BLACK	16	B	DEUTSCH HD 30 SERIES	R	SEALED END	V	3/16 FEMALE SPADE	X	3-WIRE W/P TOWER	W	DEUTSCH DT06-6S	GROUND-12
JYSTK-A	BROWN/BLUE	16	B	DEUTSCH HD 30 SERIES	X	3 WIRE W/P TOWER							POWER TO JOYSTICK ON/OFF SWITCH
JYSTK-B	BROWN/ORANGE	16	B	DEUTSCH HD 30 SERIES	X	3 WIRE W/P TOWER							POWER TO JOYSTICK PILOT SOLENOID
AC CLUTCH	GRAY/RED	16	B	DEUTSCH HD 30 SERIES	G	FEMALE BULLET							AIR CONDITION CLUTCH (OPTIONAL)
JYSTK/DB PWR	ORANGE/GRAY	16	B	DEUTSCH HD 30 SERIES	Q	PACKARD CONNECTOR							JOYSTICK/DIG BRAKE POWER
			D	AMP MATE-N-LOK PLUG									
TRV HI	VIOLET/WHITE	16	A	DEUTSCH HD 30 SERIES	Q	PACKARD CONNECTOR							HI SPEED CRAWLER TRAVEL
JYSTK JUMPER	YELLOW	16	B	2X DEUTSCH HD 30 SERIES									JOYSTICK POWER JUMPER
CLUTCH A	GRAY/WHITE	16	G	FEMALE BULLET	S	1/4 FEMALE SPADE							AIR CONDITION CLUTCH (OPTIONAL)
HTR HI	ORANGE/BROWN	16	S	1/4 FEMALE SPADE	G	3-WIRE W/P TOWER							HEATER HIGH
HTR MED	RED/BLACK	16	S	1/4 FEMALE SPADE	G	3-WIRE W/P TOWER							HEATER MEDIUM
HTR LOW	GREEN/ORANGE	16	S	1/4 FEMALE SPADE	G	3-WIRE W/P TOWER							HEATER LOW
TILT SUPPLY PWR	ORANGE/TAN	16	U	MALE BULLET	F	3X AMP MATE-N-LOK PLUG							PWM POWER SUPPLY TO TILT SWITCH
PARK	ORANGE	16	W	DEUTSCH DT06-6S	E	FEMALE BULLET							WINDSHIELD WIPER PARK (OPTIONAL)
HI	GREEN	16	W	DEUTSCH DT06-6S	E	FEMALE BULLET							WINDSHIELD WIPER HIGH (OPTIONAL)
LOW	WHITE	16	W	DEUTSCH DT06-6S	E	FEMALE BULLET							WINDSHIELD WIPER LOW (OPTIONAL)
RT SPK PWR	GRAY/LT GREEN	18	Z	SEALED END	AA	.187 FEMALE SPADE							RIGHT SPEAKER POWER
RT SPK GND	BLACK	18	Z	SEALED END	AA	.110 FEMALE SPADE							RIGHT SPEAKER GROUND
LFT SPK PWR	GRAY/ORANGE	18	Z	SEALED END	AB	.187 FEMALE SPADE							LEFT SPEAKER POWER
LFT SPK GND	BLACK	18	Z	SEALED END	AB	.110 FEMALE SPADE							LEFT SPEAKER GROUND

NOTE: ALL BULLET TERMINALS ARE .157" SIZE

ITEM	QTY	PART NUMBER	DESCRIPTION
.	.	.	.

NOTE

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TOLERANCES UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

PURCHASE COMPLETE

PAINT .

APPROVED BY RDM

CHECKED BY BEB

DRAWN BY SE GREEN

DATE 03/14/03

THE GRADALL COMPANY NEW PHILADELPHIA, OHIO

TITLE: CAB HARNESS

MATERIAL: XL4200 II

SIZE 5 | CAGE CODE 10086 | 8046-3043 | REV. A

SCALE NONE | WGT . | SHEET 2 OF 2

SUPERSEDED BY .

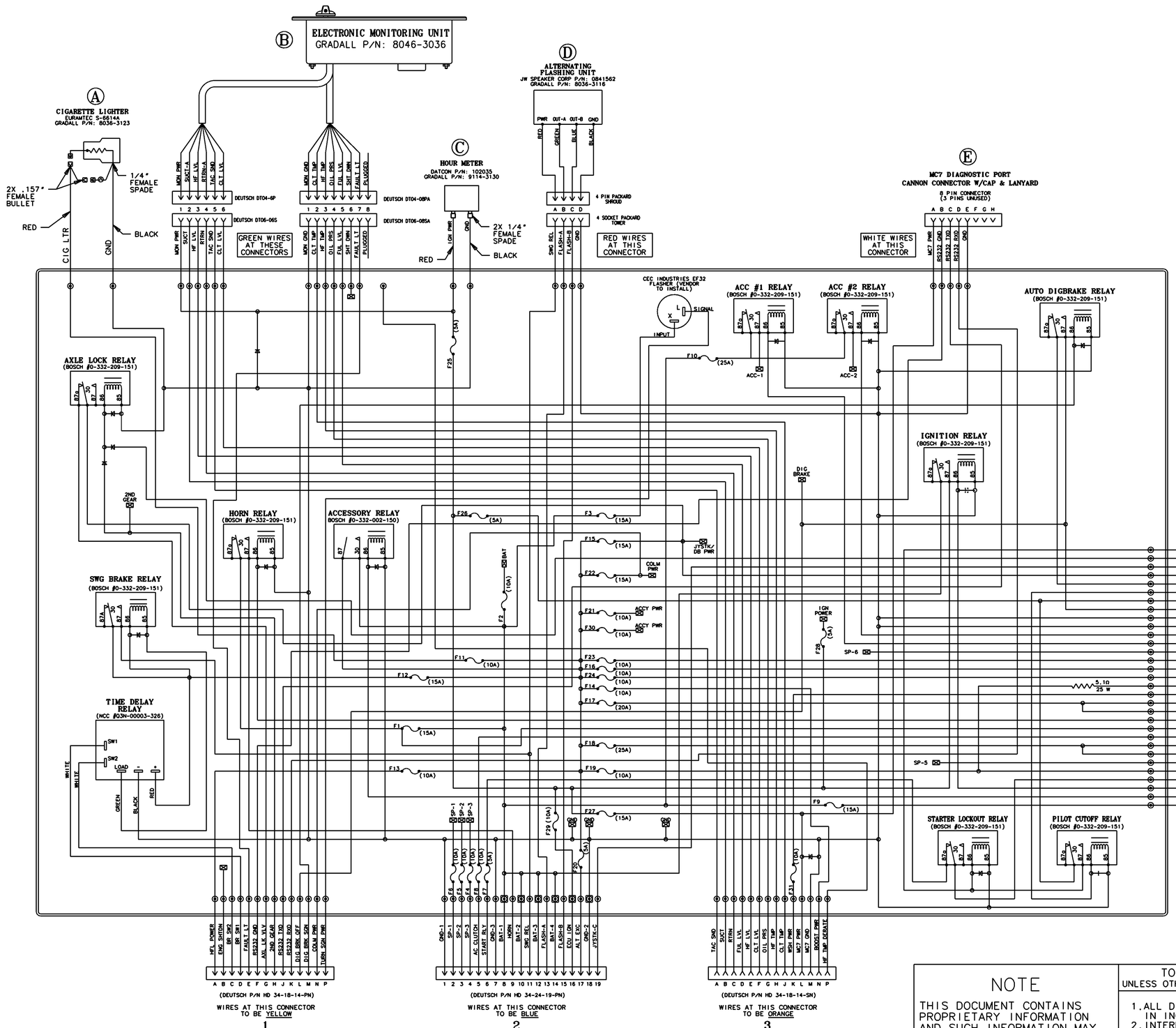
ORIGINAL RELEASE: WR #8040-033

FORMAT_30_51ZS.dwg REV. B 03/07/01

SUPERSEDES . | SIMILAR TO 8046-3003 | M-8046-5005

https://truckmanualshub.com/

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
.	A	EC 050149 JGK 11/7/05 ADDED OBSOLETE NOTE	JGK	GTB
D3 D6 D7	2	PROTO #8043-006 RAC 15OCT02 REVISED FUSE CHART; UPDATED SCHEMATIC WITH LATEST DESIGN.	MMK	RDM
.	1	WR #8043-006 JRP 10/29/01 PROTOTYPE RELEASE.	SEG	RDM



FUSE#	AMP	DESIGNATION
F1	15A	HORN POWER
F2	10A	SPARE BATTERY POWER
F3	15A	FLASHER POWER
F4	10A	SP-3 (OPTION)
F5	10A	SP-2 (OPTION)
F6	10A	SP-1 (OPTION)
F7	5A	STARTER RELAY
F8	10A	A.C. CLUTCH
F9	15A	KEY SWITCH POWER
F10	25A	ACCESSORY RELAY POWER
F11	10A	CIGARETTE LIGHTER
F12	15A	SWING BRAKE RELEASE
F13	10A	HYD LEVEL SENDER
F14	10A	BOOST POWER
F15	15A	JOYSTICK/DIGBRAKE POWER
F16	10A	POWER OUTLET #2
F17	20A	WIPER POWER
F18	25A	HEATER POWER
F19	10A	TILT/AUX POWER
F20	5A	ALTERNATOR EXCITE
F21	10A	SPARE ACCESSORY POWER
F22	15A	STEER COLUMN POWER
F23	10A	SWITCH/DOME LIGHT POWER
F24	10A	POWER OUTLET #1
F25	5A	EMU/HOURMETER POWER
F26	5A	JOYSTICK PILOT CUTOFF
F27	15A	MC7 CONTROLLER POWER
F28	5A	SPARE IGNITION POWER
F29	10A	ECU IGNITION POWER
F30	10A	SPARE ACCESSORY POWER
F31	10A	W/WASHER POWER

OBSOLETE

(8046-5002)

(_) NO LONGER USE FOR SERVICE OR PRODUCTION

(X) USE FOR SERVICE ONLY

(_) FOR SERVICE USE: XXXX-XXXX (OR SEE EC# FOR MULTIPLE)

(X) REFERENCE SIMILAR PART: 8046-5048

EC 050130 JGK 10/07/05

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3. TOLERANCES: ±.060°
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
.	.	.	.

PAINT .

APPROVED BY RDM

CHECKED BY SEG

DRAWN BY JR POLAK

DATE 10/29/01

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: CONSOLE ASSEMBLY

MATERIAL: XL4300/XL4200 II

SIZE	CAGE CODE		REV.
4	10086	8046-5002	A

SCALE NONE | WGT . | SHEET 2 OF 2

SUPERSEDED BY .

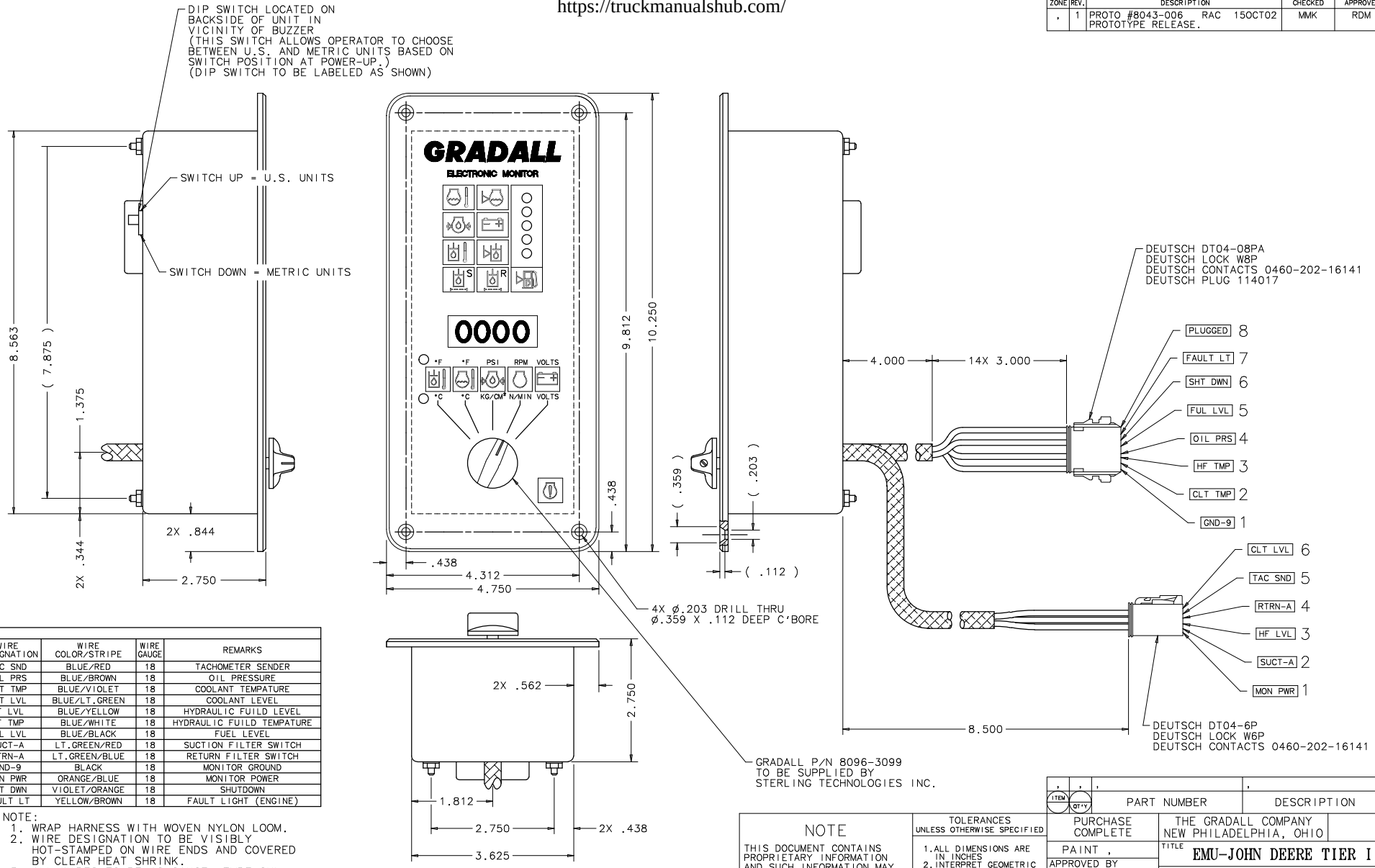
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REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	1	PROTO #8043-006 RAC 15OCT02 PROTOTYPE RELEASE.	MMK	RDM



WIRE DESIGNATION	WIRE COLOR/STRIPE	WIRE GAUGE	REMARKS
TAC SND	BLUE/RED	18	TACHOMETER SENDER
OIL PRS	BLUE/BROWN	18	OIL PRESSURE
CLT TMP	BLUE/VIOLET	18	COOLANT TEMPATURE
CLT LVL	BLUE/LT.GREEN	18	COOLANT LEVEL
HF LVL	BLUE/YELLOW	18	HYDRAULIC FUILD LEVEL
HF TMP	BLUE/WHITE	18	HYDRAULIC FUILD TEMPATURE
FUL LVL	BLUE/BLACK	18	FUEL LEVEL
SUCT-A	LT.GREEN/RED	18	SUCTION FILTER SWITCH
RTRN-A	LT.GREEN/BLUE	18	RETURN FILTER SWITCH
GND-9	BLACK	18	MONITOR GROUND
MON PWR	ORANGE/BLUE	18	MONITOR POWER
SHT DWN	VIOLET/ORANGE	18	SHUTDOWN
FAULT LT	YELLOW/BROWN	18	FAULT LIGHT (ENGINE)

NOTE:
1. WRAP HARNESS WITH WOVEN NYLON LOOM.
2. WIRE DESIGNATION TO BE VISIBLY HOT-STAMPED ON WIRE ENDS AND COVERED BY CLEAR HEAT SHRINK.
3. ALL WIRES TO BE 18 GAUGE, TYPE SXL, 16/30 STRANDING.

NOTE

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TOLERANCES
UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060°
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
,	,	,	,

PURCHASE COMPLETE
PAINT ,
APPROVED BY RDM
CHECKED BY MMK
DRAWN BY RAE
DATE 15OCT02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE EMU-JOHN DEERE TIER II
MATERIAL ,
SIZE 4 | CAGE CODE 10086 | 8046-3036 | REV. 1
SCALE FULL | WGT , | SHEET 1 OF 2

SUPERSEDES ,
SIMILAR TO 8036-3023
M-8046-5002
ORIGINAL RELEASE: WR #8043-006
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,	1	PROTO #8043-006 RAC 15OCT02 PROTOTYPE RELEASE.	MMK	RDM

ITEM #	DESCRIPTION	BACKGROUND COLOR: TELL-TALE IND. LIGHT	BACKGROUND COLOR: DIGITAL DISPLAY IND. LIGHT	TELL-TALE TRIGGER POINT	AUDIO ALARM TRIGGER	SHUT-DOWN TRIGGER	DIGITAL DISPLAY* MIN.	DIGITAL DISPLAY* MAX.	DIGITAL DISPLAY* INC.	SENDOR	COMMENTS
1	WATER TEMP	RED	GREEN	230°F 110°C	234°F 112°C	234°F 112°C	150°F 66°C	240°F 116°C	5°F 2°C	7738-3752 (DATCON #02025-00)	
2	FUEL LEVEL	RED	-----	15% FULL **	---	---	---	---	---	8366-3299 (ISS PRO #8601868)	
3	BATTERY CHARGE	RED	GREEN	11.6VDC	---	---	10v	16v	.2v	----------	
4	HYD. FILTER (SUCTION)	YEL.	-----	SWITCHES (NORMALLY OPERATE CLOSED) MUST OPEN FOR AT LEAST 5 SEC. CONTINUOUS	ALARM NOT ACTIVE UNTIL 2.5 MINUTES AFTER START	---	---	---	---	N.C. VACUUM SWITCH (8023-3077)	CIRCUIT IS GROUNDED FOR NORMAL CONDITION*** (NO IND. LIGHT)
5	HYD. TEMP	YEL.	GREEN	200°F 93°C	---	---	50°F 10°C	200°F 93°C	5°F 2°C	8096-3220 (S.T.I. #12147)	
6	WATER LEVEL	RED	-----	LEVEL	LEVEL	LEVEL	---	---	---	8097-3018 (S.T.I. #10680)	
7	OIL PRESSURE	RED	GREEN	10 PSI 0.7 Kg/cm^2	10 PSI 0.7 Kg/cm^2 (10 SECOND DELAY)	8 PSI 0.6 Kg/cm^2	0 PSI 0.0 Kg/cm^2	100 PSI 7.0 Kg/cm^2	5 PSI 0.2 Kg/cm^2	9103-3246 (DATCON #02505-00)	
8	HYD. FILTER (RETURN)	YEL.	-----	SWITCHES (NORMALLY OPERATE CLOSED) MUST OPEN FOR AT LEAST 5 SEC. CONTINUOUS	---	---	---	---	---	N.C. SWITCH (PART OF PARKER FILTER ASSEMBLY)	CIRCUIT IS GROUNDED FOR NORMAL CONDITION**** (NO IND. LIGHT)
9	HYD. LEVEL	RED	-----	LEVEL	LEVEL	---	---	---	---	8093-3061 (S.T.I. #CK 3100)	
10	ENGINE SPEED	---	GREEN	---	---	---	600 RPM	3000 RPM	25 RPM	SQUARE WAVE FREQUENCY FROM ENGINE ECU	30 PULSES/REV.
11	ENGINE FAULT LIGHT	YEL.	-----	SWITCHED FROM ENGINE ECU	---	---	---	---	---	SWITCHED OUTPUT FROM ENGINE ECU	LIGHT IS TURNED ON WITH A GROUND SIGNAL FROM ENGINE ECU

* DIGITAL DISPLAY TO FLASH ON & OFF IF READING IS OUTSIDE ESTABLISHED DISPLAY RANGE (MIN. OR MAX.)

DIGITAL DISPLAY TO BE 4 DIGIT 1/2" HIGH CHARACTERS (LIQUID CRYSTAL)

DIGITAL DISPLAY TO HAVE BACKLIGHTING

DIGITAL DISPLAY TO PERFORM ON AUTOMATIC SELF-TEST UPON STARTUP (5 SECOND DURATION)

** GREEN LED'S OF FUEL INDICATOR ACT AS FOLLOWS:

# OF LIGHTS ON	SENDER RESISTANCE	FUEL LEVEL
5	42	90% FULL
4	65	75% FULL
3	103	50% FULL
2	152	25% FULL
1	198	10% FULL
0	198	10% FULL

(TELL-TALE TRIGGER POINT IS 15% OR APPROXIMATELY 180 OHMS)

*** NORMAL CONDITION IS POSITIVE PRESSURE ABOVE TRIP POINT

**** NORMAL CONDITION IS POSITIVE PRESSURE BELOW TRIP POINT

ELECTRONIC MONITOR SPECIFICATIONS
INSTRUMENTATION PACKAGE DATA

TEMP. RANGE:
- FULL PERFORMANCE: -40°C TO 70°C
- STORAGE: -40°C TO 85°C

ENVIRONMENTAL COMPATIBILITY:

THE MONITOR WILL BE INSTALLED AND USED IN THE CONTROL CONSOLE OF HYDRAULIC EXCAVATORS.

THE TOP SURFACE OF THE MONITOR WILL BE EXPOSED TO WEATHER WHEN THE CAB DOOR OR WINDOWS ARE OPEN.

THE MONITOR MUST OPERATE IN THE PRESENCE OF THE FOLLOWING:
- VIBRATION & SHOCK
- HUMIDITY
- AIRBORNE DUST
- SOLAR RADIATION
- VOLTAGE SURGES PRESENT IN THE EXCAVATOR ELECTRICAL SYSTEM

THE TOP SURFACE MUST BE SEALED AGAINST MOISTURE INGRESSION (ROTARY SWITCH MUST BE SEALED)

DURABILITY:

MACHINE LIFE IS EXPECTED TO BE 10 YEARS (10,000 HOURS)

MONITOR DURABILITY

B_{10} 5,000 HOURS

B_{50} 10,000 HOURS

WARRANTY:

STANDARD GRADALL WARRANTY IS 12 MONTHS OR 1500 HOURS AFTER DELIVERY TO CUSTOMER.

THE MONITOR WARRANTY MUST MEET OR EXCEED THE GRADALL WARRANTY.

POWER SUPPLY:

+9 TO +30 V.D.C.

CURRENT DRAW: 120mA (NORMAL)
800mA (MAX. WITH BUZZER LIGHTS)

SPIKE PROTECTION:
- +80 VOLTS PULSE FOR 1 MILI-SECOND
- +200 VOLTS PULSE FOR 1 MICRO-SECOND
- -50 VOLTS PULSE FOR 2 MILI-SECOND

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THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: EMU-JOHN DEERE TIER II

MATERIAL ,

SIZE 4 | CAGE CODE 10086 | 8046-3036 | REV. 1

SCALE , | WGT , | SHEET 2 OF 2

SUPERSEDED BY ,

ORIGINAL RELEASE: WR #8043-006

SUPERSEDES , | SIMILAR TO 8036-3023 | M-8046-5002

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Testing Procedures

When equipment operates less than its normal, specified running time, it should be brought into the shop and the batteries examined as follows:

A. Check terminal connections for corrosion, loose connections and broken or frayed cables.

B. If terminal connections appear to be in good condition. check all cells with a hydrometer for variation in specific gravity. When there are variations of 30 points or more, mark low cells. 1his may mean an aging or detective battery,

C. Recharge the batteries as recommended by the manufacturer

D. Read all gravities again after recharge. Batteries are serviceable at gravities of 1.250 to 1.280. If one cell in a battery varies by 30 points or more than another cell in the same battery, it is an indication of a bad cell, assuming no acid has been spilled or pumped from cells with low specific gravity.

E. **For golf car vehicles only:**
Connect a 36-volt load tester to the set of batteries, discharge the batteries at 75 amps and record the time to a terminal voltage of 31.5 volts. Testers are now available with an automatic shut-off at this voltage. New batteries should run a minimum of 75 minutes on this test

1. If the batteries run less than 40 minutes, they have either reached the end of life or a detective battery is in the circuit. Replacement of the detective battery is then necessary.
2. If batteries run 40-50 minutes, they have lost capacity and may be nearing the end of their useful life. In golf car service, one round of golf may be expected on an average golf course at this capacity.
3. If batteries run more than 72 minutes, they are in good condition and satisfactory for continued service. Prior to putting the car back in service, check for the existence of other problems as outlined in the instruction manual.

Long after other batteries have been scrapped, Trojan batteries continue to give excellent service. Trojan batteries provide lasting value for your purchase dollar.

Replacement Procedures

A. **Detective Batteries**

1. A detective battery can be determined either by observation of gravity variance at the end of the 75 amp discharge (30 or more points between cells of a battery) or by turning the discharge tester on and determining the battery or cell which is detective by use of a voltmeter.
2. Mark the detective battery.
3. Recharge the batteries with the defective battery in the circuit
4. Remove the detective battery and replace, with a new battery or battery of comparable age which is fully charged.

B. **Worn Out Batteries**

1. Remove the old set of batteries.
2. Clean and epoxy paint battery trays and holddowns.
3. Inspect new batteries for broken containers and proper electrolyte level.
4. Replace them with long-lasting Trojan deep-cycle batteries. You and your customer deserve the best product available.
5. Install batteries, make sure that they are properly held dowr; firm, but not too tight.
6. Replace cables, make sure terminals and connectors are clean and tight.
7. Apply a light coating of non-metallic grease or protective coating.

Storage Procedures

A. Prior to storing, batteries should be cleaned, fully chaiged and properly leveled.

B. While in storage the batteries should be recharged to full charge at time intervals.

Storage Temperature	Charge
Below 40° F	Every 6 months
40° F to 60° F	Ever y 2 months
60° F and above	Once a month

C. Check batteries after storage and before service begins, Follow inspection and trouble shooting procedures to deter mine the condition of batteries.

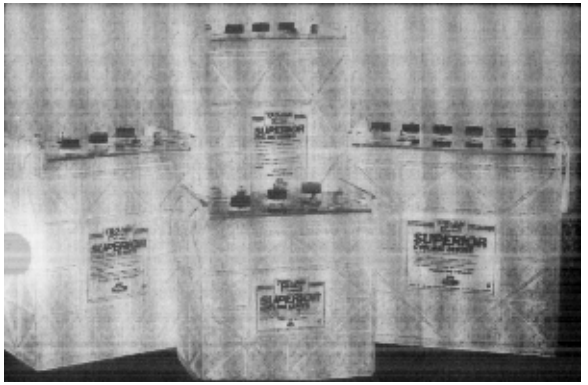
Trojan batteries will give years of excellent service with proper care.

Trojan Battery Company
12380 Clark Street, Santa Fe Springs, CA 90670
Phone: 562-946 8381, 800-423-6569
in Georgia, 770-981-8674, 800-246-2550, fax 770-981-7717
Trojan manufacturers specialty deep cycle batteries for a variety of applications, including golf, floor machine, marine, RV, EV, aerial work platform, renewable energy, industrial motive power, and auto/truck.
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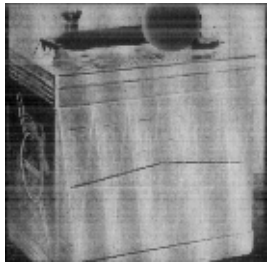

Pallet Jacks


Highway EV


Electric Fork Lifts

Trojan®
The Better Battery

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Inspection and Installation Procedures

A. Always inspect incoming shipments of batteries for damage.
B. If damaged batteries are found, contact your supplier for battery replacement.
C. If batteries are received wet and not immediately placed in service, they must be charged with a matched charger at regular intervals as follows:

Storage Temperature	Charge
Below 40° F	Every 6 months
40° F to 60° F	Ever y 2 months
60° F and above	Once a month

D. Post damage and/or container damage may occur from improper stacking. If batteries are stored individually place supporting boards between layers. Do not stack layers more than three high.
E. Batteries should be installed in accordance with the equipment vehicle manufacturer's instructions. Connections should be tight. Always charge sets of batteries immediately after installation in the equipment.
F. When moving, stacking or installing batteries **never** lift by the positive or negative terminals.
Many Trojan batteries have handle brackets and removable handles for ease in lifting.

Maintenance Procedures

A. Water batteries as needed. Water should be added when the level drops about 1/2" below the full level.
1. Add only approved water to the cells. Distilled water is recommended. Water with a high mineral content must not be used.
2. Add water to batteries after charging to prevent overflow of acid due to expansion.
3. Fill all cells to the proper level. Do not overfill cells. Fill to within 1/8" level indicator or 1/2" over the top of the separators Do not use a hose to water batteries. Watering guns or automatic watering systems are available and recommended.
4. Spot check cells between watterings to assure electrolyte is above separators. Excess water usage indicates the presence of any one or all of the following conditions:
a. Overcharging. b. High temperature operations. c. Nearring end of service life.





5. Do not allow the electrolyte level to drop below the top of the separators since this will lead to shortened battery life.
B. Clean batteries after watering or when washing equipment.
1. Wash the tops of the batteries making sure the vent caps are in place. Do not allow water or other foreign matter to enter the cells.
2. Use a solution of bicarbonate of soda, one cup for each bucket of water, to wash batteries if there is an accumulation of acid residue.
C. Inspection.
1. When watering batteries inspect battery and other terminal connections for:
a. Corrosion-Clean connections with soda solution, (See Charging Procedures) and wire brush and apply a nonmetallic grease or protective spray to retard further corrosion.
b. Connectors-Be sure all connections are tight and that there is good contact with terminals. Loose connectors can also cause explosions and serious injury.
c. Broken or Frayed Cables-Replace any which look suspicious.
2. Once a week after the batteries have been charged, spot check two or more cells for specific gravity reading. Gravity should be 1.250-1.280. If low readings are noted:
a. Check charqer to insure that proper charge is being returned to the batteries.
b. Check connections as specified (See Inspection above).
c. Check all cells to determine if batteries are near the end of life. (See Testing Procedures).
B. **For golf car vehicles,** regularly check for the following conditions which will shorten battery life: a. Brake drag. b. Improper tire pressure. c. Improper alignment. d. Improper lubrication. e. Improper operation of electrical system. f. Improper operation of drive and transmission system. g. Poor condition of charger plug and receptacle in equipment.

The combination of Trojan's exclusive multi-rib Flexsil separator, which lowers end-of-charge current and reduces water consumption, and Trojan's unique Vent Master vent plug greatly reduces overall maintenance/service time.

Charging Procedures

(Improper procedures may shorten battery life.)
A. Become familiar with instructions issued with the charger or equipment manual.
B. Batteries are to be charged after each period of use. Charging between short intervals of nonuse is permissible. In cold weather batteries should come off charge just prior to use.
C. Do not charge batteries if equipment was not used that day.
D. Do not allow batteries to set in a state of discharge.
E. Always be sure batteries are fully charged each day prior to use of equipment.
F. Do not smoke near batteries. Avoid flames and sparks which may cause an explosion and serious injury.
G. Use of battery additives can shorten the life of batteries. Do NOT use them.

Trojan deep cycle batteries deliver two key benefits
- **Longer Life, and**
- **Maximum Purchase Value**

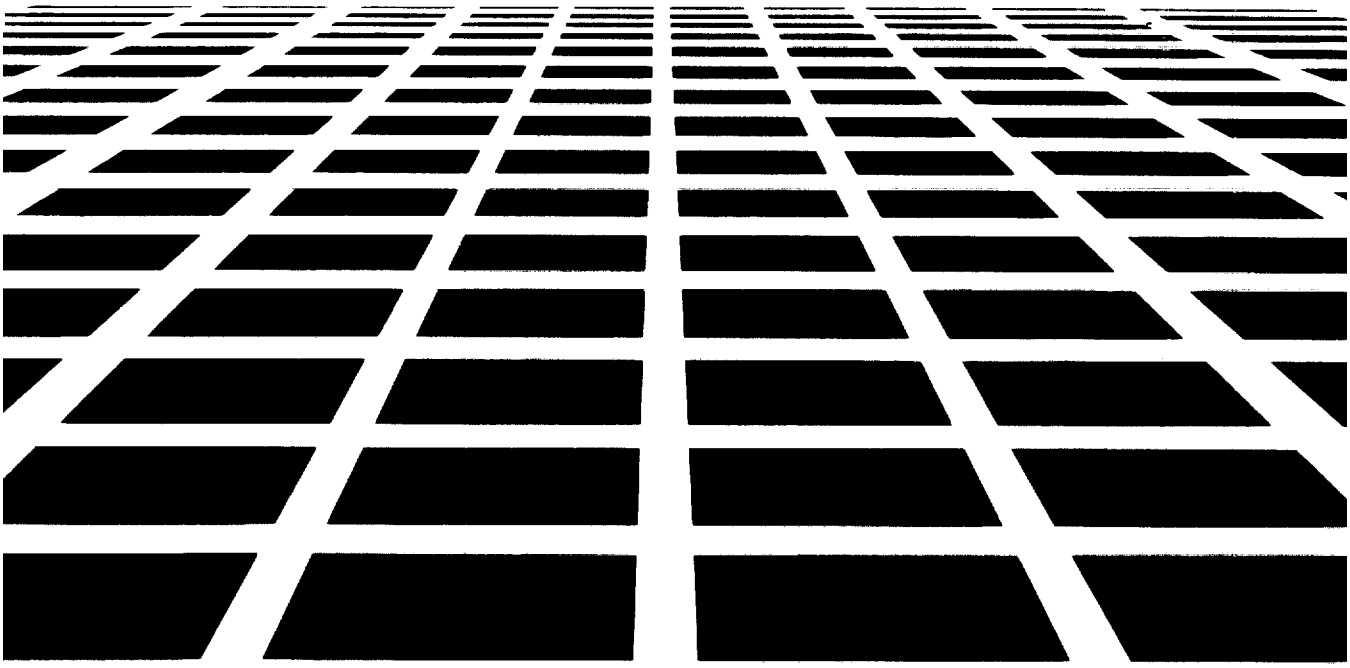
This winning combination is a function of our exclusive Alpha Plus, high density paste formulation and Multi-rib Flexsil separator.

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LEECE-NEVILLE

(Formerly LoadHandler)

‘MA/MR/MH/HC’ Series Alternators for Electronic Charging Systems



125-189

SERVICE MANUAL

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SECTION 1
SYSTEM DESCRIPTION

INTRODUCTION

The alternator converts mechanical and magnetic energy to A.C. (Alternating Current) and voltage, by the rotation of an electromagnetic field (rotor) inside a three phase stator assembly. The alternating current and voltage is changed to direct current and voltage, by passing A.C. energy through a three phase, full wave rectifier system. Generally, six silicon rectifier diodes are used.

The Leece-Neville alternators and regulators described in this
manual are designed for marine, industrial, construction, off highway, and agricultural applications where enclosed brush/ slip-ring construction is required because of high particulate or hazardous environments.

These compact and efficient charging systems are designed for 12, 24, 30 and 32 volt applications, as negative, positive or insulated ground machines.

The “MA” alternator series is used in general charging system applications encountering normal belt loads, and normal to medium duty operating requirements. This series also includes U.L. listed and SAE J1171 tested models designed for marine applications.

The “MR” series is essentially the same as the MA series except for inclusion of an integral regulator. This series also includes some U.L. listed and SAE J1171 tested models designed for marine applications.

The “MH” series is a heavy-duty version of the MA series with a 25mm front bearing, more output current and dual mounting feet (on some models) for heavy-duty applications.

The “HC” series is a heavy-duty version of the MR series (contains a 25mm front bearing for heavier belt loads).

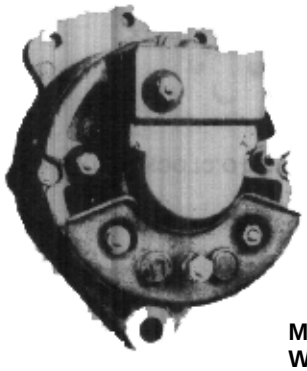
Some alternator models are equipped with dust screens for agricultural and industrial applications to minimize the possibility of overheating the alternator due to a build-up of debris within the unit. Should overheating problems occur in the field, the appropriate dust screen can be added to most of the alternators covered in this manual.

The regulators used with these charging systems are all-electronic, solid-state devices. No mechanical components are used to perform the regulation function. The regulators are temperature compensated to permit the ideal charging rate at all operating temperatures.

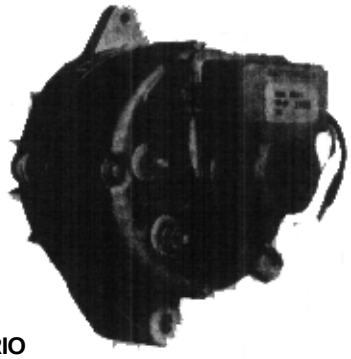
Model variation is based on the requirements of Original Equipment customer. Generally this difference involves the pulley selection, front housing (alternator mounting) and the choice of voltage regulator.

Figure No. 1-1 (Pages 1 and 2), illustrates several of the units in this product group.

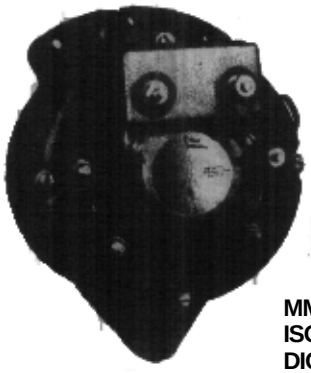
This manual provides (1) General product information, (2) In-vehicle electrical test procedures, (3) Alternator repair/overhaul instructions, and performance test of repaired units.



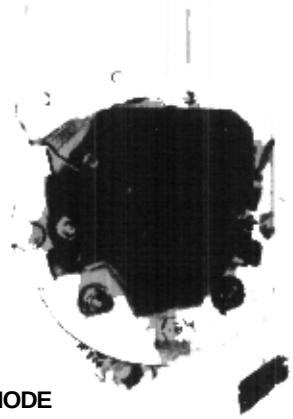
MA SERIES WITH ISOLATION DIODE



MR SERIES WITH DIODE TRIO



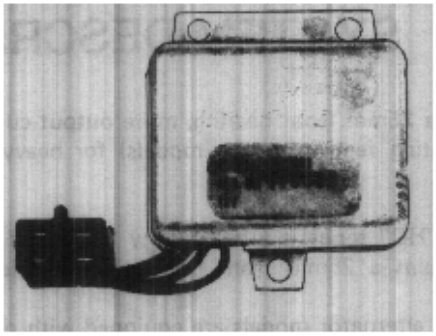
MM SERIES WITHOUT ISOLATION DIODE OR DIODE TRIO



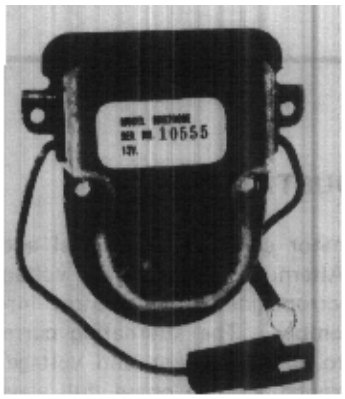
HC/MR SERIES WITH ISOLATION DIODE

FIG. 1-1 TYPICAL CHARGING SYSTEM PRODUCTS

https://truckmanualshub.com/



8RH SERIES REGULATOR



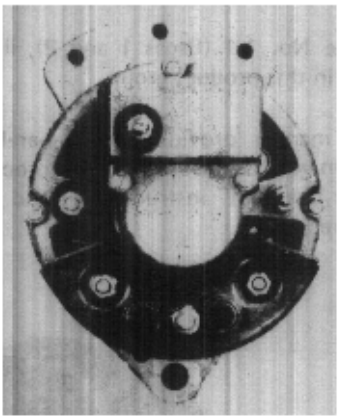
8RG SERIES REGULATOR

FIG. 1-1 TYPICAL CHARGING SYSTEM PRODUCTS

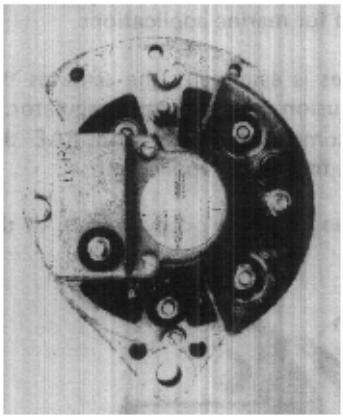
GENERAL INFORMATION

REAR HOUSING ROTATION

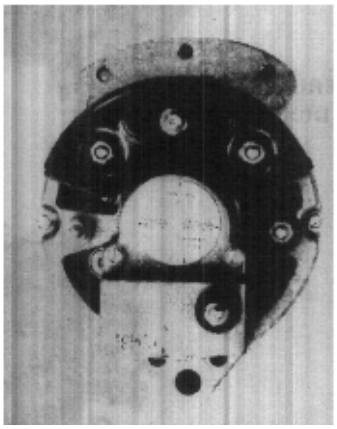
The four housing thru-bolts are spaced 90° apart, thus allowing four possible positions for the alternator rear housing with reference to the mounting foot, as shown in Figure No. 1-2.



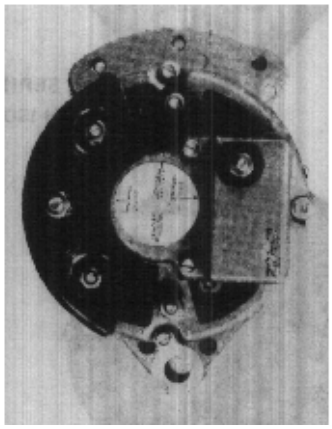
12:00 O'CLOCK



9:00 O'CLOCK



6:00 O'CLOCK



3:00 O'CLOCK

FIG. 1-2 ALTERNATOR MOUNTING POSITIONS

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ALTERNATOR

A diagram of a typical alternator without an isolation diode or diode trio is shown in Figure No. 1-3. In this system, both regulator sense and field power functions are obtained from a switched battery positive source such as the ignition switch. Figure 1-4 shows a diagram of an alternator which uses a diode trio. The diode trio is a low current version of the rectifier diode and must be of the same polarity. In this system, the regulator senses the voltage at the regulator terminal which is at battery reference. The diode trio also allows use of a charging lamp and prevents battery drain when the charging system is not in operation.

Since diodes pass direct current in only one direction, their arrangement in the alternator eliminates the need for a cut-out relay in the voltage regulator. The individual rectifier diodes, three positive and three negative, are assembled in two temperature dissipating heat sinks. The heat sinks are placed in the alternator with threaded studs that also serve as circuit terminals, Figure No. 1-5.

Maximum charging current is limited by the design and connections in the stator assembly, eliminating the need for a current regulating relay in the voltage regulator.

The Isolation Diode, shown in Figures No. 1-6 and 1-7, is mechanically and electrically connected to one of the studs in the left rectifier diode heat sinks. This places the isolation diode in a series circuit between the rectifier diodes and the output terminal stud on the isolation diode. The junction formed by the rectifier stud and the isolation diode is the “Auxiliary” or Regulator terminal of the alternator. This is the voltage sensing terminal of alternators using the isolation diode, Figure No. 1-7.

Continued on Page 6.

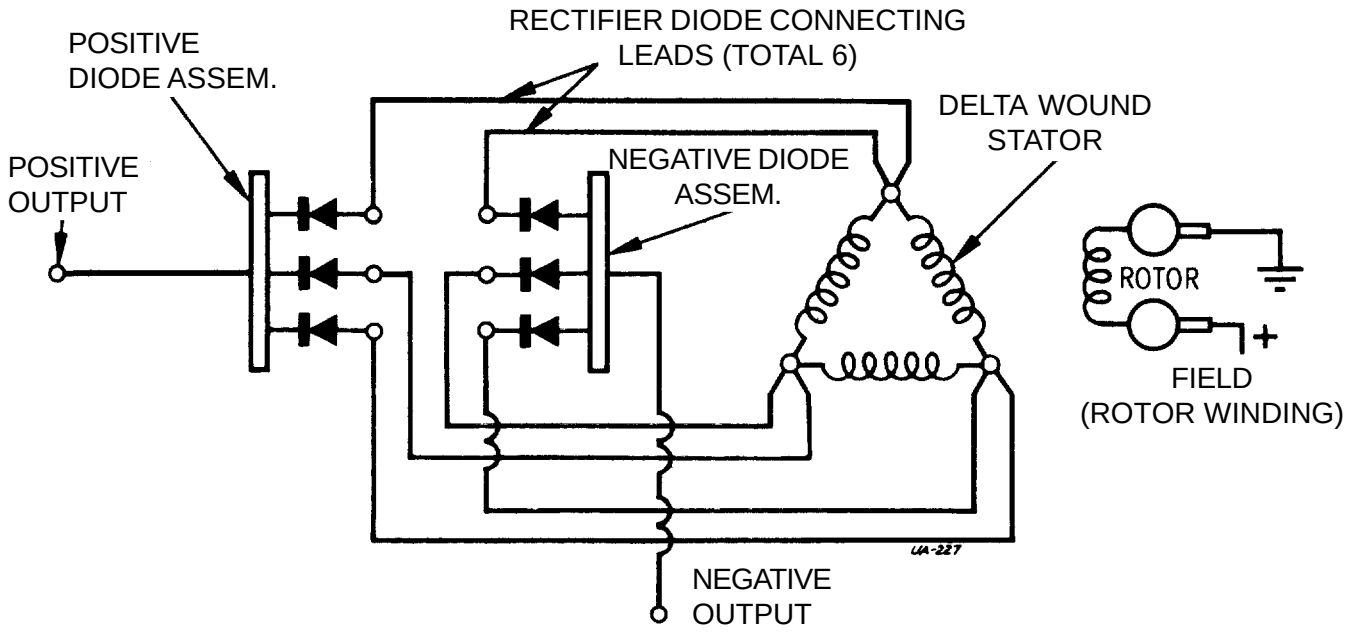


FIG. 1-3 ALTERNATOR SCHEMATIC DIAGRAM (WITHOUT ISOLATION DIODE OR DIODE TRIO)

https://truckmanualshub.com/

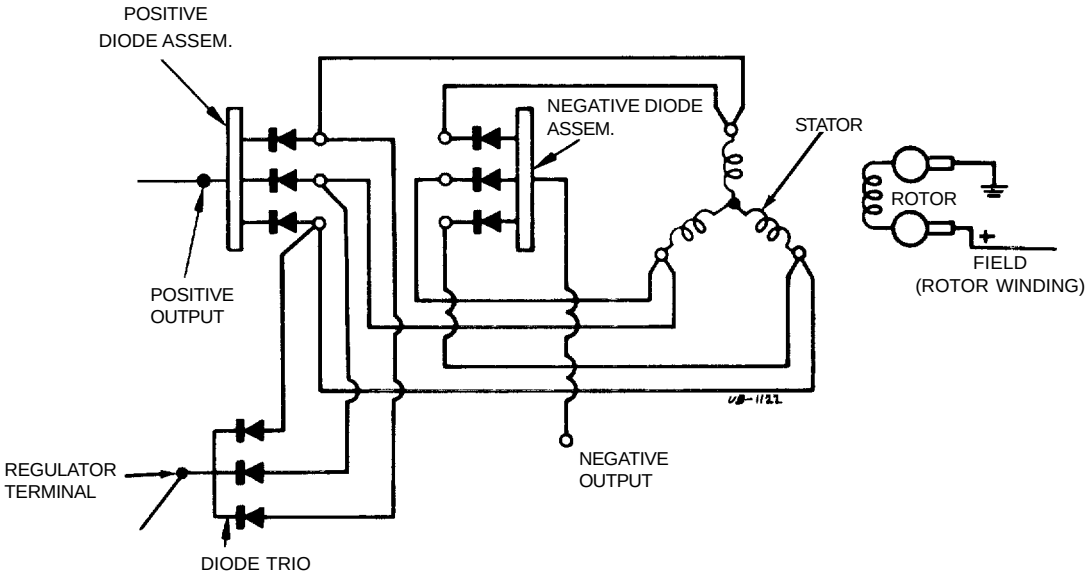


FIG. 1-4 ALTERNATOR SCHEMATIC DIAGRAM WITH DIODE TRIO

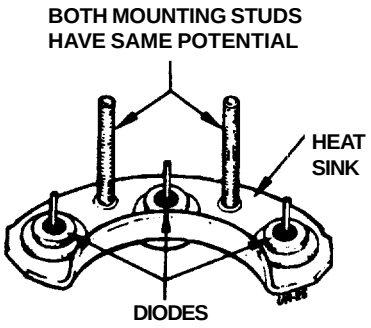


FIG. 1-5 RECTIFIER DIODE ASSEMBLY

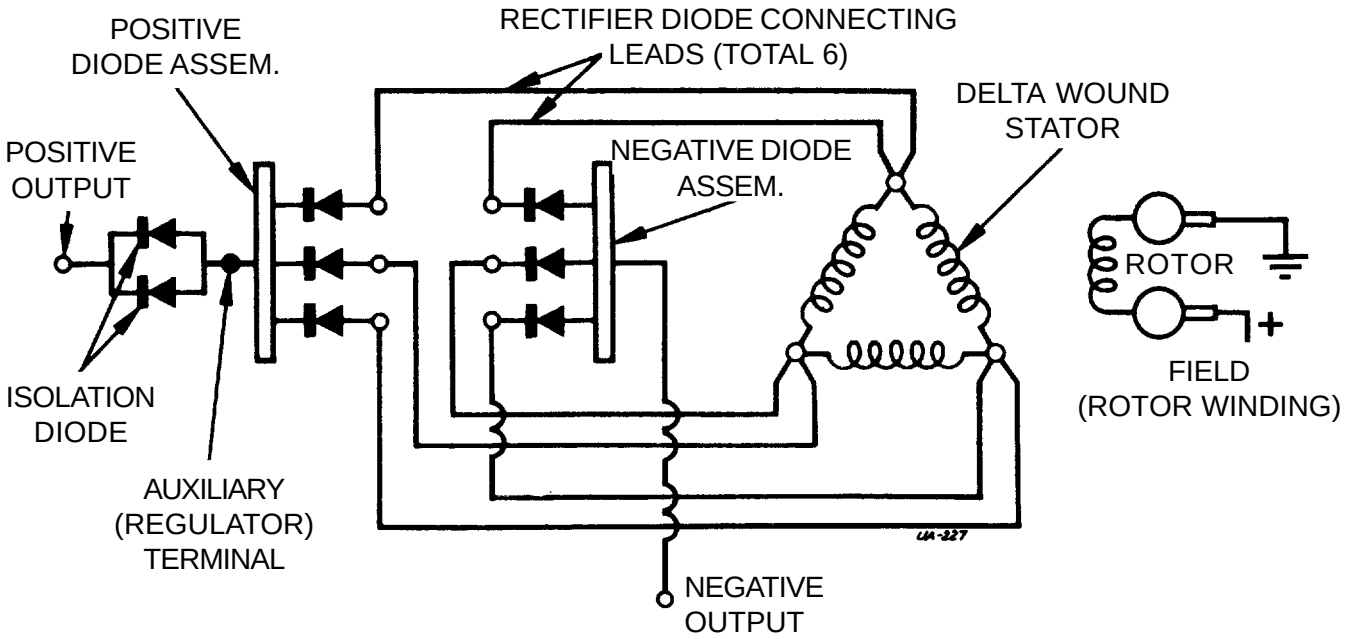


FIG. 1-6 ALTERNATOR SCHEMATIC DIAGRAM WITH ISOLATION DIODE

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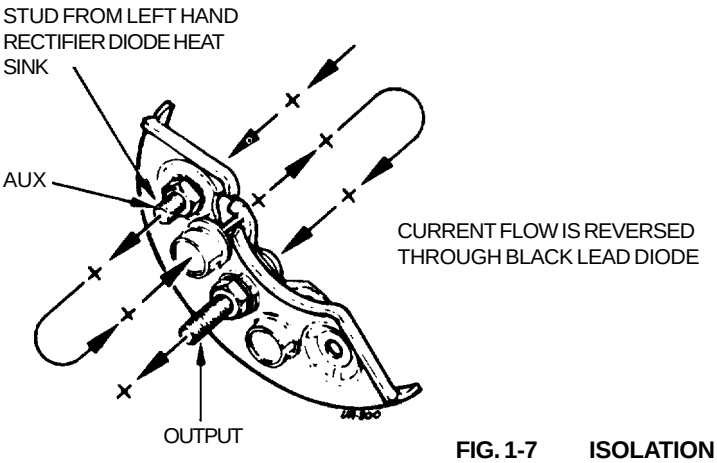
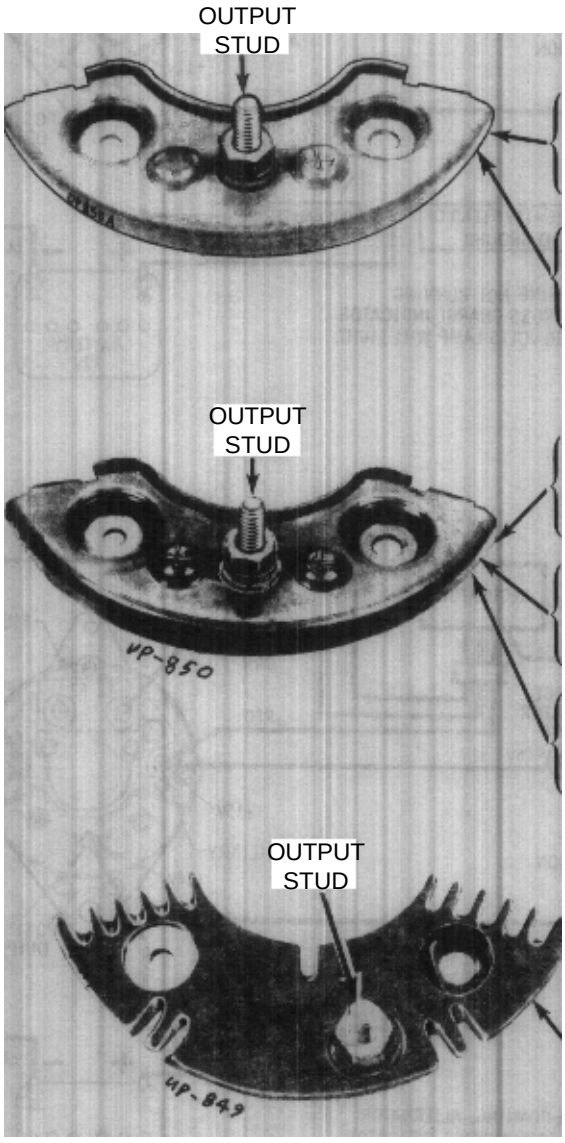


FIG. 1-7 ISOLATION DIODE ASSEMBLY



BLUE COLOR, SINGLE DIODE,
12 VOLT, 35 AMPERE,
OUTPUT STUD IS POSITIVE
TERMINAL

BLUE COLOR, SINGLE DIODE,
24 - 32 VOLT, 35 AMPERE,
OUTPUT STUD IS
POSITIVE TERMINAL

BLUE COLOR, DUAL DIODE,
12 VOLT, 40 OR 55 AMPERE
OUTPUT STUD IS POSITIVE
TERMINAL

BLACK COLOR, DUAL DIODE,
12 VOLT, 40 OR 55 AMPERE,
OUTPUT STUD IS NEGATIVE
TERMINAL

BLUE COLOR, DUAL DIODE,
24 - 32 VOLT, 35 AMPERE,
OUTPUT STUD IS POSITIVE
(SPECIAL) TERMINAL

BLACK COLOR, TRIPLE DIODE,
12 VOLT, 70 AMPERE,
OUTPUT STUD IS POSITIVE
TERMINAL

NOTE: IF ENGINE MANUFACTURER PAINTS ENTIRE ALTERNATOR A SINGLE COLOR, CHECK ALTERNATOR NAMEPLATE FOR VOLTAGE AND GROUND POTENTIAL INFORMATION.

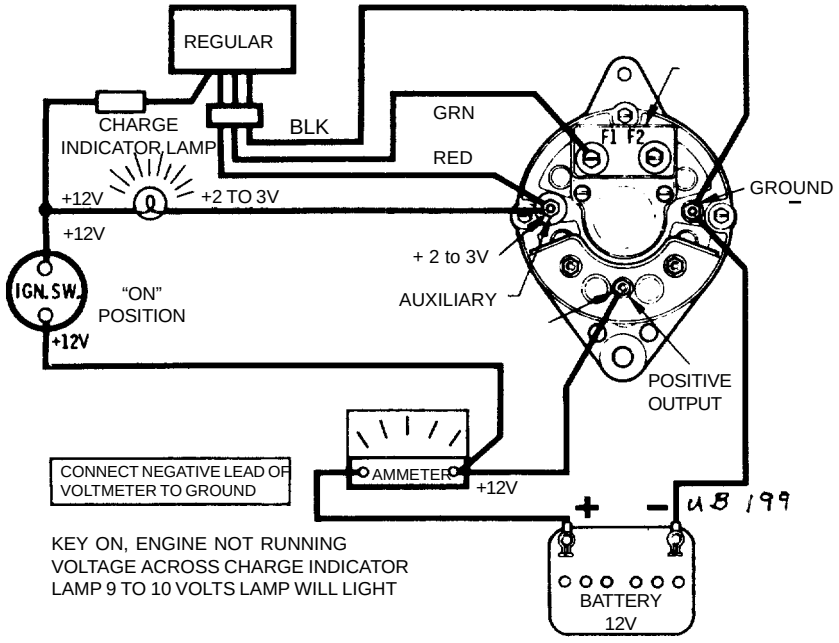
FIG. 1-8 ISOLATION DIODE ASSEMBLY

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The “Isolation Diode” consists of a single, or two, parallel connected diodes mounted in a heat sink. The heat sink is factory-coated with a special corrosion resistant paint. The color of the paint assists in identifying the ground potential of the alternator, see Figure No. 1-8.

The Isolation Diode provides the means for operating an alternator charge indicator lamp without using a mechanical relay. Electrically, the charge indicator lamp is connected in parallel with the isolation diode. When the alternator produces a normal charge, the voltage differential across the isolation diode is so small that the charge lamp will not light, Figure No. 1-9 illustrates this operation.

CONDITION:
KEY ON, ENGINE NOT RUNNING, VOLTMETER: 0 - 50 D.C. VOLT SCALE VOLTAGE ACROSS INDICATOR LIGHT MEASURES 9 TO 10 VOLTS WITH LAMP LIT.



CONDITION:
KEY ON, ENGINE RUNNING.
VOLTMETER: 0 - 50 D. C. VOLT SCALE VOLTAGE ACROSS INDICATOR LIGHT MEASURES APPROXIMATELY 1 VOLT. LAMP WILL NOT LIGHT.

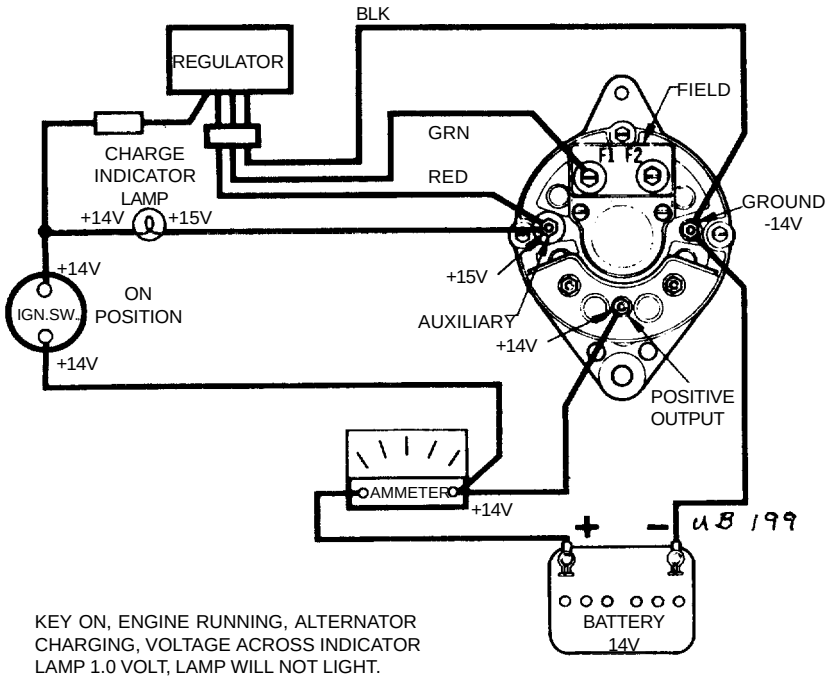


FIG. 1-9 CHARGE INDICATOR LAMP OPERATION

https://truckmanualshub.com/

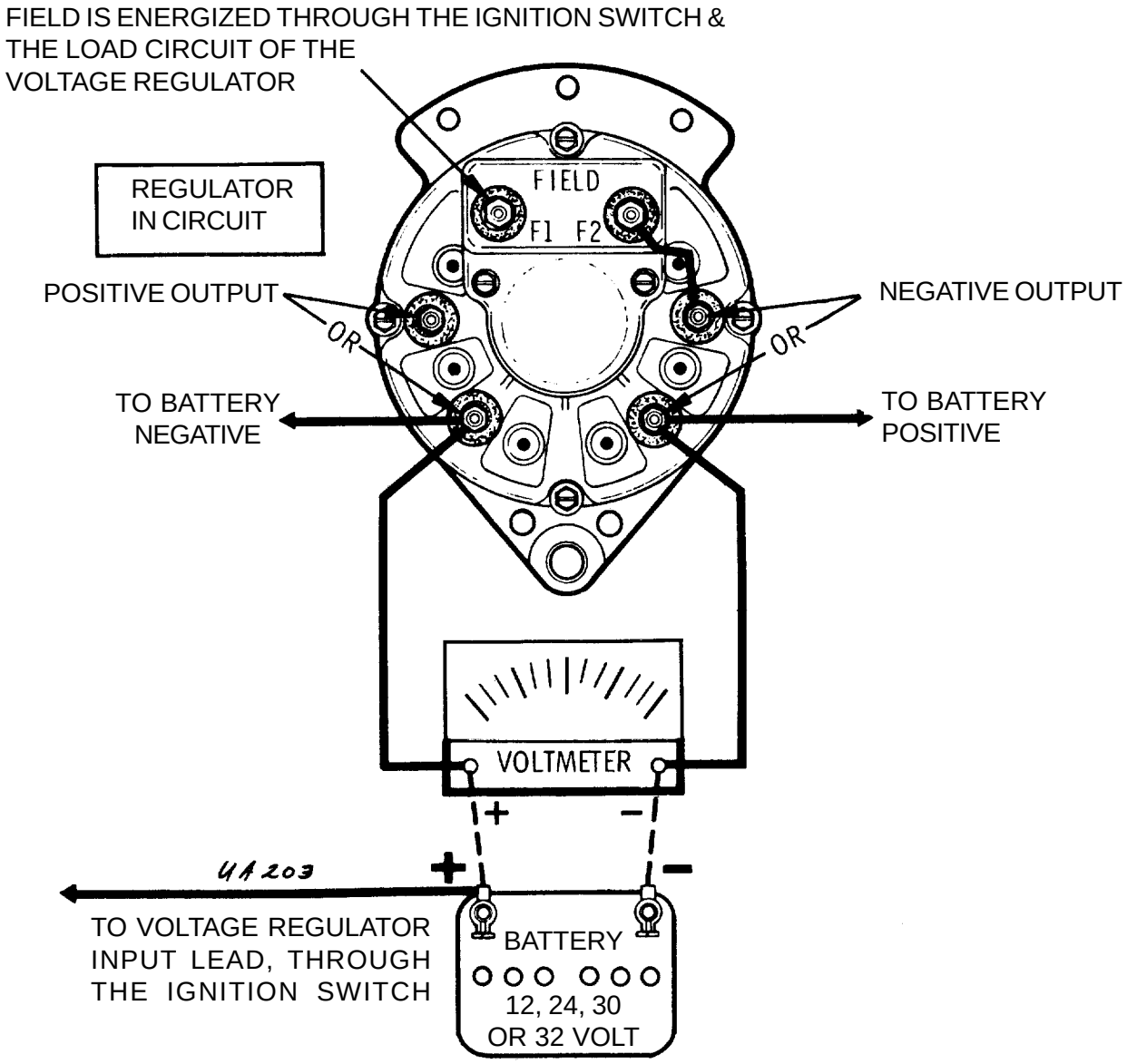
ALTERNATOR EXCITATION

The steel pole fingers of the rotor are treated to resist residual or permanent magnetism. It becomes necessary to electrically magnetize the rotor winding to develop a charge. This circuit differs depending on whether the alternator has an isolation diode or not. The voltage regulator will differ too.

Figure No. 1-10 shows a 12 volt alternator without an isolation diode. The voltage at the alternator output terminals and across the battery posts is the same during no charge and charging conditions.

When the ignition switch is turned on, there is approximately a 2.0 volt drop through the regulator, providing 10.0 volts to excite the alternator.

The voltage regulator is designed to regulate at 13.9 to 14.6 volts at the ignition switch.



VOLTMETER CONNECTIONS ACROSS BATTERY POSTS & ALTERNATOR TERMINALS	ALTERNATOR NOT CHARGING	ALTERNATOR CHARGING
	12.4V, 12 Volt System	14.4V, 12 Volt System
	24.4V, 24 Volt System	28.4V, 24 Volt System
	31.2V, 30 Volt System	36.0V, 30 Volt System
	32.6V, 32 Volt System	38.4V, 32 Volt System

FIG. 1-10 ALTERNATOR WITHOUT ISOLATION DIODE

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Figure No. 1-11 shows an alternator with an isolation diode. Note the voltage readings are similar to the alternator without the isolation diode, except for the auxiliary terminal. Here, the voltage is 1.0 volt higher than output voltage, and is due to the natural voltage drop across the isolation diode.

The voltage regulator input lead connects to the auxiliary terminal and is designed to sense at 1.0 volt higher than output voltage.

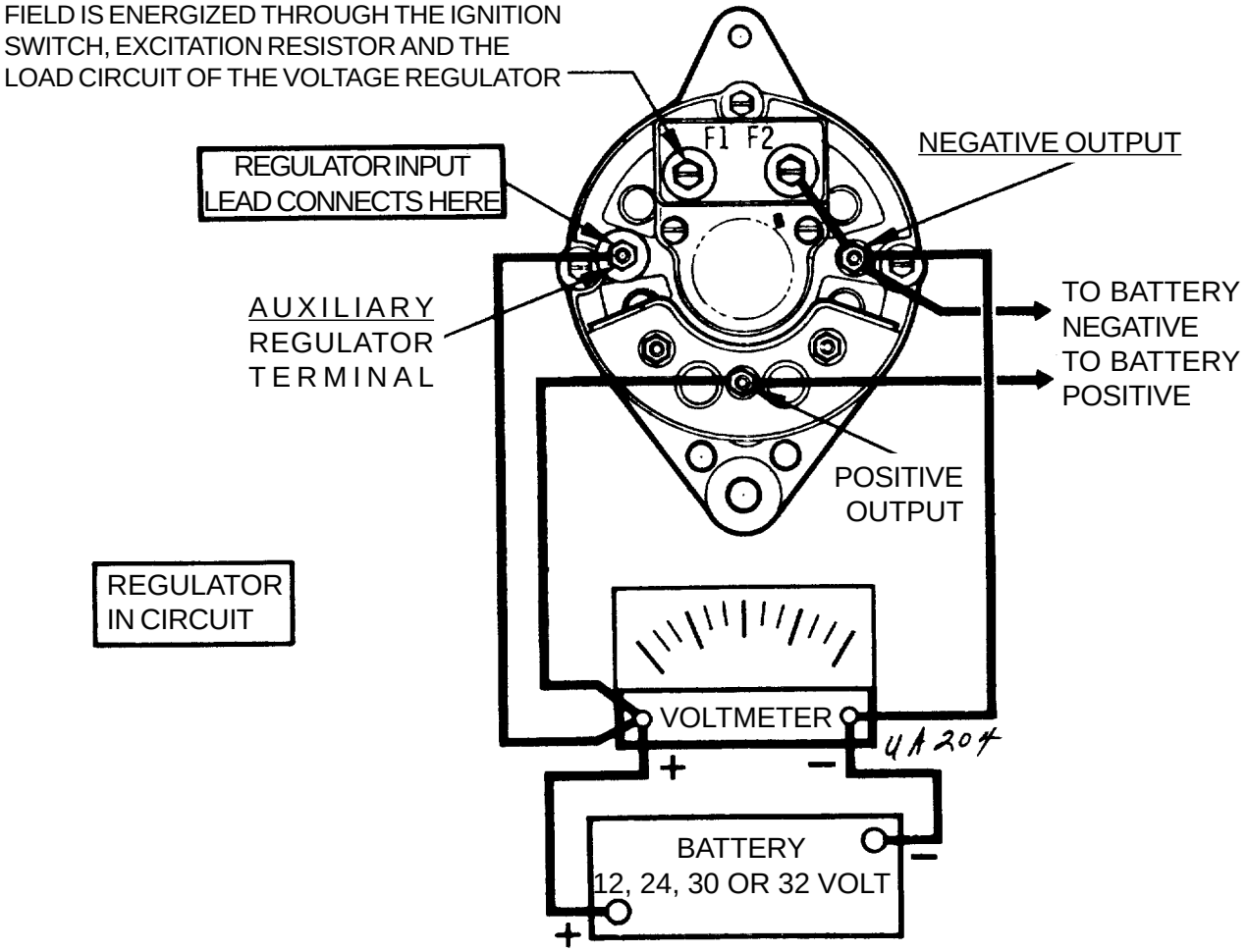
If the regulator for an isolation diode type alternator was connected to an alternator without an isolation diode, the charging voltage would be 1.0 volt higher.

Connecting a non-isolation diode regulator to an alternator with an isolation diode would result in a 1.0 volt lower charge rate.

If the lead from the ignition switch was connected directly to the auxiliary terminal, to meet the regulator input lead, the alternator would have approximately 10.0 volts for excitation.

However, when the alternator is charging normally, the 15.0 volts at the auxiliary terminal would attempt to charge the battery through the ignition switch. Overcharging may result.

A resistor is placed in series with the ignition switch to accommodate this system.



VOLTMETER ACROSS BATTERY POSTS & ALTERNATOR OUTPUT TERMINALS	ALTERNATOR NOT CHARGING 12.4V, 12 Volt System 24.4V, 24 Volt System 31.2V, 30 Volt System 32.6V, 32 Volt System	ALTERNATOR CHARGING 14.4V, 12 Volt System 28.4V, 24 Volt System 36.0V, 30 Volt System 38.4V, 32 Volt System
VOLTMETER ACROSS AUXILIARY & NEGATIVE OUTPUT TERMINALS	Zero Volts All Systems	15.4V, 12 Volt System 29.4V, 24 Volt System 37.0V, 30 Volt System 39.4V, 32 Volt System

FIG. 1-11 ALTERNATOR WITH ISOLATION DIODE

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Figure No. 1-12, Diagram A, illustrates the circuit with an external resistor. 1.5 ro 2.0 volts at the auxiliary terminal was sufficient to magnetize the field. When the alternator is charging the resistor will not allow higher voltage feed back to the ignition switch.

Diagram B shows a 12 volt charge indicator lamp connected in parallel with the resistor. This combination provides higher excitation voltage. If the lamp or the resistor would open circuit, the remaining component could carry excitation current.

Diagram C is the excitation circuit through a 5 wire voltage regulator. The resistor is incorporated in the regulator, with two connecting leads. The charge indicator lamp could be applied to this system too, between the ignition switch and auxiliary terminals.

Five Lead regulators can be applied to positive and negative ground alternator systems. One excitation lead would connect to the ignition switch and the other to auxiliary regardless of auxiliary polarity.

Four Lead regulators shown in Diagram D, have one excitation lead from the resistor, this must connect to positive at the ignition switch. The opposite end of the resistor connects to the regulator input lead within the regulator.

The excitation diode in Diagram E, can be applied to positive or negative ground alternators by reversing the diode. Do not use a charge indicator lamp with the excitation diode.

The diode provides the highest available excitation voltage and can be used on 12 to 32 volt systems. Feedback from the auxiliary terminal to the ignition switch is zero. This feature is very desirable when a diesel fuel solenoid valve is connected to a key switch. The valve closes immediately when the switch is turned off.

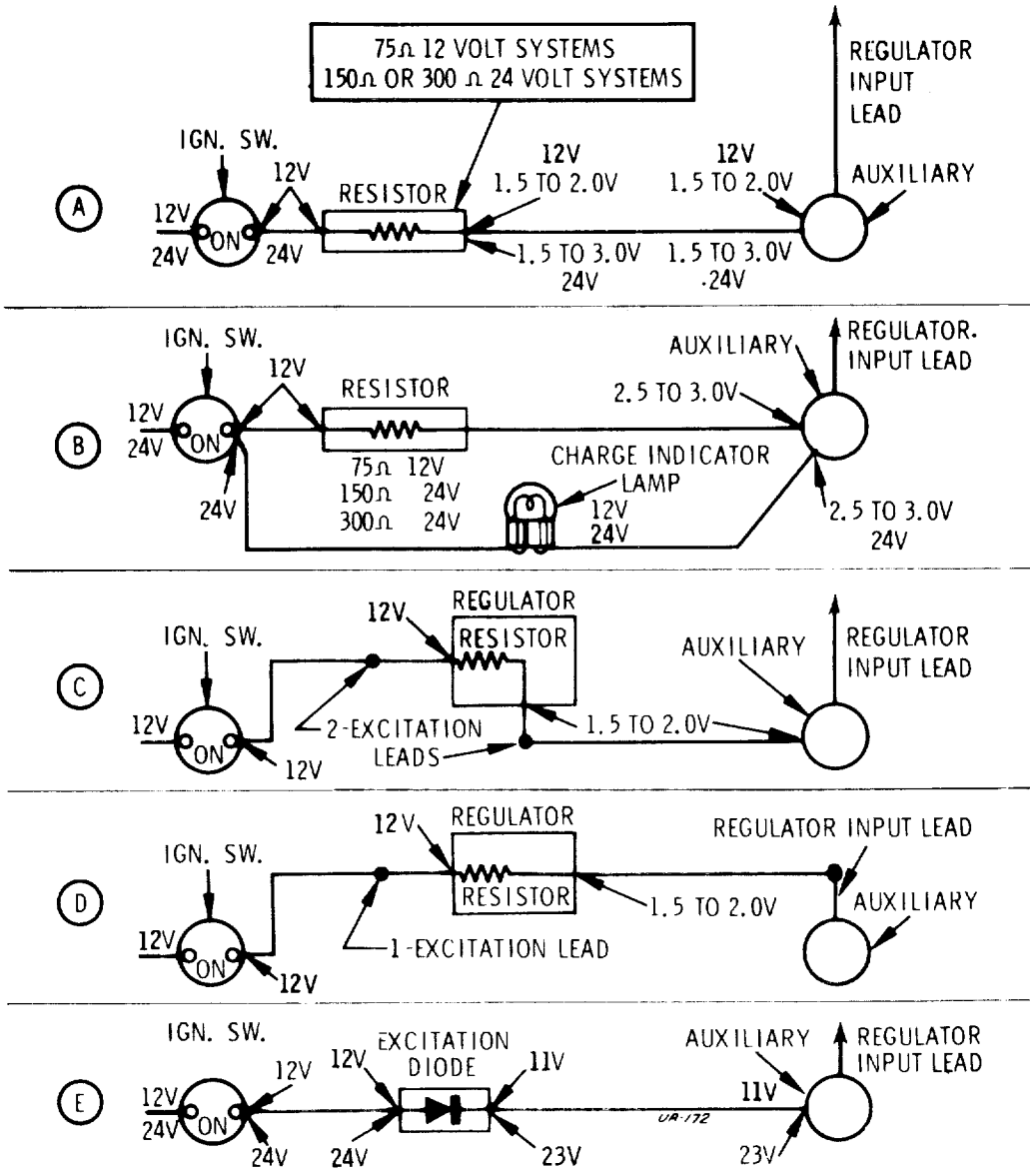


FIG. 1-12 EXCITATION METHODS

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Some HC and MR alternators use the excitation/regulator circuit (or a variation thereof) shown in Figure 1-13.

When the ignition switch is turned “on”, current will flow from the battery through the indicator lamp, the voltage regulator (resistor and transistor) and through the field to ground. This causes the lamp to be lit at the same time providing a small amount of current to energize the field coil. When the alternator begins producing power, field current is supplied through the voltage regulator from the diode trio terminal of the alternator. Since the voltage at this point is the same as the battery voltage, no current will pass through the indicator lamp and the bulb will be extinguished.

A secondary current path exists through the regulator diode
and resistor to the ignition switch positive terminal. Should the indicator bulb burn out, or if no lamp is used, the system will excite through this excitation circuit.

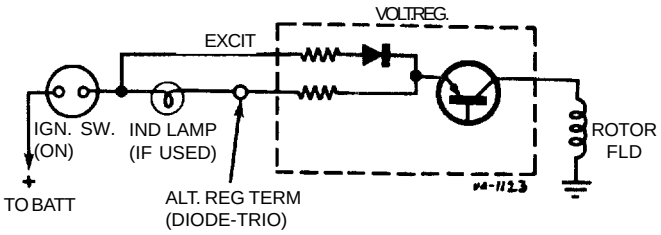


FIG. 1-13 TYPICAL ALTERNATOR EXCITATION CIRCUIT (WITH DIODE TRIO)

NOTE: For additional information concerning alternator theory and operation refer to separate “Basic Alternator Theory” manual, **125-138.**

VOLTAGE REGULATOR

The voltage regulator is an electronic switching device which senses the system voltage level and switches the voltage applied to the field in order to maintain proper system voltage, Figure 1-14. The circuit is a variable duty cycle switch which determines what the average field current in the alternator will be. A high ratio of “on-to-off” time will result in a near full field condition while a low ratio will result in a low field current condition. Alternator RPM and system load conditions are the factors which determine what the field current must be.

Both regulator sense and operating power (including field power) are obtained from the “Regulator” terminal of the alternator.

NOTE: For additional information concerning regulator theory and operation, refer to separate “Basic Electronic Regulator Theory” manual, 125-139.

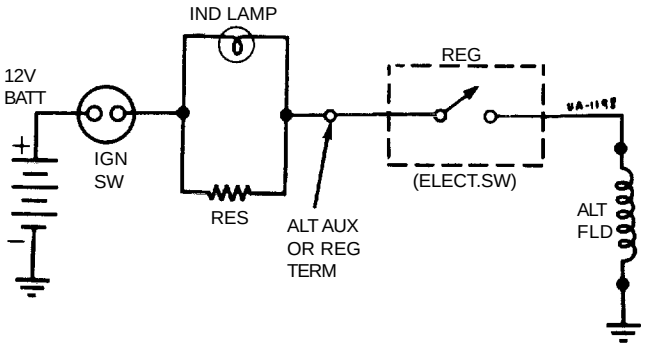


FIG. 1-14 SIMPLIFIED ELECTRONIC REGULATOR OPERATING DIAGRAM

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SECTION 2
TEST PROCEDURE

GENERAL

It is desirable to test the charging system (alternator and voltage regulator) in the vehicle using the vehicle wiring harness and electrical loads that are a permanent part of the system. In-vehicle testing will then provide the technician with an operational test of the charging system as well as the major components of the electrical system.

PRELIMINARY CHECKS AND TESTS

Before starting the actual electrical test procedure, the charging system, battery and wiring should be checked to eliminate possible problem areas. The following procedure is recommended:

1. Check the condition and adjustment of belts.
   A. If the alternator fan can be moved by pushing on a fan blade with your finger, the belts should be adjusted.
   B. Replace any worn or glazed belts.

2. Check to see that all terminals, connectors and plugs are clean and tight.
   A. Loose, broken or corroded connections cause high resistance and this could cause overcharging, undercharging or damage to the charging system.
   B. Badly corroded battery cables could prevent the battery from reaching a fully charged condition.

3. Check battery condition and charge if necessary. A low or discharged battery may cause false or misleading readings on the in-vehicle tests.

4. Testing Precautions
   DO NOT disconnect load (alternator output lead) from alternator while the alternator is operating.

   DO NOT remove alternator from car without first disconnecting the grounded battery cable. If battery must be removed, disconnect grounded cable first.

   DO NOT under any circumstances, short FIELD terminal of alternator to ground.

   DO NOT disconnect voltage regulator while alternator is operating.

TEST EQUIPMENT REQUIREMENTS

The equipment required for electrical in-vehicle testing of the alternator and voltage regulator should include meters that provide the following scales:

Voltmeter, D.C. - 0 to 20 volts for 12 volt system tests, 0 to 50 volts for 24, 30 and 32 volt system tests.

Ammeter, D.C. - 0 to 10 amperes, for testing field (rotor) current. 0 to 100 amperes for testing alternator output.

Field Rheostat - 0 to 50 ohms resistance, 50 watt capacity, with 3' connecting leads with alligator clips.

¼ Ohm Resistor - Sun Electric RES-1 or equal, with terminals or leads for connection in the alternator output circuit. This item is usually incorporated with most combination volt-amp-resistance test units.

Carbon Pile - Sun Electric Y-20 or equal, capable of 0 to 600 ampere load, controlled by operating knob.

12 Volt Test Lamp - May be home-made with 3 to 15 candlepower lamp in a socket, with two 3' test leads provided with alligator clips.

110 Volt A.C. Test Lamp - using 15 to 25 watt lamp.

Ohmmeter - Any commercial type, like a Simpson 260 or equal.

Battery Hydrometer - any commercial type, with temperature correction scale.

Assortment of jumper leads - 2, 4, 6 and 10 feet in length, with alligator clips attached to the ends. Make with good quality No. 10 wire.

STORAGE BATTERY

The vehicle storage battery circuit represents a continuous although variable electrical load to the alternator. If the circuit, positive or negative, is opened or broken while the alternator is charging, the loss of the battery will result in the charging voltage rising to unsafe levels.

High voltage may damage the alternator and regulator, as well as damage either electrical accessories or instruments.

The following rule applies to all alternator charging systems:

CAUTION: IF A BATTERY IS BEING INSTALLED, MAKE CERTAIN THAT THE GROUND POLARITY OF THE BATTERY AND THE GROUND POLARITY OF THE ALTERNATOR ARE THE SAME. REVERSE POLARITY WILL DESTROY RECTIFIER DIODES IN THE ALTERNATOR.

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BATTERY INSPECTION

The following table illustrates typical ranges of specific gravity for a cell in various states of charge. THE BATTERY MUST BE AT LEAST 75% OF FULL CHARGE FOR EFFECTIVE ALTERNATOR TESTING.

1,260 SP. GR. BATTERY	1,280 SP. GR BATTERY	CHARGE STATE
1,230 Sp. Gr.	1,250 Sp. Gr.	75% Charged
1,200 Sp. Gr.	1,220 Sp. Gr.	50% Charged
1,170 Sp. Gr.	1,190 Sp. Gr.	25% Charged
1,140 Sp. Gr.	1,160 Sp. Gr.	Very Low Cap.
1,110 Sp. Gr.	1,130 Sp. Gr.	Discharged

CAUTION: CARE SHOULD BE TAKEN WHEN WORKING AROUND THE BATTERY AS A SPARK COULD IGNITE THE GASES WHICH COLLECT ABOVE THE BATTERY WHEN CHARGING.

CHARGE INDICATOR LAMP

Ocassionally the charge indicator lamp may glow due to excessive voltage drop between the output terminals and the vehicle battery. Replacement of the original charge indicator lamp, with another lamp that requires more voltage to glow, may correct the problem; or a series resistor in the charge indicator lamp circuit may also be used.

To determine the resistance required to eliminate lamp glow, place a variable resistance in the lamp circuit as shown in Figure No. 2-1.

Start the engine, apply the accessory load that induced lamp glow. Gradually increase resistance with field rheostat
until lamp glow is eliminated. Leave the rheostat slider at this setting. Stop engine, turn accessories off.

Measure the resistance of field rheostat with an ohmmeter, select a fixed resistor of equal value to be placed in the charge lamp circuit. The wattage of the fixed resistor should equal that of the lamp.

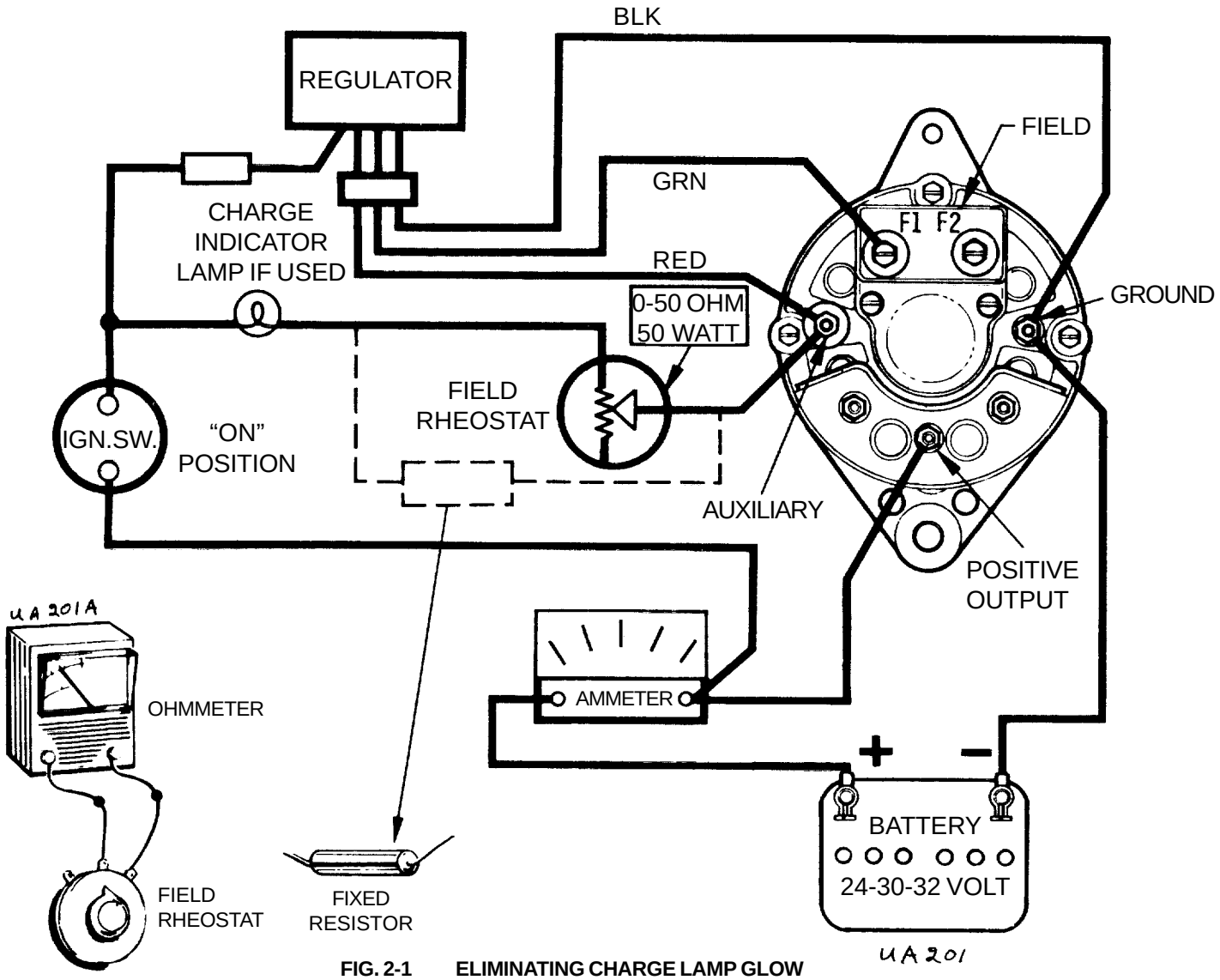


FIG. 2-1 ELIMINATING CHARGE LAMP GLOW

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IN-VEHICLE ALTERNATOR/REGULATOR TESTS

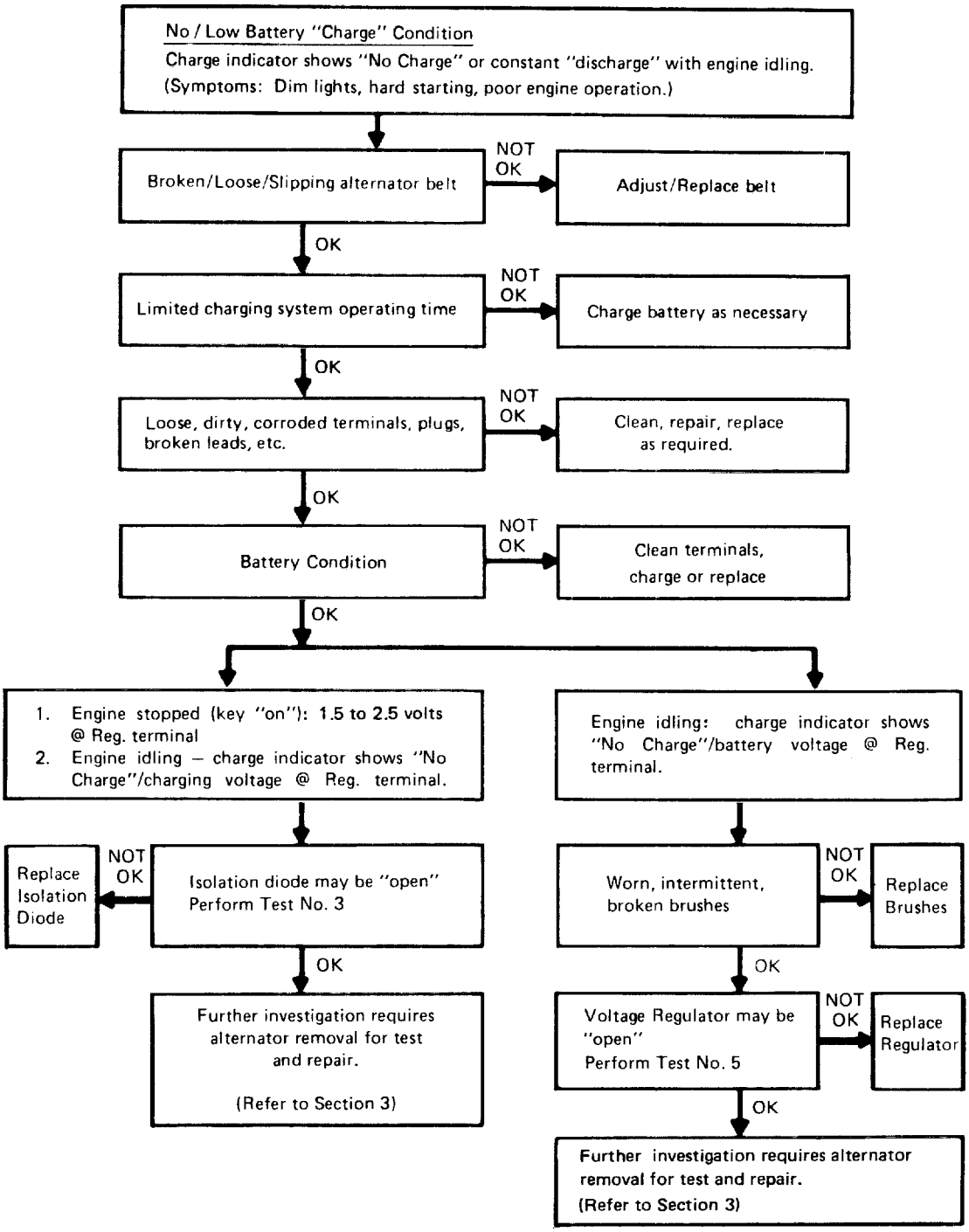
GENERAL

The following test information covers all the HC and M series alternator/regulator models listed in this service manual. The overall test information is divided into several sections according to model, type of system and application. Each section has its own specific procedure outlined in both step-by-step order and in diagnostic chart form. The charts are designed to provide fast sympton-to-solution analysis of the more common causes of charging system problems. Chart application begins by first selecting the proper chart according to the symptoms exhibited by the malfunctioning charging system. The tests are then followed from the top on down through the blocks until the problems are resolved. Note that some of the tests recommended in the charts refer back to the tests outlined in the associated step-by-step procedure.

The step-by-step procedure following the charts lists the tests in numerical order and may be used separately or in conjunction with the charts if desired. The procedure may sometimes be more extensive than the charts alone and contain additional tests which may prove helpful in trouble-shooting some of the more difficult problems.

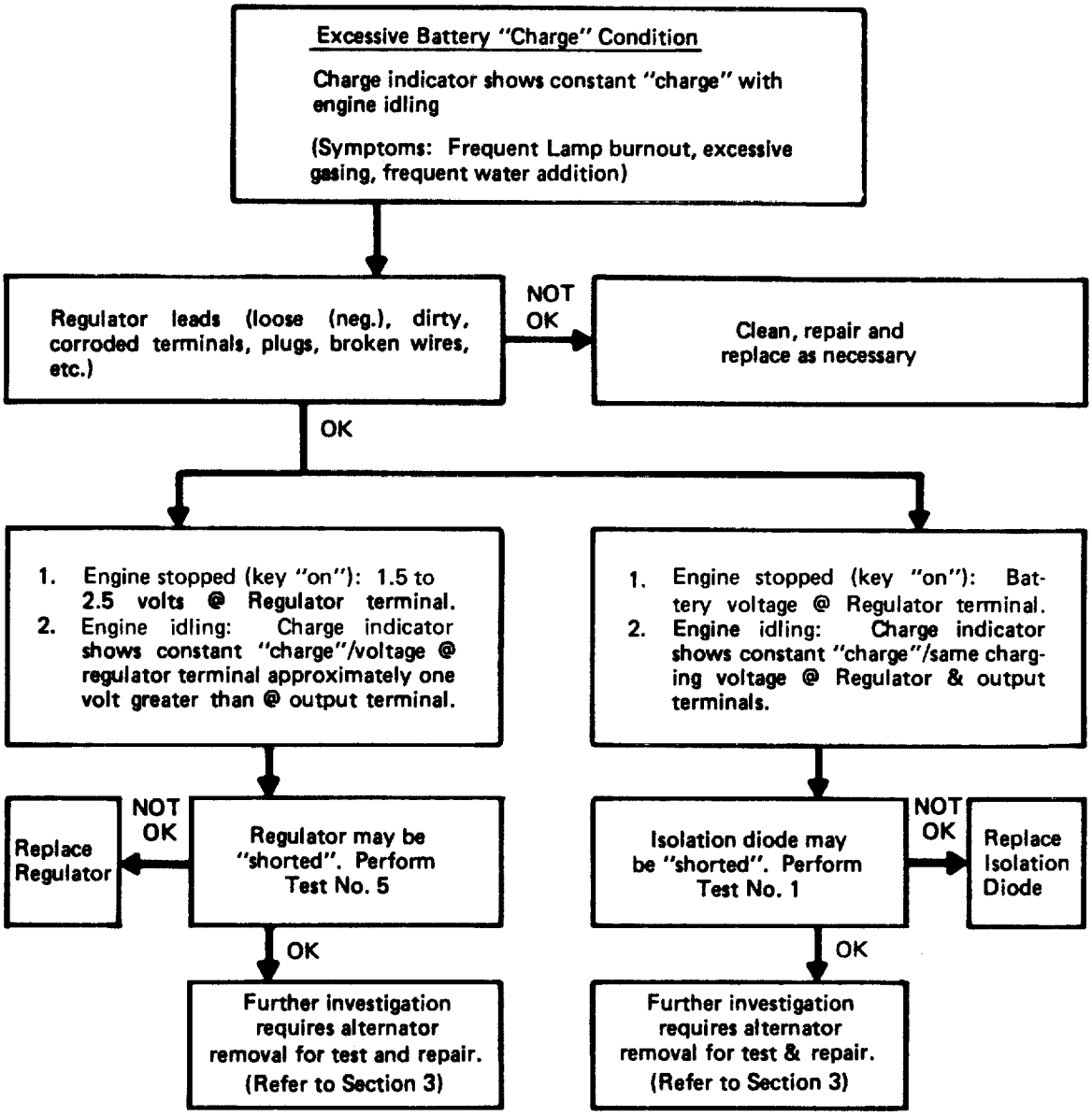
TEST PROCEDURE FOR 12 VOLT MA/8MA, MH/8MH ALTERNATORS
35-72 AMPERES, NEGATIVE GROUND SYSTEM WITH ISOLATION DIODE

CHARGING SYSTEM DIAGNOSTIC CHART NO. 1



https://truckmanualshub.com/

CHARGING SYSTEM DIAGNOSTIC CHART NO. 2



https://truckmanualshub.com/

TEST NO. 1- BATTERY VOLTAGE AND SHORTED ISOLATION DIODE TEST.

CONDITIONS: IGNITION SWITCH OFF. ENGINE NOT RUNNING.

This test will determine if the battery is properly connected to the alternator. Secondly, the isolation diode will be tested for a shorted condition. An improperly connected battery or a shorted isolation diode can damage the aternator and/or voltage regulator.

A shorted isolation diode would allow the battery to discharge through the voltage regulator to ground.

Refer to Figure No. 2-2, connect voltmeter, negative to ground, positive to output (positive) terminal on the isolation diode, voltmeter will indicate battery voltage. With the voltmeter connected at this point, check the leads between the alternator and battery. If movement of the leads causes the voltmeter reading to vary, check for loose connections. Repair as needed.

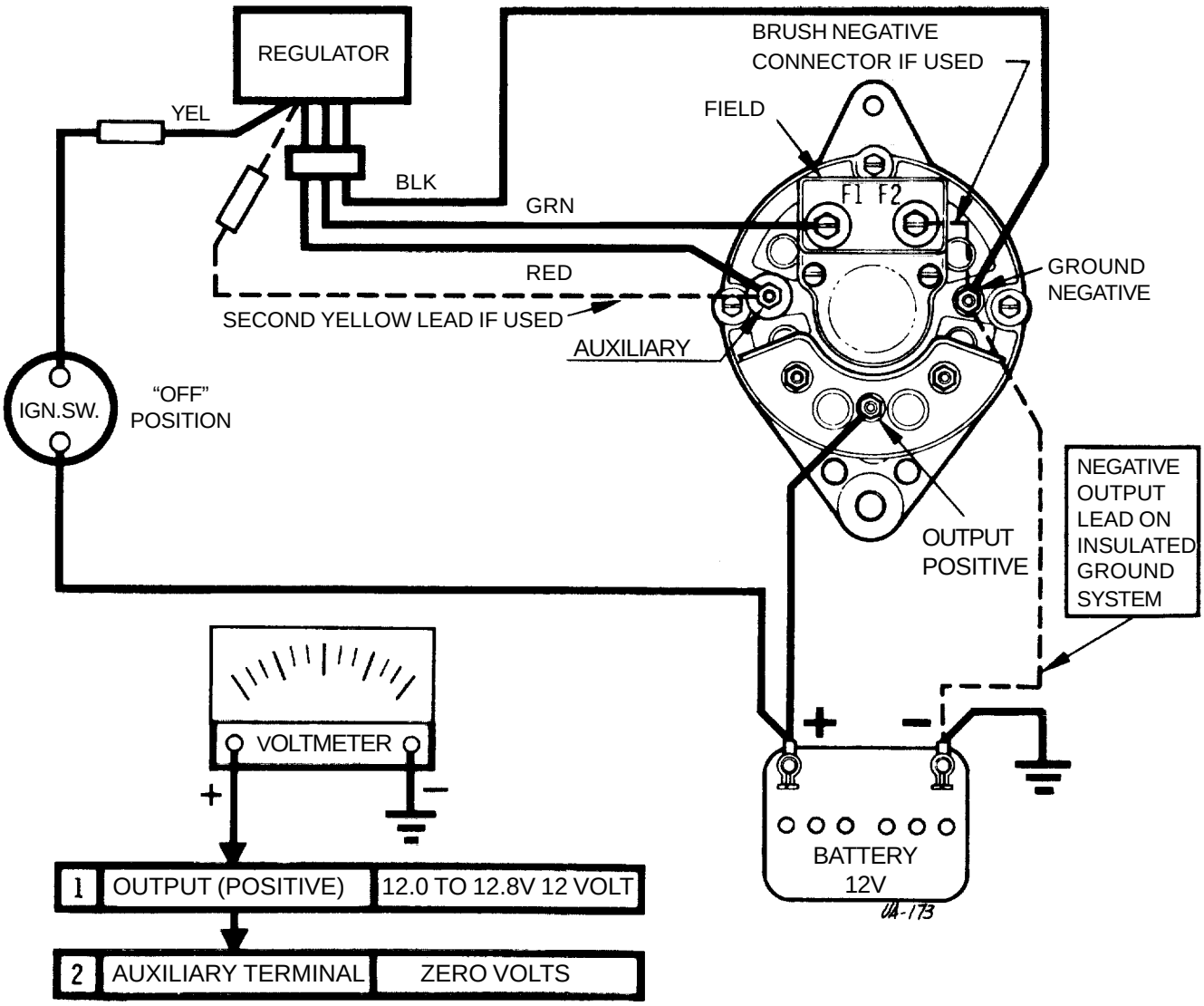


FIG. 2-2 BATTERY VOLTAGE & SHORTED ISOLATION DIODE TEST

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Move positive voltmeter lead to the alternator auxiliary terminal. Voltmeter should indicate zero volts. One of two faults will cause voltmeter to indicate above zero volts, (1) the metal wire terminal on the alternator output (positive) lead may contact the heat sink, as shown in Figure No. 2-3. Relocate and retest. or (2) the isolation diode may be shorted. Remove battery ground cable when replacing defective diode.

Figure No. 2-4 shows the correct arrangement of heat sink insulators.



FIG. 2-3 FAULTY TERMINAL CONNECTION

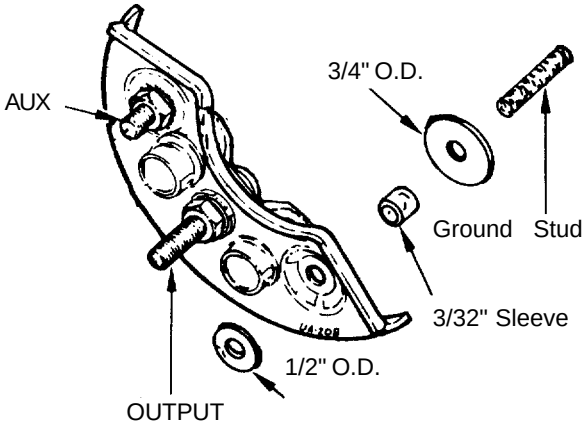


FIG. 2-4 ISOLATION DIODE ASSEMBLY

TEST NO. 2- EXCITATION VOLTAGE TEST.

CONDITIONS: IGNITION SWITCH ON.
ENGINE NOT RUNNING.
Figure 2-5.

This test will indicate if the excitation current circuit, from the vehicle's ignition switch to the rotor (field) winding is correct. Figure No. 2-6 shows the circuit. Note that the Load Circuit of the voltage regulator is part of this system.

When the current for the voltage regulator and the rotor winding is passed through the field excitation resistor, a voltage drop develops across the resistor. This action reduces battery voltage from 12.0 - 12.6 volts at the ignition switch side of the resistor, to 1.5 - 2.5 volts on the alternator side of the resistor. If the circuit through the regulator or the rotor is not correct, and a lighter load was passed through the excitation resistor, the voltage drop would be less.

This circuit may be defective in two ways; an open circuit or a shorted circuit.

Connect voltmeter negative to ground, positive to auxiliary terminal. Meter should indicate 1.5 - 2.5 volts, or if the circuit is defective due to:

Open rotor (field) circuit, 6.0 to 7 volts.
Grounded rotor circuit, .75 to 1.1 volts.
Open in regulator's Load Circuit, 8.5 to 10.0 volts.
Open key switch, or open excitation resistor, zero volts.

If initial test results are uncertain, the voltage regulator may be bypassed with a short jumper between the auxiliary and field terminals. If the jumper provides approximate correct voltage, fault is in the regulator. No charge from high voltage indicates that the defect is in the brush or rotor circuit, see Figure No. 2-7.

The rotor (field) circuit may be checked in more detail as outlined in Test No. 4.

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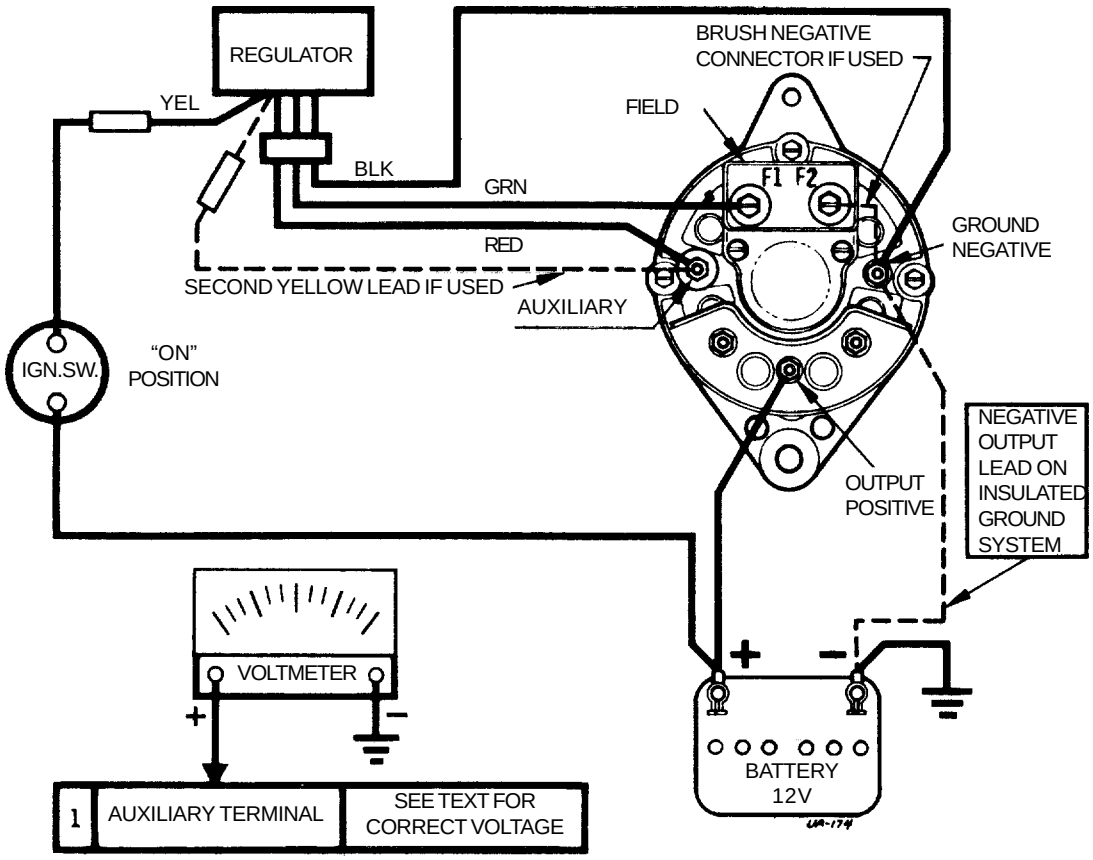


FIG. 2-5 EXCITATION VOLTAGE TEST

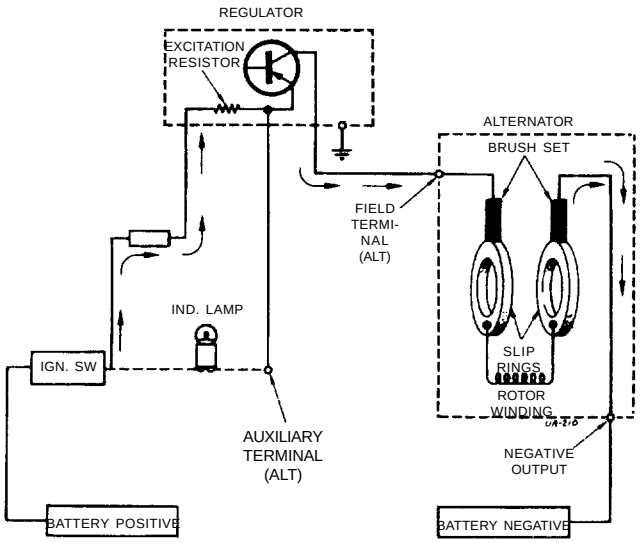


FIG. 2-6 EXCITATION CIRCUIT

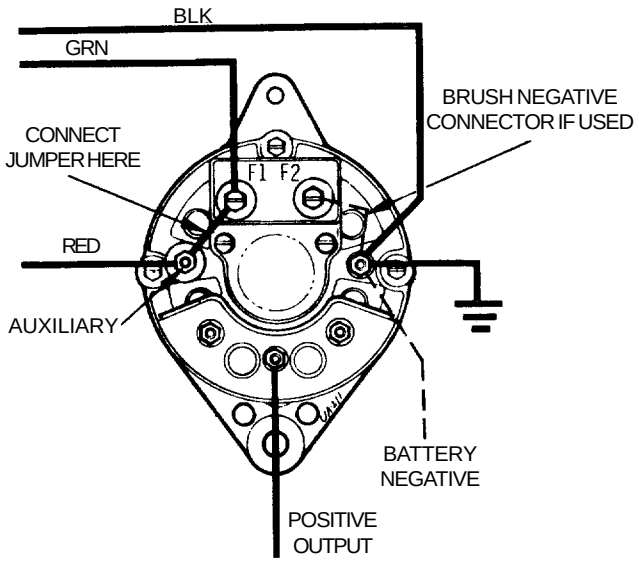


FIG. 2-7 BY-PASS REGULATOR LOAD CIRCUIT

https://truckmanualshub.com/

TEST NO. 3- OPEN ISOLATION DIODE TEST.

CONDITIONS: IGNITION SWITCH ON.
ENGINE RUNNING AT
FAST IDLE.

This test will determine if the isolation diode is conducting alternator energy, from the rectifier diode assembly, to the output stud. If the isolation diode is open, alternator energy would not travel beyond the rectifier diodes. A high voltage may develop in the alternator that could damage the voltage regulator.

With the engine running at fast idle, connect voltmeter, negative lead to ground, positive lead to the auxiliary terminal, as shown in Figure No. 2-8. Note voltmeter reading at this point.

Move voltmeter positive lead to the alternator output terminal. Note voltmeter reading.

The voltage indicated at the output (positive) terminal should be .8 to 1.2 volts lower than voltage noted at the auxiliary terminal. If voltmeter reading at the output (positive) terminal is battery voltage (12.0 - 12.6 volts) the isolation diode is “open”.

Replace diode assembly, if necessary, and proceed with Test No. 4.

NOTE: Disconnect ground battery cable during replacement of isolation diode.

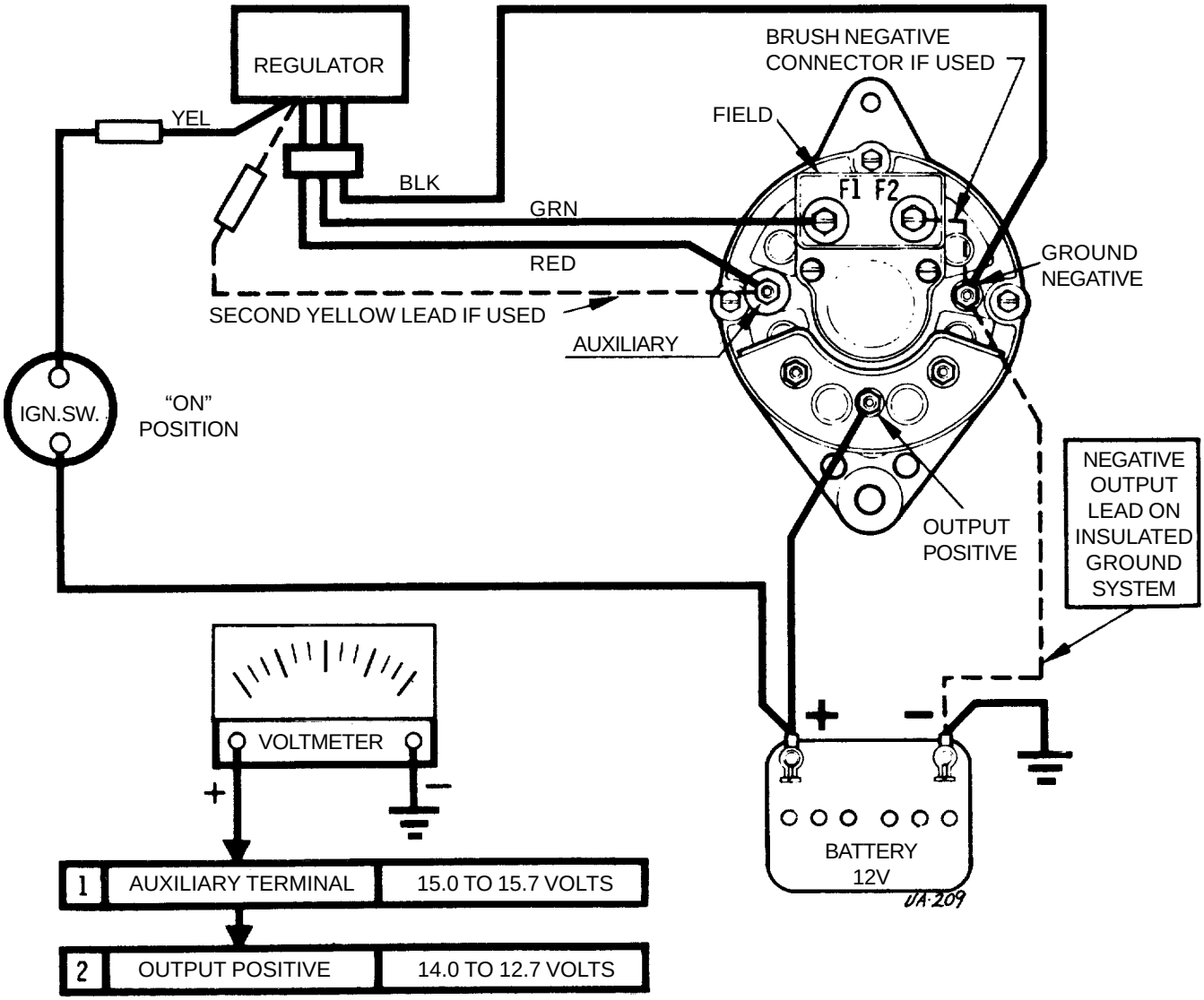


FIG. 2-8 OPEN ISOLATION DIODE TEST

https://truckmanualshub.com/

TEST NO.4- FIELD CURRENT TEST.

CONDITIONS: IGNITION SWITCH OFF.
ENGINE NOT RUNNING.

This test will determine if the electrical circuit (field winding) of the alternator rotor is in good condition. The field circuit, including the brush assembly, is shown in Figure No. 2-9.

High field current may produce uncontrolled alternator output and probable damage to the voltage regulator. Low field current will result in low alternator output.

Disconnect the field lead from the alternator brush connecting terminal. Switch test ammeter to the low current scale (0 to 10 amperes). Set control knob of field rheostat in maximum resistance position. The field rheostat will prevent damage to the test ammeter if the rotor winding is shorted or grounded. Place the field rheostat and the test ammeter in a series circuit between the alternator output (positive) and field terminals, as shown in Figure 2-10.

Slowly reduce field rheostat resistance, noting test ammeter reading. If entire field rheostat resistance can be eliminated with the ammeter indicating less than 3.5 amperes, the field winding is not shorted or grounded. The test ammeter reading, with the field rheostat resistance eliminated, is the current draw of the rotor (field) circuit.

Generally, this is approximately 2.0 to 2.5 amperes at battery voltage (12.0 - 12.6v). If the ammeter tends to vary when the rotor is slightly turned, the slip rings and brushes require cleaning. Use a fine grade of crocus cloth for this purpose.

If normal rotor current can not be obtained, the alternator will require disassembly and replacement of defective parts. If a satisfactory ammeter reading is noted, proceed with the next test.

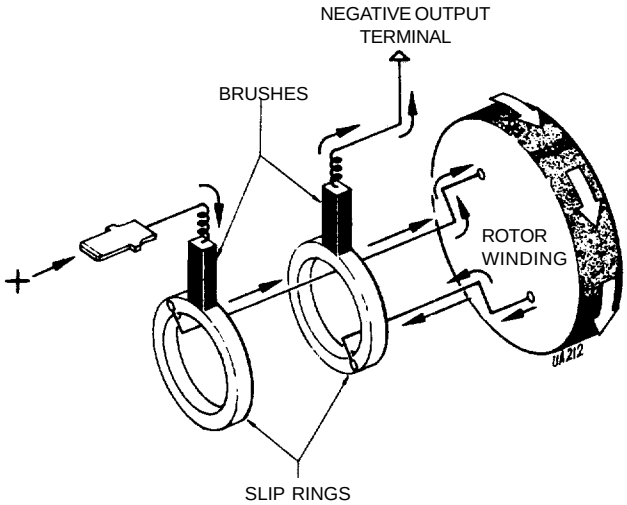


FIG. 2-9 ROTOR (FIELD) CIRCUIT

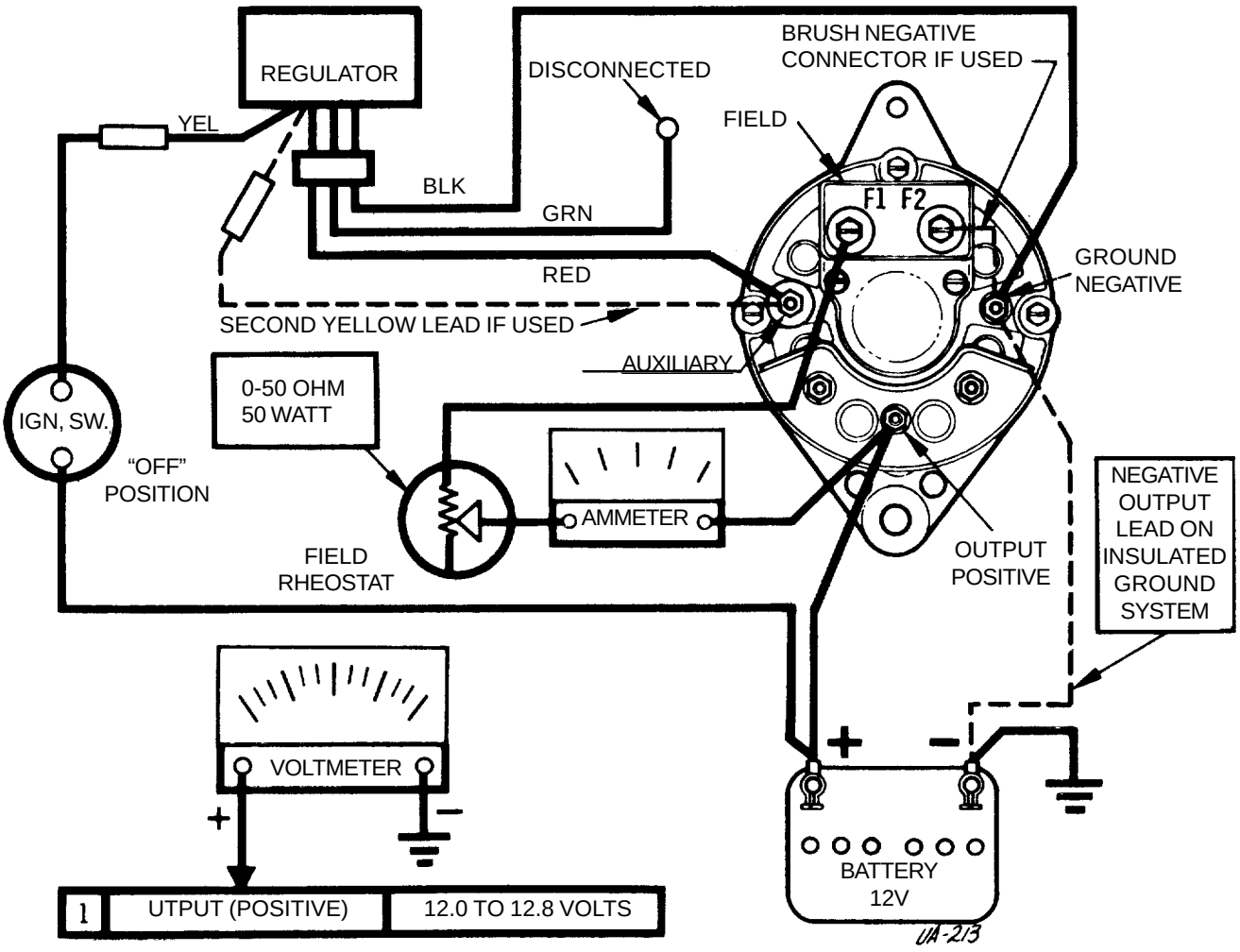


FIG. 2-10 FIELD CURRENT DRAW TEST

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TEST NO. 5- VOLTAGE REGULATOR OPERATING VOLTAGE.

CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING AT FAST IDLE.

This test will determine operating level of the voltage regulator. Voltage tests are most accurate when the alternator is charging a fully charged battery, as current output is at minimum. Under this condition, charging voltage will rise to regulator limiting maximum.

However, if the battery is less than fully charged, a 1/4 ohm 25 watt resistor may be placed in series with the alternator output lead to reduce current to 8 to 10 amperes. The connections for the 1/4 ohm resistor and test ammeter is shown in Figure No. 2-11.

Connect voltmeter negative to ground, positive to output terminal.

Start engine, run for a few minutes to stabilize component temperature. Voltage indicated, is the level established by the voltage regulator. Usually 13.9 volts to 14.7 volts depending on regulator ambient temperature.

High voltage may be due to a poor ground connection for the voltage regulator circuit board. Since the circuit board is insulated from the regulator housing, one regulator lead, usually black, serves as the ground connection. The ground lead must be a clean and tight connection at the alternator ground.

If ground connection is not faulty, the regulator is probably inoperative and will require replacement.

A low charging rate is usually due to a faulty regulator. Replace regulator if necessary.

Remove the 1/4 ohm resistor from the alternator positive output lead immediately after this test.

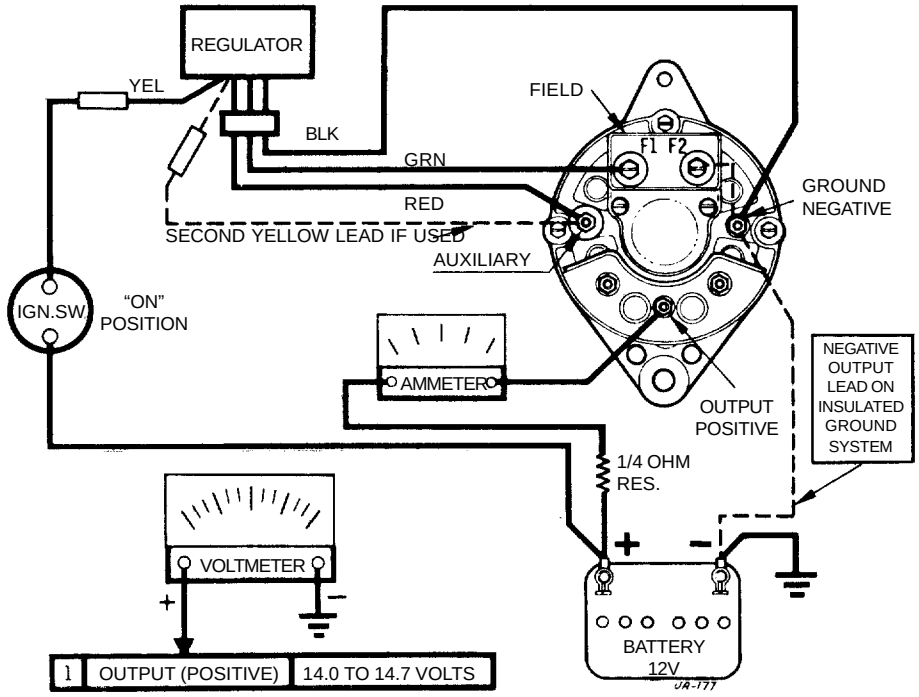


FIG. 2-11 VOLTAGE REGULATOR SETTING TEST

https://truckmanualshub.com/

TEST NO. 6 - ALTERNATOR OUTPUT AND SYSTEM TEST.

CONDITIONS: IGNITION SWITCH ON, ENGINE RUNNING.

This is a test of the alternator capability to produce maximum current. A carbon pile load is applied to the battery to induce maximum charging current. Figure No. 2-12 shows this circuit.

Place ammeter on 0-100 amp scale and connect as shown in Figure No. 2-12. Unload carbon pile when connecting to battery posts. Start engine, set at fast idle. Apply partial carbon pile load, or vehicle accessory load, to produce a 20 ampere charge for a few minutes to warm up components.

Adjust engine speed to provide 3000 to 4000 alternator R.P.M. Increase carbon pile load, note maximum current produced with voltmeter between 13.0 to 15.0 volts. Refer to Table for minimum acceptable readings.

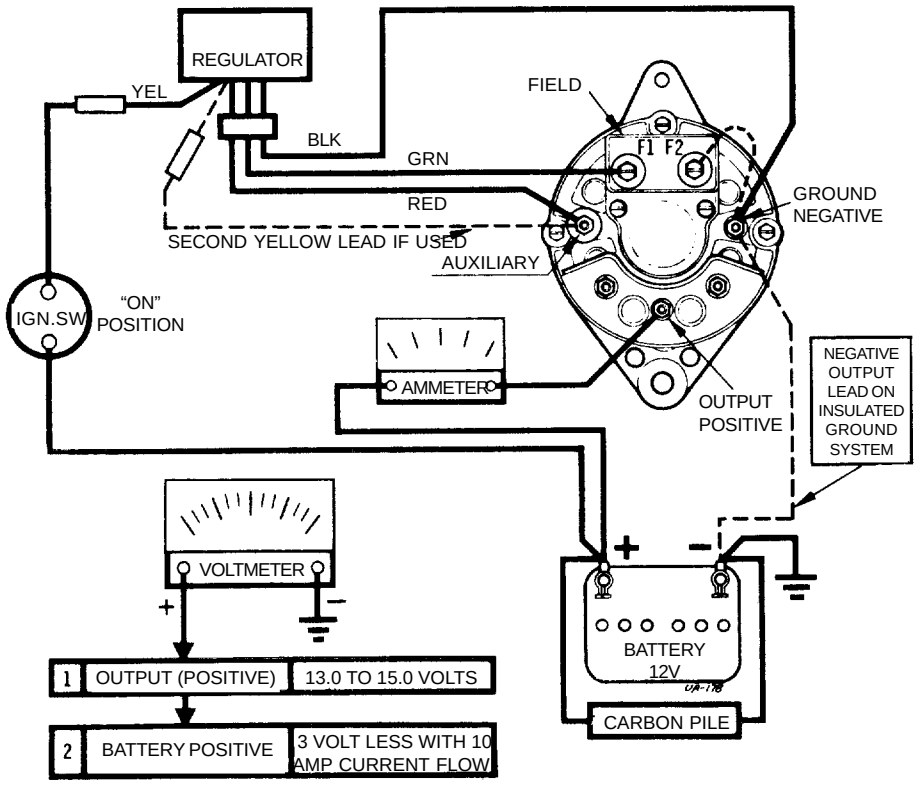


FIG. 2-12 ALTERNATOR OUTPUT & SYSTEM TEST

https://truckmanualshub.com/

TABLE FOR MINIMUM ACCEPTABLE OUTPUT

Alternator Model	Minimum Acceptable Output
35 to 37 amperes	28.0 to 30.0 amperes
40 amperes	35.0 to 37.0 amperes
51 to 55 amperes	43.0 to 46.0 amperes
72 amperes	66.0 amperes

Output voltage must remain between 13.0 and 15.0 volts.

Unload carbon pile immediately after test to avoid battery discharge. If the alternator cannot produce its minimum rated output it should be disassembled for inspection and repair.

System voltage drop is tested with the alternator producing 10 amperes. The maximum allowable voltage drop between the alternator and the battery is .3 (three tenths) volts. Figure No. 2-13 shows this test.

Voltage loss above allowable maximum may require cleaning and tightening connections or use of heavier gauge output cables.

If the alternator repairs are necessary, refer to instructions in the Repair/Overhaul Procedure section of this manual.

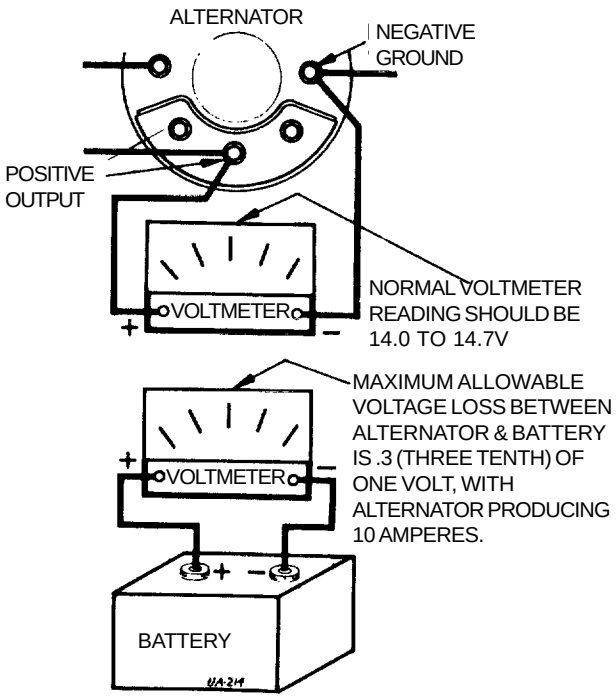
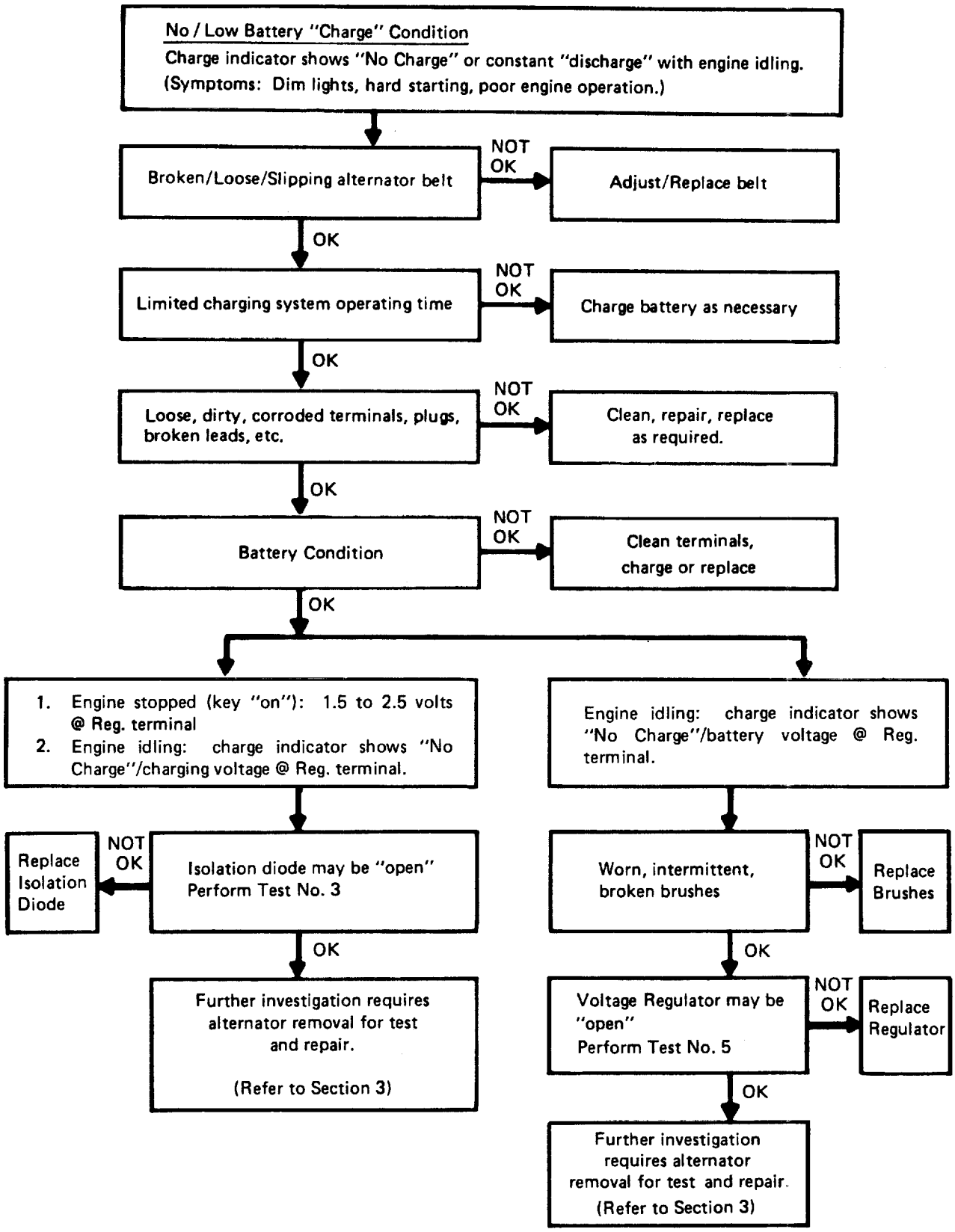


FIG. 2-13 VOLTAGE DROP TEST

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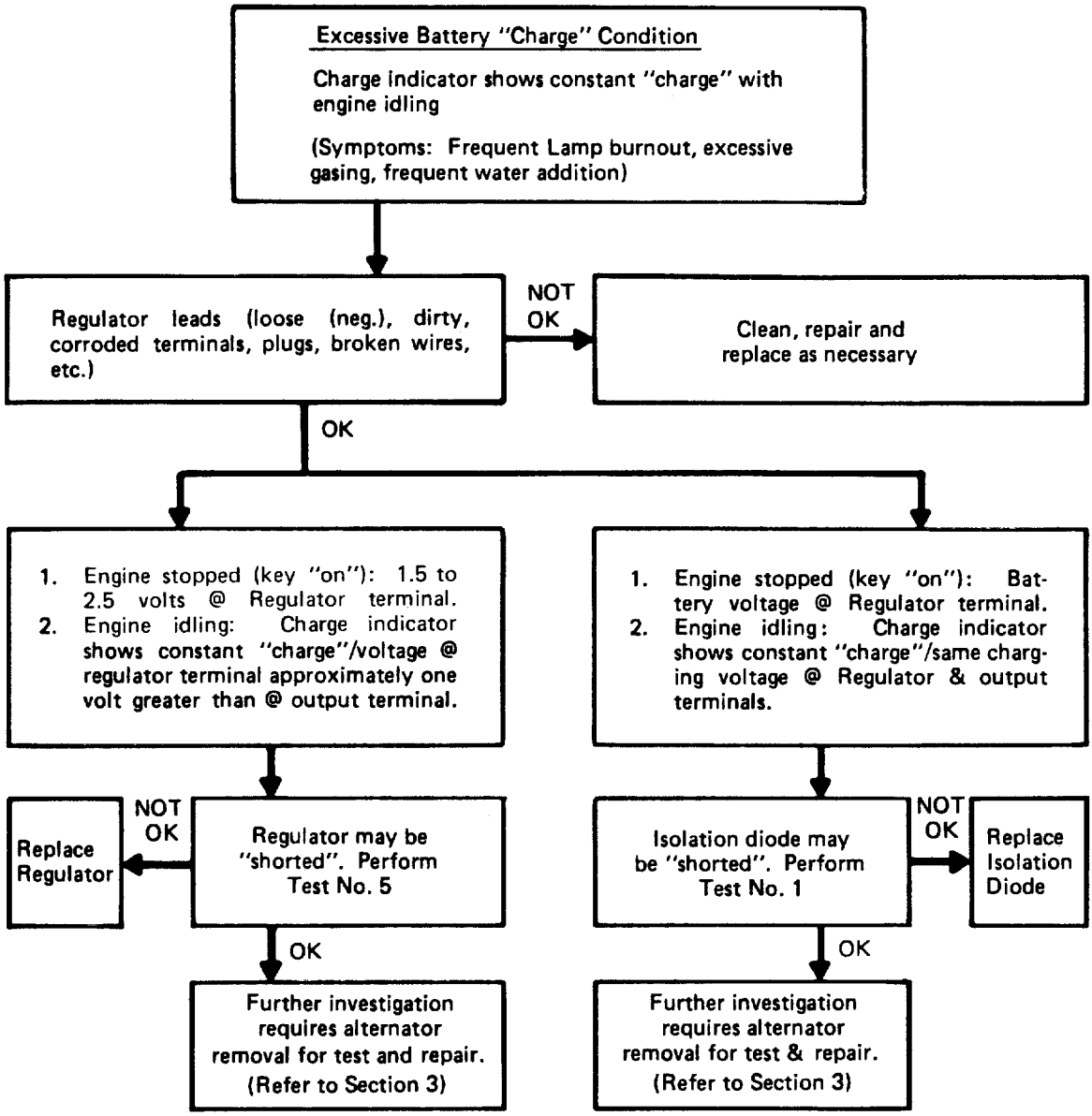
TEST PROCEDURE FOR 12 VOLT, MA ALTERNATORS, 35-55 AMPERES - POSITIVE GROUND SYSTEM WITH ISOLATION DIODE

CHARGING SYSTEM DIAGNOSTIC CHART NO. 1



https://truckmanualshub.com/

CHARGING SYSTEM DIAGNOSTIC CHART NO. 2



TEST NO. 1 BATTERY VOLTAGE AND SHORTED ISOLATION DIODE TEST

CONDITIONS: IGNITION SWITCH OFF, ENGINE NOT RUNNING.

This test will determine if the battery is properly connected to the alternator. Secondly, the isolation diode will be tested for a shorted condition. An improperly connected battery or a shorted isolation diode can damage the alternator and/or voltage regulator.

Refer to the circuit in Figure No. 2-14. Connect voltmeter, positive to ground, negative to battery negative terminal. Move negative voltmeter lead to alternator negative output terminal stud. Voltage should be the same at both points. If movement of connecting cables causes voltmeter to vary, check for loose connections. Repair as needed.

Connect negative voltmeter lead to auxiliary terminal. Zero volts is correct reading. Reading above zero volts may be due to shorted isolation diode or from negative output cable terminal touching the heat sink, see Figure No. 2-3. Repair as needed. If diode is to be replaced, disconnect positive battery cable during repair. Figure No. 2-4 illustrated proper assembly of isolation diode insulators.

Proceed with next test.

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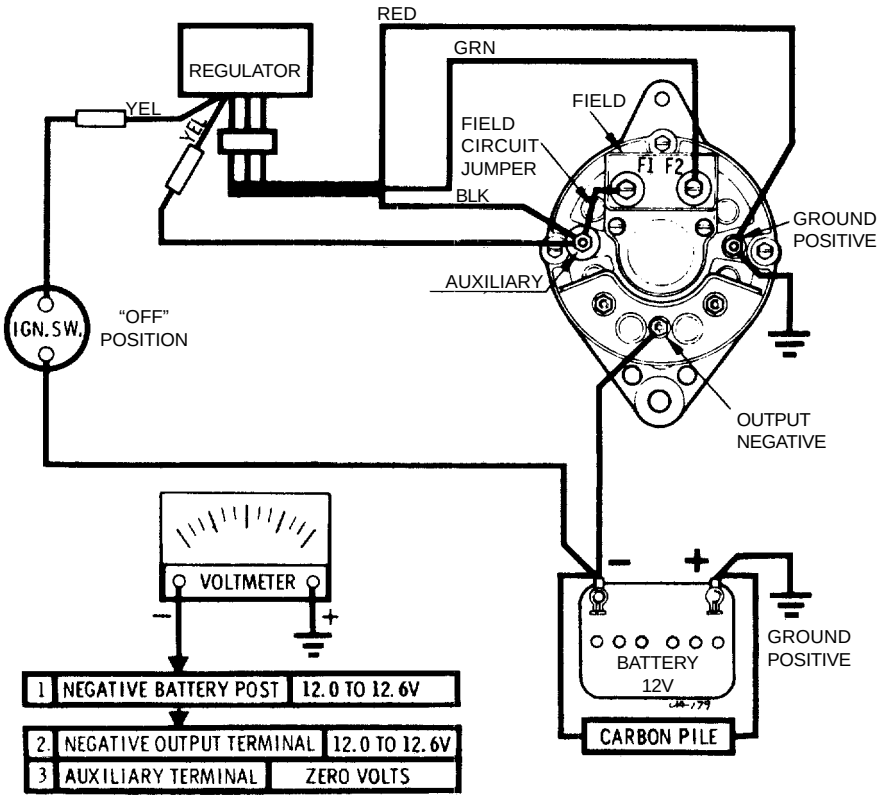


FIG. 2-14 BATTERY VOLTAGE & SHORTED ISOLATION DIODE TEST

TEST NO. 2 – EXCITATION VOLTAGE TEST

CONDITIONS: IGNITION SWITCH ON. ENGINE NOT RUNNING.

This test indicates if excitation energy controlled by the vehicle ignition switch, through the voltage regulator, to the field winding, is correct. Figure No. 2-15 shows the circuit. Notice, the regulator load circuit is part of this system.

The electrical load of the field and voltage regulator creates a voltage drop across the excitation resistor, reducing battery voltage to approximately 1.5 to 2.5 volts. A defect in this circuit could be an open or short, either would change the value of the load across the excitation resistor. See Figure No. 2-16.

Connect voltmeter positive to ground, negative to auxiliary terminal. Voltmeter should indicate 1.5 to 2.5 volts, or if circuit is faulty due to:

Open field circuit: 6.0 to 7.0 volts.
Grounded Field Circuit: 7.5 to 1.1 volts.
Open in regulator load circuit: 8.5 to 10.0 volts.
Open key switch: zero volts.

If test results are uncertain and high voltage is indicated, connect a short test jumper from ground to F-2 field terminal. If jumper provides corrected voltage load, circuit in regulator is faulty. No change with jumper application indicates fault in brush-rotor circuit. Field circuit is checked in detail in Test No. 4.

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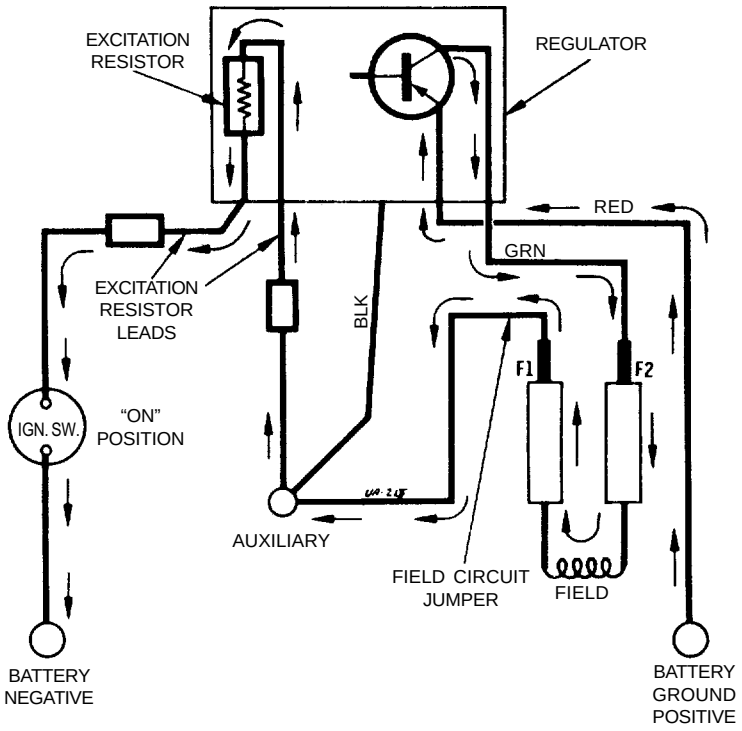


FIG. 2-15 EXCITATION CIRCUIT

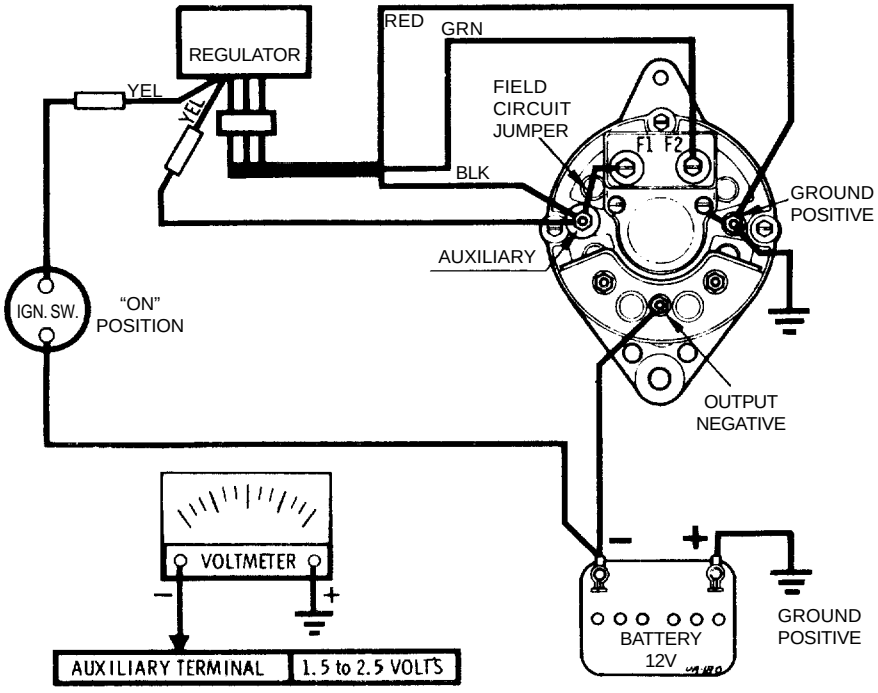


FIG. 2-16 EXCITATION VOLTAGE TEST

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TEST NO. 3 – OPEN ISOLATION DIODE TEST

CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING AT FAST IDLE.

This test will determine if alternator energy is conducting through the isolation diode. An open diode will not provide battery charge and may damage the alternator rectifier diodes and the voltage regulator. Figure No. 2-17.

With ignition switch on, engine running at fast idle, connect positive voltmeter lead to ground. Place negative voltmeter lead on auxiliary, then on output, note voltage readings.

Auxiliary voltage should be .8 to 1.2 volts higher than output voltage. If output voltage is only equal to battery, the isolation diode is open.

Disconnect positive battery cable while defective diode is replaced.

Proceed with next test.

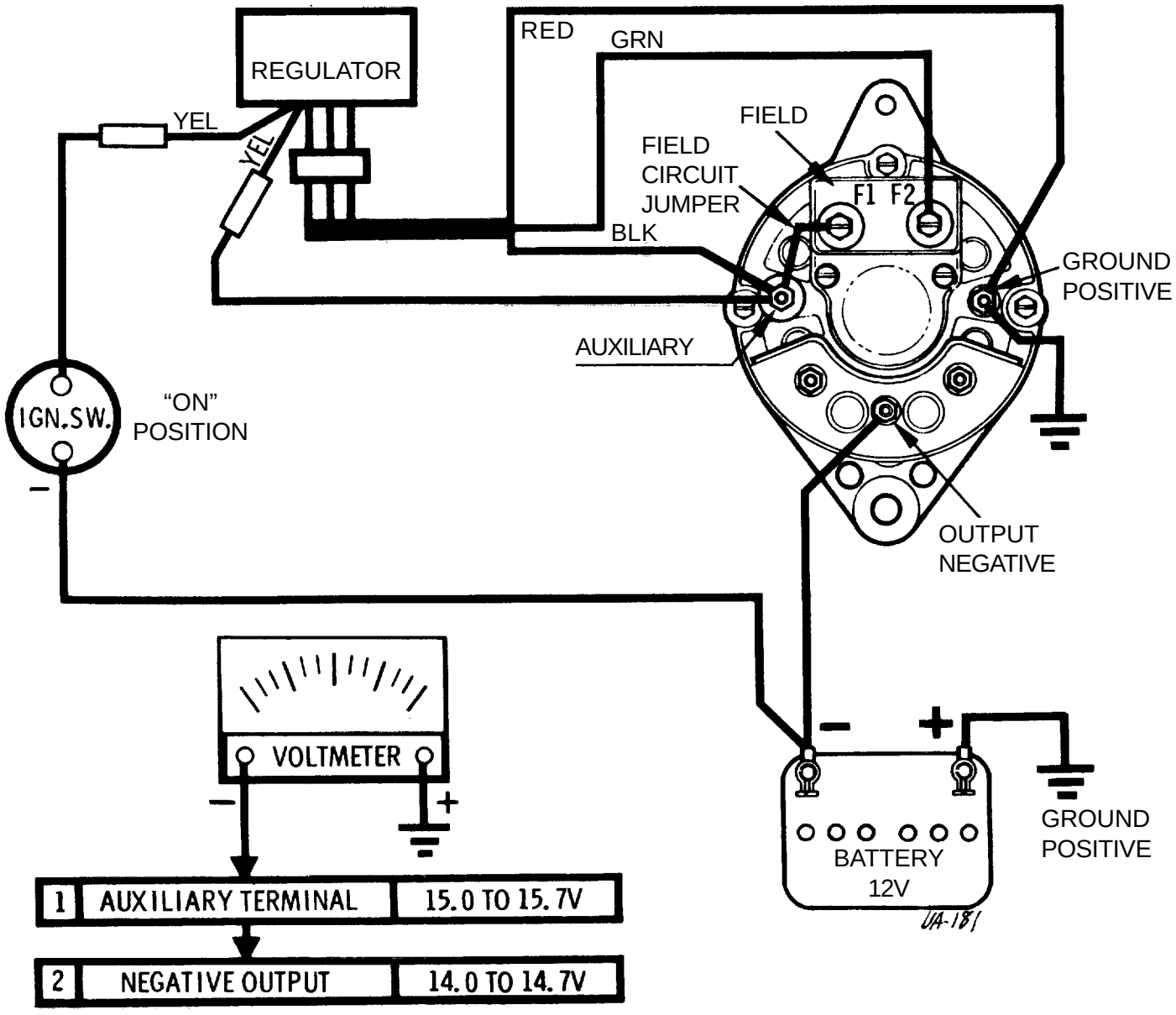


FIG. 2-17 OPEN ISOLATION DIODE TEST

https://truckmanualshub.com/

TEST NO. 4 – FIELD CURRENT TEST

CONDITIONS: IGNITION SWITCH OFF.
ENGINE NOT RUNNING.

This test will measure the field current draw in amperes. The brushes and slip rings are in the total field circuit. Excess field current may produce high alternator output and may damage the voltage regulator. Low field current will result in low alternator output.

Refer to Figure No. 2-18. Disconnect the field circuit jumper from No. 1 Field terminal. Disconnect green lead from No. F-2 Field terminal. Place a test jumper between F-2 and ground terminals.

Switch test ammeter to 0-10 ampere scale. Set field rheostat to maximum resistance. Place ammeter and rheostat in a series circuit between F-1 and battery negative. The rheostat will protect the ammeter from damage if the field is shorted.

Reduce rheostat resistance, note rise in ammeter reading. If ammeter indicates more than 3.5 amperes, the field is faulty. Stop test, remove rear housing cover to inspect brushes and slip rings for fault.

An ammeter reading around 2.0 to 3.0 amp, without rheostat resistance is a normal value.

If the ammeter reading varies when the rotor is slightly turned, the slip rings and brushes require cleaning. Use a fine grade of crocus cloth for this purpose.

Reconnect original circuit leads if test is satisfactory.

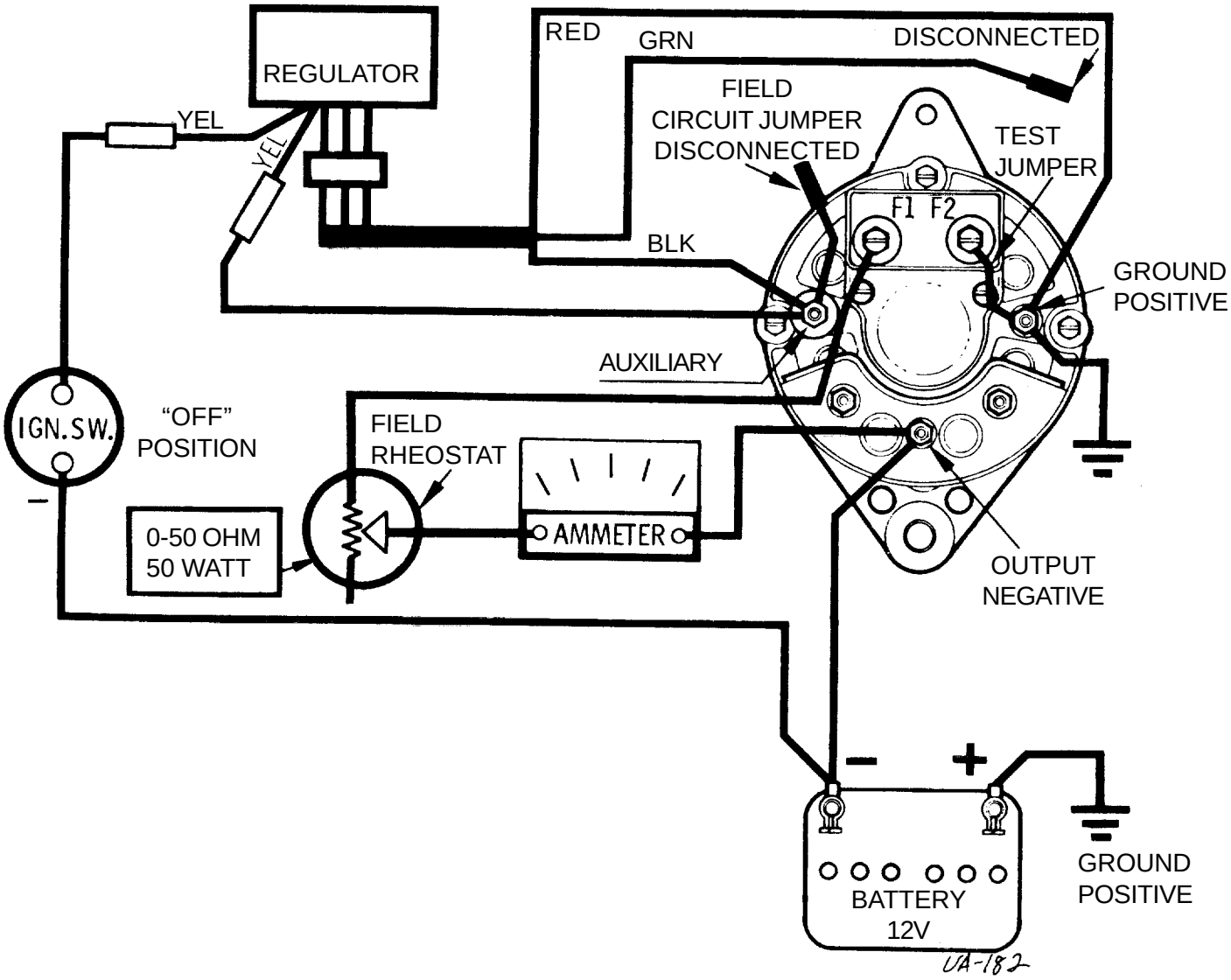


FIG. 2-18 FIELD CIRCUIT TEST

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TEST NO. 5 – VOLTAGE REGULATOR OPERATING TEST
CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING AT FAST IDLE.

This test will determine if the voltage regulator is operating within designed limits. The battery in the system should be fully charged so charging current will be limited, thus allowing charging voltage to rise to the designed level.

However, if the battery is at low charge, a 1/4 ohm, 25 watt fixed resistor may be placed in series with alternator output to limit the charging current into the low-charged battery. Figure No. 2-19 shows the circuit.

Connect the voltmeter positive to ground, negative to output terminal. Startengine, run at fast idle for a few minutes to stabilize temperature of components.

The voltmeter will indicate the voltage level established by the regulator, usually between 13.9 and 14.7 volts, variation due to regulator ambient temperature.

A low voltage is usually due to a faulty regulator circuit. Replace regulator and retest.

Higher voltage may be due to a poor connection for the black regulator lead wire. Replace the regulator and retest if the black wire is free of fault.

Remove the 1/4 ohm resistor after this test. Proceed with Test No. 6.

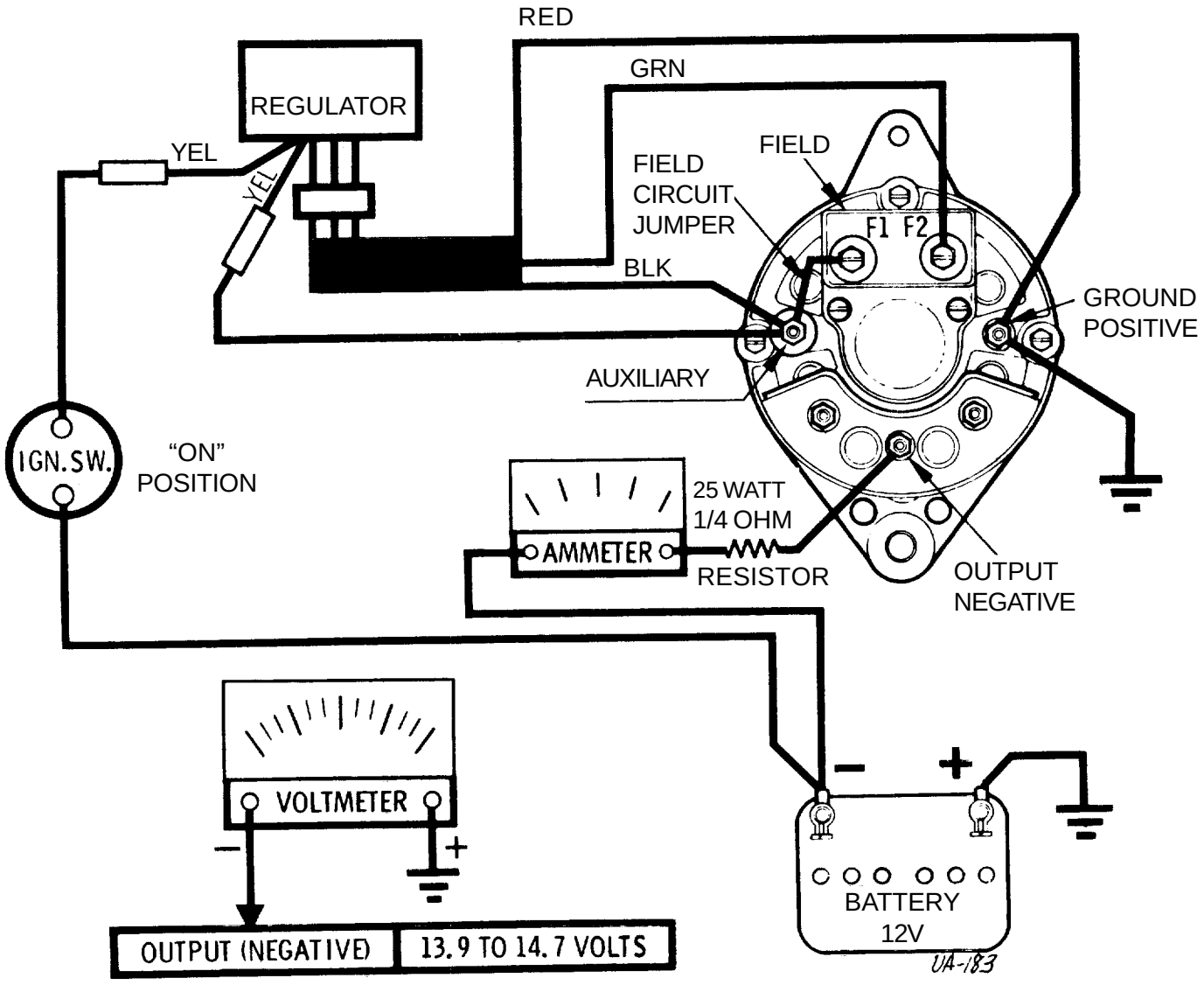


FIG. 2-19 VOLTAGE REGULATOR OPERATING VOLTAGE

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TEST NO. 6 – ALTERNATOR OUTPUT AND SYSTEM TEST.
CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING.

This is a test of the alternator capability to produce maximum current. A carbon pile load is applied to the battery to induce high charging current. Figure No. 2-20 shows the circuit.

Place ammeter on 0-100 Amp scale. Unload the carbon pile when connecting to the battery posts. Start engine, set at fast idle. Apply partial carbon pile load, or vehicle accessory load, to produce a 20 amp charge for a few minutes for component warm-up.

Adjust engine speed to provide 3000 to 4000 alternator RPM. Increase carbon pile load, note maximum current produced with voltmeter between 13.0 and 15.0 volts. Refer to Table for minimum acceptable reading.

TABLE FOR MINIMUM ACCEPTABLE OUTPUT

ALTERNATOR MODEL	REDMINIMUM ACCEPTABLE OUTPUT
35 Ampere	28.0 to 30.0 Amperes
40 Ampere	35.0 to 37.0 Amperes
55 Ampere	43.0 to 46.0 Amperes

Output voltage must remain between 13.0 and 15.0 volts.

Unload carbon pile immediately after test to avoid battery discharge. If the alternator cannot produce its minimum rated output it should be disassembled for inspection and repair.

System voltage drop is tested with the alternator producing 10 amperes. The maximum allowable voltage drop between the alternator and battery is .3 (three tenths) Volt.

Voltage loss above allowable maximum may require cleaning and tightening connections or use of heavier gauge, outputleads.

If alternator repairs are necessary refer to the Repair/Overhaul Procedure section of this manual for instructions.

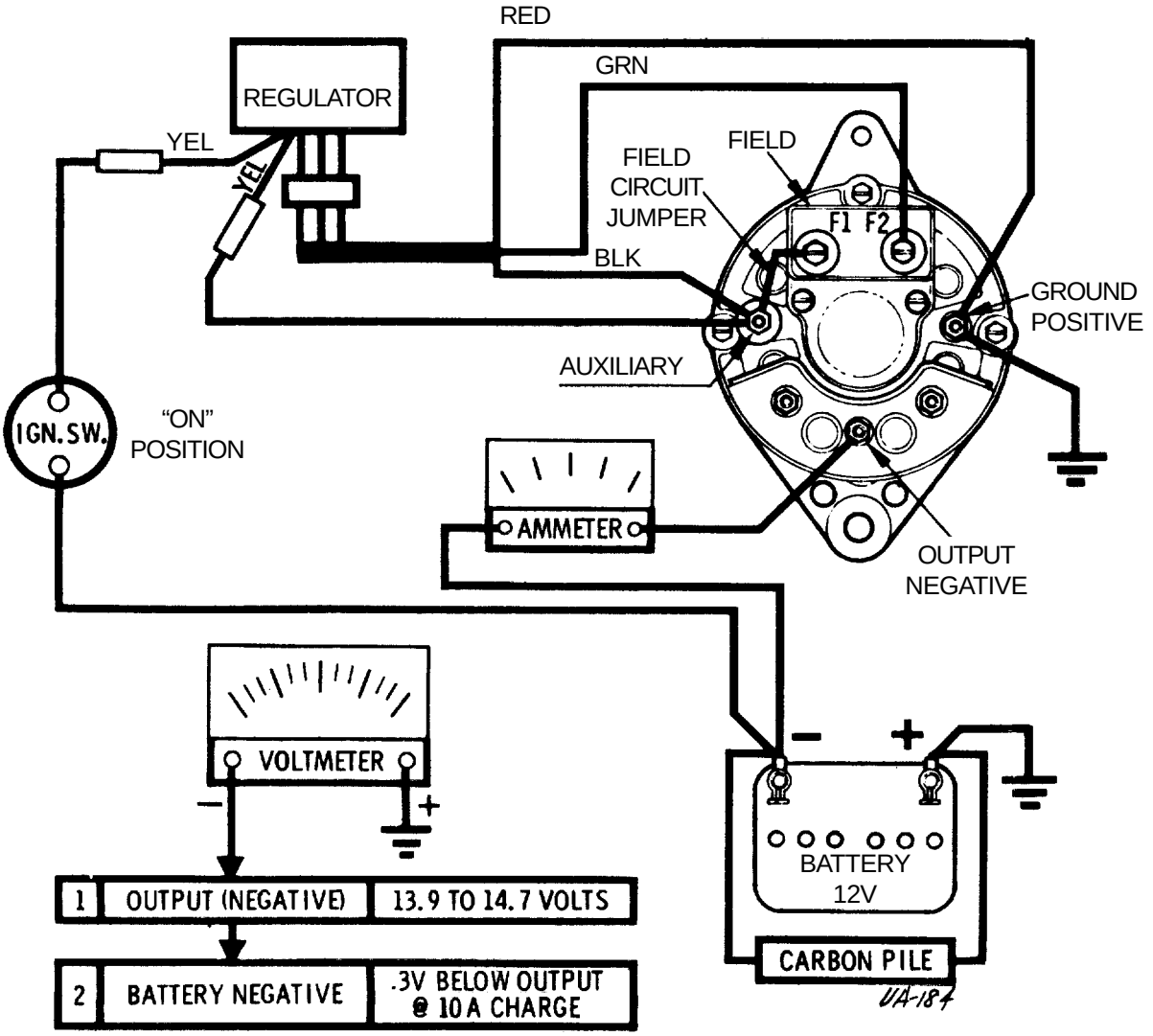
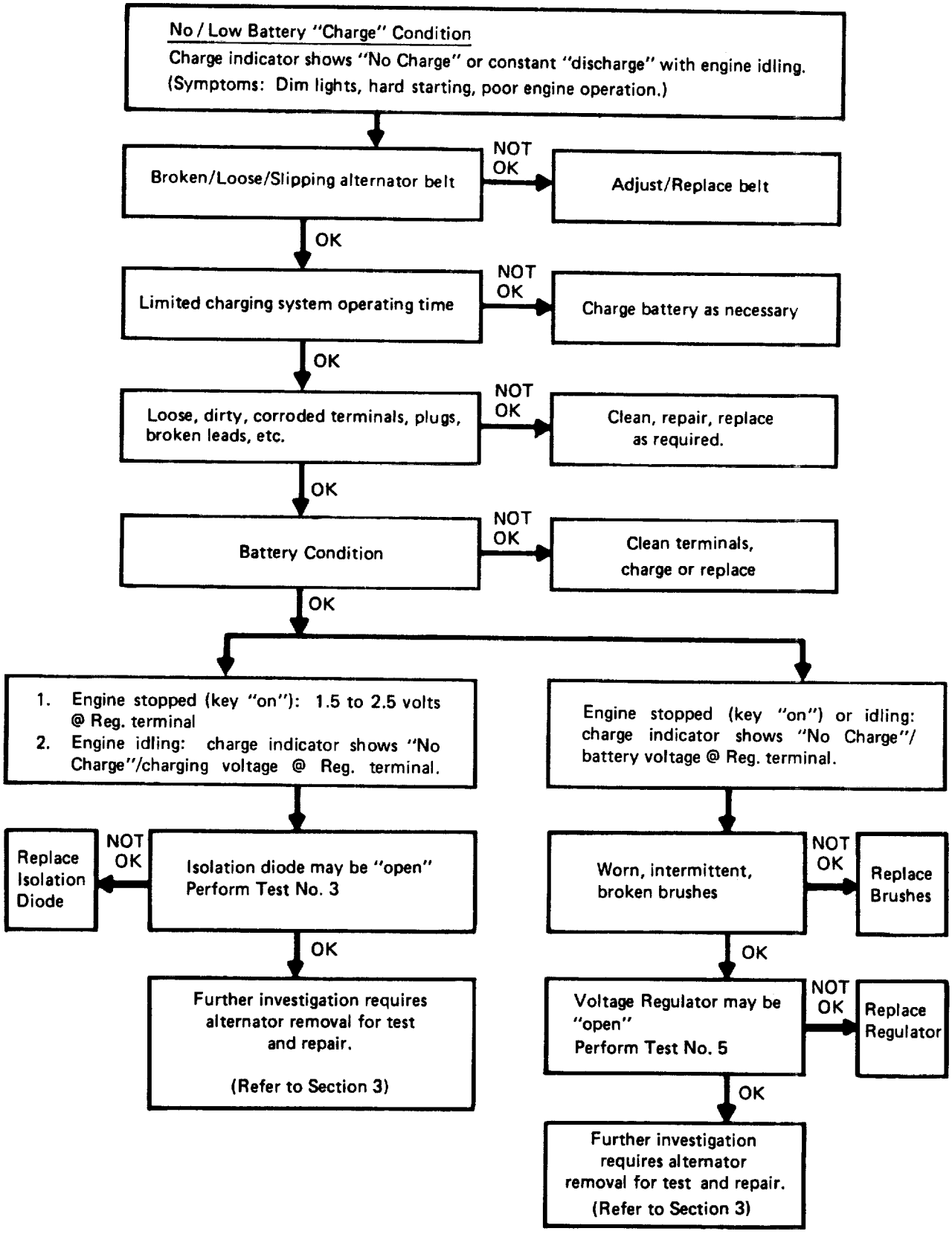


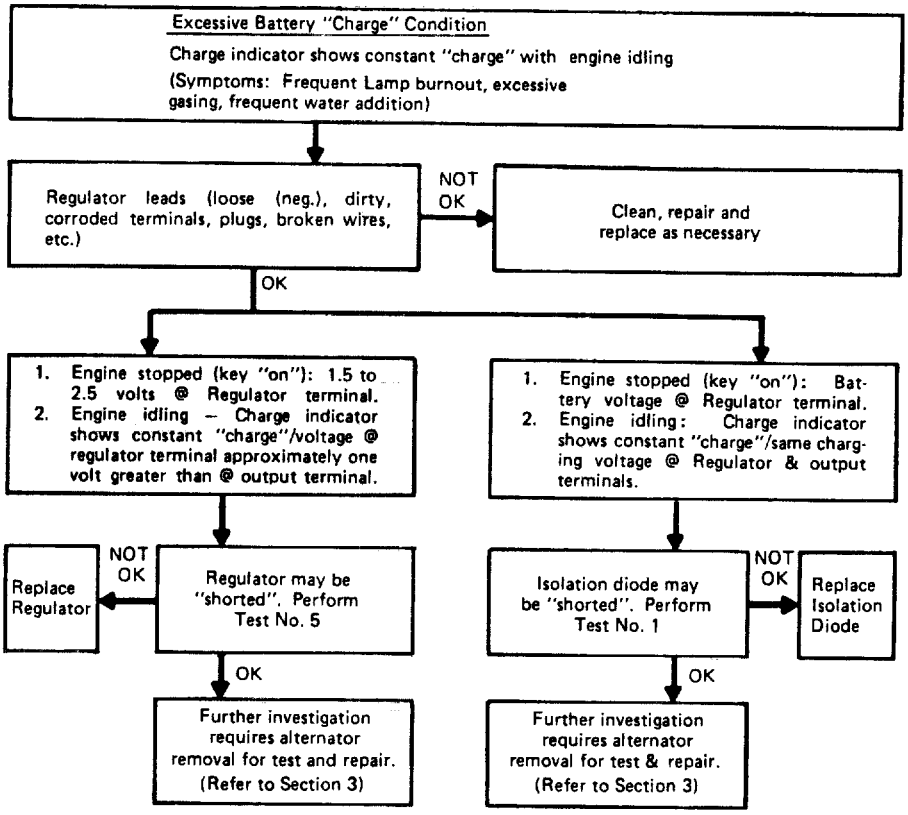
FIG. 2-20 ALTERNATOR OUTPUT & SYSTEM TEST

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CHARGING SYSTEM DIAGNOSTIC CHART NO. 1



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The in-vehicle test procedure for MR Series alternators requires some consideration for the circuit lead dress. The connecting plug of the yellow excitation lead should be positioned to avoid an accidental disconnect.

The voltage regulator may have a felt or synthetic mounting gasket to exclude dust from the brush cavity, this must be properly installed. (Refer to Figure 3-70). The voltage regulator circuit does not ground on the regulator casting, the black lead wire functions as the ground connection.

Refer to Figure No. 2-21 for terminal identification and the provisions for connecting a **Prestolite** Alternator Tachometer to the alternator.

Some alternator models have a regulator with a cable which terminates in a 2-pin plug, Figure 2-22. When connected to the mating wire harness, this arrangement provides excitation and indicator lamp functions. Otherwise, these alternators are the same as those described in this test section.

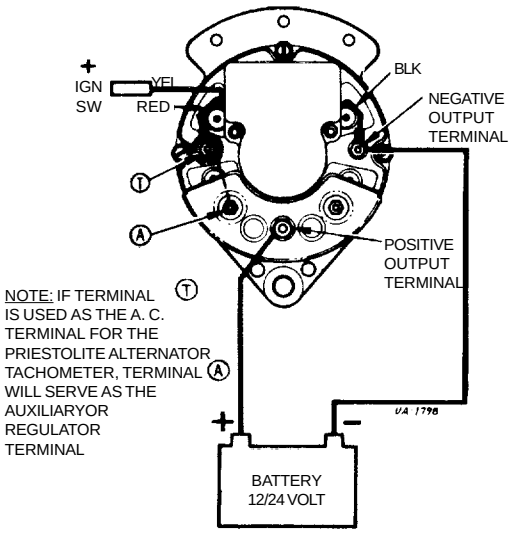


FIG. 2-21 TERMINAL IDENTIFICATION

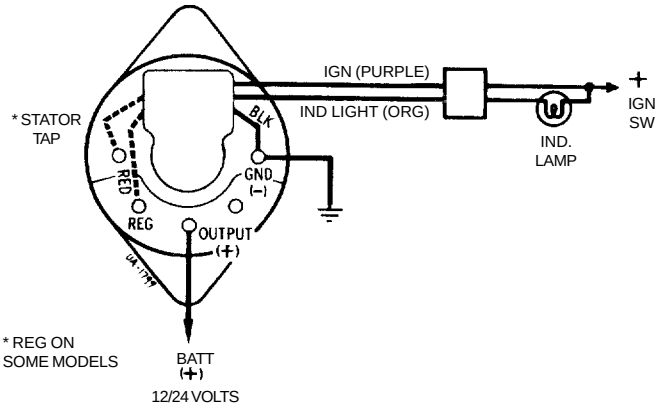


FIG. 2-22

https://truckmanualshub.com/

TEST NO. 1- BATTERY VOLTAGE AND SHORTED ISOLATION DIODE TEST.

CONDITIONS: IGNITION SWITCH OFF. ENGINE NOT RUNNING. Figure 2-23.

This test will determine if the vehicle battery is properly connected to the alternator, as a reversed battery connection would damage the alternator and voltage regulator. Secondly, the isolation diode is tested for a shorted condition that could allow the battery to discharge through the voltage regulator to ground.

When the positive voltmeter lead is connected to the alternator positive output terminal, and the battery is properly connected to the system, check the alternator output cables for possible loose connections. If moving the cables causes the voltmeter to vary, clean and tighten the related connections.

Step No. 2, requires a Zero voltmeter reading for a correct condition. If a voltage is indicated, it may be due to an improperly installed positive output lead, as shown in Figure 2-3, relocate if necessary and retest. If this fails to eliminate voltage at the auxiliary terminal, replace the isolation diode assembly. Figure No. 2-4 shows the proper arrangement of the insulators for the isolation diode. Battery ground cable should be removed while isolation diode is being replaced, as it is necessary to remove the voltage regulator to remove the diode.

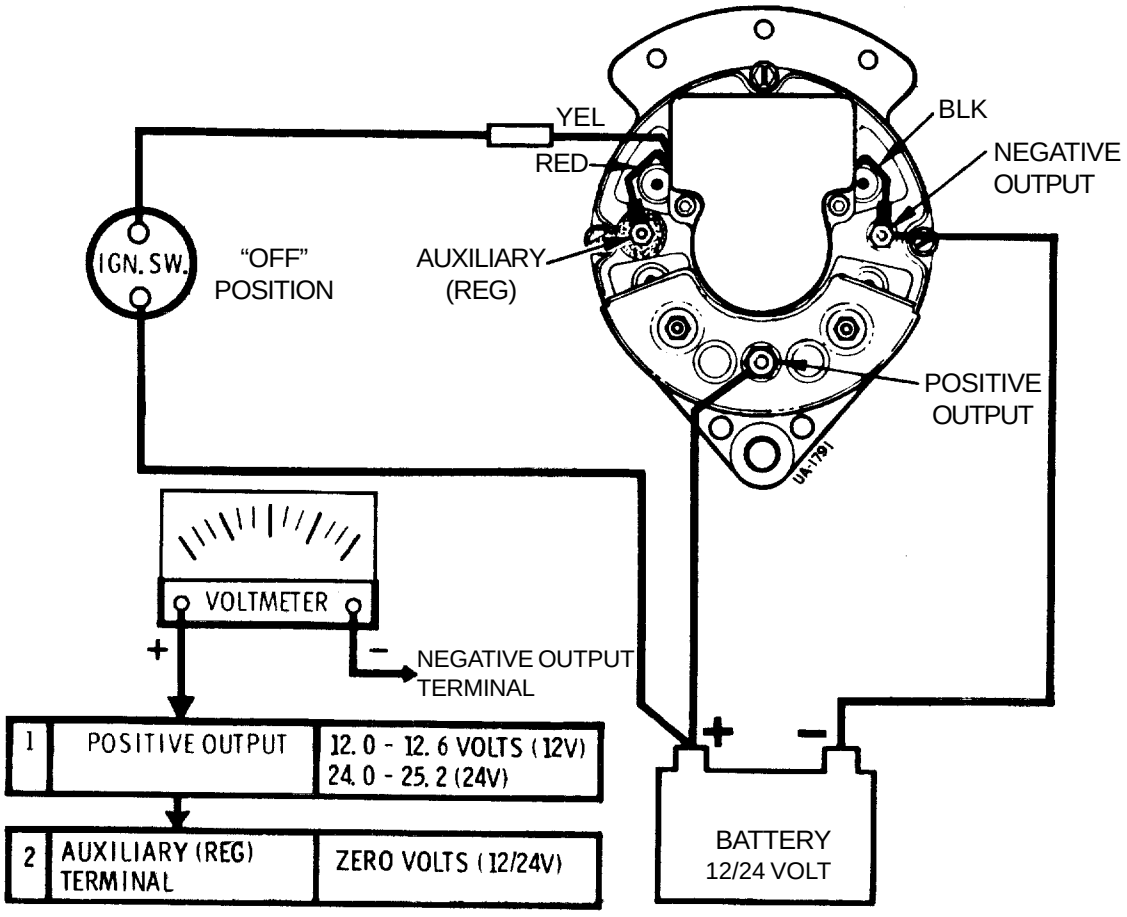


FIG. 2-23 BATTERY VOLTAGE & SHORTED ISOLATION DIODE TEST

https://truckmanualshub.com/

TEST NO. 2 - EXCITATION VOLTAGE TEST.

CONDITIONS: IGNITION SWITCH ON. ENGINE NOT RUNNING.

This test is an evaluation of the battery voltage supplied to the alternator field circuit. This energy is controlled by the ignition switch, and passes through the load circuit of the voltage regulator. Figure No. 2-6 shows this circuit.

Applying the correct field circuit load to the excitation resistor will provide a predictable voltage drop across that resistor. A shorted field will cause a greater voltage drop while an open field will cause less voltage drop. Defects in the regulator load circuit may test as open or shorted, and cause excitation voltage variation.

Connect the voltmeter to the circuit as shown in Figure No. 2-24, the voltmeter should indicate: 1.5 to 2.5 Volts.

If test results are uncertain, the regulator load circuit may be bypassed by carefully connecting a temporary jumper from the alternator auxiliary terminal to the brush terminal, as shown in Figure No. 2-25.

If the jumper provides correct voltmeter reading, the voltage regulator is faulty. No voltage change would indicate a faulty alternator field circuit.

Proceed with next test if these results have been satisfied.

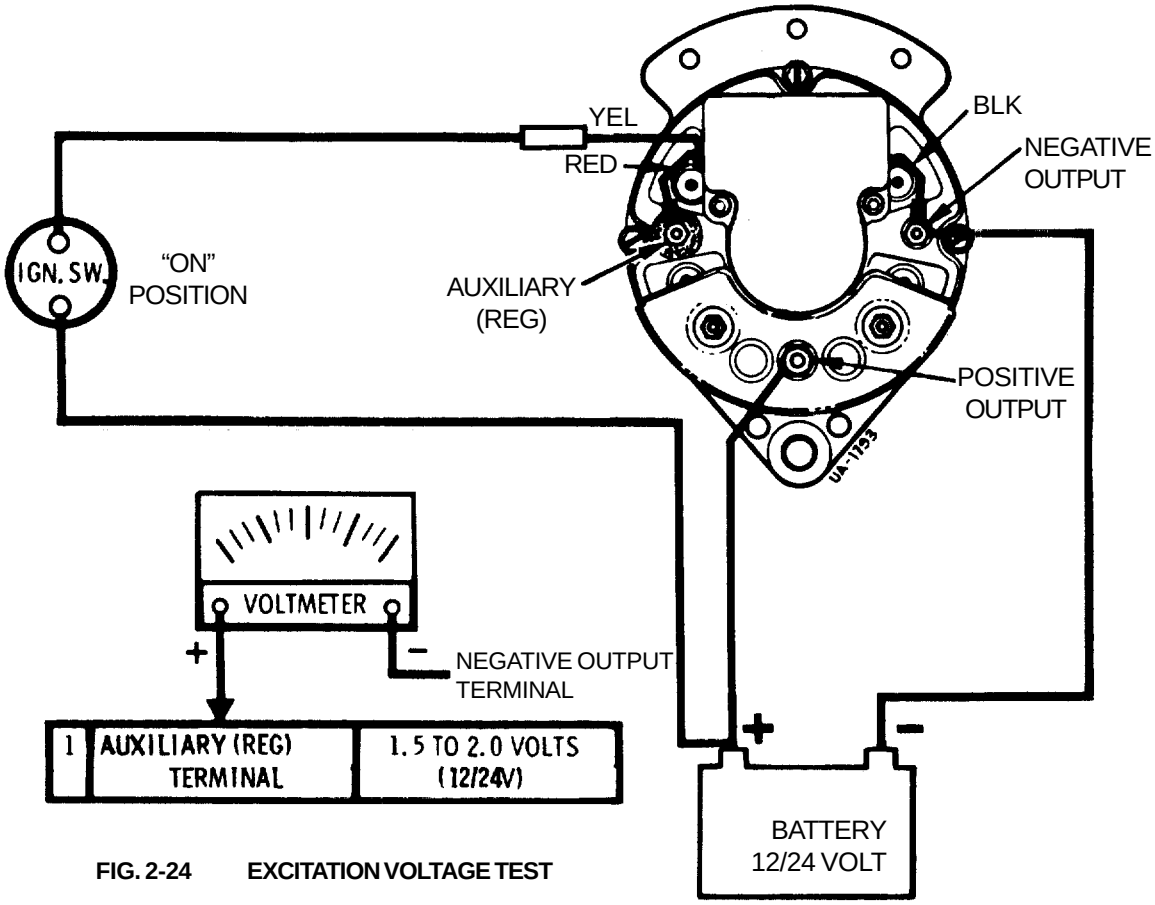


FIG. 2-24 EXCITATION VOLTAGE TEST

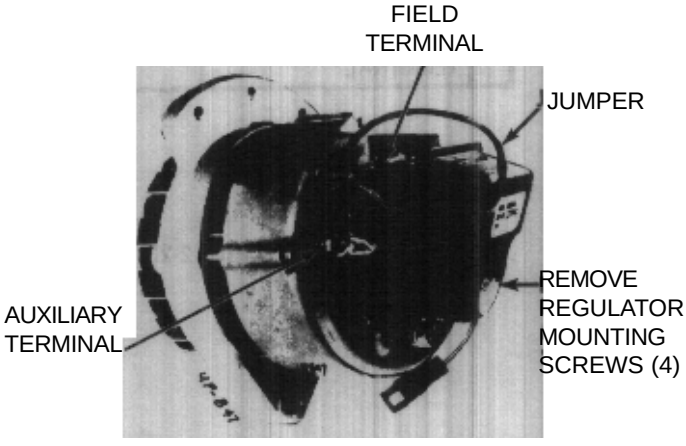


FIG. 2-25 BY-PASS REGULATOR LOAD CIRCUIT

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TEST NO. 3 - OPEN ISOLATION DIODE TEST.

CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING.

This test will determine if the isolation diode is conducting alternator energy from the positive rectifier diode to the alternator positive output stud. An open isolation diode will not allow the alternator to charge the battery.

With the engine running at fast idle, connect the voltmeter to the alternator as shown in Figure No. 2-26. Indicated voltages are correct. Noting battery voltage in Step 2, would indicate an open isolation diode.

Replace the isolation diode if necessary, refer to Figure No. 2-4 for correct placement of insulators, battery ground cable should be disconnected during this repair. It is necessary to remove the regulator to remove the diode assembly.

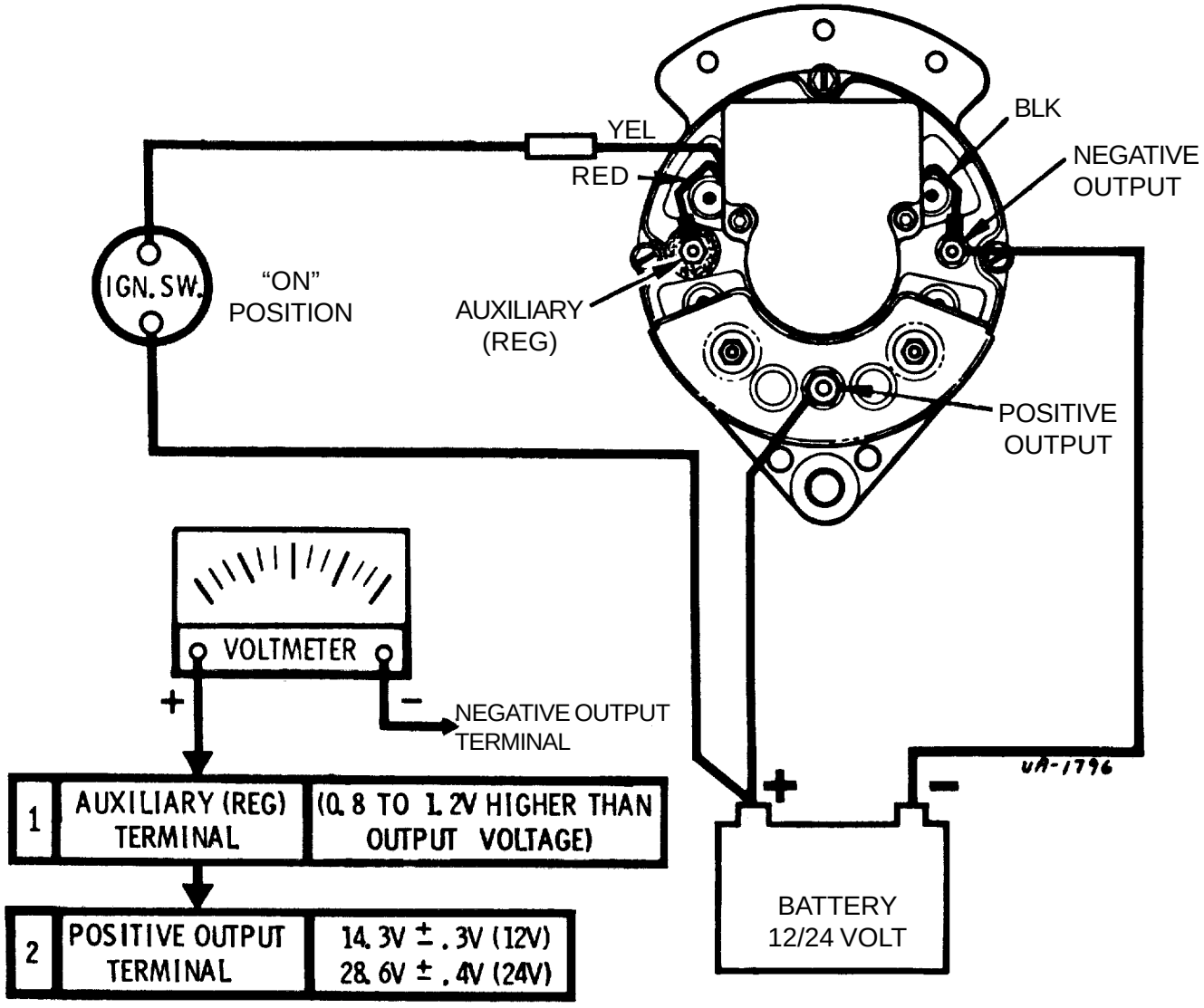


FIG. 2-26 OPEN ISOLATION DIODE TEST

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TEST NO. 4 - FIELD CURRENT DRAW TEST.

CONDITIONS: IGNITION SWITCH OFF.
ENGINE NOT RUNNING.
REMOVE REGULATOR FROM THE ALTERNATOR.

Place test ammeter on the 0-10 amp. scale. Set field rheostat control knob to maximum resistance. Connect ammeter and rheostat in series between positive output and brush terminals, as shown in the Figure No. 2-27. The rheostat will protect the ammeter, from damage if the field circuit is shorted or grounded.

Gradually reduce rheostat resistance noting test ammeter reading. If all rheostat resistance can be eliminated with ammeter indicating less than 3.5 amperes, the field winding is in good condition. Indicated current with rheostat resistance eliminated, is the current draw of the field (rotor) circuit.

Generally, this is approximately 2.0 to 2.5 amperes at battery voltage. If ammeter tends to vary when the rotor is slightly turned, the slip rings or brushes require cleaning. Use a fine grade of crocus cloth for this purpose.

If normal rotor current cannot be obtained, the alternator will require disassembly and replacement of defective parts.

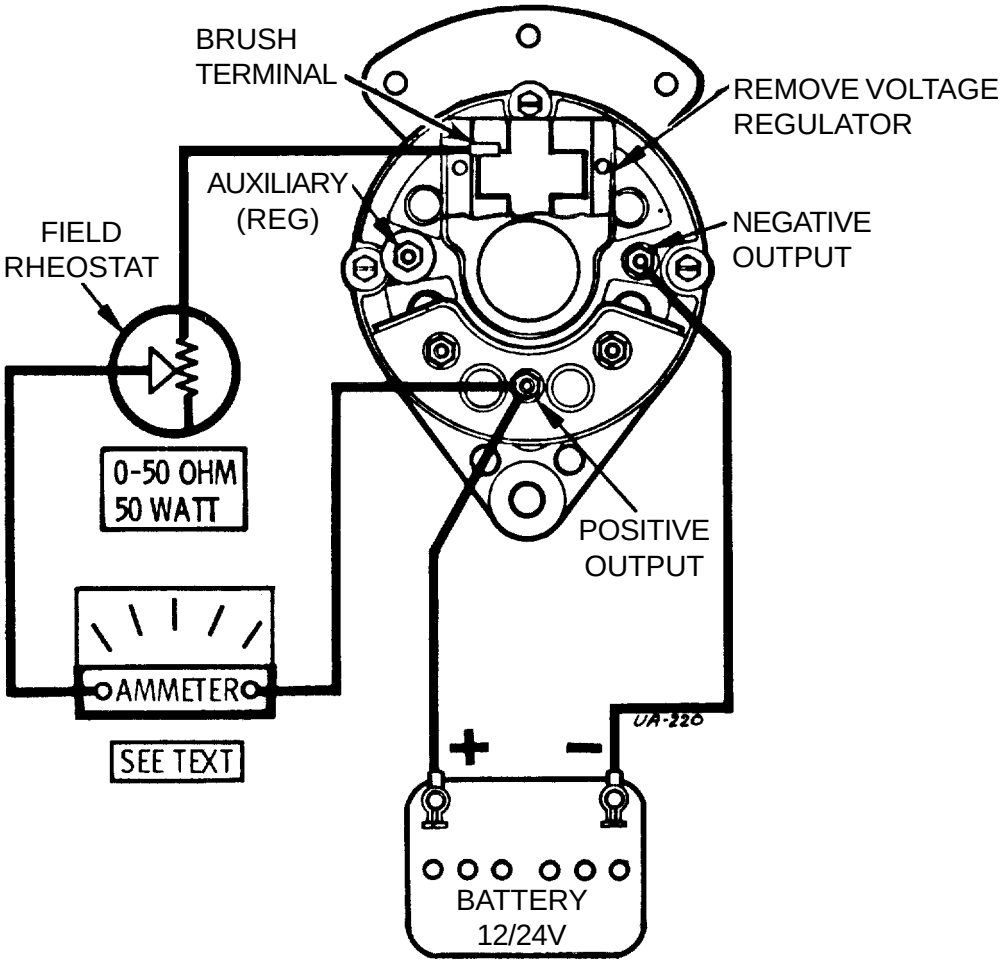


FIG. 2-27 FIELD CURRENT DRAW TEST

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TEST NO. 5 - VOLTAGE REGULATOR OPERATING TEST.

CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING.

This test will determine the operating level of the voltage regulator. A series resistance, 1/4 ohm, 25 watt, is placed in the alternator output positive lead, to reduce charging current. This will allow system voltage to rise to the level established by the regulator control circuit. Figure No. 2-28 shows the circuit.

Run the alternator for a few minutes to stabilize component temperature, the voltage should be within indicated levels.

Low voltage is usually due to a faulty regulator, high voltage may be due to a faulty regulator or a poor grounding connection for the black regulator lead. Check the metal wire end on the black lead very carefully.

After the regulator is known to be satisfactory, proceed with alternator output test.

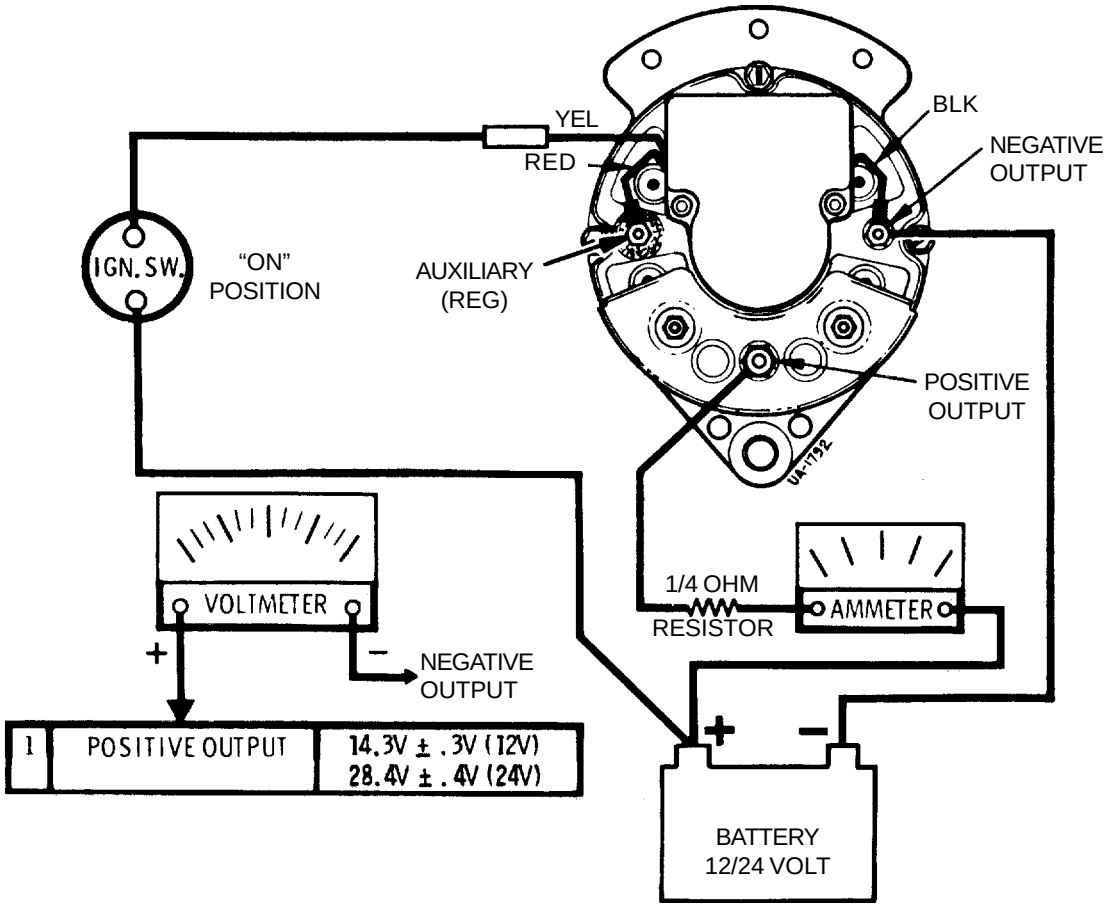


FIG. 2-28 VOLTAGE REGULATOR SETTING TEST

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TEST NO. 6 - ALTERNATOR OUTPUT AND SYSTEM TEST.

CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING.

This operation tests the alternators capability to produce its maximum (hot) output. A carbon pile load is applied to the battery to induce maximum charging current. Figure No. 2-29 shows the circuit. Be sure test ammeter is on the 0-100 ampere scale.

Start the vehicle engine, set a fast idle. Apply a partial carbon pile or accessory load to the system to produce a 20 ampere charge for a few minutes in order to stabilize component temperature.

After warm-up, adjust engine speed to provide 3000 to 4000 alternator R.P.M. Increase carbon pile load, note the maximum current developed with voltmeter indication as shown in the diagram. Refer to Table below for minimum acceptable output.

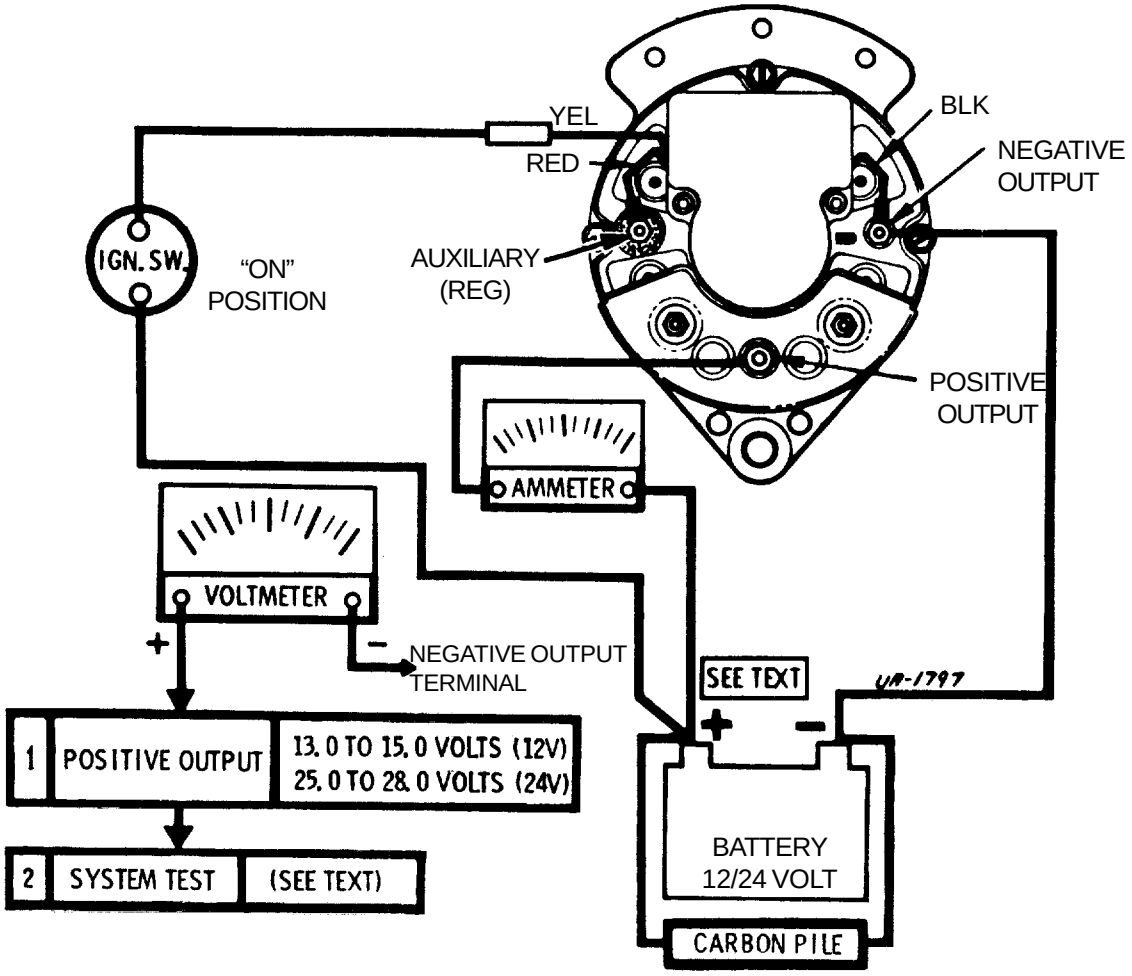


TABLE FOR MINIMUM ACCEPTABLE OUTPUT

Alternator Model	Minimum Acceptable (hot) Output
35 Ampere	28.0 to 30.0 Amperes
40 Ampere	35.0 to 37.0 Amperes
55 Ampere	43.0 to 46.0 Amperes
72 Ampere	66.0 Amperes

NOTE: Out put voltage must be between 13.0 and 15.0 volts for 12 volt system, and from 25 to 28 volts for 24 volt system.

Disconnect carbon pile load immediately after test to avoid discharging vehicle battery.

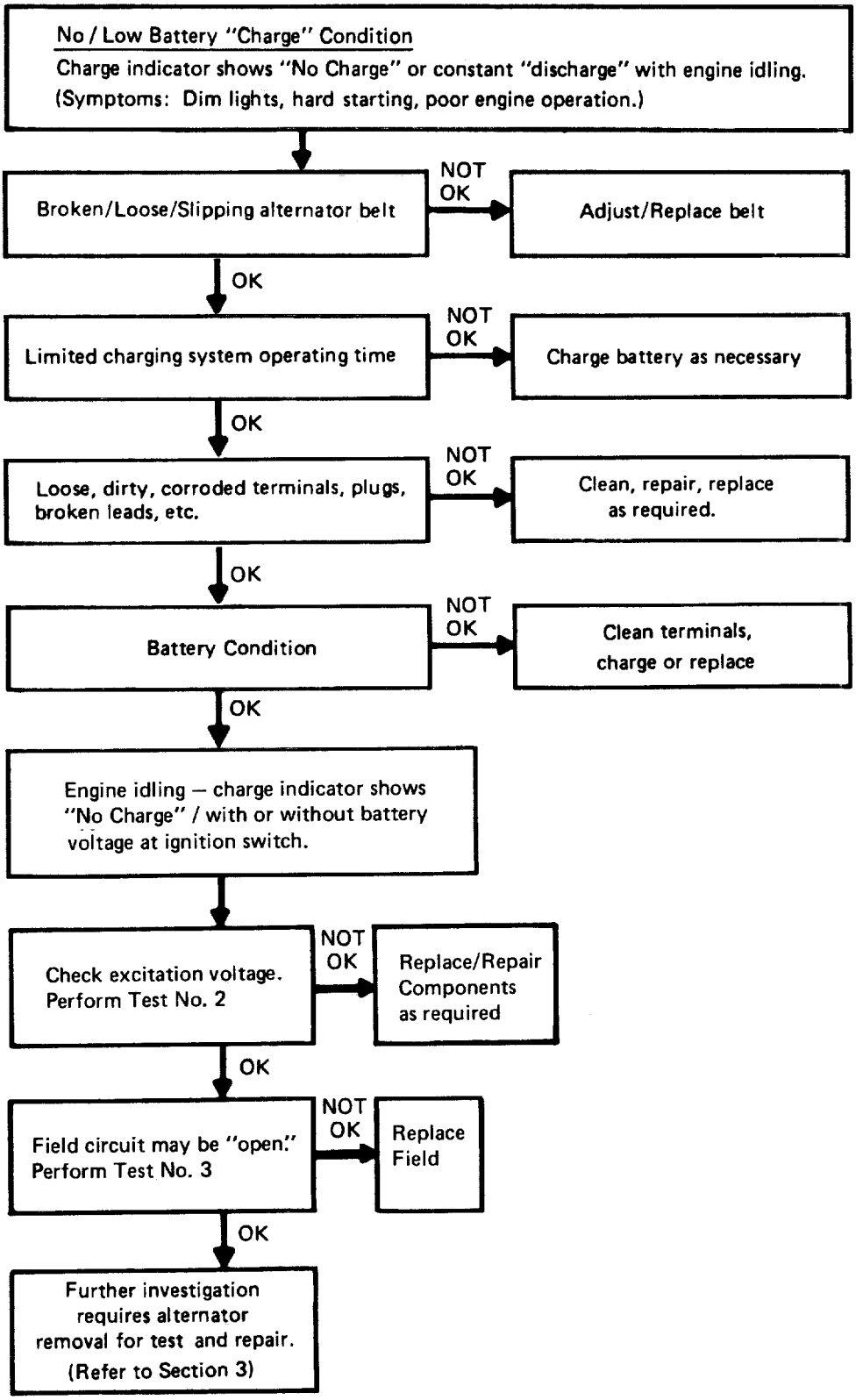
If the alternator cannot produce its minimum (hot) rated output it should be disassembled for inspection and repaired.

System voltage drop, Step No. 2, is determined by measuring the voltage differential across the battery terminals and across the alternator output terminals. With the alternator producing 10 amperes, the maximum voltage differential is .3 (three tenths) volt.

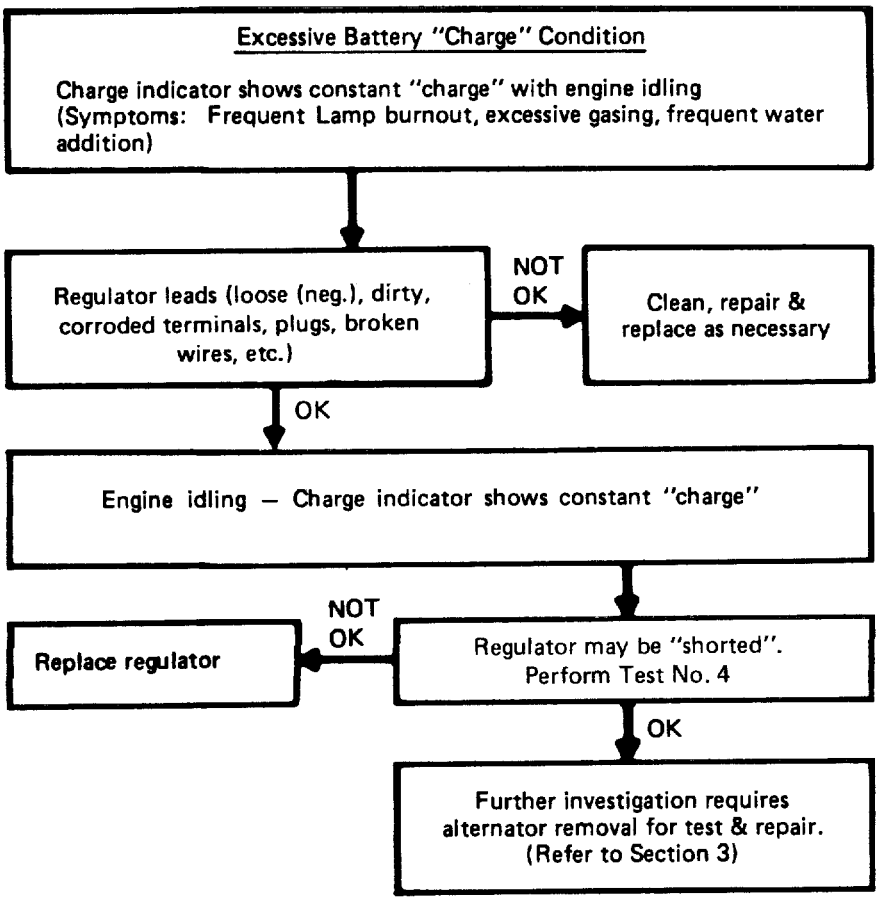
Excess voltage drop may require cleaning and tightening connections or the use of heavier gauge output cables.

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CHARGING SYSTEM DIAGNOSTIC CHART NO. 1



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GENERAL

The in-vehicle testing procedure for HC, MA and MH Alternators, 12 and 24 volt, without an isolation diode, is a five step process.

System charging voltage is sensed at the vehicle ignition or control switch. The switch must be in good condition. Do not connect other electrical accessories to the "regulator" or "load side" of the switch, this will induce excessive voltage drop across the switch and inaccurate voltage sensing.

The alternator terminal marked (TACH) in the test procedure has been used as the sensing terminal for the **Prestolite** Alternator Tachometer. To avoid possible misconnection, the lower diode stud is used as the "positive output terminal."

Alternators with insulated ground circuits must use a jumper between F-2 Field Terminal and the Negative output terminal, this is indicated by a dotted line.

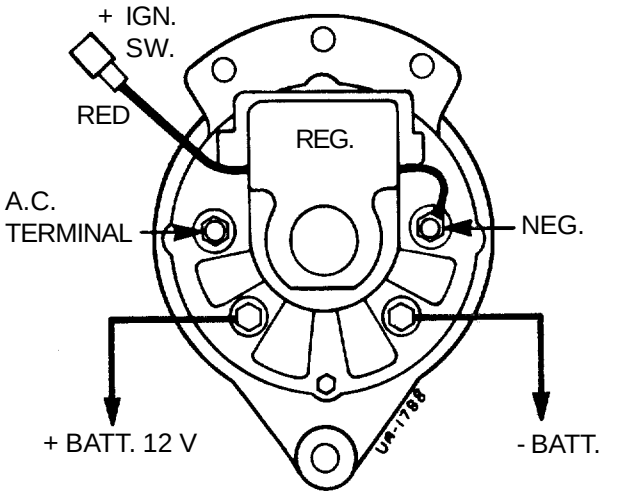


FIG. 2-30 INTEGRAL REGULATOR HC ALTERNATOR WITHOUT ISOLATION DIODE

The FIC model series without an isolation diode include an integral regulator as shown in Figure 2-30. Aside from the attached regulator, these alternators are essentially the same as those described in this test section.

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TEST NO. 1 - SHORTED RECTIFIER DIODE TEST.

CONDITIONS: IGNITION SWITCH OFF. ENGINE NOT RUNNING.

Connect voltmeter as shown in Figure No. 2-31. Note battery voltage at Alternator Positive Output terminal. Place positive voltmeter load on any rectifier diode terminal, indicated as point Ⓐ, correct voltmeter reading is Zero volts.

The alternator must be removed from the engine for repair if a rectifier diode is shorted. Disconnect negative battery cable prior to removing alternator. Refer to the alternator Repair/Overhaul section of this manual for diode replacement procedure.

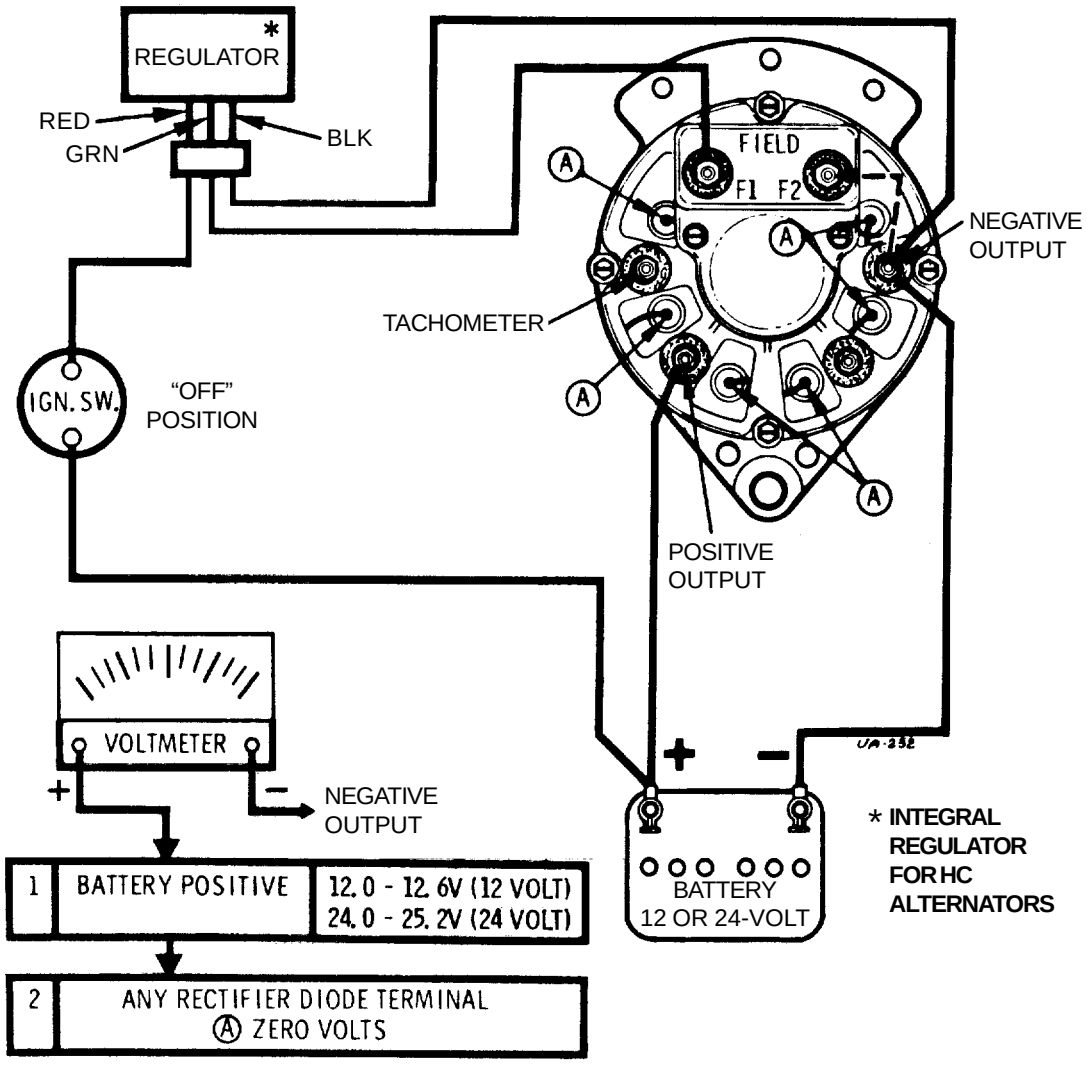


FIG. 2-31 SHORTED RECTIFIER DIODE TEST

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TEST NO. 2 - EXCITATION VOLTAGE TEST

CONDITIONS: IGNITION SWITCH ON.
ENGINE NOT RUNNING.

This is a test of the voltage regulator load circuit, where an allowable voltage drop is present.

An open load circuit would provide low excitation voltage and no alternator output. A shorted output transistor would result in higher excitation voltage and overcharge when the alternator is operating.

A suspected defect in the ignition switch may be eliminated by the temporary application of a test jumper as shown in Figure No. 2-32. Replace switch if necessary.

A defective field circuit may provide an incorrect load for the excitation circuit. Test the field circiut as shown in Test No. 3 to eliminate this possibility.

Replace the regulator if the load circuit tests as open or shorted.

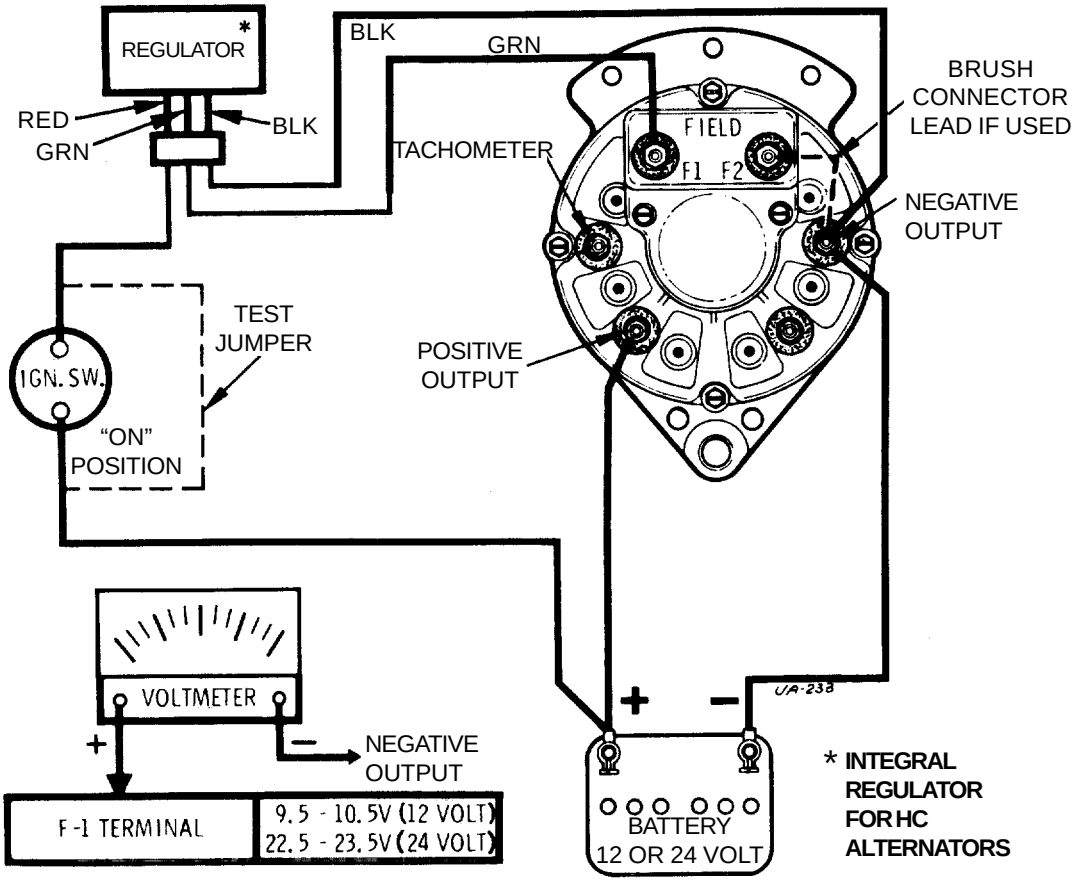


FIG. 2-32 EXCITATION VOLTAGE TEST

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TEST NO. 3 - FIELD CIRCUIT TEST.

CONDITIONS: IGNITION SWITCH OFF. ENGINE NOT RUNNING, REMOVE REGULATOR LEAD FROM F-1 TERMINAL.

Place test ammeter in 0 to 10 amperes scale. Set control knob of field rheostat in maximum position connect in series as shown in Figure No. 2-33. The rheostat will protest the ammeter from damage if the field circuit is shorted.

Slowly reduce rheostat resistance, noting rise in ammeter reading. Stop test if meter indicates more than 3.0 amperes, as alternator disassembly may be necessary to correct condition.

If entire rheostat resistance can be eliminated with test ammeter below 3.0 amperes, the indicated current is the field current draw. If the test ammeter fluctuates when the rotor is move slightly, the brushes and slip rings require cleaning. Use fine grade of crocus cloth.

Proceed with next test if the Field Circuit test correctly.

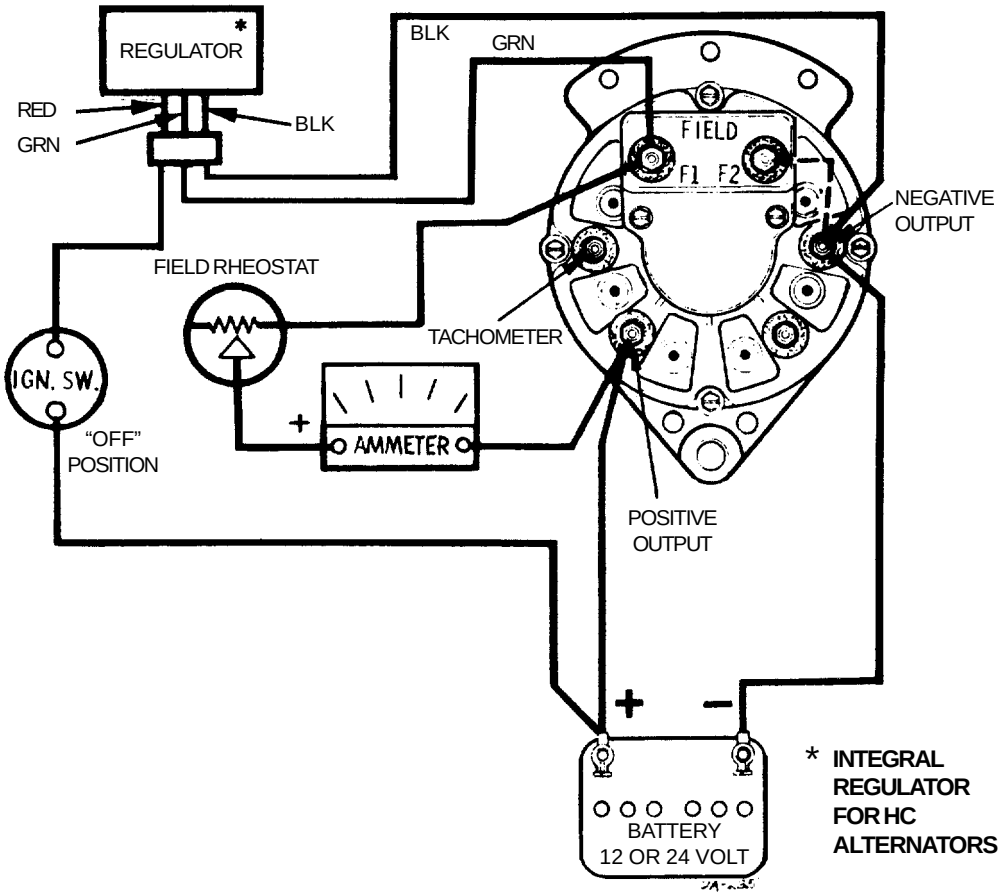


FIG. 2-33 FIELD CURRENT TEST

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TEST NO. 4 - VOLTAGE REGULATOR OPERATING TEST.

CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING AT FAST IDLE, AFTER THE RESISTOR AND THE TEST AMMETER ARE CONNECTED TO THE SYSTEM.

This test will indicate the level of alternator charging voltage, controlled by the voltage regulator.

A 1/4 ohm 25 watt resistor is placed in series with the test ammeter, then applied to the circuit as shown in Figure No. 2-34.

The resistor will reduce charging current to less than 10 amperes, thus allowing charging voltage to rise to the regulator controlled maximum.

If test result indicates a lower voltage it may be due to a defective voltage regulator (the field circuit was checked in Test No. 3).

High voltage may be due to a high resistance regulator ground circuit (black lead), or to a defective voltage regulator, Make necessary repairs or replace regulator. Proceed with next test.

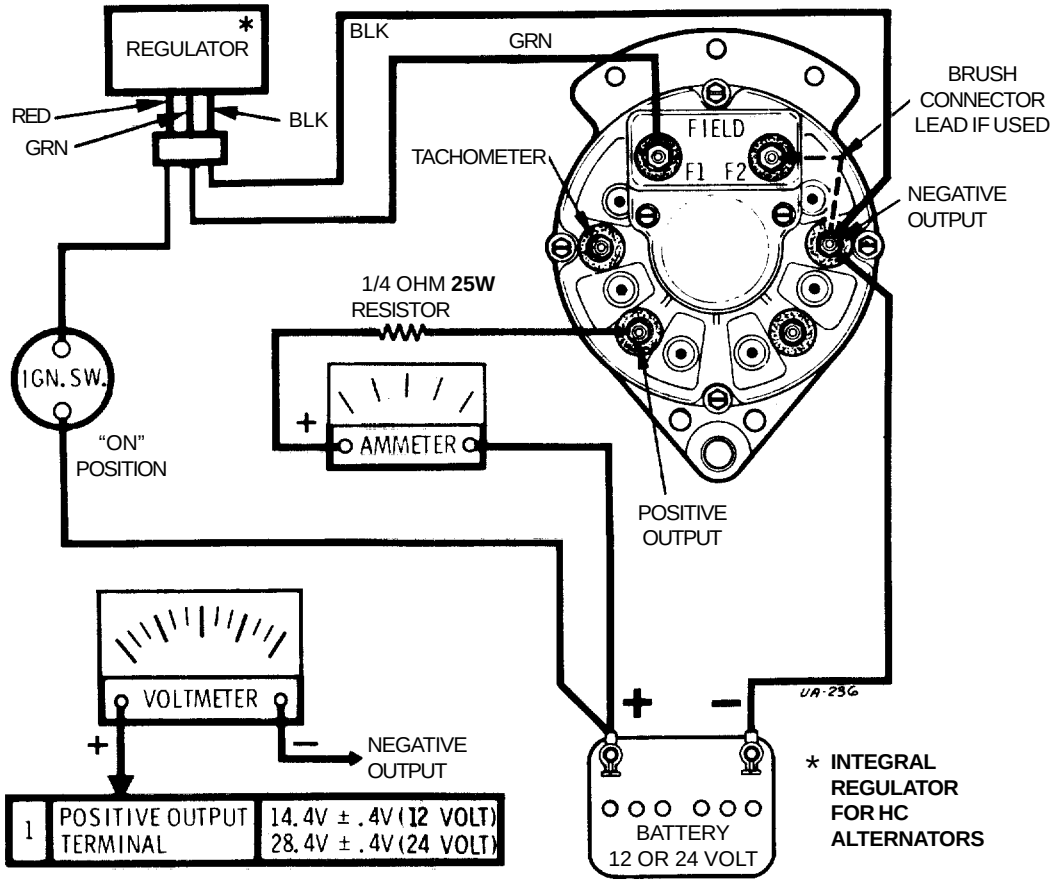


FIG. 2-34 VOLTAGE REGULATOR SETTING TEST

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TEST NO. 5 - ALTERNATOR OUTPUT AND SYSTEM TEST.

CONDITIONS: IGNITION SWITCH ON. ENGINE RUNNING.

This test requires the test ammeter to be switched to the 0-100 ampere scale, and placed in series with the alternator positive output terminal and battery positive terminal, as shown in Figure No. 2-35. Place load control knob of carbon pile to the “off” position before connecting load leads to the battery terminals.

Connect voltmeter as shown in Figure No. 2-35.

Start engine, run a few minutes at fast idle to stabilize component temperature. Set engine throttle to provide 3000 to 5000 alternator R.P.M. Apply carbon pile load to the battery to induce highest alternator current output. Note voltage at this point. Refer to Table for minimum acceptable (hot) alternator output.

TABLE FOR MINIMUM ACCEPTABLE OUTPUT

12 Volt Models	**Minimum Acceptable Output**
35 Ampere	28.0 to 30.0 Amperes
40 Ampere	35.0 to 37.0 Amperes
55 Ampere	43.0 to 46.0 Amperes
72 Ampere	66.0 Amperes

Output voltage must remain between 13.0 and 15.0 Volts.

24 Volt Models	**Minimum Acceptable Output**
35 Ampere	30.0 Amperes

Output voltage must remain between 25,0 and 28.0 Volts.

If the alternator cannot provide required output, it should be removed from the engine for overhaul service. Reduce carbon pile load on battery immediately after testing to avoid discharging battery.

System voltage drop, between the alternator and the battery, is tested with the alternator producing 10 amperes. The maximum allowable voltage drop, between alternator and battery is .3 (three tenths) volt.

Excess voltage loss may require cleaning and tightening of all circuit connections or the use of heavier gauge output cables between the alternator and battery.

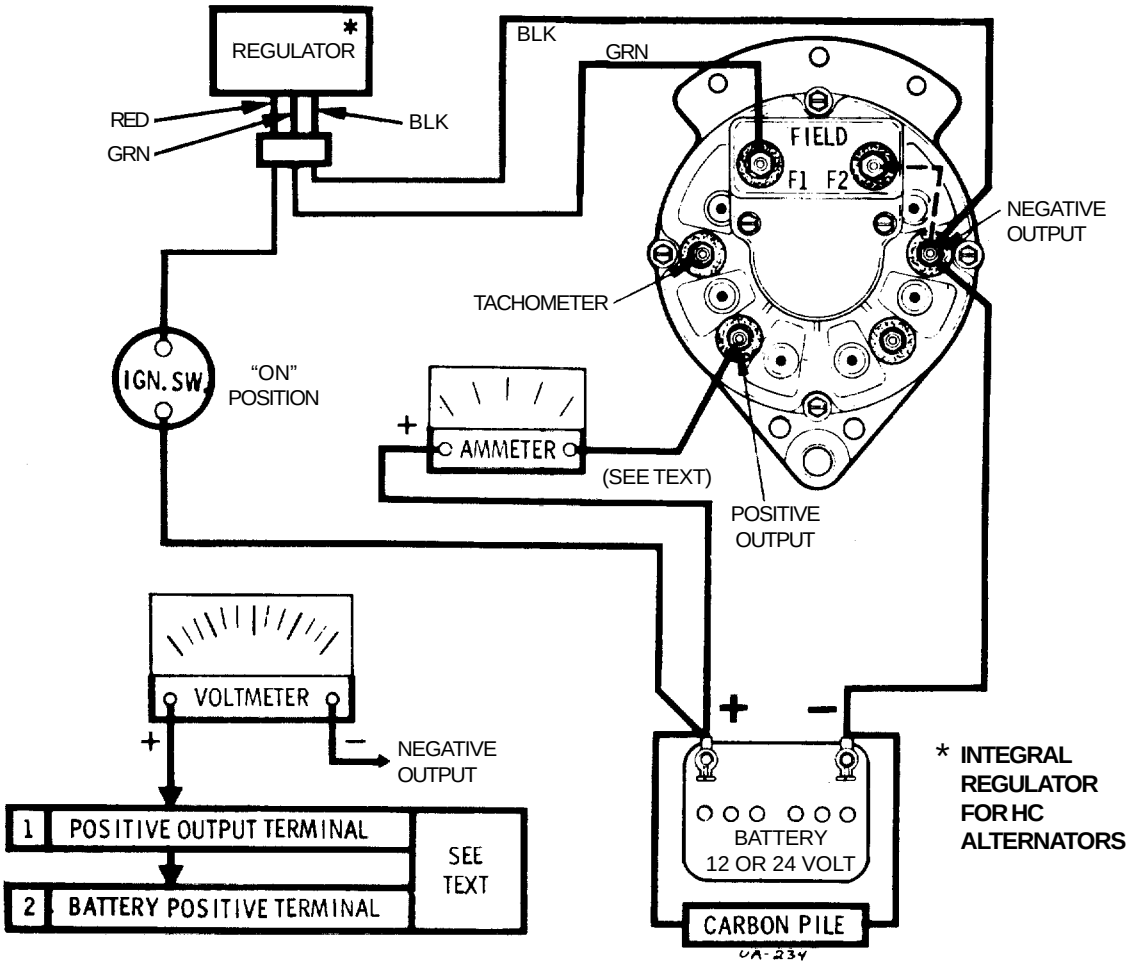
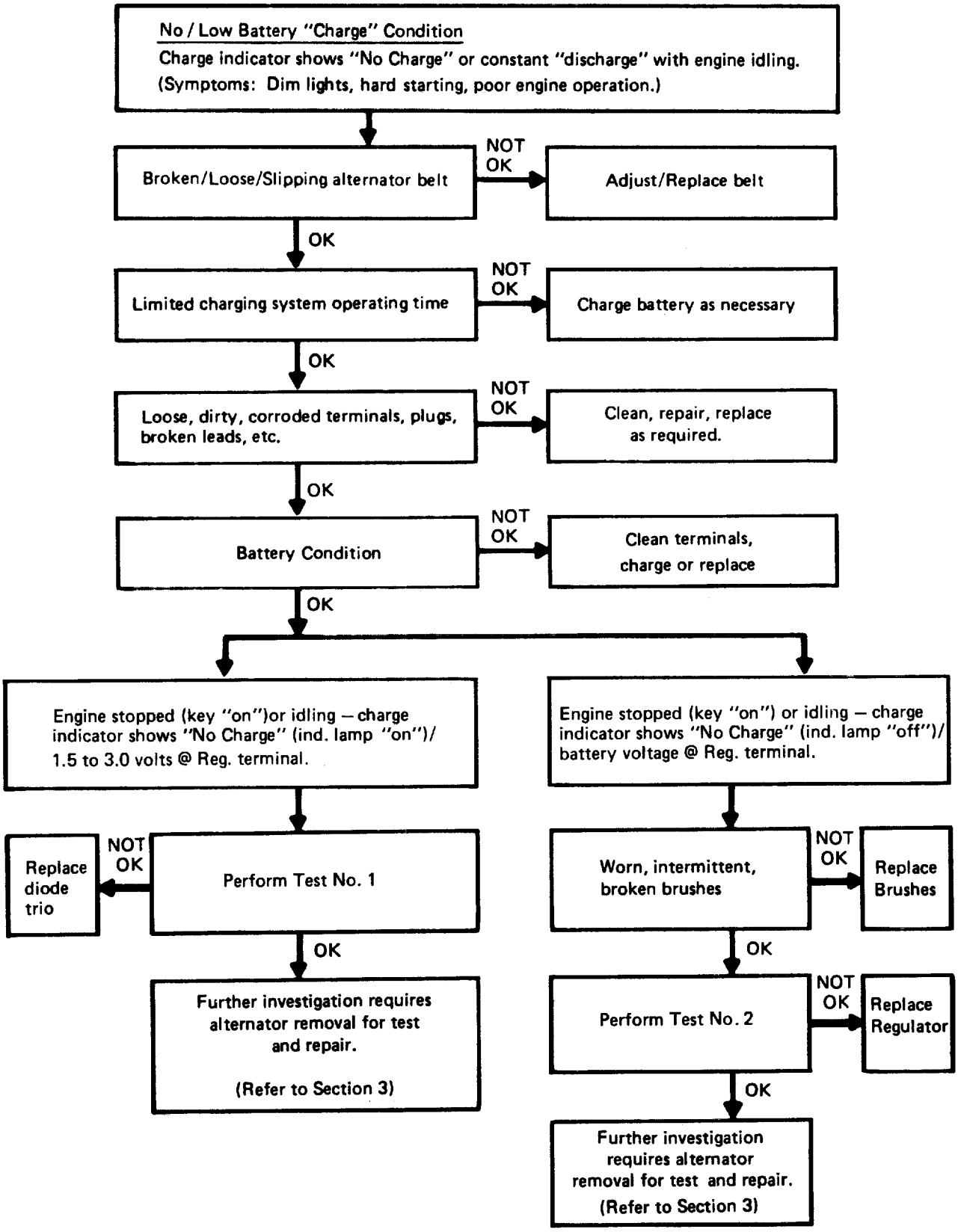


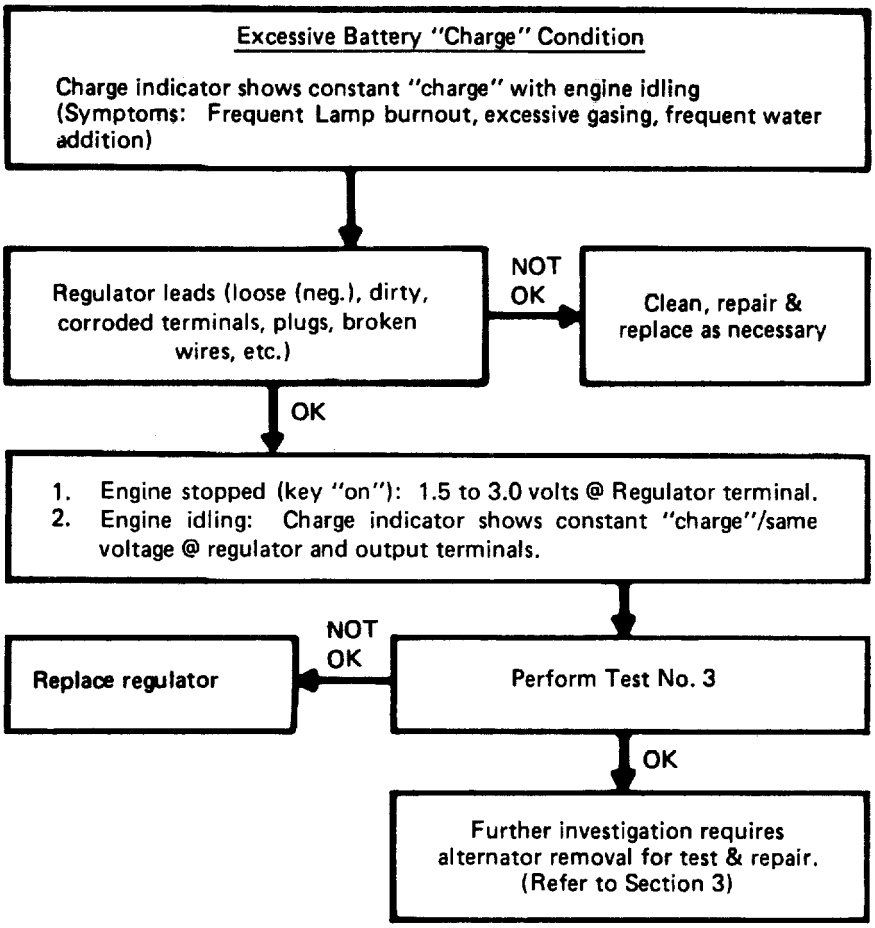
FIG. 2-35 ALTERNATOR OUTPUT & SYSTEM TEST

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CHARGING SYSTEM DIAGNOSTIC CHART NO. 1



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TEST NO. 1 - DIODE TRIO TEST (OPEN)

CONDITIONS: ENGINE IDLING (AFTER PROPER HOOK-UP IS MADE AND TEST LEADS CONNECTED), NO ELECTRICAL LOADS.

Check for battery voltage at output terminal and for 1.5 to 3 volts at regulator terminal, Figure 2-36. Add jumper 01-11) between these terminals. Start engine. If indicator lamp is now “off” and charging voltage is present at output terminal, the diode trio is probably “open” (defective) and alternator should be removed for repair.

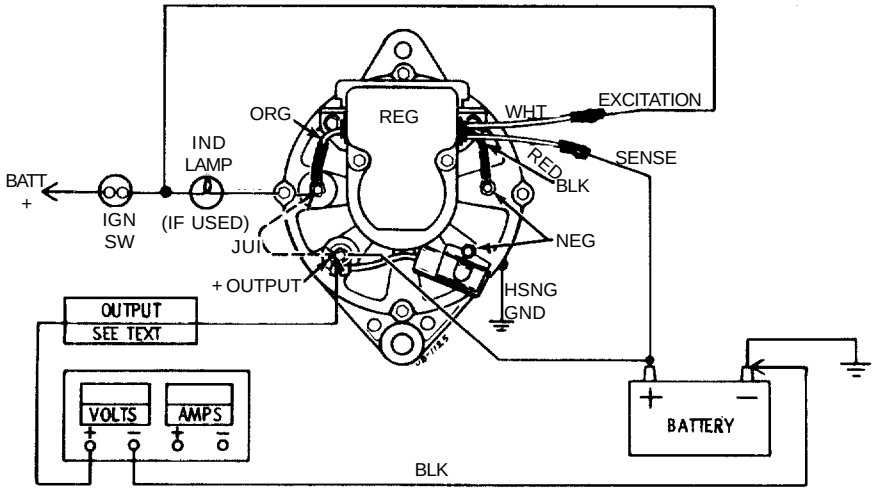


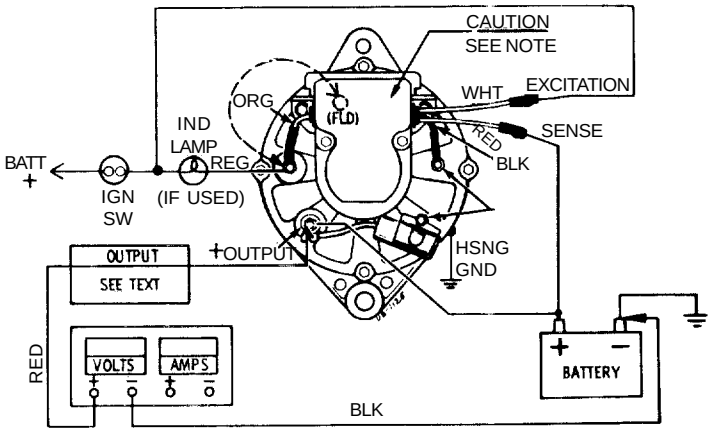
FIG. 2-36 DIODE TRIO TEST (OPEN)

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TEST NO. 2 - REGULATOR TEST (OPEN)

CONDITIONS: ENGINE STOPPED (KEY "ON") OR IDLING (AFTER PROPER HOOK-UP IS MADE AND TEST LEADS CONNECTED) AND VOLTMETER SET-UP AS SHOWN IN FIGURE NO. 2-37. REMOVE REGULATOR SCREWS TO ADD JU1.

The indicator lamp will be "off" and battery voltage will be present at alternator reg. terminal. After jumper (JU1) addition, the indicator lamp should now be "on" (and 1.5 to 3 volts should be present at reg. terminal of alternator), with key "on" and engine stopped, thus indicating an open (defective) regulator. If lamp is still not "on", an open field circuit (brushes, slip-rings, etc.) is indicated and alternator repair is required.



NOTE BEFORE PERFORMING TEST: REMOVE REG. MTG. SCREWS & CONNECT AN INSULATED JUMPER (JU1) BETWEEN REG & FLD TERMINAL, MTG REG TO ALT WITH TWO SCREWS FOR TEST.

FIG. 2-37 REGULATOR TEST (OPEN)

TEST NO. 3 - REGULATOR TEST (SHORTED)

CONDITIONS: ENGINE IDLING (AFTER CONNECTING VOLTMETER AS SHOWN IN FIGURE NO. 2-38.

Start engine and run at fast idle (approx. 1,000 RPM) with no electrical loads. Continue running engine until voltmeter reading stabilizes at the regulator high end setting. This high end voltage reading must not exceed 15 volts for a correctly operating charging system.

If excessive voltage readings are obtained, the regulator is probably shorted (defective) and should be replaced. However, make sure "sense" voltage is approximately the same (not less) as output voltage or overcharging will result (even with a good regulator). For example, if the sense-to-output terminal voltage difference is greater than a few tenths of a volt, and the regulator is good, check for voltage drops in the wiring system.

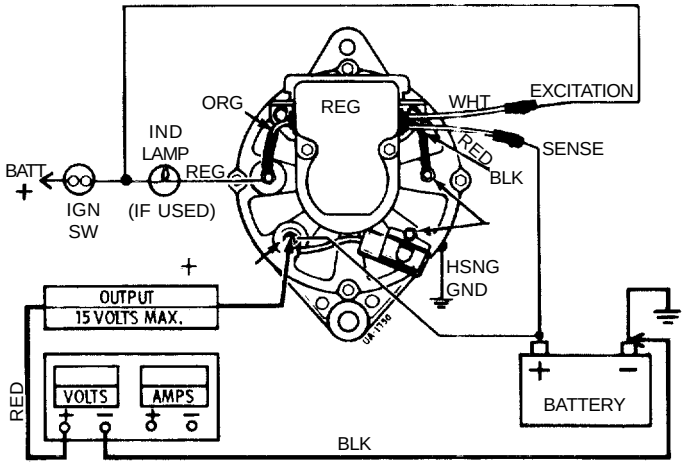


FIG. 2-38 REGULATOR TEST (SHORTED)

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TEST NO. 4 - ALTERNATOR OUTPUT TEST

CONDITIONS: ENGINE RUNNING AT FAST IDLE (AFTER VOLTMETER IS CONNECTED AS SHOWN IN FIGURE 2-39.

Start and run engine at a fast idle of approximately 1,000 RPM. Turn on vehicle headlights and lower fan (low speed). Check for nominal system output voltage of between 14.2 - 14.7 volts for a properly operating charging system. (Voltages may vary a few tenths of a volt (higher or lower) due to ambient temperature variations).

If the alternator output voltage does not fall within the proper range, the alternator should be disassembled for further inspection and tests. Refer to Section 3 (Repair/ Overhaul Procedure) for additional information.

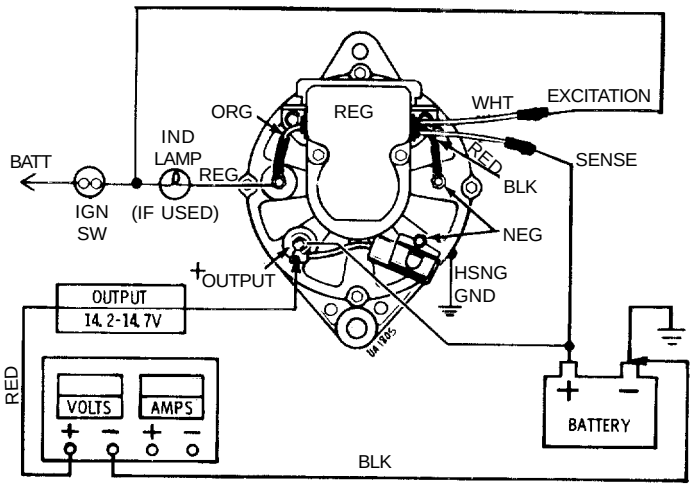


FIG. 2-39 ALTERNATOR OUTPUT TEST

Some MR/HC alternators have different terminal and wiring details as illustrated in Figure 2-40 on pages 49 and 50. However, they are essentially the same as the other alternators described in this section since they all are diode trio type machines. Hence, the tests outlined in this section are applicable to these models also.

Note that some MR alternators are equipped with a dust screen attached to the rear housing of the unit. This screen is used to prevent build-up of debris within the unit and eliminate overheating problems. This screen may have to be removed temporarily to expose the alternator terminals when performing some of the test procedures.

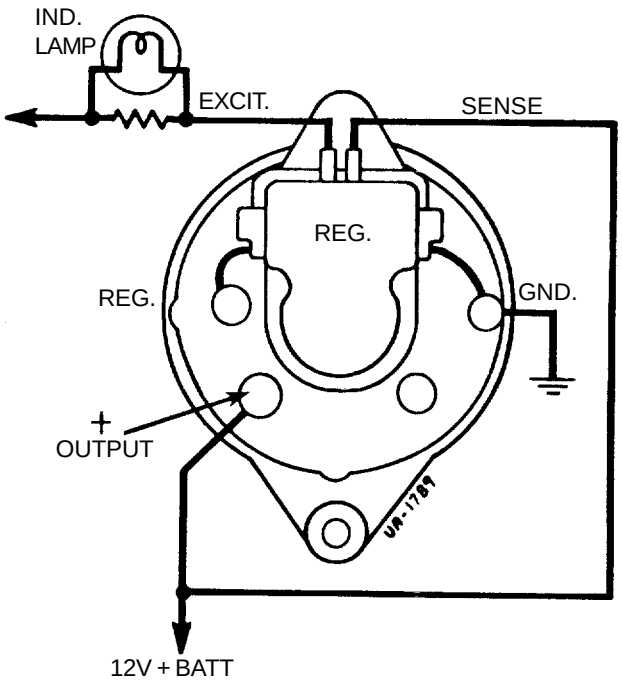
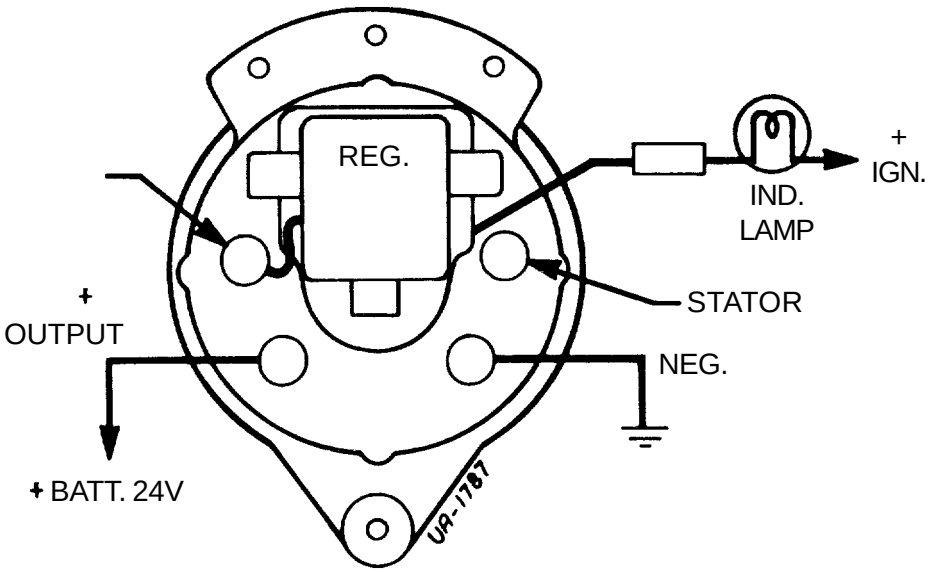
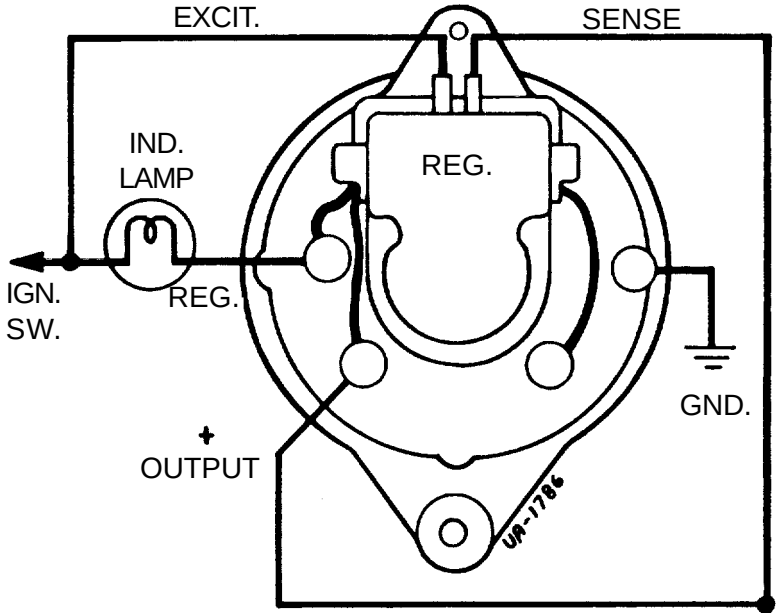


FIG. 2-40 TYPICAL TERMINAL/WIRING DETAILS FOR 12/24 VOLT HC/MR ALTERNATORS WITH DIODE TRIO

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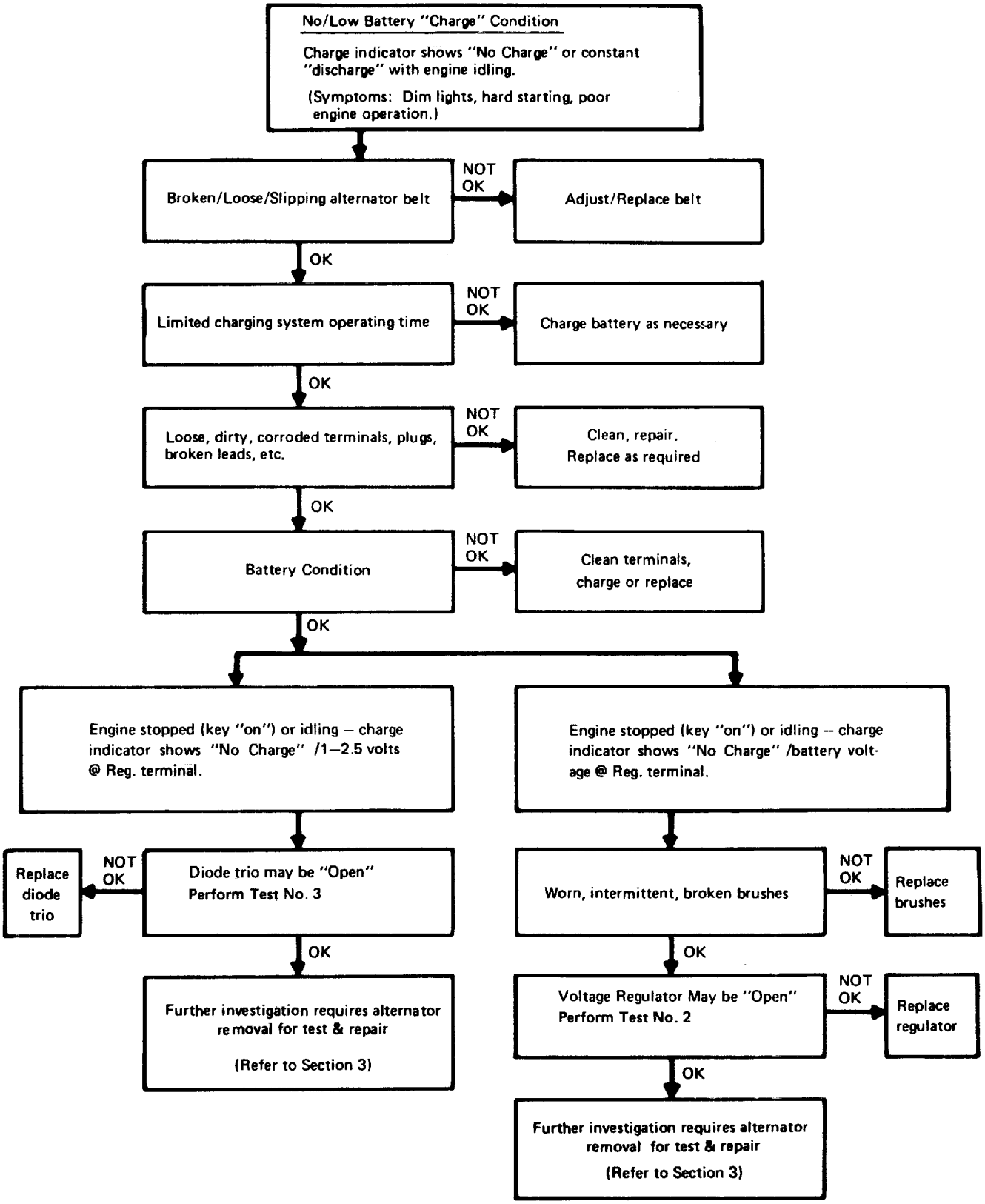


NOTE: SOME MR ALTERNATORS ARE EQUIPPED WITH A DUST SCREEN WHICH MUST BE REMOVED TO EXPOSE TERMINALS FOR TESTS.

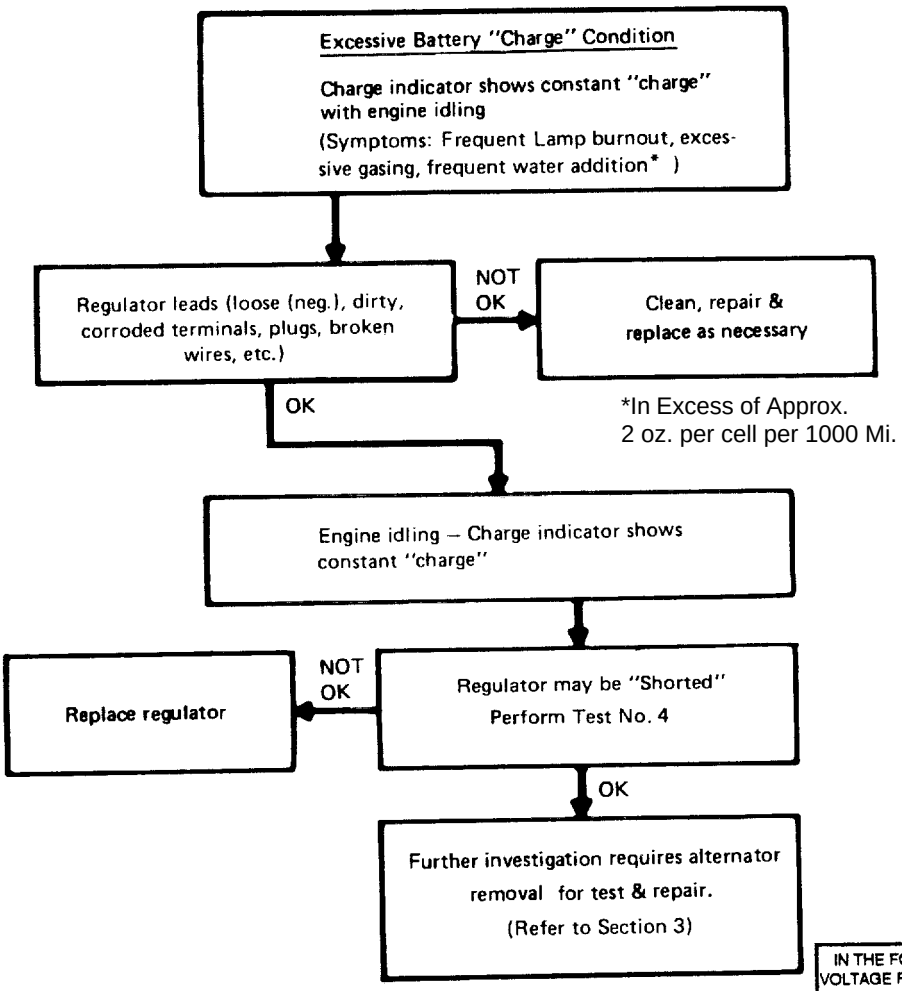
FIG. 2-40 **TYPICAL TERMINAL/WIRING DETAILS FOR 12/24 VOLT HC/MR ALTERNATORS WITH DIODE TRIOS**

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CHARGING SYSTEM DIAGNOSTIC CHART NO. 1



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TEST NO. 1 - ALTERNATOR/REGULATOR DEFECT ISOLATION TEST. CONDITIONS: REFER TO TEXT.

This test will determine whether the alternator or regulator is the cause of the charging system failure.

A. Connect a DC voltmeter to the alternator as shown in Figure 2-41. Also, turn off all accessories such as heater tan, lights, radio, etc.

B. Connect an Insulated jumper wire (JU1) from the regulator TP to Black lead (minus) terminal on alternator. Measure and note initial output voltage with engine off.

C. Start and run engine at a speed equivalent to approximately 2000 alternator RPM. If the output voltage Increases over the initial value noted in Step B, the alternator is probably good and the regulator defective (perform Alternator Excitation Voltage Test). If output voltage does not increase over initial voltage value, the alternator is probably defective and requires service. CAUTION: Limit time duration of charging test (Step C) to about one minute as relatively high voltages can quickly develop with consequent harm to the system.

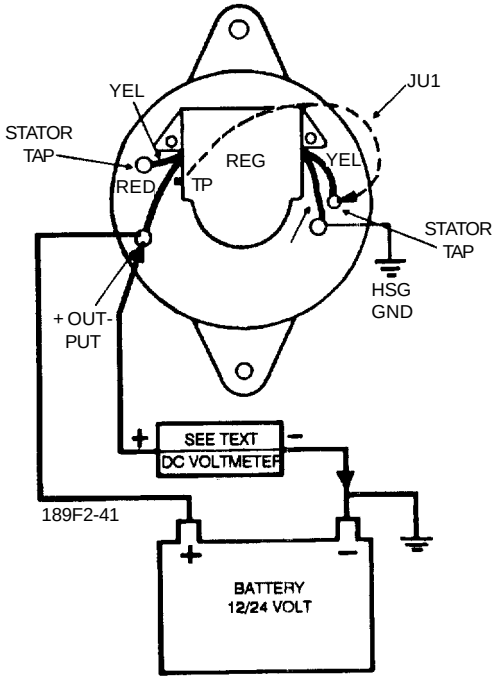


FIG. 2-41 ALTERNATOR/REGULATOR DEFECT ISOLATION TEST

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TEST NO. 2 - ALTERNATOR EXCITATION VOLTAGE TEST. CONDITIONS: ENGINE RUNNING AT A SPEED EQUIVALENT TO 2000 ALTERNATOR RPM.

This test will determine if the excitation circuit within the alternator is functioning properly.

A. Connect an AC voltmeter across the two stator (phase) tap terminals as shown in Figure 2-42.

B. If voltmeter indicates 0.50-1.50 volts for a no-charge condition, the alternator is probably good and the regulator may be defective (regulator check is indicated). Typically, a voltmeter should read 11-13 volts or 27-29 volts for a properly operating alternator.

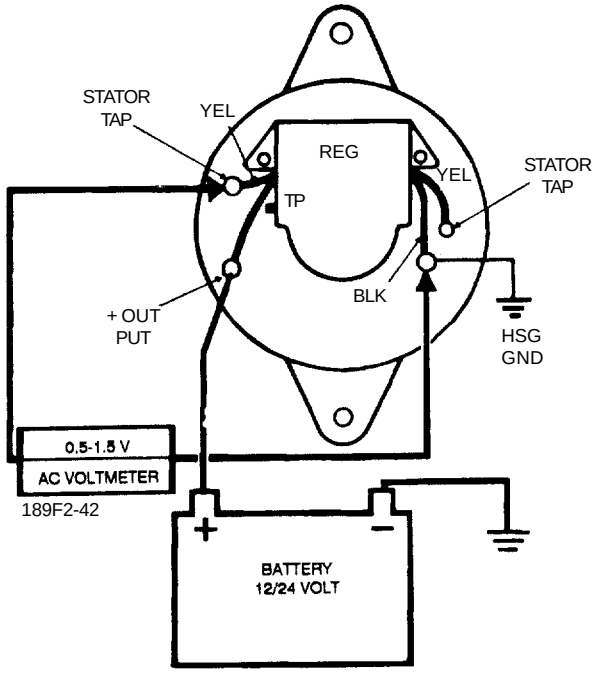


FIG. 2-42 ALTERNATOR EXCITATION VOLTAGE TEST

TEST NO. 3 - SHORTED RECTIFIER DIODE TEST. CONDITIONS: ENGINE NOT RUNNING.

Connect voltmeter as shown in Figure 2-43. Note battery voltage at Alternator Positive Output terminal. Place positive voltmeter lead on either stator terminal. Correct voltmeter reading is Zero volts.

The alternator must be removed from the engine for repair if a rectifier diode is shorted. Disconnect grounded battery cable prior to removing alternator. Refer to the alternator overhaul section of this manual for diode replacement procedure.

TEST NO. 4 - FIELD CIRCUIT TEST. CONDITIONS: ENGINE NOT RUNNING. REMOVE REGULATOR LEAD FROM F1 TERMINAL.

Dismount regulator and disconnect green regulator lead at alternator F1 (FLD) terminal. Also, connect a jumper lead (JU1) from alternator F2 terminal to regulator blk lead connection (minus). Place test ammeter in low circuit, 1 to 10 amperes. Set control knob of field rheostat in maximum position and connect in series as shown in

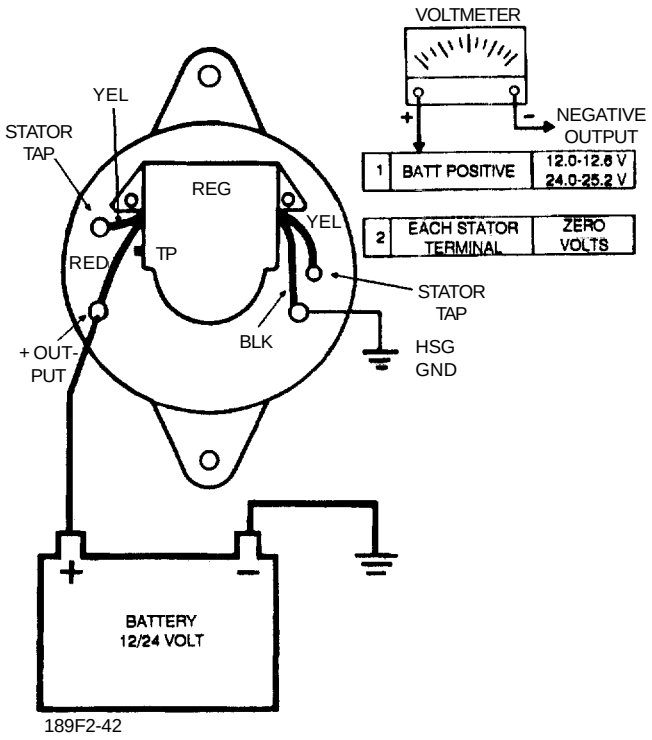


FIG. 2-43 SHORTED RECTIFIER DIODE TEST

Figure 2-44. The rheostat will protect the ammeter from damage if the field circuit is shorted.

Slowly reduce rheostat resistance, noting rise in ammeter reading. Stop test if meter indicates more then 3.0 amps for a 12 volt, 51 amp unit or 5.5 amps for a 12 volt, 90 amp unit or 2.0 amps for a 24 volt, 35 amp unit. Alternator disassembly may be necessary to correct condition.

If entire rheostat resistance can be eliminated with test animeter below listed readings, the indicated current is the field current draw. If the test ammeter fluctuates when the rotor is moved slightly, the brushes and silp rings require cleaning.

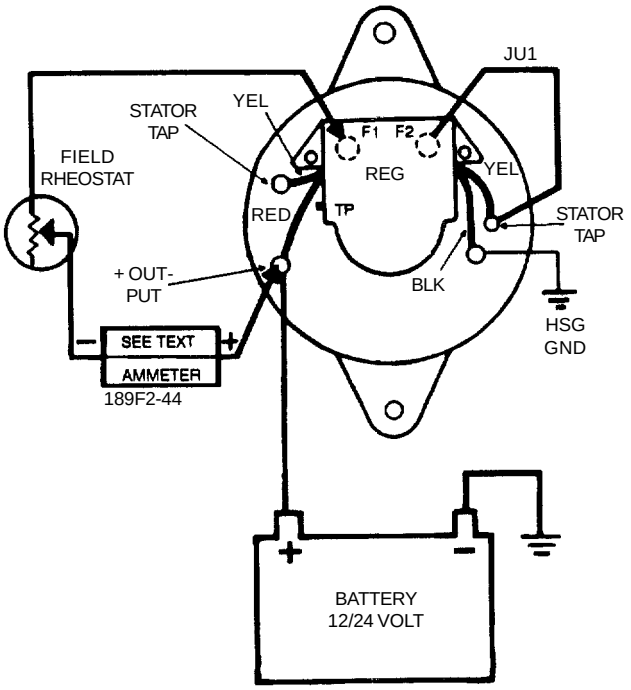


FIG. 2-44 FIELD CURRENT TEST

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TEST NO. 5 - VOLTAGE REGULATOR SETTING. CONDITIONS: ENGINE RUNNING AT FAST IDLE, AFTER THE RESISTOR AND THE TEST AMMETER ARE CONNECTED TO THE SYSTEM.

This test will indicate the level of alternator charging voltage, controlled by the voltage regulator.

A 1/4 ohm resistor is placed in series with the test ammeter, then applied to the circuit as shown in Figure 2-45. The resistor will reduce charging system voltage to less than 10 amperes, thus allowing charging voltage to rise to the regulator controlled maximum.

If test result indicates a lower voltage, it may be due to a defective voltage regulator.

High voltage may be due to a high resistance regulator ground circuit (black lead) or to a defective voltage regulator. Make necessary repairs or replace regulator.

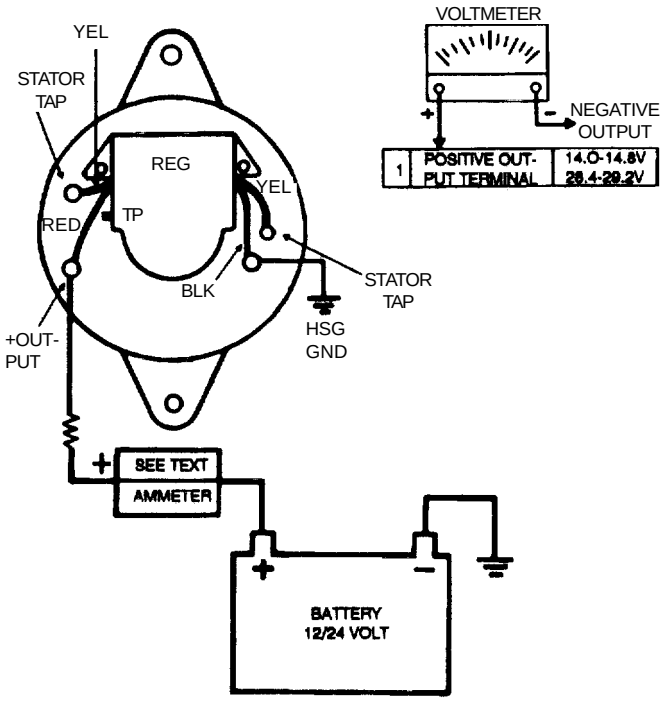


FIG. 2-45 VOLTAGE REGULATOR SETTING TEST

TEST NO. 6 - ALTERNATOR OUTPUT AND SYSTEM TEST. CONDITIONS: ENGINE RUNNING.

This test requires the test ammeter to be switched to the 0-100 ampere scale, and placed in series with the alternator positive output terminal and battery positive terminal, as shown in Figure 2-46. Place load control knob of carbon pile to the “off” position before connecting load leads to the battery terminals. Connect voltmeter as shown in Figure 2-46.

Start engine, run a few minutes at fast idle to stabilize component temperature. Set engine throttle to provide 3000 to 5000 alternator RPM. Apply carbon pile load to induce highest alternator current output. Note voltage at this point. See table below for the minimum acceptabe (hot) output amperage and voltage.

MINIMUM ACCEPTABLE OUTPUT		
ALTERNATOR	AMPERAGE	VOLTAGE
12V, 51 Amp	43-46 Amps	13.0-15.0 Volts
12V, 90 Amp	79-82 Amps	13.0-15.0 Volts
24V, 36 Amp	30amps	26.0-29.5 Volts

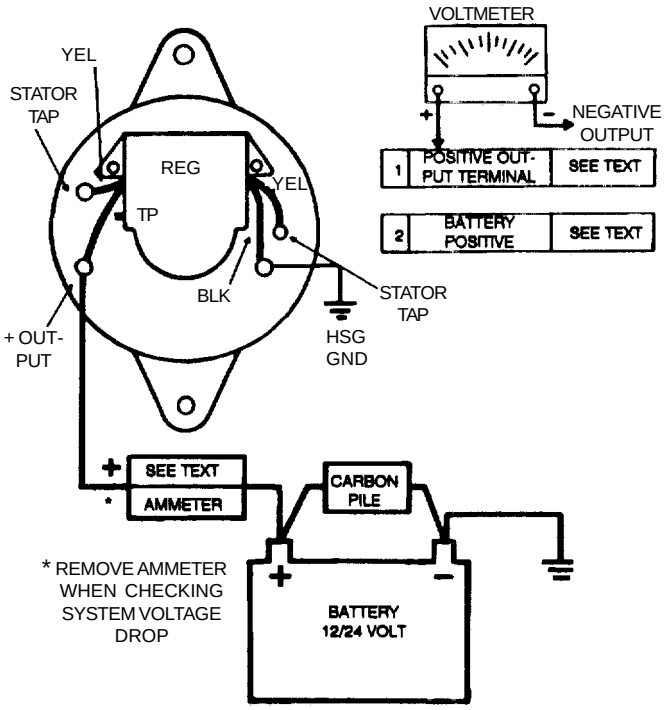


FIG. 2-46 ALTERNATOR OUTPUT AND SYSTEM TEST

If the alternator can not provide the required output, it should be removed from the engine for over haul service Reduce carbon pile load on battery immediately after testing to avoid discharging battery.

System voltage drop, between the afternator and the battery is tested with the alternator producing 10 amperes. The maximum allowable voltage drop, between alternator and battery is .3 (three-tenths) volt.

Excess voltage loss may require cleaning and tightening of all circuit connections or the use of heavier gauge output cables between the alternator and battery.

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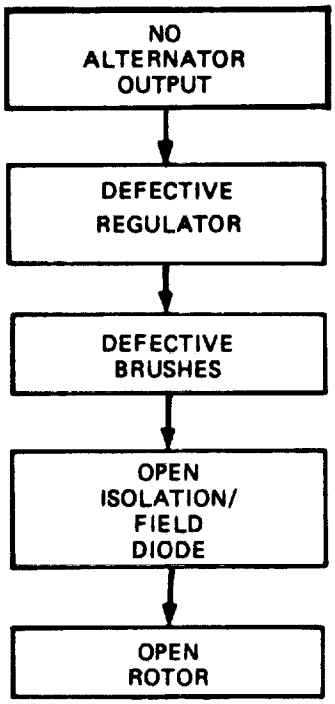
GENERAL

The following instructions are presented as a general overall procedure for complete dissassembly of an alternator. In cases where the causes of the malfunction are known, it is only necessary to follow that portion of the procedure directly related to resolving the problem.

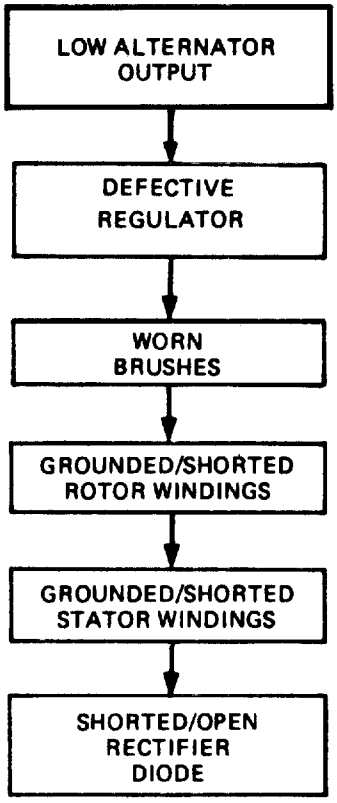
Similarly, when the reasons for the malfunction are uncertain, it will be necessary to follow the procedure in greater depth in order to isolate and correct the problem in a systematic and efficient manner.

In addition, referring to the following troubleshooting diagrams should help identify some of the more common problems to concentrate on during the overhaul/repair procedure.

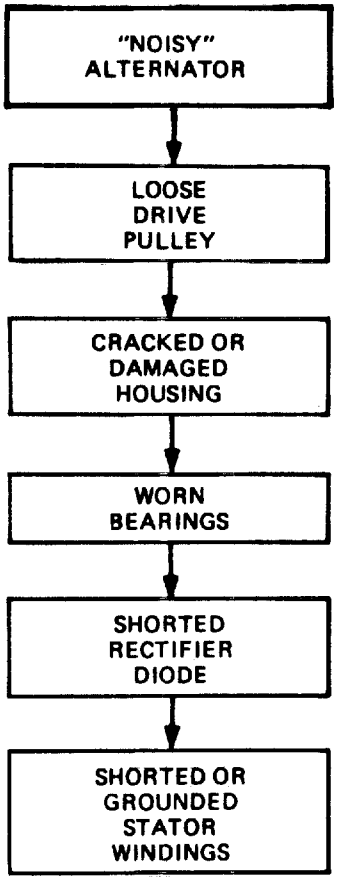
ALTERNATOR TROUBLESHOOTING DIAGRAM NO. 1 (NO OUTPUT)



ALTERNATOR TROUBLESHOOTING DIAGRAM NO. 2 (LOW OUTPUT)



ALTERNATOR TROUBLESHOOTING DIAGRAM NO. 3 (NOISY)



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DISASSEMBLY

REMOVE BRUSH COVER (MA & MH MODELS)

See Figure No. 3-1

Mount the alternator in a vise, with the rear housing facing you.

Remove hex head mounting screws. Hold cover away from the rear housing, remove brush assembly mounting screws. If the brush assembly mounting screws fastened the insulator for the brush shunt leads, lift the insulator and brush set out of the cavity as an assembly.

REMOVE VOLTAGE REGULATOR (MR MODELS)

See Figure No. 3-2

Remove regulator leads from Auxiliary and Ground (Negative Output) terminals. Remove regulator mounting screws. Hold regulator away from rear housing, remove brush assembly attaching screws. Lift brush set and insulator out of cavity, as indicated above.

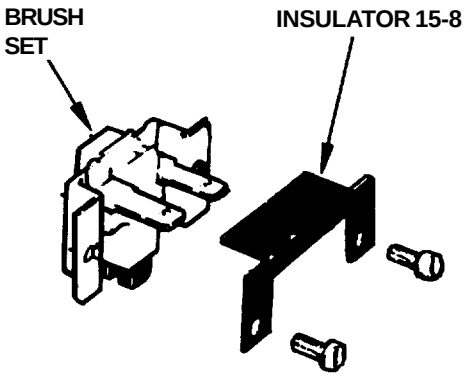


FIG. 3-1 BRUSH LEAD INSULATOR

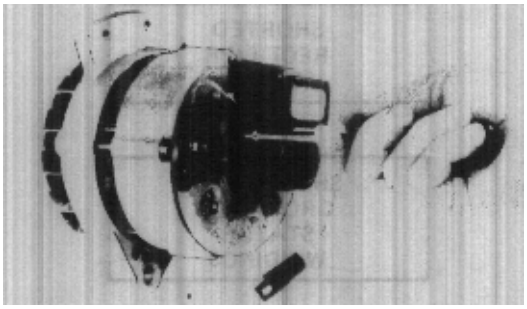
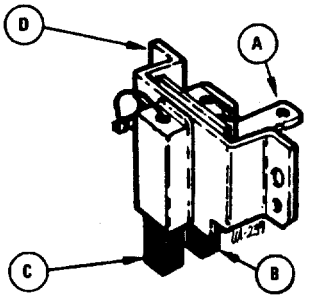


FIG. 3-2 VOLTAGE REGULATOR REMOVAL

BRUSH TESTING AND INSPECTION

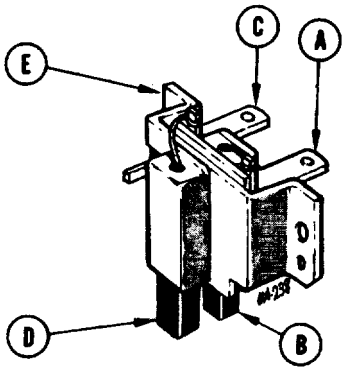
Figure No. 3-3 shows terminal arrangement and testing procedure for single terminal brush assemblies, Figure No. 3-4 shows dual terminal arrangement and testing procedure. Brush material is copper graphite.



TEST WITH 12 VOLT DC TEST LAMP OR OHMMETER SHOULDSHOW:

CONTINUITY	FROM A TO B
CONTINUITY	FROM C TO D
NO CIRCUIT	FROM A TO C OR D

FIG. 3-3 SINGLE TERMINAL BRUSH TEST



TEST WITH 12 VOLT DC TEST LAMP OR OHMMETER SHOULD SHOW:

CONTINUITY	FROM A TO B
CONTINUITY	FROM C TO D
NO CIRCUIT	FROM E TO A OR C

FIG. 3-4 DUAL TERMINAL BRUSH TEST

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The original brush set may be reused if the brushes are 3/16" or longer, and if brushes are not oil soaked or cracked. Compare spring tension to a new set, Figure No. 3-5.

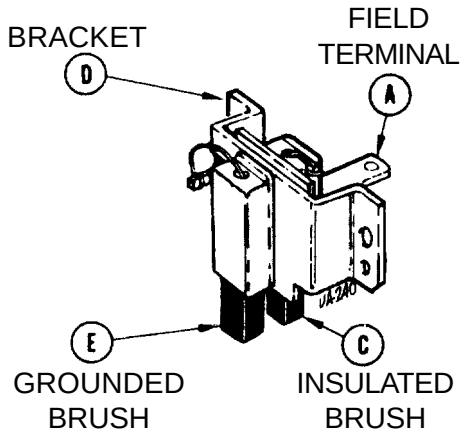


FIG. 3-5 BRUSH SET INSPECTION

REMOVE ISOLATION DIODE (IF USED IN ASSEMBLY)

Remove hex-nuts and insulators fastening the isolation diode assembly to the rectifier diode terminal studs, see Figure No. 3-6. Insulating washers and sleeve may be reused if in good condition.

Test the isolation diode to determine if the diode will pass direct current voltage and current in only one direction while rejecting the opposite polarity. A 12 volt D.C. Test Lamp or an ohmmeter may be used for this test. Do not use an A.C. test lamp.

Blue painted isolation diodes, used in 12 and 24 to 32 volt systems, should test alike. Positive potential should pass from the bare metal input area through the heat sink and diode(s), to the output stud, as shown in Figure No. 3-7.

Reverse test leads and retest as shown in Figure No. 3-8, the test lamp should not light.

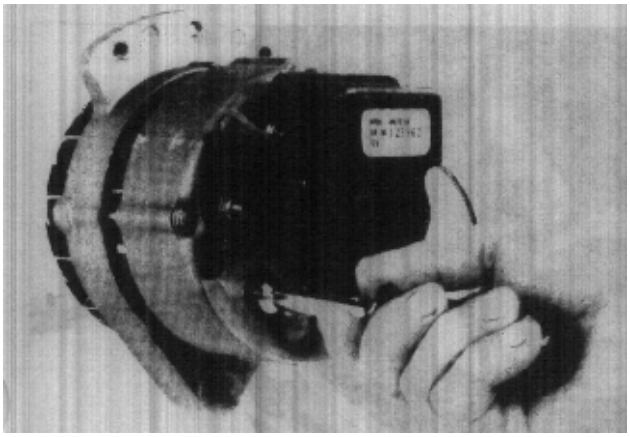


FIG. 3-6 ISOLATION DIODE REMOVAL

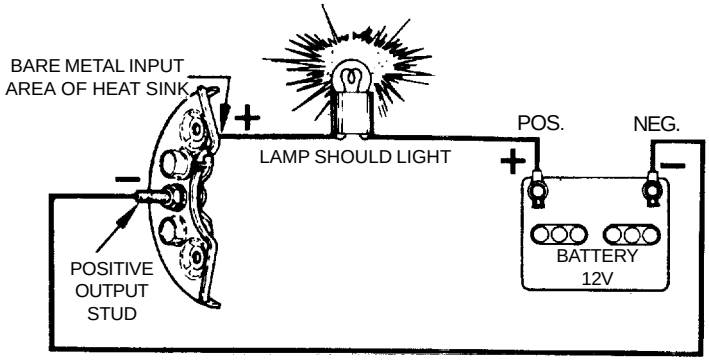


FIG. 3-7 ISOLATION DIODE TEST - BLUE

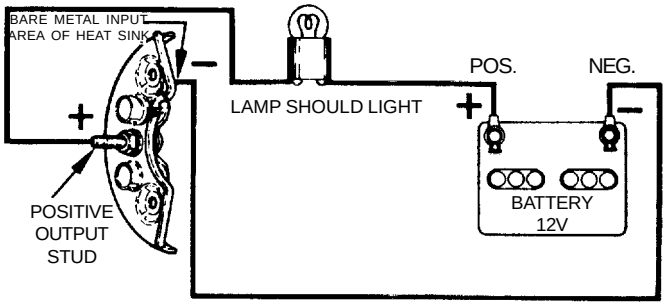


FIG. 3-8 ISOLATION DIODE TEST - BLUE

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Positive Ground MA units use a black isolation diode. Figure No. 3-9 is the foreward bias test that should light test lamp.

Figure No. 3-10 is the reverse bias test, the test lamp should not light.

If test lamp lights regardless of how test leads are switched the isolation diode is shorted. If test lamp fails to light regardless of test lead switching, the isolation diode is open. Replace diode if necessary.

Some manufacturers may paint the alternator to match their engine color, concealing the identifying color of the isolation diode. Check ground polarity and system voltage information on alternator name plate to insure correct test procedures are followed.

Do not soak the isolation diode in any solvent that could remove the protective, corrosion resistant paint.

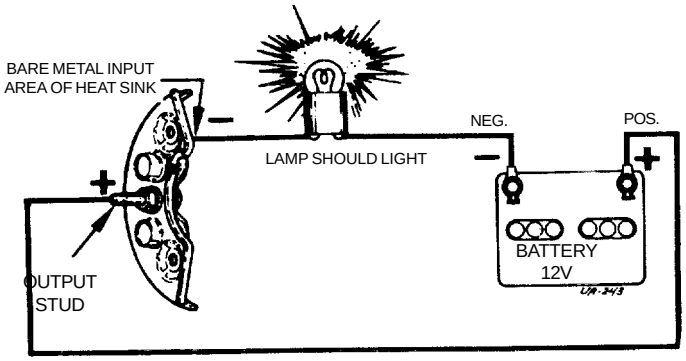


FIG.3-9 ISOLATION DIODE TEST - BLACK (12 VOLT)

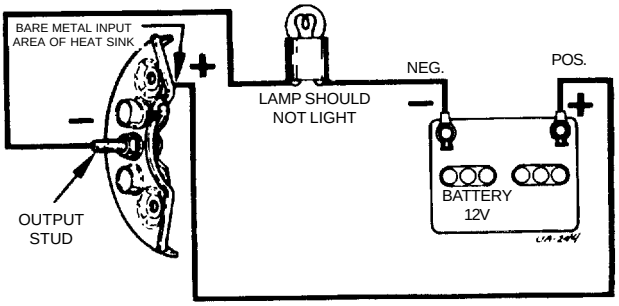


FIG. 3-10 ISOLATION DIODE TEST - BLACK (12 VOLT)

REMOVE THRU-BOLTS

See Figure No. 3-11, remove four thru-bolts, some models will use square nuts with the thru-bolts, others will use threaded holes in the front housing.

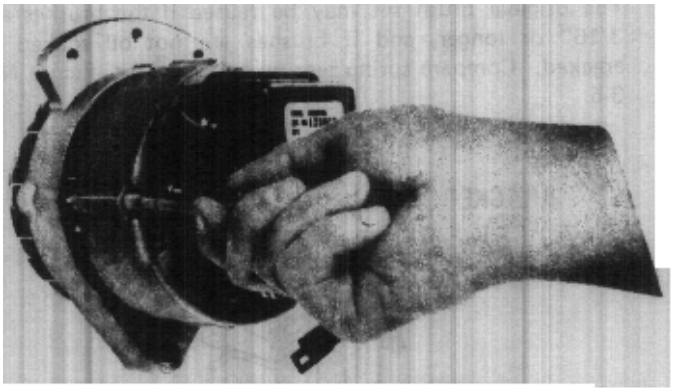


FIG. 3-11 THRU-BOLT REMOVAL

SEPARATE STATOR - REAR HOUSING FROM FRONT HOUSING

Carefully insert two screwdriver blades in opposite openings between the stator and front housing, as shown in Figure No. 3-12, pry units apart. Do not allow screwdriver blades to touch stator winding, Figure No. 3-13, shows the relationship between the current carrying windings and the stator lamination.

At this time, the rear housing and stator are one assembly, the front housing and rotor are another assembly. Continue with disassembly of the stator and rear housing.

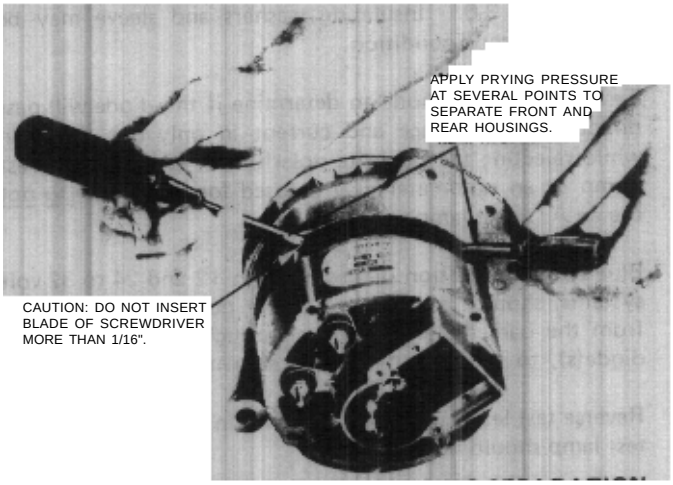


FIG. 3-12 STATOR-REAR HOUSING SEPARATION

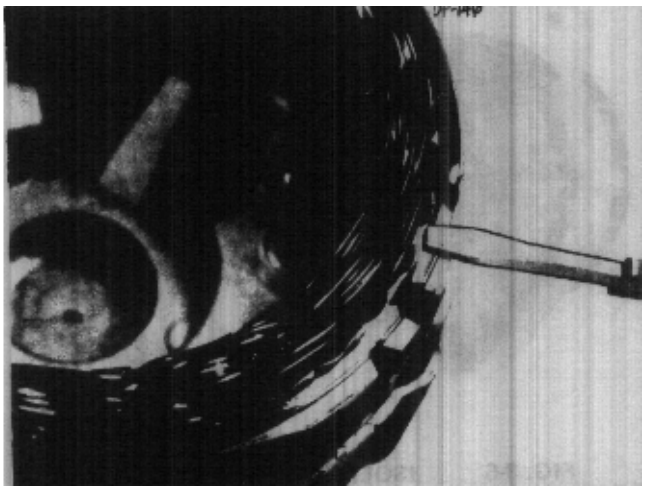


FIG. 3-13 STATOR WINDING TOOL CLEARANCE

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REMOVE REAR HOUSING

Place the open end of the stator on a clean work surface, free of metal chips that could damage the stator windings. Remove all hex-nuts and insulators from the diode terminal studs, Figure No. 3-14.

If alternator provides a “AC Terminal”, for operating a **Prestollte** Alternator Tachometer, lift the AC lead off the diode stud, as shown in Figure No. 3-15.

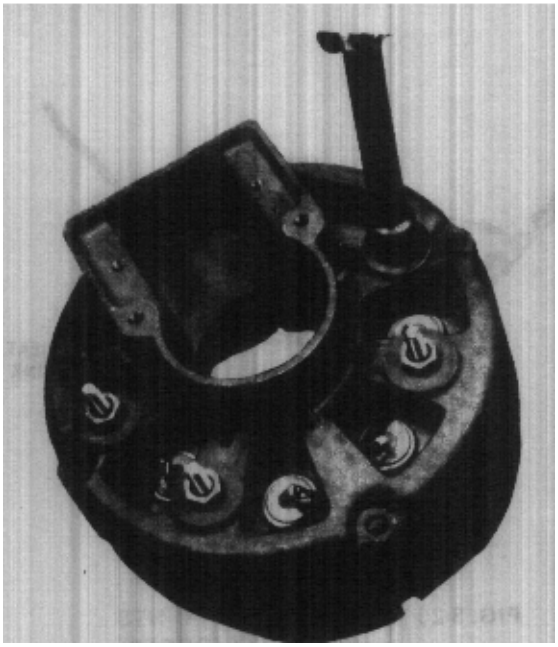


FIG. 3-14 LOCKNUT REMOVAL

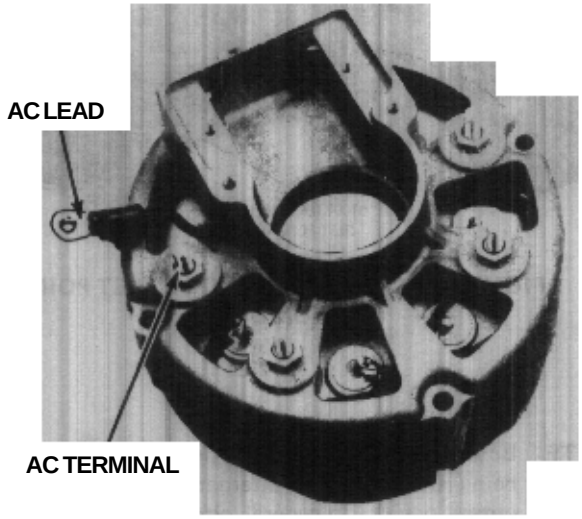


FIG. 3-15 A.C. LEAD REMOVAL

SEPARATE REAR HOUSING FROM RECTIFIER DIODE TERMINALS

Carefully and evenly, tap the rectifier diode terminal studs out of the rear housing, as shown in Figure No. 3-16. Lift rear housing off the studs. Remove any insulating sleeves remaining in terminal stud holes.

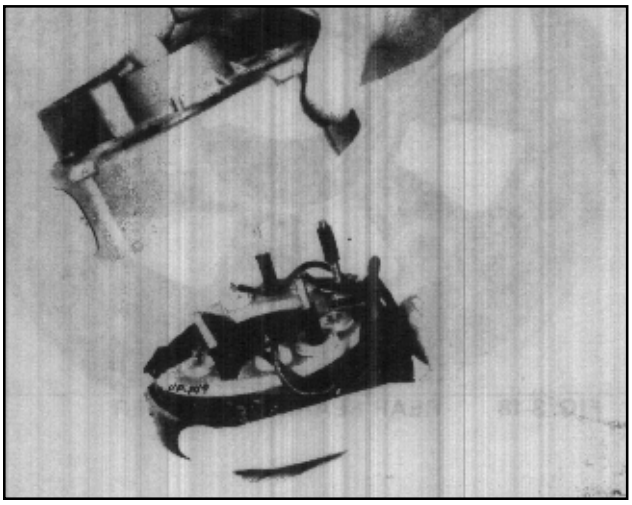


FIG. 3-16 RECITIFIER DIODE TERMINAL SEPARATION

INSPECTION OF REAR HOUSING

Inspect the rear housing for a cracked or broken casting, stripped threads or evidence of severe wear in the bearing bore due to a worn rear bearing, as shown in Figure No. 3-17.

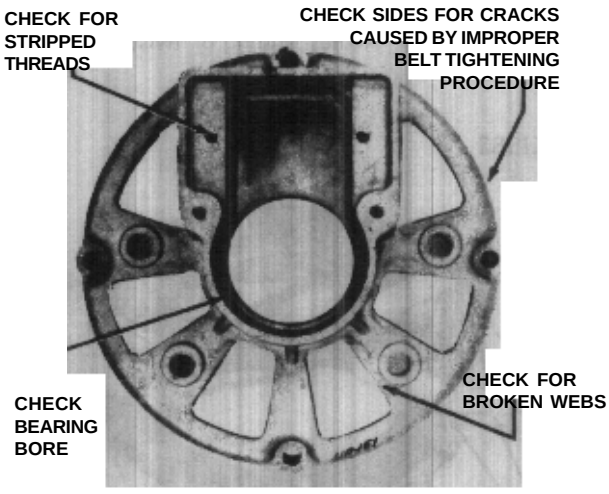


FIG. 3-17 REAR HOUSING INSPECTION

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If casting is to be reused, clean in solvent, dry with compressed air, and install a new rear bearing retainer, as shown in Figure 3-18. If the casting uses a cemented brush shunt lead insulator, make certain it is properly installed.

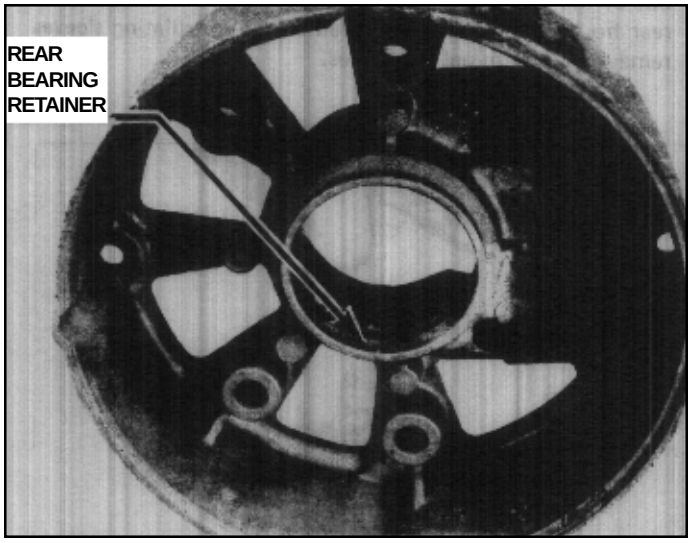


FIG. 3-18 REAR BEARING RETAINER

DISCONNECT RECTIFIER DIODES FROM STATOR

It is necessary to unsolder the stator leads from the rectifier diode terminals, in order to properly test each diode.

However, some leads are crimped and cannot be unsoldered. On the 90 amp MR machine, it is recommended to use a commercial diode tester that can test the diodes without lead removal.

Figure No. 3-19 shows a heat dam in place between the top of the diode and diode body, in order to protect the diode from damage in removing and replacing the stator leads. Allow solder joint to cool for a few seconds before removing heat dam. Avoid bending or twisting diode terminal.

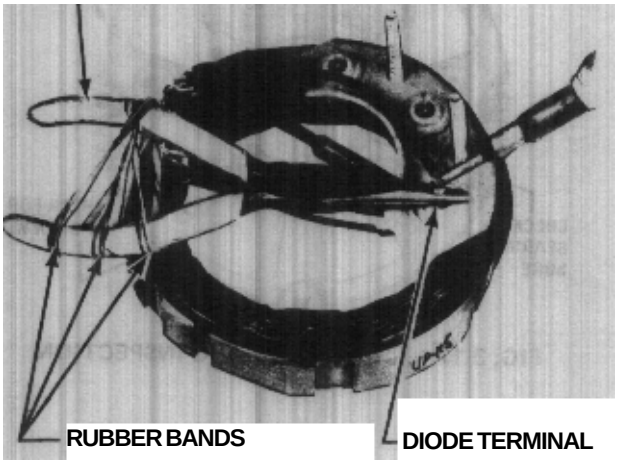


FIG. 3-19 UNSOLDERING RECTIFIER DIODES

TESTING RECTIFIER DIODES

On diode trio models, disconnect trio leads to simplify the test procedures.

If a commercial diode tester is available, test the diodes according to the equipment manufacturer's instructions. Test points are shown in Figures No. 3-20 and 3-21.

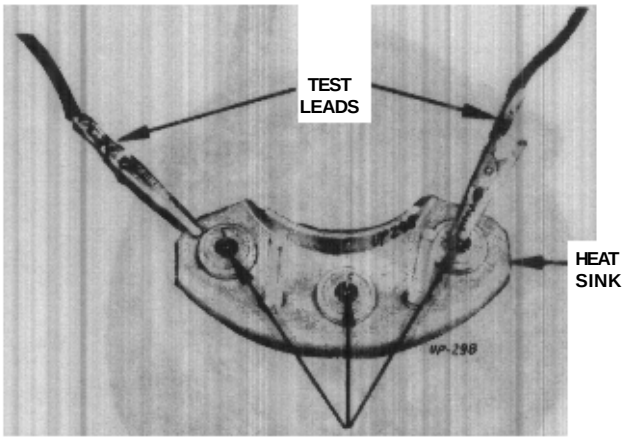


FIG. 3-20 DIODE TEST POINTS (PRESS FIT DIODES)

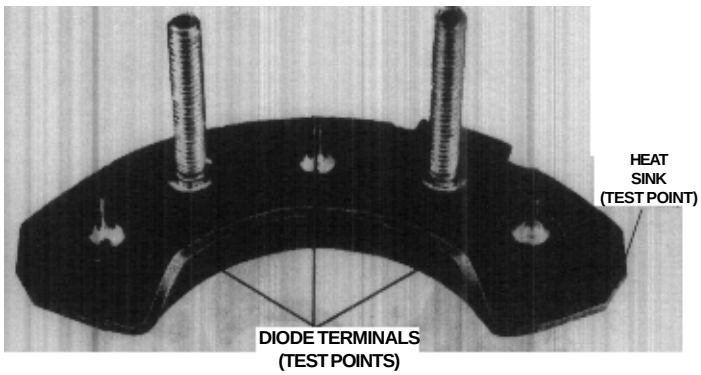


FIG. 3-21 RECTIFIER DIODE TEST POINTS (BUTTON DIODES)

NOTE: Both press-fit and button type diodes are currently being used in these alternators depending upon output power. In general, alternators with outputs of 62 amperes or more use press-fit diodes in the rectifier diode assembly. Other units with lower outputs use button type diodes.

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When using a 12v. D.C. test lamp or ohmmeter, the same test points are used. All diodes in the positive heat sink, where the part number is printed in RED, should test as indicated in Figures No. 3-22 and 3-24.

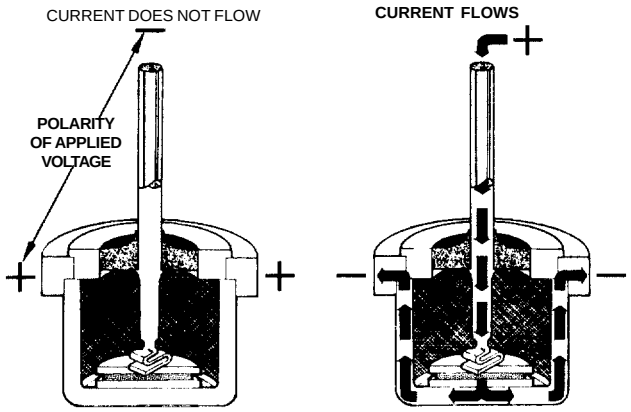


FIG. 3-22 POSITIVE DIODE TESTING (PRESS FIT DIODE)

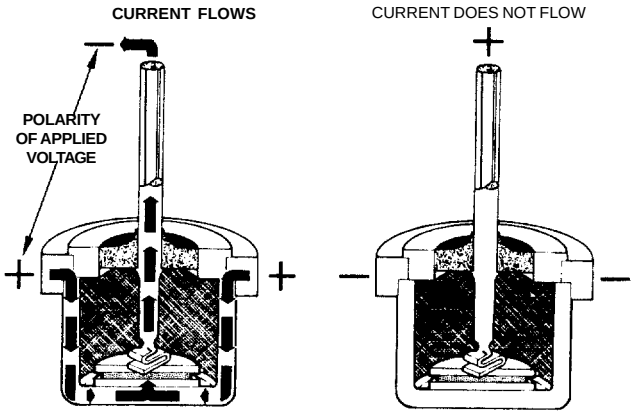


FIG. 3-23 NEGATIVE DIODE TESTING (PRESS FIT DIODE)

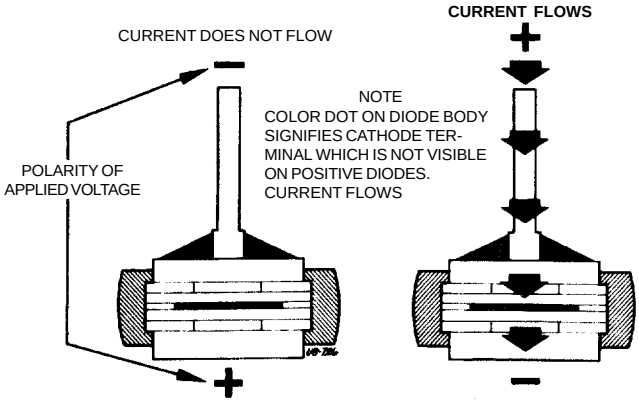


FIG. 3-24 POSITIVE DIODE TESTS (BUTTON DIODE)

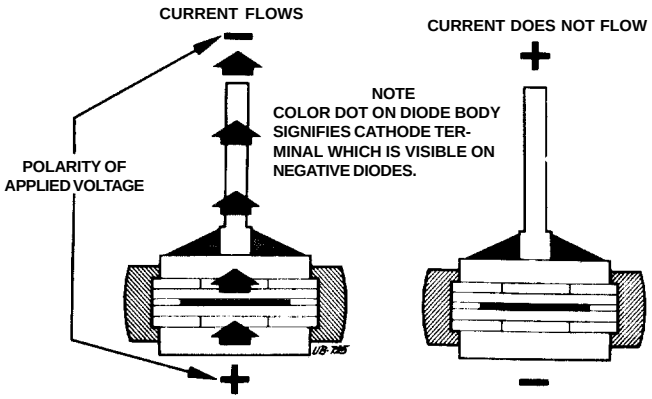


FIG. 3-25 NEGATIVE DIODE TESTS (BUTTON DIODE)

Figures No. 3-23 and 3-25, show testing of the negative rectifier diode assembly, where the part number is printed in BLACK.

Replace the complete rectifying diode assembly if any diode in the assembly is open or shorted. See Page 67 for replacing a rectifier diode assembly that has stator leads crimped to rectifier diode terminals.

NOTE: Do not connect test lead to the terminal studs, they may be loose. Loose studs are secured to the heat sink when the diode assembly is assembled to the rear housing.

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REMOVE AND TEST DIODE TRIO ASSEMBLY (DIODE TRIO MODELS)

Remove hex nut and washer securing the diode trio assembly to the ungrounded rectifier diode heat sink, Figure 3-26. Unsolder the three leads at the rectifier diode terminals to free or test the field diode assembly. Use heat dams to protect the rectifier diodes in all soldering operations.

Using a commercial diode tester or 12 volt DC test lamp; check for continuity from each lead separately to the center metal contact stud; continuity should be observed in one direction (polarity) only, and all diodes should check alike, Figure 3-27. If any diode is defective replace the entire diode trio assembly; refer to Figure 3-28 for component layout details.

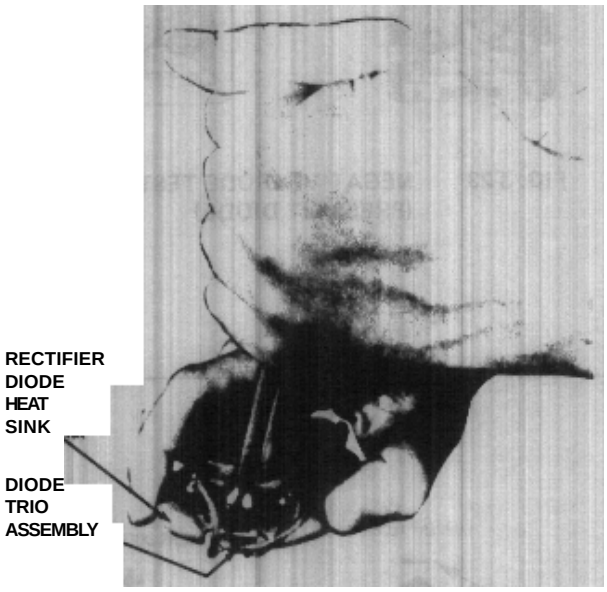


FIG. 3-26 **REMOVING DIODE TRIO ASSEMBLY (DIODE TRIO MODELS)**

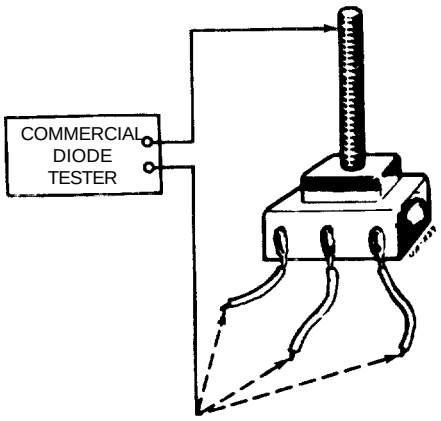


FIG. 3-27 **DIODE TRIO TESTS (DIODE TRIO MODELS)**

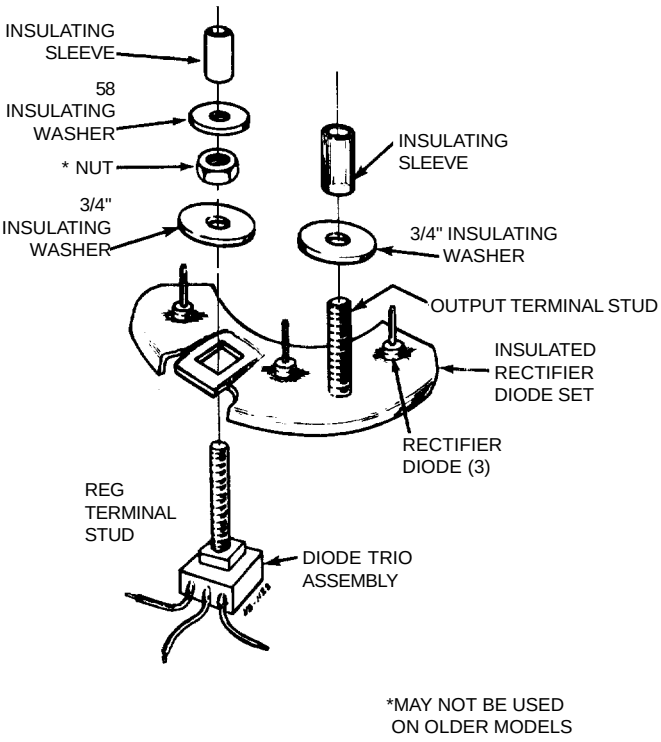


FIG. 3-28 **DIODE TRIO ASSEMBLY DETAIL (DIODE TRIO MODELS)**

STATOR TESTING

The alternator stator assembly consists of three individual windings, wound on a common metal core or lamination. The lamination is epoxy coated to provide durable insulation, Figure No. 3-29.

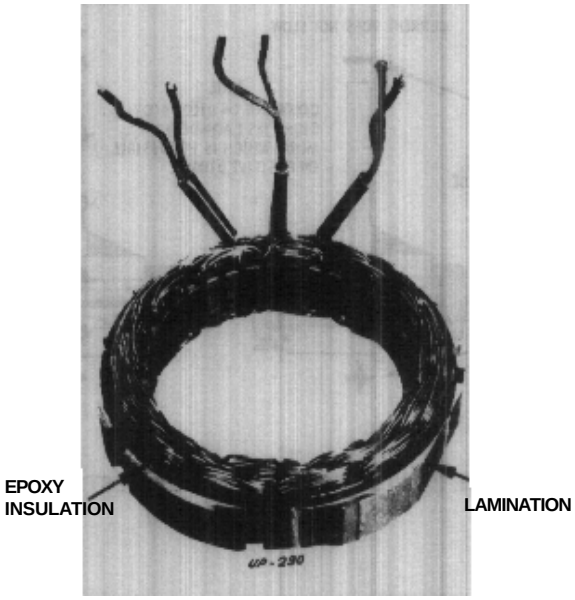


FIG. 3-29 **STATOR ASSEMBLY**

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The usual reference to stators concerns the method of terminating the ends of the three windings. They may be connected in a Wye or a Delta circuit, as shown in Figure No. 3-30.

Discoloration of the winding insulating enamel is evidence of an overheated stator that may result in shorted or grounded windings. Testing the stator with a 110v A.C. Test Lamp, Figure No. 3-31, may be a primary or a specific test.

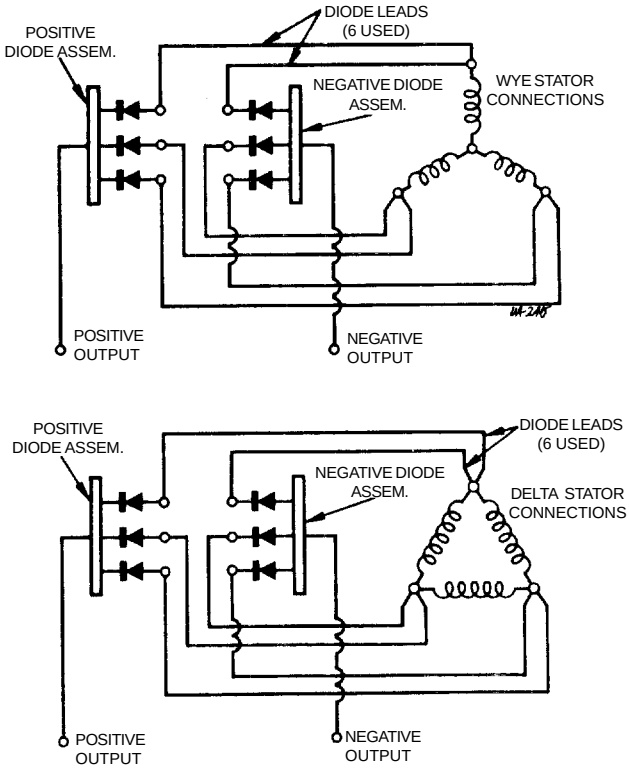


FIG. 3-30 STATOR WINDINGS & CONNECTIONS

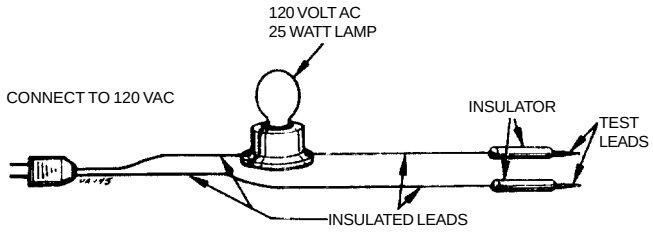


FIG. 3-31 STATOR TEST CIRCUIT

With diodes separated from leads, but all connecting leads intact, test between each junction, and from each junction to the lamination, as shown in Figure No. 3-32. Replace the stator if test indicates open or grounded winding.

Specific testing requires unsoldering the diode connecting leads from each junction. The common terminal an Wye type windings must be unsoldered and wire ends separated.

Figure No. 3-33 shows the three circuits of a Wye wound stator. Figure No. 3-34 shows a Delta wound stator.

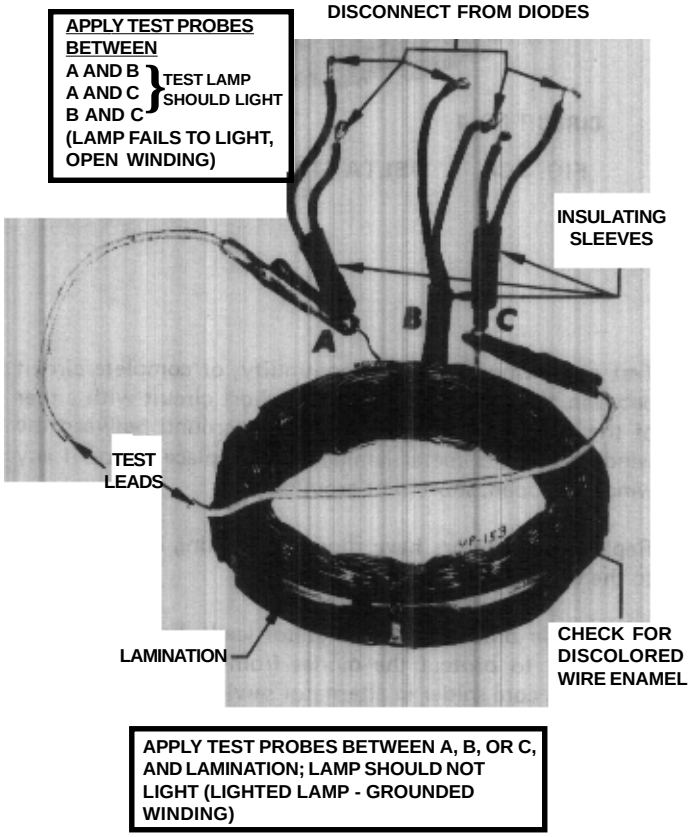


FIG. 3-32 STATOR TEST

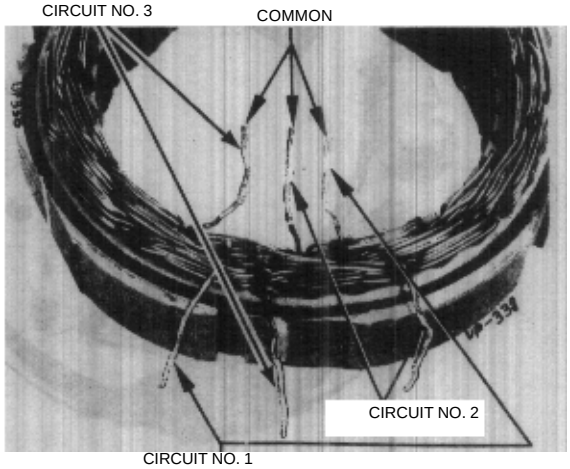


FIG. 3-33 WYE STATOR TEST POINTS

https://truckmanualshub.com/

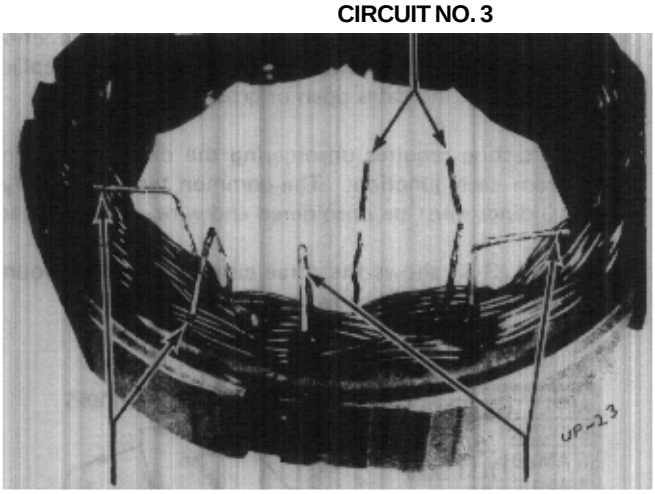


FIG. 3-34 DELTA STATOR TEST POINTS

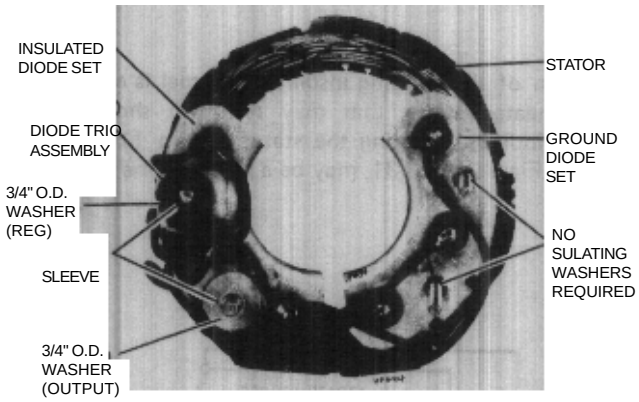


FIG. 3-36 DIODE TRIO AND RECTIFIER DIODES ASSEMBLED TO STATOR (DIODE TRIO MODELS)

Test each winding for, (1) continuity, or complete circuit between the wire ends, (2) for a short circuit with either of the other windings, and (3) for a ground between the winding and the metal lamination. Replace stator if any winding is open, shorted or grounded.

Replacement stators have diode connecting leads soldered to the windings.

Reassemble diode sets to the stator leads, be sure to use a heat dam to protect the diodes from heat damage. Use only rosin core solder in alternator service. If the alternator provides an A.C. Terminal for **Prestollte** Alternator Tachometer, solder this lead to the proper diode terminal, Figure No. 3-35.

Figure No. 3-36 shows the diode trio and rectifier diodes assembled to the stator as used in diode trio equipped model alternators.

REMOVE PULLEY, FAN AND SPACER

The pulley is a slip-fit on the rotor shaft, positioned with a Woodruff Key. To remove the nut and lockwasher from the shaft, clamp the pulley in a vise using an old over-size belt to protect the pulley from the vise jaws, as shown in Figure No. 3-37. An impact wrench may also be used if available.

After nut and lockwasher are removed the alternator may be separated from the pulley. Stubborn cases may require the use of special service tools.

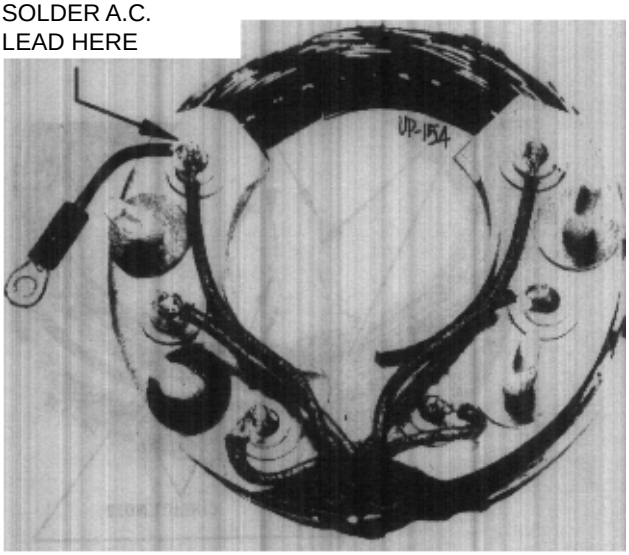


FIG. 3-35 A.C. LEAD PLACEMENT

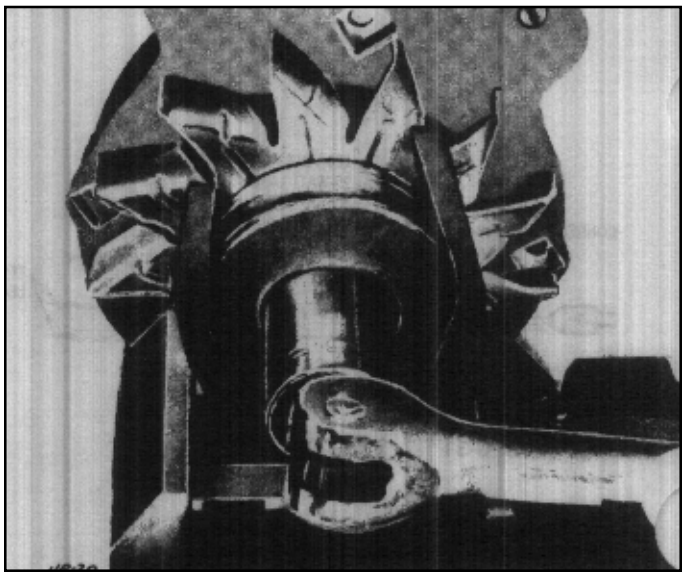


FIG. 3-37 PULLEY REMOVAL

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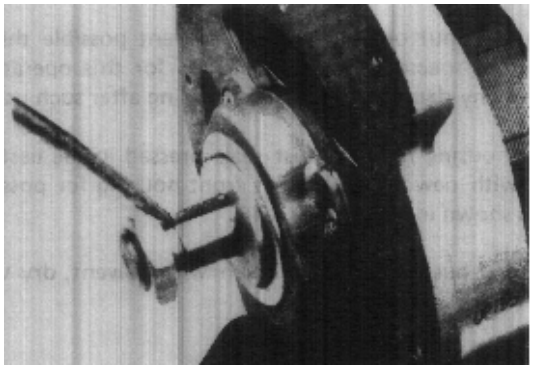


FIG. 3-38 WOODRUFF KEY REMOVAL

The fan will slide over the key. The key may be removed with diagonal pliers, or with a screwdriver as shown in Figure No. 3-38.

Figure No. 3-39 shows the fans used with the MA, MH and MR series alternators. U.L. listed alternators require a steel guard, No. 7 to be used in front of the fan.

Inspect the fan for cracked or broken fins, note the condition of the mounting hole. If worn from running loose replace the fan to insure balance, Figure No. 3-40.

Inspect pulley for possible faults as listed in Figure No. 3-41.

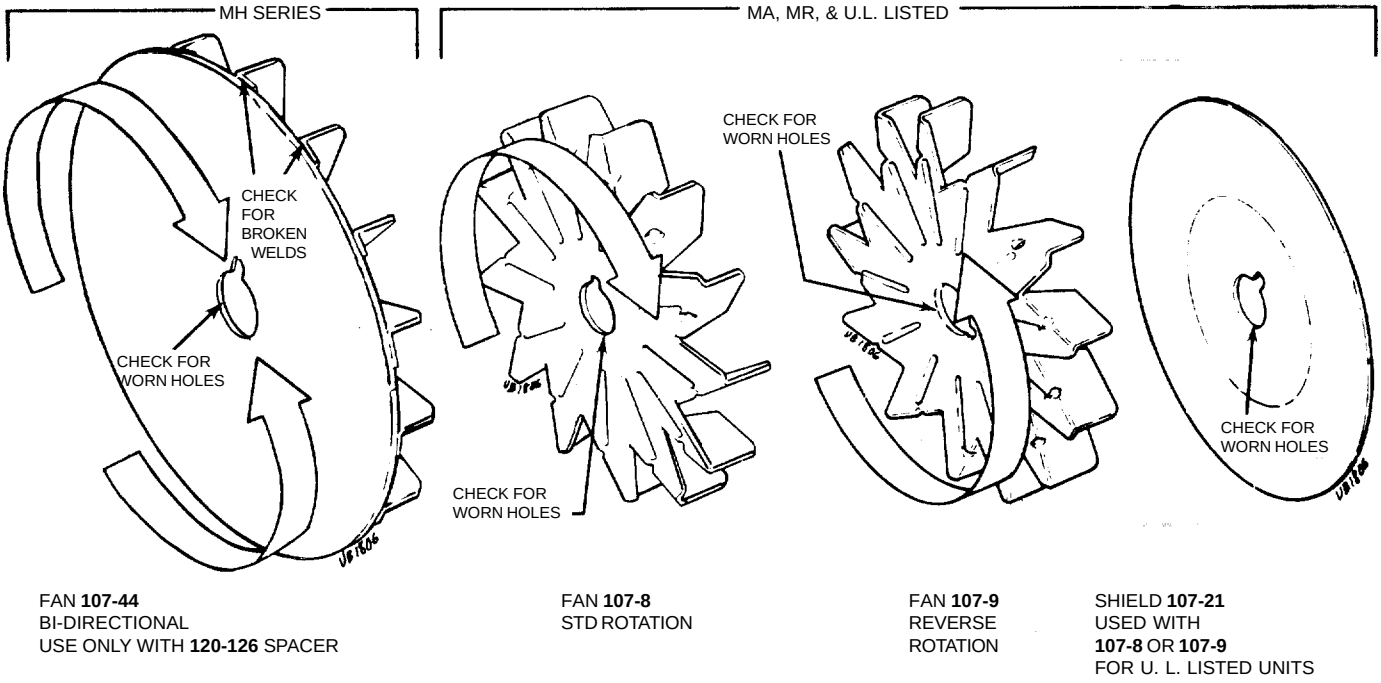


FIG. 3-39 FANS USED WITH MA, MH, MR & U.L. LISTED ALTERNATORS

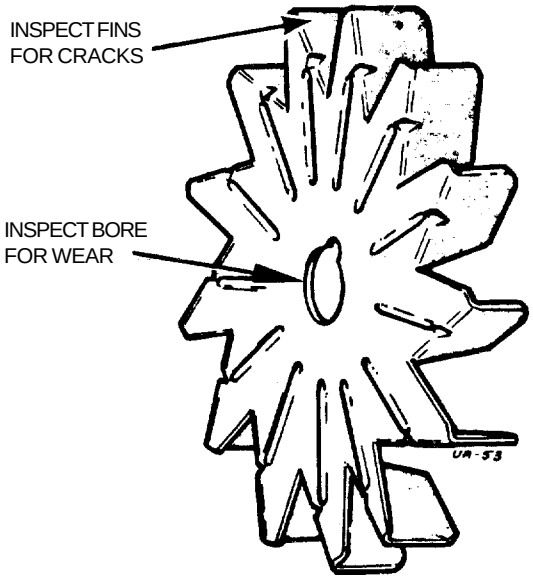


FIG. 3-40 FAN INSPECTION

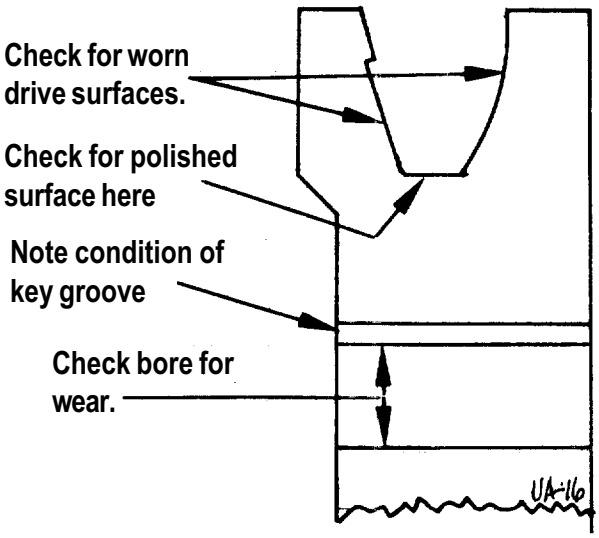


FIG. 3-41 PULLEY INSPECTION POINTS

https://truckmanualshub.com/

REMOVE FRONT BEARING RETAINER

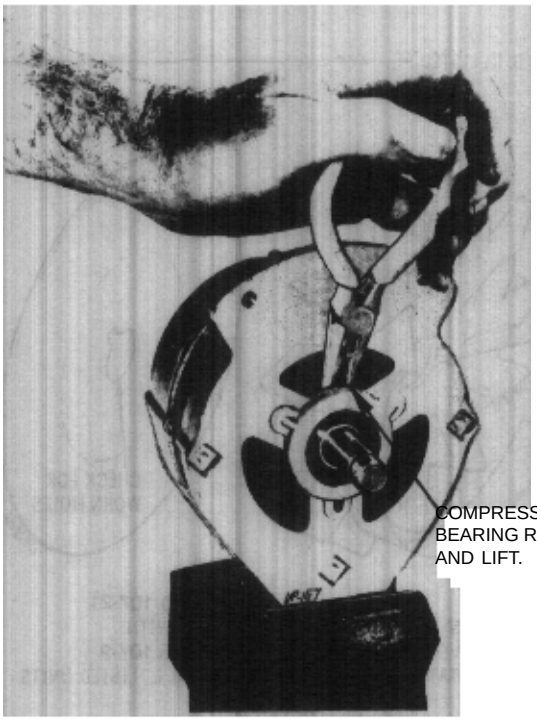
On MA and MR units, use a pair of long nose pliers to compress the ears of the front bearing retainer, lift retainer free of recess, as shown in Figure No. 3-42.

On HC and MH units, remove three front bearing retainer screws and lock washers.

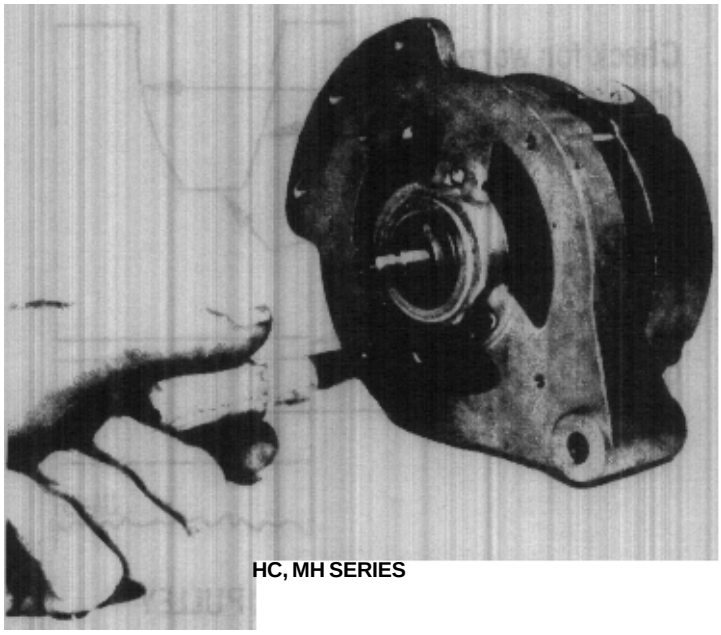
Tap the shaft on a wooden block, as shown in Figure No. 3-43, to separate front housing from the front bearing. Note use of nut on shaft end to prevent possible thread damage. If special pullers are needed for this operation, check for any damage to the front housing after such use.

If front housing has felt dust seals pressed in the casting, replace with new seals. Inspect front housing for possible faults as shown in Figure No. 3-44.

If original housing is reused, clean with solvent, dry with compressed air.



MA, MR SERIES



HC, MH SERIES

FIG. 3-42 REMOVING FRONT BEARING RETAINERS

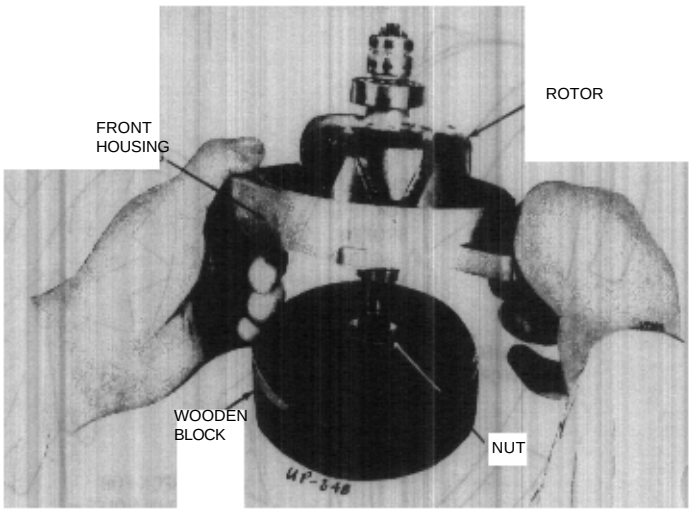


FIG. 3-43 SEPARATE FRONT HOUSING FROM ROTOR

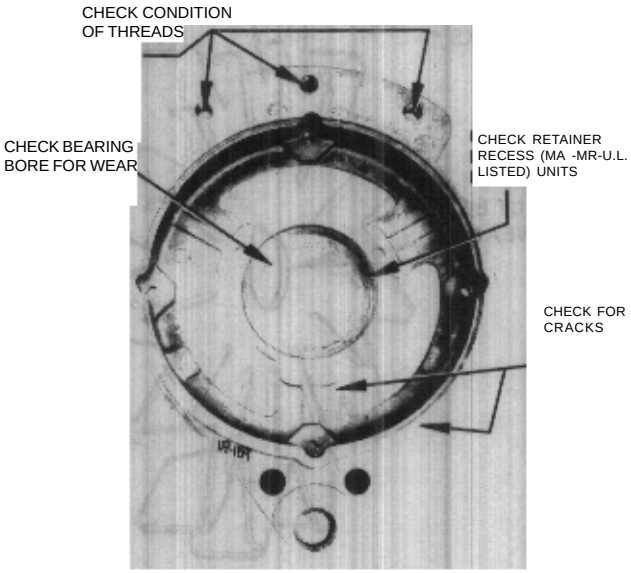


FIG. 3-44 FRONT HOUSING INSPECTION

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REMOVE FRONT BEARING FROM ROTOR

Using a universal bearing puller, remove the front bearing from the rotor shaft, Figure No. 345. HC and MH models use a bearing sleeve between the inside of the bearing bore and the rotor shaft, remove sleeve from rotor shaft, Figure No. 3-46.

Inspect all hardware and retainers related to the front bearing assembly for possible reuse.

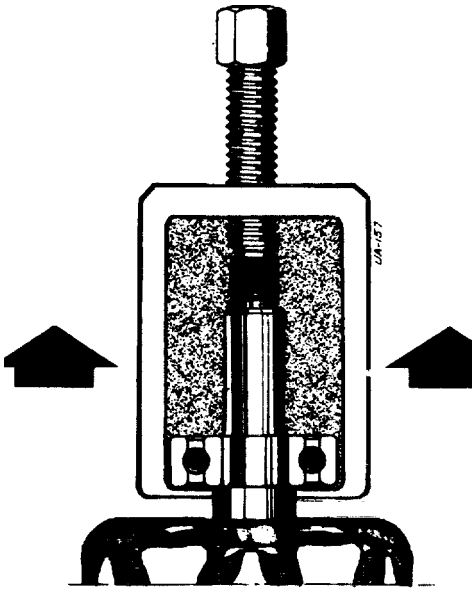


FIG. 3-45 REMOVING FRONT BEARING - MA SERIES

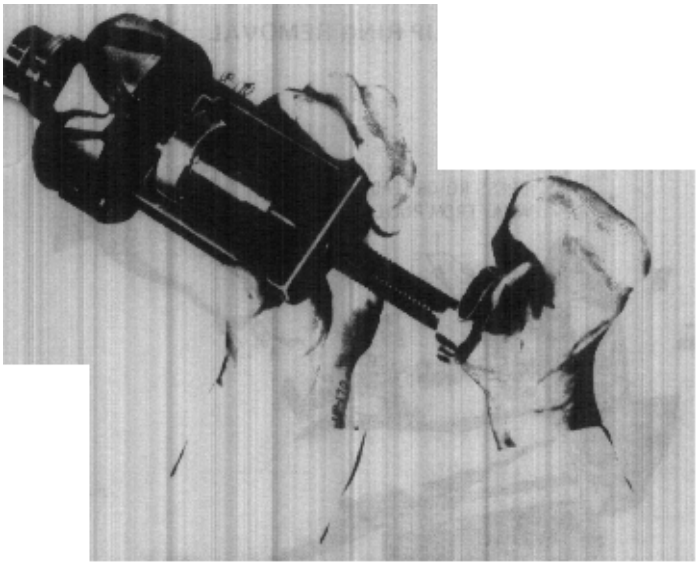


FIG.3-46 REMOVING FRONT BEARING AND SLEEVE HC, MC SERIES

ROTOR INSPECTION & ELECTRICAL TESTING

Check the rotor assembly for the following electrical properties, see Figure No. 3-47.

A. Current Draw or Resistance of the Winding

1. CURRENT DRAW IN AMPERES, @ 70° to 80° F.

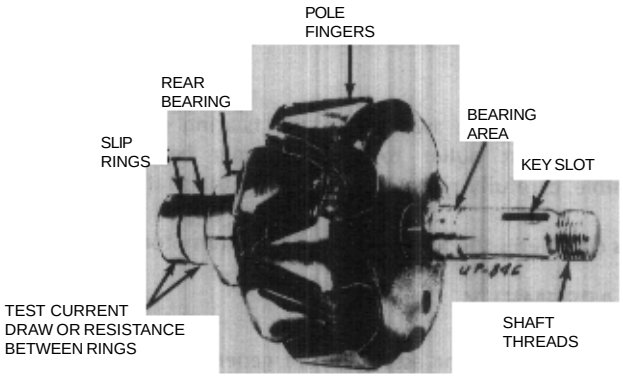
12 VOLT MODELS, RATED AT:	CORRECT CURRENT DRAW @110.0V
35 - 37 AMPERES	1.95 - 2.55 AMPERES
40 AMPERES	1.65 - 2.25 AMPERES
51 - 55 AMPERES	1.65 - 2.25 AMPERES
62 AMPERES	2.1 - 2.5 AMPERES
72 AMPERES	1.8 - 2.0 AMPERES
90 AMPERES	4.1 - 4.4 AMPERES

24 VOLT MODELS, RATED AT:	CORRECT CURRENT DRAW @20.0 V
35 AMPERES	1.28 - 1.88 AMPERES

2. RESISTANCE OF WINDING IN OHMS, @ 70° to 80° F.

12 VOLT MODELS, RATED AT:	CORRECT WINDING RESISTANCE
35 - 37 AMPERES	4.2 - 5.5 OHM
40 AMPERES	4.0 - 5.2 OHM
51 - 55 AMPERES	4.0 - 5.2 OHM
62 AMPERES	4.1 - 4.7 OHM
72 AMPERES	5.0 - 5.4 OHM
90 AMPERES	2.3 - 2.4 OHM

24 VOLT MODELS, RATED AT:	CORRENT WINDING RESISTANCE
35 AMPERES	11.0 - 14.0 OHM



NOTE: PLACE TEST LEADS ON EDGES OF SLIP RINGS TO AVOID CREATING ARCS ON BRUSH CONTACT SURFACES.

FIG. 3-47 ROTOR INSPECTION & ELECTRICAL TESTING

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B. Grounded Slip Ring or Winding

Use 12 volt D.C. test lamp ohmmeter or 110v A.C. test lamp. Place one test lead to the rotor body and the other on either slip ring. Open circuit from either slip ring to the rotor body is a correct condition.

C. Condition of Slip Rings

1. Clean brush contacting surfaces with fine crocus cloth, wipe dust and residue away.

2. If surfaces are worn beyond this restoration, replace the slip ring assembly.

D. Rotor Shaft and Body

(1) Stripped threads on shaft
(2) Worn key slot
(3) Worn bearing surface
(4) Scuffed pole fingers
(5) Worn or dry rear bearing

Replace rotor assembly if any of the above faults are noted (except for Item 5).

NOTE: New rotors include a new rear bearing and new slip rings as part of the assembly.

If rear bearing and/or slip rings require replacement, follow instructions for these operations.

REMOVE SLIP RINGS FROM ROTOR

Unsolder the rotor leads from the slip ring terminals. Carefully unwind the ends of the rotor coil leads from the slip ring terminals, as shown in Figure No. 348.

Remove the cap screw from end of shaft. Thread a 1/4" - 28 X 11/2" cap screw into the slip ring hub, this will back the slip ring assembly off the shaft, Figure No. 3-49.

REMOVE REAR BEARING FROM ROTOR Figure No. 3-50

Dress rotor leads away from the bearing puller contact area. Adjust puller to contact inner bearing race, if possible, carefully remove bearing from the shaft.

This completes the disassembly of the alternator.

REASSEMBLY

The instructions for assembly are generally in the reverse order of the procedures of disassembly. If all of the foregoing steps were followed, (1) the rectifier diodes are soldered to the stator leads, (2) the front alternator housing is assembled with the front bearing, bearing retainer and required dust seals.

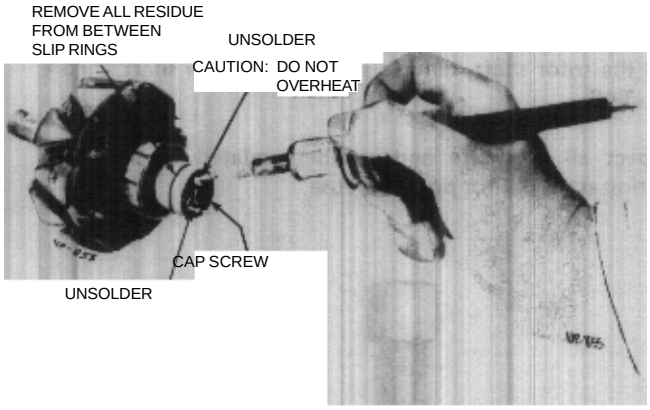


FIG. 3-48 UNSOLDER ROTOR LEADS FROM SLIP RINGS

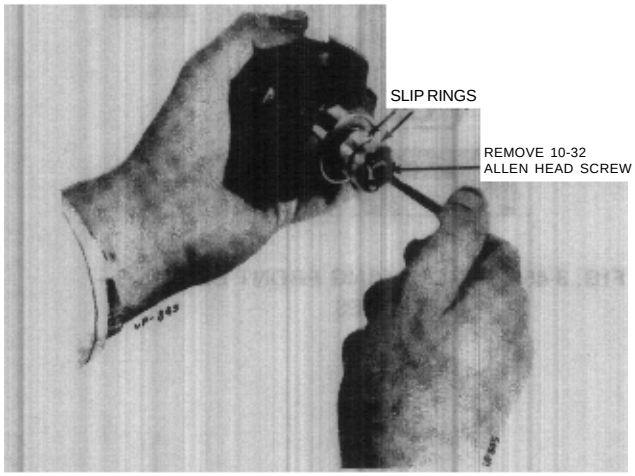


FIG. 3-49 SLIP RING REMOVAL

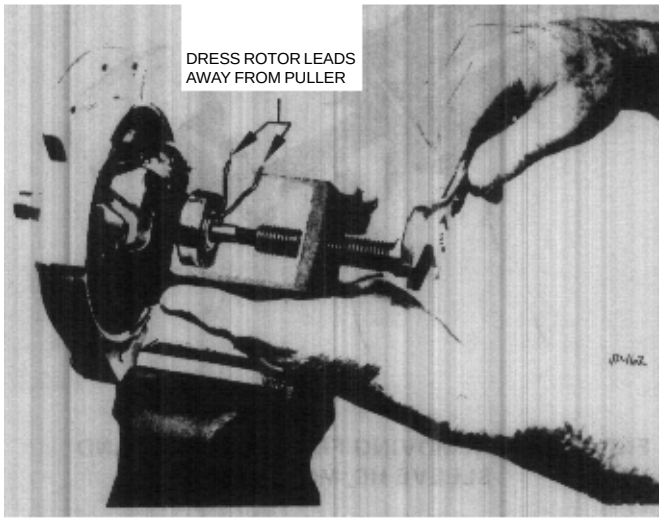


FIG. 3-50 REMOVING REAR BEARING

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INSTALL FRONT BEARING AND RETAINER (MA AND MR UNITS)

Remove any burrs or foreign material from bearing cavity in housing. Press bearing into housing using driver tool that exerts pressure on the outer race only, as shown in Figure No. 3-51.

Place bearing retainer in recess, make certain retainer ears line up with opening in the housing. Use wooden dowel to exert pressure on the retainer while locking edge of retainer in recess, as shown in Figure No. 3-52.

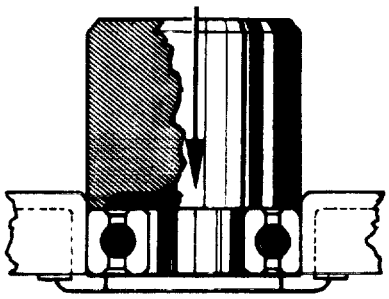


FIG. 3-51 INSTALLING FRONT BEARING

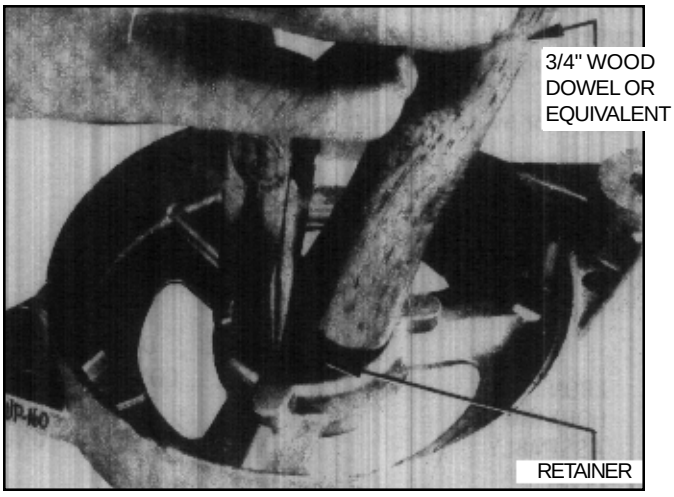


FIG. 3-52 INSTALLING FRONT BEARING RETAINER

INSTALL FRONT BEARING AND RETAINER (HC/MH SERIES)

Assemble front bearing and sleeve as shown in Figure No. 3-53.

There are two variations of this assembly depending on the dimension of “A” in Figure No. 3-54 and Figure No. 3-55.

If this dimension is 1.40", the front bearing is installed in the housing and secured with the bearing retainer and attach ing screws, as shown in Figure No. 3-54.

If dimension is 1.84", Seal No. 11-17 or 11-32 (Iridite Coated) must be placed in the housing as shown in Figure No. 3-55. Seal must be flush with outer surface as shown. Remove outer front bearing seal as shown.

Extra grease may be placed between the seal assembly and the bearing.

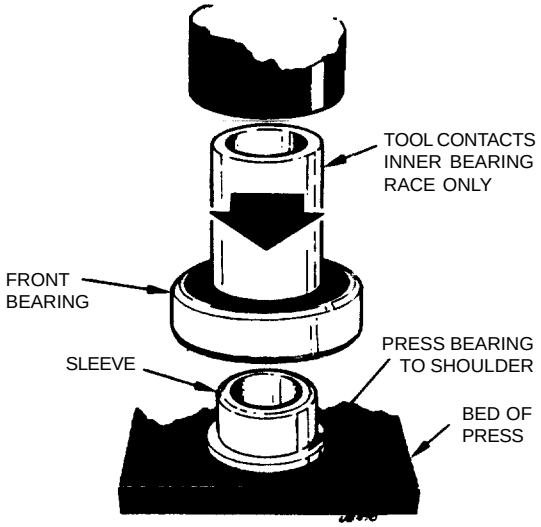


FIG. 3-53 ASSEMBLY OF FRONT BEARING & SLEEVE

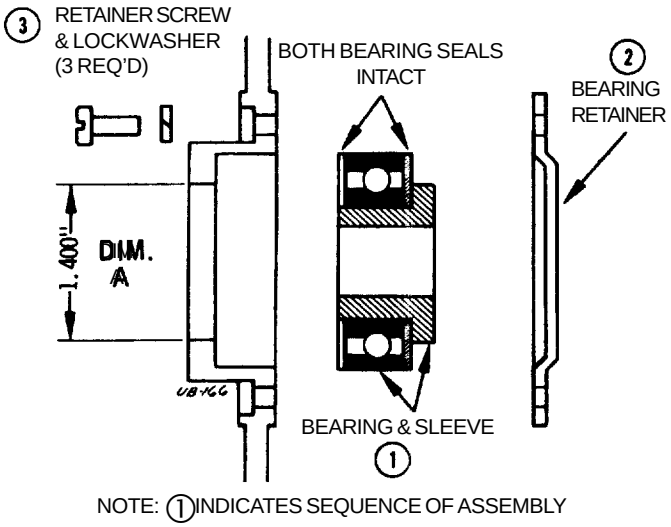


FIG. 3-54 FRONT HOUSING ASSEMBLY WITHOUT FELT SEAL

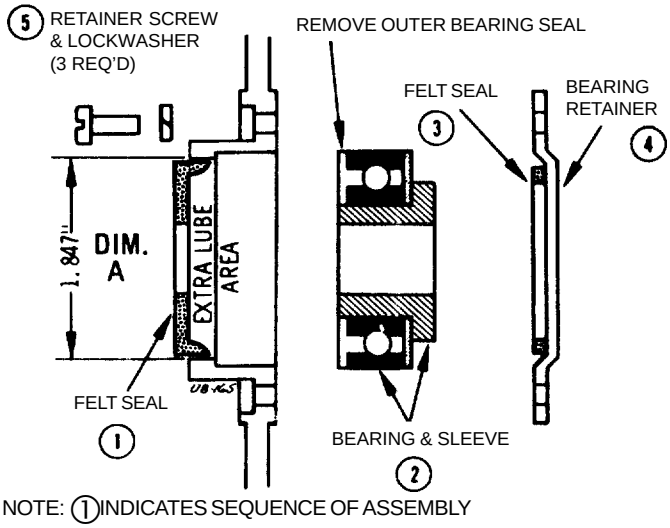


FIG. 3-55 FRONT HOUSING ASSEMBLY WITH FELT SEAL

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INSTALL REAR BEARING ON ROTOR

Support the pulley end of the rotor on an arbor press. Place the new bearing over the end of the shaft. Dress rotor leads away from work area. Select a bearing driver that contacts only the inner bearing race, press bearing on the shaft until inner race contacts the shoulder, see Figure No. 3-56.

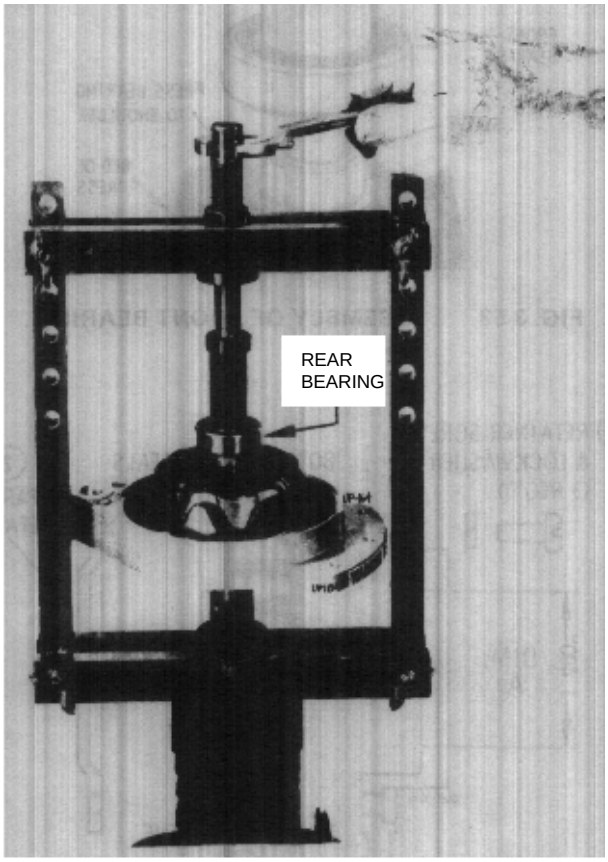


FIG. 3-56 INSTALLING REAR BEARING

INSTALL SLIP RINGS

Guide rotor winding leads through the square passage in the slip ring hub. Hand press the slip rings on the shaft while maintaining alignment of winding leads and passage. Install cap screw and lock washer, tighten to 45 inch pounds.

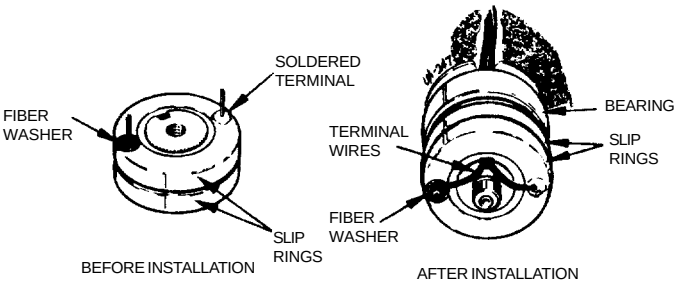


FIG. 3-57 ATTACHING ROTOR LEADS TO SLIP RINGS

ATTACH ROTOR WINDING LEADS TO SLIP RINGS

Figure No. 3-57 shows correct placement of the fiber insulating washer, it prevents a short circuit by not allowing the lead to the inner slip ring to touch the outer slip ring.

Wrap leads around slip ring terminals, solder with rosin core solder. Do not overheat, Secure wires to the end of the rotor with a synthetic sealer, like G.E. Silicone Rubber.

Retest electrical circuit to insure that a short circuit or ground did not develop during repair operation.

ASSEMBLE ROTOR AND FRONT HOUSING (ALL MODELS)

Place the rotor on the bed of an arbor press, using two steel blocks for support, as shown in Figure No. 3-58. Place front housing over shaft. Using driver sleeve that contacts inner bearing race only, press front housing down until inner bearing race contacts shoulder on the shaft.

ASSEMBLE SPACER, FAN AND PULLEY

Place pulley spacer over shaft. Install Woodruff Key. Install fan. If U.L. listed unit, install fan guard between fan and pulley. Install pulley, lock washer and nut. Mount pulley in vise as shown in Figure No. 3-37, tighten to 35 to 50 foot pounds.

Spin rotor by hand to test freedom of bearing and seals.

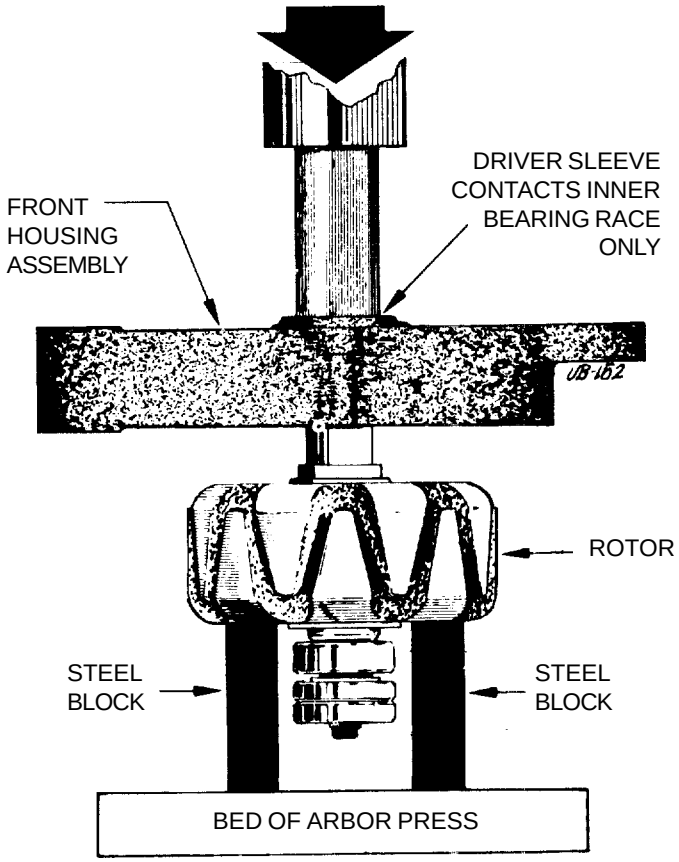


FIG. 3-58 ASSEMBLE FRONT HOUSING TO ROTOR

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CONNECT STATOR LEADS TO RECTIFIER DIODE ASSEMBLY (90 AMP ALTERNATOR)

The 90 Amp alternators with 50 Amp press-fit diodes use crimp sleeves to connect stator leads and diode trio leads to the rectifier diodes.

To replace a rectifier diode assembly, detach stator leads and diode trio leads from rectifier diodes by cutting these leads as close as possible to the rectifier diode. Strip off 1/2" insulation from each lead. Before making connections to the replacement rectifier diode assembly, be sure the mylar insulators are in place. Position lead(s) against rectifier lead and place sleeve connector over leads as indicated in Figure 3-59A. Then crimp connector and solder.

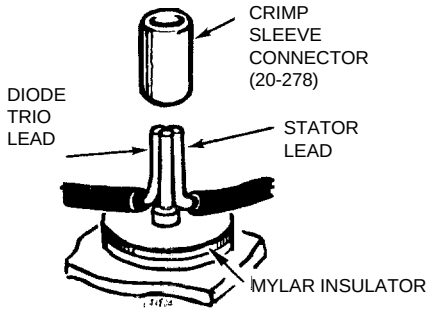
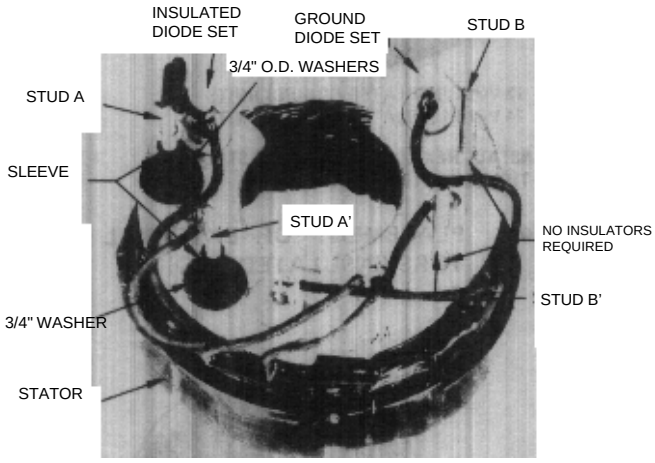


FIG. 3-59 ACONNECT STATOR LEADS (90 AMP ALTERNATOR)

ASSEMBLE INSULATORS TO RECTIFIER DIODE STUDS

See Figure No. 3-59B for the placement of the internal insulating washers and sleeves for alternators having one diode set grounded to the alternator rear housing. In this arrangement, Stud A is considered to be the Auxiliary Terminal.



PLACEMENT OF INTERNAL INSULATORS FOR:

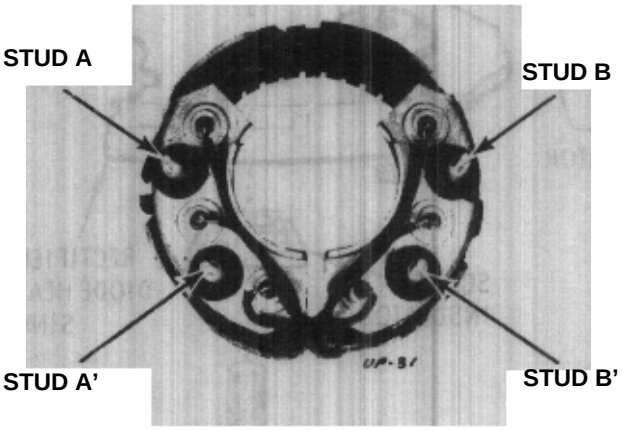
12 VOLT NEGATIVE GROUND UNITS
12 VOLT POSITIVE GROUND UNITS
24 VOLT NEGATIVE GROUND UNITS
NOTE: STUD A AND A' PROVIDE A POTENTIAL
STUD B AND B' PROVIDE A POTENTIAL

FIG. 3-59B PLACEMENT OF INTERNAL INSULATORS (POS. & NEG. GROUND)

Figure No. 3-60 shows that insulating washers and sleeves are placed over all (4) rectifier diode terminal studs, for alternators with both diode sets insulated from the rear housing. In this arrangement, Stud A is considered to be the Auxiliary terminal stud and Stud B is negative or positive output, depending on the type of alternator circuit.

When the alternator provides an A.C. Terminal for operating a **Prestolite** Alternator Tachometer, the function of Stud A is changed from the Auxiliary Terminal to the A.C. Terminal. Now, Stud A becomes the Auxiliary Terminal.

Figure 3-61 shows the placement of insulating washers and sleeves for alternators containing a field diode with one rectifier diode set grounded to the rear housing.



PLACEMENT OF INTERNAL INSULATORS FOR:

12 VOLT INSULATED GROUND UNITS
24 VOLT INSULATED GROUND UNITS

NOTE: STUD A AND A' PROVIDE SAME POTENTIAL
STUD B AND B' PROVIDE SAME POTENTIAL

FIG. 3-60 PLACEMENT OF INTERNAL INSULATORS INSULATED GND

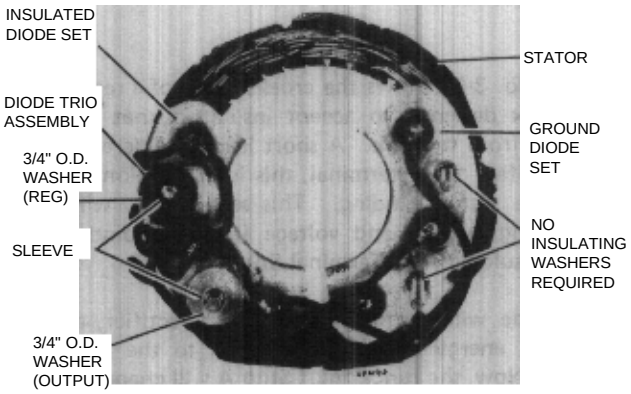


FIG. 3-61 PLACEMENT OF INTERNAL INSULATORS FOR UNITS WITH FIELD DIODE

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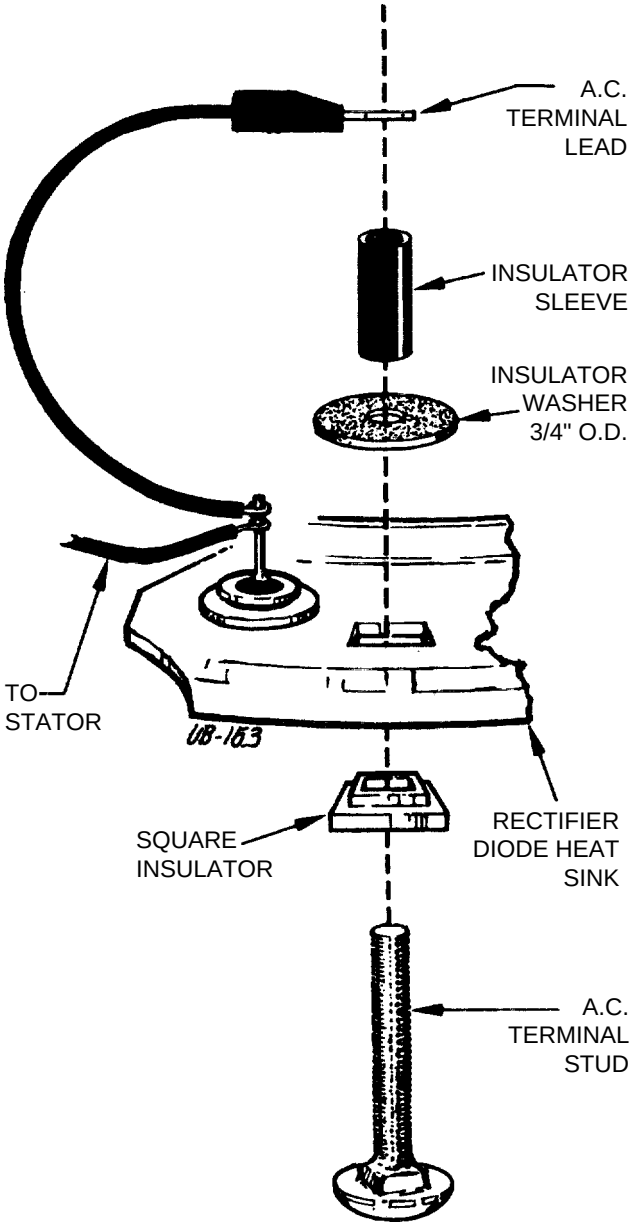
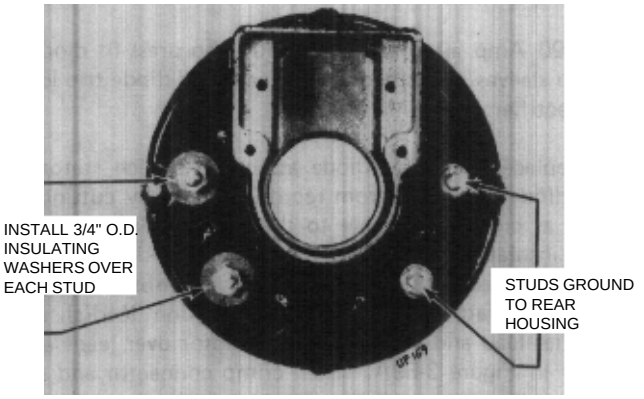
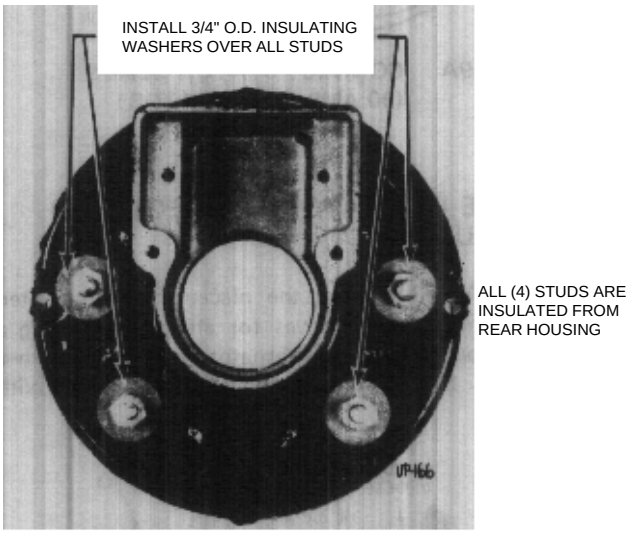


FIG. 3-62 INSULATORS FOR A.C. TERMINAL STUD



PLACEMENT OF EXTERNAL INSULATING WASHERS FOR:
12 VOLT NEGATIVE GROUND UNITS
12 VOLT POSITIVE GROUND UNITS
24 VOLT NEGATIVE GROUND UNITS
INSTALL HEX-LOCKNUTS ON ALL STUDS,
TIGHTEN 33 TO 40 INCH POUNDS.

FIG. 3-63 PLACEMENT OF EXTERNAL INSULATORS (POS. & NEG. GND)



12 VOLT INSULATED GROUND UNITS
24 VOLT INSULATED GROUND UNITS

INSTALL HEX-LOCKNUTS ON ALL STUDS,
TIGHTEN 33 TO 40 INCH POUNDS.

FIG. 3-64 PLACEMENT OF EXTERNAL INSULATORS (INSULATED GND)

Figure No. 3-62 shows the cross-section of a rectifier diode heat sink designed to accept insulators that will “float” Stud A, from the sink. A short lead is soldered to the top left rectifier diode terminal, this is in addition to the lead from the stator winding. This second lead will conduct alternating current and voltage from the diode terminal to the insulated A.C. Terminal Stud.

The diode will continue to act as a rectifier, passing its share of energy through the diode to the heat sink as before. Now, the function of Stud A will change.

Install external insulating washers and locknuts as indicated in Figure No. 3-63, Figure No. 3-64 or Figure No. 3-65.

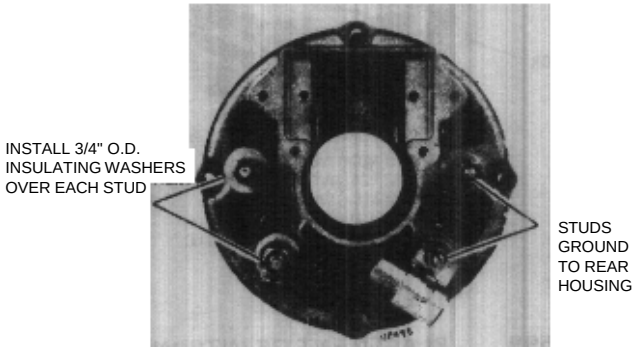


FIG. 3-65 PLACEMENT OF EXTERNAL INSULATORS FOR MODELS WITH FIELD DIODE

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Refer to Figure No. 3-66 for correct placement of the lead to the A.C. Terminal if used in the assembly.

INSTALL REAR BEARING RETAINER IN REAR HOUSING

Place new synthethic “O” Ring bearing retainer in the recess in the rear bearing bore, Figure No. 3-67. Lubricate the exposed surface of the ring with minimum amount of hydraulic brake fluid to ease assembly over the rear bearing. Do not use oil.

ASSEMBLE FRONT AND REAR HOUSING

Determine correct position of the rear housing with reference to the alternator mounting foot.

Place rear housing over the slip ring end of the rotor and hand press housings together. Install thru bolts, and square nuts if used, tighten evenly, 50 to 60 inch pounds. Spin rotor by hand to test freedom of bearings.

INSTALL BRUSH ASSEMBLY (MA AND MH UNITS)

Figure No. 3-68 shows the assembly of the brush connector lead to the rear housing cover, for a Negative Ground alternator. Positive Ground and Insulated Ground alternators would require two leads and terminals assembled in the same order.

Make certain that brush shunt lead insulator is installed, Figure No. 3-1.

Place brush set in cavity, align and install mounting screws, tighten 16 to 20 inch pounds.

INSTALL REAR HOUSING COVER (MA AND MH MODELS)

Place felt gasket between rear housing and cover. Two methods for spacing cover over the felt gasket are used. First, a metal sleeve over each cover screw, as shown in Figure No. 3-69. Second, the rear housing cover provides two shoulders that serve the same purpose. Tighten screws 20 to 30 inch pounds.

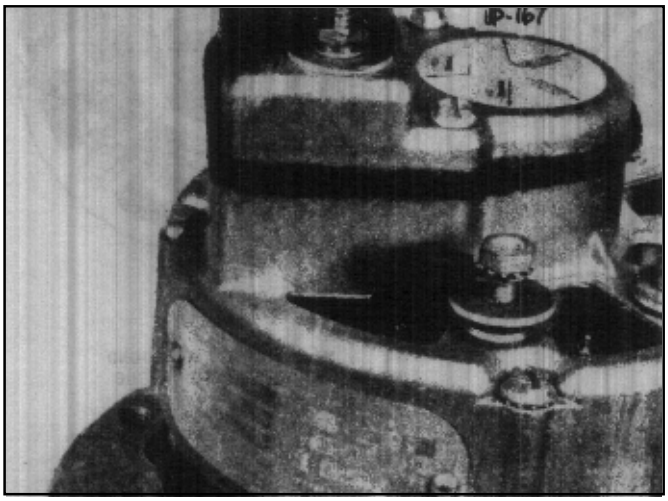
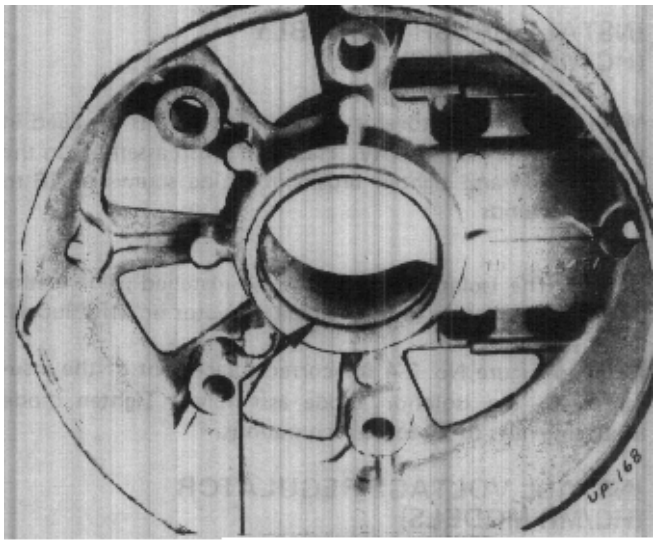


FIG. 3-66 PLACEMENT OF A.C. LEAD



REAR BEARING RETAINER

FIG. 3-67 REAR BEARING RETAINER

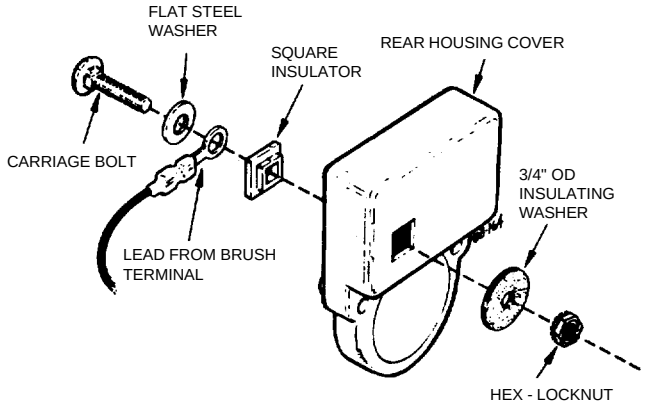


FIG. 3-68 BRUSH ASSEMBLY INSTALLATION MA AND MH SERIES

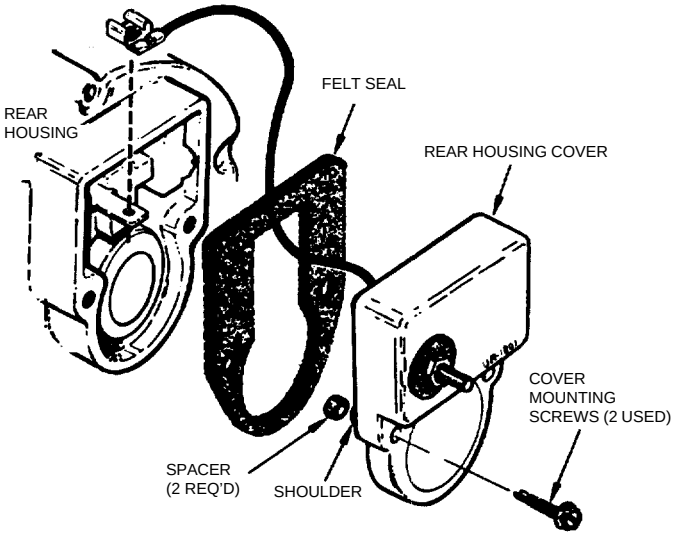


FIG. 3-69 REAR COVER ASSEMBLY

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INSTALL BRUSH ASSEMBLY (HC/MR MODELS)

Make certain insulator for brush shunt lead is installed in the top of the brush cavity. Place the brush assembly in the cavity, align and tighten brush mounting screws to 16 to 20 inch pounds.

NOTE: The isolation diode must be installed prior to the installation of the voltage regulator on MR Models.

Refer to Figure No. 2-4 for correct placement of the insulators for the isolation diode assembly. Tighten diode mounting nuts to 20 to 30 inch pounds.

INSTALL VOLTAGE REGULATOR (HC/MR MODELS)

Connect regulator brush lead to brush terminal, as shown in Figure No. 3-70. Place felt seal between the regulator and rear housing. Spacing the felt gasket is similar to the instructions for the rear housing cover, see Figure No. 3-69. Tighten regulator mounting screws 40 to 45 inch pounds.

Place regulator leads on auxiliary and ground (or negative output) terminals, install hex locknuts, tighten 20 to 30 inch pounds.

This completes the reassembly of the MR Series alternator. Refer to manual section “Alternator Performance Tests”, for instructions for bench testing repaired alternators.

INSTALL ISOLATION DIODE (MA AND MH MODELS)

For models using the isolation diode, refer to Figure No. 2-4 for correct placement of insulators.

Connect any brush lead jumpers required as shown in Figure No. 3-71. Place hex-locknuts over terminals, tighten 20 to 30 inch pounds.

This completes the reassembly of the MA and MH Models.

Refer to Manual section “Alternator Performance Tests” for instructions for bench testing repaired alternators.

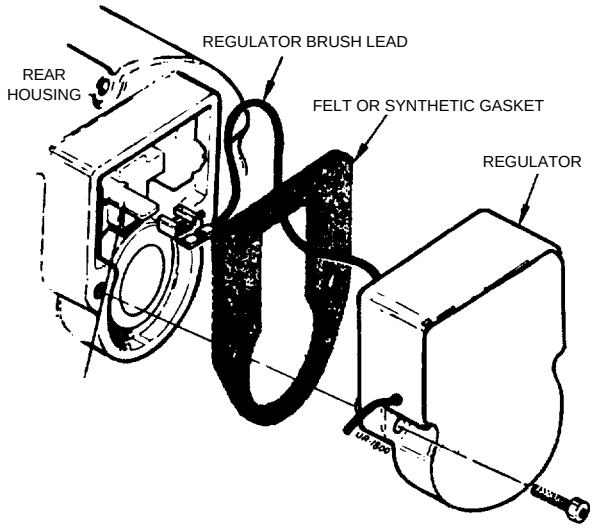


FIG. 3-70 VOLTAGE REGULATOR INSTALLATION

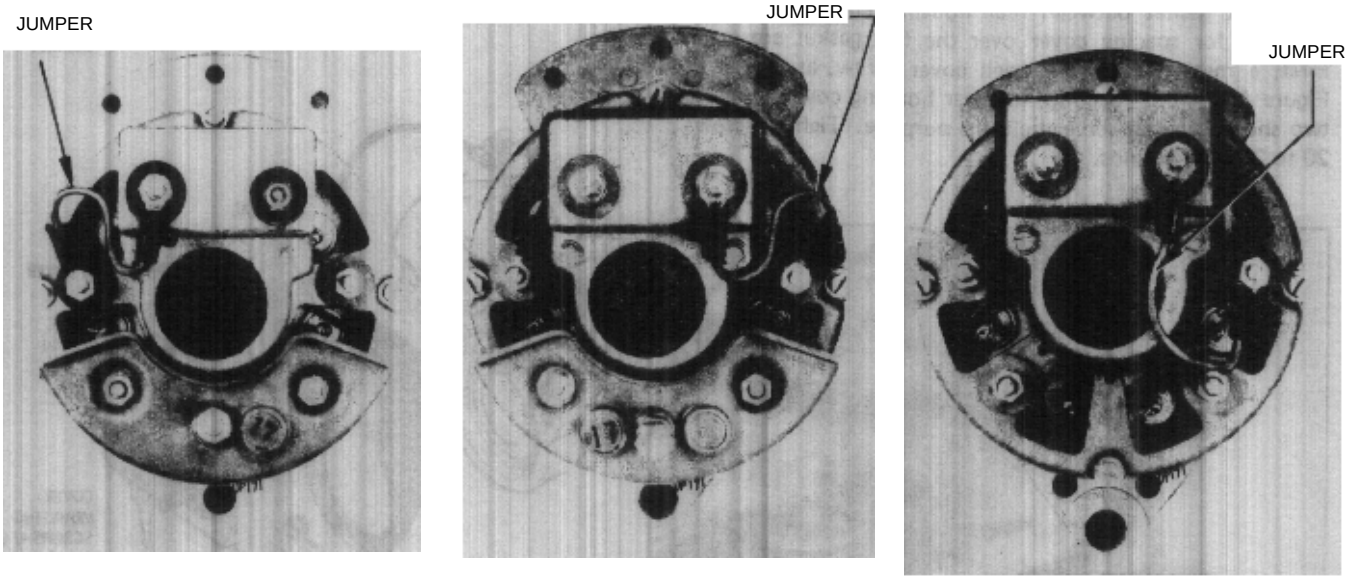


FIG. 3-71 APPLICATION OF FIELD CIRCUIT JUMPERS

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ALTERNATOR PERFORMANCE TESTS

The following test will determine the current producing capability of the repaired alternator. Except for models with internal voltage regulator, alternator output is manually controlled with a field rheostat.

Mount the alternator in a test fixture capable of providing 3000 to 4000 alternator RAM. Select required battery voltage and circuit polarity. Connect fixture circuit leads and instruments to the alternator terminals as shown in Figure No. 3-72, Diagram A to K, depending on the alternator being tested. Place field rheostat in maximum resistance position.

Turn drive motor on, adjust to obtain 3000 to 4000 alternator R.P.M. Slowly reduce field rheostat resistance, alternator should develop a charge. Continue to reduce resistance until alternator reaches rated current output in amperes. DO NOT operate the alternator for more than a few minutes in this manner, due to the lack of voltage control. If the alternator will deliver its rated output, terminate the test.

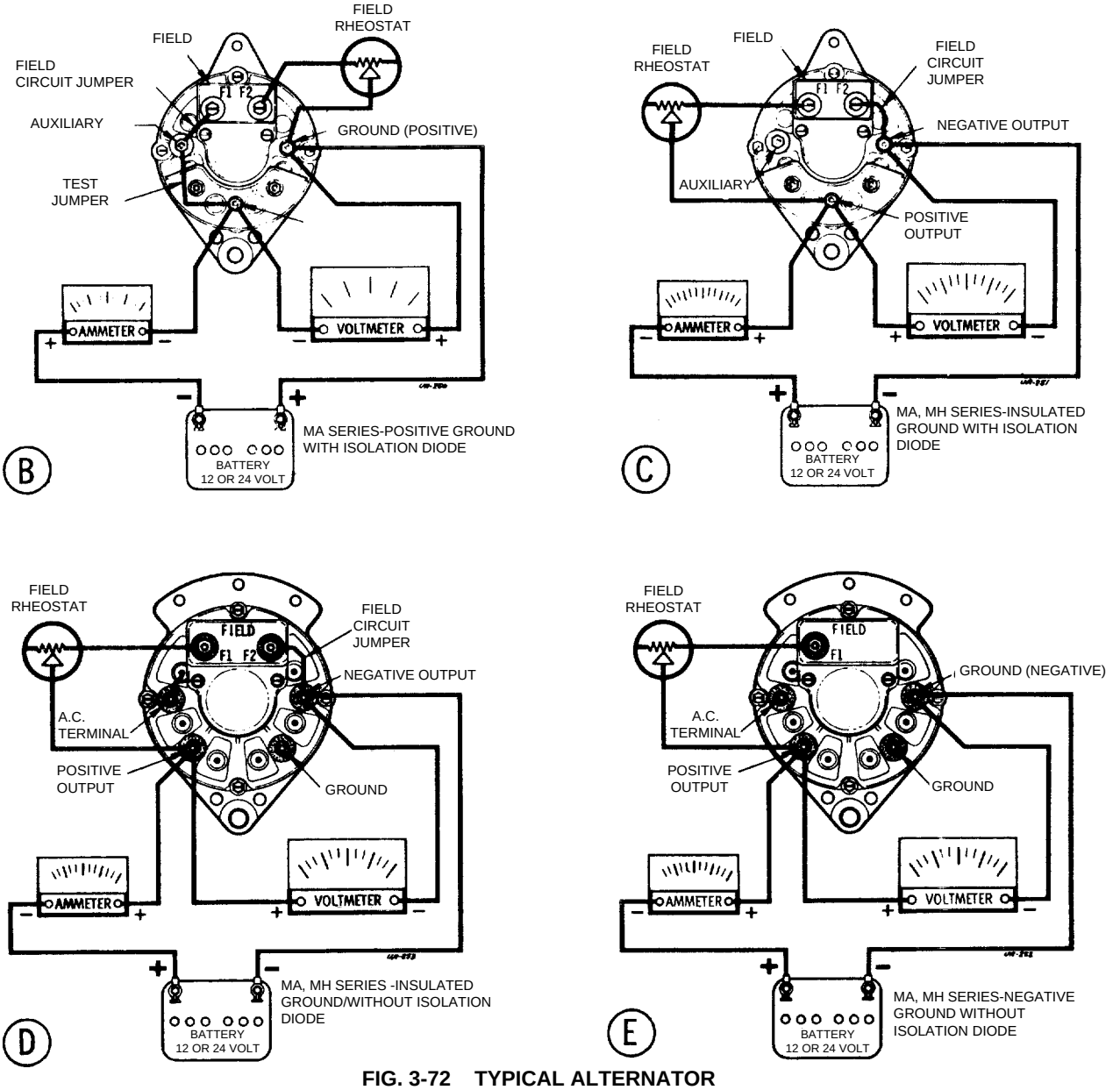
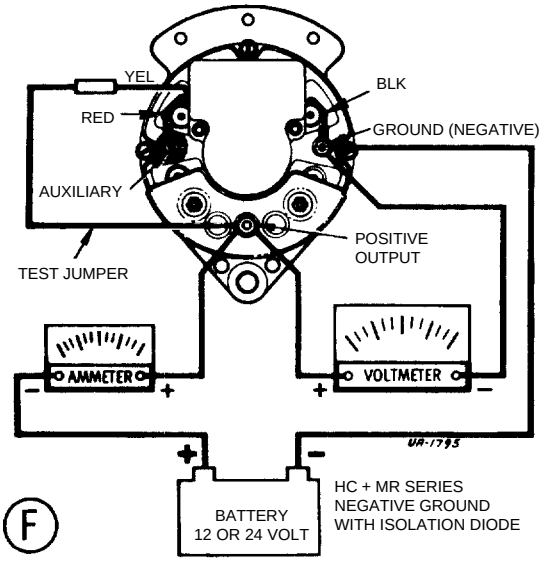


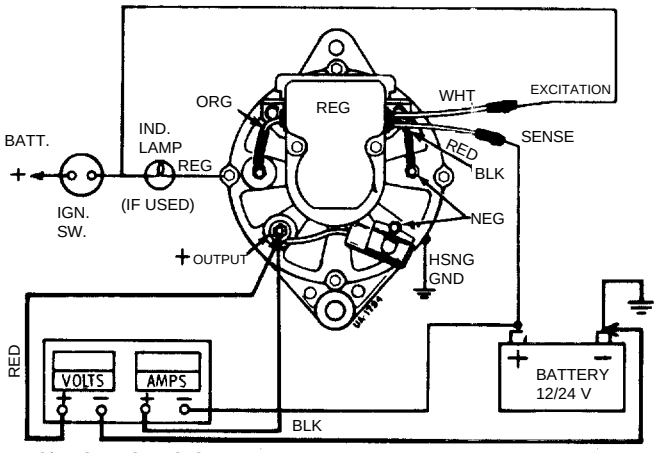
FIG. 3-72 TYPICAL ALTERNATOR PERFORMANCE TESTS

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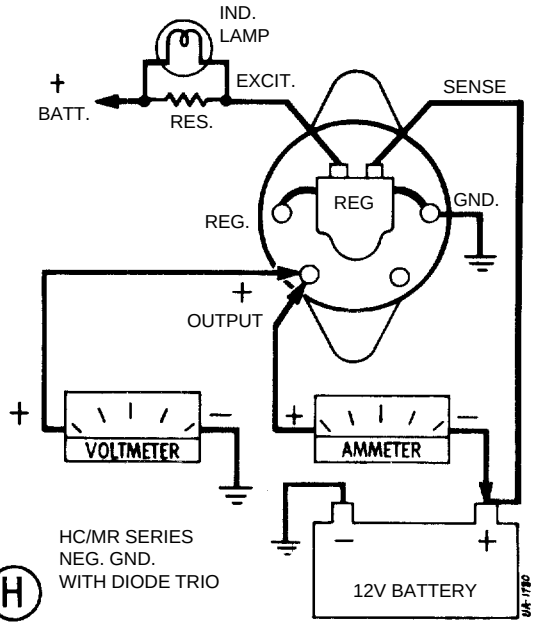
F

HC + MR SERIES
NEGATIVE GROUND
WITH ISOLATION DIODE



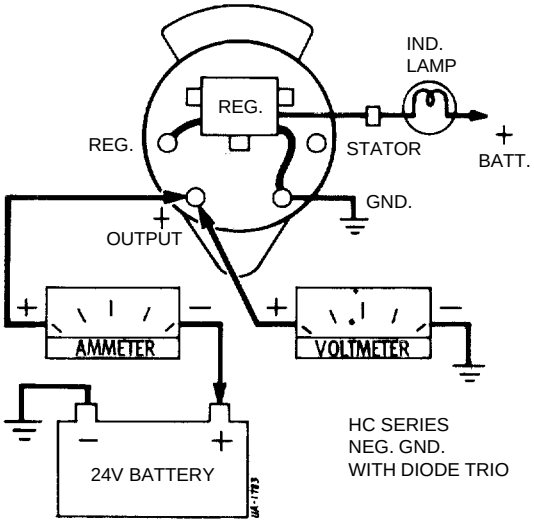
G

HC/MR SERIES, NEG. GND.
WITH DIODE TRIO



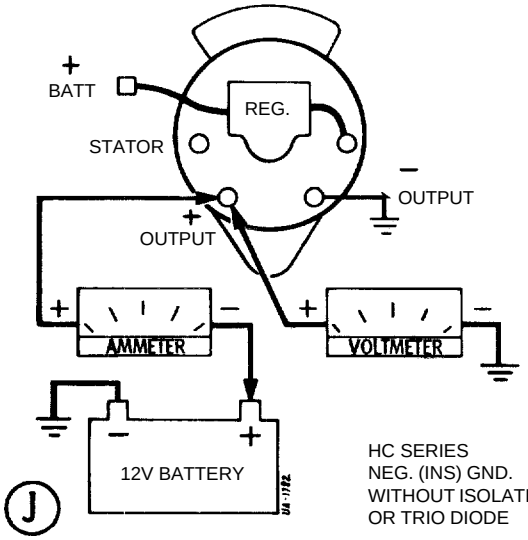
H

HC/MR SERIES
NEG. GND.
WITH DIODE TRIO



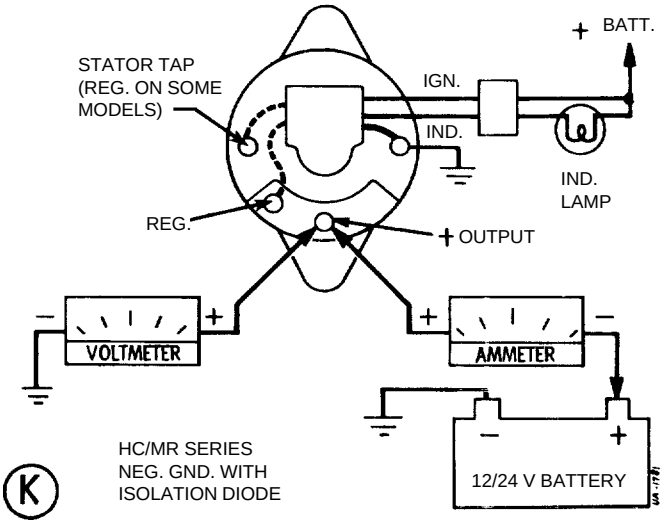
I

HC SERIES
NEG. GND.
WITH DIODE TRIO



J

HC SERIES
NEG. (INS) GND.
WITH OUT ISOLATION
OR TRIO DIODE



K

HC/MR SERIES
NEG. GND. WITH
ISOLATION DIODE

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HANDLING / MAINTENANCE MANUAL

MODEL : MAG-150VP-3600

NAME : MAG MOTOR ASSY

KAYABA P/N : 20450-65021
OR
KAYABA P/N : 20450-65037

KYB

KYB CORPORATION OF AMERICA

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1. Introduction

This MAG-150VP-3600 motor has been developed as a travelling motor for construction machinery. This instruction manual describes specifications, construction, and handling method of the travelling motor assy so as to prevent malfunction from being caused during its operation and also maintain its good performance over a long period.

2. Outline

2-1. Construction of travelling motor assy

This MAG motor is composed of parking brake, double counter balance valve, two step speed mechanism, cross-over relief valve, swash plate piston motor and reduction gear.

The hydraulic motor converts fluid energy into mechanical torque and rotating speed. The generated torque is further raised by the reduction gear and transmitted to the crawler.

2-2. Features

2-2-1. Piston motor

a) A parking brake is built into the motor and prevents the machine (vehicle) from going back on a slope, and makes a mechanical brake work positively when the machine is parked or stopped.

b) This motor is designed with good hydraulic balance maintains stable performance over a long period and excels in mechanical efficiency, volumetric efficiency, starting torque efficiency and slip performance.

c) This motor is, in its design, compact and light-weighted and self-contained type of reduction gear.

d) This motor displays high durability even under severe conditions.

e) A double counter balance valve and cross-over relief valves are unified compactly and perform as hydraulic brake.

f) A double counter balance valve as built in this motor can control the travel speed according to the amount of oil flow supplied and over-running of motor can be prevented.

g) Cross-over relief vaives as built in this motor perform shock-less function, alleviate shock at time of start and stop, and thereby providing a good ride.

h) Two step speed mechanism as built in this motor can provide two travel speed. (high and low)

2-2-2.Reduction gear

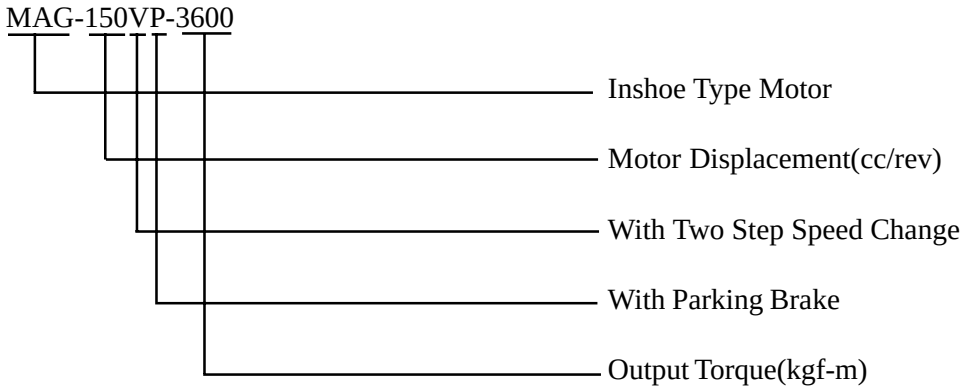
a) This motor excels in reliability and displays sufficient durability because of its high-precision machining and equal-load distributing mechanism adopted.

b) This motor is of casing-rotation shape and of light-weight and compact design so that full durability can be displayed as a reduction gear for travelling.

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c) Since floating seals are adopted in this motor, mixture of mud, sand, water, etc. is prevented, and sealability raised.

2-3. Model Indication

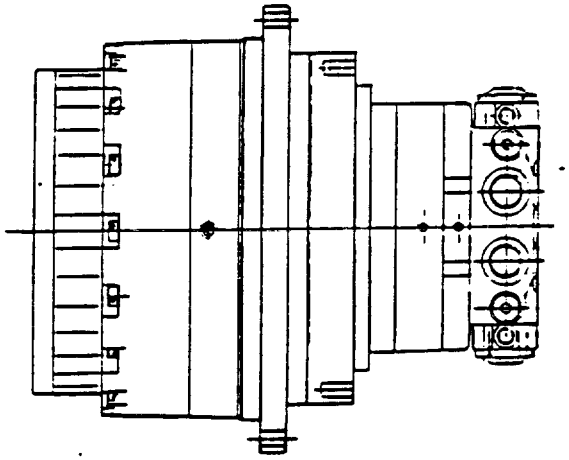


2-4. Specifications

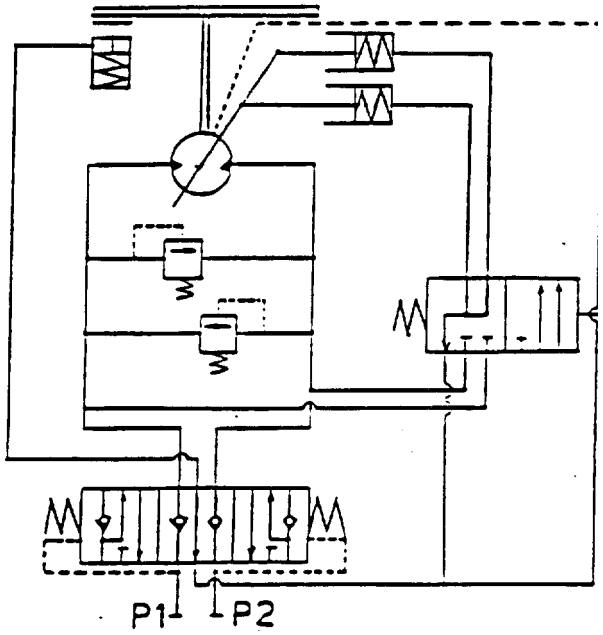
Displacement	Motor		152.9/96.6 cc/rev
	Equivalent (w/ Reduction Gear)		7574.5/4785.4 cc/rev
Gross-over Relief Valve	Cracking Pressure		345 kgf / cm 2 at 1.2 1/m
	Full Flow Pressure		360 kgf/cm2 at 40.0 1/m
Double Counter Balance Valve	Plunge Changeover Pressure		70.--10.0 kgf/cm2
	Check Valve Cr-cking pressure		Less than 0.3 kgf/cm2
Two Step Speed Control Valve	Pilot Pressure		More than 10 kgf/cm2
Reduction Gear	Construction		Planetary Gear 3-Stages
	Gear Ratio		1:49.539
Parking Brake	Brake Torque	Static	More than 2030 kgf-m
		Dynamic	More than 1450 kgf-m
	Parking Brake Release Pressure		less than 13 kgf/cm2
Hydraulic Fluid			ISO VG 32 - 56
Gear Lubrication Oil			Gear Oil GL-4 #90 or Equivalent
Dry Weight			270 kg

2-5. Components

Component Name	Model Name	Part Number
Piston Motor	MSF-150VP-8	20460-51435
reduction Gear	RGC-150VP-50-1	20945-65405



2-6. Hydraulic Circuit



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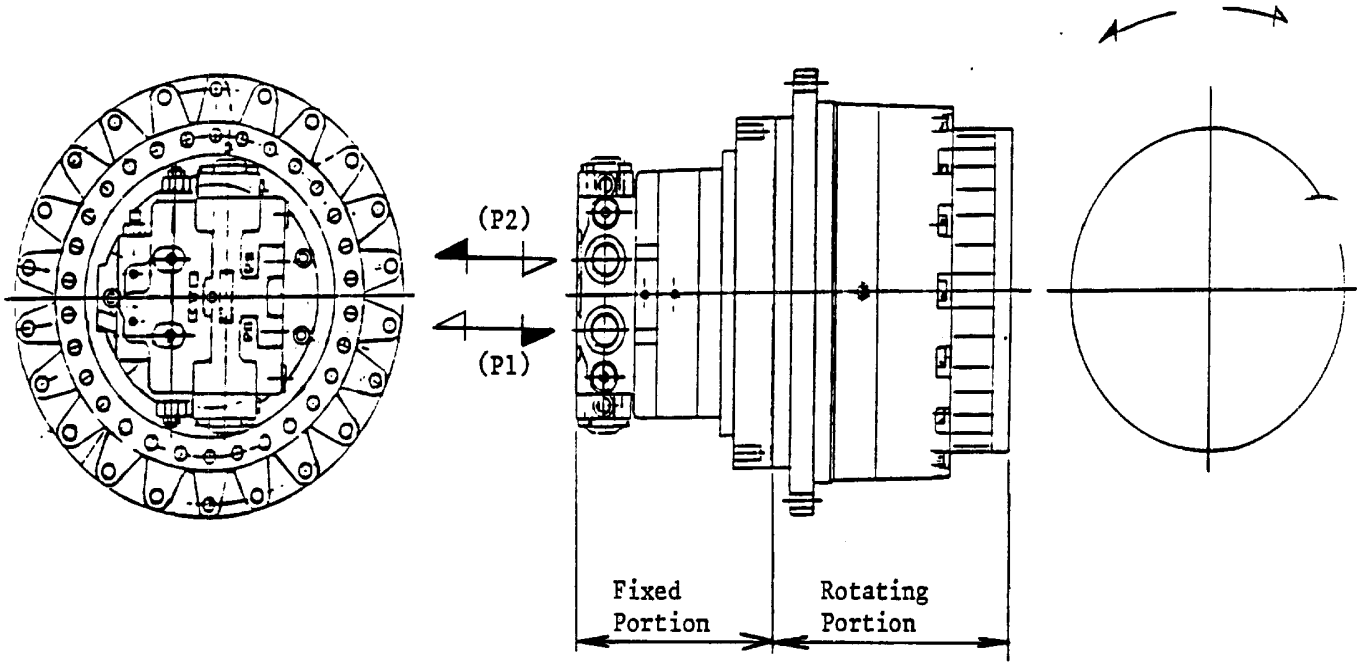
3. Handling

Described in this chapter are handling points necessary as a motor assy.
For details of 1) piston motor and 2) reduction gear , refer to the handling manual of individual items.

1) Piston Motor GB-MS-63-
2) Reduction Gear GB-MS-63-

3-1. Direction of Rotation

Inlet Port	Outlet Port	Direction of Rotation (shown from reduction gear)
P1	P2	Anti-clockwise
P2	P1	Clockwise

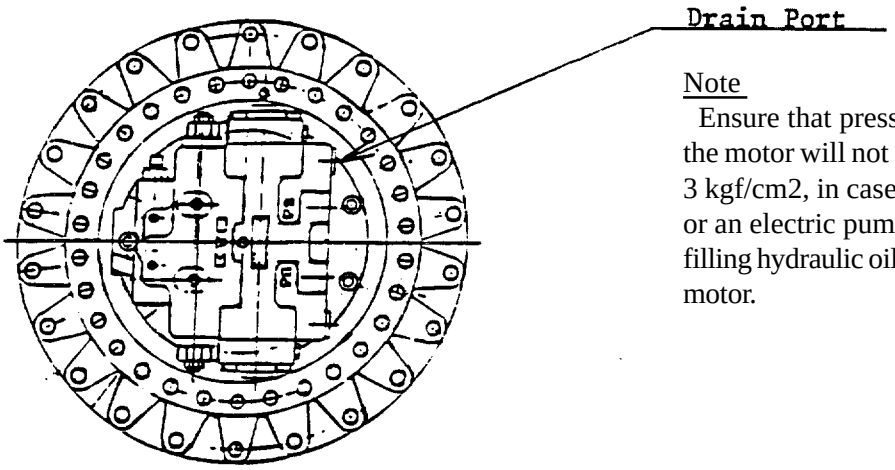


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3-2. Caution on trial operation

Be sure to check and make preparation for starting in the following procedure after installing a new or overhauled travelling motor.

3-2-1. Fill the piston motor case with hydraulic oil. And, remove air inside motor and pipings.
Oil volume: 400 cc



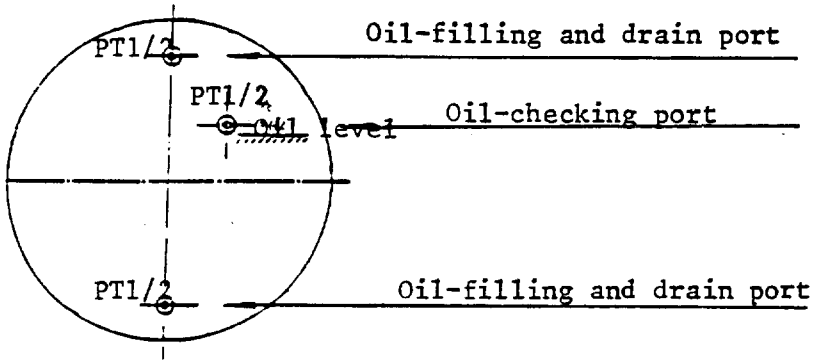
Note

Ensure that pressure inside the motor will not go up beyond 3 kgf/cm2, in case a hand pump or an electric pump is used for filling hydraulic oil into the motor.

3-2-2. Fill the reduction case with lubricating oil up to the volume(about 6.0 litre). After removing the plugs for the oil-filling and drain port(226) and Oil-checking port(226) of the cover(224), fill oil until oil flows out from the oil-checking port. After that, tighten the plugs.

Note

Oil is filled in appropriate amount at the time of shipment from our factory.



3-2-3. Initial Operation

Reiterate operation at low speed at first. It is likely that abnormal sound is generated from the valve owing to air remaining in the circuit during such operation, continue to operate at low speed.

Confirm at the same time that there is no oil leakage.

After that, confirm that there is no abnormal sound and vibration from the travelling motor assy under load operation, and start full operation.

3-3. Oil temperature at time of operation

Control of the oil temperature within the hydraulic circuit will ensure stable operation for a long period to user's satisfaction, If the oil temperature goes up, the oxidation stability of the oil is lowered and its deterioration is accelerated. Therefore, be sure to observe the following.

a) Use the motor in continuous operation under the temperature of 10-80 C(50-176 F).
b) Minimum temperature at the time of starting operation is -20 C(-4 F), and maximum permissible temperature is 95 C(203 F) for intermittent operation.

These are determined by viscosity and anti-oxidation stability of the fluid and deterioration of the "O"rings and oil seals.

The operation under the temperature higher than 80 C(176 F) will shorten the life span of the motor.

3-4. Maintenance and Inspection

Daily checking points are as follows.

1) Is there any oil leakage from joints and piping flanges?
2) Are the bolts for mounting bracket tightened rigid enough?
3) Is there any damages on surface of the motor?
4) Is the volume of lubricating oil in the reduction gear case appropriate?

Lubricating oil should be replaced periodically with new oil.

Recommend hours for replacement are as follows.(by engine hour meter)

First replacement : 100-250 hrs
Secondary replacement : each 1000-1500 hrs

1) Checking of oil volume

Remove the plugs for oil-filling and drain port and oil-checking port (226) and check the oil level. (refer to 3-2-2)

2) Replacement of oil

Remove the plugs for oil-filling and drain port and oil-checking port (226), and then drain the used oil completely.

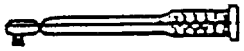
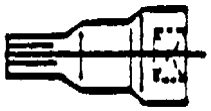
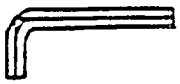
After that, fill the new oil until it flows from the checking port.

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3-5. Disassembly and Reassembly

Maintenance and replacement of the individual components should be made in the following procedure

3-5-1. Tools

No.	Tool Name	tools to used for	Configuration
1	Torque wrench 0.7-0.9 kgf-m (5-6ft-lbs	(228) Air removal Plug	
2	Torque Wrench 4-5kgf-m (29-36ft-lbs)	(226) Oil-filling, Drain and Oil-cheking Plug	
3	Torque Wrench 10-11kgf-m (72-78ft-lbs	(300) Socket Head Bolt	
4	Hexagonal Bit (cross Flat 5mm)	(228) Air removal Plug	
5	Hexagonal Bit Cross Flat 10mm)	(226) Oil-filling, Drain and Oil-cheking Plug	
		(300) Socket Head Bolt	
6	Allen Wrench (Cross Flat 5mm)	(228) Air removal Plug	
7	Allen wrench (Cross Flat 10mm)	(226) Oil-filling Drain and Oil-cheking Plug (300) socket Head Bolt	

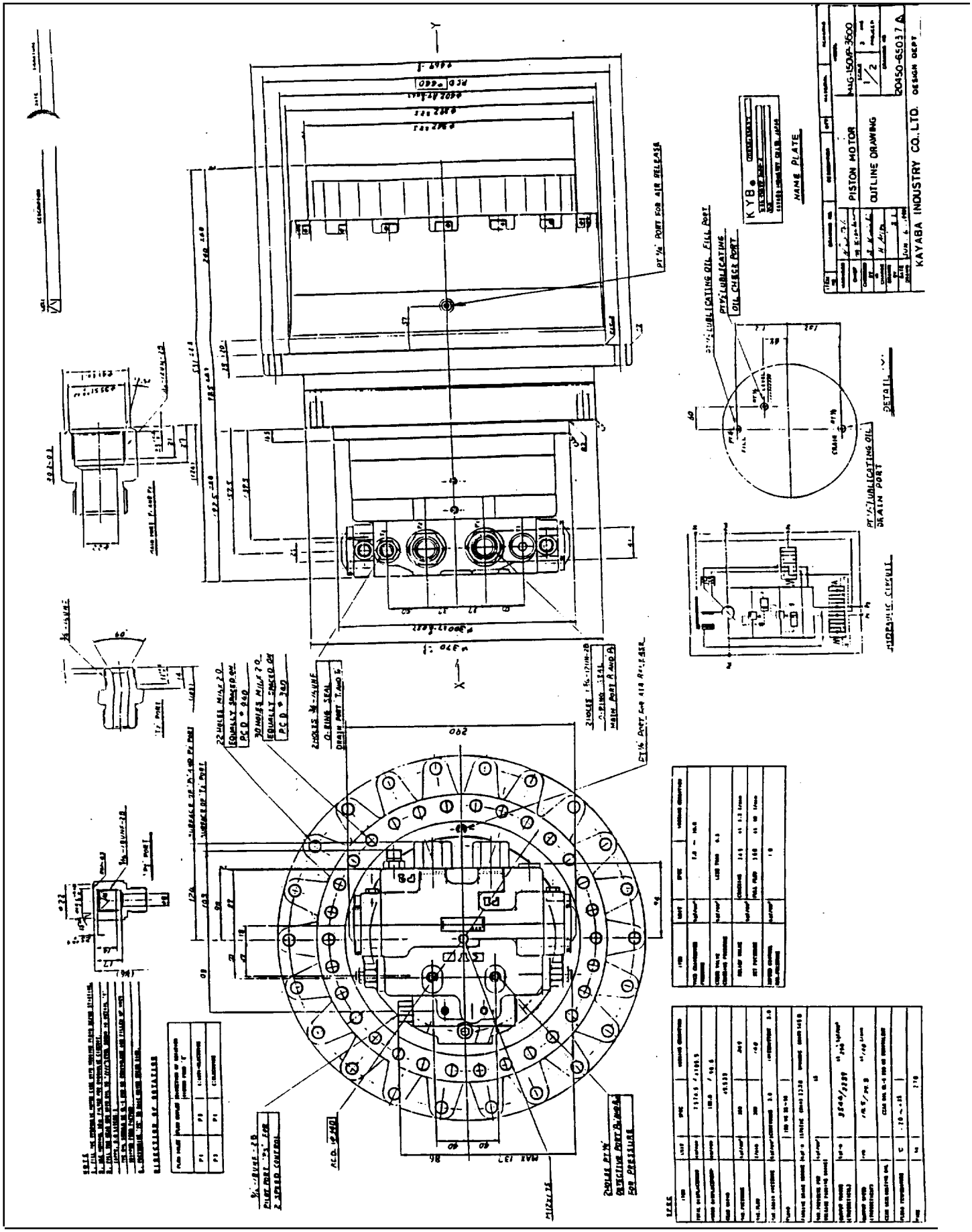
3-5-2. Disassembly Procedure

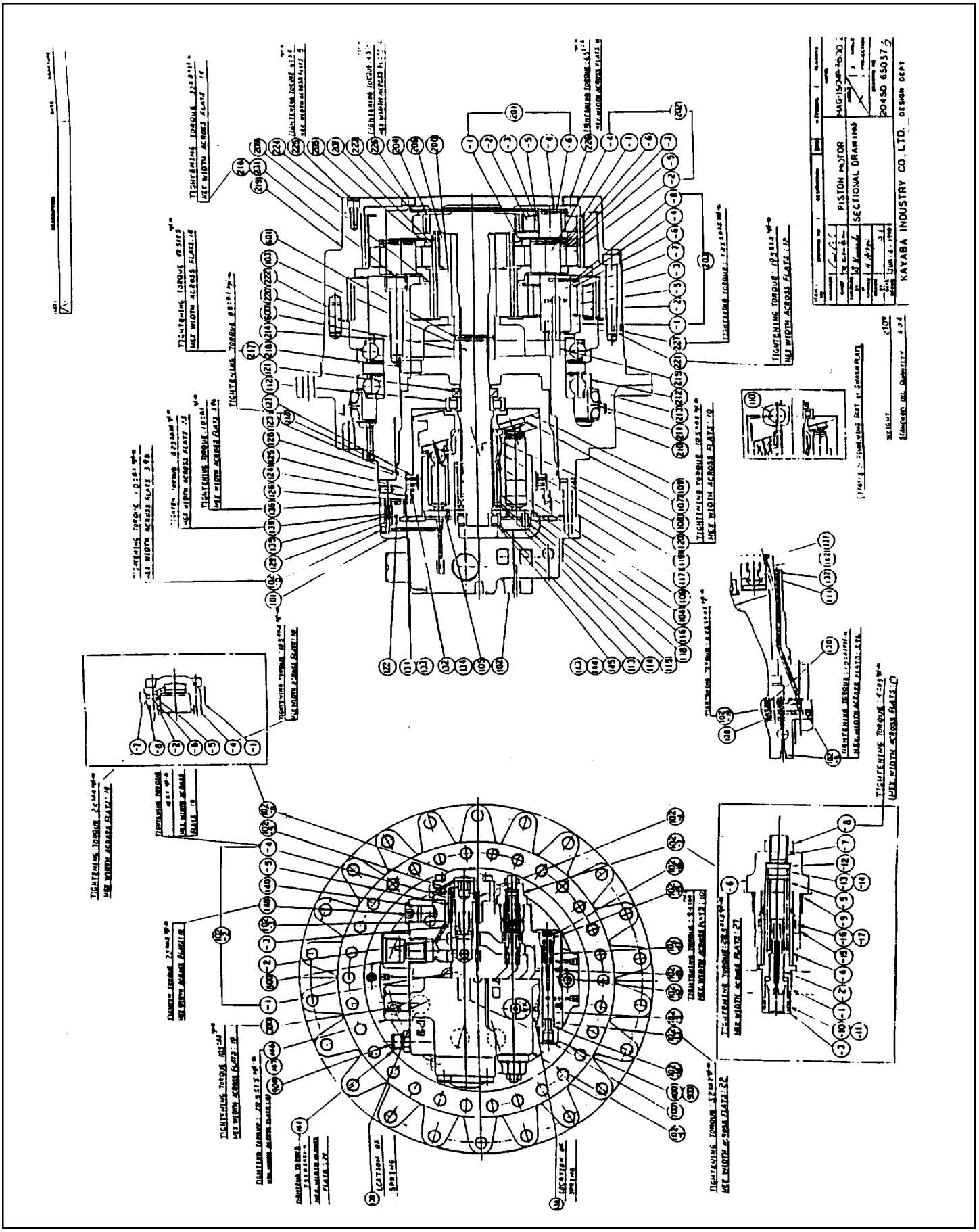
1) Clean the piping flanges and remove mud,dust,etc.
2) Disconnect the pipings.
3) Plug each ports to prevent the oil from raining out of (P1), (P2),(T),(Ps) port of piston motor(100) and foreign articles from entering.
4) Remove the MAG motor from the machine.
5) Place the MAG motor in the horizontal place with the piston motor upside.
6) Clean the outside of MAG motor and remove mud, dust,etc.
7) Remove the socket head bolts(300) and detach the piston motor from the reduction gear.

3-5-3. Reassembly procedure

1) Reduction gear
   a) After confirming that the plugs for oil-checking port and oil-filling port(226) are tightened properly, place the reduction gear in the horizontal place.
   b) Remove the air-removal plug(228) from the flange(210).
   c) Fill the reduction gear case with lubricating oil.
      Oil volume is about 6.0 litre. (refer to 3-2-2)
2) Put the “O”ring(123) on the groove of piston motor(100), and then install the piston motor into the reduction gear(200) with socket head bolts(300). Tightening torque is 10-11kgf-m(72-78 ft-lbs).
3) After that, install the air removal plug(228) on the reduction gear. Tightening torque is 0.7-0.9kgf-m(5-6.5ft-lbs, PT1/8)
4) Mount the MAG motor on the machine with the bolts(52pcs of M16). Tightening torque is 26-30kgf-m(188-217ft-lbs).
5) Arrange pipings for (P1),(P2),(T1 or T2) and (Ps) ports of the piston motor. Tightening torques are as follows.
   (P1) ant (P2) ports(1 5/16-12UN) : 36-40kgf-m(260-289ft-lbs)
   (T1 or T2) port(PF 1/2) : 6-7kgf-m(43-50ft-lbs)
   (Ps) port(9/16-18unf) : 3.5-4kgf-m(25-29ft-lbs)
6) Fill the piston motor case with the oil from either T1 or T2 port. (refer to 3-2-1)
7) Check the lubricating oil level.

   Note
   1) If the oil level is too low, fill the oil
   2) If the oil level is too high, drain the oil.
8) After checking the oil level, tighten the oil-filling plug and oil-checking plug. Tightening torque is 4-5kgf-m(29-36ft-lbs, PT1/2).


KAYABA INDUSTRY CO.,LTD. DESIGN DEPT.
PISTON MOTOR
OUTLINE DRAWING
MAG-150VP-3500
20450-65017 A
NAME PLATE
KYB
DETAIL
HYDRAULIC CIRCUIT
MAIN PORT
DRAIN PORT
OIL CHECK PORT
OIL FILL PORT
LUBRICATING OIL
PT 1/4 PORT FOR AIR RELEASE
O-RING SEAL
SURFACE OF PISTON


PISTON MOTOR
SECTIONAL DRAWING
KAYABA INDUSTRY CO.,LTD.

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CLASS	ITEM NO.	DRAWING NO.	DESCRIPTION	QTY	MATERIAL	REMARKS
B	100	20460-51435	MOTORAXIAL PISTON	1		MSF-150VP-5-2
D	101	20461-53210	CASE	1		
D	102	20463-51320	PLATE ASSY. BASE	1		
D	-1	20461-51904	PLATE BASE	1		
D	-2	21963-50217	PLUNGER ASSY	1		
(D)	-2-1	21961-50217	PLUNGER	1		
(D)	-2-2	21961-50306	VALVE CHECK	2		
(D)	-2-3	21961-50403	SPRING	2		
(D)	-2-4	21961-50622	PLUG	2		
(D)	-2-5	95113-02100	O-RING	2		JIS B 2401, 1B P21
C	-3	21961-50502	SEAT, SPRING	2		
C	-4	21961-50418	SPRING	2		
C	-5	21961-50513	SEAT,SPRING	2		
B1	-6	21963-50611	CAP ASSY	2		
(B1)	-6-1	21961-50716	CAP	1		
A1	-6-2	95123-04500	O-RING	1		JIS B 2401,1B,G45
(B1)	-6-4	92703-12400	BOLT,SCH.	4		JIS B 1176, M12” 40L
(B1)	-6-5	96321-06350	BALL STEEL	1		JIS B 1501,1/4
(B1)	-6-6	21961-60411	SPRING	1		
(B1)	-6-7	21961-60611	PLUG	1		
A1	-6-8	95113-00800	O-RING	1		JIS B 2401,1B P8
(B2)	-7	21963-40150	VALVE ASSY. RELIEF	2		
(B2)	-7-1	21962-40305	HOUSING S/A, RELIEF	1		
(B2)	-7-2	21961-41009	POPPET	1		
(B1)	-7-3	21961-41112	SEAT. POPPET	1		
(B2)	-7-4	21961-40522	SEAT, SPRING	1		
(B2)	-7-5	21961-40433	SPRING	1		
(B2)	-7-6	21961-40627	PLUG	1		
(B2)	-7-7	21961-99032	SCREW,SET	1		
(B2)	-7-8	93367-12072	NUT	1		JIS B 1181, M12
A1	-7-9	21001-00182	O-RING	1		AS568-916 HS 90
A1	-7-10	95113-01500	O-RING	1		JIS B 2401,1B, P15
A1	-7-11	95712-01500	RING, BACK-UP	2		JIS B 2407,P15,T2
(B2)	-7-12	21961-41508	GUIDE SPRING	1		
(B2)	-7-13	95113-01250	O-RING	1		JIS B 2401, 1B, P12.5
(B2)	-7-14	91712-01250	RING,BACK-UP	1		JIS B2407,P12.5 T2
(B2)	-7-15	21961-41414	PISTON	1		
A1	-7-16	95113-02100	O-RING	1		JIS B 2401,1B,P21
A1	-7-17	95173-12100	RING,BACK-UP	2		KIS 2407,P21,T3
D	-8	15096-01010	PLUG	6		NPFT 1/16
C	-9	97123-02111	PLUG	2		PT 1/4
C	-12	20461-55801	VALVE	1		
C	-13	20001-00743	CONNECTOR	1		
A1	-14	95113-01400	O-RING	1		JIS N 2401,1B,P14
C	-15	20461-52406	PLUD	1		
A1	-16	95113-01800	O-RING	1		
C	-17	20461-51305	SPRING	1		JIS B 2401,1B,P18
D	-18	20461-32414	PLUG	2		
D	-19	21961-40802	ORIFICE	2		
C	103	20461-50203	SHAFT	1		
B3	104	20461-51506	BLOCK CYLINDER	1		
B3	105	20461-52306	PLSTE,VALVE	1		
B3	106	20462-50106	PISTON ASSY.	9		
(B3)	-1	20461-50503	PISTON	1		
(B3)	-2	20462-51403	MSHOE S/A	1		
B1	107	20461-51103	PLATE RETAINER	1		
B4	108	20461-57703	HOLDER RETAINER	1		
C	109	20461-57401	PLATE SWASH	1		
C	110	20461-59202	BALL STEEL	2		

PARTS LIST **MAG-150VP** **P/N: 20450-65037**

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CLASS	ITEM NO.	DRAWING NO.	DESCRIPTION	QTY	MATERIAL	REMARKS
C	111	20462-50107	PISTON ASSY.	2		
(C)	-1	20461-50504	PISTON	1		
(C)	-2	20462-51405	SHOE ASSY.	1		
C	112	20461-56903	BEARING, ROLLER	1		
C	113	20461-56902	BEARING, ROLLER	1		
C	114	20461-58601	RING, SNAP	1		
C	116	20461-51306	SPRING	1		
C	117	20461-51406	COLLER	1		
C	118	20461-50801	PIN	1		
C	119	20461-50803	PIN	3		
C	120	92703-12500	BOLT, SCH.	14		JIS B 1176, M12* 50 L
C	121	20631-42102	SEAL OIL	1		TCN40-62-11 (NOK)
A1	122	20941-63104	O-RING	1		AS568-266, HS70
A1	123	20461-65204	O-RING	1		AS568-226, HS90
A1	124	20461-55205	O-RING	1		AS568-263, HS90
C	125	20461-59401	PISTON BEAR	1		
C	126	20461-51803	COLLAR	1		
C	127	20461-59601	PLATE FRICTION	3		
C	128	20461-59501	DISC	2		
C	129	20631-20815	PIN	2		10*22L
C	130	20461-51302	SPRING	8		
A1	131	20461-65201	O-RING	1		AS568-264, HS90
A1	132	20461-55206	O-RING	1		AS568-261, HS90
A1	133	20461-65206	RING,BACK-UP	1		SUN-3WG, AS568-26
A1	134	20461-65107	RING, BACK-UP	1		SUN-3WG, AS568-26
A1	135	95113-00700	O-RING	3		JIS B 2401, 1B, P7
D	136	15096-01010	PLUG	1		NPTF 1/16
D	137	20461-32414	PLUG	4		
C	138	20461-51310	SPRING	4		
D	139	21961-40802	ORIFICE	1		
A1	140	95113-01800	O-RING	2		JIS B 2401, 1B, P18
C	141	20461-52403	PLUG	1		
C	142	20461-51307	SPRING	2		
B5	143	20461-51903	SHIM	3		T=0.05
B5	144	20461-51904	SHIM	3		T=0.1
B5	145	20461-51905	SHIM	3		T=0.2
C	146	20461-52416	PLUG	2		
A1	147	95113-02900	O-RING	2		JIS B 2401, 1B, P29
C	148	20461-52406	PLUG	1		
B	200	20940-65405	GEAR,BOX	1		RGC-150VP-50
C	201	20943-60104	HOLDER, A S/A	1		
C	-1	20941-61006	HOLDER A	1		
C	-2	20941-61605	GEAR, PLANETARYA	3		
C	-3	20946-80708	BEARING, NEEDLE	3		
C	-4	20941-61907	SHAFT, GEAR A	3		
C	-5	20946-49010	WASHER, THRUST	6		
C	-6	93711-40221	PIN, SPRING	3		JIS B 2808, 4*22L
C	202	20943-60105	HOLDER B S/A	1		
C	-1	20946-89706	HOLDER B	1		
C	-2	20946-89706	GEAR, PLANETARY B	4		
C	-3	20946-83404	GEAR, NEEDLE	4		
C	-4	20941-61908	SHAFT, GEAR B	4		
C	-5	20946-89707	WASHER, THRUST	8		
C	-6	93771-40221	PIN, SPRING	4		JIS B 2808, 4*22L
C	203	20943-60106	HOLDER, C S/A	1		
C	-1	20941-61202	HOLDER C	1		
C	-2	20946-89709	GEAR, PLANETARY C	4		
C	-3	20941-60409	ROLLER	68		

PARTS LIST **MAG - 150VP - 3600** **P/N : 20450 - 65037**

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CLASS	ITEM NO.	DRAWING NO.	DESCRIPTION	QTY	MATERIAL	REMARKS
C	-4	20941-61909	SHAFT, GEAR C	4		
C	-5	20946-98712	BUSHING, FLOATING	4		
C	-7	20946-89714	WASHER, THRUST	8		
C	-8	93711-50251	PIN, SPRING	4		JIS B 2808, 5*25L
C	204	20941-61306	GEAR, DRIVE	1		
C	205	20946-89721	PLATE, THRUST	1		
C	206	20946-89706	GEAR, SUN B	1		
C	207	20946-89722	RING, SNAP	1		WR105N (NTN)
C	208	20946-89717	GEAR, SUN C	1		
C	109	20946-89723	RING, SNAP	1		WR115(NTN)
D	210	20941-60105	FLANGE	1		
A2	211	20366-99837	SEAL, FLOATING	1		
C	212	10846-89720	BEARING, SNGULAR	2		
D	213	20946-89719	HOUSING	1		
B6	214	20946-89725	SHIM	1		T=1.0
B6	214	20946-89726	SHIM	1		T=0.5
B6	214	20946-89727	SHIM	1		T=0.3
B6	214	20946-89727	SHIM	1		T=0.1
B6	214	20946-89729	SHIM	1		T=0.05
C	215	20946-89730	PIN	4		
C	216	92703-16900	BOLT, SCH.	4		JIS B 1176, M16*90L
C	217	92703-18550	BOLT, SCH.	16		JIS B 1176, M18*55L
C	218	20946-89731	PLATE	4		
C	219	20946-91624	GEAR RING	1		
A2	220	20946-89732	O-RING	1		
C	221	92703-14950	BOLT, SCH.	16		JIS B 1176, M14*95L
C	222	20946-89733	PIN	3		
B7	223	20941-62305	PLATE THRUST	1		T=1.8
B7	233	20941-62306	PLATE THRUST	1		T=2.3
B7	233	20941-62307	PLATE THRUST	1		T=2.8
B7	233	20941-62308	PLATE THRUST	1		T=3
B7	223	20941-62309	PLATE THRUST	1		T=3.2
C	224	20946-89734	COVER	1		
C	225	92703-10200	BOLT, SCH.	16		JIS B 1176, M10*20L
C	226	97123-04111	PLUG	3		PT 1/2
C	227	97123-02111	PLUG	1		PT 1/4
C	228	97123-01111	PLUG	1		PT 1/8
C	231	94101-16401	WASHER, SPRING	4		JIS B 1251, M16
C	300	92703-12800	BOLT, SCH.	3		JIS B 1176, M12*80L
D	400	20631-33836	PLATE, NAME	1		
D	500	91911-01489	SCREW, DRIVE	1		1.85*4.8L
C	600	20946-92640	COUPLING	1		
C	601	3711-60501	PIN, SPRING	1		JIS B 2808, 6*50L
D	700	21001-01041	PLUG, SHIPPING	1		
D	800	99001-03100	PLUG, SHIPPING	2		
D	900	21001-01230	PLUG, SHIPPING	1		

CLASS	DESCRIPTION
A	PARTS WHICH SHOULD BE REPLACED AT DISASSEMBLY AND THOSE WHICH WILL BE SUPPLIED AS REPAIR KIT
B	PARTS WHICH WILL BE SUPPLIED AS ONLY MATCHING PARTS DUE TO QUALITY ASSURANCE REASON AND FOR THE CONVENIENCE OF ASSEMBLY
C	PARTS WHICH WILL BE SUPPLIED ON SINGLE PART BASE
D	PARTS WHICH ARE NOT REGARDED AS REPAIR PARTS

PARTS LIST **MAG-15-VP-3600** **P/N : 20450-65037**

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HANDLING / MAINTENANCE MANUAL

MODEL : MSF-l50VP
(FOR MAG- 150VP-3600)

NAME : PISTON MOTOR

KAYABA P/N : 20460-51424
or
KAYABA P/N : 20640-51435

KYB

KYB CORPORATION OF AMERICA

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MSF-150VP

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1. Introduction

This manual describes construction, principle of operation and handling method of the piston motor MSF-150VP which has been developed for travelling motors of construction machines, in order to protect mis-handling and maintain their good performance during a long period.

2. Outline

2.1 Features

a) A parking brake is built into the motor and prevents the machine (vechicle) from going back on a slope, and makes a mechanical brake work positively when the machine is parked or stopped.

b) This motor is designed with good hydraulic balance maintains stable performance over a long period and excels in mechanical efficiency,volumetric efficiency,starting torque efficiency and slip performance.

c) This motor is,in its design,compact and light-weighted and self-contained type of reduction gear.

d) This motor displays high durability even under severe conditions.

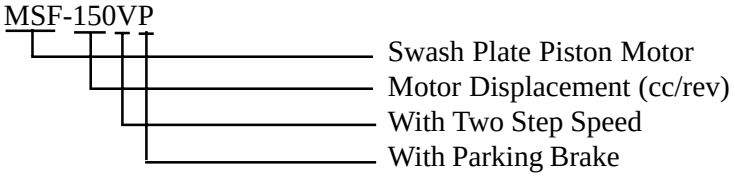
e) A double counter balance valve and cross-over relief valves are unified compactly and perform as hydraulic brake.

f) A double counter balance valve as built in this motor can control the travel speed according to the amount of oil flow supplied and over-runnning of motor can be prevented.

g) Cross-over relief vaives as built in this motor perform shock-less function,alleviate shock at time of start and stop, and thereby providing a good ride.

h) Two step speed mechanism as built in this motor can provide two travel speed.(high ant low)

2.2 Model Indication



2.3 Specification

Displacement	Motor		152.9 / 96.6 cc / rev
Cross-over Relief Valve	Cracking Pressure		345 kgf / cm2 at 1.2 1 / m
	Full Flow Pressure		360 kgf / cm2 at 40.0 1/m
Double Counter Balance	Plunger Changeover Pressure		7.0--10.0 kkgf /cm2
	Check VAlve Cr-cking Pressure		Less than 0.3 kgf /cm2
Two Step Speed Control Valve	Pilot Pressure		More than 10 kgf /cm2
Parking Brake	Brake Torque	Static	More than 2030 lgf -m
		Dynamic	More than 1450 kgf-m
	Parking BRake Release Pressure		Less than 13 kgf /cm2
Hydraulic Fluid			ISO vg 32-56
Dry Weight			kg

3. Operation and Function

Refer to the hydraulic circuit of a piston motor.

The piston motor is including the following functions.

1) Parking Brake
2) Double Counter Balance Valve.
3) Relief Valve(w/ shockless)
4) Two Step Speed Control

3-1. Principle of Operation(Motor)

Fig-2 shows the structures of the MSF motor.
Nine pistons are built in the cylinder block which is in contact with the valve plate having two kidney-shaped ports, “B” and “C”.(suction and delivery port)

When the pressurized oil is distributed to “B” port, the piston is pushed and force(F) is generated on the swash plate. The cylinder block is rotated by the component force(Ft) of the force(F) which is generated in the rotary direction. When the pressurizzed oil is delivered to “C” port, the motor is rotated reversely.

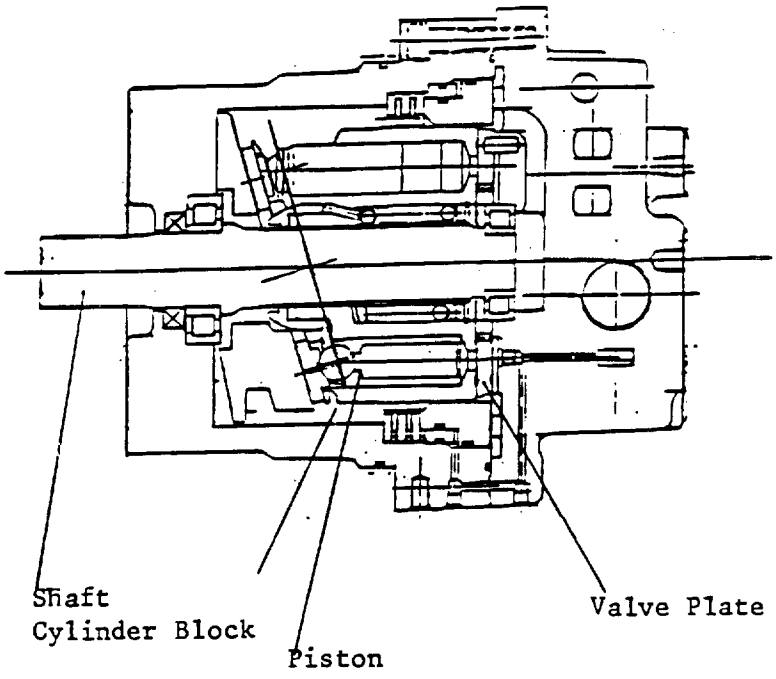
Output torque and speed of the motor is determined by the pressure and the inlet flow, as follows.

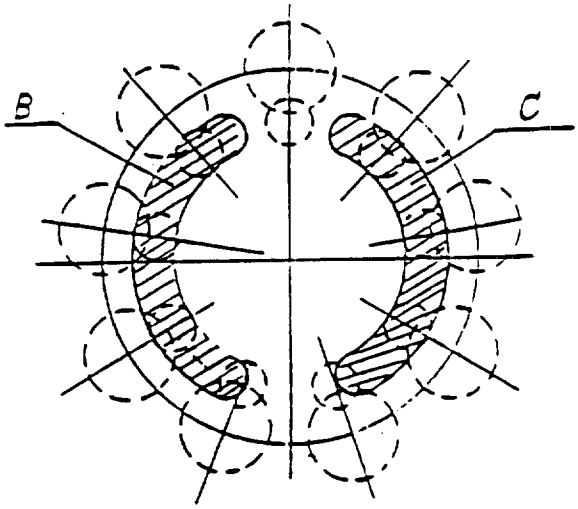
$$T = \frac{P \times D \times \eta m}{2 \times \pi \times 100}$$

T: output torque(kgf-m)
P: differential pressure(kgf/cm²)
D: theoretical displacement of motor (cc/rev)
ηm: mechanical efficiency(% x 10 -²)

$$N = \frac{Q \times 1000 \times \eta \surd}{D}$$

N: speed (rpm)
Q: inlet flow to motor(1/min)
$\eta \surd$: volumetric efficiency(76 x 10 ²)
D: theoratical displacement of motor (cc/rev)





3-2. Principle of Operation(Parking Brake)

The parking brake is composed of disc, brake piston, and spring.
Refer to Fig-1.

By pressurizing the cylinder chamber for releasing the brake through (P3) port, the force proportional to the piston area is generated and pushes the brake piston, and the brake is released. When the fluid in the cylinder chamber for brake-releasing is connected to the tank, brake force is applied by the spring force.

3-3. Principle of Operation(Brake Valve)

3-3-1. Double Counter Balance Valve

1). Counter Balance Valve

By controlling the return flow to keep the primary pressure(P1 or P2) constant, this valve can control the motor speed when the motor is driven as a pump. Due to that, the valve can control the travel speed according to the amount of oil flow supplied and prevent over-running.
When the directional cotrol valve is in neutral position, the spool of this valve is also in neutral position and motor does not rotate.

2). Shuttle Valve

When the spool is moving from the neutral position, a port for parking brake release is open and pressurized oil flows to the chamber to release the parking brake.
When the motor is stopped, the port for parking brake release is closed and the drain port to the motor housing is open, then ressurized oil in the chamber of parking brake flows to the motor housing and the parking brake is operated by the spring force.

3-3-2. Relief Valve

A relief valve is used to determine the driving force and the braking capacity of an excavator at the time of its travelling.

This relief: valve is the valve with shock-less fuction by which generated shock at the time of acceleration and deceleration is reduced.

This relief valve consist, of
(a) differential area direct type relief valve
(b) shock-less piston.
as shown in Fig-3.

The relief valve works in the following two steps when this piston motor is driven and braked.

First Step

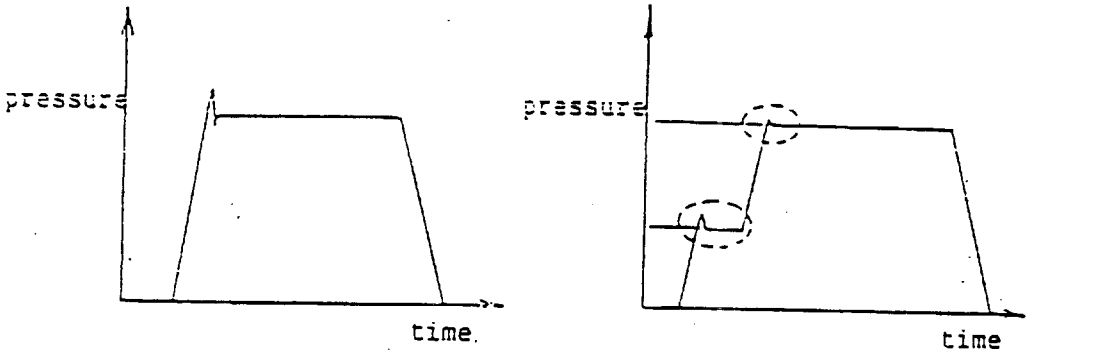
There are an orifice between “A” chamber and “B” chamber, and a hole between “B” chamber and “C” chamber. The oil passage between “C” chamber and “D” chamber is a groove around the free piston, and “D” chamber is connected to the tank port while the free piston is moving.

When “A” chamber is pressurized, the pressure in “B” and “C” chambers increases and the free piston is moved to the left as shown in Fig 3-2. Low pressure(=abt. F/S1) is maintained while the free piston is moving. The valve’s low pressure retaining time is determined by poppet orifice diameter, piston area, and piston stroke.

$P1 >> Pb$, $Pb = Pc$, $Pd = 0$, $P1 \times S1 = F + Pb \times S2$

Second Step

When the free piston reaches the stroke end, the pressure (Pb) increases and becomes to the pressure P1.
The relief valve works at F/(S1 - S2).



Conventional Type　　Shock-less Type　　Fig-4

Since the operation time of the relief valve for the first step is set for about 0.1 second, there is no difference in travelling and breaking capacities between our valve and other convensional type valve. By installing this valve, effects such as less stress applied on the reduction gear and low noise are expected.

Setting pressure of relief valve vs. Adjusting screw about 88 kgf/cm^2 /turn

Since proper pressure is set at the time of shipment from our factory, do not adjust the setting pressure as far as the valve is operated normally.

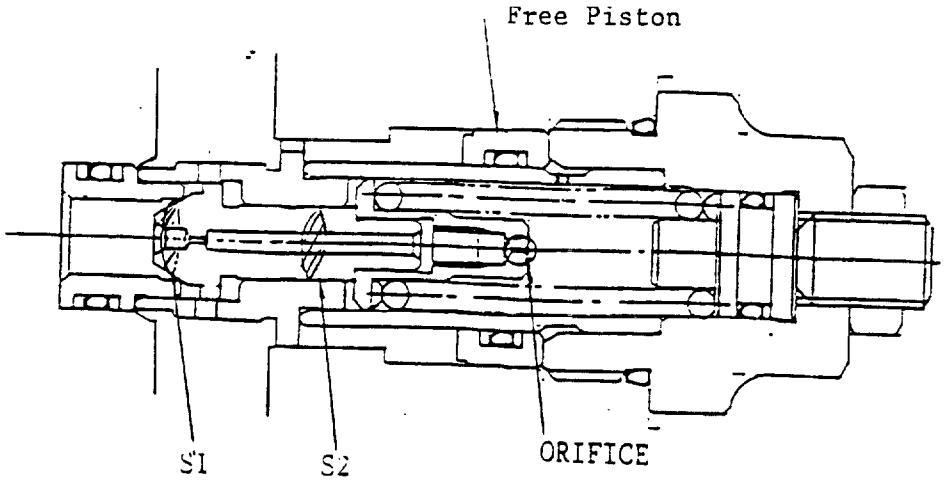
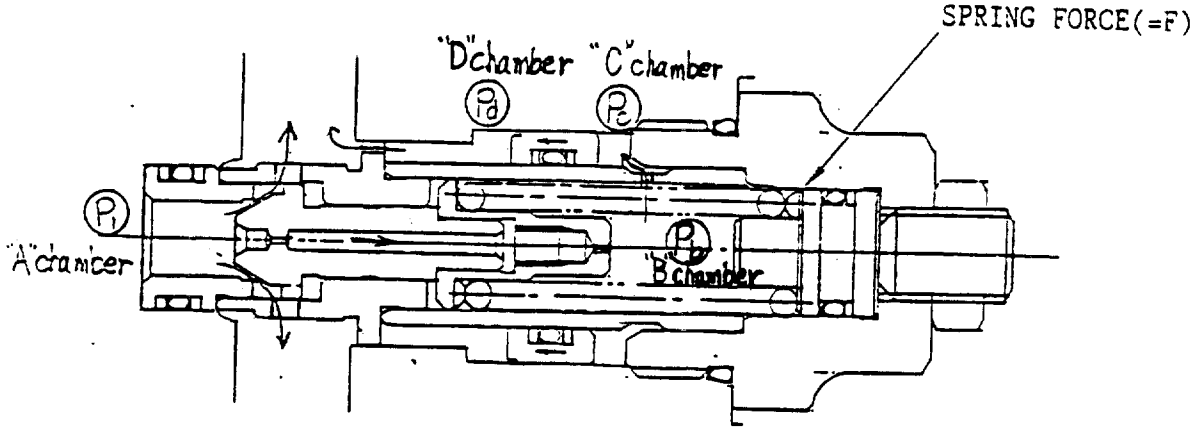
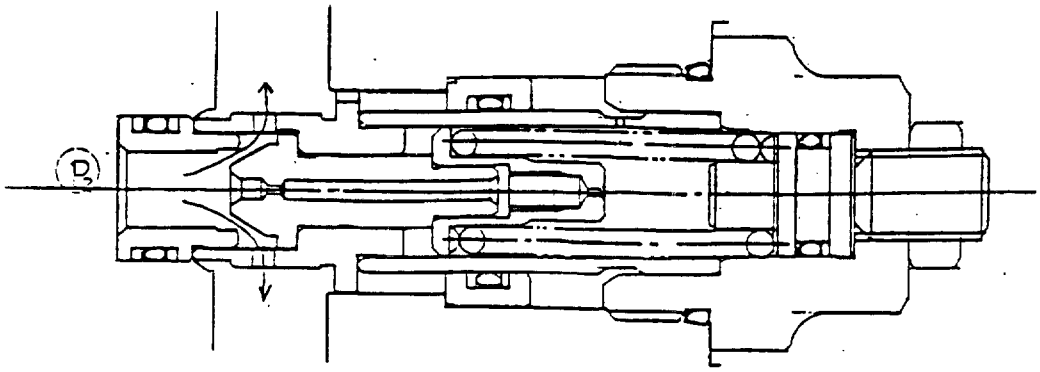


Fig 3-1



FIRST STEP Fig 3-2



SECOND STEP Fig 3-3

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3-4. Principle of Operation(Two Speed Control)

Two speed control system is composed of two speed change valve(hereafter called “VALVE”), two speed control piston(hereafter called “PISTON”) and swash plate.

The swash plate has three machined faces(A,B and C) as below and this swash plate is supported with two steel balls. those two steel balls allow the swash plate to change the angle as a fulcrum.

When the pilot pressure is operated from PS port, the VALVE is shifted to the position of Fig 5-2 and the motor operating pressure is applied to the PISTON. According to that, the swash plate is moved and changed the angle until the resultant force between the thrust force (FP) on nine pistons and the spring force(FS) is balanced to the thrust force(FC) of PISTON.

The swash plate should be stable after the machined face”B” cotact to the the housing. Then, the swash plate angle is ß and the motor has a high speed.

When the pilot pressure is cut, the VALVE is shifted to the position of Fig5-1 and the chamber of PISTON is connected to the drain line of motor. According to that, the swash plate is moved by a resultant force between thrust force(FP) and spring force(FS), and changed the angle until the machined face”A” contact to the housing. then, the swash plate is (X and motor has a low speed.

In case of no pressure, the swash plate is moved by the spring force(FS) and changed the swash plate until the machined face”A” contact to the housing. then, the swash plate angle is (X and the motor speed has a low speed.

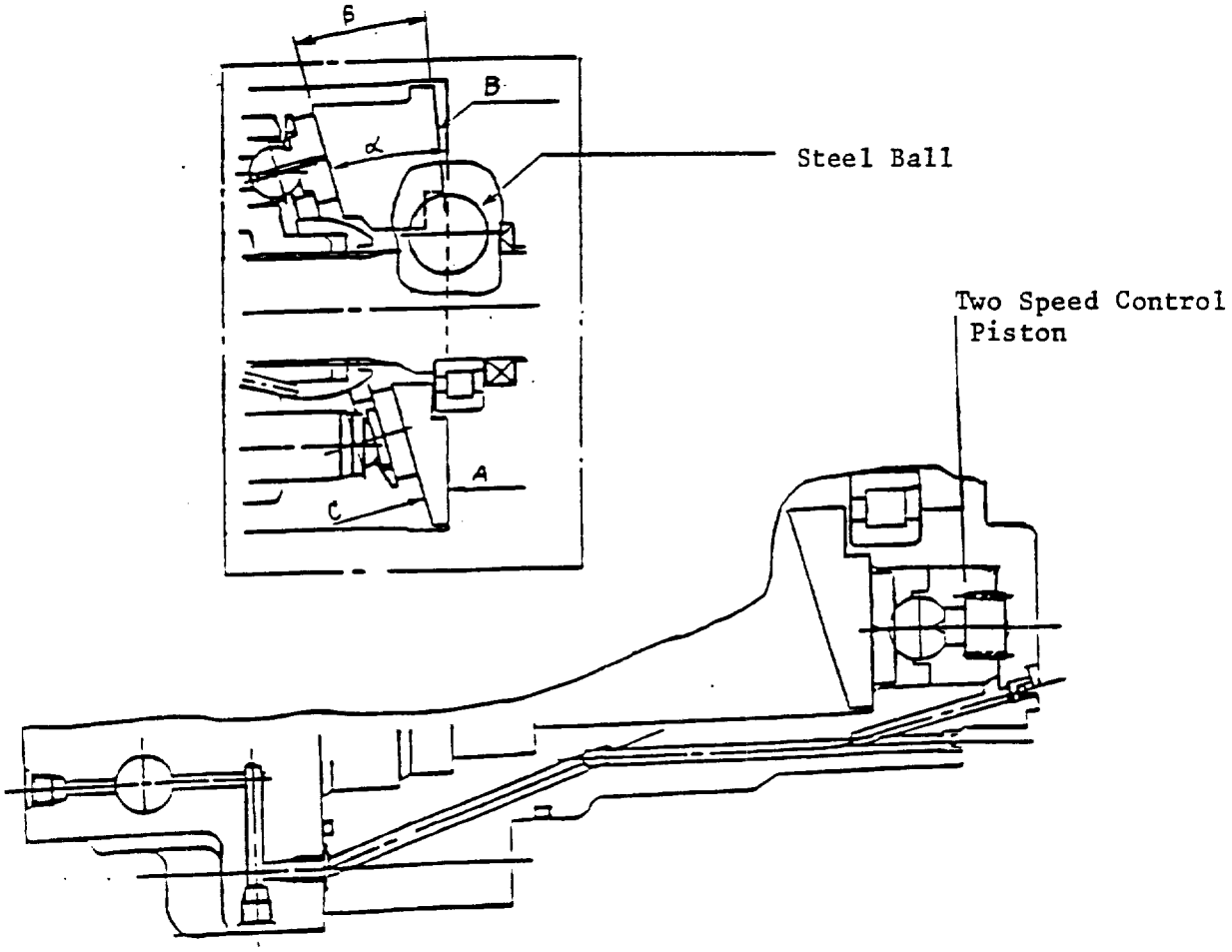
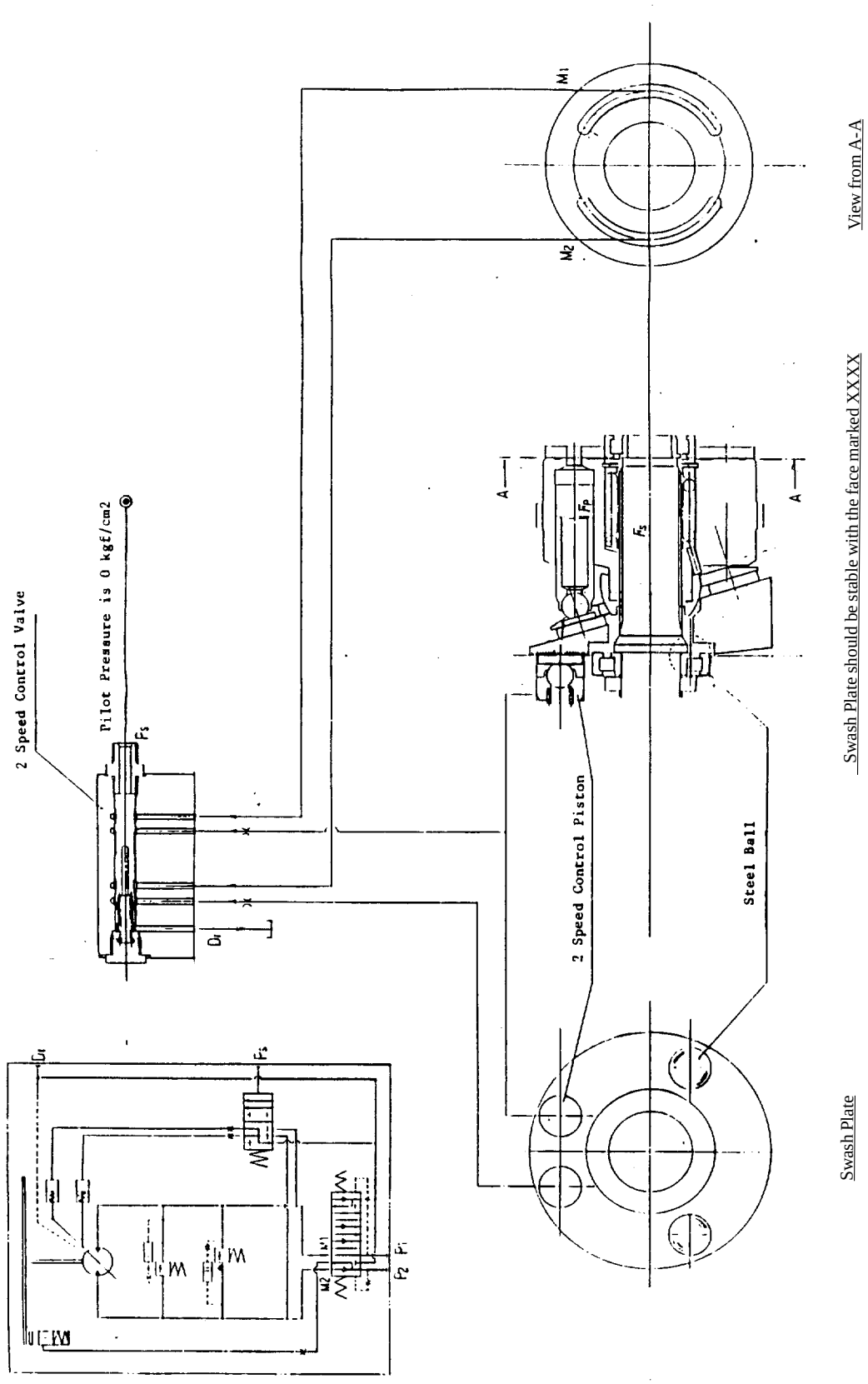


Fig 5-1 Low Speed Condition



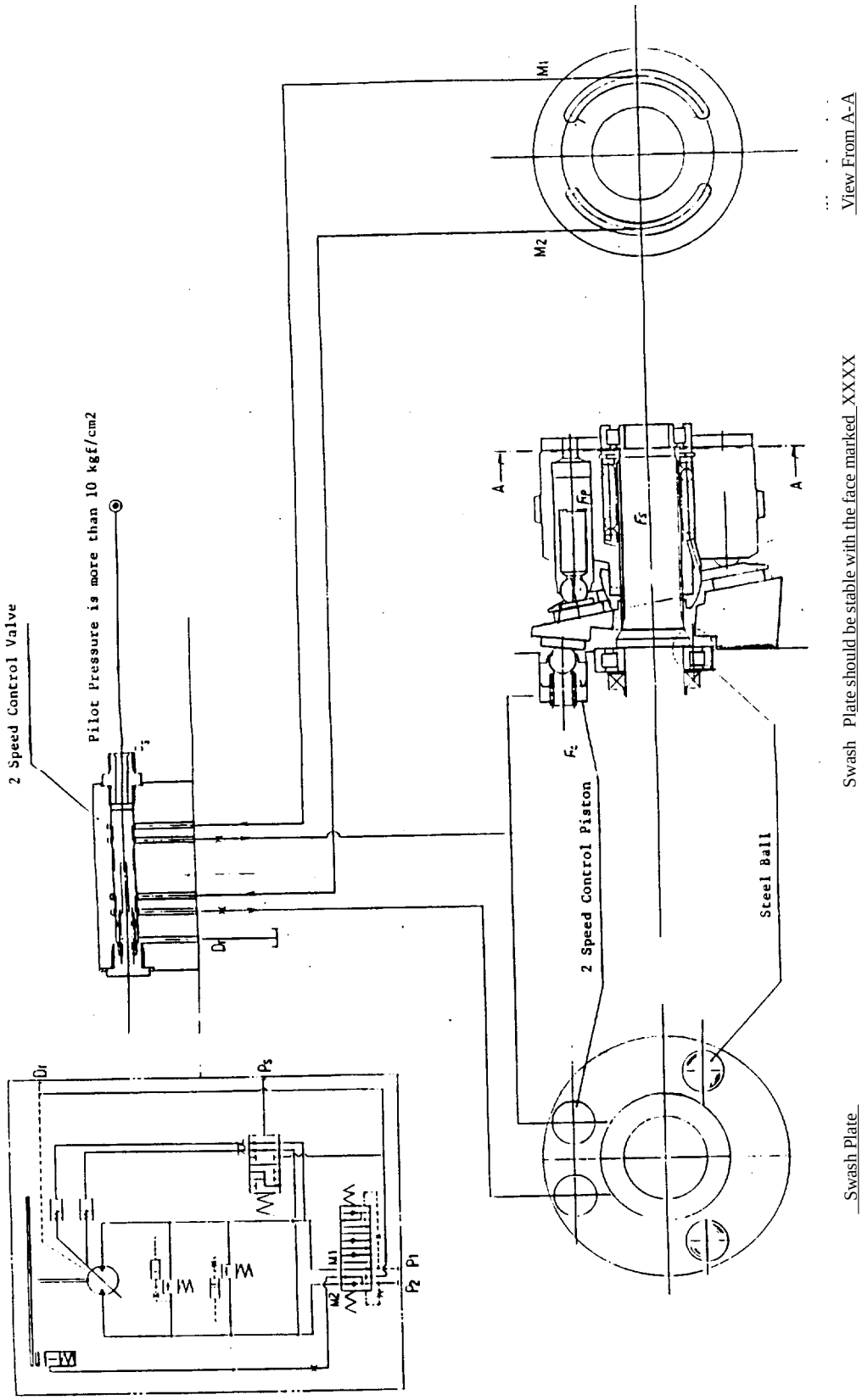


Fig 5-2 High Speed condition

4. Proper Handling

4-1. Checking

Check the following before the piston motor is installed.

a) Are these any portions of the motor damaged during the transportarion? Are these any missing parts?

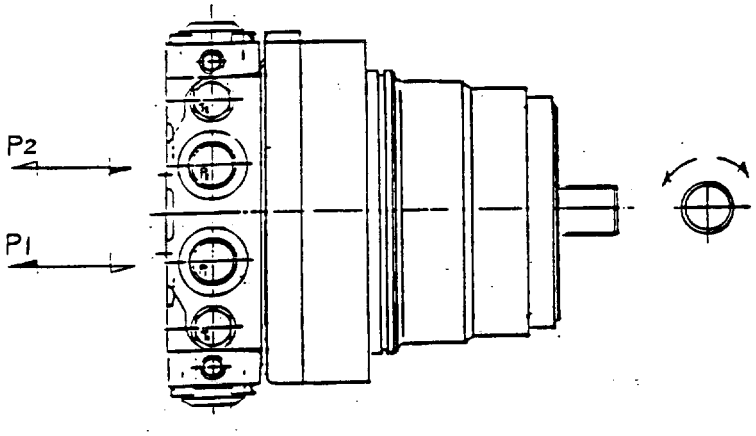
b) Are the bolts for tightening the motor loosened?

c) Are these ant foreign articles inside the motor

4-2. Direction of Rotation

The relation between the direction of the oil folw and the rotation is shown in the following table.

Inlet Port	Outlet Port	Direction of Rotation (shovrn from ;he motor output shaft)
P 1	P2	clockwise
P2	P1	anti-clockwise



4-3. Shaft Load

Do not apply the thrust and radial load on the output shaft.

4-3. Hydraulic Oil

4-4-1. Hydraulic Oil

The hydraulic oil plays an important role in transmitting the power and lubricating each portion of the hydraulic components. The selection and handling Of the oil have influence on the perrormance and life span of the hydraulic components.

In general, Ther oil to be used is required to have excellent lubrication characteristic, oxidation stability, anticorrosiveness, and antiemulsification. Properties not eroding packings and seals are necessary.
Take care not to mix the hydraulic oil with the oil of different property.

4-4-2. Viscosity Range

	Viscosity	Oil Temperature
Appropriate	25 - 100 cSt	23 - 55 °C
Practical	20 - 500	-1 - 62 °C

Operate it in idle with no load when starting at low temperature.
Oil temperature range - 20 - 90 °C

4-5. Filter

The piston motor is so designed that each of its parts is high in accuracy, clearance(gap) among parts is very much limited, and parts are much sensitive to foreign matters, such as sludge, iron powder, rust, filings ,grinding powder, etc. Therefore, performance deterioration of the piston motor and wear in the sliding parts can be avoided by keeping the oil clean.
Contamination control of the oil should be done within “NAS” class 9 or cleaner by installing a proper filter, which provides durability and reliability of the motor with less maintenance.
Use a nominal 10 micron filter or finner at the appropriate place in the pressure line or return line of the piston pump.
Use filter(s) with a visual indicator by which the clogging is found from the outside, and with a relief valve which by-passes the oil when the filter element is clogged.

4-6. Mounting and Piping

4-6-1. Mounting
This piston motor is assembled with a reduction gear. Refer to the Manual No. GB-MS-62-13 for assembly procedure.

4-6-2. Piping

o acid-cleaning and remove scales inside the tubes prior to the assembly.

b) Ensure that foreign articles will not enter into the piston motor case from each port during the piping work.

c) Flush fully after piping.

d) Drain pressure in the piston motor case should be maintained within 2 kgf/cm² at regulated flow.

e) Return the drain piping directly to the reservoir.

Note: Drain pressure in the piston motor case should not exceed continuous pressure 2 kgf/cm² intermittent 5 kgf/cm².

f) This piston motor case should be filled with oil for lubrication. Drain piping should be made through a higher point than the motor body.

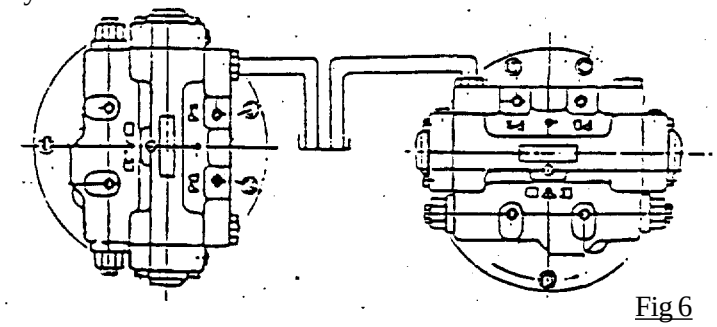


Fig 6

4-7. Do the following before and after start-up.

a) Fill the piston motor with the clean oil before operation.

required oil volume about 400cc

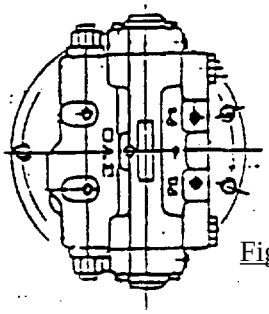


Fig 7

b) Remove air from the hydraulic circuit.

c) Operate the motor at low speed at first and confirm if there is any abnormal sound and vibration. After that, operate under full load and prescribed speed.

d) Check the following during operation.
1. Is there any oil leakage?
2. Are the direction of rotation and number of rotation correct?
3. Is the oil temperature increased abnormally?
4. Are there any abnormal sound and vibration?

5. Periodical check and replacement

5-1. Hydraulic Oil

Although hydraulic oil is clean at first, it will be dirtied with sediment such as sludge in the circuit and the tank after a long operation. The hydraulic components may be damaged by deteriorated oil. The oil itself deteriorates gradually, lubrication characteristic is worsened, and wear at the sliding portion progresses.

Therefore, it is recommended to check the oil period the degree of deterioration, and replace the oil with

However, it is difficult to grasp the degree of contamination or deterioration of the oil at the working places. Then, visual assessment of the oil is described below for your reference.

It is recommended to replace the oil with new one at about 500 hours after use. For replacement of the oil, use new oil after cleaning inside the tank, flushing inside the pipings, and removing the deteriorated oil, sludge, and water from the tank.

Appearance	Smell	Judgement	Measure to be taken
transparent(no color change)	good	good	Use as it is
transparent (small black dots)	good	foreign matter mixed	Use after filtration
changed to milky white	good	moisture mixed	Replace oil
changed to black	foul	oxidized and deteriorated	Replace oil

5-2. Filter

When the filter element is clogged, filtration characteristic is lowered. It is, therefore, necessary to check the oil periodically.

Check the filter after initial 50 hours operation and every 250 hours operation thereafter. If the indicator shows clogging of the element, replace the element with the new one. When the filter without differential pressure indicator is used, it is recommend to replace he filter element after initial 50 hours and every 250 hours thereafter.

Whenever the oil is changed, the filter element should be replaced at the same time.

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6. TROUBLESHOOTING

6-1. Piston Motor

Troubles	Causes	Countermeasures
IMotor Fails to Rotate	1. The components other than the piston motor and the reduction gear don't work properly	Check if the inlet port of the motor is pressurized or not, and repair it thereafter.
	2. Presurized oil is leaked by abnormal wear at the sliding portion of the motor	Replace worn parts with new ones. Reassemble after removing scratch an burr, and clean all parts completely
	3. Seizure of the parts caused by damages of motor's min parts	Disassemble and replace damage parts. After cleaning all parts thoroughly , reassemble to prevent foreign particles from entering
	4. The relief valve is operating , because of overload of the motor	Check the load, and lower the load Check oil low at the inlet port of the monitor, and repair the components thereafter.
II Number of Revolution is Different from the Planned Value	1. Insufficient inflow caused by the oil pump and the pressure control valve.	
	2. Deterioration of pump volmetric eficiency.	Check if there is abnormal leakage on sliding portions, thereafter repair or replace worn parts.
IIIMotor Rotates at Unstable Speed.	1. Pressurized oil in large amount is flowed to the drain line , because of wear on the motro's sliding portion.	Reassemble and replace worn parts. Clean all parts completely and reassemble the components to prevent fprin particles from entering the motor.
IV Oil Leakage	1. Oil seal and "O" ring damage	Replace it with a new one. Pay attention not to damage the lip of the new seal at the time. If oil temparature exceeds 80°C, an oil cooler should be installed in the circuit.
	2. Oil seal damaged for reasons mentioned in (I-2) (III-1) Oil seal (Pressure) intermittent max 5kgf/cm2 continious max 2kgf/cm2	Repair the motor acorrding to the countermeasures taken against (I-2) and (III-I) and replace the oil seal with a new one. Pay attention not to damage the lip.

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Troubles	Causes	Countermeasures
(Oil Leakage)	3. Oil seal damaged because of high back pressure in the drain Life (clogs by foriegn articles, and thin and long pipings,etc.	Remove clogs in the drain pipings. Reduce pressure loss in the pipes by changing the piping size. Replace with new one thereather. Pay full attention not to damage the lip.
VAbnormal Noise, Large Flictuation in Rotating Speed and Pressure Caused by Cavitation	1. Boost predssure in the closed circuit is lower than kgf/cm² when the motor is in sucking operation. When a double counter balance valve is not working properly, inlet port of the motor is in minus pressure and cavitation is generalized	Check the oil hyraulic circuit and avoid minus pressure by repairing or replacing the the double counter balance valve. Thereafter, disassembled the motor, replace worn or damaged parts. After that, clean all parts and reassembled them.

6-2. Parking Brake

Troubles	Causes	Countermeasures
I Shortage of Braking Force or Onesided Braking	1. Wear on the disc	Replace the disc. Therefore, remove foreigm articles thoroughly, repair damage portion, and reassemble after clearing.
	2. Deterioration on the disc surface	Grind it and reassemble after clearing. Replace it when deterioration is excessive.
	3. Permanent set or damage of the spring	Replace the spring. then, remove foreign articles and reassemble a new spring after cleaning.
II High Temparature on the Half-braked Surface	1. Brake cannot be released. 1. Oil leakage by damage "O" ring 2. Orifice is clogged.	1. Replace the damged "O" ring. 2. Reassemble it after clearing.

6-3. Relief Valve

Troubles	Causes	Countermeasures
I Motor Fails to Rotate (Stop) or Rotates (Stops) slowly.	1. The seat surface of the relief valve is damaged. 1) Foreign matters are bitten.	1) Remove foreign articles thoroughly. Damaged portions are to be reassembled. However, in case the damage is so serious, and much oil leaks thereon, replace the portions so damage with new ones.
	2) Spring is broken.	2) Replace the spring. Thereafter, remove foreign articles thoroughly. Damaged portions are to be reassembled. However, in case the damage is so serious, and much oil leaks threon, replace the portions so damaged with new ones.
	2. Cracking pressure of the relief valve is lowered. 1) Permanent set of spring 2) poppet orifice is clogged.	1)Replace the relief valve assy with a new one. 2)Reassemble it (poppet orifice) after clearing.
II Shock Given When the Machine is Stopped.	1. Shock-lessening function doen not work. 1) Foreign articles are bitten on the stock-lessening piston portion.	1) Remove foreign articles thoroughly. Damaged portions are to be reassemed. However, in case the damage is so serious, and much oil leaks thereon, replace the portions so damage with new ones.
	2) Spring is broken.	2) Replace the spring. Thereafter, remove foreign articles thoroughly. Damage portions are to be reassembled. However, in case the damage is so serious, and much oil leaks theron, replace the portion so damaged with new ones.
	2. Setting pressure of the relief valve is increased.	1) Adjusting the setting pressure again.

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6-4. Double Counter Balance Valve

Trouble	Causes	Contermeasures
1. Motor fails to rotate or rotate slowly.	1. Plunger is not shifted. 1) No pilot pressure 2) foreign articles are bitten between the plunger and the body 3) Orifice is clogged.	1) Check if the piping are damaged. 2) Remove the foreign articles completely. Repair the damaged portion and assemble them after cleaning. However, in case the damage is so serious and much oil leaks, replace them with new ones. 3) Reassemble it after cleaning.
2. Motor fails to stop or stops slowly.	Plunger is not returned 1) foreign articles are bitten. 2) Spring is broken. 3) Spring is not installed. 4) Orifice is clogged.	1) Remove the foreign articles completely. Repair the damaged portions and assemble them after cleaning. However, in case the damage is so serious and much oil leaks, replace them with new ones. 2) Replace the spring. 3) Install the spring in proper position. 4) Reassemble it after cleaning.
3. Motor rotates at unstable speed	1. Plunger is not shifted smoothly. 1) foreign articles are bitten. 2) Orifice is clogged.	1) Remonve the foreign artivles completely. Repair the damaged portions and assemble them after cleaning. However, in case the damage is so serious and much oil leaks, replace them with new ones. 2) Reassemble it after cleaning.

Troubles	Causes	Countermeasures
4. abnormal noise	1. Plunger is not returned 1) Foreign articles are bitten. 2) spring is broken. 3) Orifice is clogged.	1) remove the foreign articles completely. Repair the damaged portions and assemble them after cleaning. However, in case the damage is so serious and much oil leaks, replace them with new ones. 2) Install the spring in proper position. 3) Reassemble it after cleaning

6-5.2 speed control system

Troubles	Causes	Countermeasures
1. Motor rotates at improper speed.	1. Plunger is not shifted. 1) foreign articles are bitten between the plunger and the body 2) Spring is not installed. 3) Spring is broken.	1) Remove the foreign articles completely. Repair the damaged portions and assemble them after cleaning. However, in case the damage is so serious and much oil leaks, replace the with new ones. 2) Install the spring in proper position. 3) replace the spring.
	2. Pressurized oil is leaked by abnormal wearing of 2 speed control piston.	•Replace 2 speed control piston.
	3.2 speed control piston is not installed.	•Install 2 spedd control piston in proper position
	4. Abnormal wearing of steel balls.	•Replace the steel balls.

7-2. Disassembly Procedure

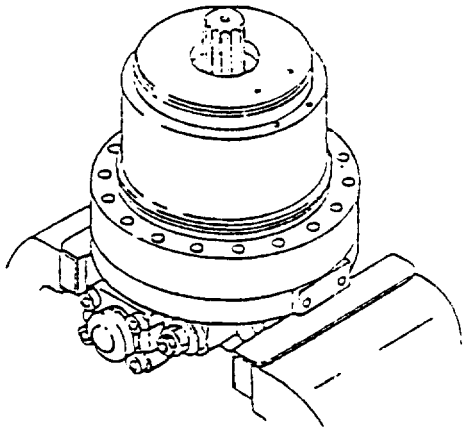
7-2-1. Caution before Disassembly

a) Be sure to remove mud, dust, etc. attached on the outside of the MAG motor. (Clean outside of the motor thoroughly.)
b) Drain all oil from the piston motor case and the port oil passage.
c) Select a working place free from dust and ensure that all parts are clean without any stain or mud.
d) Be careful for handling so that the parts may not be dented or scratched when such parts drop or contact with one another.

7-2-2. Disassembly by the following procedures

1. Motor-fixing

Fix the motor's Base Plate Portion(2) to a vice with its output shaft upside.



2.Disasembly of Base Plate S/A(sub assy.)

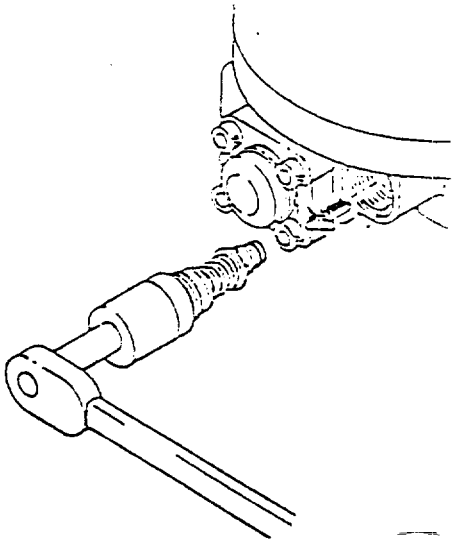
a) Disassembly of Relief Valve S/A

Loosen Plug(2-7-6) and remove Relief Valve S/A.

Plug(2-7-6) is assembled into Relief Housing S/A(2-7-1) with slight press-fitting, however, if the plug is detached, put the needle into the hole(2-3) of the relief housing s/a and **remove it while turning.**

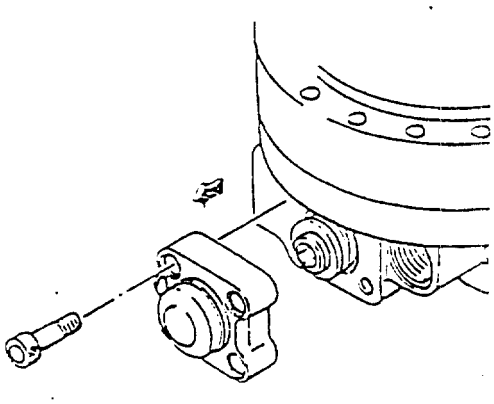
Take care not to loosen Nut(2-7-7) and Setscrew(2-7-8), When Relief Valve S/A(2-7) is disassembled. By loosening the nut and the setscrew, setting pressure of the relief valve is changed.

Don t disassemble the relief valve s/a so long as there is no need to do so.

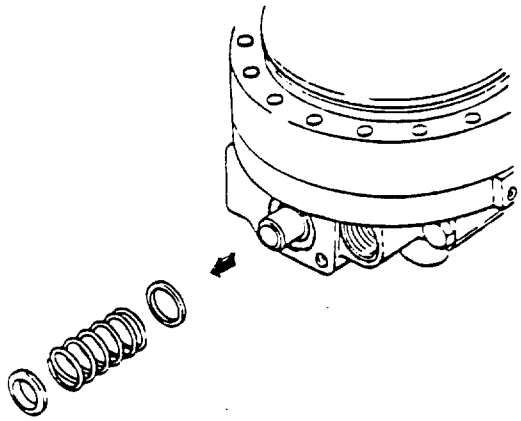


b) Disassembly of Plunger

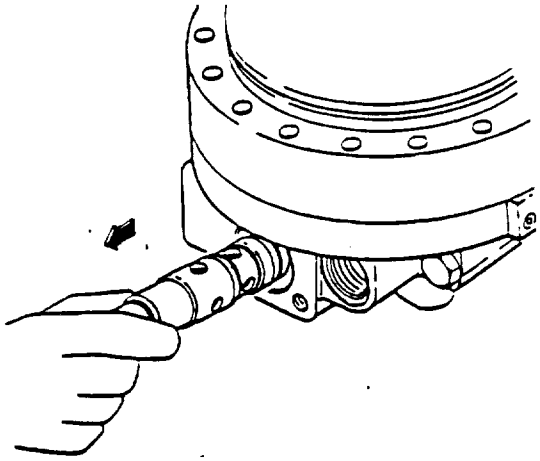
Loosen Socket Head Bolts(2-6-4) and remove Cap S/A(2-6).



Remove Spring Seat (2-5) and Spring (2-4).



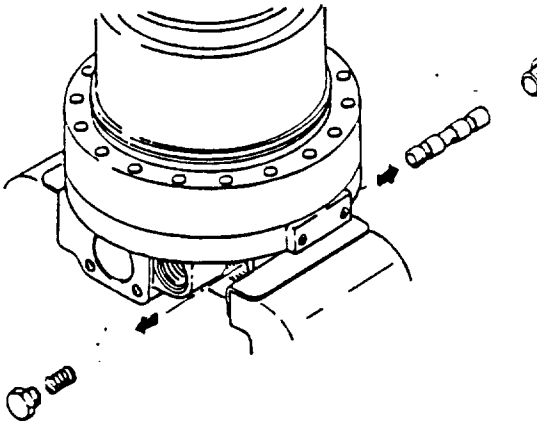
Pull out Plunger (2-2)slowly while it turning.
Remove Spring Seat (2-3) also.



C. Disassembly of 2 Speed Control Valve

Loosen Plug (2-15), (2-13) and pull out Spring (2-17) and Spool (2-12).

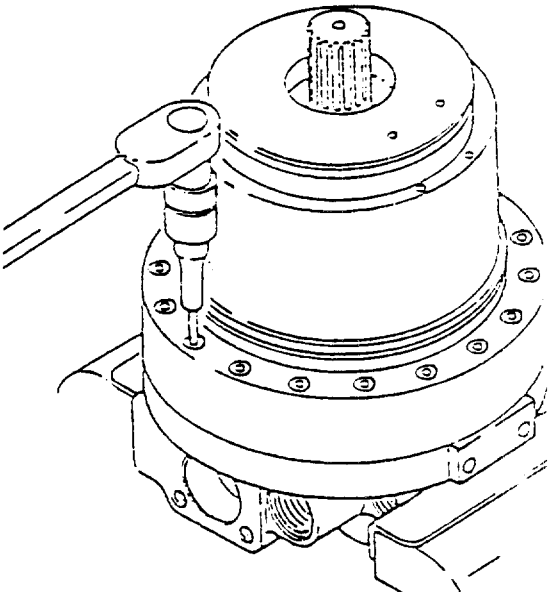
Note
Pull out the spool while it turning.



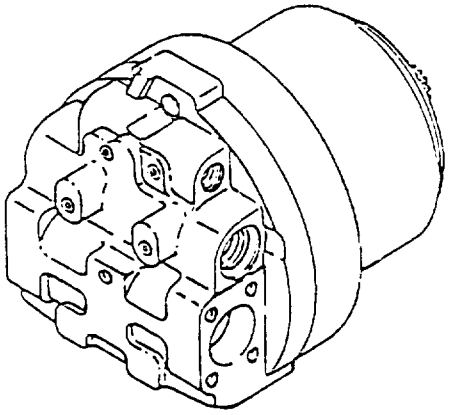
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3. Disassembly of Base Plate

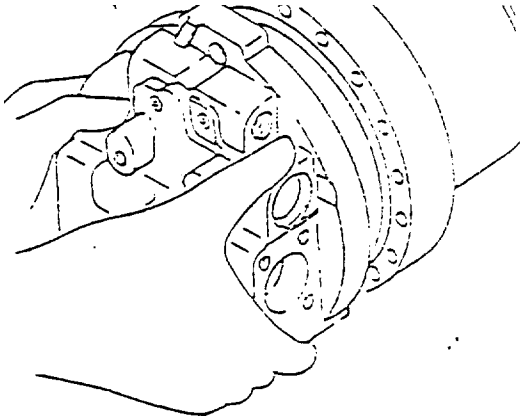
a) Loosen Socket Head bolts (20).



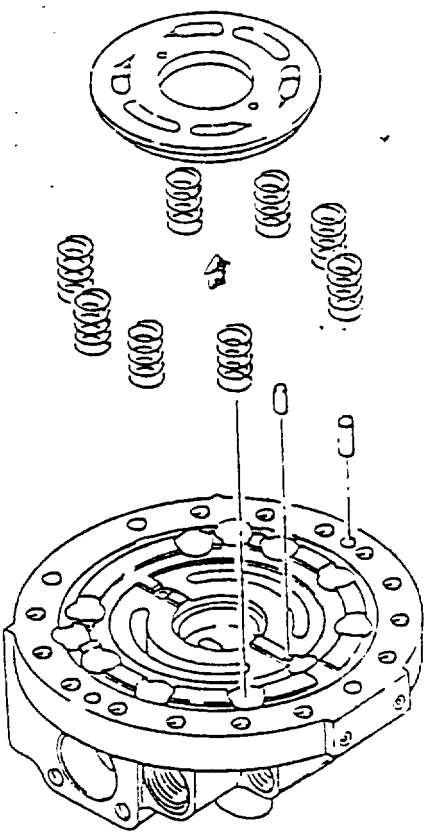
b) Take out the motor from the vice and fix it on the working table with its output shaft downside.



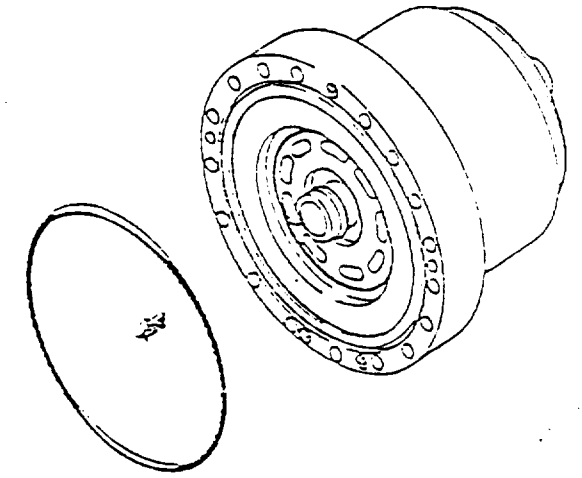
c) Unscrew Socket Head Bolts(20), and remove Base plate (2) with a driver.
Do not pry the base plate with driver.



d) Remove Valve Plat(5),Pin (18)/(29), and Spring(30) from the base plate.

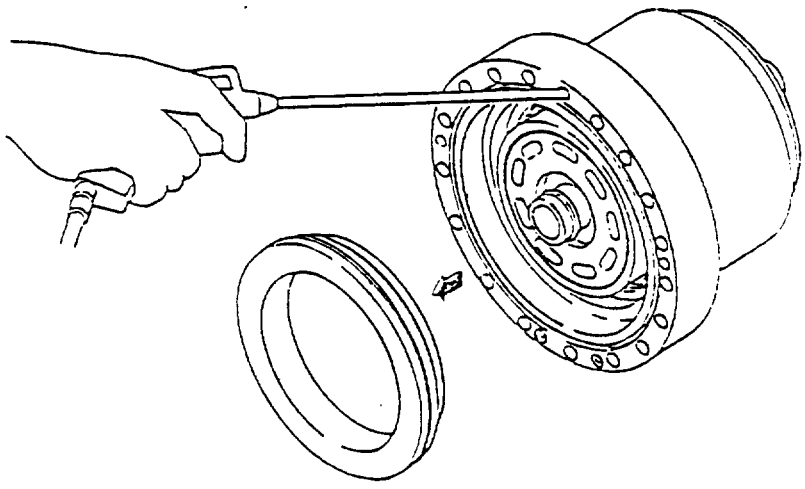


4. Remove “O’ Ring(22) from Case(1).



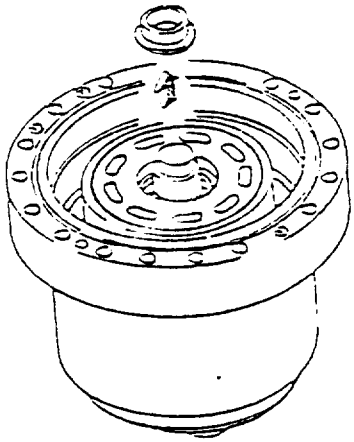
5. Disassembly of Brake Piston

Blow air to the pilot port’s hole of Case(1) to remove Brake Piston(25) from Case(1). Since the piston is ejected out occationally by the air flow, use a jig necessary to protect an operator. Pay full attention to such work.



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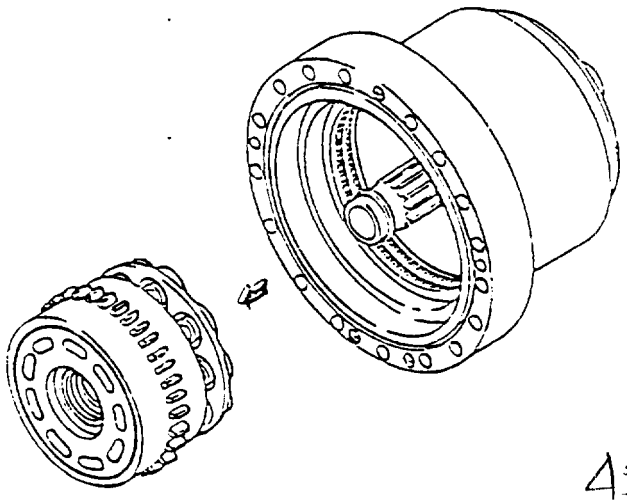
6. Remove the inner race or Roller Bearing(13) from Shaft(3) with a disassembly jig.



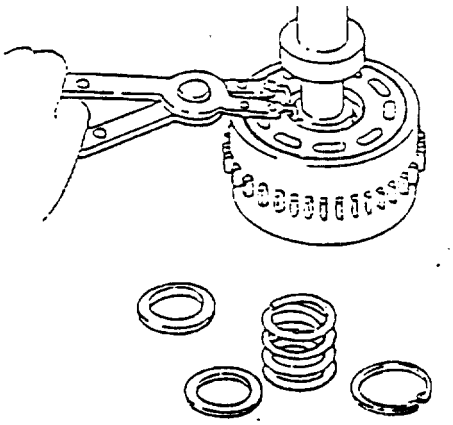
7. Disassembly of Cylinder Block S/A

   a) Pull out the cylinder block s/a from, Case(1). Cylinder block s/a consists of the following parts.

   Cylinder Block C/B(4), Piston S/A(6), Retainer Plate(7), Retainer Holder(8), Spring Seat(15), Snap Ring(14), spring(l6), Collar(17), Pin(19)

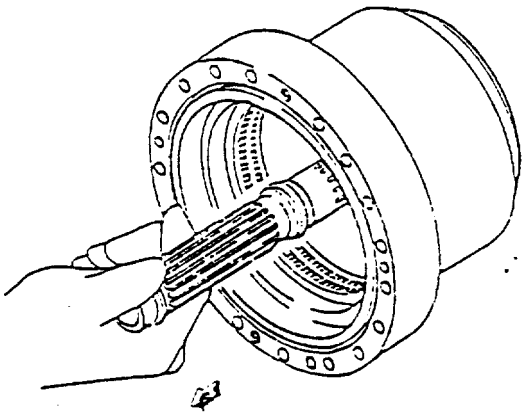


b) Pull out the piston s/a from cylinder block and disassemble the cylinder block s/a.



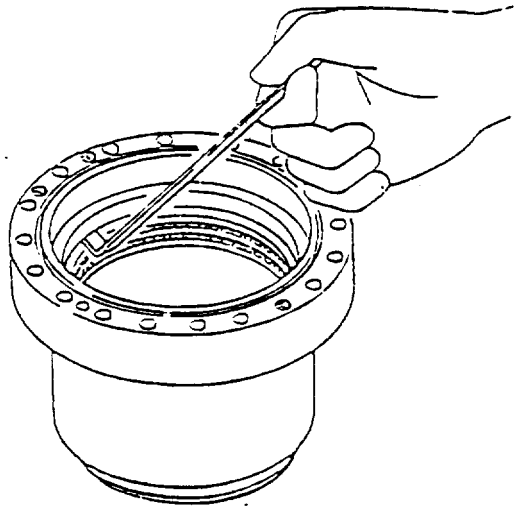
11. Disassembly of Shaft

Remove Shaft(103) from Case(101).



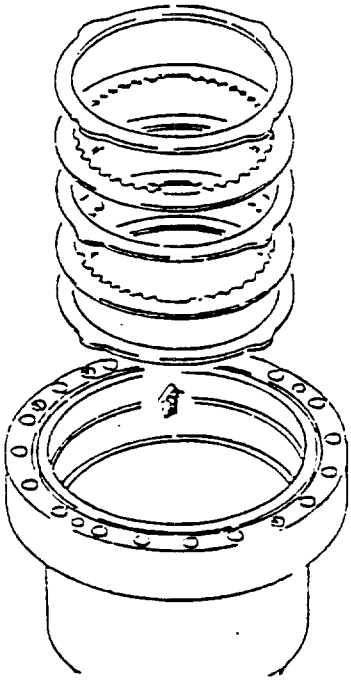
8. Disassembly of Collar

Remove Collar(26) from Case(1).



9. Disassembly of Disc Plate

Remove Friction Plate(27) and Disc Plate(28) from Case(1).

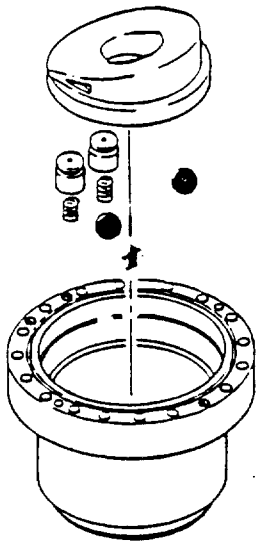


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11. Disassembly of Swash Plate

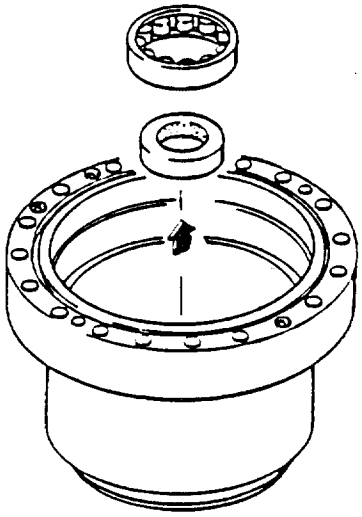
11. Disassembly of Swash Plate

Remove Swast Plate(9) from Case(1) and remove Steel Balls(10) and Piston S/A(11).



12. Disaasembly of Oil Seal and Bearing.

Remove Bearing(12) from Case(1). Then, remove Oil Seal from Case(1) with Screw Driver.



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7-3. Criterion for replacement of consumable parts

Replace parts in the following criterion when disassembling the motor.
Handle each of parts with deliberation and take care not to damage them.
Replace all seals when disassembling the motor, even though no damage is found on them.

Name	Item	Basic Dimension	Permissible Limit	Parts to be replaced
(6) Piston S/A	1. Serious damage or roughness on the sliding portion	0.2 a	0.8 a	Cylinder Block Kit
	2. Large clearance between Piston S/A and Cylinder Block Kit	0.035	0.050	
	3. Play between Shoe Ball portions	0.15	0.40	
(4) Cylinder Block	1. Serious damage or roughness on the sliding portion	0.2 a	0.8 a	Cylinder
	2. Large wear inside Bore			
(5) Valve Plate	Roughness of the sliding portion caused by serious damage, seizure, and partial wear	0.2 a	0.8 a	Cylinder
(7) Retainer Plate (8) Retainer	"	"	"	Retainer Plate Kit
(9) Thrust Plate	Roughness on the sliding portion caused by serious damage, seizure, and partial wear	0.2 a	0.8 a	
(3) Shaft	1. Roughness or serious damage on the sliding portion for Oil Seal (21)	0.8 a	1.6 a	Shaft
	2. Abnormal wear or breakage on gears			
(25) Brake Piston (27) Friction Plate	1. Roughness or serious damage on the sliding	1 a	2.5 a	Brake Piston Friction Plate
(28) Disc. Plate	1. serious damage or spalling on the Disc	Disc Plate		
(12) Roller Bearing (13) Roller	1. Flaking or spalling on the rolling face			Roller Bearing
	2. Pressed dent on the rolling face			
	3. Abnormal rotation (abnormal soundn, un-smooth rotation			

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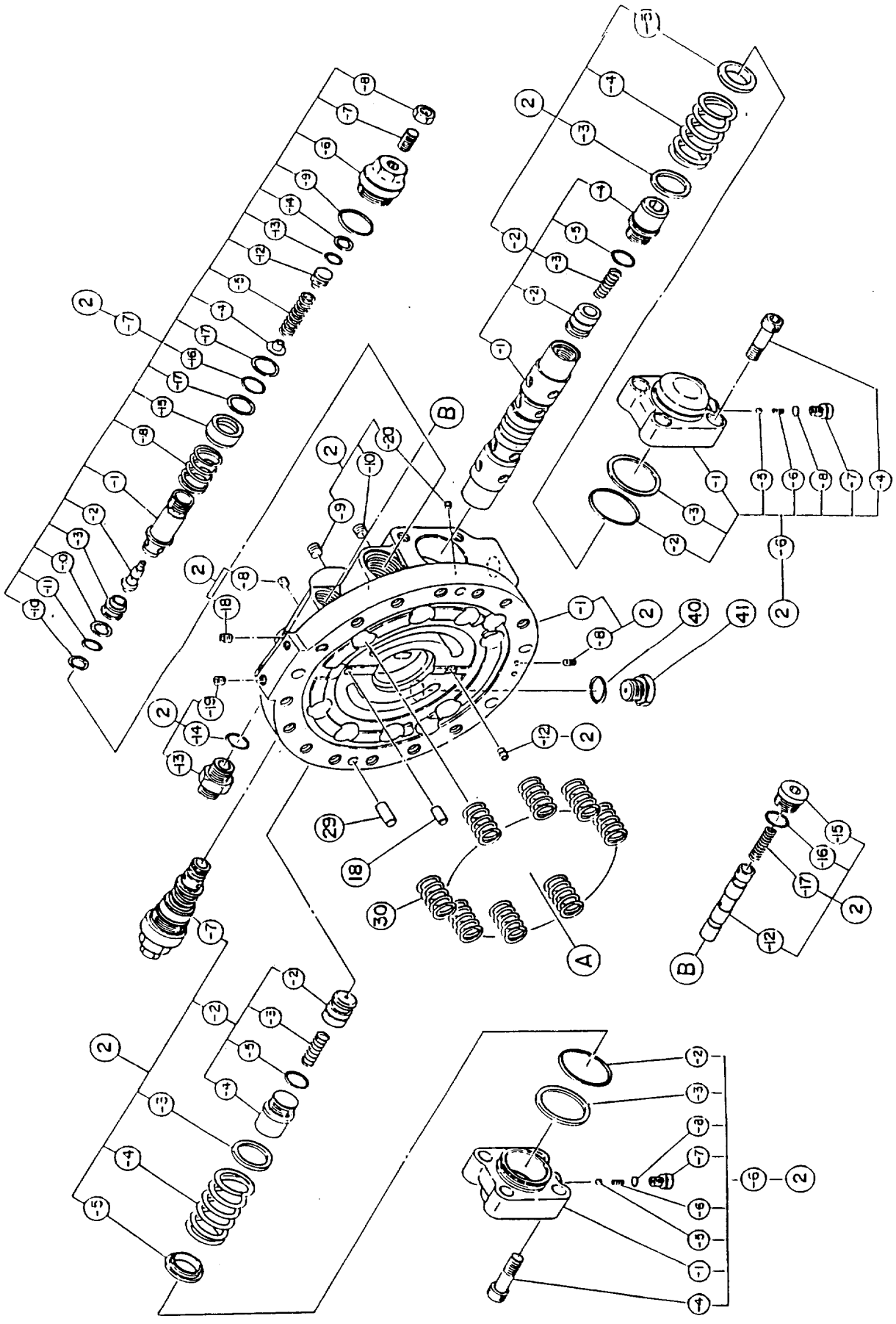
Name	Item	Basic Dimensions	Permissible Limit	Parts to be replaced
(2-2-1) Plunger	1. Roughness or serious damage on the sliding portion			Base Plate S/A
(2-1) Base Plate	1. Roughness or serious damage on the sliding portion 2. Damage which causes oil leakage			Base Plate S/A
(2-7-15) Free Piston	1. Play between Base Plate (2-1) and Free Piston (2-7-15) 2. Roughness or seriousn damage on the sliding portion			Relief Valve S/A
(2-7-1) Relief Housing S/A	1 . Roughness or serious damage on the free piston sliding portion			Relief Valve S/A
(2-2-3) Spring (2-4) Spring (2-6-6) Spring (2-7-5) Spring (2-13) Spring (16) Spring (30) Spring (42) Spring	1. Remanent set or breakage of the spring Spring			

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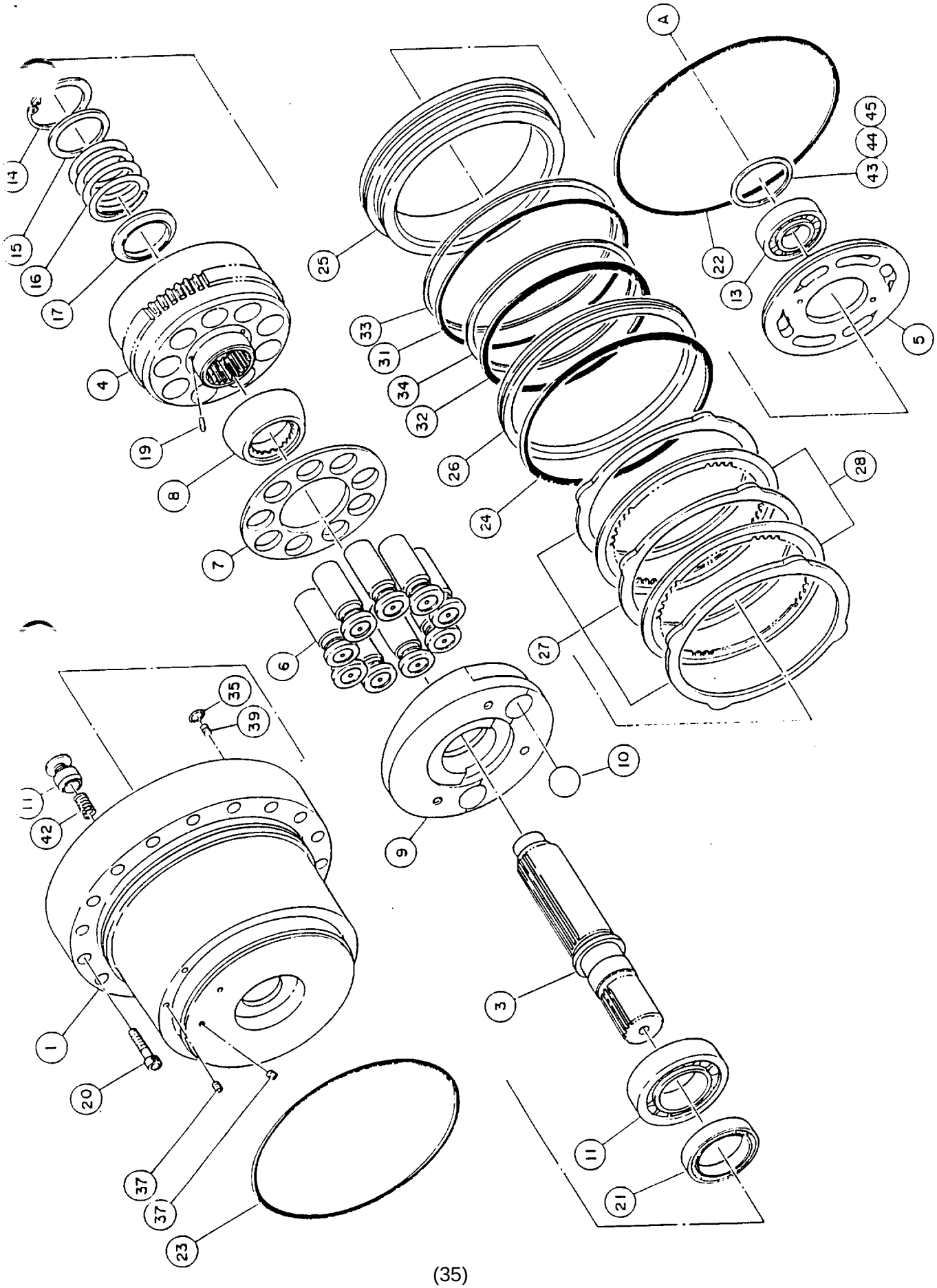
7-4. Tightening Torque

Item No.	Description	Screw Size	Qty.	Tightening Torque (ft.lbs)
2-2-8	Plug	M24 x 1.5	2	94-108
2-6-4	Sockethead Bolt	M12 x 1.75 401	8	72-80
2-6-7	Plug	PF 1/8	2	14-16
2-7	Relief Valve	1 5/16 12UN-2A	2	195-217
2-13	Plug	PF 3/8	1	36-39
2-15	Plug	PF 1/2	1	50-58
20	Sockethead Bolt	M12 x 1.75 501	14	72-80

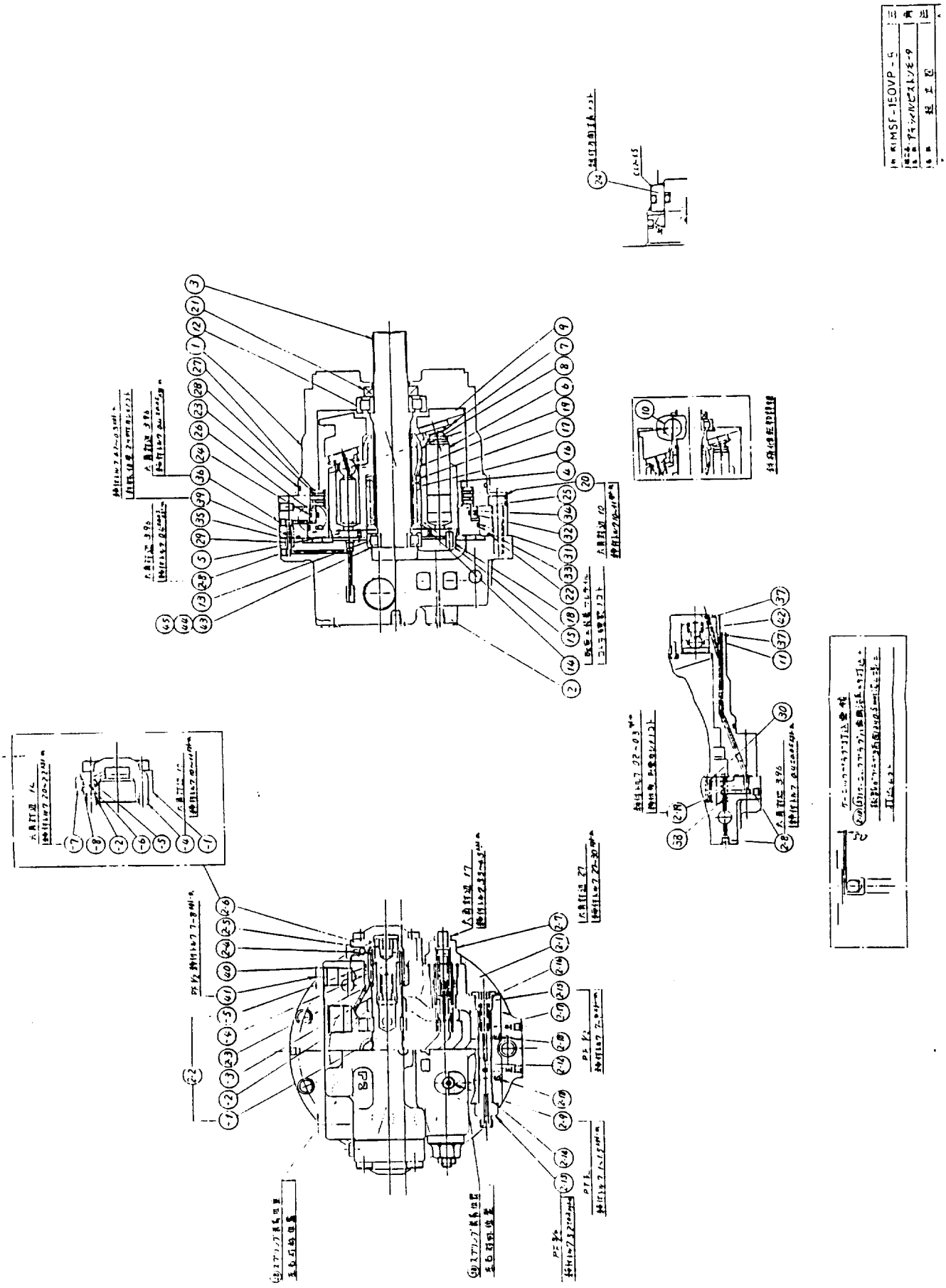
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構成区分	参照番号	品番	名称	員数	材質	備考
B3	5	20461-52306	ﾊﾞｷｭｰﾌﾟﾚｰﾄ	1		
(B3)	6	20462-50106	ﾋﾞｽﾄﾝ ASSY	9		
(B3)	-1	20461-50503	ﾋﾞｽﾄﾝ	1		
B4	-2	20462-51403	ﾘﾔｰ S/A	1		
B4	7	20461-51103	ﾘﾔｰﾌﾟﾚｰﾄ	1		
C	8	20461-57703	ﾘﾔｰﾌﾞﾗｹｯﾄ	1		
C	9	20461-57401	ﾋﾟﾎﾞｯﾄﾝ	1		
C	10	20461-59202	ﾋﾟﾎﾞｯﾄｼｰﾙ	2		
C	11	20462-50107	ﾋﾞｽﾄﾝ ASSY	2		
(C)	-1	20461-50504	ﾋﾞｽﾄﾝ	1		
(C)	-2	20462-51405	ﾘﾔｰ ASSY	1		
C	12	20461-56903	ﾘﾔｱｰﾑﾊﾟﾝﾌﾟ	1		
C	13	20461-56902	ﾘﾔｱｰﾑﾊﾟﾝﾌﾟ	1		
C	14	94721-62201	ﾘﾔﾌﾗｯﾌﾟﾊﾟﾝﾌﾟ	1		ﾌｼﾞ53 2404 ﾏﾂﾀﾞ62ｼｷｻ
C	15	20461-51405	ﾘﾔﾌﾞﾗｹｯﾄｼｰﾙ	1		
C	16	20461-51306	ﾘﾔﾌﾞﾗｹｯﾄ	1		
C	17	20461-51408	ﾘﾔｰ	1		
C	18	20461-50801	ﾋﾟﾝ	1		
C	19	20461-50803	ﾋﾟﾝ	3		
C	20	92703-12500	ﾊﾞﾗﾌﾞﾍｯﾄﾎﾞﾙﾄ	14		ﾌｼﾞB1176 M12x1.75x50 ｼﾛﾒｯｷ
A1	21	20631-42102	ﾎｲｰﾙﾍﾞｰｽ	1		TCY40-62-11 (NOK)
A1	22	20941-83104	ﾛｯｸﾘﾝｸﾞ	1		AS568-269 HS70
A1	23	20461-45201	ﾛｯｸﾘﾝｸﾞ	1		AS568-267 HS90
A1	24	20461-55205	ﾛｯｸﾘﾝｸﾞ	1		AS568-263 HS90
C	25	20461-59101	ﾘﾔﾚｰﾋﾞｱﾋﾟﾝ	1		
C	26	20461-51303	ﾘﾔｰ	1		
C	27	20461-59601	ﾘﾔｻﾎﾟｰﾄﾌﾟﾚｰﾄ	3		
C	28	20461-59501	ﾎﾞﾙﾄｶﾊﾞｰ	2		
C	29	20631-20815	ﾋﾟﾝ	2		
C	30	20461-51302	ﾌﾞｯｼｭﾒﾝﾄ	8		
A1	31	20461-85201	ﾛｯｸﾘﾝｸﾞ	1		AS568-264 HS90
A1	32	20461-55206	ﾛｯｸﾘﾝｸﾞ	1		AS568-261 HS90
A1	33	20461-85108	ﾊﾞｯｸｱｯﾌﾟﾘﾝｸﾞ	1		ｾﾙｶﾝ-3WG AS568-264
A1	34	20461-85107	ﾊﾞｯｸｱｯﾌﾟﾘﾝｸﾞ	1		ｾﾙｶﾝ-3WG AS568-261
A1	35	95113-00700	ﾛｯｸﾘﾝｸﾞ	3		ﾌｼSB2401 13 P7
D	36	15096-01010	ﾌﾟﾗｸﾞ	1		ｾPTF 1/8
D	37	20461-32314	ﾌﾟﾗｸﾞ	4		ｾMB700-050
C	38	20461-51310	ﾌﾞｯｼｭﾒﾝﾄ	4		
D	39	21961-40802	ﾘﾔﾌﾗｲﾊﾟ	1		
A1	40	95113-01800	ﾛｯｸﾘﾝｸﾞ	2		ﾌｼSB2401 18 P18
C	41	20461-52106	ﾌﾟﾗｸﾞ	2		
C	42	20161-51237	ﾌﾞｯｼｭﾒﾝﾄ	2		
B5	43	20461-51503	ﾎﾞﾙﾄ	2		005ﾋﾞ
B5	44	20461-51504	ﾎﾞﾙﾄ	2		0.1ﾋﾞ
B5	45	20461-51505	ﾎﾞﾙﾄ	2		0.2ﾋﾞ

構成区分	参照番号	品番	名称	員数	材質	備考
D	1	20461-53210	ﾎﾞｽ	1		
G	2	20463-51311	ﾊﾞｯｸｱｯﾌﾟｼｰﾄ ASSY	1		
D	-1	20461-57904	ﾊﾞｯｸｱｯﾌﾟﾌﾟﾚｰﾄ	1		
D	-2	21963-50217	ﾋﾞｽﾄﾝﾋﾟﾝ ASSY	1		
(D)	-2-1	21961-50217	ﾋﾞｽﾄﾝﾋﾟﾝ	1		
(D)	-2-2	21961-50306	ｽﾌﾟﾗｲﾗﾝｸﾞ	2		
(D)	-2-3	21961-50403	ｶﾌﾟﾘﾝｸﾞ	2		
(D)	-2-4	21961-50622	ﾋﾟﾝ	2		
(D)	-2-5	95113-02100	ﾛｯｸﾘﾝｸﾞ	2		ﾌｼSB2401 18 P21
C	-3	21961-50502	ｶﾌﾟﾘﾝｸﾞｼｰﾄ	2		
C	-4	21961-50418	ｶﾌﾟﾘﾝｸﾞ	2		
C	-5	21961-50513	ｶﾌﾟﾘﾝｸﾞｼｰﾄ	2		
B1	-6	21963-50611	ﾋﾟｽﾄﾝ ASSY	2		
(B1)	-6-1	21961-50716	ﾋﾟｽﾄﾝ	1		
A1	-6-2	95123-04500	ｵﾘﾝｸﾞ	1		ﾌｼSB2401 1B G35
(B1)	-6-4	92703-12400	ﾊﾞﾗﾌﾞﾍｯﾄﾎﾞﾙﾄ	4		ﾌｼSB1176 M12x1.75x30 ｼﾛﾒｯｷ
(B1)	-6-5	96321-06350	ﾎﾞｰﾙﾍﾞｱ	1		
(B1)	-6-6	21961-60411	ｶﾌﾟﾘﾝｸﾞ	1		
(B1)	-6-7	21961-60611	ﾌﾟﾗｸﾞ	1		
A1	-6-8	95113-00800	ｵﾘﾝｸﾞ	1		ﾌｼSB2401 1B P8
B2	-7	21963-40150	ﾊﾘｰﾌﾟﾚｽﾄﾋﾟﾝ ASSY	2		
D	-8	15096-01010	ﾌﾟﾗｸﾞ	8		ｾPTF 1/8
C	-9	97123-02111	ﾌﾟﾗｸﾞ	2		ｾPT 1/8
C	-12	20461-55801	ﾊﾞﾙﾌﾞ	1		
C	-13	20461-32419	ﾌﾟﾗｸﾞ	1		
A1	-14	95113-01400	ｵﾘﾝｸﾞ	1		ﾌｼSB2401 1B P14
C	-15	20461-52406	ﾌﾟﾗｸﾞ	1		
A1	-16	95113-01800	ｵﾘﾝｸﾞ	1		ﾌｼSB2401 1B P18
C	-17	20461-51305	ｶﾌﾟﾘﾝｸﾞ	1		
D	-18	20461-32414	ﾌﾟﾗｸﾞ	2		ｾMB700-050
D	-19	21961-40802	ﾘﾔﾌﾗｲﾊﾟ	2		
C	3	20461-50203	ﾋﾟｽﾄﾝ	1		
B3	1	20461-51506	ﾛｯｸﾘﾝｸﾞﾌﾞｯｼｭ	1		

記号	内容
A	
B	
C	
D	

機種 MSF-150V2-E

名称 ハーフリヤー

三角点

図番 20450-51434-A

カヤバ工業株式会社

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HANDLING / MAINTENANCE MANUAL

MODEL : RGC- 150VP-50
(FOR MAG- 150VP-3600)

NAME: REDUCTION GEAR

KAYABA P/N : 20940-65405

KYB CORPORATION OF AMERICA

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1. Introduction

This manual describes the specifications, construction, and handling method of the reduction gear RGC-150vp, in order to protect mis-handling and maintain their good performance over a long period.

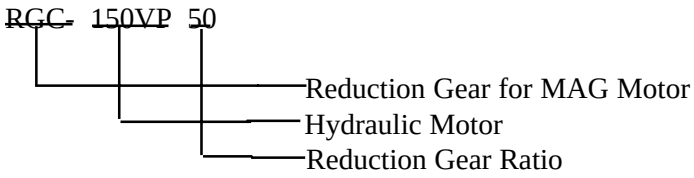
2. Outline

2-1. Features

a) This reduction gear adopts a 3-stage planetary gear and is of case-rotating type and of compact and light weight desigin.

b) High reliability and long endurability are secured by high precision machining and equal-load distributing mechanism adopted for this reduction gear.

2-2. Model Indication



Specifications

Construction	Planetary Gear (3 Stage)
Reduction Gear Ratio	1/49.539
Lubricating Mothod	Oil -bath Lubrication
Weight	abiut 204 kgf

3. Operation and Function

Refer to Fig. 1.

Drive Gear ① is connected to Planetary Gear ② , each of Sun Gear ④ ⑦ is connected to each of Planetary Gear ⑤ ⑧ and each of Planetary Carrier ③ ⑥ respectively.
The Planetary Carrier (11) is fixed on the housing.

Each planetary gear is connected to the ring gear ⑨ which is fixed on the housing. ⑩

3-2. Principle of Operation

Driving force from the oil motor is transmitted to the drive gear with the speed reduced. Its driving force is transmitted to Housing ⑩ through Planetary Gear⑧ in Planetary Carrier ⑪, and Ring Gear ⑨

Direction of input rotation and that of output rotation are reverse.

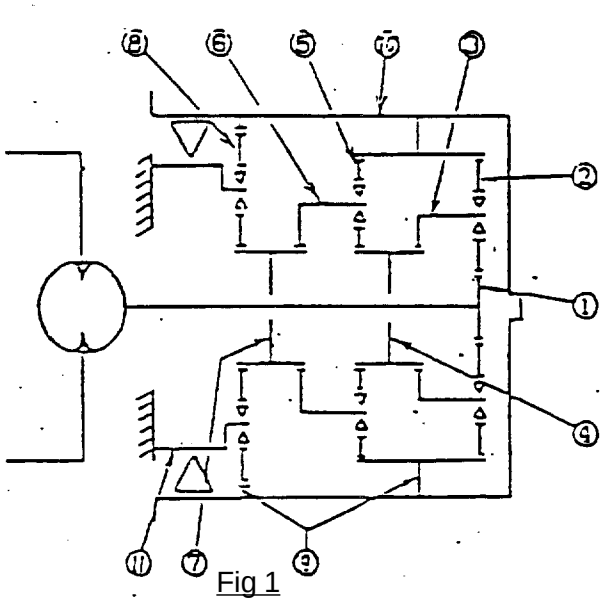


Fig 1

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4. Proper Handling

4-1. Checking

Check the following before the reduction gear is installed.

a) Are there any damaged portions during the transportation?
Are there any missing parts?

b) Are tighting portions loosend?

4-2. Lubricating Oil

4-2-1. Recommended Lubricating Oil

The following brand is recommended for the lubricating oil.

DIAMOND HIPOND GEAR OIL 90 (MITSUBISHI OIL CO.)
(Equivalent to API GL-4 #9O)

The above oil is filled in the reduction gear case at the time of shipment from our factory.

4-2-2. Filling Oil

Remove the plugs(26),(27) from the oil filling port and checking port.
Fill the reduction gear case with the lubricating oil before and until the oil flows out of the oil-checking port.
After confirming that the oil flows out, tighten each of the plugs of the ports.

Standard Oil	about 6.0 litre
Tightening torque for Plug(26)	28.9-36.1 ft-lbs
Tightening torque for Plug(27)	7.7-10.8 ft-lbs

Note

1. Check the oil in a flat place when the reduction gear is installed on the machines.

2. Oil-checking after inspection must be done after the lapse of a few minutes.

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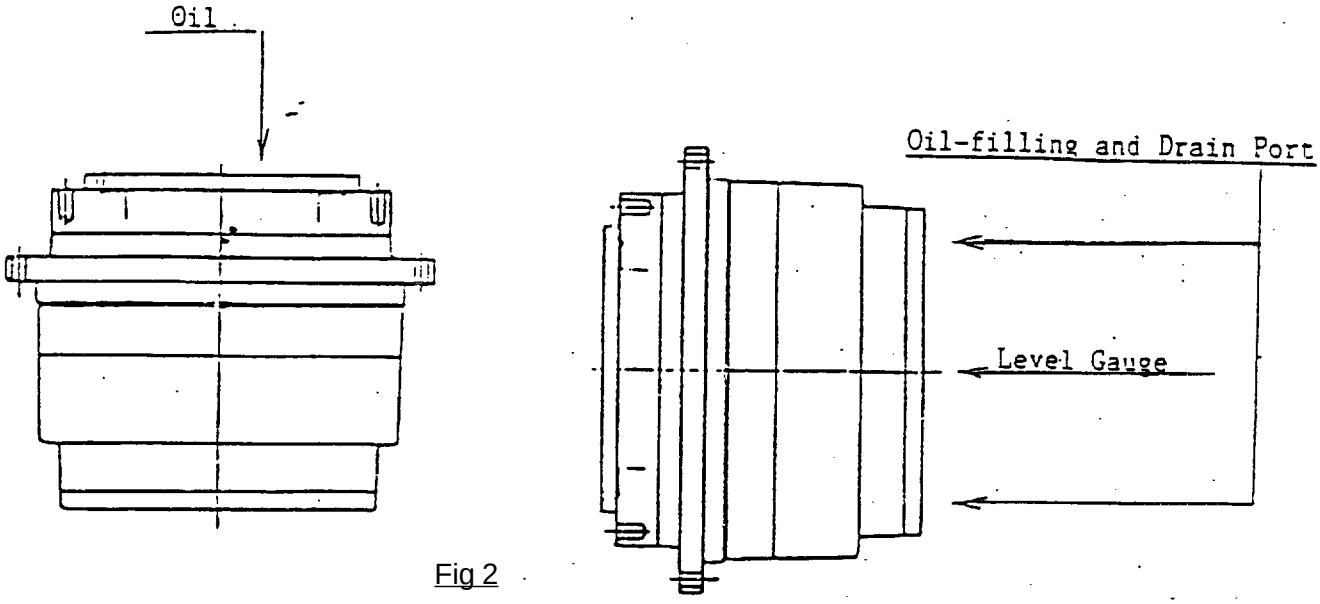


Fig 2

4-3. Mounting

This reduction gear is used with a piston motor.

4-4. Checking Before and After Start-up

4-4-1. Check the following before operation.

a) Is the lubricating oil in appropriate volume?
b) Is there looseness in tightening portions?
c) Is there any oil leakage?

4-4-2 Check the following during operation.

a) Is there any oil leakage?
b) Has there been any abrormal heat generated in the case?
c) Are there any abnormal noise and vibration?

5. Maintenance and Check

Maintenance and check should be done with the following items.

5-1. Oil leakage at each tightened portions
5-2. Possible looseness of the bolts at the tightened portions
5-3. The volume of the lubricating oil and periodical replacement
5-4. Contamination of the lubricating oil

* Recommended replacement time of the lubricating oil(By Engine Hour Meter)

First replacement	100-250 hours
Secondary replacement	every 1000-1500 hours

* Oil check procedure
Remove the plugs for Oil-filling Port(26) and Oil-checking Port(27), and check oil.

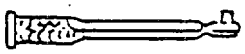
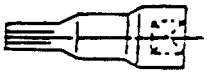
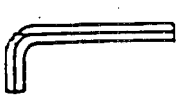
* Oil- replacement procedure
Unscrew the plugs for Oil-filling and Drain Port(26), Oil-checking Port(27), and Air Removal Port(28) and drain the old oil thoroughly. Fill new oil from the oil-filling port thereafter.(Refer to Item 4-2-2)

Tighten the plugs with prescribed tightening torque.

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6. Disassembly and Reassembly

6-1. Tools

No	Tool Name	Tool to be used for	Configuration
1	Torque Wrench (5-6.5 ft-lbs)	(28) Air Removal Plug	
2	Torque Wrench (39-47 ft-lbs)	(25) Socket Head Bolt	
3	Torque Wrench (29-36 ft-lbs)	(26) Oil-filling and Drain Plug	
4	Torque Wrench (130-151 ft-lbs)	(21) Socket Head Bolt	
5	Torque Wrench (202-231 ft-lbs)	(16) Socket Head Bolt	
6	Torque Wrench (289-325 ft-lbs)	(17) Socket Head Bolt	
7	Torque Wrench (7-11ft-lbs)	(27) Oil-checking Plug	
8	Hexagonal Bitt (cross flat 5 mm)	(28) Air Removal Plug	
9	Hexagonal Bitt (cross flat 6 mm)	(27) Oil-checking Plug	
10	Hexagonal Bitt (cross flat 8 mm)	(25) Socket Head Bolt	
11	Hexagonal Bitt (cross flat 10 mm)	(26) Oil-filling and Drain Plug	
12	Hexagonal Bitt (cross flat 12 mm)	(21) Socket Head Bolt	
13	Hexagonal Bitt (cross flat 14 mm)	(16)(17) socket Head Bolt	
14	Allen Wrench (cross flat 5 mm)	(28) Air Removal	
15	Allen Wrench (cross flat 6 mm)	(27) Oil-ckecking Plug	
16	Allen Wrench (cross flat 8 mm)	(25) Socket Head Bolt	
17	Allen Wrench (cross flat 10 mm)	(26) Oil-filling and Drain Plug	
18	Allen Wrench (cross flat 12 mm)	(21) Socket Head Bolt	
19	Allen Wrench (cross flat 14 mm)	(16)(17) Socket Head Bolt	

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6-2. Disassembly Procedure

6-2-1 Caution before Disassembly

a) Be sure to remove mud, dust, etc. attached on the outside of the reduction gear.
(Clean the outside of the reduction gear thoroughly.)

b) Put a mark on it so that the reduction gear can be reassembled in the original position before disassembly.

c) Drain the lubricating oil from the case.

d) Select a working place free from dust and endure that all parts are neither stained nor mudded.

e) Be careful for handling so that the parts may be neither dented nor scratched by drop and/or contact of such parts.

6-2-2. Disassembly

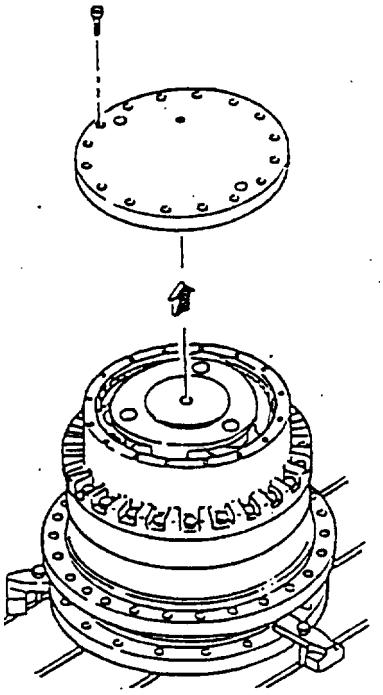
Disassembly Procedure

1. Disassembly of Cover

Fix the reduction gear with the motor's mounting face placed downward. Loosen Socket Head Bolts(25) and remove Cover(24).

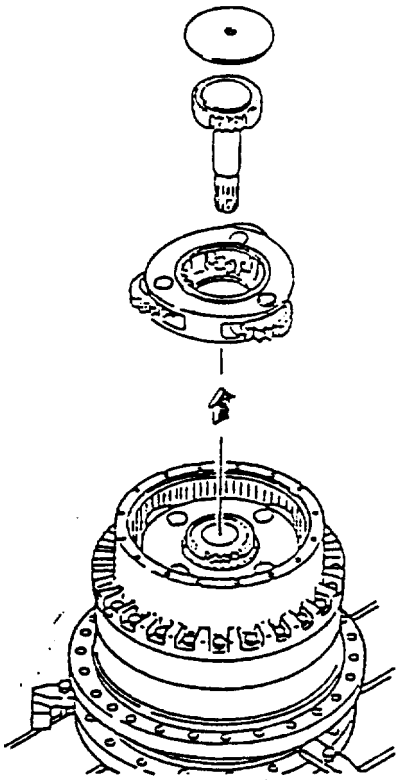
Tools

Torque Wrench	2
Allen Wrench	16
Hexagonal Bitt	10

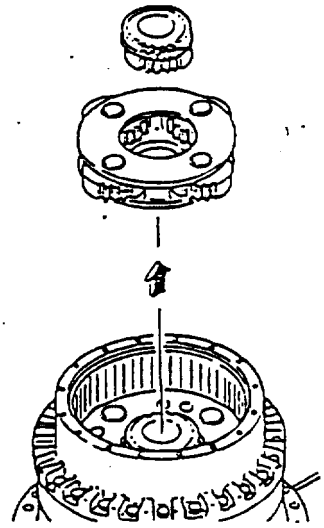


2. Disassembly of Gears

a) Remove Thrust Plate(23), then Drive Gear(4), and Holder “A” S/A(l)



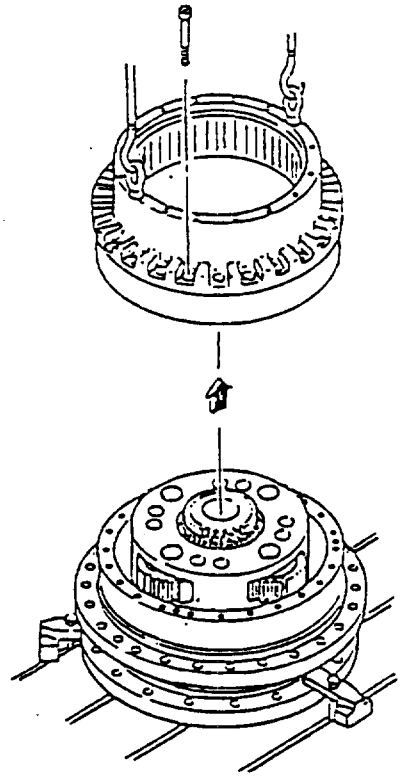
b) Remove Sun Gear “B”(6) snd Holder “B” S/A(2).



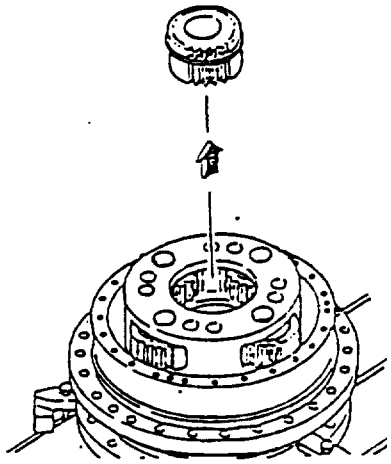
c) Loosen Socket Head Bolts(21) and remove Ring Gear(l9).

Tools

Torque wrench	4
Hexagonal Bitt	12
Allen Wrench	18

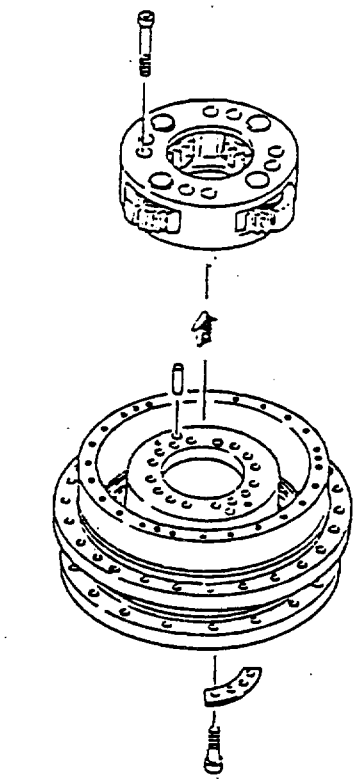


d) Remove Sun Gear “C”(8).



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e) After loosening Socket Head Bolts(16) and Socket Head Bolts(17) from the motor mounting face, remove Holder “C” S/A.(3).



Tools

Torque Wrench	5 6
Hexagonal Bitt	13
Allen Wrench	19

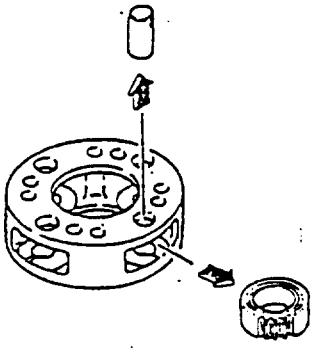
3. Disassembly of each Holder S/A

Tap the spring pin into the gear shaft and remove the holder s/a.

Holder “A”
- (1-6) Spring Pin ϕ4
- (1-4) Gear Shaft “A”

Holder “B”
- (2-6) Spring Pin ϕ4
- (2-4) Gear Shaft “B”

Holder “C”
- (3-8) Spring Pin ϕ45
- (3-4) Gear Shaft “C”

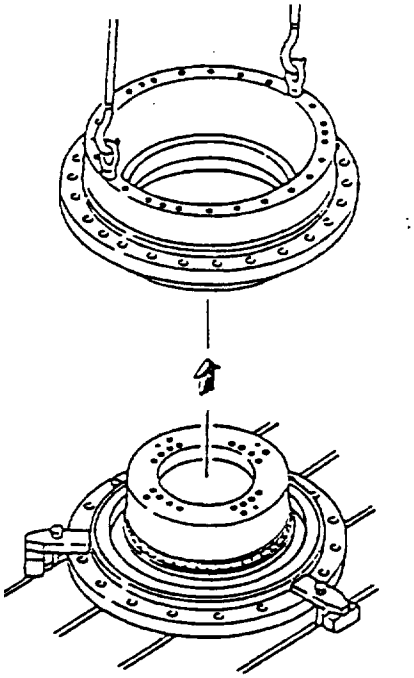


Note

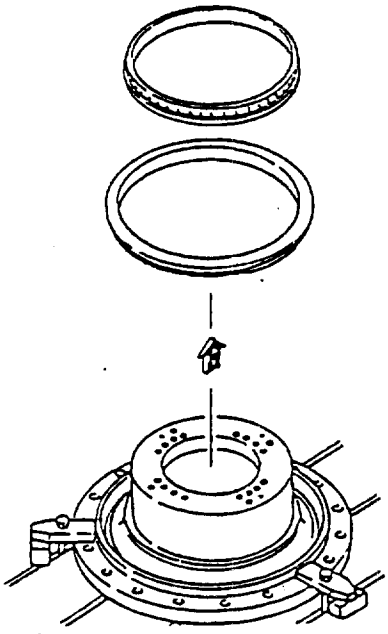
Don’t tap too much.

4. Disassembly cf Flange

a) Fix Flange(10) and remove Housing(13).



b) Remove Floating Seal(11) and Angular Bearing(12) from Flange(10) and Housing(13).



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6-3. Criterion for replacement of consumable parts

Replace parts in the following criterion.

Name	Criterion for replacement
(1) Holder A S/A (2) Holder B S/A (3) Holder C S/A	1. Pitting or spalling on the gear face 2. Flaking on the rolling face of “Needle Bearing , Gear Shaft, and Planetary Gear 3. Abnormal rotation of Bearing (abnormal sound, unsmooth rotation) 4. Axial play of the gears.
(4) Drive Gear (6) Sun Gear B (8) Sun Gear C (19) Ring Gear	1. Pitting or spalling on the gear face
(1-2) Planetary Gear A (2-2) Planetary Gear B (3-2) Planetary Gear C	1. Pitting or spalling on the gear face 2. Pitting or spalling on the rolling face of Needle
(1-3) Needle Bearing (2-3) Needle Bearing (3-3) Roller Bearing (1-4) Gear Shaft (2-4) Gear Shaft, (3-4) Gear Shaft	1. Flaking or spalling on the rolling face of Needle and Shaft 2. Dent etc. on the rolling face of needle Bearing and Shaft 3. Abnormal rotation of Bearing (abnormal sound, unsmoothness rotation) (3-5) Floating Bushing
(1-1) Holder A (2-1) Holder B (3-1) Holder C	1. Play between Gear Shaft and Holder
(23) Thrust Plate	Basic / Permissible 1.8 / 1.7 2.3 / 2.2 2.8 / 2.7 3.0 / 2.9 3.2 / 3.1
(5) Thrust Plate	2.0 / 1.9
(12) Angular Bearing	1. Abnormal rotation (abnormal sound, unsmooth rotation)
(11) Floating Seal	1. Damage which causes oil leakage on the sliding portion.

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6-4 Reassembly Procedure

6-4-1. Caution before Reassembly

Clean all of the parts with fresh flushing oil and blow them out.

Ensure that there is no dust, damage or scratch on all cleaned parts.

Replace seals and bearings with new ones.

Tighten all tightening parts.

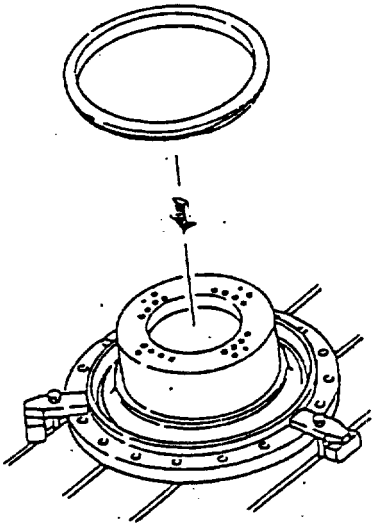
6-4-2. Reassembly Procedure

1. Reassembly of Housing Portion

a) Fix Flange(10) and put one side of Floating Seal(11) on it.

Note

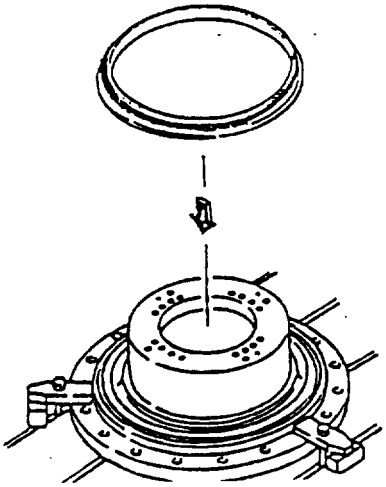
Grease fully Floating Seals(11).



b) Put the other piece of Floating Seal(11) on one piece of the floating seal with concentricity.

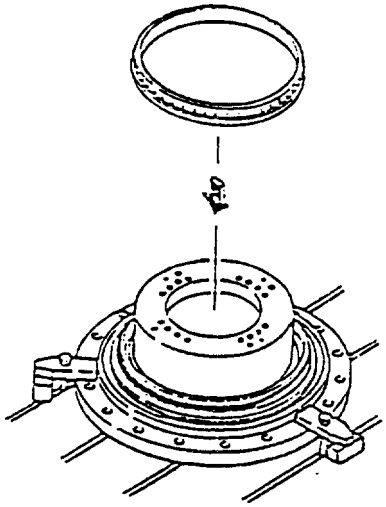
Note

Grease seals.

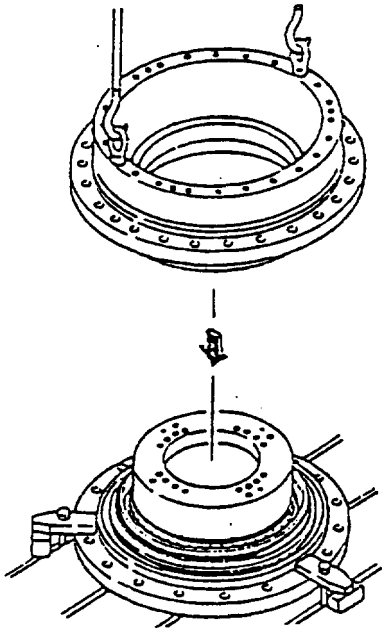


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c) Press the Inner Race S/A of Angular Bearing(12) into Flange(10).

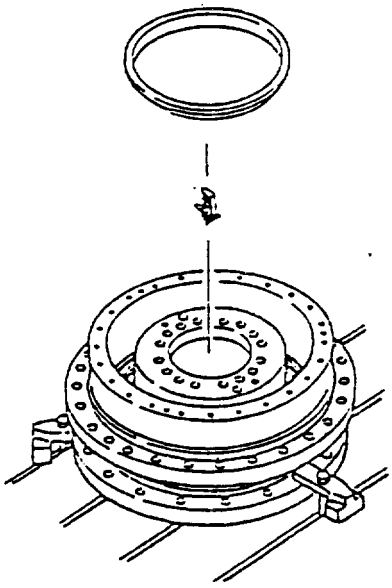


d) Press the Outer Race of Angular Bearing(12) into Housing(13), put it on Flange(10) quitely.

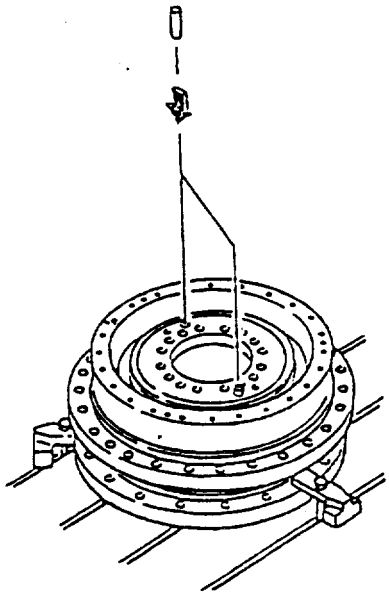


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e) Press the other Inner Race of Angular Bearing(12) into Flange(10).



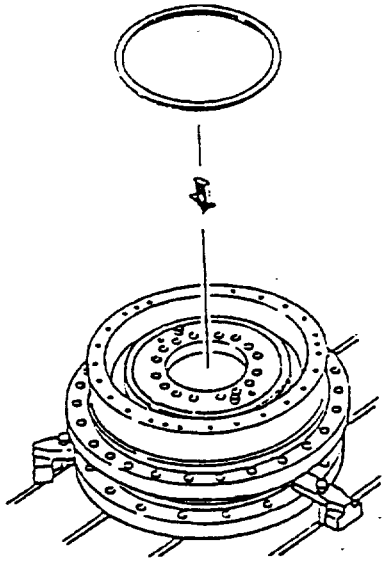
f) Press Pin(15) into Flange(10) so that the pin may be adjusted to protrude from the flange end by 26.5 - 27.5 mm.



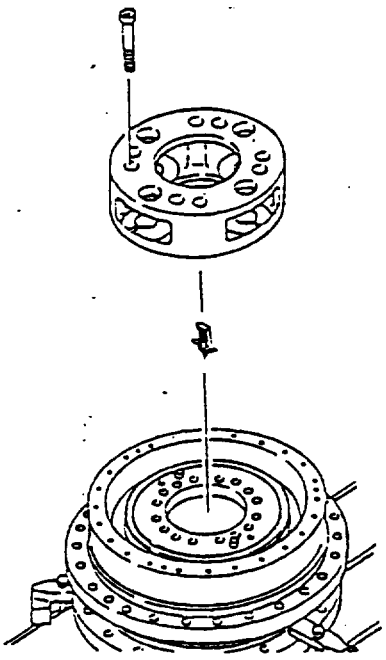
https://truckmanualshub.com/

2. Reasembly of Holder “C”(3-1)

a) Ensure that the shims of the same quantity as before assembly will be put on Holder “C” (3-1).



b) Put Holder “C” into Flange(10) after matching the position of Pin(215) with that of the pin hole of Holder”C”, and then tighten Socket Head Bolts(16).



Note

Use Loctite No. 271 on the surface of bolts after degreasing.

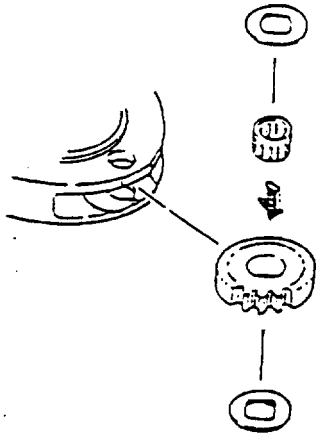
Tightening Torque	202-231ft-lbs

Tools

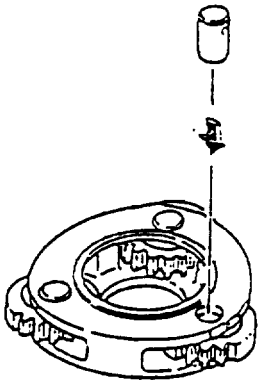
Torque Wrench	5
Hexagonal Bitt	13
Allen Wrench	19

3. (1) Reassembly of Holder “A” S/A

a) Install Needle Bearing(1-3) into Planetary Gear(1-2) and put Thrust Washer(1-5) on both sides of the gear.



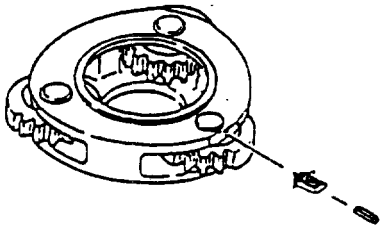
b) Put (1-2)(1-3)(1-5) into Holder “A”(1-1) and and assemble Gear Shaft(1-4) into the hole of Holder “A”.



Note

Pay attention not to damage the thin thrust washer when inserting the shaft after surely matching the hole of the thrust washer and hat of Holder “A”.
Insert the shaft after aligning the spring pin hole of the shaft with that of the holder.
Confirm that the gear rotates smoothly.

c) Tap Spring Pin(1-6) until it becomes even with the outer circle of Holder “A” and calk 4 symmetrical points.



4. (2) Reassembly of Holder “B” S/A

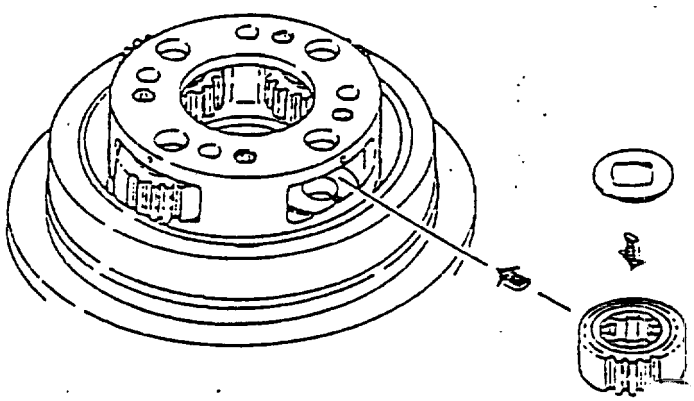
Install holder “B” S/A in. the same way with Holder “A” S/A.

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5.(3) Reassembly of Holder “C” S/A

a) Grease the inner surface of Planetary Gear C(3-2), put Thrust Washer(3-7)on the bottom side only. Install Floating Bush(3-5) and Collar(3-6) and assemble rollers.

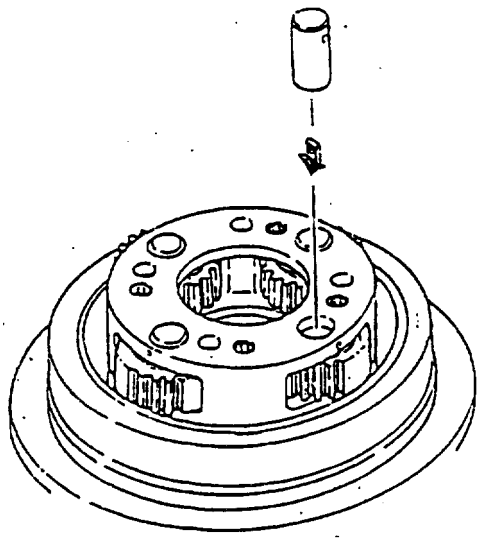
b) Place Collar(3-6) and Thrust Washer(3-7) in turn on Holder “C”(3-1) with the hole of the gear shaft aligned.



c) Put Gear Shaft “C”(3-4).

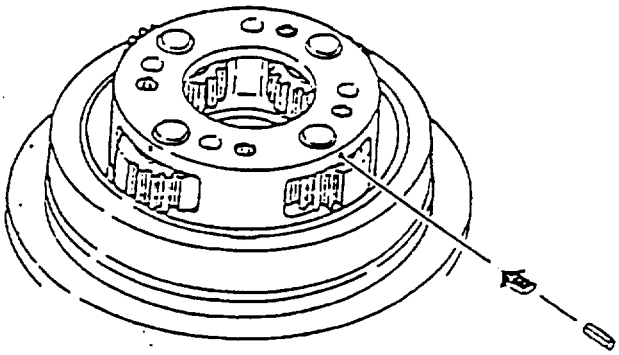
Note

Align the pin hole of the gear shaft with that of Holder “C”.
Confirm that the gear turns smoothly.



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d) Tap Spring Pin(3-8) until it becomes even with the outer circle of Holder “C”(3-1) and calk 4 symmetrical points.

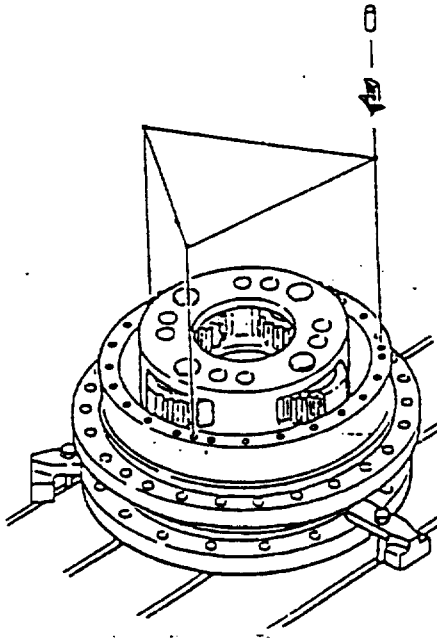


6. Reassembly of Ring Gear(l9)

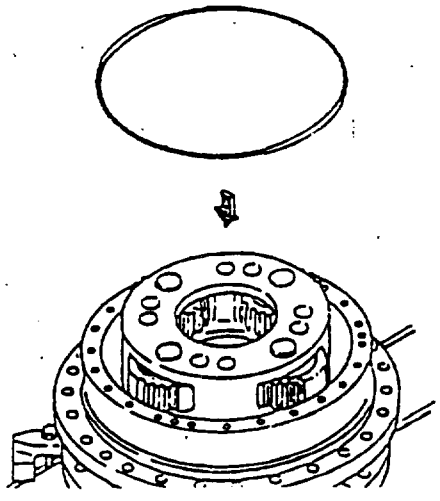
a) Tap 3 pieces of pins on Ring Gear.

Note

Tap them until the end of the pin is protruded by 17 mm outside of the gear face.



b) Put “O” Ring(20) on Housing(13).



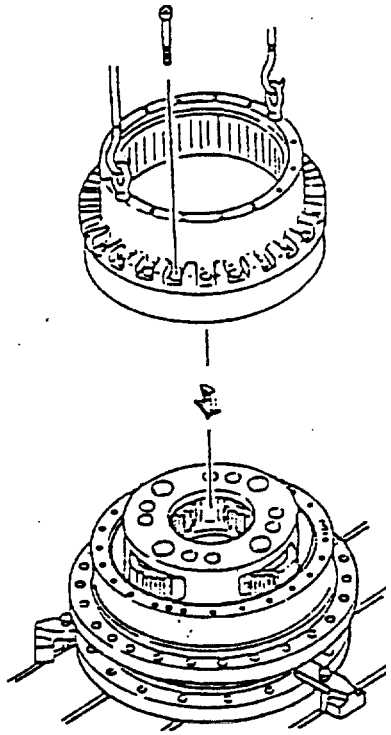
https://truckmanualshub.com/

c) Put Ring Gear(l9) into Housing(l9) and tighten it with Socket Head Bolt(21).

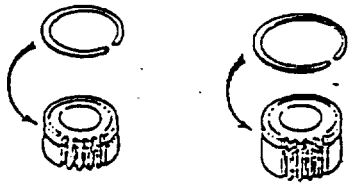
Tightening Torque 131-151flt -lbs

Tools

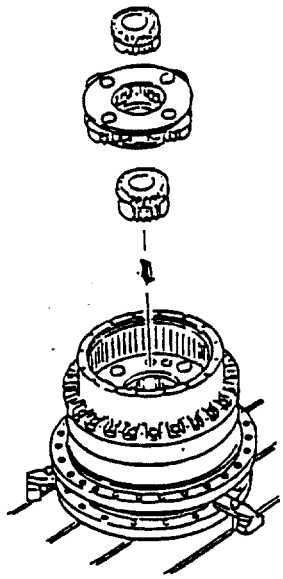
Torque Wrench	4
Hexagonal Bitt	12
Allen Wrench	18



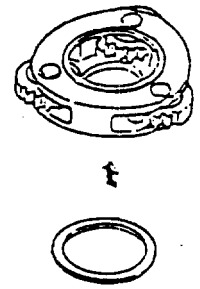
7. Put Snap Rings(7) and (9) on Sun Gear B(6) and Sun Gear C(8) respectively.



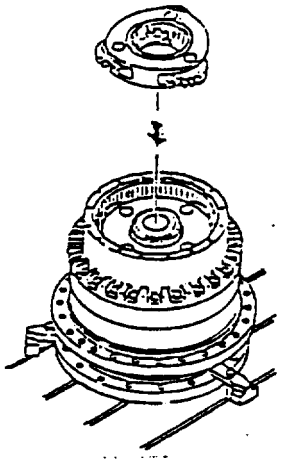
8. Put parts into Housing(13), in the order of Sun Gear C(8), Holder B S/A(2), and Sun Gear B(6).



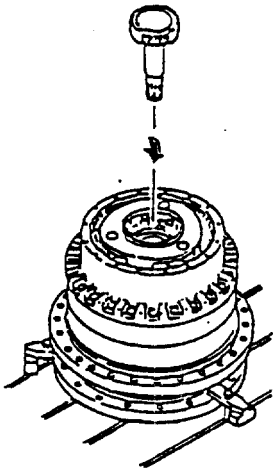
9. Grease Thrust Plate(5) and put it into Holder A S/A(1).



10. Place Holder A S/A(1) into Housing(13).

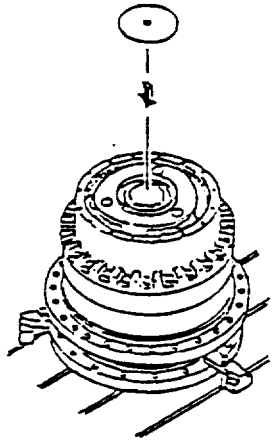


11. Put Drive Gear(4) into Housing(13).



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12. Then, Put Thrustn Plate (23) into the housing.



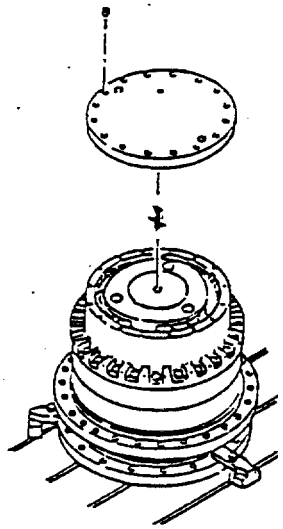
13. Adhere uniformly “Three Bond 211” on the end face of Ring Gear(19). After that, place Cover(24) on Housing(13) and tighten the cover with Socket Head Bolt(25).

    Note

    Be sure to degrease the contact face.

    Tools

    Torque Wrench 2
    Hexagonal Bitt 10
    Allen Wrench 16

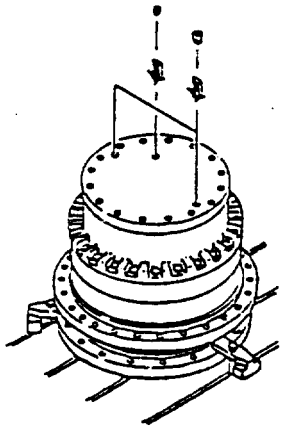


14. Wind seal tape on Plugs(26) and (27), and tighten them on Cover(21).

    Tightening Torque 7-11ft-lbs for (26)
    29-36 ft-lbs for (27)

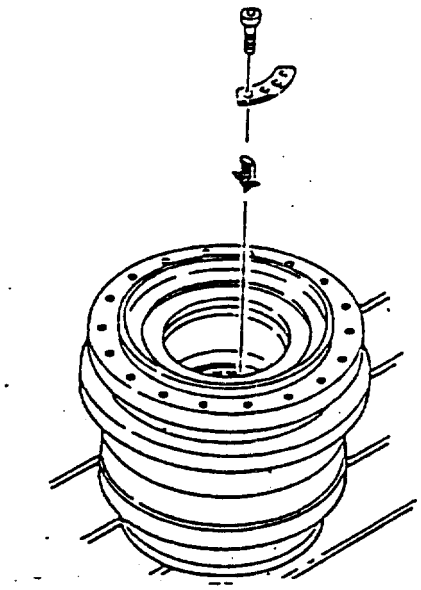
    Tools

    Torque Wrench 3 7
    Hexagonal Bitt 11 9
    Allen Wrench 17 15



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15. After turning the reduction gear upside down, put Plate(18) in it with Socket Head Bolt(17).



Note

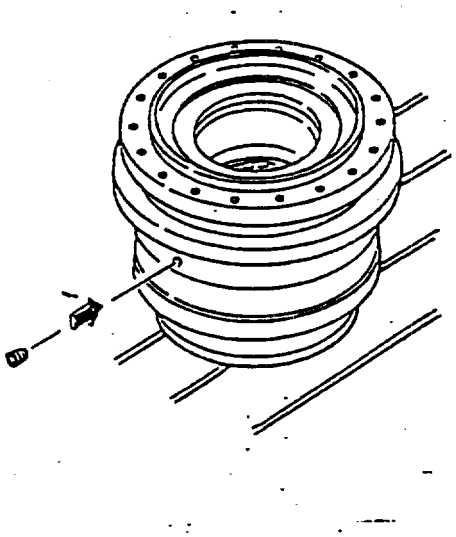
Remove grease from the surface of Bolt(17) and female thread portion, and put Loctite No. 217 on Bolt(l7).

Tightening Torque 289-325ft-lbs

Tools

Torque Wrench	6
Hexagonal Bitt	13
Allen Wrench	19

16. Wind seal tape on Plugs(28), and tighten them on the reduction gear.

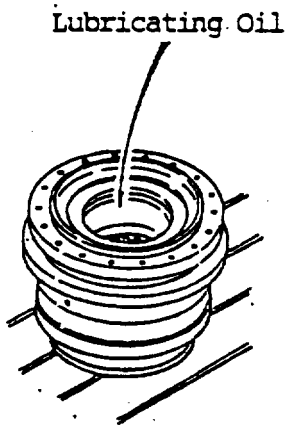


Tightening Torque5-6.5 ft-lbs

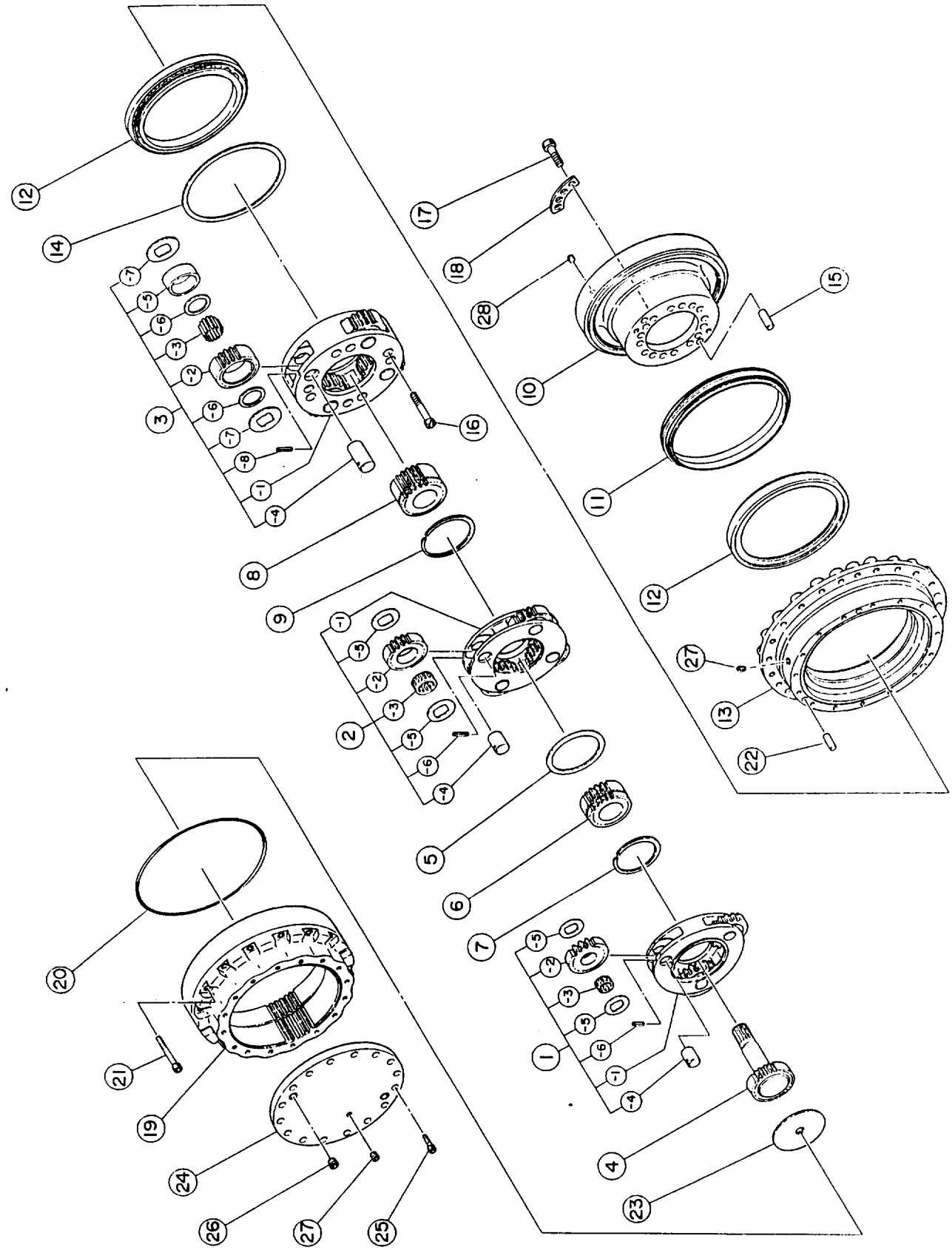
Tools

Torque Wrench (1)
Hexagonal Bitt (8)
Allen Wrench (14)

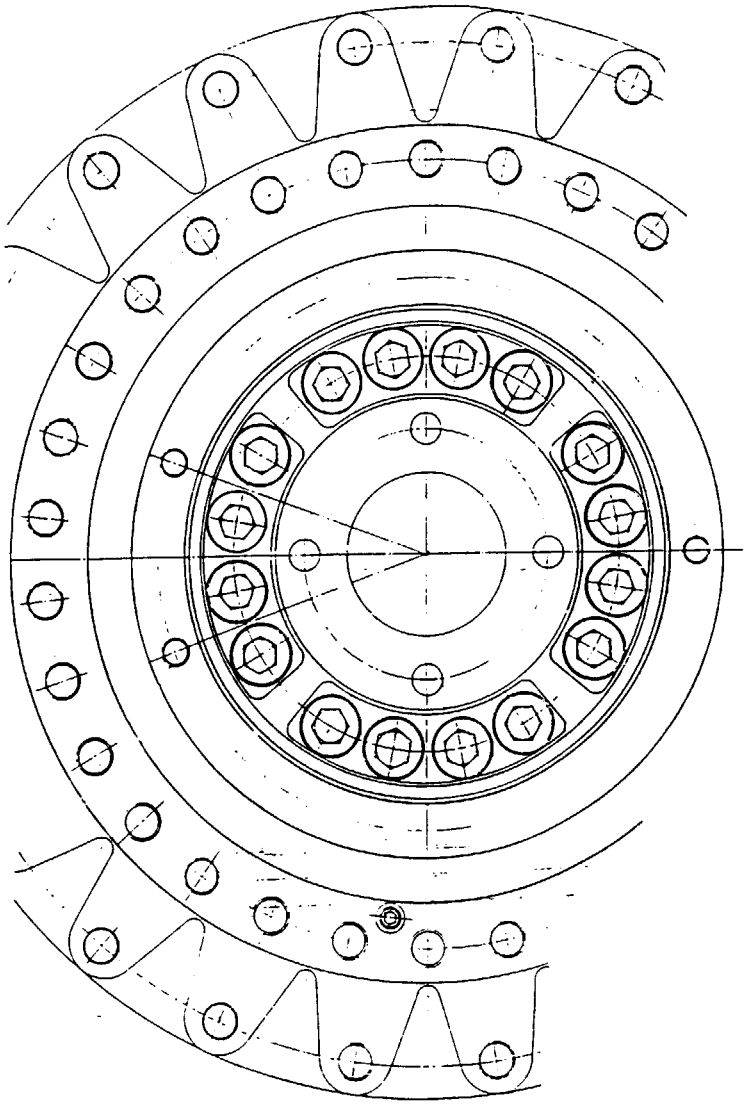
17. Fill the case with lubricating oil.
(Oil Volume 5.6 litre)

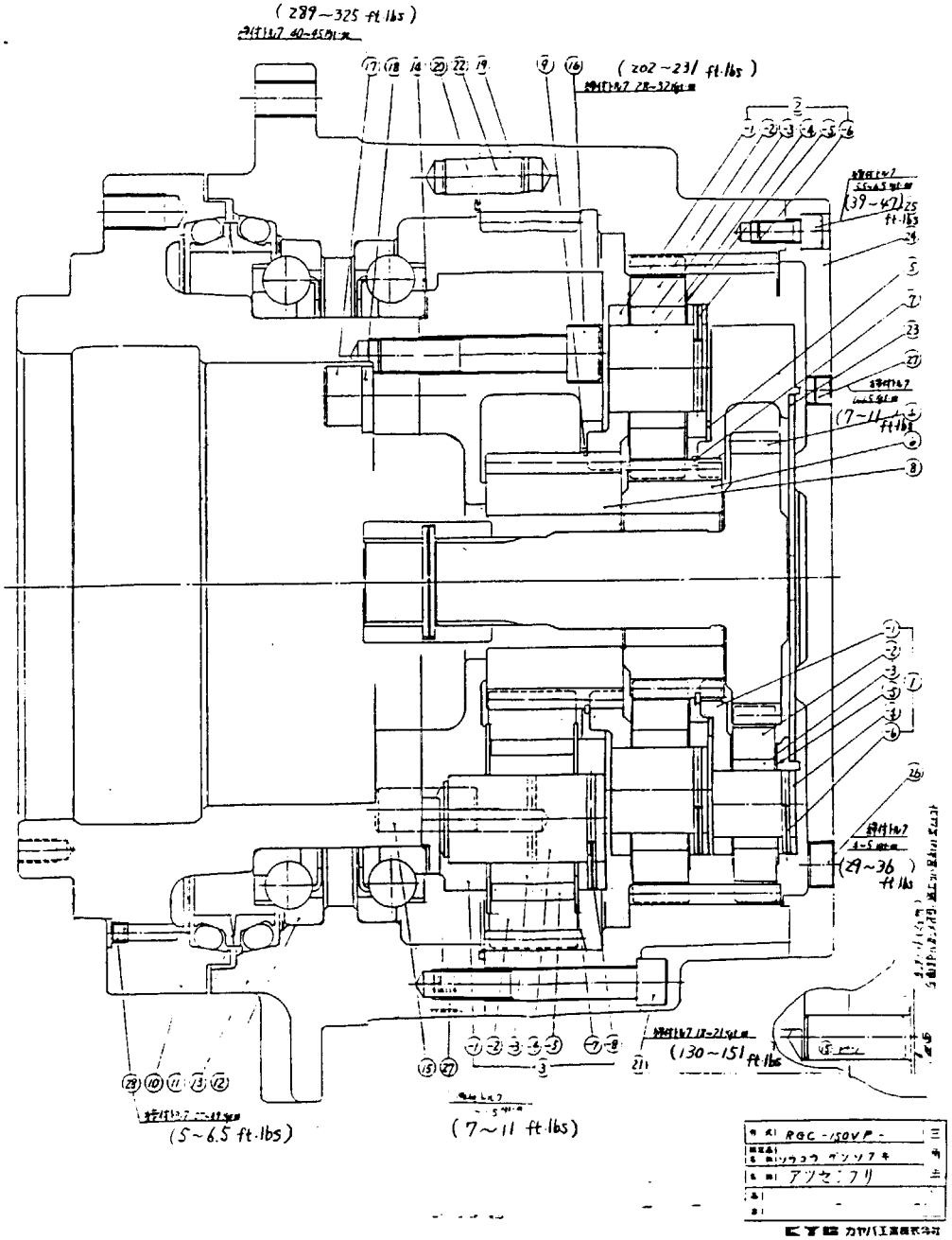


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CLASS	ITEM NO.	PARTS NO.	DESCRIPTION	QTY	DESCRIPTIN	REMARKS
構成区分	図番号	品番	名称	員数	材質	備考
D	10	120941-60105	ワッシャ	1		
A2	11	120366-99837	ロワーウインクアーム	1		
C	12	120946-89720	ホンネットスライドアサンブ	2		
D	13	120946-89719	ハウジング	1		
B4	14	120946-89725	ロム	1		10 C
B4	14	120946-89726	ロム	1		0.5 :
B4	14	120946-89727	ロム	1		0.3 :
B4	14	120946-89728	ロム	1		0.1 :
B4	14	120946-89729	ロム	1		0.05 :
C	15	120946-89730	ピン	4		
C	16	192703-16900	ウオッシャヘッドボルト	4		JIS B 1176 M16X20X90 12.9T
C	17	192703-18550	ウオッシャヘッドボルト	16		JIS B 1176 M8X1.25X55 12.9T
C	18	120946-89731	プレート	4		
C	19	120946-91624	ホンネット	1		
A2	20	120946-89732	ロサンク	1		
C	21	192703-14950	ウオッシャヘッドボルト	16		JIS B 1176 M14X2.0X95 12.9T
C	22	120946-89733	ピン	3		
B7	23	120941-62305	ロウエストプレート	1		1.8t
B7	23	120941-62306	ロウエストプレート	1		2.2t
B7	23	120941-62307	ロウエストプレート	1		2.8t
B7	23	120941-62308	ロウエストプレート	1		3.2t
B7	23	120941-62309	ロウエストプレート	1		3.6t
C	24	120946-89734	ロハブ	1		
C	25	192703-10200	ウオッシャヘッドボルト	16		JIS B 1176 M10X1.5X20 12.9T
C	26	197123-04111	カラク	2		PT 1/2
C	27	197123-02111	カラク	2		PT 1/4
C	28	197123-01111	カラク	1		PT 1/8
C	31	194101-16401	スプリングワッシャ	4		

CLASS	ITEM NO.	PARTS NO.	DESCRIPTION	QTY	DESCRIPTIN	REMARKS
構成区分	図番号	品番	名称	員数	材質	備考
C	1	120943-60104	ホルダ A S/A	1		
C	-1	120941-61006	ホルダ A	1		
C	-2	120941-61605	ブラケット A	3		
C	-3	120946-80708	ヒートホルアサンブ	3		
C	-4	120941-61907	ホワークレスト A	3		
C	-5	120946-49010	ロウエストブラケ	6		
C	-6	193711-40221	スプリングピン	3		JIS B 2808 φ4x22
C	2	120943-60105	ホルダ B S/A	1		
C	-1	120946-89706	ホルダ B	1		
C	-2	120946-89704	ブラケット B	4		
C	-3	120946-83404	ヒートホルアサンブ	4		
C	-4	120941-61908	ホワークレスト B	4		
C	-5	120946-89707	ロウエストブラケ	8		
C	-6	193711-40221	スプリングピン	4		
C	3	120943-60106	ホルダ C S/A	1		
C	-1	120941-61202	ホルダ C	1		
C	-2	120946-89709	ブラケット C	4		
C	-3	120941-60409	ホワッシャ	68		8.4x 35.5 GE
C	-4	120941-61909	ホワークレスト C	4		
C	-5	120946-89712	ロウインクブラケ	4		
C	-7	120946-89714	ロウエストブラケ	8		
C	-8	193711-50221	スプリングピン	4		JIS B 2808 φ5x25
C	4	120941-61306	ホライナー B	1		
C	5	120946-89721	ロウエストプレート	1		
C	6	120946-89716	ホンネット B	1		
C	7	120946-89722	ロウアサンク	1		WR 105 (NTH)
C	8	120946-89717	ホンネット C	1		
C	9	120946-89723	ロウアサンク	1		WR 115 (NTH)

構成区分記号	名称
A	分解組立時ユーザーズ交換シテテレハナラナイ部品 ※リペアオートシナ流動スルモノ
B	品質保証上アルイハ加工上ノ理由ナ、組合セ部品シテ供給スルモノ
C	単一部品ナ供給スルモノ
D	供給ナキナイモノ

形式	RGC-150VP-50-1
図番名称	パーツリスト
図番	20940 - 65405 - A

三角法

カヤバ工業株式会社

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GRADALL®

XL SERIES CRAWLER MAINTENANCE MANUAL



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Rev. 9/00

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XL SERIES CRAWLER MAINTENANCE MANUAL

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NOTE! “High Pressure” denotes 10,000 psi gauge
“Low Pressure” denotes 1,000 psi gauge

COVERS XL SERIES EXCAVATORS
STARTING SERIAL NUMBER:
XL 2200: 0221400
XL 3200: 0321100
XL4200: 0424200
XL 5200: 0522100

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Introduction

Orientation:
"Right", "left", "front" and "rear" relate to the direction of a person sitting in the upperstructure cab. The front of the machine is the idler end. The excavating (working) function should always be performed over the front to minimize track component wear.

Related Materials:
Other manuals related to your machine should be reviewed for information about a specific subject other than XL CRAWLER UNDERCARRIAGE maintenance.

Other manuals available for your machine:
Owner/Operator Manual
Service Manual
Safety Manual
Parts Manual
Sales Literature
Miscellaneous Vendor Manuals covering specific components

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Introduction (continued)

This Manual covers technical repair and maintenance information for the CRAWLER UNDERCARRIAGE of the XL SERIES GRADALL.

Charts showing component dimensions, part numbers, wear percentage, fastener torque values, hydraulic hose and fitting torque values and lubrication capacity information are included.

Information about track chain adjustment, repair and replacement is also supplied.

This Manual does not cover machine operation or the hydraulic system. Refer to appropriate manuals for that information.

Familiarize yourself with this Manual and its contents. Should you have questions concerning information supplied or a specific machine, please contact your GRADALL distributor for assistance.

Safety

The following symbols are used to call your attention to safety notices.

⚠ DANGER DANGER: This symbol indicates an extreme hazard which could result in high probability of death.

⚠ WARNING WARNING: This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.

⚠ CAUTION CAUTION: This symbol indicates a hazard which could result in injury or damage to equipment or property if proper precautions are not taken.

DAILY:

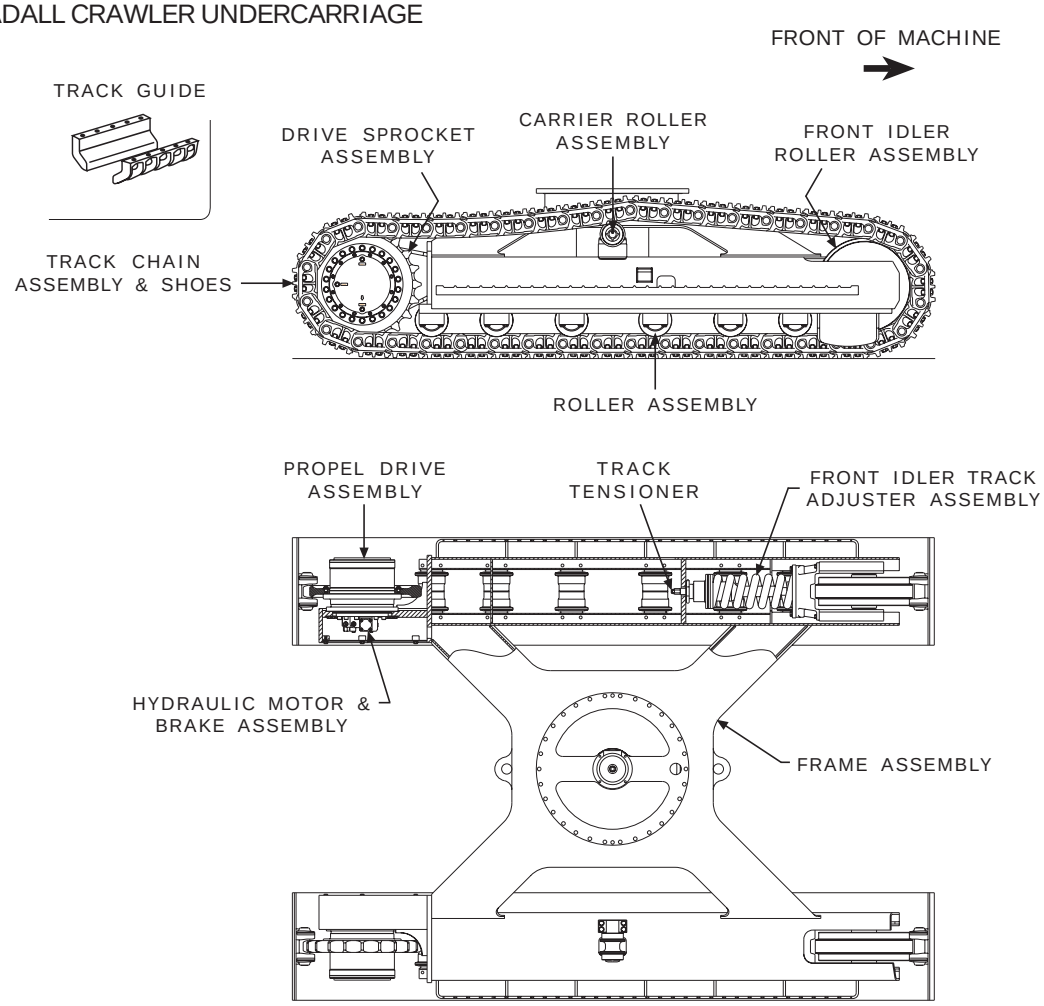
Read and adhere to all safety notices placed on the machine and in the various technical and operator's manuals.
Clean the machine as required.
Be sure all grab handles, steps, and walking areas are clean and clear.
Be sure the fire extinguisher works (if equipped).
Check that all safety decals are in place as when the machine was received new.
Be sure all safety and operator's manuals are with the machine.
Report any safety hazard to the correct personnel.
DO NOT operate the machine in an unsafe manner.
DO NOT operate the machine if you are unfamiliar with the controls.
DO NOT operate the machine if you are under the influence of alcohol or drugs.
Be certain controller shut-off safety switch functions properly when the operator's seat handle or lever is raised.

⚠ WARNING DO NOT remove track tensioning hydraulic cylinder fitting while it is pressurized. Relieve pressure by loosening the fitting one or two turns until grease escapes through the vent slot and pressure is relieved. Refer to the warning decal on the inside of the side frame cover protecting the track tensioning device.

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I. Nomenclature

FIGURE 1
GRADALL CRAWLER UNDERCARRIAGE



This Manual covers the undercarriage mechanical running gear. Components such as planetary drive, hydraulic drive motor and crawler brakes are not covered. Refer to the respective manual for information on these components. The undercarriage frame (carbody and side frame) is only covered in welding repairs.

A quick reference chart is supplied above as an aid to find major components in their respective parts manual.

Refer to the contents page for specific components covered in this Manual.

To extend Undercarriage Life:

- Dig only with the attachment over the idler end of the tracks. This gives even pin and bushing contact, reducing wear. An attachment working over the sprockets will result in overloading the surfaces between the sprocket and track bushing.
- Travel in the forward position with the sprockets at the rear end of the machine. Travelling in reverse causes excessive wear on the sprockets and chains.
- When turning, utilize both tracks. Using power to one track only causes the opposite track to drag, wearing components more rapidly.
- Keep track and drive components clean and free of mud and debris.

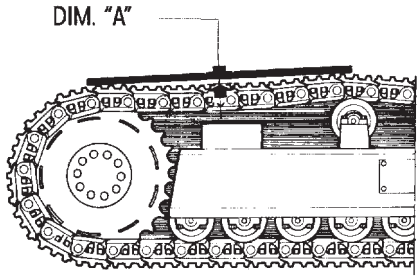
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- Perform daily inspections, checking for loose bolts, leaking seals, structural damage, correct track adjustment and any abnormal wear. Report problem areas to appropriate personnel.
- Operate the machine in a smooth professional manner, especially over obstacles or rough terrain. This will usually prevent premature roller and component wear and reduce the possibility of track shoe bending.
- Always park the machine on level ground. If parked on an incline or uneven terrain, the roller seals could become deformed or damaged resulting in lubricant loss. Without lubricant the internal parts of a roller will be destroyed within hours.
- Keep the machine lubricated per lube chart.
- Replace or rebuild track chain components as required. Refer to **Section VI, "Track Chain,"** for specific component information.
- Keep a supply of metric fasteners in stock to replace broken or lost components.
- When replacing bolts, nuts, hydraulic hoses and/or hydraulic fittings, torque them to the values shown in the torque charts on **pages 28-30.**

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II. Track Adjustment

FIGURE 2
TRACK ADJUSTMENT CHECK



Proper track adjustment is achieved when the link assembly is properly tensioned. This condition is reached when the maximum sag between the top carrier roller and the drive sprocket matches the dimension "A" shown on ***Figure 2.*** The allowable sag for your machine is as follows:

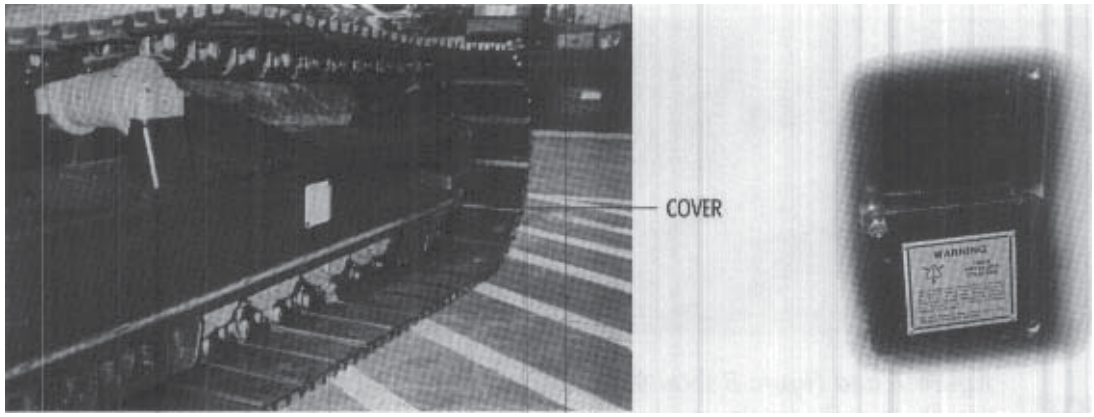
XL 5200 ---- 35mm ---- 1.375 in.
XL 4200 ---- 35mm ---- 1.375 in.
XL 3200 ---- 35mm ---- 1.375 in.
XL 2200 ---- 20mm ---- 0.781 in.

Track Adjustment Procedures:

- Clean track components so foreign material does not obstruct the tensioning assembly from full free movement.
- Install a straight edge on the track and measure sag per ***Figure 2***.
- If tightening adjustment is required, add grease to the tensioning cylinder until the proper dimension "A" in ***Figure 2*** is achieved.
- TO ADD GREASE TO THE TENSIONING CYLINDER, PROCEED AS FOLLOWS:

FIGURE 3
SIDE FRAME TRACK TENSIONING DEVICE COVER

FIGURE 4
WARNING DECAL



Remove the track tensioning device cover (if equipped) from the side frame. ***See Figure 3.*** Follow the warning decal instructions on the inside of the cover. ***See Figure 4.***

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II. Track Adjustment (continued)

FIGURE 5
BUTTON HEAD HYDRAULIC FITTING

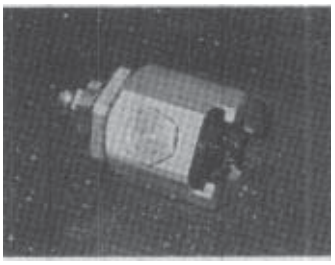
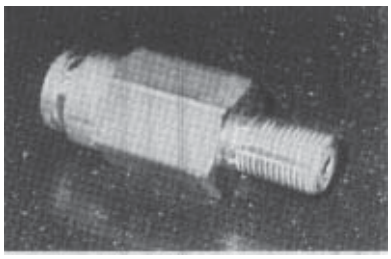


FIGURE 6
FILL VALVE (TRACK TENSIONING CYLINDER)



- Attach the button head hydraulic fitting (furnished in the tool kit) to the fill valve that is screwed into the tensioning cylinder. ***See Figure 5 and Figure 6.***

  NOTE! The XL 5200 also has a relief valve installed in the tensioning cylinder.
- Pressurize the cylinder until the proper dimension "A" is achieved. ***See Figure 2.***
- Reinstall the track tensioning device cover to the side frame. ***See Figure 3.***
- **IF THE TRACK TENSION IS TOO TIGHT AND NEEDS LOOSENING PROCEED AS FOLLOWS:**
- Remove the track tensioning device cover from the side frame. ***See Figure 3.*** Follow the warning decal instructions on the inside of the cover. ***See Figure 4.***
- Carefully back out the hydraulic fill valve from the tensioning cylinder until lube starts to escape from the relief slot machined in the threads. ***See Figure 5 and Figure 6.***
- Release the amount of lube necessary to achieve proper dimension "A" in ***Figure 2*** for your machine.

FIGURE 7
TENSIONING CYLINDER FILL VALVE WITH
BUTTON HEAD FITTING

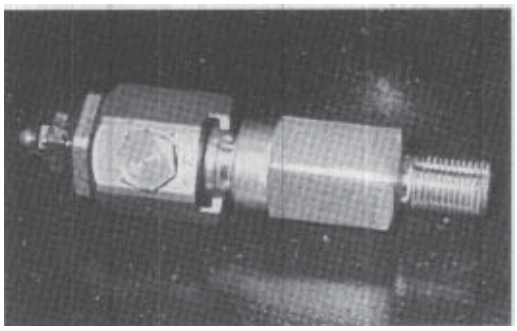
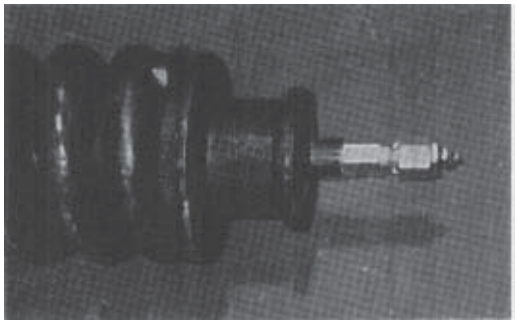


FIGURE 8
FILL VALVE AND BUTTON HEAD FITTING INSTALLED
IN TENSIONING CYLINDER



NOTE! ***Figure 7*** and ***Figure 8*** show the tensioning cylinder fill valve and the button head fitting that fits to it. Be certain you understand how to install the buttonhead fitting to the fill valve (one-way check valve) before attempting adjustment.

- Reinstall the side frame cover.

⚠ WARNING Do not remove any parts until all pressure in the tensioning cylinder has been relieved. Serious injury could occur. Refer to the decal on the undercarriage side frame tensioning cylinder cover.

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II. Track Adjustment (continued)

Improper Adjustment Hazards:
TRACKS TOO TIGHT:
If track is too tight, excessive friction will cause a reduction in machine performance and may cause accelerated wear of rolling track components.

TRACKS TOO LOOSE:
If track is too loose, component service life is drastically reduced. Loose tracks easily become misaligned and may jump off the sprockets when the machine is turned. A loose track may also jump sprocket teeth causing damage or premature wear. At best, loose tracks make it difficult to travel in a straight line.

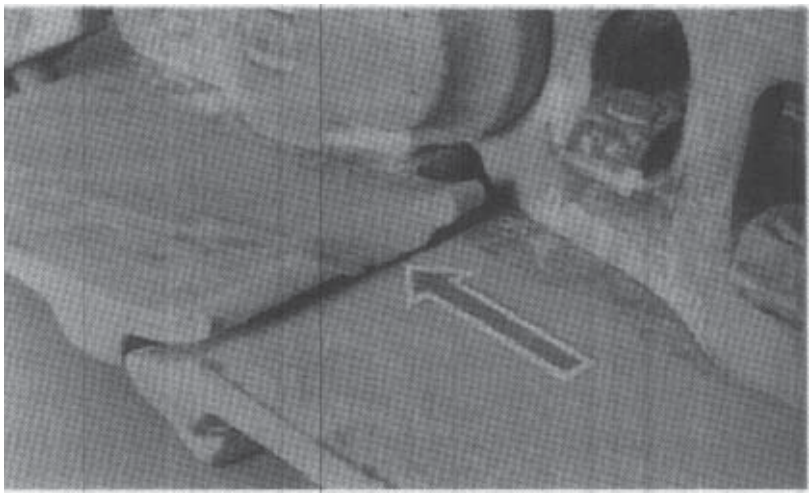
NOTE! Both tracks must be adjusted equally to ensure proper travel performance.

III. Shoe Contact with Rock Guard

Contact with the rock guard may result in wear on a portion of the leading edge. The track chain may flex up between rollers as the machine travels over the ground. The amount that the chain can flex in this direction is increased when internal pin and bushing wear occurs. As the chain flexes up, the leading edge of the shoe may contact the rock guard. ***See Figure 9***. Also, rail and track roller tread wear reduces the clearance between the track shoes and the rock guards. This would increase the possibility of contact. Normal contact may also occur if the track chain is tipped up on one side by rough terrain.

This type of wear does not affect the function of the track shoe and, therefore, is a minor wear pattern. It does, however, reduce the bending strength of the shoe.

FIGURE 9
SHOE CONTACT WITH ROCK GUARD



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IV. Crawler Travel Speed

Adjustment for crawler undercarriage travel speed is performed at the control valves. ***See Figure 10 and Figure 10A.*** There are stroke limiters (speed adjustments) provided on each crawler propel valve end cap. Use the following tests to set free-running speed and actual travel speed. A stopwatch and paint (for marking the tracks) will be required for these tests.

Before checking travel speed, be certain the tracks, chains, and rollers are free of mud, and other debris that could interfere with achieving correct test results. Check track tension before testing travel speed. If track tension is not correct, perform track adjustment procedures outlined on **pages 3 and 4.**

Travel Speed Testing and Adjustment Procedures:

1. Rotate the upperstructure so the boom is perpendicular to the right-hand track. Place the bucket on the ground with the boom extended. Apply down pressure to the boom to raise the right hand track off the ground. Paint a stripe on the track to be used as a reference point.

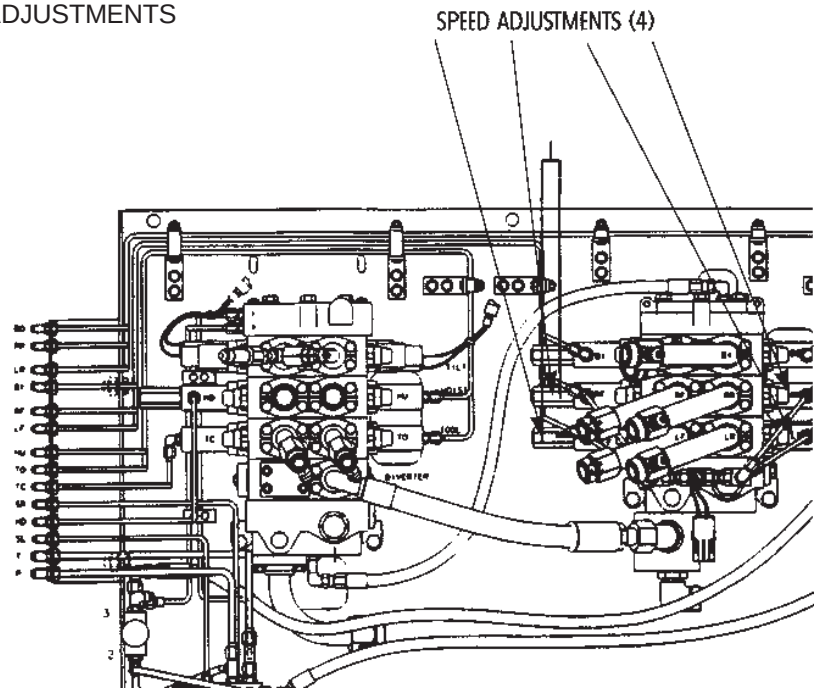
2. Set the crawler speed to “High”. Push the right-hand forward travel pedal. When the paint stripe reaches your desired location, start the stopwatch and time the track for one complete revolution. The correct speed is as follows: XL 5200: 8.6 seconds (27.9 RPM sprocket speed). XL 4200: 7.8 seconds (27.9 RPM sprocket speed). XL 3200: 5.15 seconds (44 RPM sprocket speed). XL 2200: 4.2 seconds (38 RPM sprocket speed).

3. If travel speed needs to be corrected, remove the plug from the rear stroke limiter (speed adjustments). Insert an allen wrench in the stroke limiter screw. Loosen the stroke limiter housing and adjust it to achieve the correct travel speed. Turning the stroke limiter screw clockwise decreases travel speed, turning it counter clockwise increases travel speed. Re-test travel speed after adjustment. ***See Figure 10, Figure 10A & Figure 10B.***

4. Repeat test for right-hand reverse travel using the front stroke limiter. After this travel speed is set, **carefully** raise the boom to lower the right hand track to the ground.

5. Rotate the upperstructure so the boom is perpendicular to left-hand track. Repeat forward and reverse track speed test for the left hand track using steps **1** thru **4.**

FIGURE 10
CRAWLER SPEED ADJUSTMENTS
XL 4200 / XL 5200



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IV. Crawler Travel Speed (continued)

6. After free-running speed has been checked, mark off a level, linear distance of 100 feet. Set the crawler undercarriage for high speed and enter the 100-foot marked course travelling straight and at full travel speed forward. Begin timing as the machine enters the course and end timing when it exits. Correct travel speed is as follows: XL 5200: 28.8-31.8 seconds. XL 4200: 27.6-30 seconds. XL 3200: 19.7-21.7 seconds. XL 2200: 17.8-21.8 seconds.

NOTE! If travel speed is slower than the above times and free-running speed was tested correctly, do not increase track speed to achieve the above times. Use free-running speed as the maximum speed for the crawler undercarriage.

7. Repeat step 6 for reverse travel.

FIGURE 10A
CRAWLER SPEED
ADJUSTMENTS
XL 2200

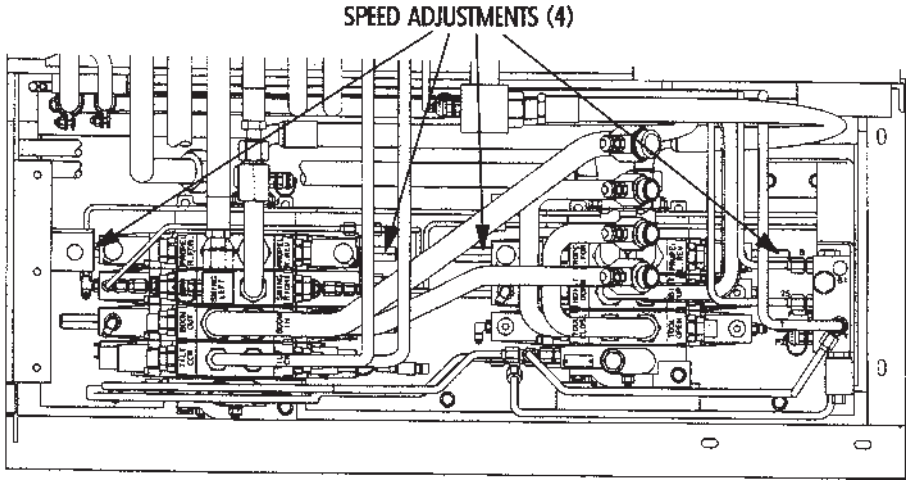
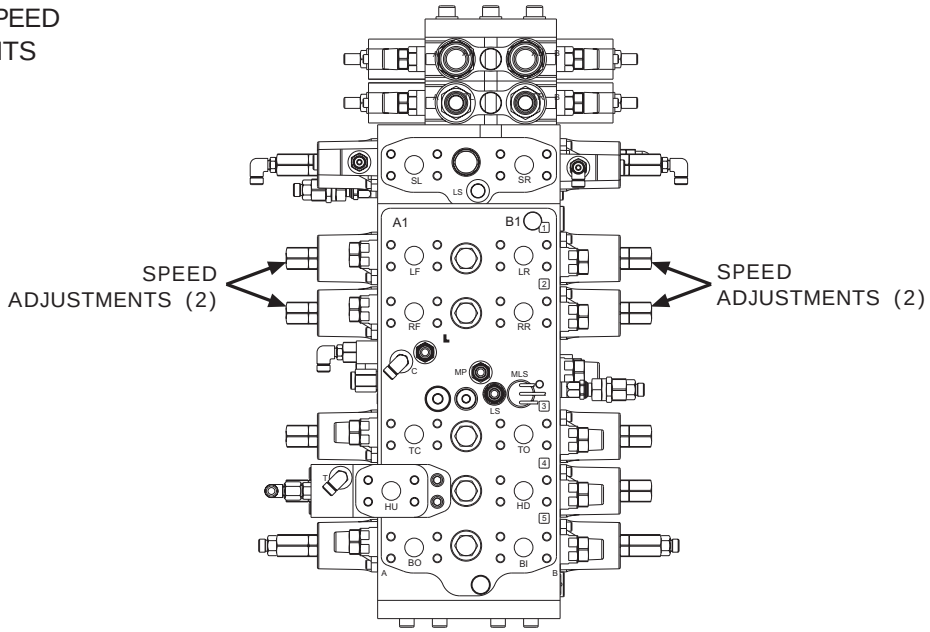


FIGURE 10B
CRAWLER SPEED
ADJUSTMENTS
XL 3200



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V. Crawler Tracking

Crawler Undercarriage Tracking

The crawler undercarriage is allowed a small deviation from straight travel. If this deviation is excessive, it can be adjusted using the crawler propel valve stroke limiters. Whenever tracking is adjusted, the free-running travel speed of the undercarriage must be checked to ensure it does not exceed specifications for the model being tested. It may be necessary to slow one track, rather than speed up the other.

To Check Undercarriage Tracking Proceed as Follows:

1. Mark off a level, linear distance of 100 feet. Set the crawler undercarriage for “High” speed. Enter the 100-foot marked-off course straight and at full travel speed forward.

2. After completing the course, measure the machine’s path of travel for deviation from a straight line. Maximum allowable deviation is: XL 4200/XL 5200, 10 feet: XL2200/XL 3200, 3 feet. If free-running speed has been checked and is correct, it is best to slow the fast track when adjusting tracking. The stroke limiter adjustment screw should not be adjusted more than 1/8 of a turn before retesting. The stroke limiter adjustment is very sensitive. Use the rear stroke limiter to adjust forward travel.

3. After forward travel tracking test is complete, repeat for reverse travel. Use the front stroke limiter to adjust for reverse travel. ***See Figure 10, 10A or 10B.***

VI. Track Chain

The track chain assembly known in the industry consists of a series of links, pins and bushings on which the track shoes are bolted. The chain contacts the drive sprocket on one end of the machine and the idler roller chain tensioning assembly on the other end. As the sprocket turns, the teeth contact the bushings pulling them around the circumference resulting in machine travel.

The links are fastened together by pins and bushings which are sealed. ***See Figure 11 and Figure 18.*** The chain must be installed with the pin end of the links facing the back of the machine at ground level.

To split open a track, first locate the master pin. It has a (machined center) countersink in the center of each end. ***See Figure 17.*** Then position the track so it is accessible. Use a portable press to push the pin out. The chain is now broken apart and both ends are free.

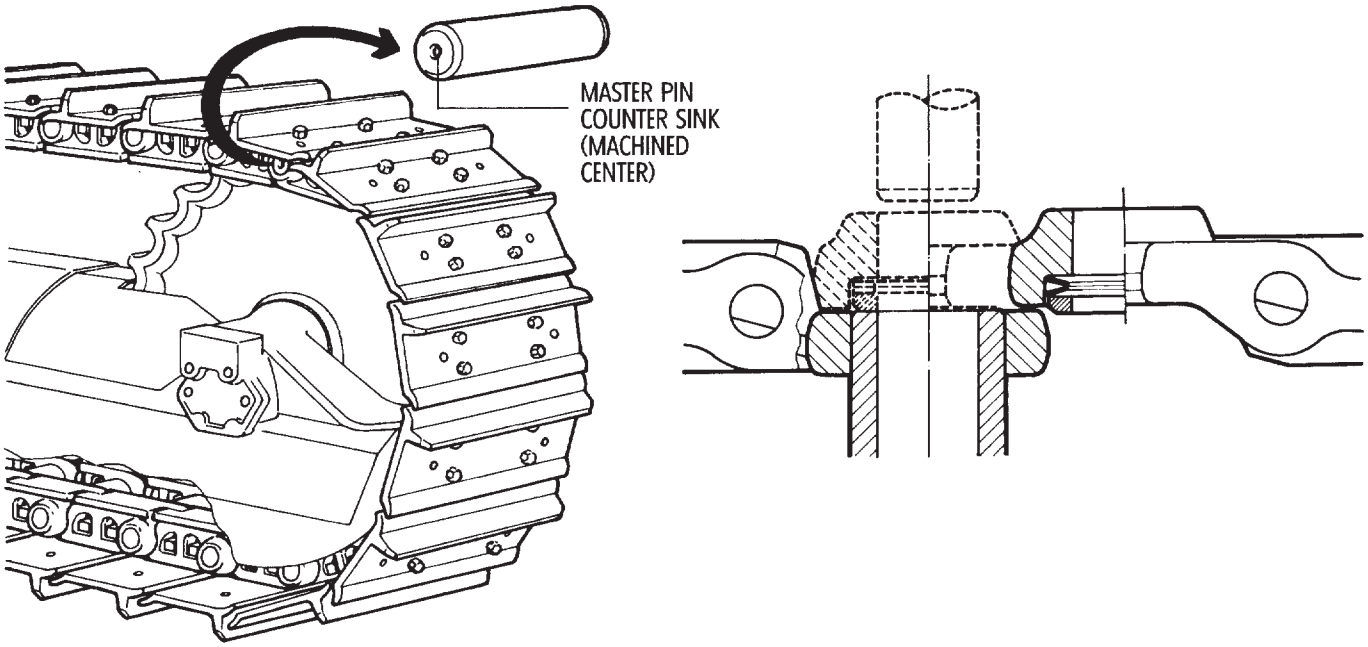
⚠WARNING Stay clear of the end of the chain to prevent injury should it roll uncontrolled to the ground. We recommend you use a “come-a-long” or similar fastening device to lower the end of the chain to the ground.

Reverse the procedure for reassembly.

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VI. Track Chain (continued)

FIGURE 11
TRACK PIN & BUSHING



The accumulated operating (traveling) hours on the machine result in link wear. Replace whenever the 100% value is reached. Allowable link wear is per ***Table 1:***

FIGURE 12
TRACK LINK

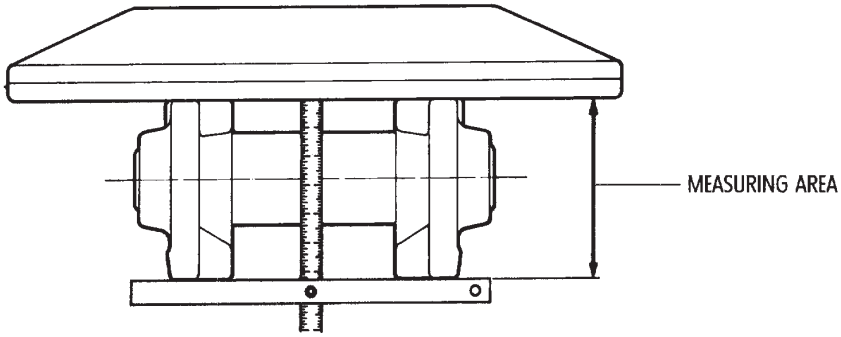


TABLE 1
TRACK LINK WEAR PERCENTAGE DATA

Model	Part No.	New Link		Wear Percentage							
				25%		50%		75%		100%	
		mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 5200	8091-4018 & 4019	103.2	4.062	101.8	4.015	100	3.937	97.5	3.843	94	3.703
XL 4200	8369-4050 & 4051	97	3.812	95.6	3.750	94	3.703	92	3.625	89	3.500
XL 3200	8031-4001 & 4002	104.0	4.09	102.9	4.050	100.5	3.960	99.4	3.91	97.0	3.820
XL 2200	8021-4035 & 4036	84	3.312	83.3	3.265	82.3	3.234	81	3.187	79.5	3.125

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Track Shoes

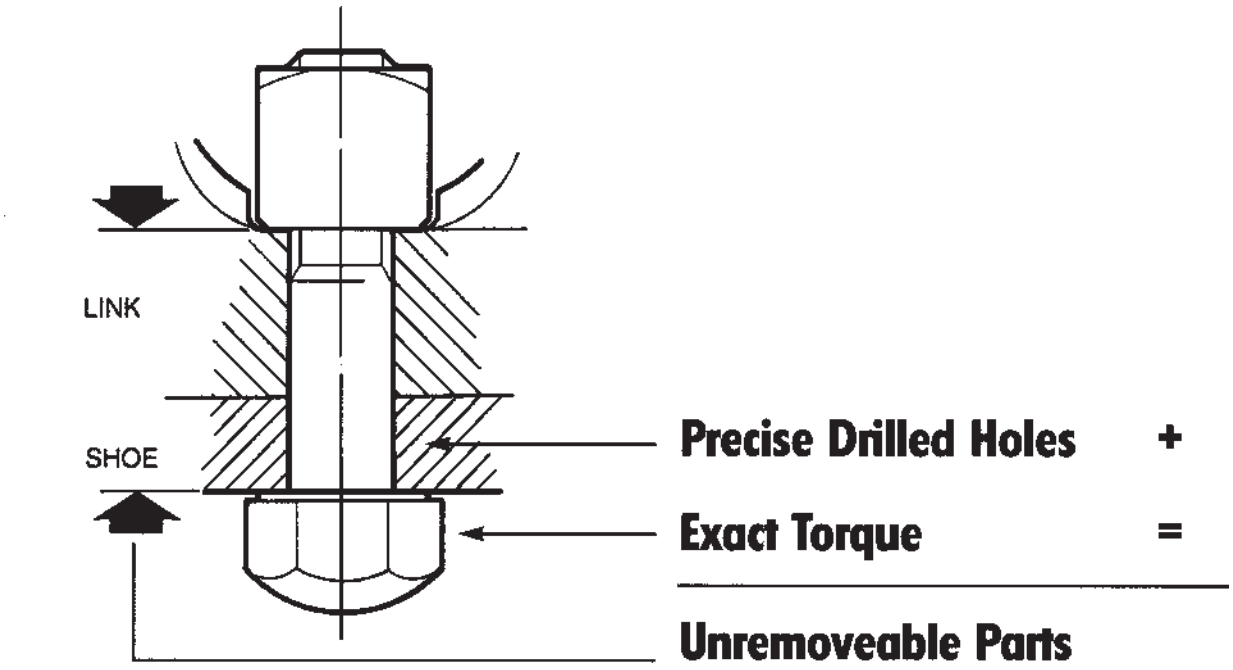
The standard track shoes (pads) used on the GRADALL crawler machines are the triple grouser type. This design gives a lower penetration into the surface, reduces turning resistance, improves maneuverability and reduces loads on other undercarriage parts.

Other style track shoes are also available.

To minimize shoe bending or breaking, do not use a wider shoe than is required. If track shoes show a tendency to bend or break, the shoes may be too wide for the working surface.

It is important to keep the track bolts properly torqued. Refer to the metric bolt section of the torque chart shown on **page 28** of this manual for torque values. Values shown are for lubricated bolts. The bolt torque should be checked approximately every 100 hours. Visually check for loose or missing bolts at the start of each operating shift. If the track bolts or nuts are replaced, be sure to install the nut correctly. The chamfered side fits into the recess in the track chain link. **See Figure 12A.** Failure to install the nut in this manner will result in premature loss of torque.

FIGURE 12A
TRACK BOLT INSTALLATION



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VI. Track Chain (continued)

Maximum track shoe wear of 100% (***See Table 2*** for values applicable to your machine) is allowable if the machine is normally working on medium soft ground. Operating on rocky ground the shoes must be replaced when the wear is 75%. (**Second column from right, Table 2.**)

FIGURE 13
TRIPLE GROUSER SHOES

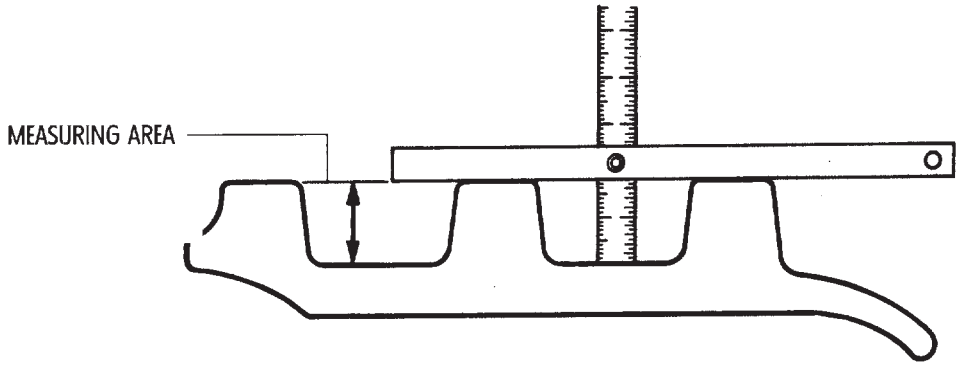


TABLE 2
TRIPLE GROUSER SHOE WEAR PERCENTAGE DATA

Model	Track Shoe	Track Shoe	New Shoe		Wear Percentage							
					25%		50%		75%		100%	
	800mm 31.5 in.	600mm 23.5 in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 5200	8691-4024	8691-4045	25.3	1.00	22	0.859	19	0.750	15	0.593	11	0.437
XL 4200	8369-4056	8369-4054	25.3	1.00	22	0.859	19	0.750	15	0.593	11	0.437
XL 3200	N/A	8031-4007	25.5	1.00	21.75	0.860	18.0	.710	14.25	.560	11.0	0.437
XL 2200	N/A	8021-3015	22	0.859	19	0.750	16	0.640	12	0.408	9	0.359

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Track Pin

The hardened (surface hardness Rc 60) track pin is pressed into the right and left link of the chain. It is also installed through the bushing at each end of the link. There are seals at each end to prevent contamination.

The outside diameter (O.D.) of the pin wears against the inside diameter (I.D.) of the bushing with which it is making contact. ***See Figure 14.***

For allowable track chain wear tolerances, see ***"When to Repair Track Group" (Page 15), Figure 19 and Table 4.*** Once the pin reaches the allowable wear limit it may be rotated 180 degrees for extended life. ***See Figure 15.***

FIGURE 14
TRACK PIN

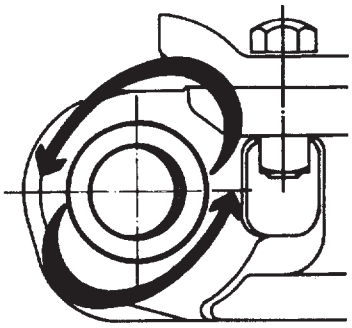
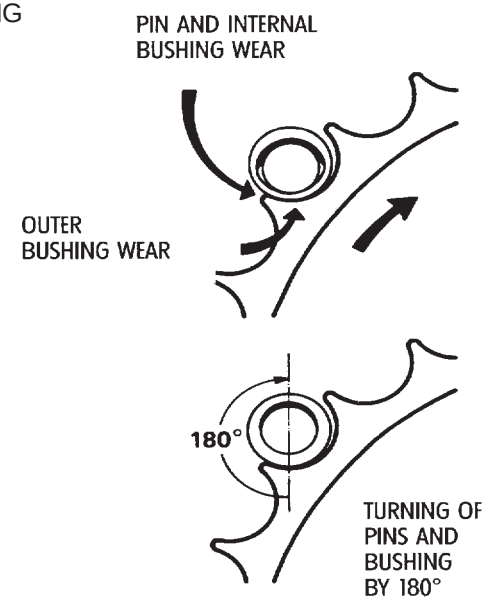


FIGURE 15
TRACK PIN TURNING



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Track Bushing

The track bushings fit into the counterbore of each link. There is one bushing per link set. The track pin fits through the bushing.

The O.D. of the bushing contacts the teeth of the drive sprocket during travel. This results in bushing wear at the sprocket side only. This wear along with pin wear is a major factor in causing looseness and damage to the chain by increasing pitch length.

Outside wear of the bushings is of three types: Radial Wear, Forward Drive Side Wear, and Reverse Drive Side Wear. ***See Figure 16.*** Measurements should be taken at each position; use the one which indicates maximum wear. ***Refer to Table 3.***

FIGURE 16
TRACK BUSHING WEAR

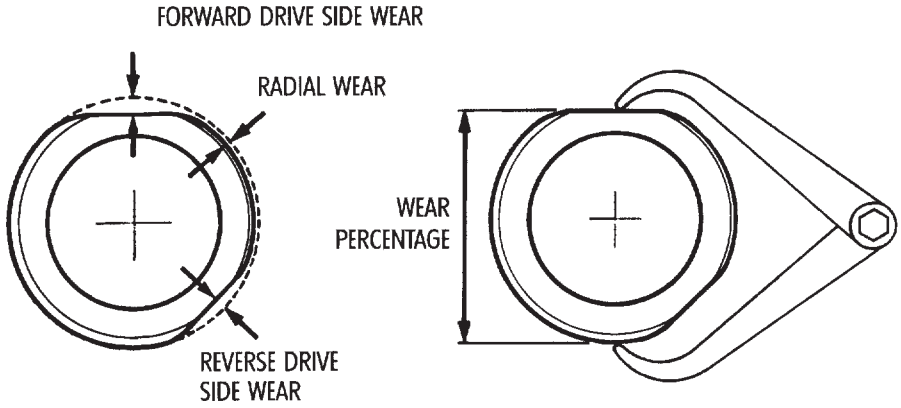
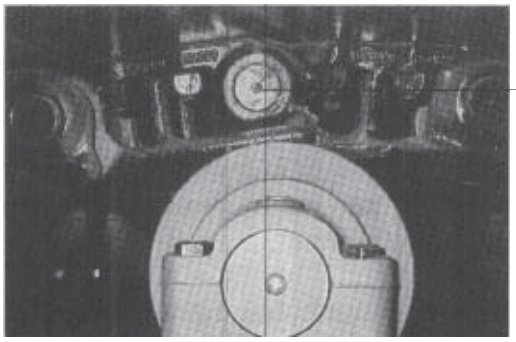


TABLE 3
OUTSIDE BUSHING WEAR

Model	Part No.	New Bushing		Wear Percentage							
				25%		50%		75%		100%	
		mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 5200	8691-4062	53.975	2.125	53.4	2.109	53	2.093	52.3	2.062	50.8	2.00
XL 4200	8061-4052	52	2.047	51.7	2.031	51.2	2.015	50.5	1.984	49.2	1.937
XL 3200	8031-4004	59.0	2.32	58.7	2.31	57.8	2.28	56.2	2.21	54.0	2.13
XL 2200	8021-4039	46.8	1.859	46.5	1.843	46.1	1.828	45.5	1.796	44.3	1.750

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FIGURE 17
MASTER PIN



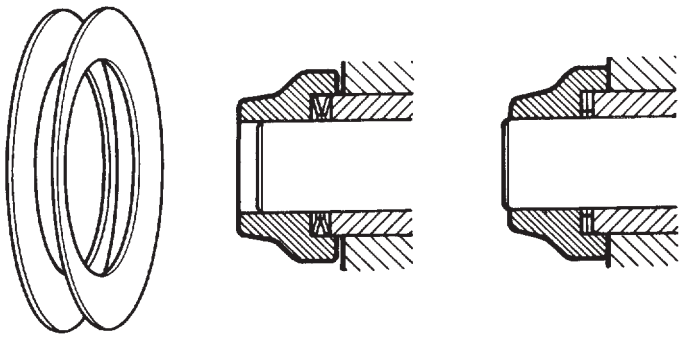
Master Pin and Bushing
A master pin and bushing is used on each track. These components are the ones used to take the track apart and put it together. ***See Figure 17.*** The master pin and bushing wear more rapidly than do other pins and bushings. This is because the bushing does not extend into the counterbore of the link.

The master pin can be identified by the countersink (center) machined in the center of each end.

A portable press is used to remove the master pin.

⚠ WARNING Once the master pin is removed, the track may roll uncontrolled to the ground. To avoid injury, **stay clear.**

FIGURE 18
TRACK PIN SEALS



The track chain link is sealed at each end of the track pin. This design helps guard against contaminants, a major source of premature wear. The seals must be installed. ***See Figure 18.***

When the pins and bushings are assembled they must be well lubricated.

Track Bolts
The track bolts have special wear-resistant heads, self-locking, square nuts and rolled threads. These bolts meet American standard Grade 8 and European standard 12.9 class.

Torque values are found in the torque chart. ***See Pages 28-30.***

The bolts should be randomly checked for torque approximately every 100 hours. Check for loose or missing bolts at the start of each operating shift.

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When To Repair Track Group
Once you determine exactly when to replace each worn part of your undercarriage, you have maximized your opportunity to exact the most economical use of your undercarriage.

This Manual contains tables showing the maximum wear limit for each track moving part. If these limits are observed, you will realize economical performance without costly expenses resulting from component damage, replacement parts and machine downtime.

For measurement of component wear, a few simple tools are needed: flexible tape, small caliper, large caliper, depth gauge, steel ruler and straight edge.

Links, Pin and Bushing Wear Measurement
To establish the average wear measurement, choose a length of 4 sections of link assembly on top of the undercarriage in a well tensioned zone. Do not include master pin and link in the four sections of link measured. ***See Figure 19 and Table 4.***

Once the wear measurement reaches the 100% limit the pins may be turned 180° for extended life. If this operation has been previously performed the worn parts must be replaced.

FIGURE 19
FOUR SECTIONS OF THE LINK ASSEMBLY

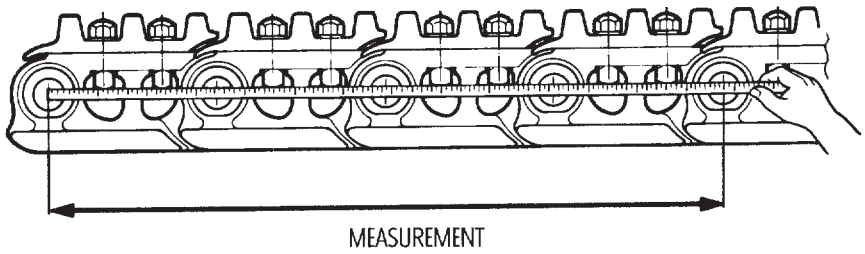


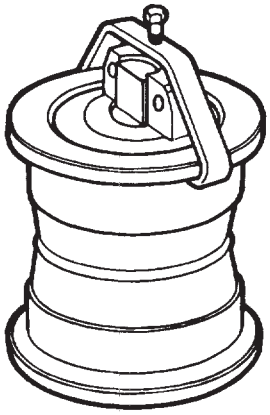
TABLE 4
WEAR DATA: 4 SECTIONS OF THE LINK ASSEMBLY

Model	New Chain		Wear Percentage							
			25%		50%		75%		100%	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 5200	685.8	27.000	687.5	27.062	690	27.171	693.5	27.312	697.5	27.468
XL 4200	680	26.765	682.5	26.875	686	27.000	690	27.171	693	27.281
XL 3200	761.0	29.960	764.2	30.09	767.5	30.220	770.7	30.340	774.0	30.470
XL 2200	622.3	24.500	624	24.532	625.8	24.600	627.5	24.703	632.3	24.875

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VII. Track Rollers

FIGURE 20
TRACK ROLLER



The track rollers used on the XL SERIES GRADAIL CRAWLER are sealed units that normally require no resealing or refilling (unless they have been damaged). The rollers are filled with SAE 30 or SAE 40 weight oil. To fill the roller, remove the fill plug from the body and fill with the quantity of oil shown for your machine in ***Table 5.***

The XL 5000 and XL 4000 use the bottom roller design for the top and bottom of the track. The XL 2200/XL 3200 uses a bottom design on the bottom of the track and a carrier design roller for the top of the track. Refer to the quick reference chart or the applicable parts manual for part number identification.

TABLE 5
TRACK ROLLER LUBE CAPACITY CHART

Model	Part No.	Quantity of Lubricant		
		Kg	lb.	oz.
XL 5200	8091-3006	0.355	0.74	11.8
XL 4200	8061-3006	0.360	0.79	12.6
XL 3200	8031-3004	0.250	0.55	8.8
XL 2200	8021-3004	0.250	0.55	8.8

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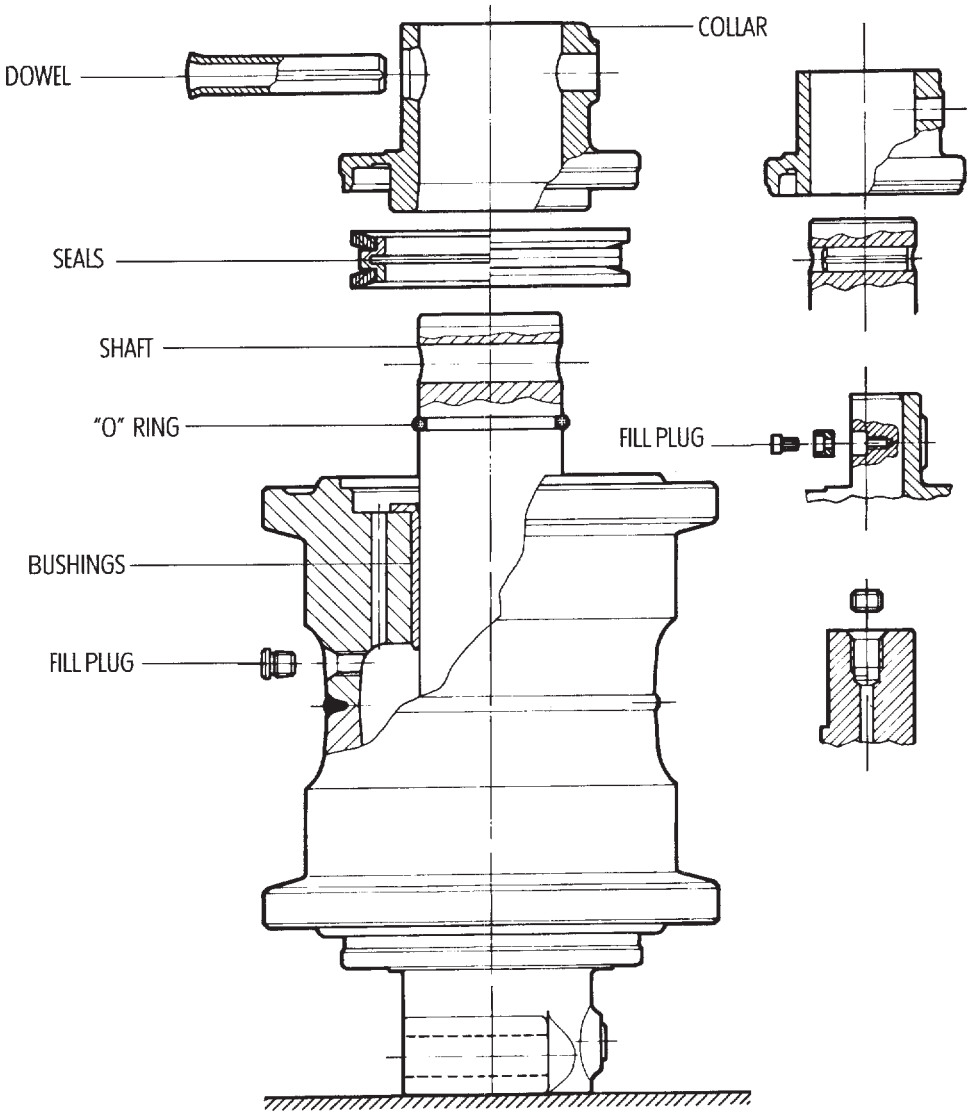
VII. Track Rollers (continued)

Roller Seals

If the seal group is being replaced, use new parts only. Used seals will most likely fail shortly after rebuild. Installation procedure for roller seals is as follows:

1. The mating surface where the seals contact must be dry and clean, free of dirt, nicks and burrs.
2. Install O-ring on the roller shaft.
3. Install the seal group into the roller shell seat. Remove the plastic band holding the rings together.
4. Press the collar onto the roller shaft and lock in place with the dowel.
5. Invert the roller assembly and perform steps 1 through 4.
6. Fill roller with lube. ***See Table 5.***

FIGURE 21
ROLLER SEALS



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VII. Track Rollers (continued)

Track Roller Disassembly (See Figure 21)

1. Remove lube fill plug and dump lube into a container.
2. Press dowel pin out of collar.
3. Remove seals and shaft.
4. Press out bushings.

Track Roller Assembly (See Figure 21)

1. Install bushings into roller shell.
2. Install collar to roller shaft.
3. Install dowel pin through collar and shaft.
4. Install O-ring in roller shaft.
5. Install seal group in roller shell seal seat.
6. Insert collar and shaft into shell until collar bottoms to the seal group.
7. Invert roller 180°.
8. Complete component assembly as in steps 2 through 6.
9. Fill Roller with lube. ***See table 5.***

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VII. Track Rollers (continued)

Bottom and Carrier Track Rollers

The rail diameter of the bottom and carrier roller for your machine when it was new is shown in ***Table 6 and Table 7.*** Whenever the wear percentage reaches the 75% range the roller diameter should be resurfaced to size or the roller replaced.

The track roller rail surface hardness is Rc 55.

FIGURE 22
BOTTOM ROLLER

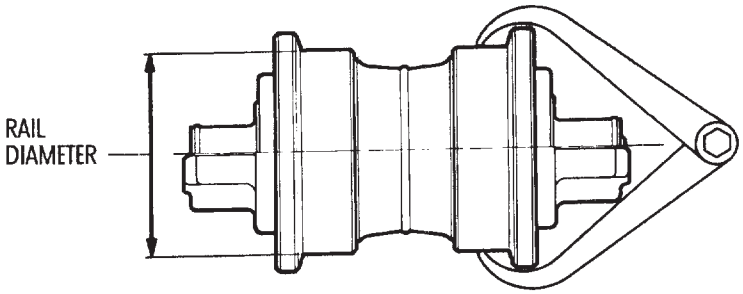


FIGURE 23
CARRIER ROLLER XL 2200

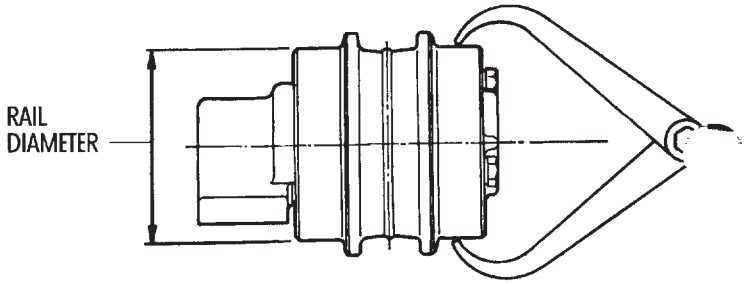


TABLE 6
BOTTOM ROLLER WEAR PERCENTAGE DATA

Model	Part No.	New Roller		Wear Percentage							
				25%		50%		75%		100%	
		mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 5200	8091-3006	154	6.062	152	5.984	149.5	5.890	146	5.750	141	5.546
XL 4200	8061-3004	155	6.109	153	6.015	150.5	5.921	147	5.781	142	5.593
XL 3200	8031-3004	150	5.91	146.9	5.780	143.7	5.660	140.6	5.54	137	5.390
XL 2200	8021-3004	145	5.703	143.5	5.656	141.5	5.578	139	5.468	136	5.359

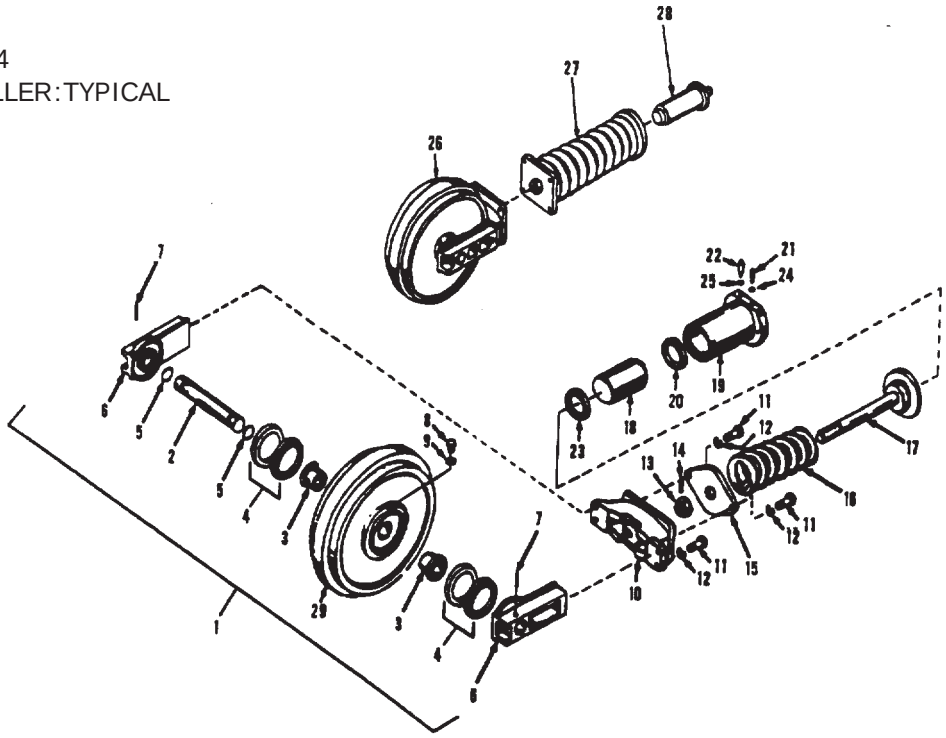
TABLE 7
CARRIER ROLLER WEAR PERCENTAGE

Model	Part No.	New Roller		Wear Percentage							
				25%		50%		75%		100%	
		mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 3200	8031-3003	120	4.72	117.2	4.61	114.2	4.50	111.4	4.39	107.2	4.22
XL 2200	8021-3002	149	5.859	147	5.781	144.5	5.687	141	5.546	137	5.39

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VIII. Idler Roller with Track Tension and Adjuster Components

FIGURE 24
IDIER ROLLER:TYPICAL



Item	Part No.	Qty.	Description of Part
		2	FRONT IDLER TRACK ADJUSTER ASSY, (includes all items)
1		1	IDLER WITH SUPPORT, (includes items 2, 4, 5, 6, 7, 8, 9 & 29)
2		1	PIN
3		2	BUSHING
4		2	SEAL GROUP
5		2	O-RING
6		2	SUPPORT GROUP
7		2	ELASTIC PIN
8		1	PLUG
9		1	SEAL
10		1	BRACKET
11		6	CAPSCREW
12		6	WASHER
13		1	HEX NUT
14		1	ELASTIC PIN
15		1	FLANGE
16		1	SPRING
17		1	PIN BASE

Item	Part No.	Qty.	Description of Part
18		1	PISTON
19		1	CYLINDER, (includes items 20 & 23)
20		1	SEAL
21		1	THROTTLE
22		1	FITTING
23		1	SEAL
24		1	SEAL
25		1	SEAL
26		1	IDLER WITH FORK, (includes items 2, 4, 5, 6, 7, 8, 9, 10, 11, 12 & 29)
27		1	RECOIL DEVICE GROUP, (includes items 13, 14, 15, 16 & 17)
28		1	TRACK TENSIONING GROUP, (includes items 18, 19, 21, 22, 24 & 25)
29			FRONT IDLER, (includes item 3)
			NOTE: QUANTITIES SHOWN ARE FOR ONE SIDE FRAME ASSY ONLY
			NOTE: ONLY ITEMS WITH PART NUMBERS ARE AVAILABLE FOR SERVICE.

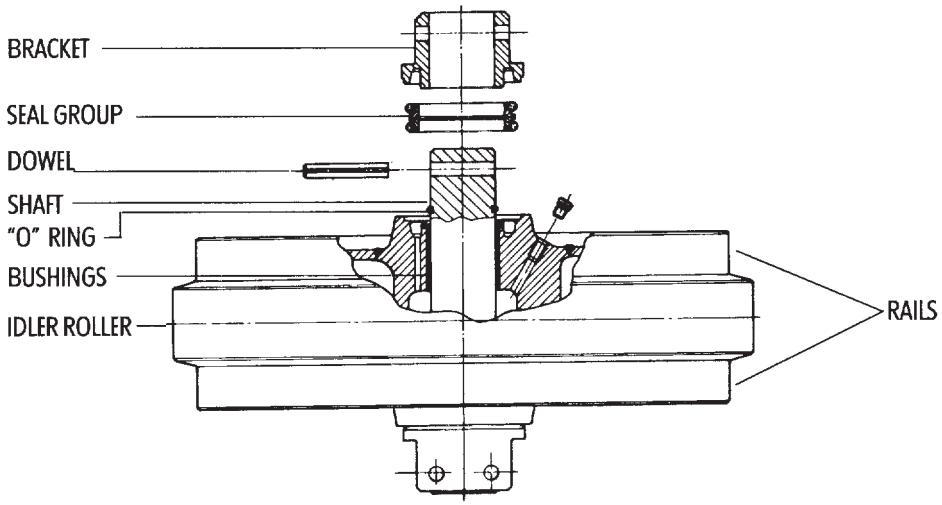
The idler roller assembly is located at the front of each side frame. Major components are Idler Roller, Tensioning Spring, Hydraulic Adjusting Cylinder, Idler Slides and Connecting Bracket.

This assembly acts as a shock absorber for the track system. It compensates for shock loads (caused by large rocks, uneven terrain, etc.) imposed by momentarily adjusting the chain pitch. Compensation is accomplished by the tensioning spring and hydraulic cylinder collapsing the required amount, thus minimizing the chance of chain breakage.

The XL 5200 hydraulic adjusting cylinder is equipped with a relief valve to assist in accepting major shock loads that could be imposed on this size machine. The relief valve will relieve lubrication to compensate for excessive shock loads. Should this occur very often it may be necessary to recharge the cylinder with lubricant once the travel cycle returns to normal.

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FIGURE 25
IDLER ROLLER



The idler roller has two outside rails which is the area that the track links make contact. These rails are hardened to Rc 55.

The rollers are “lifetime” lubricated and under normal working conditions no further lubrication maintenance is required. The idlers should be randomly checked while working to protect against destruction should a seal be damaged.

To install lubrication we recommend the use of a low pressure pump with a nozzle on the end that will fit through the fill hole in the idler body. Use SAE 30 or SAE 40 oil at capacities for your machine. ***See Table 8.***

TABLE 8
IDLER ROLLER LUBRICANT CAPACITY

Model	Part No.	Capacity		
		Kg	lb.	oz.
XL 5200	8691-4017	0.200	0.44	7
XL 4200	8061-4002	0.300	0.66	10.6
XL 3200	8031-3006	0.300	0.66	10.6
XL 2200	8021-3006	0.450	0.99	15.8

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VIII. Idler Roller with Track Tension and Adjuster Components (cont.)

Idler Roller Disassembly *(See Figure 25)*

ASSUMPTION: RECOIL COMPONENTS HAVE BEEN REMOVED AND THE ROLLER IS FREE.

1. Remove one of the dowel pins that fasten the bracket to the shaft.
2. Remove the remaining components which are now free of the shaft.
3. Press out the bushing. (The bushing can only be removed by use of a vertical press with correct tooling.)
4. If necessary, remove the remaining dowel pins and bracket.

Idler Roller Assembly *(See Figure 25)*

1. Press the bushings into the idler shell.
2. Mount a bracket on to the shaft.
3. Insert seal group into the idler shell seal seat.
4. Install O-ring on the shaft.
5. Insert the complete sub assembly in the idler shell to the point where it bottoms the seal group.
6. Invert the idler and assemble components as in steps 1 through 4.
7. After loose assembly press tightly together using a vertical press.

NOTE! The seal group is assembled the same as in the bottom rollers. ***See Figure 21.***

Idler Roller and Track Tensioner Removal and Replacement to the Side Frame

⚠ WARNING Serious injury could result if the pressure is not relieved from the tensioner and recoil system. See decal on the side frame cover and **Section II, "Track Adjustment"**

To remove pressure from the cylinder, carefully back off one or two turns on the fill fitting. ***(Refer to Section II, "Track Adjustment").*** As soon as lube starts to come out the vent hole **STOP backing off the fitting.** Once pressure is relieved it is safe to remove the roller and tensioner assembly.

It will be necessary to collapse the tensioning cylinder fully for reassembly of the group.

See Table 9 for the part number and stroke of the cylinder for your particular machine.

TABLE 9
IDLER ROLLER TENSION CYLINDER

Model	Part No.	Cylinder Stroke	
		mm	in.
XL 5200	8369-4044	80	3.156
XL 4200	8061-4008	80	3.156
XL 3200	8031-4037	80	3.156
XL 2200	8061-4008	80	3.156

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VIII. Idler Roller with Track Tension and Adjuster Components (cont.)

Track Tension and Idler Roller Disassembly ***(See Figure 24)***

1. Relieve all pressure from the track tensioning cylinder. ***See Figure 3 and Figure 4.***
2. Carefully separate the track chain and lay it on the ground.
3. Remove the recoil device group (refer to the correct page in the ***Parts Manual*** for your machine).
4. Remove the track tension group (refer to the correct page in the ***Parts Manual*** for your machine).
5. Remove the two (slide brackets) support groups and idler pin from the side frame.
6. Remove idler roller from the machine.
7. Examine all fasteners and seals for damage. Replace any damaged component.

Track Tension and Idler Roller Reassembly

1. Clean, lubricate, and check all components for damage.
2. Reassemble idler roller with support group and fork and install into side frame (refer to ***Parts Manual*** for parts required).
3. Install track tension group (refer to ***Parts Manual*** for parts required).
4. Torque all fasteners to correct value.
5. Reassemble track chain to side frame and lock master pin and bushing as required.
6. Using button head coupling (8381-3109) supplied in the GRADALL Tool Kit, pressurize the tensioning cylinder to achieve the correct track adjustment. **Refer to Section II, "Track Adjustment".**
7. Install cover over the opening in the side frame for the valve that is used for the tensioning cylinder adjustment.
8. Check that the **"WARNING"** for track adjustment is in place. If it is not on the inside of the side frame cover, (installed at step 7) or is illegible, notify the correct personnel to have it replaced immediately.

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Idler Roller Rail Weld Refacing

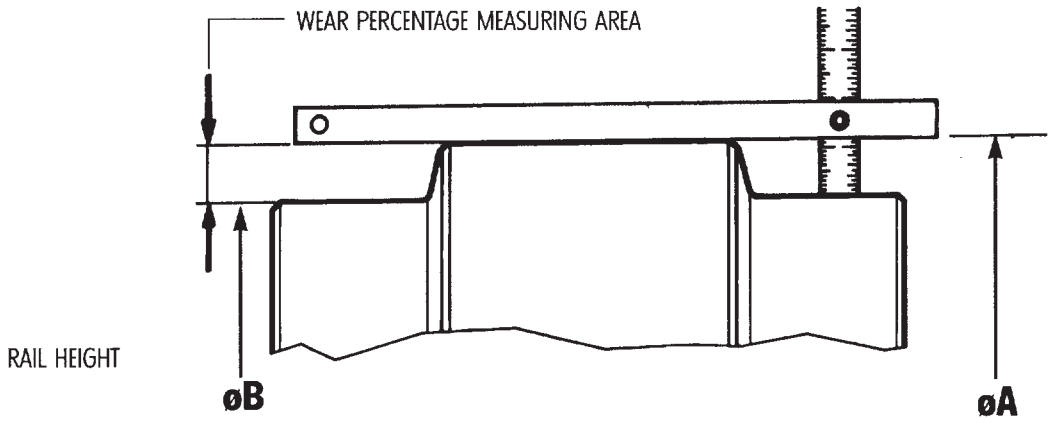
TABLE 10
WEAR PERCENTAGE DATA

Model	Part No.	øA		øB		New Idler		Wear Percentage							
								25%		50%		75%		100%	
		mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 5200	8691-4017	590	23.234	550	21.656	20	0.781	21	0.828	22.2	0.875	23.7	0.937	26	1.035
XL 4200	8061-4002	588	23.156	536	21.109	26	1.031	26.8	1.046	27.8	1.093	29	1.140	31	1.218
XL 3200	8031-4029	544	21.42	506	19.92	19.0	0.75	20.5	0.81	22.0	0.870	23.5	0.93	25	0.98
XL 2200	8021-4023	522	20.546	490	19.296	16	0.740	16.6	0.656	17.4	0.687	18.5	0.734	20	0.781

ø - Diameter

Figure 26 and Table 10 show the allowable wear on the rail height of the idler roller. A good undercarriage shop has the ability to rebuild (reweld) the roller to its original dimensions. When wear percentage reaches 100% the idler roller must be rebuilt or replaced.

FIGURE 26
FRONT IDLERS



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IX. Drive Sprocket

The drive sprocket is sized to provide proper travel performance for the model machine on which it is used. It is bolted to a gear box that is also sized for correct performance. The drive sprocket always has an uneven number of teeth. As they rotate the drive chain is engaged which results in machine travel.

The six major types of drive sprocket wear are:

1. Drive Chain Wear --- when operating forward.
2. Reverse Drive Side Wear --- when operating in reverse.
3. Climbing Wear --- result of increased track pitch.
4. Root Wear --- when bushings slide from side to side.
5. Rotative Wear --- when bushings rotate as they leave (forward) or enter (reverse) the sprocket.
6. Reverse Drive Side Tip Wear --- when sprocket pitch is greater than track pitch.

The drive sprocket is cast of special manganese steel hardened to Rc 55. If it is reconditioned by welding it must conform to the dimensions of a new sprocket.

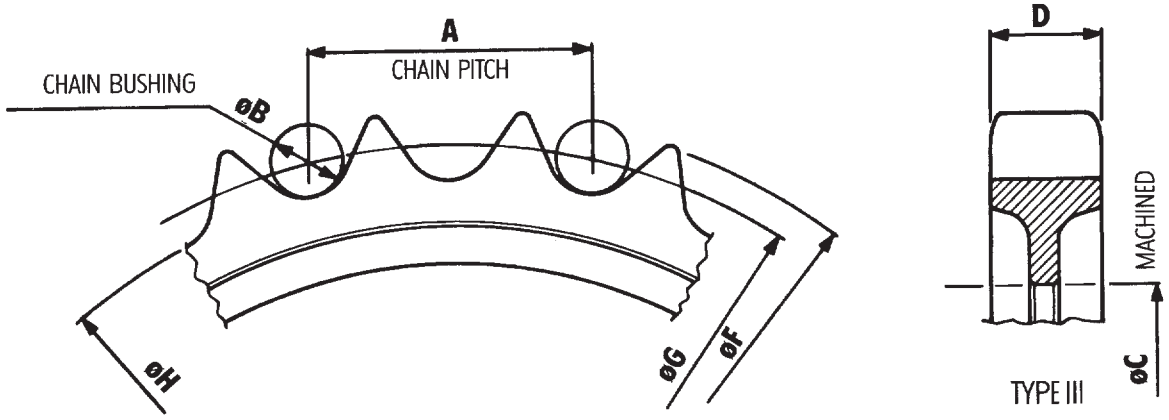
Table 11 gives the new and allowable wear tolerances of the sprocket on your machine.

TABLE 11
NEW DRIVE SPROCKET DIMENSIONS

Model	Part No.	Wear Percentage													
		A		øB		øC		D		øF		øG		øH	
		mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
XL 5200	8091-6005	171.45	6.750	53.975	2.125	500	19.687	72	2.828	715	28.156	689.41	27.140	635.4	25.015
XL 4200	8061-6015	170	6.687	52	2.046	590	23.234	60	2.359	764	30.078	437.14	29.015	685	29.968
XL 3200	8031-3001	190	7.48	72	2.83	365.1	14.37	66	2.60	659	25.94	644.6	25.38	582.5	22.93
XL 2200	8021-3038	155.58	6.125	46.8	1.859	NA	NA	50.8	2.000	554.8	21.844	527.813	20.780	482.96	19.014

ø - Diameter

FIGURE 27
DRIVE SPROCKET



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IX. Drive Sprocket (continued)

Wear on the sprocket is very difficult to measure. As the machine works, wear takes place in such a way that no trace of the original teeth are left for use as a measuring point. Sprockets should be rebuilt or replaced whenever wear percentage reaches 100%.

Wear is never uniform, so measurements should be taken at different points on the sprocket teeth. ***See Figure 27.*** Use the area showing the most wear as your gauge for determining wear percentage on ***Table 11.*** Dimension “ØF” is the original diameter of your respective sprocket. Dimension “ØG” is the dimension to the centerline of the bushing for your track as it lays against the root of the sprocket tooth when new.

Drive Sprocket Reassembly to Drive Mechanism
To reassemble the drive sprocket, proceed as follows:

1. Clean all areas of the side frame and drive mechanism where the sprocket fits.
2. Use “Never-seez” on mounting surfaces (pilots).
3. Lift drive sprocket into place (pilot mounting surface).
4. Install mounting capscrews (socket head metric)
5. Torque mounting screws to correct value as required. ***Refer to Table 12 and 13.***
6. Lift track chain in place and fasten together at the master pin and bushing.
7. Adjust the track chain to correct specifications.

X. Miscellaneous

Towing
If power is lost to the crawler drive and it becomes necessary to tow the unit proceed as follows:

1. Drain oil from drive.
2. Remove the planetary drive cover from the drive mechanism, as required for access to the planetary gears, by removing the socket head capscrews and store in a safe place for reuse.
3. Remove the sun gear from the planetary drive and store in a safe place for later reuse. Do not contaminate gears with dirt or foreign objects.
4. Reinstall the planetary drive cover.
5. Perform steps 1 through 4 on the opposite track.
6. Intsall towing chain and or cable to towing area on the carbody.
7. Carefully tow the machine to the area designated.

When the machine is to be put back into service, it will be necessary to reinstall the removed sun gear to the planetary drive. Retorque fasteners to correct value per the torque chart. Lubricate the machine per specifications before resuming normal operations.

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Undercarriage (Carbody and Side Frames)

The undercarriage (carbody and side frames) of the GRADALL CRAWLER is designed correctly for the size of machine it is mounted under. The integrity of the design is assured during manufacture by the use of intricately designed welding and machining fixtures.

Welding Repairs

Should welding repairs be required, adhere to the following procedures:

1. Disconnect the battery leads to prevent electrical component damage.
2. Position the ground clamp adjacent to the area being welded. This will prevent arcing between components such as bearings, etc. which could cause damage to them. **Do not ground through rotating parts.**
3. Use welding rod or wire conforming to AWS 7018 low hydrogen process.

Piston Motor

A bent axis piston type motor is fastened to the planetary drive at the sprocket end of the side frame. It can be shifted from low speed to high speed or vice versa as required. Refer to the ***Crawler Hydraulic Schematic*** and the ***Vendor Service Manual*** for more detail.

Planetary Drive and Crawler Holding Brake

A planetary gear reduction box and disc brake assembly is connected to the drive sprocket. The brake is normally set. It is released by hydraulic pressure whenever the travel cycle is activated and remains disengaged as long as the travel circuit is pressurized. The brake is not a dynamic stopping brake. It is a holding brake only.

Track Guides

The function of the track guides bolted to the side frame is to keep the track chain in line. It also may keep the track chain from jumping the sprockets when turning if the chain pitch is outside the allowable tolerances.

Planetary Drive and Crawler Holding Brake

The planetary gear box operation is explained in a separate Manual supplied by the Vendor. Refer to that manual for information on the function of this assembly. Refer to the lubrication chart for the type and capacity of the gear box.

Tools

Standard heavy equipment maintenance tools are required to work on the GRADALL XL SERIES CRAWLER UNDERCARRIAGE.

Torque wrenches capable of achieving rated fastener values, wrenches for metric bolts and English S.A.E. bolts must be available.

Large and small calipers, straight edges, steel measuring tape and a depth gauge are required for component wear measurement.

Miscellaneous tools such as “come-a-long”, large” “C” clamps, etc. may also be required for some repairs.

A grease gun and other tools GRADALL determines “unique” and necessary for good maintenance are furnished in the tool kit supplied with each machine.

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Appendix A Bolt Torque Charts

Bolt Torque Charts

The following bolt torque charts ***(Table 12 and 13)*** covering English and Metric fasteners are the ones used by GRADALL Ratings are for lubricated fasteners. Do not exceed the allowable rating. An overtorqued bolt in most cases will fail as rapidly as an undertorqued one. Bolt sizes and torque values are shown in most cases with the description given in the ***GRADALL Parts Manual.***

NOTE! To check Gradall torque values, set the torque wrench at 95% of reted torque value and check fastener. If the torque wrench releases before the fastener moves, assume that the fastener torque is correct. When setting Gradall torque values, use the values given on the chart not exceeding allowances.

TABLE 12
BOLT TORQUE VALUES FOR METRIC FASTENERS

NOMINAL SIZE	Stress Area (mm^2)	CLASS 4.6 400 Megapascals Min. Tensile Str. (Nm)	CLASS 4.6 (ft.-lb.)	CLASS 8.8 830 Megapascals Min. Tensile Str. (Nm)	CLASS 8.8 (ft.-lb.)	CLASS 9.8 900 Megapascals Min. Tensile Str. (Nm)	CLASS 9.8 (ft.-lb.)	CLASS 10.9 1040 Megapascals Min. Tensile Str. (Nm)	CLASS 10.9 (ft.-lb.)	CLASS 12.9 1220 Megapascals Min. Tensile Str. (Nm)	CLASS 12.9 (ft.-lb.)
M 2.0	2.1	0.14	0.10	0.37	0.27	0.40	0.30	0.52	0.38	0.61	0.45
M 2.5	3.4	0.28	0.21	0.76	0.56	0.82	0.61	1.06	0.78	1.24	0.92
M 3.0	5.0	0.51	0.37	1.35	1.00	1.47	1.08	1.88	1.39	2.21	1.63
M 3.5	6.8	0.80	0.59	2.13	1.57	2.31	1.70	2.96	2.18	3.47	2.56
M 4.0	8.8	1.18	0.87	3.15	2.32	3.41	2.52	4.38	3.23	5.14	3.79
M 5.0	14.2	2.39	1.76	6.36	4.69	6.90	5.09	8.86	6.54	10.59	7.67
M 6.0	20.1	4.05	2.99	10.81	7.97	11.72	8.65	15.05	11.10	17.66	13.02
M 6.3	22.6	4.78	3.53	12.76	9.41	13.84	10.21	17.77	13.11	20.84	15.37
M 8.0	36.6	9.84	7.26	26.25	19.36	28.46	20.99	36.54	26.95	42.87	31.62
M 10.0	58.0	19.49	14.37	51.99	38.35	56.38	41.58	72.38	53.39	84.91	62.63
M 12.0	84.3	33.99	25.07	90.68	66.88	98.33	75.52	126.25	93.12	148.10	109.23
M 14.0	115.0	54.10	39.90	144.32	106.45	156.49	115.42	200.93	148.20	235.70	173.85
M 16.0	157.0	84.40	62.25	255.18	166.08	244.17	180.09	313.50	231.22	367.76	271.24
M 20.0	245.0	164.64	121.43	439.24	323.96	476.28	351.29	611.52	451.03	717.36	529.10
M 24.0	353.0	284.66	209.95	759.43	560.13	823.48	607.37	1057.31	779.83	1240.30	914.80
M 30.0	561.0	565.49	417.08	1508.64	1112.72	1635.88	1206.56	2100.38	1549.16	2463.91	1817.29
M 36.0	817.0	988.24	728.89	2636.49	1944.58	2858.85	2108.58	3670.62	2707.31	4305.92	3175.88
M 42.0	1120.0	1580.54	1165.75	4216.66	3110.05	4572.29	3372.35	5870.59	4329.93	6886.66	5079.34

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TABLE 13
BOLT TORQUE VALUES AND TOLERANCES FOR LUBRICATED ENGLISH BOLTS

BOLT SIZE	GRADE 5 BOLTS			GRADE 8 BOLTS		
	TORQUE ft.-lb.	TOLERANCE + or - ft.-lb.	CLAMP LOAD lb.	TORQUE ft.-lb.	TOLERANCE + or - ft.-lb.	CLAMP LOAD lb.
1/4 - 20	9	+3 -0	2,700	10	+3 -0	3,000
1/4 - 28	11	+3 -0	3,300	12	+3 -0	3,600
5/16 - 18	17	+5 -0	4,080	20	+5 -0	4,800
5/16 - 24	19	+5 -0	4,560	24	+5 -0	5,760
3/8 - 16	30	+5 -0	6,000	40	+5 -0	8,000
3/8 - 24	32	+5 -0	6,400	48	+5 -0	9,600
7/16 - 14	44	+10 -0	7,540	68	+10 -0	11,660
7/16 - 20	48	+10 -0	8,230	76	+10 -0	13,030
1/2 - 13	68	+10 -0	10,200	100	+10 -0	15,000
1/2 - 20	76	+10 -0	11,400	115	+10 -0	17,250
9/16 - 12	100	+10 -0	13,330	140	+10 -0	18,670
9/16 - 18	112	+10 -0	14,930	160	+10 -0	21,330
5/8 - 11	140	+15 -0	16,800	200	+15 -0	24,000
5/8 - 18	168	+15 -0	20,160	215	+15 -0	25,800
3/4 - 10	240	+25 -0	24,000	340	+25 -0	34,000
3/4 - 16	265	+25 -0	26,500	370	+25 -0	37,000
7/8 - 9	360	+35 -0	30,860	530	+35 -0	45,430
7/8 - 14	390	+35 -0	33,430	560	+35 -0	48,000
1 - 8	545	+50 -0	40,875	795	+50 -0	59,625
1 - 14	570	+50 -0	42,750	840	+50 -0	63,000
1 1/8 - 7	710	+50 -0	47,330	1175	+50 -0	78,330
1 1/8 - 12	795	+50 -0	53,000	1325	+50 -0	88,330
1 1/4 - 7	1005	+75 -0	60,300	1680	+75 -0	100,800
1 1/4 - 12	1105	+75 -0	66,300	1850	+75 -0	111,000
1 3/8 - 6	1310	+75-0	71,450	2200	+75 -0	120,000
1 3/8 - 12	1500	+75 -0	81,820	2490	+75 -0	135,820
1 1/2 - 6	1745	+75 -0	87,250	2910	+75 -0	145,500
1 1/2 - 12	1945	+75 -0	97,250	3280	+75 -0	164,000

NOTE! Never-seez® to be used on master link pin before assembly torque pad bolts over master link to 185 ft. lb. +10 -0.

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X. Appendix B Hose/Fitting Charts (continued)

Hydraulic Hose and Hose Fitting Torque Charts

To minimize leakage, the hydraulic hoses and hydraulic hose fittings are torqued to specified values. Whenever a hose or fitting is removed, it should be retorqued to the correct value when it is replaced. Refer to the hydraulic hose and hydraulic fitting torque charts ***(Table 14, Table 15 and Table 16)*** for correct values used on the GRADALL product line.

TABLE 14

SAE Dash Size	Thread Size	Tube Side Assembly Torque
-2	5/16 - 24	3 ± 1
-3	3/8 - 24	6 ± 1
-4	7/16 - 20	12 ± 1
-5	1/2 - 20	15 ± 1
-6	9/16 - 18	21 ± 1
-8	3/4 - 16	45 ± 2
-10	7/8 - 14	60 ± 5
-12	1 1/16 - 12	85 ± 5
-14	1 3/16 - 12	105 ± 5
-16	1 5/16 - 12	120 ± 5
-20	1 5/8 - 12	170 ± 10
-24	1 7/8 - 12	200 ± 15
-32	2 1/2 - 12	270 ± 20

TABLE 15

SAE Dash Size	Thread Size	Port Side Assembly Torque
-2	5/16 - 24	7.5 ± 0.5 *
-3	3/8 - 24	14 ± 1*
-4	7/16 - 20	16 ± 1
-5	1/2 - 20	22 ± 1*
-6	9/16 - 18	35 ± 1
-8	3/4 - 16	60 ± 2
-10	7/8 - 14	105 ± 5
-12	1 1/16 - 12	140 ± 6
-14	1 3/16 - 12	145 ± 6*
-16	1 5/16 - 12	210 ± 8
-20	1 5/8 - 12	260 ± 12
-24	1 7/8 - 12	315 ± 12
-32	2 1/2 - 12	325 ± 15*

*Torque values with an asterisk are from JIC Fitting Torque Chart.

TABLE 16
ORS FACE SEAL TUBE/HOSE TO FITTING

SAE Dash Size	Thread Size	Tube Side Assembly Torque
-4	9/16 - 18	18 ± 1
-6	11/16 - 16	27 ± 2
-8	13/16 - 16	40 ± 2
-10	1 - 14	63 ± 3
-12	1 3/16 - 12	90 ± 4
-16	1 7/16 - 12	120 ± 8
-20	1 11/16 - 12	140 ± 8
-24	2 - 12	165 ± 8

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406 Mill Avenue, SW, New Philadelphia, Ohio 44663

Phone (330) 339-2211 • Fax (330) 339-8468

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Cyclopac® Service Procedures

Proper air cleaner servicing results in maximum engine protection against the ravages of dust. Proper servicing can also save time and money by maximizing filter life and dust cleaning efficiency.

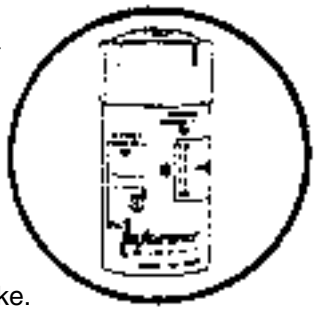
Two of the most common problems:

A) Over Servicing. New filter elements increase in dust cleaning efficiency as dust builds up on the media. Don't be fooled by filter appearance.... the filter should look dirty. By using proper filter measurement tools you will use the full life of the filter at maximum efficiency.

B) Improper Servicing. Your engine is vulnerable to abrasive dust contaminants during servicing. The most common cause of engine damage is careless servicing procedures. By following the steps shown, you can avoid unnecessary risk to the engine.

Measure Restriction

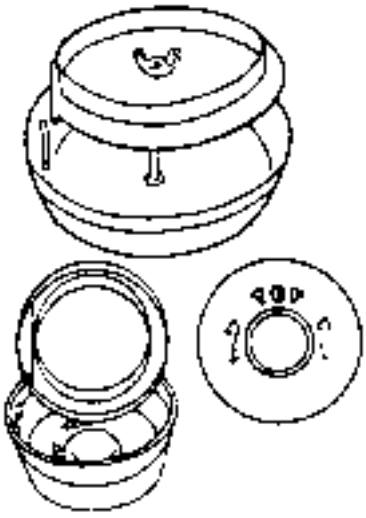
Measure the restriction of the air cleaner with a Donaldson restriction indicator, such as The Informer, a service gauge, or water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake.



One of two conditions will exist
(1) If the reading indicates the maximum restriction (per engine manufacturer's recommendations), change out the filter.
(2) If the reading shows below the maximum, the filter still has life left and should not be touched.

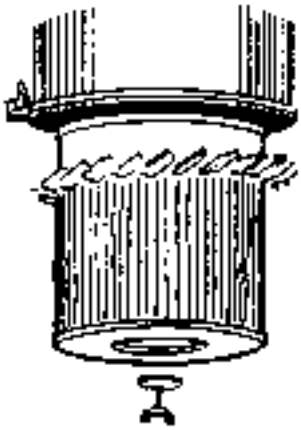
Empty the Dust Cup

Dust should not be allowed to build up closer than one inch from the baffle. On models equipped with a Donaldson Vacuator valve, dust cup service is cut to a minimum; all that is necessary is a quick check to see that the Vacuator valve is not inverted, damaged, or plugged.



Filter Servicing

When restriction indicates that filter servicing is required, loosen the wingnut and remove the primary filter. Before installing new filter, inspect the filter and gasket for shipping or storage damage. (See service tips on reverse side of this document.) Carefully install new element and wingnut.



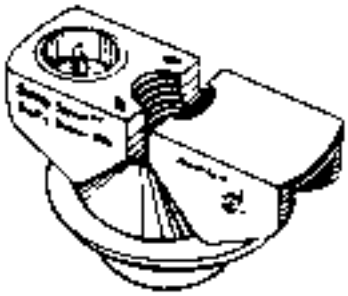
Always use authentic replacement Donaldson filters, which have been engineered to fit the air cleaner and engine intake system exactly.

Cover the Inlet

Don't leave the air inlet exposed! If the new filter won't be installed immediately, cover the opening to prevent stray contaminant from entering the induction system.

Safety Element Service

For Maximum engine protection and air cleaner service life, replace the safety filter **every third** primary filter change or cleaning, or as indicated by the Donaldson Safety Signal service indicator. Note that the safety element is not intended to be cleaned.



Reinstall the Dust Cup

Be sure the dust cup is sealed 360° around the air cleaner body. Reset the restriction indicator to green.

Check Connections

Ensure that all connections between the air cleaner and the engine are tight and leak-free.

Donaldson®

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Air Filter Service Tips

7 Important Steps to Follow

(1) Remove the old element gently to prevent knocking dust off of it.





2) Always clean the inside of the housing carefully



3) Always clean the gasket sealing surfaces of the housing



4) Check for uneven dirt patterns in your old filter that indicate gasket leakage



5) Press your fresh gasket to see that it springs back



6) Make sure the gasket seats evenly



7) Ensure an airtight fit on all connections and ducts

T

The Important "Don't"

<u>Don't</u> remove filter for inspection.



Never rap a filter to clean it. Rapping only damages the filter.



<u>Never</u> judge the filter's life by looking at it. Measure how restricted its airflow is.





<u>Never</u> leave an air cleaner open longer than necessary.

<u>Don't</u> ignore a worn or damaged gasket in the housing....replace it!





Don't use a damaged or bunched filter.



Never use a warped cover on a housing.



Never substitute an incorrect filter model number.

Brochure No. F114004 (4/96) Replaces 1400-23

For more Information, Contact:

Donaldson

P.O. Box 1299
Minneapolis, MN 5544-1399 USA
Tel: 800-374-1374
FAX: (612) 887-3716

Interleuvenlaan, 1
B-3001 Leuven, Belgium
Tel. (32)-(16)-383811
Telefax: (32)-(16)-400077
Telex: 23205 Beldo B

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P/N 2460-4161 Form No. 20013 Issued 3/01

HYDRAULIC EXCAVATOR SAFETY MANUAL

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HYDRAULIC EXCAVATOR SAFETY MANUAL

Nomenclature

Note on Illustrations

Introduction

1 Safety Alert Symbol

2 A Word to the Operator

3 Prepare for Safe Operation

4 Start Safely

5 Operate Safely

6 Park Safely

7 Load and Unload the Machine Safely

8 Perform Safe Maintenence

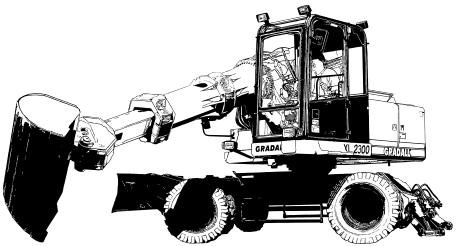
9 Test Your Knowledge

GRADALL

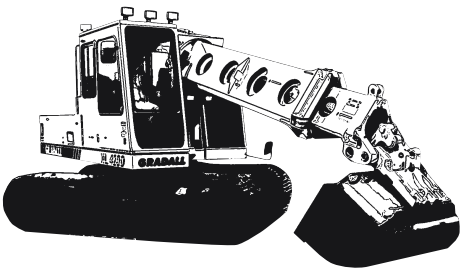
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There are four basic types of Gradall Hydraulic Excavators:

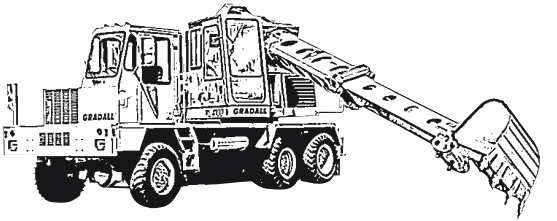
1. Wheel Mounted; Integral Carrier



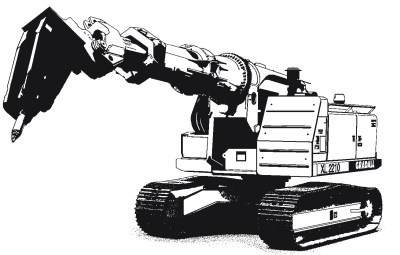
2. Track Mounted; Integral Crawler



3. Wheel Mounted; Separate Operation and Transport Cabs



4. Track Mounted IMM's; Truck Mounted Radio Remote Controlled, Scalers, Railroad Guide Wheels and Gantries.



Gradall also manufactures a range of Industrial Maintenance Machines (IMMs) designed less for construction applications and more for specialized industrial applications; primarily steel mills, underground mining, railroad maintenance and gantries. All these machines are covered in this Manual.

NOTE! *The terms "hydraulic excavator" and "excavator" are used interchangeably throughout this* Safety Manual.

NOTE ON ILLUSTRATIONS

Illustrations in red circles overlayed with a diagonal cross-bar indicate prohibitions and could include:

- Unsafe working practices
- Safety violations
- Potential hazards



As far as these are concerned, there is one simple rule: **Just Don't Do It!**

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WARNING

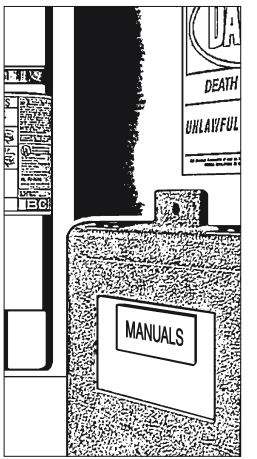
This Safety Manual is not comprehensive. It does not cover all possible eventualities. Additional precautions may be necessary, depending on the specific conditions of a particular work site.

This *Hydraulic Excavator Safety Manual* underlines basic safety issues regarding the normal operation and maintenance of a Gradall Hydraulic Excavator. The Manual recommends certain procedures, precautions and other appropriate actions for safe operation and maintenance of the machine.

This *Safety Manual* is not comprehensive. It does not cover all possible eventualities. Additional precautions may be necessary, depending on the specific conditions of a particular work site. **REMEMBER!** It is **YOUR** responsibility to use sensible and appropriate safe practices when operating the excavator.

The information in this Manual supplements specific details about the excavator contained in the appropriate *Gradall Owner/Operator Manual* and the *EMI Excavator Safety Manual.* Other information which may affect the safe operation of the excavator is featured on safety decals affixed to the machine; in your employer's safety programs; in safety codes; in local, state, provincial, and/or federal laws, rules and regulations.

IMPORTANT! Before you operate a Gradall Hydraulic Excavator, make sure you have all the proper manuals. The *Gradall Hydraulic Excavator Safety Manual*, the appropriate *Owner/Operator Manual* for the machine and the *EMI Excavator Safety Manual** should all be contained in the manual holder/tray in the operator's cab. If any manual is missing or illegible, get a replacement from your employer, your equipment distributor or directly from Gradall. Keep all Safety and Instruction manuals with the excavator at all times. Read, understand and comply with the instructions and warnings in these manuals **AT ALL TIMES.**



**Highway speed machines are also furnished with a* CIMA Dumper Safety Manual.

SAFETY ALERT SYMBOL

The Safety Alert Symbol means:

ATTENTION!

BE ALERT!

YOUR SAFETY IS AT RISK!



The Safety Alert Symbol spotlights important safety messages on hydraulic excavators, safety signs, in manuals or elsewhere. The symbol will typically appear in one of three dominant colors: Red, Orange, or Yellow. These colors follow a descending hierarchy of hazard or risk. In other words, red indicates the highest level of risk. Yellow the lowest.

When you see the Safety Alert Symbol, pay particular attention to the **DANGER**, **WARNING** or **CAUTION** note for the sake of your safety and the safety of others.

SIGNAL WORDS

DANGER . . . WARNING . . . CAUTION . . .

Signal words are distinctive words that are typically found on safety decals on a Gradall Hydraulic Excavator as well as on other equipment on the work site. These words highlight a range of potential hazards and risks.

Typically, the Safety Alert Symbol *and* the appropriate **SIGNAL WORD** will appear as a header bar on a machine decal.



This symbol indicates an extreme hazard which would result in high probability of death or serious injury if proper precautions are not taken.



This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.



This symbol indicates a hazard which may result in injury or damage to equipment or property if proper precautions are not taken.



When you see this symbol, pay particular attention to the DANGER, WARNING or CAUTION note for the sake of your safety and the safety of others.

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CAUTION

BE A RESPONSIBLE OPERATOR

For safe operation of a Gradall Excavator, you must be a responsible operator. Make sure you:

- *Clearly understand written instructions supplied by Gradall*
- *Are fully trained, including actual operation of the excavator*
- *Understand and comply with all safety rules and regulations for the work site*

SAFETY AND YOU

It is **YOUR** responsibility to read and understand this *Safety Manual*. It will help you avoid accidents and keep the excavator in sound operating condition. **ALWAYS THINK SAFETY FIRST!** Follow a carefully constructed plan for inspection, maintenance and safe operation. **REMEMBER!** The Manual is not intended to cover all eventualities.

Any procedure must be thoroughly evaluated from the standpoint of safety before it is put into practice. If you are not sure, contact your Authorized Gradall Distributor for specific recommendations.

To help ensure safe operation, do not modify any Gradall Excavator without written permission and procedures from Gradall.

A WORD ABOUT OPERATORS

All operators must be responsible, reliable and safety-conscious. Inexperienced personnel must not be allowed to operate the excavator. All operators must know all job site safety rules.

PRACTICE MAKES PERFECT

Before operating the excavator, make sure you practice operating all controls. Practice until you are completely familiar and comfortable with the excavator's response. Practice maneuvering the excavator in a safe, open area well away from people, equipment and buildings.

OPERATE SAFELY

A Gradall Hydraulic Excavator must **ONLY** be operated by trained and qualified personnel. Check that all required maintenance is completed before operating the excavator. **NEVER** operate the excavator without a correct and legible Capacity Chart in the operator's cab for the specific excavator/attachment combination you are using.

Note! There are no Capacity Charts in the Industrial Maintenance Machines.



WARNING

SPECIAL NOTE ON CONTROLLED SUBSTANCES

Drugs and alcohol affect your alertness, your coordination and therefore your ability to safely operate a Hydraulic Excavator. **NEVER** use drugs or alcohol while operating a hydraulic excavator. If you are taking prescription or over-the-counter medication, consult a medical professional regarding any side effects that would hinder your ability to safely operate this equipment. **NEVER** operate the excavator when your alertness or coordination is impaired.

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PROTECT YOURSELF

Wear all the protective clothing and personal safety devices issued to you or called for by job conditions.

You May Need:

- Hard Hat
- Safety shoes
- Safety glasses, goggles, or face shield
- Heavy gloves
- Hearing protection
- Reflective clothing
- Wet weather gear
- Respirator or filter mask

Wear whatever is needed.
Take no chances.



WARNING

DO NOT wear loose fitting clothes, flopping cuffs, dangling neckties and scarves, or rings and wrist watches that might get snagged in moving parts.

KNOW WHAT YOU'RE DOING

Most employers have rules governing operation and maintenance of equipment. Before you start work at a new location, check with your supervisor or the safety coordinator. Ask about rules you may be expected to obey.

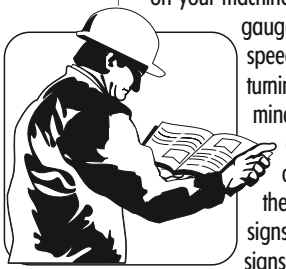
These are some of the rules you must work by:

- Know the capacity and operating characteristics of the excavator
- Never modify or remove any part of the machine (except for service)
- Never allow riders on the machine
- Keep others away from the operation
- Before leaving the cab, always place the excavator boom in the boom rest or the attachment on the ground. Engage the parking brake, (if the machine is so-equipped) stop the engine, cycle the hydraulic controls, and remove the key, see page 6.0, "Machine Shutdown."

Make sure you understand the rules covering traffic at your jobsite. Know what all signs, flags, and markings mean. Understand hand, flag, horn, whistle, siren, and bell signals. Know when to use lights, turn signals, flashers, and horns.

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KNOW THE EQUIPMENT



Get to know the machine. Know how to operate all equipment on your machine. Know the purpose of all the controls, gauges, and indicators. Know the load capacity, speed range, braking and steering characteristics, turning radius, and operating clearances. Keep in mind that rain, snow, ice, loose gravel, soft ground, and uneven terrain, change the operating capabilities of the excavator. Study the DANGER, WARNING, and CAUTION safety signs on the machine. Study all the informational signs too.

Study the *Owner/Operators Manual* before starting the engine. If there is no Manual with the machine, **GET ONE.** Study it before you start work. If there is something in the Manual you don't understand, ask your supervisor to explain it to you.

IMPORTANT: This Manual covers safe operating practices for Gradall Hydraulic Excavators. If your machine is equipped with other devices or special accessories, read the manufacturer's literature pertaining to that equipment before using it.

CHECK THE SAFETY EQUIPMENT

To protect you and others around you, the excavator may be equipped with the following safety equipment. See that each item is securely in place and in good operating condition.



- Brakes
- Falling Object Guard
- Front Guard
- Lights
- Safety Signs
- Horn
- Guards
- Shields
- Travel Alarm
- Mirrors
- Fire Extinguisher/Fire Suppression System (if equipped)
- First Aid Kit
- Windshield Wipers & Washers
- Reflective Strips

Use Them! Never remove or disconnect any safety device.

WARNING

NEVER remove a falling object guard, or front guard except for service. After service or repair, replace the guard(s) immediately.

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KNOW THE RULES OF OPERATION

The Occupational Safety and Health Administration (OSHA) enforces federal laws that apply to the safety of operation, application and maintenance of equipment on a work site. Because it is an employer's responsibility to comply with these laws, an OSHA representative may periodically inspect a work site to see that these laws are being obeyed. There may also be local or state/provincial laws that apply to the excavator and/or its use, as well as specific work site or employer rules. It is important that you understand and comply with all applicable laws and rules.

KEY RULES OF OPERATION

Before starting, operating, or performing maintenance procedures on a Gradall Hydraulic Excavator, there are a number of key **Rules of Operation** with which you must comply:

- Conduct a thorough walk-round inspection before starting
- Conduct a complete operational check of the horn before starting the excavator and make sure you can hear the travel alarm inside the operator's cab with the engine running
- Conduct a complete operational check of all controls, brakes and steering
- Know the capacity and operating characteristics of the excavator
- Know the requirement for "line-of-sight" while operating
- Never modify or remove any part of the excavator
- Always wear the safety belt while operating the machine (if equipped)
- Keep all other personnel away from the excavator before starting the engine
- Never use attachments that are not approved by Gradall
- Always make sure the excavator is equipped with a correct and legible Capacity Chart for the specific excavator / attachment combination
- Follow all traffic rules when traveling
- If your visibility is impaired, use a spotter or signal person

CLEAN UP

Clean windshields, mirrors and all lights. Make sure the operator's area, steps and hand holds are clean. Oil, grass, snow, ice or mud in these areas can cause you to slip and fall. Clean the mud off your boots before climbing onto the machine.





Remove all loose personal items or other objects from the operator's area. Secure all items or remove them from the machine. Do not store water cans, signs, tools, chains or any other unauthorized item on the deck of the excavator.



KNOW THE WORKING AREA

Before operating the excavator, learn as much as possible about your working area. Check for:

- Location of slopes
- Open trenches
- Drop offs or overhangs
- Soil conditions (soft or hard)
- Standing water and marshy areas
- Rocks and stumps
- Traces of buried foundations, footings or walls
- Traces of buried trash or landfill
- Conditions of haul roads
- Direction of travel on haul roads
- Holes, obstructions, mud or ice
- Heavy traffic
- Thick dust, smoke or fog
- The exact location of any buried and/or overhead electrical, gas, telephone, water, sewer or other utility lines. If necessary, have the utility company mark, shut off, or relocate the line before you begin working

WARNING

Never approach power lines with any part of your machine unless all local, state/provincial and federal (OSHA) required safety precautions have been taken. Use extreme caution.

When operating the excavator inside a building, make sure you know what clearance limitations you will encounter overhead and behind you, through doorways and down aisles. Also know the weight limitations of floors and ramps. Make sure the working area is well ventilated.

USE CAUTION WHEN FUELING

WARNING

Never fill the fuel tank with the engine running, while smoking or when near an open flame.

Never overfill the tank or spill fuel. If fuel is spilled, clean it up immediately.

Ground the fuel funnel or nozzle against the filler neck to prevent sparks and be sure to replace the fuel tank cap.

(For additional information on fire hazards, see “Avoid Fire and Explosion Hazards,” page 8.4)



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RULES OF THE ROAD

If driving a highway-speed-capable excavator over the road, **DON'T SPEED.** Know your axle weights and machine height and width. Know your stopping distance at any given speed and regulate your travel speed accordingly. Avoid panic stops and sharp turns. If traffic backs up, pull over and allow other vehicles to pass.

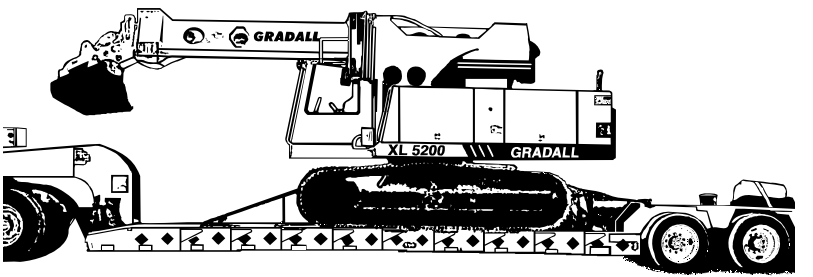


Stop at all railroad crossings and look both ways before proceeding. Never park in traffic areas. If you have to stop at night, pull off the road and set up flares or reflectors. When driving at night, use appropriate lights. If traveling slowly, use hazard lights.

Always use hand signals or turn signals when turning. Approach intersections with caution. Observe speed and traffic control signs. Crawler-mounted machines may damage road surfaces. For over-the-road travel, transport the machine by truck. Some wheel-mounted Gradall excavators are highway-speed capable. In other words, they can be driven on the road at normal (if lower) highway speeds.

If you are transporting a Gradall excavator over the road, make sure clearance flags, lights and warning signs are all in place, and visible. Place the boom and bucket in the transport position. Fold in mirrors to reduce width and secure all accessory equipment.

While traveling on public roads or streets, obey all local traffic regulations appropriate to local classifications. If required, make sure the "Slow Moving Vehicle" emblem is visible to any vehicle approaching from the rear. Always use hazard warning lights if traveling at a low rate of speed. Find out if you must use an escort vehicle or are required to have a roading permit.



EMERGENCY!

Always know where to get assistance in an emergency.



Know where to find and how to use a first aid kit.



Know where to find and how to use a fire extinguisher/fire suppression system.

Never leave the operator's seat without first safely shutting down the excavator, setting the Park Brake (if equipped), and removing the key. A running, unattended excavator could unexpectedly move or be operated by inexperienced personnel.

NO SMOKING

Never smoke while operating and/or refueling the excavator. Never fill the fuel tank with the engine running or near an open flame. Make sure you have adequate visibility and good ventilation.

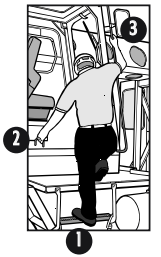


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MOUNT SAFELY

Whenever you mount or dismount:

- Make sure the steps and handrails are clean
- Maintain three point hand/foot contact with the access system
- Face the machine
- Never jump on or off the machine.
- Never attempt to mount or dismount a moving machine



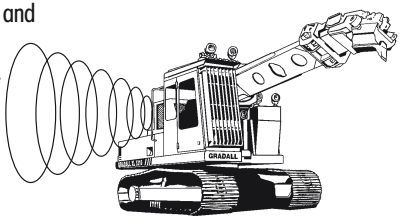
CAUTION

Do not use the steering wheel or any control lever as a hand hold when mounting or dismounting.

The cab must be aligned with the undercarriage centerline and the boom must be properly stowed before you enter or exit the cab.

WARN PERSONNEL BEFORE STARTING

Before starting, walk completely around the machine. Make sure no one is under the machine, on it, or close by and that all guards and covers are in place or closed. Sound the horn to let other workers and bystanders know you are starting up. Don't start up until **EVERYONE** is clear of the machine.



STARTING THE ENGINE

Start the engine while seated in the operator's seat only. Never attempt to start the engine by shorting across starter terminals or reaching the key from the ground or outside the cab. The excavator may start in gear if neutral-start circuitry is bypassed. This could cause the machine to move suddenly and cause serious injury or death to anyone in its path.

Know the exact starting procedure for your excavator. You will find this information in the *Owner/Operator Manual* that shipped with the excavator.

1. Sit in the operator's seat and adjust the seat so you can operate all the controls properly.
2. Familiarize yourself with warning devices, gauges and operating controls.
3. Engage the parking brake (if the excavator is so equipped) and put all controls in the Neutral/Park position.
4. Clear the area of all personnel.
5. Start the engine following the instructions in the *Owner/Operator Manual.*

If it is necessary to run the engine or operate the excavator within an enclosed area, be absolutely certain there is adequate ventilation.

WARNING

Exhaust fumes can kill. Always make sure there is adequate ventilation



WARNING

NEVER allow passengers to ride with you. A Gradall Hydraulic Excavator is designed for ONE-PERSON operation only. NEVER allow anyone to occupy the machine other than the operator.



STARTING AIDS

If jumper cables are used, follow the instructions in the *Owner/Operator Manual*. The operator must be seated in the operator's seat when jump-starting the engine so the machine will be under control when the engine starts. Jump-starting is a two person operation. A battery explosion or run-away machine could result from improper jump starting procedures. Never jump-start a frozen battery.

Ether Cold-Start Fluid is highly flammable and explosive. Before using it, always read the instructions on the ether container and the instructions in the *Owner/Operator Manual*.

DO NOT use ether if the engine is equipped with a glow plug-type pre-heater or other intake manifold-type pre-heater.

AFTER STARTING THE ENGINE

Observe all gauges, instruments, and warning lights to make sure they are functioning and their readings are within the correct operating range.

RUN AN OPERATING CHECK

DO NOT use a machine that is not in proper operating condition. It is the **OPERATOR'S RESPONSIBILITY** to check the condition of all systems and to run the check in a safe area.

TEST THE CONTROLS

Make sure the engine is operating correctly. With the transmission in "Neutral", test the engine speed control. Operate each equipment control lever to make sure all functions are correct.

Operate the shift control(s) to ensure correct operation in "Forward", "Neutral", and "Reverse". Release the swing lock (if the machine is so equipped).

Check the parking brake, service brakes and swing brakes. Test steering—right and left—while moving slowly.

WARNING

Be certain you can control the speed, direction, braking, swing and boom operations before operating the machine.

Look and listen for malfunctions. Stop if a malfunction or erratic operation is detected. Correct or report any trouble **IMMEDIATELY** before further operation.

ONE MACHINE, ONE PERSON

A Gradall Excavator is designed for one-person operation only. NEVER allow passengers to ride with you. On wheeled excavators **NEVER** have both the upper and carrier cabs occupied at the same time.

RADIO-REMOTE MACHINES

Some Gradall Industrial Maintenance Machines (IMMs) are operated by radio remote control and have no operators cab. **NEVER** allow passengers to ride on these machines.

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ALWAYS THINK SAFETY FIRST!

Never allow an untrained or unqualified person to operate a Gradall Excavator. Handled improperly, this machine could cause severe injury or death. In addition there are several fundamental safety rules which apply in every situation where a Gradall Excavator is being operated;

- Always look around before you back up, hook up, or swing an attachment. Be sure that everyone is in the clear
- Know the pinch points and rotating parts on the machine. Do not allow other personnel to place their arms or hands in boom holes at any time
- Do not allow other personnel to lean on the boom or any other part of the excavator
- Keep your head, arms, and other body parts inside the cab at all times
- Make sure access systems (steps, handrails etc.) are clean and in good condition at all times. If damaged, make sure repairs are made immediately



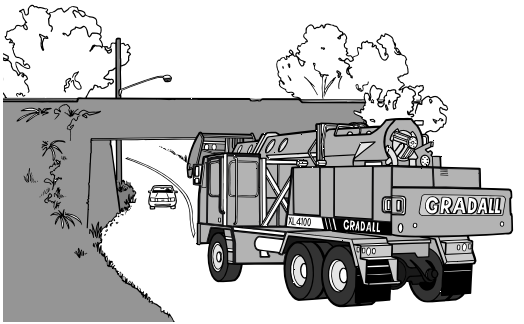
NEVER use a bucket (or other attachment) on a Hydraulic Excavator as a work platform or personnel carrier. Do not use a Gradall Excavator or Industrial Maintenance Machine to lift personnel.

WARNING

Without exception, Gradall explicitly prohibits the use of Hydraulic Excavators to lift personnel.

TRAVELING ON OR TO THE JOBSITE

Take it slow and easy when traveling through congested areas. Traffic courtesy pays off.



Give right of way to loaded machines. Maintain a safe distance from other machines. Pass cautiously.

Don't obstruct your vision when traveling. Carry the bucket or other attachments in the transport position for maximum stability, visibility and adequate clearance. Operate at speeds slow enough so you have complete control at all times. Travel slowly over rough or slippery ground and on hillsides.

Stay in gear when traveling downhill. Do not shift into "Neutral". Maintain engine RPM to provide steering and braking functions so that engine compression can help you control the excavator.

Use the same gear for traveling down a grade as you would for traveling up the grade.

Before entering an underpass, check for hazards or obstructions. Also check the clearance height.

Avoid steep slopes or unstable surfaces. When operating on a slope, keep the bucket and boom low and proceed with extreme caution. Do not drive **ACROSS** a steep slope under any circumstances. Drive straight up and down a steep slope.

Avoid turning on an incline. If turning is unavoidable, use extreme caution and make the turn wide and **SLOW** with the bucket and boom in the retracted and lowered position.

When using Carrier engine to travel on or to the jobsite, do not let upperstructure engine idle to warm hydraulic oil. It could affect steering.

When traveling, always fully raise the stabilizers, if equipped, to minimize machine width.

TRANSPORTING ATTACHMENTS

Always position the attachment for maximum visibility and proper overhead clearance when traveling with the attachment connected to the boom end. In some cases attachments are shipped with additional manuals. Consult attachment manual for additional transport information.

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SAFETY PRECAUTIONS

Completely familiarize yourself with the appropriate *Owner/ Operator Manual* and *Safety Manual* before you operate a Gradall Hydraulic Excavator.

Make sure the area is clear of all persons before operating.

Before operating the excavator, engage park brake. If equipped, lower the stabilizers, and/or level the machine as much as possible.

WARNING Never operate the excavator from outside the cab. Severe injury or death can result. Always operate the excavator from the correct seated position.

WARNING Never lift, move or swing a load over personnel or any other machine.

WARNING Do not store shovels, water cans, chains, signs, footballs etc. on machine.

WARNING If machine is equipped with 2 cabs, only one cab is to be occupied at any time.

WARNING Before starting to excavate, set up safety barriers to the sides and back of machine to prevent anyone from walking into the working area without the operators knowledge.

WARNING Never enter, or allow anyone else to enter, the excavator swing area. Death or serious injury can result. Be sure there are no obstructions and that there is sufficient clearance for tail swing.

USING ATTACHMENTS

Listed below are some of the more common types of attachments used on a Gradall Hydraulic Excavator.

- Buckets
- Hammers
- Mowers
- Rippers
- Grapples
- Boom Extensions
- Augers
- Telestick
- Shears
- Blades
- Barrel Handler

In some cases, attachments are shipped with additional manuals. Consult attachment manual for proper operating information.



Keep others clear of swing radius!

WARNING

Pinch Point locations will vary with different types of attachments. Keep clear of all pinch points.

WARNING

Flying debris is a hazard to the operator and all nearby personnel when using power attachments such as Hammers, Augers or Mowers. Ensure that the operator has all windows and guards in place and that all personnel are wearing all the protective clothing and personal safety devices issued to you or called out by job conditions.



WARNING

Never undercut a high bank. The edges could collapse and/or a slide might occur causing severe injury or death. Never operate the machine close to the edge of an overhang or stockpile.



WARNING

Do not dig under the machine or stabilizers. A cave-in could result and the machine could fall into the excavation.



WARNING

Scaling toward the machine could cause scale to land on the machine causing severe injury or death.

FLAGPERSON

It is the operator's responsibility to know where the flagperson is and to establish communication that both the flagperson and operator understand. Don't allow the flagperson out of sight or to remove items from the excavator while it is running or to get in the excavator swing or boom path.

DON'T UNDERMINE YOURSELF

The overall rule of thumb here is that you need to maintain a solid footing underneath the excavator. If you are not careful and attentive while you work, you might inadvertently dig yourself into some serious trouble.

Work the jobsite in such a manner as to avoid creating overhangs or the need to be on top of banks or slopes.

Extreme caution should be used when working along the top of banks or slopes. Keep away from the edge. If possible, level the area before starting work.

When working at the base of a bank, overhang, stockpile or construction, avoid dangers such as rock and/or earth slides, overhanging trees or a cave-in.

When using a mine scaler or scaling attachment, insure there is adequate lighting to perform the task. Always scale while booming toward the rock face.

Be careful that the machine does not roll into the excavation when the stabilizers are raised.

When operating the excavator on a slope, swing to the uphill side to dump the load. If downhill dumping is unavoidable, swing only as far as required to dump the bucket. Use extreme caution. Always drop the spoil a sufficient distance from the trench to avoid a cave in.

Situate the undercarriage parallel to the direction of a slope, (i.e. facing up or down the slope, not "across" the slope).

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LIFTING A LOAD WITH THE EXCAVATOR

Before lifting a load, make sure you know the machine's lifting capacity. Do not attempt to lift a load without the proper Capacity Chart. Perform a "trial" lift first.



WARNING

Overloading is hazardous. Make certain you are within the safe load and work radius limitations of this machine. Also make sure you are on solid, level ground before lifting any load.

Attach chains and slings to the designated lifting points on the excavator boom. Consult the Owner/Operator Manual for the proper procedure.

When using the excavator to lift and place objects, such as a pipe, position your machine so that lowering is over the rear of the machine rather than either side.

Always lower the stabilizers, if equipped, to the ground before lifting. If the ground is soft, place pads or timbers under each stabilizer.

When lifting, make sure the load is properly balanced. Move slowly so the load does not sway or swing around. If necessary, use a tag line for additional control. Do not lift and carry over sides, stability is reduced.

STAY CLEAR

Check overhead clearances. Know the size of doorways and canopies. Know exactly how much clearance you have under power and telephone lines.

Make sure you know the location of gas lines, water pipes and power cables before excavating. Contact the "diggers hot line" in your area—and/or utility company—and have them mark all underground utilities.

Check overhead clearances. Know your margin of safety. (see note above) Have power to the lines disconnected or de-energized. If de-energizing the lines is not possible, request a signal person for guidance to maintain at least OSHA's minimum clearance.

DO NOT approach power lines, overhead or underground cables or other power sources with any part of the excavator or load unless all local, state/provincial and federal regulations have been met and the appropriate utility company's hotline has been contacted to de-energize the lines.



WARNING

You must maintain the minimum distance required, by law, from underground gas, power, telephone and water utilities.



WARNING

A cut fiber optic cable can cause severe eye injury if you look into the damaged end of the cable.

SELECT A PARKING SITE

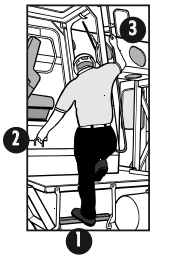
Whenever possible, park on level ground. If you *must* park on an incline, position the machine across the slope, engage the parking brake, if equipped, and lower the attachment to the ground and block the machine.

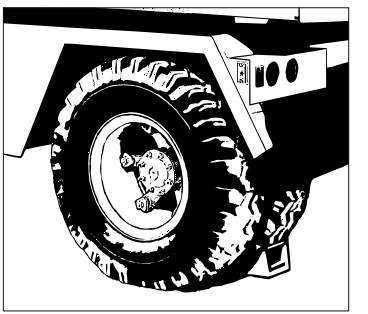
Haul roads are not suitable for parking. If you must park on one—or if your machine is disabled on one—mark the machine with flags in daytime and flares or flashing lights at night, according to federal, state and local regulations.

MACHINE SHUTDOWN

Refer to the appropriate *Owner/Operator Manual* for detailed shutdown procedures. In general, the procedure should include the following:

- Stop the machine using the service brake
- Swing the machine to align upperstructure with the undercarriage
- Engage the swing lock, if equipped
- Lower any attachments or the boom to the ground or place it in a secure position
- Engage the parking brake, if equipped
- Shift controls to "Neutral"/"Park" and if possible lock them
- Idle the engine for a short cool-down period
- Stop the engine
- Cycle all hydraulic controls to relieve system pressure
- Remove the ignition key
- Shut off the master electrical switch (if the machine has one)
- Lock the cab
- When dismounting, always maintain three point contact with the access system and face the machine. Never jump off the machine. And *never* try to dismount a moving machine
- Be careful of slippery conditions on platform, steps, ladders and hand holds when dismounting
- Block the wheels or tracks if the excavator is on a slope





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LOADING AND UNLOADING

Not all excavators are loaded onto a trailer the same way. Follow all instructions outlined in the appropriate *Owner/Operator Manual* for your machine.

Several precautions are, however applicable to all excavators:

- Know the weight of the machine you are operating
- Know the correct loading and unloading procedures for your machine
- Keep everyone clear of the area
- Load and unload on a level and stable surface
- Block the transport vehicle to prevent it from moving
- Use ramps of adequate size and strength; low angle, and proper height.
- Keep the tires/tracks, trailer bed and ramps clear of mud, oil, ice, snow and all materials which can become slippery
- Engage the swing lock, if equipped
- Back the machine onto the trailer
- Cover or remove the Slow Moving Vehicle emblem
- Chain and block the machine securely
- Secure any boom or attachment in the transport mode.
- Chain machine down using chain of adequate size.

Know the overall height and combined width of the transporter and machine to avoid overhead and narrow obstructions.

LIFTING AN EXCAVATOR

For lifting instructions and machine weight consult your Machine's Serial Number Plate, Owner/Operator's Manual and/or Gradall Distributor.



WARNING

Keep clear of all rotating components. Wrapping or entanglement may result in serious injury or death.



GENERAL MAINTENANCE SAFETY CONSIDERATIONS

Do not perform any work on a machine unless you are authorized and qualified to do so. If you have been authorized to do maintenance, Read all applicable *Service* and *Owner/Operator Manuals*. Study the instructions; check the lubrication charts; examine all the warnings and instruction messages on the machine. Maintenance can be dangerous unless performed properly. Be sure you have the necessary skill, information, correct tools and equipment to do the job correctly.

Attach a "Do Not Operate" tag or similar warning tag to the steering controls before performing maintenance on the machine. If the engine should not be started, remove the ignition key.

PREPARE THE WORK AREA

Choose a clean level work area. Make sure you have sufficient room. Check clearances. Make certain there is adequate light and ventilation.

Clean the walking and working surfaces. Remove oil, grease, and water to eliminate slippery areas. Put sand or other absorbent material on slippery areas.

PREPARE YOURSELF

Wear all the protective clothing the job requires. Wear a rubber apron and rubber gloves when working with corrosive materials. Wear gloves and safety shoes when handling wooden blocks, wire rope or sharp-edged metal.

Always wear safety glasses, goggles or a face shield when working with fluids under pressure, while grinding, while servicing batteries, and where there is any possibility of injury from flying debris. Wear a face-shield when you disassemble spring loaded components. Wear a helmet or goggles with special lenses when you weld or cut with a torch.

Do not sand, grind, flame-cut, braze or weld without a NIOSH / MSHA approved respirator or appropriate ventilation. If you are welding on the machine, refer to the *Service Manual* and *Owner/Operator Manual* for instructions.

WARNING

Keep hands—and clothing—away from all moving parts. Don't tempt fate with dangling ties, loose sleeves, rings or long hair. Keep pockets free of all objects which could fall out, and into the machinery.

Handle tools and heavy parts carefully, with regard to yourself and other persons. Lower items, don't drop them.

Always use a safety platform (steps, ladders, etc) to service those areas which are slippery or too high reach and where surfaces of the machine cannot support your weight.

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PREPARE THE MACHINE

Locate the machine on a level surface. Stop the engine, release all hydraulic pressure. (see Machine Shutdown, page 6.0) Block all hydraulically operated attachments (if they must be in a raised position). Place all controls in "Neutral" and block the wheels/tracks.



WARNING

NEVER work on machinery with the engine running unless you are specifically instructed to do so by the *Service* or *Owner/Operator Manual.*

NEVER operate any type of engine without proper ventilation – Exhaust fumes can kill.

- If it is necessary to run an engine in an enclosed area, ventilate the exhaust fumes with an exhaust pipe extension. If you do not have an exhaust pipe extension, make sure you open the doors and get outside air into the area. Unless the swing function is required, you must engage the swing lock, if equipped, before performing any maintenance.
- If adjustments must be made with the engine running, always work as a 2-person team, with one person sitting in the operator's seat while the other works on the machine. Know what each person is supposed to be doing at all times. Activate controls slowly and only when directed.
- Remove only guards or covers that provide access. Wipe away excess grease and oil.
- Never leave guards off or access doors open with the machine unattended. Keep bystanders away if access doors are open.
- Make certain all guards, screens or panels, and safety signs are re-installed on the machine.

When servicing an air conditioning system, refer to the freon container for proper use. Use a recovery and recycling system to avoid venting the freon to the atmosphere. Contact with the freon stream can cause severe frost burns.

COMPLETE ALL SERVICES AND REPAIRS BEFORE OPERATING THE MACHINE



WARNING

Inspect all parts during repair and replace if worn, cracked or damaged. Excessively worn or damaged parts can fail and cause injury or death. Replace any damaged or illegible decals.

Tighten all bolts, fittings, and connections to torque specified in the Owner/Operator Manual.

Install all guards, covers, and shields after servicing. Replace or repair if damaged. Refill and recharge pressurized systems only with Gradall approved fluids.

Start the engine and check for leaks. Operate all controls to make sure the machine is functioning properly. Road test the machine if necessary. After testing, shut down, check the work you performed. Re-check all fluid levels before releasing the machine for operation.

DRAIN AIR TANKS DAILY

Drain tanks daily. In cold weather, it is especially important that the air tank(s) be thoroughly drained at least once per shift. Be sure the drain is closed before starting the engine.

USE JACKS AND HOISTS CAREFULLY

If you must work beneath raised equipment, always use wood (NOT CONCRETE) blocks, jack-stands or other rigid and stable supports. When using jacks and hoists, be sure they are adequately supported.



WARNING Never use concrete blocks for supports. They can collapse under even light loads.

Make sure the hoists and jack stands you use are in good repair. Never use jack stands with cracked, bent or twisted parts. Never use frayed, twisted or pinched cables. Never use bent or distorted hooks.

BRAKE SAFETY TIPS

Carefully follow instructions in the *Service* and *Owner/Operator Manuals* when adjusting brakes. Improperly adjusted brakes could cause a serious accident.



WARNING On crawler mounted machines, block the tracks before releasing the park brake, if possible. Otherwise, the excavator may roll.

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HYDRAULIC SYSTEM HAZARDS

The hydraulic system may be under pressure whenever the engine is running and may hold pressure even after shutdown. Block the cylinders and equipment securely before working on the hydraulic system.

Cycle all hydraulic functions, steering and other controls after shutdown to relieve system pressure. For pilot-actuated systems, follow the instructions in the *Owner/Operator* and *Service Manuals* to relieve the pressure. When venting or filling the hydraulic system, loosen the filler cap slowly and remove it gradually. If the system is equipped with an accumulator, see the *Service Manual* for discharge and recharge instructions.

Keep all open flames away from the hydraulic system.

Clean up spilled fluid immediately.

Before loosening any hydraulic fitting be sure there is no trapped hydraulic pressure.

WARNING Diesel fuel or hydraulic fluid under pressure can penetrate the skin or eyes and cause serious injury, blindness or death. Fluid leaks under pressure may not be easily visible. Use a piece of cardboard or wood to find leaks but do not use your bare hand. Wear a face shield or safety goggles for eye protection. If any fluid is injected into the skin, **seek medical attention immediately!**

COOLING SYSTEM HAZARDS

Liquid cooling systems build up pressure as the engine gets hot. Before removing the radiator cap, stop the engine and let the system cool. Remove the radiator cap only after the coolant is cold using a heavy rag for protection.



WARNING For cooling systems with an overflow tank, the coolant can usually be checked at the tank without removal of the radiator cap.

ELECTRICAL SYSTEM HAZARDS

Disconnect the battery before working on the electrical system. Remove the ground cable first. When re-connecting the battery, connect the ground cable last.

Never work on the electrical system unless you are thoroughly familiar with system details and the special handling required.

AVOID BATTERY HAZARDS



WARNING

Lead-acid batteries contain sulfuric acid which will damage eyes or skin on contact. Always wear a face shield to avoid acid in eyes. If acid contacts eyes, flush immediately with clean water and get medical attention. Wear rubber gloves and protective clothing to keep acid off skin, wash off immediately with clean water, then seek medical attention.

Lead-acid batteries produce flammable and explosive gasses. Keep arcs, sparks, flames and lighted tobacco away. Use a flashlight to check battery electrolyte level. Always check with the engine stopped.



WARNING

For a sealed battery, a bulged end indicates that the battery is frozen. Do not charge a battery or jump-start the engine if the battery is frozen. Warm to 60°F (15°C) or the battery may explode.

AVOID FIRE AND EXPLOSION HAZARDS

Stop the engine and shut off the electrical equipment while filling the fuel tank. Use extra caution when fueling a hot engine. Always ground the fuel nozzle against the filler neck to avoid any sparks.



WARNING

Never smoke while handling fuel or working on the fuel system. The fumes in an empty fuel container are explosive. Never cut or weld on fuel lines, tanks or containers.

Handle all solvents and dry chemicals according to procedures identified on manufacturers' containers. Work in a well ventilated area. Make sure you know where fire extinguishers are kept and how to use them.

Remove all trash or debris from the machine. Make sure that oily rags or other flammable material are removed from the machine.

Check for fuel, oil or hydraulic fluid leaks. Repair the leaks and clean the machine before you operate it.

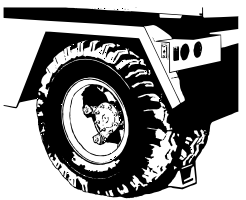
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Ether is flammable. Do not smoke when using ether. Always follow the instructions on the ether can and in the *Owner/ Operator Manual* for your machine. Do not use ether if the engine is equipped with a glow plug or other type of preheater. Always use a nonflammable solvent when you clean parts. Do not use gasoline, diesel fuel or other flammable fluid.

Store all flammable fluids and materials away from your work area in suitable containers, per local regulations.



Check the readiness of all fire extinguishers, fire suppression systems and fire detectors.



TIRE MAINTENANCE

Check your tires and wheels every day. The stability of the excavator is dramatically reduced by improperly inflated tires.

Check tires for:

- Correct inflation pressure
- Cuts or bulges
- Nails or other punctures
- Uneven or excessive wear
- Condition of valve stems and caps

Check wheels for:

- Damage to the rims
- Missing or loose lug nuts or bolts
- Obvious misalignment

TIRE AND WHEEL HAZARDS

Changing tires is **DANGEROUS**. All tire service should be performed by a qualified tire service center or by an authorized person that has been properly trained in the procedures and use of safety equipment designed for tire servicing. The wheels and tires installed on Gradall Excavators require special care and professional attention. Here are some important factors to remember:

- Always maintain the proper tire pressure. **NEVER** over-inflate a tire as it could explode
- **NEVER** reinflate a tire that has been run flat or seriously under-inflated without removing the tire from the wheel. Have the tire and wheel closely inspected for damage before remounting
- Clean the area around all wheel lug nuts or bolts and periodically check the torque per Gradall specifications. After torque has stabilized at the proper rated value, check at regularly scheduled intervals
- **NEVER** weld on a Gradall wheel
- Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure.
- Inspect tires and wheels daily. Do not operate with low pressure, cuts, bubbles, damaged rims or missing lug nuts or bolts
- Never cut or weld the rim or rim parts. This could cause explosive decompression

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- An increase in tire pressure during operation is normal. It should **NOT** be reduced. High speeds during transport may produce excessive tire pressure due to heat. **REDUCE YOUR SPEED** or stop and let the tires cool down.

- When adjusting tire pressure, do so from a distance. Use a long hose with self-attaching chuck. Always stand behind the tread when adjusting tire pressure. Be sure the area to the side of the tire is clear of other people.

- Do not inflate tires with flammable gasses or from a system utilizing an alcohol injector.

Explosive separation of a tire and/or rim parts can cause serious injury or death. Always follow the manufacturer's recommendations or see your tire supplier.

TRACK MAINTENANCE

Maintain proper track tension. When operating in mud, snow, etc., material will stick to the track parts and cause the tracks to become too tight. Refer to the *Service Manual* and/or *Owner/Operator Manual*.



WARNING

The pins and bushing in a dry joint can become very hot. Wear gloves to prevent burns.

Check tracks for loose, bent or broken track shoes and bolts, worn or damaged pins and bushings. Check the carrier and idler rollers.



WARNING

Never strike or pound on track tension springs; they may be under tremendous compression and could shatter explosively.

SPECIAL NOTE: ASBESTOS

Some machines (especially older ones) may have components containing asbestos in friction and gasket materials. These precautions pertain to these machines.

Avoid exposure to asbestos dust.



CAUTION

Extreme caution must be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health. Components that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates and some gaskets. The asbestos used in new components is bound in a resin or sealed. Normal handling is usually not hazardous as long as airborne dust which contains asbestos is not generated.

If dust which may contain asbestos is present, there are several common sense guidelines that should be followed:

1. Never use compressed air for cleaning (such as blowing out brakes prior to repair).
2. Avoid brushing or grinding of asbestos containing materials.
3. For clean up, use wet methods or a vacuum equipped with a High Efficiency Particulate Air (HEPA) filter.
4. Use exhaust ventilation on permanent machine installations.
5. Wear an approved respirator.
6. Comply with applicable rules and regulations for the work place (for example in the U.S.A., OSHA requirements as set forth in 29 CFR 1926.58).
7. Follow environmental rules and regulations for disposal of asbestos.
8. Avoid areas where asbestos particles may be in the air.
9. Shower after any contact.
10. Store food, drink and personal belongings away from the work area.
11. Never eat, drink or smoke where asbestos is in the area.

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NOW THAT YOU HAVE READ THIS SAFETY MANUAL, DO YOU UNDERSTAND . . .

- Your safety program?
- The *Owner/Operator Manual* for the particular machine you are operating.
- Proper clothing and personal safety equipment?
- The excavator controls, warning signs, devices, and safety equipment?
- How to properly inspect, mount, and start the excavator?
- How to check the excavator for proper operation?
- The work area and special hazards that may exist?
- Proper operating procedures?
- Operating safety precautions?
- Proper loading and unloading procedures for transporting?
- Under what conditions you should not operate the excavator?
- Proper parking, shutdown, and dismounting procedures?
- Proper maintenance procedures?

A FINAL WORD TO THE USER

You have just finished reading the Gradall Hydraulic Excavator Safety Manual. It is impossible for this Manual to cover every hazardous situation you may encounter. But, your knowledge of these safety precautions and your compliance with the basic rules of safety will help build good judgement. Our objective is to help you develop good safety habits and make you a safer Hydraulic Excavator Operator.

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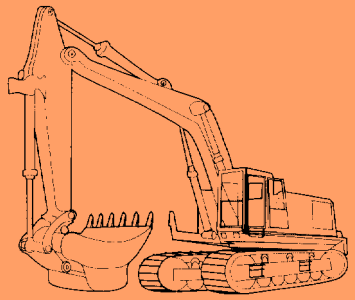
GRADALL® Hydraulic Excavators

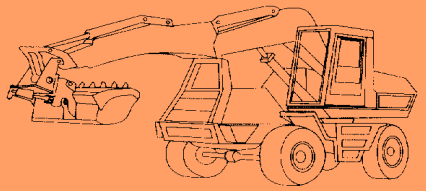
406 Mill Ave. SW, New Philadelphia, Ohio 44663 USA
Phone (330) 339-2211 Fax (330) 339-8468
www.gradall.com

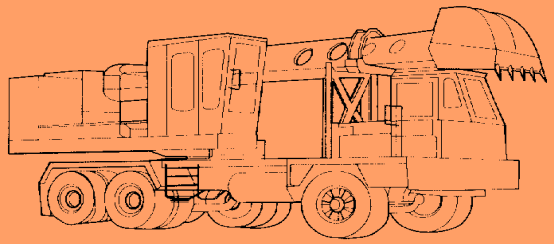
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Hydraulic Excavator







safety manual

For operators and mechanics

Equipment Manufacturers Institute
10 S. Riverside Plaza ✹ Chicago, Illinois 60606 U.S.A.

Acknowledgement

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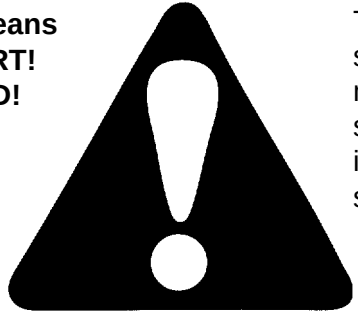
We wish to acknowledge the contributions of all the members of the Equipment Manufacturers Institute in the preparation of this Safety Manual.

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Safety alert symbol

This Safety Alert Symbol means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!



The Safety Alert Symbol identifies important safety messages on machines, safety signs, in manuals, or elsewhere. When you see this symbol, be alert to the possibility of personal injury or death. Follow the instructions in the safety message.

Why is SAFETY important to You?

3 BIG REASON:

- **ACCIDENTS DISABLE AND KILL**
- **ACCIDENTS COST**
- **ACCIDENTS CAN BE AVOIDED**

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Foreword

This Safety Manual is intended to point out some of the basic safety situations which may be encountered during the normal operation and maintenance of your machine and to suggest possible ways of dealing with these conditions. This manual is NOT a substitute for the manufacturer's manual(s). Additional precautions may be necessary, depending on attachments used and conditions at the worksite or in the service area. The manufacturer has no direct control over machine application, operation, inspection, lubrication, or maintenance. Therefore, it is YOUR responsibility to use good safety practices in these areas.

The information provided in this manual supplements the specific information about your machine that is contained in the manufacturer's manual(s). Other information which may affect the safe operation of your machine may be contained on safety signs, or in insurance requirements, employer's safety programs, safety codes, local, state/provincial, and federal laws, rules, and regulations.

IMPORTANT: IF YOU DO NOT HAVE THE MANUFACTURER'S MANUAL(S) FOR YOUR PARTICULAR MACHINE, GET A REPLACEMENT MANUAL FROM YOUR EMPLOYER, EQUIPMENT DEALER, OR FROM THE MANUFACTURER OF YOUR MACHINE. KEEP THIS SAFETY MANUAL AND THE MANUFACTURER'S MANUAL(S)) WITH THIS MACHINE. READ AND UNDERSTAND THE MANUFACTURER'S MANUAL(S).

A word to the user / operator

It is YOUR responsibility to read and understand the safety manual and the manufacturer's manual(s) before operating this machine. This safety manual takes you step-by-step through your working day.

In reading this manual, you will note that any illustration depicting an unsafe work procedure or situation is labeled both with the words "wrong" and the mark of an "X" on the illustration. Each illustration is also numbered and the same number appears in the text in parenthesis. This number is placed at the end of the written text that refers to the illustration. While some of the illustrations appearing in this manual are in the nature of "cartoons", this approach is intended solely as a means to promote your attention to the text. As noted repeatedly throughout this manual, EMI and its Earth moving Equipment Council are very serious about risks to human life and health caused by unsafe practices.

Remember that YOU are the key to safety. Good safety practices not only protect you but also protect the people around you. Study this manual and the manufacturer's manual(s) for your specific machine. Make them a working part of your safety program. Keep in mind that this safety manual is written for only this type of machine. Practice all other usual and customary safe working precautions, and above all-

REMEMBER - SAFETY IS UP TO

YOU

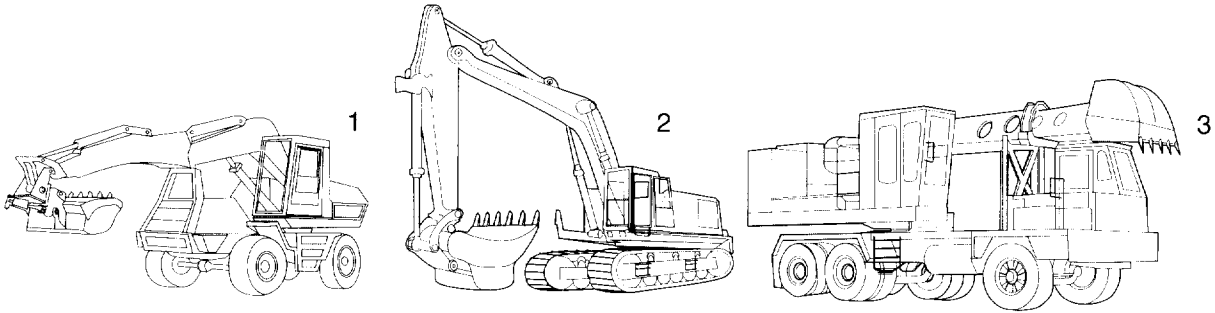
YOU CAN PREVENT SERIOUS INJURY OR DEATH

Types of hydraulic excavators

There are three basic types of hydraulic excavators:

1. Wheel Mounted-Integral Chassis
2. Track Mounted-Integral Chassis
3. Wheel Mounted-Separate Operation and Transport Stations

These machines are covered in this manual. The manual does not include safety information on special attachments such as feller bunchers, grapples, lift forks, augers, jack hammers and other items.



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Follow a safety program

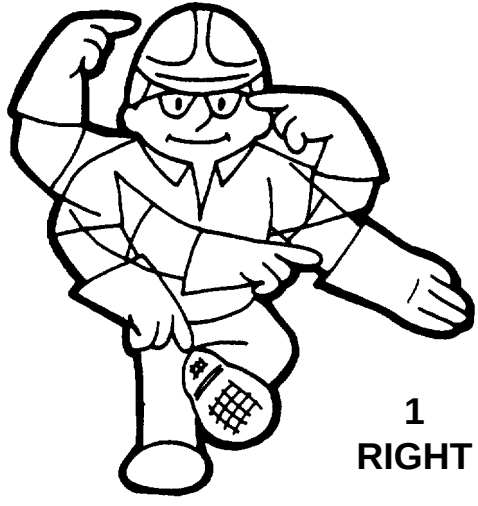
Protect Yourself

Wear all the protective clothing and personal safety devices issued to you or called for by job conditions. (1)

You may need:

- A hard hat
- Safety shoes
- Safety glasses, goggles, or face shield
- Heavy gloves
- Hearing protection
- Reflective clothing
- Wet weather gear
- Respirator or filter mask.

Wear whatever is needed, don't take chances.



1
RIGHT

WARNING: Do NOT wear loose fitting clothes, flopping cuffs, dangling neckties and scarves, or rings and wrist watches that can catch in moving parts.

Use your head-and your hard hat.

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Follow a safety program

Be Alert!

Know where to get assistance. Know how to use a first aid kit and fire extinguisher/fire suppression system.

Be Aware!

Take advantage of training programs offered.

Be Careful!

Human error is caused by many factors: carelessness, fatigue, overload, preoccupation, drugs, and alcohol to name a few. Damage to the machine can be fixed in a short period of time, but injury, or death, has a lasting effect. For your safety and the safety of others, encourage your fellow workers to act safely.

For Safe Operation

For safe operation of this machine, you must be a qualified and authorized operator. To be qualified, you must understand the written instructions supplied by the manufacturer, have training, including actual operation of this machine and know the safety rules and regulations for the jobsite.

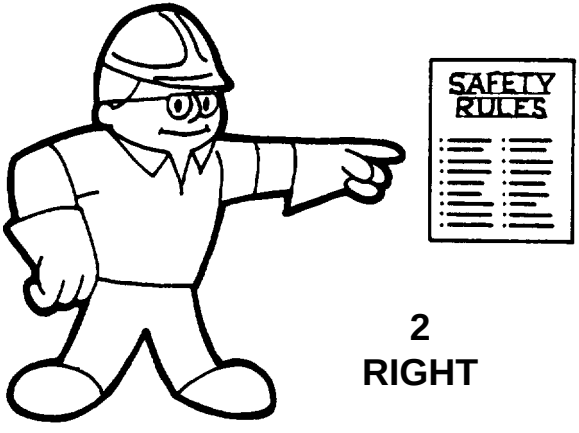
On the job, an operator must not use drugs or alcohol which can impair his alertness or coordination. An operator on prescription or over-the-counter drugs needs medical advice regarding whether or not he or she can safely operate machines.

Know The Rules

Most employers have rules governing operation and maintenance of equipment. Before you start work at a new location, check with your supervisor or the safety coordinator. Ask about rules you may be expected to obey.

Stay Alert; Avoid accidents. Don’t learn safety the hard way.

Follow a safety program



2
RIGHT

Know The Rules (continued)

These are some of the rules you must work by: (2)

- Know the capacity and operating characteristics of this machine.
- Never modify or remove any part of the machine (except for service).
- Never allow riders on your machine.
- Keep others away from your operation.
- Whenever you leave your machine, always lower the excavator bucket or other attachments to the ground. Engage the parking brake, stop the engine, cycle the hydraulic controls, and remove the key. (See page 32, Machine Shutdown.)

Make sure you understand the rules covering traffic at your jobsite. Know what all signs, flags, and markings mean. Understand hand, flag, horn, whistle, siren, and bell signals. Know when to use lights, turn signals, flashers, and horns.

Know the rules-LIVE by them.

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Follow a safety program

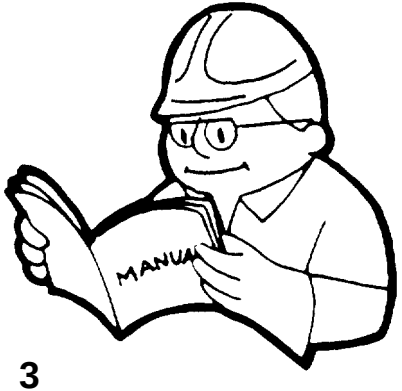
Know Your Equipment

Know your machine. Know how to operate all equipment on your machine. Know the purpose of all the controls, gauges, and indicators. Know the rated load capacity, speed range, braking and steering characteristics, turning radius, and operating clearances. Keep in mind that rain, snow, ice, loose gravel, soft ground, etc., change the operating capabilities of your machine. Study the DANGER, WARNING, and CAUTION safety signs on your machine and the information signs too.

STUDY THE MANUFACTURER'S OPERATOR'S MANUAL BEFORE STARTING THE ENGINE. IF THERE IS NO MANUAL WITH THE MACHINE - GET ONE. STUDY IT BEFORE YOU START WORK. (3)

IF THERE IS SOMETHING IN THE MANUAL YOU DON'T UNDERSTAND, ASK YOUR SUPERVISOR TO EXPLAIN IT TO YOU.

IMPORTANT: This manual covers safe practices for Hydraulic Excavators. If your machine is equipped with other devices or special accessories, read the manufacturer's operating and safety manuals pertaining to that equipment before using it.



3
RIGHT

Respect your equipment. Make sure you know how to operate it.

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Prepare for safe operation

Check The Safety Equipment

To protect you and others around you, your machine may be equipped with the following safety equipment. See that each item is securely in place and in operating condition.

- Falling Object Guard
- Front Guard
- Lights
- Safety Signs
- Horn
- Guards
- Shields
- Travel Alarm
- Mirrors
- Fire Extinguisher/Fire Suppression System
- First Aid Kit
- Windshield Wipers & Washers

Use them! Never remove or disconnect any safety device.



WARNING: NEVER REMOVE A FALLING OBJECT GUARD, OR FRONT GUARD EXCEPT FOR SERVICE.

Check The Machine

Before you begin your workday, you should inspect your machine and have all systems in good operational condition. Do not operate the machine until all deficiencies are corrected.

- Check for broken, missing or damaged parts. Make necessary repairs.
- Check the tires for cuts, bulges and correct pressure.
- Replace badly worn or damaged tires.
- Check the tracks for broken or damaged pins, bushings and other track parts.
- Check service, parking, and swing brake for proper operation.
- Check cooling system.



WARNING: Allow the radiator to cool before checking the level. (See page 41, **Be Careful with Hot Cooling Systems.)**

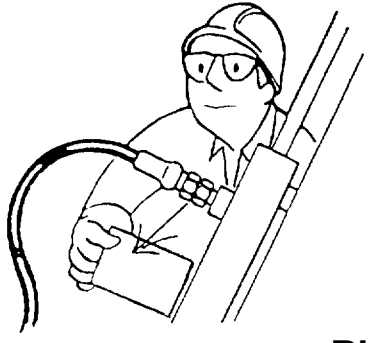
Safe operation begins with a safe operator.

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Check the Machine (continued)

- Perform all maintenance procedures outlined by the manufacturer of your machine.
- Check the hydraulic system. Repair any leaks.
- Check the turntable lock.

WARNING: Diesel fuel or hydraulic fluid under pressure can penetrate the skin or eyes and cause serious injury, blindness or death. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks but do not use your bare hand. (4) Wear a face shield or safety goggles for eye protection. If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. (See page 41, **Be Careful With Fluids Under Pressure.)**



4
RIGHT

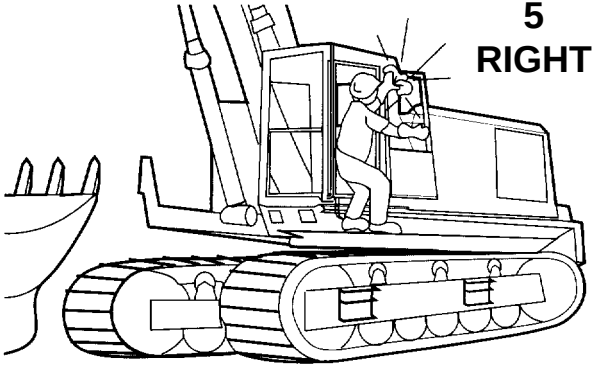
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Prepare for safe operation

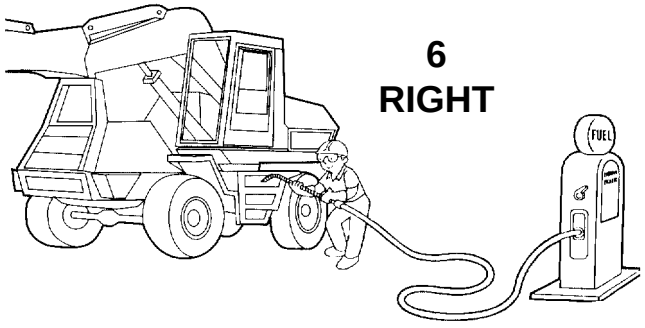
Clean Up

Clean windshields, mirrors and all lights. Make sure the operator's area, steps and hand holds are clean. Oil, grass, snow, ice or mud in these areas can cause you to slip and fall. Clean your boots of mud before getting on the machine. (5)

Remove all loose personal items or other objects from the operator's area. Secure these items in the tool box or remove them from the machine.



5
RIGHT



6
RIGHT

Use Caution When Fueling

WARNING: Never fill the fuel tank with the engine running, while smoking or when near an open flame. (6)

Never overfill the tank or spill fuel. If fuel is spilled, clean it up immediately.

Ground the fuel funnel or nozzle against the filler neck to prevent sparks and be sure to replace the fuel tank cap.

(For additional information on fire hazards, refer to the section **Avoid Fire and Explosion Hazards,** page 42.)

Don't fool with fuel.

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Prepare for safe operation

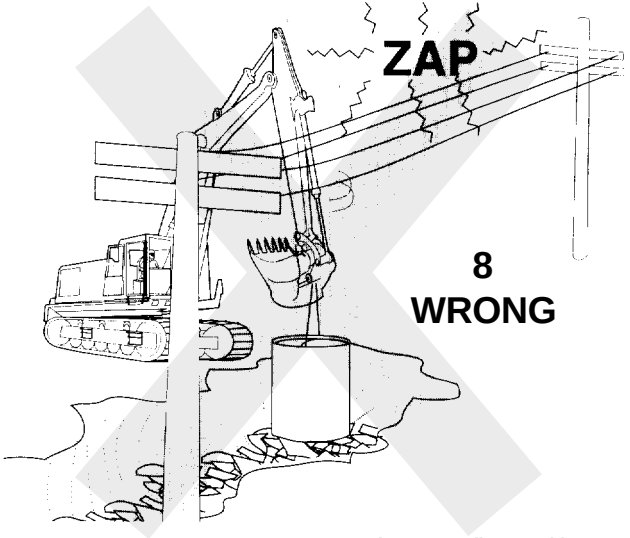
Know The Working Area (7)

Learn - beforehand - as much about your working area as possible. Check for:

- Location of slopes.
- Open trenches
- Dropoffs or overhangs.
- Soil conditions (soft or hard).
- Standing water and marshy areas.
- Rocks and stumps.
- Traces of buried foundations, footings or walls.
- Traces of buried trash or landfill.
- Conditions of haul roads.
- Direction of travel on haul roads.
- Holes, obstructions, mud or ice.
- Heavy traffic.
- Thick dust, smoke, fog.
- Exact location of any buried and/or overhead electrical, gas, telephone, water, sewer, or other utility lines. If necessary, have the utility company mark, shut off, or relocate them before you begin working.



7
RIGHT



8
WRONG

WARNING: Never approach power lines with any part of your machine unless all local, state/provincial and federal (OSHA) required safety precautions have been taken. Use extreme caution. (8)

When operating machine inside a building, know what clearances you will encounter - overhead, doorway, aisles, etc.; also, the weight limitations of floors and ramps. Make sure there is sufficient ventilation for inside operation.

What you don't know CAN hurt you.

Prepare for safe operation

Rules of The Road

If the machine is to be driven or transported over the road, refer to the manufacturer's manual for instruction.

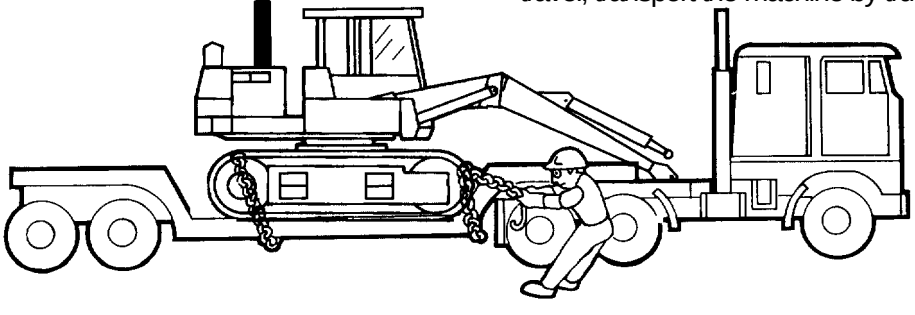
Make sure clearance flags, all lights and warning signs are in place and visible. Make sure the "Slow Moving Vehicle" emblem is visible to any vehicle approaching from the rear. While traveling on public roads or streets, obey all local traffic regulations appropriate to your machine use and local classification. Always use hazard warning lights. Find out if you must use an escort vehicle or roading permit. Place the boom and bucket in the transport position and secure all accessory equipment. (9)

Don't speed. Know your stopping distance at a given speed. Always regulate your travel speed accordingly. Avoid panic stops and sharp turns. If traffic backs up, pull over and allow other vehicles to pass.

Stop at all railroad crossings and look both ways before proceeding. Never park in traffic areas. If it is necessary to stop at night, pull off the road and set up flares or reflectors. When driving at night, use appropriate lights.

Always use hand signals or turn signals when turning. If you are going to transport a machine by truck, you must cover or remove the SMV emblem. Approach intersections with caution, observe speed and traffic control signs.

Crawler mounted machines may damage road sufaces. Allowable travel on road surfaces is limited. For over the road travel, transport the machine by truck.



9
RIGHT

Know the rules or pay the price.

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Start safely

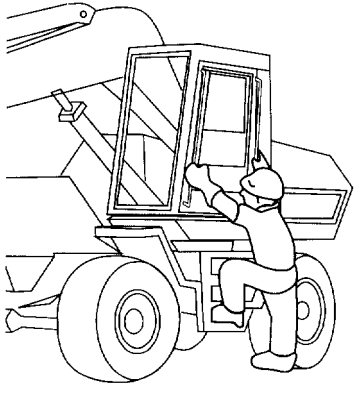
Mount Safely

When you get on or leave the machine, always:

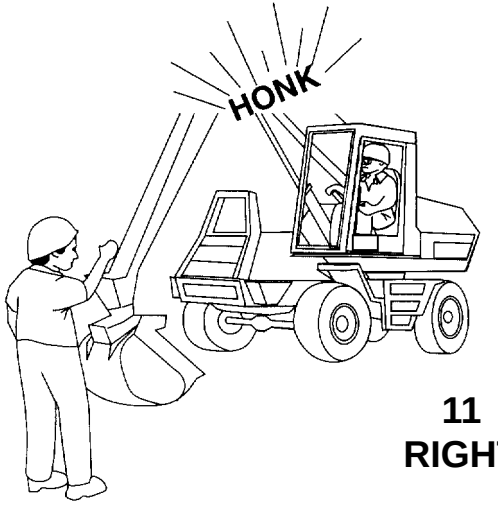
- Maintain a three point hand/foot contact with the access system. (10)
- **Face** the machine when either mounting or dismounting.
- Never jump on or off the machine. Never attempt to mount or dismount a moving machine.

Do not use the steering wheel or any control lever as a hand hold when you enter or leave the machine.

WARNING: The cab must be aligned with the undercarriage centerline before you enter or exit the cab.



10
RIGHT



11
RIGHT

Warn Personnel Before Starting

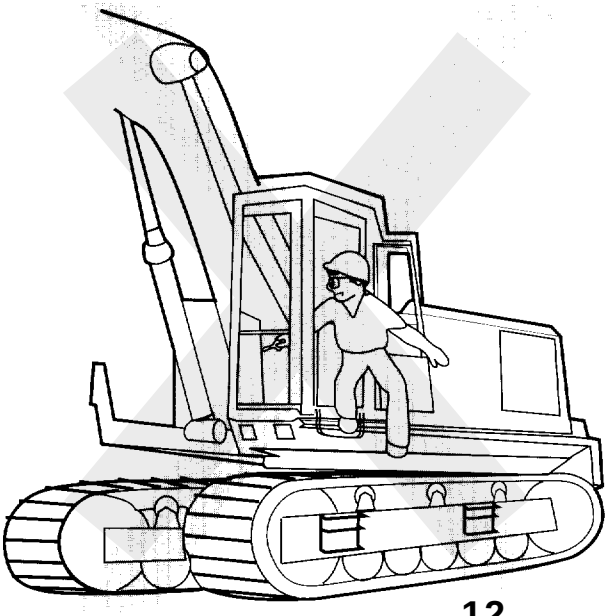
Before starting, walk completely around the equipment. Make sure no one is under the machine, on it, or close to it. Sound the horn and let other workers and bystanders know you are starting up. (11) Don't start until everyone is clear of the machine.

Look out for others.

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Start safely

Starting The Engine



12
WRONG

WARNING: START THE ENGINE FROM THE OPERATOR'S SEAT ONLY. NEVER ATTEMPT TO START THE ENGINE BY SHORTING ACROSS STARTER TERMINALS OR REACHING THE KEY FROM THE GROUND OR OUTSIDE THE CAB. (12) The machine may start in gear if neutral-start circuitry is bypassed. This could cause the machine to move suddenly and cause serious injury or death to anyone in its path.

Know the exact starting procedure for your machine. See the manufacturer's manual(s) for starting.

1. Sit in the operator's seat and adjust the seat so you can operate all the controls properly.
2. Familiarize yourself with warning devices, gauges and operating controls.
3. Engage the parking brake (if so equipped) and put all controls in the neutral/park position.
4. Clear the area of all persons.
5. Start the engine following the instructions in the manufacturer's manual(s).

If necessary to run the engine or operate the machine within an enclosed area, be positive there is adequate ventilation.

WARNING: Exhaust fumes can kill.

A machine without a driver is dangerous.

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Start Safely

Starting Aids

If jumper cables are used, follow the instructions in manufacturer's manual(s). The operator must be in the operator's seat when jump starting the engine so that the machine will be under control when engine starts. Jump starting is a two person operation. A battery explosion or a run-away machine could result from improper jump starting procedures. Never jump start a frozen battery (see page 43).

Ether Cold-Start Fluid is highly flammable and explosive. Before using it, always read the instructions on the ether container and the instructions in the manufacturer's manual(s).

Do NOT use ether if the engine is equipped with a glow plug type preheater or other intake manifold type preheater.

After Starting Engine

Observe gauges, instruments, and warning lights to assure that they are functioning and their readings are within the operating range.

Run An Operating Check

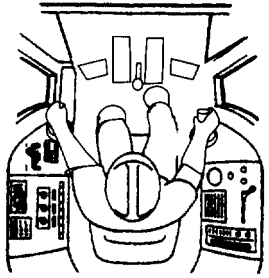
Do not use a machine that is not in proper operating condition. It is the OPERATOR'S RESPONSIBILITY to check the condition of all systems, and to run the check in a safe area.

Test Controls

Make sure the engine is operating correctly. With the transmission in neutral, test engine speed control. Operate each equipment control lever to make sure all functions are correct. (13)

Operate the shift control(s) to insure correct operation in forward, neutral, and reverse. Release the swing lock.

Check the parking brake and service brakes and swing brakes according to the manufacturer's manual(s). Test steering - right and left -while moving slowly.



13
RIGHT

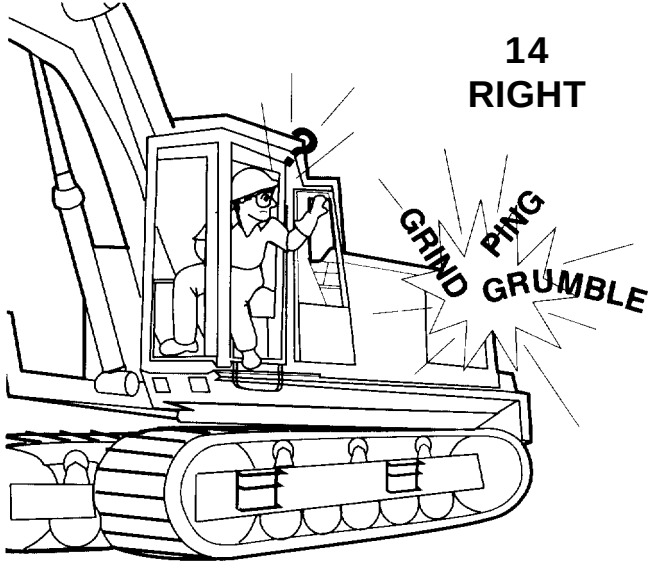
WARNING: BE CERTAIN YOU CAN CONTROL SPEED, DIRECTION, BRAKING, SWING AND BOOM BEFORE OPERATING THE MACHINE.

If there's something wrong, don't use the machine.

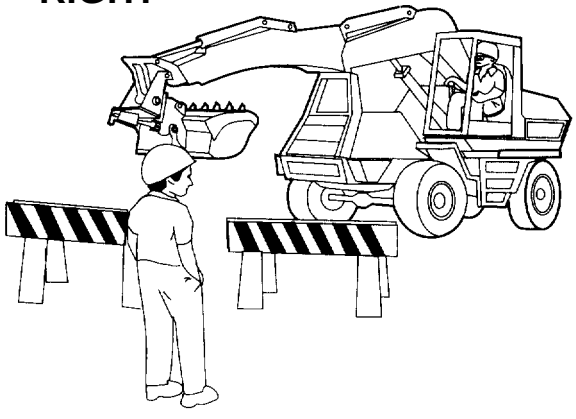
Start Safely

Look and listen for malfunctions. Stop (14) if a malfunction or erratic operation is detected. Correct or report trouble **immediately,** before further operation.

14
RIGHT



15
RIGHT



Remember These Rules

Stay in the operator's seat at all times when operating. Be in control of your machine at all times. Assure yourself that the work area is clear of all persons. (15)

If you don't think you can stop-don't start.

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Remember The Other Person

Never allow an untrained or unqualified person to operate your machine. Handled improperly, this machine could cause severe injury or death.

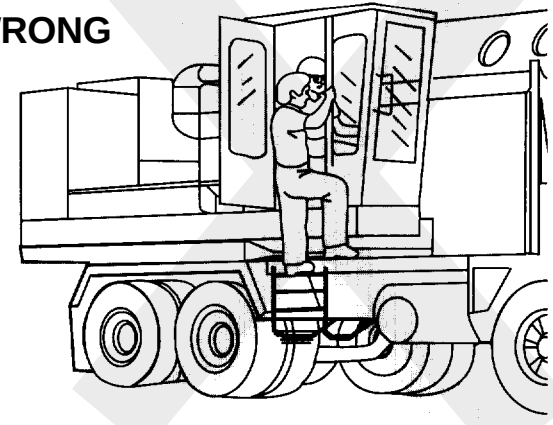
WARNING: YOUR HYDRAULIC EXCAVATOR IS A ONE-PERSON MACHINE. NEVER PERMIT RIDERS. (16)

Never use a bucket for a work platform or personnel carrier.

Always look around before you back up, hook up, or swing an attachment. Be sure that everyone is in the clear.

Know the pinch points and rotating parts on the machine. Awareness on your part can prevent accidents.

16
WRONG



No riders allowed.

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Traveling On The Jobsite

Take it slow and easy when traveling through congested areas. Traffic courtesy pays off.

Give the right of way to loaded machines. Maintain a safe distance from other machines. Pass cautiously.

Don't obstruct your vision when traveling. Carry the bucket or other attachments in the transport position for maximum stability and visibility. Operate at speeds slow enough so you have complete control at all times. Travel slowly over rough or slippery ground and on hillsides.

Stay in gear when traveling downhill. Do not shift into neutral. Maintain engine RPM to provide steering and braking functions. Use the same gear for traveling down a grade as you would for traveling up the grade.

Always use service brakes and parking brakes carefully and maintain them in accordance with the manufacturer's manual(s).

Before entering an underpass, check for hazards or obstructions. Also check clearance height.

Avoid steep slopes or unstable surfaces. When operating on a slope, keep the bucket and boom low and proceed with extreme caution. Do not drive ACROSS a steep slope under any circumstances. (17) Drive straight up and down a steep slope.

Avoid turning on an incline. If it is necessary, use extreme caution and make the turn wide and SLOW with the bucket and boom in the retracted lowered position.

17
WRONG



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Safety Precautions

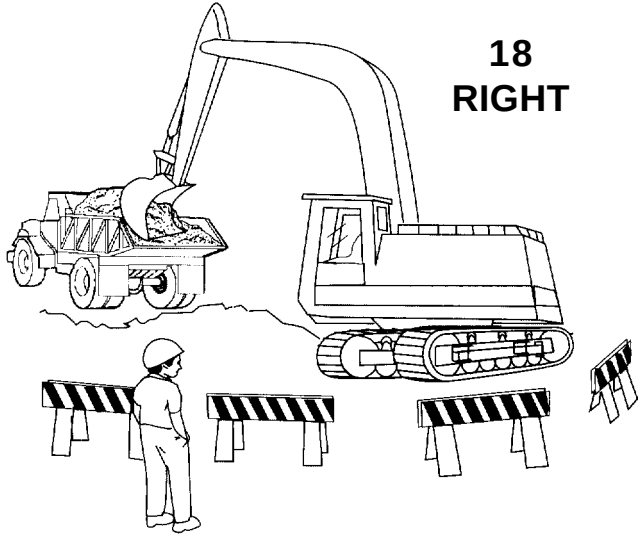
Make sure the area is clear of all persons before you start operating.

Before operating the excavator, engage the parking brake. Shift the transmission controls to neutral, lower the stabilizers (if so equipped), and level the machine as much as possible. If equipped with a leveling device, level the upper structure as much as possible.

Always make sure that you follow the manufacturer's recommendations before you operate the excavator.

WARNING: Never operate the excavator from outside the cab. Severe injury or death can result. Always operate the excavator from the correct operating position.

WARNING: Before starting to excavate, set up safety barriers to the sides and rear area of your swing pattern to prevent anyone from walking into the working area. (18)



Swing Safely

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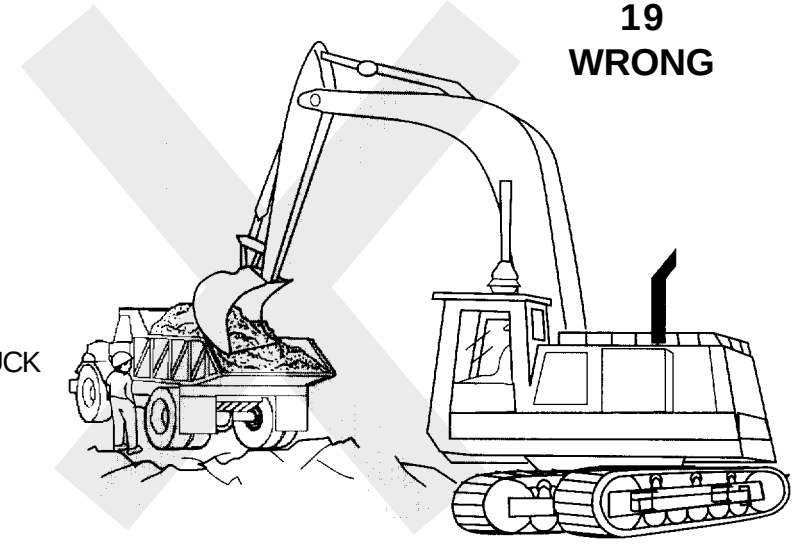
Safety Precautions (continued)

WARNING: Never enter, or allow anyone else to enter, the excavator swing pivot area. Death or serious injury can result.

Be sure there are no obstructions and sufficient clearance for tail swing.

WARNING: NEVER LIFT, MOVE OR SWING A LOAD OVER ANYONE OR THE CAB OF A TRUCK OR OTHER MACHINE. (19)

19
WRONG



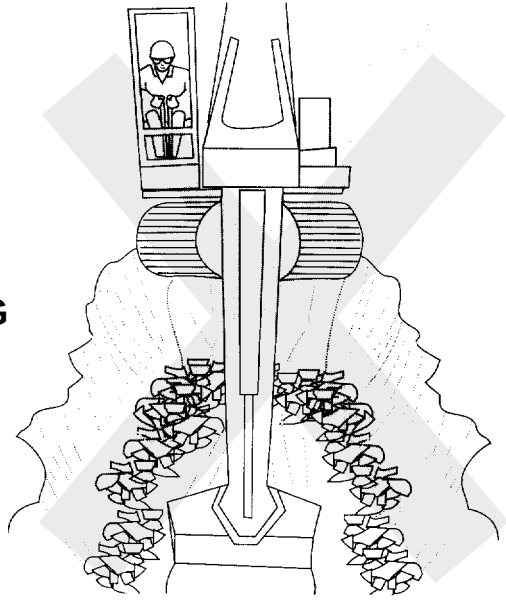
Keep your work area clear.

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Excavator Operating Safety Precautions

When working in hazardous areas, be extremely alert. Extreme caution is required when working at the edge of an excavation. Keep machine well back. Avoid undercutting. (20)

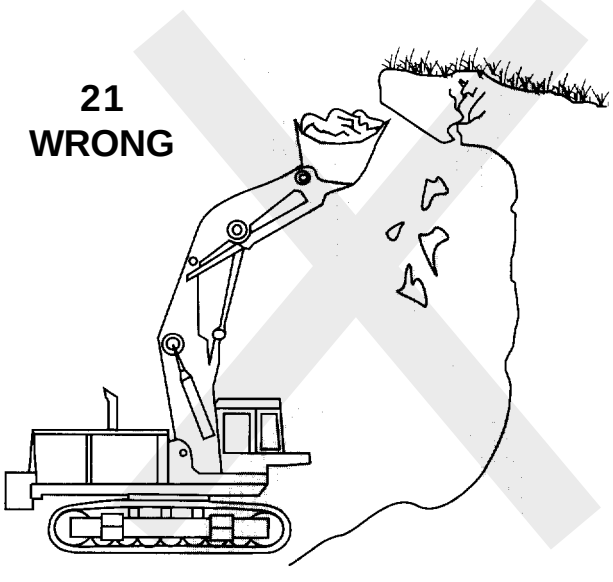
20
WRONG



Don’t dig yourself into a hole.

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Safety Precautions (continued)



WARNING: Never undercut a high bank. (21) The edges could collapse or a slide could occur causing severe injury or death. Never operate the machine close to the edge of an overhang or stockpile.

When working at the base of a bank, overhang, stockpile, or construction avoid dangers such as rock or earth slides, overhanging trees or a cave-in.

Work the jobsite in a manner to avoid creating overhangs or the need to be on top of banks or slopes.

Extreme caution should be used when working along the top of banks or slopes. Keep away from the edge. If possible, level the area.

.

Don’t bank on a bank

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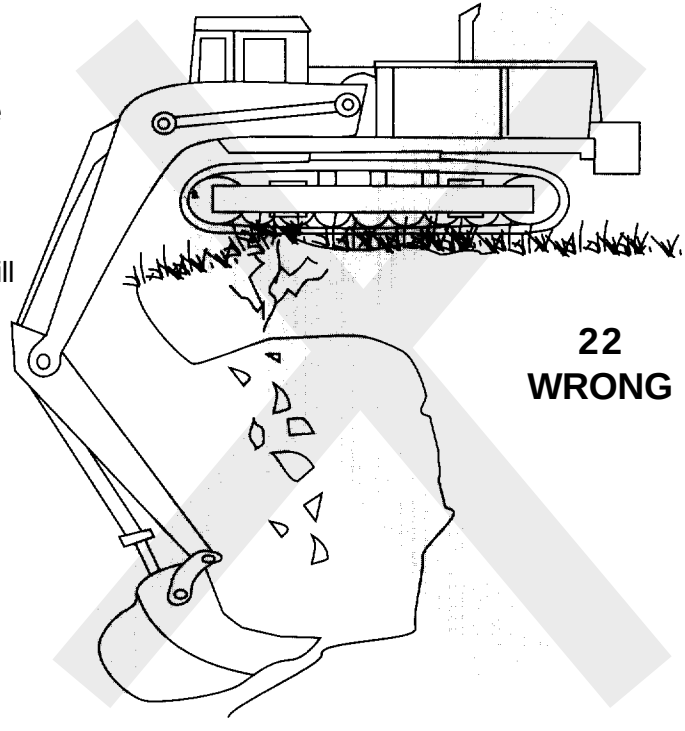
Safety Precautions (continued)

WARNING: Do not dig under the machine or stabilizers. A cave-in could result and the machine could fall into the excavation. (22)

Be careful that the machine does not roll into the excavation when the stabilizers are raised.

When operating the excavator on a slope, swing to the uphill side to dump load, if possible. (23) If downhill dumping is necessary, swing only as far as required to dump the bucket. Use extreme caution. Always drop spoil a sufficient distance from trench to prevent cave-ins.

If possible, place the undercarriage up or down a slope, rather than across, a slope for maximum stability.



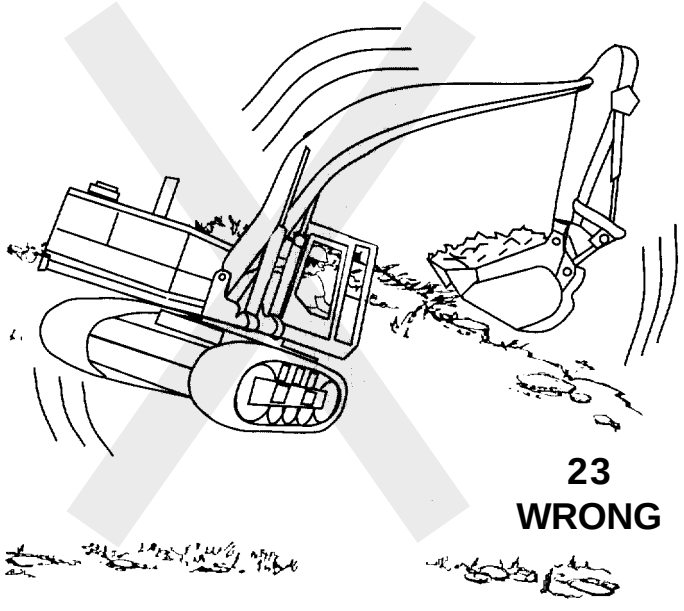
22
WRONG

Don’t cause a cave-in.

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Safety Precautions (continued)

Before moving the machine, raise the stabilizers sufficiently to clear the ground, and then drive the machine forward or backwards as required. After the machine has been repositioned, engage the parking brake and shift transmission controls to neutral. Lower the stabilizers and level the machine.



Use caution on an incline.

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Work Safely

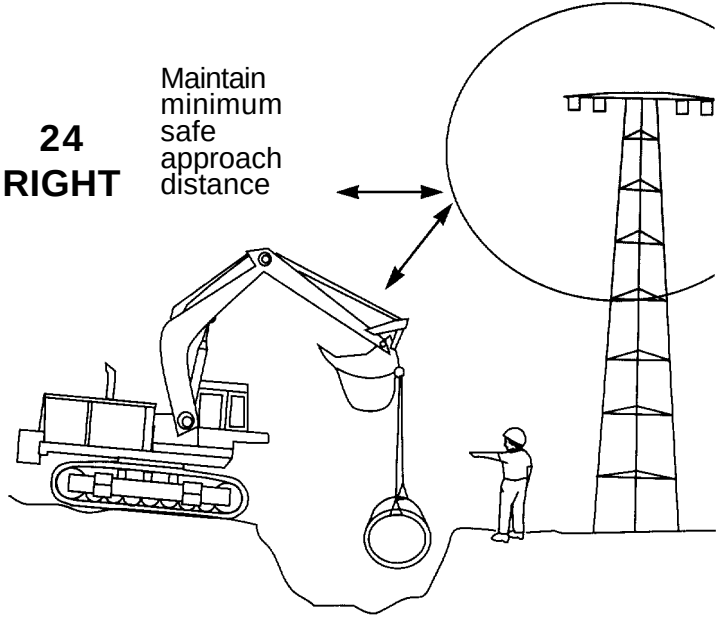
Utilities - Overhead and Underground

Electrocution can result from contacting or approaching underground or overhead power cables.

DANGER: Electrocution can result from touching or being near a machine that is in contact or near an electrical source. Never approach overhead power lines with any part of your machine unless all local, state/provincial and federal (OSHA) required safety precautions have been taken. Use extreme caution.

Check overhead clearances: know your margin of safety. If possible, have power to the lines disconnected. If not possible, request a signal person for guidance to maintain at least minimum distance required by law from the overhead power lines. (24)

24 RIGHT



Stay away from power lines.

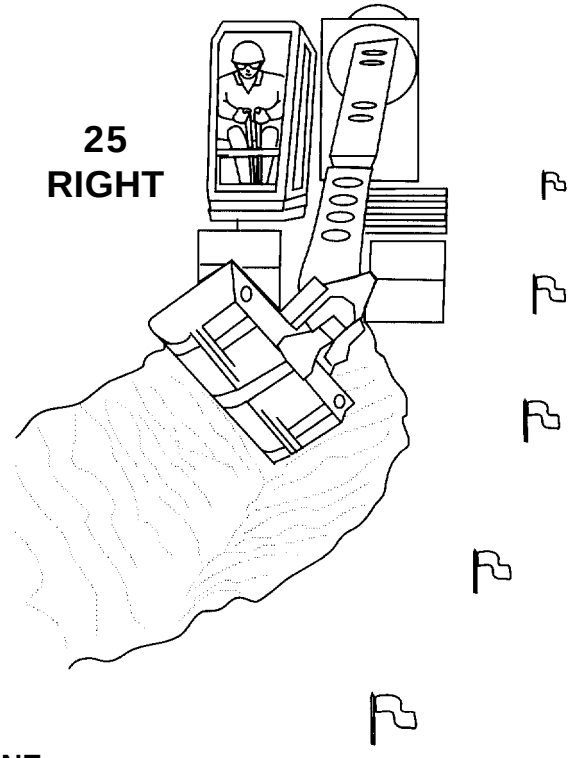
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Utilities - Overhead and Underground

Make sure you know the location of gas lines, water pipes, and power cables before excavating. Contact your “diggers hot line” if available, in your area, and/or utility company, and, have them mark all underground utilities. (25)

WARNING: You must maintain the minimum distance required, by law, from underground gas, power, telephone and water utilities.

A cut fiber optic cable can cause severe eye injury if you look into the damaged end of the cable.



Call the diggers HOT LINE

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Lifting Load With Excavator

Before lifting a load, see the manufacturer's manual for excavator lifting capacity.

WARNING: OVERLOADING IS HAZARDOUS. Make certain you are within the safe load and work radius limitations of this machine and are on solid, level ground before lifting any load. (26)

Attach chains and slings to the manufacturer's designated lifting points on the excavator bucket.

When using the excavator to lift and place objects, such as sewer pipe, position your machine so that lowering is over the end of the machine rather than either side.

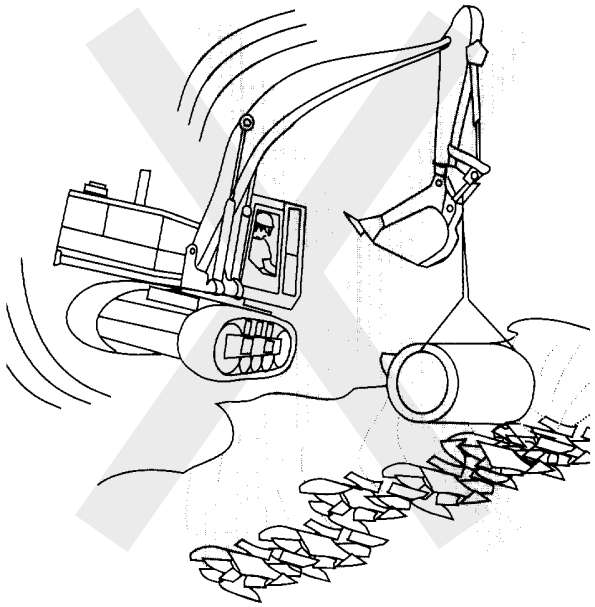
Always lower the stabilizers to the ground before lifting. if ground is soft, place pads or timbers under each stabilizer.

When lifting, be sure the load is properly balanced. Move slowly so the load does not sway or swing around. If necessary, use a tag line for additional control.

Towing

Towing over-the-road is not recommended. If your machine must be towed on the jobsite, use a rigid tow bar (not a chain or cable). The operator must be in the operator's seat to maintain control of the machine. See the manufacturer's manual for towing instructions.

26
WRONG



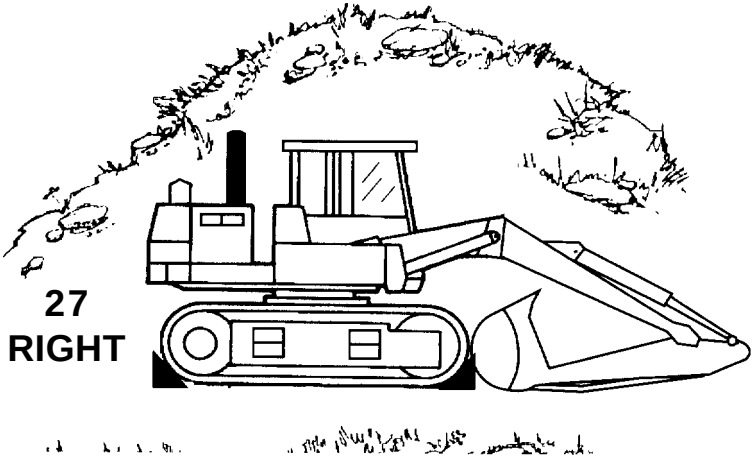
Lift Safely

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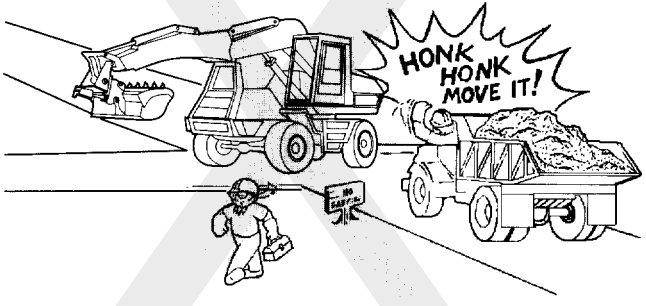
Park Safely

Select A Site

Select level ground, whenever possible. If you must park on a slope or incline, position the machine across to the slope, engage the parking brake, lower the bucket or blade to the ground and block the machine. (27)



27
RIGHT



28
WRONG

Haul roads are not suitable for parking. If you must park on one - or if your machine is disabled on one - mark the machine with flags in daytime and flares or flashing lights at night, according to local regulations. (28)

Never leave a machine unattended with the engine running.

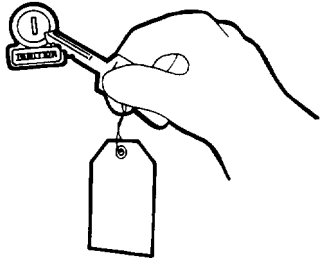
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Park safely

Machine Shutdown

Refer to your manufacturer's manual(s) for detailed shutdown procedures. In general, the procedure should include the following:

- Stop machine - using service brake.
- Swing the machine to align excavator with the undercarriage.
- Engage the swing lock.
- If machine has attachments, lower them to the ground or place in a secure position.
- Shift controls to neutral/park and lock (if so equipped).
- Engage parking brake.
- Idle engine for short cool-down period.
- Stop Engine
- Cycle all hydraulic controls to relieve system pressure,
- Remove ignition key. (29)
- Shut off master electric switch (if so equipped).



29
RIGHT



30
RIGHT

- Lock the cab.
- When you leave the machine, always maintain a three point contact with the access system and face the machine. Never jump off machine. (30)
- Be careful of slippery conditions on platform, steps, ladders and hand holds when leaving machine.
- Block wheels or tracks if on a slope or incline.

Don't give anyone the key to an accident.

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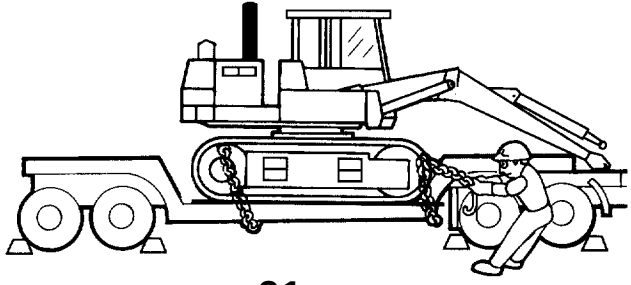
Loading and Unloading

All machines are not loaded the same way, and the procedures recommended by the manufacturer should always be followed.

Several precautions are applicable to all machines:

- Know the correct loading and unloading procedures for your machine.
- Load and unload on a level surface.
- Block transport vehicle so it cannot move.
- Use ramps of adequate size and strength; low angle, and proper height.
- Keep trailer bed and ramps clear of mud, oil, ice, snow and all materials which can become slippery.
- Engage the swing locking device (if so equipped).
- Back the machine onto the trailer.
- Cover or remove the SMV (Slow Moving Vehicle) emblem.
- Chain and block machine securely for transport. (31)
- Keep everyone clear of the area.
- Secure attachments in transport mode. Lower bucket and boom.

Know the overall height and width of the transporter and machine combined to avoid overhead and narrow obstructions.



31
RIGHT

Check your overall transport height.

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Perform maintenance safely

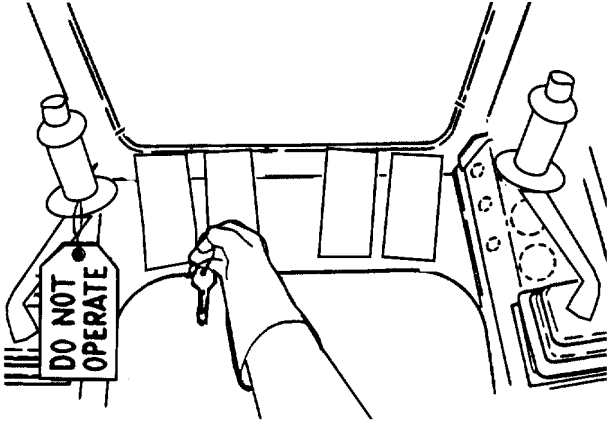
General Procedures

Do not perform any work on a machine unless you are authorized - and qualified - to do so.

If you have been authorized to do maintenance, READ THE MANUFACTURER'S SERVICE AND OPERATOR'S MANUALS. Study the instructions; check the lubrication charts; examine all the instruction messages on the machine. Maintenance can be dangerous unless performed properly. Be sure you have the necessary skill, information, correct tools and equipment to do the job correctly.

Attach a **DO NOT OPERATE** tag or similar warning tag to the starter switch or steering controls before performing maintenance on the machine. (32)

If the engine should not be started, remove the ignition key.



32
RIGHT

If you don't know what you're doing-don't do it.

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Perform maintenance safely

Prepare the Work Area

Choose a clean level work area. Make sure you have sufficient room. Check clearances. Make certain there is adequate light and ventilation.

Clean the walking and working surfaces. Remove oil, grease, and water to eliminate slippery areas. Put sand or other absorbent material on slippery areas. (33)



33
RIGHT



34
RIGHT

Prepare Yourself

Wear all the protective clothing the job requires.

Wear a rubber apron and rubber gloves when working with corrosive materials. (34) Wear gloves and safety shoes when handling wooden blocks, wire rope or sharp-edged metal.

Wear safety shoes-sandals are for the beach.

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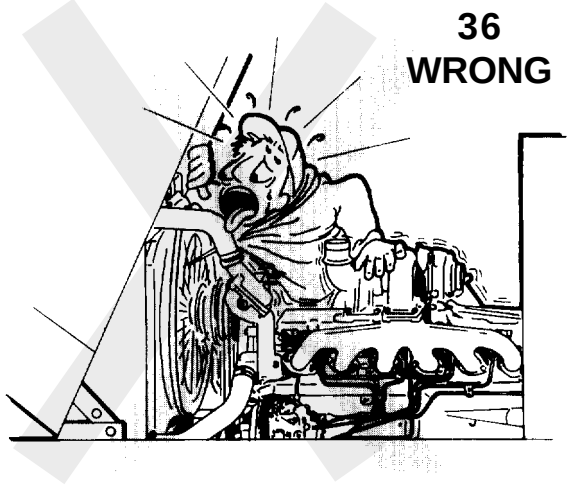
Perform maintenance safely

Prepare Yourself (continued)

Safety glasses, goggles or a face shield are always needed for eye protection from fluids under pressure, while grinding, servicing batteries, and from flying debris or loose material when engine is running or tools are used. (35)

Wear a face-shield when you disassemble spring loaded components or work with battery acid. Wear a helmet or goggles with special lenses when you weld or cut with a torch.

Do not sand, grind, flame-cut, braze or weld without a NIOSH/MSHA approved respirator or appropriate ventilation. If welding is required on this machine, refer to the manufacturer's manuals or consult your equipment dealer for proper procedures.



36
WRONG



35
RIGHT

WARNING: Keep clear of all rotating components. Wrapping or entanglement may result in serious injury or death. (36)

KEEPS HANDS - AND CLOTHING - AWAY FROM ALL MOVING PARTS. Don't tempt fate with dangling ties, loose sleeves, rings or long hair.

Wear eye protection.

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Prepare Yourself (continued)

Keep pockets free of all objects which could fall out - and into machinery.

Handle tools and heavy parts CAREFULLY - with regard for yourself and other persons. LOWER ITEMS - DON'T DROP THEM. (37)

37
RIGHT

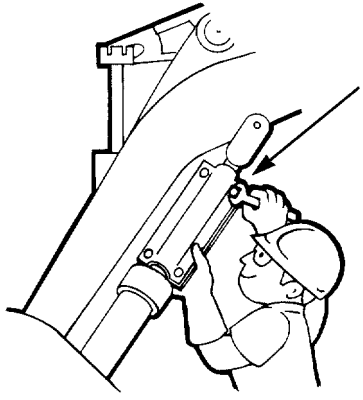


Prepare The Machine

WARNING: START THE ENGINE FROM THE OPERATOR'S SEAT ONLY. NEVER ATTEMPT TO START THE ENGINE BY SHORTING ACROSS STARTER TERMINALS OR REACHING FROM THE GROUND OR OUTSIDE THE CAB. The machine may start in gear if neutral-start circuitry is bypassed. This could cause machine to move suddenly and cause serious injury or death to anyone in its path.

Move the machine onto a level surface. Stop engine, release all hydraulic pressure. (See MACHINE SHUTDOWN, page 32.) Attach cylinder rod support struts or block all hydraulically operated attachments if they must be in a raised position. (38) Place controls in Neutral and block the wheels.

WARNING: Never work on machinery with the engine running unless so instructed for specific service, by the manufacturer's operator's or service manuals.

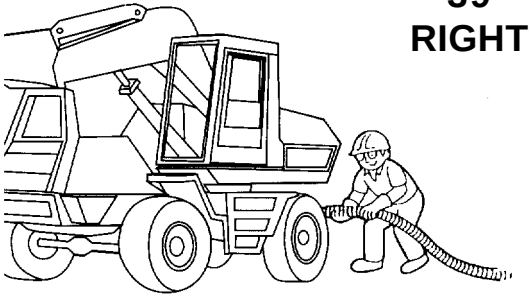


38
RIGHT

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Perform maintenance safely

WARNING: Never operate any type of engine without proper ventilation - EXHAUST FUMES CAN KILL. (39)



39
RIGHT

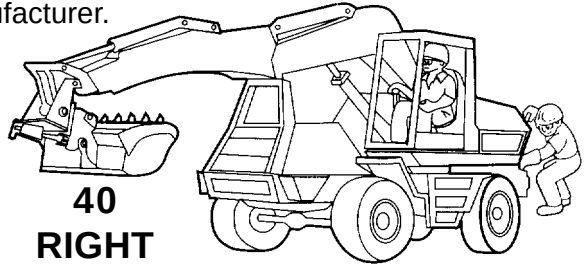
If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension. If you do not have an exhaust pipe extension, make sure you open the doors and get outside air into the area. Unless the swing function is required, you must engage the swing lock before performing any maintenance.

If adjustments must be made with the engine running, always work as a 2-person team with one person sitting in the operator's seat while the other works on the machine. (40)

Remove only guards or covers that provide access. Wipe away excess grease and oil.

Never leave guards off or access doors open when unattended. Keep bystanders away if access doors are open.

Make certain all guards, screens or panels, and safety signs are reinstalled on the machine as recommended by the manufacturer.



40
RIGHT

When servicing an air conditioning system, refer to the freon container for proper use. Use a recovery and recycling system to avoid venting the freon to the atmosphere. Contact with the freon stream can cause severe frost burns.

Exhaust fumes can kill.

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Perform maintenance safely

Use Jacks And Hoists Carefully

If you must work beneath raised equipment, always use wood (NOT CONCRETE) blocks, jack-stands or other rigid and stable supports. (41) When using jacks and hoists always be sure they are adequately supported.

WARNING: Never use concrete blocks for supports. They can collapse under even light loads.

Make sure the hoists or jacks you use are in good repair. Never use jacks with cracked, bent or twisted parts. Never use frayed, twisted or pinched cables. Never use bent or distorted hooks.



41
RIGHT

42
RIGHT



Avoid Electrical System Hazards

Disconnect the battery before working on the electrical system. Remove the ground cable first. When reconnecting the battery, reconnect the ground cable last.

Never work on the electrical system unless you are thoroughly familiar with system details and the special handling required. (42)

Brake Safety Tips

Always follow manufacturer's manuals(s) when adjusting brakes. Improperly adjusted brakes could cause an accident. Block wheels before purging air from the brake system. Air trapped in brake lines can cause erratic performance or loss of brakes. Use only brake fluid recommended by manufacturer.

Never trust a jack by itself.

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WARNING: On a crawler machine, block the tracks before releasing the service brakes. The machine can roll free if not blocked.

Avoid Asbestos Hazards

Some machines (especially older ones) may have components containing asbestos in friction and gasket materials. These precautions pertain to these machines.

CAUTION: Avoid exposure to asbestos dust.

Extreme caution must be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health. Components that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates and some gaskets. The asbestos used in new components is bound in a resin or sealed. Normal handling is usually not hazardous AS LONG AS AIRBORNE DUST WHICH CONTAINS ASBESTOS IS NOT GENERATED.

If dust which may contain asbestos is present, there are several common sense guidelines that should be followed:

1. Never use compressed air for cleaning (such as blowing out brakes prior to repair).
2. Avoid brushing or grinding of asbestos containing materials.
3. For clean up, use wet methods or a vacuum equipped with a High Efficiency Particulate Air (HEPA) filter.
4. Use exhaust ventilation on permanent machine installations.
5. Wear an approved respirator if there is no other way to control the dust.
6. Comply with applicable rules and regulations for the work place (for example in the U.S.A., OSHA requirements as set forth in 29 CFR 1926.58).
7. Follow environmental rules and regulations for disposal of asbestos.
8. Avoid areas where asbestos particles may be in the air.
9. Shower after any contact.
10. Store food, drink and personal belongings away from the work area.
11. Never eat, drink or smoke where asbestos is in the area.

NOTE: Newer machines have parts with non-asbestos or bonded asbestos which does not give off fibers and poses no danger to health or the environment.

Don’t mess with asbestos.

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Be Careful With Fluids Under Pressure

The hydraulic system may be under pressure whenever the engine is running and may hold pressure even after shutdown.

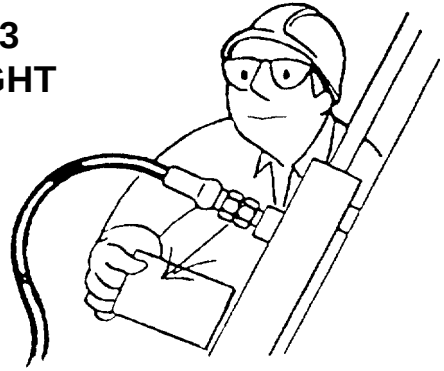
Install cylinder rod support struts or block the cylinders and equipment securely before working on the hydraulic system.

Cycle all hydraulic steering and other controls after shutdown to relieve system pressure. If pilot actuated systems are on the machine, follow the manufacturer's instructions to relieve the pressure. When venting or filling the hydraulic system, loosen the filler cap slowly and remove it gradually. If the system is equipped with an accumulator, see the manufacturer's service manual for discharge and recharge instructions.

Do not permit an open flame around the hydraulic system.

Clean up spilled fluid immediately.

WARNING: Diesel fuel or hydraulic fluid under pressure can penetrate the skin or eyes and cause serious injury, blindness or death. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks but do not use your bare hand. Wear a face shield or safety goggles for eye protection. If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. (43)



Be Careful With Hot Cooling Systems

WARNING: Liquid cooling systems build up pressure as the engine gets hot. Before removing the radiator cap, stop the engine and let the system cool. Remove the radiator cap only after the coolant is cold.

For cooling systems with an overflow tank, the coolant can usually be checked at the tank without removal of the radiator cap. See manufacturer's instructions.

Pressurized fluid can cause injuries.

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Avoid Fire And Explosion Hazards

Stop the engine and shut off electrical equipment while filling the full tank. Use extra caution when fueling a hot engine. Always ground the fuel nozzle against the filler neck to avoid sparks.

WARNING: NEVER SMOKE WHILE HANDLING FUEL OR WORKING ON THE FUEL SYSTEM. THE FUMES IN AN EMPTY FUEL CONTAINER ARE EXPLOSIVE. NEVER CUT OR WELD ON FUEL LINES, TANKS OR CONTAINERS. (44)

Handle all solvents and dry chemicals according to procedures identified on manufacturers' containers. Work in a well ventilated area. Make sure you know where fire extinguishers are kept and how to use them.

Remove all trash or debris from the machine. Make sure that oily rags or other flammable material are removed from the machine.

Check for fuel, oil or hydraulic fluid leaks. Repair the leaks and clean the machine before you operate.

Ether is flammable. Do not smoke when using ether. Always follow the instructions on the ether can and in the manufacturer's manual(s) for your machine. Do not use ether if the engine is equipped with a glow plug or other type of preheater.



Always use a nonflammable solvent when you clean parts. Do not use gasoline, diesel fuel or other flammable fluids.

Store all flammable fluids and materials away from your work area in suitable containers, as per local regulations.

Check readiness of fire extinguishers, fire suppression systems and fire detectors (if so equipped).

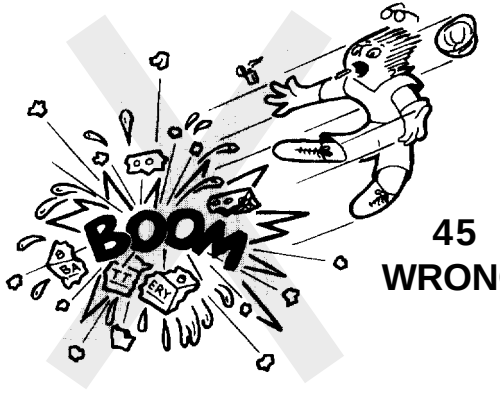
Fuel and flame are a dangerous combination.

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Avoid Battery Hazards

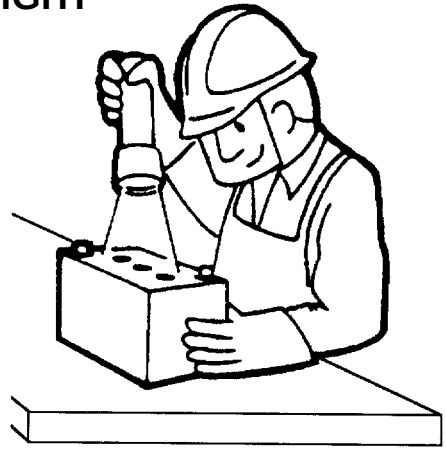
WARNING: Lead-acid batteries contain sulfuric acid which will damage eyes or skin on contact. Always wear a face shield to avoid acid in eyes. If acid contacts eyes, flush immediately with clean water and get medical attention. Wear rubber gloves and protective clothing to keep acid off skin. If acid contacts skin, wash off immediately with clean water, then seek medical attention.

WARNING: Lead-acid batteries produce flammable and explosive gases. Keep arcs, sparks, flames and lighted tobacco away. (45)



45
WRONG

46
RIGHT



Use a flashlight to check battery electrolyte level. Always check with engine stopped. (46) For a sealed battery, a bulged end indicates that the battery is frozen.

Do not charge a battery or jump-start the engine if the battery is frozen. Warm to 60F (15C) or the battery may explode.

Use care when servicing batteries.

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Tire Maintenance

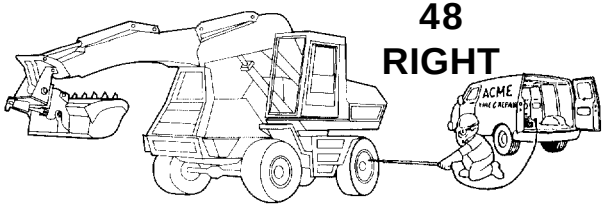
WARNING: Explosive separation of a tire and/or rim parts can cause serious injury or death. Always follow the manufacturer's recommendations or see your tire supplier. (47)

Special tools and procedures are required to change off-highway tires. To do it safely, it must be done correctly. Follow the step by step instructions given in a tire repair manual. Changing tires is a job better done by your tire service company.

Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Be sure to replace tire ballast if machine is so equipped. See manufacturer's specifications for ballast requirements.



47
WRONG



48
RIGHT

Inspect tires and wheels daily. Do not operate with low pressure, cuts, bubbles, damaged rims or missing lug bolts or nuts.

Never cut or weld on the rim or rim parts. This could cause explosive decompression.

If the tires are filled with nitrogen DO NOT add air. Fill only with dry nitrogen, using proper inflating equipment.

Keep wheel lug nuts tightened to manufacturer's recommendations.

A rise in tire pressure is normal during operation. It should NOT be reduced. High speeds during transport may produce excessive tire pressure due to heat. REDUCE YOUR SPEED or stop and let tires cool.

When adjusting tire pressure, do so from a distance. Use a long hose with self-attaching chuck. Always stand behind tread when adjusting tire pressure. (48) Be sure the area to the side of the tire is clear of other people.

You're riding on them- you keep them safe.

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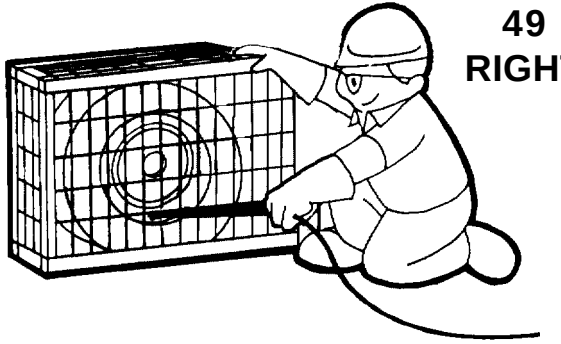
Tire Maintenance (continued)

Do not inflate tires with flammable gases or from a system utilizing an alcohol injector.

Tire Repair

Tires are to be repaired only by an authorized person using the proper procedures and safety equipment.

WARNING: Always use a safety cage or cable restraints when reinflating a repaired tire. (49) Inflate the tire from a distance, using a long hose with self-attaching chuck. Always stand behind the tread, with the area to the side of the tire clear of other people.



49
RIGHT

Overinflation is dangerous.

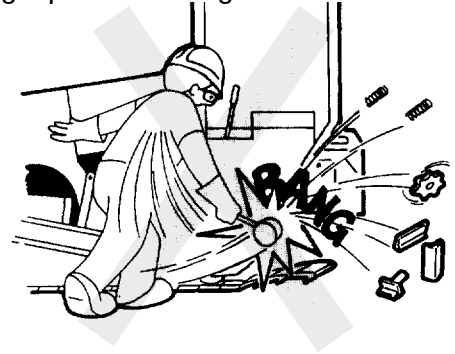
Track Maintenance

Maintain proper track tension. When operating in mud, snow, etc., material will stick to the track parts and cause the tracks to become too tight. Refer to your manufacturer's service manual for correct tension adjustments.

WARNING: The pins and bushing in a dry joint can become very hot. Wear gloves to prevent burns.

Check tracks for loose or broken track shoes and shoe bolts, worn or damaged pins and bushings. Check the carrier and idler rollers.

50
WRONG



WARNING: Never strike or pound on track tension springs; they may be under tremendous compression and could shatter explosively. (50)

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Air Reservoir Tank

Drain tanks (if so equipped) daily. In cold weather, it is especially important that the air tank(s) be thoroughly drained at least once per shift. Be sure drain is closed before starting engine.

Complete Service And Repairs Before Machine Is Operated

Inspect all parts during repair and replace if cracked or damaged. Excessively worn or damaged parts can fail and cause injury or death. Replace any damaged or illegible decals.

Tighten all bolts, fittings, and connections to torques specified by the manufacturer.

Install all guards, covers, and shields after servicing. Replace or repair any damaged ones. Refill and recharge pressure systems only with manufacturer approved or recommended fluids.

Start the engine and check for leaks. (See hydraulic fluid warning, page 12 and 41). Operate all controls to make sure machine is functioning properly. Road test machine if necessary. After testing, shut down, check the work you performed (any missing cotter pins, washers, locknuts, etc.?). Recheck all fluid levels before releasing machine for operation.

Check and check again.

Test your knowledge

Now that you have read this safety manual, do you understand.



- Your safety program?
- Your machine manufacturer's manual(s)?
- Proper clothing and personal safety equipment?
- Your machine's controls, warning signs, devices, and safety equipment?
- How to properly inspect, mount, and start your machine?
- How to check your machine for proper operation?
- Your work area and any special hazards that may exist?
- Proper operating procedures?
- Operating safety precautions?
- Proper loading and unloading procedures for transporting?
- Under what conditions you should not operate your machine?
- Proper parking, shutdown, and dismounting procedures?
- Proper maintenance procedures?

A final word to the user

You have just finished reading the EMI Hydraulic Excavator Safety Manual. It is impossible for this manual to cover every hazardous situation you may encounter. But, your knowledge of these safety precautions and your adherence to the basic rules of safety will help build good judgment in all situations. Our objective is to help you develop good safety habits and make you a better Hydraulic Excavator operator.

Remember, safety is your business AND your responsibility. Have a good day; have a safe day.