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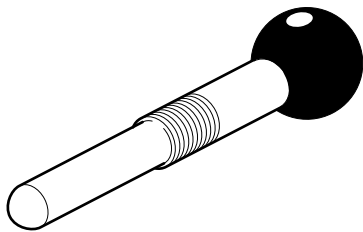
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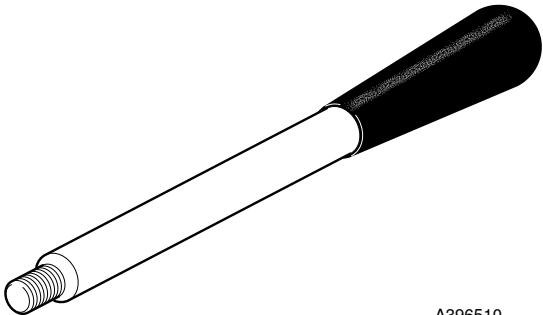
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892/01077 Synchro Shuttle Gearbox - Selector
Shaft Lock Screw



A395350

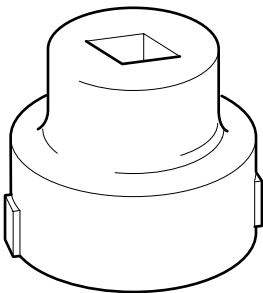
892/01078 Synchro Shuttle Gearbox - Mainshaft
Adjuster



A396510

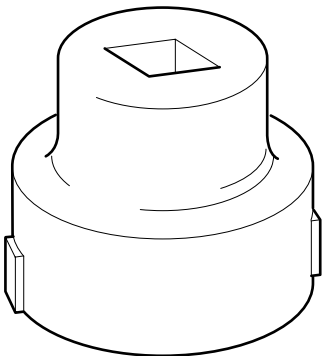
Synchro Shuttle Gearbox - Setting ring socket spanners

892/01079
(Mainshaft setting ring)



A396590

892/01080
(Layshaft setting ring)

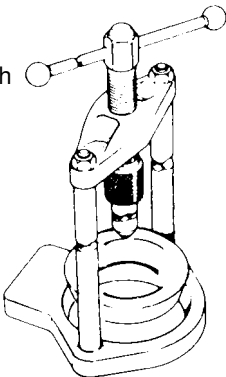


A396600

Service Tools (cont'd)

892/00179

Bearing Press (use with appropriate adapters)



S188200

992/07608

Bearing Adapter

992/07609

Bearing Adapter

992/07610

Bearing Adapter

992/07611

Bearing Adapter

992/07612

Bearing Adapter

992/07613

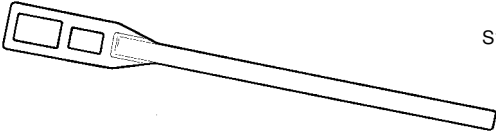
Bearing Adapter



S188160

892/00812

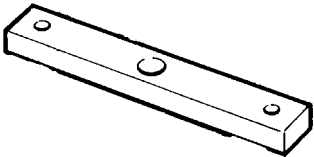
Drive Coupling Spanner



S107750

892/00922

12.2" Torque Converter Alignment Tool



S267260

A

892/00920

Flow Test Adapter

B

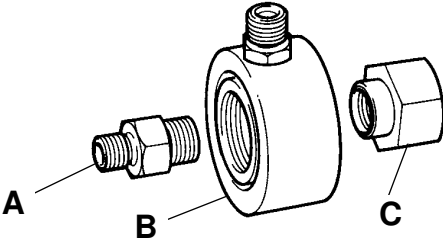
892/00301

Flow Test Adapter

C

892/00302

Flow Test Adapter



S188210

Powershift Gearbox Flow Test Adaptor

1

460/15708

Flow Test Adapter

2

460/15707

Banjo Bolt

3

2401/0222

O-ring

4

2403/0110

O-ring

5

2403/0108

O-ring

6

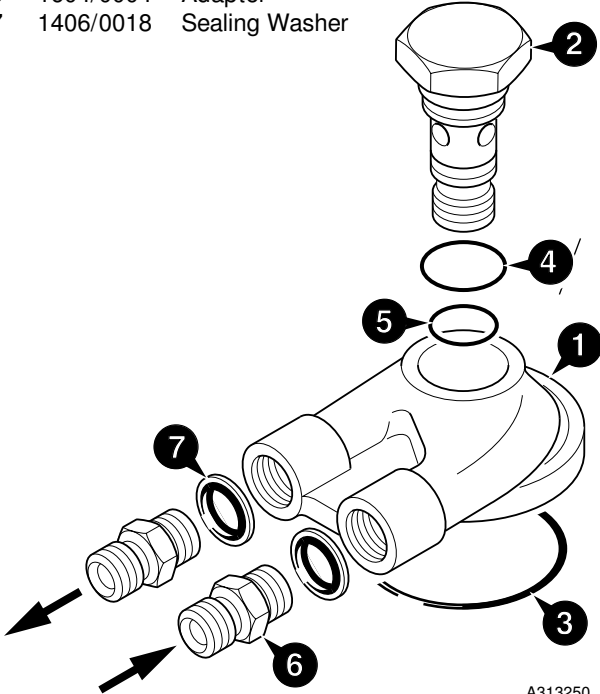
1604/0004

Adapter

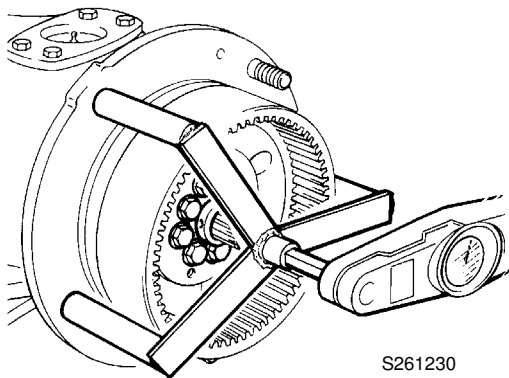
7

1406/0018

Sealing Washer



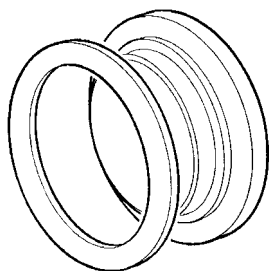
A313250



Torque Measuring Tool for Wheel Hub Seals

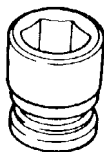
Manufacture locally, procedures in this manual show checking the wheel hub seal using a rolling force. However, the torque can be measured using above locally manufactured tool.

Bearing rolling torque is 12 to 22 Nm (9 to 16 lbf ft) excluding seal drag. Maximum permissible including seal drag is 40 Nm (29.5 lbf ft).



892/00891
Fitting Tool Assembly for
Wheel Hub Seals

S227760

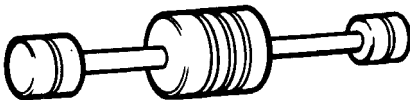


S216290

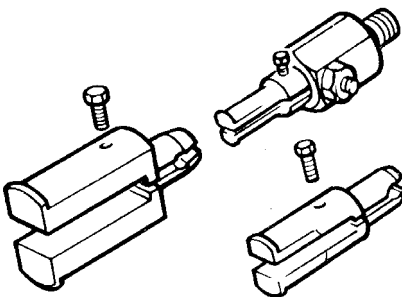
- 892/00817 17 mm A/F x 3/4in. square drive
- 892/00818 22 mm A/F x 3/4in. square drive
- 892/00819 15 mm A/F x 1/2in. square drive
- 892/00333 19 mm A/F x 3/4in. square drive

892/00224

Impulse Extractor Set for Hub Bearing Seals

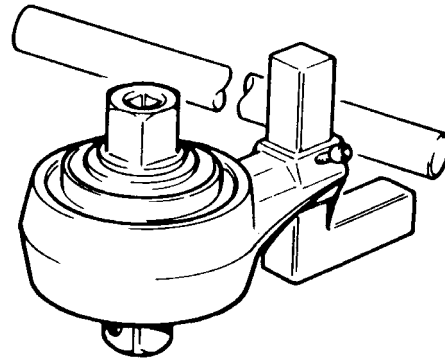


S197070



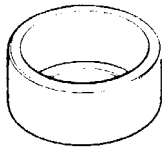
- 892/00225 Adapter - Impulse Extractor
 - Small 17mm to 25mm
 - Medium 25mm to 45mm
 - Large 45mm to 80mm
- 993/59500 Adapter - Impulse Extractor (syncro shuttle and powershift transmission)

992/04000 Torque Multiplier (use in conjunction with a torque wrench to give a 5:1 multiplication when tightening pinion nuts)



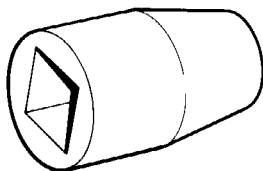
S197030

892/00174 Measuring Cup - Pinion Head Bearing



S190770

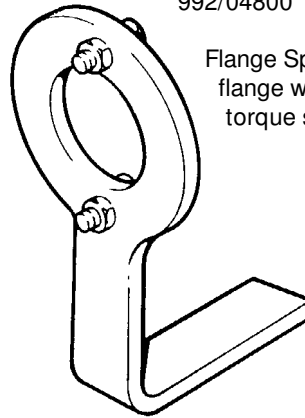
892/00822 Splined Bolt Socket for driveshafts



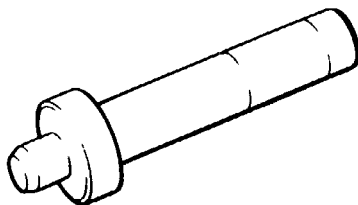
S197060

992/04800

Flange Spanner - for locking brake disc flange while pinion nut is slackened or torque set

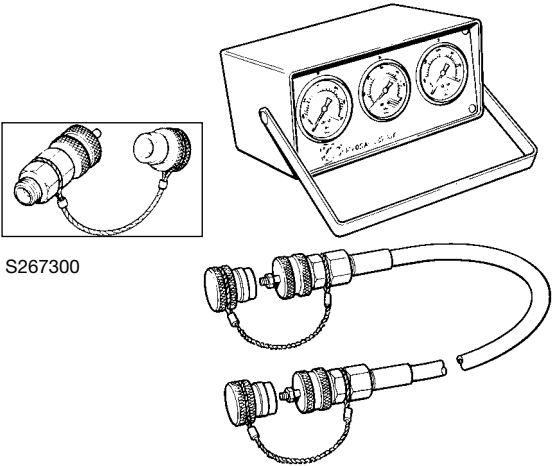


S197040



S216310

892/00182 Bearing Pad Driver



S267300

Hydraulic Circuit Pressure Test Kit (also used for main hydraulic system tests)

892/00253

Pressure Test Kit

:892/00201

Replacement Gauge 0-20 bar (0-300 lbf/in²)

:892/00202

Replacement Gauge 0-40 bar (0-600 lbf/in²)

:892/00203

Replacement Gauge 0-400 bar (0-6000 lbf/in²)

:892/00254

Replacement Hose

993/69800

Seal Kit for 892/00254 (can also be used with probe 892/00706)

892/00706

Test Probe

S188121

Flow Test Equipment (also used for main hydraulic system tests)

892/00268

Flow Monitoring Unit

892/00269

Sensor Head 0 - 100 l/min (0 - 22 UK gal/min)

892/00293

Connector Pipe

892/00270

Load Valve

1406/0021

Bonded Washer

1604/0006

Adapter 3/4 in M x 3/4 in M BSP

1612/0006

Adapter 3/4 in F x 3/4 in M BSP

892/00271

Adapter 3/4 in F x 5/8 in M BSP

892/00272

Adapter 5/8 in F x 3/4 in M BSP

816/20008

Adapter 3/4 in F x 1/2 in M BSP

892/00275

Adapter 1/2 in F x 3/4 in M BSP

892/00276

Adapter 3/4 in F x 3/8 in M BSP

892/00277

Adapter 3/8 in F x 3/4 in M BSP

892/00273

Sensor Head 0 - 380 l/min

892/00294

Connector Pipe

1606/0015

Adapter 1.1/4 in M BSP x 1 in M BSP

892/00078

Connector 1 in F x 1 in F BSP

1604/0008

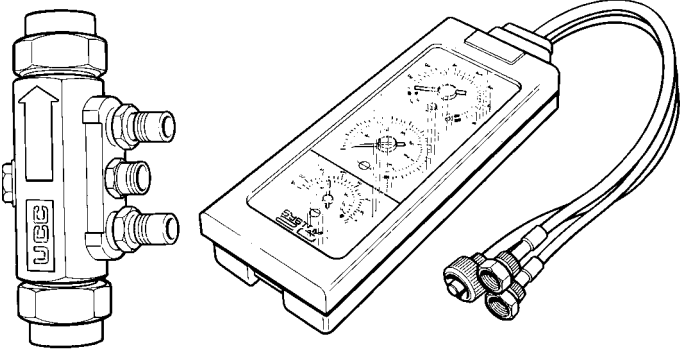
Adapter 1 in M x 1 in M BSP

1606/0012

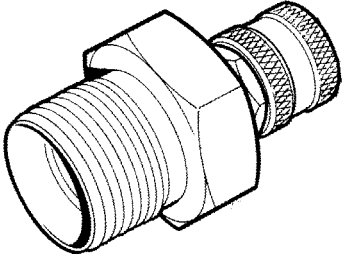
Adapter 1 in M x 3/4 in M BSP

816/20013

Adapter 3/4 in F x 1 in M BSP



S188151



S316250

Test Point

1

892/00964

Test point (1/8 BSP) Powershift

2

892/00965

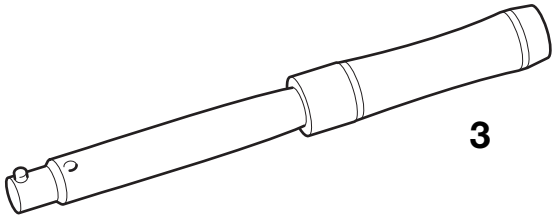
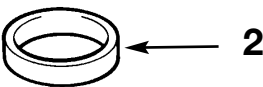
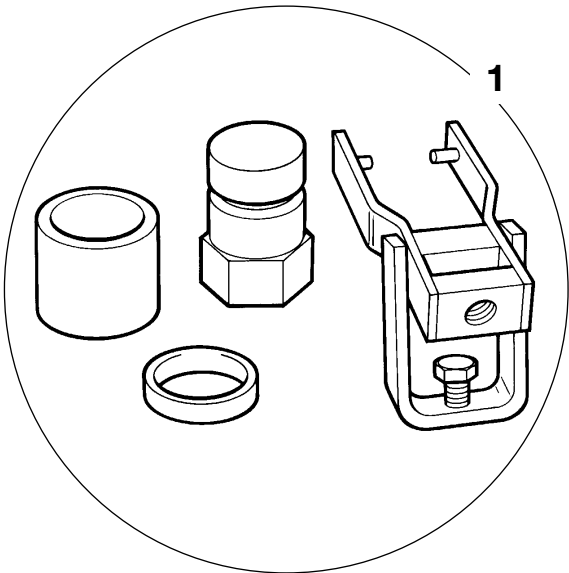
Test point (3/8 BSP) Powershift

3

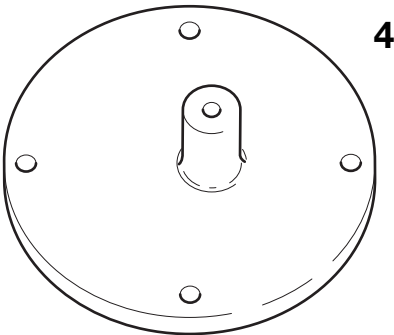
892/00966

Test point (1/4 BSP) Synchro Shuttle

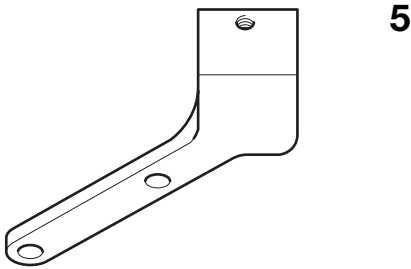
These test points can be left in position after testing.



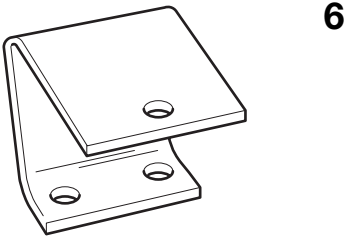
A396950



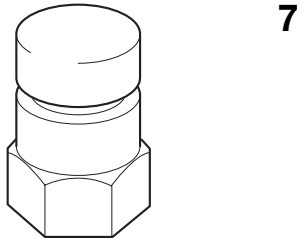
A396580



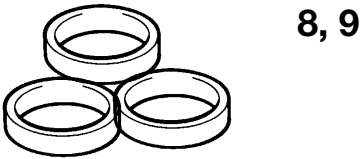
A396960



A396930



A396940



Service Tools (cont'd)**Solid Spacer Setting Kit
Synchro Shuttle Gearbox, SD70, SD80
Axles**

1	892/00918	Setting Tool Kit
2	921/52627	Spacer 14.20 Service use
3	993/70111	Breakback Torque Wrench
4	892/01076	Support Bracket - Synchro Shuttle Gearbox
5	892/01075	Support Bracket PD70, SD80 Rear Axles
6	997/11000	Support Bracket SD55, SD70 Front Axles
7	998/10567	SD80 Pinion Shaft Adaptor
8	921/53300	Spacer Kit - SD55 Axles

Comprises of:

	Spacer thickness mm
921/53322	13.550
921/53323	13.575
921/53324	13.600
921/53325	13.625
921/53301	13.650
921/53302	13.675
921/53303	13.700
921/53304	13.725
921/53305	13.750
921/53306	13.775
921/53307	13.800
921/53308	13.825
921/53309	13.850
921/53310	13.875
921/53311	13.900
921/53312	13.925
921/53313	13.950
921/53314	13.975
921/53315	14.000
921/53316	14.025
921/53317	14.050
921/53318	14.075
921/53319	14.100
921/53320	14.125
921/53321	14.150

9 921/53400Spacer Kit - Sychro Shuttle Gearbox,
SD70, SD80 Axles

Comprises of:

	Spacer thickness mm
921/52628	12.600
829/30405	12.625
921/52629	12.650
829/30406	12.675
921/52630	12.700
829/30407	12.725
921/52601	12.750
829/30408	12.775
921/52602	12.800
829/30409	12.825
921/52603	12.850
829/30410	12.875
921/52604	12.900
829/30411	12.925
921/52605	12.950
829/30412	12.975
921/52606	13.000
829/30413	13.025
921/52607	13.050
829/30414	13.075
921/52608	13.100
829/30415	13.125
921/52609	13.150
829/30416	13.175
921/52610	13.200
829/30417	13.225
921/52611	13.250
921/53424	13.275
921/53425	13.300
921/53426	13.325
921/53427	13.350
921/53428	13.375
921/53401	13.400
921/53402	13.425
921/53403	13.450
921/53404	13.475
921/53405	13.500
921/53406	13.525
921/53407	13.550
921/53408	13.575
921/53409	13.600
921/53410	13.625
921/53411	13.650
921/53412	13.675
921/53413	13.700
921/53414	13.725
921/53415	13.750
921/53416	13.775
921/53417	13.800
921/53418	13.825
921/53419	13.850
921/53420	13.875
921/53421	13.900
921/53422	13.925
921/53423	13.950
921/52626	14.000

Note: After using a spacer, obtain a replacement to keep
the set complete

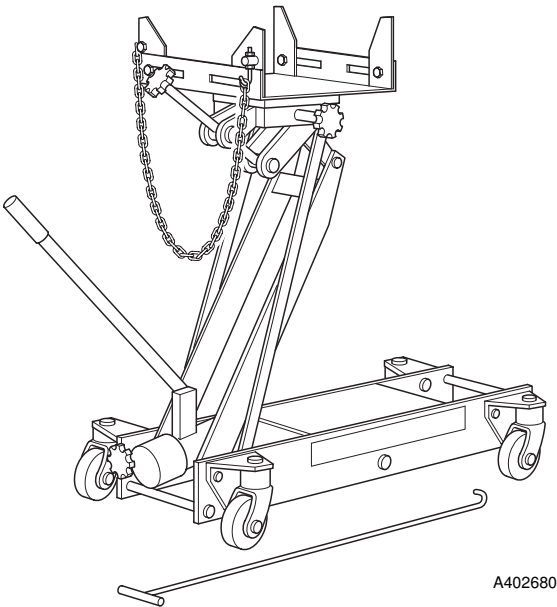
Service Tools (cont'd)

892/01083	Powershift - Assembly tool, transfer gear
892/01084	Powershift - Transfer gear, bearing assembly
892/01085	Powershift - Seal fitting tool

*

892/01094 Transmission Jack

When removing the Powershift gearbox use of a special transmission jack is strongly recommended. This jack can also be used when removing Synchro Shuttle gearboxes.
Note that the jack must be used with special support plates, see the facing page for details.



*

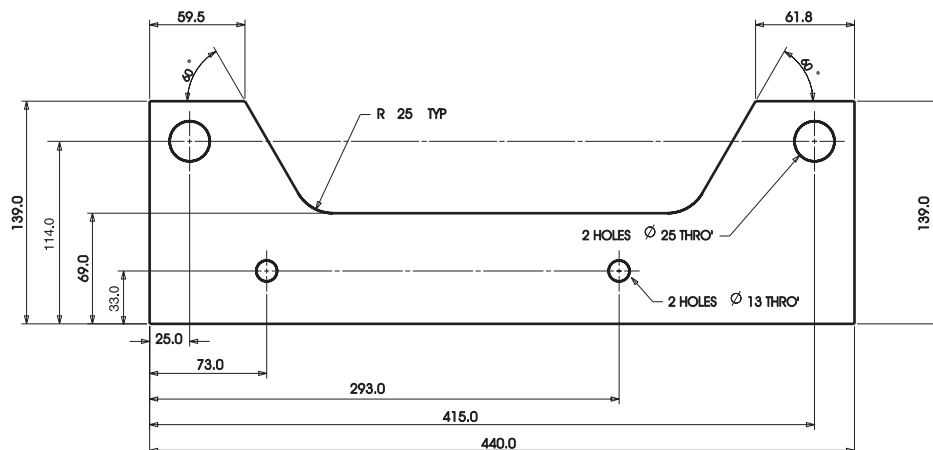
823/10420	Thrust Washer Kit - Powershift gearbox - Layshaft clutch
Comprises of:	
	Washer thickness mm
823/10421	4.3
823/10422	4.4
823/10423	4.5
823/10424	4.6
823/10425	4.7
823/10426	4.8

*

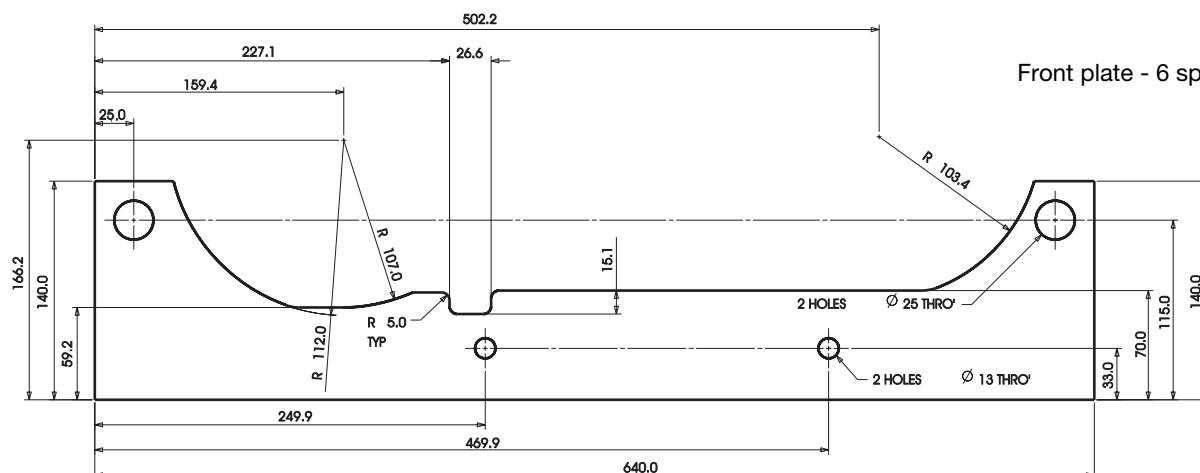
892/01096	Speed Sensor Test Harness - Powershift Gearbox
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Service Tools (cont'd)

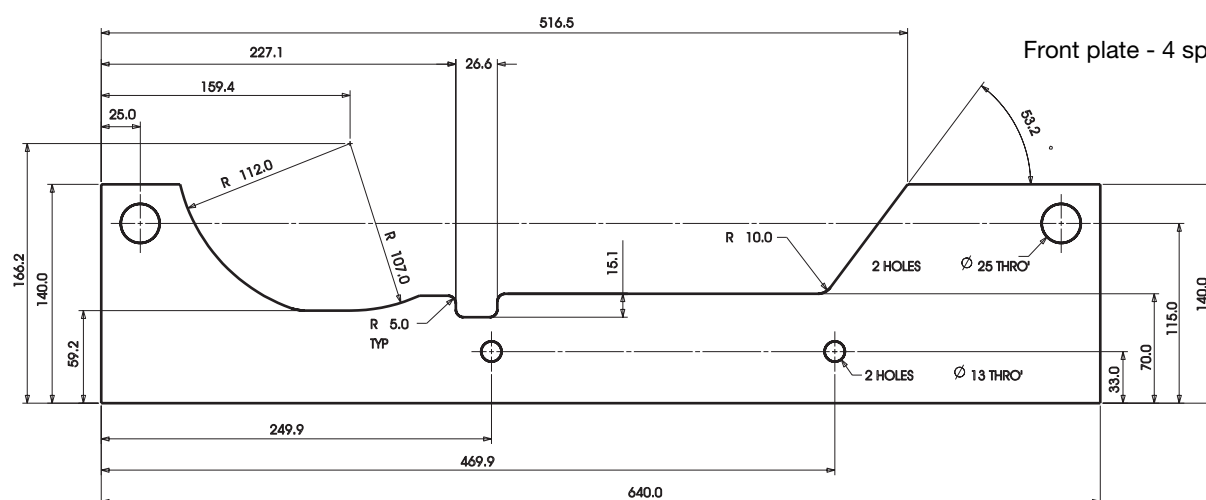
* Powershift gearbox - support plates for use with hydraulic jack. Plates should be locally manufactured from 5 mm thick mild steel plate.



Rear plate - 4 speed
and 6 speed.



Front plate - 6 speed.

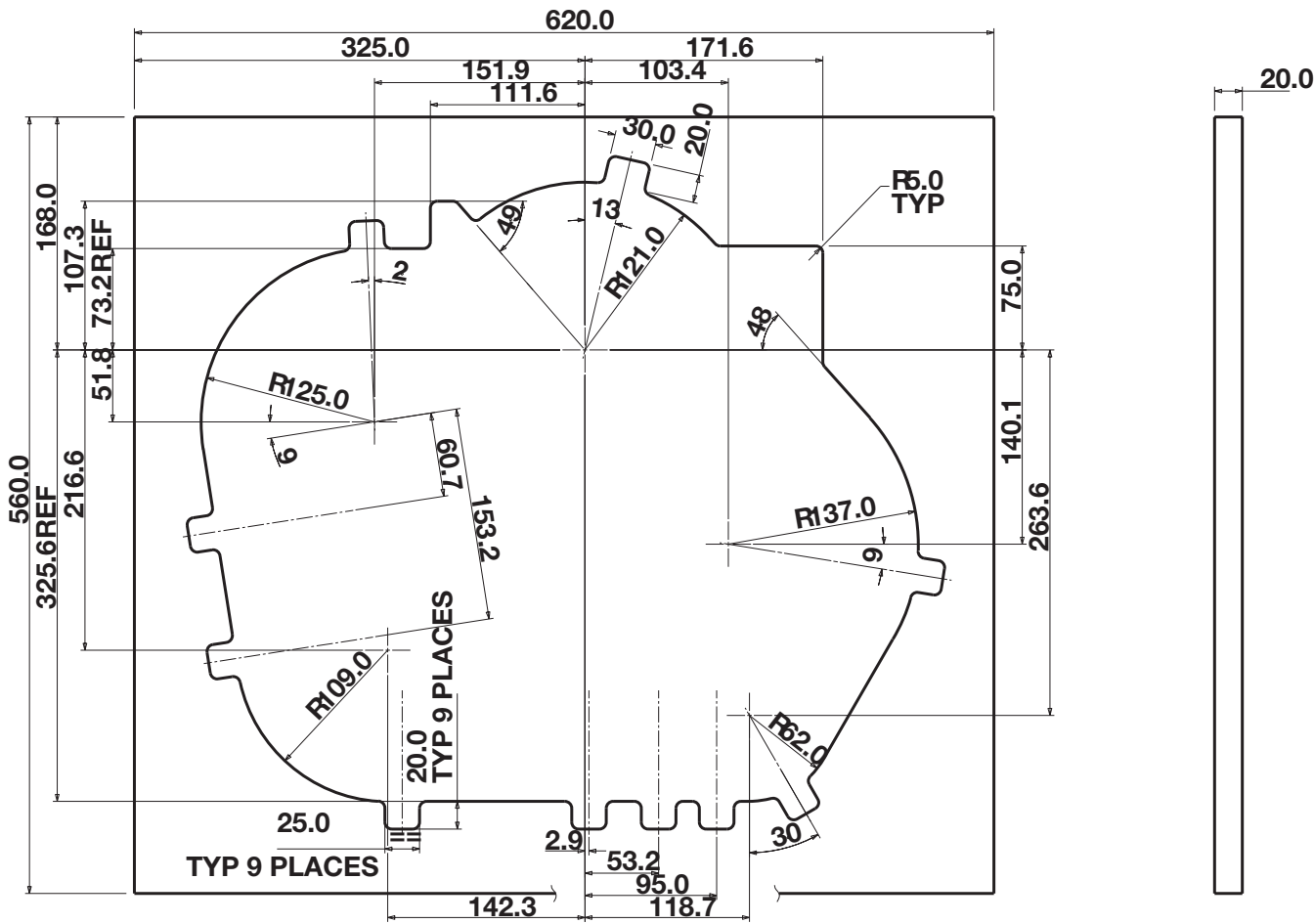


Front plate - 4 speed.

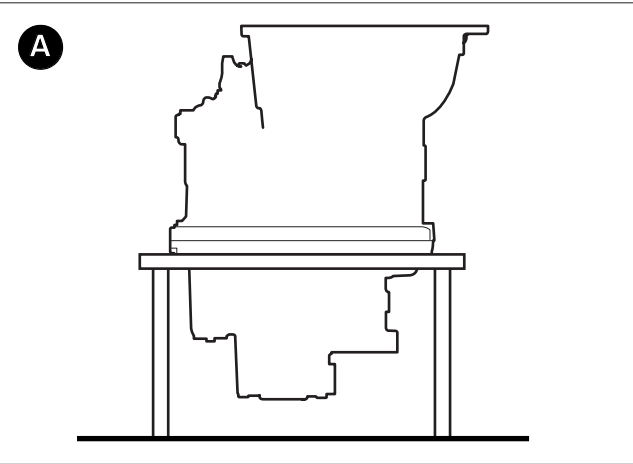
Service Tools (cont'd)

892/01082 Powershift - Assembly Cradle

Note: Support legs will also be required. These must be locally manufactured so that the gearbox can be supported as shown at **A**.



A402690

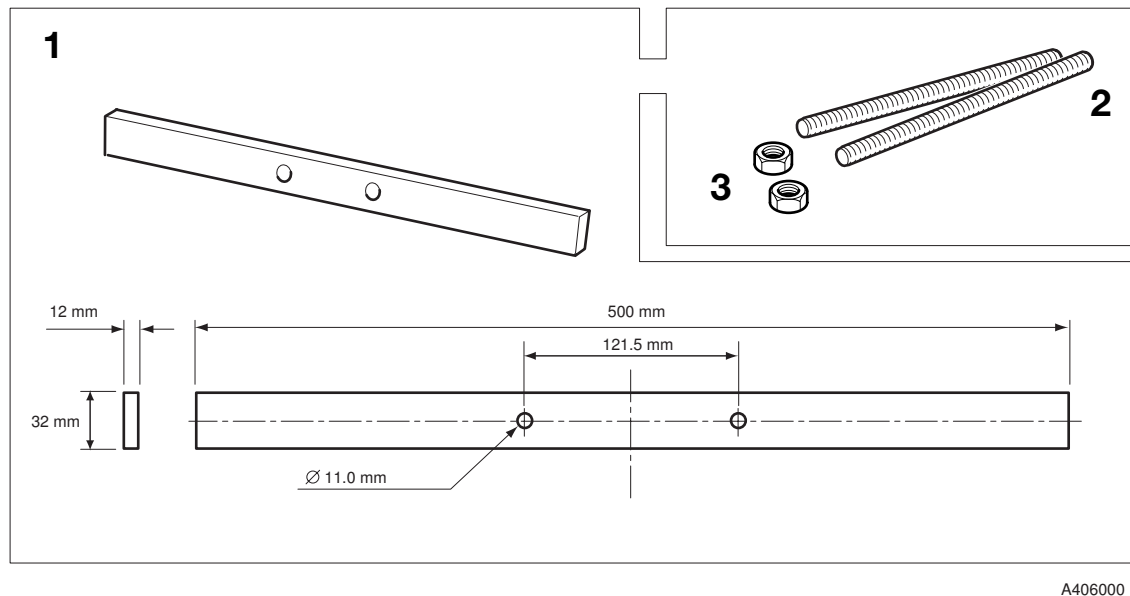


Service Tools (cont'd)**Powershift Gearbox - hydraulic pump removal tools**

The tools detailed below enable the pump to be removed with the torque converter housing in place.

- 1 Reaction bar. Locally manufacture from mild steel bar. Drill the 2 holes through the bar as shown.
- 2 2 off lengths of M10 x 1.5 threaded rod 250 mm (10 in) long.
- 3 2 off M10 x 1.5 nuts.

A set of M10 x 1.5 taps will also be required.

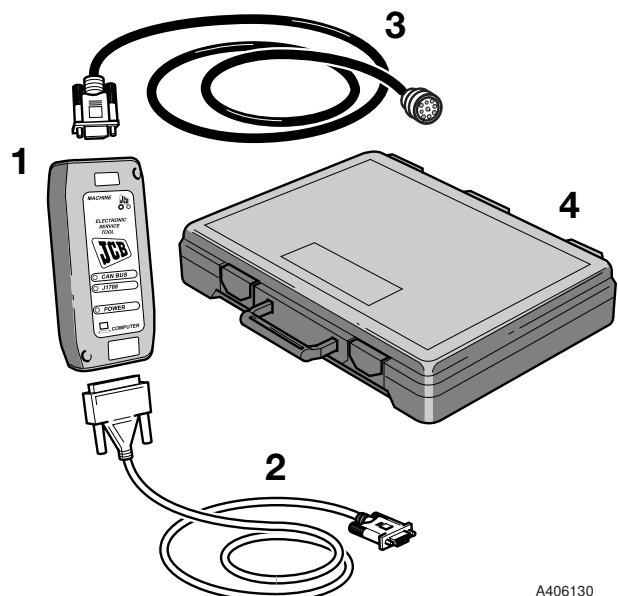


A406000

Powershift Gearbox - 6 Speed (ShiftMaster) Electronic Service Tool Kit

892/01033 Kit comprises:

- 1 Data Link Adaptor (DLA), enables data exchange between the machine ECU (Electronic Control Unit) and a laptop PC loaded with the applicable ShiftMaster diagnostics software.
- 2 Interconnecting cable, DLA to laptop PC. Several cables are included to enable compatibility with different PC port types.
- 3 Interconnecting cable, DLA to machine ECU diagnostics socket.
- 4 Kit carrying case.



A406130

Tyre Pressures

Note: If the tyres fitted to your machine are not listed, then contact JCB for advice, DO NOT guess tyre pressures.

Front Wheels

AWS/4WD MACHINES

Item	Size x Ply	Type	Make	Remarks	Pressure	
					bar	lbf/in ²
1	16.9x24x12	IND	ARMSTRONG	TUBELESS	2.6	38
2	16.9x24x12	IND	GOODYEAR	TUBELESS	2.6	38
3	15.5x25	XTLA	MICHELIN	TUBELESS	2.5	36
4	16.9x28x12	IND	ARMSTRONG	TUBELESS	2.6	38
5	16.9x28x12	IND	GOODYEAR	TUBELESS	2.6	38
6	16.9x28x10	IND	GOODYEAR	TUBELESS	2.2	32
7	16.9x28	XM27	MICHELIN	TUBELESS	2.7	39
8	16.9x28x14	IND	NOKIA	TUBE	2.6	38
9	16.9x24x12	IND	GOODYEAR	TUBELESS	2.6	38
10	16.9x28x12	TRAC	OLYMPIC	TUBELESS	2.6	38
11	16.9x28x12	IND	OLYMPIC	TUBE	2.6	38
12	14.9x24x12	IND	GOODYEAR	TUBELESS	2.75	40
13	16.9x28	IND	GOODYEAR	TUBELESS	2.5	36

2WS/2WD MACHINES

21	11.0x16x12	RIB	ARMSTRONG	TUBELESS	4.4	64
22	11.0x16x12	RIB	GOODYEAR	TUBELESS	4.2	61
23	11Lx16x12	IND	ARMSTRONG	TUBELESS	4.4	64
24	10.5x18x10	IND	FIRESTONE	TUBELESS	3.8	55
25	12.0x18x12	IND	FIRESTONE	TUBELESS	3.5	51

2WS/4WD MACHINES

31	14x17.5x10	IND	ARMSTRONG	TUBELESS	3.8	55
32	14x17.5x10	IND	GOODYEAR	TUBELESS	3.8	55
34	12.0x18x12	IND	FIRESTONE	TUBELESS	3.5	51
35	12.0x18x12	IND	OLYMPIC	TUBELESS	4.25	62
36	335 x18	XM27	MICHELIN	TUBELESS	3.5	51
37	12.5x18x10	IND	GOODYEAR	TUBELESS	4.25	62
38	335 x20	XM27	MICHELIN	TUBE	3.0	43.5
39	340 x18	IND	GOODYEAR	TUBELESS	3.2	46

Items 4, 5, 6, 7, 8, 9, 10, 11, 13, 38 must have steering lock restriction stops fitted.

Tyre Pressures

Note: If the tyres fitted to your machine are not listed, then contact JCB for advice, DO NOT guess tyre pressures.

Rear Wheels

AWS MACHINES

Item	Size x Ply	Type	Make	Remarks	Pressure	
					bar	lbf/in ²
1	16.9x24x12	IND	ARMSTRONG	TUBELESS	2.6	38
2	16.9x24x12	IND	GOODYEAR	TUBELESS	2.6	38
3	15.5x25	XTLA	MICHELIN	TUBELESS	2.5	36
4	16.9x28x12	IND	ARMSTRONG	TUBELESS	2.6	38
5	16.9x28x12	IND	GOODYEAR	TUBELESS	2.6	38
6	16.9x28x10	IND	GOODYEAR	TUBELESS	2.2	32
7	16.9x28	XM27	MICHELIN	TUBELESS	2.7	39
8	16.9x28x14	IND	NOKIA	TUBE	2.6	38
9	16.9x24x12	IND	GOODYEAR	TUBELESS	2.6	38
10	16.9x28x12	TRAC	OLYMPIC	TUBELESS	2.6	38
11	16.9x28x12	IND	OLYMPIC	TUBE	2.6	38
12	14.9x24x12	IND	GOODYEAR	TUBELESS	2.75	40
13	16.9x28	IND	GOODYEAR	TUBELESS	2.5	36

2WS MACHINES

21	16.9x24x10	IND	ARMSTRONG	TUBELESS	2.2	32
22	16.9x24x12	IND	GOODYEAR	TUBELESS	2.2	32
23	19.5x24x10	IND	ARMSTRONG	TUBELESS	1.9	28
24	19.5x24x12	IND	ARMSTRONG	TUBELESS	2.3	33
25	21L x24x12	IND	GOODYEAR	TUBELESS	2.2	32
26	18.4x26x12	TRAC	GOODYEAR	TUBELESS	2.5	36
27	18.4x26x12	TRAC	OLYMPIC	TUBELESS	2.4	35
28	18.4x26x12	IND	GOODYEAR	TUBELESS	2.0	29
29	16.9x28x12	TRAC	OLYMPIC	TUBELESS	2.2	32
30	16.9x28x12	TRAC	FIRESTONE	TUBE	2.2	32
31	16.9x28x12	IND	GOODYEAR	TUBELESS	2.2	32
32	16.9x28	XM27	MICHELIN	TUBELESS	2.5	36
33	18.4x30x14	IND	GOODYEAR	TUBE	2.0	29
34	16.9x28	IND	GOODYEAR	TUBELESS	2.5	36

Note: 12 ply tyres must be fitted on rear wheels when any backhoe attachment is used. For the correct pressure see the table above.

Items 4, 5, 6, 7, 8, 9, 10, 11, 13 must have steering lock restriction stops fitted.

Front Axle

Note: It is essential that the correct ratio axle in relationship to the gearbox ratio is fitted to the machine. Do not fit a new axle with a different ratio to the axle being replaced.

ALL WHEEL STEER MACHINES

Type	JCB spiral bevel input with epicyclic hub reduction
Designation	SD70
Installation	Centre pivot
Weight	
(dry, with no steer rams and without wheels)	385 kg (850 lbs) approximately
Overall Gear Ratio	24.975:1
Crownwheel and Pinion Ratio	4.625:1
Number of Teeth	
Crownwheel	37
Pinion	8
Hub Reduction	5.4:1
Input Type	Yoke
Oscillation	± 5°
Toe - in	0°
Castor Angle	0°
Camber Angle	1°
King - pin inclination	0°

2 WHEEL STEER MACHINES (4 Wheel Drive)

Type	JCB spiral bevel input with epicyclic hub reduction	
Designation	SD55	
Installation	Centre pivot	
Weight		
(dry, with no steer rams and without wheels)	330 kg (728 lbs) approximately	
Hub Reduction	5.4:1	
Input Type	Yoke	
Oscillation	± 5 °	
Toe - in	0 °	
Castor Angle	0 °	
Camber Angle	1 °	
King - pin inclination	0 °	
Ratios	OPTION 1	OPTION 2
Overall	16.2:1	19.2:1
Crownwheel and Pinion	3:1	3.556:1
Number of Teeth		
Crownwheel	33	32
Pinion	11	9

2 WHEEL STEER MACHINES (2 Wheel Drive)

Type	JCB centre oscillation, non-driven
Installation	Centre pivot
Weight	
(dry, with steer ram and without wheels)	239 kg (525 lbs) approximately
Oscillation	± 5°
Toe - in	0°
Castor Angle	0°
Camber Angle	3° positive

Rear Axle

Note: It is essential that the correct ratio axle in relationship to the gearbox ratio is fitted to the machine. Do not fit a new axle with a different ratio to the axle being replaced.

ALL WHEEL STEER MACHINES

Type	3 piece, JCB spiral bevel input with epicyclic hub reduction and inboard braking. Pinion mounted park brake disc.		
Designation	SD80		
Installation	Rigid pad mount		
Number of steer rams	1 (Double rod)		
Weight (dry, with no steer rams and without wheels)	410 kg (904 lbs) approx.		
Half (Axle) Shaft Braking/Type	5 friction plate, 6 counter plate (each half shaft)		
Input Type	Yoke		
Oscillation	± 5°		
Toe - in	0 °		
Castor Angle	0 °		
Camber Angle	1 °		
King - pin inclination	0 °		
Hub Reduction	5.4:1		
Ratios	OPTION 1	OPTION 2	OPTION 3
Overall	15.78:1	18.16:1	13.7:1
Crownwheel and Pinion	2.923:1	3.363:1	2.538:1
Number of Teeth			
Crownwheel	38	37	33
Pinion	13	11	13

2 WHEEL STEER MACHINES

Type	3 piece, JCB spiral bevel input with epicyclic hub reduction and inboard braking. Pinion mounted park brake disc.		
Designation	PD70		
Installation	Rigid pad mount		
Weight (dry and without wheels)	386 kg (851 lbs) approx.		
Half (Axle) Shaft Braking/Type	5 friction plate, 6 counter plate (each half shaft)		
Input Type	Yoke		
Hub Reduction	5.4:1		
Ratios	OPTION 1	OPTION 2	OPTION 3
Overall	15.78:1	18.16:1	13.7:1
Crownwheel and Pinion	2.923:1	3.363:1	2.538:1
Number of Teeth			
Crownwheel	38	37	33
Pinion	13	11	13

Synchro Shuttle Gearbox

Description	Combined torque converter, reverser, and gearbox unit. Synchromesh manual gear selection. Electro hydraulic selection of forward and reverse.		
Designation	SS700 (4 wheel drive)		
Weight (dry)			
2WD	* 170 kg (375 lb)		
4WD	* 200 kg (441 lb)		
Gear Ratios	Std Ratio	Low Ratio	
1st	5.56:1	6.56:1	
2nd	3.45:1	4.06:1	
3rd	1.83:1	1.90:1	
4th	1.00:1	1.00:1	
Torque Converter			
Torque Converter Dia.	310 mm (12.2 in.)		
Torque Converter Identification	04/600580	04/600581	
Torque Multiplication at Stall	2.52:1	3.01:1	

Converter Pressures (in neutral)		bar	kgf/cm²	lbf/in²
Converter In at 50 deg.C	1000 rev/min	1.5 - 2.5	1.5 - 2.5	22 - 36
	2000 rev/min	5.3 - 6.7	5.4 - 6.8	77 - 97
Converter In at 100 deg.C	1000 rev/min	0.5 - 1.3	0.5 - 1.3	7 - 19
	2000 rev/min	4.1 - 4.9	4.2 - 5.0	59 - 71
Converter Out at 50 deg.C	1000 rev/min	0.8 - 1.6	0.8 - 1.6	12 - 23
	2000 rev/min	3.0 - 4.0	3.1 - 4.1	43 - 58
Converter Out at 100 deg.C	1000 rev/min	0.3 - 0.9	0.3 - 0.6	4 - 9
	2000 rev/min	2.1 - 2.9	2.1 - 3.0	30 - 42

Lubrication Pressures (in neutral)		bar	kgf/cm²	lbf/in²
At 50 deg.C	1000 rev/min	0.3 - 0.9	0.3 - 0.9	4 - 13
	2000 rev/min	1.8 - 2.4	1.8 - 2.4	26 - 35
At 100 deg.C	1000 rev/min	0.1 - 0.3	0.1 - 0.3	1 - 4
	2000 rev/min	1.3 - 2.1	1.3 - 2.1	19 - 30

Main Line Pressure (in neutral) †		bar	kgf/cm²	lbf/in²
At 50 deg. C	1000 rev/min	11.0 - 13.0	11.2 - 13.3	159 - 188
	2000 rev/min	13.0 - 15.6	13.3 - 16.0	188 - 226
At 100 deg.C	1000 rev/min	10.2 - 12.2	10.4 - 12.4	148 - 177
	2000 rev/min	11.4 - 14.0	11.8 - 14.3	165 - 203

Clutch Pressures † All clutch pressures should be the same as **Mainline Pressure** to within 0.7 bar (10 lbf/in²)

Flow Rates (in neutral)		L/min	US gal/min	UK gal/min
Cooler at 50 deg.C	1000 rev/min	7.7 - 11.0	2.0 - 2.9	1.7 - 2.4
	2000 rev/min	13.9 - 20.0	3.6 - 5.3	3.0 - 4.4
Cooler at 100 deg.C	1000 rev/min	5.2 - 8.2	1.1 - 2.2	1.1 - 1.8
	2000 rev/min	14.5 - 17.5	3.8 - 4.6	3.2 - 3.8
Pump at 50 deg.C	1000 rev/min	11.5 - 15.5	3.0 - 4.1	2.5 - 3.4
	2000 rev/min	24.0 - 33.0	6.7 - 8.8	5.3 - 7.3

Powershift Gearbox - 6 Speed

Description

Full electro-hydraulic transmission unit with input, reverse, layshaft, mainshaft, 6 speed and 4 wheel drive clutch packs giving 6 forward and 4 reverse speeds. Electronically controlled gear selection.

Designation

PS766 (4 wheel drive)

Weight (dry)

2WD

4WD

Gear Ratios

1st

2nd

3rd

4th

5th

6th

T.B.A.**T.B.A.****Forward****Reverse**

8.17:1

6.45:1

4.90:1

4.76:1

3.62:1

1.78:1

2.25:1

1.31:1

1.35:1

-

1.00:1

-

Torque Converter

Torque Converter Dia.

310 mm (12.2 in.)

Torque Converter Identification

04/600580 04/600581

Torque Multiplication at Stall

2.52:1

3.01:1

Converter Pressures (in neutral)**bar****kgf/cm²****lbf/in²**

Converter In at 50 °C 1000 rev/min

2.0 - 4.95

2.0 - 5.0

29 - 72

2000 rev/min

4.0 - 6.8

4.1 - 6.9

58 - 99

Converter Out at 50 °C 1000 rev/min

0.6 - 2.25

0.6 - 2.3

8.7 - 33

2000 rev/min

1.25 - 2.50

1.3 - 2.6

18 - 36

Converter Inlet Relief Valve Pressure (max.)

7.1

7.2

103

Lubrication Pressures (in neutral)

At 50 °C

1000 rev/min

0.25 - 1.0

0.26 - 1.0

3.6 - 14.5

2000 rev/min

0.50 - 1.0

0.51 - 1.0

7.3 - 14.5

Main Line Pressure (in neutral)

At 50 °C

1000 rev/min

11.4 - 15.7

11.6 - 16.0

165 - 228

2000 rev/min

12.4 - 17.0

12.6 - 17.3

180 - 246

Flow Rates (in neutral)**L/min****US gal/min****UK gal/min**

Cooler at 50 °C

1000 rev/min

14.0 MIN

3.7 MIN

3.1 MIN

2000 rev/min

17.0 MIN

4.5 MIN

3.7 MIN

Pump at 50 °C

1000 rev/min

16.0 MIN

4.2 MIN

3.5 MIN

2000 rev/min

34.0 MIN

9.0 MIN

7.5 MIN

*** Control Solenoid Valves**

3 way, 2 position, normally closed, integral suppression diode.

Coil Resistance

7.5 Ohm @ 20 °C

Powershift Gearbox - 4 Speed

Description		Full electro-hydraulic transmission unit with input, reverse, layshaft, mainshaft and 4 wheel drive clutch packs giving 4 forward and 4 reverse speeds.			
Designation		PS764 (4 wheel drive)			
Weight (dry)		T.B.A.			
2WD					
4WD		T.B.A.			
Gear Ratios					
1st		7.97:1			
2nd		4.29:1			
3rd		1.86:1			
4th		1.00:1			
Torque Converter					
Torque Converter Dia.		310 mm (12.2 in.)			
Torque Converter Identification		04/600580	04/600581		
Torque Multiplication at Stall		2.52:1		3.01:1	
Converter Pressures (in neutral)		bar	kgf/cm²	lbf/in²	
Converter In at 50 °C	1000 rev/min	2.0 - 4.95	2.0 - 5.0	29 - 72	
	2000 rev/min	4.0 - 6.8	4.1 - 6.9	58 - 99	
Converter Out at 50 °C	1000 rev/min	0.6 - 2.25	0.6 - 2.3	8.7 - 33	
	2000 rev/min	1.25 - 2.50	1.3 - 2.6	18 - 36	
Converter Inlet Relief Valve Pressure (max.)		7.1	7.2	103	
Lubrication Pressures (in neutral)					
At 50 °C	1000 rev/min	0.25 - 1.0	0.26 - 1.0	3.6 - 14.5	
	2000 rev/min	0.50 - 1.0	0.51 - 1.0	7.3 - 14.5	
Main Line Pressure (in neutral)					
At 50 °C	1000 rev/min	11.4 - 15.7	11.6 - 16.0	165 - 228	
	2000 rev/min	12.4 - 17.0	12.6 - 17.3	180 - 246	
Flow Rates (in neutral)		L/min	US gal/min	UK gal/min	
Cooler at 50 °C	1000 rev/min	14.0 MIN	3.7 MIN	3.1 MIN	
	2000 rev/min	17.0 MIN	4.5 MIN	3.7 MIN	
Pump at 50 °C	1000 rev/min	16.0 MIN	4.2 MIN	3.5 MIN	
	2000 rev/min	34.0 MIN	9.0 MIN	7.5 MIN	
* Control Solenoid Valves		3 way, 2 position, normally closed, integral suppression diode.			
Coil Resistance		7.5 Ohm @ 20 °C			

Engine Stall Speed Combinations

The stall speed figures on the following pages are intended as a guide to assist with machine fault diagnosis. The figures relate to tests conducted at an ambient of 25 deg. C and barometric pressure of 100 kPa (sea level). Note that changes in ambient temperature, pressure and humidity and fuel grade will affect engine power and hence the stall figures.

As an example, at 10,000 ft the power reduction of a naturally aspirated engine could be 29% and for a turbo engine 8%.

Engine Stall Speed Combinations - Two wheel steer (2WS) machines, Low emission 1000 series engine

Note. On all double pump options the test is to be carried out with single pump option selected.

	3CX	3CX	3CXT Std. Lft	3CXT Std. Lft	3CXT Hi. Lft	3CXT Hi Lft	3CX Contra	3CX Contra						
Engine Speed @ Stall Combination														
1.Convertor only.														
Max.r.p.m.	2160	2150	2150	2140	2140	2130	2190	2190						
Min.r.p.m.	2060	2040	2045	2035	2035	2025	2100	2090						
2.Convertor + M.R.V.														
Max.r.p.m.	1700	1690	1805	1800	1745	1735	1835	1825						
Min.r.p.m.	1550	1530	1665	1655	1590	1585	1700	1690						
Build specification.														
Engine size.														
N.A. (75hp) (56kw)	●	●		●	●	●								
T2 (92hp) (69kw)			●	●	●	●								
T3 (100hp) (75kw)							●	●						
Convertor type.														
W300 (3.01)	●	●												
W300 (2.52)			●	●	●	●	●	●						
Pump size.														
29 + 23cc														
33/23cc	●	●		●										
36/26cc			●	●										
41/26cc					●	●	●	●						
41/29cc														
74cc variable														
Fan Ratio.														
1 to 0.85	●													
1 to 1.06		●	●		●		●							
1 to 1.16				●		●		●						
Air Conditioning														
None	●		●		●		●							
Europe		●	●		●		●							
R.O.W.				●		●		●						

Engine Stall Speed Combinations - All wheel steer (AWS) machines, Low emission 1000 series engine

Note. On all double pump options the test is to be carried out with single pump option selected.

	3CX Super Std. Lft	3CX Super Std. Lft	3CX Super Hi. Lft	3CX Super Hi. Lft	4CX	4CX	4CX Super 4C	4CX Super 4C	4CX Super 4CX	4CX Super 4CX				
Engine Speed @ Stall Combination														
1.Convertor only.														
Max.r.p.m.	2150	2140	2140	2130	2190	2190	2200	2190	2235	2230				
Min.r.p.m.	2045	2035	2035	2025	2100	2090	2095	2090	2140	2130				
2.Convertor + M.R.V.														
Max.r.p.m.	1805	1800	1745	1735	1835	1825	1825	1820	N/A	N/A				
Min.r.p.m.	1665	1655	1590	1585	1700	1690	1685	1685	N/A	N/A				
Build specification.														
Engine size.														
N.A. (75hp) (56kw)														
T2 (92hp) (69kw)	●	●	●	●										
T3 (100hp) (75kw)					●	●	●	●	●	●				
Convertor type.														
W300 (3.01)														
W300 (2.52)	●	●	●	●	●	●	●	●	●	●				
Pump size.														
29 + 23cc														
33/23cc														
36/26cc	●	●												
41/26cc			●	●	●	●								
41/29cc							●	●						
74cc variable									●	●				
Fan Ratio.														
1 to 0.85														
1 to 1.06	●		●		●		●		●					
1 to 1.16		●		●		●		●		●				
Air Conditioning														
None	●		●		●		●		●					
Europe	●		●		●		●		●					
R.O.W.		●		●		●		●		●				

Engine Stall Speed Combinations - Two wheel steer (2WS) machines, Low emission 1000 series engine, (North America)

Note. On all double pump options the test is to be carried out with single pump option selected.

	214E	214e	214	214	215E 214T	215E 214T	214T	215 217						
Engine Speed @ Stall Combination														
1.Convertor only.														
Max.r.p.m.	2130	2130	2160	2140	2270	2270	2190	2190						
Min.r.p.m.	2020	2020	2060	2025	2170	2160	2090	2090						
2.Convertor + M.R.V.														
Max.r.p.m.	1330	1330	1700	1685	1870	1865	1825	1820						
Min.r.p.m.	970	970	1550	1520	1720	1715	1690	1685						
Build specification.														
Engine size.														
N.A. (75hp) (56kw)	●	●	●	●		●								
T2 (92hp) (69kw)					●	●								
T3 (100hp) (75kw)							●	●						
Convertor type.														
W300 (3.01)	●	●	●	●	●	●								
W300 (2.52)							●	●						
Pump size.														
29 + 23cc	●	●												
33/23cc			●	●										
36/26cc														
41/26cc					●	●	●							
41/29cc								●						
74cc variable														
Fan Ratio.														
1 to 0.85	●	●	●											
1 to 1.06					●									
1 to 1.16				●		●	●	●						
Air Conditioning														
None	●	●	●		●		●	●						
Air Con.				●		●	●	●						

Engine Stall Speed Combinations - All wheel steer (AWS) machines, Low emission 1000 series engine, (North America)

Note. On all double pump options the test is to be carried out with single pump option selected.

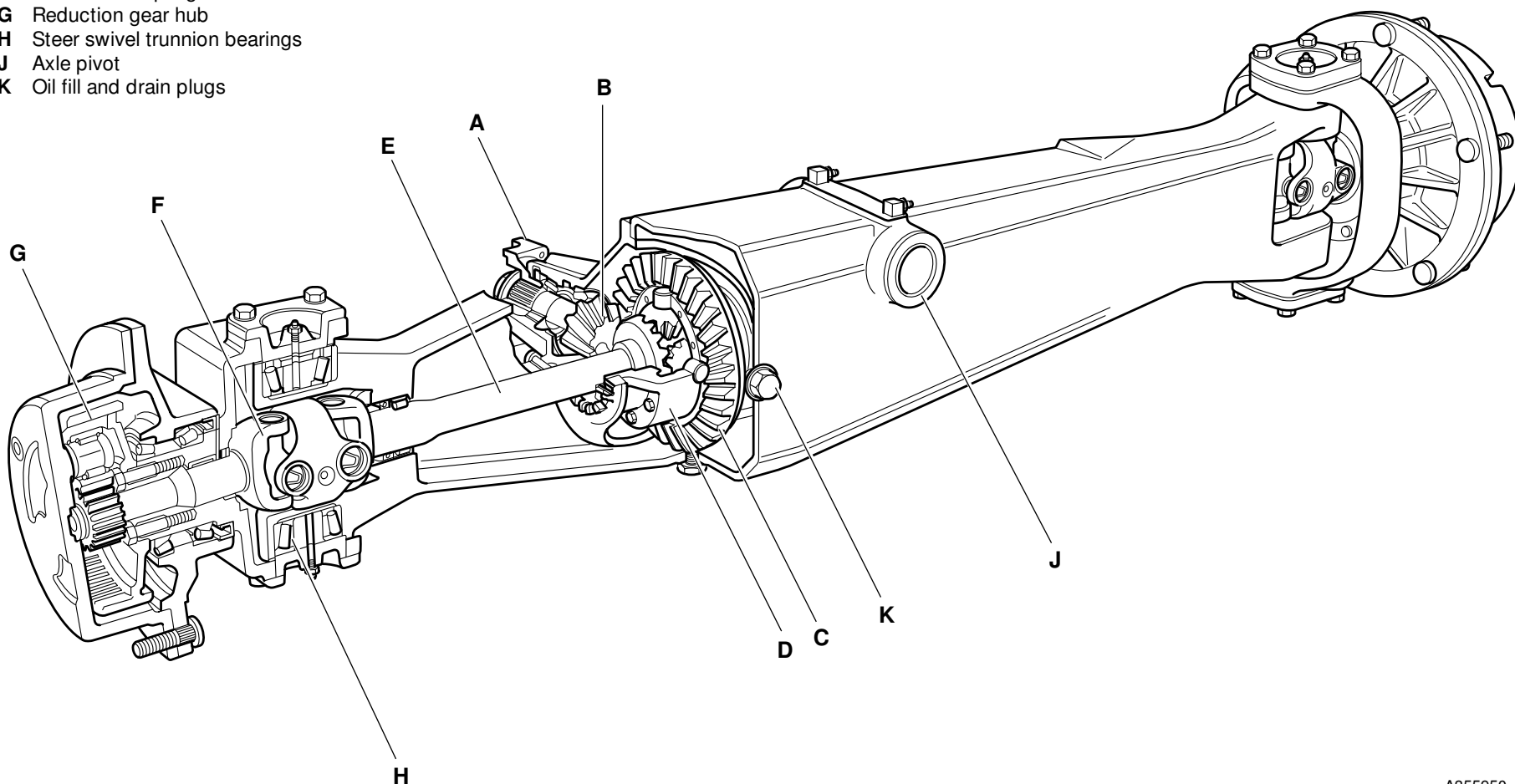
	214S	215S 217S												
Engine Speed @ Stall Combination														
1.Convertor only.														
Max.r.p.m.	2190	2190												
Min.r.p.m.	2090	2090												
2.Convertor + M.R.V.														
Max.r.p.m.	1825	1820												
Min.r.p.m.	1690	1685												
Build specification.														
Engine size.														
N.A. (75hp) (56kw)														
T2 (92hp) (69kw)														
T3 (100hp) (75kw)	●	●												
Convertor type.														
W300 (3.01)	●	●												
W300 (2.52)														
Pump size.														
29 + 23cc														
33/23cc														
36/26cc														
41/26cc	●													
41/29cc		●												
74cc variable														
Fan Ratio.														
1 to 0.85														
1 to 1.06														
1 to 1.16	●	●												
Air Conditioning														
None	●	●												
Air Con.	●	●												

Front Axle - Steer Drive Type SD55, SD70

Component Identification

The illustration shows a typical steer drive front axle.

- A Yoke connection to propshaft
- B Pinion
- C Crownwheel
- D Differential unit
- E Drive shaft
- F Universal coupling
- G Reduction gear hub
- H Steer swivel trunnion bearings
- J Axle pivot
- K Oil fill and drain plugs



A355950

Rear Axle - Steer Drive Type SD80

Component Identification

The illustration shows a typical steer drive rear axle. 2WS machines are fitted with non steer axles (PD70). These axles are similar to the axle shown but do not feature steer swivels or drive shaft universal joints.

A Park brake disc. The disc is fitted to the pinion instead of a yoke. The propshaft is bolted to the centre of the disc. The axle casing also carries a bracket for location of the park brake caliper.

B Pinion

C Crownwheel

D Differential unit

Note: Items A, B, C, and D form the 'drive head' part of the axle.

E Drive shaft

F Universal coupling

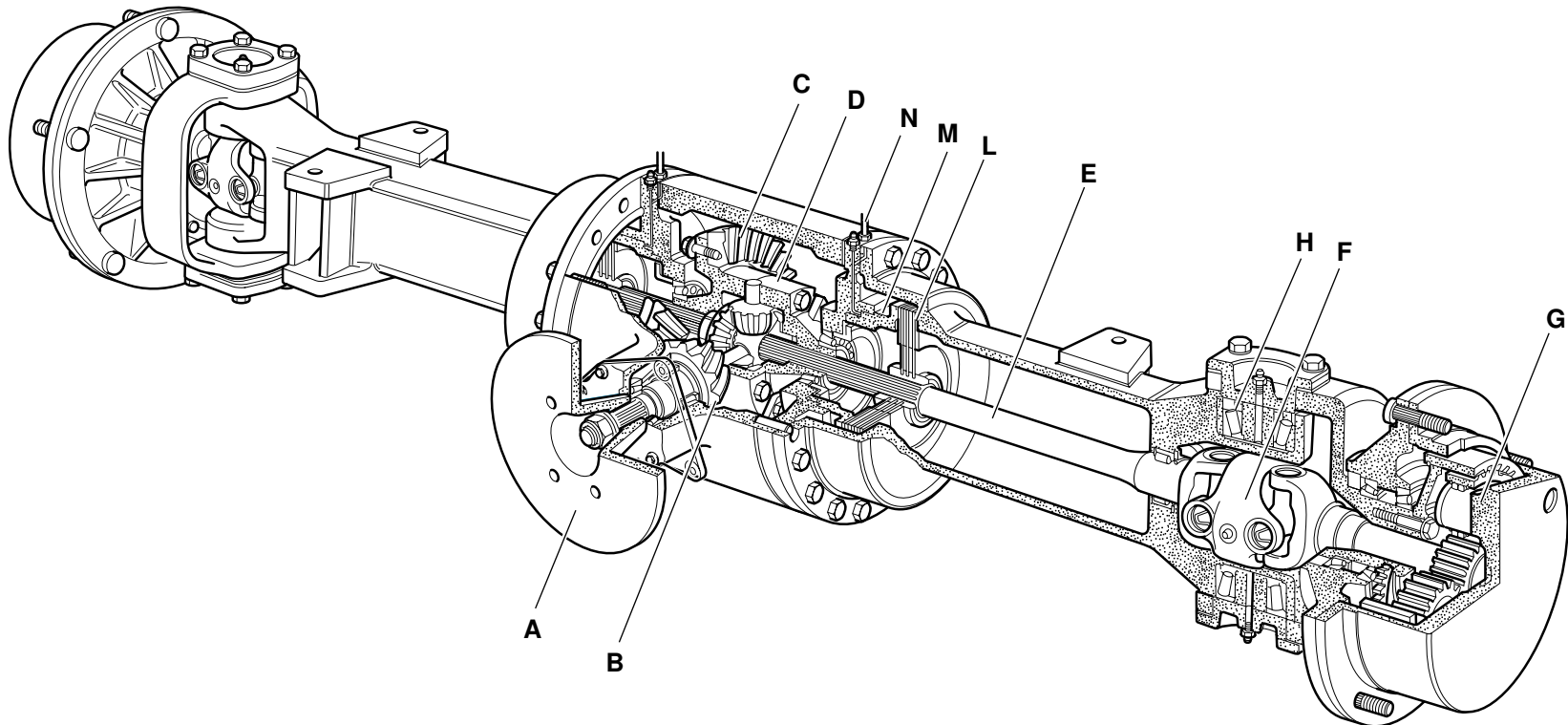
G Reduction gear hub

H Steer swivel trunnion bearings

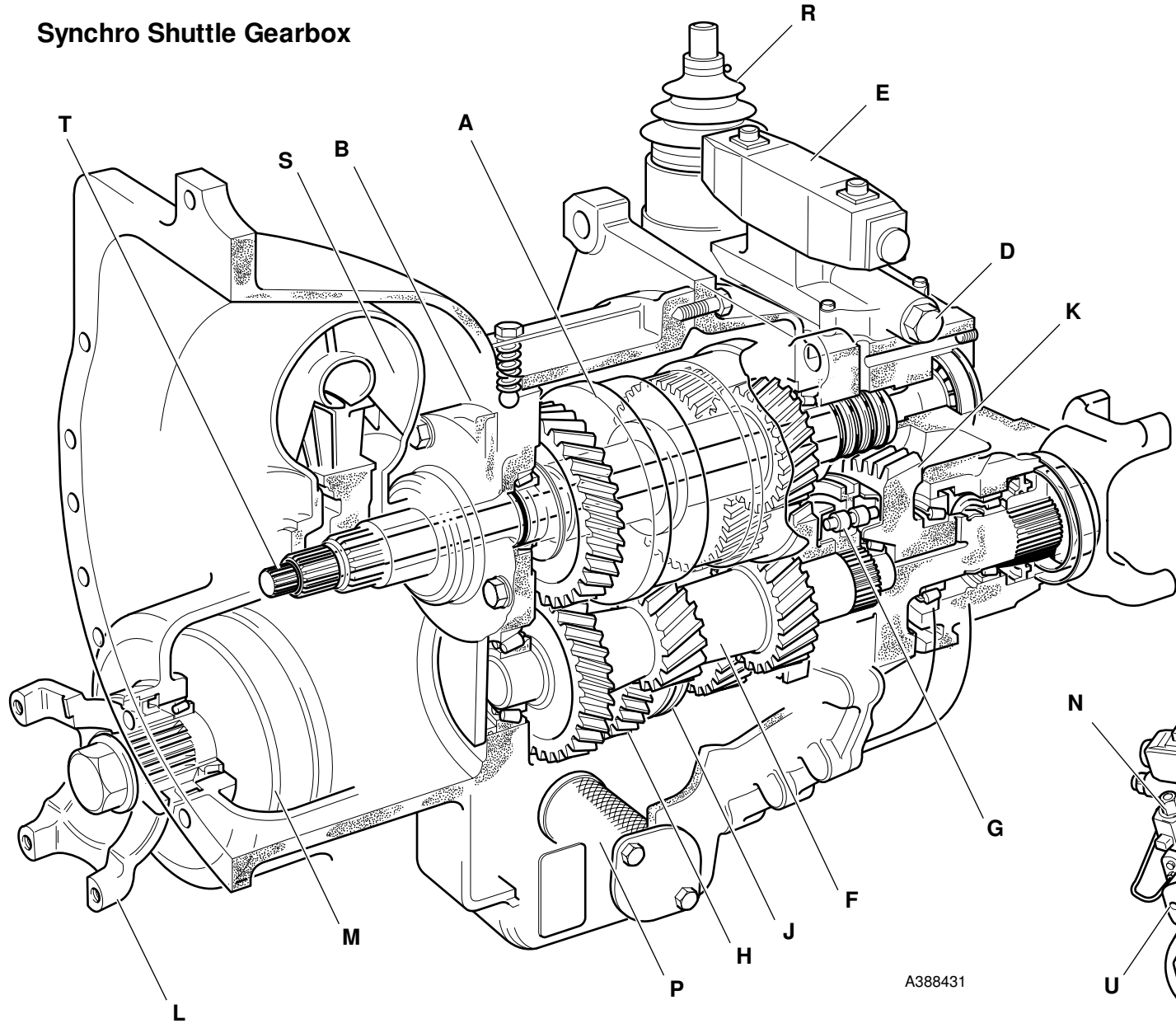
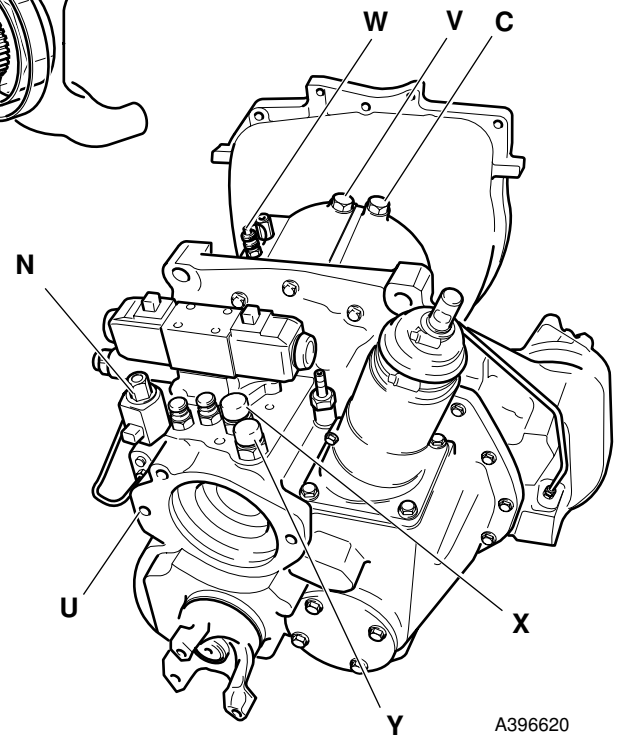
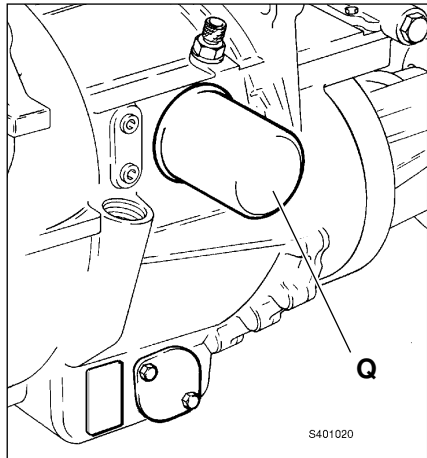
L In-board oil immersed multi-plate disc brakes

M Brake actuating piston

N Hydraulic brake lines



A396760



Synchro Shuttle Gearbox

Synchro Shuttle Gearbox

Component Identification

- A** Forward/reverse clutch unit
- B** Transmission oil pump
- C** Torque converter pressure regulating valve
- D** Oil pressure maintenance valve
- E** Solenoid control valve
- F** Mainshaft
- G** Synchromesh unit - 3rd/4th gears
- H** Layshaft
- J** Synchromesh unit - 1st/2nd gears
- K** Transfer gear, output shaft and yoke
- L** 4WD output yoke (if fitted)
- M** 2/4WD clutch unit (if fitted)
- N** 4WD solenoid control valve (if fitted)
- P** Oil strainer
- Q** Oil filter
- R** Gear selection turret assembly
- S** Torque Converter
- T** Driveshaft (drives machine main hydraulic pump)
- U** Hydraulic pump mounting face
- V** Torque converter relief valve
- W** Oil pressure switch
- X** Hose connection - to cooler
- Y** Hose connection - from cooler
- Z** Gearbox oil cooler

Principle of Operation

This illustration shows a typical JCB Synchro Shuttle which consists of a torque converter, hydraulic reverser unit, and integral manual 4-speed gearbox.

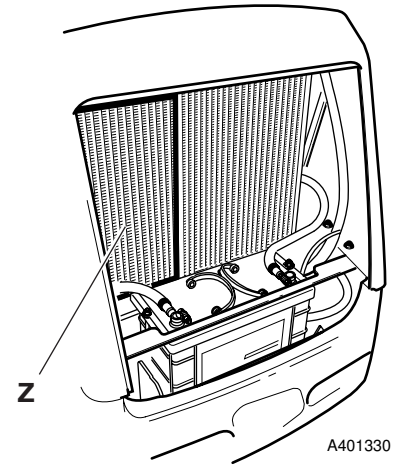
The reverser unit **A** has a pair of hydraulically operated clutches giving forward - neutral - reverse drive. Oil pressure is provided by a crescent type pump **B** driven at engine speed by the drive lugs of the torque converter. The oil pressure is controlled by maintenance valve **D**, and clutch selection is achieved by means of an electric solenoid valve **E**.

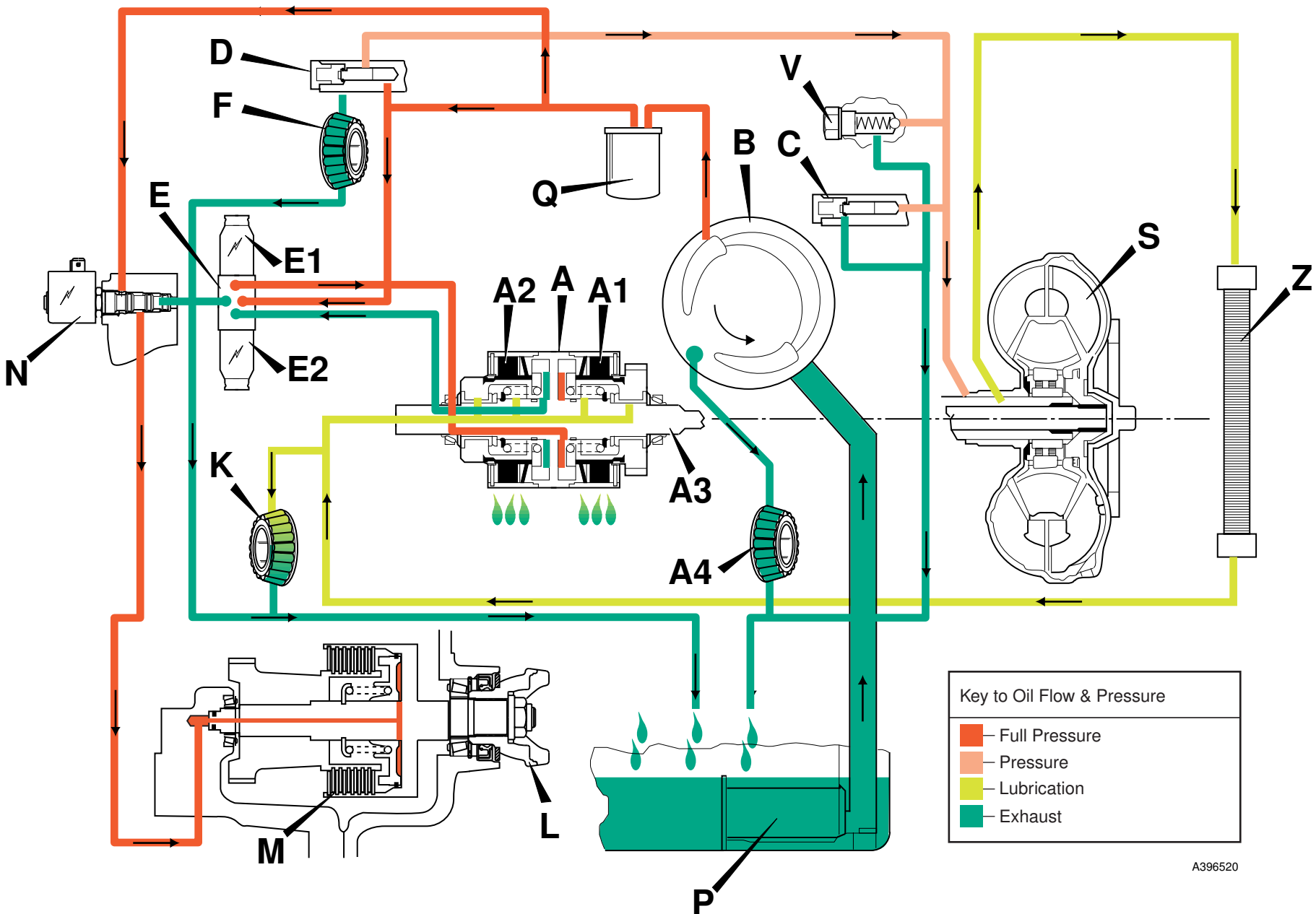
Drive is transferred from the reverser unit by helical gears to the mainshaft **F**, which carries the 3rd/4th synchromesh unit **G**, and to the layshaft **H**, which carries the 1st/2nd synchromesh unit **J**. Synchromesh unit **G** is of the 'Blocking Pin' type, a full description of which is given in this section. Synchromesh unit **J** features rings and cones with a sliding sleeve.

Drive is transmitted finally via the output shaft **K** to the rear axle. If 4 wheel drive is selected, the front wheels are also driven via 4 wheel drive output yoke **L**.

Driveshaft **T** is permanently driven by the engine and runs through the hollow forward/reverse unit shaft to the back of the gearbox. The shaft (**T**) drives the gearbox mounted machine main hydraulic pump.

Gearbox oil is cooled by an air blast cooler **Z**. The cooler is part of the front mounted machine 'cooling pack'.





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Synchro Shuttle Gearbox

Hydraulic and Electrical Operation

Oil from the pump **B** is fed through an internal passage via the filter to the pressure maintenance valve **D**, which maintains pressure to the solenoid valve **E** for clutch selection. Excess oil from the maintainance valve flows back through the casing to the torque converter **S**. Oil enters the converter between the converter hub and the stator support, and leaves between the stator and the input shaft. Pressure in the converter is controlled by a regulating valve **C** which dumps oil from the converter line back to the sump.

Torque converter relief valve **V** acts as a safety valve should the system pressure suddenly rise above normal, protecting the torque converter from being damaged.

Oil from the torque converter **S** flows out of the transmission to the external oil cooler **Z**, returning at the rear of the transmission unit to pass through the centre of the reverser shaft for clutch lubrication.

Lubrication oil is also provided via a pump drain line to the forward/reverse front shaft bearing **A4**. The drain from pressure maintenance valve **D** also provides lubrication for idler gear bearing **F**.

Solenoid Valve (E) Operation

Pressurised oil at the solenoid valve **E** is used to control the forward/reverse clutches **A1** and **A2**.

Forward:

In the diagram, electrical solenoid **E1** is energised by the forward/reverse control lever in the cab. Pressurised oil is diverted to the forward clutch **A1** and forward is selected. A restrictor orifice in the feed to the solenoid valve modulates the pressure to the clutch to smooth engagement. At the same time oil from reverse clutch **A2** is diverted back to the sump via solenoid valve **E**.

Reverse:

When the reverse is selected electrical solenoid **E2** is energised and pressurised oil is diverted to the reverse clutch **A2**. At the same time oil from clutch **A1** is diverted back to the sump

Neutral:

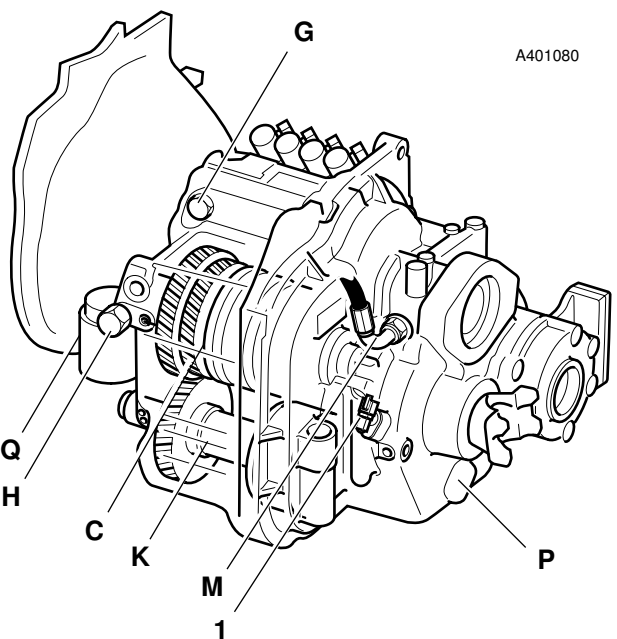
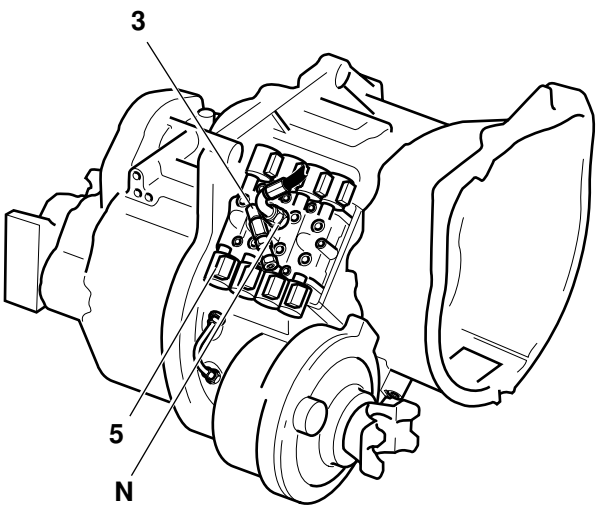
When neutral is selected (via the control lever or the transmission dump button), the flow of the pressurised oil is blocked at the solenoid valve. No solenoids are energised and no clutches engaged.

For a further detailed description refer to **Forward/Reverse Clutch - Operation**.

The 2/4WD unit **M** is controlled by solenoid valve **N**. For a full description of 2/4 wheel drive clutch operation refer to **2/4WD Clutch Operation**.

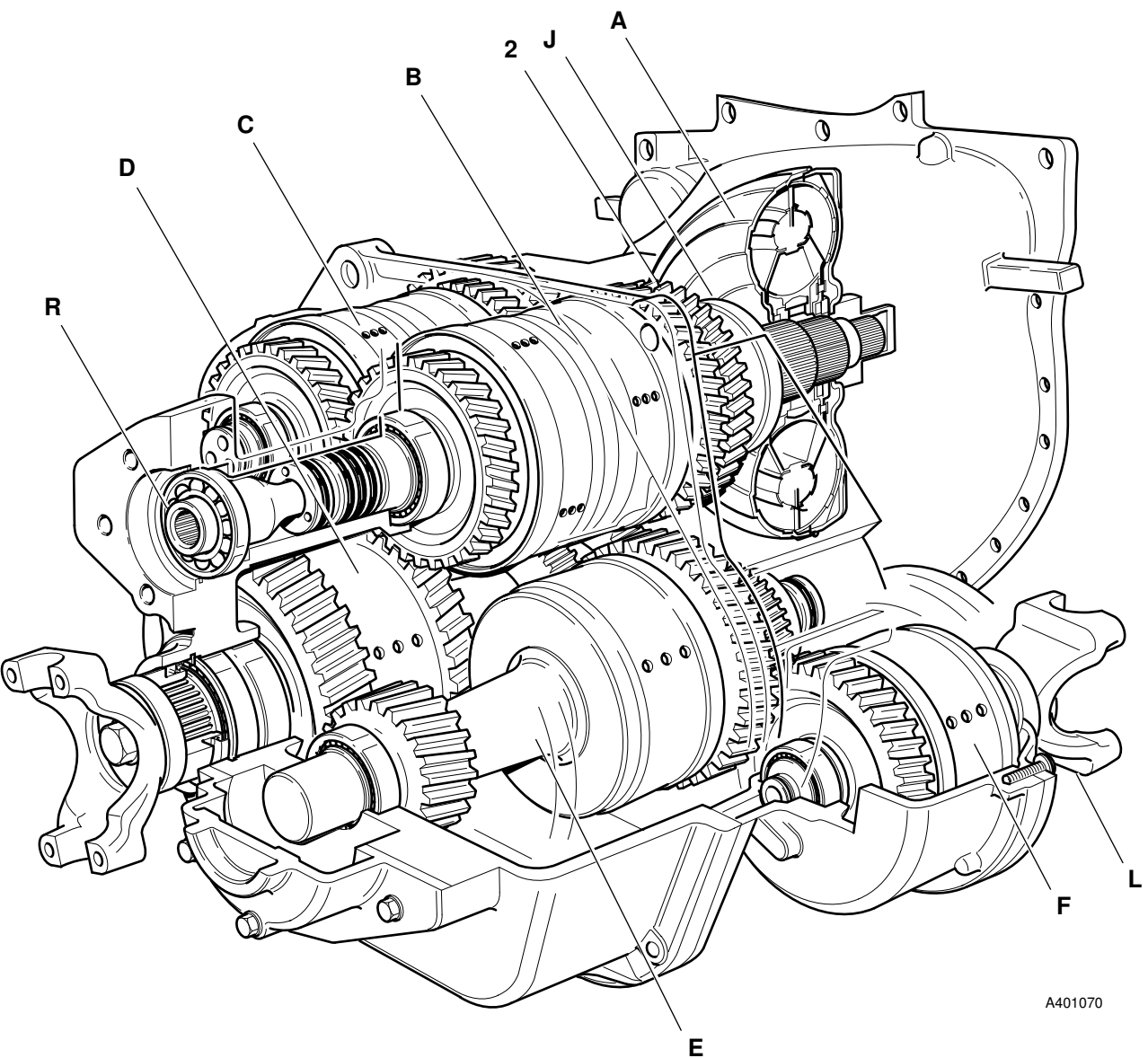
Key

A	Forward/reverse clutch unit
A1	Forward clutch
A2	Reverse clutch
A3	Forward/reverse front shaft
A4	Forward/reverse front shaft bearing
B	Transmission oil pump
C	Torque converter pressure regulating valve
D	Oil pressure maintenance valve
E	Solenoid control valve
F	Idler gear bearing
K	Output shaft bearing
L	4WD output yoke (if fitted)
M	2/4WD clutch unit (if fitted)
N	4WD solenoid control valve (if fitted)
P	Oil strainer
Q	Oil filter
S	Torque Converter
V	Torque converter relief valve
Z	Oil Cooler



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Powershift Gearbox

Component Identification

- A** Torque converter
 - B** Forward/input clutch assembly
 - C** Reverse clutch assembly
 - D** Mainshaft assembly
 - E** Layshaft assembly
 - F** 2/4 wheel drive clutch assembly
 - G** Torque converter relief valve
 - H** Oil pressure maintenance valve
 - J** Transmission oil pump
 - K** 6 speed assembly (if fitted)
 - L** 4WD output yoke
 - M** Hose connection - to oil cooler
 - N** Hose connection - from oil cooler
 - P** Oil strainer
 - Q** Oil filter
 - R** Driveshaft (drives machine main hydraulic pump)
-
- 1** Speed sensor
 - 2** Gear drive to reverse unit clutch assembly
 - 3** Transmission oil pressure switch
 - 4** Steering column mounted gear selection switch
 - 5** Solenoid control valves
 - 6** Gearbox oil cooler

Principle of Operation

The JCB Powershift is an electro-hydraulic transmission unit. Gear shifting and direction selection are controlled using multi-disc clutch packs.

Electrically operated solenoid valves **5** divert pressurised oil (provided by pump **J**) to the selected clutch packs.

A combined lever/swivel switch **4** on the steering column actuates both gear ratio and direction solenoids.

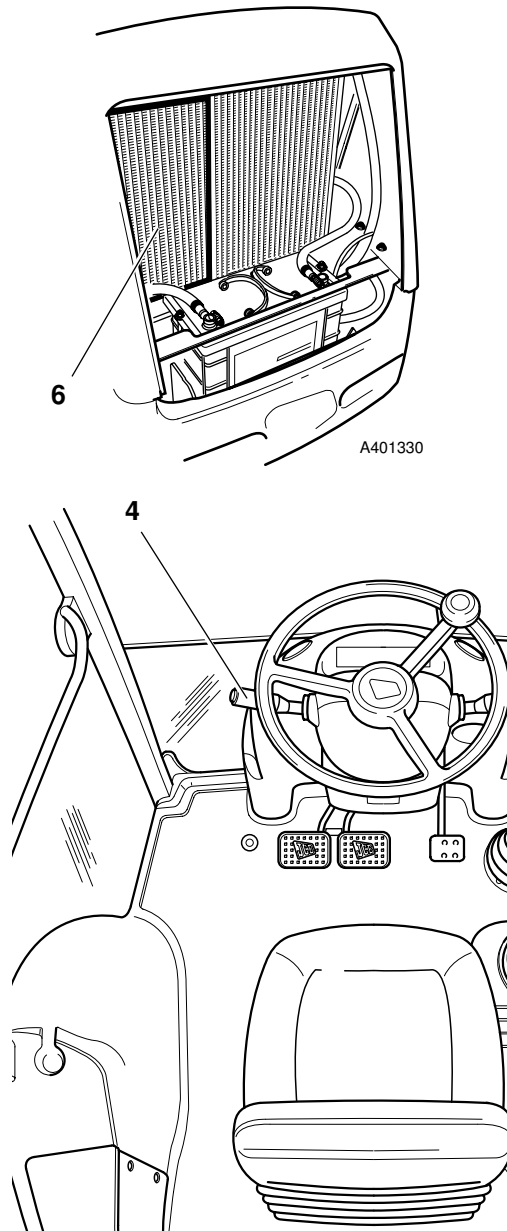
The Powershift unit consists of a torque converter **A**, forward clutch assembly **B**, reverse clutch assembly **C**, layshaft assembly **E**, mainshaft assembly **D**, 2/4 wheel drive clutch assembly **F**. 6 speed gearboxes incorporate a '6 speed' shaft and clutch assembly **K**.

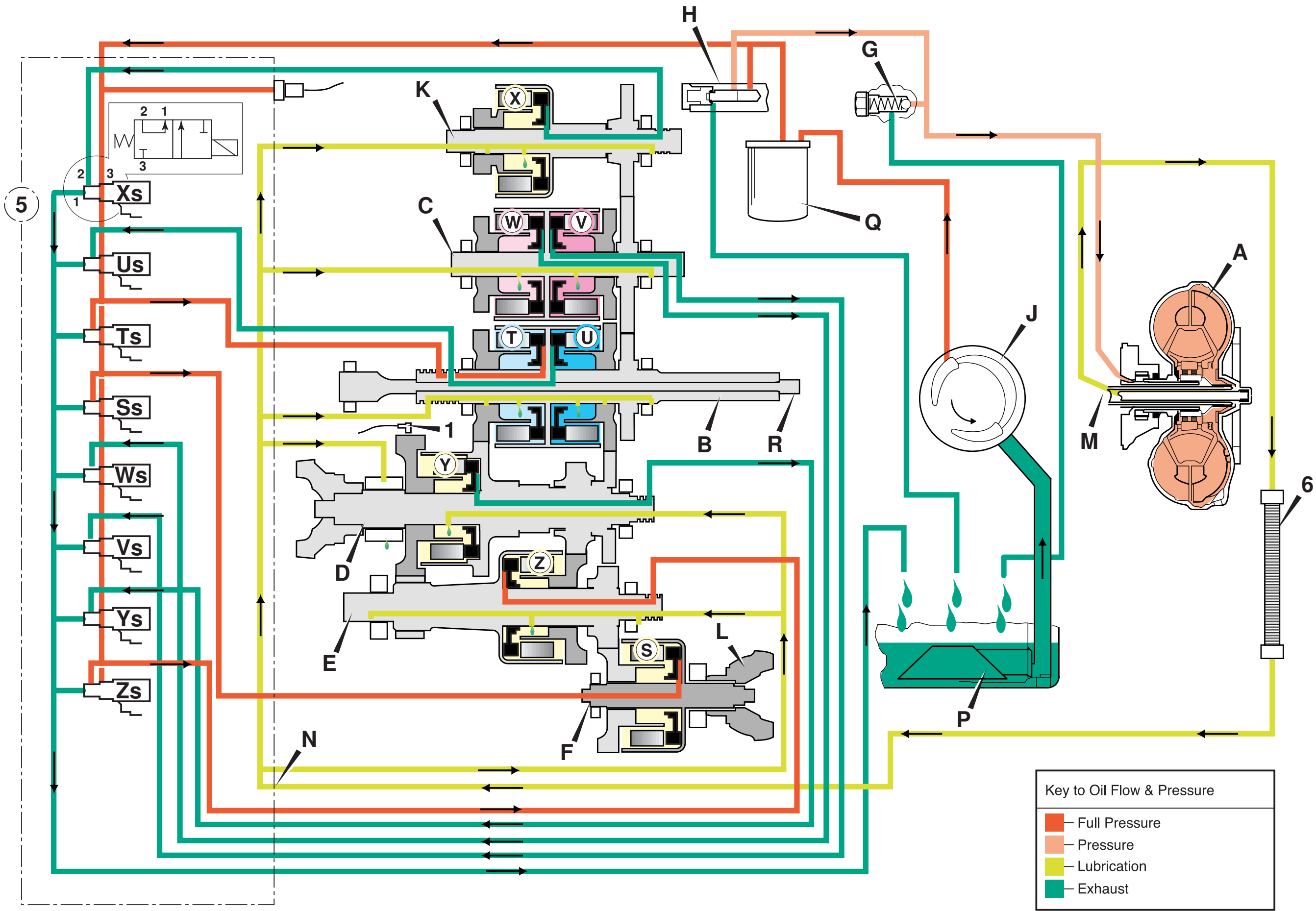
The forward clutch assembly **B** is driven by the torque converter **A**. The reverse clutch assembly **C** is permanently driven via constant meshing of spur gears **2**. On 6 speed gearboxes the 6 speed assembly is also driven via meshing gears **2**.

Driveshaft **R** is permanently driven by the engine and runs through the hollow forward/reverse unit shaft to the back of the gearbox. The shaft (**R**) drives the gearbox mounted machine main hydraulic pump.

Strainer **P** and filter **Q** are used to prevent potential system contamination by filtering dirt particles.

Gearbox oil is cooled by an air blast cooler **6**. The cooler is part of the front mounted machine 'cooling pack'.





Powershift Gearbox

Hydraulic and Electrical Operation

Oil pump **J** is directly driven by the engine via the torque converter.

Oil from the pump **J** is fed through an internal passage via the filter **Q** to the pressure maintenance valve **H**, which maintains pressure to the solenoid valve block for clutch selection. Excess oil from the maintainance valve flows back through the casing to the torque converter **A**. Pressure in the converter is controlled by a relief valve **G** which dumps oil from the converter line back to the sump.

Oil from the torque converter **A** flows out of the gearbox at position **M** to the external oil cooler **6**, returning to the solenoid valve manifold block **5** at position **N**. The oil then flows through internal oilways providing lubrication for clutches and bearings before returning to the gearbox sump.

The torque converter **A** is a fluid coupling bolted to a drive plate which in turn is bolted to the engine flywheel. As the engine starts to rotate, the converter gives smooth power take off gradually increasing the torque transmitted. This torque is transferred from the converter assembly to the clutch/gear assemblies via input shaft on the forward clutch assembly **B**.

Forward clutch assembly **B** contains two hydraulically operated clutches; one clutch (**T**) provides a forward low ratio drive and the other (**U**) a forward high ratio drive. Each clutch is controlled by a 2-position solenoid valve. When the applicable solenoid is energised, pressurised oil is directed to either the forward low (solenoid **Ts**) or forward high (solenoid **Us**) clutch.

The reverse clutch assembly **C** is similar to the forward clutch assembly. It contains two hydraulically operated clutches; one clutch (**W**) provides a reverse low ratio drive and the other (**V**) a reverse high ratio drive. 2-position solenoid valves when energised, direct pressurised oil to either the reverse low (solenoid **Ws**), or reverse high (solenoid **Vs**) clutch.

Both the mainshaft and the layshaft assemblies have a single clutch each. Solenoid valve **Zs**, when energised, directs pressurised oil to the layshaft clutch **Z**. Solenoid valve **Ys**, when energised, directs pressurised oil to the mainshaft clutch **Y**.

On 6 speed gearboxes, the 6 speed clutch **X** is controlled via solenoid valve **Xs**.

Note: The 6 speed clutch assembly is so called as it is fitted to 6 speed, and not 4 speed gearboxes. However, the clutch is NOT engaged when 6th gear is selected. See the adjacent table.

Note: All the clutches work on the same principle. For a full description of operation see **Systems Description**.

The 2/4 wheel drive unit **F** also has a single clutch **S**. When 4WD is selected, pressurised oil is directed via solenoid valve **Ss** to the 4WD clutch. When 2WD is selected a connection from the clutch to the transmission sump is made. For a full description of 2/4 wheel drive clutch operation see **Systems Description, 2/4WD Clutch Operation**

When a gear is selected via the control switch in the cab, 2 clutches are always engaged. By selecting different pairs of clutches different gear ratios are engaged. On 4 speed gearboxes the solenoids are electrically controlled using relays. On 6 speed gearboxes the solenoids are controlled by an electronic control unit (ECU) mounted in the cab. Speed sensor **1** is used to enable the gear selection to be managed automatically as required.

Example - 2nd gear forward 4WD (6 speed gearbox)

In the schematic, the gearbox is shown with 2nd gear forward engaged. 2nd gear forward requires the forward low clutch **T** and layshaft clutch **Z** to be engaged. When the gear selection switch is moved to 2nd gear forward, the electrical control system energises solenoid valves **Ts** and **Zs**. Pressurised oil is diverted to the back of pistons in both clutches to engage the drive. At the same time all other solenoids are de-energised, diverting oil from the back of the other clutch pistons to the gearbox sump. 4WD clutch **S** is also energised to give 4 wheel drive.

The tables show which clutches and solenoids are engaged for each gear selection.

Note: Solenoid valve **Xs** controls clutch **X**, solenoid valve **Zs** controls clutch **Z** and so on.

4 Speed Powershift		
Gear	Clutches engaged	
	Forward	Reverse
1st	T,Z	W,Z
2nd	U,Z	V,Z
3rd	T,Y	W,Y
4th	U,Y	V,Y

6 Speed Powershift		
Gear	Clutches engaged	
	Forward	Reverse
1st	X,Z	W,Z
2nd	T,Z	V,Z
3rd	U,Z	W,Y
4th	X,Y	V,Y
5th	T,Y	-
6th	U,Y	-

Key

- A**

Torque converter
- B**

Forward clutch assembly
- C**

Reverse clutch assembly
- D**

Mainshaft assembly
- E**

Layshaft assembly
- F**

2/4 wheel drive clutch assembly
- G**

Torque converter relief valve
- H**

Oil pressure maintenance valve
- J**

Transmission oil pump
- K**

6 speed assembly (if fitted)
- L**

4WD output yoke
- M**

Hose connection - to oil cooler
- N**

Hose connection - from oil cooler
- P**

Oil strainer
- Q**

Oil filter
- R**

Driveshaft (drives machine main hydraulic pump)
- S**

2/4WD clutch
- Ss**

2/4WD clutch solenoid
- T**

Forward low ratio clutch
- Ts**

Forward low ratio clutch solenoid
- U**

Forward high ratio clutch
- Us**

Forward high ratio clutch solenoid
- V**

Reverse high ratio clutch
- Vs**

Reverse high ratio clutch solenoid
- W**

Reverse low ratio clutch
- Ws**

Reverse low ratio clutch solenoid
- X**

6 speed clutch (6 speed gearbox only)
- Xs**

6 speed clutch solenoid (6 speed gearbox only)
- Y**

Mainshaft clutch
- Ys**

Mainshaft clutch solenoid
- Z**

Layshaft clutch
- Zs**

Layshaft clutch solenoid

1

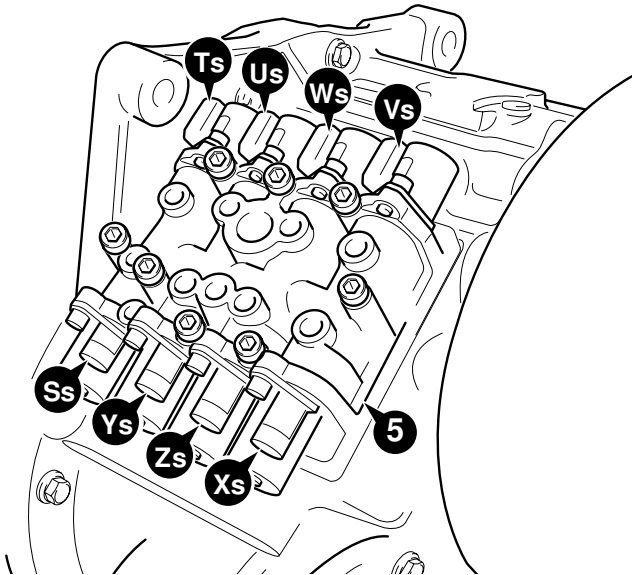
Speed sensor

5

Solenoid valve manifold block

6

Gearbox oil cooler



Powershift Gearbox - 6 Speed

ShiftMaster Operation Characteristics

Central to the system is the ShiftMaster ECU (Electronic Control Unit) **A**. The unit receives 'inputs' from electrical devices such as the gear select switch **B**. Depending on the input signals the ECU 'outputs' energise electrical devices such as gearbox solenoid control valves **C**. For a full description of how the ShiftMaster electrical system works see **Electrical Connections - Powershift Gearbox - 6 Speed**

Start up

When the starter switch is set to the ON position the ECU performs a series of self checks. If the checks are valid **three beeps** sound. After the checks the ECU selects neutral even if forward or reverse is selected on the column lever. To select forward or reverse the operator must cycle the lever through neutral.

If the checks fail, **1 or 2 beeps** will sound and the ECU will enter an appropriate limp mode (see **Limp modes**)..

'Manual' gear select

The operator can 'manually' select 1st, 2nd and 3rd gears using the column switch. When down shifting (say from 3rd to 2nd) the ECU checks to see if the machine road speed is suitable before down shifting the gearbox. If the road speed is too high a **repeating double beep** is sounded. When the road speed reduces to a pre-set value the ECU down shifts the gearbox and the beeps will stop.

Kick down operation

A floor mounted kickdown switch enables the operator to down shift to the next lowest gear. The ECU checks to see if the machine road speed is suitable before down shifting the gearbox. If the road speed is too high a **single double beep** is sounded.

Pressing the kick down switch a second time causes the ECU to select the previous gear.

'Automatic' gear selection

When A (auto) and F (forward) are selected on the column switch, the ECU selects 4th, 5th or 6th gears, mainly according to road speed. The gearbox will automatically up shift and down shift. 2WD†† will also be selected.

To enable up shifts the accelerator pedal must be pressed, this prevents up shifting when coasting down hill for example, thus ensuring maximum machine control.

Note that the ECU does not automatically shift gears in response to engine load.

When A (auto) and R (reverse) are selected the ECU selects 4th gear and 2WD††. There is no automatic gear shifting in reverse.

†† On machines with 4WB (4 wheel brake), if the operator has selected 4WB the ECU will automatically select 4WD (4 wheel drive) when the brake pedal is pressed.

Park brake ON

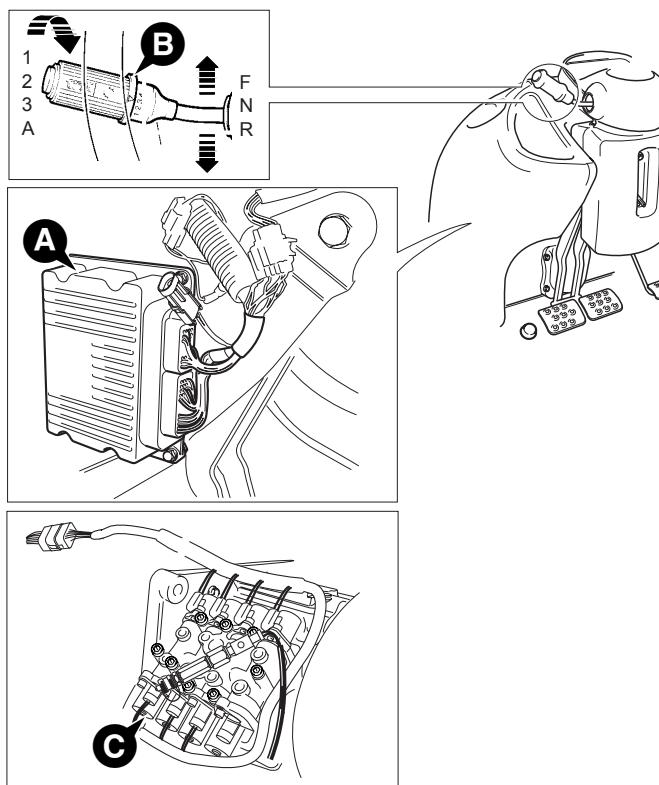
When the park brake is on, the ECU will hold the gearbox in neutral even if forward or reverse are selected. A **continuous tone** is sounded.

Transmission dump

When the operator presses the dump switch the ECU selects neutral by de-energising one clutch only. This enables smooth re-engagement of gears when the dump button is released.

Limp modes

When necessary the ECU will provide alternative gear selection should faults occur. This enables the machine to be moved ('limped') under its own power. For full details of the limp modes see **Fault Finding - Powershift Gearbox**.



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Powershift Gearbox

Drivepaths - 4 Speed

1F

1st GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
T	Forward Low	Ts	
Z	Layshaft	Zs	
S	2/4 Wheel Drive	Ss	

2F

2nd GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
U	Forward High	Us	
Z	Layshaft	Zs	
S	2/4 Wheel Drive	Ss	

3F

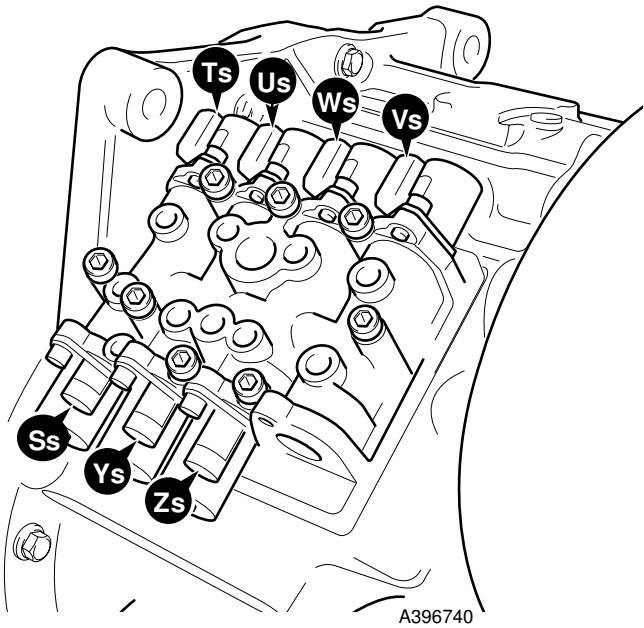
3rd GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
T	Forward Low	Ts	
Y	Mainshaft	Ys	
S	2/4 Wheel Drive	Ss	

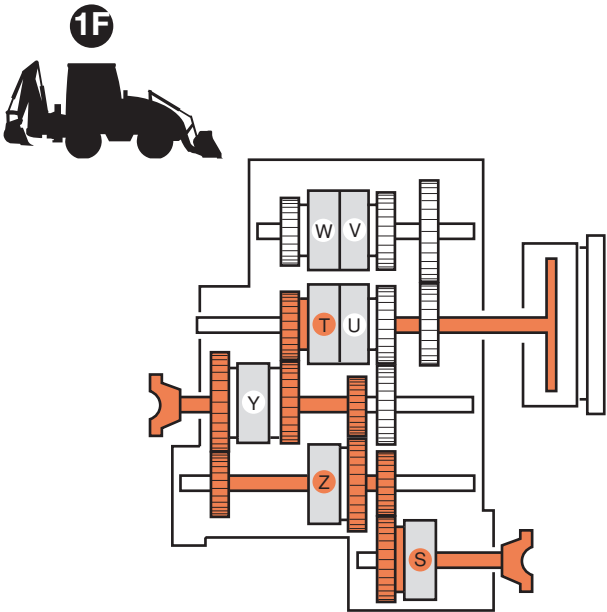
4F

4th GEAR FORWARD (4 wheel drive)

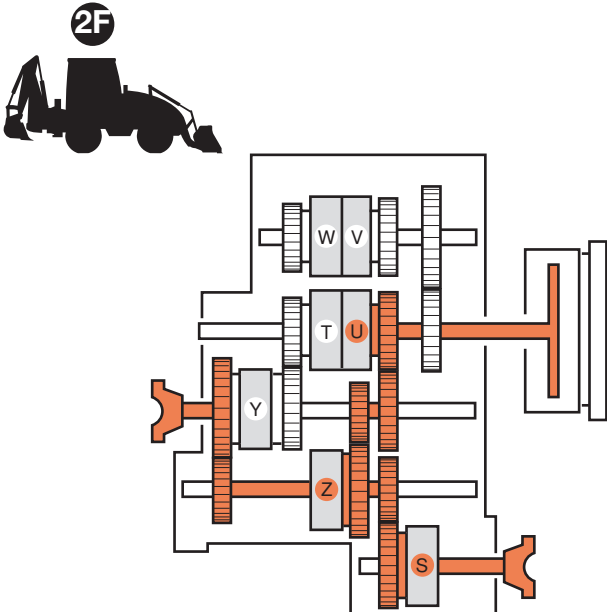
Clutches Engaged		Solenoids Energised	
U	Forward High	Us	
Y	Mainshaft	Ys	
S	2/4 Wheel Drive	Ss	



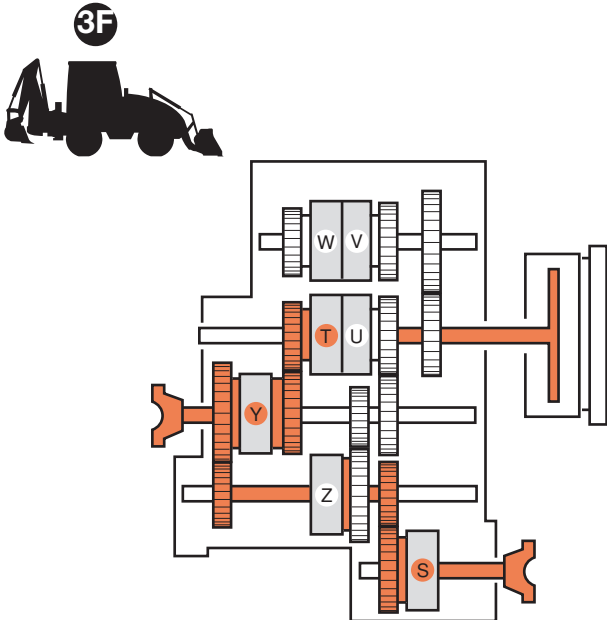
Powershift Gearbox



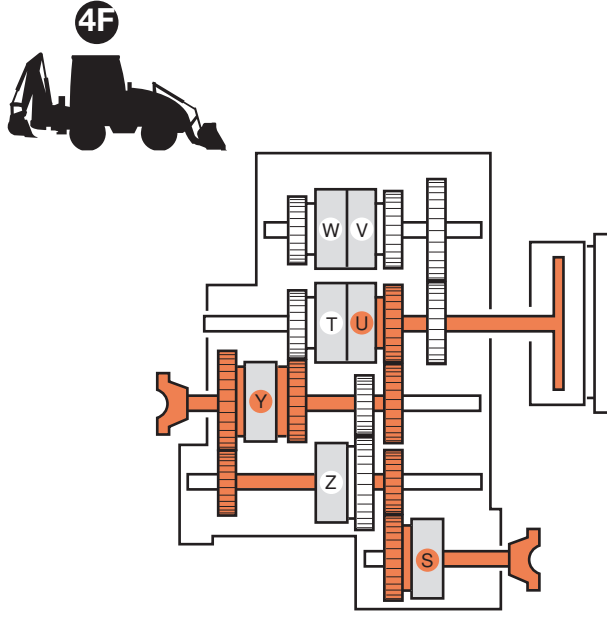
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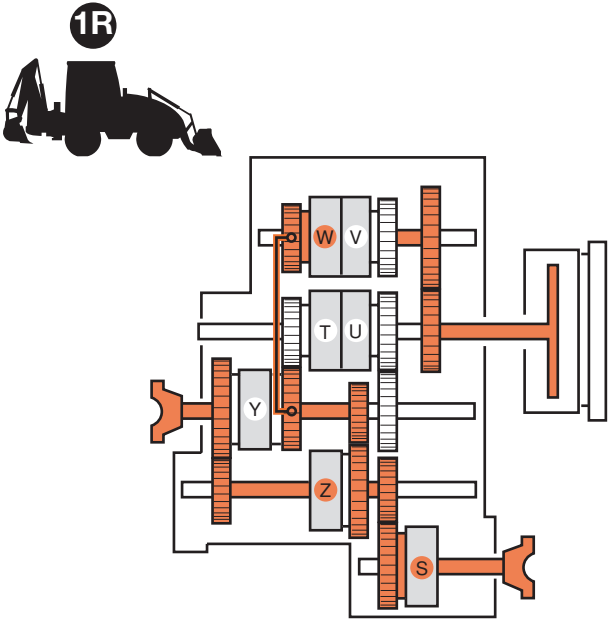


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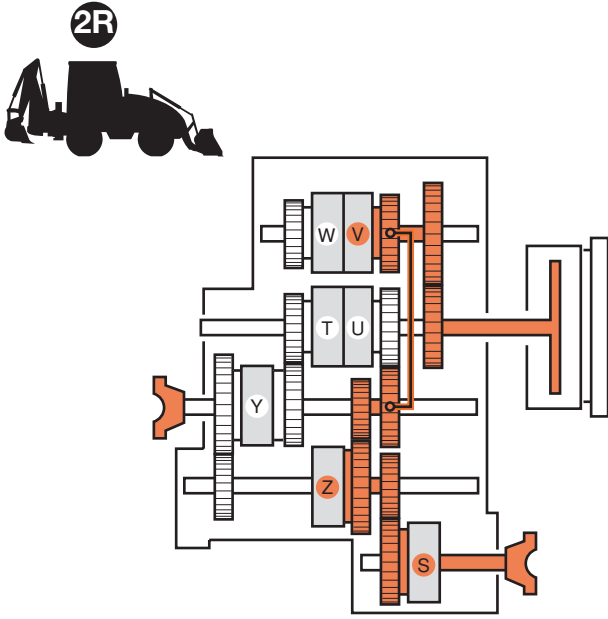


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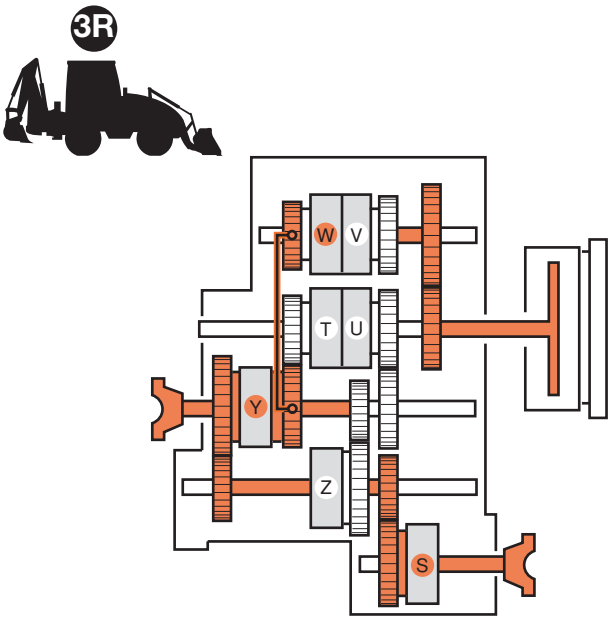
Powershift Gearbox



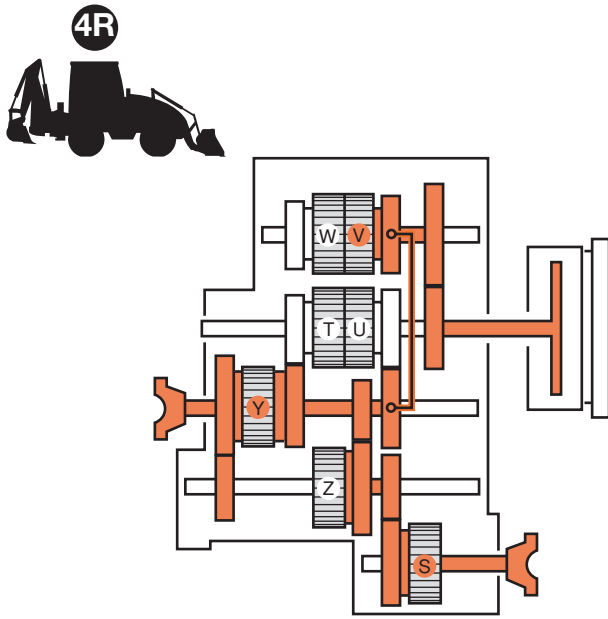
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Powershift Gearbox

Drivepaths - 4 Speed

1R

1st GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised
W	Reverse Low	Ws
Z	Layshaft	Zs
S	2/4 Wheel Drive	Ss

2R

2nd GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised
V	Reverse High	Vs
Z	Layshaft	Zs
S	2/4 Wheel Drive	Ss

3R

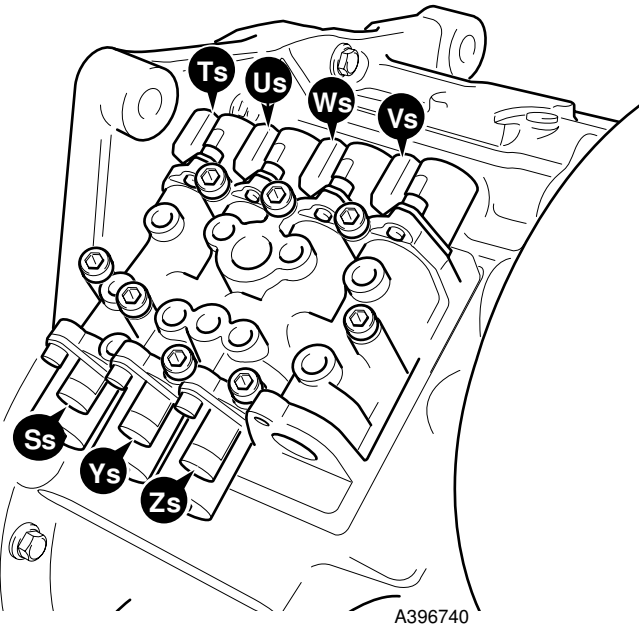
3rd GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised
W	Reverse Low	Ws
Y	Mainshaft	Ys
S	2/4 Wheel Drive	Ss

4R

4th GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised
V	Reverse High	Vs
Y	Mainshaft	Ys
S	2/4 Wheel Drive	Ss



Powershift Gearbox

Drivepaths - 6 Speed

1F

1st GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
X	'6 Speed'	Xs	
Z	Layshaft	Zs	
S	2/4 Wheel Drive	Ss	

2F

2nd GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
T	Forward Low	Ts	
Z	Layshaft	Zs	
S	2/4 Wheel Drive	Ss	

3F

3rd GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
U	Forward High	Us	
Z	Layshaft	Zs	
S	2/4 Wheel Drive	Ss	

4F

4th GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
X	'6 Speed'	Xs	
Y	Mainshaft	Ys	
S	2/4 Wheel Drive	Ss	

5F

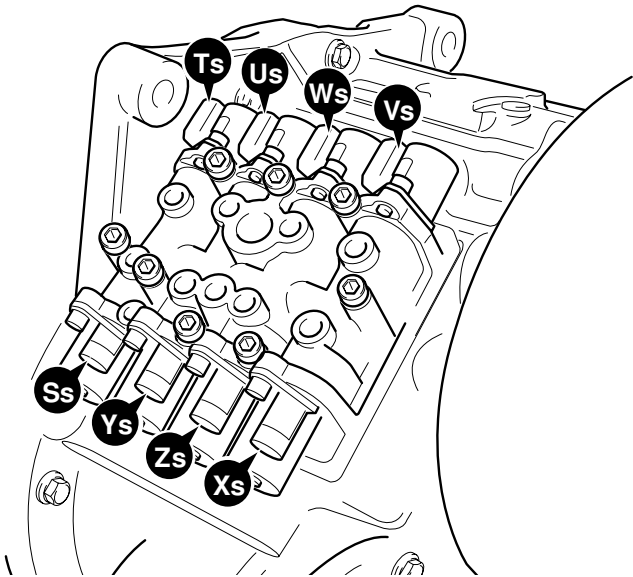
5th GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
T	Forward Low	Ts	
Y	Mainshaft	Ys	
S	2/4 Wheel Drive	Ss	

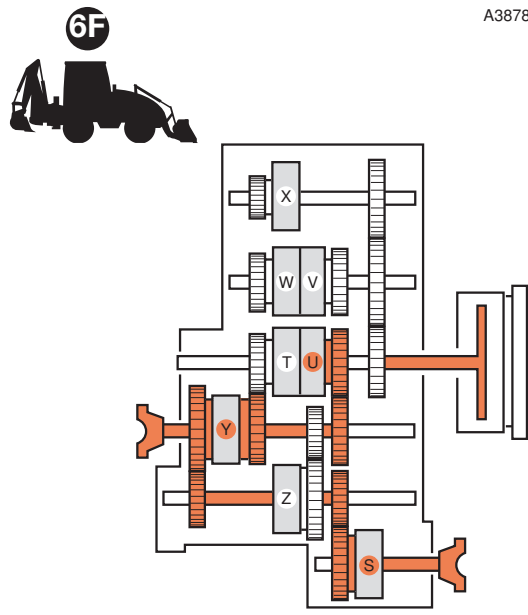
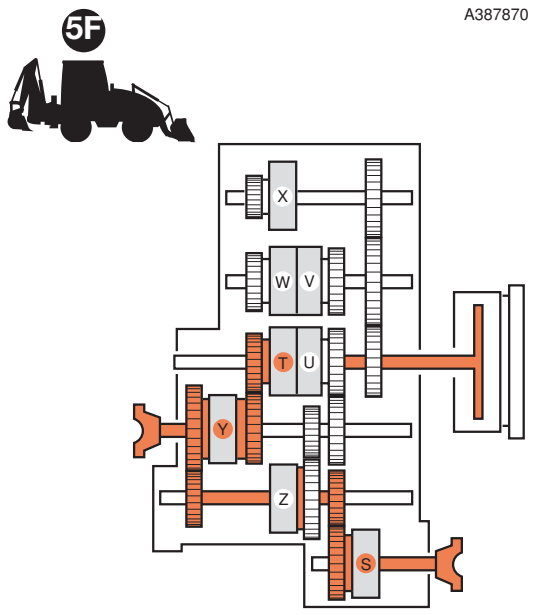
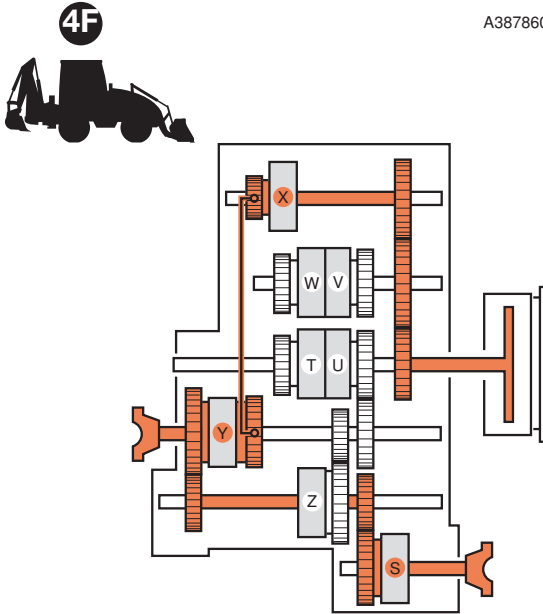
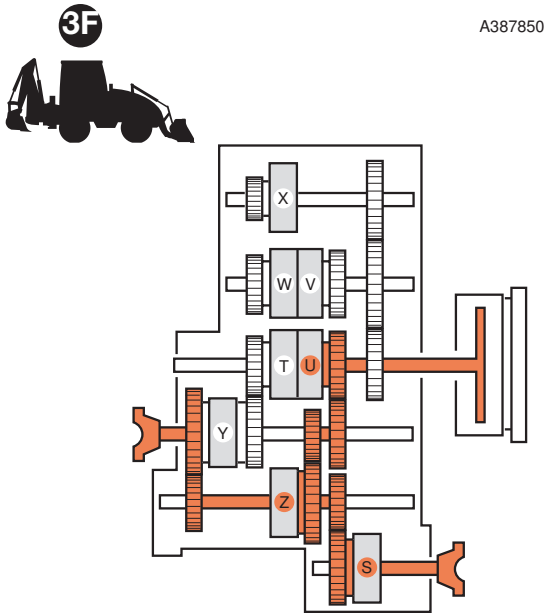
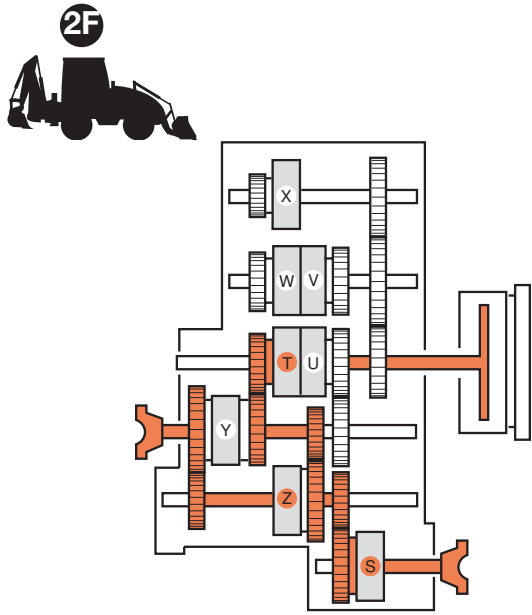
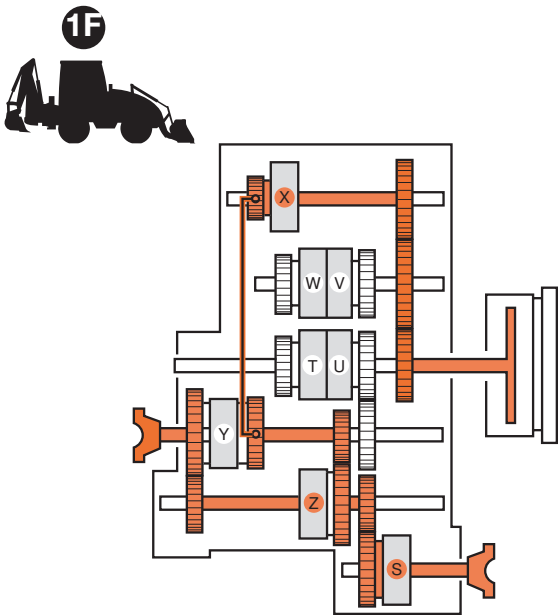
6F

6th GEAR FORWARD (4 wheel drive)

Clutches Engaged		Solenoids Energised	
U	Forward High	Us	
Y	Mainshaft	Ys	
S	2/4 Wheel Drive	Ss	



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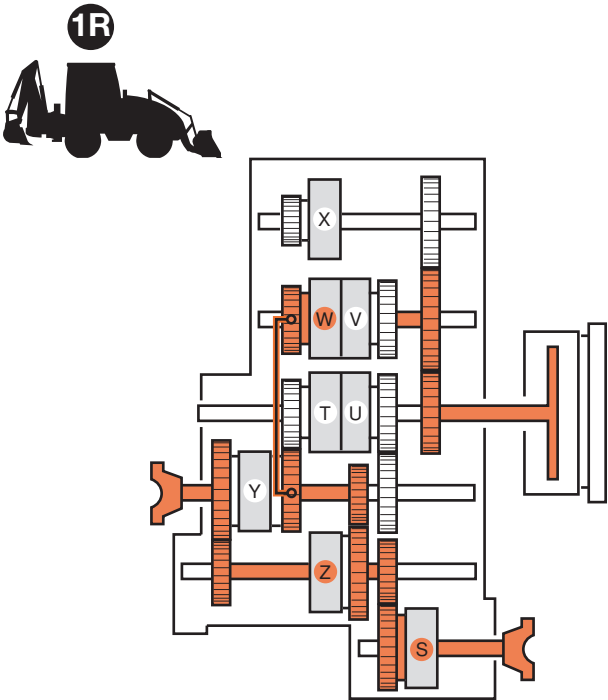
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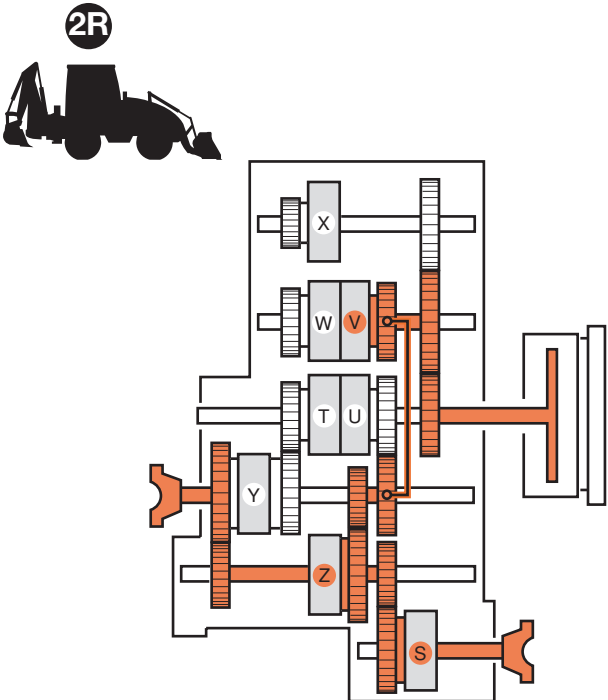
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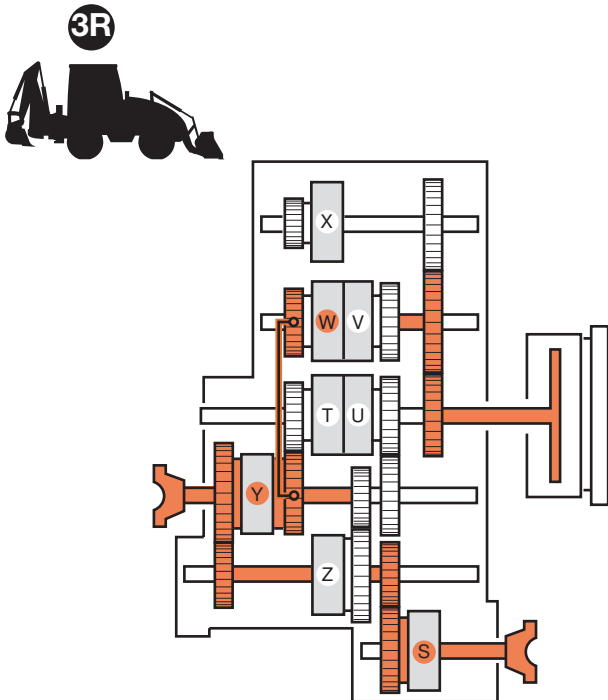
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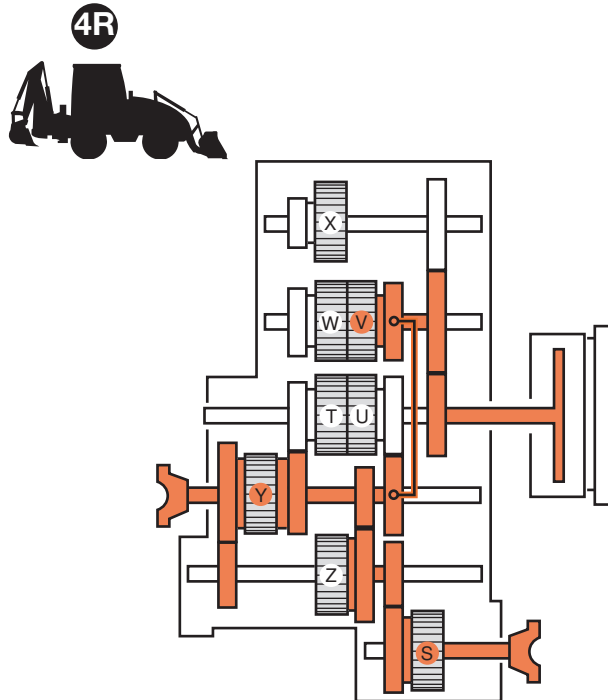
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Powershift Gearbox

Drivepaths - 6 Speed

1R

1st GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised	
W	Reverse Low	Ws	
Z	Layshaft	Zs	
S	2/4 Wheel Drive	Ss	

2R

2nd GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised	
V	Reverse High	Vs	
Z	Layshaft	Zs	
S	2/4 Wheel Drive	Ss	

3R

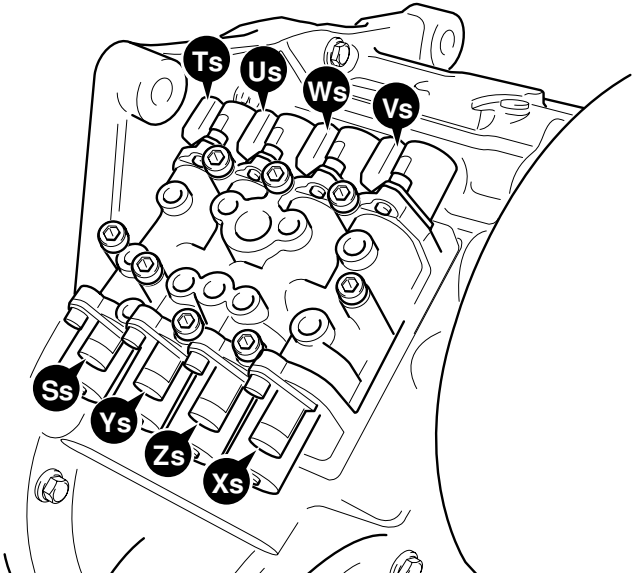
3rd GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised	
W	Reverse Low	Ws	
Y	Mainshaft	Ys	
S	2/4 Wheel Drive	Ss	

4R

4th GEAR REVERSE (4 wheel drive)

Clutches Engaged		Solenoids Energised	
V	Reverse High	Vs	
Y	Mainshaft	Ys	
S	2/4 Wheel Drive	Ss	



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Torque Converter

Component Identification

- A** Impeller
- B** Turbine
- C** Reaction member
- D** Drive plate
- E** Engine flywheel
- F** Drive to gearbox input shaft
- G** Spline location for reaction member
- H** Direct drive from the engine to the gearbox oil pump
- J** Direction of oil flow

Principle of Operation

The torque converter is similar to a fluid coupling, which utilises the centrifugal force exerted in the transmission oil to transmit power from the engine to the gearbox. It multiplies the torque from the engine and functions as a combined clutch and infinitely variable reduction gearbox.

The torque converter is enclosed in a casing and consists of three basic parts, the impeller **A**, reaction member **C**, and turbine **B**.

Impeller **A** is driven by the engine.

Reaction member **C** does not rotate. Its hub engages with a splined tube on the gearbox oil pump and is held stationary.

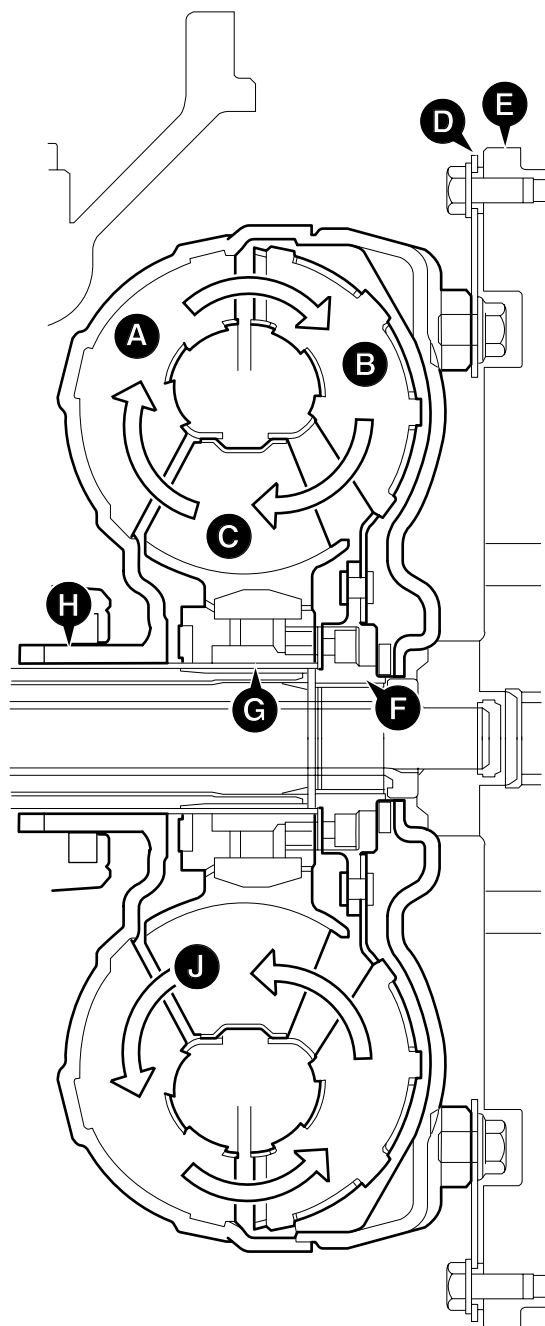
Turbine **B** is engaged with the splined end of the gearbox input shaft.

The impeller **A**, driven by the engine, forms one set of shaped blades, it can be likened to a centrifugal pump imparting energy to the transmission oil. This energy is transferred to another set of shaped blades, which form the turbine **B**. The turbine is connected to the gearbox and converts the energy back to a mechanical torque.

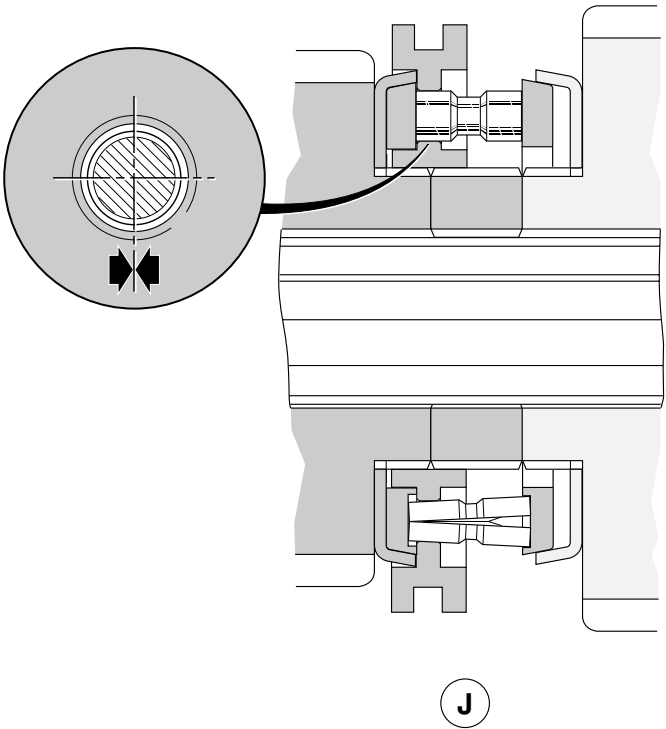
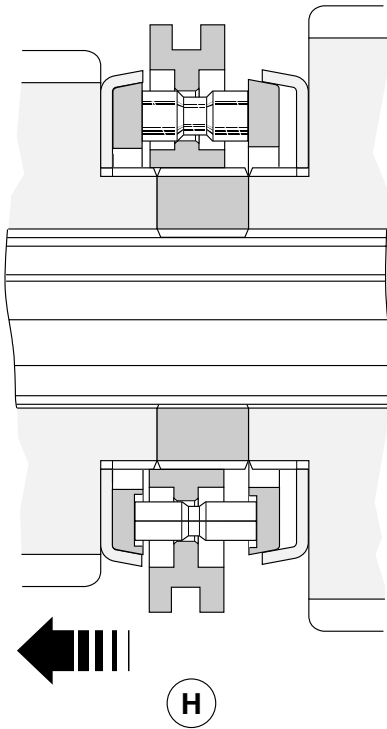
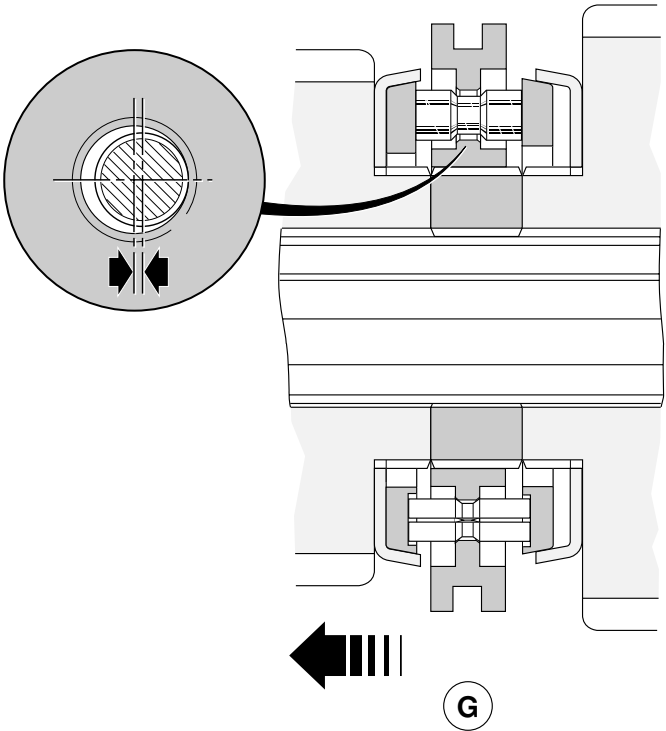
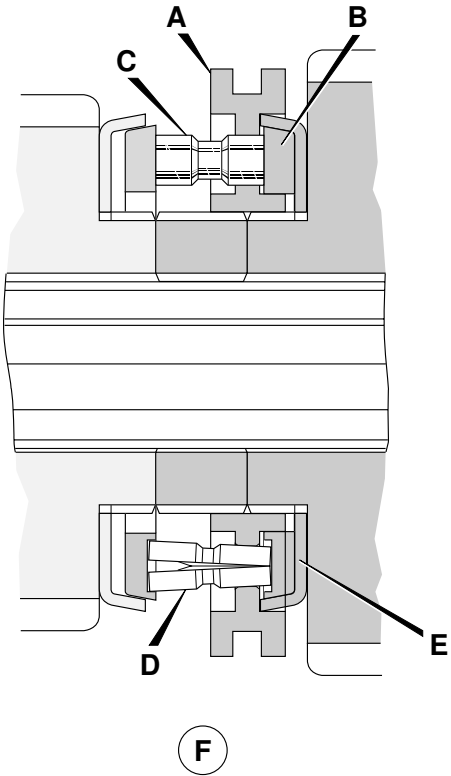
When the impeller **A** is rotating faster than the turbine **B**, the fixed reaction member **C** causes some of the energy in the oil to be transferred back to the impeller **A**. This has the effect of multiplying the torque available.

When the impeller **A** (input) is running much faster than the turbine **B** (output) there is a substantial circulation of transmission oil around the blades. The oil circulation is maximum when the turbine (output) is stalled, and is almost zero when the impeller and turbine speeds are equal i.e. the ratio is near 1:1. If the turbine (output) is stalled whilst the impeller (input) is revolving, all the power is dissipated as heat.

Because of the absence of a direct mechanical connection between the engine and the gearbox therefore, the flexibility of the torque converter drive greatly reduces wear on the transmission, absorbing shocks and torsional vibration from the engine. The engine cannot be stalled due to overload, as the fluid coupling slips.



A401340



Syncro Shuttle Gearbox

Synchromesh (Blocking Pin Type)

The gearbox is fitted with 'Blocking Pin' synchromesh, comprising the following parts.

SYNCRO HUB (A) controls the operation of the synchromesh unit and gear selection, the selector fork fitting into the outer groove. Internal dog teeth link the selected gear to the drive shaft. Through the syncro hub centre are two sets of holes for the blocker pins (C) and the split energiser pins (D), spaced alternately.

SYNCRO RINGS (B) are rigidly joined by the blocker pins, with the split energiser pins held, in counterbores, between the two syncro rings.

BLOCKER PINS (C) have a narrow neck in the centre, against which the syncro hub transmits radial drive during gear changes. The edges of the blocker pin neck and their mating syncro hub holes are designed so that, as the radial loads are reduced, the syncro hub can slide over the shoulder of the blocker pin.

SPLIT ENERGISER PINS (D) take the initial axial load of the syncro hub on the shoulder of the split energiser pin neck. As the axial load reaches approximately 400 N (40.8 kg; 90 lb) the internal springs allow the split energiser pin to collapse and the syncro hub to move axially.

SYNCRO CUPS (E) take the frictional drive from the syncro ring on their inner faces. The syncro cups are splined to drive their respective gears whilst synchronisation is taking place.

SYNCHROMESH - OPERATION

Diagram F shows the gearbox with first gear engaged. Syncro ring B is in contact with syncro cup E and the syncro hub dog teeth are linking first gear to the shaft gear. In this position the split energiser pins D are 'collapsed'.

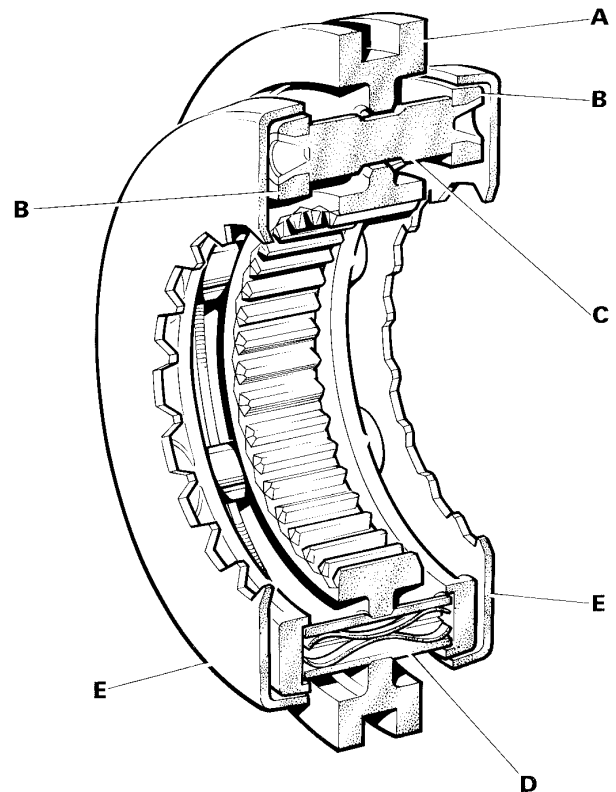
When selecting second gear the syncro hub A slides along the split energiser pins until the pin recess and the syncro hub flange are in line. At this point the split energiser pins open and the syncro rings are moved by the syncro hub pushing on the split energiser pin shoulder.

Initial contact between the syncro ring and the syncro cup starts to synchronise the speed of the shaft and second gear. The rotational force of the syncro ring is taken by the blocker pin against the edge of the syncro hub hole, as at G.

As the axial load on the syncro hub increases, the split energiser pin 'collapses' and the conical faces of the blocking pin and syncro hub hole come into contact, as at H.

Further increases in the axial loads increase the frictional grip of the syncro ring and the syncro cup, causing the shaft and gear speeds to synchronise.

As the speeds are synchronised the radial load on the blocker pin and the syncro hub is reduced. This allows the syncro hub to slide freely along the blocker pin and engage its dog teeth with second gear, see diagram J.



Syncro Shuttle Gearbox

Forward/Reverse Clutch Operation

The forward/reverse clutch unit **1** transfers drive from the input shaft **A3** to either gear **G1** or gear **G2** depending on which of the two clutches (**A1** or **A2**) is engaged, giving forward or reverse drive. When neither clutch is engaged, neutral is selected.

The clutches are of the wet, multi-plate type.

The clutch housings and input shaft are a one piece assembly **A3**. The assembly is permanently driven by the engine via the torque converter. Clutch counter plates **3** are also permanently driven via meshing teeth inside the clutch housings.

Clutch friction plates **4** are meshed with the gear/plate carriers (**G1** and **G2**).

In the diagram, clutch **A1** is engaged. The counter plates **3** and friction plates **4** are pressed together by hydraulically actuated piston **5**. Drive is then transmitted from the input shaft to the gear **G1**.

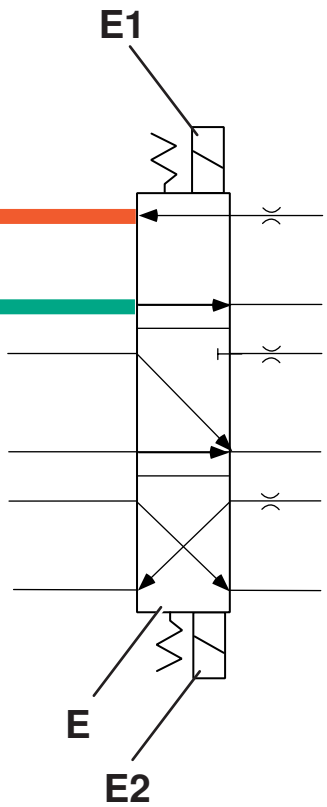
Clutch **A2** is disengaged and no drive is transmitted to gear/plate carrier **G2**. The gear is also free to rotate on the input shaft assembly.

Actuation of the hydraulic pistons **10** and **5** is controlled via three position solenoid valve **E†**.

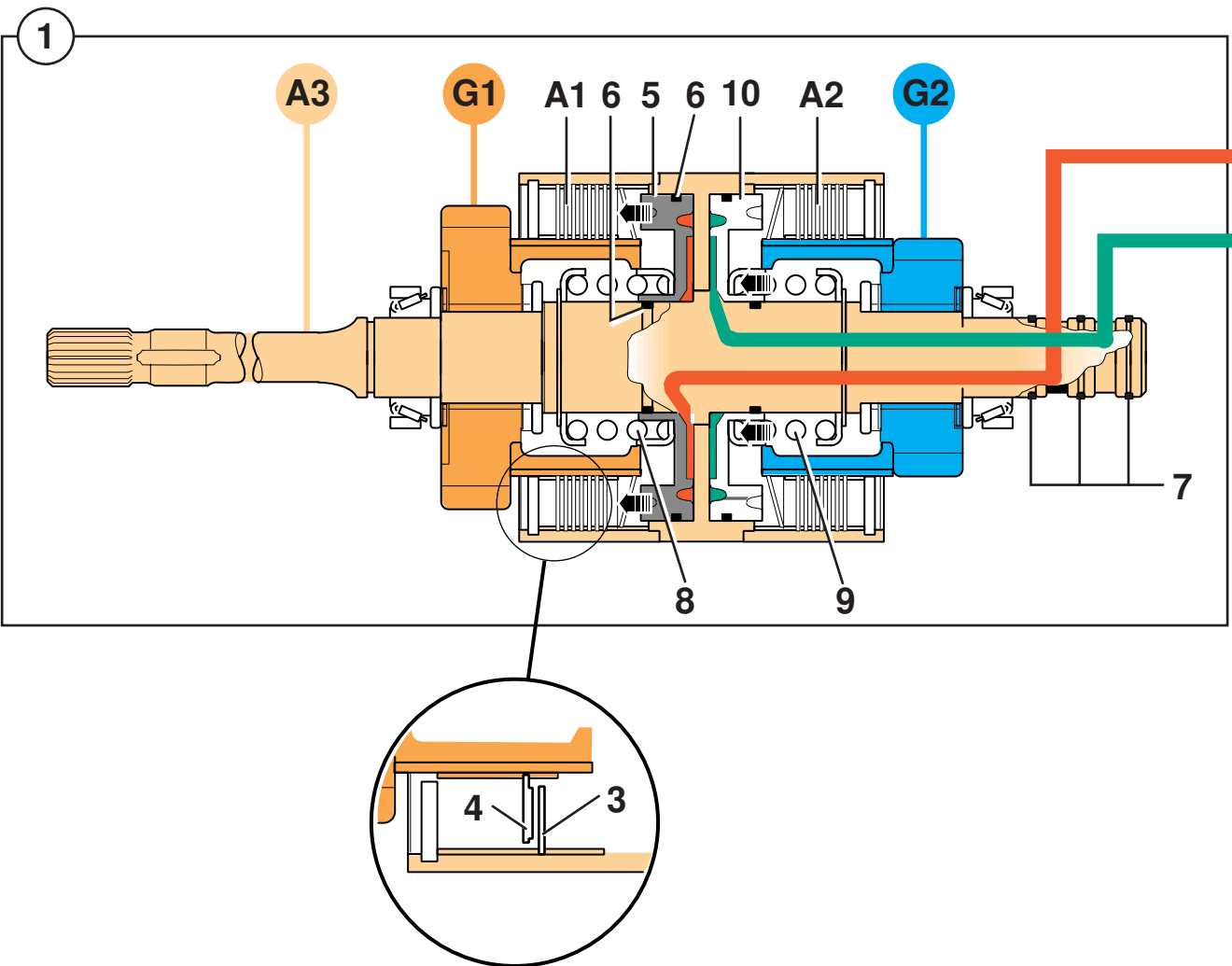
When neutral is selected, solenoids **E1** and **E2** are deactivated and the flow of pressurised oil to the clutches is blocked. Springs **8** and **9** move the pistons away from the clutch plates and oil from both pistons is vented to the sump.

When either forward or reverse is selected, the solenoid valve **E** diverts pressurised oil via cross drillings inside the input shaft **A3** to the appropriate clutch (piston **10** or **5**) in the unit. Pressure from the other clutch is vented to the sump via the solenoid valve spool. Oil is prevented from leaking by seals **6** on the pistons and ring seals **7** on the input shaft **A3**.

†The valve **E** is shown using symbols. For an explanation of how the symbols work, see **Section E, Introduction to Hydraulic Schematic Symbols**.



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Syncro Shuttle Gearbox Forward/Reverse Clutch Operation

Synchro Shuttle Gearbox

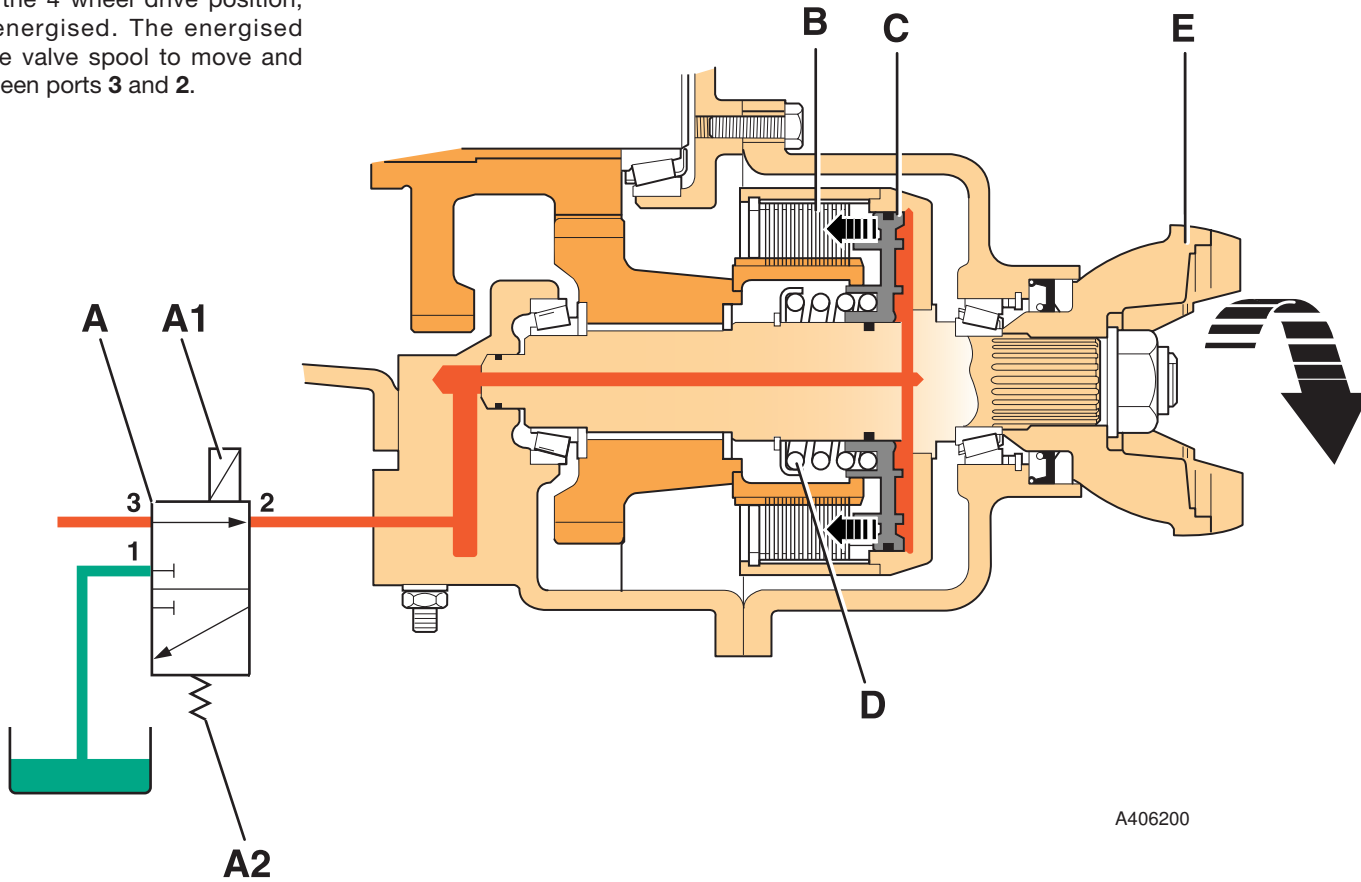
2/4 Wheel Drive Clutch Operation - Pressure ON/Spring OFF Type

4 Wheel Drive Operation

This clutch is of the 'Pressure-ON (4WD)/Spring-OFF (2WD)' type. The clutch is engaged and disengaged by introducing or dumping pressurised oil behind piston **C** via a solenoid valve **A**. The solenoid valve is operated by a switch in the cab.

When the switch is in the 4 wheel drive position, solenoid valve **A** is energised. The energised solenoid **A1** causes the valve spool to move and form a connection between ports **3** and **2**.

Pressurised oil is directed to piston **C** via ports **3** and **2**. The piston moves, against spring **D**, to press the friction/counter plates of clutch pack **B** together, thus driving the output yoke **E**.



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Synchro Shuttle Gearbox

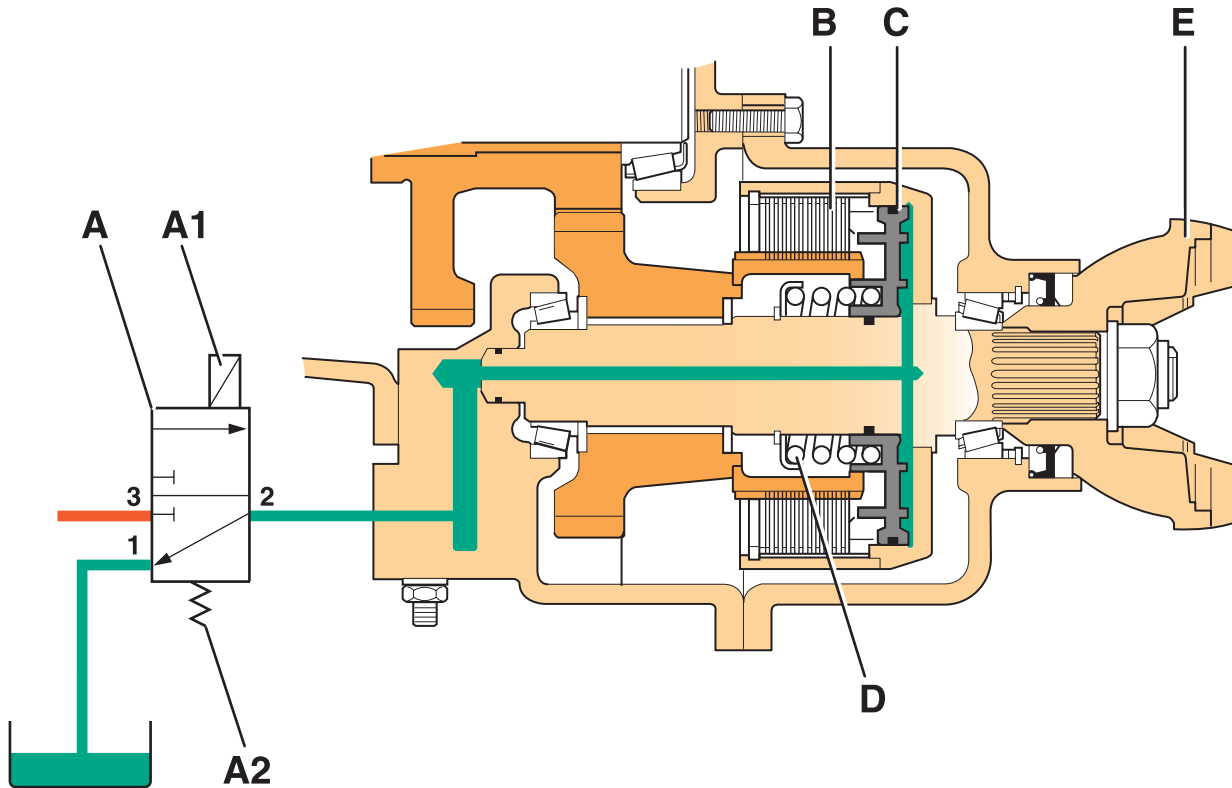
2/4 Wheel Drive Clutch Operation

- Pressure ON/Spring OFF Type (cont'd)

2 Wheel Drive Operation

When the switch is in the 2 wheel drive position, solenoid valve **A** is de-energised. With the solenoid **A1** de-energised, the valve spool moves under the force of the spring **A2**. The oil supply to the piston **C** is blocked (shown at port **3**). At the same time oil vents from the back of piston **C** to the sump via ports **1** and **2**.

Because there is no pressure behind piston **C**, the friction/counter plates of clutch pack **B** now freely rotate on the output shaft, thus disengaging drive to the front axle.



A406210

Synchro Shuttle Gearbox

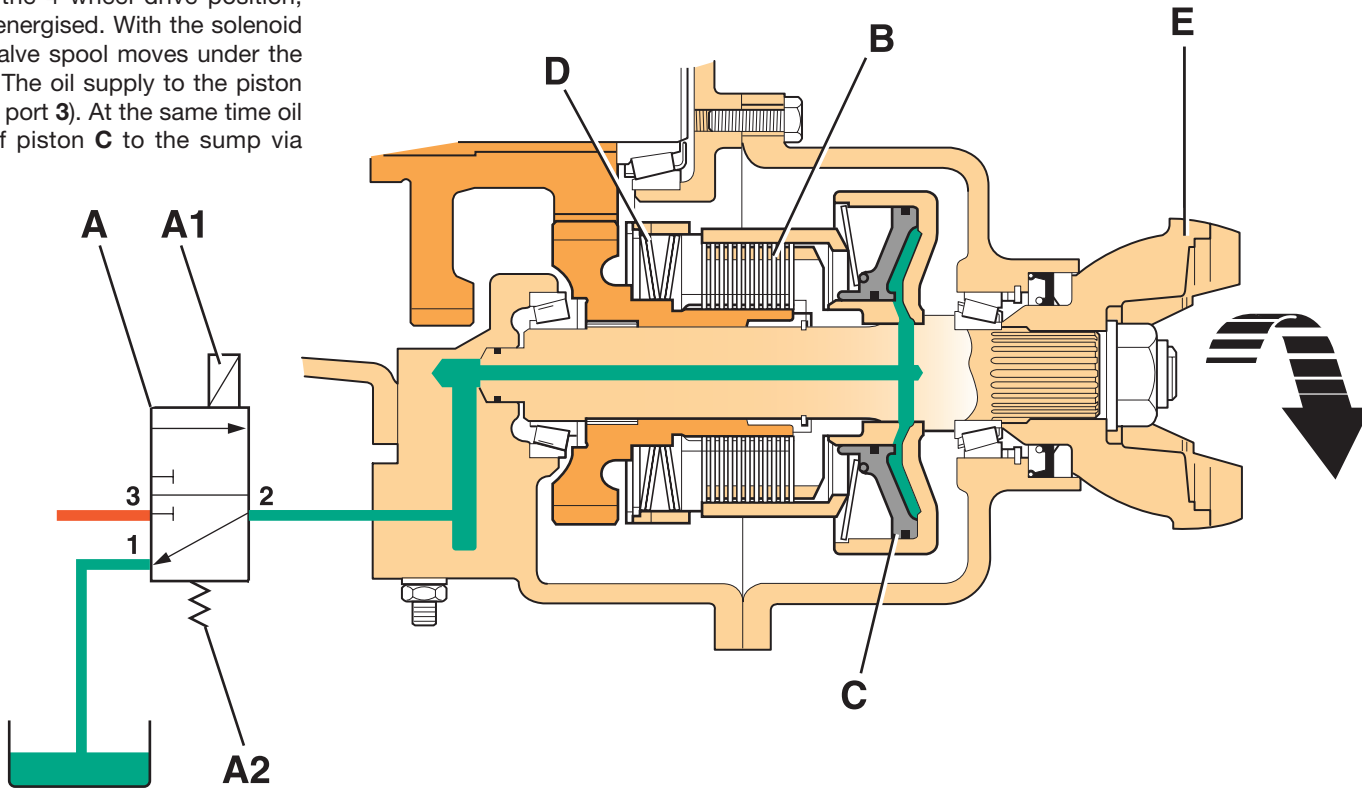
2/4 Wheel Drive Clutch Operation - Spring ON/Pressure OFF Type

4 Wheel Drive Operation

This clutch is of the 'Spring-ON (4WD)/Pressure-OFF (2WD)' type. The clutch is engaged and disengaged by introducing or dumping pressurised oil behind piston **C** via a solenoid valve **A**. The solenoid valve is operated by a switch in the cab.

When the switch is in the 4 wheel drive position, solenoid valve **A** is de-energised. With the solenoid **A1** de-energised, the valve spool moves under the force of the spring **A2**. The oil supply to the piston **C** is blocked, (shown at port **3**). At the same time oil vents from the back of piston **C** to the sump via ports **1** and **2**.

Because there is no pressure behind piston **C**, the clutch friction/counter plates of clutch pack **B** are forced together by disc springs **D**, thus driving the output yoke **E**.



A406220

Synchro Shuttle Gearbox

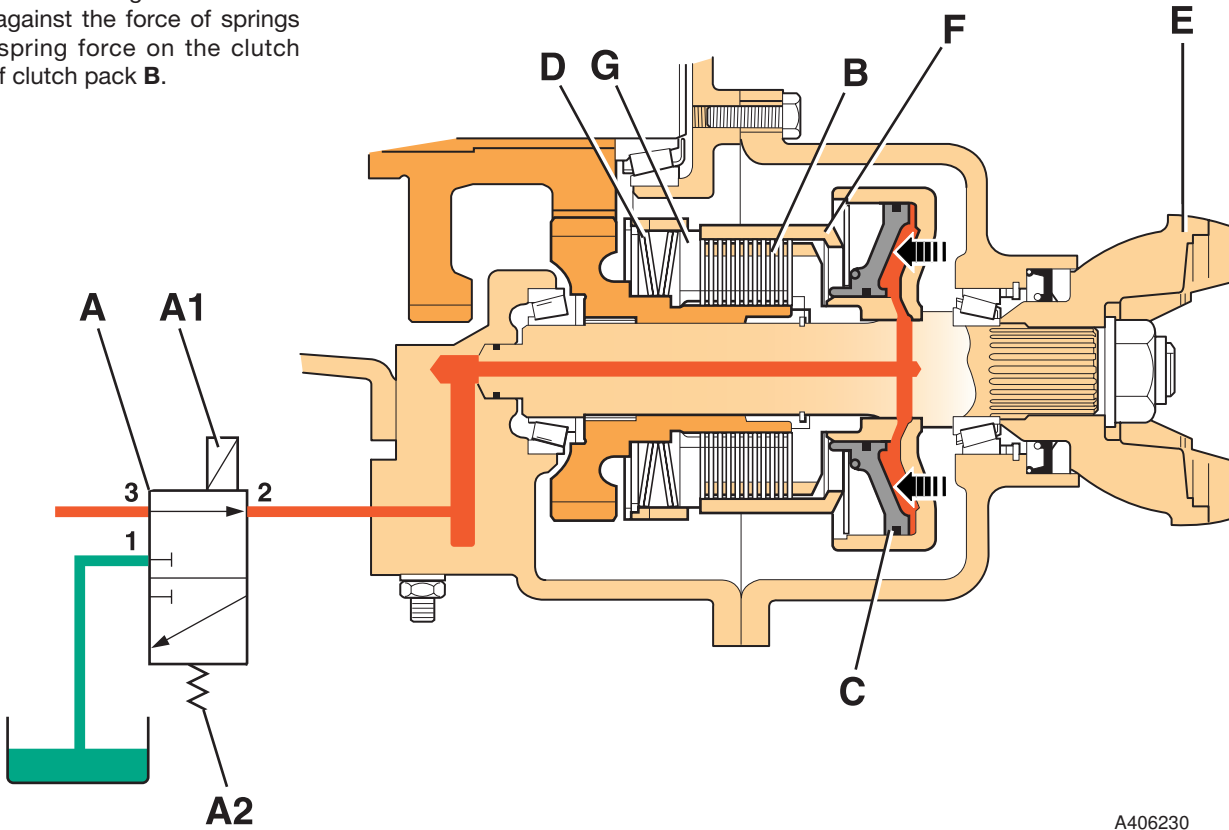
2/4 Wheel Drive Clutch Operation - Spring ON/Pressure OFF Type (cont'd)

2 Wheel Drive Operation

When the switch is in the 2 wheel drive position, solenoid valve **A** is energised. The energised solenoid **A1** causes the valve spool to move and form a connection between ports **3** and **2**.

Pressurised oil is directed to piston **C** via ports **3** and **2**. The piston moves actuating sleeve **F** and then pressure plate **G** against the force of springs **D**, thus releasing the spring force on the clutch friction/counter plates of clutch pack **B**.

Because there is no spring force, the friction/counter plates of clutch pack **B** now freely rotate on the output shaft, thus disengaging drive to the front axle.



A406230

Powershift Gearbox

Clutch Operation - Forward, Reverse

The forward and reverse clutch units are very similar in design and operate in the same way. The following description refers to one unit and can be applied to either the forward or reverse clutch units.

The clutch **1** transfers drive from the input shaft **A3** to either gear **G1** or gear **G2** depending on which of the two clutches (**A1** or **A2**) is engaged, transferring drive to the mainshaft. When neither clutch is engaged, neutral is selected.

The clutches are of the wet, multi-plate type.

The clutch housings and input shaft are a one piece assembly **A3**. The assembly is permanently driven by the engine via the torque converter. Clutch counter plates **3** are also permanently driven via meshing teeth inside the clutch housings.

Clutch friction plates **4** are meshed with the gear/plate carriers (**G1** and **G2**).

In the diagram, clutch **A1** is engaged. The counter plates **3** and friction plates **4** are pressed together by hydraulically actuated piston **5**. Drive is then transmitted from the input shaft to the gear **G1**.

Clutch **A2** is disengaged and no drive is transmitted to gear/plate carrier **G2**. The gear is also free to rotate on the input shaft assembly.

Actuation of the hydraulic pistons **10** and **5** is controlled via two position solenoid valves **E1** and **E2**[†].

When neutral is selected, solenoids **E1** and **E2** are deactivated and the flow of pressurised oil to the clutches is blocked. Springs **8** and **9** move the pistons away from the clutch plates and oil from both pistons is vented to the sump.

When for example clutch **A1** is selected to be engaged, solenoid valve **E1** is energised and solenoid valve **E2** is de-energised. Pressurised oil is diverted via cross drillings inside the input shaft **A3** to the clutch piston **5**. Pressure from clutch **A2** is vented to the sump via the solenoid valve spool **E2**. Oil is prevented from leaking by seals **6** on the pistons and ring seals **7** on the input shaft **A3**.

[†]The valve **E** is shown using symbols. For an explanation of how the symbols work, see **Section E, Introduction to Hydraulic Schematic Symbols**.

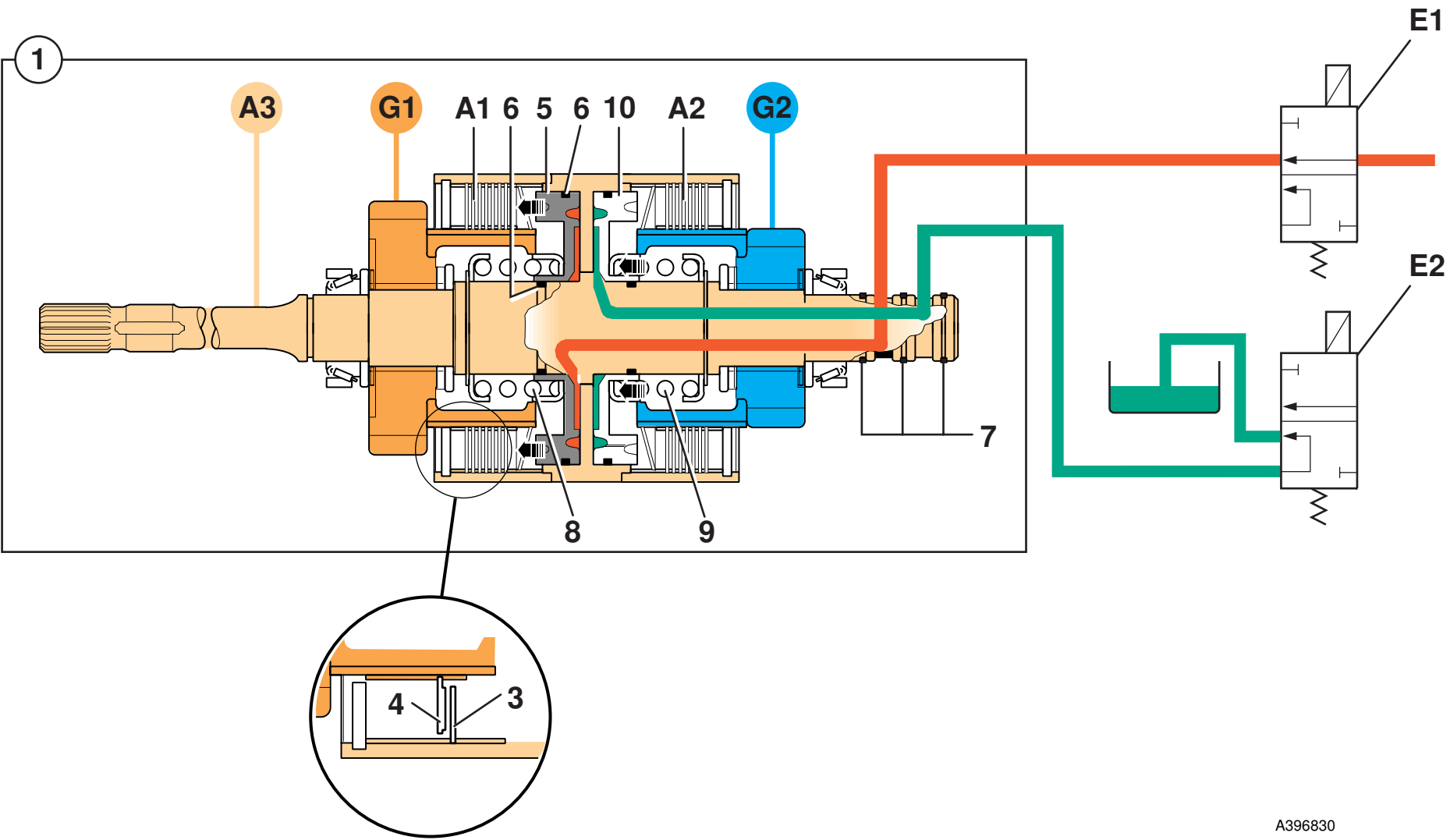
Clutch Operation - Mainshaft, Layshaft, 6 Speed

The mainshaft, layshaft and 6 speed units all incorporate one clutch and not two, as in the forward and reverse units. The operation of the single clutches is the same as for one clutch in the forward or reverse units.

Clutch Operation - 2/4 Wheel Drive Clutch

The 2/4 wheel drive clutch is similar to the Synchro Shuttle 2/4 wheel drive clutch. See **Synchro Shuttle Gearbox, 2/4 Wheel Drive Clutch Operation**.

A396830



Powershift Gearbox **Clutch Operation - Forward, Reverse**

Powershift Gearbox - 4 Speed

Introduction

This section explains how the electrical system works when the following gearbox functions are operated:

1st, 2nd, 3rd and 4th gears forward

Neutral

1st, 2nd, 3rd and 4th gears reverse

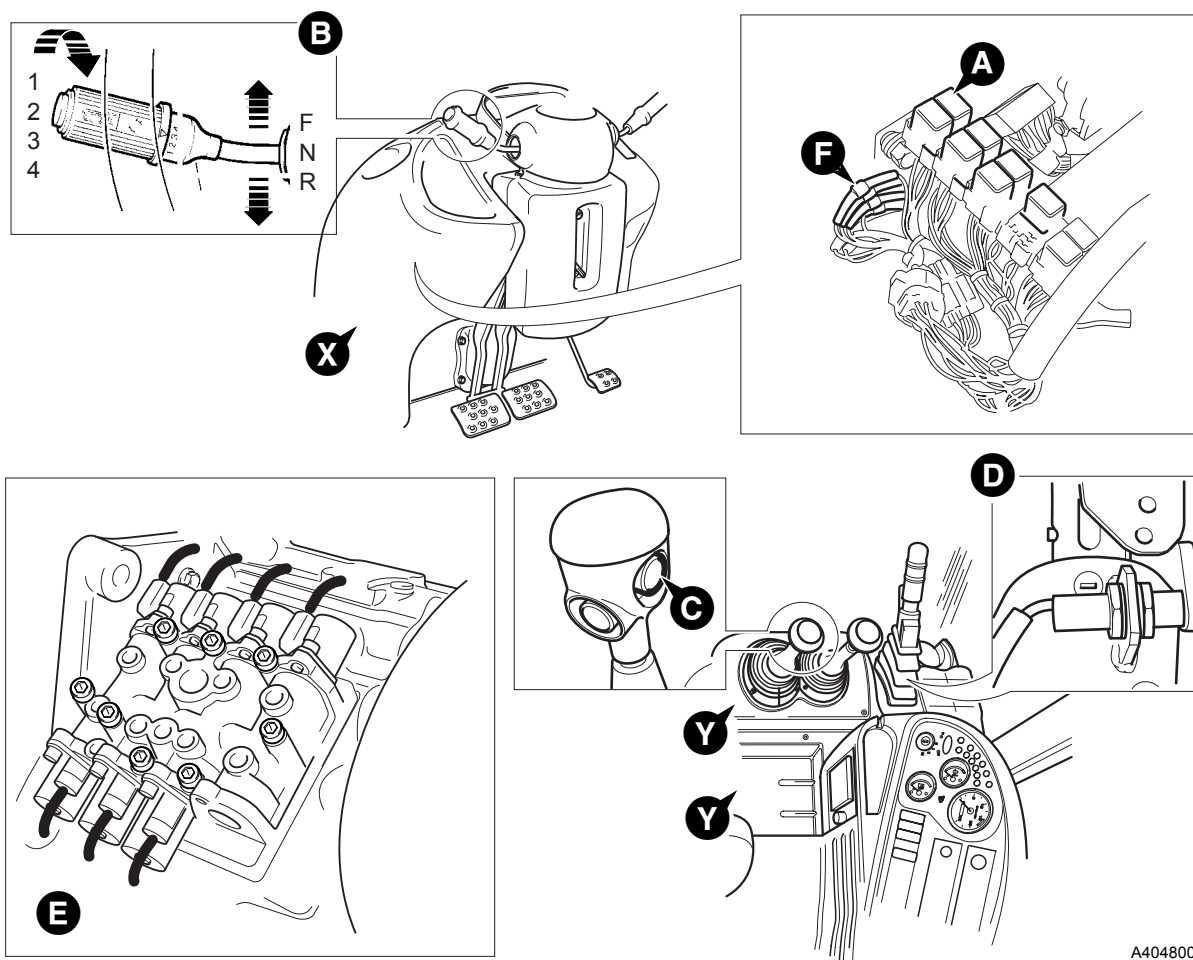
Transmission dump

Park brake switch

The 4-speed powershift gearbox is controlled using conventional relays. The relays at **A** are operated via the column mounted gear and forward/reverse lever **B**. The transmission dump switch **C** or park brake switch **D** also operate a relay at **A**. The contacts inside the relays energise the gearbox mounted solenoid control valves **E**.

Diode 'gates' **F** are also used as logic switches.

To access the relays and connectors it is necessary to remove the front/steering console panel **X** and side panels **Y**, refer to **Section B** for the correct procedure.



A404800

Powershift Gearbox - 4 Speed (cont'd)

Electrical Connections - Quick Reference

The tables show switch positions together with energised relay and gearbox solenoids for each gearbox function (reverse gears are shown on the next page). The numbers show which contacts are 'live' and also relate to the actual connector pin numbers.

When fault finding it should be remembered that the system relies on the dump switch and park brake switches functioning correctly, failure of these switches will prevent forward or reverse gears being selected. From the tables it is possible to see common relay functions which can help trace faults. For example we can see that relay FF2 is energised to engage 1st or 2nd gear. Failure of these gears to select may indicate a fault with relay FF2.

Note that a non functioning relay or solenoid may not indicate a faulty component, the associated wires and connectors may have failed. For wire and connector details see the relevant schematic.

Diagram X

The diagram **X** (opposite) shows the electrical circuit for the gearbox control. It is shown with 3rd gear forward selected. 'Live feed' wires are coloured red and feed to earth are green.

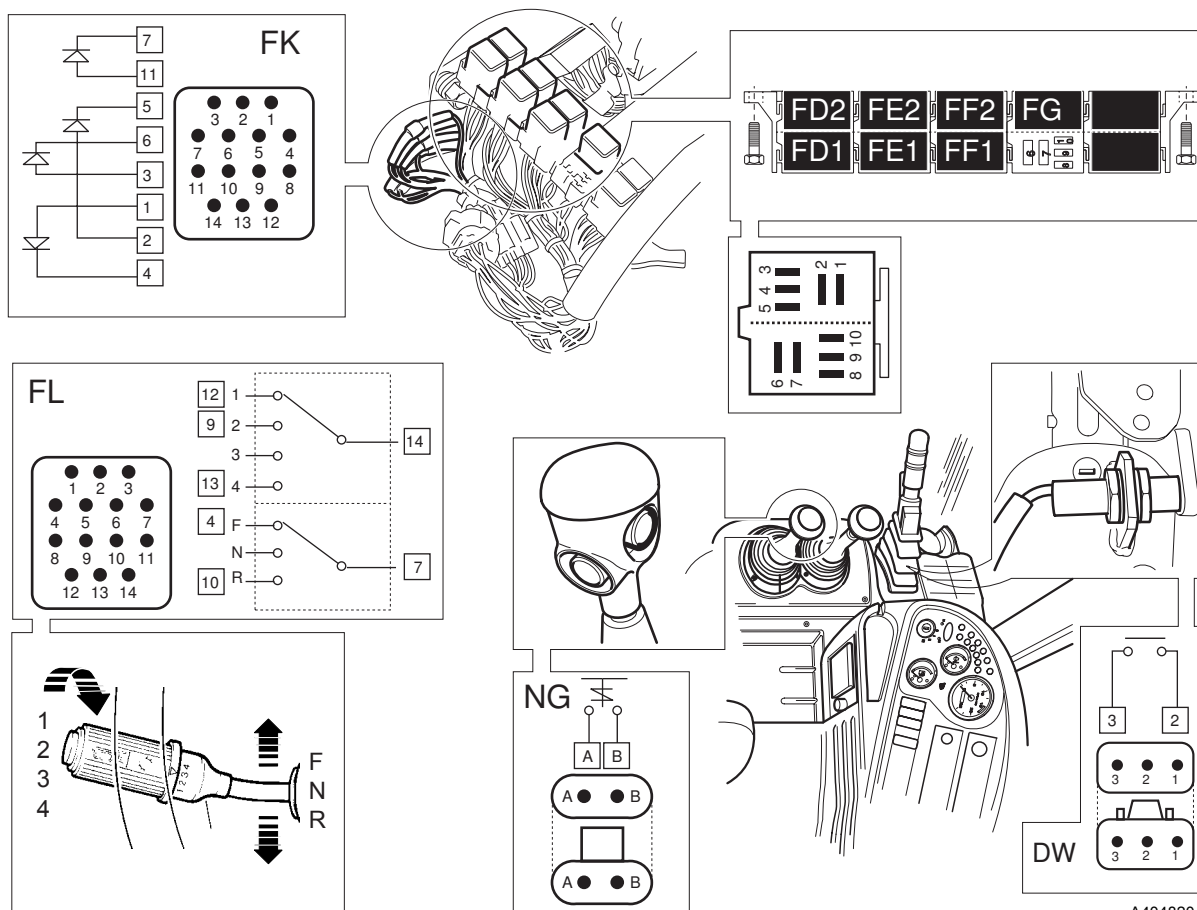
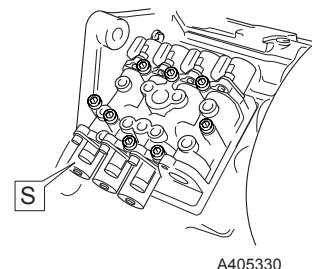
Key

C50	Reverse alarm
DW	Park brake switch
FL	Column switch connector
FK	Diode gate connector
FG	Transmission dump relay
FD2	Forward relay
FE2	Reverse relay
FF1	Interlock relay
FD1	Forward Hi/Lo relay
FE1	Reverse Hi/Lo relay
FF2	Mainshaft/Layshaft relay
NG	Dump switch

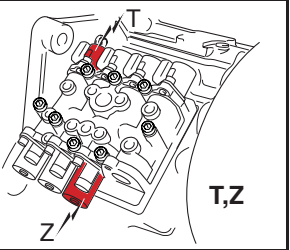
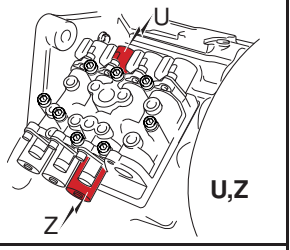
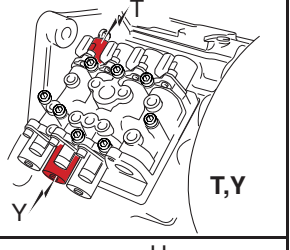
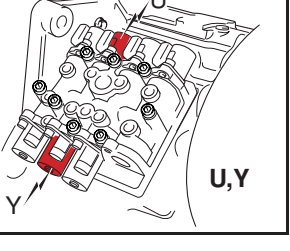
Gearbox Solenoids

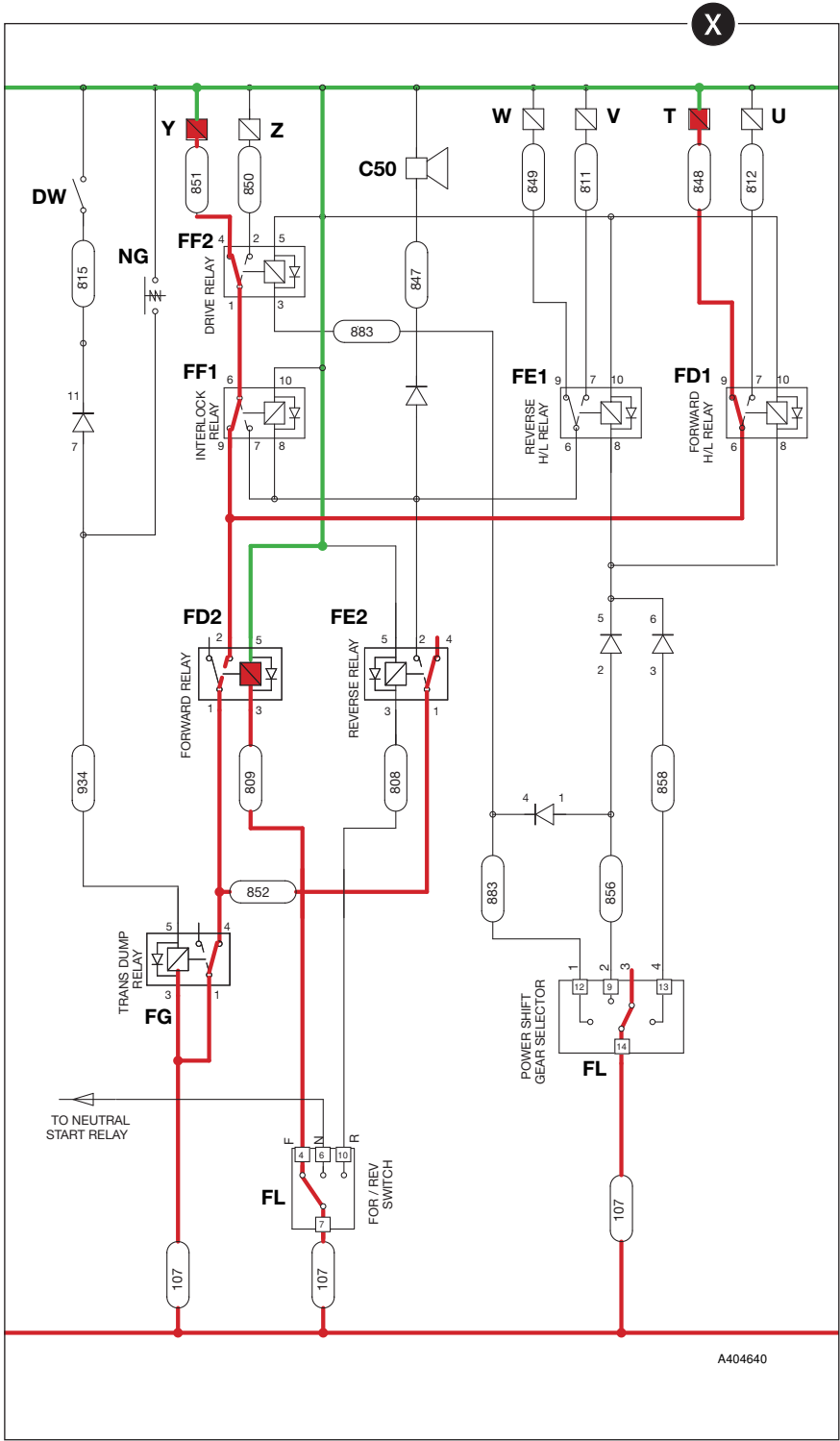
T	Forward low
U	Forward high
Y	Mainshaft
Z	Layshaft

Note: Solenoid **S** is the 2/4WD solenoid. The 2/4WD select electrical system is not described in this section.



Powershift Gearbox - 4 Speed

Gearbox function	Column Switch FL	Relay FG Dump	Relay FD2 Forward	Relay FE2 Reverse	Relay FF1 Interlock	Diode Gate FK	Relay FD1 Forward Hi Lo	Relay FE1 Reverse Hi Lo	Relay FF2 Mainshaft Layshaft	Gearbox Solenoid
1st GEAR FORWARD	14 - 12 7 - 4	1 - 4	3 - 5, 1 - 2	1 - 4-1	9 - 6	4	6 - 9		3 - 5, 1 - 2	
2nd GEAR FORWARD	14 - 9 7 - 4	1 - 4	3 - 5, 1 - 2	1 - 4-1	9 - 6	2 - 5, 1 - 4 1 - 4	8 - 10, 6 - 7		3 - 5, 1 - 2	
3rd GEAR FORWARD	7 - 4	1 - 4	3 - 5, 1 - 2	1 - 4-1	9 - 6		6 - 9		1 - 4	
4th GEAR FORWARD	14 - 13 7 - 4	1 - 4	3 - 5, 1 - 2	1 - 4-1	9 - 6	3 - 6 2 - 5	8 - 10, 6 - 7		1 - 4	
NEUTRAL			1 - 4-1	1 - 4-1						
TRANSMISSION DUMP / PARK BRAKE ON		5 - 3, 1 - 2								



[illegible]

Powershift Gearbox - 4 Speed (cont'd)

Electrical Connections - Quick Reference (cont'd)

The tables show switch positions together with energised relay and gearbox solenoids for each gearbox function. The numbers show which contacts are 'live' and also relate to the actual connector pin numbers.

When fault finding it should be remembered that the system relies on the dump switch and park brake switches functioning correctly, failure of these switches will prevent both forward and reverse being selected. From the tables it is possible to see common relay functions which can help trace faults. For example we can see that relay FF2 is energised to engage 1st or 2nd gear. Failure of these gears to select may indicate a fault with relay FF2.

Note that a non functioning relay or solenoid may not indicate a faulty component, the associated wires and connectors may have failed. For wire and connector details see the relevant schematic.

Diagram Y

The diagram Y opposite shows the electrical circuit for the gearbox control. It is shown with 3rd gear reverse selected. 'Live feed' wires are coloured red and feed to earth are green.

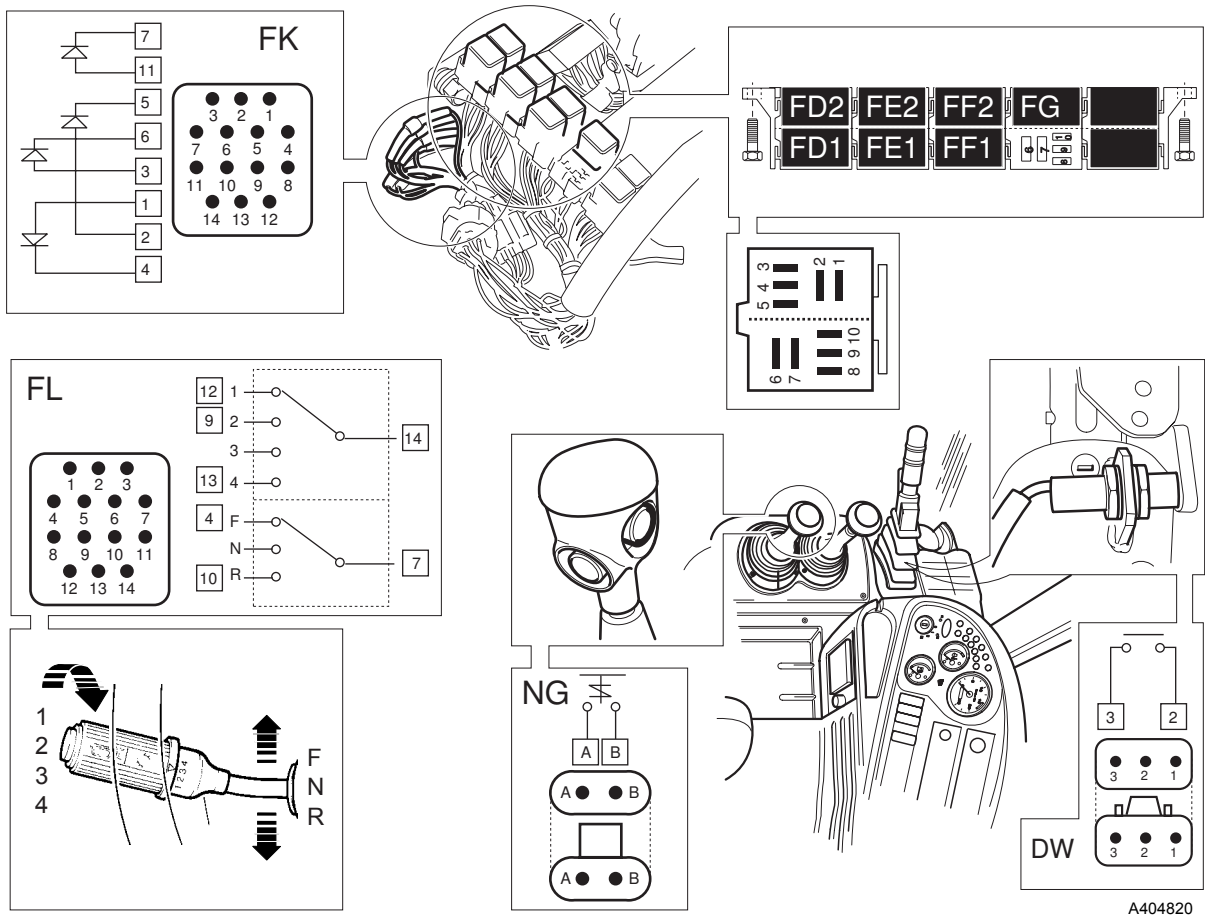
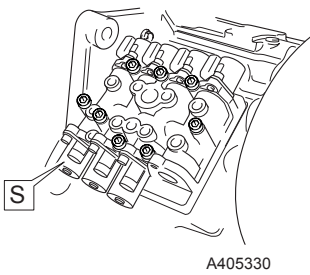
Key

C50	Reverse alarm
DW	Park brake switch
FL	Column switch connector
FK	Diode gate connector
FG	Transmission dump relay
FD2	Forward relay
FE2	Reverse relay
FF1	Interlock relay
FD1	Forward Hi/Lo relay
FE1	Reverse Hi/Lo relay
FF2	Mainshaft/Layshaft relay
NG	Dump switch

Gearbox Solenoids

V	Reverse high
W	Reverse low
Y	Mainshaft
Z	Layshaft

Note: Solenoid **S** is the 2/4WD solenoid. The 2/4WD select electrical system is not described in this section.



Powershift Gearbox - 4 Speed
(Machines up to 933756)

Electrical Connections - Wires and Connectors

Although the system is straight forward in design it is never the less fairly complex in practice. For this reason schematics are divided into 2 parts: **Relay Actuation** and **Gearbox Solenoid Actuation**.

On the electrical diagram opposite the electrical connectors (example, FA to LA) are shown looking on the mating face of each connector when they are disconnected.

The wire numbers and colours, where appropriate, are shown as an aid to identification whilst fault finding.

Before fault finding make sure that you understand how the the electrical circuits work. Most potential faults can be traced using a multimeter to carry out continuity checks on wires, switches and soleniod coils. Gearbox solenoid coils can be checked for the correct resistance value as given in **Technical Data**. See **Service Procedures, Electrical Testing Methods** for more details.

Relay Actuation

For gearbox solenoid actuation see subsequent pages.

Component Key (Relay actuation):

The following key identifies the component connectors on the opposite diagrams. Note that the wires coloured red show the electrical ‘live feed’ to the column gear lever.

- h1** Harness - 721/10940 Front console
- h2** Harness - 721/10942 Link
- h3** Harness - 721/10936 Side console
- h4** Harness - 721/10935 Engine/mainframe

Note: For harness drawings see **Section C**.

Connectors (h1)

- FA** h1 → h2
- FB1** Earth point
- FD1** Forward high/low relay
- FD2** Forward relay
- FE1** Reverse high/low relay
- FE2** Reverse relay
- FF1** Interlock relay
- FF2** Mainshaft/layshaft relay
- FG** Transmission dump relay
- FK** Diode gate
- FL** Column gear lever

Connectors (h2)

- LA** h2 → h1
- LB** h2 → h3

Connectors (h3)

- CA** h3 → h4
- CB** h3 → h2
- CCA** Fuses
- CCB** Fuses
- CM** Park brake relay
- DW** Park brake switch
- EA** Immobiliser
- EAB** Link - immobiliser (if immobiliser is not fitted)

Connectors (h4)

- NH** h4 → h3
- NG** Transmission dump switch
- MB1** Earth point

Splices (h1)

- SL**
- SC**
- SG**
- SH**
- SK**
- SS**
- ST**

Splices h2

- SA**
- SB**

Splices h3

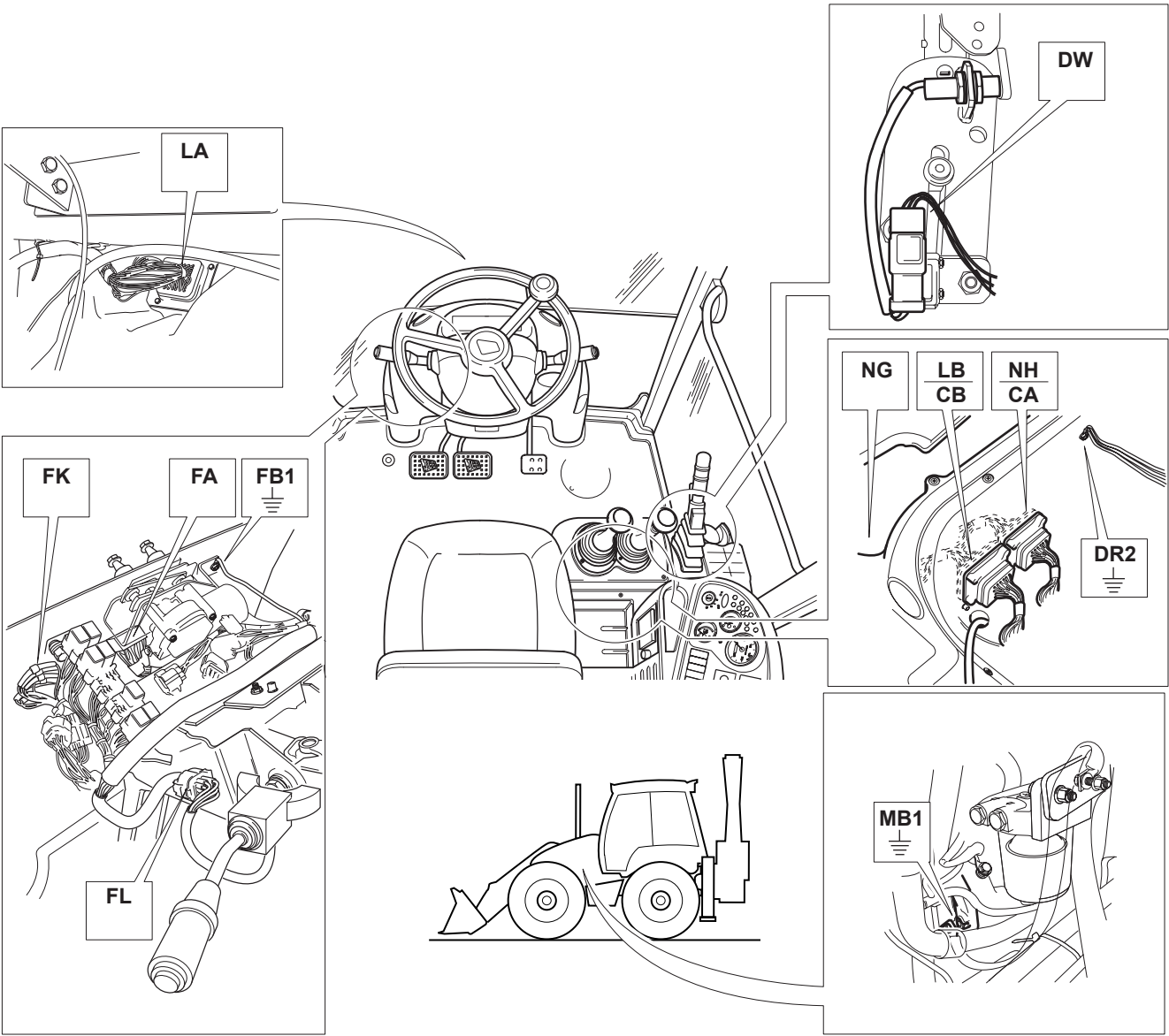
- SC**

Splices h4

- SA**

Earth Points

Faults may be caused by poor earth connections. Although earth connections are shown opposite, it must be remembered that the cab assembly is earthed via further earth strap and cable connections. For details of these connections see **Section C, Machine Earth Connections**.



A405320

Powershift Gearbox - 4 Speed (cont'd)
(Machines up to 933756)

Electrical Connections - Wires and Connectors
Gearbox Solenoid Actuation

For relay activation see previous page.

Component Key (solenoid activation):
The following key identifies the component connectors on the diagrams opposite. Note that the wires coloured green show the electrical 'feed to earth' for the gearbox mounted solenoids. Live feed (wires coloured red) to the relay switches is supplied via the dump relay **FG**. Note that the destination for wire 107 from splice **SS** is shown on the relay actuation diagram (previous page).

- h1** Harness - 721/10940 Front console
- h2** Harness - 721/10942 Link
- h5** Harness - 721/10939 Gearbox

Note: For harness drawings see **Section C**.

- Connectors (h1)**
- FA** h1 → h2
 - FB1** Earth point
 - FD1** Forward high/low relay
 - FD2** Forward relay
 - FE1** Reverse high/low relay
 - FE2** Reverse relay
 - FF1** Interlock relay
 - FF2** Mainshaft/layshaft relay
 - FG** Transmission dump relay
 - X** For wire 107 destination see **Relay Actuation** diagram

- Connectors (h2)**
- LA** h1 → h2
 - LC** h2 → h5

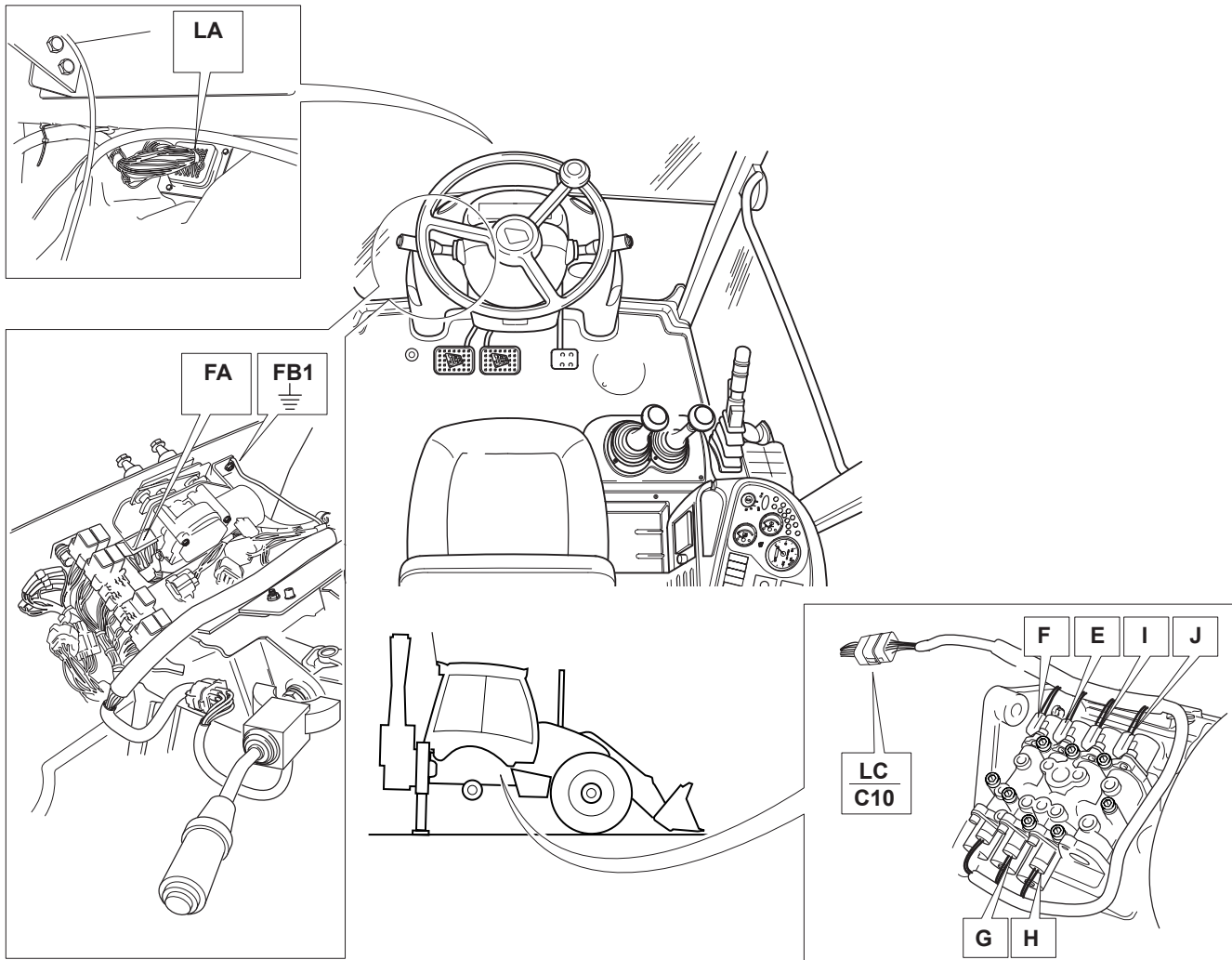
- Connectors (h5)**
- C10** h5 - h2
 - C20** Gearbox solenoid U (labelled **E**)
 - C30** Gearbox solenoid T (labelled **F**)
 - C40** Gearbox solenoid Y (labelled **G**)
 - C50** Gearbox solenoid Z (labelled **H**)
 - C60** Gearbox solenoid W (labelled **I**)
 - C70** Gearbox solenoid V (labelled **J**)

- Splices (h1)**
- SS**
 - ST**

- Splices (h2)**
- SC**

- Splices (h5)**
- SA**

Earth Points
Faults may be caused by poor earth connections. Although earth connections are shown opposite, it must be remembered that the cab assembly is earthed via further earth strap and cable connections. For details of these connections see **Section C, Machine Earth Connections**.



A404900

Powershift Gearbox - 6 Speed

Introduction

This section explains how the Powershift 6 speed (ShiftMaster) electrical system works .

Central to the system is the ShiftMaster ECU (Electronic Control Unit) **1**. The unit receives 'inputs' from electrical devices such as the gear select switch **B**. Depending on the input signals the ECU 'outputs' energise electrical devices such as gearbox solenoid control valves **2**.

The ECU can be connected to diagnostics software loaded on a laptop PC. The communications link is facilitated via diagnostics socket 3. See **Powershift Gearbox - 6 Speed, ShiftMaster Diagnostics - User Guide**.

Note: The ECU also controls 2/4WD selection by activating relay **S**. 2/4WD electrical system is not described in this section.

Component Identification

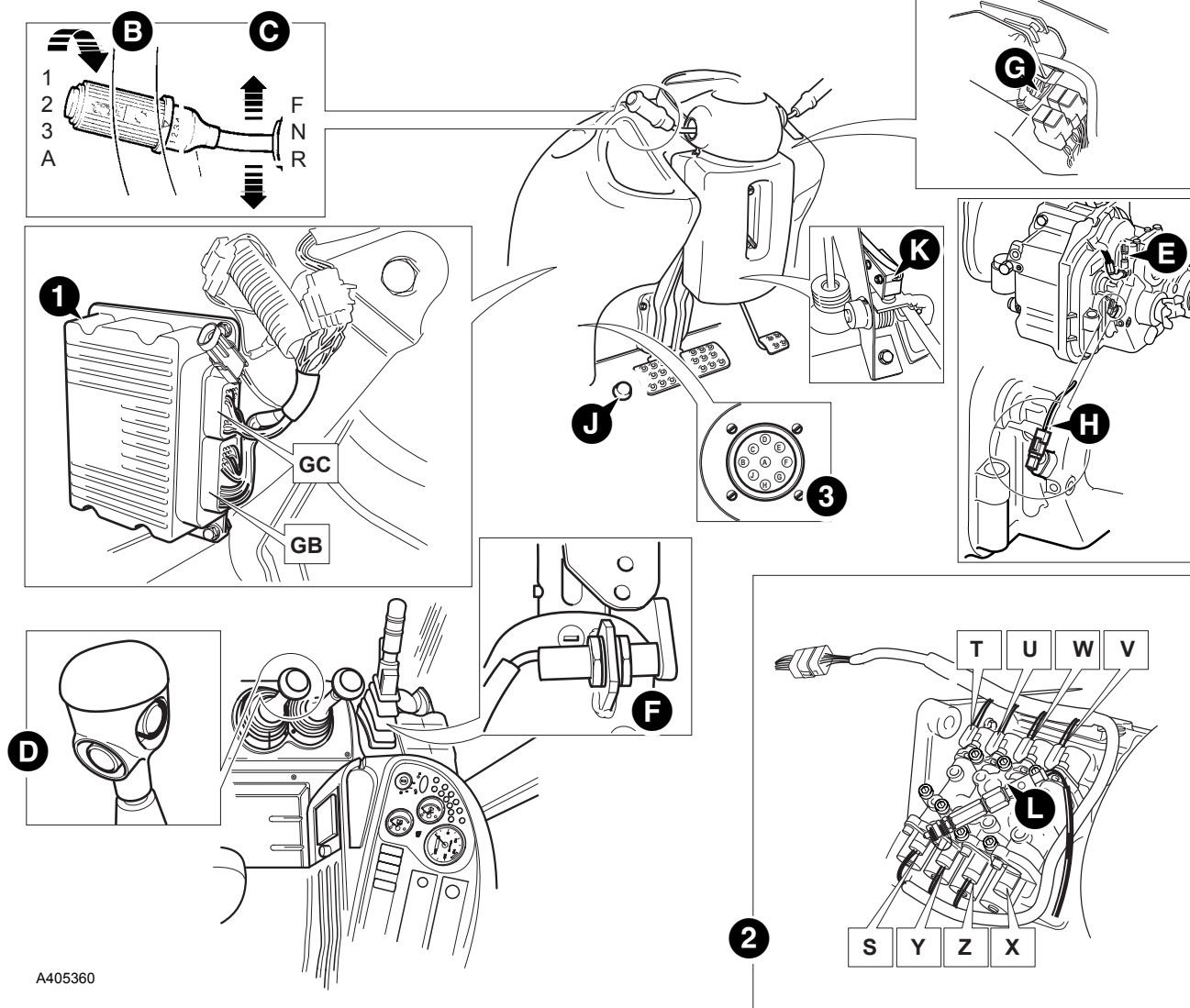
ECU input devices

- | | |
|----------|---------------------------------------|
| B | Gear select switch |
| C | Forward/Neutral/Reverse select switch |
| D | Transmission dump switch |
| E | Gearbox oil temperature switch |
| F | Park brake switch |
| G | Transmission dump relay |
| H | Speed sensor - gearbox mounted |
| J | Kick down switch |
| K | Throttle switch |
| L | Gearbox oil pressure switch |

ECU output - activated devices

- | | |
|------------|---|
| N | In-cab warning light - high gearbox oil temperature |
| P | In-cab warning light - low gearbox oil pressure |
| R | In-cab master warning light and buzzer |
| S-Z | Gearbox solenoid control valves |

Note: For identification of in-cab warning lights see the machine Operator Handbook.



Powershift Gearbox - 6 Speed

ECU Electrical Connections

Electrical connections at the ECU are shown in the diagram below. Connections are divided into two groups;

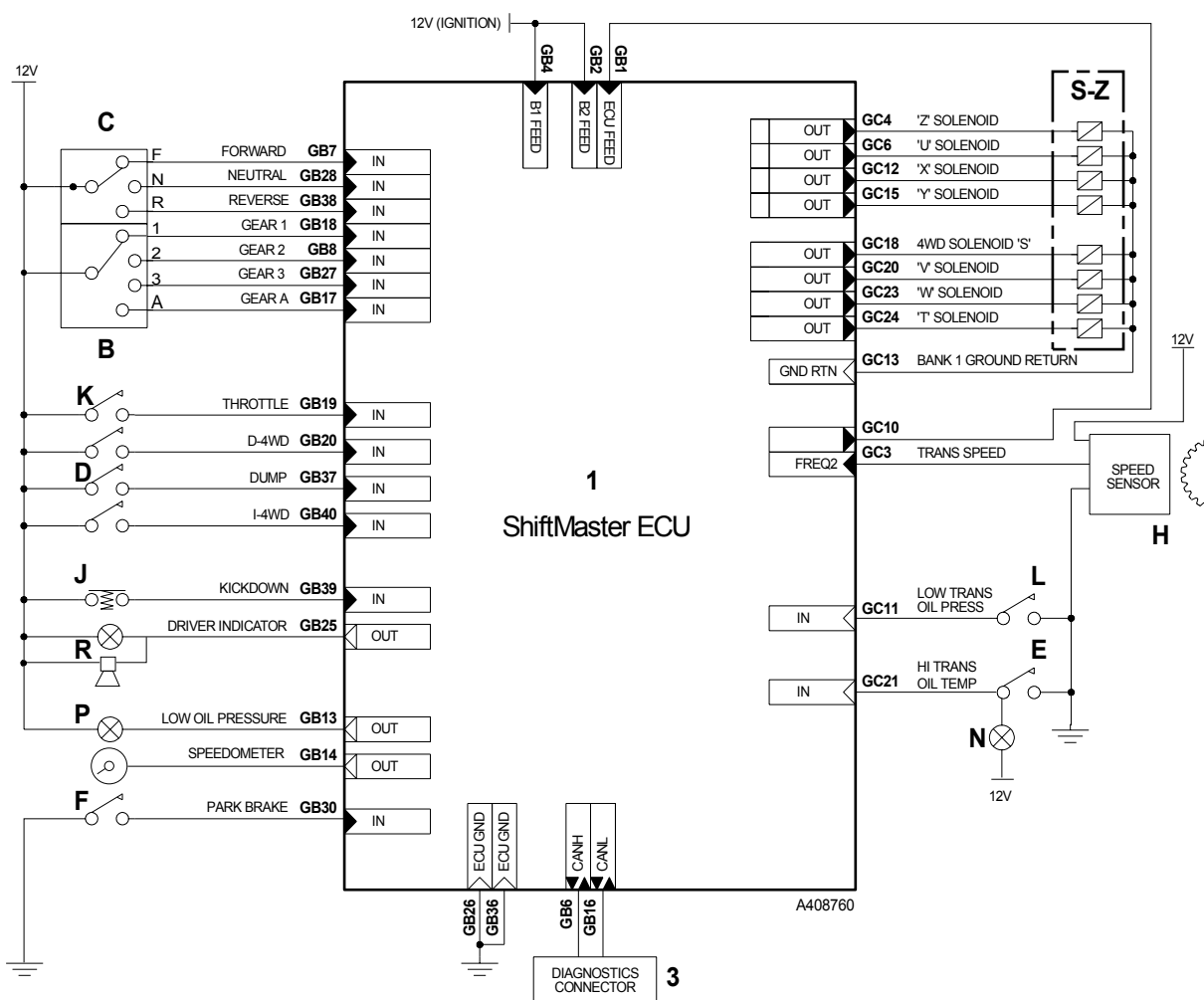
GB Connections to components mounted on the gearbox

GC Connections to components mounted elsewhere on the machine.

For the key to the main components see **Component Identification** on the previous page. For more detailed explanations of the electrical connections for gearbox control see subsequent pages.

Note: When fault finding DO NOT use a multimeter on the ECU connector pins. Only test the associated wiring, uncouple connectors GB and GC and then use a multimeter at the pins inside these connectors as applicable. Use the ShiftMaster Diagnostics system to identify possible faults with the ECU See **Powershift Gearbox - 6 Speed, ShiftMaster Diagnostics - User Guide**.

GB1	Feed from GC10	GC3	Speed sensor - input
GB2	12v Feed	GC4	Output - 'Z' solenoid
GB4	12v Feed	GC6	Output - 'U' solenoid
GB6	Diagnostics connector	GC10	Feed to GB1
GB7	Forward switch	GC11	Switch
GB8	2nd gear switch		Low trans oil pressure
GB13	Warning lamp	GC12	Output - 'X' solenoid
	Low trans oil pressure	GC13	ECU Earth
GB14	Speedometer input	GC15	Output - 'Y' solenoid
GB17	Auto gear switch	GC18	Output - 'S' 4WD solenoid
GB18	1st gear switch	GC20	Output - 'V' solenoid
GB19	Throttle switch	GC21	Switch
GB20	Foot brake switch (4WD/4 wheel brake)		Trans oil temperature
GB24	Diagnostics connector	GC23	Output - 'W' solenoid
GB25	Master warning lamp	GC24	Output - 'T' solenoid
GB26	ECU Earth		
GB27	3rd gear switch		
GB28	Neutral switch		
GB30	Parkbrake ON switch		
GB36	ECU Earth		
GB37	Trans dump switch		
GB38	Reverse switch		
GB39	Kickdown switch		
GB40	4WD switch		



Powershift Gearbox - 6 Speed

Electrical Connections - Quick Reference

The tables show live connector pins and also relevant earth destinations for given gearbox functions/systems as follows:

E.C.U. feeds and earths

Transmission Dump

Park Brake ON (Transmission Dump)

1, 2, 3, 4(A), 5(A), 6(A) Forward (see following pages)

Neutral (see following pages)

1, 2, 3, 4 Reverse (See following pages)

The information is intended as an aid when checking for faulty wires or connectors by means of continuity tests using a multimeter. DO NOT use a multimeter on the ECU connector pins (connectors A and B). Only test the associated wiring, uncouple connectors GB and GC and then use a multimeter at the pins inside these connectors as applicable. Use the ShiftMaster Diagnostics system to identify possible faults with the ECU See **Powershift Gearbox - 6 Speed, ShiftMaster Diagnostics - User Guide**.

Note that interconnecting harness connectors are not shown here. For full details see the relevant expanded harness schematic in this section.

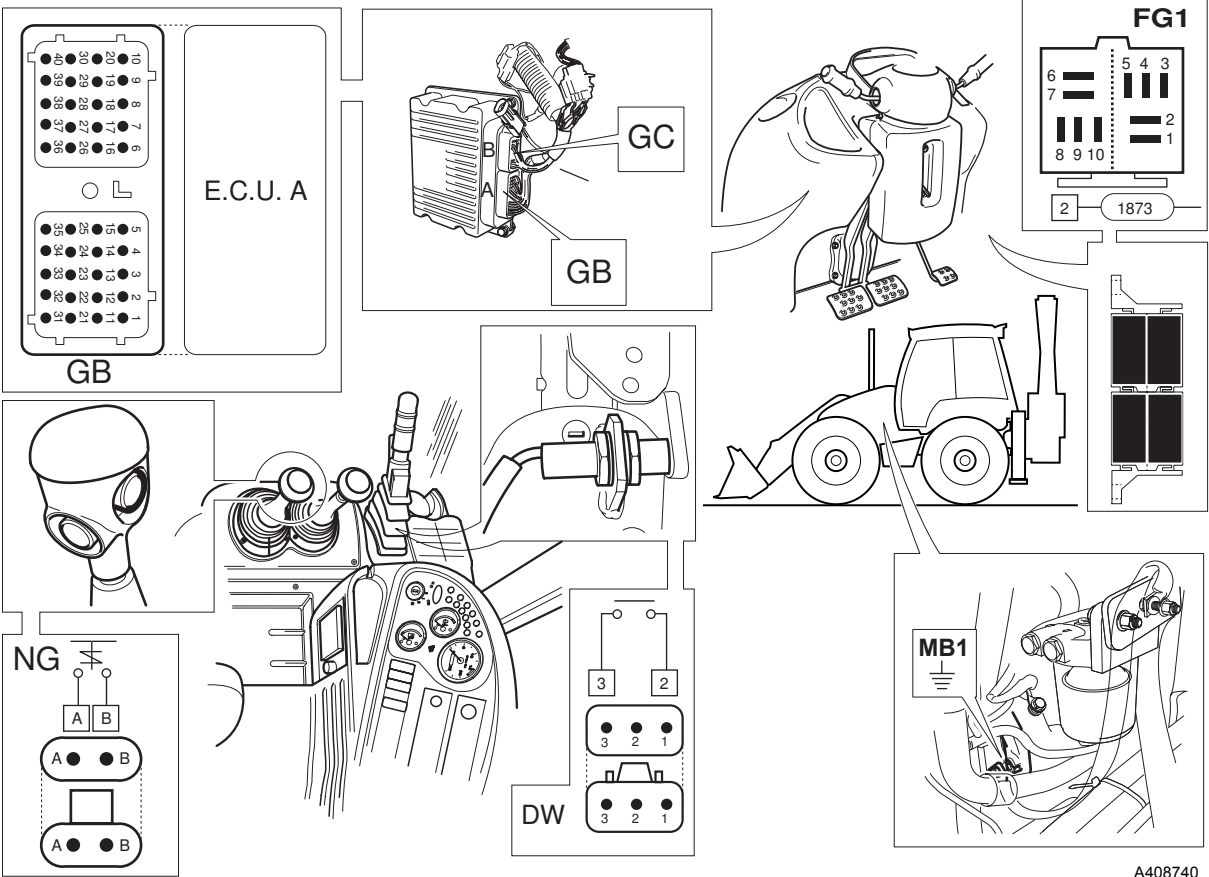
Note: Identify dump relay FG1 by locating wire 1873 at pin 2 of the corresponding relay base.

Diagram X

The diagram X (opposite) shows the electrical circuit for the gearbox control. It is shown with neutral selected and the park brake ON. 'Live feed' wires are coloured red and feed to earth are green.

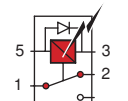
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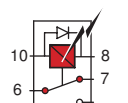
- A Gearbox solenoids
- C50 Reverse alarm
- CM Park brake warning light relay
- DW Park brake switch
- DZ Park brake relay
- FL Column switch
- FG1 Transmission dump relay
- FG2 Reverse alarm relay
- GB Harness connector - ECU 'A'
- GC Harness connector - ECU 'B'
- GG Throttle switch
- LE Kick down switch
- NG Transmission dump switch



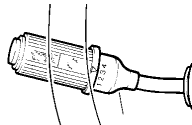
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Powershift Gearbox - 6 Speed

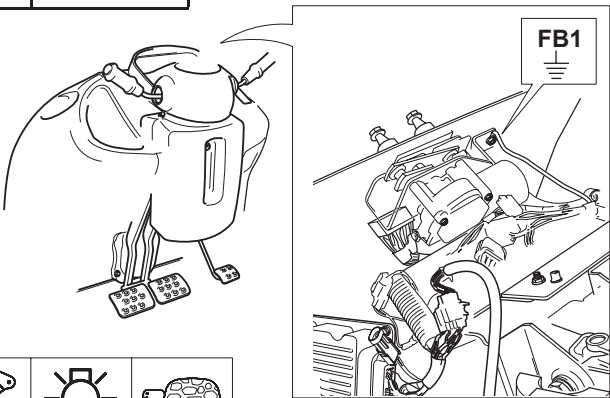
Gearbox function	Dump Switch NG	Relay FG1	E.C.U. GB
TRANSMISSION DUMP	A - B  (MB1)	3 - 5, 1 - 2 	37

Gearbox function	Park Brake Switch DW	Relay DZ	E.C.U. GB
PARK BRAKE ON (TRANSMISSION DUMP)	1, 3, 2  (DR2)	8 - 10, 6 - 7 	30

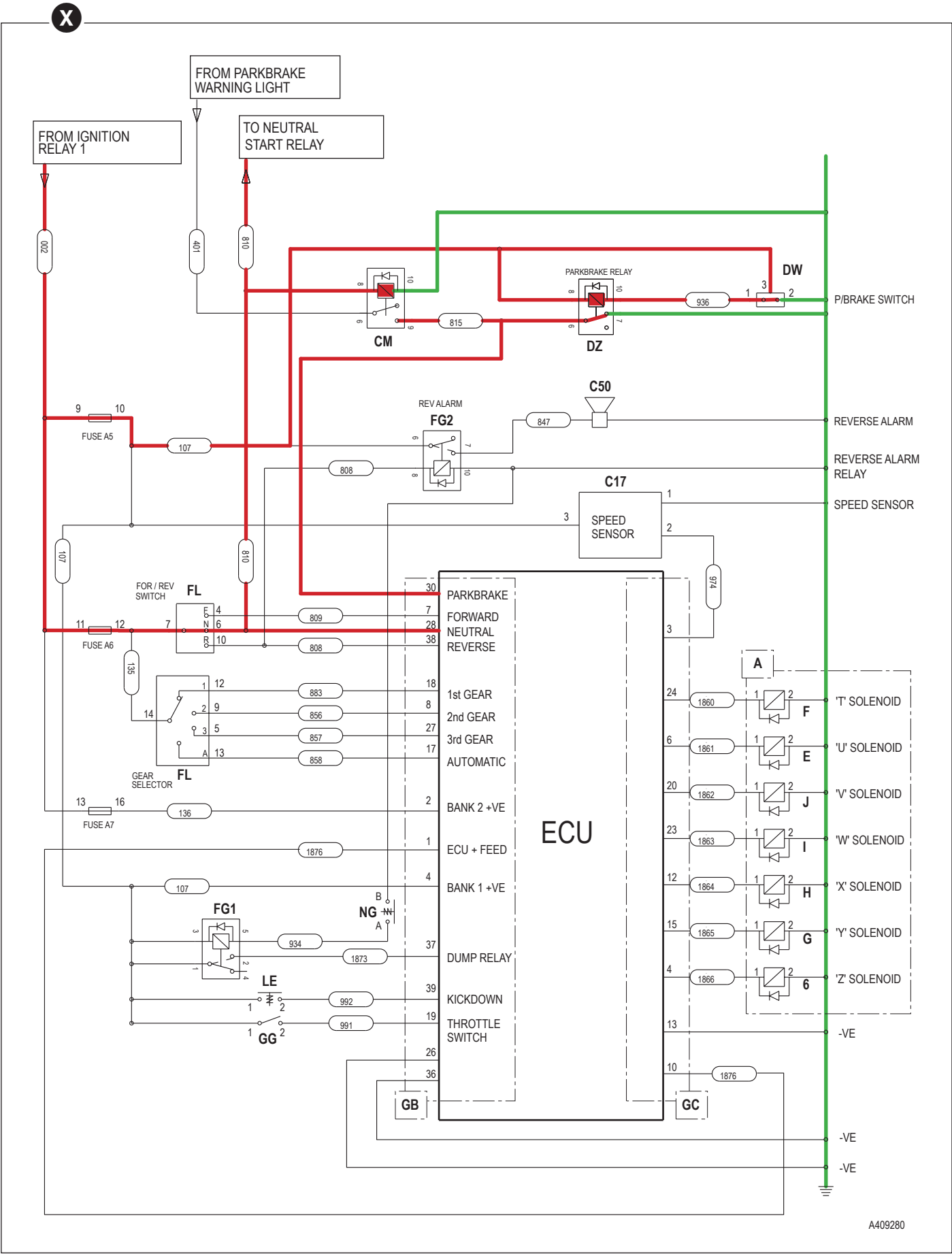
E.C.U. Power supply & Earths	Fuse	E.C.U. GB	E.C.U. GC	Earth Point 
POWER FEED I	A5	4		
POWER FEED II	A7	2		
EARTH I		26		FB1
EARTH II		36		FB1
EARTH III			13	FB1

Column Switch FL Power supply	Fuse	Switch Connector FL
	A6	7, 14

817/18221	A7	A6	A5			
						
5A	5A	7.5A	10A	3A	10A	7.5A
						
25A	20A	25A	5A	10A	10A	15A
						
15A	3A	15A	3A	30A	20A	5A
						
10A	15A	15A	7.5A	15A	7.5A	7.5A
						
15A	3A	15A	3A	30A	20A	5A



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Powershift Gearbox - 6 Speed

Electrical Connections - Quick Reference

The tables show live connector pins and also relevant earth destinations for given gearbox functions/systems as follows:

ECU feeds and earths (see previous pages)

Transmission Dump (see previous pages)

Park Brake ON (Transmission Dump) (see previous pages)

1, 2, 3, 4(A), 5(A), 6(A) Forward

Neutral

1, 2, 3, 4 Reverse

The information is intended as an aid when checking for faulty wires or connectors by means of continuity tests using a multimeter. DO NOT use a multimeter on the ECU connector pins (connectors A and B). Only test the associated wiring, uncouple connectors GB and GC and then use a multimeter at the pins inside these connectors as applicable. Use the ShiftMaster Diagnostics system to identify possible faults with the ECU See **Powershift Gearbox - 6 Speed, ShiftMaster Diagnostics - User Guide**.

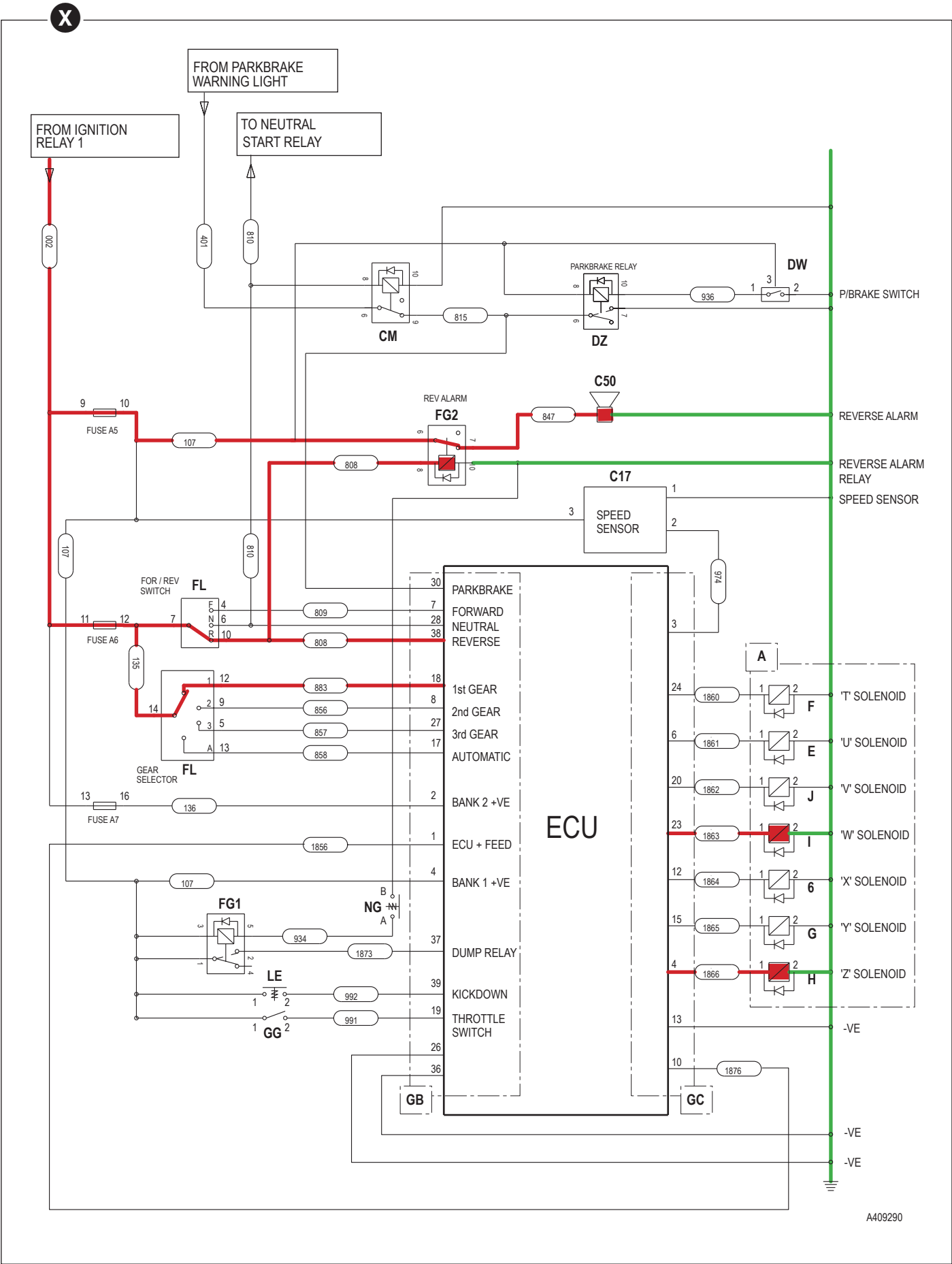
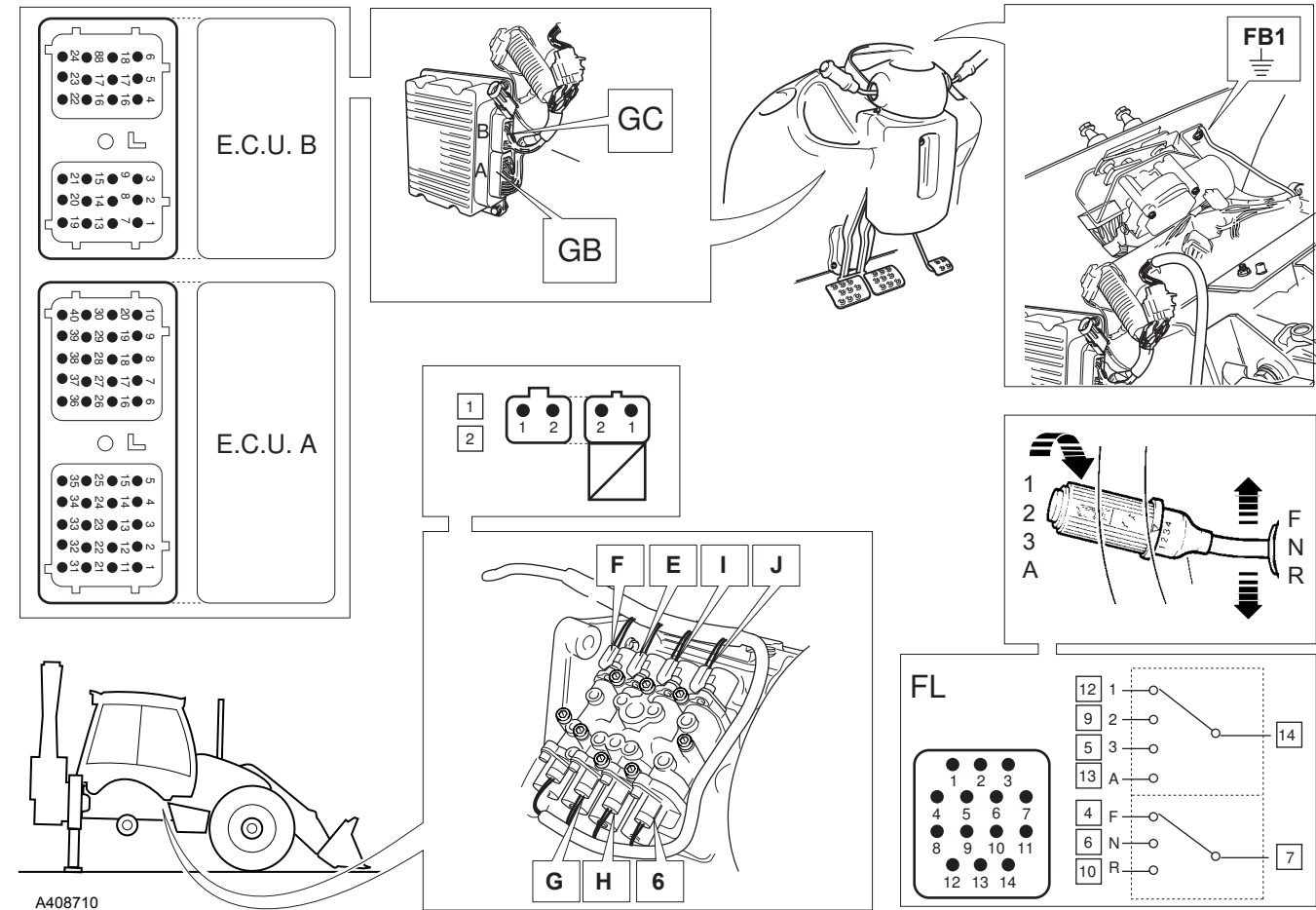
Remember that any interconnecting harness connectors are not shown here. For full details see the relevant expanded harness schematic in this section.

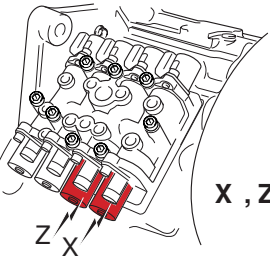
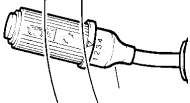
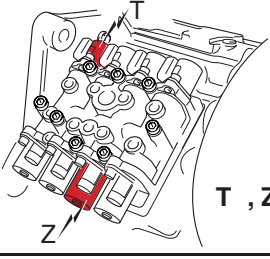
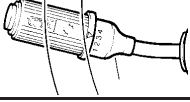
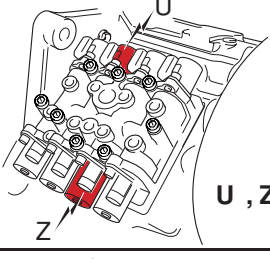
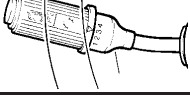
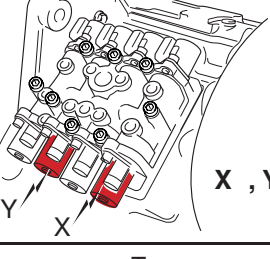
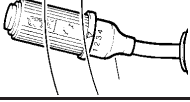
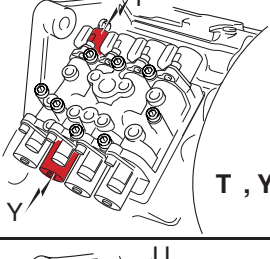
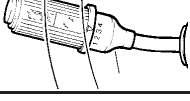
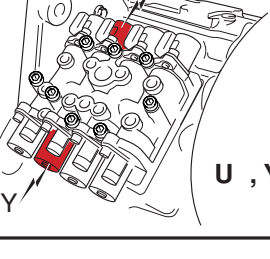
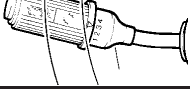
Diagram X

The diagram **X** (opposite) shows the electrical circuit for the gearbox control. It is shown with 1st gear reverse selected. 'Live feed' wires are coloured red and feed to earth are green.

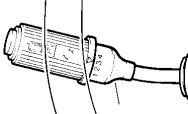
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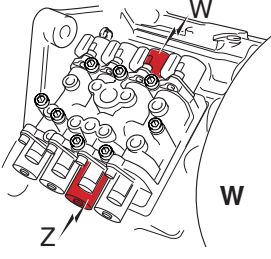
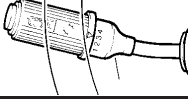
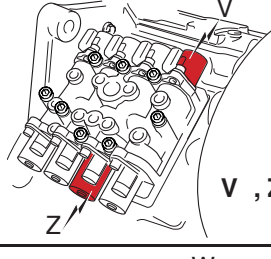
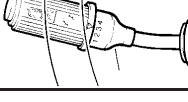
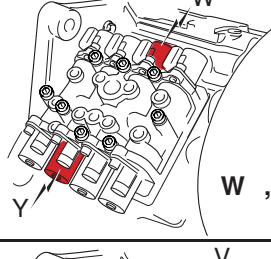
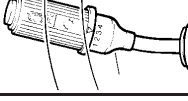
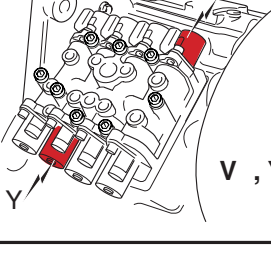
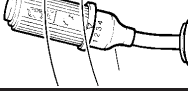
- A** Gearbox solenoids
- C50** Reverse alarm
- CM** Park brake warning light relay
- DW** Park brake switch
- DZ** Park brake relay
- FL** Column switch
- FG1** Transmission dump relay
- FG2** Reverse alarm relay
- GB** Harness connector - ECU 'A'
- GC** Harness connector - ECU 'B'
- GG** Throttle switch
- LE** Kick down switch
- NG** Transmission dump switch



Gearbox function	Column Switch FL	E.C.U. GB (Inputs)	E.C.U. GC (Outputs)	Solenoid Connector	Labelled	Gearbox Solenoid
1st GEAR FORWARD	14 - 12 7 - 4	18 7	4 (Z) 12 (X)	+1, 2 (FB1) +1, 2 (FB1)	H 6	
1F						
2nd GEAR FORWARD	14 - 9 7 - 4	8 7	4 (Z) 24 (T)	+1, 2 (FB1) +1, 2 (FB1)	H F	
2F						
3rd GEAR FORWARD	14 - 5 7 - 4	27 7	4 (Z) 6 (U)	+1, 2 (FB1) +1, 2 (FB1)	H E	
3F						
4th GEAR (A) FORWARD	14 - 13 7 - 4	17 7	15 (Y) 12 (X)	+1, 2 (FB1) +1, 2 (FB1)	G 6	
A						
5th GEAR (A) FORWARD	14 - 13 7 - 4	17 7	15 (Y) 24 (T)	+1, 2 (FB1) +1, 2 (FB1)	G F	
A						
6th GEAR (A) FORWARD	14 - 13 7 - 4	17 7	15 (Y) 6 (U)	+1, 2 (FB1) +1, 2 (FB1)	G E	
A						

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Gearbox function	Column Switch FL	E.C.U. GB
NEUTRAL	7 - 6	28
N		

Gearbox function	Column Switch FL	E.C.U. GB (Inputs)	E.C.U. GC (Outputs)	Solenoid Connector	Labelled	Gearbox Solenoid
1st GEAR REVERSE	14 - 12 7 - 10	18 38	4 (Z) 23 (W)	+1, 2 (FB1) +1, 2 (FB1)	H I	
1R						
2nd GEAR REVERSE	14 - 9 7 - 10	8 38	4 (Z) 20 (V)	+1, 2 (FB1) +1, 2 (FB1)	H J	
2R						
3rd GEAR REVERSE	14 - 5 7 - 10	27 38	15 (Y) 23 (W)	+1, 2 (FB1) +1, 2 (FB1)	G I	
3R						
4th GEAR REVERSE	14 - 13 7 - 10	17 38	15 (Y) 20 (V)	+1, 2 (FB1) +1, 2 (FB1)	G J	
4R (A)						

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Powershift Gearbox - 6 Speed

Electrical Connections - Wires and Connectors

Schematics are divided into 2 parts: **Input Controls** and **Gearbox Solenoid Actuation**.

On the electrical diagram opposite the electrical connectors (example, FA to LA) are shown looking on the mating face of each connector when they are disconnected.

The wire numbers and colours, where appropriate, are shown as an aid to identification whilst fault finding.

Before fault finding make sure that you understand how the the electrical circuits work. The most effective method of fault finding is by means of ShiftMaster Daignostics software and a laptop PC, see **Service Procedures, Powershift Gearbox - 6 speed, ShiftMaster Diagnostis - User Guide**. Having identified a faulty system, use the schematics to identify the relevant wires and connectors, continuity checks can then be carried out using a multimeter. Gearbox solenoid coils can be checked for the correct resistance value as given in **Technical Data**. See **Service Procedures, Electrical Testing Methods** for more details.

Input Controls

For gearbox solenoid actuation see subsequent pages.

Component Key (Input controls):

The following key identifies the component connectors on the opposite diagrams. Note that the wires coloured red show the electrical ‘live feed’ to the column gear lever and gearbox E.C.U..

- h1** Harness - 721/10937 Front console
- h2** Harness - 721/10971 Link
- h3** Harness - 721/10970 Side console
- h4** Harness - 721/10935 Engine/mainframe
- h5** Harness - 721/10941 Transmission

Note: For harness drawings see **Section C**.

Connectors (h1)

- FA** h1 → h2
- FB1** Earth point
- FG** Transmission dump relay

Note: Identify dump relay FG by locating wire 1873 at pin 2 of the corresponding relay base.

- FL** Column gear lever
- GB** E.C.U. connector A
- GC** E.C.U. connector B
- GG** Throttle switch

Connectors (h2)

- LA** h2 → h1
- LB** h2 → h3
- LC** h2 → h5
- LE** Kick down switch

Connectors (h3)

- CA** h3 → h4
- CB** h3 → h2
- CM** Park brake warning light relay
- CCA** Fuses
- DR2** Earth point
- DZ** Park brake relay
- DW** Park brake switch
- EA** Immobiliser
- EAB** Link - immobiliser (if immobiliser is not fitted)

Connectors (h4)

- NH** h4 → h3
- NG** Transmission dump switch
- MB1** Earth point

Splices (h1)

- SA**
- SC**
- SF**
- SJ**
- SL**
- SS**

Splices h2

- SB**
- SC**

Splices h3

- DW**
- TF**

Splices h4

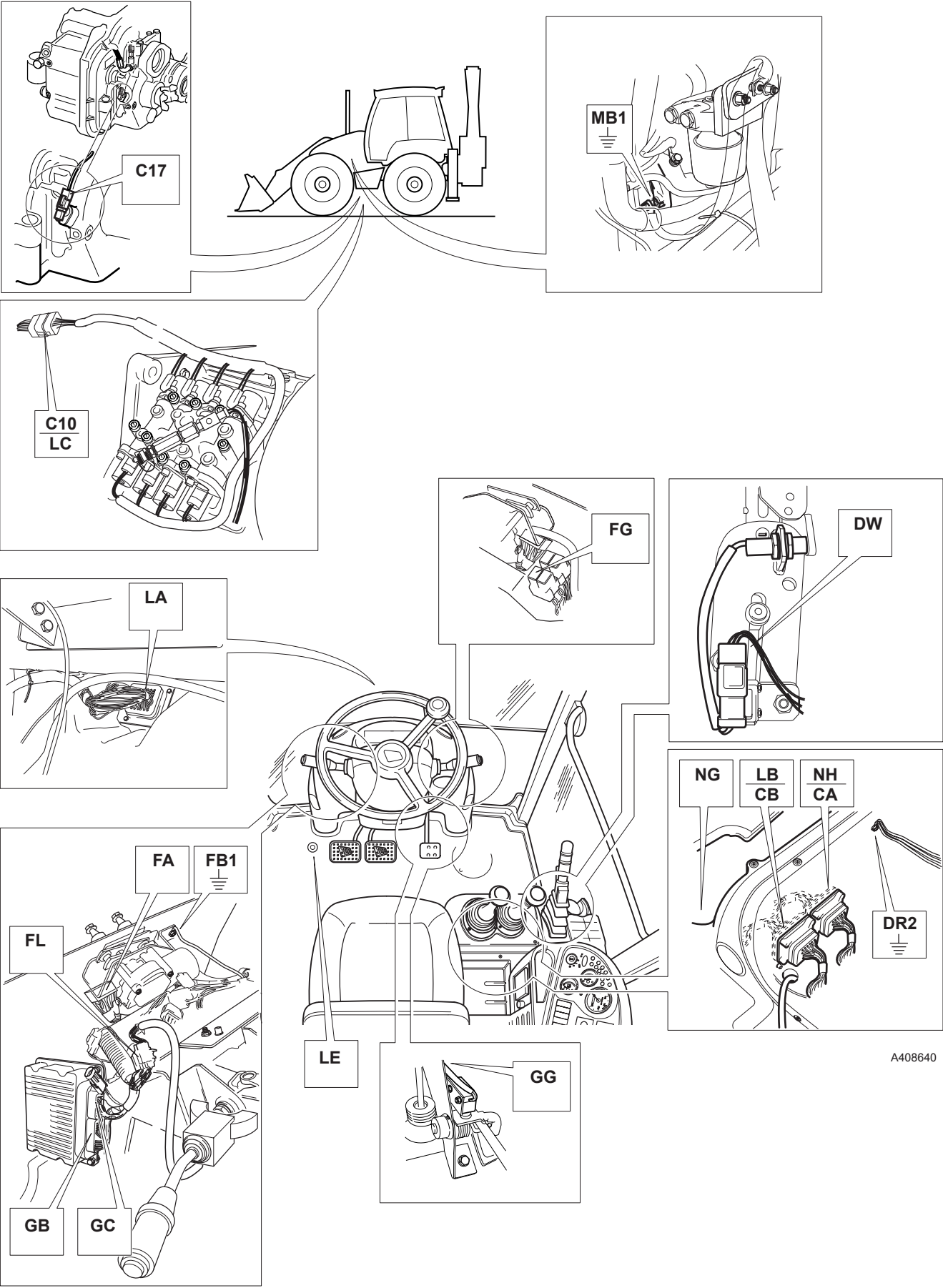
- SA**

Splices h5

- SA**

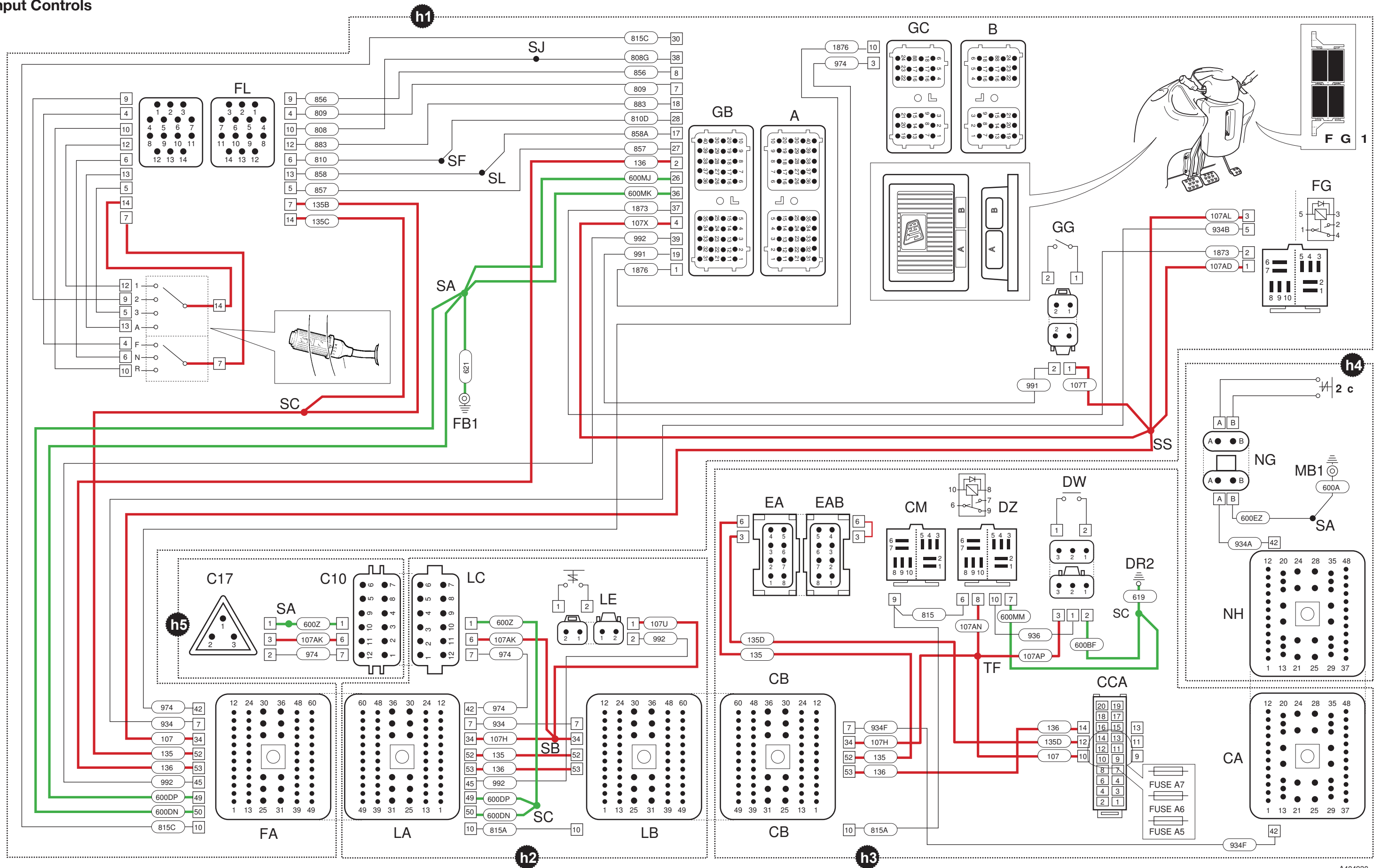
Earth Points

Faults may be caused by poor earth connections. Although earth connections are shown opposite, it must be remembered that the cab assembly is earthed via further earth strap and cable connections. For details of these connections see **Section C, Machine Earth Connections**.

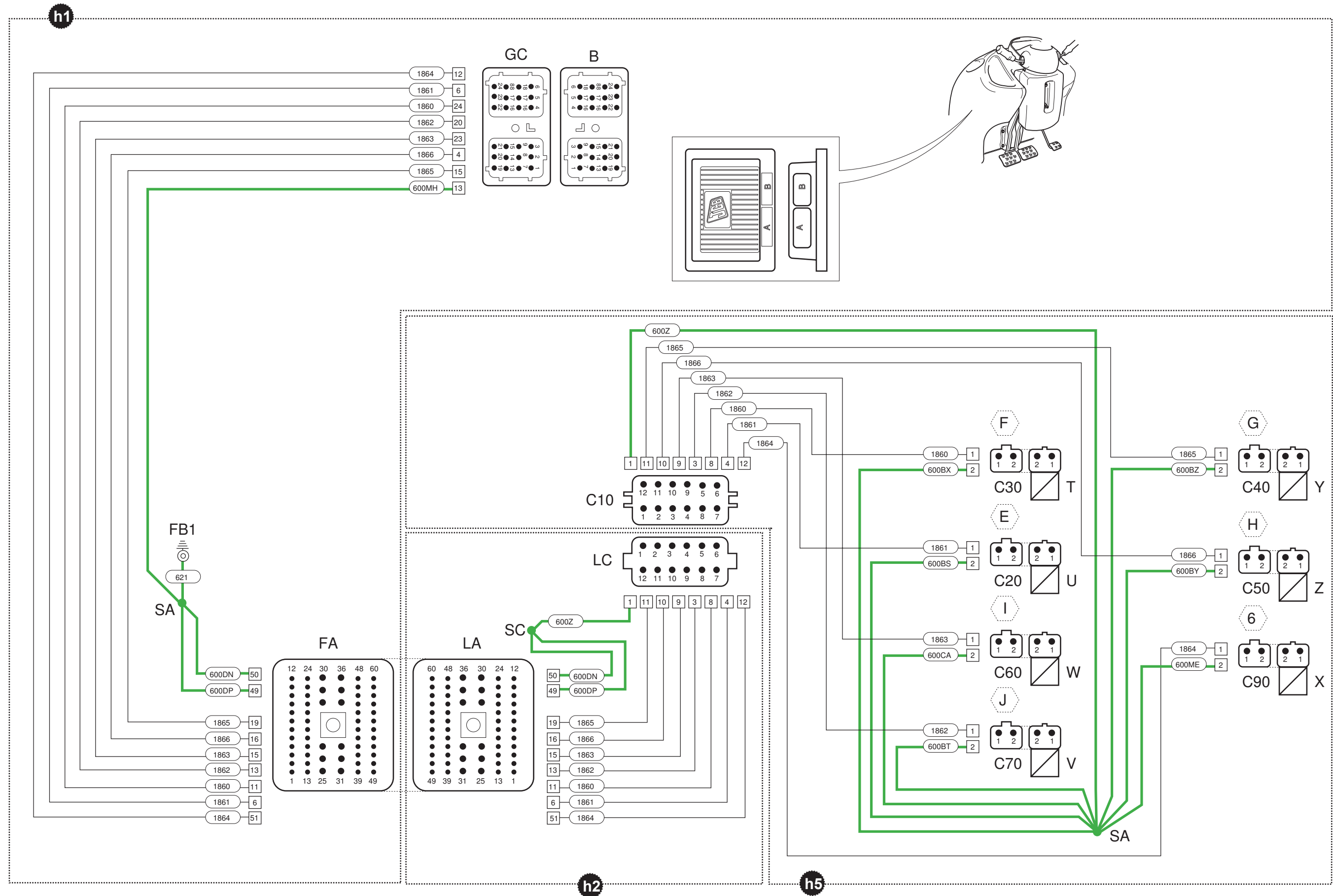


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Powershift Gearbox - 6 Speed Input Controls



Powershift Gearbox - 6 Speed Gearbox Solenoid Actuation



Powershift Gearbox - 6 Speed (cont'd)

Electrical Connections - Wires and Connectors
Gearbox Solenoid Actuation

For input controls see previous page.

Component Key (solenoid activation):
The following key identifies the component connectors on the diagrams opposite. Note that the wires coloured green show the electrical 'feed to earth' for the gearbox mounted solenoids and gearbox ECU.

- h1** Harness - 721/10937 Front console
- h2** Harness - 721/10971 Link
- h5** Harness - 721/10941 Gearbox

Note: For harness drawings see **Section C**.

Connectors (h1)

- GC** E.C.U. connector B
- FA** h1 → h2
- FB1** Earth point

Connectors (h2)

- LA** h1 → h2
- LC** h2 → h5

Connectors (h5)

- C10** h5 → h2
- C20** Gearbox solenoid U (labelled **E**)
- C30** Gearbox solenoid T (labelled **F**)
- C40** Gearbox solenoid Y (labelled **G**)
- C50** Gearbox solenoid Z (labelled **H**)
- C60** Gearbox solenoid W (labelled **I**)
- C70** Gearbox solenoid V (labelled **J**)
- C90** Gearbox solenoid X (labelled **6**)

Splices (h1)

SA

Splices (h2)

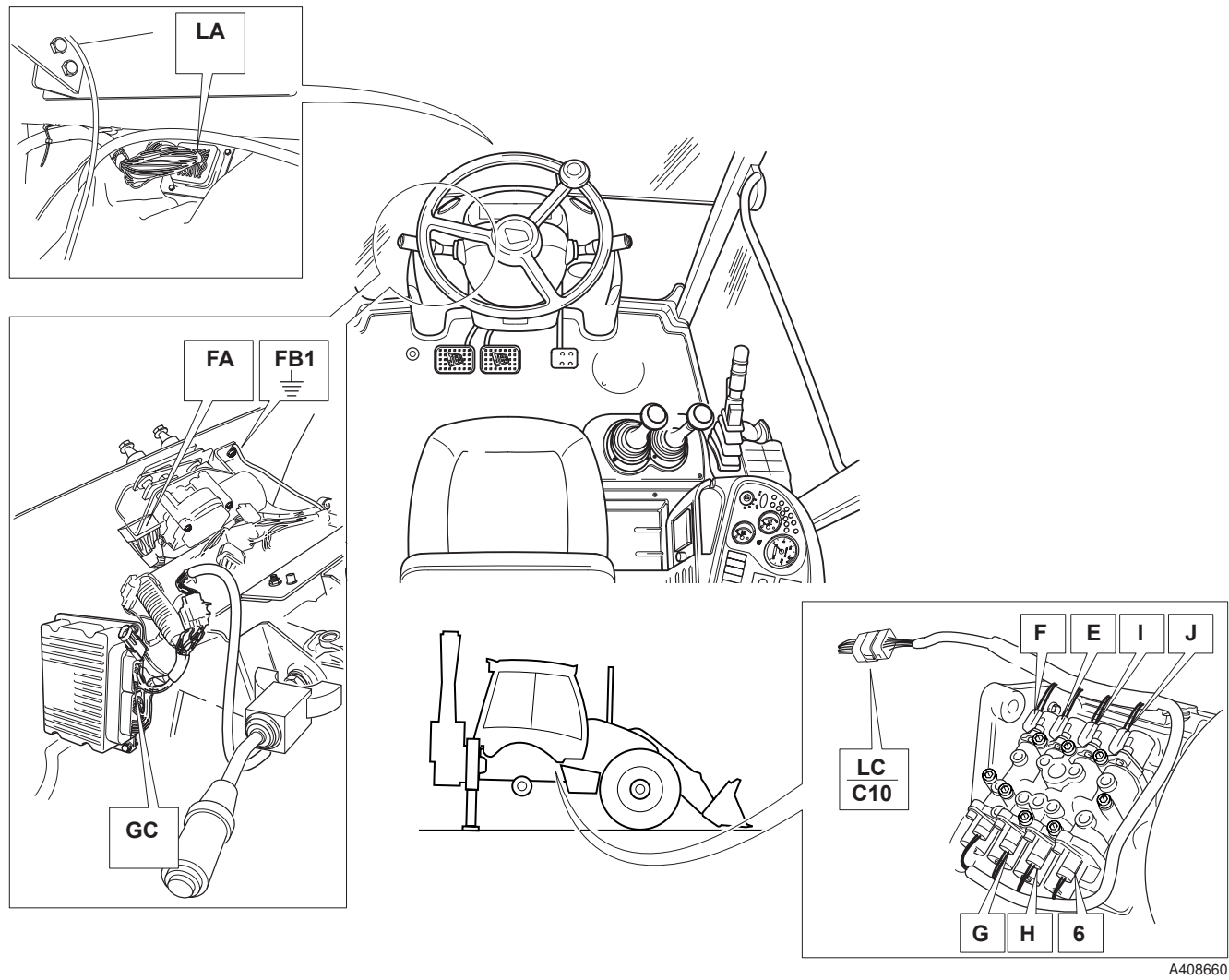
SC

Splices (h5)

SA

Earth Points

Faults may be caused by poor earth connections. Although earth connections are shown opposite, it must be remembered that the cab assembly is earthed via further earth strap and cable connections. For details of these connections see **Section C, Machine Earth Connections**.



Synchro Shuttle Gearbox

Before carrying out the checks listed the machine should, if possible, be operated to determine the fault area(s), and bring the systems to their normal working temperatures.

Ensure that the correct quantity and grade of oil is used and that there are no obvious leaks.

- A** If the transmission is noisy, start at check 1.
- B** If the transmission is overheating, start at check 4.
- C** If the transmission will not pull, start at check 12.
- D** If there is no drive in one or both directions, start at check 17.
- E** If the transmission is jumping out of gear, start at check 29.
- F** If the transmission is sticking in gear, start at check 39.
- G** If ratios are 'crash changing', start at check 41.

CHECK	ACTION
1 Is there noise when selecting direction?	YES: Check 3 NO: Check 2
2 Is there noise when running with direction selector in neutral and ratio selector in 1st?	YES: Check 9 NO: Check 19
3 Is there air in the hydraulic system?	YES: Continue running to expel air. NO: Check 4
4 Is the fluid level correct?	YES: Check 5 NO: Check level only when machine is cold and top-up as required.
5 Are the oil passages restricted?	YES: Clear the restriction. NO: Check 6
6 Is the suction strainer restricted?	YES: Remove and clean strainer. NO: Check 7
7 Is pump pressure as specified?	YES: Check 9 NO: Check clutch pressure maintenance valve is free to operate.
8 When flow testing pump, is output low?	YES: Renew pump. NO: Check converter sprag clutch for wear or slip.
9 Does the noise continue when direction selector is in forward or reverse?	YES: Check 10 NO: Check 11
10 Is transmission misaligned?	YES: Renew mountings and check position. NO: Check 'converter out' pressure and flow.
11 Are the pump bushes worn?	YES: Renew NO: Check converter for wear or cooler for restriction to flow.
12 Is the transmission not pulling in one direction only?	YES: Check 16 NO: Check 13
13 Is the transmission not pulling in both Forward and Reverse?	YES: Stall test machine, Check 14. NO: Check 16

Synchro Shuttle Gearbox (cont'd)

CHECK	ACTION
14 Is 'converter in' pressure as specified?	YES: Check 15 NO: Inspect converter relief valve for damage. Check cooler bypass valve pressure setting.
15 Is pump being driven by converter?	YES: Check pump pressure. NO: Renew damaged parts.
16 Are clutch sealing rings damaged?	YES: Tap pressure gauge into clutch feed lines to monitor pressure. NO: Check clutch plates for damage.
17 Is there drive in one direction only?	YES: Check 19 NO: Check 18
18 Is the start switch in the run position and supplying current to the neutral start relay?	YES: Check 19 NO: Rectify.
19 Is the fault only when the transmission is hot?	YES: Dismantle solenoid and check components. NO: Check microswitches, relay and wiring loom.
20 Is the noise a growl, hum or grinding?	YES: Check gears for damage or wear. NO: Check 21
21 Is the noise a hiss, thump or bumping?	YES: Check bearings for damage or wear. NO: Check 22
22 Is the noise a squeal?	YES: Check free running gears for seizure. NO: Check 23
23 Is the noise present when in neutral or when in gear?	NEUTRAL: Check 24 IN GEAR: Check 27
24 Is the countershaft or its bearings worn or damaged?	YES: Renew damaged parts. NO: Check 25
25 Is there excessive backlash in the gears?	YES: Adjust by checking shaft end float. NO: Check 26
26 Is the mainshaft pilot bearing worn?	YES: Renew. NO: Check gear teeth for scuffing.
27 Is the mainshaft rear bearing worn?	YES: Renew. NO: Check 28
28 Are the sliding gear teeth worn or damaged?	YES: Renew gears. NO: Check 29
29 Are the selector forks loose?	YES: Tighten screws. NO: Check 30
30 Are the selector fork pads or grooves in gears worn?	YES: Renew worn parts. NO: Check 31
31 Are the dog gear teeth worn?	YES: Renew. NO: Check 32
32 Are the selector rod detent springs broken?	YES: Renew. NO: Check 33

Synchro Shuttle Gearbox (cont'd)

CHECK	ACTION
33 Are the selector rods worn or damaged?	YES: Renew. NO: Check 34
34 Are the selector fork pads out of position?	YES: Reposition or renew (check interlock). NO: Check 35
35 Is there excessive end float in gears or shafts?	YES: Adjust. NO: Check thrust washers and mating faces.
36 Is the synchroniser bronze worn?	YES: Renew synchro pack. NO: Check 37
37 Are steel chips embedded in the bronze?	YES: Continue using, chips will either embed below bronze or be rejected. NO: Check 38
38 Are the synchroniser components damaged?	YES: Renew. NO: Check free running gears for seizure or damage.
39 Are the sliding gears tight on the splines?	YES: Free or renew. NO: Check 40
40 Are chips wedged between splines of shaft or gear?	YES: Remove chips. NO: Ensure that clutch is disengaged when dump pedal is pressed.
41 Are steel chips embedded in the bronze?	YES: Continue using, chips will either embed below bronze or be rejected. NO: Check 42
42 Are the synchroniser spring pins damaged?	YES: Renew synchro. NO: Check 43
43 Is the synchroniser bronze worn?	YES: Renew synchro. NO: Check blocker pins.

Synchro Shuttle Gearbox - 2/4 Wheel Drive Clutch

4WD CANNOT BE ENGAGED

In normal operation the 2/4 wheel drive clutch is spring loaded off and therefore disengaged to give 2 wheel drive. The clutch must be pressurised to give 4 wheel drive. Before starting the more detailed fault finding procedures - eliminate the obvious:

- 1 Check that the transmission oil level is correct.
- 2 Check that the fuse for the 2/4WD circuit is intact.
- 3 Check that the 4-wheel drive external pipework is not damaged and that the drive train is intact.
- 4 Check that all the electrical connections are clean and secure. Also check that the solenoid spool is not sticking (in the 2WD position).
- 5 Check that the mainline pressure is correct (see 'Low Mainline Pressure').
- 6 Check that the pump flow rate is correct.

If the fault is not rectified after eliminating the obvious, check the following:

Possible Cause	Remedy
7 Low mainline pressure	7 Identify if the fault is related to the 2/4WD disconnect: 7.1 Disconnect the external pipework to the 2/4WD clutch. Cap and plug open orifices. 7.2 Check the mainline pressure - if the pressure is correct, the fault must be within the 2/4WD (see step 8). If the reading is still low check the transmission in the normal manner.
8 Low mainline pressure (due to 2/4WD clutch): 8.1 2/4WD solenoid spool sticking. 8.2 2/4WD solenoid spool O-ring failed. 8.3 Clutch shaft sealing rings leaking. 8.4 Excessive clutch shaft end float. 8.5 Wrong type clutch piston fitted. 8.6 Clutch piston O-ring failed.	8 Rectify fault: 8.1 Strip, clean and re-assemble solenoid valve, renew valve if required. 8.2 Renew O-ring. 8.3 Renew clutch shaft sealing rings. 8.4 Rectify fault, renew parts as required, reset end float (should not exceed 0.03 mm; 0.001 in) 8.5 Fit correct type clutch piston (ie, without bleed hole). 8.6 Replace clutch piston O-ring.
9 Defective 2/4WD clutch: 9.1 Worn friction/counter plates 9.2 Mechanical failure of 4WD unit 9.3 Incorrect clutch pack end float.	9 Rectify fault: 9.1 Inspect friction/counter plates, renew as required. 9.2 Strip and inspect 4WD unit. Check that the electrical and hydraulic circuits are functioning correctly. 9.3 Measure clutch pack end float (should be 1.0 to 2.3 mm). Correct as required.

Synchro Shuttle Gearbox - 2/4 Wheel Drive Clutch (cont'd)**2WD CANNOT BE ENGAGED**

No pressure is required to engage 2WD(spring loaded). Check that the solenoid spool is not sticking (in the 4WD position), then see below.

Possible Cause	Remedy
10 Incorrect type of solenoid valve fitted.	10 Check solenoid. Note: Powershift and Syncro Shuttle machines have different types of solenoid - check parts list.
11 Non-return valve faulty (noticeable because 2WD cannot be engaged).	11 Check the non-return valve.
12 2/4WD solenoid permanently energised.	12 Check the 2/4WD relay and select switch, replace as necessary.

Powershift Gearbox

Introduction

The fault finding procedures are given in the form of flow charts. There are a number of charts, each one dedicated to a particular fault. The charts are designed to identify possible causes by performing checks and where applicable, specific tests on the gearbox. Having identified a cause the suggested remedy is given. The charts are designed to identify causes through a process of elimination, starting with the simplest, most easily rectified faults.

- * Gearbox faults may be caused by faulty electrical connectors or components as indicated in the fault finding charts. Full explanations of the relevant electrical systems for both 4 speed and 6 speed (Shiftmaster) gearboxes are given in **Electrical Connections**.

Due to the time and effort involved in removing, dismantling, assembling and replacing a gearbox, it is recommended that fault finding procedures are carried out until a fault can be identified with a good degree of certainty.

Full details of the test procedures referred to in the charts are given in **Service Procedures, Powershift Gearbox**.

Fault Finding Charts:

Chart A - Machine drives but lacks power in all gears.
Gearbox oil may also be overheating.

Chart B - Machine does not drive in any gear.

Chart C - Some gears fail to engage or lack power. 4WD fails to engage.

Chart D - (6 speed gearbox only) Shiftmaster fails to function normally - fails to autoshift - shifts at incorrect road speed.

Note: 4th, 5th and 6th gears utilise clutches used for 1st, 2nd and 3rd gears. If 4th, 5th or 6th gears fail to engage, check that the lower 3 gears function correctly before investigating a possible Shiftmaster fault. See **Fault Finding Chart C**.

Chart E - Gearbox oil overheats

Chart F - External oil leakage

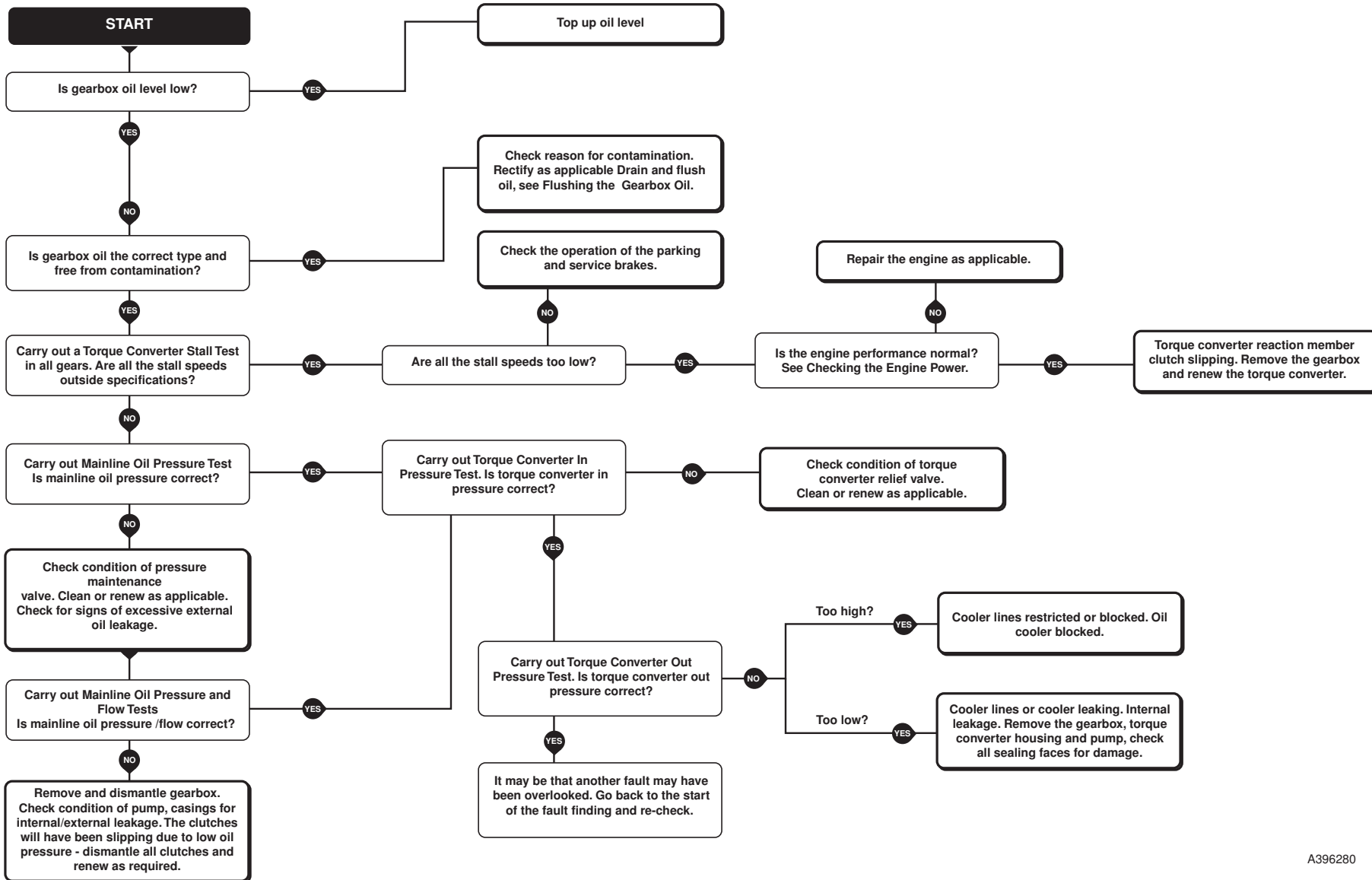
Chart G - Noisy operation

Further Fault Finding Information

Gearbox Oil Contaminated with Water

Powershift Gearbox

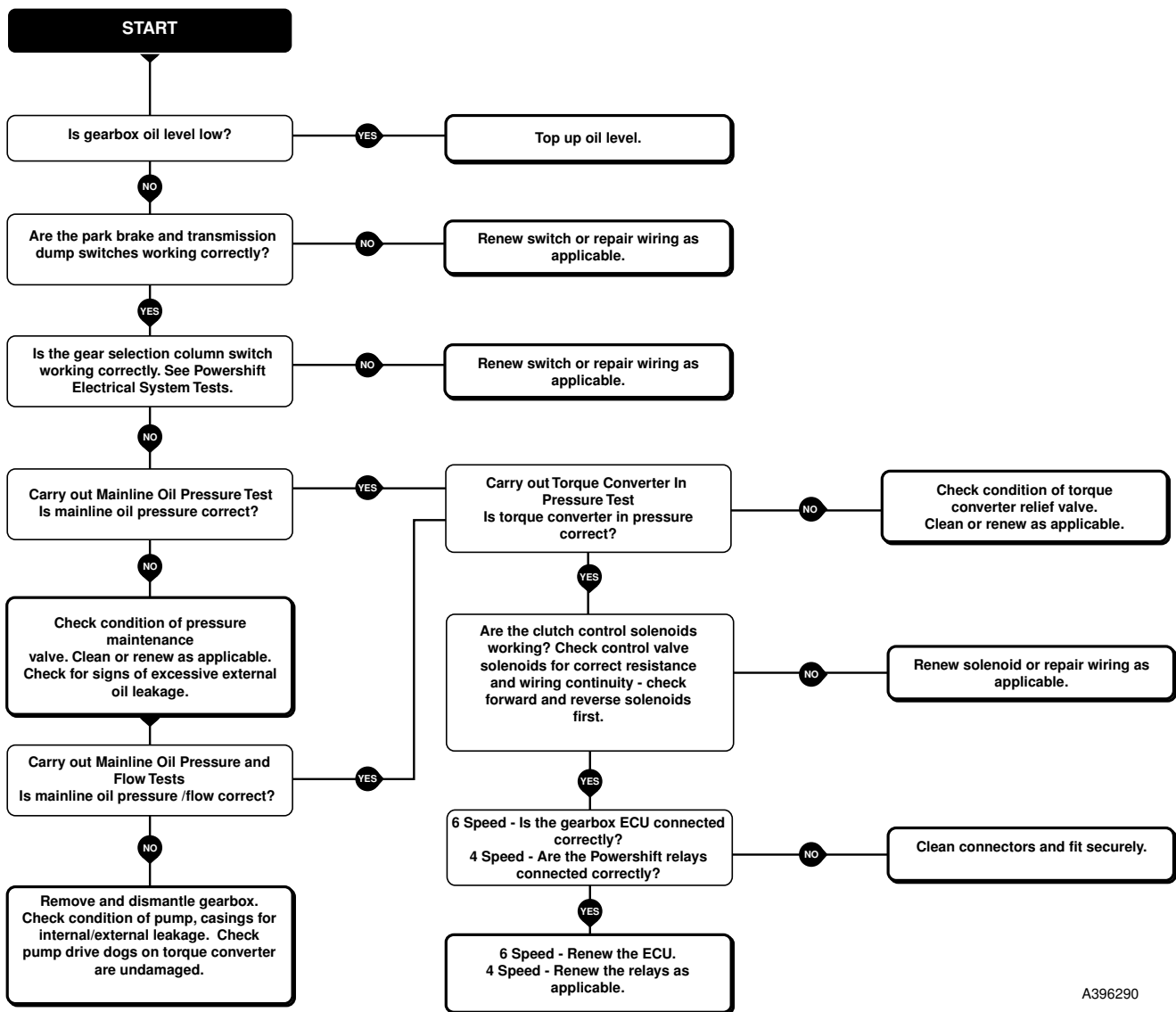
Chart A - Machine drives but lacks power in all gears. Gearbox oil may also be overheating.



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Powershift Gearbox

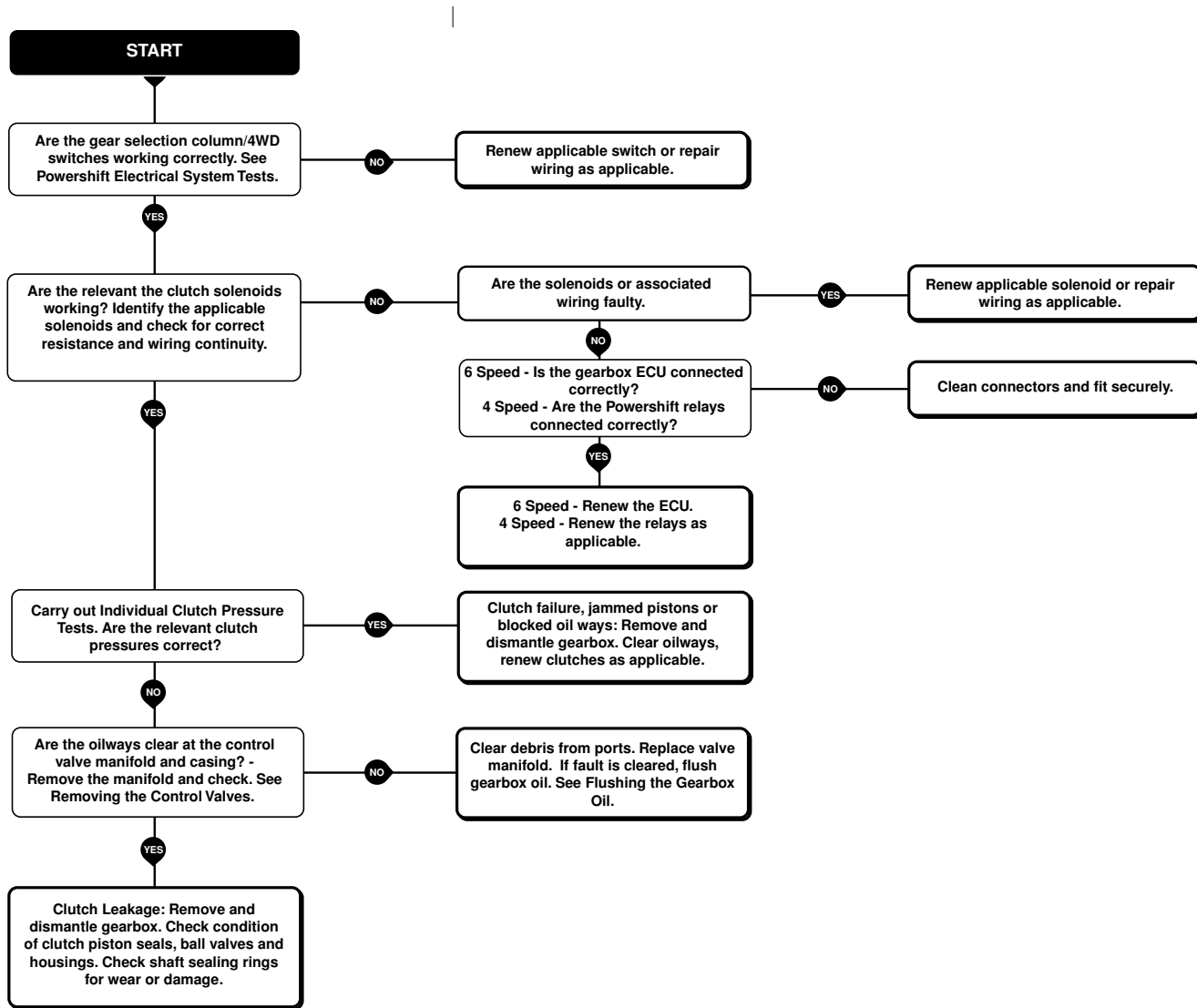
Chart B - Machine does not drive in any gear.



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Powershift Gearbox

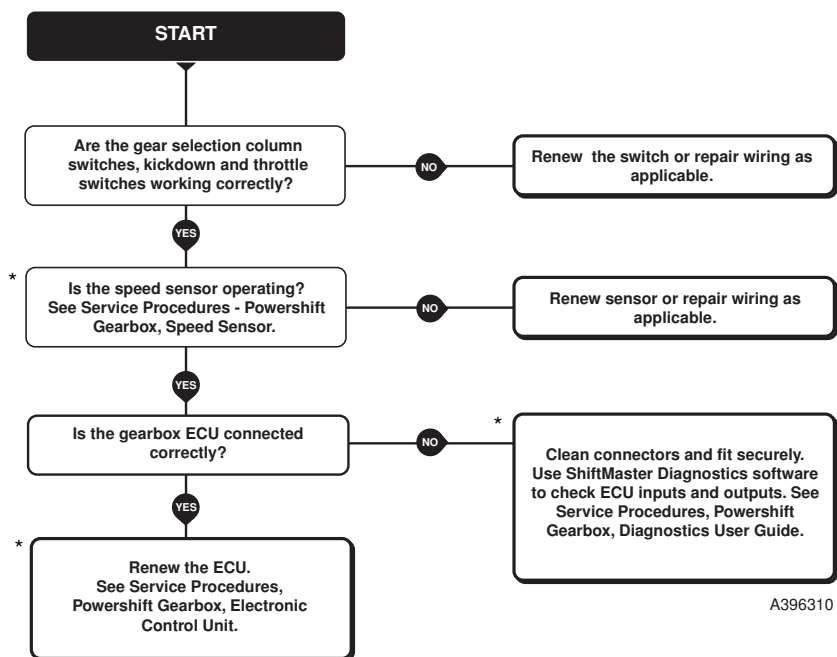
Chart C - Some gears fail to engage or lack power. 4WD fails to engage.



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Powershift Gearbox

Chart D - (6 speed gearbox only) ShiftMaster fails to function normally - fails to autoshift - shifts at incorrect road speed.



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Note: 4th, 5th and 6th gears utilise clutches used for 1st, 2nd and 3rd gears. If 4th, 5th or 6th gears fail to engage, check that the lower 3 gears function correctly before investigating a possible ShiftMaster fault. See **Fault Finding Chart C**.

* The simplest and best way to fault find the 6 speed gearbox electrical system, (including the ECU) is by using ShiftMaster Diagnostics software and a laptop PC. See **Diagnostics User Guide**. This diagnostics system enables the engineer to quickly identify faults with specific electrical circuits or devices. The devices electrical connections, locations and wire identifications are given in **Electrical Connections - Powershift Gearbox - 6 Speed**. See also **Section C - Harness Data**.

'Limp Modes'

When applicable the ShiftMaster ECU provides restricted or modified gearbox operation if faults are detected by the ECU. Typical 'Limp Mode' forms of operation are:

Limp Mode 1

Machine autoshifts at different road speeds than normal.
2 Beeps at power-up.

Possible Reason

Internal 'Setup Data' ECU fault.
If on power-up the ECU detects an internal fault with its 'Setup Data' it will revert to use of a default set of values.

Limp Mode 2

Machine remains in neutral at all times.
1 Beep at power-up.

Error with ECU 'Application Software'.
If on power-up the ECU detects an internal fault with its 'core operating software' it will prevent operation of the gearbox.

Limp Mode 3

Only 1st, 2nd, and 3rd gears available.
Machine will not autoshift.

Error reading transmission speed.
If the ECU does not detect any input from the speed sensor it will prevent selection of any gear above 3rd.

Limp Mode 4

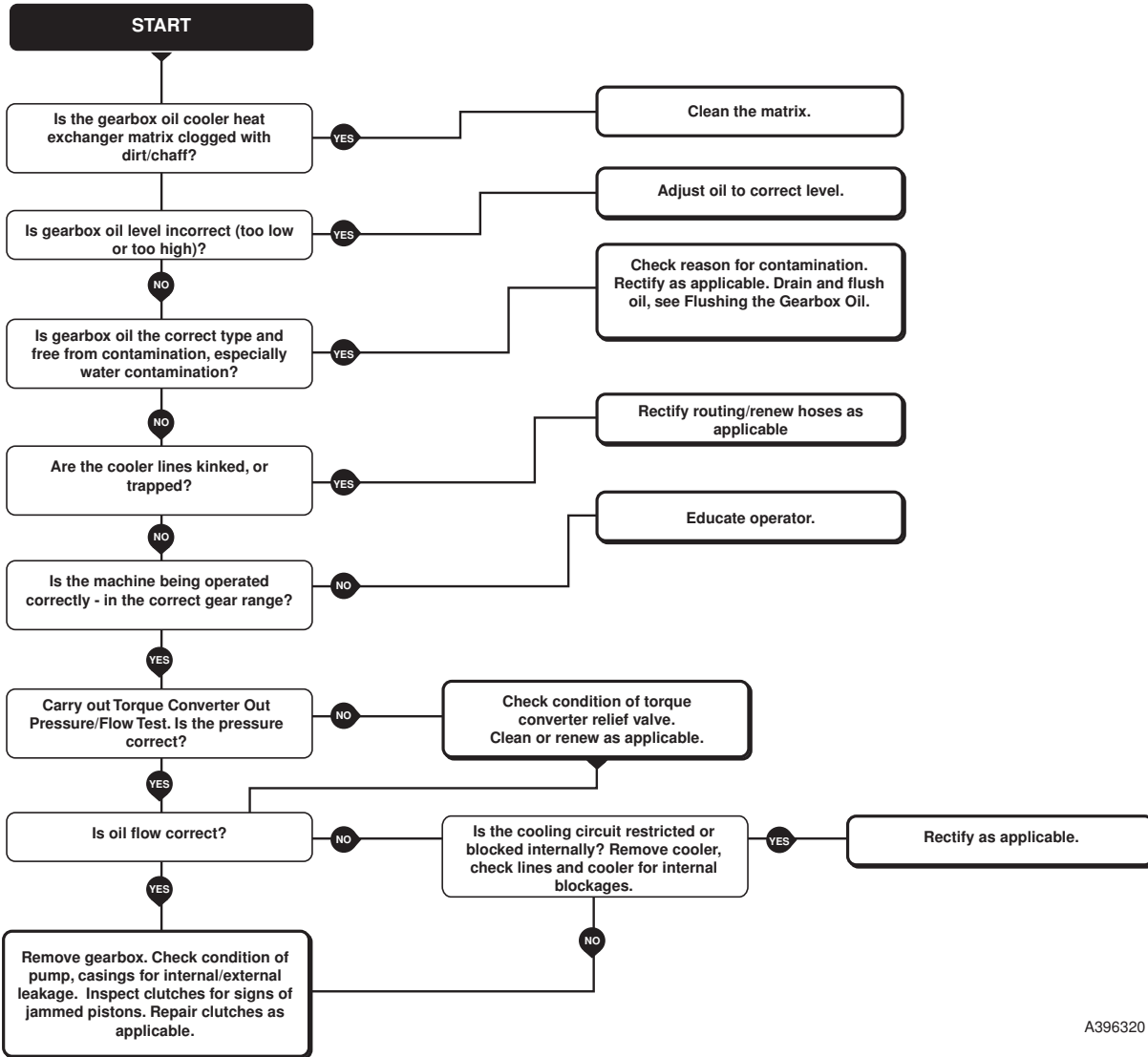
Machine holds a gear.
Repeating beeps until ECU power is reset.

Error reading transmission speed.
If the ECU detects an error with the speed sensor whilst operating it prevents autoshifting.

Note: On power-up the ECU will normally sound 3 beeps. These beeps can be masked by other audible warnings on start up.

Powershift Gearbox

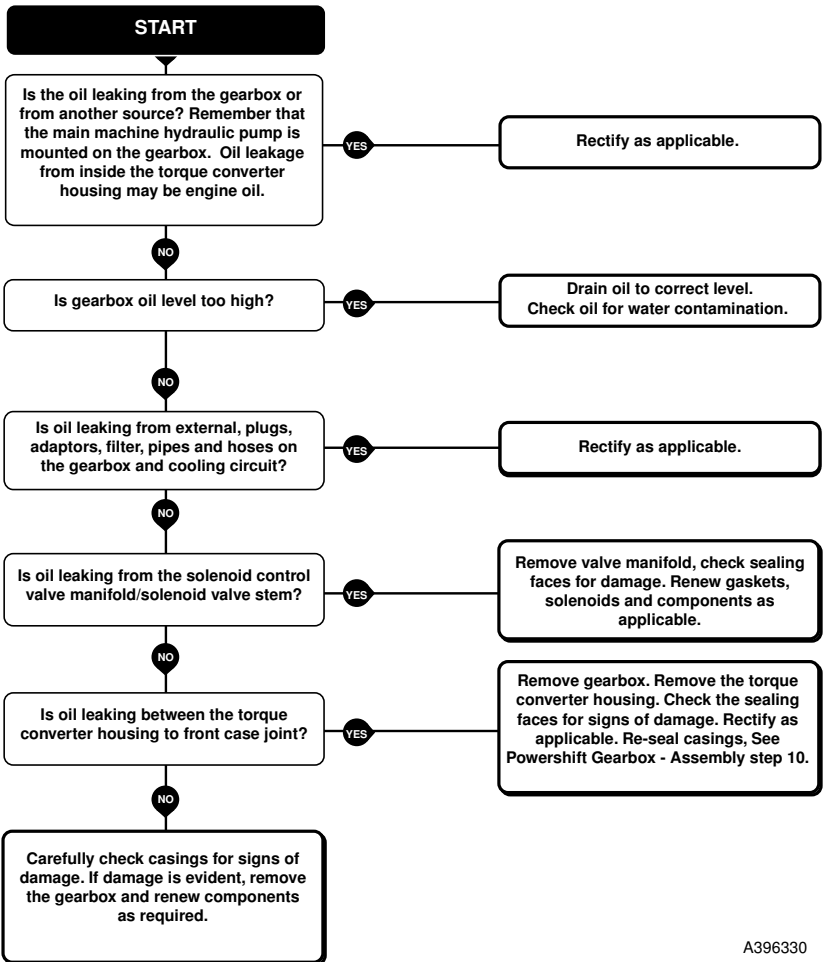
Chart E - Gearbox oil overheats



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Powershift Gearbox

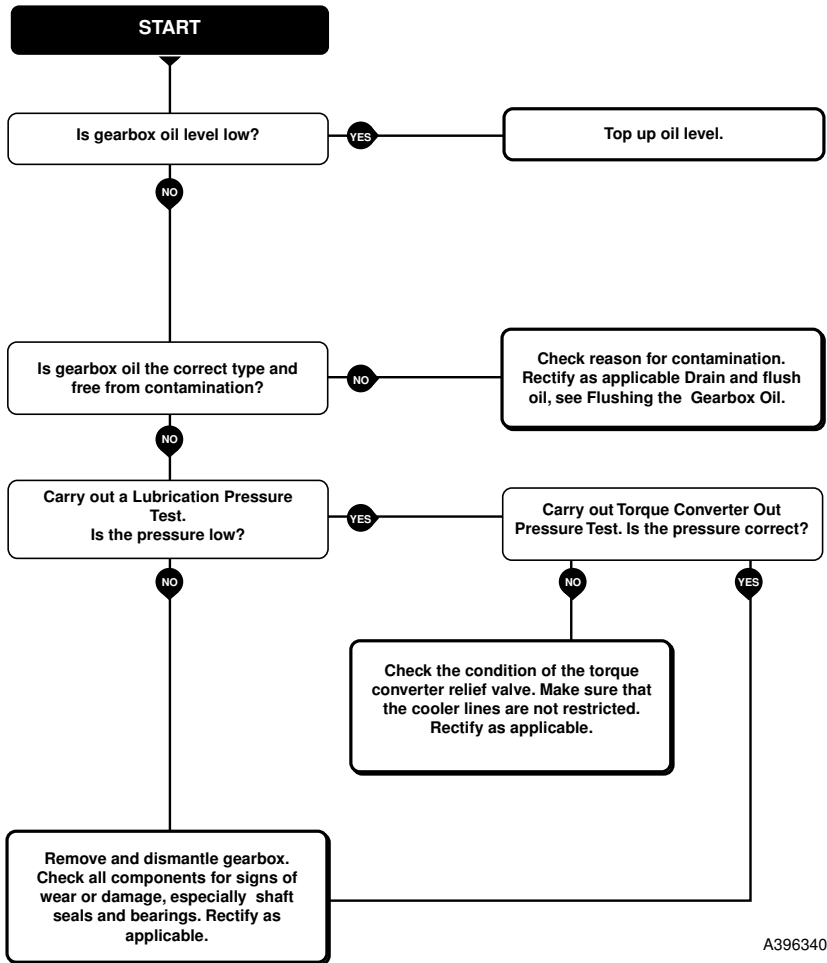
Chart F - External oil leakage



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Powershift Gearbox

Chart G - Noisy operation



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Powershift Gearbox

Gearbox Oil Contaminated with Water

Carefully inspect the gearbox oil for signs of water contamination. Contaminated oil will contain water droplets or be visibly emulsified. Water droplets may be visible on the dipstick or inside the filler tube. For oil analysis purposes, the maximum permissible water content of the oil is 0.10%.

If the gearbox oil has been contaminated with water, faults or damage to the gearbox may be apparent as a result. Before remedying, thoroughly investigate and rectify the cause of the water contamination.

Note: The correct gearbox oil is given in Section 3, **Service Capacities and Lubricants**.

Possible Cause	Remedy
1 Water ingress during filling/topping up.	Carry out flushing procedure. Refill with the correct oil, see Section 3,
2 Missing/incorrect dipstick, damaged filler tube.	Renew missing/incorrect/damaged components. Carry out flushing procedure. Refill with the correct oil, see Section 3,
3 Machine operated in deep water.	Carry out flushing procedure. Refill with the correct oil, see Section 3,
4 Gearbox casings damaged.	Inspect, renew damaged components. Carry out flushing procedure. Refill with the correct oil, see Section 3,
5 Gearbox oil circuit pipes/hoses damaged.	Inspect, renew damaged components. Carry out flushing procedure. Refill with the correct oil, see Section 3,

Gearbox faults caused typically by water contamination and other factors related to the gearbox oil:

Fault	Possible Cause	Remedy
1 Pressurisation of gearbox casing - Dipstick blows out/oil leaking from dipstick tube.	Water in oil combined with heat from torque converter causes steam.	Replace/renew dipstick. Carry out flushing procedure. Refill with the correct oil, see Section 3,
	Gearbox over filled with oil.	Drain the oil level to the correct level, see Routine Maintenance - Checking Transmission Oil Level .
2 Clutch Failure - Friction Lining Separation.	Water ingress.	Renew friction plates. Carry out flushing procedure. Refill with the correct oil, see Section 3,
	Overheating transmission oil.	See Fault Finding - Overheating .
3 Badly worn/noisy bearings.	Water ingress.	Fit new bearings. Carry out flushing procedure.
	Insufficient lubrication.	Refill with the correct oil, see Section 3,

Front Axle - SD55, SD70

Renewing the Pinion Oil Seal

The pinion oil seal **3** may be renewed without removing the axle from the machine.

⚠ WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-001

- 1 Remove the roadwheels and uncouple the axle propshaft. Measure the axle rolling torque and record the reading. Mark the relative positions of the pinion shaft **4** and nut **2** with a scribe.
- 2 Using Service Tool 892/00812, remove the drive yoke **1** together with its stake nut **2**.
- 3 Remove the seal **3** and fit a new one. Be sure not to damage the seal housing. Pack between the lips of the new seal with grease before fitting.

- 4 Check the sealing surface on the yoke for wear or damage. renew the yoke if necessary.

- 5 Fit the yoke and temporarily fit the old stake nut **2**. Tighten the nut with a torque wrench, aligning the scribe marks. Note the tightening torque required.

- 6 Remove and discard the old nut. Fit a new nut and tighten to the torque determined at step 5.

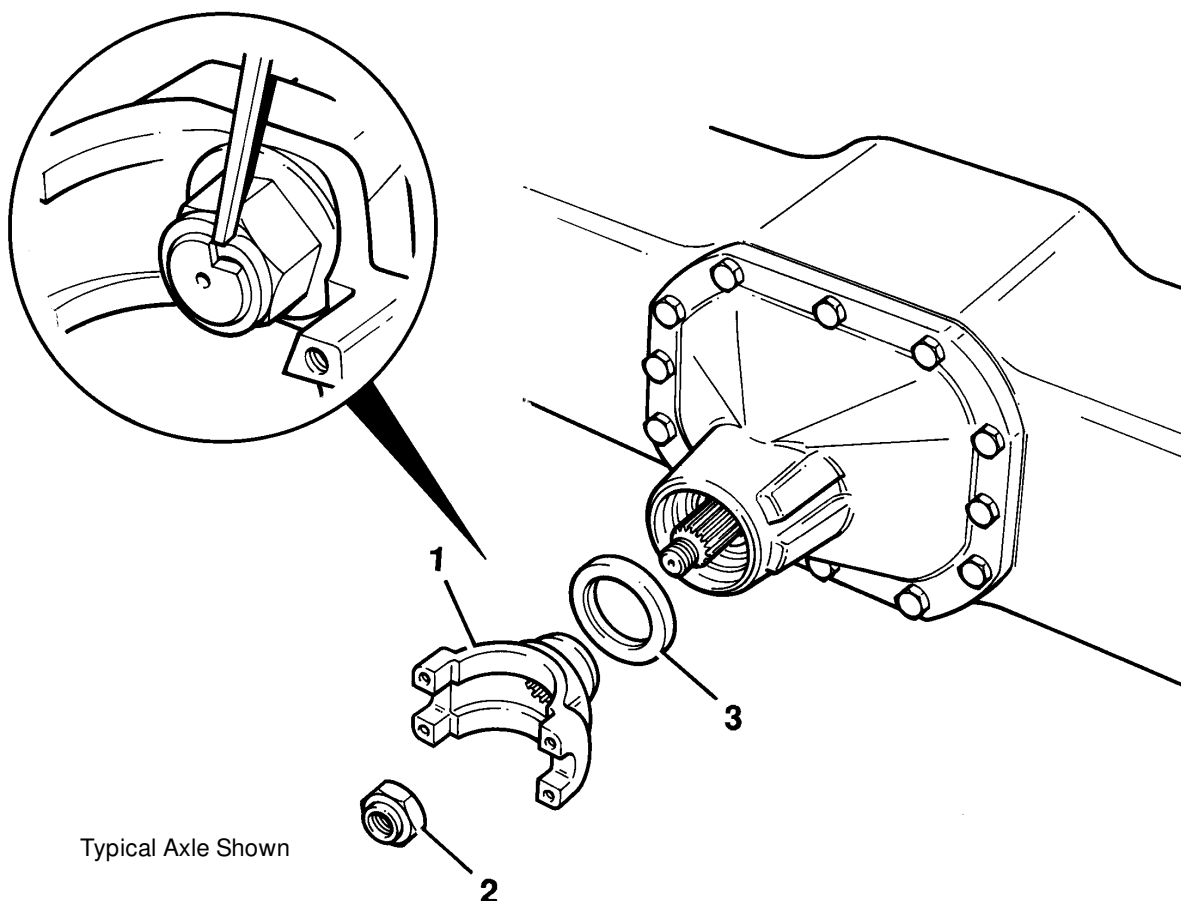
6.1 Measure the rolling torque. The reading should be 0.5 to 1 Nm (0.37 to 0.74 lbf ft; 0.05 to 0.1 kgf m) more than that recorded in Step 1 (see Note).

6.2 If necessary, progressively torque tighten the nut to a maximum of 300 Nm (221 lbf ft) to achieve correct rolling torque.

Note: If the rolling torque figure (new pinion seal fitted) exceeds the reading recorded in step 1 by 1 Nm (0.74 lbf ft; 0.1 kgf m) or more, or a minimum torque of 250 Nm (184 lbf ft) can not be achieved then the pinion assembly must be rebuilt using a solid spacer, see the appropriate axle assembly procedure.

6.3 Stake the nut using a square ended staking tool.

- 7 Refit the roadwheels and couple the propshaft.



Typical Axle Shown

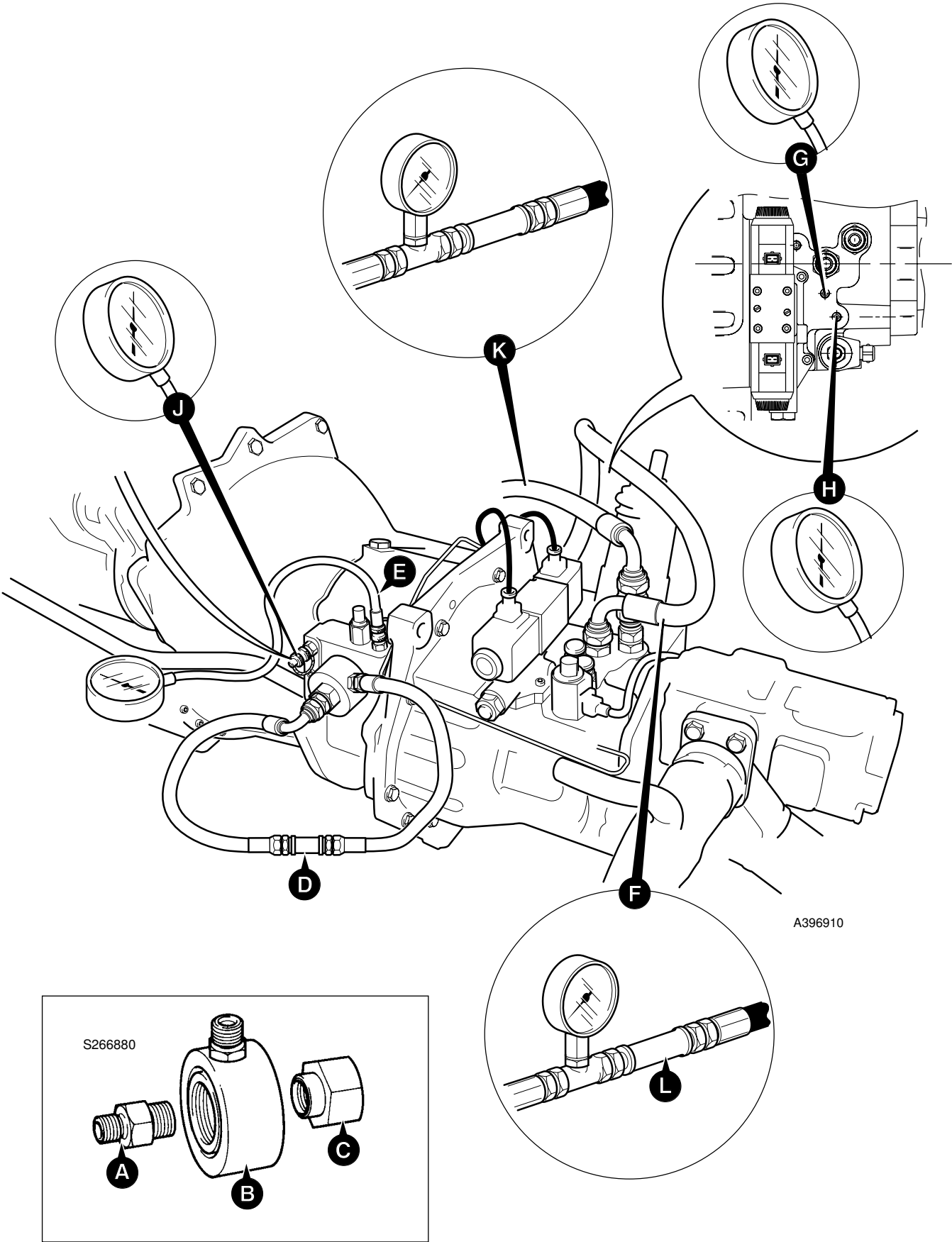
Rear Axle - SD80, PD70**Renewing the Pinion Oil Seal**

The rear axle pinion oil seal is renewed using the same procedure as **Front Axle SD55, SD70** but note the following:

The rear axles are fitted with a brake disc/drive flange in place of the yoke on front axles. For the brake disc removal procedure see **Section G, Brakes, Service Procedures**.

Rear Axle - SD80, PD70**Brakes - Testing for Piston Seal Leakage**

See **Section G, Brakes, Service Procedures.**



Synchro Shuttle Gearbox

Torque Converter Stall Test

Ensure that the engine and transmission are at normal working temperature. Run engine at maximum speed and check the **No Load Speed (High Idle Speed - U.S.A.)**. See Engine Technical Data for correct figure; adjust if necessary.

Apply parking brake and footbrake firmly, select 4th Speed Forward and open throttle fully. Engine speed should be as specified at **Torque Converter Stall** in Transmission Technical Data. Select Reverse and repeat test.

Note: When fully engaged, the parking brake electrically disconnects the transmission drive; this prevents the machine from being driven with the parkbrake on. Therefore, so that we can complete the test, move the parkbrake lever fractionally forward until the warning light is just extinguished; hold the lever in this position for the duration of the test. DO NOT move the lever too far forward, otherwise the parkbrake will not be fully operational. Alternatively, disconnect the switch at the park brake.

DO NOT stall the converter for longer than 10 seconds or the transmission fluid will overheat.

If engine speeds are higher than the stated figures check the transmission for clutch slippage or internal leakage.

If engine speeds are below the stated figures either the engine is losing power and should be serviced/overhauled or the torque converter reaction member clutch is slipping. To check the engine, select Neutral, open throttle fully and operate an excavator service to 'blow off' the main relief valve. Engine speed should fall to slightly above the **Maximum Governed Speed** (see Engine Technical Data). If engine speed is correct the torque converter is faulty.

Note: **Maximum Governed Speed** is a datum figure only. It cannot be adjusted or checked with the engine installed in the machine.

Pressure and Flow Test

Note: The tests must be carried out only in the following order, step by step.

WARNING

Take care when disconnecting hydraulic hoses and fittings as the oil will be HOT.

Trans 1-2

- 1 Stop engine, remove transmission filter and filter head adapter. Fit adapter **A** (892/00920) into the gearbox casing. Fit test adapter **B** (892/00301) and secure with adapter **C** (892/00302). Connect flowmeter **D** (892/00229) as shown and connect a 0-20 bar (0-300 lbf/in²) pressure gauge to test connector **E** (see Service Tools, Section 1).

- 2 Start engine and run at 1000 rev/min. The flowmeter will show the **Pump Flow** which should be as shown in Technical Data. A low reading indicates a worn pump or blocked suction strainer. The pressure gauge will show the **Main Line Pressure** (see Technical Data). A low reading can be caused by either a faulty pressure maintenance valve or a worn pump. A high reading indicates a faulty pressure maintenance valve or, if the pump flow is low, the oil cooler may be blocked.
- 3 Stop engine, remove flow test adapters and refit filter. Connect pressure gauge and flowmeter into converter out line as shown at **F**. Run engine at 1000 rev/min with transmission in Neutral and note **Converter Out Pressure** and **Oil Cooler Flow**, which should be as shown in Technical Data. A high pressure together with low flow could be caused by a blocked oil cooler. (See also check 7.)
- 4 With parking brake and footbrake firmly applied, select Forward and check flow reading, which should not fall by more than 4.5 litres (1 UK gal; 1.2 US gal) per minute. A low reading indicates a high leakage rate in that particular clutch, which could be caused by worn or broken piston seals or shaft sealing rings. Select Reverse and repeat the test.
- 5 If the clutch leakage rate is high, the **Clutch Pressures** may be checked by connecting the pressure gauge into ports **G** and **H** and repeating test 4. A low reading (see Technical Data) would confirm a high leakage rate in the particular clutch selected.
- 6 Stop engine, connect the pressure gauge into port **J** in the transmission, and fit a load valve **L** into the converter out line (see note).

Note: Make sure that the load valve **L** has been screwed fully out before starting the engine, otherwise the converter seals will be damaged.

Start engine, run at 1000 rev/min and slowly screw down the load valve whilst observing the gauge reading, which should rise to the setting of the **Converter Relief (Safety) Valve** (see Technical Data). **DO NOT** allow the pressure to exceed 10.3 bar (150 lbf/in²) or damage to the converter seals will be caused.

If the reading is higher than specified, the relief (safety) valve must be faulty. A low reading indicates a faulty relief (safety) valve, leaking converter 'piston ring' type seal or leaking pump seal.

- 7 Stop engine and connect pressure gauge and flowmeter into return line from oil cooler to transmission as shown at **K**. Start engine, and with transmission in Neutral check flowmeter reading, which will show the **Cooler Flow Rate** (see Technical Data). The pressure gauge will show the **Lubrication Pressure** (see Technical Data). Low flow and pressure readings could indicate a blocked oil cooler.

Synchro Shuttle Gearbox Forward/Reverse Solenoid Control Valve

Dismantling

Unscrew the knurled nut **2** and remove 'O' ring **3**, withdraw the solenoid **4** and 'O' ring **5**.

Hold the solenoid valve body **6** in a vice, using the spanner flats **A**, remove spindle **7** and 'O' ring **8**.

Pull out actuating pin **9**, spring **10**, spring retainer **11**, and spool **12**.

Inspect the spool and spool bore for signs of wear, nicks scratches etc.

Assembling

Assembly is reversal of the dismantle procedure.

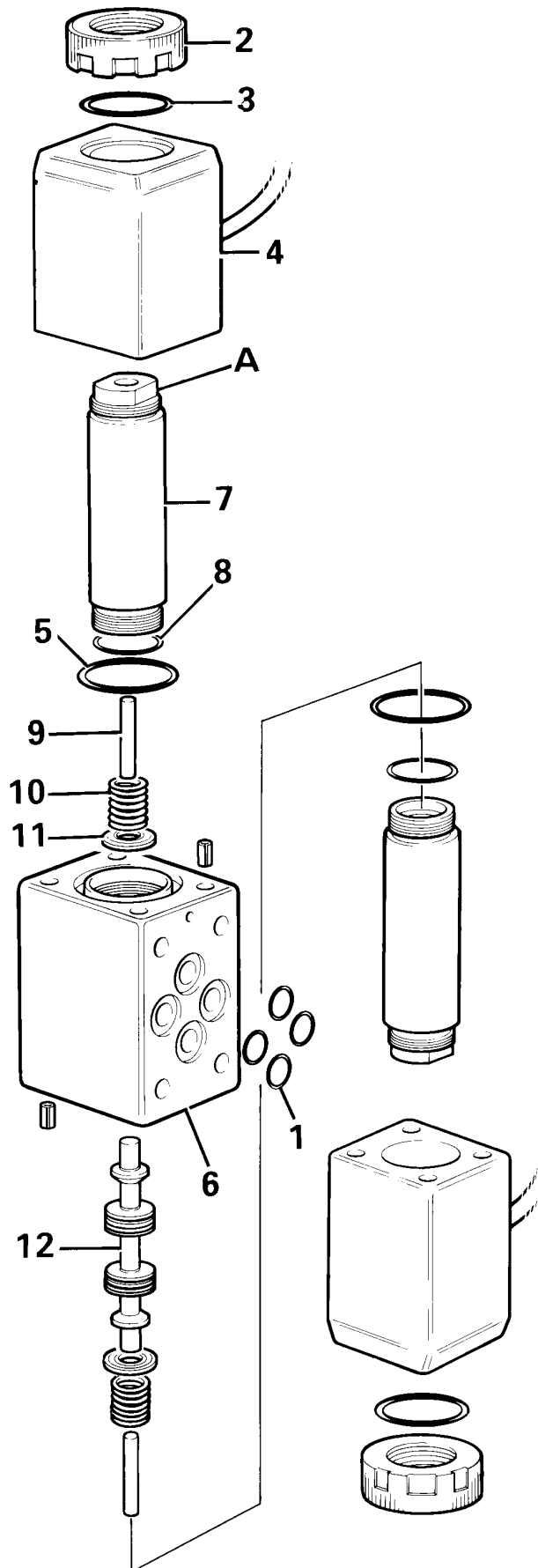
Renew all 'O' rings.

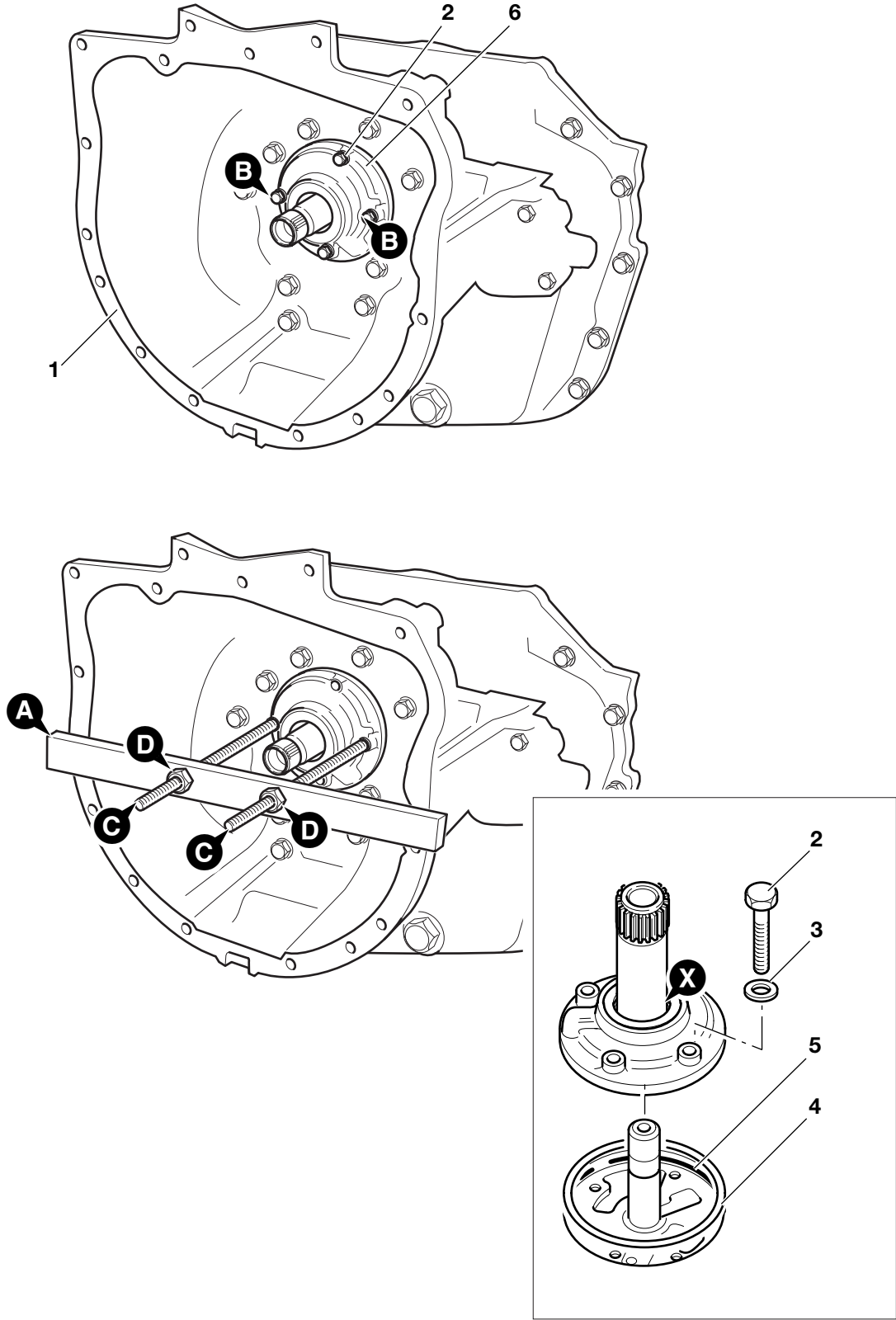
Lightly lubricate all parts with clean transmission fluid before assembling.

Check that the flying leads are secure and that the connectors are intact.

Torque Settings

Item	Nm	kgf m	lbf ft
2	10 to 15	1 to 1.5	8 to 10





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Powershift Gearbox

Gearbox Hydraulic Pump - Removal and Replacement

The gearbox hydraulic pump is located at the input end of the gearbox. The gearbox must be removed from the machine to enable removal and replacement of the pump.

Removal

- 1 Remove the gearbox from the machine, see **Powershift Gearbox Removal and Replacement**.

IMPORTANT NOTE: After removing the gearbox DO NOT REMOVE THE TORQUE CONVERTER HOUSING **1** from the gearbox. A simple service tool (**A**) must be manufactured to enable the pump assembly to be removed. See **Transmission, Service Tools** for details.

- 2 Undo the 4 fixing bolts **2**. Discard the sealing washers **3**.
- 3 Using a set of M10 x 1.5 taps carefully tap the 2 holes **B** in the pump assembly **6**. Start with the taper tap (be sure not to damage the tapped holes in the gearbox front case beneath) and finish with the plug tap. Ensure that the thread is at least 35 mm (1.38 in) deep and both the pump body and stator are threaded. Be sure to remove ALL swarf before proceeding.
- 4 Screw in a 250 mm (10 in) length of M10 threaded rod **C** into each hole **B**. Position the reaction bar **A** as shown. Progressively screw down the M10 nuts **D** to withdraw the pump assembly from its housing.
- 5 Remove and discard the pump sealing ring **4**. Remove and discard the 'O' ring **5** from the pump locating bore in the housing **1**.

Note: The pump should be dismantled and inspected, see **Powershift Gearbox - Inspection**. Note that a pump which is badly worn or damaged may have caused further damage to the gearbox, see **Powershift Gearbox - Dismantling**.

Replacement

- 1 Fit a new 'O' ring **5** to the locating bore inside the housing **1**. Lightly oil the 'O' ring.
- 2 Make sure that the pump is fitted with a new oil seal, see **Powershift Gearbox, Inspection, step 4**. Fit a new sealing ring **4**. Locate the pump over the input shaft aligning the bolt holes. Apply JCB Threadlocker and Sealer to bolts **2**. Fit the bolts together with new sealing washers **3**. Progressively torque tighten the bolts to 28 Nm (20 lbf ft).
- 3 Pour some clean, new, oil into the pump at position **X**.

Powershift Gearbox

Suction Strainer - Removal and Replacement

Removal

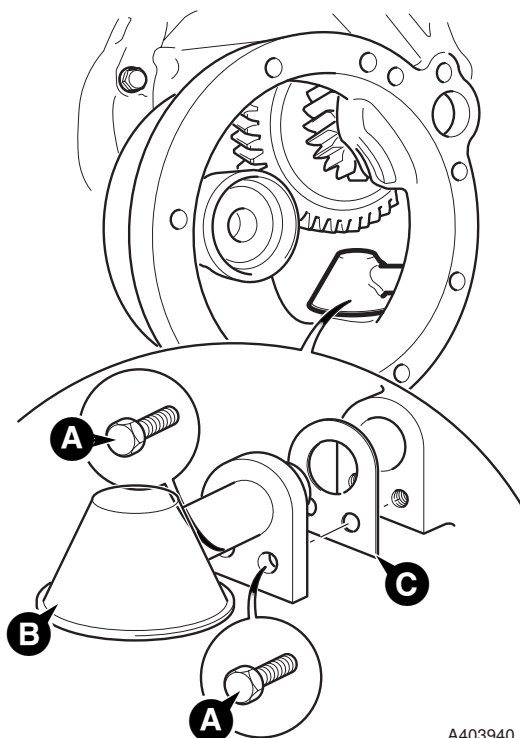
The suction strainer is located inside the gearbox front case. Access is gained by removing the 4WD clutch assembly.

- 1 Park the machine on level ground, apply the parking brake and chock the wheels.
- 2 Allow transmission oil to cool and then drain the oil, see **Powershift Gearbox, Changing the Oil, Routine Maintenance**.
- 3 Disconnect the propshaft from the 4WD unit, see **Propshaft, Removal and Replacement**.
- 4 Remove the 4WD unit, see **Powershift Gearbox, Dismantling Step 6 - Remove the 4WD Clutch Assembly**.
- 5 Using a 13 mm ring spanner, reach inside the casing and undo the 2 suction strainer retaining bolts **A**. Be sure to retrieve the bolts from inside the gearbox.
- 6 Push the suction strainer **B** away from you (towards the rear of the gearbox) to disengage it from the gearbox casing. Remove the strainer via the 4WD aperture.
- 7 Make sure that the gasket **C** is retrieved. Discard the gasket.
- 8 Clean the suction strainer by flushing with a solvent cleaner. Inspect the strainer mesh for tears or splits. Renew the suction strainer if the mesh is damaged.

Replacement

Replacement is the reverse of the removal sequence but note the following:

- 1 Fit a new gasket **C**.
- 2 Make sure that no loose components or debris have been left inside the gearbox casing.
- 3 Before replacing the 4WD assembly make sure that all traces of gasket or gasket compound have been removed from the mating faces, see **Powershift, Gearbox, Inspection**.



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Powershift Gearbox

Torque Converter Stall Test

The purpose of the stall test is to check the performance of the transmission by 'stalling' the torque converter. This is the point at which, due to torque applied by the engine the torque converter stops transmitting drive to the gearbox. The engine speed at which 'stalling' occurs is compared to speeds recorded for a machine in normal condition (given in **Technical Data**). Abnormal stall speed results can be used to identify a number of possible faults with the transmission, typically gearbox hydraulic and clutch faults.

Note: DO NOT stall the converter for longer than 10 seconds or the transmission fluid will overheat. Make sure that the oil level is correct and at normal operating temperature.

Before completing the following test, remove the transmission dipstick. If there is any sign of smoke emitting from the dipstick tube STOP THE TEST IMMEDIATELY and dismantle the transmission for servicing.

By performing the tests in the first 3 gears in forward and reverse we can see from the tables below that all the clutches in the gearbox will be engaged, ensuring faults will be easy to identify. Draw a table as shown so that you can record the results.

Stall Test Results - 6 Speed Powershift				
Gear	Clutches engaged			
	Forward	Rev/min	Reverse	Rev/min
1st	X,Z		W,Z	
2nd	T,Z		V,Z	
3rd	U,Z		W,Y	

Stall Test Results - 4 Speed Powershift				
Gear	Clutches engaged			
	Forward	Rev/min	Reverse	Rev/min
1st	T,Z		W,Z	
2nd	U,Z		V,Z	
3rd	T,Y		W,Y	

- 1 Ensure that the engine and transmission are at normal working temperature (the transmission oil must be above 50°C). Run engine at maximum speed and check the **No Load Speed (High Idle Speed - U.S.A)**. See Engine Technical Data for correct figure; adjust if necessary.
- 2 Apply parking brake and footbrake firmly. If necessary, set the machine against a fixed obstruction.

Note: When fully engaged, the parking brake electrically disconnects the transmission drive; this prevents the machine from being driven with the parkbrake on. Therefore, so that we can complete the test, move the parkbrake lever fractionally forward until the warning light is just extinguished; hold the lever in this position for the duration of the test. DO NOT move the lever too far forward, otherwise the parkbrake will not be fully operational. Alternatively, disconnect the switch at the park brake.

- 3 Select 1st speed forward drive and open throttle fully. Record the engine speed from the tachometer. Repeat the test for 2nd and 3rd speed forward and record the readings.
- 4 Repeat step 3 except this time select 1st, 2nd and 3rd gear reverse drive respectively. Record the readings.
- 5 All recorded readings should be as specified at **Torque Converter Stall** in Transmission Technical Data.

Key to Clutches

- T - Forward low ratio clutch pressure
- U - Forward high ratio clutch pressure
- V - Reverse high ratio clutch pressure
- W - Reverse low ratio clutch pressure
- X - 6 speed clutch pressure (6 speed gearbox only)
- Y - Mainshaft clutch pressure
- Z - Layshaft clutch pressure

Powershift Gearbox

Torque Converter Stall Test, cont'd

Interpreting the Test Results

If all the engine speeds are below the stated figures either the engine is losing power and should be serviced/overhauled or the torque converter reaction member clutch is slipping. To check the engine, select Neutral, open throttle fully and operate an excavator service to 'blow off' the main relief valve. Engine speed should fall to slightly below the **Maximum Governed Speed** (see **Engine Technical Data**). If engine speed is correct the torque converter reaction member clutch is slipping.

If all the engine speeds are higher than the stated figures in all gears the torque converter safety relief valve may be faulty. Alternatively there may be internal oil leakage.

If engine speeds are higher than the stated figures in some gears, check the transmission for clutch slippage or internal leakage. Look at the example below and see how the results can be used to isolate a suspect clutch.

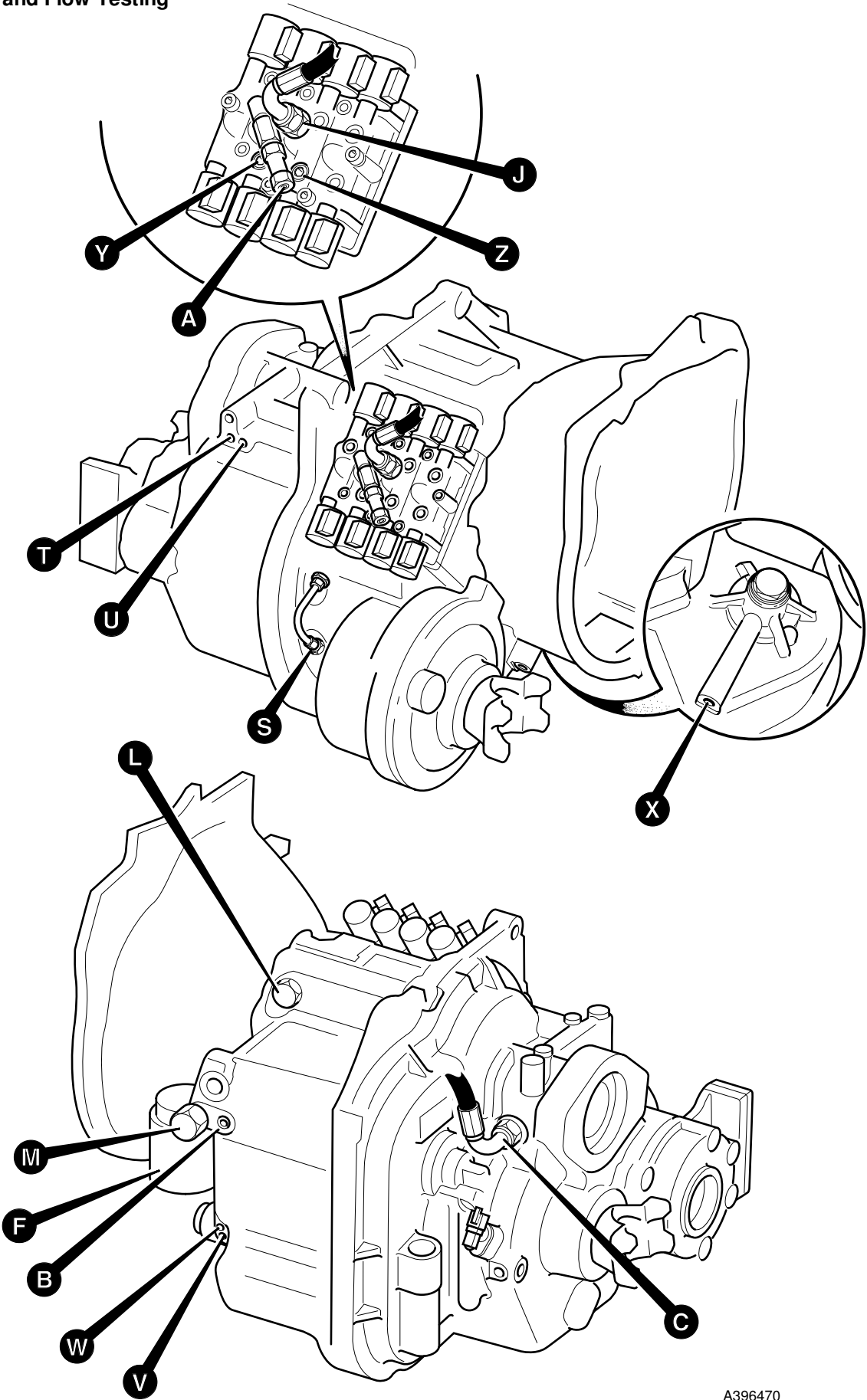
Stall Test Results - 6 Speed Powershift				
Gear	Clutches engaged			
	Forward	Rev/min	Reverse	Rev/min
1st	X,Z	1990	W,Z	1980
2nd	T,Z	2060	V,Z	1975
3rd	U,Z	1985	W,Y	1990

In the example shown, we can see that the engine speed is abnormally high when 2nd gear forward drive is selected, indicating a slipping clutch, possibly **T** or **Z**. We can now use the results to determine which clutch is at fault.

From the table we can see that there is no problem with clutch **Z** since it is engaged in other gears, the stall speeds for those gears are normal. This indicates that clutch **T** is slipping.

Clutches may be slip for several reasons. Hydraulic leakage is possible and this can be confirmed by carrying out a pressure test, see **Pressure Testing - Individual Clutches**.

Powershift Gearbox
Pressure and Flow Testing



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Powershift Gearbox

Pressure and Flow Testing

Before completing any of the transmission pressure/flow tests, make sure that the oil level is correct and at normal operating temperature (not less than 50 °C).

All gauges etc used in the following pressure/flow tests are shown in **Service Tools**.

WARNING

Fine jets of hydraulic oil at high pressure can penetrate the skin. Do not use your fingers to check for hydraulic oil leaks. Do not put your face close to suspected leaks. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of hydraulic oil. If hydraulic oil penetrates your skin, get medical help immediately.

HYD 1-1

WARNING

Take care when disconnecting hydraulic hoses and fittings as the oil will be HOT.

Trans 1-2

WARNING

DO NOT go underneath the machine with the engine running. Switch off the engine, apply the parking brake and chock both sides of all wheels before going underneath the machine.

Trans 2-1

WARNING

If a 4 wheel drive machine is to be raised and the engine/transmission run, make sure all four wheels are off the ground and supported by axle stands. If only one pair of wheels is raised, the machine could still drive through the other axle.

Trans 2-2/2

WARNING

Under no circumstances must the engine be run with the transmission in gear and only one driving wheel jacked clear of the ground, since the wheel on the ground will move the machine.

INT-3-1-16

TEST POINTS

- A** - Mainline pressure
- B** - Converter inlet/converter relief valve pressure
- C** - Converter outlet pressure
- F** - Pump flow (remove filter and fit adapters)
- J** - Lubrication pressure

Clutches:

- S** - 2/4 wheel drive clutch pressure
- T** - Forward low ratio clutch pressure
- U** - Forward high ratio clutch pressure
- V** - Reverse high ratio clutch pressure
- W** - Reverse low ratio clutch pressure
- X** - 6 speed clutch pressure (6 speed gearbox only)
- Y** - Mainshaft clutch pressure
- Z** - Layshaft clutch pressure

Other items:

- L** - Torque converter relief valve
- M** - Pressure maintenance valve

Test Procedures

Pump Flow

Mainline Pressure

Converter In Pressure

Converter Relief (Safety) Valve Pressure

Converter Out Pressure/Oil Cooler Flow Rate

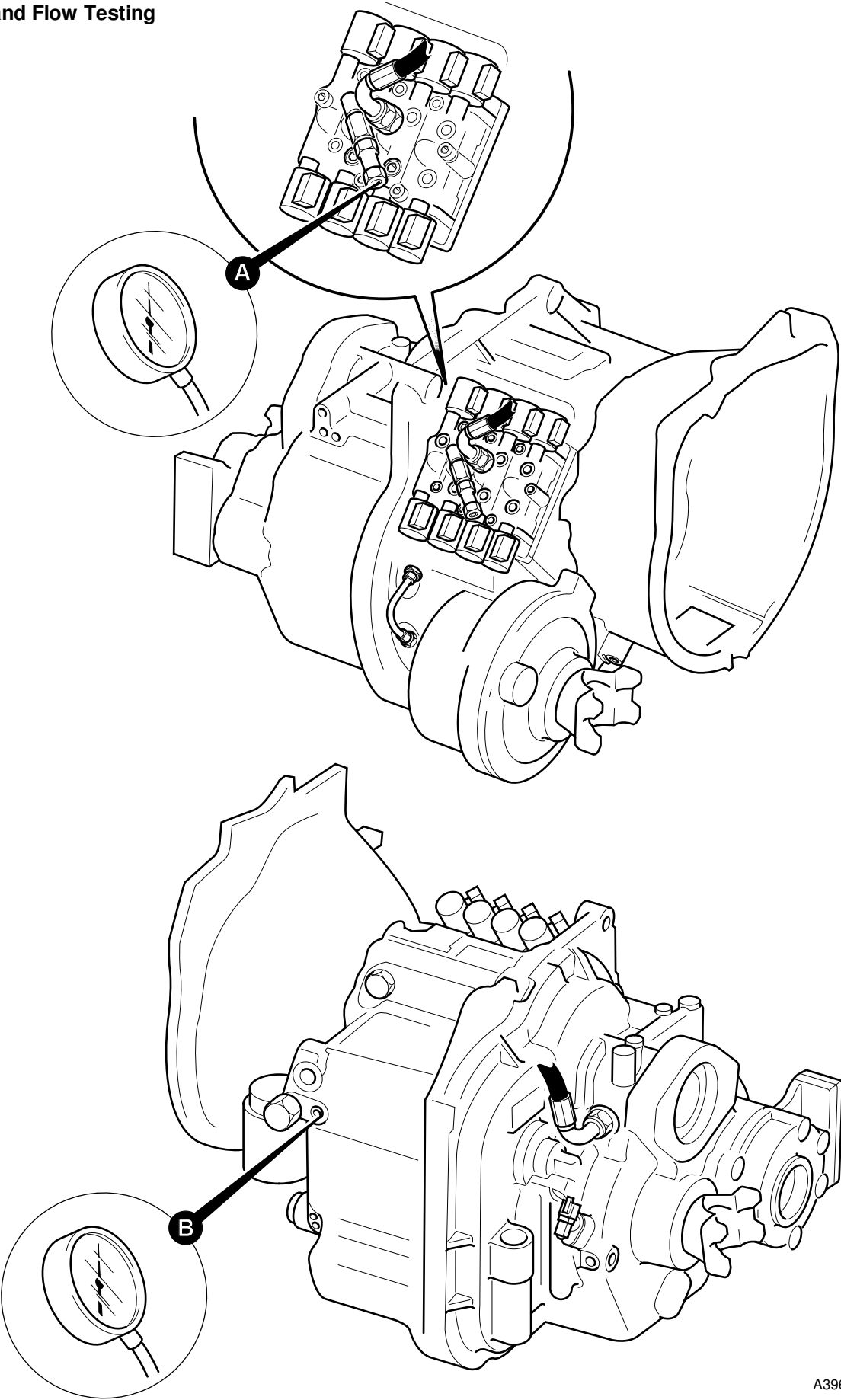
Lubrication Pressure

Clutches:-

Isolating a Suspect Clutch

Individual Clutch Leakage Test

Powershift Gearbox
Pressure and Flow Testing



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Powershift Gearbox

Pressure and Flow Testing, cont'd

Pump Flow

- 1 Stop engine, remove the gearbox oil filter and fit adapter **X** (460/15708) into the gearbox casing. Connect flowmeter **W** (892/00268).
- 2 Start engine and run at 1000 rev/min. With the transmission in neutral the flowmeter will show the **Pump Flow** which should be as shown in **Technical Data**. A low reading indicates a worn pump or blocked suction strainer.
- 3 Repeat step 2 and note gauge readings with engine running at 2000 rev/min.
- 4 Stop engine and remove test adapters, refit filter.

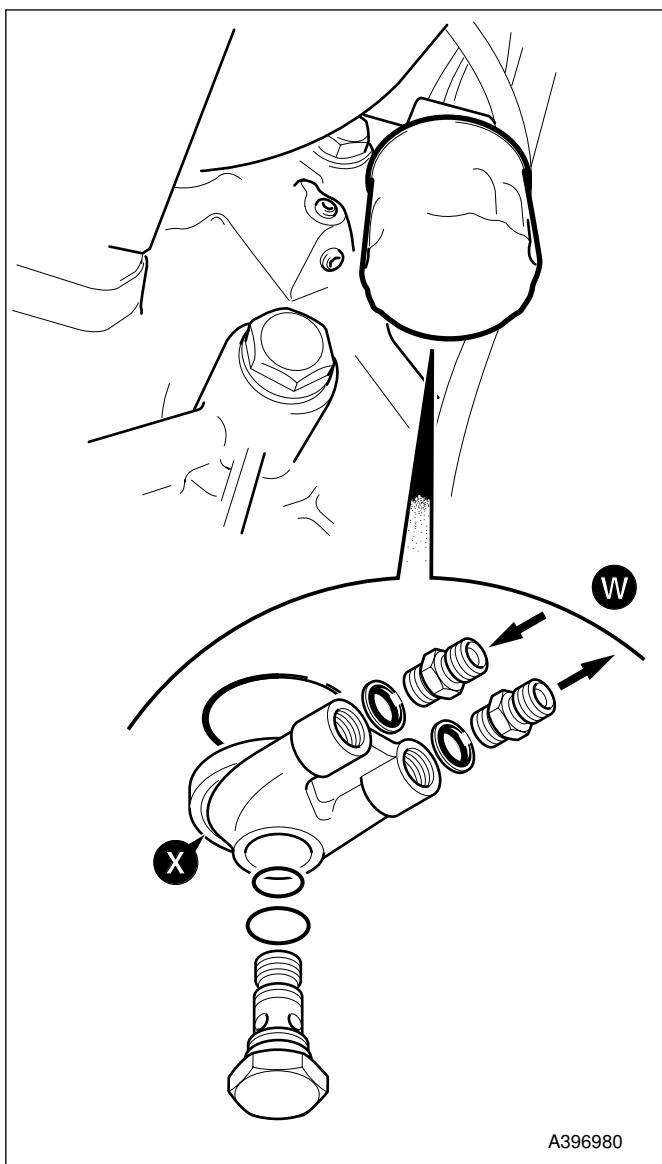
Mainline Pressure

- 1 Stop engine, connect a 0-20 bar (0-300 lbf/in²) pressure gauge to test connector **A**.
- 2 Start engine and run at 1000 rev/min. With the transmission in neutral the pressure gauge will show the **Main Line Pressure** which should be as shown in **Technical Data**. A low reading can be caused by either a faulty pressure maintenance valve or a worn pump. A high or low reading may indicate a faulty pressure maintenance valve.
- 3 Repeat step 2, with engine running at 2000 rev/min note gauge readings which should be as shown in **Technical Data**.
- 4 Stop engine and remove test gauge.

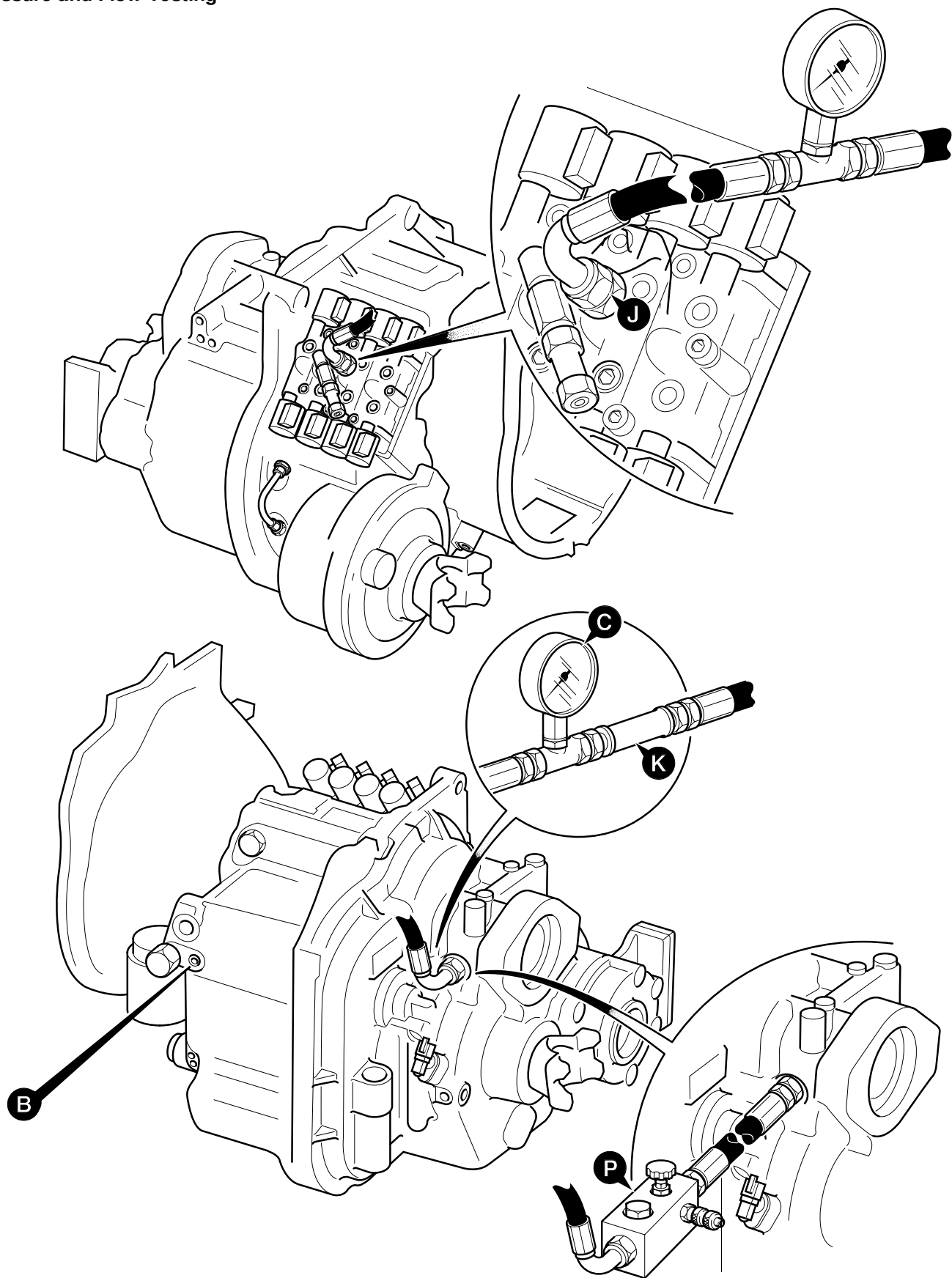
Converter In Pressure

Note that the converter in pressure is affected by the torque converter relief valve operation. Before carrying out tests check the operation of the relief valve (see **Converter Relief (Safety) Valve Pressure**).

- 1 Stop engine, connect a 0-20 bar (0-300 lbf/in²) pressure gauge to test point **B**.
- 2 Start the engine and run at 1000 rev/min. With the transmission in neutral the pressure gauge will show **Converter In Pressure** which should be as shown in **Technical Data**. A high or low reading could indicate a faulty converter relief valve.
- 3 Remove pressure test gauge.



Powershift Gearbox
Pressure and Flow Testing



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Powershift Gearbox

Pressure and Flow Testing, cont'd

Converter Relief (Safety) Valve Pressure

The purpose of the torque converter relief valve is to protect the torque converter from excessive oil pressure. Excessive oil pressure can be generated when the transmission oil temperature is below 50°C and/or the engine is run at over 2000 rev/min. In this event the relief valve opens and returns oil directly to the transmission sump, bypassing the torque converter, cooler and clutch lubrication circuits, protecting against damage due to excessive pressure. For this reason it is essential that the transmission oil is above 50°C and the engine is run between idle and 1000 rev/min when testing the relief valve.

- 1 Connect a 0-20 bar (0-300 lbf/in²) pressure gauge to test point **B**.
- 2 Fit a load valve **P** into the converter out line.

CAUTION

Make sure the load valve is in the OPEN position, (the adjusting knob screwed fully OUT), before starting the following pressure test. Failure to do this could damage the pump.

HYD 4-4/1

DO NOT allow the pressure to exceed 8.3 bar (120 lbf/in²) or damage to the converter seals will be caused.

- 3 Start the engine and run at 1000 rev/min. With the transmission in neutral, slowly screw down the load valve **P** whilst observing the gauge reading which should rise to the **Converter Relief (Safety) Valve** setting as specified in Technical Data.

Note that the gauge pressure will fall once the valve has opened. This is normal relief valve operation and does not indicate a fault. If necessary reset the load valve **P** and perform the test again, watching the pressure gauge carefully.

- 4 If the converter relief valve opens at a pressure higher than specified then the valve is faulty. A low opening pressure indicates a leaking pump to casing seal or a faulty converter relief valve.
- 5 Stop engine, remove test gauges and load valve. Refit hoses to original position.

Converter Out Pressure/Oil Cooler Flow Rate

Note that the converter out pressure and oil cooler flow rate are affected by the torque converter relief valve operation. Before carrying out tests check the operation of the relief valve (see **Converter Relief (Safety) Valve Pressure**).

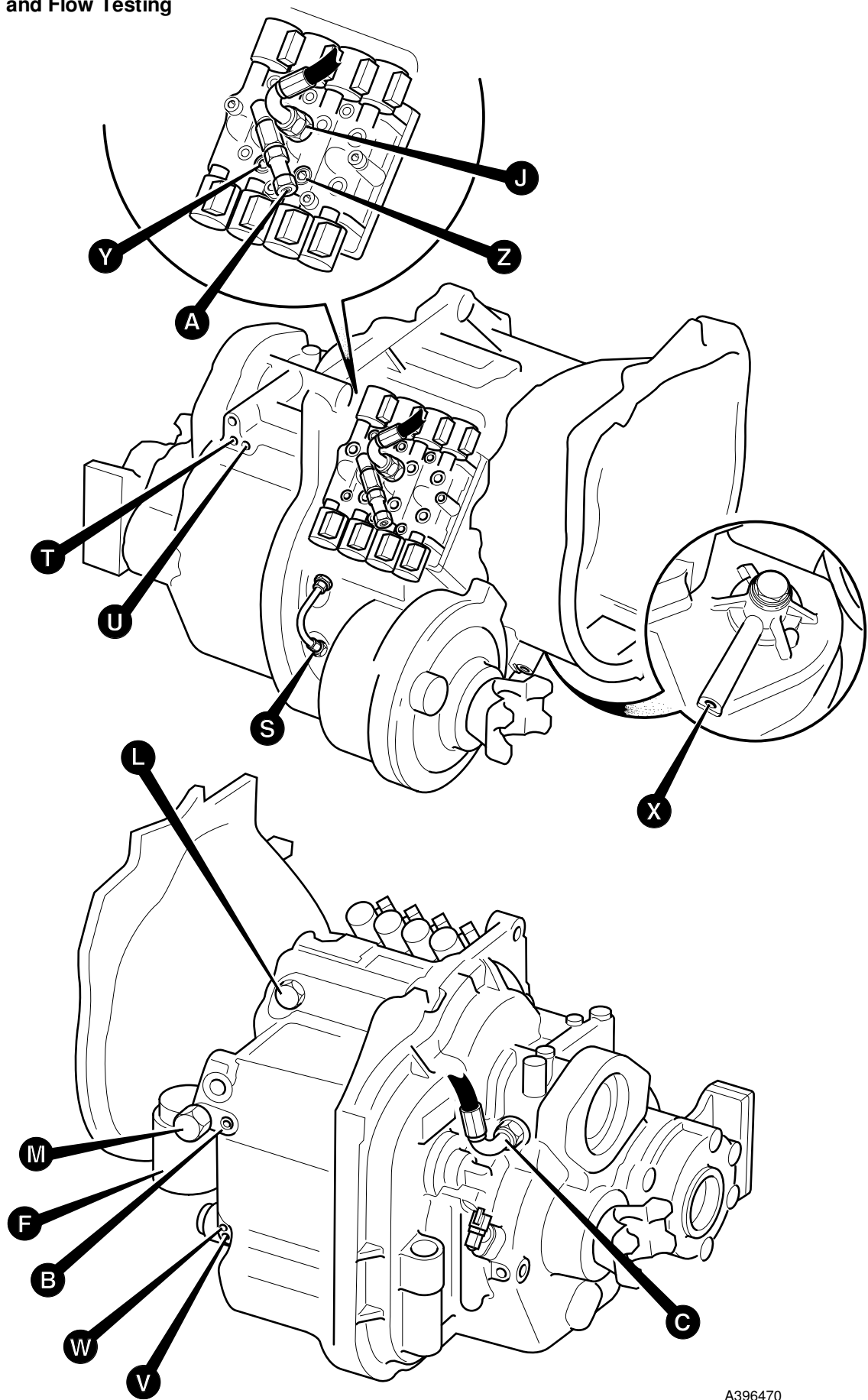
- 1 Stop engine, connect a 0-20 bar (0-300 lbf/in²) pressure gauge and flowmeter into the converter out line as shown at **C** and **K** respectively.
- 2 Run the engine at 1000 rev/min with transmission in neutral. The pressure gauge indicates the **Converter Out Pressure** and the flowmeter indicates the **Oil Cooler Flow Rate**, both readings should be as specified in **Technical Data**. A high pressure together with low flow could be caused by a blocked oil cooler or internal leakage.
- 3 Repeat step 2, with engine running at 2000 rev/min note gauge readings which should be as shown in **Technical Data**.
- 4 Stop engine, remove test gauges and refit hoses to original position.

Lubrication Pressure

Note that the lubrication pressure is affected by the torque converter relief valve operation. Before carrying out tests check the operation of the relief valve (see **Converter Relief (Safety) Valve Pressure**).

- 1 Stop engine, connect a suitable pressure gauge into the return line from the oil cooler to the transmission as shown at **J**.
- 2 Start the engine and run at 1000 rev/min. With the transmission in neutral the pressure gauge will indicate the **Lubrication Pressure** which should be as specified in **Technical Data**.
- 3 Repeat step 2 and note gauge readings with engine running at 2000 rev/min. If the pressure is high the oil cooler may be blocked, (see **Converter Out Pressure/Oil Cooler Flow Rate**).
- 4 Stop engine and remove pressure gauge.

Powershift Gearbox
Pressure and Flow Testing



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Powershift Gearbox

Pressure Testing - Clutches

Isolating a Suspect Clutch

By performing the tests in the first 3 gears in forward and reverse all the clutches in the gearbox will be engaged, ensuring any clutch leakage will be easy to identify. Draw a table as shown so that you can record the results.

Clutch Pressure Test Results - 6 Speed Powershift						
Gear	Clutches engaged					
	Forward	bar	lbf/in ²	Reverse	bar	lbf/in ²
1st	X,Z			W,Z		
2nd	T,Z			V,Z		
3rd	U,Z			W,Y		

Clutch Pressure Test Results - 4 Speed Powershift						
Gear	Clutches engaged					
	Forward	bar	lbf/in ²	Reverse	bar	lbf/in ²
1st	T,Z			W,Z		
2nd	U,Z			V,Z		
3rd	T,Y			W,Y		

- 1 Stop engine, connect a 0-20 bar (0-300 lbf/in²) pressure gauge to test connector **A** (mainline pressure test point).
- 2 Make sure that both sides of all four wheels are chocked. Apply the footbrake and parking brake.

Note: When fully engaged, the parking brake electrically disconnects the transmission drive; this prevents the machine from being driven with the parkbrake on. Therefore, so that we can complete the test, move the parkbrake lever fractionally forward until the warning light is just extinguished; hold the lever in this position for the duration of the test. DO NOT move the lever too far forward, otherwise the parkbrake will not be fully operational. Alternatively, disconnect the switch at the park brake.

- 3 Start engine and run at 1000 rev/min, engage 1st gear forward. Record the pressure reading. Repeat the test for 2nd and 3rd gears forward and 1st, 2nd and 3rd gears reverse. Record the pressure readings as shown in the example below:

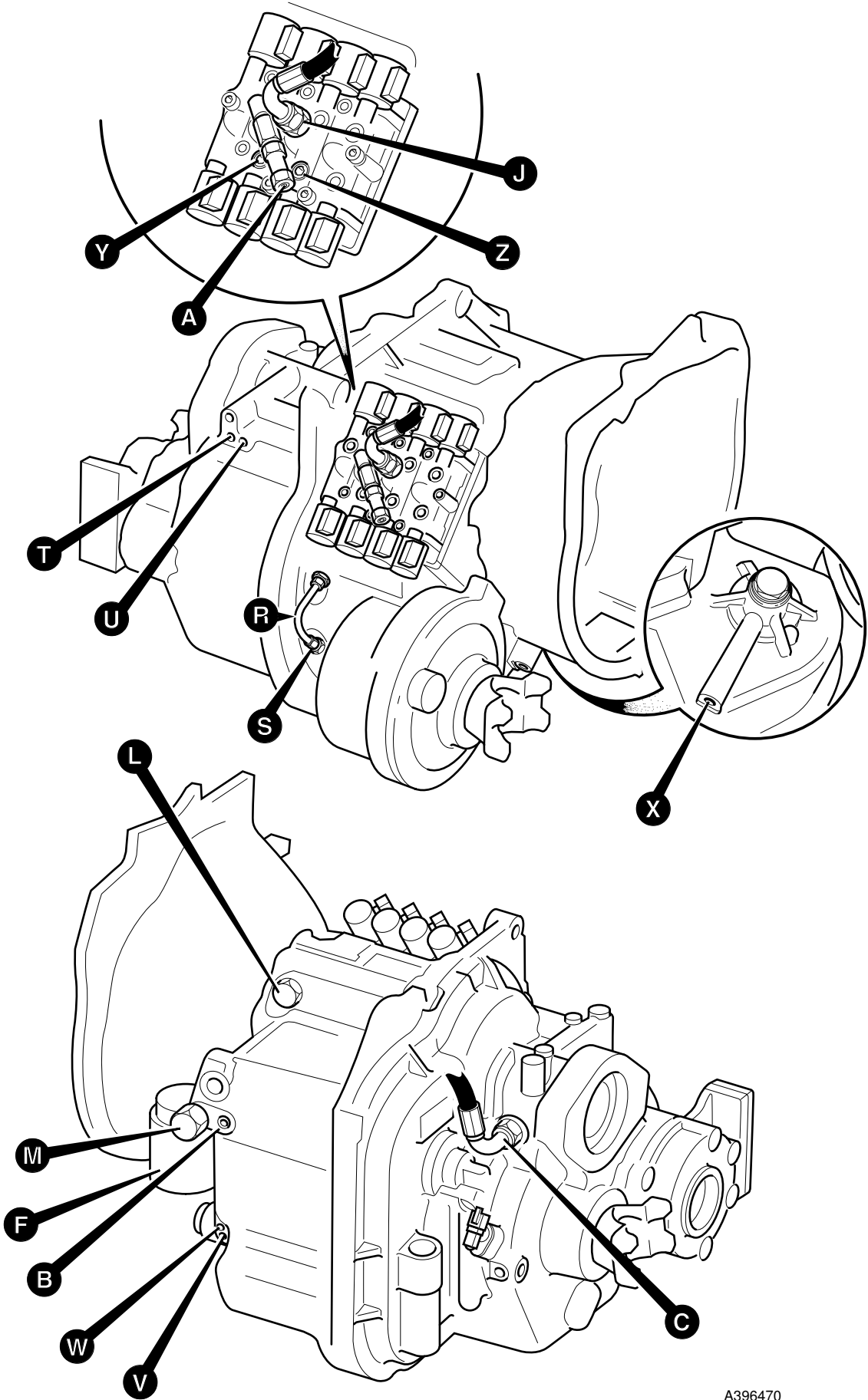
Clutch Pressure Test Results - 6 Speed Powershift						
Gear	Clutches engaged					
	Forward	bar	lbf/in ²	Reverse	bar	lbf/in ²
1st	X,Z	13.4	194	W,Z	13.4	194
2nd	T,Z	12.0	175	V,Z	13.6	197
3rd	U,Z	13.5	195	W,Y	13.5	195

Readings should not vary between clutches by more than 0.7 bar (10 lbf/in²). In the example shown, we can see that pressure is low when 2nd gear forward is selected, indicating clutch leakage.

From the table we see that the layshaft clutch **Z** is working normally (1st and 3rd gear forward and 1st and 2nd gears reverse all show normal operating pressure). We can assume that the forward low clutch **T** is leaking.

By carrying out 'Individual Clutch Leakage Tests', (see next page) we can confirm that the forward low clutch **T** is leaking.

Powershift Gearbox
Pressure and Flow Testing



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Powershift Gearbox

Pressure Testing - Clutches

Individual Clutch Leakage Test

When testing individual clutch pressures it is necessary to isolate the clutch being tested. So for instance, on a 6 speed gearbox, to check the **forward low clutch T** we must select 2nd gear forward - this would energise the **forward low (T) and layshaft (Z)** clutches. Because we only want to check the **forward low (T)** clutch pressure and not the **layshaft (Z)** clutch pressure, remove the electrical connector to the **6 speed** clutch solenoid **Zs** BEFORE selecting 2nd gear.

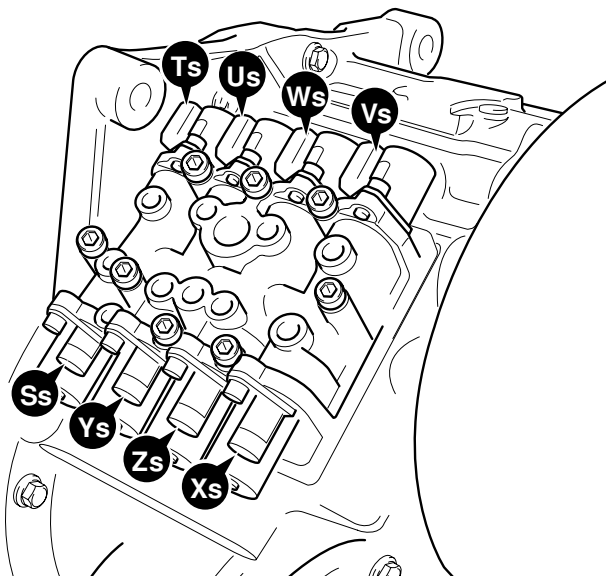
Use the table below to determine which solenoid electrical connectors should be removed when pressure testing individual clutches. Note that as the first 3 forward and reverse gears utilise all clutches, there is no need to select other gears when testing for leakage.

6 Speed Gearbox

Gear Selected	Clutches Engaged (Solenoids Energised)	
1st Forward	6 Speed & Layshaft - X,Z	(Xs,Zs)
2nd Forward	Forward Low & Layshaft - T,Z	(Ts,Zs)
3rd Forward	Forward High & Layshaft - U,Z	(Us,sZ)
1st Reverse	Reverse Low & Layshaft - W,Z	(Ws,Zs)
2nd Reverse	Reverse High & Layshaft - V,Z	(Vs,Zs)
3rd Reverse	Reverse Low & Mainshaft - W,Y	(Ws,Ys)

4 Speed Gearbox

Gear Selected	Clutches Engaged (Solenoids Energised)	
1st Forward	Forward Low & Layshaft - T,Z	(Ts,Zs)
2nd Forward	Forward High & Layshaft - U,Z	(Us,Zs)
3rd Forward	Forward Low & Mainshaft - T,Y	(Ts,Ys)
1st Reverse	Reverse Low & Layshaft - W,Z	(Ws,Zs)
2nd Reverse	Reverse High & Layshaft - V,Z	(Vs,Zs)
3rd Reverse	Reverse Low & Mainshaft - W,Y	(Ws,Ys)



In the following procedures the forward low clutch (**T**) is tested, therefore in step **2** a pressure gauge is connected to the forward low clutch test point.

When testing other suspect clutches connect a gauge to the relevant suspect clutch test point. Because the forward low clutch is suspect, a gear must be selected that will use the forward low clutch, in this instance 2nd gear forward.

Note: When testing the 2/4WD clutch remove the feed pipe **R** and fit service tool. This pipe incorporates a test point. Replace the original pipe when testing is complete.

- 1 Stop engine, connect a 0-20 bar (0-300 lbf/in²) pressure gauge to test connector **A**, (mainline pressure test point).
- 2 Connect a 0-20 bar (0-300 lbf/in²) pressure gauge to test connector **T** (forward low ratio clutch test point).
- 3 Remove the layshaft clutch solenoid feed connector **Zs**, at the solenoid control valve. This ensures that only the forward low clutch **T** is energised when 2nd gear forward is selected.
- 4 Make sure that both sides of all four wheels are chocked. Apply the footbrake and parking brake.

Note: When fully engaged, the parking brake electrically disconnects the transmission drive; this prevents the machine from being driven with the parkbrake on. Therefore, so that we can complete the test, move the parkbrake lever fractionally forward until the warning light is just extinguished; hold the lever in this position for the duration of the test. DO NOT move the lever too far forward, otherwise the parkbrake will not be fully operational. Alternatively, disconnect the switch at the park brake.

- 5 Start engine and run at 1000 rev/min, select 2nd gear forward. Note the pressure readings on both gauges, which should not vary by more than 0.7 bar (10 lbf/in²). If the difference on the gauges is greater than 0.7 bar (10 lbf/in²) do the following:
 - a Stop the engine and interchange the gauges.
 - b Start the engine and run at 1000 rev/min, select 2nd gear forward. If the difference on the gauges is still greater than 0.7 bar (10 lbf/in²) dismantle the forward low clutch for servicing.
 - c If after interchanging the gauges, the readings are different than at step 5, have the gauges calibrated and repeat the testing procedure.

Powershift Gearbox Speed Sensor

Powershift machines fitted with an electronic control unit (ShiftMaster ECU) or a speedometer have a speed sensor **D** fitted. The speed sensor detects the speed of rotation of the gearbox output shaft and relays this information to the ECU or speedometer as applicable.

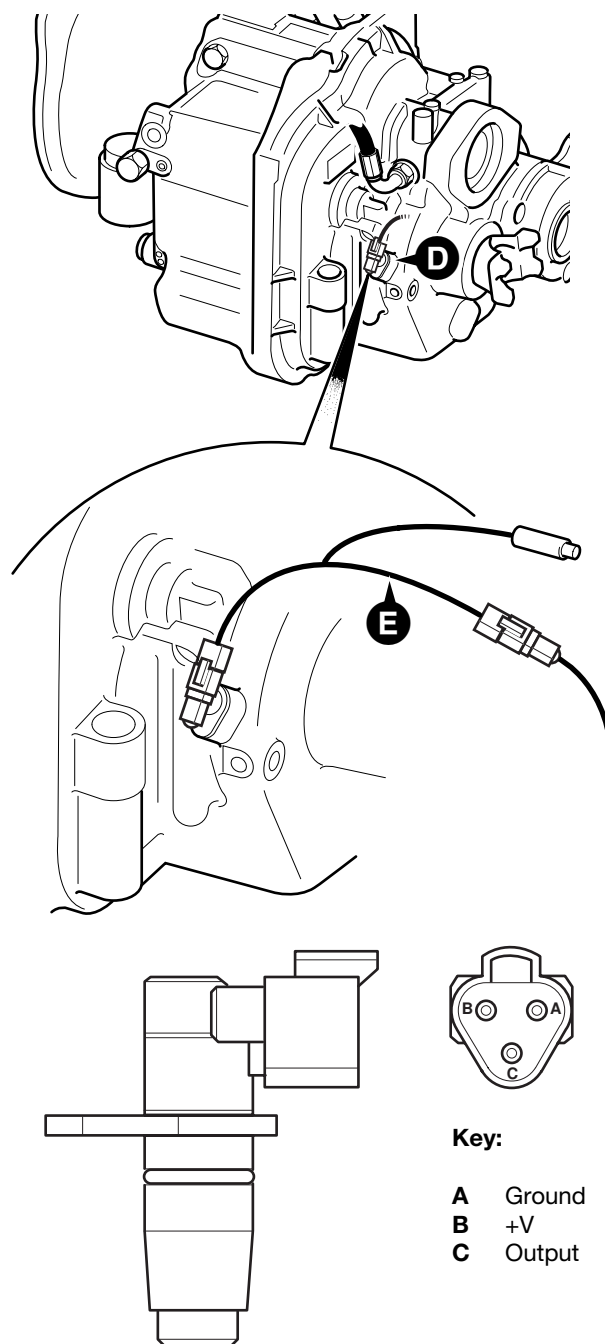
The sensor detects the passing of the gear teeth on the output gear. When adjacent to the top of a gear tooth the sensor electrical output turns ON, when adjacent to a gap between the teeth the sensor output turns OFF. In this way the frequency of the electrical signal changes according to the speed of gear rotation and therefore machine road speed.

The ShiftMaster ECU uses the input from the speed sensor to determine gear shift points. Failure of the speed sensor or its wiring will enable an ECU 'Limp Mode', preventing the use of 4th, 5th, and 6th gears. See **Fault Finding - Powershift Gearbox**.

Testing

The speed sensor can be tested in situ without removing it by means of service test harness 892/01096.

- 1 Park the machine on firm level ground, engage the parking brake and set the transmission to neutral. Lower the loader arms to the ground. Switch OFF the engine and remove the starter key.
- 2 Connect the test harness **E** as shown. Tie back and secure the wires clear of the driveshaft and other moving components, in a position where the light emitting diode (LED) can be seen while operating the machine.
- 3 Turn the engine ON and drive the machine forward approximately 2 m (6 ft), make sure it is clear in front. Alternatively raise the wheels off the ground. If the sensor is operating correctly the LED will illuminate as the gear teeth pass the sensor, when the speed increases the LED will flash at a greater frequency until becoming continuously illuminated at higher speeds.
- 4 If the LED fails to illuminate carefully check the relevant wires and connectors for damage. Repair as required and re-test the sensor as described above. It should be noted that the speed sensor is normally a reliable component and a fault is more likely attributed to damaged wires or electrical connectors, see **Electrical Connections - Powershift Gearbox - 6 Speed**.



Key:

- A Ground
- B +V
- C Output

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Powershift Gearbox - 6 Speed (ShiftMaster)

Electronic Control Unit

The PS766 6 speed gearbox is controlled by an Electronic Control Unit (ShiftMaster ECU). The ECU is located behind the front console as shown at **A**.

The ECU is housed in a rugged case protected from ingress of dirt and moisture. Gearbox faults are more likely to be caused by faulty or damaged wiring, electrical components or hydraulic faults than by failure of the ShiftMaster ECU.

Fault Finding

When fault finding note the following:

Make sure you understand the normal operation characteristics of the 6 speed gearbox. Some characteristics may be interpreted as faults by some operators. See **Basic Operation - ShiftMaster Operation Characteristics**.

The ShiftMaster ECU incorporates 'Limp Modes'. These modes can operate in response to other gearbox faults. Make sure you understand the characteristics of the 'Limp Modes', see **Fault Finding - Powershift Gearbox**.

The simplest and best way to fault find the 6 speed gearbox electrical system, (including the ECU) is by using ShiftMaster Diagnostics software and a laptop PC. See **Diagnostics User Guide**. This diagnostics system enables the engineer to quickly identify faults with specific electrical circuits or devices. The devices electrical connections, locations and wire identifications are given in **Electrical Connections - Powershift Gearbox - 6 Speed**. See also **Section C - Harness Data**.

If the facilities to use the ShiftMaster Diagnostics software system are not available, the gearbox and ECU can still be checked using a conventional multimeter, see **Electrical Connections - Powershift Gearbox - 6 Speed**. See also **Section C - Harness Data**.

Software Upgrades

From time to time a ShiftMaster ECU 'Application Software' upgrades may be made available by JCB Service. If necessary 'Application Software' can be loaded into the ECU flash memory using a laptop PC and the **ShiftMaster Flash Programmer** application. This application is part of the **JCB Service Master** package found on the JCB Service Technical Information CD's. The Flash Programmer application includes comprehensive help files.

Note that the ECU contains 2 sets of software, 'Application Software' and 'Setup Data'. The 'Setup Data' is specific to a machine variant and can not be changed or replaced.

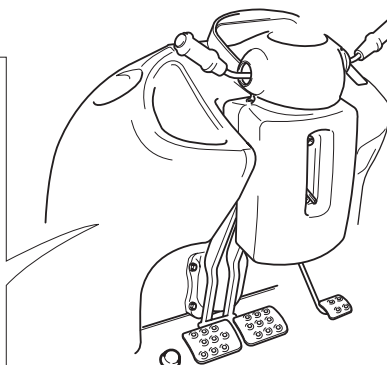
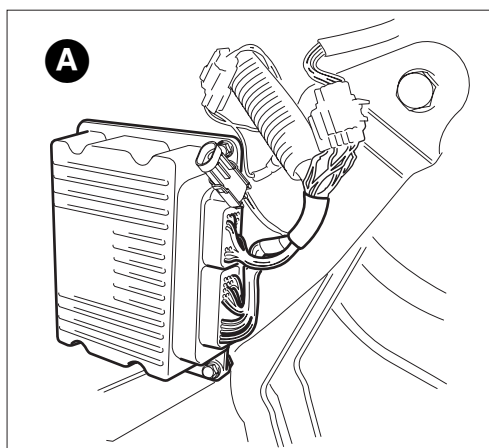
Renewing The ECU

Before renewing the ECU note the following:

The ShiftMaster ECU is a **non serviceable part**. Any units returned under warranty found to have been tampered with will invalidate any claim.

ECU's are configured at the factory for each machine variant and are not interchangeable between machines. Although the part numbers may be the same, the internal software may not be. **DO NOT interchange ECU's between machines**.

Before renewing the ECU carry out all the relevant fault finding and diagnostics to **confirm ECU failure**. Units returned under warranty found not to be faulty will invalidate any claim.



A405370

Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - User Guide

1. Introduction

ShiftMaster Diagnostics software is a PC based Diagnostics Tool designed to be an easy to use fault finding tool for the Service Engineer using a laptop PC. **ShiftMaster Diagnostics** employs the graphical strengths of the Microsoft Windows operating environment to simplify electrical fault finding within the ShiftMaster ECU control system used on Powershift PS766 6 speed gearboxes.

ShiftMaster Diagnostics is only intended for use with the ShiftMaster ECU and does not support older versions of Powershift Controllers used on the PS750 series gearboxes.

To utilise any supporting ShiftMaster Service Tools requires the use of the JCB Data Link Adaptor [or DLA] (717/ 20138) which is part of the standard JCB Electronic Service Tool Kit, part number 892/01033.



S404170

This software is intended for use on IBM Compatible Personal Computers (**PCs**) running **Windows 9x** or **Windows2000** operating systems but is not compatible with either earlier versions of **Windows 3.x**.

All distributed software can be found on Disk 3 (CD3 - Adobe) of the JCB Technical Information Parts and Service CD-ROM set from **Issue 19** onwards. This disk is also supplied as part of the Electronic Service Tool Kit. Copies of this CD-ROM can be purchased from JCB Service. Alternatively, in due course software will become available for download over the internet via JCBs' Techweb service. Please refer to the available software for full installation instructions.

2. Care & Safety

WARNING

Be sure to read and follow any on-screen instructions issued by ShiftMaster Diagnostics. Failure to follow correct procedure could result in death or injury.



S404180

3. Installing ShiftMaster Diagnostics

The **ShiftMaster Diagnostics** tool is fully integrated within JCB ServiceMaster.

For full instructions on how to install the **ShiftMaster Diagnostics** software please refer to the documentation which accompanies JCB Service Master.

If you have successfully installed **ShiftMaster Diagnostics** but are experiencing difficulties with getting your PC to communicate with an ECU then there is a Troubleshooting Guide built into the **ShiftMaster Diagnostics** Help menu.

Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - User Guide

4. Starting ShiftMaster Diagnostics

This document assumes that JCB Service Master has already been installed.

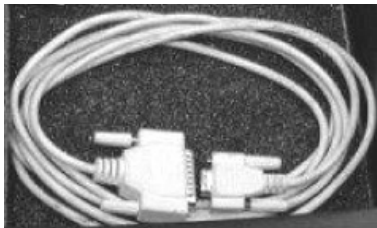
Step 1: Connect either the 'Serial PC Cable' (717/20138) or the 'Parallel PC Cable' (721/11071) between the DLA and a free port your laptop computer.

The 'Parallel PC Cable' has a 25-way D-type connector on both ends or the lead.



S404190

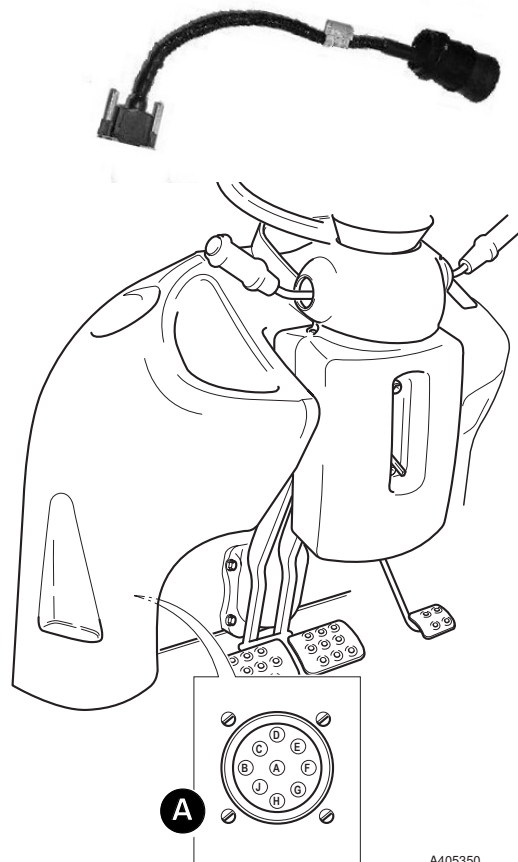
The 'Serial PC cable' has a 9-way D-type connector on one end and a 25-Way D-type connector on the other.



S404190

Plug the 25-way male connector into the DLA and the other connector into a free port on your laptop PC, remembering to tighten any thumb-screws appropriately.

Step 2: Connect the 'Machine Cable' between the DLA and the machines' Diagnostic Connector. The 'Machine Cable' has a 15-way D-type connector on one end and a 9-way CAN connector on the other. Plug the 15-way connector into the DLA and tighten the thumb-screws, then connect the 9-way CAN connector into the machines' Diagnostics Connector **A** and twist the lock-ring to secure it.



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Step 3: Turn ON the machine ignition and additionally start the engine if required (taking normal precautions).

Note: Be sure to follow all the cautionary notes given earlier and those which accompany the software.



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Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - User Guide

Step 4: Start **JCB Service Master**. And go to the BHL section.



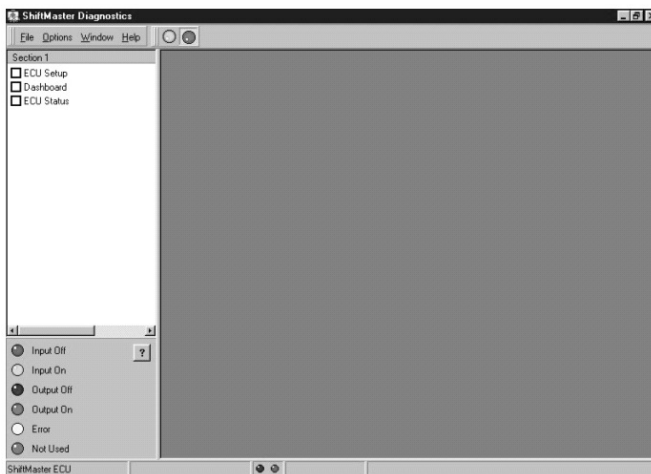
S404210

Step 5: Start the diagnostics tool running by clicking on the **ShiftMaster Diagnostics** icon.



S404220

Step 6: The **ShiftMaster Diagnostics** tool will then open up displaying the main window as shown here.



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Step 7: To start the **ShiftMaster Diagnostics** tool communicating with the ShiftMaster ECU either click on the **Start** button or select **Start Diagnostics** from the Options Menu. (See later sections for full details.)

Connection Problems:

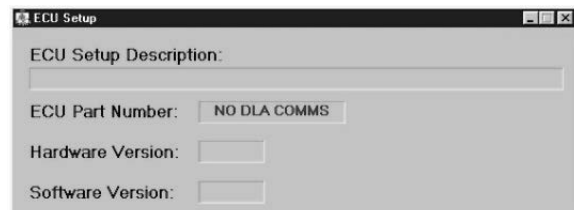
ShiftMaster Diagnostics will start and can be partly used even if there are connection problems.

In general, whenever there are problems communicating with the DLA there will be an error message displayed.



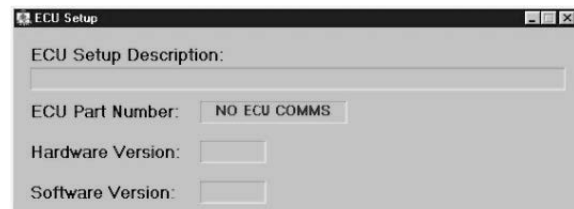
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More specifically, if communications can not be established with the DLA then the ECU Setup Page will display '**NO DLA COMMS**' where the ECU Part Number should be.



S404150

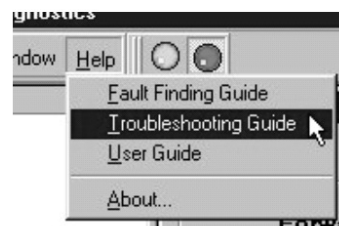
If communications can not be established with the ECU then the ECU Setup Page will display '**NO ECU COMMS**' where the ECU Part Number should be.



S404160

Note: The ECU must be powered for communications to work, i.e. the machine ignition must be ON (but the engine need not be running).

For further details on possible communication problems please consult the **Troubleshooting Guide** included in the Help menu.



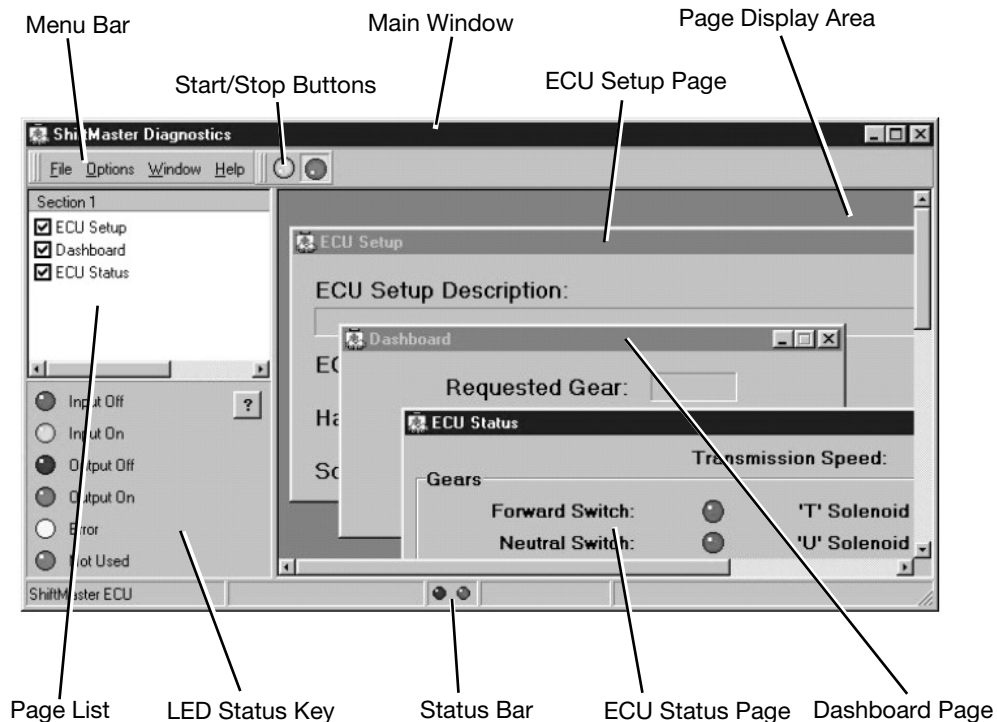
S404240

Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - User Guide

5. ShiftMaster Diagnostics: Overview

There are several key elements to the **ShiftMaster Diagnostics** tool. These can be seen labelled below. Each element is explained in detail in later sections.



S404250

Navigating within ShiftMaster Diagnostics

Navigation is designed to be via a mouse. On Laptop PCs this may take the form of a small joystick or touch sensitive pad and some buttons, usually located near to the keyboard.

As with most Windows based programs, it is possible to navigate **ShiftMaster Diagnostics** using the keyboard by pressing certain combinations of keys.

Note: This can be particularly useful for certain Laptop PCs where the mouse/joystick can be over-sensitive. Try out the following, it may come in useful one day.

There are two main methods of navigation described below;

- Pressing the **ALT** key will cause the File option on the Menu Bar to be highlighted. You can then use the arrow keys to navigate the menus.
- Notice that all the menu items on the Menu Bar have a letter that is underlined (e.g. the 'F' in **File**). Holding down the ALT key and pressing the required letter key will activate that option (i.e. either open the menu or execute a function). For example, if you wish to open the Preferences Dialogue this can be done by pressing **ALT + O** (to open the **Options** menu) then **ALT + P** (to execute the **P**references... option).

Powershift Gearbox - 6 speed
ShiftMaster Diagnostics - User Guide

6. Menu Bar

File Menu

The File Menu contains and **Exit** option to close down the program.



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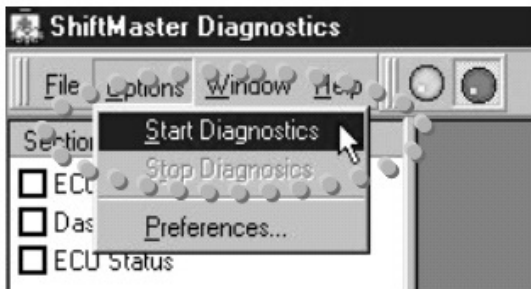
On exiting the program communications with both ECU and DLA are shut down.

Options Menu

Select either:

Start Diagnostics to commence communications with the ShiftMaster ECU.

or



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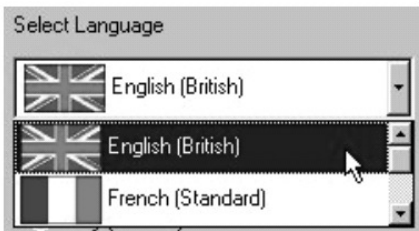
Stop Diagnostics to cease communications.

Clicking on the **Preferences...** option opens up the Preference Dialogue.



S404280

From the Preferences Dialogue there is support for multiple languages. Use the drop-down menu and scroll bar to chose the required language. Languages presently on offer are:



S404290

- **English (British)**
- **French (Standard)**
- **German (Standard)**
- **Spanish (Modern Sort)**

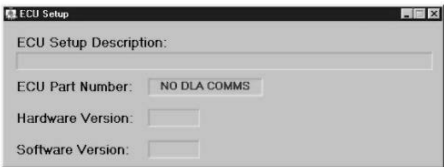
Note: The language option only effects text within the Main Window (e.g. Page List, LED Status Key, etc...). At present language support is not offered for the text within the Page displays.

The Preferences Dialogue also offers the ability to change the background colour of the Page displays. Select the required background colour using the radio buttons.



S404300

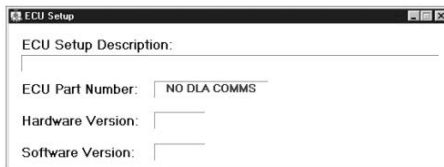
Note: When using a laptop PC it can often be difficult to see the screen in bright sunlight. Changing the background colour can help improve the contrast (especially with the different LED colours) and so make viewing the screen easier. Examples of the different colours are shown below;



S404310



S404320



S404330

Once your preferences have been selected either:

Click on **OK** to apply them or click on **Cancel** to leave them unchanged.

Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - User Guide

Window Menu

Like most other Windows based programs where there are multiple sub-windows or Pages used, there are usually options to organise how they are laid-out. **ShiftMaster Diagnostics** is no different and offer the following options;

- **Cascade**
- **Tile Horizontally**
- **Tile Vertically**

Note: Laptop PCs, particularly older ones, tend to have a low screen resolution. If this is the case then the Horizontal and Vertical tile options will probably be of little use and Cascade will offer the best advantage.

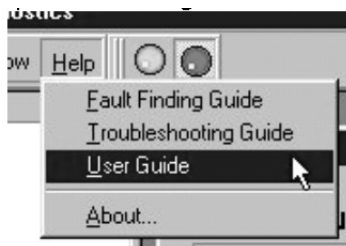
Help Menu

To assist the Service Engineer, **ShiftMaster Diagnostics** is supplied with a set of documentary Guides. These Guides can be accessed directly from within the **ShiftMaster Diagnostics** tool itself, via the Help menu.

Note: All the Guides are provided in Adobe Acrobat PDF format. In order to read these guides the user must first have the Adobe Acrobat Reader installed on the PC. This software is supplied on the JCB CD-ROM where full installation instructions are provided.

At present these guides are as follows;

User Guide: This file is provided to explain how all the functions of the **ShiftMaster Diagnostics** tool operate.



S404360

Troubleshooting Guide: Sometimes users may experience problems with getting **ShiftMaster Diagnostics** to communicate properly with the ShiftMaster ECU. The Trouble shooting Guide has been provided to explain possible causes of problems with communications.



S404240

Fault Finding Guide: Provided to help the user to understand how the PS760 gearbox electrical system operates. This Guide also offers advice on fault diagnosis along with example scenarios, hints and tips.

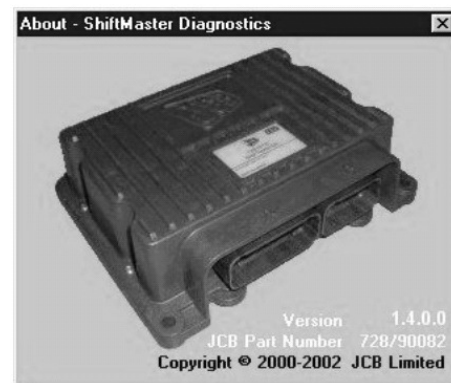


S404370

Selecting the **About...** option will bring up a window showing the JCB part number and the version number of the installed copy of **ShiftMaster Diagnostics**.



S404380



S404390

7. Start/Stop Buttons

These offer the same function as the **Start Diagnostics** and **Stop Diagnostics** options within the Options Menu.

To start the **ShiftMaster Diagnostics** tool communicating with the ShiftMaster ECU simply click on the **Start Button** (big green LED) at the top of the Main Window. Similarly, click on the **Stop Button** (big red LED) to cease communications.

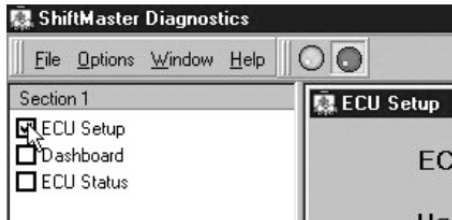


S404400

Powershift Gearbox - 6 speed ShiftMaster Diagnostics - User Guide

8. Page List

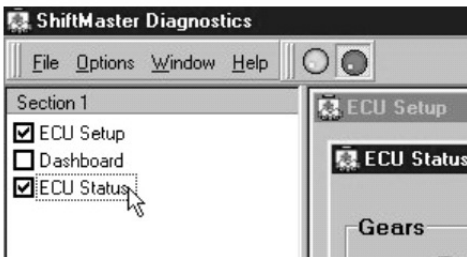
In the top left corner of the main window is displayed a list of pages which can be displayed.



S404410

Clicking in the box next to the required page will make that page appear in the main window display area. (A tick will also appear in the box to show it is being displayed.)

At any time the user may swap between displayed pages simply by clicking on the title of the required page in the page list.

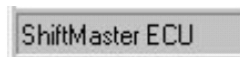


S404420

9. Status Bar

There are 2 items of interest displayed on the **Status Bar**, which is located along the bottom of the **ShiftMaster Diagnostics Main Window**.

Connected ECU: The type of ECU connected to the **ShiftMaster Diagnostics** tool is indicated on the far left side of the Status bar.



S404430

CAN communications: Two small LEDs indicate data being transmitted (red) and received (green) over the CAN communications link.

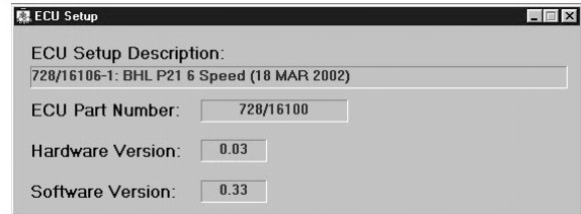


S404440

These LEDs can be seen to be flashing rapidly as data is transported. This can be another useful aid to determining the state of any established communications.

10. ECU Setup Page

This page displays crucial information about the ECU configuration.



S404450

It is always useful to confirm that this is the correct configuration for the machine before commencing any fault finding.

The ECU Setup Page displays the following information;

ECU Part Number

This will display the part number of the connected ShiftMaster ECU.

If there are communications errors present then this will contain either;

- a). '**NO DLA COMMS**' if there are problems communication with the DLA, or
- b). '**NO ECU COMMS**' if the DLA is working but the ShiftMaster ECU is not responding.

Note: If communications problems are suspected then please consult the accompanying **Troubleshooting Guide** for further information.

Hardware Version

This hardware version is a reference to the build level of the electronics. Future developments may mean that hardware upgrades are required. This may effect which software can be used.

Software Version

The software version refers to the issue level of the ECU operating software. Again, future developments may require software revisions.

ECU Setup Description

As well as its' operating software, the ShiftMaster ECU also stores a group of **Setup Data** (or Settings). This Setup Data is used to tailor how a certain ECU part number functions. The Setup Data is loaded during the manufacturing process and has been approved for use in the intended application.

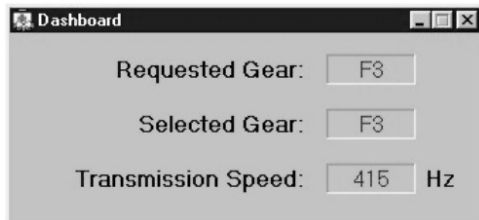
Contained as part of the Setup Data is a Description. This Description is what is displayed here. The Engineer can use this description to verify that the correct Setup Data is being used.

At present there is no service tool available to load new **Setup Data**.

Powershift Gearbox - 6 speed ShiftMaster Diagnostics - User Guide

11. Dashboard

This offers a simple uncluttered display showing;



S404460

Requested Gear

This is the demand from the driver.

Selected Gear

This is the actual gear being selected by the ECU.

Note: The driver **Request Gear** is not always the same as the Selected Gear, e.g. when the ECU blocks shifts when offering protection.

Transmission Speed

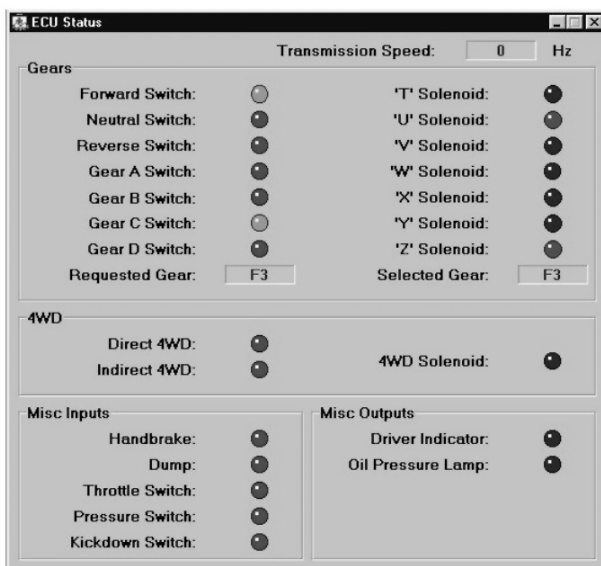
This is the current transmission output speed which is directly related to the road speed (through axle ratio and tyre size). The transmission speed sensor is located next to the output gear and detects the passing of the gear teeth. The sensor has a fixed installation, no adjustment is necessary.

The Transmission Speed value is a frequency reading and is displayed in Hertz (Hz), or teeth per second.

This signal is used by the ECU to determine gear-shifting and protection strategies.

12. ECU Status Page

This page gives a detailed picture of how the ECU is operating.



S404470

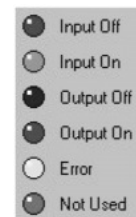
Information in this display is constantly updated in real-time. (Some older PCs may experience a slight delay in updating this page, but usually only less than one second.)

The left hand side shows the inputs to the ECU, their status indicated by green LEDs.

The right hand side shows the outputs from the ECU, their status shown by red LEDs.

The exact colour of the LED indicates the status of that feature.

A key in the bottom left corner of the main window explains the colours.



S404480

The following is a brief explanation of each feature. For further information and examples of typical scenarios please refer to the accompanying Fault Finding Guide accessible via the Help menu.

Transmission Speed

This is exactly the same signal as explained in the previous section.

Gears

Inputs: The items on the left show the signal lines connected to the gear selection lever. This lever is the left hand half of the control lever assembly mounted on the steering column.

Outputs: The items on the right are the power signals going down to the transmission solenoid valves. The LEDs will indicate which solenoids are being energised. Error detection on the output electrics is continually running. If any output were to develop a fault (e.g. open circuit or short circuit) then the LED will turn yellow. Fix the fault and the LED will revert back to red.

During certain gear-shifts the ShiftMaster ECU will perform electrical **Modulation** to improve gear-shift quality. The ECU does this by adding delays to off-going and/or on-coming clutches and so overlapping energised outputs. These delays are in the order of a few hundred milli-seconds but it is sometimes long enough to be observed on the status LEDs. Thus, during certain shifts it is quite normal to observe more than 2 outputs ON at any one time.

Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - User Guide

4WD

The machine driver has 2 inputs which are used to influence the state of the 4WD solenoid output. These features interact as follows;

Firstly there is a **Direct 4WD** input which is, in general, connected to the machine footbrake switch (which in turn controls the brake lights). Whenever this signal is present the **4WD Solenoid output** is energised.

The second input is **Indirect 4WD** which is usually derived from a command from a console mounted '4WD selector' switch. (However, this switch arrangement may change between machines.) If the transmission speed is too high then the ECU will over-ride this signal and automatically disengage the 4WD.

Misc. Inputs

These inputs are derived from the remaining driver controls. A brief summary follows but refer to the **Fault Finding Guide** for full details.

Handbrake Switch: Signal derived from the Parkbrake switch. Used to hold the transmission in Neutral if the parkbrake is applied.

Dump Switch (or Transmission Disconnect): Signal usually derived from a momentary switch fitted to a loader lever. Temporarily selects Neutral when pressed (usually to divert engine power to hydraulics).

Throttle Switch: Dedicated switch fitted to the machines' accelerator pedal. Used to interact with the Automatic Mode of gear-shifting.

Pressure Switch: Signal is derived from the transmission mounted Low Oil Pressure Switch.

Kickdown Switch: Another momentary button (mounted on the cab floor) used to temporarily select the next lowest gear.

Misc. Outputs

These are the additional ECU outputs, generally used to control cab instrumentation like the low **Oil Pressure Lamp** and Driver **Indicator** (lamp and buzzer where fitted).

13. General Information

For all enquiries about the **ShiftMaster Diagnostics** tool please follow your normal channels of enquiry. This ensures that useful information can filter through to JCB Service personnel at all levels.

Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - Troubleshooting Guide

1. Introduction

If you are experiencing difficulties with getting **ShiftMaster Diagnostics** and your PC to communicate with a **ShiftMaster ECU** then please take a little time to read the following information which has been compiled to guide diagnosis of such problems.

To utilise any supporting ShiftMaster Service Tools requires the use of the **JCB Data Link Adaptor (DLA)** which is part of the standard **JCB Electronic Service Tool Kit**, part number **892/01033**.

This software is intended for use on IBM Compatible Personal Computers (**PCs**) running **Windows 9x** or **Windows2000** operating systems but is not compatible with either earlier versions of **Windows 3.x**.

It is known that some laptop PCs can experience problems with serial communications.

In a few rare cases the PCs hardware does not allow the diagnostics software access to communications (COM) ports.

JCB Service are in the process of compiling a 'recommended' list of laptops which we know to work satisfactorily with JCB Software.

In the majority of cases conflicts are caused by either software already running on the PC, or by certain 'driver' files which hog the COM port(s).

Note: a PC which has many users and uses is likely to contain some redundant software and drivers.

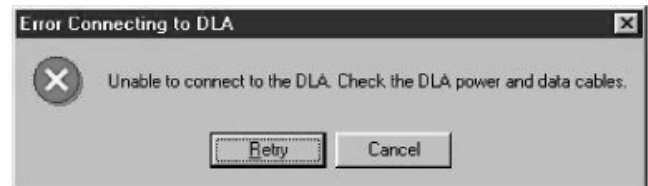
If you do not feel technically competent to adjust PC software & set-up, please enlist the help of someone suitably trained before proceeding.

2. Elementary Checks

Please make sure that the correct communications leads are being used and are not damaged in any way.

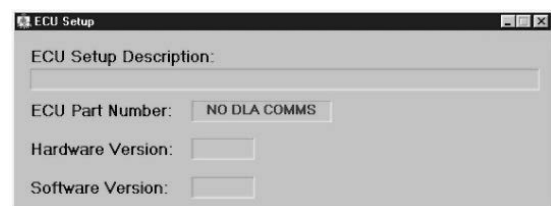
Non Communication with DLA

In general, whenever there are problems communicating with the DLA there will be an error message displayed.



S404140

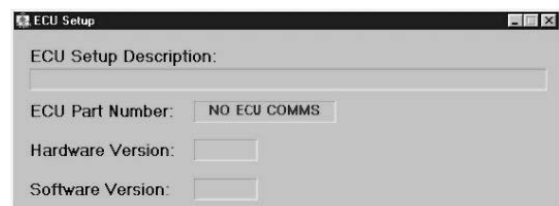
More specifically, if communications can not be established with the DLA then the ECU Setup Page will display '**NO DLA COMMS**' where the ECU Part Number should be.



S404150

Non Communication with ECU

If communications can not be established with the ECU then the ECU Setup Page will display '**NO ECU COMMS**' where the ECU Part Number should be.



S404160

Note: The ECU must be powered for communications to work, i.e. the machine ignition must be ON (but the engine need not be running).

Powershift Gearbox - 6 speed

ShiftMaster Diagnostics - Troubleshooting Guide

3. DLA Drivers

The DLA has software 'drivers' (i.e. programs which handle communications) programmed into the unit. There are matching drivers that must also be resident on your PC.

The update of both these sets of drivers is handled by JCB Service Master. Please refer to the applicable supporting literature.

4. PC Power Management

Some laptops' Power Management software can disrupt the COM ports.

This problem occurs with many other software applications and is not unique to JCB Service Master applications. The following advice is worth bearing in mind.

If the user experiences communications problems with a **ShiftMaster ECU** turn OFF the laptops' power management software.

Problems may be;

- (a) Complete failure to establish communications with an ECU.
- (b) A drop-out of communications (i.e. connects to the ECU and after a while the link fails).
- (c) Intermittent failure (i.e. seems to disconnect and re-connect at random intervals).

Item (a) is probably the most common.

To turn OFF the laptops power management open **Windows Control Panel** (Start > Settings > Control Panel). There will normally be an icon to run that particular laptops' power management software. Turn OFF the power management, close the tool and then close the control panel.

These power management tools are specific to the laptop. Some may require the PC to be re-booted before the changes take effect.

5. IR Drivers

Many Laptop PCs have a built in InfraRed (IR) communications port. There is likely to be some resident software to control this port. If this type of port is present, but never used, then try disabling the driver;

System Properties > Device Manager > Ports > (infrared)

6. Modem Drivers

Check that only the correct modems are installed on the machine.

Experience has shown that multi-user PCs often contain many modems, perhaps installed for use other than in the office.

Disable any unused modems.

There has been no experience of correctly installed internal modems or PCMCIA cards (modem or network) causing significant problems.

7. Windows XP & Windows NT

Please note the ShiftMaster Diagnostics software is NOT designed to run on Windows NT. In addition JCB can not guarantee that this software will be fully functional with the latest versions of Windows (e.g. WindowsXP) although JCB are continually developing support for different operating systems.

8. Further Assistance

If a communication problem persists, then the following contacts may be able to provide further assistance;

- a). If applicable, try seeking assistance from your Computer Systems Engineer/Technician.
- b). The first port of call outside your company should be the laptop machine dealer or agent.
- c). Your next enquiries should be with the laptop machine OEM (Original Equipment Manufacturer). If the OEM is unable to assist they will make the relevant enquires on your behalf.

If you continue to have a communications problem, note the applicable laptop make and model. Contact JCB Service so that further investigations can be made..

For all enquiries about the ShiftMaster Diagnostics tool please follow your normal channels of enquiry. This ensures that useful information can filter through to JCB Service personnel at all levels.

Propshafts

Removing and Replacing

When Removing

Before removing propshafts always mark both companion flanges and also mark the sliding joints prior to removal.

When Replacing

Upon reassembly, after lubricating sliding joints with JCB MPL Grease, align the shafts against identification marks previously made or, in the case of a shaft being renewed, use the manufacturer's alignment markings.

Apply JCB Threadlocker and Sealer to threads of all flange bolts.

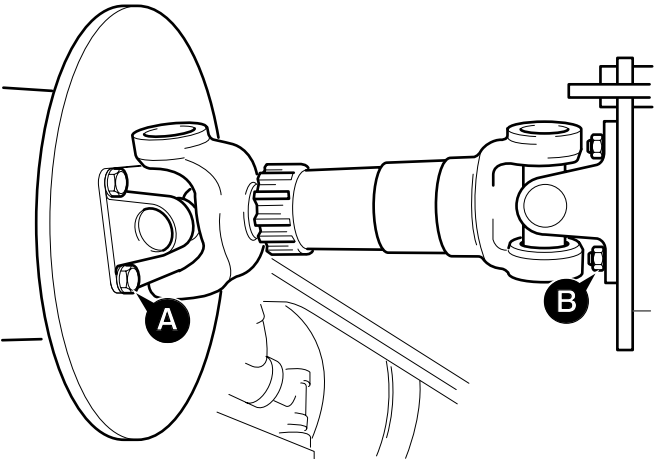
Retaining straps **C** stretch with use, therefore these straps must always be replaced with new ones.

The propshaft must have both ends exactly on the same plane as shown at **X**. The yokes must not be at right angles as at **Y** or at an intermediate angle as at **Z**.

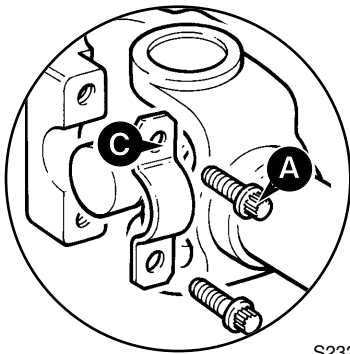
Torque Settings

Item	Nm	kgf m	lbf ft
A	75 - 85	7.7 - 8.7	55 - 63
B	118	12	87

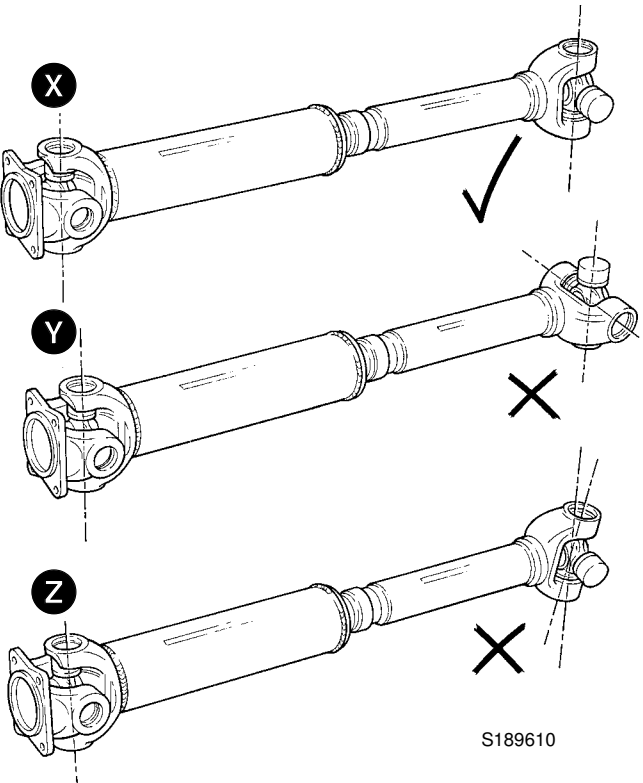
REAR



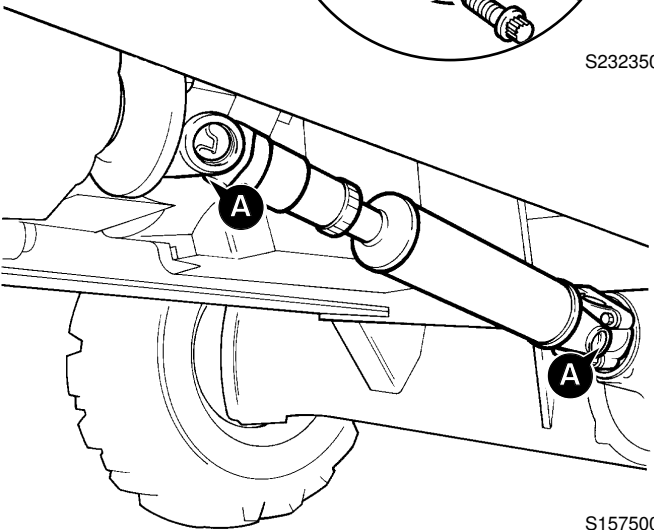
A396840



S232350



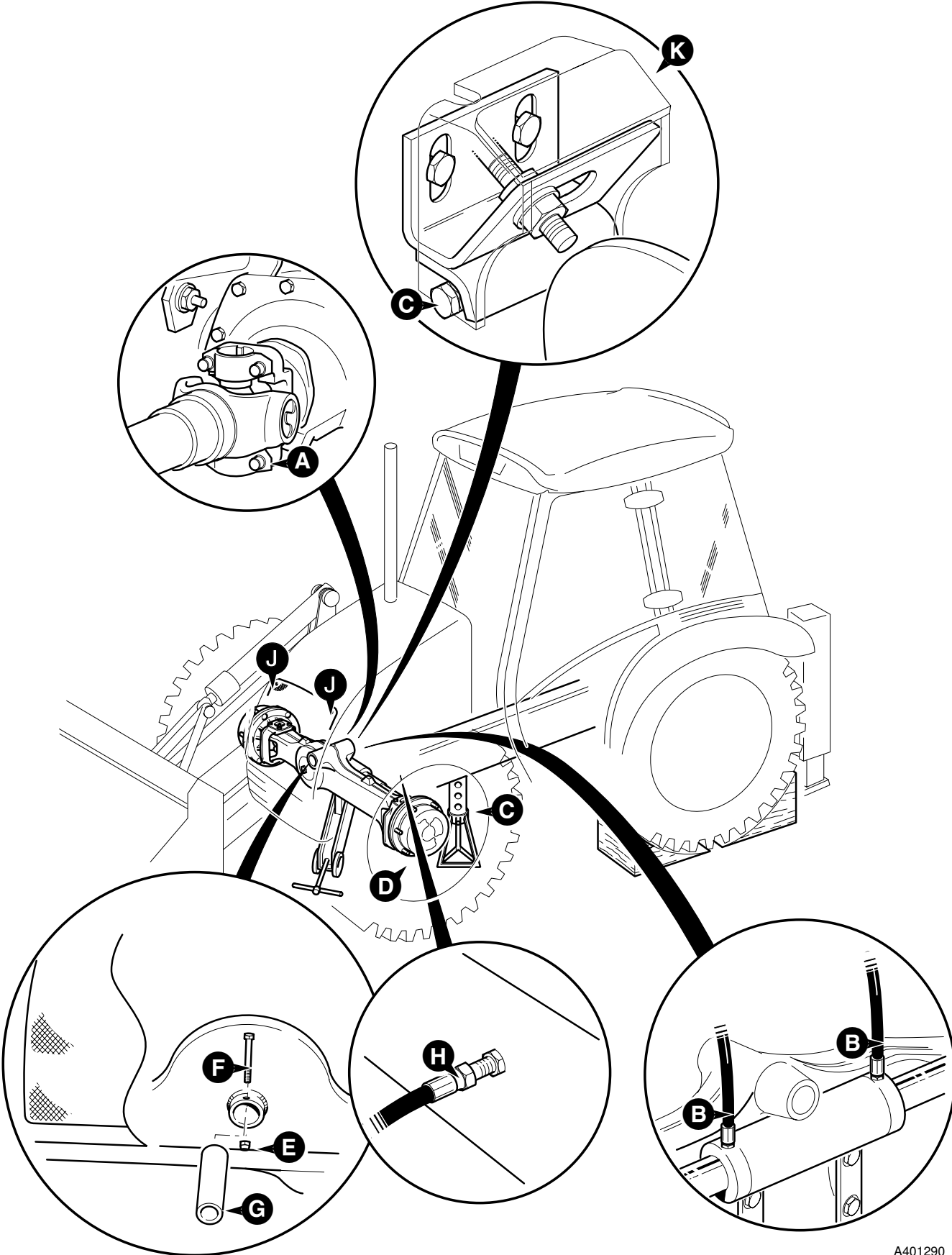
S189610



S157500

FRONT

Removal and Replacement



cardiagn.com

A401290

Removal and Replacement (cont'd)

Note: The following procedure can be applied to both AWS and 2WS machines. Dis-regard information not applicable to your machine type, for instance, 2 wheel steer machines will not have steering proximity switches fitted.

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN 1-1

Removal

WARNING

Raised loader arms can drop suddenly and cause serious injury. Before working under raised loader arms, fit the loader arm safety strut.

GEN 3-2

- 1 Release screws **J** and remove the front grille.
- 2 Remove the cover **K** from the proximity switch and then remove the bracket and switch assembly.
- 3 Using tool 892/00822 remove bolts **A** to disconnect the drive shaft from the axle.
- 4 Disconnect the hydraulic pipes **B** from the steer rams, blank off all exposed connections.
- 5 Disconnect remote grease nipple hose **H**.
- 6 Loosen the road wheel retaining nuts **D**.
- 7 Make sure that the rear wheels are blocked, use the loader arms to raise the front end of the machine.
- 8 Prop the machine on each side as shown at **C**.
- 9 Remove the front road wheels.
- 10 Position a jack underneath the balance point (see Note) of the axle and support the axle weight.

Note: Because the drivehead assembly is offset, the balance point of the axle is not the centre of the axle. Attach a 'cradle' to the jack that will partially embrace the axle.

- 11 Remove nut **E** and pivot pin retaining bolt **F**.
- 12 Remove pivot pin **G** seals, use puller (tool no. 993/68100) and remove the pivot pin **G** and axle shims.
- 13 Lower the jack so that the axle is clear of the mounting yoke and remove the axle.

Removal and Replacement (cont'd)

Replacement

Replacement is the reverse of the removal sequence.

⚠ WARNING

If, for whatever reason, a wheel stud is renewed, all the studs for that wheel must be changed as a set, since the remaining studs may have been damaged.

2-3-2-8

Whenever a wheel has been removed, check the wheel nut torques every two hours until they stay correct.

Apply JCB Lock & Seal to the threads of bolts **A**.

The front axle must be shimmed to give a maximum fore and aft movement of 0.5 mm (0.020 in).

Nylon shims must be fitted as follows:

AWS Machines

- a** Fit a 5.0 mm thick master shim (coloured blue) between the front of the axle and the yoke plate as shown at **X**.
- b** Measure the fore and aft movement and subtract 0.5 mm to obtain the required shim thickness. Fit the correct thickness shim between the rear of the axle and the yoke plate as shown at **Y**.

2WS Machines

- a** Fit a 5.0 mm thick master shim (coloured blue) between the rear of the axle and the yoke plate as shown at **Y**.
- b** Measure the fore and aft movement and subtract 0.5 mm to obtain the required shim thickness. Fit the correct thickness shim between the front of the axle and the yoke plate as shown at **X**.

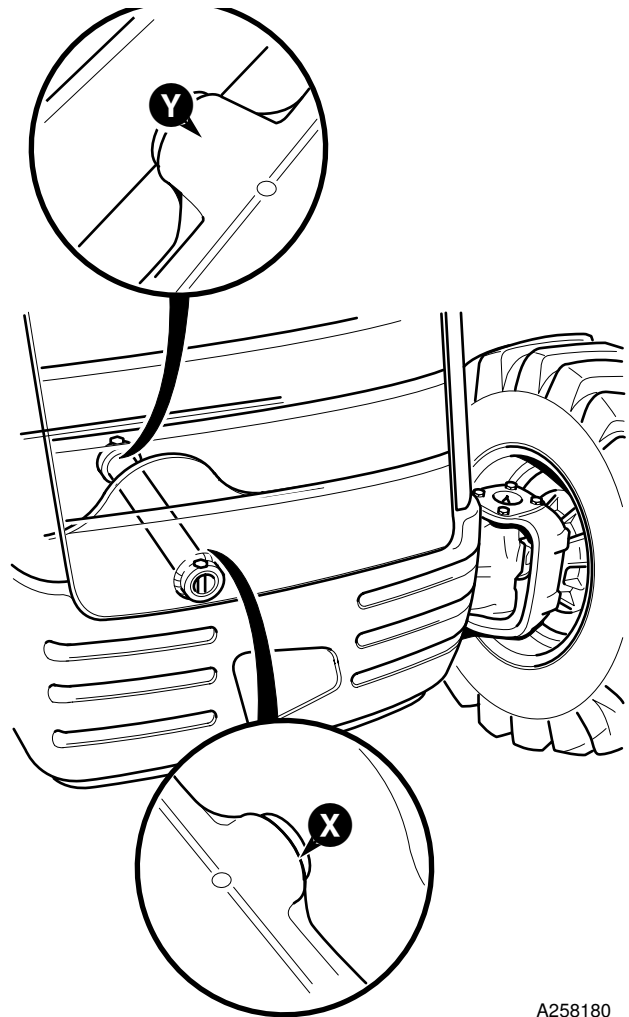
Note 1: DO NOT fit more than 2 shims (including the master shim).

Note 2: To assist assembly, use the double sided tape ring supplied to retain the shims on the yoke plate.

If the setting of the steering proximity switch has been disturbed, then complete the front axle proximity switch setting procedure, see **Section H, Service Procedures**.

Torque Settings

Item	Nm	kgf m	lbf ft
A	79	8	58
D	680	69	500



A258180

Hub and Driveshaft - Dismantling

The following illustrations show the axle removed from the machine but the hubs may be dismantled without removing the axle.

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

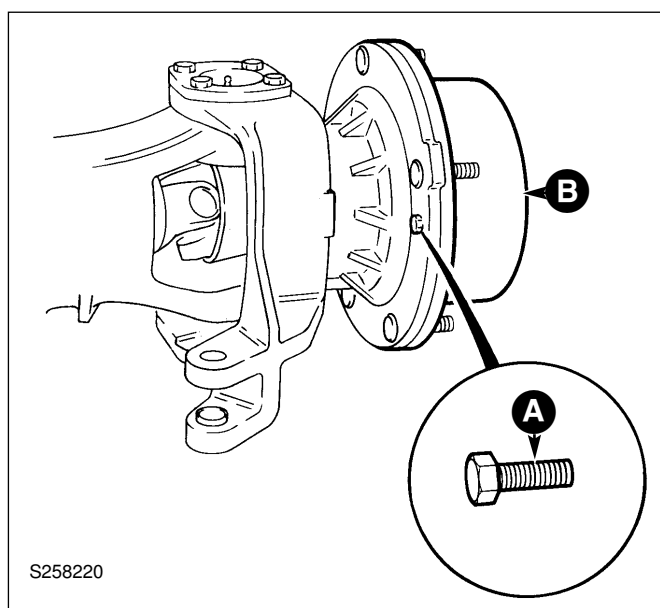
Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN 1-1

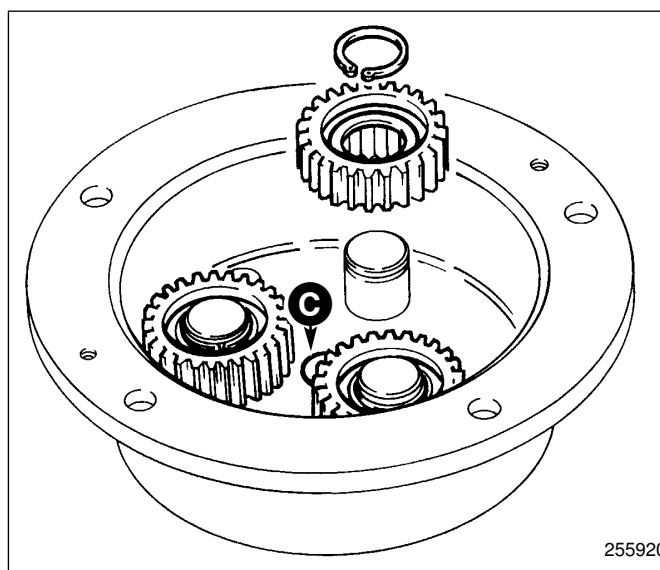
- 1 Disconnect the steering track rod. Drain oil from the hub.

Note: The illustration shows a typical axle.

- 2 Remove screws **A**.
- 3 Lever the planet gear carrier **B** off the bearing carrier. Clean off all traces of sealant from the mating faces or remove 'O' ring as applicable.

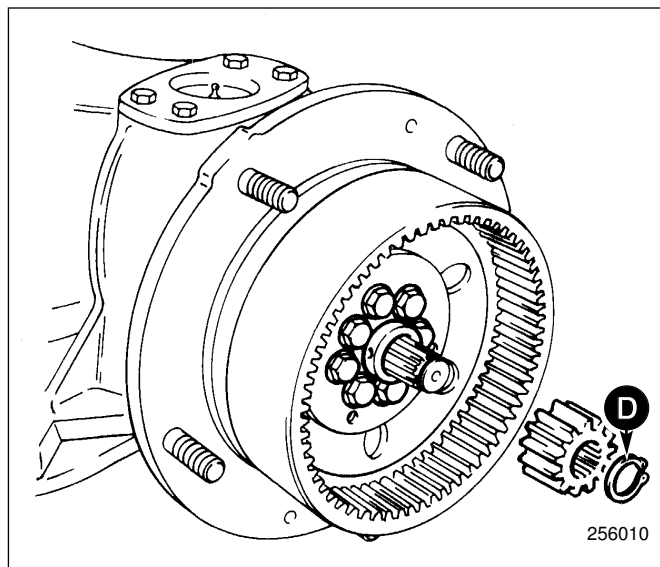


- 4 Remove planet gears only if defective. Note that gears can only be removed as assemblies, which comprise the gear, the bearing and two 'L' shaped circlips. To remove a planet gear, first remove the external circlip.
- 5 Pull off the planet gear.
- 6 The driveshaft thrust pad **C** is drilled and tapped M6 for removal purposes.

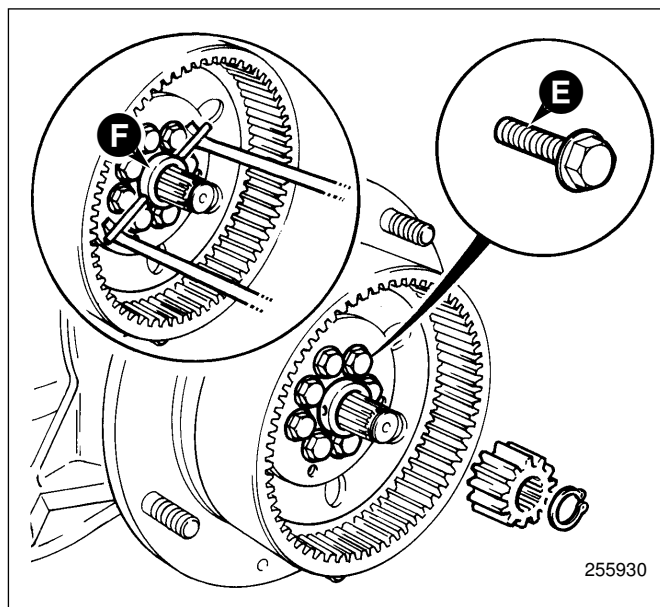


Hub and Driveshaft - Dismantling (cont'd)

- 7 Remove circlip **D** to allow the sun gear to be slid off the drive shaft.

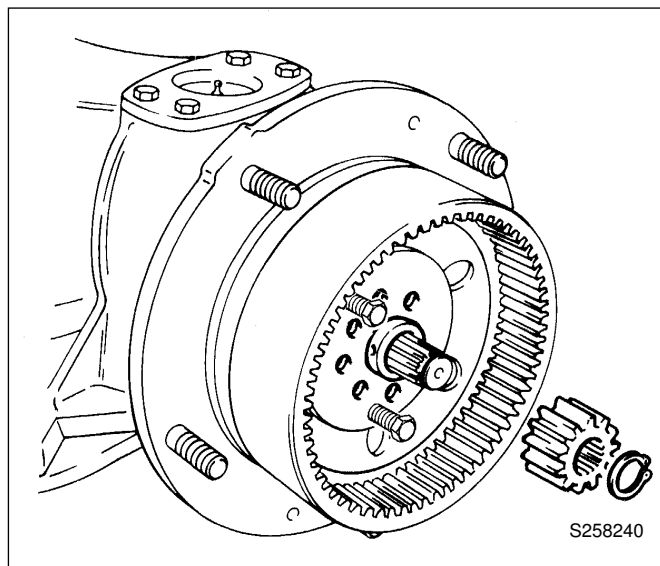


- 8 To remove the 'Verbus Ripp' bolts **E**, it is necessary to remove the spacer **F**. Revolve the spacer with a suitable drift to align the holes in the spacer with the space between the bolts.
- 9 Using two dowels and two heel bars, remove the spacer using the method shown.
- 10 Remove the 'Verbus Ripp' bolts using a special tool (part number 892/00333). These bolts are very tight and care must be taken not to distort the bolt heads. Use as short an extension bar as possible.



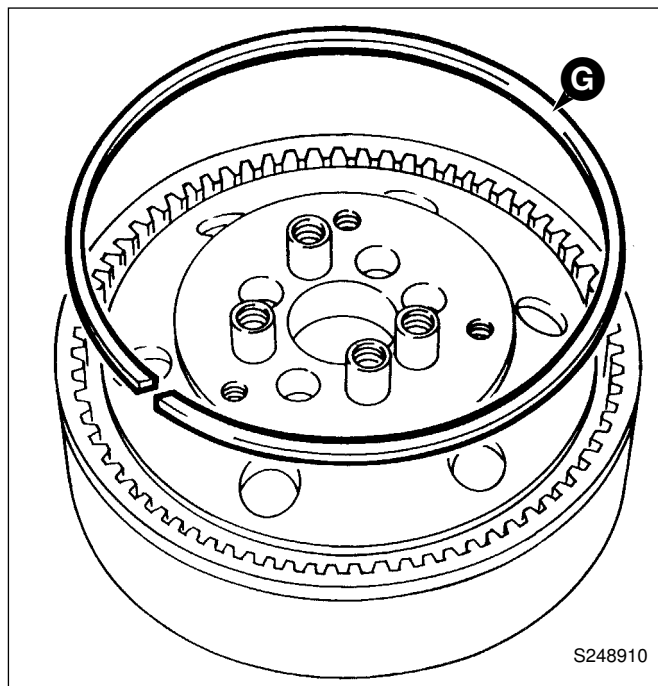
- 11 Using 2 high grade M14 bolts as jacking screws, remove the annulus carrier.

Note: Fretting between the hub swivel and annulus carrier mating faces might be evident; this condition is normal, do not attempt to repair. If the hub swivel and annulus carrier are to be re-used, the carrier must be assembled in the same angular position it was removed; match mark the hub swivel and carrier before removing the carrier.



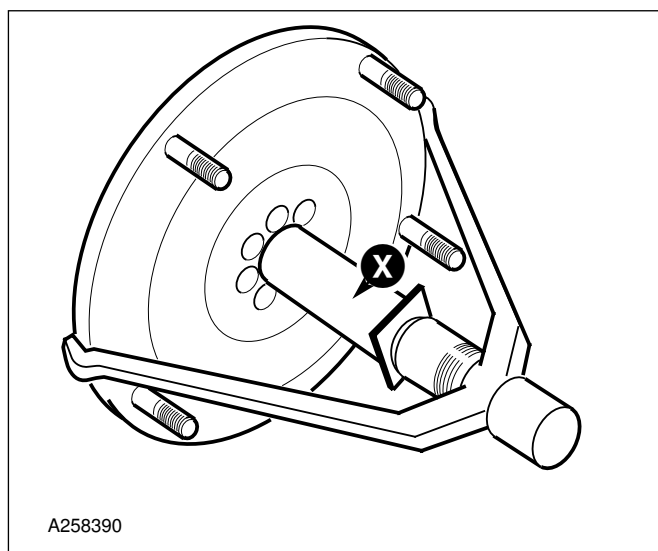
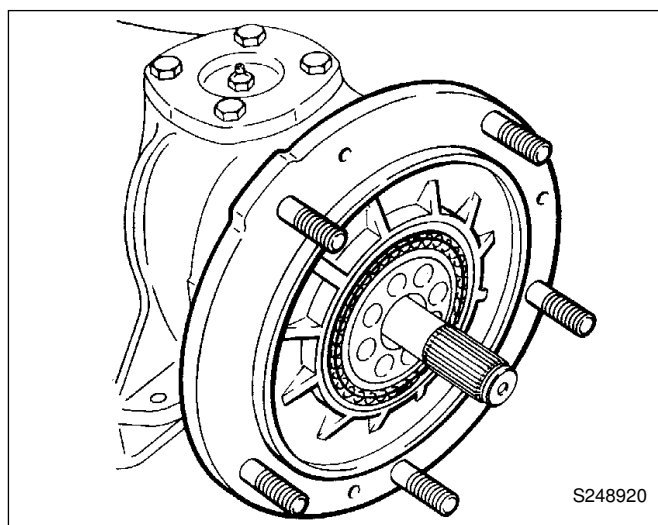
Hub and Driveshaft - Dismantling (cont'd)

- 12** Remove circlip **G** to separate the annulus ring from the annulus carrier.



- 13** Pull off the bearing carrier together with the outer bearing cone and its bearing cup. Withdraw the inner bearing cup from the inboard side of the carrier.

Note: To prevent damaging the axle case inner seal, do not lever against the half shaft. Place a tube over the half shaft and lever against the tube, as shown at **X**.

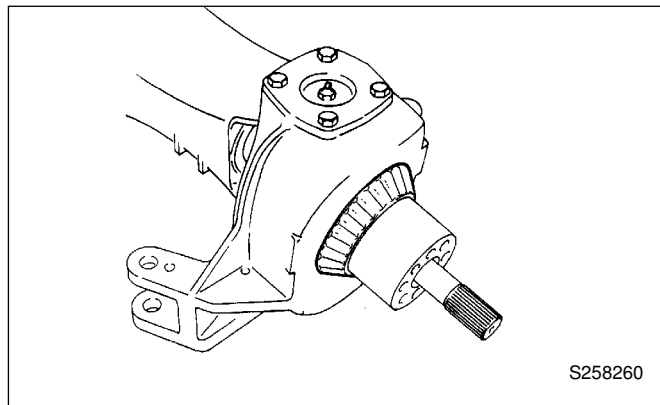


Hub and Driveshaft - Dismantling (cont'd)

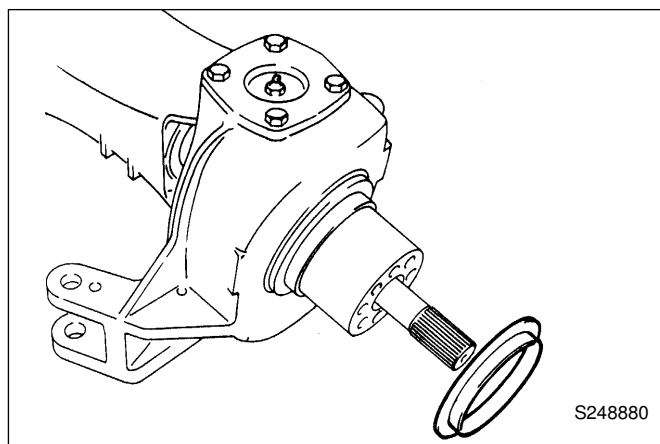
14 Pull off the inner bearing - see Note at step 13.

15 Remove and discard the seal.

Note: The inner bearing and oil seal may withdraw with the bearing carrier.

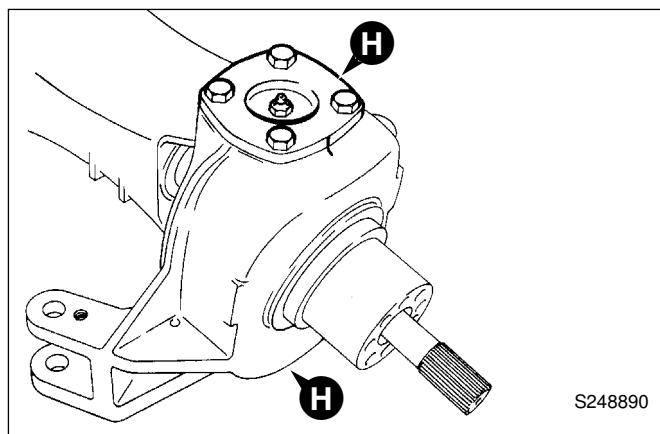


16 Remove and discard the combination seal. When assembling the axle, a new combination seal must be used.

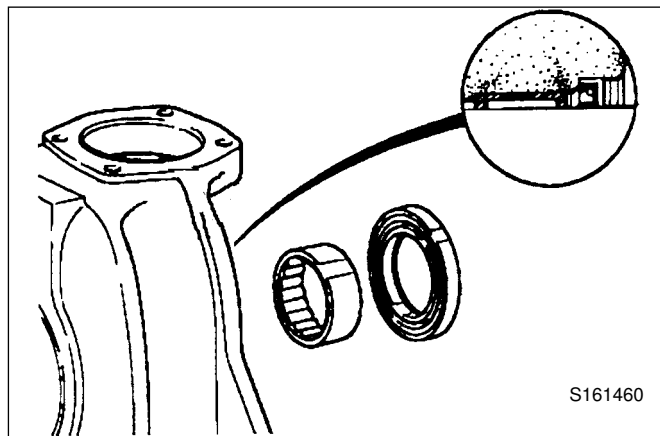


17 Mark position of top and bottom trunnions **H** and remove. Withdraw the hub carrier.

Note 1: Trunnions may be removed easily by pumping grease through the grease nipple.

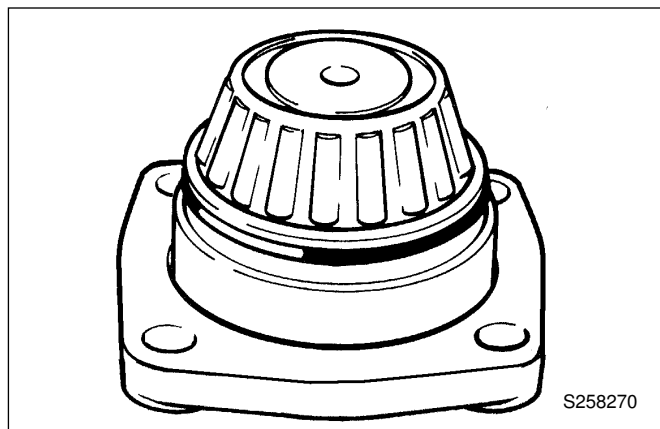


18 Use adaptor 993/59500 with slide hammer tool 892/00224 and remove driveshaft seal and needle roller bearing from the hub carrier.



Hub and Driveshaft - Dismantling (cont'd)

- 19 Use a puller to remove the trunnion seal and bearing.

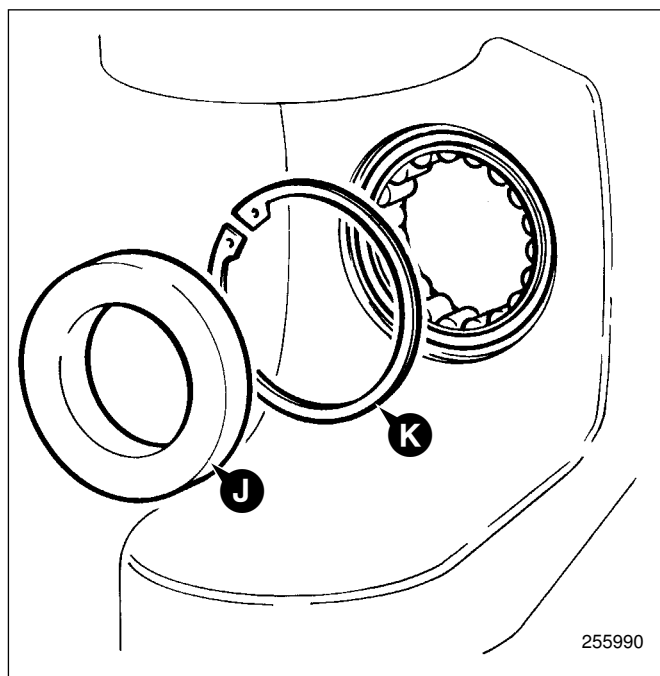


- 20 Withdraw drive shaft.

- 21 Prise out drive shaft inner oil seal **J**.

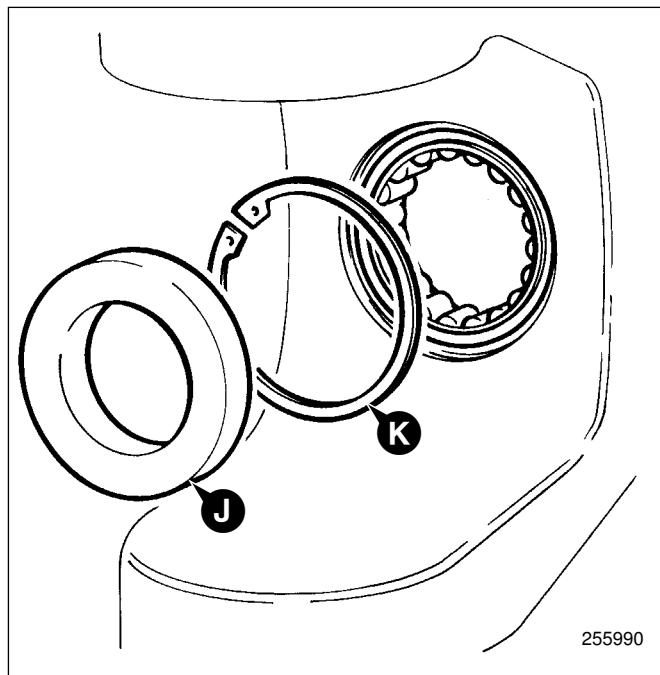
- 22 Remove circlip **K**

- 23 Remove bearing using tool 892/00225.

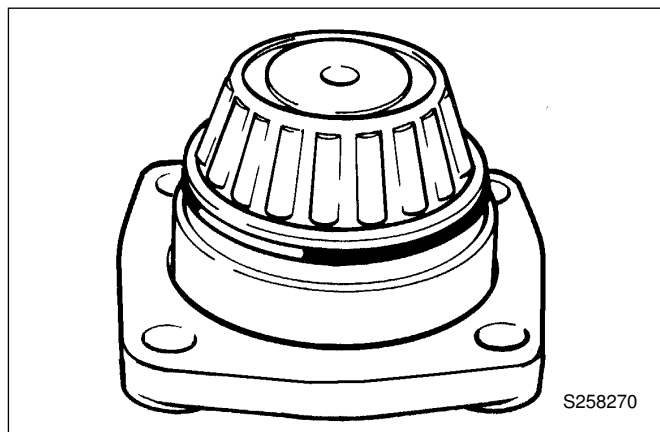


Hub and Driveshaft - Assembly

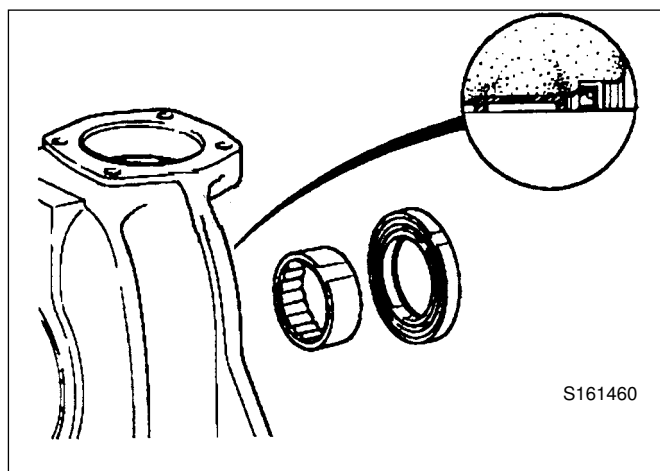
- 1 Tap drive shaft inner bearing into position and secure with circlip **K**.
- 2 Fit new oil seal **J**. Pack grease between lips of seal.
- 3 Fit drive shaft, taking care to locate inner end into splines of differential gears.



- 4 Press new trunnion oil seal into position followed by the bearing. Grease bearing and oil seal before fitting to axle.

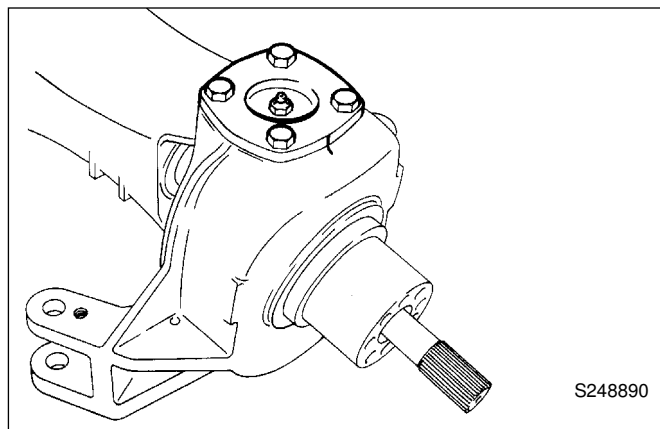


- 5 Fit driveshaft needle roller bearing to the hub carrier. Pack the cavity between the oil seal lips with grease and then fit the seal.

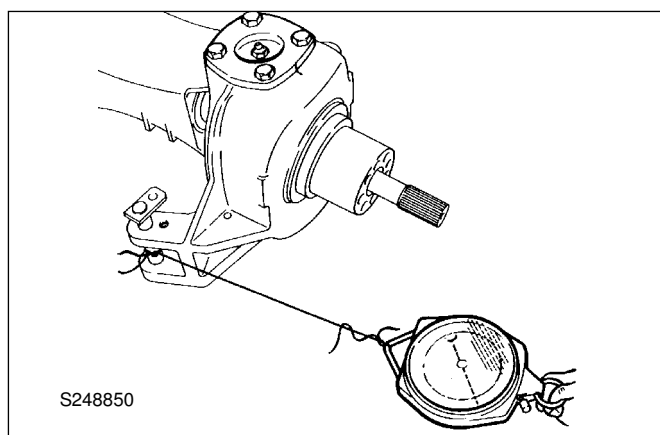


Hub and Driveshaft - Assembly (cont'd)

- 6 Locate hub carrier and fit bottom trunnion. Apply JCB Lock and Seal (part no. 4101/0202) to the bottom trunnion bolt threads, fit and tighten to 98Nm (72 lbf ft). Fit top trunnion and leave top trunnion bolts finger tight.

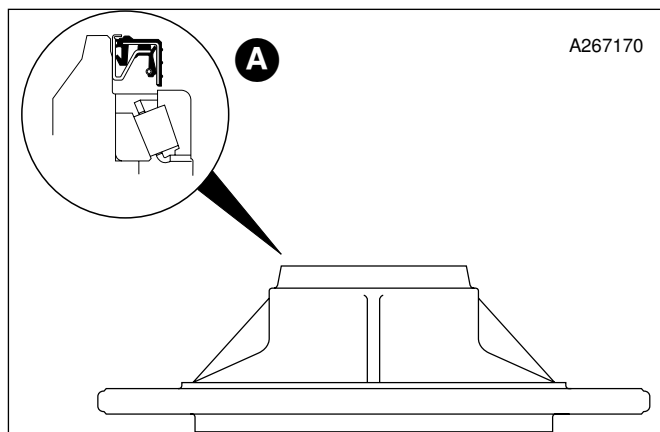


- 7 Attach a spring balance to track rod swivel as shown and note the reading. Tighten the top trunnion bolts to eliminate end float but no bearing pre-load, ie no increase in spring balance reading.



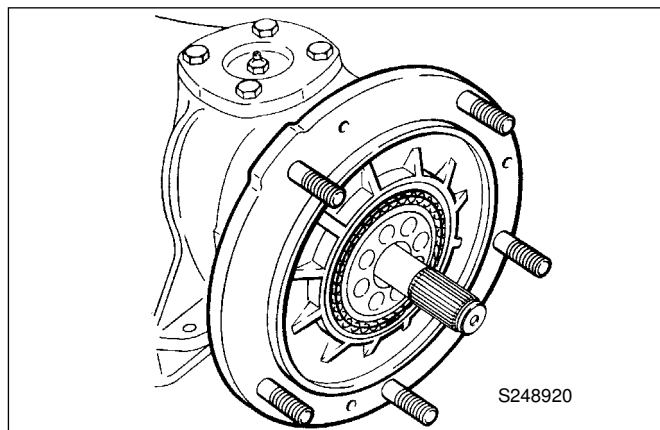
- 8 Refit top trunnion. Apply JCB Threadlocker and Sealer to the top trunnion bolt threads, fit and tighten to 98 Nm (72 lbf ft). Check spring balance reading which should be 4.5 kgf (10 lbf) more than the reading recorded at fig. 7.

- 9 Lightly oil the inner wheel bearing. Assemble the inner and outer bearing cups, and the inner bearing cone into the bearing carrier.



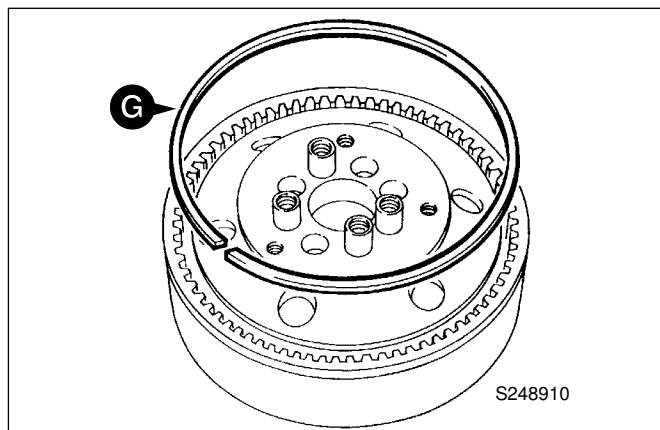
- 10 Fit a new combination oil seal. Do not lubricate before fitting. Drive the seal squarely into the carrier until the locating lip is flush as shown at A.

- 11 Fit the bearing carrier onto the axle arm. Lightly oil the outer wheel bearing race. Fit the bearing onto the axle arm. Rotate the bearing during fitting.



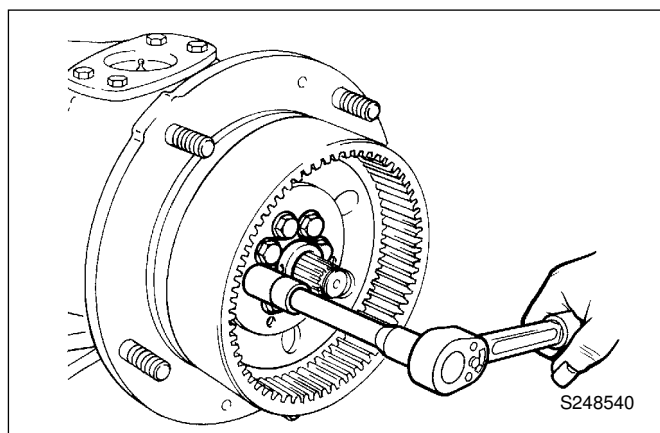
Hub and Driveshaft - Assembly (cont'd)

- 12** Assemble the annulus ring to the annulus carrier. Secure with the circlip **G**.



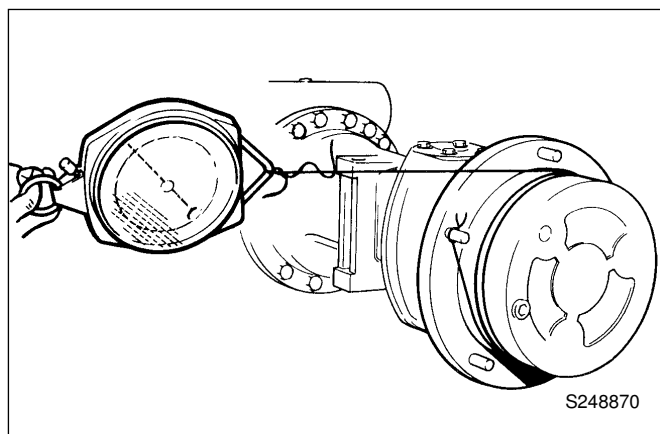
- 13** Fit annulus assembly in the same angular position as removal (see **Note, Dismantling**, step 11) using new 'Verbus Ripp' bolts. Do not fully tighten bolts but allow the bearing carrier to rock slightly. Measure seal drag rolling force - see step 14.

Note: Steps 13 to 16 describe measurement of rolling force. To measure rolling torque (simplified process), a special tool is required. Refer to **Service Tools**.

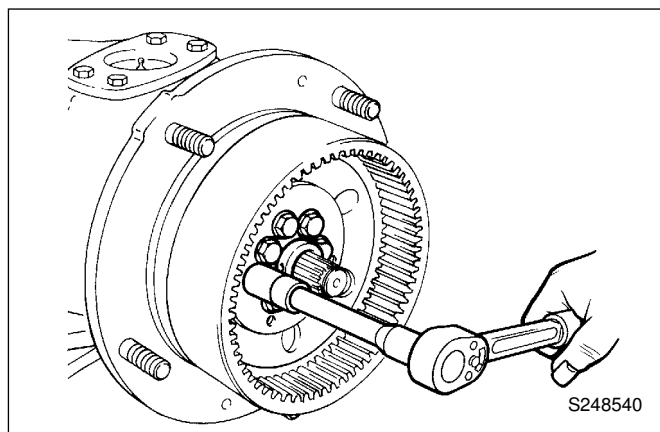


- 14** To measure seal drag rolling force:

- Refit the planet gear carrier - DO NOT FIT THE SUN GEAR.
- Use a spring balance and cord wrapped around the planet carrier flange as shown.
- Pull the spring balance so that the hub rotates, do several times to let the seal bed in and record the reading.
- Remove planet gear carrier.



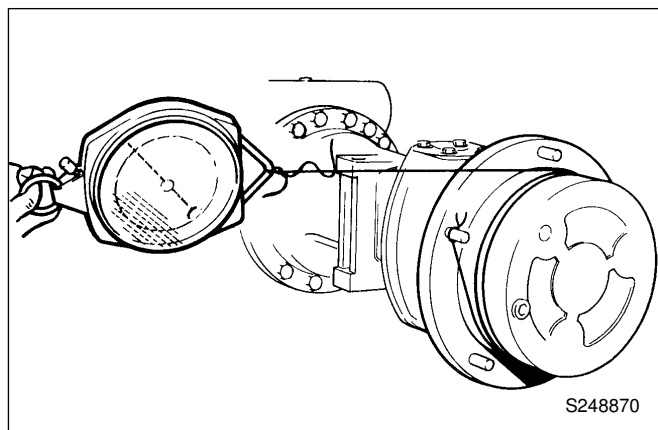
- 15** Tighten M14 Verbus Ripp bolts to 320 Nm (236 lbf ft, 33 kgf m) and then measure rolling force - see step 16.



Hub and Driveshaft - Assembly (cont'd)

16 To measure rolling force:

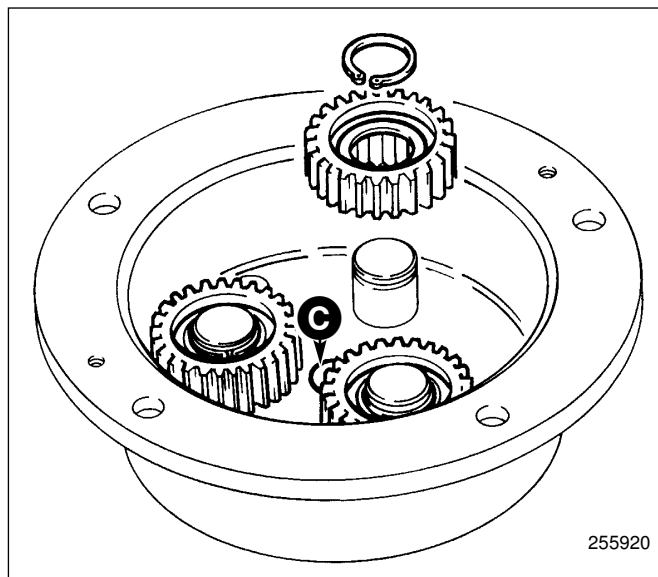
- Refit the planet gear carrier - **DO NOT FIT THE SUN GEAR**. Use a spring balance and cord wrapped around the planet gear carrier flange as shown. Pull the spring balance so that the hub rotates and record the reading.
- To get the rolling force, subtract seal drag rolling force (see step 14) from reading obtained at this step, the result should be 64 to 117 N (14 to 26 lbf).
- If the resulting figure is outside these limits check: the seal is fitted correctly; and/or renew bearings if necessary; and /or new fitted components.
- Remove planet gear carrier.



17 Press the drive shaft thrust pad **C** (chamfered side lowermost) into the recess in the planet carrier.

18 Fit new planet gears in place of any that were removed. (See step 4 in 'Dismantling'). Secure with circlip.

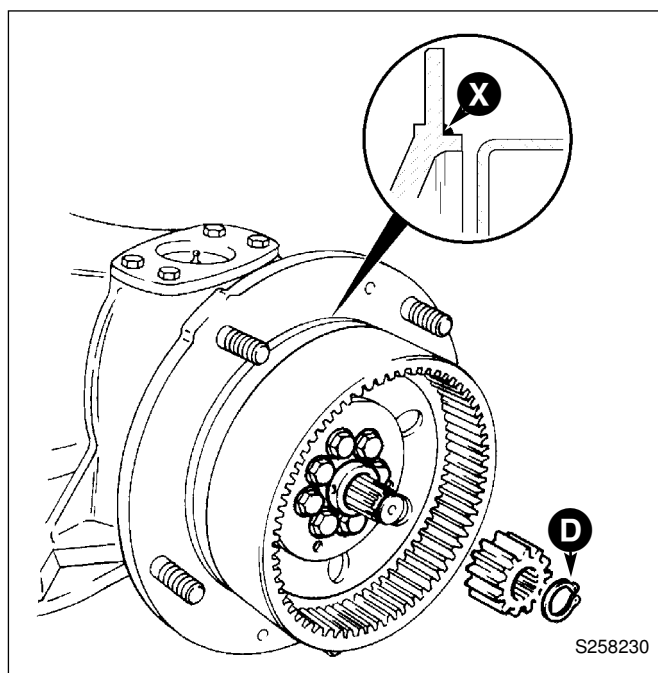
Note: Make sure that the SMALL radius on the gear bearing internal diameter is facing uppermost, that is at the circlip end of the planet pin.



19 Fit spacer and slide the sun wheel onto the driveshaft and secure with circlip **D**. Apply a fillet of sealant 4102/0900 evenly around the bearing carrier as shown at **X**.

Note: Some machines may have an 'O' ring instead of sealant - where appropriate fit a new 'O' ring.

Note: The sun gear must be fitted with the 1.5 mm (0.060 in) x 45° chamfer inboard.

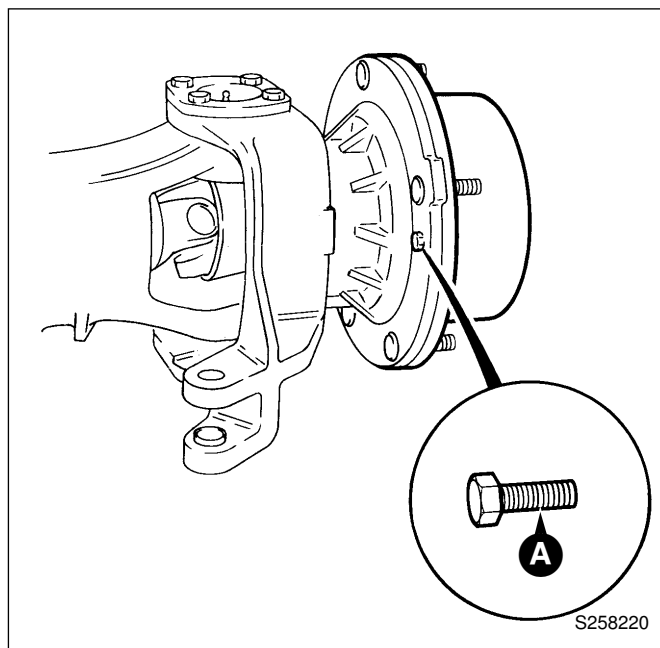


Hub and Driveshaft - Assembly (cont'd)

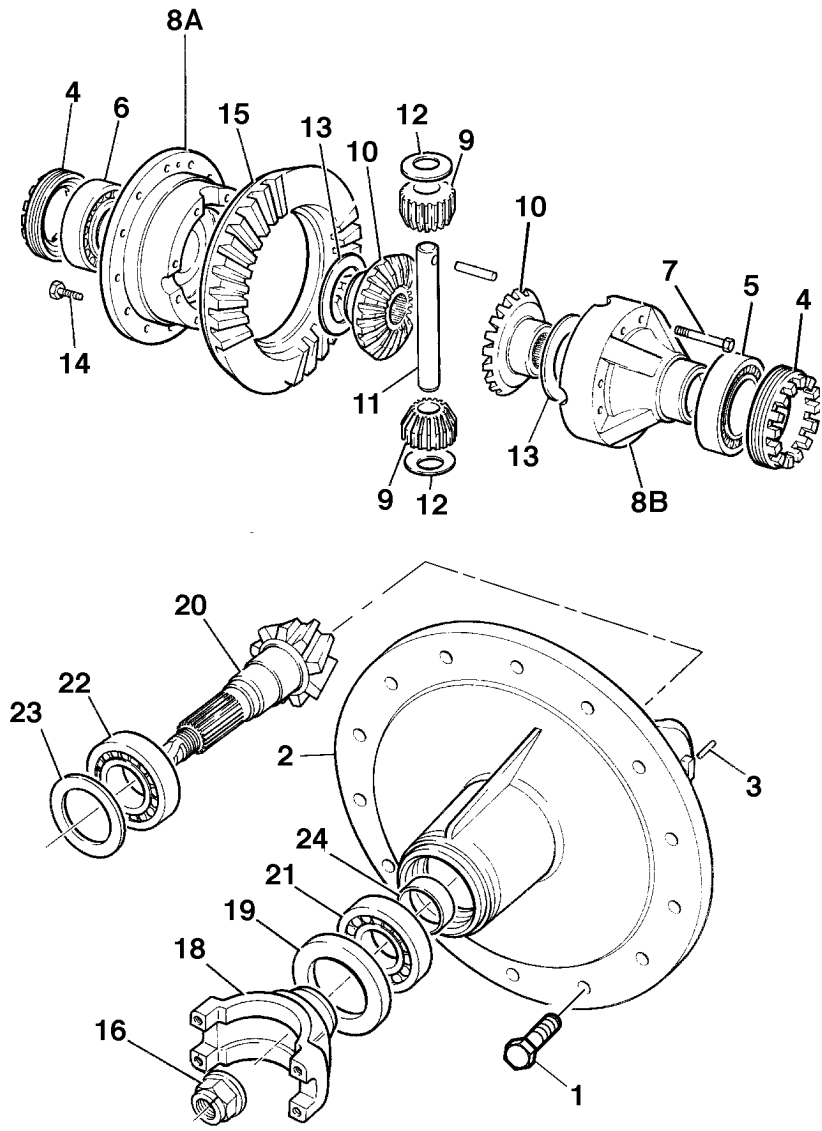
- 20** Fit the planet carrier onto the bearing carrier, ensuring that the two tapped holes are in line with those on the bearing carrier. Fit and torque tighten screws **A** to 56Nm (41lbf ft; 5.7kgf m) after applying JCB Lock and Seal to the threads.

Note: Do not strike the centre of the planet gear carrier when fitting as this may dislodge the driveshaft thrust pad fitted at step 17.

Re-fill hubs with the correct grade oil.



Drive Head - Dismantling

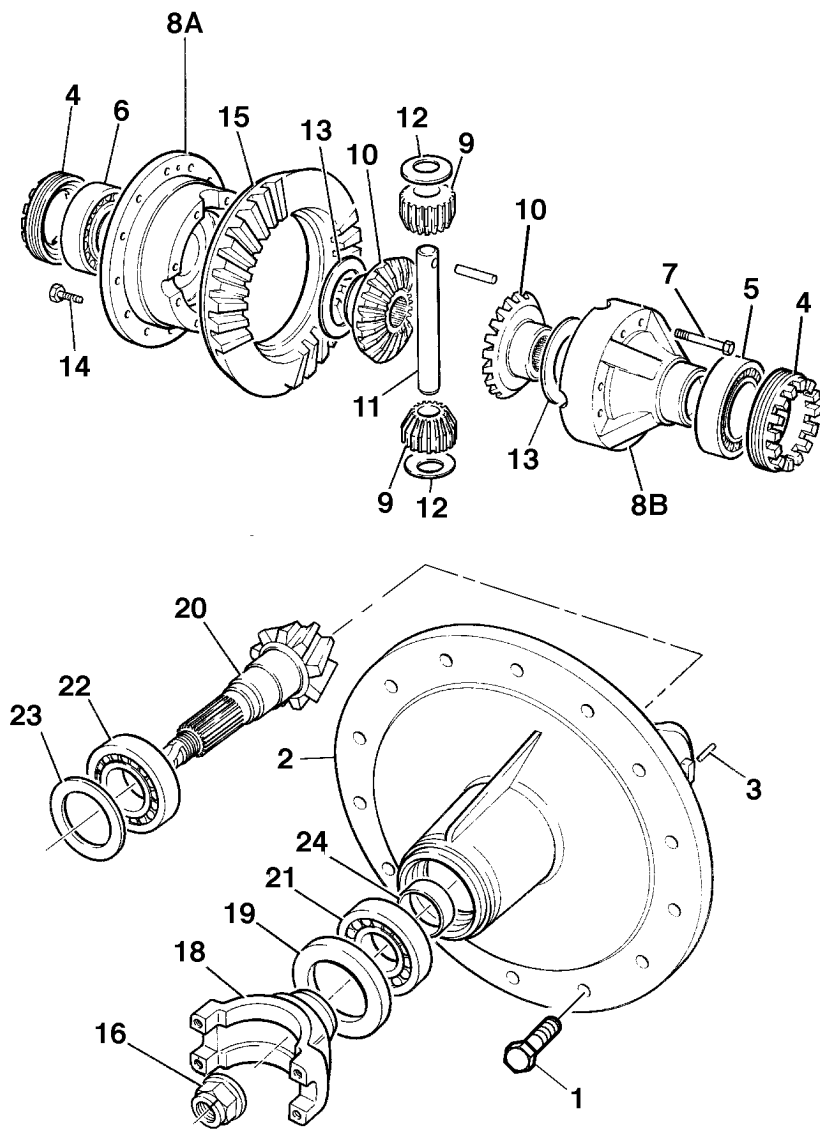


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Drive Head - Dismantling (cont'd)

- 1 Drain the oil from the drive head. Remove the propshaft.
- 2 To remove the drive head it is necessary to withdraw both drive shafts from the axle.
- 3 Remove the drive head carrier screws **1**. Mark the installation position of drive head carrier **2** relative to the axle housing.
- 4 Remove the drive head carrier from the axle housing.
- 5 Pull out the roll pins **3** and remove the castellated nuts **4**. Remove the outer races of bearings **5** and **6** from the drive head carrier bores.
- 6 Remove inner bearing races of **5** and **6**.
- 7 Remove differential assembly **8** from carrier.
- 8 Loosen the differential case half bolts **7** and pull the case halves **8A** and **8B** apart. Remove the axle bevel gears **9**, the differential bevel gears **10**, trunnion pin **11** and thrust washers **12** from the case halves.
- 9 Remove the thrust washers **13** from both case halves.
- 10 Pull off the bearing **6** from case half **8A**.
- 11 Remove the Verbus Ripp bolts **14** and separate the crownwheel **15** from the case half **8A**.
- 12 Remove pinion nut **16**. Use Service Tool 892/00812 to prevent drive yoke **18** from rotating.
- 13 Mark the position of the drive yoke on the splined shaft. Remove the drive yoke.
- 14 Drive pinion shaft **20** out of drive head carrier **2**.
- 15 Prise shaft seal **19** out of the bore.
- 16 Remove taper roller bearing **21** and tap out the outer bearing race.
- 17 Tap out the outer race of bearing **22** from the opposite bearing housing and remove the drive pinion shim(s) **23**.
- 18 Remove spacer **24** from drive pinion **20**. Prise taper roller bearing **22** to raise it sufficiently to insert bearing pullers. Pull the bearing from the pinion shaft.

Drive Head - Assembly (cont'd)



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Drive Head - Assembly

The outline procedure below refers also to the following aspects of the drivehead assembly, which are covered separately in detail as sub topics later in this section:

Pinion Depth Setting Collapsible Spacer Assembly Crown Wheel and Pinion Meshing

Note: Both the crownwheel **15** and pinion **20** and the bevel gears **9** and **10** are matched and should be renewed as sets if any of their components are damaged or excessively worn. The two differential housing halves **8A** and **8B** are also matched. Do not use unmatched halves.

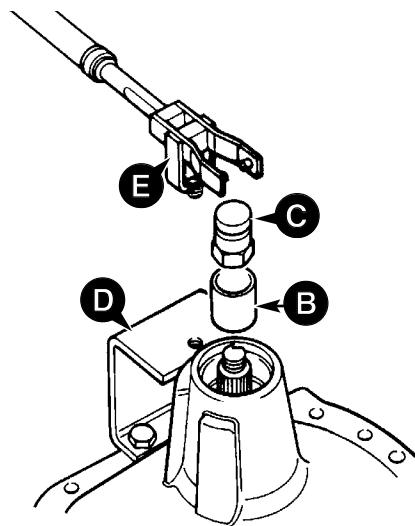
Make sure all bearings are lightly oiled before fitting and setting. Make sure bearings are rotated whilst being set.

- 1 Determine the correct thickness required for the shims **23**, refer to **Pinion Depth Setting**.
- 2 Fit shims **23** behind new bearing cup **22**.
- 3 Fit new pinion head bearing cone **22** onto pinion **20**.
- 4 Install pinion and bearings into the drive head casing. Install largest available solid spacer **24** e.g (14.20 mm) and fit pinion tail bearing **21** (lightly oiled). Do not fit the oil seal **19** at this stage.

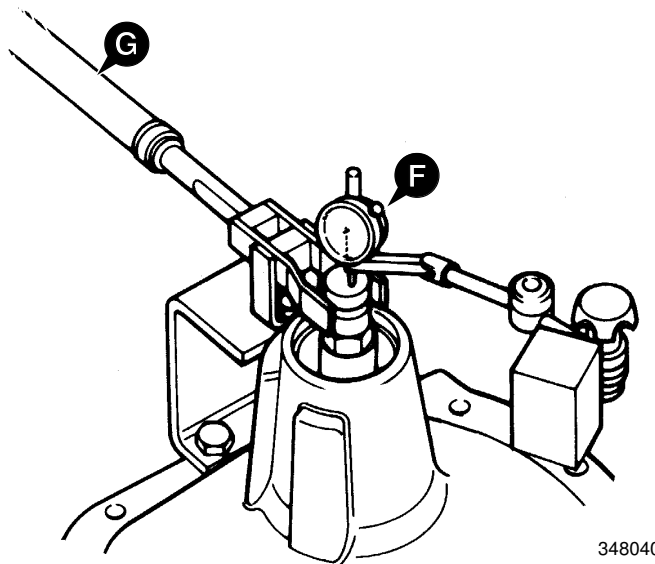
Note: It should be noted that the axle is assembled using a solid spacer. However, in the absence of the special tools required or the correct size solid spacer **24** it is acceptable to fit a collapsible spacer, refer to **Collapsible Spacer Assembly**.

- 5 Fit special tool sleeve **B** and special pinion shaft adapter **C**. Tighten adapter **C** to approximately 50 Nm, making sure the pinion is free to rotate and there is end float, this will prevent any damage to the bearing. If the pinion is not free to rotate or there is no end float at this stage check the bearing is fitted correctly. Also check the correct size spacer has been fitted.

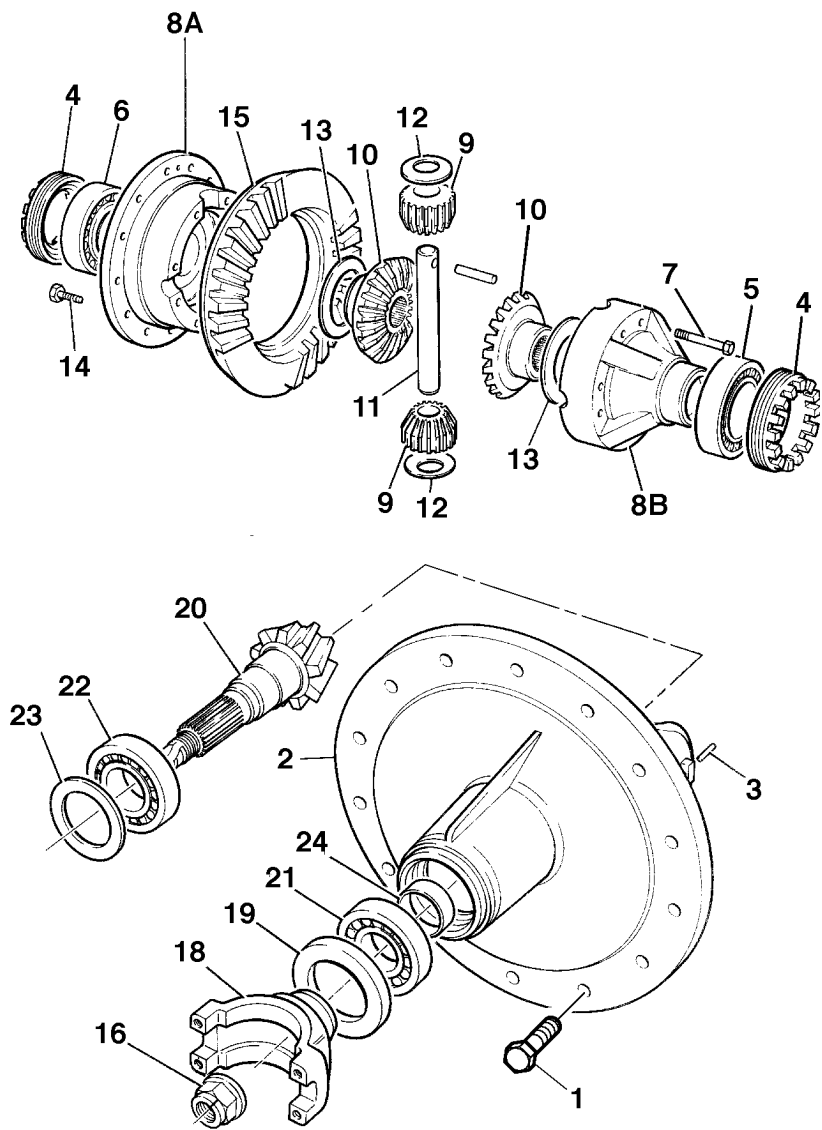
- 6 Fit special bracket **D** to the drive-head housing using two M10 x 30 nuts and bolts. Fit special tool support pillar **E** to bracket **D** so that the fork end engages in adapter **C**. Ensure that fork **E** is centrally located on adapter **C**. If necessary, re-align bracket **D** to suit.



- 7 Fit dial test indicator (DTI) **F**. Ensure that the DTI is mounted on the drive head and not on bracket **D**.
- 8 Set torque wrench **G** to 35 Nm (25.8 lbf ft) and measure the end float while rotating the shaft.



Drive Head - Assembly (cont'd)



Drive Head - Assembly (cont'd)

- 9** To select the right size spacer **24**, subtract the end float obtained at step 7 from the solid spacer size (14.20 mm). Also subtract 0.04 mm to allow for theoretical bearing tolerance and pre load. The result is the size of spacer to be fitted from the solid spacer setting kit. If there is no spacer of this size, fit the next nearest size spacer, refer to **Service Tools - Axles**.

Example

Temporary spacer size	14.20
Subtract end-float	0.25
Total	13.95
Subtract tolerance & preload	0.04

Result 13.91

(No spacer available this size, use next nearest size spacer i.e 13.900)

- 10** Remove sleeve **B** and temporary spacer. fit correct size spacer from solid spacer setting kit, refer to **Service Tools - Axles**. During removal take care to avoid damaging the outer bearing.
- 11** Fit sleeve **B**. Tighten adapter **C** to no more than 50 Nm to protect against bearing damage while spacer selection is verified making sure the pinion is free to rotate. Check there is no end float and pinion is free to turn smoothly by hand. Remove adapter **C** and fit nut **16**. Then check that rolling torque is less than 2.0 Nm. If the rolling torque exceeds 2.0 Nm, check that the shaft has been assembled correctly.

Note: If the pinion is not free to rotate check the correct size spacer has been fitted.

- 12** If rolling torque measured at step 10 is too high, fit the next larger size spacer. If rolling torque is too low, fit the next smallest size spacer. If a correct spacer is not available from the range, check that drive head is assembled correctly.
- 13** Remove adapter **C** and sleeve **B**. Fit new oil seal **19**, grease between seal lips before fitting. Fit coupling yoke **18** and NEW stake nut **16**.
- 14** Progressively torque tighten stake nut **16**, occasionally rotating coupling yoke, up to 250 Nm. Providing the correct size spacer has been selected the rolling torque should be between 2.3 and 3.4 Nm including seal drag.

Note: The nut tightening torque can be increased to a maximum of 300 Nm provided that the pinion rolling torque does not exceed the maximum of 3.4 Nm.

- 15** Finally stake the nut **16** into the slot.

- 16** Assemble the trunnion pin **11**, bevel gears **9** and **10** and their thrust washers **12** and **13** into differential half case **8A**.

- 17** Position differential half case **8B** onto half case **8A**, aligning the match-mark letters. Apply JCB Threadlocker and Sealer to the threads of bolts **7**, then fit and torque tighten to 46 Nm (34 lbf ft, 4.7 kgf m). Check the gears for free rotation.

- 18** Fit crownwheel **15** using new Verbus Ripp bolts **14** tightened to 94 Nm (69 lbf ft, 9.59 kgf m).

- 19** Locate crownwheel assembly (without bearings) into housing.

- 20** Drive bearing cones **5** and **6** onto differential case spigots. Lightly oil the bearings then fit their bearing cups and castellated nuts **4** into drive head carrier **2**. Do not fit the roll pins **3** at this stage.

- 21** Adjust castellated nuts **4** to give an increase in input pinion rolling torque of between 1.36 - 2.5 Nm (12 - 22 lbf in) more than that recorded in Step 13.

- 22** Measure the backlash between crownwheel **15** and pinion **20**, which should be 0.17 - 0.28 mm (0.006 - 0.010 in). Adjust castellated nuts **4** by equal amounts when altering backlash. When backlash and preload are both correct, fit roll pins **3**.

- 23** Check tooth marking to verify crownwheel and pinion are set correctly, refer to **Crownwheel and Pinion Meshing**.

- 24** Apply JCB Multigasket to the mating faces of drive head carrier **2** and the axle casing. Fit the drive head carrier to the axle casing with the crownwheel towards the short drive shaft. Fit securing bolts **1** and tighten to 98 Nm (72 lbf ft, 10 kgf m).

- 25** Reassemble both driveshafts and hub assemblies, refer to **Axle Hub and Driveshaft - Dismantling and Assembly**.

- 26** Re-fill the hubs and differential with the correct grade of oil, refer to Section 3 **Lubricants and Capacities**.

- 27** Refit the propshaft, refer to **Propshafts - Removing and Replacing**.

Pinion Depth Setting

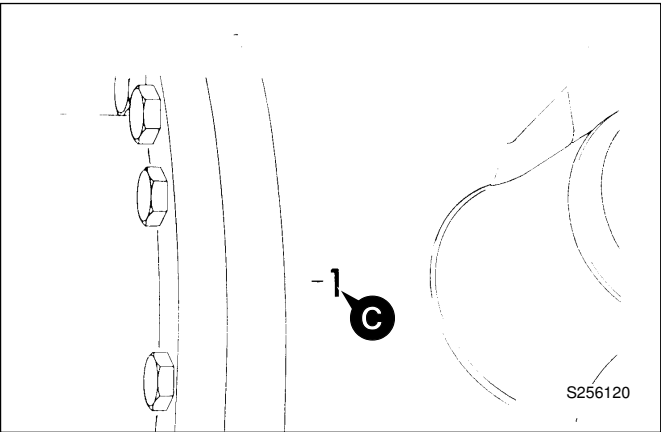
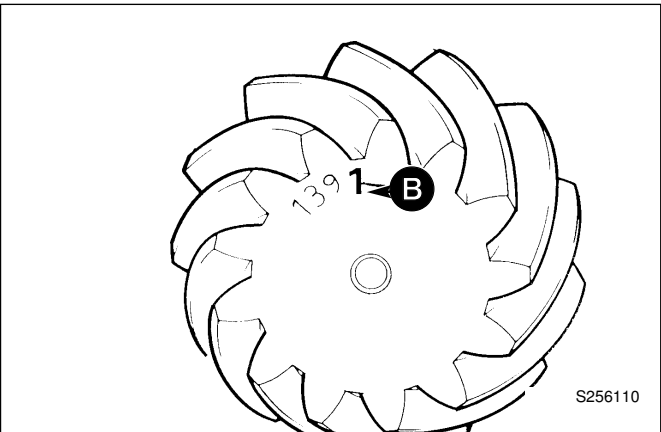
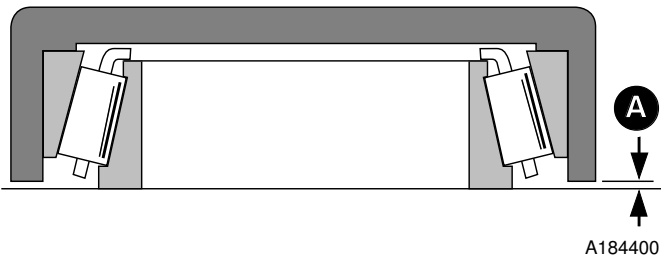
- 1 Place new pinion head inner bearing assembly on a flat surface and position service tool 892/00174 over the bearing. Measure gap **A** (e.g. 0.20 mm) and add this to the cup depth stamped on the tool (e.g. 30.01 mm) to obtain the bearing depth.
- 2 From the face of the pinion, obtain the etched deviation figure **B** (e.g. + 2) which is in units of 0.01 mm. If positive, add this to the bearing depth; if negative, subtract from the bearing depth.
- 3 Obtain the deviation figure **C** (e.g. - 1) stamped on the differential housing bolt flange. If negative, add to bearing depth; if positive, subtract from bearing depth.
- 4 Subtract the total of the above figures from the standard value of 31.19 mm. The result will be the thickness of shims required behind the pinion head bearing cup.

Example (all dimensions in millimetres)

Cup depth	30.01
Gap A	+0.20
Bearing depth	<u>30.21</u>
Pinion deviation B (+ 2)	+0.02
Housing deviation C (- 1)	+0.01
Total	<u>30.24</u>
Standard value	31.19
Less Total above	<u>30.24</u>
Shim Thickness	<u>0.95</u>

Note: In the event that the setting data stamp has been omitted from the drivehead casing, adopt the following setting procedure:

Revise the shim pack size by the difference in setting height marked on the old and new crownwheel pinion sets.

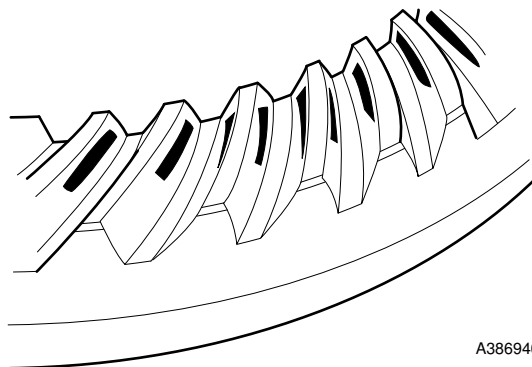


Crownwheel and Pinion Meshing

Meshing of the gears should be checked by marking three of the pinion teeth with engineers marking compound and rotating the pinion.

The marking will then be transferred to the crown wheel teeth.

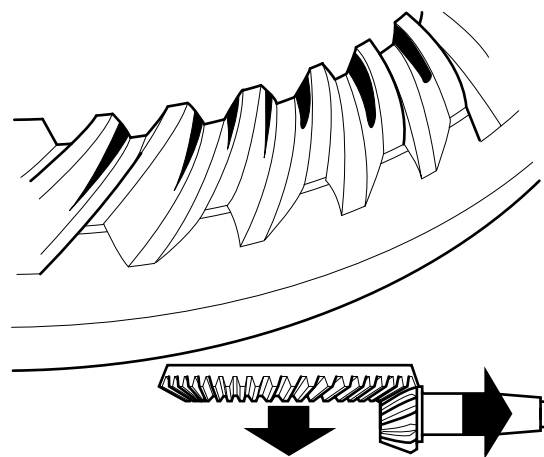
Correct tooth marking.



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Pinion too deeply in mesh.

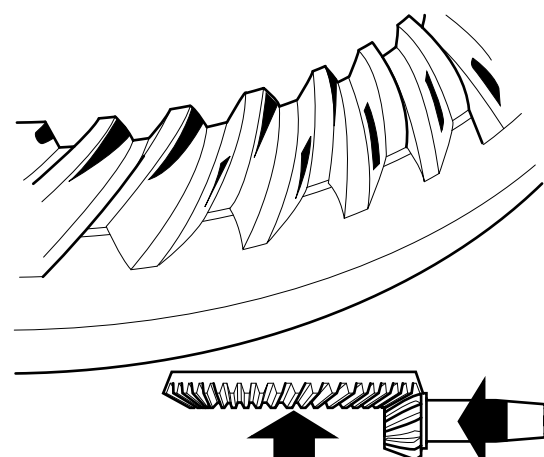
Decrease the shim thickness between the pinion inner bearing cup and the axle casing. Move the crown wheel towards the pinion to correct the backlash.



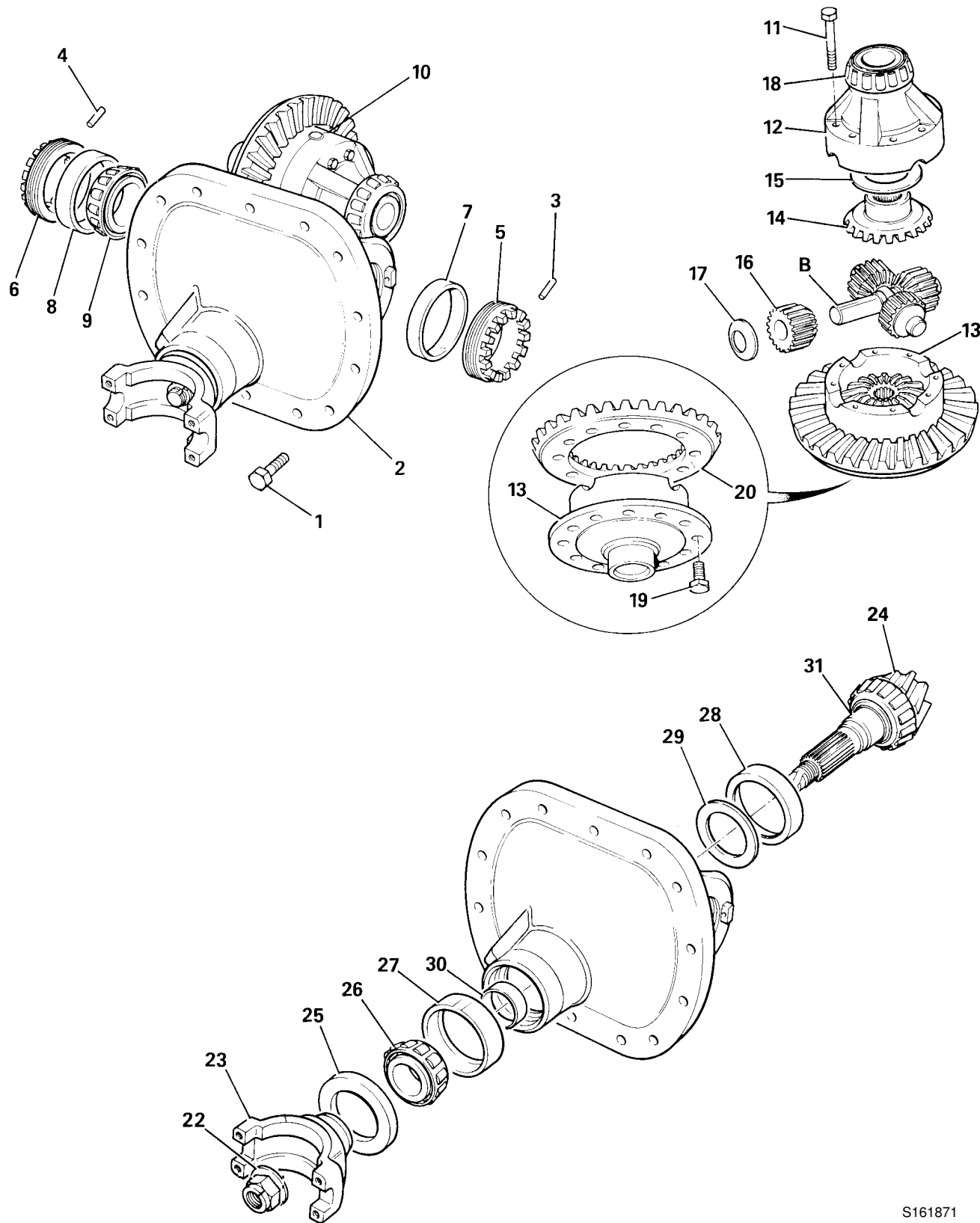
A386950

Pinion too far out of mesh.

Increase the shim thickness between the pinion inner bearing cup and the axle casing. Move the crown wheel away from the pinion to correct the backlash.



A386960



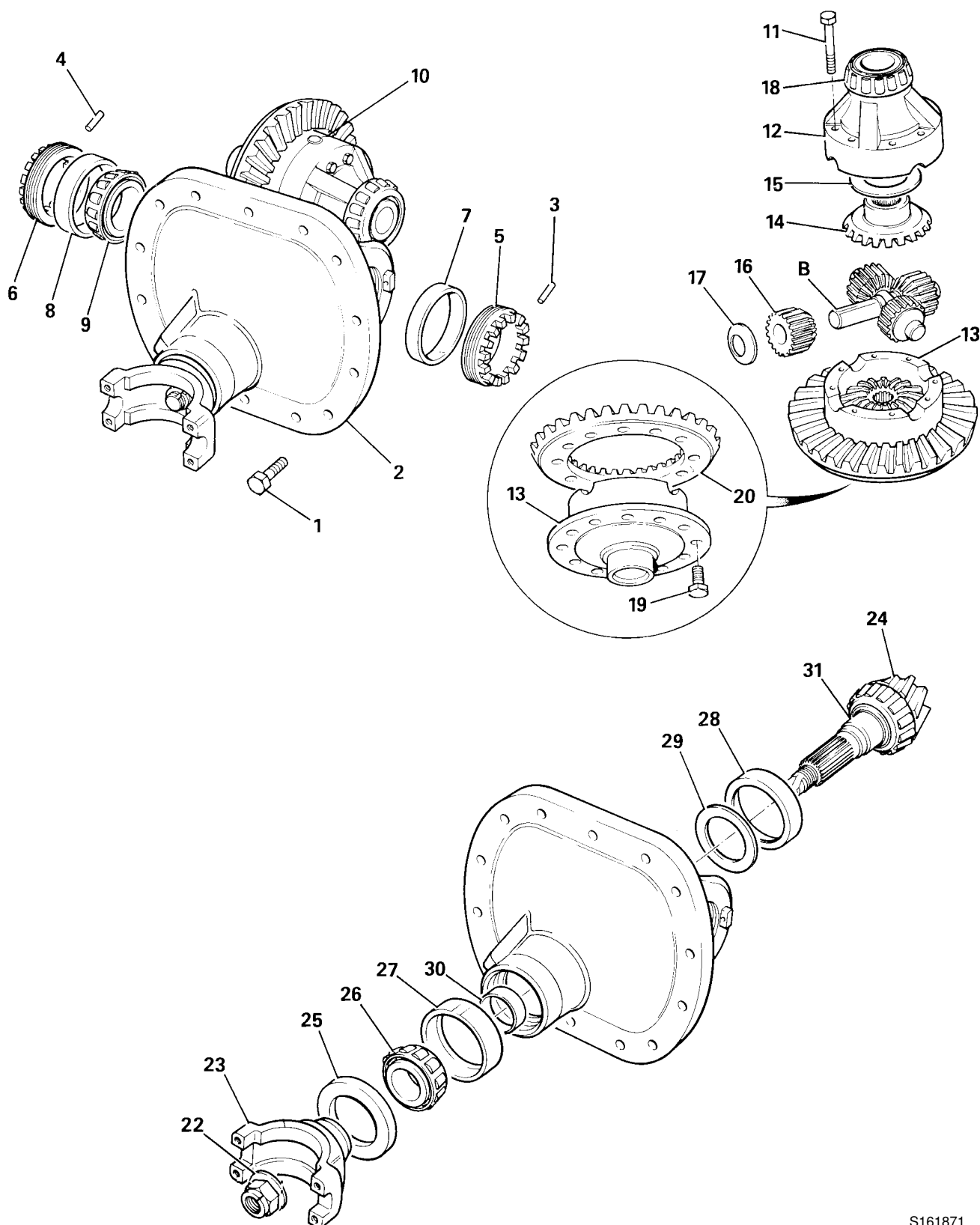
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Drivehead, SD70 - Dismantling

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

- 1 Drain the oil from the axle centre casing. Remove the propshaft from the gearbox to the front axle.
- 2 Remove both hub assemblies complete with driveshafts (see **Hub and Driveshaft Dismantling**).
- 3 Mark the installation position of the drive head carrier, item **2**.
- 4 Remove the drive head carrier retaining bolts, item **1**, and remove the drive head carrier **2** from the axle casing.
- 5 Clean the drive head carrier and axle casing mating faces.
- 6 Pull out tension pins **3** and **4**, and remove castellated nuts **5** and **6**.
- 7 Remove bearing outer races **7** and **8**.
- 8 Drive off the taper roller bearing cone **9** from the crownwheel differential case half.
- 9 Remove the differential assembly **10** from the carrier.
- 10 Remove the differential assembly retaining bolts **11** and separate case halves **12** and **13**.
- 11 Remove the differential side gears and thrust washers **14** and **15** respectively (2 off each).
- 12 Remove planet gears and thrust washers **16** and **17** respectively (4 off each) from trunnion pins **B**.
- 13 Pull off taper roller bearing cone **18** from differential case half **12**.
- 14 Remove 'verbus ripp' bolts **19** and separate the crownwheel **20** from the differential case half **13**.
- 15 Mark the position of the drive yoke on the splined shaft. Use service tool 892/00812 to prevent drive yoke **23** from rotating and remove pinion nut **22**. Remove the drive yoke.
- 16 Press the pinion **24** from the drive head carrier **2**.
- 17 Withdraw the pinion oil seal **25** and taper roller bearing cone **26**. If necessary, remove bearing outer race **27**.
- 18 If necessary, drive out the pinion bearing outer race **28** and shim(s) **29** from inner side of the drive head carrier.
- 19 Remove the spacer **30** and taper roller bearing cone **31** from pinion **24**.



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Drive Head - Assembly

The outline procedure below refers also to the following aspects of the drivehead assembly, which are covered separately in detail as sub topics later in this section:

Pinion Depth Setting Collapsible Spacer Assembly Crown Wheel and Pinion Meshing

Note: Both the crownwheel **20** and pinion **24** and the bevel gears **14** and **16** are matched and should be renewed as sets if any of their components are damaged or excessively worn. The two differential housing halves **12** and **13** are also matched. Do not use unmatched halves.

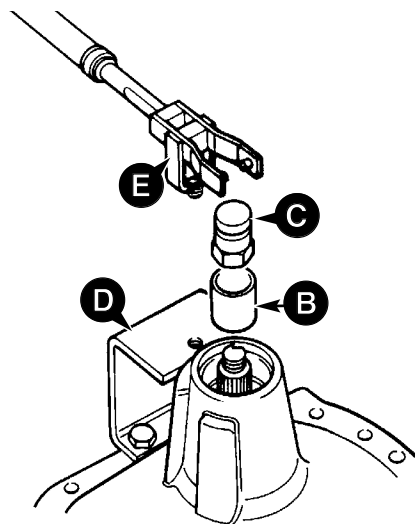
Make sure all bearings are lightly oiled before fitting and setting. Make sure bearings are rotated whilst being set.

- 1 Determine the correct thickness required for the shims **29**, refer to **Pinion Depth Setting**.
- 2 Fit shims **29** behind new bearing cup **28**.
- 3 Fit new pinion head bearing cone **28** onto pinion **24**.
- 4 Install pinion and bearings into the drive head casing. Install largest available solid spacer **30** e.g (14.20 mm) and fit pinion tail bearing **26** (lightly oiled). Do not fit the oil seal **25** at this stage.

Note: It should be noted that the axle is assembled using a solid spacer. However, in the absence of the special tools required or the correct size solid spacer **30** it is acceptable to fit a collapsible spacer, refer to **Collapsible Spacer Assembly**.

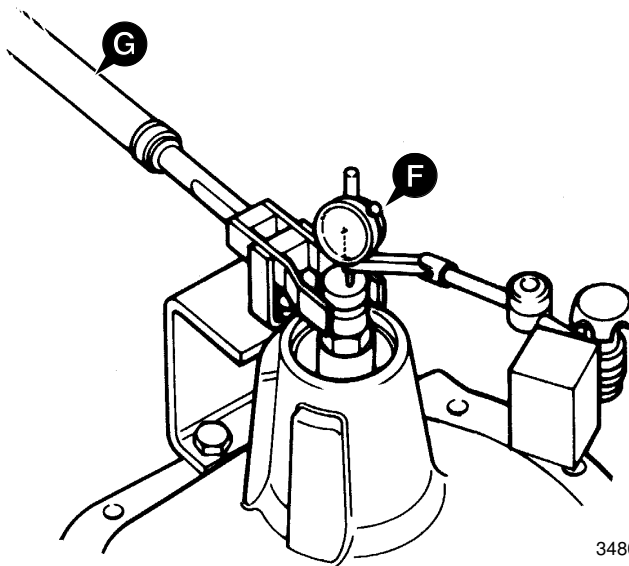
- 5 Fit special tool sleeve **B** and special pinion shaft adapter **C**. Tighten adapter **C** to approximately 50 Nm, making sure the pinion is free to rotate and there is end float, this will prevent any damage to the bearing. If the pinion is not free to rotate or there is no end float at this stage check the bearing is fitted correctly. Also check the correct size spacer has been fitted.

- 6 Fit special bracket **D** to the drive-head housing using two M10 x 30 nuts and bolts. Fit special tool support pillar **E** to bracket **D** so that the fork end engages in adapter **C**. Ensure that fork **E** is centrally located on adapter **C**. If necessary, re-align bracket **D** to suit.



348030

- 7 Fit dial test indicator (DTI) **F**. Ensure that the DTI is mounted on the drive head and not on bracket **D**.
- 8 Set torque wrench **G** to 35 Nm (25.8 lbf ft) and measure the end float while rotating the shaft.



348040

Drive Head - Assembly (cont'd)

- 9** To select the right size spacer **30**, subtract the end float obtained at step 7 from the solid spacer size (14.20 mm). Also subtract 0.04 mm to allow for theoretical bearing tolerance and pre load. The result is the size of spacer to be fitted from the solid spacer setting kit. If there is no spacer of this size, fit the next nearest size spacer, refer to **Service Tools - Axles**.

Example

Temporary spacer size	14.20
Subtract end-float	0.25
Total	13.95
Subtract tolerance & preload	0.04

Result 13.91

(No spacer available this size, use next nearest size spacer i.e 13.900)

- 10** Remove sleeve **B** and temporary spacer. fit correct size spacer from solid spacer setting kit, refer to **Service Tools - Axles**. During removal take care to avoid damaging the outer bearing.
- 11** Fit sleeve **B**. Tighten adapter **C** to no more than 50 Nm to protect against bearing damage while spacer selection is verified making sure the pinion is free to rotate. Check there is no end float and pinion is free to turn smoothly by hand. Remove adapter **C** and fit nut **16**. Then check that rolling torque is less than 2.0 Nm. If the rolling torque exceeds 2.0 Nm, check that the shaft has been assembled correctly.

Note: If the pinion is not free to rotate check the correct size spacer has been fitted.

- 12** If rolling torque measured at step 10 is too high, fit the next larger size spacer. If rolling torque is too low, fit the next smallest size spacer. If a correct spacer is not available from the range, check that drive head is assembled correctly.
- 13** Remove adapter **C** and sleeve **B**. Fit new oil seal **25**, grease between seal lips before fitting. Fit coupling yoke **23** and NEW stake nut **22**.
- 14** Progressively torque tighten stake nut **22**, occasionally rotating coupling yoke, up to 250 Nm. Providing the correct size spacer has been selected the rolling torque should be between 2.3 and 3.4 Nm including seal drag.

Note: The nut tightening torque can be increased to a maximum of 300 Nm provided that the pinion rolling torque does not exceed the maximum of 3.4 Nm.

- 15** Finally stake the nut **22** into the slot.

- 16** Assemble the trunnion pin **B**, bevel gears **14** and **16** and their thrust washers **15** and **17** into differential half case **13**.

- 17** Position differential half case **12** onto half case **13**, aligning the match-mark letters. Apply JCB Threadlocker and Sealer to the threads of bolts **7**, then fit and torque tighten to 56 Nm (42 lbf ft, 6 kgf m). Check the gears for free rotation.

- 18** Fit crownwheel **20** using new Verbus Ripp bolts **19** tightened to 166 Nm (122 lbf ft, 16.9 kgf m).

Note: Verbus Ripp bolts must not be reused.

- 19** Install the differential assembly **10** onto the drive head carrier **2**.

- 20** Press taper roller bearing cone **9** onto the spigot of case half **13**.

- 21** Fit bearing outer races **7** and **8**, castellated nuts **5** and **6** to the drive head carrier **2**.

- 22** Adjust castellated nuts **5** and **6** to give an increase in input pinion rolling torque of between 1.36 - 2.5 Nm (12 - 22 lbf in) more than that recorded in Step 11.

- 23** Measure the backlash between crownwheel **20** and pinion **24**, which should be 0.17 - 0.28 mm (0.006 - 0.010 in). Adjust castellated nuts **5** and **6** by equal amounts when altering backlash. When backlash and preload are both correct, fit roll pins **3** and **4**.

- 24** Check tooth marking to verify crownwheel and pinion are set correctly, refer to **Crownwheel and Pinion Meshing**.

- 25** Apply JCB Multigasket to the mating faces of drive head carrier **2** and the axle casing. Fit the drive head carrier to the axle casing with the crownwheel towards the short drive shaft. Fit securing bolts **1** and tighten to 166 Nm (122 lbf ft, 16.9 kgf m).

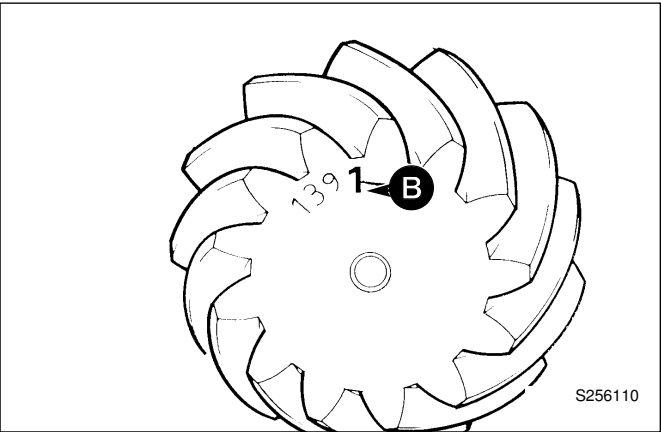
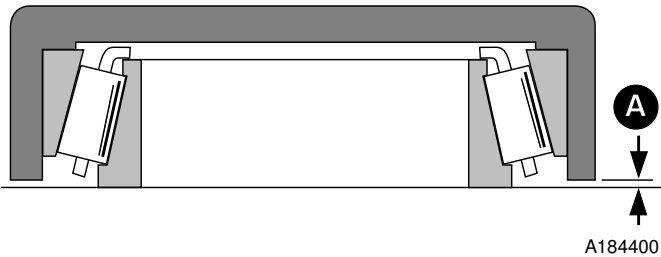
- 26** Reassemble both driveshafts and hub assemblies, refer to **Axle Hub and Driveshaft - Dismantling and Assembly**.

- 27** Re-fill the hubs and differential with the correct grade of oil, refer to Section 3 **Lubricants and Capacities**.

- 28** Refit the propshaft, refer to **Propshafts - Removing and Replacing**.

Pinion Depth Setting

- 1 Place new pinion head inner bearing assembly on a flat surface and position service tool 892/00174 over the bearing. Measure gap **A** (e.g. 0.20 mm) and add this to the cup depth stamped on the tool (e.g. 30.01 mm) to obtain the bearing depth.
- 2 From the face of the pinion, obtain the etched deviation figure **B** (e.g. + 2) which is in units of 0.01 mm. If positive, add this to the bearing depth; if negative, subtract from the bearing depth.
- 3 Obtain the deviation figure **C** (e.g. - 1) stamped on the differential housing bolt flange. If negative, add to bearing depth; if positive, subtract from bearing depth.
- 4 Subtract the total of the above figures from the standard value of 31.19 mm. The result will be the thickness of shims required behind the pinion head bearing cup.

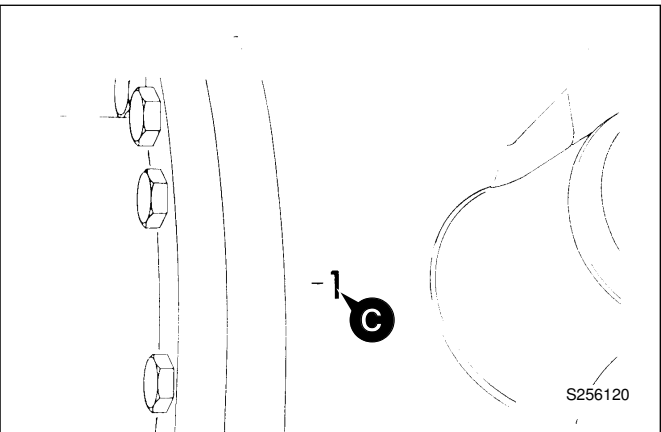


Example (all dimensions in millimetres)

Cup depth	30.01
Gap A	+0.20
Bearing depth	<u>30.21</u>
Pinion deviation B (+ 2)	+0.02
Housing deviation C (- 1)	+0.01
Total	<u>30.24</u>
Standard value	31.19
Less Total above	<u>30.24</u>
Shim Thickness	<u>0.95</u>

Note: In the event that the setting data stamp has been ommited from the drivehead casing, adopt the following setting procedure:

Revise the shim pack size by the difference in setting height marked on the old and new crownwheel pinion sets.

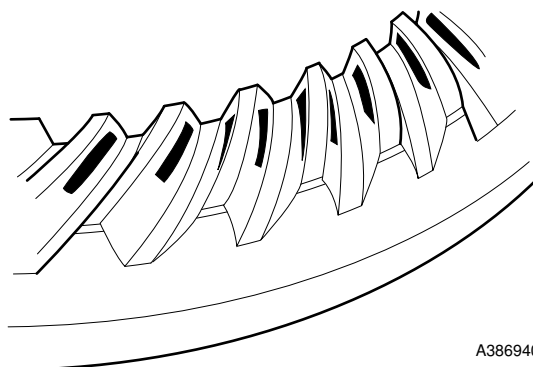


Crownwheel and Pinion Meshing

Meshing of the gears should be checked by marking three of the pinion teeth with engineers marking compound and rotating the pinion.

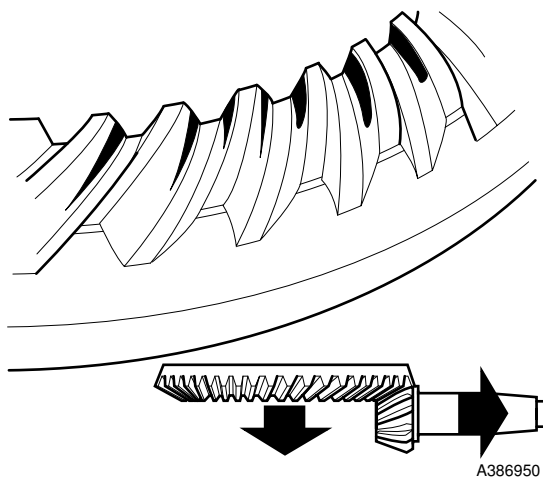
The marking will then be transferred to the crown wheel teeth.

Correct tooth marking.



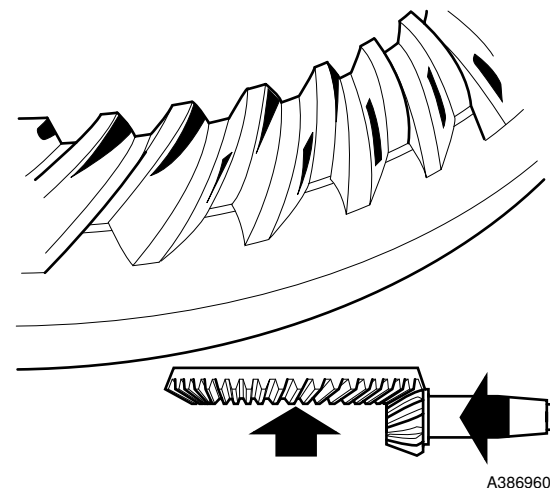
Pinion too deeply in mesh.

Decrease the shim thickness between the pinion inner bearing cup and the axle casing. Move the crown wheel towards the pinion to correct the backlash.



Pinion too far out of mesh.

Increase the shim thickness between the pinion inner bearing cup and the axle casing. Move the crown wheel away from the pinion to correct the backlash.



Removal and Replacement

(2 Wheel Drive Machines)

The removal and replacement procedures for the 2 wheel drive axle (beam type) is the same as described on pages F/80-1 and F/80-2. Dis-regard any information which is not pertinent to the 2 wheel drive axle.

Please note when using a 'cradle' to remove the axle from the machine, the balance point (see step 10, page F/80-2), of the axle on 2 wheel drive machines will be the centre of the axle, NOT offset as described on page F/80-2.

Dismantling and Assembly
(2 Wheel Drive Machines)

When Dismantling

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

A suitable press will be required to remove and replace stub axle **22**.

When Assembling

Fit bushes **18** and **20** with open ends of grease grooves facing the axle beam.

Add shims **16** as required to give zero to 0.1mm (0.004in) clearance between axle beam and bearing **15**.

Apply JCB Lock and Seal to threads of bolt **9**.

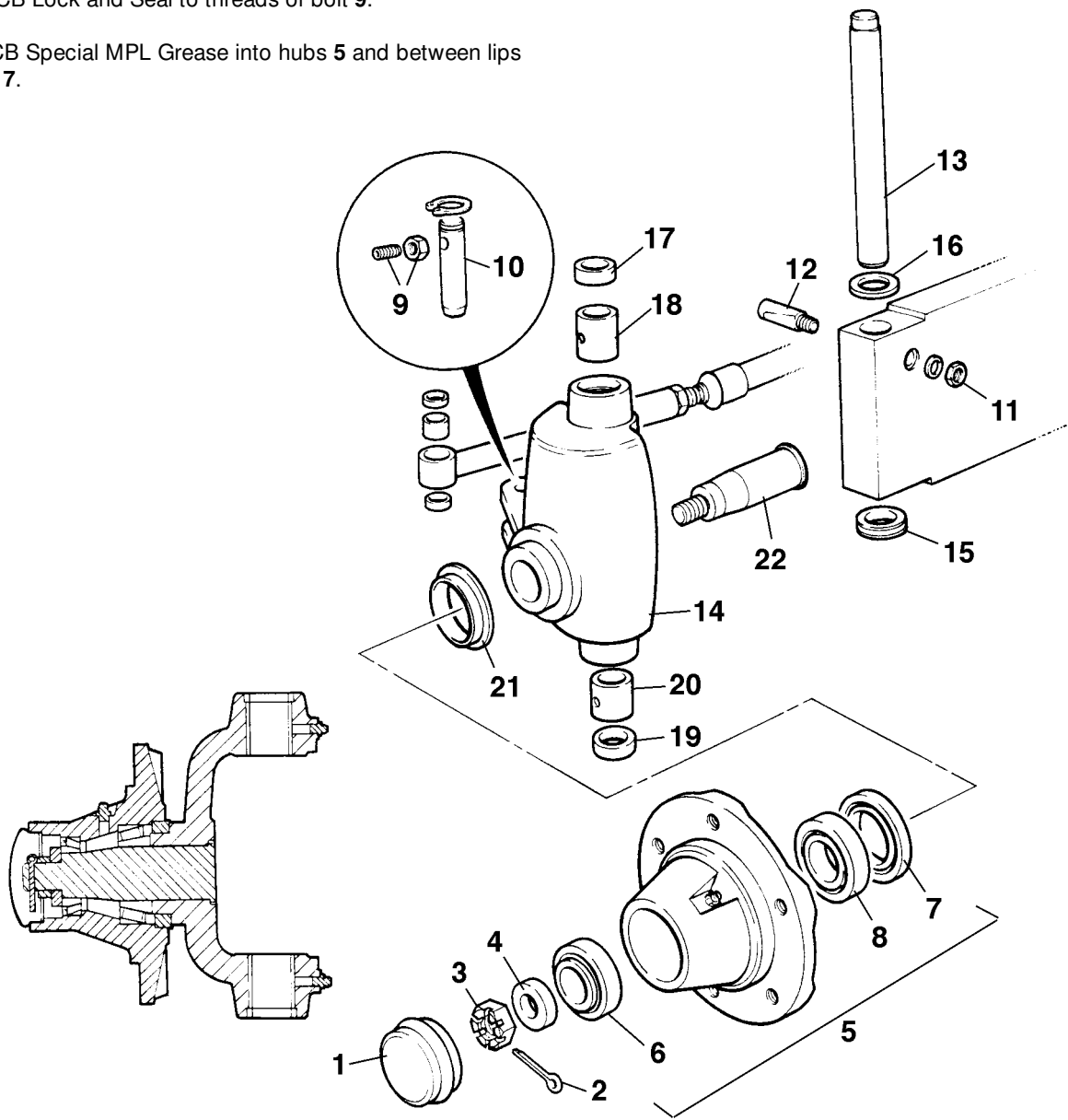
Pack JCB Special MPL Grease into hubs **5** and between lips of seals **7**.

Bed in bearings **6** and **8** by rotating hub in each direction whilst tightening nut **3**. When correct torque setting has been achieved, back off one flat and fit split pin **2**.

Torque Settings

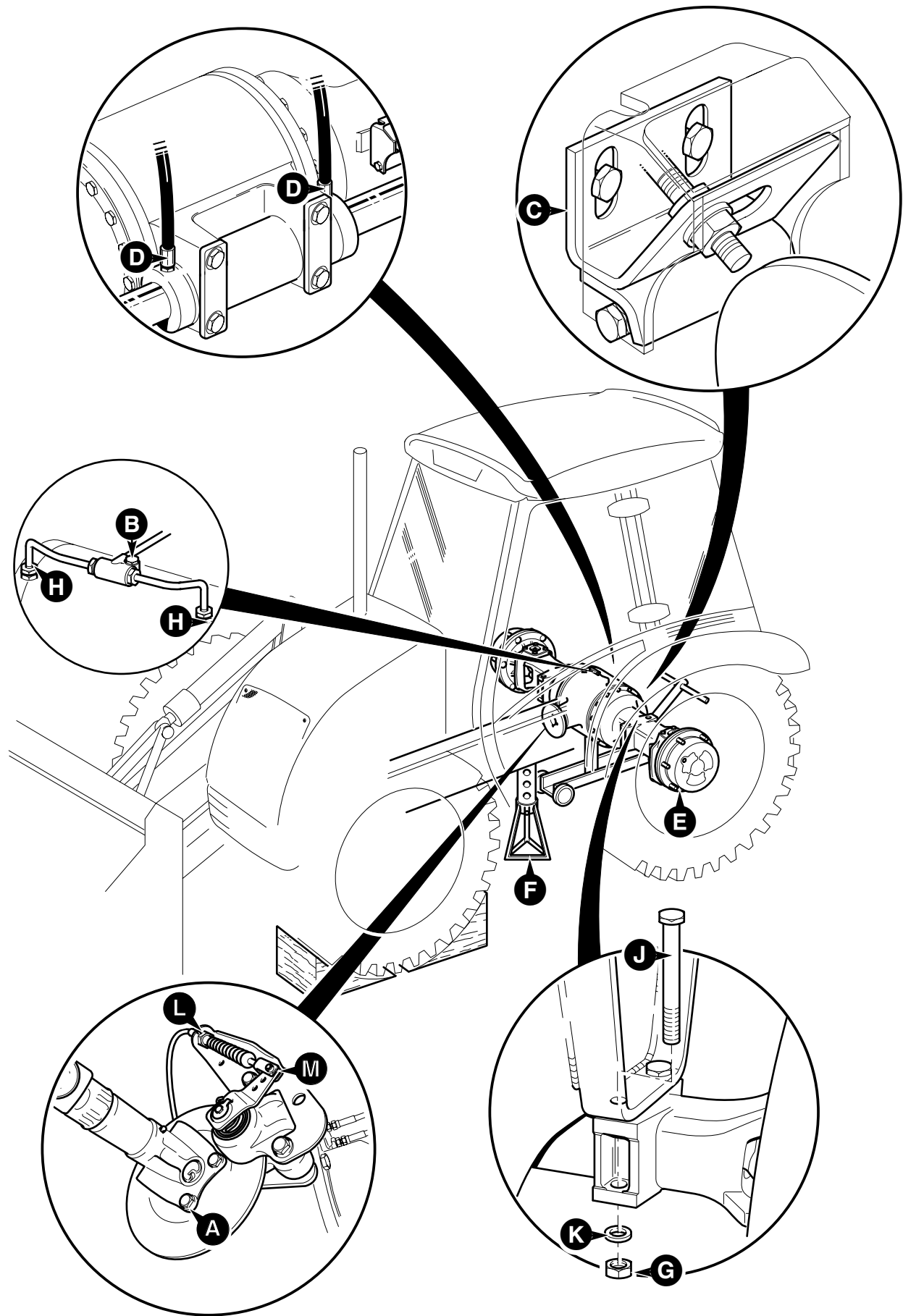
Item	Nm	kgf m	lbf ft
3	40†	4.0†	30†
9	30	3.0	21

†Back off one flat before fitting split pin.



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Removal and Replacement



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Removal and Replacement (cont'd)

 WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN 1-1

Removal

 WARNING

When the propshaft is disconnected the parking brake will no longer function. The machine must be securely chocked to prevent any machine movement before disconnecting the propshaft.

TRAN 1-3

Removing

- 1 Release the parking brake. Loosen the parking brake cable bulkhead nuts at the bracket **L**. Disconnect the cable from the calliper **M**. Tie the cable up, out of harms way.
- 2 Remove bolts **A** to disconnect the drive shaft from the axle.
- 3 Disconnect the brake pipes from the brake piston housings, shown at **H**. Remove tee piece **B** retaining bolt and remove the tee piece. Blank off exposed connections.
- 4 **SD 80 Steer axles only;** Remove the cover **C** from the proximity switch and then remove the bracket and switch assembly.
- 5 **SD 80 Steer axles only;** Label and then disconnect hydraulic pipes **D** from the steer rams, blank off all exposed connections.
- 6 Loosen the road wheel retaining nuts **E**.
- 7 Make sure that the front wheels are blocked, use the stabiliser legs to raise the rear end of the machine with the wheels and tyres clear of the ground.
- 8 Prop the machine on each side as shown at **F**.
- 9 Remove the rear road wheels.
- 10 Position a jack underneath the balance point (centre) of the axle and support the axle weight.

Note: Attach a 'cradle' to the jack that will partially embrace the axle.

- 11 Remove nuts **G**, bolts **J** and washers **K**.

- 12 Lower the jack and remove the axle.

Replacement

Replacement is the reverse of the removal sequence.

 WARNING

If, for whatever reason, a wheel stud is renewed, all the studs for that wheel must be changed as a set, since the remaining studs may have been damaged.

2-3-2-8

Whenever a wheel has been removed, check the wheel nut torques every two hours until they stay correct.

 WARNING

Bleed the brake system before driving the machine.

BRAK 1-6

Bleed the brake system as described in **Section G, Service Procedures**.

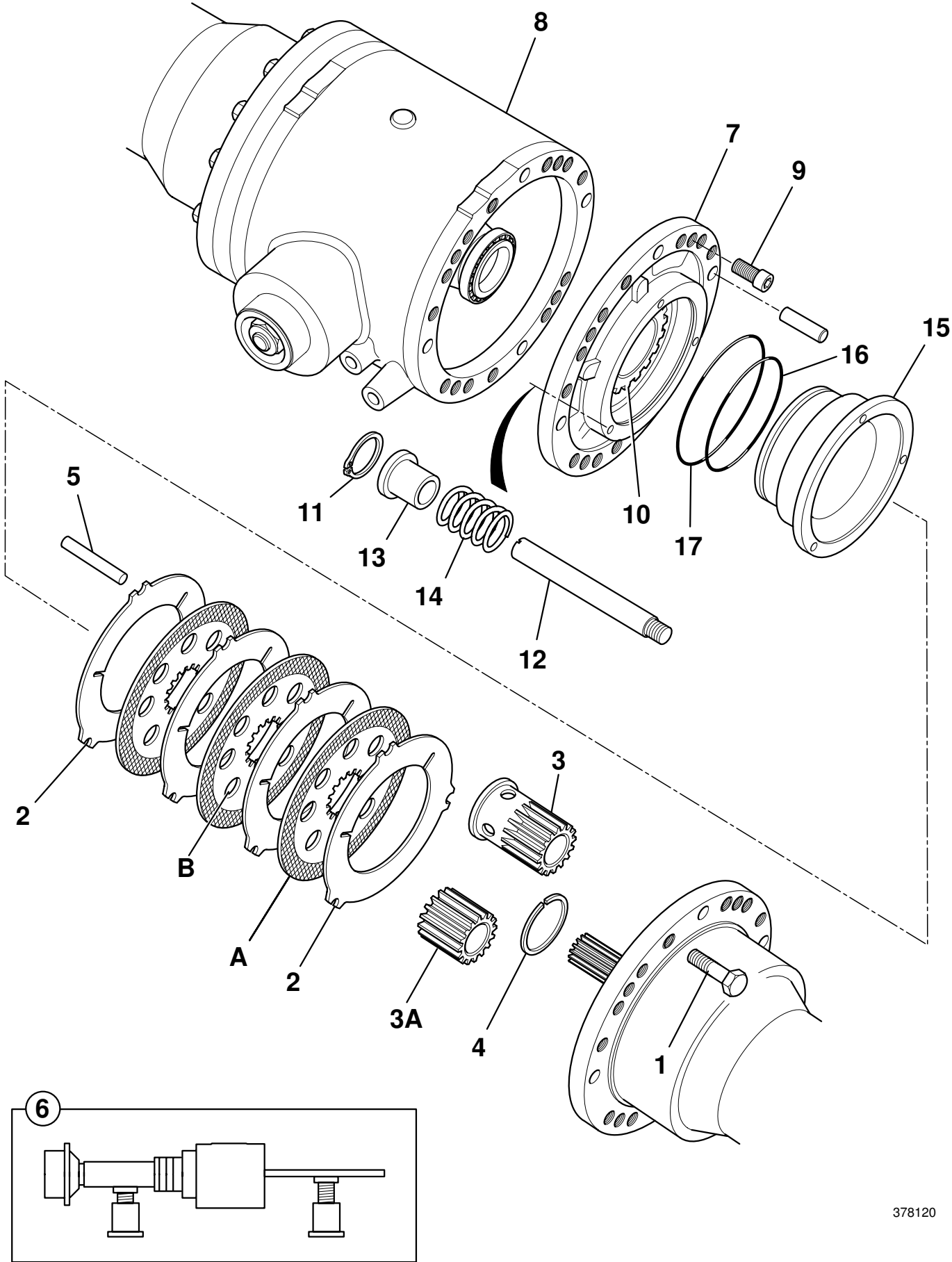
Check and adjust the operation of the parking brake as described in **Section G, Service Procedures**.

Apply JCB Threadlocker and Sealer to the threads of bolts **A**.

SD 80 Steer axles only; If the setting of the steering proximity switch has been disturbed, then complete the rear axle proximity switch setting procedure, as described in **Section H, Service Procedures**.

Torque Settings

Item	Nm	kgf m	lbf ft
A	79	8	58
E	680	69	500
G	607	62	448



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Brakes (with controlled back off)

Axles are fitted with brake controlled back off to maintain a constant clearance of 0.6mm (0.02in) within the brake pack.

It is important that only one side at a time is dismantled to prevent damage to the bearings and preserve the crownwheel and pinion backlash setting.

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN 1-1

Dismantling

- 1 It is recommended that the axle be removed from the machine when dismantling the rear axle brakes.
- 2 Remove bolts 1. Use a heavy duty socket to unscrew them.
- 3 Jack the axle arm off the drive head, using the drive head securing bolts. Remove all traces of gasketing from the mating faces.
- 4 There are two counterplates 2, one at each end of the brake pack, which are not secured to the plate carrier 3. If the plates are to be re-used, note their positions and which way round they are then withdraw the brake pack.
- 5 Remove the circlip 4. If the brake pack is to be re-used, note the positions of the plates before removing them.
- 6 Wear limit of friction plates is to the depth of the cross hatching A. Check all plates for flatness and damage. (Some scoring of the counterplates is normal.) Renew the brake pack complete if worn or damaged. Do not renew individual plates.
- 7 Remove the three reaction pins 5. Inspect for damage.

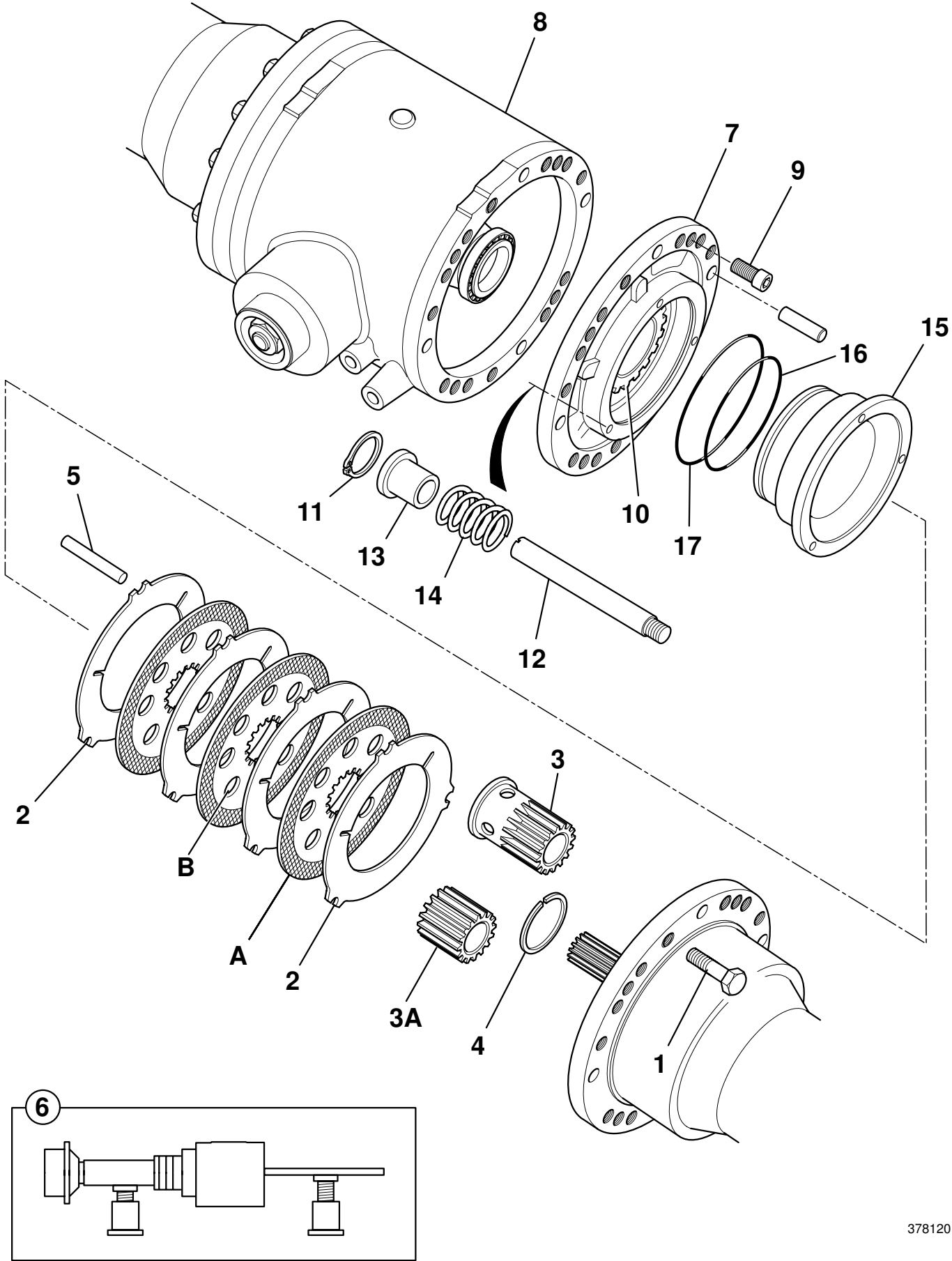
Note: If new brake and friction plates are being fitted new brake back off pins and tension bushes must also be fitted. Failure to do so could result in the brake being permanently on.

- 8 Before removing the brake housing and piston assembly support the differential with a drive shaft or other suitable support, as shown at 6.

- 9 Match mark the brake piston housing 7 and the drive head. Undo four capscrews 9 and remove the brake housing and piston assembly.

Note: Do not disturb nut 10 otherwise the bearing pre load will have to be reset.

- 11 Remove circlips 11, remove back off pins 12, tension bushes 13 and springs 14.
- 12 Remove brake piston 15 from brake housing 7.
- 13 Remove and discard seals 16 and 17. Inspect the housing bore for damage and scoring. Nicks or cuts in the seals may be responsible for loss of brake fluid.



Brakes (with controlled back off) continued

Assembly

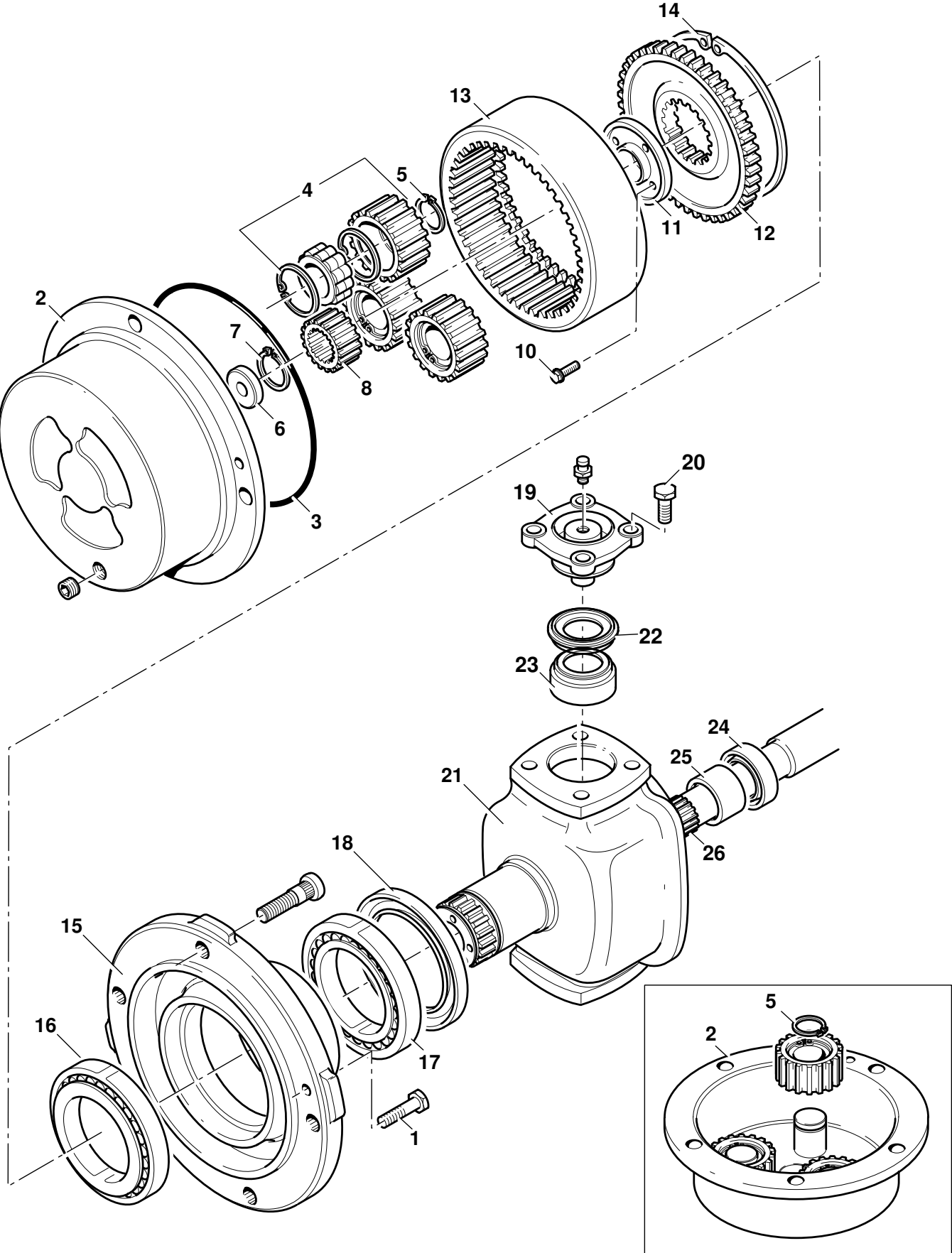
- 1 Clean all sealant from the mating faces of the drive head and the brake piston housing.
- 2 Fit new seals **17** and **16**. Make sure they seat squarely in their grooves.
- 3 Carefully press the piston **15** all the way into its housing **7**. Make sure the brake back off holes in the piston and housing align.
- 4 Apply JCB Threadlocker and Sealer to threads of back off pins **12**. Screw the back off pins **12** into the brake piston and fit the springs **14** over the back off pins.
- 5 Place the tension bush **13** over the back off pin **12**. Using a suitable tool (steel tube) drive the tension bush onto the back off pin using a soft face hammer until the circlip **11** can just be fitted.
- 6 Apply JCB High Strength Gasketing to the drive head mating face, then fit the brake piston housing assembly. Ensure that the match marks made during dismantling are aligned.
- 7 Fit capscrews **9** and torque tighten to 56 Nm (42 lbf ft, 5.7 kgf m).
- 8 Remove the differential support.
- 9 Assemble the friction plates and counterplates **2** onto the brake carrier **3**. If the original brake pack is being re-used, return the plates to their original positions, see 'Dismantling'. Soak new friction plates in JCB Special Gear Oil before assembly. Fit circlip **4**.

On assembly of the brake packs, the oil flow holes **B** must be aligned with each other when being fitted to the brake plate carrier.
- 10 Locate the three reaction pins **5** into their grooves, securing them with grease. Push the pins fully into their location holes in the housing.
- 11 Install one counterplate **2** into the housing, then the brake pack, then the other counterplate. Return re-used counterplates to their original positions. Push the brake pack fully home.
- 12 Apply JCB High Strength Gasketing to the mating face of the drive head, and JCB Threadlocker and Sealer to the threads of bolts **1**. Locate the axle arm onto the drivehead, with the embossed word 'TOP' on the axle arm uppermost.
- 13 Fit bolts **1** and torque tighten.

Note: Check the grade of bolts fitted. Grade 8.8 should be tightened to 244 Nm (178lbf ft, 24.9 kgf m), grade 12.9 should be tightened to 400 Nm (295 lbf ft, 40.8 kgf m).

Note: Item **3A** is fitted to non steer axles.

Note: The illustration is typical only, refer to parts book or General Bulletin 061 (G20/N.Am) for exact number of friction and counter plates.



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Hub - Dismantling

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN 1-1

- 1 Disconnect power track rod. Drain oil from hub.
- 2 Remove screws 1.
- 3 Lever off the planet gear carrier 2 at the levering points. Remove and discard the 'O' ring 3.
- 4 Remove planet gears 4 only if defective. Note that gears can only be removed as assemblies, which comprise the gear, the bearing and two 'L' shaped circlips. To remove a planet gear, first remove the external circlip 5.
- 5 Pull off the planet gear assembly 4.
- 6 The driveshaft thrust pad 6 is drilled and tapped M6 for removal purposes.
- 7 Remove circlip 7 to allow the sun gear 8 to be slid off the drive shaft.
- 8 Remove Verbus Rip bolts 10. These bolts are very tight and care must be taken not to distort the bolt heads. Use as short an extension bar as possible with a six sided socket. Discard the bolts after removal.

Note: Fretting between the hub swivel and annulus carrier mating faces might be evident; this condition is normal, do not attempt to repair.

If the hub swivel and annulus carrier are to be renewed they must be renewed as a pair, not individually

- 9 Remove retaining plate 11.
- 10 Mark the relationship between the annulus carrier, annulus ring and hub swivel, remove the annulus carrier 12 with annulus ring 13.
- 11 Remove circlip 14 to separate the annulus ring 13 from the annulus carrier 12.
- 12 Pull off the bearing carrier 15 together with the outer bearing 16.
- 13 Pull off the inner bearing 17.

- 14 Remove and discard combination oil seal 18.

- 15 Mark the position of top and bottom trunnions 19, undo bolts 20 and remove trunnions 19. Withdraw the hub carrier 21.

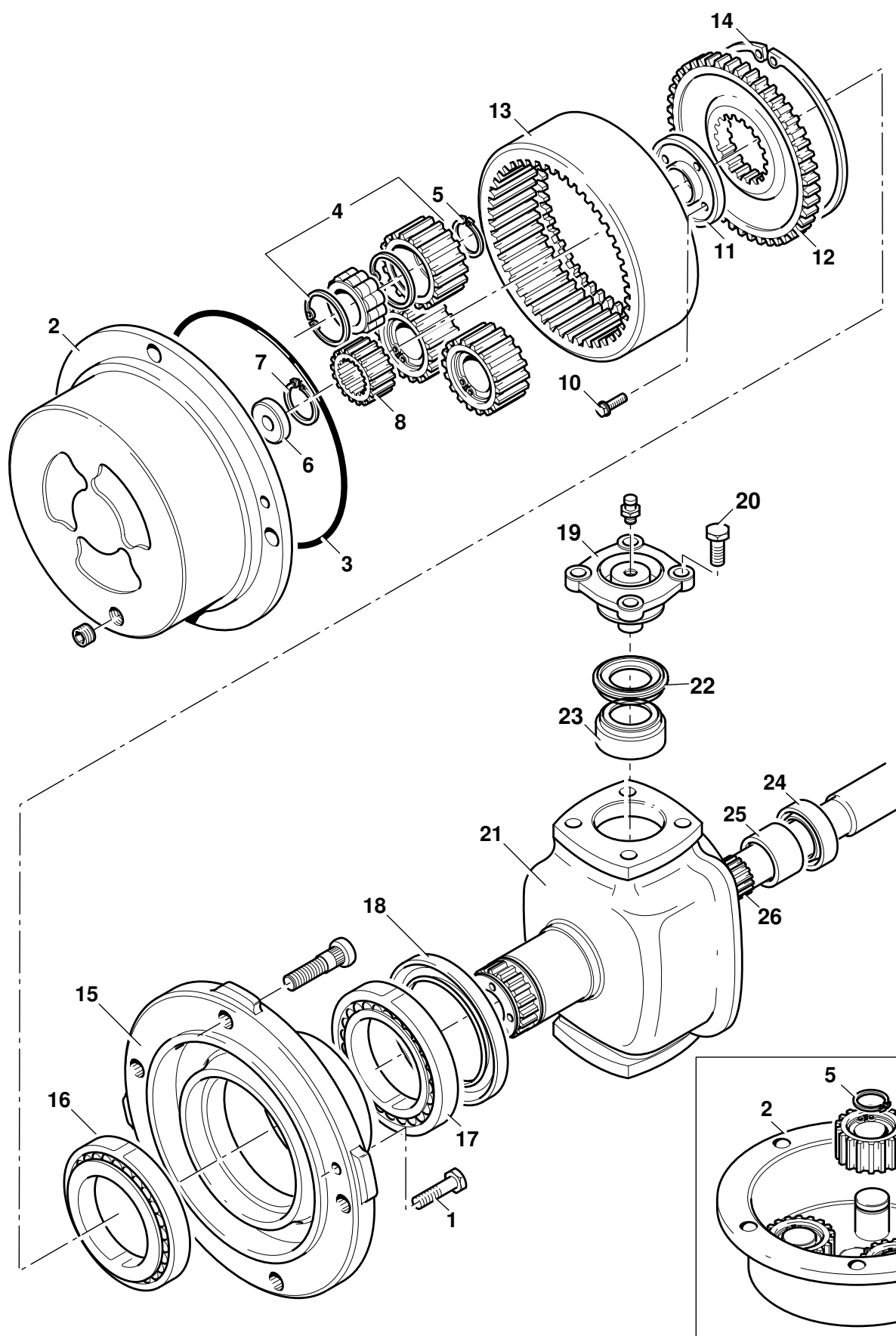
Note: Trunnions may be removed easily by pumping grease through the grease nipple.

- 16 Using a puller, remove the trunnion seal 22 and bearing 23.

- 17 Remove seal 24 and needle roller bearing 25 from hub carrier 21.

Note: Seal and needle roller bearing may be left on drive shaft. Production axles may be fitted with foam 'masking rings'. These are used to protect the shaft from paint during axle spraying. The rings can be removed and discarded.

- 18 Withdraw drive shaft 26.



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Hub-Assembly

- 1 Fit drive shaft **26** inner end into splines of differential gears.
- 2 Fit needle roller bearing **25** and seal **24** into hub carrier **21**. Pack grease between the lips of seal **24**.

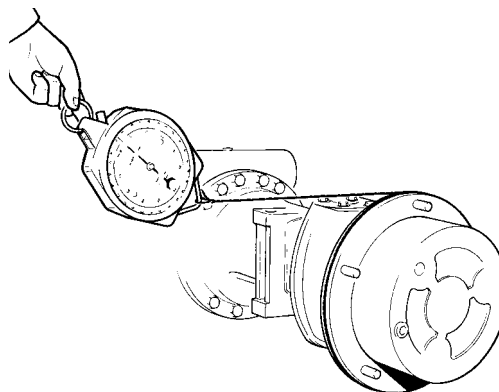
Note: Do not force fit bearing **25** and make sure the manufacturer's mark is facing out.

- 3 Locate hub swivel, aligning relationship lines, assemble top and bottom trunnions **19** together with trunnion seal **22** and bearing **23**. Apply Threadlocker and Sealer to the threads of bolt **20**, torque tighten trunnion retaining bolts **20** to 98 Nm (72 lbf ft).
 - 4 Lightly oil the inner wheel bearing race. Assemble the bearing cup and bearing race **17** into the bearing carrier **15**.
 - 5 Fit a new combination seal **18** into the bearing carrier **15** so that the chamfer faces the hub swivel. Do not disassemble seal or use excessive force when fitting. Do not lubricate before fitting. Use service tool (892/00891) and spacer to drive the seal squarely into the carrier until flush.
 - 6 Lightly oil the outer wheel bearing race. Assemble the bearing cup and bearing race **16** into the bearing carrier **15**. Fit bearing carrier assembly onto axle stub.
- Note:** The bearing carrier must be fully supported during the fitting operation; do not allow any weight to rest on the bearings, otherwise the inner bearing will be displaced and damage the seal.
- 7 Align relationship marks made on dismantling. Assemble the annulus ring **13** to the annulus carrier **12**. Secure with circlip **14**.
 - 8 Fit annulus assembly in the same angular position as removal, fit retaining plate **11** using new bolts **10**. Do not fully tighten bolts but allow the bearing carrier to rock slightly.

Note: Steps 10 to 12 describe measurement of rolling force. To measure rolling torque (simplified process), a special tool is required. See **Service Tools** in this section.

- 9 Measure seal drag rolling force as follows:

- a Refit the planet gear carrier **2** - DO NOT FIT THE SUN GEAR **8**.
- b Use a spring balance and cord wrapped around planet gear carrier **2** as shown. Pull the spring balance so that the hub rotates, do several times to let the seal bed in and record the reading. Remove planet gear carrier **2**.



- 10 Torque tighten bolts **10** evenly to 166 Nm (122 lb ft, 17 kgf).
- 11 Measure the rolling force as follows:
 - a Refit the planet gear carrier **2** - DO NOT FIT THE SUN GEAR **8**. Use a spring balance and cord wrapped around the planet carrier as shown. Pull the spring balance so that the hub rotates and record the reading.
 - b To get the rolling force, subtract seal drag rolling force (see step **9**) from reading obtained at this step, the result should be 64 to 117N (14 to 26 lbf).
 - c If the resulting figure is outside these limits, check: the seal is fitted correctly; and/or renew bearings if necessary; and/or new fitted components. Remove planet gear carrier **2**.
- 12 Press the drive shaft thrust pad **6** (chamfered side lowermost) into the recess in the planet carrier **2**.
- 13 Fit new planet gears **4** in place of any that were removed.
- 14 Slide the sun gear **8** (chamfer to be inboard) onto the drive shaft **26** and secure with circlip **7**. Fit a new 'O' ring **3** in place of the one discarded during dismantling.
- 15 Fit the planet carrier **2** onto the bearing carrier **15** ensuring that the two tapped holes are in line with those on the bearing carrier. Fit and tighten screws **1** after applying Threadlocker and Sealer to the threads. Torque tighten screws to 56 Nm (41 lb ft).
- 16 Fill hubs with correct grade oil.

Hub-Dismantling & Assembly

The procedures for dismantling and assembling the hub on a PD70 axle are virtually the same as for a SD80 axle - described on the previous pages (F/92-1 to F/92-4).

However, note that the wheel bearing carrier (shown as item **15** on page F/92-1) is mounted directly on to the axle arm. Disregard references to the hub carrier (shown as item **21** on page F/92-1).

Drive Head-Dismantling

As the drivehead cannot be dismantled whilst fitted on the machine, we recommend that the complete axle is removed. See **Brakes** and **Hub and Driveshaft** for axle arm removal procedure.

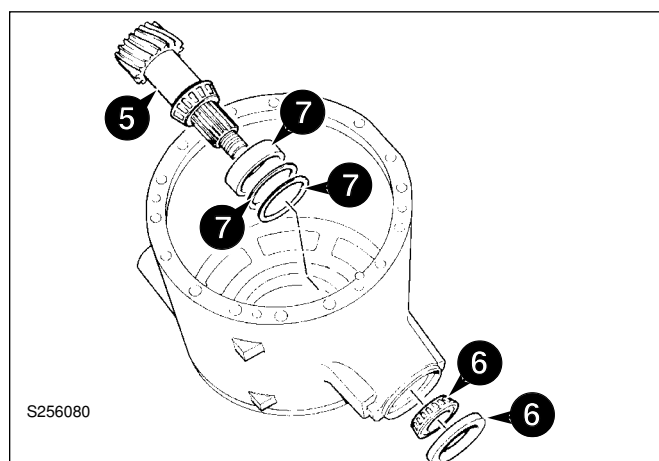
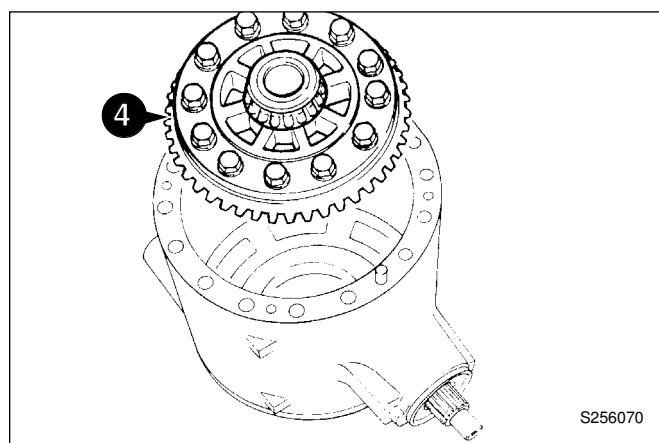
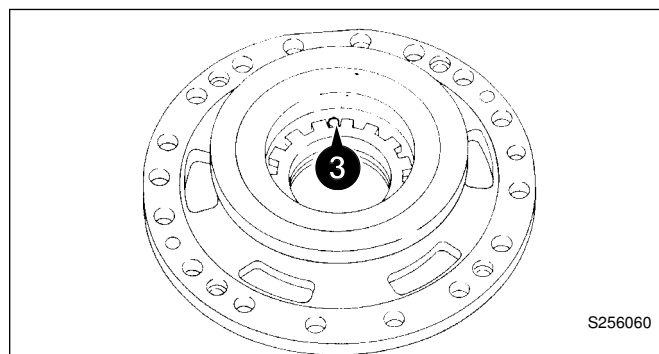
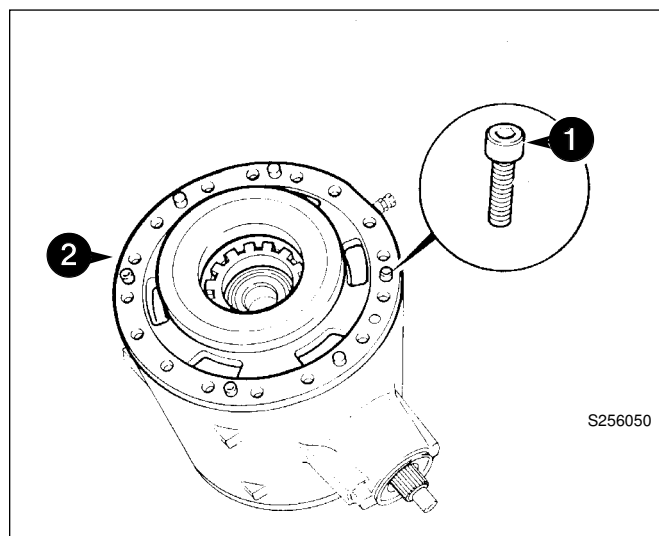
The crownwheel and pinion are matched and should be renewed as a pair if either one is damaged or excessively worn. The two differential case halves are also matched as are the differential side gears and planet gears, do not use unmatched halves or gears.

- 1 Position the drive head as shown, with the crownwheel at the top.
- 2 Match - mark the brake piston housing and drive head. Pull off the brake piston housing.
- 3 Drive out the differential side nut locking pin, to allow readjustment on assembly. Remove the other brake piston housing only if damaged, but remove its locking pin regardless (to allow sideload adjustment on assembly).

- 4 Lift out the crownwheel/differential assembly.

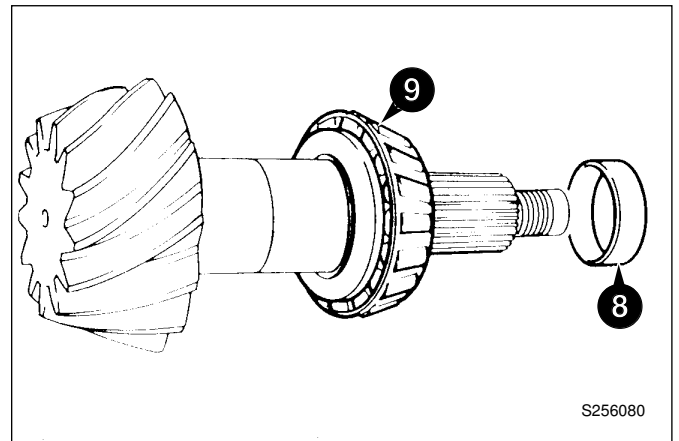
Note: If both brake piston housings are to be removed, mark the crownwheel end of the drive head casing to ensure that the assembly is returned to its original position.

- 5 Using a soft faced hammer, hit the pinion end shaft until the pinion is free from its front bearing, then withdraw the pinion.
- 6 Withdraw the pinion seal and outer bearing cone.
- 7 If necessary, drive out the pinion inner bearing cup and shims. Discard the shims. Repeat for the outer bearing cup if required. Note that there are no shims for the outer bearing cup.

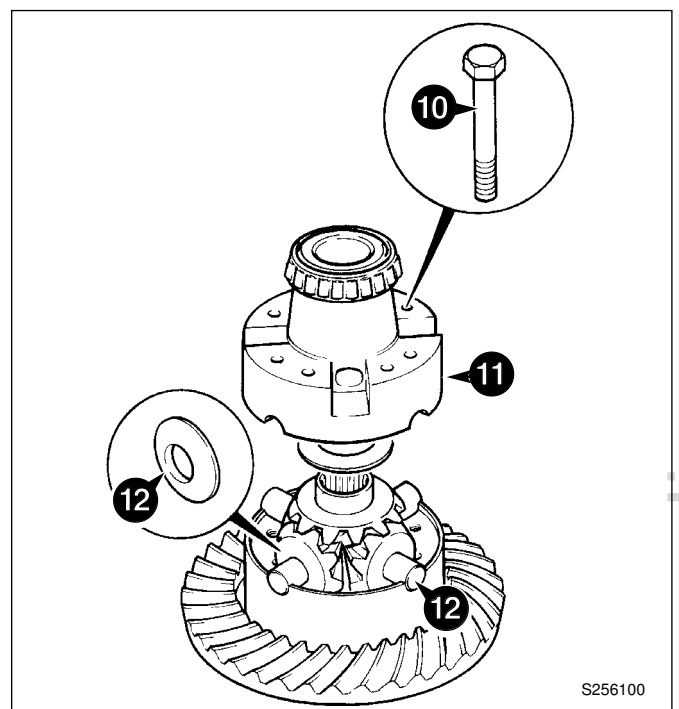


Drive Head-Dismantling (cont'd)

- 8 Remove the pinion spacer.
- 9 Pull off the bearing cone.



- 10 To dismantle the differential assembly, first remove bolts.
- 11 Lift off the top half housing.
- 12 Remove the differential gears and spherical washers. Pull off both differential bearing cones.



Drive Head-Assembly

Pinion Depth

Determine the pinion depth setting as follows:

Note: See page **Crownwheel and Pinion** for general guidance on crownwheel and pinion adjustment.

- 1 Assemble the pinion inner bearing and its cup on a flat surface.
- 2 Place Service Tool 892/00174 over the bearing assembly. Measure gap **A**. Add tool depth (30.01 mm) to gap **A** to give bearing depth.
- 3 Note the mounting distance figure **B** etched on the pinion and the deviation figure **C** on the drive head housing. Both figures are in units of 0.01 mm.

Note: The pinion depth may be etched on the gear face **B** or on the rear of a gear tooth **D**.

- 4 If dimension **B** is **positive**, **add** it to the bearing depth. If dimension **B** is **negative**, **subtract** it from the bearing depth.
- 5 If dimension **C** is **positive**, **subtract** it from the total. If dimension **C** is **negative**, **add** it to the total.
- 6 Subtract the result from the standard value of 31.19 mm to give the required shim thickness.

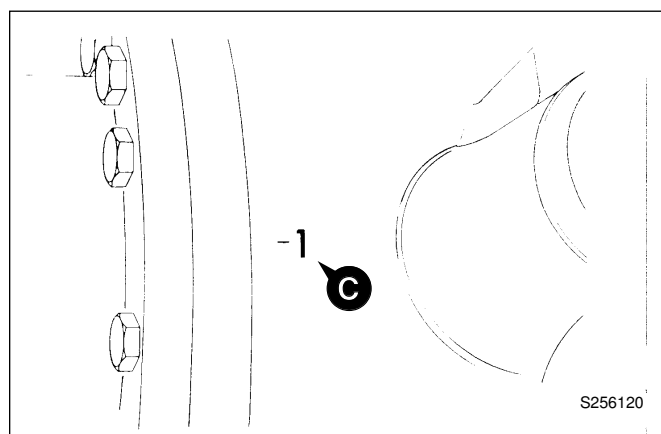
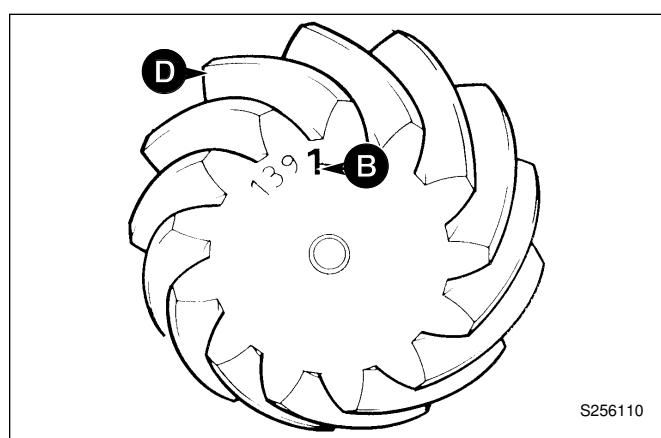
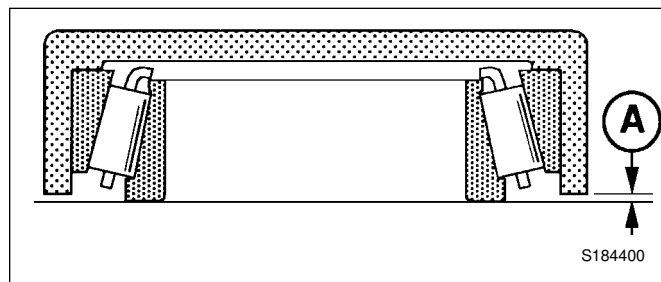
Example (Dimensions in mm)

Dimension A	0.25
Add tool depth	+ 30.01
Total	30.26

Add dimension B if positive. (Subtract if negative.)	+ 0.01
Total	30.27

Add dimension C if negative. (Subtract if positive.)	+ 0.01
Total	30.28

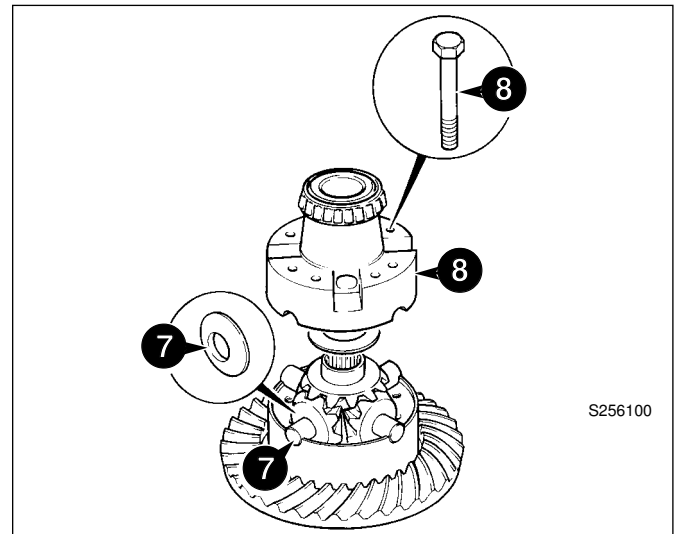
Standard Value	31.19
Less calculated total from above	- 30.28
SHIM THICKNESS	0.91



Drive Head-Assembly (cont'd)

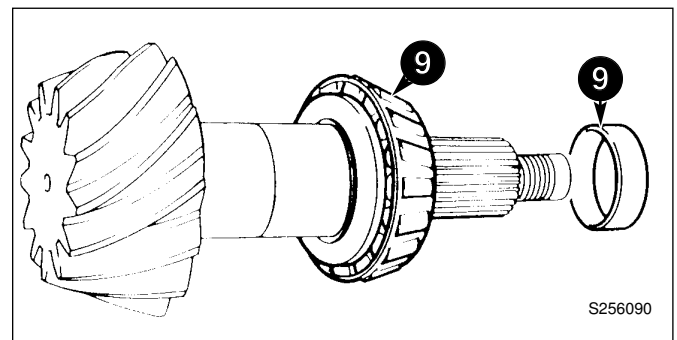
Note: The crown wheel and pinion are matched and should be renewed as a pair if either one is damaged or excessively worn. The two differential housing halves are also matched. Do not use unmatched halves. If required, fit a new crownwheel to the differential case half, torque tighten crownwheel retaining bolts to 166 Nm 122 lbf ft; 17 kgf m).

- 7 Assemble the differential gears and their spherical washers into the bottom half housing. Fit the differential bearing cones.
- 8 Position the top half housing onto the differential, aligning the match mark letters (see Note above). Apply JCB Threadlocker & Sealer to the threads of bolts, then fit and torque - tighten to 56 Nm (42 lbf ft, 6 kgf m). Check the gears for free rotation.

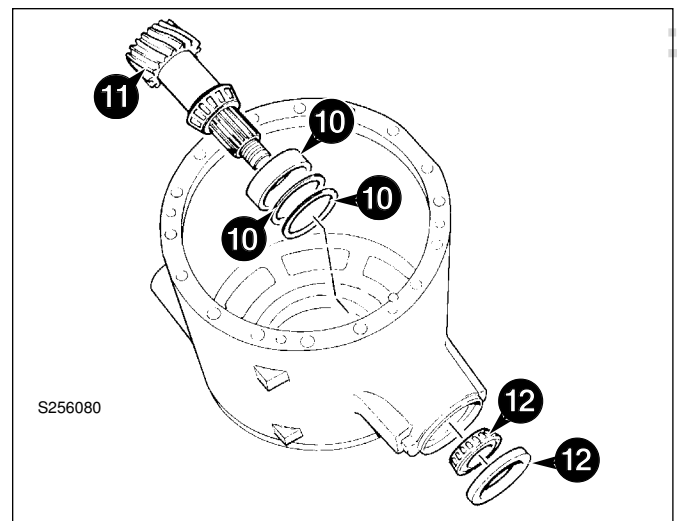


- 9 Fit the pinion inner bearing cone and the largest available spacer (e.g. 14.20 mm)

Note: It should be noted that the axle should be assembled using a solid spacer. However, in the absence of the special tools required or the correct size solid spacer it is acceptable to fit a collapsible spacer, refer to **Axles, Collapsible Spacer Assembly**.



- 10 Fit the pinion inner bearing cup, together with the required thickness of shims to give correct pinion depth, see Pinion Depth, steps 1 to 6. To ensure the cup is fitted square, use a suitable puller assembly. Do not use a hammer. Fit the outer bearing cup.
- 11 Insert the pinion into its bore. (Before inserting, ensure that the pinion matches the crownwheel. The code numbers etched on the pinion end face and the crownwheel perimeter should be the same.
- 12 Fit the pinion outer bearing cone. Do not fit the oil seal at this stage.



Drive Head-Assembly (cont'd)

- 13 Fit special tool sleeve **B** and special pinion shaft adapter **C**. Tighten adapter **C** to approximately 50 Nm, making sure the pinion is free to rotate and there is end float, this will prevent any damage to the bearing. If the pinion is not free to rotate or there is no end float at this stage check the bearing is fitted correctly. Also check the correct size spacer has been fitted.
- 14 Fit special bracket **D** to the drive-head housing using two M10 x 30 nuts and bolts. Fit special tool support pillar **E** to bracket **D** so that the fork end engages in adapter **C**. Ensure that fork **E** is centrally located on adapter **C**. If necessary, re-align bracket **D** to suit. Fit dial test indicator (DTI) **F**. Ensure that the DTI is mounted on the drive head and not on bracket **D**.
- 15 Set torque wrench **G** to 35 Nm (25.8 lbf ft) and measure the end float while rotating the shaft.
- 16 To select the right size spacer, subtract the end float obtained at step 14 from the solid spacer size (14.20 mm). Also subtract 0.04 mm to allow for theoretical bearing tolerance and pre load. The result is the size of spacer to be fitted from the solid spacer setting kit. If there is no spacer of this size, fit the next nearest size spacer, refer to **Service Tools - Axles**.

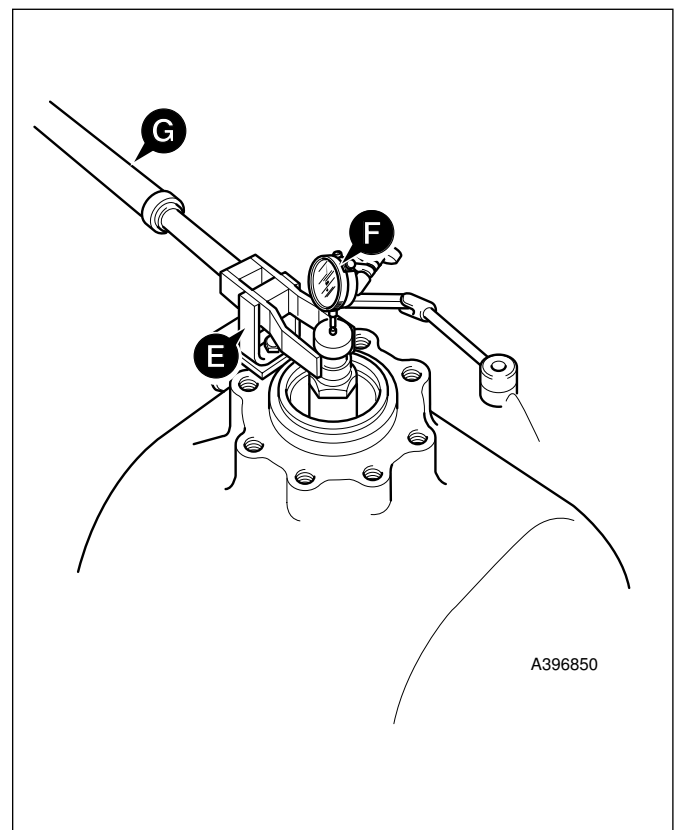
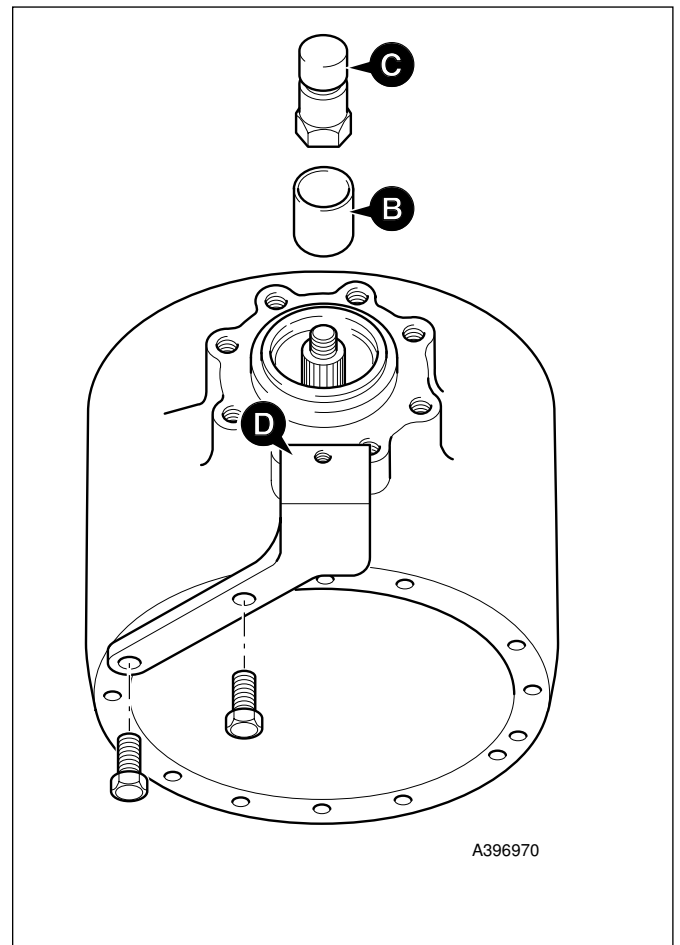
Example

Temporary spacer size	14.20
Subtract end-float	0.25
Total	13.95
Subtract tolerance & preload	0.04

Result 13.91**(No spacer available this size, use next nearest size spacer i.e 13.900)**

- 17 Remove sleeve **B** and temporary spacer. fit correct size spacer from solid spacer setting kit, refer to **Service Tools - Axles**. During removal take care to avoid damaging the outer bearing.
- 18 Fit sleeve **B**. Tighten adapter **C** to no more than 50 Nm to protect against bearing damage while spacer selection is verified making sure the pinion is free to rotate. Check there is no end float and pinion is free to turn smoothly by hand. Remove adapter **C** and fit nut **16**. Then check that rolling torque is less than 2.0 Nm. If the rolling torque exceeds 2.0 Nm, check that the shaft has been assembled correctly.

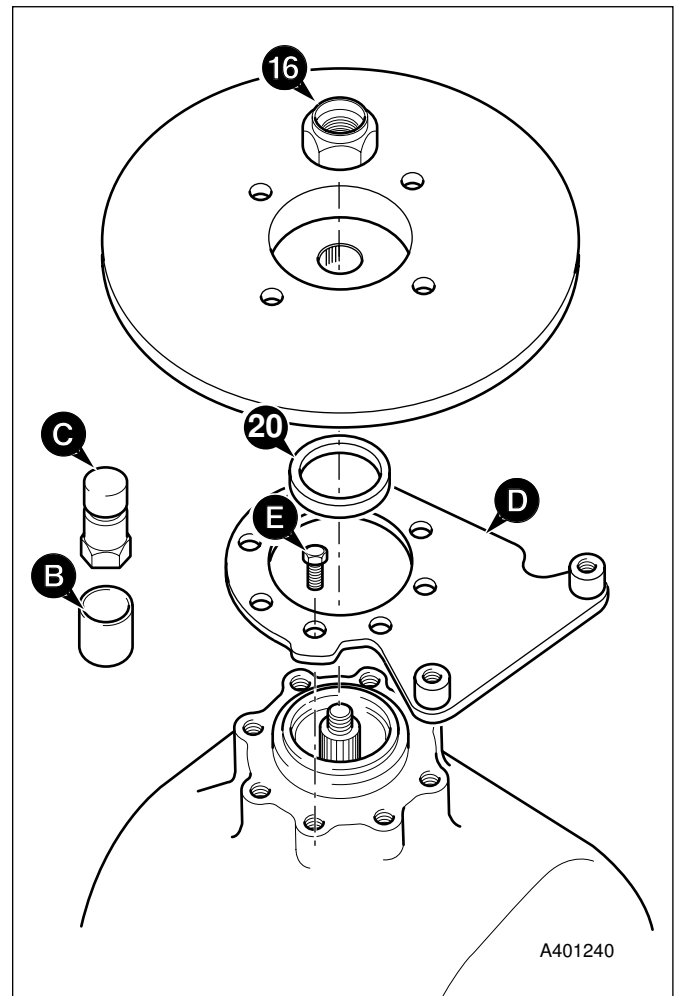
Note: If the pinion is not free to rotate check the correct size spacer has been fitted.



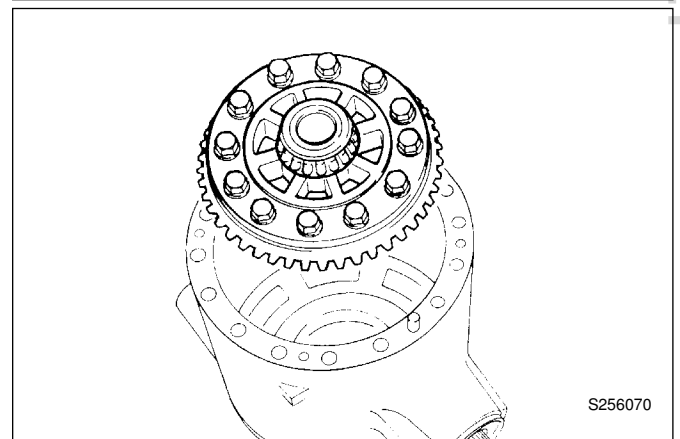
- 19** If rolling torque measured at step 18 is too high, fit the next larger size spacer. If rolling torque is too low, fit the next smallest size spacer. If a correct spacer is not available from the range, check that drive head is assembled correctly.
- 20** Remove adapter **C** and sleeve **B**. Fit a new oil seal, grease between seal lips before fitting. Fit the brake calliper bracket **D**. Apply JCB Threadlocker and Sealer to the fixing bolts **E**. Fit the brake disc/coupling and a NEW stake nut **16**.
- 21** Progressively torque tighten the stake nut, occasionally rotating coupling yoke, up to 250 Nm. Providing the correct size spacer has been selected the rolling torque should be between 2.3 and 3.4 Nm including seal drag.

Note: The nut tightening torque can be increased to a maximum of 300 Nm provided that the pinion rolling torque does not exceed the maximum of 3.4 Nm.

- 22** Finally stake the nut **16** into the slot.

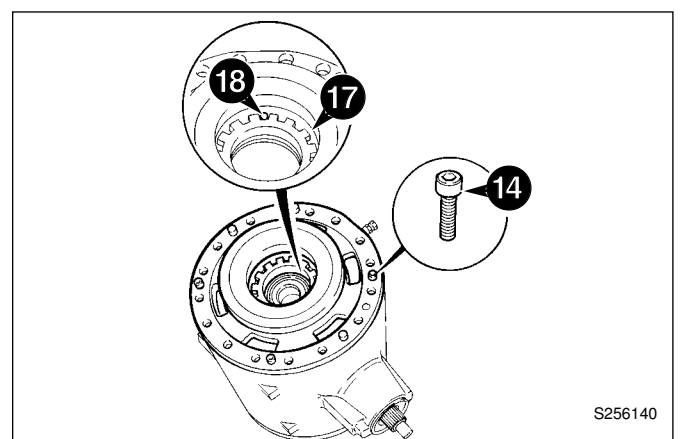


- 23** If both brake piston housings were removed, fit the one at the opposite end to the crownwheel, using the procedure in Step 24. Then install the crownwheel/differential assembly into the drive head.

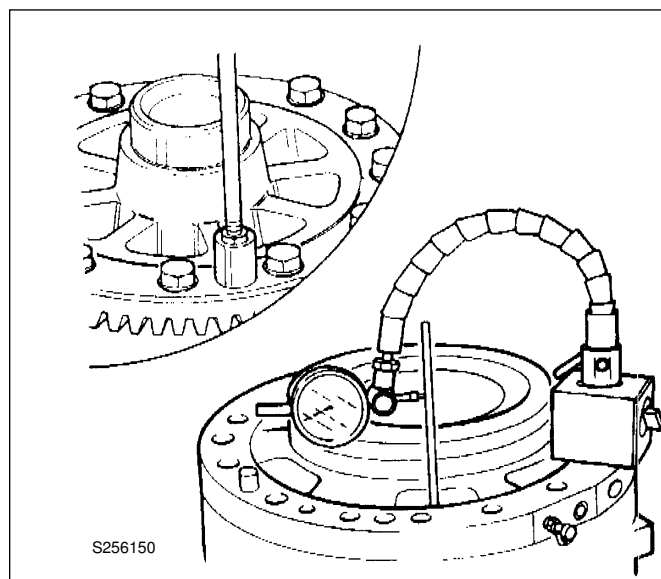


- 24** Apply JCB Multi-Gasket to the drive head mating face, then fit the brake piston housing. Ensure that the match - marks made during dismantling are aligned. Fit capscrews. Torque - tighten to 56 Nm (42 lbf ft, 5.7 kgf m). (Applies to both piston housings.)

- 25** Adjust differential side nuts to give a bearing preload of 1.13-2.26 Nm (0.8-1.6 lbf ft; 0.1-0.2 kgf m). (Measure the preload by taking another rolling torque reading and subtracting the torque figure measured at step 21. The difference is the bearing preload.)



- 26** Measure the crownwheel backlash, which should be 0.17-0.28 mm (0.006-0.010 in). Adjust the differential side nuts by equal amounts when altering backlash. When backlash and preload are both correct, fit the sidenut locking pins, see step 25.

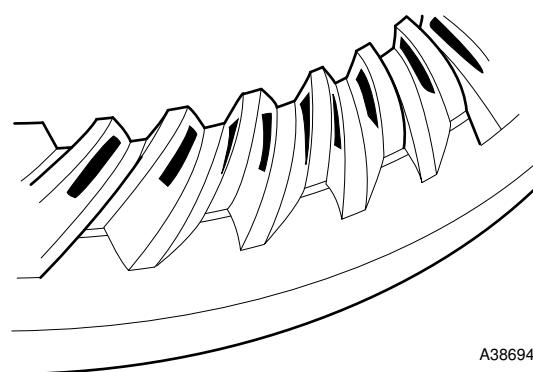


Crownwheel and Pinion Meshing

Meshing of the gears should be checked by marking three of the pinion teeth with engineers marking compound and rotating the pinion.

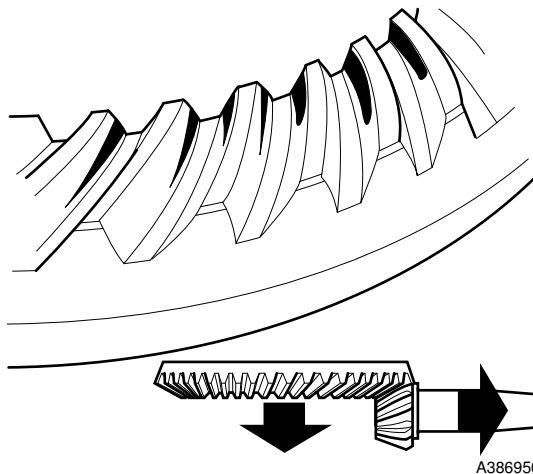
The marking will then be transferred to the crown wheel teeth.

Correct tooth marking.



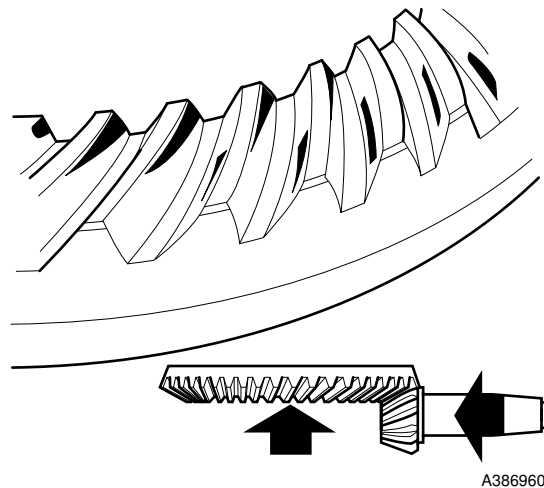
Pinion too deeply in mesh.

Decrease the shim thickness between the pinion inner bearing cup and the axle casing. Move the crown wheel towards the pinion to correct the backlash.



Pinion too far out of mesh.

Increase the shim thickness between the pinion inner bearing cup and the axle casing. Move the crown wheel away from the pinion to correct the backlash.



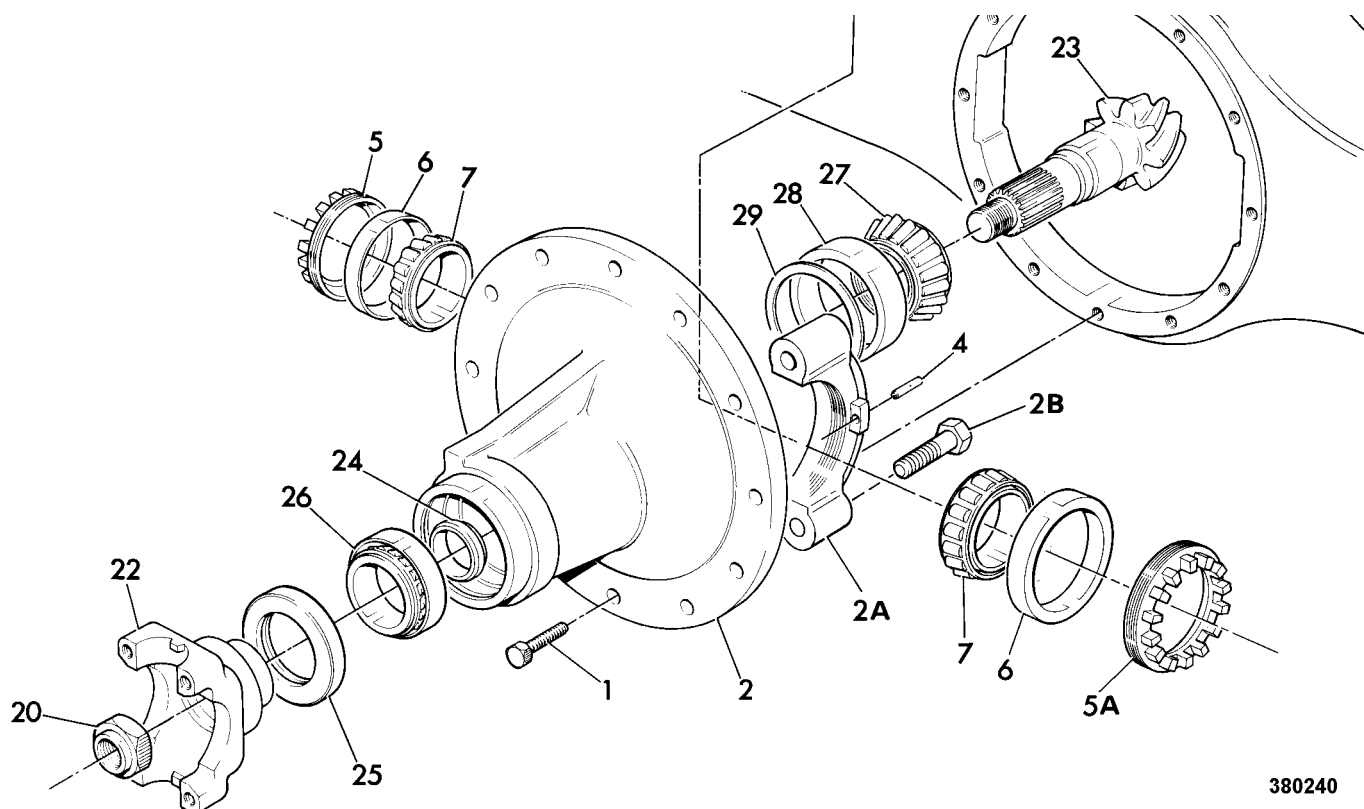
Collapsible Spacer Assembly

When assembling the axle, if the special tools listed in the **Service Tools - Axles** section or if the correct size solid spacer is not available it is acceptable to fit a collapsible spacer using the procedure below. The illustration shows a typical axle, note that rear axles are fitted with a brake disc, not the yoke 22 shown.

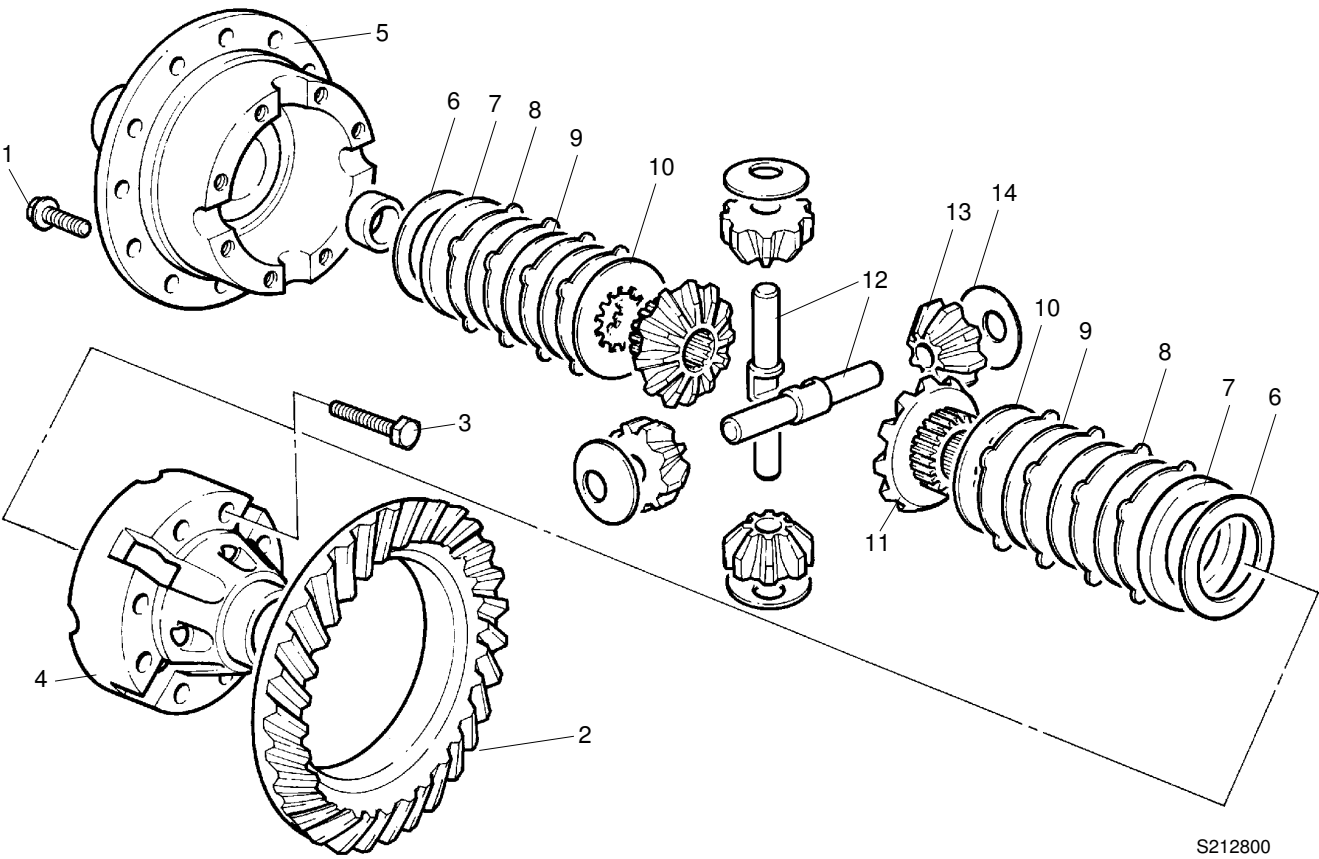
- 1 Smear output shaft inner bearing **27** with JCB HP Grease before refitting. Fit bearing cup **28** over pinion shaft **23** and assemble into drive head casing.
- 2 Fit NEW collapsible spacer **24**, after smearing with JCB HP Grease fit outer bearing **26** followed by a new oil seal **25**. Grease between seal lips before fitting. Assemble yoke **22** and NEW stake nut **20** with integral washer.
- 3 Tighten stake nut to achieve a rolling torque of 1.5 to 2.8 Nm (1.1 to 21. lbf ft), inclusive of seal drag.

Note: If this figure is accidentally exceeded the output shaft must be dismantled and the collapsible spacer **24** renewed.

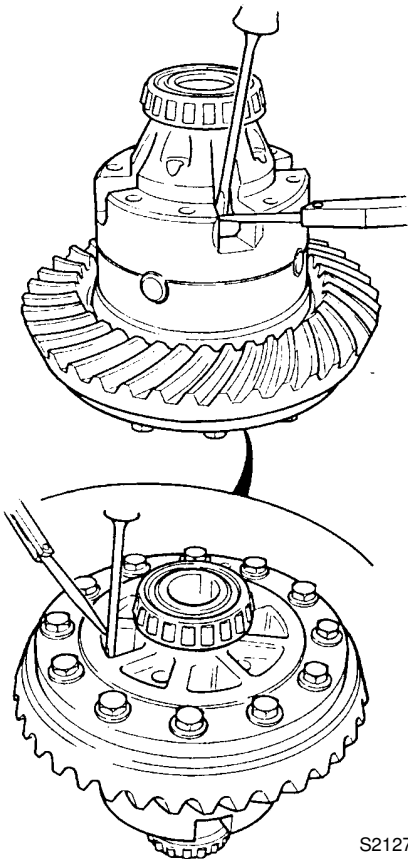
- 4 Finally stake nut into slot.



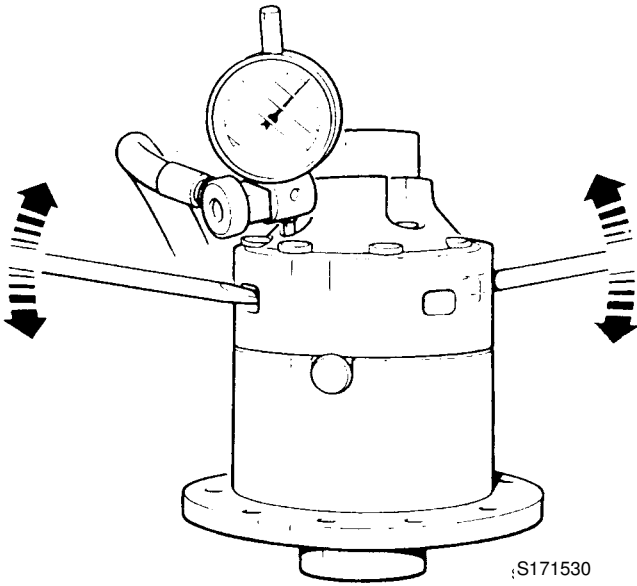
380240



S212800



S212790



S171530

Dismantling and Assembly

The numerical sequence shown on the illustration is intended as a guide to dismantling

When Dismantling

Mark the two differential halves before dismantling, for subsequent assembly.

Note the relative positions of the friction and counter plates before dismantling, they must be fitted in the same positions.

If worn, the friction and counter plates must be renewed as a complete set.

When Assembling

- 1
- Assemble trunnion pins **12**, side gears **11** with pressure plates **10**, counter plates **8**, friction plates **9**, planet gears **13** and thrust washers **14** into the 'crownwheel half of the differential assembly **5**.

Note: Do not fit the shims **6** at this point.

- 2
- Align the two halves of the differential assembly with the marks made during dismantling. Assemble using bolts **3**.
- 3
- Using a dial test indicator (or feeler gauges), with two screwdrivers or suitable levers, gently apply pressure to side gear **11** away from the trunnion pins **12** as shown. Measure and note the end-float of the side gear.
- 4
- Turn the differential assembly over and repeat step 3 for the second side gear.
- 5
- Dismantle the differential assembly. Add shims **6** to give end-float between 0.1 and 0.2mm (0.004 and 0.008in.).

Note: Shimming must be carried out whenever the differential is dismantled, however the end float 0.1 and 0.2 mm (0.004 and 0.008 in.) can be exceeded on previously assembled differential as this is only an initial setting figure which allows for bedding in.

- 6
- Repeat steps 2, 3, and 4. If the end float is correct, tighten bolts **3** to 56 Nm (41 lbf ft).
- 7
- Fit crownwheel **2** using new Verbus Ripp bolts **1**.

Friction Plate Wear Limits

Measure and note the thickness of the friction plate, the result must not be less than 1.25 mm (0.049 in).

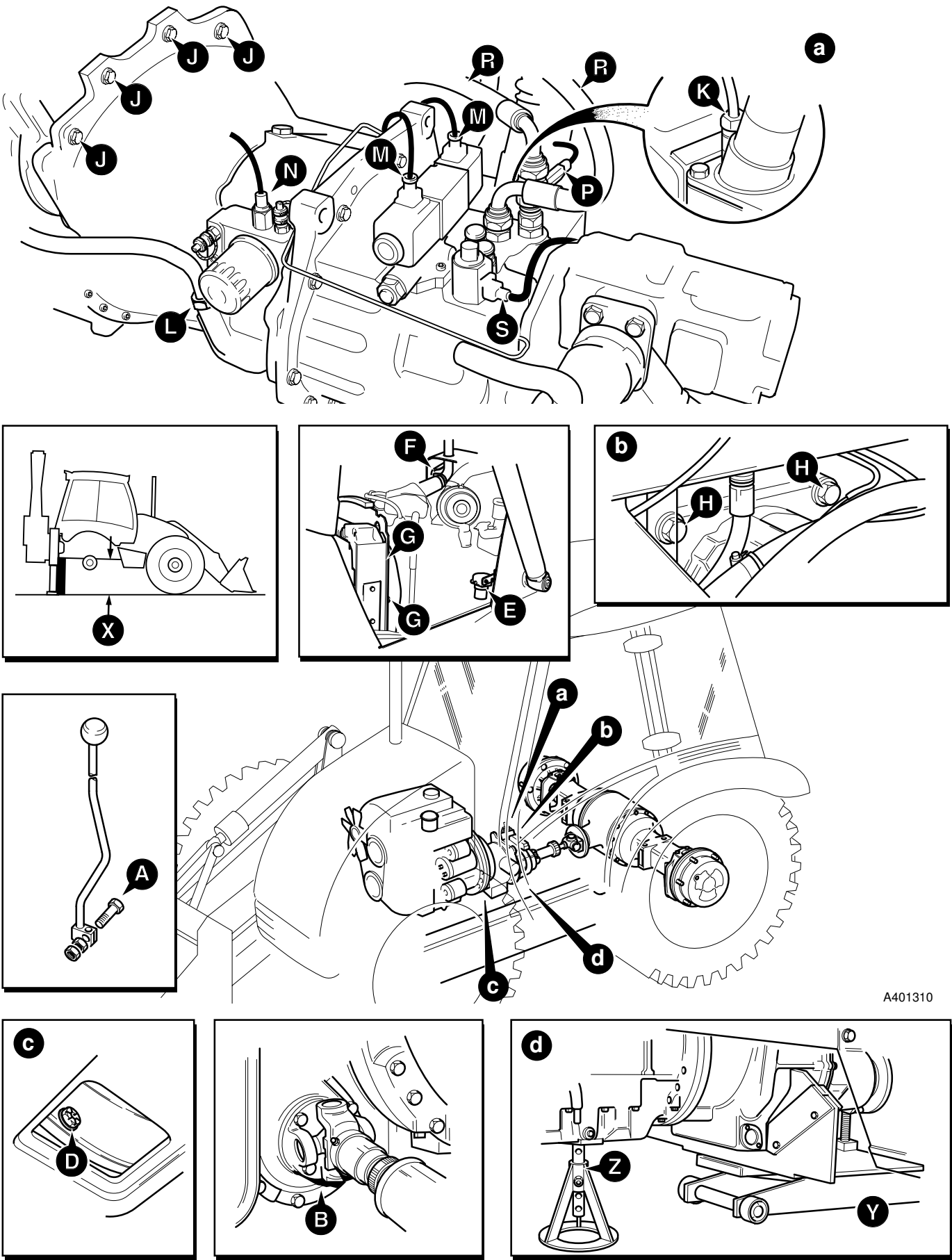
Check the condition of the friction material, which should be even over both surfaces.

If in doubt, discard the set (friction and counter plates).

Torque Settings

SD55			
Item 1	94 Nm	9.6 kgf m	70 lbf ft
SD70, PD70, SD80			
Item 1	166 Nm	16.9 kgf m	122 lbf ft

Removal and Replacement



A401310

Removal and Replacement (cont'd)

IMPORTANT: The gearbox is heavy. Unless it is safely supported during removal and replacement it could fall and cause injury. Make sure that you have access to suitable jacks and a gearbox locating 'cradle' before attempting to remove the gearbox.

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface. Before raising one end ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN 1-1

Removal

- 1 Park the machine on firm level ground. The gearbox is heavy. If the ground is soft or uneven it will not be possible to remove the gearbox safely.
- 2 Loosen the right side rear wheel nuts. Rest the shovel on the ground and lower the stabilisers to raise the rear of the machine. Check dimension **X** which must be at least 800 mm. This will allow the gearbox to be pulled clear. Block/support the machine.

Note: On sideshift machines, suitable lengths of steel channel can be used as safety struts between the stabiliser feet and chassis, one at each stabiliser.

- 3 Remove the right hand side rear wheel.
- 4 Remove the bonnet - see Section 3, **Routine Maintenance**.
- 5 Disconnect the gearshift from the top of the gearbox, as shown at **A**.
- 6 Remove the rear axle propshaft - see **Propshafts**.
- 7 Disconnect the front axle driveshaft bolts **B** (use tool 892/00822).
- 8 Drain the hydraulic tank and remove the main hydraulic pump (see Section E, **Service Procedures and Main Hydraulic Pump**). Tie the suction hose up clear of the gearbox.
- 9 Drain the gearbox oil, see Section 3, **Routine Maintenance**.
- 10 Remove the access bung/plate at the bottom of the torque converter housing. Through the access hole, loosen and remove the torque converter to engine flywheel retaining bolts **D**.

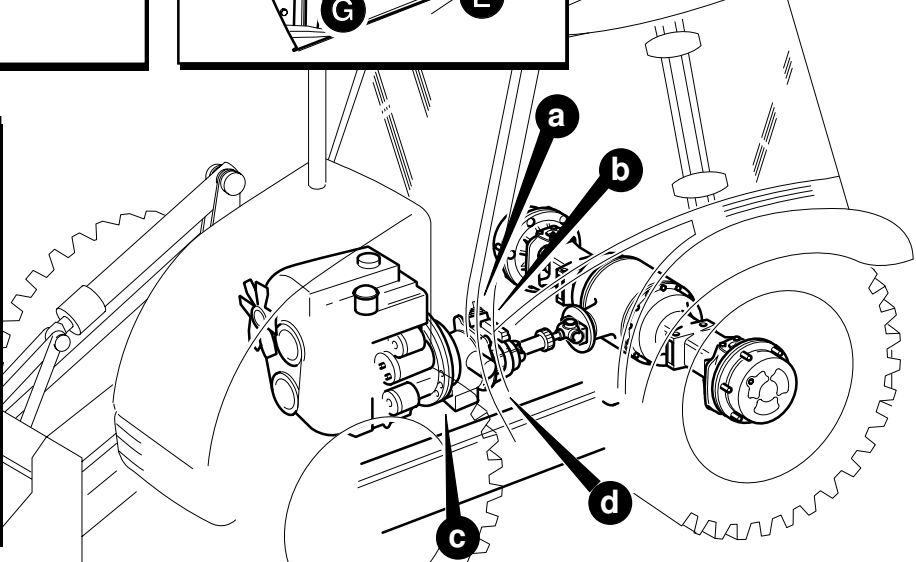
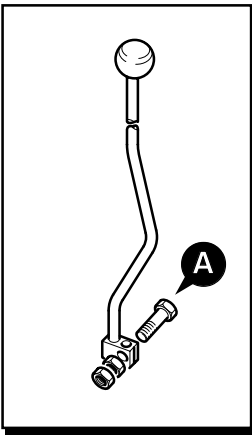
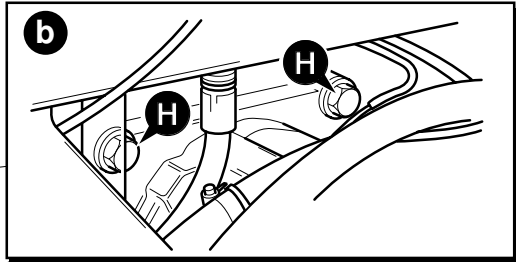
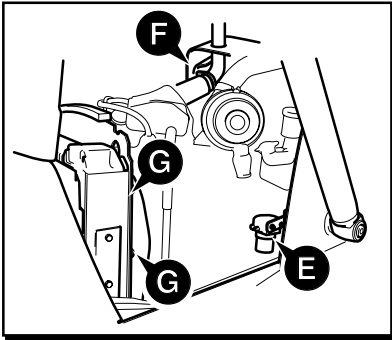
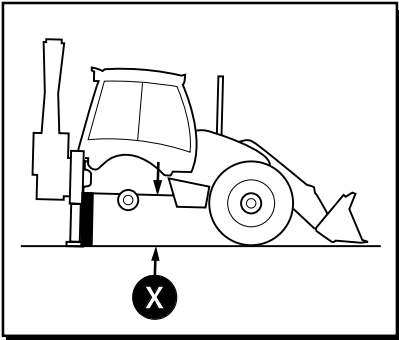
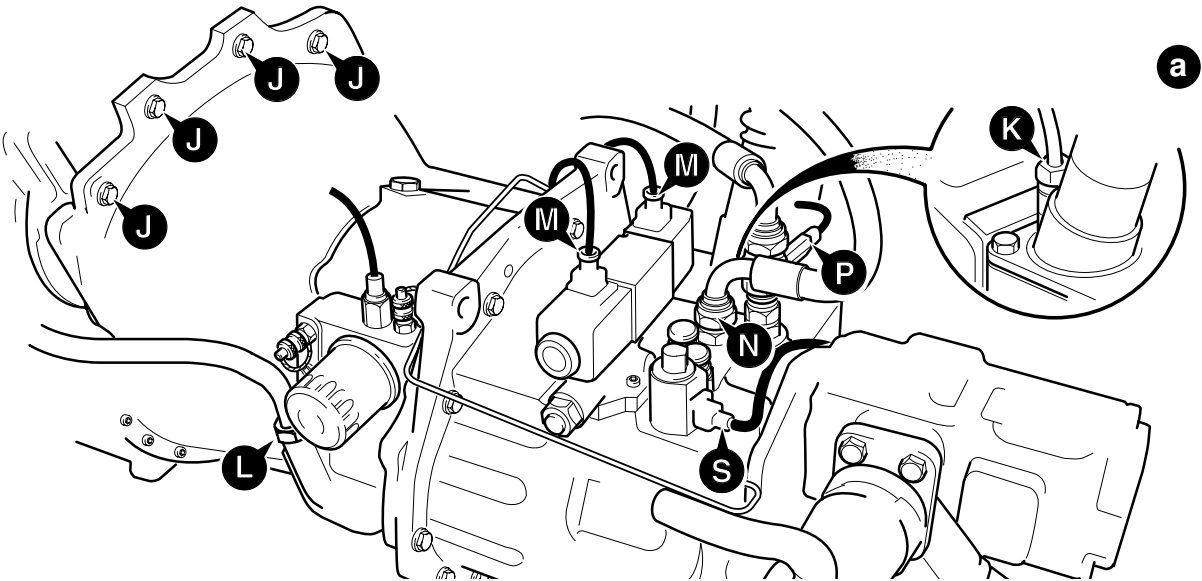
- 11 At a later stage the gearbox and engine assembly is tilted to allow access to fixing bolts. To prevent damage as the engine is tilted components must have their fixings removed as follows:

- a Fuel sediment bowl assembly **E** (2 bolts).
- b Exhaust stack fixing bracket **F** (2 bolts).
- d Radiator fan cowl **G** (4 bolts).

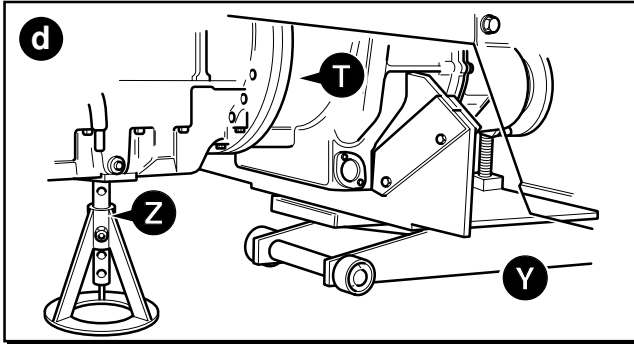
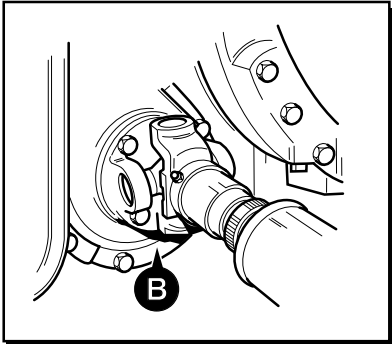
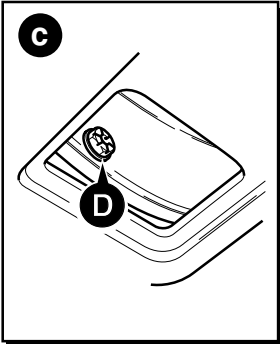
It is not necessary to remove these components, only release them from their fixings.

- 12 Support the gearbox using a suitable trolley jack and cradle. The gearbox must be securely located on the cradle as shown at **Y**.
- 13 Make sure that the weight of the gearbox is supported by the trolley jack and then remove the gearbox mounting bolts **H**.
- 14 Using the trolley jack, lower the gearbox and engine to gain access to the top torque converter housing to engine block retaining bolts **J**. Put a support under the engine as shown at **Z** to prevent it from dropping when the gearbox is removed.
- 15 Undo the four bolts **J** at the top of the torque converter housing. Note that the two outer most bolts have nuts instead of screwing into the engine block. Also note the position of the electrical earth straps.
- 16 Pull off the breather tube **K**. Undo the gearbox dipstick fixing nut **L** and then remove the dipstick tube.
- 17 Uncouple the forward/reverse solenoid valve connectors **M**, oil pressure sender **N** and temperature sender **P** (if fitted). Label the connectors for identification when refitting.
- 18 Disconnect the gearbox oil cooler hoses **R**.
- 19 On 4 wheel drive machines, uncouple the electrical connector at the 4WD solenoid **S**.
- 20 Remove the flywheel housing to engine bolts **T**.
- 21 Manoeuvre the gearbox with the torque converter clear of the engine housing.
- 22 Lower the trolley jack and pull the gearbox and torque converter clear of the machine.

Removal and Replacement (cont'd)



A401310



Removal and Replacement (cont'd)

Replacement

Replacement is a reversal of the removal procedure but note the following:

- 1 Before replacing the gearbox remove circlip **5** and withdraw the pump driveshaft **6** together with its bearing **7** approximately 50 mm (2.0 in). The shaft can then be engaged after the gearbox has been fitted, making replacing the gearbox easier. Remember to engage the pump drive shaft, refit the bearing and circlip after the gearbox has been fitted.
- 2 Set the torque converter as described in **Torque Converter, Removal and Replacement**.
- 3 **Align the Torque Converter**

It is vitally important that the torque converter is fitted at the gearbox and engine flywheel correctly. Failure to locate the converter correctly will result in damage to the gearbox oil pump on engine start up. Proceed as follows:

Make sure that the torque converter drive dogs **1** are correctly engaged with the pump **2** on the gearbox. Temporarily tie the converter onto the gearbox. Use wire tied at a drive plate bolt hole to a convenient point on the outside of the gearbox.

Take note of the flywheel and drive plate fixing hole phasing. The heads of the bolts **3** will foul the flywheel **4** if phasing is incorrect.

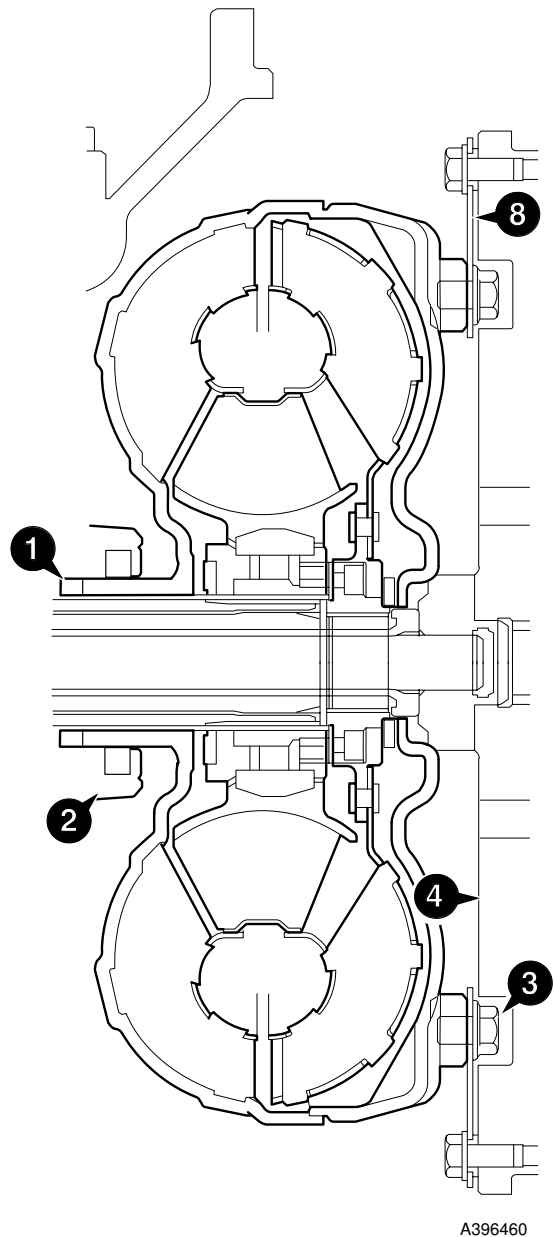
Before bolting the torque converter housing to the engine make sure the mating faces are fully together (DO NOT USE FORCE). The drive plate **8** should also be mated close to the flywheel. Do not force the components together with the fixing bolts.

Make sure that the torque converter is free to rotate slightly within the clearance of the location bolt holes. If you cannot rotate the converter it is trapped either by bolt heads **3** or by incorrectly located pump drive dogs. Make sure that all is well before tightening the bolts.

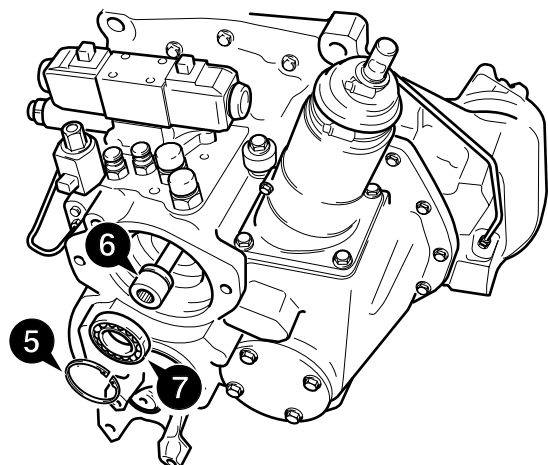
- 4 Fill the gearbox with the specified amount and type of oil (see **Section 3, Routine Maintenance**). Leave hose **N** off until the filling operation is complete. After filling refit hose **N**.

Torque Settings

Item	Nm	kgf m	lbf ft
B	79	8	58
D	44	4.5	32
H	237	24	175
J,T	98	10	72



A396460



A396890

Dismantling

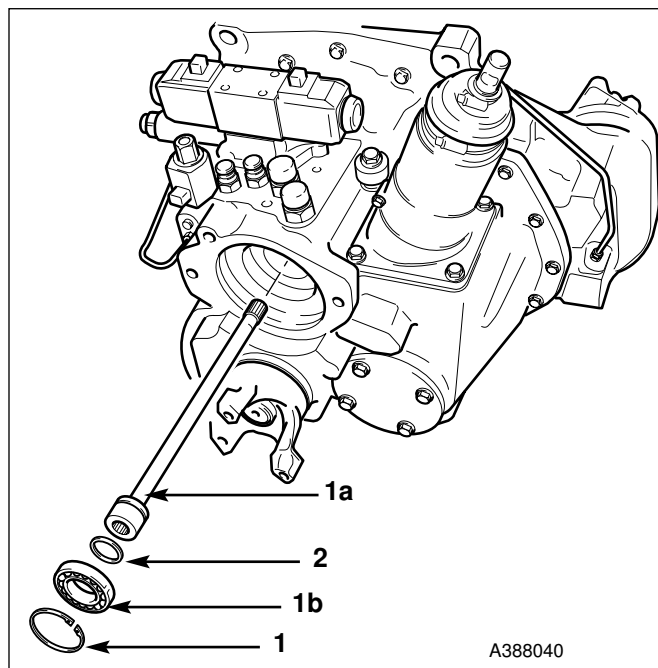
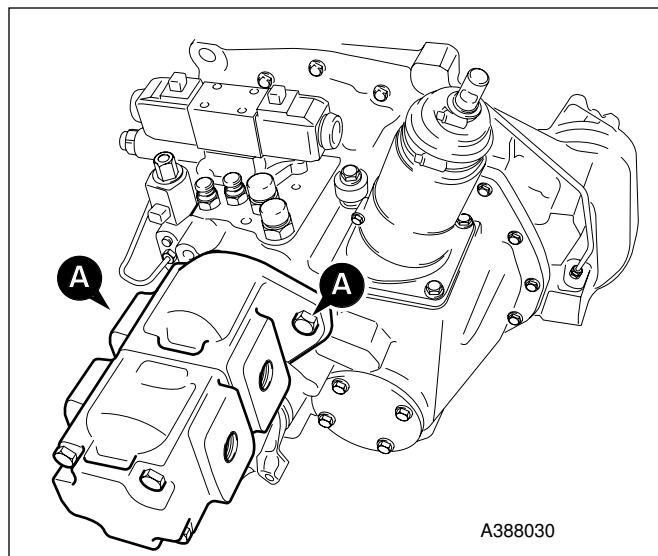
Cleanliness is of the utmost importance when servicing the gearbox. All precautions to prevent any ingress of dirt, grit etc. must be taken. To this end wash the exterior of the gearbox assembly as follows;

Make sure that all open ports and orifices are effectively plugged. Remove any deposits of dirt, grit and oil from the outer casings using a suitable degreaser and water. Dry the casings.

Note: For details of service tools referred to, see **Service Tools** at the front of this section.

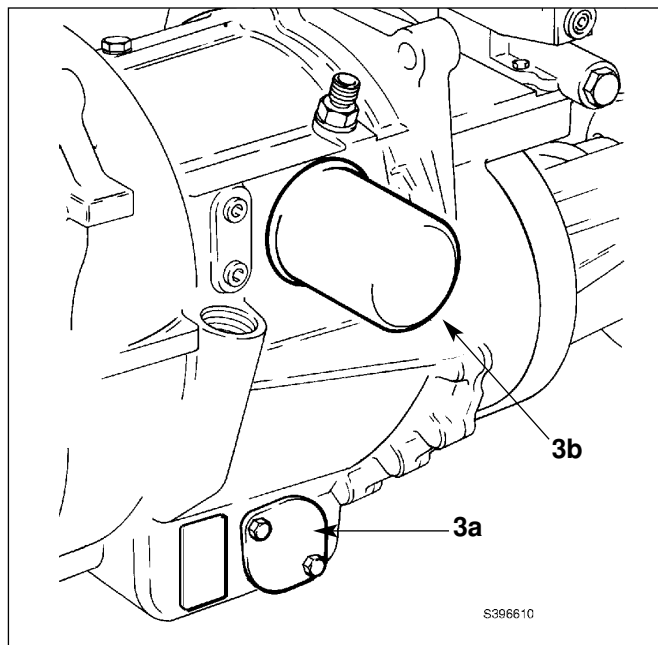
Note: If the main hydraulic pump has not been removed, remove it. Support the pump, undo the 2 fixing bolts **A** and then withdraw the pump from the gearbox.

- 1 Remove the circlip and then withdraw the pump driveshaft **1a** together with its bearing **1b**.
- 2 Remove and discard the shaft sealing ring.

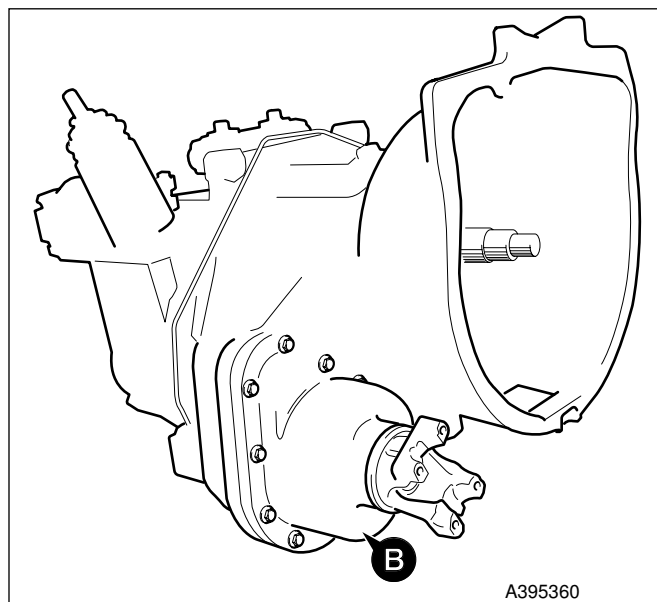


Dismantling (cont'd)

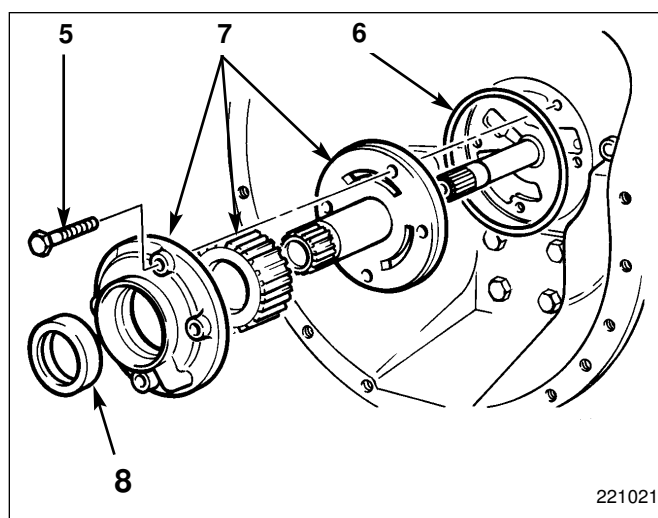
- 3 Drain the oil from the casing by removing the suction strainer **3a**. Remove and discard the oil filter **3b**.



- 4 If the gearbox is fitted with a 2/4 wheel drive unit **B**, remove it. For the correct procedure see **Hydraulic 2/4 wheel Drive Unit, Dismantling**.



- 5 Unscrew bolts and withdraw pump.
- 6 Remove and discard pump sealing ring.
- 7 Separate pump components. Note that the pump components are held together with a security screw at the rear of the assembly.
- 8 Remove and discard oil seal from pump housing.



Dismantling (cont'd)

Position transmission vertically, standing on the face of the torque converter housing.

- 9 Unscrew capscrews and remove solenoid control valve.

Note 'O' rings fitted around ports on mating face of solenoid valve body.

Note: See **Service Procedures, Forward/Reverse Control Valve** for solenoid dismantle/assembly .

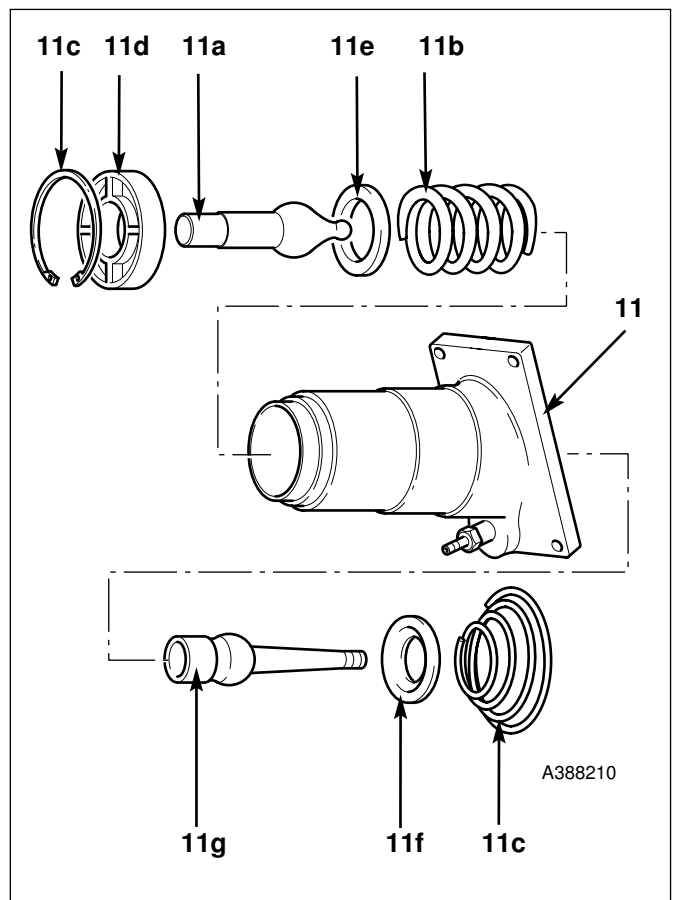
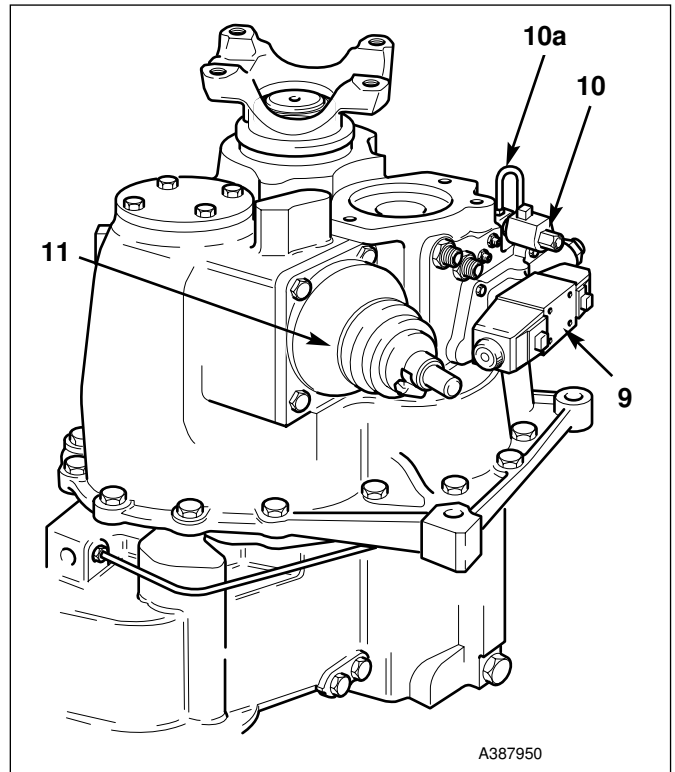
- 10 On 4 wheel drive transmissions remove the 4 wheel drive hydraulic pipe and control valve **10a**.

- 11 Undo the 4 bolts and remove the gear lever turret. Remove the baffle plate beneath if fitted. If necessary the turret assembly can be dismantled as follows:

- a Slacken worm drive clips and remove rubber boot.
- b Using a suitable press or clamp, carefully press the top lever **11a** down to compress spring **11b**, just enough to release pressure on circlip **11c**.

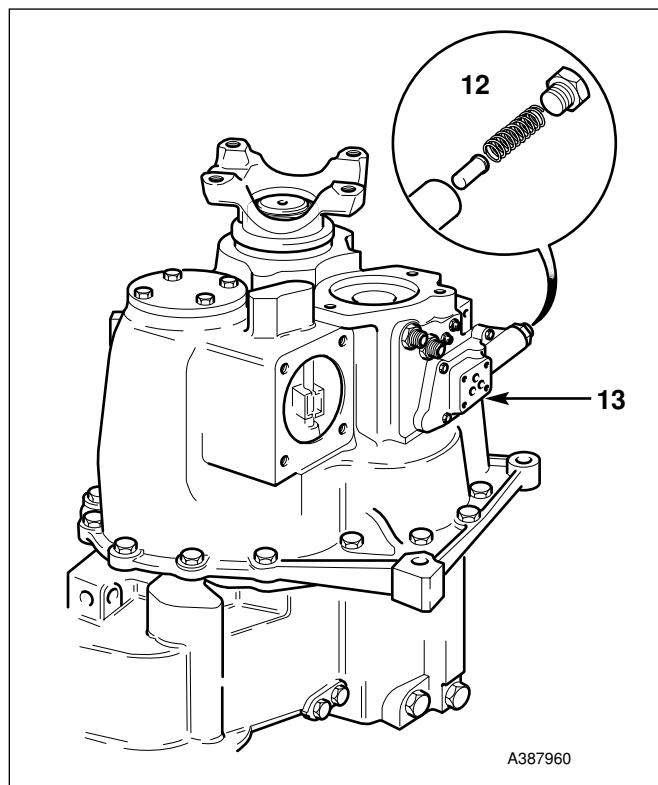
Note: BEWARE of spring pressure acting on nylon seat when circlip is removed.

- c Remove circlip **11c**.
- d Slowly release the pressure from the top lever **11a** and remove it, together with bush **11d**, washer **11e** and spring **11b**.
- e Rotate spring **11c** so as to disengage from the retaining tabs inside the turret **11**. Be aware that the spring may suddenly disengage while still under pressure. Repeat this operation until all the coils are disengaged and the spring can be removed.
- f Remove retainer **11f** and bottom lever **11g**.

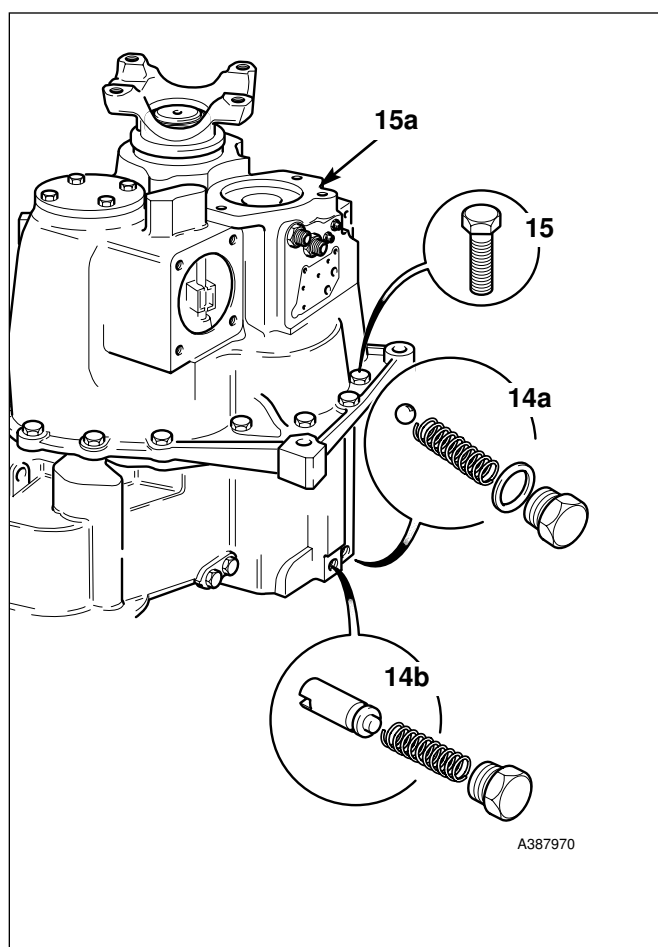


Dismantling (cont'd)

- 12 Unscrew plug and withdraw pressure maintenance valve spool and spring.
- 13 Unscrew four bolts and remove pressure maintenance valve body. Remove and discard gasket.

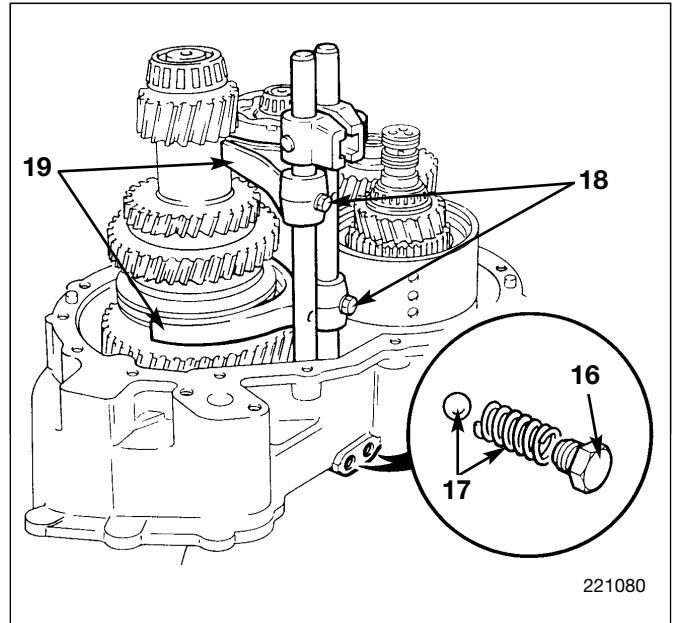


- 14 Remove the torque converter pressure relief valve ball and spring assembly **14a**. Remove the torque converter pressure regulating valve spool and spring assembly **14b**.
- 15 Unscrew bolts and lift off output end casing **15a**. Be sure to retrieve bearing outer cups from inside the casing. Keep the cups together with their associated bearing.

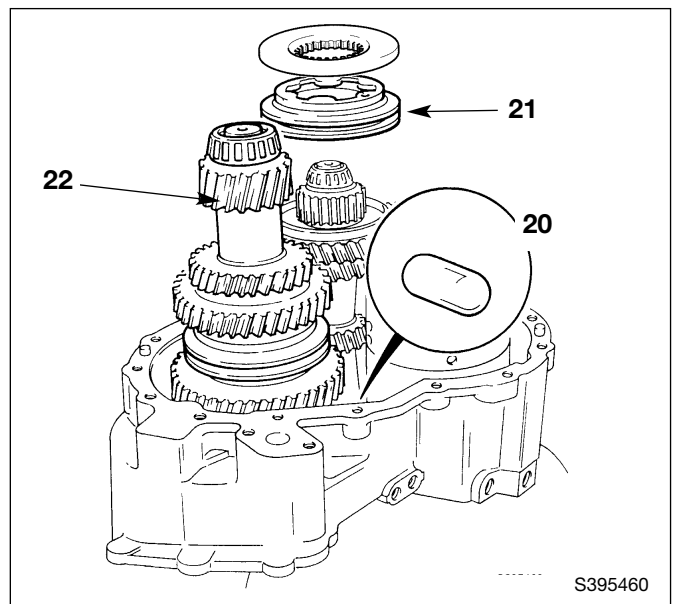


Dismantling (cont'd)

- 16 Unscrew selector detent plugs.
- 17 Remove selector detent balls and springs.
- 18 Unscrew selector fork retaining screws and lift out selector rods.
- 19 Note that the selector forks are not interchangeable. Mark the forks to ensure they are replaced correctly. Remove selector forks.

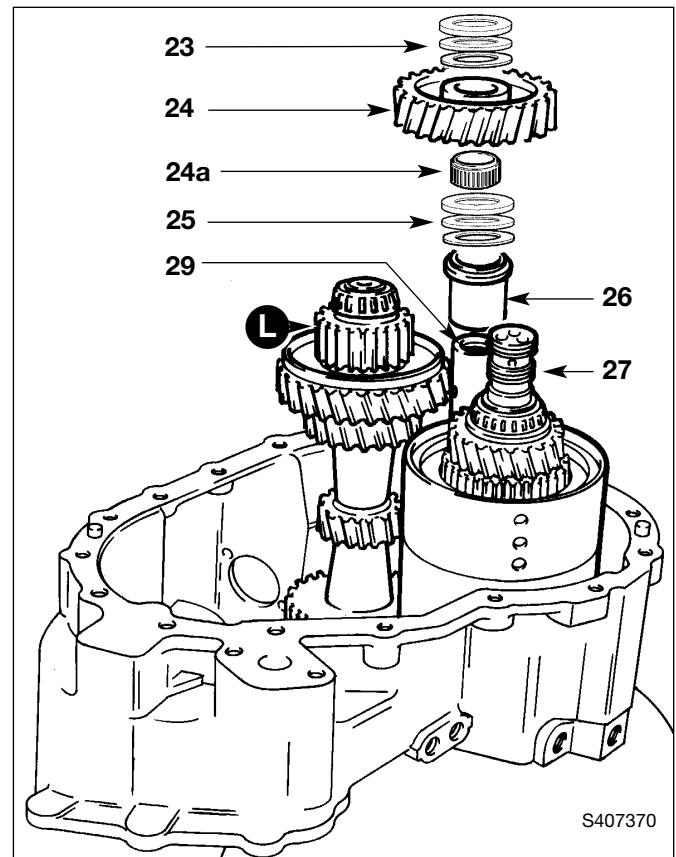


- 20 Push out the interlock plunger on disassembly.
- 21 Lift off 3rd/4th synchro-hub. Note the positions for refitting with mating cups.
- 22 Lift out layshaft assembly .

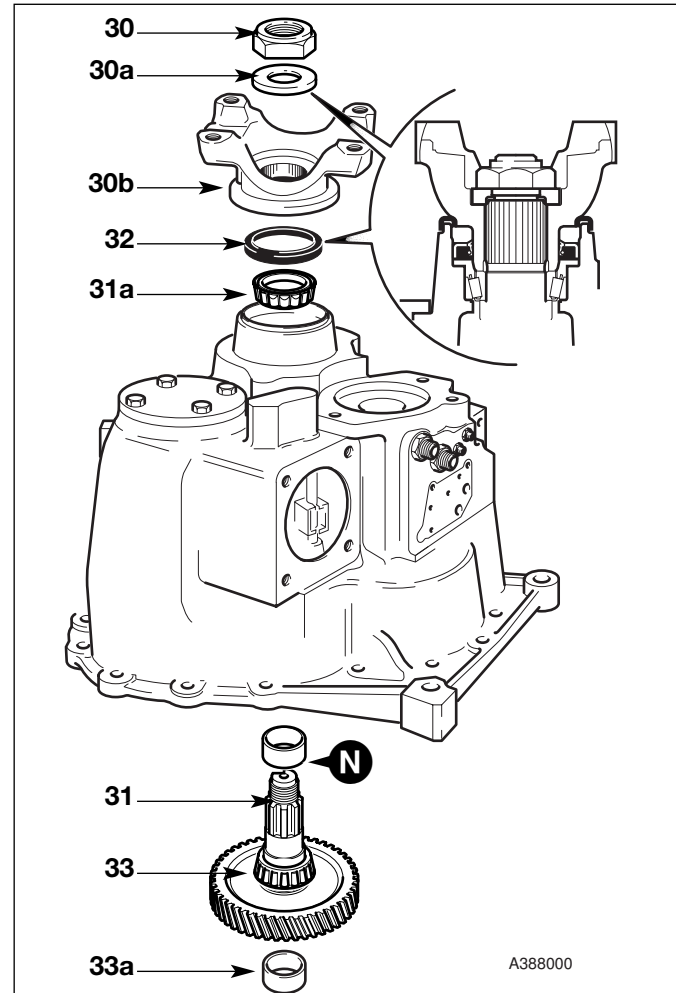


Dismantling (cont'd)

- 23** Remove idler gear upper thrust washers and bearing. Keep the thrust washers and bearing together.
 - 24** Tilt mainshaft **L** to one side and lift off idler gear together with its needle roller bearing **24a**.
 - 25** Remove idler gear lower thrust washers and bearing. Keep the thrust washers and bearing together.
 - 26** Lift off idler gear spacer.
 - 27** Tilt mainshaft **L** to one side and lift out the forward/reverse assembly. Discard sealing rings.
- Note:** See **2/4 Wheel Drive Clutch** for forward/reverse unit dismantling and assembly procedures.
- 28** Remove mainshaft **L**.
 - * **29** The idler gear spindle is a press fit in the casing. Use a suitable puller screwed into the 1/2in. B.S.P. hole in the end of the spindle for extraction. Note that the spindle should only be removed if it is damaged and is required to be replaced.

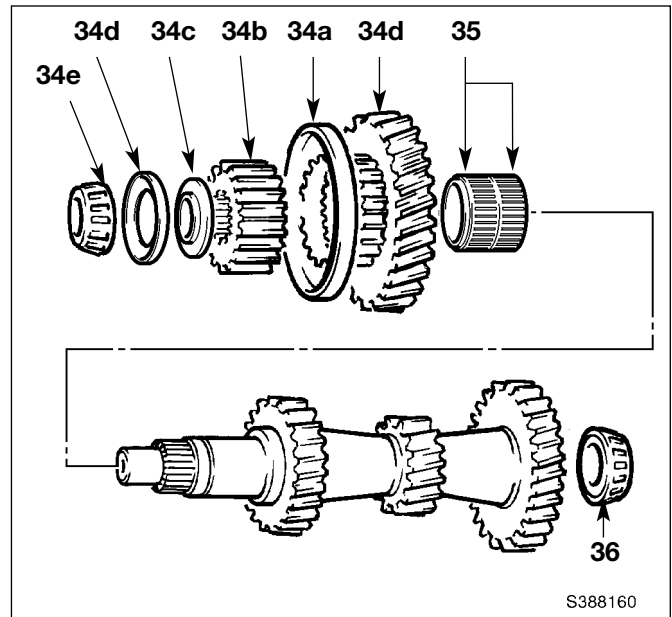


- 30** Unstake the nut. Whilst holding the output yoke with service tool 892/00812, unscrew output shaft nut and remove the washer **30a** beneath. Support output shaft from beneath and lift off the yoke **30b**.
- 31** Withdraw output shaft assembly and lift out outer bearing **31a**. Remove spacer **N** and retain for assembly.
- 32** Prise out oil seal and discard.
- 33** Using a suitable puller, withdraw output shaft inner bearing. Remove the mainshaft bearing outer cup **33a** from the centre of the output shaft transfer gear.

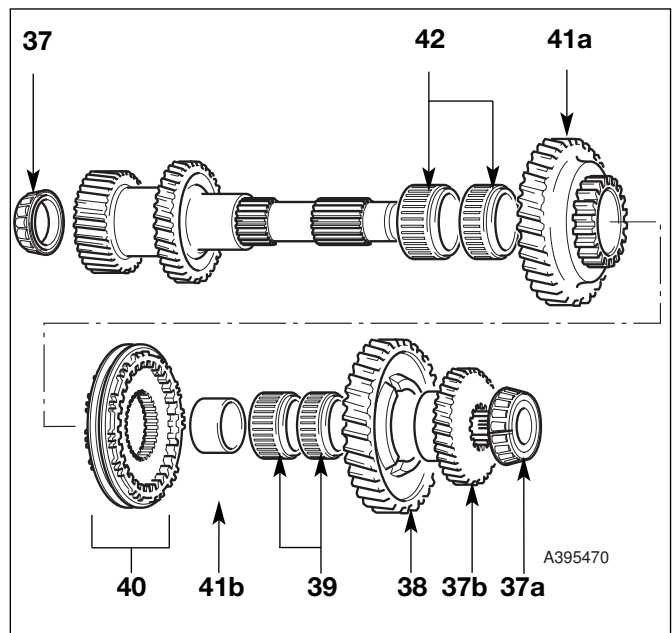


Dismantling (cont'd)**Mainshaft**

- 34** Using service tool 892/00179 and adapter 992/06300 pull off 3rd gear together with synchro cup **34a**, gear **34b**, spacer washer **34c**, oil retention washer **34d** and bearing **34e**. Keep the synchro hubs and cups in their original relationship.
- 35** Remove needle roller bearings **35**.
- 36** Remove bearing from converter end of mainshaft using press 892/00179.

**Layshaft**

- 37** Remove the bearing **37**. Remove 4WD transfer gear **37b** and bearing **37a** from layshaft. On 2WD machines a spacer is fitted in place of the transfer gear.
- 38** Lift off 1st gear.
- 39** Remove 1st gear needle roller bearings.
- 40** Note that the 1st/2nd synchro unit **40** is of a different design to the 3rd/4th gear unit. There are components which may be lost during removal unless care is taken. Hold the unit together with the synchro cones on each side and lift off. Keep the synchro cones, rings and hubs in their original relationship.
- * **41** Use a press to push off 2nd gear **41a**, synchro assembly **40** and 1st gear needle roller track ring **41b**.
- 42** Remove 2nd gear needle roller bearings.



Dismantling (cont'd)

Setting Ring Removal

The mainshaft and layshaft end float is controlled by a threaded 'setting ring' screwed into the casing.

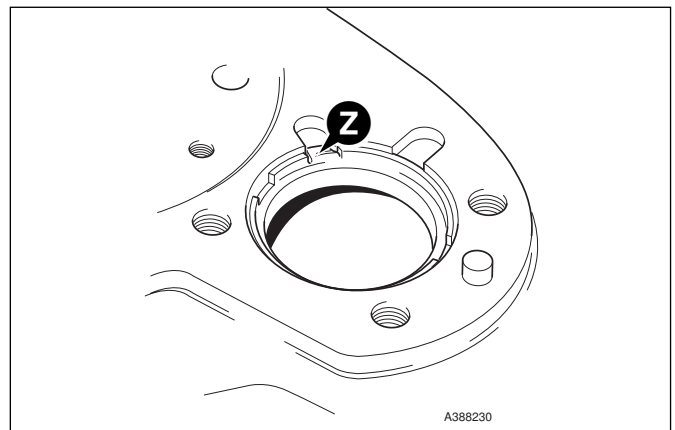
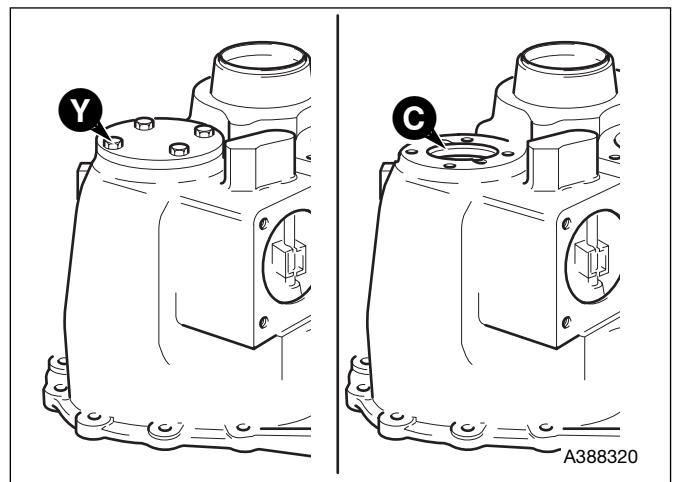
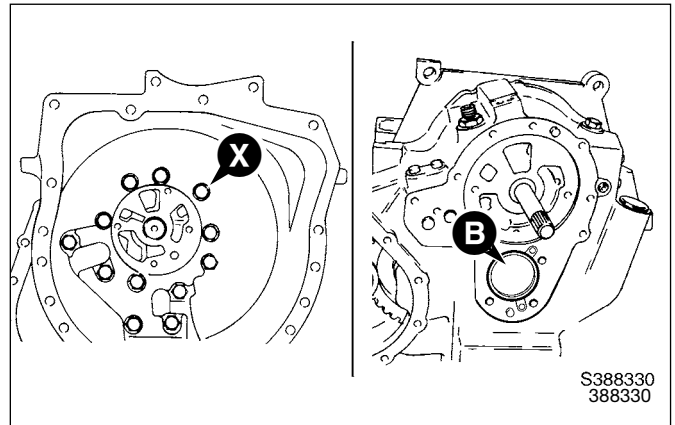
To enable access to the mainshaft setting ring the torque converter housing must be removed. Undo the 12 fixing bolts **X** and remove the housing. The setting ring is located at position **B**.

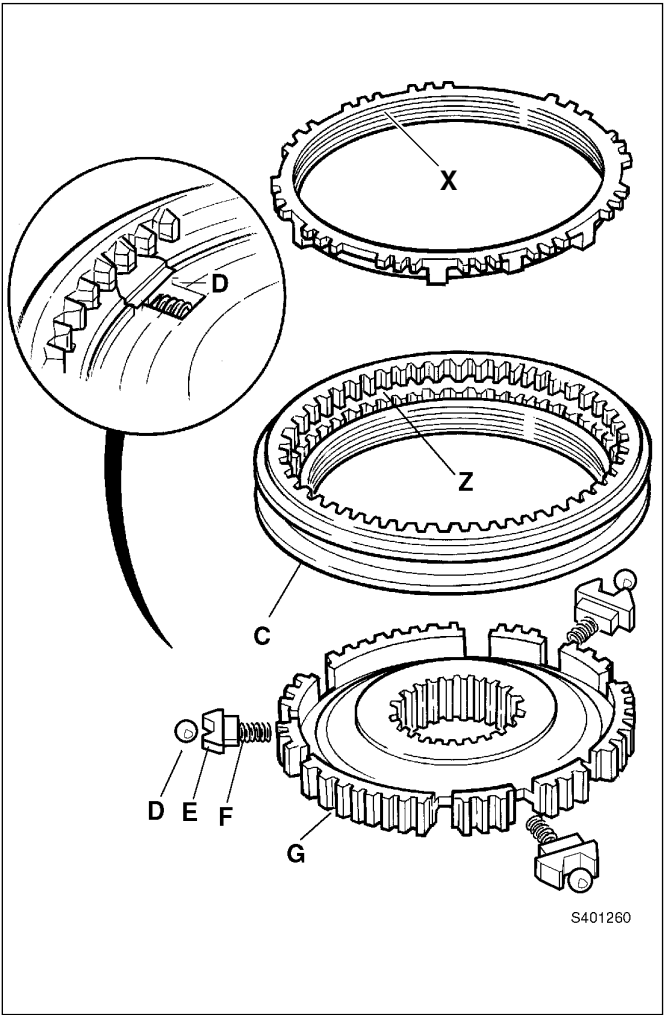
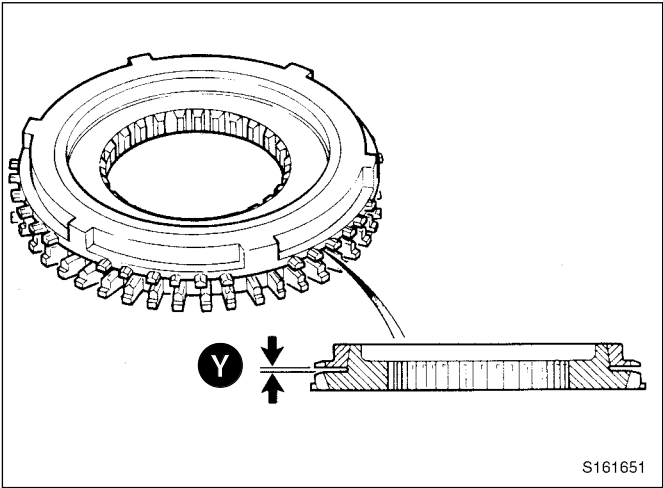
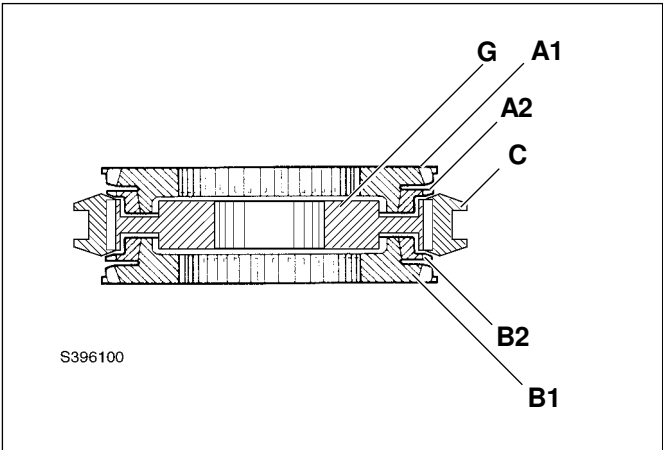
To enable access to the layshaft setting ring the bearing cover must be removed. Undo the 4 fixing bolts **Y**, remove the cover and discard the gasket beneath. The setting ring is located at position **C**.

If the bearings or shaft are to be renewed the associated setting ring must be removed and discarded as follows:

- 1 Carefully prise out the staked section of the ring **Z** clear of the casing.
- 2 Using the special socket adaptor, unscrew and discard the ring. (Use adaptor 892/01080 for the layshaft ring and 892/01079 for the mainshaft.)
- 3 Be sure to remove any shards of metal that may have fallen into the casing.

Note: Once removed, the setting rings must not be re-used. Discard the ring and obtain a new one. Note that the mainshaft and layshaft setting rings are not interchangeable.





Inspection

Before assembling the gearbox make sure that a thorough inspection of all components is carried out. Remember that although a failed component may be easy to identify, the cause of that failure may be less easy to trace. It is also possible that a failed component may have caused damage to other areas of the gearbox.

- 1 Carefully remove all traces of gasket compound from components as follows:
 - a Front and rear casing mating faces.
 - b Front casing and torque converter housing mating faces.
- 2 Clean the inside of the casings using a suitable degreasing agent.
- 3 Carefully inspect all gears, bearing and shafts for signs of excessive wear or damage. If wear or damage is evident, components must be renewed.
- 4 Make sure that all oil way cross drillings in the casings, shafts and gears are clear and free from debris. Blocked oil ways are a common cause of bearing failure. Use an air line to blow through cross drillings.

Note: If failure of the forward/reverse or 4 wheel drive clutch is suspected see the relevant dismantling and assembly procedure in this section.

1st/2nd Gear Synchromesh Unit

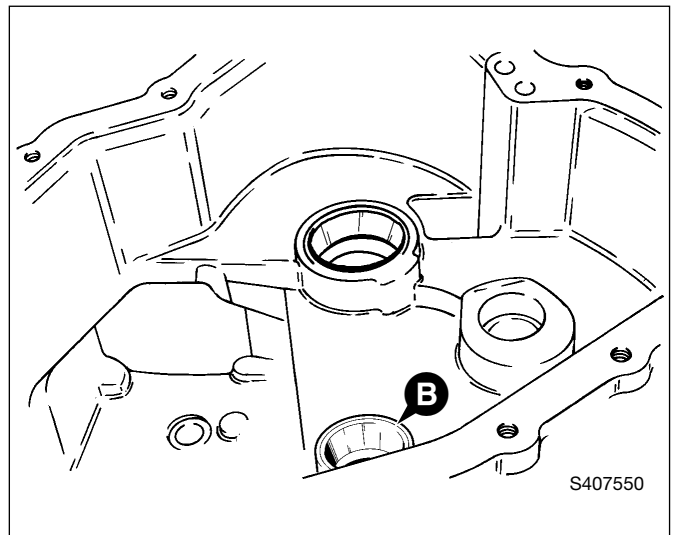
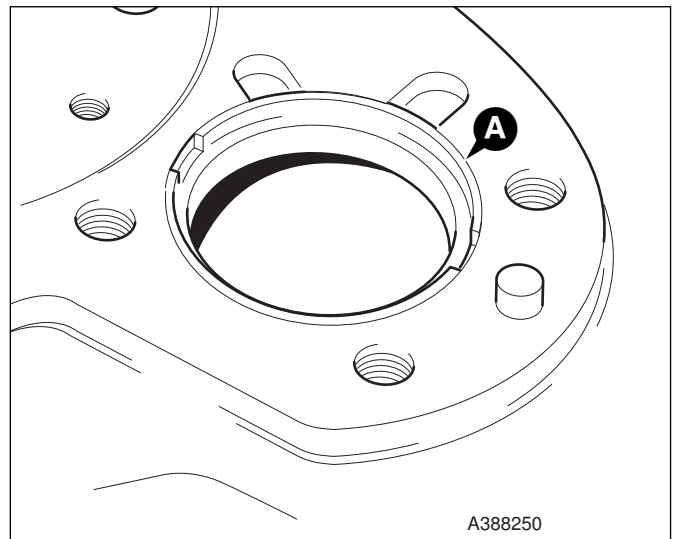
The 1st/2nd gear synchro unit must be checked for wear before assembly as follows:

- 1 Before dismantling the unit be aware that on re-assembly, the components must be kept in their original relationships.
- 2 Dismantle the unit by removing the cones and rings **A1**, **A2** and **B1**, **B2**. Push off the sleeve **C** taking care to retrieve the sets of balls **D**, poppets **E** and springs **F**.
- 3 Inspect the mating faces of cones and rings. The wear indicator grooves **X** must still be visible. As a further check, locate the cones and rings together (as shown at **Y**) and measure the clearance between them using feeler gauges. The clearance should be between 0.5 and 1.9 mm for both **A** and **B** pairs. If either is outside these limits then the complete synchro unit must be renewed.
- 4 Inspect the teeth on all cones and rings for excessive wear or damage. If wear or damage is evident the unit must be renewed.

Assembly

Bearing Setting Rings

If the bearing outer cups and setting rings have been removed, fit new rings so that they are flush with the outer face of case as shown at **A**. Press in the outer bearing cups from the inside of the casing as shown at **B**. Push in the cup until it is up against the setting ring.

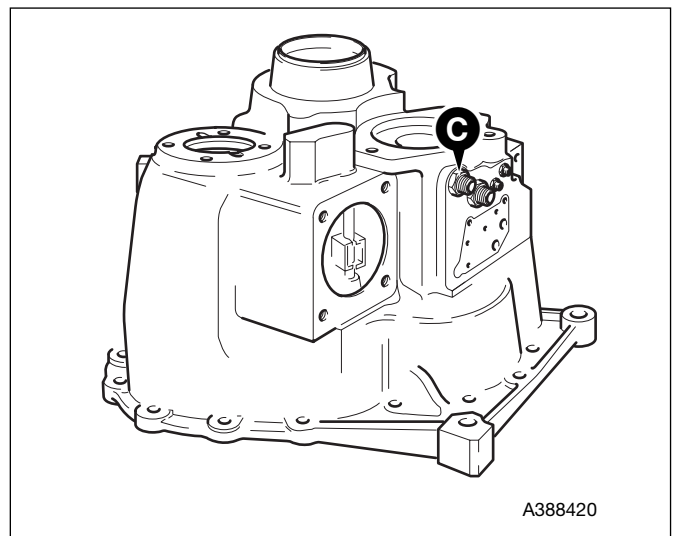


Casings

If the gearbox casings are to be renewed, be sure to fit blanking plugs and adapters as required. Inspect the original casings and identify the blanking plug and adapter positions. Transfer the plugs and adapters to the new casings. Apply JCB Threadlocker and Sealer to the threads.

Note that new plugs may be supplied with a sealant 'patch', in which case sealant need not be applied. Torque tighten plugs to 25 - 28 Nm (18.4 - 20 lbf ft).

Before fitting adapter **C**, be sure to fit the orifice restrictor inside the port.

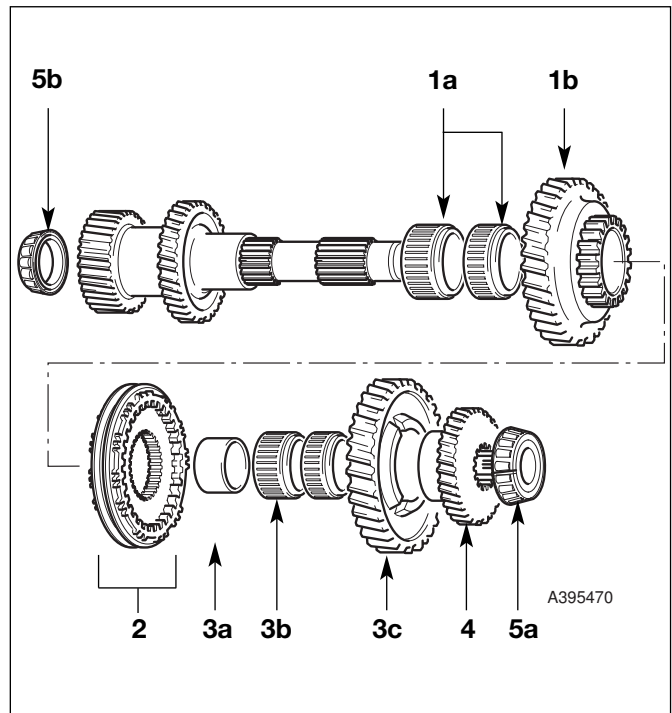


Gearbox - Assembly (cont'd)

If the torque converter housing has been removed, temporarily replace it. The gearbox can again be positioned standing on the face of the housing ready for assembly.

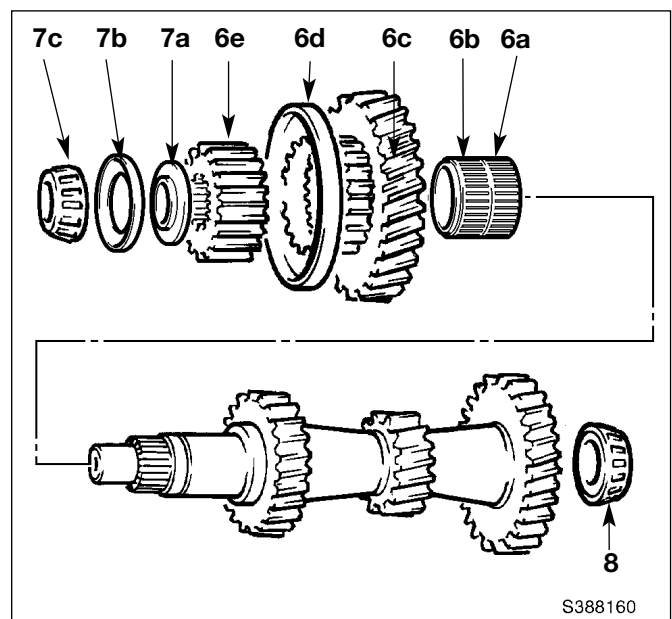
Layshaft Assembly

- 1 Smear bearing surface of shaft with JCB HP Grease and fit needle roller bearings **1a** (wider bearing first), followed by 2nd gear **1b**.
- * 2 Fit the synchro assembly **2**, then press fit the bearing track **3a**.
- 3 Slide 1st gear needle roller bearings **3b** over the track. Smear bearings with oil. Fit 1st gear **3c** over needle roller bearings.
- * 4 Assemble 4WD transfer gear **4** over splines. On 2WD machines slide spacer over splines.
- 5 Press bearing **5a** and **5b** onto the assembled layshaft. Smear the bearings with JCB HP Grease.



Mainshaft Assembly

- 6 Smear bearing surface of mainshaft with JCB HP Grease. Fit the needle roller bearings **6a** and **6b**. Assemble 3rd gear **6c** and synchro-cup **6d**. Fit synchro gear **6e**.
- 7 Fit spacer washer **7a** and oil retention washer **7b**. Note the correct way round of components **7a** and **7b**. Press bearing **7c** onto shaft and smear with JCB HP Grease.
- 8 Press bearing onto assembled mainshaft and smear bearing with JCB HP Grease.

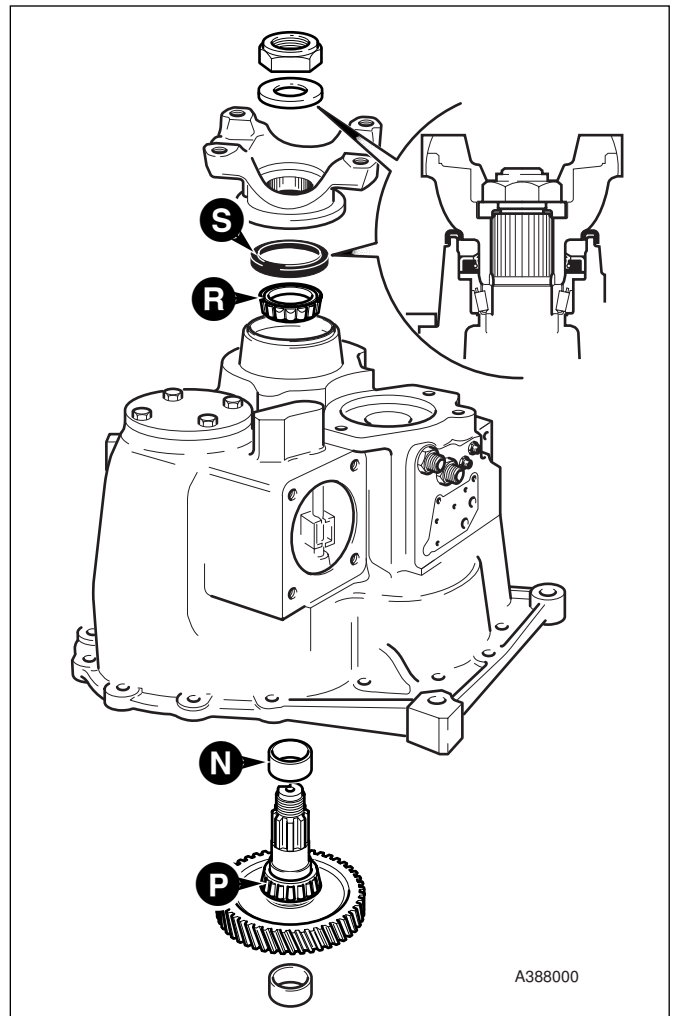


Assembly (cont'd)

9 Transfer Gear/Output Shaft Assembly

Note: Make sure that the layshaft bearing outer cup is fitted to the rear casing before fitting the transfer gear/output shaft.

- a Liberally coat output shaft inner bearing with JCB HP Grease before fitting inner bearing **P**.
- b Fit the service solid spacer **N** (13.70 mm) over output shaft and assemble into casing.
- c Lightly oil output shaft outer bearing and cup **R** and fit to output shaft, do not fit oil seal **S** at this stage.



- 10 a Fit special tool sleeve **A** which temporarily replaces the output yoke and secure with special tool nut **B**, torque tighten to 50 Nm (36.9 lbf ft).

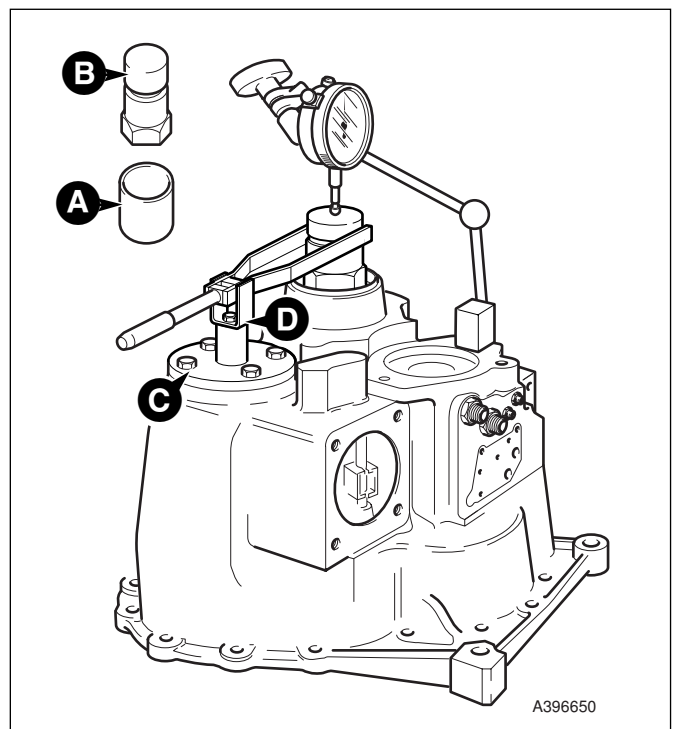
Note: Check for end float while tightening nut **B**, if there is no end float check:

The bearing cups are pushed fully into the casing.

The correct bearings are fitted, check parts catalogue.

The solid spacer **N** is 13.70 mm.

- b Ensure that the layshaft setting ring is slightly below layshaft cover facing on the rear case. Fit special tool support pillar **C** (892/01076) so that the fork end engages in special tool nut **B**, tighten bolt **D**.



Assembly (cont'd)

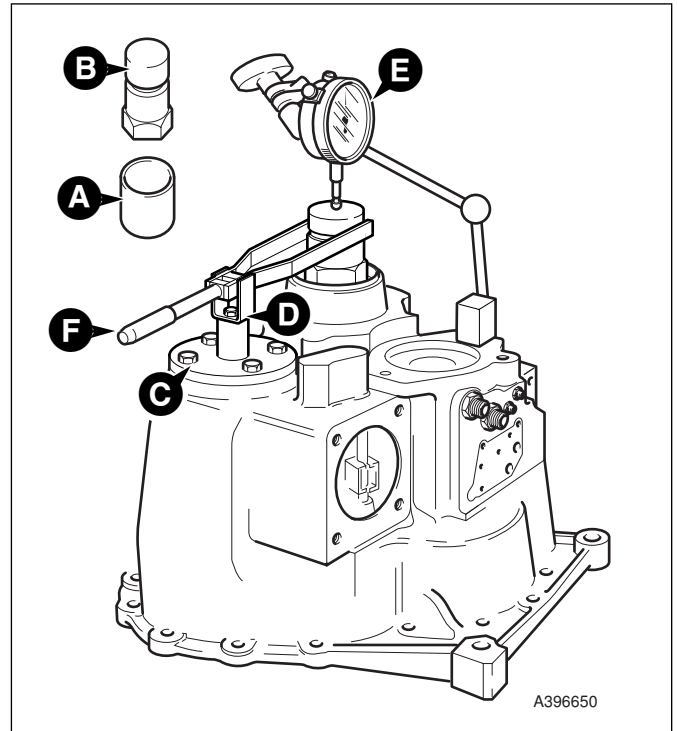
- 11 a** Fit dial test indicator **E** (DTI) .
- b** Set torque wrench **F** to 35 Nm and measure the end float while rotating the output shaft.
- c** To select the right size spacer, subtract the end float obtained at step **11b** from the solid spacer (13.70 mm). Also subtract 0.120 mm to allow for theoretical bearing tolerance and pre load. If there is no spacer of this size, fit the next smallest spacer.

Example

Service spacer	13.70
Subtract end float	<u>0.41</u>
Total	13.29
Subtract tolerance & preload	<u>0.12</u>
Result	13.17

Use next smallest spacer ie. **13.15**

- d** Remove special nut **B** and sleeve **A**. Remove rear bearing and 13.70 mm spacer. Fit correct size spacer (Do not fit the oil seal at this stage). Take care to avoid damaging the outer bearing.
- e** Fit sleeve **A** and initially tighten nut **B** to 50 Nm (36.9 lbf ft). Check there is no end float and rolling torque less than 1.5 Nm (1.0 lbf ft). If the rolling torque exceeds 1.5 Nm (1.0 lbf ft) check that the output shaft has been assembled correctly.
- f** If the rolling torque measured is too high, fit the next larger size spacer. If there is end float, fit the next smaller size spacer.



Assembly (cont'd)

- 12 a** Remove nut **B** and sleeve **A**. Fit new oil seal **S**, grease between seal lips before fitting. Note that the seal does not fix to the back of the housing - use servicel tool to locate the seal. Fit the output yoke **Y**.
- b** Fit the stepped washer **W** the correct way round with the plain face uppermost as shown.
- c** Fit NEW retaining nut **T** and progressively torque tighten to 300 Nm (221 lbf ft). Provided the correct size spacer has been selected, the rolling torque should be 2.0 Nm (1.5 lbf ft) when nut **T** is fully torque tightened.

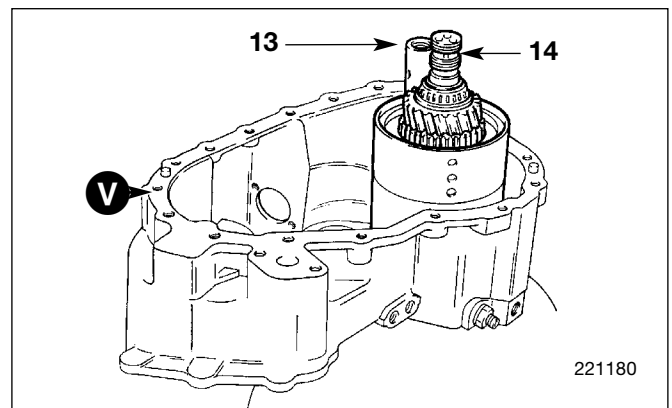
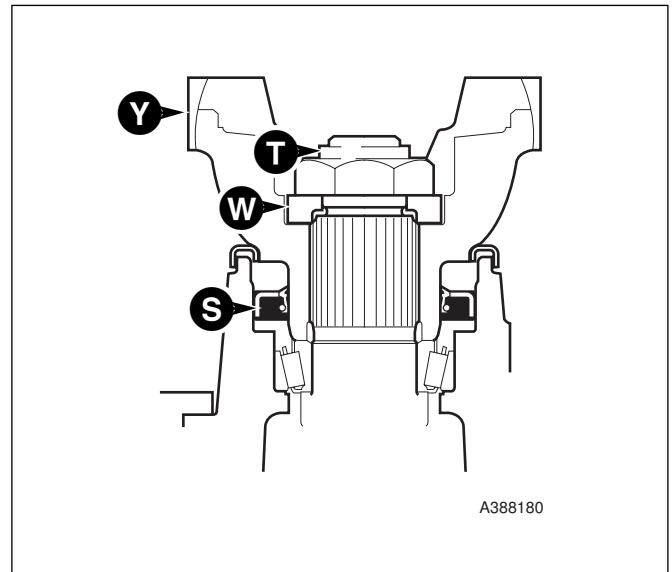
Note: If the rolling torque measured is too high, fit the next larger size spacer. If the rolling torque is too low, fit the next smaller size spacer.

- d** Finally, carefully stake nut **T** into slot using a square-ended staking tool.

- 13** Press idler gear spindle into front casing.

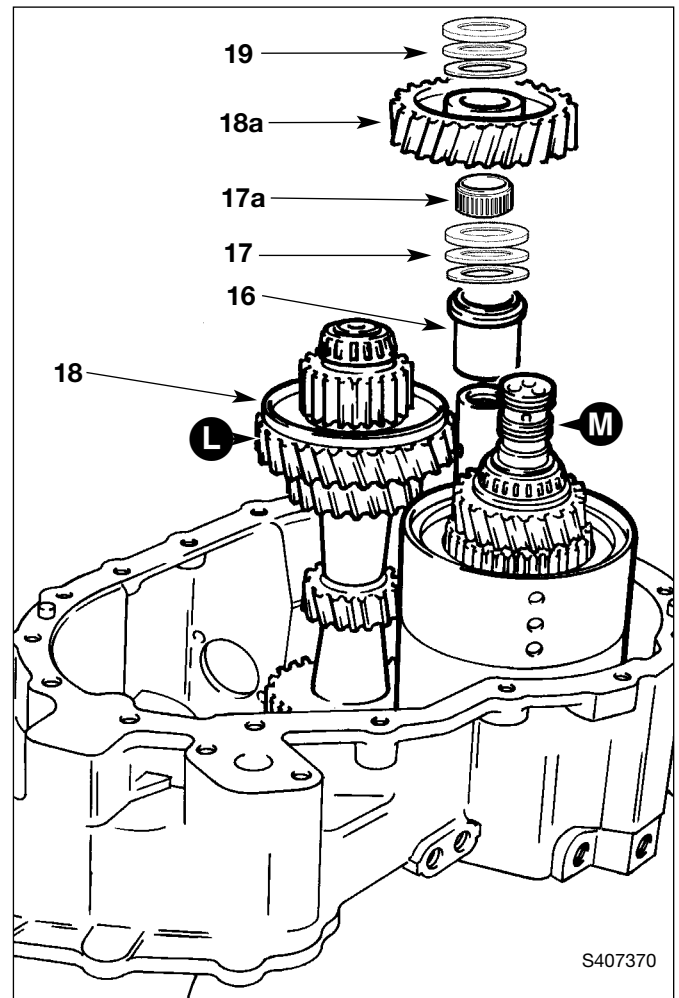
Note: Before proceeding further, make sure that the 3 shaft front bearing outer cups are correctly located inside the casing **V**.

- 14** Grease forward reverse shaft front bearing, then carefully lower forward/reverse unit into casing. Fit the shaft sealing rings and smear with grease.

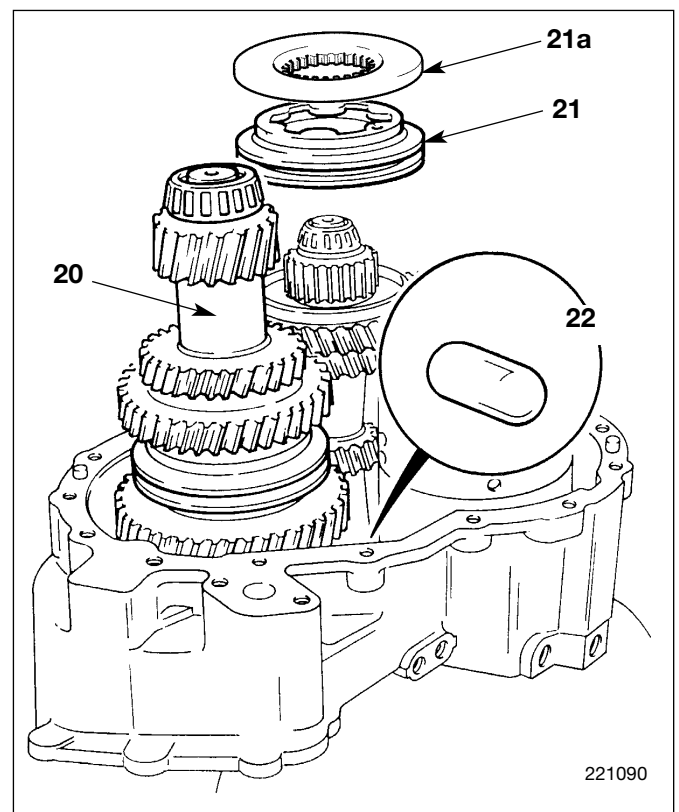


Assembly (cont'd)

- 15** Smear mainshaft output end bearing with JCB HP Grease and place mainshaft **L** in position, followed by the forward/reverse assembly **M**.
- 16** Fit idler gear spacer.
- * **17** Fit thrust washers and bearing assembly. Lubricate and fit the needle roller bearing **17a**.
- 18** Fit synchro cone to 3rd gear (mainshaft **L**). Fit the idler gear **18a** to the spindle whilst tilting mainshaft **L** to one side.
- * **19** Fit thrust washers and bearing assembly.

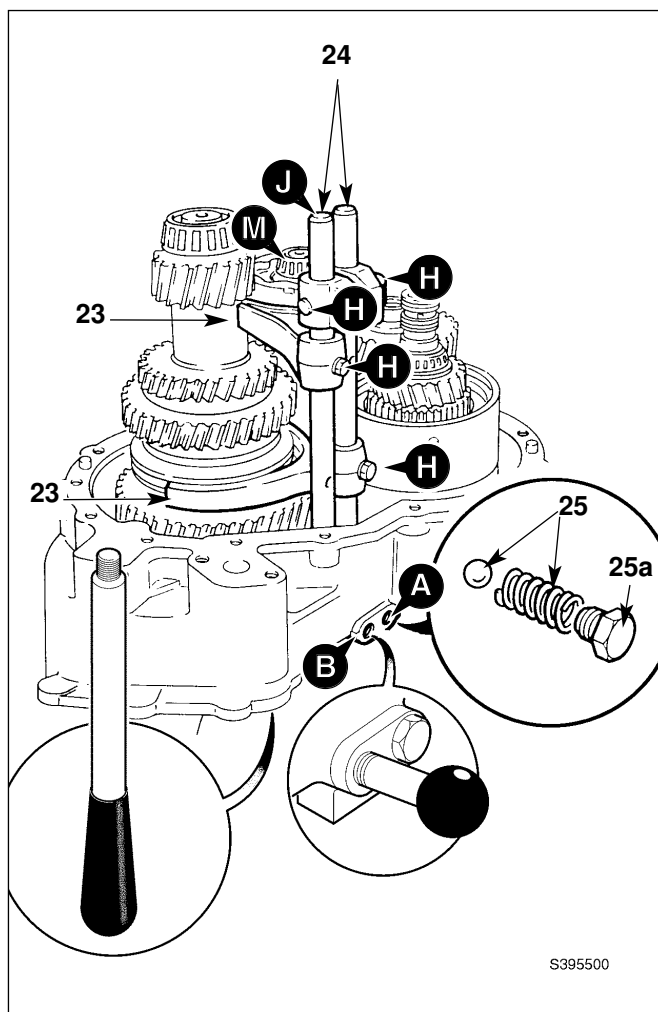


- 20** Smear front end bearing of layshaft with JCB HP Grease, and carefully lower layshaft into position.
- 21** If re-using synchro assembly fit the parts in their original positions.
- 22** Using a suitable wire support locate interlock plunger into its bore. A smear of grease will hold the plunger in position. If required, access is available via a $\frac{1}{4}$ BSP side drilling.



Assembly (cont'd)

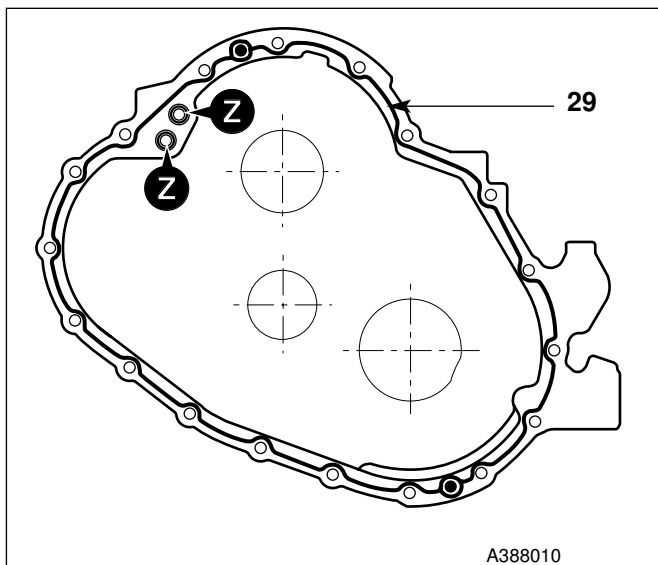
- 23** Fit selector forks into position.
- 24** Slide selector rods into position, taking care not to dislodge the interlock plunger. Apply JCB Threadlocker and Sealer to selector fork retaining screws **H**, and tighten to 35 Nm (26 lbf ft).
- 25** Fit 1st gear selector detent ball and spring at position **A**. Apply JCB Threadlocker and Sealer to the detent plug **25a**, screw in and tighten.
- 26** Temporarily fit the 3rd and 4th gear selector detent assembly at position **B**, do not apply sealant to the plug at this stage.
- 27** Check that each gear engages fully, and that the interlock plunger prevents simultaneous engagement of 2 ratios.
- 28** Remove the 3rd and 4th gear selector detent assembly from position **B**. Lift the selector rod **J** to select 4th gear. With 4th gear selected, temporarily lock the rod in position by screwing in service tool 892/01077 at **B**. Temporarily fit service tool 892/01078 to the torque converter end of mainshaft **M**. If the tool is not available a suitable M8 bolt approximately 100 mm long can be used.



S395500

- 29** Apply a bead of JCB Multigasket to mating face of casing. Insert 'O' rings **Z**. Smear grease onto reverser shaft ring seals, and apply JCB HP Grease to bearings prior to fitting output end casing.

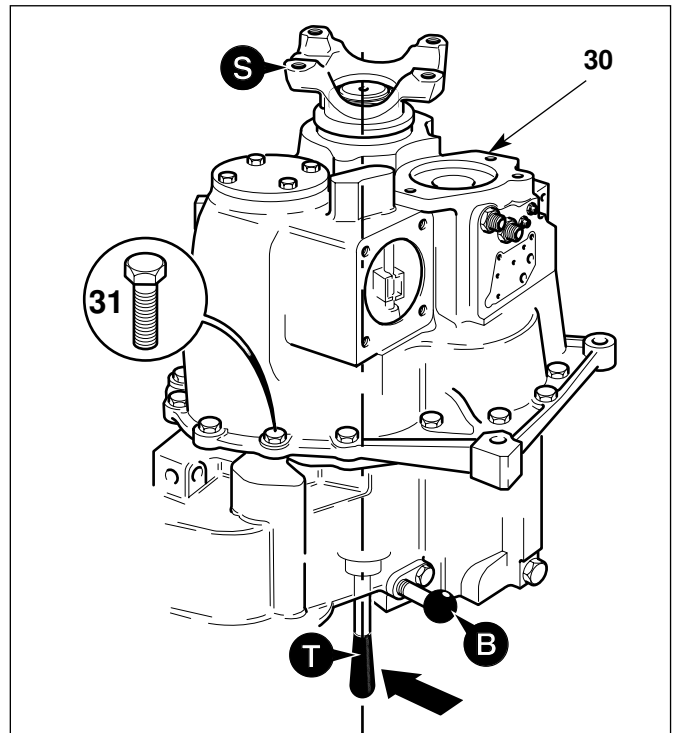
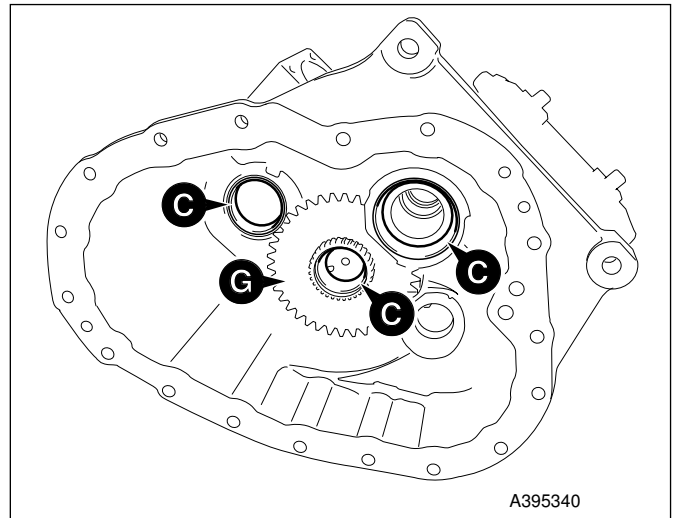
Note: Make sure that the forward/reverse shaft ring seals are in good condition before fitting output end casing.



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Assembly (cont'd)

- 30** Make sure that the 3 bearing outer cups **C** are correctly located; note that 2 cups locate inside the casing and 1 locates in the centre of the output shaft transfer gear **G**. Carefully lower rear casing into position. Note that the forward/reverse unit shaft engages with the casing first, followed by 3rd/4th gear selector rod. To ensure that the mainshaft locates with the output shaft it will be necessary to push on tool **T** to keep the shaft correctly aligned. Rotate the output shaft **S** back and forth to engage the gears on the layshaft. Do not use excessive force when fitting the casing.
- 31** Apply JCB Threadlocker and Sealer to bolts and torque to 56 Nm (42 lbf ft).
- 32** Remove service tool at position **B**. Fit the detent ball and spring. Apply JCB Threadlocker and Sealer to selector detent plug, install and tighten.



Assembly (cont'd)

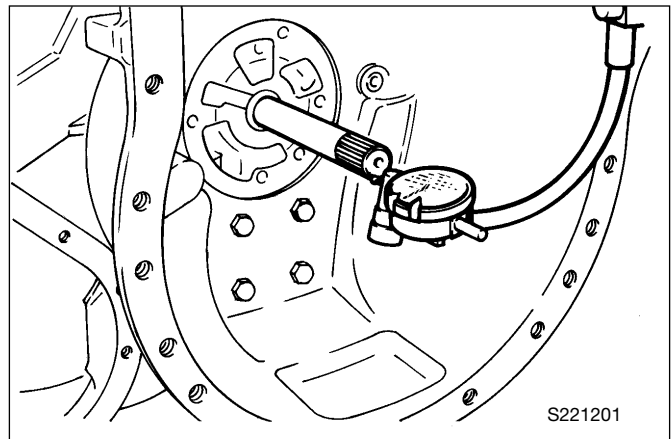
33 End Float Checking - Forward/Reverse Unit

- * Measure end float of forward/reverse unit shaft which should be 0.01 to 0.16 mm (0.0004 to 0.006 in).

Note: Rotate shaft whilst measuring to seat bearings fully. Position pointer of dial test indicator (DTI) on the chamfer of the shaft, not the end face. This will ensure a constant reading is given.

The forward/reverse shaft and its associated components are manufactured using a 'Setright' system. Provided components are assembled correctly the end float will be within the limits given above.

If there is no float, or too much end float, separate the casings and check that the bearings inner and outer cups are fitted correctly. If the forward/reverse shaft and clutch assemblies have been dismantled check that the assembly has been carried out correctly.

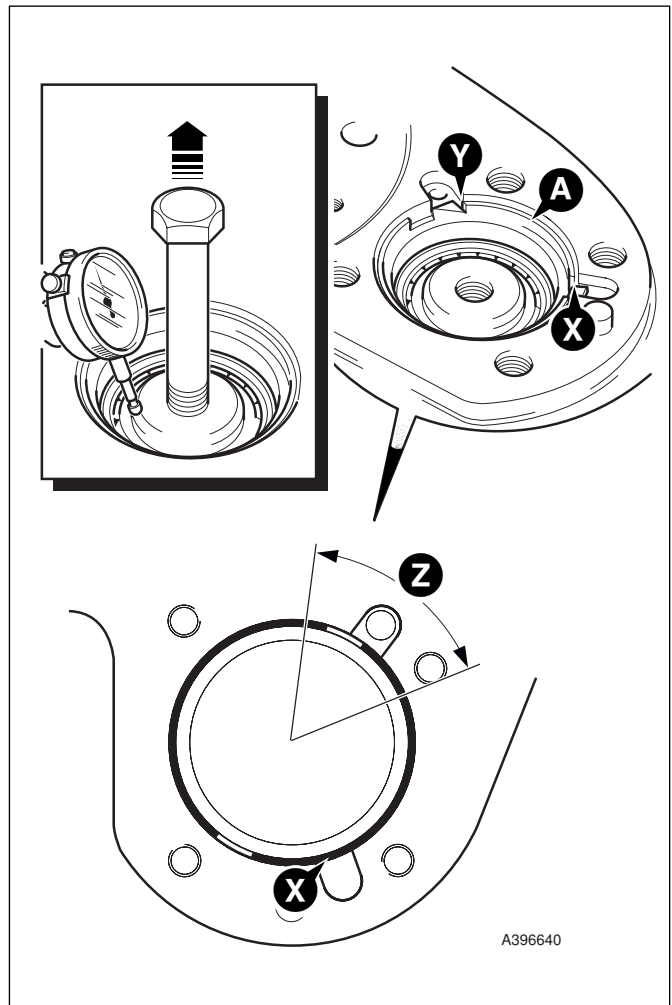
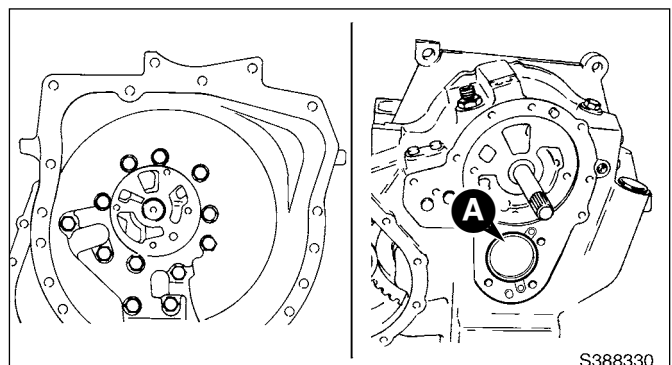


34 End Float Setting - Mainshaft

If the mainshaft, output shaft and/or associated bearings have been renewed, the shaft end float must be reset.

- Remove the torque converter housing and position the gearbox to gain access to setting ring **A**.
- Using service tool 892/01079 tighten the setting ring to 25 Nm (18.4 lbf ft) whilst at the same time rotating the shaft via the output yoke (a gear must be engaged). Do not over tighten the ring. Overtightening will damage the bearings.
- Undo the ring a small amount to obtain a shaft end float of 0.03 to 0.08 mm (0.001 to 0.003 in). To measure the endfloat screw in a bolt (or service tool 892/01078) at the threaded hole in the end of the shaft. Set up a DTI with the probe on the chamfer of the shaft. Zero the DTI. Rotate the shaft and at the same time pull up on the bolt, noting the reading on the DTI. Screw the ring in or out until the end float is correct.
- When the correct setting has been obtained, stake the setting ring to the casing as shown at **Y** (see the note below). Note that once staked the setting ring can not be used again. If the ring is disturbed it must be discarded and a new one used to re-set the end float.

Note: If the slots in the setting ring fall close (within zone **Z**) to the staking position **Y**, stake at position **X** instead. In this event the ring must also be folded on one side at position **Y**, fold on the side furthest away from the slot in the ring. This is important as the ring will otherwise restrict the flow of lubrication oil.



Assembly (cont'd)

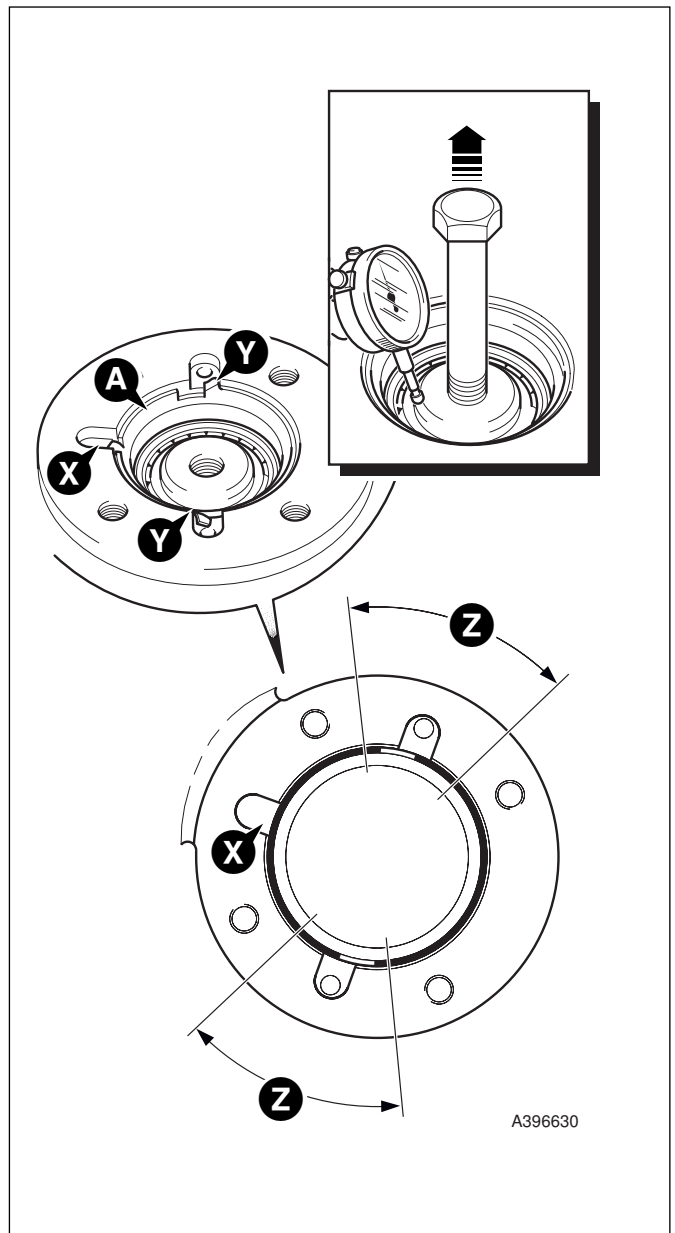
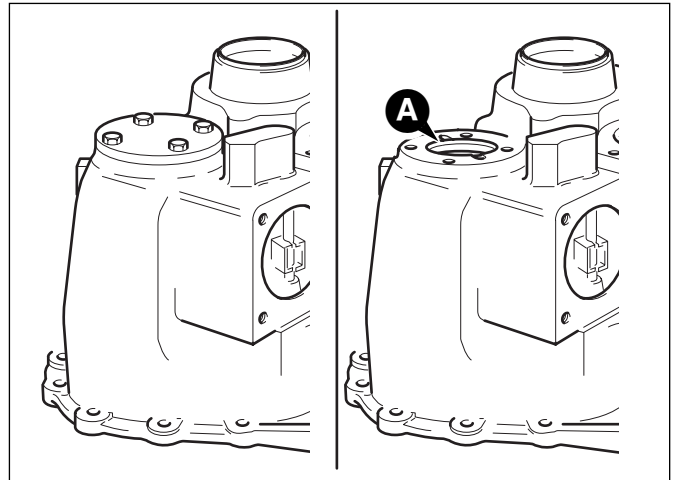
35 End Float Setting - Layshaft

If the layshaft and/or its bearings have been renewed, the shaft end float must be reset.

- a Fit the torque converter housing and stand the gearbox on the housing.
- b Using service tool 892/01079 tighten the setting ring **A** to 25 Nm (18.4 lbf ft) whilst at the same time rotating the shaft via the output yoke (a gear must be engaged). Do not over tighten the ring. Overtightening will damage the bearings.
- c Undo the ring a small amount to obtain a shaft end float of 0.03 to 0.08 mm (0.001 to 0.003 in). To measure the endfloat screw in a bolt (or service tool 892/01078) at the threaded hole in the end of the shaft. Set up a DTI with the probe on the chamfer of the shaft. Zero the DTI. Rotate the shaft and at the same time pull up on the bolt, noting the reading on the DTI. Screw the ring in or out until the end float is correct.
- d When the correct setting has been obtained, stake the setting ring to the casing as shown at the two positions **Y** (see the note below). Note that once staked the setting ring can not be used again. If the ring is disturbed it must be discarded and a new one used to re-set the end float.

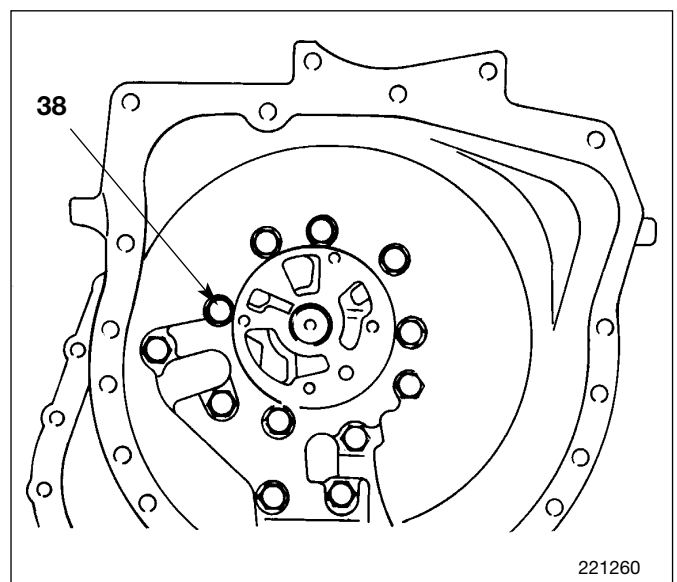
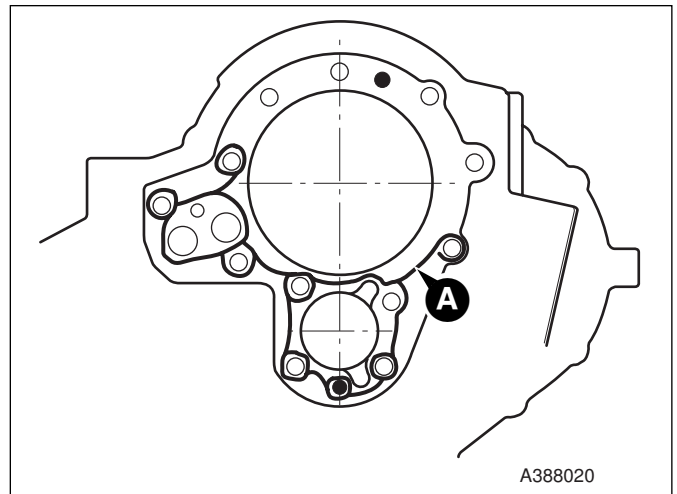
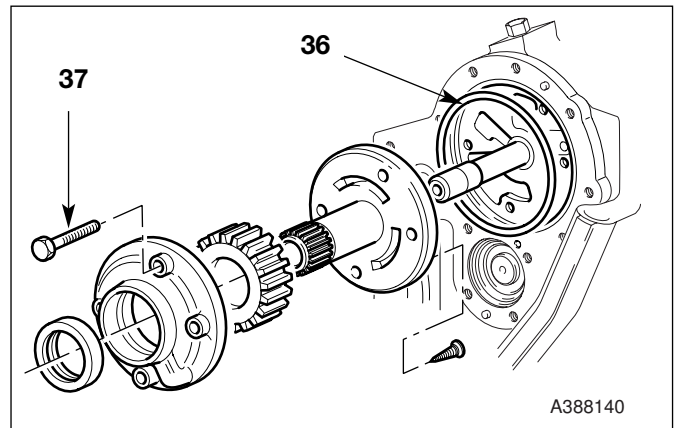
Note: If the slots in the setting ring fall close (within zone **Z**) to the staking positions **Y**, stake at position **X** instead. In this event the ring must also be folded on one side at the two positions **Y**, fold on the side furthest away from the slot in the ring. This is important as the ring will otherwise restrict the flow of lubrication oil.

- e Using a new gasket, refit the layshaft bearing cover. Apply JCB Threadlocker and Sealer to the fixing bolts and tighten to 56 Nm (42 lbf ft).



Assembly (cont'd)

- 36** Place new pump sealing ring in position. Make sure that the charge pump drain hole is clear before fitting a new oil seal to the pump housing.
- 37** Install pump taking care to align mounting holes. Apply JCB Threadlocker and Sealer to bolts and, using new sealing washers, tighten to 28 Nm (21 lbf ft).
- 38** Apply a bead of JCB Multigasket to the mating face of the gearbox cover as shown at **A**. Refit the torque converter housing. Apply JCB Threadlocker and Sealer to the 12 bolts and tighten to 56 Nm (42 lbf ft).



Assembly (cont'd)

- 39** Fit torque converter pressure relief valve assembly **39a**; Fit the valve ball and spring. Ensure that larger diameter of spring is located securely over the spigot on the plug. Use a new sealing washer, apply JCB Threadlocker and Sealer to the plug, then tighten. Fit the torque converter pressure regulating valve assembly **39b**; Fit the spool and spring. Apply JCB Threadlocker and Sealer to the plug, then tighten.

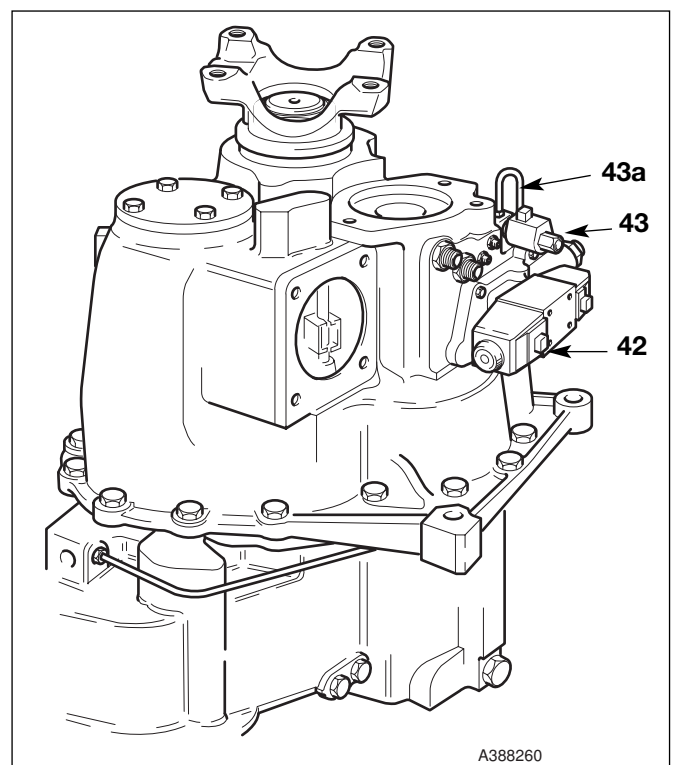
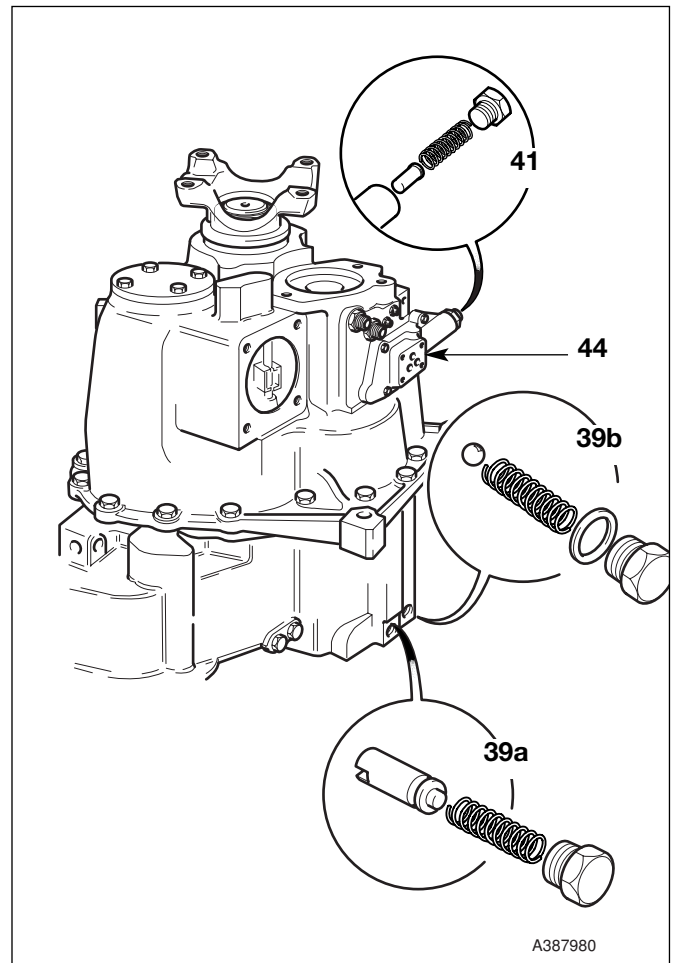
- 40** Using a new gasket mount pressure maintenance valve onto casing. Apply JCB Threadlocker and Sealer to bolts and tighten to 10 Nm (7.4 lbf ft).

Note: To avoid contamination of sealant printed on gasket face keep in protective wrapper until needed.

- 41** Assemble pressure maintenance valve spool and spring into adaptor block. Apply JCB Threadlocker and Sealer to plug, fit and tighten. **Do not overtighten** as damage to the aluminium housing could result.

- 42** Fit new 'O' rings around ports on mating face of solenoid valve. Mount solenoid valve onto pressure maintenance valve, ensuring that port 'P' aligns with metering orifice in the pressure maintenance valve body. Apply JCB Threadlocker and Sealer to capscrews and tighten to 5Nm (3.7 lbf ft).

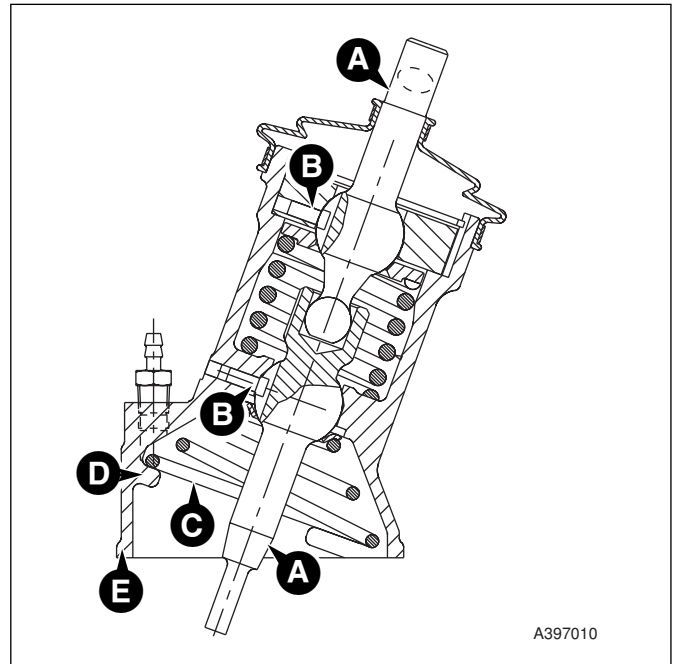
- 43** Fit the 4 wheel drive solenoid valve. Fit the hydraulic pipe **43a**.



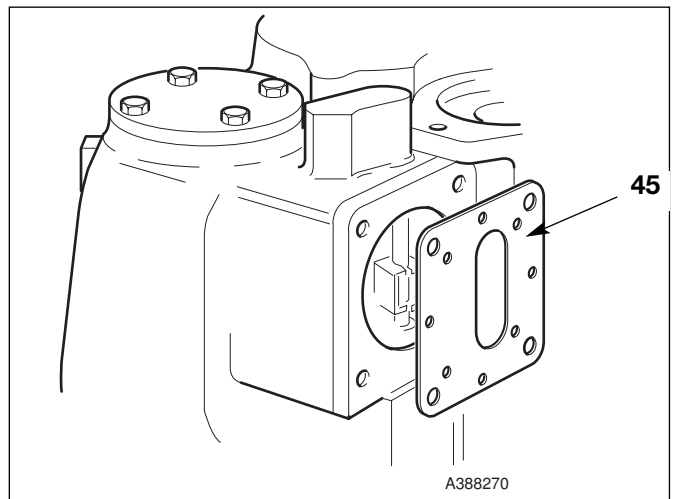
Assembly (cont'd)

44 If the gear lever turret assembly has been dismantled, apply grease liberally to the working surfaces before assembling. Assembly is the reverse of the procedure detailed in **Gearbox - Dismantling**, Step 1, but note the following:

- * **a** Be sure to locate the slots in the levers **A** with the pegs **B** in the housing **E**.
- b** After fitting spring **C**, rotate it so that the end of the bottom coil butts with the the spigot **D** in the housing **E**.

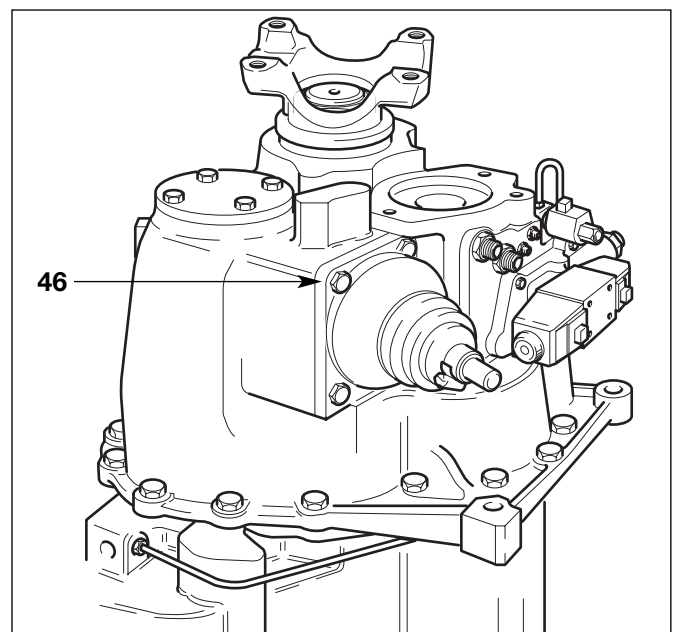


45 Locate a new gasket (not shown) on the casing followed by the gear lever turret baffle plate. Make sure the plate is the correct way round.



46 Locate a second gasket and then fit the turret assembly.

Apply JCB Threadlocker and Sealer to mounting bolts and tighten to 56 Nm (42 lbf ft). Check for gear selection.



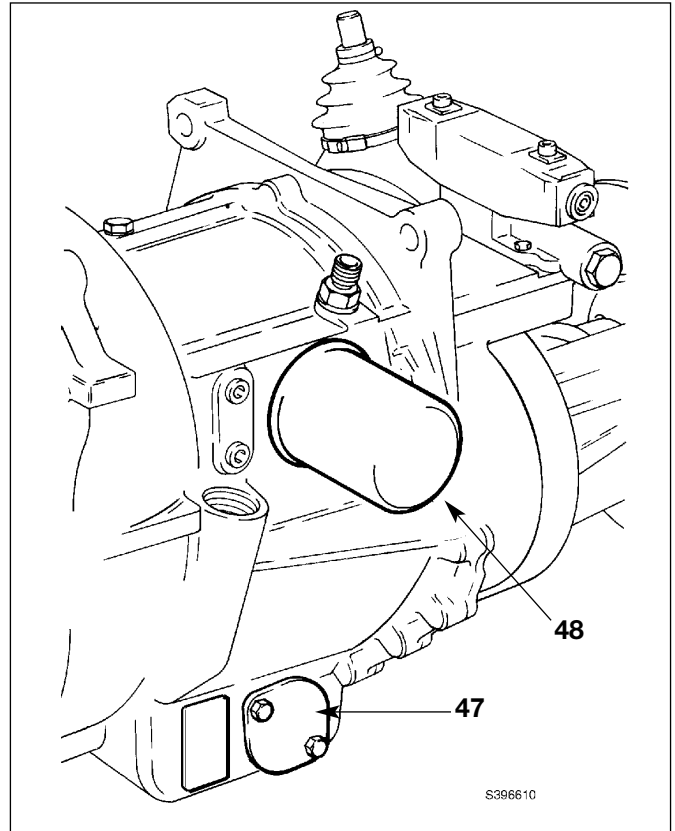
Assembly (cont'd)

Note: It is recommended that a 75 micron (0.075mm) service suction strainer (892/00970) is fitted to clean the system after a major overhaul.

Remove the service strainer and fit a production strainer after the first 100 hours operation. Renew the oil.

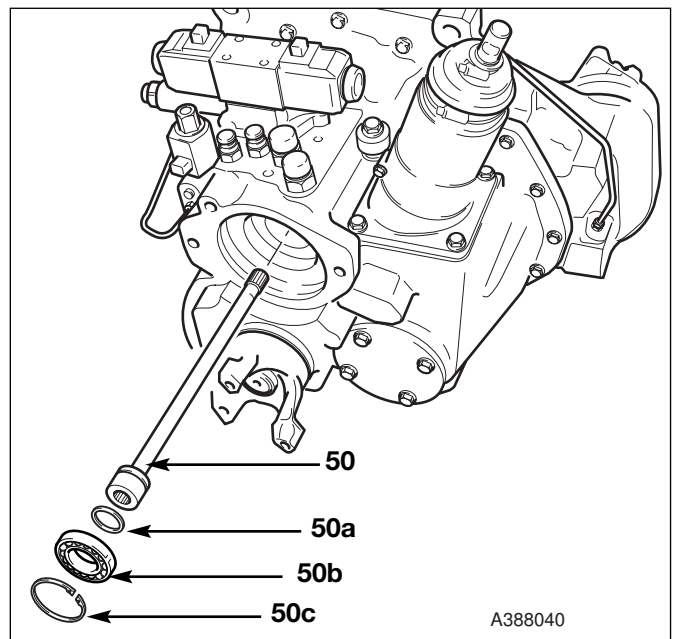
- 47** Using a new gasket, install suction strainer. Apply JCB Threadlocker and Sealer to bolts and tighten to 10 Nm (7 lbf ft).
- 48** Fit a new filter:
 - a** Smear seal with transmission oil.
 - b** Screw the filter on until it just contacts the filter head.
 - c** Turn the filter at least another 3/4 of a turn.
- 49** Install dipstick/oil filler tube (not shown) as follows:
 - a** Fit nut to tube followed by seal.
 - b** Insert tube fully down bore in casing. Engage nut and tighten down loosely onto seal.
 - c** Tighten nut fully after tube has been correctly phased.

See **2/4 Wheel Drive Clutch** for hydraulic 4WD dismantling and assembly procedures.



- 50** Fit a new sealing ring **50a** to the pump drive shaft. Insert the pump drive shaft followed by bearing **50b** and circlip **50c**.

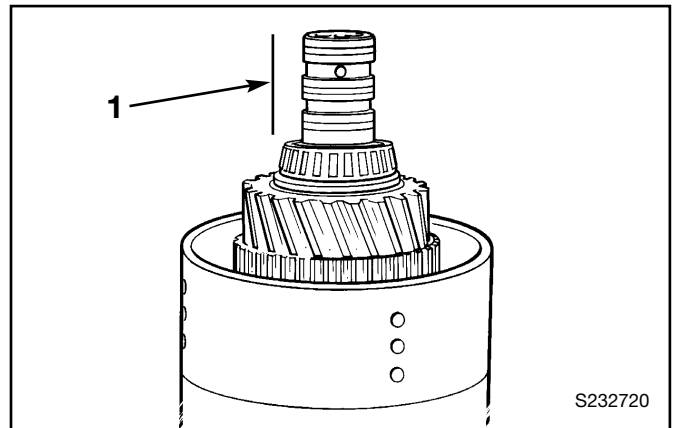
Note: The main hydraulic pump may be fitted at this stage, or, after the gearbox has been refitted to the machine.



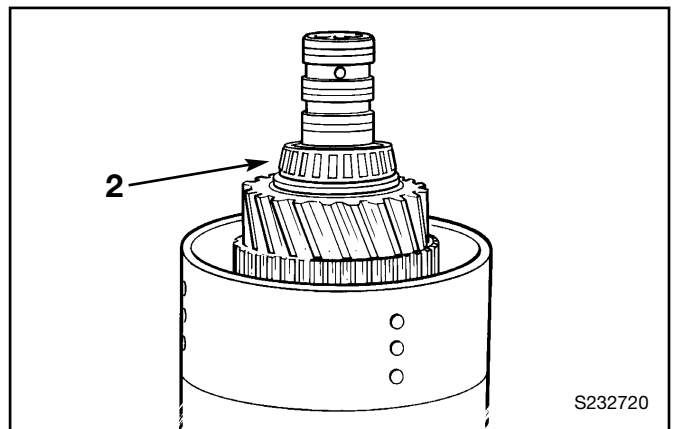
Reverser Unit - Dismantling

- 1 Carefully remove piston ring seals.

Note: If the piston ring seals are excessively worn then check for burrs or damage on the shaft grooves. If necessary remove burrs with a fine grade abrasion paper and oil.

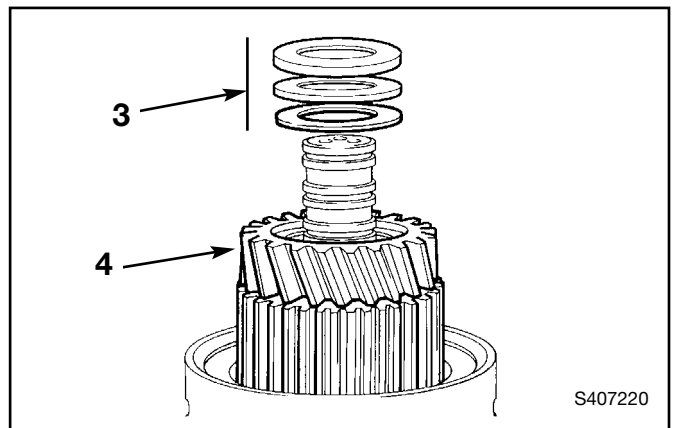


- * 2 Remove the taper bearing using pullers.



- * 3 Remove the thrust bearing and thrust washers.

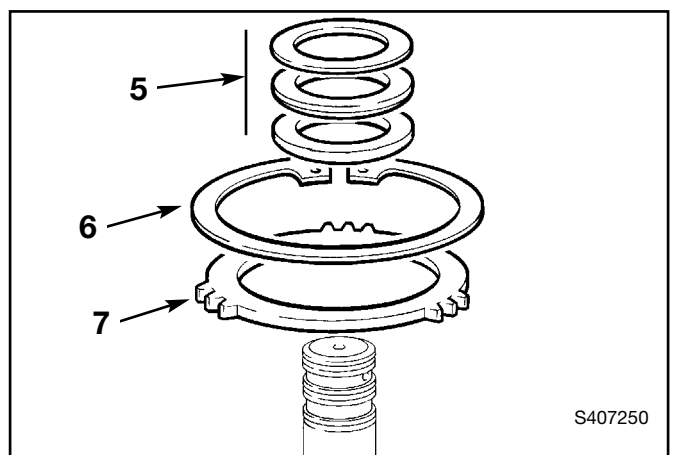
- * 4 Withdraw the gear and splined hub assembly 4 with the needle roller bearing and spacer. Note the location of the spacer to ensure it is returned to its original position on re-assembly.



- * 5 Remove the thrust bearing and thrust washers.

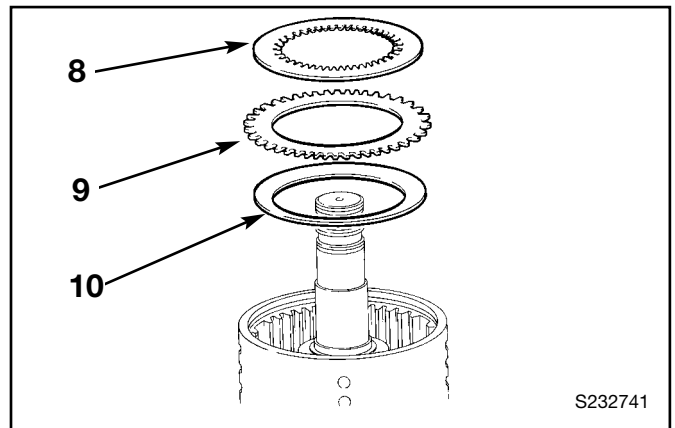
- 6 Remove the clutch friction/counter plates retaining circlip.

- 7 Remove pressure (end) plate.

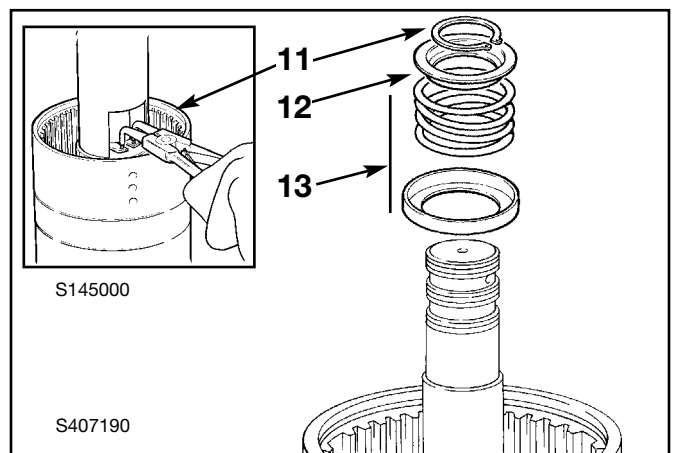


Reverser Unit - Dismantling (cont'd)

- 8 Remove the clutch friction/counter plates. Keep them together in sets, DO NOT mix the plates with those from other clutches.
- 9 Remove last counter plate.
- * 10 Remove disc spring.

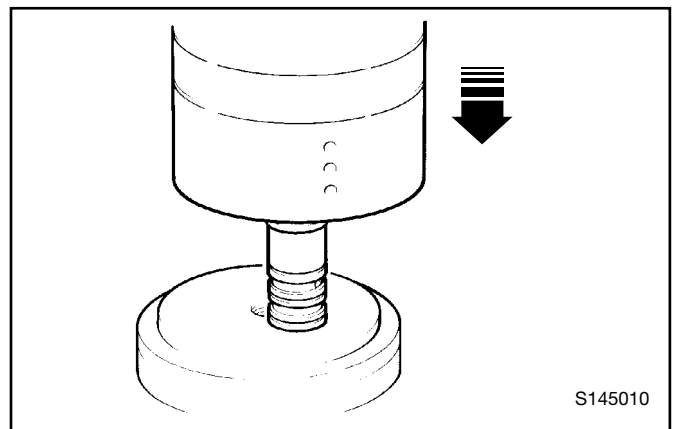


- 11 Position clutch assembly in press to compress piston spring then remove circlip.
- 12 Lift off spring retaining plate.
- * 13 Remove spring and oil baffle.

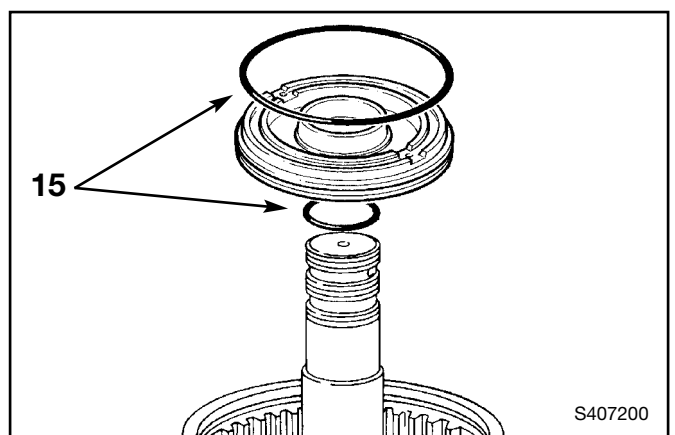


- 14 Knock the clutch shaft on a piece of aluminium (or wood) to remove the piston.

Note: If the piston does not loosen when the clutch shaft is knocked on aluminium, then hand pump air down the shaft oil inlet hole.

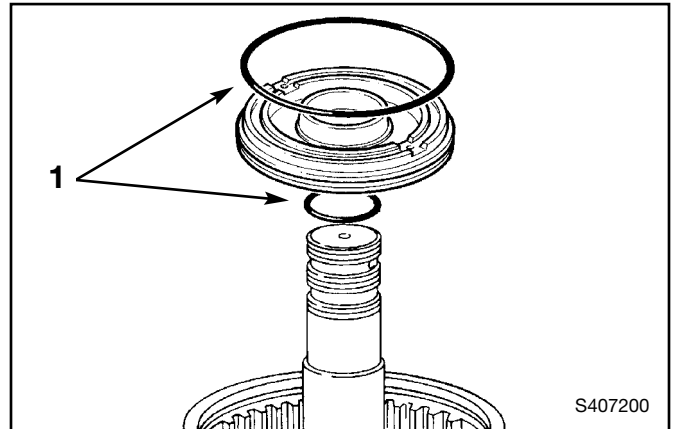


- * 15 Remove and discard piston and shaft 'O' rings.
- * 16 Repeat steps 2 to 15 to dismantle the opposite clutch. Note that a spacer is not fitted on the opposite (Forward) clutch. Refer to step 4.

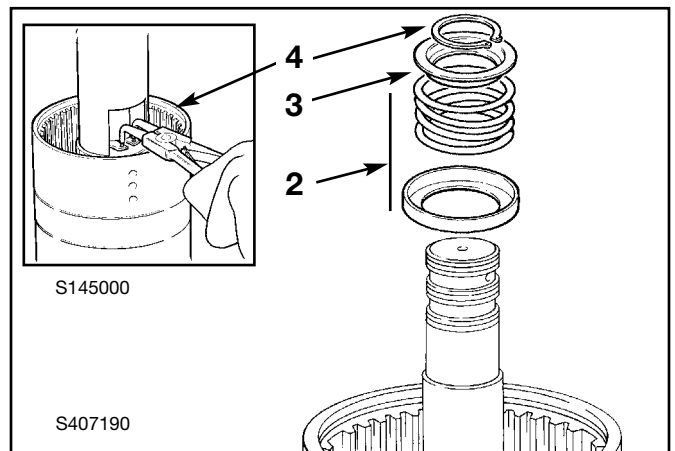


Reverser Unit - Assembly

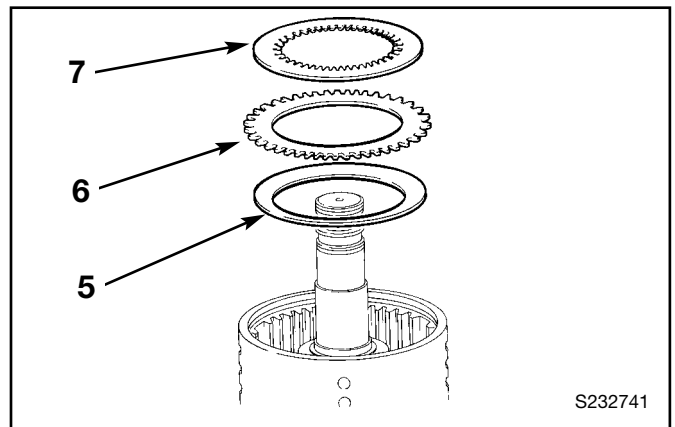
- 1 Fit new 'O' rings onto the piston and shaft, lubricate with oil then press piston fully into bore of clutch housing.



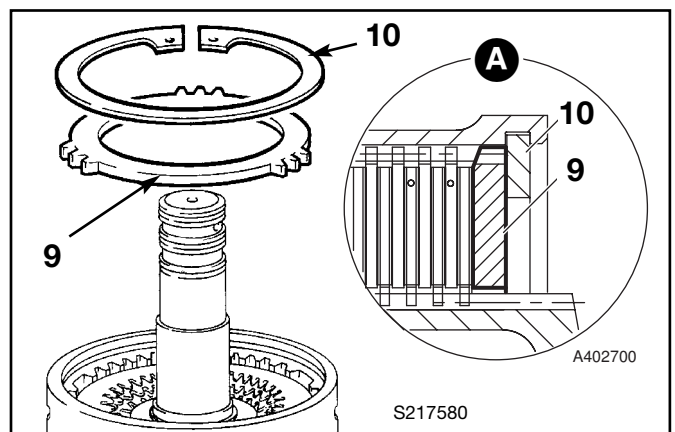
- * 2 Install the oil baffle and piston spring, make sure the spring seats in the piston.
- 3 Fit the spring retaining plate.
- 4 Compress spring and secure with circlip.



- 5 Fit the disc spring assembly. Fit the assembly so that the outer diameter curves away from the clutch piston.
- 6 Firstly, fit one counter plate.
- 7 Fit one friction plate followed by one steel counter plate.
- 8 Continue fitting alternate friction and plain steel plates, finishing with a friction plate.



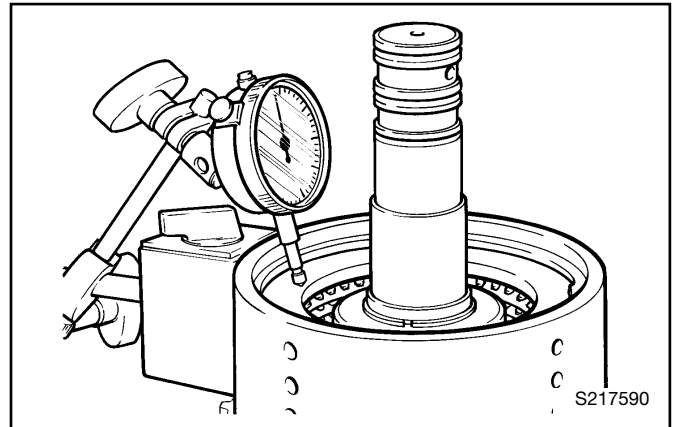
- 9 Fit the pressure (end) plate. Make sure that the chamfered face is fitted facing the clutch pack as shown at **A**. Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes).
- * 10 Fit the clutch friction/counter plates retaining circlip. Using an air line, blow air down the shaft oil inlet hole and check the piston and clutch pack is free to operate smoothly.



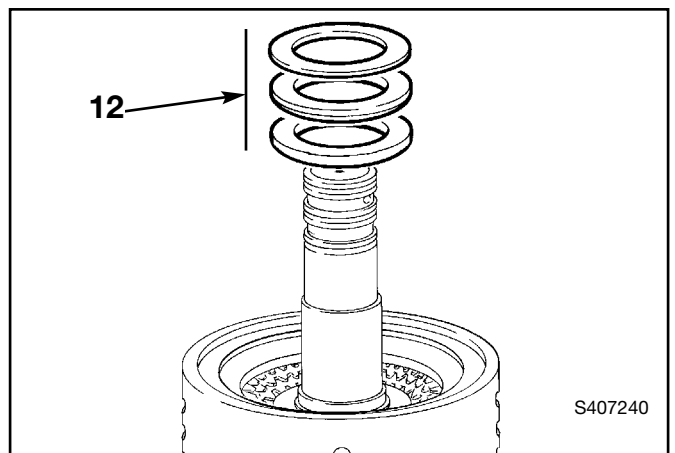
Reverser Unit - Assembly (cont'd)

- 11** Using a dial test indicator as shown, measure the end float of the pressure (end) plate, which should be 3.2 to 4.4 mm (0.126 to 0.173 in). If necessary, fit shim between the retaining circlip and pressure (end) plate to correct end float inaccuracies.

*



- 12** Fit the thrust bearing and thrust washers.



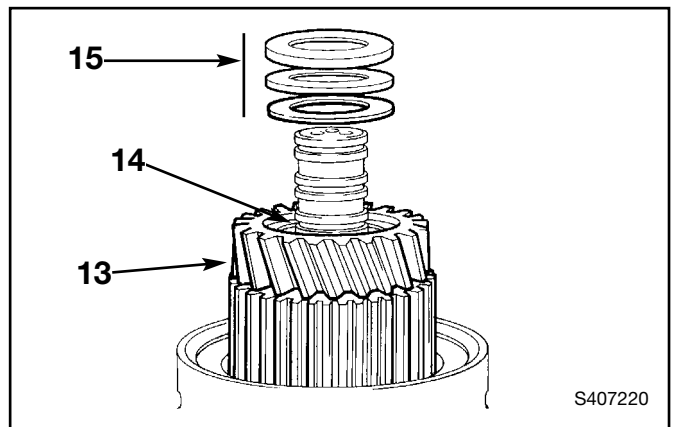
- 13** Fit gear and splined hub assembly.

Note: Prior to fitting gear, align teeth of clutch plates using a thin rod (screwdriver).

- * **14** Fit the spacer followed by the needle roller bearing.

* **Note:** Ensure that the spacer is fitted first.

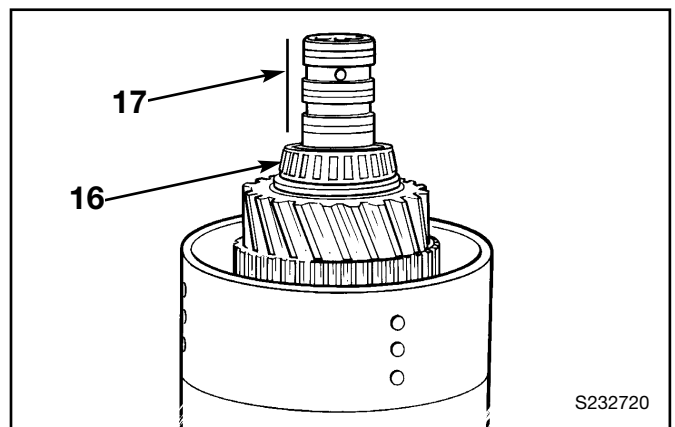
- * **15** Fit the thrust bearing and thrust washers.



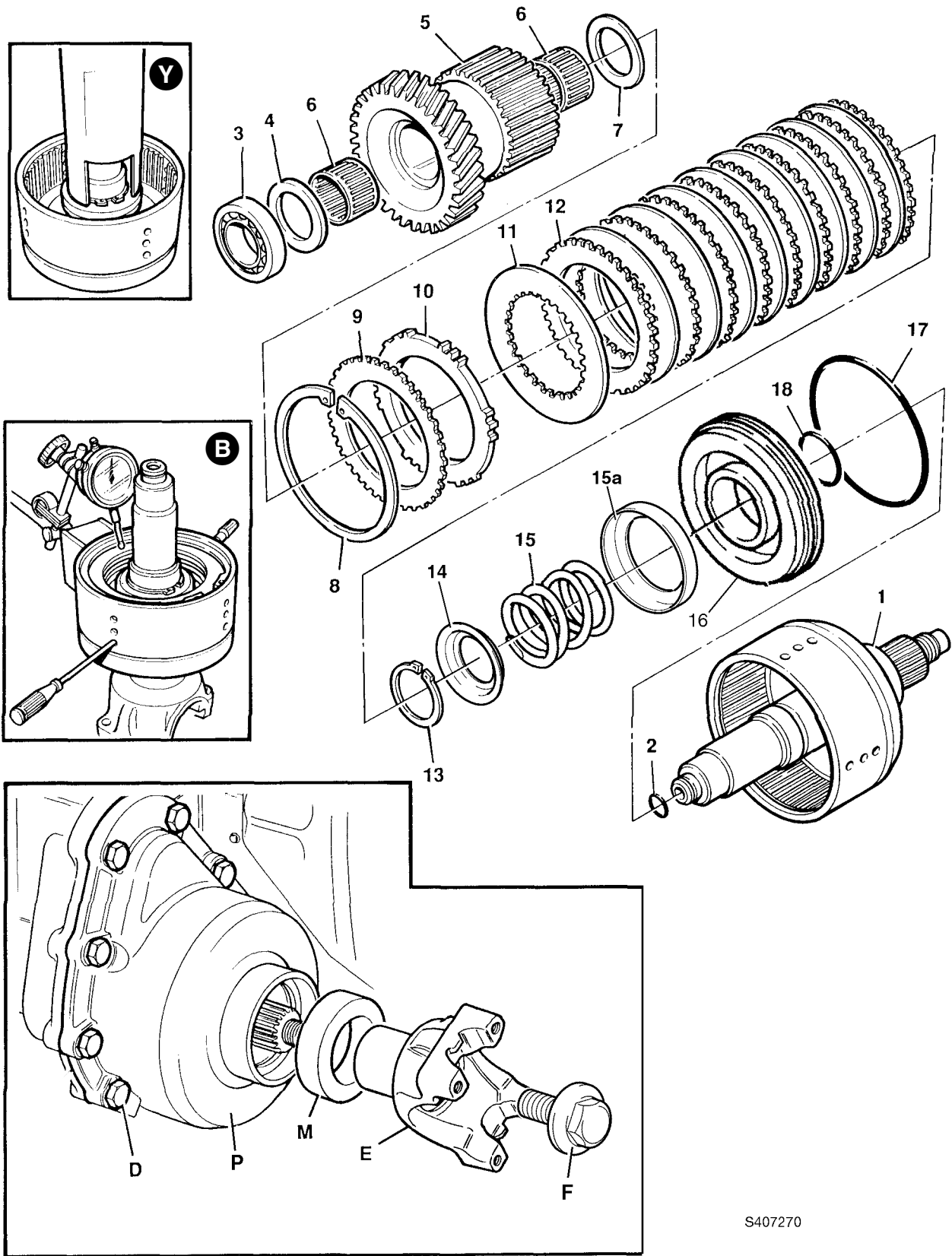
- 16** Smear the clutch end bearing with JCB HP Grease and press the bearing onto shaft.

- * **17** Fit piston ring seals, refer to **Piston Ring Seals - Fitting Procedure**.

- * **18** Repeat steps 1 to 16 for the opposite clutch. Note that a spacer is not fitted on the opposite (Forward) clutch. Refer to step 14.



Hydraulic 2/4 Wheel Drive Unit (4WD Pressure ON)



S407270

Hydraulic 2/4 Wheel Drive Unit (4WD Pressure ON)

Dismantling

Note: To aid working on this item, use the output yoke as a stand.

Before dismantling the unit drain the gearbox oil.

- 1 Hold the yoke **E** using service tool 892/00812 and undo bolt **F**. Remove the yoke. Carefully remove and discard oil seal **M**. Be sure not to damage the seal housing.
- 2 Undo bolts **D**. Lift off the 4WD casing **P**. Lift out the 4WD unit from the gearbox.
- 3 Remove bearing **1**, only if to be renewed.
- 4 Remove seal ring **2**. Note, If the piston ring seal is damaged or excessively worn then check for burrs or damage on the shaft groove. If necessary remove burrs with a fine grade abrasion paper and oil.
- * 5 Using a puller remove the 4WD output gear **5**, together with its bearing **3**, needle roller bearings **6** and thrust washer **4**. Remove thrust washer **7**. (Note that thrust washers **4** and **7** are not interchangeable).
- 6 Remove circlip **8** and shim(s) **9** if fitted. Retain any shims as a set for assembly.
- 7 Remove pressure plate **10**, the clutch pack friction plates **11** and counter plates **12**.

Note: If only the clutch pack was to be removed, the job is now complete.

- 8 Using a suitable press and an adapter similar to **Y**, compress spring **15** and remove circlip **13**.
- 9 Remove spring retainer plate **14**, spring **15** and oil baffle **15A**.
- 10 Withdraw piston **16** then remove and discard 'O' rings **17** and **18**.

Note: The piston housing cannot be separated from the shaft, as on the other types of 2/4WD units.

Inspection

Carry out a visual inspection of the friction and counter plates.

Counter plates - light scoring/polishing is permissible, plates that are not flat, worn or heavily marked or scored must be replaced with a new set.

Friction plates - the cross hatching should be clearly visible, plates that are not flat, have friction material damage or scoring must be replaced with a new set.

Do not mix old, new and worn plates.

Two different suppliers of the thinner friction plates (1.6 to 1.7 mm, 0.062 to 0.067 in approx) have been used (identify as brown or green), do not mix the different plates in the same clutch pack.

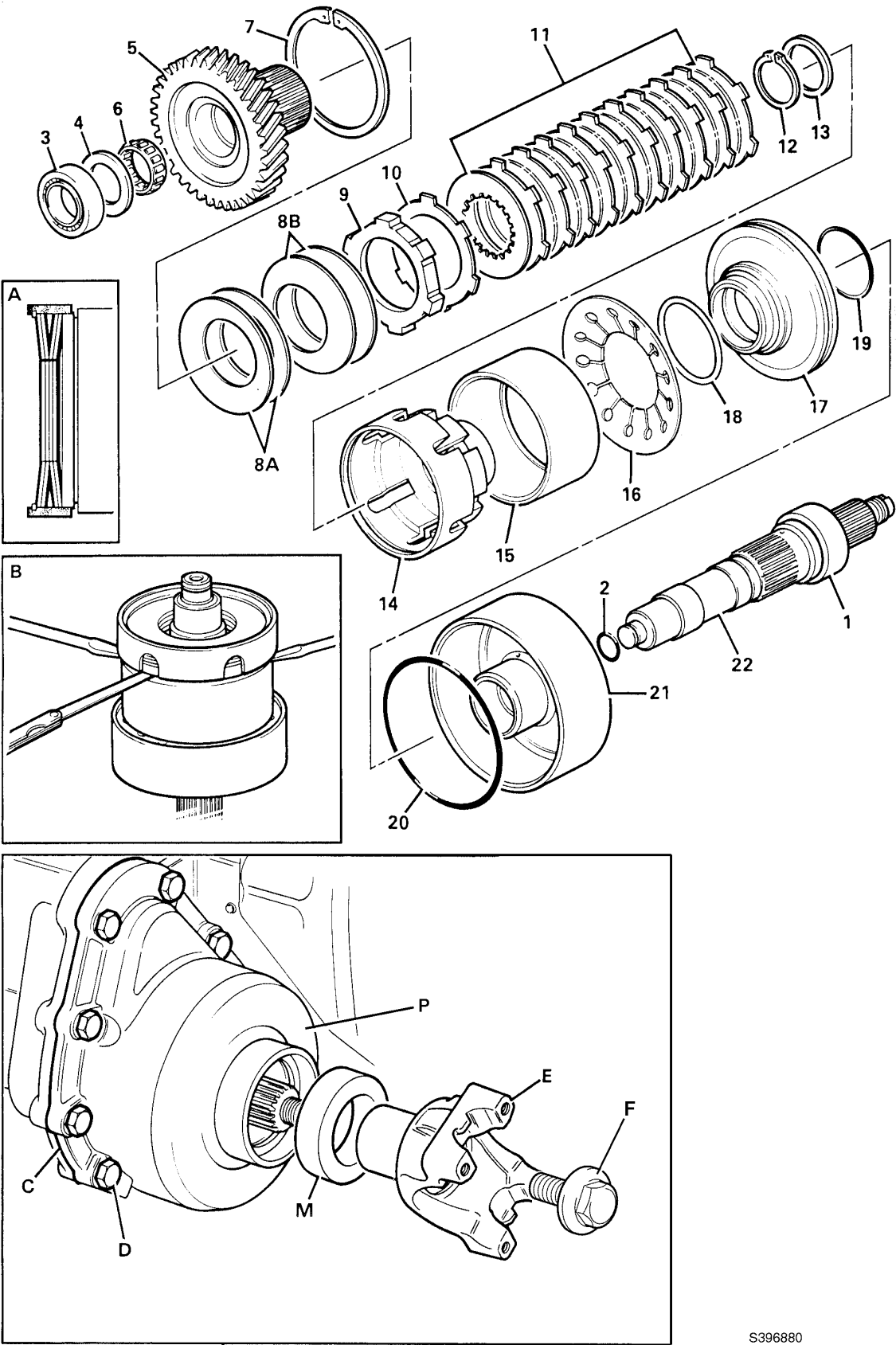
Inspect the mating faces of the gearbox and 4WD casings for damage.

Assembly

If only the clutch pack has been removed, begin at step 4.

- * 1 Grease the shaft, fit new 'O' rings **17** and **18** then locate piston **16** over the shaft and into the housing.
 - 2 Locate oil baffle **15A**, spring **15** into the piston and position the retainer plate **14** over the spring.
 - 3 Using a press and adapter **Y**, compress spring **15** and fit circlip **13**.
 - 4 Build up the clutch pack, installing friction plates **11** and counter plates **12** alternately, starting with a counter plate and ending with a friction plate.
 - * 5 Install pressure plate **10**, shim(s) **9** and circlip **8**. Using an air line, blow air down the shaft oil inlet hole and check the piston and clutch pack is free to operate smoothly.
 - 6 Measure the clutch pack end float using two screwdrivers as shown at **B**. End float should be between 1.0 mm and 2.3 mm. Adjust as necessary, by adding or removing shims **9**.
 - * 7 Fit thrust washer **7**, 4WD gear **5**, needle roller bearings **6** and thrust washer **4**.
 - 8 Press bearing **3** squarely onto the shaft to seat on thrust washer **4**, taking care not to exert any force on the housing i.e. rest the unit on the opposite shaft end, not the housing.
 - 9 Fit new seal **2**.
 - 10 If required, press a new bearing **1** into position, taking care not to exert any force on the housing (see Step 8).
 - 11 Fit the 2/4WD unit to the gearbox.
 - 12 Apply a thin bead of JCB Multigasket to the 4WD mating face of the gearbox front case. Fit the case **P**, apply JCB Threadlocker and Sealer to bolts **D** and progressively torque tighten to 56 Nm, 46 lbf ft.
 - * 13 The 4WD clutch and its associated components are manufactured using a 'setright' system. Provided that components have been assembled correctly, the shaft end float will be 0.01 to 0.16 mm (0.0004 to 0.006 in).
- Rotate the shaft by hand and ensure that it runs smoothly. Pull the shaft up and down to detect any excessive end float. If there is excessive end float or the shaft runs roughly, dismantle the unit and check for correct assembly.
- 14 Fit a new oil seal **M**, fit the output yoke **E**, and flanged bolt **F**. Torque tighten the bolt to 395 Nm; 291 lbf ft.

Hydraulic 2/4 Wheel Drive Unit (4WD Spring ON)



S396880

Hydraulic 2/4 Wheel Drive Unit (4WD Spring ON)

Dismantling and Assembly

Note: Before dismantling the unit drain the gearbox oil.

Dismantling

- 1 Hold the yoke **E** using service tool 892/00812 and undo bolt **F**. Remove the yoke. Carefully remove and discard oil seal **M**. Be sure not to damage the seal housing.
- 2 Undo bolts **D**. Lift off the 4WD casing **P**. Lift out the 4WD unit from the gearbox.
- 3 Remove bearing **1**, only if to be renewed.
- 4 Remove seal ring **2**. Note, If the piston ring seal is damaged or excessively worn then check for burrs or damage on the shaft groove. If necessary remove burrs with a fine grade abrasion paper and oil.
- 5 Pull off the 4WD output gear **5**, together with its bearing **3**, needle roller bearing **6** and thrust washer **4**.
- 6 Using a suitable press, compress disc springs **8A**, **8B** and remove the circlip **7**.

CAUTION: There is approximately 26700N (6000lbf) clamping force acting on the springs.

- 7 Remove disc springs **8A**, **8B**, pressure plate **9**, shim(s) **10** (keep the shim(s) separate from the counter plates), and clutch pack friction plates and counter plates **11**.
- 8 Remove the clutch drum retaining circlip **12** and support washer **13**.
- 9 Remove clutch drum **14** and actuating sleeve **15**.
- 10 Remove disc spring **16**.
- 11 Remove the piston **17** and its spring steel ring **18**.
- 12 Remove and discard piston O-rings **19** and **20**.
- 13 Remove the piston housing **21** only if necessary, the housing is a press fit on shaft **22**.

Inspection

Carry out a visual inspection of the friction and counter plates.

Counter plates - light scoring/polishing is permissible, plates that are not flat, worn or heavily marked or scored must be replaced with a new set.

Friction plates - the cross hatching should be clearly visible, plates that are not flat, have friction material damage or scoring must be replaced with a new set.

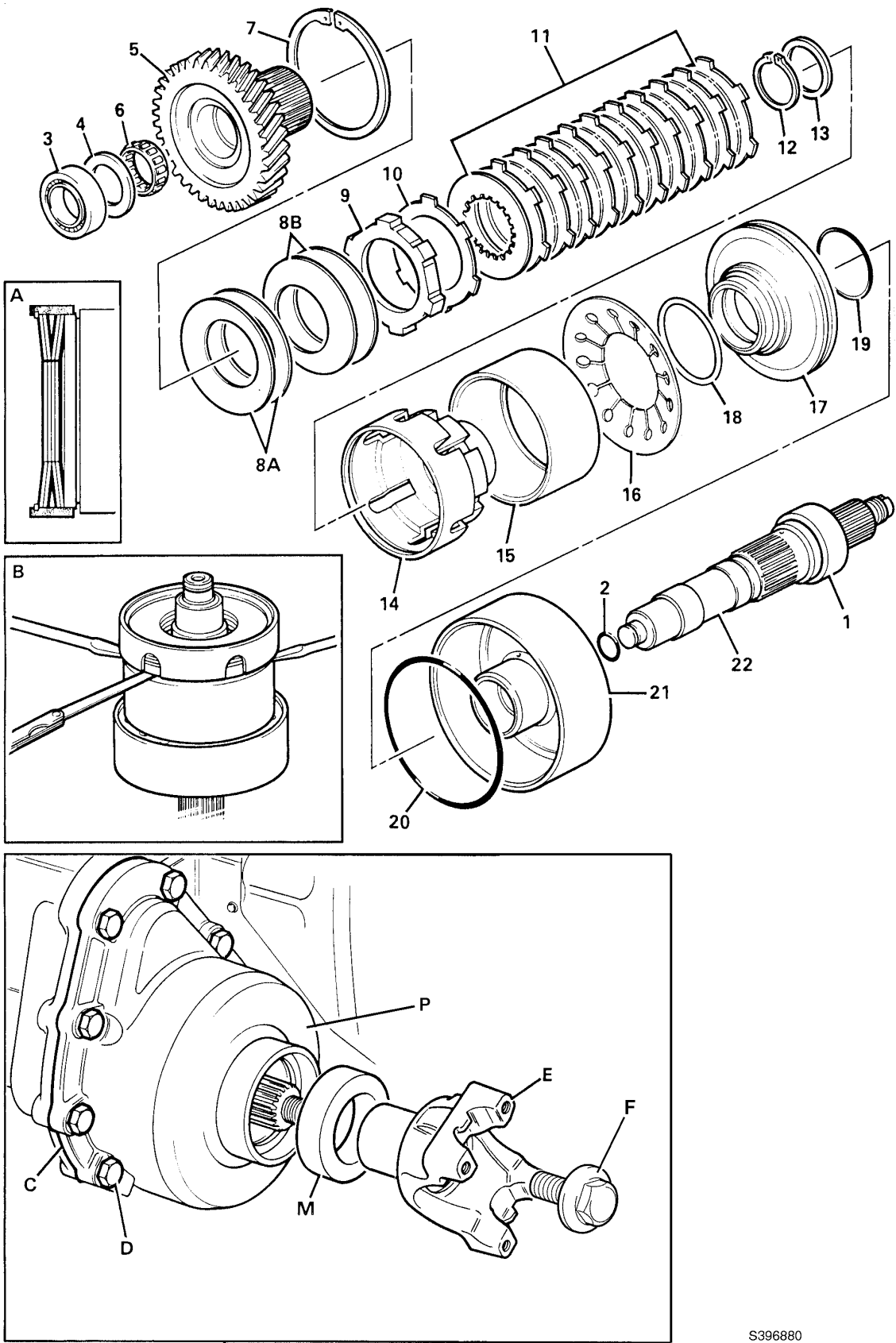
Do not mix old, new and worn plates.

Two different suppliers of the thinner friction plates (1.6 to 1.7 mm, 0.062 to 0.067 in approx) have been used (identify as brown or green), do not mix the different plates in the same clutch pack.

Assembly

Note: Use the pressure test adaptor and clamp assembly (see **Service tools**) to 'bench test' the clutch. Bench testing will ensure the clutch operates correctly prior to - assembling and installing in the machine. Refer to **Hydraulic 2/4 Wheel Drive Unit, Pressure Testing the 2/4 WD Clutch**.

- 1 Grease the shaft **22** then fit the piston housing **21** by pressing the shaft squarely into the housing (make sure the housing is securely supported on the centre boss).
- 2 Fit new O-rings **19** and **20** to piston **17**, locate the piston into housing **21**. Fit spring steel ring **18** ensuring that it seats firmly in its groove.
- 3 Place the disc spring **16** into the housing **21**.
- 4 Position the actuating sleeve **15** onto the disc spring **16**.
- 5 Install the clutch drum **14** in the housing. Fit support washer **13** and drum securing circlip **12**.
- 6 Build up the clutch pack **11**, installing friction plates and counter plates alternately, starting with a counterplate and finishing with a friction plate.
- 7 Install shim(s) **10** and pressure plate **9**.
- 8 Use the output gear **5** to align the clutch plate splines. Ensure that all the plates are engaged with the gear shaft splines. Rotate the output gear back and forth to create maximum backlash then withdraw the gear taking care not to disturb the pack.
- 9 Place the first two disc springs **8B** with their convex sides uppermost, onto the clutch pack. (There are four disc springs, which are identical). Place the other two disc springs **8A**, with their convex sides down, onto the first two - refer to inset **A**.



S396880

Hydraulic 2/4 Wheel Drive Unit (4WD Spring ON)

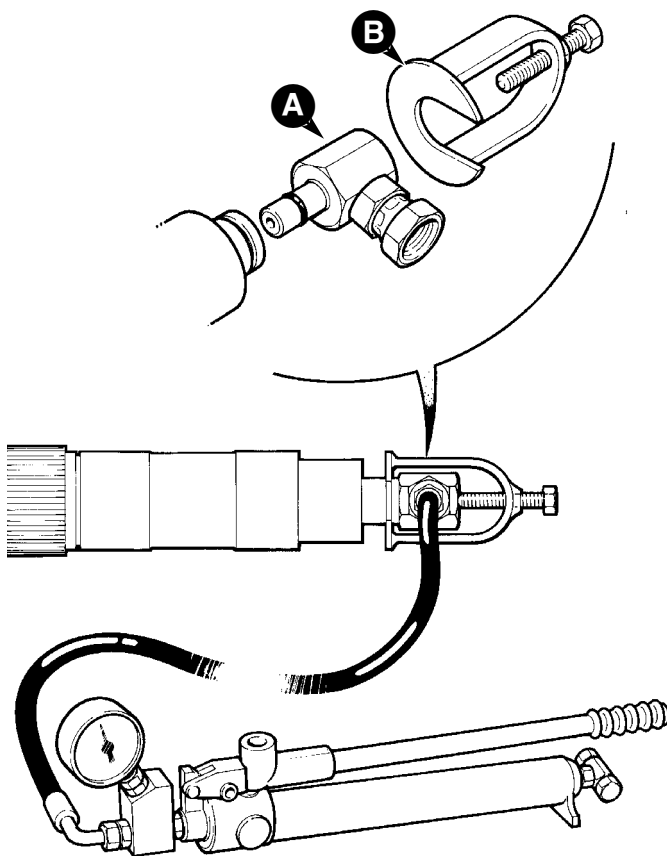
Assembly (continued)

- 10 Using a suitable press, compress the disc springs **8A** and **8B**, fit circlip **7**.
- 11 Use levers to remove free play, as shown at **B**. Measure the gap between pressure plate **9** and actuating sleeve **15**. The gap should be 0.75 - 1.5 mm; 0.030 - 0.059 inches. If necessary fit new shim **10** to achieve the correct gap. (Shim **10** can be a combination of a single counter plate, shim (thinner than the counter plate) or both counter plate and shim). Check that the clutch pack splines are still aligned - see step 8.
- 12 Install the 4WD output gear **5** and its needle roller bearing **6**.
- 13 Install thrust washer **4** and bearing **3**.
- 14 Fit sealing ring **2** and bearing **1**.
- 15 Fit the 2/4WD unit to the gearbox.
- 16 Apply a thin bead of JCB Multigasket to the 4WD mating face of the gearbox front case. Fit the case **P**, apply JCB Threadlocker and Sealer to bolts **D** and progressively torque tighten to 56 Nm, 46 lbf ft.
*
- 17 The 4WD clutch and its associated components are manufactured using a 'setright' system. Provided that components have been assembled correctly, the shaft end float will be 0.01 to 0.16 mm (0.0004 to 0.006 in).
*

Rotate the shaft by hand and ensure that it runs smoothly. Pull the shaft up and down to detect any excessive end float. If there is excessive end float or the shaft runs roughly, dismantle the unit and check for correct assembly.
- 18 Fit a new oil seal **M**, fit the output yoke **E**, and flanged bolt **F**. Torque tighten the bolt to 395 Nm; 291 lbf ft.

Pressure Testing the 2/4WD Clutch

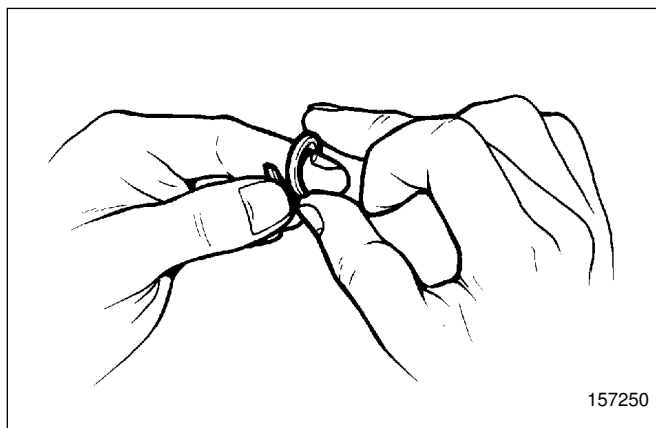
- 1 Assemble the 2/4 wheel drive clutch, as described in 'Assembly'.
- 2 Check the clutch pack end float and adjust as required (see **Assembly**).
- 3 Using special tool 993/59300, insert the adaptor **A** into the oil gallery in the end of the 2/4 wheel drive clutch shaft as shown. Hold the adaptor in position with clamp **B**.
- 4 Use a hand pump to pressurise the clutch assembly until gear, item **5** can be turned by hand. Note the pressure gauge reading - DO NOT EXCEED 200 lb/in² (13.8 bar).
- 5 If the pressure gauge reading is between 125 - 135 lbf/in² (8.6 - 9.3 bar) then the clutch is operating correctly and can be fitted in the transmission.
- 6 If however the pressure gauge reading is above 135 lbf/in² (9.3 bar) then check the clutch for assembly defects, especially the clutch pack end float (the shim may not be to the correct thickness). -test after checking for (and rectifying) assembly defects.



S185720

Polytetrafluoroethylene (PTFE) Piston Ring Seals - Fitting Procedure

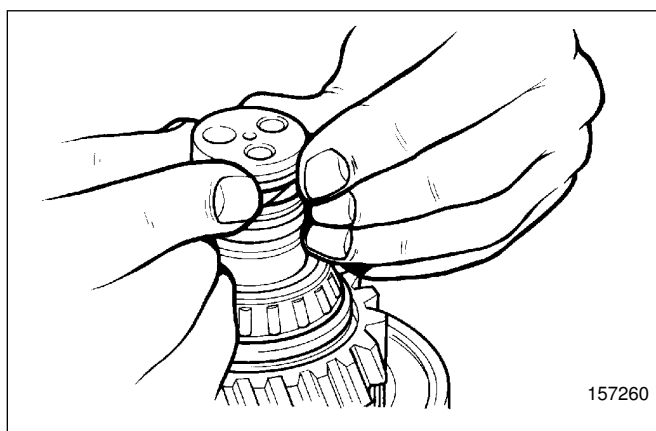
- 1 Wind the PTFE piston ring seal around your finger as shown, so that the seal forms a 'coil'.



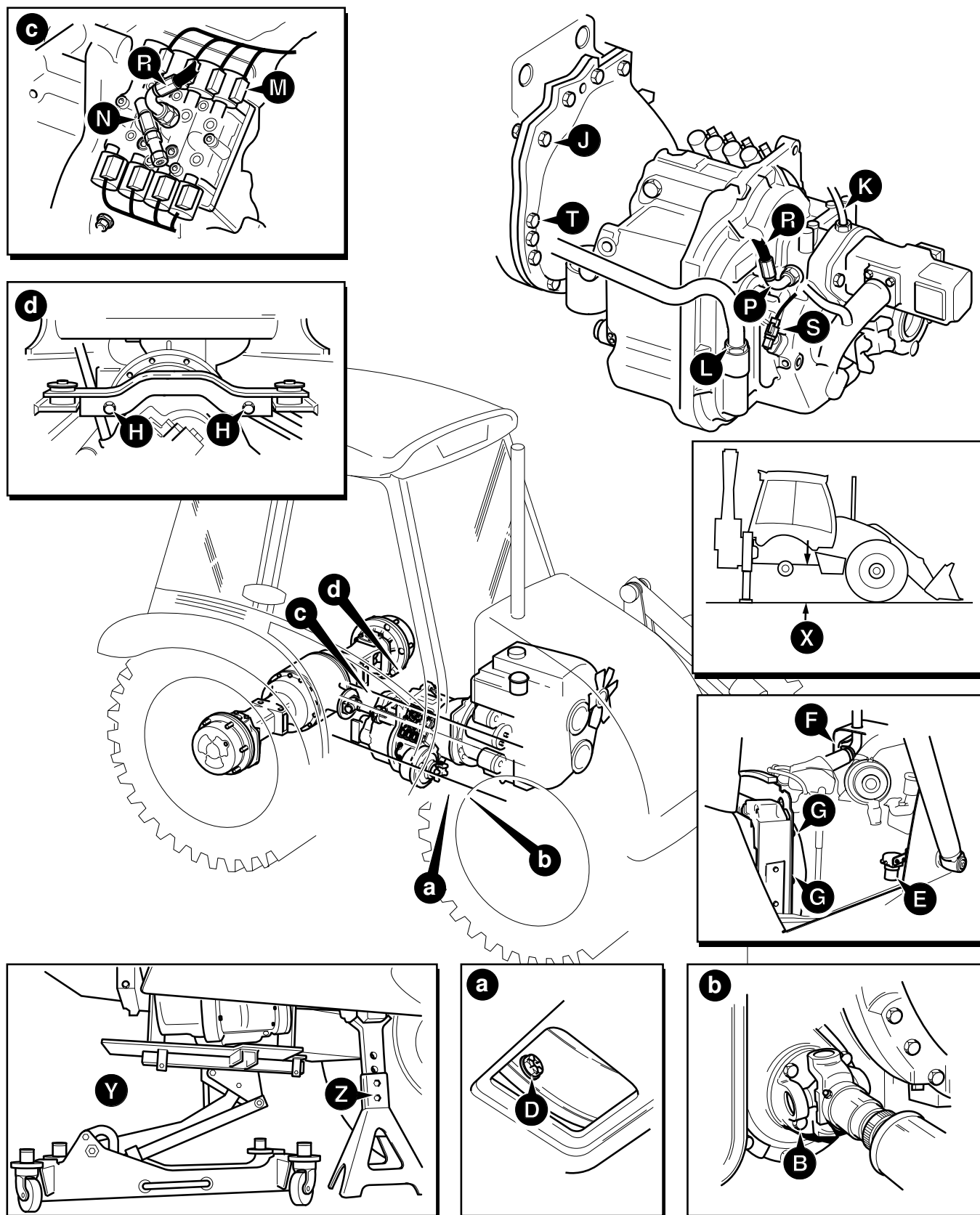
- 2 Smear the seal with grease and then fit the seal to the shaft.

Make sure that the seal sits below or flush with the outer diameter of the shaft. If necessary, use finger pressure as shown to make the seal flush with the shaft.

CAUTION: If the seal is not set below or flush with the outer diameter of the shaft, then the seal will 'cut' when the shaft is fitted to its mating component.



Removal and Replacement



A401320

Removal and Replacement (cont'd)

IMPORTANT: The gearbox is heavy. Unless it is safely supported during removal and replacement it could fall and cause injury. Make sure that you have access to suitable jacks and a gearbox locating 'cradle' before attempting to remove the gearbox.

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface. Before raising one end ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN 1-1

Removal

- 1 Park the machine on firm level ground. The gearbox is heavy. If the ground is soft or uneven it will not be possible to remove the gearbox safely.
 - 2 Loosen the right side rear wheel nuts. Rest the shovel on the ground and lower the stabilisers to raise the rear of the machine. Check dimension **X** which must be at least 800 mm. This will allow the gearbox to be pulled clear. Block/support the machine.
- Note:** On sideshift machines, suitable lengths of steel channel can be used as safety struts between the stabiliser feet and chassis, one at each stabiliser.
- 3 Remove the right hand side rear wheel.
 - 4 Remove the bonnet - see Section 3, **Routine Maintenance**.
 - 5 Remove the rear axle propshaft - see **Propshafts**.
 - 6 Disconnect the front axle driveshaft bolts **B** (use tool 892/00822).
 - 7 Drain the hydraulic tank and remove the main hydraulic pump (see Section E, **Service Procedures and Main Hydraulic Pump**). Tie the suction hose up clear of the gearbox.
 - 8 Drain the gearbox oil, see Section 3, **Routine Maintenance**.
 - 9 Remove the access bung/plate at the bottom of the torque converter housing. Through the access hole, loosen and remove the torque converter to engine flywheel retaining bolts **D**.

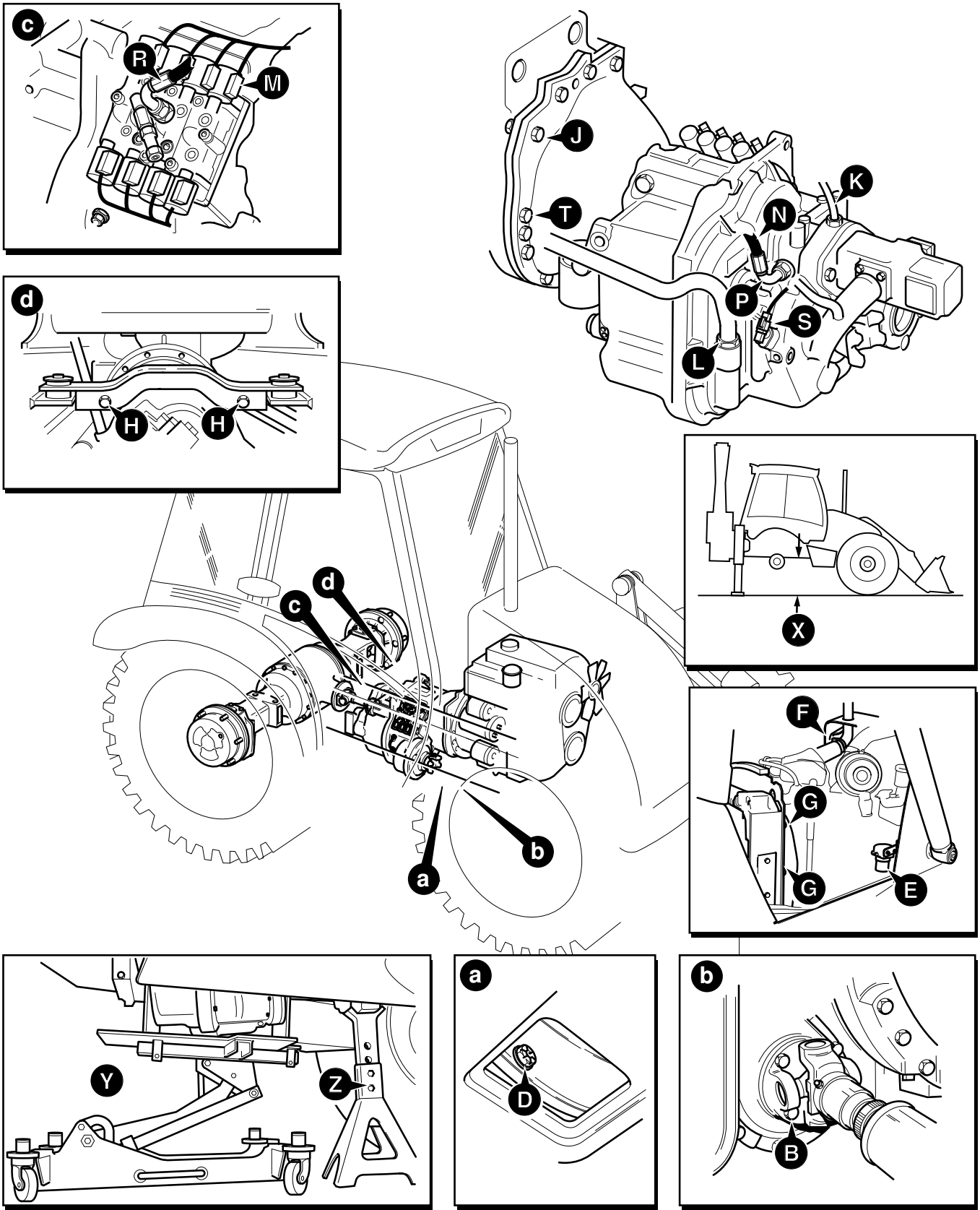
- 10 At a later stage the gearbox and engine assembly is tilted to allow access to fixing bolts. To prevent damage as the engine is tilted components must have their fixings removed as follows:

- a Fuel sediment bowl assembly **E** (2 bolts).
- b Exhaust stack fixing bracket **F** (2 bolts).
- d Radiator fan cowl **G** (4 bolts).

It is not necessary to remove these components, only release them from their fixings.

- 11 Support the gearbox using a suitable trolley jack and cradle. The gearbox must be securely located on the cradle as shown at **Y**.
- 12 Make sure that the weight of the gearbox is supported by the trolley jack and then remove the gearbox mounting bolts **H**.
- 13 Using the trolley jack, lower the gearbox and engine to gain access to the top torque converter housing to engine block retaining bolts **J**. Put a support under the engine as shown at **Z** to prevent it from dropping when the gearbox is removed.
- 14 Undo the four bolts **J** at the top of the torque converter housing. Note that the two outer most bolts have nuts instead of screwing into the engine block. Also note the position of the electrical earth straps.
- 15 Pull off the breather tube **K**. Undo the gearbox dipstick fixing nut **L** and then remove the dipstick tube.
- 16 Label and then uncouple the solenoid control valve electrical connectors **M**, oil pressure sender **N** and temperature sender **P** (if fitted). Uncouple the electrical connector at the speed sensor **S**.
- 17 Disconnect the gearbox oil cooler hoses **R**.
- 18 Remove the flywheel housing to engine bolts **T**.
- 19 Manoeuvre the gearbox with the torque converter clear of the engine housing.
- 20 Lower the trolley jack and pull the gearbox and torque converter clear of the machine.

Removal and Replacement (cont'd)



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Removal and Replacement (cont'd)

Replacement

Replacement is a reversal of the removal procedure but note the following:

- 1 Before replacing the gearbox remove circlip **5** and withdraw the pump driveshaft **6** together with its bearing **7** approximately 50 mm (2.0 in). The shaft can then be engaged after the gearbox has been fitted, making replacing the gearbox easier. Remember to engage the pump drive shaft, refit the bearing and circlip after the gearbox has been fitted.
- 2 Set the torque converter as described in **Torque Converter, Removal and Replacement**.
- 3 **Align the Torque Converter**

It is vitally important that the torque converter is fitted at the gearbox and engine flywheel correctly. Failure to locate the converter correctly will result in damage to the gearbox oil pump on engine start up. Proceed as follows:

Make sure that the torque converter drive dogs **1** are correctly engaged with the pump **2** on the gearbox. Temporarily tie the converter onto the gearbox. Use wire tied at a drive plate bolt hole to a convenient point on the outside of the gearbox.

Take note of the flywheel and drive plate fixing hole phasing. The heads of the bolts **3** will foul the flywheel **4** if phasing is incorrect.

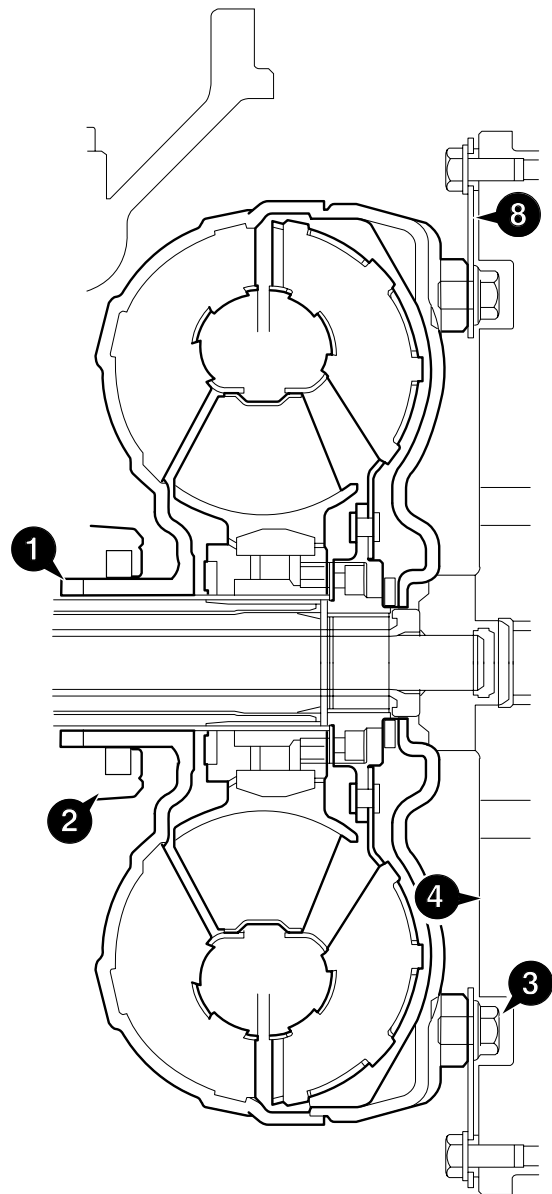
Before bolting the torque converter housing to the engine make sure the mating faces are fully together (DO NOT USE FORCE). The drive plate **8** should also be mated close to the flywheel. Do not force the components together with the fixing bolts.

Make sure that the torque converter is free to rotate slightly within the clearance of the location bolt holes. If you cannot rotate the converter it is trapped either by bolt heads **3** or by incorrectly located pump drive dogs. Make sure that all is well before tightening the bolts.

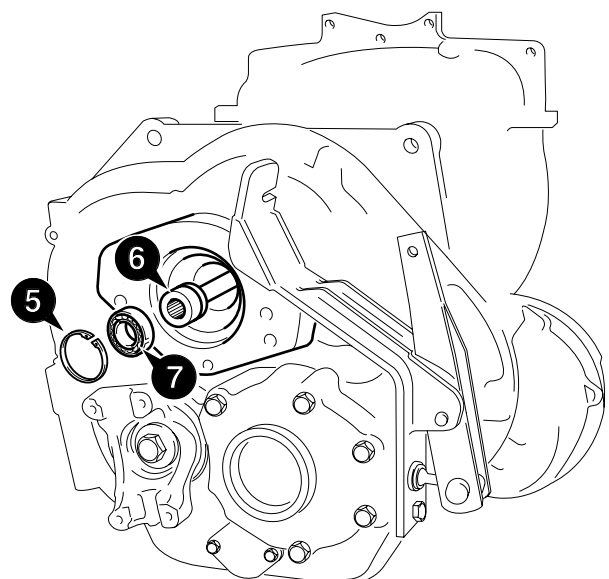
- 4 Fill the gearbox with the specified amount and type of oil (see **Section 3, Routine Maintenance**). Leave hose **N** off until the filling operation is complete. After filling refit hose **N**.

Torque Settings

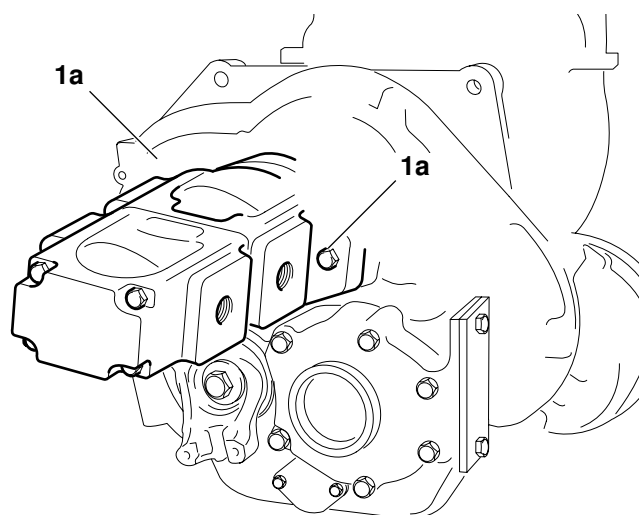
Item	Nm	kgf m	lbf ft
B	79	8	58
D	44	4.5	32
H	237	24	175
J,T	98	10	72



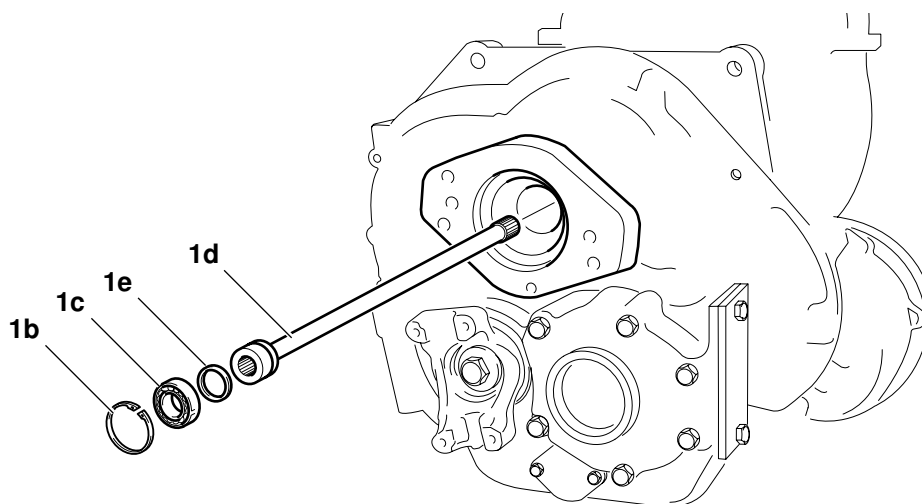
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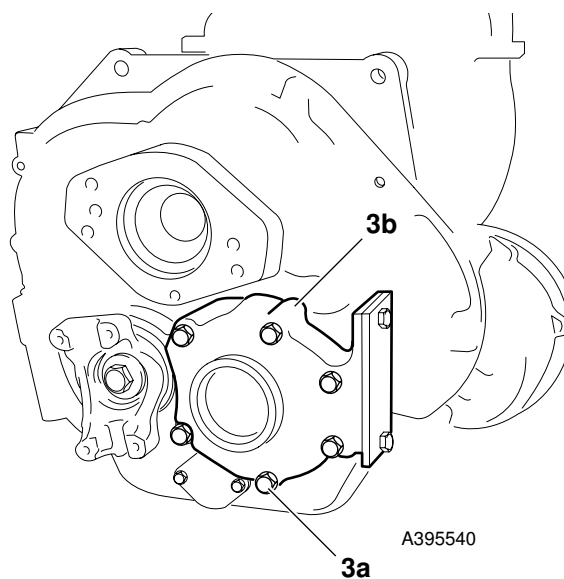
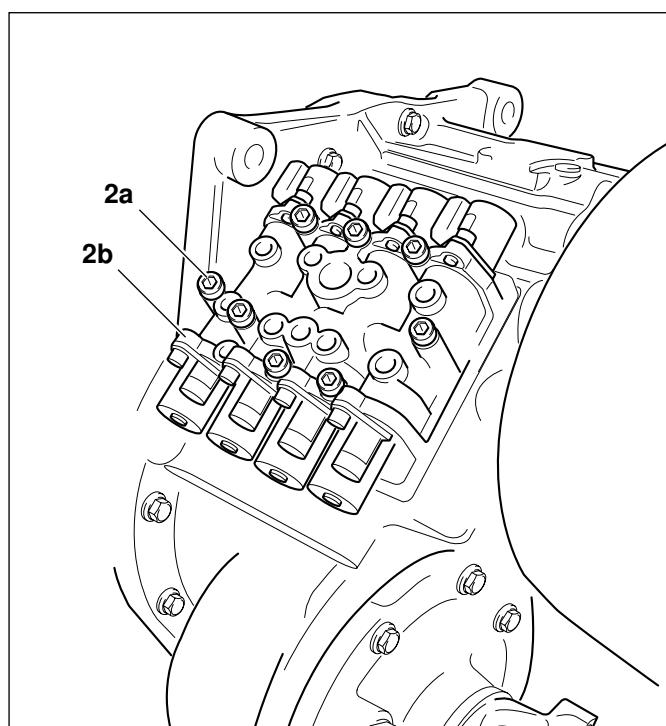
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Dismantling

Note: The Dismantling, Inspection and Assembly procedures in this manual illustrate and describe the 6x4 gearbox. Procedures for the 4x4 version of the gearbox are identical in most respects. Where there are differences procedures are identified under the heading '**4x4 Gearbox**'.

With the gearbox removed from the machine, place suitable wooden blocks to securely support the assembly.

Cleanliness is of the utmost importance when servicing the gearbox. All precautions to prevent any ingress of dirt, grit etc. must be taken. To this end wash the exterior of the gearbox assembly as follows;

Make sure that all open ports and orifices are effectively plugged. Remove any deposits of dirt, grit and oil from the outer casings using a suitable degreaser and water. Dry the casings.

1 Remove the Main Hydraulic Pump and Driveshaft

- a** If the main hydraulic pump has not already been removed proceed as follows. Support the pump, undo the 2 bolts **1a**. Draw the pump away from the gearbox, disengaging the drive shaft. Lift the pump clear.
- b** Remove the circlip **1b** followed by bearing **1c**. Withdraw the driveshaft **1d**. Remove the sealing ring **1e**.

2 Remove the Solenoid Control Valve Block

- a** Undo the 8 socket head cap screws **2a** and lift off the valve block assembly **2b**. Do not use a screwdriver to lever the block, the sealing faces will be damaged. If the block is difficult to remove, lightly tap the manifold block with a soft faced hammer.

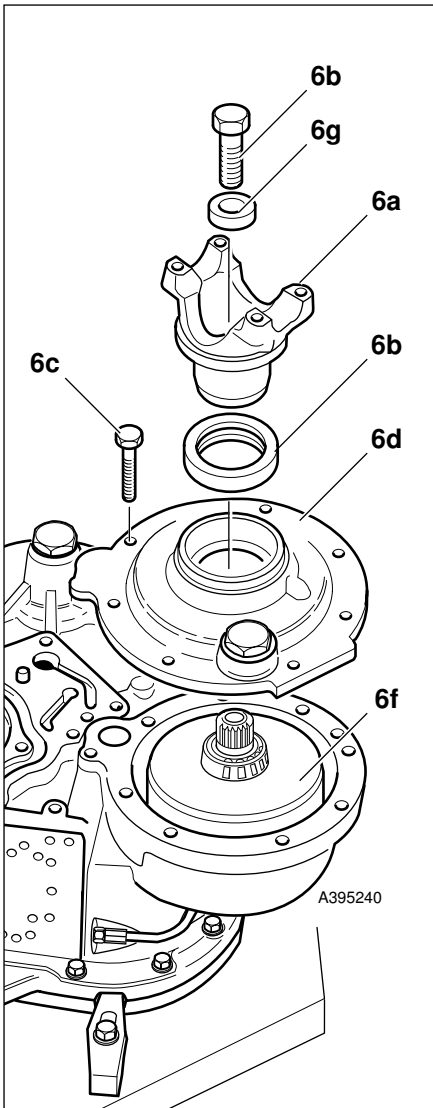
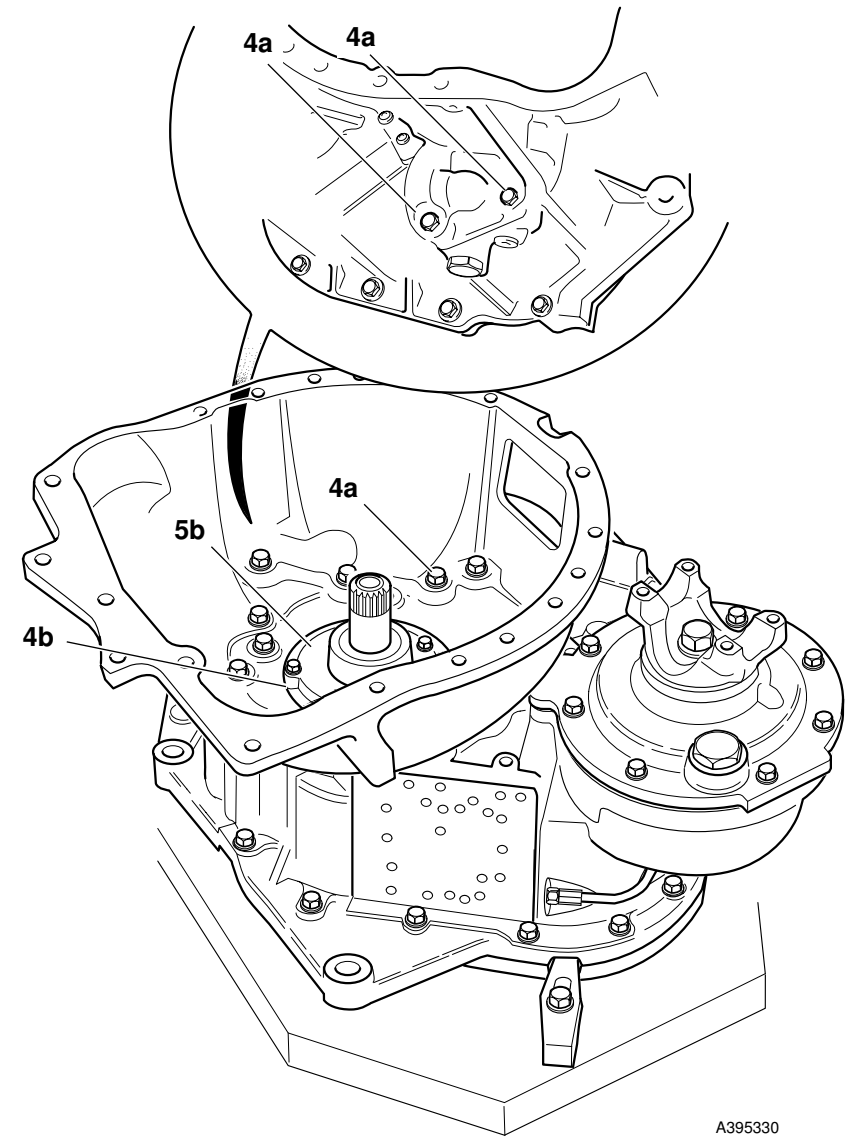
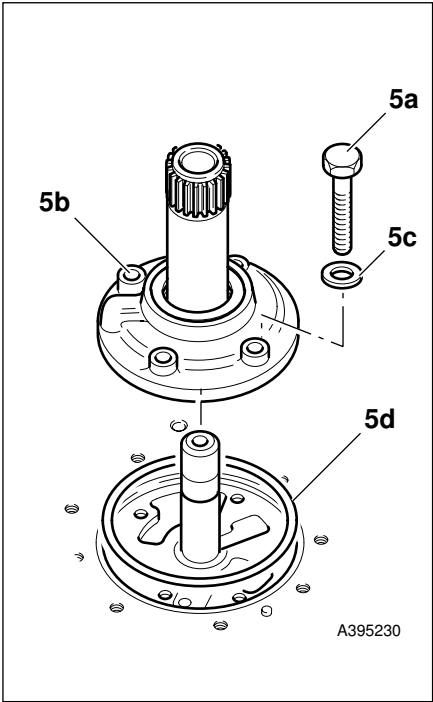
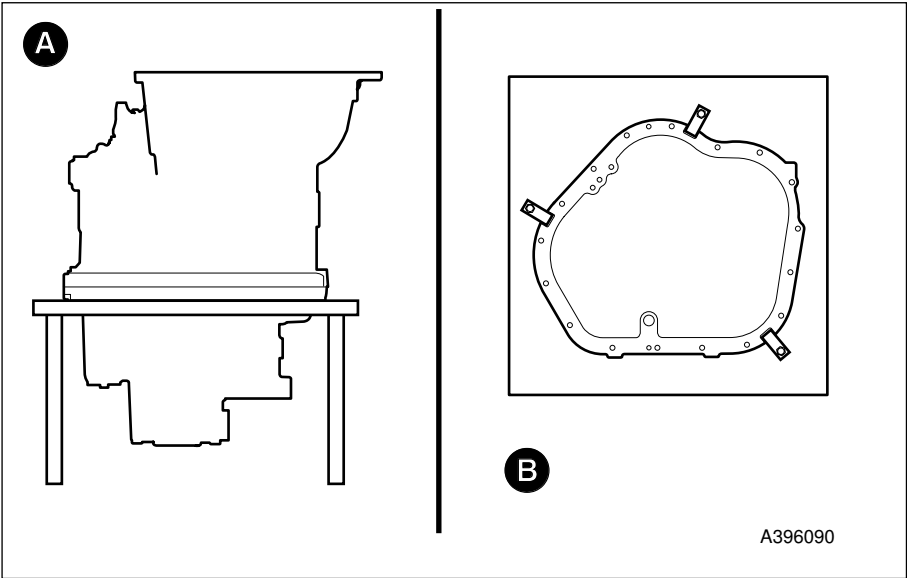
Note: Some gearboxes are fitted with a valve block sub-base plate. Be sure to retrieve the plate. The plate is thin, make sure it is not damaged when removing. Take care not to damage the surfaces of the plate.

- b** Remove and discard the valve block sealing gasket. The gasket may disintegrate on removal, make sure all traces are removed and discarded. Gearboxes fitted with a sub-base plate have two gaskets, one each side of the plate.

3 Remove the Layshaft Cover

Note: Unless the casings are to be renewed, or the gearbox oil has been contaminated it is not necessary to remove the cover.

- a** Undo the 6 bolts **3a** and lift off the cover **3b**.



Dismantling (cont'd)

Using suitable lifting equipment locate the gearbox in a work cradle (892/01082) as shown at **A**. Clamp the gearbox in position at the 3 clamping points on the rear casing as shown at **B**. DO NOT ATTEMPT TO DISMANTLE THE GEARBOX FURTHER UNLESS IT IS SAFELY LOCATED IN A SUITABLE WORK CRADLE.

4 Remove the Torque Converter Housing

- * **a** Undo the bolts **4a**[†]. Note that 2 bolts are located on the outside of the housing just above the oil filter mounting. Lift off the housing. Retrieve the sealing 'O' ring **4b**.
[†]Early gearboxes feature a total of 18 bolts while late gearboxes have 23 bolts

5 Remove the Gearbox Hydraulic Pump

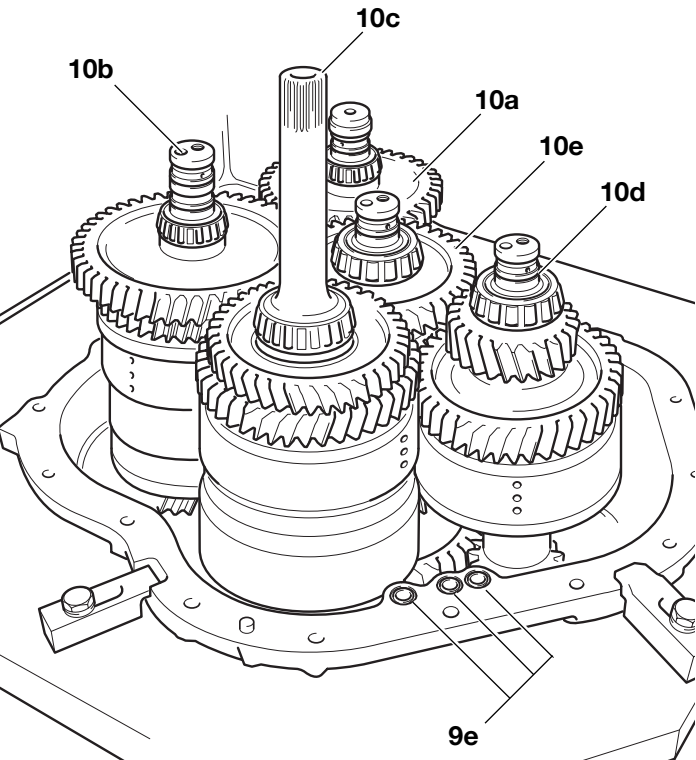
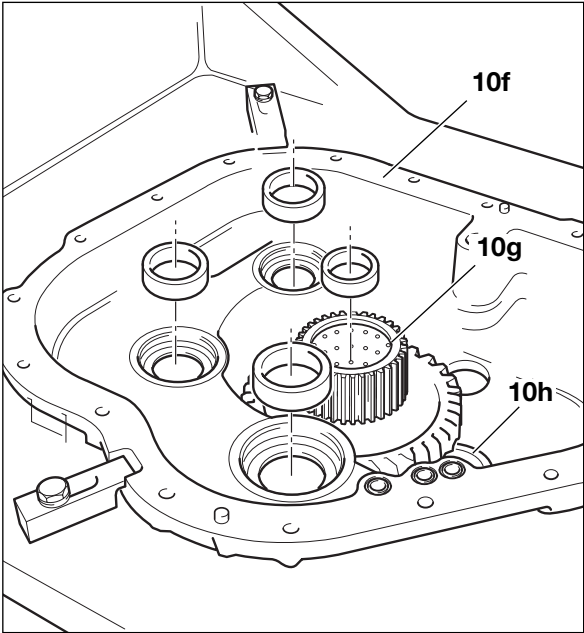
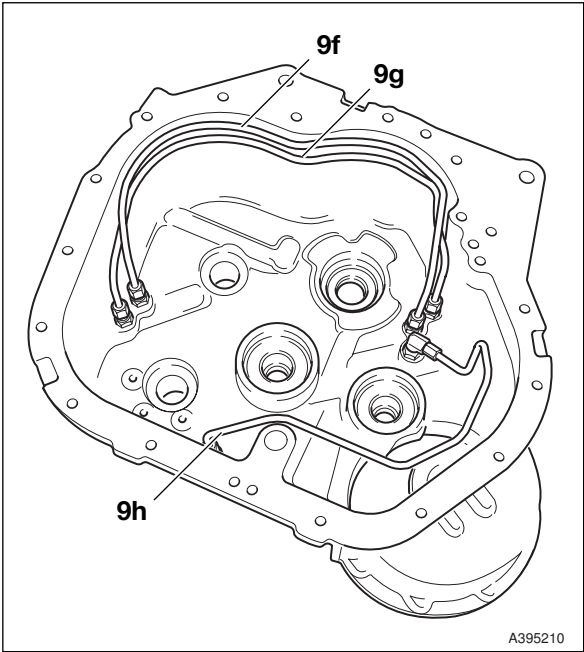
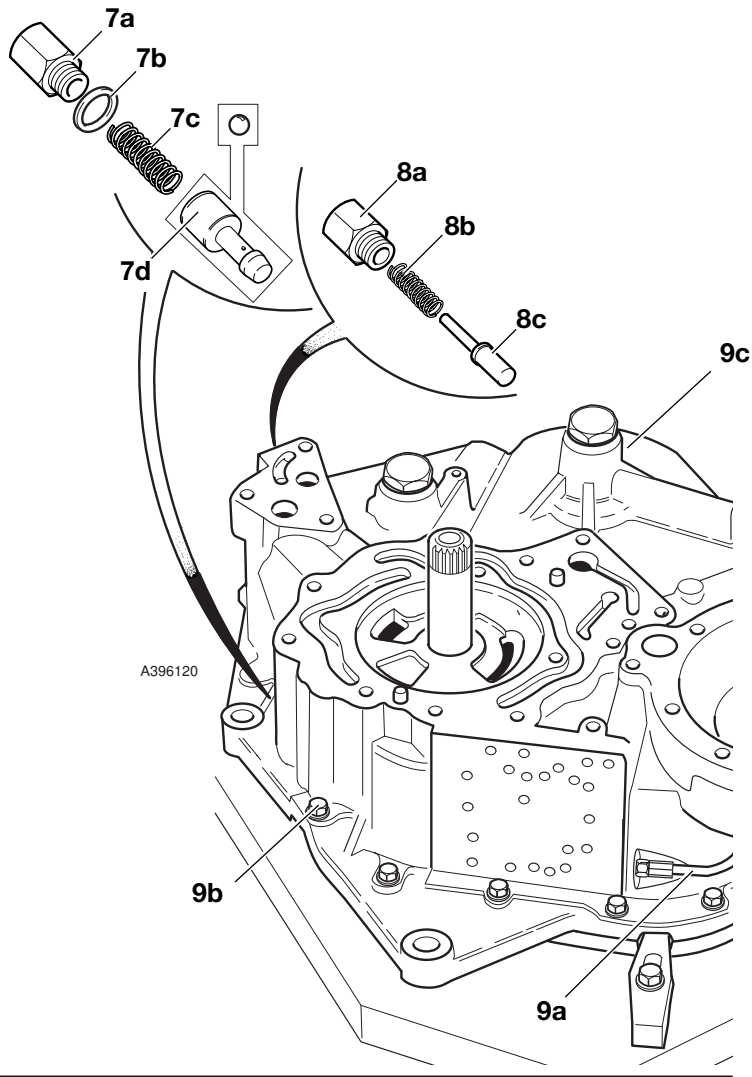
- a** Undo the 4 fixing bolts **5a** and lift the pump assembly **5b** off the input shaft. Retrieve the 4 sealing washers **5c** and pump sealing ring **5d**.

Note: A pump which is worn or damaged may have caused further damage to the gearbox. Dismantle and inspect the gearbox fully. For details of dismantling and inspecting the pump, see **Powershift Gearbox - Inspection**.

6 Remove the 4WD Clutch Assembly

- a** Using service tool 892/00812 hold the output yoke **6a** and at the same time undo the bolt **6b**. The bolt is very tight, the help of an assistant will be required.
- b** Remove the thick washer **6g** and yoke **6a**. Undo the 8 bolts **6c** and lift off the cover **6d**, be sure to retrieve the bearing outer cup from inside the cover. Remove the output shaft oil seal **6b**. Take care not to damage the seal housing.
- c** Lift the clutch and shaft assembly **6f** from the housing. Retrieve the inner bearing outer cup from the casing.

For 4WD clutch dismantling and assembly procedure see **4WD Clutch - Dismantling and Assembly** in this section.



Dismantling (cont'd)

7 Remove the Torque Converter Relief Valve

- * a Undo the plug **7a** and remove the sealing washer **7b**, spring **7c** and poppet **7d**. Note that some gearboxes are fitted with a ball instead of a poppet.

8 Remove the Pressure Maintenance Valve

- a Undo the plug **8a**, remove spring **8b** and valve spool **8c**.

9 Separate the Front and Rear Casings

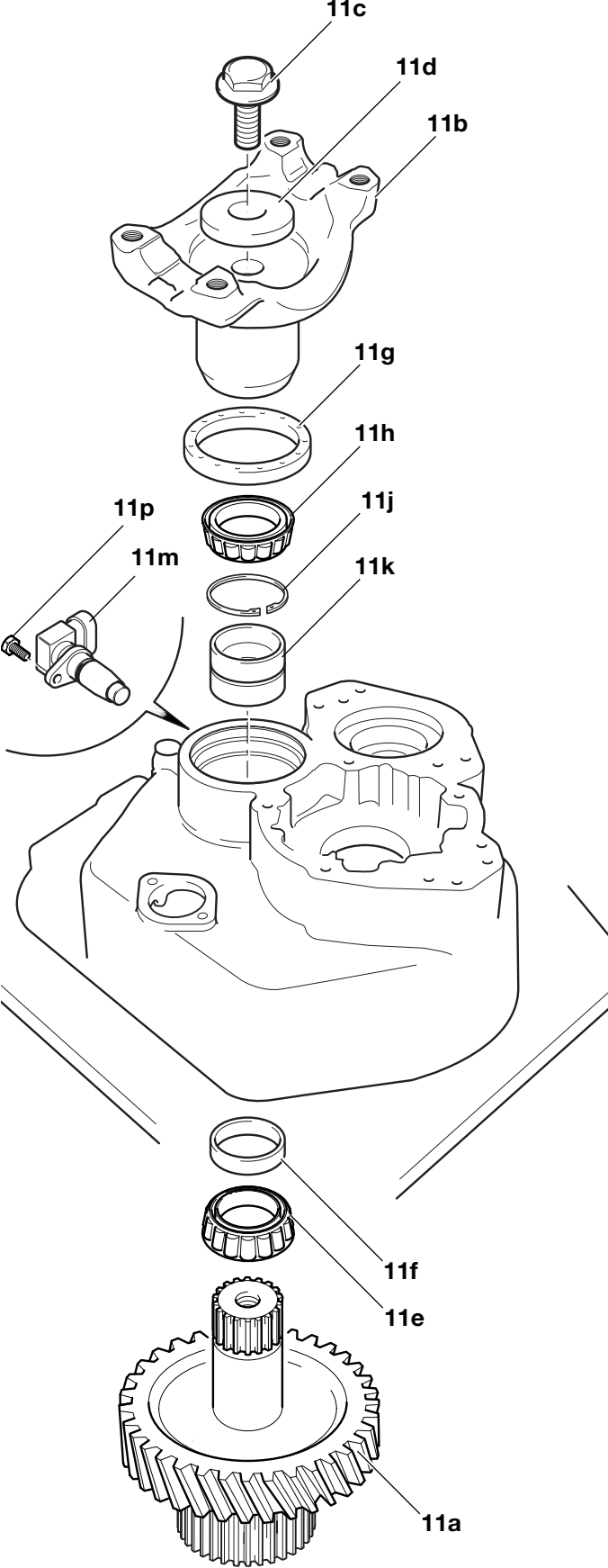
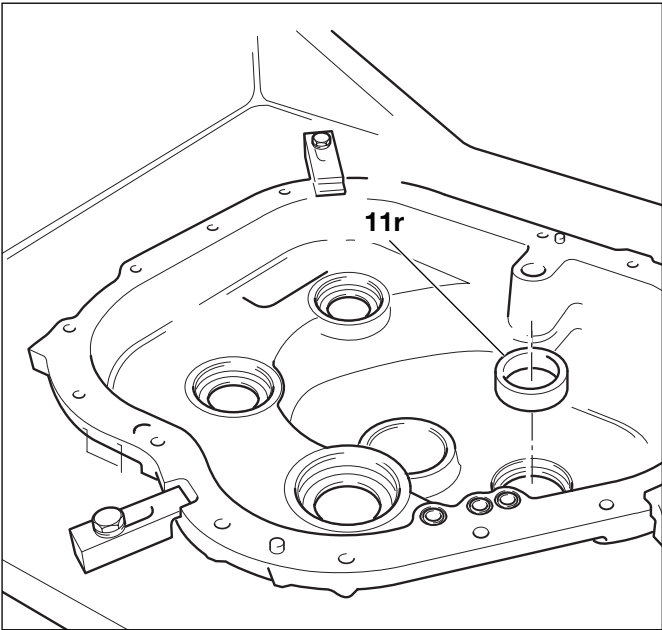
- a Remove the 4WD clutch oil pipe **9a**.
- b Undo the 17 casing bolts **9b**.
- c Using suitable lifting equipment carefully lift off the front case **9c**. Be sure to retrieve all the shaft bearing outer cups. The cups may be left on the bearings, or inside the front case. Keep the cups with their associated bearings.
- d Remove and discard the 3 sealing 'O' rings **9e** from the front case.

Note: The 3 oil transfer pipes **9f**, **9g** and **9h** located inside the front case need not be removed unless they are damaged, or the gearbox oil has been contaminated. If they are to be removed see **Powershift Gearbox - Inspection**.

4x4 Gearbox: pipe **9h** not fitted.

10 Remove the Clutch/Shaft Assemblies

- a Carefully lift out the clutch/shaft assemblies in the following order:
 - 10a** - 6 speed clutch shaft (not fitted to **4x4 Gearbox**)
 - 10b** - Reverse clutch unit
 - 10c** - Forward/Input clutch shaft
 - 10d** - Layshaft clutch
 - 10e** - Mainshaft clutch
- b Retrieve the bearing outer cups from the rear case **10f** and centre of the transfer gear **10g**. Note that the layshaft bearing cup **10h** can not be removed until the transfer gear/output shaft has been removed, see step 11. Keep the cups together with their associated bearings.



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Dismantling (cont'd)

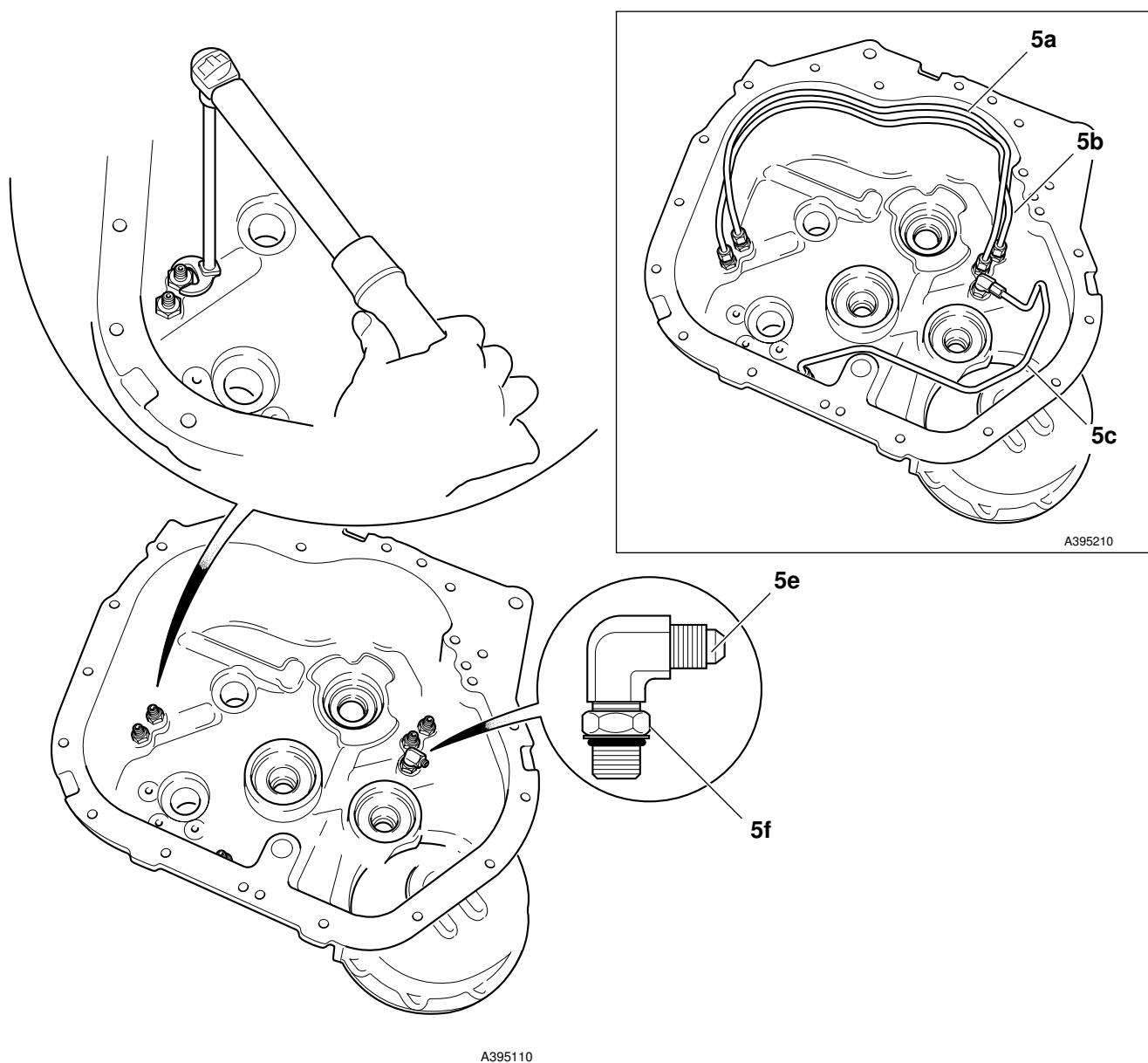
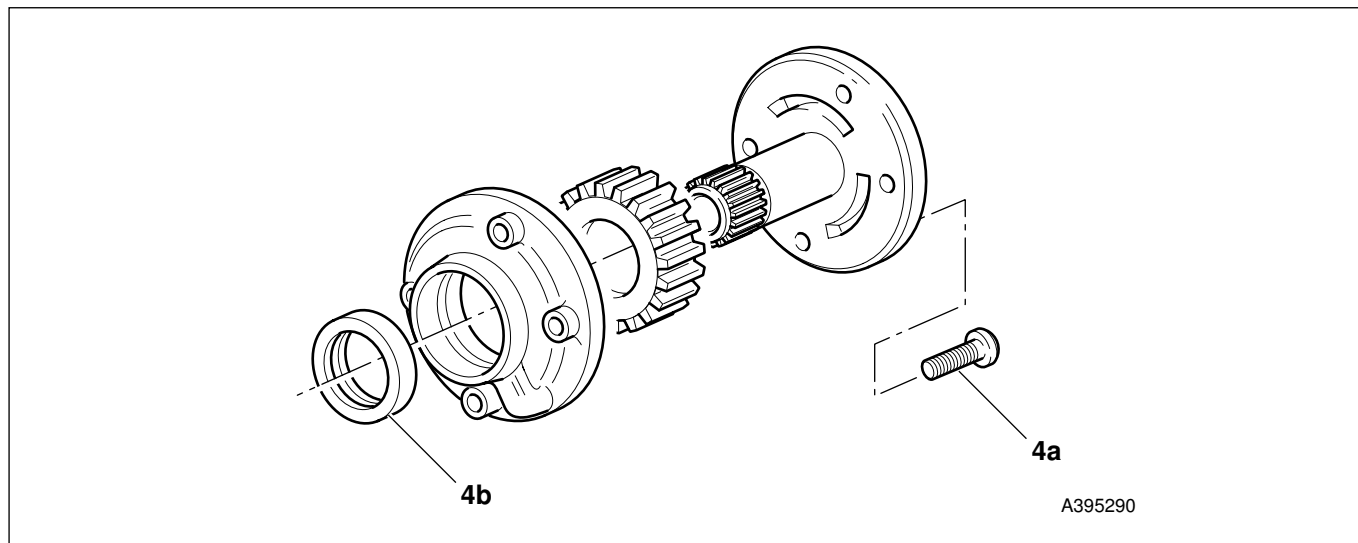
11 Remove the Transfer Gear

- b** Using service tool 892/00812 hold the output yoke **11b** and at the same time undo the bolt **11c**. The bolt is very tight, the help of an assistant will be required. Remove the bolt, thick washer **11d** followed by the yoke.
- c** Remove and discard the oil seal **11g**. Take care not to damage the seal housing.
- d** Support the transfer gear/shaft assembly **11a**. Withdraw the gear from inside the casing. The assembly will lift away complete with the inner taper roller bearing **11e** and spacer **11f**.
- e** Remove the outer taper roller bearing **11h**.
- f** Remove circlip **11j** followed by bearing double outer cup **11k**.

Note: The inner and outer taper roller bearing assembly (comprising double outer cup **11k**, inner bearing **11e**, spacer **11f** and outer bearing **11h**) is a matched set. Keep all the components together in their original relationships. Components from another set are not interchangeable. If any components are worn or damaged the whole assembly must be renewed as a complete matched set.

- g** Retrieve the layshaft bearing outer cup **11r** from the rear casing.
- h** If the speed sensor **11m** is to be removed, undo bolt **11p** and withdraw the sensor together with its sealing 'O' ring.

Inspection



Inspection

Before assembling the gearbox, make sure that a thorough inspection of all components is carried out. Remember that although a failed component may be easy to identify, the cause of that failure may be less easy to trace. It is also possible that a failed component may have caused damage to other areas of the gearbox.

1 Cleaning

- a Carefully remove all traces of gasket or gasket compound from the following components:

* **Note:** When removing gasket compound use a gasket removal product such as Loctite Chisel. Take care not to damage the mating faces. Clean the faces with a fine carborundum paper. Use a solvent cleaner and a clean cloth to finally remove all traces of oil or debris.

Front and rear casing mating faces.
Front casing and torque converter housing mating faces.
Main hydraulic pump and rear casing mating faces.
Solenoid control valve manifold and casing mating faces.
4WD casing mating faces.
Layshaft cover and rear casing mating faces.
Pressure maintenance valve bore (front case)

- b Clean the inside of the casings using a suitable degreasing agent.

2 General Inspection

- a Carefully inspect all gears, bearings and shafts for signs of excessive wear or damage. If wear or damage is evident, components must be renewed.

Note: The transfer gear shaft inner, outer bearing and spacer assembly is a matched set. If any of the components are damaged or worn the complete assembly must be renewed. Components are not interchangeable between bearing sets.

- b Make sure that all oil way cross drillings are clear and free from debris. Blocked oil ways are a common cause of bearing failure. If necessary use an air line to blow through the oil ways.

3 Clutch Units

- a If clutch failure is suspected see the relevant clutch dismantling and assembly procedure in this section.

4 Gearbox Hydraulic Pump

- a If tests have shown the pump performance to be unacceptable, the pump must be renewed as a complete unit.

- b If the existing pump is to be re-installed proceed as follows;

Undo the security screw **4a** and separate the pump body. Carefully inspect the gear teeth, white metal bearing and gear/body mating faces for signs of wear and damage, (If either is evident, the pump must be renewed).

Carefully remove and discard the oil seal **4b**. Take care not to damage the seal housing. Fit a new seal and then re-assemble the pump.

- c Make sure that pump the mating face on the gearbox front cover is clean and free from surface damage.

5 Oil Transfer Pipes

The front case incorporates oil transfer pipes **5a**, **5b** and **5c**. If the pipes are damaged or if the gearbox has been contaminated, the pipes must be removed for cleaning or renewal.

4x4 Gearbox: pipe **5c** not fitted.

- a Using a 'crows foot' type spanner and a ratchet wrench undo the pipes from the adaptors in the casing. Unless pipes are being transferred to a new casing it will not be necessary to remove the pipe adaptors.

6x4 Gearbox Only: If the adaptors are to be removed, adaptor **5e** must be removed last.

- b If the adaptors have been removed make sure that the sealing rings are renewed and fitted correctly.

6x4 Gearbox Only: Position the lock nut **5f** on adaptor **5e** as shown and then fit the adaptor to the case. Screw in until the locking nut reaches the case. Do not tighten the locking nut down at this stage.

All Gearboxes: Fit the adaptors. Torque tighten to 70 Nm.

- c Make sure the pipes are clear and free from debris before refitting. Loosly fit the pipes **5a** and **5b**. Make sure they are fitted at the correct adaptors as shown.

6x4 Gearbox Only: Loosly fit the pipe **5c**, rotate adaptor **5e** so that the pipe is not strained. Torque tighten down the lock nut **5f** to 70 Nm.

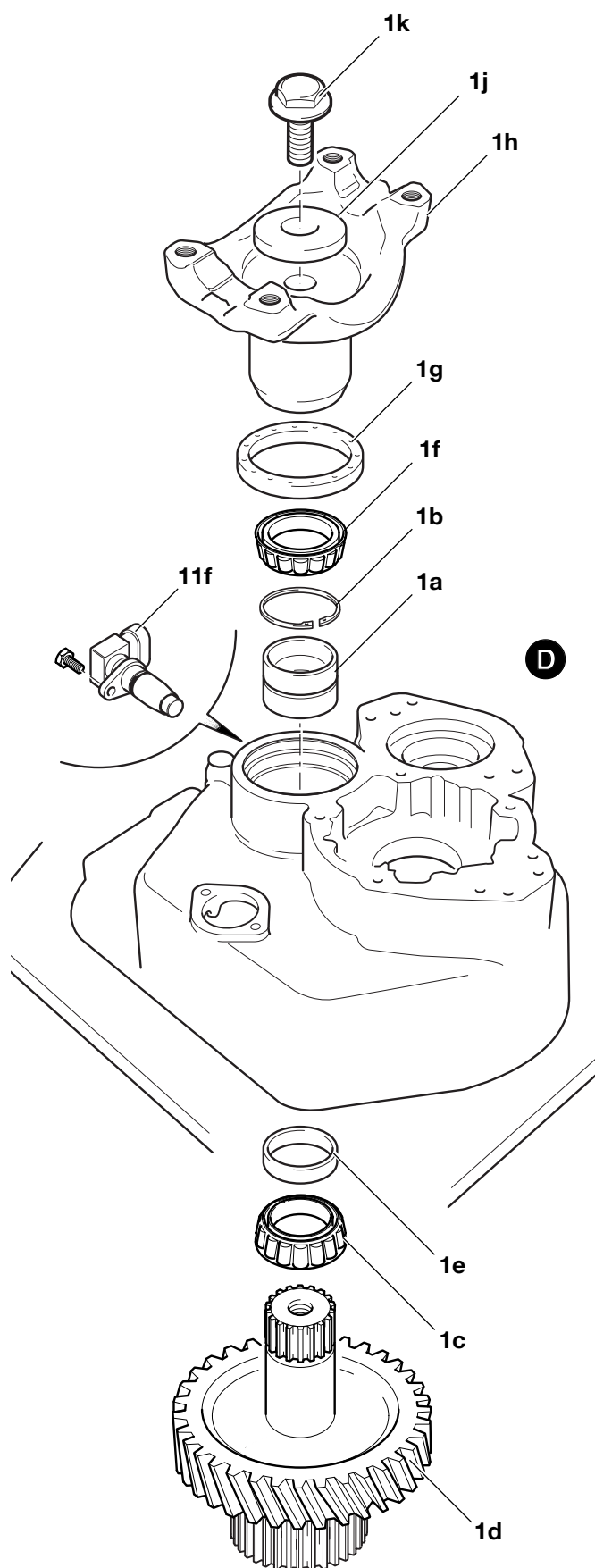
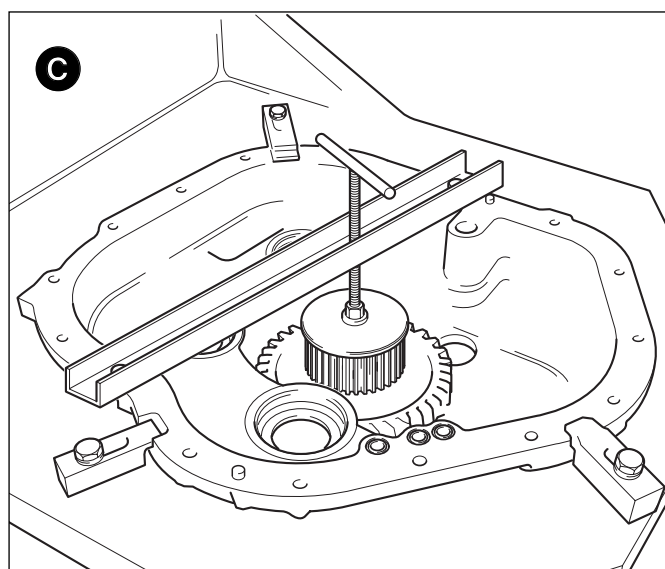
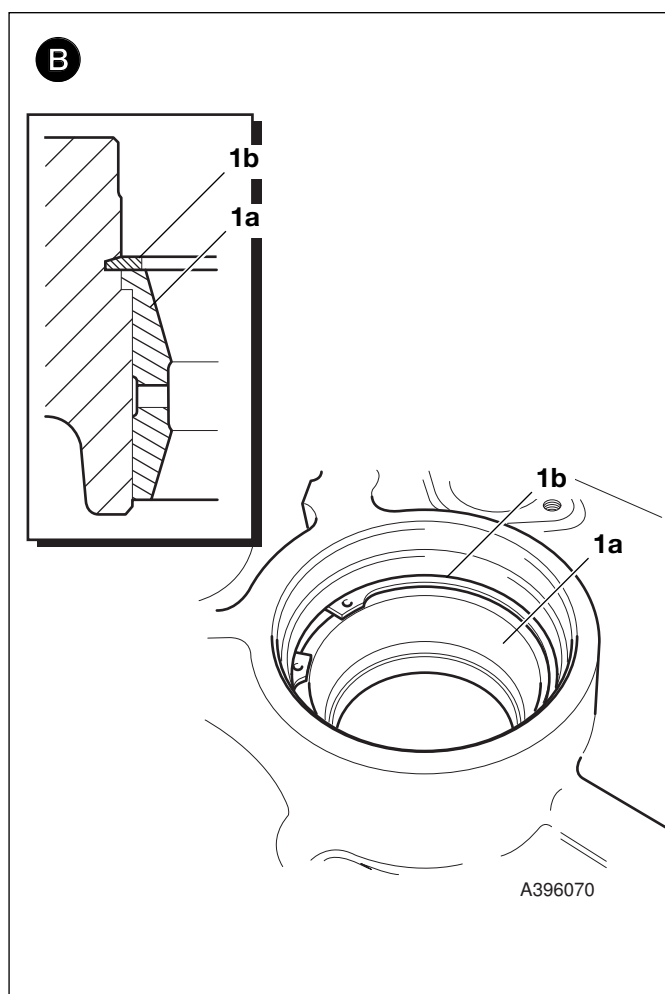
All Gearboxes: Torque tighten the pipes to 30 Nm.

6 Casings

If the gearbox casings are to be renewed, be sure to fit blanking plugs and adapters as required. Inspect the original casings and identify the blanking plug and adapter positions. Transfer the plugs and adapters to the new casings. Apply JCB Threadlocker and Sealer to the threads.

Note that new plugs may be supplied with a sealant 'patch', in which case sealant need not be applied.

* **Note:** Early gearboxes feature a '18 bolt fix' torque converter housing. It is strongly recommended that a new '23 bolt fix' housing and matching front case is fitted on assembly of the gearbox. A compatible torque converter relief valve will also be required.



Assembly

Using suitable lifting equipment locate the gearbox rear casing in a work cradle. Clamp the casing in position at the 3 clamping points as shown at **A**. DO NOT ATTEMPT TO ASSEMBLE THE GEARBOX UNLESS IT IS SAFELY LOCATED IN A SUITABLE WORK CRADLE.

Where 'oil' is referred to, use new, clean transmission oil of the correct specification for the gearbox. See **Section 3, Lubricants and Capacities**.

1 Assemble the Transfer Gear/Output Shaft

Note 1: Before fitting the transfer gear/output shaft assembly **1d**, fit the layshaft outer bearing cup to the casing (shown at **E**).

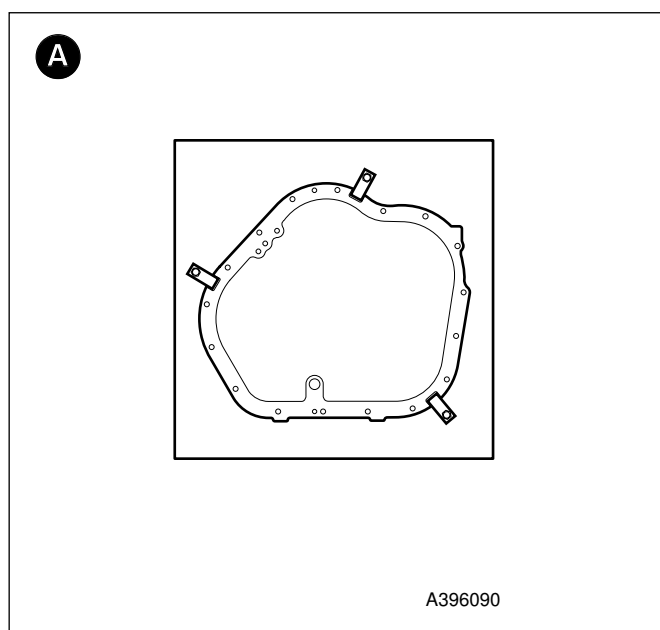
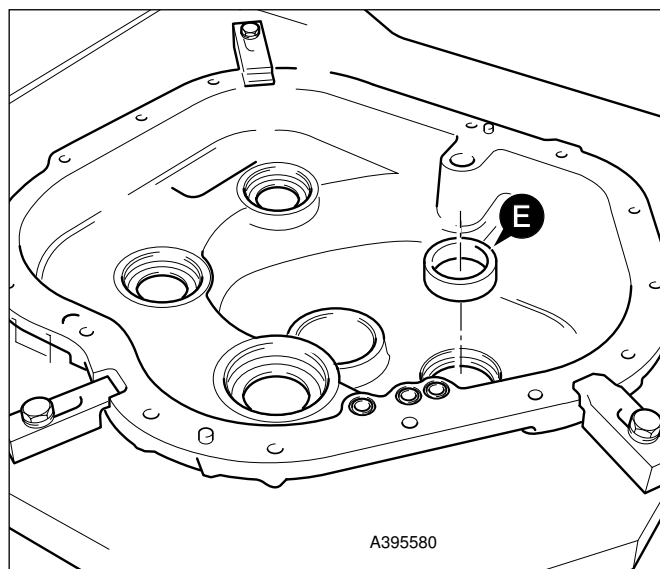
Position the casing as shown at **D**.

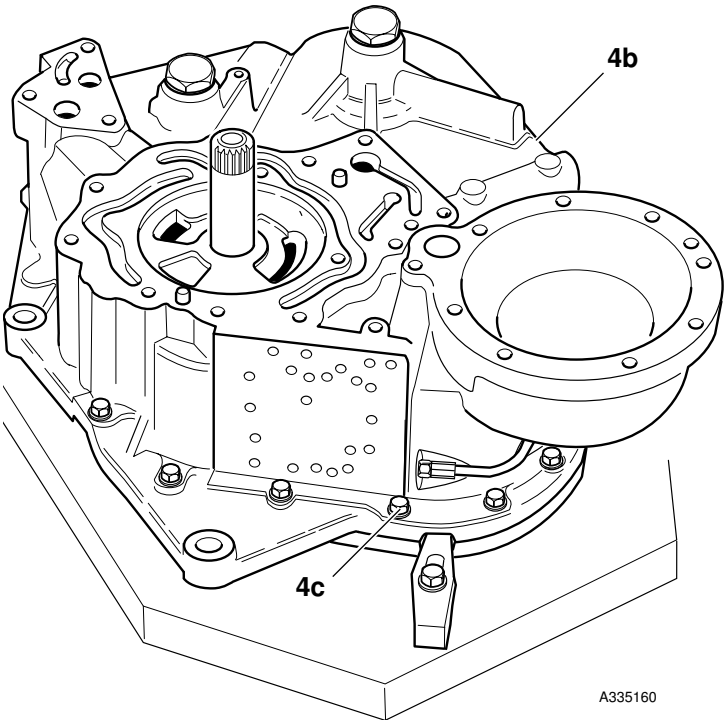
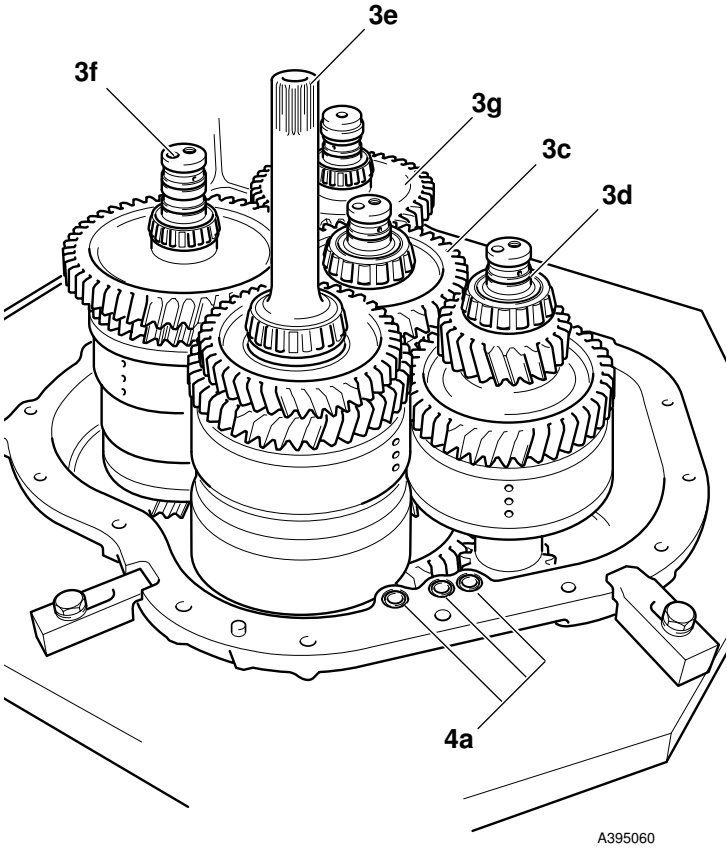
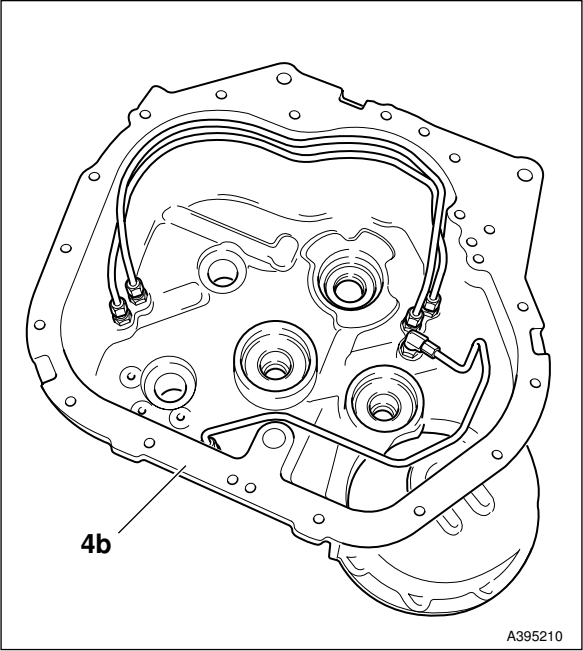
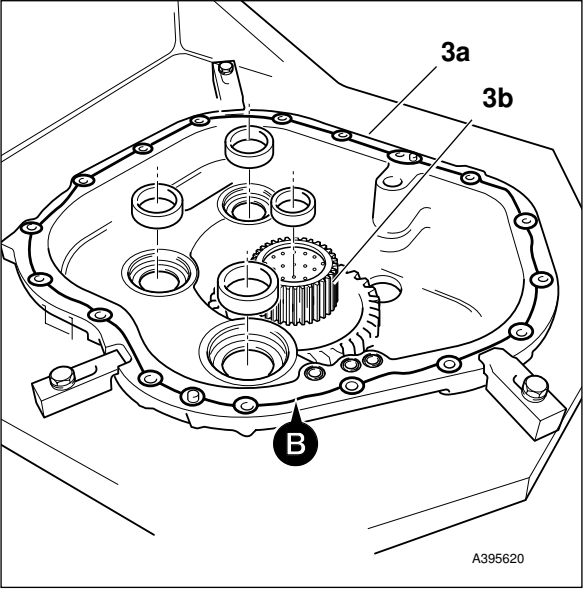
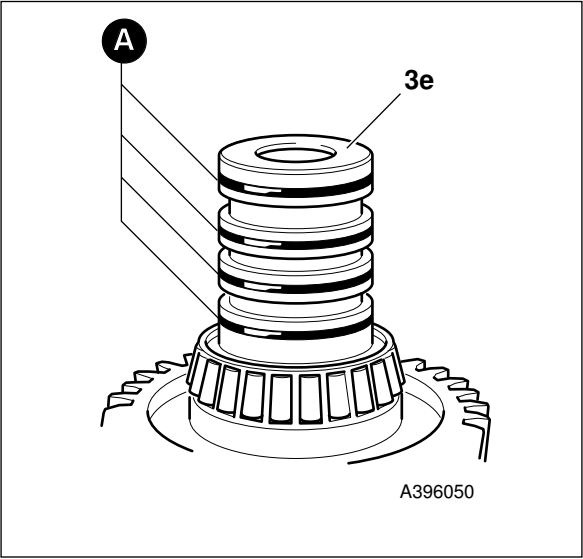
Note 2: The inner and outer taper roller bearing assembly (comprising double outer cup **1a**, inner bearing **1c**, spacer **1e** and outer bearing **1f**) is a matched set. Keep all the components together in their original relationships. Components from another set are not interchangeable. If any components are worn or damaged the whole assembly must be renewed as a complete matched set.

- a** Make sure that you have fitted the layshaft outer bearing cup, see **Note 1** above. Fit the bearing double outer cup **1a** into the casing. Note the correct way up of circlip **1b**, with the chamfer uppermost. Make sure that the circlip locates fully in its groove as shown at **B**. The tangs of the circlip must not overhang the inner diameter of the bearing cup **1a**. An incorrectly located circlip can foul and damage the outer bearing.
- b** Push the inner bearing **1c** onto the transfer gear/shaft **1d** followed by spacer **1e**.
- d** Locate the transfer gear assembly in the casing from inside. Using service tool 892/01083 retain the gear in position (shown at **C**). If the gear is not held in position the bearings may be damaged during assembly.
- c** Using service tool 892/01084 push on the outer bearing **1f**. Using service tool 892/01085 fit a new oil seal **1g**. Make sure the seal is pushed square to the housing.
- e** Fit yoke **1h** followed by thick washer **1j** and bolt **1k**. Hold the yoke using service tool 892/00812 and torque tighten the bolt to 400 Nm (295 lbf ft).
- f** If applicable fit the speed sensor **11f**. Make sure that the sealing 'O' ring is correctly located and then torque tighten the bolt to 28Nm (20 lbf ft).

2 Checking Transfer Gear/Output Shaft Assembly End Float

The transfer gear/output shaft and its associated components are manufactured using a 'Setright' system. Measure the rolling torque at the yoke **1h**. Provided components have been assembled correctly the torque will be between 0.6 and 2.2 Nm (0.5 and 1.6 lbf ft).





Assembly (cont'd)

3 Fit the Clutch/Shaft Assemblies

- a** Fit the bearing outer cups at their correct locations in the rear case **3a** and centre of the transfer gear **3b**.
- b** Carefully fit the clutch/shaft assemblies in the following order:

Note: When fitting the layshaft clutch take care not to damage the rear bearing on the transfer gear teeth.

Note: Before fitting the input clutch shaft make sure that the 4 sealing rings (shown at **A**) are in good condition and lubricated with oil.

3c - Mainshaft clutch

3d - Layshaft clutch

3e - Forward/Input clutch shaft

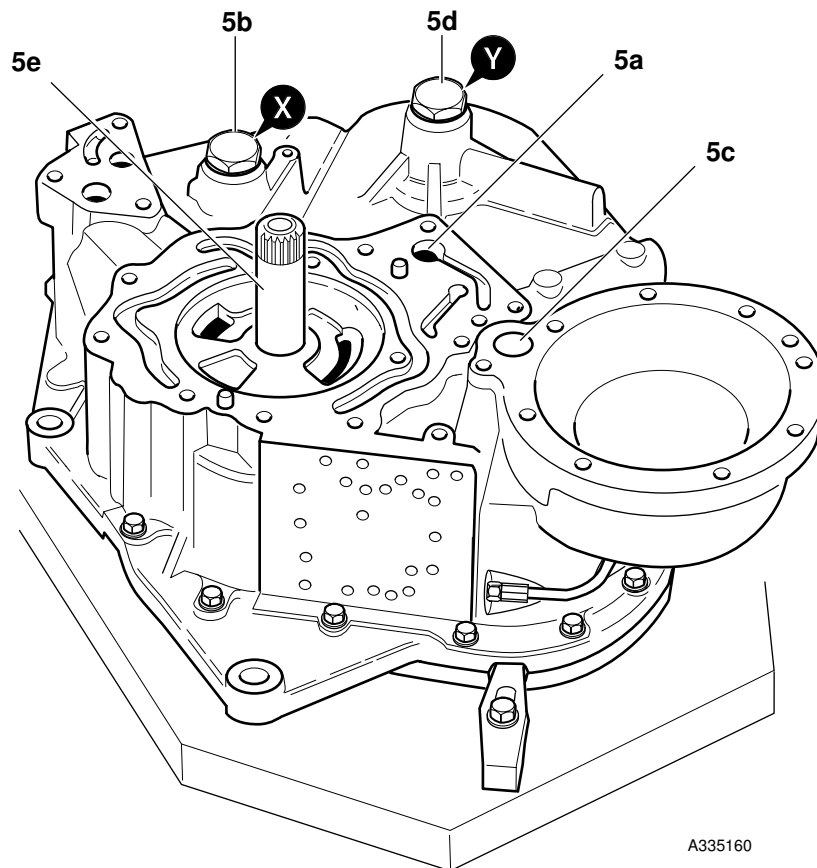
3f - Reverse clutch unit

3g - 6 speed clutch shaft (not fitted to **4x4 Gearbox**)

- c** Make sure that the sealing rings on the ends of the clutch shafts **3c**, **3d**, **3f** and **3g** are in good condition and lubricated with oil.
4x4 Gearbox: clutch **3g** (6 speed) not fitted.

4 Assemble the Front and Rear Casings

- a** Make sure that the 3 off 'O' rings **4a** are correctly fitted to the rear case.
- b** Apply a thin bead of JCB Multigasket to the rear casing mating face as shown at **B**.
- c** Make sure that the shaft bearing outer cups are correctly located in the front case **4b** and then carefully lower the case over the clutch shafts until it mates with the rear case. Do not use excessive force when fitting the case.
- d** Fit the 17 casing bolts **4c** and progressively torque tighten to 56 Nm (41 lbf ft).



Assembly (cont'd)

5 Checking the Clutch Shaft End Floats

Provided components are assembled correctly the end float will be within the limits given. Check that the shafts can be rotated by hand (turn the input shaft and output yoke). The shafts should rotate smoothly. The end floats can be checked to confirm correct assembly.

End float for all shafts will be within the range 0.02 mm to 0.16 mm (0.0008 to 0.0063 in).

All shafts except the Input Shaft:

Shaft **5a** - Mainshaft

Shaft **5b** - Reverse clutch unit

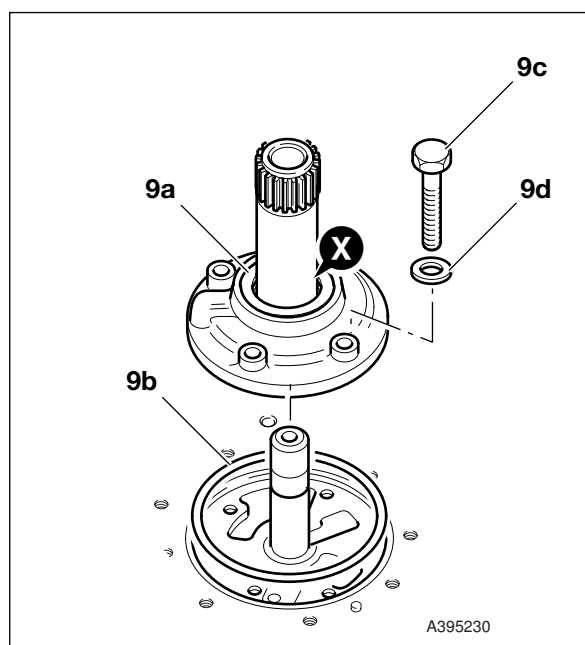
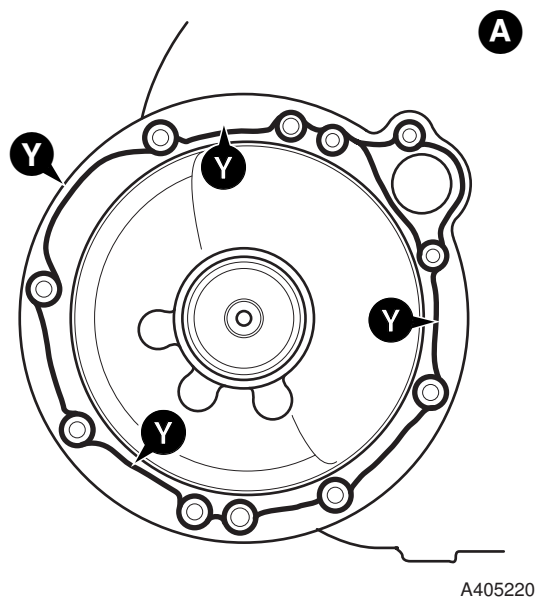
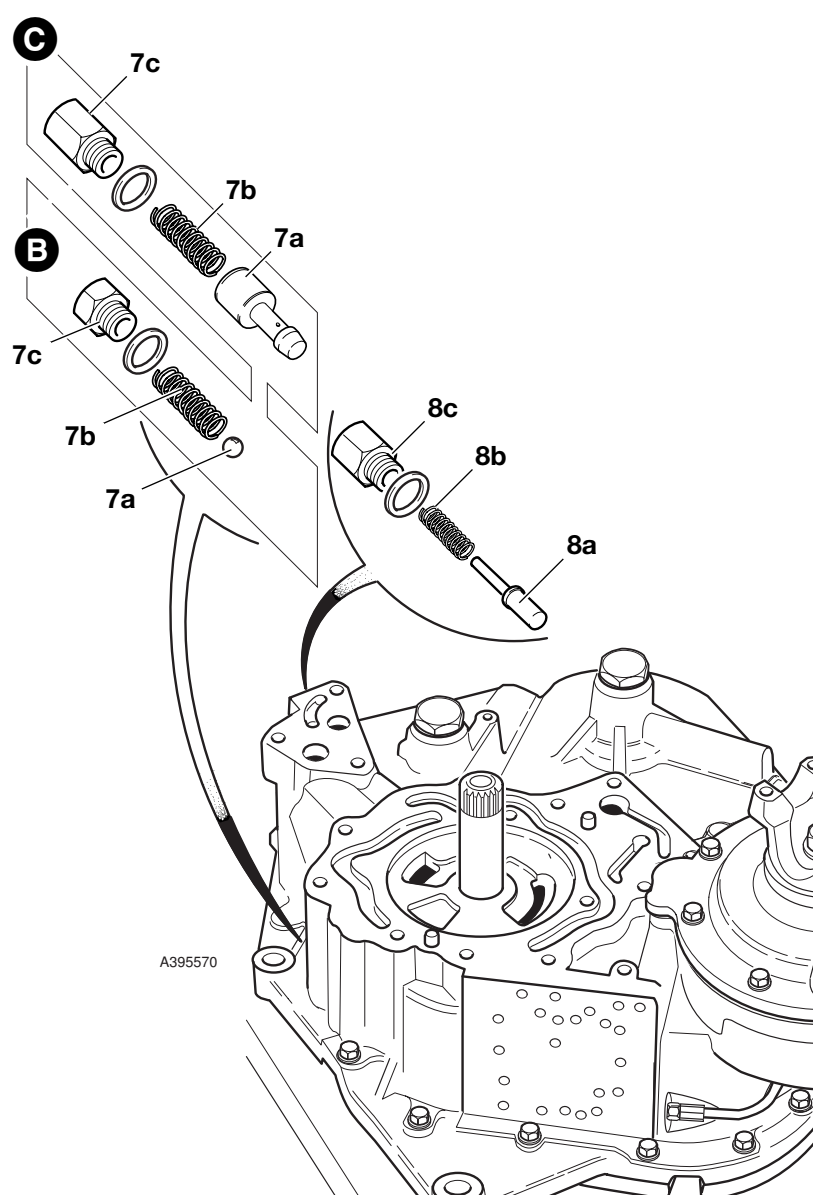
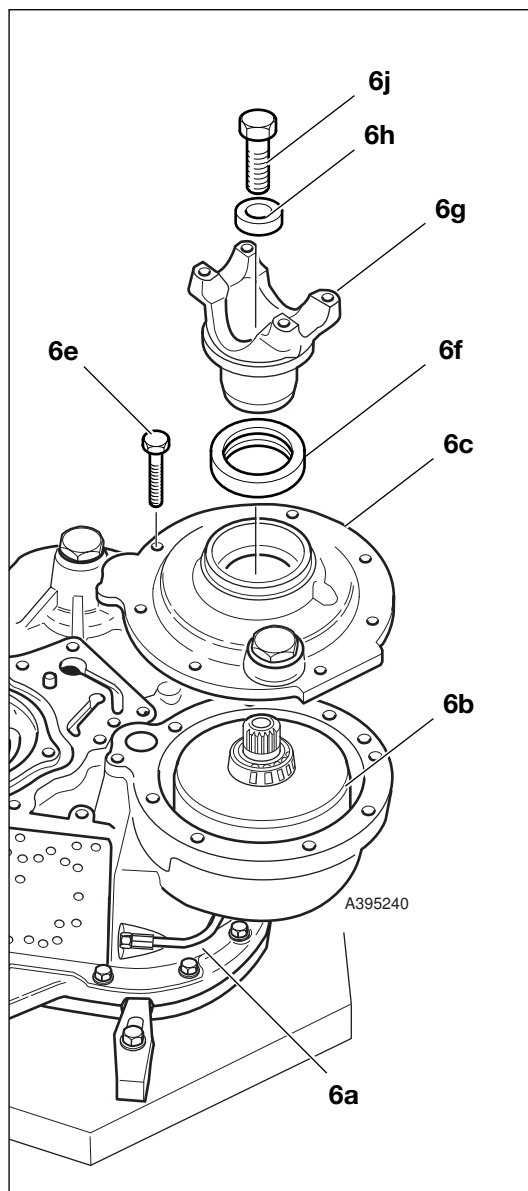
Shaft **5c** - Layshaft

Shaft **5d** - 6 speed shaft (not fitted to 4x4 gearboxes)

- a** Remove the plugs **X** and **Y** from the front casing.
4x4 Gearbox: plug **Y** not fitted.
- b** Fit a bolt to the threaded hole in the end of the shafts. Pull up on the bolt to detect excessive end float. Remove the bolt.
- c** Apply JCB Threadlocker and Sealer to the plugs **X** and **Y** as applicable. Torque tighten the plugs to 102 Nm (75 lbf ft).

Input Clutch Shaft:

- a** Pull on the input shaft **5e** to detect excessive end float.



Assembly (cont'd)

6 Fit the 4WD Clutch Assembly

- a Fit the 4WD clutch oil feed pipe **6a** at the casing.
- b Make sure the shaft bearing outer cup is correctly located in the front casing (not shown) and then locate the clutch and shaft assembly **6b** in the the housing.
- * c Make sure that the front and 4WD casing (**6c**) mating faces are clean and undamaged. Apply a 3 mm bead of Loctite 509 to the front casing as shown at **A**. Note that the bead is applied near the inner or outer edge of the flange as applicable at positions **Y**. Make sure that the shaft bearing outer cup (not shown) is correctly located inside the 4WD casing and then fit the casing. Fit 8 off bolts **6e** and progressively torque tighten to 56 Nm

Check the 4WD clutch shaft end float:

Provided components are assembled correctly the end float will be within the limits given. Rotate the shaft by hand, it should rotate smoothly.

The end float can be checked to confirm correct assembly. End float must be within the range 0.01 mm to 0.16 mm (0.0004 to 0.0063 in).

- d Fit a bolt to the threaded hole in the end of the shaft. Pull up on the bolt to detect excessive end float.
- e Fit a new oil seal **6f**. Make sure the seal is pushed square to the housing.
- f Fit the output yoke **6g**, followed by thick washer **6h** and bolt **6j**. Hold the yoke using service tool 892/00812 and at the same time torque tighten the bolt to 400 Nm (295 lbf ft).

7 Fit the Torque Converter Relief Valve

- * **Note:** The torque converter relief valve may be of a ball type (shown at **B**), or poppet type (shown at **C**).

- a Fit the ball or poppet (see note above) **7a** followed by the spring **7b**. Using a new sealing washer fit plug **7c**.

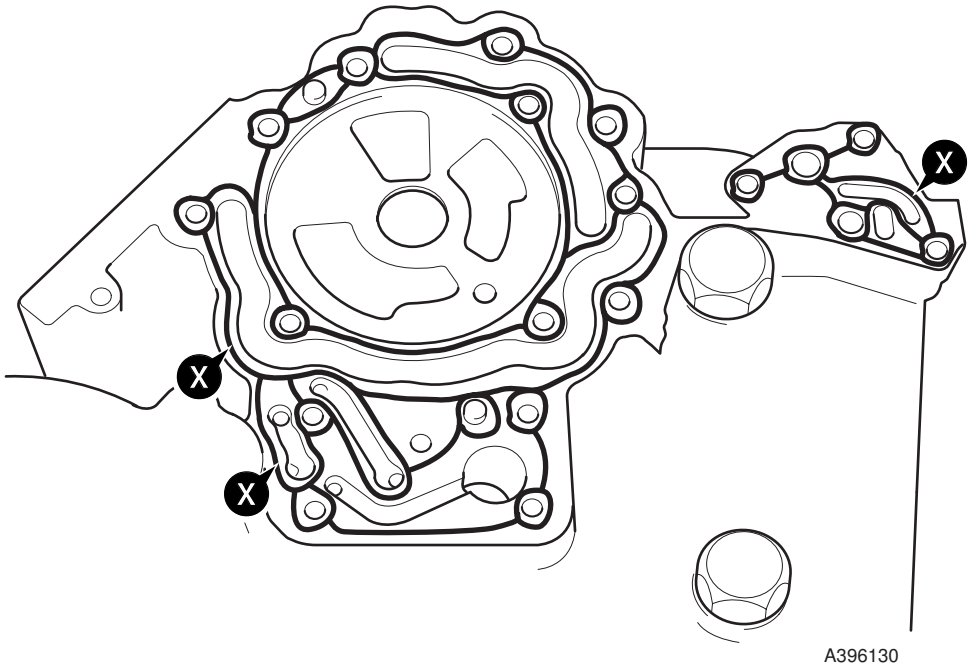
8 Fit the Pressure Maintenance Valve

- a Oil the spool **8a** and fit to the casing. Fit spring **8b**. Apply JCB Threadlocker and Sealer to the plug **8c**. Using a new sealing washer fit plug.

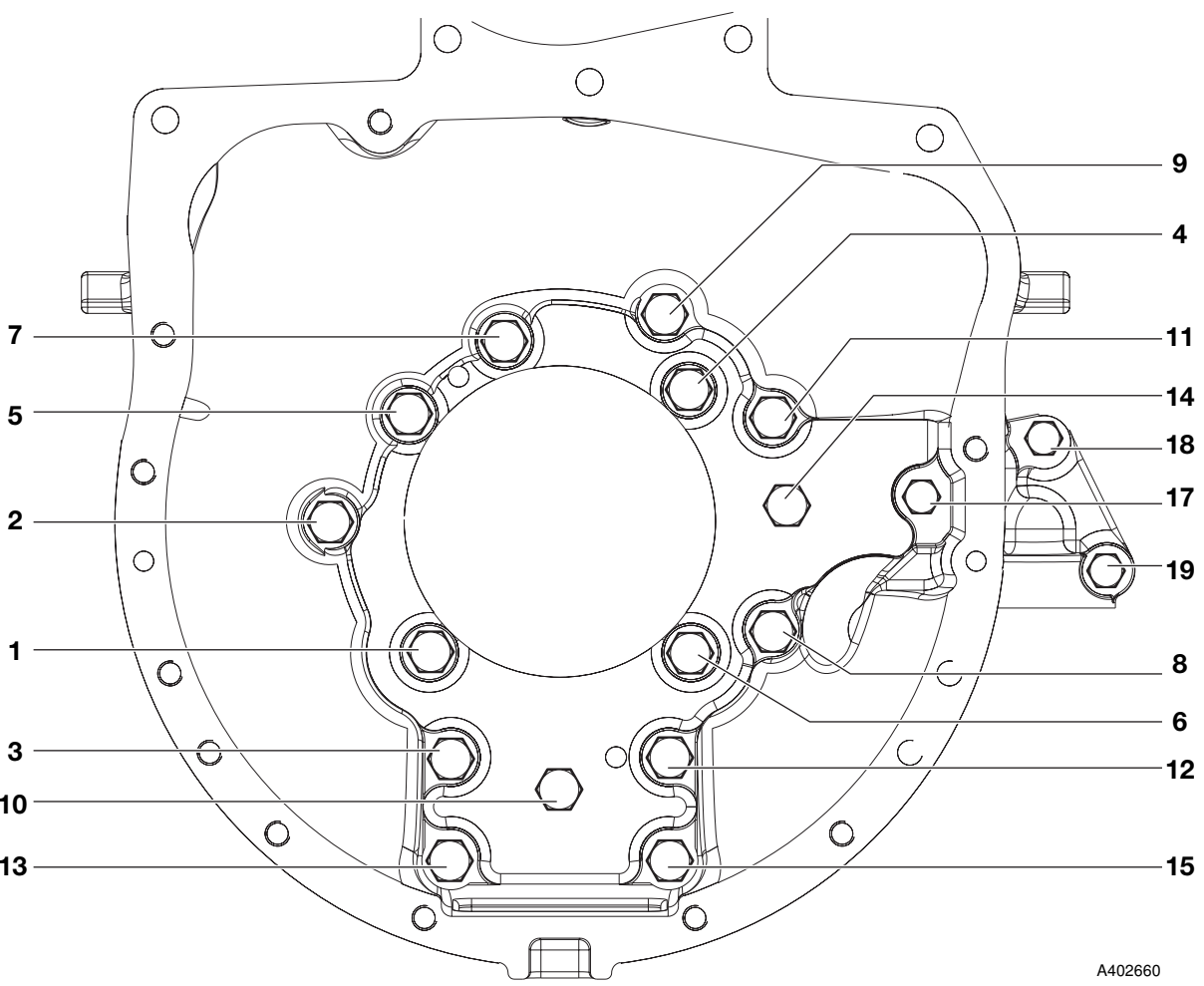
9 Fit the Gearbox Hydraulic Pump

- a Make sure that the pump is fitted with a new oil seal **9a**, see **Powershift Gearbox, Inspection, step 4**. Fit a new sealing ring **9b**. Locate the pump over the input shaft aligning the bolt holes. Apply JCB Threadlocker and Sealer to bolts **9c**. Fit the bolts together with new sealing washers **9d**. Progressively torque tighten the bolts to 28 Nm (20 lbf ft).
- b Pour some clean, new, oil into the pump at position **X**.

A



B



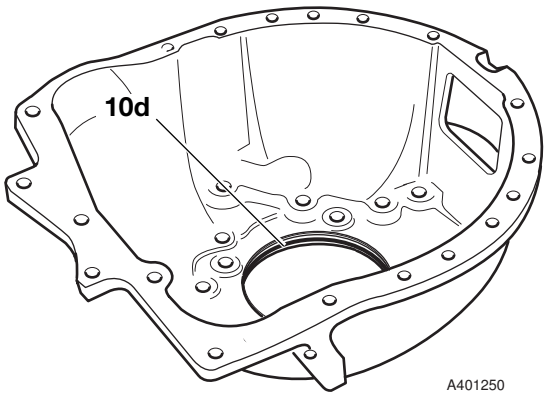
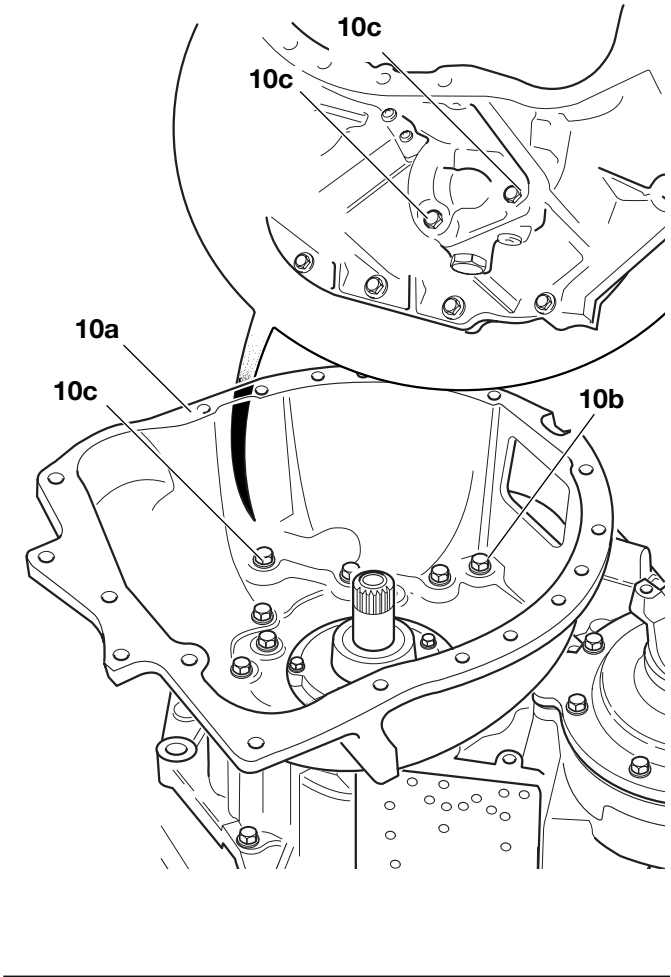
Assembly (cont'd)

10 Fit the Torque Converter Housing - Gearboxes with 18 bolt fix only

* **Important Note:** Only the specified sealant can be used. The machine **MUST NOT** be operated for at least 6 hours after sealant has been applied and the converter housing assembled. This is to allow time for the sealant to cure.

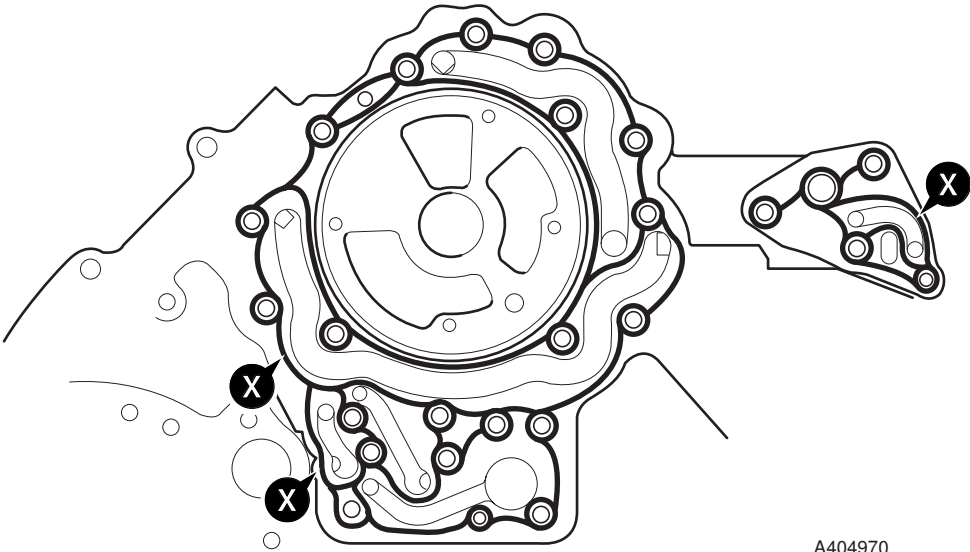
- a** Make sure that the front case and torque converter housing (10a) mating faces are clean, dry and undamaged. Apply a 3 mm wide bead of Bondloc B574 sealant to the front casing as shown at **A** (pump not shown for clarity). Make sure that sealant is applied between all the port channels as shown. Take extra special care in the area **X** as sealing is critical in these areas. Be sure not to block galleries with sealant. Fit a new 'O' ring 10d to the housing 10a.
- b** Carefully locate the torque converter casing on the front case. Fit new 10.9 grade bolts as follows:
M10 bolts 10b (15 off). Note that spacers are fitted under bolts at positions 10 and 14.
M8 bolts 10c (3 off)
Progressively torque tighten the bolts in the sequence shown. Note that the bolt at position 1 is re-torqued after tightening the bolt at position 15.

Sequence	Bolt Position (shown at B)	Torque	
		Nm	lbf ft
1 - 9	1 - 9	78	57.5
10	10	60	44.25
11 - 13	11 - 13	78	57.5
14	14	60	44.25
15	15	78	57.5
16	1 (Re-torque)	78	57.5
17 - 19	17 - 19	38	28



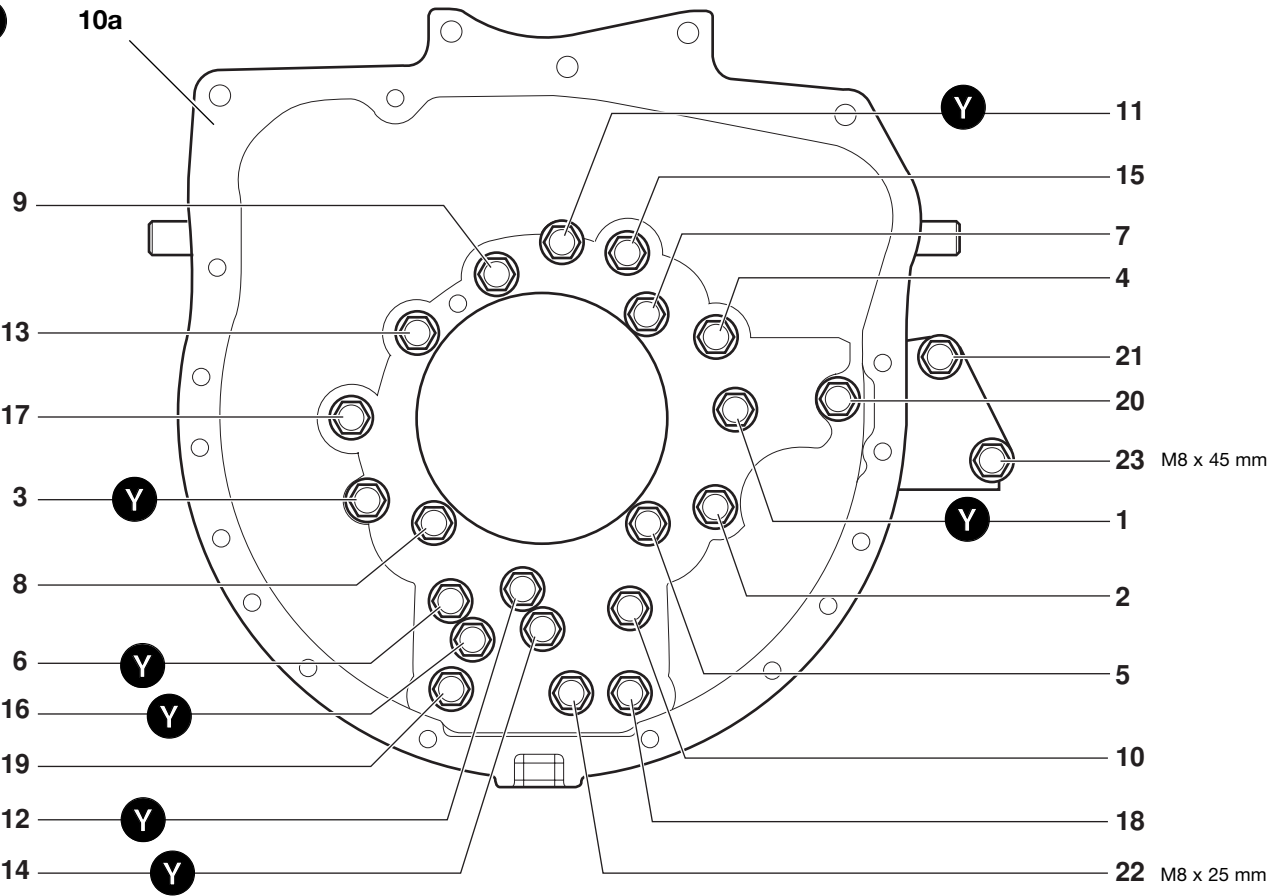
A401250

A



A404970

B



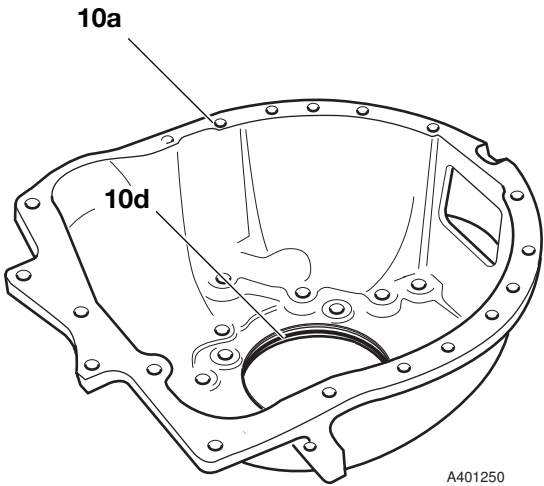
A404980

Assembly (cont'd)

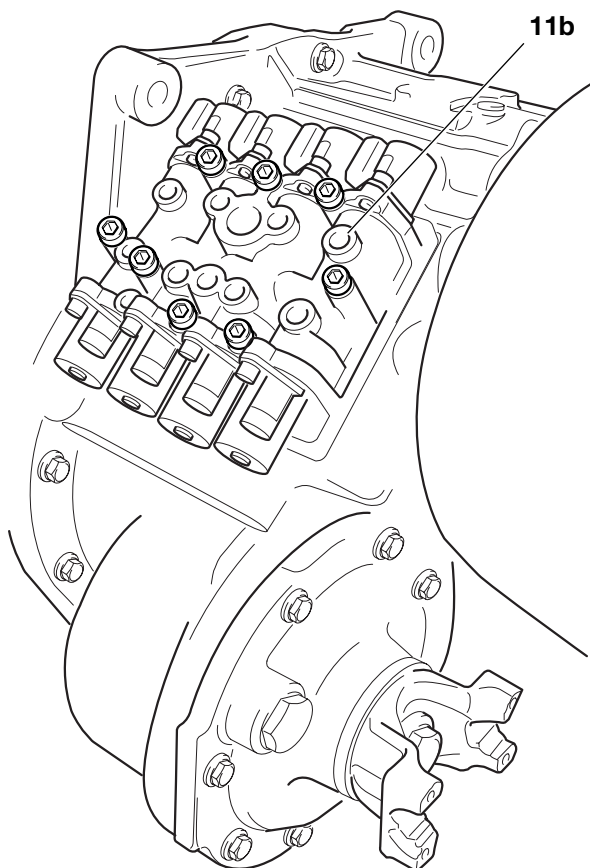
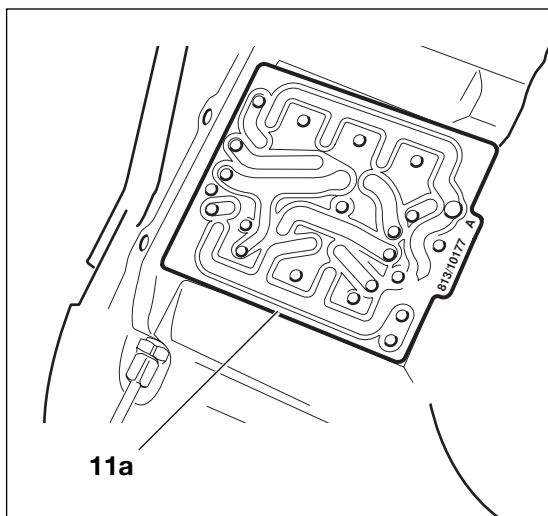
10 Fit the Torque Converter Housing - Gearboxes with 23 bolt fix only

Important Note: Only the specified sealant can be used. The machine **MUST NOT** be operated for at least 6 hours after sealant has been applied and the converter housing assembled. This is to allow time for the sealant to cure.

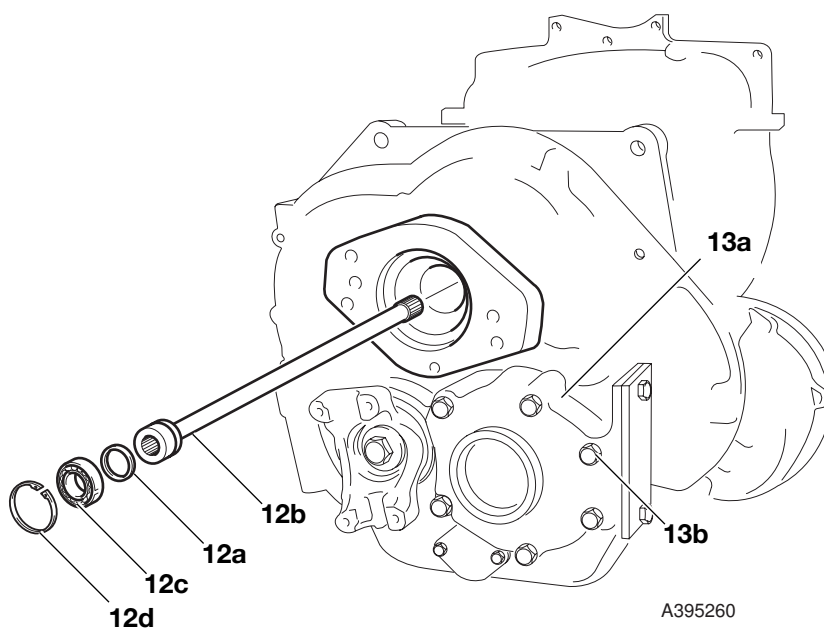
- a Make sure that the front case and torque converter housing (10a) mating faces are clean, dry and undamaged. Apply a 3 mm wide bead of Loctite 509 sealant to the front casing as shown at **A** (pump not shown for clarity). Make sure that sealant is applied between all the port channels as shown. Take extra special care at positions **X** as sealing is critical in these areas. Be sure not to block galleries with sealant. Fit a new 'O' ring 10d to the housing 10a.
- b Carefully locate the torque converter casing on the front case. Fit new 10.9 grade bolts (shown at **B**) as follows:
M10 x 35 mm bolts (21 off). Note that on some gearboxes spacers are fitted under bolts at positions **Y**.
M8 x 25 mm bolt at position 22.
M8 x 45 mm bolt at position 23.
Progressively torque tighten the bolts in the sequence shown.



Sequence	Bolt Position (shown at B)	Torque	
		Nm	lbf ft
1 - 21	1 - 21	78	57.5
22 - 23	22 - 23	35 - 40	26 - 30



A390510



A395260

11 Fit the Solenoid Control Valve Block

- a** Fit two guide studs at the valve interface on the front case. Locate a new valve block sealing gasket **11a** as shown at **C**. Care is needed as the gasket is thin. Gearboxes fitted with a sub-base plate have two gaskets, one each side of the plate.
- b** Fit the 8 socket head cap screws and washers **11b**. The screws must be progressively torque tightened. Gradually tighten all the screws to 35 Nm (26 lbf ft).

12 Fit the Main Hydraulic Pump Driveshaft

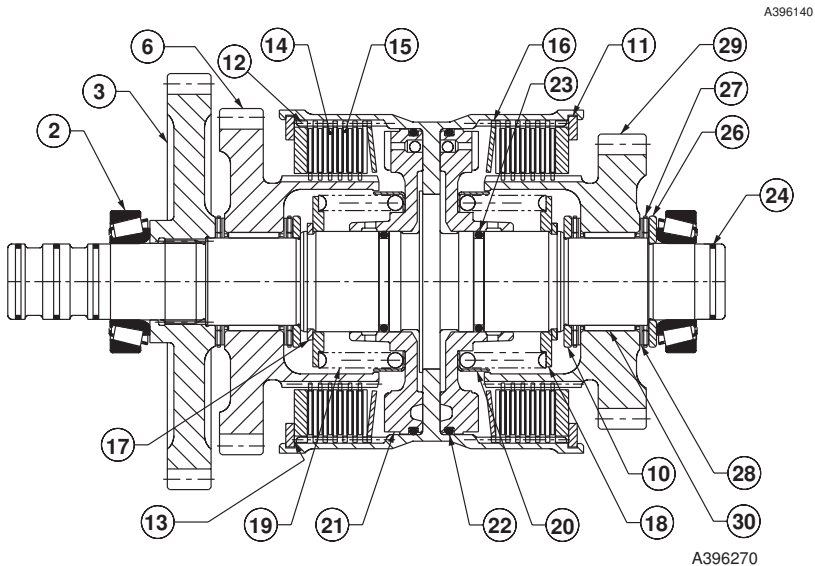
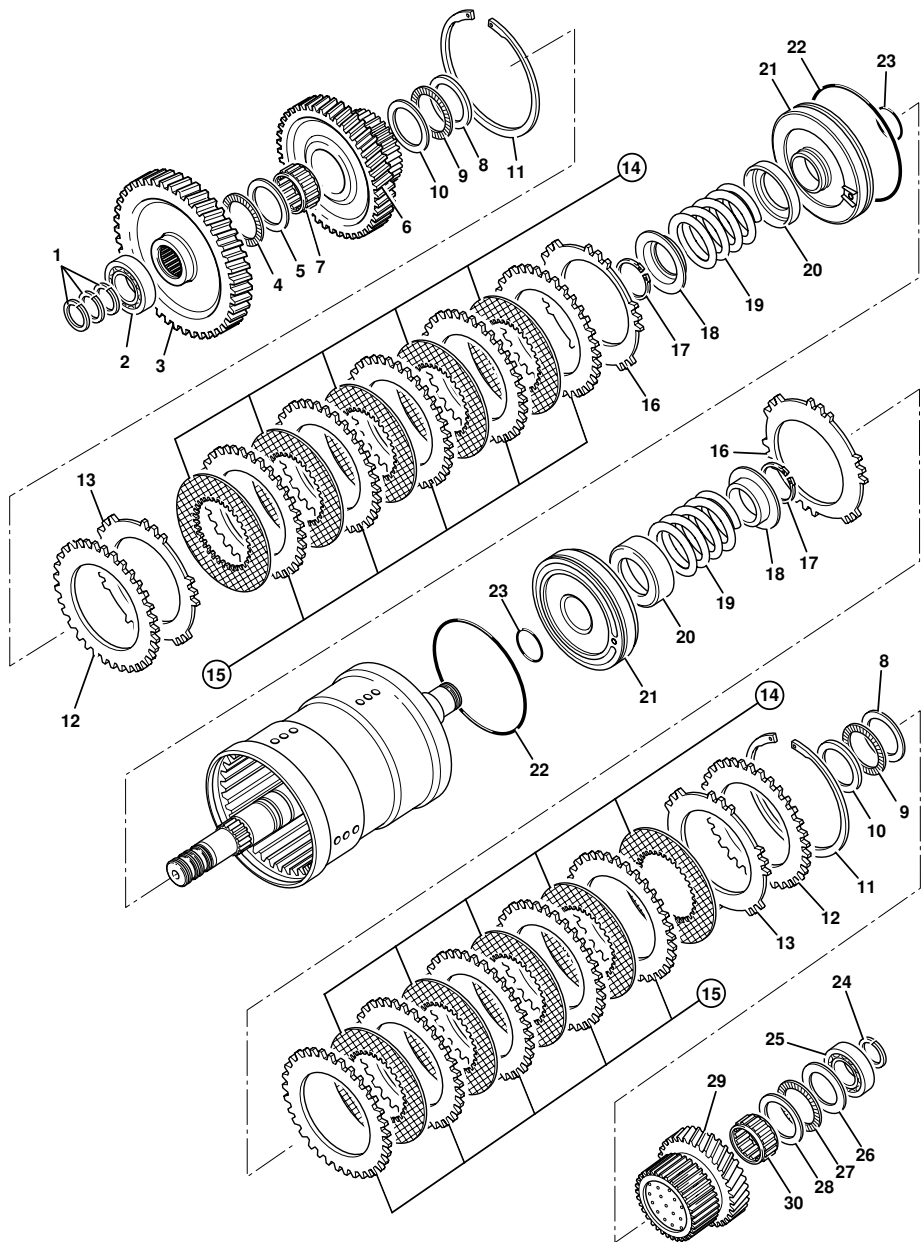
- a** Fit a new sealing ring **12a** to the shaft **12b**. Apply clean oil to the sealing ring and fit the shaft inside the gearbox.
- b** Apply clean oil to the ball bearing **12c**. Fit the bearing followed by circlip **12d**.

13 Fit the Layshaft Cover

- a** If applicable fit the layshaft cover **13a**. Make sure the casing mating faces are clean and undamaged. Apply a thin bead of JCB Multigasket to the rear casing and fit the cover. Fit bolts **13b** and progressively torque tighten to 56Nm (41 lbf ft).

Note: The main machine hydraulic pump can be fitted at this stage. However, it is easier to fit the gearbox to the machine and then fit the pump. **See Section E, Main Hydraulic Pump, Replacement.**

PS 760 - Forward/Input & Reverser Clutch - Dismantling



PS 760 - Forward/Input & Reverser Clutch - Dismantling

Note: The illustration shows a reverser shaft assembly for the 6 - speed transmission. The input shaft assembly has some small differences. An explanation of the differences will be given as they occur in the procedure. The input and reverser shaft assemblies for the 6 - speed transmission and the 4 - speed transmission are the same basic construction, except the 4 - speed transmission have fewer friction/counter plates.

- 1 Carefully remove piston ring seals **1**. The input shaft does not have piston ring seals fitted at this end of the shaft.

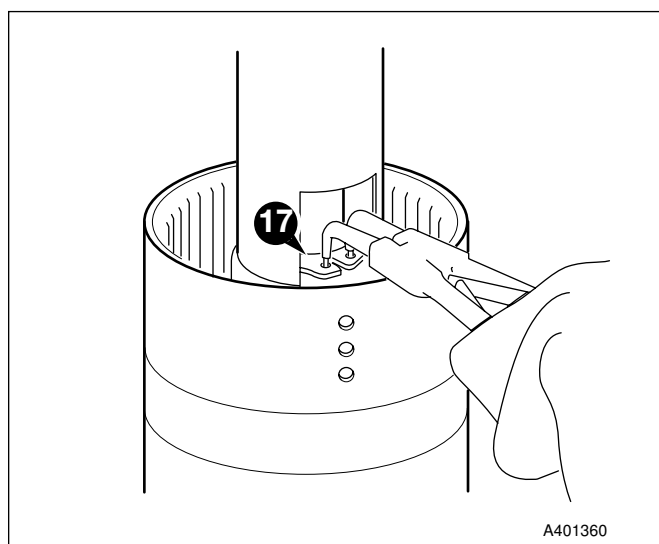
Note: If the piston ring seals are excessively worn then check for burrs or damage on the shaft grooves. If necessary remove burrs with a fine grade abrasion paper and oil.

- 2 Remove the clutch end bearing **2** and gear **3**, using a puller or press.
- 3 Remove the thrust bearing **4** and thin thrust washer **5**.
- 4 Withdraw the gear and splined hub **6** with the needle roller bearing **7**.
- 5 Remove thrust bearing **9** and thick and thin thrust washers **8** and **10**.
- 6 Remove the friction/counter plates retaining circlip **11**.
- 7 Remove pressure end plate **13** and shim **12**, if fitted.
- 8 Remove the friction plates **14** and counter plates **15**. Keep them together in sets, DO NOT mix the plates with those from other clutches.
- 9 Remove disc spring assembly **16**.
- 10 Position clutch assembly in a suitable press, with a cut away tube compress the piston spring then remove circlip **17**.

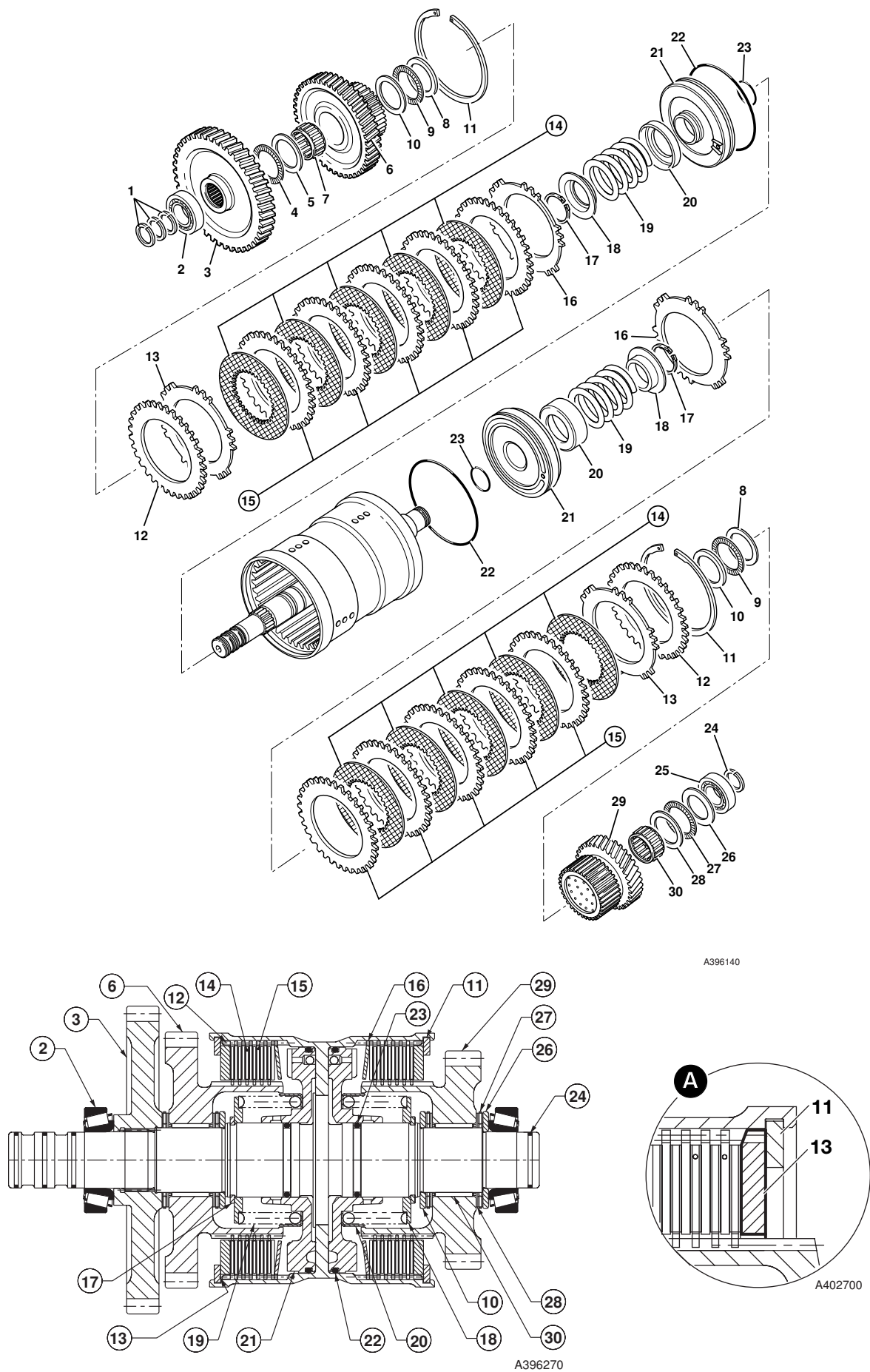
- 11 Lift off spring retaining plate **18**.
- 12 Remove spring **19** and oil baffle **20**.
- 13 Turn the assembly over and knock the clutch shaft on a piece of aluminium (or wood) to loosen the piston **21**.

Note: If the piston does not loosen when the clutch shaft is knocked on aluminium, then hand pump air down the shaft oil inlet hole.

- 14 Remove the piston **21**. Remove and discard the piston 'O' ring **22** and shaft 'O' ring **23**.
- 15 To dismantle the opposite clutch, carefully remove piston ring seal **24**. The input shaft has four piston ring seals fitted at this end of the shaft.
- 16 Loosen the clutch end bearing **25** and remove using a puller.
- 17 Remove thrust bearing **27** and thick and thin thrust washers **26** and **28**.
- 18 Withdraw the gear and splined hub **29** with the needle roller bearing **30**.
- 19 Repeat steps **5** to **14** to dismantle the clutch assembly.



PS 760 - Forward/Input & Reverser Clutch - Assembly



PS 760 - Forward/Input & Reverser Clutch - Assembly

Visually inspect the friction and counter plates:

Counter plates - light scoring/polishing is permissible, plates that are not flat, worn or heavily marked or scored must be replaced with a new set.

Friction plates - the cross hatching should be clearly visible, plates that are not flat, have friction material damage or scoring must be replaced with a new set.

DO NOT mix old and new plates, if a plate is damaged/worn fit a complete new set.

Needle roller bearings should slide into position freely, do not bend or distort the cage to fit. If the cage has been distorted fit new bearings.

Take care when handling disc spring assemblies **16** to avoid marking or damage, which could result in stress cracking. If in doubt fit a new disc spring.

Note: The piston incorporates a small check valve. Visually inspect the piston to ensure the ball is in place and that the seat is free from contamination. If necessary clean the valve by blowing through with an air line. DO NOT use a wire rod (or screwdriver) as damage to the valve seat could occur.

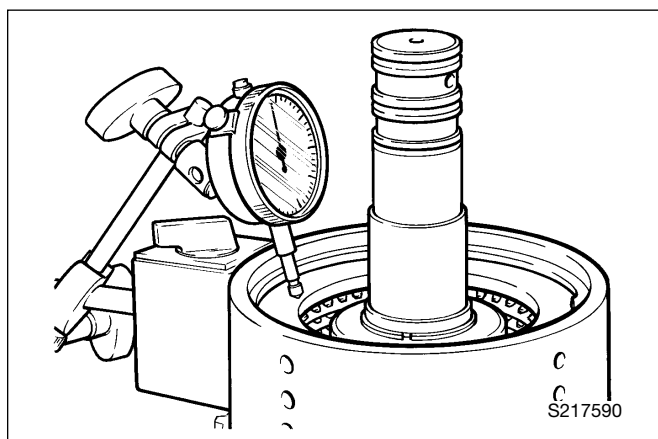
- 1 Fit new 'O' rings **23** and **22**. Lubricate the piston **21** with oil and press fully into bore of clutch housing.
- 2 Fit the oil baffle **20**, piston spring **19**, make sure the spring seats in the piston.
- 3 Fit the spring retaining plate **18**.
- 4 Compress the spring and secure with circlip **17**.
- 5 Fit the disc spring assembly **16**. Make sure that the disc spring is fitted with the teeth towards the clutch pack. Make sure the teeth are not aligned with the lubrication slots in the housing.
- 6 Fit one counter plate **15**, followed by one friction plate **14**. Continue fitting alternate counter and friction plates, finishing with a friction plate.
- * 7 Fit the pressure end plate **13**. Make sure that the chamfered face is fitted facing the clutch pack as shown at **A**. Make sure the teeth are not aligned with the lubrication slots in the housing. Do not fit shim **12** at this stage.
- 8 Fit the clutch friction/counter plates retaining circlip **11**.

- 9 Using a dial test indicator as shown, measure the end float of the pressure end plate **13**, which should be 1.90 to 2.50 mm (0.075 to 0.098 in).

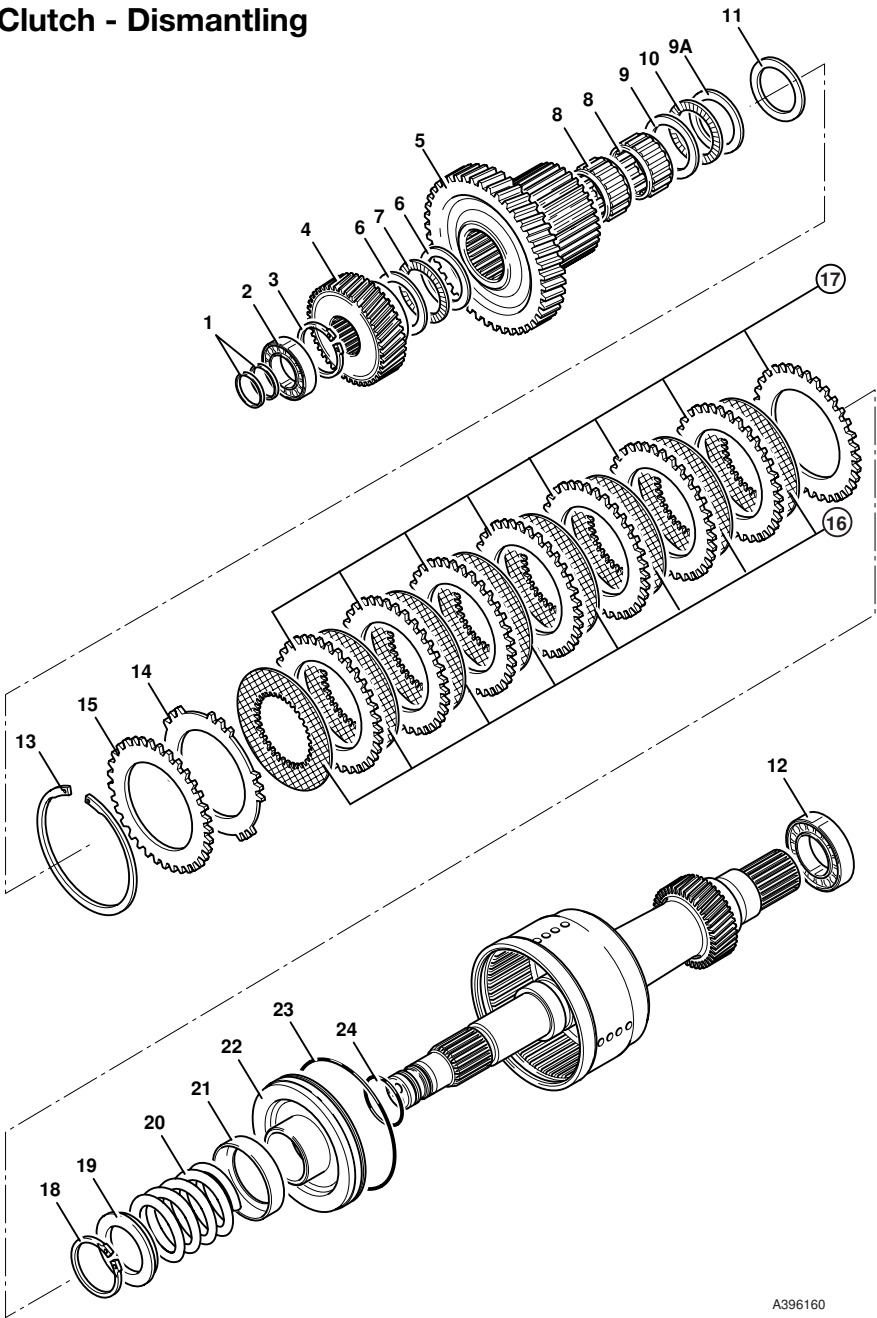
If it is necessary to adjust the end float to bring it within tolerance, there is a choice of fitting a 6.0mm (0.23in) or 6.5mm (0.25in) thick pressure end plate **13**, with either a shim **12** or an extra counter plate **15** between the retaining circlip **11** and pressure end plate **12**.

Use an airline to check the operation of the clutch.

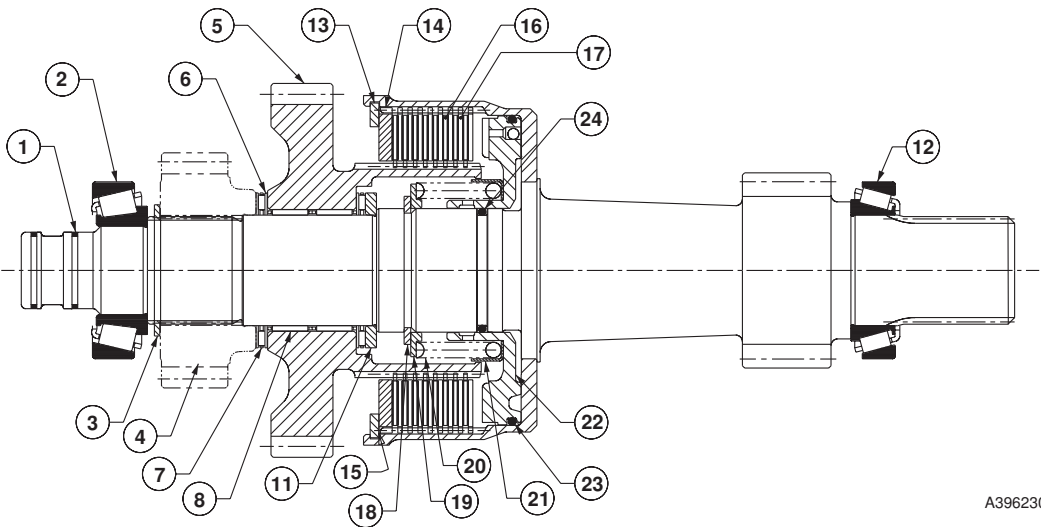
- 10 Fit thick and thin thrust washers **8** and **10**, and thrust bearing **9**.
- 11 Carefully align the teeth of the clutch plates using a thin rod (or screwdriver) and fit the gear and splined hub **6**.
- 12 Fit needle roller bearing **7**.
- 13 Fit thrust bearing **4** and thin thrust washer **5**.
- 14 Smear the clutch end bearing with gearbox oil and press the gear **3** and bearing **2** onto the shaft.
- 15 Fit piston ring seals **1**, refer to **Piston Ring Seals - Fitting Procedure**. The input shaft does not have piston ring seals fitted at this end of the shaft.
- 16 To assemble the opposite clutch repeat steps **1** to **10**.
- 17 Carefully align the teeth of the clutch plates using a thin rod (or screwdriver) and fit the gear and splined hub **29**.
- 18 Fit needle roller bearing **30**.
- 19 Fit thrust bearing **27** and thick and thin thrust washers **26** and **28**.
- 20 Smear the clutch end bearing with gearbox oil and press bearing **25** onto the shaft.
- 21 Fit piston ring seal **24**, refer to **Piston Ring Seals - Fitting Procedure**. The input shaft has four piston ring seals fitted at this end of the shaft.



PS760 - Layshaft Clutch - Dismantling



A396160



A396230

PS760 - Layshaft Clutch - Dismantling

Note: The illustration shows a layshaft assembly for a 6 - speed transmission. The layshaft assembly for a 4 - speed transmission has some small differences. An explanation of the differences will be given as they occur in the procedure.

- 1 Carefully remove piston ring seals **1**.

Note: If the piston ring seals are excessively worn then check for burrs or damage on shaft grooves. If necessary remove burrs with a fine grade abrasion paper and oil.

- 2 Remove taper roller bearing **2** using a suitable puller or press.
- 3 Remove circlip **3** and withdraw the 4 wheel drive transfer gear **4**. Make a note which way round the gear is fitted for assembly. The 2 wheel drive machines have a spacer fitted instead of a gear.
- 4 Withdraw the gear and splined hub **5** together with thin thrust washers **6** and thrust bearing **7**.
- 5 Remove the two needle roller bearing assemblies **8**. 4-speed transmissions have only one needle roller bearing fitted.
- 6 * Remove the thin thrust washer **9**, thrust bearing **10**, thin thrust washer **9A** (if fitted) and thick thrust washer **11**.
- 7 If end bearing **12** is to be removed it must be renewed. Remove the bearing using puller. Discard the bearing.

Note: This bearing would not normally be removed unless it was damaged. If a collet tool is not available, then it is permissible to use standard bearing puller, although damage to the bearing cage may be incurred which will require a new bearing.

- 8 Remove the clutch friction/counter plates retaining circlip **13**.
- 9 Remove pressure end plate **14** and shim **15**, if fitted.
- 10 Remove the clutch friction plates **16** and counter plates **17**. Keep them together in sets, DO NOT mix the plates with those from other clutches.
- 11 Position clutch assembly in a suitable press, with a cut away tube compress the piston spring as shown, then remove circlip **18**.

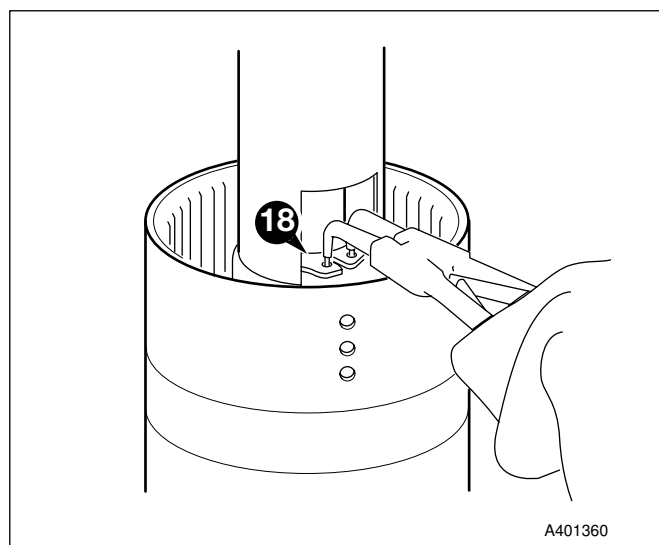
- 12 Lift off spring retaining plate **19**.

- 13 Remove the spring **20** and oil baffle **21**.

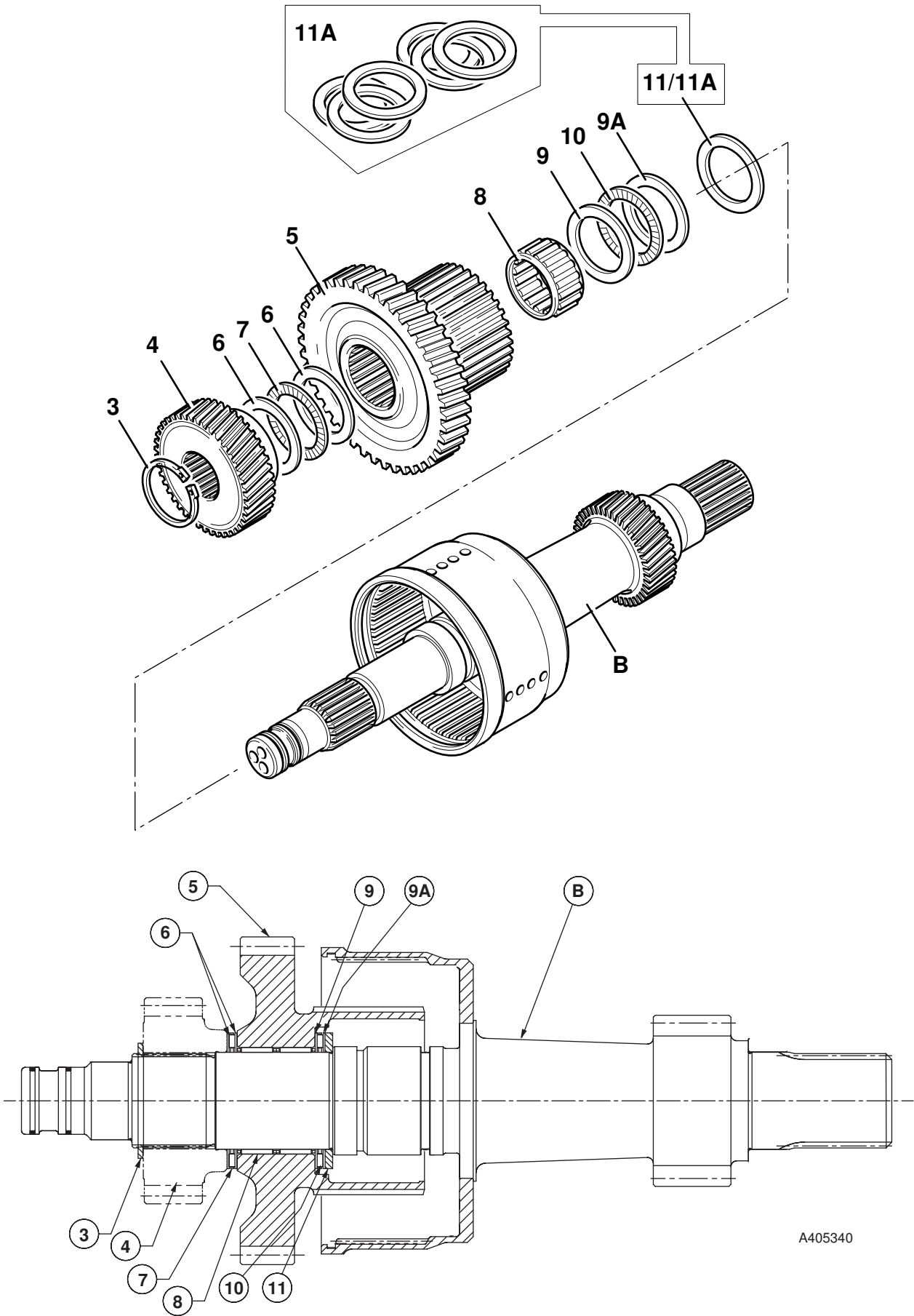
- 14 Turn the assembly over and knock the clutch shaft on a piece of aluminium (or wood) to loosen the piston **22**.

Note: If the piston does not loosen when the clutch shaft is knocked on aluminium, then hand pump air down the shaft oil inlet hole.

- 15 Remove the piston **22**. Remove and discard the piston 'O' ring **23** and shaft 'O' ring **24**.



PS760 - Layshaft Clutch - Assembly



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PS760 - Layshaft Clutch - Assembly

End Float Setting - Plate Carrier and Gear

(Only clutch assemblies fitted with thrust washer **9A**)

Later clutch assemblies feature an additional thrust washer **9A**. If any of the components listed below are to be renewed, the end float of gear **5** must be measured and reset as required:

Item

- B** Shaft assembly
- 5** Gear and plate carrier assembly
- 6,7** Thrust washer assembly
- 9,10** Thrust washer assembly
- 4** 4WD transfer gear or spacer as applicable

Check and reset the endfloat of gear **5** as follows:

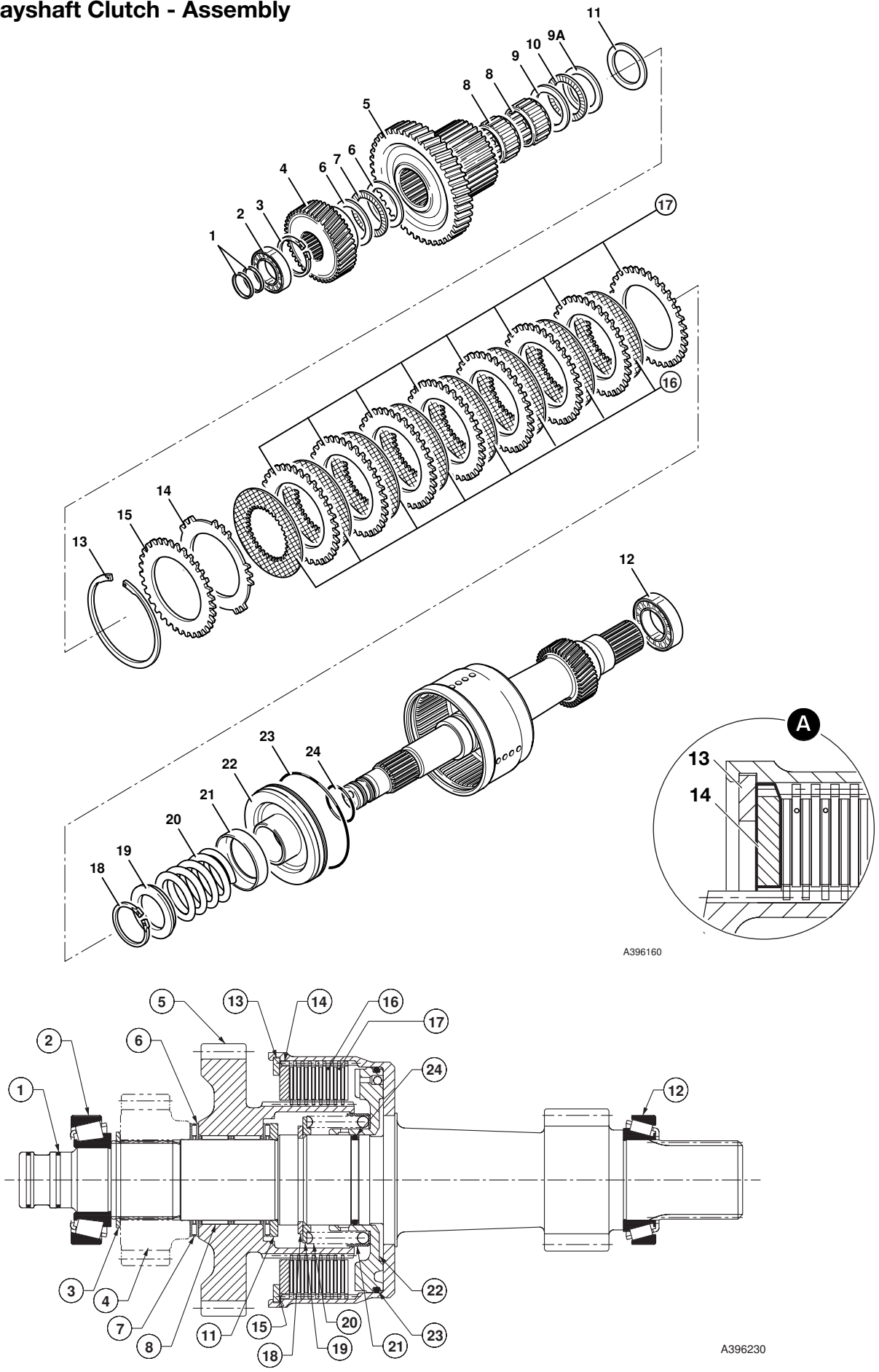
- 1** Temporarily fit thick thrust washer **11**, thin thrust washer **9A**, thrust bearing **10** and thin thrust washer **9**. Fit needle roller bearing **8**.
- 2** Temporarily fit the gear and plate carrier assembly **5**. Fit the thin thrust washer **6** and thrust bearing **7** followed by the remaining thrust washer **6**.
- 3** Temporarily fit the 4 wheel drive transfer gear **4** onto the layshaft spline. Make sure that the gear is fitted the correct way round. 2 wheel drive machines have a spacer fitted instead of a gear. Fit the circlip **3**.
- 4** Make sure that the 4 wheel drive gear (or spacer) is fully seated against circlip **3**. Measure the end float of gear **5**. It must be between 0.01 to 0.15 mm (0.0004 to 0.006 in). If the end float requires adjustment select a suitable thrust washer from **11A** and reassemble the components as described above.

Note: **11A** = kit 823/10420 - comprises 6 thrust washers of the following thicknesses:

- 4.3 mm (0.169 in)
- 4.4 mm (0.173 in)
- 4.5 mm (0.177 in)
- 4.6 mm (0.181 in)
- 4.7 mm (0.185 in)
- 4.8 mm (0.189 in)

- 5** Recheck the end float and then dismantle the components. Assemble the clutch as detailed on the next page. Be sure to fit the correct thrust washer **11** on final assembly.

PS760 - Layshaft Clutch - Assembly



PS760 - Layshaft Clutch - Assembly

Visually inspect the friction and counter plates:

Counter plates - light scoring/polishing is permissible, plates that are not flat, worn or heavily marked or scored must be replaced with a new set.

Friction plates - the cross hatching should be clearly visible, plates that are not flat, have friction material damage or scoring must be replaced with a new set.

DO NOT mix old and new plates, if a plate is damaged/worn fit a complete new set.

Needle roller bearings should slide into position freely, do not bend or distort the cage to fit. If the cage has been distorted fit new bearings.

Note: The piston incorporates a small check valve. Visually inspect the piston to ensure the ball is in place and that the seat is free from contamination. If necessary clean the valve by blowing through with an air line. DO NOT use a wire rod (or screwdriver) as damage to the valve seat could occur.

- 1 Fit new 'O' rings **24** and **23**. Lubricate the piston **22** with oil and press fully into bore of clutch housing.
- 2 Fit oil baffle **21**, piston spring **20**, make sure the spring seats in the piston.
- 3 Fit the spring retaining plate **19**.
- 4 Compress the spring and secure with circlip **18**.
- 5 Fit one counter plate **17** followed by one friction plate **16**. Continue fitting alternate counter and friction plates, finishing with a friction plate.
- 6 Fit the pressure end plate **14**, do not fit shim **15** at this stage. Make sure that the chamfered face is fitted facing the clutch pack as shown at **A**. Make sure the teeth are not aligned with the lubrication slots in the housing.

Note: A spring disc is not fitted in this clutch pack.

- 7 Fit the clutch friction/counter plates retaining circlip **13**.
- 8 Using a dial test indicator as shown, measure the end float of the pressure end plate **14**, which should be 1.9 to 2.5 mm (0.075 to 0.098 in).

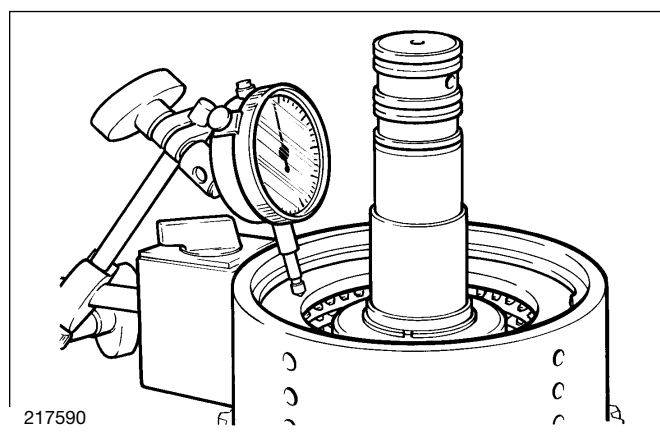
If it is necessary to adjust the end float to bring it within tolerance, there is a choice of fitting a 6.0mm (0.23in) or 6.5mm (0.25in) thick pressure end plate **14**, with either a shim **15** or an extra counter plate **17** between the retaining circlip **13** and pressure end plate **14**.

Use an airline to check the operation of the clutch.

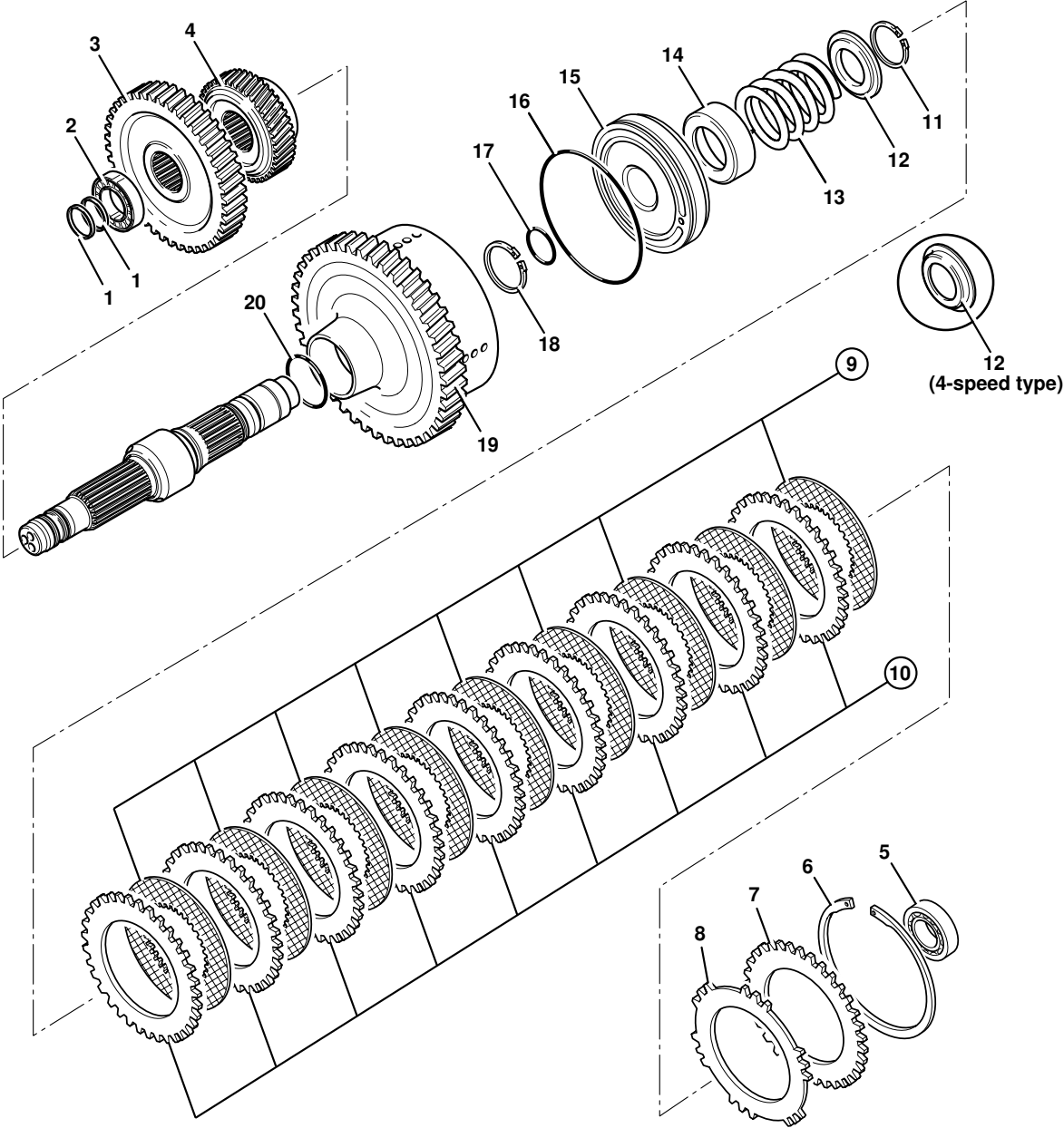
- 9 * Fit the thick thrust washer **11**, thin thrust washer **9A†**, thrust bearing **10** and thin thrust washer **9**.

* † Thrust washer **9A** not fitted to early clutch assemblies.

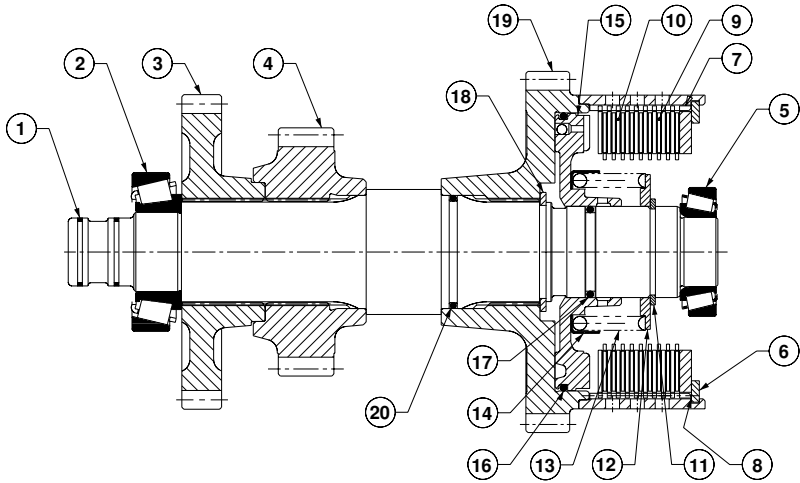
- 10 Fit the two needle roller bearings **8**. The 4-speed transmissions have only one needle roller bearing fitted.
- 11 Carefully align the teeth of the clutch plates using a thin rod (or screwdriver) and fit the gear and splined hub **5**.
- 12 Fit the thin thrust washers **6** and thrust bearing **7**.
- 13 Fit the 4 wheel drive transfer gear **4** onto the layshaft spline. Make sure that the gear is fitted the correct way round. The 2 wheel drive machines have a spacer fitted instead of a gear. Fit the circlip **3**.
- 14 Smear the clutch end bearings **2** and **12** with gearbox oil. Oil and press the bearings onto the shaft.
- 15 Fit piston ring seals **1**, refer to **Piston Ring Seals - Fitting Procedure**.



PS760 - Mainshaft Clutch - Dismantling



A396150



A396250

PS760 - Mainshaft Clutch - Dismantling

Note: The illustration shows a mainshaft assembly for a 6 - speed transmission. The mainshaft assembly for a 4 - speed transmission has some small differences. An explanation of the differences will be given as they occur in the procedure. The mainshaft assemblies for the 6 - speed and the 4 - speed transmission are the same basic construction, except the 4 - speed transmission have fewer friction/counter plates.

- 1 Carefully remove piston ring seals 1.

Note: If the piston ring seals are excessively worn then check for burrs or damage on shaft grooves. If necessary remove burrs with a fine grade abrasion paper and oil.

- 2 Remove taper roller bearing 2 using a puller or press.
- 3 Withdraw the gears 3 and 4. Make a note which way round the gears are fitted for assembly.
- 4 At the opposite end, use a suitable puller to remove the taper roller bearing 5.
- 5 Remove the clutch friction/counter plates retaining circlip 6.
- 6 Remove the pressure end plate 7 and shim 8, if fitted.
- 7 Remove the clutch friction plates 9 and counter plates 10. Keep them together in sets, DO NOT mix the plates with those from other clutches.
- 8 Position clutch assembly in a suitable press, with a cut away tube compress the piston spring as shown, then remove circlip 11.

- 9 Lift off spring retaining plate 12. The 4 - speed transmissions have a different shaped spring retaining plate fitted.

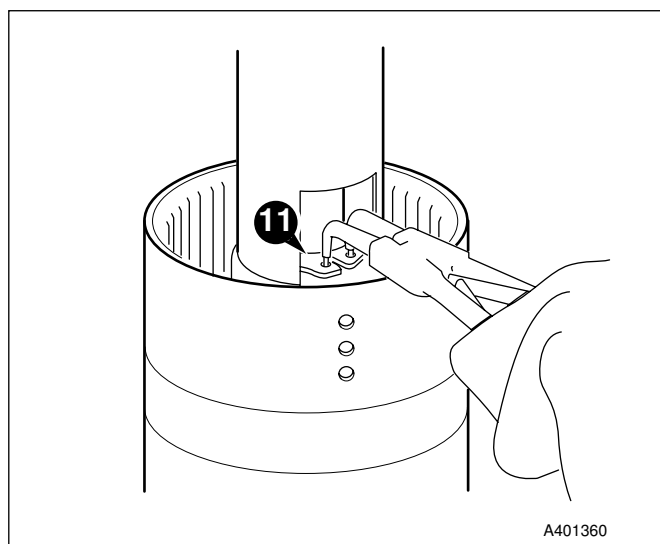
- 10 Remove the spring 13 and oil baffle 14.

- 11 Turn the assembly over and knock the clutch shaft on a piece of aluminium (or wood) to loosen the piston 15.

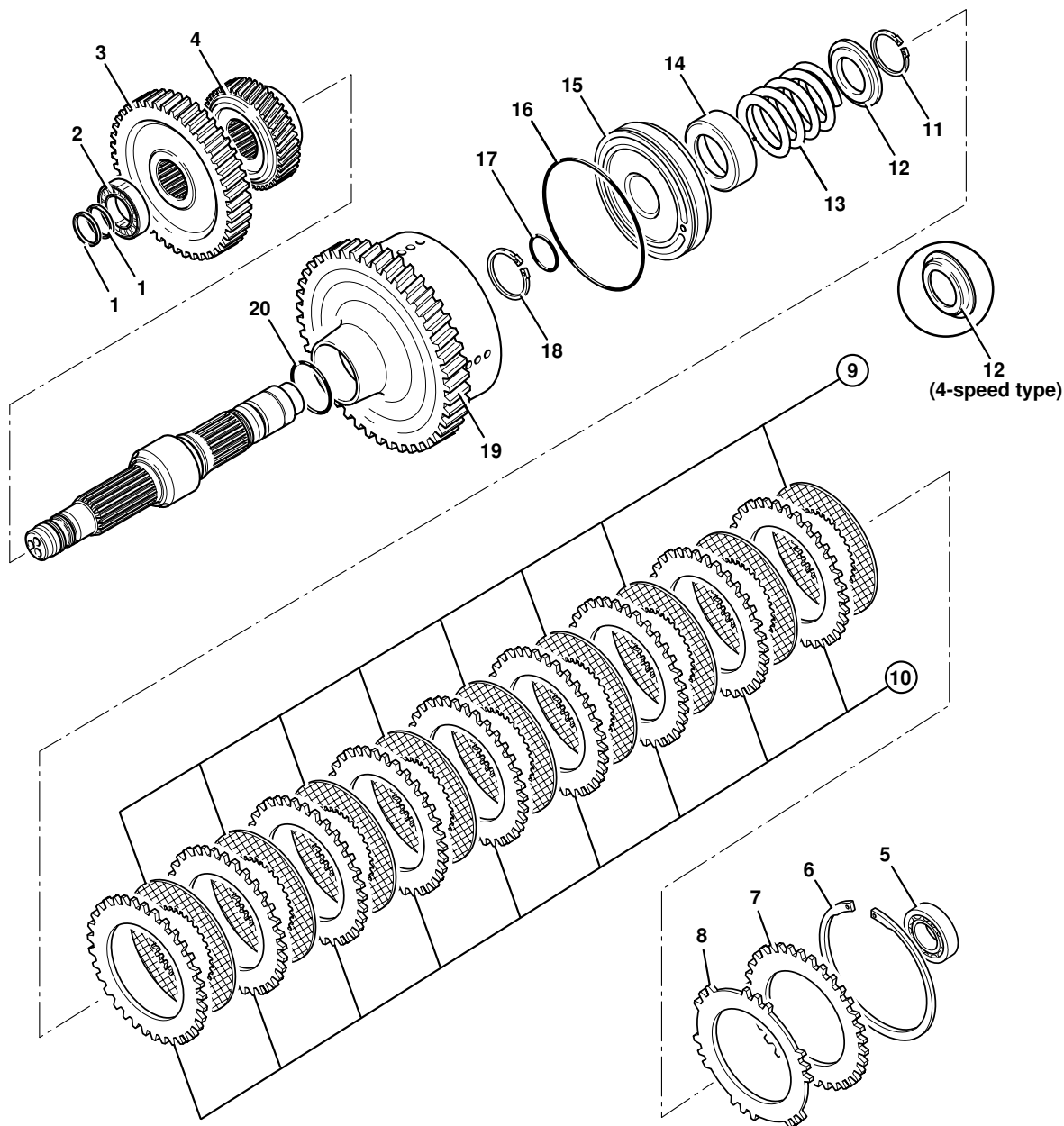
Note: If the piston does not loosen when the clutch shaft is knocked on aluminium, then hand pump air down the shaft oil inlet hole.

- 12 Remove the piston 15. Remove and discard the piston 'O' ring 16 and shaft 'O' ring 17.

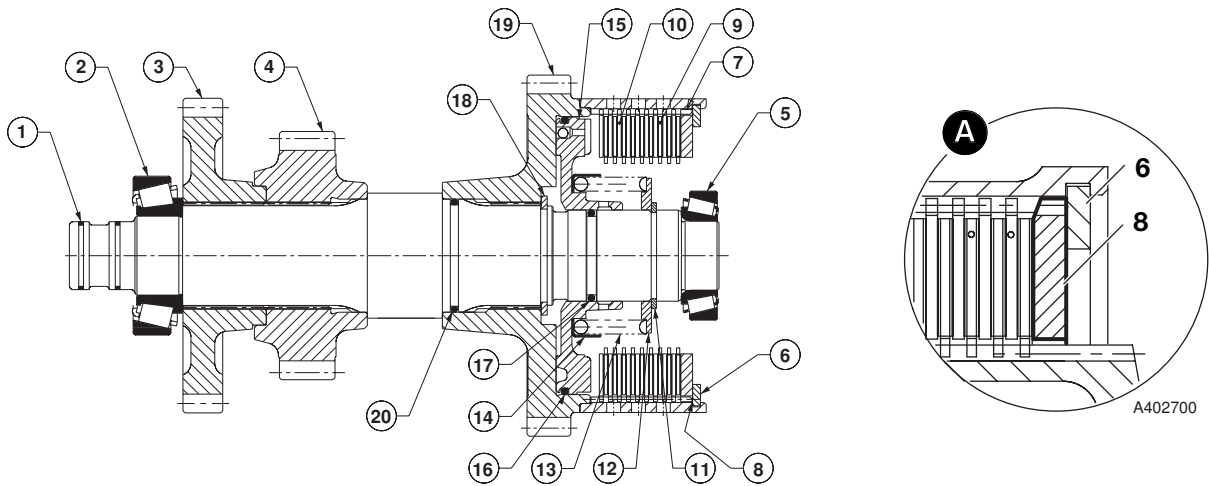
- 13 Remove circlip 18 and withdraw the clutch housing 19 from the shaft. Remove and discard the 'O' ring 20.



PS760 - Mainshaft Clutch - Assembly



A396150



A396250

PS760 - Mainshaft Clutch - Assembly

Visually inspect the friction and counter plates:

Counter plates - light scoring/polishing is permissible, plates that are not flat, worn or heavily marked or scored must be replaced with a new set.

Friction plates - the cross hatching should be clearly visible, plates that are not flat, have friction material damage or scoring must be replaced with a new set.

DO NOT mix old and new plates, if a plate is damaged/worn fit a complete new set.

Needle roller bearings should slide into position freely, do not bend or distort the cage to fit. If the cage has been distorted fit new bearings.

Note: The piston incorporates a small check valve. Visually inspect the piston to ensure the ball is in place and that the seat is free from contamination. If necessary clean the valve by blowing through with an air line. DO NOT use a wire rod (or screwdriver) as damage to the valve seat could occur.

- 1 Fit a new 'O' ring **20**.
- 2 Press the clutch housing **19** onto the shaft spline and fit circlip **18**.
- 3 Fit a new 'O' rings **17** and **16**. Lubricate the piston **15** with oil and press fully into bore of clutch housing.
- 4 Fit oil baffle **14**, piston spring **13**, make sure the spring seats in the piston.
- 5 Fit the spring retaining plate **12**. The 4 - speed transmissions have a different shaped spring retaining plate fitted.
- 6 Compress the spring and secure with circlip **11**.
- 7 Fit one counter plate **8** followed by one friction plate **9**. Continue fitting alternate counter and friction plates, finishing with a friction plate.
- * 8 Fit pressure end plate **7**. Make sure that the chamfered face is fitted facing the clutch pack as shown at **A**. Make sure the teeth are not aligned with the lubrication slots in the housing. Do not fit shim **7** at this stage.

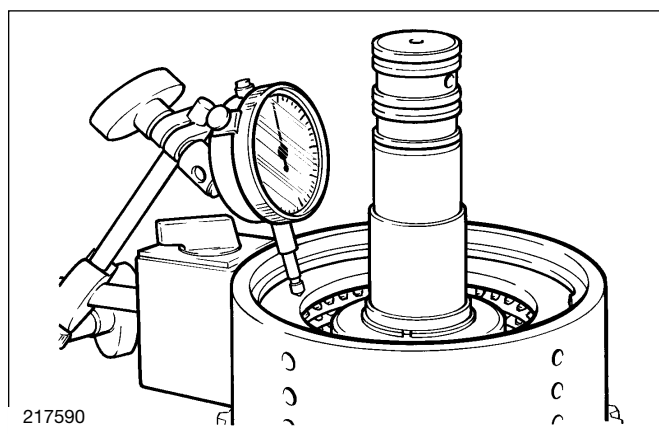
Note: A spring disc is not fitted in this clutch pack.

- 9 Fit the clutch friction/counter plate retaining circlip **6**.
- 10 Using a dial test indicator as shown, measure the end float of the pressure end plate **7**, which should be 1.9 to 2.5 mm (0.075 to 0.098 in).

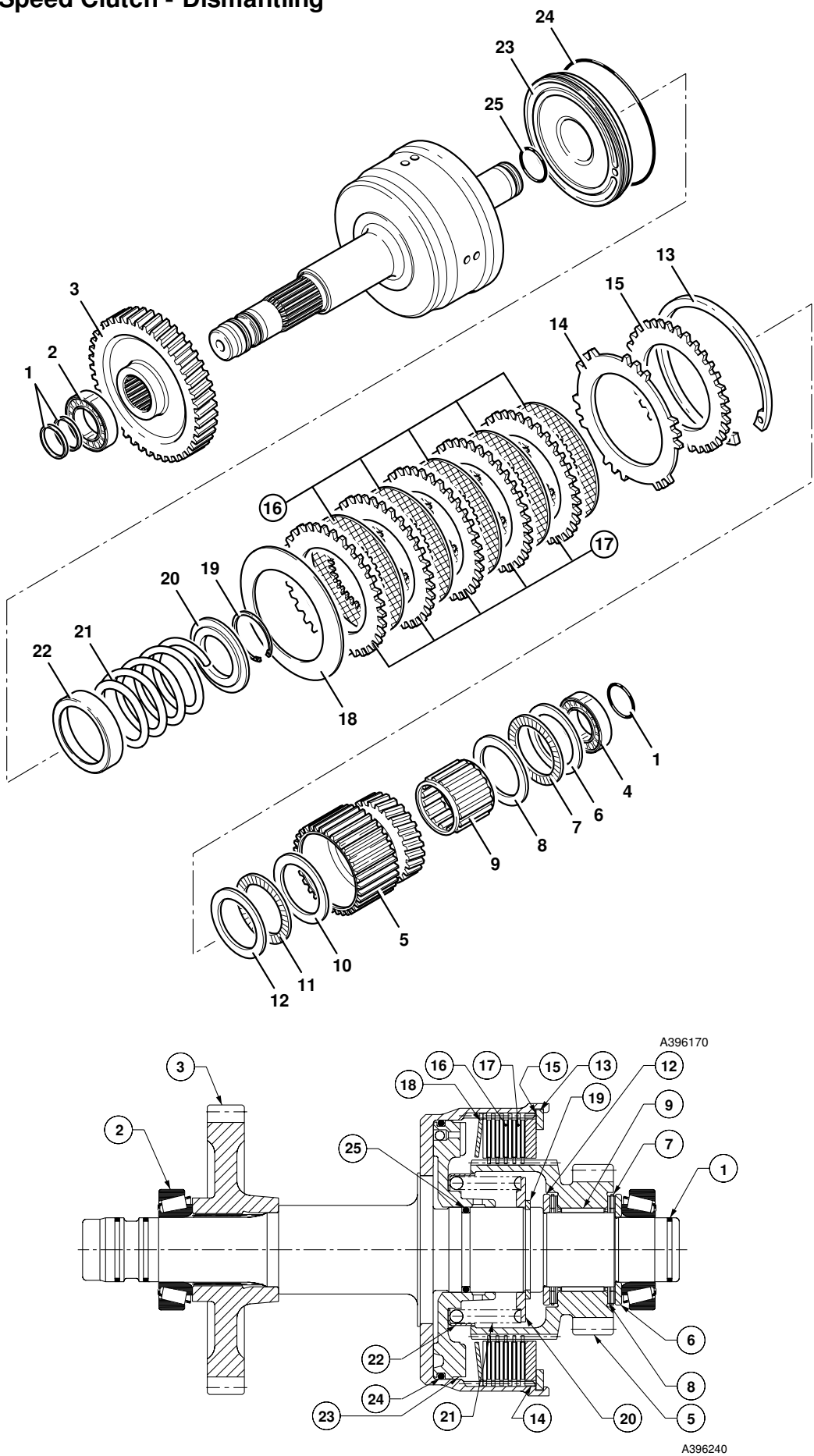
If it is necessary to adjust the end float to bring it within tolerance, there is a choice of fitting a 6.0mm (0.23in) or 6.5mm (0.25in) thick pressure end plate **7**, with either a shim **8** or an extra counter plate **10** between the retaining circlip **6** and pressure end plate **7**.

Use an airline to check the operation of the clutch.

- 11 Smear the taper roller bearing **5** with gearbox oil and press the bearing onto the shaft.
- 12 At the opposite end press gears **3** and **4** onto shaft spline. Make sure that the gears are fitted the correct way round.
- 13 Smear the taper roller bearing **2** with gearbox oil and press the bearing onto the shaft.
- 14 Fit piston ring seals **1**, refer to **Piston Ring Seals - Fitting Procedure**.



PS760 - 6 Speed Clutch - Dismantling



PS760 - 6 Speed Clutch - Dismantling

- 1 Carefully remove piston ring seals 1 at each end of the shaft.

Note: If the piston ring seals are excessively worn then check for burrs or damage on shaft grooves. If necessary remove burrs with a fine grade abrasion paper and oil.

- 2 Remove taper roller bearing 2 using a collet tool and press.
- 3 Withdraw the gear 3. Make a note which way round the gear is fitted for assembly.
- 4 At the opposite end, remove the clutch end bearing 4 using a puller.
- 5 Withdraw the gear and splined hub 5 together with thick thrust washer 6, thrust bearing 7 and thin thrust washer 8.
- 6 Remove the needle roller bearing 9.
- 7 Remove the thin thrust washer 10, thrust bearing 11 and thick thrust washer 12.
- 8 Remove the clutch friction/counter plates retaining circlip 13.
- 9 Remove pressure end plate 14 and shim 15, if fitted.
- 10 Remove the clutch friction plates 16 and counter plates 17. Keep them together in sets, DO NOT mix the plates with those from other clutches.
- 11 Remove the disc spring assembly 18.
- 12 Position clutch assembly in a suitable press, with a cut away tube compress the piston spring as shown, then remove circlip 19.

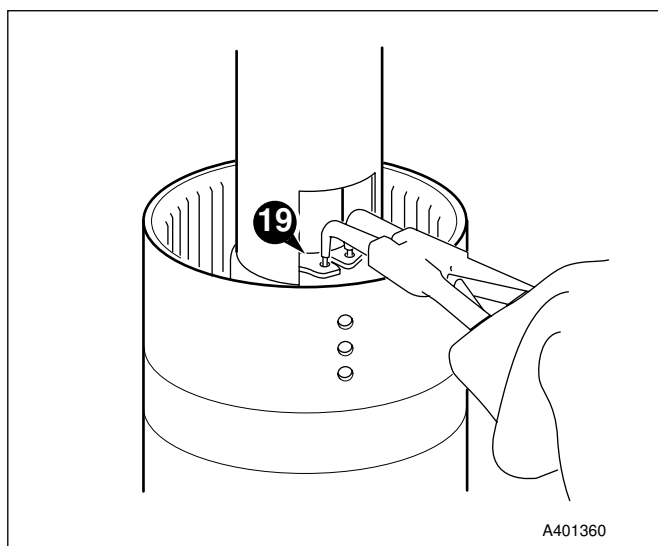
- 13 Lift off spring retaining plate 20.

- 14 Remove the spring 21 and oil baffle 22.

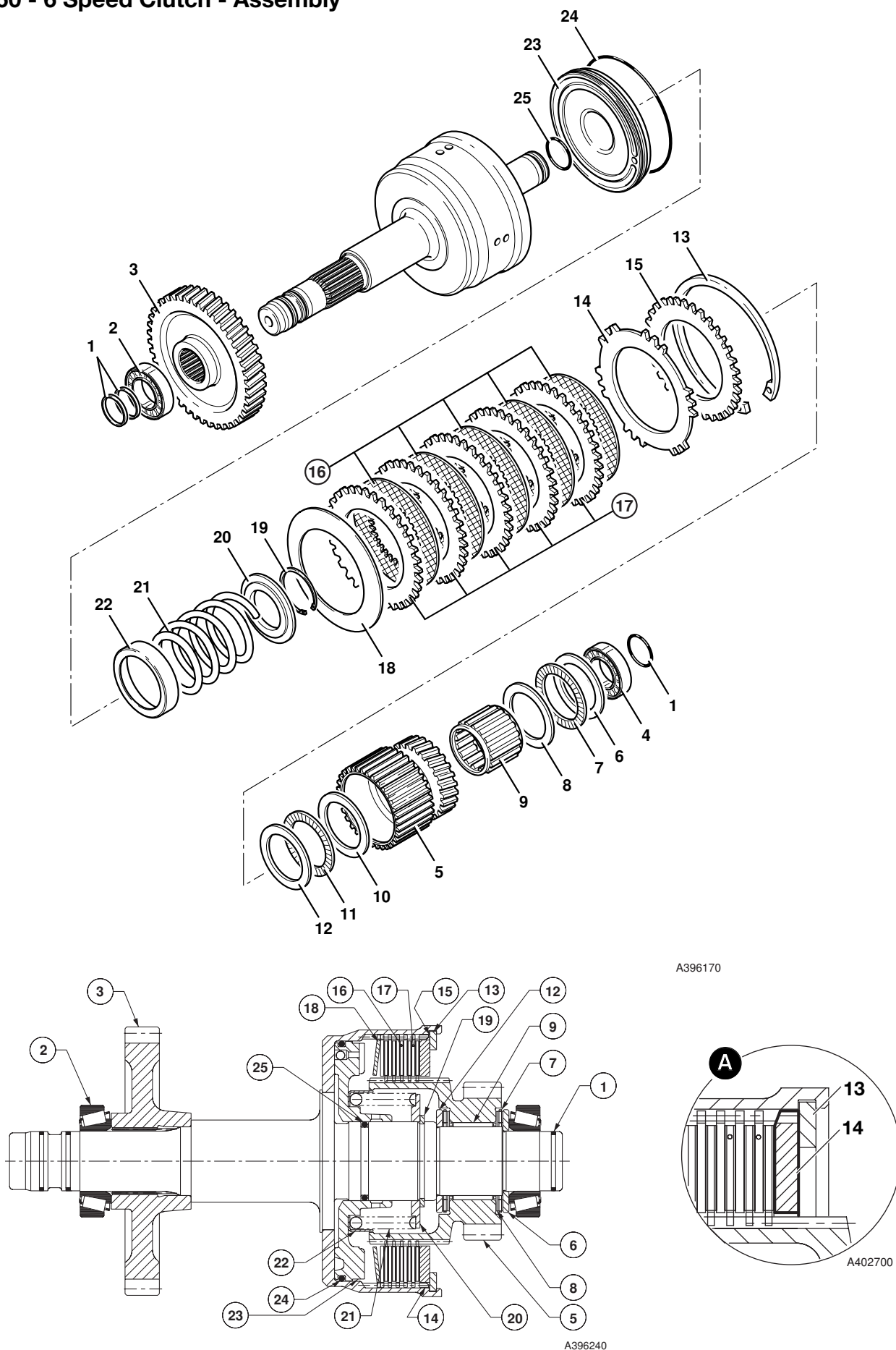
- 15 Turn the assembly over and knock the clutch shaft on a piece of aluminium (or wood) to loosen the piston 23.

Note: If the piston does not loosen when the clutch shaft is knocked on aluminium, then hand pump air down the shaft oil inlet hole.

- 14 Remove the piston 23. Remove and discard the piston 'O' ring 24 and shaft 'O' ring 25.



PS760 - 6 Speed Clutch - Assembly



PS760 - 6 Speed Clutch - Assembly

Visually inspect the friction and counter plates:

Counter plates - light scoring/polishing is permissible, plates that are not flat, worn or heavily marked or scored must be replaced with a new set.

Friction plates - the cross hatching should be clearly visible, plates that are not flat, have friction material damage or scoring must be replaced with a new set.

DO NOT mix old and new plates, if a plate is damaged/worn fit a complete new set.

Needle roller bearings should slide into position freely, do not bend or distort the cage to fit. If the cage has been distorted fit new bearings.

Take care when handling disc spring assemblies **18** to avoid marking or damage, which could result in stress cracking. If in doubt fit a new disc spring.

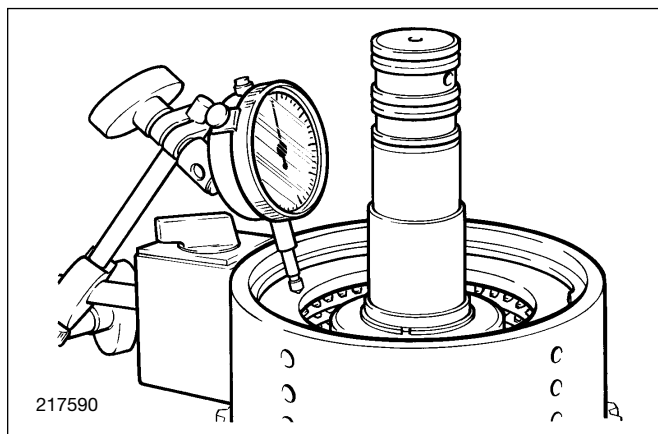
Note: The piston incorporates a small check valve. Visually inspect the piston to ensure the ball is in place and that the seat is free from contamination. If necessary clean the valve by blowing through with an air line. DO NOT use a wire rod (or screwdriver) as damage to the valve seat could occur.

- 1 Fit new 'O' rings **25** and **24**. Lubricate the piston **23** with oil and press fully into bore of clutch housing.
- 2 Fit oil baffle **22**, piston spring **21**, make sure the spring seats in the piston.
- 3 Fit the spring retaining plate **20**.
- 4 Compress the spring and secure with circlip **19**.
- 5 Fit the disc spring assembly **18**. Make sure that the disc spring is fitted with the teeth towards the clutch pack. Make sure the teeth are not aligned with the lubrication slots in the housing.
- 6 Fit one counter plate **17** followed by one friction plate **16**. Continue fitting alternate counter and friction plates, finishing with a friction plate.
- * 7 Fit the pressure end plate **14**, do not fit shim **15** at this stage. Make sure that the chamfered face is fitted facing the clutch pack as shown at **A**. Make sure the teeth are not aligned with the lubrication slots in the housing.
- 8 Fit the clutch friction/counter plates retaining circlip **13**.

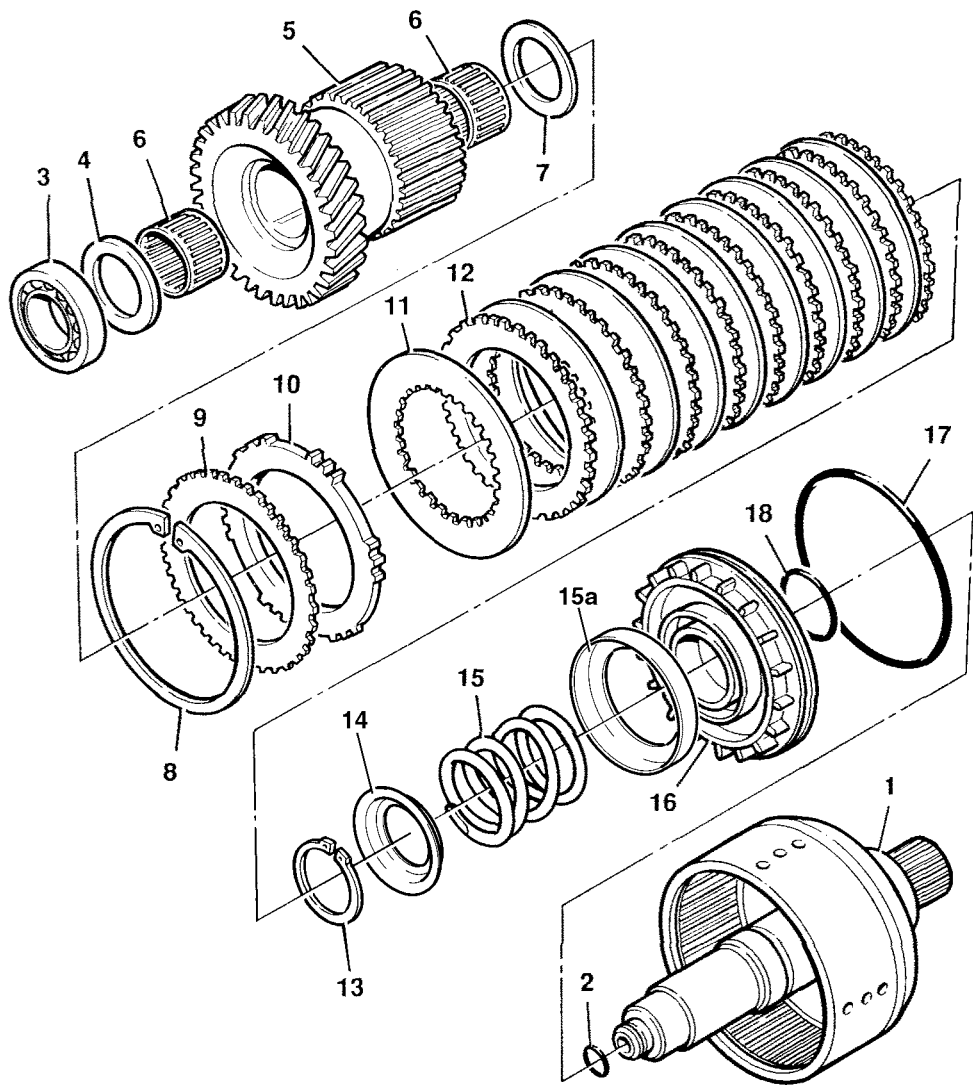
- 9 Using a dial test indicator as shown, measure the end float of the pressure end plate **14**, which should be 1.9 to 2.5 mm (0.075 to 0.098 in).

If it is necessary to adjust the end float to bring it within tolerance, there is a choice of fitting a 6.0mm (0.23in) or 6.5mm (0.25in) thick pressure end plate **14**, with either a shim **15** or an extra counter plate **17** between the retaining circlip **13** and pressure end plate **14**. Use an airline to check the operation of the clutch.

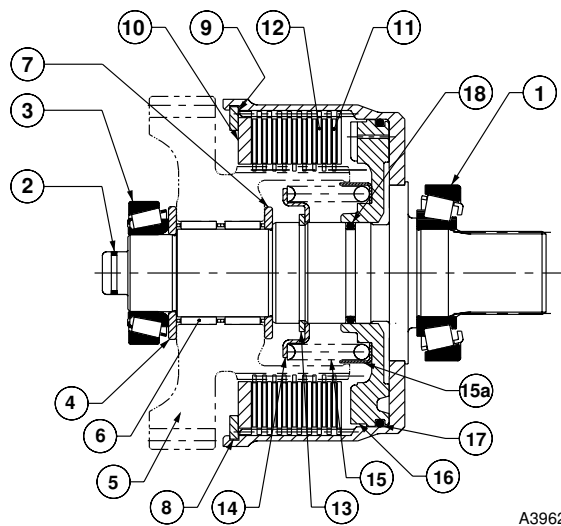
- 10 Fit the thick thrust washer **12**, thrust bearing **11** and thin thrust washer **10**.
- 11 Fit the needle roller bearing **9**.
- 12 Carefully align the teeth of the clutch plates using a thin rod (or screwdriver) and fit the gear and splined hub **5**.
- 13 Fit the thin thrust washer **8**, thrust bearing **7** and thick thrust washer **6**.
- 14 Smear the clutch end bearing **4** with gearbox oil and press the bearing onto the shaft.
- 15 At the opposite end, press the gear **3** onto the shaft spline. Make sure that the gear is fitted the correct way round.
- 16 Smear the clutch end bearing **2** with gearbox oil and press the bearing onto the shaft.
- 17 Fit piston ring seals **1** at each end of the shaft, refer to **Piston Ring Seals - Fitting Procedure**.



PS 760 - 2/4WD Clutch (Pressure ON) - Dismantling



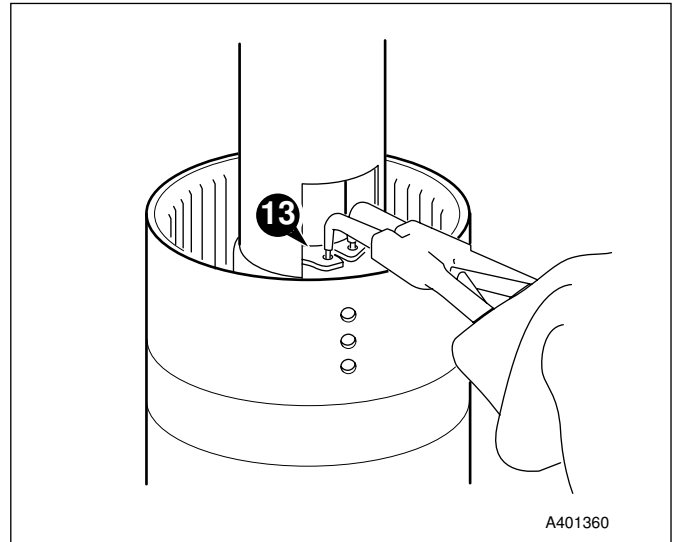
S396200



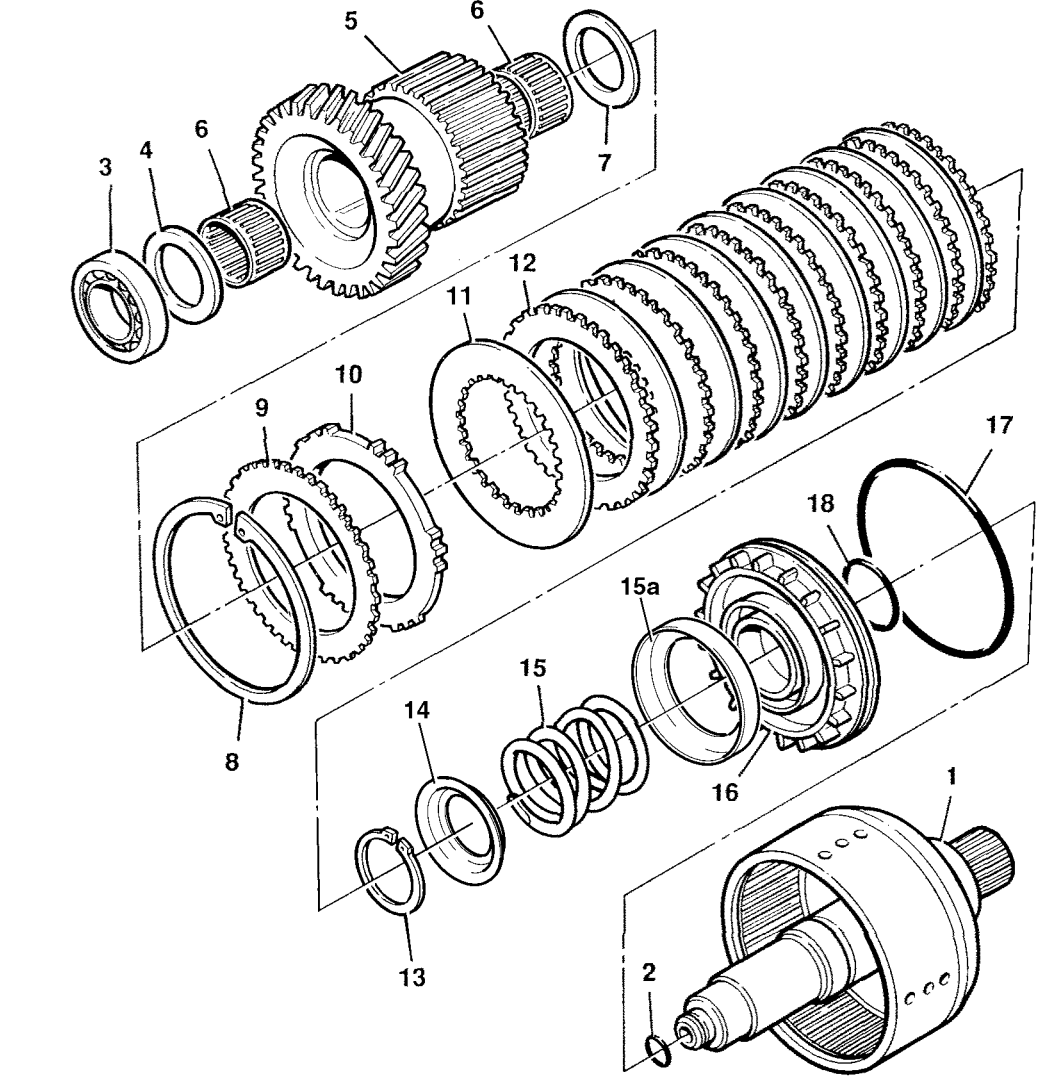
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PS 760 - 2/4WD Clutch (Pressure ON) - Dismantling

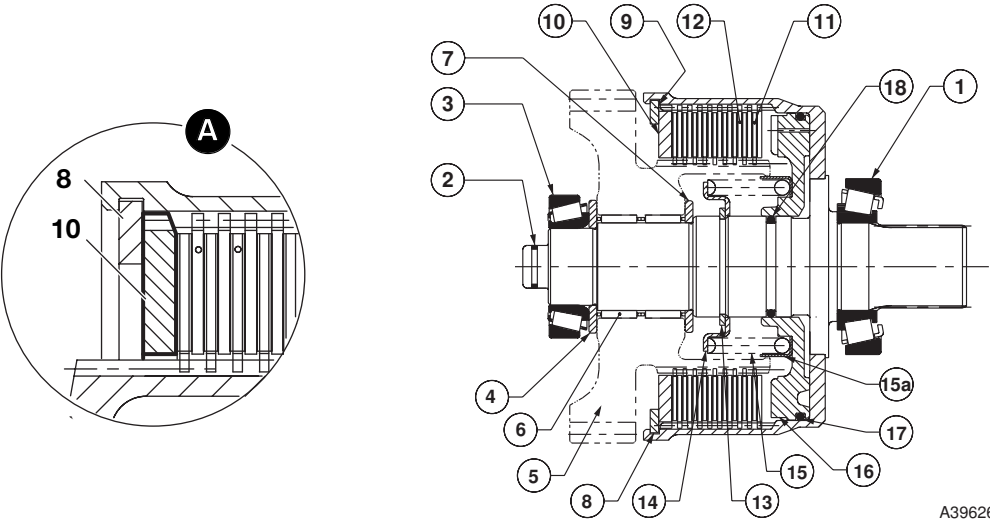
- 1 Remove bearing 1, only if to be renewed.
 - 2 Carefully remove piston ring seal 2. Note, If the piston ring seal is damaged or excessively worn then check for burrs or damage on the shaft groove. If necessary remove burrs with a fine grade abrasion paper and oil.
 - 3 Using a puller or press, withdraw the 4WD gear and splined hub 5, together with its bearing 3, needle roller bearings 6 and thrust washer 4. Remove thrust washer 7. (Note that thrust washers 4 and 7 are not interchangeable).
 - 4 Remove the clutch friction/counter plates retaining circlip 8.
 - 5 Remove pressure end plate 10 and shim 9, if fitted.
 - 6 Remove the clutch friction plates 11 and counter plates 12. Keep them together in sets, DO NOT mix the plates with those from other clutches.
 - 7 Position clutch assembly in a suitable press, with a cut away tube compress the piston spring as shown, then remove circlip 13.
 - 8 Lift off spring retaining plate 14.
 - 9 Remove the spring 15 and oil baffle 15A.
 - 10 Turn the assembly over and knock the clutch shaft on a piece of aluminium (or wood) to loosen the piston 16.
- Note:** If the piston does not loosen when the clutch shaft is knocked on aluminium, then hand pump air down the shaft oil inlet hole.
- 11 Remove the piston 16. Remove and discard the piston 'O' ring 17 and shaft 'O' ring 18.



PS 760 - 2/4WD Clutch (Pressure ON) - Assembly



S396200



A396260

PS 760 - 2/4WD Clutch (Pressure ON) - Assembly

Visually inspect the friction and counter plates:

Counter plates - light scoring/polishing is permissible, plates that are not flat, worn or heavily marked or scored must be replaced with a new set.

Friction plates - the cross hatching should be clearly visible, plates that are not flat, have friction material damage or scoring must be replaced with a new set.

DO NOT mix old, new and worn plates, if a plate is damaged/worn fit a complete new set.

Needle roller bearings should slide into position freely, do not bend or distort the cage to fit. If the cage has been distorted fit new bearings.

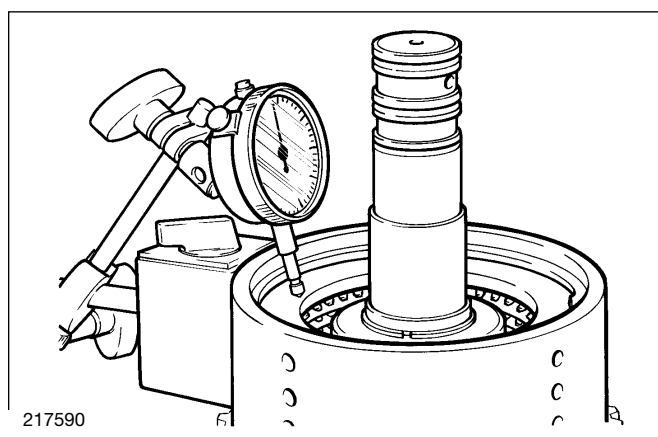
Note: The piston incorporates a small check valve. Visually inspect the piston to ensure the ball is in place and that the seat is free from contamination. If necessary clean the valve by blowing through with an air line. DO NOT use a wire rod (or screwdriver) as damage to the valve seat could occur.

- 1 Fit new 'O' rings **17** and **18**. Lubricate the piston **16** with oil and press fully into bore of clutch housing.
- 2 Fit oil baffle **15A**, piston spring **15**, make sure the spring seats in the piston.
- 3 Fit the spring retaining plate **14**.
- 4 Compress the spring and secure with circlip **13**.
- 5 Fit one counter plate **12** followed by one friction plate **11**. Continue fitting alternate counter and friction plates, finishing with a friction plate.
- * 6 Fit the pressure end plate **10**, do not fit shim **9** at this stage. Make sure that the chamfered face is fitted facing the clutch pack as shown at **A**. Make sure the teeth are not aligned with the lubrication slots in the housing.
- 7 Fit the clutch friction/counter plates retaining circlip **8**.
- 8 Using a dial test indicator as shown, measure the end float of the pressure end plate **10**, which should be 1.9 to 2.5 mm (0.075 to 0.098 in).

If it is necessary to adjust the end float to bring it within tolerance, there is a choice of fitting a 6.0mm (0.23in) or 6.5mm (0.25in) thick pressure end plate **10**, with either a shim **9** or an extra counter plate **12** between the retaining circlip **8** and pressure end plate **10**.

Use an airline to check the operation of the clutch.

- 9 Fit thrust washer **7**.
- 10 Carefully align the teeth of the clutch plates using a thin rod (or screwdriver) and fit the 4WD gear and splined hub **5**, needle roller bearings **6** and thrust washer **4**.
- 11 Smear the clutch end bearing **3** with gearbox oil and press the bearing onto the shaft to seat on thrust washer **4**.
- 12 Fit piston ring seal **2**, refer to **Piston Ring Seals - Fitting Procedure**.



Polytetrafluoroethylene (PTFE) Piston Ring Seals - Fitting Procedure

See **Synchro Shuttle Gearbox, Piston Ring Seals - Fitting Procedure**.

Torque Converter

Removal

See the relevant gearbox removal procedure for torque converter removal.

Replacing

Ensure that flywheel face, drive plate, and hardware are clean and free from burrs or other surface imperfections.

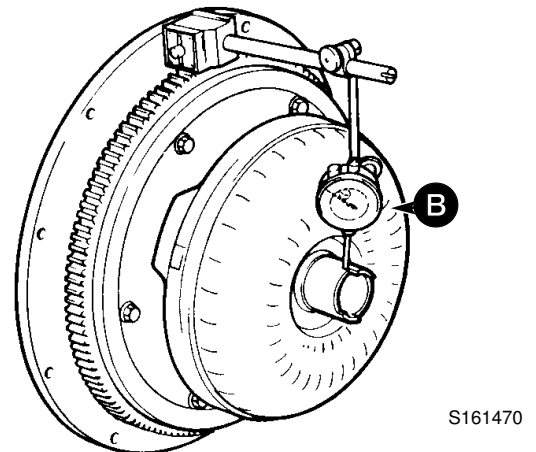
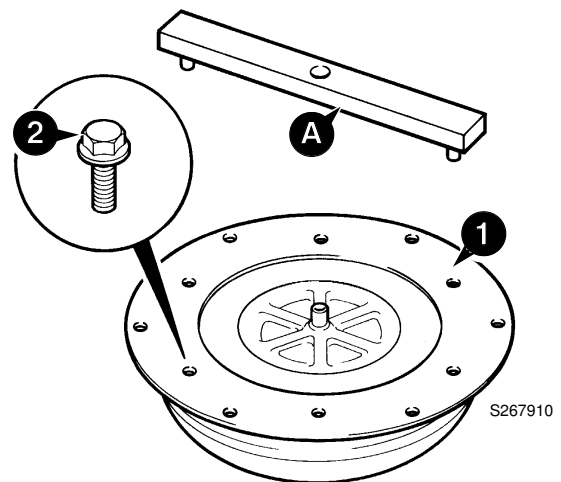
When Replacing

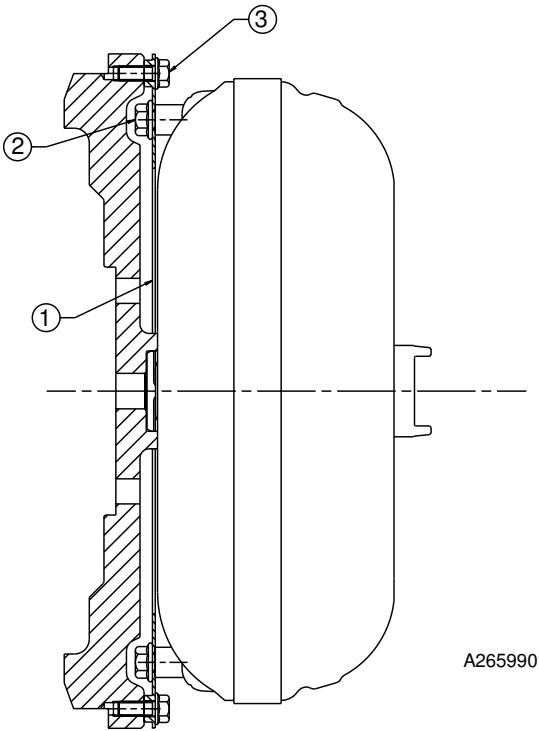
- 1 Offer drive plate **1** to the torque converter.
- 2 Place the torque converter alignment tool **A** over the torque converter spigot, make sure that the tool locates in two of the converter bolt holes as shown. It is important to note that the converter drive tube must be protected against damage or contamination at all times.
- 3 Fit four of the M10 flanged bolts **2** and torque tighten to 84 Nm (62 lbf ft). Remove the alignment tool and fit the remaining two retaining bolts **2**.
- 4 Offer the torque converter and drive plate assembly to the flywheel, bolt the drive plate to the flywheel (use only 3 bolts). Check the converter run-out as shown at **B**, which should not exceed 0.38mm (0.015 in.).

Note: In the unlikely event that the run-out exceeds 0.38 mm (0.015 in.), remove the converter and check the spigot for burrs, remove the drive plate and rotate it 180° on the torque converter, repeat steps **2** to **4**.

- 5 Remove the torque converter and drive plate assembly from the flywheel.
- 6 Install the torque converter with its drive plate assembly onto the transmission input shaft, make sure that the dogs on the converter pump drive shaft engage with the recesses in the pump, also take care not to damage the oil seal.
- 7 Rotate the engine flywheel so that one bolt hole is in a six O' clock position.
- 8 Rotate the torque converter and drive plate assembly so that one bolt hole is in a six O' clock position.
- 9 Install the transmission/torque converter assembly to the engine. See the relevant gearbox replacement procedure. **It is vitally important that the torque converter is fitted at the gearbox and engine flywheel correctly.** Failure to locate the converter correctly will result in damage to the gearbox oil pump on engine start up.
- 10 Remove the access plate from the bottom of the engine flywheel housing and through the access hole fit and hand tighten one M8 flanged bolt (item 3) in the six 'O' clock position

- 11 Rotate the flywheel until the next bolt hole is accessible, fit and hand tighten the next bolt **3**. Repeat the operation until all bolts are fitted. Finally torque tighten bolts **3** to 44 Nm (32 lbf ft), rotating the flywheel each time to align bolts **3** with access hole. Refit access plate.





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