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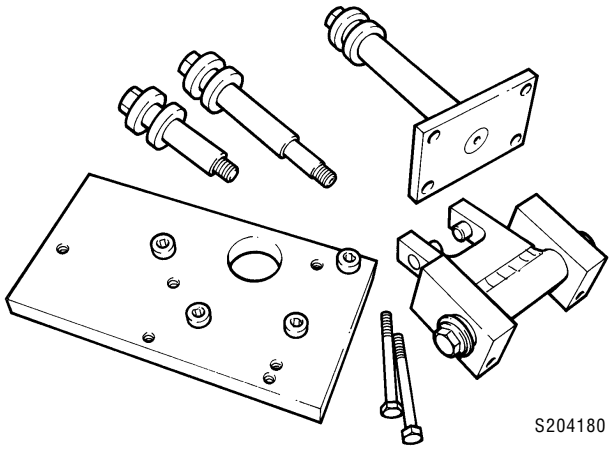
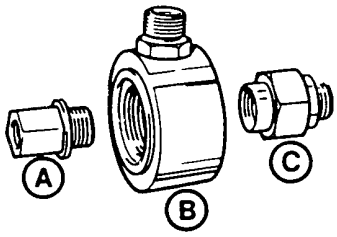
Syncro Shuttle Gearbox

993/59400 End Float Setting Tool for gearbox:
993/59401 Base Plate
993/59402 Setting Yoke
993/59403 Mainshaft Adapter (long)
993/59404 Mainshaft Adapter (short)
993/59405 Ouput Yoke Adapter Plate
993/59406 Setting Yoke Support Pillars



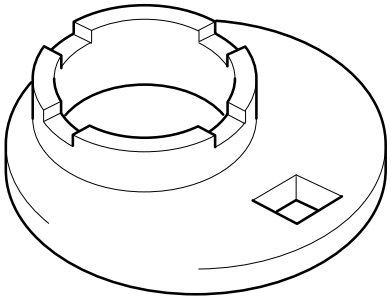
S204180

A 892/00304 Flow Test Adapter
B 892/00301 Flow Test Adapter
C 892/00302 Flow Test Adapter



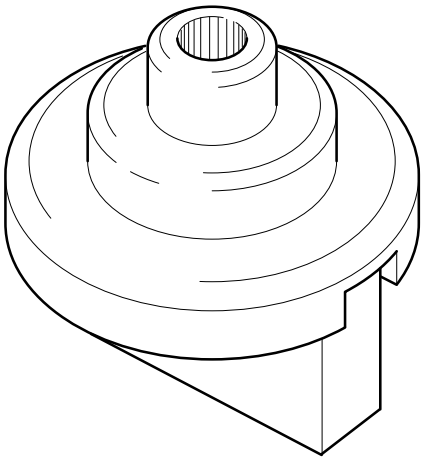
S188210

892/01064 Adaptor Spanner for reverser unit stake nut.



A388070

892/01065 Holding Fixture for reverser unit dismantling/assembly.



A388060

Front Axle (SD55)

Type	JCB spiral bevel input with epicyclic hub reduction
Designation	SD55 (without brakes)
Installation	Centre pivot
Weight (dry, with no steer rams and without wheels)	354 kg (780 lb) approx
Overall Gear Ratio (20'' wheels)	18.6:1
Overall Gear Ratio (18'' wheels)	16.2:1
Crownwheel & Pinion Ratio	3:1
Number of Teeth	
Crownwheel	33
Pinion	11
Hub reduction	5.4:1
Toe-in	0°
Castor angle	0°
Camber angle	1°
Kingpin inclination	0°
Number of steer rams	1

Rear Axle (SD55)

Type	JCB spiral bevel input with epicyclic hub reduction
Designation	SD55 (with brakes)
Type of Brakes	Oil immersed multi-plate disc located centre section
Installation	Rigid pad mount
Weight (dry, with no steer rams and without wheels)	425 kg (937 lb) approx
Overall Gear Ratio (20'' wheels)	18.6:1
Overall Gear Ratio (18'' wheels)	16.2:1
Crownwheel & Pinion Ratio	3:1
Number of Teeth	
Crownwheel	33
Pinion	11
Hub reduction	5.4:1
Toe-in	0°
Castor angle	0°
Camber angle	1°
Kingpin inclination	0°
Number of steer rams	1

Syncro Shuttle

Syncro Shuttle		Combined torque converter, reverser, and gearbox unit with brake disc/caliper type parking brake on output shaft to front wheels.	
Type		SS400	
Drive Output		Permanent 4 wheel-drive, double yoke	
Weight (dry)		150 kg (330 lb)	
Gear Ratios		30 kph (18 mph)	20 kph (12 mph)
	1st	4.27:1	6.31:1
	2nd	2.50:1	3.70:1
	3rd	1.18:1	1.75:1
	4th	0.70:1	1.03:1

Syncro Shuttle (cont'd)

Converter Pressures (in neutral)		**bar**	**kgf/cm²**	**lbf/in²**
Converter In at 50 deg.C	1000 rev/min	2.4 - 3.4	2.5 - 3.5	35 - 50
	2000 rev/min	5.2 - 6.5	5.3 - 6.7	75 - 95
Converter In at 100 deg.C	1000 rev/min	1.3 - 2.0	1.4 - 2.1	20 - 30
	2000 rev/min	5.2 - 5.9	5.3 - 6.0	75 - 85
Converter Out (measure at 50 deg.C and 2000 rev/min)		3.4	3.5	50 max
Converter Relief (Safety) Valve Pressure		6.5	6.7	95 max
Lubrication Pressures (in neutral)				
At 50 deg.C	1000 rev/min	0.2 - 0.3	0.2 - 0.4	3.0 - 5.0
	2000 rev/min	0.4 - 0.7	0.4 - 0.7	6.0 - 10.0
At 100 deg.C	1000 rev/min	0.1 - 0.2	0.1 - 0.2	2.0 - 3.0
	2000 rev/min	0.3 - 0.6	0.3 - 0.6	4.0 - 8.0
Main Line Pressure (in neutral)				
At 50 deg. C	1000 rev/min	9.3 - 10.3	9.5 - 10.5	135 - 150
	2000 rev/min	10.7 - 11.7	10.9 - 12.0	155 - 170
At 100 deg.C	1000 rev/min	9.3 - 10.3	9.5 - 10.5	135 - 150
	2000 rev/min	9.3 - 10.3	9.5 - 10.5	135 - 150
Clutch Pressure (forward and reverse) †				
At 50 deg. C	1000 rev/min	7.6 - 9.7	7.7 - 9.8	110 - 140
	2000 rev/min	9 - 11	9.1 - 11.25	130 - 160
At 100 deg.C	1000 rev/min	7.6 - 9.7	7.7 - 9.8	110 - 140
	2000 rev/min	7.6 - 9.7	7.7 - 9.8	110 - 140

† Note: The forward and reverse clutch pressures should always be the same as the mainline pressure less (a maximum of) 1.7bar (25lbf/in²; 1.8kgf/cm²). If the mainline pressure is in the lower part of the tolerance band, then the forward and reverse clutch pressures should also be in the lower part of the tolerance band and vice versa.

Flow Rates (in neutral)		**litres/min**	**UK gal/min**	**US gal/min**
Cooler at 50 deg.C	1000 rev/min	10.4 - 13.6	2.3 - 3.0	2.8 - 3.6
	2000 rev/min	14.5 - 20.0	3.2 - 4.4	3.8 - 5.3
Cooler at 100 deg.C	1000 rev/min	10.2 - 12.5	2.3 - 2.8	2.7 - 3.3
	2000 rev/min	22.7 - 26.1	5.0 - 5.7	6.0 - 6.9
Pump at 50 deg.C	1000 rev/min	11.0 - 15.0	2.5 - 3.3	2.9 - 4.0
	2000 rev/min	22.5 - 29.5	5.0 - 6.5	6.0 - 7.8

Syncro Shuttle (cont'd)

Torque Converters

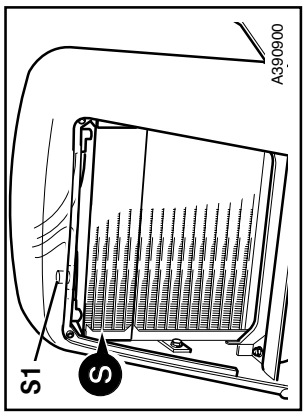
Ratio	2.8:1	2.78:1	2.4:1
Colour Coded Dots	3 Brown	1 Pink & 1 Yellow	2 Orange & 1 Green
Designation	SSL11	SSS11	WH11

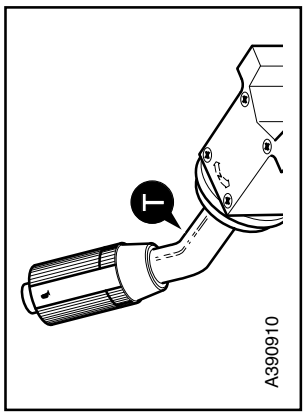
Stall Figures

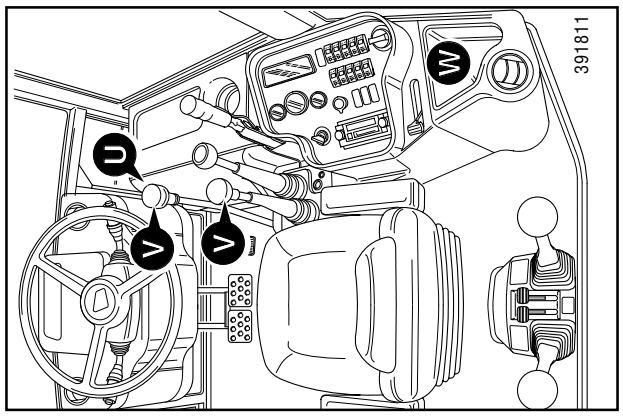
		2CX 210S	Airmaster	Farm Master	2CX - 20 kph	2CXU 210SU
Engine Stall Speed						
1 Converter only						
	max r.p.m.	2127	2127	1790	2170	2127
	min. r.p.m.	2027	2027	1700	2070	2027
2 Converter + MRV						
	max. r.p.m.	1825	1825	1490	1848	1825
	min. r.p.m.	1725	1725	1400	1748	1725
Build Specification						
Engine Size	65 bhp	•	•		•	•
	74 bhp			•		
Converter Type	SSL11 (2.8:1)	•	•			•
	SSS11 (2.78:1)				•	
	WH11 (2.4:1)			•		
Pump Size	58 l/min (12.7 gal/min) (15.3 USA gal/min)	•	•	•	•	•
Fan Ratio	1 to 1	•	•		•	
	1 to 1.25			•		•

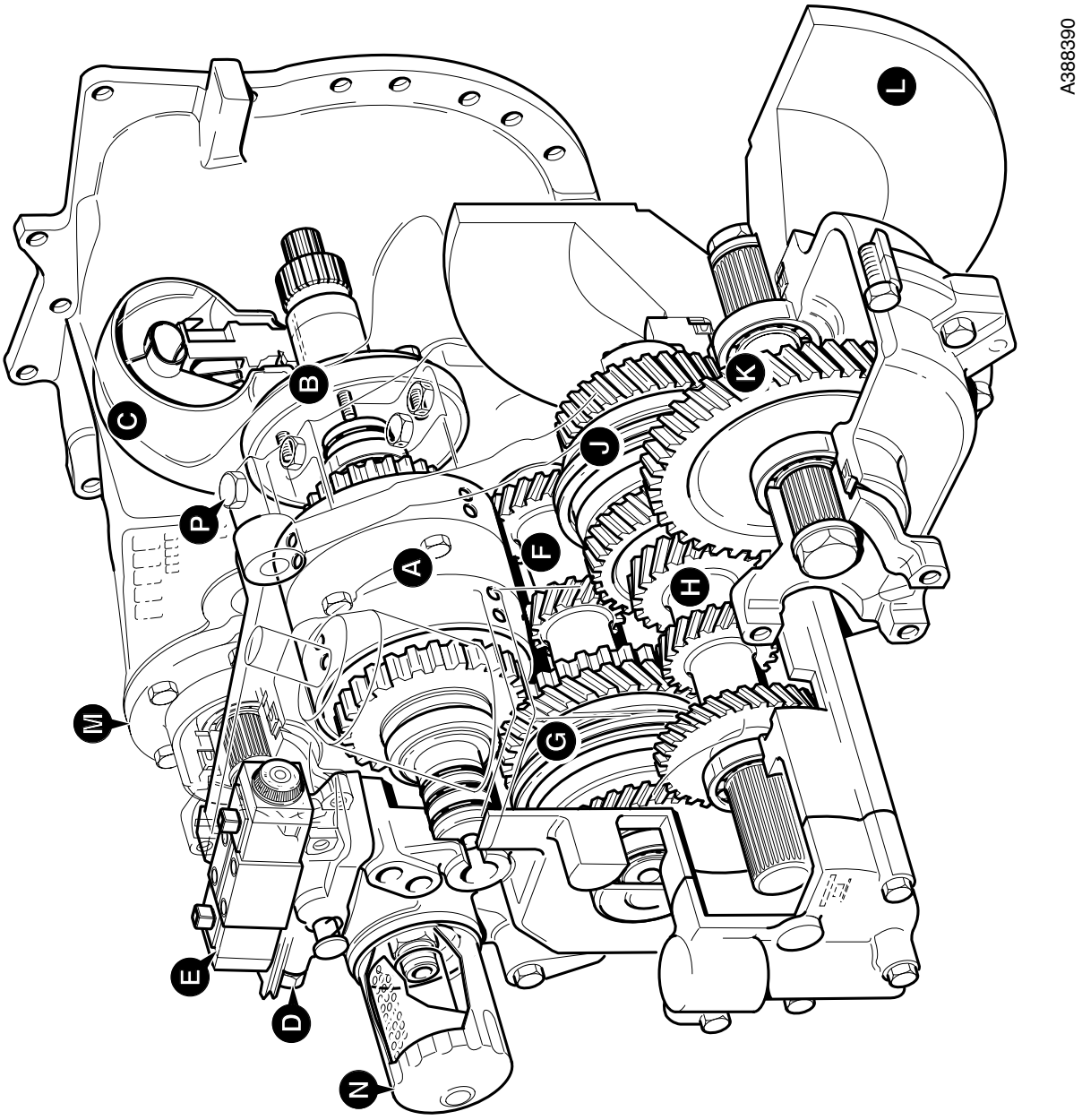
Low Emission Engines

		2CX 2CXL	2CXU 212SU
Engine Stall Speed			
1 Converter only	r.p.m.	2078	1576
2 MRV	r.p.m.	2121	2320
MRV (Loader)	r.p.m.		
MRV (Excavtor)	r.p.m.		
2 Converter + MRV (Loader)	r.p.m.	1825	1398
Build Specification			
Engine Size	66 bhp	•	
	75 bhp		•
Converter Type	SSL11 (2.8:1)	•	
	WH11 (2.4:1)		•









Syncro Shuttle Gearbox

Syncro Shuttle Gearbox

This Illustration shows a typical JCB Syncro Shuttle which consists of a torque converter, hydraulic forward/reverse unit, and integral manual 4-speed synchromesh gearbox.

The 4 gears are selected manually via a lever in the cab. Drive is transmitted in forward or reverse direction (in any gear) by means of the forward/reverse unit **A**. When reverse is selected, drive is transmitted via an idler gear which has the effect of reversing the gear train.

The forward/reverse 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 **C**. The oil pressure is controlled by maintaining valve **D**, and clutch selection is achieved by means of an electric solenoid valve **E**.

Drive is transferred from the forward/reverse 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**. The synchromesh units are of the 'Blocking Pin' type, for a full detailed description refer to **Synchromesh - Description of Operation**.

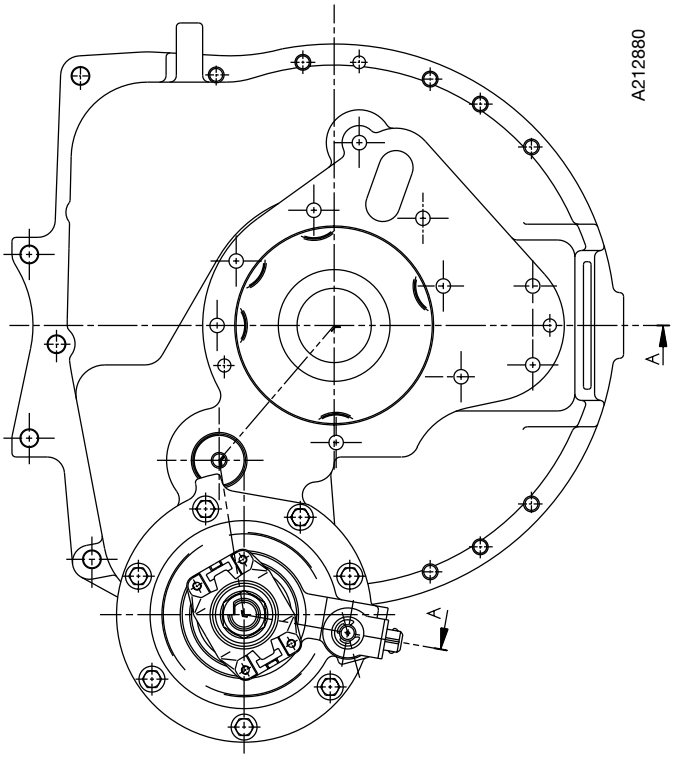
Drive is transmitted finally via the output shaft **K** to the front and rear axles. The output shaft also incorporates a brake disc/calliper type parking brake **L**.

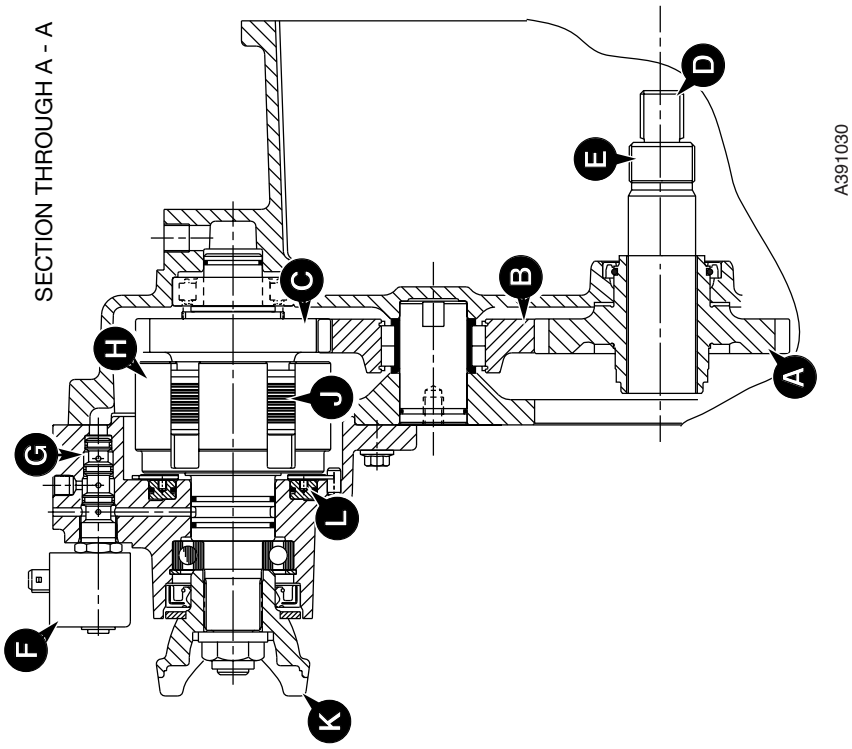
The illustration shows a gearbox which also incorporates a P.T.O. **M**, for a full detailed description refer to **Power Take Off Clutch - Operation.**
Note: The P.T.O. is not fitted on some machine variants.

Component Identification

Key
A Forward/Reverse Clutch Unit
B Oil Pump
C Torque Converter
D Pressure Maintaining Valve
E Solenoid Valve
F Mainshaft
G 3rd/4th Synchromesh Unit
H Layshaft
J 1st/2nd Synchromesh Unit
K Output Shaft
L Brake Disc
M Power Take Off
N Oil Filter
P Pressure Relief Valve

Associated Components
S Oil Cooler (gearbox oil)
S1 Oil Temperature Sender
T Forward/Reverse/Neutral Control Lever (electrical)
U Gear Lever
V Transmission Dump Switch (electrical)
W Electrical Relays (solenoid valve)





Syncro Shuttle Gearbox - Power Take Off

Syncro Shuttle Gearbox - Power Take Off

The drive for the compressor or transfer gearbox is transmitted by constant mesh from gear **A** through idler gear **B** onto the power take off clutch gear **C**. Gear **A** is mounted on the input shaft **D** and is driven via the torque converter. The converter has an additional integral splined spigot when compared to a 'standard' converter, this additional spline is used to directly drive gear assembly **A** via splines **E**.

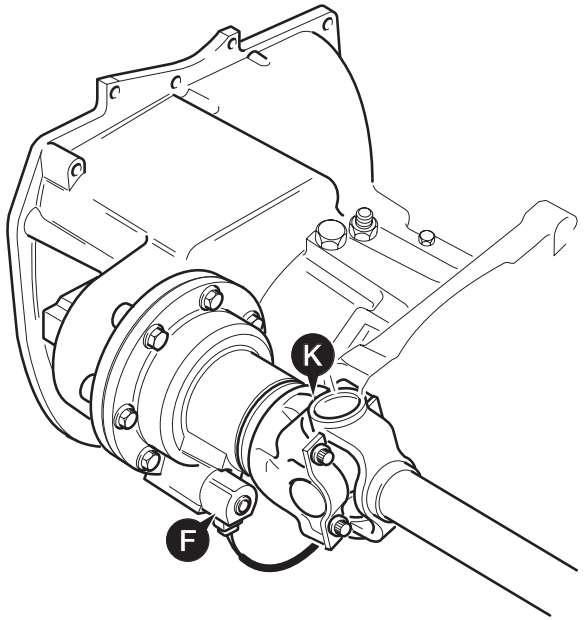
The constant meshing gears will freely rotate until the PTO clutch solenoid **F** is energised. When the solenoid is energised, pressurised oil is diverted via a solenoid spool **G** to the power take off clutch pack assembly **H**, engaging the clutch. Drive is transmitted to the PTO drive yoke **K**.

When the solenoid **F** is de-energised, the clutch is disengaged and the constant meshing gears will once again freely rotate (with no drive being transmitted). At the same time pressurised oil is diverted via the solenoid spool **G** to the back of piston **L,** applying the PTO brake. This prevents the yoke and its drive shaft rotating as soon as the operator disengages the PTO.

For more details of how the PTO clutch and brake systems work, see **Syncro Shuttle Gearbox - Hydraulic and Electrical Operation**

Component Identification

Key
A Drive Gear
B Idler Gear
C Clutch Gear
D Input Shaft
E Drive Gear Splines
F Solenoid Valve
G Solenoid Spool
H PTO Clutch
K PTO Drive Yoke
L PTO Brake Piston



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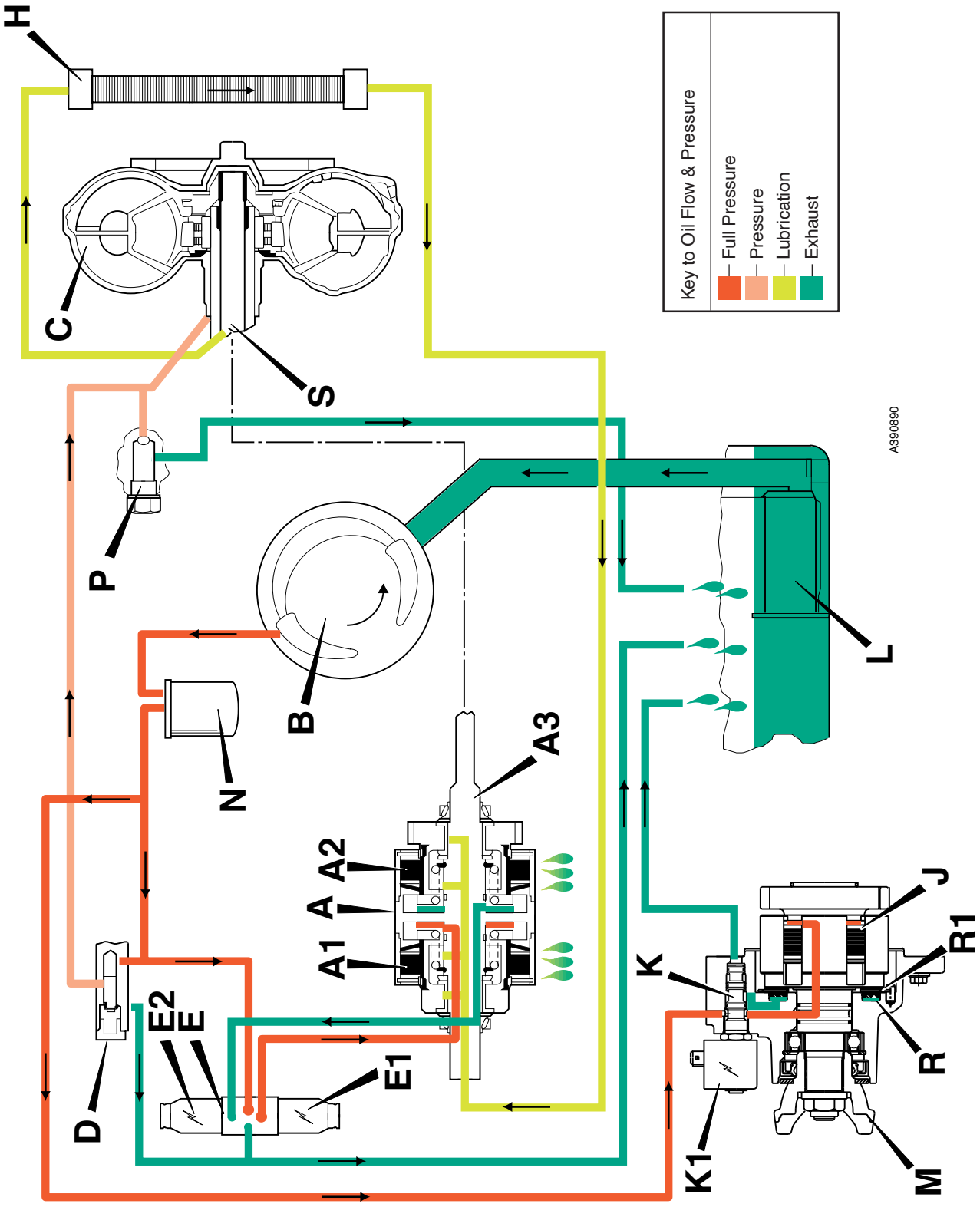


Syncro Shuttle Gearbox

Hydraulic and Electrical Operation

Oil is drawn from the gearbox sump via strainer **L** by pump **B**. Pressurised oil from the pump is fed through an internal passage via the filter **N** to the pressure maintaining valve **D**, which maintains pressure to the solenoid valve **E** for forward/reverse clutch selection. Excess oil from the maintaining valve flows back through casing cross drillings to the torque converter **C**. 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 relief valve **P** which dumps excess oil from the converter line back to the sump.
Oil from the torque converter flows out of the transmission to the external oil cooler **H**, returning at the rear of the transmission unit to pass through the centre of the input shaft **A3** for clutch lubrication. Oil then returns to the sump.

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**.

Power Take Off Operation (If fitted)

The PTO drive is controlled by a hydraulic clutch similar in design to the forward/reverse clutches. A hydraulic brake is also incorporated to prevent the drive shaft rotating when the PTO is deselected.

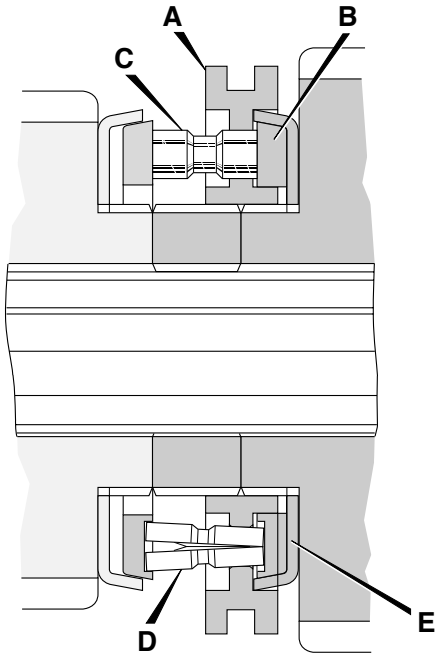
Pressurised oil is fed directly to the PTO solenoid control valve **K**.

PTO Drive Selected
When the PTO drive is selected via a switch in the cab, the electrical solenoid **K1** is enegised. Pressurised oil is diverted to the clutch **J**, engaging drive to the output shaft **M**. At the same time oil from the brake piston **R** is diverted back to the sump, releasing the brake.

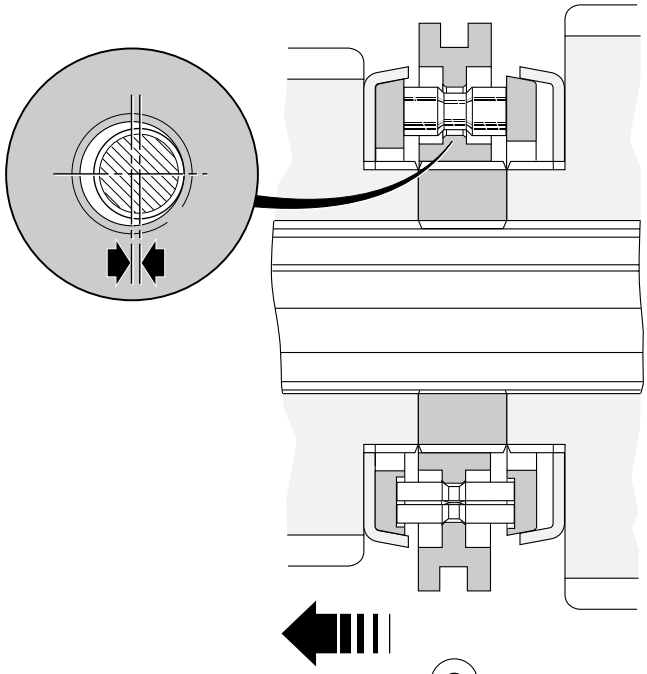
PTO Drive Deselected
When the PTO drive is deselected via a switch in the cab, the electrical solenoid **K1** is de-energised. Pressurised oil is diverted to the brake piston forcing a brake disc **R1** onto the output shaft assembly **M**. At the same time oil from the clutch **J** is diverted back to the sump, disengaging the clutch.

Key
A Forward/Reverse Clutch Unit
A1 Forward Clutch
A2 Reverse Clutch
A3 Input Shaft
B Oil Pump
C Torque Converter
D Pressure Maintaining Valve
E Solenoid Valve
E1 Electrical Solenoid - Forward
E2 Electrical Solenoid - Reverse
H Oil Cooler
L Oil Strainer
N Oil Filter
P Pressure Relief Valve (Torque Converter)

Key - Power Take Off Components (If fitted)
M Output Shaft Assembly
J PTO Clutch
K Solenoid Valve
K1 Electrical Solenoid
R Brake Piston
R1 Brake Disc



F



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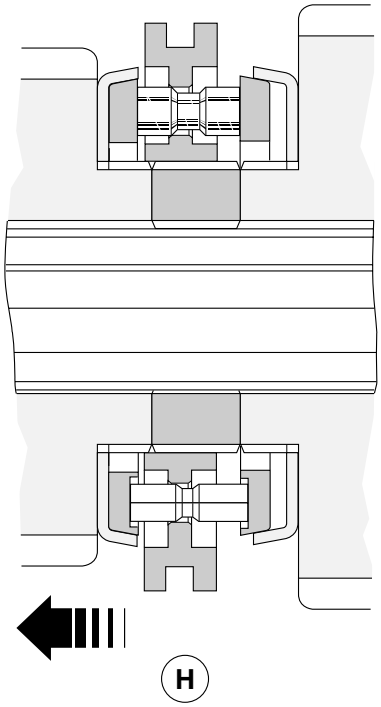
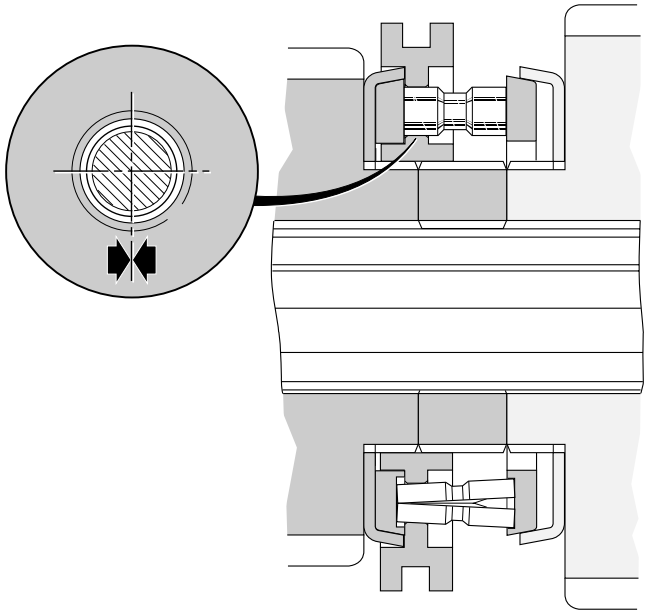


H



J

Syncro Shuttle Gearbox

Synchromesh - Operation

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'.

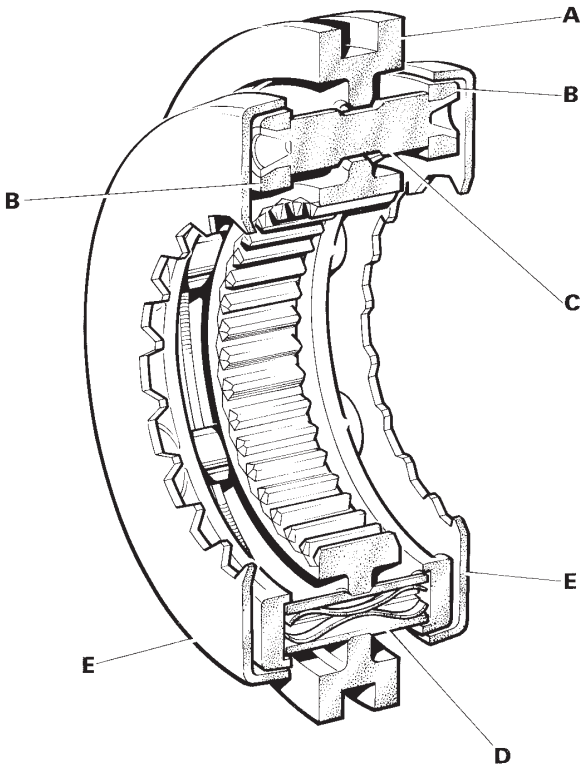
When selecting second gear the syncro hub **A** slides along the split energiser pins until the pin recess and the syncro hub flange are in line. At this point the split energiser pins open and the syncro rings are moved by the syncro hub pushing on the split energiser pin shoulder.

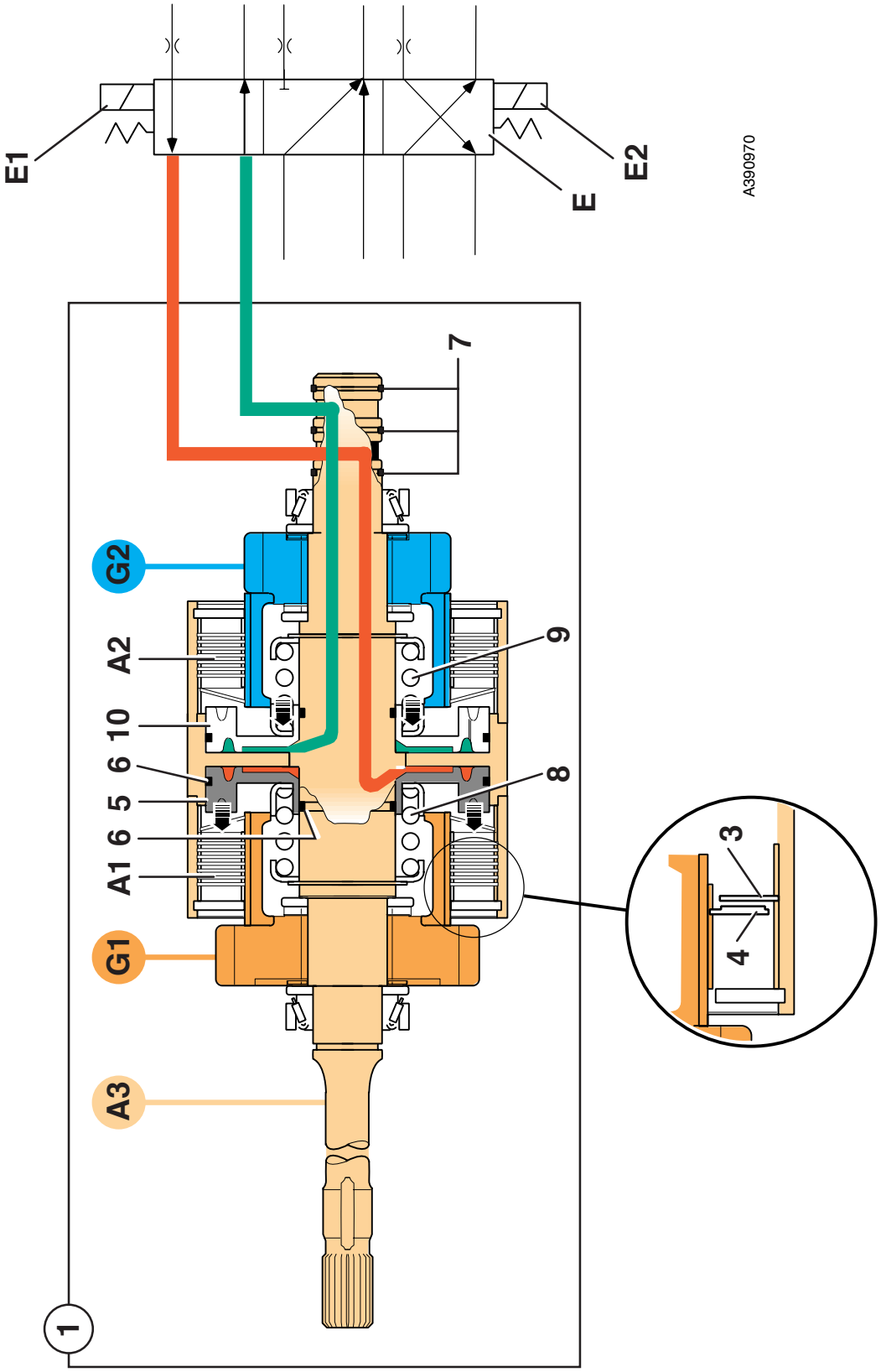
Initial contact between the syncro ring and the syncro cup starts to synchronise the speed of the shaft and second gear. The rotational force of the syncro ring is taken by the blocker pin against the edge of the syncro hub hole, as at **G**.

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

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 permanenty 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**.

Syncro-Shuttle Gearbox - Hydraulic

Before commencing with the fault finding procedure make sure that the correct type of transmission fluid has been used.

LACK OF POWER

Possible Cause	Remedy
1 Poor engine condition.	1 Check and if necessary repair engine.
2 Low oil level.	2 Top up system.
3 Worn pump.	3 Check flow and if necessary repair or renew pump.
4 Torque converter damage.	4 Check and if necessary repair or renew torque converter.
5 Low mainline pressure.	5 See fault 'Low Mainline Pressure'.
6 Clutches slipping.	6 See fault 'Low Clutch Pressure'.
7 Internal leakage.	7 a) Check internal cored galleries and casting for porosity. b) Check condition of seals.
8 High stall speeds.	8 See fault 'High Stall Speeds'.
9 Low stall speeds.	9 See fault 'Low Stall Speeds'.
10 Overheating.	10 See fault 'Overheating'.

LOW MAINLINE PRESSURE (in neutral)

Possible Cause	Remedy
1 Worn pump.	1 Check flow and if necessary repair or renew pump.
2 Blocked suction strainer.	2 Clean suction strainer.
3 Pressure maintaining valve sticking/leaking.	3 Free off or renew valve.
4 Oil aerated (foaming).	4 a) Internal leakage (cored galleries) - inspect/repair transmission. b) Dirty suction strainer - clean strainer. c) High oil level - drain to proper level. d) Incorrect grade of oil - drain then refill with correct oil.

HIGH STALL SPEEDS (Forward & Reverse Clutches)

Possible Cause	Remedy
1 Damaged converter blades.	1 Check and if necessary renew converter.
2 Clutches slipping.	2 See fault 'Low Clutch Pressure'.
3 Internal leakage.	3 a) Check internal cored galleries and casting for porosity. b) Check condition of seals.

LOW STALL SPEEDS (Forward & Reverse Clutches)

Possible Cause	Remedy
1 Poor engine condition.	1 Check and if necessary repair engine.
2 Torque converter reaction member clutch slipping.	2 Check and if necessary renew torque converter.

LOW CONVERTER OUT PRESSURE

Possible Cause	Remedy
1 Low mainline pressure.	1 See fault heading 'Low Mainline Pressure'.
2 Converter internal leakage.	2 Check and if necessary renew converter.
3 Converter relief valve faulty.	3 Check and if necessary repair relief valve.
4 Restriction in converter feed.	4 See item 10 in fault 'Overheating'

LOW PUMP FLOW

Possible Cause	Remedy
1 Low oil level.	1 Top up system.
2 Blocked suction strainer.	2 Clean suction strainer.
3 Worn pump.	3 Repair or renew pump.

Syncro-Shuttle Gearbox - Hydraulic (cont'd)

HIGH CONVERTER OUT PRESSURE

Possible Cause		Remedy
1	Oil cooler/lines blocked.	1 Clean cooler, free blockage.
2	Converter in pressure incorrect	2 Check converter in pressure correct
3	Converter relief valve faulty.	3 Check and if necessary repair relief valve.

LOW LUBRICATION PRESSURE

Possible Cause		Remedy
1	Low mainline pressure.	1 See fault heading 'Low Mainline Pressure'.
2	Oil cooler/lines blocked.	2 Clean cooler, free blockage.
3	Ruptured lubrication line.	3 Repair line.
4	Converter internal leakage.	4 Check and if necessary renew converter.
5	Converter relief valve faulty.	5 Check and if necessary repair or renew relief valve.
6	Leak at pump to case joint (indicated by low cooler flow)	6 Check and if necessary repair or replace as necessary.
7	Restriction in converter feed	7 See item10 in fault 'Overheating'

LOW CLUTCH PRESSURE AND/OR CLUTCH SLIPPING

Possible Cause		Remedy
1	Low mainline pressure.	1 See fault heading 'Low Mainline Pressure'.
2	Worn pump.	2 Check flow and if necessary repair or renew pump.
3	Blocked restrictor orifice in F/R solenoid valve block. (Both F/R clutches will indicate low pressure).	3 Remove F/R solenoid and clear restriction in solenoid valve block.
4	Clutch seals worn.	4 Confirm with a clutch leak test, if required renew clutch seals
5	Clutch piston rings worn.	5 Confirm with a clutch leak test, renew piston rings.
6	Mechanical failure.	6 Strip and rebuild clutch, renew parts as required.

LOW COOLER FLOW

Possible Cause		Remedy
1	Converter relief valve faulty.	1 Check and if necessary repair or renew relief valve.
2	Leak at pump to case joint .	2 Check and if necessary repair or replace as necessary.
3	Worn pump.	3 Check flow and if necessary repair or renew pump.
4	Internal leakage.	4 a) Check internal cored galleries and casting for porosity. b) Check condition of seals.
5	Restriction in converter feed.	5 See item 10 in fault 'Overheating'.

OVERHEATING

Possible Cause		Remedy
1	Low oil level.	1 Top up system.
2	High oil level.	2 Drain oil to correct level.
3	Trapped or kinked hoses in cooler system.	3 Renew or repair hoses.
4	Low converter out pressure and flow rate.	4 Repair or renew the converter relief valve.
5	Oil cooler blocked.	5 Clean cooler.
6	Operating in wrong gear range.	6 Select correct gears to suit working conditions.
7	Water system overheating. low water level etc.	7 Rectify water system problems, eg radiator, cooler lines,
8	Oil aerated (foaming).	8 See fault 'Low Mainline Pressure', item 4.
9	Clutch piston(s) sticking on return stroke.	9 Check and repair clutch piston(s) and seal(s).
10	Cored galleries on front housing pump mounting face wrong depth (indicated by excessively low pressure and flow on converter out cooling line).	10 Replace front housing (or rectify existing housing).
11	Leakage across pump mounting face and front case. loose	11 Check for damaged surface on both components and pump mounting bolts.

Syncro Shuttle Gearbox - Mechanical

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

Syncro Shuttle Gearbox - Mechanical (cont'd)

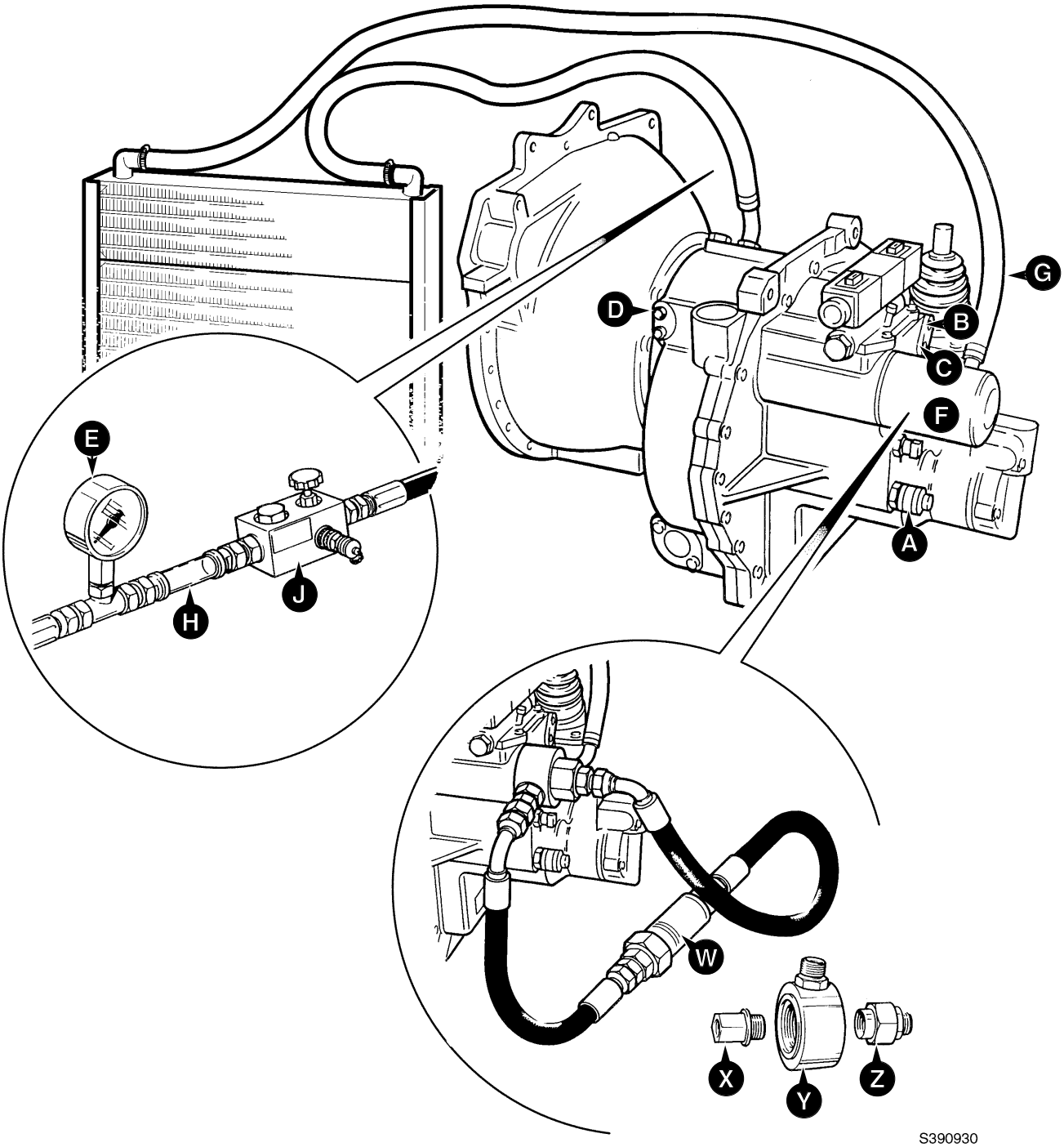
CHECK			ACTION
14	Is 'converter in' pressure as specified?	YES: NO:	Check 15 Inspect converter relief valve for damage. Check cooler bypass relief valve pressure setting.
15	Is pump being driven by converter?	YES: NO:	Check pump pressure. Renew damaged parts.
16	Are clutch sealing rings damaged?	YES: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

Syncro Shuttle Gearbox - Mechanical (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.

Power Take-Off Clutch

FAULT	POSSIBLE CAUSE	ACTION
A PTO shaft does not turn.	1 Solenoid valve faulty.	1 Dismantle solenoid valve and check component parts, renew valve if necessary.
	2 Solenoid not energising.	2 Check electrical connections, switch, relay and wiring loom.
	3 Insufficient hydraulic pressure.	3 Check hydraulic pressure at test point.
	4 PTO brake not releasing/siezed.	4 Check.
B Excessive PTO noise in operation.	1 Friction/counter plates in poor condition/distortion.	1 Renew friction/counter plates.



Pressure and Flow Tests

Before completing any of the transmission pressure/flow tests, make sure that the oil level is correct and at normal operating temperature.

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

⚠ 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

TEST POINTS

A - Mainline pressure

B - Forward clutch pressure

C - Reverse clutch pressure

D - Converter inlet/converter relief valve pressure

E - Converter outlet pressure

F - Pump flow (remove filter and fit adapters)

G - Lubrication pressure

H - Cooler flow (flowmeter in line from transmission to cooler)

J - Load Valve

If testing the complete transmission, the following procedures are listed in a logical sequence and should therefore be completed in the same sequence. Also, refer to the **Fault Finding** procedures at the beginning of the transmission section for reference to specific tests.

Mainline Pressure

1 Stop engine, connect a 0-20 bar (0-300 lbf/in^2) 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 **Mainline Pressure** which should be as given in **Technical Data**.

3 Repeat step 2 and note gauge readings with engine running at 2000 rev/min.

4 Stop engine and remove test gauge.

If the mainline pressure is low, refer to **Fault Finding** 'Low Mainline Pressure' for a list of possible reasons. A high reading could indicate a faulty pressure maintenance valve.

Clutch Pressure (Forward Clutch Given in Example)

1 Stop engine, connect a 0-20 bar (0-300 lbf/in^2) pressure gauge to test connector **B** (item **C** for reverse clutch).

2 Start engine and run at 1000 rev/min. With parking brake and footbrake firmly applied, select **Forward**, the pressure gauge will show the **Clutch Pressure** which should be as given in **Technical Data**.

Note: If the mainline pressure is in the lower part of the tolerance band (refer to **Technical Data**), then the forward and reverse clutch pressures should also be in the lower part of the tolerance band and vice versa.

3 Repeat step 2 and note gauge readings with engine running at 2000 rev/min.

4 Stop engine and remove test gauge.

If the clutch pressure is low, the clutch could be leaking. A leaking clutch is easier to detect when the engine is running at idle. With the engine at idling speed, check the mainline pressure and then check the clutch pressure as described above, if the clutch pressure is 1.7 bar (25 lbf/in^2) less than the mainline pressure, then the clutch is probably leaking. Refer to **Fault Finding** 'Low Clutch Pressure', before dismantling the clutch.

A high reading could indicate a faulty pressure maintaining valve.

Pressure and Flow Tests (continued)

Pump Flow

1 Stop engine, remove transmission filter **F**, and screw adapter **X** (service tool 892/00304) on to the threaded spigot. Fit test adapter **Y** (service tool 892/00301) and secure with adapter **Z** (service tool 892/00302). Connect flowmeter **W** (service tool 892/00229).

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 given in **Technical Data**.

3 Repeat step 2 and note gauge readings with engine running at 2000 rev/min.

4 Stop engine and remove test adapters, refit filter.

If the pump flow is low, refer to **Fault Finding** 'Low Pump Flow'.

Converter Out Pressure/Oil Cooler Flow Rate

1 Stop engine, connect a 0-10 bar (0-145 lbf/in^2) pressure gauge and flowmeter (see note) into the converter out line as shown at **E** and **H** respectively.

Note: The flowmeter must have a low back pressure, otherwise an incorrect reading will be obtained.

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 given in **Technical Data**.

3 Repeat step 2 and note gauge readings with engine running at 2000 rev/min.

4 Stop engine, remove test gauges and refit hoses to original position.

If the pressure is low, refer to **Fault Finding** 'Low Converter Out Pressure' for a list of possible reasons. A high pressure together with low flow could be caused by a blocked oil cooler.

Converter In Pressure

1 Stop engine, connect a 0-10 bar (0-145 lbf/in^2) pressure gauge to test point **D**.

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 given in **Technical Data**. A high or low reading could indicate a faulty converter relief valve, or a problem with the pump.

3 Remove pressure test gauge.

Converter Relief (Safety) Valve Pressure

1 Connect a 0-10 bar (0-145 lbf/in^2) pressure gauge to test point **D**.

2 Fit a load valve **J** 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. If the load valve is not fully open, damage to the converter seals will be incurred.

CAUTION: DO NOT allow the pressure to exceed 7.6 bar (110 lbf/in^2) 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 **J** whilst observing the gauge reading which should rise to the **Converter Relief (Safety) Valve** setting as given in **Technical Data**.

4 If the reading is higher than specified then the converter relief valve is faulty. A low reading indicates a leaking pump seal or a faulty converter relief valve.

5 Stop engine, remove test gauges and refit hoses to original position.

Lubrication Pressure

1 Stop engine, connect a suitable pressure gauge into the return line from the oil cooler to the transmission as shown at **G**.

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 given in **Technical Data**.

3 Repeat step 2 and note gauge readings with engine running at 2000 rev/min.

4 Stop engine and remove pressure gauge.

Solenoid Valve

Dismantling and Assembly

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

For assembly the sequence should be reversed.

For clarity, only one solenoid has been numbered in the dismantling sequence.

Dismantling

1 Remove the surface mounted 'O' rings **1**.

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

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

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

5 Dismantle the opposite solenoid in the same sequence as described above.

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

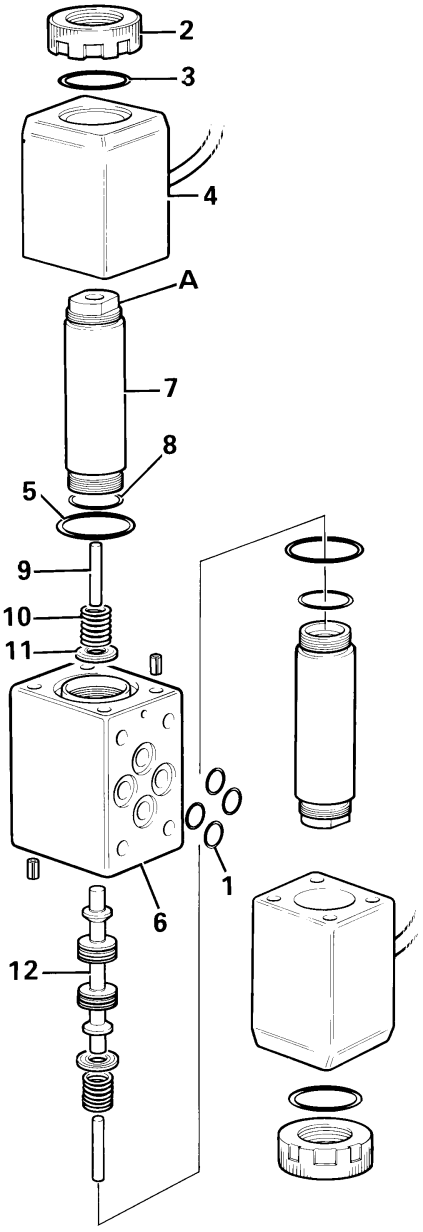
Assembly

1 Renew all O-rings.

2 Lightly lubricate all parts with clean transmission fluid before assembling.

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

4 Apply a small quantity of JCB Threadlocker & Sealer to the threads in the knurled nut **2** before fitting.



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Torque Converter Stall Test

Note: Before completing the torque converter stall test, make sure that the mainline and clutch pressures are correct. If the pressures are incorrect, the clutches could slip, causing premature wear of the clutch friction plates.

Also, make sure that the machine neutral circuit pressure (including steer circuit) is correct (14 bar; 200 lbf/in^2 maximum).

1 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.

2 Apply parking brake **A** and footbrake firmly **B**, select 4th Speed Forward and open throttle **C** 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 30 seconds or the transmission fluid will overheat.

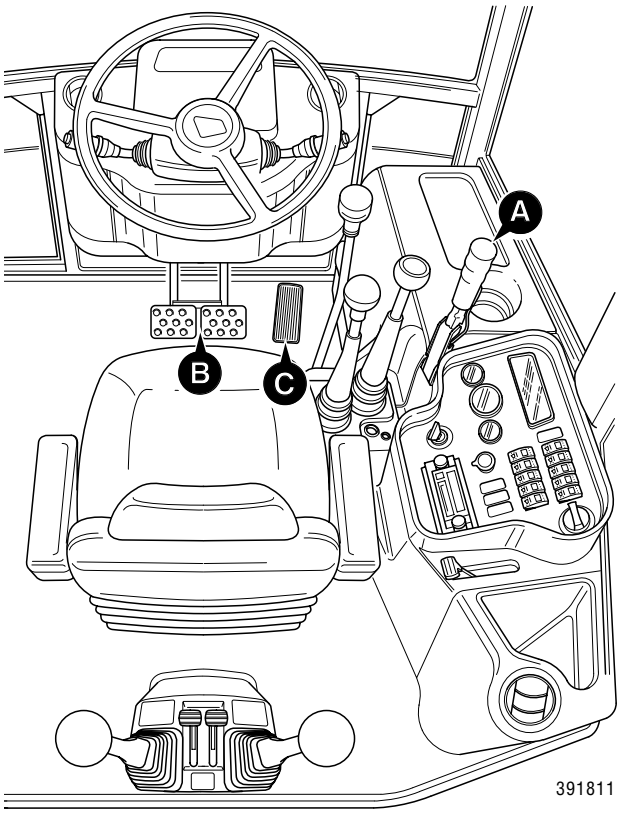
3 If engine speeds are higher than the stated figures check the transmission for clutch slippage or internal leakage.

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.

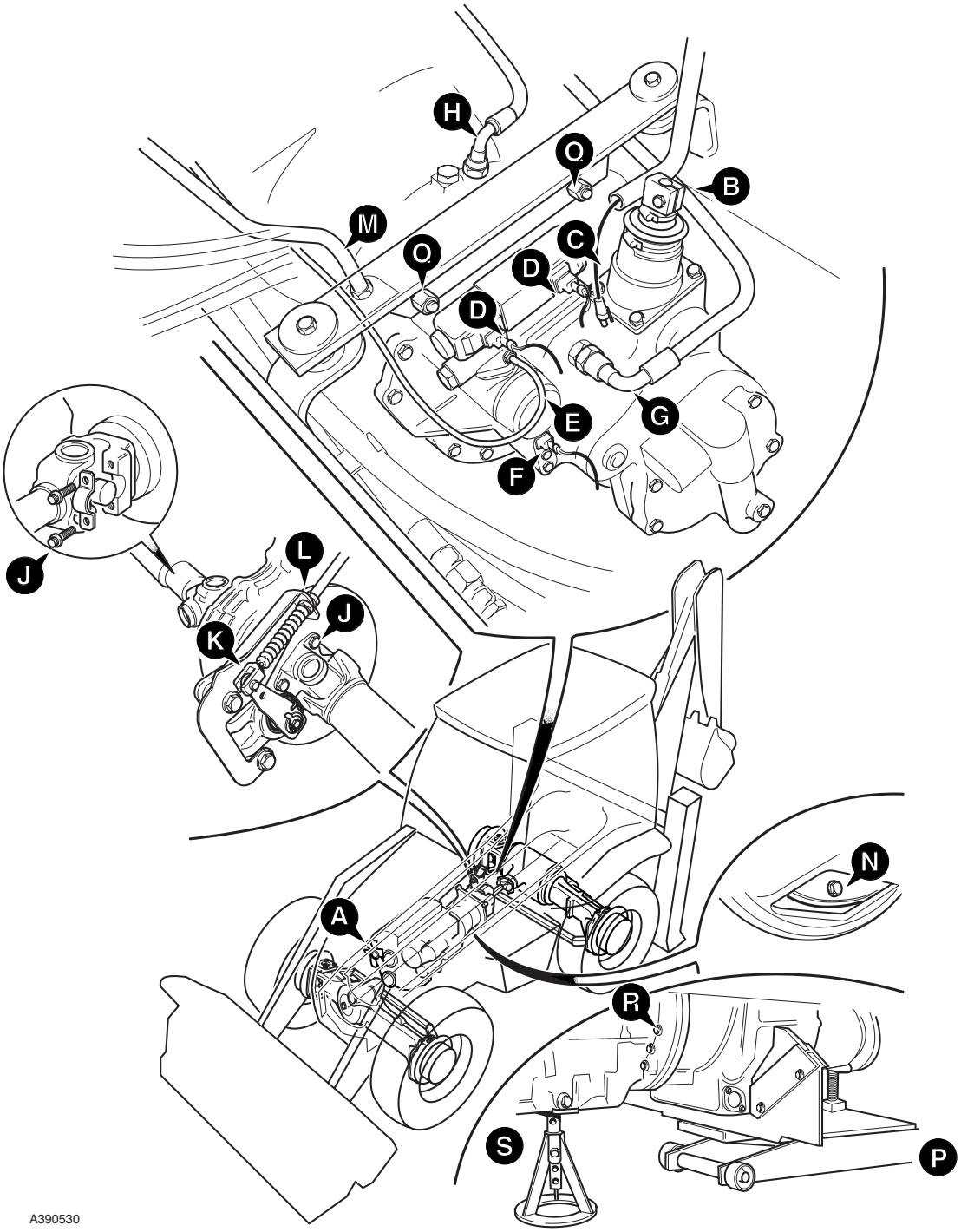
To check the engine, make sure the main relief valve is set correctly, select Neutral, open throttle fully and operate an excavator service to 'blow off' the main relief valve. Engine speed should fall to slightly above the **Maximum Governed Speed** (see **Engine Technical Data**). If engine speed is correct the torque converter is faulty.

Note 1: The engine can also be checked by doing a stall test and 'blowing off' the main relief valve simultaneously. The speed should be as stated in **Technical Data, Torque Converters (Converter + MRV)**

Note 2: Maximum Governed Speed is a datum figure only. It cannot be adjusted or checked with the engine installed in the machine.



Removal and Replacement



Removal and Replacement

Park the machine on firm level ground.

⚠ 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 Rest the loader shovel on the ground and lower the stabiliser legs to raise the machine sufficiently to allow room for the transmission to be pulled clear. Block/support the machine.

2 Drain the synchro shuttle gearbox oil, refer to Section 3 **Syncro Shuttle Transmission - Change Oil and Clean Strainer**.

3 Remove the engine bonnet, refer to Section 3 **Engine Panels - Opening and Closing the Bonnet**.

4 Remove the engine fan retaining bolts as shown at **A** (4 off) and remove the fan, see note 1.

Note 1: At a later stage the transmission is tilted to give access to retaining bolts, if the fan is not removed at this stage it will foul.

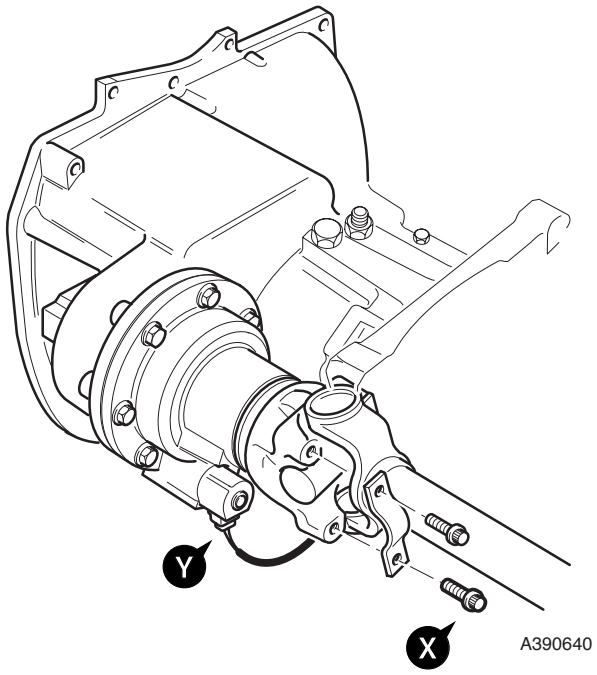
5 In the cab remove the floor mat and open the inspection cover in the cab floor to gain access the top of the syncro shuttle gearbox and carryout the following, see note 2.

- **a** Disconnect the gearshift lever **B** from the top of the gearbox.
- **b** Disconnect the flying lead connector to the transmission dump switch as shown at **C**.
- **c** Disconnect the solenoid valve flying lead connectors **D**.
- **d** Disconnect the breather pipe from the pressure maintaining valve block and the top of the dipstick tube as shown at **E**.
- **e** Disconnect the gearbox oil pressure switch flying lead connector as shown at **F**.
- **f** Disconnect the gearbox oil cooler hoses **G** and **H**, blank off all exposed connections.

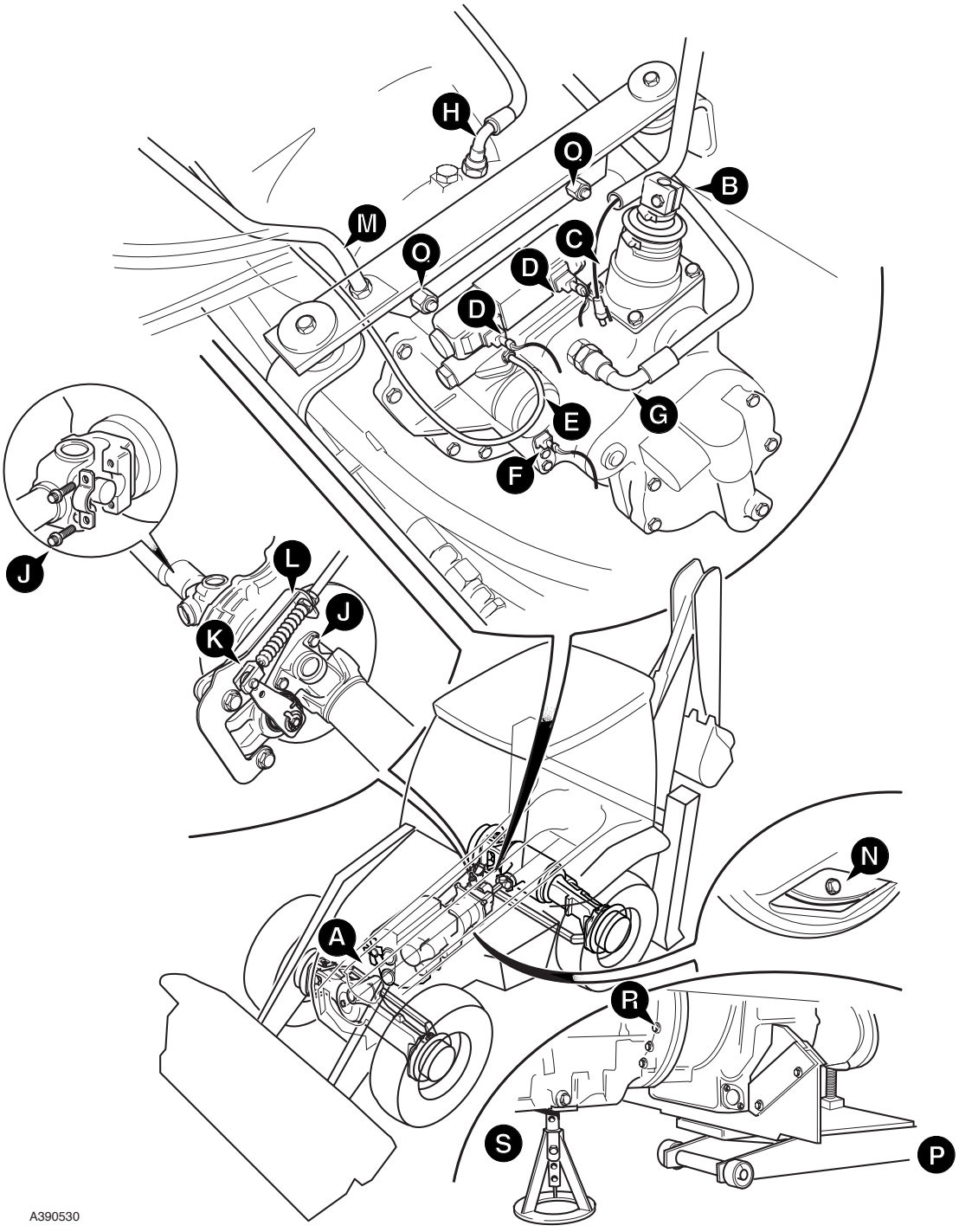
Note 2: Label the hoses and the electrical connectors for identification when refitting.

6 Remove front and rear axle drive shaft bolts **J**.

7 For machines fitted with the power take off option, remove the PTO drive shaft bolts **X**, and the PTO solenoid valve flying lead connector as shown at **Y**.



Removal and Replacement



Removal and Replacement (cont'd)

8 Disengage the parking brake clevis at the parking brake calliper as shown at **K**, loosen the locknuts **L** and remove the cable from the bracket, tie the cable up clear of the gearbox.

9 Remove the transmission dipstick tube **M**.

10 Remove the access bung/plate at the bottom of the flywheel housing. Through the access hole, loosen and remove the torque convertor to engine flywheel retaining bolts **N**.

11 Support the transmission with a trolley jack as shown at **P**, see note 3.

12 Make sure that the weight of the transmission is supported by the trolley jack and remove the gearbox mounting bolts **Q** on the transmission cross mount.

Note 3: Attach a 'cradle' to the trolley jack that will partially embrace the transmission.

13 Using the trolley jack, lower the transmission and engine to gain access to the top flywheel housing to engine block retaining bolts **R**.

14 Put a support under the engine as shown at **S** to prevent it from dropping when the transmission is removed.

15 Remove the flywheel housing to engine bolts **R**.

16 Manoeuvre the transmission with the torque convertor clear of the engine housing.

17 Lower the trolley jack and pull the transmission and torque convertor clear of the machine.

Replacement

Replacement is a reversal of the removal procedure.

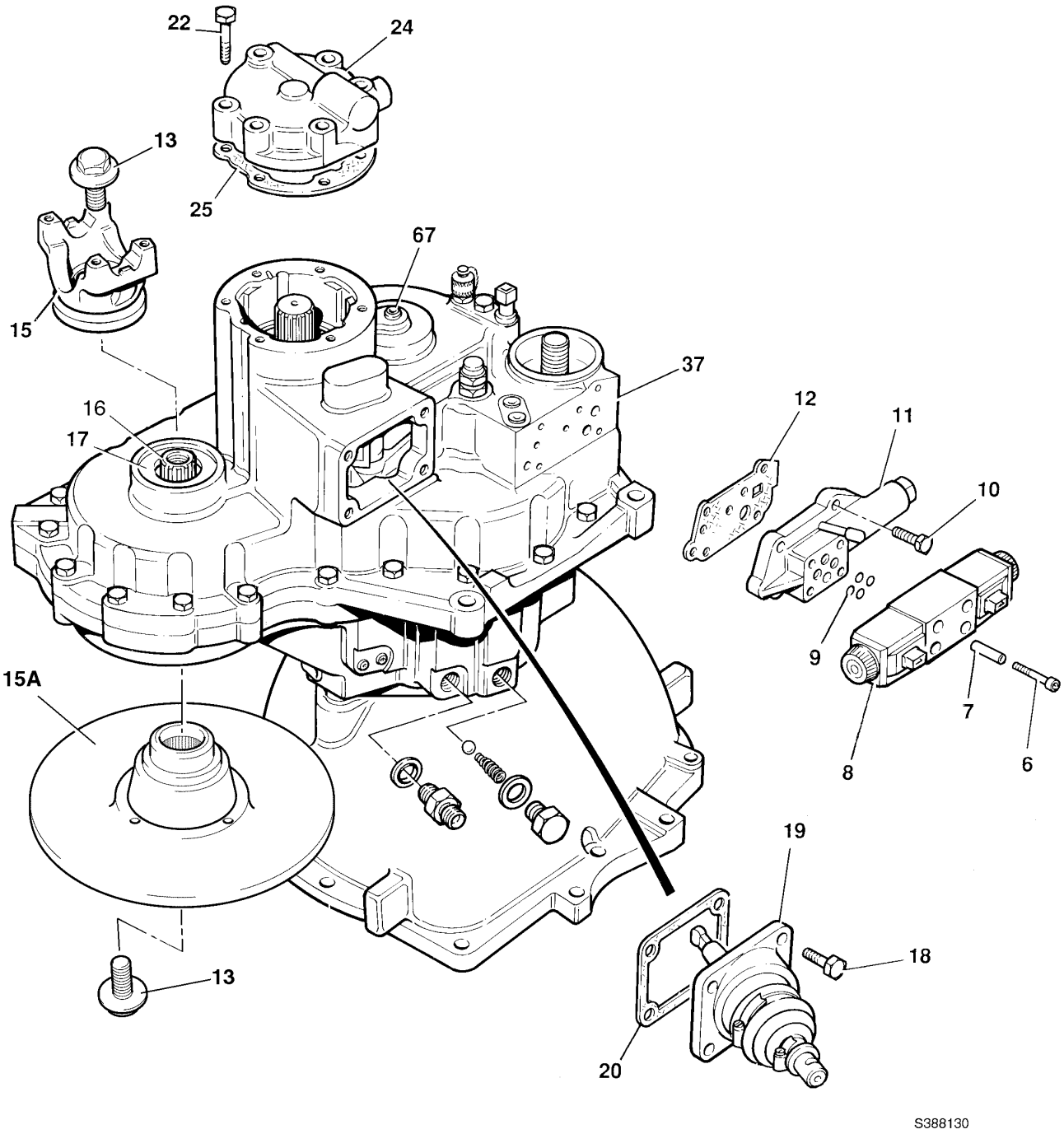
Set the parking brake cable as described in Section G **Service Procedures, Parking Brake - Adjustment**. If the parking brake calliper has been removed reset central to the parking brake disc, refer to Section G **Parking Brake - Calliper Removal and Replacement**.

Set the torque converter as described in **Torque Converter**.

Fill the transmission with the specified amount of JCB Special Transmission Fluid (refer to Section 3 **Lubricants and Capacities** and **Syncro Shuttle Transmission, Changing the Oil and Filter**). Leave hose **G** off until the filling operation is complete. After filling refit hose **G**.

Torque Settings

Item	Nm	kgf m	lbf ft
A	25	2.5	18
J	40 - 48	4.08 - 4.9	29.5 - 35.4
N	44	4.5	32
Q	237	24	175
R	98	10	72
X	20.9 - 23.7	2.13 - 2.42	15.4 - 17.5

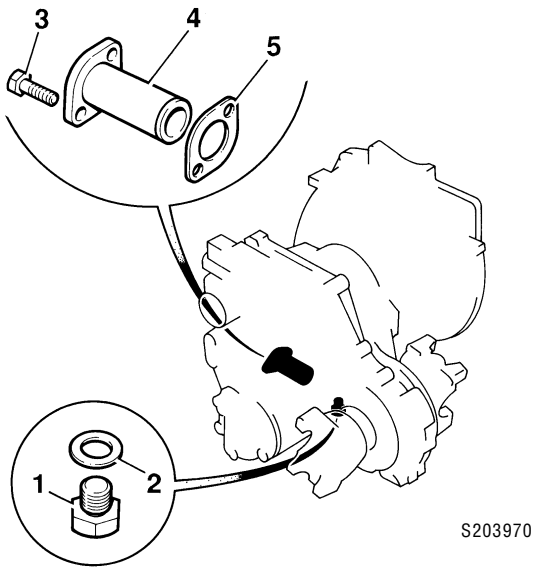


Dismantling

1 Drain the oil from the casing into a suitable container by removing the drain plug **1** and sealing washer **2**. Discard the sealing washer.

2 Remove suction strainer retaining bolts **3** and remove the strainer **4**. Remove and discard the strainer cap gasket **5**.

3 Remove and discard the oil filter.



4 Position the gearbox with the rear casing **37** uppermost.

5 Unscrew capscrews **6** and remove spacers **7** (4 off). Remove the solenoid valve assembly **8.** Retain the spacers (4 off) but discard the 'O' rings **9** (4 off).

6 Remove output yoke **15** and brake disc **15A** attachment bolts **13** using service tool 892/00812. Remove yoke **15** and brake disc **15A** from the output shaft **16**.

7 Remove and discard the output shaft oil seals **17**.

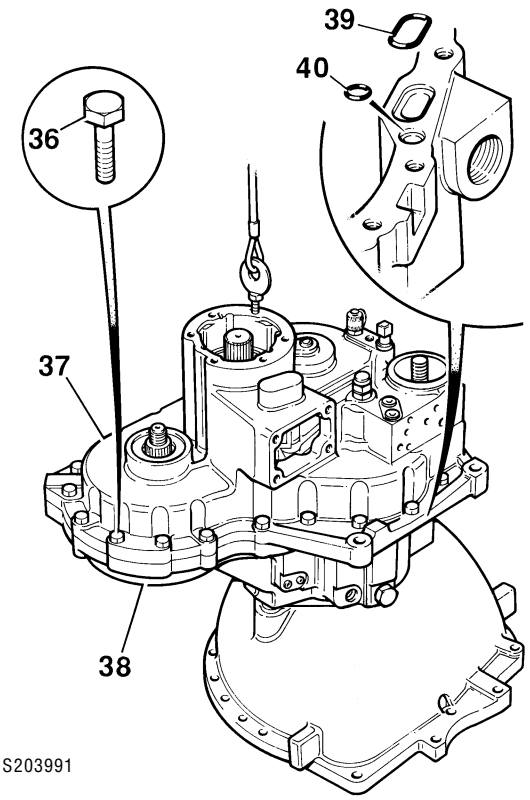
8 Remove the gear change turret retaining bolts **18** (4 off). Remove the turret **19** and gasket **20**. Discard the gasket.

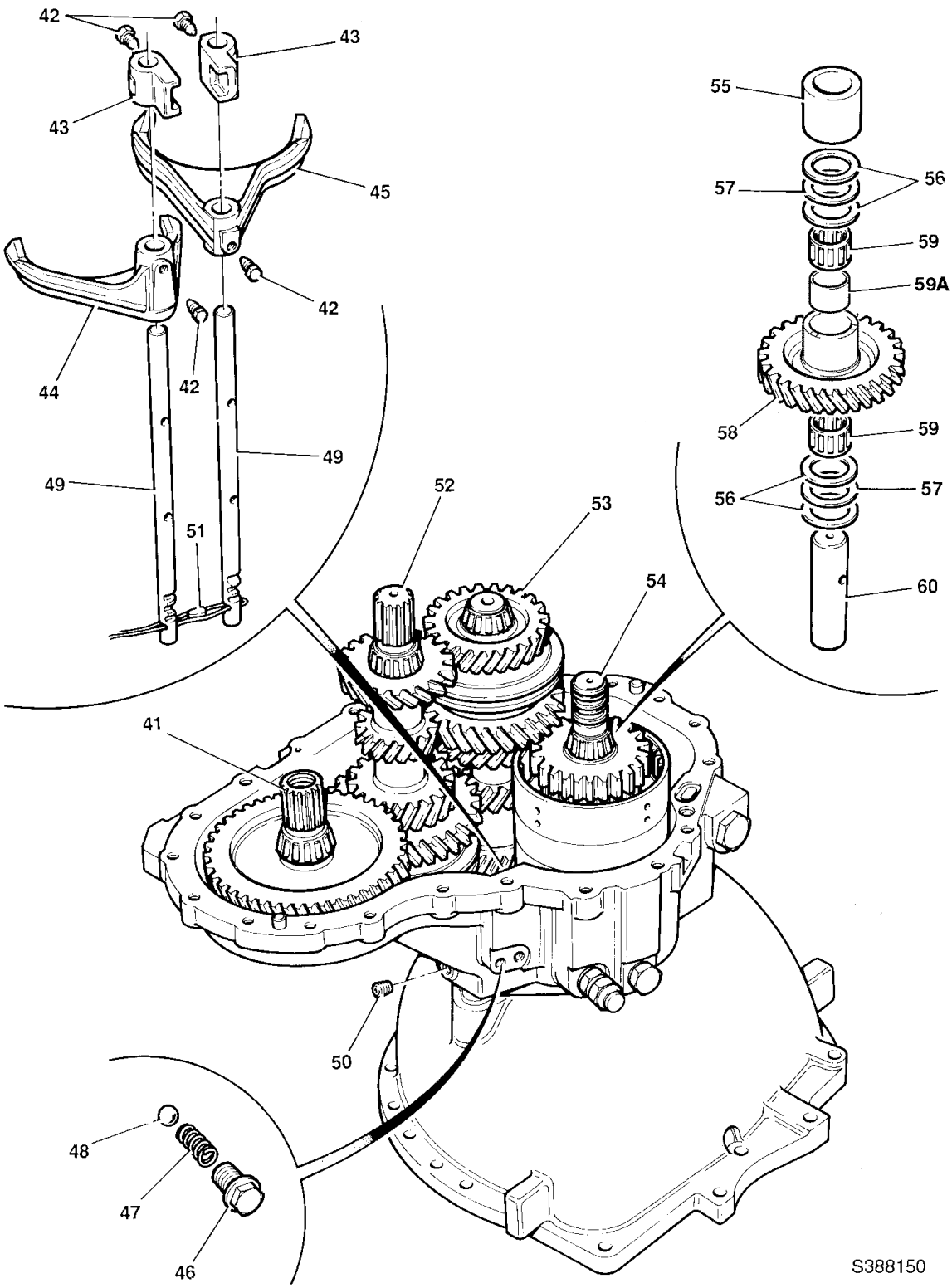
9 Remove layshaft cover plate retaining bolts **22 (6 off)**, remove cover plate **24**, discard gasket **25**.

10 Remove the adaptor block assembly retaining setscrews **10** (4 off) and remove the block **11**. Remove and discard the gasket **12.**

11 Remove the casing retaining bolts **36**.

12 Screw a lifting eye into a layshaft end cover bolt hole. Using a suitable hoist, lift the rear casing **37** away from the front casing **38**. Pry bars may be used at the points provided to assist in 'cracking' the joint. Remove and discard the face 'O' rings **39** and **40**.





Dismantling (Cont'd)

13 Remove the output shaft assembly **41.**

14 Remove locking screws **42** (2 off) from selector forks **44** and **45**.

15 Remove the detent plugs **46**, springs **47** and balls **48** (2 off each).

16 Slide selector shafts **49** from selector forks **44** and **45**.

17 Remove taper plug **50** from the casing. Thread a piece of thin looped wire to the bottom of the RH selector shaft locating hole. Using a small diameter screwdriver through the taper plug hole, push the baulk roller **51** into the wire loop. Carefully withdraw the baulk roller.

18 Remove the layshaft assembly **52**.

19 Remove the main shaft assembly **53**.

20 Remove the reverser unit **54**. See page 62-1 for Dismantling and Assembly instructions.

21 Remove idler gear spacer **55**, thrust washers **56**, thrust bearing **57**, idler gear **58**, needle roller bearings **59**, bearing spacer **59A**, thrust washers **56** and thrust bearing **57** from idler shaft **60.**

22 Remove the idler shaft **60** using a slide hammer if necessary.

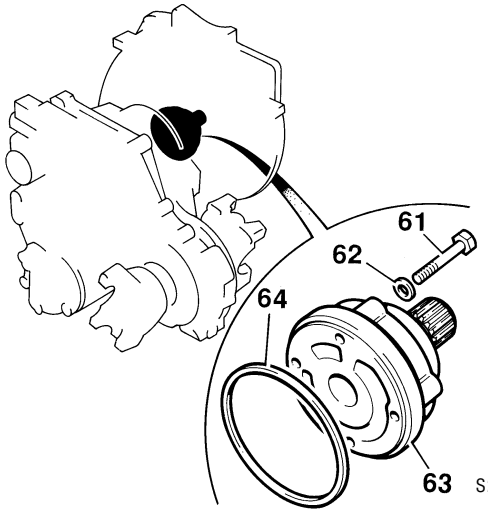
23 Remove the bearing cups located in the front casing using a slide hammer.

24 Turn the gearbox into the horizontal position.

25 Remove the pump assembly retaining bolts **61** (4 off) and washers **62** (4 off) and withdraw the pump assembly **63**. Remove and discard 'O' ring **64**.

26 Remove the pump and shaft from the pump case.

27 Remove the bearing cups located in the rear casing using a slide hammer.



Assembly

Note: All bearings must be lightly oiled before assembly. Make sure all components are thoroughly clean and renew all 'O' rings.

1 Clean the mating faces of front casing **38** and rear casing **37**.

2 Fit new bearing cups into front and rear casings using a bearing dolly.

3 Fit the idler shaft **60** using a soft faced hammer.

4 Fit the idler gear assembly (thrust washers **56**, thrust bearing **57**, needle roller bearings **59**, bearing spacer **59A**, idler gear **58**, thrust washers **56**, thrust bearing **57** and idler gear spacer **55**).

5 Fit the reverser unit **54**.

6 Fit the main shaft assembly **53**.

7 Fit the layshaft assembly **52**.

8 Fit the output shaft assembly **41**.

9 Thread the RH gear selector rod **49** through selector fork **45** and into the casing. Secure with locking screw **42**. Torque tighten to 35 Nm (25.8 lbf ft).

10 Using a piece of looped wire, lower the baulk roller **51** down the LH selector rod channel in the casing. When in position at the bottom, push the roller into position using a small screwdriver through the taper plug hole (item **50**). Remove the wire and screwdriver. Fit the taper plug **50** and torque tighten to 28 Nm (20.7 lbf ft).

11 Thread the LH selector rod **49** through selector fork **44** and into the casing. Secure with locking screw **42.** Torque tighten to 35 Nm (25.8 lbf ft).

12 Fit detent balls **48**, springs **47** and plugs **46** (2 off each). Torque tighten plugs to 35 Nm (25.8 lbf ft).

13 Screw a lifting eye into a layshaft housing bolt hole of the rear casing **37**. Using a suitable hoist, lift the rear casing into position over the front casing **38**. Carefully lower the rear casing onto the front casing, ensuring that the locating pegs are fully engaged. Secure the casings with six equally spaced bolts **36**. Torque tighten to 56 Nm (41.3 lbf ft). Remove the lifting eye.

Assembly (Cont'd)

Shaft End Float Measurements

14 Clean the layshaft end cover mating face.

15 Using service tool kit 993/59400, fit base plate **A** onto the layshaft end cover mating face and secure with socket head set screws **B**. Torque tighten to 56 Nm (41.3 lbf ft).

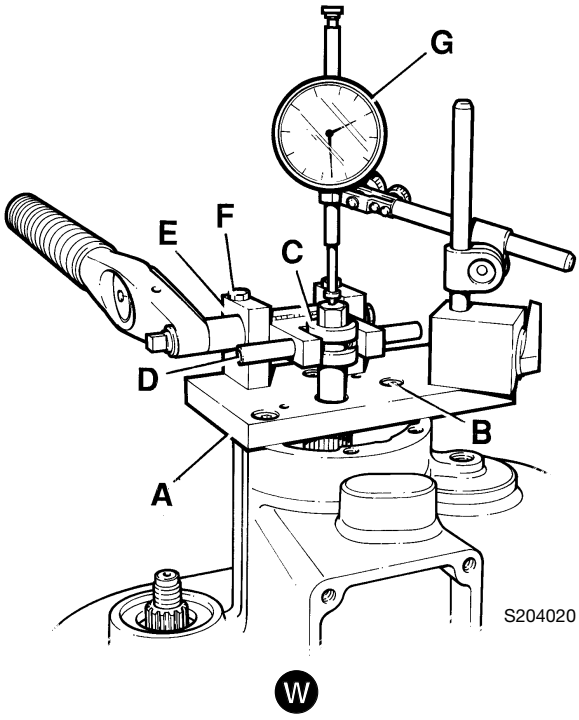
16 Pass the adaptor **C** through the large diameter hole in the base plate and screw into the end of the layshaft.

17 Fit the lever arm pegs **D** into the adaptor annular space. Position the lever unit mounting blocks **E** on the base plate and secure with bolts **F**. Tighten the bolts.

18 Fit a magnetic base dial test indicator (DTI) **G** onto the base plate with the pin resting on the top of the adaptor.

19 Measure layshaft end float as follows (refer to view **W**):

- **a** Using a torque spanner on the nut of the lever unit as shown, apply a torque of 30 Nm (22.1 lbf ft) clockwise while turning the output shaft backwards and forwards using a turning handle. Zero the DTI.
- **b** Apply a torque of 30 Nm (22.1 lbf ft) anti-clockwise while turning the output shaft backwards and forwards using a turning handle. Take the layshaft end float reading from the DTI.



20 Calculate the required shim thickness.

Example:

- **a** End Float Tolerance : 0.03 to 0.08 mm. (Identical clearance for all shafts.)
- **b** Measured End Float : 0.20 mm
- **c** To give an end float within the tolerance, subtract 0.05mm from dimension at para. b for the required shim thickness,
  e.g., 0.20 - 0.05 = 0.15 mm.

21 Remove the bolts **F** securing the lever unit mounting blocks **E** and remove the lever unit. Unscrew and remove the adaptor **C**.

22 Remove taper plug **67**.

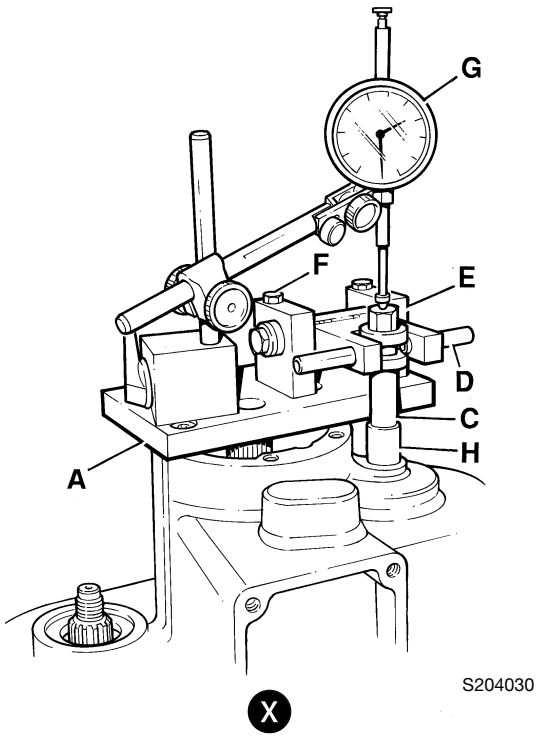
23 Fit the short extension **H** to the adaptor **C**.

24 Using a lever, put the gearbox in gear.

25 Screw the adaptor into the end of the main shaft. Fit the lever arm pegs **D** into the adaptor annular space. Position the lever unit mounting blocks **E** in the appropriate position on the base plate **A** and secure with bolts **F**. Tighten the bolts.

26 Fit a magnetic base DTI **G** onto the base plate with the pin resting on the top of the adaptor.

27 Measure main shaft end float and determine shim thickness by repeating steps 19 and 20. Refer to view **X**.



Assembly (Cont'd)

28 Temporarily refit taper plug **67**.

29 Remove short extension from adaptor.

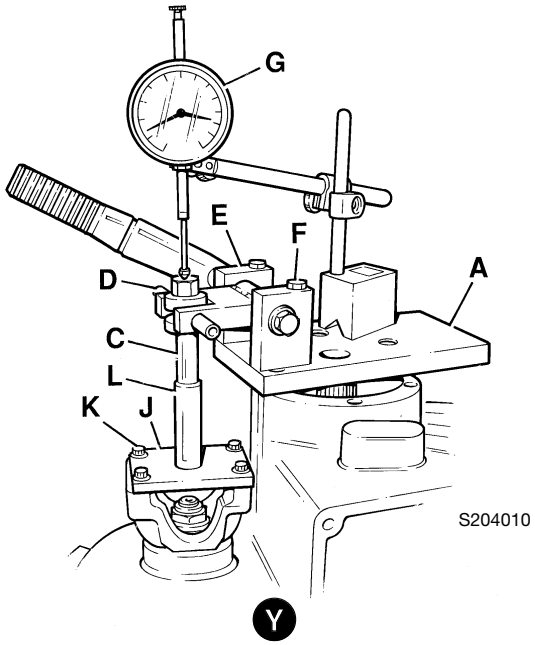
30 Fit the rear output yoke **15 a**nd attachment bolt **13.** Torque tighten to 350 Nm (258.2 lbf ft).

31 Fit the output yoke adaptor **J** and secure with bolts **K**. Torque tighten to 22 Nm (16.2 lbf ft). Screw the adaptor **C** into the yoke adaptor extension **L** until tight.

32 Fit the lever arm pegs **D** into the adaptor annular space. Position the lever unit mounting blocks **E** in the appropriate position on the base plate **A** and secure with bolts **F**. Tighten the bolts.

33 Fit a magnetic base DTI **G** onto the base plate with the pin resting on the top of the adaptor.

34 Measure the output shaft end float and determine shim thickness by repeating steps 19 and 20. Refer to view **Y**.



35 Remove the lever unit, adaptor, base plate and output yoke adaptor.

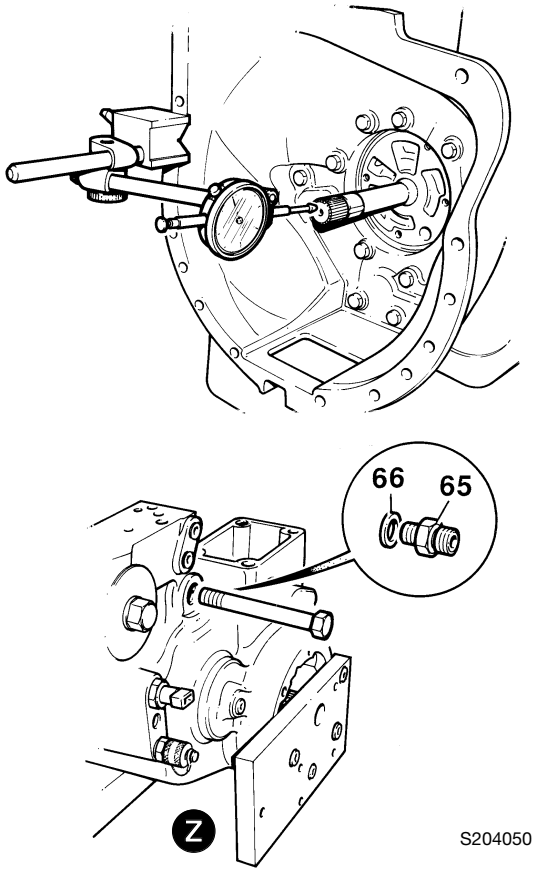
36 Remove the attachment bolt **13** and output yoke **15**.

37 Remove oil inlet adaptor **65** and sealing washer **66** from the rear casing.

38 Turn the gearbox into the horizontal position.

39 Clean the mounting face of the flywheel housing. Mount the DTI on the face with the probe resting on the end of the reverser unit shaft. Firmly press the reverser unit shaft in to take up any shaft end float. Zero the DTI. Refer to view **Z**.

40 Screw a threaded bolt or rod into the threads exposed when oil inlet adaptor **65** was removed, until it touches the end of the reverser unit shaft.



41 Screw bolt or rod in further (approx. 10 Nm; 7.4 lbf ft) whilst turning output shaft. Stop when increasing resistance is felt. DO NOT overtighten. Take the DTI reading.

42 Calculate the required shim thickness as detailed in step 20.

43 Remove bolt or rod and the DTI. Temporarily refit oil inlet adaptor **65** and sealing washer **66**.

44 Turn the gearbox into the vertical position, with the rear casing upwards.

45 Screw a lifting eye into a layshaft end cover bolt hole. Using a suitable hoist, lift the rear casing **37** away from the front casing **38**. Pry bars may be used at the points provided to assist in 'cracking' the joint. Turn the rear casing over.

Assembly (Cont'd)

46 Using a bearing puller, remove the layshaft bearing cup from the rear casing. Referring to the shim thickness calculation for the layshaft **52,** fit the required shims into the rear casing. Using a bearing dolly, refit the layshaft bearing cup.

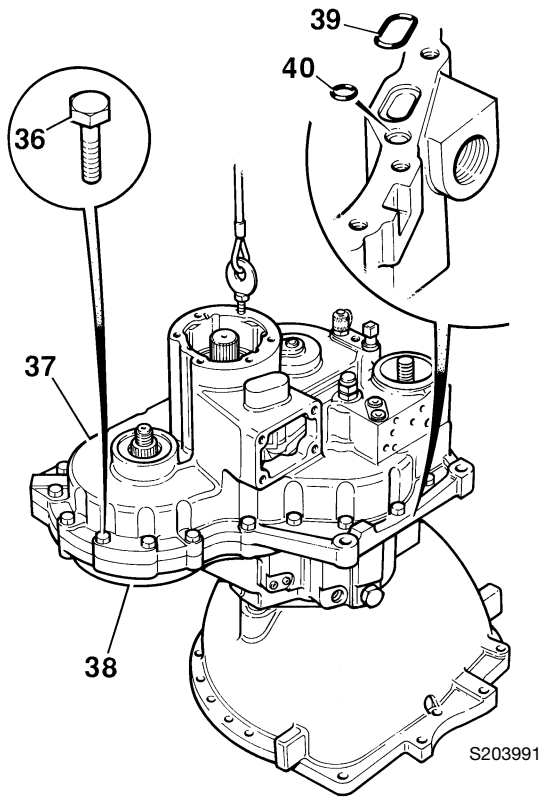
47 Repeat step 46 for the main shaft **53**, output shaft **41** and reverser unit **54**.

48 Turn the rear casing over.

49 Fit the face 'O' rings **39** and **40** into the front case mating face recesses.

50 Apply a bead of sealant to the front case mating face, smoothing the sealant around the 'O' ring areas.

51 Screw a lifting eye into the layshaft end cover bolt hole of the rear casing **37.** Using a suitable hoist, lift the rear casing into position over the front casing **38.** Carefully lower the rear case onto the front case, ensuring that the locating pegs are fully engaged. Secure the casings with bolts **36.** Torque tighten to 56 Nm (41.3 lbf ft). Remove the lifting eye.



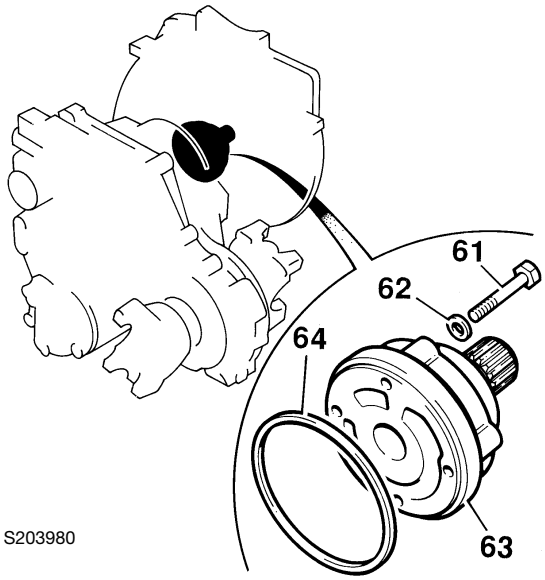
52 Repeat end float measurements, as detailed in steps 15 to 36 inclusive, to check that end float on all shafts remains within the tolerance of 0.03 to 0.08 mm.

53 If any measurement is outside the tolerance, remove rear casing, see step 45. Using a bearing puller, remove the bearing cap(s) of the shaft(s) that is outside the tolerance. Add or remove shim(s) to bring the measurement(s) within the tolerance. Using a bearing dolly, refit the bearing cup(s) into the rear casing.

54 Remove the front case 'O' rings **39** and **40** and clean the sealant from the front case mating face.

55 Repeat steps 49 to 52 inclusive. The end float measurements should now be within the tolerance for all shafts. If any measurement is still outside the tolerance, repeat step 53.

56 Turn the gearbox into the horizontal position. Fit new 'O' ring **64** to the oil pump assembly. Refit the oil pump assembly and secure with new washers **62** and bolts **61.** Torque tighten to 28 Nm (20.7 lbf ft). Make sure that the pump rotors rotate.



57 Pack the cavity between the lips of both front and rear output shaft oil seals **17** with grease and fit the seals.

58 Fit the rear output yoke **15** and front output brake disc **15A** and secure with attachment bolts **13.** Do not fully tighten. Align the front and rear output yokes.

59 Fit the gear change turret **19** with a new gasket **20** and secure with setscrews **18.** Torque tighten to 56 Nm (41.3 lbf ft).

60 Fit oil inlet adaptor **65** with new sealing washer **66** into the rear casing. Torque tighten to 102 Nm (75.2 lbf ft).

61 Fit taper plug **67**. Torque tighten to 56 Nm (41.3 lbf ft).

Assembly (Cont'd)

62 Fit a new gasket **25**. Fit layshaft end cover **24**, torque tighten retaining bolts **22** (6 off) to 56 Nm (41.3 lbf ft.

63 Fit adaptor block assembly **11** and new gasket **12** to the rear casing. Secure with setscrews **10** and torque tighten to 10 Nm (7.4 lbf ft).

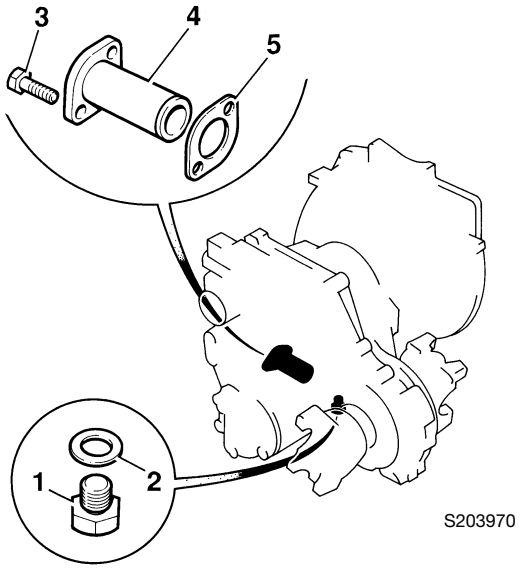
64 Fit new 'O' rings **9** to the underside of solenoid valve **8**. Fit solenoid onto the adaptor block assembly **11**, ensuring that 'O' rings remain in position in solenoid base. Secure solenoid using spacers **7** and cap screws **6** (4 off). Torque tighten to 5.8 Nm (4.3 lbf ft).

65 Fit a new gasket **5** to a clean suction strainer **4** and insert into the casing. Apply JCB Threadlocker and Sealer to the threads of setscrews **3** (2 off) and torque tighten to 10 Nm (7.4 lbf ft).

66 Torque tighten the output yoke and brake disc attachment bolts **13** to 350 Nm (258.2 lbf ft).

67 Fit drain plug **1** with new sealing washer **2**. Torque tighten to 102 Nm (75.2 lbf ft).

68 Fit a new oil filter.



Dismantling

1 Carefully remove the piston ring seals **1** (3 off).

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 stake nut **1A** as follows.

a Carefully prise away the staked area of the nut.

b Clamp the holding fixture (service tool 892/01065) in the jaws of a vice as shown at **A**.

c Locate the clutch assembly into the holding fixture.

d Undo the nut using the adaptor spanner (service tool 892/01064) and a 1/2" square drive socket wrench as shown at **B**.

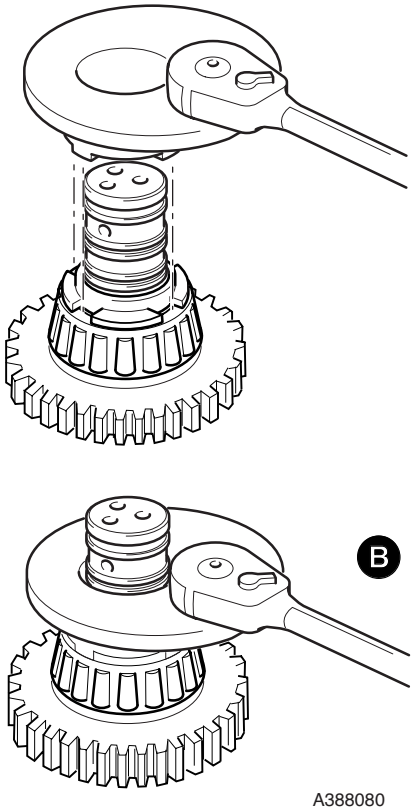
Note: The nut must be discarded - DO NOT re-use.

3 Turn the assembly over and knock the clutch shaft on a wooden block to loosen the clutch end bearing **2**. Remove the bearing using pullers.

4 Remove the thick thrust washer **3,** thrust bearing **4** and thin thrust washer **5**.

5 Withdraw the gear and splined hub assembly **6** and the needle roller bearing **7**.

6 Remove the thin thrust washer **8**, thrust bearing **9** and thick thrust washer **10**.



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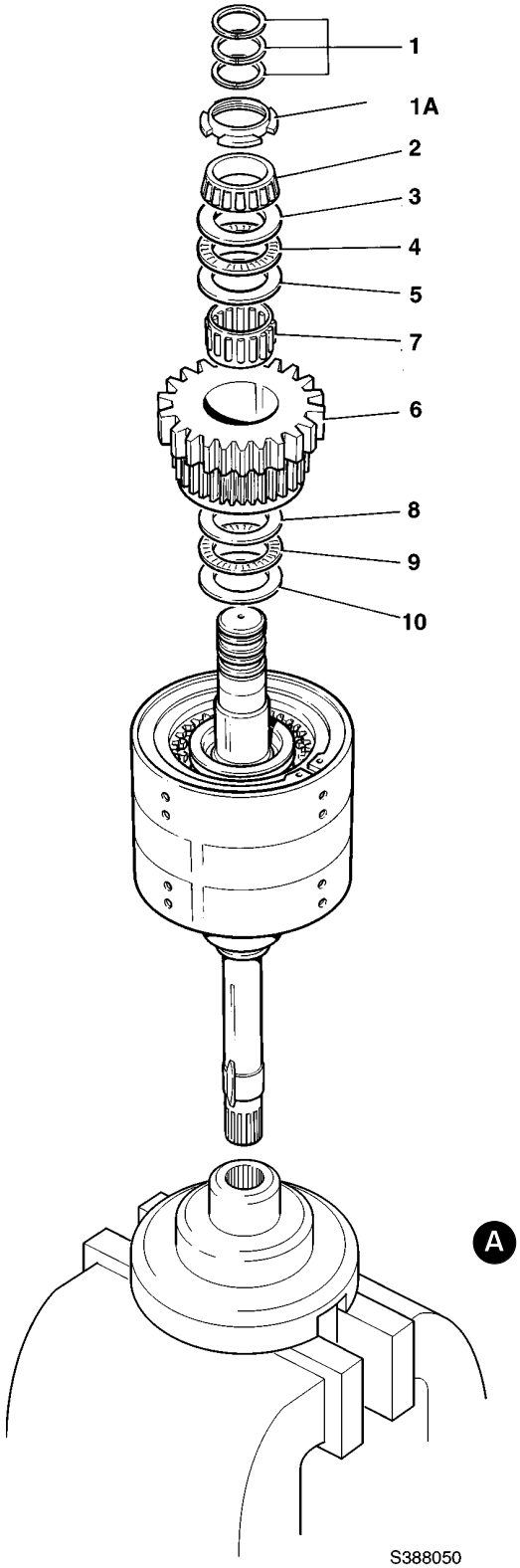

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Dismantling (Cont'd)

7 Remove the clutch friction/counter plate retaining circlip **11**.

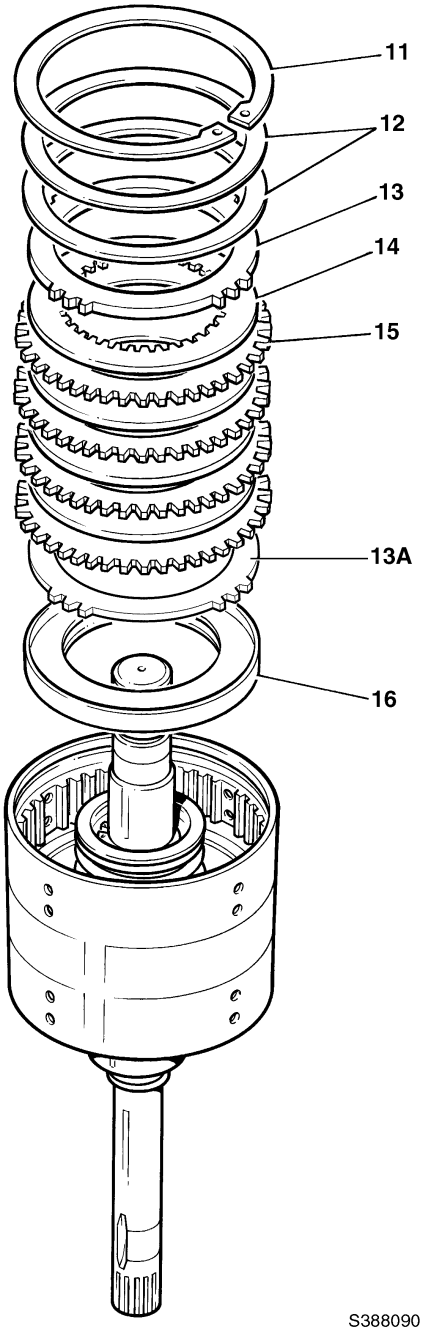
8 Remove the thick pressure end plate (6mm thick) **13**.

Note: If the reverser unit has been previously dismantled, shims **12** may also be fitted.

9 Remove clutch friction plates **14** (4 off) and counter plates **15** (4 off). Keep plates together in sets, DO NOT mix with those from other clutches.

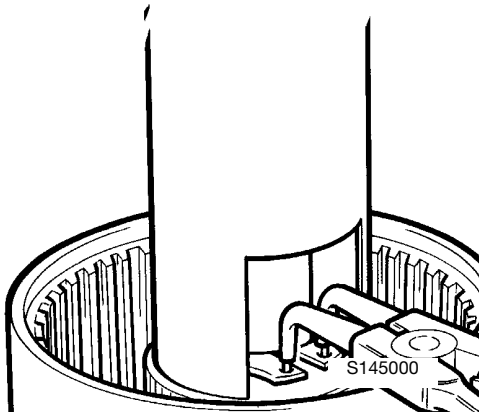
10 Remove the thin pressure plate (4mm thick) **13A**.

11 Remove the disc spring assembly **16**.



Dismantling (Cont'd)

12 Position clutch assembly in a suitable press to compress the piston spring then remove circlip **17**.



13 Lift off spring retaining plate **18.**

14 Remove spring **19** and oil baffle plate **20**.

15 Turn the assembly over and knock the clutch shaft on a wooden block to loosen the piston **21**.

Note: If the piston does not loosen, hand pump air down the shaft oil inlet hole.

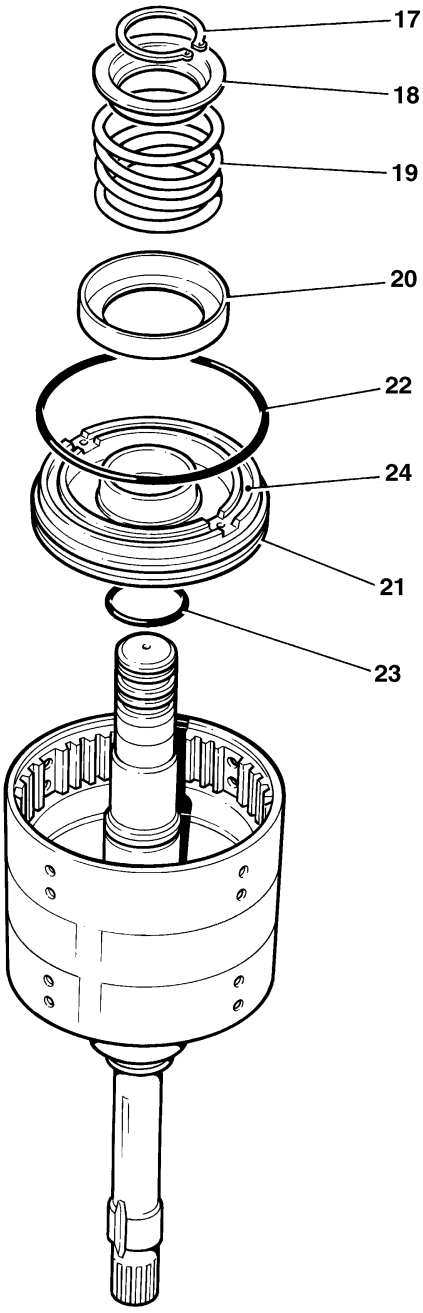
16 Remove the piston **21.** Remove and discard the piston 'O' ring **22** and shaft 'O' ring **23.**

17 Make sure that the piston liner **24** is secure and is a tight fit on the piston.

18 Dismantle the opposite clutch assembly (torque converter end) by repeating steps 1 to 17 and observing the following notes.

Note: The clutch shaft has only one piston ring seal **1** fitted at this end.

Note: Spacer **A** is fitted on the clutch shaft after the needle roller bearing **7**. The spacer may be fitted at either end of the needle roller bearing.



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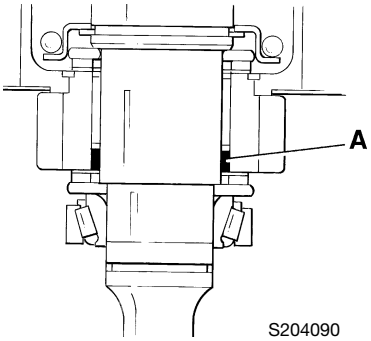

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Assembly

The assembly procedure is the reverse of the dismantling procedure.

Make sure all components are thoroughly clean prior to assembly. Renew all 'O' rings.

1 Lubricate the piston **21** with hydraulic oil and press fully into bore of clutch housing.

2 Fit oil baffle **20**, spring **19** and spring retaining plate **18.**

3 Compress spring and fit circlip **17.**

4 Fit the disc spring assembly **16** and the thin pressure plate (4mm thick) **13A.**

5 Fit counter plates **15** and friction plates **14** alternately, starting with a counter plate.

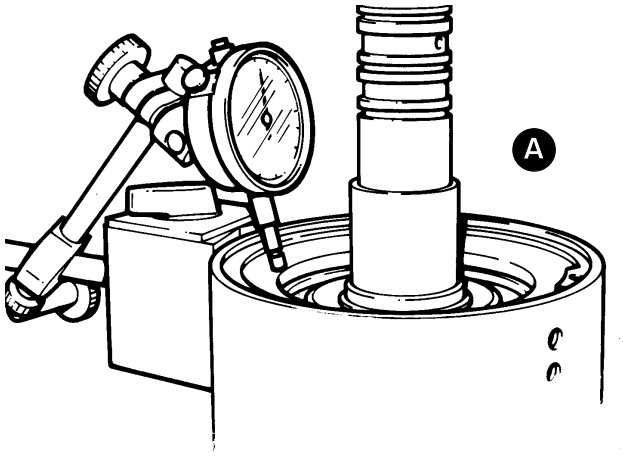
6 Fit the thick pressure end plate (6mm thick) **13** and clutch friction/counter plate retaining circlip **11**.

7 Using a dial test indicator as shown at **A**, measure the end float of the pressure end plate **13**, which should be 2.0 to 3.3 mm (0.079 to 0.130 in). If the float is above 3.3mm (0.130 in), fit shim **12** between the retaining circlip and pressure end plate to bring end float within tolerance. If the float is below 2.0 mm (0.079 in), remove the thin pressure plate (4mm thick) **17** at piston end and replace with a counter plate **13**, then shim as necessary to bring end float within tolerance.

8 Fit thrust washers **10** and **8** and thrust bearing **9**.

9 Carefully align teeth of clutch plates using a thin rod or screwdriver. Fit gear and splined hub assembly **6**.

10 Fit needle roller bearing **7**, thrust washers **5** and **3** and thrust bearing **4.**



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11 Pack the clutch end bearing with JCB MPL Grease and press the bearing onto clutch shaft.

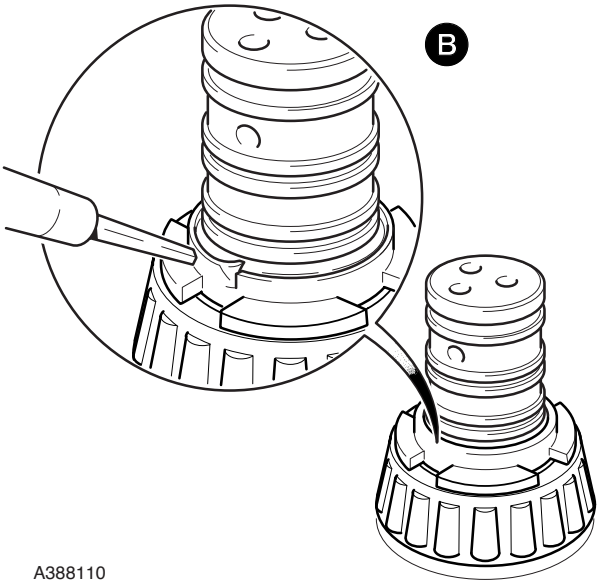
12 Fit a new stake nut **1A** and torque tighten to 200 Nm (147.5 lbf ft).

Note: To tighten the nut locate the clutch assembly into the holding fixture (service tool 892/01065) as shown in dismantling and use the adaptor spanner (service tool 892/01064) and a 1/2" square drive torque wrench.

13 Re-stake the nut using a square ended staking tool as shown at **B**.

14 Fit piston ring seals.

15 Assemble the opposite clutch assembly (torque converter end) by repeating steps 1 to 14.



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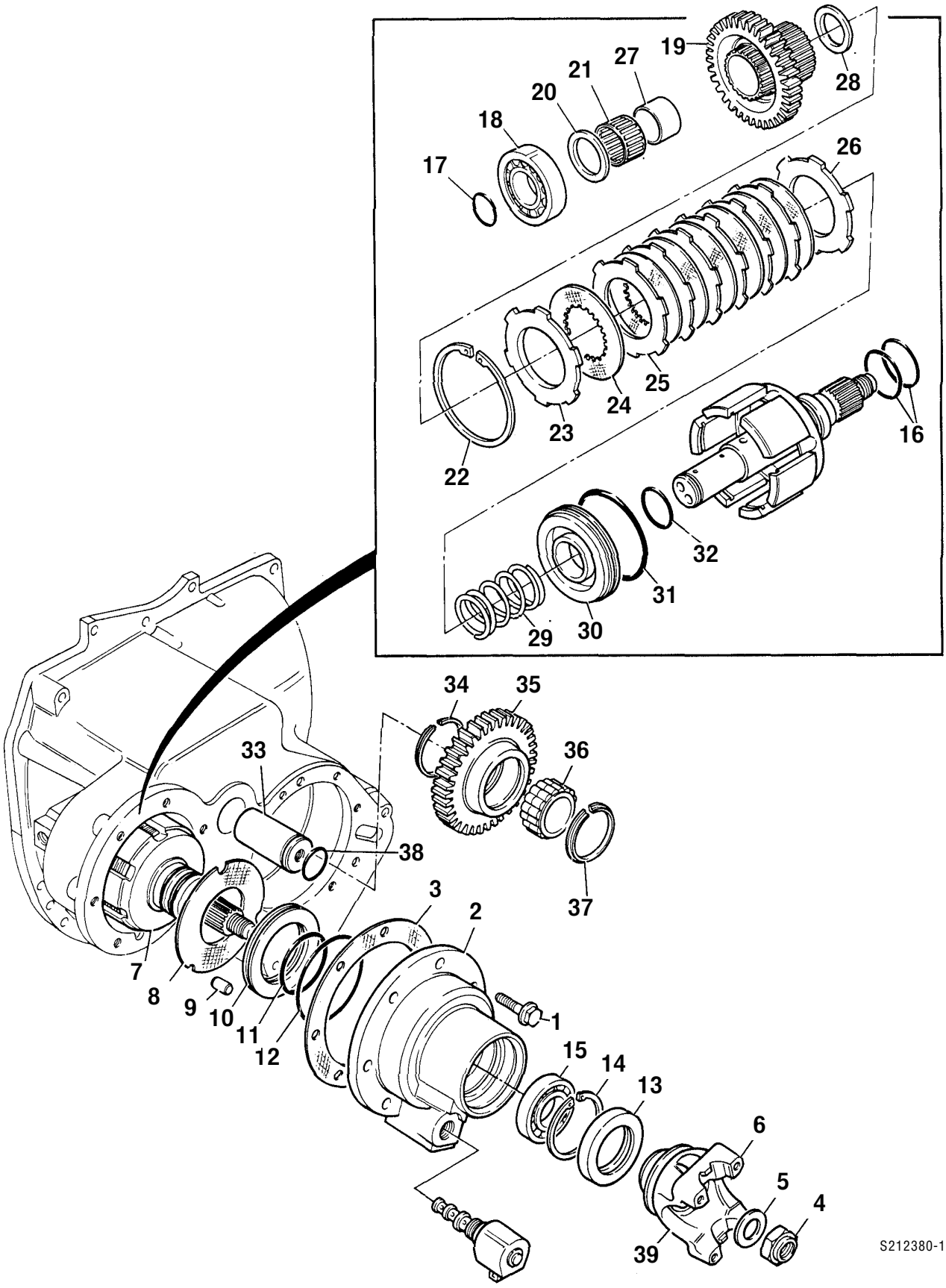


Power Take Off Clutch

Removal and Replacement

Removal

Note: If the PTO clutch is to be dismantled, the drive yoke stake nut **4** should be loosened before the clutch is removed from the gearbox.

Disconnect the hydraulic pipe connection from the PTO housing. Plug the exposed connections to prevent ingress of dirt.

Loosen and remove the 8 bolts **1** which secure the PTO housing **2** to the gearbox.

Carefully lift the PTO clutch from the gearbox. Remove and discard gasket **3**.

Replacement

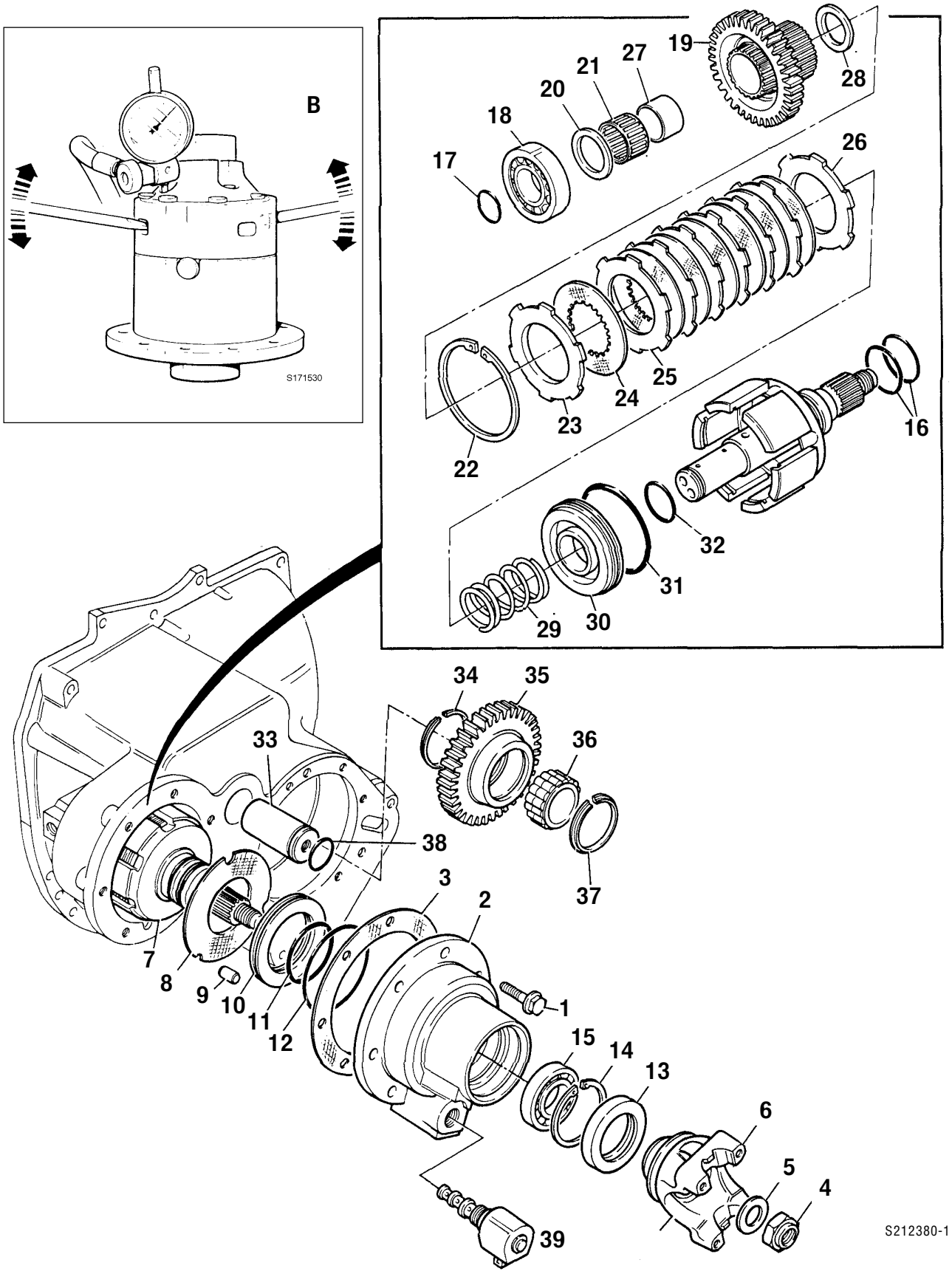
Replacement is the reverse of the removal procedure.

Torque tighten bolts **1**.

When fitting stake nut **4**, torque tighten as indicated then split the nut sleeve axially using a square ended staking tool. (This operation may be easier performed after the clutch has been replaced in the gearbox.)

Torque Settings

Item			
1	56 Nm	41 lbf ft	5.7 kgf m
4	350 Nm	258 lbf ft	35.7 kgf m



Power Take Off Clutch

Dismantling and Assembly

Idler Assembly

The idler assembly (items **33** - **37**) can be dismantled after the PTO clutch has been removed and must be assembled before the PTO is replaced. Withdraw shaft **33** using an impulse extractor screwed into the M12 tapped hole in the end of the shaft, then remove the remaining components via the PTO cavity. Assembly is the reverse of the dismantling sequence.

Dismantling

Follow the numerical sequence on the illustration to dismantle the unit, noting the points listed below.

Use suitable screws, inserted into the threaded holes provided, to remove the brake piston **10**.

Dowels **9** (3 off) should be removed if they are loose, to prevent losing them.

Bearing **18** will either remain on the clutch shaft or in its housing in the gearbox when the clutch is removed.

Dismantling of the clutch assembly **7** will be easier if it is secured in a soft-jawed vice, coupling end lowermost.

Thrust washer **28** and ring **27** should be removed using a bearing puller applied to thrust washer **28**. Discard ring **27**. Take care not to damage the clutch housing and the oil holes in the end of the shaft when using the puller.

Note: Do not attempt to lever off these components. Always use the correct tool.

The clutch pack comprises alternate friction plates **24** and counter plates **25**, beginning and ending with a friction plate. The pack is sandwiched between two spacers **23** and **26**, and secured by circlip **22**. Retain these items as a set for assembly.

Note that the clutch housing cannot be removed from the shaft.

Discard all seals and O rings.

Inspection

Thoroughly clean all components. Ensure that all oil ways are clear.

Inspect generally for damage. Check for scoring inside the piston housing and at the oil feed end of the shaft. Polish out if necessary.

Check the operation of the non-return valve located in piston **30**.

Check the clutch pack for damage and excessive wear. Replace the complete set of friction and counter plates if necessary. Do not mix plates from different clutch packs.

Check the condition of brake disc **8**. Renew if necessary.

Assembly

Assembly is basically the reverse of the dismantling sequence, but please note the following.

Use new seals and O rings. Lightly oil components before installing them.

Pack the cavity between the lips of seal **13** with grease before assembly.

Thrust washer **28** should be installed using a bearing press, ensuring that the plate is pressed squarely onto its shoulder on the shaft. Ring **27** should similarly be installed using a bearing press.

When installing the clutch pack, ensure that the friction/counter plates are installed in the correct sequence, see **Dismantling**. Note that there are seven friction plates **24**, and six counter plates **25**. Use the pinion assembly **19** to align the inner teeth of the friction plates.

Lightly oil bearings **15**, **18** and **21** before installing and rotate them during setting.

After assembly, and using an airline, check that the clutch operates smoothly and that there is endfloat.

Measure the clutch pack end float using two screwdrivers as shown at **B**. The clutch pack endfloat should be 1.3 - 3.6 mm. If incorrect, check for damage, correct assembly and that the correct number of clutch plates have been installed. Note that shims are not necessary.

Fitting stake nut **4** may be easier performed after the clutch has been replaced in the gearbox, see **Removal and Replacement**.

Torque Settings

Item			
39	47-54 Nm	35-40 lbf ft	4.8-5.5 kgf m

Power Take Off Clutch

Dismantling and Assembly (cont'd)

Brake Operation

With the assembly mounted on the gearbox, check the operation of the clutch brake as follows:

With no electrical power or pressure connected, check that the coupling **6** is free to rotate.

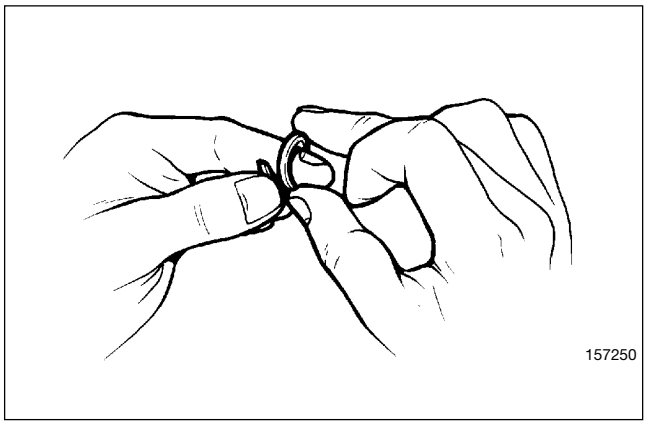
With air pressure connected to the solenoid valve **39** and the solenoid de-energised, check that the coupling cannot be rotated (i.e. brake on).

With air pressure connected and the solenoid energised, check that the coupling can be rotated back and forth as far as the gear backlash allows (i.e. brake off).

Note: The solenoid can be damaged if it is connected the wrong way round. Ensure correct polarity before applying power.

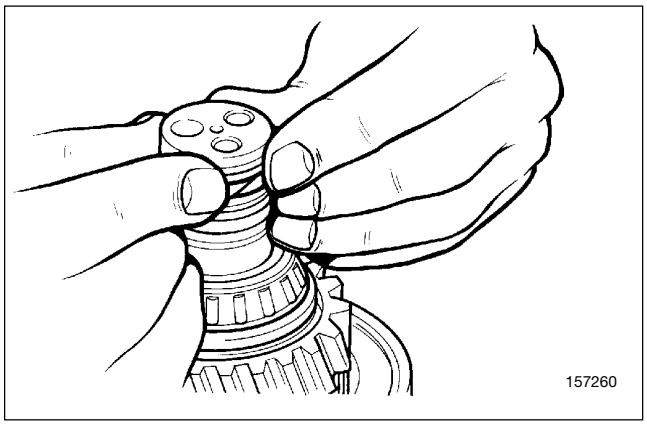
Piston Ring Seals - Fitting Procedure

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

The torque converter must be removed together with the syncro shuttle gearbox, refer to **Syncro Shuttle Gearbox - Removal and Replacement**.

Replacement

1 Ensure that flywheel face, drive plate, and hardware are clean and free from burrs or other surface imperfections.

2 Offer drive plate **1** to the torque converter.

3 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.

4 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**.

5 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 **3** to **5**.

6 Remove the torque converter and drive plate assembly from the flywheel.

7 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.

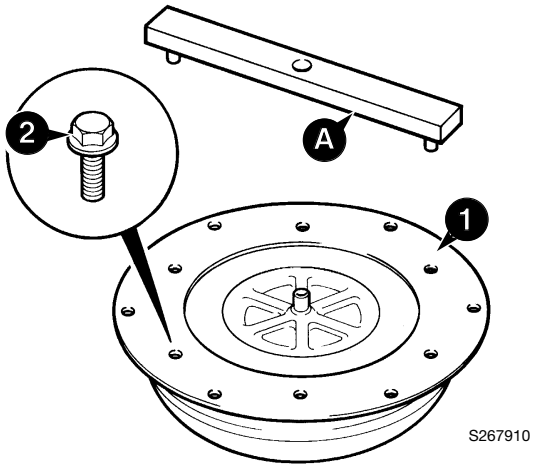
8 Rotate the engine flywheel so that one bolt hole is in a six O' clock position.

9 Rotate the torque converter and drive plate assembly so that one bolt hole is in a six O' clock position.

10 Install the transmission/torque converter assembly to the engine.

11 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

12 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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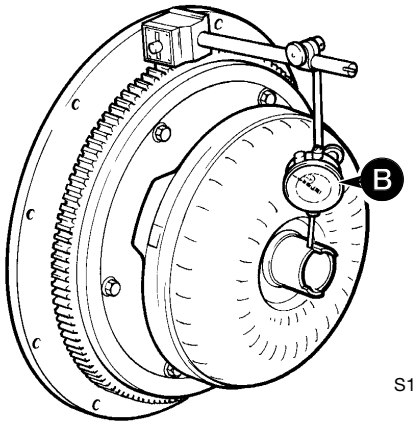

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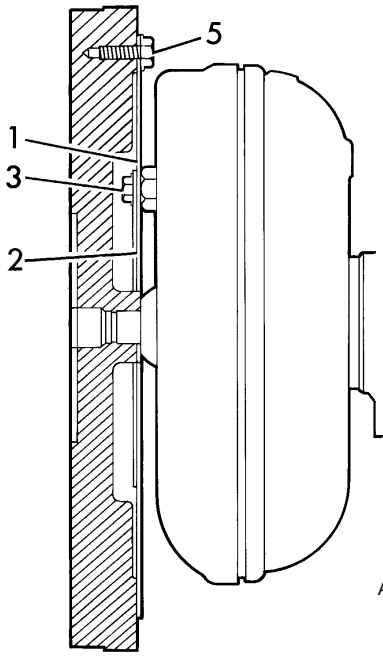

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