

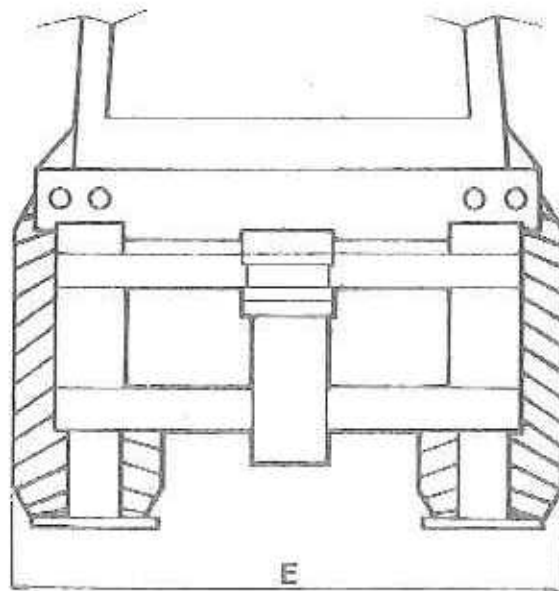
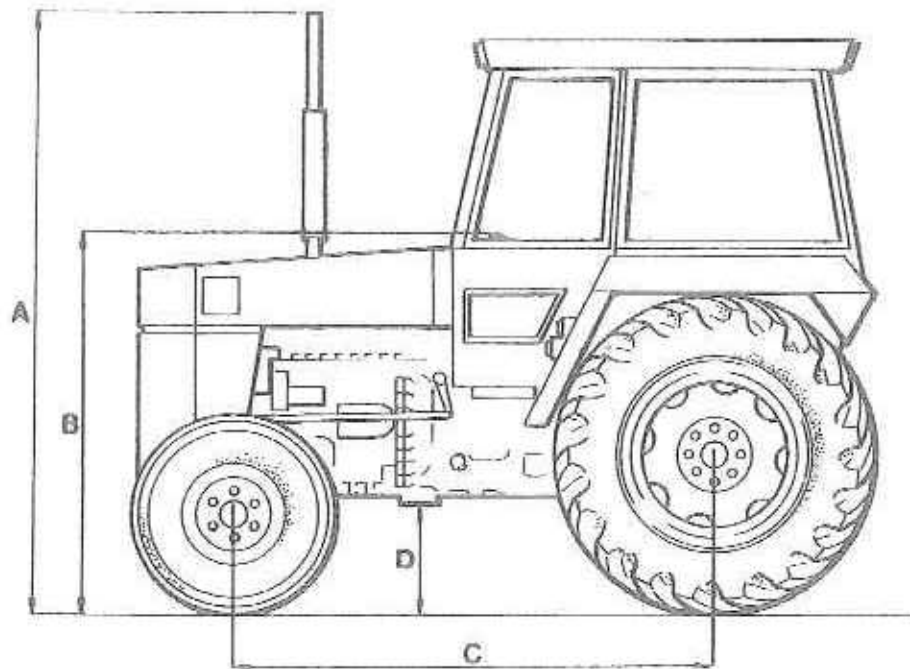
SPECIFICATIONS

CONTENTS

	PAGE
GENERAL DETAILS	4
SPECIFICATIONS:	
ENGINE	4
COOLING SYSTEM	5
ELECTRICAL SYSTEM	5
TRANSMISSION	5
ROAD SPEEDS	6
STEERING	6
BRAKES	7
CAPACITIES	7
GENERAL DETAILS	7
SPECIFICATIONS:	
WEIGHT	7
HYDRAULIC SYSTEM	8
ATTACHMENTS	8
GENERAL DETAILS	8
SPECIFICATIONS:	
HYDRAULIC SYSTEM	9
ATTACHMENTS	9

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	DIMENSIONAL DIAGRAM	4
2	DIMENSIONAL DIAGRAM	8
3	DIMENSIONAL DIAGRAM	9





SPECIFICATIONS

General

This section deals with the specification of the MF 50B Tractor. The tractor is available in two models, one with standard transmission and the other with reversomatic transmission. The reversomatic transmission incorporates a torque converter in place of the usual clutch. The torque converter is operated by two pedals and produces either forward or reverse motion without rear reselection. This method allows rapid backward and forward shuttling between lorry and work pile. Standard equipment includes full power steering, five plate wet brakes, full lighting, heater and hazard warning lights.

Key to Fig 1

A	Overall height to exhaust	104" (2640 mm.)
B	Overall height over steering wheel	73" (1855 mm.)
C	Wheel base	81½" (2100 mm.)
D	Ground clearance	16" (406.4 mm.)
E	Overall width	82" (2085 mm.)

GENERAL

Total weight, with fuel, oil, water loader, digger and cab, less operator	13,300 lb. (6050 kg.)
---	-----------------------

ENGINE

Maker	Perkins — to M.F. Specifications
Type and Model	Diesel A4.212 — Direct Injection
Number of Cylinders	4
Bore	3.875 (98.43 mm.)
Stroke	4.5 in. (114.3 mm.)
Capacity	212 cu. ins. (3.47 litres)
Compression Ratio	15.5:1
Firing Order	1, 3, 4, 2.
B.H.P. Governed Speed	62 at 2,000 rpm
Maximum Torque	173 lb/ft (23.7 kg/m) at 1250 rpm.
Lubrication	System Pressure 50 - 65 p.s.i. (3.515 - 4.75 kg/cm ²). Replacement cartridge type, oil filter, full flow external, Overhead type
Valves	
Working Valve Tip Clearance	
Inlet	0.012 in. (0.30 mm.) cold
Exhaust	0.010 in. (0.25 mm.) hot
Fuel Lift Pump	A.C. Delco
Fuel Filters	Two with replaceable elements. Primary incorporates transparent sediment bowl.
Injection Pump	C.A.V. Distributor type fitted with mechanical governor.
Fuel Injectors	C.A.V. type nozzles and nozzle holders. Injection timing 22° B.T.D.C. Working Pressure, 170 A.T.S. Initial Setting (New Injector) 175 A.T.S. C.A.V. Thermostart Mark IIIC. Dry element, removable for cleaning.
Easy Starting Aid	
Air Cleaner	

GENERAL . . . Cont'd

COOLING SYSTEM

System Pressure

10 p.s.i. (0.703 kg/cm²).

Circulation assisted by centrifugal pump driving a cooling fan.

Normal Temperature

170° - 180°F (76.7° - 82.2°C)

Fan Belt Deflection

¾ in (19 mm) midway between fan pulley and crankshaft pulley.

ELECTRICAL SYSTEM

Voltage

12 volt - NEGATIVE EARTH.

Battery

12 volt Heavy Duty

96 amp hour in 20 hours (Standard Transmission).

12 volt Heavy Duty 125 amp hour, (Reversomatic Transmission).

Starter Motor

Lucas M50 Solenoid engaged pinion.

Alternator

Lucas 18 A.C.R.

Lights

Front and Rear worklamps fitted as integral part of cab.

Headlights

Panel Lights

Interior Lights

Side Lights

Indicator Lights

Tail Lights

Number Plate Lights

Front windscreen wiper

Rear wiper optional

Cab

Heater

TRANSMISSION

Standard Range

Single clutch Laycock Spicer (composite) 12 in. drive disc, coil spring operated.

Dual Range

Constant mesh spur primary reduction gears with three speed forward and one reverse sliding spur gear compounded by a planetary reduction gear set on the output end of the mainshaft to provide 6 speeds forward and 2 reverse.

Planetary Reduction

3.14:1

Final Drive

Bevel drive with epicyclic final hub reduction gives a ratio of 10.88:1

Instant Reverse Transmission

Automatic shuttle transmission with hydraulically operated clutches for forward and reverse travel. Shuttle transmission comprises two speed sliding spur gear and 4:1 planetary reduction gear giving 4 speeds forward, 4 reverse. Two multi-plate clutch packs combine with a gear train so that engagement of forward clutch locks the input shaft to the output shaft and reverse clutch 'drive' and 'driven' plates are forced to counter rotate. Engagement of the reverse clutch locks the reverse gear to the output shaft creating drive from the input shaft, through the reverse idler and layshaft causing forward clutch 'drive' and 'driven' plates to counter rotate. Bevel drive with epicyclic final hub reduction giving a ratio of 10.9:1.

Final Drive

PART 1 SECTION A

MF WORKSHOP SERVICE MANUAL 1457 087 M1

GENERAL . . . Cont'd

ROAD SPEEDS

STANDARD TRANSMISSION

16.9/14 - 28 (10 Ply) Tyres
No allowance made for Tyre Slip.

SELECTED GEAR		2000 r.p.m.	
		m.p.h.	k.p.h.
LOW	1st	1.4	2.3
	2nd	2.1	3.4
	3rd	3.8	6.0
	Rev.	1.9	3.0
HIGH	1st	5.5	8.9
	2nd	8.3	13.3
	3rd	15.2	24.4
	Rev.	7.5	12.0

REVERSOMATIC TRANSMISSION

16.9/14 - 28 (10 Ply) Tyres
No allowance made for Tyre Slip.

SELECTED GEAR		2000 r.p.m.	
		m.p.h.	k.p.h.
FORWARD	1st	1.7	2.7
	2nd	4.6	7.4
	3rd	6.6	10.7
	4th	18.5	29.7
REVERSE	1st	1.7	2.7
	2nd	4.6	7.4
	3rd	6.6	10.7
	4th	18.5	29.7

STEERING

Type	Power Steering worm and peg with single Pitman arm.
Pump	Plessey
Relief Valve	1450 - 1600 p.s.i. (101.50 - 112.48 kg/cm ²).
Turning Circle Between Kerbs	27 ft. 5 in. (8360 mm).
Tyre Size	Front 9.00 x 16 (10 Ply) tubeless.
	Rear 16.9 x 14.28 (10 Ply) tubeless.
Tyre Pressure	Front 50 p.s.i. (3.52 kg/cm ²).
	Rear 26 p.s.i. (1.41 kg/cm ²).

GENERAL . . . Cont'd

BRAKES

Service Brake

Mechanically operated five plate disc brakes, fully enclosed, oil immersed.

Parking Brake (Duel Brakes)

Mechanical Linkage to 14 in. x 2 in. (35.5 cm x 5.08 cm) wheel drum brakes on each driven wheel.

CAPACITIES

Fuel Tank

17 Imp Gallons (20.4 U.S. Gallons; 77.3 litres).

Engine Sump (Inc. Filters)

Dipstick low :— 10% pints (1.575 U.S. Gallons; 5.98 litres).

full : — 16 pints (2.4 U.S. Gallons; 9.09 litres)

Transmission and Axle Standard

7.2 Imp. galls. (8.64 U.S. Gallons; 32.2 litres)

Instant Reverse

6.7 Imp. galls. (8.04 U.S. Gallons; 30.5 litres)

Torque Converter

2.1 Imp. galls. (2.52 U.S. Gallons; 9.55 litres), Reverso-matic Transmission.

Epicyclic Hubs

2 pints (0.3 U.S. Gallons; 1.14 litres)

Steering Gearbox

2 pints (0.3 U.S. Gallons; 1.14 litres)

Cooling System

3 Imp. galls. (3.6 U.S. Gallons; 13.64 litres)

Power Steering Reservoir

1½ pints (0.85 litres)

SPECIFICATIONS - DIGGER

General

The MF 50B Digger is designed for use with the 50B Tractor and 50B Loader.

The digger is operated by means of a seven spool valve. A reversible seat is incorporated on the 50B tractor and when swivelled round this seat becomes the digger control position. A platform around the tractor seat enables the operator to transfer to the digger control position quickly and safely.

KEY TO FIG. 2

A	Length from pivot post to centre rear axle	50"
B	Maximum digging reach from pivot	209"
C	Maximum height fully raised	130"
D	Transport height	122"
E	Clearance height maximum	123"
F	Bucket angular movement	190°
G	Maximum digging depth	169"
H	Width	81½"
J	Total slewing arc	186°
K	Maximum offset position	24½"
L	Maximum side reach, boom fully offset	230½"

WEIGHT

Basic weight digger unit plus spool valve and covers

3480 lb. (1579 kg)

GENERAL

WEIGHT . . . Cont'd

Weight of attaching sills, links and pins	258 lb. (117 kg).
Weight of foot well	110 lb. (50 kg).
Total weight of digger plus attachment parts, foot well and 24 in. (60 cm.) trench bucket	4209 lb. (1909 kg).

HYDRAULIC SYSTEM

Pump (Supplied with loader)	Dowty gear type, driven from front of engine crankshaft.
Pump Output	23.8 Imp. Gallons (28.5 U.S. Gallons; 108 litres) per minute at 2000 r.p.m.
System Pressure	2500 - 2650 p.s.i. (175 - 185 kg/sq.cm.).
System Capacity (including loader)	12 Imp. Gallons (14.4 U.S. Gallons; 5.4 litres).
System Capacity (excluding loader)	5½ Imp. Gallons (6 U.S. Gallons; 23.9 litres).

ATTACHMENTS

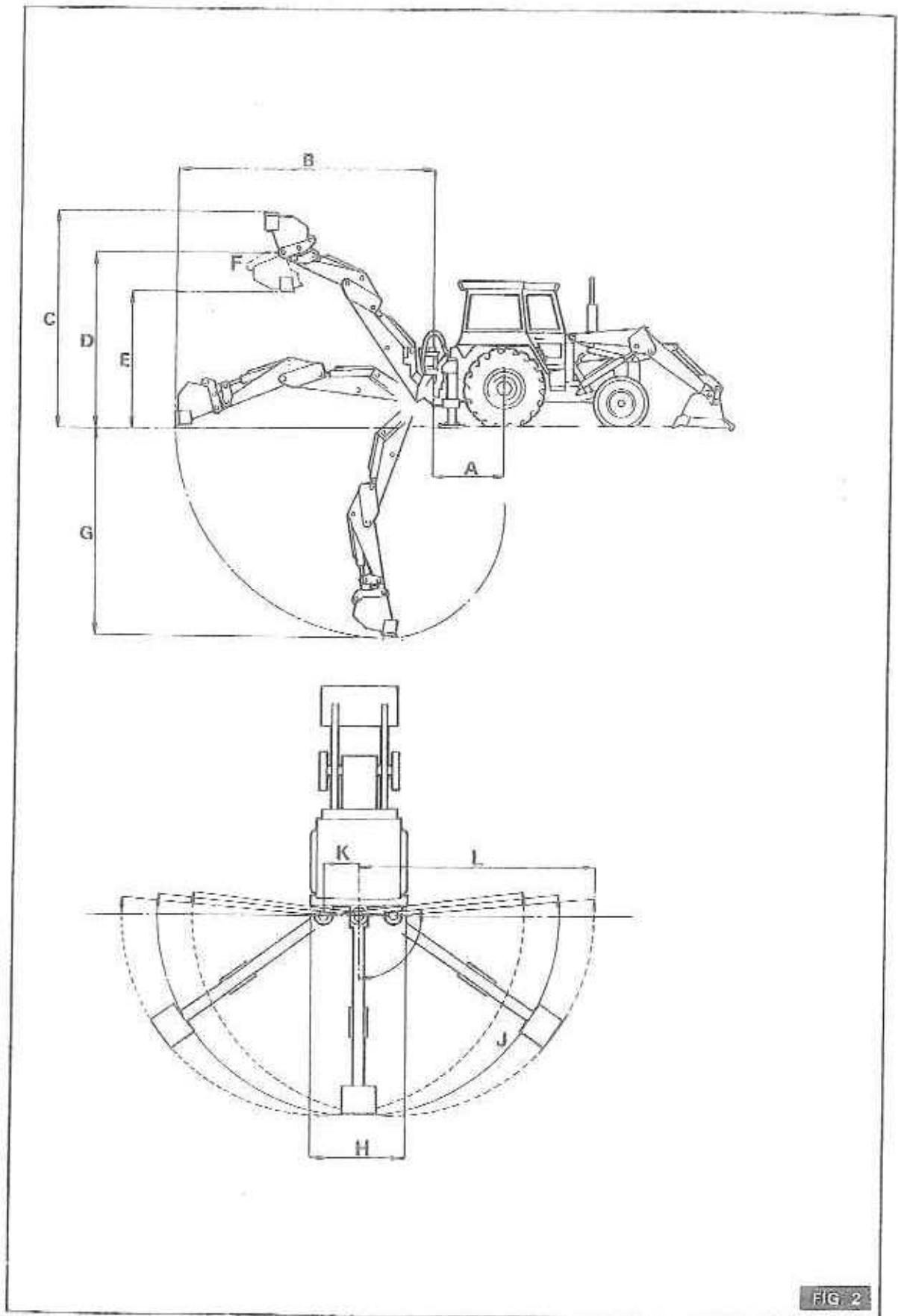
French Buckets						
Size (ins. and cms.)	12 (30)	18 (45)	24 (60)	30 (76)	36 (91)	42 (106)
Number of teeth	3	3	4	5	6	7
Weight (lbs.) (kgs.)	190 86	234 106	345 156	387 175	432 195	398 180
S.A.E. rated heaped capacity (cu. ft.)	(2.3)	(3.4)	(6.8)	(8.2)	(10.2)	(7.9)
Ditch Digging Bucket						
Size	Top 48" (121.9 cm.) Bottom 15" (38.1 cm)					
Number of teeth	3					
Weight	357 lbs. (162 kgs).					
S.A.E. rated heaped capacity (cu. ft.)	7 cu. ft. (0.198 cu.m.)					
Ditch Cleaning Bucket						
Size	48" (121.9 cm.)					
Extensions (2)	12 (30).					
Weight	342 lbs. (155 kgs.) with extensions					
Capacity	4 cu. ft. (0.113 cu. m.) without extensions.					

SPECIFICATIONS - LOADER

General

The MF 50B Loader is designed for use with the 50B Tractor and 50B Digger. The loader is operated by means of a two spool valve. The loader is fitted with a general purpose 1 cu. yd. (765 litres) capacity bucket. As an alternative a 4 in. 7/8 cu. yd. (669 litres) capacity bucket may be fitted.

The design of the bucket ram and linkage is such that the bucket can be completely filled during each cycle and as the bucket can be rolled back through 45° from the horizontal, it will remain full whilst the machine is moved to the unloading point.



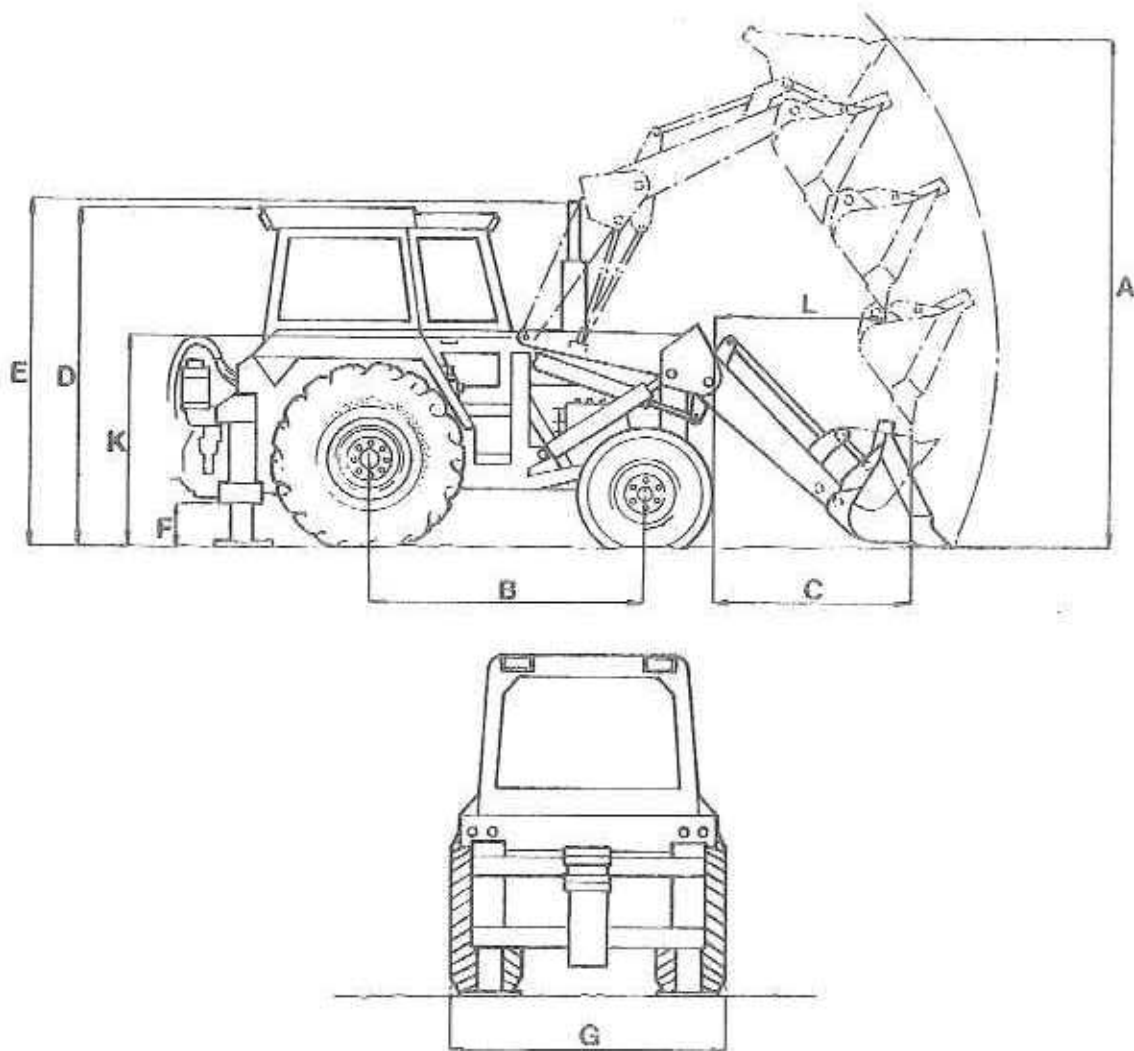


FIG 3

Key to Fig 3

A	Overall height, beam raised bucket crowded	165½" (420.4 mm)
B	Wheel base	81½" (207 mm)
C	Maximum reach when bucket dumped at 45°	64" (162.6 mm)
D	Overall height, to top of cab	101½" (254.8 mm)
E	Overall height, without cab	104½" (265.4 mm)
F	Ground Clearance Minimum	10½" (26.7 mm)
G	Overall width, less bucket	84" (213.3 mm)

GENERAL

Lift capacity at full height with bucket	4670 lb. (2120 kg)
Breakout force	7650 lb. (3445 kg)
Maximum lift capacity (SAE to full height, with bucket)	4670 lb. (2120 kg)
Breakout force (SAE)	7650 lb. (3445 kg)
Cycle times:	
Raise to full height	4.3 secs.
Lower time (power)	3.0 secs.
Bucket dump time	1.2 secs.
Bucket crowd time	1.5 secs.

HYDRAULIC SYSTEM

Pump	Dowty gear type, driven from front of engine crankshaft.
Pump Output	23.8 Imp. Gallons (28.5 U.S. Gallons; 108 litres) per minute at 2000 r.p.m.
System Pressure	2500 - 2650 p.s.i. (175 - 185 kg/sq.cm.)
System Capacity (including digger)	12 Imp. Gallons (14.4 U.S. Gallons; 5.4 litres)
System Capacity (excluding digger)	6½ Imp. Gallons (8.1 U.S. Gallons; 30.7 litres)
Filter Type	Full flow with renewable paper element.

ATTACHMENTS

Drott 4 in. 1 Bucket width	80" (203 cm.)
S.A.E. Heaped Capacity	7/8 cu.yd. (1.145 cu.m.)
Number of teeth	7
Weight	1000 lb. (454 kg)
General Purpose Bucket	
Width	83 ¾" (213 cm)
S.A.E. Heaped Capacity	27 cu. ft. (3.924 cu. m.)
Number of teeth	8
Weight	689 lb. (312.4 kg)

ENGINE REMOVAL AND INSTALLATION



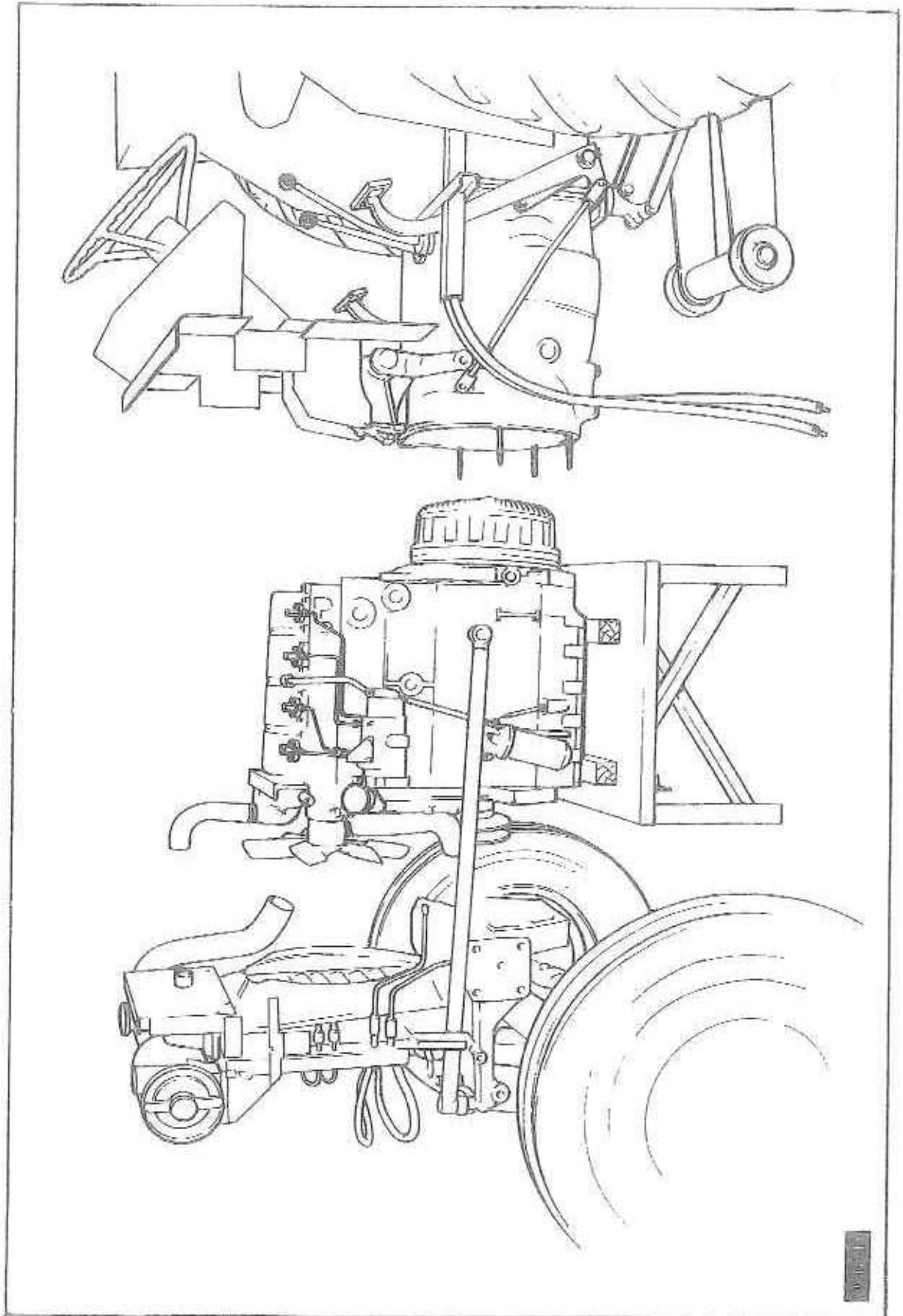
CONTENTS

	PAGE
ENGINE, Removal	4
ENGINE, Refitting	4

LIST OF ILLUSTRATIONS

Facing
Page

Fig 1	ENGINE, Removal	4
-------	---------------------------	---



PART 2 SECTION A

MF WORKSHOP SERVICE MANUAL 1457 087 M1

A4-212 DIESEL ENGINE

Removal

(2A/1)

1. The operations in this section assume that the cab, digger and loader have been removed from the machine.
2. Remove the hood assembly.
3. Insert wooden wedges between the upper side of the axle and the axle support casting.
4. Remove the drag link from the steering box drop arm.
5. Remove the sump drain plug and drain the engine oil. Refit the drain plug.
6. Remove the oil filter centre securing bolt and remove the filter container and filter.
7. Drain the water from the cylinder block, heater and radiator.
8. Release the fuel tank rear mountings.
9. Position the rails of dismantling stand MF 27X and support the engine sump and transmission housing on rail trolleys.
10. Disconnect the battery leads.
11. Disconnect the wiring from the thermostart, starter motor, alternator, horn, lights and neutral safety switch.
12. Disconnect heater hoses at the water pump.
13. Disconnect the water temperature gauge wire, oil pressure gauge pipe, tachometer cable, tube from the air filter restriction indicator, fuel sender unit wire.
14. Disconnect the fuel cut-off cable.
15. Release all harness securing clips.
16. Switch off the fuel and disconnect the fuel pipes at the injection pump.
17. Disconnect the fuel pipe between the primary and secondary fuel filters.
18. Disconnect the throttle control rod from the injection pump.
19. Remove the starter motor.
20. Remove the filler and drain plugs and drain the torque converter and instant reverse transmission. Replace the filler and drain plugs in the transmission case.
21. Remove the hydraulic pipes from the transmission case to the oil filter and oil cooler, and the pipes from the oil cooler to the transmission.
22. Remove two bolts securing the torque converter oil filter to the transmission case.
23. Disconnect the torque converter oil thermo unit on the transmission case.
24. Disconnect the torque converter oil pressure gauge pipe.
25. Remove two bolts and spring washers securing the steering box to the engine.
26. Remove the bolts securing the engine to the transmission housing.
27. Push the rear part of the machine out of engagement with the engine.
28. (Fig. 1) Fit support stand MF 27G to the front of the transmission housing and secure with two bolts each side.
29. Support the engine on a table and separate the front axle from the engine as described in operation.

Refitting

(2A/2)

1. Refit the front axle assembly to the engine as described in operation.
2. Support the transmission on a rail trolley.
3. Remove support stand MF 27G from the front of the transmission housing.
4. Wedge the rear part of the fuel tank in a slightly raised position.
5. Align the transmission with the engine then using guide studs join the two halves together.
6. Bolt the engine to the transmission housing and refit the starter motor.
7. Replace the two bolts and washers securing the steering box to the engine.
8. On instant reverse transmission machines connect the torque converter oil pressure gauge pipe.
9. Connect the torque converter oil thermo unit on the transmission case.
10. Refit the torque converter oil filter to the transmission case.
11. Replace the hydraulic pipes from the transmission case to the filter and oil cooler and from the oil cooler to the transmission case.
12. Remove the wedge from under the fuel tank and bolt the fuel tank to the tank support bracket.
13. Reconnect the fuel pipe between the primary and secondary fuel filters and the fuel pipes at the injection pump.

A4-212 DIESEL ENGINE

Refitting . . . Cont'd

14. Reconnect the throttle rod at the injection pump, fuel cut-off cable, tachometer cable, oil pressure pipe, water temperature gauge wire and blockage indicator tube.
15. Reconnect the wiring to the thermostart, alternator, starter motor, horn, lights, fuel sender unit and neutral safety switch. Connect battery leads.
16. Secure wiring harness with clips.
17. Reconnect the heater hoses at the water pump.
18. Clean the oil filter container, fit a new element, and sealing rings and refit the container to the engine.
19. Refill the torque converter and instant reverse transmission with oil of the correct grade up to the full level.
20. Refill the engine with oil up to the full mark on the dipstick.
21. Fit the drag link back onto the drop arm.
22. Remove the wooden wedges from between the axle and the axle support casting. Then remove the rail trolley.
23. Replace the hood assembly.
24. Open the fuel shut-off tap and bleed the fuel system.
25. Refill the engine cooling system with fresh water containing the correct amount of anti-freeze solution as required.



GENERAL INFORMATION

CONTENTS

Technical Data—Engine Manufacturing Data and Dimensions

	PAGE
Cylinder Block	4
Cylinder Liners	4
Pistons	5
Piston Rings	5
Gudgeon Pin	5
Small End Bush	5
Connecting Rod	6
Connecting Rod Alignment	6
Crankshaft	6
Crankshaft Thrust Washers	6
Main Bearings	7
Connecting Rod Bearings	7
Camshaft	7
Camshaft Thrust Washer	7
Cylinder Head	8
Exhaust Valves	8
Inlet Valves	8
Inner Valve Springs	8
Outer Valve Springs	8
Tappets	8
Rocker Shaft	9
Rocker Levers	9
Valve Clearances	9
Timing Gears	
Camshaft Gear	9
Fuel Pump Gear	9
Idler Gear and Hub	9
Crankshaft Gear	9
Timing Gear Backlash	9
Lubrication System	9
Sump	9
Oil Pump	9
Pump Clearances	10
Oil Pump Drive Gear	10
Oil Pump Idler Gear	10
Relief Valve	10
Lubricating Oil Filter	10
Cooling System	
Type of Cooling System	10
Thermostat	10
Water Pump	11
Fuel System	11
Fuel Lift Pump	11
Secondary Fuel Filter	11
Fuel Injection Pump	11
Static Timing Position	11
Atomisers	11
Alternator	11
Starter Motor	11
Service Wear Limits	12

Contents Cont'd

General Data

	PAGE
Cooling System	12
Front Axle	12
Steering	12
Transmission Standard	12
Single Clutch	12
Instant Reverse Transmission	13
Oil Pump	13
Oil Distribution Housing	13
Clutch Packs	13
Torque Converter	13
Planetary Pinion Carrier	13
Epicyclic Carrier Bearing	13
Wheel Axle and Drive Cover	13
Differential Bearing Pre-Load	14
Disc Brake	14
Drum Brake	14
Hydraulic Pump	14
Two Spool Control Valve	14
Seven Spool Control Valve	14
Rotary Actuator	15
Loader Lift Ram	15
Loader Bucket Ram	15
Digger Boom Ram	15
Digger Bucket Ram	15
Stabilizer Ram	15
Torque Settings	15

TECHNICAL DATA

Bore	3.875 in (98,43 mm)
Stroke	4.5 in (114,3 mm)
No. of Cylinders	Four
Cubic Capacity	212 in ³ (3,47 litres)
Compression Ratio	15.5 : 1
Firing Order	1, 3, 4, 2
Cycle	Four Stroke
Combustion System	Direct Injection

Recommended Torque Tensions

Cylinder Head nuts	90 lbf. ft (12,4 kg f m)
Connecting Rod nuts	65-70 lb ft (8,99-9,68 kg m)
Main Bearing Setscrews	140-150 lb ft (19,35-20,74 kg m)
Idle Gear hub nuts	21-24 lb ft (2,8-3,32 kg m)
Flywheel setscrews	60 lb ft (11 kg m)
Camshaft Gear retaining setscrew	45-50 lb ft (6,23-6,91 kg m)
Crankshaft dog nut or retaining screw	280-300 lb ft (37,0-41,48 kg m)
Lub. Oil Filter setscrew	26-30 lb ft (3,6-4,15 kg m)
Atomiser Securing nuts	10-12 lb ft (3,6-4,15 kg m)
Dynamo Pulley Retaining nuts	15-20 lb ft (2,1-2,8 kg m)

MANUFACTURING DATA AND DIMENSIONS

Total Height of Cylinder Block between Top and Bottom Faces	17.367/17.375 in (441,12/441,33 mm)
Parent Bore Dia: for Cylinder Liner (Chrome Thin Wall)	3.9825/3.9835 in (100,65/100,67 mm)
Parent Bore Dia for Cylinder Liner (Chrome Thick Wall)	4.0625/4.0635 in (103,19/103,22 mm)
Parent Bore Dia. for Flangeless Cylinder Liner (Cast Iron)	4.0615/4.0625 in (103,16/103,19 mm)
Parent Bore Dia. for Flanged Cylinder Liner (Cast Iron)	4.0625/4.0635 in (103,19/103,22 mm)
Depth of Recess for Liner Flange (Chrome Thin Wall) early type	0.046/0.049 in (1,17/1,25 mm)
Depth of Recess for Liner Flange (Chrome Thin Wall) later type	0.049/0.051 in (1,25/1,30 mm)
Depth of Recess for Liner Flange (Chrome) Thick Wall	0.150/0.152 in (3,81/3,86 mm)
Main Bearing Parent Bore Dia.	3.166/3.167 in (80,42/80,44 mm)
Camshaft Bore Dia. No. 1	2.000/2.001 in (5,08/50,83 mm)
Camshaft Bore Dia. No. 2	1.990/1.9918 in (50,55/50,59 mm)
Camshaft Bore Dia. No. 3	1.970/1.9718 in (50,04/50,08 mm)

Cylinder Liners

Outside Dia. Of Flangeless (Production) Cylinder Liner	4.0655/4.0685 in (103,26/103,29 mm)
Outside Dia. of Flanged (Production) Cylinder Liner	4.0645/4.0655 in (103,24/103,26 mm)
Outside Dia. of Flanged (Pre-finished Service) Cylinder Liner	4.0625/4.0635 in (103,19/103,21 mm)
Interference Fit of Flangeless (Production) Liner in Cylinder Block Parent Bore	0.003/0.005 in (0,08/0,13 mm)
Interference Fit of Flanged (Production) Liner in Cylinder Block Parent Bore	0.001/0.003 in (0,025/0,08 mm)
Transition Fit of (Pre-finished Service) Liner in Cylinder Block Parent Bore	± 0.001 in (± 0,025 mm)
Finished Bore Dia. for Flangeless (Production) Cylinder Liner	3.877/3.878 in (98,48/98,50 mm)

Cylinder Liners Cont'd

Finished Bore Dia. for Flanged (Production) Cylinder Liner	3.877/3.878 in (98,48/98,50 mm)
Finished Bore Dia. for Flanged (Pre-finished Service)	
Cylinder Liner	3.878/3.879 in (98,50/98,52 mm)
Height of Liner above Cylinder Block Face (All Types)	0.030/0.035 in (0,76/0,89 mm)
Maximum Oversize (Rebore) Flangeless Liner	+ 0.030 in (+ 0,76 mm)
Overall Length of Liner (Flangeless)	9.005/9.015 in (228,7/229 mm)
Overall Length of Liner (Flanged)	8,941/8,954 in (227,10/227,43 mm)

Pistons

Type	Cavity in Crown
Overall Height (Skirt to Crown)	5.030 in (127,76 mm)
Centre Line of Gudgeon Pin to Piston Crown	3.0275/3.0325 in (76,90/76,03 mm)
Piston Skirt Dia. (Across Thrust)	3.8705/3.8715 in (98,31/98,34 mm)
Piston Crown Dia. (Across Thrust)	3.8500/3.8530 in (97,79/97,87 mm)
Piston to Bore Clearance (Across Thrust)	0.0053/0.0073 in (0,13/0,19 mm)
Piston Height in Relation to Cylinder Block	0.015/0.021 in (0,38/0,53 mm)
Bore Dia. for Gudgeon Pin	1.37485/1.37505 in (34,92/34,93 mm)
Compression Ring Groove Width, Numbers 1,2 & 3	0.0957/0.0967 in (2,43/2,46 mm)
Scraper Ring Groove Width, Number 4	0.2525/0.2535 in (6,41/6,44 mm)
Weight of Piston	2 lbs 14 ozs (1,304 kg)

Piston Rings

Top Compression	Chromium Plated
Second Compression	Cast Iron—Plain
Third Compression	Internally Stepped
Compression Ring Width—Number 1	0.0927/0.0937 in (2,35/2,38 mm)
Compression Ring Widths—Numbers 2 and 3	0.0928/0.0938 in (2,36/2,38 mm)
Ring Clearance in Groove—Number 1	0.002/0.004 in (0,05/0,10 mm)
Ring Clearance in Groove—Numbers 2 and 3	0.0019/0.0039 in (0,05/0,10 mm)
Ring Gap—Number 1	0.016/0.021 in (0,41/0,53 mm)
Ring Gap—Numbers 2 and 3	0.012/0.017 in (0,30/0,43 mm)

The above ring gaps are for a bore dia. of 3.877 in (98,48 mm). In practice, for every 0.001 in (0,025 mm) difference in cylinder bore diameter from 3.877 in, then 0.003 in (0,076 mm) in ring gap should be allowed.

Gudgeon Pin

Type	Fully Floating
Outside Dia. of Gudgeon Pin	1.3748/1.375 in (34,92/34,93 mm)
Length of Gudgeon Pin	3.297/3.312 in (83,74/84,12 mm)
Fit in Piston Boss	Transition

Small End Bush

Type	Steel Backed, Lead Bronze Lined
Outside Dia. of Small End Bush	1.535/1.5365 in (39,99/39,03 mm)

Small End Bush Cont'd

Length of Small End Bush	1.326/1.336 in (33,68/33,93 mm)
Inside Dia. before Reaming	1.359/1.363 in (34,52/34,62 mm)
Inside Dia. after Reaming	1.37575/1.3765 in (34,94/34,96 mm)
Clearance between Small End Bush and Gudgeon Pin	0.00075/0.0017 in (0,02/0,04 mm)

Connecting Rod

Type	"H" Section
Cap location to Connecting Rod	Serrations
Big End Parent Bore Dia.	2.6460/2.6466 in (67,21/67,22 mm)
Small End Parent Bore Dia.	1.53125/1.53225 in (38,90/38,92 mm)
Length from centre line of Big End to centre line of Small End	8.624/8.626 in (219,05/219,10 mm)
Big End Width	1.577/1.579 in (40,00/40,11 mm)
Connecting Rod End float on Crankpin	0.0085/0.0145 in (0,24/0,37 mm)
Big End Bolt Dia.	0.500 in (12,7 mm)
Thread of Bolt	U. N. F.

Connecting Rod Alignment

Large and small end bores must be square and parallel with each other within the limits of ± 0.010 in (0,25 mm) measured 5 in (127 mm) each side of the axis of the rod with the small end bush fitted, the limit of ± 0.010 in (0,25 mm) is reduced to 0.0025 in (0,06 mm).

Crankshaft

Overall Length	24.01/24.04 in (609,85/620 mm)
Main Journal Dia.	2.9985/2.999 in (76,16/76,18 mm)
Main Journal Length—No. 1	1.453/1.473 in (36,91/37,41 mm)
Main Journal Length Nos. 2, 4 and 5	1.545/1.549 in (39,24/39,34 mm)
*Main Journal Length—No. 3	1.738/1.741 in (44,15/44,22 mm)
*Main Journal Fillet Radii	0.145/0.156 in (3,68/3,96 mm)
Crankpin Dia.	2.489/2.4905 in (63,48/63,49 mm)
Crankpin Length	1.5885/1.5915 in (40,35/40,42 mm)
*Crankpin Fillet Radii	0.145/0.156 in (3,68/3,96 mm)
*Surface Finish—All Journals	16 micro inches (0,4 microns)
Main Journal and Crankpin Regrind Undersizes	—0.010, 0.020 and 0.030 in (—0,25, 0,51 and 0,76 mm)
Oil Seal Helix Dia.	3.124/3.125 in (79,35/79,38 mm)
Oil Seal Helix Width	0.050/0.080 in (1,27/2,03 mm)
Oil Seal Helix Depth	0.004/0.008 in (0,10/0,20 mm)
Flange Dia.	5.248/5.250 in (133,30/133,35 mm)
Flange Width	0.500 in (12,70 mm)
Spigot Bearing Recess Depth	0.781 in (19,84 mm)
Spigot Bearing Recess Bore	1.8497/1.8502 in (46,98/47,00 mm)
Crankshaft End Float	0.002/0.015 in (0,05/0,38 mm)

*Fillet radii and surface finish must be maintained during crankshaft regrinding. Length of No. 3 main journal not to exceed 1.759 in (44,68 mm) after regrinding. Width of crankpins must not exceed 1.635 in (41,53 mm) after regrinding. Where necessary use oversize thrust washers to suit.

Crankshaft Thrust Washers

Type	Steel Backed, Aluminium Tin or Lead Bronze Faced
Position in Engine	Centre Main Bearing

Crankshaft Thrust Washers Cont'd

Thrust Washer Thickness (STD)	0.089/0.093 in (2,26/2,36 mm)
Thrust Washer Thickness (O/S)	0.0965/0.1005 in (2,45/2,55 mm)
Thrust Washer Outside Dia.	4.088/4.098 in (103,84/104,90 mm)
Thrust Washer Inside Dia.	3.420/3.430 in (86,87/87,12 mm)

Main Bearings

Type	Pre-finished, Steel Backed, Aluminium Tin Faced
Shell Width—Nos. 1,2,4, and 5	1.245/1.255 in (31,62/31,88 mm)
Shell Width—No. 3	1.435/1.445 in (36,45/36,70 mm)
Outside Dia. of Main Bearing	3.167 in (80,41 mm)
Inside Dia. of Main Bearing	3.0015/3.003 in (76,24/76,28 mm)
Main Bearing Running Clearance	0.0025/0.0045 in (0,06/0,11 mm)
Steel Thickness	0.070 in (1,78 mm)
Aluminium Thickness	0.012/0.0125 in (0,030/0,32 mm)

Connecting Rod Bearings

Type	Pre-Finished, Steel Backed, Aluminium Tin Faced
Shell Width	1.245/1.255 in (31,62/31,88 mm)
Outside Dia. of Con. Rod Bearing	2.6465 in (67,22 mm)
Inside Dia. of Con. Rod Bearing	2.501/2.502 in (63,53/63,55 mm)
Con. Rod Bearing Running Clearance	0.0015/0.003 in (0,04/0,08 mm)
Steel Thickness	0.050 in (1,27 mm)
Aluminium Thickness	0.02225/0.0225 in (0,56/0,57 mm)

Camshaft

No. 1 Journal Length	1.2105 in (30,75 mm)
No. 1 Journal Dia.	1.9965/1.9975 in (50,71/50,74 mm)
No. 1 Cylinder Block Camshaft Bore Dia.	2.000/2.001 in (50,8/50,83 mm)
No. 1 Journal Running Clearance	0.0025/0.0045 in (0,06/0,11 mm)
No. 2 Journal Length	1.625 in (41,27 mm)
No. 2 Journal Dia.	1.9865/1.9875 in (50,46/50,48 mm)
No. 2 Cylinder Block Camshaft Bore Dia.	1.990/1.992 in (50,55/50,60 mm)
No. 2 Journal Running Clearance	0.0025/0.0053 in (0,06/0,14 mm)
No. 3 Journal Length	1.1875 in (30,16 mm)
No. 3 Journal Dia.	1.9665/1.9675 in (49,95/49,98 mm)
No. 3 Cylinder Block Camshaft Bore Dia.	1.970/1.972 in (50,04/50,09 mm)
No. 3 Journal Running Clearance	0.0025/0.0053 in (0,06/0,14 mm)
Cam Lift	0.3035 in (7,73 mm)
Oilways for Rocker Shaft Lubrication	No. 2 Journal

Camshaft Thrust Washer

Type	360°
Thrust Washer Outside Dia.	2.872/2.874 in (72,95/73,00 mm)
Cylinder Block Recess Dia. for Thrust Washer	2.875/2.885 in (73,03/73,28 mm)
Clearance Fit of Washer in Recess	0.001/0.013 in (0,03/0,33 mm)
Thrust Washer Inside Dia.	1.75 in (44,45 mm)
Thrust Washer Thickness	0.216/0.218 in (5,47/5,54 mm)
Cylinder Block Recess Depth for Thrust Washer (Later Type)	0.187/0.190 in (4,75/4,83 mm)
Thrust Washer Protrusion beyond Cylinder Block Front Face (Later Type)	0.026/0.031 in (0,66/0,79 mm)
Camshaft End Float	0.004/0.016 in (0,10/0,41 mm)

Cylinder Head

Cylinder Head Length	19.875 in (454,02 mm)
Cylinder Head Depth	4.0625 in $\pm$ 0.15 in (103,20 mm $\pm$ 0,38 mm)
Skimming allowance on Cylinder Head Face	0.012 in (0,30 mm)
Min. Cylinder Head Depth after Skimming	4.0355 in (102,51 mm)*
Max. Nozzle Protrusion after Skimming	0.175 in (4,44 mm)
Leak Test Pressure	30 lb/in ² (2.11 kgf/cm ²)
Valve Seat Angle	45°
Valve Bore in Cylinder Head	0.3745/0.37525 in (9,51/9,53 mm)

*Minimum Cylinder Head Depth quoted is nominal and Skimming Allowance must be governed by the Maximum Nozzle Protrusion Permissible.

Exhaust Valves

Valve Stem Dia.	0.372/0.37275 in (9,45/9,47 mm)
Clearance Fit of Valve in Guide	0.00175/0.00325 in (0,04/0,08 mm)
Valve Head Dia.	1.438/1.442 in (36,54/36,64 mm)
Valve Face Angle	45°
Valve Head Depth below Cylinder Head Face	0.029 in (0,74 mm) Minimum 0.055 in (1,40 mm) Maximum
Overall Length of Valve	4.845/4.862 in (123,03/123,54 mm)
Service Valve Stem Oversizes	0.015 and 0.030 in (0,38 and 0,76 mm)
Sealing Arrangement	Rubber Deflectors (Low Rated Engines only)

Inlet Valves

Valve Stem Dia.	0.3725/0.3735 in (9,46/9,48 mm)
Clearance Fit of Valve in Guide	0.0015/0.0035 in (0,04/0,09 mm)
Valve Head Dia.	1.742/1.746 in (44,25/44,36 mm)
Valve Face Angle	45°
Valve Head Depth below Cylinder Head Face	0.035 in (0,89 mm) Minimum 0.061 in (1,55 mm) Maximum
Overall Length of Valve	4.830/4.845 in (122,9/123,03 mm)
Service Valve Stem Oversizes	0.015 and 0.030 in (0,38 and 0,76 mm)
Sealing Arrangement	Rubber Deflectors (High Rated Engines only)

Inner Valve Springs

Fitted Length	1.5625 in (39,7 mm)
Load at Fitted Length	15.4 lb $\pm$ 2lb (7 kg $\pm$ 0,91 kg)
Fitted Position	Damper Coils to Cylinder Head

Outer Valve Springs

Fitted Length	1.780 in (45,22 mm)
Load at Fitted Length	40 lb $\pm$ 2 lb (18,1 kg $\pm$ 0,91 kg)
Fitted Position	Damper Coils to Cylinder Head

Tappets

Overall Length	2.96875 in (75,41 mm)
Outside Dia. Tappet Shank	0.7475/0.7485 in (18,99/19,01 mm)
Cylinder Block Tappet Bore Dia.	0.750/0.75125 in (19,05/19,08 mm)
Tappet Running Clearance in Bore	0.0015/0.00375 in (0,04/0,09 mm)
Outside Dia. of Tappet Foot	1.1875 in (30,16 mm)

Rocker Shaft

Overall Length of Shaft	16.796 in (426,62 mm)
Outside Dia. of Shaft	0.7485/0.7495 in (19,01/19,04 mm)

Rocker Levers

Inside Dia. of Lever Bore	0.7505/0.7520 in (19,06/19,10 mm)
Lever Clearance on Rocker Shaft	0.001/0.0035 in (0,03/0,09 mm)

Valve Clearances

Clearances between Valve Stem and Rocker Lever	0.012 in (0,30 mm) Cold
--	-------------------------

TIMING GEARS

Camshaft Gear

Number of Teeth	56
Inside Dia. of Gear Boss	1.375/1.376 in (34,93/34,98 mm)
Outside Dia. of Camshaft Hub	1.3751/1.3757 in (34,93/34,95 mm)
Fit of Gear on Camshaft Hub	-0.0007/+0.0009 in (0,017/0,022 mm)

Fuel Pump Gear

Number of Teeth	56
Inside Dia. of Gear Bore	1.750/1.751 in (44,45/44,47 mm)
Fuel Pump Hub Dia.	1.748/1.7488 in (44,40/44,42 mm)

Idler Gear and Hub

Number of Teeth	83
Bore Dia. of Gear Bush (requires boring in situ)	1.9998/2.0007 in (50,79/50,82 mm)
Outside Dia. of Gear Hub	1.996/1.997 in (50,70/50,72 mm)
Running Clearance of Gear on Hub	0.0028/0.0047 in (0,07/0,12 mm)
Idler Gear Width including Bushes	1.1865/1.1875 in (30,14/30,16 mm)
Hub Width	1.1905/1.1935 in (30,24/30,31 mm)
Idler Gear End Float	0.003/0.007 in (0,08/0,18 mm)

Crankshaft Gear

Number of Teeth	28
Gear Bore	1.875/1.876 in (47,63/47,65 mm)
Crankshaft Dia. for Gear	1.8750/1.8755 in (47,63/47,64 mm)

Timing Gear Backlash

All Gears	0.003/0.006 in (0,08/0,15 mm)
---------------------	-------------------------------

LUBRICATION SYSTEM

Lubricating Oil Pressure	25 lb/in ² (1,76 kg/sq cm) minimum at normal working speed.
------------------------------------	---

Sump

Sump Capacity, Dipstick 'FULL'	16 pints (9,092 litres)
Dipstick Position	Left Hand Side
Strainer Location	On Suction Pipe of Lub. Oil Pump.

Oil Pump

Type of Pump	Rotor Type
No. of Lobes—Inner Rotor	Four or Three
No. of Lobes—Outer Rotor	Five or Four
Drive Position on Engine	By Idler Gear from Crankshaft Gear

Pump Clearances

Pump Part No. 41314054 (Concentric)

Inner Rotor to Outer Rotor	0.001/0.003 in (0,025/0,076 mm)
Inner Rotor End Clearance	0.0015/0.003 in (0,038/0,076 mm)
Outer Rotor End Clearance	0.0005/0.0025 in (0,013/0,076 mm)
Outer Rotor to Pump Body	0.001/0.003 in (0,025/0,076 mm)

Pump Part No. 41314061 (Hobourn Eaton)

Inner Rotor to Outer Rotor	0.001/0.006 in (0,025/0,152 mm)
Inner and Outer Rotor End Clearance	0.001/0.005 in (0,025/0,127 mm)
Outer Rotor to Pump Body	0.0055/0.010 in (0,139/0,254 mm)

Oil Pump Drive Gear

Number of Teeth	19
Inside Dia. of Gear Bore	0.497/0.4978 in (12,62/12,64 mm)
Outside Dia. of Oil Pump Shaft	0.4990/0.4995 in (12,67/12,69 mm)
Interference Fit of Gear on Shaft	0.0012/0.0025 in (0,03/0,06 mm)
Clearance between Drive and Pump Body	0.003/0.007 in (0,08/0,18 mm)

Oil Pump Idler Gear

Number of Teeth	20
Inside Dia. of Gear Bore	1.000/1.0012 in (25,40/25,43 mm)
Outside Dia. of Gear Bush	1.000/1.0008 in (25,40/25,42 mm)
Inside Dia. of Gear Bush	0.8750/0.8763 in (22,23/22,26 mm)
Outside Dia. of Idler Gear Shaft	0.8738/0.8742 in (22,19/22,20 mm)
Running Clearance of Gear on Shaft	0.0008/0.0026 in (0,02/0,07 mm)
Idler Gear End Float	0.002/0.016 in (0,05/0,41 mm)

Relief Valve

Type	Spring Loaded Plunger
Pressure setting	50/60 lbf/in ² (3,52/4,22 kgf/cm ²)
Length of Plunger	0.9375 in (23,81 mm)
Outside Dia. of Plunger	0.5585/0.5595 in (14,19/14,21 mm)
Inside Dia. of Valve Housing Bore	0.5605/0.5625 in (14,23/14,30 mm)
Clearance of Plunger in Bore	0.001/0.004 in (0,03/0,10 mm)
Outside Dia. of Spring	0.368/0.377 in (9,35/9,58 mm)
Spring—Free Length	1.5 in (38,10 mm)
Spring—Solid Length	0.754 in (19,15 mm)

Lubricating Oil Filter

Type of Filter	Full Flow
Element Type	Paper
By-Pass Valve Setting	Opens between 13/17 lbf/in ² (0,91/1,2 kgf/cm ²) pressure differential
Type of Valve	Spring Loaded Ball
Torque Tension for Filter Bowl Retaining Screw	15.0 lb ft (2,07 kgf m)

COOLING SYSTEM

Type of Cooling System

Cylinder Head	Water Pump Circulation
Cylinder Block	Thermo-Syphon
Engine Water Capacity (less radiator)	16.5 pints (9,36 litres)

Thermostat

Type	Bellows or Wax
Opening Temperature	170—180°F (77—83°C)
Fully open at	202°F (94°C)
Valve Lift	0.312/0.469 in (7,94/11,91 mm)

Water Pump

Type	Centrifugal
Outside Dia. of Shaft for Pulley	0.7501/0.7506 in (19,052/19,065 mm)
Inside Dia. of Pulley Bore	0.7500/0.7508 in (19,05/19,07 mm)
Transition Fit of Pulley on Shaft	0.0006/0.0007 in (0,015/0,018 mm)
Outside Dia. of Shaft for Impeller	0.6262/0.6267 in (15,90/15,92 mm)
Inside Dia. of Impeller Bore	0.6249/0.6257 in (15,87/15,89 mm)
Interference Fit of Impeller on Shaft	0.0005/0.0018 in (0,01/0,05 mm)
Outside Dia. of Impeller	3.094/3.096 in (78,58/78,63 mm)
Impeller Blade to Body Clearance	0.012/0.032 in (0,30/0,81 mm)
Water Pump Seal Type	Synthetic Rubber, Carbon Faced
Outside Dia. of Water Pump Seal	1.856/1.718 in (42,07/43,64 mm)
Inside Dia. of Seal for Impeller Shaft	0.678/0.684 in (17,22/17,37 mm)
Bearing Seal Type	Tallow Impregnated Felt
Bearing Seal Thickness	0.218 in (5,54 mm)
Outside Dia. of Seal	1.375 in (34,93 mm)
Inside Dia. of Seal	0.921 in (23,39 mm)

FUEL SYSTEM

Fuel Lift Pump

Type of Pump	A.C. Delco V.P. Series
Method of Drive	Eccentric on Camshaft
Delivery Pressure	2½–4½ lb/in ² (0,19/0,30 kg/cm ²)
Pump to Cylinder Block Gasket Thickness	0.025 in (0,64 mm)
Spring Colour Code	Green

Secondary Fuel Filter

Element Type	Paper
Valve Type	Gravity Vent Valve

Fuel Injection Pump

Make	C.A.V.
Type	D.P.A.
Pump Rotation	Clockwise
Plunger Dia.	8,5 mm
Timing Letter	'C'
No. 1 Cylinder Outlet	'W'

Static Timing Position

Piston Displacement	Static Timing
0.205 in (5,21 mm)	22°

Atomisers

Working Pressure	Setting Pressure
170	175

Alternator

Make	Lucas
Type	18 ACR

Starter Motor

Make	Lucas
Type	M50 Solenoid engaged pinion
No. of Teeth on Pinion	10/11

SERVICE WEAR LIMITS

The following "wear limits" indicate the condition when it is recommended that the respective items should be serviced or replaced:

Cylinder Head Bore—Transverse	0.003 in (0,08 mm)
Longitudinal	0.006 in (0,15 mm)
Maximum Bore Wear (when re-boring or new liners are necessary)	0.008 in (0,2 mm)
Crankshaft Main and Big End Journal wear, Ovality	0.0015 in (0,04 mm)
Maximum Crankshaft End Float	0.014 in (0,35 mm)
Valve Stem to Bore/Guide Clearance Inlet	0.005 in (0,13 mm)
Exhaust	0.006 in (0,15 mm)
Valve Head Thickness between run-out of Valve Seat and Face of Valve	1/32 in (0,79 mm)
Rocker Clearance on Rocker Shaft	0.005 in (0,13 mm)
Camshaft Journals—Ovality and Wear	0.002 in (0,05 mm)
Camshaft End Float	0.030 in (0,51 mm)
Idle Gear End Float	0.010 in (0,25 mm)

GENERAL DATA

Cooling System

System Pressure	10 p.s.i. (0,703 kg/cm ²)
Thermostat Opening Temperature	180°F (82°C)
Fan Belt Deflection	3/8 in (19 mm)
Water Pump Impeller Clearance	0.012 in—0.032 in (0,30 mm—0,81 mm)
Water Pump Pulley Nut Torque	55—60 lb ft (8,0—8,5 kg m)

Front Axle

Clearance between Axle and Support Bracket	0.003—0.010 in (0,076—0,254 mm)
Steering Arm Securing Nut Torque	90—100 lb ft (12,45—13,83 kg m)
Maximum Clearance between Steering Arm Lower Face and Top of Kingpin Housing	0.004 in (0,101 mm)
Stub Axle Retaining Nut Torque	60 lb ft (8,3 kg m)
Wheel Nut Torque	170 lb ft (23,5 kg m)
Axle Casting Bolt Torque	100—125 lb ft (13,83—17,28 kg m)
Axle Casting Float	0.010 in (0,25 mm)

Steering

Steering Arm and Cylinder End Float not to exceed	0.007 in (0,179 mm)
Shims are available in two sizes:	0.003—0.005 in (0,076—0,127 mm) 0.020—0.022 in (0,508—0,509 mm)
Control Valve End Float not to exceed	0.007 in (0,179 mm)

Transmission Standard

Reduction Unit Ratio	4:1
Rear Drive Shaft/Mainshaft End Float	0.015—0.100 in (0,38—2,54 mm)

Single Clutch

Friction Disc Diameter	12 in (30,48 cm)
Coil Springs Fitted Load	117 lb ± 5% (53,07 kg ± 5%)
Free Length (approx)	2.32 in (58,93 mm)
Release Levers, Height from Flywheel Face	4.406—4.469 (111,912—111,513 mm)

Single Clutch Cont'd

Clutch Pedal Free Travel	1 in (2,54 cm)
Flywheel Bolt Torque	75 lb ft (10,37 kg m)
Pedal Lever Pinch Bolt Torque	76-85 lb ft (10,51-11,76 kg m)

Instant Reverse Transmission

Clutch Pack Oil Pressure	160 p.s.i. (11,25 kg/sq cm)
Reduction Unit Ratio	4:1

Oil Pump

Oil Pump Bolt Torque	15-20 lb ft (2,07-2,77 kg m)
--------------------------------	------------------------------

Oil Distribution Housing

Oil Distribution Housing Bolt Torque	25-30 lb ft (3,46-4,15 kg m)
Sump Bolt Torque	45-60 lb ft (6,22-8,91 kg m)

Clutch Packs

Drive Plate Clearance	0.005 - 0.007 in (0,127-0,177 mm)
End Float	0.031-0.050 in (0,768-1,27 mm)

Torque Converter

Oil Working Temperature	180-210°F (82-99°C)
Stall Speed approximately	1350-1450 rpm
Maximum Torque Ratio	2.1:1
Temperature of Oil, not to exceed	250°F (121.1°C)
Securing Nuts Torque	22 lb ft (3,04 kg m)
Maximum Wear on Impeller Hubs	.125 in (3,175 mm)
Hub Securing Bolt Torque	8-10 lb ft (1,106 kg m)
Flywheel Setscrew Torque	70-80 lb ft (10,5-11,1 kg m)
Impeller Hub Run Out not to exceed	0.010 in. (0,154 mm)

Planetary Pinion Carrier

Planetary Pinion Shaft Socket Screw Torque	10-13 lb ft (1,38-1,79 kg m)
--	------------------------------

Epicyclic Carrier Bearing

Table of Shims Required to Adjust Pre-Load:

Gap measured by Feeler Gauges	Shim Thickness Required
0.001-0.005 in (0,0254-0,127 mm)	0.030 in (0,762 mm)
0.006-0.010 in (0,1524-0,254 mm)	0.025 in (0,635 mm)
0.011-0.015 in (0,2794-0,381 mm)	0.020 in (0,508 mm)
0.016-0.020 in (0,4064-0,508 mm)	0.015 in (0,381 mm)
0.021-0.025 in (0,5334-0,635 mm)	0.010 in (0,254 mm)
0.026-0.030 in (0,6604-0,762 mm)	0.005 in (0,127 mm)
0.031-0.035 in (0,7874-0,889 mm)	0 in (0 mm)

Shims are available in three sizes:-

0.005 in (0,127 mm), 0.010 in (0,254 mm), 0.015 in (0,381 mm)

Wheel Axle and Drive Cover

Table of Wheel Axle Snap Rings:

Snap rings are available in the following nine thicknesses:-

0.230 in/0.232 in (5,842/5,893 mm)	Marked 0
0.2321 in/0.234 in (5,895/5,944 mm)	Marked 1

Wheel Axle and Drive Cover Cont'd

0.2341 in/0.236 in (5,947/5,944 mm)	Marked 2
0.2361 in/0.238 in (5,997/6,045 mm)	Marked 3
0.2381 in/0.240 in (6,048/6,096 mm)	Marked 4
0.2401 in/0.242 in (6,099/6,147 mm)	Marked 5
0.2421 in/0.244 in (6,150/6,198 mm)	Marked 6
0.2441 in/0.246 in (6,201/6,248 mm)	Marked 7
0.2461 in/0.248 in (6,251/6,299 mm)	Marked 8

When assembled a maximum clearance of 0.001 in (0,0254 mm) is permissible between the snap ring and bearing cone.

Differential Bearing Pre-Load

Bearing Shields are available in five sizes as follows:

Shield Thickness	Means of Identification
0.029/0.031 in (0,737/0,787 mm)	No Dots
0.034/0.036 in (0,864/0,914 mm)	One Dot
0.039/0.041 in (0,991/1,041 mm)	Two Dots
0.044/0.046 in (1,118/1,168 mm)	Three Dots
0.049/0.051 in (1,245/1,295 mm)	Four Dots

Disc Brake

Pedal Free Travel Allowance	2 5/8 in (67 mm)
---------------------------------------	------------------

Drum Brake

Two Shoe Brakes—Total Lining Area	108 sq in (696 sq cm)
Size of each Brake Shoe	14 x 2 in (35,6 x 50,8 cm)
Renew linings when worn to within	1/16 in (1,59 mm) of shoe face.

Hydraulic Pump

Pump Output	23.8 imp gall/min (108,19 litres/min) at 2000 rpm
Hydraulic System Pressure	2500/2650 psi (175,7/186,3 kg/sq cm)
Bolt Securing End Cover to Pump—Torque	34–36 lb ft (4,7–4,98 kg m)

Two Spool Control Valve

Main Relief Valve set at	2500/2650 psi (175,7/186,3 kg/sq cm)
Shock Relief Valve—Bucket Ram Head Side set at	3000 lbs/in ² (210,9 kg m)
Shock Relief Valve—Bucket Ram Rod side set at	5000 lbs/in ² (351,5 kg m)
Shock Relief Valve—Lift Ram Head side set at	3500 lbs/in ² (246, kg m)
Shock Relief Valve—Lift Ram Rod side set at	5000 lbs/in ² (351,5 kg m)

Seven Spool Control Valve

Boom Direct Operated Relief Valve Pressures	3000 lbs/in ² (211,0 kg/cm ²)
	2750 lbs/in ² (193,3 kg/cm ²)
Slew Spool Operated Relief Valve Pressure	
Circuit Relief Valve	2000 lbs/in ² (140,6 kg/cm ²)
Dipperstick Ram Operated Relief Valve Pressures	3000 lbs/in ² (211,0 kg/cm ²)
	2750 lbs/in ² (193,3 kg/cm ²)
Bucket Ram Operated Relief Valve Pressures	2750 lbs/in ² (193,3 kg/cm ²)
	2750 lbs/in ² (193,3 kg/cm ²)

Seven Spool Control Valve Cont'd

Apex Tie Bolts Torque	20/25 lb ft (2,76/3,46 kg m)
Nests, to Tie Bolts, Torque	35/55 lb ft (4,84/7,60 kg m)

Rotary Actuator

Cap Screw Torque	200 lb ft (27,5 kg m)
Barrel Cap Screws Torque	87 lb ft (12 kg m)
Relief Valve Capsule Torque	55/60 lb ft (7,6/8,3 kg m)
Relief Valve Retainer Torque	10/15 lb ft (1,4/2 kg m)
The addition or subtraction of one 0.010 in shims will alter setting of Relief Valve approx.	
Relief Valve Torque	100 lb/in ² (7 kg f/cm ²)
Check Valve Torque	55/60 lb ft (7,6/8,3 kg m)
	60 lb ft (8,5 kg m)

Loader Lift Ram

Securing Nut Torque	300–330 lb ft (41,49–45,63 kg m)
Bearing Nut Torque	160–180 lb ft (22,13–24,89 kg m)

Loader Bucket Ram

Securing Nut Torque	250–275 lb ft (34,58–38,03 kg m)
Bearing Nut Torque	80–100 lb ft (11,06–13,83 kg m)

Digger Boom Ram

Securing Nut Torque	350–375 lb ft (48,4–51,86 kg m)
Bearing Nut Torque	275–300 lb ft (38,03–41,49 kg m)

Digger Bucket Ram

Securing Nut Torque	330–350 lb ft (41,49–48,4 kg m)
Bearing Nut Torque	200–220 lb ft (27,66–30,43 kg m)

Stabilizer Ram

Securing Nut Torque	300–330 lb ft (41,49–45,6 kg m)
Bearing Nut Torque	160–180 lb ft (22,13–24,89 kg m)

RECOMMENDED TORQUE SETTINGS

**TORQUING AND STRENGTH OF THREADED FASTENERS
CADMIUM OR ZINC PLATED**

The purpose of these notes is to establish the Specifications for proper tightening of nuts on bolts and studs, and to provide design strength data.

Column 'A'

Column 'A' specifies the spanner torques to be used with non-rigid joints where extrusion deformity or other damage would result when higher clamping forces are used; for weld nuts, slotted nuts or other limited strength nuts, and when lock washers are used under nuts.

Laboratory tests indicate that lock washers substantially reduce friction under the nut, this being especially true if the bolt, nut and lock washer are oiled.

Column 'B'

Column 'B' is the recommended spanner torque to be used for the assembly of rigid joints where extrusion, deformity or other damage will not result, and it is desirable to obtain more elastic elongation of the bolt or stud to ensure that it remains tight.

RECOMMENDED TORQUE SETTINGS' . . . , Cont'd

SPANNER TORQUE VALUES

NOMINAL SIZE	SPANNER TORQUE LB/FT	
	COLUMN A	COLUMN B
1/4	5-6	8-10
5/16	10-12	15-18
3/8	19-22	30-35
7/16	33-38	60-55
1/2	47-53	76-85
9/16	65-73	115-125
5/8	100-125	155-170
3/4	175-200	270-300

Unless specific torque figures are quoted, the above torque values will apply.

ENGINE



CONTENTS

	PAGE
GENERAL	6
OPERATION	6
VALVES	6
VALVE SEATS	6
VALVE SPRINGS	7
VALVE STEM BORES	7
THE LUBRICATION SYSTEM	7
THE ENGINE SUMP	8
LUBRICATING OIL FILTER	8
THE FULL FLOW FILTER	8
THE OIL PUMP	8
PISTONS AND CONNECTING RODS	8
PISTONS	9
CYLINDER LINERS	9
MAIN BEARING CAPS	9
MAIN BEARING LINERS	10
THE CRANKSHAFT	10
DATA	10
SERVICING	10
TO REMOVING CYLINDER HEAD (ENGINE IN SITU) (2B/1)	10
TO REMOVE CYLINDER HEAD (2B/2)	11
TO DISMANTLE THE ROCKER SHAFT ASSEMBLY (2B/3)	11
TO ASSEMBLE ROCKER SHAFT (2B/4)	11
TO ADJUST VALVE CLEARANCES (2B/5)	11
TO REMOVE VALVES (2B/6)	12
HAND GRINDING (2B/7)	12
TO FIT VALVE SEAT INSERTS (2B/8)	12
TO REPLACE THE VALVES (2B/9)	14
TO REPLACE THE CYLINDER HEAD (2B/10)	14
TO REMOVE AND REPLACE THE SUMP (2B/11)	14
TO REMOVE THE FILTER BOWL (2B/12)	14
TO REFIT THE FILTER BOWL (2B/13)	15
TO REMOVE AND REPLACE THE OIL PUMP (2B/14)	15
OIL PRESSURE RELIEF VALVE (2B/15)	18
TO REMOVE TIMING CASE COVER (2B/16)	16
TO RENEW CRANKSHAFT FRONT OIL SEAL (2B/17)	16
TO REFIT TIMING CASE COVER (2B/18)	16
TO CHECK TIMING GEAR BACKLASH (2B/19)	16
TO REMOVE IDLER GEAR AND HUB (2B/20)	17
TO REFIT IDLER GEAR AND HUB (2B/21)	17
TO REMOVE THE CAMSHAFT GEAR (2B/22)	17
TO REFIT THE CAMSHAFT GEAR (2B/23)	17
TO REMOVE FUEL PUMP GEAR (2B/24)	17
TO REPLACE FUEL PUMP TEAR (2B/25)	18
TO REMOVE CAMSHAFT (2B/26)	18
TO REFIT CAMSHAFT (2B/27)	18
CAMSHAFT THRUST (2B/28)	18
TO REMOVE TIMING CASE (2B/29)	18
TO REPLACE TIMING CASE (2B/30)	19
VALVE AND FUEL INJECTION TIMING (2B/31)	19
TO CHECK VALVE TIMING (2B/32)	19
TO REMOVE FLYWHEEL (2B/33)	19
TO RENEW FLYWHEEL RING GEAR (2B/34)	19
TO REPLACE FLYWHEEL (2B/35)	19

CONTENTS . . . Cont'd

	PAGE
TO REMOVE CRANKSHAFT REAR OIL SEAL (2B/36)	20
TO REPLACE CRANKSHAFT REAR OIL SEAL (2B/37)	20
TO REMOVE CONNECTING ROD AND PISTON ASSEMBLIES (2B/38)	21
TO REPLACE CONNECTING ROD AND PISTON ASSEMBLIES (2B/39)	21
TO REMOVE A PISTON FROM A CONNECTING ROD (2B/40)	21
TO FIT A PISTON TO A CONNECTING ROD (2B/41)	22
TO RENEW CONNECTING ROD BEARINGS (2B/42)	22
TO REMOVE AND REPLACE GUDGEON PIN BUSH (2B/43)	22
TO REMOVE CYLINDER LINERS (2B/44)	22
PREPARATION FOR FITTING NEW LINERS (2B/45)	23
TO FIT NEW LINERS (2B/46)	23
TO RENEW MAIN BEARINGS WITH CRANKSHAFT IN POSITION (2B/47)	23
TO SET CRANKSHAFT END FLOAT (2B/48)	24
TO REMOVE CRANKSHAFT (2B/49)	24
TO REGRIND THE CRANKSHAFT (2B/50)	24
TO REPLACE THE CRANKSHAFT (2B/51)	24
SCHEDULE OF FITS AND TOLERANCES	25
TORQUE TIGHTENING FIGURES	31

LIST OF ILLUSTRATIONS

Figure	Facing Page
1a General View of A4.212 Engine	6
1b General View of A4.212 Engine	7
2 Recutting Valve Seats	8
3 Full Flow Filter	8
4 Exploded View of Oil Pump	8
5 Oil Pump	9
6 Numbers on Connecting Rod Cap and Connecting Rod	9
7 Markings on Piston	10
8 Checking Piston Height	10
9 Reaming Small End Bush	10
10 Serial Numbers on Main Bearing Caps and Cylinder Block	10
11 Removing the Rocker Assembly	11
12 The Rocker Assembly	11
13 Adjusting Valve Clearances	12
14 Removing the Valves	12
15 Handgrinding Valves	13
16 Checking Valve Head Depth	13
17 Valve Seat Cutting Diameter	13
18 Press Tool for Valve Seat Inserts	14
19 Flare to be cut at 30°	14
20 Exploded Views of Valve Assemblies	14
21 Sequence for Tightening Head Nuts	15
22 Removing Filter	15
23a Removing Oil Pump Idler Gear Circlip	15
23b Removing Oil Pump	16
24 Removing 'O' Ring Seal	16
25a Checking Clearance between Inner and Outer Rotors	16
25b Checking Clearance between Outer Rotor and Pump Body	16
25c Checking Rotor End Float	17
26 Checking Oil Pump Drive Gear Backlash	17
27 Aligning Crankshaft Pulley with Crankshaft	17
28 Checking Timing Gear Backlash	17
29 Aligning Timing Marks	18
30 Removing Camshaft Gear	18
31 Removing Setscrews on Fuel Pump Gear	18
32 Replacing the Fuel Pump Gear	18
33 Removing Fuel Lift Pump	18
34 Removing Camshaft Thrust Plate	18
35 Withdrawing Camshaft	19
36 Checking Flywheel Run Out on Periphery	19
37 Checking Flywheel Run Out on Clutch Face	19
38 Bedding in the Rubber Cored Asbestos Strip	19
39 Tightening Setscrews on Seal Housing	20
40 Removing Big End Caps	20
41 Piston Ring Compressor	20
42 Checking Gap between Crankshaft Web and Crankshaft Thrust Washer	21
43 Removing Main Bearing Caps	21
44 Serial Numbers on Main Bearing Caps and Cylinder Block	21
45 Fitting Bridge Piece	24
46 Checking Alignment of Bridge Piece and Cylinder Block	24



ENGINE

GENERAL

This section is concerned with the repair and overhaul of the A4. 212 engine as fitted to the MF 50B Tractor Digger Loader. Where applicable, reference is made to special toolage recommendations. Unless stated otherwise, the overhaul and disassembly instructions which follow assume that the engine has been removed from the machine. When executing repairs in situ, the reader is requested to refer to other sections of this Manual for the information required to render the engine accessible.

The following instructions assume the availability of a dismantling stand and a full range of service tools and equipment.

Where "left-hand" side and "right-hand" side are referred to, this denotes the side of the engine looking from the flywheel end.

OPERATION

The A4. 212 engine is a four cylinder four stroke diesel unit with a bore of 3.7/8 in. (98, 43 mm.) and stroke of 4.1/2 in. (114,3 mm.) It has a capacity of 212 cu.in. (3,47 litres). A direct injection system is employed, the pistons having a combustion chamber formed in their crowns. Fuel is injected into each chamber by means of a four hole nozzle. The overhead valves are operated by means of rocker levers, push rods and tappets driven by a cast iron camshaft located on the right hand side of the cylinder block. The valves which are vertical, operate direct in the cast iron cylinder head and have two springs per valve. The inlet valve head is of a larger diameter than that of the exhaust valve. Aluminium pistons are fitted with four piston rings; top ring chrome plated compression, second plain and third cast iron internally stepped, fourth oil control ring. The gudgeon pins are fully floating and are retained in position by circlips.

The cylinder block and crankcase are integrally cast and full length renewable cast iron dry liners are fitted.

The crankshaft is supported in five main bearings. The main bearings and connecting rod big end bearings are pre-finished thin wall, steel backed aluminium tin lined. Crankshaft end float is controlled by four thrust washers located on both sides of the centre main bearing and presenting a 360° thrust face to the crankshaft.

A flange mounted distributor type fuel injection pump is mounted to the rear of the timing case on the left hand side of the engine. The fuel injection pump body incorporates a mechanical governor.

To assist starting under cold conditions, an electric heater and fuel igniting unit is fitted into the induction manifold.

The valves are mounted vertically and operate direct in the cylinder head. They are operated from the camshaft by means of tappets and push rods.

If the valve face is found to be unduly pitted or distorted, it should be refaced on a suitable valve grinding machine to an angle of 45°. The grinding should continue only until the face is true and free from pitting. The removal of an excessive amount of metal may thin the edge of the valve head to a degree where it may overheat and curl under normal operating conditions. For a similar reason the valve may be unduly lowered in its seating in the cylinder head and pocketing may result. If a valve tends towards thinness at the edge, particularly after refacing, it should be replaced. Valves which are badly burned, distorted or which have previously been reground to their maximum limits should be discarded.

Valve Seats (Refer to Fig. 2)

If the valve seats in the cylinder head show signs of pitting, burning or other evidence of gas leakage, they should

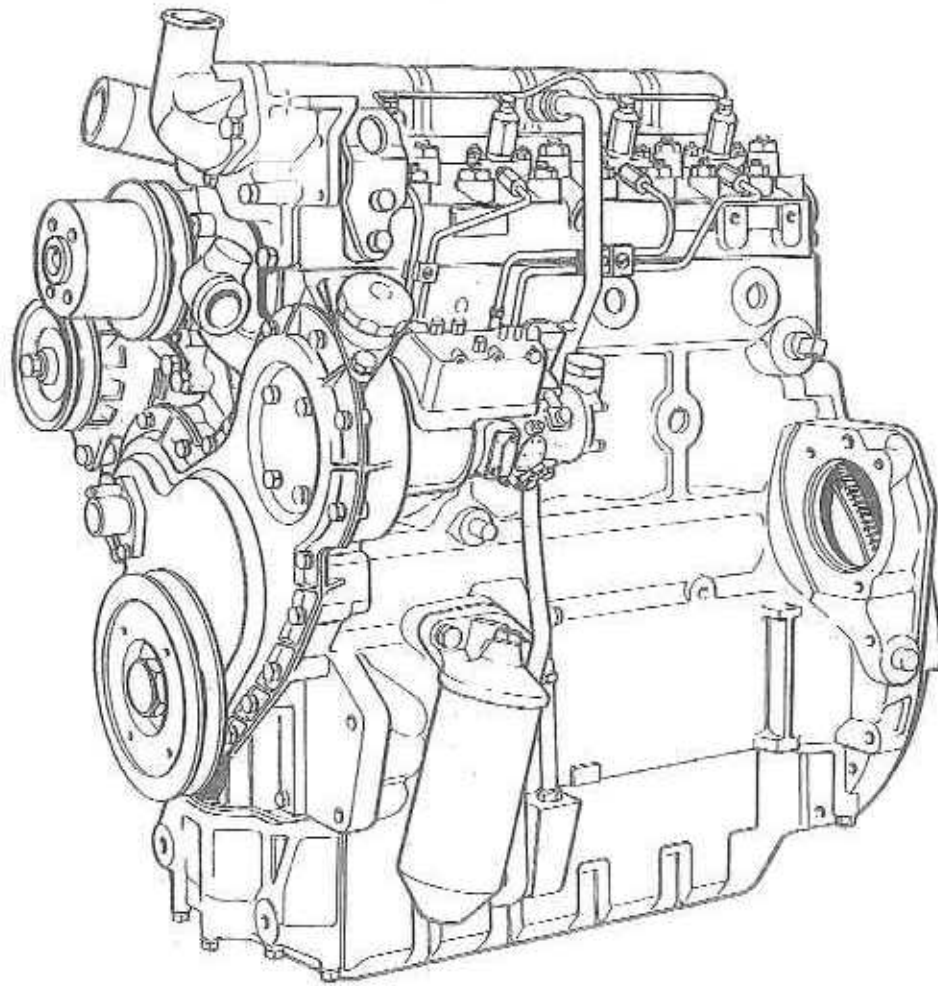


FIG 1A

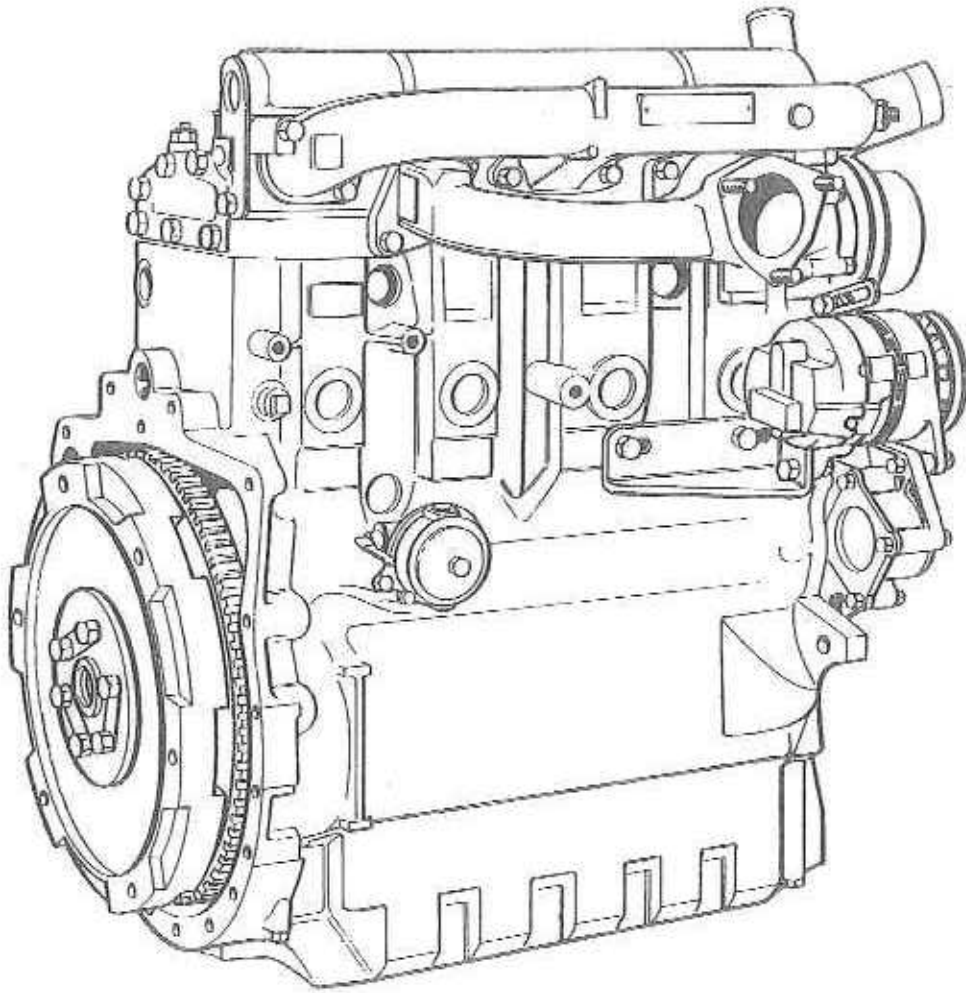


FIG. 18

Valve Seats . . . Cont'd.

be machined or hand ground according to their condition. Hand grinding is a finishing process and on no account should excessive and continuous hand grinding be attempted, otherwise the seat angles may be altered and the seat width increased excessively. Throughout the operation, as narrow a valve seat as possible should always be maintained. Care should be taken when recutting the valve seat to ensure that only enough metal is removed to confirm that there is an even seat without distortion.

Service tools, 317-30 inlet and exhaust seat cutter, 316X valve seat cutter handle, 316-12 valve seat cutter pilot (std), 316-125 valve seat cutter pilot (+ .015 in.) and 316-13 valve seat cutter pilot (+ .030 in.) are recommended.

Valve Springs

Two valve springs are fitted to each valve, an inner and outer.

Damper coils are incorporated in the springs and should be fitted nearest the cylinder head.

Before re-use, all springs should be carefully examined with particular regard to squareness of ends and pressure developed at specified lengths. The fitted lengths are 1.780 in. (45.22 mm.) at a load of 40 lbs. 2 lbs. (18.1 kg $\pm$ 0.91 kg) for the outer springs and 1.5625 in. (39.69 mm.) at a load of 15.4 lb $\pm$ 0.77 lb. (7 kg. 0.35 kg.) for the inner springs.

Valve Stem Bores

The valves operate direct in the cylinder head. When wear takes place in the valve bores of these cylinder heads, restoration of the original clearance between the valve stem and its bore is accomplished by fitting valves with oversize stems.

Three service valves are available, for both inlet and exhaust, with oversize stems of .003, .015 and .030 in. (0.08, 0.38 and 0.76 mm.).

In order to fit the oversize valves, the bore in the cylinder head must be reamed with a piloted reamer to ensure that the valve position relative to the valve seat is maintained. Suitable reamers for carrying out this operation are available viz. PD 137 (+ .015 in.) and PD 138 (+ .030 in.). Reaming is not required when fitting valves with .003 oversize stems.

The Lubrication System

The lubrication is of the forced feed type, the oil being circulated under pressure by a rotary type oil pump mounted on the front of the front main bearing cap. The oil is drawn through a sump strainer before entering the sump itself. Oil is then pumped via an internal drilling to the full flow oil filter mounted externally on the fuel pump side of the engine, and having a renewable paper element.

Oil passes through the filter and then through an internal drilling in the cylinder block to the pressure rail which is an internal passage within the crankcase.

From the pressure rail, oil is fed through oilways in the crankcase webs to the five main bearings and then from these through oilways drilled in the crankshaft webs to the big end bearings. Pistons, cylinders, liners and connecting rod small end bearings are lubricated by splash and oil mist, as are the cams and tappets of the valve mechanism.

An oil seal prevents oil leading along the crankshaft at the rear end. Oil thrown from this seal returns to the sump.

The three camshaft bearings are lubricated through oilways in the crankcase webs from numbers one, three and five main bearings.

The camshaft centre bearing supplies a controlled feed of oil through an oilway in the cylinder block and cylinder head to the rocker shaft assembly. This controlled feed is achieved by allowing oil under pressure to be forced to the rocker shaft only when the oilways in the camshaft journal and camshaft centre bearing are in line, this occurring once per camshaft revolution.

Oil from the rocker shaft escapes through a small bleed hole in each rocker lever and lubricates the valves and bores by splash, the surplus oil being returned to the sump by gravity.

The Lubrication System . . . Cont'd.

The idler gear and hub are pressure lubricated direct from the pressure rail. Oil enters the rear of the hub and passes through drillings in the hub to lubricate the idler gear bush and gear retaining plate. Timing gear teeth are splash lubricated by surplus oil from the front camshaft bearing and idler gear hub.

The Engine Sump

The lubricating oil sump is a one piece cast iron casting with a solid underside; flange fitted to the engine crankcase and incorporating a front face drilled to take the front axle assembly and a rear face for the flywheel housing.

Lubricating Oil Filter

The oil filters consist of a gauze sump strainer and main full flow filter. The sump strainer can only be removed when the sump is removed.

The main full flow filter is mounted on the fuel pump side of the engine crankcase. A paper cartridge element is employed.

Full Flow Filter

Oil is pumped from the sump through the inlet port of the filter head to the outside surface of the filter element. Impurities are removed as the oil passes through the material to the inside of the element and escapes through the outlet port. Should the element become clogged and the passage of oil severely restricted, a pressure difference will be built up between the inlet and outlet ports, opening the spring loaded ball valve in the by-pass between the two ports and allowing unfiltered oil to pass through the outlet port.

The spring loaded ball valve opens at 13-17 lb./in.² (0.914 - 1.195 kg/sq.cm.) pressure difference. The filter consists of a bowl positioned by a centre bolt to the filter head. A central threaded tube integral with the bowl is used to secure the bowl to the head by a suitable setscrew. The replaceable element contained within the bowl is spring loaded and sealed at the bottom. It is also sealed at the top by a seal contained within the filter head. The joint between the filter bowl and the filter head is sealed by a rubber ring contained in a groove in the filter head. The filter head is formed with the inlet and outlet passages connected through a by-pass valve.

KEY TO FIGURE 3

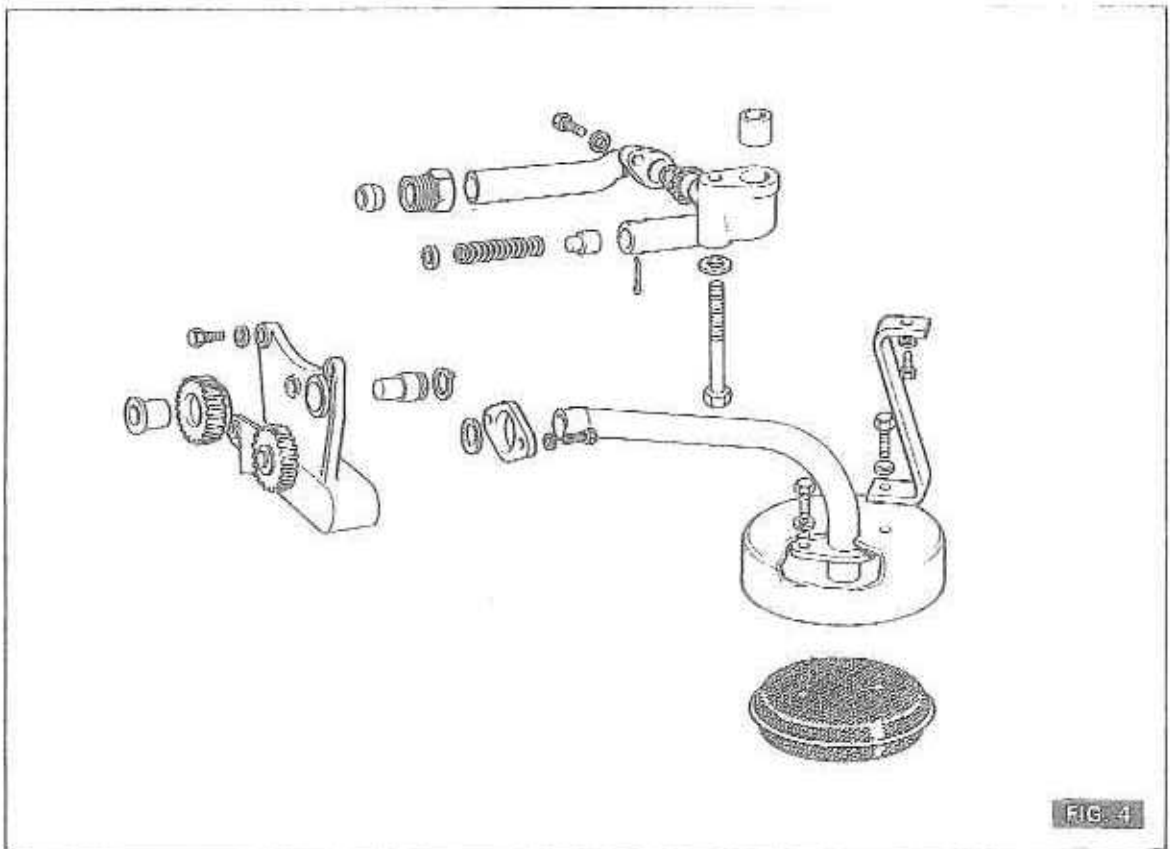
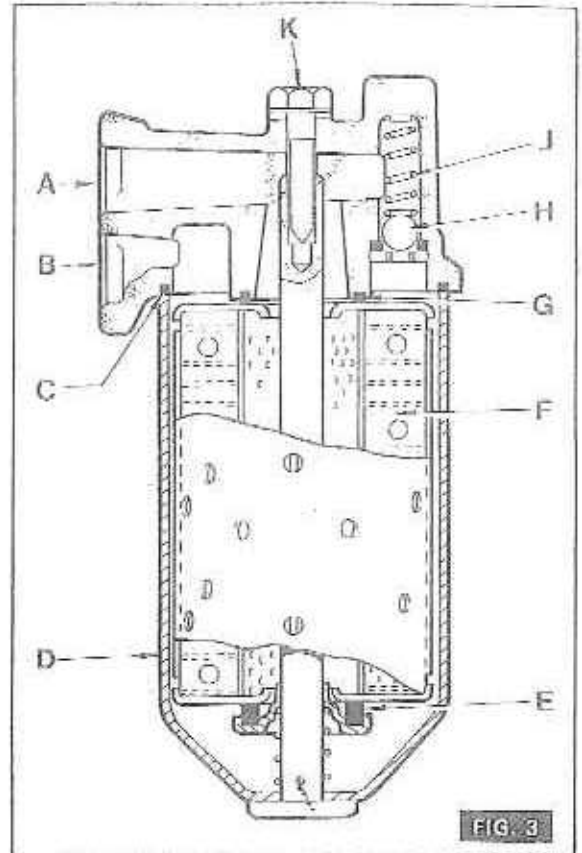
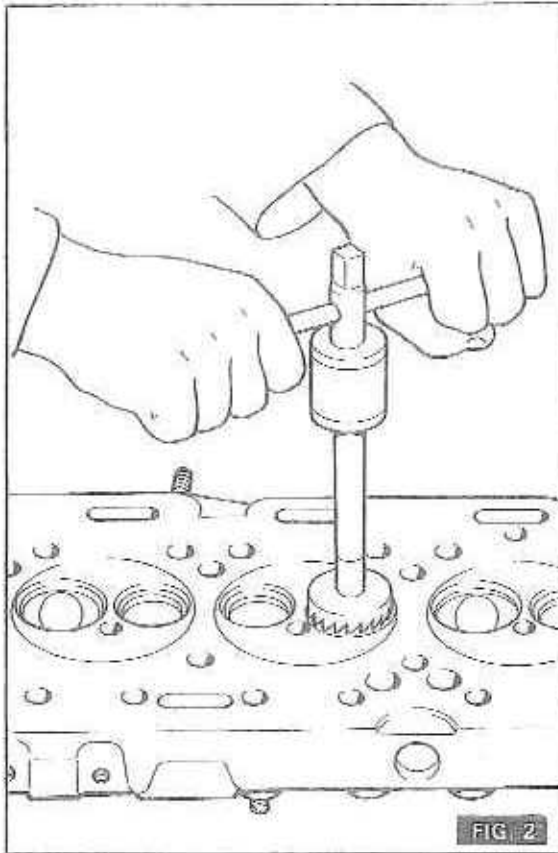
A	Outlet Port
B	Inlet Port
C	Bowl to Filter Head Seal
D	Bowl
E	Spring Loaded Seal
F	Replaceable Element
G	Element to Filter Head Seal
H	Ball Valve
J	By-Pass Valve Screw
K	Securing Setscrew

The Oil Pump (See Fig. 4)

The oil pump is mounted on the front main bearing cap. It is of the lobed rotor type, oil being drawn through the gauze sump strainer and into the pump body. From the inlet side the oil is carried to the pressure side by means of pockets between the lobed rotors increasing and decreasing in volume passing the oil, under pressure, out of the pump via a pipe to the relief valve. This controls maximum oil pressure. Excess pressure opens the valve and oil is returned direct to the sump. Access to the oil pump involves removal of the sump.

Pistons and Connecting Rods

Connecting rods are numbered red on cap and rod when fitted to production engines and the assembly is fitted to



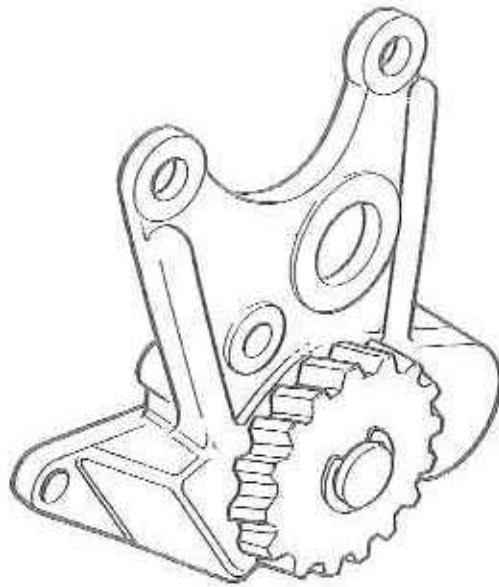


FIG. 5:

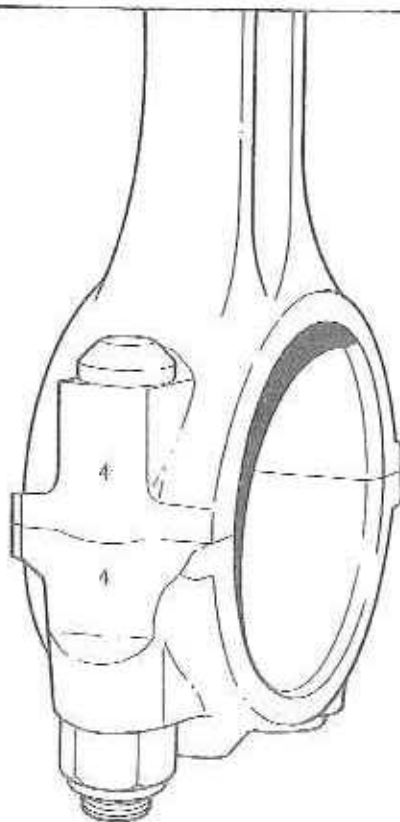


FIG. 6:

Pistons and Connecting Rods . . . Cont'd

the crankshaft so that these numbers always appear on the fuel pump side of the engine. Always fit the cap to the connecting rod so that these numbers appear on the same side. (See Fig. 6).

It is advisable when removing the piston assembly from the engine to check whether or not the connecting rod and cap are suitably marked, as they may have been replaced at some time after the engine left the factory, in which case the numbering may not have been carried out. Such connecting rods and caps should be suitably marked.

To ensure that the toroidal cavity of each piston is correctly positioned within the cylinder bore, the crown of each piston is marked with the word "FRONT" and the portion of the piston which carries this location mark should be towards the front of the engine. (see Fig. 7).

Gudgeon Pins

The piston gudgeon pins are fully floating and are located in the pistons by circlips.

Pistons

If new liners have been fitted to the engine, it is advisable to fit new pistons. The piston height relative to the top face of the cylinder block at T.D.C. is not less than .003 in. (.08 mm.) or more than .010 in. (.25 mm.) above the top face of the cylinder block. This can be checked by means of a special tool (see Fig. 8), or by means of a straight edge and feeler gauges.

Connecting Rods

Misaligned connecting rods must be discarded and new ones of the same weight grade fitted. Service Tool No. 335 with multi-purpose arbor 336 can be used for checking connecting rod alignment.

When fitting and reaming small end bushes, a reaming fixture should be employed. Tools 6200 and set of reamers PD, 6200-3 are recommended (see Fig. 9).

All connecting rods are graded for weight and the set of four rods in any one engine must weigh the same within two ounces. The weight of the rod includes cap, small end bush, nuts and bolts.

The code number of the connecting rod weight is etched on the machined surface at the bottom end of the rod in proximity to the connecting rod number. It is essential when ordering spare rods to quote the code number as found on the engine to be replaced.

Cylinder Liners

Cast iron renewable liners are employed. The factory production liner is an interference fit and requires boring to finished size in situ.

For service use, a pre-finished cylinder liner is available, this being a transitional fit in the cylinder block.

Main Bearing Caps

The main bearing caps are of high duty cast iron and are located on ring dowels in the cylinder block. Two high tensile setscrews are fitted per cap and are locked by tabwashers. The tabwashers should only be used once. In production, the main bearing parent bores are machined with the caps in position. If for any reason, a main bearing cap becomes damaged and replacement is required, then it will be necessary to replace the cylinder block complete with main bearing caps.

The caps must always be replaced to their correct position on the cylinder block and the correct way round. Each cap is numbered with its appropriate position to the block, No. 1 being at the front of the engine.

The serial numbers stamped on the bearing caps and on the bottom face of the cylinder block must be related as shown in Fig. 10.

Main Bearing Liners

The steel backed, aluminium tin lined, bearing liners are held in position by tongues which register with suitably machined locations in the cylinder block and cap.

Replacement bearings are supplied in four sizes, i.e. standard, -.010 in. -.020 in. and -.030 in.

The Crankshaft

The crankshaft is forged from chrome molybdenum steel, the main and big end journals being induction hardened to reduce wear. The rear of the shaft is machined to provide an oil thrower and oil return scroll.

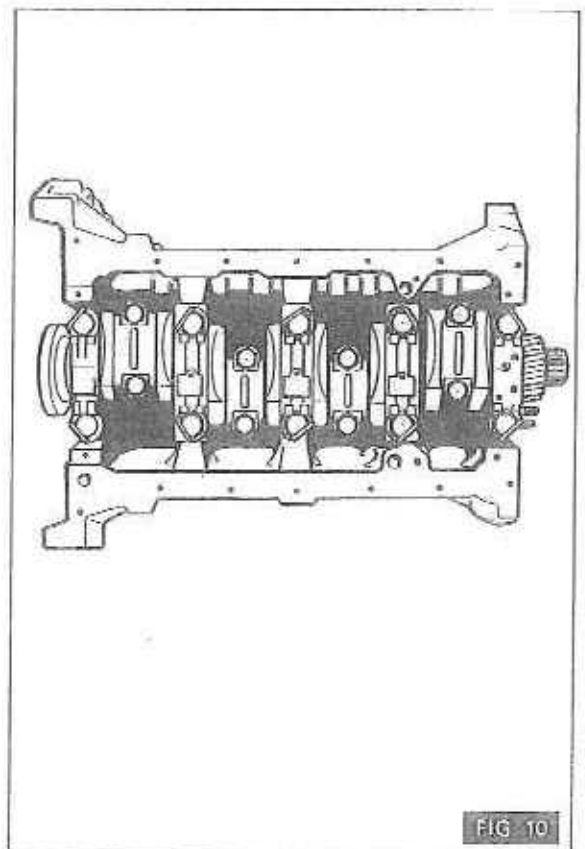
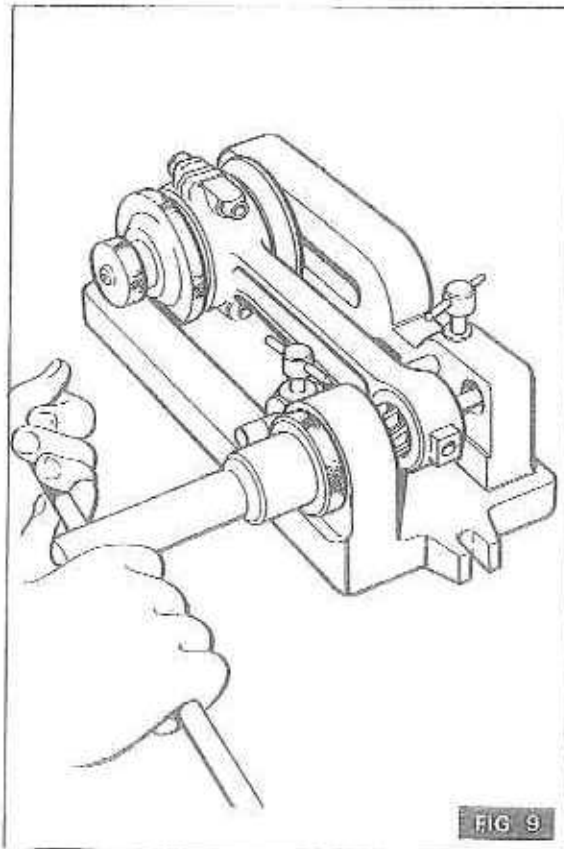
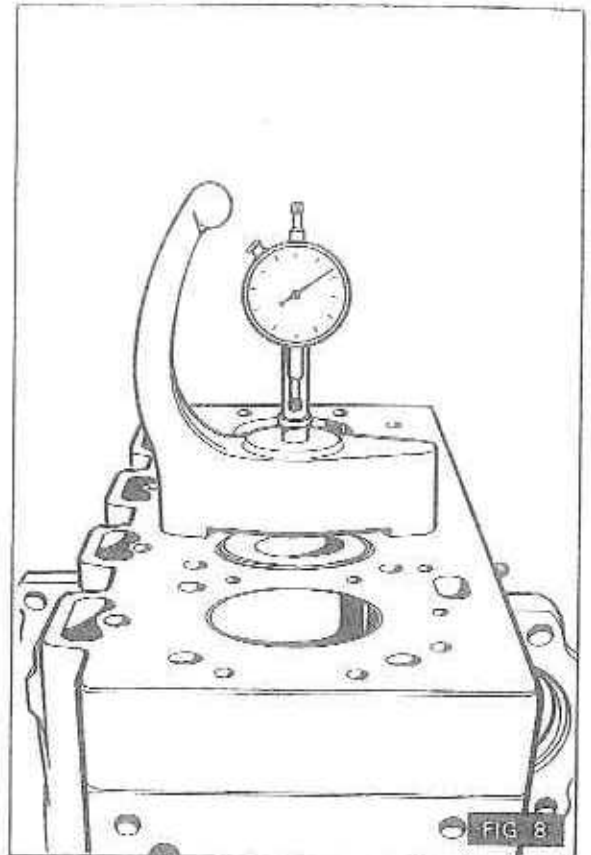
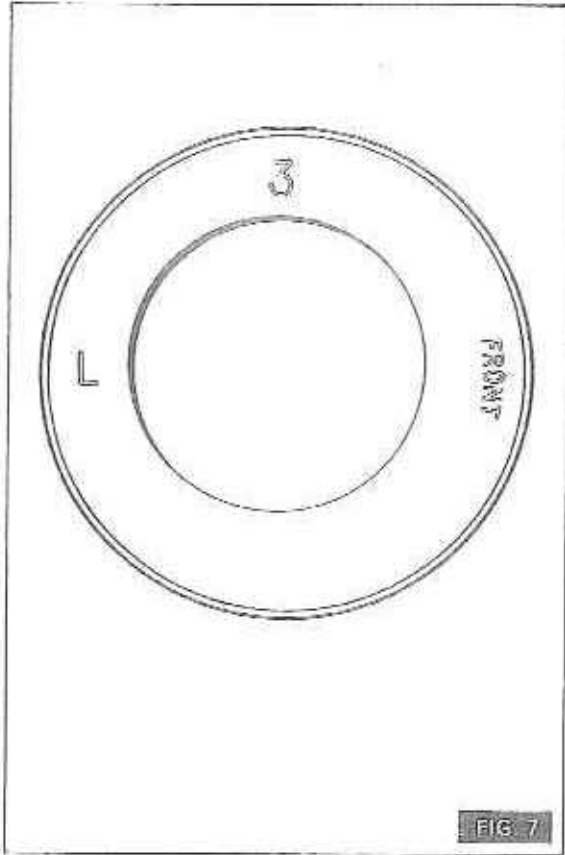
DATA

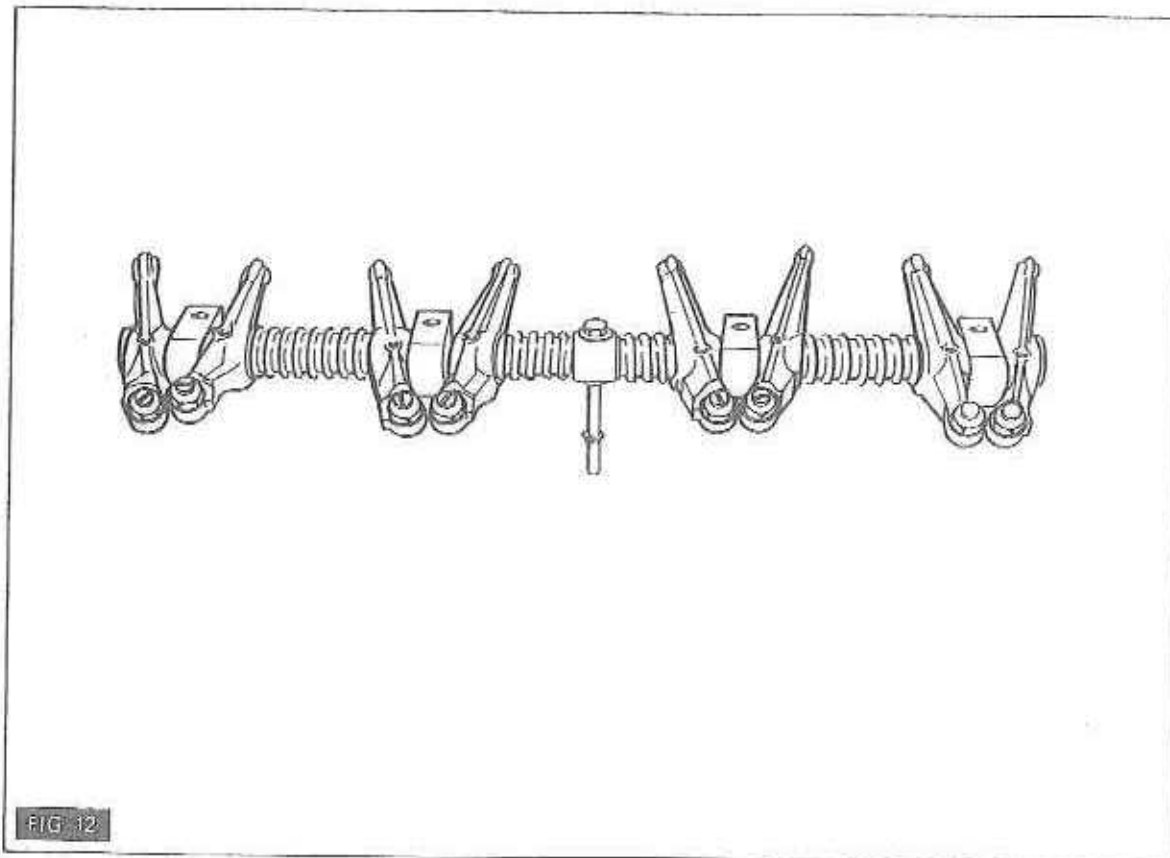
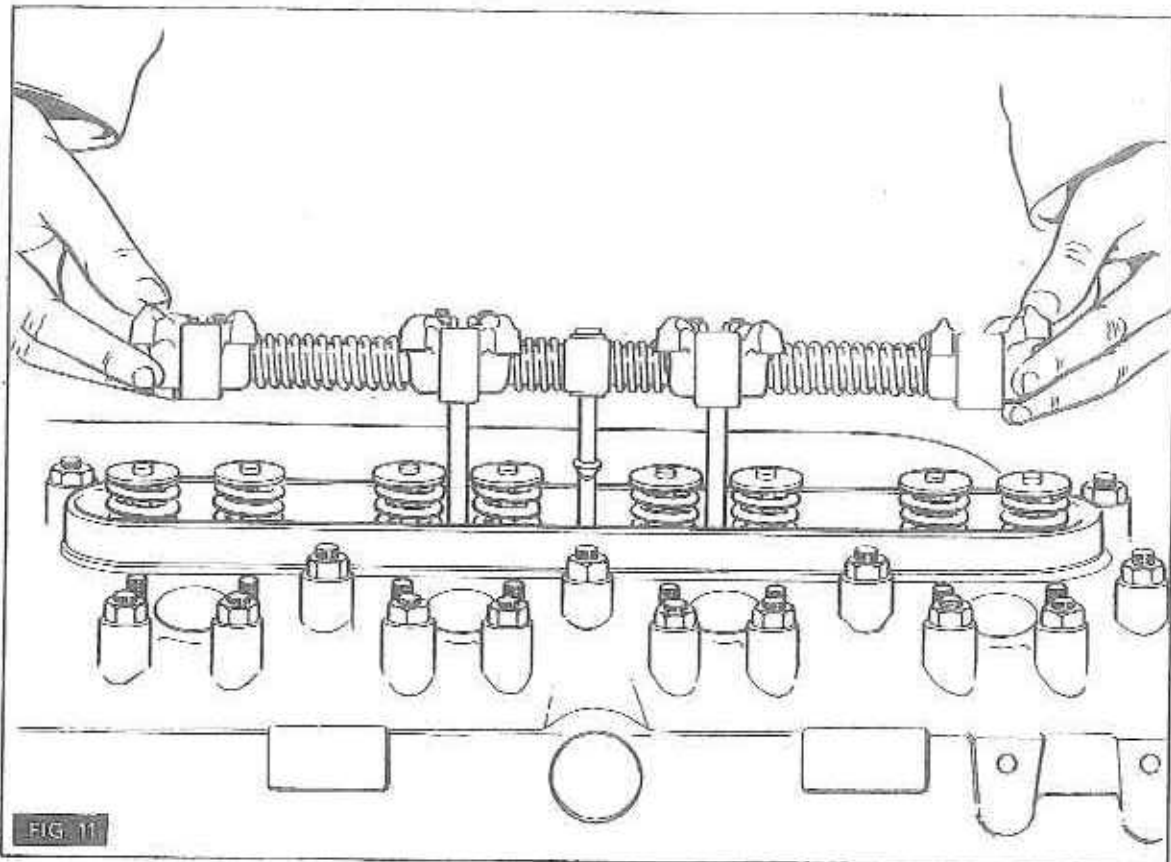
Bore	3.875 in. (98,43 mm.)
Stroke	4.5 in. (114,3 mm.)
No. of Cylinders	4
Cubic Capacity	212 cu.in. (3,47 litres)
B.H.P.	60 b.h.p. @ 2,000 rev./min.
Maximum Torque	168 lbs.ft. @ 1,250 rev./min.
Combustion System	Direct injection
Compression Ratio	15.5 : 1
Firing Order	1, 3, 4, 2
Cycle	4 stroke
Location of No. 1 Cylinder	Front of Engine
Cylinder Liners	Dry Cast Iron (replaceable)
Lub. Oil Pump Delivery	5 Imp. Gall. per minute at 2,000 (pump) rev./min.
Lub. Oil Pump Relief Valve Setting	40/55 lb. / in. ² (2,81/3, 87 kg/sq.cm.)
Operating Oil Pressure	25 lb./in. ² (1,76 kg/sq.cm.) minimum at normal working speed
Oil Capacity (including oilways sump and filter) :	
Sump Capacity, Dipstick "FULL"	16 pints (9,092 litres)
Lub. Oil Filter	Full Flow Type Replaceable Cartridge Element
Lub. Oil Filter By-pass opens	13 - 17 lb./in. ² (0,91 - 1,2 kg./sq.cm.) Pressure Differential
Flywheel Diameter	14½ in.
No. of Teeth on Starter Ring Gear	115
Starter Ring Gear Retention	Shrunk On
Flywheel Periphery Run-out	0.012 in. (0,305 mm.) total indicator reading
Flywheel Clutch Face Run-out	0.001 in. per inch (0,025 mm. per 25 mm.) of flywheel radius to gauge stylus
One inch on flywheel rim equals	7.75°
One degree on flywheel rim equals	0.129 in. (3,28 mm.)
Backlash, Timing Gears	0.003 - 0.006 in. (0,076 - 0,152 mm.)
Backlash, Lub. Oil Pump Gears	0.006 - 0.009 in. (0,151 - 1, 23 mm.)
Valve Clearance (cold)	0.012 in. (0,305 mm.)
Valve Clearance (hot)	0.010 in. (0, 25 mm.)

TO REMOVE CYLINDER HEAD (Engine in situ)

(2B/1)

1. Remove Hood Assembly
2. Remove Fuel Tank
3. Drain Cooling System.
4. Disconnect the electrical lead from the cold start equipment.
5. Remove securing nuts and remove exhaust pipe from manifold.
6. Disconnect and remove atomiser leak off pipe assembly. Blank off atomiser leak off ports.
7. Remove all low pressure fuel pipes and blank off where necessary.





TO REMOVE CYLINDER HEAD . . . Cont'd.

8. Remove breather pipe assembly from cylinder head cover.
9. Remove high pressure pipes from fuel injection pump to atomisers. Blank off fuel pump and atomiser unions. Remove atomisers.
10. Remove induction and exhaust manifolds.
11. Remove rocker cover.
12. Remove rocker assembly and push rods. (See Fig. 11).
13. Release cylinder head nuts in reverse order to the tightening sequence and remove cylinder head.
14. Place on flat surface (preferably wood) to avoid damage.

TO REMOVE CYLINDER HEAD (Engine removed)

(2B/2)

1. Remove atomisers (if not already removed).
2. Remove induction and exhaust manifolds. (if not already removed).
3. Remove rocker cover.
4. Remove rocker assembly and push rods. (See Fig. 11).
5. Release cylinder head nuts in reverse order to the tightening sequences and remove cylinder head.
6. Place on flat surface (preferably wood) to avoid damage.

TO DISMANTLE ROCKER SHAFT ASSEMBLY

(2B/3)

1. Remove the circlips and washers from each end of the rocker shaft.
2. Withdraw the rocker levers, springs and support brackets from the shaft.
3. Remove the locating screw from the rocker oil feed connection and withdraw the connection from the shaft.
4. Wash in clean paraffin. Examine rocker lever bores and shaft for wear. The rockers should be an easy fit on the shaft without excessive side play.

TO ASSEMBLE ROCKER SHAFT

(2B/4)

1. Fit the support brackets, springs, oil feed and rocker levers to rocker shaft in their correct order as shown in Fig. 12.
2. Complete the assembly by fitting new circlips at each end of the shaft with end washers.

TO ADJUST VALVE CLEARANCES (See Fig. 13)

(2B/5)

Valve clearance should be set at 0.010 in. (.25 mm.) hot and 0.012 in. (.30 mm.) cold. Clearance should be set between rocker lever and valve tip.

The sequence for adjusting clearance is as follows :-

- | | |
|--|--------------------------------|
| 1. Valve No. 8 fully open (spring fully compressed). | Set clearance on No. 1 Valve. |
| Valve No. 7 fully open (spring fully compressed). | Set clearance on No. 2 Valve. |
| Valve No. 6 fully open (spring fully compressed). | Set clearance on No. 3 Valve. |
| Valve No. 5 fully open (spring fully compressed). | Set clearance on No. 4 Valve. |
| Valve No. 4 fully open (spring fully compressed). | Set clearance on No. 5 Valve. |
| Valve No. 3 fully open (spring fully compressed). | Set clearance on No. 6 Valves. |

TO ADJUST VALVE CLEARANCES . . . Cont'd

Valve No. 2 fully open (spring fully compressed).

Set clearance on No. 7 Valve.

Valve No. 1 fully open (spring fully compressed).

Set clearance on No. 8 Valve.

For the purpose of this exercise valves are numbered from the front of the engine.

2. Replace the rocker cover and gasket, ensuring the gasket is correctly located.

TO REMOVE VALVES

(2B/6)

1. Place the cylinder head on the bench with the gasket downwards.
2. Compress the spring caps and springs with a suitable valve spring compressor (6118A with adaptor PD. 6118-4). (See Fig. 14).
3. Remove the two half conical collects from each valve.
4. Remove the spring caps, springs and rubber oil deflectors from the valve stems, thus liberating the valves which can be taken out when the cylinder head is turned over.
5. Valves must be returned to their original locations.

HAND GRINDING

(2B/7)

1. With the valves removed, apply a small amount of medium or fine grinding paste according to the condition and replace the valve in its guide.
2. Rotate the valve lightly, using a suitable suction grinding tool (see Fig. 15) rotating in alternate directions, lifting the valve from its seat from time to time and turning it continuously to ensure a concentric seat.
3. Add more grinding paste as necessary and continue the operation until an even, clean, matt grey finish has been obtained.
4. After grinding operations have been completed, check the valve head depths relative to the cylinder head face to ensure that they are within the specified limit of .029 (.74 mm.) to .055 (1.4 mm.) below the head face (see Fig. 16).
5. In the case of the maximum limit being exceeded, valve seat inserts should be fitted.

TO FIT VALVE SEAT INSERTS

(2B/8)

Valve seat inserts are not normally fitted to A4.212 production engines. It is permissible, however, to fit inserts on engines where necessary, i.e. if the existing seat is worn or damaged to such an extent that re-cutting would place the valve head depth relative to the head face beyond the limit of .055 in. (1.4 mm.).

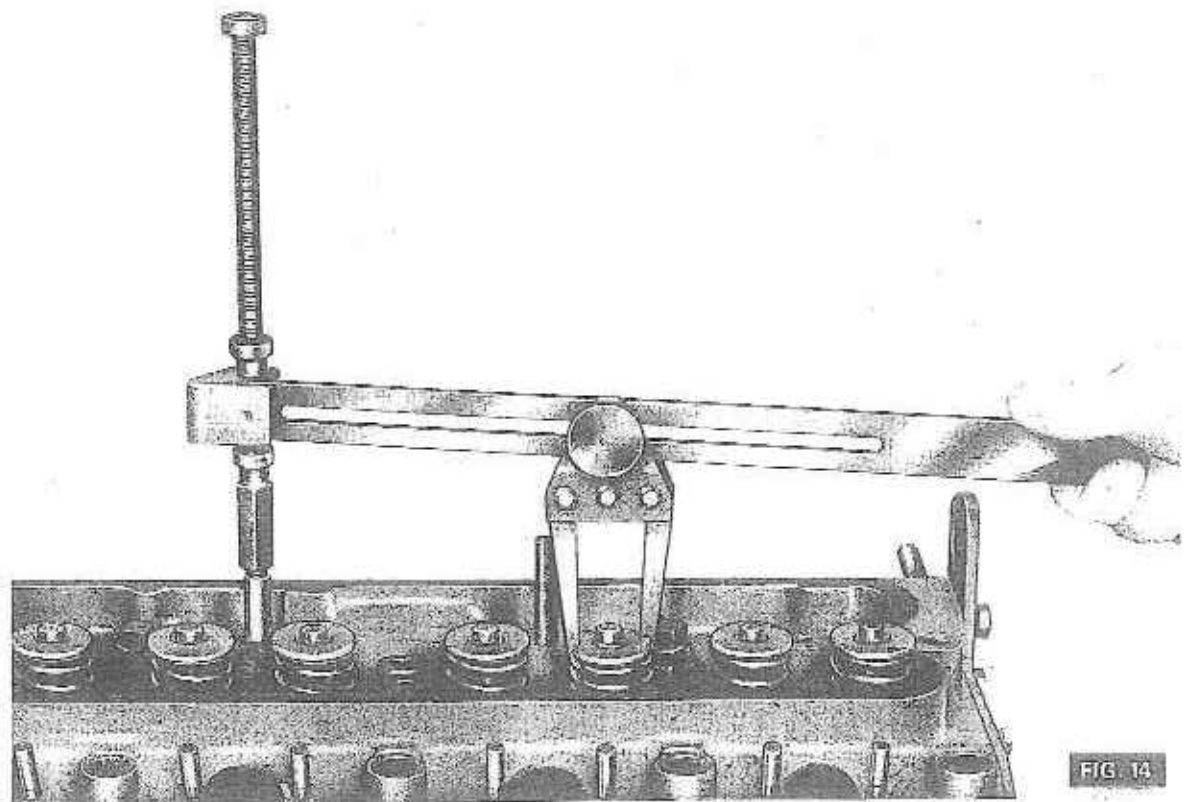
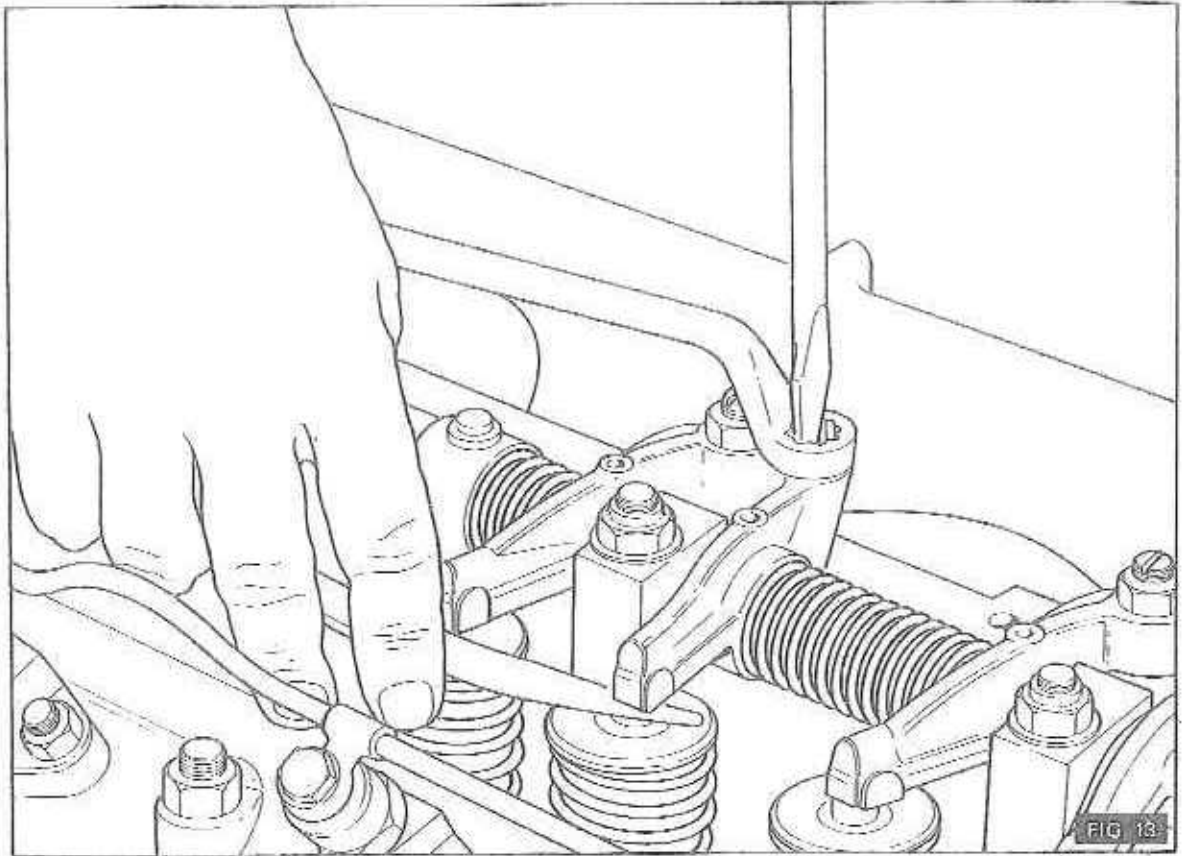
When fitting inserts, ensure that genuine parts are used.

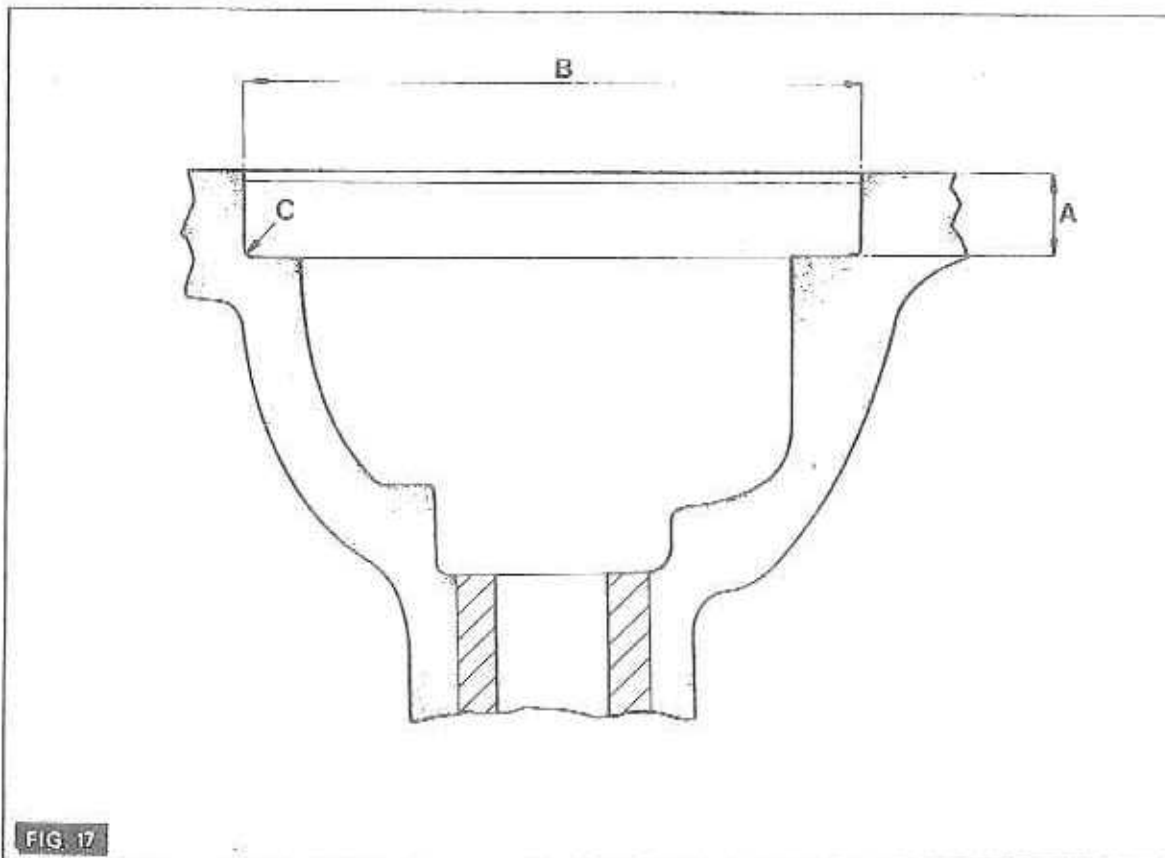
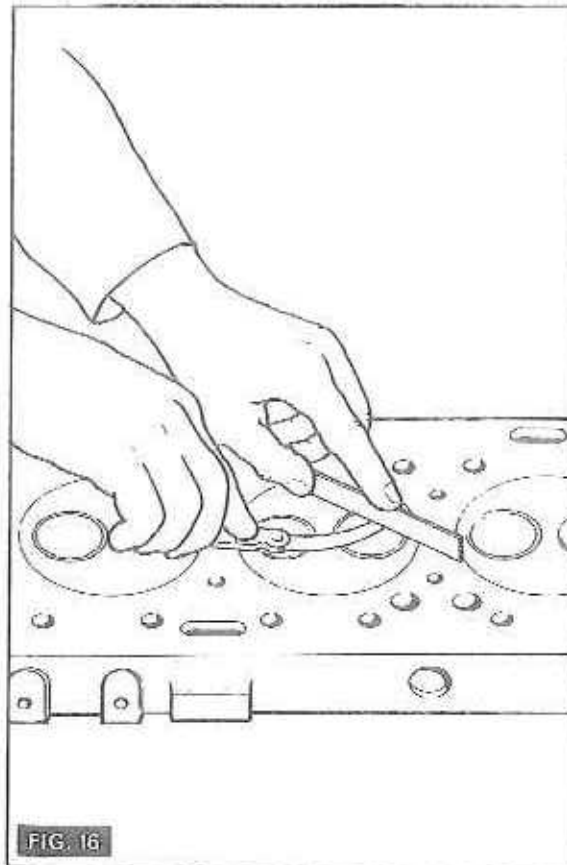
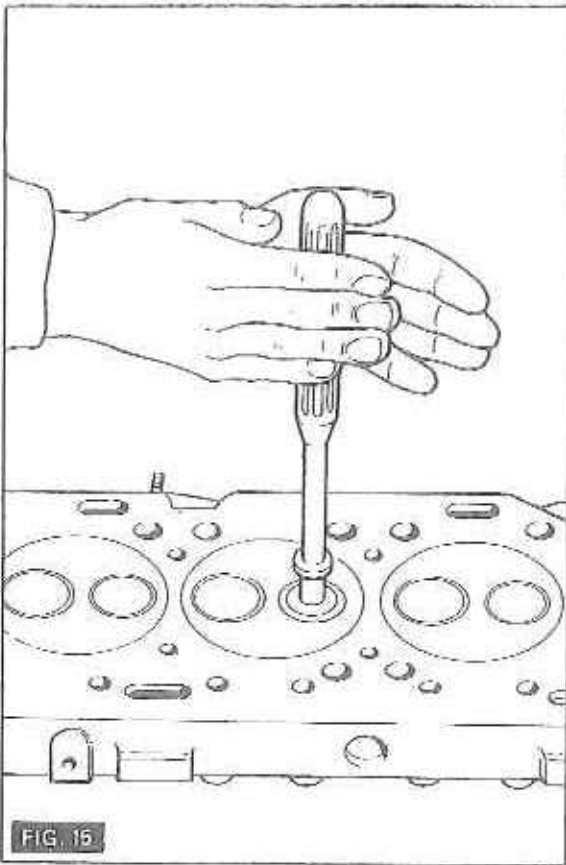
1. Using the valve stem bore (providing it is not worn) as a pilot, machine the recess in the cylinder head face to the dimensions quoted in Fig. 17.

KEY TO FIGURE 17

INLET

- | | |
|-----------------------|-------------------------|
| A - 0,283 - 0,288 | (7,188 - 7,315 mm.) |
| B - 2,0165 - 2,0175 | (51,2191 - 51,2445 mm.) |
| C - RADIUS 0.015 Max. | (0,381 mm.) |





TO FIT VALVE SEAT INSERTS . . . Cont'd

KEY TO FIGURE 17 . . . Cont'd

EXHAUST

A -	0,375 - 0,380	(9,525 - 9,65 mm.)
B -	1,678 - 1,679	(42,6212 - 42,6466 mm.)
C -	RADIUS 0,015 Max.	(0,381 mm.)

- Remove all machining swarf and thoroughly clean the insert recess (removing any burrs which may be present) and once more using the valve stem bore as a pilot, press the insert home with the inserting tool (Fig. 18) using a steady pressure with either a hand or hydraulic press.
The tool will ensure squareness. Under no circumstances should the insert be hammered in; neither should lubrication be used when pressing in the insert.
- Using the valve stem bore as a pilot, machine the "flare" to the dimensions given in Fig. 19.
- Remove all machining swarf and any burrs which may be present.
- Recut the valve seat at an angle of 45° so that the valve head depth below the cylinder head face is within the production limits of .029 / .039 in. (0,74/0,99 mm.) for inlet and exhaust.

Note

It is advisable to work as closely as possible to the minimum figure in order to allow for re-seating at a later date if required.

Important

It is permissible to re-skim the gasket face of the cylinder head and it should be noted that a maximum of .012 in. (.30 mm.) may be removed, providing the minimum cylinder head thickness is not reduced below 4.0365 in. (102.51 mm.).

KEY TO FIGURE 18

A -	3"	(76.20 mm.)	F -	2.009"	Inlet	(51.029 mm.)
				2.019"		(51.283 mm.)
B -	.250"	Inlet	(6.35 mm.)			
	.312"	Exhaust	(7.925 mm.)	1.670"	Exhaust	(42.418 mm.)
				1.680"		(42.672 mm.)
C -	3/4"	(19.05 mm.)				
D -	.372"	(9.449 mm.)	G -	Grind	(where indicated)	
	.373"	(9.474 mm.)	H -	1/16" rad.	(1.587 mm.)	
E -	1.582"	Inlet	(40.183 mm.)	J -	1/32" rad.	(0.794 mm.)
	1.583"		(40.208 mm.)	K -	1/16" (1.587 mm.) at 45°	
	1.248"	Exhaust	(31.699 mm.)			
	1.249"		(31.725 mm.)			

KEY TO FIGURE 19

A - 0.094 / 0.099 (2.388 / 2.515 mm.)

TO REPLACE THE VALVES

(2B/9)

1. Smear oil on the valve stems and in their bores, to provide initial lubrication.
2. Insert each valve into its correct port.
3. Fit the spring seat locating washers, oil deflectors, valves springs with damper coils nearest cylinder head, spring caps and secure with valve collets. An exploded view of the valve assembly is shown in Fig. 20.

TO REPLACE THE CYLINDER HEAD

(2B/10)

Before refitting the cylinder head to the engine, it is extremely important to ensure that the cylinder block and cylinder head faces are perfectly clean. Care must be taken to ensure that the rocker assembly oil feed passage in the cylinder head is free from obstruction. When refitting the cylinder head, a new cylinder head gasket should be used.

The "Klinger" type cylinder head gasket should be fitted dry. On no account should jointing compound be used. Gaskets are marked to indicate how they should be fitted.

1. Place the cylinder head in position on the cylinder block and fit the cylinder head securing nuts.
2. Tighten down the nuts in the sequence shown in Figure 21. The cylinder head nuts should be tightened progressively in three stages until the torque setting of 85 lb.ft. (11.75 kg.m.) is achieved. The final stage should be repeated to ensure that no loss of tension has occurred on the nuts early in the tightening sequence.
3. Fit the push rods in their respective positions and fit the rocker shaft assembly to the cylinder head.
4. Ensure that a new rubber sealing ring is fitted to the rocker oil feed connection and that it is correctly positioned before tightening down the rocker shaft assembly.
5. Adjust the valve clearances to .012 in. (.30 mm.). Using a new joint, fit the rocker cover.
6. Refit the atomisers, using new copper sealing washers, and tighten down the securing nuts evenly, ensuring the atomiser is squarely on its seat. The atomiser securing nuts should be tightened to the torque given in Schedule of Fits and Tolerances.
7. Refit the high pressure fuel pipes to the injection pump and atomisers.
8. Refit the breather pipe assembly to cylinder head cover.
9. Refit atomiser leak-off pipe assembly.
10. Refit the inlet and exhaust manifolds to the cylinder head, using new joints.
11. Using a new gasket, connect exhaust pipe to exhaust manifold.
12. Connect up all remaining external connections to cylinder head.
13. After warming up the engine should be shut down and the cylinder head nuts again tightened with a torque wrench, set to the correct torque and in the order given in Fig. 21.
14. Reset valve clearance to .010 in. (.25 mm.) hot.
15. Refit rocker cover ensuring there are no oil leaks at the joint.

TO REMOVE AND REPLACE THE SUMP

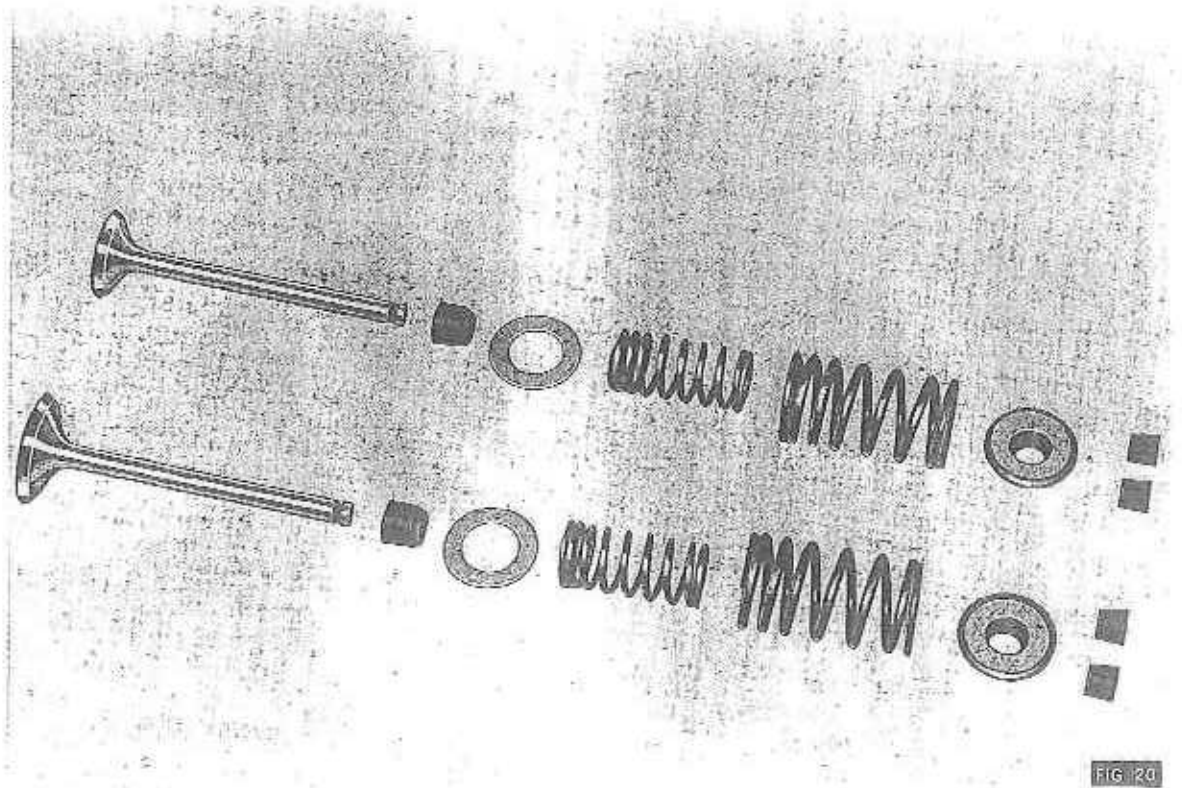
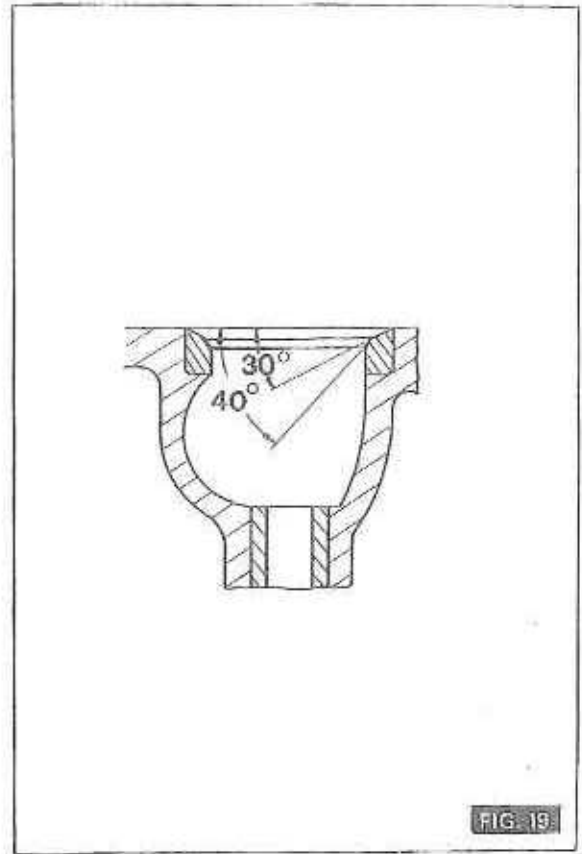
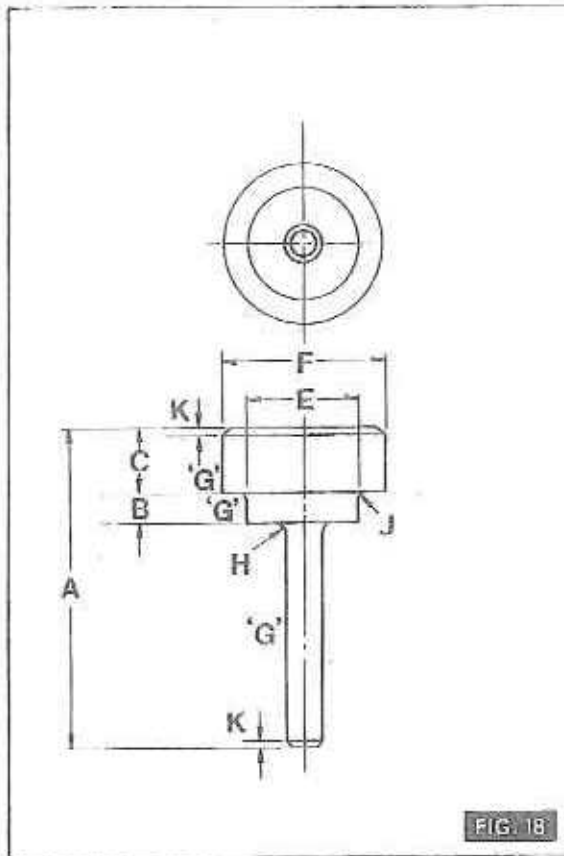
(2B/11)

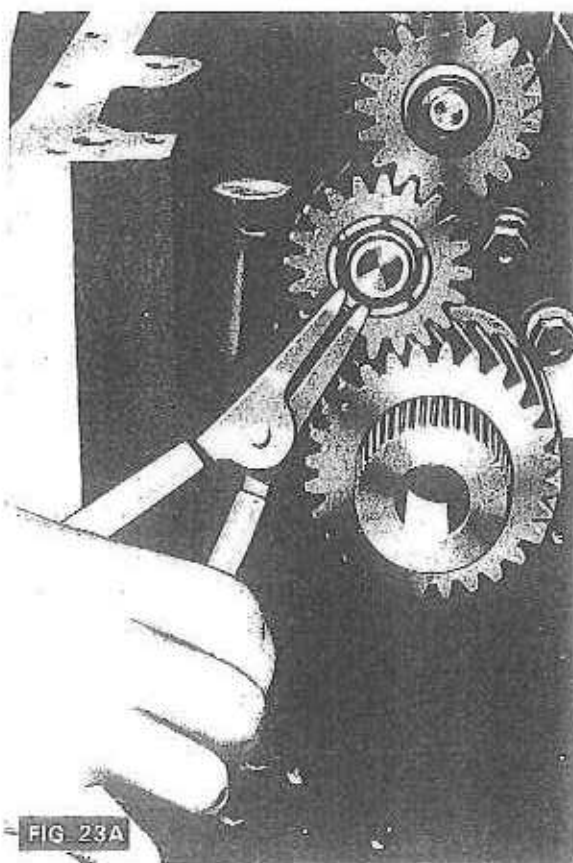
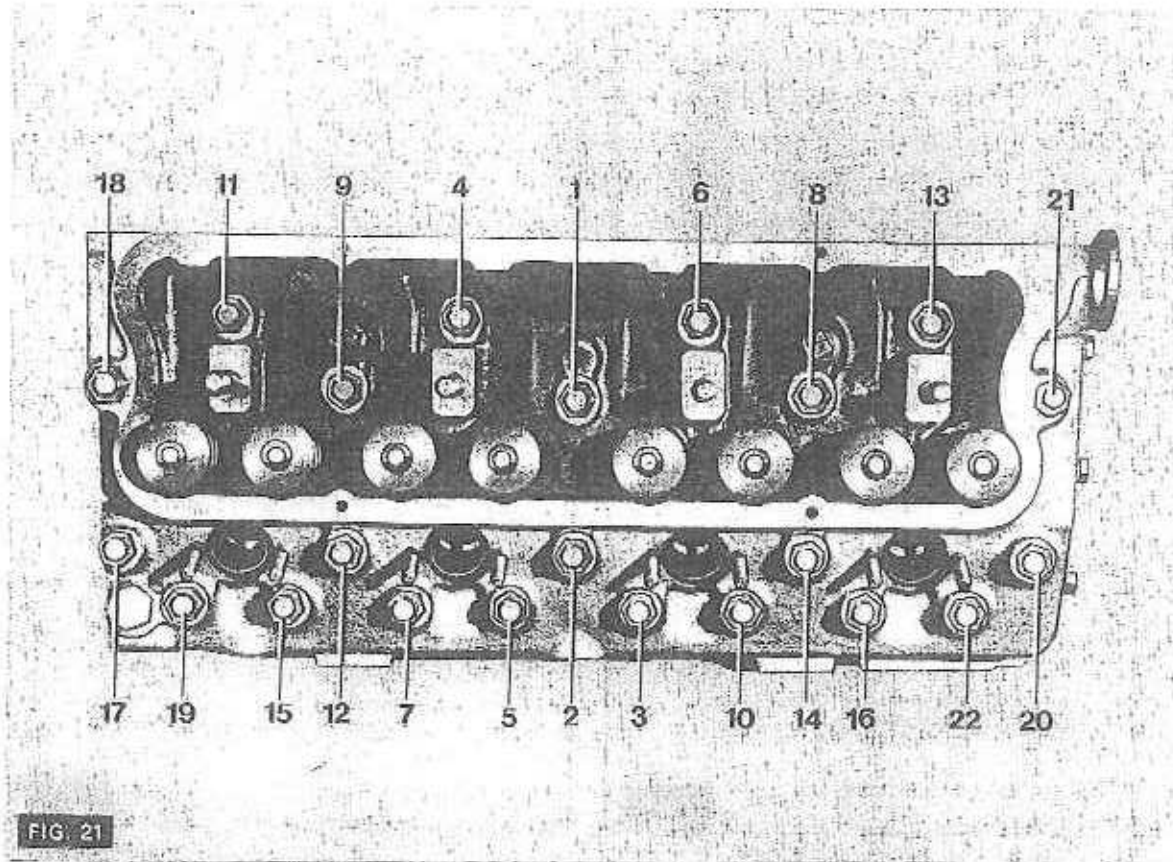
1. Remove sump securing setscrews and carefully remove sump from engine crankcase.
2. Remove the gauze strainer from the oil pump inlet elbow and clean both sump and strainer thoroughly.
3. Replacement of the sump is a reversal of the removal procedure. When replacing the sump, it should be loosely secured by the corner setscrews, when it can be aligned by means of a straight edge across the rear of the sump and flywheel housing adaptor. Finally replace remaining sump securing setscrews.

TO REMOVE THE FILTER BOWL

(2B/12)

1. Unscrew the centre bolt located in the top of the filter head and lower the filter bowl.
2. Remove the replaceable paper filter element.
3. Remove both sealing rings from their recesses in the filter head.





TO REFIT THE FILTER BOWL

(2B/13)

1. Fit new sealing rings in the filter head and place a new element in the filter bowl.
2. Partly fill the bowl with new (engine) oil and offer the bowl to the filter head, ensuring the bowl rim locates squarely against the sealing ring located in the recess in the filter head.
3. Tighten the centre bolt carefully, do not over-tighten.

TO REMOVE AND REPLACE THE OIL PUMP

(2B/14)

1. Remove the sump as previously described. Remove the strainer from the suction pipe of oil pump.
2. Disconnect and remove the suction pipe.
3. Disconnect and remove the oil delivery pipe between the pump and relief valve housing.
4. Remove the crankshaft pulley, timing case front cover, timing gears and timing case as described in the appropriate section.
5. Remove the idler gear circlip and idler gear. (See Fig. 23A).
6. Remove the three setscrews securing the pump to No. 1 main bearing cap and withdraw the pump from the cap (Fig. 23B).
7. Remove the oil pump drive gear retaining circlip and using a suitable extractor, remove the drive gear.
8. Remove the key from the keyway of the drive shaft.
9. Unscrew the three screws which secure the end plate to the pump and remove plate.
10. Inspect parts for signs of cracking, wear or corrosion. Should an oil pump be worn to such an extent where it adversely affects the working oil pressure, a replacement pump should be obtained.
11. Dismantle oil relief valve by removing split pin, cap, spring and plunger. Examine for wear, paying particular attention to plunger and plunger seating.
12. Re-assembly and replacement of oil pump is the reversal to removal. The oil relief valve is non-adjustable.

To dismantle the Oil Pump

(2B/15)

1. With the pump assembly held in a vice, remove the oil pump drive gear retaining circlip also, using a suitable extractor, remove the drive gear.
2. Remove the key from the keyway of the drive shaft.
3. Unscrew the three screws which secure the end plate to the pump and remove the plate.
4. Carefully remove the drive and the driven rotors from the pump body.
5. Remove the 'O' sealing ring from the pump body (Figure 24).

Inspection

1. After thoroughly cleaning all the parts, they should be examined for signs of cracking, wear or corrosion.
2. Install the inner and outer rotors in the pump body, bearing in mind that the chamfered edge of the outer rotor enters the pump body first.
3. The clearance of a new pump are given on page 39, and are checked as shown in Figures 25A, B and C.

Note

Should an oil pump be worn to such an extent it adversely affects the working oil pressure, a replacement pump should be obtained. The component parts of the pump are not supplied individually, therefore if any parts require replacing, a replacement assembly should be fitted.

To assemble the Oil Pump

(2B/16)

1. Fit the drive and driven rotors to the pump body entering the chamfered end of the outer rotor to the body first. Refit the 'O' sealing ring and end plate. Secure the plate with the three screws.
2. Refit the key in the keyway of the drive shaft and refit the drive gear to the shaft with the flat face towards the circlip groove. Ensure that a clearance of 0.003/0.007 in. (0.08/0.18 mm.) exists between the rear face of the gear and the pump body.
3. Fit the drive gear retaining circlip.

To Refit the Oil Pump

(2B/17)

1. Fit the oil pump to No. 1 main bearing cap and secure with the three setscrews.
2. Refit the idler gear to the shaft with the recessed face towards the front and secure with the circlip. Check the idler gear end float which should be within the tolerance of 0.002/0.016 in. (0.05/0.4 mm.). Check the backlash between the oil pump gear and idler gear which should be within the limit of 0.006/0.009 in. (0.15/0.23 mm.). See Figure 26.
3. Using new joints, refit timing case, timing gears, timing case front cover and crankshaft pulley, as described in the appropriate section.
4. Refit the oil delivery pipe between the oil pump and pressure relief valve housing.
5. Refit the suction pipe to the oil pump, using a new flange seal.
6. Fit the sump strainer to the pump suction pipe, and using new joints, refit the sump to the engine and secure with the retaining setscrews. Refill the sump with clean oil of an approved grade.

OIL PRESSURE RELIEF VALVE

(2B/15)

The oil pressure relief valve is contained in a housing bolted to the bottom face of the cylinder block, and is set to operate at 40/55 lb./in.² (2.81/3.87 kg./cm.²).

TO REMOVE TIMING CASE COVER

(2B/16)

1. Slacken the dynamo mounting bolts and remove fan belt.
2. Remove crankshaft pulley retaining setscrew and washer and withdraw crankshaft pulley.
3. Remove the timing case cover securing setscrews and nuts and remove cover, taking care not to damage the crankshaft front oil seal which is located in the cover.

TO RENEW CRANKSHAFT FRONT OIL SEAL

(2B/17)

1. Using a suitable dolly and press, remove the oil seal from the timing case cover.
2. Locate the new seal in the bore of the cover from the front.
3. Press the new seal into position until the front face of the seal is 0.38/0.39 in. (9.65/9.90 mm.) below the front face of the cover.

TO REFIT THE TIMING CASE COVER

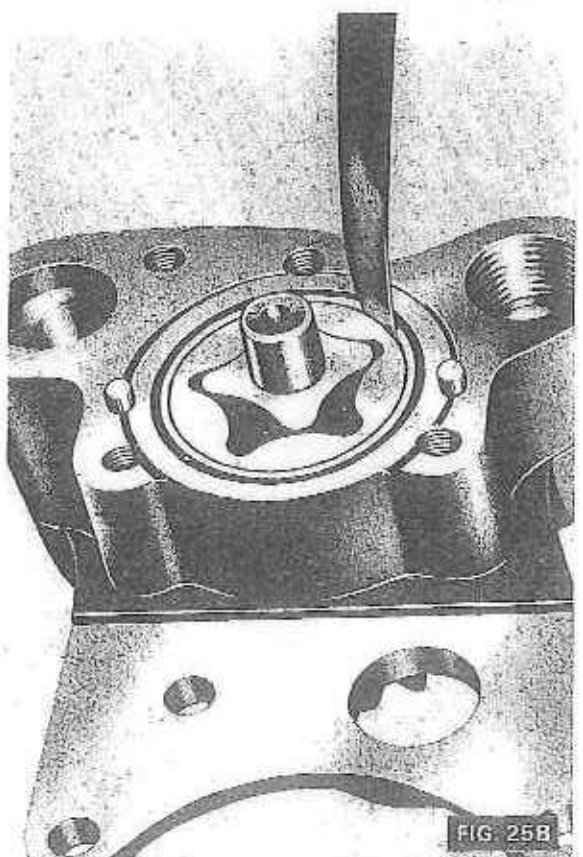
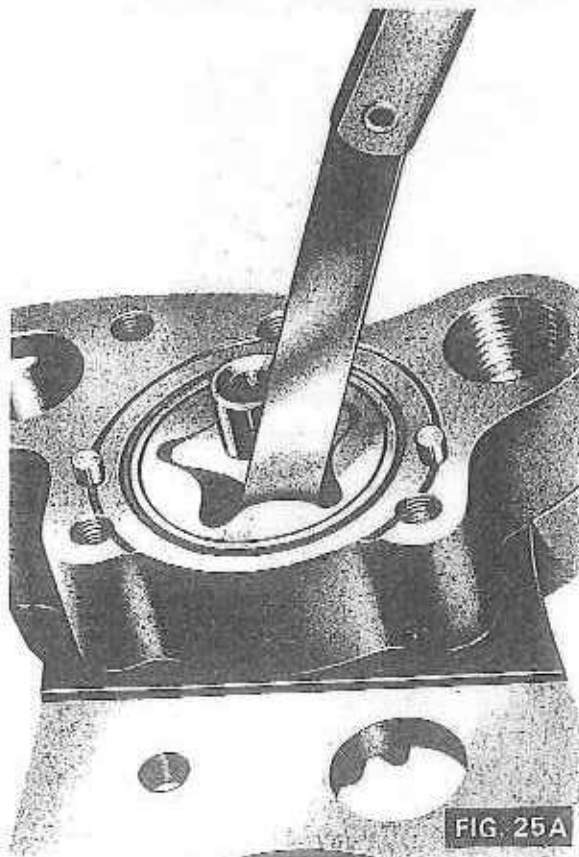
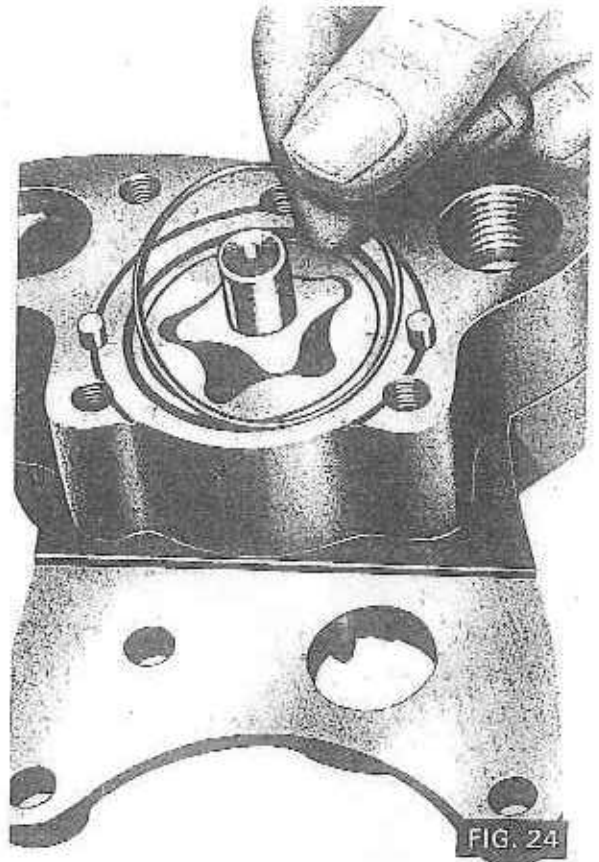
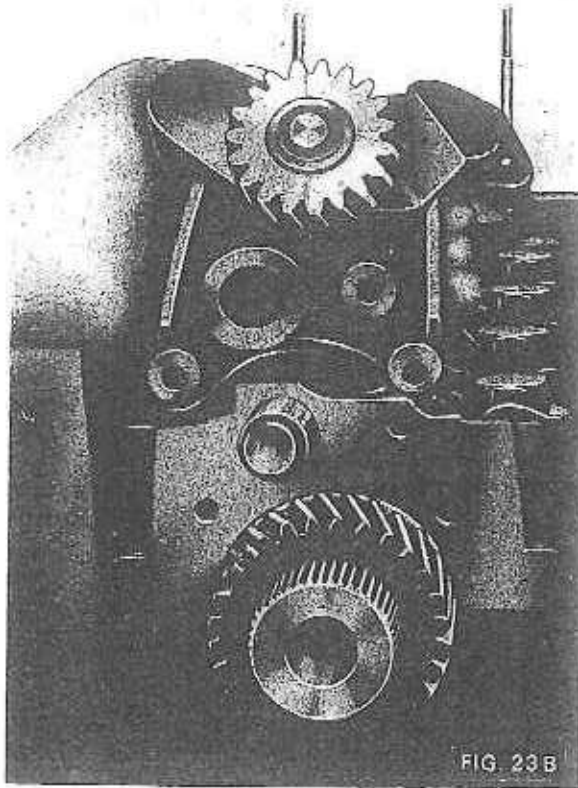
(2B/18)

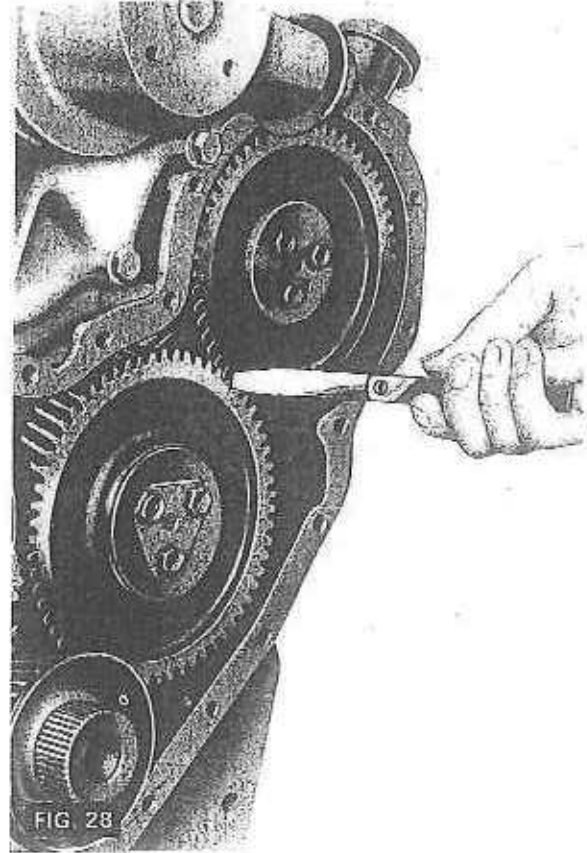
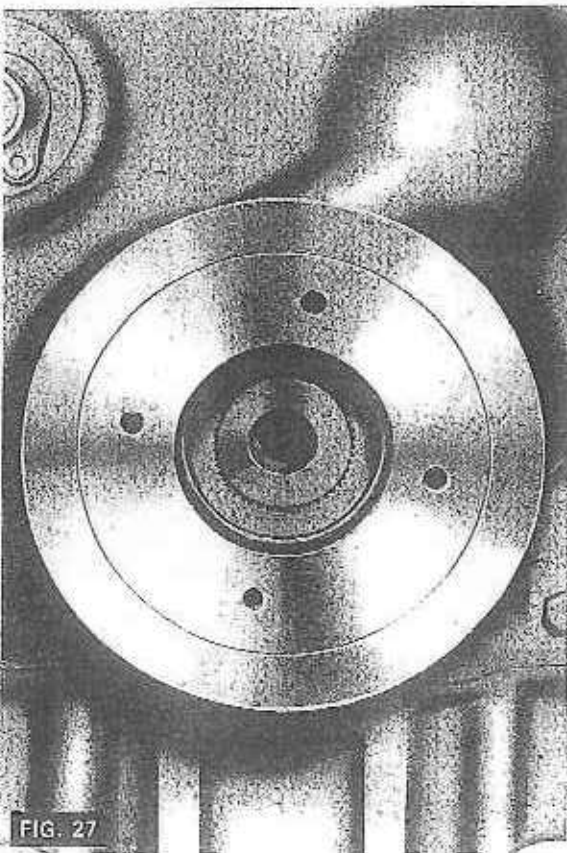
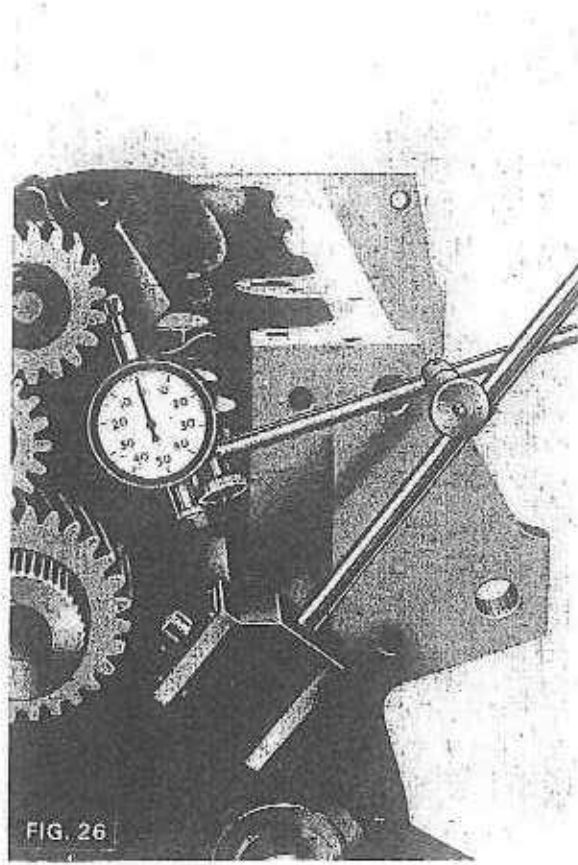
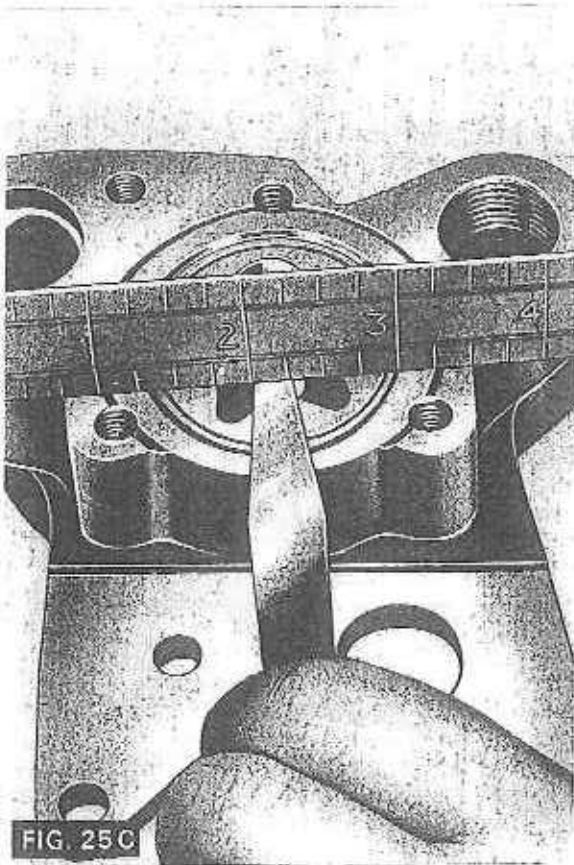
1. Thoroughly clean the faces of the timing case and front cover.
2. Using a new joint, refit the cover and slide the crankshaft pulley into position, thus centralising the cover.
3. Tighten some of the setscrews and then remove the pulley to gain access to the nuts at the bottom of the cover.
4. Evenly tighten all the cover setscrews and nuts.
5. Refit the crankshaft pulley ensuring that the centre punch mark on the pulley coincides with the scribed line on the front face of the crankshaft. (See Fig. 27).
6. Fit the retaining setscrew and washer and tighten to a torque setting of 250/300 lb.ft. (34.56/41.48 kg/m.).
7. Refit fan belt and adjust.

TO CHECK TIMING GEAR BACKLASH

(2B/19)

1. Remove timing case cover as previously described.
2. Check the timing gear backlash as shown in Fig. 28. The backlash should be between .003/.006 in. (0.08/0.15 mm.).
3. If the backlash is within these limits, refit the timing case cover. If not, replace the timing gears affected, as detailed.





TO REMOVE IDLER GEAR AND HUB

(2B/20)

1. Remove timing case cover as previously described.
2. Slacken and remove the three setscrews securing the idler gear retaining plate to the idler gear hub and remove the retaining plate.
3. Remove the idler gear from the hub. The hub can now be withdrawn from its location in the timing case.
4. Clean and thoroughly examine the gear and hub for wear, cracks and pitting.

TO REFIT IDLER GEAR AND HUB

(2B/21)

After ensuring that the oilways in the hub are perfectly clean, refit the hub to its location in the timing case. The boss at the rear of the hub locates in a recess machined in the front face of the cylinder block.

1. Remove the top cover and slacken off the rocker assembly securing nuts. Turn the crankshaft to T.D.C. No. 1 and 4 cylinders, i.e. with the crankshaft gear keyway at the top of its periphery.
2. Refit the idler gear to its hub, ensuring the timing marks on the camshaft, crankshaft fuel pump and idler gears are correctly aligned as shown in Fig. 29.
3. Assemble the idler gear retaining plate and secure with the three setscrews tightened to a torque setting of 21/24 lb.ft. (2.9-3.32 kg.m.).
4. Tighten down the rocker assembly securing nuts and adjust the valve clearances to .012 in. (0.3 mm.) cold.
5. Refit the timing case front cover as previously described.

TO REMOVE THE CAMSHAFT GEAR

(2B/22)

1. Remove the timing case front cover as previously described. Knock back the locking washer tab and remove the camshaft gear retaining setscrew, locking washer and camshaft gear retaining plate.
2. Using a suitable extractor, remove the camshaft gear. (Ref to Fig. 30).
3. After removal, clean and thoroughly examine the gear for signs of undue wear and chipping.

TO REFIT THE CAMSHAFT GEAR

(2B/23)

1. Remove the idler gear as described previously. Slacken off the rocker assembly securing nuts.
2. Carefully refit the gear to the camshaft by drawing it onto the shaft by means of the camshaft gear retaining plate and setscrew. Turn the engine until No.1 piston is at T.D.C. i.e. with the crankshaft gear keyway at the top of its periphery.
3. Refit the idler gear to its hub ensuring that the timing marks on the crankshaft gear, fuel pump gear, camshaft gear and idler gear are correctly aligned as shown in Fig. 29.
4. Refit the idler gear retaining plate and secure with three setscrews to a torque setting of 21/24 lb.ft. (2.9/3.32 kg.m.).
5. Remove the camshaft gear retaining setscrew, fit a new lockwasher.
6. Refit the setscrew and tighten to a torque setting of 45/50 lb.ft. (6.23/6.91 kg.m.).
7. Secure the setscrew with the locking washer tab. Refit the timing case front cover as described previously.
8. Re-tighten the rocker assembly securing nuts and adjust the valve clearances to .012 (0.3 mm.) cold.

TO REMOVE FUEL PUMP GEAR

(2B/24)

1. Remove the timing case cover as described previously. Turn the crankshaft until all the timing marks are correctly aligned. (Refer to Fig. 29.).
2. Remove the three setscrews and spring washers which secure the gear to the fuel pump shaft. (Refer to Fig. 31).

TO REPLACE FUEL PUMP GEAR (See Fig. 32)

(2B/25)

1. Fit the gear by locating the dowel into the slot in the fuel pump shaft and align the tooth bearing the centre punch mark with the double centre punch marks on the idler gear.
2. Secure the gear with the three setscrews and spring washers.
3. Refit the timing case cover as described previously.

TO REMOVE CAMSHAFT

(2B/26)

Removal of the camshaft necessitates turning the engine upside down to prevent the tappets from falling into the sump during its removal. The engine will therefore need to be removed from the tractor and mounted in a dismantling stand suitable for this operation.

To remove the camshaft proceed as follows : -

1. Remove the engine from the tractor and mount in a suitable dismantling stand.
2. Remove the rocker cover, rocker assembly and push rods.
3. Remove the timing case front cover, timing gears and timing case (this involves removal of the fuel pump and timing cover securing setscrews). Turn the engine over to bring the sump uppermost.
4. Remove the fuel lift pump. (Refer to Fig. 3).
5. Remove the camshaft thrust plate from its location on the front on the cylinder block. (Refer to Fig. 34).
6. The camshaft may now be withdrawn from the cylinder block. Care should be exercised to avoid possible damage to the cams or journals during withdrawal. (Refer to Fig. 35).

TO REFIT CAMSHAFT

(2B/27)

1. Refitting the camshaft is a reversal of the removal procedure.
2. Carefully refit the camshaft into the cylinder block and refit the camshaft thrust plate, ensuring it is correctly positioned on the dowel.
3. Check the thrust plate protrusion beyond the front face of the cylinder block. This protrusion should be within the limits of .062/.066 in. (1.53/1.68 mm.).
4. Turn the engine to the normal upright position and refit the fuel lift pump.
5. Using new joints, refit the timing case, fuel pump, timing gears and timing case cover.
6. Finally refit the push rods, rocker assembly and adjust the valve clearance to .012 in. (0.3 mm.).
7. Refit the rocker cover then remove the engine from the dismantling stand and refit to tractor.

CAMSHAFT THRUST

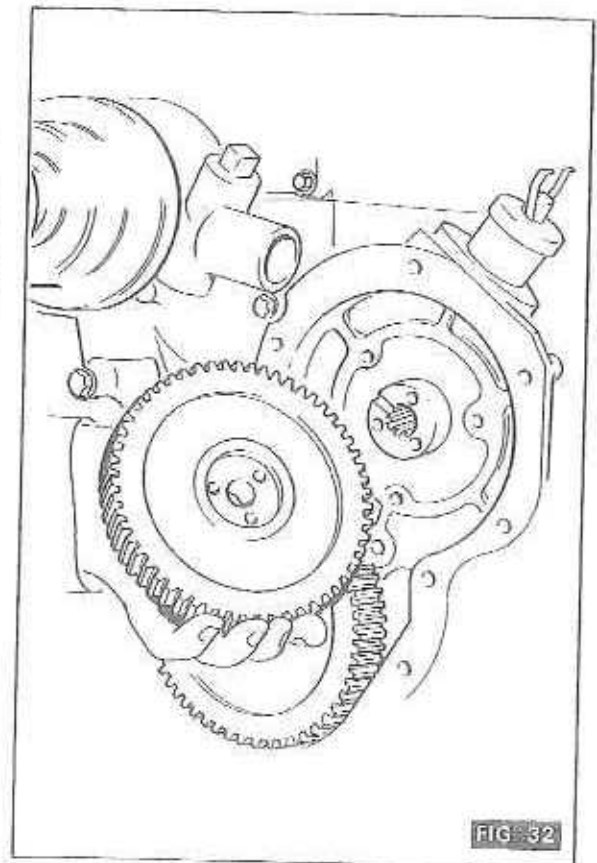
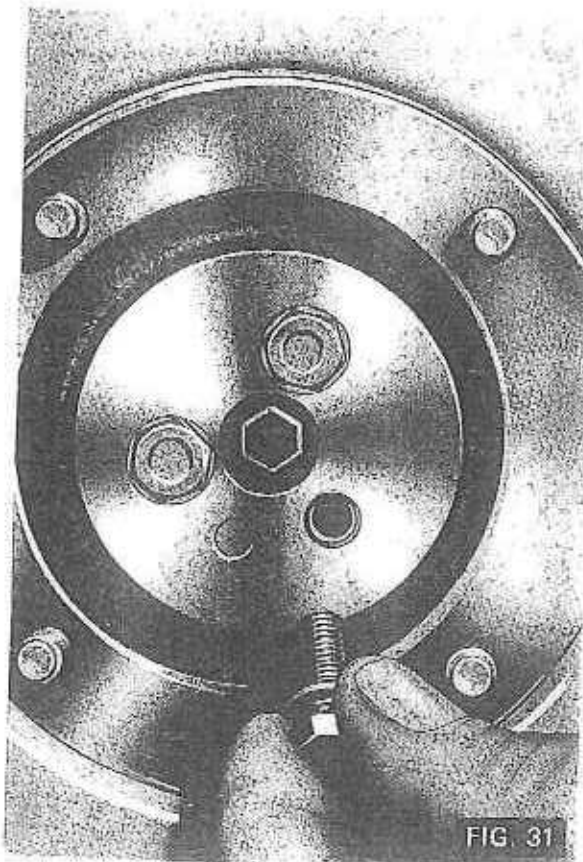
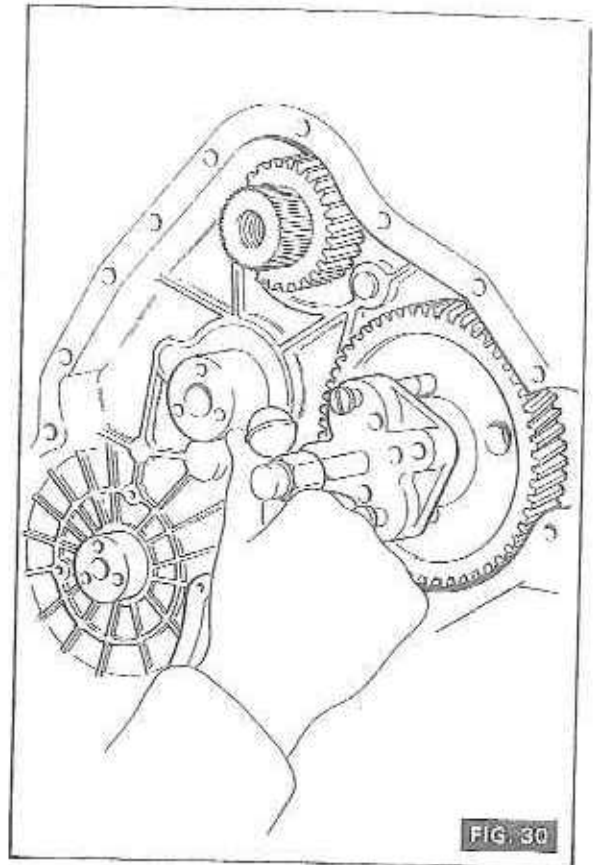
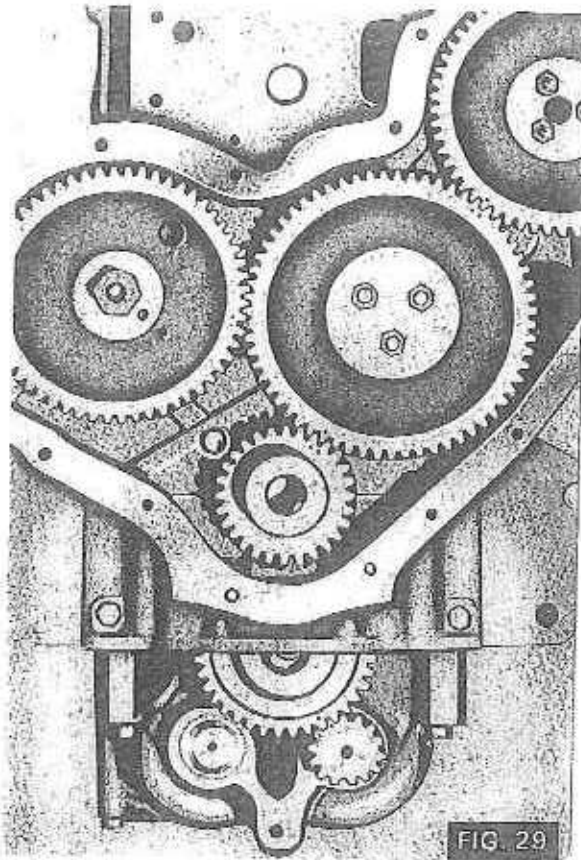
(2B/28)

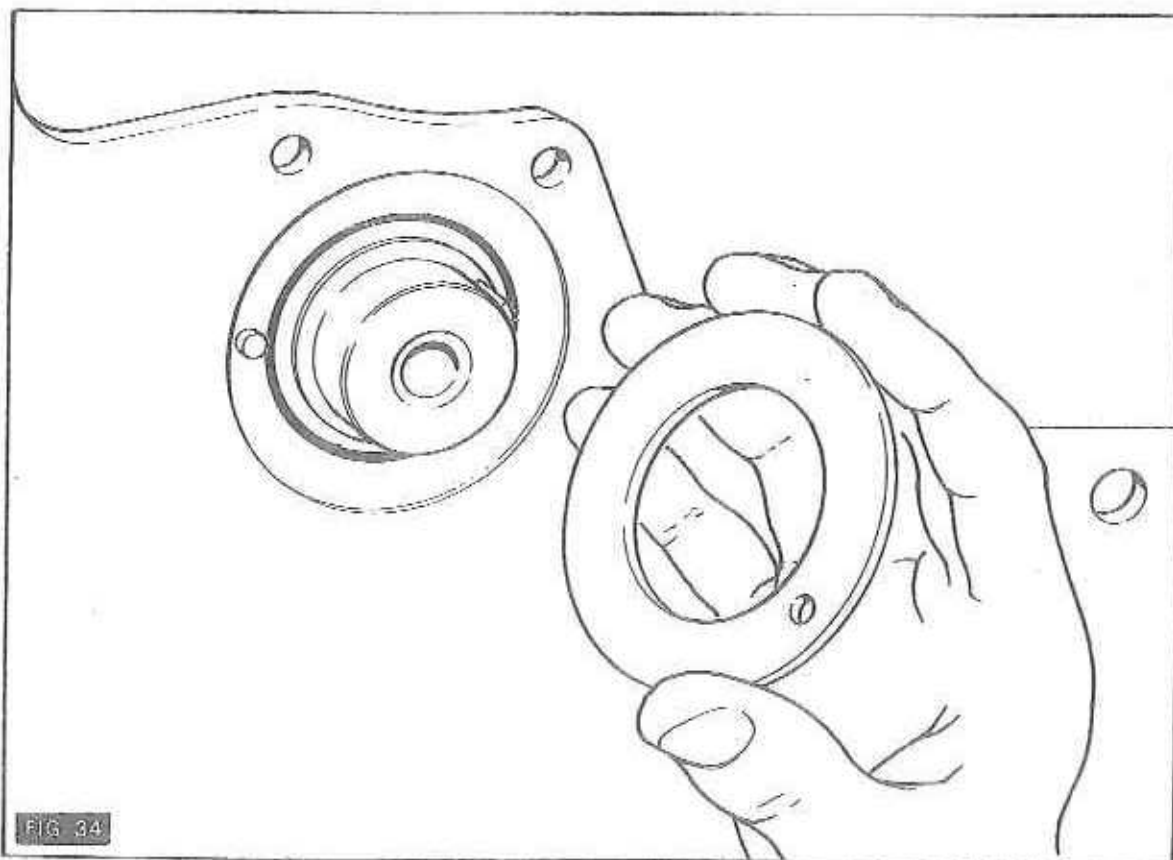
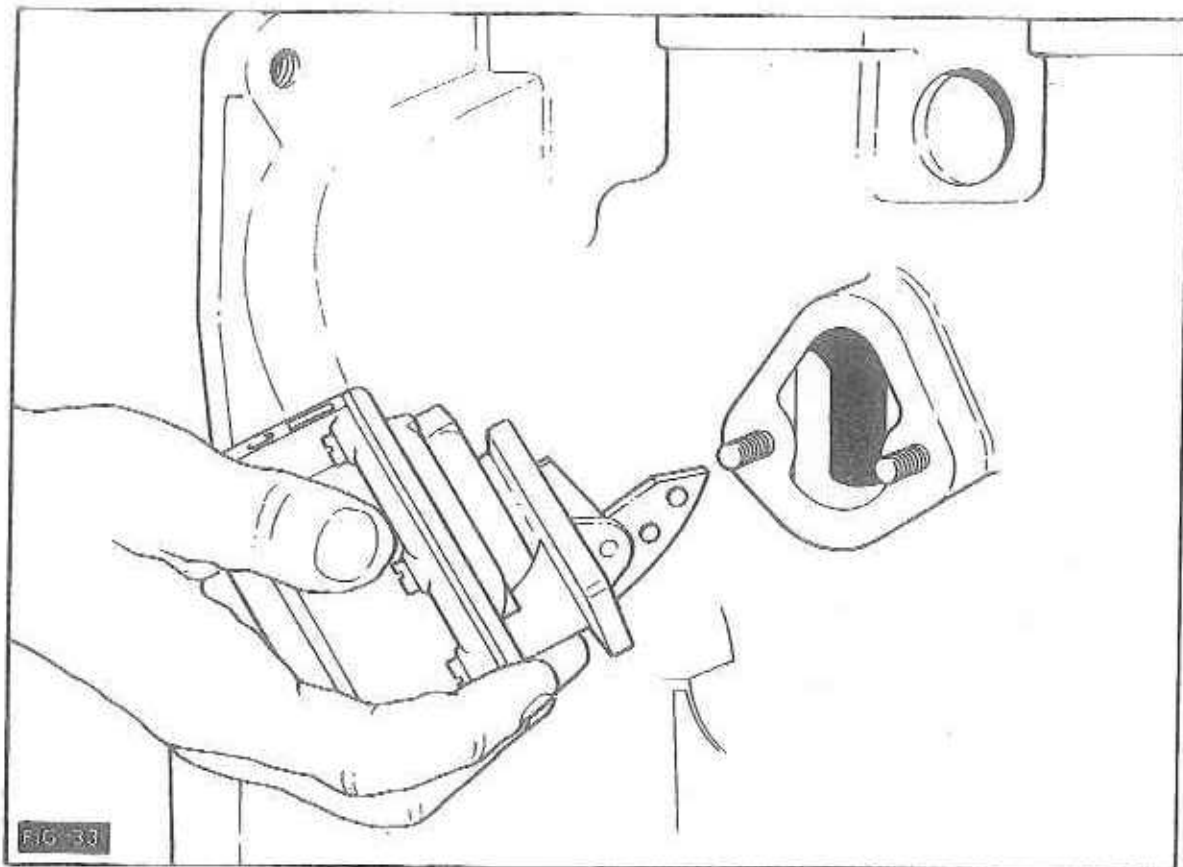
1. Camshaft end float is controlled by a thrust plate located in a recess machined in the front face of the cylinder block. The plate is dowelled to prevent rotation and is held in position by the timing case.

TO REMOVE TIMING CASE

(2B/29)

1. Remove the timing case cover and timing gears as described previously.
2. Remove the fuel pump.
3. Remove all the setscrews securing the timing case to the cylinder block, remove remaining setscrews securing the sump to the timing case.
4. Withdraw the timing case from the cylinder block taking care not to damage that portion of the sump joint in the process.





TO REPLACE TIMING CASE

(2B/30)

1. First ensure that the cylinder block and timing case faces are both perfectly clean.
2. Fit the timing case to the cylinder block, using a new joint.
3. Replace the setscrews securing sump to timing case and timing case to cylinder block.
4. Secure the setscrews, starting with those securing sump to timing case, then timing case to cylinder block.
5. Firmly tighten the securing setscrews in that order.
6. Refit the fuel pump as described in the appropriate section.
7. Refit the timing gears and front cover, as previously described.

VALVE AND FUEL INJECTION TIMING

(2B/31)

1. The fuel injection static timing point is at 22° B.T.D.C., this point being clearly marked on the flywheel.

TO CHECK VALVE TIMING

(2B/32)

1. To check the valve timing, turn the crankshaft until the valves of No. 4 cylinder are rocking. In this position, set the clearance of No. 1 inlet valve to .021 in. (.533 mm).
2. Now turn the crankshaft in the normal direction of rotation until the push rod of No. 1 cylinder inlet valve just tightens. Check that Nos. 1 and 4 pistons are at T.D.C. $\pm 2.1/2^\circ$. When the valve timing has been checked, reset the valve clearance on No. 1 cylinder inlet valve to .010 in. (0.254 mm.) hot.

Note

There is no adjustment provided for valve timing. Should the timing be incorrect, then the gears can only be one or more teeth out of correct mesh.

3. With all the timing gear marks aligned, check that the scribed line on the fuel injection pump coincides with the scribed line on the rear of the timing case.

TO REMOVE THE FLYWHEEL

(2B/33)

1. Separate engine from transmission housing. Remove clutch and clutch cover.
2. Straighten out locking washers and remove six flywheel securing setscrews.
3. Remove flywheel.

TO RENEW FLYWHEEL RING GEAR

(2B/34)

1. The flywheel ring gear is a shrunk fit on the flywheel and to remove it partly cut through the gear and chisel cut it from the flywheel. Alternatively, localized heat in flame form should expand the ring gear sufficiently to tap it off the flywheel.
2. Clean the ring gear location on the flywheel face. Heat the new ring gear to a temperature of no greater than 475°F. (210.3°C.).
3. Fit the gear over the flywheel with the lead on the teeth facing the engine side of the flywheel and allow to cool.

TO REPLACE FLYWHEEL

(2B/35)

1. It is most important before fitting a flywheel that the crankshaft flange face and periphery are perfectly clean and free from burrs. Failure to observe these conditions may result in damage due to the flywheel running out of true.
It will be noted that the flywheel will only fit the crankshaft flange in one position as the securing holes are offset.

TO REPLACE FLYWHEEL . . . Cont'd

2. Offer the flywheel to the crankshaft flange and engage the six securing setscrews using new locking washers and tighten sufficiently to hold the flywheel to the crankshaft.
3. It is essential that the flywheel runs true so before tightening and locking the setscrews, the run-out should be checked with a dial indicator and the total indicator reading should not exceed .012 in. (0.30 mm.) when checking the run-out on the periphery as shown in Fig. 36.
4. When checking the run-out on the clutch face as shown in Fig. 37 the total indicator reading should not exceed .001 in. (.025 mm.) per inch (25.4 mm.) of radius from the flywheel centre to the stylus of the dial indicator. It is advisable to apply pressure to the centre of the flywheel to eliminate crankshaft end float.
5. If flywheel run-out exceeds the specified limits, the flywheel must be removed and the mating faces checked for dirt or burrs. Refit the flywheel and again check the run-out.
6. When satisfied that the flywheel is running true, use a suitable torque wrench and tighten the six securing setscrews to a torque of 75 lb.ft. (10.37 kg. m.).
7. Lock the setscrews with tabwashers.
8. Replace clutch assembly and rebuild engine to tractor.

TO REMOVE CRANKSHAFT REAR OIL SEAL

(2B/36)

1. Separate engine from transmission housing.
2. Remove clutch assembly and flywheel.
3. Release and remove the two clamping setscrews which pass through the two halves of the rear oil seal housing.
4. Unscrew the setscrew from each half housing and remove the housing from the rear of the cylinder block and rear main bearing bridge piece.

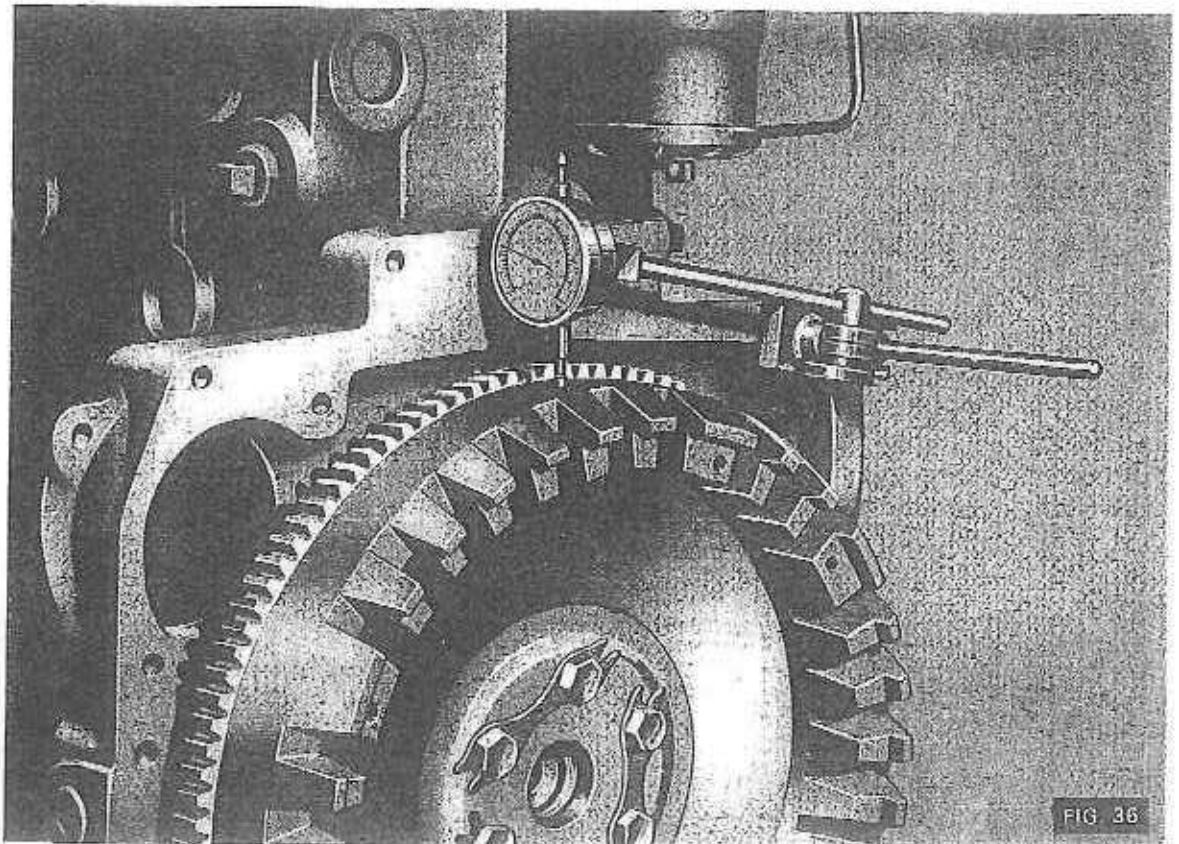
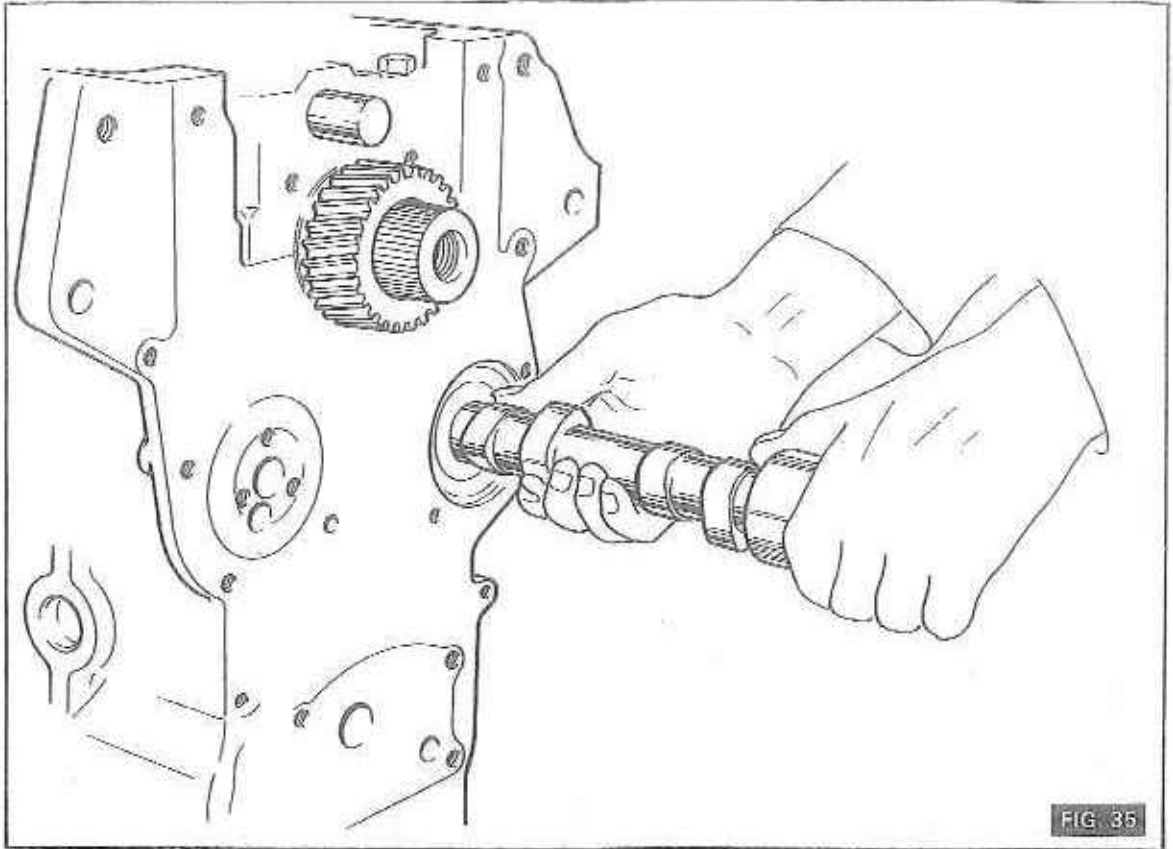
TO REPLACE CRANKSHAFT REAR OIL SEAL

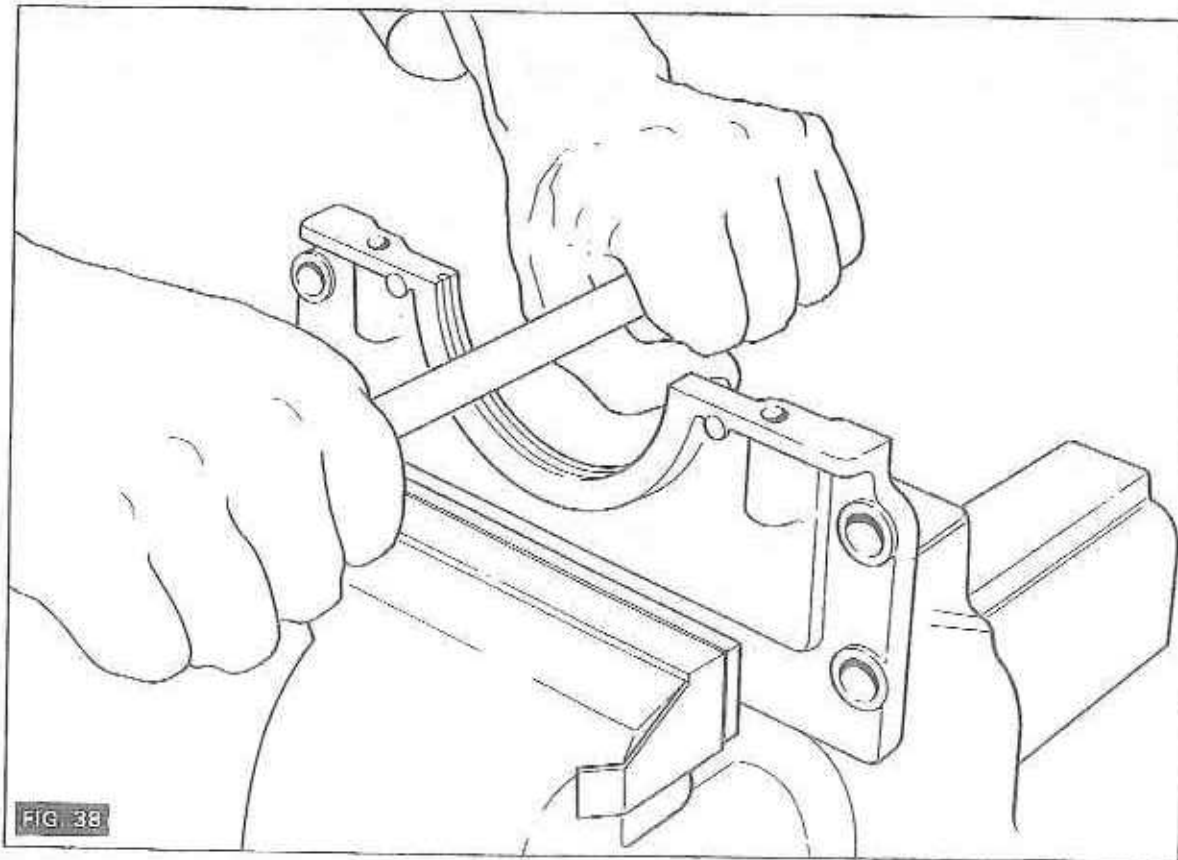
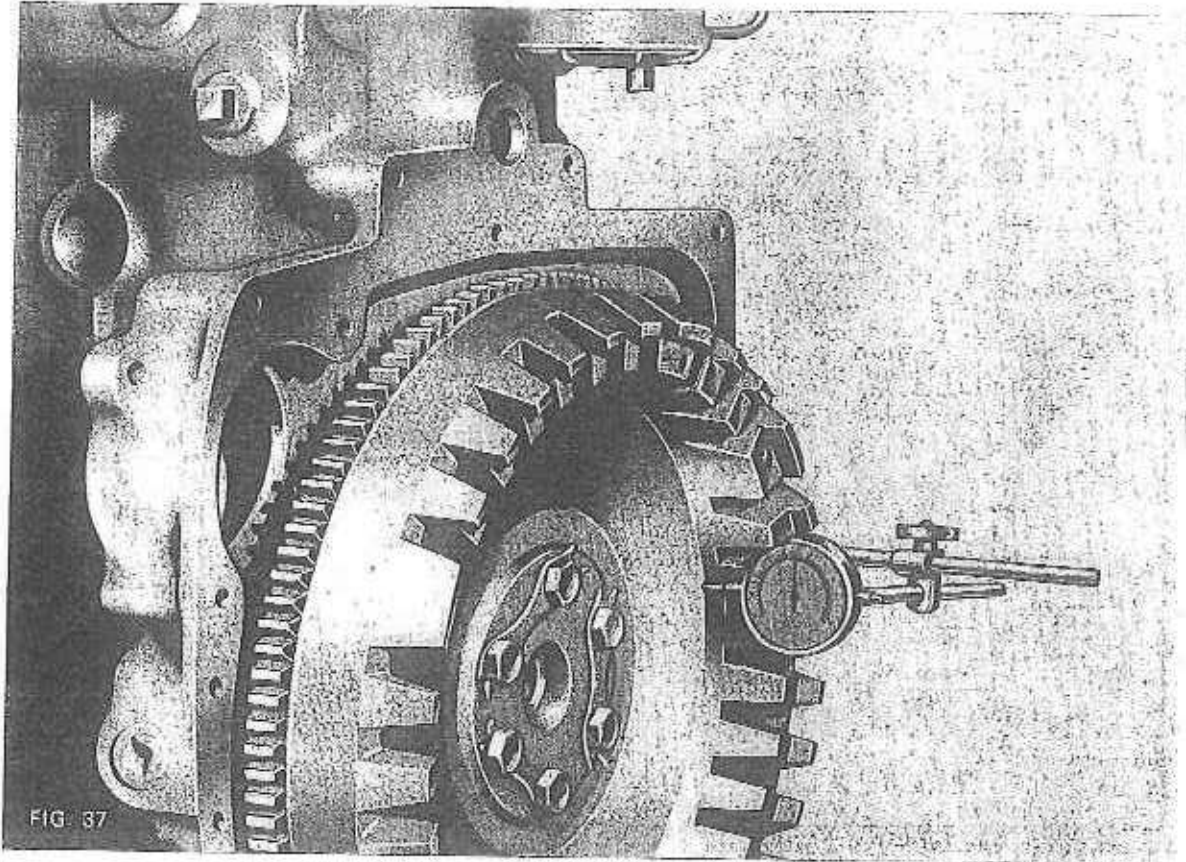
(2B/37)

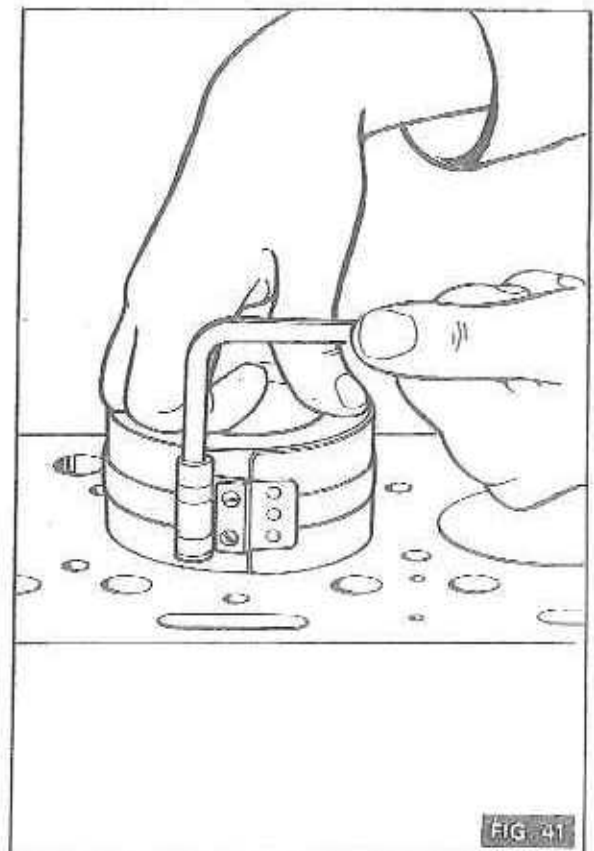
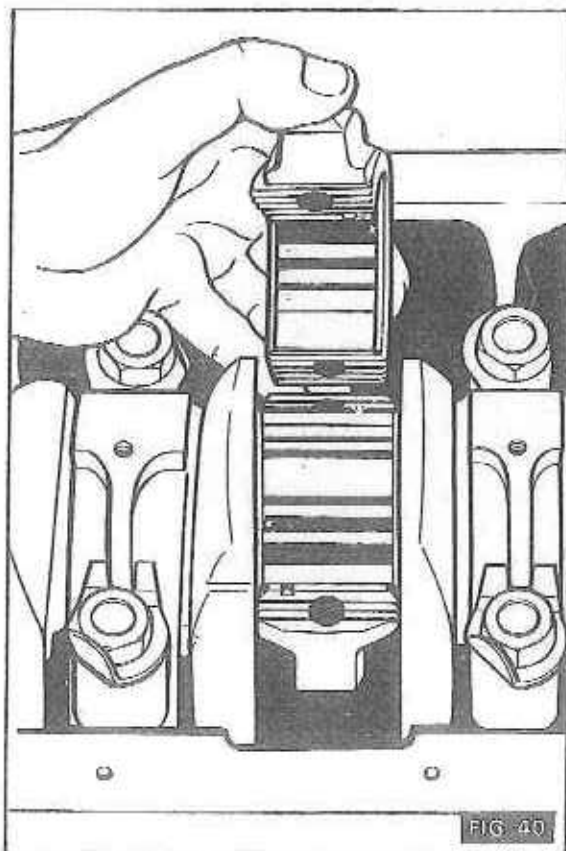
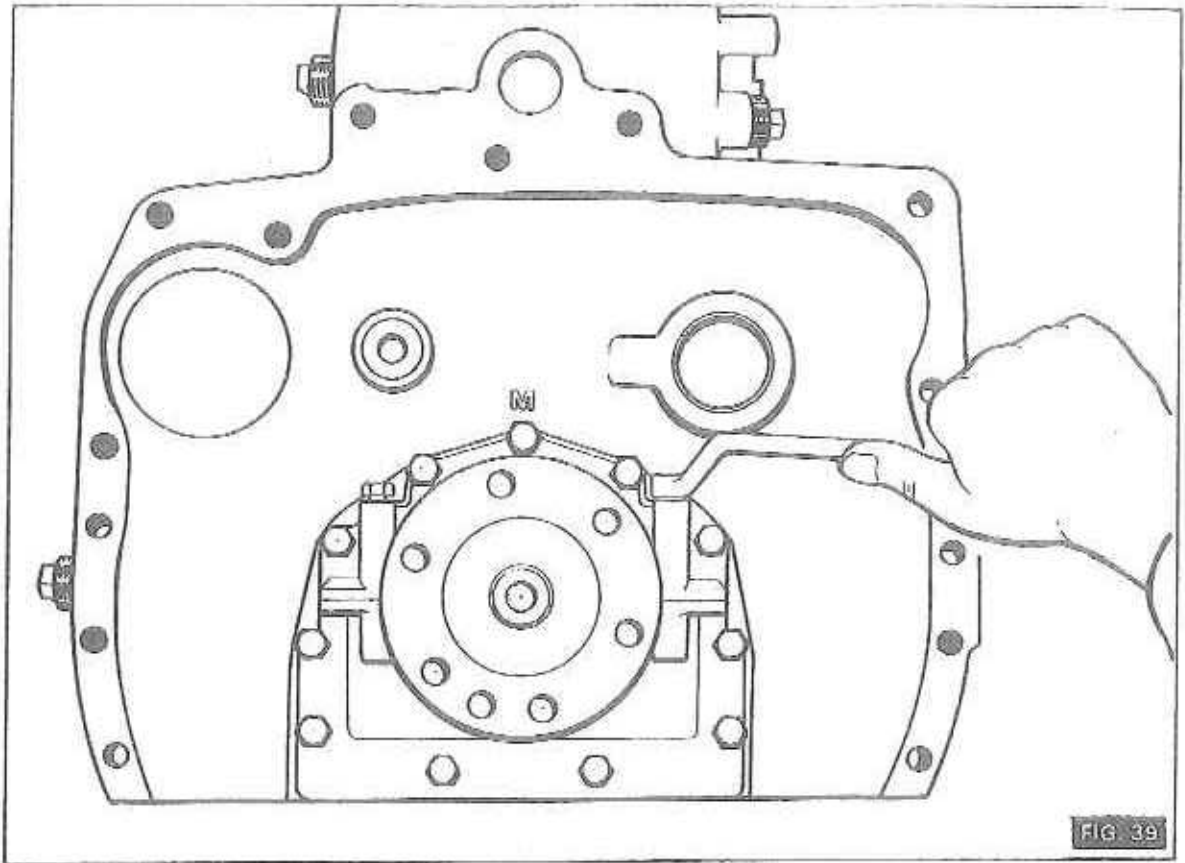
The bore of the rear oil seal housing is machined to accommodate a rubber cored asbestos strip. The strip consists of two sections, one for each half of the oil seal housing.

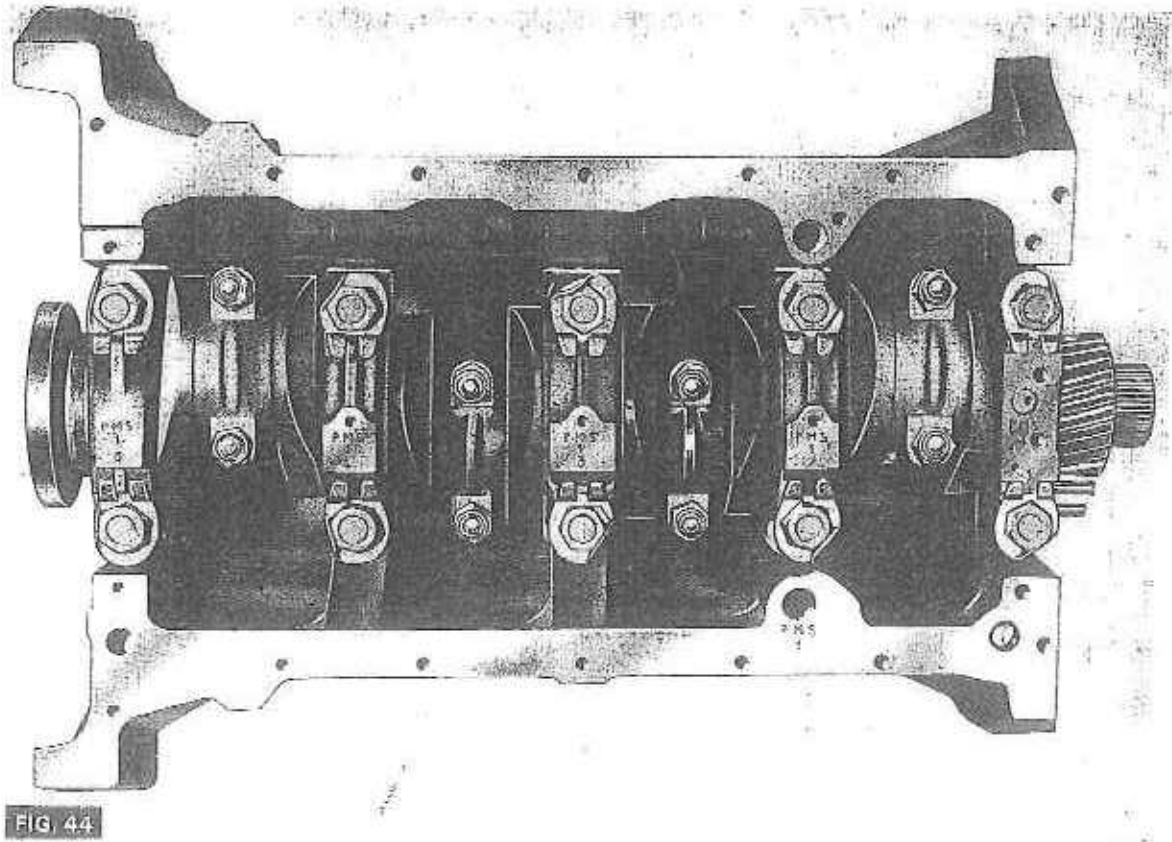
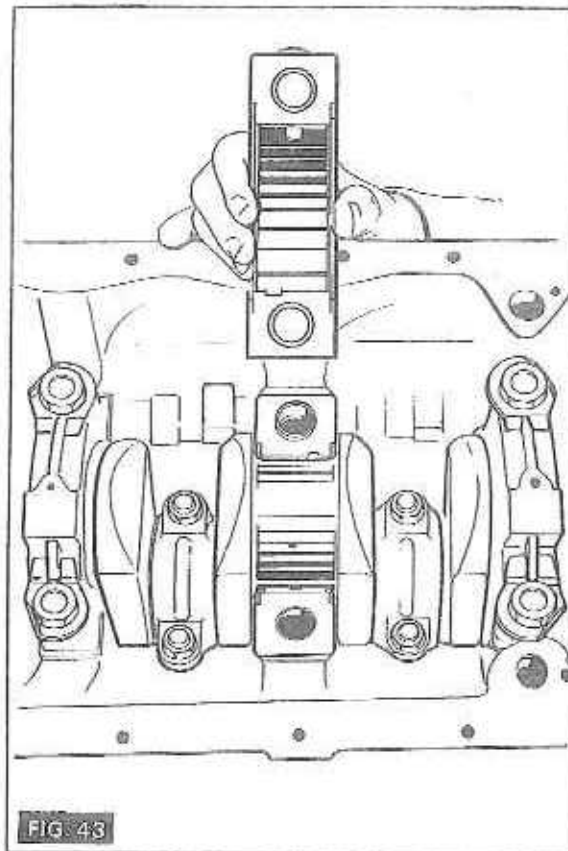
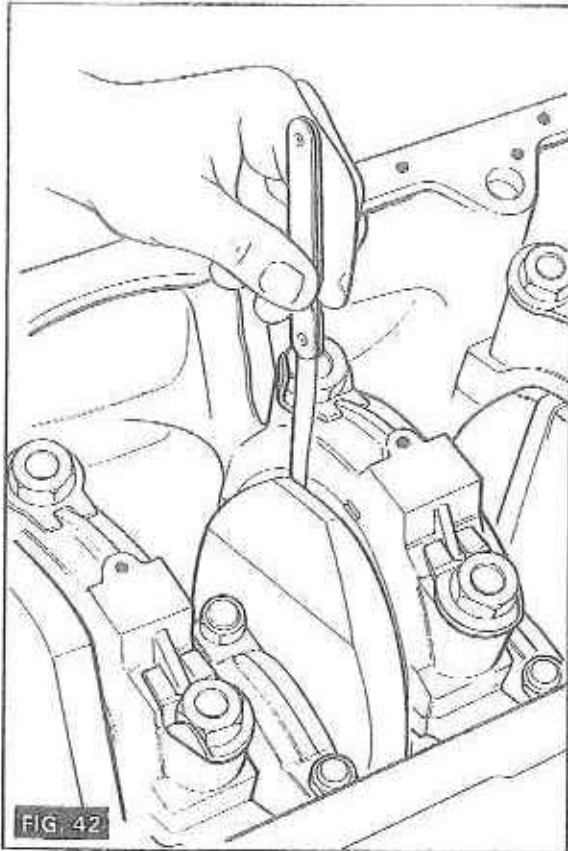
To fit new seals, proceed as follows :—

1. Set up half housing in a vice with the seal recess uppermost.
2. Settle approximately 1 in. (25 mm.) of the strip at each end, into the ends of the groove ensuring that each end of the strip projects .010/.020 in. (.25/.50 mm.) beyond the half housing joint face. Allow the middle of the seal to bulge out of the groove during this operation.
3. With the thumb or finger, press the remainder of the strip into the groove working from the centre. Then use any convenient round bar to further bed in the strip by rolling and pressing its inner diameter. This procedure takes advantage of the friction between the strip and the grooves at the ends to compact the strip whilst ensuring that the projection of the end faces of the strip remain as set. (See Fig. 38).
4. Fit the sealing strip to the other half housing in a similar manner.
5. Remove all traces of the old joint from the rear face of the cylinder block and fit a new joint treated with suitable jointing compound.
6. Spread a film of graphite grease over the exposed inside diameter surface of the sealing strips.
7. Assemble the half housing around the rear of the crankshaft and fasten together by means of the two setscrews.
8. Swivel the complete seal housing on the shaft to bed in the strips and to establish that the assembly turns easily on the shaft.
9. Bolt the seal housing in position on the block and rear main bearing cap bridge piece and finally tighten the setscrew. (see Fig. 39).
10. Refit flywheel and check run-out. Replace clutch assembly.
11. Rebuild engine to tractor.











V L CHURCHILL

OPERATING INSTRUCTIONS - PD 145A /H/E/ CRANKSHAFT REAR OIL SEAL REPLACER

1. Reference should always be made to the appropriate Workshop Manual..

2. FITTING NEW SEAL

- a. Unless the crankshaft oil seal journal has been re-ground a new seal should never be fitted flush or to the same depth as the previous seal. Neither should it be fitted to the 3mm position if the previous seal was fitted to the 6mm position.
- b. Lubricate the outside diameter of the seal and fit into its housing to the desired depth.
- c. Lubricate bore of seal with clean engine oil and carefully push it on to guide.
- d. Lubricate the crankshaft journal with clean engine oil.
- e. Holding the guide onto the end of the crankshaft, push seal/housing assembly into position.
- f. Remove guide.

3. FITTING NEW SEAL, IN SITU

- a. Unless the crankshaft oil seal journal has been re-ground a new seal should never be fitted flush or to the same depth as the previous seal. Neither should it be fitted to the 3mm position if the previous seal was fitted to the 6mm position.
- b. Lubricate outside diameter and bore of seal with clean engine oil and carefully push it onto the guide.
- c. Lubricate the crankshaft journal with clean engine oil.
- d. Holding the guide on to the end of the crankshaft, push seal on to crankshaft journal and remove guide.
- e. Fit adaptor ring over the crankshaft with the appropriate depth stop towards the seal.
- f. Fit disc to end of crankshaft using the existing screws and progressively tighten each a few turns at a time until the shoulder of the adaptor ring abuts the face of the oil seal housing.
- g. Remove screws, disc and adaptor ring.

V L CHURCHILL LIMITED P O BOX 3 DAVENTRY NORTHANTS NN11 4NF ENGLAND

Telephone: Daventry (03272) 4461 Telex: 31326

ALL



W L. CHURCHILL LTD.
 TRUCKS, BUSES, TRAILERS

DESPATCH NOTE

ORDER No.

To 72?

C 72004

PLEASE QUOTE THESE NUMBERS ON
 ALL CORRESPONDENCE REGARDING THIS
 INVOICE

KELLANDS (PLANT SALES) LTD.
 SALMON PARADE,
 BRIDGWATER,
 SOMERSET,
 TA6 5TY.

SAME.

Payment To: VL Churchill Ltd

P.O. Box No.3 London Road
 Daventry Northants England
 NN11 4NF

telephone: Daventry 4461
 telex: 31326

V.A.T. Regn. No. 119 2860 65

YOUR ORDER No. & DATE 62329		9.9.83		37/2		CARRIAGE CHARGE		SHIPPED BY		INVOICE DATE TAX POINT DATE	
SYMBOL		DESCRIPTION						VAT CODE		QUANTITY ORDERED	
PD		PD 145B WAS IN FACT A C. INSERTER PD145C W/SHP TOOLS						B		1	
											
										3 holes to see studs nuts to draw in the rods to the choice of two depths by reaming	

UNIT PRICES EXCLUDE V.A.T.

CODE	GOODS VALUE	VAT	VAT CODE	GOODS VALUE	VAT	PRE VAT
%	£	£	B - %	£	£	VAT TOT
%	£	£	D - %	£	£	INVOICE

TO REMOVE CONNECTING ROD AND PISTON ASSEMBLIES

(28/38)

1. Remove the cylinder head assembly.
2. Remove the lubricating oil sump.
3. Remove lubricating oil pump strainer, suction pipe and relief valve pipe.
4. Turn the engine crankshaft until two big ends are at bottom centre and then remove the self locking nuts from the big end bolts. Remove the big end caps. (see Fig. 40).
5. Remove bearing shells and big end bolts. If the bearing shells removed are serviceable, care must be taken to refit them to their original positions.
6. Push pistons and connecting rods out of the top of the cylinders.
7. Turn the engine crankshaft until the next two big ends are at bottom centre and repeat the removal operations.

Note

Carbon deposits around the top of the cylinder bores should be removed before attempting to remove the pistons. Keep each piston and connecting rod assembly separate, in respective pairs as marked.

TO REPLACE CONNECTING ROD AND PISTON ASSEMBLIES

(28/39)

1. Clean out the cylinder bores with a clean, dry, non-fluffy rag and apply a liberal coating of lubricating oil to each cylinder bore.
2. Fit the piston rings to each piston, an oil control ring above the gudgeon pin, a cast iron internally stepped ring in the third, a cast iron in the compression ring groove and the chrome plated compression ring to the top groove.
3. Position all ring gaps around the piston so that they are equally spaced.
4. Ensure that each piston is thoroughly clean and free from scoring. Liberally oil.
5. Using a piston assembly ring compressor (Tool No. 38 UX), fit piston and connecting rod assemblies in their respective cylinder bores (see Fig. 41). Check that the word "FRONT" on the crown of the piston is towards the front of the engine; also that the number on the connecting rod is to the fuel pump side of the engine.
6. Turn the crankshaft until the relative big end journals are at bottom centre.
7. Liberally oil and fit the top half bearing to the connecting rod, ensuring the tongue on the bearing engages in the machined recess in the big end bore.
Pull the connecting rod to the crankshaft and fit the big end bolt ensuring they are correctly located. The bolt heads are so machined that they locate on the connecting rod in one position only.
8. Liberally oil and locate the lower half big end bearing in the connecting rod cap with the tongue registering in the machined recess. Fit the cap to the connecting rod with the stamped numbers together.
9. Using new self-locking nuts, secure the cap to the connecting rod and tighten to a torque of 65/70 lb.ft. (8.99/9.68 kg.m.).
10. Refit relief valve, delivery pipe, suction pipe and strainer; engine lubricating oil sump and cylinder head assembly.

TO REMOVE A PISTON FROM A CONNECTING ROD

(28/40)

1. In production, the crown of each piston is stamped with a number denoting its position in the engine, No. 1 piston being at the front. The number on the piston crown is the same as that on the corresponding connecting rod and cap.
2. Check that the piston is numbered, as it may have been installed some time after the engine left the factory, without being marked. If the piston is to be used again, ensure that it is marked relative to the connecting rod so that it can be replaced in the same position on the rod.
3. Remove the two circlips retaining the gudgeon pin in the piston.
4. Warm the piston in hot water or oil at a temperature of 100° / 120°F. (38° - 49°C.) and push out the gudgeon pin.

(2B/41)

TO FIT PISTON TO A CONNECTING ROD

1. With the piston thoroughly clean, fit one new circlip in position in the piston.
2. Heat the piston in hot water or oil at a temperature of 100° / 120° F. (38° - 49° C.) to allow easy assembly of the pin.
3. Insert the connecting rod between the gudgeon pin bosses so that cavity in the piston crown is towards the side of the connecting rod which carries the rod and cap identification numbers.
4. Insert the gudgeon pin and fit the second circlip to the piston.
5. Ensure both circlips are fully located in their grooves.

(2B/42)

TO RENEW CONNECTING ROD BEARINGS

1. Connecting rod big end bearings may be renewed without removing the piston and connecting rods from the engine. The bearings are available in standard sizes and in undersizes of .010 in. (25 mm.), .020 in. (.51 mm.) and .030 in. (.76 mm.).
2. Remove lubricating oil sump strainer, suction pipe and relief valve pipe.
3. Turn the crankshaft to bring the required big end to bottom centre.
4. Remove the self locking nuts and detach the connecting rod cap. Push up the connecting rod sufficiently to clear the crankpin and move the big end to one side. The upper half bearing may now be removed from the connecting rod and the new one inserted with the tongue of the bearing located in the machined recess in the big end bore.
5. The lower half of the bearing may be extracted from the cap and a new one inserted, engaging the tongue of the bearing in the machined recess in the cap. Both top and bottom half bearings are interchangeable when new, but after service, if they are to be used again, must be kept to their respective positions in rod and cap.
6. Liberally lubricate the top half bearing and pull home to crankpin.
7. Similarly lubricate cap half bearing and replace big end cap with the stamped numbers on connecting rod and cap together.
8. Ensure that the cap bolts are fully located with the bolt heads against the sides of the rod.
9. Fit new self locking nuts and tighten with a torque wrench to a torque of 85/70 lb.ft. (8.99/9.68 kg.m.).
10. Fit relief valve delivery pipe, suction pipe and strainer.
11. Replace lubricating oil sump.

(2B/43)

TO REMOVE AND REPLACE GUDGEON PIN BUSH

In addition to examining visually the connecting rod for damage, the small end bush should be checked for condition and the fit on its gudgeon pin. Should renewal of the bush be necessary proceed as follows :-

1. Using Tool No. PD.42B and Adaptor PD.42B-4, remove the old bush by pressing in a new one. The oil hole in the new bush should be carefully aligned with the feed drilling in the top of the connecting rod. Remove old bush from removal tool before attempting a further removal.
2. Before reaming the new bush to size, check connecting rod for alignment as previously described.

(2B/44)

TO REMOVE CYLINDER LINERS

1. Remove cylinder head as previously described.
2. Remove pistons and connecting rod assemblies, crankshaft and all component parts of the cylinder block.
3. Remove the cylinder head studs from the cylinder block.
4. By means of cylinder liner removal tool No. PD.150 and adaptor tool No. 150-2 remove the liners from the cylinder block. The aforementioned tool will easily cope with service liners which are a transitional fit in the cylinder block and may also be used for the occasional removal of production liners which are an interference fit. Where it is necessary to remove a full set of production liners, then the use of a heavy duty press is recommended.
5. The cylinder liner removal tool can also be used for the replacement of cylinder liners.

PREPARATION FOR FITTING NEW LINERS

(2B/45)

1. Great care must be taken in handling, transit and storage of new service liners as the slightest burr or damage to the outside diameter of the liner is sufficient to cause considerable local distortion of the liner bore when fitted.
2. After removing the old liners, the parent bore of the cylinder block must be thoroughly cleaned, as must be the top recess for the liner flange.
3. A check must be made to ensure that the whole area of contact with the liners in the cylinder block is free from burrs or damage.
4. Ensure that the new liner is thoroughly cleaned before fitting. If kerosene is used to wash the liner, it is important that the liner be thoroughly dried and well oiled before fitting.
5. Throughout the complete operation, extreme cleanliness is essential as the smallest particle of dirt or foreign matter is sufficient to cause local distortion of the cylinder bore.

TO FIT NEW LINERS

(2B/46)

1. Using clean engine oil, lubricate the cylinder bore and the external surfaces of the cylinder liner. This oil should be applied with a pressure gun or by hand. A brush or cloth must not be used for this purpose.
2. Press in the new liner by means of a press, ensuring that the flange at the top of the liner does not foul the counter-bore at the top of the parent bore, thus causing distortion at the top of the internal diameter of the liner.
3. When fully home, the top face of the liners should protrude .030 / .035" (0.762 / 0.889 mm.) above the top face of the cylinder block.
4. Bore and hone the production liner to size.
5. It is advisable to allow a settling period to elapse before checking the fitted internal bore diameter of the liner. The acceptable limit is 3.877 / 3.878" (98.48/98.50 mm.). If on checking, the bore diameter of the prefinished liner is found to be within the above limits, it should be honed to the correct size.
6. Each liner should be checked in three positions — top, centre and bottom.
7. Having fitted the new liners, the remainder of the re-assembly operations are a reversal of the removal procedure.

Note

For engines undergoing a complete overhaul, it is recommended that production liners be obtained and fitted.

TO RENEW MAIN BEARINGS WITH CRANKSHAFT IN POSITION

(2B/47)

Under normal circumstances, by the time the main bearings require renewing, the crankshaft will need to be removed for regrinding. However, renewal of the main bearings can be carried out without removing the crankshaft. Proceed as follows. :-

1. Remove lubricating oil sump, strainer, suction pipe, relief valve and delivery pipe.
2. Remove the cap of the bearing to be removed. No more than one bearing cap may be removed at a time. Should No. 1 cap require removal, the oil pump must be removed as described previously.
3. Slacken the remaining bearing cap setscrews.
4. Remove the top half of the bearing by rotating it on the crankshaft, applying a suitable soft tool, e.g. wood, to the side opposite the locating tongue. The main bearing locating recesses are machined in the cylinder block on the camshaft side.
5. Remove the lower half bearing from its cap.
6. Liberally oil the new bearings to be fitted.
7. Fit the new top half by rotating it on the crankshaft, inserting the plain end first, pushing it into position with the soft tool.
8. Fit the bottom half bearing to cap.
9. Replace the cap, using new tabwashers, and tighten the setscrews lightly before proceeding to the next bearing.

TO RENEW MAIN BEARINGS WITH CRANKSHAFT IN POSTION . . . Cont'd

10. To gain access to the rear main bearings, the rear main bearing bridge piece must be removed. This is secured by two recessed setscrews to the cylinder block and the two lower rear main oil seal housing securing setscrews.
11. Having completed the bearing replacement operation, tighten the setscrews to a torque of 140/150 lb.ft. (19.35/20.74 kg.m.) and to the tabwashers.

TO SET CRANKSHAFT END FLOAT

(2B/48)

Crankshaft end float is controlled by detachable thrust washers, fitted each side of the centre main bearing cap and cylinder block half housing.

The lower halves of these thrust washers fitted to the centre main bearing cap have suitable locating lugs to prevent them from turning out of position.

1. Fit the crankshaft thrust washers to each side of the bearing housing with the vertical oil grooves facing outwards. The lower half thrust washers are replaced by removing the centre main bearing cap.
It is not necessary to remove the crankshaft to replace these thrust washers, as it is possible to slide the upper halves out by rotating the crankshaft using a soft tool in a similar manner to main bearing replacement.
2. To check crankshaft end float, push the crankshaft forward as far as it will go and, by means of feeler gauges, check the gap between the machined shoulder on the crankshaft web and the crankshaft thrust washer as shown in Fig. 42. Production limits for crankshaft end float are .002 in. to .014 in. (0.05/0.36 mm.).

TO REMOVE CRANKSHAFT

(2B/49)

1. Separate the engine from the tractor.
2. Remove the clutch assembly, flywheel, lubricating oil sump and strainers.
3. Remove the timing gears, timing case and lubricating oil pump.
4. Remove the connecting rod caps and big end bearings.
5. Remove the setscrews securing the two halves of rear main oil seal housing.
6. Remove the lower half of the rear main oil seal housing.
7. Take off the rear main bearing bridge piece.
8. Knock back the tab washers locking the main bearing setscrews and remove the setscrews.
9. Remove the main bearing caps and half bearings. (see Fig. 43).
10. Lift out crankshaft and remove the other half bearings.

TO REGRIND THE CRANKSHAFT

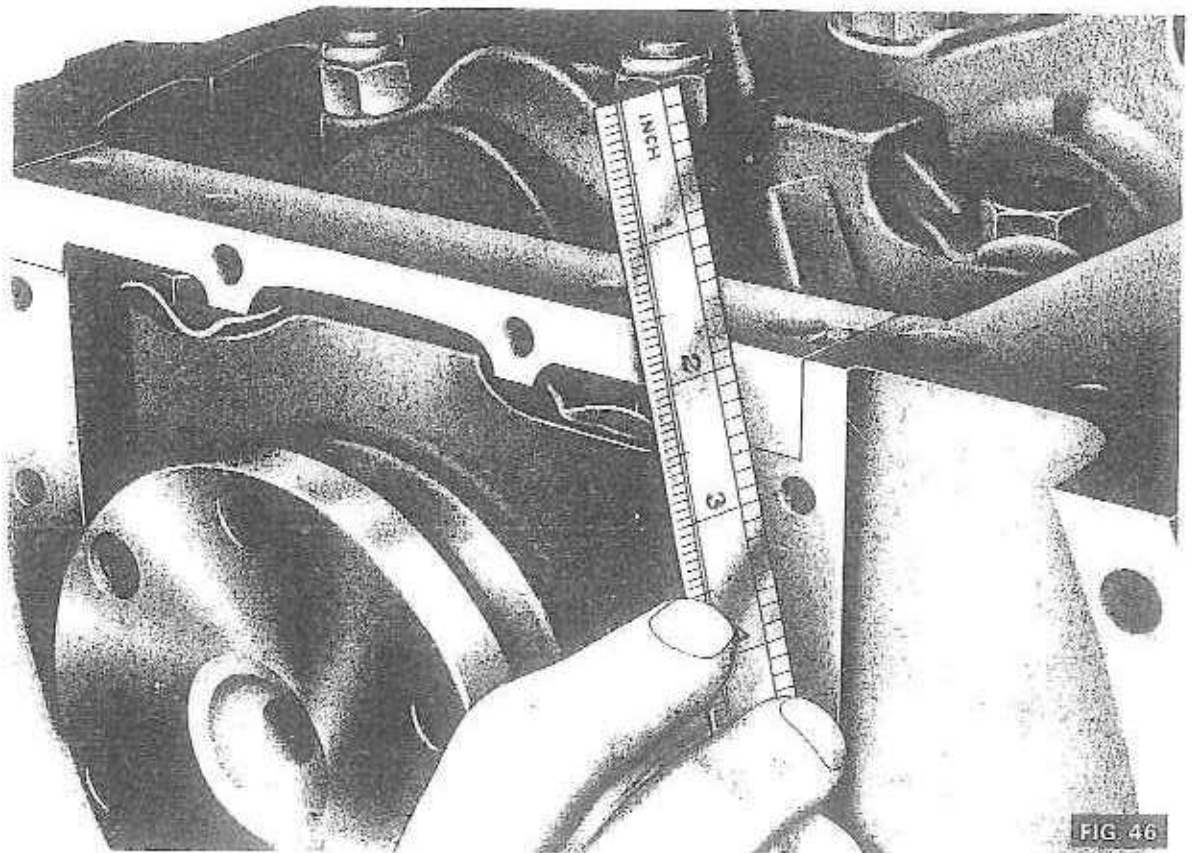
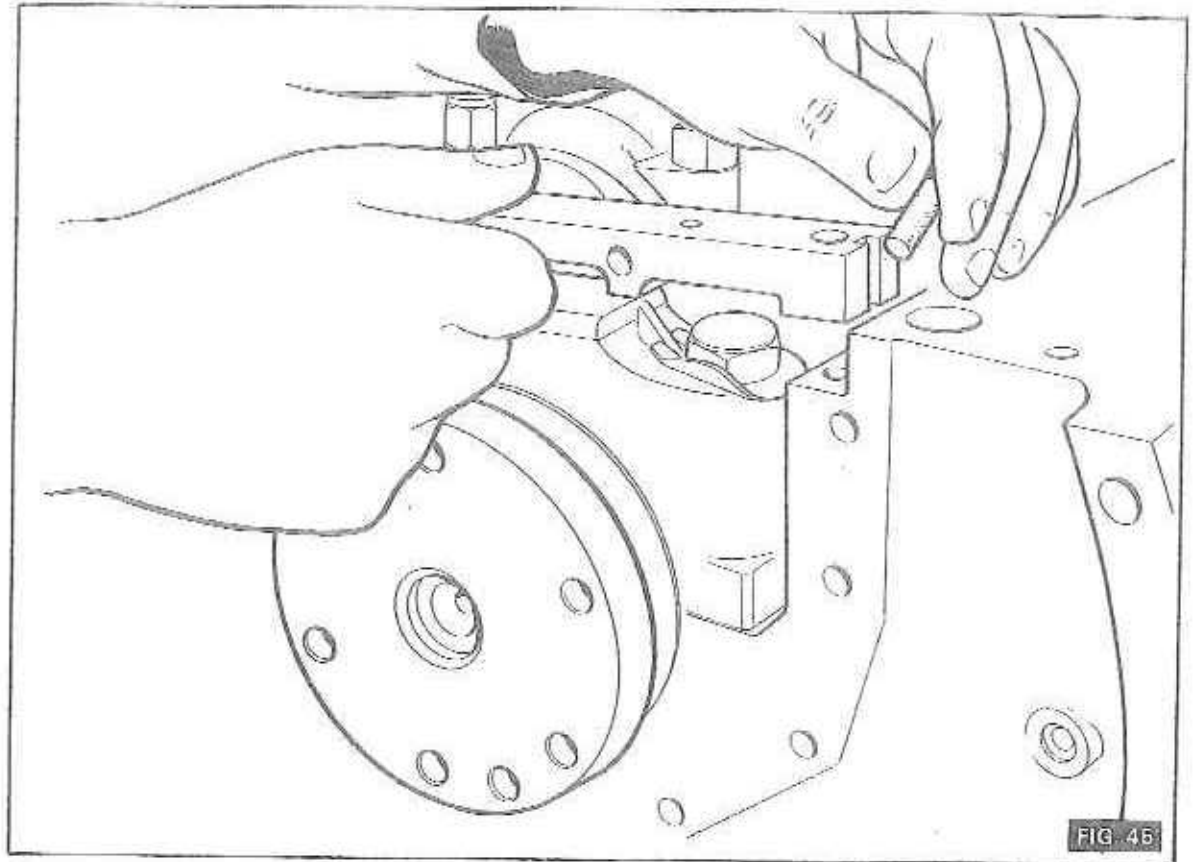
(2B/50)

1. Check the crankshaft main bearing and crankpin journals to determine the size to which the crankshaft must be reground.
2. Crack detect the crankshaft.
3. Demagnetize before proceeding with the regrinding.

TO REPLACE THE CRANKSHAFT

(2B/51)

1. Ensure all oilways are free from obstruction. Check the main bearing setscrews for stretch or damage to threads. In no case should setscrews other than those supplied by the engine manufacturer be used as they are of a special heat-treated high grade steel.
2. Clean the bearing housings and place top half bearings in position.
3. Liberally oil the bearing with clean oil.
4. Place the crankshaft in position.



TO REPLACE THE CRANKSHAFT . . . Cont'd

5. Oil the two upper thrust washer halves and slide them into the recesses provided on either side of the centre main bearing housing.
6. Fit the lower halves of the main bearings to the bearing caps. Oil the bearings and place the caps in their respective positions ensuring that the lower halves of the thrust washers are correctly positioned on either side of the centre main bearing cap. When replacing the main bearing caps, ensure they are fitted the correct way round. The caps are numbered commencing at the front of the engine. Each cap is also marked with a serial number as stamped on the cylinder block bottom face. (see Fig. 44).
7. It will have been noted during dismantling that a shim washer is fitted between the head of the main bearing setscrews and the tab washers. This shim washer is fitted to reduce the tendency of the tab washer to turn during tightening of the setscrew.
8. Fit a new shim washer and tabwasher to each setscrew and fit the setscrews to the cylinder block.
9. Tighten evenly the main bearing setscrews to a torque wrench setting of 140/150 lb.ft. (19.35/20.74 kg.m.). Lock the setscrews in position by means of the tab washers.
10. Check the crankshaft end float to ensure that a clearance of .002/.014 in. (.05/.36 mm.) exists. Oversize thrust washers may be fitted where necessary.
11. Refit the connecting rod caps and big end bearings.
12. Refit the rear main bearing bridge piece to the cylinder block together with new joints and sealing rubbers (see Fig. 45).
13. Ensure that the rear face of the bridge piece is in alignment with the rear face of the cylinder block (see Fig. 46).
14. Fit new sealing strips to the rear main bearing oil seal housings where necessary and refit the housings. Refit the flywheel and correctly align.
15. Rebuild remainder of engine using new seals in accordance with instructions given in the respective sections of this repair manual.

SCHEDULE OF FITS AND TOLERANCES

All threads used, except perhaps on proprietary equipment are Unified Series and American Pipe Series. The crankshaft and pulley retaining setscrew are threaded 7/8 U.N.F.

The following data of clearances and tolerances are given as a guide for personnel engaged upon major overhauls and the figures are those used in the factory for production methods.

The figure quoted in the columns headed "Bore" and "O/Diameter" represents the minimum and maximum sizes to which parts may be accepted when new.

The difference between these maximum and minimum figures is known as the manufacturing tolerance and this tolerance is necessary as an aid to manufacturing and its value is an expression of the desired quality of manufacture.

For example, where the outside diameter of a crankshaft main journal is quoted as $\frac{2.9800}{2.9885}$ in. then the manufacturing tolerance is 0.0005 in.

During the overhaul of an engine, it is reasonable to expect the use of personal initiative. It is obviously uneconomical to return worn component parts into service to involve labour costs again at an early date.

Description	Bore		O/Diameter		Fit	Remarks
	inches	mm	inches	mm		
Cylinder Liner (Production)			4.0655	103.20	.001 in.	Interference
			4.0645	103.24	.003 in.	Fit
Cylinder Block Bore	4.0625	103.19			.076 mm	
	4.0635	103.21			.025 mm	

SCHEDULE OF FITS AND TOLERANCES . . . Cont'd

Description	Bore		O/Diameter		Fit	Remarks
	inches	mm	inches	mm		
Liner, Finished	3.877	98.48				
Bore	3.878	98.50				
Total Height	17.375	441.33				
Cylinder Block	17.367	441.12				
Height of Liner above Cylinder Block	0.030 0.035	0.76 0.89				Below block top face
Cylinder Block No. 1	2.1875	55.56			.0058 in.	
Camshaft Bearing	2.1885	55.59			.0028 in.	
Bush			2.1933 2.1915	55.71 55.66	.15 mm .07 mm	Interference Fit
Bush	2.0000 2.0017	50.80 50.84			.0025 in. .0052 in.	
Camshaft No. 1 Bearing Diameter			1.9975 1.9965	50.74 50.71	.06 mm .13 mm	Clearance
Camshaft No. 2 Bearing Diameter			1.9875 1.9865	50.483 50.46	.0025 in. .0053 in.	Clearance
Cylinder block No. 2 Bearing	1.990 1.9918	50.55 50.59			.06 mm .13 mm	
Camshaft No. 3 Bearing Diameter			1.9675 1.9665	49.97 49.95	.0025 in. .0053 in.	Clearance
Cylinder block No. 3 Bearing	1.970 1.9718	50.04 50.08			.063 mm .13 mm	
Cam Lift			0.299 0.301	7.59 7.65		
Camshaft Thrust Washer Thickness			0.218 0.216	5.54 5.49		0.026/0.031" (0.66/0.79 mm) proud of front face of Cylinder Block
Cylinder Block recess for Thrust Washer	0.187 0.190	4.75 4.83				
Camshaft Groove Width	0.222 0.232	5.64 5.89			.004 in. .016 in.	Clearance
Thrust Washer Thickness			0.218 0.216	5.54 5.49	.10 mm .41 mm	
Camshaft, Lift Pump Cam (Eccentricity)			0.103 0.100	2.62 2.54		
Hub Idler Gear			1.997 1.996	50.72 50.70	.0028 in. .0047 in.	
Idler Gear Bush Bore	1.9998 2.0007	50.78 50.82			.07 mm .12 mm	Clearance

SCHEDULE OF FITS AND TOLERANCES ... Cont'd

Description	Bore		O/Diameter		Fit	Remarks
	inches	mm	inches	mm		
Idler Gear End Float			0.003 0.007	0.08 0.18		
Timing Gear Backlash			0.003 0.006	0.08 0.15		
Crankshaft Main Journal Diameter			2.9990 2.9985	76.17 76.16	.0025 in. .0045 in.	Running Clearance measured assembled
Main Bearing Bore	3.0015 3.003	76.24 76.28			.06 mm .11 mm	0.010/0.030" undersizes available
Housing Main Bearing Cylinder Block Crankshaft End Float	3.116 3.117	80.42 80.44			.002 in. .015 in.	.05 mm .038 mm
Thrust Washer Thickness	0.093 0.089	2.36 2.27	includes 0.002 out of flatness tolerance			
Thrust Washer Diameter Cylinder Block recess For Thrust Washer			4.098 4.088 4.098 4.106	104.09 103.83 104.09 104.29	.000 in. .018 in. .00 mm .46 mm	Clearance
Conn. Rod Big End Bore	2.6460 2.6465	67.21 67.22				
Crank Pin Diameter			2.4996 2.4990	63.49 63.47	.0015 in. .003 in.	Running Clearance Measured
Bearing Big End Bore	2.501 2.502	63.53 63.55			.04 mm .08 mm	Assembled .010/.030" Undersizes Available
Conn. Rod Big End Width Crankpin Width			1.579 1.577 1.5885 1.5915	40.11 40.06 40.35 40.42	.0095 in. .013 in. .24 mm .37 mm	End Float Clearance
Bush Conn. Rod Small End Diameter Conn. Rod Small End Bore			1.5365 1.535 1.531 1.532	39.13 38.99 38.89 38.92	.00525 in. .00272 in. .13 mm .07 mm	Interference Fit
Gudgeon Pin Diameter Bush Conn. Rod			1.3750 1.3748 1.37575 1.3765	34.925 34.92 34.94 34.96	.00075 in. .0017 in. .02 mm .04 mm	Clearance
Gudgeon Pin			1.3750 1.3748	34.925 34.92	.00015 in. .00025 in.	Transition Fit

PART 2 SECTION B

MF WORKSHOP SERVICE MANUAL 1457 087 M1

SCHEDULE OF FITS AND TOLERANCES . . . Cont'd

Description	Bore		O/Diameter		Fit	Remarks
	inches	mm	inches	mm		
Piston Gudgeon	1.37485	34.921			.004 mm	
Pin Bore	1.37505	34.926			.006 mm	
Conn. Rod Alignment	At 5 in.		± 0.010 in. measured on each side of axis of rod on test mandrel			
Compression Rings Width			0.0938	2.38	.0019 in.	Clearance
Compression Ring Groove Width	0.0957	2.43	0.0928	2.36	.0039 in.	
Compression Ring Gap (Chrome)	0.0967	2.46			.05 mm	
					.10 mm	
					.021 in.	At 3.876 in.
					.016 in.	Bore
					0.53 mm	
					0.41 mm	
Compression Ring Gap (Cast Iron)					.019 in.	At 3.876 in.
					.015 in.	bore
					0.38 mm	
					0.48 mm	
Compression Ring Gap (Cast Iron Internally Stepped)					0.011/0.016 in.	
					0.28 /0.41 mm	
Scraper Ring Width			0.251	6.38	.0015 in.	Clearance
Scraper Ring Groove Width	0.2525	6.41	0.249	6.32	.0045 in.	
	0.2535	6.44			.04 mm	
					.11 mm	
Crankshaft Diameter for Gear			1.8755	47.64	.0005 in.	Transition
Crankshaft Gear Bore	1.8750	47.62	1.8750	47.62	.0001 in.	Fit
	1.8755	47.64			.01 mm	
					.02 mm	
Crankshaft Pulley Seal Diameter			2.380	60.45		
			2.375	60.32		
Crankshaft Rear Seal Diameter			3.125	79.37		
			3.124	79.35		
Width of Crankshaft Centre Main Journal	1.741	44.22				
	1.738	44.15				
Rocker Shaft Diameter			0.7495	19.04	.001 in.	Clearance
			0.7485	19.01	.0035 in.	
Rocker Bore	0.7505	19.06			.02 mm	
	0.7520	19.10			.09 mm	
Tappet Shank Diameter			0.7485	19.01	.0015 in.	Clearance
			0.7475	18.99	.00375 in.	
Cylinder Block Tappet Bore	0.7500	19.05			.04 mm	
	0.75125	19.08			.09 mm	
Valve Inlet Stem Diameter			0.3735	9.49	0.0008 in.	Clearance
			0.3725	9.46	0.0028 in.	

SCHEDULE OF FITS AND TOLERANCES . . . Cont'd

Description	Bore		O/Diameter		Fit	Remarks
	inches	mm	inches	mm		
Cylinder Head Bore	0.37425	9.506			0.02 mm	
	0.37525	9.531			0.07 mm	
Valve Exhaust Stem Diameter			0.373	9.47	0.0013 in.	Clearance
			0.372	9.45	0.0035 in.	
Cylinder Head Bore	0.37425	9.506			0.03 mm	
	0.37525	9.531			0.09 mm	
Valve Head Depth Below Head Face					.029 in.	
(Exhaust)					.039 in.	
					.74 mm	
(Inlet)					.99 mm	
					0.035/0.045 in.	
					0.89 /1.14 mm	
Water Pump Shaft Dia.			0.6267	15.92	.0018 in.	Interference
			0.6262	15.91	.0005 in.	Fit
Water Pump Impeller Bore	0.6249	15.87			.05 mm	
	0.6257	15.89			.01 mm	
Water Pump Shaft Dia.			0.7506	19.07		Transition
			0.7501	19.05		Fit
Water Pump Pulley Bore	0.7500	19.05			.015 mm	
	0.7509	19.07			.017 mm	
Water Pump Body Bore	1.8494	46.91			.0013 in.	Interference
	1.8504	47.00			.0000 in.	Fit
Water Pump Bearing			1.8504	47.00	.03 mm	
			1.8507	47.01	.00 mm	
Water Pump Shaft Diameter			0.7877	20.01	.0007 in.	Interference
			0.7874	20.00	.0000 in.	Fit
Water Pump Bearing	0.7870	19.99			.003 mm	
	0.7874	20.00			.000 mm	
Impeller Running Clearance					.010 in.	Measured between
					.035 in.	impeller vanes and
					.25 mm	water pump body
					.89 mm	(front half)
Lubricating Oil Pump Inner Rotor End Clearance					0.015 in.	Clearance
					0.003 in.	Fit
					0.38 mm	
					0.08 mm	
Gear—L.O.P. Drive					0.008 in.	
Gear—L.O.P. Idle					0.009 in.	
Backlash at 2.0608 in CRS					0.15 mm	
					0.23 mm	

PART 2 SECTION B

MF WORKSHOP SERVICE MANUAL 1457 087 M1

SCHEDULE OF FITS AND TOLERANCES . . . Cont'd

Description	Bore		O/Diameter		Fit	Remarks
	inches	mm	inches	mm		
L.O.P. Rotor and Annulus					0.001 in. 0.003 in. 0.03 mm 0.08 mm	Clearance Fit
L.O.P. Annulus End Clearance					0.0005 in. 0.0025 in. 0.01 mm 0.06 mm	Clearance Fit
L.O.P. Annulus to Annulus Bore					0.001 in. 0.003 in. 0.03 mm 0.08 mm	Clearance Fit
Bush Idler Gear Bore	1.5000	38.10			.001 in.	Clearance
Hub Idler Gear	1.5016	38.14	1.4990 1.4984	38.07 38.06	.0032 in. .02 mm .08 mm	
Idler Gear Bore	1.6563 1.6573	42.07 42.09				
Idler Gear Length			1.007 1.005	25.58 25.53	.008 in. .014 in.	End Float
Hub Idler Gear Length	1.015 1.019	25.78 25.88			.20 mm .36 mm	

Crankshaft Main Journal Diameter

Standard	2.9985/2.999 in. (76.16/76.17 mm)
Undersizes	-.010 in., -.020 in., -.030 in.
Width of No. 1 Main Journal	1.453/1.473 in. (36.91/37.41 mm)
Width of Nos. 2, 4 and 5 Main Journals	1.545/1.549 in. (39.24/39.34 mm)
Width of No.3 Main Journal	1.738/1.741 in. (44.15/44.22 mm)
Main Journal Fillet Radii	.145/.156 in. (3.68/3.96 mm)

Length of No. 3 Main Journal must not exceed 1.759 in. (44.68 mm) after regrinding. Where necessary, use oversize thrust washers to suit.

Crankshaft Crankpin Diameter

Standard	2.499/2.4995 in. (63.48/63.49 mm)
Undersizes	-.010 in., -.020 in., -.030 in.
Width of Crankpin	1.5885/1.5915 in. (40.35/40.42 mm)
Crankpin Fillet Radii	.145/.156 in. (3.68/3.96 mm)

Width of Crankpins must not exceed 1.635 in. (41.53 mm) after regrinding. The surface finish on all diameters should not be coarser than 16 micro inches. It is most important that the radii on the main journals and crankpins are maintained to the figures quoted.

After regrinding, the sharp corners on the oil holes must be removed and the crankshaft crack detected and demagnetized.

Torque Tightening Figures

Cylinder Head Securing Nuts	85 lb. ft. (11,75 kg m)
Connecting Rod Nuts	65–70 lb. ft. (8,88–9,68 kg m)
Main Bearing Setscrews	140–150 lb. ft. (19,35–20,74 kg m)
Flywheel Setscrews	75 lb. ft. (10,37 kg m)
Idle Gear Hub Setscrews	21–24 lb. ft. (2,9–3,32 kg m)
Camshaft Gear Retaining Setscrew	45–50 lb. ft. (6,22–6,91 kg m)
Crankshaft Locknut	280–300 lb. ft. (37,0–41,48 kg m)
Lub. Oil Filter Setscrews	26–30 lb. ft. (3,6–4,15 kg m)
Atomizer Securing Nuts	10–12 lb. ft. (1,3–1,7 kg m)



ENGINE COOLING SYSTEM



CONTENTS

	PAGE
GENERAL	4
RADIATOR, Removal and Refitting (3A/1)	4
THERMOSTAT, Removal and Refitting (3A/2)	4
THERMOSTAT, Testing (3A/3)	5
WATER PUMP, Removal and Refitting (3A/4)	5
WATER PUMP, Disassembly (3A/5)	5
WATER PUMP, Reassembly (3A/6)	6
FAN BELT, Adjustment (3A/7)	6

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	GENERAL ARRANGEMENT, Cooling System	4
2	HOOD AND SIDE PANELS, Removal	4
3	OIL COOLER SUPPORT FRAME, Removal	4
4	THERMOSTAT, Removal	5
5	WATER PUMP, Removal	5
6	WATER PUMP, Disassembly	5
7	PULLEY, Removal	5
8	SPINDLE, Removal	5
9	PUMP IMPELLER, Clearance	5

ENGINE COOLING SYSTEM

GENERAL

Engine cooling is achieved by means of water which is circulated through the engine and then passed through a radiator. The water is cooled in the radiator by the passage of air drawn through the radiator by a 6 bladed puller type fan (Fig. 1).

A belt driven centrifugal water pump, fitted to the cylinder block, circulates the water throughout the system.

To improve engine efficiency and to ensure rapid engine warm up, a thermostat fitted in the system allows the cooling water to by-pass the radiator until the engine reaches normal working temperature. The thermostat is set to open at 180°F (82°C) at which temperature the water is then allowed to pass through to the radiator. The thermostat then maintains the engine temperature within a defined range.

The complete system is pressurised to 10 p.s.i. (0.703 kg./cm²) by a pressure cap fitted to the top of the radiator.

RADIATOR

Removal and Refitting

(3A/1)

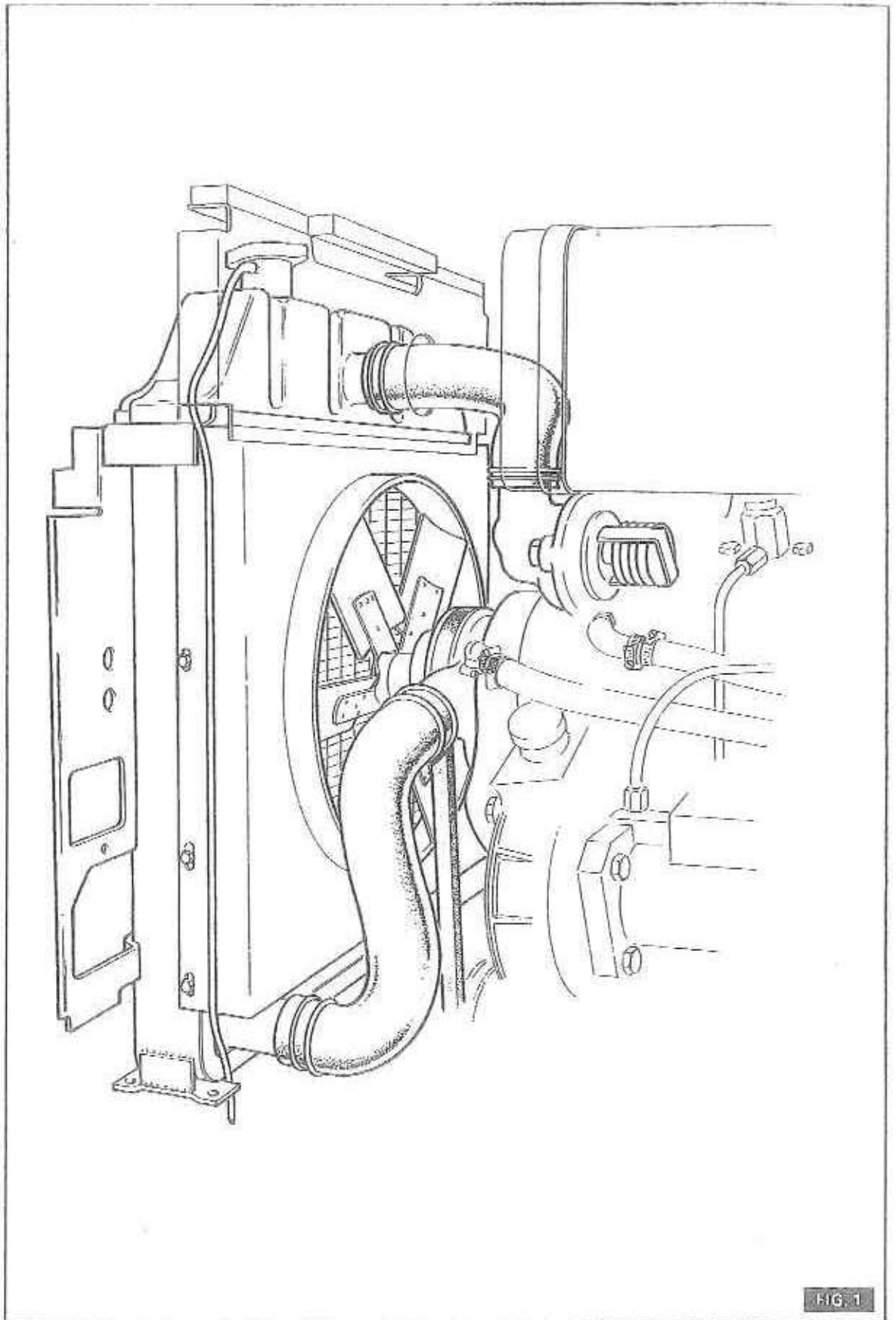
1. The operations in this section assume that the Digger and Loader have been removed from the machine.
2. Remove the three nuts and washers securing the exhaust pipe in position. Remove the exhaust pipe complete with silencer.
3. (Fig. 2) Remove the hood and side panel assemblies. The hood is secured to the bulkhead at each side by a screw and lockwasher, to the hard nose by two screws and lockwashers on the top of the hood and to the rear frame of the hard nose by two screws, plain washers and lockwashers. Disconnect the side panels by removing three bolts and washers securing the side panels to the hard nose rear supports and two bolts and washers securing side panel brackets to the nose front support.
4. Remove the radiator filter cap and open the radiator and cylinder block drain taps.
5. Disconnect the air cleaner hose at the air cleaner.
6. Disconnect the top and bottom radiator hoses.
7. Release the four bolts and washers securing the top panel of the radiator shroud. Remove the top panel.
8. (Fig. 3) Remove four bolts and washers securing the air cleaner and oil cooler support frame to the radiator support frame panels. Move the support frame, complete with air cleaner, hydraulic oil cooler and torque converter oil cooler (where fitted) clear of the radiator.
9. Remove two bolts and washers securing the radiator support frame panels to the support frame. Move the panels clear of the radiator.
10. Remove the eight bolts securing the shroud to the radiator. Manoeuvre the shroud away from the radiator and over the fan.
11. Remove four bolts and washers securing the radiator support frame to the front axle support. Lift the frame complete with radiator clear of the machine.
12. Remove six bolts retaining the radiator support frame and panels. Lift the radiator through the top of the support frame.
13. To replace the radiator, reverse the above procedure.

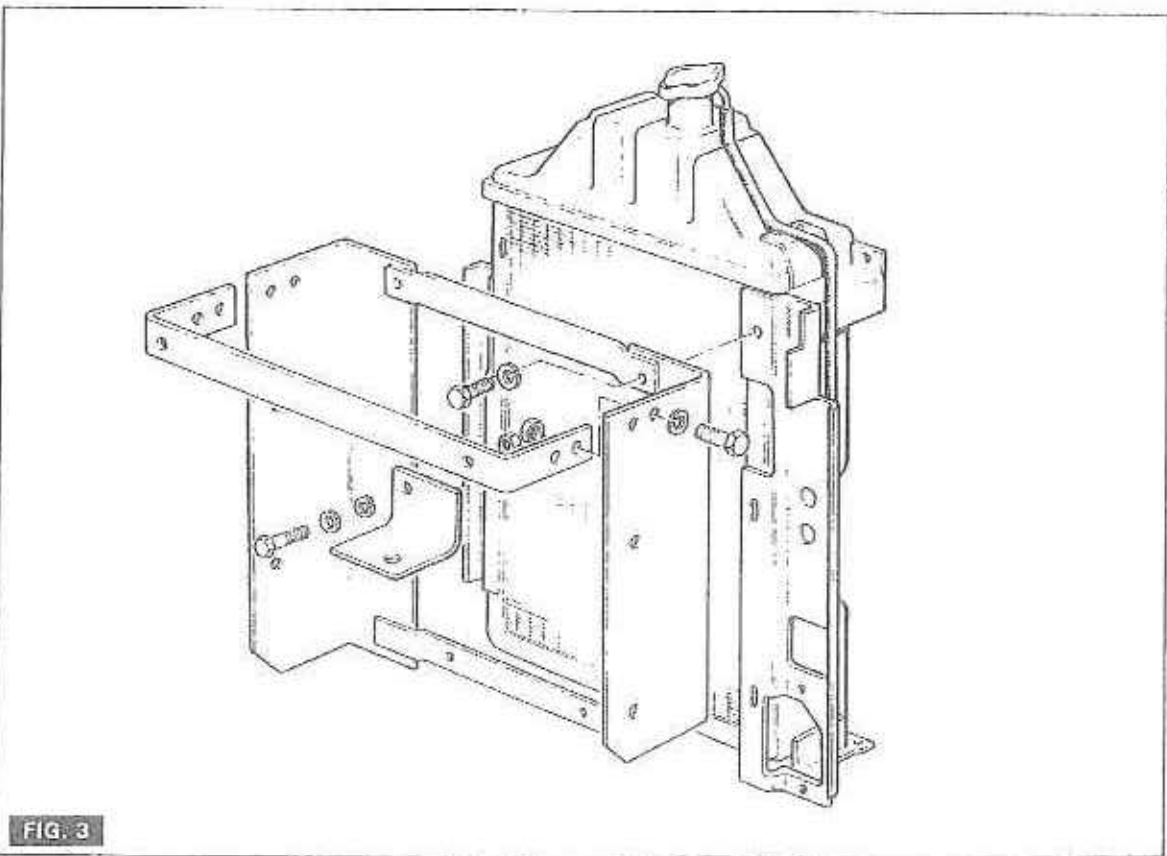
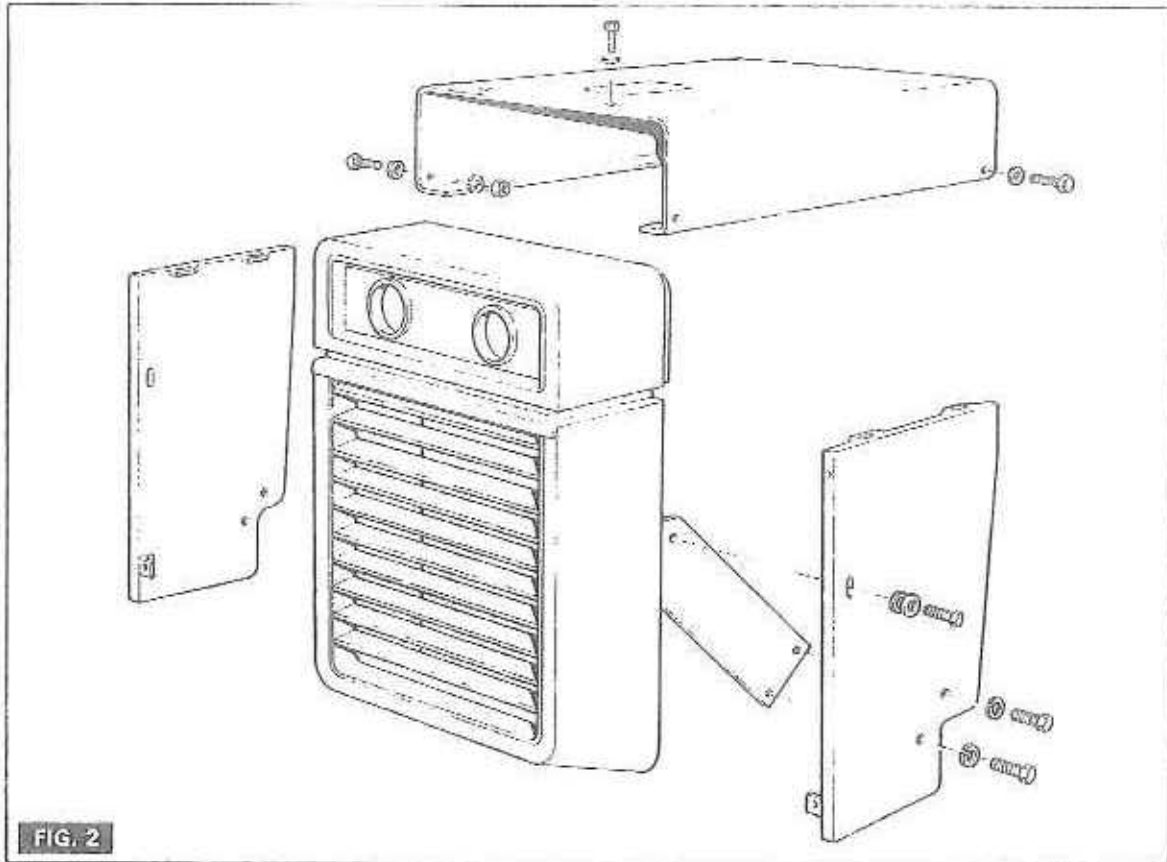
THERMOSTAT

Removal and Refitting

(3A/2)

1. Drain the coolant from the radiator and engine.
2. (Fig. 4) Remove the top water hose from the water outlet connection.





THERMOSTAT . . . Cont'd

Removal and Refitting . . . Cont'd

3. Remove the two bolts which secure the water outlet connection (1) to the water outlet body (2).
4. Lift off the water outlet connection and withdraw the thermostat.
5. To replace the thermostat, reverse the above procedure, ensure that a new gasket is fitted between the water outlet body and the water outlet connection.

THERMOSTAT

Testing

(3A/3)

1. Remove the thermostat as described in operation 3A/2.
2. Gently ease open the thermostat valve and insert a 0.002 in. (0.05 mm.) feeler gauge between the valve and its seat, allow the valve to close thus trapping the feeler gauge between the valve and its seat.
3. Suspend the thermostat by the feeler gauge in a container partially filled with clean water.
4. Heat the water gradually. Check the temperature at frequent intervals. Note the temperature at which the thermostat valve opens, thus releasing the feeler gauge.
5. If the temperature is not as specified (see SPECIFICATIONS) a new thermostat should be fitted.

WATER PUMP

Removal and Refitting

(3A/4)

1. Remove the radiator as described in operation 3A/1.
2. Disconnect the cab heater water pipes from the water pump body.
3. Remove the water inlet hose from the radiator to the water pump.
4. (Fig. 5) Remove the four setscrews (1) which secure the water pump to the cylinder block.
5. Slip the fan belt off the water pump pulley.
6. Manoeuvre the complete water pump and fan assembly clear of the cylinder block.
7. To replace the water pump, reverse the above procedure, using a new gasket between the pump and the cylinder block.

Note

It will be necessary to slacken the adjustable link of the dynamo in order to replace the fan belt onto the water pump pulley. When the water pump is bolted into place, adjust the tension of the fan belt by means of the adjustable link on the dynamo. Fan belt tension should be adjusted to give a deflection of 3/4 in. (19 mm.) between the dynamo and crankshaft pulley.

WATER PUMP

Disassembly

(3A/5)

1. Remove the water pump as described in operation 3A/4.
2. (Fig. 6) Remove the four nuts which hold the front body (1) to the rear body (2). Lift the front body, complete with pulley, spindle and impeller from the rear body.
3. Remove the four setscrews which secure the fan and distance piece to the water pump pulley. Lift off the fan and distance piece.
4. Remove the self locking nut and washer which secures the pulley to the pump spindle.
5. (Fig. 7) Draw the pulley off the spindle and remove the key, use service tools PD 155B and PD 155-1.
6. (Fig. 8) Press the pump spindle, complete with impeller and seal, from the front body of the pump. Use service tool MF 200 with adaptor MF 200-4.
7. Remove the impeller and seal from the spindle.

WATER PUMP . . . Cont'd

Disassembly . . . Cont'd

8. (Fig. 6) Remove the bearing retaining circlip (3) from the front of the pump body.
9. Press out the two bearings and distance piece.
10. Remove the seal, seal retainer and flange.

WATER PUMP

Reassembly

(3A/6)

Before reassembling the water pump carefully check all the components for damage or wear. Renew any parts that show signs of damage or wear.

1. Assemble the seal retainer housing, seal and deflector plate onto the pump shaft.
2. Press the rear bearing onto the shaft against the seal deflector plate.

Note

The deflector plate is 'dished' and when in position the centre of the plate must not be in contact with the bearing. The bearing must be fitted with the shielded face towards the seal.

3. Fit the distance piece and front bearing to the pump shaft. Ensure that the shielded side of the bearing faces outwards.
4. Half fill the space between the two bearings with high melting point grease. Press the shaft and bearing assembly into the pump housing from the front end.
5. Fit the front bearing retaining circlip into the pump body.
6. Fit the water seal to the pump shaft, ensure that the carbon face of the seal faces the rear.
7. Fit the pulley key and press the water pump pulley into place on the shaft.
8. (Fig. 9) Press the impeller into place on the shaft, so that a clearance of 0.012 in. — 0.032 in. (0.30 mm. — 0.81 mm.) is maintained between the impeller vanes and the pump body.
9. Refit the washer and new self locking nut to hold the pulley in place. Tighten the nut with a torque load of 55-60 lb.ft. (8.0-8.5 kg.m.).
10. Fit the front body of the pump, complete with spindle bearings, seals and pulley to the rear body of the pump. Ensure that a new gasket is fitted between the two pump halves.
11. Refit the distance piece and fan to the pulley, and fasten them in place with the fan setscrews.
12. Refit the water pump as described in operation.

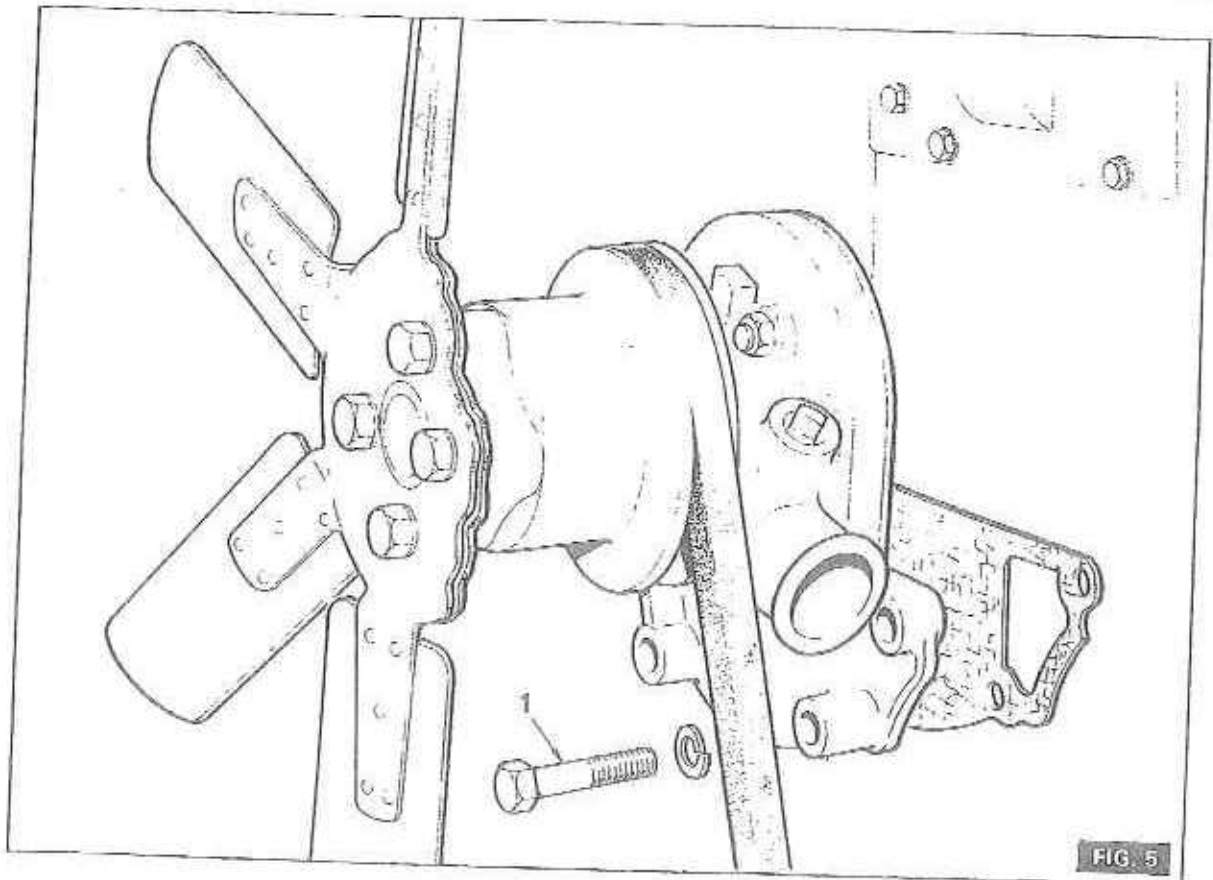
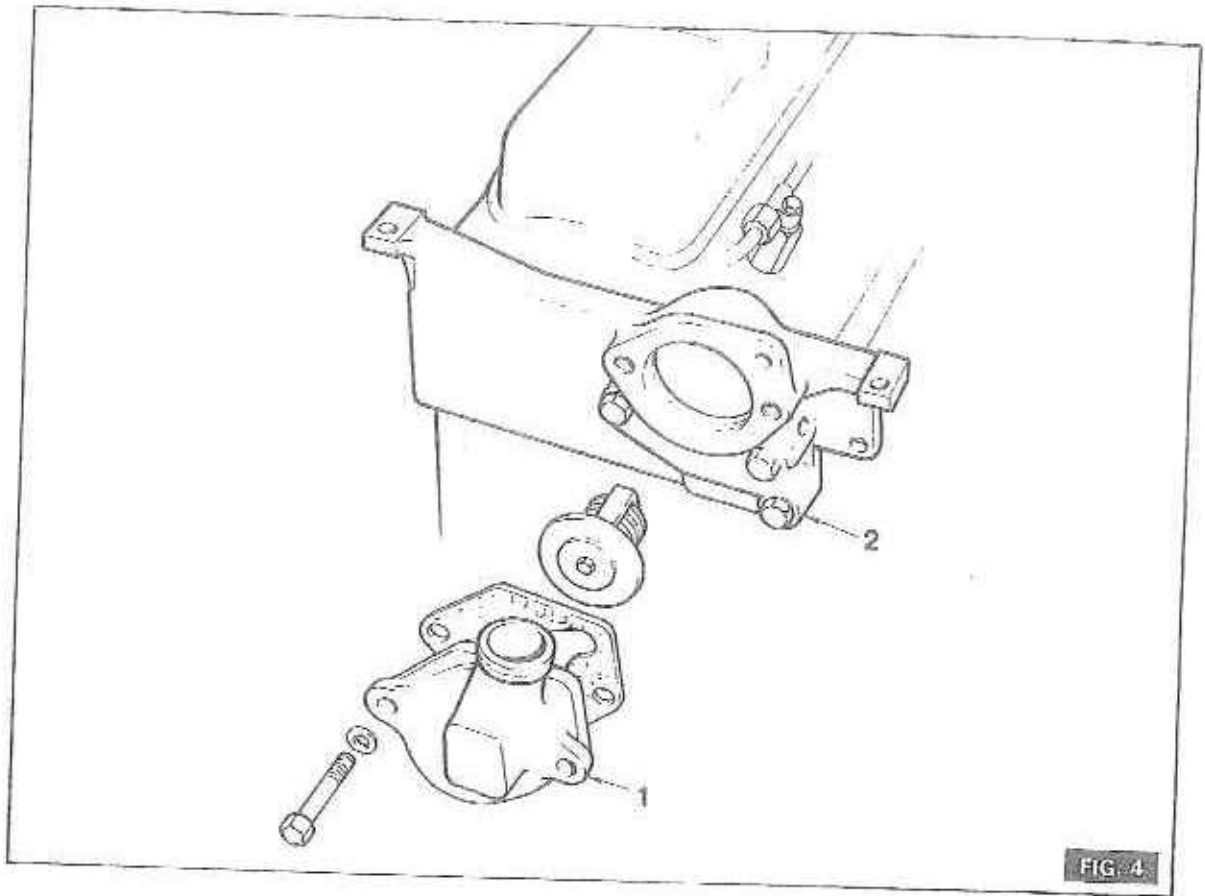
FAN BELT

Adjustment

(3A/7)

The fan belt should be adjusted to give a deflection of approximately 3/4" (19 mm.) midway between the dynamo and crankshaft pulley. To adjust the tension proceed as follows :—

1. Slacken the adjustable link of the dynamo.
2. With a suitable lever pivot the dynamo away from the engine block, thus increasing the tension of the belt.
3. When the belt is at the required tension, re-tighten the adjustable link.
4. Check the condition and tension of the fan belt at regular intervals. When it begins to show signs of excessive wear or fraying, renew the belt.



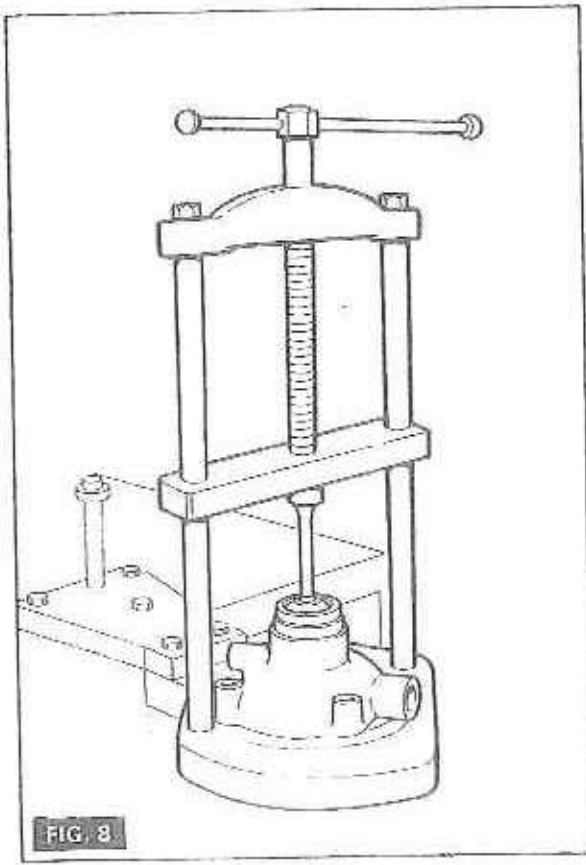
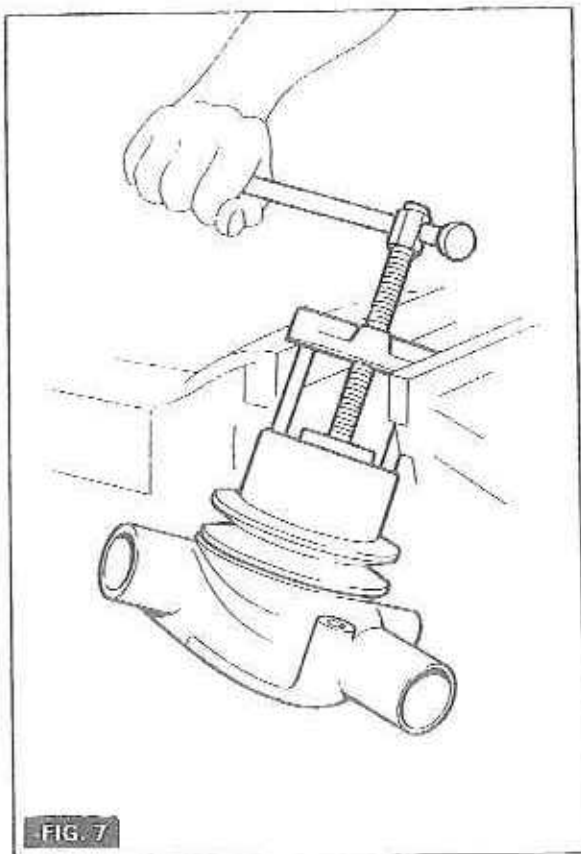
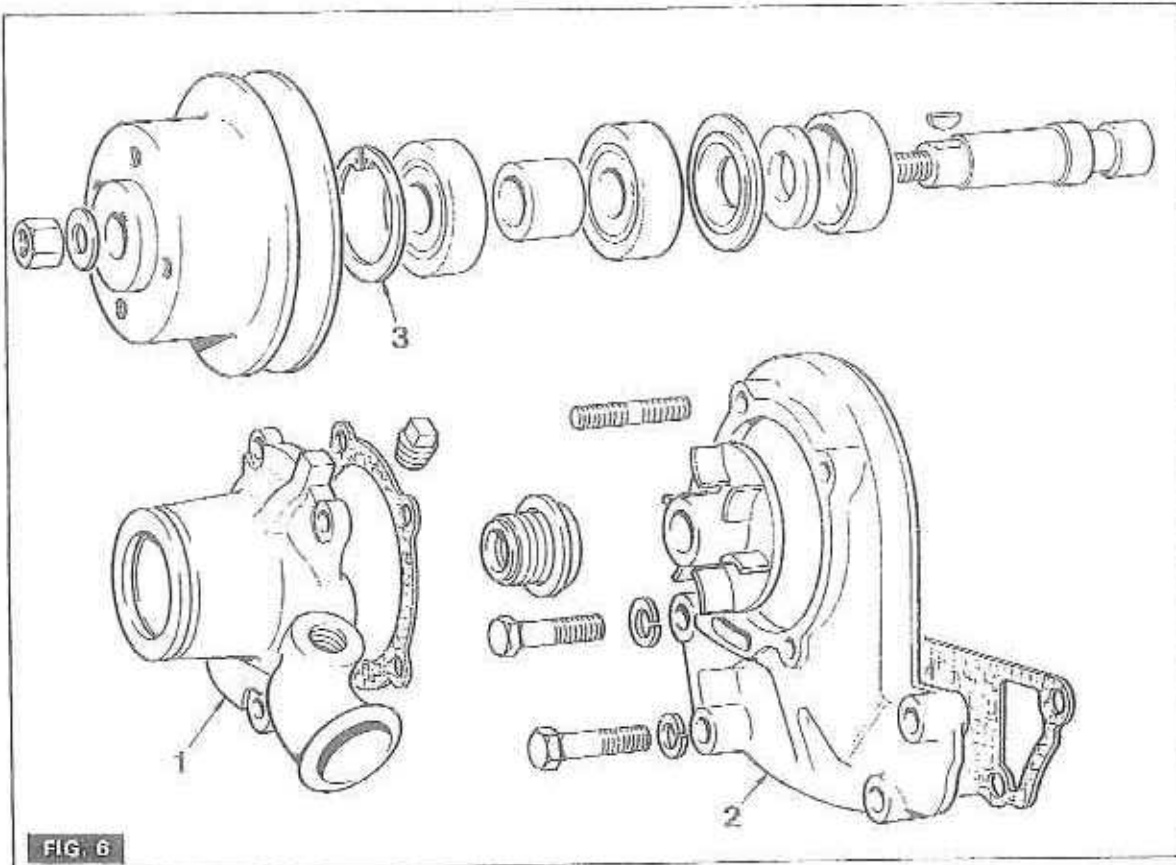
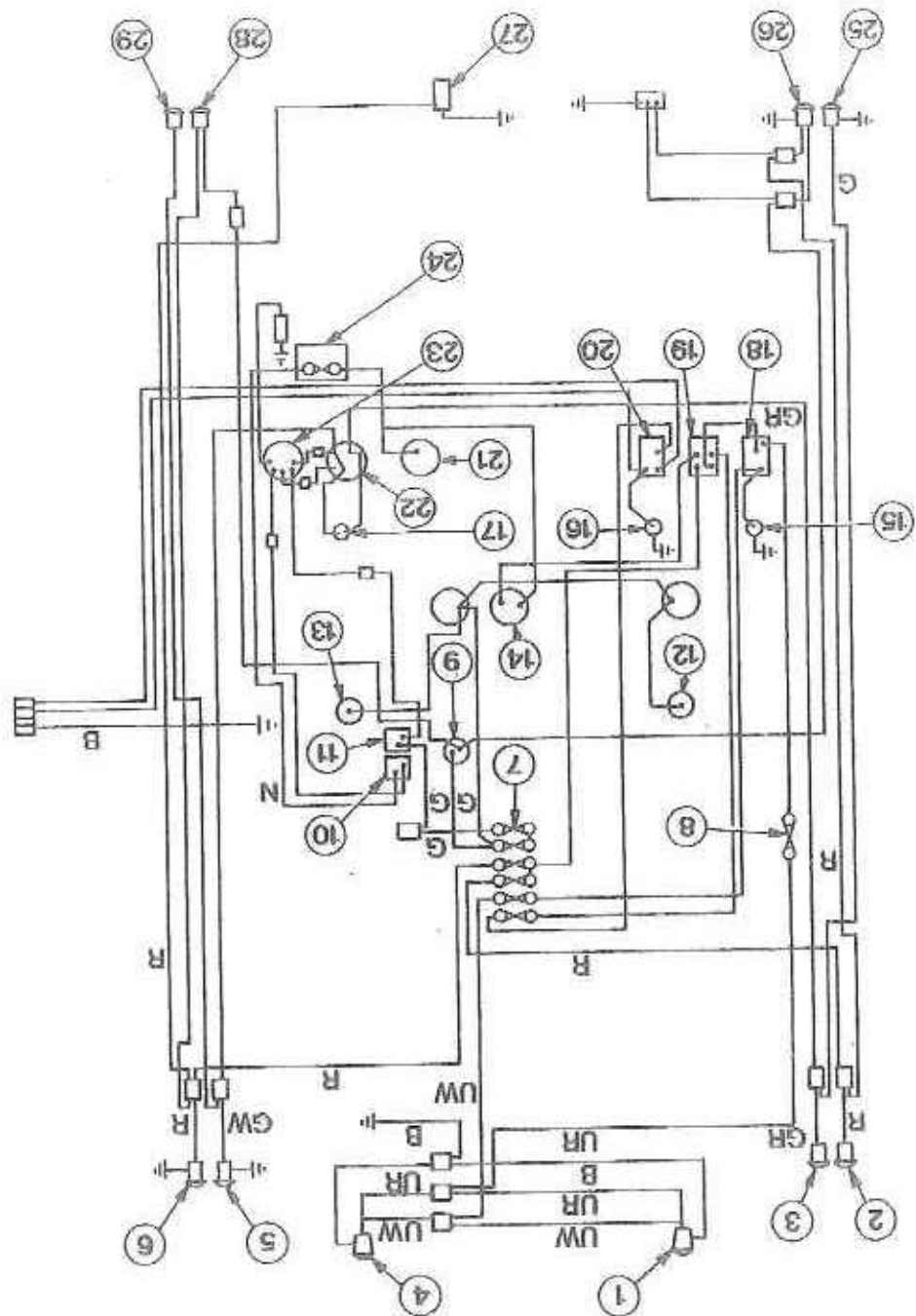
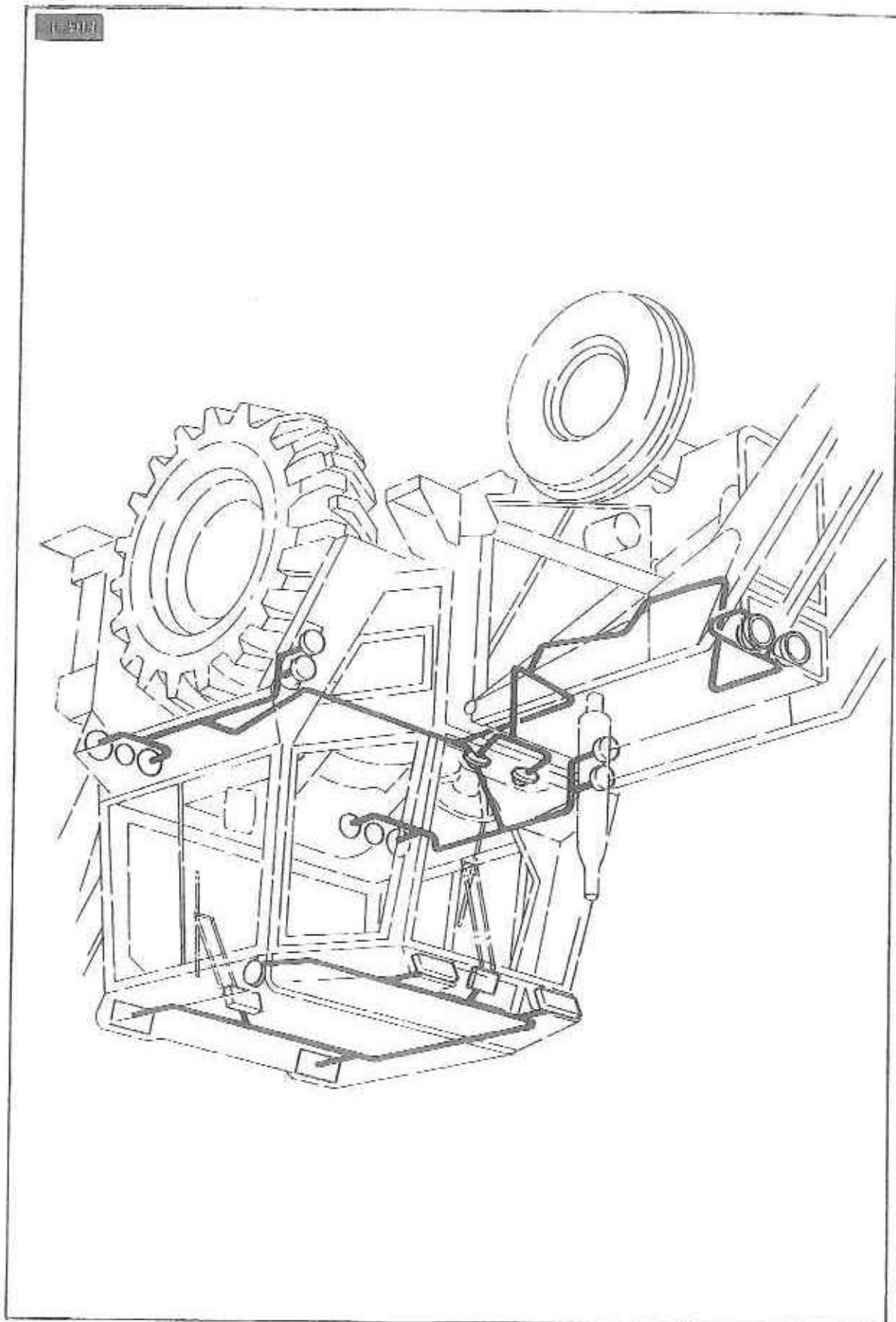
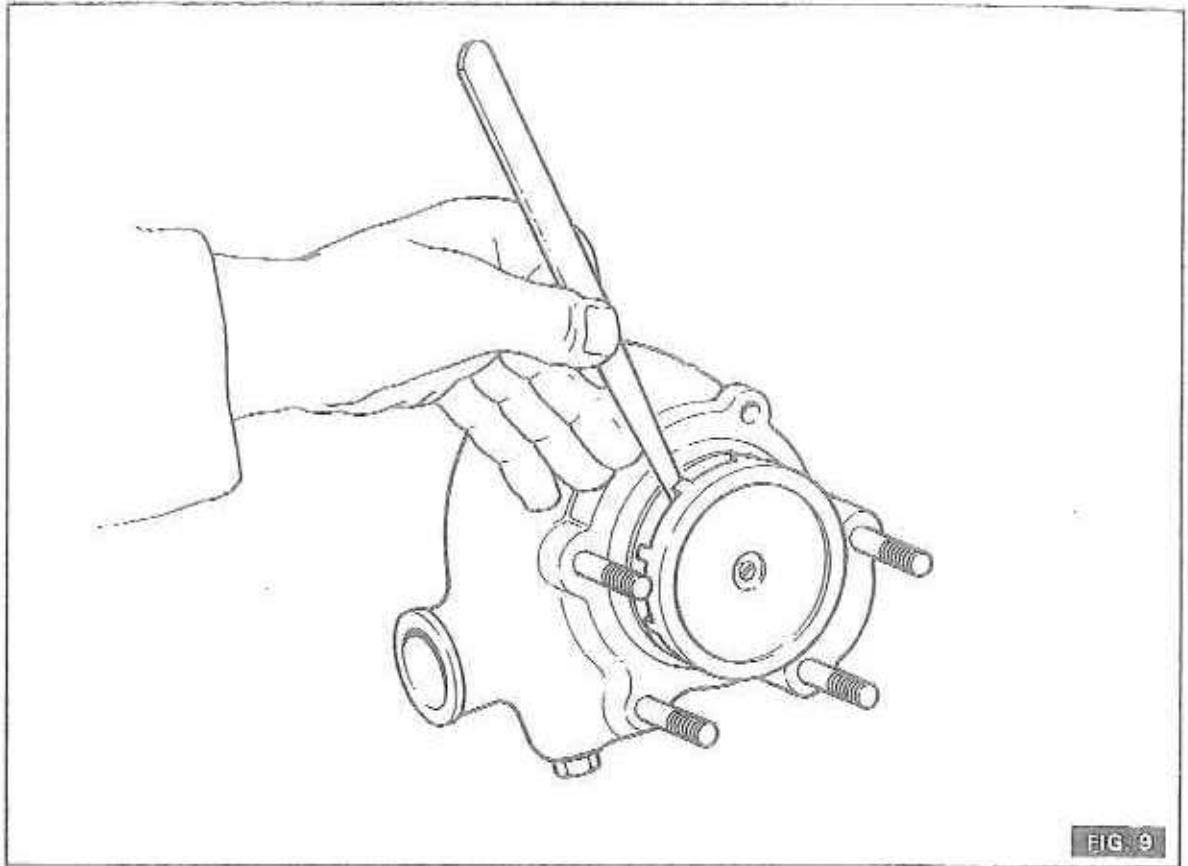


FIG. 2









FUEL SYSTEM

CONTENTS

	PAGE
GENERAL	4
AIR FILTER, General	4
AIR FILTER, Removal and Replacement (3B/1)	4
AIR FILTER, Disassembly and Reassembly (3B/2)	4
FUEL TANK, Removal and Replacement (3B/3)	5
FUEL GAUGE SENDER UNIT, Removal and Replacement (3B/4)	5
FUEL LIFT PUMP, Removal and Replacement (3B/5)	5
FUEL LIFT PUMP, Disassembly (3B/6)	6
FUEL LIFT PUMP, Reassembly (3B/7)	6
FUEL LIFT PUMP, Testing (3B/8)	7
PRIMARY FUEL FILTER ELEMENT, Renewal (3B/9)	7
PRIMARY FUEL FILTER ASSEMBLY, Removal and Refitting (3B/10)	7
SECONDARY FUEL FILTER ELEMENT, Renewal (3B/11)	7
SECONDARY FUEL FILTER ASSEMBLY Removal and Refitting (3B/12)	8
FUEL INJECTION PUMP, Removal and Refitting (3B/13)	8
FUEL INJECTION PUMP TIMING, Checking and Adjusting (3B/14)	8
FUEL INJECTORS, Removal and Replacement (3B/15)	9
FUEL INJECTORS, Testing (3B/16)	9
FUEL SYSTEM, Bleeding (3B/17)	10
START AID TANK General (3B/18)	10
FUEL CUT-OFF CONTROL, Removal and Refitting (3B/19)	10
FOOT THROTTLE LINKAGE STANDARD TRANSMISSION, Removal and Replacement (3B/20)	10
FOOT THROTTLE LINKAGE, STANDARD TRANSMISSION, Adjustment (3B/21)	11
HAND THROTTLE LINKAGE, STANDARD TRANSMISSION, Removal and Replacement (3B/22)	11
HAND THROTTLE LINKAGE, STANDARD TRANSMISSION, Adjustment (3B/23)	11
FOOT THROTTLE LINKAGE, REVERSOMATIC, Removal and Replacement (3B/24)	11
FOOT THROTTLE LINKAGE, REVERSOMATIC, Adjustment (3B/25)	12
HAND THROTTLE LINKAGE, REVERSOMATIC, Removal and Replacement (3B/26)	12
HAND THROTTLE LINKAGE, REVERSOMATIC, Adjustment (3B/27)	13

LIST OF ILLUSTRATIONS

Figure	Facing Page
1 GENERAL ARRANGEMENT, FUEL SYSTEM	4
2 AIR FILTER, Disassembly	4
3 FUEL TANK, Removal	5
4 FUEL TANK, Fuel Sender Unit	6
5 FUEL PUMP, Disassembly	6
6 PRIMARY FUEL FILTER, Removal	7
7 SECONDARY FUEL FILTER, Removal	7
8 FUEL INJECTION PUMP, Refitting	7
9 FUEL INJECTION PUMP, Retiming	8
10 FUEL SYSTEM, Bleeding	8
11 FUEL SYSTEM, Bleeding	9
12 FUEL CUT-OFF CONTROL, Removal	9
13 FOOT THROTTLE LINKAGE, STANDARD TRANSMISSION, Removal	10
14 FOOT THROTTLE LINKAGE, STANDARD TRANSMISSION, Adjustment	11
15 HAND THROTTLE LINKAGE, STANDARD TRANSMISSION, Removal	11
16 HAND THROTTLE LINKAGE, Replacement	12
17 HAND THROTTLE LINKAGE, STANDARD TRANSMISSION, Adjustment	12
18 FOOT THROTTLE LINKAGE, REVERSOMATIC, Removal	12
19 FOOT THROTTLE LINKAGE, REVERSOMATIC, Adjustment	13
20 HAND THROTTLE LINKAGE, REVERSOMATIC, Removal	13
21 HAND THROTTLE LINKAGE, Replacement	13
22 HAND THROTTLE LINKAGE, REVERSOMATIC, Adjustment	13

FUEL SYSTEM

GENERAL

Fig. 1 Shows the layout of the fuel system, as fitted to the MF 50B Tractor Digger Loader.

The fuel tank, which is situated above the rocker cover, supplies fuel to the diaphragm type fuel lift pump. From here the fuel is passed, under light pressure, through the filters to the fuel injection pump.

The distributor type injector pump forces the fuel, under high pressure, to the injectors. Any fuel which is surplus to the requirements of the injectors is allowed to flow back, through a return pipe to the secondary fuel filter. A pipe from the filter to the tank provides a permanent 'bleed off' whilst the engine is running. In this way the fuel is kept in constant circulation, thus bleeding off any air which may be in the system.

When working on the fuel system, it is most important to maintain absolute cleanliness. Always blank off any open fuel connections. Always use lint free rags to wipe clean any equipment. DO NOT use cotton waste or fluffy rags.

AIR FILTER

General

The dry air filter body and enclosed elements are mounted under the engine bonnet in front of the radiator.

To gain access to the air filter, lift the hinged access panel in the left-hand side of the bonnet.

As the air is drawn in it swirls around the filter thus causing any dirt or abrasive particles to be flung out by centrifugal force. The dust then collects at the bottom of the air filter where it can be expelled by means of the unloader valve fitted to the bottom of the air filter.

Attention should also be paid to the hose and clips which connect the air cleaner outlet to the engine induction manifold, as a perished hose or loose clips will render the air cleaner inoperative.

AIR FILTER

Removal and Replacement

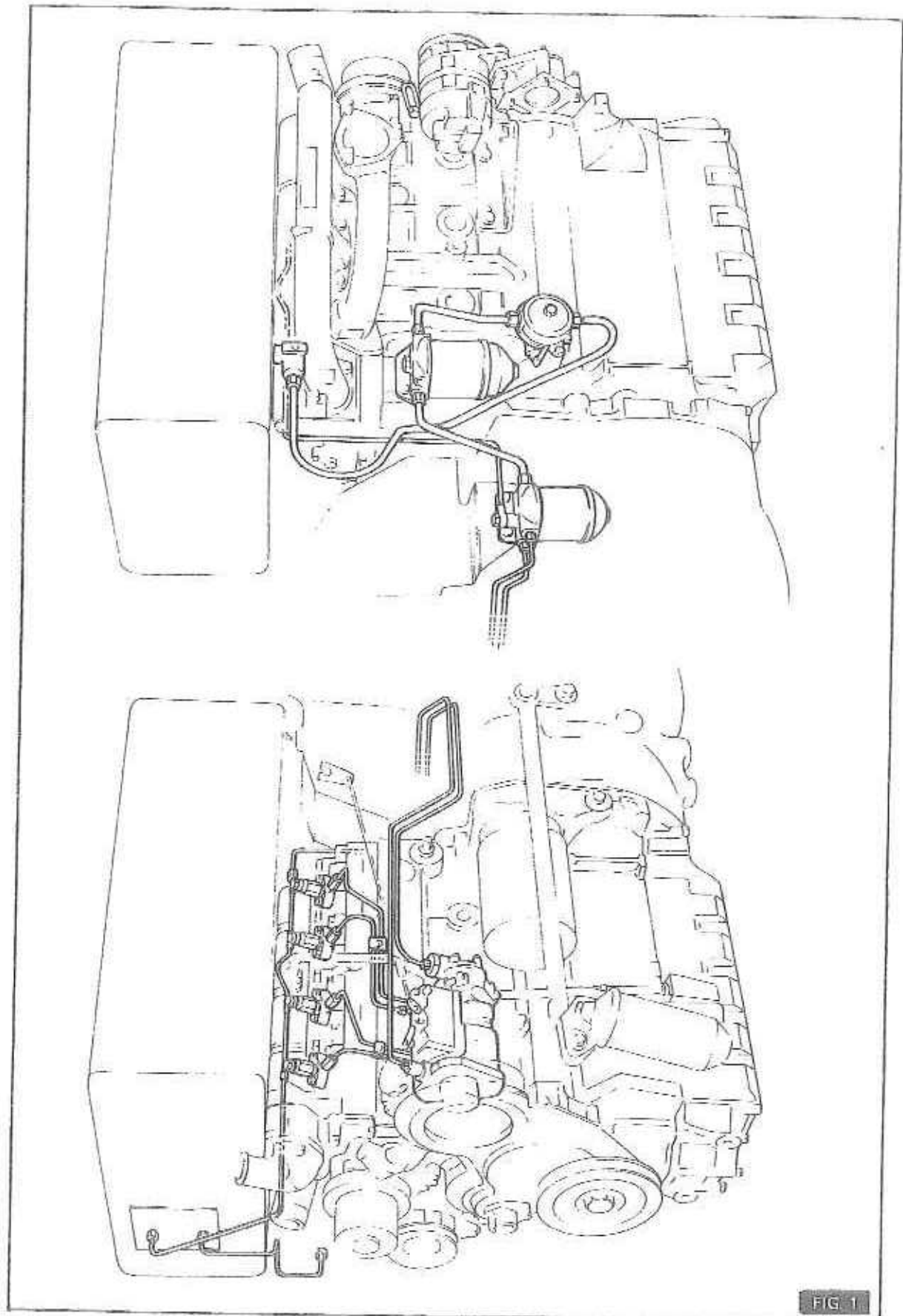
(3B/1)

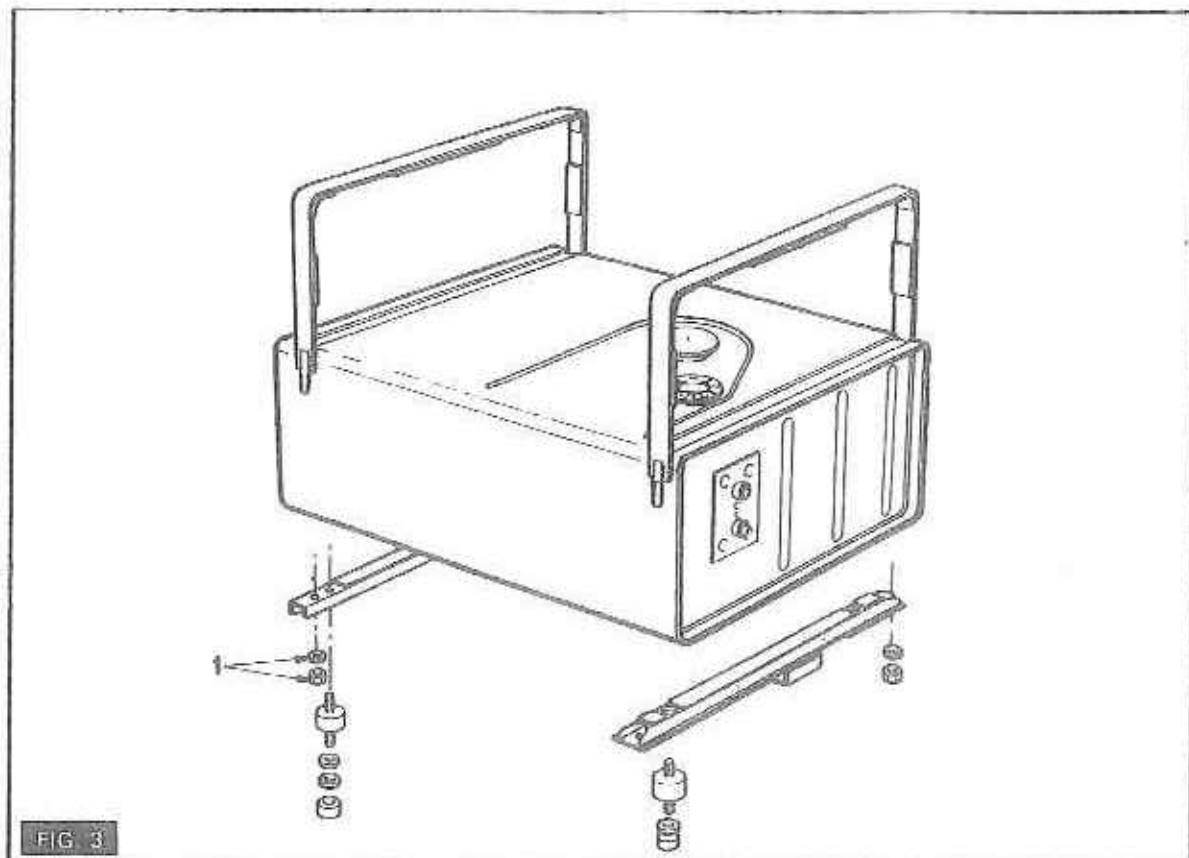
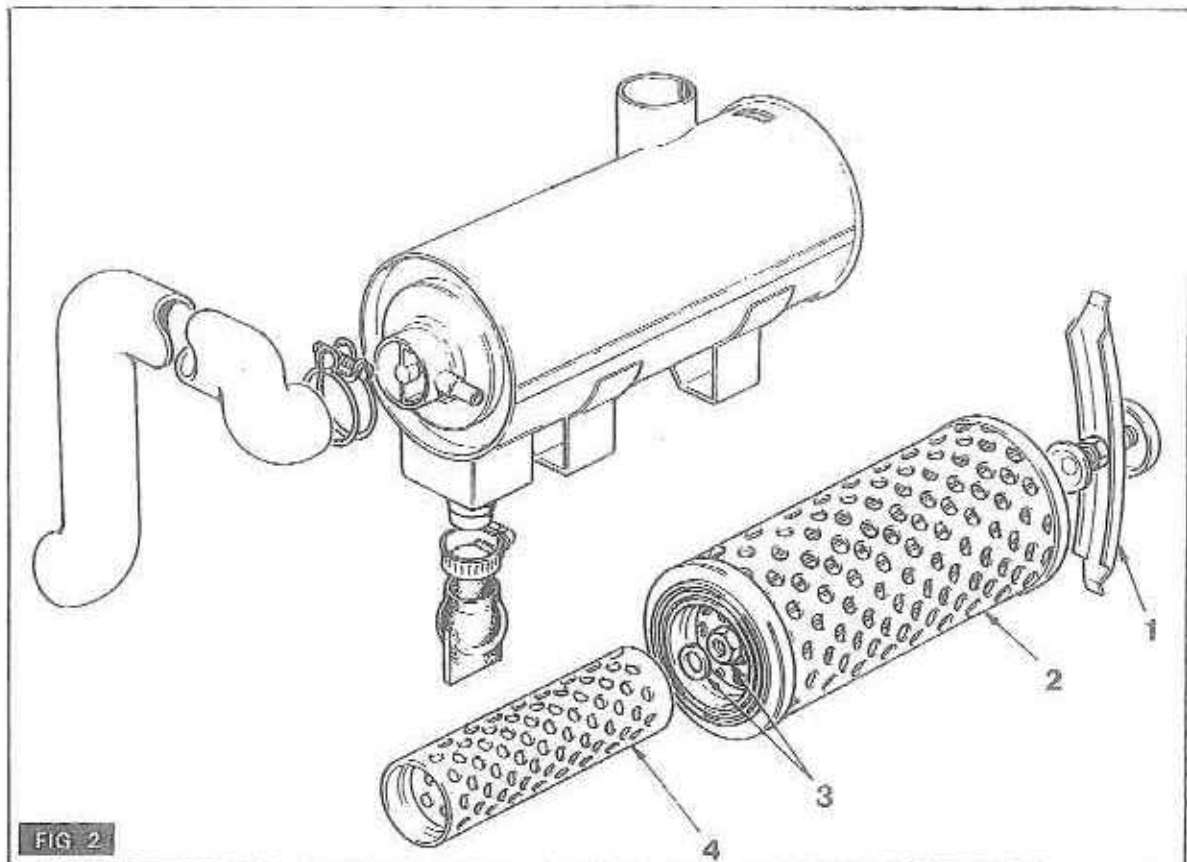
1. Remove the radiator grille.
2. Remove the hood.
3. Disconnect the air intake hose from the air filter to the air inlet manifold.
4. Disconnect the air cleaner obstruction indicator tube at the air cleaner.
5. Remove four screws and lock washers securing the air cleaner assembly to the air cleaner support bracket. Remove the air cleaner assembly.
6. Replacement is a reversal of the above procedure.

Disassembly, Cleaning and Reassembly

(3B/2)

1. Remove the air filter as described in operation 3B/1
2. (Fig. 2) Unscrew the clamp bar (1) and remove the outer element (2).
3. Remove the washer and lock nut (3) and withdraw the inner element (4).
4. Clean the outer filter element using one of the following methods: --
 - (a) Blow dry compressed air (pressure NOT to exceed 100 p.s.i. (7 Kg/cm²)) into the inside of the element. Blow the dust from the outside of the element, repeat the procedure until all the dust is removed.
 - (b) If the element is contaminated with oil or soot, or if no compressed air is available, wash the element using water containing a non-suds detergent (temperature NOT to exceed 100°F (35°C)). Flush out the





AIR FILTER

Disassembly, Cleaning and Reassembly . . . Con'd

element with clean water from a low pressure hose. Thoroughly shake out any excess water and allow element to dry naturally. Never fit a damp element.

5. To clean the inner filter element proceed as follows : –
Rinse the element in kerosene or petrol. Shake out the excess kerosene or petrol and allow the element to dry naturally. Under no circumstances must a damp element be fitted.
6. After cleaning, inspect the outer element for damage by holding a light inside the element. Any large spots of light showing through the element indicate that it is unfit for further use.
7. Refit the filter as described in operation 3B/1

Note

The filter should be cleaned at intervals of approximately 150 hours. If the machine is working in dusty conditions the filter should be cleaned at more frequent intervals. At least once a year and in any case after ten cleanings the filter element should be renewed.

FUEL TANK

Removal and Replacement

(3B/3)

1. Remove the hood.
2. Disconnect the leak-off pipe from the secondary fuel filter to the fuel tank at the fuel tank.
3. Disconnect the pipe from the fuel tank to the start aid at the fuel tank.
4. Close the shut-off cock on the tank and disconnect the pipe from the fuel tap to the fuel lift pump.
5. Disconnect the wire from the fuel gauge sender unit.
6. (Fig. 3) Remove the nuts (1) securing the strap assemblies to the fuel tank supports. Remove the strap assemblies.
7. Lift the fuel tank clear.
8. To replace the fuel tank, simply reverse the above procedure.
9. Bleed the fuel system as described in operation 3B/17.

FUEL GAUGE SENDER UNIT

Removal and Replacement

(3B/4)

1. Remove the hood.
2. Disconnect the wiring from the sender unit.
3. (Fig. 4) Remove the 5 screws securing the sender unit to the tank.
4. Draw the sender unit out of the fuel tank and remove the gasket.
5. When refitting the sender unit, renew the gasket and reverse the above procedure.

FUEL LIFT PUMP

Removal and Replacement

(3B/5)

1. Close the fuel tap at base of the fuel tank.
2. Disconnect the pipe from the fuel tank to the fuel lift pump at the fuel lift pump.
3. Disconnect the pipe from the fuel lift pump to the primary fuel filter.
4. Remove the two nuts and washers which secure the fuel lift pump to the engine block.
5. Withdraw the pump from the studs.

FUEL LIFT PUMP

Removal and Replacement . . . Cont'd

6. To replace the pump, reverse the above procedure. Ensure that a new gasket is fitted between the pump and engine block.

Disassembly

(3B/6)

1. Remove the lift pump as described in operation 3B/5.
2. (Fig. 5) Scribe a line across the flanges of the cover (1) and pump body (2). This will ensure correct reassembly.
3. Remove the six screws and washers (3) and separate the cover from the pump body.
4. Remove the diaphragm (4) by unhooking it from the rocker arm link (5). The diaphragm spring may now be removed.
5. Drive out the rocker arm pivot pin (6) and remove the rocker arm (7), spring (8) and link (5).
6. Remove the priming lever pin (9) and withdraw the priming lever (10), seal (11) and spring (12).
7. Remove the valves (13) and valve gaskets (14) from the cover (1).
8. Remove the retaining bolt and washer (15) and lift off the pulsator cover (16) and pulsator (17).

FUEL LIFT PUMP

Reassembly

(3B/7)

Before reassembling the pump, examine all the components for damage or wear. The main points to check are :—

- (a) Diaphragm for cracking or hardening.
- (b) Pull rod for excessive wear.
- (c) Diaphragm spring for corrosion or distortion.
- (d) Rocker arm, link, spring and pin.
- (e) Pulsator diaphragm.

Note

The pump valves should be renewed whenever the pump is stripped down.

Having checked all the components, reassemble the pump as follows :—

1. Fit the new valves and valve gaskets into the pump cover. The inlet valve must be fitted so that it can open to admit fuel. Fit the outlet valve in the reverse position to the inlet valve. The valves should be staked in position using a suitable punch.
2. Fit the pulsator, diaphragm and pulsator cover to the pump cover. Secure them in place with the washer and bolt.
3. Fit the rocker arm pin through its hole in the pump body, at the same time engaging the link and the rocker arm. Tap the rocker arm pin until it is flush with the pump body. Stake the casting in three places at each side in order to retain the pin.
4. Place the diaphragm spring in position.
5. Fit the diaphragm assembly over the spring with the pull rod downwards. Ensure that the upper end of the spring is centred in the protector washer of the diaphragm.
6. Press the diaphragm down. Ensure that the downward tag on the lower diaphragm protector washer is on the priming lever side of the body. This tag is required to be in the hole of the body for fitment to the priming lever. Engage the diaphragm pull rod eye with link, at the same time lining up the holes in the diaphragm.
7. Push the rocker arm towards the pump to pull the diaphragm down to the pump body flange.
8. Fit the top cover to the pump body, making sure that the two parts are correctly aligned.
9. Fit the six screws and washers to hold the two halves of the pump together. DO NOT tighten the screws at this stage.

FUEL LIFT PUMP

Reassembly . . . Cont'd

10. Push the end of the pull rod to hold the diaphragm at the top of its stroke and tighten the screws diagonally.

Note

With the two halves of the pump bolted together, the diaphragm should be flush with the flanges all round. Any appreciable protrusion of the diaphragm indicates incorrect fitting.

11. Fit the priming lever to the side of the pump body and retain with the pin clip on the priming lever spring.

Testing

(3B/8)

When a fuel lift pump fault is suspected mechanics are advised to test the pump, using the special equipment available, before refitting the pump to the engine.

Manual testing is not recommended for the following reason; movement of the pump rocker arm will produce a greater diaphragm movement than that produced by the engine camshaft when the pump is in situ. Furthermore, manual testing cannot reliably reproduce the conditions in which some faults occur unless the fault is severe.

PRIMARY FUEL FILTER ELEMENT

Renewal

(3B/9)

1. Wipe clean the outside of the filter and surrounding area.
2. (Fig. 6) Slacken the bleed screw (1) and remove the drain cock (2) allowing the fuel to drain off.
3. Remove the centre bolt (3) from the filter head.
4. Remove the sediment bowl (4) complete with filter element (5). Discard the element.
5. Flush out the sediment bowl with clean diesel fuel or paraffin. Do not use rags.
6. Insert a new filter element, renew the sealing rings and fit the filter assembly into place against the filter head. Secure the whole assembly with the centre bolt.
7. Bleed the fuel system as described in operation 3B/17

PRIMARY FUEL FILTER ASSEMBLY

Removal and Refitting

(3B/10)

1. Disconnect the pipes from the fuel lift pump to the primary filter and from the primary to the secondary filter. Blank off the open connections.
2. Remove the two securing bolts which hold the filter assembly to the engine.
3. To replace the filter assembly, reverse the above procedure and bleed the fuel system as described in operation 3B/17

SECONDARY FUEL FILTER ELEMENT

Renewal

(3B/11)

1. Clean the outside of the filter assembly.
2. (Fig. 7) Remove the centre bolt (1) from the filter head.
3. Ease the base and sediment bowl (2) from the filter head.

SECONDARY FUEL FILTER ASSEMBLY

Renewal . . . Cont'd

4. Discard the filter element.
5. Fit a new filter element and sealing rings and reassemble the filter by reversing the above procedure. Bleed the fuel system as described in operation 3B/17.

Note

Never attempt to clean or reclaim a used filter element

SECONDARY FUEL FILTER ASSEMBLY

Removal and Refitting

(3B/12)

1. Disconnect and blank off the following pipes at the secondary filter :—
 - (a) Pipe from primary to secondary filter.
 - (b) Pipes from secondary filter to fuel injection pump, (2 pipes).
 - (c) Pipe from secondary filter to start aid tank.
2. Remove the two bolts which hold the filter to the engine.
3. To replace the filter assembly, reverse the above procedure and bleed the fuel system as described in operation 3B/17.

FUEL INJECTION PUMP

Removal and Refitting

(3B/13)

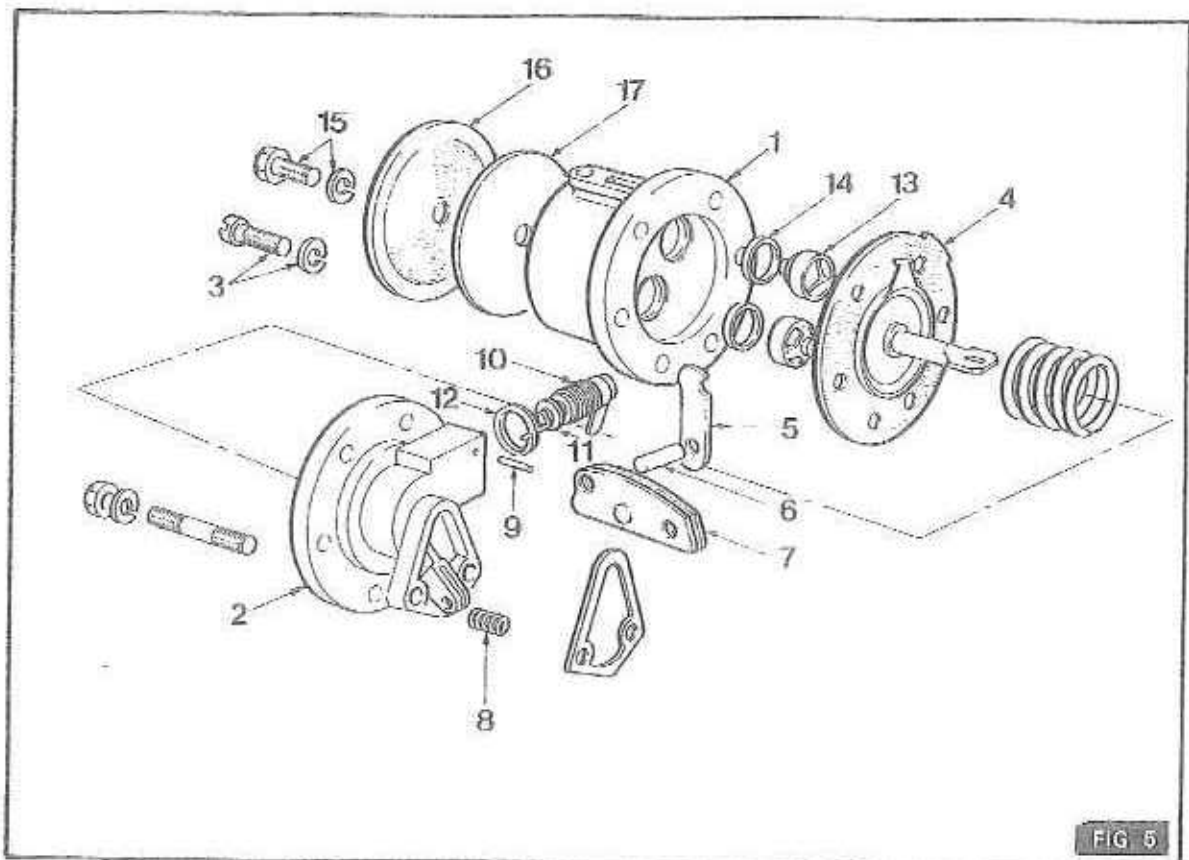
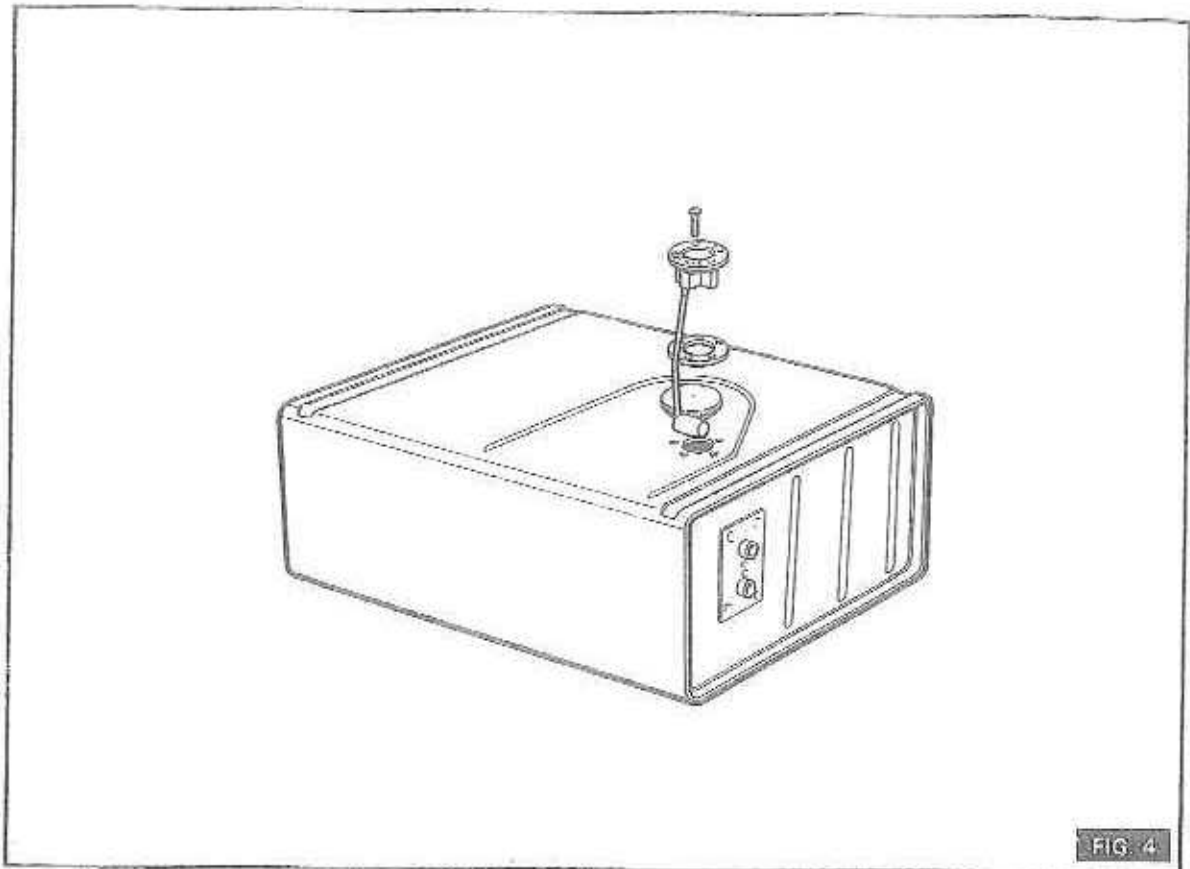
1. Turn the engine to T.D.C. No. 1 cylinder on compression. In this position the T.D.C. mark on the fly-wheel should be in the mid position of the inspection port.
2. Remove the pipes from the injection pump to the injectors. Blank off the connections.
3. Remove all the fuel supply pipes and blank off the connections.
4. Disconnect the throttle and fuel cut-off control rods.
5. Remove the setscrews which hold the engine oil filler tube to the timing gear case. Lift the oil filler clear.
6. Remove the inspection cover from the timing gear casing in order to gain access to the injection pump gear.
7. Remove the three setscrews which hold the fuel pump gear to its hub. Take great care that these setscrews do not drop into the timing case.
8. Check that the scribed line on the rear of the timing case coincides with the scribed line on the fuel pump mounting flange.
9. Remove the three nuts and washers securing the injection pump at the timing case.
10. Withdraw the injection pump, leaving the pump driving gear in the timing case. Do not move the drive gear out of mesh with the idler gear or attempt to turn the engine until the injection pump has been replaced.
11. To refit the injection pump, reverse the above procedure. Ensure that the pump driving gear dowel is properly located and that the scribed marks on the engine timing case and fuel pump mounting flange are aligned (see Fig. 8). Renew the gaskets on the pump and timing case inspection cover.
12. Bleed the fuel system as described in operation 3B/17.

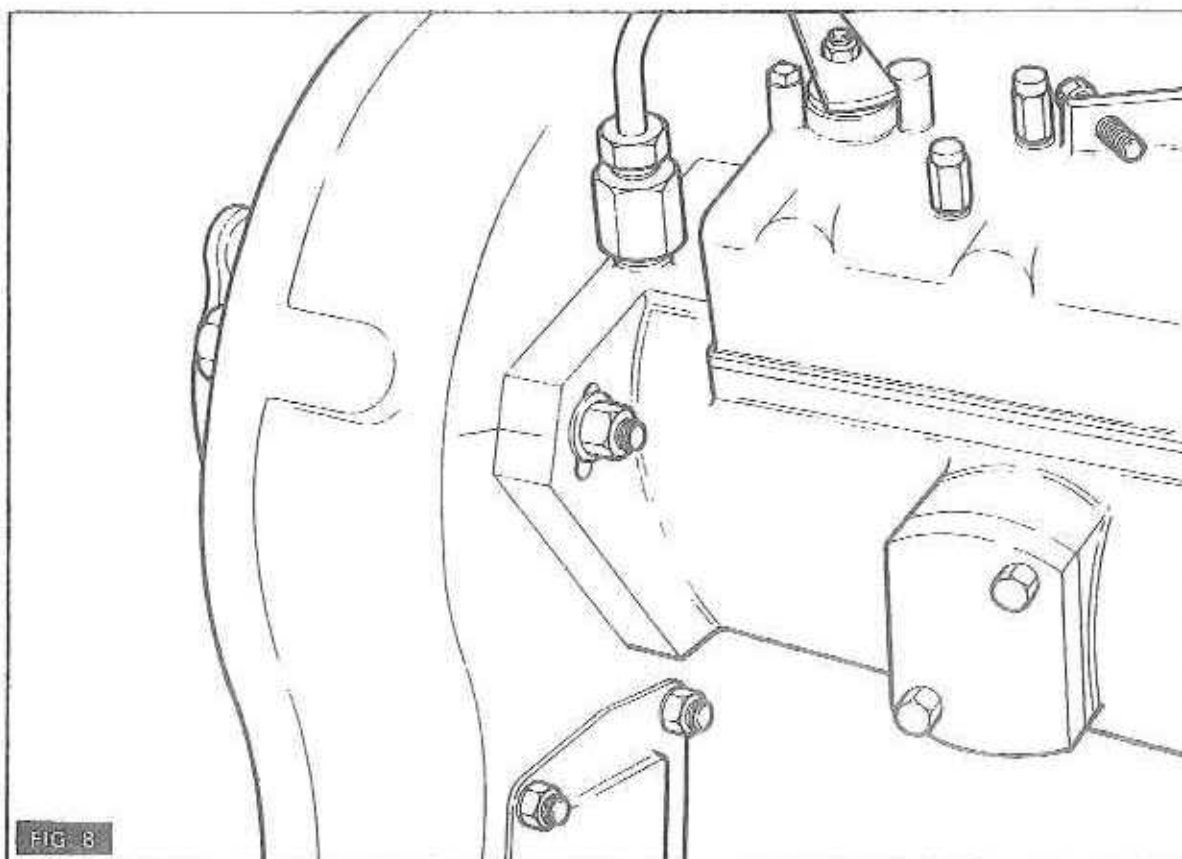
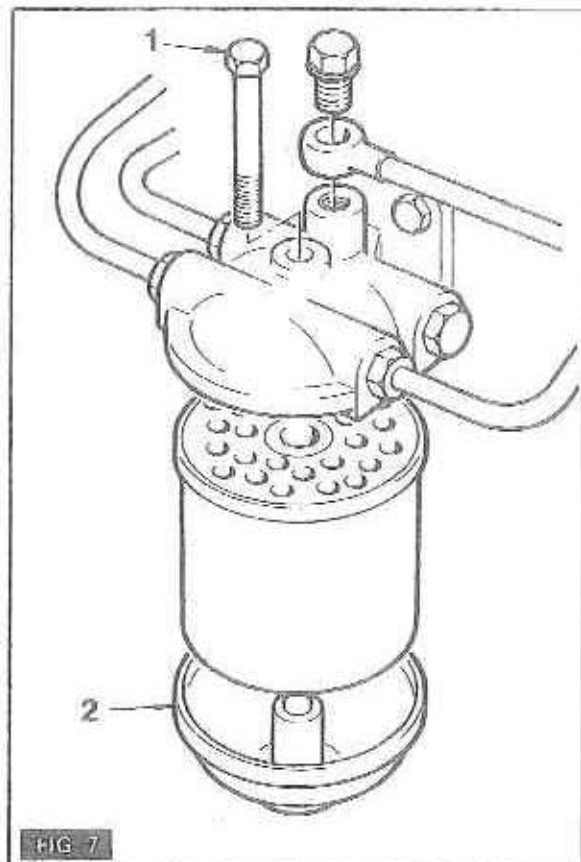
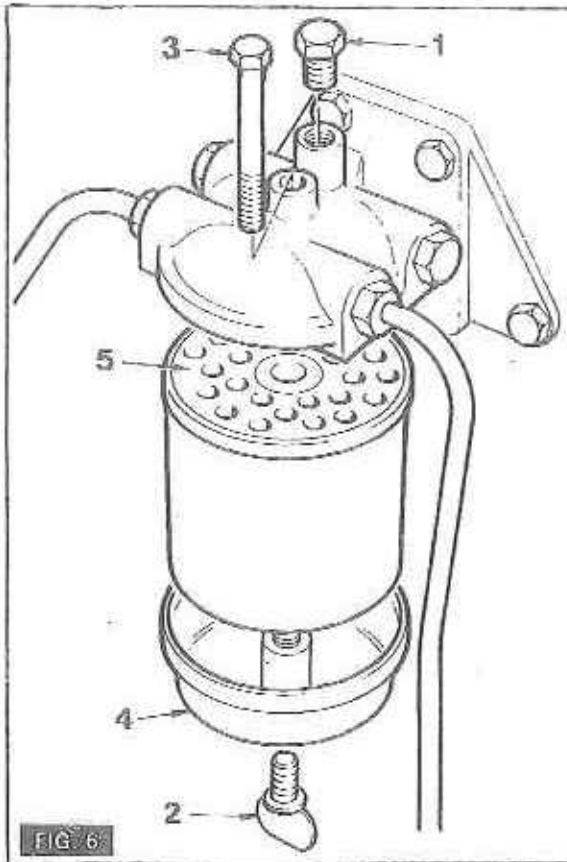
FUEL INJECTION PUMP TIMING

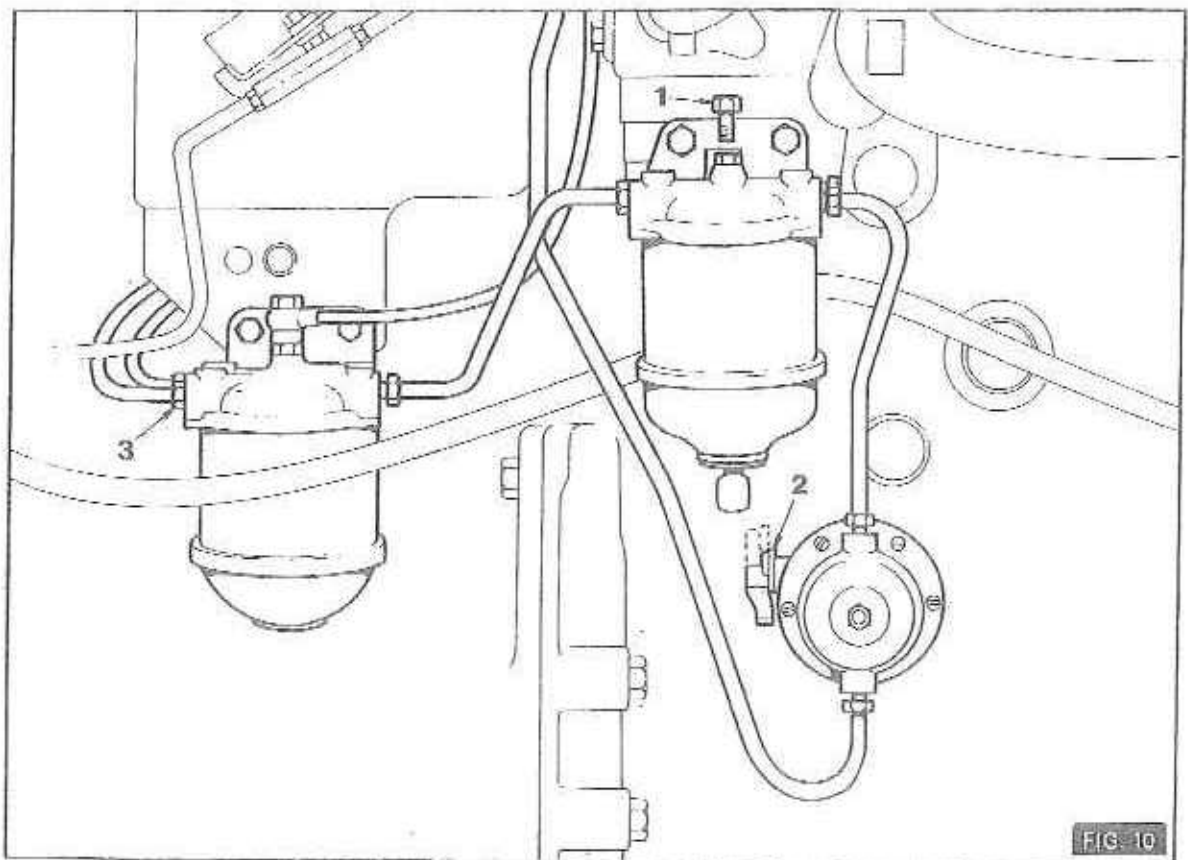
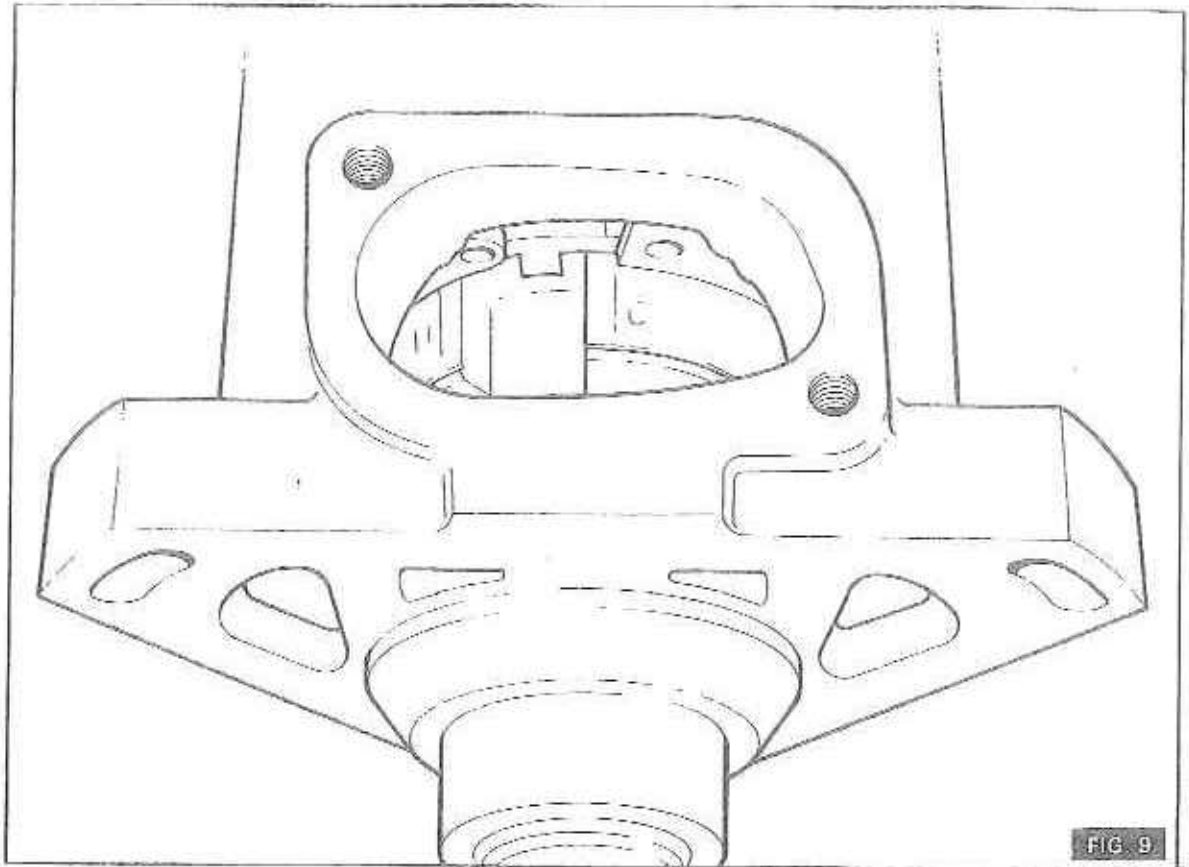
Checking and Adjusting

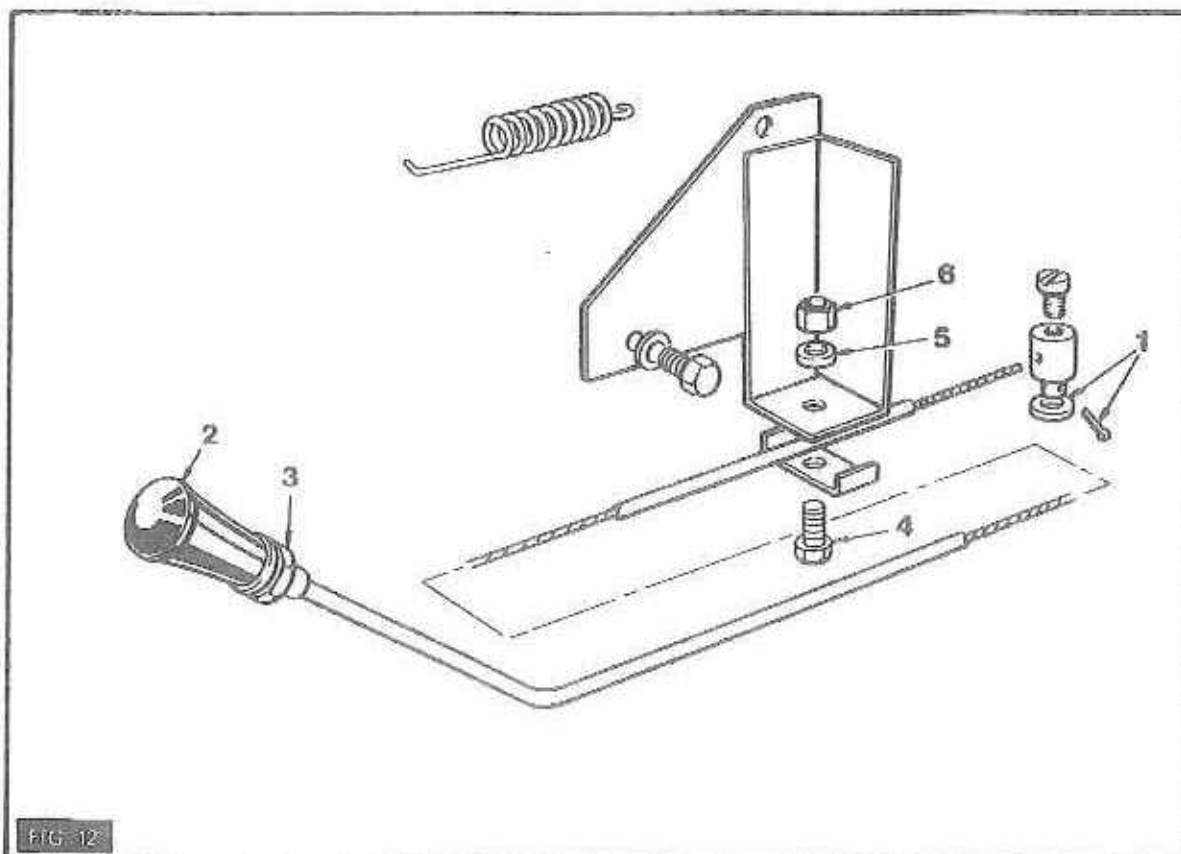
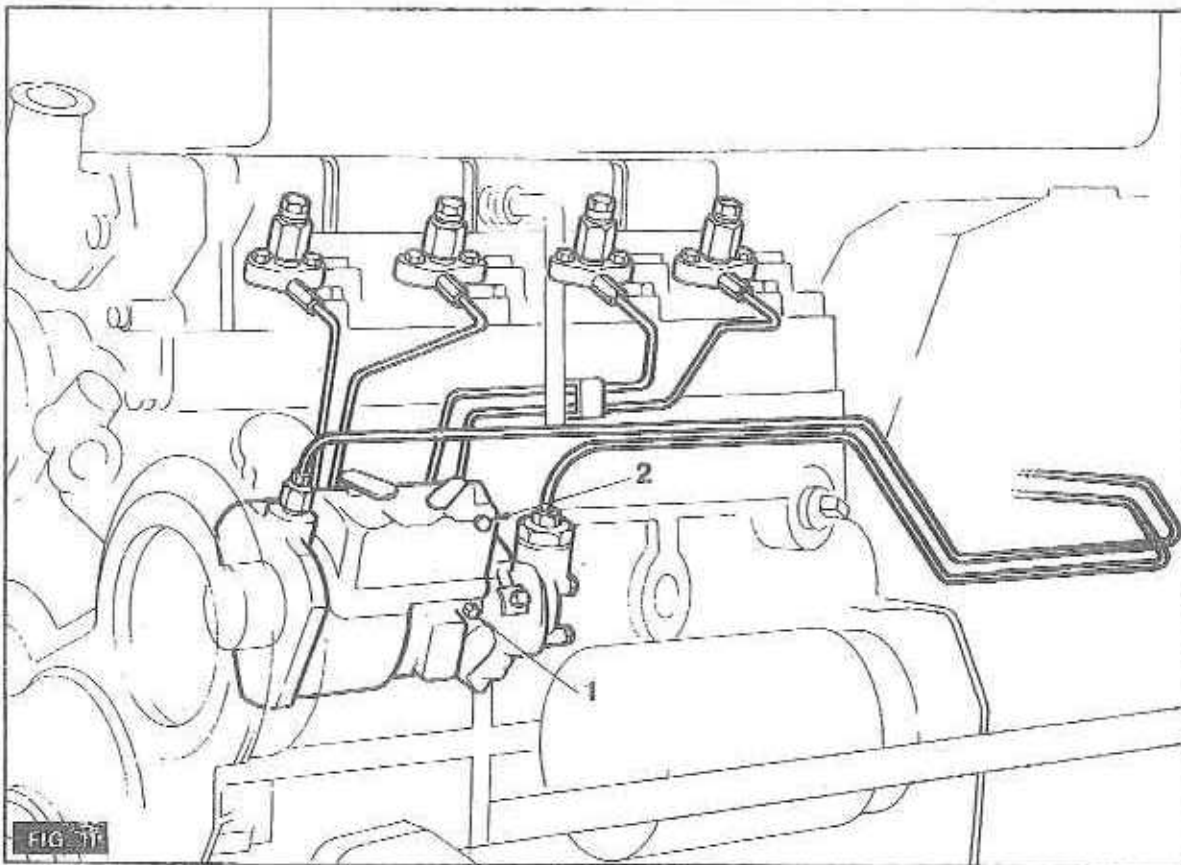
(3B/14)

The seal on the fuel injection pump must only be broken by an experienced and authorised person who must re-seal the cover with a suitable identification seal.









FUEL INJECTION PUMP TIMING

Checking and Adjusting

1. Remove the plug from the flywheel housing inspection port.
2. Turn the crankshaft to position No. 1 and No. 4 piston on T.D.C. No. 1 cylinder on compression. In this position the T.D.C. mark on the flywheel should be in the mid position of the inspection port.
3. Rotate the crankshaft 90° in reverse direction to normal rotation.
4. Slowly turn the engine in the direction of normal rotation until the mark indicating 22° B.T.D.C. is at the centre of the inspection port.
5. Remove the inspection cover from the fuel injection pump.
6. (Fig. 9) If the timing gear has not been disturbed, a scribed line marked 'C' will be visible inside the fuel pump inspection hole. This scribed line should align with the squared end of the circlip when the crankshaft is 22° B.T.D.C. If the scribed line does not align with the squared end of the circlip, proceed as follows :—
7. Slacken the nuts securing the injection pump to the timing case. Twist the body of the pump in the required direction to enable the squared end of the circlip to line up with the mark 'C' on the rotor.
8. Tighten the nuts to hold the pump securely to the timing case.
9. Check again the timing mark 'C' with the circlip.
10. Replace the inspection cover on the pump and reseal.
11. Replace the plug in the flywheel housing inspection port.
12. Bleed the fuel system as described in operation 3B/17.

FUEL INJECTORS

Removal and Replacement

(3B/15)

1. Disconnect the fuel injection pipes and leak off pipe from the injectors.
2. Remove the two nuts which hold the injector to the cylinder head. Ensure that the nuts are slackened evenly.
3. Gently prise the injector out of position and lift clear.
4. To replace the injector, reverse the above procedure, ensuring that the copper sealing washer is renewed. Tighten the securing nuts evenly and progressively.

FUEL INJECTORS

Testing

(3B/16)

If no proper injector testing equipment is available, the following method of testing may be adopted.

1. Run the engine at a fast 'tick over' speed.
2. Slacken off the injector pipe union at each injector in turn.
3. If, after slackening an injector pipe union, the engine revolutions remain constant, this would indicate a faulty injector. On the other hand, a drop in engine speed indicates that the injector is working properly.
4. When one injector is found to be defective, it is advisable to remove all the injectors for reconditioning or replacement.

Note

Servicing the injectors requires special equipment and should not be attempted unless the equipment is available.

Bleeding the Fuel System

(3B/17)

Air in the fuel system will result in poor engine performance and may even prevent the engine from starting. For this reason, whenever any part of the fuel system has been disconnected, disturbed or removed it will be necessary to bleed the fuel circuit in order to expel any air from the system before attempting to start the engine.

To bleed the system, proceed as follows :-

1. (Fig. 10) Open the vent plug (1) on primary filter and operate the hand priming lever (2) on the fuel lift pump.
2. Continue to operate the hand priming lever until the fuel from the vent plug is free of air bubbles.
3. When the fuel is free of air bubbles, close the vent plug.
4. (Fig. 11) Slacken the outlet pipe (1) on the secondary fuel filter and once again operate the hand priming lever until fuel free of air bubbles issues from the union. Tighten the connection.
5. Open the lower vent plug (2) on the fuel injection pump and repeat the priming procedure to clear the air from the vent plug.
6. Close the lower vent plug and open the upper vent plug (3) in the fuel injection pump, repeat the priming procedure.
7. Close the upper vent plug.
8. Slacken off Nos. 1 and 4 OR 2 and 3 injection pipe unions. Operate the starter motor until fuel spurts from the slackened unions.
9. Tighten the union nuts and check through the system to make sure all connections are tight.

Note

The fuel stop control must be in the 'on' position when cranking the engine. Having carried out the above operations, the engine will then be ready for starting.

START AID TANK

(3B/18)

The start aid tank is an integral part of the fuel tank and is a maintenance free item.

FUEL CUT-OFF CONTROL

Removal and Refitting

(3B/19)

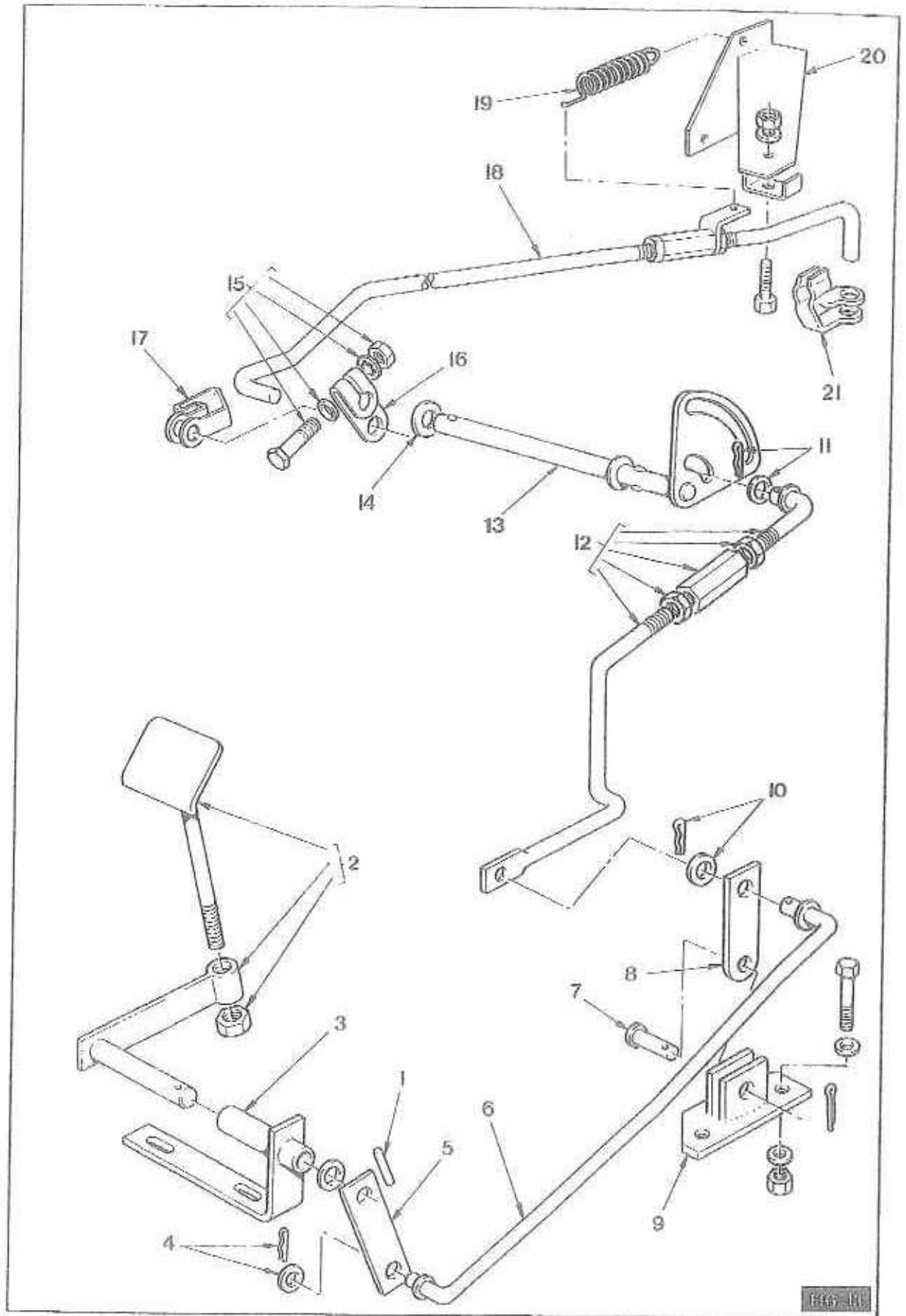
1. (Fig. 12) Remove the cotter pin and washer (1) from the rod at the fuel injection pump.
2. Remove the screw (4) washer (5) and nut (6) securing the cable to the fuel injection pump bracket. Release the cable.
3. Remove the knob (2), nut (3). Pull the rod clear.
4. To replace the cut-off control, reverse the above procedure.

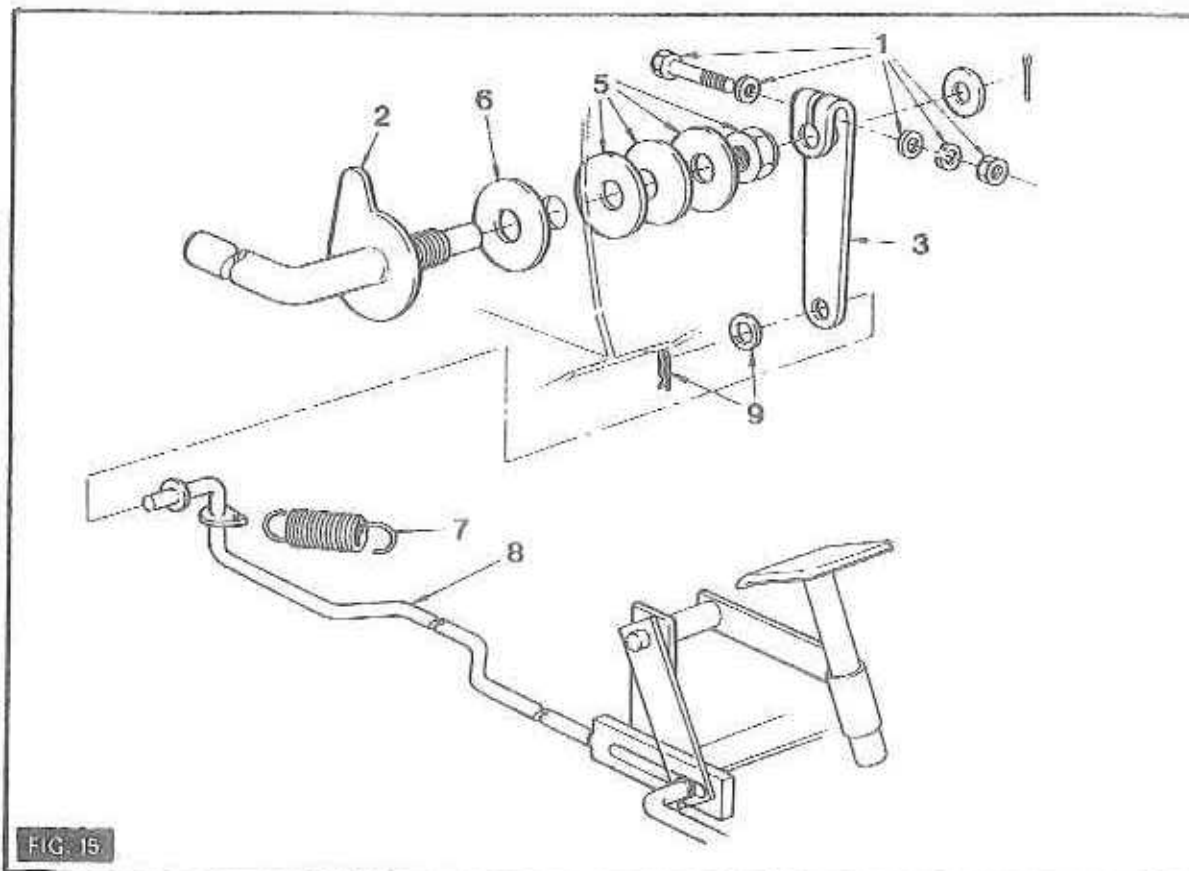
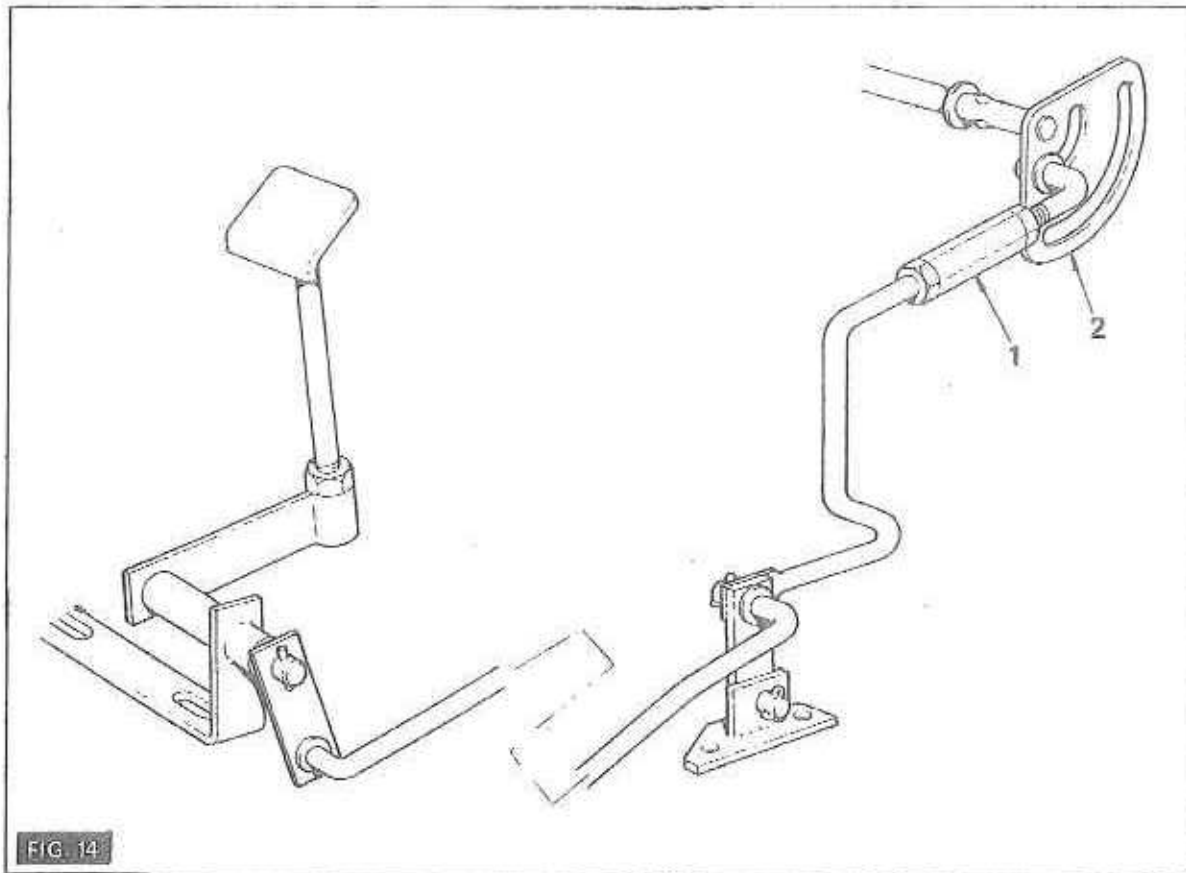
FOOT THROTTLE LINKAGE STANDARD TRANSMISSION

Removal and Replacement

(3B/20)

1. Remove the right hand floor access panel.
2. (Fig. 13) Remove the spiral pin (1) securing the throttle pedal assembly (2) to the pedal bracket (3). Remove the throttle pedal.
3. Withdraw the clip and flat washer (4) securing the throttle control rod (6) to the rod lever plate (5).
4. Remove the clevis pin (7) securing the throttle lever (8) to the pivot (9). Release the lever from the pivot and remove the clip and washer (10) securing the throttle control rod and withdraw the throttle rod and lever.
5. Remove the clip and flat washer (11) securing the throttle rod (12) to the throttle cross-shaft (13). Remove the throttle rod.
6. Remove the throttle rod (18) from the clip (21) at the fuel injection pump. Disconnect the throttle rod





FOOT THROTTLE LINKAGE STANDARD TRANSMISSION

Removal and Replacement . . . Cont'd

- spring (19) at the fuel injection pump bracket (20).
7. Disconnect the throttle rod at the left hand side of the throttle cross-shaft by releasing clip (17).
8. Remove the bolt, washers and nut (15) and remove lever (16) from cross-shaft.
9. To remove the throttle cross-shaft remove washers (14) and withdraw cross-shaft.
10. To replace the throttle linkage, reverse the above procedure.

FOOT THROTTLE LINKAGE STANDARD TRANSMISSION

Adjustment

(3B/21)

1. (Fig. 14) Adjust the turnbuckle (1) such that maximum throttle opening is attained (2).
2. When fully depressed, the pedal lever end to contact the centre housing in order to avoid overloading the linkage.

FOOT THROTTLE LINKAGE STANDARD TRANSMISSION

Removal and Replacement

(3B/22)

1. Remove the four screws and washers securing the seat cowl to the floor. Remove cowl together with the seat.
2. (Fig. 15) Remove the bolt washers and nut (1) securing the lever assembly (2) to the throttle control lever (3). Remove the split pin and flat washer (4) from the throttle lever assembly.
3. Withdraw the throttle control lever from the lever assembly, remove the nut and belleville washers (5) and remove the throttle control lever and friction disc (6).
4. Remove the spring (7) securing the throttle rod (8) to the bracket on the underside of the floor.
5. Remove the clip and washer (9) securing the throttle rod to the throttle control lever. Remove the throttle control lever.
6. To dismantle the remainder of the hand throttle linkage proceed as in operation 3B/20.
7. Replacement is a reversal of the above procedure.

Note

When reassembling the throttle lever assembly it is important that the belleville washers are arranged exactly as shown in Fig. 16.

HAND THROTTLE LINKAGE STANDARD TRANSMISSION

Adjustment

(3B/23)

1. (Fig. 17) With the foot pedal in the off position set the angular position of the throttle control lever (1) so that the lever assembly is at the end of the slot on the throttle rod assembly. In this position adjust the throttle lever assembly to the horizontal.

FOOT THROTTLE LINKAGE REVERSOMATIC

Removal and Replacement

(3B/24)

1. Remove the throttle pedal and brake pedal gaiters.
2. Remove the front floor plate.
3. (Fig. 18) Remove the split pins and washers (1) which secure the selector rods (2) to the pedal assemblies (3).

FOOT THROTTLE LINKAGE REVERSOMATIC

Removal and Replacement . . . Con'd

4. Remove the spring pin (4) and withdraw the shaft, together with thrust washers (5) from the pedal assemblies (3). Remove the pedal assemblies.
5. Remove the nuts and lock washers (6) securing the lower end of the selector rods to the fork assembly (7). Remove the selector rods.
6. Remove the cotter pin, washer and clevis pin (8) securing the clevis spring assembly (9) to bracket assembly (10). Release the spring assembly at the throttle lever (11) and remove the spring assembly.
7. Remove the plain washers and retaining clips (13) securing the throttle rod (12) to the throttle quadrant (14) and throttle lever. Remove the rod.
8. Disconnect the gear selector lever by removing the pin and washer securing the shift selector assembly (15).
9. Withdraw the pin and washer which secures the shift selector assembly to the pivot shaft assembly (16), and remove the shift selector assembly.
10. Remove greaser (17) from the pivot shaft assembly.
11. Remove the lever and pivot shaft assembly from the front of the throttle lever assembly.
12. Remove the fork assembly from the rear of the throttle lever.
13. Remove the stub shaft (18) from the transmission control system carrier and remove the throttle lever assembly.
14. Remove three bolts, washers and nuts securing the transmission control carrier to the transmission case.
15. Replacement is a reversal of the above procedure.

FOOT THROTTLE LINKAGE REVERSOMATIC

Adjustment

(3B/25)

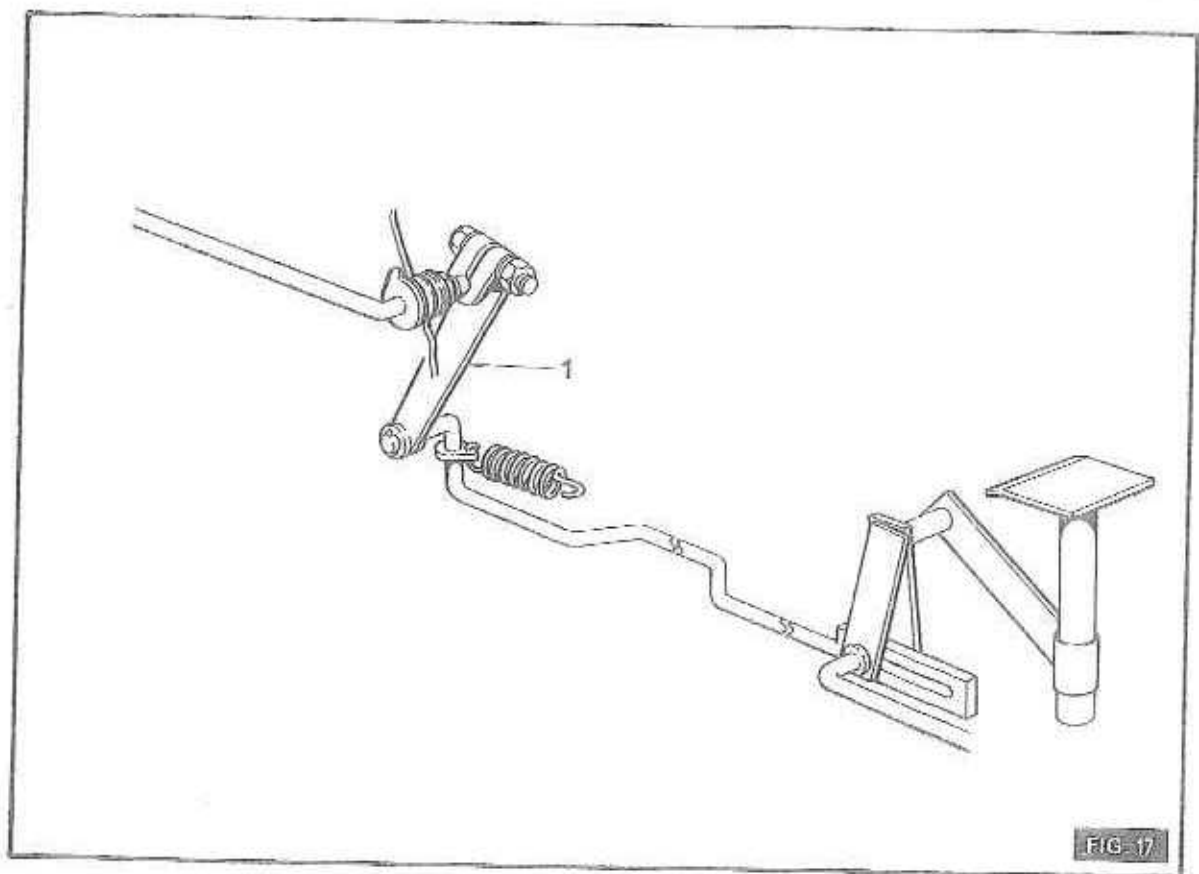
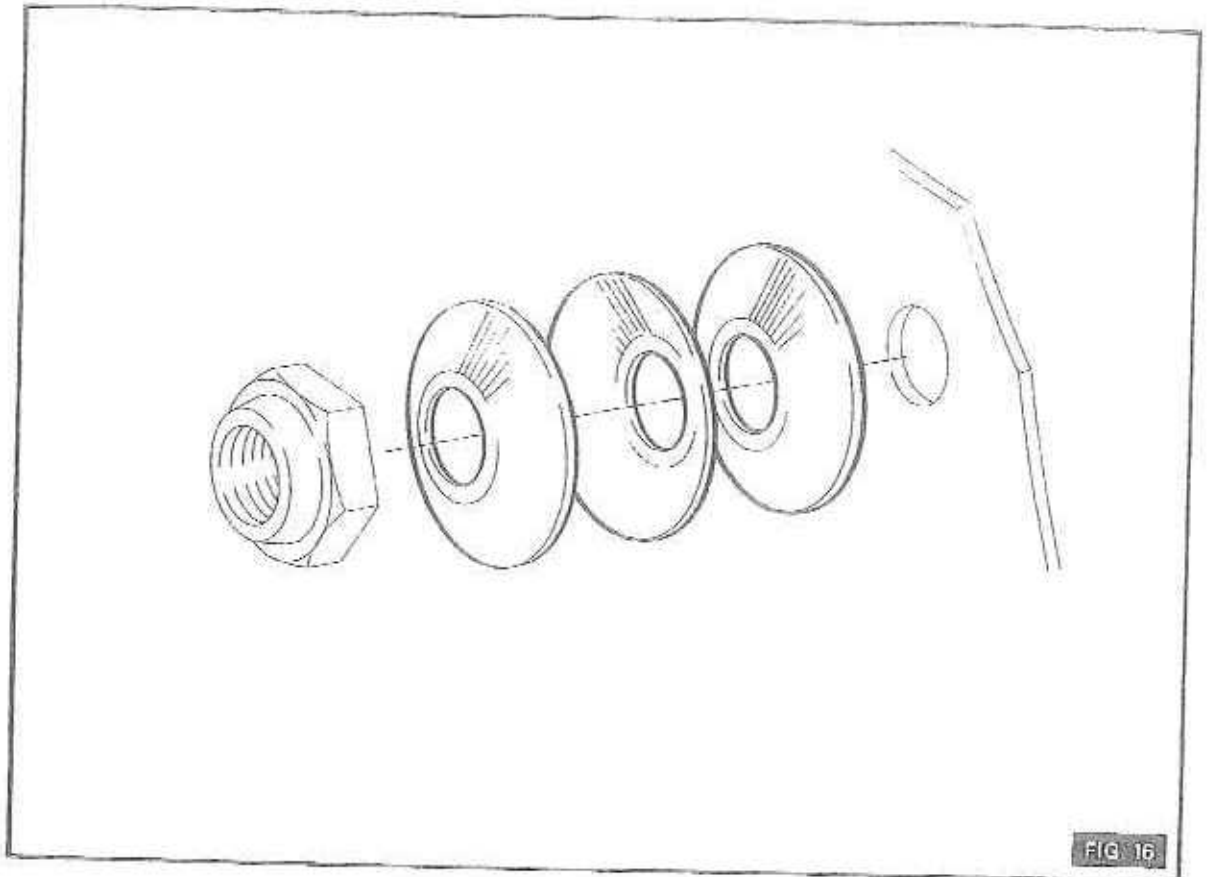
1. (Fig. 19) With the throttle rod assembly disconnected, position the cross shaft quadrant in the idling position and set the hand throttle in the horizontal position.
2. With the hand throttle connected to the quadrant, set the hand throttle lever to the maximum speed position. With the throttle lever on the fuel injector pump set against the maximum speed stop, connect the throttle rod to suit.
3. Return the hand throttle to the idling position and fit the throttle return spring. With the linkage in the idling position, set the throttle pedal idle screw to suit and tighten the adjusting nut. Fit the throttle control spring with light tension.
4. Set the fuel cut off lever on the fuel injection pump in the "engine running" position, thread the core of the cable through the cable pivot until taut, then tighten the screw.
5. With both foot pedals level, adjust the nuts so that the direction engagement lever is in the neutral position. Tighten down the nuts onto the pivot shift selector.
6. Increase the tension in the spring assembly by screwing the locknut clockwise into the clevis. Spring tension to be such that, by application of the forward and reverse pedals, the transmission spool is fully selected in the appropriate direction via movement of the lever and pivot shaft assembly before movement of the throttle lever assembly occurs. Tighten the locknuts against the clevis.

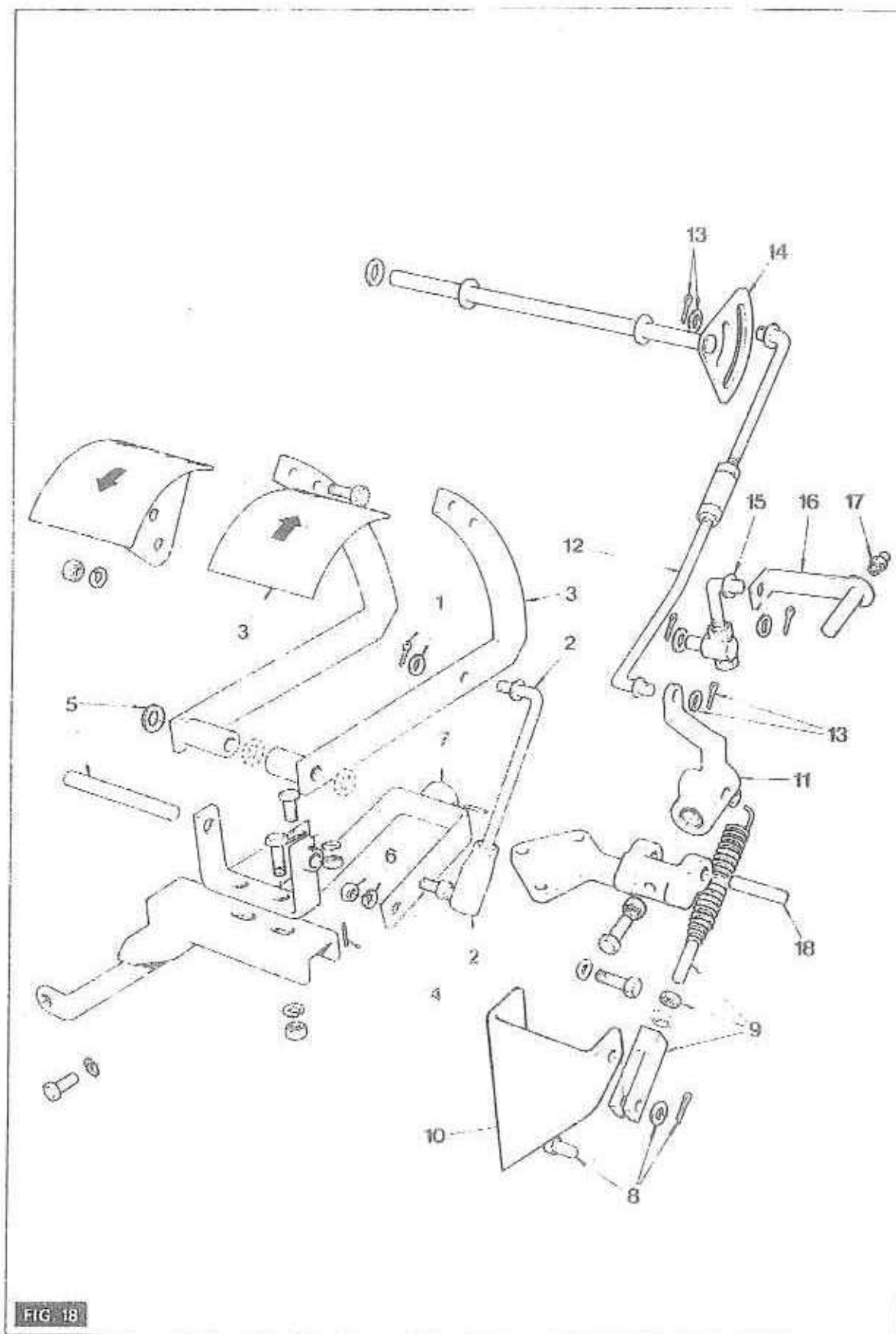
HAND THROTTLE LINKAGE

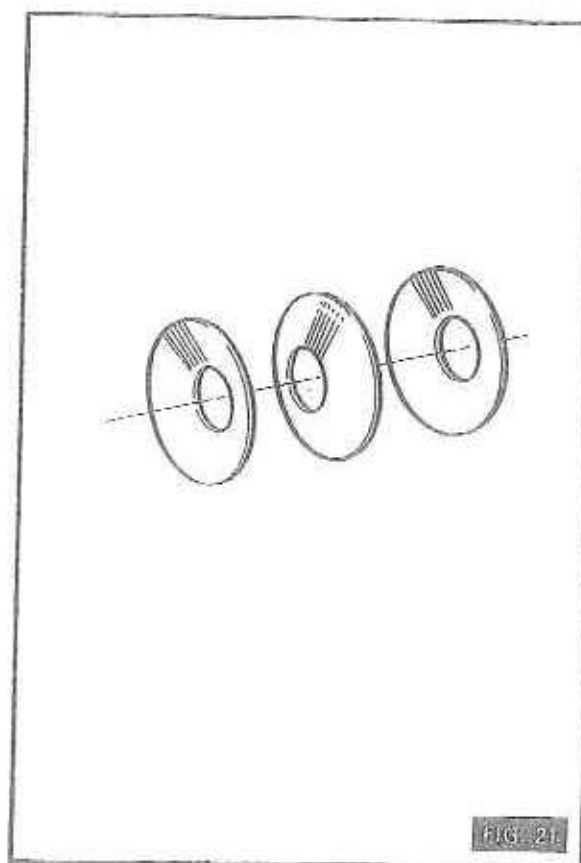
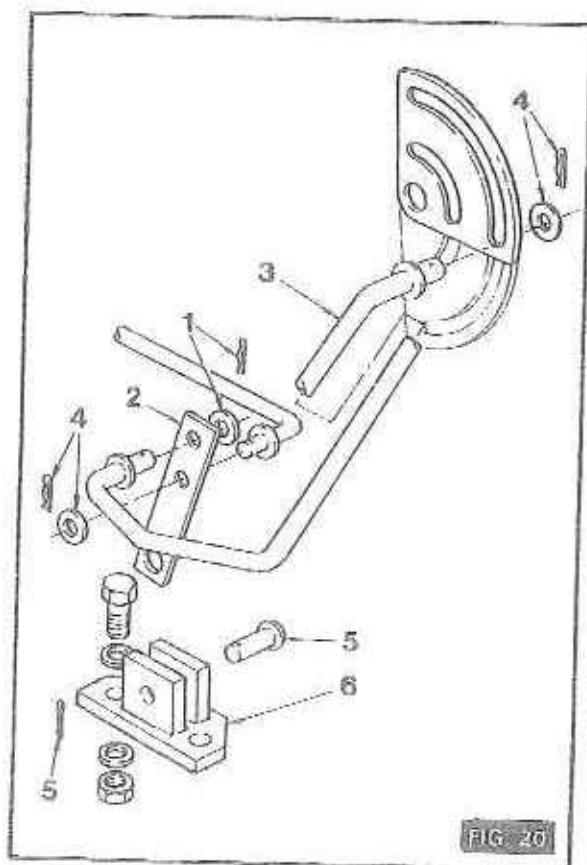
Removal and Replacement

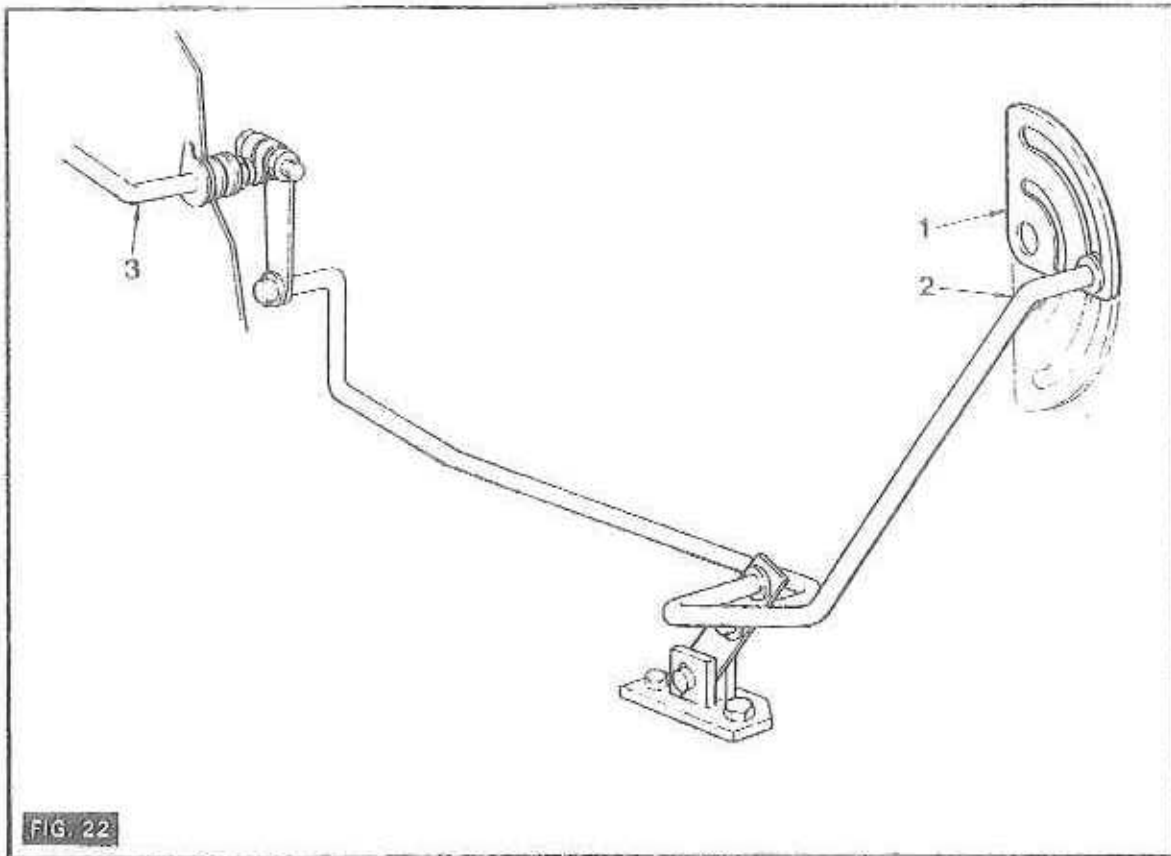
(3B/26)

1. Remove the front floor plate.
2. Remove four screws and washers securing the seat cowl to the floor. Remove cowl together with the seat.
3. To remove the throttle rod from the throttle lever assembly, proceed as items 2-5 of operation 3B/22.
4. (Fig. 20) Remove washer and clip (1) securing the lower throttle rod to the lever (2). Remove the throttle rod.









HAND THROTTLE LINKAGE

Removal and Replacement . . . Cont'd

5. Disconnect the upper throttle rod (3) by removing clips and washers (4), securing the rod at the throttle lever and at the quadrant. Remove the throttle control rod.
6. Withdraw split pin and remove clevis pin (5) securing throttle rod lever to the pivot post (6). Remove the lever.
7. Replacement is a reversal of the above procedure.

Note

When reassembling the throttle lever assembly it is important that the belleville washers are arranged exactly as shown in Fig. 21.

HAND THROTTLE LINKAGE

Adjustment

(3B/27)

1. (Fig. 22) With the accelerator quadrant (1) set in the idling position connect the pull rod (2) to the quadrant. In this position adjust the assembly (3) to the horizontal.



ELECTRICAL SYSTEM

CONTENTS

	PAGE
GENERAL	4
COMPONENT LOCATION AND DATA	4
WIRING HARNESS, Removal and Replacement 4A/1	5
BATTERY, Removal and Replacement 4A/2	6
ALTERNATOR, Removal and Replacement 4A/3.	6
STARTER, Removal and Replacement 4A/4	7
HORN, Removal and Replacement 4A/5.	7
HORN PUSH, Removal and Replacement 4A/6	8
STARTER SWITCH, Removal and Replacement 4A/7	8
FUSE BOX, Removal and Replacement 4A/8	8
LINE FUSES, Removal and Replacement 4A/9	8
CIGAR LIGHTER, Removal and Replacement 4A/10	8
TRAILER SOCKET, Removal and Replacement 4A/11	9
HEATER, Removal and Replacement 4A/12	9
HEATER, Disassembly and Reassembly 4A/13	9

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	GENERAL ARRANGEMENT OF ELECTRICAL EQUIPMENT	4
2	WIRING DIAGRAM FOR CAB	5
3	WIRING DIAGRAM FOR INSTRUMENTS	6
4	BATTERY, Removal from Carrier	7
5	ALTERNATOR, Removal	7
6	STARTER, Removal from Machine	8
7	HORN, Removal from hard nose	8
8	HORN PUSH, Removal from instrument panel	8
9	STARTER SWITCH, Removal from instrument panel	8
10	FUSE BOX, Removal from fairing	8
11	LINE FUSE, Disassembly	8
12	CIGAR LIGHTER, Removal from instrument panel	8
13	TRAILER SOCKET, Removal from cowl	9
14	HEATER, Breakdown	9

ELECTRICAL SYSTEM

GENERAL

This section covers the removal and replacement of all the electrical components (lights excepted).

The battery in this 12 volt negative earth system is situated under the floor plates and complete access is gained by lifting one section of the floorplates.

An alternator of the rotating field, ventilated design is fitted. It is fitted with sealed bearings and incorporates a voltage regulator on the slip ring end of the casting.

Fig. 1 shows the layout of all the electrical components and associated wiring.

Key to Fig 1

- 1 Battery
- 2 Horn
- 3 Alternator
- 4 Starter
- 5 Fusebox
- 6 Line Fuses
- 7 Trailer Socket

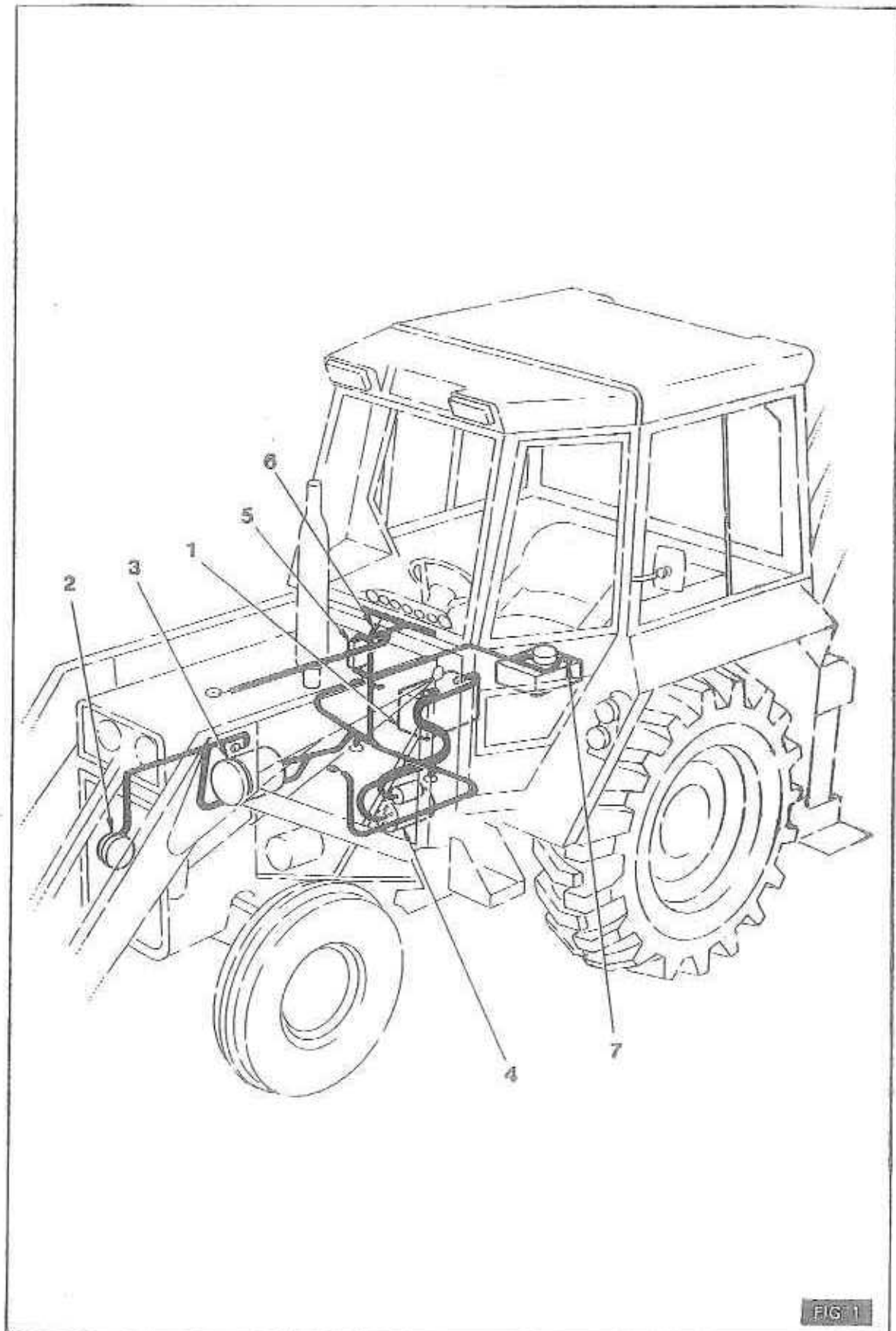
COMPONENT LOCATION AND DATA

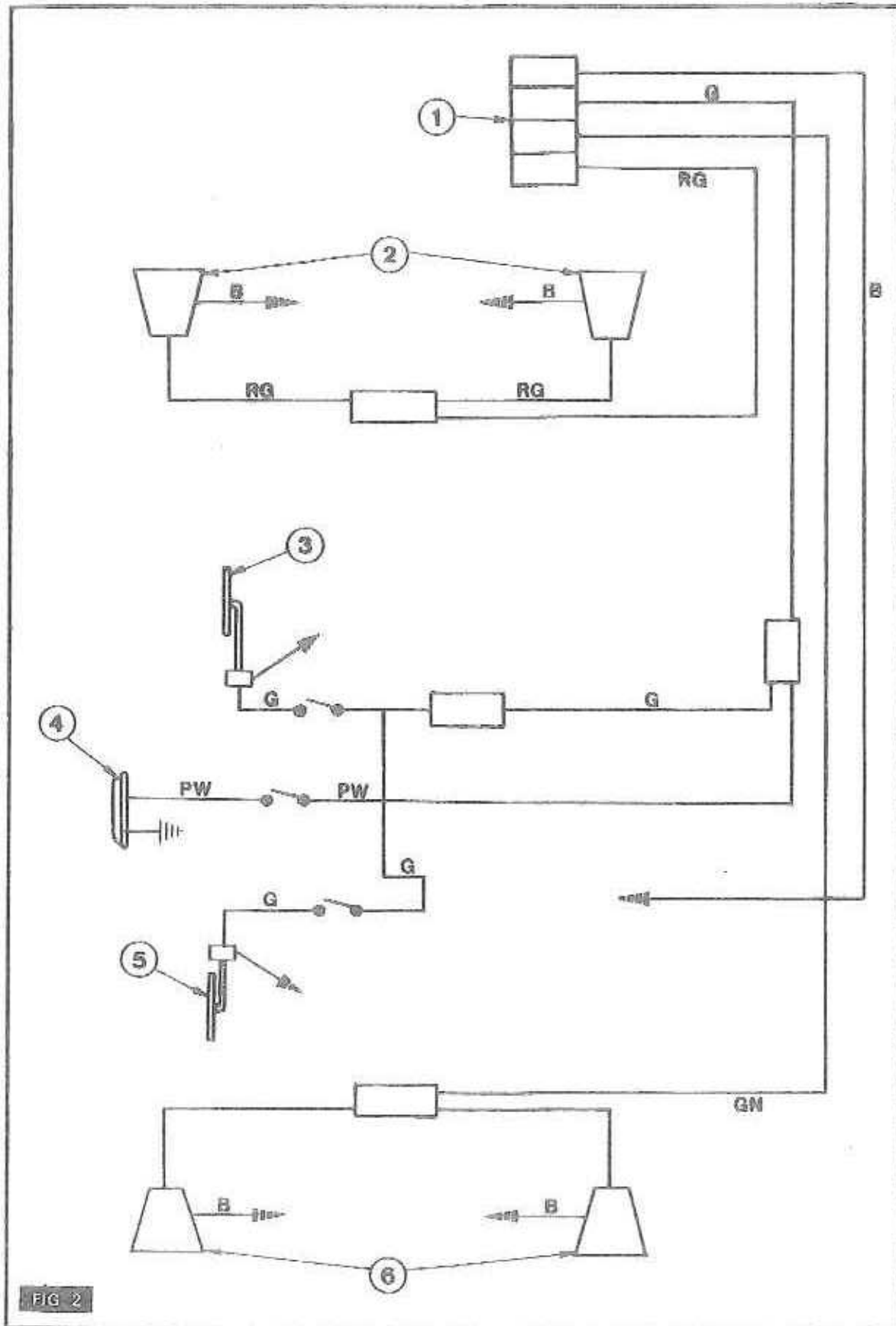
CIRCUIT:	12 Volt Negative Earth
BATTERY:	12 volt, 17 plate, Exide, having a capacity of 128 a.h. in 20 hours. Situated under the platform to the right of the operator.
ALTERNATOR:	Lucas 18 ACR. Situated on the front off-side of the engine and belt driven from the crankshaft pulley. The alternator can be adjusted to give the correct tension on the fan belt.
STARTER MOTOR:	Lucas M50. Solenoid engaged pinion. Situated on the rear L.H. side of the engine.
CONTROL UNIT:	Incorporated in the alternator.
FUSE BOX:	The fuses in the fuse box are as follows:- two 5 amp, two 8 amp, one 15 amp and one 25 amp. The box is situated on the right hand side of the fairing under the instrument panel.
LINE FUSES:	Four line fuses are incorporated to protect the main beam system, lighter, starting aid and hazard warning lights. All four are situated at the rear of the instrument panel.
HEATER:	Smiths, 2-speed motor. Controls for the heater are fastened under the right hand side of the instrument panel and the Radiator/fan unit is positioned under the operator seat cowl.

Key to Fig 2

CAB WIRING

- | | |
|---------------------|--------------------|
| 1 Multi Connector | 4 Interior Light |
| 2 Front Work Lights | 5 Rear Wiper |
| 3 Front Wiper | 6 Rear Work Lights |





COMPONENT LOCATION AND DATA ... Cont'd

Key to Fig 3

INSTRUMENTS

1	Neutral Safety Switch	12	Amp Meter
2	Starter	13	Fuel Gauge
3	Alternator	14	Oil Temperature Gauge
4	Starting Aid	15	Engine Thermo Unit
5	25 amp Fuse	16	Transmission Thermo Unit
6	5 amp Fuse	17	25 amp Fuse
7	25 amp Fuse	18	Heater Switch
8	Battery	19	Cigar Lighter
9	Horn	20	Heat/Start Switch
10	Fuel Sender Unit	21	Horn Push
11	Water Temperature Gauge	22	Heater

COLOUR CODE:

R	Red	B	Black	N	Brown
W	White	Y	Yellow	P	Purple
G	Green	U	Blue	LG	Light Green

WIRING HARNESS

Removal and Replacement

(4A/1)

1. Disconnect the battery.
2. Disconnect the following wires:
 - 10 at Fuse box
 - 2 at Neutral Safety Switch (Standard Transmission only)
 - 1 at Transmission Thermo Unit (Reversomatic Transmission only)
 - 1 at Engine Thermo Unit
 - 3 at Starter
 - 2 at Horn
 - 3 at O/S Headlights
 - 3 at N/S Headlights
 - 1 at Start Aid
 - 1 multi connector at Alternator
 - 2 at Stop Lamp Switch
 - 2 at Heater
 - 2 at Heater Resistor
 - 2 at Trailer Socket
 - 1 at Fuel Tank
 - 1 Multi Connector and Earth at L. H. Side Lights
 - 1 Multi Connector and Earth at R. H. Side Lights
3. Release harness from all clips and cleats.
4. Remove the four bolts which secure the instrument panel.
5. Lift the instrument panel from the cowl and remove all non electrical connections to the instrument panel. The panel can be lifted away gently pulling the wiring harness up the centre-fairing.
6. If necessary the harness can be removed from the rear of the instrument panel by removing the following wires:
 - 2 at Horn Push
 - 3 at Transmission Temperature Gauge
 - 3 at Indicator Switch

WIRING HARNESS

Removal and Replacement . . . Cont'd

- 1 at Indicator Warning Light
- 3 at Fuel Gauge
- 2 at Ammeter
- 1 at Cigar Lighter
- 4 at Heat/Start Switch
- 6 at Hazard Switch
- 3 at Water Temperature Gauge
- 1 at Work Light Warning Lamp
- 1 at Main Beam Warning Lamp
- 2 at Main Beam Dip Switch
- 4 at Side/Headlight Switch
- 3 at Work Light Switch
- 3 at Heater Switch
- 4 at Flasher Units

7. Replacement is a reversal of the above procedure.

BATTERY

Removal and Replacement

(4A/2)

1. Fig. 4. Remove the access panel.
2. Disconnect the battery leads from the terminals.
3. Unscrew the clamping bar and lift out the battery.
4. Replace the battery in a reverse order of the above procedure ensuring that the terminal posts are free from corrosion. If corrosion has occurred, clean terminals and smear with petroleum jelly.

CAUTION

- A. When refitting the battery, use the following procedure, as reversed battery connections will damage the alternator rectifier. First connect the earth strap to the negative terminal then the other lead to the positive terminal.
- B. The battery must NEVER be disconnected while the engine is running or damage may occur to the regulator semiconductor devices.

ALTERNATOR

Removal and Replacement

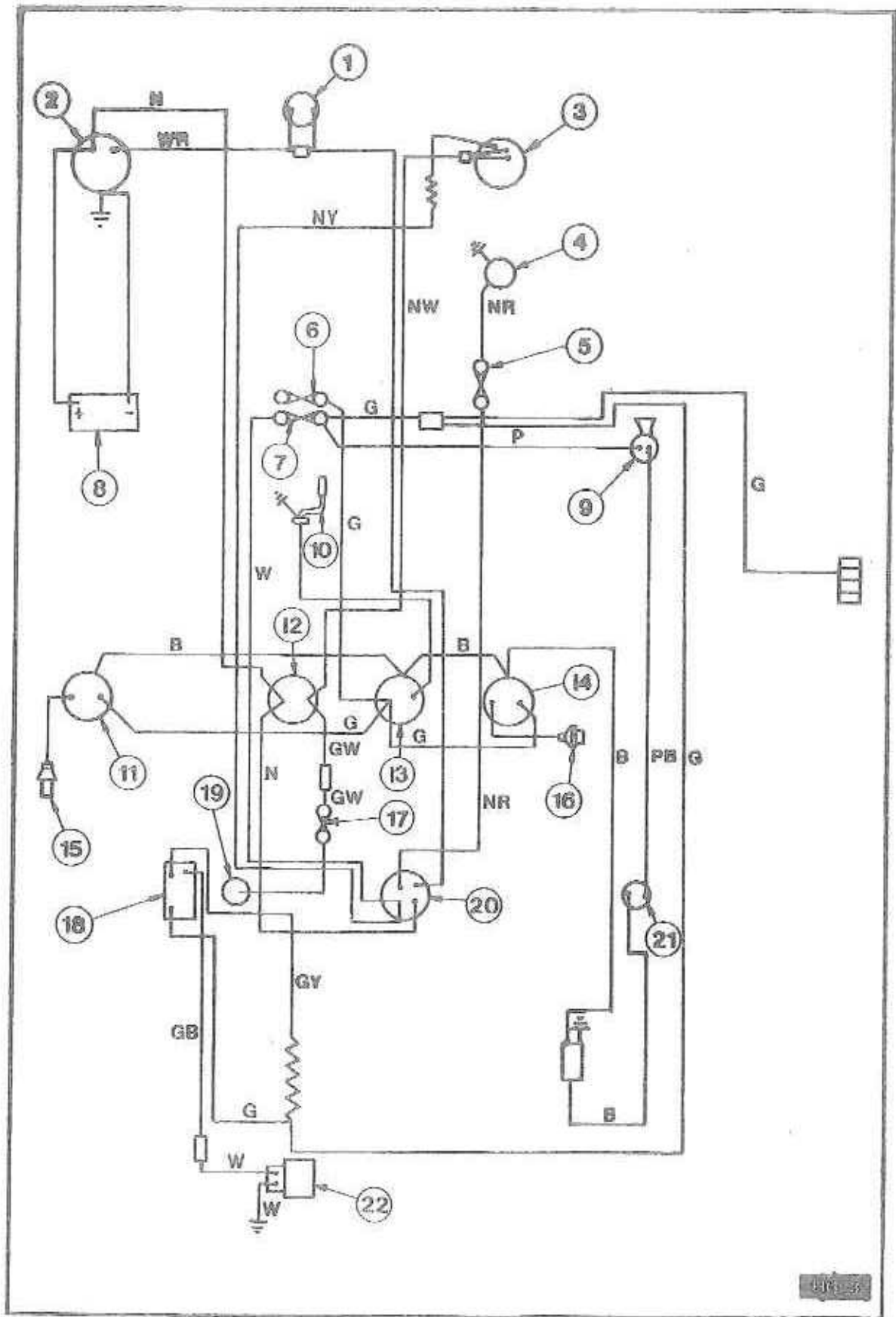
(4A/3)

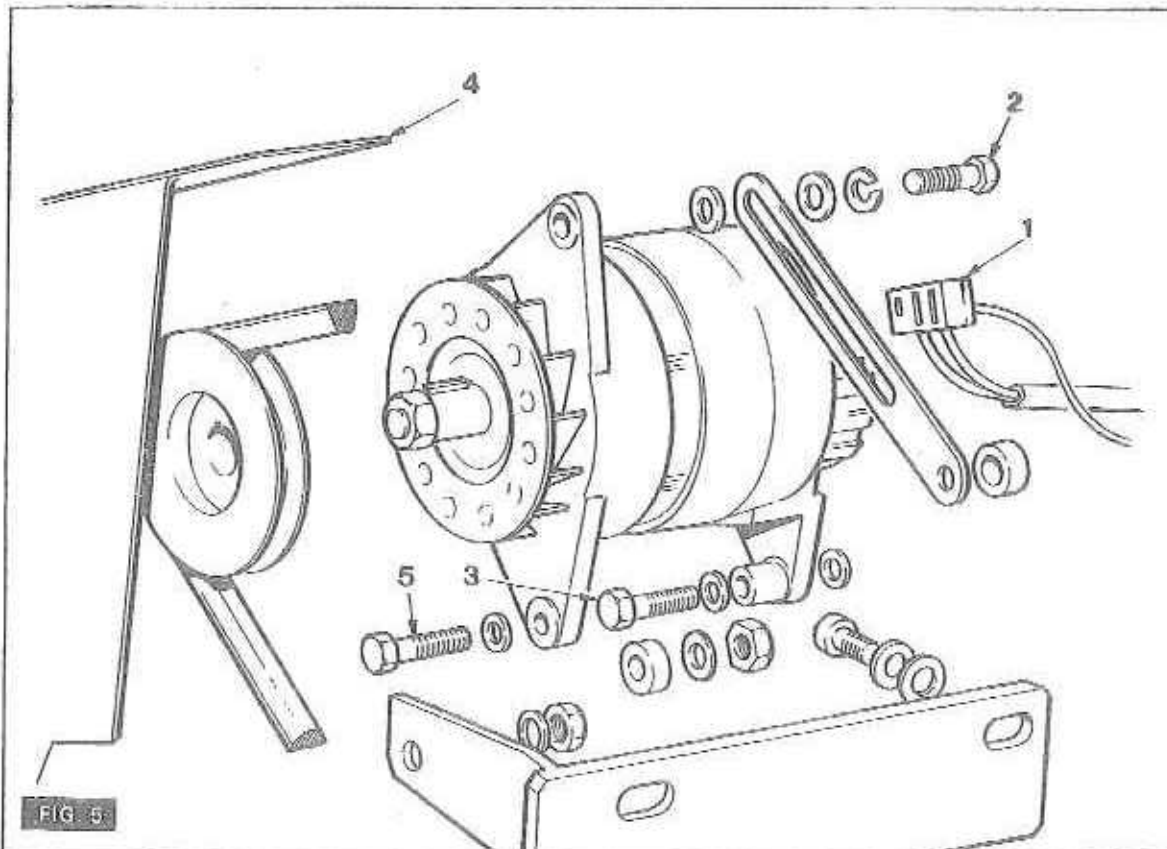
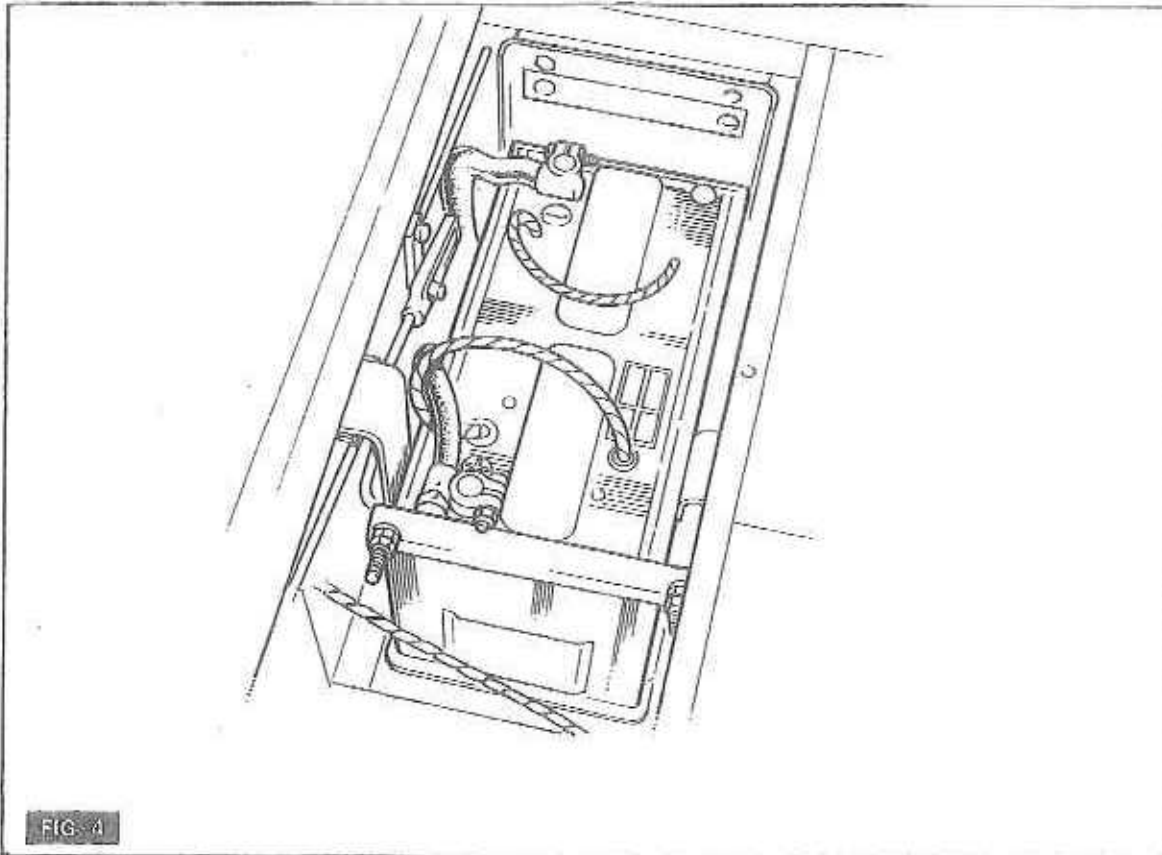
1. (Fig. 5) Disconnect the Multi Connector (1) from the rear of the alternator.
2. Unscrew and remove the upper adjusting bolt (2) and the lower adjusting bolt (3). The guard (4) can now be removed.
3. Remove the remaining pivot bolt (5), slip the fan belt from round the pulley and remove the alternator.
4. Replace in a reverse order of the above procedure.

NOTE

The following precautions should always be taken to safeguard the alternator.

- a) When fitting a replacement alternator, ensure it is of the same polarity as the original and that the connections are made correctly. The alternator polarity cannot be reversed by 'flashing' the field terminal as can a dynamo.
- b) When refitting the batteries, use the following procedure as reversed battery connections will damage the alternator rectifiers. First connect the earth strap to the negative terminal on each battery, then connect the other lead to the positive terminals.





ALTERNATOR

Removal and Replacement . . . Cont'd

- c) When using a high rate battery charger, take the connectors from the regulator before boost charging and reconnect when charging is completed.
- d) When starting engine with the aid of a high rate charger, employ the following procedure:-
Before connecting the charger, remove the connectors from the regulator terminals. Start the engine. Do not reconnect the regulator until the charger has been disconnected and the engine speed reduced to idling.
- e) The battery must NEVER be disconnected while the engine is running or damage may occur to the regulator semiconductor devices. For this reason the practice (often adopted with dynamos) of using a slave battery to start the engine and subsequently reconnecting the original batteries with the engine running must NOT be attempted.
- f) The cable connecting alternator and batteries is 'live' even when the engine is not running. Care must be taken not to earth the alternator terminal or the cable end if removed from the terminal, or damage to the cable will occur.
- g) The alternator must never be run with the main output cable disconnected either at the alternator or battery end while the field remains energised, or the rectifiers may be damaged.
- h) Do not make or break any other connections in the alternator circuit while the engine is running.
- j) If any arc welding is to be done on the machine, isolate the regulator and alternator by removing their connectors.
- k) Never use an ohmmeter of the type incorporating a hand-driven generator for checking the rectifiers or transistors.

STARTER

Removal and Replacement

(4A/4)

1. (Fig. 6) Disconnect the leads (1) at the three terminals on the starter unit.
2. Remove the three setscrews (2) which secure the starter to the engine.
3. Pull the starter clear of the engine.
4. Replace the starter in a reverse order of the above sequence.

HORN

Removal and Replacement

(4A/5)

1. (Fig. 7) Remove the front grille (1).
2. Disconnect the two wires (2) at the horn.
3. Remove the two bolts (3) which secure the horn to the hard nose.
4. Remove the horn (4).
5. Replace in a reverse order of the above sequence.

HORN PUSH

Removal and Replacement

(4A/6)

1. (Fig. 8) Remove the instrument panel to gain access to the rear of the horn push.
2. Disconnect the two wires (1) from the unit.
3. Remove the securing nut (2) and extract the unit through the front of the panel.
4. Replace in a reverse order of the above procedure.

STARTER SWITCH

Removal and Replacement

(4A/7)

1. (Fig. 9) Lift the instrument panel from the cowl to gain access to the rear of the starter switch.
2. Disconnect the four wires () from the switch.
3. Remove the securing nut () from the front of the switch.
4. Extract the unit through the rear of the instrument panel.

FUSE BOX

Removal and Replacement

(4A/8)

1. (Fig. 10) Remove the six bolts (1) which secure the fairing (2) to the fuel tank support, remove the fairing.
2. Remove the Fuse box cover (3).
3. Disconnect the ten wires (4) from the six fuses.
4. Unscrew the two nuts (5) and remove the bolts (6). The fuse box can then be removed from the bracket.
5. Replace the fuse box using a reversal of the above procedure.

NOTE

When refitting the wires to the fuse terminals ensure that they are correctly located.

LINE FUSES

Removal and Replacement

(4A/9)

1. Lift off the instrument panel from the cowl. This gives access to the four line fuses which are incorporated in the electrical system.
2. Hold both ends of the fuse casing, push top of casing in and turn it in an anti-clockwise direction.
3. Separate the casing halves and tip out the fuse. Insert new fuse of equal amperage to the one that has been removed.
4. Reassemble the casing.

CIGAR LIGHTER

Removal and Replacement

(4A/10)

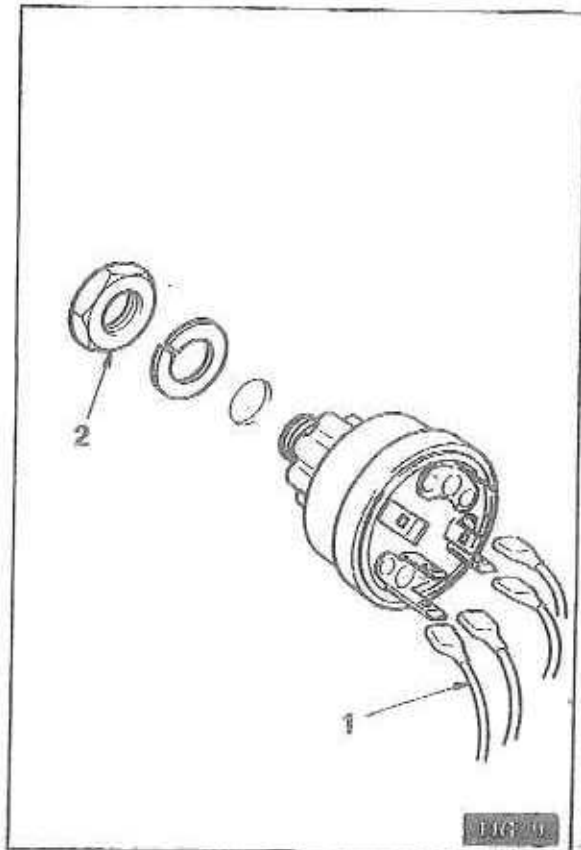
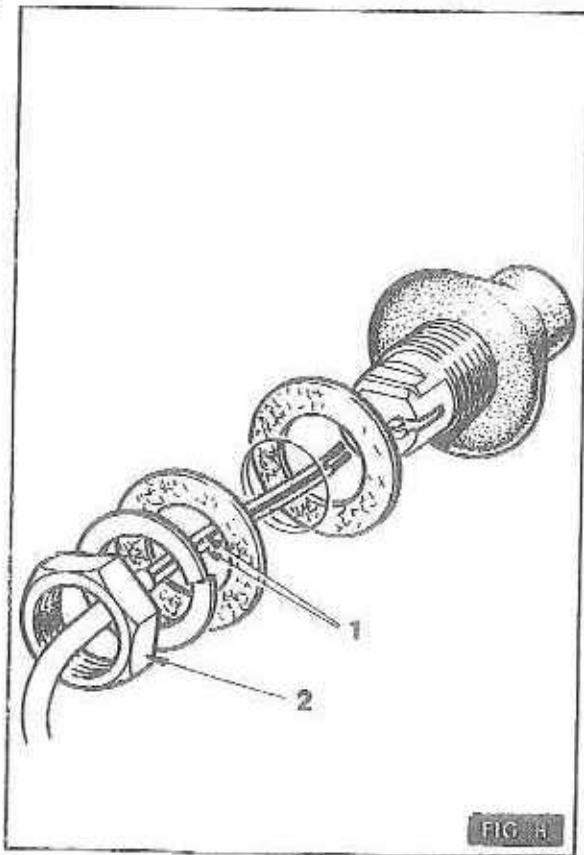
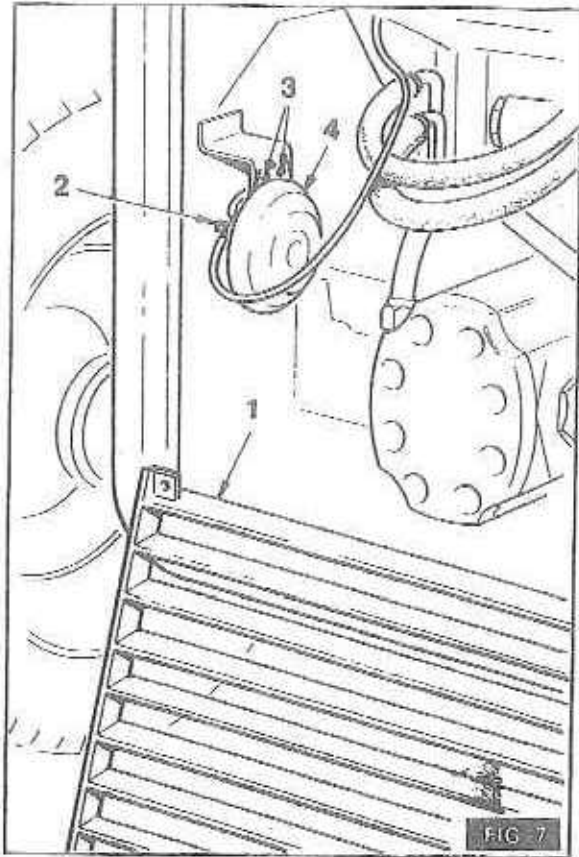
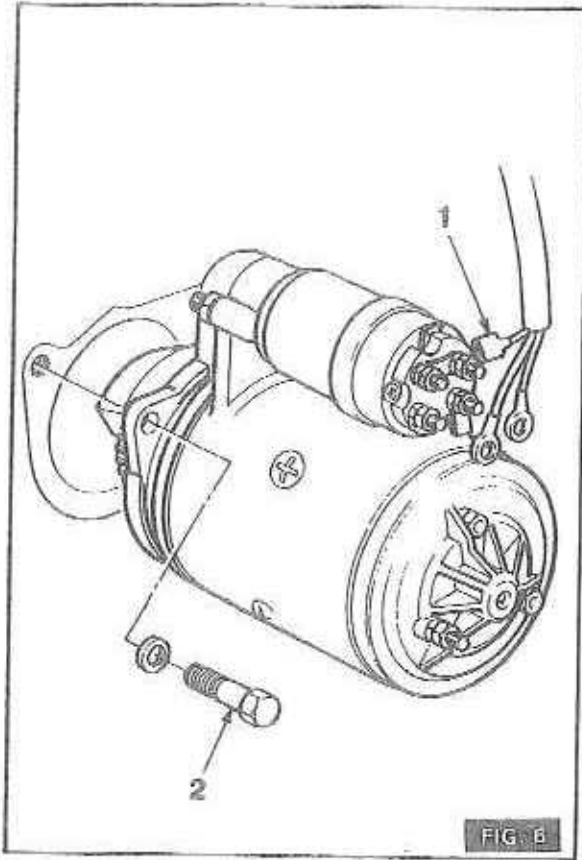
1. (Fig. 12) Lift the instrument panel from the cowl to gain access to the rear of the cigar lighter.
2. Remove the lighter unit (1).
3. Disconnect the wire at the line fuse (2).
4. Unscrew the outer cover (3) and pull the heater unit (4) through the front of the panel.

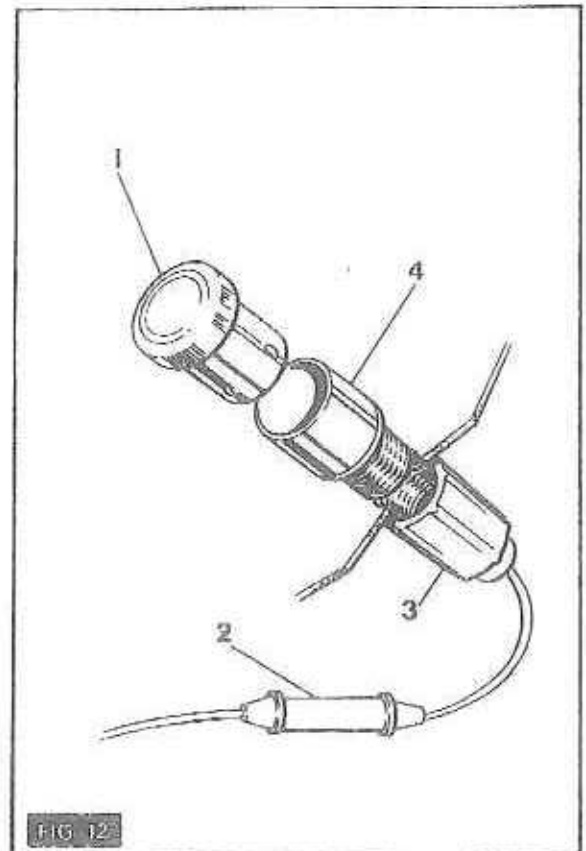
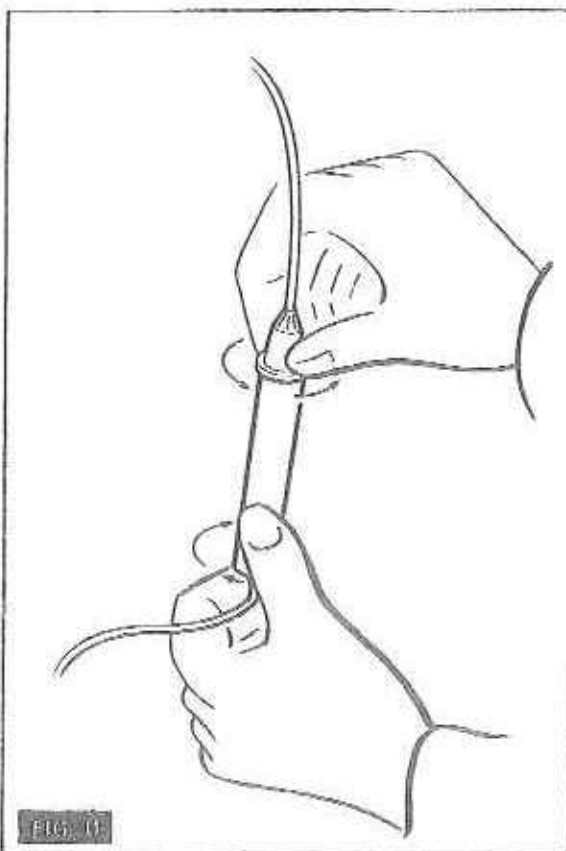
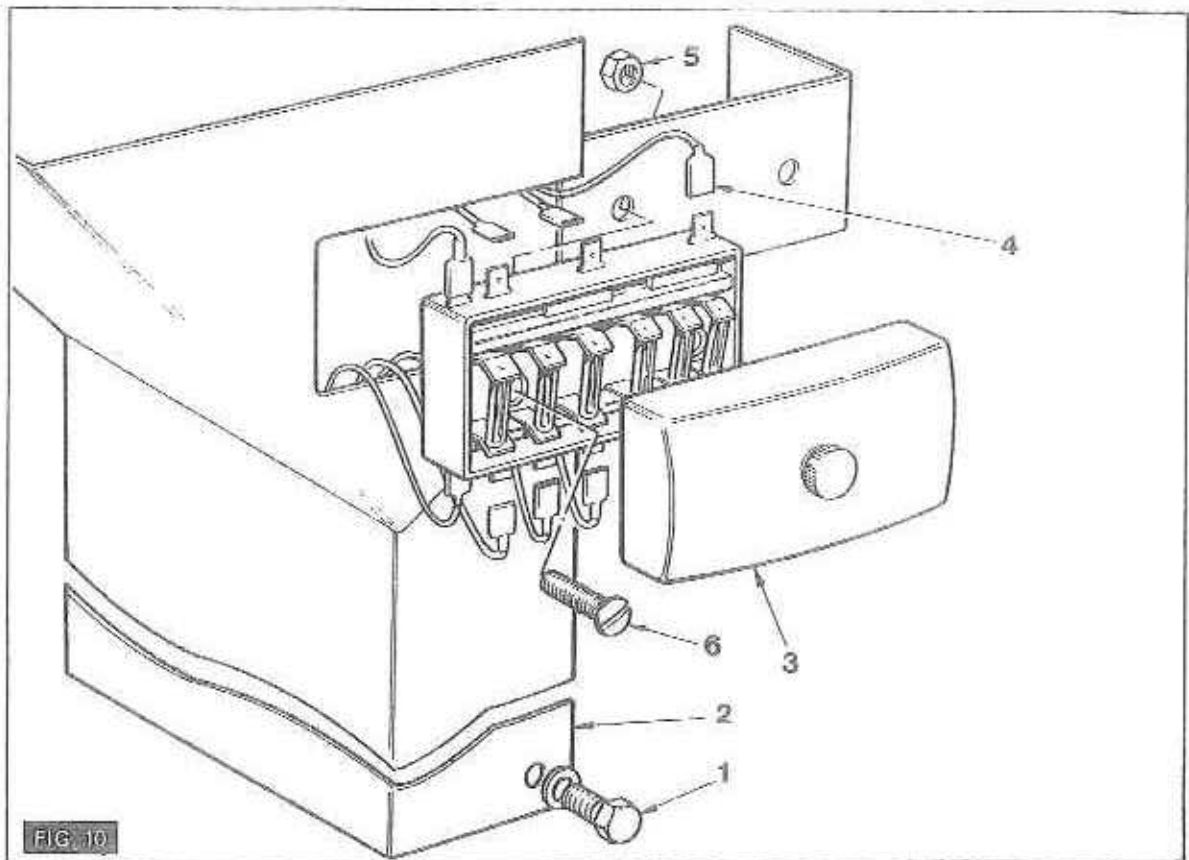
TRAILER SOCKET

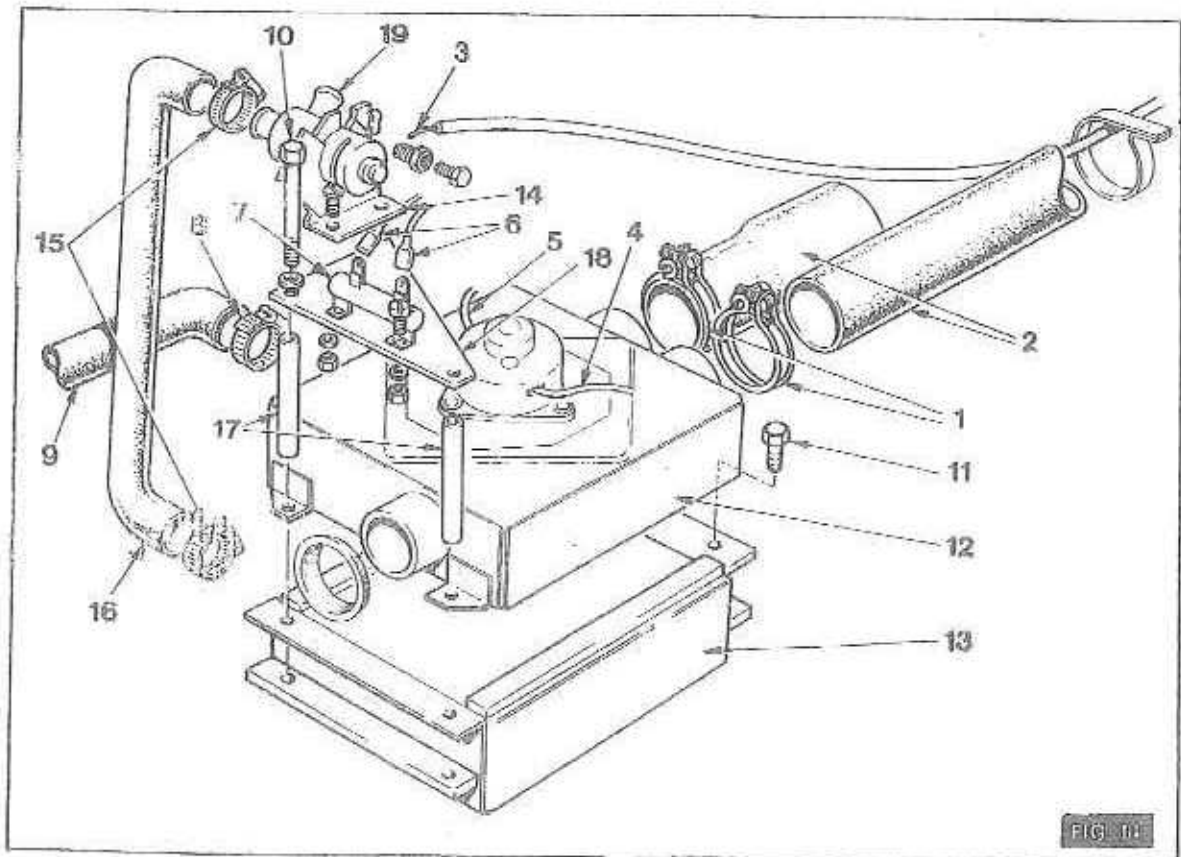
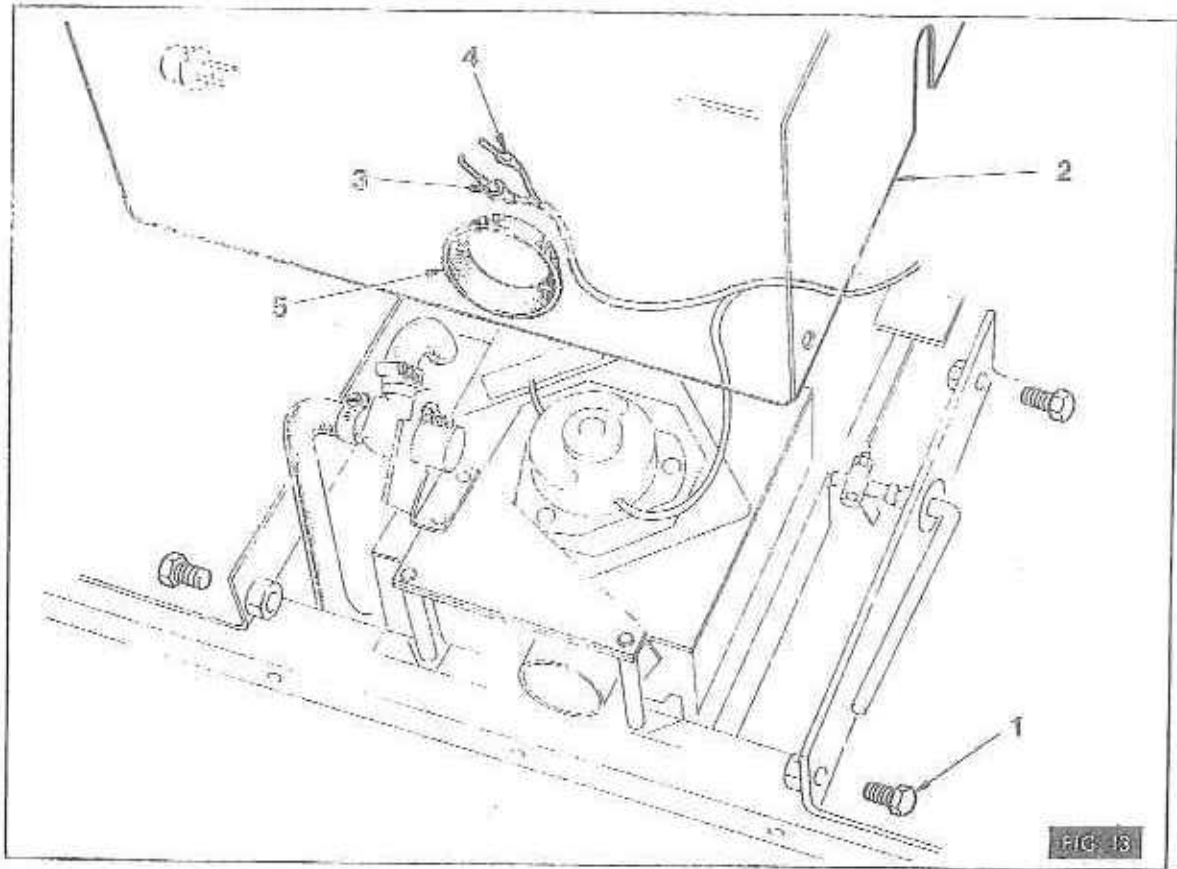
Removal and Replacement

(4A/11)

1. (Fig. 13) Remove the four bolts (1) which secure the heater cowl (2) to the platform.
2. Tip the seat and cowl forward to expose the wiring connections.
3. Disconnect the earth lead (3) and positive lead (4) from the main wiring harness.
4. Lower the seat and cowl back on to the platform and extract the rubber socket () from the hole in the cowl.









HEATER

Removal and Replacement

(4A/12)

1. Disconnect the trailer socket as described in parts 1 to 3 of operation 4A/11
2. Manoeuvre the seat and cowl assembly over the handbrake lever and remove from the machine.
3. (Fig. 14) Unfasten the clips (1) and remove the air outlet hoses (2) from the fan unit.
4. Disconnect the control cable (3) at the water valve.
5. Disconnect the earth lead (4) and positive lead (5) from the fan unit, then remove the two leads (6) from the resistor (7).
6. Unfasten the clip (8) and remove the outlet hose (9) from the radiator.
7. Unscrew the two long bolts (10) then the two short bolts (11) and lift the heater unit from the machine ensuring that the fan unit (12) radiator (13) and control valve mounting plate (14) are held together.

HEATER

Disassembly and Reassembly

(4A/13)

1. Remove the heater as described in operation 4A/12.
2. (Fig. 14) Loosen the two clips (15) and remove the hose assembly (16) from the control valve and reservoir.
3. Remove the two bolts (10) and distance pieces (11) then take the support plate (18) complete with heater control (19) and resistor (7), away from the machine.
4. Remove the two bolts (11) and separate the fan unit (12) from the radiator (13).
5. If necessary the control unit and resistor can be removed from the support plate by removing the appropriate securing screws.
6. Reassembly is a reversal of the above procedure.



LIGHTING SYSTEM

CONTENTS

	PAGE
GENERAL	4
HEADLIGHT, Removal and Replacement (4B/1)	5
WORKLIGHT, Removal and Replacement (4B/2)	5
INSTRUMENT PANEL ILLUMINATOR, Removal and Replacement (4B/3)	5
FRONT SIDE LIGHT, Removal and Replacement (4B/4)	5
FRONT INDICATOR, Removal and Replacement (4B/5)	6
REAR LIGHT, Removal and Replacement (4B/6)	6
REAR INDICATOR, Removal and Replacement (4B/7)	6
REAR NUMBER PLATE ILLUMINATOR, Removal and Replacement (4B/8)	7
STOP LIGHT, Adjustment (4B/9)	7
DIRECTION INDICATOR SWITCH, Removal and Replacement (4B/10)	7
LIGHT SWITCHES, Removal and Replacement (4B/11)	7
HAZARD WARNING SWITCH, Removal and Replacement (4B/12)	8

LIST OF ILLUSTRATIONS

Figure	Facing Page
1 GENERAL ARRANGEMENT, Lighting	4
2 WIRING DIAGRAM, Lighting	4
3 WIRING DIAGRAM, Cab	5
4 HEADLIGHT, Removal	5
5 HEADLIGHT, Disassembly	5
6 WORKLIGHT, Removal	5
7 INSTRUMENT PANEL ILLUMINATOR, Removal	6
8 FRONT SIDE LIGHT, Removal	6
9 FRONT INDICATOR, Removal	6
10 REAR LIGHT, Removal	6
11 REAR LIGHT, Disassembly	6
12 REAR INDICATOR, Disassembly	6
13 REAR NUMBER PLATE ILLUMINATOR, Removal	7
14 STOP LIGHT, Adjustment	7
15 DIRECTION INDICATOR SWITCH, Removal	7
16 LIGHT SWITCH, Removal	7
17 HAZARD WARNING SWITCH, Removal	7

LIGHTING SYSTEM

General

The lighting system consists of two front headlights, two front worklights, two front sidelights, two rear facing worklights, two rear lights, four indicators, one illuminated rear number plate, two panel lights, one interior light, all associated cables, harness and wires.

The cab is fitted with two front facing work lights, two rear facing worklights and an interior light.

All the lighting on the MF 50B Tractor Digger Loader complies with the road traffic regulations.

KEY TO FIG. 2 - LIGHTING

- | | |
|-------------------------------------|--|
| 1. Left Hand Head Light. | 15. Warning Light, Main Beam / Dip Switch. |
| 2. Left Hand Side Light. | 16. Warning Light, Work Light Switch. |
| 3. Left Hand Front Indicator Light. | 17. Warning Light, Indicator Switch. |
| 4. Right Hand Head Light. | 18. Main Beam / Dip Switch. |
| 5. Right Front Indicator Light. | 19. Side Light Switch. |
| 6. Right Hand Side Light. | 20. Work Light Switch. |
| 7. Fuse Box | 21. Heat / Start Switch. |
| 8. 8 Amp Fuse. | 22. Indicator Switch. |
| 9. Stop Light Switch. | 23. Hazard Warning Switch. |
| 10. Flasher Unit. | 24. 10 Amp Fuse. |
| 11. Flasher Unit. | 25. Left Hand Rear Indicator Light. |
| 12. Panel Light. | 26. Left Hand Stop / Tail Light. |
| 13. Panel Light. | 27. Trailer Socket. |
| 14. Amp Meter. | 28. Right Hand Stop / Tail Light. |
| | 29. Right Hand Rear Indicator Light. |

KEY TO FIG. 3 - CAB WIRING

- | | |
|-----------------------|----------------------|
| 1. Multi Connector. | 4. Interior Light. |
| 2. Front Work Lights. | 5. Rear Wiper. |
| 3. Front Wiper. | 6. Rear Work Lights. |

COLOUR CODE

- | | | |
|---------|----------|----------------|
| R Red | B Black | N Brown |
| W White | Y Yellow | P Purple |
| G Green | U Blue | LG Light Green |

WATTAGE OF BULBS

LIGHT	NO. OF	WATTAGE
Head Light	2	36W/35W
Work Light	4	36W Single Contact
Panel Light	2	2 - 2 W
Interior Light	1	18W
Side Light	2	5W
Indicator Light	4	21W
Tail Light	2	5W
Number Plate Light	1	8W

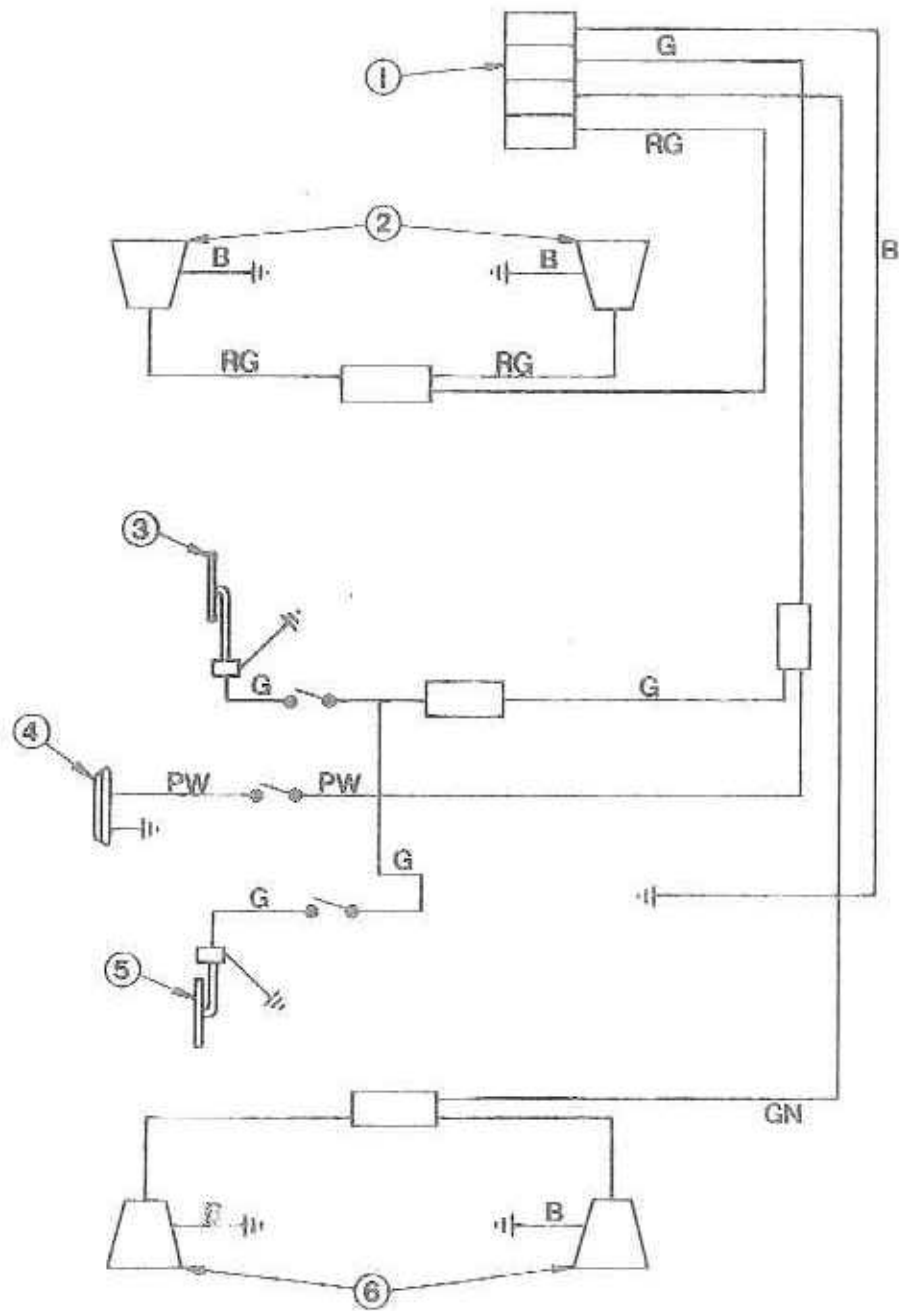
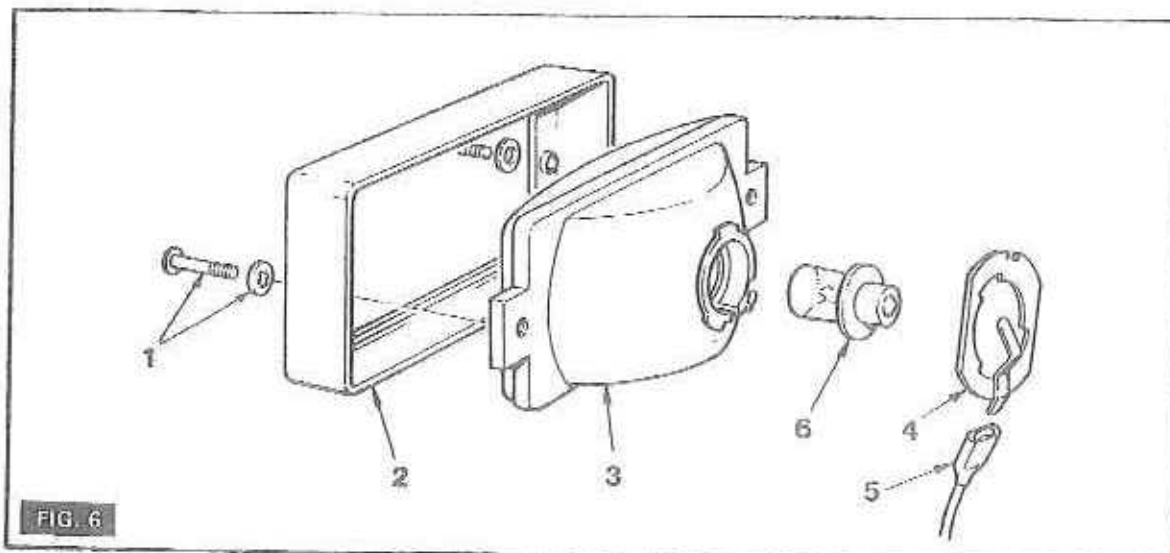
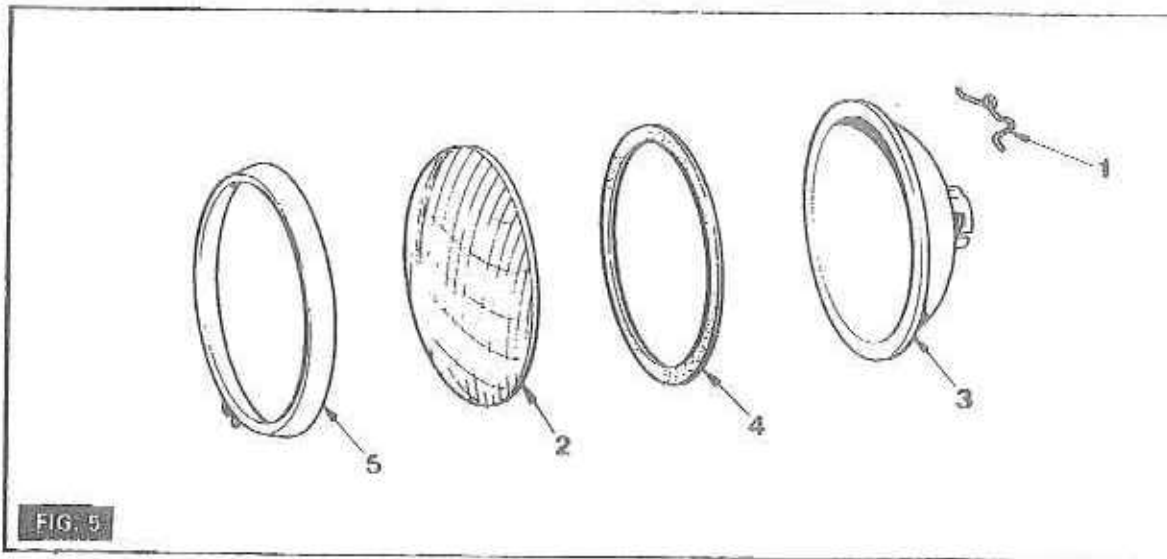
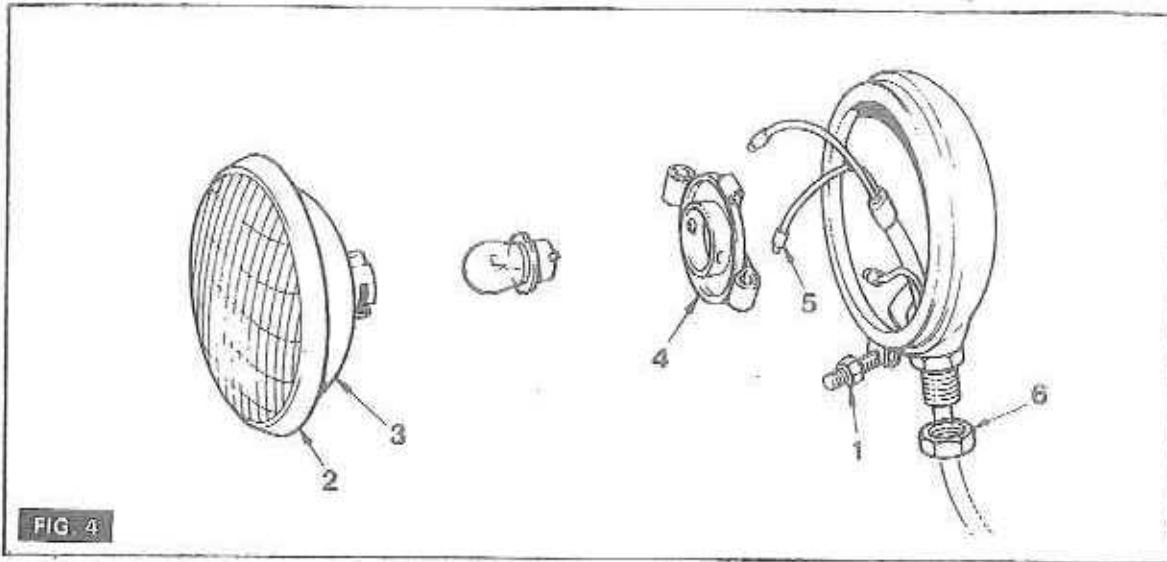


FIG 3



LIGHTING SYSTEM

General . . . Cont'd

WARNING

BEFORE COMMENCING ANY WORK ON THE ELECTRICS ALWAYS DISCONNECT THE BATTERIES.

HEADLIGHT

Removal and Replacement

(4B/1)

1. (Fig. 4) Slacken the hinged retaining screw (1) and swing the screw clear of the light.
2. Remove the rim (2) and reflector (3) assembly.
3. Press the cable holder (4) in, turn it in an anti-clockwise direction and lift out.
4. Remove the terminal posts (5) from the contact plate and pull the wires backwards through the mounting spigot.
5. Unscrew the securing nut (6) and remove the lamp.
6. (Fig. 5) Remove the bulb then extract the five clips (1) and remove the lens (2), reflector (3) and gaskets (4) from the rim (5).
7. Replace in a reverse order of the above procedure.

WORKLIGHT

Removal and Replacement

(4B/2)

1. (Fig. 6) Remove the screws and lockwashers (1). Remove the lamp unit and separate the rim (2) and sponge lining from the lens unit (3).
2. Press the cable holder (4) in, turn it in an anti-clockwise direction and lift out.
3. Remove the terminal posts (5) from the contact plate and pull the wires clear.
4. Extract the bulb (6).
5. Replacement is a reversal of the above procedure.

INSTRUMENT PANEL ILLUMINATOR

Removal and Replacement

(4B/3)

1. (Fig. 7) Remove the two screws (1) that secure the bulb cover (2) and glass (3) to the unit.
2. Extract the bulb and disconnect the cable at the back to back connector (4).
3. Unscrew the two securing nuts (5) and remove the lockwashers (6).
4. Withdraw the unit and cable from the instrument panel.
5. Refitting is a direct reversal of the above procedure.

FRONT SIDE LIGHT

Removal and Replacement

(4B/4)

1. (Fig. 8) Remove the four bolts (1) Extract the plate and front lamp assembly.
2. Unfasten the two securing screws (2) and remove the lens (3).
3. Extract the bulb (4).
4. Unfasten the two nuts (5) and washers (6), remove the bulb holder and rubber sheath assembly.

FRONT SIDE LIGHT

Removal and Replacement . . . Cont'd

5. Separate the rubber sheath (7) from the bulb holder and draw it back along the wire to expose the end of the bulb holder (8).
6. Pull the two bullet connectors (9) from their sockets.
7. Remove the bulb holder and rubber sheath.
8. Replacement is a reversal of the above procedure.

FRONT INDICATOR

Removal and Replacement

(4B/5)

1. (Fig. 9) Remove the four bolts (1) and screws (2). Extract the plate and front lamp assembly.
2. Unfasten the two screws (3) on the front of the lens and remove the lens (4).
3. Extract the bulb (5).
4. Unfasten the two nuts (6) and washers (7). Remove the bulb holder and rubber sheath assembly.
5. Separate the rubber sheath (9) from the bulb holder and draw the sheath back along the wire to expose the end of the bulb holder (8).
6. Pull the two bullet connectors (10) from their sockets.
7. Remove the bulb holder and rubber sheath.
8. Replacement is a reversal of the above procedure.

REAR LIGHT

Removal and Replacement

(4B/6)

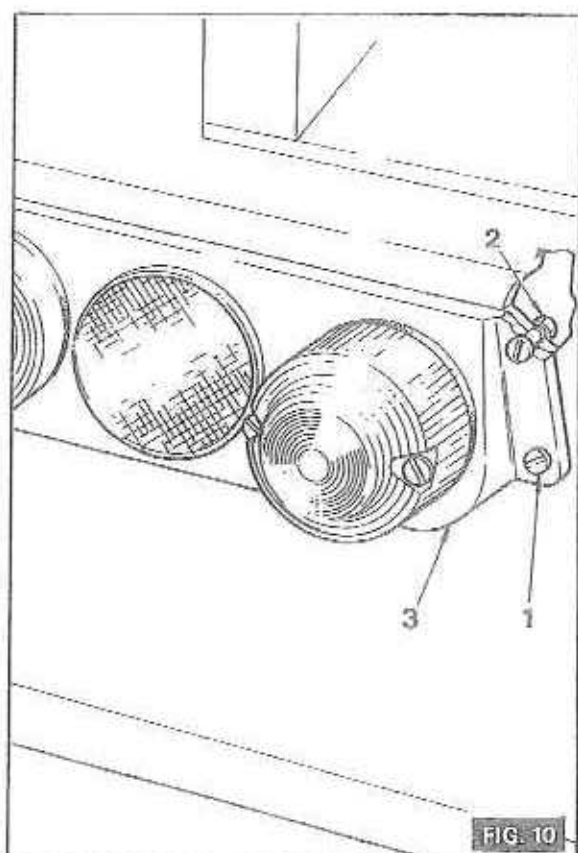
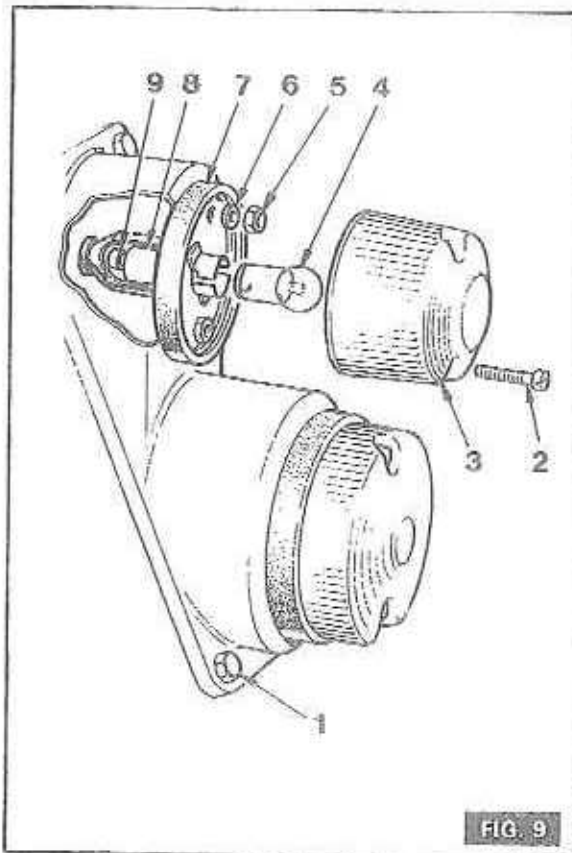
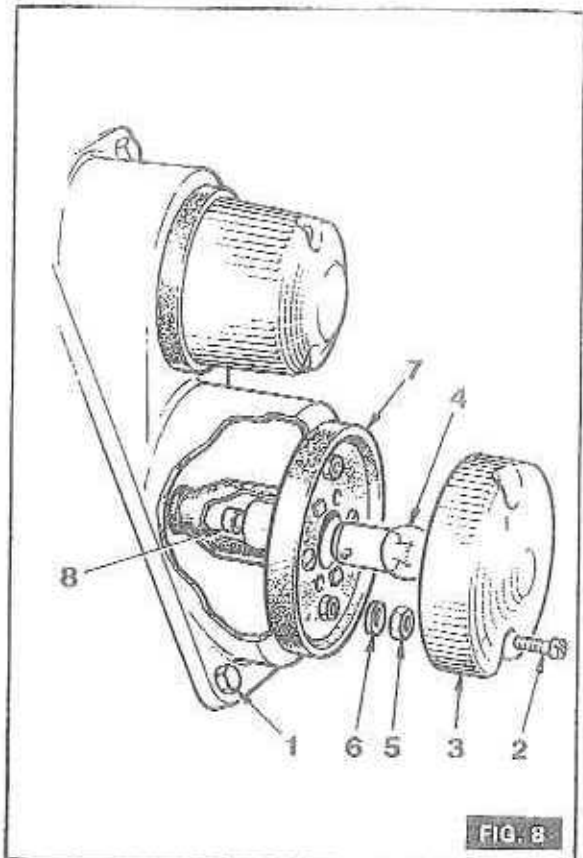
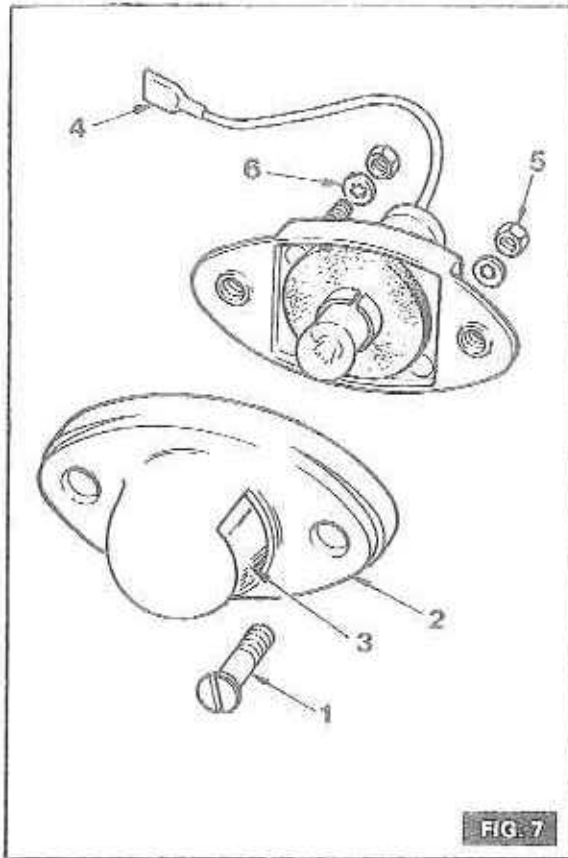
1. (Fig. 10) Unfasten four screws (1) and nuts (2) and extract the plate complete with rear side light and indicator light (3).
2. (Fig. 11) Unfasten the two screws (1) on the front of the lens and remove the lens (2).
3. Remove the bulb (3).
4. Unfasten the two screws, lock washers and nuts (4), remove the bulb holder and rubber sheath assembly.
5. Separate the rubber sheath (6) from the bulb holder and draw the sheath back along the wire to expose the end of the bulb holder (5).
6. Pull the two bullet connectors (7) from their sockets.
7. Remove the bulb holder and rubber sheath.
8. Replacement is a reversal of the above procedure.

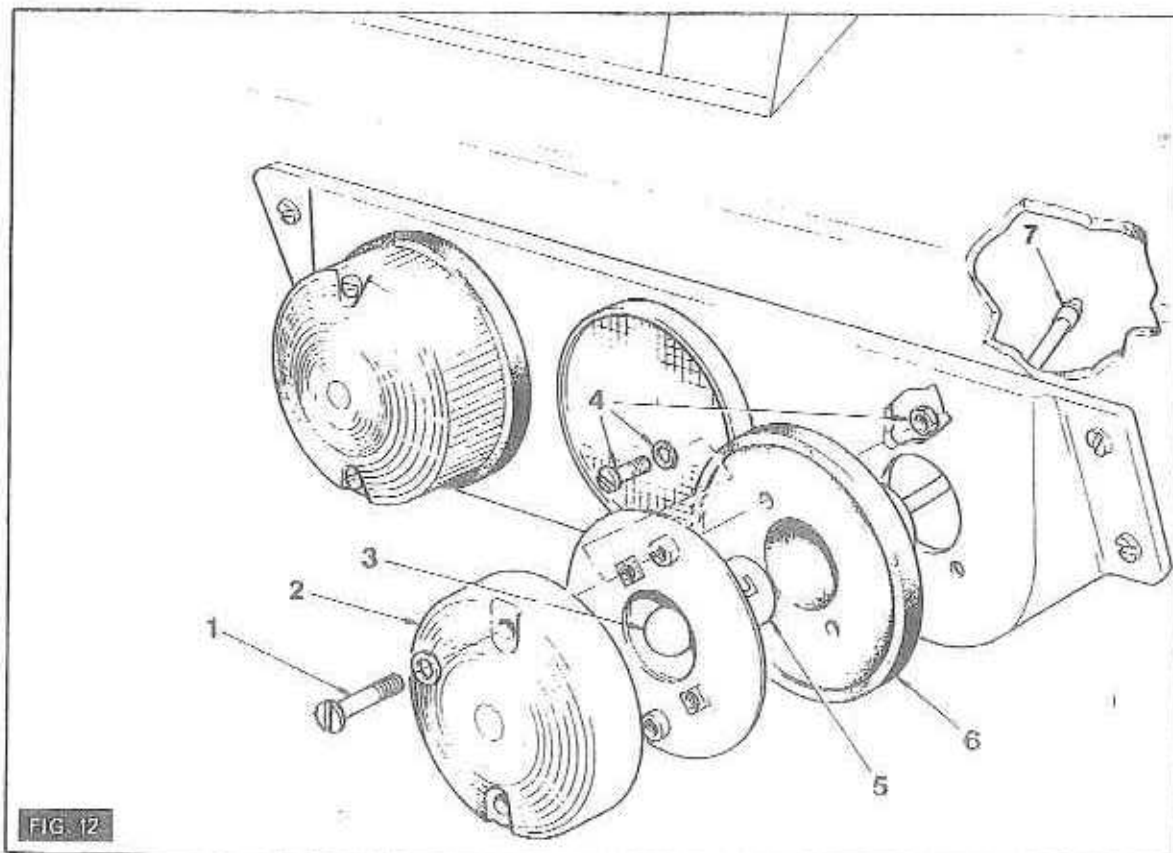
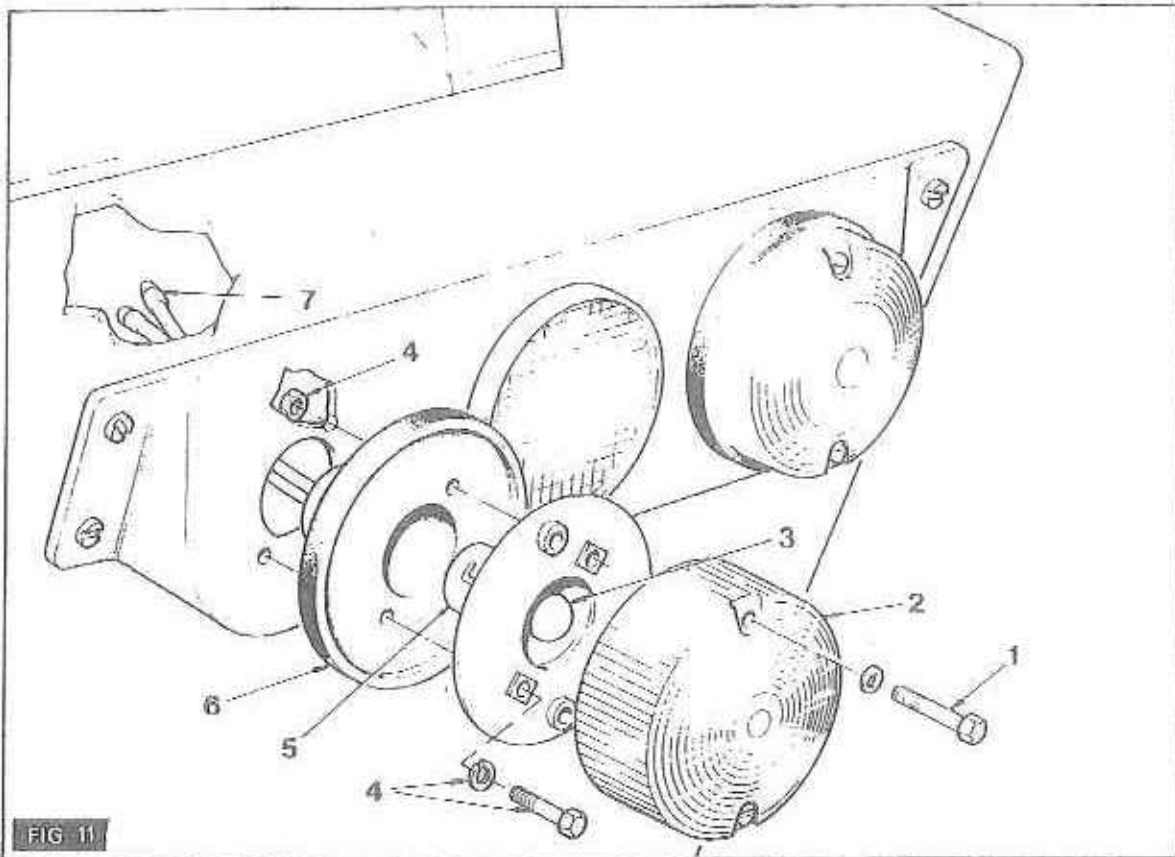
REAR INDICATOR

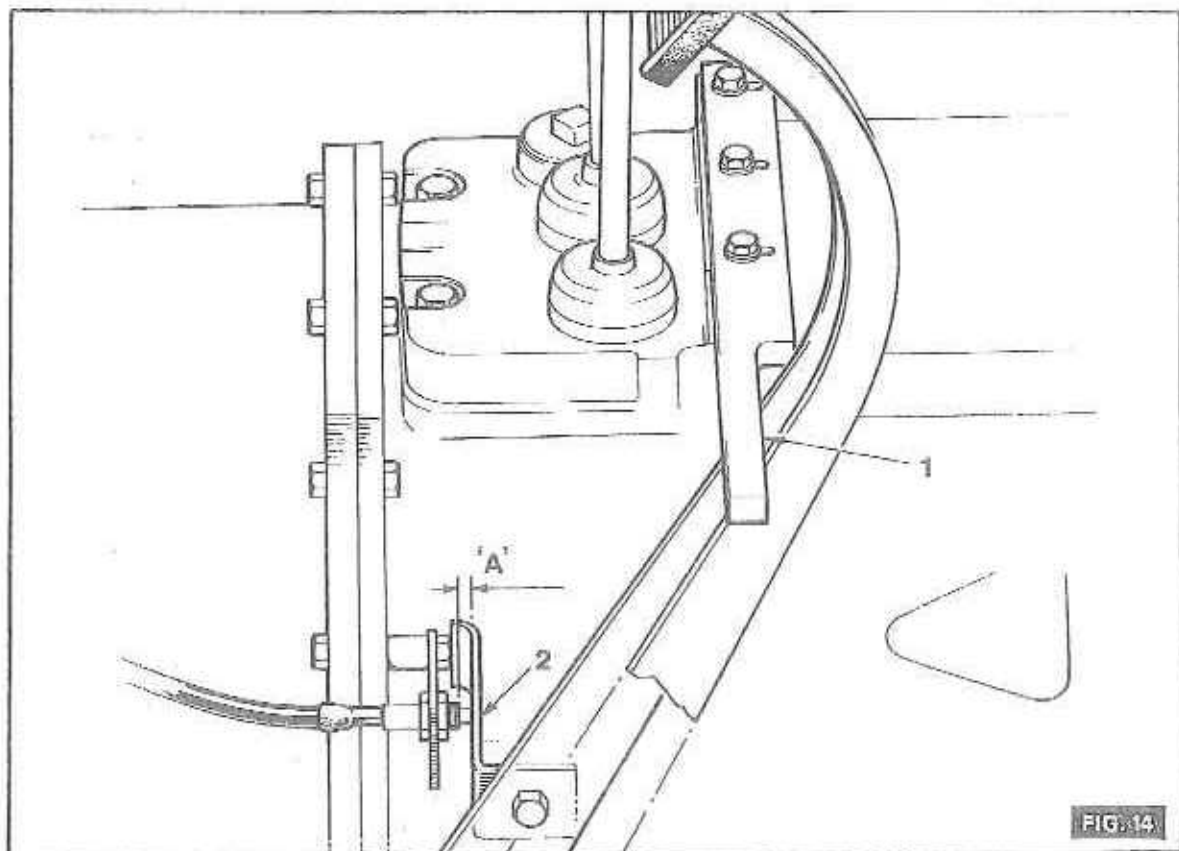
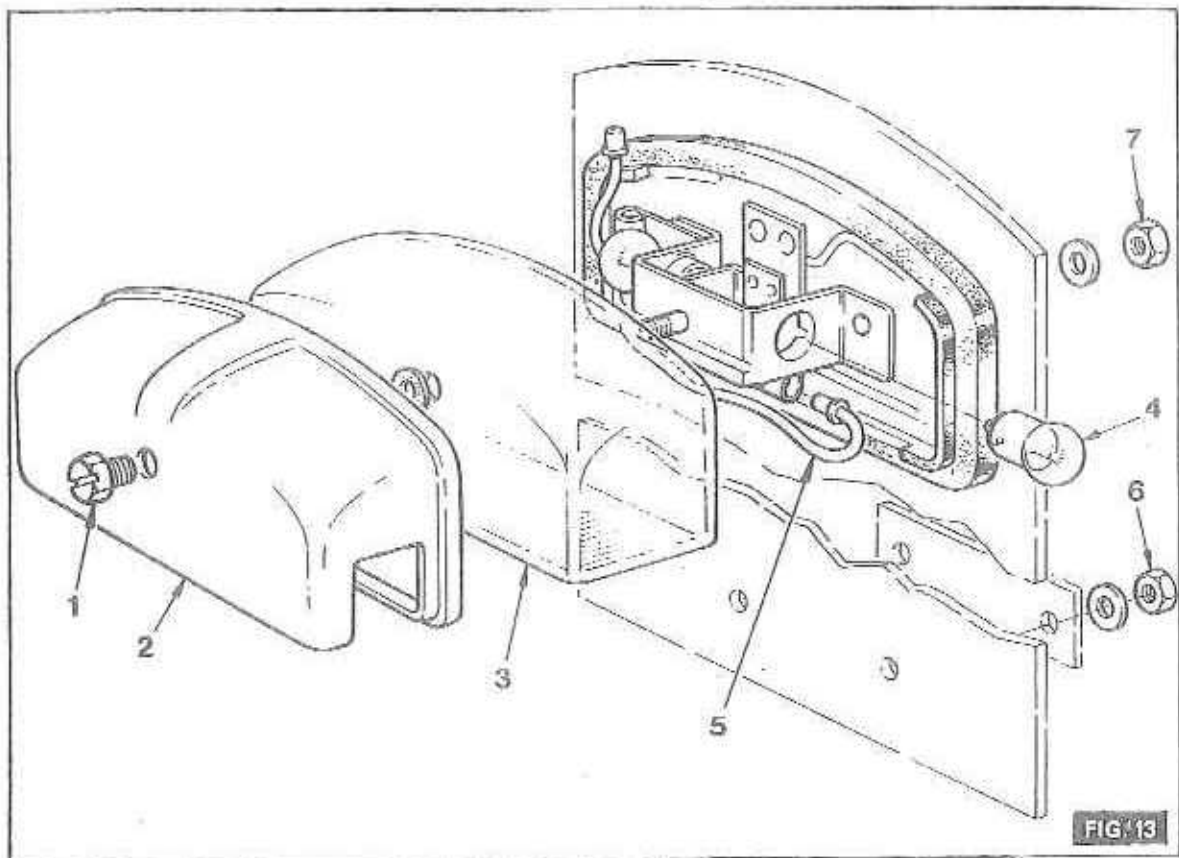
Removal and Replacement

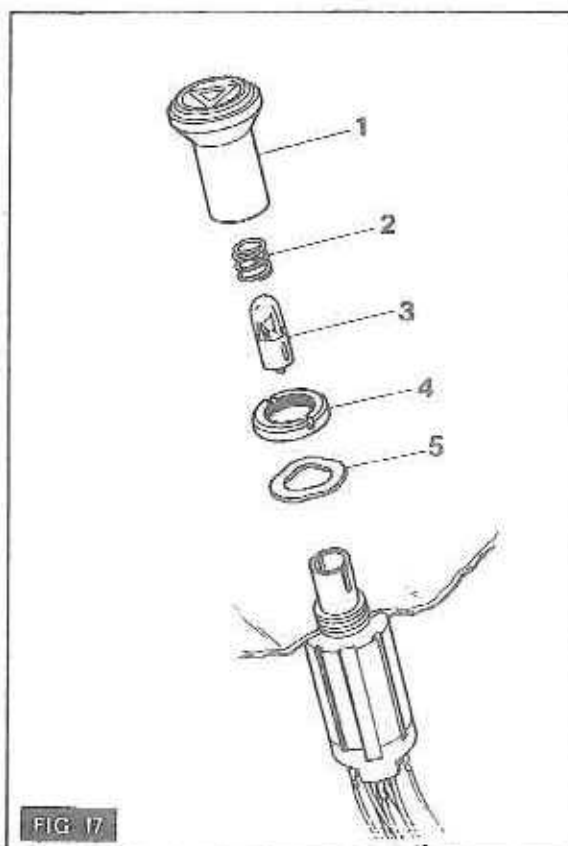
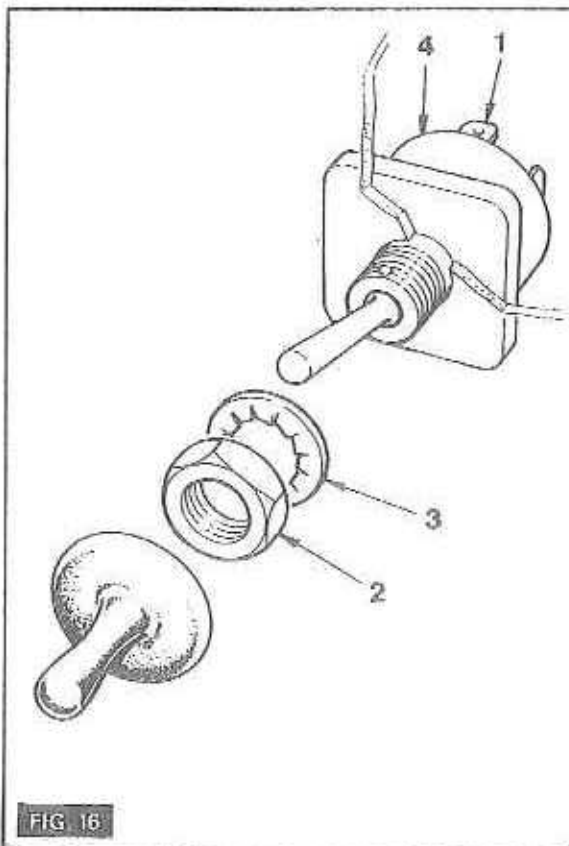
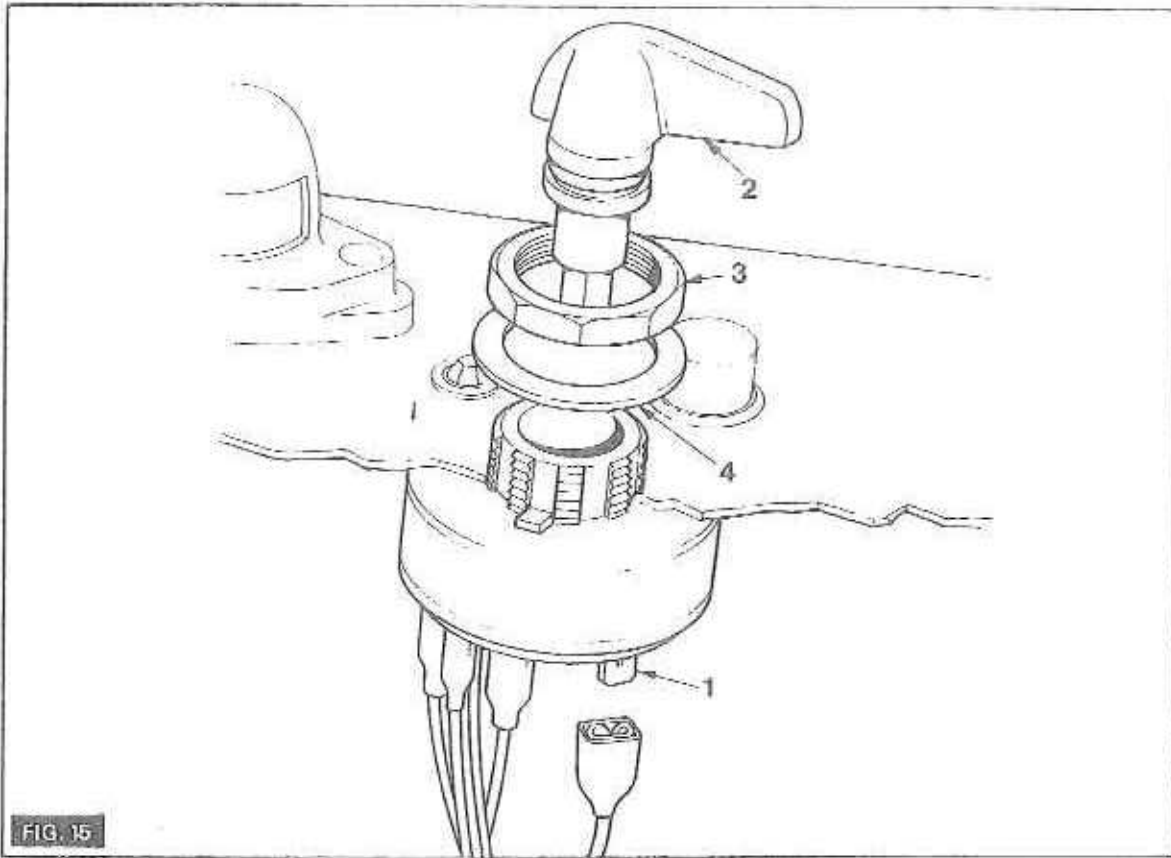
(4B/7)

1. (Fig. 10) Unfasten four screws (1) and nuts (2) and extract the plate, complete with rear side light and indicator light (3).
2. (Fig. 12) Unfasten two screws (1) on the front of the lens and remove the lens (2).
3. Remove the bulb (3).
4. Unfasten the two screws, lock washers and nuts (4), remove the bulb holder and rubber sheath assembly.
5. Separate the rubber sheath (6) from the bulb holder and draw the sheath back along the wire to expose the end of the bulb holder (5).
6. Pull the two bullet connectors (7) from their sockets.









REAR INDICATOR

Removal and Replacement . . . Cont'd

7. Remove the bulb holder and rubber sheath.
8. Replacement is a direct reversal of the above procedure.

REAR NUMBER PLATE ILLUMINATOR

Removal and Replacement

(4B/8)

1. (Fig. 13) Unfasten the screw (1), remove the cover (2), rubber washer and lens (3).
2. Remove the bulbs (4) then disconnect the two bullet terminals (5).
3. Unscrew the two nuts (6) and remove the number plate complete with bulb holder.
4. To remove the bulb holder from the number plate, simply unscrew the two securing nuts (7).
5. To replace the unit, reverse the above procedure ensuring that the lens is located correctly on the rubber surround and that the rubber washer is located between the cover and the lens.

STOP LIGHT

Adjustment

(4B/9)

(Fig. 14) With the brake pedals in contact with the brake pedal stop (1), adjust the stop light switch bracket (2) to give dimension A, — Dimension A is 0.1875 - 0.2185 in. (4.762 - 5.555 mm.).

Note

The brake pedal stop light switch is situated on the brake pedal bracket. On standard transmission tractors the switch is situated on the right hand side of the transmission case. On Instant Reverse machines the switch is situated on the left hand side of the transmission case.

DIRECTION INDICATOR SWITCH

Removal and Replacement

(4B/10)

1. (Fig. 15) Disconnect the four connectors from the terminals (1).
2. Lift the lever (2) from the switch main shaft.
3. Unscrew the nut (3), remove the washer (4). The unit can then be extracted through the rear of the panel.
4. Replacement is a direct reversal of the above procedure.

LIGHT SWITCHES

Removal and Replacement

(4B/11)

1. (Fig. 16) Disconnect all the connectors from the light switch terminals (1).
2. Remove the rubber protectors from the switch levers.
3. Unscrew the securing nut (2), remove the washer (3) and extract the switch (4) through the rear of the panel.
4. Replacement is a direct reversal of the above procedure.

HAZARD WARNING SWITCH

Removal and Replacement

(48/12)

1. (Fig. 17) Disconnect all the connectors from the warning switch terminals.
2. Lift the switch cover (1) from the mainshaft and remove the spring (2) from the cover.
3. Remove the bulb (3).
4. Unscrew the nut (4), remove the washer (5). The unit can then be extracted through the rear of the panel.
5. Replacement is a direct reversal of the above procedure.

FRONT AXLE



CONTENTS

Figure		Facing Page
1	GENERAL ARRANGEMENT OF FRONT AXLE	4
2	HARN NOSE, Removal	5
3	AXLE BEAM, Removal	5
4	PIVOT PIN, Clearance	5
5	KING PIN HOUSING, Breakdown	6
6	HUB, Breakdown	6
7	SUPPORT CASTING TO ENGINE, Bolting Arrangement	7

LIST OF ILLUSTRATIONS

	PAGE
GENERAL	4
FRONT AXLE BEAM, Removal 5A/1	4
FRONT AXLE BEAM, Replacement 5A/2	4
FRONT AXLE BEAM, Disassembly 5A/3	5
FRONT AXLE BEAM, Reassembly 5A/4	5
FRONT AXLE HUB AND KING PIN ASSEMBLY, Removal 5A/5	5
FRONT AXLE HUB AND KING PIN ASSEMBLY, Replacement 5A/6	5
FRONT HUB AND BEARINGS, Removal 5A/7	6
FRONT HUB AND BEARINGS, Replacement 5A/8	6
AXLE SUPPORT BRACKET, Removal and Replacement 5A/9	6

FRONT AXLE

GENERAL

The front axle is a one piece fabricated unit and comprises of an inverted channel section main beam, stiffened and closed by additional steel plates, heavy duty king pin housings welded to each end and a bushed horizontal tube through the axle centre to form a pivot.

The Pivot pin is housed at its front and rear in the axle support casting and is retained in position by a peg bolt and locknut and also by a special retaining bracket fitted to the front end of the shaft.

Front and rear float of the axle within the support casting is limited between .003" (.076 mm) and .010" (.254 mm) by shims and a thrust washer positioned between the pivot tube ends and the support casting.

The vertical king pin housings have bushes fitted at the upper and lower ends whilst a counter bore at the lower end of the housing accommodates a thrust race bearing. The counter bored portion of the housing is also stepped to provide steering lock stops.

A grease nipple is fitted in the centre pivot and one grease nipple fitted in each of the king pin housings to allow lubrication of the moving parts.

FRONT AXLE BEAM

Removal

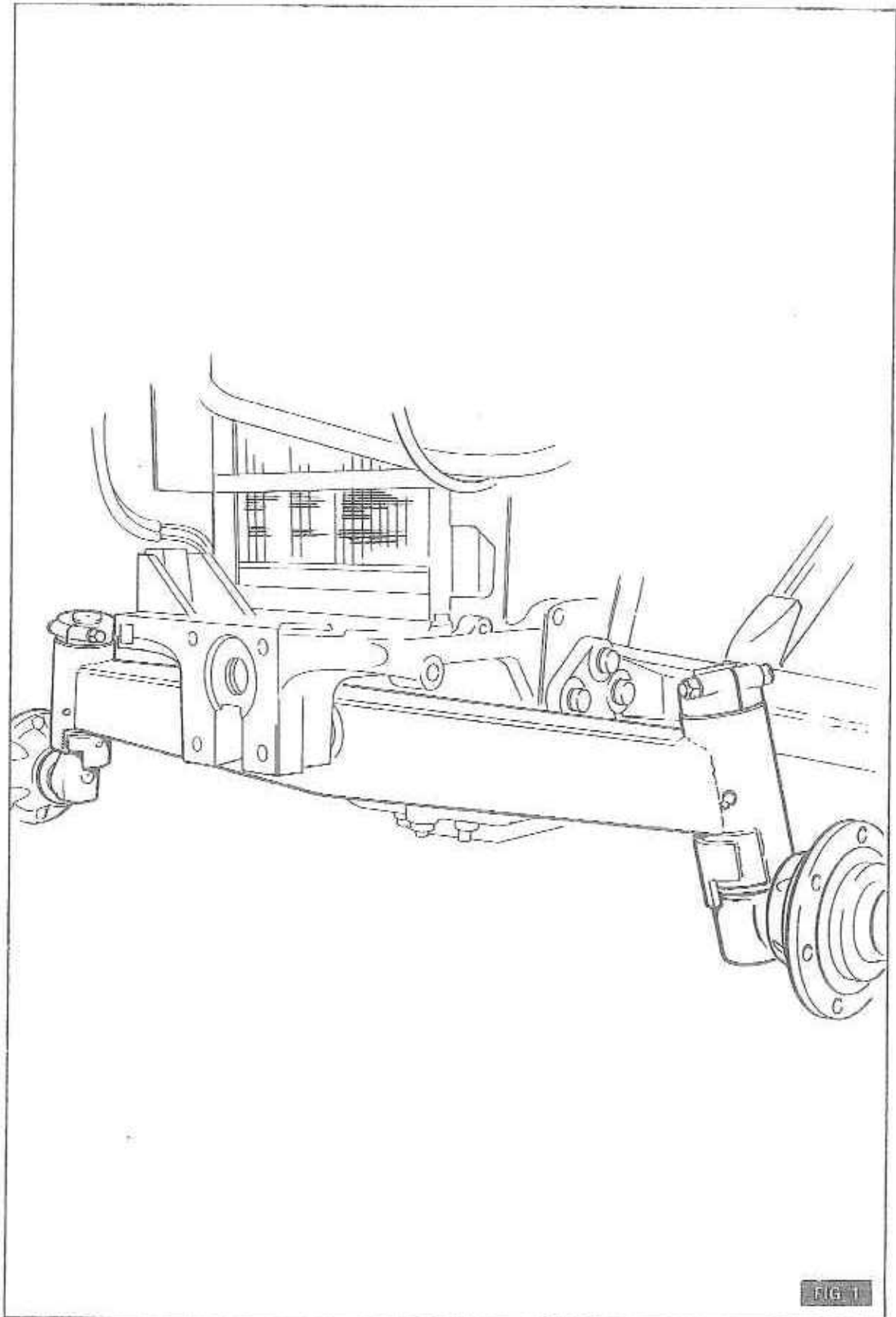
1. If loader is fitted raise the loader arms and insert the ram stops.
2. Remove the front grille, the exhaust from the manifold, the hood and the side panels.
3. Disconnect the headlights and horn from the main wiring harness.
4. Drain the hydraulic oil into a suitable container.
5. Disconnect the suction and pressure pipes from the hydraulic pump and pull them outside the hard nose.
6. Remove the two bolts which secure the top assembly of the hard nose to the air cleaner support bracket.
7. (Fig. 2) Sling the complete hard nose assembly and take the weight on some suitable lifting gear, remove the two lower securing bolts and lift the hard nose away from the machine.
8. Remove the hydraulic pump and drive shaft as stated in operation 9C/1.
9. Remove the drag link as stated in operation 5B/8.
10. Remove the power steering unit as described in operation 5B/9.
11. Jack up each side of the machine in turn and insert suitable stands. If the loader is fitted they can be positioned under the loader side frames. The stands should be of such a height that the front wheels are clear of the ground.
12. Remove the two front wheels.
13. Place a trolley jack under the front axle at the centre point and take the weight of the axle.
14. Remove the pivot pin retaining bolt from the axle support casting and withdraw the pivot pin complete with retainer bracket.
15. (Fig. 3) Lower the axle beam until it is clear of the support bracket then carefully remove it from the machine.
16. Gather up the shims and thrust washer which are released from between the axle beam and the support bracket when the axle is lowered.

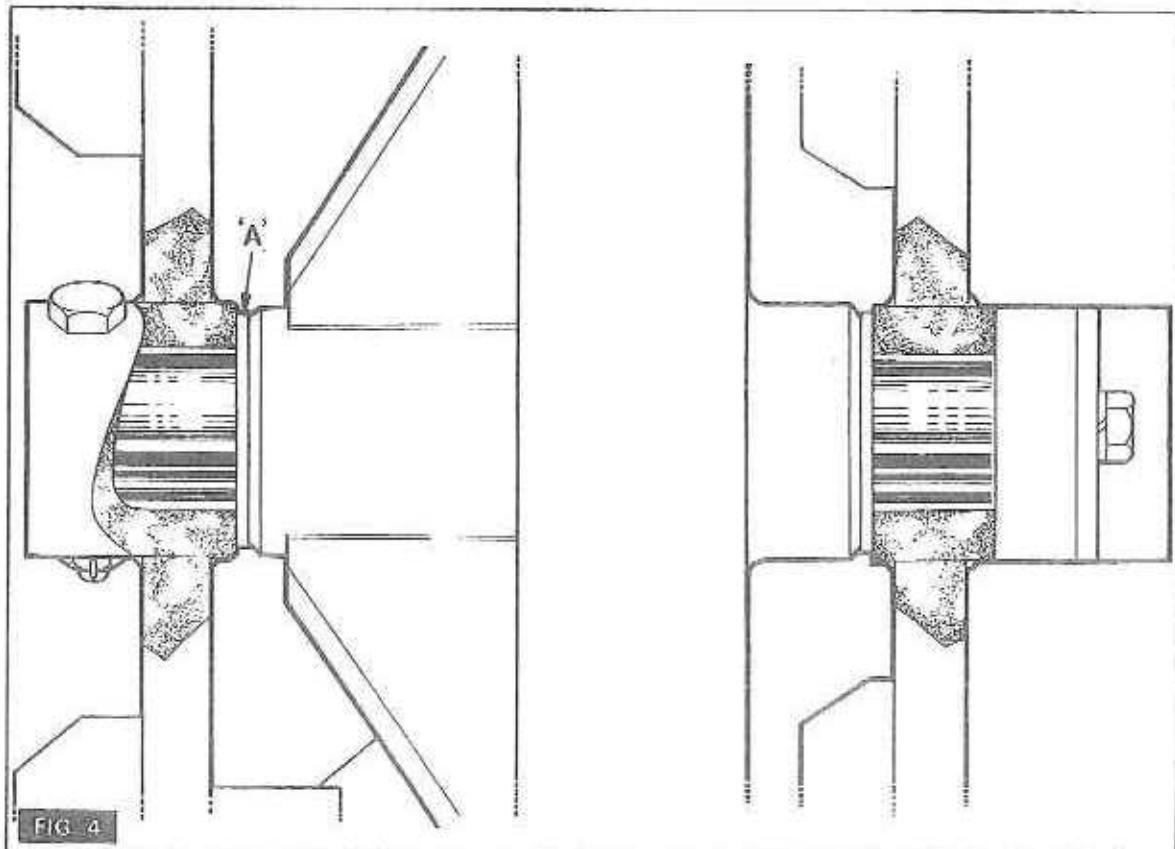
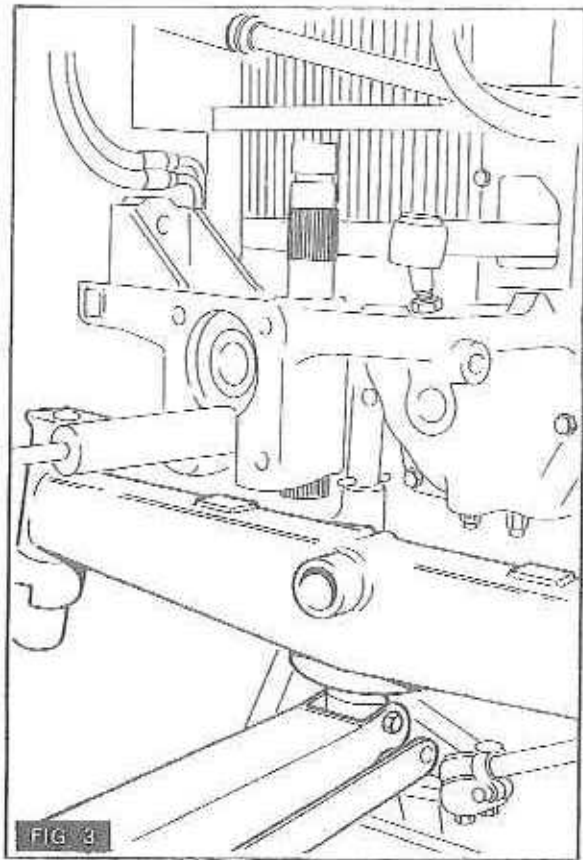
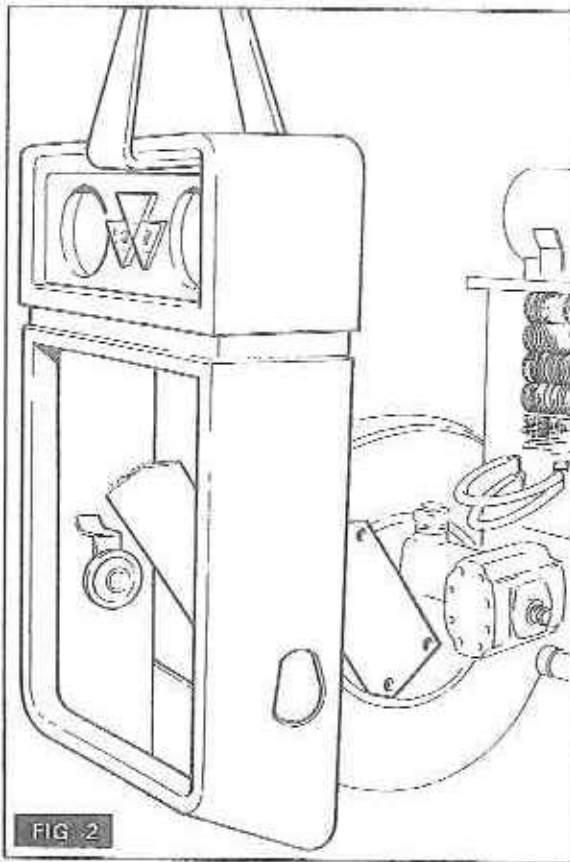
FRONT AXLE BEAM

Replacement

1. Raise the axle beam up to the support bracket.
2. Insert the pivot pin and retaining bracket through the support bracket and axle beam. Ensure that the thrust washer is fitted.
3. (Fig. 4) Check the clearance between the axle and support bracket at Point 'A'. This clearance should be 0.003 - 0.010 in. (0.076–0.254 mm). Adjust by means of shims.







FRONT AXLE BEAM

Replacement Cont'd

4. Replace the wheels and remove the stands from under the machine.
5. Replace the power steering unit as described in operation 5B/9.
6. Refit the drag link as described in operation 5B/8.
7. Replace the hydraulic pump and drive shaft as described in operation 9C/1.
8. Replace the hard nose and secure it in position with the six bolts, remove the sling.
9. Reconnect the suction and pressure pipes to the pump.
10. Re-set the power steering mechanism as described in operation 5B/13.
11. Reconnect the horn and headlights to the main wiring harness.
12. Refit the side panels, hood, exhaust and front grille.
13. Refill the hydraulic reservoir.

FRONT AXLE BEAM

Disassembly

1. Remove the axle beam as stated in operation 5A/1
2. Remove the left and right hand king pins as stated in operation 5A/5.
3. Check the bushes in the king pin housing and pivot housing if scored, renew. Use tool MF 263/3 to remove the king pin bushes.

FRONT AXLE BEAM

Reassembly

1. If pivot housing bushes and king pin bushes are to be renewed, fit them into the housings with a suitable drift. Reamer the king pin bush with tool MF 264/7.
2. Refit the left hand and right hand spindle and hub assemblies as stated in operation 5A/5.
3. Replace the axle assembly as stated in operation 5A/2.

FRONT AXLE HUB AND KING PIN ASSEMBLY

Removal

1. Jack the front wheel clear of the ground.
2. Place an axle stand in position and remove the front wheel.
3. (Fig. 5) Remove the nut (1), washer (2) and bolt (3) from the steering arm (4).
4. Lightly tap the steering arm in an upward direction to release it from the king pin.
5. Support the weight of the king pin and hub, remove the Woodruff key (5) and slide the felt seal (6) off the pin.
6. Thoroughly clean the top of the king pin to remove any dirt, swarf or burrs. If the king pin is not cleaned before withdrawal the king pin housing bushes may be scored.
7. Lower the king pin and hub assembly out of the housing.
8. Remove the thrust bearing (7).
9. To ream the king pin bushes (8) use special tool MF 264/7.

FRONT AXLE HUB AND KING PIN ASSEMBLY

Replacement

1. (Fig. 5) Reverse the procedure in operation 5A/5 to refit the king pin and steering arm. Tighten the steering arm securing nut (1) to a torque of 90–100 lb. ft. (12.45–13.83 kgm). A clearance of .004 in. (.101 mm) maximum should exist between the lower face of the steering arm (4) and the top of the king pin housing (9) when the unit is fully assembled and resting on the ground. The bolt (3) should be replaced with the head nearest to the tyre.

FRONT HUB AND BEARING

Removal

1. Jack up the tractor, place axle stand under axle and remove the wheel.
2. (Fig. 6) Remove four bolts (1) detach hub cap (2) and sealing gasket (3).
3. Extract the cotter pin (4), unscrew retaining nut (5) and remove washer (6).
4. Slide the hub (7) off the stub axle (8) complete with bearings and seal.
5. Lift out taper roller bearing (9) from the bearing housing and drive out the bearing cup (10).
6. Remove the oil seal (11) from the bearing housing.
7. Remove the inner taper roller bearing (12) and drift out the inner bearing cup (13).

FRONT HUB AND BEARING

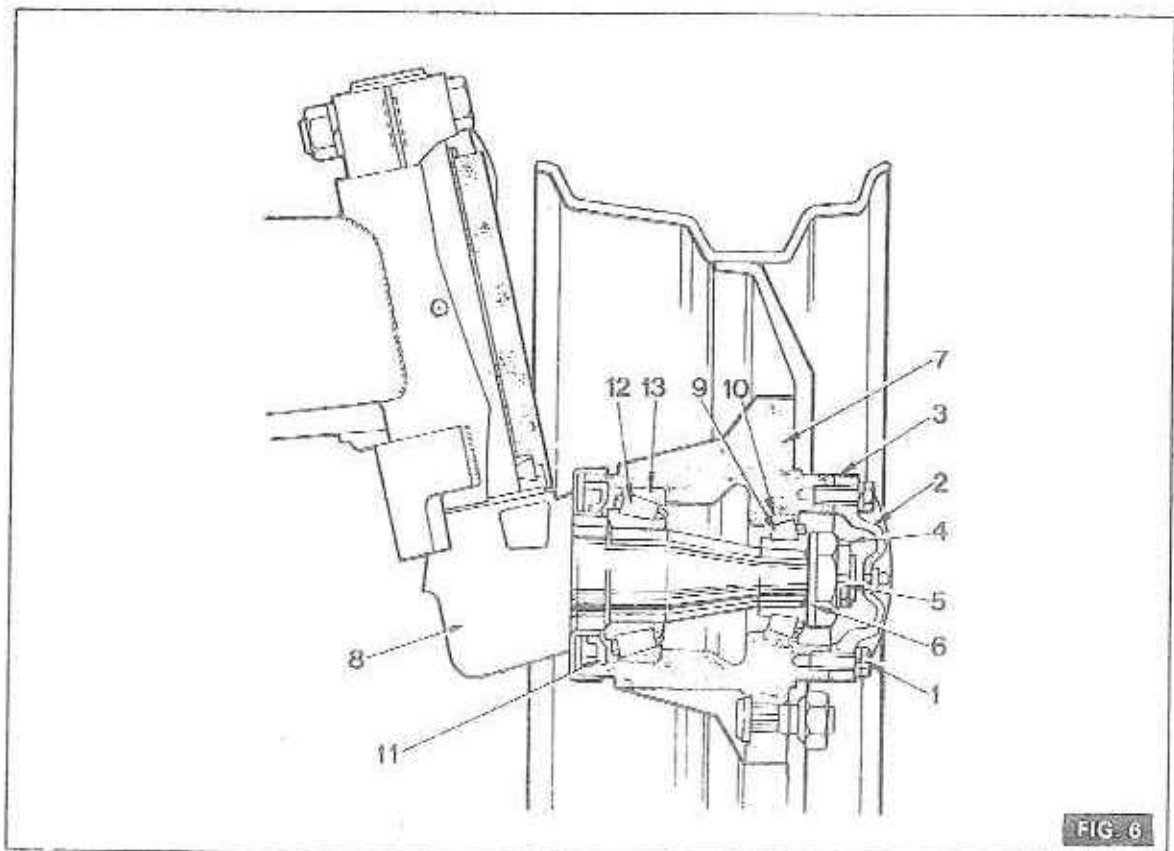
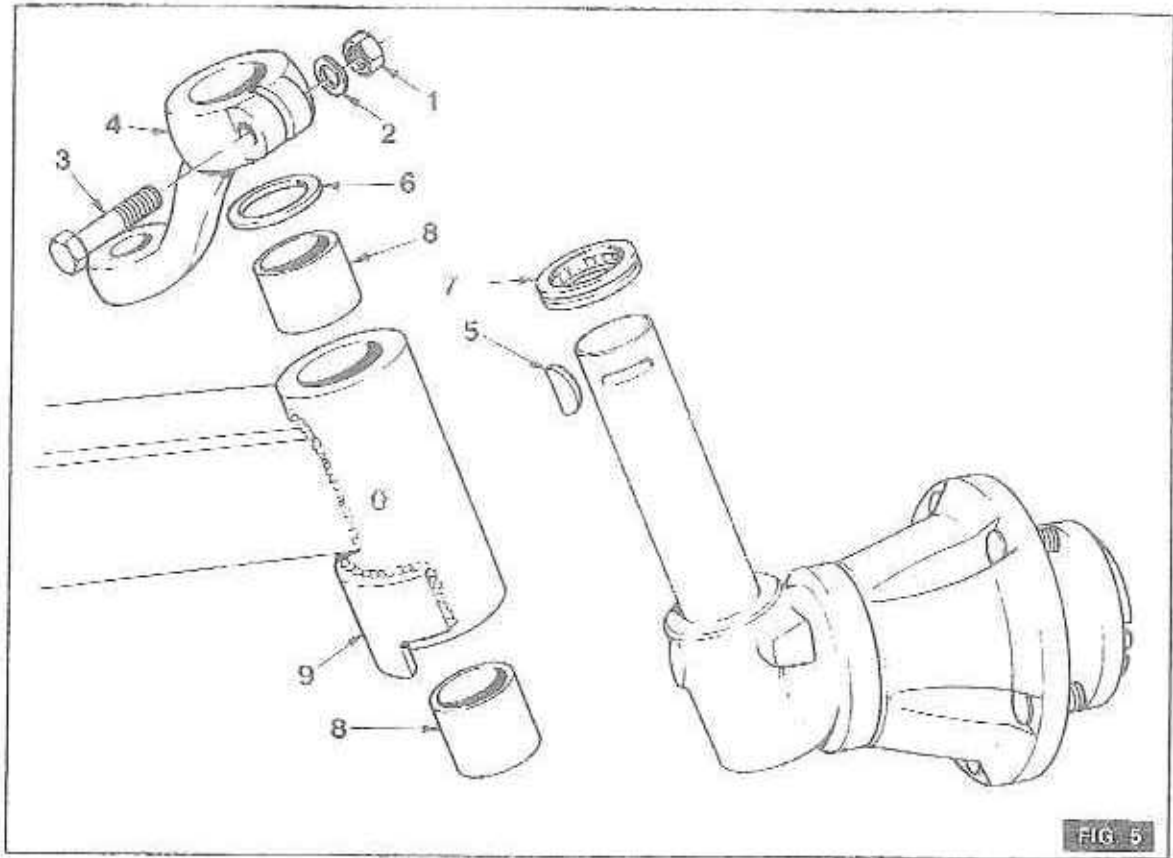
Replacement

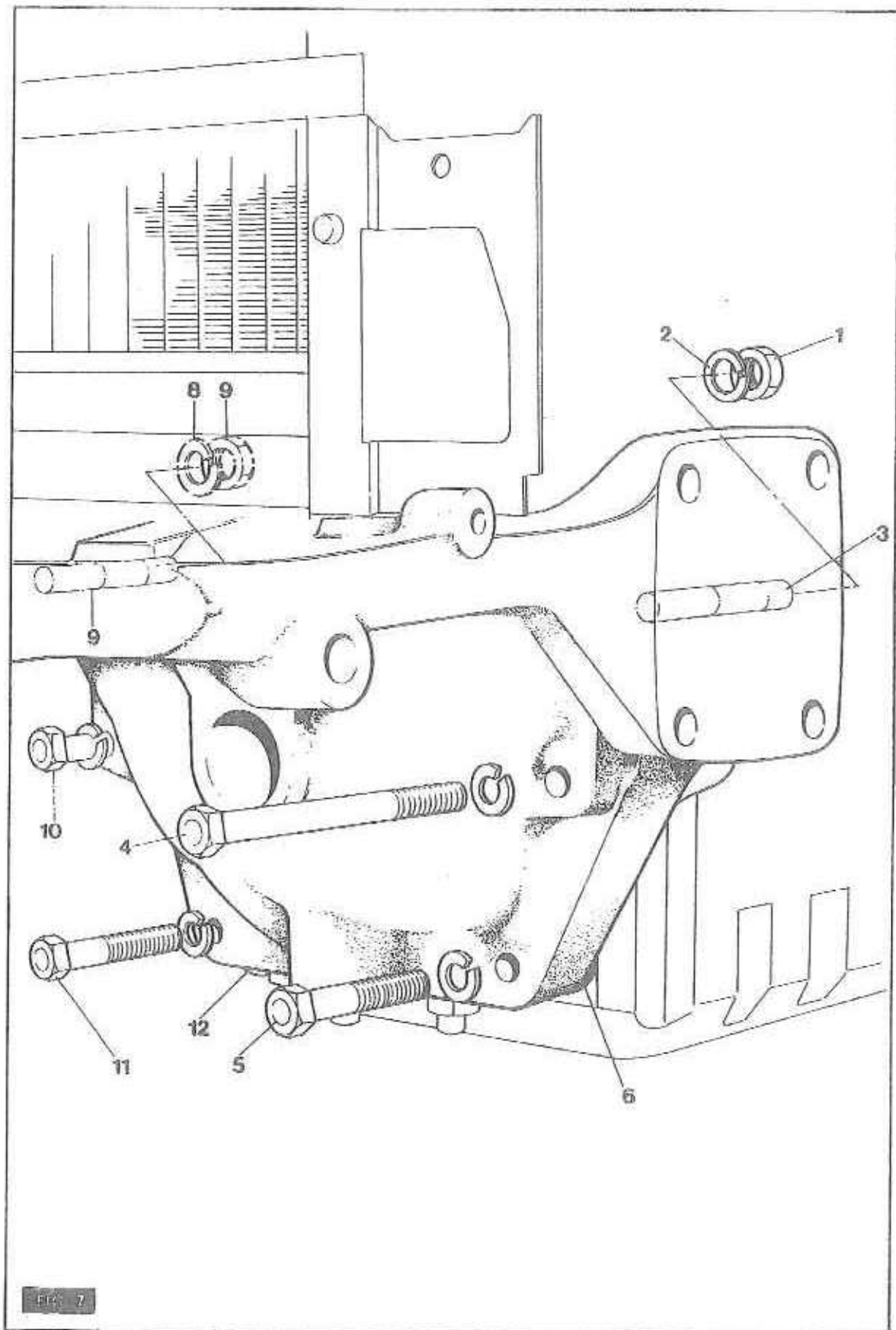
1. Clean all bearing seats before starting reassembly.
2. Press inner bearing cup (13) into position.
3. Insert the taper roller bearing (12) into its cup, pack the bearing with appropriate grease.
4. Clean the seal seat and lightly tap the seal (11) into position with its flat face towards the king pin.
5. Pack the hub with grease and slide the hub into position on the stub axle.
6. Press the outer bearing cup (10) into position and replace the outer taper roller bearing (9), pressing it firmly home.
7. Replace the thrust washer (6) onto the stub axle and screw on the retaining nut (5). Tighten to a torque of 60 lbs. ft. (8.3 kgm). Back off to the nearest pin hole then further back off one complete flat to give .002 in. - .005 in. (0.05-0.13 mm) backlash. Insert and secure a new cotter pin (4).
8. Fill the hub cavity with grease. Fit a new gasket (3) to the hub and bolt the hub cap into position.
9. Fill the hub with grease through the grease nipple in the hub cap, until grease exudes from the inboard seal. Wipe off any surplus grease.
10. Replace the wheel and tighten the wheel nuts to a torque of 170 lb. ft. (23.5 kgm).

AXLE SUPPORT BRACKET

Removal and Replacement

1. Remove the loader side frames.
2. Complete parts 2 to 9 of operation 5A/1
3. Drain water from the radiator and cylinder block.
4. Disconnect the upper and lower radiator hoses.
5. Disconnect the oil cooler supply and return pipes and move them to one side.
6. If machine has reversomatic transmission disconnect the torque converter oil cooler pipes.
7. Disconnect and remove the feed and return pipes from the power steering pump.
8. Disconnect and remove the air cleaner hose.
9. Insert wooden wedges between the upper side of the axle and the axle support bracket.
10. Adequately support the engine and rear part of the machine.
11. Remove the alternator pulley guard to gain access to the support bracket securing nuts.
12. (Fig. 7) Remove the nut (1) and washer (2) from the stud (3) on the L. H. side of the housing.
13. Remove bolt (4) then bolt (5).
14. Remove the nut (6) and washer (7) from the stud (8) on the R. H. side of the housing.
15. Remove bolt (9) then bolt (10).
16. Manoeuvre the front axle unit away from the engine. Gather up the shims (11).
17. Push the unit from the machine; chock the wheels to prevent rolling and support the axle housing on a stand.
18. Remove drag link as in operation 5B/8.
19. Remove the power steering unit as described in operation 5B/9.
20. Remove the four bolts which secure the radiator to the support casting, lift off the unit complete with air cleaner, oil cooler and torque converter oil cooler (if fitted).





AXLE SUPPORT BRACKET

Removal and Replacement

21. Support the axle beam on a jack independently of the casting and take the weight of the casting on a suitable lifting apparatus.
22. Remove the pivot pin retaining bolt from the axle support casting and extract the pivot pin complete with retainer.
23. Lift off the support casting, gather up the shims and thrust washer which are released from between the axle beam and the support casting.
24. Replacement is a reversal of the removal procedure.

Notes

- a. The dimension 'A' in Fig. 4 must be maintained.
- b. When the casting is bolted to the engine, ensure that the bolts are fitted in their correct respective locations and that they are tightened to a torque of 100–125 lb. ft. (13.83–17.28 kg m).
- c. Shims should be refitted in the joint between the support casting and the engine (11) Fig. 7 to provide a float of .010 in. (0.25 mm).

KEY TO FIG 7

L. H. SIDE

1. Nut $\frac{5}{8}$ " —18 UNF
2. Washer Lock $\frac{3}{8}$ "
3. Stud $3\frac{1}{8}$ " LG
4. Bolt $\frac{5}{8}$ " UNC x $5\frac{1}{2}$ " LG
5. Bolt $\frac{5}{8}$ " UNC x $2\frac{3}{4}$ " L
6. Shims

R. H. SIDE

7. Nut $\frac{5}{8}$ " —18 UNF
8. Washer Lock $\frac{3}{8}$ "
9. Stud $3\frac{3}{8}$ " LG
10. Bolt $\frac{5}{8}$ " UNC x $5\frac{1}{2}$ " LG
11. Bolt $\frac{5}{8}$ " UNC x $2\frac{3}{4}$ " LG
12. Shims

CONTENTS

GENERAL	PAGE
STEERING WHEEL, Removal and Refitting (5B/1)	4
STEERING COLUMN, Removal and Refitting (5B/2)	4
STEERING BOX, Removal and Refitting (5B/3)	5
STEERING BOX, Disassembly (5B/4)	5
STEERING BOX, Reassembly (5B/5)	5
STEERING BOX ROCKER SHAFT BUSHES, Removal (5B/6)	6
STEERING BOX ROCKER SHAFT BUSHES, Refitting (5B/7)	6
DRAG LINK, Removal and Replacement (5B/8)	6
STEERING CYLINDER, VALVE ASSEMBLY ARMS AND SHAFT, Removal and Replacement (5B/9)	6
MAIN STEERING SHAFT BUSHES, Removal (5B/10)	6
MAIN STEERING SHAFT BUSHES, Replacement (5B/11)	7
CYLINDER AND VALVE ASSEMBLY TO STEERING ARMS, Removal and Replacement (5B/12)	7
CONTROL VALVE CLEARANCE, Adjustment (5B/13)	7
STEERING ARMS, Removal and Replacement (5B/14)	7
CONTROL VALVE, Disassembly (5B/15)	8
SPOOL VALVE ASSEMBLY, Disassembly (5B/16)	8
SPOOL VALVE ASSEMBLY, Reassembly (5B/17)	8
CONTROL VALVE, Reassembly (5B/18)	8
CONTROL VALVE, Pressure Checking (5B/19)	9
STEERING PUMP AND RESERVOIR, Removal and Replacement (5B/20)	9
STEERING PUMP AND RESERVOIR, Disassembly and Reassembly (5B/21)	9
TIE ROD ASSEMBLIES, Removal and Replacement (5B/22)	10

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	GENERAL ARRANGEMENT, Steering System	4
2	STEERING WHEEL, Removal	4
3	HEATER CONTROLS, Removal	5
4	FUEL FILTER CONNECTION PIPE, Removal	5
5	THROTTLE ROD ASSEMBLY, Disassembly	6
6	STEERING DROP ARM, Removal	6
7	STEERING BOX, Exploded View	6
8	UPPER BEARING AND BEARING CUP, Refitting	6
9	ROCKER SHAFT BUSHES, Removal	6
10	ROCKER SHAFT BUSHES, Refitting	6
11	ROCKER SHAFT BUSHES, Reaming	6
12	STEERING CYLINDER ASSEMBLY, General Arrangement	6
13	STEERING CYLINDER ASSEMBLY, Removal	6
14	MAIN STEERING SHAFT BUSHES, Removal	7
15	MAIN STEERING SHAFT BUSHES, Replacement	7
16	MAIN STEERING SHAFT BUSHES, Reaming	7
17	STEERING CYLINDER VALVE LINK PIN, Removal	7
18	STEERING CYLINDER AND ARMS, Exploded View	7
19	STEERING ARM ADJUSTMENT PIN, Lightening	7
20	STEERING CONTROL VALVE, Adjustment	7
21	STEERING ARMS AND STEERING SHAFT, Exploded View	7
22	STEERING ARM AND SHAFT, Replacement	7
23	SPECIAL TOOL, Removal and Cylinder Pivot Pin	7
24	STEERING CYLINDER CIRCLIP, Removal	7
25	STEERING CYLINDER RAM, Removal	7
26	STEERING CYLINDER PISTON, Disassembly	7
27	STEERING VALVE, Removal	7
28	STEERING VALVE, Disassembly	7
29	CONTROL VALVE, Pressure Checking	7
30	STEERING PUMP RESERVOIR, Removal	8
31	STEERING PUMP RESERVOIR FILTER, Removal	8
32	PUMP DRIVE SHAFT CIRCLIP, Removal	8
33	STEERING PUMP GEAR AND KEY, Removal	8
34	STEERING PUMP RELIEF VALVE, Disassembly	9
35	STEERING PUMP, Disassembly	9
36	STEERING PUMP COVER AND SEALS, Removal	10
37	STEERING PUMP BEARING, Removal	10
38	STEERING PUMP GEAR, Removal	10
39	STEERING PUMP, Disassembly	10
40	STEERING PUMP BEARING BLOCKS, Refitting	10
41	STEERING PUMP AND RESERVOIR, Exploded View	10
42	TIE ROD ASSEMBLY, Exploded View	10
43	TIE ROD AND CRANK ARM, Disassembly	10

STEERING

GENERAL

A full power steering system, operating on the front wheels, is fitted as standard equipment on the MF 503 Tractor Digger Loader.

The Steering System comprises; an engine driven pump, control valve, hoses and piping and a double acting hydraulic ram.

The gear type pump, bolted to the engine timing case and driven by the timing gears, draws hydraulic oil from the reservoir, which is attached to the rear of the pump. Oil is pumped

STEERING WHEEL

Removal and Replacement

(5B/1)

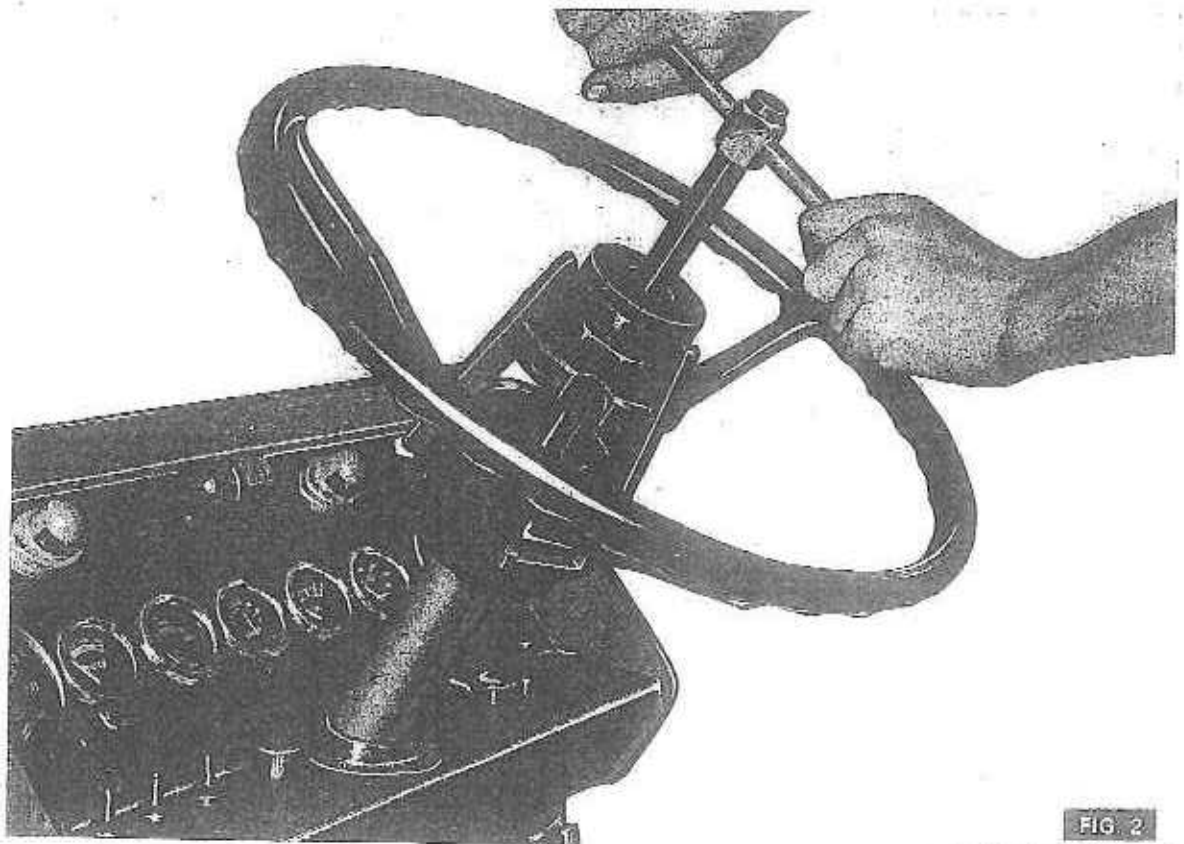
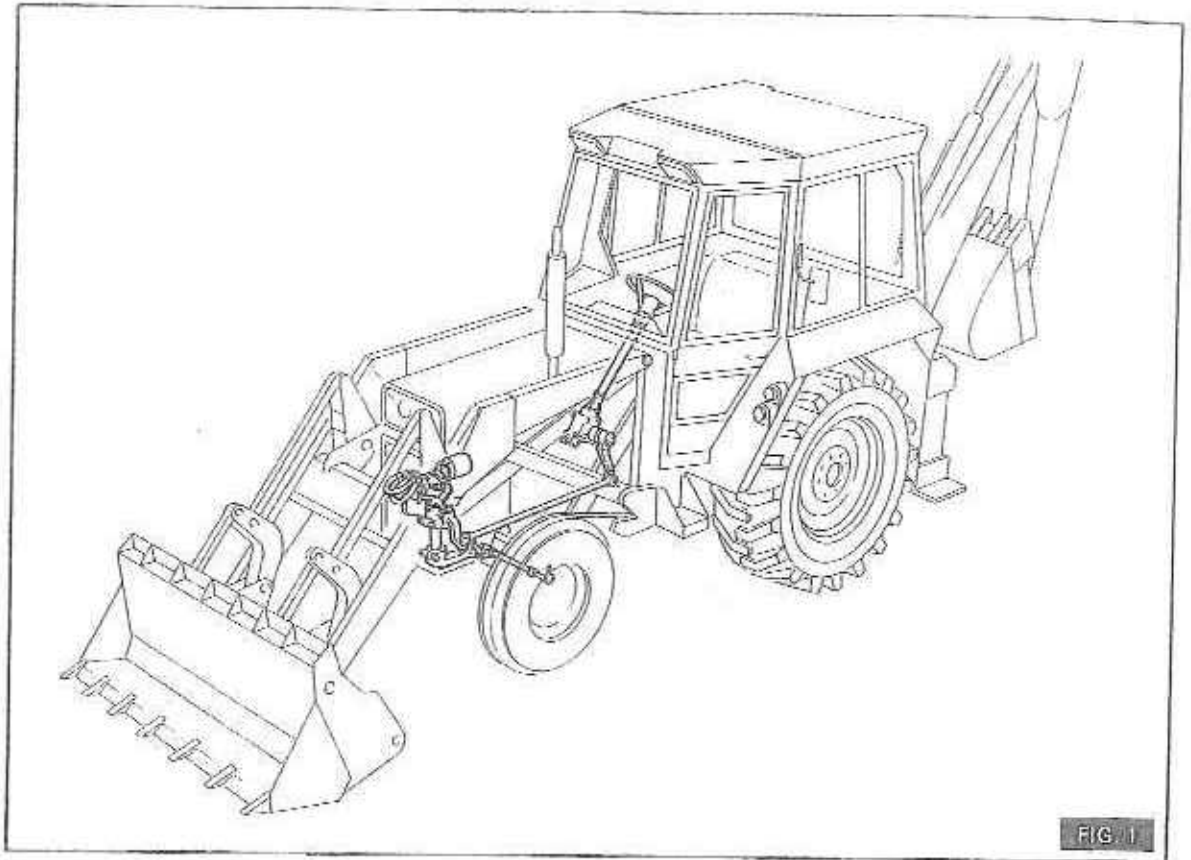
1. Detach the cap from the centre of the steering wheel and remove the nut securing the steering wheel to the steering shaft.
2. (Fig. 2) Pull the wheel off the splined shaft using tool MF 268. Remove the cap spring and grommet from the steering column.
3. Replacement is a reversal of the above procedure.

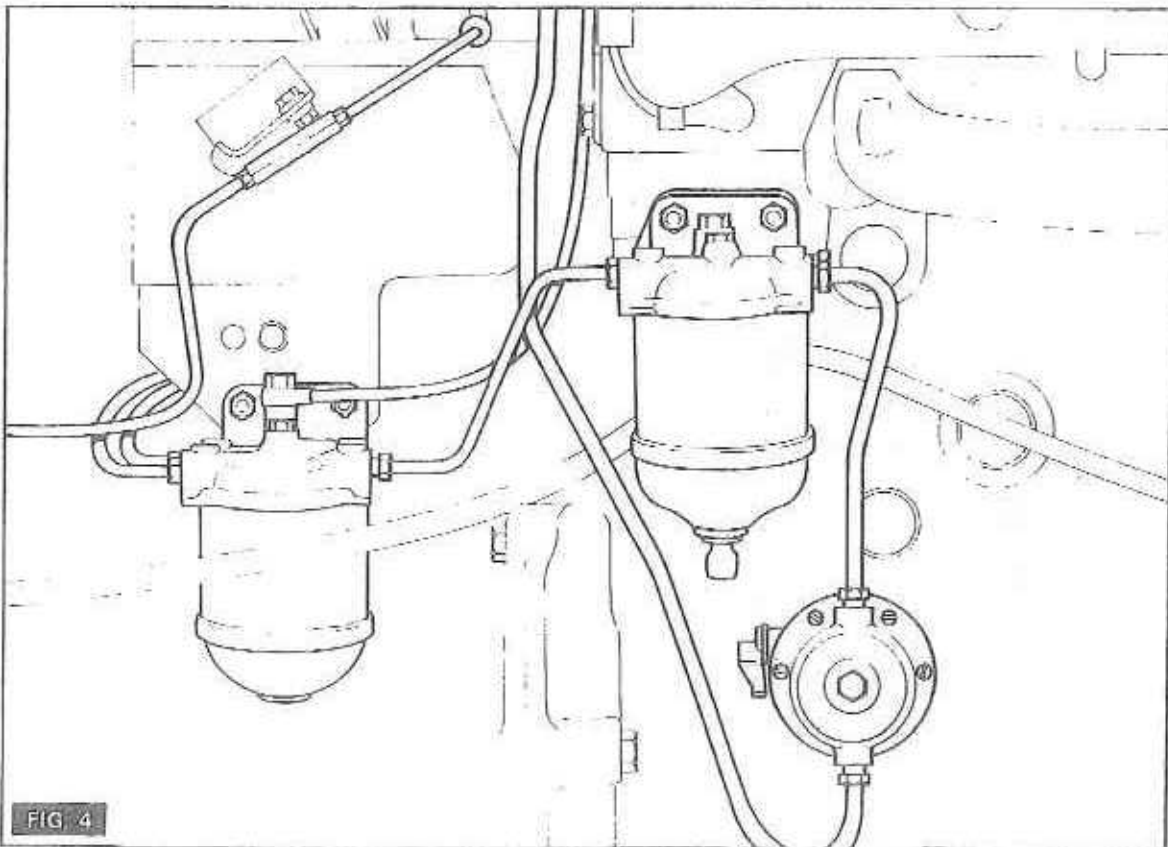
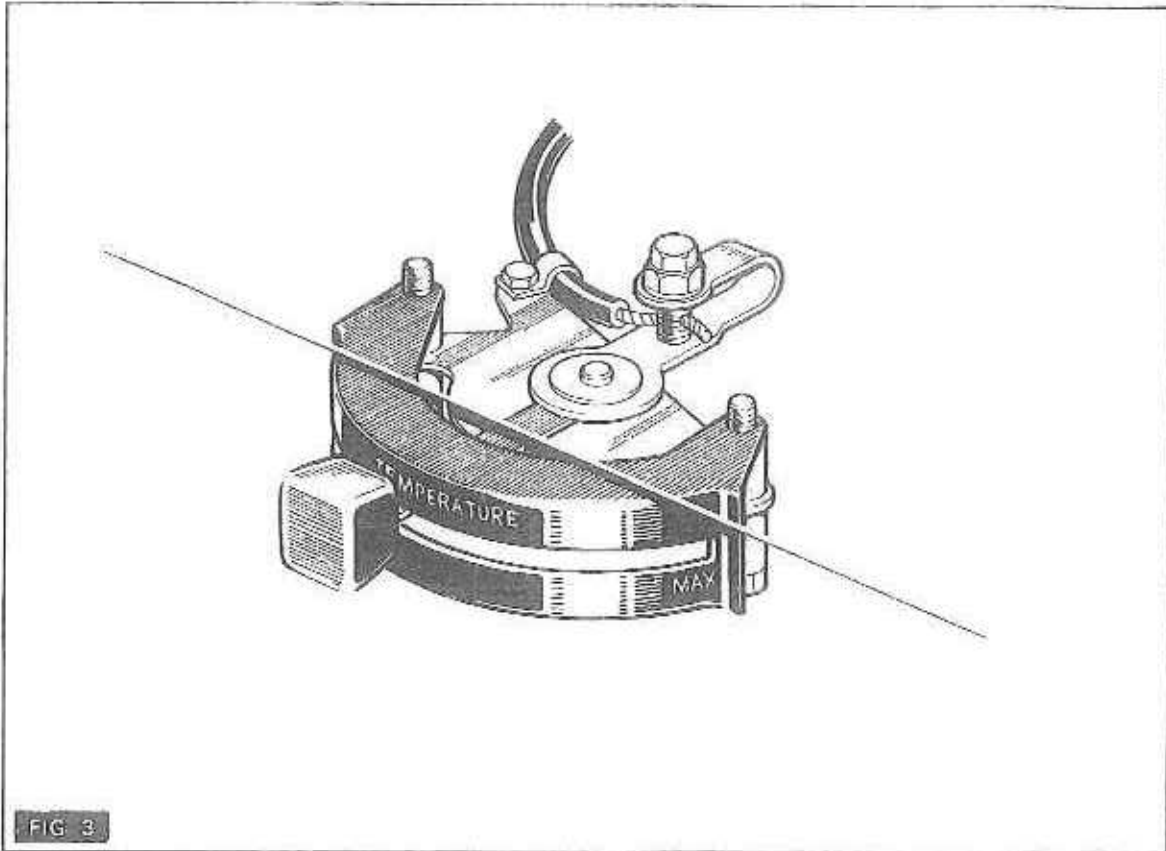
STEERING COLUMN

Removal and Replacement

(5B/2)

1. Disconnect the battery.
2. Remove the hood assembly as described in operation 3A/1.
3. Remove the steering wheel as described in operation 5B/1.
4. (Fig. 3) Remove the nut securing the heater cable to the heater control quadrant, and the two bolts securing the control quadrant to the underside of the instrument panel.
5. Remove four screws and lock washers, securing the instrument panel in position.
6. Disconnect the speedometer drive cable, the oil pressure gauge pipes and all the electrical connections to the underside of the instrument panel. The location of all these connections should be carefully noted in order to facilitate reassembly.
7. Lift the instrument panel clear.
8. Remove the four screws and lock washers which secure the instrument panel cowl in position.
9. Remove the instrument panel cowl.
10. Remove four screws and lock washers securing the instrument panel support.
11. Remove the instrument panel support.
12. The fuse box can now be removed as described in operation 4A/8.
13. Remove two screws and lockwashers securing the bulkhead to the cowl support bar assembly and two nuts and lock washers securing the rubber bulkhead mounting to the fuel tank support assembly.
14. Lift the bulkhead clear, complete with rubber mounting.
15. Check rubber mounting for wear and replace if excessively worn.
16. Remove the four bolts securing the steering column to the steering box. remove the column together with shims and joint.
17. Replacement is a reversal of the above procedure.





STEERING BOX

Removal and Replacement

(5B/3)

1. Remove the steering wheel as described in operation 5B/1.
2. Remove the steering column as described in operation 5B/2.
3. Remove the two upper nuts securing the fuel tank rear rubber mountings. Insert suitable wedges between the fuel tank and the engine rocker cover.
4. Turn off the fuel supply.
5. (Fig. 4) Disconnect the pipe connecting the primary to the secondary fuel filter at the secondary filter.
6. Disconnect the fuel pipe, from the secondary fuel filter to the injector on top of the filter.
7. Disconnect two pipes from the secondary filter to the fuel pump.
8. Remove two bolts securing the secondary filter to the fuel tank support assembly.
9. Disconnect the throttle linkage by removing the split pin securing the foot throttle rod to the quadrant and release the rod at the right hand side of the steering box.
10. Disconnect the left hand throttle rod assembly from its lever by releasing the clip (1 Fig. 5).
11. Remove two bolts each side of the steering box securing the bulkhead to the steering box.
12. Disconnect the drag link from the lower drop arm.
13. Remove the bulkhead.
14. (Fig 6) Remove the nut and spring washer securing the drop arm and pull off the drop arm; using tool 6312 Detach the sealing washer from the rocker shaft.
15. Remove two bolts securing the front of the steering box to the cylinder block and two bolts securing the rear of the box to the transmission housing.
16. Lift the steering box off the tractor.
17. Replacement is a reversal of the above procedure.

Note

The master splines on the rocker shaft and drop arm must be correctly aligned when refitting.

STEERING BOX

Disassembly

(5B/4)

1. Remove the steering box from the machine as described in operation 5B/3.
2. (Fig. 7) Remove the plug (7) from the left hand side of the box and drain off the oil.
3. Remove four bolts (12) and spring washers (11) securing the side cover (10) to the box (6) Detach the cover (10) and joint (9).
4. Withdraw the rocker shaft (3) from the steering box (6)
5. Withdraw the steering shaft (3) together with the upper bearing cup (1) and upper bearing (2) from the steering box.
6. Remove the lower bearing (4) from the steering box.
7. Pull out the peg (8) from the rocker shaft.
8. Replace the rocker shaft oil seal (14) and the steering shaft lower bearing cup (5)

STEERING BOX

Reassembly

(5B/5)

1. Refit the lower bearing cup (5) and lower bearing to the steering box.
2. (Fig. 8) Position the upper bearing (2) and upper bearing cup (1) onto the steering shaft.
3. Lower the steering shaft into the steering box locating the bottom end of the shaft onto its lower bearing. Fit the upper bearing cup onto its bore in the steering box.
4. (Fig. 7) Refit the peg (8) to the rocker shaft (13). Assemble the rocker shaft into the box, locating the peg into its thread on the column.
5. Refit the side cover (10) and joint (9) and secure in position with four bolts (12) and spring washers (11).
6. Refill the steering box with recommended oil and refit the filler plug.
7. Refit the steering box to the machine as described in operation 5B/3.

PART 5 SECTION B

MF WORKSHOP SERVICE MANUAL 1457 057 M1

STEERING BOX ROCKER SHAFT BUSHES

Removal

(5B/6)

1. Disassemble the steering box as described in operation 5B/4.
2. Using tool MF 263 and 263-2 (together with a bar 6" long, 1" wide, 5/8" thick and suitably radiused to suit main tool MF 263 for the inner bush only (as shown in Fig. 9), cut a thread into the bush by turning the upper handle fully clockwise.
3. Remove the bush by turning the lower handle clockwise.

STEERING BOX ROCKER SHAFT BUSHES

Replacement

(5B/7)

1. (Fig. 10) Position the new bush squarely over its bore and drive the bush in using tool MF 263-2 and 550 handle.
2. (Fig. 11) Ream the bushes in position using tool MF 264 and 264-1. Remove all metal cuttings.

DRAG LINK

Removal and Replacement

(5B/8)

1. Turn the wheels to the full right hand lock.
2. Remove the two nuts securing the drag link ends to the steering box drop arm and the upper steering arm.
3. Release the tapered ball pins and detach the drag link.
4. Replacement is a reversal of the above procedure.

STEERING CYLINDER, VALVE ASSEMBLY, ARMS AND SHAFT

Removal and Replacement

(5B/9)

1. Remove the front grille assembly.
2. Turn the wheels to the full right hand lock.
3. (Fig. 12) Remove the bolt (1) nut and spring washer securing the lower crank arm to the main steering shaft.
4. Remove two banjo bolts and copper washers securing the hoses to the valve assembly. Allow oil to drain out of the hoses.
5. Remove the nut (2) and release the drag link from the upper steering arm.
6. Remove the split pin (3), retaining the ram arm pivot (4), withdraw the pivot pin and push the ram arm (5) out of its bore in the front engine support.
7. (Fig. 13) Lift the cylinder, valve assembly, steering arms and shaft up from the front engine support and tap the lower crank arm off the main steering shaft.
8. Replacement is a reversal of the above procedure. Top up the power steering reservoir.

Note

Ensure that the hoses are connected up correctly. Align the master splines on the lower crank arm and main steering shaft.

*KING PIN BUSHES see S Bulletin 50B/1700/25 for { MF263-5 Bush Removal/Reflector }
MF264-8 Reamer 9 Pilot.*

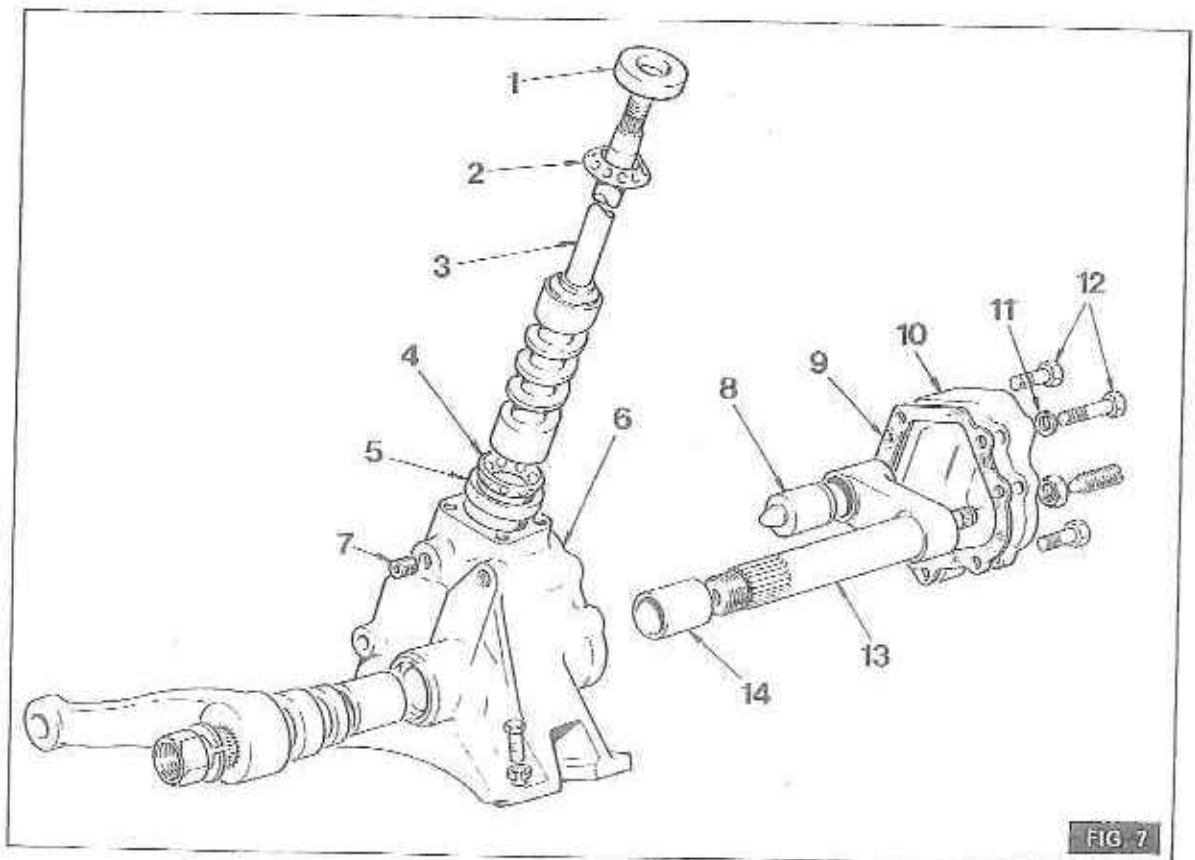
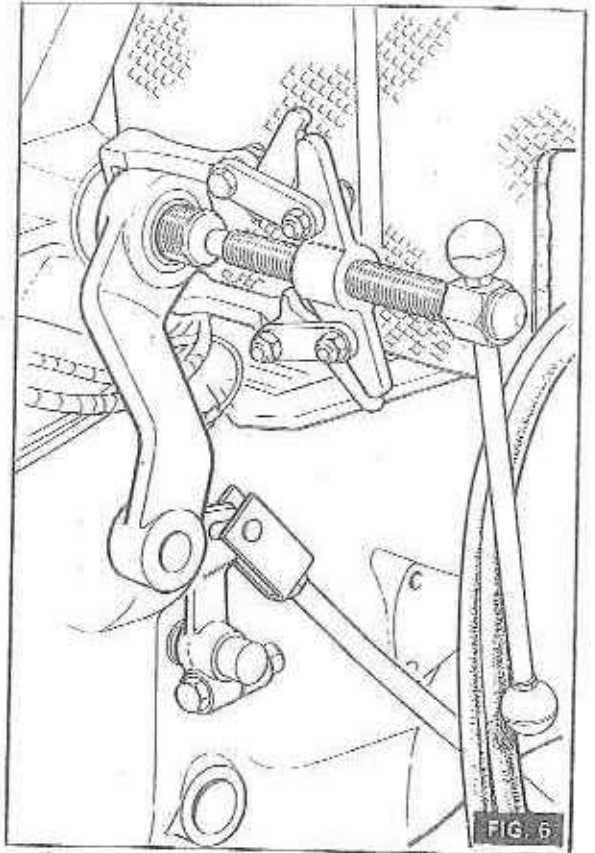
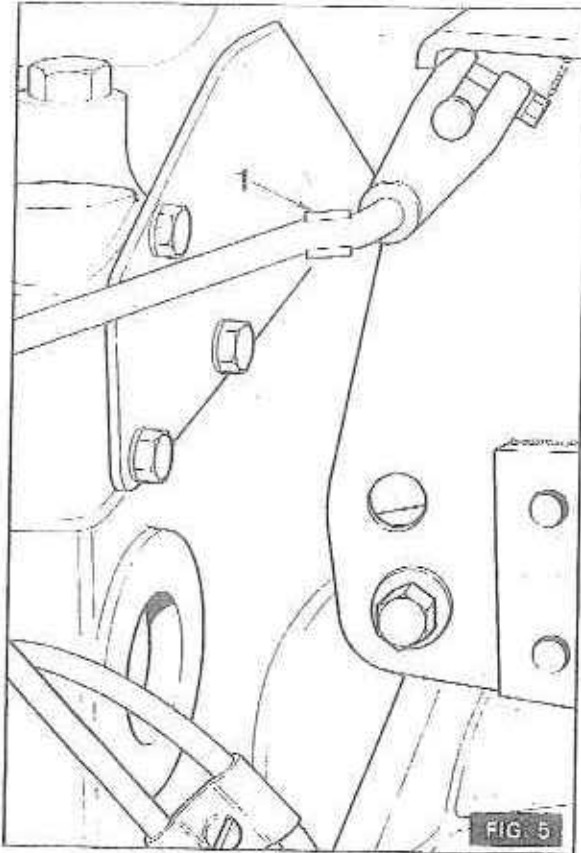
MAIN STEERING SHAFT BUSHES

Removal

(5B/10)

1. (Fig. 14) Using tool MF 263 and 263-2, cut a thread into the bush by turning the upper handle fully clockwise.
2. Remove the bush by turning the lower handle clockwise.

897235 Bush is 1 7/8" ID.



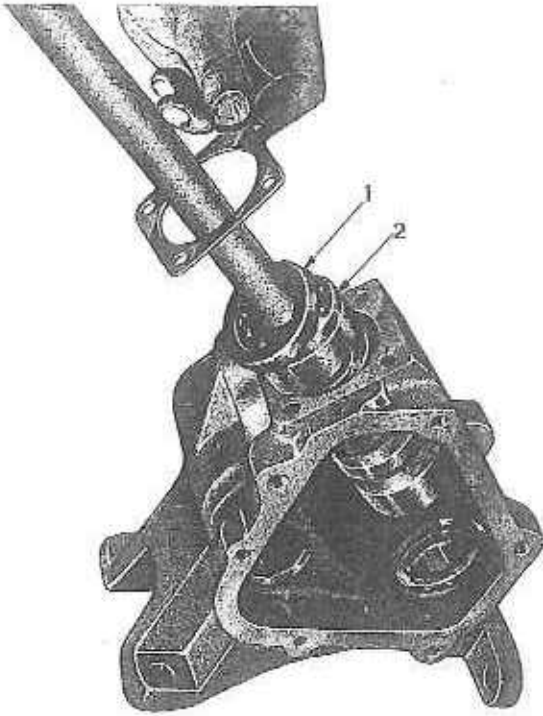


FIG 8

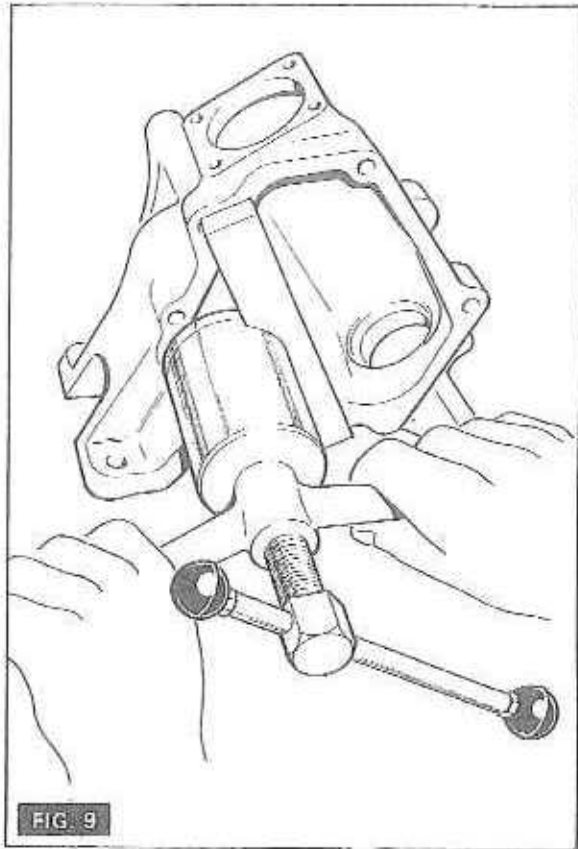


FIG 9

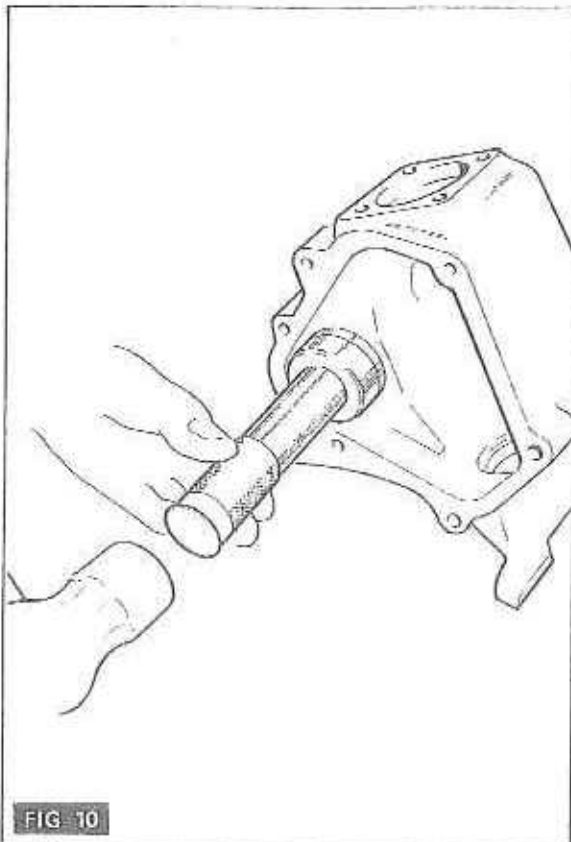


FIG 10

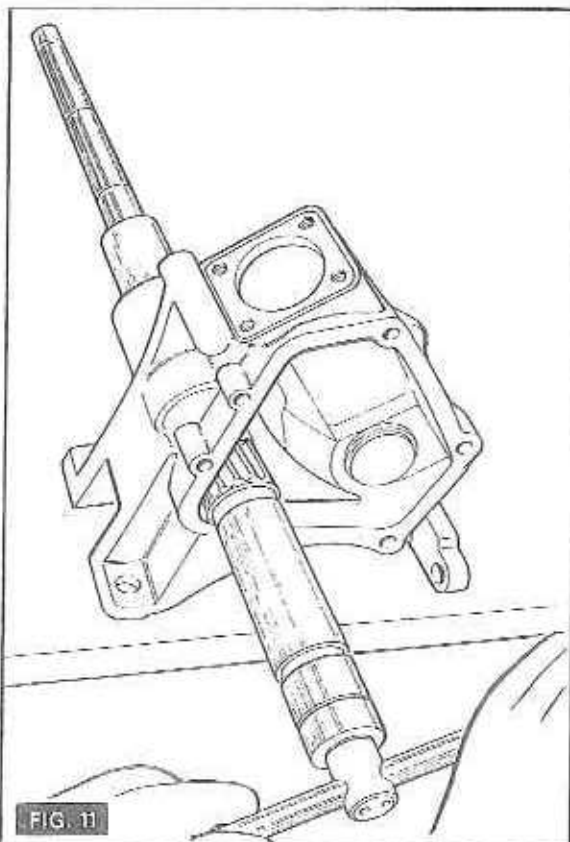
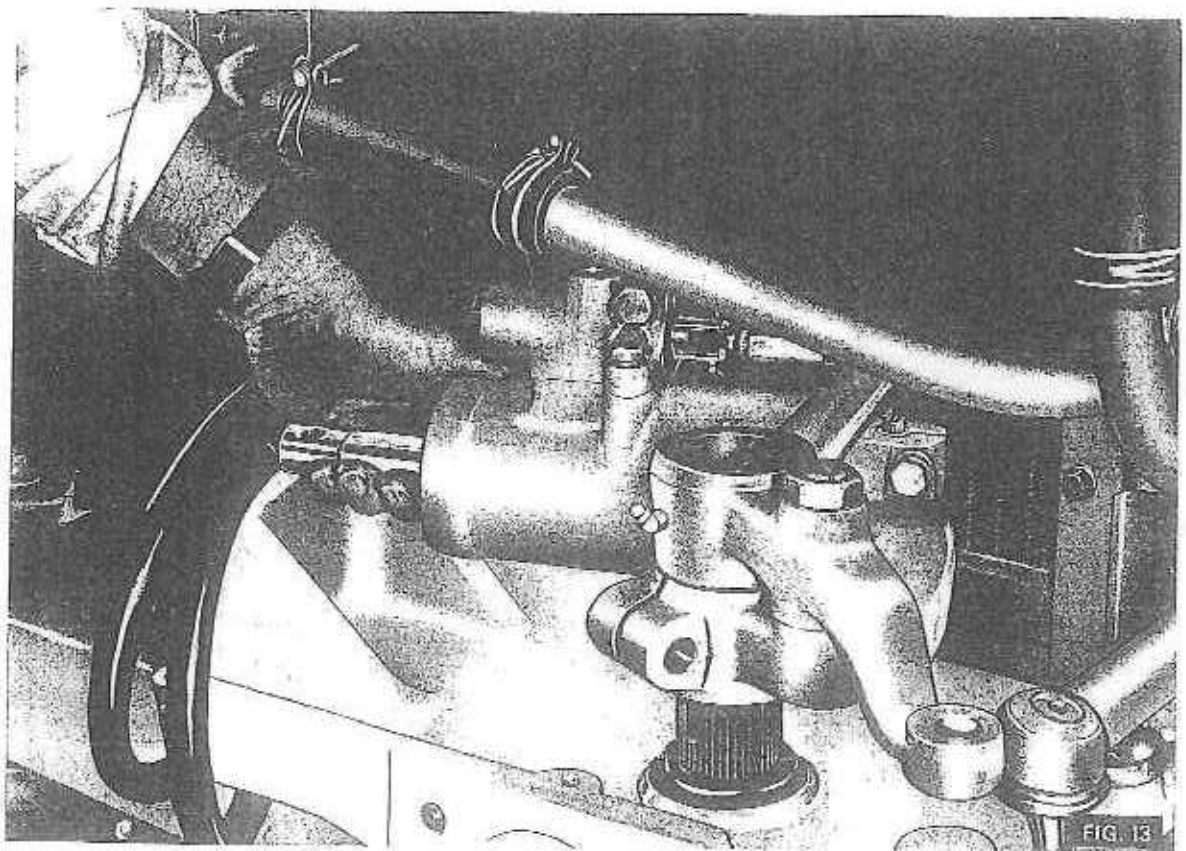
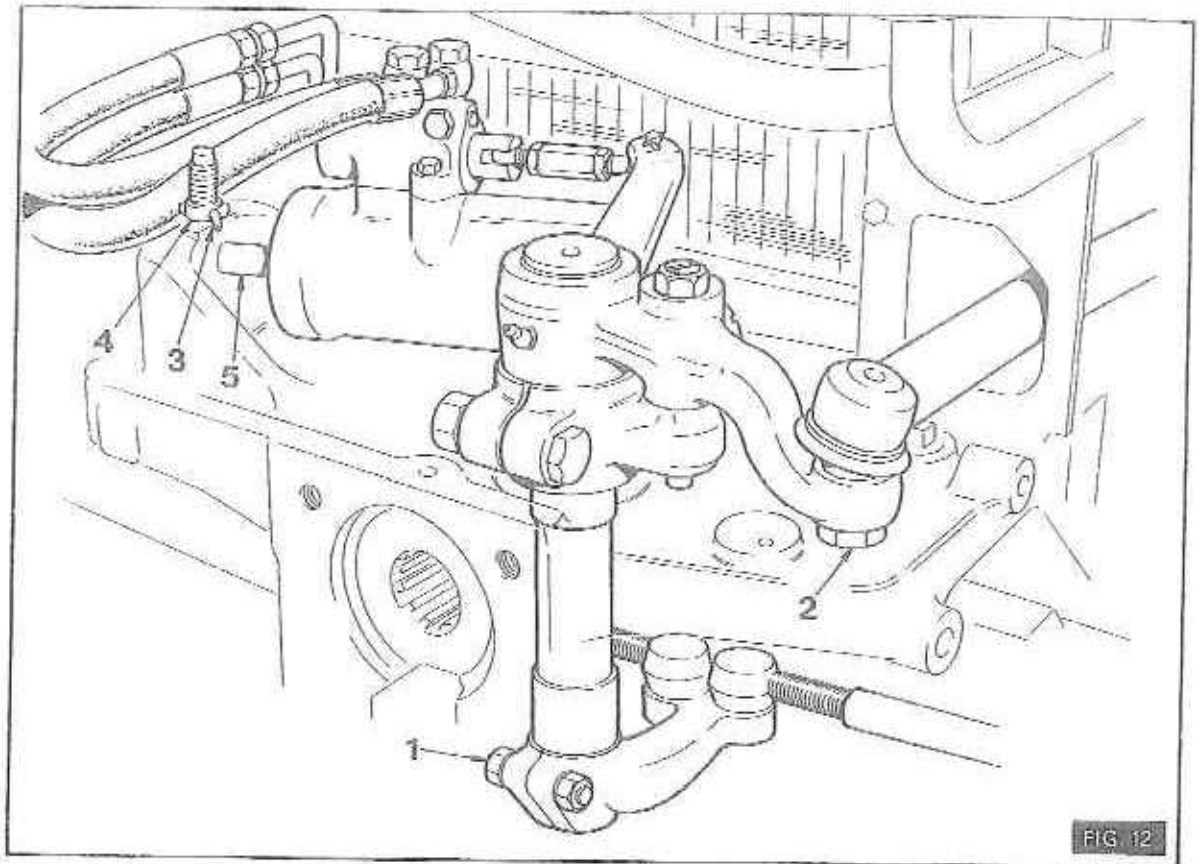
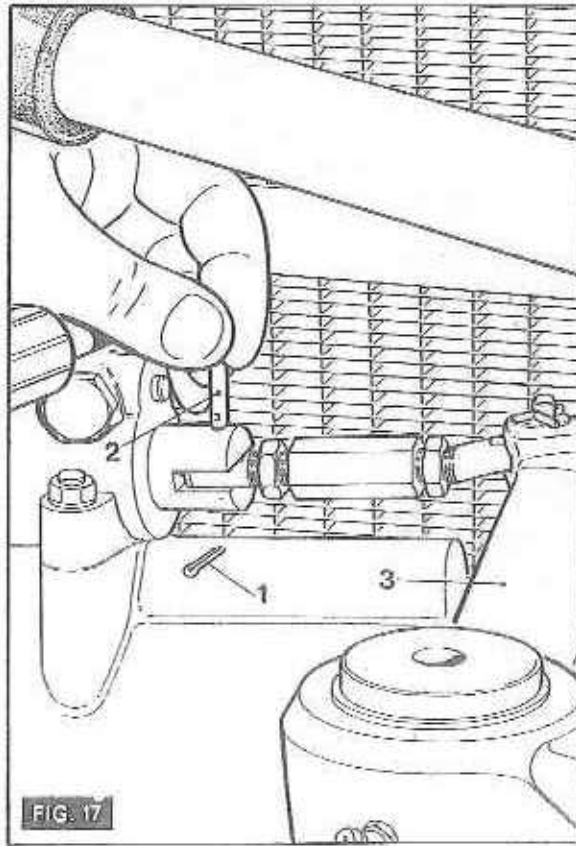
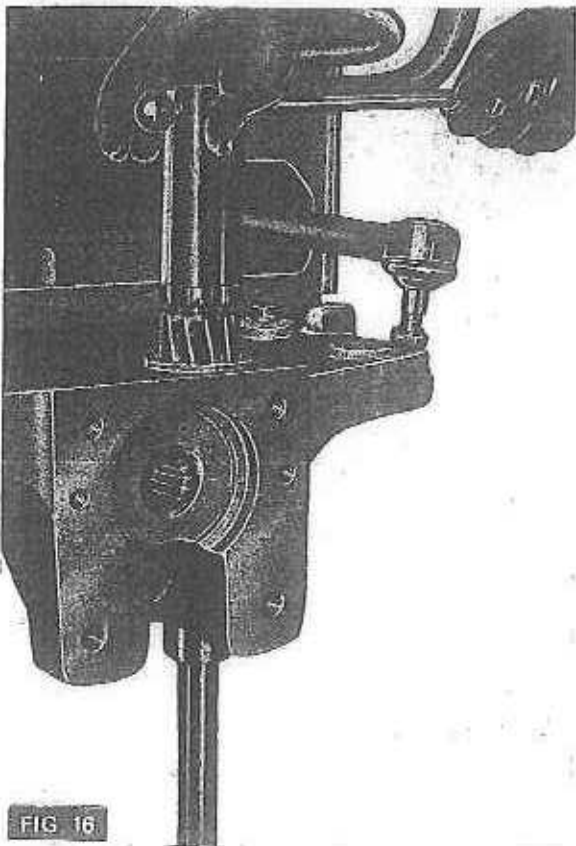
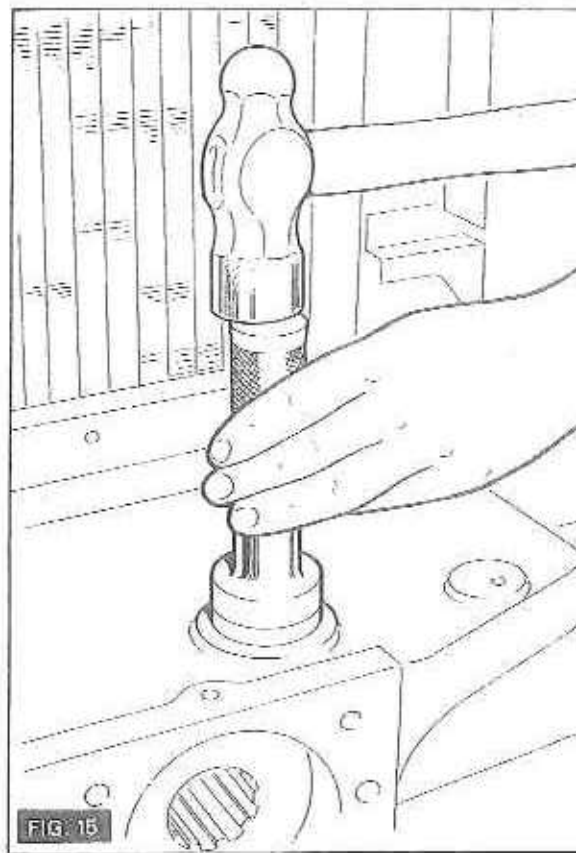
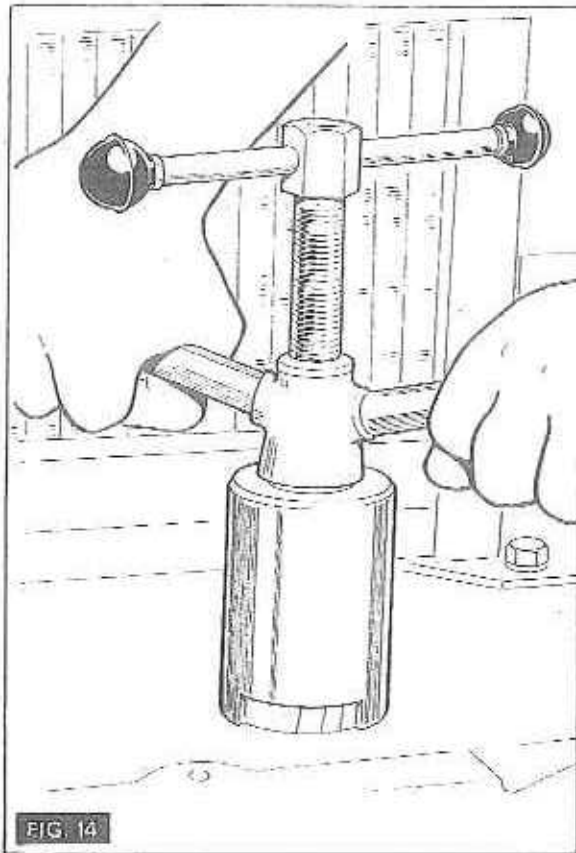
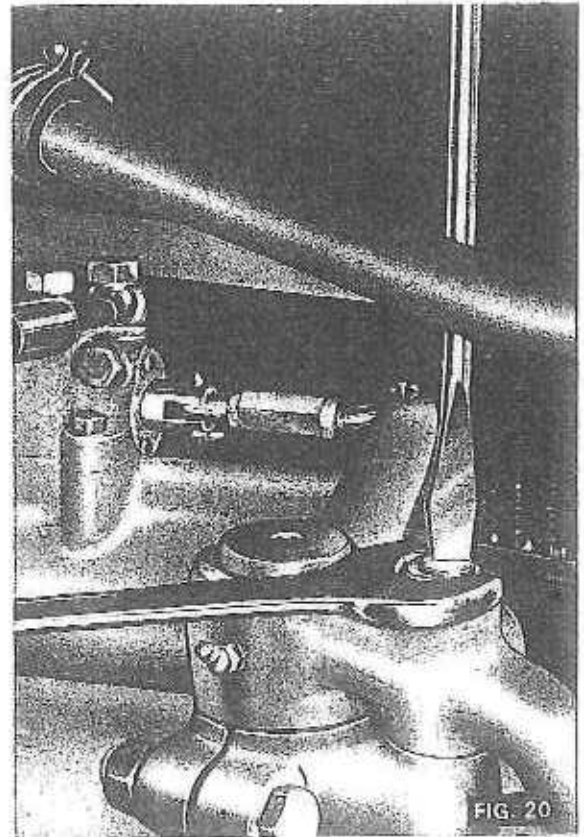
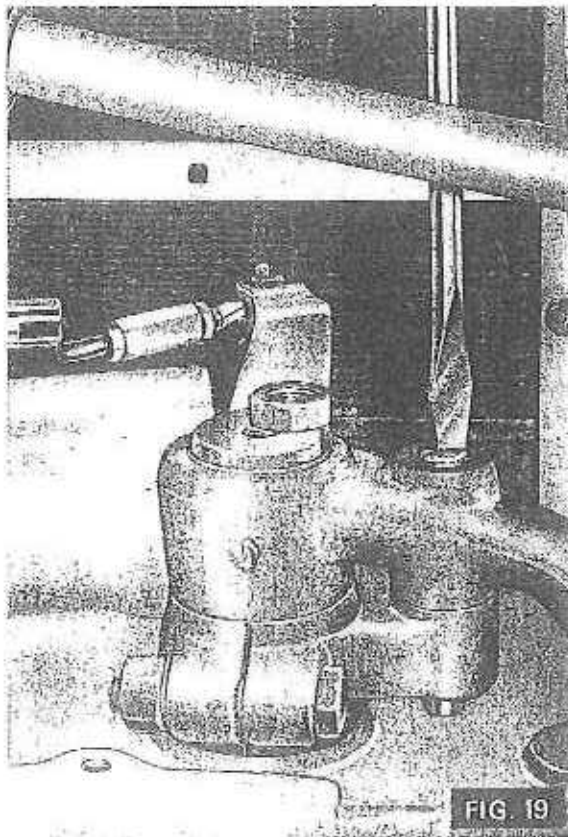
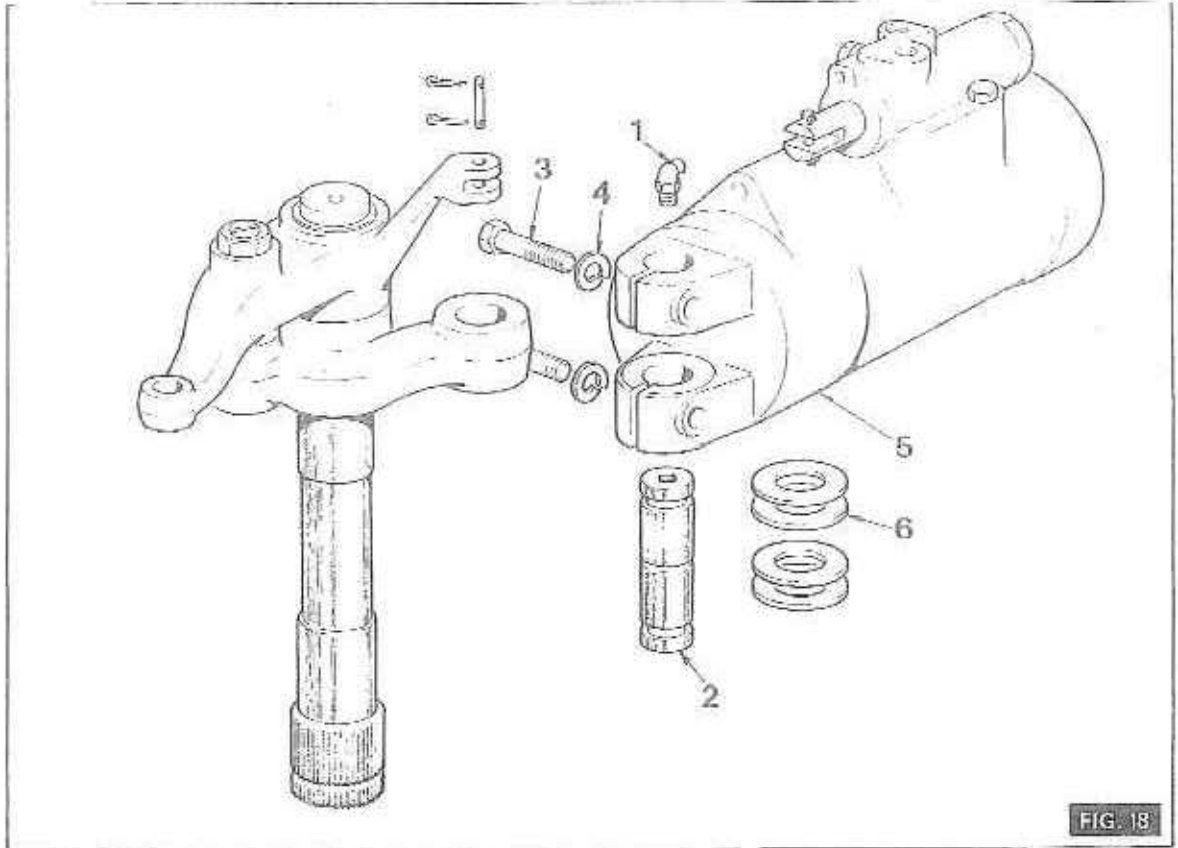
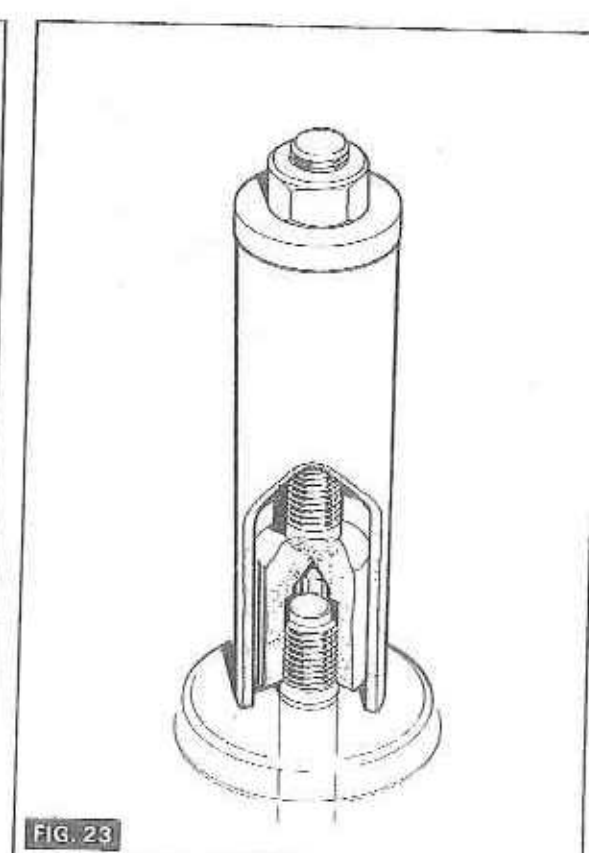
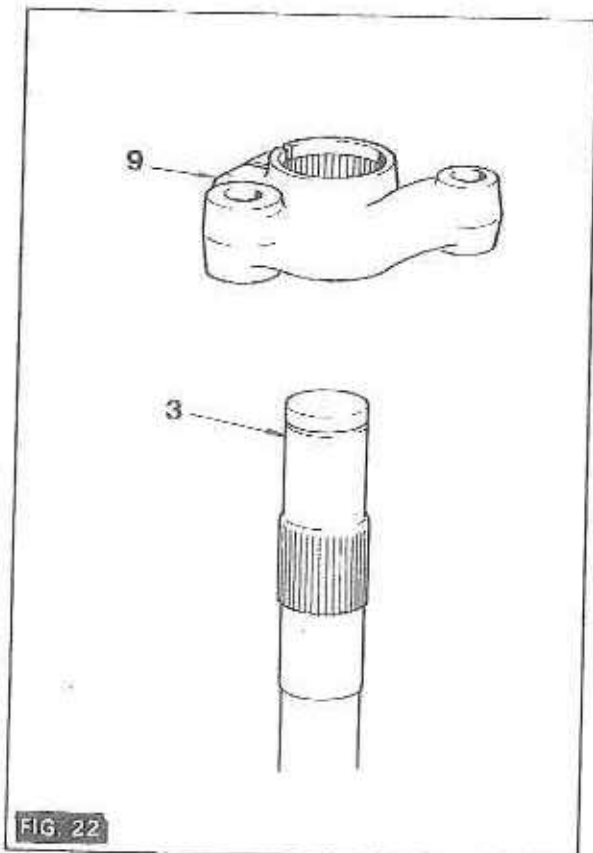
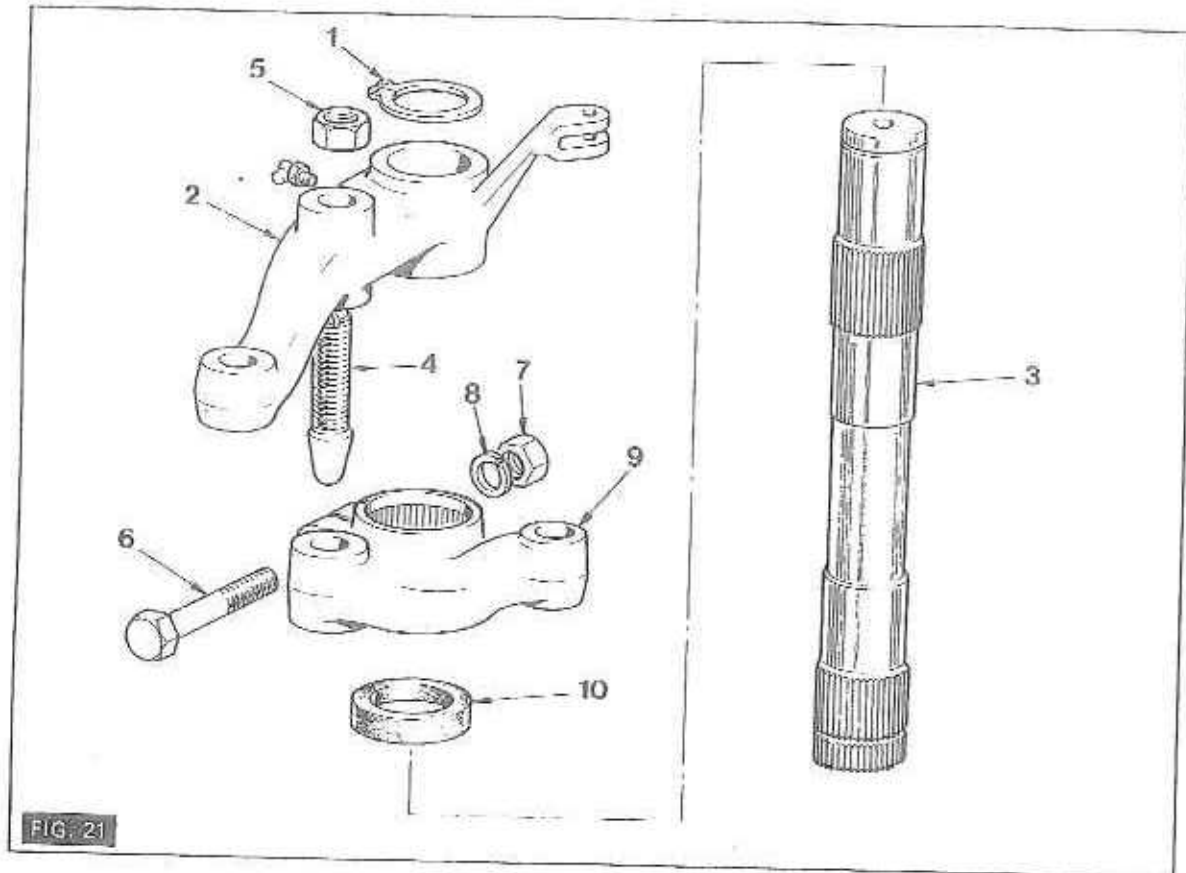


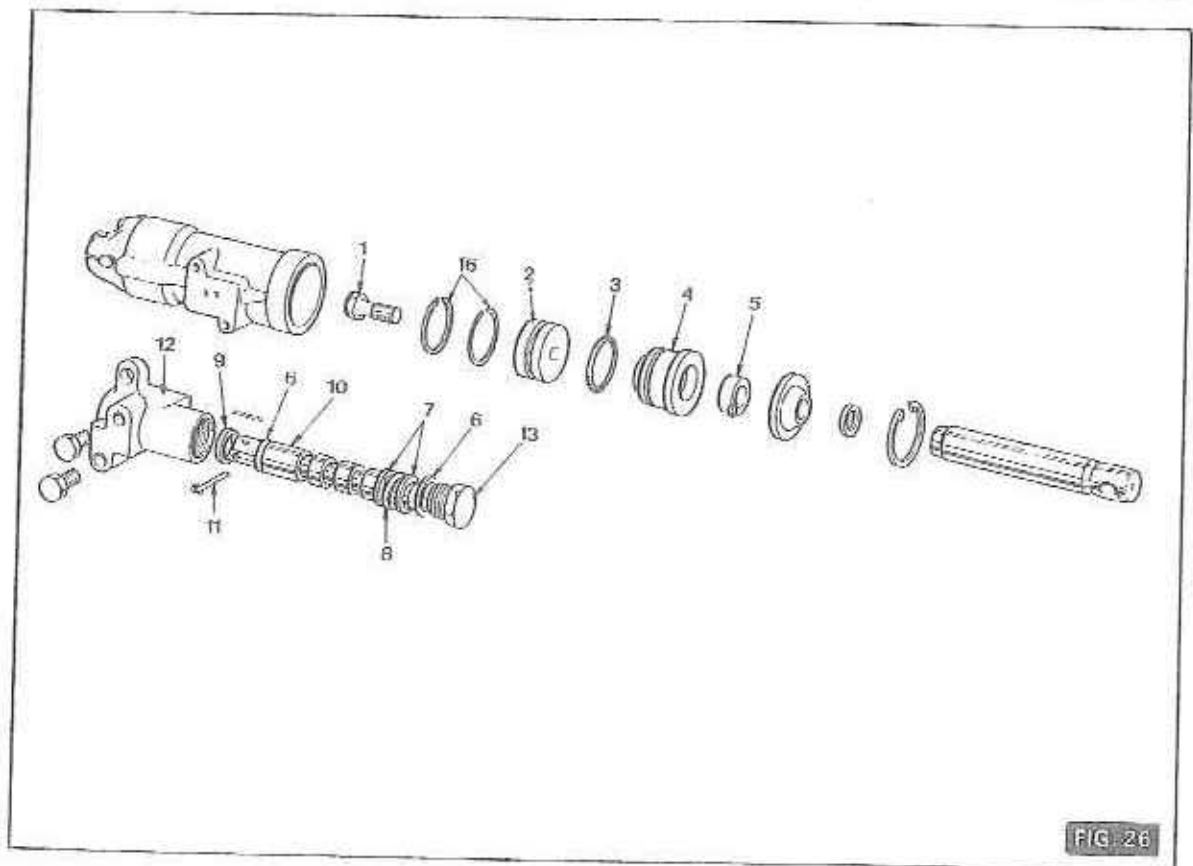
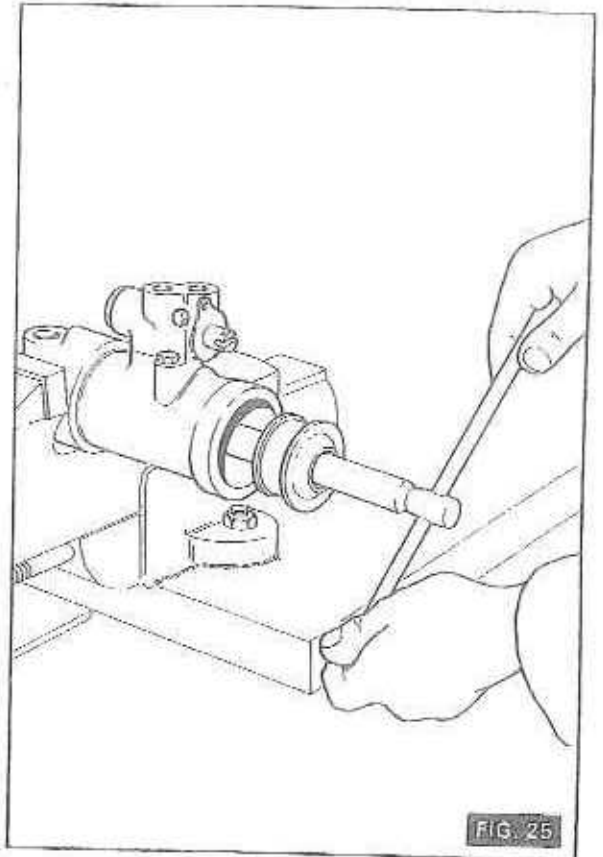
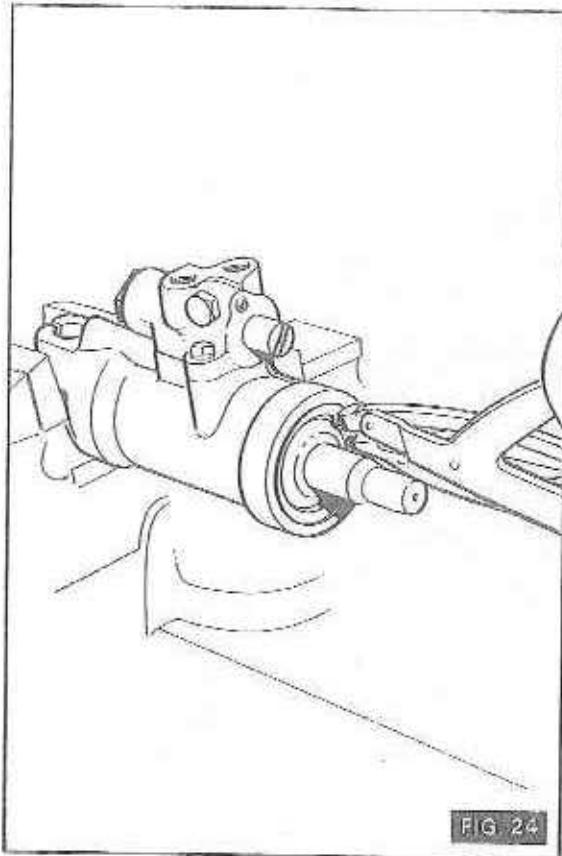
FIG 11

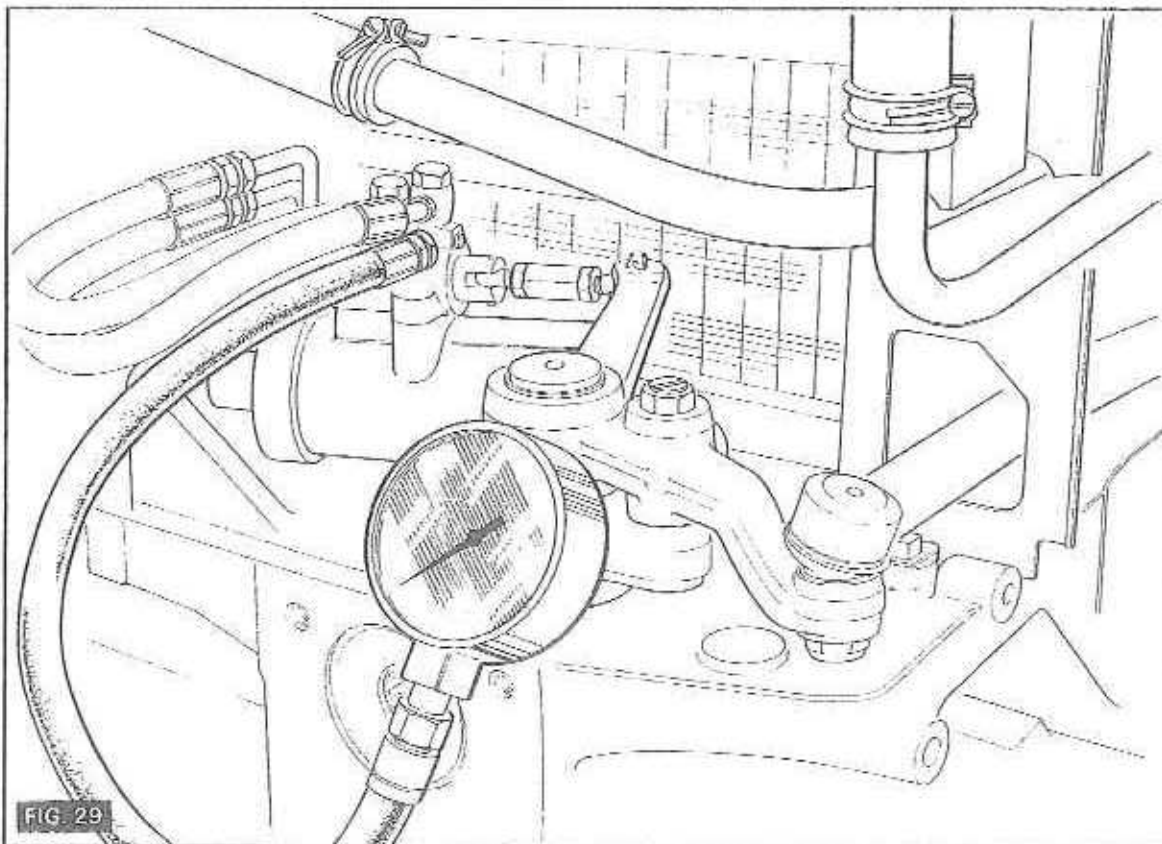
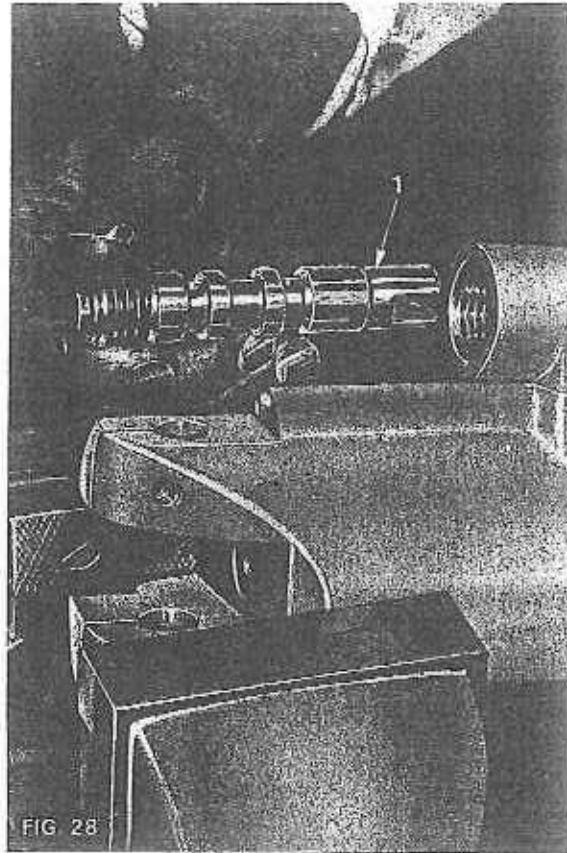
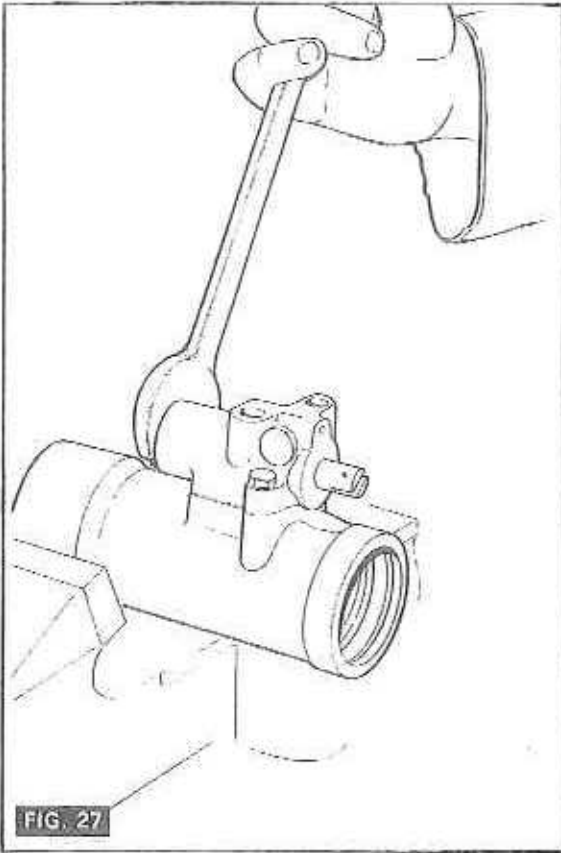












MAIN STEERING SHAFT BUSHES

Replacement

(5B/11)

1. (Fig. 15) Position the new bush squarely over its bore and drive the bush in, using tool MF 263-2³ and 550 handle.
2. (Fig. 16) Ream the bushes in position, using tool MF 264 and 264-2. Remove all metal cuttings.

CYLINDER AND VALVE ASSEMBLY TO STEERING ARMS

Removal and Replacement

(5B/12)

1. Remove the complete assembly from the front engine support, as described in operation 5B/9.
2. (Fig. 17) Remove the lower split pin (1) securing the valve link pin (2) to the upper steering arm (3). Withdraw the valve link pin (2).
3. (Fig. 18) Remove the grease nipple (1) from the cylinder pivot pin (2).
4. Remove two setscrews (3) and spring washers (4) securing the cylinder pivot pin, (2) to the cylinder end casting (5).
5. Withdraw the pivot pin and collect the shims (6) fitted between the cylinder and arm.
6. Replacement is a reversal of the above procedure.

Note

The main steering arm and cylinder must be shimmed to give not more than 0.007" (0.179 mm.) end float. Shims are available in two sizes : 0.003"/0.005" (0.076/0.127 mm.) and 0.020"/0.022" (0.508/0.509 mm.).

CONTROL VALVE CLEARANCE

Adjustment

(5B/13)

1. (Fig. 19) Disconnect the upper steering arm link from the spool valve fork. Fully tighten the adjusting pin.
2. Slacken the two locknuts and turn the valve adjusting sleeve until the pin passes freely through the spool valve fork and link. Fit the pin and secure with the split pin. Tighten the locknuts.
3. (Fig. 20) Slacken off the adjusting pin seven complete turns and tighten the locknut.

STEERING ARMS

Removal and Replacement

(5B/14)

1. (Fig. 21) Remove the circlip (1) retaining the upper arm (2) onto the shaft (3). Lift off the arm (2), adjusting pin (4) and locknut (5).
2. Remove the bolt (6), nut (7) and spring washer (8) securing the main steering arm (9) to the shaft (3). Lift off the arm (9) and seal (10).
3. Drive out the bush from the main steering arm, using tool 550 handle and drift MF 203A/1.
4. Replacement is a reversal of the above procedure.

Note

The main steering arm (9) has a master spline which must be aligned with a master spline on the shaft (3) on assembly (Fig. 22). Set the adjustment pin (4) as described in operation 5B/13.

CONTROL VALVE

Disassembly

(5B/15)

- 1 Remove the steering cylinder, valve assembly, arms and shaft from the front engine support, as described in operation 5B/9.
- 2 Remove the steering cylinder and valve assembly from the steering arm, as described in operation 5B/12
- 3 Hold the cylinder assembly securely in a clamp or vice.
- 4 (Fig 24) Remove the circlip retaining the steering cylinder piston in position.
- 5 (Fig 25) Remove the ram, complete with piston from the cylinder.
- 6 (Fig 26) Hold the ram securely in a clamp or vice. Remove the bolt (1), slide off the piston (2). "O" ring (3) the second piston half (4) and seal (5).
- 7 Slide the retainer of the piston ram and remove the wiper ring.

SPOOL VALVE ASSEMBLY

Disassembly

(5B/16)

- 1 (Fig. 27) With the cylinder body suitably held in a clamp or vice, remove the valve securing bolt.
- 2 (Fig. 28) Withdraw spool assembly (1).
- 3 Remove two bolts and washers securing the valve body to the cylinder body.
- 4 Remove the retaining screw (2) from the spool assembly.
- 5 Remove the relief valve from the valve body.

Reassembly

(5B/17)

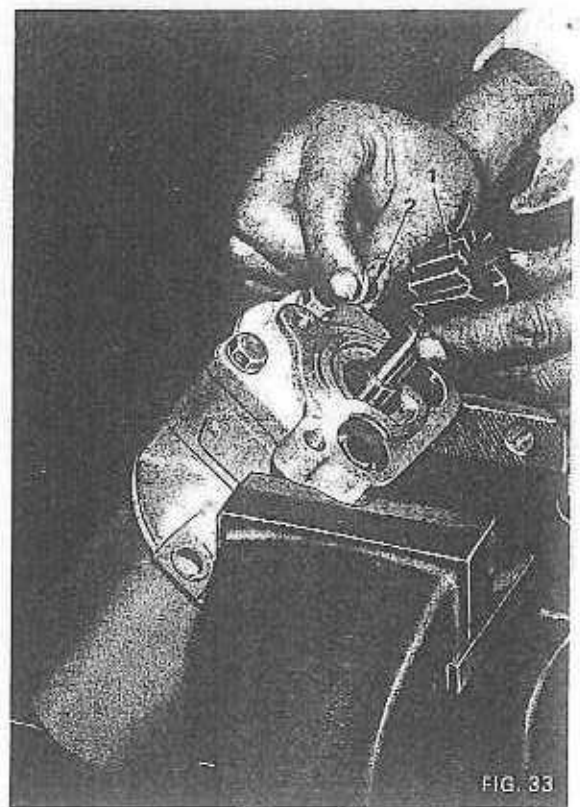
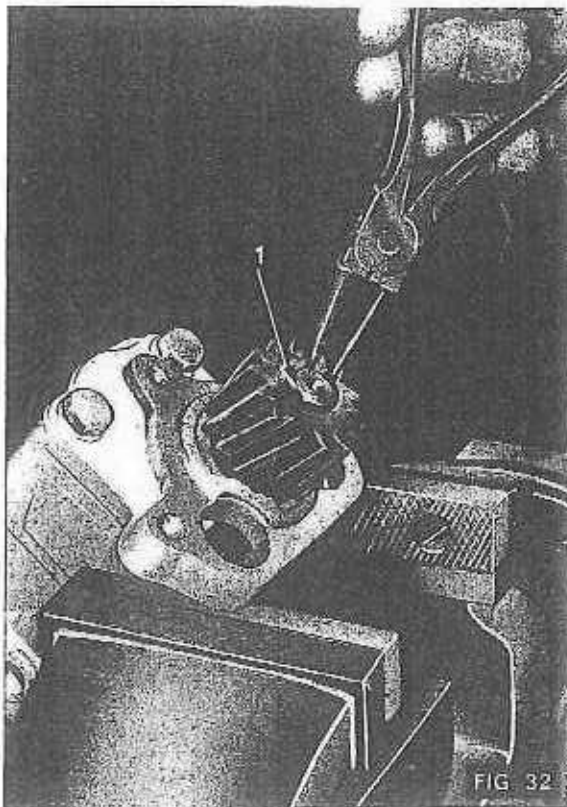
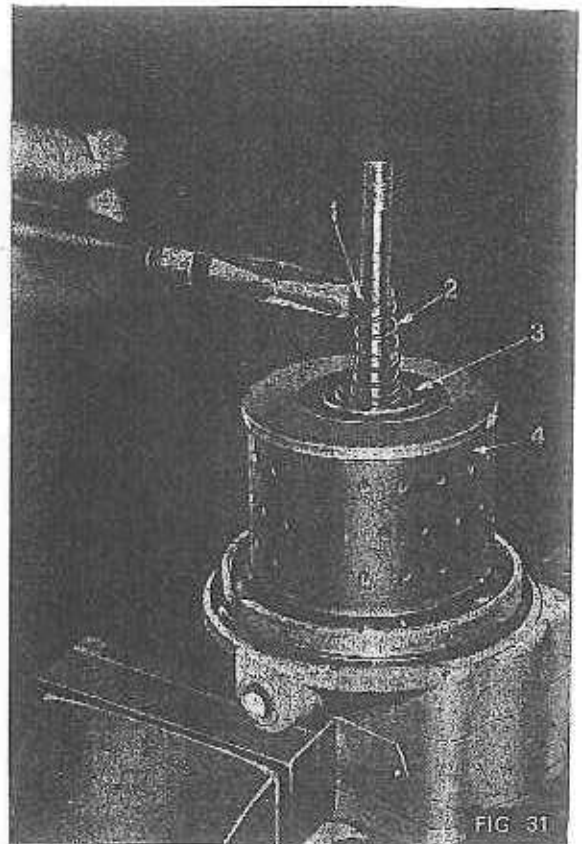
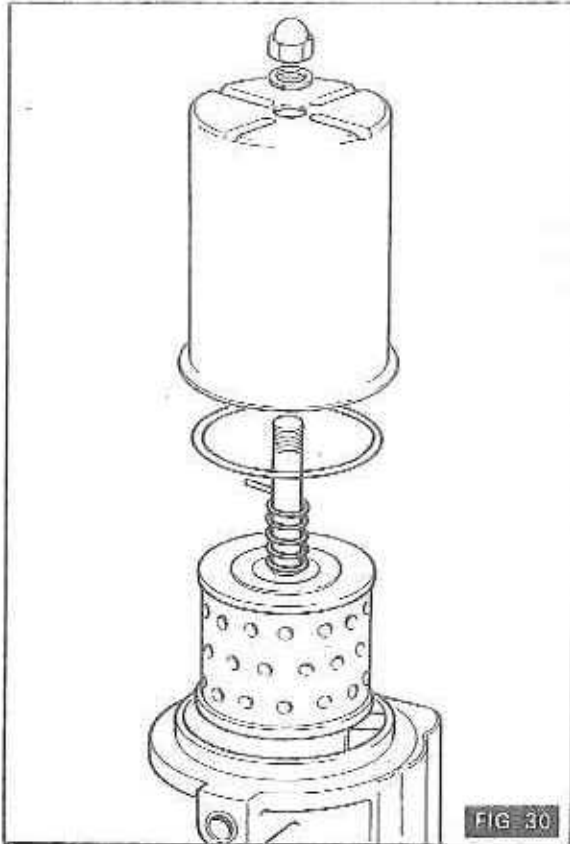
- 1 Examine all the component parts of the assembly for damage or excessive wear. Thoroughly clean all the parts.
- 2 When reassembling the relief valve, renew the bonded seal.
- 3 When fitting the valve body to the cylinder body fit new "O" rings in the top of the cylinder body. Bolt the valve to the cylinder.
- 4 (Fig. 26) When reassembling the spool assembly fit new "O" rings (6), fit new washers (7) either side of spring (8), a new back up washer (9) and secure on spool rod (10) with screw (11).
- 5 Refit the spool assembly to the valve body (12).
- 6 Refit the valve securing bolt (13).

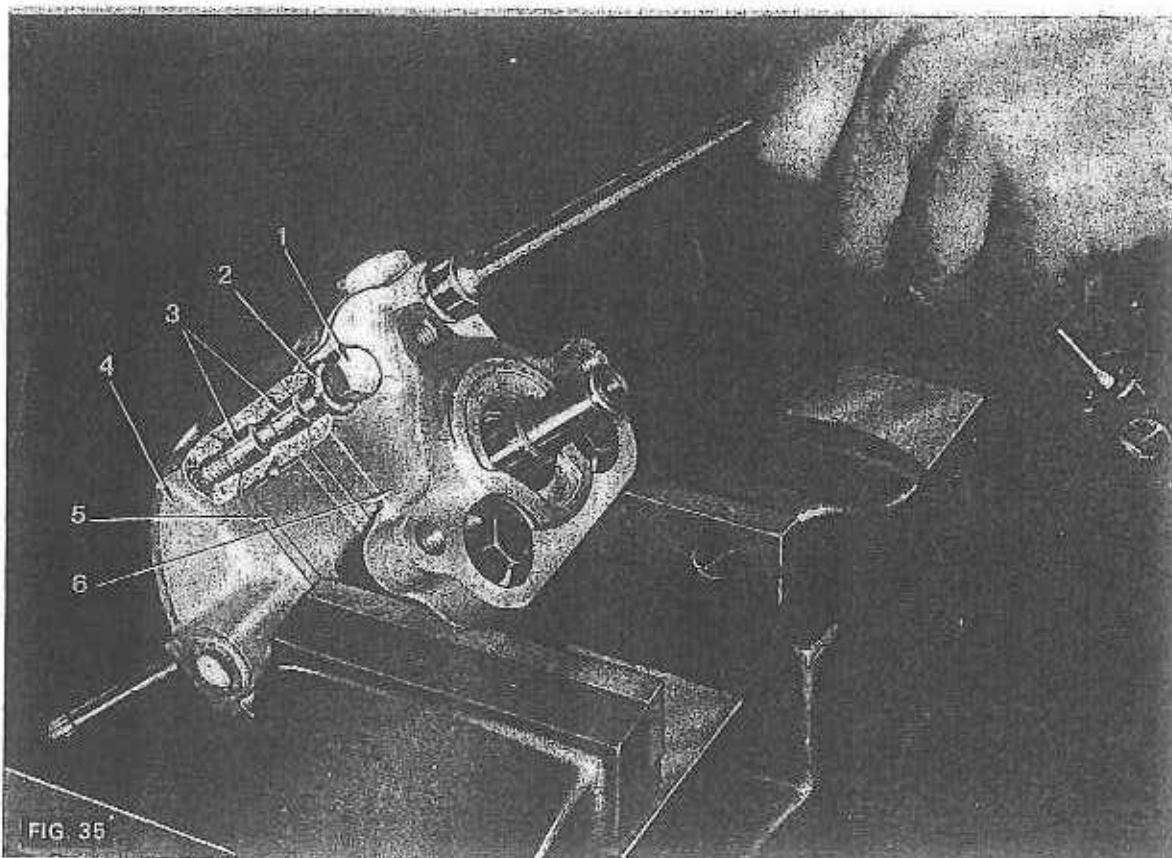
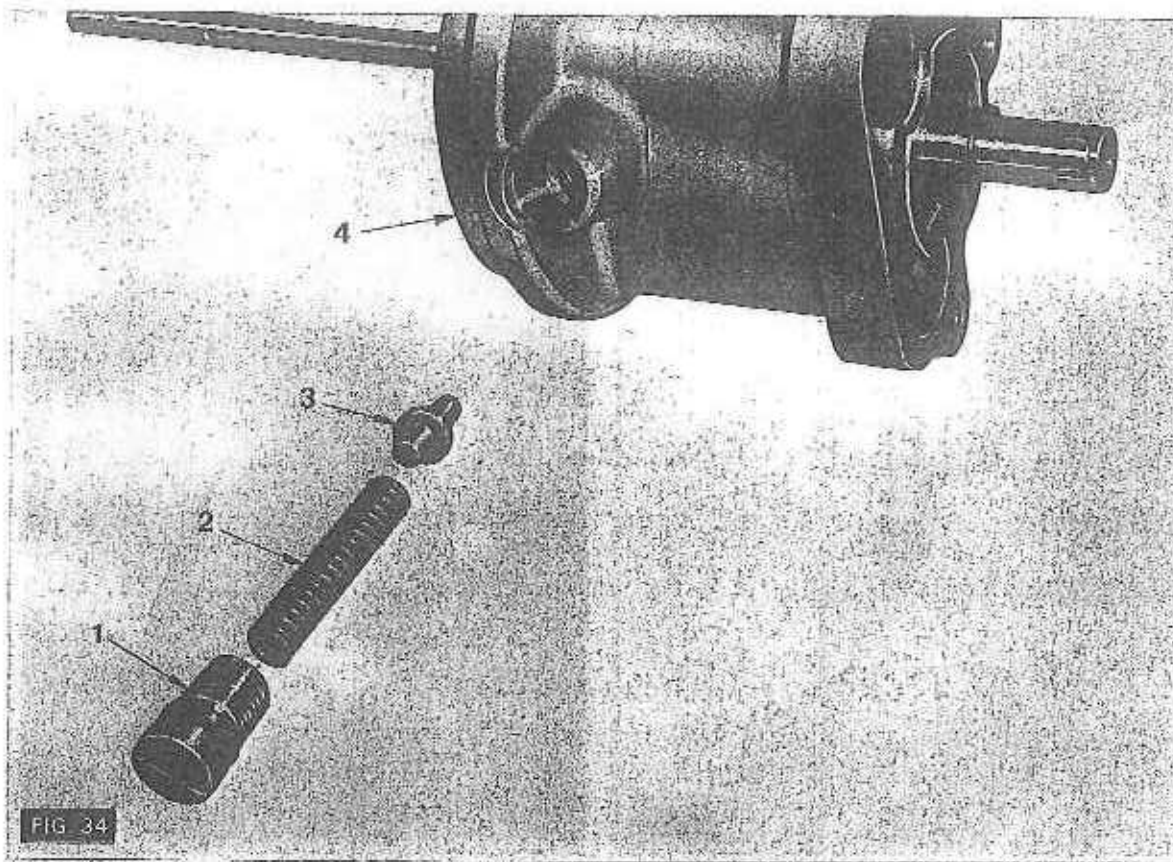
CONTROL VALVE

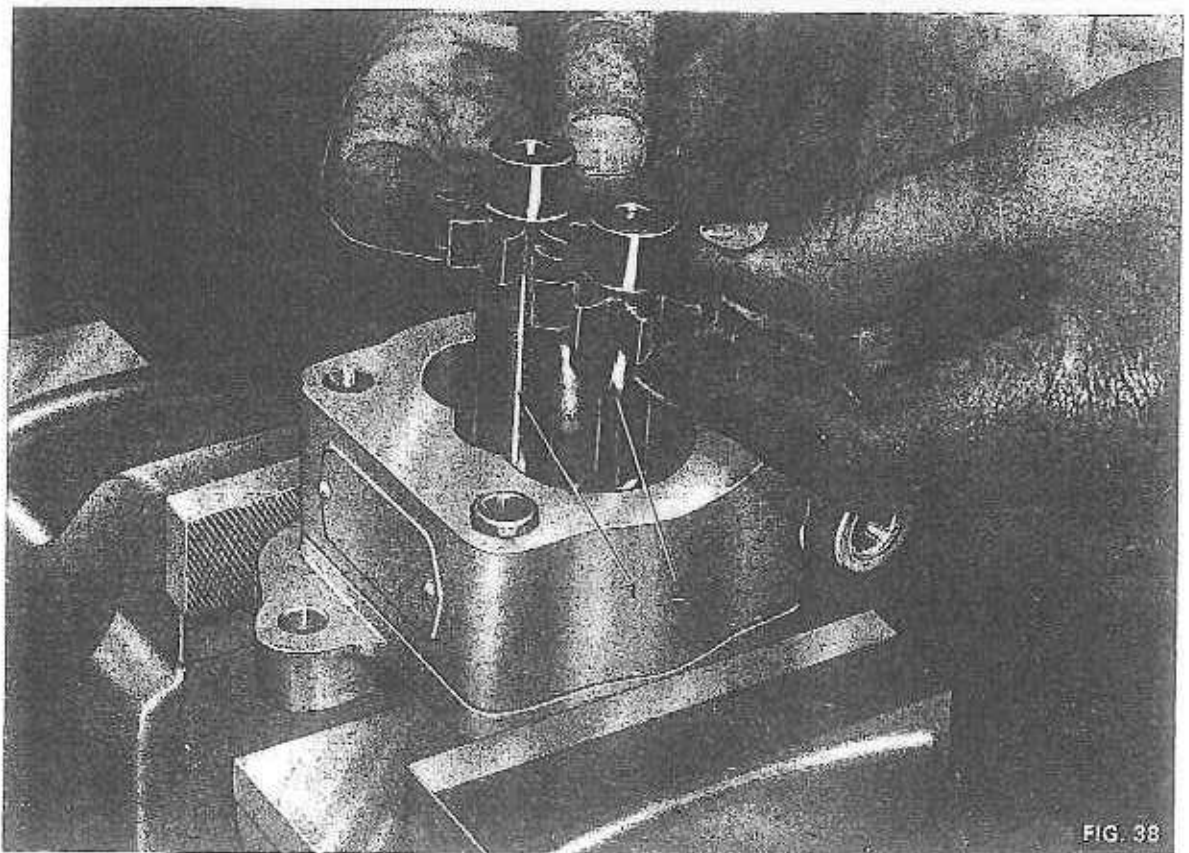
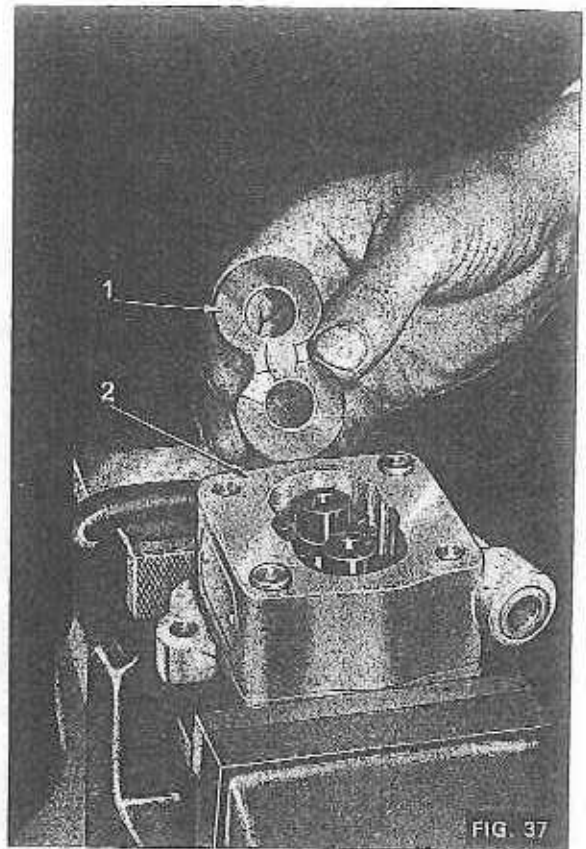
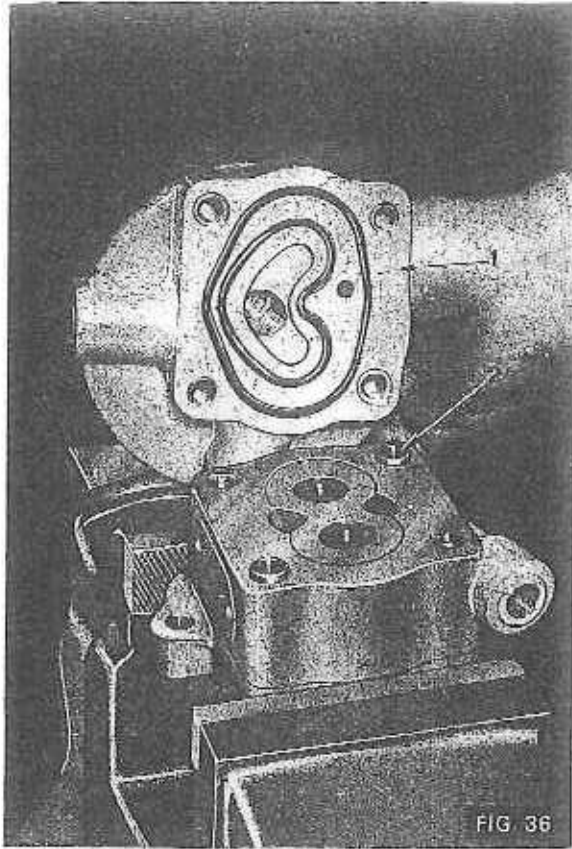
Reassembly

(5B/18)

- 1 Examine all the component parts of the assembly for damage or excessive wear. Thoroughly clean all the parts.
- 2 (Fig 26) Fit a new wiper ring (14) to the retainer (15).
- 3 Lubricate the piston rod with clean hydraulic oil and slide the retainer onto the rod.
- 4 Fit a new seal (5) and new "O" ring (3) to piston head (4). Place the assembly onto the piston rod. Fit the piston rings (16) to the second piston half (2), and replace the piston half on the rod.
- 5 Lock in place with the piston bolt and tighten the piston bolt with a torque load of ??
- 6 Lubricate the outer edges of the piston assembly, insert the piston and rod assembly into the cylinder, taking great care not to damage the seals in the process.
- 7 Lock the piston assembly in position in the cylinder housing with the circlip.
- 8 Refit the pivot pin between the steering cylinder and arm, using the number of shims required to give the required end float. The end float is not to exceed 0.007 in (0.179 mm).
- 9 Refit the two bolts and washers securing the cylinder pivot pin to the cylinder end casting.
- 10 Refit the greaser to the top of the cylinder pivot pin.
- 11 Refit the steering arms as described in operation 5B/14.
- 12 Refit the valve link pin to the upper steering arm and secure with two split pins.
- 13 Refit the steering cylinder, valve assembly, arms and shaft as described in items 1-6 of operation 5B/9.







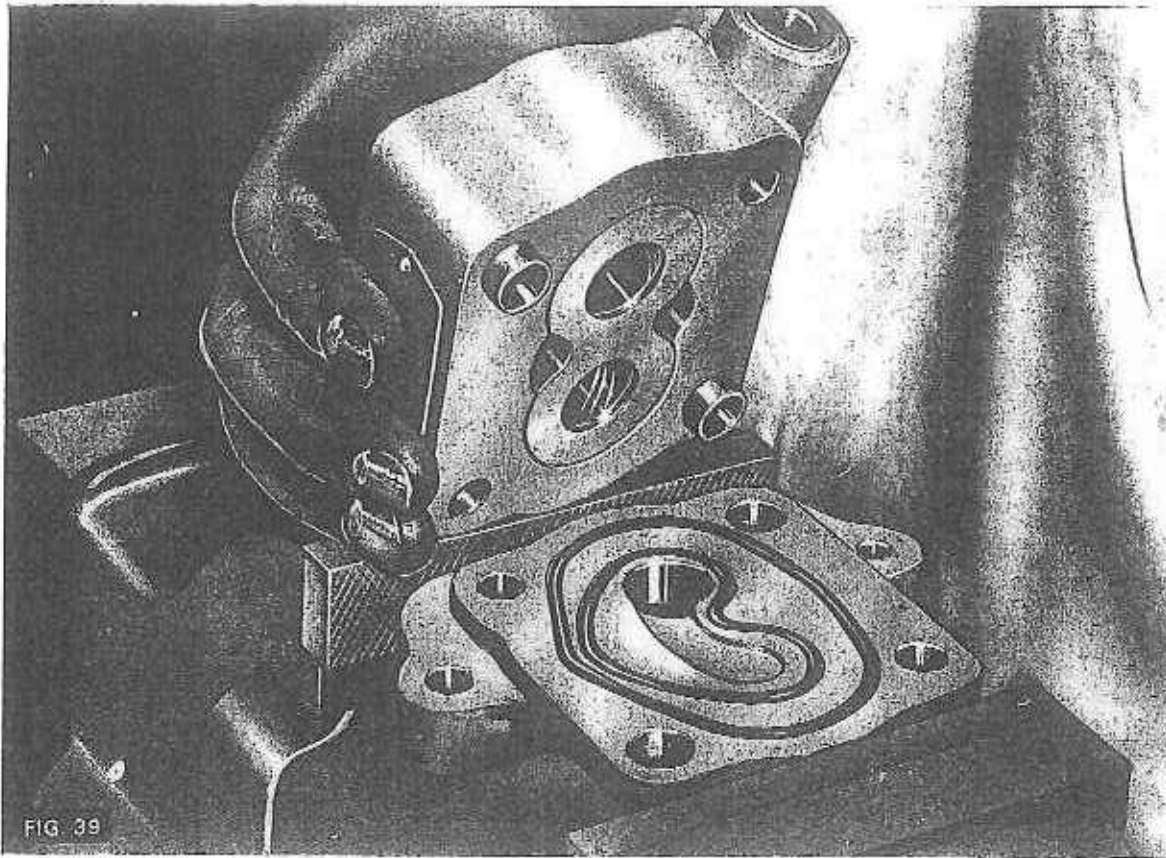


FIG 39

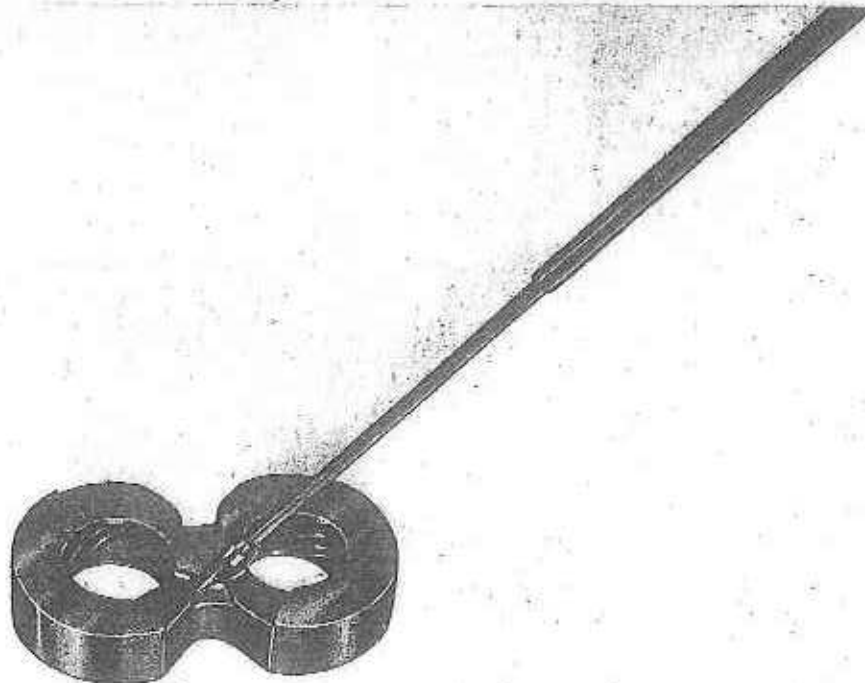
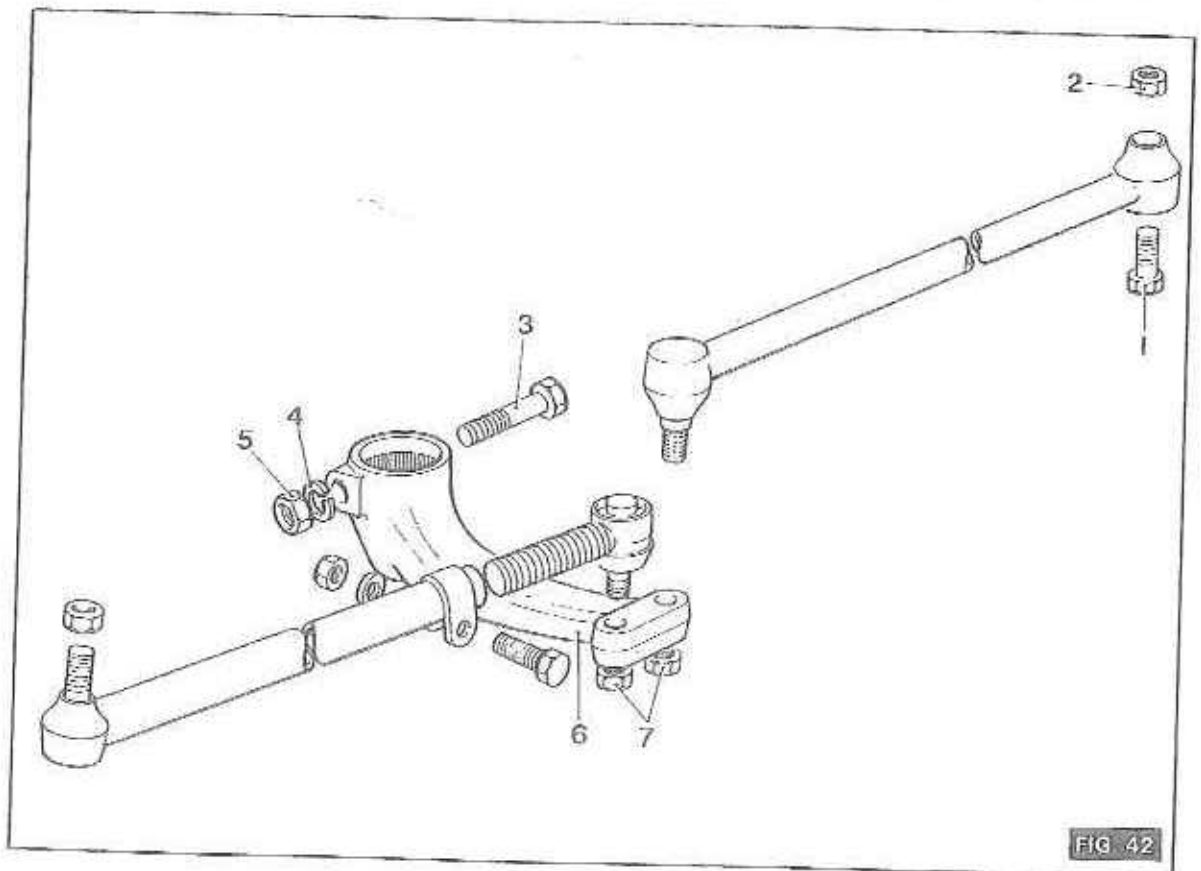
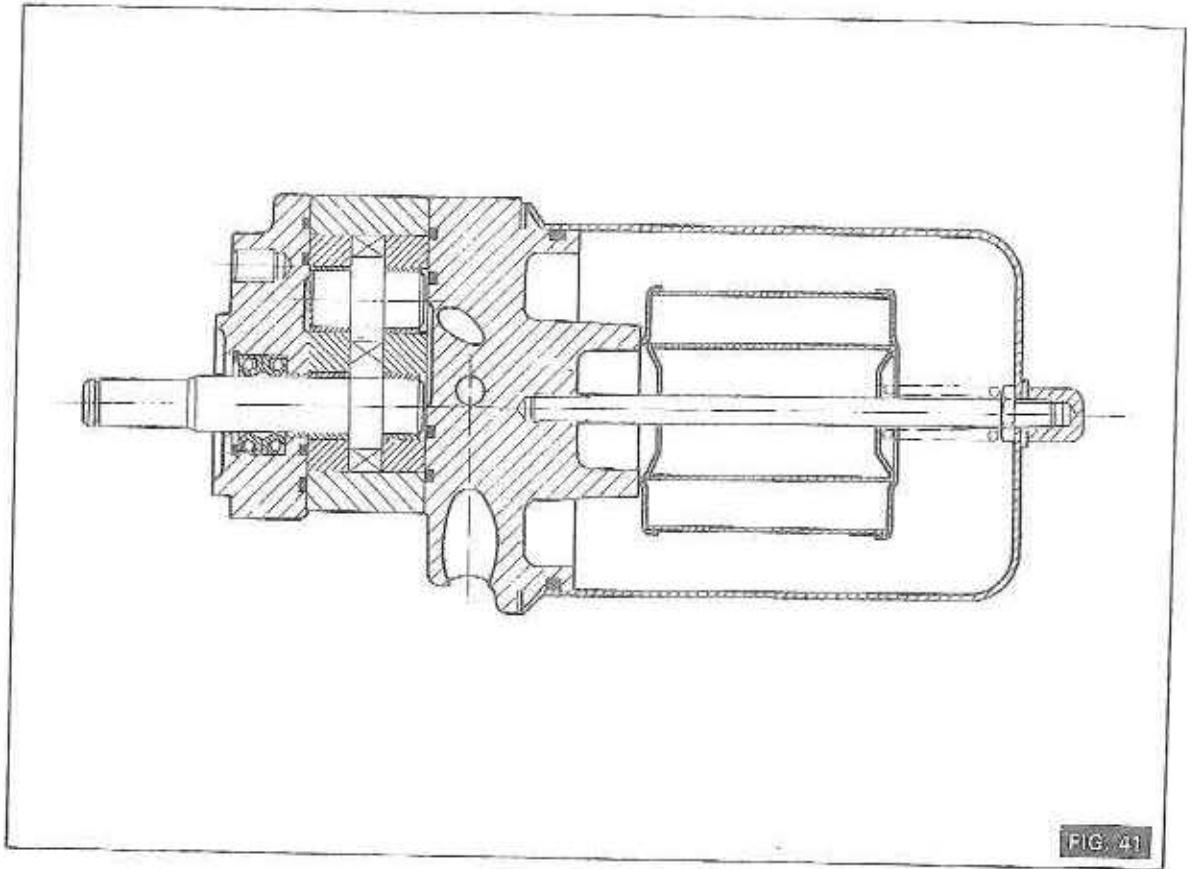
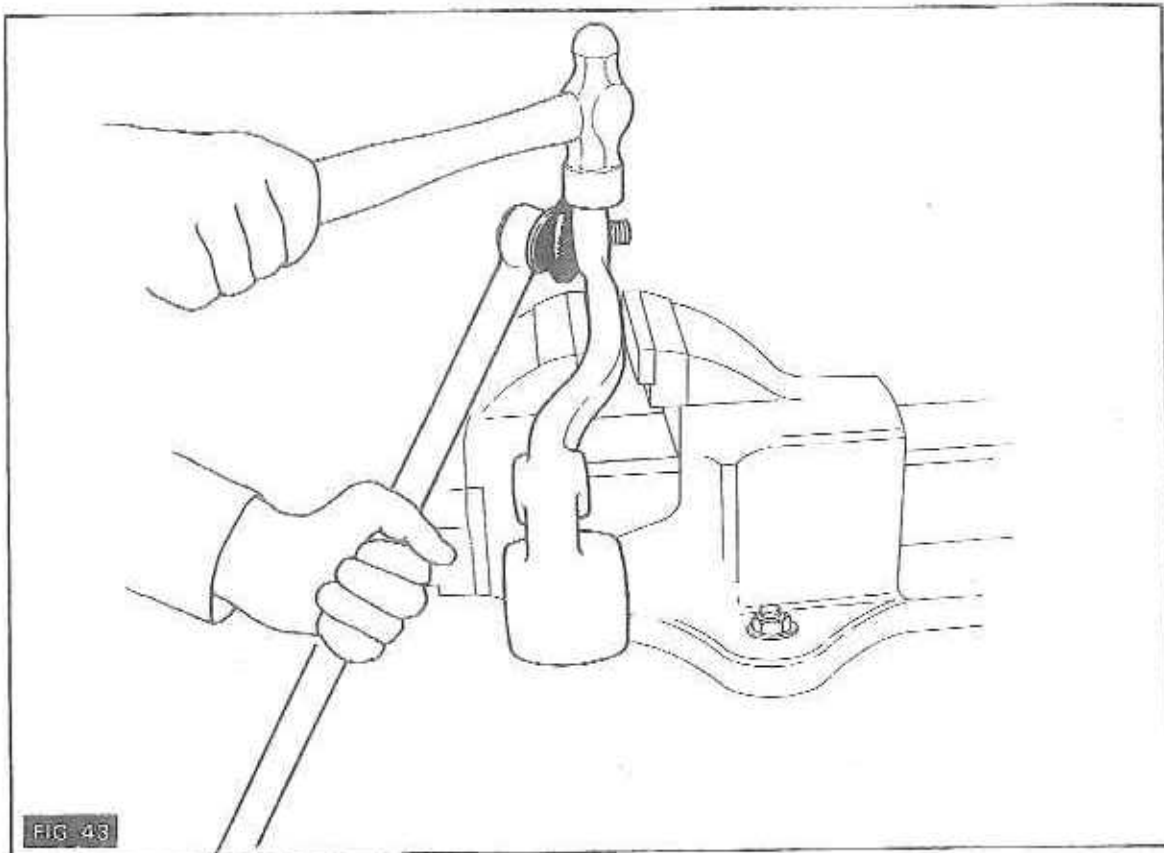


FIG 40





STANDARD TRANSMISSION



CONTENTS

	PAGE
GENERAL	4
TRANSMISSION FROM ENGINE REMOVAL 6A/1	4
TRANSMISSION TO ENGINE REPLACEMENT 6A/2	5
MAIN DRIVE SHAFT AND RETAINER—Removal and Refitting 6A/3	5
MAIN DRIVE SHAFT AND RETAINER—Disassembly and Reassembly 6A/4	5
TRANSMISSION ASSEMBLY, Removal 6A/5	5
TRANSMISSION ASSEMBLY, Replacement 6A/6	6
TRANSMISSION DISASSEMBLY, 6A/7	6
A Preparation	6
B Clutch Release	6
C Shift Rails and Forks	7
D Epicyclic Reduction Unit	7
E Main Drive Shaft and Retainer	7
F Mainshaft	7
G Countershaft	7
H Reverse Idler Gear and Shaft	7
J Bearings	8
TRANSMISSION REASSEMBLY 6A/8	8
A Reverse Idler Gear and Shaft	8
B Countershaft	8
C Mainshaft	8
D Main Drive Shaft and Retainer	9
E Epicyclic Reduction Unit	9
F Shift Rails and Fork	9
G Clutch Release	9
GEAR SHIFT LEVER, Disassembly and Reassembly 6A/9	9
HIGH/LOW GEAR SHIFT LEVER, Disassembly and Reassembly 6A/10	10

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	GENERAL ARRANGEMENT OF STANDARD TRANSMISSION	4
2	CLUTCH RELEASE MECHANISM, Removal	5
3	DRIVE SHAFT RETAINER, Removal	5
4	MAIN DRIVE SHAFT, Breakdown	6
5	MAIN DRIVE SHAFT SEAL, Replacement	6
6	SELECTOR FORKS AND SHAFTS, Breakdown	7
7	EPICYCLIC REDUCTION UNIT, Breakdown	7
8	MAINSHAFT, Breakdown	8
9	MAINSHAFT, Removal	8
10	COUNTER SHAFT, Breakdown	8
11	REVERSE IDLER GEAR, Breakdown	8
12	BEARINGS, Removal	9
13	BEARING RETAINER	9
14	GEAR SHIFT LEVERS, Section	9

PART 6 SECTION A

MF WORKSHOP SERVICE MANUAL 1457 087 M1

TRANSMISSION STANDARD

General

The transmission assembly provides three forward gears and one reverse gear. An additional lower range of gears is obtained from a planetary reduction unit. This combination produces a total of six forward gears and two reverse gears.

There are two gear levers — the gear shift lever for the change speed gears, and the dual range selector lever for the reduction unit. The three forward gears and one reverse gear are indicated by cast figures on the top of the gear shift lever. The high, start (neutral) and low ranges of the dual range selector lever are also indicated by letters on the lever. The dual range selector lever must be in its start (neutral) position to close the starter motor circuit and so allow the tractor to be started. Low or high range must be selected before the tractor will move. When low range is engaged, the reduction unit is also engaged and effects a 4:1 reduction of all transmission speeds.

The reduction unit is coupled to the rear (output) end of the transmission main shaft. The planet pinion carrier assembly rotates inside a ring gear which is bolted to the transmission housing. When the reduction unit is disengaged (dual range selector lever in high), the main drive through the tractor is coupled directly to the transmission mainshaft. When the reduction unit is engaged (dual range selector lever in low), the main drive through the tractor is coupled to the planet carrier assembly, and the drive is through the planet gears.

DATA

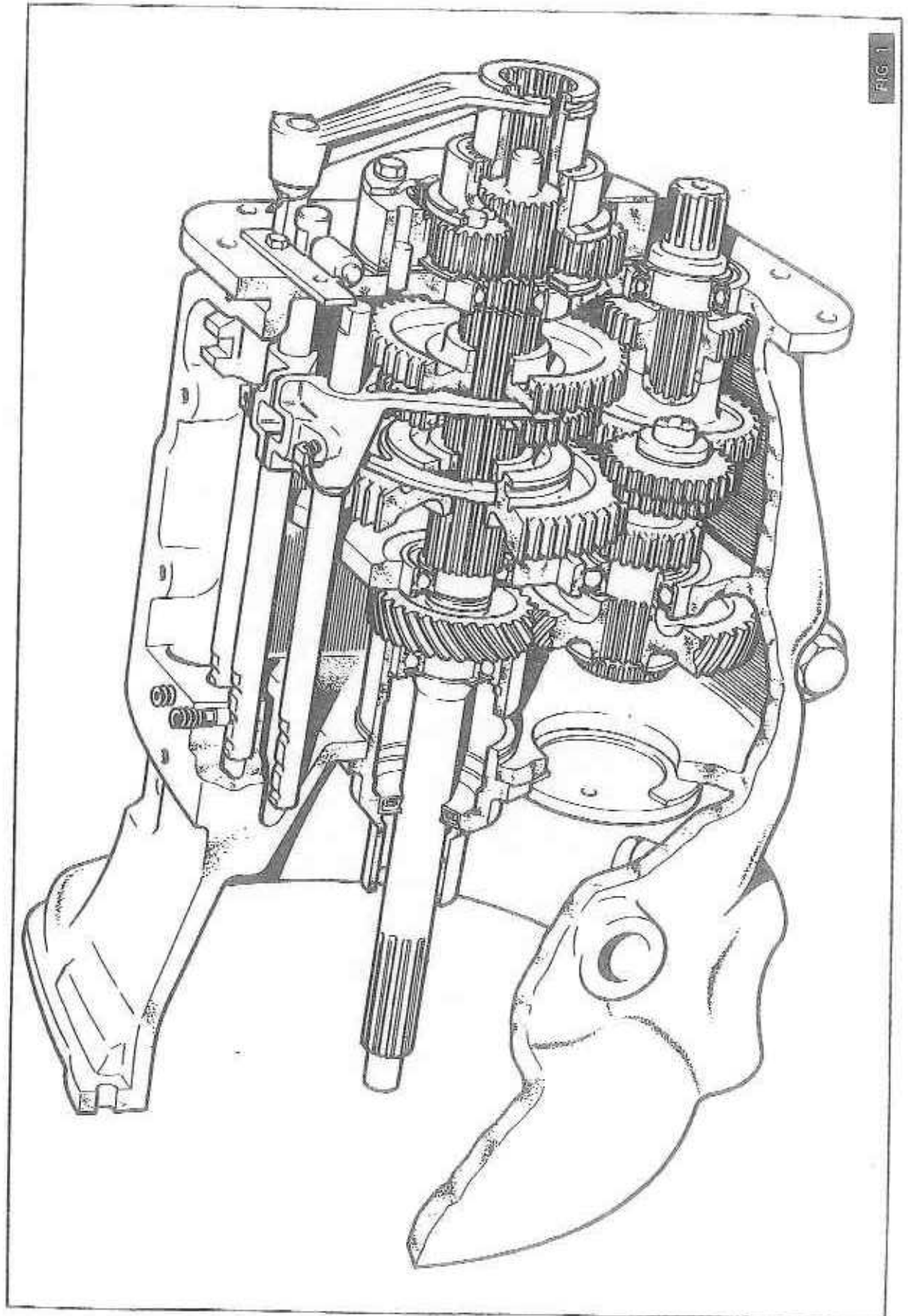
Number of forward speeds	6
Number of reverse speeds	2
Reduction unit ratio	4:1
Oil Capacity includes transmission, centre housing and rear axle	6.5 imp. galls. (7.8 U.S. Galls., 29.54 L.)

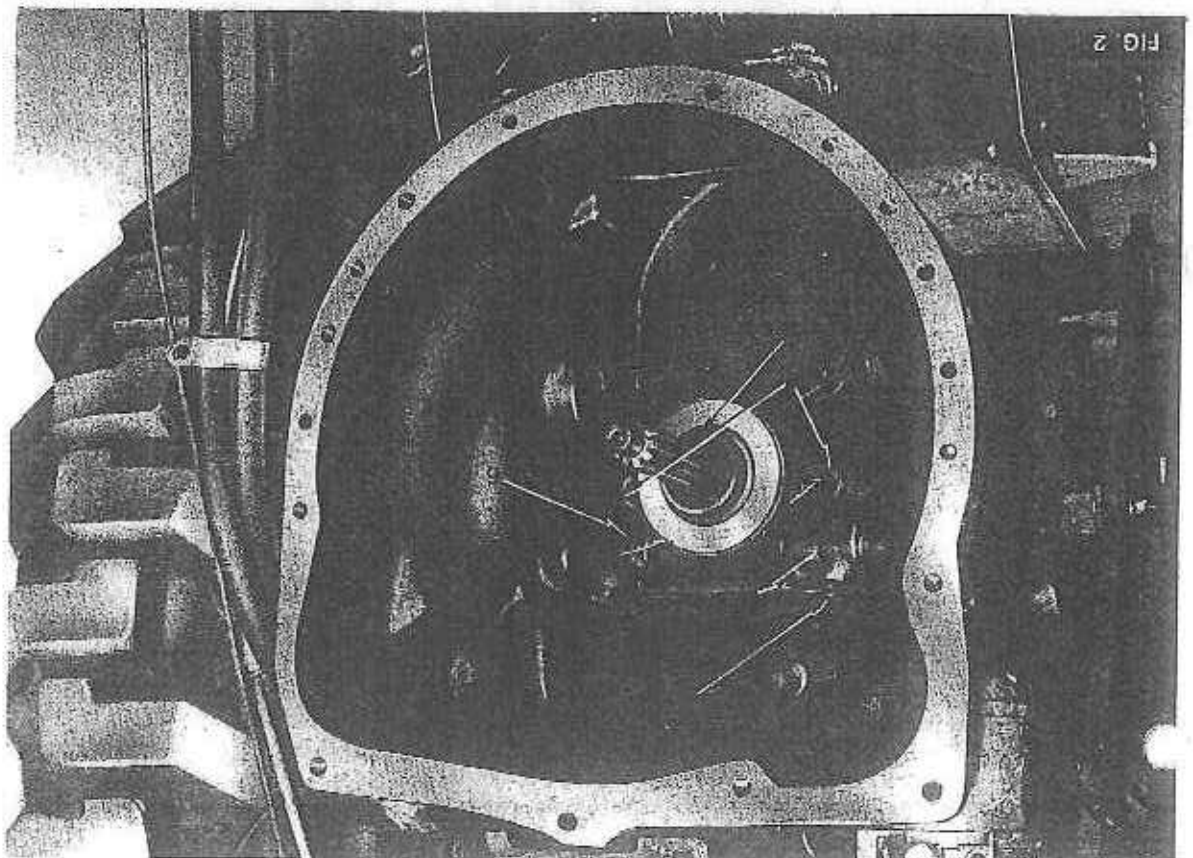
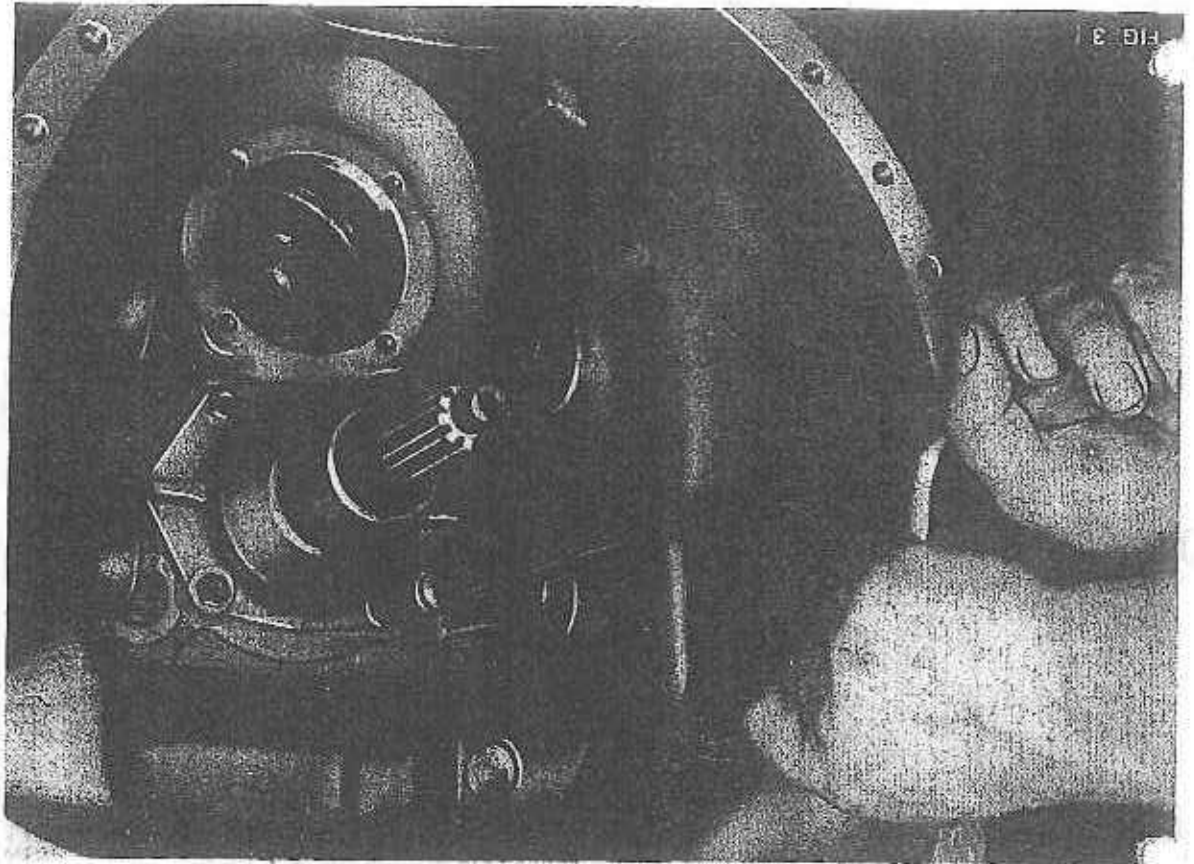
TRANSMISSION FROM ENGINE

Removal

(6A/1)

1. Remove the hood assembly.
2. Insert wooden wedges between the upper side of the axle and the axle support casting.
3. Remove the drag link from the steering box drop arm.
4. Release the fuel tank rear mountings.
5. Position the rails of dismantling stand MF 27X and support the engine sump and transmission housing on rail trolleys.
6. Disconnect the battery leads.
7. Disconnect the wiring from the thermostart, starter motor, alternator, horn, lights and neutral safety switch.
8. Disconnect heater hoses at water pump.
9. Disconnect the water temperature gauge wire, oil pressure, gauge pipe, tachourmeter cable, tube for the air filter restriction indicator, fuel sender unit wire.
10. Disconnect the fuel cut off cable.
11. Release all harness securing clips.
12. Switch off the fuel and disconnect the fuel pipes at the injection pump.
13. Disconnect the fuel pipe between primary and secondary fuel filters.
14. Disconnect the throttle control rod from the injection pump.
15. Remove the starter motor.
16. Remove two bolts and spring washers securing the steering box to the engine.
17. Remove the bolts securing the engine to the transmission housing.
18. Push the rear part of the machine out of engagement with the engine.
19. Fit support stand MF 27G to the front of the transmission housing and secure with two bolts each side.





TRANSMISSION TO ENGINE

Replacement

(6A/2)

1. Support the transmission on a rail trolley.
2. Remove support stand MF 27G from the front of the transmission housing.
3. Wedge the rear part of the fuel tank in a slightly raised position.
4. Align the transmission with the engine then using guide studs join the two halves together.
5. Bolt the engine to the transmission housing and refit the starter motor.
6. Replace the two bolts and washers securing the steering box to the engine.
7. Remove the wedge from under the fuel tank and bolt the fuel tank to the tank support bracket.
8. Reconnect the fuel pipe between the primary and secondary fuel filters and the fuel pipes at the injection pump.
9. Reconnect the throttle rod at the injection pump, fuel cut-off cable, tachourmeter cable, oil pressure pipe, water temperature gauge wire and blockage indicator tube.
10. Reconnect the wiring to the thermostat, alternator, starter motor, horn, lights, fuel sender unit and neutral safety switch. Connect battery leads.
11. Secure wiring harness with clips.
12. Reconnect the heater hoses at the water pump.
13. Fit the drag link back onto the drop arm.
14. Remove the wooden wedges from between the axle and the axle support casting then remove the rail trolley.
15. Replace the hood.
16. Switch on the fuel and bleed the fuel system.
17. Top up the radiator with water.

MAIN DRIVE SHAFT AND RETAINER UNIT

Removal and Refitting

(6A/3)

1. Split the machine between the engine and transmission as stated in operation 6A/1.
2. (Fig. 2) Release the two springs (1) securing the release bearing carrier (2) then slide the carrier and bearing assembly off the input shaft retainer (3).
3. Release the locking wire (4) and remove the two locking pegs (5) from the clutch release shafts and fork (6).
4. Remove the clutch release shafts and forks.
5. (Fig. 3) Remove the four bolts securing the main drive shaft retainer then remove the main drive shaft and retainer assembly, complete with gasket.
6. Replacement is a reversal of the above procedure.

Disassembly and Reassembly

(6A/4)

1. Remove the drive shaft and retainer as described in operation 6A/3.
2. (Fig. 4) Remove the snap ring (1) that secures the bearing and drive shaft assembly (2) to the retainer (3).
3. Drive the shaft with its bearing out of the retainer.
4. Extract the snap ring (4).
5. Carefully remove the oil seal (5) from the retainer.
6. Reassembly is a reversal of the above procedure. Using tool MF 179 and handle 550 to replace the oil seal. (Fig. 5).

Note

When reassembling the main input shaft with the retainer, use tool MF 177 to protect the oil seal.

TRANSMISSION ASSEMBLY

Removal

(6A/5)

1. Split the machine between engine and transmission as stated in operation 6A/1.

TRANSMISSION ASSEMBLY

Removal . . . Cont'd

2. Drain off the oil in the transmission and centre housing.
3. Remove steering wheel as described in operation 5B/1.
4. Unscrew the four bolts which secure the instrument panel and bulkhead to the fuel tank support frame.
5. Lift the complete instrument panel and bulkhead from the steering column.
6. Remove the fuel tank support frame.
7. Remove the steering box and column from the top of the transmission case.
8. Disconnect the clutch pedal operating rod from the clutch release shaft.
9. Disconnect both the left and right hand brake operating shafts.
10. Unbolt and remove the brake pedal stop from the top of the transmission case.
11. Remove the three nuts from the studs which secure the brake and clutch lever assembly to the underside of the transmission housing and lower the complete assembly to the floor.
12. Support the centre housing on a trolley jack.
13. Support the transmission housing with suitable lifting gear then remove the bolts which secure the transmission housing to the centre housing.
14. Push rear part of machine out of engagement with the transmission.
15. Fasten support stands MF 27G to the front and rear of the housing.

Replacement

(6A/6)

1. Support the transmission assembly with suitable lifting gear and remove the stands MF 27G.
2. Fit the rear drive shaft to the gearbox then the shear tube to the rear drive shaft.
3. Push the centre housing into engagement with the transmission, simultaneously aligning the shear tube splines into the rear axle pinion splines.
4. The end float between the rear drive shaft and the mainshaft must be governed to 0.015" to 0.100" (0.38 mm to 2.54 mm) by fitting the split pin to the appropriate hole in the shear tube.
5. Bolt the transmission to the centre housing.
6. Fit the brake and clutch lever assembly to the underside of the transmission case and secure with the three studs and nuts.
7. Connect the brake linkage and clutch operating rods.
8. Replace the brake pedal stop onto the transmission housing.
9. Refit the steering box and column to the housing cover.
10. Bolt the tank support frame to the steering box.
11. Replace the instrument panel and bulkhead over the steering column and secure to the fuel tank support frame.
12. Replace steering wheel as described in operation 5B/1.
13. Reassemble the engine to transmission as stated in operation 6A/2.
14. Refill the transmission and centre housing with a recommended oil.
15. Check the brakes and clutch, adjust if necessary.

TRANSMISSION

Disassembly

(6A/7)

A Preparation

1. Remove the transmission assembly from the machine and fix onto stands as stated in operation 6A/5.
2. Remove the main drive shaft and retainer unit as stated in operation 6A/3.
3. Remove the transmission cover complete with shift levers (for removal of levers from cover see operations 6A/9 and 6A/10).

B Clutch Release

1. Remove clutch release bearing, shafts and fork as stated in operation 6A/3.

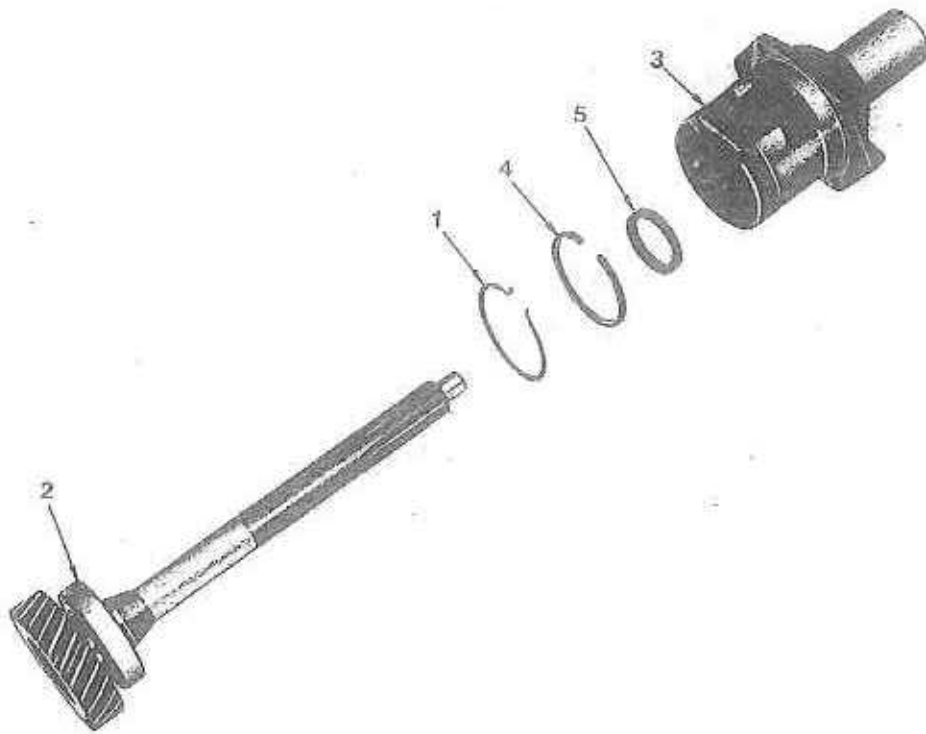


FIG. 4

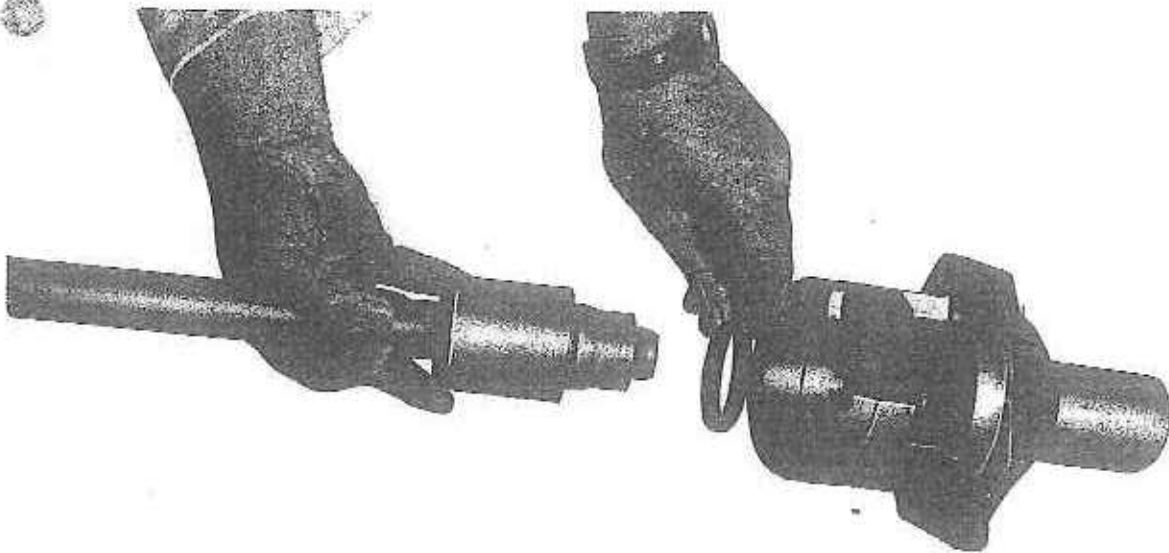
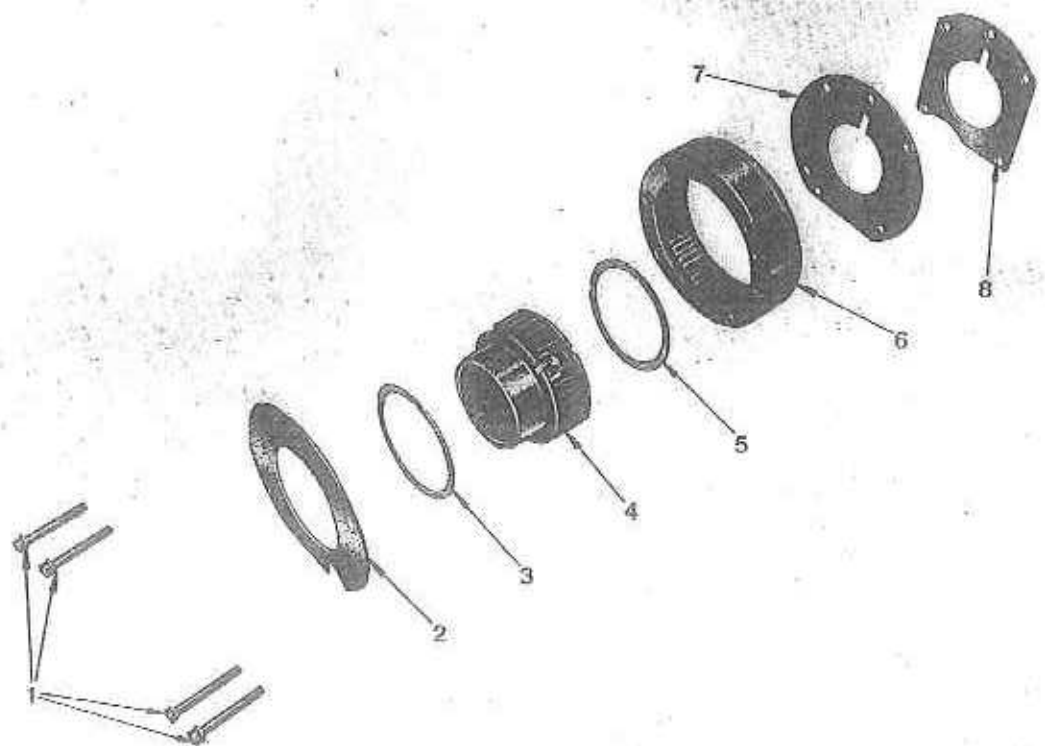
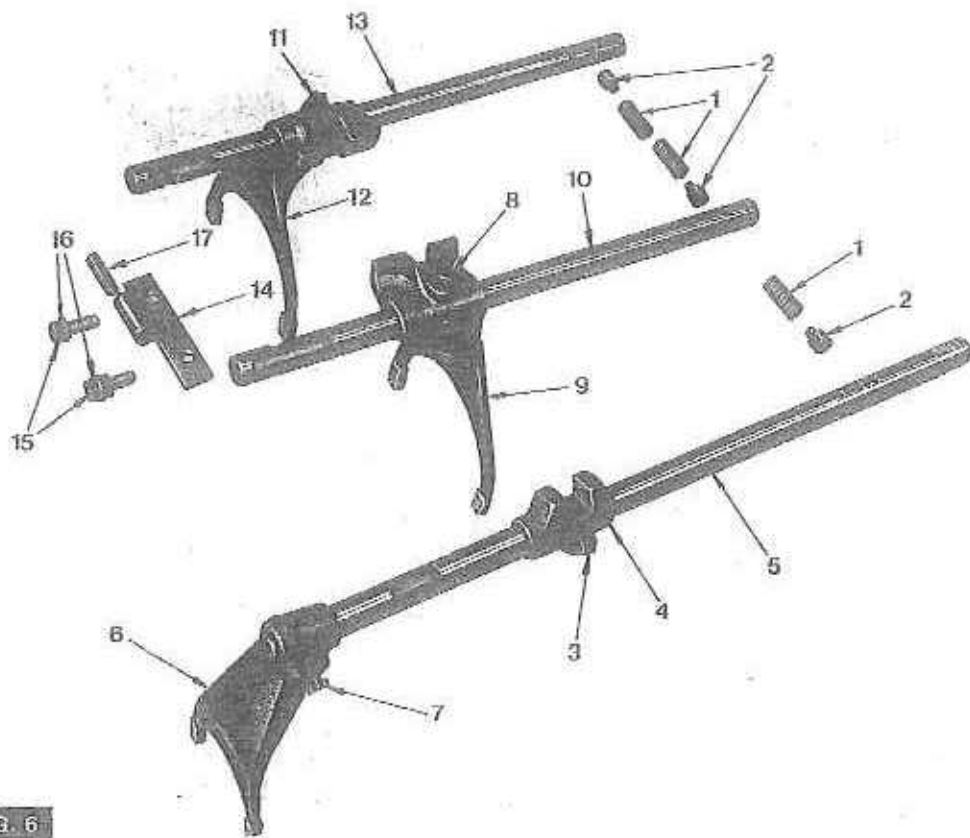


FIG. 5



TRANSMISSION

Disassembly . . . Cont'd

C Shift Rail and Forks

1. (Fig. 6) Remove the locking wire from the 1st/Rev. shift rail (10), the 2nd/3rd shift rail (13), and from the rear end of the high/low shift rail (5).
2. Remove the locking peg (7) from the high/low shift fork (6), detach the fork and coupler (4).
3. Remove the gear lever stop plate (14) and interlock (17), by unscrewing the two bolts (16) and spring washers (15).
4. Lift out the three shift rail springs (1) and plungers (2).
5. Remove the locking pegs (8) (11) from the 1st/Rev. fork (9) and the 2nd/3rd fork (12).
6. Slide the 1st/Rev. shift rail (10) and the 2nd/3rd shift rail (13) rearwards out of the transmission housing. Lift out the 1st/Rev. shift fork (9) and the 2nd/3rd shift fork (12).
7. Release the locking wire and remove the locking peg (3) from the high/low shift selector (4).
8. Slide the high/low shift rail (5) rearwards out of the transmission housing then lift out the high/low shift selector (4).

D Epicyclic Reduction Unit

1. (Fig. 7) Remove the four bolts and spring washers (1) which secure the unit to the rear of the transmission housing.
2. Remove the rear cover plate (2) thrust washer (3) planet pinion carrier assembly (4), planet ring gear (5), thrust washer (6), front cover plate (7) and shim (8).

E Main Drive Shaft and Retainer Unit

1. Remove and disassemble unit as described in operations 6A/3 and 6A/4.

F Mainshaft

1. (Fig. 8) Remove the snap ring (1) from the front end of the mainshaft.
2. (Fig. 9) Suitably wedge the mainshaft 1st and 2nd/3rd gears and drive the mainshaft rearwards out of its front bearing.
3. (Fig. 8) Withdraw the mainshaft (2) with its rear bearing. (3).
4. Lift out the mainshaft, 1st gear (4) and 2nd/3rd gear (5).
5. Remove main shaft front bearing (6).

G Countershaft

1. Remove the countershaft cover by removing the 4 securing bolts.
2. (Fig. 10) Remove the snap ring (1) from the front end of the countershaft (2).
3. Slide the constant mesh gear (3) off the front of the countershaft and lift out the gear.
4. Remove the snap ring (4) from the rear end of the countershaft forwards out of its rear bearing.
5. Lift out the countershaft (2) with its front bearing (6) then lift out the countershaft 2nd gear (7) and 3rd gear (8).
6. Remove the countershaft rear bearing (5).

H Reverse Idler Gear and Shaft

1. (Fig. 11) Release the tabwasher (1), then remove the bolt (2) and reverse shaft stop (3).
2. Withdraw the reverse shaft (4) slightly rearwards. Insert a dummy shaft 1" dia. by 2½" long (25.4 mm x 55.56 mm), into the front of the reverse shaft bore and push out the reverse shaft rearwards with the dummy shaft. This enables the reverse cluster gear assembly to be removed without dropping the 56 bearing rollers (5).

TRANSMISSION

H Reverse Idler Gear and Shaft . . . Cont'd

3. Lift out the reverse cluster gear assembly with spacer (6), washer (7), washer (8) and dummy shaft.
4. The reverse cluster gear (9) is dismantled by removing the spacer (6) washer (7), washer (8), dummy shaft, roller retainers (10), 56 rollers (5) and roller spacer (11).

J Bearings

1. (Fig. 12) Press the bearings off the mainshaft, countershaft, main drive shaft using multi-purpose bearing remover/replacer tool MF 220-25 and press.

Reassembly

(6A/8)

A Reverse Idler Gear and Shaft

1. (Fig. 11) Assemble to the reverse idler gear (9) the roller spacer (11), 56 rollers (5) (using grease to retain them), roller retainers (10), dummy shaft, washer (7), washer (8) and spacer (6). Ensure the spacer (6) is next to the larger gear.
2. Position the reverse roller gear assembly into the transmission housing with the larger gear to the rear.
3. Push the shaft (4) through the gear (9) and remove the dummy shaft.
4. Fit the reverse shaft stop (3) to the slot in the shaft and secure with the bolt (2) and tabwasher (1).

B Countershaft

1. (Fig. 10) Position the countershaft 2nd gear (7) and 3rd gear (8) into the transmission housing with their bosses together. The smaller 2nd gear fits to the rear.
2. Fix the countershaft (2) with its front bearing (6) through the front of the transmission housing and slide the 2nd and 3rd gears onto the splines of the countershaft.
3. Fit the countershaft rear bearing (5) into its bore, attach a suitable bearing retainer plate to the transmission housing (Fig. 13) to prevent the countershaft bearing from being ejected when the countershaft is driven rearwards into this bearing.
4. Drive the countershaft rearwards until the rear snap ring can be fitted to the end of the countershaft.
5. Detach the bearing retainer plate from the rear of the housing and fit the snap ring (4) to the countershaft.
6. Assemble the constant mesh gear (3) (with boss forward) to the splines on the front end of the countershaft.
7. Refit the snap ring (1) to the front end of the countershaft.
8. Refit the countershaft cover securing it with the four bolts.

C Mainshaft

1. (Fig. 8) Fit the mainshaft front bearing (6) to its housing. The shield must face forward.
2. Place the mainshaft 1st gear (4) and 2nd/3rd gear (5) in position. The bosses must be together.
3. Fit the mainshaft (2) with its rear bearing (3) through the rear of the transmission housing and assemble the mainshaft 1st and 2nd/3rd gears to their splines on the mainshaft.
4. Assemble the main drive shaft retainer assembly as stated in operation 6A/4 temporarily refit the assembly and secure with the four bolts. This will retain the mainshaft front bearing when the mainshaft is driven forwards into the front bearing.
5. Remove the mainshaft rear bearing outer snap ring and drive the mainshaft forwards into its front bearing until the mainshaft front snap ring (1) can be fitted to its groove.
6. Remove the main drive shaft and retainer assembly.
7. Fit the snap ring (1) to the front end of the shaft.
8. Refit the mainshaft rear bearing outer snap ring.

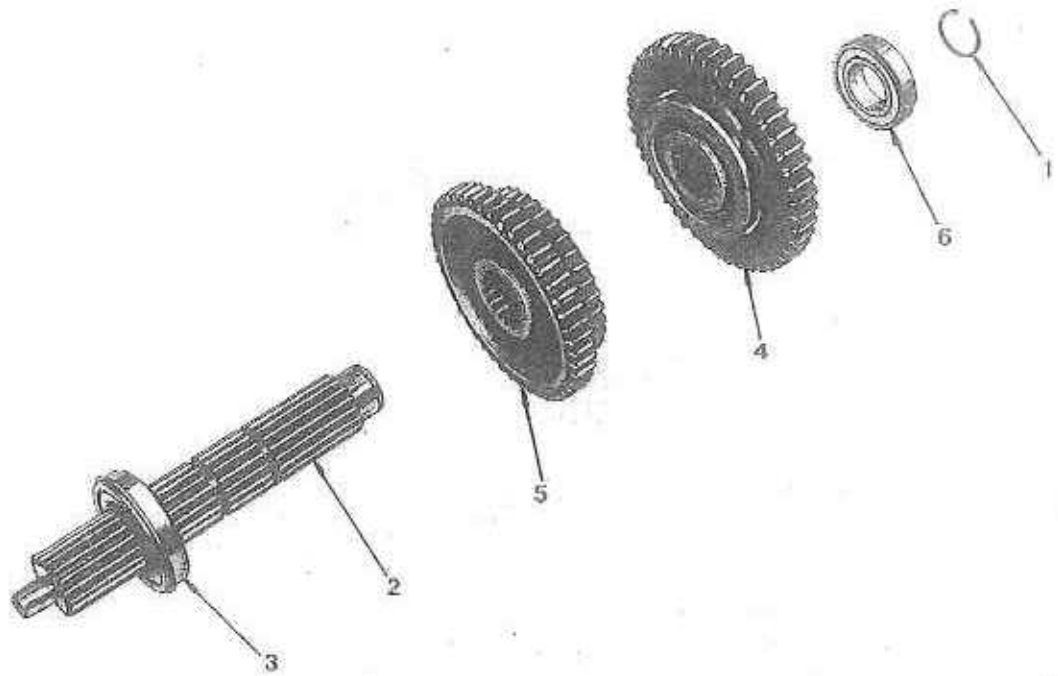


FIG. 8

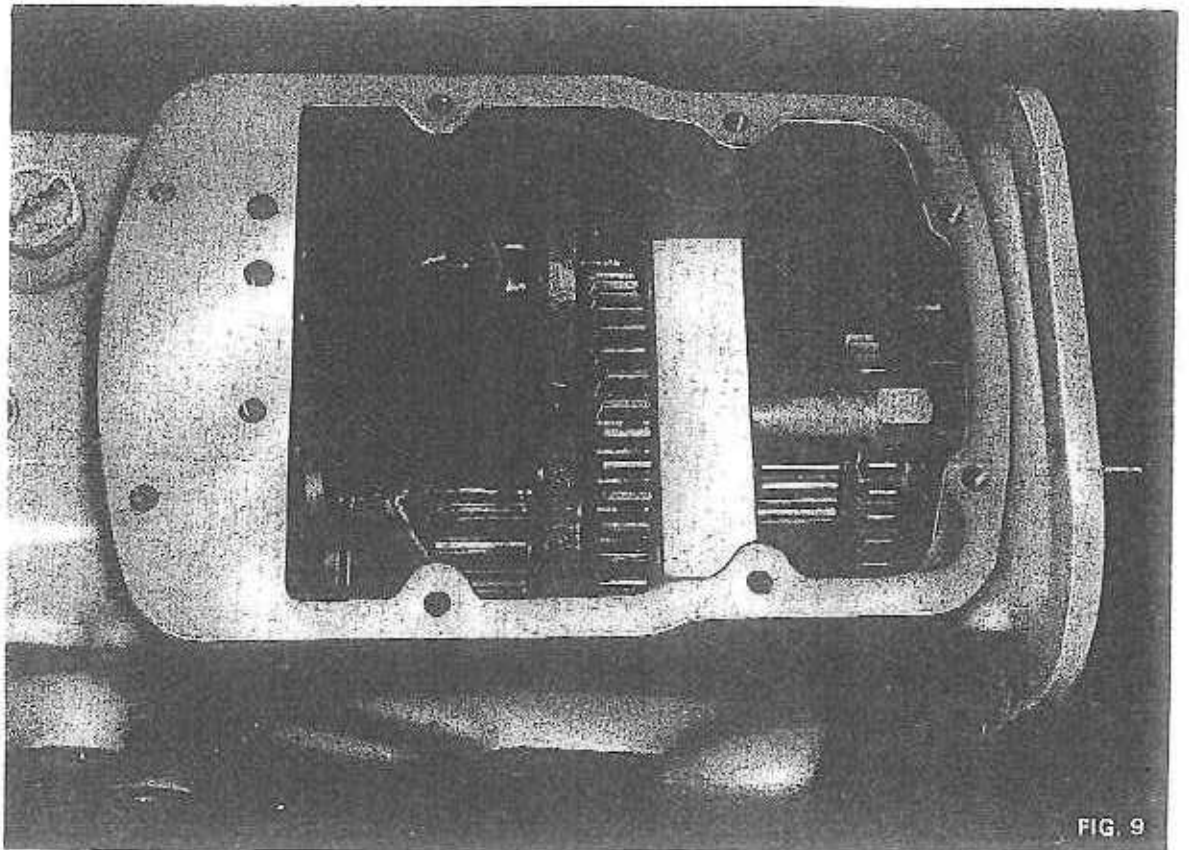
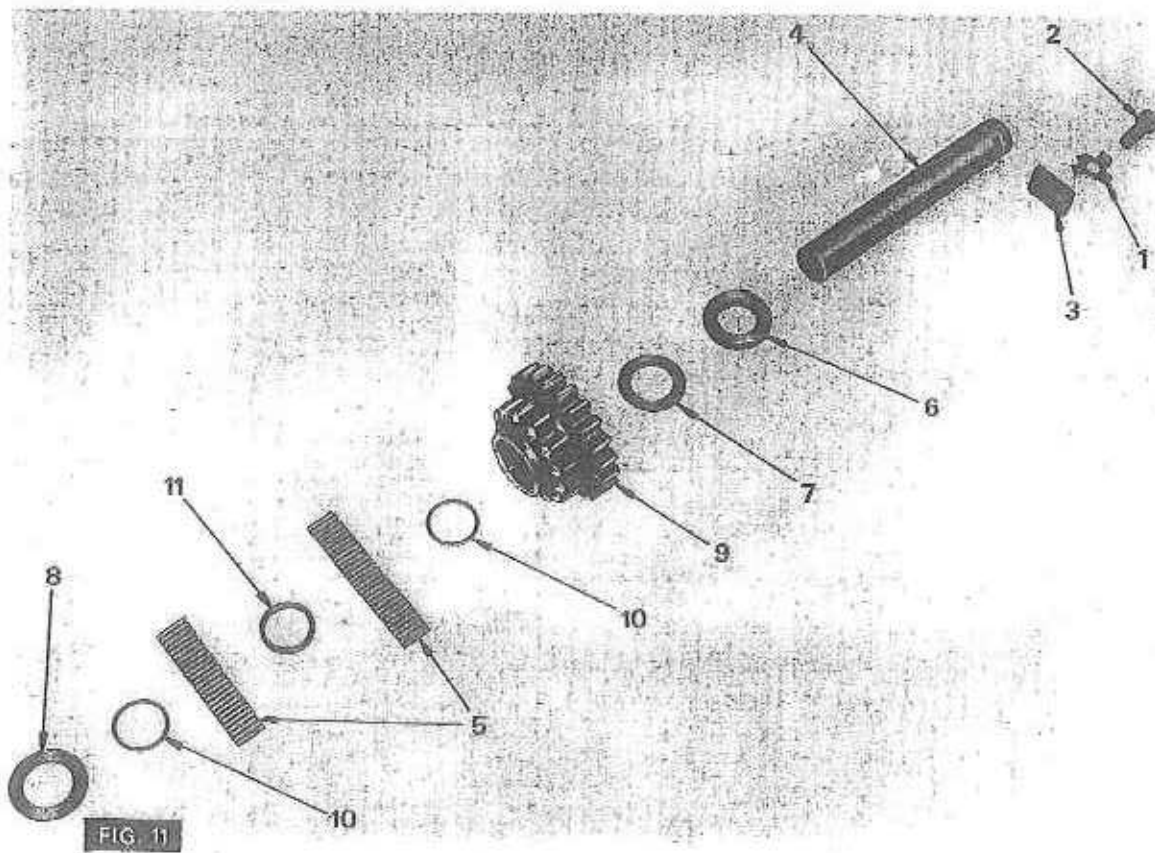
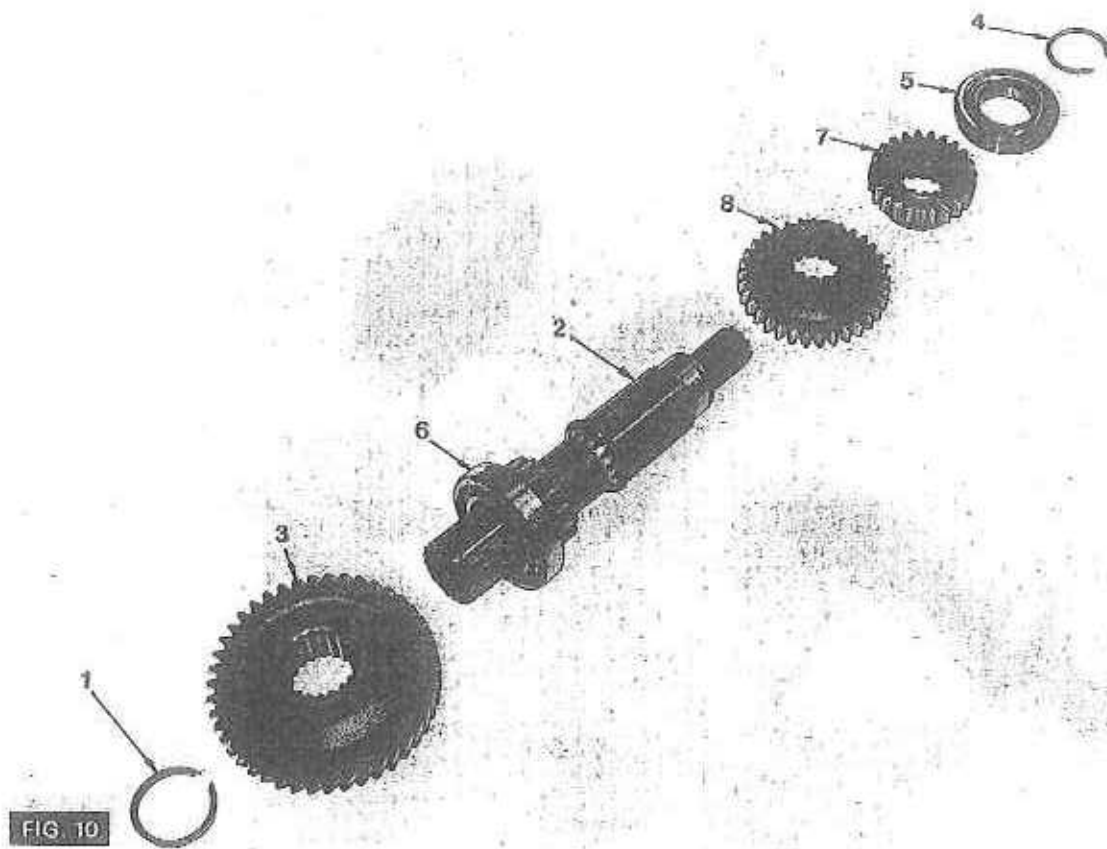
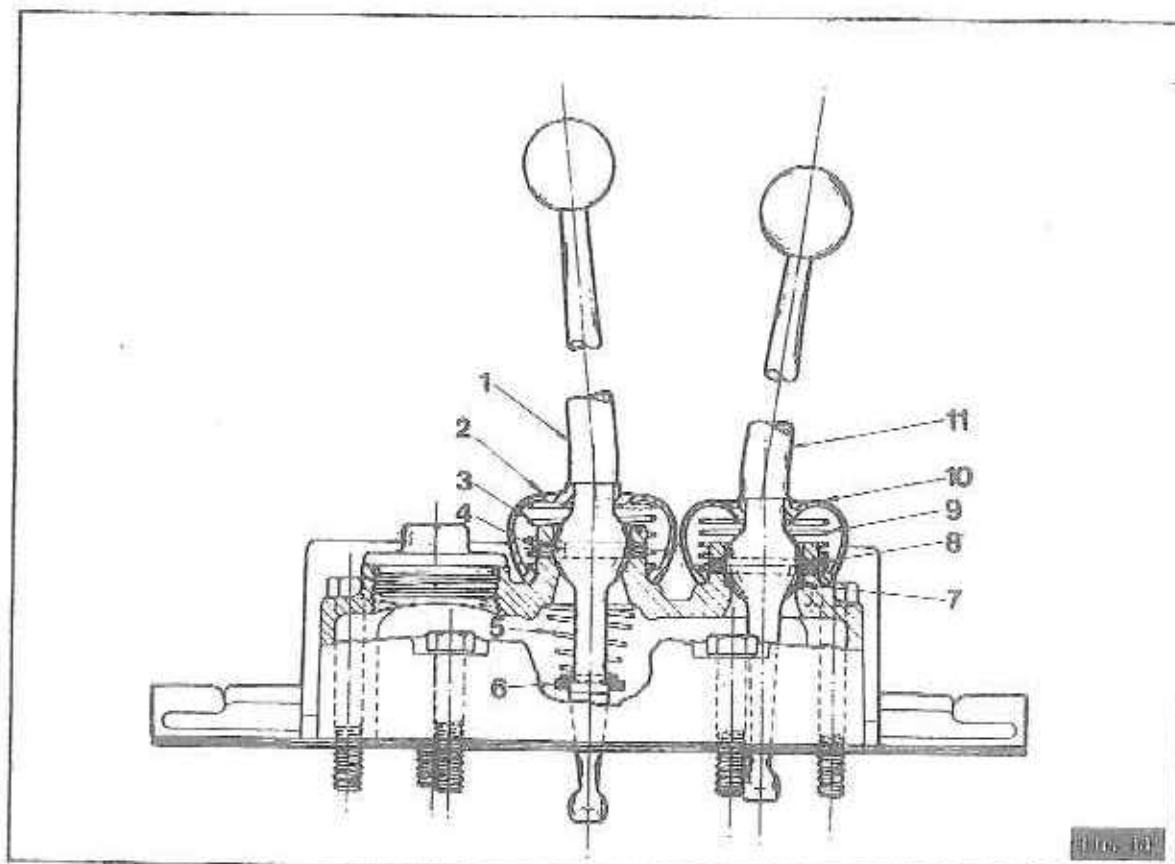
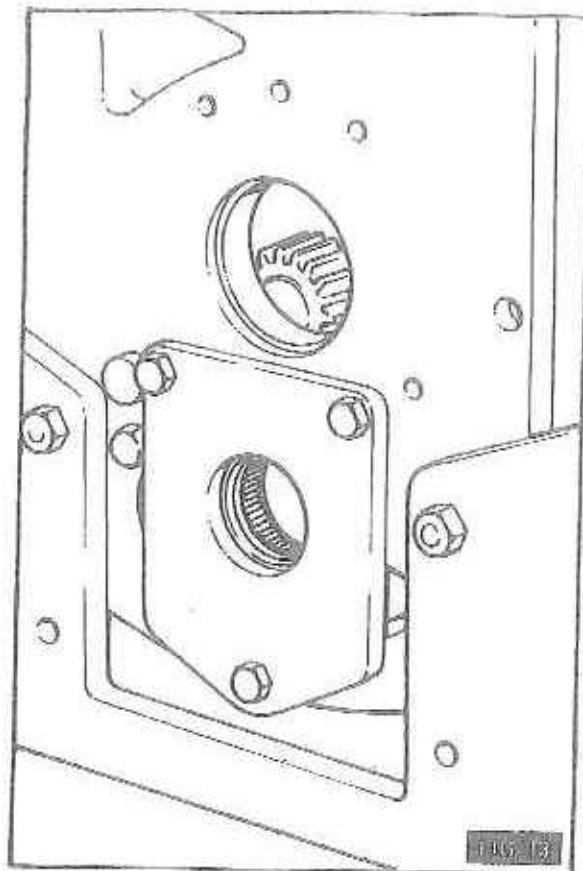
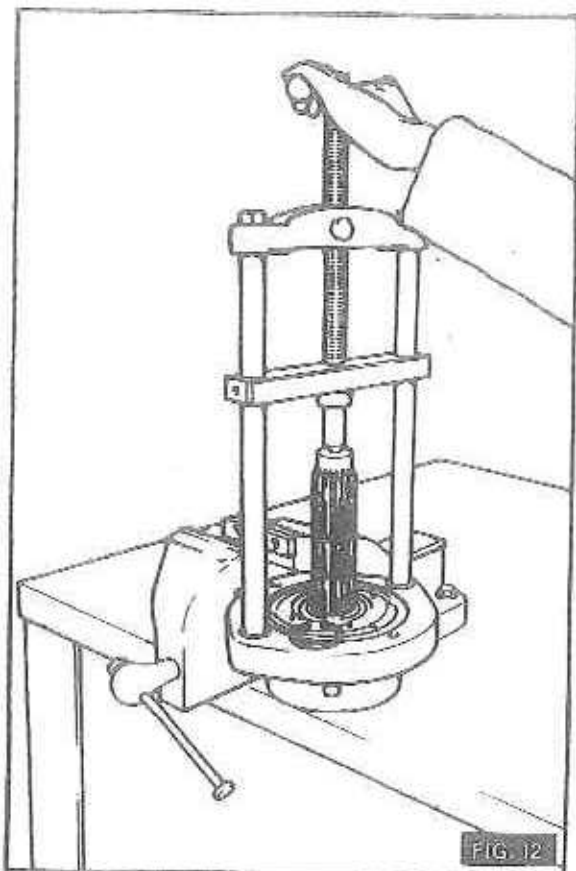


FIG. 9







TRANSMISSION

Reassembly ... Cont'd

D Main Drive Shaft and Retainer Unit

1. Reassemble and refit as described in operation

E Epicyclic Reduction Unit

1. (Fig. 7) Fit the front thrust washer (6), front cover plate (7) and shim (8) to the planet ring gear (5). Ensure that the grooved face on the front cover face is to the rear.
2. Position the ring gear, dowel located, to the rear face of the transmission housing. Ensure that the front thrust washer is located into its groove in the ring gear.
3. Fit the planet pinion carrier assembly (4) to the ring gear.
4. Assemble the rear thrust washer (3) to the carrier and the rear cover plate (2) to the ring gear. Ensure that the grooved face on the rear cover plate is facing forwards.
5. Secure the epicyclic reduction unit with four bolts and spring washers (1).

F Shift Rails and Forks

1. (Fig. 6) Fit the high/low shift rail (5), slide the high/low shift selector (4) onto the rail and secure with a locking peg (3). Wire lock the peg to the rail.
2. Locate the 1st/Rev. shift fork (9) and the 2nd/3rd shift fork (12) to their respective grooves in the main-shaft gears. The two forks are identical.
3. Assemble the 1st/Rev. shift rail (10) and 2nd/3rd shift rail (13) with interlock pin grooves facing each other, to the forks. Secure each fork with its locking peg (8) (11). Wire lock the pegs to the rails. The shorter 2nd/3rd shift rail (13) is fitted to the left hand side.
4. Locate the high/low shift fork (6) to the groove in the coupler. Assemble the coupler into the planet pinion carrier assembly, simultaneously sliding the fork (6) onto the high/low shift rail (5).
5. Secure the high/low shift fork (6) to its rail with the locking peg (7). Wire lock the peg to the rail.
6. Fit interlock pin (17) to the stop plate (14) and secure the stop plate with two bolts (15) and spring washers (16).
7. Fit the three plungers (2) (pointed and downwards) and the three springs (1).

G Clutch Release

1. Fit the clutch release shafts and fork as described in items 2-4 in operation 6A/3.

When transmission assembly is complete replace the transmission into the machine as stated in operation 6A/6.

GEAR SHIFT LEVER

Disassembly and Reassembly

(6A/9)

1. Remove the steering box as described in operation 5B/3.
2. Remove the eight bolts securing the transmission cover to the transmission housing, then lift the cover complete with levers off the machine.
3. (Fig. 14) Release and remove the spring retaining seat (6) from the lower end of the gear lever (1) then remove the spring (5).
4. Remove the gear lever rubber cover (2) and spring (3) fitted under the cover.
5. Drive out the pin (4) securing the gear lever (1) to its housing.
6. Lift out the gear lever (1).
7. Reassembly is a reversal of the above procedure.

TRANSMISSION

HIGH/LOW RANGE GEAR SHIFT

Disassembly and Reassembly

6A/10

1. Remove transmission cover as in items 1 and 2 of operation 6A/9.
2. (Fig. 14) Remove the rubber cover (10) and spring (9), fitted under the cover.
3. Lift out the lever (11) and 'O' ring (7).
4. Reassembly is a reversal of the above procedure.

CLUTCH

2

25

CONTENTS

	PAGE
GENERAL	4
CLUTCH UNIT, Removal 6B/1	4
CLUTCH UNIT, Replacement 6B/2	4
CLUTCH UNIT, Disassembly 6B/3	4
CLUTCH UNIT, Reassembly 6B/4	5
CLUTCH RELEASE LEVERS, Adjustment 6B/5	6
CLUTCH PEDAL, Adjustment 6B/6	6

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	GENERAL ARRANGEMENT	4
2	THREE 1/4" U.N.C. SLAVE BOLTS, Fitting	4
3	CLUTCH UNIT, Breakdown	4
4	THREE 5/16" U.N.C. SETSCREWS, Release	5
5	CLUTCH UNIT, Reassembly	5
6	CLUTCH UNIT, Reassembly	5
7	CLUTCH RELEASE LEVERS, Adjustment	5
8	CLUTCH PEDAL, Adjustment	6

CLUTCH

General

A heavy duty single clutch 12" diameter is used on the MF 50B Fig.1. The primary plate is operated by a pressure plate against the flywheel.

Pressure plate movement is obtained by three clutch release levers which, when the clutch pedal is depressed, causes the pressure plate to move rearwards against spring pressure and break the drive from the engine to the transmission.

DATA

Friction Disc Diameter	12" (30.48 cm.)
Coil Springs	
Number	12
Colour	Red
Fitted Load	117 lb $\pm$ 5% (53.07 kg. $\pm$ 5%)
Free Length (approx.)	2.32" (58.93 mm.)
Release Levers	
Height From Flywheel Face	4.406" / 4.469" (111.912 / 113.513 mm.)
Clutch Pedal	
Free Movement	1" (2.54 cm.)
Measured between Clutch Pedal and rear of floorplate slot	

WARNING

SPRING PRESSURE WILL CAUSE THE CLUTCH COVER TO FLY APART IF PRESSURE IS NOT RELEASED SLOWLY AND EVENLY. THE GIVEN SEQUENCE OF INSTRUCTIONS MUST BE CAREFULLY FOLLOWED.

CLUTCH UNIT

Removal

(6B/1)

1. Split the machine between transmission and engine as described in operation 6A/1.
2. (Fig. 2) Fit three slave bolts 1/4" U.N.F. by 2 1/8" (53.98 mm) to the three equispaced holes in the clutch cover plate.
3. Progressively slacken and remove the six bolts that secure the clutch assembly to the flywheel. Detach the complete clutch assembly from the flywheel.
4. If necessary the clutch release mechanism in the bell housing of the transmission case, can be serviced as stated in operations 6A/3 and 6A/4.

Replacement

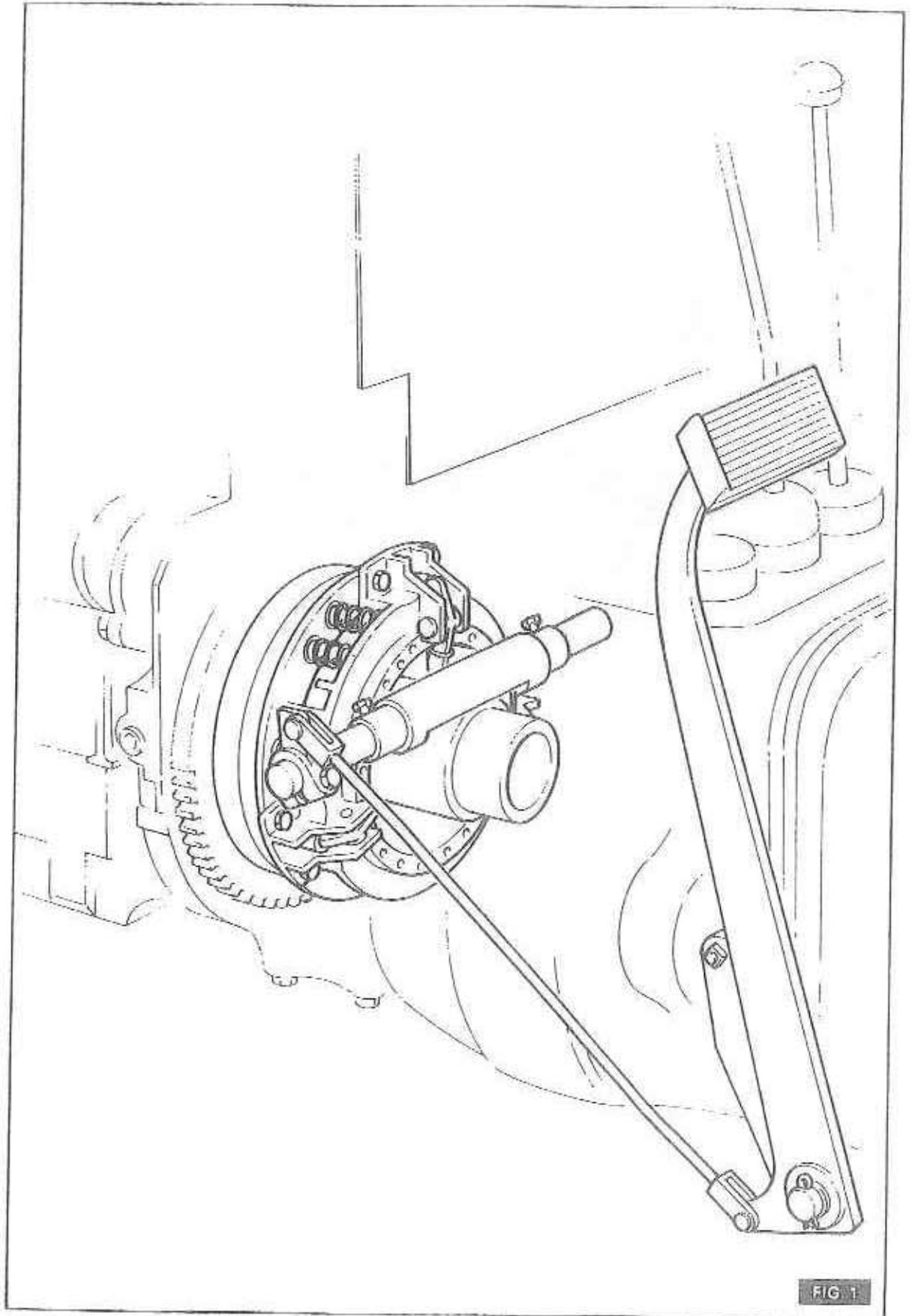
(6B/2)

1. Fit the friction disc to the flywheel with the splined boss falling away from the flywheel. A very slight smear of H.M.P. grease should be applied to the friction disc splines.
2. Position the clutch assembly onto the flywheel and centralise the assembly and friction disc with centralising tool MF 159A.
3. Fit the six bolts and washers securing the clutch to the flywheel and progressively tighten the bolts.
4. Remove the three 1/4" U.N.C. slave bolts and then the centralising tool.

Disassembly

(6B/3)

1. Remove the clutch assembly from the flywheel as stated in operation 6B/1
2. Release the three tab washers and remove the six bolts which secure the flywheel to the engine and lift off the flywheel.



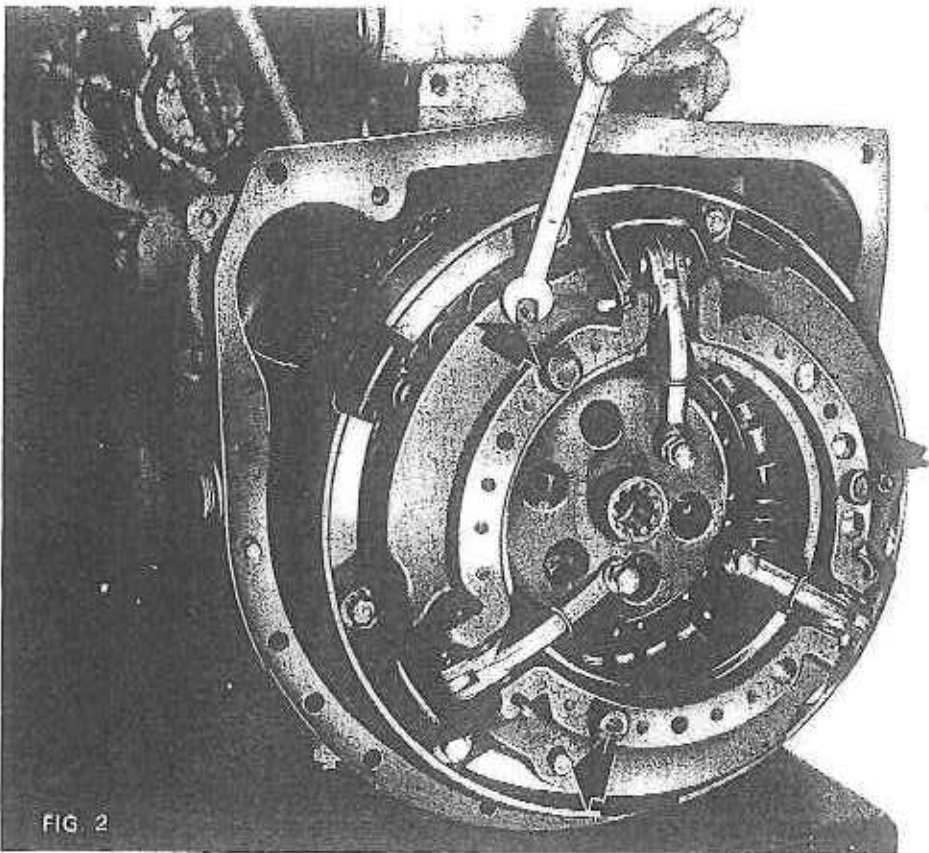


FIG. 2

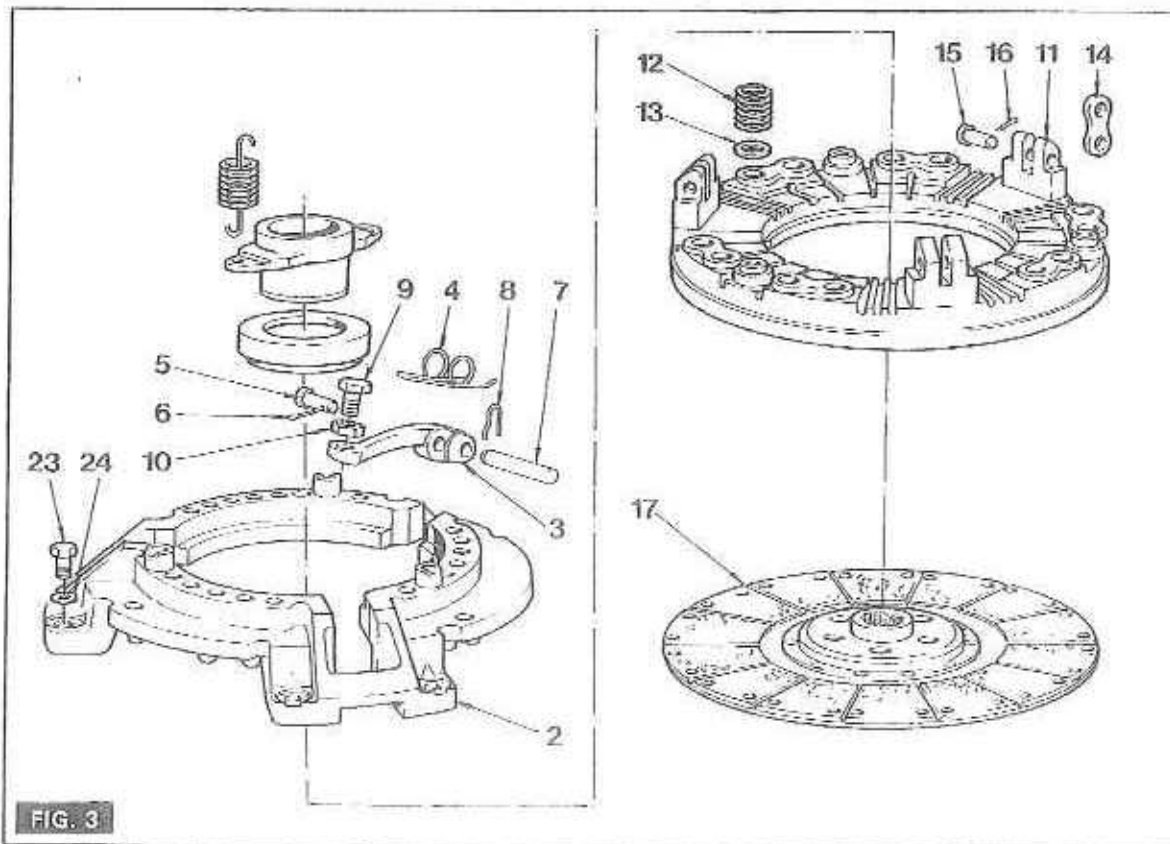


FIG. 3

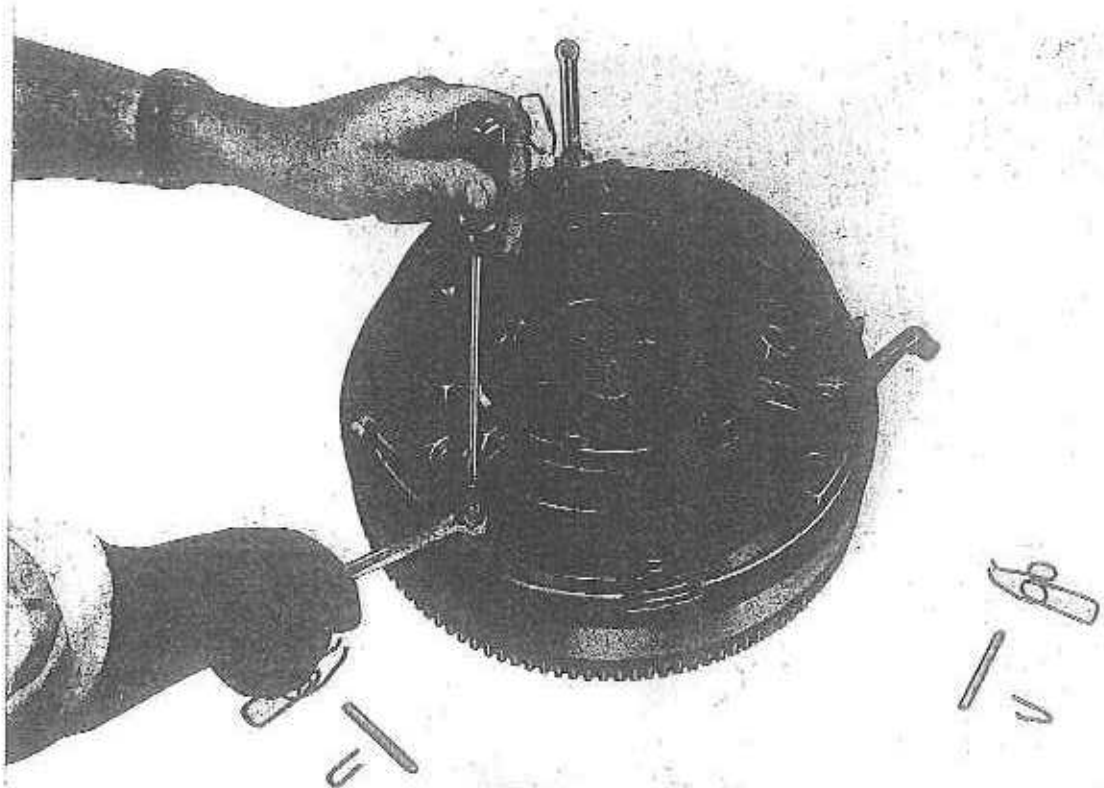


FIG. 4

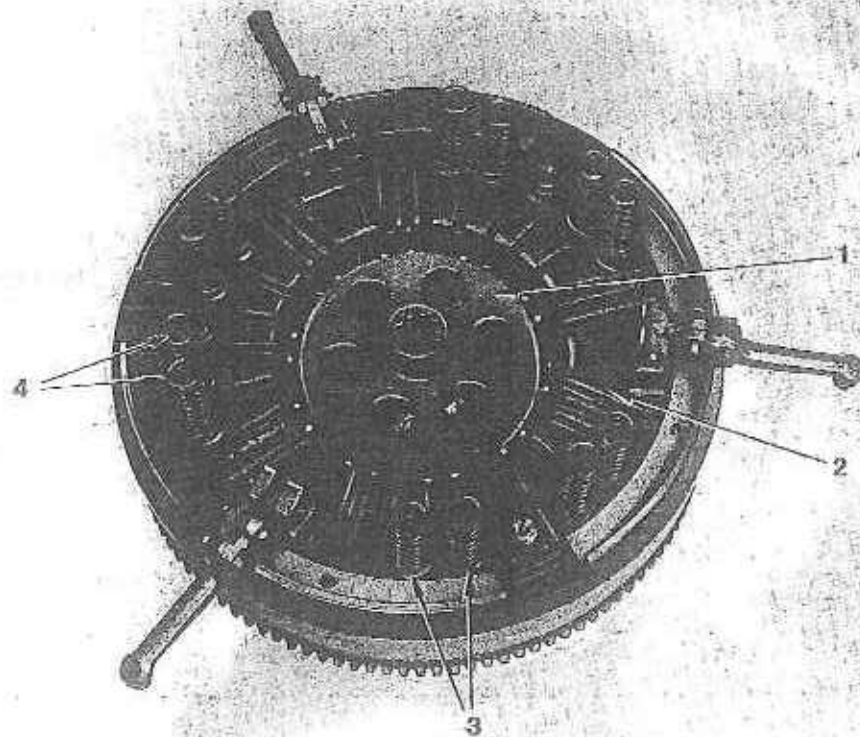
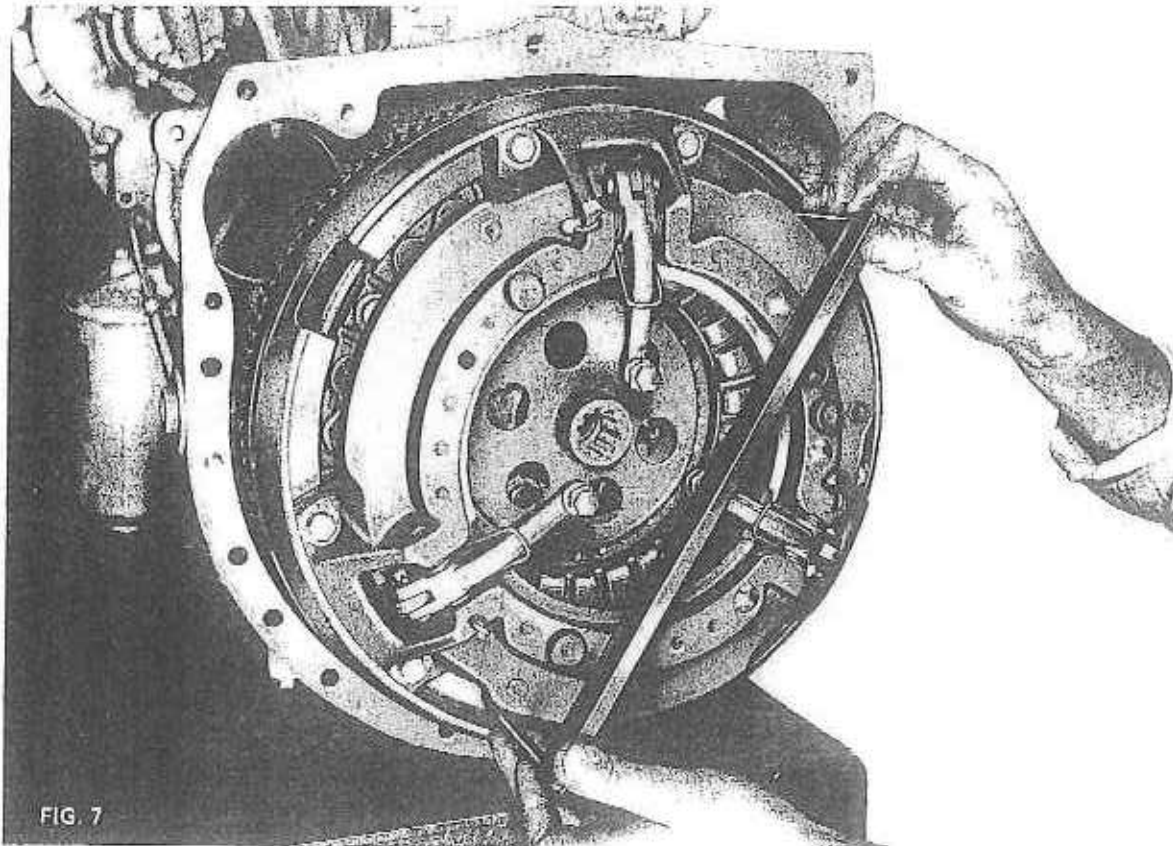
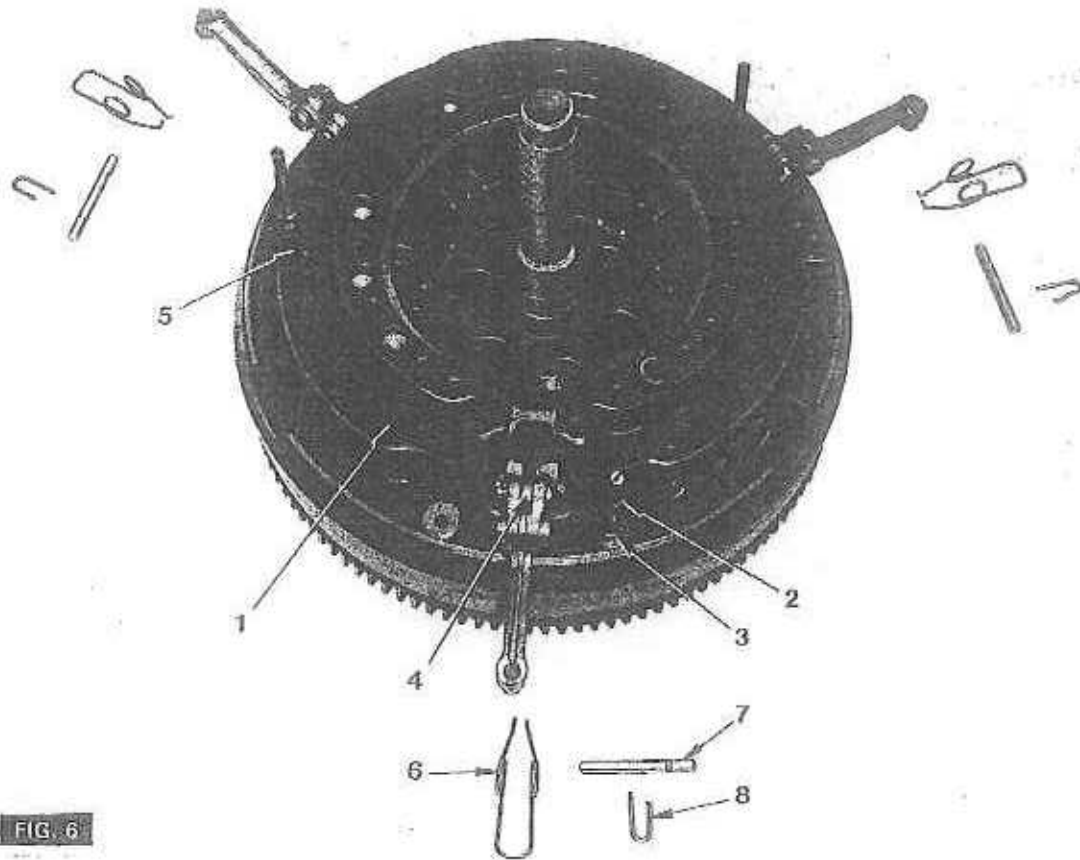


FIG. 5



CLUTCH UNIT

Disassembly . . . Cont'd

3. (Fig. 3) Mark the cover plate (2) and pressure plate (11) so that they can be reassembled in the same relative position.
4. Fit the friction disc (17) and the clutch assembly to the flywheel using three setscrews 5/16" U.N.C. by 3 1/4" (82.55 mm) equispaced in three of the six holes in which the clutch to flywheel bolts were fitted.
5. Screw in the setscrews as far as possible and secure each setscrew with a locknut.
6. Remove the clips (8) which secure the release lever pivot pins (7) and remove the pivot pins.
7. Remove the release lever securing springs (4).
8. Progressively slacken and remove the three 1/4" U.N.C. slave bolts.
9. (Fig. 4) Progressively slacken the three 5/16" U.N.C. locknuts two flats at a time until all spring pressure has been released. Remove the three slave setscrews.

Note

Spring pressure can also be released by using a press. Proceed as follows :—

Mount the clutch assembly on the press cover plate upwards and position a suitable bar across the centre of the cover plate, clear of the release levers. Compress the clutch assembly until the three 1/4" U.N.C. slave bolts can be removed, then gradually release the press.

10. (Fig. 3) Remove the following components. Cover plate (2), twelve coil springs (12), twelve washers (13), three release levers (3), pressure plate (11) and drive plate (17).

Reassembly

(6B/4)

1. (Fig. 5) Place the friction disc (1) on the flywheel. Ensure that the splined boss faces away from the flywheel.
2. Fit the pressure plate (2) noting the position of the mark.
3. Position the twelve washers (3) onto the pressure plate.
4. Locate the twelve red springs (4) onto the washers.
5. (Fig. 6) Place the cover plate (1) on top of the springs passing the three release levers through the plate. Align the mark on the cover plate with the mark on the pressure plate. Ensure that the coil springs are correctly located.
6. Fit centralising tool MF 159A.
7. Refit the three 5/16" U.N.C. slave setscrews (2), and screw in as far as possible. Fit a locknut (3) to each screw.
8. Progressively tighten the three locknuts ensuring during tightening that the three release lever links (4) do not contact the cover plate.

Note

The clutch springs can also be compressed by using a press. Proceed as follows :—

Mount the clutch assembly on the press, cover plate upwards and position a suitable bar across the centre of the cover plate clear of the release levers. Compress the clutch assembly until the three 1/4" U.N.C. slave bolts can be fitted.

9. Refit and tighten the three 1/4" U.N.C. slave bolts (5).
10. Refit the release lever securing springs (6), locating the ends of the springs into the recesses in the cover plate.
11. Refit the release lever pivot pins (7) and securing clips (8). Locate the clips into the slots in the pivot pins.
12. Remove the centralising tool MF 159A and progressively slacken and remove the three 5/16" U.N.C. locknuts (3) and setscrews (2).
13. Refit the flywheel to the engine. Torque the flywheel bolts to 75 lb. ft. (10.37 Kg.m.).
14. Reattach the clutch assembly to the flywheel as stated in operation 6B/2

CLUTCH RELEASE LEVERS

Adjustment

(6B/5)

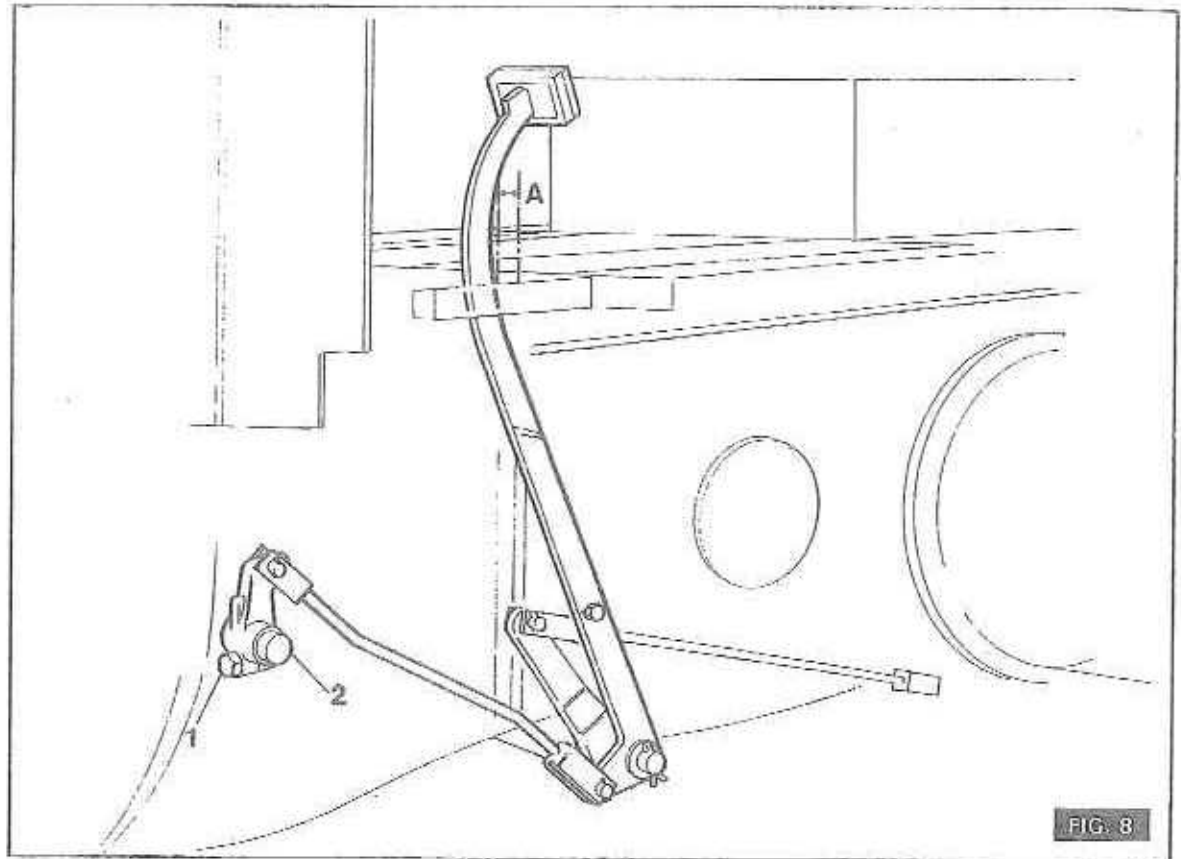
1. (Fig. 7) Fit gauge MF 314 to the clutch assembly as shown and check the height of each release lever. The domed head of the release lever setscrew must be just touching the gauge.
2. If necessary adjust setscrew by slackening the locknut and moving setscrew in required direction. Tighten the locknut after adjustment.

CLUTCH PEDAL

Adjustment

(6B/6)

1. (Fig. 8) Slacken the pinch bolt (1) on the clutch actuating lever.
2. Using a tommy bar rotate the actuating shaft (2) clockwise against the resistance of the internal return springs until all free travel is taken up.
3. Holding the shaft in this position set the pedal lever to dimension 'A'. Dimension 'A' is 1" (2.54 cm.) and tighten the pinch bolt to a torque of 76–85 lb.ft. (10.51–11.76 Kg.m.).





REVERSOMATIC TRANSMISSION

CONTENTS

	PAGE
GENERAL	4
INSTANT REVERSE TRANSMISSION Removal 7A/1	4
INSTANT REVERSE TRANSMISSION Disassembly and Reassembly	5
OIL PUMP Removal And Refitting 7A/2	5
OIL DISTRIBUTION HOUSING Removal and Replacement 7A/3	5
CONTROL VALVE Disassembly and Reassembly 7A/4	6
INSTANT REVERSE TRANSMISSION Disassembly 7A/5	6
INSTANT REVERSE TRANSMISSION Reassembly 7A/6	6
CLUTCH PACKS AND SHAFTS Disassembly 7A/7	7
OUTPUT SHAFT Reassembly 7A/8	8
INPUT SHAFT Reassembly 7A/9	8
CLUTCH DRUM Reassembly 7A/10	8
CLUTCH PACKS Reassembly 7A/11	9
CLUTCH PACK ASSEMBLY To Check End Float 7A/12	9
OIL FILTER Removal and Refitting 7A/13	10
OIL COOLER UNIT Removal and Refitting 7A/14	10
THE TWO SPEED GEARBOX Disassembly 7A/15	11
MAINSHAFT Removal 7A/16	11
COUNTERSHAFT BEARING Removal 7A/17	11

LIST OF ILLUSTRATIONS

Figure	Facing Page
1 General Arrangement, Instant Reverse Transmission	4
2 Transmission Case Stand	4
3 Transmission Oil Pump, Removal	5
4 Transmission Sump, Removal	5
5 Clutch Selector Levers, Removal	5
6 Oil Distribution Housing, Removal	5
7 Transmission Sump, Bolt Tightening Sequence	5
8 Clutch Control Valve, Disassembly	6
9 Countershaft and Reverse Idler, Shaft Removal	6
10 Countershaft Gear, Removal	7
11 Special Tool, Removal of Countershaft Gear	7
12 Clutch Pack Assembly, Removal	7
13 Countershaft, Reassembly	8
14 Reverse Idler Gear, Reassembly	8
15 Clutch Pack, Removal of Input Shaft	8
16 Forward Clutch Thrust Washer, Removal	8
17 Forward Clutch Retaining Circlip, Removal	8
18 Forward Clutch Drum, Disassembly, Special Tool MF 244	8
19 Forward Clutch Drum, Disassembly	8
20 Reverse Clutch Cover, Removal	8
21 Clutch Plates, Checking Wear	8
22 Reverse Clutch Cover And Gear Assembly, Replacement	8
23 Thrust Washer to Output Shaft, Replacement	8
24 Removal of Clutch Drum to Replace Retaining Circlip	9
25 Retaining Circlip, Replacement	9
26 Clutch Cover Retaining Circlip, Replacement	9
27 Forward Clutch Drum, Replacement	9
28 Input Shaft and Clutch Cover, Replacement	9
29 Forward Clutch Retaining Circlip, Replacement	10
30 Dial Indicator, To Check the End Float	10
31 End Float Adjustment, Fitting Shims	10
32 End Float Adjustment, Fitting Extra Gaskets	10
33 Transmission Oil Filter, Disassembly	10
34 Transmission Oil Cooler, Removal	11
35 Planetary Reduction Gear, Removal	11
36 Gear Selector Rail, Removal	11
37 First and Second Gear, Removal	11
38 Countershaft and Outer Bearing, Removal	11
39 Pinion and Driven Gears, Removal	11

INSTANT REVERSE TRANSMISSION

GENERAL

The instant reverse transmission is an automatic shuttle transmission with hydraulically operated clutches for forward and reverse travel. The shuttle transmission comprises a two speed sliding spur gear and a 4:1 planetary reduction gear, giving 4 speeds forward and 4 reverse.

The drive is taken from the input shaft (1), through a reverse idler (2) to the layshaft (3) which is engaged to a gear rotating on the output shaft. The hubs of both multi-plate clutches are splined to the output shaft and to their respective driven plates. Both clutch drums are splined to their respective drive plates. The forward clutch drum is also attached to the input shaft, the reverse clutch drum to the output shaft. When the forward clutch is engaged, the output shaft is locked to the input shaft and the 'drive' and 'driven' plates in the reverse clutch are forced to counter rotate. When the reverse clutch is engaged, the reverse clutch locks the reverse gear to the output shaft, thereby creating a drive from the input shaft, through the reverse idler and layshaft, thus causing the 'drive' and 'driven' plates in the forward clutch to counter rotate.

Both clutches are actuated by hydraulic pressure which is generated by a gear pump mounted on the input shaft and driven by the impeller hub of the torque converter. The torque converter is bolted to the flywheel on the engine crankshaft. As soon as the engine is started, the oil pump operates and supplies oil to the torque converter and to the oil distribution housing.

The oil passes through two 80 p.s.i. (5.625 kg./sq.cm.) valves thus giving a total of 160 p.s.i. (11.25 kg./sq.cm.). The oil is then directed via drillings in the manifold to the pedal operated control valve. From the control valve, the oil is fed to either the forward or the reverse clutch, whenever the appropriate pedal is depressed. Oil to the forward clutch passes round the sleeve, fitted to the output shaft and through the bore of the sleeve to the reverse clutch.

Two shift levers positioned in front of the operator's seat, select the appropriate gear and speed range. The left hand lever is the gear shift lever and moves the 'change speed' gears into engagement, whilst the right hand lever, the dual range selector lever alters the high or low range at the planetary reduction unit. Both levers must be engaged before the machine will move. When the dual range selector lever is in the 'L' (low) position, the planetary gears effect a 4:1 reduction of the transmission speed for both gears. The gear selector forks are secured to the selector rails by lock pins, and the rails slide in bores in the end walls of the transmission case. Cone ended spring plungers, attached to the casing end walls, locate in recesses on the rails, thus ensuring a positive selection of the gears.

The planetary reduction unit is coupled directly to the rear or output end of the transmission mainshaft. The planetary pinion is the rotating member whilst the ring gear, which is an extension of the conventional gearbox mainshaft, is fixed. In the high range the selector fork brings the sleeve forward to engage the splines of the sun-wheel giving a direct drive. In the low range the splined sleeve is pulled back, locating the planetary carrier to the rear drive, giving a 4:1 reduction in shaft speed.

INSTANT REVERSE TRANSMISSION

Removal

(7A/1)

1. Remove the engine, transmission and final drives from the machine as stated.
2. Level the whole unit using a trolley jack under the transmission housing. Take the weight of the engine with chain blocks or other suitable lifting gear.
3. Drain the oil from the torque converter housing.
4. Remove the bell housing bolts.
5. With the engine supported by the chain blocks, roll clear the transmission and final drive assembly. A drip tray should be positioned to contain any spillage from the torque converter.
6. Drain the transmission housing.
7. Support the centre housing on a rail trolley end, with the transmission case supported on a suitable jack, re-

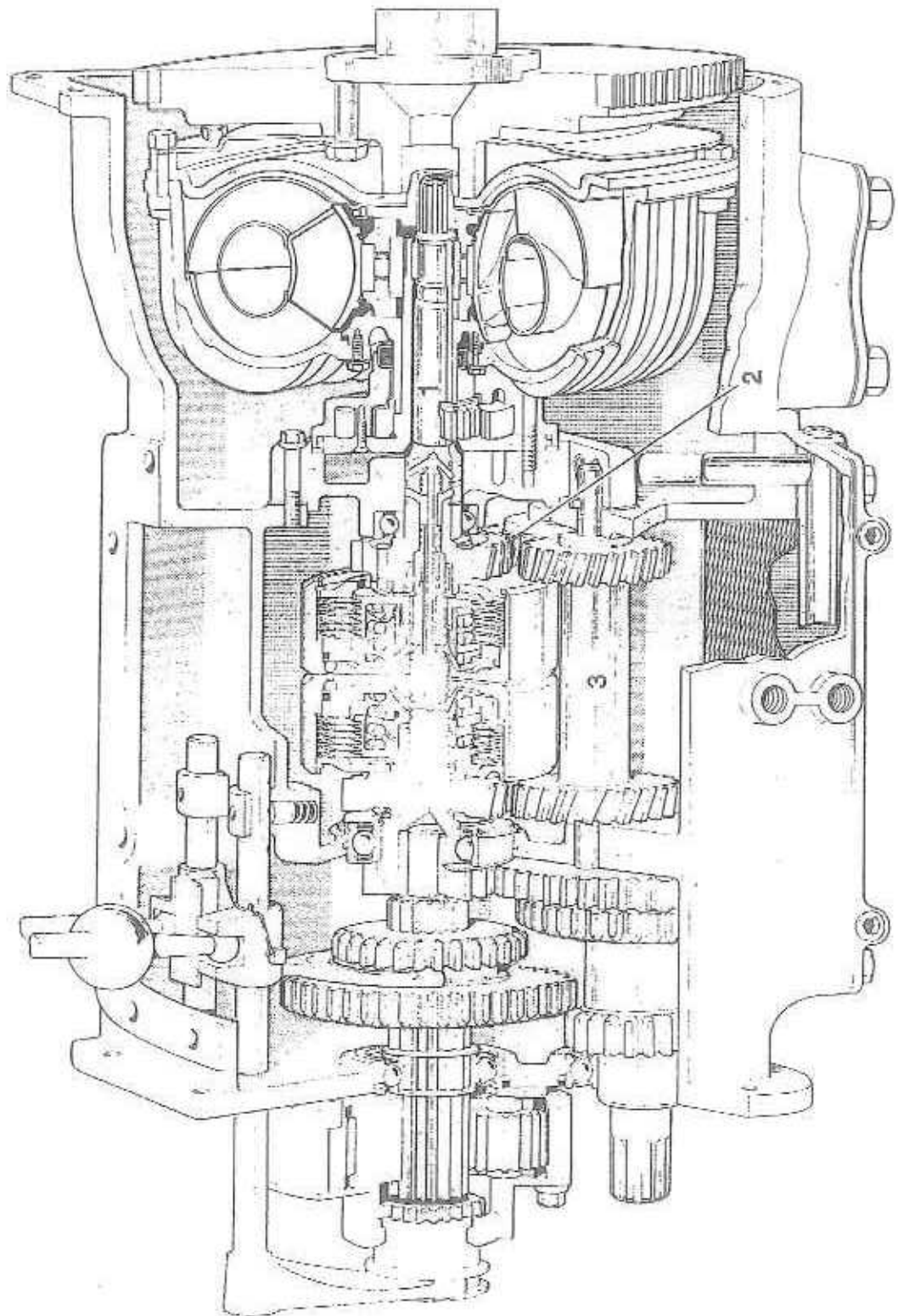


FIG. 1

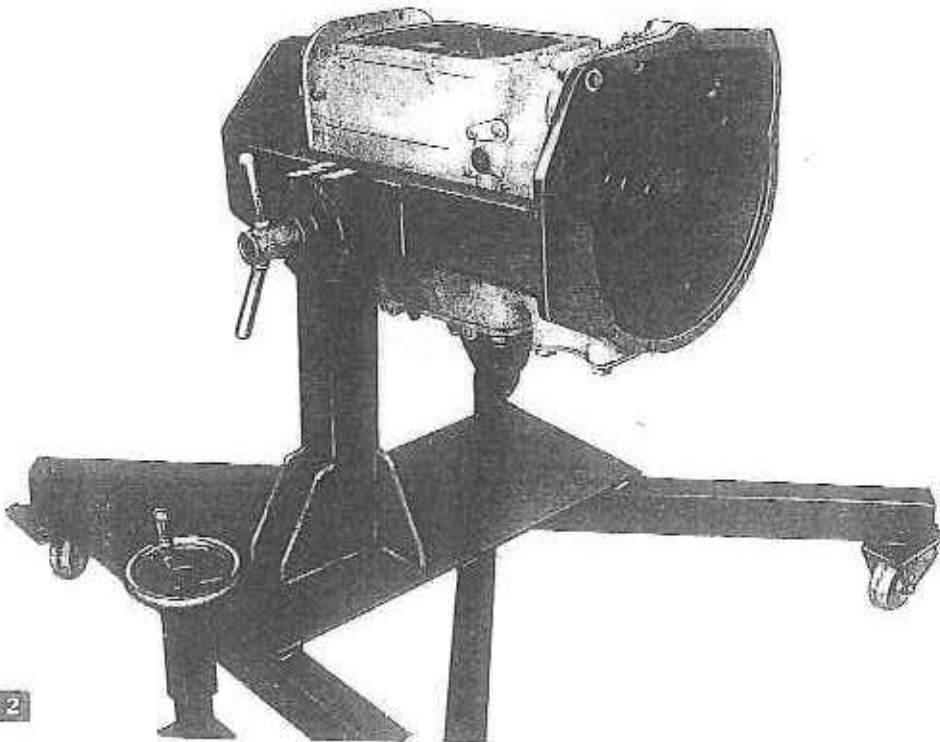
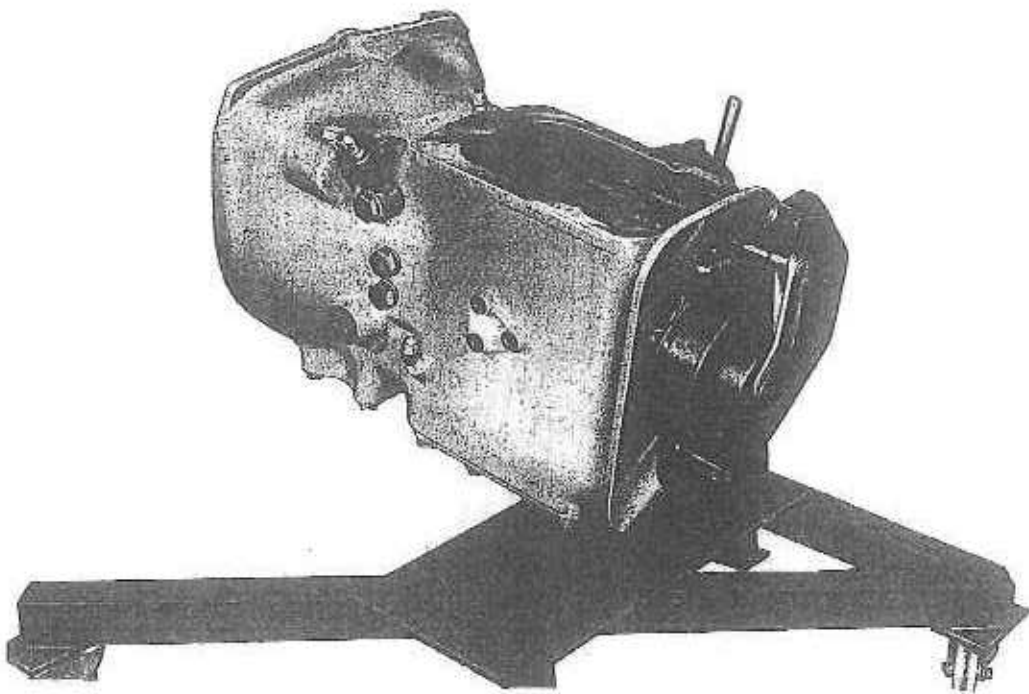


FIG. 2

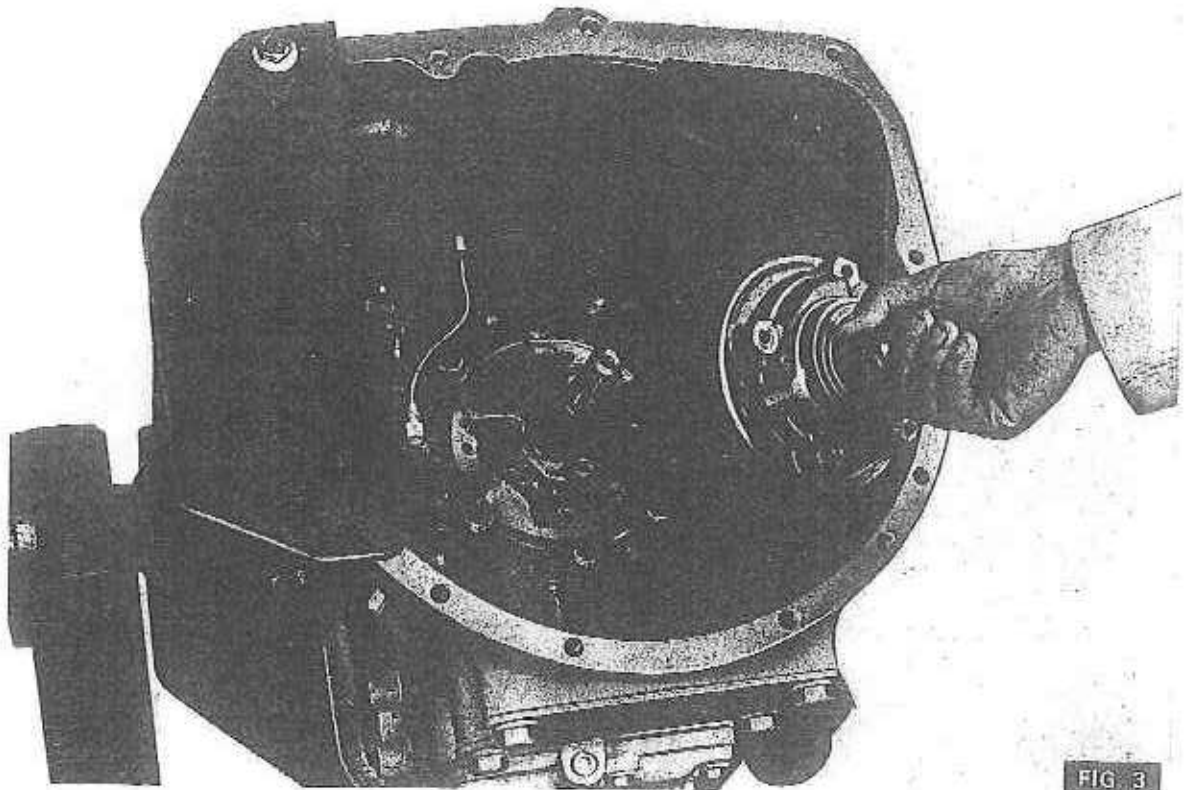


FIG. 3

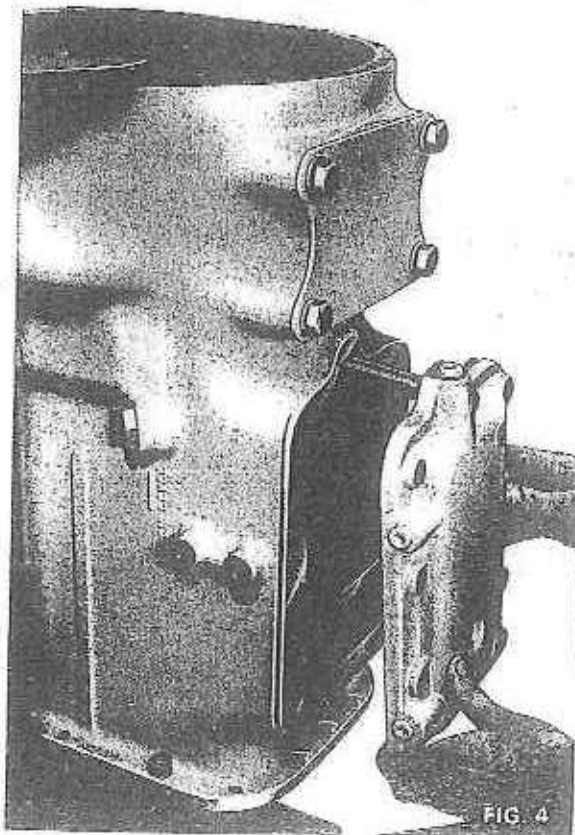


FIG. 4

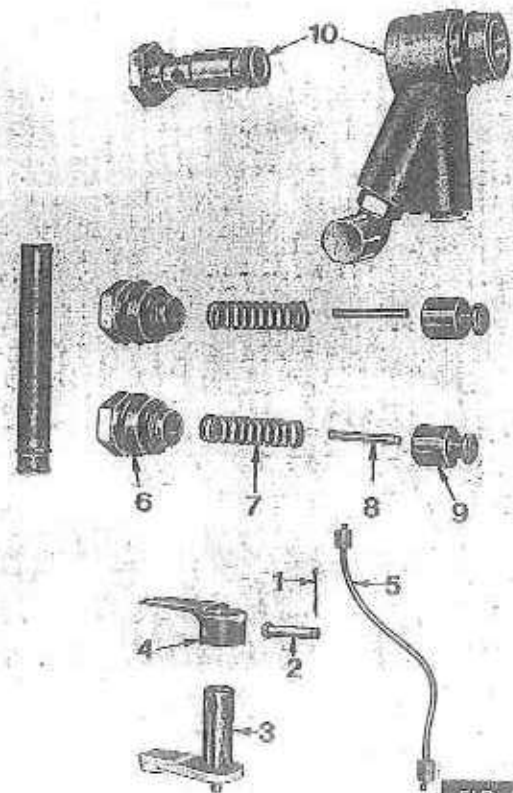
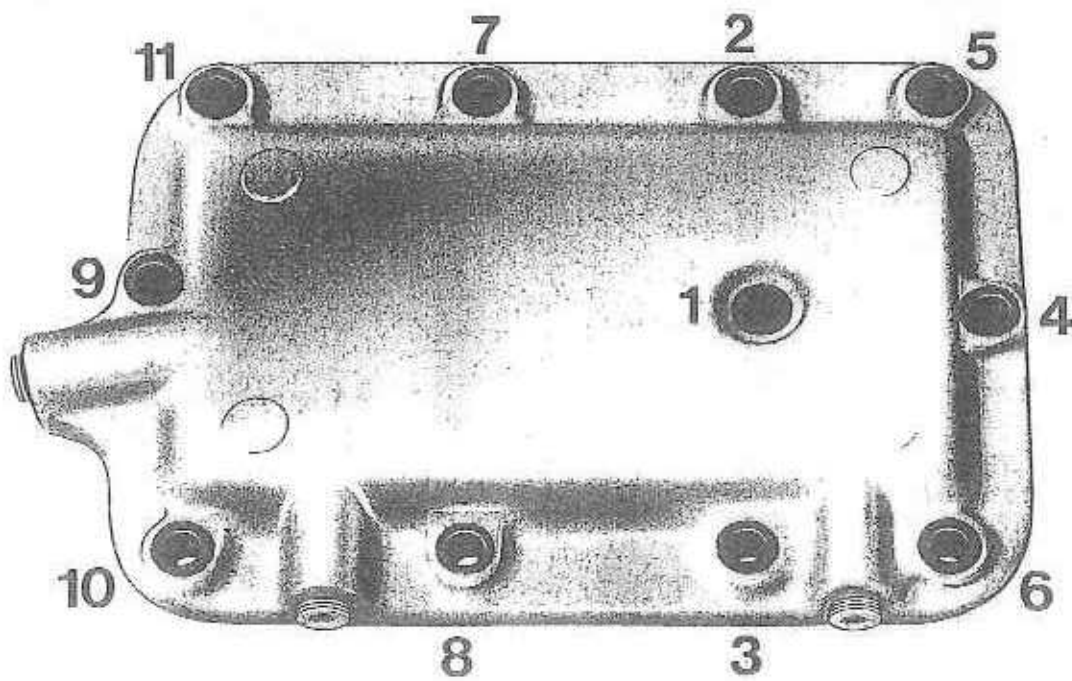
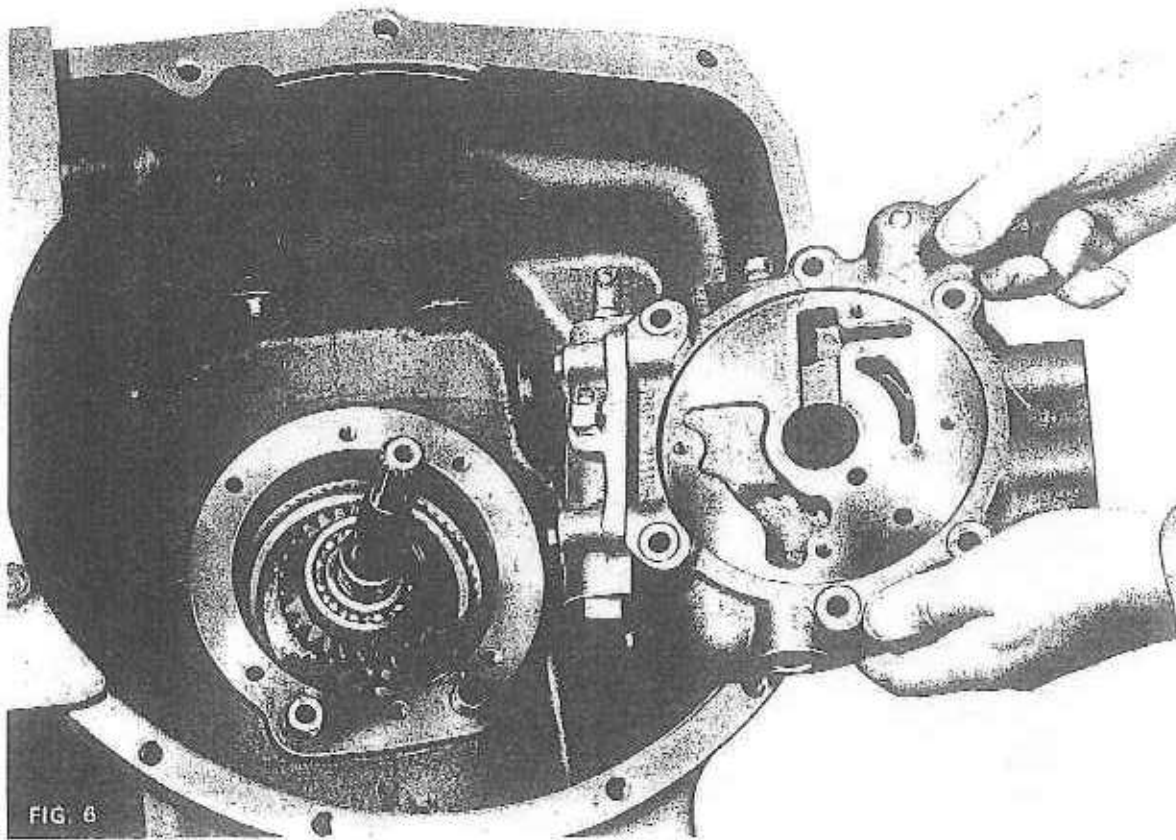


FIG. 5



INSTANT REVERSE TRANSMISSION

Removal . . . Cont'd

- move the bolts holding the transmission case and centre axle housing together. The centre axle housing may now be rolled clear on the trolley rails leaving the complete transmission case on the trolley jack.
8. In order to simplify further disassembly of the transmission, the case should be attached to a suitable stand as shown in Fig. 2.
 9. To replace the transmission assembly, reverse the above procedure.

INSTANT REVERSE TRANSMISSION

Disassembly and Reassembly

OIL PUMP

Removal and Refitting

(7A/2)

1. (Fig. 3) Remove the four bolts and washers securing the oil pump to the oil distribution housing and lift the pump clear over the input shaft.
2. Replace the oil pump using a new seal. Tighten the four bolts to a torque setting of 15 - 20 lb.ft. (2.07 - 2.77 kg.m.).

The pump should be examined for any damage, especially to the white metal bearing in the pump body. If this is scored or damaged in any way the efficiency of the seal between the impeller hub and the pump will be impaired.

The only servicing which can be carried out on the oil pump is the renewal of the front oil seal. This is done by tapping out the seal with a punch and drifting in the new seal until it bottoms against the white metal bearing.

INSTANT REVERSE TRANSMISSION

OIL DISTRIBUTION HOUSING

Removal and Replacement

(7A/3)

1. Remove the oil pump as described in operation 7A/2.
2. (Fig. 4) Remove the bolts and spring washers securing the sump to the transmission housing. Remove the sump and oil suction pipe.
3. Remove the gasket.
4. (Fig. 5) Remove the split pin (1) and clevis pin (2) securing the spool valve operating lever (3) to the internal lever (4). Remove the levers.
5. Remove the oil pressure test pipe (5).
6. Remove the two regulator valves, i.e. cap (6), spring (7), guide pin (8) and valve (9), and the outlet manifold (10).
7. (Fig. 6) Remove the six bolts and washers securing the oil distribution housing to the transmission case. Lift the housing and gasket clear over the input shaft.
8. To replace the housing, reverse the above procedure ensuring that any damaged gaskets, sealing washers and 'O' rings are renewed. Tighten the oil distribution bolts to a torque setting of 25 - 30 lbs.ft. (3.48 - 4.15 kg.m.). The bolts should be tightened evenly on opposite pairs in order to avoid any possible distortion of the housing.
9. Replace the oil suction pipe and the sump and tighten the bolts to a torque setting of 45 - 50 lb.ft. (6.22 - 6.91 kg.m.) following the correct sequence shown in fig. 7.

INSTANT REVERSE TRANSMISSION

CONTROL VALVE

Disassembly and Reassembly

(7A/4)

1. Remove the oil distribution housing as described in operation 7A/3.
2. (Fig. 8) Withdraw the split pin (1) and the clevis pin (2) from the valve spool (3).
3. Unscrew the valve end cap (4) and push the spool out of the control valve body (5).
4. Remove the circlip (6) and slide the two spring guides (7) and spring (8) off the spool.
5. Unscrew the two bolts holding the spool valve housing to the oil distribution housing.
6. Remove the five 'O' rings. When the housing is replaced these 'O' rings should be renewed.
7. To reassemble the control valve, reverse the above procedure.

INSTANT REVERSE TRANSMISSION

Disassembly

(7A/5)

1. Remove the engine, transmission and final drives from the machine as stated.
2. Separate the transmission case from the final drives as stated in operation 7A/1.
3. With the transmission bell housing facing upwards, remove the oil pump and oil distributor housing as stated in operations 7A/2 and 7A/3.
4. (Fig. 9) Withdraw the internal shafts from the countershaft gear and the reverse idler gear.
5. Remove the reverse idler gear, retaining the thrust washers.
6. (Fig. 10) Remove the countershaft gear; the special tool detailed in Fig. 11 will ensure that the thrust washers and roller bearings are not displaced or lost in the transmission case when removing the countershaft gear.
7. (Fig. 12) Lift out the complete clutch pack assembly from the bell housing and remove the shim(s) (if fitted).

INSTANT REVERSE TRANSMISSION

Reassembly

(7A/6)

1. Reassemble the countershaft, fig. 13.
2. Reassemble the reverse idler gear, fig. 14.

Note

The fibre thrust washer (1) must be fitted between the reverse gear (2) and the outer shaft (3). The bronze thrust washer should be fitted on the front face of the gear.

3. Replace the clutch pack assembly into the transmission casing, ensuring that any shim(s) which were removed are replaced between the rear bearing and its bore face.
4. Fit the countershaft back into position using the special 'C' tool to hold the rear thrust washer in place. Check that the front thrust washer is properly located and replace the inner shaft.
5. Replace the idler shaft gear in position engaging the gears in the clutch pack and the countershaft, replace the inner shaft.
6. Replace the oil distribution housing using a new gasket and sealing washers. Tighten the bolts to a torque setting of 25 - 30 lb.ft. (3.456 - 4.148 kg.m.).
7. Refit the oil pump using a new sealing ring and washers. Tighten the bolts to a torque setting of 15 - 20 lbs. ft. (1.974 - 2.765 kg.m.).
8. Replace the regulator valves, oil pressure test pipe and the control valve lever assembly.
9. Carry out the end float check as described in operation 7A/12.
10. Clean the sump and gauze filter and replace the sump and the oil suction pipe using a new gasket and 'O' rings.

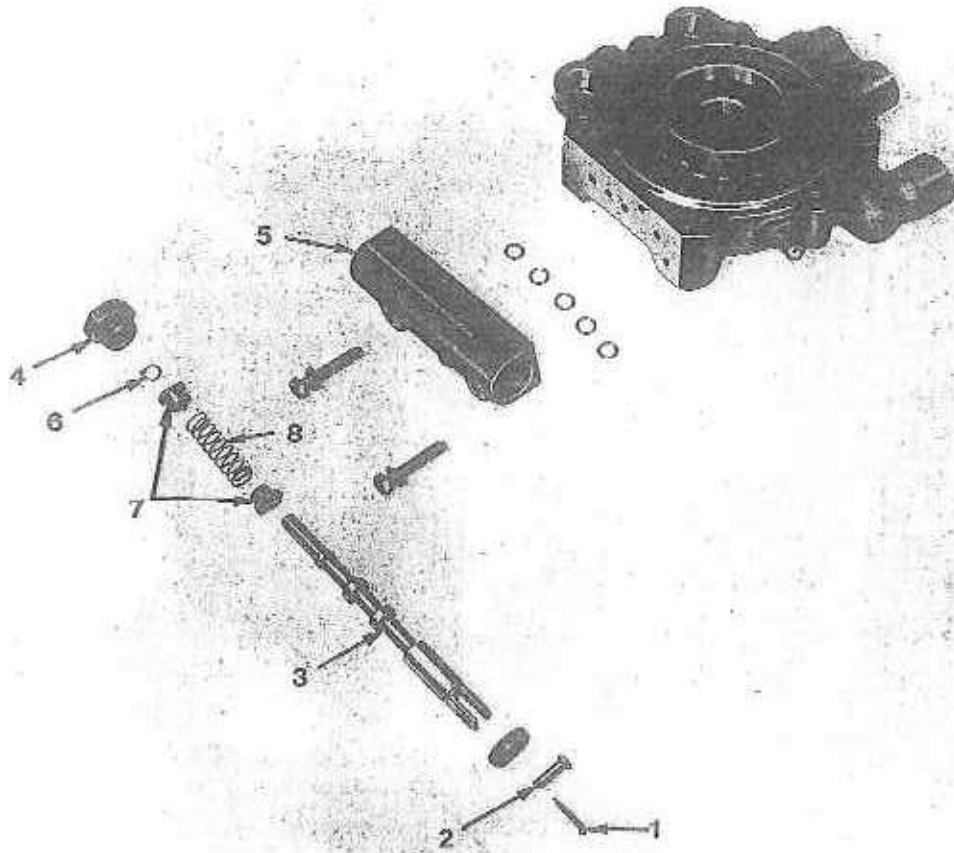


FIG. 8

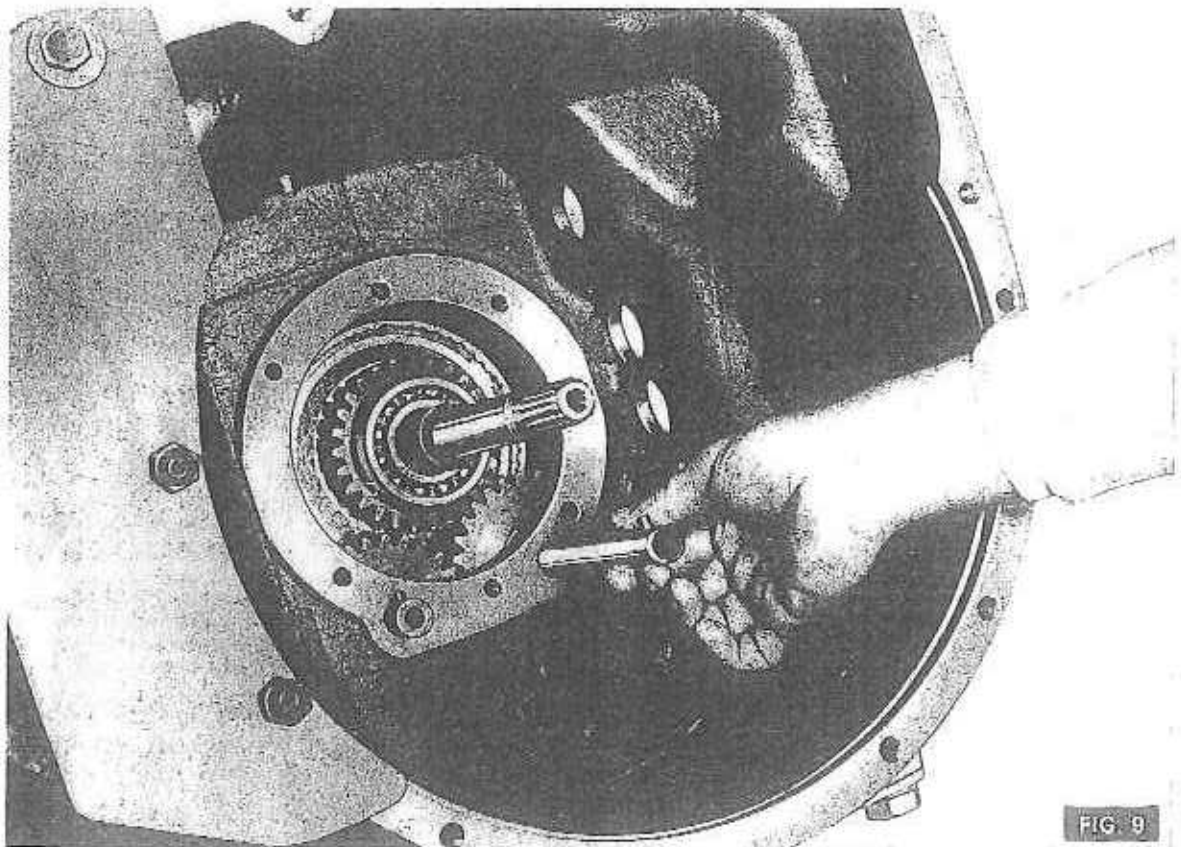
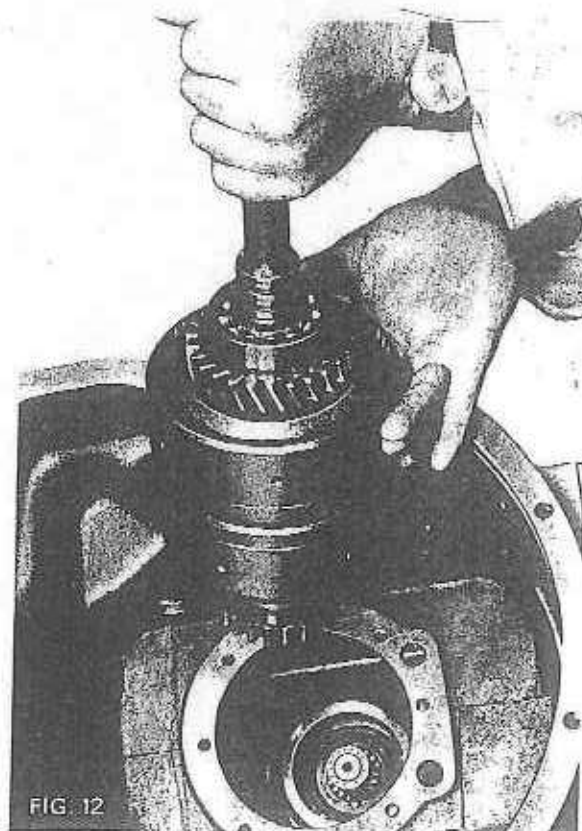
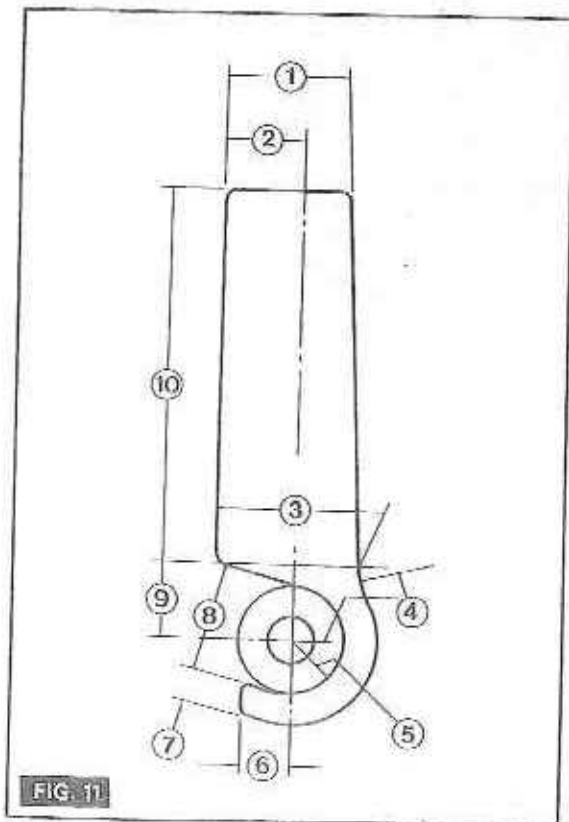
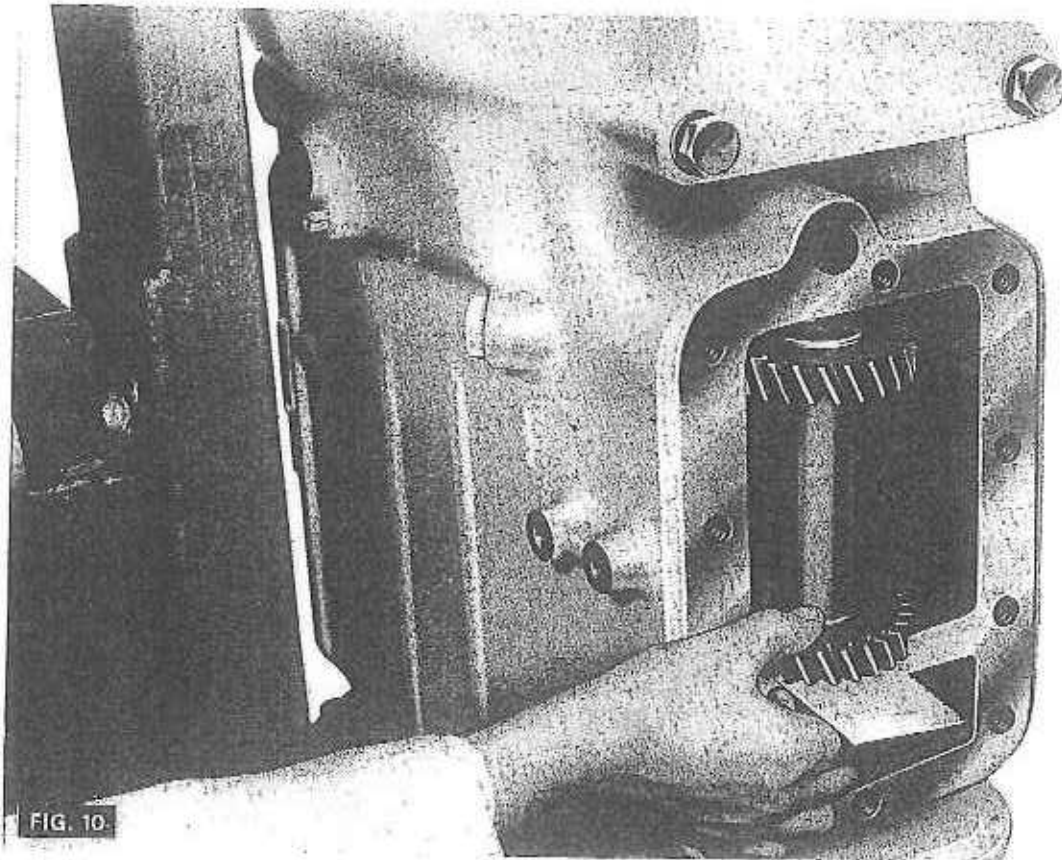


FIG. 9



INSTANT REVERSE TRANSMISSION

Reassembly . . . Cont'd

Note

The special tool illustrated in Fig. 11 should be made from a piece of mild steel 9 in. x 3 in. (22.8 cm. x 7.6 cm.) 17 S.W.G. (.056 in.) (1.42 mm.) to the dimensions given.

(1)	2 in.	(50.8 mm.)		(6)	¾ in.	(19 mm.)
(2)	1½ in.	(31.75 mm.)		(7)	½ in.	(12.7 mm.)
(3)	2 3/8 in.	(60.3 mm.)		(8)	1 3/8 in.	(35 mm.)
(4)	1 3/8 in.	(35 mm.)	Rad.	(9)	1 3/16 in.	(30.2 mm.)
(5)	7/8 in.	(22.23 mm.)	Rad.	(10)	6 in.	(152.4 mm.)

INSTANT REVERSE TRANSMISSION

CLUTCH PACKS AND SHAFTS

Disassembly

(7A/7)

1. Remove the clutch pack assembly from the transmission case as described in operation 7A/5.
2. Stand the assembly upright with the input shaft uppermost.
3. (Fig. 15) Remove the large circlip from the forward clutch drum and lift off the input shaft.

To further dismantle the shaft :

- (a) Remove 3 steel sealing rings.
 - (b) Lever off the bearing.
 - (c) Remove the inner bearing.
4. (Fig. 16) Remove the thrust washer (1).
 5. Lift out the forward clutch hub (2) which is splined to the driven plates of the clutch and to the output shaft.
 6. Remove the sintered bronze driven plates (3) and the dished steel drive plates (4) from the clutch drum (5).
 7. (Fig. 17) Remove the small circlip retaining the forward clutch.
 8. Lift off the clutch drum.

To further dismantle the drum :

- (a) Fig. 18. Compress the spring using tool MF 244.
 - (b) Fig. 19. Remove the coil circlip (1). Release the tension on the spring and remove the spring retainer (2) and the spring (3).
 - (c) Use compressed air directed into the hole in the back of the drum to remove the piston (4).
 - (d) Remove the two sealing rings and the ball bearing (5).
9. (Fig. 20) Turn the clutch assembly over and remove the large circlip (1) retaining the reverse clutch cover (2).
 10. Turn the clutch back to the upright position and remove the reverse clutch drum and the plates from the output shaft.
 11. Remove the small circlip retaining the reverse clutch hub to the output shaft taking great care not to damage the seal rings on the shaft.
 12. Remove the reverse clutch hub.
 13. Remove the reverse clutch gear and clutch cover and the thrust washers.
 14. To further dismantle the clutch drum, procedure is as described at reference 8 above.
 15. To further dismantle the output shaft, proceed as follows :-

INSTANT REVERSE TRANSMISSION CLUTCH PACKS AND SHAFTS

Removal . . . Cont'd

- (a) Remove the circlip retaining the bearing.
- (b) Remove the forward oil slinger plate.
- (c) Tap off the bearing.
- (d) Remove the rear oil slinger plate.

Note

If any of the six steel sealing rings on the output shaft have been damaged, remove them all, noting the order of removal. These rings should not be disturbed unless they are damaged in any way.

INSTANT REVERSE TRANSMISSION OUTPUT SHAFT

Reassembly

(7A/8)

1. Reassemble the oil slinger plates, sealed bearing and circlip onto the output shaft.
2. If the steel sealing rings have been removed in order to replace a damaged item, refit them in the order of removal.

INSTANT REVERSE TRANSMISSION INPUT SHAFT

Reassembly

(7A/9).

1. Press the bearing onto the shaft.
2. Refit the three steel oil seal rings.
3. Press in a new inner bearing.

INSTANT REVERSE TRANSMISSION CLUTCH DRUM

Reassembly

(7A/10)

1. (Fig. 19) Fit a new rubber seal to the drum spigot and also to the piston (4).
2. Replace the steel ball (5) into its location hole.
3. Push the piston right down into the drum.
4. Fit the spring (3) and the spring retainer (2) onto the piston.
5. Use the tool MF 244 to compress the spring, ensuring equal compression all round. Replace the coil circlip (1) and remove the tool.

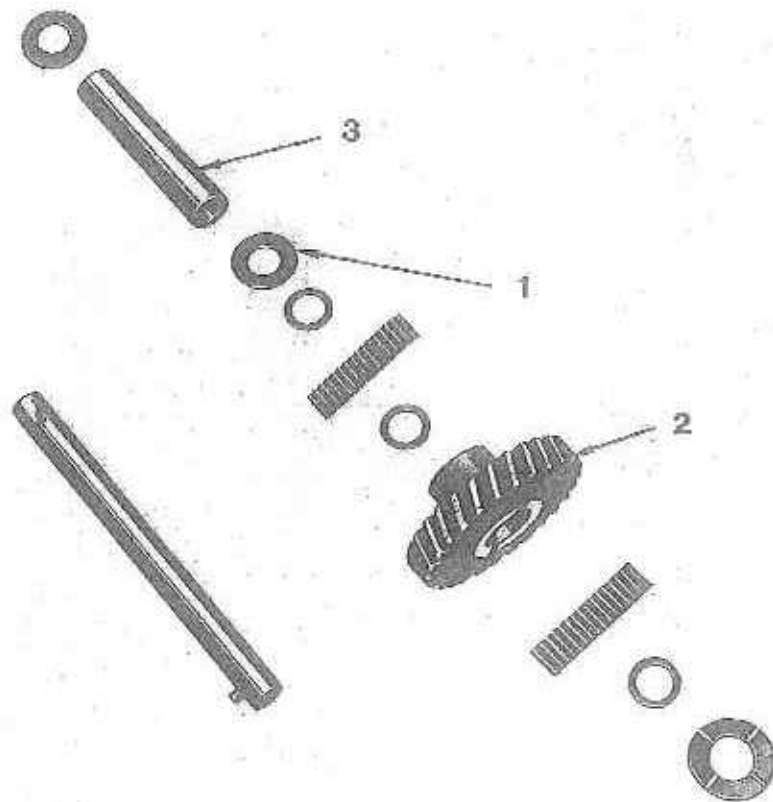
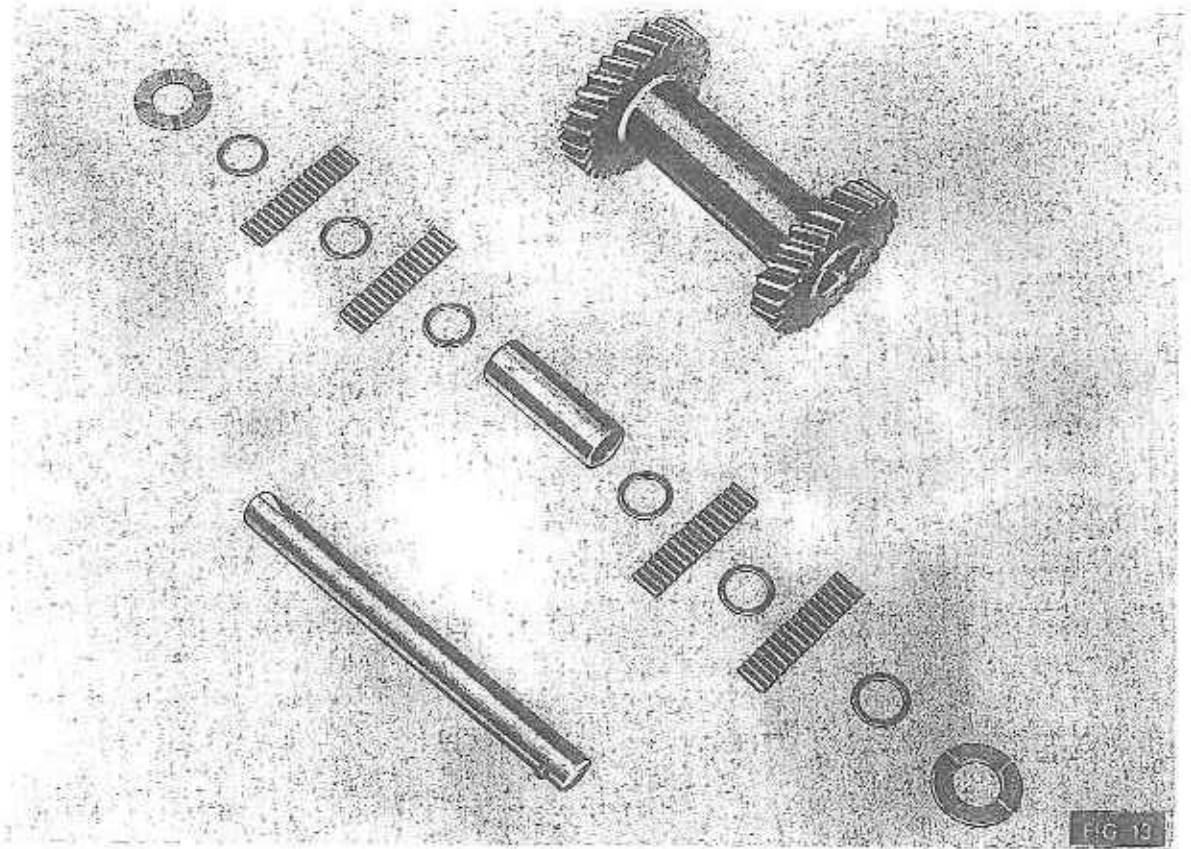
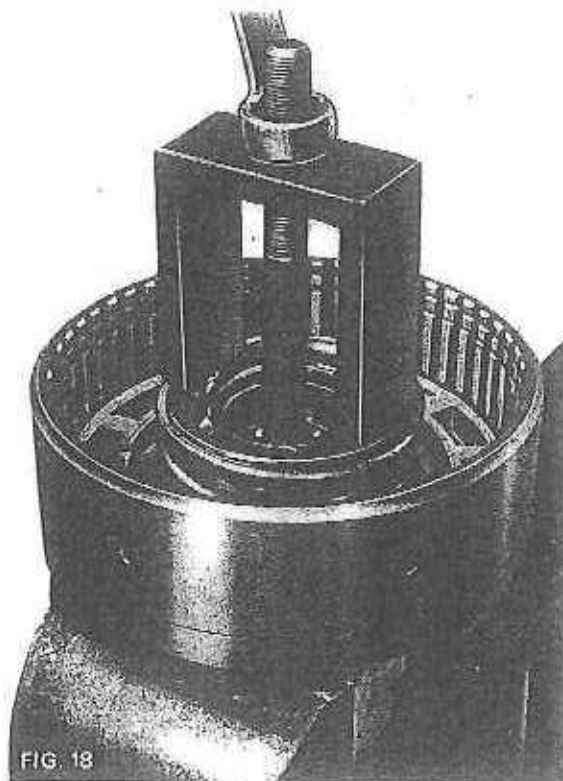
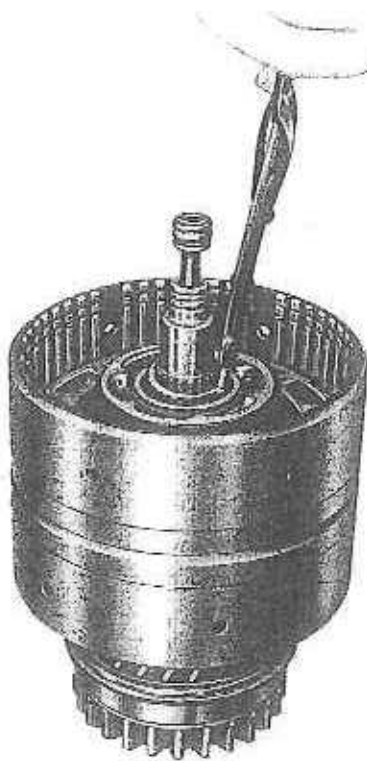
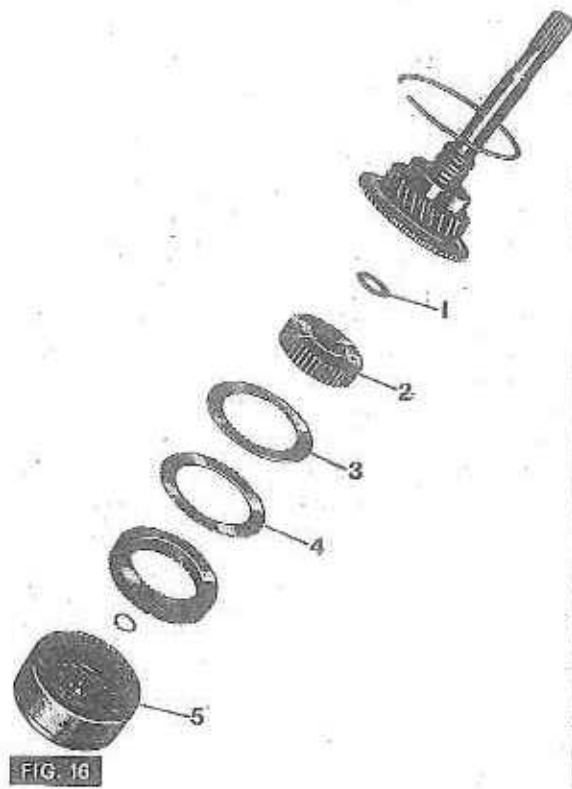
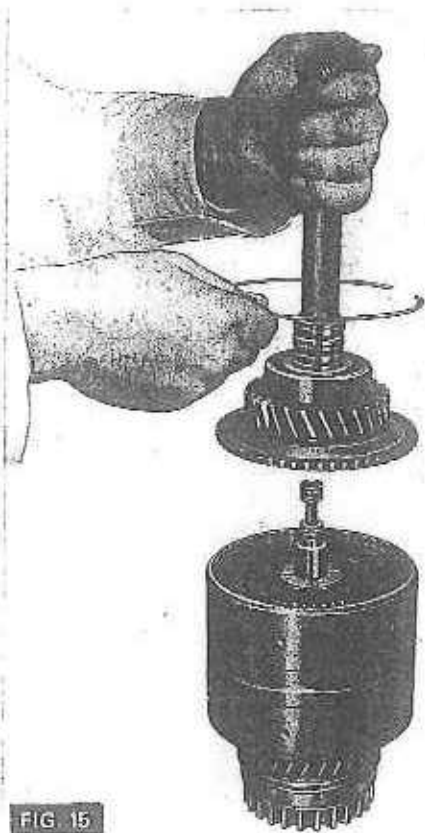
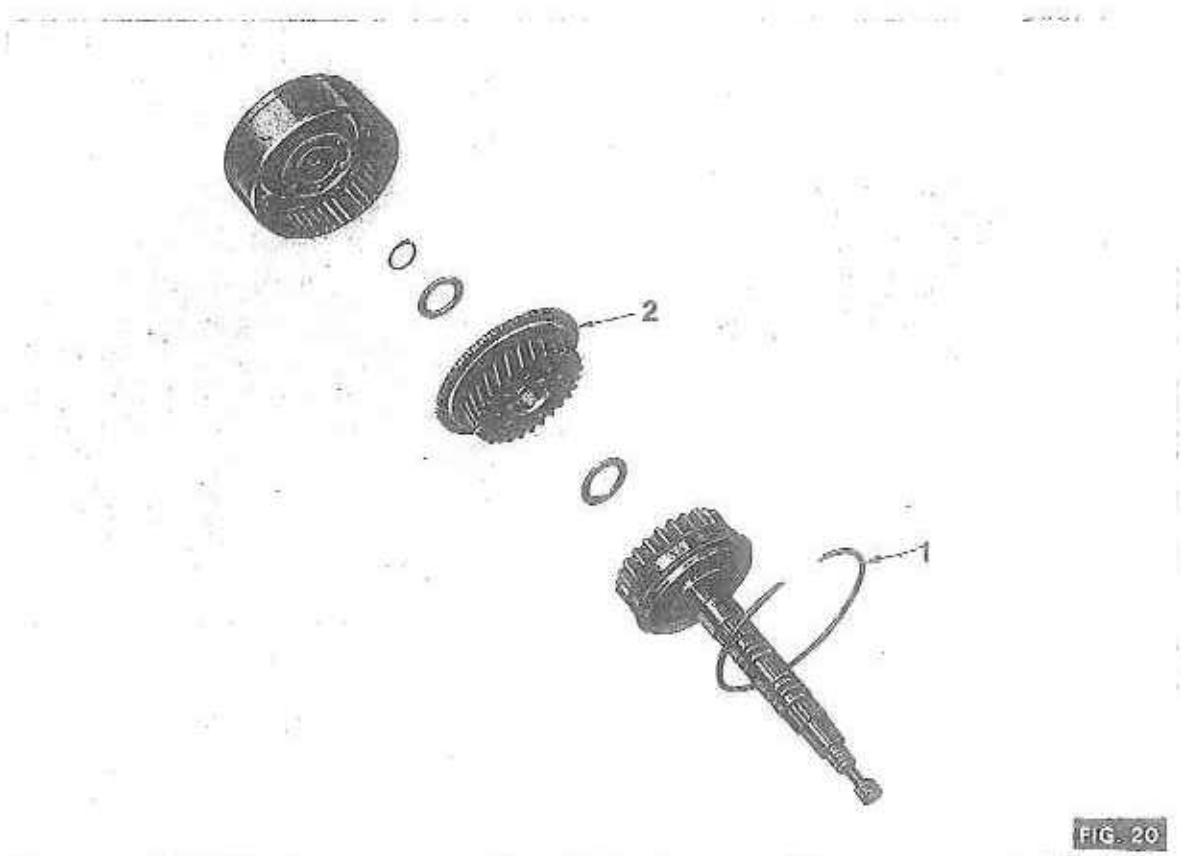
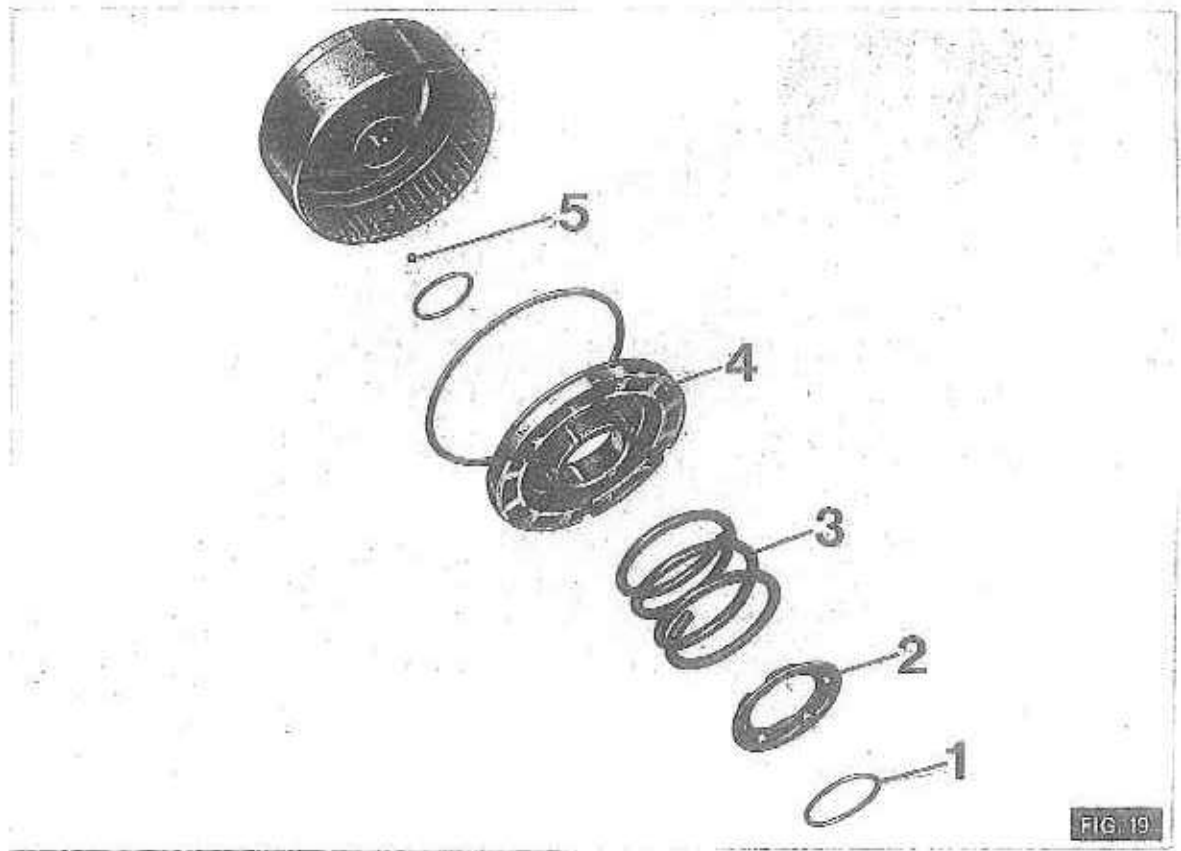


FIG. 14





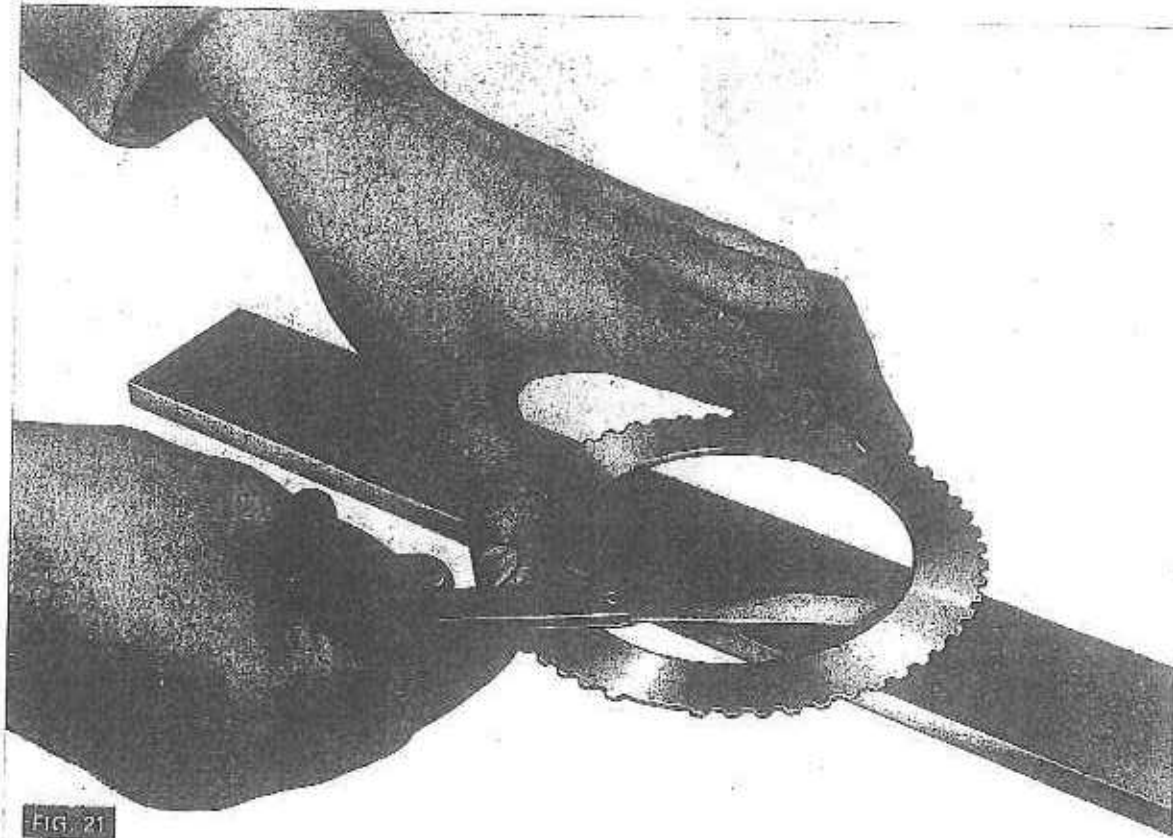


FIG. 21

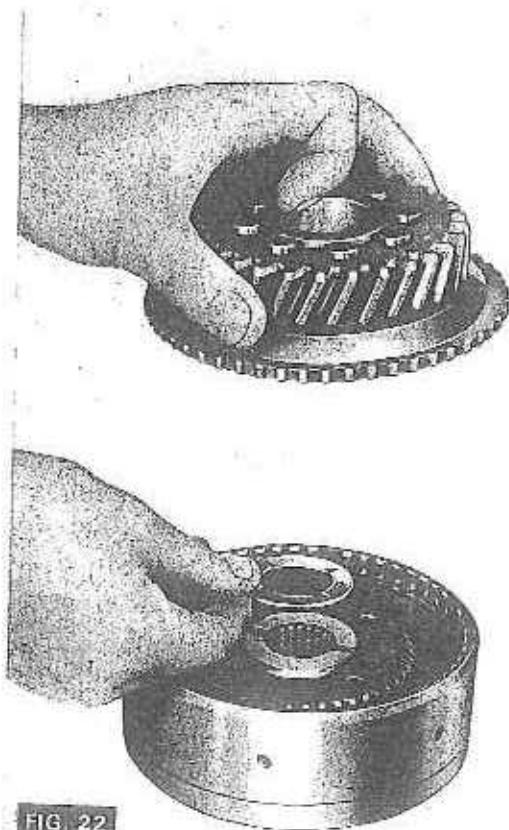


FIG. 22

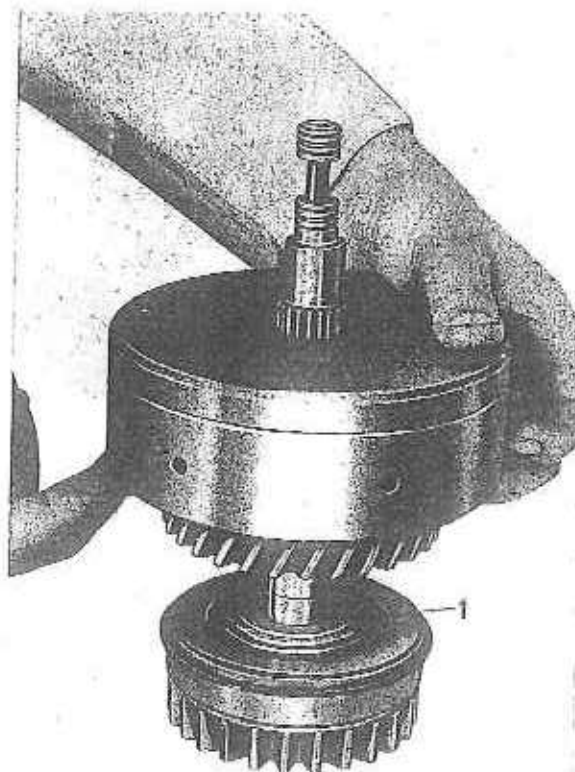


FIG. 23

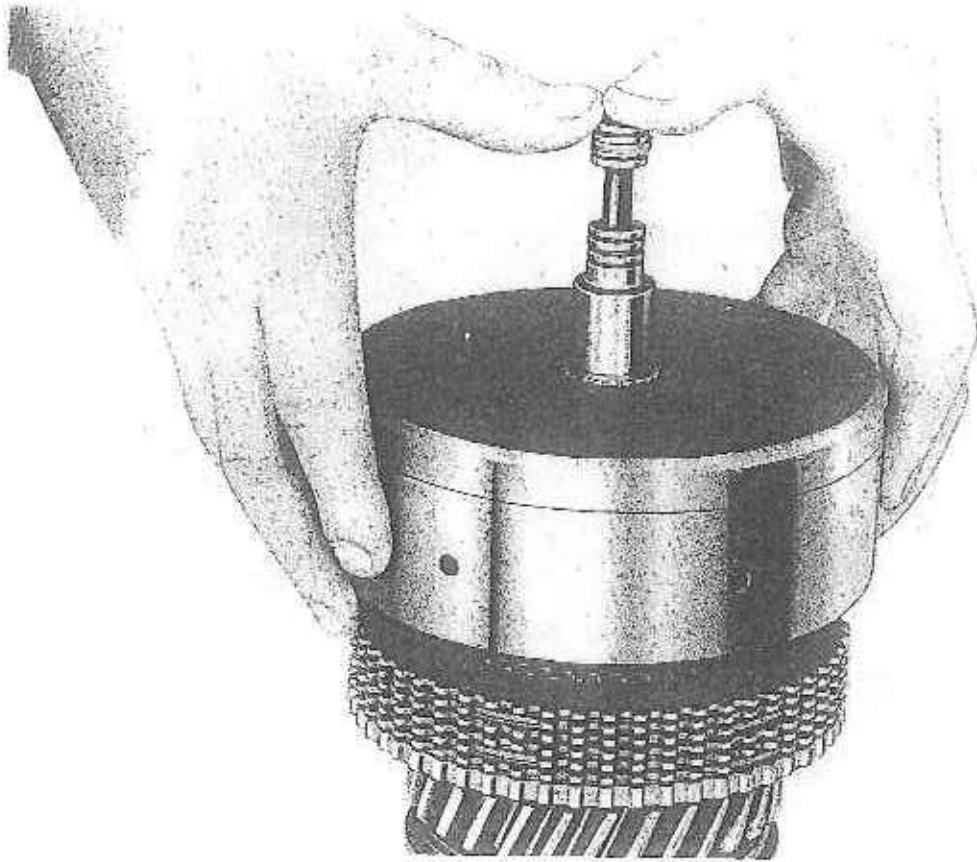


FIG. 24

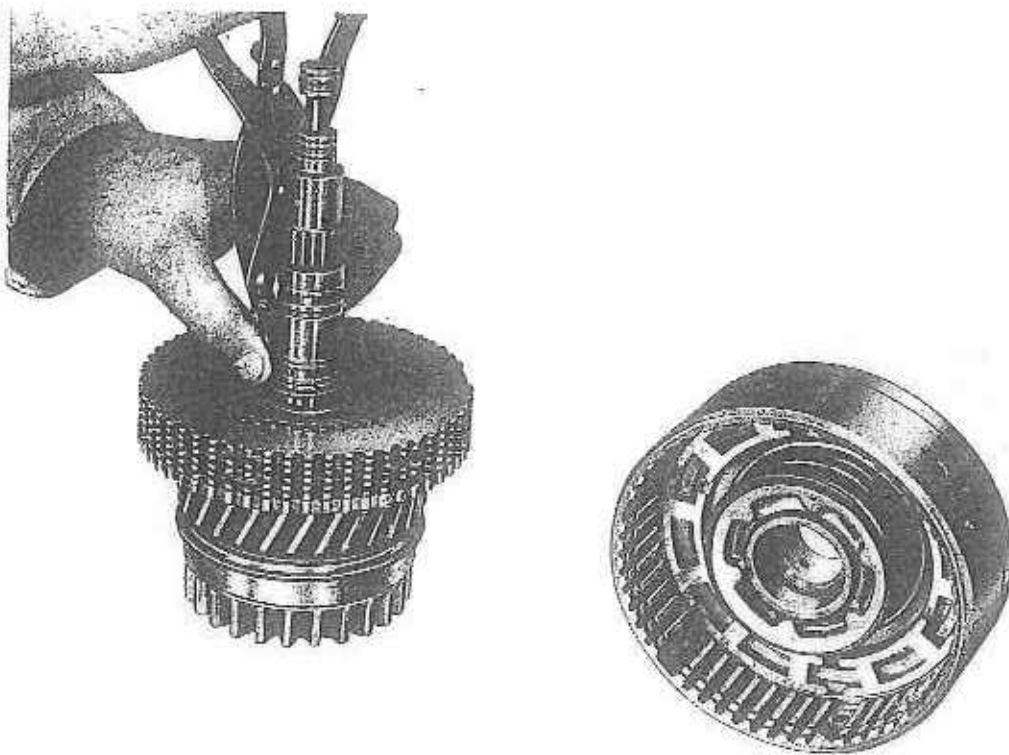


FIG. 25

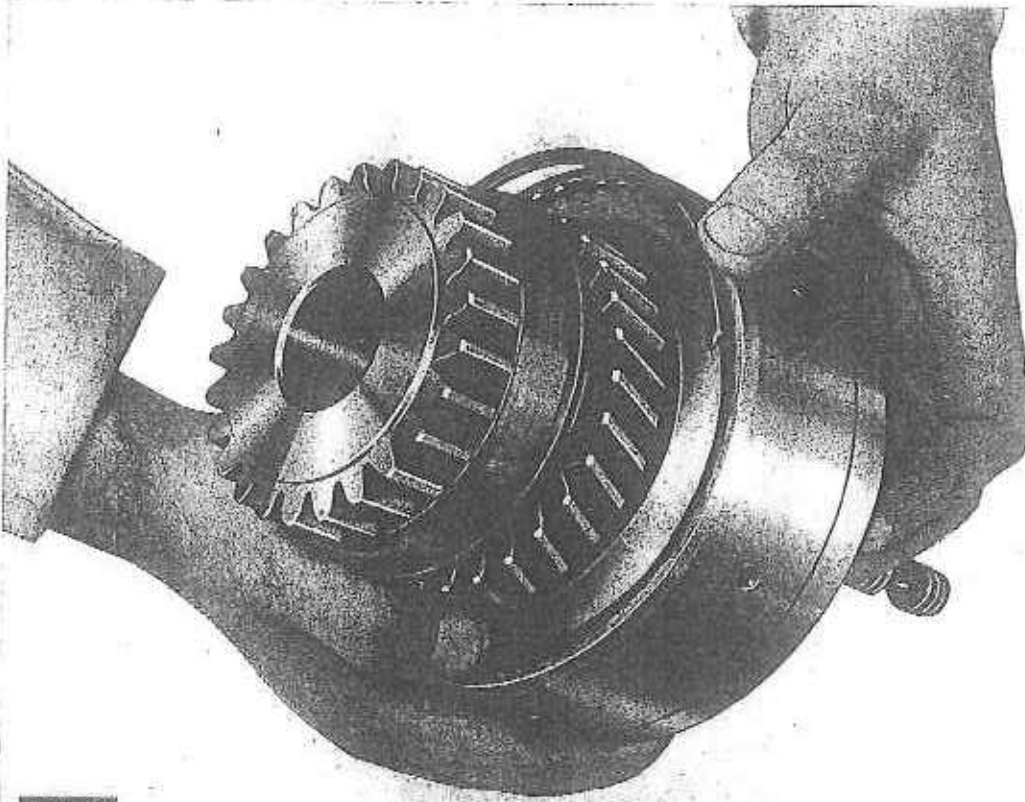


FIG. 26

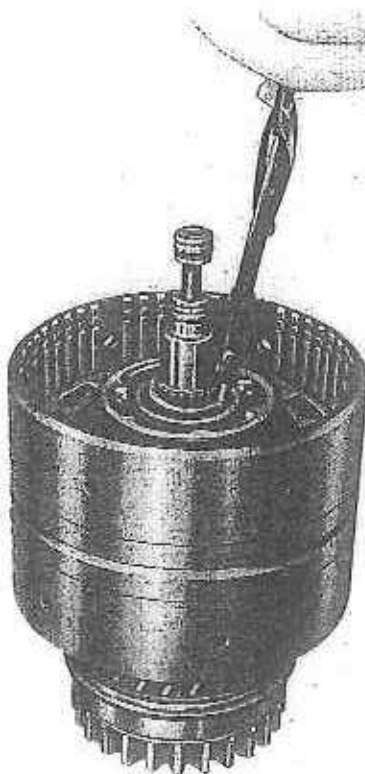


FIG. 27

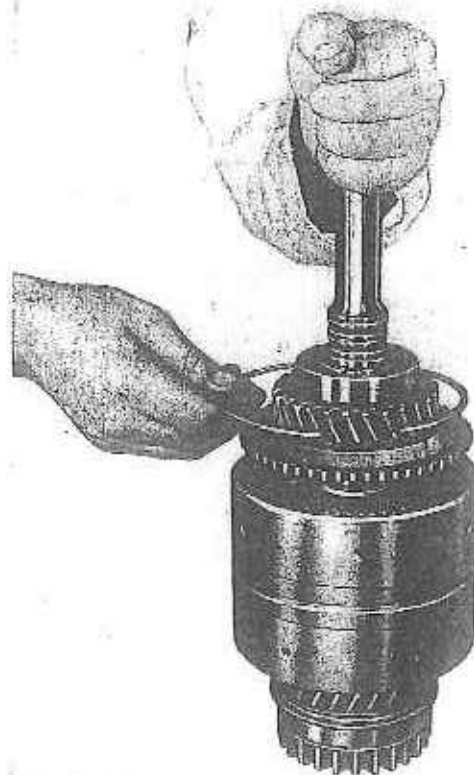


FIG. 28

INSTANT REVERSE TRANSMISSION

CLUTCH PACKS

Reassembly

(7A/11)

1. Before reassembling the clutch packs, check the clearance of the steel drive plates. Place the plates on a flat surface with the concave face down. Insert a feeler gauge under the inside edge of the plate as shown in Fig. 21. The clearance must not be less than 0.005 in. - 0.007 in. (0.127 mm. - 0.177 mm.).
2. Stack the drive plates with the concave faces uppermost.
3. Fit the reverse clutch hub inside the drum.
4. Fit the first drive plate into the drum.
5. Place the first sintered bronze driven plate over the hub. The driven plates may be fitted either way.
6. Build up the reverse clutch pack by alternately fitting the drive and driven plates into the reverse clutch drum.

Note

It is imperative that the concave faces of the steel drive plates are all lying the same way.

7. (Fig. 22) Place the thrust washer onto the hub and fit the reverse clutch cover and gear assembly into the drum.
8. (Fig. 23) Place the output shaft upright on the bench and fit the thrust washer (1) onto the shoulder above the oil slinger.
9. Turn the assembled reverse clutch over and place it onto the output shaft, pushing it fully home onto the thrust washer.
10. Line up the top of the shaft and the oil hole in the drum with a suitable mark on the bench, so that the drum may be replaced in exactly the same position.
11. (Fig. 24) Lift off the clutch drum carefully. DO NOT DISTURB THE PLATES IN ANY WAY.
12. (Fig. 25) Fit the small circlip to retain the reverse clutch hub.
13. Replace the drum ensuring the correct alignment of the shaft and oil hole with the mark on the bench. It is essential that the drum is replaced in exactly the same position.
14. (Fig. 26) Turn the assembly over and fit the large circlip to retain the clutch cover.
15. (Fig. 27) Fit the forward clutch drum over the output shaft to rest on the reverse clutch drum and secure with circlip.
16. Locate the hub in the forward clutch drum.
17. Build up the forward clutch pack in the manner described at references 5 - 8.
18. Replace the thrust washer over the output shaft.
19. (Fig. 28) Fit the input shaft and clutch cover over the output shaft and into the drum.
20. (Fig. 29) Insert a screwdriver between the two clutch drums and lever the forward clutch upwards so that the large circlip can be fitted to retain the forward clutch cover in the drum.

INSTANT REVERSE TRANSMISSION

CLUTCH PACK ASSEMBLY

To Check the End Float

(7A/12)

Note

This check must be carried out with the oil distribution housing properly seated and with the bolts tightened to the correct torque setting.

1. (Fig. 30) Set up the dial indicator on the transmission bell housing.
2. With a suitable tool, such as a screwdriver, push the clutch packs down by levering against the transmission case. Set the dial indicator to zero.
3. With the tool underneath the reverse gear, lever the clutch packs up and note the end play indicated on the gauge. The permissible end float is .031 - .050 in. (0.768 - 1.27 mm.).

INSTANT REVERSE TRANSMISSION

CLUTCH PACK ASSEMBLY

To Check the End Float . . . Cont'd

Note . . . Cont'd

4. (Fig. 31) If the end float indicated is greater than .050 in. (1.27 mm.) place a shim between the rear bearing and the transmission case.
5. (Fig. 32) If the end float is less than .031 in. (0.768 mm.) with all the shims removed, add a second gasket between the oil distribution housing and the transmission case.

Note

A maximum of three gaskets is allowed to adjust end float. At least one gasket must be fitted at all times.

INSTANT REVERSE TRANSMISSION

OIL FILTER

Removal and Refitting

(7A/13)

1. (Fig. 33) Unscrew the lower half of the body (1) and remove the filter element (3).
2. To dismantle the filter cap further, proceed as follows :--
 - (a) Release the inlet and outlet pipe connections and remove the three bolts securing the filter cap to the bracket.
 - (b) Remove the circlip (4) and then the washer (5), spring (6) and steel ball (7).
3. Reassemble in the reverse order ensuring that each part is absolutely clean.
4. Renew the rubber 'O' ring (2) and the filter element if necessary. Reassemble the oil filter.

OIL COOLER UNIT

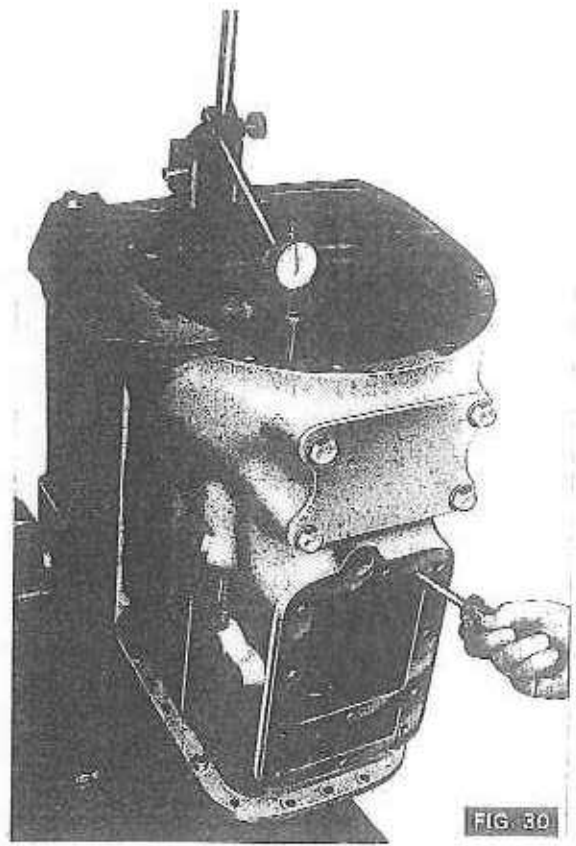
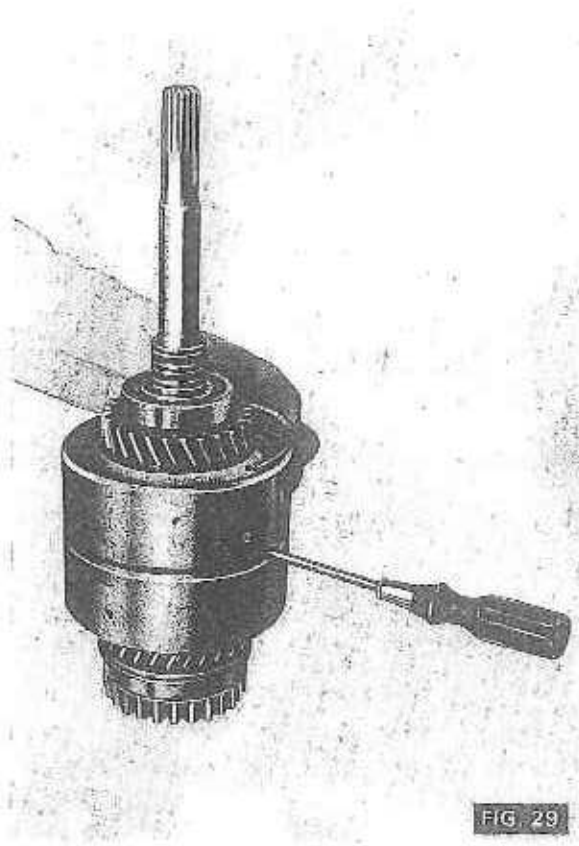
Removal and Refitting

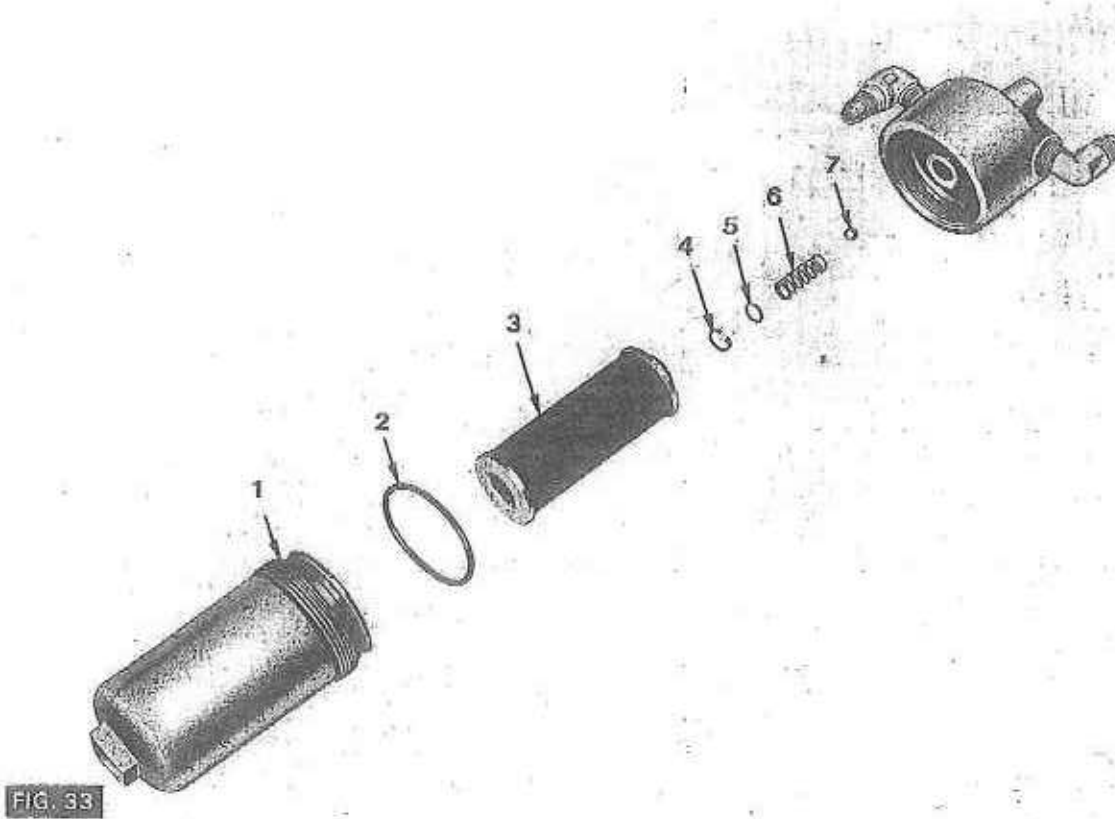
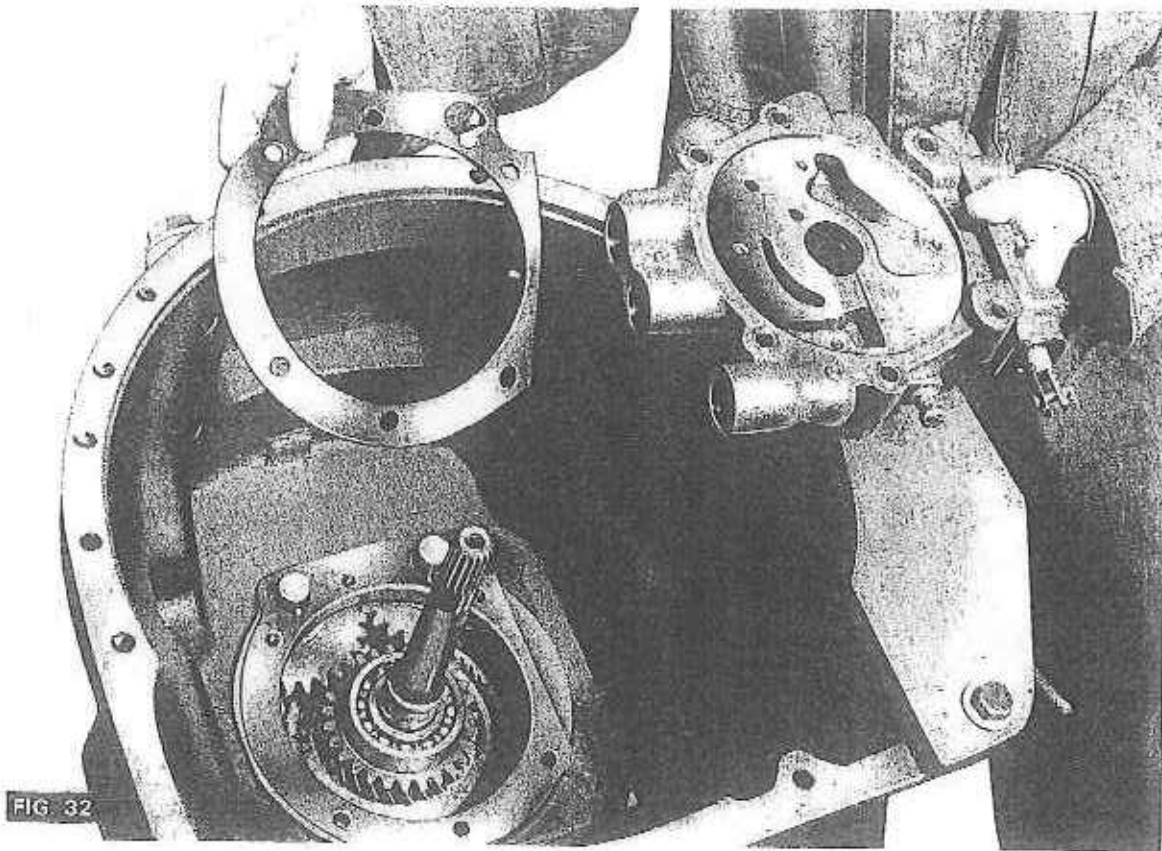
(7A/14)

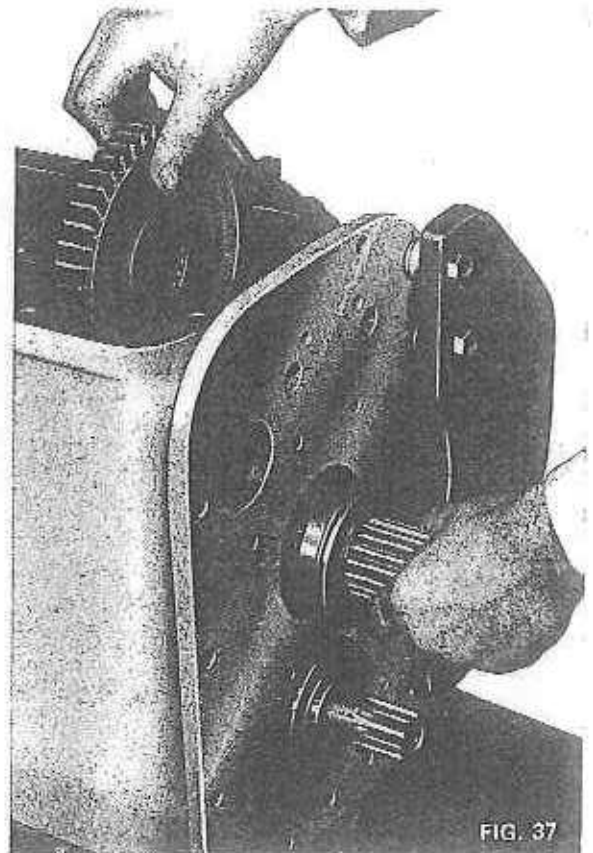
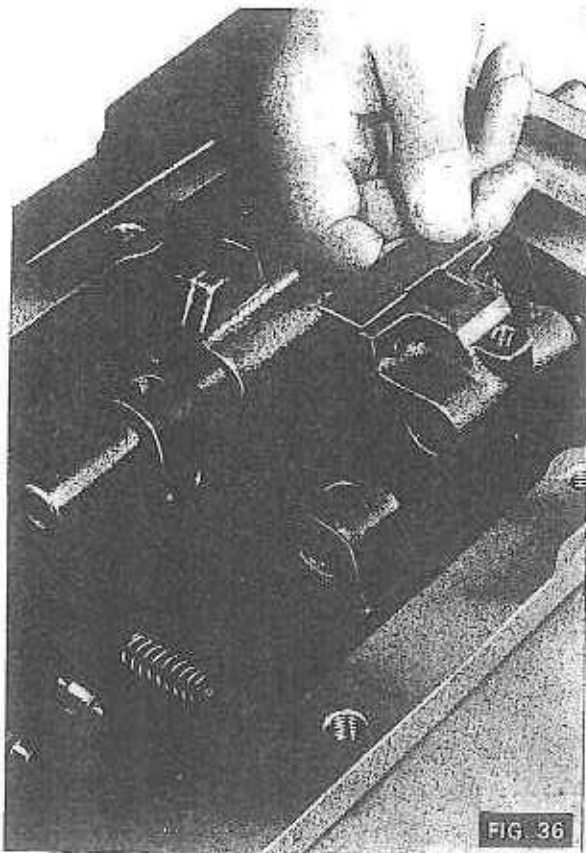
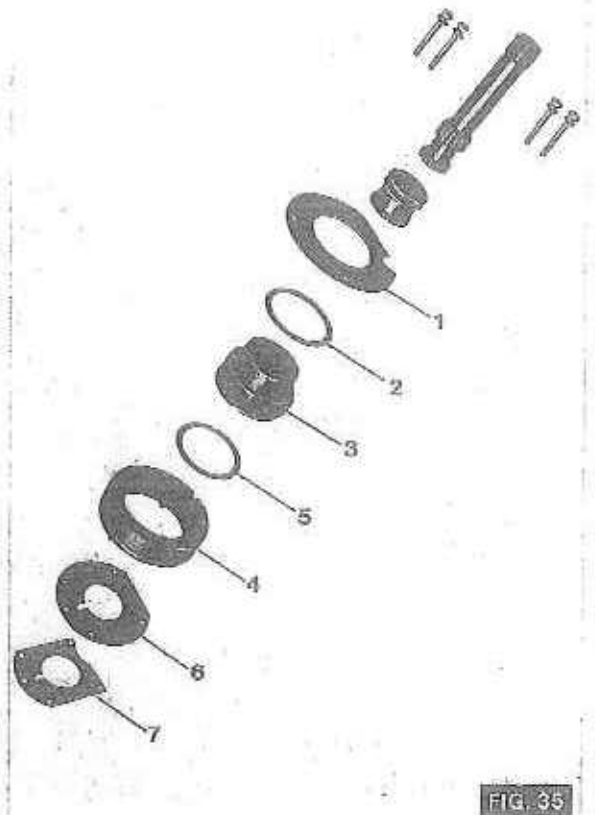
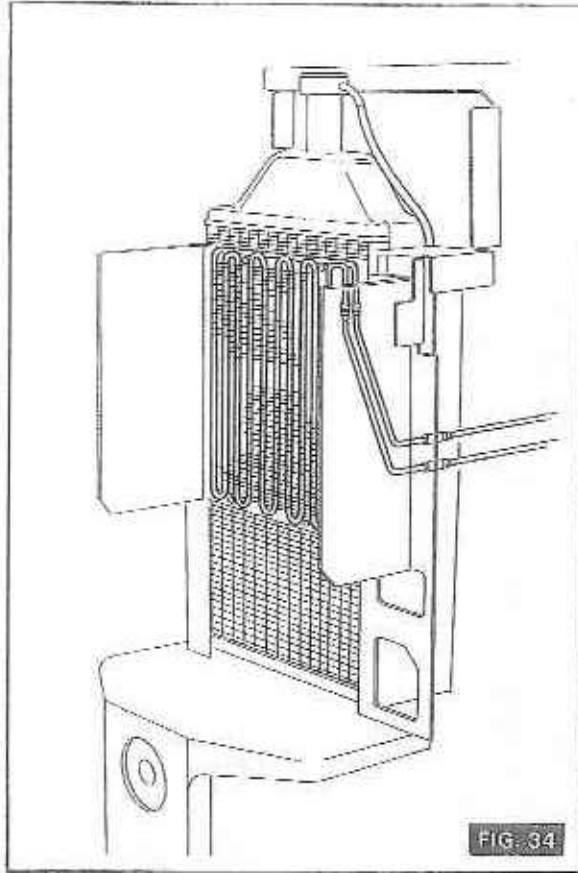
1. Remove the hood and radiator grille, as stated in operation 3A/1.
2. Disconnect the air cleaner hose at the air cleaner.
3. Remove four bolts and nuts securing the air cleaner in position.
4. Remove the four bolts and nuts securing the air cleaner support bar. Remove the support bar.
5. Slacken off the oil cooler inlet and outlet pipes by removing the screw and clip.
6. Disconnect two clips securing the oil cooler pipes and pull the inlet and outlet pipes clear.
7. Release the four bolts and nuts which hold the hydraulic oil cooler in position and withdraw the cooler.
8. Disconnect the transmission oil cooler pipes by releasing the two unions at the radiator side of the oil cooler frame.
9. Remove the four bolts and nuts securing the transmission oil cooler to the oil cooler frame.
10. (Fig. 34) Withdraw the transmission oil cooler.
11. Replacement is a reversal of the above procedure.

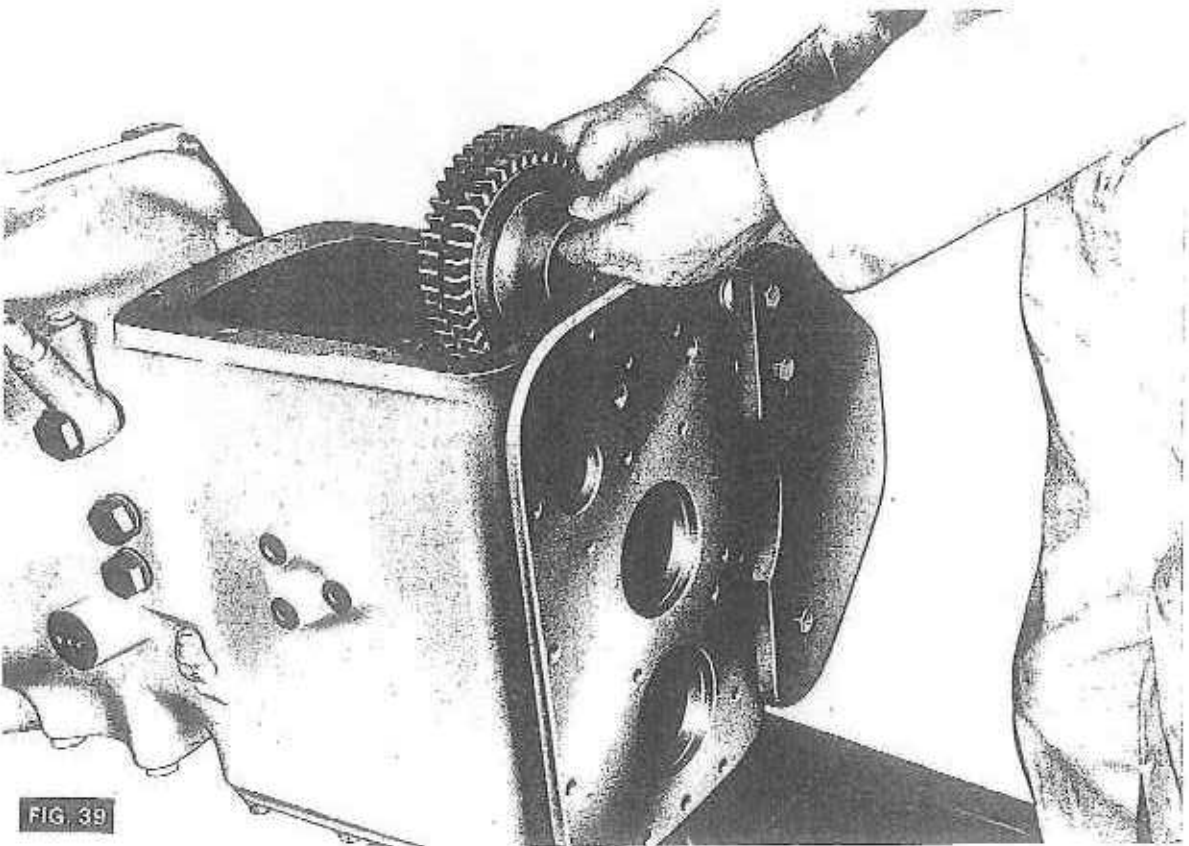
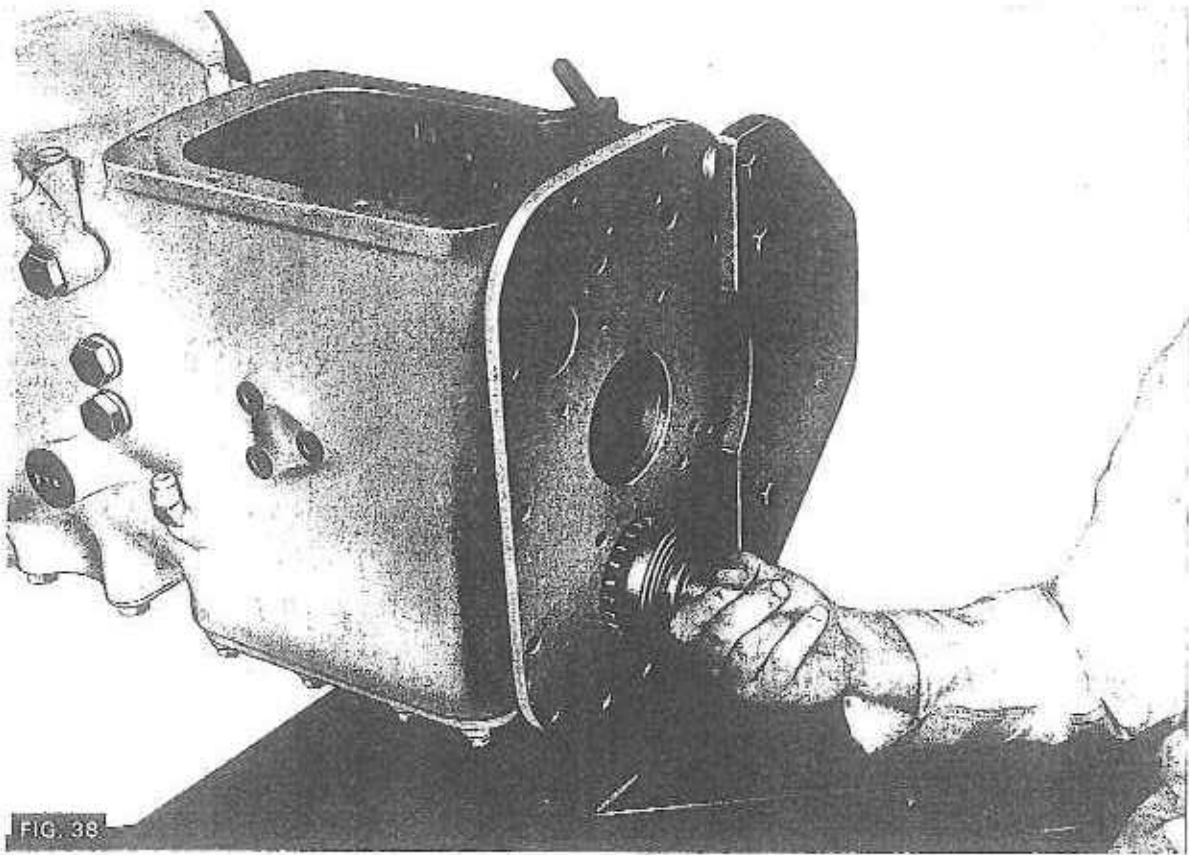
Note

Before replacing the oil cooler, ensure that the cooling fins are clean and free from mud or dust.









INSTANT REVERSE TRANSMISSION

THE TWO SPEED GEARBOX

Disassembly

(7A/15)

1. Remove the power train from the machine as described.
2. Detach the engine from the transmission case and split the power train between the transmission case and the centre axle housing as described in operation 7A/1.
3. Remove the eight bolts securing the gearbox cover to the transmission case. Lift the cover and gasket clear.
4. Remove the two bolts and washers securing the stop plate to the transmission case. Remove the stop plate.
5. Cut the locking wire and slacken the locking screws from the planetary shifter rail and selector fork. Remove the selector fork.
6. Remove the four bolts and spring washers securing the epicyclic reduction unit to the transmission case.
7. (Fig. 35) Remove the planetary gear plate (1), thrust washer (2), carrier assembly (3), planetary gear ring (4), thrust washer (5), front cover plate (6) and shim (7).
8. Slide out the planetary shifter rail and remove the plunger and spring.
9. Slacken the locking screws from the two speed shifter rail.
10. (Fig. 36) Slide out the selector rail and remove the plunger and spring.
11. Lift out the selector fork.
12. (Fig. 37) Pull out the mainshaft complete with bearing. Lift out the 1st and 2nd gear.
13. Remove the pilot bearing from the power output shaft of the instant reverse clutches.
14. (Fig. 38) Remove the countershaft with outer bearing and pinion gear through it's bore in the transmission case.
15. (Fig. 39) Lift out the pinion and driven gears from inside the transmission case.
16. Remove the countershaft inner bearing from its bore.
17. Reassembly is a reversal of the dismantling procedure.

INSTANT REVERSE TRANSMISSION

MAINSHAFT

Removal

(7A/16)

1. Remove the two snap rings.
2. Remove the bearing on an hydraulic press. Ensure that the blocks are pressing against the inner race. The bearing must be pressed off the front end of the shaft.
3. Assembly is a reversal of this procedure. Renew the snap rings.

INSTANT REVERSE TRANSMISSION

COUNTERSHAFT BEARING

Removal

(7A/17)

1. Remove the bearing using an hydraulic press, replace in the same way.

TORQUE CONVERTER

CONTENTS

	PAGE
GENERAL	4
TORQUE CONVERTER—Removal 7B/1	4
TORQUE CONVERTER—Refitting 7B/2	5
TORQUE CONVERTER—Disassembly 7B/3	5
STATOR, Disassembly 7B/4	5
STATOR, Reassembly 7B/5	5
TORQUE CONVERTER, Reassembly 7B/6	8
FLYWHEEL, Removal 7B/7	6
FLYWHEEL, Refitting 7B/8	6
CHECKING IMPELLER HUB HEIGHT 7B/9	6
CHECKING IMPELLER RUN OUT 7B/10	7
TORQUE CONVERTER AND INSTANT REVERSE TRANSMISSION, Pressure checking Procedure 7B/11	7
INSTANT REVERSE CLUTCHES—To check for oil leaks 7B/12	7
TO CHECK STALL TORQUE SPEED 7B/13	8

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	GENERAL ARRANGEMENT, TORQUE CONVERTER	4
2	DRIVE PLATE, COVER AND IMPELLER, Marked for Disassembly	4
3	TORQUE CONVERTER, Removal	4
4	COVER PLATE AND GASKET, Removal	4
5	TURBINE ASSEMBLY, Removal	5
6	STATOR, Disassembly	5
7	SNAP RING FITTED TO STATOR BODY	5
8	THRUST WASHER, Replacement	5
9	OUTER RACE FITTED INTO CLUTCH RING	5
10	OUTER RACE AND CLUTCH RING FITTED INTO STATOR	5
11	INNER RACE FITTED TO OUTER RACE	6
12	SECOND THRUST WASHER FITTED TO STATOR	6
13	HUB SEAL, Replacement	6
14	IMPELLER, COVER, Replacement	6
15	FLYWHEEL, Removal of Setscrews and Washers	6
16	FLYWHEEL AND SHIMS, Removal	7
17	FLYWHEEL AND SHIMS, Replacement	7
18	SPECIAL TOOL, MF246	7
19	SPECIAL TOOL, MF246, Wear Limits	7
20	DIAL INDICATOR, to check Impeller run out	8
21	PRESSURE TAPPING POINT, Plug removal	8
22	REGULATOR VALVE, Removal	8
23	REGULATOR VALVE, Disassembly	8

TORQUE CONVERTER

General

The drive from the engine is transmitted to the gearbox through an 11.3/4 in. (29.84 cm.) Borg and Beck torque converter coupling, comprising three main components:

- (a) An impeller assembly (1), which is bolted directly to a drive plate mounted directly onto the engine flywheel. The impeller also drives the oil pump
- (b) A turbine assembly (2), which is splined to the input shaft of the instant reverse transmission.
- (c) The stator assembly (3), which is located between the impeller and the turbine assembly and is keyed to a one way clutch. This allows the stator to revolve only in the direction of engine rotation. The clutch hub is splined to a fixed shaft of the oil pump assembly mounted on the front of the instant reverse transmission

The oil pump, attached to the front of the instant reverse transmission, supplies oil at 80 p.s.i. (5.624 kg/sq.cm.). Oil is directed through drillings in the oil pump housing and then between the fixed shaft of the oil pump and the instant reverse input shaft, which revolves inside the fixed shaft.

As the converter housing is filled with oil at all times whilst it is working, the amount of wear which takes place is negligible and therefore should cause no trouble. Any failures will usually be confined to the cover assembly gasket or the hub gasket.

The torque ratio of the converter alters according to the load imposed on it. The stall speed of the converter is approximately 1600 r.p.m. At this speed the stator is still stationary, but the oil drag is such that the power of the engine is insufficient to drive the turbine. With this condition maximum torque multiplication occurs. The maximum torque ratio is 2.1:1.

The normal working temperature of the oil is 180° - 210°F (82° - 99°C). The temperature of the oil should never be allowed to exceed 250°F (121.1°C). This is indicated by the red zone on the torque converter oil temperature gauge. If the oil does overheat, DO NOT STOP THE ENGINE. Stop work and allow the engine to idle until the temperature returns to normal.

Key to Fig 1

1. Cover Plate
2. Turbine
3. Impeller
4. Stator

TORQUE CONVERTER

Removal

(7B/1)

1. Remove the engine, transmission and final drives from the machine as described.
2. Remove the transmission and final drives from the engine as described.
3. (Fig. 2) Mark the flywheel, cover and impeller with a centre punch or scriber in order to facilitate correct reassembly.
4. Remove the six bolts, washers and special nuts holding the torque converter to the flywheel.
5. (Fig. 3) Lift the torque converter clear from the flywheel, maintaining a vertical position in order to prevent oil spillage through the hub.
6. Remove the two taper plugs from the cover plate and drain the oil. Replace the plugs when the oil has been drained.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

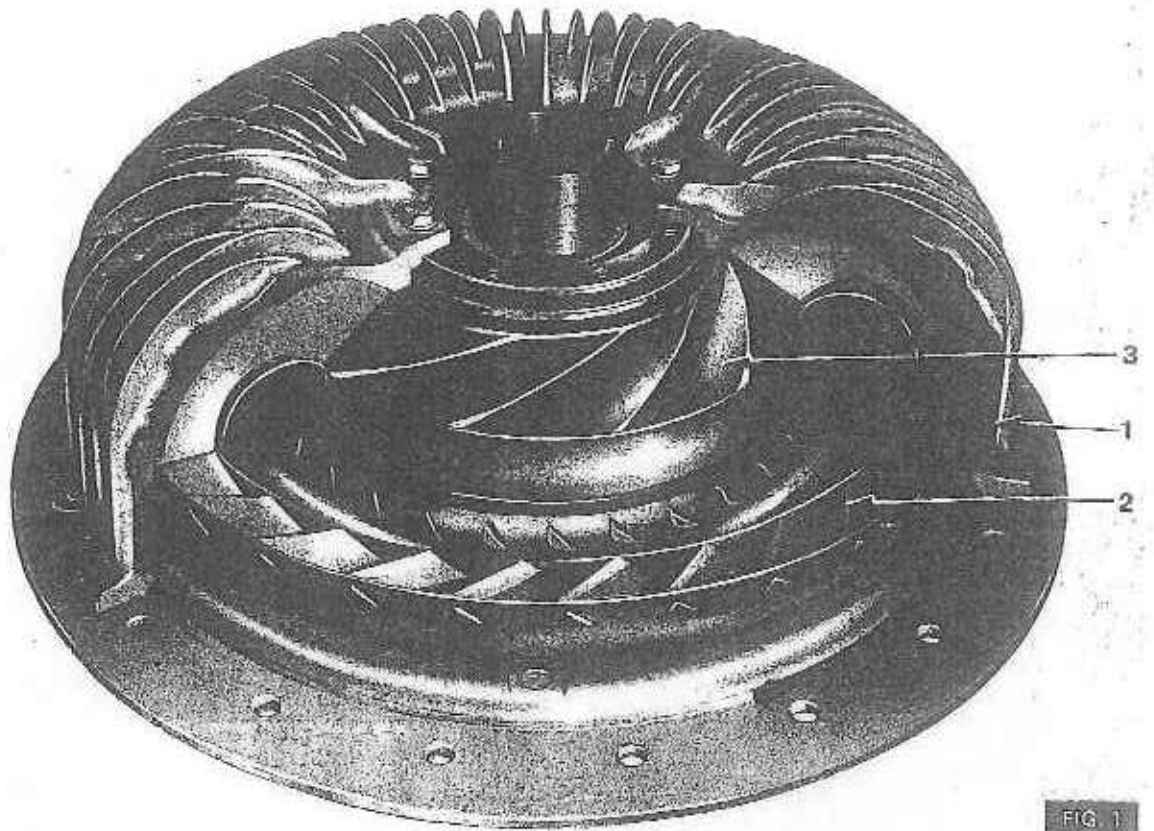


FIG. 1

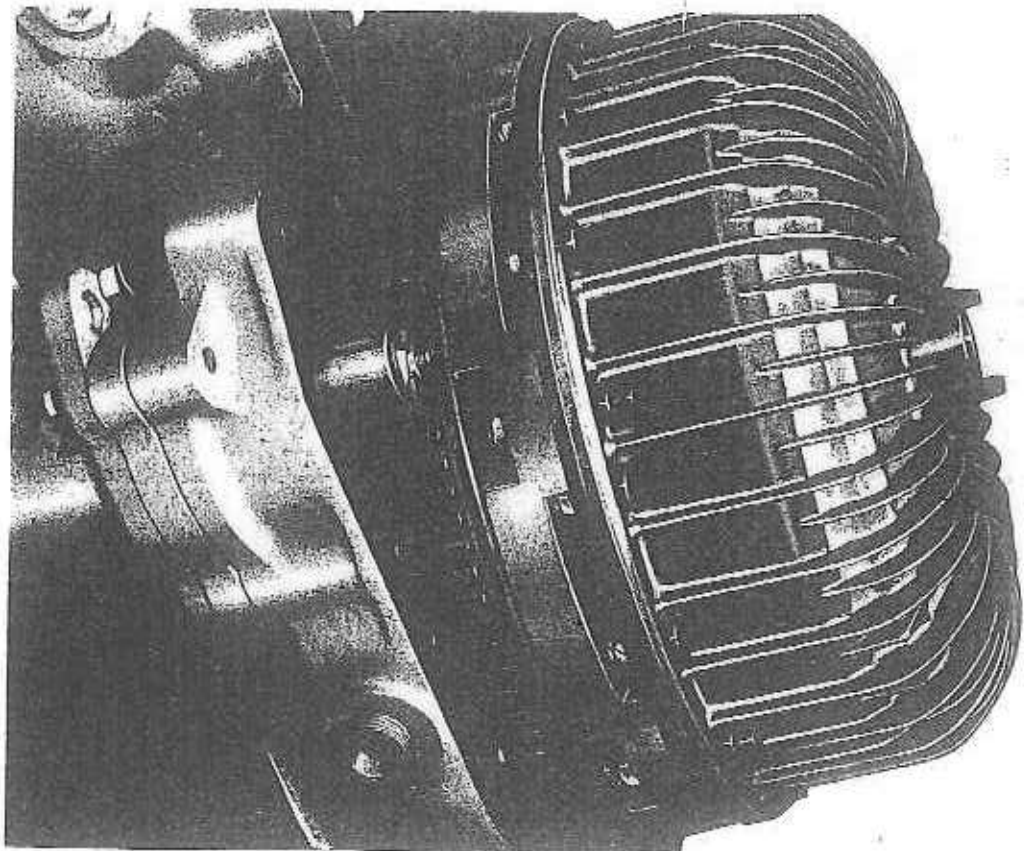
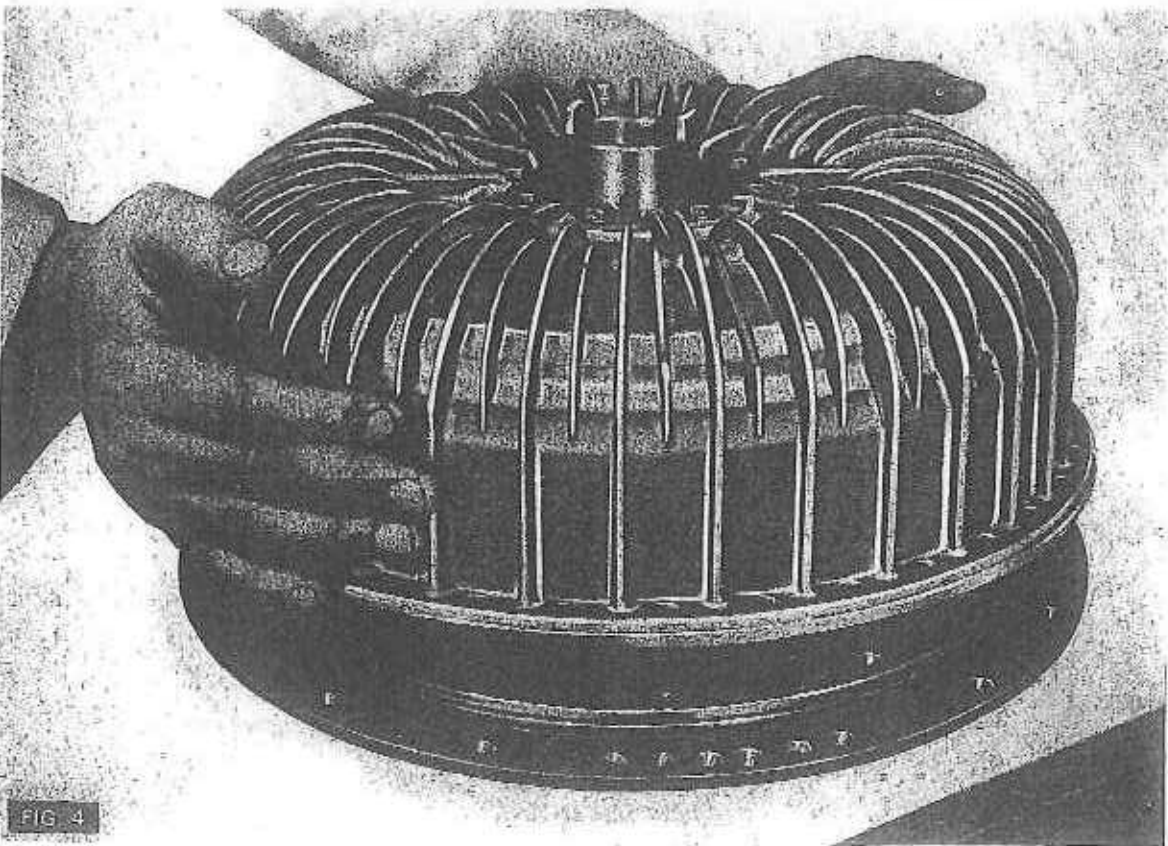
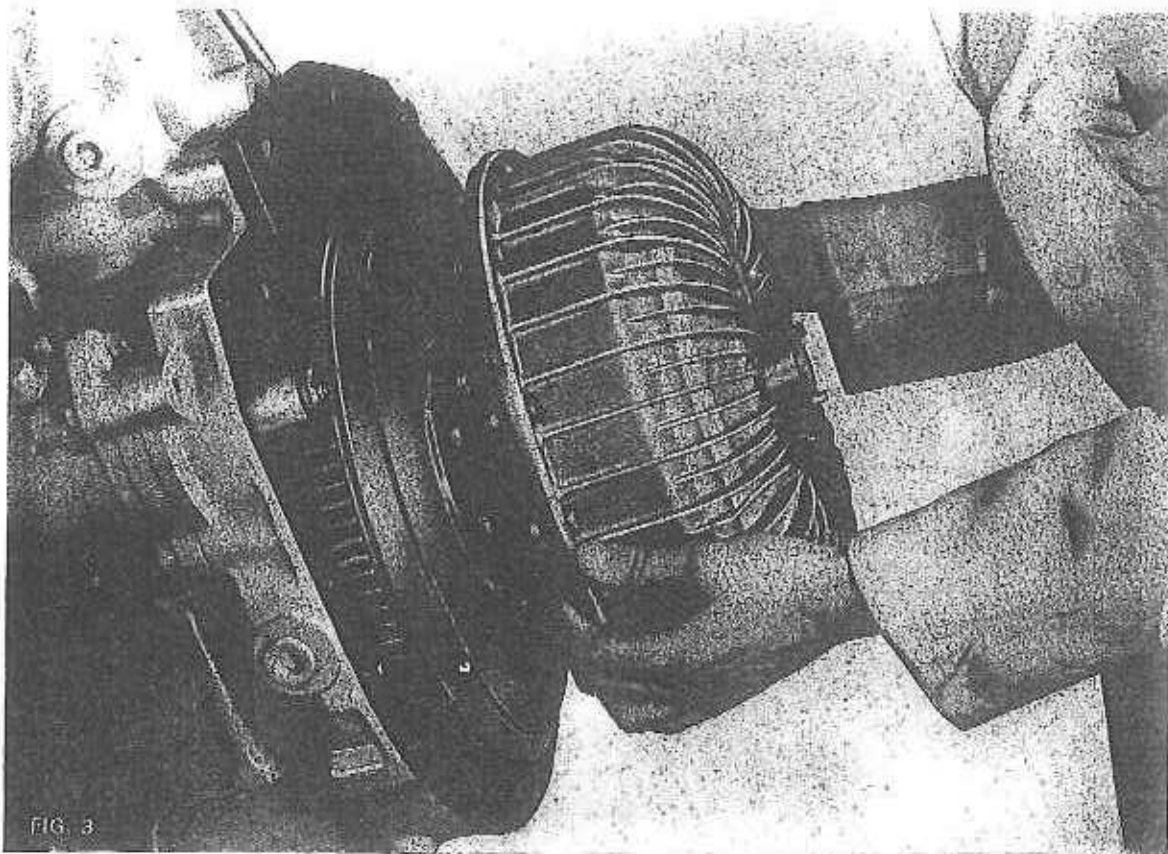
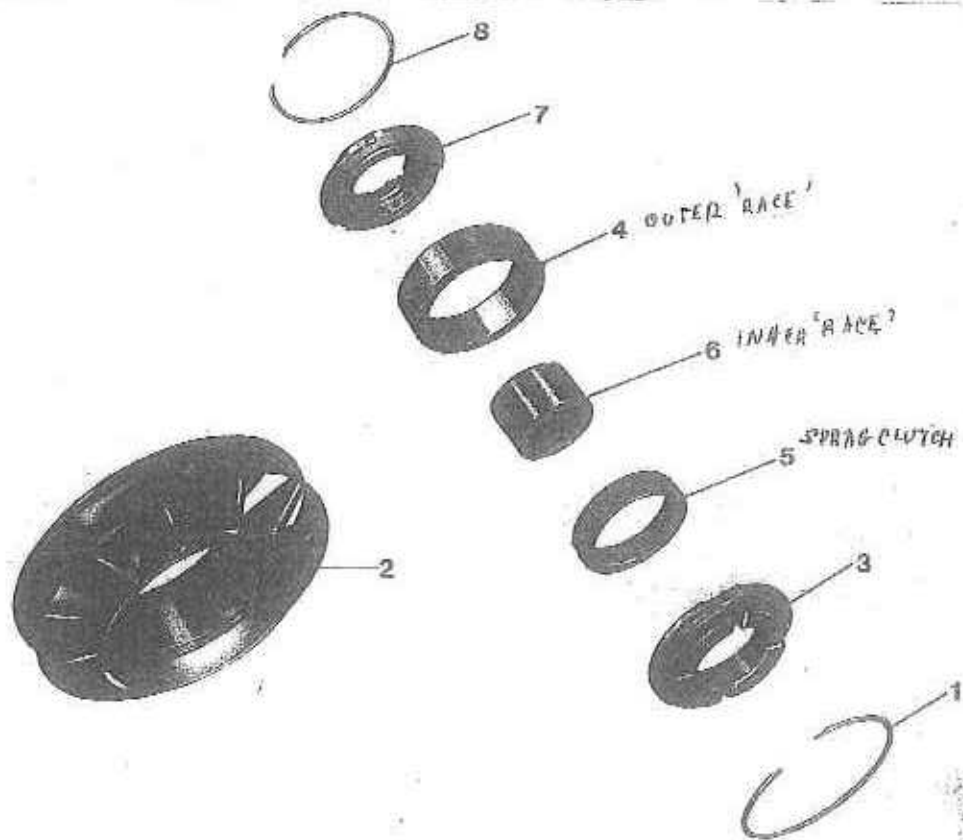
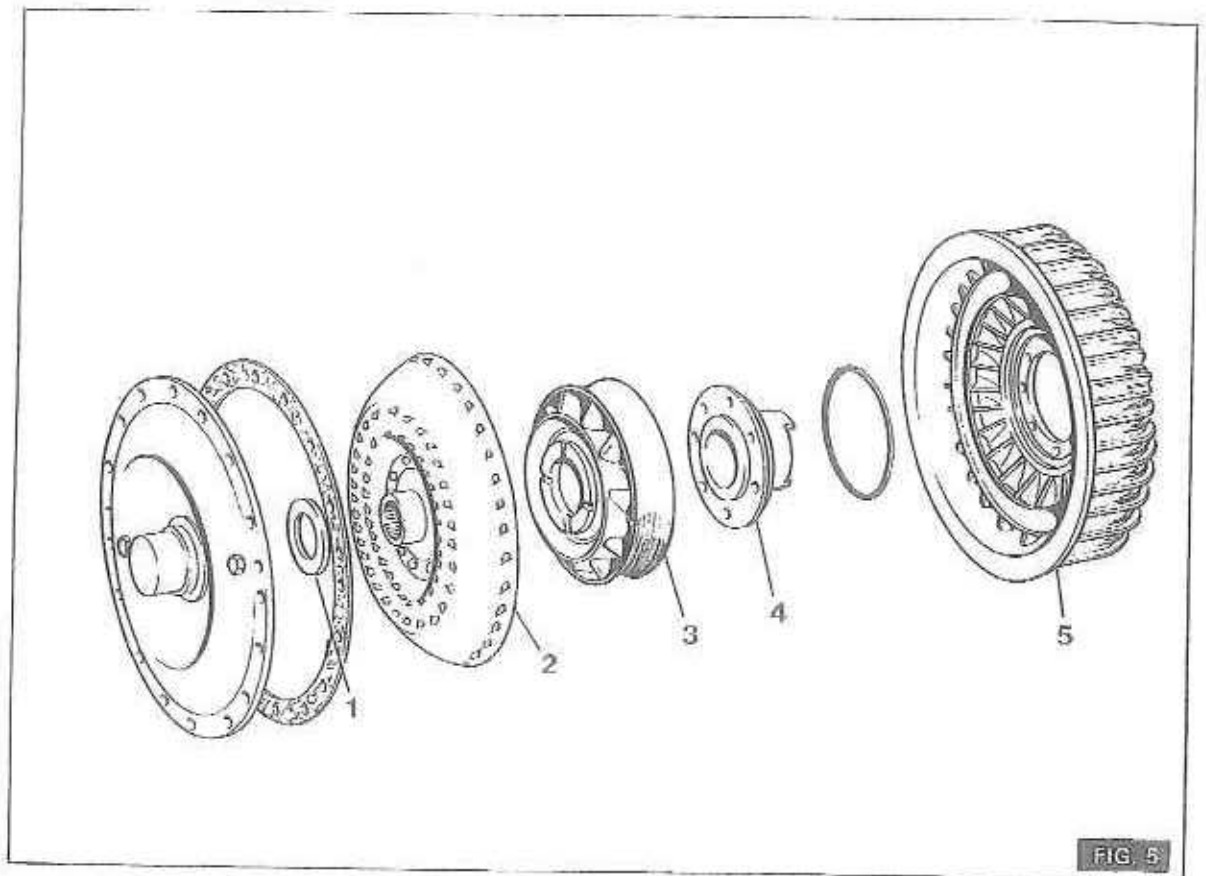


FIG. 2





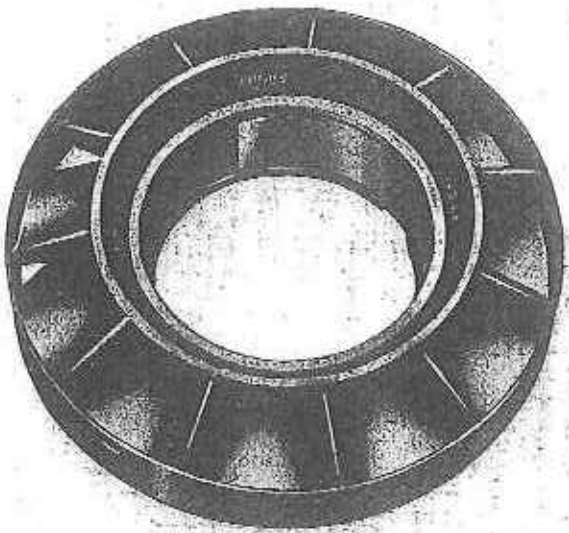


FIG 7

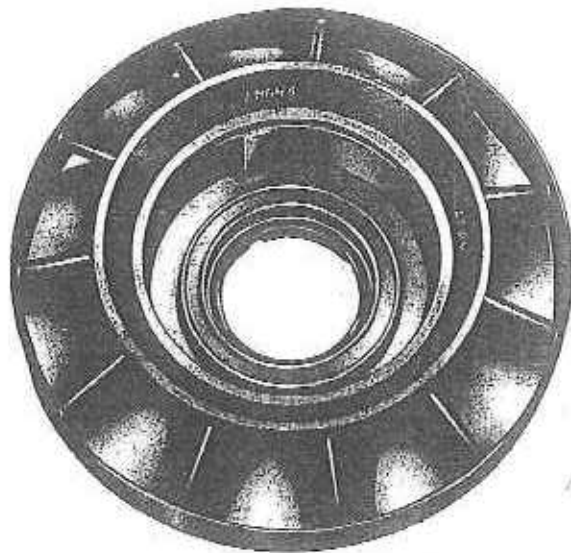


FIG 8

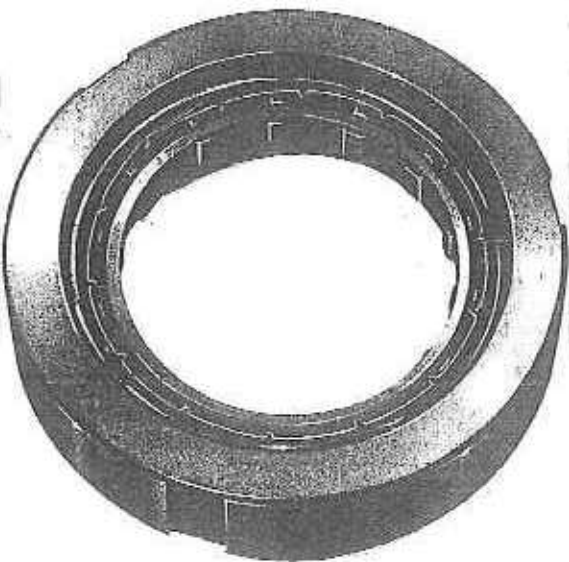


FIG 9

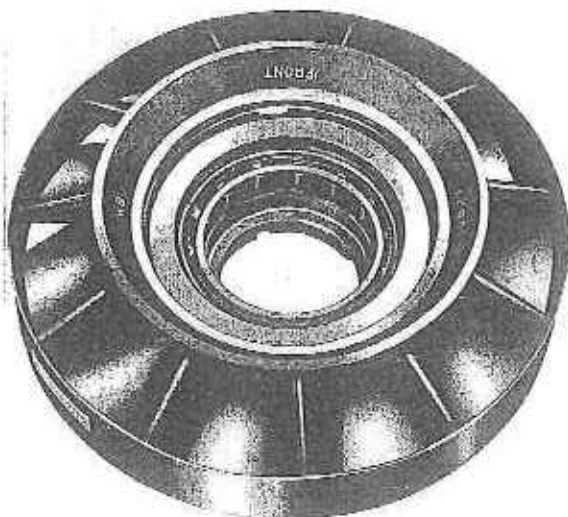


FIG 10

TORQUE CONVERTER

Refitting

(7B/2)

1. Fit the torque converter to the flywheel, ensuring that the alignment marks are correctly positioned.
2. Fit the washers to six new bolts and insert the bolts into the converter.
3. Screw on six new special nuts and tighten evenly to a torque setting of 22 lb.ft. (3.04 kg.m.).
4. Carry out the hub height test as detailed in operation 7B/9 and the hub run out test as detailed in operation 7B/10.
5. Replace the transmission and final drives to the engine.

TORQUE CONVERTER

Disassembly

(7B/3)

1. Remove the torque converter as described in operation 7B/1.
2. Remove the twelve special bolts and nuts securing the impeller to the cover assembly.
3. (Fig. 4) Lift the cover plate and gasket from the impeller.
4. (Fig. 5) Remove the turbine thrust washer (1) and the turbine assembly (2).
5. Withdraw the stator assembly (3).
6. Mark the hub and impeller assembly to indicate the reassembly position.
7. Remove the eight bolts securing the hub (4) to the impeller (5). Lift the hub and gasket from the impeller.

STATOR

Disassembly

(7B/4)

1. Remove the stator assembly as stated in operation 7B/3.
 2. (Fig. 6) Remove the snap ring (1) from the stator body (2) and lift out the thrust washer (3).
 3. Slide out the clutch mechanism, i.e. the clutch ring (4), the outer race (5) and the inner race (6).
 4. Remove the second thrust washer (7) and snap ring (8).
 5. Slide the inner race from the outer race and the outer race from the clutch ring.
 6. Carefully examine all parts of the torque converter to ensure that no component is damaged. Renew damaged items where necessary. Individual assemblies, with the exception of the stator clutch assembly, cannot be serviced and must be replaced complete.
- If the lugs on the impeller hub become worn more than .125 in. (3.175 mm.) at the tip of the lug, the hub must be replaced.

STATOR

Reassembly

(7B/5)

1. (Fig. 7) Fit the snap ring into the groove in the stator body, on the opposite side to the face of the stator marked 'FRONT'.
2. Place the stator with the face marked 'FRONT' uppermost.
3. (Fig. 8) Replace one thrust washer with the slotted side against the circlip.
4. (Fig. 9) Insert the outer race into the clutch ring.
5. (Fig. 10) Slide the outer race and clutch ring into the stator body, with the broader flange of the clutch uppermost.
6. (Fig. 11) Insert the inner race into the outer race with the splined end uppermost.
7. (Fig. 12) Replace the second thrust washer and lock in place with the snap ring.
8. Ensure that, with the inner race held stationary, the stator body will only rotate clockwise when viewed from the front.

TORQUE CONVERTER

Reassembly . . . Cont'd

Note

Reassembly must be performed with the stator body face marked 'FRONT' uppermost.
This is important.

Reassembly

(7B/6)

1. (Fig. 13) Fit a new hub seal into place in the impeller assembly.
2. Align the marks on the hub with the mark on the impeller and secure the hub in position with the eight bolts and washers. Apply a torque loading of 8-10 lb.ft. (1.106 kg.m.) to the bolts.
3. Replace the stator assembly with the face marked 'FRONT' uppermost, in the impeller assembly.
4. Fit the turbine into the impeller assembly.
5. Place the thrust washer onto the turbine hub.
6. (Fig. 14) Fit a new seal onto the cover plate and place the cover on the impeller assembly, ensuring that the alignment marks correspond.
7. Replace the twelve special bolts, fit new nuts and tighten to 22 lb.ft. (3.04 kg.m.).

FLYWHEEL

Removal

(7B/7)

1. Remove the torque converter as stated in operation 7B/1.
2. Turn the flywheel until the dowel hole is at the top.
3. (Fig. 15) Straighten the tab washers (1) and slacken the setscrews (2) that secure the flywheel to the crankshaft.
4. Insert a suitable rod into the dowel hole and remove the setscrews and tabwashers.
5. (Fig. 16) Insert the rod into the dowel hole in the flywheel and gently lever the flywheel, complete with shims, onto the rod.
6. Remove the shims from the flywheel.

FLYWHEEL

Refitting

(7B/8)

1. Insert the rod through the flywheel, place the shims onto the rod.
2. (Fig. 17) Lift the flywheel, with shims on the rod. Insert the rod into the locating hole in the crankshaft.
3. Slide the shims and flywheel into position against the crankshaft.
4. Fit three new tabwashers and the six setscrews to secure the flywheel to the crankshaft. Tighten the setscrews to a torque loading of 70-80 lb.ft. (10.5-11.1 kg.m.).
5. Bend the tabwashers over to lock the setscrews in position.

CHECKING IMPELLER HUB HEIGHT

(7B/9)

1. Remove the power train and detach the engine from the transmission as stated in operation 7A/1.
2. (Fig. 18) Place the special tool, MF 246, over the torque converter with the feet of the gauge on the engine backplate.
3. By moving the gauge, determine whether the hub height is within the limits of the gauge.
4. (Fig. 19) If the 'NO GO' limit passes over the hub face, add shims between the flywheel and crankshaft until the height is within the limits.
5. To add shims, carry out operations 7B/7 and 7B/8, fitting or removing shims as required.

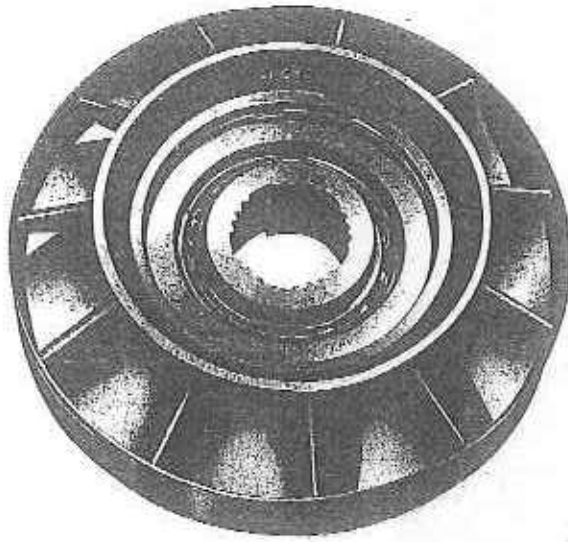


FIG 11



FIG 12

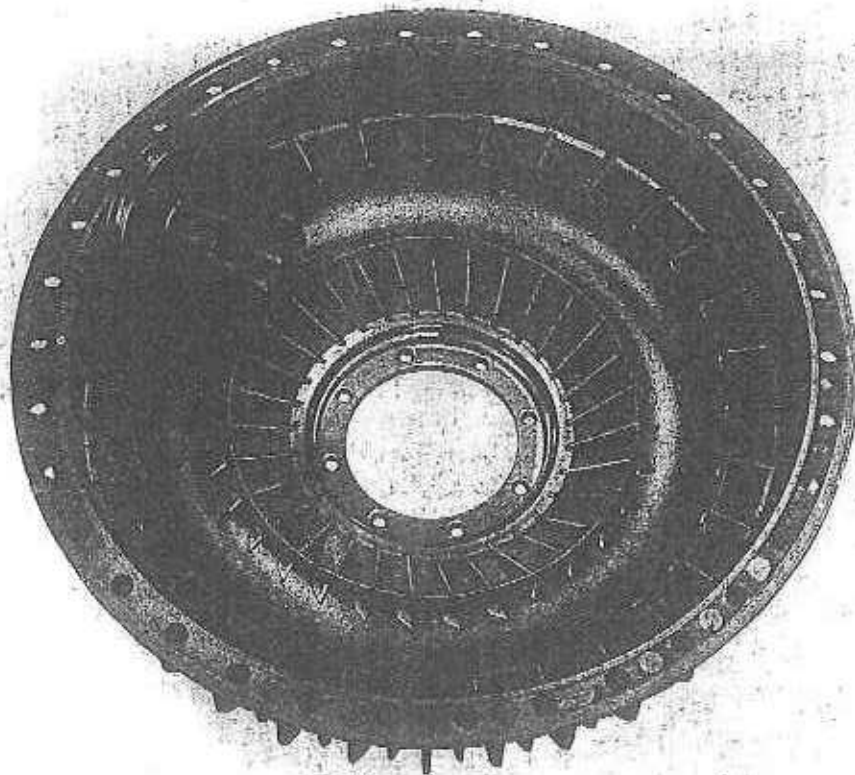


FIG 13



FIG 14

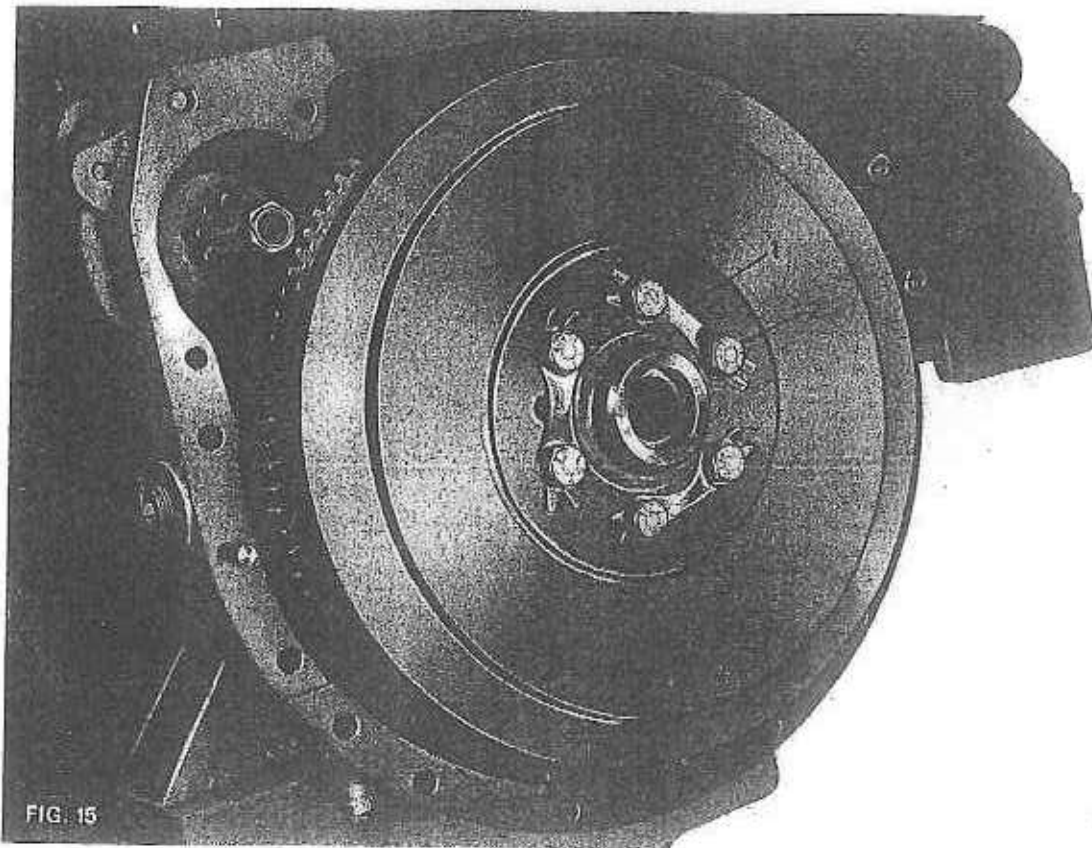


FIG 15

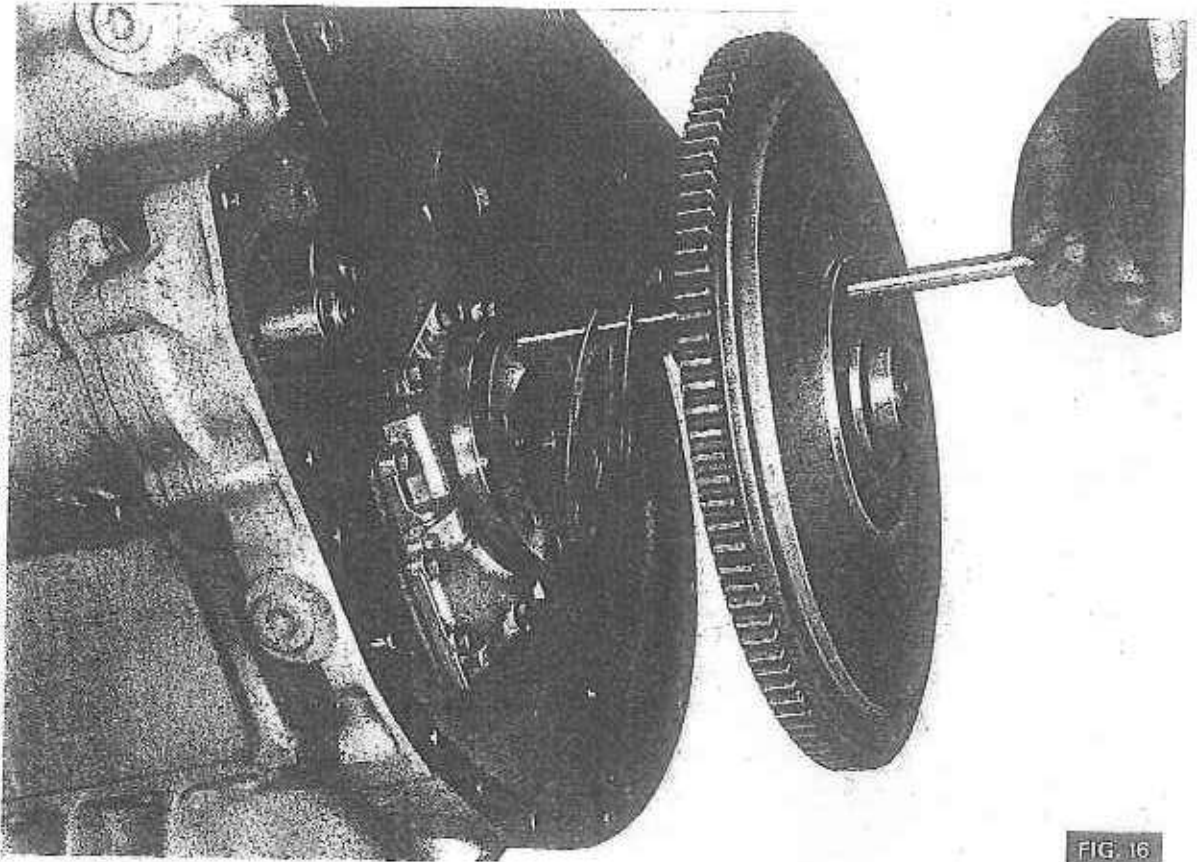


FIG. 16

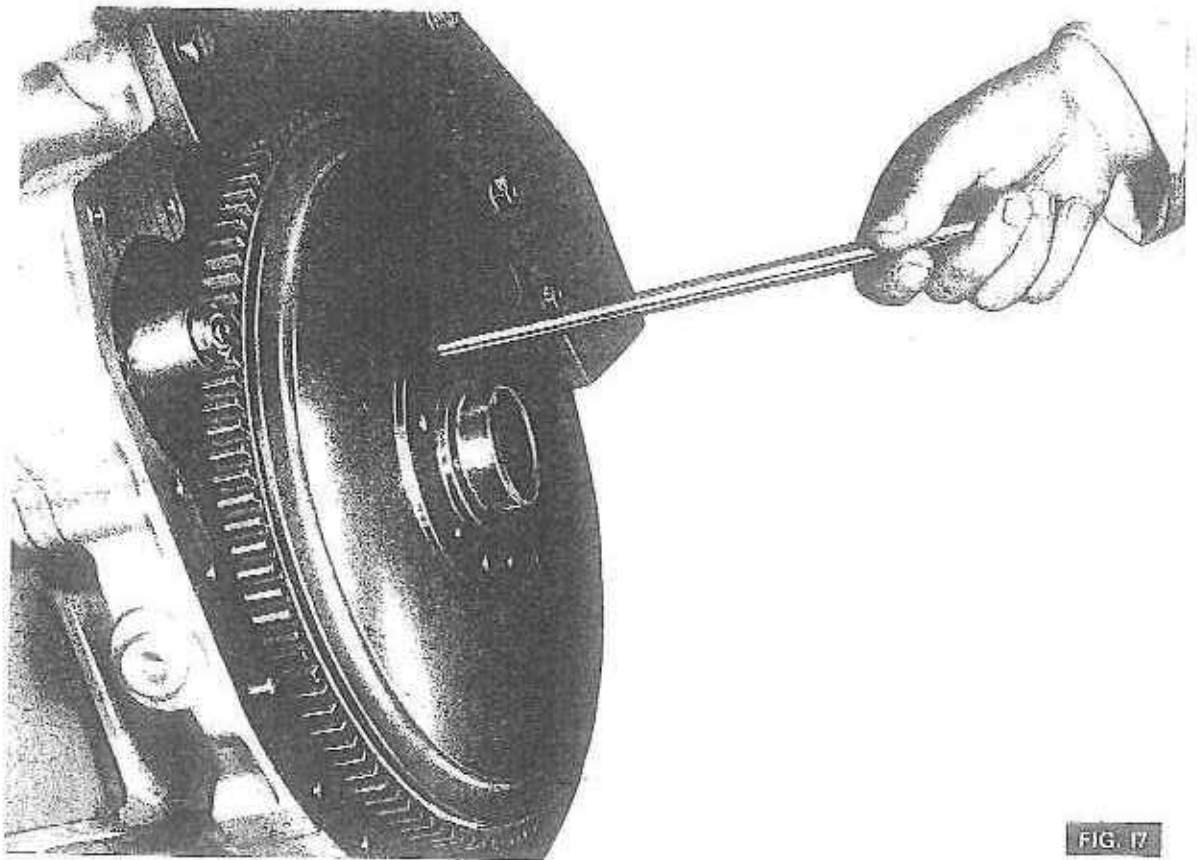
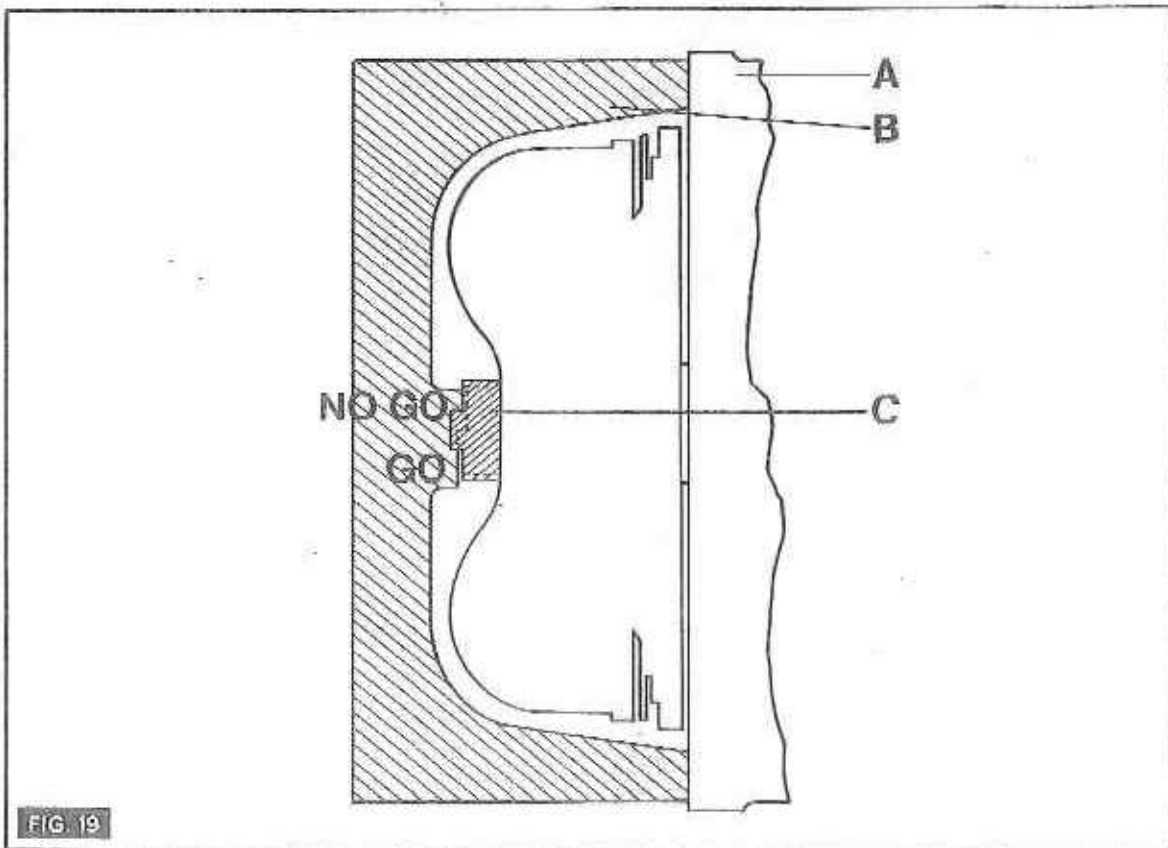
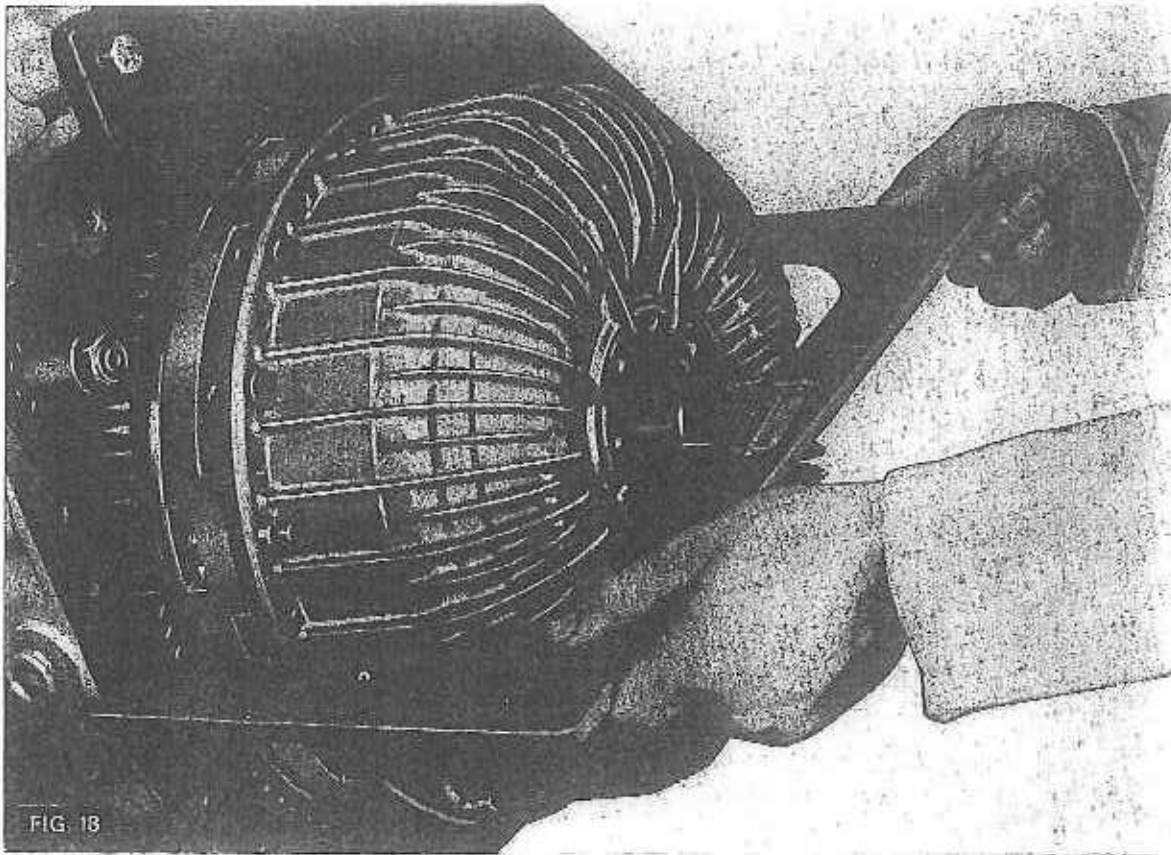


FIG. 17



CHECKING IMPELLER HUB HEIGHT ... Cont'd

Note

Shim thickness is 0.020 in. (508 mm.) and the difference between the 'GO' and 'NO GO' limit is 0.080 in. (2.032 mm.). Determine the number of shims necessary by checking with feeler gauges. Add shims between the flywheel and crankshaft until the hub height is as near to the 'GO' limit as possible.

CHECKING IMPELLER RUN OUT

(7B/10)

1. (Fig. 20) Fix a dial indicator base to the engine backplate.
2. Adjust the indicator plunger to run on the edge of the hub. Set the indicator to zero.
3. Turn the torque converter and check the indicator reading (run out).
4. Total run out should not exceed 0.010 in. (0.154 mm.). If the run out exceeds this figure, insert a suitable lever between the flywheel and drive plate. Bend the drive plate slightly at the point of maximum run out, until a satisfactory reading is obtained.

TORQUE CONVERTER AND INSTANT REVERSE TRANSMISSION

Pressure Checking Procedure

7B/11)

1. Check the oil level.
2. (Fig. 21) Remove the plug (1) from the top of the bell housing. Grip the base nut firmly with a spanner when removing the nut.

CAUTION

DO NOT TURN THE BASE NUT (2) AS THIS WILL SHEAR THE INTERNAL PIPE NECESSITATING A COMPLETE STRIP DOWN.

3. Install the pressure gauge MF 260 with adaptor MF 260/2 into the base nut on top of the bell housing.
4. (Fig. 22) Remove the top regulator valve cap (A) on the left hand side of the transmission case.
5. (Fig. 23) Remove the spring, guide pin and regulator valve. Examine the 'O' ring on the valve cap, renew if necessary, and refit the valve cap.
6. Start the engine and set the speed at 1800 r.p.m.
7. The pressure reading on the gauge should be 80 ± 5 p.s.i. (5.6 ± 0.35 kg./sq.cm.). This pressure is set by the LOWER regulator valve.
8. If the pressure reading is low, stop the engine and fit shim(s) between the spring and regulator cap on the LOWER regulator valve (B) until a satisfactory reading is obtained.
9. When a satisfactory reading is obtained, stop the engine and replace the TOP regulator valve assembly ensuring that the guide pin is correctly located in the valve poppet.
10. Set the engine speed again to 1800 r.p.m. and check the pressure reading which should now be 160 ± 5 p.s.i. (11.15 ± 0.35 kg./sq.cm.). This pressure is set by the TOP regulator valve which should be adjusted by shim(s) if necessary in the same manner as the LOWER valve. The free length of the springs in the valves should be $2.14 \pm 1/16$ in. (57 ± 1.6 mm.).

Note

The oil must be up to the correct level and at the correct working temperature of $180^{\circ} - 210^{\circ}$ F ($82^{\circ} - 99^{\circ}$ C.) when pressure testing. Always check the pressure of the lower valve before adjusting the top valve. The presence of air in the system is indicated by a buzzing noise. Do not test the pressure under these circumstances, but allow the engine to idle for a short time to dispel any air from the system.

INSTANT REVERSE CLUTCHES

To Check for Oil Leaks

(7B/12)

1. Set the engine speed at 1800 r.p.m.

INSTANT REVERSE CLUTCHES

To Check for Oil Leaks . . . Cont'd

2. With the gear levers in the neutral position, fully depress the FORWARD and REVERSE pedals in turn.
3. Check that the indicated pressure drops momentarily and then re-establishes a reading of 160 p.s.i. (11.25 kg./sq.cm.). If a low reading is apparent, this indicates a leak in the feed system to the clutches.

TO CHECK STALL TORQUE SPEED

(7B/13)

1. Check the level of the oil in the system. Run the engine until the oil temperature is within the working range of 180° - 210°F (82° - 99°C).
2. Apply the brakes to ensure that the tractor cannot move.
3. Check the maximum engine speed with the gears in neutral. This should be 2,000 r.p.m.
4. Place the planetary gear-selector in the HIGH range and the gear shift in SECOND gear.
5. Depress fully the FORWARD pedal. The engine speed should be 1350-1450 r.p.m.
6. Repeat above procedure with the REVERSE pedal. If the engine speed is higher than 1450 r.p.m. during either of the above operations, then it indicates the respective clutch is slipping or that the torque converter is cavitating, the latter condition is made apparent by a high pitched whine. If the engine speed is lower than 1350 r.p.m. then this indicates that the engine requires attention.

Note

This test must be carried out with the oil at its normal working temperature 180° - 210° (82° - 99°C). The test should be concluded as quickly as possible as the oil temperature will rise rapidly. The oil temperature must not, at any time, exceed 250°F (121°C).

OIL TEMPERATURE

Operating Range

The normal temperature range of the transmission and torque converter oil is 180° - 210°F (82° - 99°C). Under no circumstances must the oil temperature exceed 250°F (121°C).

If the oil temperature should reach 250°F (121°C), stop work and allow the engine to idle until the oil temperature drops to the normal working range.

DO NOT STOP THE ENGINE WITH THE OIL AT THIS HIGH TEMPERATURE, AS THIS WILL CAUSE THE OIL SEALS TO BE DAMAGED.

Persistent overheating is usually caused by operating the machine in too high a gear or because the oil is not up to the correct level.

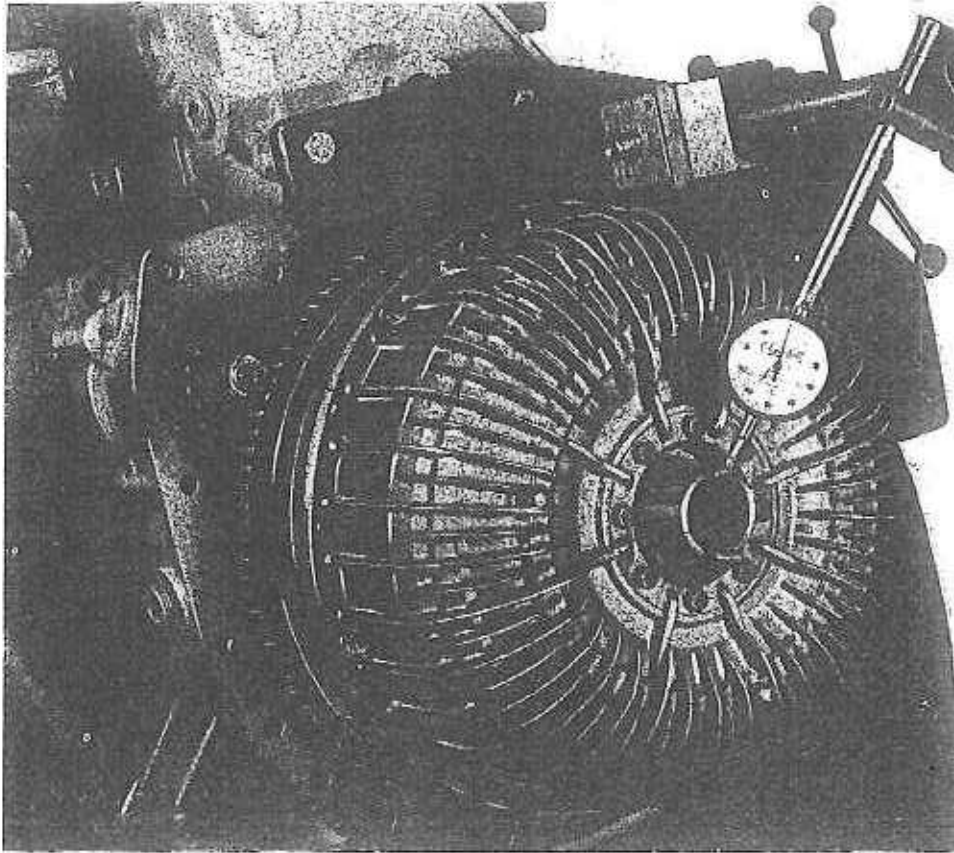


FIG. 20

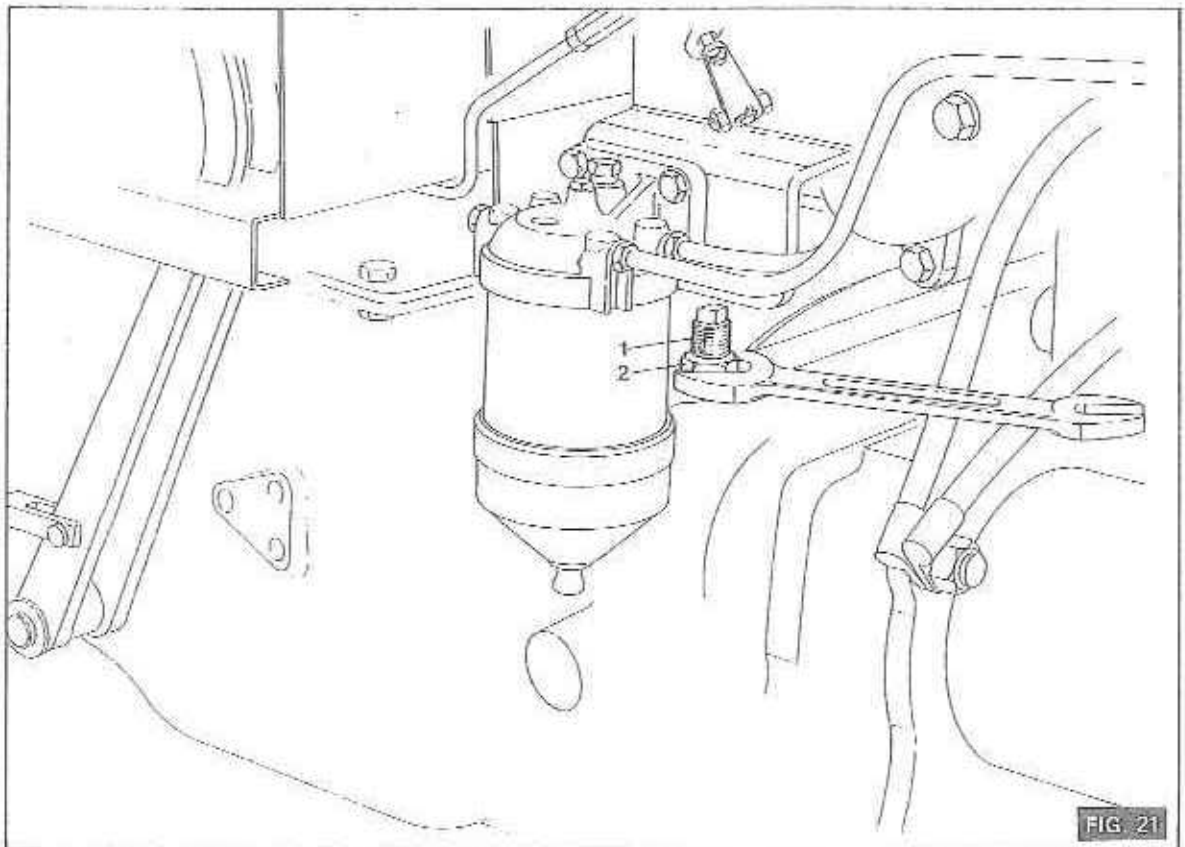
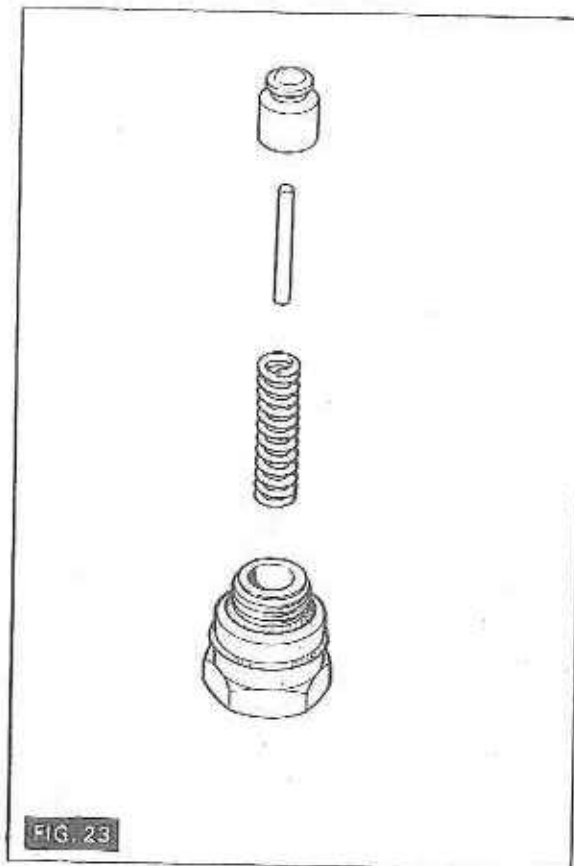
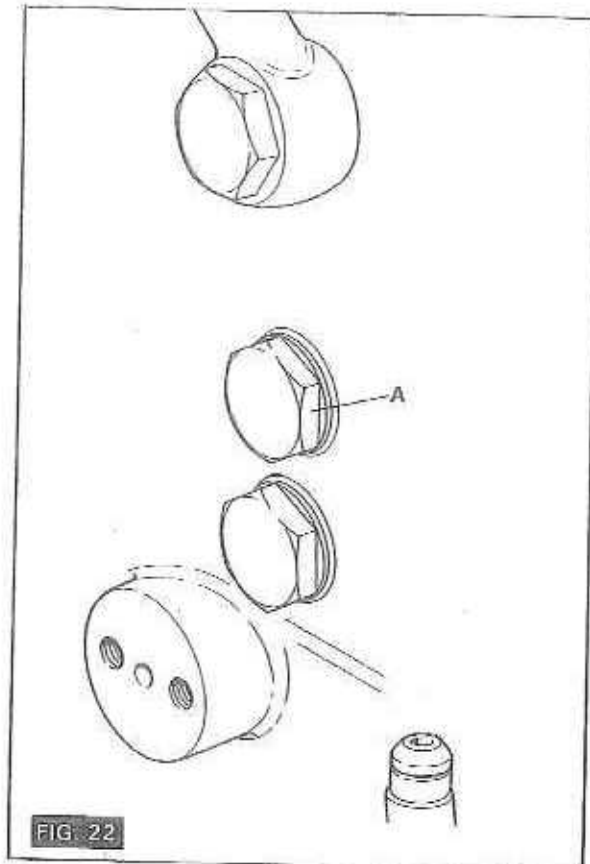


FIG. 21



ON500. 1983 APPROX JUNE (EARLY)

Aluminum Torque Converters were fitted in production again
with different ratio from the steel ones previously
in use.

From	2WD	2882	W 1372
	4WD	2915	W 582
		PLUS	W 544

} + 7 by KPS

S. CANN
AC BAKER
D. HODGES
R. CARTER
H. DUNSTON
WACKER
GOLDSWORTHY

REAR AXLE AND WET BRAKES

CONTENTS

	PAGE
GENERAL	4
EPICYCLIC UNIT, REMOVAL AND REFITTING (8A/1)	4
PLANETARY PINION CARRIER, DISASSEMBLY (8A/2)	4
PLANETARY PINION CARRIER, REASSEMBLY (8A/3)	5
EPICYCLIC CARRIER BEARING, PRE-LOAD SETTING (8A/4)	5
EPICYCLIC CARRIER INNER ROLLER BEARING, REMOVAL (8A/5)	6
EPICYCLIC CARRIER INNER ROLLER BEARING, REPLACEMENT (8A/6)	6
EPICYCLIC CARRIER INNER BEARING CUP, REMOVAL (8A/7)	6
EPICYCLIC CARRIER INNER BEARING CUP, REPLACEMENT (8A/8)	7
WHEEL AXLE AND DRIVE COVER, DISASSEMBLY (8A/9)	7
WHEEL AXLE AND DRIVE COVER, REASSEMBLY (8A/10)	7
AXLE SHAFT OUTER OIL SEAL, REMOVAL AND REPLACEMENT (8A/11)	8
AXLE SHAFT HOUSING, REMOVAL AND REFITTING (8A/12)	8
LEFT HAND DIFFERENTIAL CARRIER PLATE, REMOVAL AND REPLACEMENT (8A/13)	8
LEFT HAND DIFFERENTIAL CARRIER PLATE BEARING CONE, REMOVAL AND REFITTING (8A/14)	8
RIGHT HAND DIFFERENTIAL CARRIER PLATE, REMOVAL AND REPLACEMENT (8A/15)	9
RIGHT HAND DIFFERENTIAL CARRIER PLATE BEARING CUP, REMOVAL AND REPLACEMENT (8A/16)	9
DIFFERENTIAL CASE ASSEMBLY, REMOVAL AND REPLACEMENT (8A/17)	9
LEFT HAND DIFFERENTIAL BEARING CUP, REMOVAL AND REFITTING (8A/18)	9
RIGHT HAND DIFFERENTIAL BEARING CONE, REMOVAL AND REFITTING (8A/19)	9
DIFFERENTIAL CASE, DISASSEMBLY AND REASSEMBLY (8A/20)	10
DIFFERENTIAL BEARING PRE-LOAD, ADJUSTMENT (8A/21)	10
DRIVE PINION ASSEMBLY, REMOVAL AND DISASSEMBLY (8A/22)	11
PINION INNER BEARING CONE, REMOVAL AND REFITTING (8A/23)	11
PINION PILOT BEARING, REMOVAL AND REFITTING (8A/24)	11
DRIVE PINION ASSEMBLY, REASSEMBLY, PRE-LOAD SETTING AND REFITTING (8A/25)	11
DIFFERENTIAL LOCK MECHANISM, DISASSEMBLY (8A/26)	12
DIFFERENTIAL LOCK MECHANISM, REASSEMBLY (8A/27)	12
DIFFERENTIAL LOCK, ADJUSTMENT (8A/28)	12
DIFFERENTIAL LOCK OPERATING BRACKET, REMOVAL AND REPLACEMENT (8A/29)	12
SPEEDOMETER DRIVE ASSEMBLY, REMOVAL AND REFITTING (8A/30)	12
BRAKE ACTUATOR HOUSING, REMOVAL AND REFITTING (8A/31)	13
DISC BRAKES, ADJUSTMENT AND BALANCING (8A/32)	13
LEFT HAND DISC BRAKE UNIT, REMOVAL AND REFITTING (8A/33)	14
RIGHT HAND DISC BRAKE UNIT, REMOVAL AND REFITTING (8A/34)	14
BRAKE EXPANDER UNIT, DISASSEMBLY AND REASSEMBLY (8A/35)	14
DRUM BRAKES	14

LIST OF ILLUSTRATIONS

Figure	Facing Page
1 General Arrangement	4
2 Epicyclic Unit, withdrawal	5
3 Pinion Shaft Securing Screw, removal	5
4 Pinion Shaft, removal	6
5 Wheel Axle and Carrier, reassembly	6
6 Epicyclic Carrier, pre-load determining	6
7 Epicyclic Carrier, inner roller bearing removal	6
8 Epicyclic Carrier, inner roller bearing replacement	6
9 Epicyclic Carrier, inner bearing cup removed	6
10 Wheel Axle Drive Cover, disassembly	6
11 Drive Cover and Bearing, withdrawal	7
12 Wheel Axle and Drive Cover, reassembly	7
13 Snap Ring/Bearing Cone, shim measurement	7
14 Snap Ring, measurement	7
15 Speedometer Gearbox, removal	7
16 Axle Housing, removal	7
17 Differential Carrier Plate, removal	8
18 L. H. Carrier Plate, removal	8
19 L. H. Carrier Plate, replacement	8
20 R. H. Carrier Plate, shifter fork removal	8
21 R. H. Carrier Plate, removal	8
22 Fitting of Carrier Plate Shield	9
23 L. H. Differential Bearing Cup, removal	9
24 L. H. Differential Bearing Cup, replacement	9
25 R. H. Differential Bearing Cone, removal	9
26 R. H. Differential Bearing Cone, replacement	9
27 Differential Case, disassembly	9
28 Differential Case, disassembly	10
29 Differential Bearing, pre-load adjustment	10
30 Setting of Special Tool MF 345 C	10
31 Measuring Bearing Shield Thickness	10
32 Drive Pinion Assembly, removal	11
33 Pinion Inner Bearing Cone, Removal	11
34 Pinion Pilot Bearing, Removal	11
35 Drive Pinion, pre-load setting	11
36 Drive Pinion, re-fitting	11
37 Differential Lock Mechanism, removal	12
38 Differential Lock Operating Bracket, removal	12
39 Speedometer Drive Assemble, removal	13
40 Parking Brake Linkage, removal	14
41 Disc Brake, adjusting	14
42 Disc Brake Unit, disassembly	14
43 Brake Expander Unit, disassembly	14

REAR AXLE AND WET BRAKES

GENERAL

The drive from the transmission mainshaft is transmitted through the rear drive shaft and shear tube to a spiral bevel driving pinion and crown wheel, then through the axle shafts and epicyclic reduction units to the rear wheel axles.

The driving pinion is supported in the centre housing by a straight roller pilot bearing and a pre-loaded taper roller bearings mounted in a separate housing.

The crown wheel is attached to the split differential case, which is supported each side by a tapered roller bearing. The differential pinions run on a cross joint and thrust is taken by thrust washers behind the pinions.

The axle shaft inner ends are splined into differential gears and the outer ends are splined into the sun gear in the epicyclic unit.

The wheel axles are splined into the epicyclic carrier which is driven by the sun gear and planetary pinions. A differential lock is fitted to the right hand axle housing. When the spring loaded lever is pulled, a shaft engages a coupler with a coupling cap on the differential case, thus locking the differential.

This machine is fitted with Girling multi-disc oil cooled brakes between the axle housings and the differential carrier plates adjacent at the centre housing.

The brakes are operated by two independently operated pedals located on the right of the floorplate, on machines with standard transmission and on the left of the floorplate on machines with reversomatic transmission.

The right pedal operates the right hand brake and the left pedal operates the left hand brake, to assist turning. For highway use the brakes are used together by operating an interlocking latch which joins the two brake pedals. When only single brakes are supplied on the machine the parking brake also actuates these disc brakes. Pressure on the brake pedal brings an actuating assembly in contact with two rotating middle (friction) discs splined to each axle shaft, these in turn contact fixed friction faces provided in the axle housing and in the differential carrier plate fitted between the centre and axle housings. The mechanism of each brake consists of two cast iron actuating discs, held together by tension springs and separated by steel balls located in inclined seats. Pressure on the brake pedal, by pulling on the operating rod, rotates one actuating disc relative to the other, and the steel balls ride up their inclined seats and so spread the actuating discs apart. These come into contact with the rotating (friction) discs, which are splined to the shaft being braked. The actuating assembly will move slightly in the direction of rotation until the torque ear of one actuating disc comes into contact with a shaft in the housing. The other actuating disc tends to rotate further increasing the angular displacement between the discs, and assisting the braking action. When the operating pull is released, the tension springs cause the discs to return to their normal position.

Dual brake tractors are fitted with disc brakes at the inner end of the two rear axle shafts and have an additional and entirely separate mechanical braking system comprising two brake assemblies mounted at the outer ends of the rear axle housings. These secondary brakes are Girling 14 in x 2 in, two shoes, double acting floating cam full servo brakes.

All the operations which follow assume that the cab, platform, digger and loader have been removed.

EPICYCLIC UNIT

Removal and Refitting

(8A/1)

1. Apply the parking brake.
2. Drain the oil from the unit by removing the drain plug.
3. Jack up the machine and remove the wheel.
4. Suitably mark the axle housing, planetary ring gear and drive cover so that the same relative position can be maintained on assembly.
5. Remove the setscrews and disconnect the parking brake cross shaft at the drum brake actuator.
6. Remove the nuts and bolts which secure the epicyclic unit to the trumpet housing.
7. (Fig. 2) Withdraw the epicyclic unit complete with ring gear from the trumpet housing. Do not withdraw the axle shaft.
8. Remove the ring gear and the two cork gaskets.

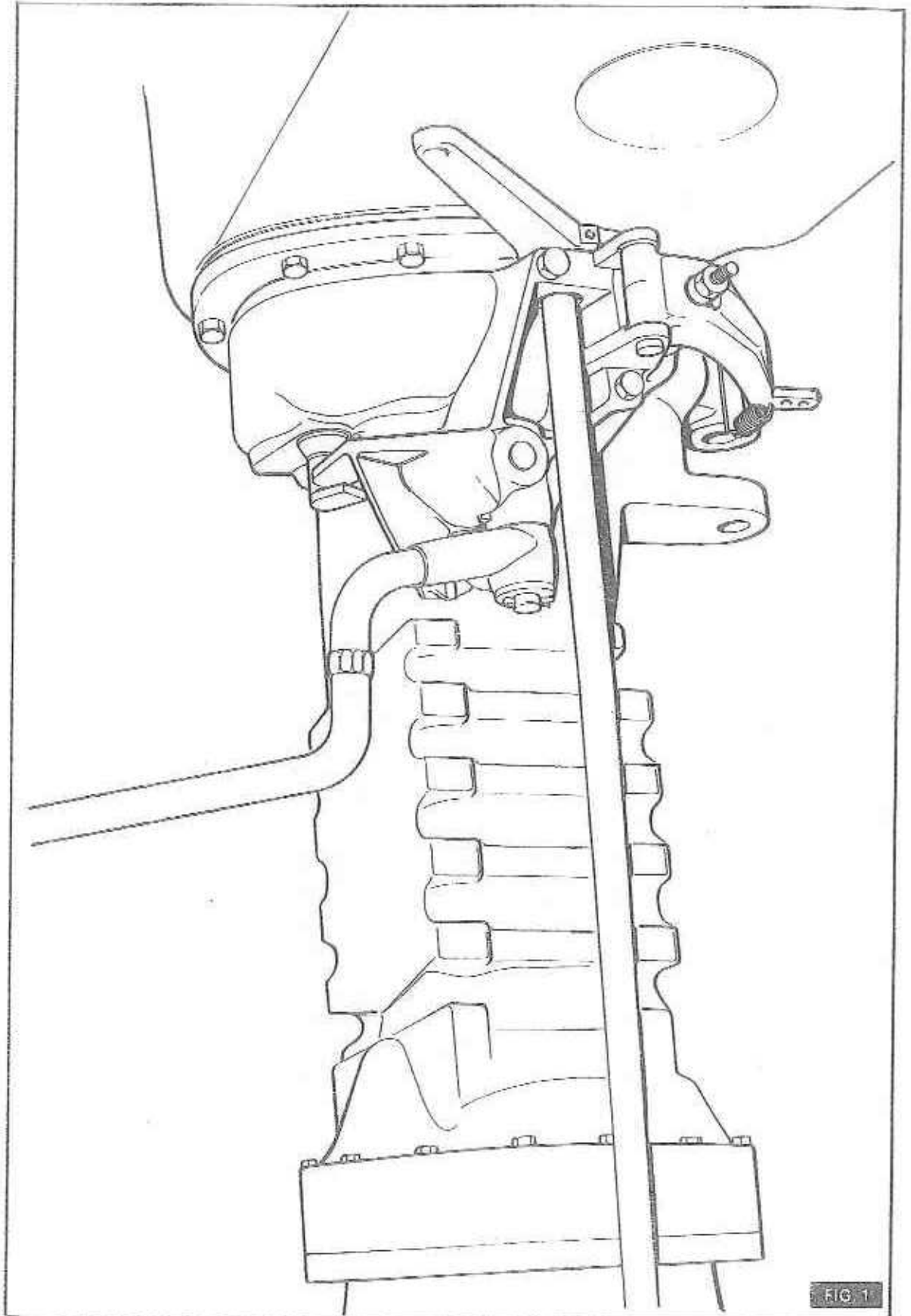
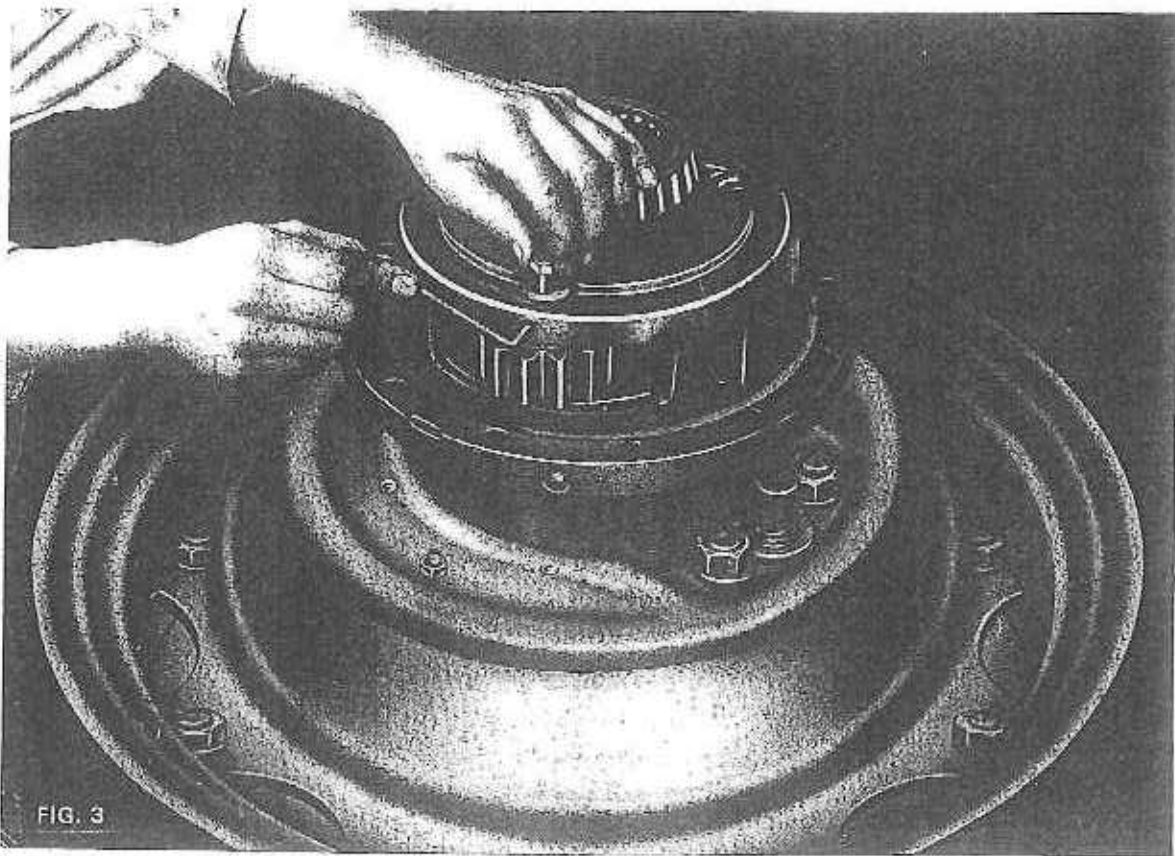
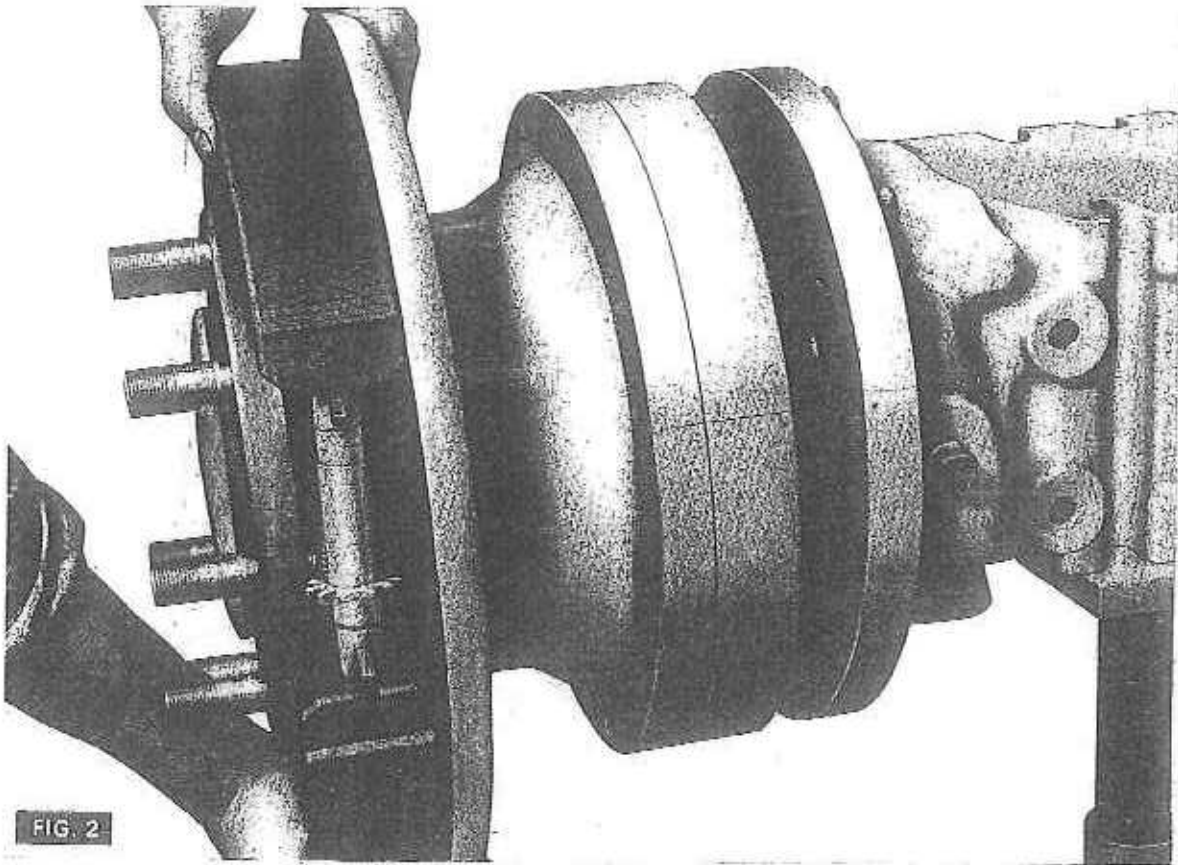


FIG. 1



EPICYCLIC UNIT

Removal and Refitting . . . Cont'd

9. To refit the unit reverse the above procedure using new cork gaskets. Ensure that the planetary ring gear is fitted the correct way round with the ring gear teeth in full engagement. Align the marks on the axle housing planetary ring gear and drive cover. Refill the epicyclic unit with a recommended oil to the level of the filler plug.

PLANETARY PINION CARRIER

Disassembly

(8A/2)

1. Remove the epicyclic unit as described in operation 8A/1.
2. Remove the planetary ring gear from the axle housing.
3. Attach the epicyclic unit to the wheel.
4. Release the staking from around the three socket screws which secure the planetary pinion shafts.
5. (Fig. 3) Remove the socket screw which secures the pinion shaft carrying the master pinion i.e. the pinion fitted in the widest of the three apertures in the carrier. Screw a bolt into the tapped hole in the end of the planet gear shaft.
6. (Fig. 4) Withdraw the shaft taking care not to dislodge the roller bearings then remove the planetary pinion complete with roller bearings and thrust washers, out of the carrier.
7. Slide the sun gear from the carrier through the widest of the three apertures.
8. Fit the special tool MF 265A into the epicyclic carrier.
9. Screw down the bolt of the special tool in order to pull the epicyclic carrier from the wheel axle.
10. Lift off the carrier and remove the tool.
11. Remove the two remaining planetary pinion shafts and pinions from the carrier.
12. Remove the taper roller bearing from the carrier using special tool MF 200 and 200-24.

PLANETARY PINION CARRIER

Reassembly

(8A/3)

1. Position the sun gear into the carrier.
2. Slide the planetary drive pinions, complete with needle rollers and thrust washers into the carrier. There are 58 rollers fitted to each planetary drive pinion.
3. Insert the planetary pinion shafts into the carrier and pinions, aligning the screw hole in the shaft with the hole in the carrier.
4. Thoroughly clean the socket screws and remove all traces of oil from the tapped holes in the carrier. Coat the socket screw threads with Loctite, fit the screws into the carrier and tighten to a torque of 10-13 lbs.ft. (1.38 - 1.79 kg.m.), thus locking the planetary pinion shafts firmly in position. Remove any surplus Loctite from the screws and stake them in position using a centre punch.
Take care that the side of the hole is not completely collapsed when staking the screws as this may well cause the screws to become loosened.
5. (Fig. 5) Mount the wheel axle assembly and carrier onto a suitable press. Press the carrier fully home onto the wheel axle.
6. Replace the roller bearing onto the carrier as stated in operation 8A/2.
7. Determine the epicyclic carrier bearing pre-load as described in operation 8A/4.

EPICYCLIC CARRIER BEARING

To Determine Pre-Load

(8A/4)

1. Assemble the epicyclic carrier assembly and press the carrier onto the wheel axle as stated in operation 8A/3.
2. Fit the ring gear to the drive cover, without gaskets, and secure the four suitable bolts, equispaced. The step in the ring gear must face towards the drive cover.

EPICYCLIC CARRIER BEARING

To Determine Pre-Load . . . Cont'd

3. Remove the planetary carrier inner bearing cup, and shim(s) if fitted, as described in operation 8A/7. Fit the cup without shims to the pre-load gauge MF 267.
4. (Fig. 6) Position the complete epicyclic carrier onto the pre-load gauge, locating the carrier inner roller bearing in its cup.
5. (Fig. 6) Measure the clearance between the gauge posts and the ring gear with two feeler gauges. Note the clearance and select the appropriate shim from the list below.
6. Replace the correct shim(s) and the inner bearing cup as described in operation 8A/8.

TABLE OF SHIMS TO ADJUST PRE-LOAD ON EPICYCLIC CARRIER BEARING

Gap Measured by Feeler Gauges (Both Sides)		Shim Thickness Required	
mm	ins	mm	ins
0,025 to 0,13	0,001 to 0,005	0,76	0,030
0,15 to 0,25	0,006 to 0,010	0,64	0,025
0,28 to 0,38	0,011 to 0,015	0,51	0,020
0,41 to 0,51	0,016 to 0,020	0,38	0,015
0,53 to 0,64	0,021 to 0,025	0,25	0,010
0,66 to 0,76	0,026 to 0,030	0,13	0,005
0,79 to 0,89	0,031 to 0,035	0	0

Shims are available in three sizes :-

0.005 in.(0.127 mm.), 0.010 in.(0.254 mm.), 0.015 in.(0.381 mm.)

EPICYCLIC CARRIER, INNER ROLLER BEARING

Removal

(8A/5)

1. Remove the epicyclic as stated in operation 8A/1.
2. (Fig. 7) Assemble the special tool MF 200 and 200 - 24 onto the epicyclic carrier bearing and remove the bearing.

Replacement

(8A/6)

1. (Fig. 8) Place the roller bearing squarely onto the carrier.
2. Drive the bearing home fully using special Tool No. MF 266 and 550 handle.

EPICYCLIC CARRIER, INNER BEARING CUP

Removal

(8A/7)

1. Remove the epicyclic unit as described in operation 8A/1.
2. Remove the planetary ring gear from the axle housing.
3. Ensure that the disc brakes are still fully applied, then slide out the axle shaft from its housing.
4. (Fig. 9) Using pry bars, lever the epicyclic inner bearing cup out of the trumpet housing.
5. Remove the shim(s), if fitted, from behind the cup.

EPICYCLIC CARRIER, INNER BEARING CUP ... Cont'd

Replacement

(8A/8)

1. Fit the shim(s), if required, into place.
2. Place the cup squarely into position and drive the cup firmly into place with tools MF 1105 - B, 1105 - 7A/3 and 550 handle.
3. Smear the wiping edges of the outer oil seal with grease.
4. Ensure that the brakes are still applied, align the splines and slide the axle shaft into its housing through the brake discs to the differential.
5. Refit the planetary ring gear.
6. Replace the epicyclic unit as described in operation 8A/1.

WHEEL AXLE AND DRIVE COVER

Disassembly

(8A/9)

1. Remove the epicyclic unit as described in operation 8A/1.
2. Carry out items 2 to 10 of operation 8A/2.
3. (Fig. 10) Remove the circlip securing the wheel axle bearing to the axle.
4. (Fig. 11) Assemble tool MF200 and 200 - 24 onto the drive cover and draw the drive cover and roller bearing off the axle shaft.
5. Lift out the taper roller bearing from its cup in the drive cover.
6. Remove the bearing cup and oil seal from the drive cover.

Reassembly

(8A/10)

1. Replace the oil seal and bearing cup into the drive cover.
2. Fit the drive cover assembly to the wheel axle, taking care not to damage the oil seal.
3. (Fig. 12) Position the taper roller bearing squarely in place on the axle shaft and, with a suitable press, push the bearing fully home.
4. There are nine sizes of wheel axle snap rings. Use half of one of the thinnest snap rings 0.230" / 0.232" (5.842/5.893 mm) thick as a guide to measure the clearance between the snap ring and bearing cone.
5. Fit half of the thinnest snap ring to the groove in the wheel axle and measure the clearance between the snap ring and bearing cone with feeler gauges as shown in Fig. 13. Note this clearance (if there is no clearance the thinnest ring is the required size). Calculate the required snap ring thickness by adding the clearance between the thinnest snap ring and bearing cone, to the thickness of the thinnest snap ring.
6. (Fig. 14) Measure snap rings with a micrometer as shown and obtain the required thickness.

Snap rings are available in the following nine thicknesses :-

0.230"/0.232" (5.842/5.893 mm)	Marked 0
0.2321"/0.234" (5.895/5.944 mm)	Marked 1
0.2341"/0.236" (5.947/5.944 mm)	Marked 2
0.2361"/0.238" (5.997/6.045 mm)	Marked 3
0.2381"/0.240" (6.048/6.096 mm)	Marked 4
0.2401"/0.242" (6.099/6.147 mm)	Marked 5
0.2421"/0.244" (6.150/6.198 mm)	Marked 6
0.2441"/0.246" (6.201/6.248 mm)	Marked 7
0.2461"/0.248" (6.251/6.299 mm)	Marked 8

ONE SIZE ONLY AVAILABLE

See Bulletin 50B/2700/27

20th June 77.

When assembled a maximum clearance of 0.001" (0.0254 mm) is permissible between the snap ring and bearing cone.

[LATEST INFORMATION SHEET IN 57B] SIMPLY DELETES item 4, 5, 6, gear no mention of alternate sizes



WHEEL AXLE AND DRIVE COVER

Reassembly . . . Cont'd

7. Fit the correct snap ring to its groove in the wheel axle.
8. Carry out items in operation 8A/3.
9. Replace the epicyclic unit as described in operation 8A/1.

AXLE SHAFT OUTER OIL SEAL

Removal and Replacement

(8A/11)

1. Remove the planetary carrier inner bearing cup as stated in operation 8A/7.
2. Remove the axle shaft outer oil seal.
3. Apply a thin coating of "Well Seal" to the bore of the axle housing and fit the new oil seal using tool MF 266 and 500 handle.

AXLE SHAFT HOUSING

Removal and Refitting

(8A/12)

1. Drain oil from the centre axle housing.
2. Release the brake pull rods, hand brake cable (single brakes only) and return spring. If dual brakes are fitted disconnect the parking brake actuator rod at the cross shaft.
3. Jack up the machine and support it on rail trolley 270.
4. Remove rear wheel.
5. Support axle housing on trolley jack.
6. (Fig. 15) Remove the speedometer gearbox. Left hand shaft housing only.
7. If the right hand shaft housing is to be removed the differential lock lever can be removed for ease.
8. Remove the nuts and bolts which hold the axle shaft housing to the centre housing.
9. (Fig. 16) With the axle shaft housing supported by the jack manoeuvre the complete axle housing clear of the tractor.
10. To replace the axle shaft housing, reverse the above procedure and refill the centre axle housing with a recommended oil.

LEFT HAND DIFFERENTIAL CARRIER PLATE

Removal and Replacement

(8A/13)

1. Remove the axle shaft housing as described in operation 8A/12.
2. Stand the axle shaft housing on end.
3. (Fig. 17) Remove the two countersunk screws which secure the carrier plate to the housing.
4. Lift off the carrier plate complete with bearing cone.
5. Remove the inner 'O' ring from the housing.
6. Replacement is a direct reversal of above procedure using a new 'O' ring.

LEFT HAND DIFFERENTIAL CARRIER PLATE BEARING CONE

Removal and Refitting

(8A/14)

1. Remove the left hand differential carrier plate as described in operation 8A/13.
2. (Fig. 18) Remove the bearing cone using tool MF 100 and 200 - 3.
3. (Fig. 19) Replace the bearing cone using tool MF 197 and 197 - 2.



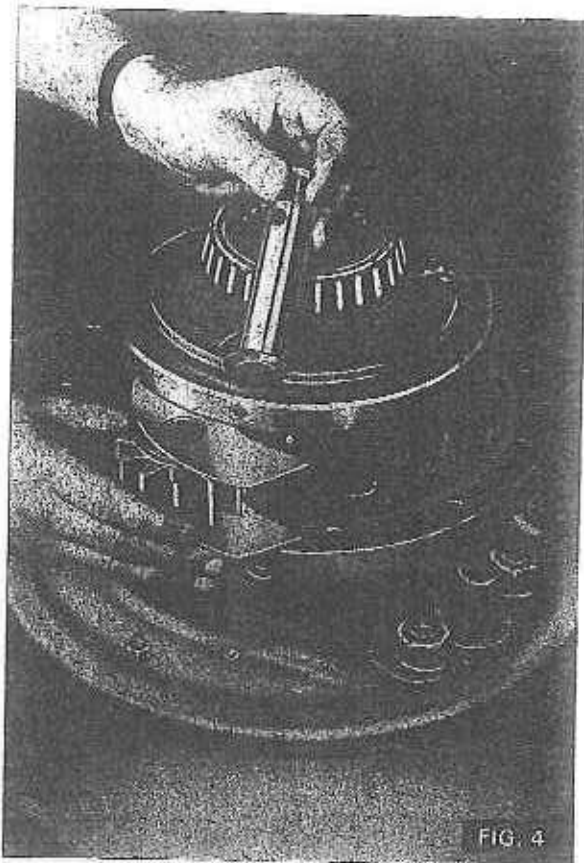


FIG. 4

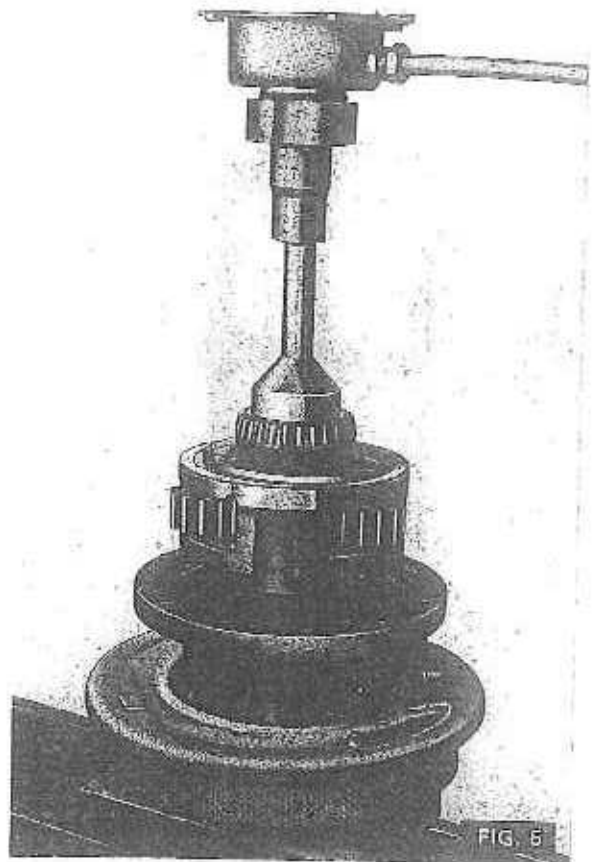


FIG. 5

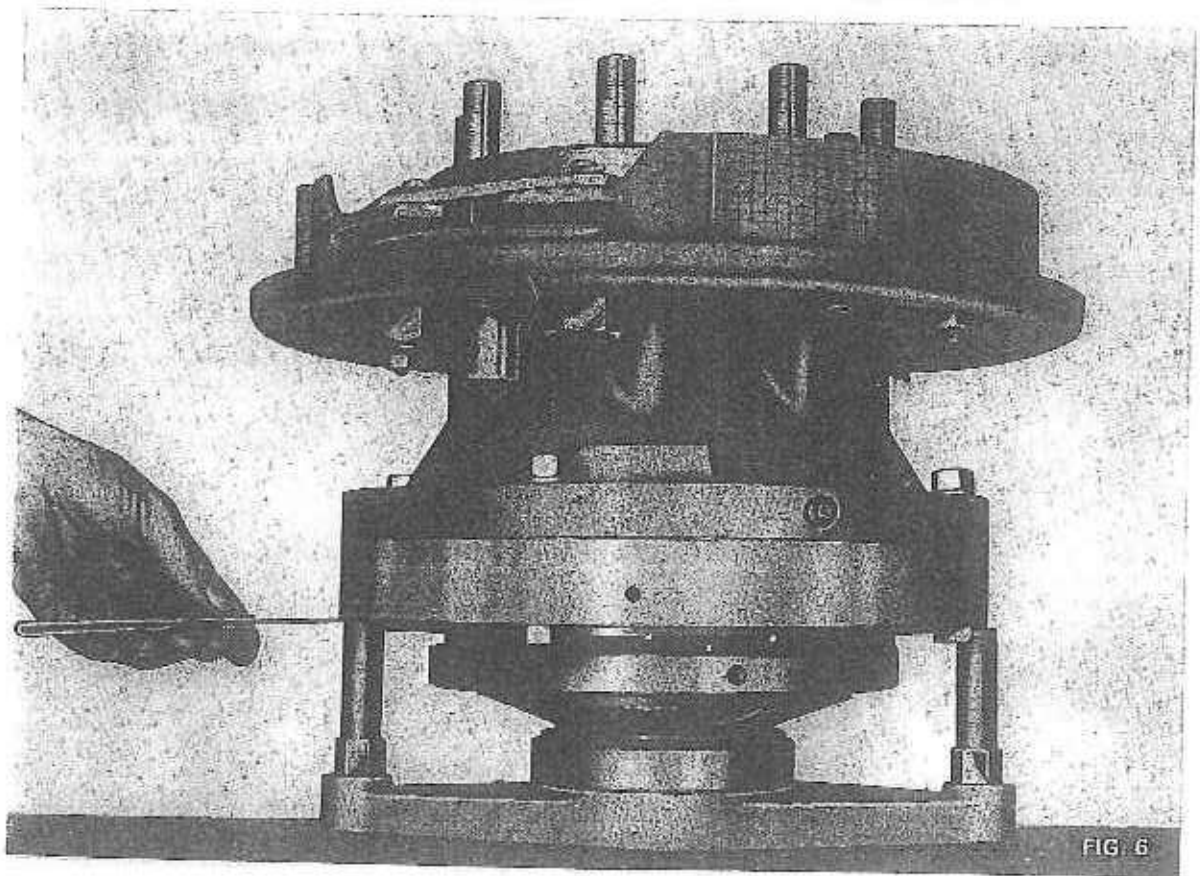


FIG. 6

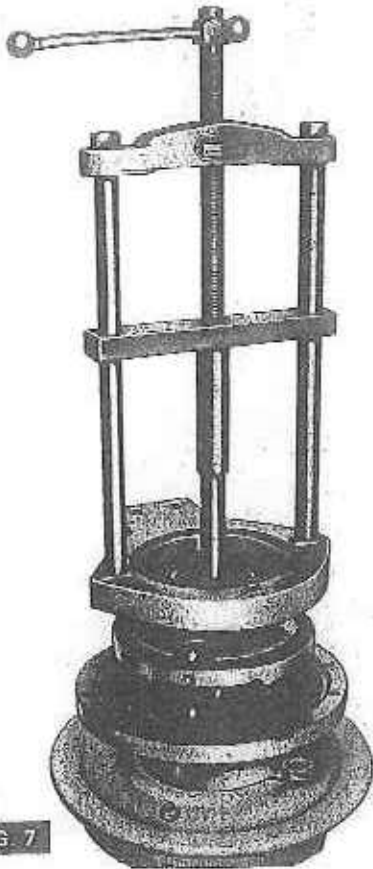


FIG. 7

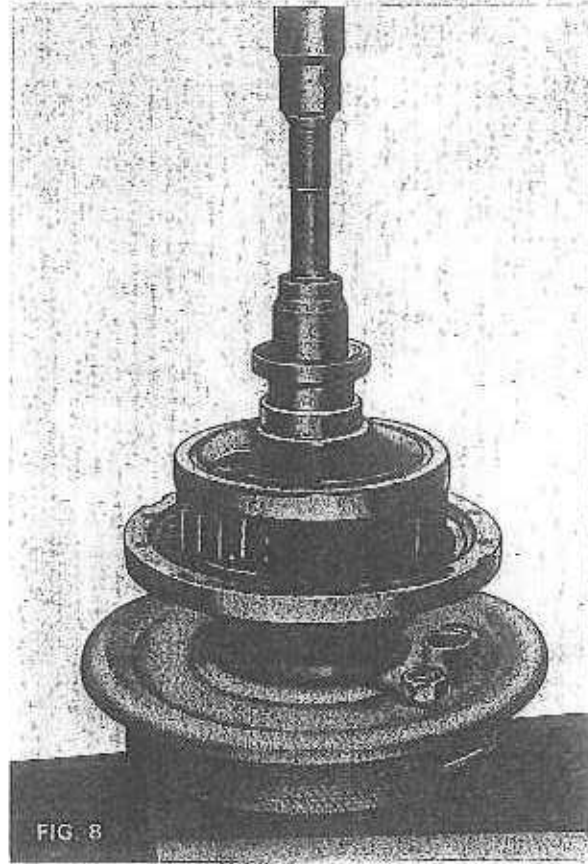


FIG. 8

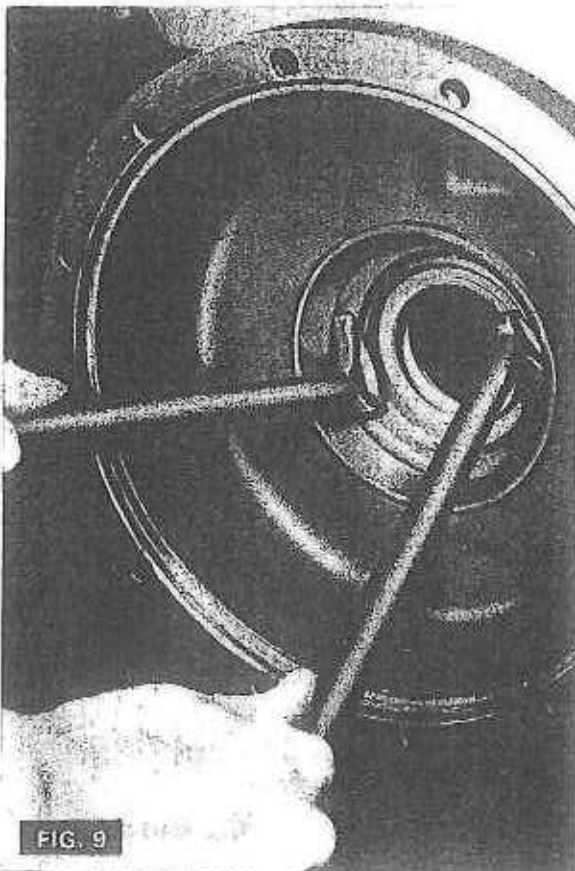


FIG. 9

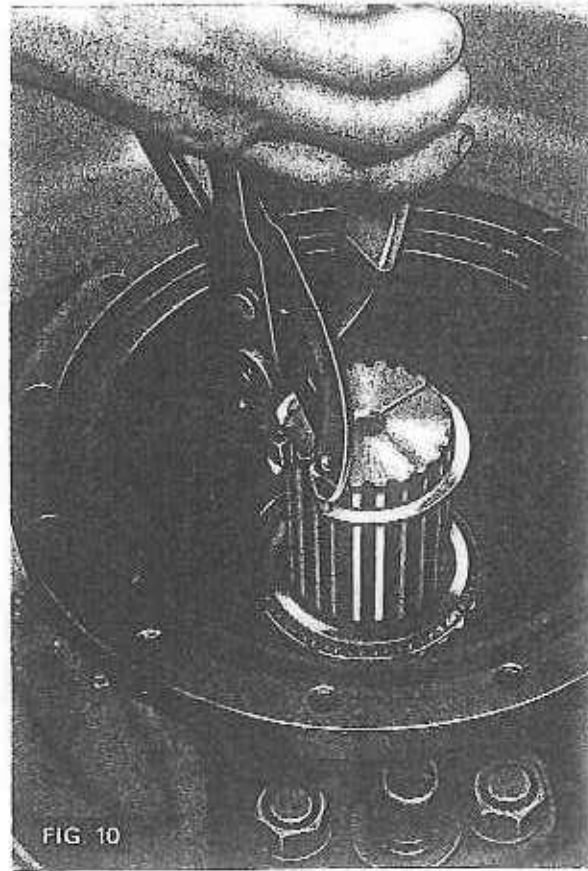


FIG. 10

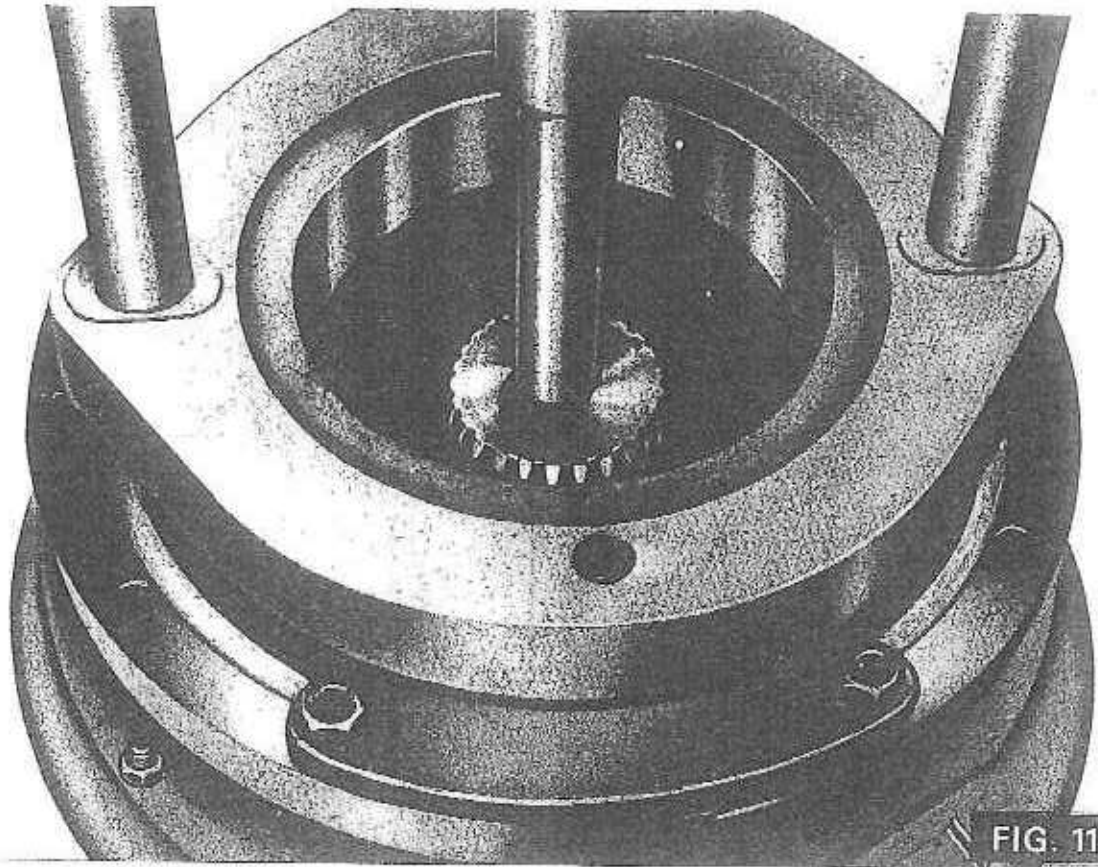


FIG. 11

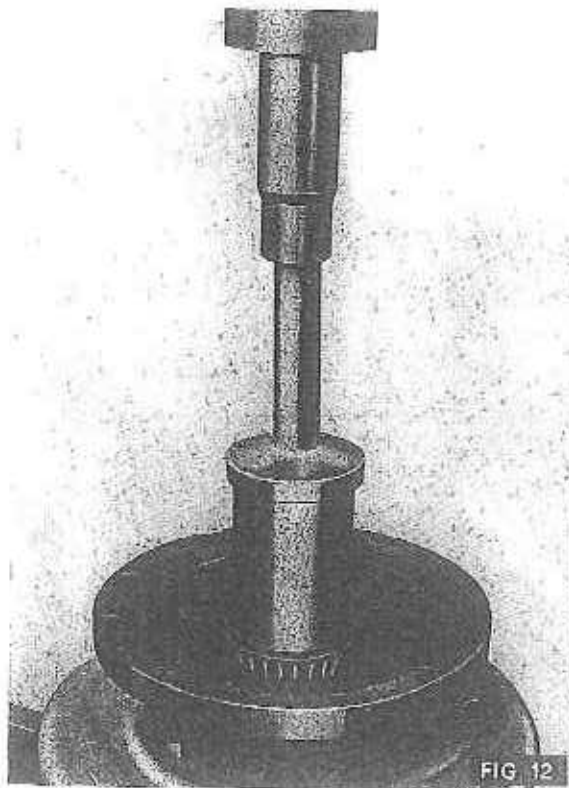


FIG. 12

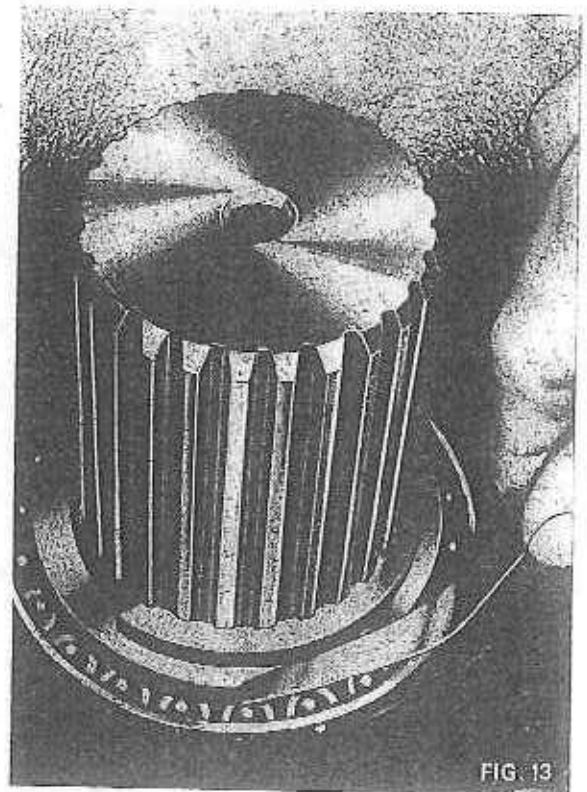
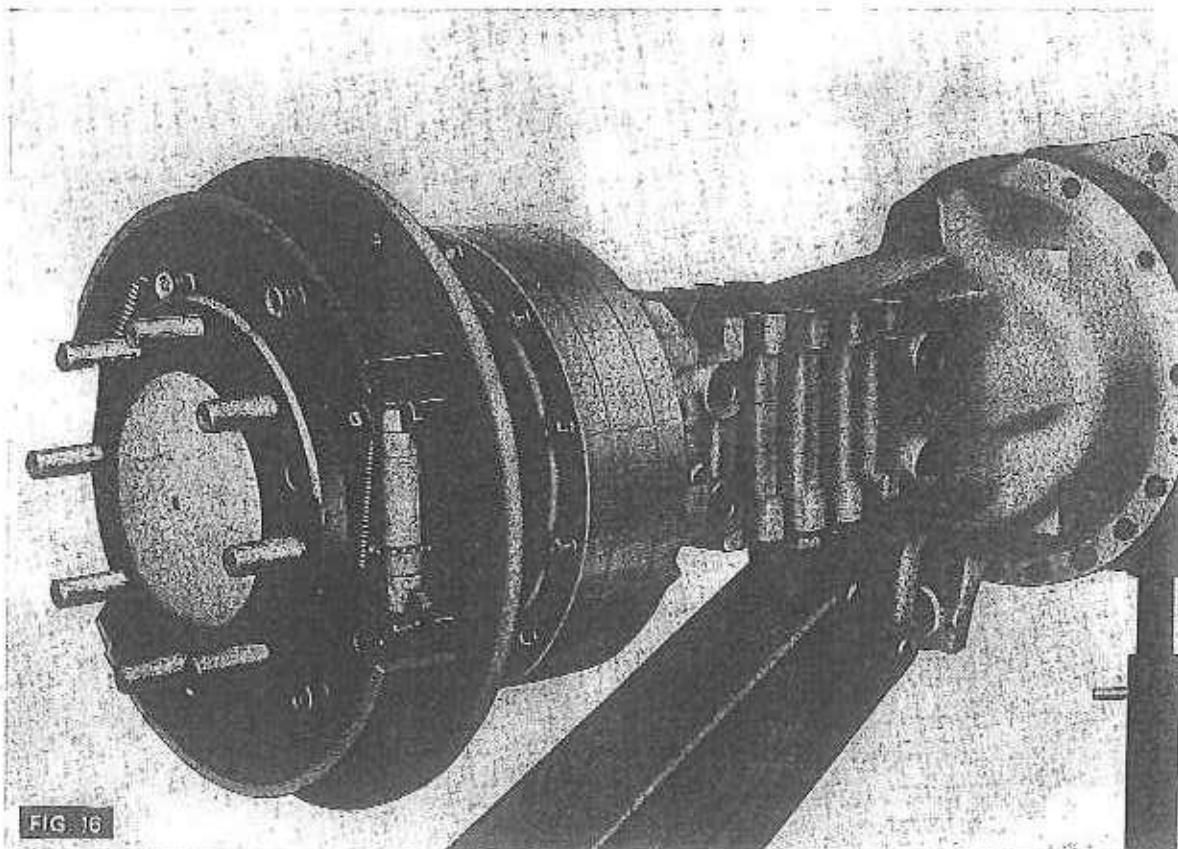
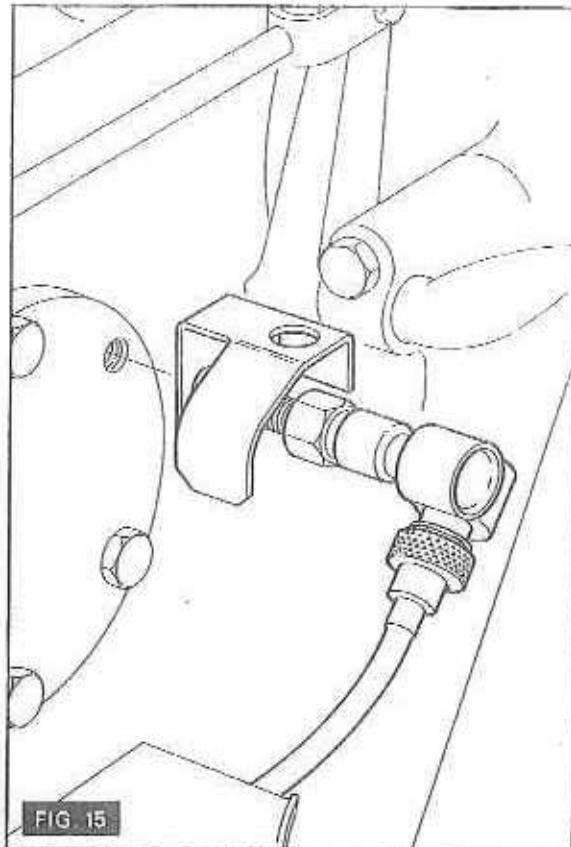
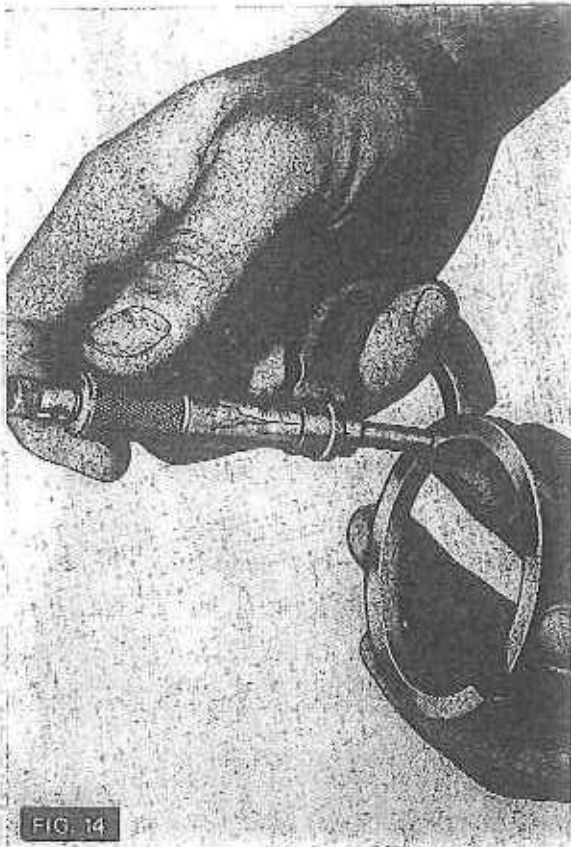


FIG. 13



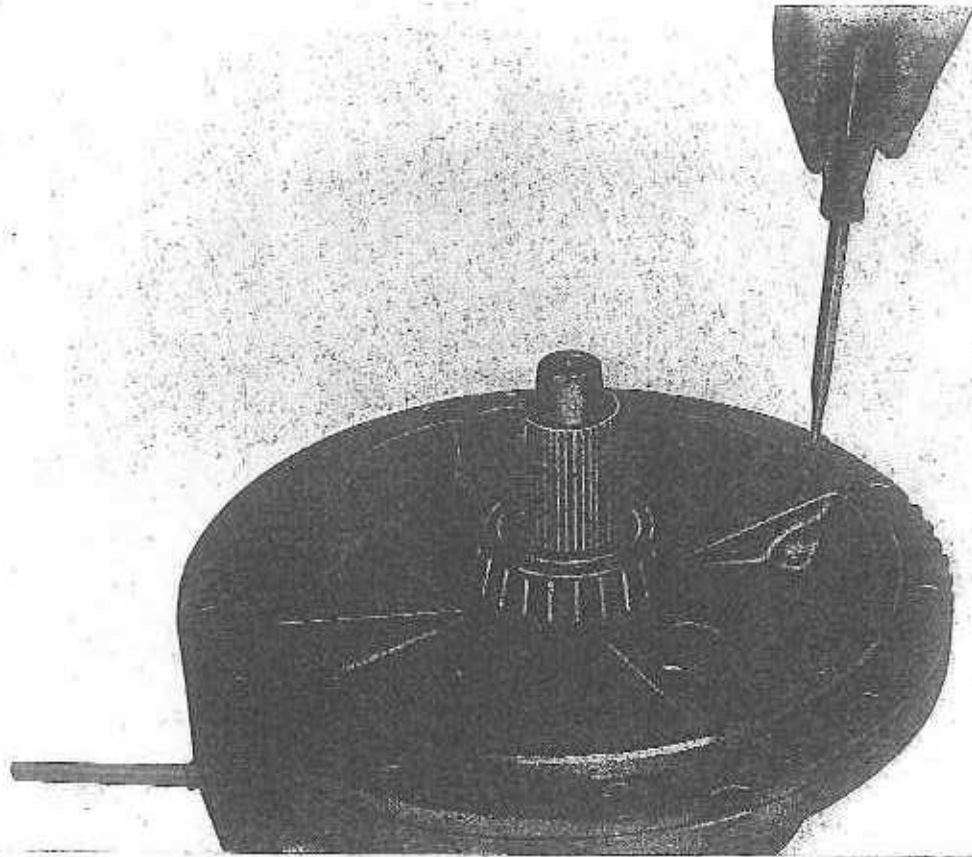


FIG. 17

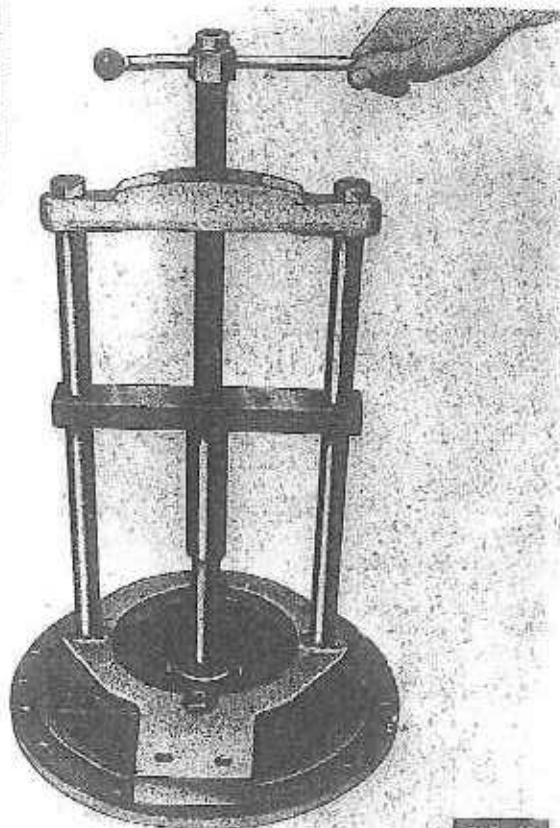


FIG. 18

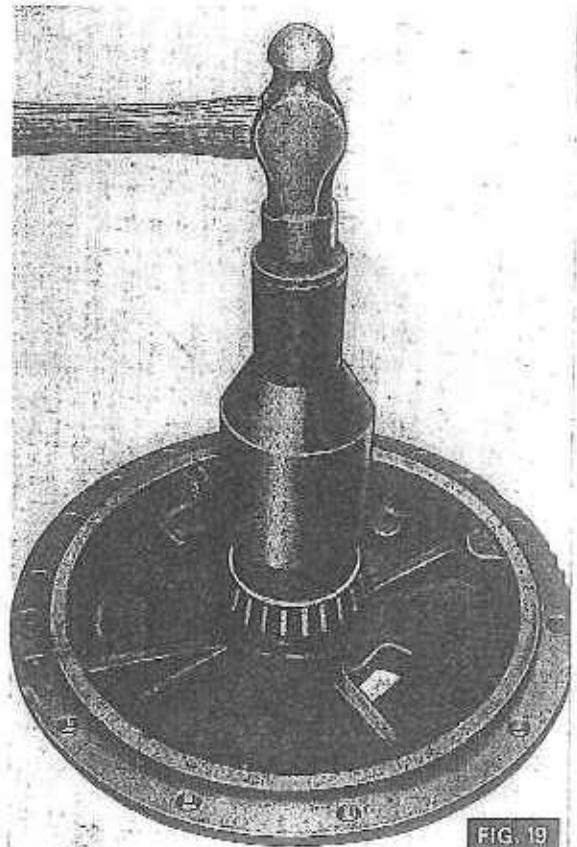
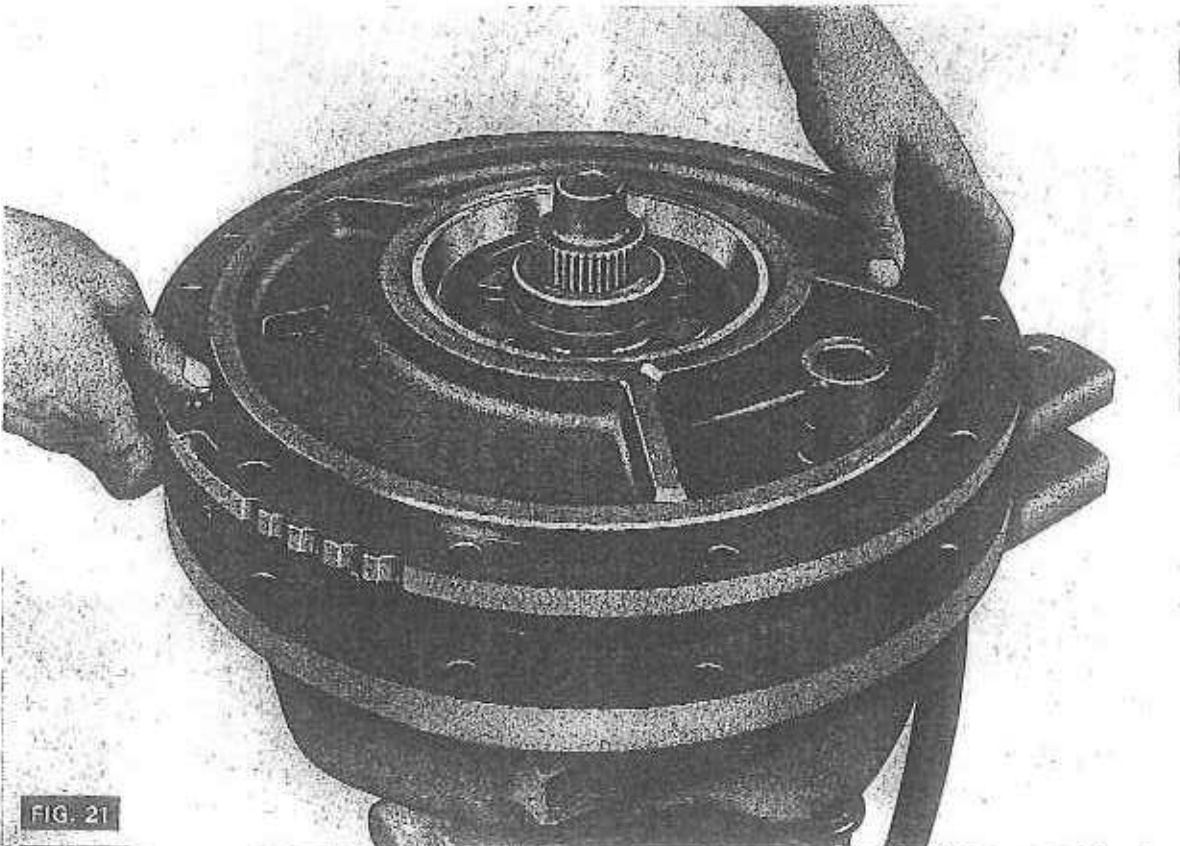
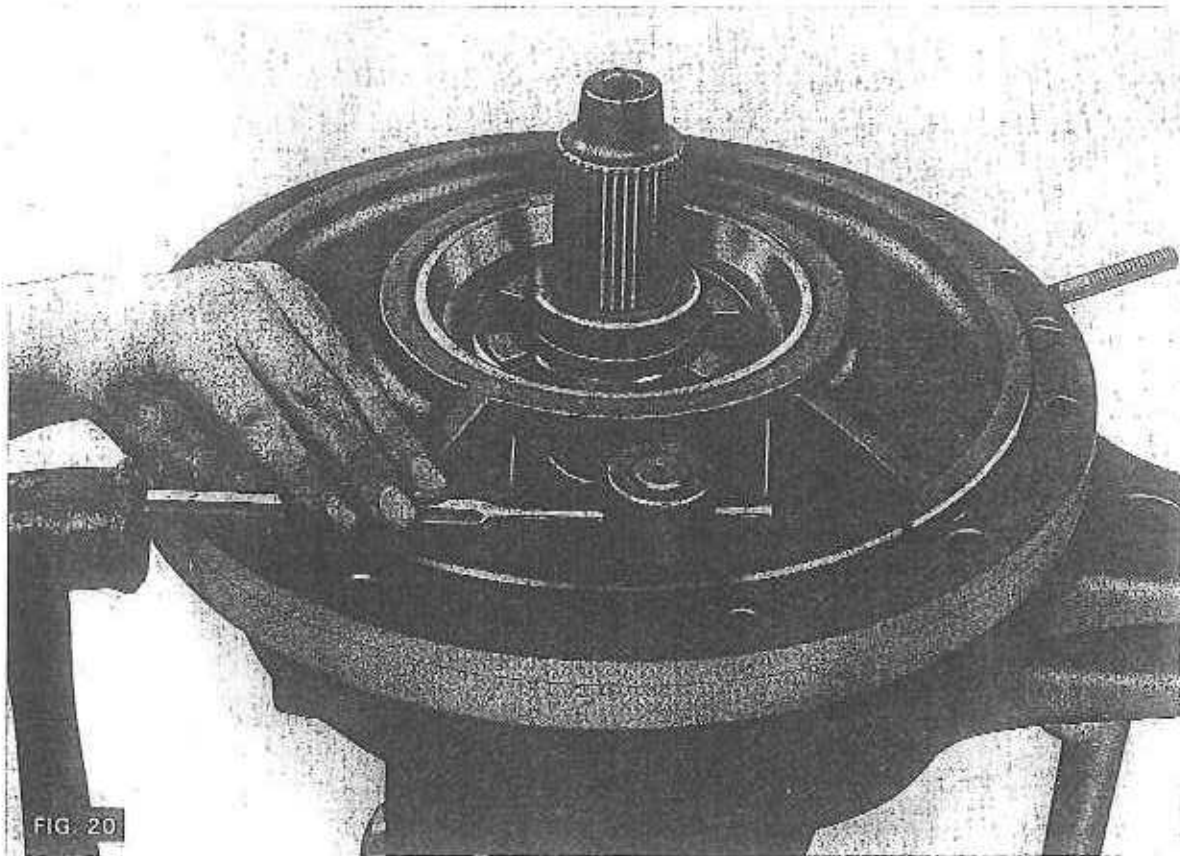
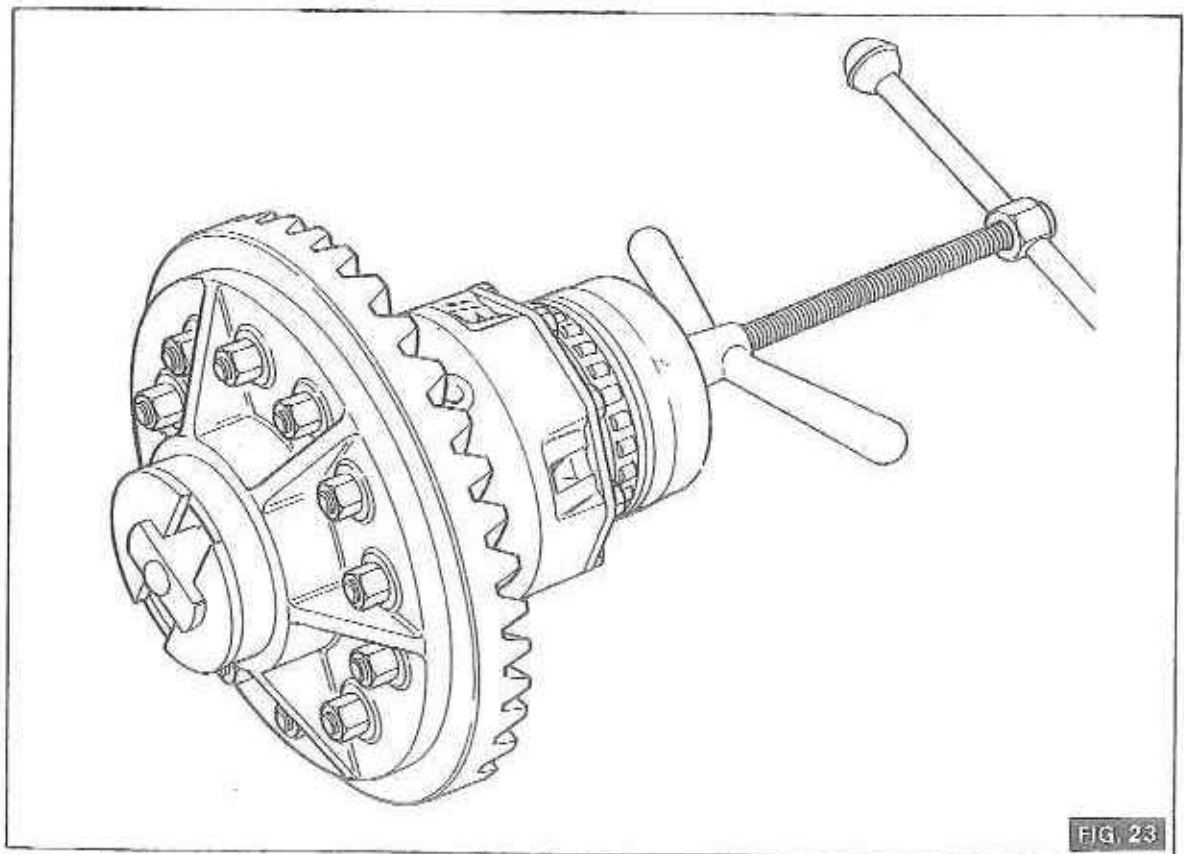
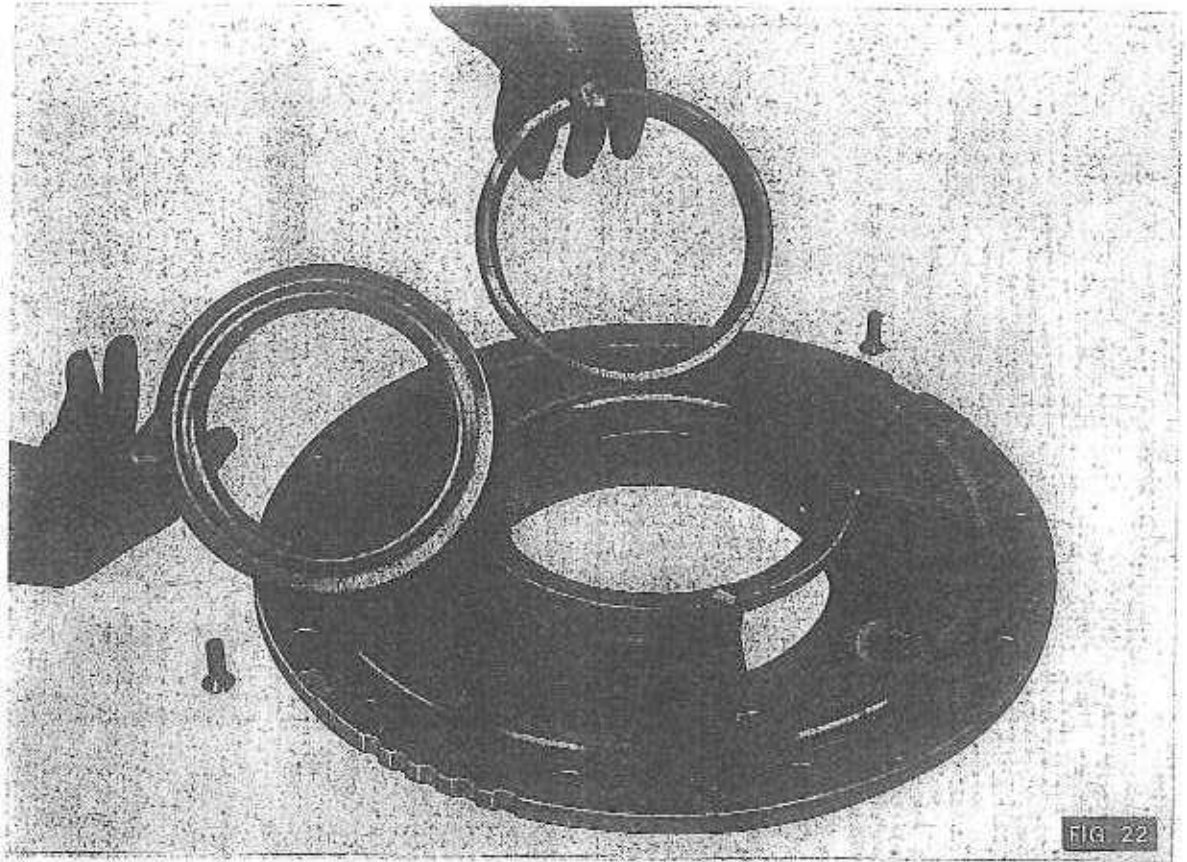
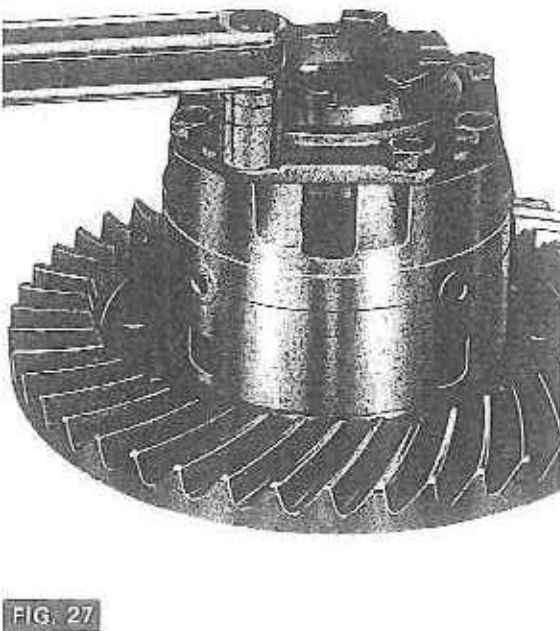
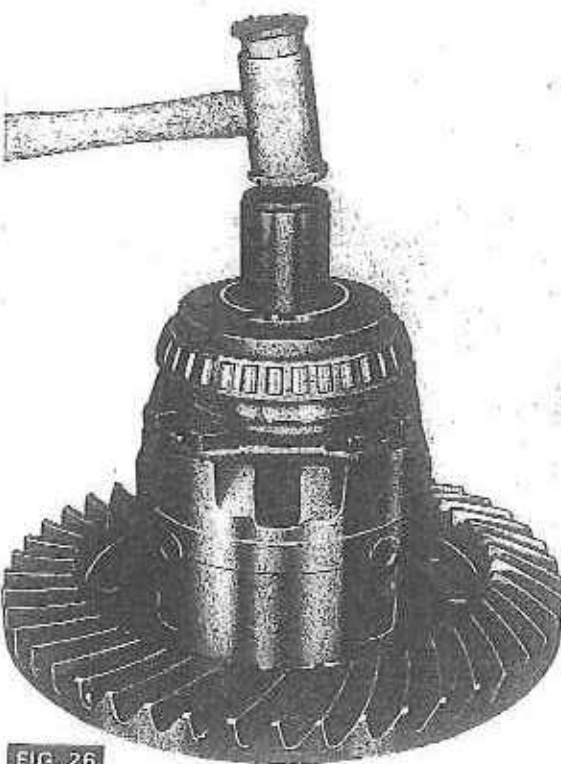
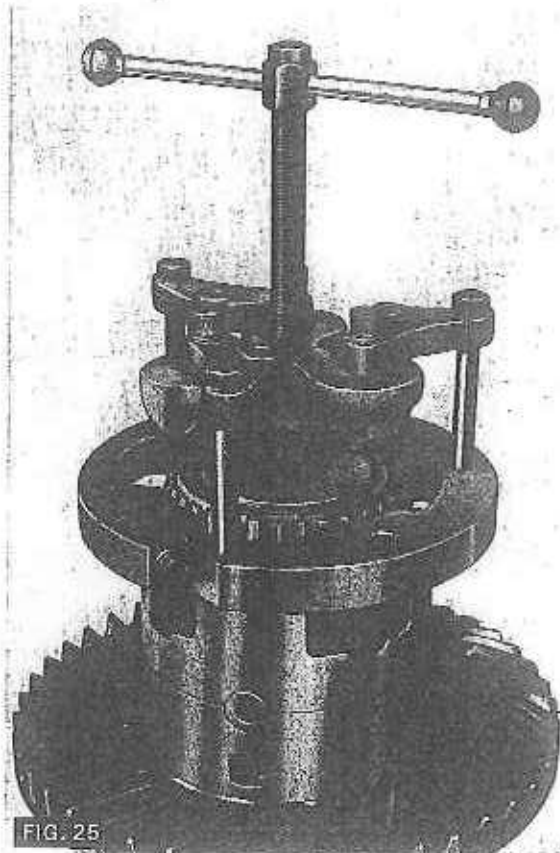
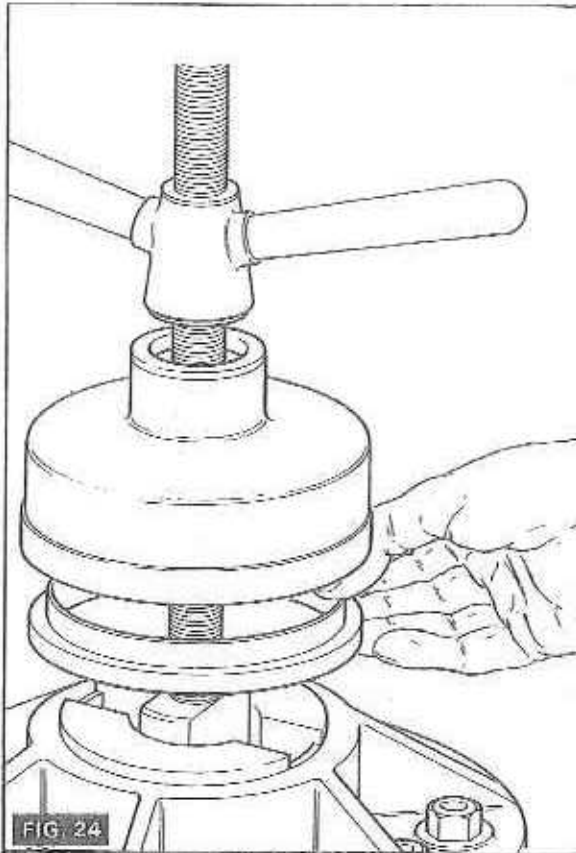


FIG. 19







RIGHT HAND DIFFERENTIAL CARRIER PLATE

Removal and Replacement

(8A/15)

1. Remove the axle shaft housing as described in operation 8A/12.
2. (Fig. 20) Drive out the roll pin securing the differential lock shifter fork to its shaft.
3. Remove the two screws securing the carrier plate to the axle housing.
4. (Fig. 21) Lift off the carrier plate complete with bearing cup, differential shifter fork and coupler.
5. Replacement is a reversal of the above procedure.

RIGHT HAND DIFFERENTIAL CARRIER PLATE BEARING CUP

Removal and Replacement

(8A/16)

1. Remove the right hand differential carrier plate as described in operation 8A/15.
2. Remove the shield from behind the bearing cup.
3. Remove the bearing cup using tool MF 1105, 1105/1, 1105/7A/1 and 1105/7A/2. Adjust the bearing preload as described in operation 8A/21.
4. (Fig. 22) Fit new shield to the carrier plate.
5. Replace the bearing cup using tool MF 1105, 1105/1, 1105/7A/1.

DIFFERENTIAL CASE ASSEMBLY

Removal and Refitting

(8A/17)

1. Remove the left hand axle shaft housing as described in operation 8A/12.
2. Insert a suitable bar into the differential case assembly, then manoeuvre the differential assembly out of the centre housing.
3. Replacement is a reversal of the removal procedure. Align the splines on the differential gears and the axle shafts.

LEFT HAND DIFFERENTIAL BEARING CUP

Removal and Refitting

(8A/18)

1. Remove the differential case as described in operation 8A/17.
2. (Fig. 23) Remove the bearing cup using tool MF 1105, 1105 - 2A/1 and 1105 - 2A/4.
3. (Fig. 24) Replace the bearing cup using tool MF 1105, 1105 - 2A/1 and 1105 - 2A/4.

RIGHT HAND DIFFERENTIAL BEARING CONE

Removal and Refitting

(8A/19)

1. Remove the differential case assembly as described in operation 8A/17.
2. (Fig. 25) Assemble tool MF 555 and 555 - 2A/2 and withdraw the bearing cone from the differential case.
3. (Fig. 26) Replace the bearing cone using MF 257.

DIFFERENTIAL CASE

Disassembly and Reassembly

(8A/20)

1. Remove the differential case assembly as stated in operation 8A/17.
2. (Fig. 27) Remove the eight bolts from the differential case assembly.
3. (Fig. 28) Lift off the differential lock coupler cap (1) and casing (2).
4. Lift out the differential gear (3), thrust washer (4), cross joint and pinions assembly (5) with thrust washers and finally remove the remaining differential gear and thrust washer.
5. To reassemble, reverse the above procedure.

NOTE All components should be examined for scoring, chipping or wear. Any component showing signs of wear should be renewed.

When reassembling the differential case, ensure that the markings on the case are aligned.

DIFFERENTIAL BEARING PRE-LOAD

Adjustment

(8A/21)

NOTE This operation must be carried out whenever the differential unit is dismantled or when the bearings are replaced. Service tool MF 245 D will be required.

1. Pre-load must be adjusted with the differential assembly and the left hand axle shaft housing assembly fitted to the centre housing. Remove the right hand axle shaft housing as stated in operation 8A/12.
2. Remove the carrier plate as described in operation 8A/13.
3. Remove the carrier plate bearing cup as described in operation 8A/16.
4. Fit the bearing cup into the centraliser (2) (Fig. 29).
5. (Fig. 29) Fit the guide (1) and centraliser (2), of tool MF 245C, into the splined differential gear.
6. Assemble the clamp bar (3) to the centraliser, with the pre-load adjusting bolt fully slackened.
7. Position the clamp bar ends over two of the studs on the centre housing and secure the bar with the two special sleeved nuts (4).
8. Screw the two setting blocks (5) onto diagonally opposite studs on the centre housing as shown in Fig. 30.
9. (Fig. 31) Place the straight edge across the two setting blocks and measure the distance between the centraliser gauge pin and the straight edge. This distance is the shield thickness required behind the bearing cup.

Bearing shields are available in five sizes as follows :-

Shield Thickness

Means of Identification

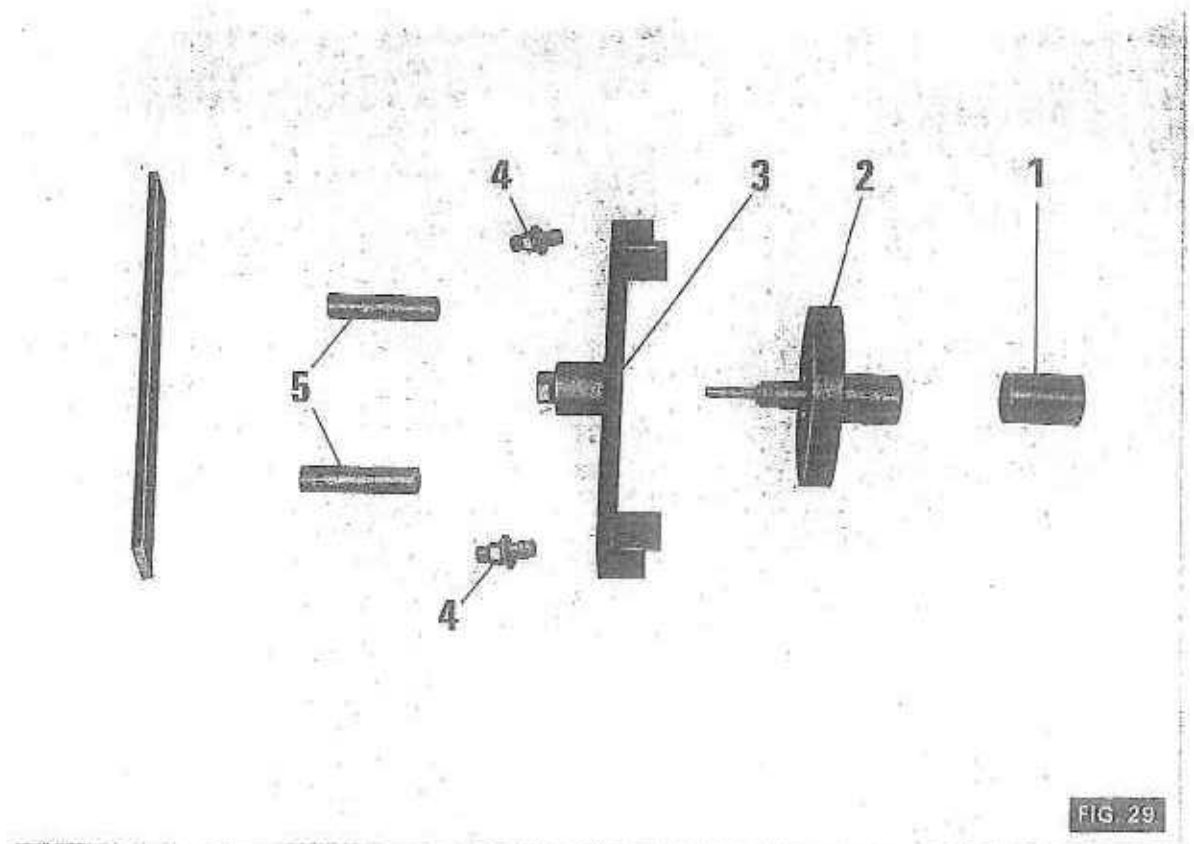
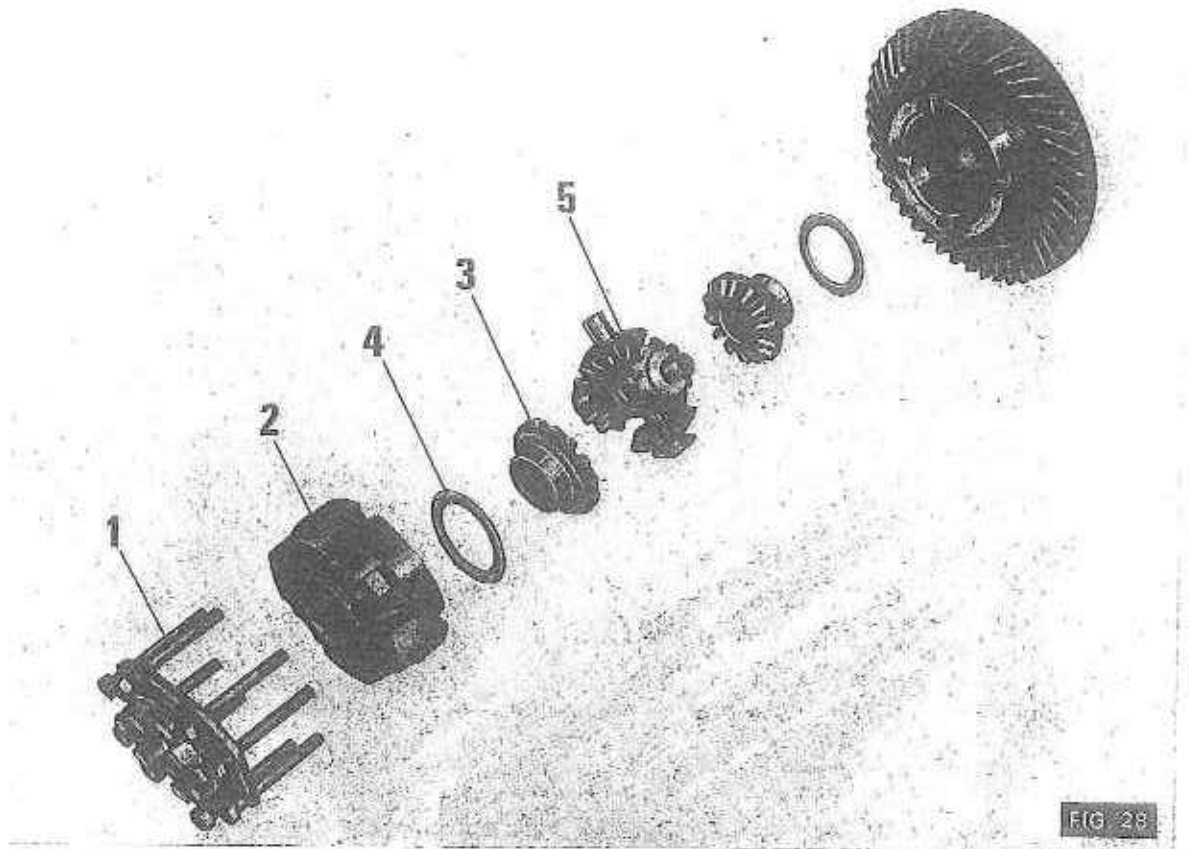
ins

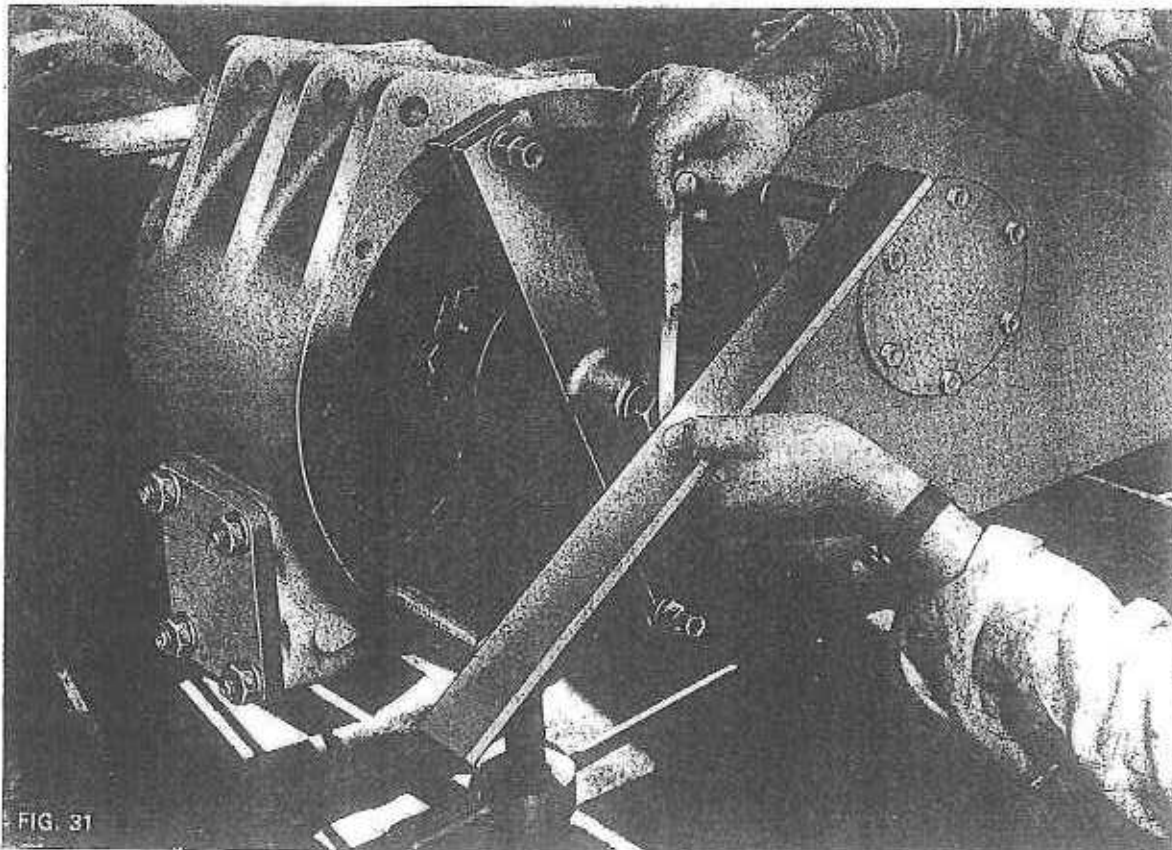
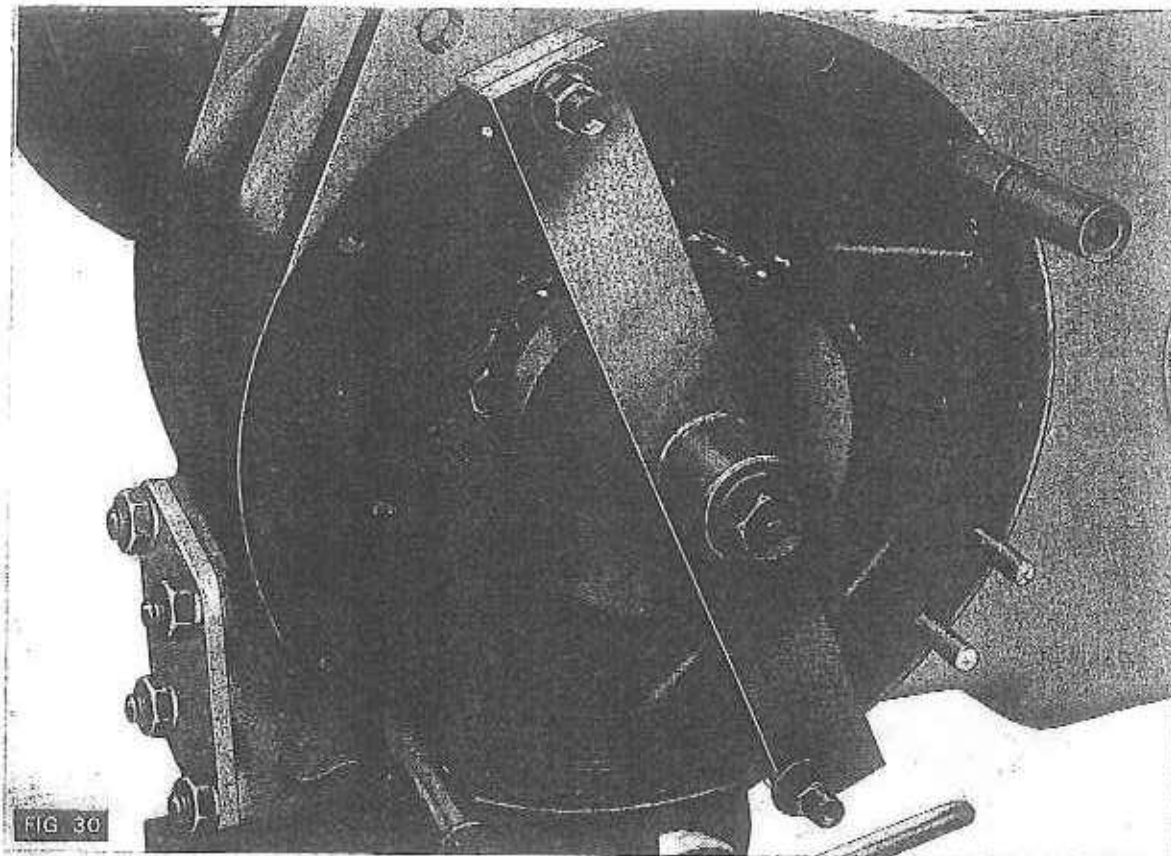
mm

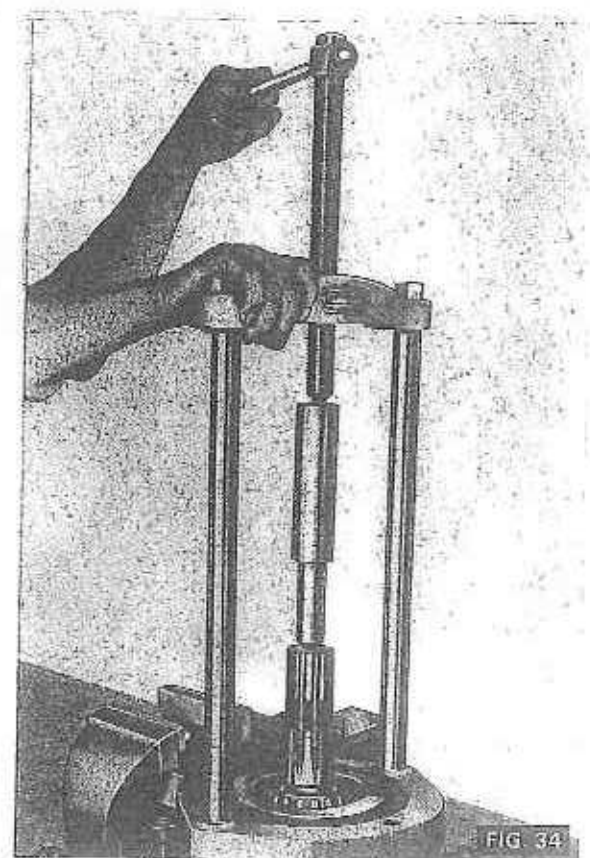
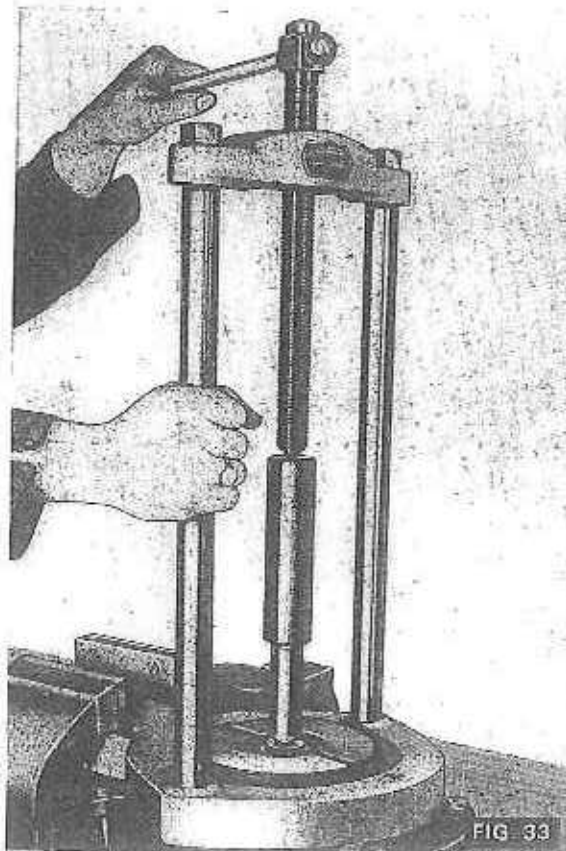
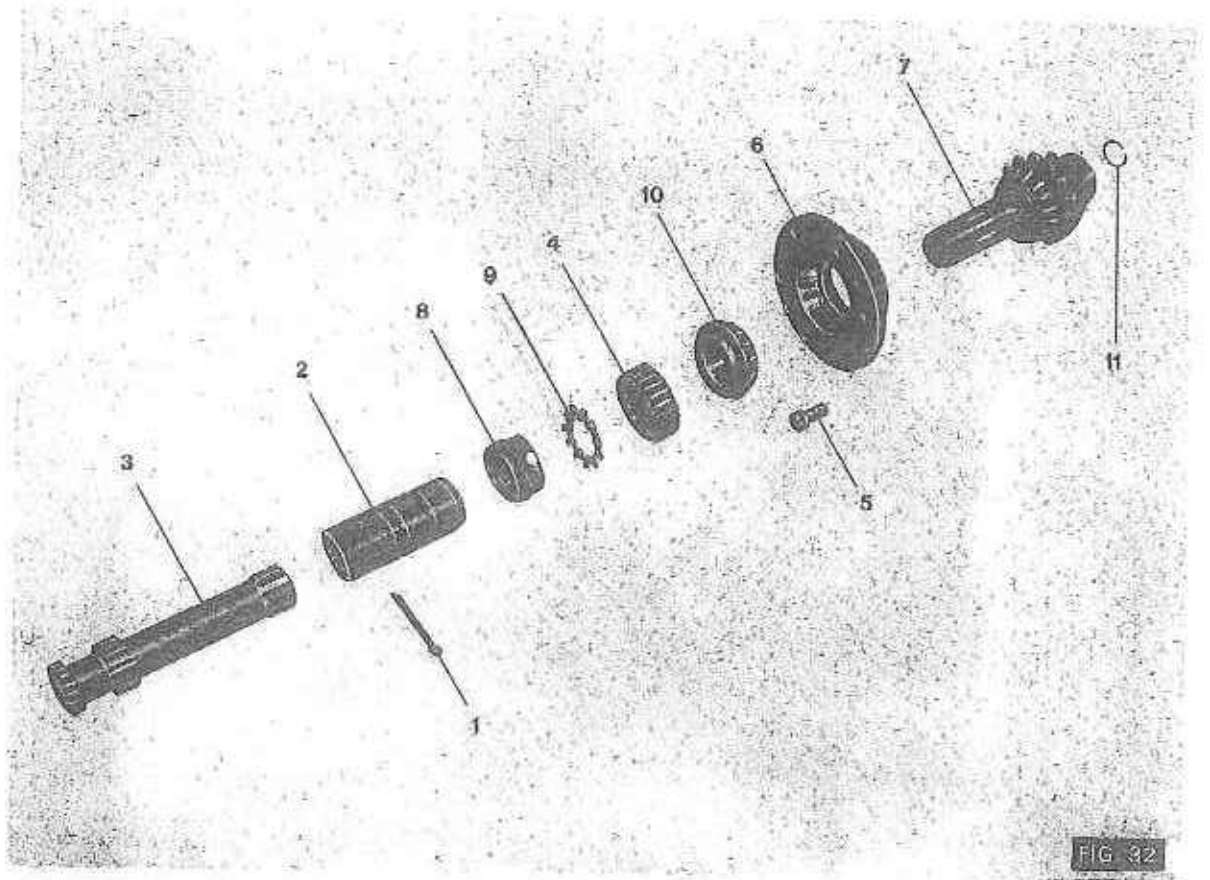
0.029/0.031	0.737/0.787
0.034/0.036	0.864/0.914
0.039/0.041	0.991/1.041
0.044/0.046	1.118/1.168
0.049/0.051	1.245/1.295

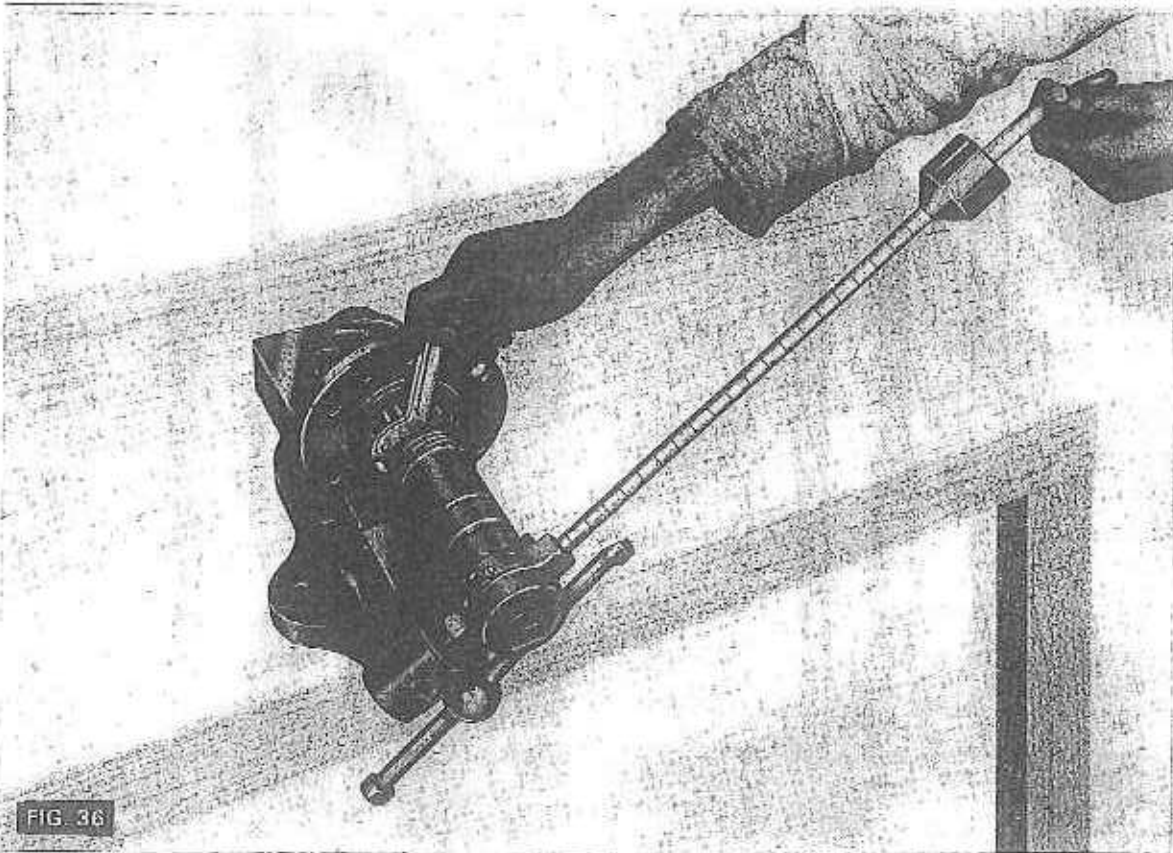
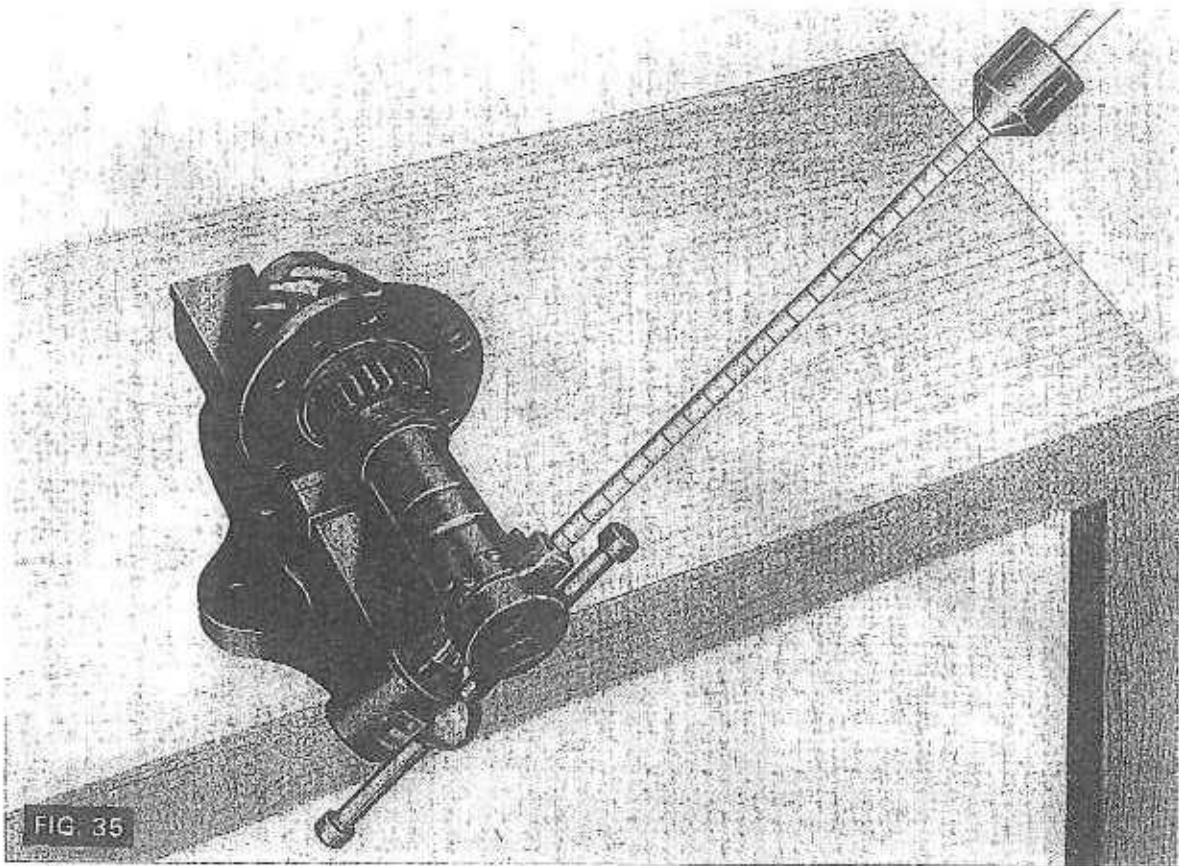
No Dots
One Dot
Two Dots
Three Dots
Four Dots

10. Fit the required shield and the bearing cup to the right hand differential carrier plate as described in operation 8A/16.









DRIVE PINION ASSEMBLY

Removal and Disassembly

(8A/22)

1. Drain the centre housing of oil.
2. Remove the hand brake support pillar assembly from the top of the centre housing. Remove centre axle housing cover.
3. (Fig. 32) Remove the split pin (1) from the shear tube (2), then remove the shear tube.
4. Remove the rear drive shaft (3).
5. Remove the speedometer drive assembly as stated in operation 8A/30.
6. Remove the six bolts (5) and spring washers securing the pinion housing (6).
7. Screw two of the bolts into the two tapped holes in the housing then extract pinion (7) from centre housing complete with locking ring (8) tab washer (9) hub (10) bearing housing (6) and bearings.
8. Release tab washer (9) and unscrew locking ring (8) from the pinion (7), remove the tab washer.
9. Slide the hub (4) bearing cone (10) and bearing housing (6) off the pinion (9).

PINION INNER BEARING CONE

Removal and Refitting

(8A/23)

1. Remove and dismantle the pinion as described in operation 8A/21.
2. (Fig. 33) Press the inner bearing cone (taper roller bearing) off the pinion using multi-purpose bearing remover/replacer MF 200 - 25 with tool MF 200 - 23.
3. Replace the inner bearing cone using adaptor MF 200 - 23 and tool MF 200 - 25.

PINION PILOT BEARING

Removal and Refitting

(8A/24)

1. Remove and dismantle the pinion as described in operation 8A/21.
2. Remove the pilot bearing snap ring (13 Fig. 32).
3. (Fig. 34) Press the pilot bearing off the pinion using tool MF 200 - 23.
4. Replace the pilot bearing using tool MF 200 - 23.
5. Refit the pilot bearing snap ring.

DRIVE PINION ASSEMBLY

Reassembly, Pre-load Setting and Refitting

(8A/25)

1. (Fig. 32) Assemble the bearing housing (6), bearing cone (10), splined hub (4), new tabwasher (9) and locking ring (8) to the pinion (7).
2. (Fig. 35) Mount the pinion assembly in a soft faced vice, then assemble the CP 4030 pre-load gauge as shown. Adjust the pre-load gauge to 18 - 22 lb.in. (0.207 - 0.249 kg.m.).
3. (Fig. 36) Tighten the locking ring using the 3150C spanner simultaneously tapping the pinion to centralise the bearing. When the pre-load is correctly set, the weight on the gauge should just fall freely under its own weight.
4. Secure the locking ring with the tab washer.
5. Fit the pinion assembly into the centre housing, locating the pin on the bearing housing. Fit the six bolts to hold the bearing housing in position.
6. Replace the speedometer drive assembly as described in operation 8A/30.
7. Replace the rear drive shaft and shear tube into the centre housing.
8. Fit a new gasket to the centre housing and replace the centre axle housing cover.
9. Refill the centre housing with a recommended oil.

DIFFERENTIAL LOCK MECHANISM

Disassembly

(8A/26)

1. Remove the right hand axle shaft housing assembly as stated in operation 8A/12.
2. (Fig. 37) With the differential lock lever removed lift up the rubber seal (1) and release the locknut (2) securing the actuator fork (3) to the shaft (4). Fully unscrew the fork from the shaft, complete with its locknut and rubber seal.
3. Remove the carrier plate as described in operation 8A/15.
4. Push the shaft (4) upwards and withdraw it from the axle shaft housing, complete with spring (5) washer (6) circlip (7) and 'O' ring (8).
5. Examine shaft for wear or scoring.

DIFFERENTIAL LOCK MECHANISM

Reassembly

(8A/27)

1. (Fig. 37) Fit a new 'O' ring (8) to the shaft (4). If the shaft has been renewed, also fit a new circlip (7) and washer (6).
2. Slide the shaft into the housing taking care not to damage the 'O' ring. Refit the spring.
3. Refit the carrier plate as described in operation 8A/15.
4. Refit the axle shaft housing as stated in operation 8A/12.
5. Refit differential lock lever and adjust as stated in operation 8A/28.

DIFFERENTIAL LOCK

Adjustment

(8A/28)

1. (Fig. 37) Lift up the rubber seal (1) covering the actuator fork locknut (2). Slacken the locknut then rotate the fork (3) out of engagement with the lever. Fully unscrew the fork from the shaft (4) complete with its locknut and seal.
2. Clean and degrease the threads of the actuator fork and the shaft.
3. Apply a small quantity of either Loctite Grade "A" or "AV", or Casco 'ML15' to the threads of the actuator fork, then screw the actuator fully into the shaft. Unscrew the actuator fork until it will engage the end of the differential lock bracket with the lever in the fully forward position. Fully tighten the locknut and push the rubber seal into place.

DIFFERENTIAL LOCK OPERATING BRACKET

Removal and Refitting

(8A/29)

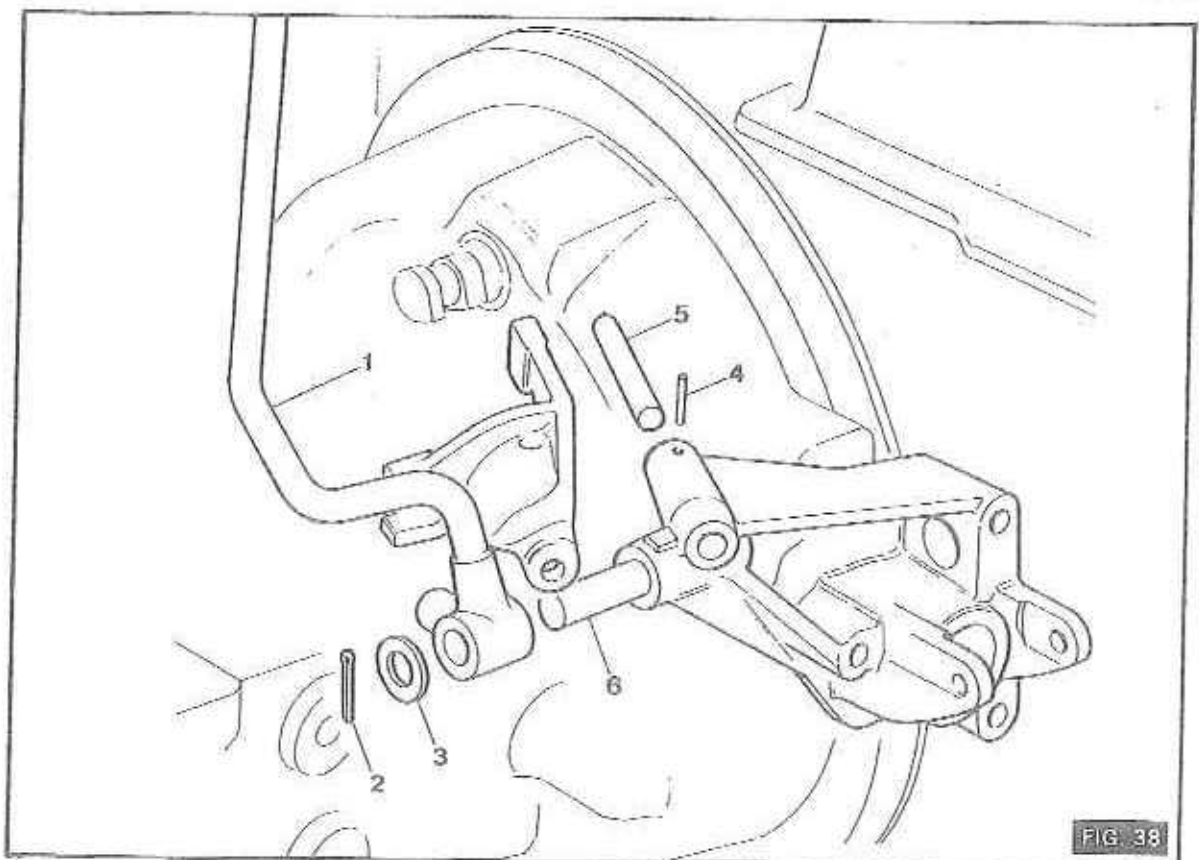
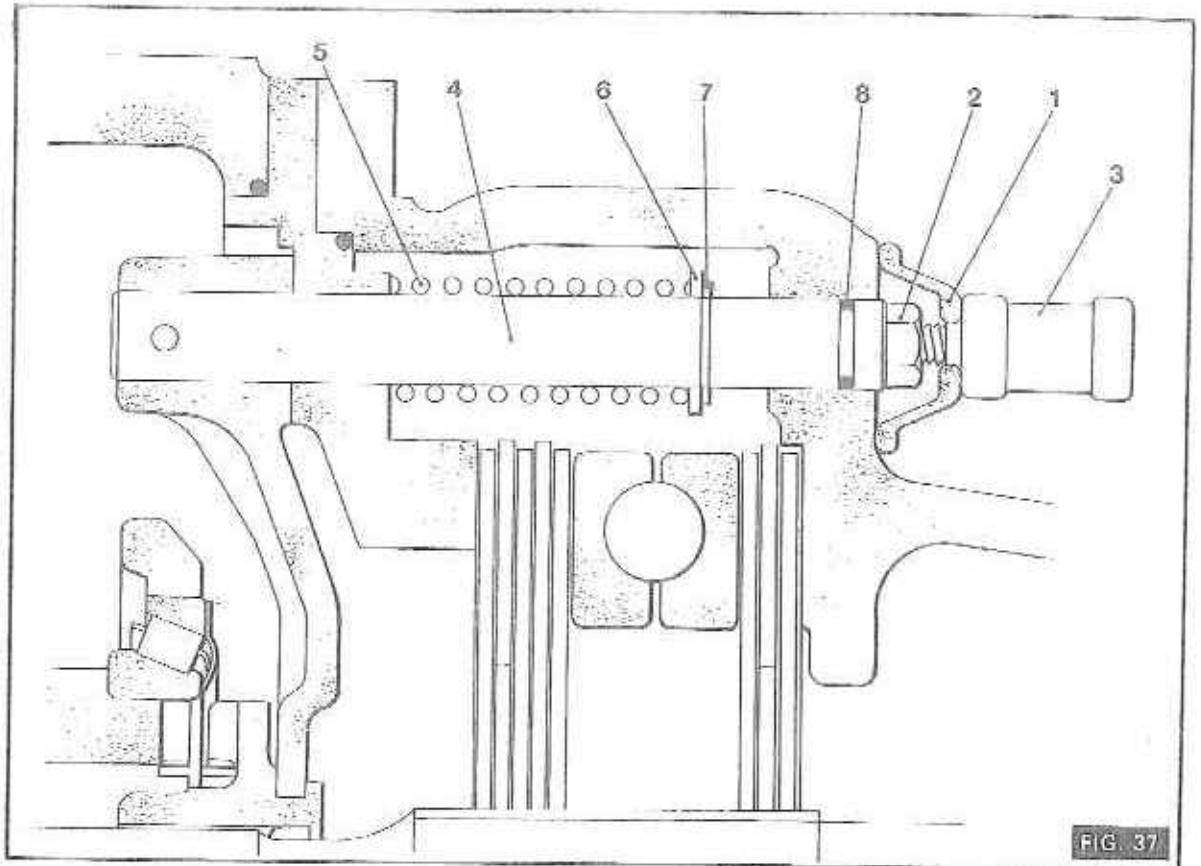
1. (Fig. 38) Remove the Differential lock lever (1) by removing the split pin (2), washer (3) and sliding the lever off the shaft.
2. Drive out the pin (4), remove the shaft (5) and lift the operating bracket clear. The shaft (6) can now be removed.
3. Replace in a reverse order of the above procedure.

SPEEDOMETER DRIVE ASSEMBLY

Removal and Refitting

(8A/30)

1. (Fig. 39) Disconnect the speedometer drive cable (1) from the speedometer and the gearbox (4).
2. Remove the centre axle housing cover.



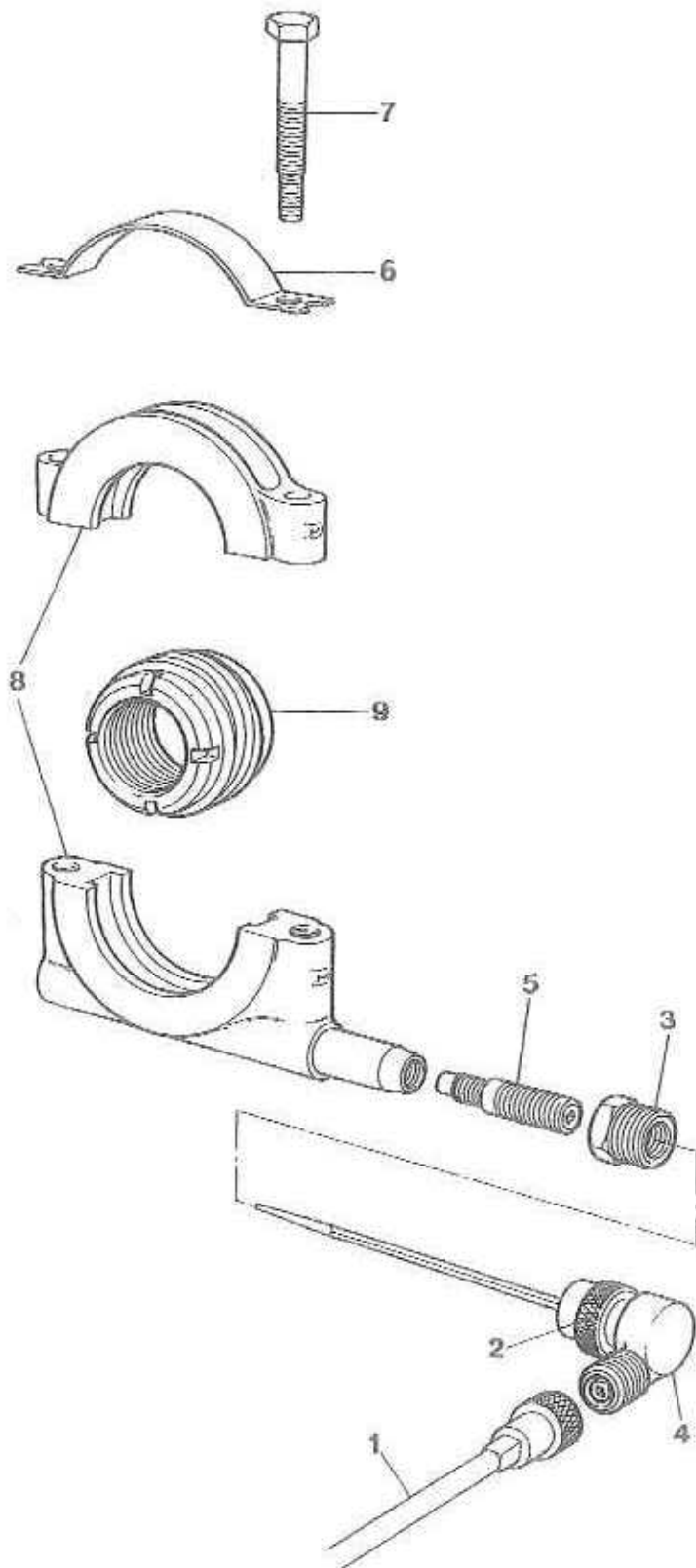


FIG 39

SPEEDOMETER DRIVE ASSEMBLY

Removal and Refitting . . . Cont'd

3. Remove the split pin, shear tube and main drive shaft.
4. Remove the guard and unscrew the knurled nut (2) from the adaptor (3). Remove the gearbox (4).
5. Remove the adaptor (3) from the stud (5).
6. Release the tabwasher (6), unscrew the two bolts (7) and lift out the two halves of the speedometer drive housing (8).
7. Remove the drive pinion assembly and the locking ring/drive wheel (9) as stated in operation 8A/22.
8. Replace the locking ring/drive wheel and the drive pinion as stated in operation 8A/25.
9. Refit the speedometer drive assembly by reversing the above procedure.

NOTE

A number is stamped on the arm of each half of the speedometer housing. These numbers should be matched up on reassembly.

BRAKE ACTUATOR HOUSING

Removal and Refitting

(8A/31)

1. Drain the transmission oil to the MIN mark on the dipstick.
2. Disconnect the brake pull rods and remove the brake return spring.
3. Remove the speedometer gearbox and guard (left hand housing only).
4. (Fig. 40) Slacken the setscrew (1) and slide the brake lever (2) off the cross shaft (3). Take care that the key (4) is not misplaced.
5. Remove the bolt (5) from the cross shaft (3) and lift the cross shaft clear of the axle taking care not to misplace the key (6).
6. (Fig. 41) Remove the brake adjusting nut (1) and spacer (2).
7. Remove the three bolts securing the actuator housing to the axle housing then lift off the housing.
8. Tap out the rubber boot.
9. Only if necessary, remove the brake pull lever by removing the split pin and pushing out the pivot shaft.
10. Refitting is a reversal of the above procedure.

NOTE

If removing the right hand brake actuator housing remove the Differential lever and manoeuvre the housing complete with differential lock operating bracket clear of the tractor.

DISC BRAKES

Adjustment and Balancing

(8A/32)

1. Jack up the machine until both wheels are clear of the ground.
2. Disengage the brake return springs and release the parking brake.
3. Measure the height of the right hand pedal from the floorboard then apply a load of approximately 10 lb. (4.5 kg). The correct free travel is 2 5/8 in. (67 mm).
4. (Fig. 41) Adjust the nut if necessary, clockwise to reduce the travel or anticlockwise to increase it.
5. After correctly setting the free travel of the right hand pedal adjust the left hand pedal to match for height and check that the latch will engage freely.
6. Remove the jack then road test the machine with the pedals locked together, checking for binding or pulling to one side.

'anti squeak' oil used at one time was 1863 434M1.

L.H. DISC BRAKE UNIT

Removal and Refitting

(8A/33)

1. Remove the left hand axle shaft housing as described in operation 8A/12.
2. Remove the brake actuator housing as described 8A/31, items 6 to 8.
3. Remove the carrier plate as described in operation 8A/13.
4. (Fig. 42) Remove the brake components, marking them as they are withdrawn to facilitate reassembly. The order of removal is: first friction plate, first interplate, second friction plate, second interplate, third friction plate, actuator unit, fourth friction plate, third interplate, fifth friction plate.
5. Check the friction plates for wear signs i.e. grooves are starting to disappear. Interplates should be replaced whenever new friction plates are fitted.
6. Refit in a reverse manner of the above removal procedure.

R.H. DISC BRAKE UNIT

Removal and Refitting

(8A/34)

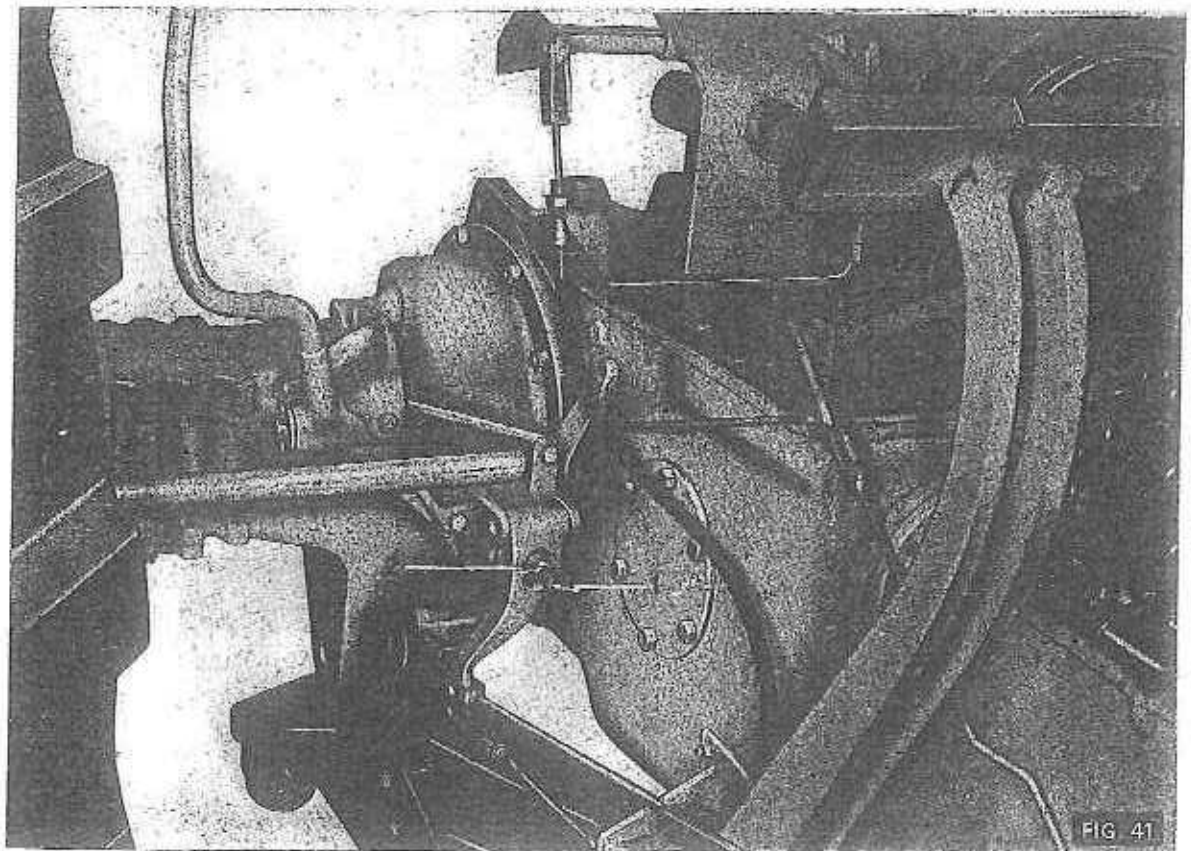
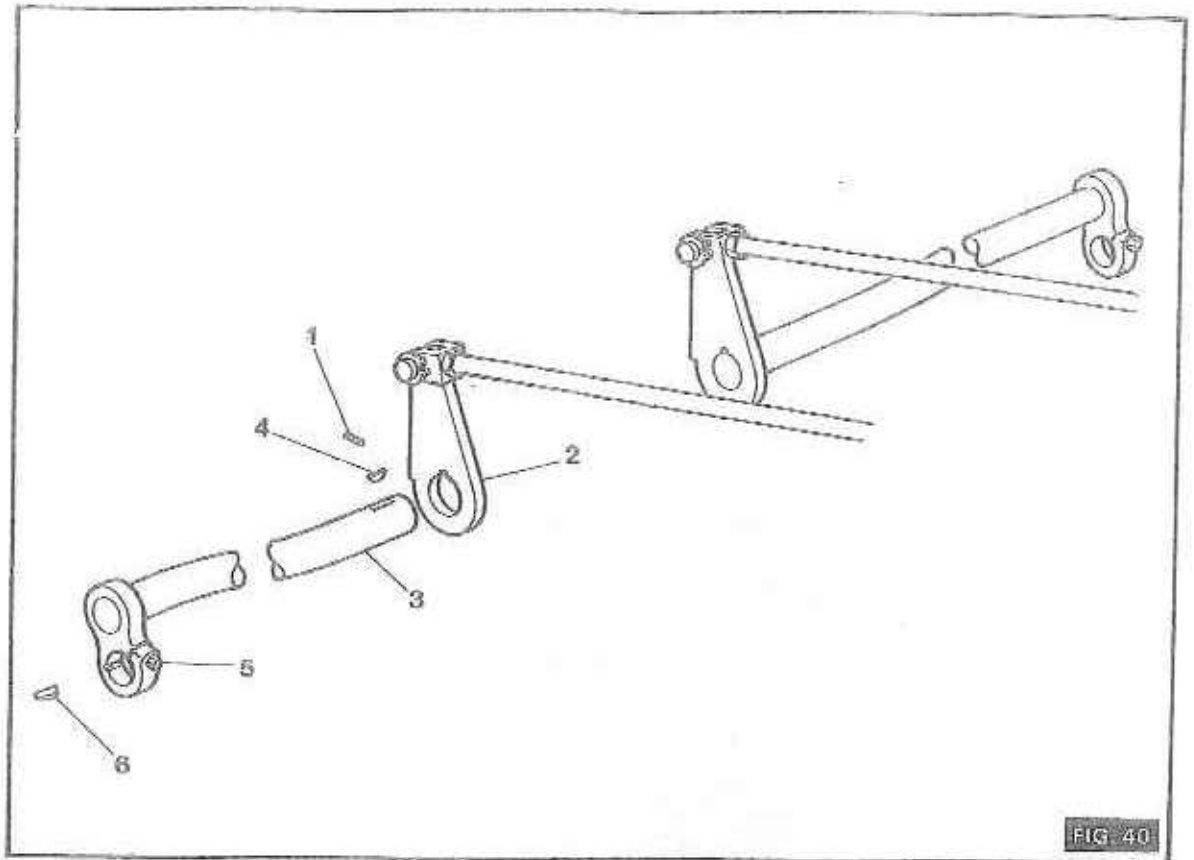
1. Remove the right hand axle shaft housing as described in operation 8A/12.
2. Remove the brake actuator housing as described in operation 8A/31 items 6 to 8.
3. Remove the carrier plate as described in operation 8A/15.
4. (Fig. 42) Remove the brake components, marking them as they are removed to facilitate reassembly. The order of removal is: first friction plate, first interplate, second friction plate, second interplate, third friction plate, actuator unit, fourth friction plate, third interplate, fifth friction plate.
5. Check the friction plates for wear signs i.e. grooves are starting to disappear. Interplates should be replaced whenever new friction plates are fitted.
6. Replacement is a reversal of the above procedure.

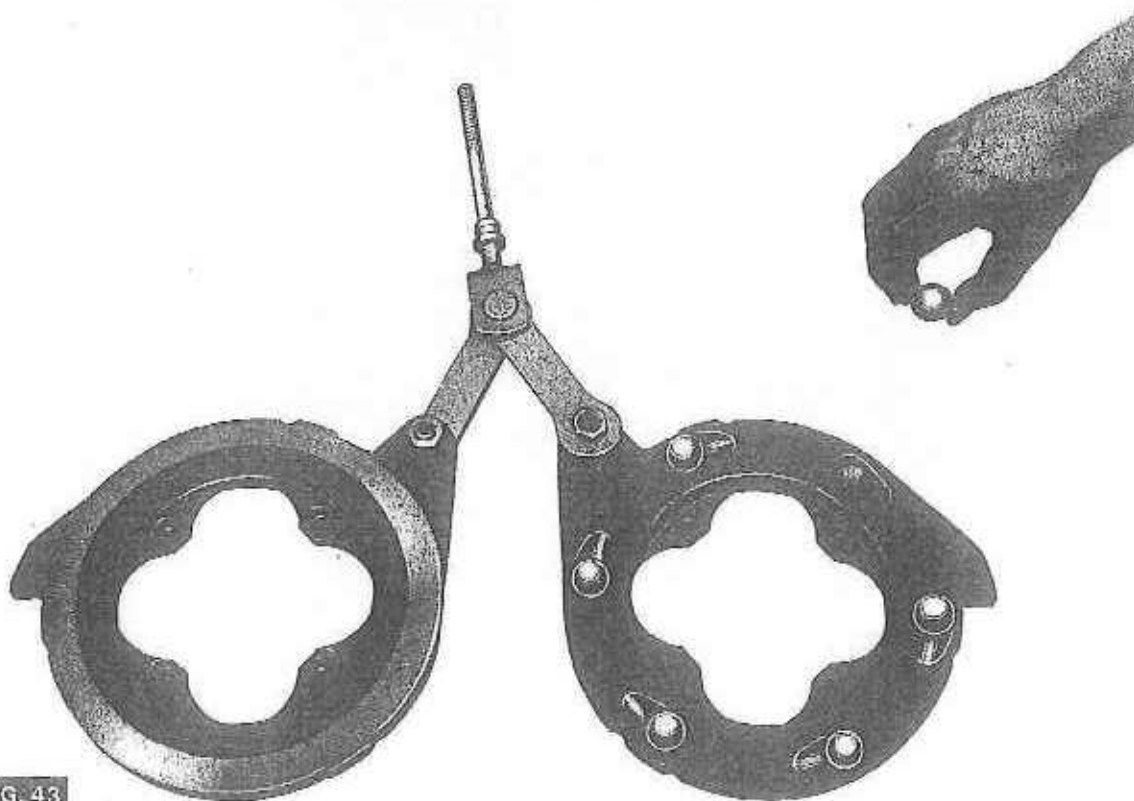
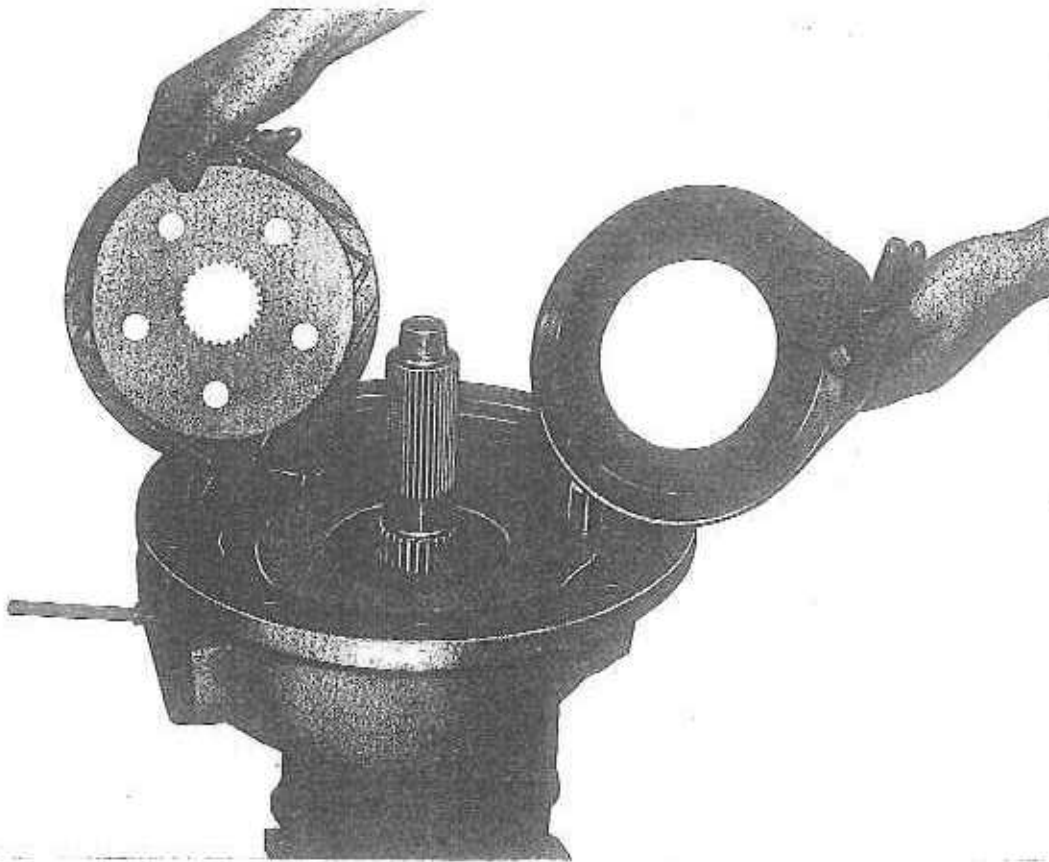
BRAKE EXPANDER UNIT

Disassembly and Reassembly

(8A/35)

1. Remove the disc brake assembly as described in operation 8A/33 or 8A/34.
2. (Fig. 43) remove the two studs and nuts (A) securing the linkage to the expander unit.
3. Remove the four springs (B), separate the two plates and remove the six steel balls (C).
4. When the unit is stripped check the following points.
 - (a) That there are no broken or damaged parts.
 - (b) That the bronze friction disc surfaces and splines are not excessively worn.
 - (c) That the steel interplates are not heavily scored.
 - (d) That the pull-off springs between the actuator plates retain sufficient tension.
 - (e) That all bolts, pins and studs are in good condition.
5. Reassembly is a reversal of the above procedure.





**DRUM BRAKES
(Parking Brake)**

CONTENTS

	PAGE
GENERAL	
DRUM BRAKES, Adjustment (8B/1)	4
BRAKE SHOES, Removal and Refitting (8B/2)	4
COMPLETE DRUM BRAKE ASSEMBLY, Removal and Disassembly (8B/3)	5
COMPLETE DRUM BRAKE ASSEMBLY, Reassembly and Refitting (8B/4)	5
PARKING BRAKE LINKAGE, Removal and Replacement (8B/5)	6
BRAKE SHOE RENEWAL	6

LIST OF ILLUSTRATIONS

Figure	Facing Page
1. PARKING BRAKES, General Arrangement	4
2. DRUM BRAKES, Adjustment	4
3. BRAKE SHOES, Removal	4
4. DRUM BRAKE ASSEMBLY, Removal	4
5. PARKING BRAKE ROD, Removal	5
6. CROSS SHAFT, Removal	5
7. DRUM BRAKE ASSEMBLY, Removal	5
8. CROSS SHAFT, Refitting	5
9. PARKING BRAKE ROD, Refitting	5
10. PARKING BRAKE LINKAGE	5

DRUM BRAKES (Parking Brakes)

GENERAL

In addition to the normal service brakes, an independent mechanically operated parking brake system can be fitted to the MF 50B Tractor Digger Loader.

The parking brake system consists of two Girling type drum brakes, actuated by hand lever control via an arrangement of connecting rods and linkage, see Fig.1.

When the parking brake lever is applied, it engages with a pawl which serves to lock the parking brake mechanism on. To release the parking brake release the hand brake lever. This will cause the locking pawl to disengage from the parking brake lever, thus allowing the parking brake mechanism to be released.

The drum brake assemblies are Girling two shoe, floating cam, double acting units with a total lining area of 108 sq. in. (696 sq. cm). The size of each brake shoe is 14 in. x 2 in. (35.6 x 50.8 cm).

DRUM BRAKES

Adjustment

(88/1)

1. Raise the rear of the machine until the rear wheels are clear of the ground.
2. Ensure that all shafts and pins work freely. Check that the brake pedals come up against their stops when the parking brakes are off.
3. Move aside the adjuster cover on the back plate.
4. (Fig. 2) Insert a screwdriver through the hole in the back plate and lever the clicker adjuster to expand the shoes in the drum, by turning the starwheel; clockwise on the R.H. wheel and anti-clockwise on the L.H. wheel. Continue to turn the adjuster until the wheels are locked.
5. Slacken the adjuster by six to eight clicks, at which point the wheels should spin freely.
6. Ensure that the brakes are evenly adjusted.

WARNING

Do not adjust the parking brakes by altering the length of the operating rods. The shoes only must be adjusted in the drums.

BRAKE SHOES

Removal and Refitting

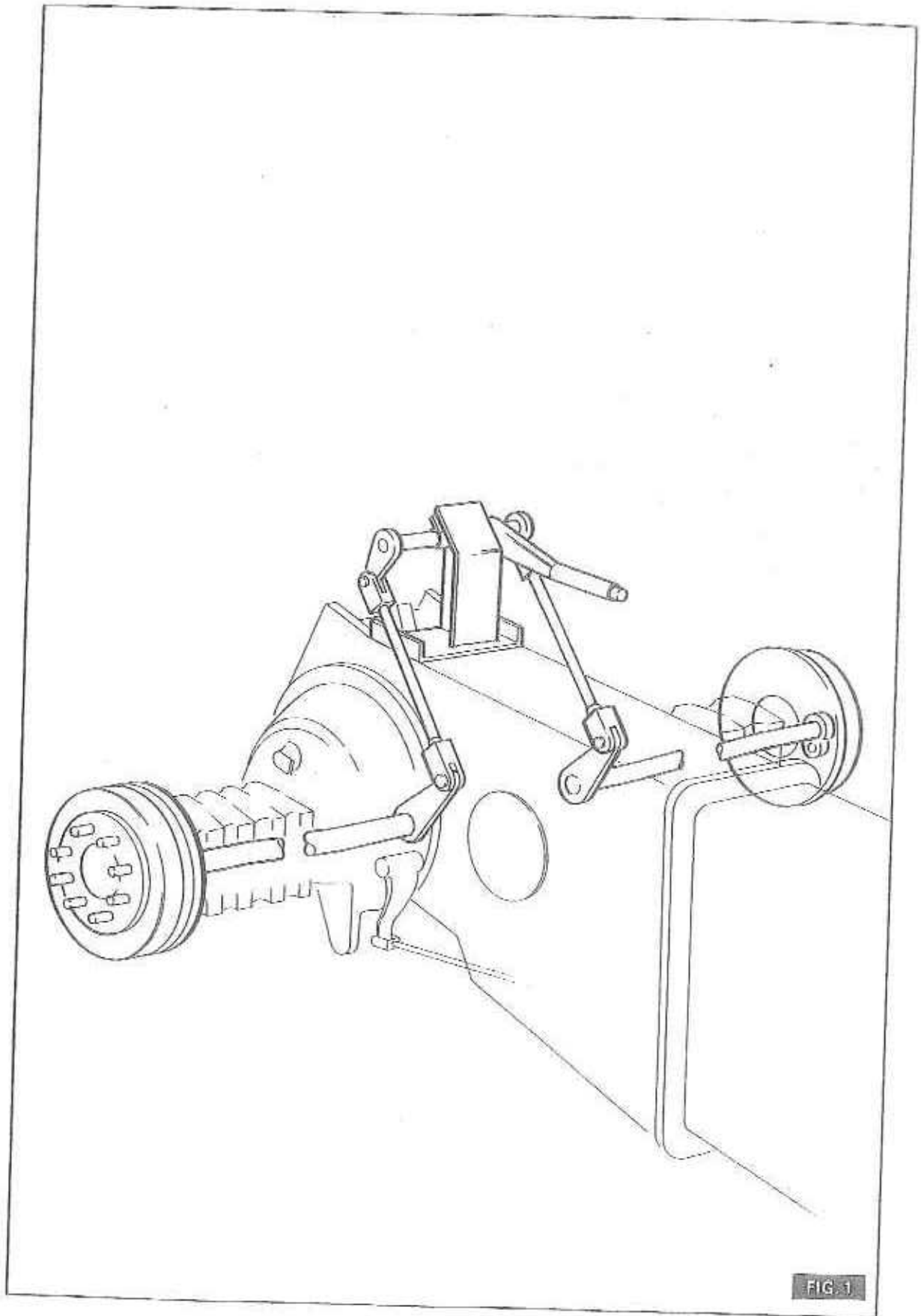
(88/2)

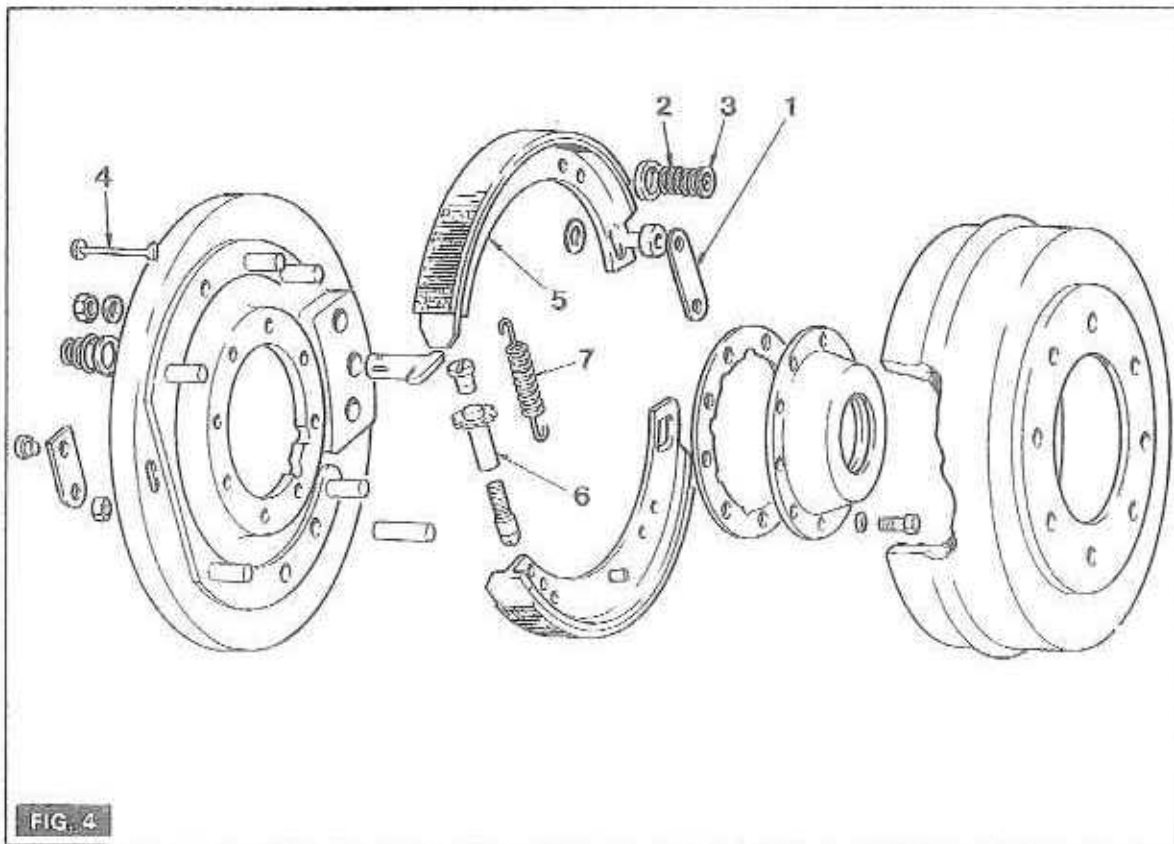
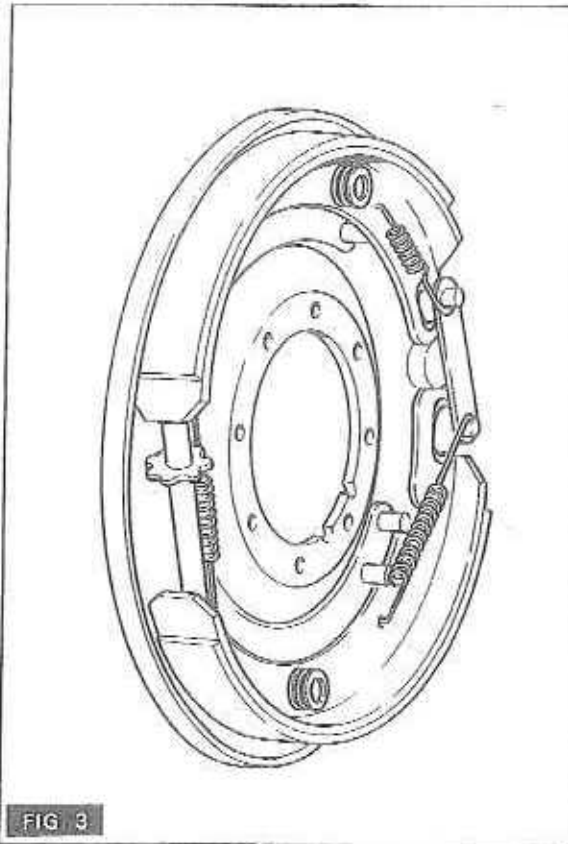
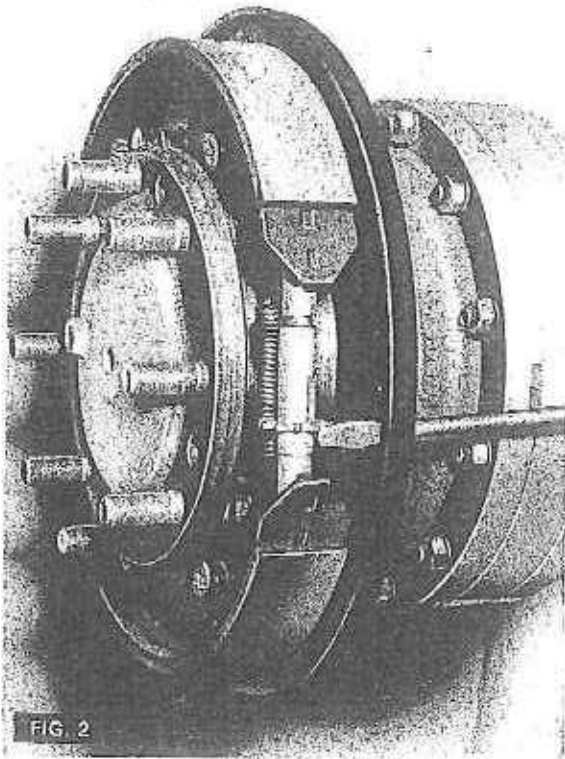
Excessive travel of the parking brake lever, or failure of the parking brake to hold the machine stationary on an incline, indicates that the brake linings are excessively or unevenly worn or possibly contaminated with oil or grease.

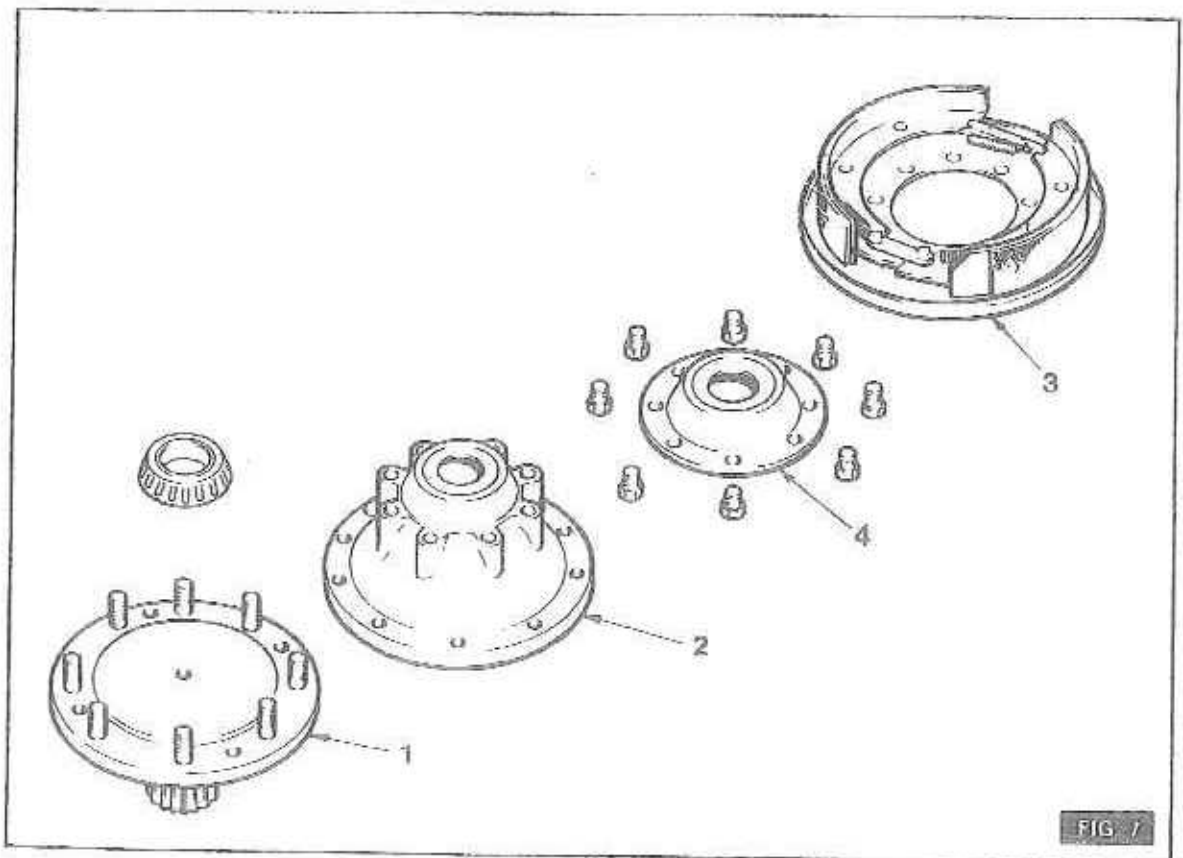
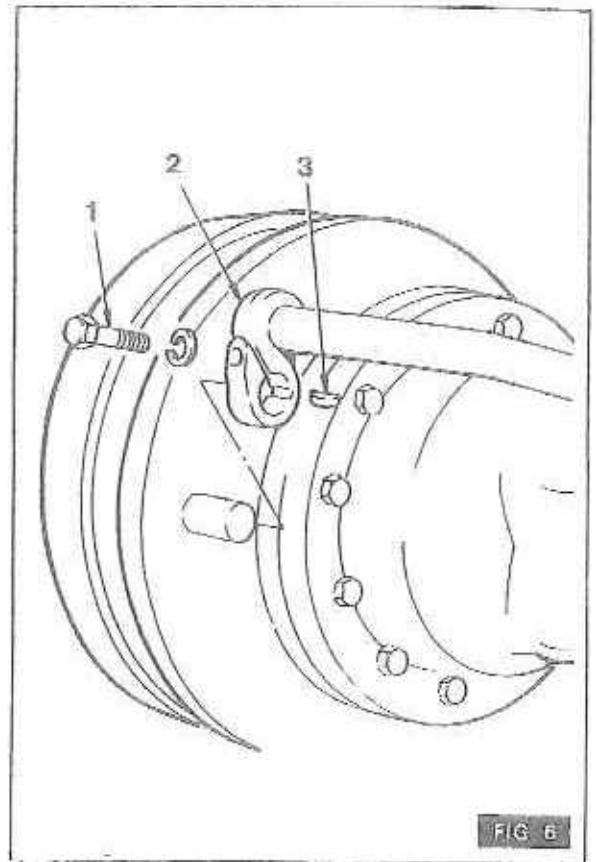
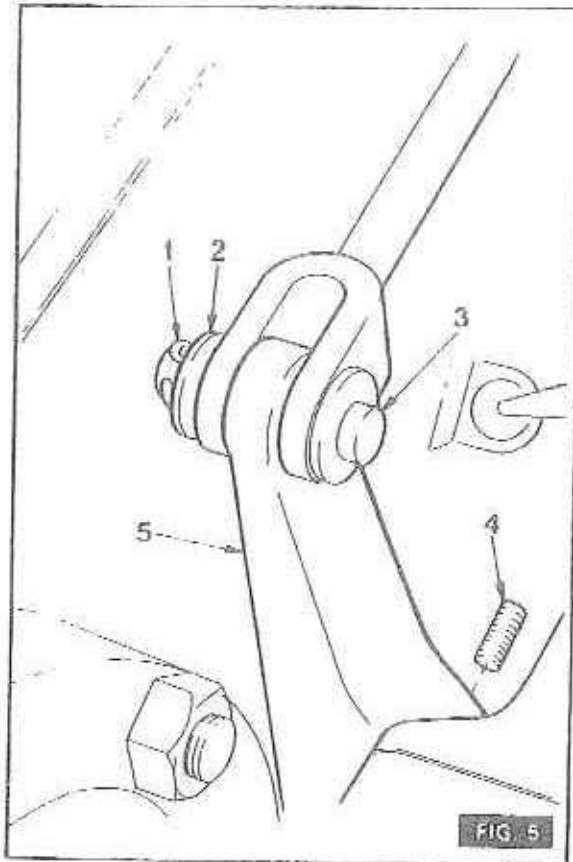
When these symptoms become evident, the brake shoes and linings should be examined. If the linings are worn to within 1/16 in. (1.59 mm) of the shoe face, they should be renewed.

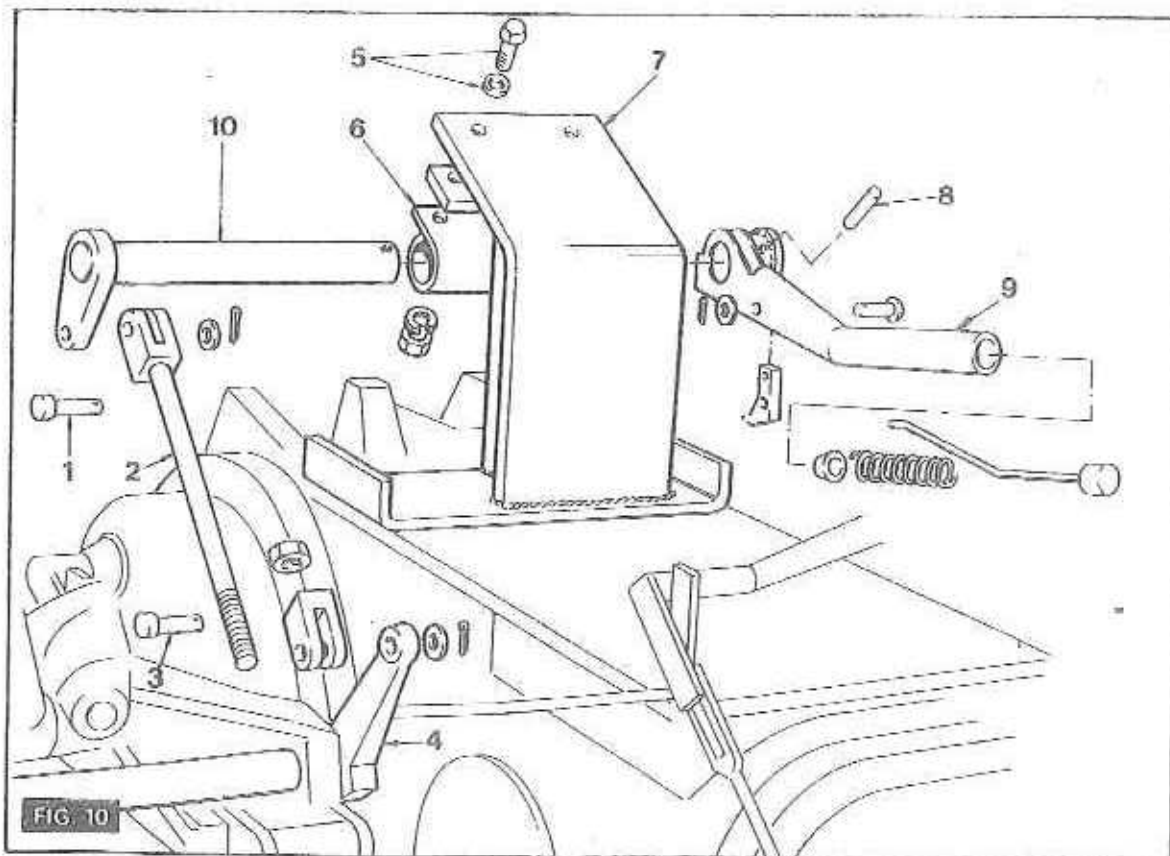
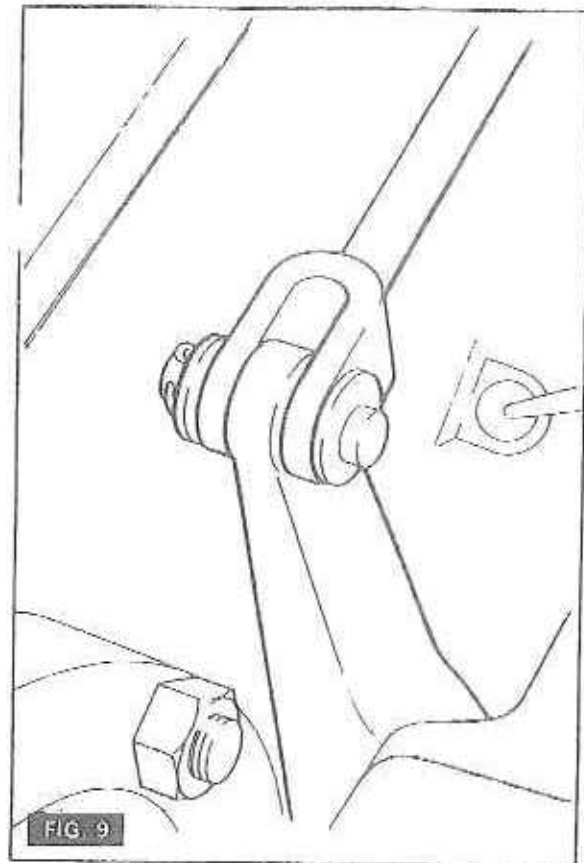
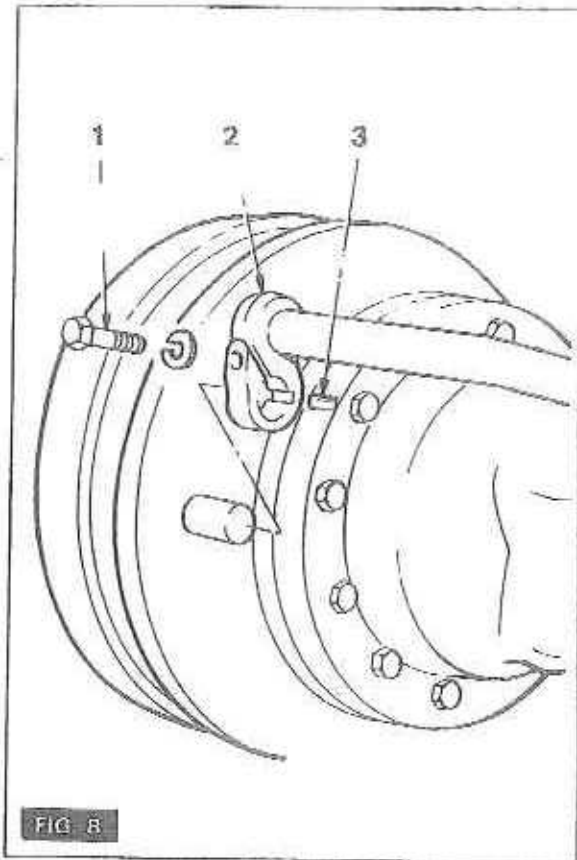
When fitting replacement shoes use only genuine spares of approved quality. If varied lining materials are used it will be difficult to achieve a satisfactory braking balance.

1. Jack up the rear of the machine until the rear wheels are clear of the ground. Remove the wheel and brake drum.
2. (Fig. 3) Remove the shoe return springs and the adjuster.
3. Remove the retainer springs and cups by pressing the cups down and turning.
4. Remove the brake shoes.
5. Reassemble in reverse order and adjust as described in operation 88/1.









BRAKE SHOES

Removal and Refitting . . . Cont'd

6. On reassembly, it is advisable to smear a light application of white grease or petroleum jelly to the pivot posts and adjuster thread.

Note

Take care not to alter the adjustment of the steady posts as these are pre-set on manufacture.

COMPLETE DRUM BRAKE ASSEMBLY

Removal and Disassembly

(8B/3)

1. Securely wedge the front axle between the axle support and the axle beam in order to prevent the machine tilting.
2. Place a jack under the centre axle housing and raise the machine until the rear wheels are clear of the ground. Place suitable stands or supports under the rear axle. Remove the wheel and brake drum.
3. (Fig. 4) Remove the springs (anchor pin to shoe) and remove the anchor pin plate (1).
4. Remove the shoe retaining springs (2), cups (3) and pins (4).
5. Remove the brake shoes (5), adjuster (6) and spring (7). Separate the shoes from the spring.
6. (Fig. 5) Disconnect the parking brake actuating rod from the parking brake linkage by removing the split pin (1), washer (2) and clevis pin (3).
7. Remove the setscrew (4) from the brake actuating lever (5).
8. Suitably mark the epicyclic unit to facilitate reassembly and drain the oil from the epicyclic unit.
9. Remove the twelve bolts, nuts and washers and lift the epicyclic unit, complete with parking brake cross shaft, away from the machine.
10. (Fig. 6) Remove the bolt (1) from the cross shaft (2) and remove the shaft, taking care not to misplace the key (3).
11. Dismantle the epicyclic unit as described in operation 8A/2, items 4 to 9 inclusive.
12. (Fig. 7) Remove the wheel axle (1) from the drive cover (2) as described in operation 8A/9 items 3 to 6 inclusive.
13. Mark the drive cover (2) to the brake back-plate (3) and the back-plate to the oil catcher (4). Remove the eight bolts and lift the back-plate from the drive cover.
14. Remove the spring and washer from the brake camshaft remove the camshaft.
15. Remove the steady posts, anchor pins and washers from the back-plate.

COMPLETE DRUM BRAKE ASSEMBLY

Reassembly and Refitting

(8B/4)

1. Fit the steady posts, anchor pins and washers to the back-plate.
2. Fit the camshaft into the back-plate and refit the washer and spring to the camshaft.
3. Renew the gasket between the oil catcher and drive cover, align the marks on the drive cover and back-plate and the back-plate and oil catcher. Replace the eight bolts to hold the assembly together.
4. Reassemble the wheel axle and drive cover assembly as described in operation 8A/10.
5. Reassemble the epicyclic unit and refit to the wheel axle as described in operation 8A/3.
6. (Fig. 8) Refit the parking brake cross shaft (2) to the brake actuator, ensuring that the key (3) is correctly located. Lock the shaft in place with the bolt (1).
7. Renew the gasket between the axle shaft housing and planetary ring gear. Fit the ring gear (check the marks for correct alignment) to the axle shaft housing. The step in the ring gear must face OUTWARDS.
8. Fit a new gasket between the planetary ring gear and the epicyclic unit, align the unit correctly and fit to the planetary ring gear and axle housing. Replace the bolts, washers and nuts to hold the unit securely in place.
9. Locate the parking brake cross shaft in the actuating lever. Refit the grub screw to the actuating lever.
10. (Fig. 9) Connect the parking brake actuating rod to the parking brake linkage with the clevis pin, split pin and washer.

COMPLETE DRUM BRAKE ASSEMBLY

Reassembly and Refitting Cont'd

11. Replace the brake shoes and springs and retain them in place with the pins, springs and cup.
12. Replace the brake adjuster, correctly aligned with the hole on the back-plate.
13. Replace the anchor pin plate and springs.
14. Refill the epicyclic unit with the recommended grade of oil up to the correct level.
15. Replace the drum brake and wheel, oil the threads of the wheel nuts and tighten with a torque load of 190/200 lb ft (27,3–27,7 kg/m).
16. Adjust the brakes as described in operation 8B/1
17. Lower the machine to the ground and, remove the wedges from between the front axle beam and front axle support.

PARKING BRAKE LINKAGE

Removal and Replacement

(8B/5)

1. Before starting the removal of the brake linkage, ensure that the wheels are securely chocked and that the machine cannot move.
2. (Fig. 10) Remove the split pin and withdraw the clevis pin (1) which secures the R.H. rod assembly (2) to the parking brake cross shaft.
3. Remove the split pin and clevis pin (3) which secures the R.H. rod assembly (2) to the brake actuator shaft (4). Remove the rod assembly.
4. Remove the L.H. rod assembly in the same manner.
5. Remove the two bolts, washers and nuts (5) securing the handbrake bracket (6) to the support (7). Remove the handbrake and bracket.
6. Remove taper pin (8) and separate the handbrake (9) from the cross shaft (10).
7. Slacken the setscrew (11) and slide the brake lever (12) off the cross shaft (10). Take care that the key (13) is not misplaced.
8. Remove the bolt (14) from the cross shaft (4) and lift the cross shaft clear of the axle, taking care not to misplace the key (15).
9. To replace the parking brake linkage, reverse the above procedure.

BRAKE SHOE RENEWAL

Check the condition of the brake shoes and linings at frequent intervals. When the linings become worn to within 1/16 in. (1.59 mm) of the shoe face, new or reconditioned shoes and linings should be fitted.

To fit new or reconditioned shoes and linings, refer to operation 8B/2.

HYDRAULIC SYSTEM GENERAL

HYDRAULIC SYSTEM

GENERAL

The hydraulic system on the MF 50B Tractor/Digger/Loader consists of the following components:
Fig. 1.

- | | |
|----------------------------------|---|
| 1. Hydraulic oil reservoir | Incorporated in the left hand side frame of the loader. An oil level indicator is fitted to the outside of the vertical pivot post. |
| 2. Filter | Situated on the inside of the left hand side frame, just in front of the rear axle. |
| 3. Gear Pump | Driven directly by the engine crankshaft and fitted at the front of the machine. |
| 4. Two spool control valve | Mounted on the left hand side frame. |
| 5. Two double acting lift rams | Fitted between the base of the lift arms and the vertical pivot post. One each side of the machine. |
| 6. Two double acting bucket rams | Fitted to the Loader side frame and the bucket transfer link one each side of the machine. |
| 7. Seven spool control valve | Mounted forward of the main frame. Directly in front of the reversed operators seat. |
| 8. Rotary actuator | Mounted at the rear of the main frame. Actuates the slew of the digger. |
| 9. Clamping cylinders | Fitted on the rear frame. When activated clamps complete digger to frame. |
| 10. Stabilizer cylinders | Housed in the main frame and independently operated. |
| 11. Boom ram | Fitted inside the boom. Raises or lowers the boom. |
| 12. Dipperstick ram | Rod side is fitted to the dipperstick and head side is fitted to the boom. |
| 13. Bucket ram | Mounted on the dipperstick. Crows or dumps the bucket. |

Hydraulic oil is drawn from the reservoir through the filter by means of the engine driven gear pump. The oil then is pumped to the two spool control valve at a pressure of 2500/2650 p.s.i. (175.7–186.3 kg/sq.cm). From the two spool valve oil can be directed to either the lift rams or the bucket rams, depending on which control lever is operated. If both levers are in neutral the oil passes through the open centre of the control valve and returns to the reservoir. When a digger is fitted oil is circulated via the pressure beyond port to the digger seven spool valve. From the seven spool valve oil can be directed to any of the seven services as required.

The reservoir for the hydraulic oil is incorporated in the L. H. side frame. The filter cap, which is situated on the top of the L.H. vertical pivot post, has also built into it a breather/cleaner which should be cleaned every 50 hours.

On the underside of the reservoir is a double drain plug. When the centre plug is removed it will allow oil to drain out to a level at which the oil filter element can be changed without draining the entire reservoir. When the large plug is removed the entire system will be drained.

A visual oil level indicator is located on the outside of the left hand vertical pivot post.

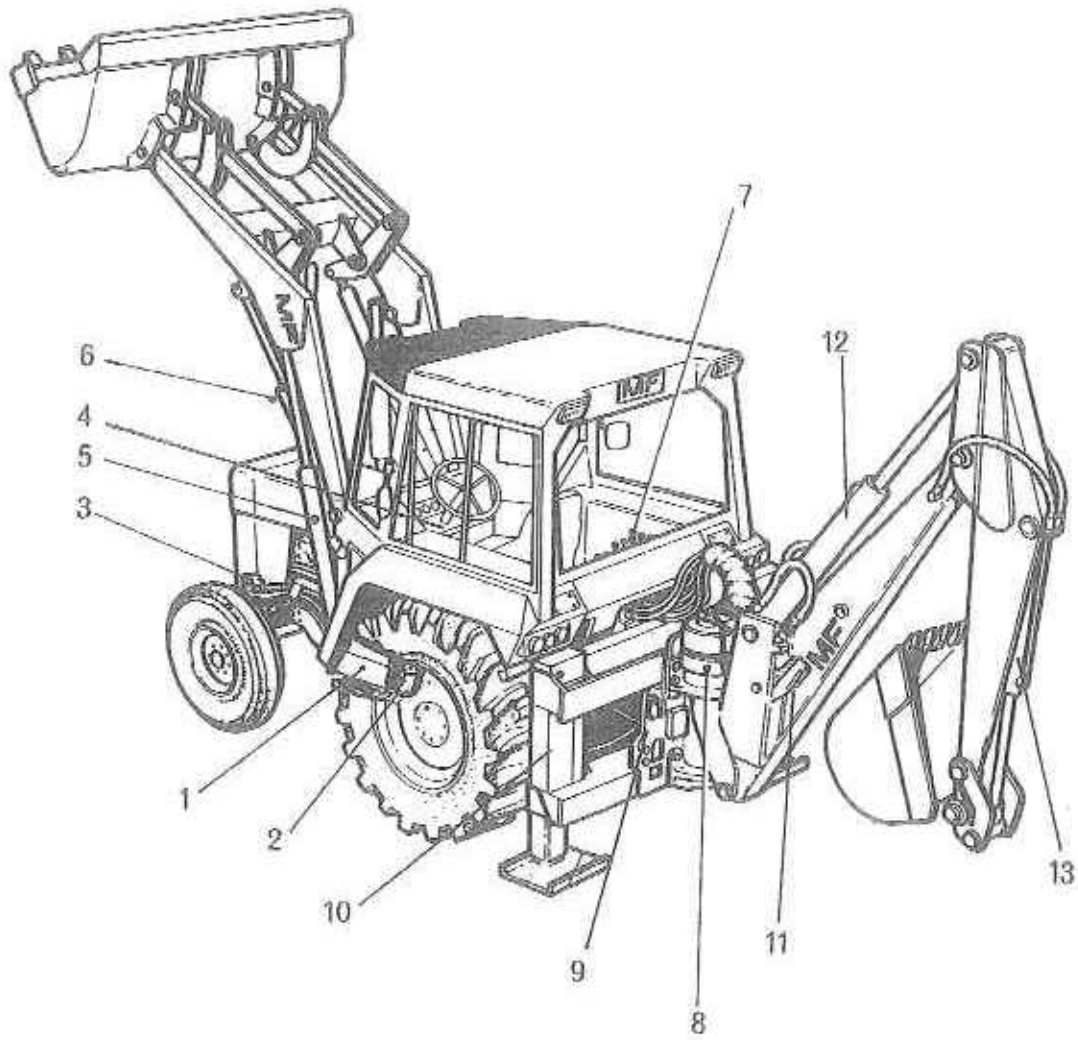


FIG 1

HYDRAULIC FILTER

CONTENTS

Page

General

FILTER, Removal and Replacement (9A/1)	4
FILTER ELEMENT, Removal and Replacement (9A/2)	4

LIST OF ILLUSTRATIONS

	Facing Page
Fig 1 GENERAL ARRANGEMENT	4
Fig 2 FILTER, Removal	4
Fig 3 FILTER, Breakdown	4

HYDRAULIC FILTER

General

Oil is drawn by the pump from the reservoir through a filter which is fitted on the side of the reservoir. The oil flows into the filter through the intake orifice. It is then drawn through the paper element, through the inner mesh filter, down into the lower part of the canister and out through the lower discharge orifice.

The filter is designed to remove foreign matter from the hydraulic oil, correct maintenance of the filter is therefore a necessity.

The element should be changed after the first 15 hours work and again after 40–45 hours. Thereafter the element should be renewed every 200 hours.

The filter is a full flow type with a paper element. The rated efficiency is 12 microns at 95% with a cut off of 30 microns.

FILTER

Removal and Replacement

1. Drain hydraulic fluid from reservoir.
2. Fig. 2 Remove the hydraulic oil filter securing bolt and nut (1).
3. Slacken the two main suction hose clips (2) and pull the hose off the filter.
4. Pull the complete filter unit (3) from the frame.
5. Replacement is a direct reversal of the above procedure.

When replacement is complete refill the reservoir with a recommended oil.

FILTER ELEMENT

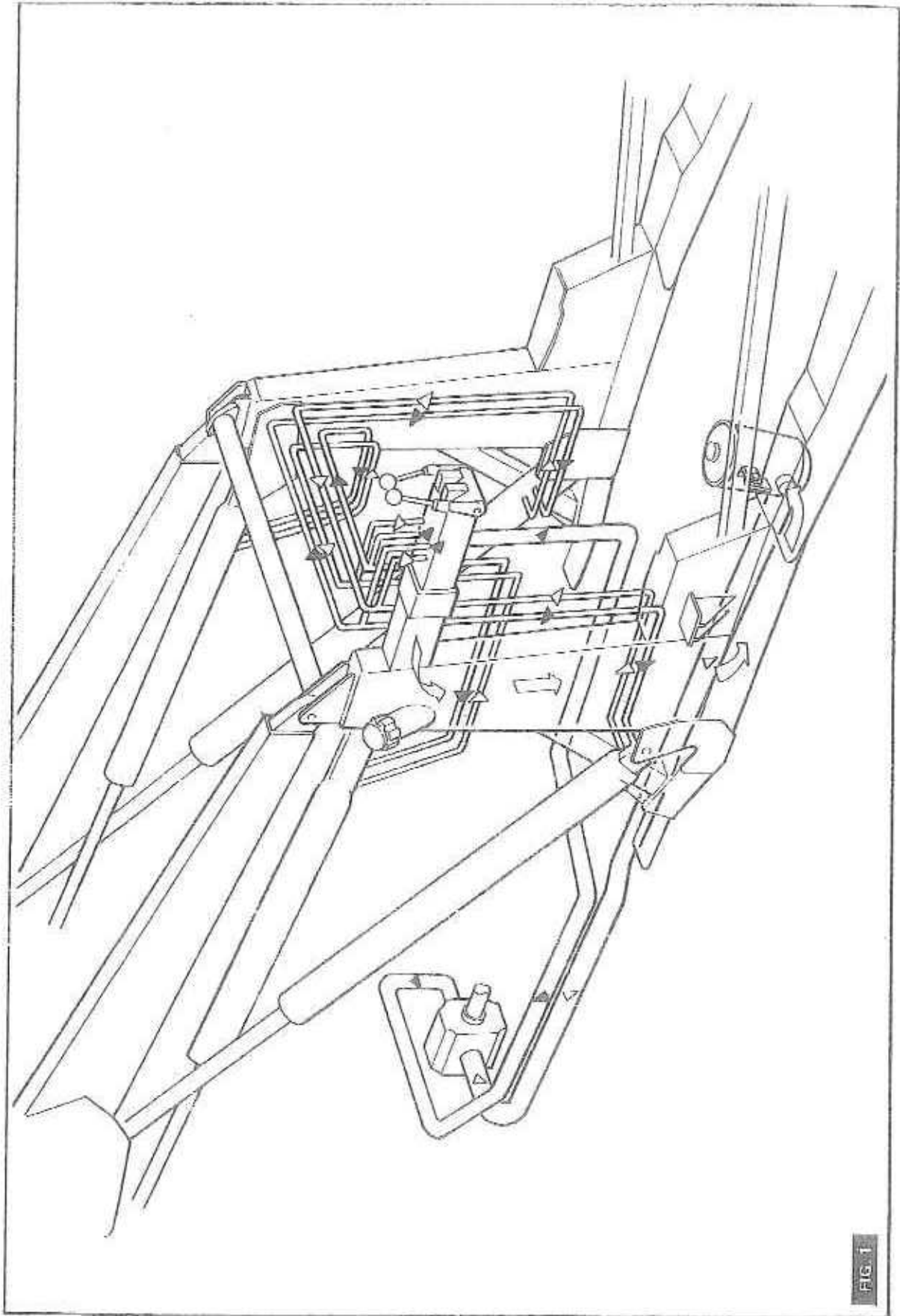
Removal and Replacement

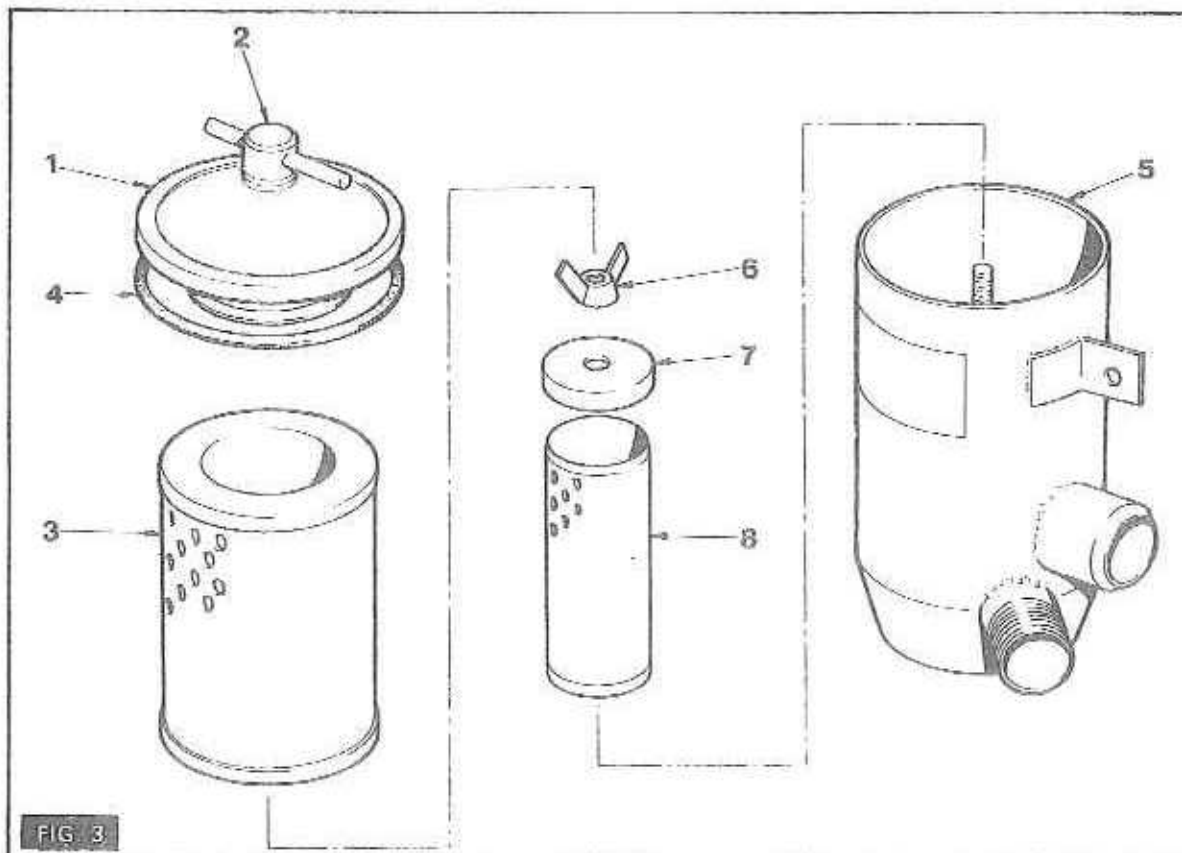
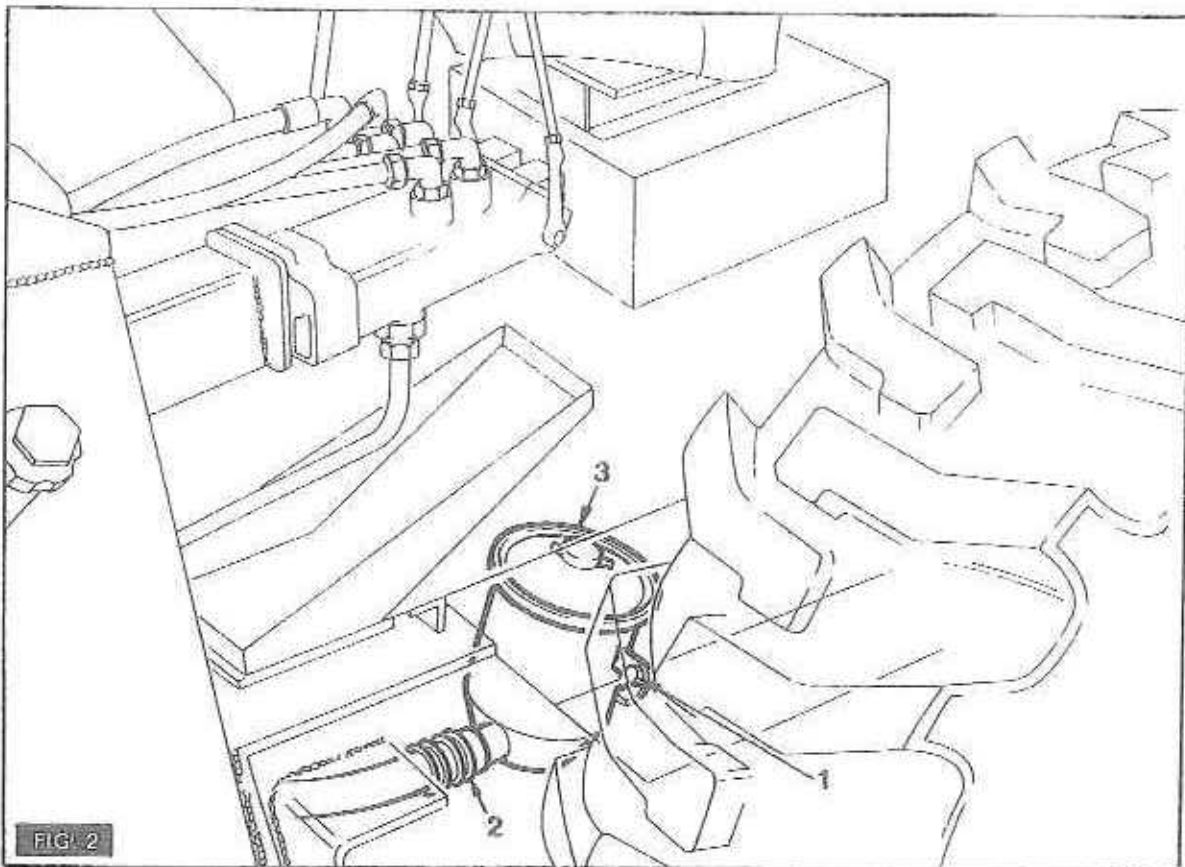
1. Extend all ram units to the fully open position.
2. Remove the inner drain plug and drain off the amount of fluid that this plug will allow (approx 3/4 gall. 3.4 litre.)
3. Remove the filter access panel from the floorplate in the cab.

4. (Fig. 3). Clean then remove the filter canister cap (1) by unscrewing the handle (2).
5. Remove filter element (3) insert new element and replace canister cap. Ensure that the gasket (4) between the cap (1) and container (5) is in good condition.

If during changing the filter element, the mesh assembly is blocked and requires cleaning, proceed as follows:

1. Remove the main drain plug and drain remaining oil from reservoir.
2. Unscrew wing nut (6) and remove washer and cap (7).
3. Withdraw mesh assembly (8) and clean in paraffin.
4. Wipe out inside of canister (5) with a clean, non fluffy cloth.
5. Replace mesh (8) washer and cap (7) and wing nut (6).
6. Replace filter element (3) and cover (1).
7. Ensure that the reservoir is refitted with a recommended oil before starting the engine.





HYDRAULIC PUMP

CONTENTS

	Page
General	4
PUMPS AND DRIVE SHAFT, Removal and Replacement (9C/1)	4
HYDRAULIC PUMP, Disassembly (9C/2)	4
HYDRAULIC PUMP, Reassembly (9C/3)	4
HYDRAULIC PUMP OIL FLOW, Checking (9C/4)	5

LIST OF ILLUSTRATIONS

	Facing Page
Fig 1 GENERAL ARRANGEMENT, Hydraulic Pump	4
Fig 2 PUMP REMOVAL	4
Fig 3 PUMP SECTION RETAINING BOLTS, Removal	4
Fig 4 BACKING WASHERS LOBE, Seal and 'O' ring Removal	4
Fig 5 BEARING BLOCK, Removal	5
Fig 6 GEAR REMOVAL	5
Fig 7 BEARING BLOCK, Replacement	5
Fig 8 OIL FLOW, Checking	5

HYDRAULIC PUMP

General

The main hydraulic pump is mounted at the front of the machine and connected by a drive shaft to the engine crankshaft. The pump output is 23.8 imp. gall./min. (108.19 litres/min.) at 2000 engine r.p.m. and at a pressure of 2500 p.s.i.

The direction of the pump rotation is clockwise when viewed from the front of the machine.

Oil is drawn from the reservoir situated in the left hand loader frame into the pump through the larger (suction) port. It is then carried round by the gears to the smaller (pressure) port and up to the loader control valve. The pump gears are supplied as a matched pair and should only be replaced as such.

The pump gears are supported by bronze bushes in the bearing blocks. The bearing blocks also act as pressurised wear plates against the gear faces. Oil from the pressure side is forced behind the blocks, via the cut out section in the blocks, thus pushing them against the gears to take up any wear. A small drilling in each block allows lubricating oil from the bushes to return to the inlet side of the pump.

HYDRAULIC PUMP AND PUMP DRIVE SHAFT

Removal and Replacement

(9C/1)

1. Raise the lift arms and place ram stops in position.
2. Remove front grille completely.
3. Drain the hydraulic system by removing the large drain plug in the underside of the reservoir, into a suitable receptacle.
4. Disconnect the suction and pressure hoses from the pump and plug the end of the hoses.
5. (Fig. 2). Remove the two pump securing bolts (1).
6. Slide the pump splined drive gear out of the drive shaft (2).
7. Insert tool No. M1 341 into the splined end of the drive shaft and extract the shaft by turning in a clockwise direction.
8. Lift the drive shaft clear of the machine.
9. Replacement is a reversal of the above procedure.

HYDRAULIC PUMP

Disassembly

(9C/2)

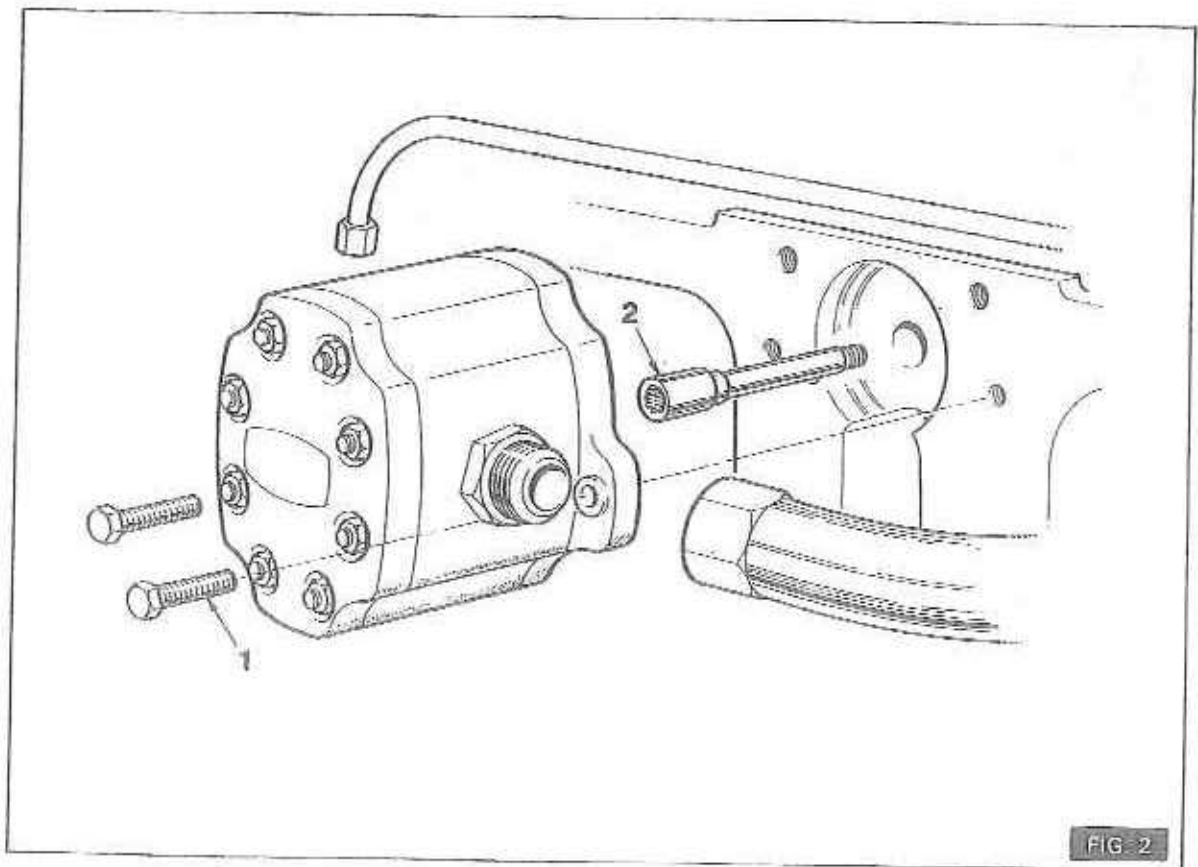
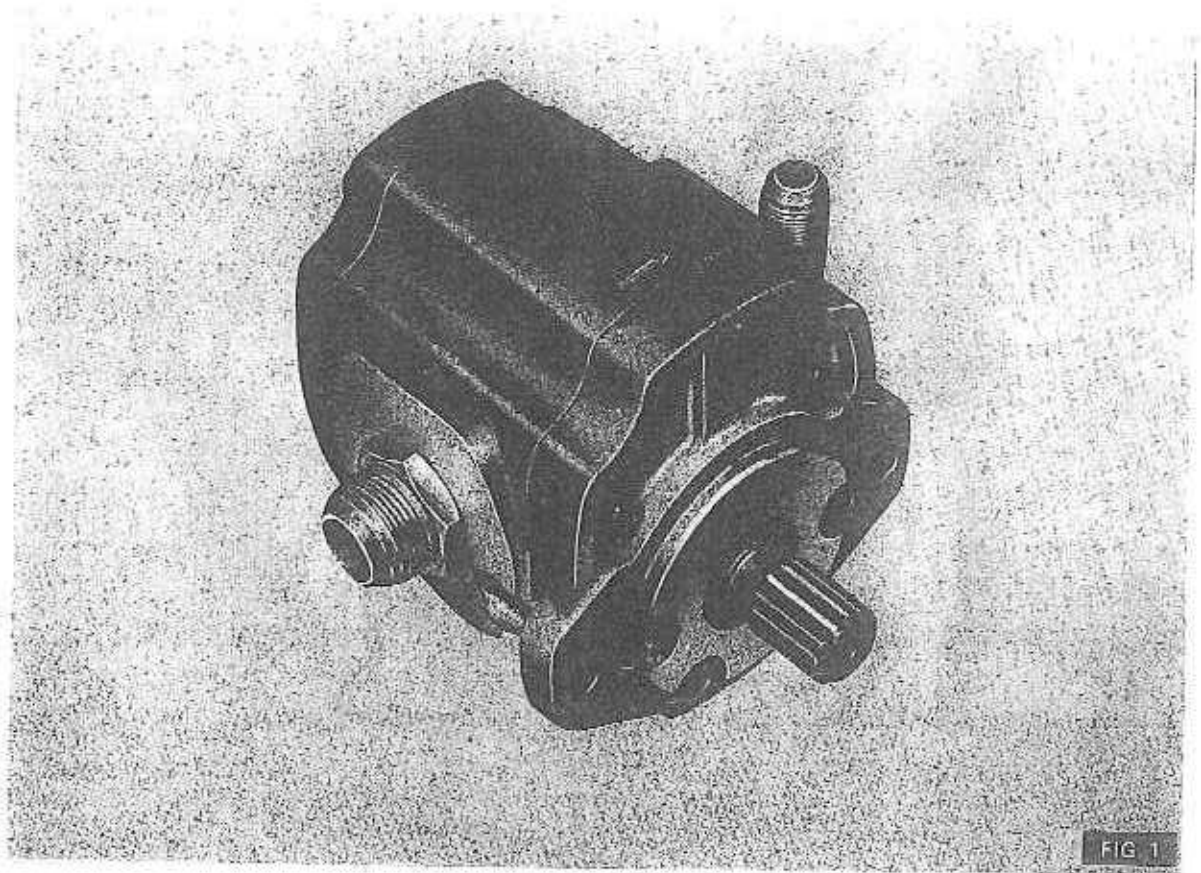
1. Remove the pump from the machine as described in operation 9C/1.
2. Clean the exterior of the pump, then using a sharp tool mark the front plate, body and back plate to facilitate reassembly.
3. (Fig. 3). Remove the eight bolts (1) which hold the three sections of the pump together. Lift off the end section (2).
4. (Fig. 4). Remove the two nylon backing washers (1), lobe seal (2) and 'O' ring (3).
5. (Fig. 5). Remove the bearing blocks from the pump body.
6. (Fig. 6). Slide the gears out of the pump body.
7. Remove the front plate, nylon backing washer, lobe seal and 'O' ring.
8. Extract the two remaining bearing blocks from the pump body.

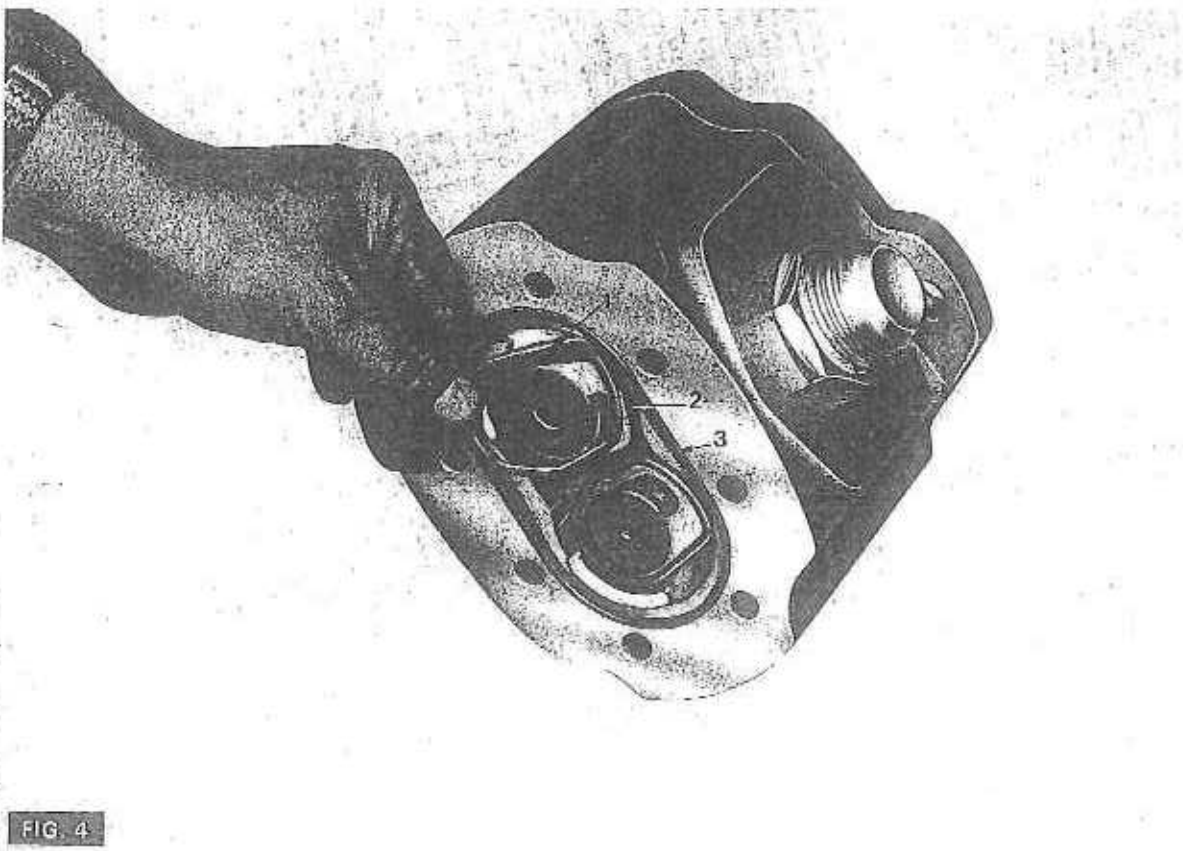
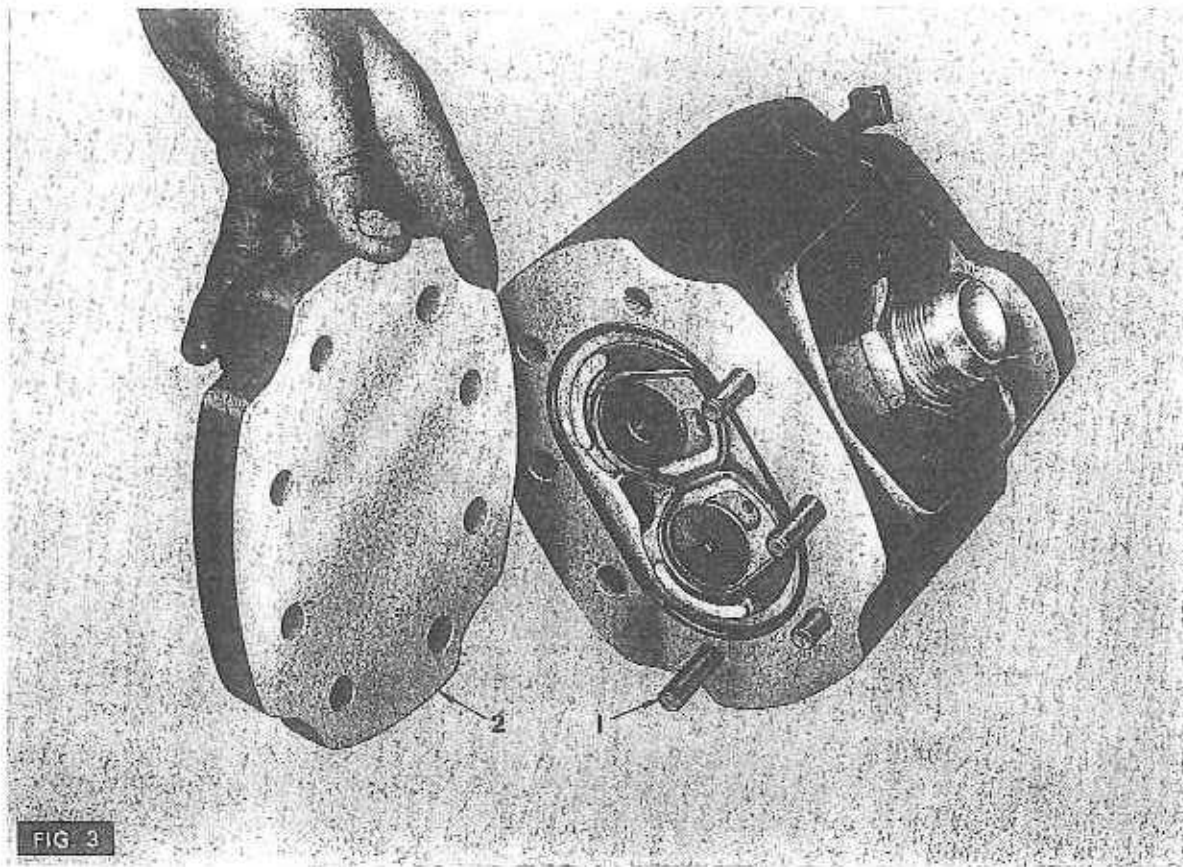
HYDRAULIC PUMP

Reassembly

(9C/3)

1. Ensure that all parts are perfectly clean and in good condition. Lubricate them with the oil to be used in the pump.
2. Fit a new wiper seal into the drive end plate. Pack the cavity between the sealing lips of the seal with a high melting point mineral grease.
3. (Fig. 7). Fit the first pair of bearing blocks (1) into the pump body (2).





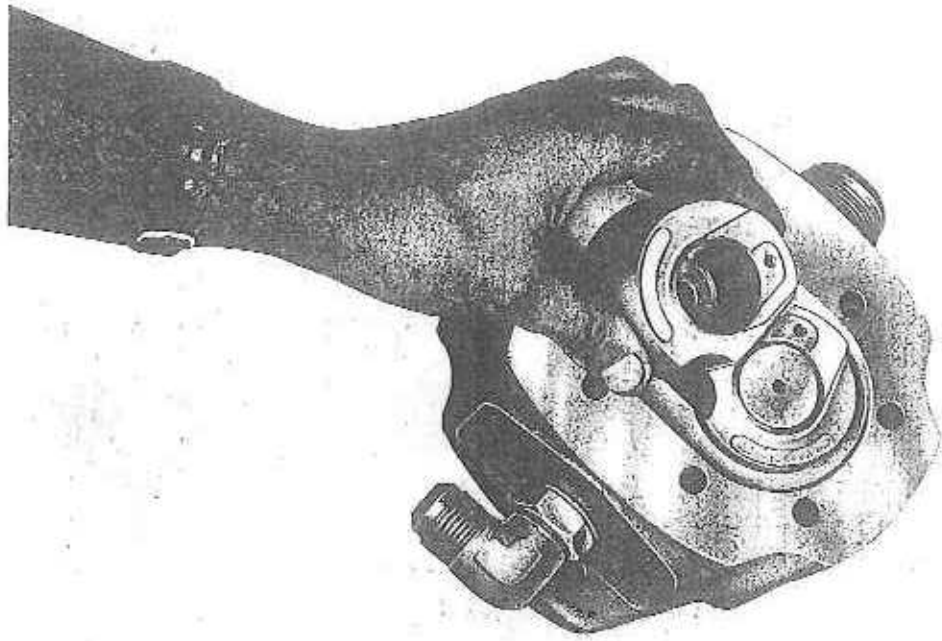


FIG. 5

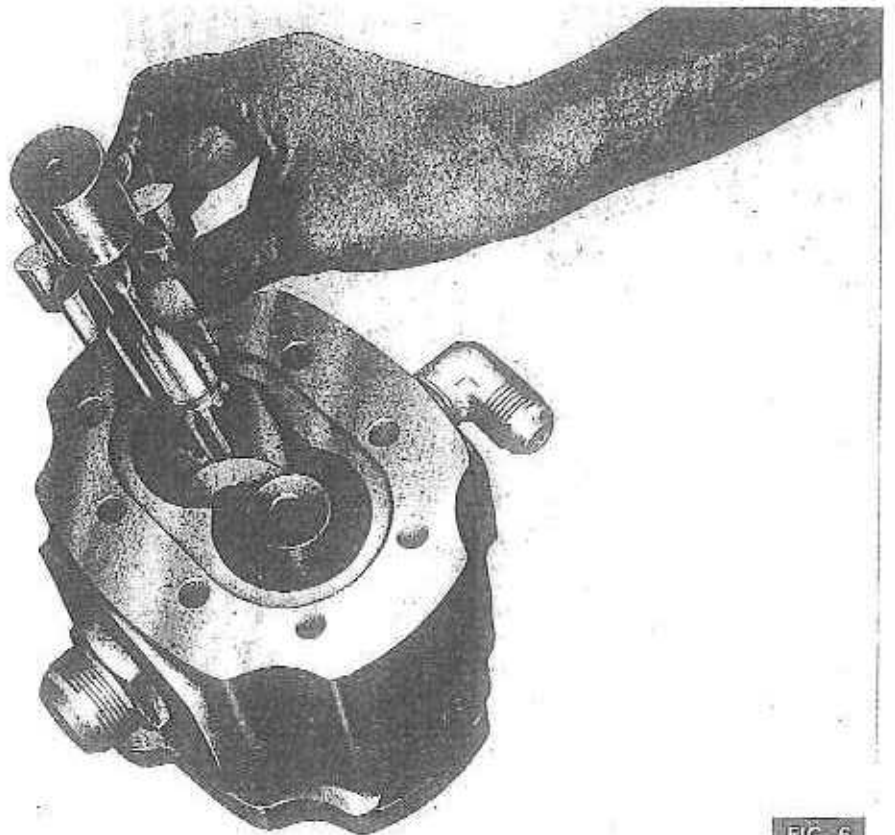


FIG. 6

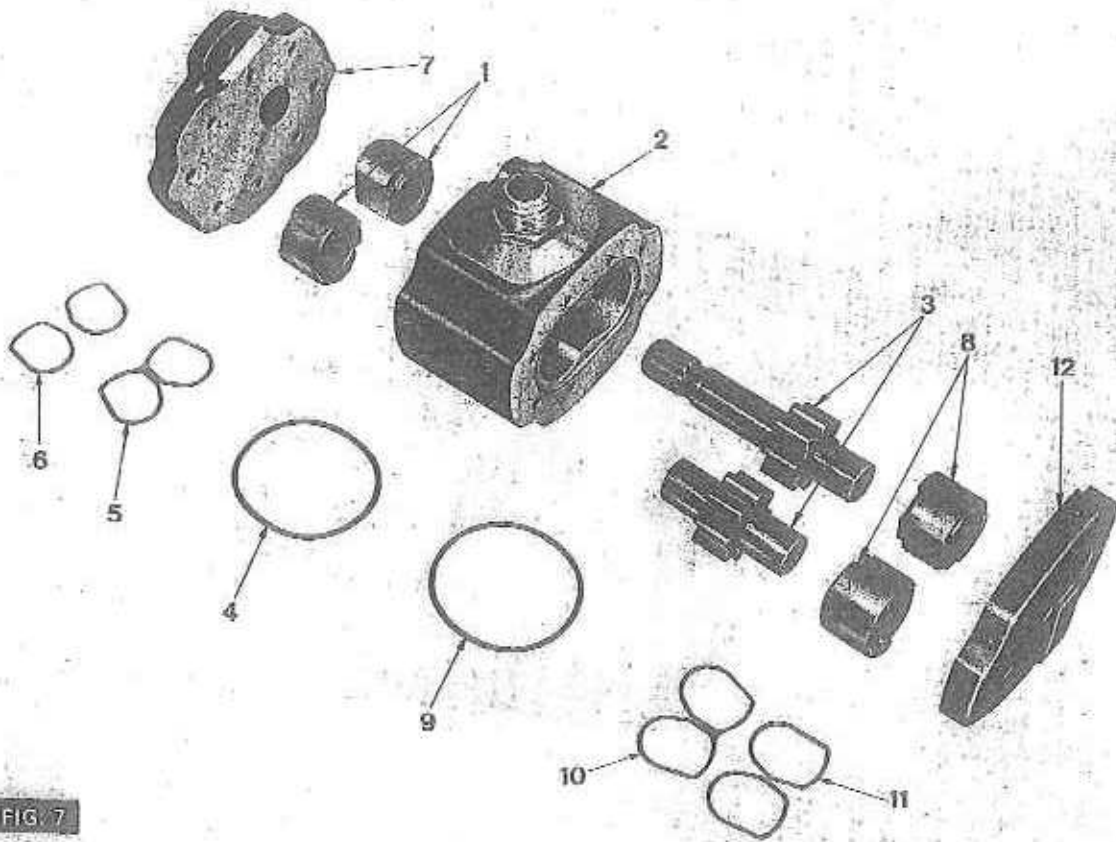


FIG 7

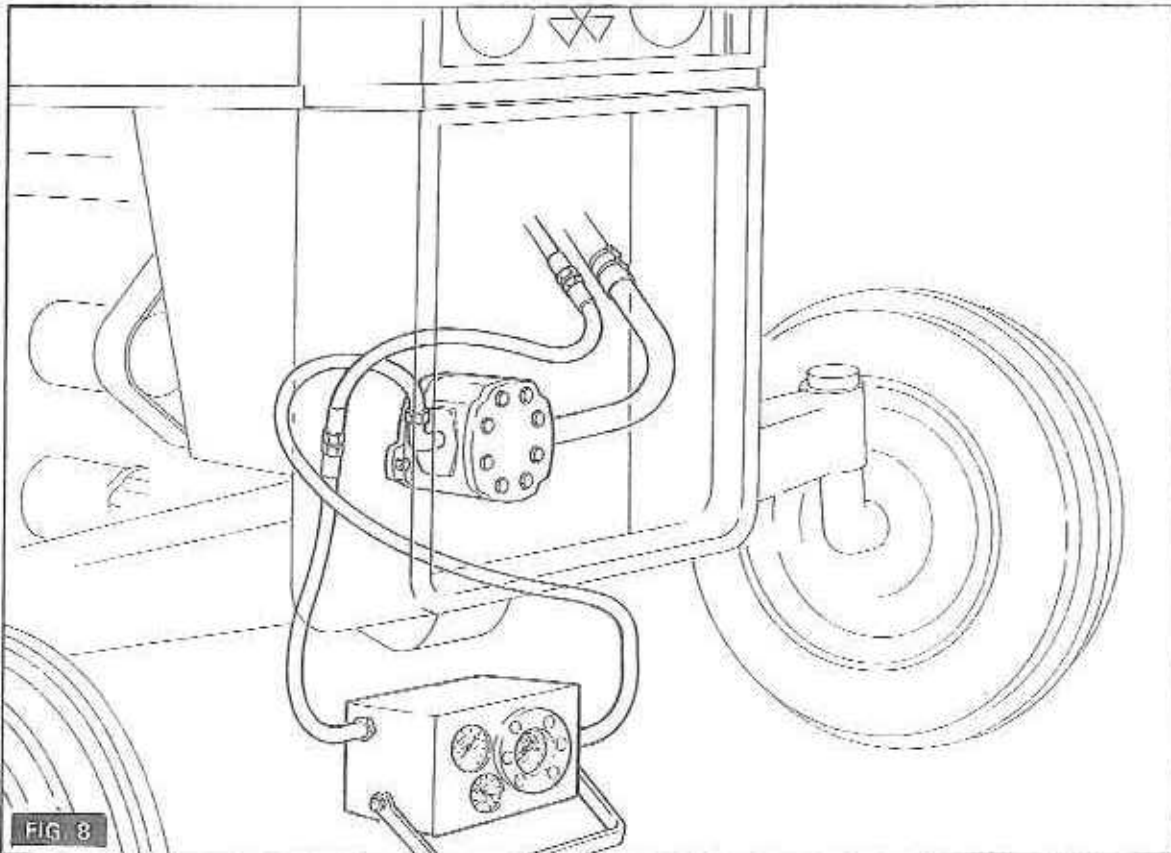


FIG 8

HYDRAULIC PUMP

REASSEMBLY ... Cont'd.

NOTE:

- When fitting the bearing blocks, the cut out side of the bushes must face the pressure side of the pump.
4. Replace the pump gear (3) into the pump body.
 5. Fit a new 'O' ring (4), lobe seal (5) and back up washers (6) between the pump body and the drive end plate. Fit the drive end plate (7) to the pump. When fitting the end plate over the pump drive shaft, use extreme care to ensure that the wiper seal in the end plate is not damaged. Replace the circlip to hold the wiper seal in place.
 6. Fit the second pair of bearing blocks (8) into the pump. The cut out side of the blocks must face the pressure side of the pump.
 7. Fit new 'O' ring (9) seal (10) and back up washers (11) between the pump body and end cover (12). Fit the end cover to the pump and replace the eight bolts to hold the pump sections together. Tighten the bolts with a torque loading of 34-36 lb. ft. (4.7-4.98 kg.m) in a diagonal sequence to pull the pump together squarely.
 8. Pour a small quantity of hydraulic oil into the ports and check the pump freedom of rotation.
 9. Replace the pump as described in operation 9C/1.

HYDRAULIC PUMP

FLOW CHECK

9C/4

1. Check that the hydraulic oil is up to the correct level.
2. Operate the loader system to bring the hydraulic oil temperature within the operating range.
3. Raise the loader arms and position ram stops on the lift rams.
4. Release any residual pressure by operating the control levers.
5. (Fig. 8). Remove the radiator grille, disconnect the pressure hose from the pump and connect the flow meter into the circuit as shown. The circuit is now continuous. Check all connections for tightness.
6. Start the engine and allow to idle until the hydraulic oil has filled the circuit. Increase the engine speed to 2000 r.p.m. and check the flow reading as indicated on the flow meter. The flow should be 23.8 imp.gall./min. (108.19 litres/min.)
7. If the flow rate is less than 80% of the specified flow rate, the hydraulic pump should be serviced or renewed.
8. After checking the flow rate, stop the engine, release any residual pressure in the system and disconnect the flow meter from the system.
9. Reconnect the hose to the pump, replace the grille and remove the ram stops.

SEVEN SPOOL VALVE

Removal and Replacement

Reassembly . . . Cont'd

Note

All 'O' rings must be renewed every time the block is dismantled.

2. Fit the outlet end cap (5) over the last section.
3. Fit the nut (2) and washer (3) to the apex tie bolt (4).
4. Fit the other two tie bolts (1) through the assembled section and tighten to a torque of 20/25 lb. ft. (2.76/3.46 Kg.m.).
5. Tighten the nut on the apex bolt to 35/55 lb. ft. (4.84/7.60 Kg.m.).
6. Replace onto machine as described in operation 9E/1.

Note

Each working section, if necessary, should be dismantled and rebuilt individually to ensure correct re-assembly.

WARNING

Before refitting the valve to the machine re-check to ensure that the sections are in correct locations and that the relief valves are correctly placed. Incorrectly replaced relief valves will cause inefficiency and serious damage to the machine.

STABILIZER SECTION

Disassembly and Reassembly

(9E/4)

1. (Fig. 13) Remove the valve from the machine as stated in operation 9E/1.
2. Dismantle the valve as stated in operation 9E/2 until the required section is reached.
3. Unscrew the cap (1) and withdraw the spool (2) complete with bush (3) and 'O' ring (4).
4. If a further breakdown of the spool is required remove the screw (5), washer (6), spring (8), sleeve (7) and washer (9).
5. Remove 'O' ring (10) from valve body.
6. Remove the check valve assembly and extract the seat (11) and spring (12).
7. Remove the 'O' ring (13) and back up washer (14) from the valve body (15) then remove the 'O' ring (16) and back up washer (17).
8. Check all parts for wear. If any scoring has taken place the spool and section will have to be replaced as they are matched.
9. When reassembling renew all 'O' rings and back up washers.

Note

When reassembling the check valve, ensure that the 'O' rings are on the pressure side. Fit them to the back up washer which has one side pre-shaped for the 'O' ring to seat into.

BOOM, DIPPERSTICK AND BUCKET SECTIONS

Disassembly and Reassembly

(9E/5)

Fig. 14 Disassembly and reassembly of these sections is exactly the same as the disassembly and reassembly of

SEVEN SPOOL VALVE BOOM, DIPPERSTICK AND BUCKET SECTIONS

Disassembly and Reassembly

the stabilizer section operation 9E/4, except that these sections have included shock valves (1) of varying pressures. If these are removed it should be ensured that the valves are refitted into the correct sections with new 'O' rings.

SLEW SECTION

Disassembly and Reassembly

(9E/6)

1. (Fig. 15) Remove the valve from the machine as stated in operation 9E/1.
2. Dismantle the valve as stated in operation 9E/2 until the required section is reached.
3. Unscrew the cap (1) and withdraw the spool (2) complete with bush (3) and 'O' ring (4).
4. Remove the screw (5), washer (6), spring (7), sleeve (8) and washer (9).
5. Unscrew the plug (10) and remove the nylon ball (11).
6. Unscrew the clevis (12) and remove from the spool. Remove the nylon ball (13).

Note

On later sections the spool is manufactured in one piece and the nylon anticavitation balls have been removed.

7. Remove the shock valves (14) and (15).
8. Remove the 'O' ring (16) from the section body (17).
9. Remove the check valve (18) then extract the seat (19) and spring (20).
10. Remove the 'O' ring (21) and back up washer (22) from the valve body (18).
11. Check all parts for wear. The spool and section body are a matched pair, if any scoring has taken place both parts will have to be renewed.
12. When reassembling renew all 'O' rings and back up washers.

Note

When reassembling the check valve, ensure that the 'O' rings are on the pressure side. Fit them to the back up washer which has one side pre-shaped for the 'O' ring to seat into.

CLAMP SECTION

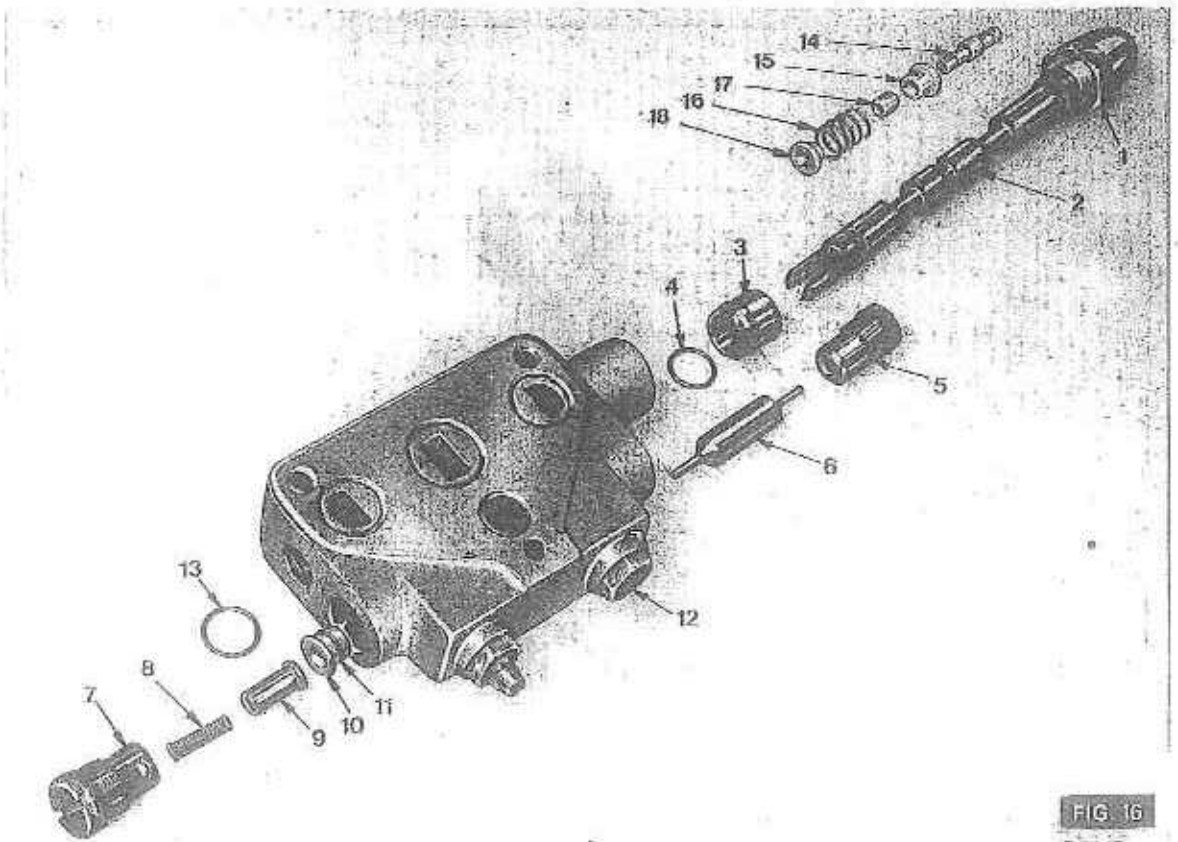
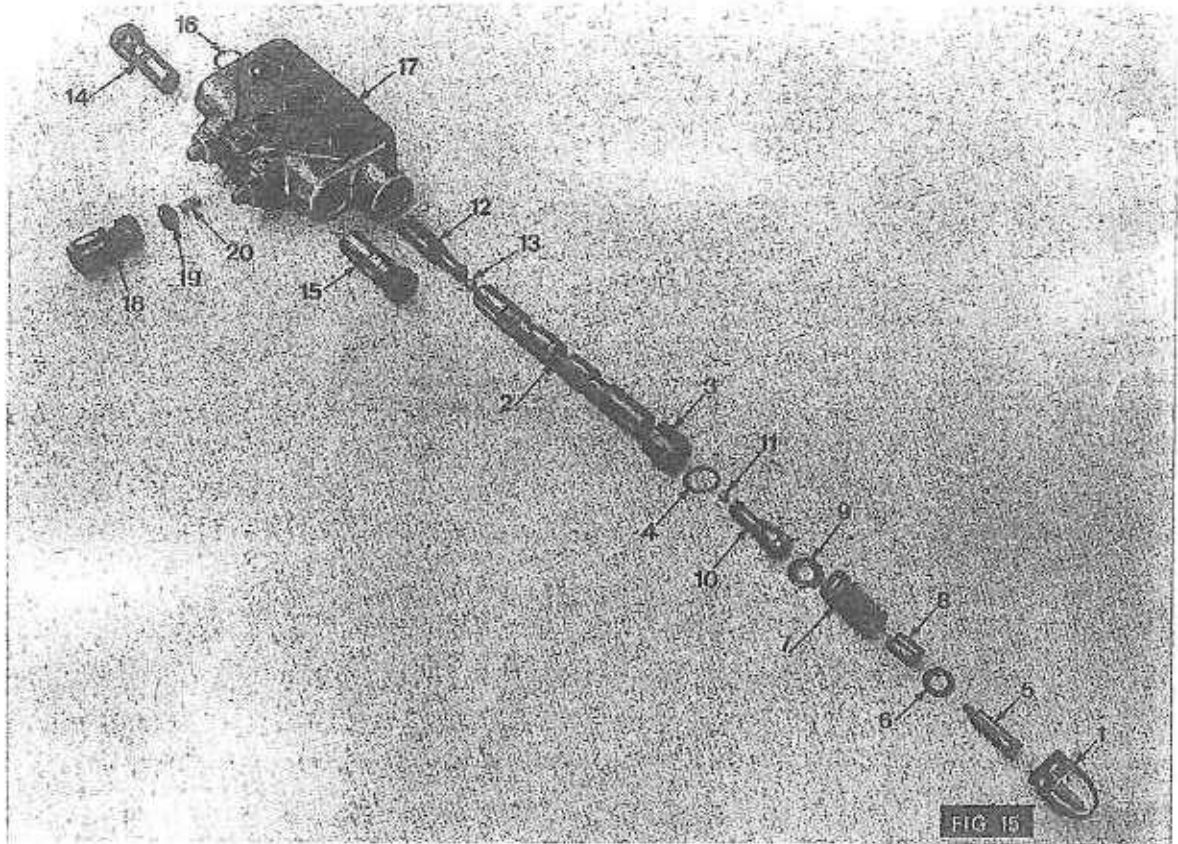
Disassembly and Reassembly

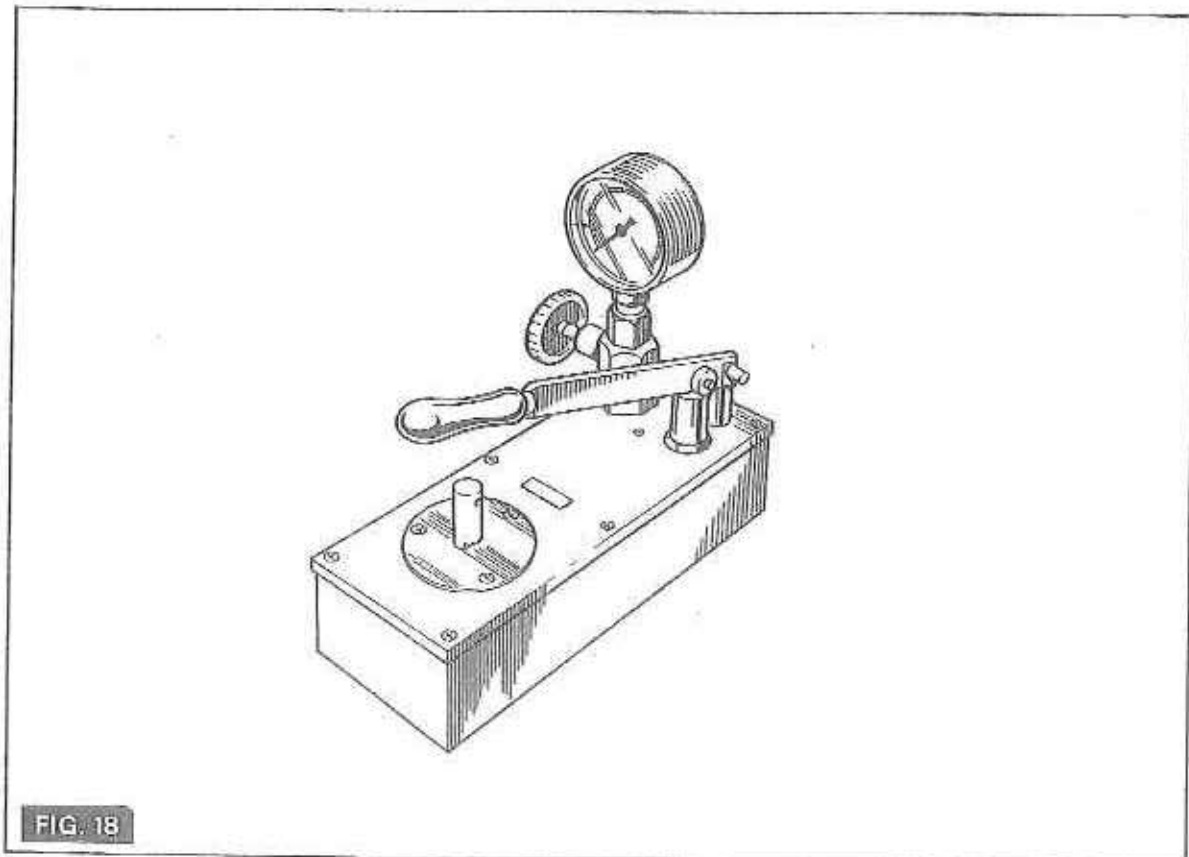
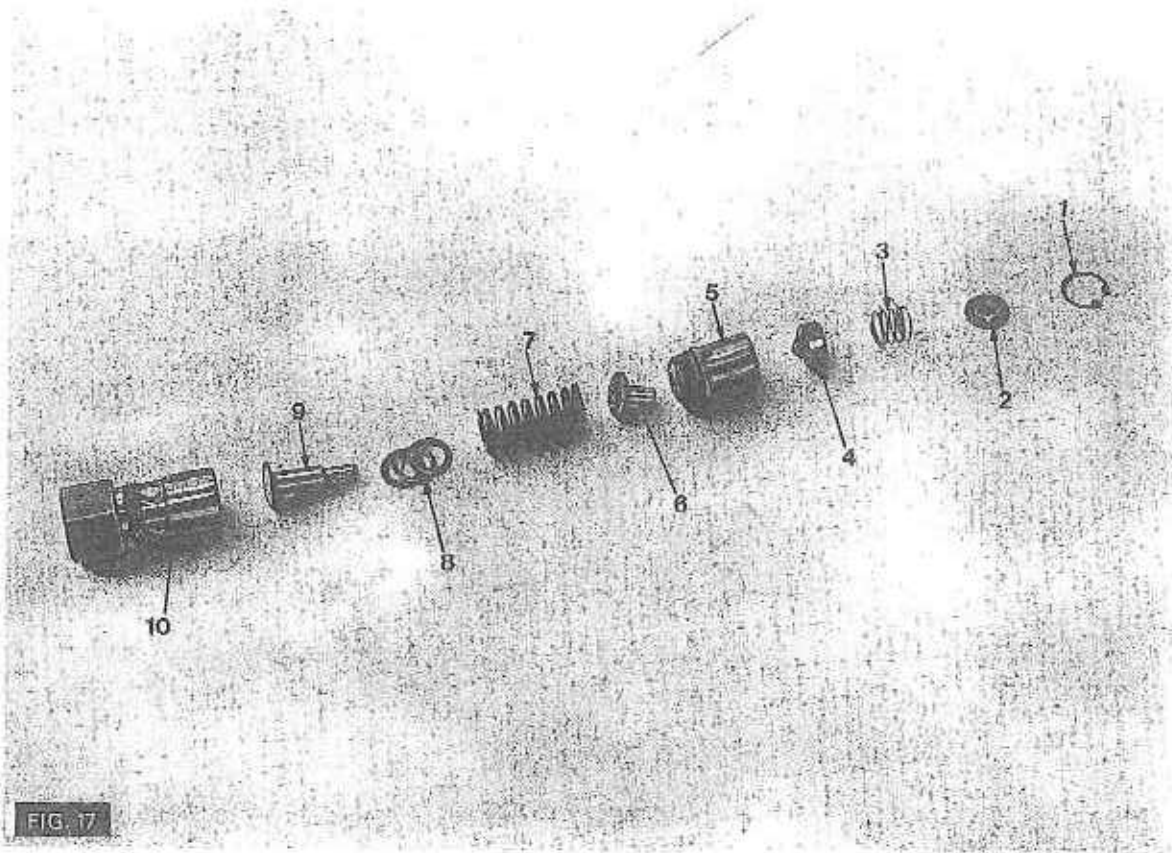
(9E/7)

1. Remove the valve from the machine as stated in operation 9E/1.
2. Dismantle the valve as stated in operation 9E/2 until the required section is reached.
3. (Fig. 16) Remove the cap (1) and withdraw the spool (2) complete with bush (3), 'O' ring (4) and detent mechanism.
4. If necessary the detent mechanism can be removed from the spool by unscrewing the spool screw (14), removing the spring cup (15), spring (16), stroke control spacer (17) and spring plate (18).

Note

If the spool screw is removed it will be seen that inside the spool is a small screw. DO NOT REMOVE THIS SCREW. IT IS LOCTITED INTO POSITION.





SEVEN SPOOL VALVE

CLAMP SECTION

Disassembly and Reassembly ... Cont'd

5. Remove the plug (5) and slide plunger (6) out of the body.
6. Remove the plug (7) and withdraw the spring (8) and plunger (9).
7. Withdraw the lock out seal (10) complete with 'O' ring (11).
8. Remove the plug (12).
9. Remove the 'O' ring (13) from the body.
10. Reassembly is a reversal of the above procedure.

Note

All 'O' rings should be renewed on reassembly.

ANTI SHOCK VALVE

General

(9E/8)

The anti shock valves can be stripped down and adjusted to the required pressure by either inserting or removing shims. If the valve fails it must be renewed as a complete item since the component parts are not serviced individually. To disassemble a valve proceed as follows :-

1. (Fig. 17) Remove the circlip (1), extract the spring retainer (2), spring (3) and the ball and retainer assembly (4).
2. Unscrew the lower half of the valve body (5), remove the seat (6), spring (7), adjusting shims (8) and guide (9) from the body (10).
3. Replace in a reverse order of the above procedure.

The 50B II (+ probably 50D).

use a Laser Multiple Block

+ Separate Clamp Spool.

Agro-connections
in Brown Envelope

MF. Wheel Regs etc
Feb 82.

**TWO SPOOL
CONTROL VALVE**

CONTENTS

	Page
TWO SPOOL VALVE, Removal and Replacement (9D/1)	4
TWO SPOOL VALVE, Disassembly (9D/2)	4
TWO SPOOL VALVE, Reassembly (9D/3)	5
MAIN RELIEF VALVE, Pressure Checking (9D/4)	5

LIST OF ILLUSTRATIONS

	Facing Page
Fig 1 GENERAL ARRANGEMENT OF TWO SPOOL VALVE	4
Fig 2 RESTRICTORS, Removed	4
Fig 3 MAIN RELIEF VALVE AND CIRCUIT RELIEF VALVES, Identification	4
Fig 4 CHECK VALVE, Removed	4
Fig 5 TWO SPOOL VALVE, Breakdown	5
Fig 6 SPOOL VALVE HANDLE, Breakdown	5
Fig 7 RELIEF VALVES, Pressure Identification	5
Fig 8 MAIN RELIEF VALVE, Checking	5

TWO SPOOL CONTROL VALVE

General

The two spool control valve which is mounted on the L.H. side frame, receives the oil from the pump and directs it through any one of the four ports to the loader lift rams and bucket rams.

Incorporated in the control valve are the following valves:

- Main Relief valve set at 2,500 2,650 lbs./in² (175.7 186.3 kg./cm²)
- Shock Relief valve—bucket ram head side set at 3000 lbs./in² (210.9 kg./cm²)
- Shock Relief valve—bucket ram rod side set at 5000 lbs./in² (351.5 kg./cm²)
- Shock Relief valve—lift ram head side set at 3500 lbs./in² (246 kg./cm²)
- Shock Relief valve—lift ram rod side set at 5000 lbs./in² (351.5 kg./cm²)

Oil enters the spool through the port at the base of the valve and is directed along the two galleries. If the controls are in neutral position the flow of oil is permitted to go straight through the open centre of the valve and go back to the reservoir. If one or both of these services is being used the oil is directed by movement of the lever, to either the bucket rams or the lift rams.

If a digger is fitted, oil is directed to the seven spool control valve through the pressure beyond port in the valve.

TWO SPOOL VALVE

Removal and Replacement

9D/1

1. Lower the bucket to the ground then ensure that the pressure has been relieved by operating the levers backwards and forwards several times.
2. Mark the four supply hoses to facilitate reassembly then remove hoses from valve.
3. Disconnect the main supply pipe from the base of the valve. If a digger is fitted, also remove the digger feed pipe from the base of the valve.
4. Extract the three bolts which secure the valve to the main side frame then remove the valve.
5. When replacing the valve renew the gasket between the mounting and the side frame, then reverse the above process.

TWO SPOOL VALVE

Disassembly

9D/2

1. Remove the valve as stated in operation 9D/1
2. (Fig. 2). Extract the two restrictors from the return ports.
3. (Fig. 3). Extract the main relief valve (1), the bucket ram head side relief valve (2), the bucket ram rod side relief valve (3), the lift ram head side relief valve (4) and lift ram rod side relief valve (5).
4. (Fig. 4). Extract the boom check valve by carefully unscrewing the check valve body (1). Remove the spring (2) then remove actual valve (3).
5. Unscrew the four hex. head screws (4) and remove the side cover (5).
6. Carefully unscrew the check valve body (6), remove the spring (7) and extract the check valve (8).
7. (Fig. 5). Unscrew the three screws (1) which secure the mounting (2) to the body (3) and remove the mounting. Extract the centering spring stop (4).
8. Unscrew the centering spring screw which secures the detent mechanism to the boom spool (5) remove the detent mechanism (6) springcup (7) centering spring (8) stroke control spacer (9) and spring plate (10).
9. Unscrew the centering screw (11) which holds the spring to the bucket spool (12), remove the spring cup (13), stroke control spacer (14), centering spring (15) and spring plate (16).
10. Remove the screws (17) and lift off the handle end covers (18) and seals (19).
11. Extract the locking clips (20), remove the chain links (21) and withdraw both spools from the body.
12. (Fig. D6). If the handles are to be removed, mark the mating teeth on the handle shaft (1) and the link (2).
13. Place a suitable spanner on the cone nut (3) and unscrew the handle shaft screw (4).
14. Extract the screw complete with 'O' ring (5). Remove the handle shaft assembly complete with 'O' ring (6).
15. Remove the link and cone nut (7) from inside the valve body.
16. Repeat the process on the remaining handle.

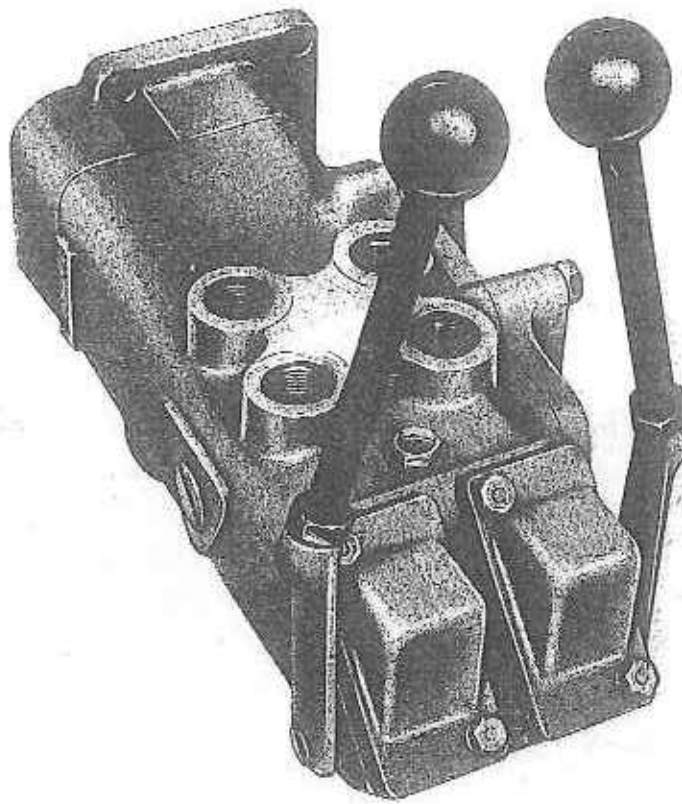


FIG. 1

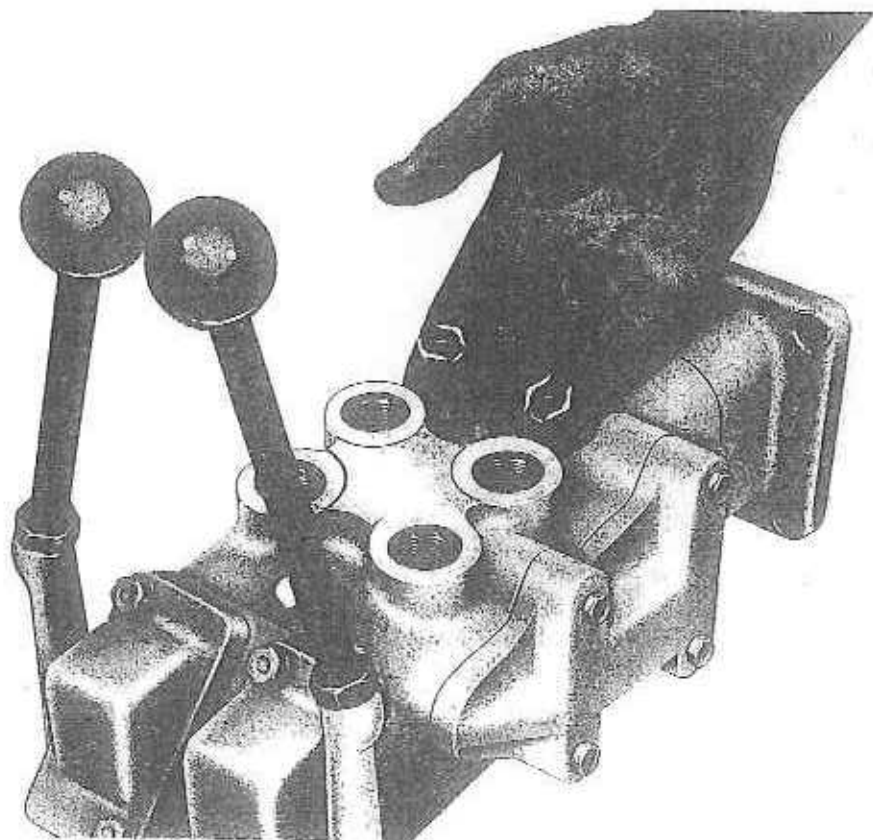
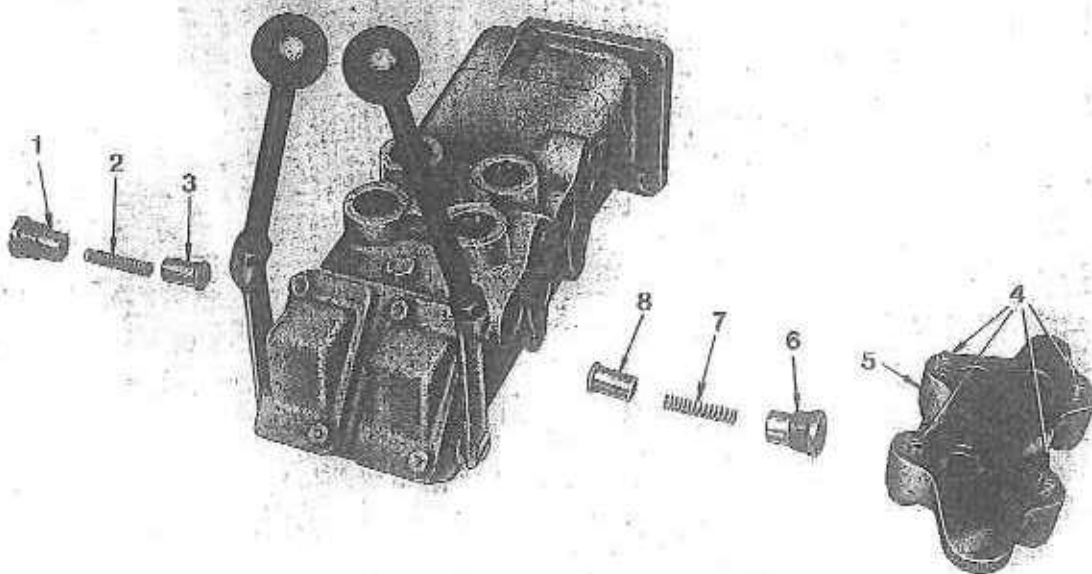
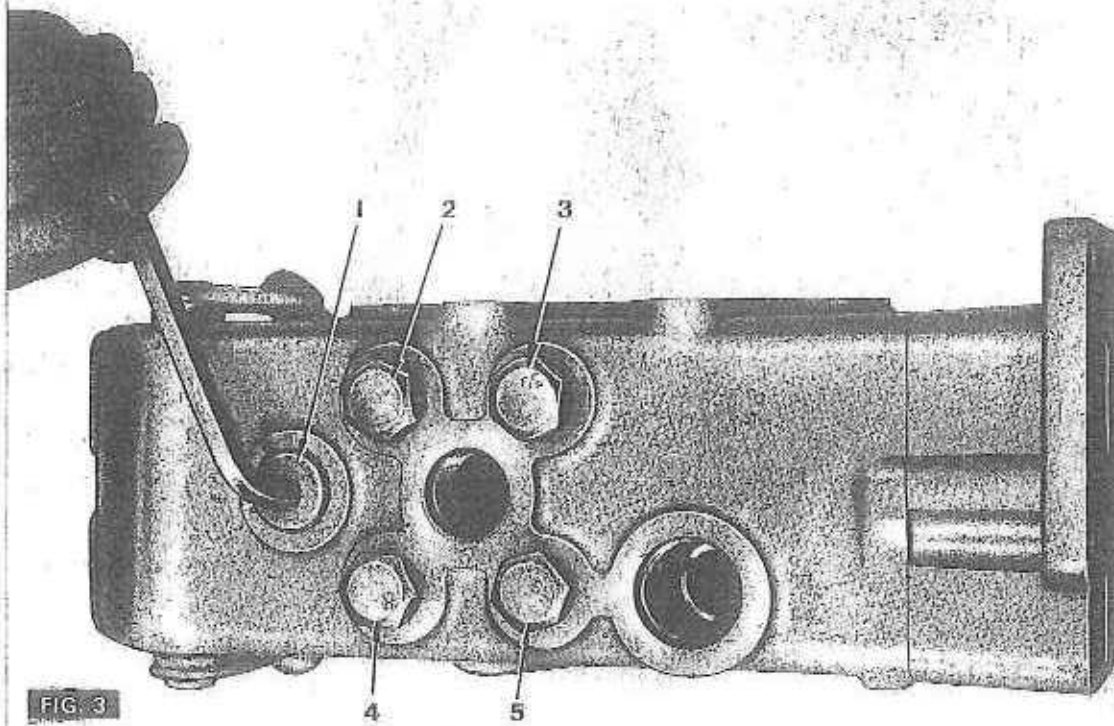
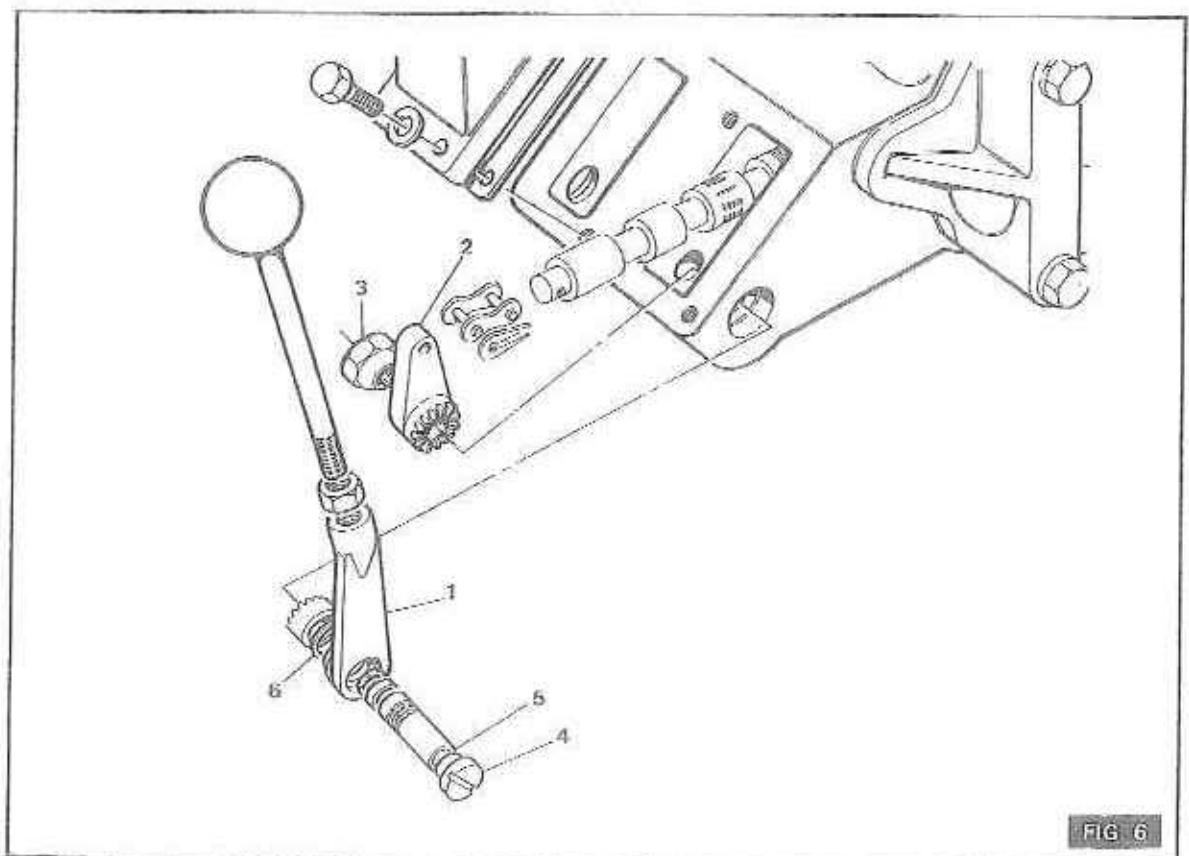
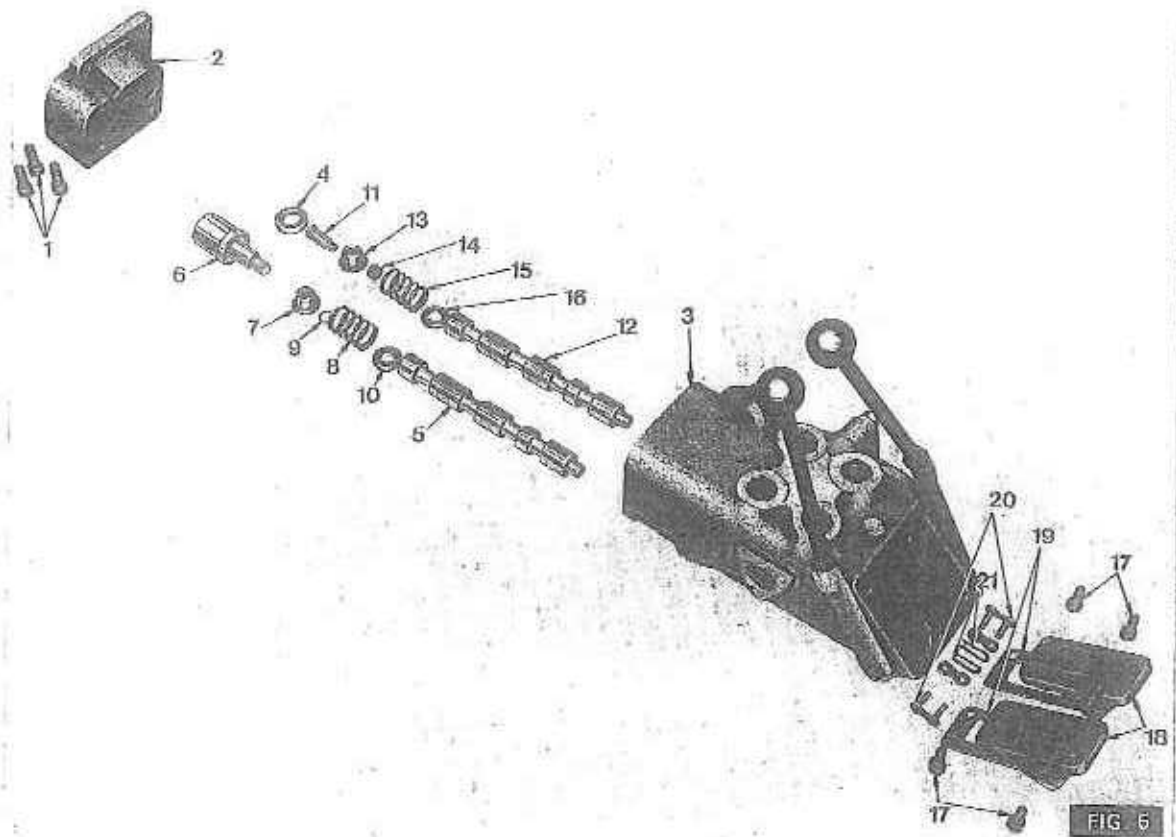


FIG. 2





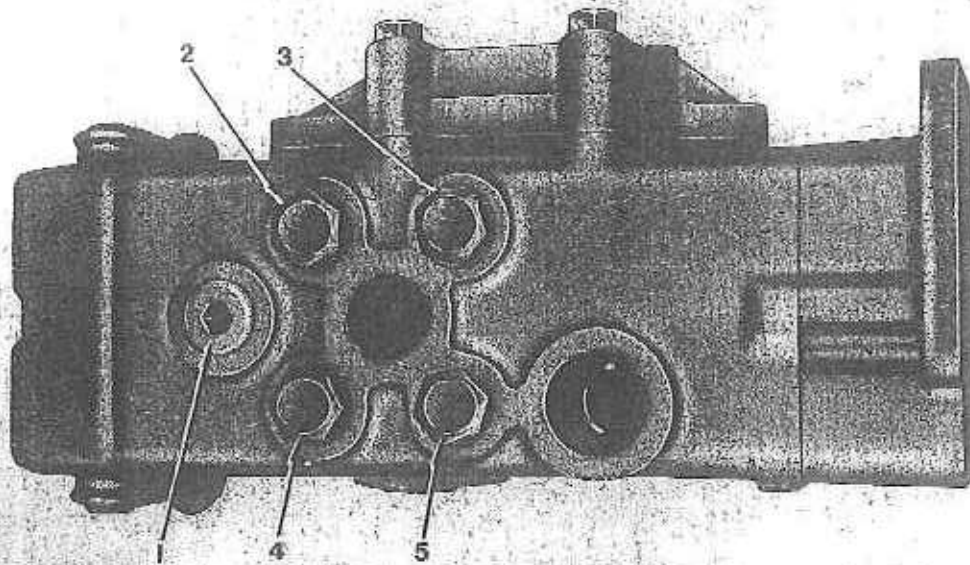


FIG 7

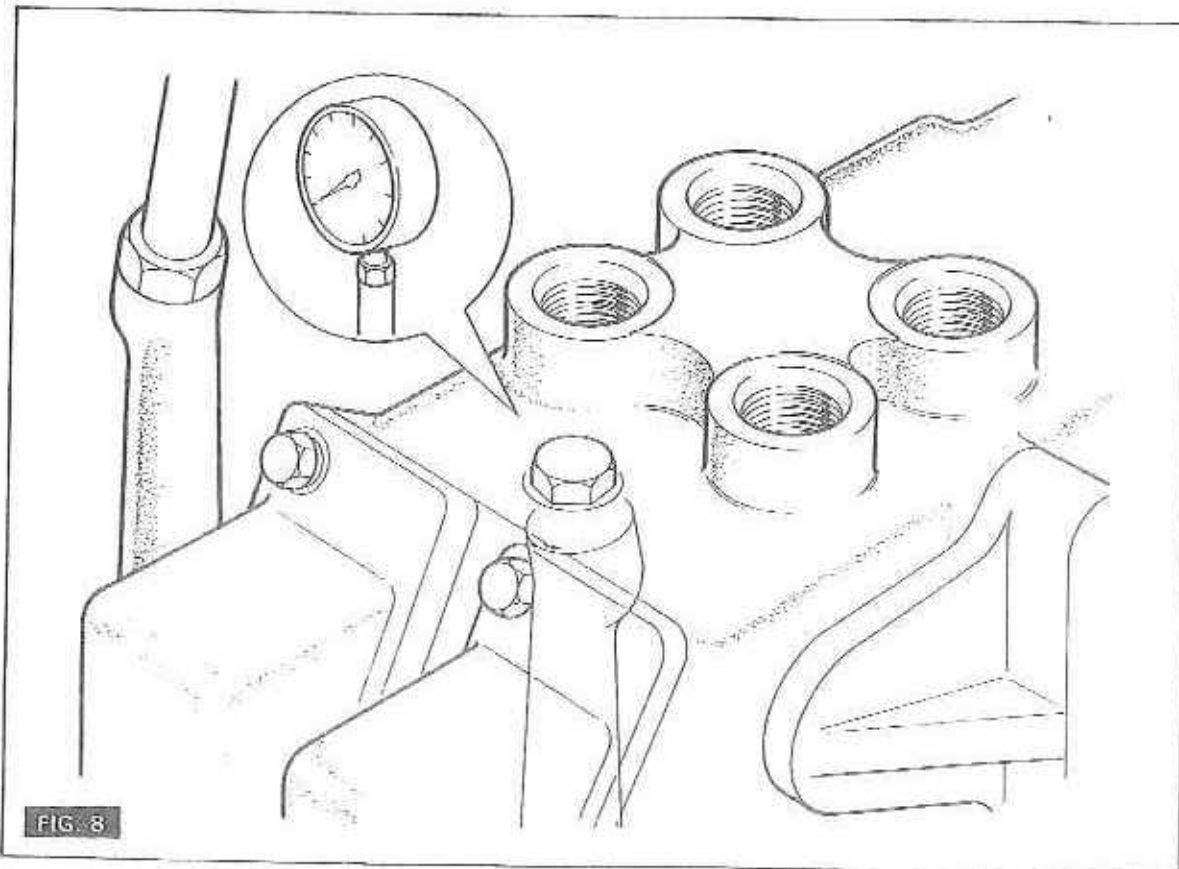


FIG 8

TWO SPOOL VALVE

REASSEMBLY

9D/3

Note

1. When reassembling the two spool valve all 'O' rings and seals should be renewed.
2. Before reassembly check all parts for wear.

1. (Fig. 6). Place the bucket spool link (2) and cone nut (3) inside the body. Fit the handle assembly (1) with new 'O' ring (6), into place ensuring that the markings on both sets of teeth are matched, then screw the pivot screw (4), complete with new 'O' ring (5), into place. Repeat the process with the other handle and link.
2. (Fig. 5). Before inserting the boom spool (5) and bucket spool (8) lightly lubricate them with hydraulic oil. Insert the spools into their respective holes then attach them to the links with the chain links (21) and locking clips (20).
3. Replace the handle end covers (18) using new seals (19). Secure with the four screws (17).
4. Put the spring plate (16), stroke control spacer (14), centering spring (15) and spring cup (13) into position at the end of the bucket spool, then secure with the centering spring screw (11).
5. Assemble the spring plate (10), stroke control spacer (9), centering spring (8) and spring cup (7) at the end of the boom spool then screw the detent assembly (6) to the spool with the detent screw going through the centre of the pre-assembled items.
6. Position the centering spring stop (4) over the end of the bucket spool.
7. Renew the 3 'O' rings in the valve mountings (2) and assemble the mounting to the body (3) with the three screws (1).
8. (Fig. 4). Replace the check valve (8), spring (7) and check valve body (6), renew the 'O' ring on the valve body. Renew the five 'O' rings which form the seal between the side cover and the body, then replace the side cover (5) using the bolts (4).
9. Replace the boom check valve (3), spring (2) and check valve body (1), renew the 'O' ring on the check valve body.
10. Replace the four circuit relief valves and the main relief valve, ensuring that they are fitted in their correct positions as shown in Fig. 7. Renew the 'O' ring on each valve.
11. (Fig. 7). Refit the restrictors in each of the ports connected to the head side of the rams. The restrictor with the largest hole dia. 0.205 in. (5 mm), is fitted in the lift ram port. The other restrictor with hole dia. 0.125 in. (3 mm) is fitted in the bucket ram port.
12. Refit the complete spool valve as described in operation.

KEY TO FIG. 7

1. Relief Valve—Main	2125 p.s.i. (149.4 kg/cm ²)
2. Relief Valve—Bucket Ram, Head Side	5000 p.s.i. (351.5 kg/cm ²)
3. Relief Valve—Bucket Ram, Rod Side	3000 p.s.i. (210.9 kg/cm ²)
4. Relief Valve—Lift Ram, Head Side	5000 p.s.i. (351.5 kg/cm ²)
5. Relief Valve—Lift Ram, Rod Side	3500 p.s.i. (246 kg/cm ²)

MAIN RELIEF VALVE

PRESSURE CHECKING

9D/4

1. Check that the hydraulic oil is up to the correct level.
2. Operate the loader system to bring the hydraulic oil temperature within the operating range.
3. Lower the bucket to the ground. Stop the engine and release any residual pressure within the system by working the loader control levers to and fro while the engine is stopped.
4. (Fig. 8). Remove the plug and connect in its place gauge No. MF 148A and adaptor No. MF 148-9.
5. Start the engine and operate the bucket control lever to crowd the bucket. Increase engine speed and crowd the bucket again thus causing the main relief valve to blow. Record the pressure at which the relief valve blows. If the relief valve is set correctly it should blow at 2125 ± 100 p.s.i. (149.4 kg/cm² ± 7 kg/cm²).
6. If the gauge registers an incorrect pressure renew the relief valve.

THE SEVEN SPOOL VALVE

CONTENTS

GENERAL

	PAGE
SEVEN SPOOL VALVE, Removal and Replacement 9E/1	6
SEVEN SPOOL VALVE, Disassembly 9E/2	6
SEVEN SPOOL VALVE, Reassembly 9E/3	6
STABILIZER SECTION, Disassembly and Reassembly 9E/4	7
BOOM, DIPPERSTICK AND BUCKET SECTIONS, Disassembly and Reassembly 9E/5	7
SLEW SECTION, Disassembly and Reassembly 9E/6	8
CLAMP SECTION, Disassembly and Reassembly 9E/7	8
ANTI SHOCK VALVE, General 9E/8	9

LIST OF ILLUSTRATIONS

Figure		Facing Page
1	GENERAL ARRANGEMENT OF SEVEN SPOOL BLOCK	4
2	HYDRULIC OIL CIRCUIT FOR DIGGER	4
3	VALVE SECTION, One Spool Operating	5
4	STABILIZER SPOOL, Operation	5
5	BOOM SPOOL, Neutral Position	5
6	SLEW SPOOL, Neutral Position	5
7	DIPPERSTICK SPOOL, Operation	6
8	BUCKET SPOOL, Operation	6
9	CLAMP SPOOL, Neutral Position	6
10	SEVEN SPOOL VALVE, Removal	6
11	SEVEN SPOOL VALVE, Disassembly	7
12	SEVEN SPOOL VALVE, Breakdown	7
13	STABILIZER SECTION, Disassembly	7
14	BOOM, DIPPERSTICK, BUCKET SECTIONS, Disassembly	7
15	SLEW SECTION, Disassembly	8
16	CLAMP SECTION, Disassembly	8
17	ANTI SHOCK VALVE, Disassembly	9

SEVEN SPOOL VALVE

General

The seven spool control valve is mounted forward of the main frame. The seven services which operate the digger are controlled by the movement of the seven levers. The seven spools are shown on Fig. 1.

Key to Fig 1

- | | |
|--------------------------|----------------|
| 1. Left hand stabilizer | 5. Dipperstick |
| 2. Right hand stabilizer | 6. Bucket |
| 3. Boom | 7. Clamp |
| 4. Slew | |

Each service can be used in conjunction with another. If a service other than the clamping service is operated, the clamping service also receives a boost of oil to ensure that the pressure of oil in the clamp cylinder is maintained.

Oil goes to the seven spool valve via the loader two spool valve and is free to flow through the block along the centre gallery which zig zags through each spool. When all the levers are in neutral, oil is free to flow through the centre gallery to the return pipe and back to reservoir.

The hydraulic circuit is shown in Fig. 2.

Key to Fig 2

- | | |
|----------------------------------|---------------------------|
| 1. Inlet Pressure Port | 10. Loader 2 spool valve |
| 2. Clamping section | 11. Left hand Stabilizer |
| 3. Bucket section | 12. Right hand Stabilizer |
| 4. Dipperstick section | 13. Boom Cylinder |
| 5. Slew section | 14. Rotary Actuator |
| 6. Boom section | 15. Dipperstick Cylinder |
| 7. Left hand stabilizer section | 16. Bucket Cylinder |
| 8. Right hand stabilizer section | 17. Clamping Cylinders |
| 9. Outlet Port | |

Fig. 3 Shows the seven spool valve with the boom spool in an operating position. The movement of the spool has blocked the centre gallery thus causing a build up of pressure in the gallery parallel to the centre. It is this oil which operates the service.

Fig. 4 Illustrates the flow of oil through the Stabilizer spool then out through the hoses to the rams. When the spool is raised oil is fed to rod side and the stabilizer retracts. Conversely when the spool is raised oil is fed to the head side and the stabilizer extends.

Key to Fig 4

- | |
|---------------------|
| 1. Stabilizer feet |
| 2. Spool |
| 3. Parallel Gallery |
| 4. Check Valve |

Fig. 5 Illustrates the oil circuit for the boom. The lever is in a neutral position, the oil will thus be flowing through the open centre and not operating the service. Direct operated relief valves are incorporated in this section.

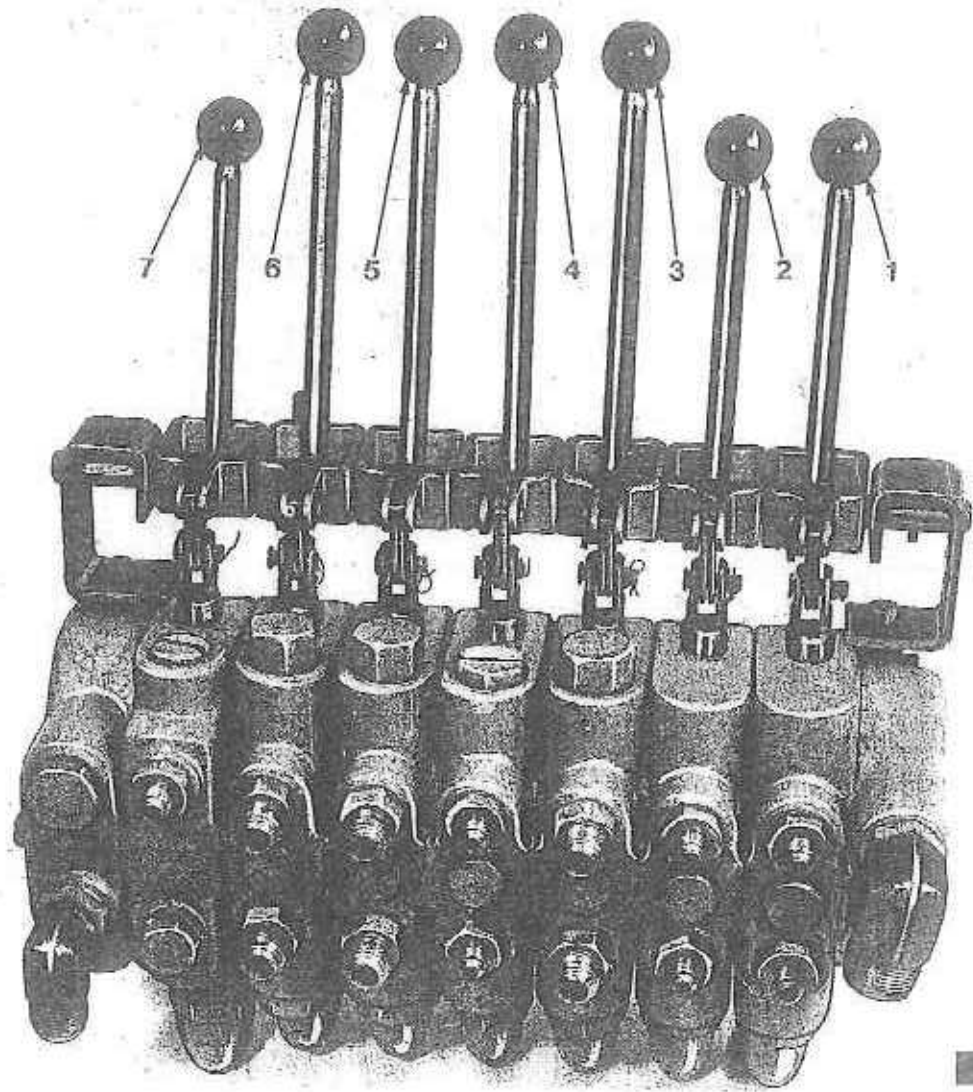
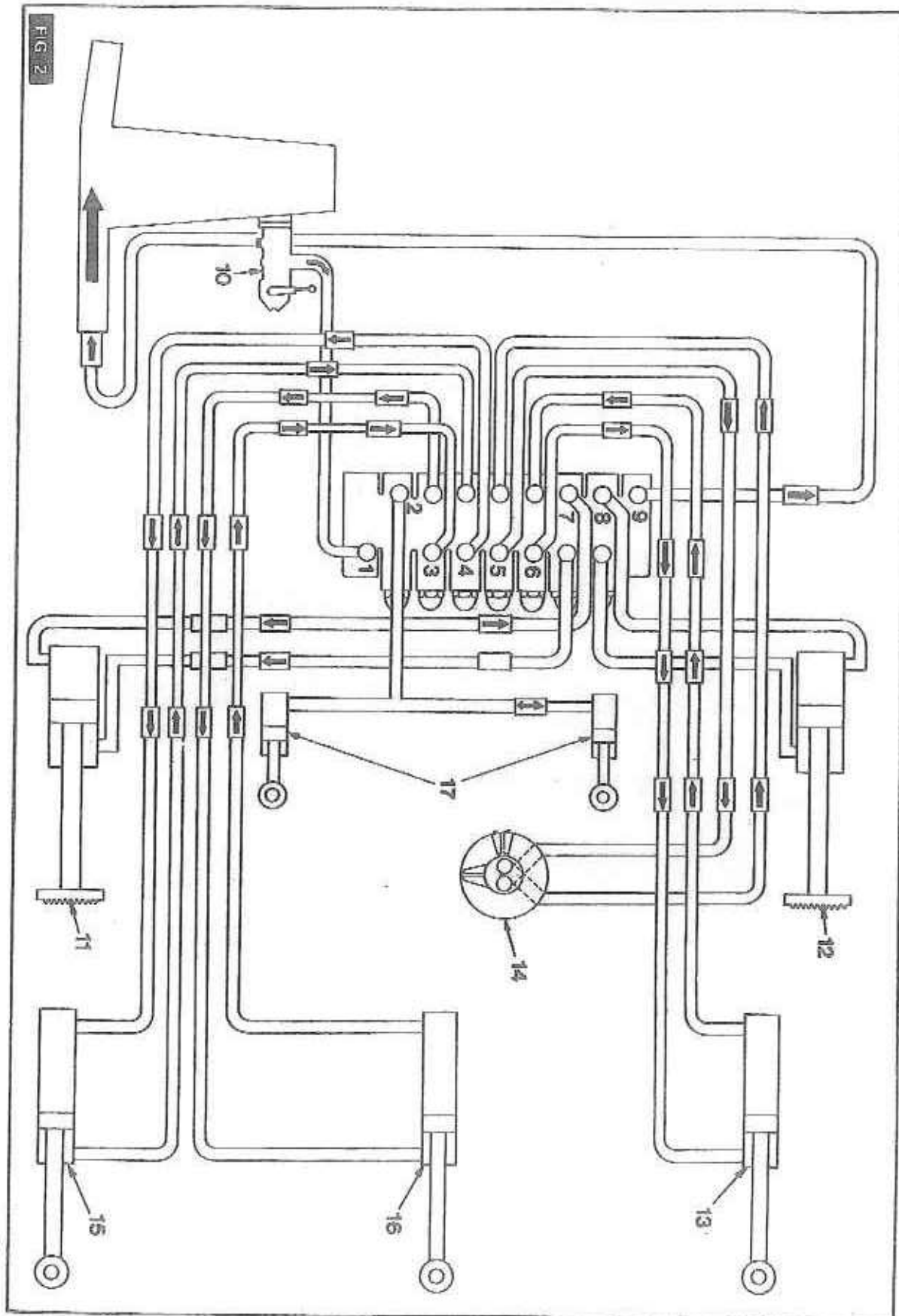
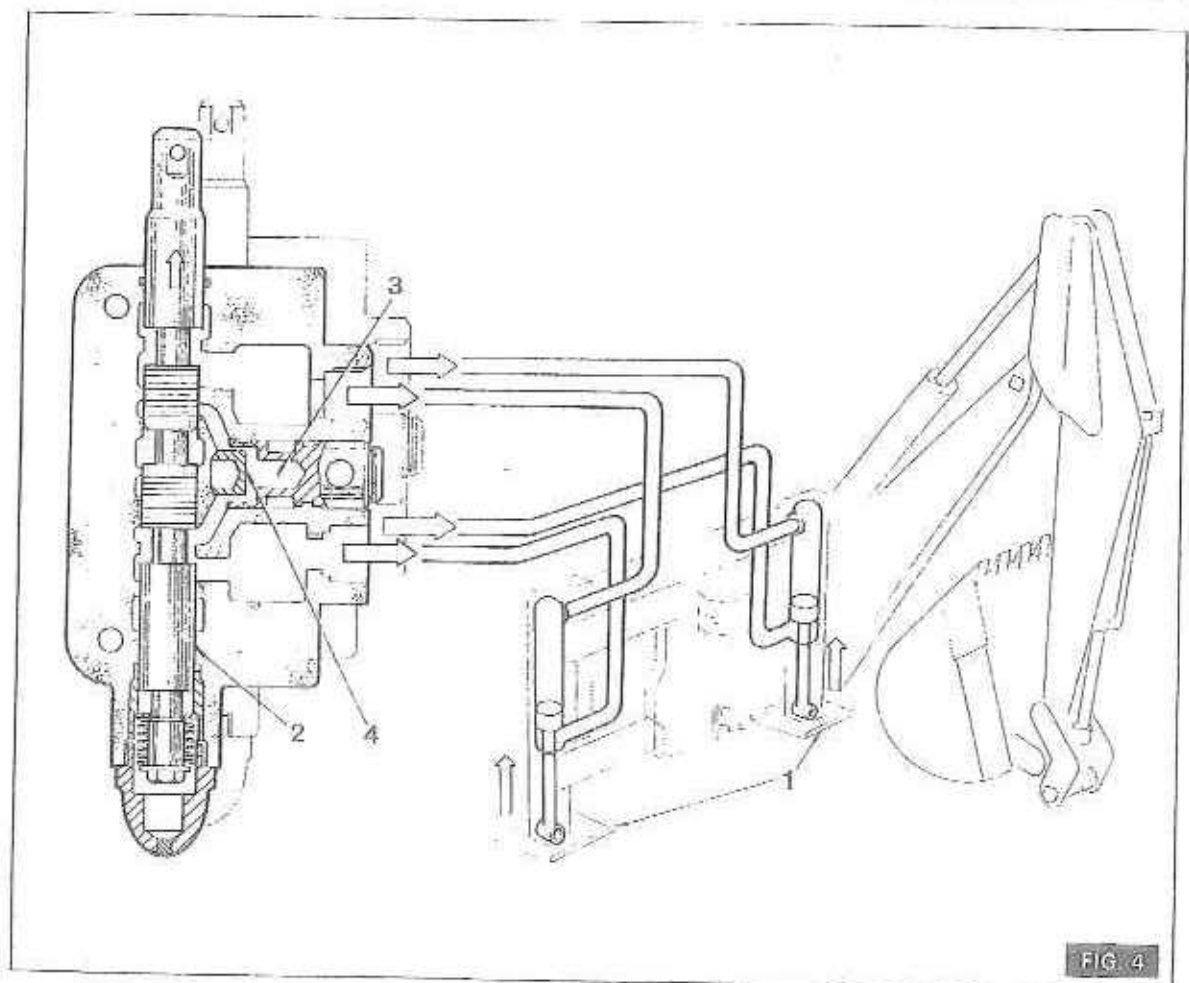
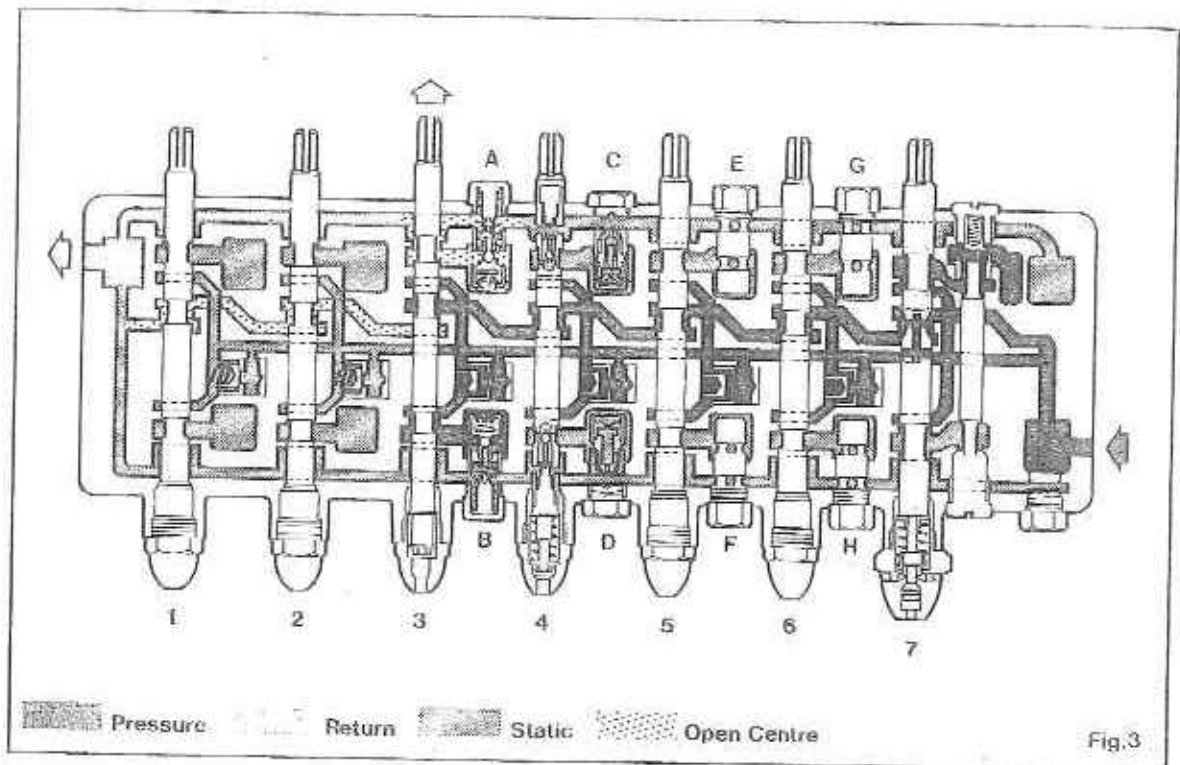
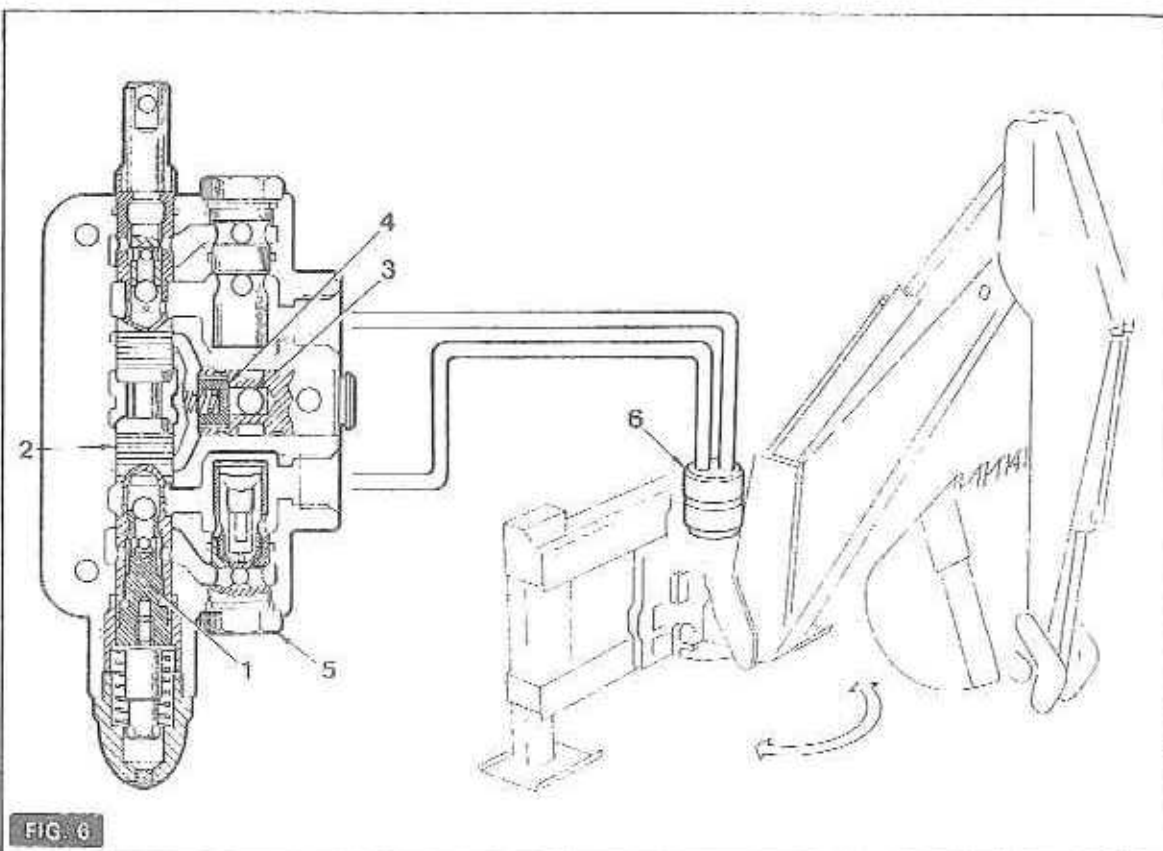
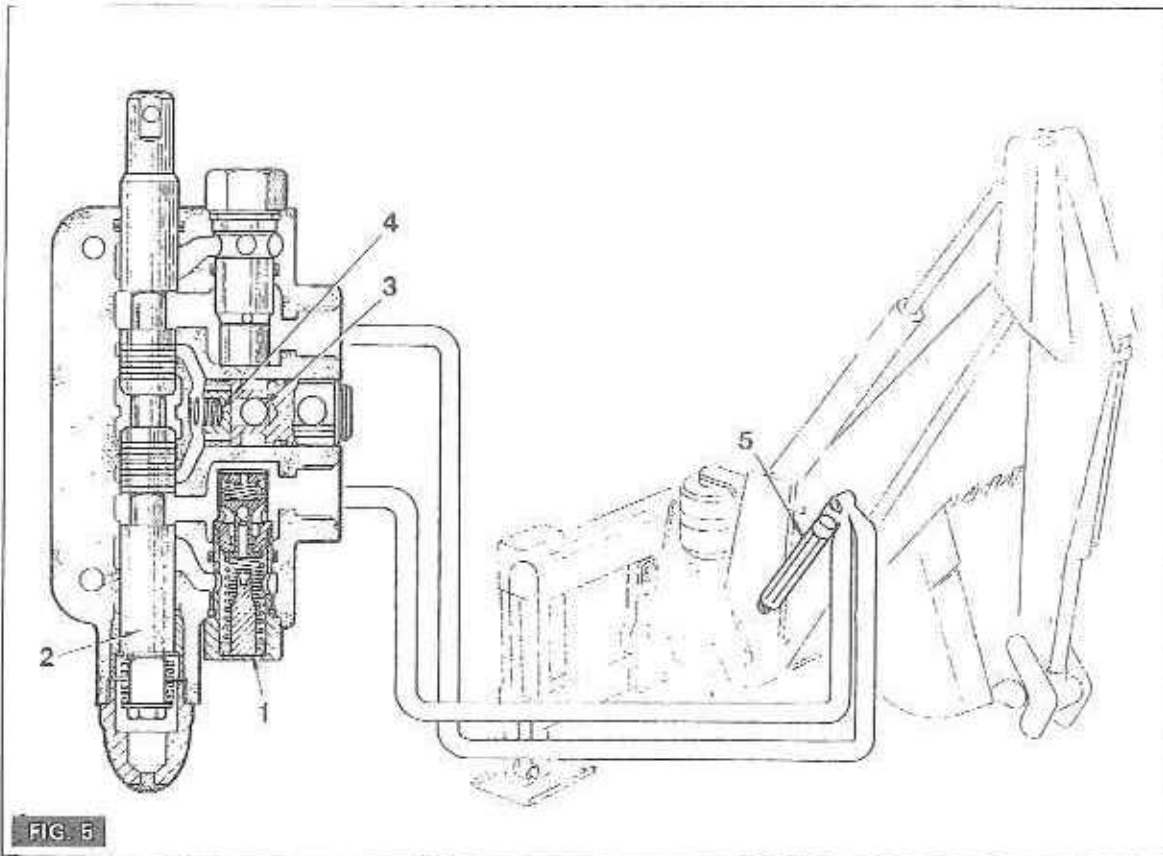


FIG. 1







SEVEN SPOOL VALVE

General ... Cont'd

Key to Fig 5

1. Relief Valve 3000 lbs/in² (211 Kg/cm²)
2. Spool
3. Parallel Gallery
4. Check Valve
5. Boom Cylinder
6. Relief Valve 2750 lbs/in² (193.3 Kg/cm²)

Fig. 6 Shows the hydraulic lines between the slew spool section of the seven spool block and the actuator. The service is not being operated thus oil will be flowing through the open centre and returning to the reservoir.

Key to Fig 6

- | | |
|--------------------------|--|
| 1. Anti-Cavitation Valve | 4. Check Valve |
| 2. Spool | 5. Circuit Relief Valve 2000 lbs/in ² (140.6 Kg/cm ²) |
| 3. Parallel Gallery | 6. Actuator |

Fig. 7 The oil circuit between the dipperstick ram and the dipperstick section of the seven spool valve is shown in this figure. The spool is in an operating position pressurising the head side of the ram and retracting the dipperstick. The returning oil enters the valve through the upper port and then to the reservoir. The direct operated relief valves which are incorporated in this section are designed for operation on induced pressures only and are not main line reliefs.

Key to Fig 7

- | | |
|--|--|
| 1. Relief Valve 3000 lbs/in ² (211 Kg/cm ²) | 4. Check Valve |
| 2. Spool | 5. Dipperstick ram |
| 3. Parallel Gallery | 6. Relief Valve 2750 lbs/in ² (193.3 Kg/cm ²) |

Fig. 8 This shows the flow of hydraulic oil when the bucket is crowded. The spool is raised pressurising the lower port which is connected to the head side of the bucket ram. Returning oil is directed to the reservoir through the upper port. Two identical direct operated relief valves are incorporated into this circuit.

Key to Fig 8

- | | |
|--|--|
| 1. Relief Valve 2750 lbs/in ² (193.3 Kg/cm ²) | 4. Check Valve |
| 2. Spool | 5. Bucket ram |
| 3. Parallel Gallery | 6. Relief Valve 2750 lbs/in ² (193.3 Kg/cm ²) |

Fig. 9 The clamping section of the seven spool valve is the only one fitted with a detent. This section is fitted with a one way valve which allows oil into the clamping cylinder but does not allow it to return except when the spool is held in the detent position. This section also allows the clamping cylinder to be pressurised when any other section of the spool valve is operated.

Oil enters the spool valve and travels along the centre gallery. When any other service is operated the centre gallery is blocked, pressure builds up in the parallel gallery and the check valve is lifted allowing oil through into the clamping cylinder.

When the spool is operated to clamp the unit, oil is diverted to the base of the check valve from the centre gallery. This lifts the check valve, allowing oil to flow to the clamping cylinder.

SEVEN SPOOL VALVE

General ... Cont'd

When the spool is held in detent, the build up of pressure in the parallel gallery operates on the base of the plunger which lifts the check valve from its seat and allows oil to flow from the cylinder to the return pipe. The cross drilling in the spool itself is provided to allow a flow of oil along the centre or "zig zag" gallery when this spool is held in detent; this allows other services to be operated when offsetting the digger.

Key to Fig 9

- | | |
|--------------------|--------------------|
| 1. Detent | 4. Check Valve |
| 2. Spool | 5. Plunger |
| 3. Cross Drillings | 6. Clamp Cylinders |

Colour Code for Figs 3, 4, 5, 6, 7, 8 & 9

Red	Pressure
Yellow	Flow
Blue	No Flow

SEVEN SPOOL VALVE

Removal and Replacement

(9E/1)

1. (Fig. 10) Extract the two bolts (1) and remove the indicator plate (2).
2. Remove the four securing bolts (3) and lift the valve cover over the valve handles.
3. Disconnect the oil return pipe from the valve.
4. Disconnect the oil pressure pipe at the union under the left hand wheel arch.
5. Quickly connect the return pipe to the fixed pressure pipe thus forming a hydraulic circuit which excludes the digger.
6. Disconnect the services supply and return pipes from the valve.
7. Remove the three securing bolts and lift the valve, complete with levers, clear of the machine.
8. To replace the valve, reverse the above procedure.

SEVEN SPOOL VALVE

Disassembly

(9E/2)

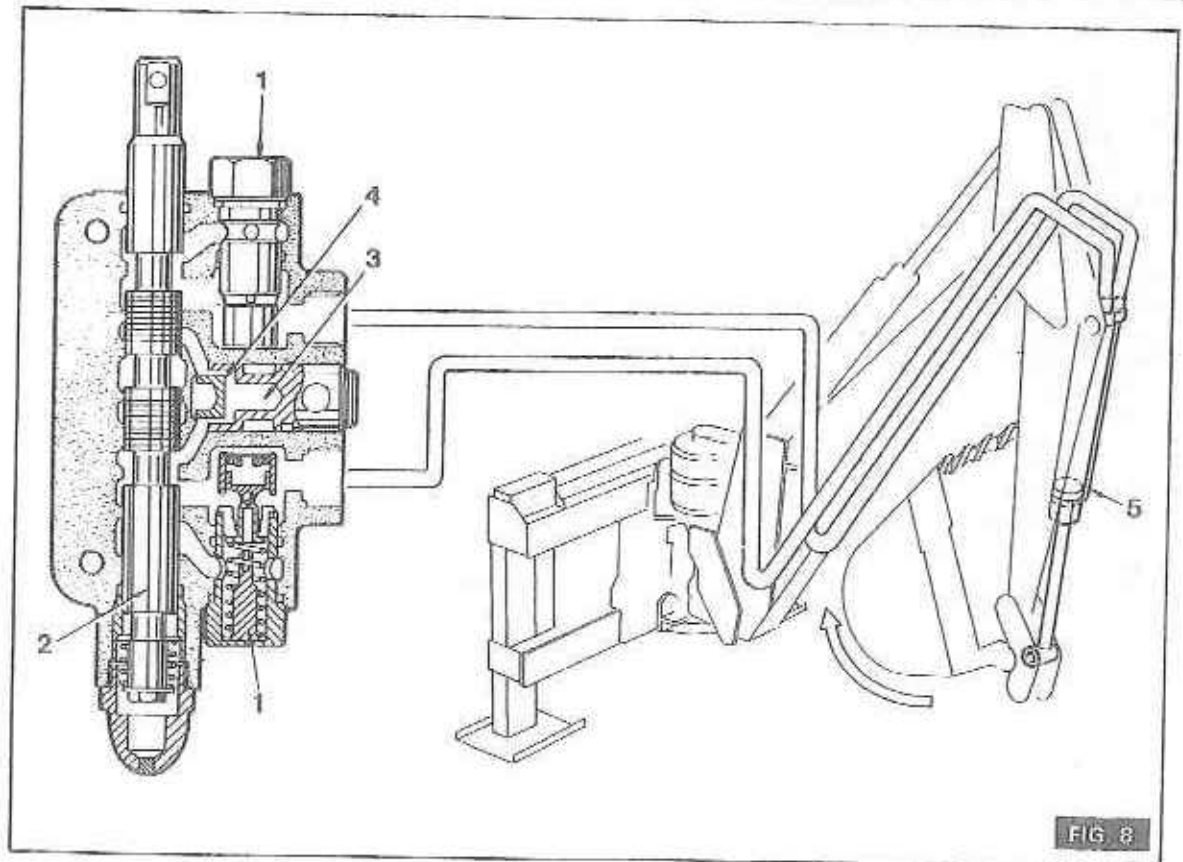
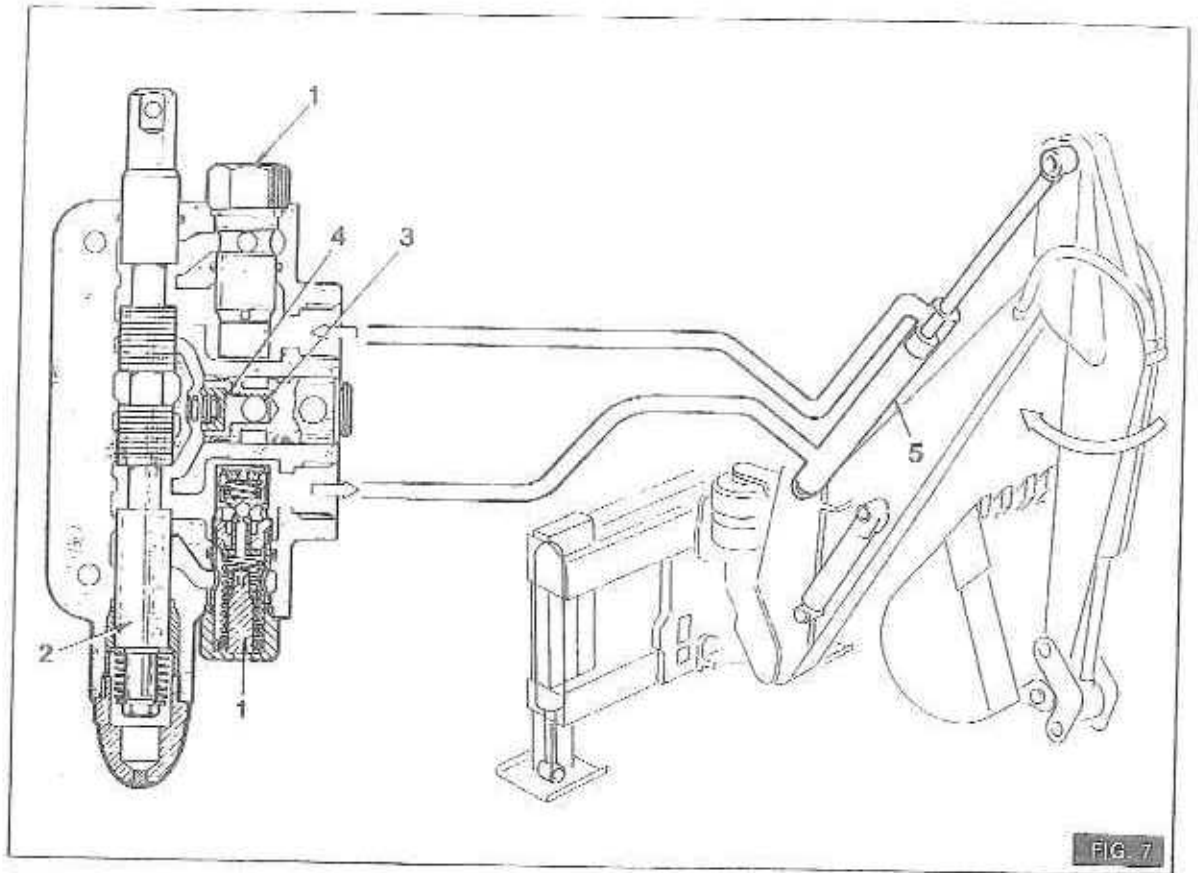
1. (Fig. 11) Remove the split pins (1) and linch pins (2) which connect the links (3) to the spools (4).
2. Unscrew the two screws (5) and remove the complete handle assembly from the spool valve.
3. Mark each section to ensure correct reassembly.
4. (Fig. 12) Unscrew and remove the two front tie bolts (1).
5. Remove the nut (2) and washer (3) from the apex tie bolt (4) and carefully withdraw the outlet end cap (5) then each section from the tie bolt.

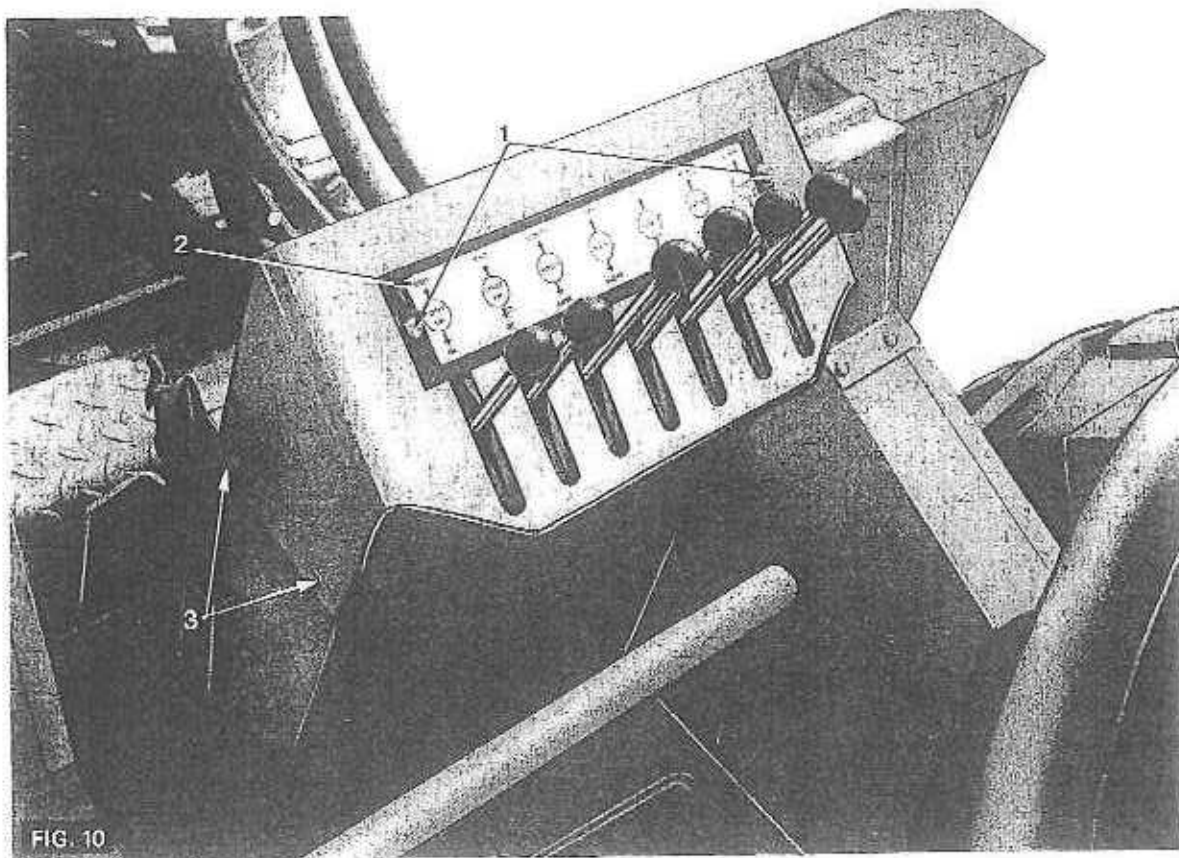
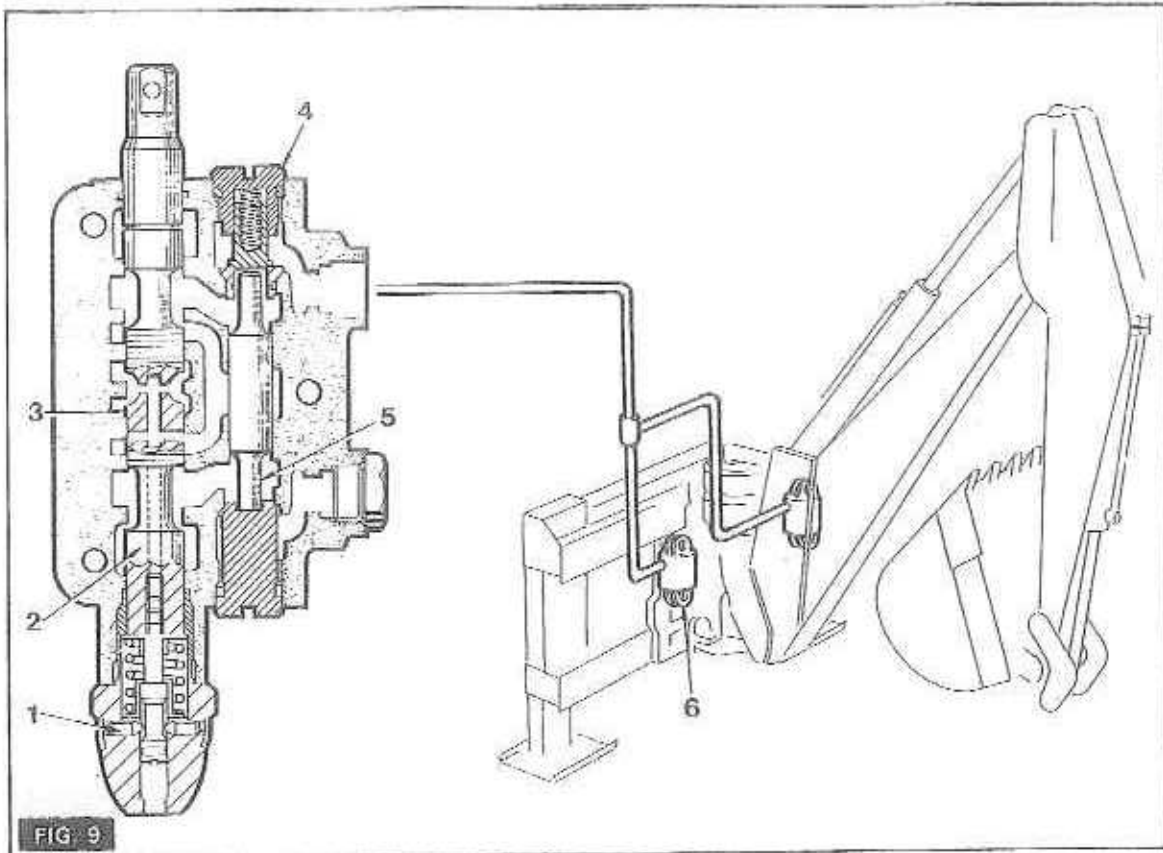
SEVEN SPOOL VALVE

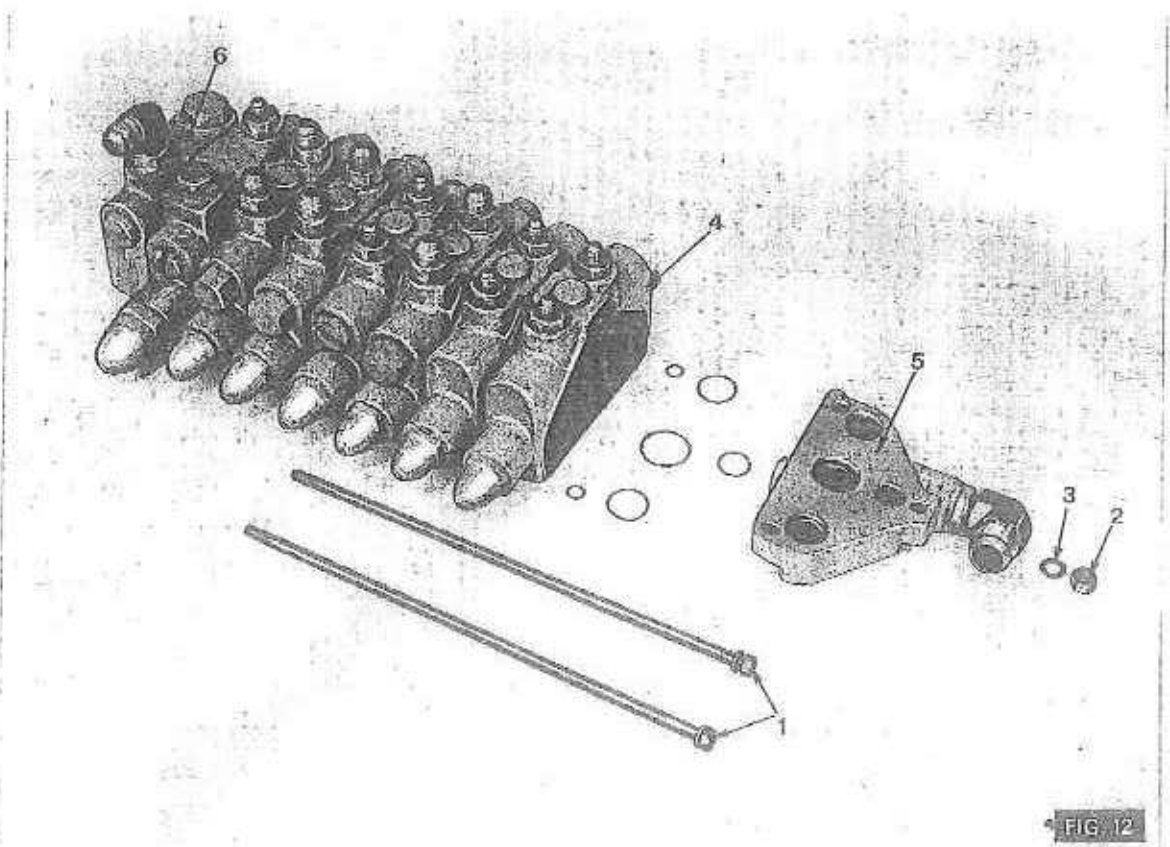
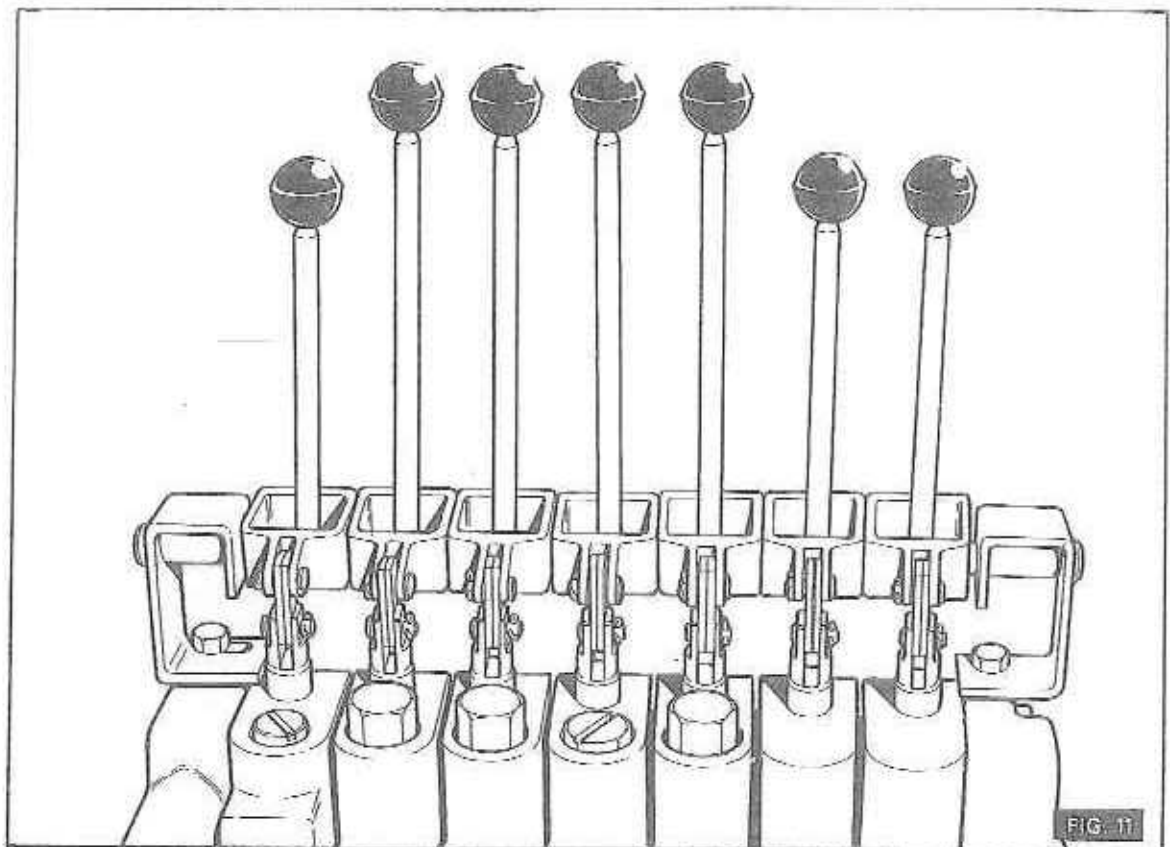
Reassembly

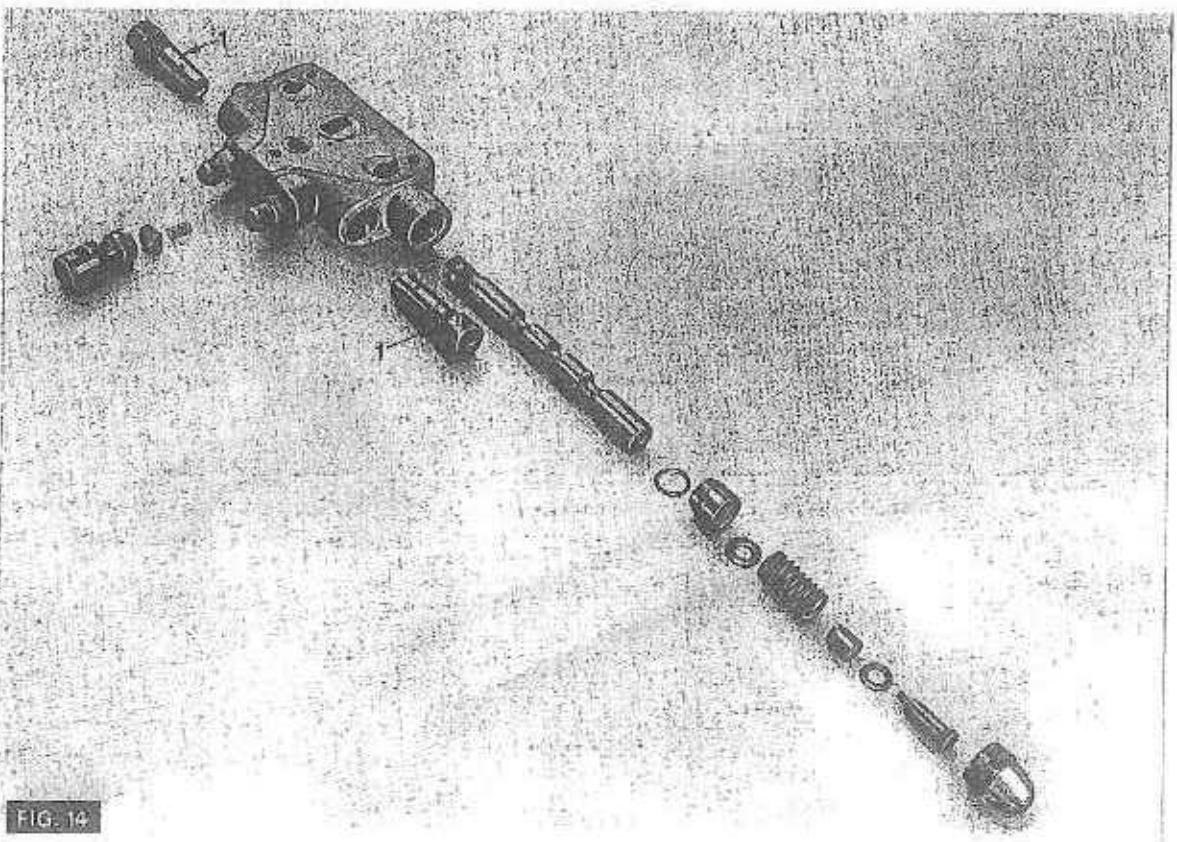
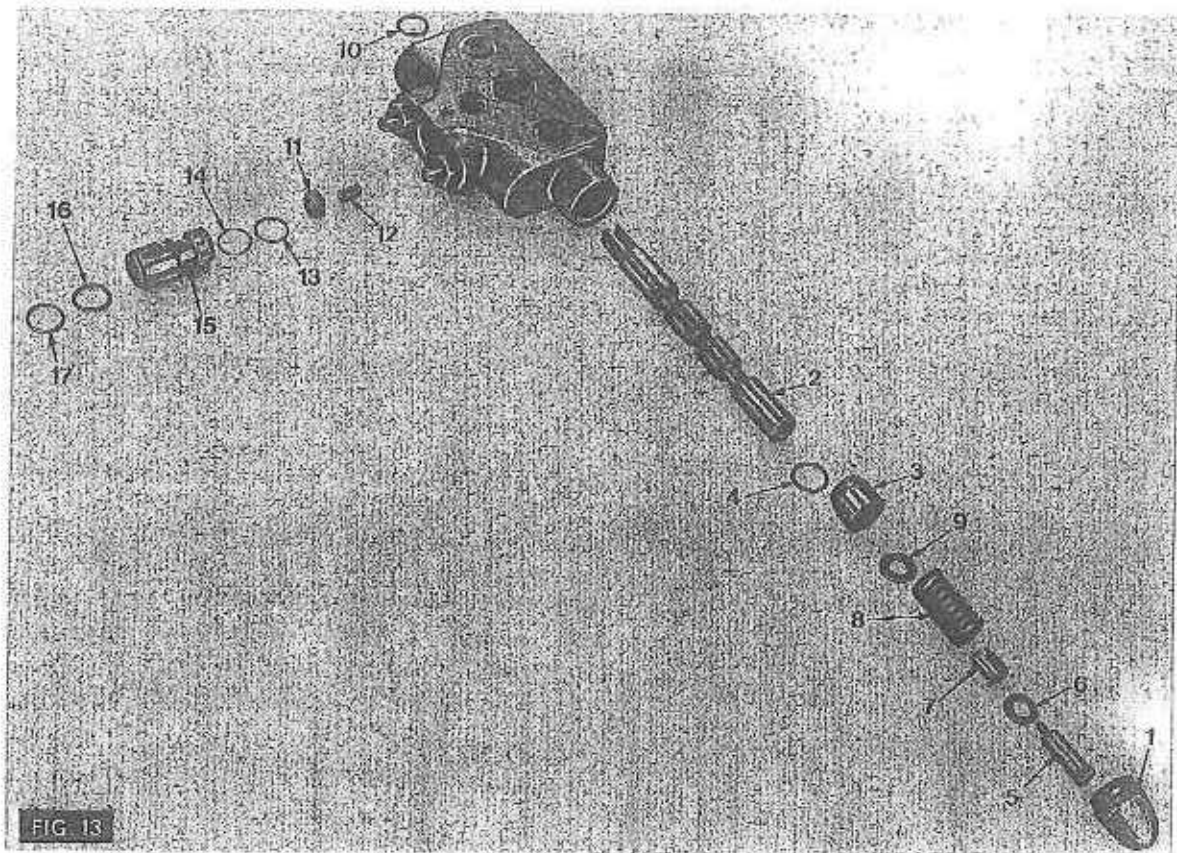
(9E/3)

1. Fit the apex tie bolt (4) through the inlet end cap (6) then reassemble the complete block ensuring that the sections are in their appropriate place.









ROTARY ACTUATOR



CONTENTS

	Page
GENERAL	4
ACTUATOR OIL FLOW	4
ACTUATOR, Removal (9F/1)	5
ACTUATOR, Replacement (9F/2)	6
ACTUATOR, Disassembly (9F/3)	6
ACTUATOR, Reassembly (9F/4)	6
ACTUATOR, Performance test (9F/5)	7
SHAFT VANE SEALS, Renewal (9F/6)	8
BARREL VANE SEALS, Removal (9F/7)	8
BARREL VANE SEALS, Replacement (9F/8)	8
CUSHIONING VALVES, Removal (9F/9)	9
CUSHIONING VALVES, Replacement (9F/10)	9
CUSHIONING VALVES, Adjustment (9F/11)	10
CROSS LINE RELIEF VALVE, General (9F/12)	10
RELIEF VALVE CAPSULE, Renewal (9F/13)	10
RELIEF VALVE, Disassembly (9F/14)	10
RELIEF VALVE, Reassembly (9F/15)	11
RELIEF VALVE, Adjustment (9F/16)	11
CHECK VALVES, Removal and disassembly (9F/17)	11
CHECK VALVES, Reassembly and Replacement (9F/18)	11

LIST OF ILLUSTRATIONS

	Facing Page
Fig 1 GENERAL ARRANGEMENT OF ACTUATOR	4
Fig 2 HYDRAULIC FLOW DIAGRAM	5
Fig 3 ACTUATOR, Removal.	6
Fig 4 ACTUATOR, Removal.	6
Fig 5 CAPSCREWS, Identification.	6
Fig 6 JACKING DOWEL AND WAIST SCREWS, Insertion.	6
Fig 7 END COVER, Lifting.	6
Fig 8 ACTUATOR INTERNAL VIEW	6
Fig 9 DUMMY END COVER, Fitting	6
Fig 10 METAL END SEAL, Removal.	7
Fig 11 SHAFT, Removal	7
Fig 12 METAL SEAL TYPE, Identification.	7
Fig 13 END COVER, Breakdown	7
Fig 14 SHAFT VANE SEAL, Removal	7
Fig 15 FIXED VANE, Breakdown	10
Fig 16 SHORT DOWEL, Location	10
Fig 17 CUSHIONING VALVE, Sectioned	10
Fig 18 SLEEVE REMOVAL CALIPI	10
Fig 19 RELIEF VALVE, Breakdown	11
Fig 20 CHECK VALVE, Breakdown	11

ROTARY ACTUATOR

GENERAL

The actuator is operated hydraulically and provides rotary movement of an output shaft over an arc of up to 186° maximum. External stops must be provided to limit this travel.

The unit comprises a cylindrical barrel housing a vane located lengthwise and fixed by cap screws and dowels to the barrel wall. Two end covers enclose the barrel and support a splined output shaft which passes axially through their centres. A second vane is formed integral with the shaft and can move over a 186° arc inside the barrel. The vanes are sealed by quad-section rubber seals sandwiched between anti-extrusion washers. Oil leakage from the shaft ends is prevented by an O ring seal and backing washer located in a groove in each end cover.

Two oil ports are provided in the upper end of the shaft and these alternate as supply and exhaust ports according to the direction of rotation selected. When the output of the system pump is supplied to the actuator pressure is generated against the shaft vane causing the shaft to rotate inside the anchored barrel. Oil in the opposite side of the vane is directed back to the system oil reservoir. Torque reaction is taken by two dowels in the drive end cover locating in holes provided on the machine structure.

Two cushioning valves are housed in the shaft and these control the slewing speed and provide cushioning at each end of the vane stroke. Protection against excessive pressure caused by inertia loads is provided by two cross-line relief valves housed in the ported end cover.

Working in conjunction with the cushioning valves are two orifice plates fitted on top of the barrel vane, one on each side of the vane oil seal groove. These provide a cushioning zone over the last 47° of travel at each end of the vane stroke. The curved edges of these plates are spring loaded into contact with the surface of the shaft and the curvature of each plate is generated on a different centre to the shaft circumference, the effect being to produce a tapered slot. As the shaft rotates, the exhaust port travels across this slot, and the passage of exhaust oil from the actuator is progressively restricted.

A 'third line' feature comes into use if adverse operating conditions are causing cavitation to occur in the actuator. A third oil port in the end cover provides for the connection of a pipe from the return side of the system to supply make-up oil to either oil chamber of the actuator through the appropriate check valve. This port is blanked by a sealed plug until the actuator is installed.

ROTARY ACTUATOR OIL FLOW

The four conditions encountered in the operating cycle of the actuator are described below and illustrated in Parts I, II & III of fig. 2. For the purpose of description the shaft is shown rotating clockwise. A similar sequence of operations will take place when the shaft rotates in the opposite direction.

Part I Start of the Slewing Cycle

Oil flow directed by the operator control spool enters the actuator at port (A) passes into the oilway, through control restrictor (B) and into the lower sleeve annulus (C) of the cushioning valve (D). From here it passes along the waist of the valve into the centre annulus (E) along transfer oilway (F) in the centre of the shaft pressurising damping restrictor plate (G) against its return spring, thereby ensuring an unrestricted oil flow into the right hand side of the actuator barrel. Oil pressure generated against the shaft vane (H) causes the shaft to rotate in a clockwise direction.

Oil from the exhaust side of the shaft vane (Left Hand) passes along the centre shaft oilway (I) and into centre sleeve annulus (J) along the waist of cushioning valve (K) to the lower sleeve annulus (L) continuing into the vertical oilway returning to reservoir via restrictor valve (M).

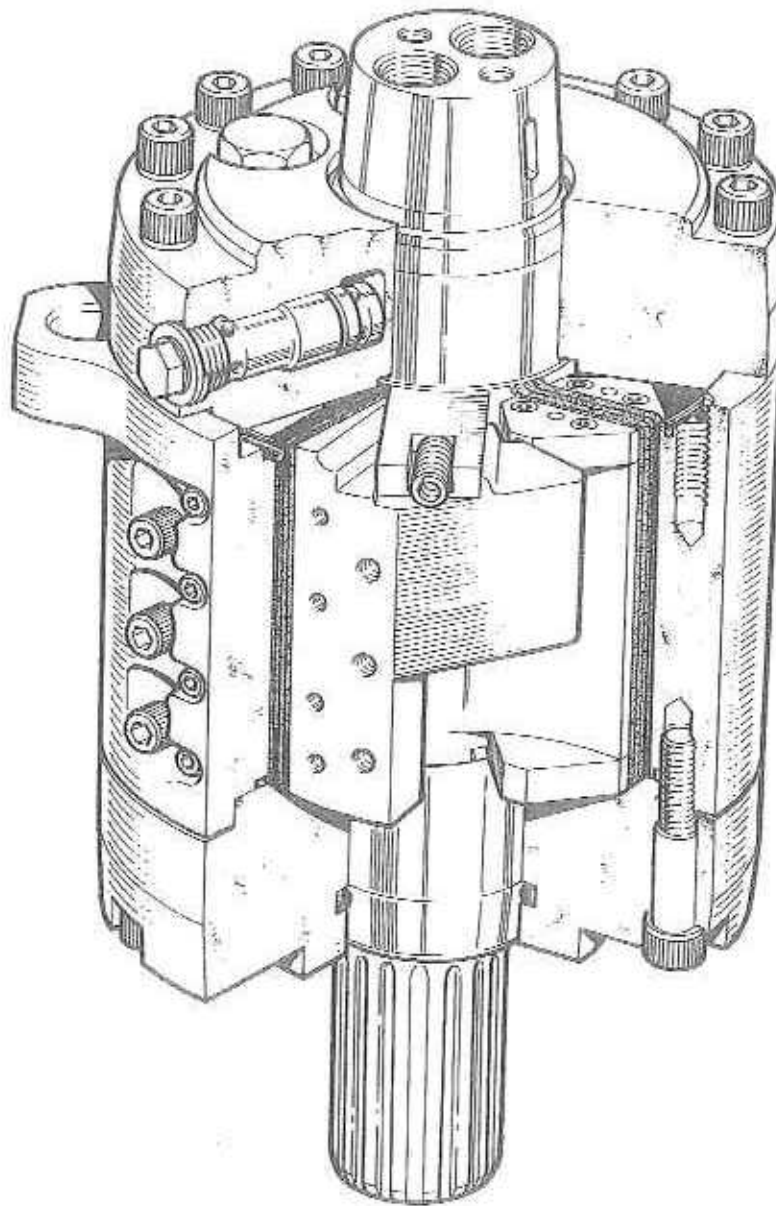
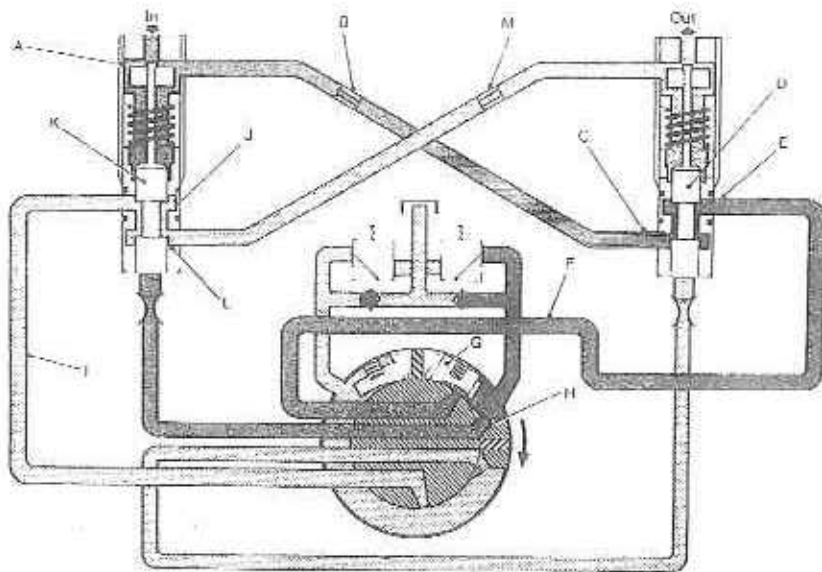
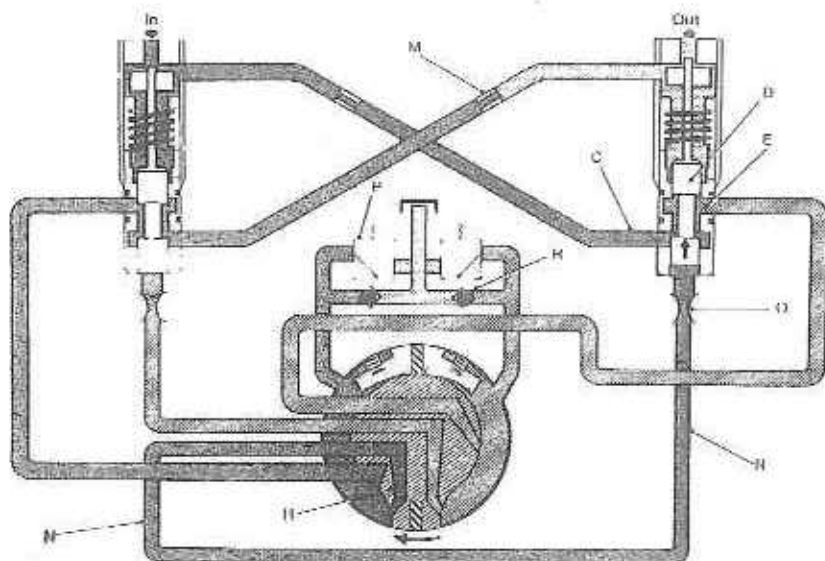


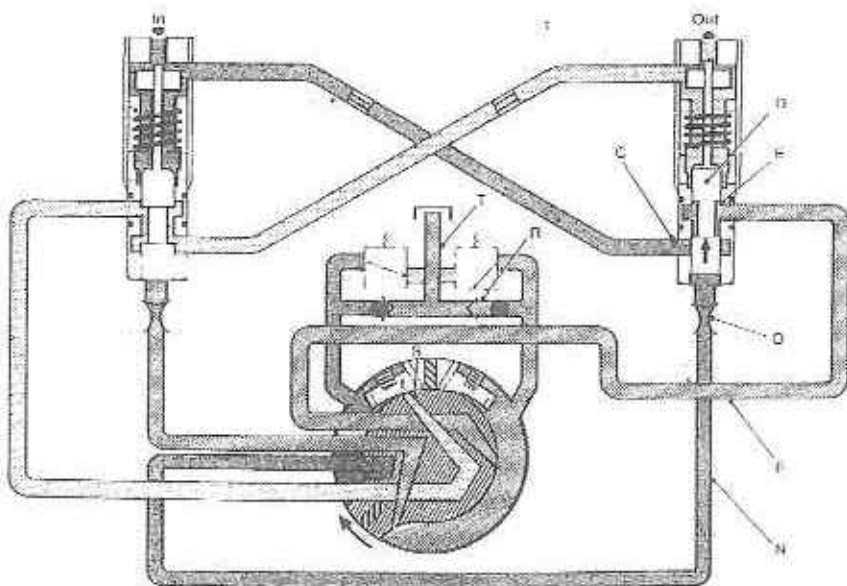
FIG 1



Pressure Flow Returns

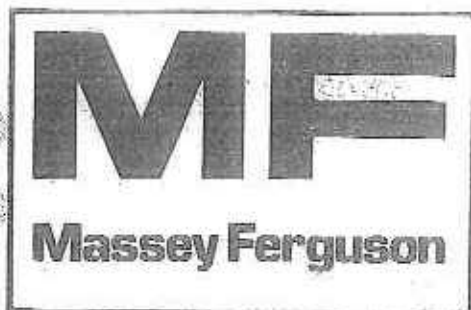


Inlet & Valve Back Pressure Restricted Inlet Flow Returns



Inlet & Valve Restricted Pressures Third Line (Make-Up) Flow Returns

FIG. 2.



MF Industrial Limited

Barton Dock Road, Stretford, Manchester M32 0YH, England
Telephone: Manchester (061) 885 4400 Telex: 657145

Distribution

UK/D/IM
EE/D/IM
WED/D/IM

No. 50H/HX/2200/02

Date 19.7.85

DOWTY ROTARY ACTUATOR - LOW PRESSURE SLEW CREEP

ADVICE

A limited number of rotary actuators have been produced with the incorrect letters stamped on the top and bottom of the rotary actuator shaft. As you are aware shafts are stamped on the top and bottom with either the letter "B" or "N", this letter denotes the type of steel corner ring to be fitted on each end of the shaft vane.

Where incorrectly sized corner rings have been fitted a high rate of slew drift will be evident when:

- The machine is transported without the safety bar fitted or
- When the digger is being used with the backframe at an angle of 2-5% off horizontal.

It is essential that all machines are checked on first service or on the next visit to the machine.

When checking proceed as follows:

- Position the machine on level solid ground.
- Warm the oil to approximately 50° (120°F) and allow the actuator body to warm through by operating the actuator.
- Extend the dipperstick fully, open the bucket and position the boom so that the bucket is approximately 30" off the ground.
- Lower the stabiliser legs so that the rear wheels are clear of the ground.
- Retract one leg slightly to allow the backframe to be 2-5% off horizontal.
- With the engine at tick over and all controls in neutral check to see if any creep occurs within 5 minutes.
- If the slew creep is above 1" per minute proceed as follows:
 - Lower the boom onto the ground and stop the engine.
 - Remove the rotary actuator assembly.
 - Note the letter "N" or "B" stamped on the top and bottom of the shaft. Dismantle the actuator.

TRY Springs & Bullets
First

50H/HX/2200/02

-2-

- d. Shaft journals graded 'B' should be fitted with the smallest end seal that will readily fit the journal ie. 'N' or 'U' grade. The 'U' grade being the smallest end seal. Part numbers for end seals are 'N' - MF 1888 303 M1 and 'U' - MF 3474 783 M1. It should also be noted that it is almost impossible to fit a 'U' end seal to a correctly graded 'B' journal and end seals should never be forced onto the journal as this could result in the end seal fracturing.

'N' graded journals should be fitted with the 'U' grade end seal.

When the actuator has been reassembled it must be RESTAMPED with the letter of the rings used, plus the letter W to signify that it has been reworked.

Having reworked the actuator repeat the slow creep test. If creep above 21" per minute is found please contact Service Department immediately.

WARRANTY

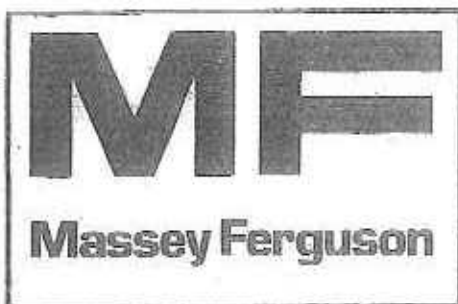
Should an incorrectly identified shaft have been fitted the problem will be found on the machine very early in its life. To this end Warranty will only be accepted on machines with less than 250 hours recorded and this will be provided the following additional information is recorded on the Warranty Claim;

Actuator Serial Number, Creep rate in inches/minute both before and after rework the letter stamped on top and bottom of shaft both before and after rework, and the number of this service bulletin.

ADMINISTRATION

Warranty claims may be submitted for consideration provided the above conditions are complied with.

GC



Massey-Ferguson (United Kingdom) Limited

P.O. Box 62 Banner Lane, Coventry CV4 9GF, England
Registered Office: 33 Davies Street, London W1Y 2EA
Registered in England No. 509133

Distribution

UK/Db/IM

No. Addendum to
50D/2200/6
50 /2200/3

Date 4.5.83

SAFETY



**MF 50D and MF 252 Diggers
Rotary Actuator**

IM Service Bulletin 50D/2200/6 and 50/2200/3 give details of the changes to the Rotary Actuators which have now cut into production. Interchangeability however, with the earlier Actuators, is affected as follows:-

Warning

Since the porting and internal galleries have changed within the shaft; should a shaft, incorporating the new design flow control valves be fitted to an earlier type actuator, it is essential to alternate the two feel pipes. FAILURE TO COMPLY WITH THIS INSTRUCTION WILL RESULT IN THE DIGGER SLEWING IN THE WRONG DIRECTION AND COULD RESULT IN A SERIOUS ACCIDENT.

Warning

In the event of a new type actuator being fitted to replace an earlier design unit, then the same changes to the pipework, as stated above, must be strictly adhered to.

Parts

In cases where the old design actuator is being overhauled and it is found that the early type shaft is not available from CPO, it is possible to convert the actuator to the new design by use of a conversion kit, part number 1810 739 M91.

This kit comprises of a new shaft complete with flow control valves, plus two new shallow grooved orifice plates. (It is extremely important that the original deep grooved orifice plates are discarded).

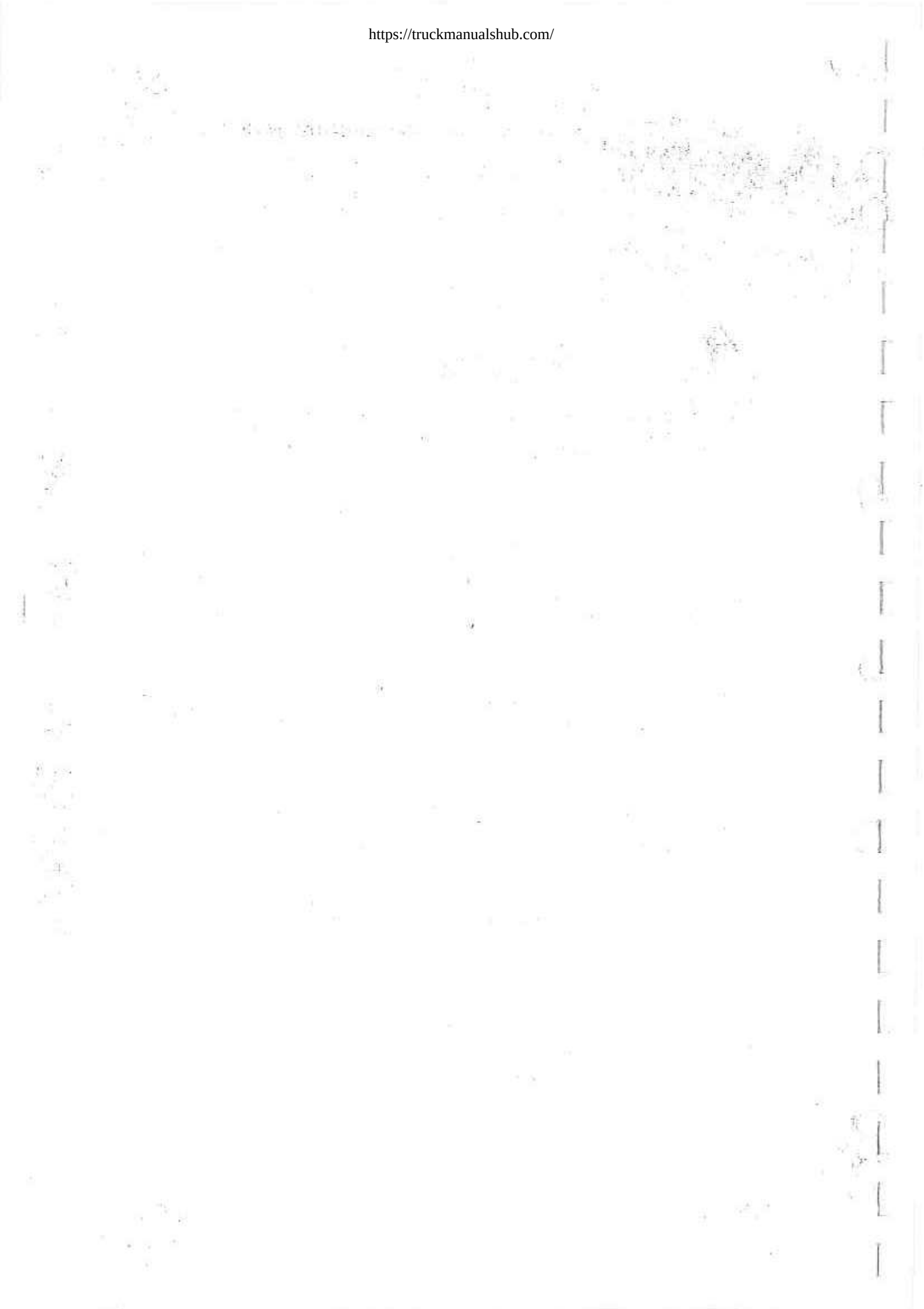
Identification

Where early type actuators are converted by use of the above kit, it is important that the actuator is marked to identify that the conversion has taken place. This should be done by embossing with a letter "D" immediately following the actuator serial number. This will obviously assist in identifying the correct pipework layout.

IM Service Bulletin

SAFETY

SAFETY



MF

Massey Ferguson

Massey-Ferguson (United Kingdom) Limited

P.O. Box 62 Banner Lane, Coventry CV4 9GF, England
Registered Office: 33 Davies Street, London W1Y 2EA
Registered in England No. 509133

Distribution

UK/Db/IM

No. 50/2200/3
500/2200/6

Date 24.5.83

This bulletin replaces issue one dated 4.5.83 which should be removed from your files and destroyed.

MF 50D and MF 252 DIGGERS

ROTARY ACTUATOR

Advice

With effect from the following serial numbers a new Rotary Actuator has cut into production.

MF 50D - 2 Wheel Drive - 2882W1237
MF 50D - 4 Wheel Drive - 2915W509, W510
W529 onwards with the exception of
2915W540 and W545
MF 525 Digger - 2877W20525

This new actuator has a change in the slew characteristics which not only affect performance but also change the hydraulic piping arrangement.

(a) Deletion of the slew cushioning valves and associated cross drillings within the shaft. Deletion also of the recess orifice plates which are spring loaded against the shaft and located on the top of the stationary vane.

(b) The above cushioning valves have now been replaced by flow control valves located in parallel feed ports. The deep recess orifice plates have been replaced with new design shallow orifice plates.

Consequential to these changes, the oil is no longer transferred internally via the cross drillings from one port to the other, hence the change in the hydraulic piping, e.g. on the earlier actuator, oil fed into the left hand feed port, slewed the digger to the left and vice versa for the other direction of slew.

On this new actuator, oil fed into the left hand feed port will slew the digger to the right. Oil fed into the right hand feed port will slew the digger to the left.

IM Service Bulletin

Servicing the New Actuator

The servicing procedure remains as detailed in the MF 50D Workshop Service Manual, Group 8, Section C, with the exception of the following:

Servicing the Shaft

In the unlikely event that the flow control valves require replacement, they should be removed by unscrewing the hexagon head. Prior to refitting, the threads on the new valve assembly and the shaft must be thoroughly cleaned and degreased. Apply Loctite Grade 222 to the outer threads of the valve assembly only, fit the valve and tighten to 2.03-2.71Nm (1.5 to 21bs ft). DO NOT OVERTIGHTEN OR ALLOW LOCTITE TO COME IN CONTACT WITH ANY OTHER PART OF THE VALVE, SINCE THIS WILL RESULT IN CUSHIONING MALFUNCTION.

Parts

The part numbers of these new items will be notified by CPO in the normal way.

Rubber Slew Stops

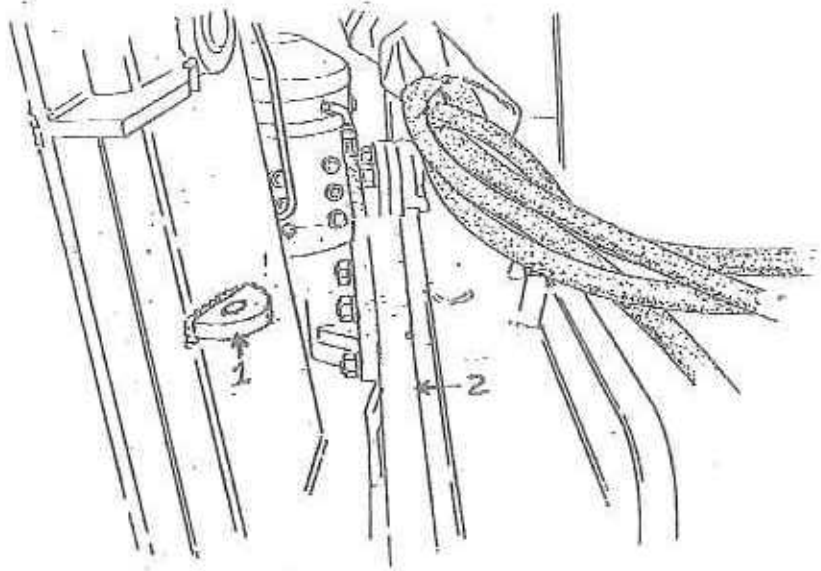
To allow correct cushioning to take place with the actuator, it is essential that the rubber slew stops, as fitted to the pivot post mast casting, are shimmed to give accurate "stand-out" between the mast and the outer face of the stop. To check this, adopt the following procedure.

- 1) With the digger central on the frame, slew the boom into the frame and raise the boom to position the transport link bracket (Item 1 on attached sketch) midway up the frame upper slide rail rear (Item 2).
- 2) Apply full system pressure to hold the boom as close to the frame as possible.
- 3) Shim the rubber stop to provide 13 to 16mm clearance between the upper slide rail and the transport lug.
- 4) Repeat for both sides.
- 5) Slew the boom assembly through 180 degree arc in both directions for a minimum of 5 times to expel all air from the system and to allow the external stops to settle. Re-check the boom to backframe clearance as detailed in item 3.

Administration

This bulletin is issued for technical advice only and does not constitute authority for mandatory action and warranty claims submission.

500/2200/6
50/2200/3.





Part II Slewing at Controlled Speed

As the vane shaft rotates and slew speed increases, the restriction afforded by control restrictor (M) in the vertical return oilway, causes a rise in back pressure on the exhaust side of shaft vane (H). This pressure is also felt along oilway (N) and damping restrictor (O) onto the area at the base of cushioning spool valve (D). When this back pressure reaches a value between 200/500 p.s.i. (14.0/35.1 Kg.cm²) cushioning spool (D) moves upwards, and out of alignment with the lower sleeve annulus (C) thus restricting the input flow to annulus (E) thereby modifying the supply of oil to the pressure side of the vane shaft controlling the slewing speed of the digger unit.

If, however, the operator control spool is returned to the neutral position before the shaft vane has completed its travel, the inertia of the digger assembly load will continue to rotate the shaft. Pressure falls on the input side of the vane and cavitation tends to occur. At the same time pressure increases on the exhaust side and it is this pressure which is sensed by the cross-line shock valve (P). At the pre-determined pressure setting of 2,800 p.s.i. (196.8 Kg.cm²) the valve will open and allow oil to transfer through check valve (R) into the input side of the actuator barrel to make up for the deficiency in supply. As the pressure falls the valve closes and the vane shaft is then hydraulically locked by oil trapped between each side of the actuator shaft vane and the operator control spool.

Part III Cushioning the End of the Stroke

At a position of 47° from the end of the vane stroke the exhaust port in the shaft starts to move across the tapered slot, formed between the damping restrictor plate (L) and the vane shaft, into the cushioning zone, as port (S) moves across the slot from the widest to the narrowest part of its taper a progressive restriction of the exhausting oil takes place, causing an increase in pressure on the exhaust side of the vane. This excess pressure is also felt in the oilway (N) and restrictor (O) onto the base of spool cushioning valve (D) causing it to lift and progressively cut off the input supply via sleeve annulus (C) and (E).

As load inertia of the digger continues and the input supply of oil is cut off cavitation tendencies will occur within supply line (F) and the input side of the actuator barrel, the relief of which is overcome by the third line check valve (R) which is drawn off its seat, thus allowing oil to replenish the input side of the actuator via supply line (T).

KEY TO FIG. 2

A. Port	G. Restrictor Plate	M. Restrictor Valve
B. Control Restrictors	H. Shaft Valve	N. Oil Way
C. Sleeve Apparatus	I. Centre Shaft Oilway	O. Damping Restrictor
D. Cushioning Valve	J. Sleeve Apparatus	P. Cross Line Shock Valve
E. Centre Apparatus	K. Cushioning Valve	R. Check Valve
F. Transfer Oilway	L. Sleeve Apparatus	S. Port
		T. Supply Line

ROTARY ACTUATOR

Removal

9F/1

1. Slew the boom to either left or right to gain access to the actuator.
2. (Fig. 3) Remove the outer half of the hose clamp (1).
3. Disconnect the two hydraulic connections (2).
4. Disconnect the anti cavitation pipe (3).
5. Extract the two securing bolts (4) and remove the bracket (5).
6. Unscrew the six bolts (6) from the underside of the actuator.
7. (Fig. 4) Screw three bolts (1) into the three equi-spaced threaded holes in the actuator attachment flange until the bolts 'bottom' against the base of the actuator.
8. Screw an eyebolt or lifting bracket into the central ½" U.N.F. threaded hole in the top of the actuator centre shaft. This will facilitate the use of adequate lifting apparatus to remove the actuator.
9. Use a scribe and mark each flange and the adjacent housing and pivot post, this will help ensure that the correct relative positions are re-obtained during re-assembly.
10. Taking each of the bolts in turn, screw in each bolt until it is tight. This method will progressively lift the actuator away from the flange and break the friction grip between the location dowels and the actuator mounting flange.
11. Using a hoist and sling lift the actuator away from the pivot post.

Warning

The actuator is heavy and cannot be lifted by one man without the use of lifting apparatus.

ROTARY ACTUATOR Replacement

9F/2

To ensure that the correct relative positions between the pivot post, the actuator and the actuator centre shaft are re-obtained, align the arrow on the splined end of the shaft with the arrow on the spline of the pivot post.

1. Apply a light coating of grease to the male and female splines.
2. Align the master splines and lower the actuator onto the mounting flange.
3. (Fig. 3) Check that the splines and locating dowels are correctly located and engaged, then tighten the six attachment bolts (6).
4. Remove the eyebolt, replace the bracket (5) and secure with two screws (4).
5. Reconnect the anti-cavitation hose (3).
6. Reconnect the hydraulic connections (2).
7. Re-clamp the hydraulic hoses by replacing the outer half of the clamp (1).

ROTARY ACTUATOR Disassembly

9F/3

1. Remove the actuator from the machine as stated in Operation. 9F/1
2. Place the actuator on a suitable stand, screw two blanking plugs into the oil ports in the shaft to prevent dirt entering the cushioning valves.
3. (Fig. 5) Remove the 14 cap screws (1) which secure the end cover to the barrel, noting the position of the three waisted screws.
4. (Fig. 6) Insert a 3/8in. x 1/2in. dowel in each of the waisted cap screw holes and refit the screws.
5. (Fig. 7) Screw the three waisted screws down onto the dowels. Progressively tighten the screws to lift the cover, at the same time, using a hide hammer, ensure that the shaft does not lift as this may cause damage to the internally fitted sealing rings.
6. Lift the end cover clear of the shaft and lay on a clean bench with the machined face uppermost, cover with a clean cloth to prevent damage.
7. Position the two vanes at 90° to each other.
8. (Fig. 8) Remove the large O-ring (1) from the barrel recess.
9. Mark then remove the restrictor plates (2) and springs (3) then carefully extract the metal sealing ring (4). Label the sealing ring 'PORTED END'.
10. (Fig. 9) Make up a dummy end cover from 3/8in. material, e.g. wood, plastic, etc., 9 1/2in. O.D. with a 4 1/8in. I.D. hole in the centre. Place this over the shaft and locate in the barrel. Secure the cover with three allen screws and flat washers.
11. Invert the actuator. Remove the bottom cover as in operations 3, 4 and 5.

Note

14 cap screws secure the bottom cover to the barrel, however, 6 of these form part of the mounting for the actuator to machine and when actuator is removed from the machine only 8 cap screws will be found in the bottom cover.

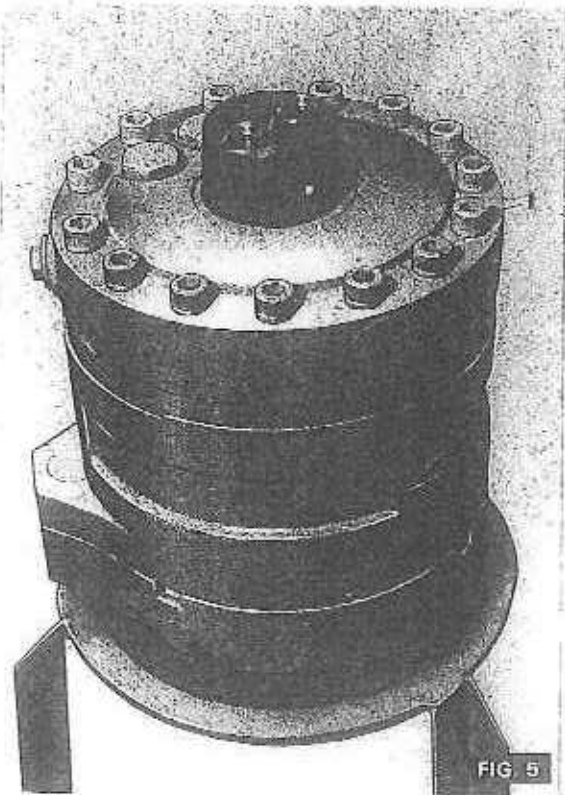
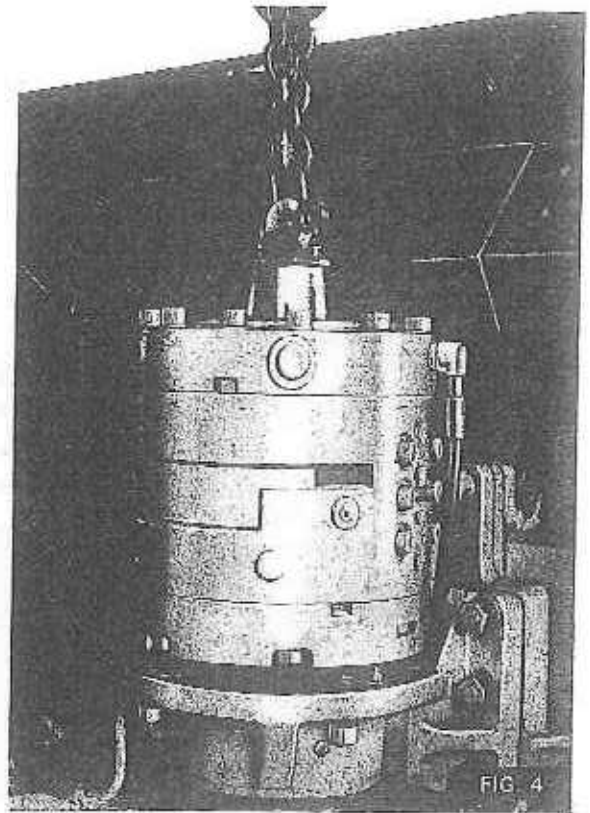
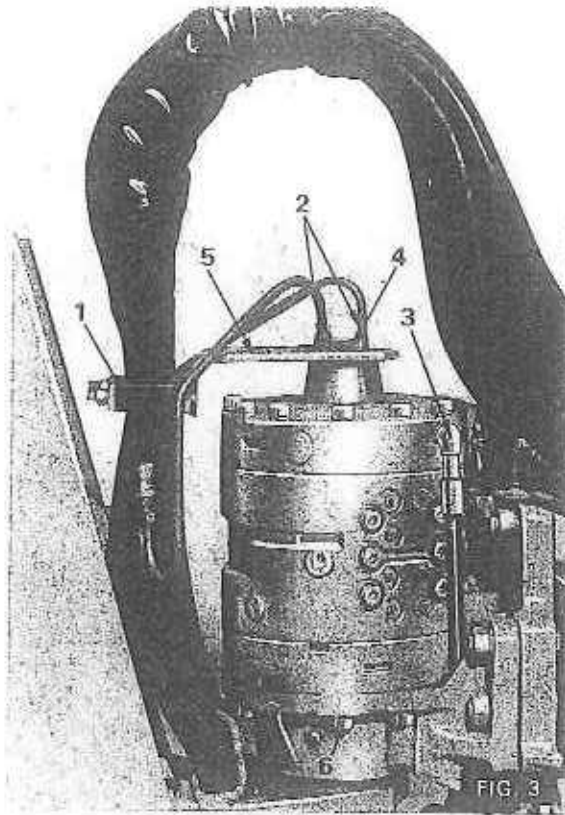
12. (Fig. 10) Remove the large O-ring (1) from the barrel recess and the metal-end seal (2) from the shaft. Label the end seal 'DRIVE END'.
13. (Fig. 11) Screw a lifting eye into the end of the shaft and raise the shaft clear of the barrel.

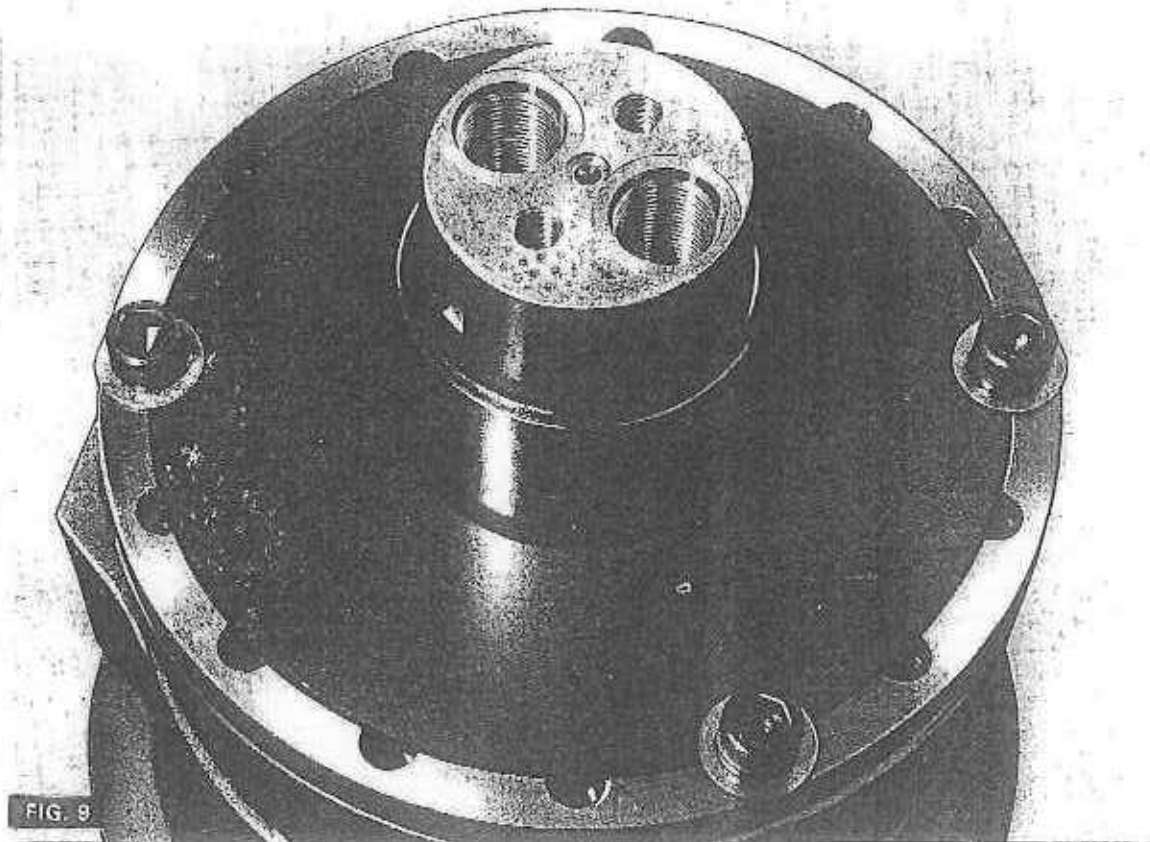
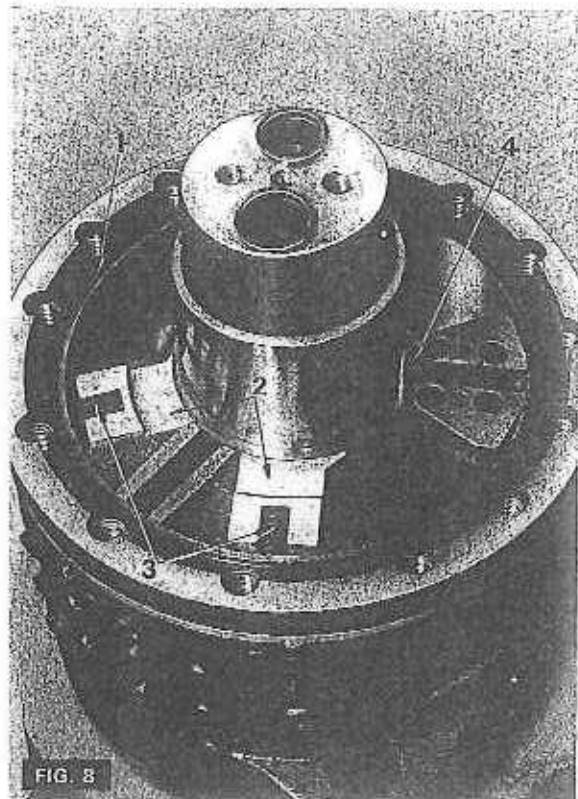
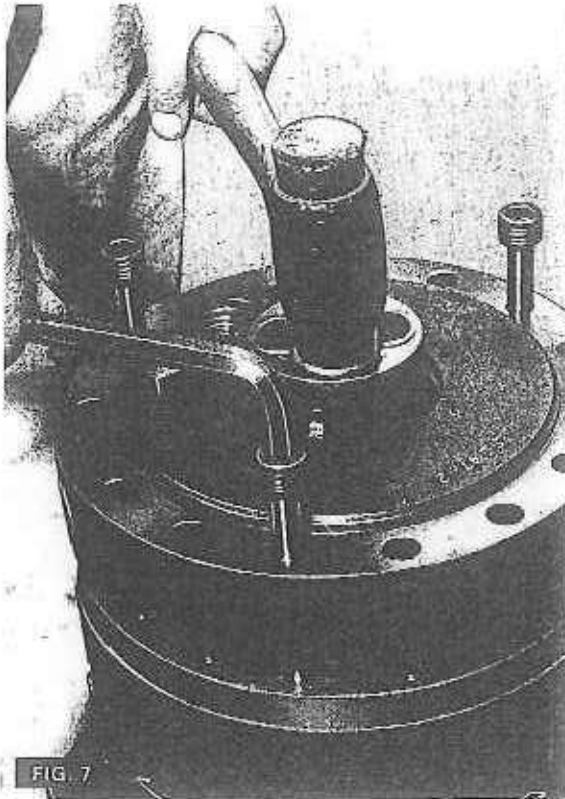
Examine the machined faces of the end covers and the swept surface of the barrel for scoring. Bad scoring will mean renewal of the complete actuator. Examine the vane seals and renew as necessary. If the actuator has had a long service life it is advisable to renew the shaft end seals.

ROTARY ACTUATOR Reassembly

9F/4

On early models the shaft corner seals are graded into two sizes and are identified by one size of seal being electronically dyed black while the other is left in its natural colour. On later models the corner seals are similarly





ROTARY ACTUATOR Reassembly . . . Cont'd

graded but identification is made by the letter B or N and the appropriate part number being etched on the flat surface of the seal.

If early seals are found in any actuator they must be replaced by the later version.

1. Fit the dummy end cover into the barrel recess and support it on two wooden blocks so that the barrel is vertical with the locating dowel end uppermost.
2. Lubricate a new O-ring with thin, mineral-base grease and place this in the barrel recess.
3. (Fig. 13) Prepare the two end covers for assembly as follows:—
Fit new O-rings (1) and spiral backing washers (2) in the grooves in the bores. The O-rings must be fitted in the side of the groove nearest the machined face of the end covers. Apply thick, mineral-base grease and push the O-rings and washers radially outwards into the grooves. Oil the bearing bores.
4. Oil the barrel wall and the bearing lands on the shaft with clean oil of the type used in the hydraulic system. If a new shaft assembly is being fitted remove the four blanking plugs from the oil ports in the vane.
5. Screw a 1/2 in. UNF eyebolt into the threaded hole in the splined end of the shaft, attach the hoist and position the shaft above the barrel with the vane at 90° to the barrel vane. Lower the shaft into the barrel, locating it against the dummy end cover.
6. Detach the hoist and fit the metal end seal, labelled 'Drive End', with the flat face uppermost, so that it is seated in the quadrantal cut-outs in the vanes.
7. Clean the machined face of the drive end cover and lower it squarely over the shaft, aligning the dowel hole with the hole in the barrel.
8. Lightly oil all fourteen cap screws and screw in finger tight. Ensure that the six longer screws and the three waisted screws are fitted in the holes previously noted. Oil the locating dowel and tap in until it has just started in the barrel hole.
9. Leave the six longer cap screws finger tight — these secure the actuator to its mounting on the machine and will be removed again when the actuator is installed. Tighten the remaining eight cap screws firmly in a diagonal sequence to pull the end cover down squarely into the barrel. Tap the locating dowel fully home in the barrel. Finally apply a torque load of 200 lbf-ft. (27,5 mkg) to each of the eight cap screws.
10. Invert the barrel, support on the two wooden blocks and remove the dummy end cover. Fit the two orifice plates and springs in the slots in the barrel vane as previously marked.
11. Lubricate and fit a new O-ring seal in the barrel recess.
12. Fit the metal end seal labelled 'Ported End' over the shaft with the flat face uppermost, so that it seats in the quadrantal cut-outs in the vanes.
13. Clean the machined face of the ported end cover and lower it over the shaft into position in the barrel, aligning the marks previously made.
14. Lightly oil the fourteen cap screws and screw in finger tight. Ensure that the three waisted screws are fitted in the holes previously noted. Tighten the cap screws firmly in a diagonal sequence to pull the end cover down squarely into the barrel. Finally apply a torque load of 200 lbf-ft. (27,5 mkg) to each cap screw.

ROTARY ACTUATOR Performance Test

9F / 5

The object of this test is to ensure that maximum slewing speed and optimum cushioning are being obtained. Before carrying out the test make certain that there is sufficient room to slew the boom over its full arc of travel without obstruction.

1. Start the engine and set to run at 1200 rev/min.
2. Stabilize the digger and fill the bucket.

ROTARY ACTUATOR**Performance Test . . . Cont'd**

3. Crowd the bucket and extend the dipstick to maximum reach. Set the boom so that the bucket is about 2ft. clear of the ground.
4. Slew the boom all the way to the left.
5. Select 'SLEW RIGHT' and hold the control lever in this position.
During the last 47° of travel the boom should slow down and come to rest gently against the travel stop. If the slewing speed is too fast the cushioning will be insufficient and the boom will hit the stop. To overcome this decrease the slewing speed by decreasing the spring compression in the left hand cushioning valve as described in 9F/11. If the slewing speed is too slow the boom will come to rest before reaching the stop and then creep slowly on to it. To overcome this increase the slewing speed by increasing the spring compression in the left hand cushioning valve as described in Operation.
6. Repeat operation 5, slewing the boom to the left. Any adjustment necessary must be made on the right-hand cushioning valve as described in Operation 9F/11.
7. Return the control lever to neutral and stop the engine.

SHAFT VANE SEALS**Renewal**

9F/6

1. Remove the actuator centre shaft as stated in Operation 9F/3.
2. (Fig. 14) Carefully prise out the old seal (1) and back-up washer (2) from the groove in the vane.
3. Clean out the groove and remove any burrs or sharp edges.
4. Lubricate the new seal and back-up washers with mineral-base grease.
5. Fit one back-up washer (3) in the groove. Next fit the oil seal (4) and finally, the second back-up washer (5).
6. Check that the seal and back-up washers are pushed in to the full depth of the groove, especially in the corners where the vane merges with the shaft.
7. Replace the shaft as stated in Operation.

BARREL VANE SEALS**Removal**

9F/7

1. Dismantle the actuator as stated in Operation 9F/3.
2. (Fig. 15) Remove the eight taper plugs (1) from the barrel.
3. Unscrew and remove the four outer cap screws (2) and their composite seals (3).
4. Using a punch tap the dowels (4) free from the barrel and vane.

Note: One dowel is shorter than the others. Its position is indicated by the words SHORT PIN and an arrow cast on the outside of the barrel. (Fig. 16).

5. Support the vane (5) remove the two remaining cap screws (6) and composite seals (7) and lift the vane out of the barrel.
6. Remove the old seal (8) and back-up washers, (9) clean out the seal groove and remove any burrs or sharp edges.

BARREL VANE SEALS**Replacement**

9F/8

1. (Fig. 15) Lubricate a new seal (8) and two new back-up washers (9) with thin, mineral-base grease. Place one of the back-up washers in the vane groove with the 45° cut in the side of the groove that will be in contact with the barrel wall. Next fit the oil seal and then the other back-up washer with the 45° cut positioned as before.

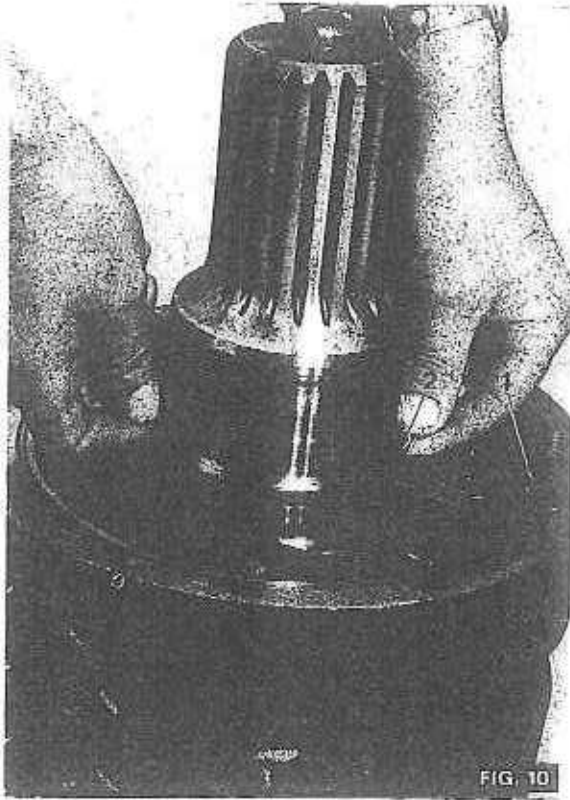


FIG. 10

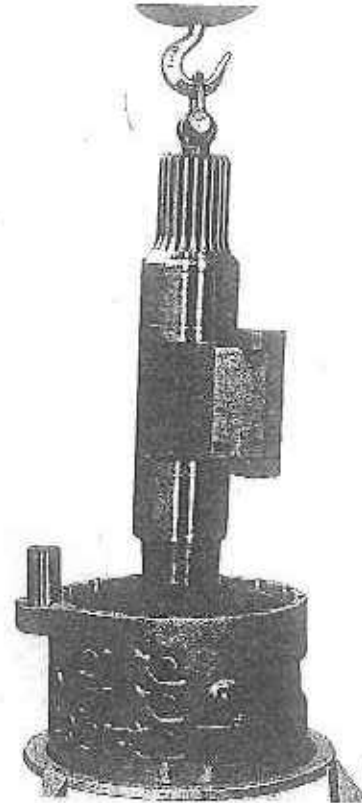


FIG. 11

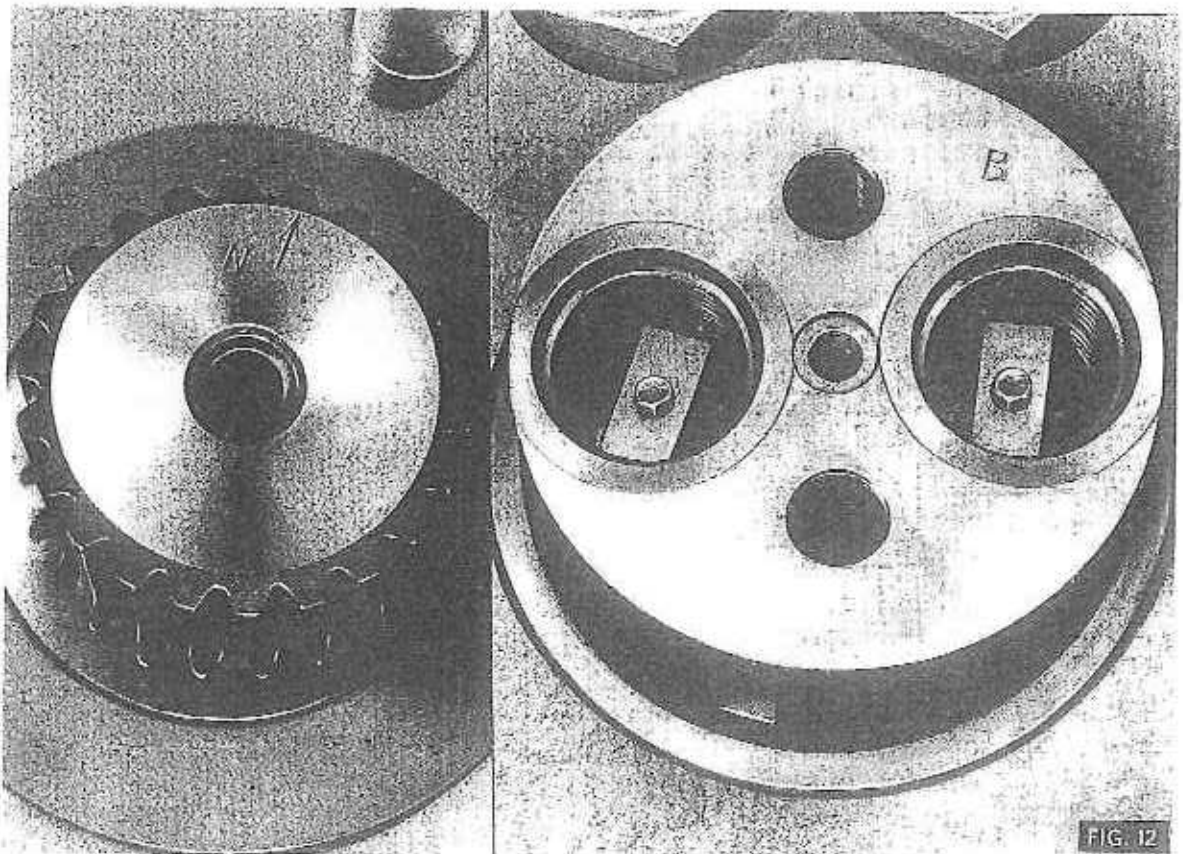


FIG. 12

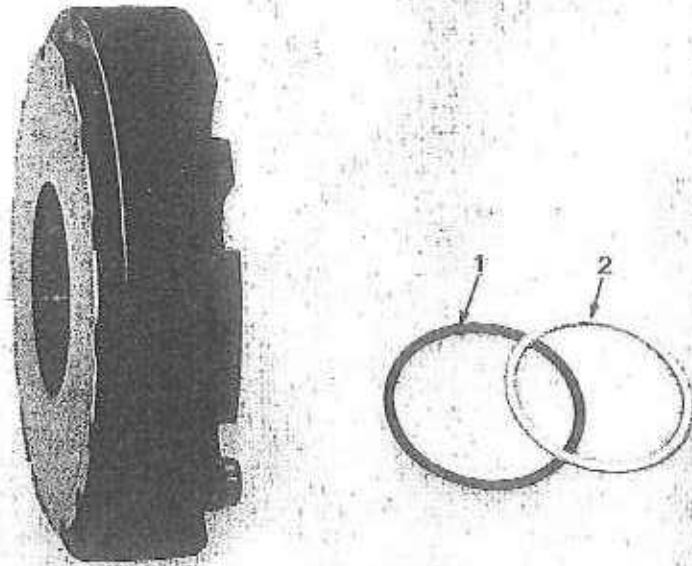


FIG. 13

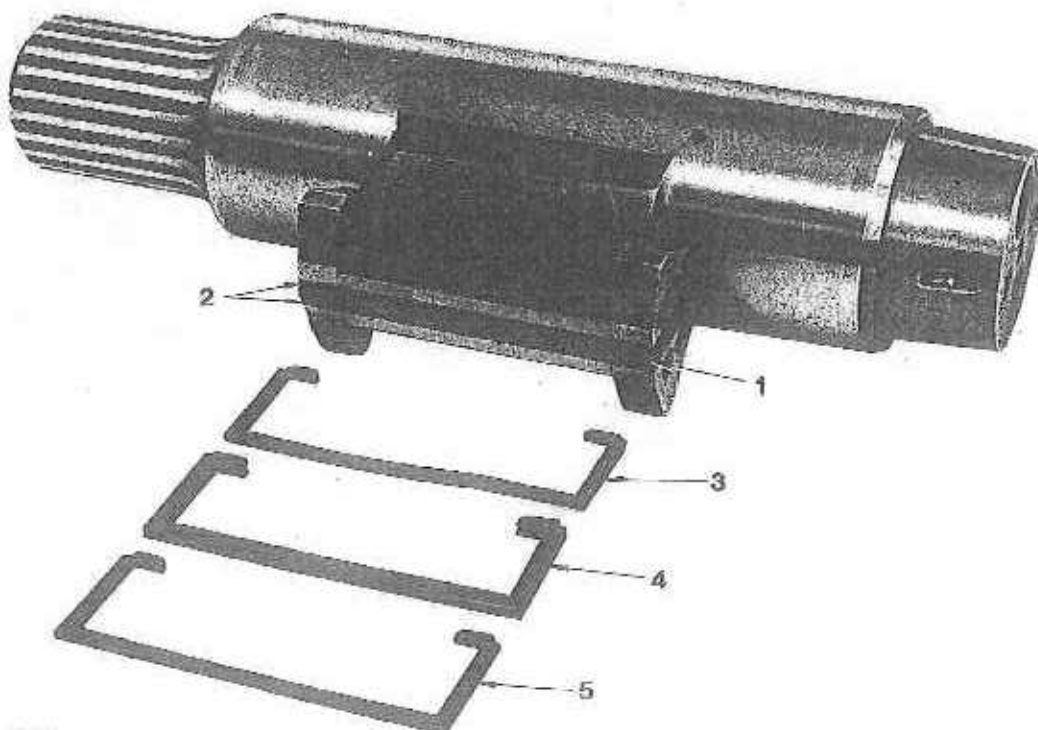


FIG. 14

BARREL VANE SEALS**Replacement . . . Cont'd**

2. Replace the vanes (5) in the barrel with the vane stops at the opposite end to the 1.3/8in. dowel hole. Lightly oil the six cap screws, (2) (6) fit the composite seals (3) (7) and screw the cap screws into the vane threads finger tight.
3. Start the dowels (4) into their holes, ensuring that the short dowel is fitted in the hole indicated by the arrow. With a socket wrench tighten the six cap screws so that the vane is in firm contact with the barrel wall.
4. Using a heavy hammer and punch, drive in each dowel until it contacts the shoulder in the vane. As a guide, the heads of the long dowels should then be 0.5in. (12.7mm) below the barrel surface. The short dowel head should be 0.8in. (20mm) below the surface.
5. Tighten each of the six cap screws to a torque of 87 lbf-ft. (12 mkg).
6. Using a wire brush, clean out the old LOCTITE from the threads of the tapered plugs. Run a 1/2in. BSPF tap through the threads in the barrel and blow out the old LOCTITE with an air jet. Apply fresh LOCTITE Hydraulic Seal to the plug threads, screw in and tighten to a torque of 45 lbf-ft. (6,2 mkg). Allow a curing time of two hours before applying pressure to the actuator.

CUSHIONING VALVES**Removal**

9F/9

The cushioning valves can be removed with the actuator assembled on the machine. Remove the valves as detailed below and keep the parts together as two separate sets.

1. Disconnect the supply pipes from the actuator shaft then remove the adaptors from the ports.
2. (Fig. 17) Lift out the end stop (1) located on the spring guide spigot (2). Measure the distance between the top surface of the collar (3) and the top face of the shaft. This will enable the same spring compression to be maintained on re assembly. Using the cushioning valve spanner MF.342 unscrew and remove the collar.
3. With a pair of long nosed pliers withdraw the spring guide (2) and spring (4).
4. Using the special tool MF.342 unscrew the sleeve retainer (5).
5. Screw special tool MF.344 into the threaded hole in the end of the spool valve (6). Withdraw the spool from its bore in the sleeve.
6. Bend a piece of 12 SWG wire into the shape of an outside caliper as in (Fig. 18), so that the two legs can be inserted in the two radial holes in the top of the sleeve (7) withdraw the sleeve complete with its two O-rings (8).
7. With the same piece of wire withdraw the O-ring (9) located in the bottom of the shaft bore.

CUSHIONING VALVES**Replacement**

9F/10

Clean the spool and sleeve and ensure that the radial ports are clear of obstructions. Examine the spool surface and sleeve bore for scoring; if badly scored renew both parts.

Check that the spool slides freely in the sleeve bore.

1. (Fig. 17) Lubricate the O-rings with the mineral base grease and place the loose O-ring (9) in the bottom of the shaft bore. The other two O-rings (8) are fitted in the grooves in the sleeve, (7) the smaller diameter ring going in the groove nearest the chamfered end of the sleeve.
2. Lightly oil the sleeve and slide it, chamfered end leading, down into the shaft bore on to the O-ring. Press on the sleeve with a suitable tool to ensure it is fully home in the bore.
3. Screw in the sleeve retainer, (5) slotted side outwards and tighten firmly against the sleeve with the special tool MF.342.
4. Screw the tool MF.344 into the spool, (6) insert the spool in the sleeve, check that it slides freely and

CUSHIONING VALVES

... Cont'd

withdraw. Locate the two spring-loaded pegs of special tool MF.343 in the retainer slots. Give the head of the punch two or three sharp blows with a hammer to peen the thread and lock the retainer. Remove the punch.

5. Finally insert the spool and unscrew the threaded rod.
6. Fit the spring (4) over the spring guide (2) and, with the guide spigot outwards, slide the guide into the shaft bore ensuring that it locates inside the retainer.
7. Using the special tool MF.342 screw in the collar (3) to the dimension noted before dismantling. Give the head of the tool two or three sharp blows with a hammer to peen the thread and lock the collar.
8. Remove the tool, place the end stop (1) over the spigot on the spring guide and refit the pipe connection adaptor.

CUSHIONING VALVES

Adjustment

9F/11

1. Disconnect the pipe and remove the pipe union above the cushioning valve to be adjusted.
2. Lift out the spring stop and fit the special tool MF.342 into the slots in the collar.
3. Turn the tool $\frac{1}{2}$ turn clockwise to increase the spring compression, or $\frac{1}{2}$ turn anti-clockwise to decrease it. Remove the tool, replace the spring stop and refit the pipe union and pipe.
4. Repeat the performance test and adjust further as necessary, in $\frac{1}{2}$ turn increments, until the correct performance is obtained.
5. When the correct performance has been obtained, disconnect the pipe and remove the pipe union and spring stop. Locate special tool MF.342 in the collar slots and give the head of the tool two or three sharp blows with a hammer to peen the thread and lock the collar. Remove the tool, replace the spring stop and refit the pipe union and pipe.

CROSS LINE RELIEF VALVE

General

9F/12

The two relief valves are located in threaded bores in the ported end cover. Both valves are identical and are built in capsule form so that they can be renewed as an assembly.

RELIEF VALVE CAPSULE

Renewal

9F/13

1. Using a 0.75in. A/F spanner on the body hexagon unscrew the relief valve capsule from the end cover.
2. On the replacement capsule, lubricate the O-ring in the valve body groove with mineral-base grease and ensure that the bonded seal is in position against the hexagon shoulder.
3. Screw the capsule into the end cover and tighten to a torque of 55 to 60 lbf-ft. (7,6 to 8,3 mkg).

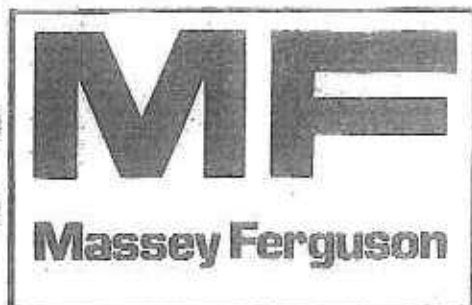
RELIEF VALVE

Disassembly

9F/14

The relief valves can be dismantled for cleaning and inspection of the parts, but means must be available for checking and, if necessary, resetting the pressure after installation on the machine.

1. (Fig. 19) Clamp the hexagon head of the body in a soft-jawed vice.
2. Remove the circlip (1) and lift out the ball and cup sub-assembly (2).



MF Industrial Limited

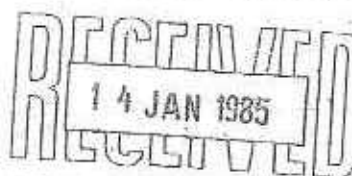
Barton Dock Road, Stretford, Manchester M32 0YH, England
Telephone: Manchester (061) 865 4400 Telex: 667145

Distribution

UK/Db/IM

No. 50D/2200/10
50B/2200/53
50/2200/5

Date 26.11.84



MF50D AND MF50B DIGGERS

ROTARY ACTUATOR SHAFT END PLATES

ADVICE

In order to reduce the cost of servicing the Dowty Rotary Actuator shaft, a shaft end plate kit Part No. 1810 767M91 has been made available. The kit consists of:

- 1 off - Shaft end plate
- 4 off - Cap screws
- 2 off - Sel Loc dowel pins

In the event of a rotary actuator shaft failure where the shaft end plate requires renewal the following instructions MUST BE STRICTLY ADHERED to:

1. Remove the shaft from the actuator as detailed in the MF50D Workshop Manual Section 8C-02-08.
2. Unscrew the 4 Alan cap screws holding the shaft end plate to the shaft vane.
3. Using a suitable extractor remove the 2 sel loc dowel pins. Then lift off the shaft end plate.
4. Matching Procedure

WARNING

- a. Carefully position the old plate directly on top of the new plate. This means the old plate will have the counterbore facing upwards and so will the new plate underneath.
- b. Using 4 off 5/16 UNF x 1½" long cap screws and nuts, secure the plates together ensuring that the vac seal grooves match PERFECTLY.
- c. Using the top plate as a pilot enter a 5/16" drill bit into the dowel hole and carefully drill out the holes in the new bottom plate.
- d. With both plates still bolted together it will be evident that the new plate has a much longer overall length. It is EXTREMELY IMPORTANT that the new plate is machined to be the same dimension as the old one by removing the step so that it becomes identical to the old plate.

-2-

e. Unbolt the two plates.

5. Cleaning and new plate fitting procedure

- a. Thoroughly clean and degrease the dowel and cap screw bores in the shaft and new plate.
- b. Apply Loctite 275 to the thread of the 4 new cap screws supplied in the kit and then coat the mating surfaces of the new end plate and the shaft with the same Loctite.
- c. Fit the end plate to the shaft and screw in the 4 cap screws finger tight.
- d. Fit the new Sel Loc dowel pins ensuring that they do not stand above the upper surface of the plate.
- e. Torque the cap screws diagonally to 22 U ft.

6. Final checking instructions

- a. Place a straight edge along the complete length of the shaft vane and both end plates close to the seal groove. Using feeler gauges ensure that the end plates do not stand out more than an absolute maximum of 0.003". In the event that the plates stand out more than 0.003", dress the plate accordingly.

WARNING

FAILURE TO COMPLY WITH THESE INSTRUCTIONS WILL RESULT IN EXCESS WEAR OF SEALS AND BARREL.

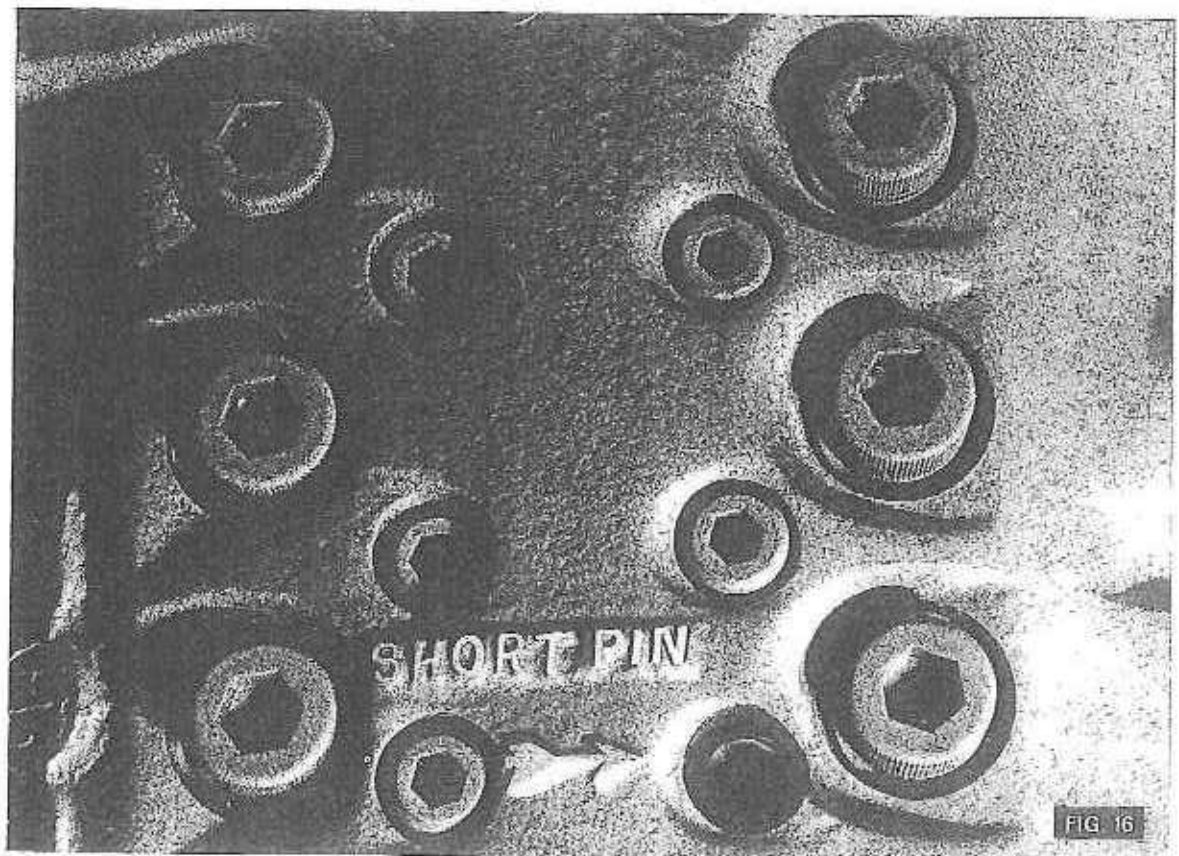
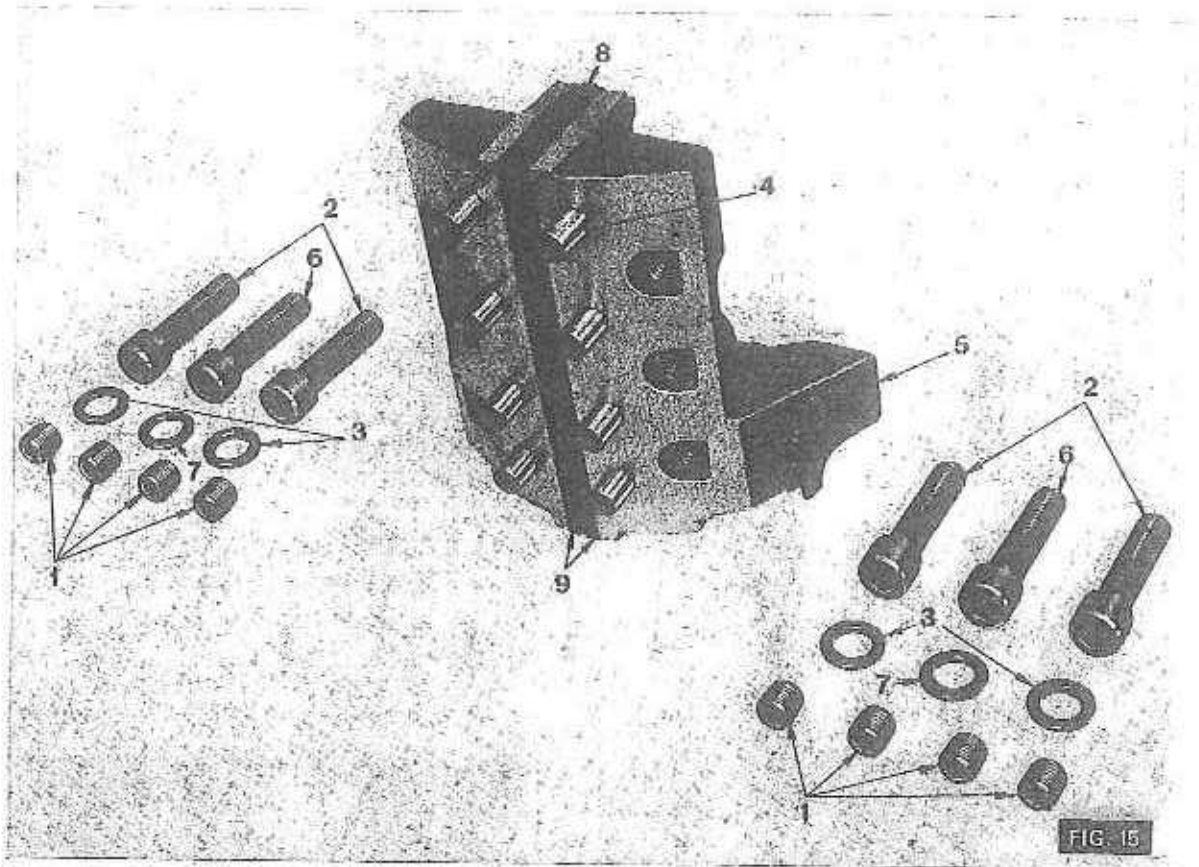
7. Reassembly

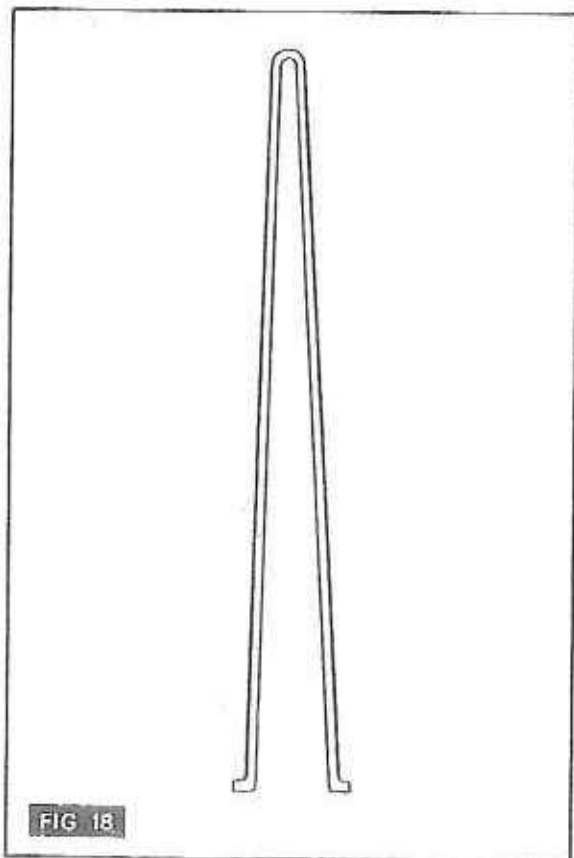
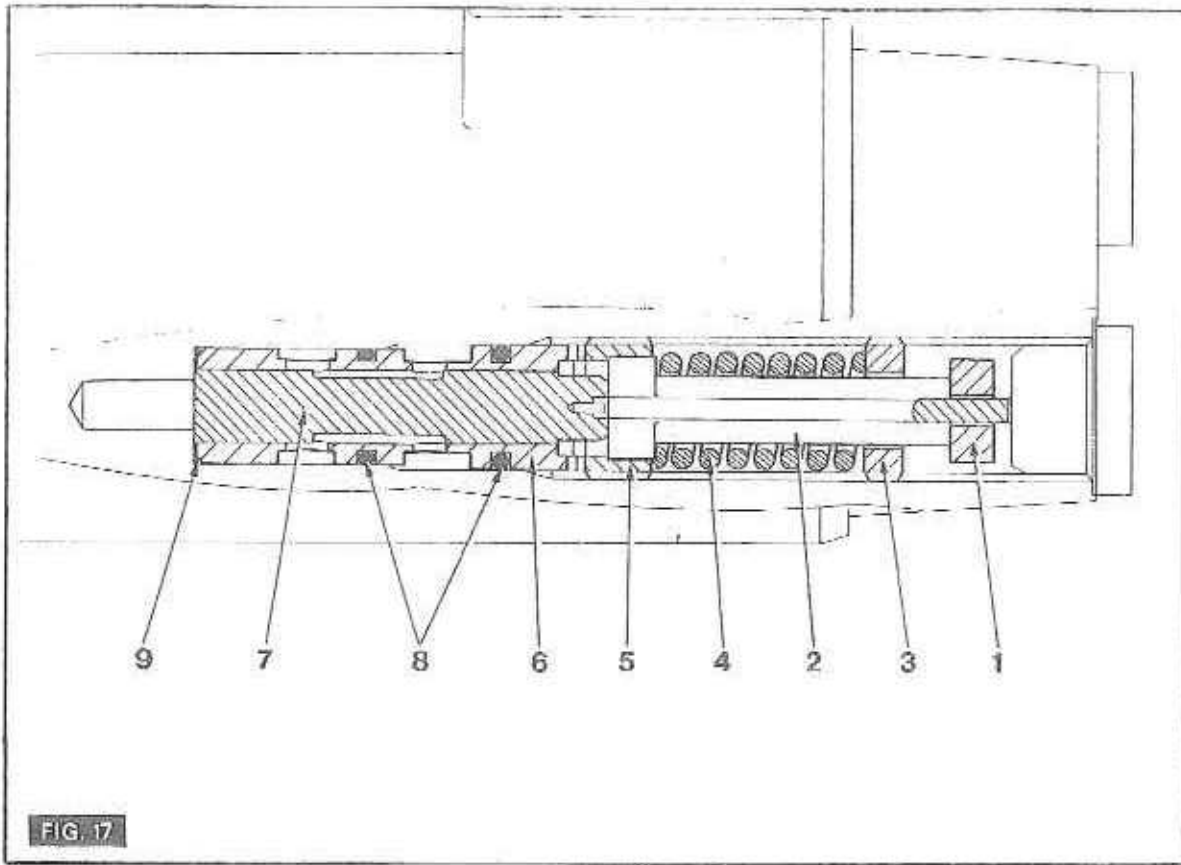
Continue as described in the MF50D Workshop Manual Section 8C-02-10.

Administration

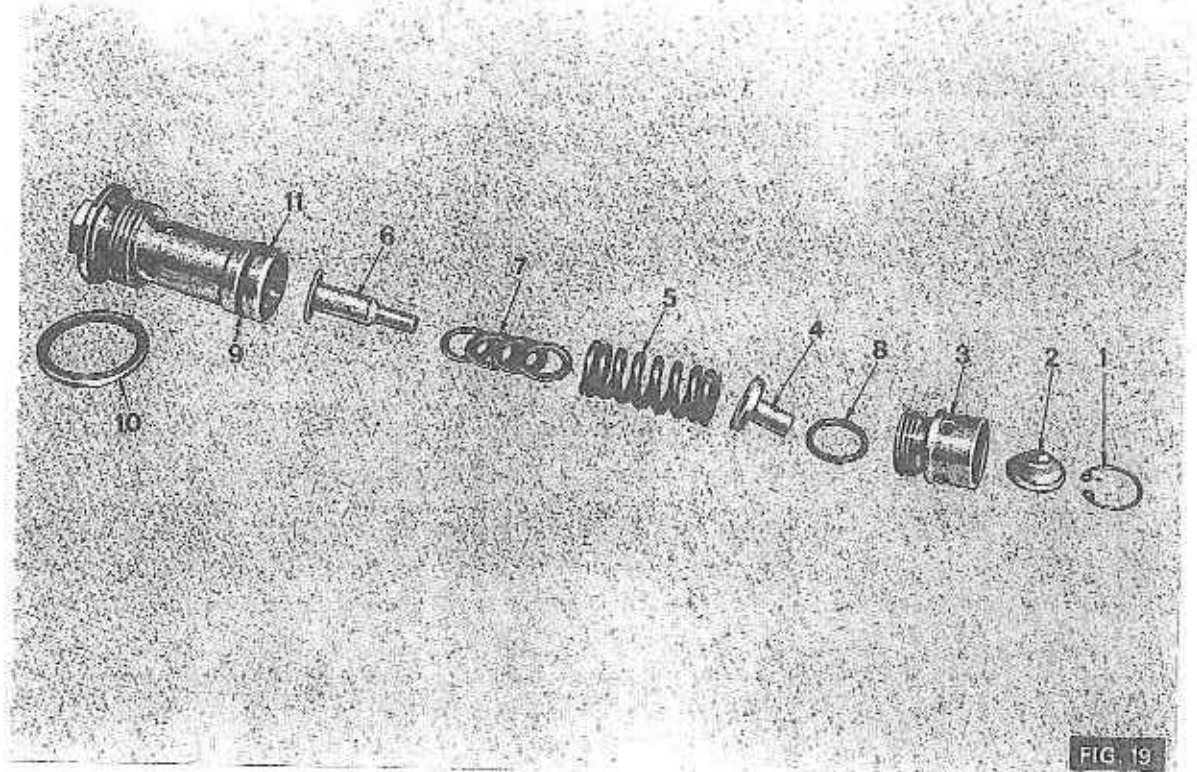
This Bulletin is issued for technical information only and does not constitute authority for mandatory replacement and Warranty claim submission.

GERARD COLLIER

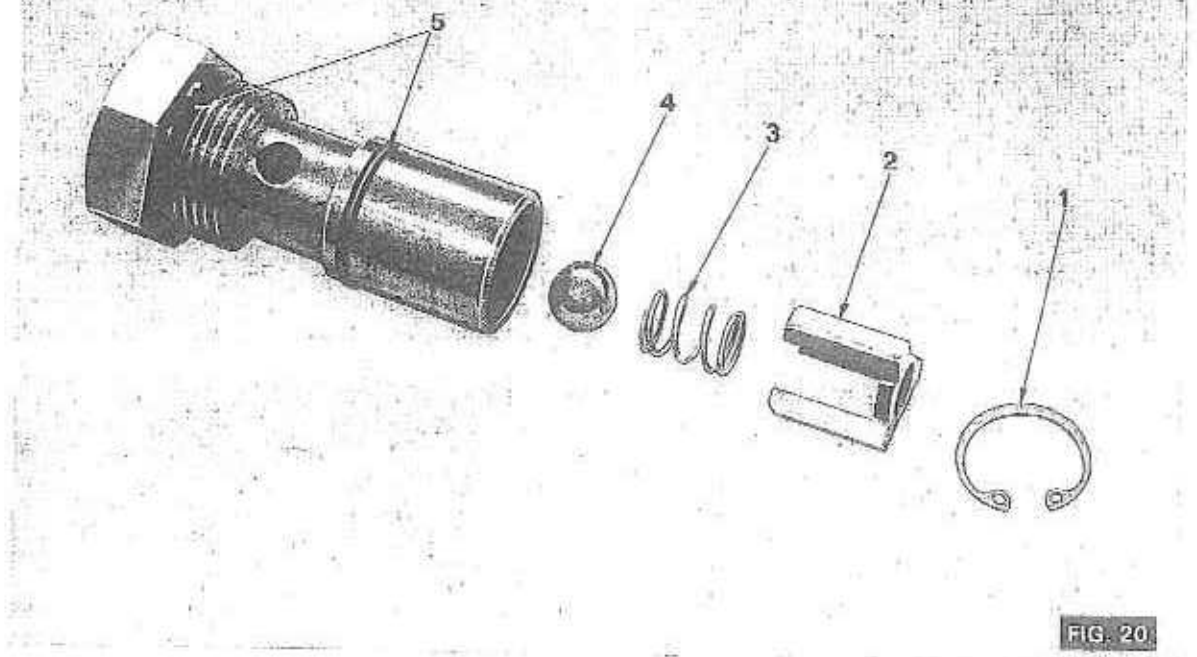




CROSS-LINE RELIEF VALVE x 2. in side of Top cover



CHECK VALVE x 2. in Top of Top cover. on nearly all 500
not used on all 500
but is internally fitted to underside
of top plate





RELIEF VALVE**Disassembly . . . Cont'd**

3. Pass a bar through the radial holes in the retainer (3) and unscrew the retainer from the body. Slide the valve seat (4) out of the retainer.
4. Withdraw the spring, (5) spring guide (6) and shim(s), (7).

Clean all parts thoroughly, examine for damage and renew as necessary.

RELIEF VALVE**Reassembly**

9F/15

New oil seals should be fitted on re-assembly. Lubricate the seals with thin, mineral-base grease before fitting.

1. (Fig. 19) Place the shim(s) (7) against the shoulder of the spring guide (6) and slide the spring over the stem of the guide. Insert these items in the body. (11).
2. Renew the O-ring and spiral backing ring located in the internal recess in the retainer. The backing ring must be positioned adjacent to the small diameter end of the retainer. Slide the seat into the retainer.
3. Fit a new O-ring (8) around the shoulder of the retainer below the thread and screw the retainer into the body. Tighten to a torque of 10 to 15 lbf-ft. (1,4 to 2 mkg).
4. Replace the ball and cup sub-assembly (2) and secure with the circlip. (1).
5. Fit a new O-ring (9) in the external groove in the body and a new bonded seal (10) beneath the hexagon shoulder.

RELIEF VALVE**Adjustment**

9F/16

1. Remove the relief valve from the actuator.
2. Dismantle the valve as described in Operation. 9F/14
3. To increase the pressure setting add a shim to the guide, conversely, subtract a shim if the pressure setting is to be reduced. The addition or subtraction of one 0.010in. shim will alter the setting approximately 100lb./in² (7kgf/cm²).
4. Reassemble the relief valve as stated in Operation. 9F/15
5. Replace the valve in the actuator and tighten to a torque of 55 to 60 lbf-ft. (7,6 to 8,3 mkg).

CHECK VALVES**Removal and Disassembly**

9F/17

The two check valves are located in threaded ports on top of the ported end cover.

To dismantle a check valve:

1. (Fig. 20) Unscrew the valve from the end cover using a 1.3/8in. A/F spanner.
2. Remove the circlip (1) and withdraw the spring cage, (2) spring (3) and steel ball. (4).

Examine the parts for damage, particularly the ball and its seat in the body. The ball must be free from pitting and the seating face smooth and free from indentations.

CHECK VALVES**Reassembly and Replacement****Reassembly**

9F/18

1. (Fig. 20) Lubricate two new O-rings (5) with thin mineral-base grease and place in the external grooves in the body.
2. Place the ball (4) on the seat and fit the spring (3) and spring cage (2) over it. Retain by fitting the circlip. (1).
3. Screw the complete unit back into the end cover and tighten to a torque of 60 lbf-ft. (8,5 mkg).

HYDRAULIC RAMS



CONTENTS

	Page
GENERAL	4
LIFT RAM—LOADER, Removal and Replacement (9G/1)	4
LIFT RAM—LOADER, Disassembly (9G/2)	4
LIFT RAM—LOADER, Reassembly (9G/3)	5
BUCKET RAM—LOADER, Removal and Replacement (9G/4)	5
BUCKET RAM—LOADER, Disassembly (9G/5)	5
BUCKET RAM—LOADER, Reassembly (9G/6)	5
BOOM RAM, Removal (9G/7)	6
BOOM RAM, Replacement (9G/8)	6
BOOM RAM, Disassembly (9G/9)	6
BOOM RAM, Reassembly (9G/10)	7
DIPPERSTICK RAM, Removal and Replacement (9G/11)	8
DIPPERSTICK RAM, Disassembly (9G/12)	8
DIPPERSTICK RAM, Reassembly (9G/13)	8
BUCKET RAM, Removal and Replacement (9G/14)	8
BUCKET RAM, Disassembly (9G/15)	8
BUCKET RAM, Reassembly (9G/16)	9
CLAMPING CYLINDER, Removal and Replacement (9G/17)	9
CLAMPING CYLINDER, Disassembly and Reassembly (9G/18)	10
STABILIZER RAM, Removal and Replacement (9G/19)	10
STABILIZER RAM, Disassembly (9G/20)	10
STABILIZER RAM, Reassembly (9G/21)	10

LIST OF ILLUSTRATIONS

	Facing Page
Fig 1 GENERAL ARRANGEMENT	4
Fig 2 LIFT RAM BEARING NUT, Removal	4
Fig 3 LIFT RAM BEARING NUT, Driven into Cylinder	4
Fig 4 LIFT RAM LOCK RING, Extraction	4
Fig 5 LIFT RAM PISTON ROD ASSEMBLY, Breakdown	5
Fig 6 LIFT RAM BEARING ASSEMBLY, Breakdown	5
Fig 7 BUCKET RAM, Section	5
Fig 8 BOOM RAM, Removal	5
Fig 9 BOOM RAM, Replacement	5
Fig 10 BOOM RAM, Section	8
Fig 11 DIPPERSTICK RAM, Removal	8
Fig 12 BUCKET RAM, Removal	9
Fig 13 BUCKET RAM TUB GUARD	9
Fig 14 BUCKET RAM, Section	9
Fig 15 CLAMP CYLINDER, Removal	10
Fig 16 CLAMP CYLINDER, Section	10
Fig 17 STABILIZER LEG AND FRAME, Section	10
Fig 18 STABILIZER RAM, Section	11

HYDRAULIC RAMS

GENERAL

Hydraulic fluid is directed in the loader system by means of a two spool valve, to either the lift rams or the bucket rams. The lift rams are attached to the beam and the base of the vertical pivot post by means of pivot pins which are retained by split pins. One end of each of the bucket rams is also connected by pivot pins and split pins to the top of the pivot post. The rod end of each ram is connected to a main transfer lever fitted to each arm of the beam.

When a digger is attached the oil flow is passed through the two spool control valve and out through the pressure beyond point to the digger hydraulic system.

The flow of hydraulic oil is directed to the various digger rams by means of a seven spool valve. Each ram is secured with pivot pins and split pins and is supplied with oil through flexible pipes.

The hydraulic rams are identified in Fig. 1.

Key to Fig 1

1. Loader Lift Rams.
2. Loader Bucket Rams.
3. Digger Bucket Rams.
4. Digger Dipperstick Rams.
5. Digger Boom Rams.
6. Digger Clamping Cylinders.
7. Digger Stabilizer Rams.

LIFT RAM - LOADER

Removal and Replacement

(9G/1)

The procedure for removing either the left hand or right hand ram is exactly the same.

1. Position the loader with the bucket resting on the ground. Check that no pressure remains in the circuit by moving the control levers several times.
2. Disconnect the flexible hydraulic pipes from the ram. Ensure that no foreign matter enters the pipes when disconnected.
3. Remove the split pin from the pivot pin on the piston rod end of the ram and tap the pivot pin out. Lower the ram until it rests on the front axle beam of the tractor.
4. Remove the split pin from the pivot pin at the cylinder end of the ram and tap out the pivot pin.
5. The ram can now be lifted clear for the examination and servicing.
6. To replace the ram reverse the above procedure.

Disassembly

(9G/2)

1. Remove the lift ram as stated in operation 9G/1.
2. Hold the ram assembly securely in a suitable clamp or vice.
3. (Fig. 2) With a 'C' Spanner, turn the bearing nut (1) in an anti-clockwise direction, remove and pull to the end of the piston rod.
4. (Fig. 3) Tap the bearing approximately 1½" into the barrel to allow removal of the lock ring.
5. (Fig. 4) Using a screw driver extract the lock ring.
6. Withdraw the piston rod assembly from the barrel.
7. (Fig. 5) Clamp the piston rod assembly securely in a vice. Remove the nut (1), packing retainer (2), piston packing set (3), 'O' ring (4) and retainer washer (5).

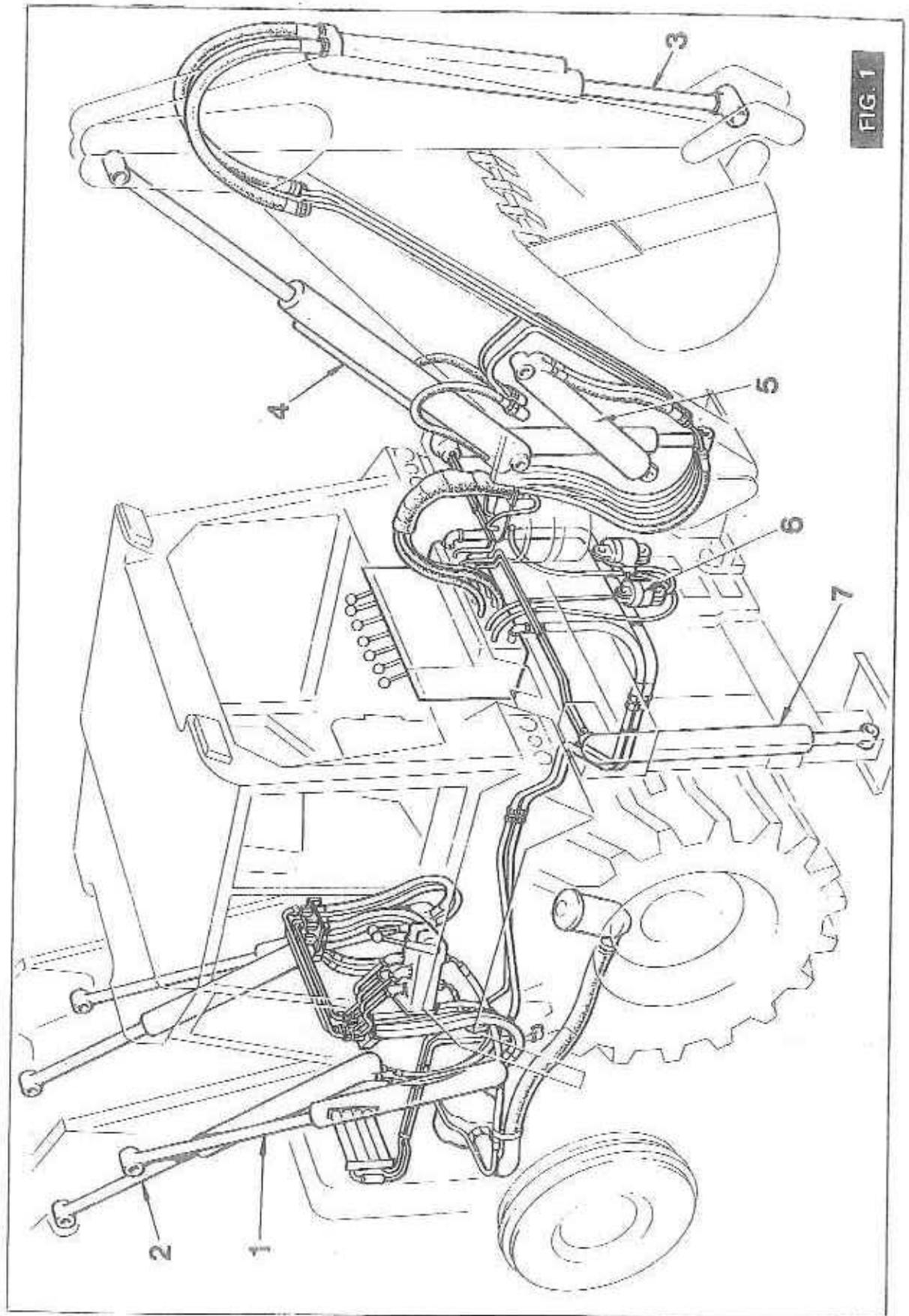
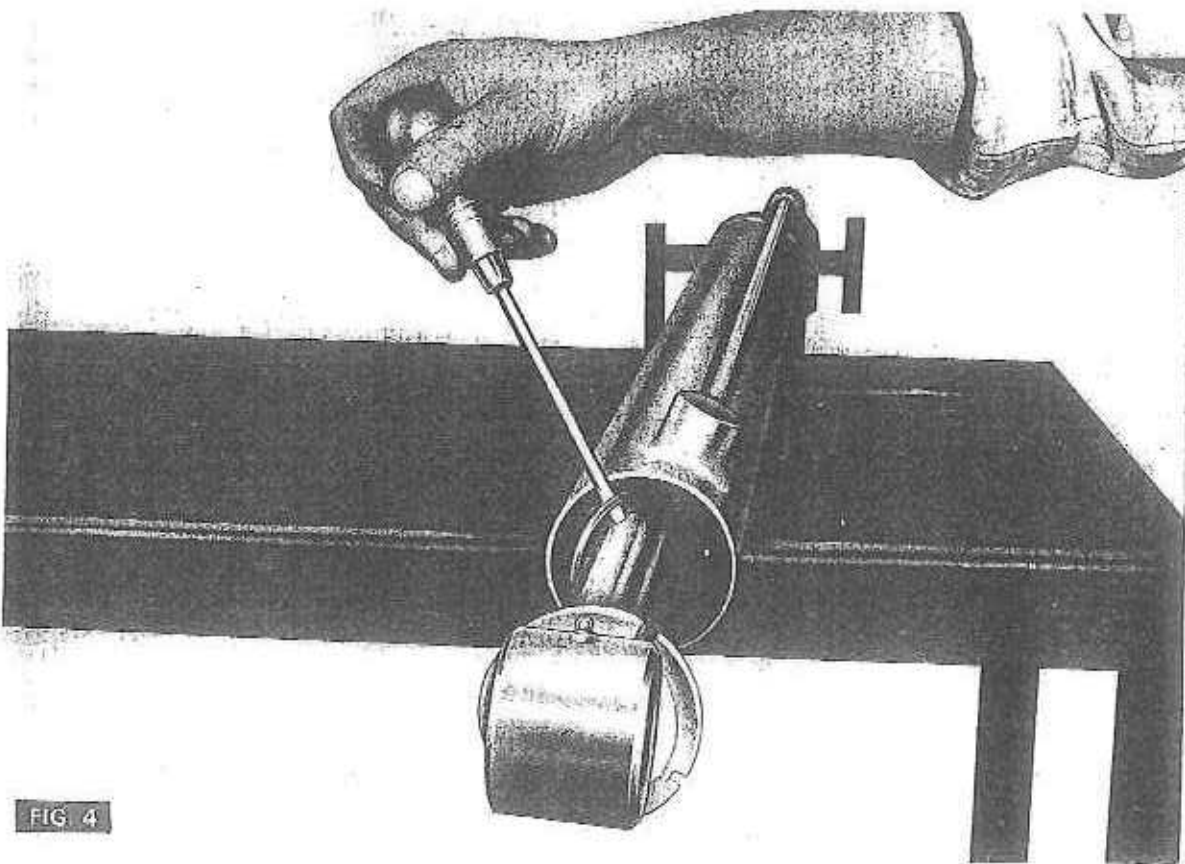
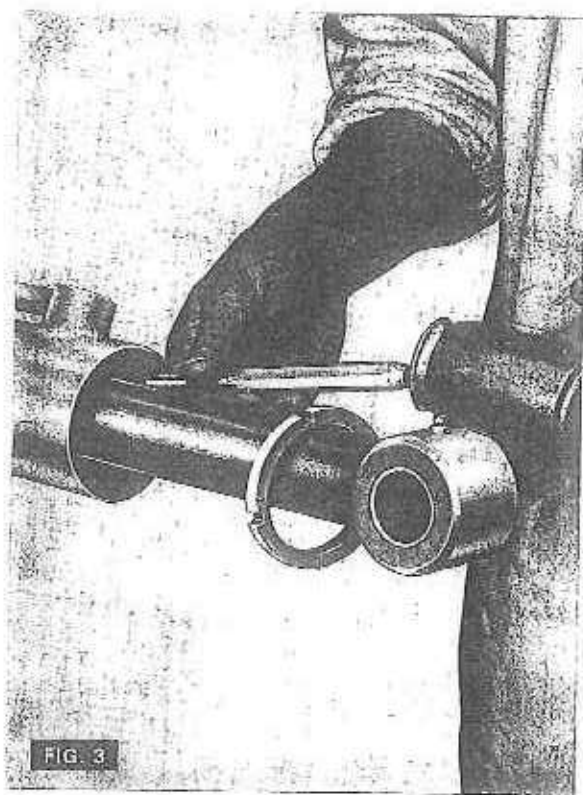
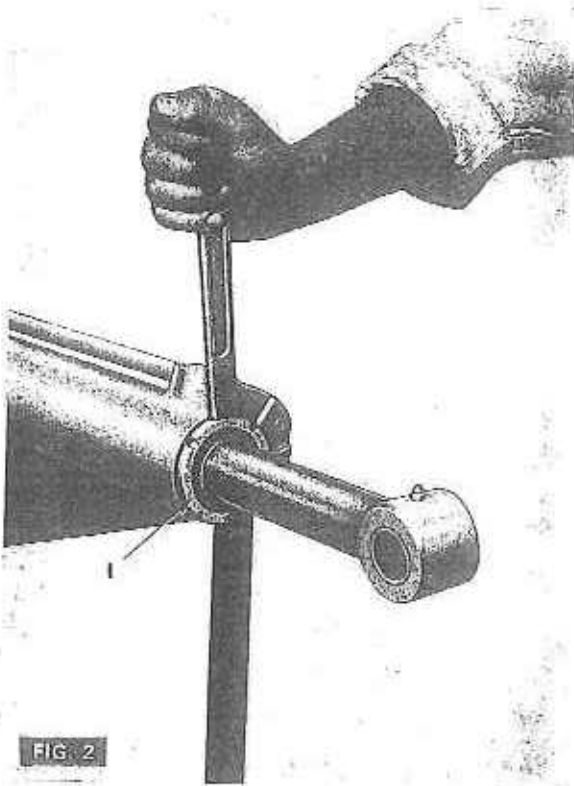
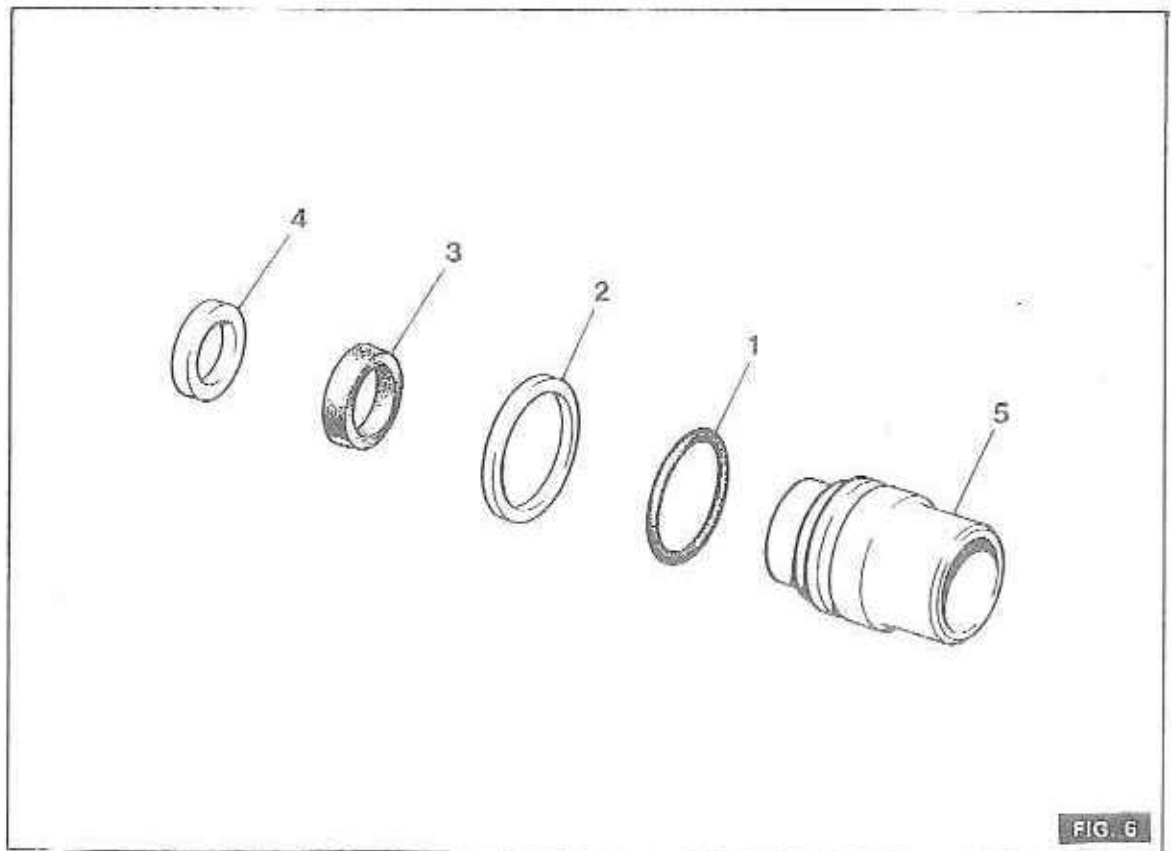
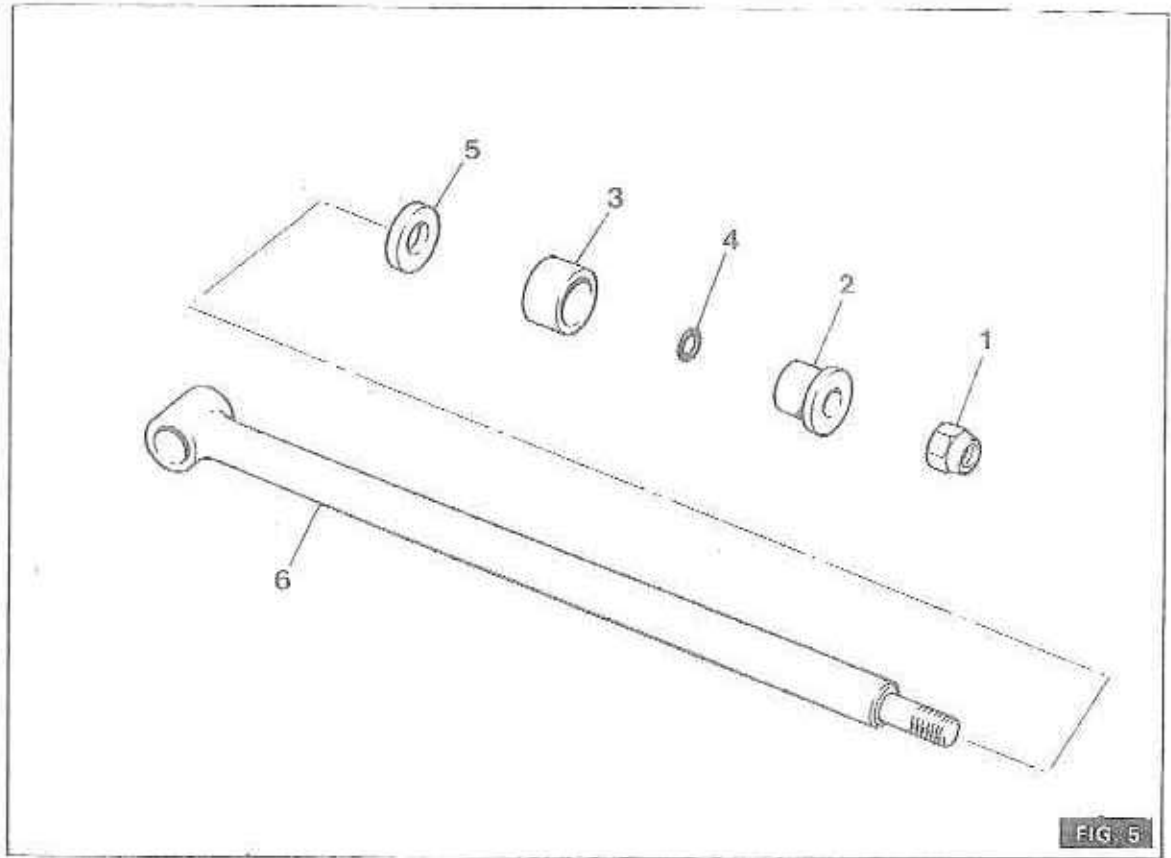
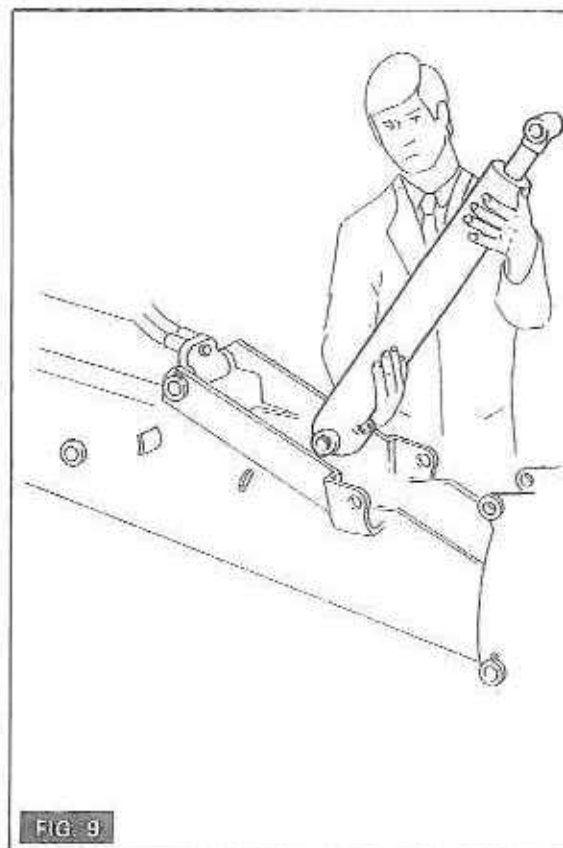
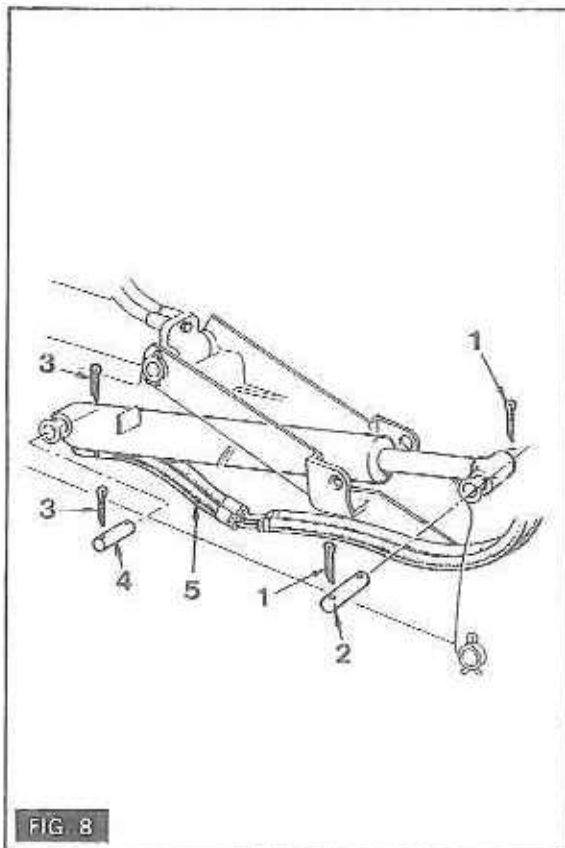
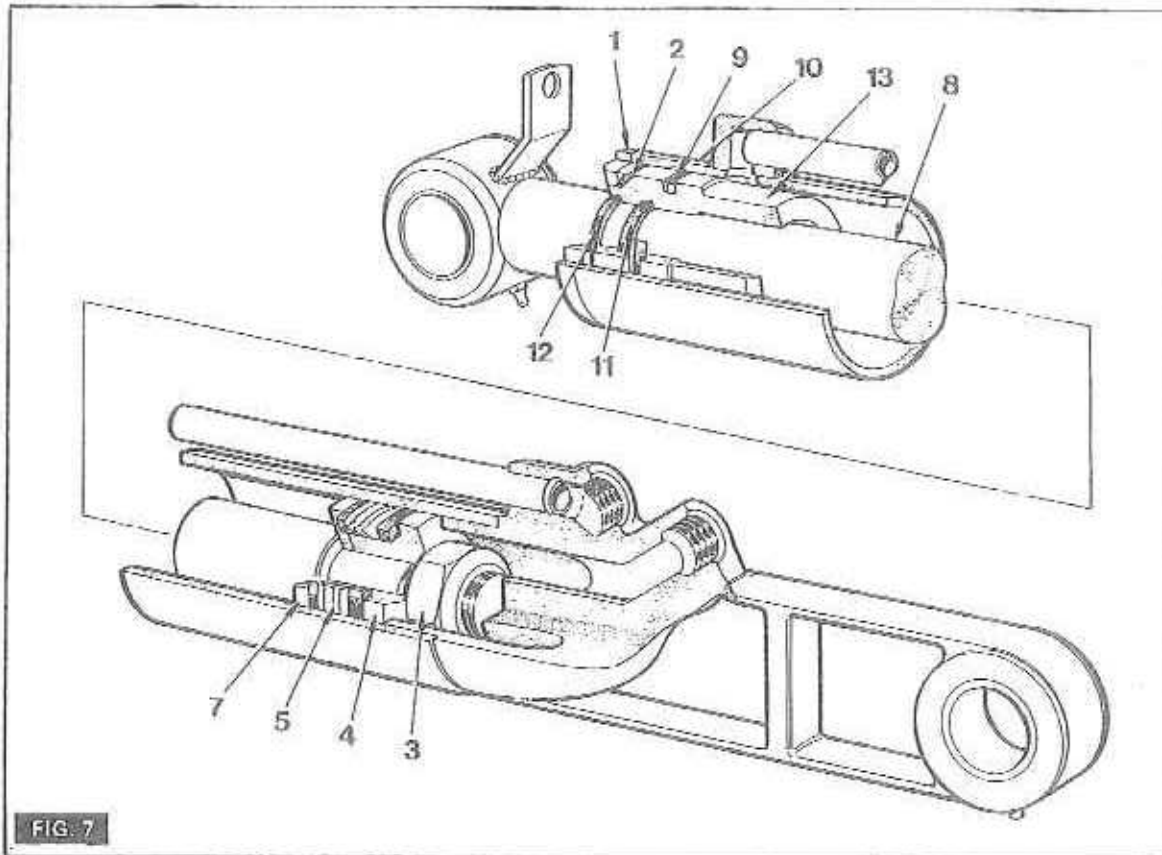


FIG. 1







LIFT RAM - LOADER

Disassembly . . . Cont'd

8. (Fig. 6) Slide the bearing assembly off the rod. Remove the 'O' ring (1) back up washer (2) and seals (3) (4) from the body (5).

Reassembly

(9G/3)

1. Examine all component parts of the assembly for excessive wear or damage. Thoroughly clean all parts.
2. Slide the bearing nut and lock ring onto the piston rod.
3. (Fig. 6) Fit new 'O' ring (1), new back up washer and new seals (3), (4) to body (5).
4. Lubricate the piston rod with clean hydraulic oil and slide the bearing assembly onto the rod.
5. (Fig. 5) Fit retainer washer (5), new packing (3), new 'O' ring (4) and packing retainer (2). Secure with nut (1) and torque to 300 - 330 lb.ft. (41.49 - 45.63 kg.m.).
6. Lubricate the 'O' rings and seals then insert the piston and rod assembly into the barrel, taking care not to damage the seals.
7. Push the bearing assembly into the barrel far enough to allow the lock ring to be replaced.
8. Withdraw the piston rod against the bearing thus forcing the bearing up to the locking ring. Fit the bearing nut and tighten to a torque of 160/180 lb.ft. (22.13 - 24.89 kg.m.).
9. Replace the lift ram as described in operation 9G/1.

BUCKET RAM - LOADER

Removal and Replacement

(9G/4)

The procedure for removing either the left hand or right hand ram is exactly the same except that if a bucket levelling indicator is fitted to the left hand ram it will have to be removed before the following procedure can be commenced.

1. Set the loader with the bucket crowded and resting on the ground.
2. Disconnect the flexible hydraulic pipes from the ram. Ensure that no foreign matter enters the pipes when disconnected.
3. Remove the split pin from the pivot pin on the piston rod end of the ram and lower the ram until it rests on the front axle beam of the tractor.
4. Remove the split pin from the pivot pin at the cylinder end of the ram and tap out the pivot pin.
5. The ram can now be removed for examination and servicing.

Disassembly

(9G/5)

1. Remove the bucket ram as stated in operation 9G/4.
2. Hold the ram assembly securely in a suitable clamp or vice.
3. (Fig. 7) With a 'C' spanner turn the bearing nut (1) in an anti-clockwise direction, remove and pull to the end of the piston rod.
4. Tap the bearing approximately 1½" into the barrel to allow removal of the lock ring (2).
5. Using a screw driver extract the lock ring.
6. Withdraw the piston rod assembly from the barrel.
7. Clamp the piston rod assembly securely in a vice. Remove the nut (3) packing retainer (4), piston packing set (5) 'O' ring (6) and retainer washer (7).
8. Slide the bearing assembly off the rod (8). Remove the 'O' ring (9), back up washer (10) and seals (11), (12) from the body (13).

Reassembly

(9G/6)

1. Examine all component parts for excessive wear or damage. Thoroughly clean all parts.

BUCKET RAM - LOADER

Reassembly . . . Cont'd

2. (Fig. 7) Slide the bearing nut (1) and lock ring (2) onto the piston rod (8).
3. Fit new 'O' ring (9), new back up washer (10) and new seals (11), (12) to the bearing body (13).
4. Lubricate the piston rod with clean hydraulic oil and slide the bearing assembly onto the rod.
5. Fit retainer washer (7), new packing (5) new 'O' ring (6) and packing retainer (4). Secure with nut (3) and torque to 250 - 275 lb.ft. (34.58 - 38.03 kg.m.).
6. Lubricate the 'O' rings and seals then insert the piston and rod assembly into the barrel, taking care not to damage the seals.
7. Push the bearing assembly into the barrel far enough to allow the lock ring (2) to be replaced.
8. When the lock ring has been replaced withdraw the piston rod against the bearing thus forcing the bearing up to the lock ring. Fit the bearing nut and tighten to a torque of 80 - 100 ft.lb. (11.06 - 13.83 kg.m.).
9. Replace the bucket ram as described in operation 9G/4.

BOOM RAM - DIGGER

Removal

(9G/7)

1. Fully extend the boom ram parallel to the floor.
2. (Fig. 8) Remove the split pins (1) from both ends of boom attaching pin.
3. Remove the pin.
4. Contract the boom ram by using the control valve lever.
5. Remove split pin (2) and drive out the pin (3) to release the ram from the swivel casting.
6. Lift the ram into a standing position and disconnect the flexible hoses (4). To ensure correct reconnection of hoses, attach and identify Tie-on labels to the hoses before disconnecting.
7. Lift the boom ram from the boom.

Replacement

(9G/8)

1. Lay a thin plank of wood, approximately the same length as the ram, along the top of the four rigid pipes inside the boom.
2. (Fig. 9) Stand the ram inside the boom, hoses towards the tractor, connect the hoses in accordance with the tie on labels. The embossed arrow head on the ram head should also be on the front face of the ram head, while the ram is in the standing position.
3. Slide the head end of the ram into the boom and align the ram attachment hole with the boom attachment holes, using the plank of wood as a lever to obtain horizontal alignment of the holes.
4. Insert the attachment pin, ensure that split pin holes are correctly aligned.
5. Insert and secure a split pin through each end of the attachment pin.
6. Start the tractor engine and select boom lower on the controls, to extend the ram to engage with the pivot post clevis.
A precise final alignment between pivot post and ram rod may be obtained by raising or lowering the boom on a lifting jack or hoist.
7. Insert the attachment pin, align the split pin hole, insert and secure the split pin.

Disassembly

(9G/9)

1. Remove the ram from the machine as stated in operation 9G/7
2. Hold the ram assembly securely in a suitable clamp or vice.
3. (Fig. 10) With a 'C' Spanner turn the bearing nut (1) in an anti-clockwise direction, remove it from the bearing and rest it on the piston rod.
4. Tap the bearing approximately 1 1/2" (38.1 mm) into the barrel to allow the removal of the lock ring (2).
5. Using a screw driver remove the lock ring and insert in its place special tool MF 327 to facilitate piston removal.
6. Withdraw the piston rod assembly from the barrel.

BOOM RAM - DIGGER

Disassembly . . . Cont'd

7. Clamp the piston rod assembly securely in a vice. Remove the nut (3), piston (4) complete with wear ring (5) and seal set (6) 'O' ring (7) and seal retainer (8).
8. Carefully withdraw the damping sleeve (9); remove retaining pin (10) from the sleeve.
9. Lift the spring (11) from the top of roll pin (12) withdraw roll pin (12) then roll pin (13).
10. Slide washer (14) from the piston rod.
11. Slide the bearing assembly off the piston rod then remove the bearing nut (1) and lock ring (2).
12. Remove the back up washer (15), 'O' ring (16), snap ring (17) and seal set (18) from the body (19).
13. Extract the wiper seal (20).
14. Remove the plug complete with 'O' ring (21), spring (22), shims (23), then withdraw the tube.
15. Remove 'O' ring (24) and back up washer (25) from the tube (26) then 'O' ring (27) and back up washer (28).

Note: If the same tube is to be re-used retain the shims.

Reassembly

(9G/10)

1. Thoroughly clean and dry all parts. Examine for excessive wear or damage.
2. All seals should be renewed as new parts.
3. (Fig. 10) Fit 'O' ring (27) and back up washer (28) to the tube (26), then 'O' ring (24) and back up washer (25).
4. Insert the tube then replace the shims (23). If new tube is to be fitted shim between the tube and spring to ensure a dimension of $1\frac{1}{4}'' \pm 1/32''$ (31.75 $\pm$ 0.793 mm) between the top of the shims and spot face of the plug (Fig10 Dimension A).
5. Replace spring (22) then refit plug (21) complete with new 'O' ring.
6. Reassemble the bearing (19) with the new back up washer (15) and new 'O' ring (16).
7. Refit a new wiper seal (20).
8. Refit a new seal set (18) and secure in position with the snap ring (17).
9. Slide the bearing lock nut (1) and lock ring (2) onto the piston rod.
10. Lubricate the piston rod with clean hydraulic oil and slide the bearing assembly onto the rod.
11. Fit the retaining washer (14) up to the shoulder in the rod then fit a new roll pin (13) into the hole in the rod and press to bottom of the hole.
12. Tap a new roll pin (12) into the roll pin (13) until $\frac{1}{4}'' \pm 1/32''$ (6.35 $\pm$ 0.793 mm) only protrudes above roll pin (13).
13. Fit stepped end of retaining pin (10) into hole in sleeve (9).
14. Position new spring (11) on top of roll pin (12). Hold spring compressed using a thin strip of metal then slide the sleeve onto the piston rod.
15. Slip the packing retainer (8) over the rod, push home until it meets the roll pins then rotate the retainer until the roll pins engage into the slot in the face of the retainer.
16. Fit a new 'O' ring (7) on the shaft close to the retainer.
17. Assemble the piston (4), new wear ring (5) and new seal set (6) then slide complete assembly onto the rod until the flat face meets the packing retainer.

Note :- The joint on the wear ring must be in line with the arrow head on the piston rod (Boom ram only).

18. Secure with the retaining nut (3) and torque to 350/375 lb.ft. (48.4 - 51.88 kg.m.).
19. Enter piston rod assembly into barrel ensuring that the arrows 'A' on the rod and barrel are aligned.
20. Push bearing into barrel far enough to allow the replacement of the lock ring (2).
21. When the lock ring has been fitted withdraw the piston rod against the bearing thus forcing the bearing up to the lock ring. Fit the bearing nut (1) and tighten to a torque of 275 - 300 ft.lb. (38.03 - 41.48 kg.m.).

Note :- The bearing nut should be tightened to the recommended torque on a test rig or after it has been refitted to the machine. Procedure is as follows :-

BOOM RAM - DIGGER

Reassembly . . . Cont'd

Note . . . Cont'd

Fully retract the ram and hold the control valve lever until R.V. pressure is obtained. While the bearing is under this pressure, tighten to the recommended torque.

DIPPERSTICK RAM

(9G/11)

Removal and Replacement

1. Completely extend the dipperstick arm, lower the boom until it is parallel to the ground with the bucket touching the ground.
2. (Fig. 11) Remove two split pins (1) and extract pin (2).
3. Remove two split pins (3) and extract pin (4).
4. Disconnect the hoses (5).
5. Remove the ram.
6. Replacement is a direct reversal of the above procedure.

Disassembly

(9G/12)

1. (Fig. 10) Remove the ram as stated in operation 9G/11.
2. Carry out items 2 to 7 and 11 to 15 of operation 9G/9.

Reassembly

(9G/13)

1. (Fig. 10) Carry out items 1 to 10 of operation 9G/10.
2. Replace the packing retaining washer (14) then carry out items 16 to 21 of operation 9G 10.

BUCKET RAM - DIGGER

Removal and Replacement

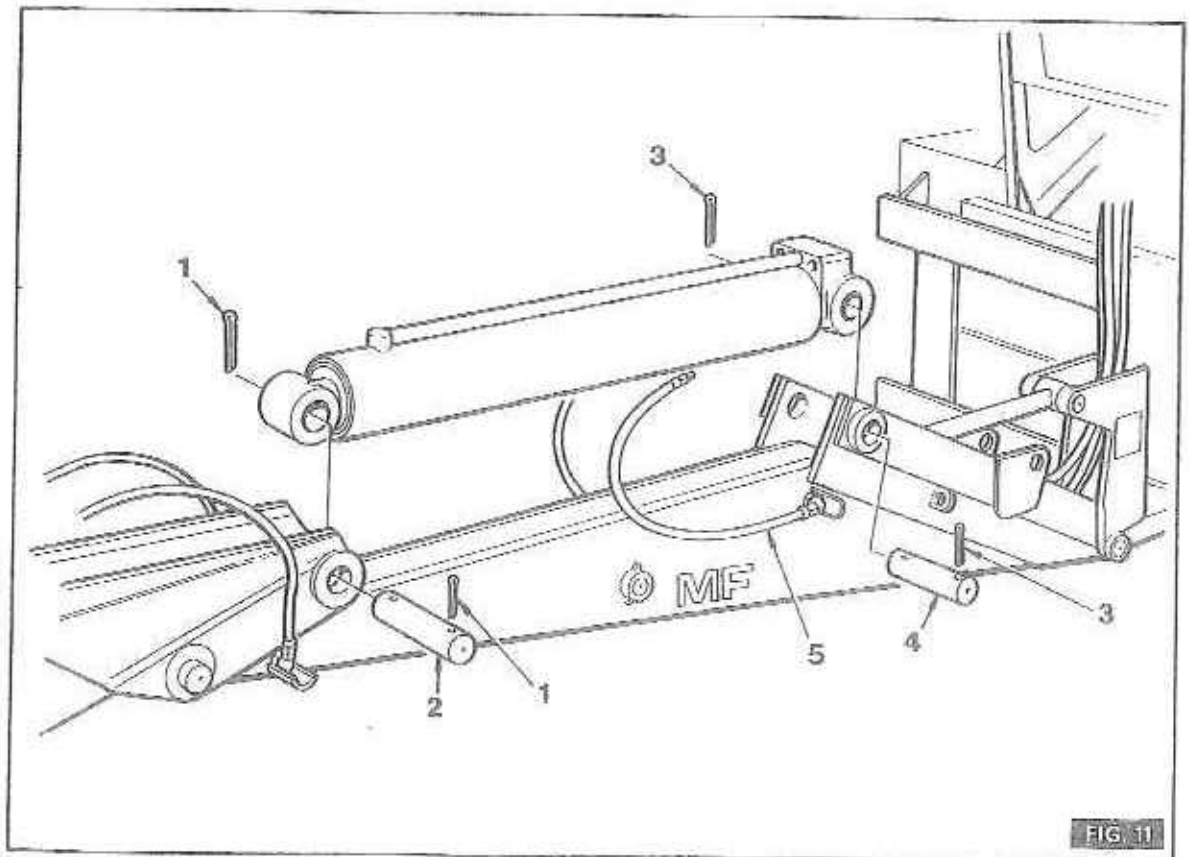
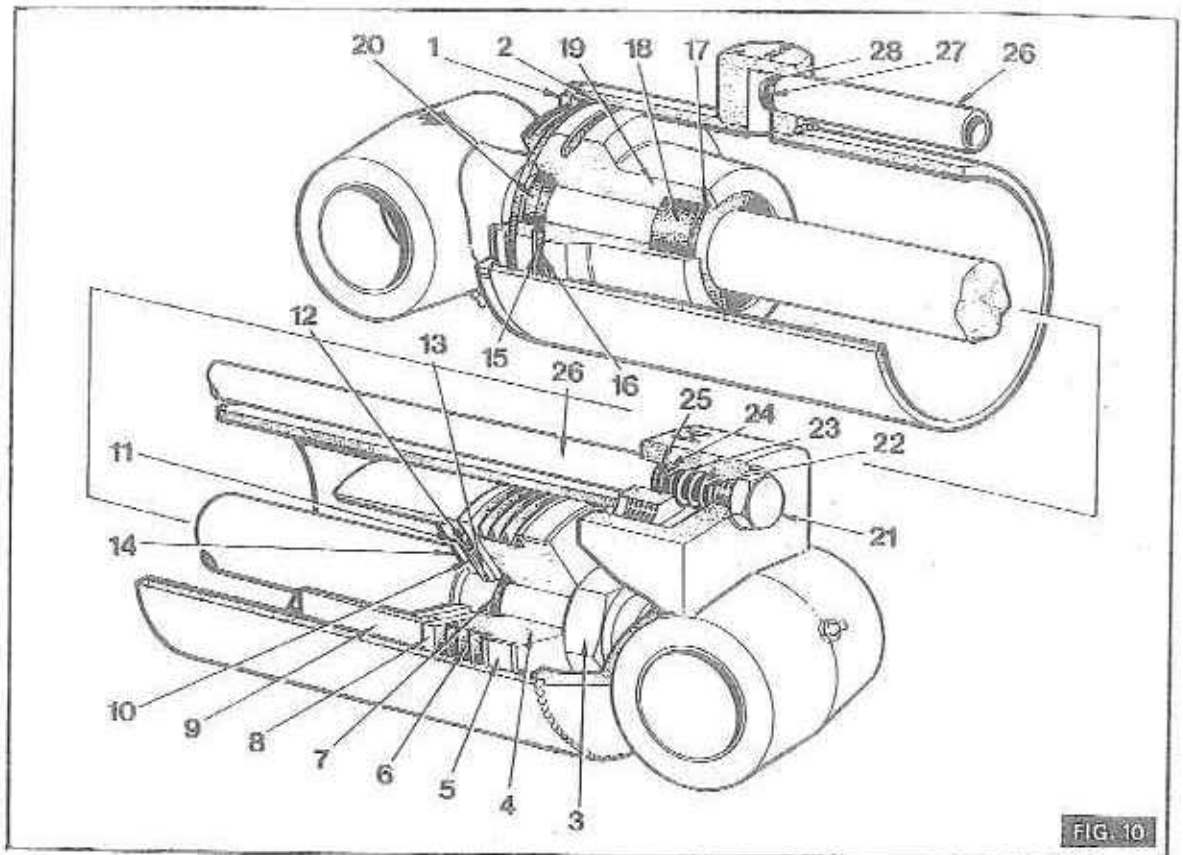
(9G/14)

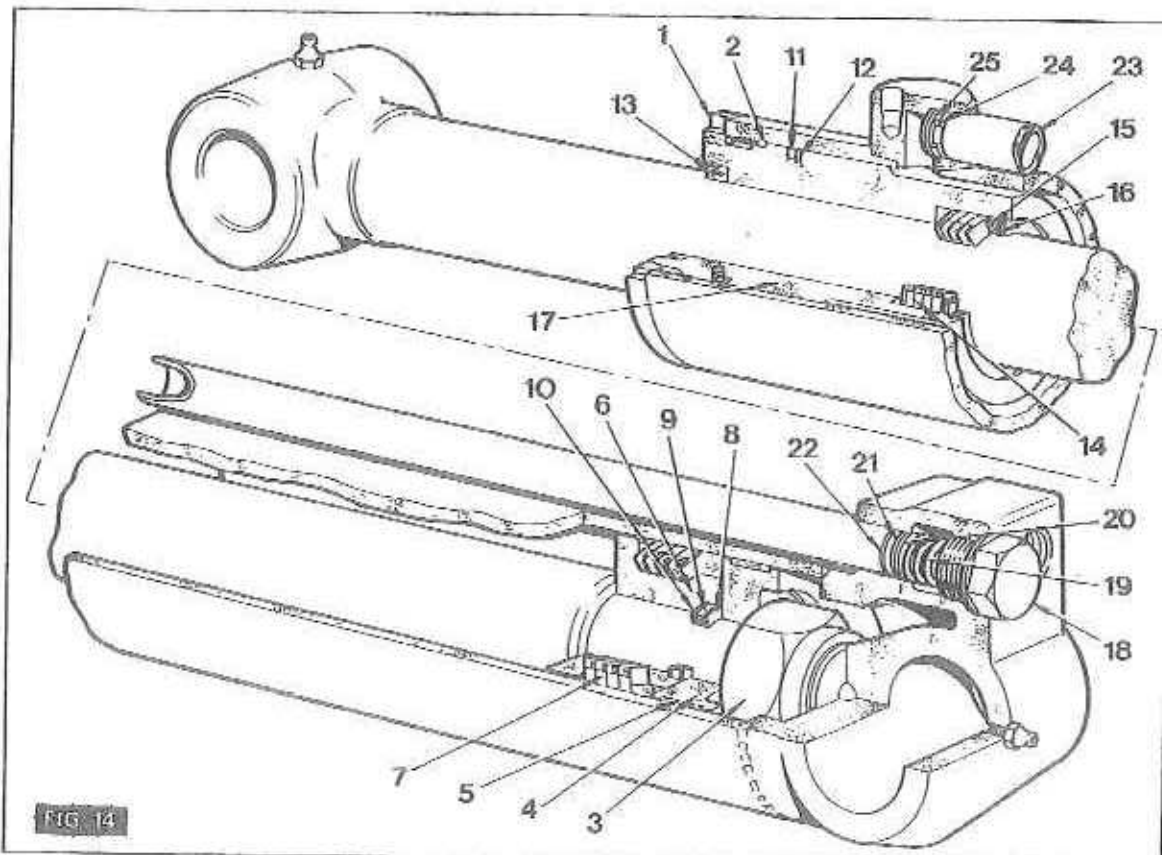
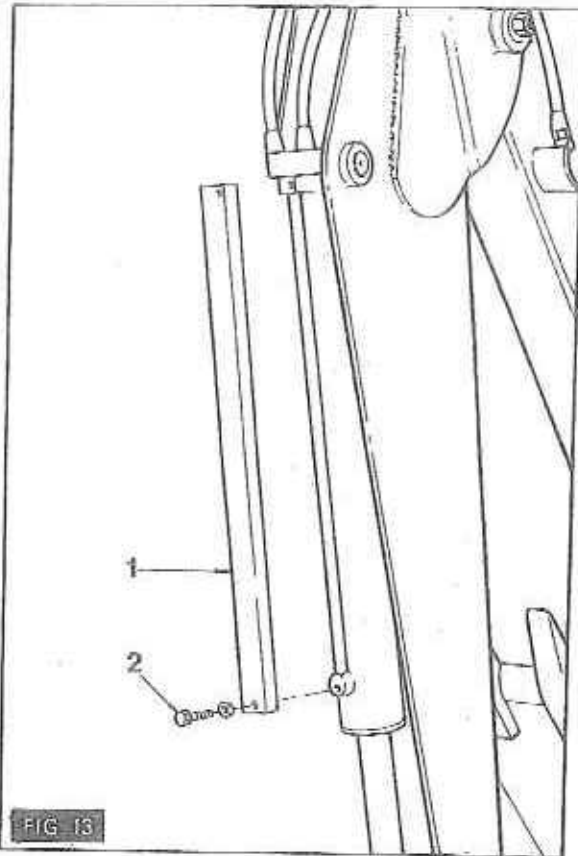
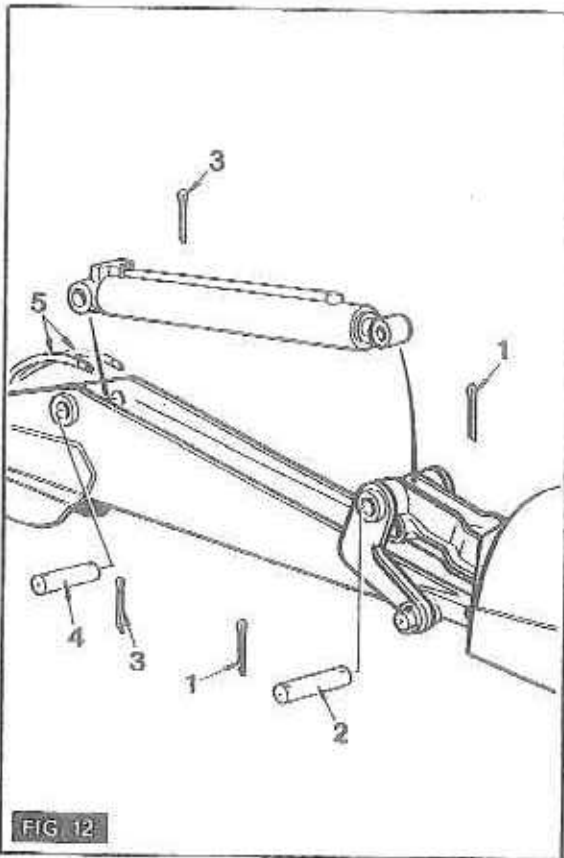
1. Position the boom and dipperstick straight out parallel to the ground with the bucket fully dumped. Release all pressure in system.
2. (Fig. 12) Remove the split pins (1) drive out the pin (2).
3. Remove the split pins (3) drive out the pin (4).
4. Disconnect the hoses (5).
5. Replacement is a reversal of the removal procedure.

Disassembly

9G/15

1. Remove the ram from the machine as stated in operation 9G/14.
2. (Fig. 13) Remove the guard (1) by unscrewing the two screws (2).
3. Hold the ram assembly securely in a suitable clamp or vice.
4. (Fig. 14) With a 'C' Spanner turn the bearing nut (1) in an anti-clockwise direction, remove it from the bearing and rest it on the piston rod.
5. Tap the bearing approximately 1½" (38.1 mm.) into the barrel to allow the removal of the lock ring (2).
6. Using a screw driver remove the lock ring.
7. Withdraw the piston rod assembly from the barrel.
8. Clamp the piston rod assembly securely in a vice. Remove the nut (3), piston (4) complete with wear ring (5).





BUCKET RAM - DIGGER**Disassembly . . . Cont'd**

9. Slide the packing retainer (6) complete with packing set (7), back up washer (8), 'O' ring (9), back up washer (10) off the rod.
10. Slide the bearing assembly off the rod. Remove the 'O' ring (11), back up washer (12), wiper seal (13), packing set (14) retainer (15) and retainer ring (16) from the body (17).
11. Remove the plug complete with 'O' ring (18), spring (19), shims (20) then withdraw the tube.
12. Remove 'O' ring (21) and back up washer (22) from the tube (23) then 'O' ring (24) and back up washer (25).

Note :- If the same tube is to be re-used retain the shims.

Reassembly

(9G/16)

1. Examine all component parts for excessive wear or damage. Thoroughly clean all parts.
2. (Fig. 14) Slide the bearing nut (1) and lock ring (2) onto the piston rod.
3. Fit new wiper seal (13), packing set (14), retainer (15), retainer ring (16), 'O' ring (9) and back up washer (10) to the bearing body (17).
4. Lubricate the piston rod with clean hydraulic oil and slide the bearing assembly onto the rod.
5. Fit back up washer (8), new 'O' ring (9), back up washer (10), and new packing set (7) onto the packing retainer (6) and slide it onto the rod.
6. Fit a new wear ring (5) to the piston (4), slide it onto the rod and secure with nut (3). Tighten to a torque of 330 - 350 lb.ft. (41.49 - 48.4 kg.m.).
7. Lubricate the 'O' rings and seals then insert the piston and rod assembly into the barrel, taking care not to damage the seals.
8. Push the bearing assembly into the barrel far enough to allow the replacement of the lock ring (2).
9. When the lock ring has been replaced withdraw the piston rod against the bearing thus forcing the bearing up to the lock ring. Fit the bearing nut (1) and tighten to a torque of 200 - 220 lb.ft. (27.66 - 30.43 kg.m.).
10. Fit new 'O' ring (21), new back up washer (22), new 'O' ring (24) and new back up washer (25) to the tube (23).
11. Insert the tube then replace the shims (20). If a new tube is to be fitted shim between the tube and spring to ensure a dimension of $1\frac{1}{4}'' \pm 1/32''$ (31.75 $\pm$ 0.793 mm) between the top of the shims and spot face of the plug (Fig 14 Dimension A).
12. Replace spring (19) then refit plug (18) complete with new 'O' ring.
13. (Fig. E13) Replace the guard (1) and secure with screws (2).

CLAMPING CYLINDER**Removal and Replacement**

(9G/17)

1. (Fig. 15) Release pressure in the cylinder by operating the clamping control lever.
2. Unscrew the 4 bolts (1) which hold the clamp retaining casting (2) to the main casting (3) and remove the clamp retaining casting.
3. Extract the split pin (4) and remove the pin (5).
4. Remove the hydraulic connection (6).
5. Force the ram piston back into the cylinder far enough to allow the clamping plate (7) to clear the 'vss' in the rear frame.
6. Turn the piston and clamping plate then slide the plate from between the cylinder lugs.

Warning: Care should be taken as the piston could drop from the cylinder.

7. Remove the split pin (8) and pin (9) then remove cylinder (10).
8. Replacement is a reversal of the above procedure.

CLAMPING CYLINDER . . . Cont'd

Disassembly and Reassembly

(9G/18)

1. Remove the cylinder from the machine as stated in operation 9G/17
2. (Fig. 16) Slide the piston (1) from the cylinder (2).
3. Remove the retaining ring (3) and seal (4).
4. Remove the grease nipple (5).
5. Check all parts for wear or damage.
6. Reassembly is a reversal of the above procedure.

Note :

1. Before reassembly fill the annular cavity in the cylinder with grease.
2. All seals should be renewed on reassembly.

STABILIZER RAM

Removal and Replacement

(9G/19)

The procedure for removing either the left hand or right hand ram is exactly the same.

1. Extend the ram until the foot is just touching the floor.
2. (Fig. 17) Remove split pin (1) and extract pin (2).
3. Retract the ram rod.
4. Remove the cover plate (3) from the top of the leg.
5. Disconnect the two hydraulic unions (4).
6. Adequately support the ram assembly, remove split pin (5) then pin (6). Lift out ram assembly (7).
7. Replacement is a reversal of removal procedure.

Disassembly

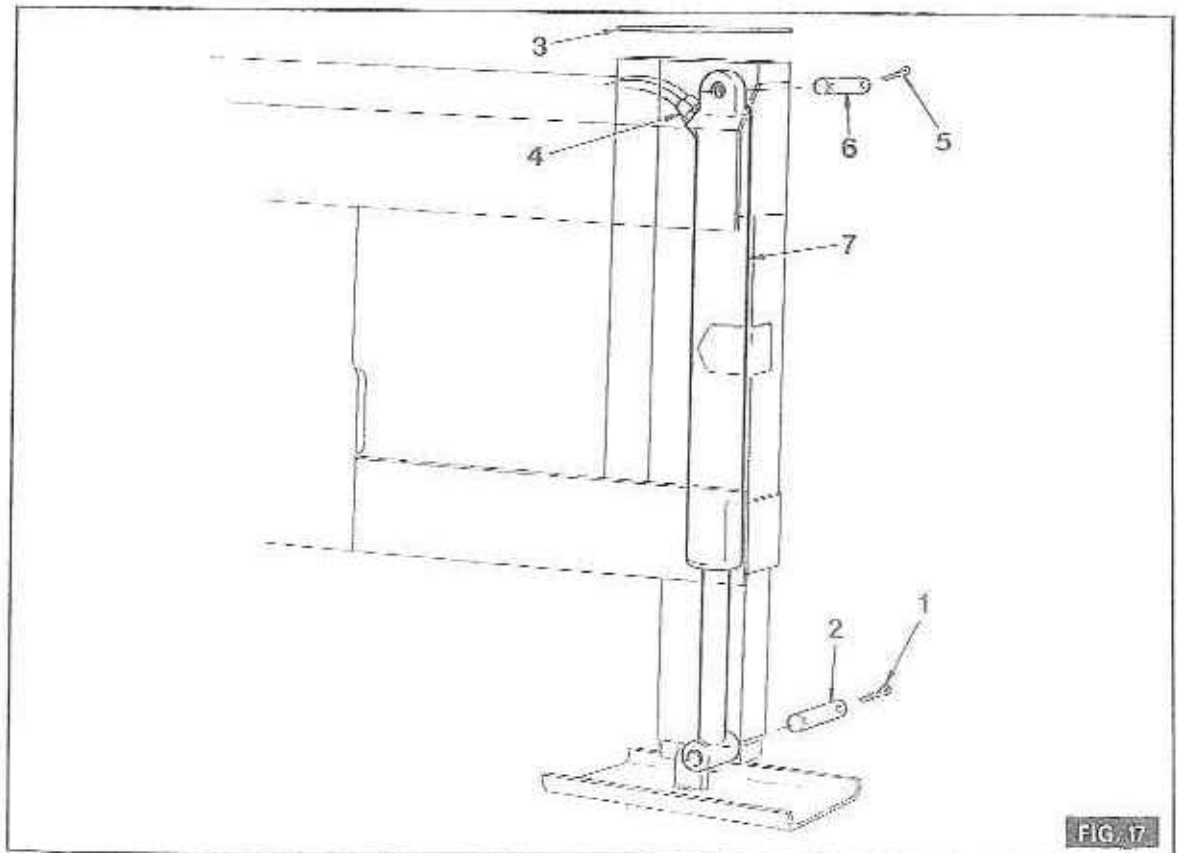
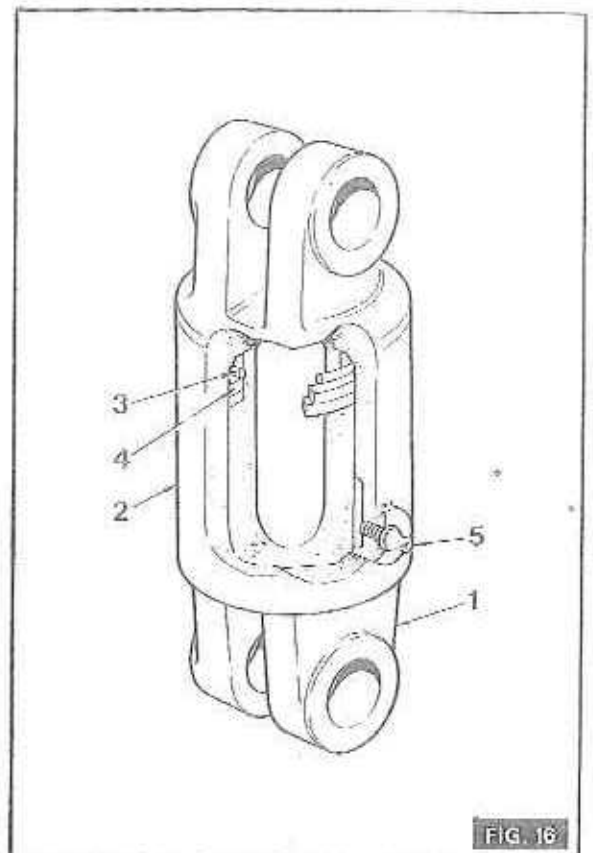
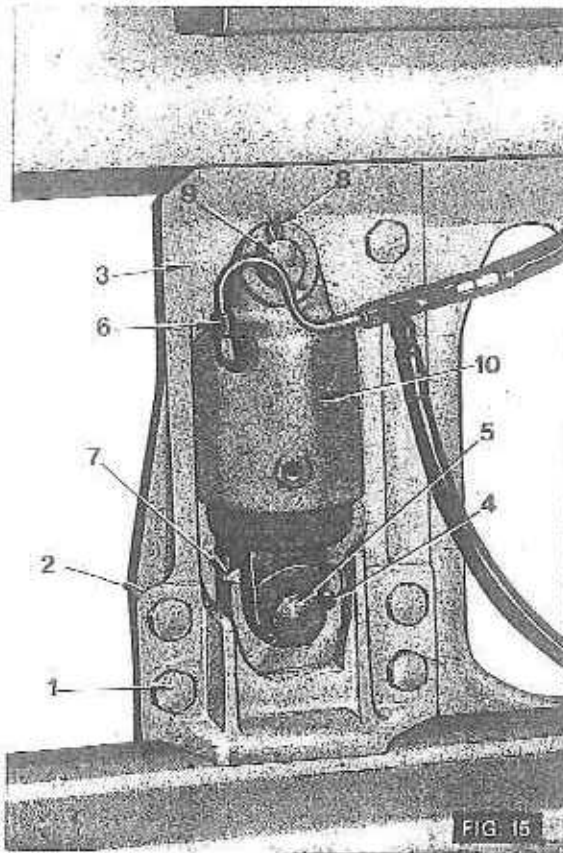
(9G/20)

1. Remove the ram as stated in operation 9G/19
2. Hold the ram assembly securely in a suitable clamp or vice.
3. (Fig. 18) With a 'C' Spanner turn the bearing nut (1) in an anti-clockwise direction, remove it from the bearing and rest it on the piston rod.
4. Tap the bearing approximately 1½" (38,1 mm) into the barrel to allow the removal of the lock ring. (2).
5. Using a screw driver remove the lock ring.
6. Withdraw the piston rod assembly from the barrel.
7. Clamp the piston rod assembly securely in a vice, remove the nut (3) piston (4) complete with wear ring (5) 'O' ring (6), packing retainer (7) complete with packing (8).
8. Slide the bearing assembly off the rod.
9. Remove the 'O' ring (9), back up washer (10), wiper seal (11), snap ring (12), washer (13) and packing (14) from the body (15).

Reassembly

(9G/21)

1. Examine all component parts for wear or damage. Thoroughly clean all parts.
2. (Fig. 18) Slide the bearing nut (1) and lock ring (2) onto the piston rod.
3. Fit new packing (14), washer (13), snap ring (12), new wiper seal (11), new back up washer (10) and new 'O' ring to the body (15).
4. Lubricate the piston rod with clean hydraulic oil and slide the bearing assembly onto the rod.
5. Fit new packing (8) onto packing retainer (7) and slide up to the shoulder on the piston rod. Fit new 'O' ring (6).
6. Fit new wear ring (5) onto the piston (4), slide it onto the rod and secure with nut (3). Torque to 300 - 330 lb.ft. (41.49 - 45.6 kg.m.).



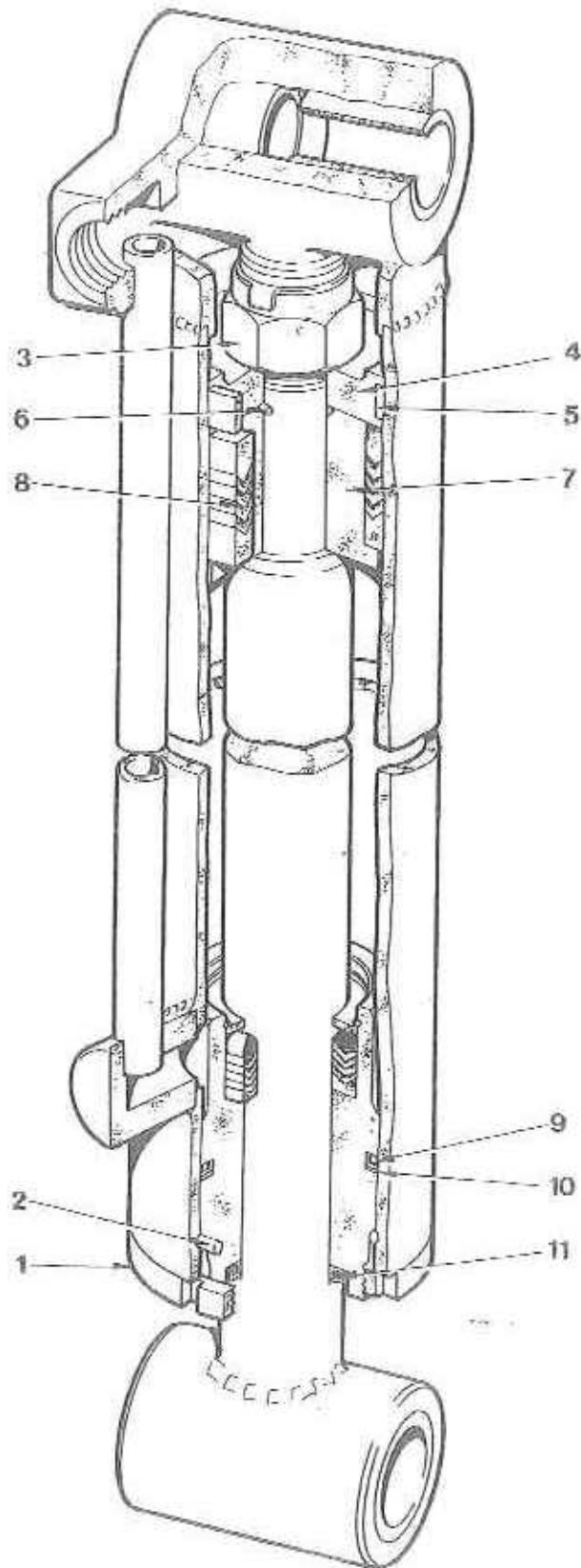


FIG 18

STABILIZER RAM

Reassembly . . . Cont'd

7. Lubricate the 'O' rings and seals then insert the piston and rod assembly into the barrel, taking care not to damage the seals.
8. Push the bearing assembly into the barrel far enough to allow the replacement of the lock ring (2).
9. When the lock ring has been replaced withdraw the piston against the bearing assembly thus forcing the bearing up to the lock ring. Fit the bearing nut (1) and tighten to a torque of 160 - 180 lb.ft. (22.13 - 24.89 kg.m.).

HAMWORTHY
SEVEN SPOOL VALVE



CONTENTS

	PAGE
GENERAL	4
SIX SPOOL VALVE, Removal and Replacement (9H/1)	5
SIX SPOOL VALVE, Disassembly (9H/2)	6
SIX SPOOL VALVE, Reassembly (9H/3)	6
SPOOL, Disassembly (9H/4)	6
SPOOL, Reassembly (9H/5)	7
SHOCK RELIEF VALVES, Removal and Replacement (9H/6)	7
SHOCK RELIEF VALVES, Pressure Checking (9H/7)	7
SHOCK RELIEF VALVES, Setting (9H/8)	8

LIST OF ILLUSTRATIONS

FACING PAGE

FIG.

1. GENERAL ARRANGEMENT, SIX SPOOL VALVE	4
2. HYDRAULIC OIL CIRCUIT FOR DIGGER	4
3. BUCKET SPOOL, Operation	4
4. DIPPERSTICK SPOOL, Operation	4
5. STABILIZER SPOOL, Operation	5
6. SLEW SPOOL, Operation	5
7. BOOM SPOOL, Neutral Position	5
8. CLAMP RAM, Operation	5
9. SIX SPOOL VALVE, Disassembly	6
10. SIX SPOOL VALVE, Breakdown	6
11. SPOOL, Disassembly	7
12. SPECIAL TOOL	7
13. SHOCK RELIEF VALVES, Pressure Checking	8
14. SHOCK RELIEF VALVES, Disassembly	8

SIX SPOOL VALVE

General

The monoblock construction of the six spool valve has the integral features of 1) an open centre, 2) series flow, 3) parallel pressure feed and a zig-zag open centre. The pressure galleries, which are either side of the zig-zag open centre, link up at the oil inlet port and the return oil galleries link up at the outlet port. With the exception of the stabilizer service each spool incorporates a shock valve assembly interconnected between the service actuator ports and the return oil galleries. The hydraulic system is shown in Fig. 2.

KEY TO FIG 1

- | | |
|--------------------------|-------------------------|
| 1. Bucket spool | 4. Left Hand stabilizer |
| 2. Dipperstick spool | 5. Rotary actuator |
| 3. Right Hand stabilizer | 6. Boom spool |

SHOCK VALVE SETTINGS

A	Bucket Rod Side	2750 lbs/in ² (193.3 kg/cm ²)
B	Bucket Head Side	2750 lbs/in ² (193.3 kg/cm ²)
C	Dipperstick Rod Side	3000 lbs/in ² (210.9 kg/cm ²)
D	Dipperstick Head Side	2750 lbs/in ² (193.3 kg/cm ²)
E	Left Slew	2000 lbs/in ² (140.6 kg/cm ²)
F	Right Slew	2000 lbs/in ² (140.6 kg/cm ²)
G	Boom Head Side	2750 lbs/in ² (193.38 kg/cm ²)
H	Boom Rod Side	3000 lbs/in ² (210.9 kg/cm ²)

KEY TO FIG. 2

- | | |
|-------------------------|-----------------------------|
| (IN) Inlet Manifold. | 3. Stabilizer, Right Hand. |
| (C/C) Clamp Cylinder. | 4. Stabilizer, Left Hand. |
| 1. Bucket Service. | 5. Actuator Service (Slew). |
| 2. Dipperstick Service. | 6. Returns Manifold. |

(Fig. 3) shows the bucket selector spool and the flow of oil when the bucket is crowded. The spool is raised pressurising the lower port which is connected to the head side of the bucket ram. Returning oil is directed to the reservoir through the upper port.

KEY TO FIG. 3

- | | |
|--------------------------|---------------------|
| 1. Open centre gallery | 4. Top port |
| 2. Pressure feed gallery | 5. Shock valves |
| 3. Service port | 6. Service cylinder |

(Fig. 4). The oil circuit for the dipperstick operation is shown in this figure. The open centre gallery has been blocked by the operation of the selector spool and pressure has built up in the parallel pressure feed galleries. The pressure is thus transferred to the dipperstick ram through the lower port while the upper port takes the return oil.

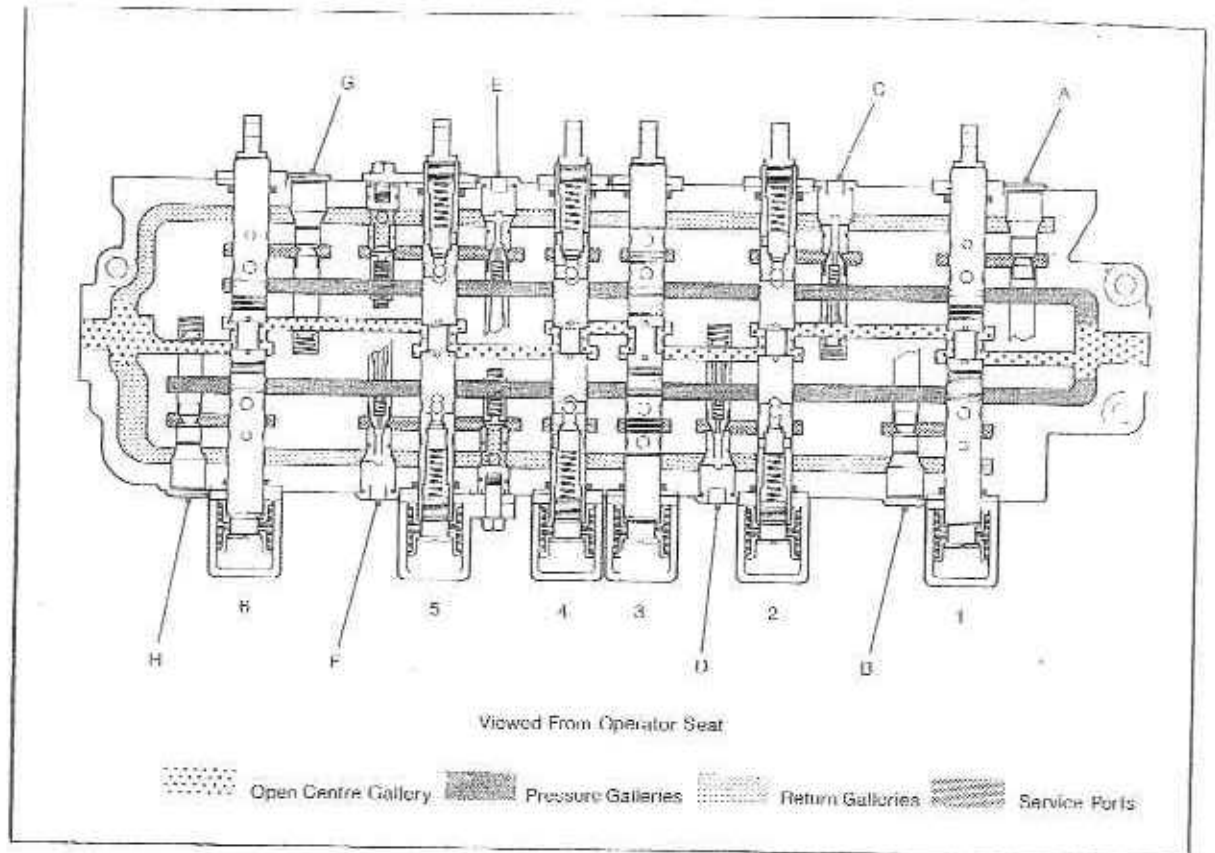


FIG. 1

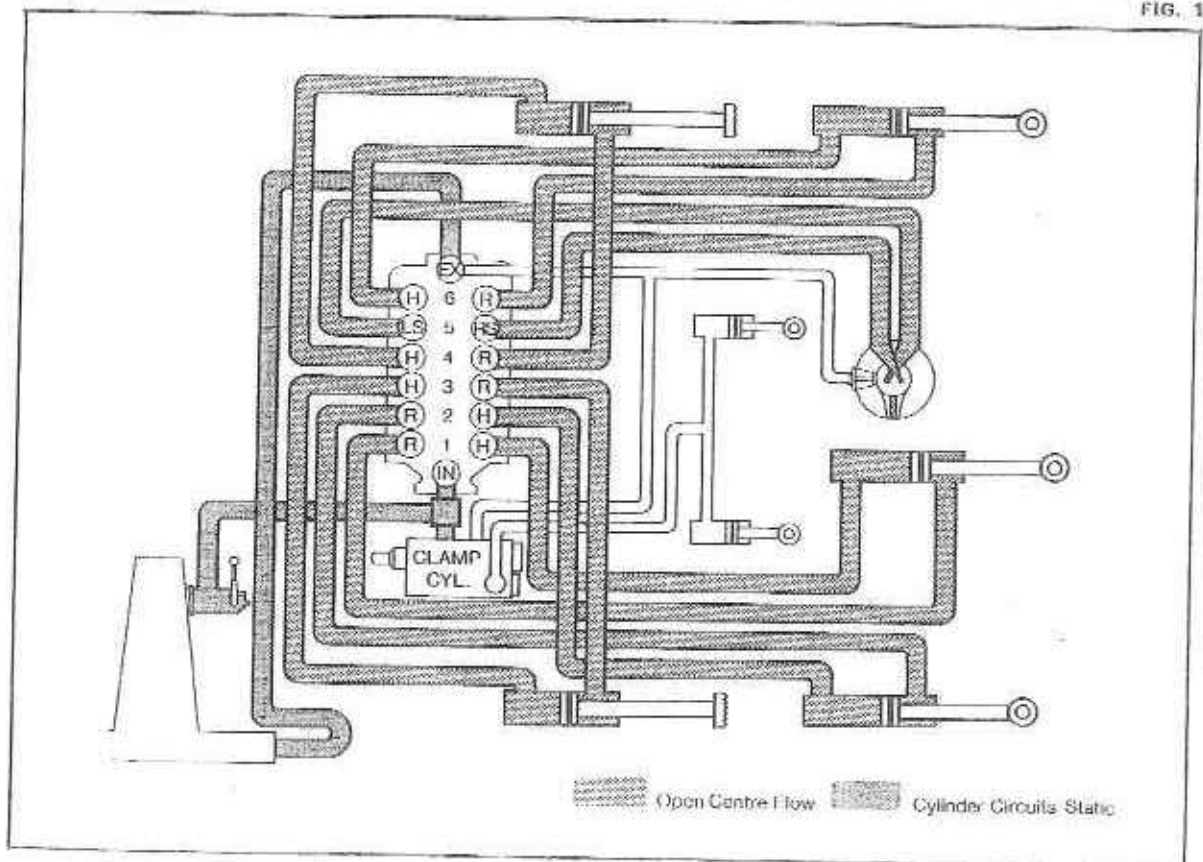


FIG. 2

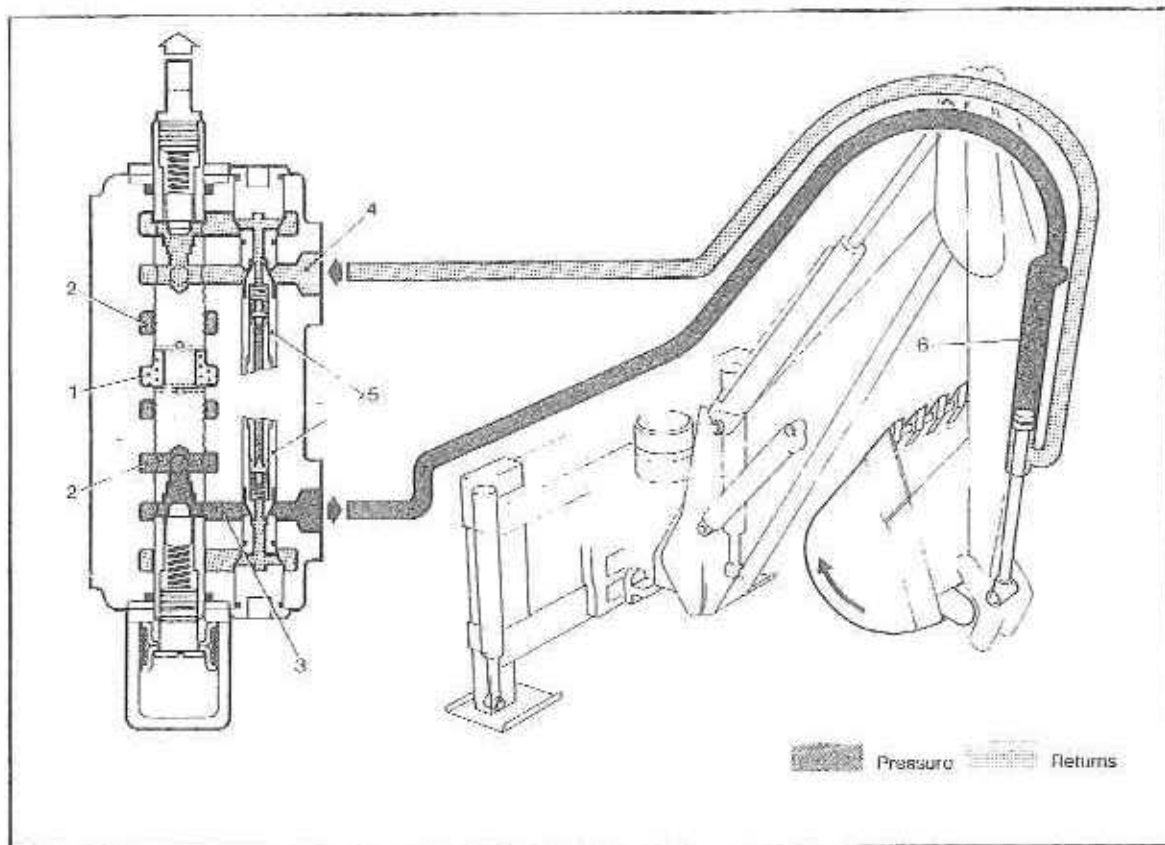


FIG. 3

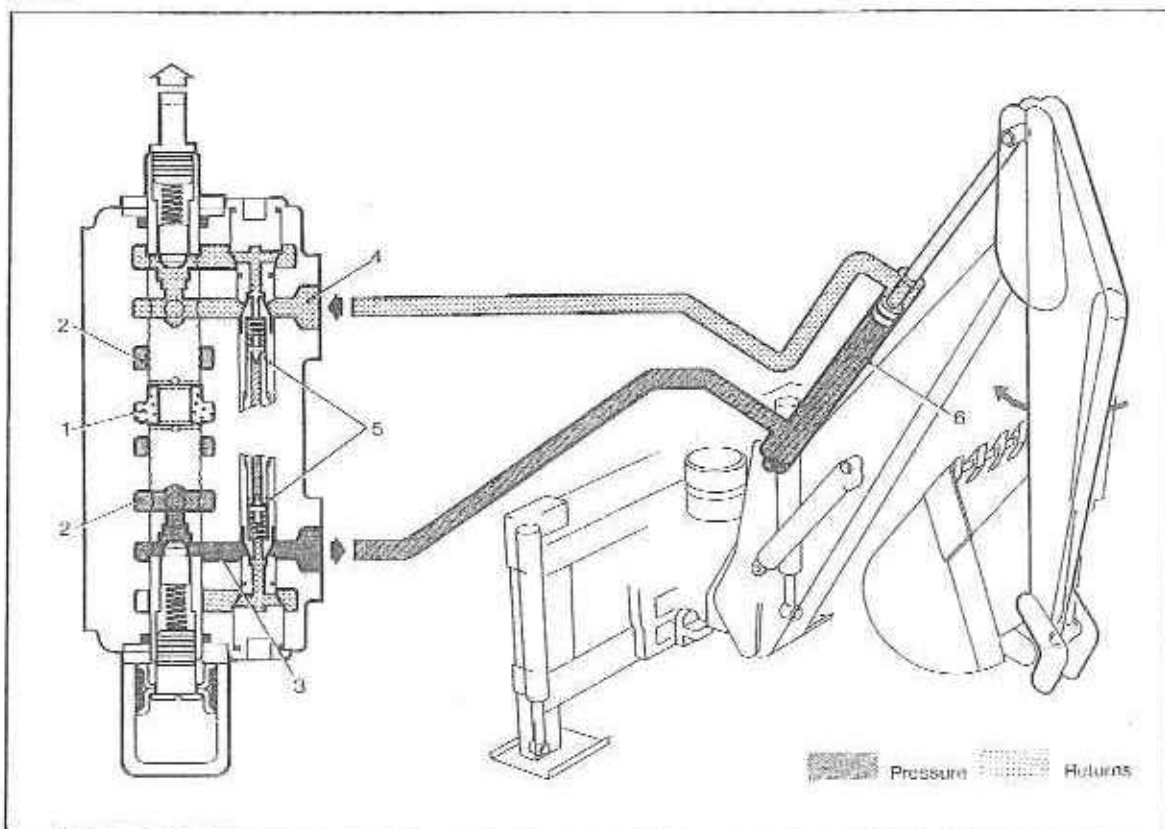


FIG. 4

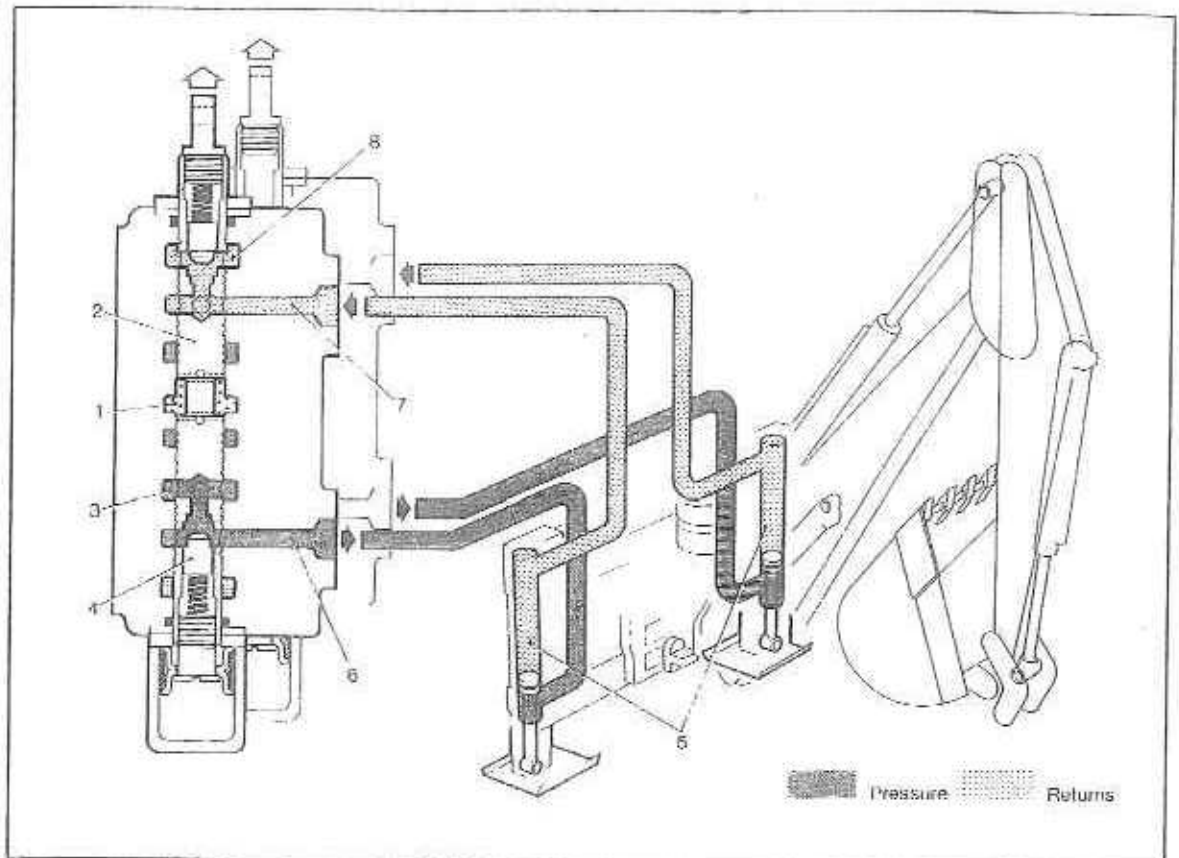


FIG. 5

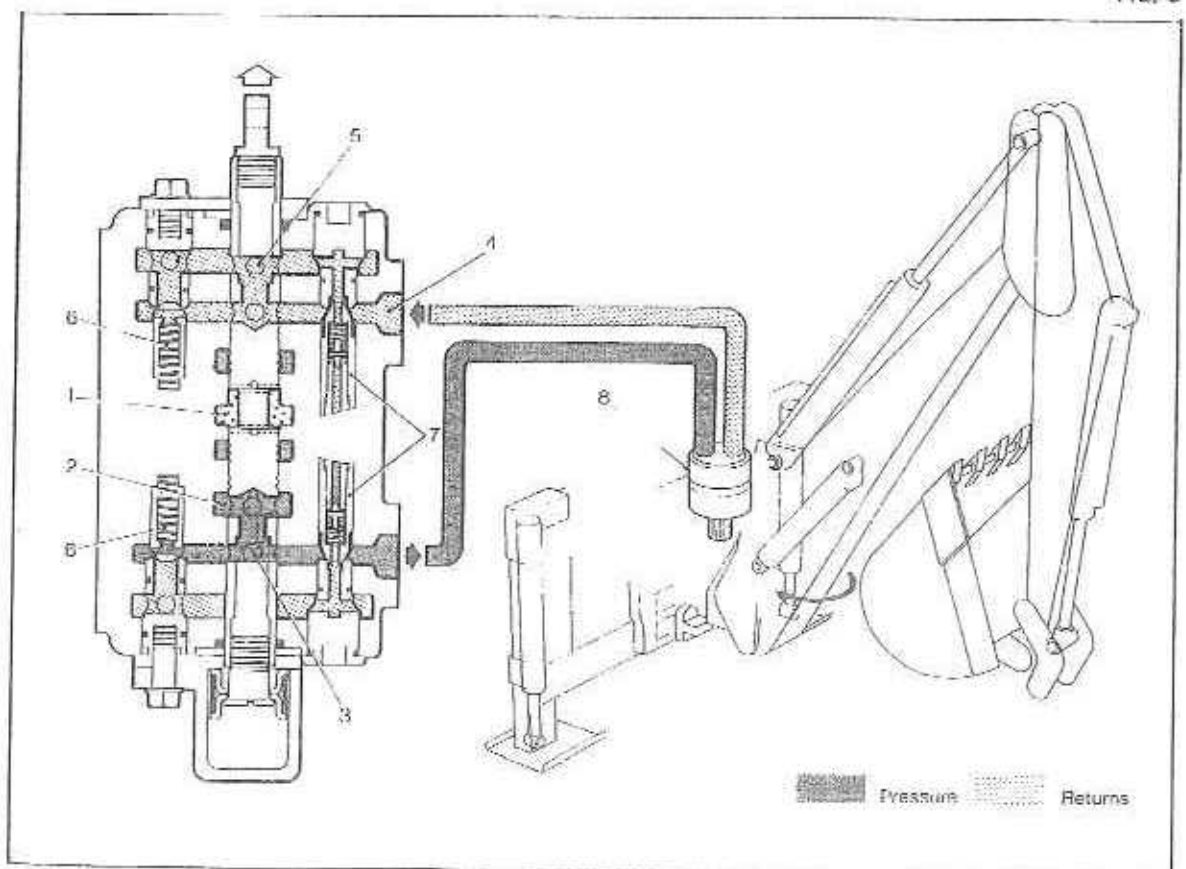
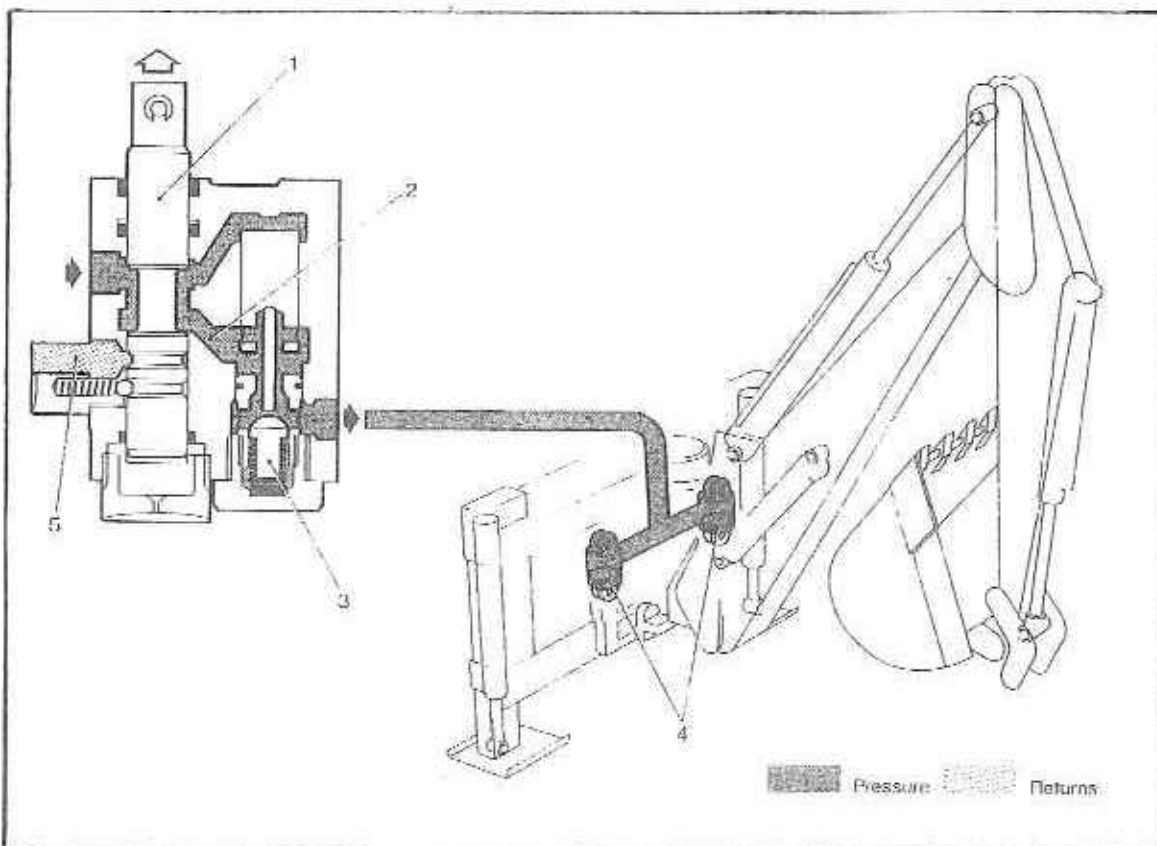
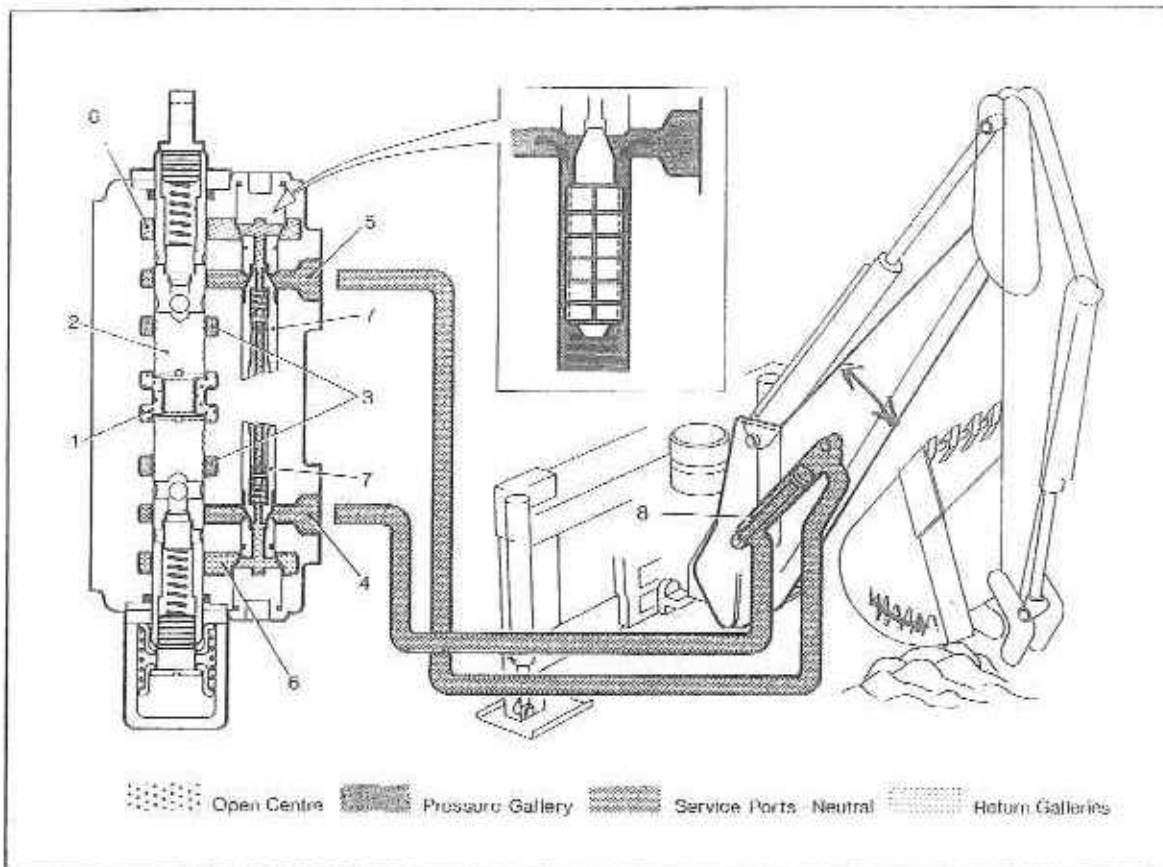


FIG. 6



KEY TO FIG. 4

- | | |
|--------------------------|---------------------|
| 1. Open centre gallery | 4. Top port |
| 2. Pressure feed gallery | 5. Shock valves |
| 3. Service port | 6. Service cylinder |

(Fig. 5) illustrates the flow of oil through the stabilizer spool then out through the hoses to the rams. When the spool is raised oil is fed to the rod side and the stabilizer retracts. Conversely when the spool is raised oil is fed to the head side and the stabilizer extends.

KEY TO FIG. 5

- | | |
|------------------------|-----------------------|
| 1. Open Centre gallery | 5. Service cylinder |
| 2. Pressure gallery | 6. Lower service port |
| 3. Pressure gallery | 7. Upper service port |
| 4. Check valve | |

(Fig. 6) shows the selector spool in an operating position whereby oil flows from the pressure gallery (2) through the lower service port (3) to the left hand vane compartment in the actuator (8). The digger will then rotate to the right. The oil which is discharged from the opposite side of the vane returns via the feed port (4), to the return gallery (5). If the build up of pressure against the actuator vane exceeds 2000 lbs/in² (140.6 kg/cm²), the lower shock valve (7) will relieve the pressure momentarily until movement of the digger is obtained.

Two anti-cavitation valves (6) are situated between the delivery port gallery and the return port gallery. These would come into operation when the actuator over runs after the spool has returned to neutral e.g. when it is impossible to stabilize the machine level and therefore it is necessary to slew "down hill". The momentum of the digger would force more oil from the actuator than the pump could replace. If this happened the valve would be drawn off its seat and oil could then flow from the return gallery to make up the deficiency on the discharge side of the system.

KEY TO FIG. 6

- | | |
|------------------------|---------------------------|
| 1. Open centre gallery | 5. Return oil gallery |
| 2. Pressure gallery | 6. Anti-Cavitation valves |
| 3. Feed port | 7. Shock valves |
| 4. Return port | 8. Rotary actuator |

(Fig. 7) illustrates the oil system for the boom. The spool is in a neutral position so the oil will flow through the open centre and not operate the service.

KEY TO FIG. 7

- | | |
|------------------------|-----------------------|
| 1. Open centre gallery | 5. Upper service port |
| 2. Land | 6. Return oil gallery |
| 3. Pressure gallery | 7. Shock valves |
| 4. Lower service port | 8. Boom ram |

KEY TO FIGURE 8

- | |
|-------------------------|
| 1. Selector Spool |
| 2. Gallery |
| 3. Check Valve |
| 4. Clamp Rail Cylinders |
| 5. Return Port |

SIX SPOOL VALVE

Removal and Replacement

(9H/1)

1. With the digger bucket resting on the ground, operate the control levers several times to ensure that all hydraulic pressure has been relieved from the digger.
Remove the spool control lever cover and rubber grommets.
2. Disconnect all hoses from the six spool valve. To make reassembly easier, label or mark all the hoses and their corresponding ports.
3. (Fig 9). Remove the three securing bolts and lift the valve clear.
4. Replacement is a direct reversal of the removal procedure.

SIX SPOOL VALVE

Disassembly

(9H/2)

1. (Fig. 9). Remove the split pins (1) and linch pins (2) which connect the links (3) to the spools.
2. Unfasten and remove the two screws (4) and remove the complete handle assembly from the valve.
3. (Fig. 10). Remove the setscrews (1) and washers (2) which secure the cap (3) and cover spacer (4) then withdraw the spool complete with centering device, retainer (5) and seal ring (6).
4. Remove all other spools as per item 3.

Note

The spools are **NOT** interchangeable. When dismantling the valve, label the spools and mark the mating bore.

5. Remove the two setscrews (7), washers (8), wiper retainer (9), wiper (10), seal retainer (11) and seal (12) from each bore.
6. Anti-cavitation valves (13) and springs (14) are incorporated in the slew system. These can be removed after the setscrews (1) have been removed from the slew section of the valve, as they are positioned in the block under the setscrews.
7. Remove the seat (15) and extract the overload auxiliary relief valve (16) from its bore. Then remove the lower seat (17) and valve (18).
8. Remove the relief valves from the other services.

SIX SPOOL VALVE

Reassembly

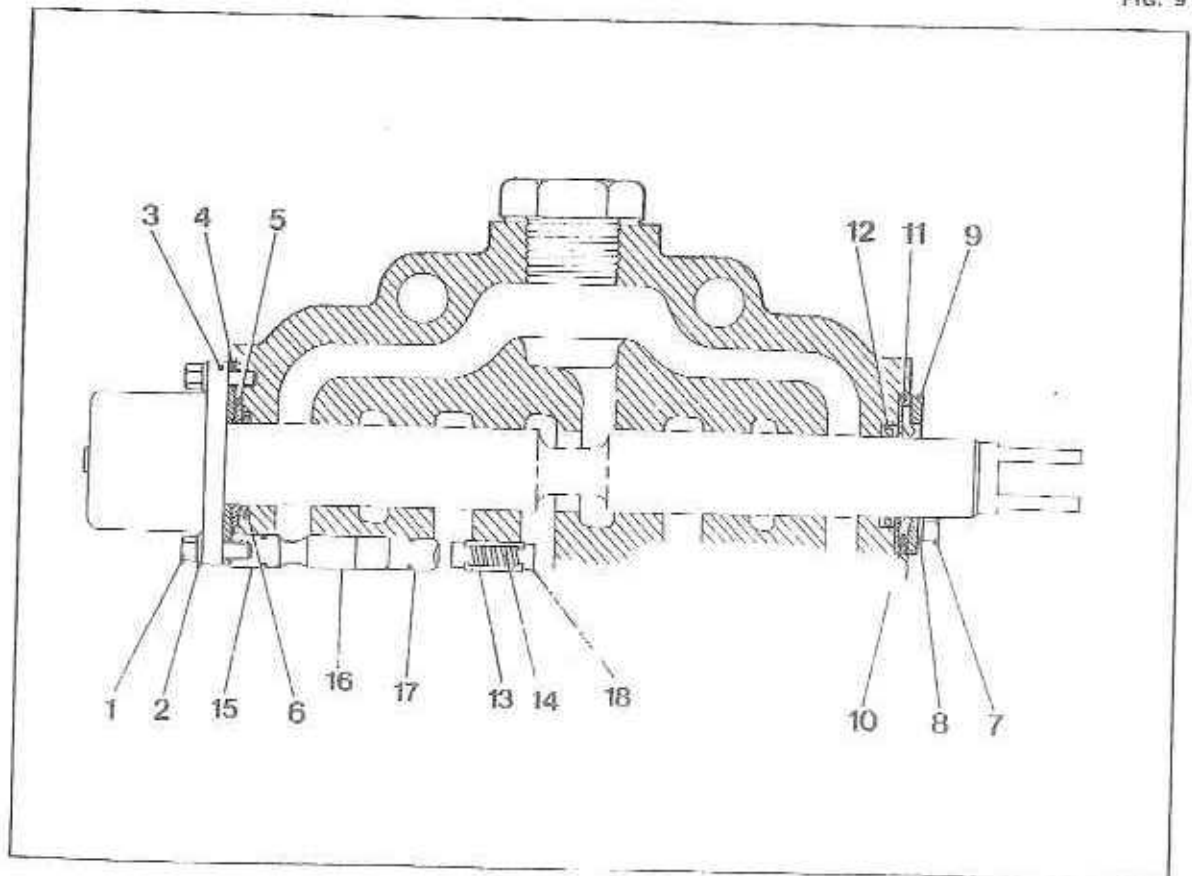
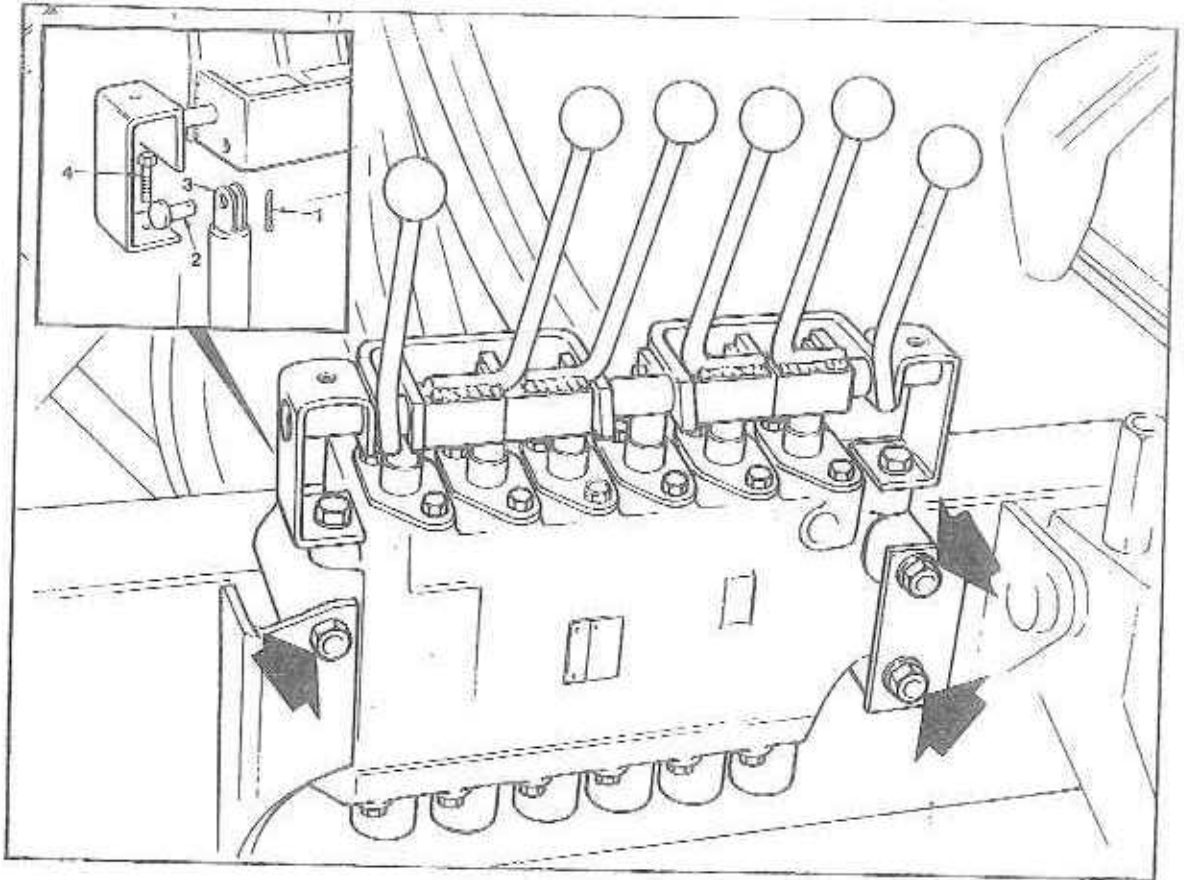
(9H/3)

1. Examine all seal rings and wipers for cuts and scoring, replace if necessary.
2. Check recesses for burrs and dirt, clean up if necessary.
3. Examine housing bore and seal recesses, if scored or damaged; fit new housing together with spools.
4. Lightly oil all components with clean hydraulic oil.
5. (Fig. 10). Replace the cover spacer (4), seal (6) and seal retainer (5) on the spool and replace the spool in the correct bore.
6. Replace the cover (3) and secure with the setscrews (1) and washers (2).
7. Check the spool operation for tendency to stick. Repositioning of the cover will normally cure this.
8. Replace the seal (12), seal retainer (11), wiper (10), wiper retainer (9), washers (8) and setscrews (7).

Note

When replacing setscrews (1) in the slew section of the valve, fit the anti-cavitation valves (12) and springs (13) in their respective bores and secure with the setscrews.

9. Replace all spools in their appropriate bores using the above procedure.
10. Replace the overload relief valves in their respective bores and refit the seat.



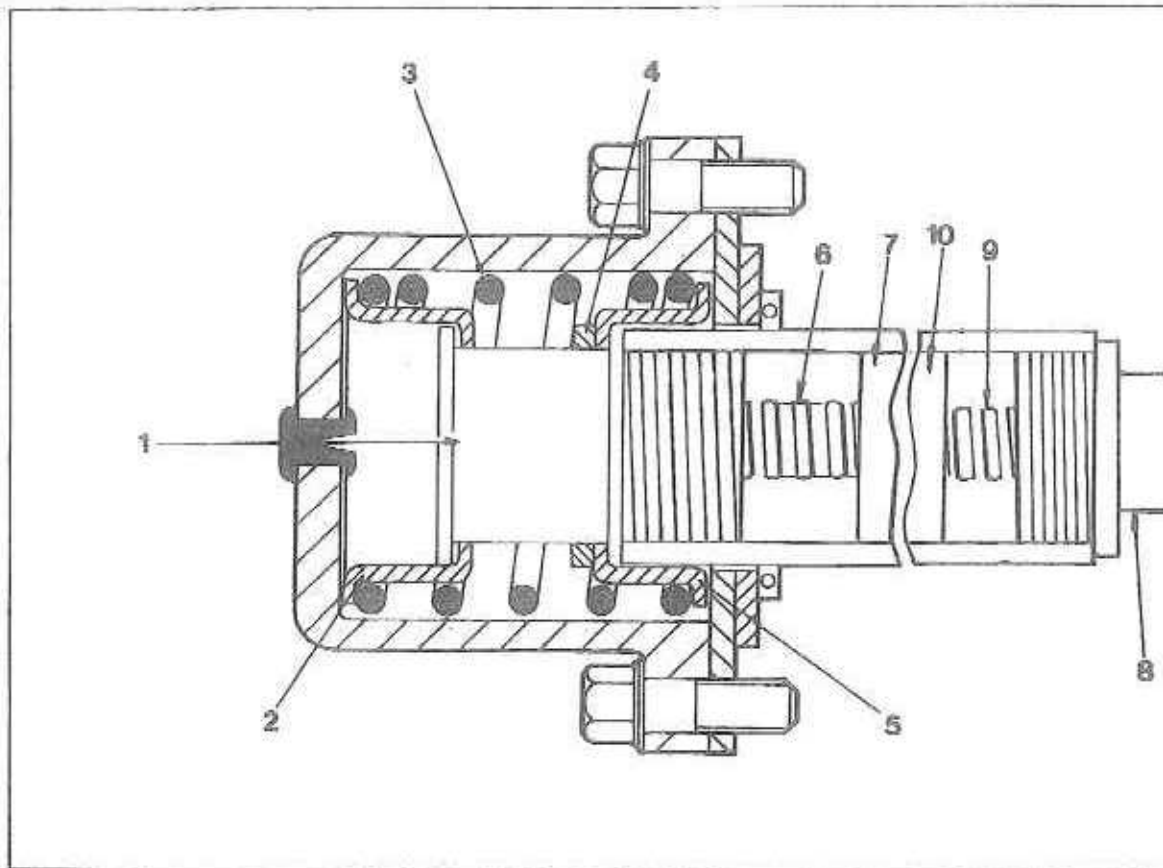


FIG. 11

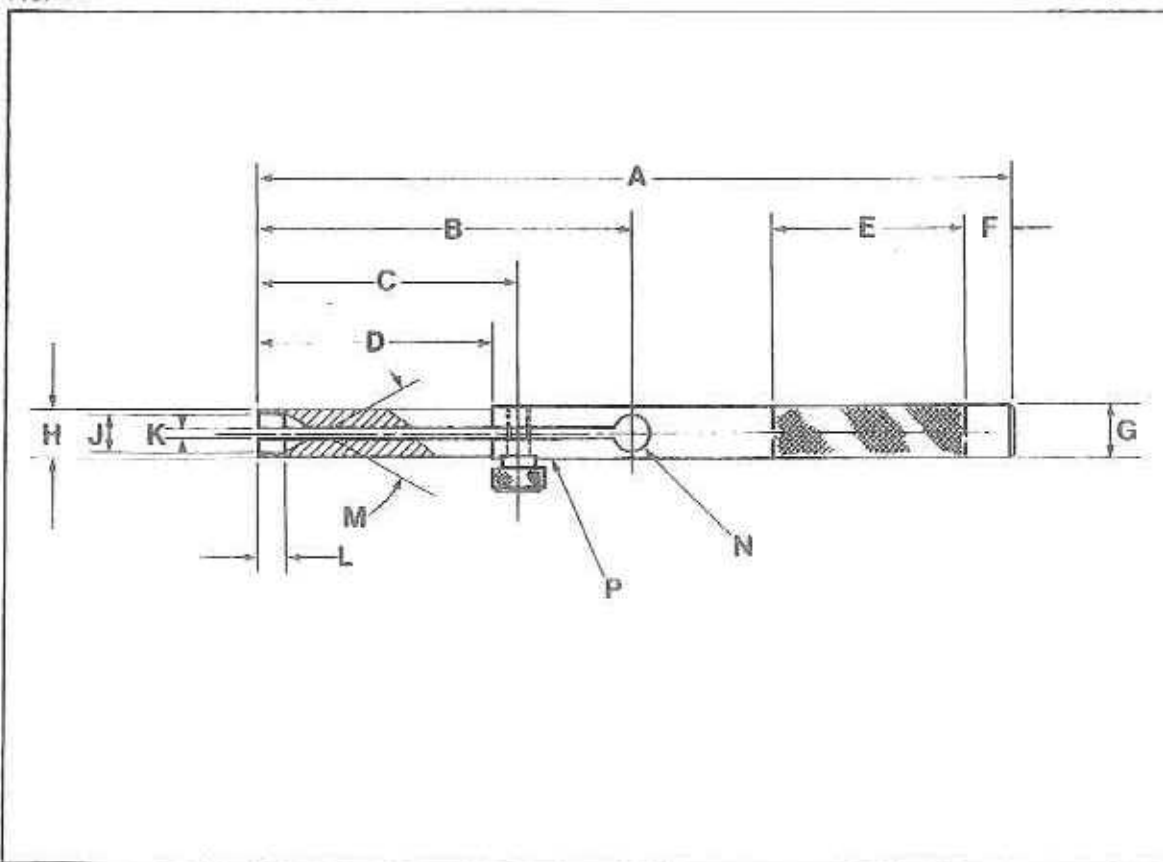


FIG. 12

9H6A

SPOOL

Disassembly

(9H/4)

1. (Fig. 11). Place the spool in a vice which is equipped with soft jaws and unscrew the cap (1).
2. Remove the retainer (2), spring (3), spacer (4) and retainer (5).
3. Extract the spring (6) and check valve (7) from the inside of the spool. Mark the spring and its respective bore.
4. Remove the spool eye (8) from the other end of the spool and extract the spring (9) and check valve (10) from inside the spool. Mark the spring and its respective bore.

SPOOL

Reassembly

(9H/5)

1. Ensure that all items are clean and lightly oiled with clean hydraulic oil.
2. (Fig. 11). Replace the check valve (10) and spring (9). Ensure that they are in their correct bore, then replace the spool eye (8).
3. Replace the check valve (7) and spring (6) in the other bore.
4. Fit the retainer (5), spacer (4), spring (3) and retainer (2) to the spool.
5. Secure the centering device assembly with the cap (1).

SHOCK RELIEF VALVES

Removal and Replacement

(9H/6)

1. Remove the valve seat to expose the valve cartridge.
2. Place extractor tool over the end of the valve cartridge, tighten the screw on the tool and lift the cartridge clear.

Note

The extractor tool which can be made locally is shown in Fig. 12.

It is advisable that the valve seat and valve cartridge, when removed from the six spool block, should be kept together to prevent any errors when refitting them.

Note

ON NO ACCOUNT MUST THE SIZE OF THE VALVE SEAT BE CHANGED AS THE PRESSURE SETTINGS VARY WITH THE SIZE OF THE SEAT.

KEY TO FIG. 12

A	8.00 in (203.2 mm)	J	0.515 in (13.081 mm)
B	4.25 in (107.95 mm)		0.516 in (13.1064 mm)
C	3.00 in (76.2 mm)	K	0.062 in (1.5748 mm)
D	2.75 in (69.85 mm)	L	0.313 in (7.9375 mm)
E	2.00 in (50.8 mm)	M	60°
F	0.5 in (12.7 mm)	N	1 Hole drill through 0.375 in (9.525 mm)
G	0.563 in (14.287 mm)	P	1 Hole drill through 0.094 in (2.381 mm)
H	0.557 in (14.1478 mm)		C Bore 0.188 in (4.762 mm) x 0.281 in
	0.555 in (14.097 mm)		(7.143 mm) deep. Spot face 0.438 in (11.112 mm)
			to clean up and tap 2BA.

Material: EN 24 Harden and Temper to 30-35 Rockwell C.

SHOCK RELIEF VALVES

Pressure Checking

(9H/7)

1. (Fig. 13). Fit the adaptor MF 348 to a Lere hand pump.
 2. Secure the relief valve into the adaptor.
 3. Pressurise the relief valve and note from the gauge the pressure at which the pilot valve cracks.
 4. If the pressure differs from the list given below, the valve can be stripped and cleaned as stated in operation 9H/8.
 5. If, after cleaning, the valve is still faulty, scrap the valve and replace with a new one.
- There are two seat diameters for the slew circuit relief valve, the old 0.197" (5.0038 mm) and the new 0.312" (7.9248 mm).

Circuit Relief Valve Setting P.S.I.	Pilot Setting for 0.312" (7.9248 mm) Seat P.S.I.	Pilot Setting for 0.197" (5.0038 mm) Seat P.S.I.
1200	750	980
1500	980	1240
2000	1325	1680
2500		2120
2800		2380
3000		2560
3500		3000

SHOCK RELIEF VALVE

(9H/8)

Setting

1. (Fig. 14). Remove the pilot seat locknut and spring (1).
2. Unscrew and remove the pilot seat (2) complete with 'O' Ring (3).
3. Extract the pilot valve (4) and spring (5) from the body (6).
4. Examine the pilot valve and seat for wear or damage. If any wear or damage is found the complete shock valve must be discarded.
5. Reassemble all the components in a reverse order of the above procedure, then re-set the pilot valve by screwing the pilot valve seat in until it just comes into contact with the pilot valve.
6. Test the pilot valve cracking pressure as described in operation 9H/7.
7. The pilot valve pressure should then be adjusted to the required setting as shown in the table in operation 9H/7.

Note

If the valve is to be stored for future use then it must be clearly indicated by means of a label and placed in a box also clearly marked.

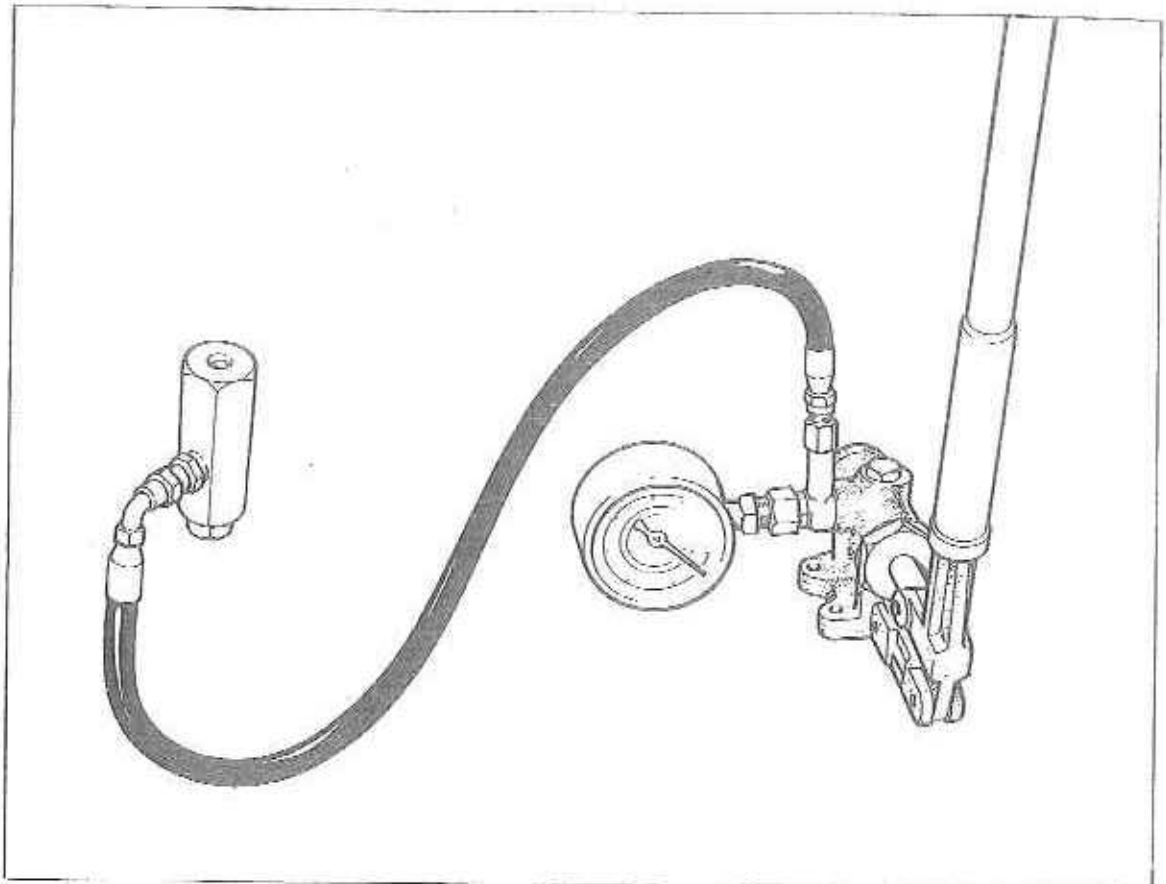


FIG. 13

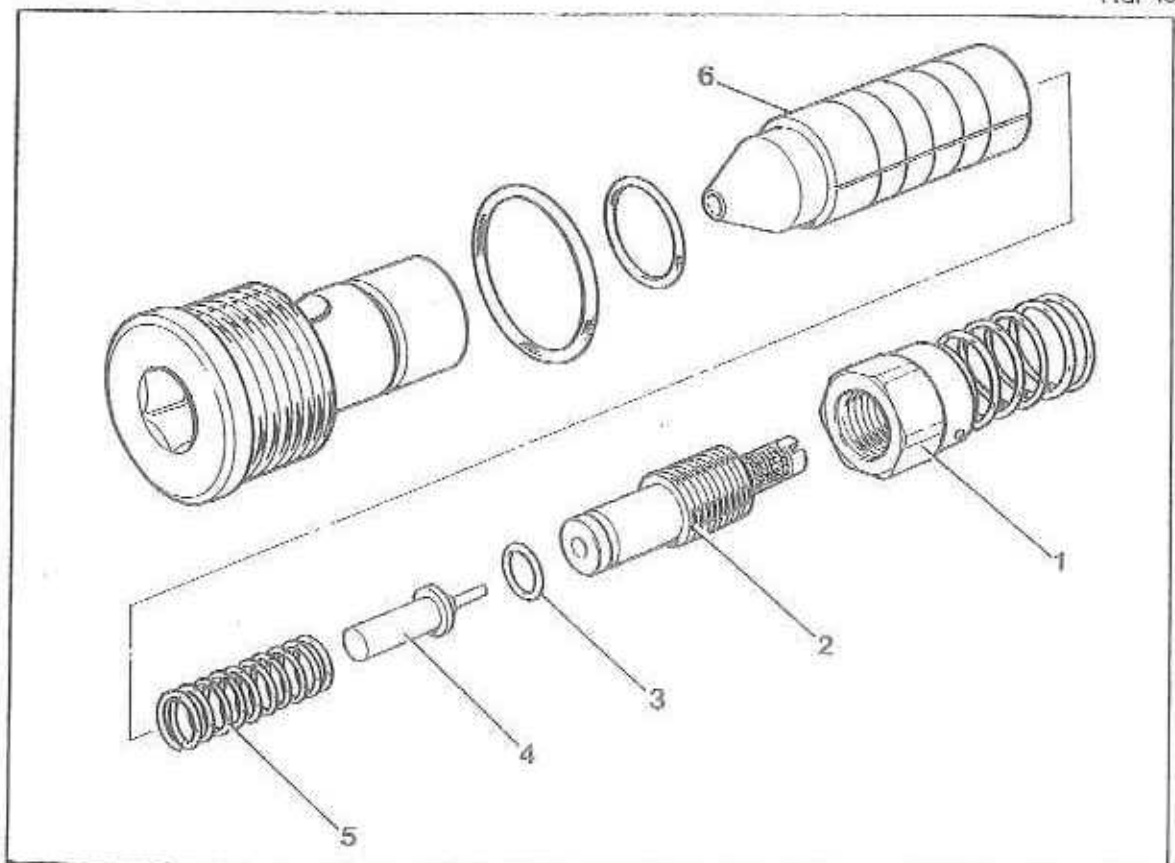


FIG. 14

ATTACHMENTS



CONTENTS

	PAGE
GENERAL	. 4
CUTTING BLADE Renewal . 10A/1	. 4

LIST OF ILLUSTRATIONS

Figure	Facing Page
1. PRE HEATED BLADE, positioning	4
2. WELDING SEQUENCE	4

ATTACHMENTS

General

LOADER

General Purpose 1 Cu. yd. (0.765 cu. m.) Bucket

This bucket has a replaceable blade and is fitted with eight replaceable teeth. The SAE Capacity is as follows:—

Struck volume	.778 cu. yd.
Heaped volume	1.000 cu. yd.
Weight of empty bucket	650 lbs.

Drott 4 in 1 Bucket

This bucket can be used as either bulldozer, scraper, loader or clamshell.

DIGGER

Trench Bucket

Various widths are available for this bucket 12 in, 18 in, 24 in, 30 in, 36 in, and 42 in (30, 45, 60, 76, 91, and 106 cm respectively).

Each bucket has a replaceable cutting edge, side cutters and teeth.

On the 50B machine the 24 in (60 cm) bucket is fitted as standard.

Ditch Cleaning Bucket

Width 48 in. (121.9 cm). Cubic Capacity (liquid level) of 4 cu. ft. (0.1132 cu.m) An extension can be fitted which increases the width to 72 in. (182.9 cm) and the cubic capacity to 6 cu. ft. (0.170 cu m).

Ditch Digging Bucket

The standard bucket is 48 in. (121.9 cm) wide at the top, 15 in. (38 cm) at the base, 30 in. (76 cm) in depth. With the extension fitted the depth is 42 in. (106 cm) and the top width is 60 in. (152.4 cm).

Hardened steel reversible blades are fitted.

CUTTING BLADE

Renewal

10A/1

1. Break the old weld and remove the cutting blade. Clean up the edges on the bucket.
2. Pre heat the new blade to a temperature of 250°–300°C.
3. (Fig. 1) Whilst the blade is still hot position it on the bucket and secure it with six bolts.
4. Tack weld the blade into position using Armoid No. 1 welding rods.

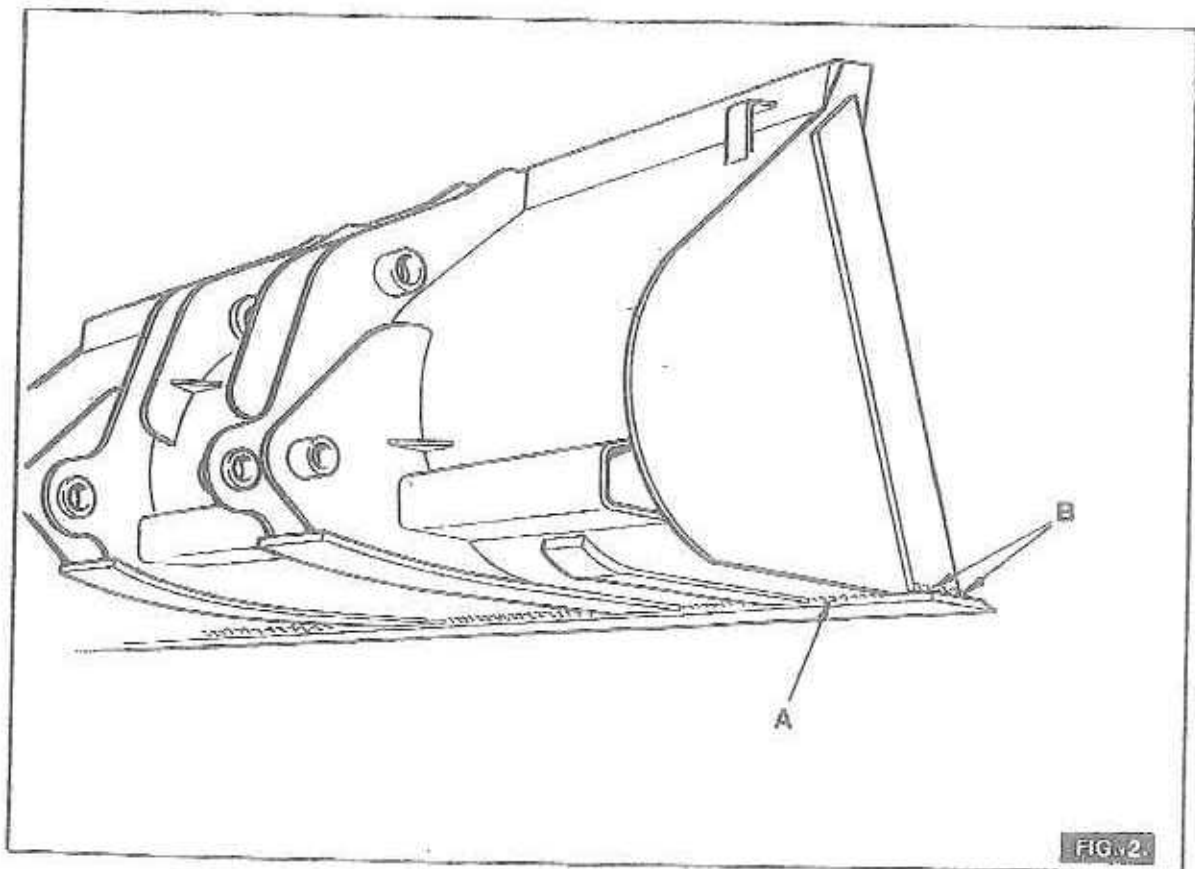
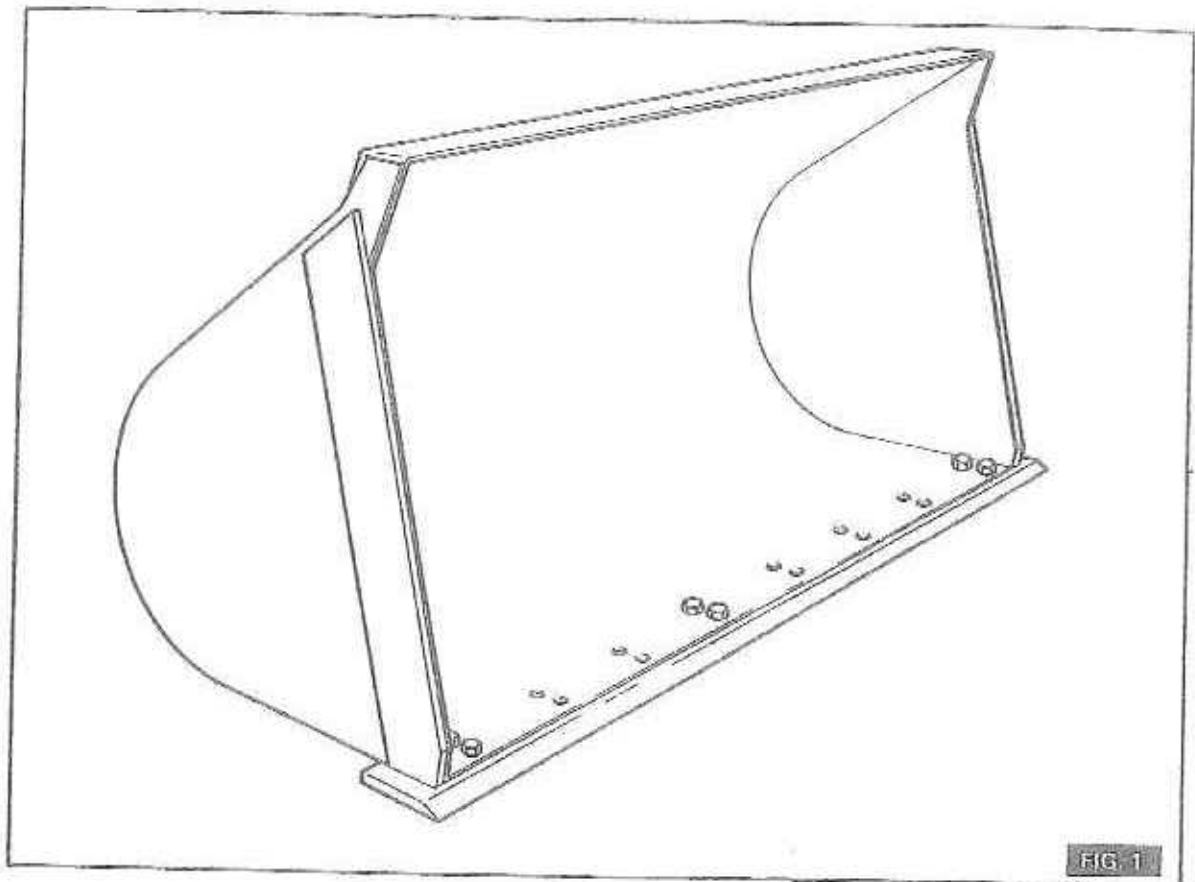
Note

The welding rods should be pre-heated to a temperature of 160°C to ensure that no dampness is present in the rod at the time of welding.

5. (Fig. 2) Complete the welds marked A before welds marked B to avoid distortion.
6. Remove the 6 bolts.

If required a further run of weld using Duroid No. 3 rods can be put over the top of the new weld. This gives a hard wearing surface.







DIGGER MECHANICAL COMPONENTS



CONTENTS

	PAGE
GENERAL	4
FRAME, Removal and Replacement 11A/1	4

LIST OF ILLUSTRATIONS

Figure	Facing Page
1. CAB REAR PANEL, Removal	4
2. DIGGER FRAME, Removal	4

DIGGER FRAME

The digger is attached to the machine at four points by means of hook type linkages and is easily removed. An attaching sill is fitted to the rear of each loader side frame, the lower attaching points on the digger are hooked over the attaching sills and the upper part of the frame is then connected by two box section links. The links are pivoted near the base of the vertical pivot post.

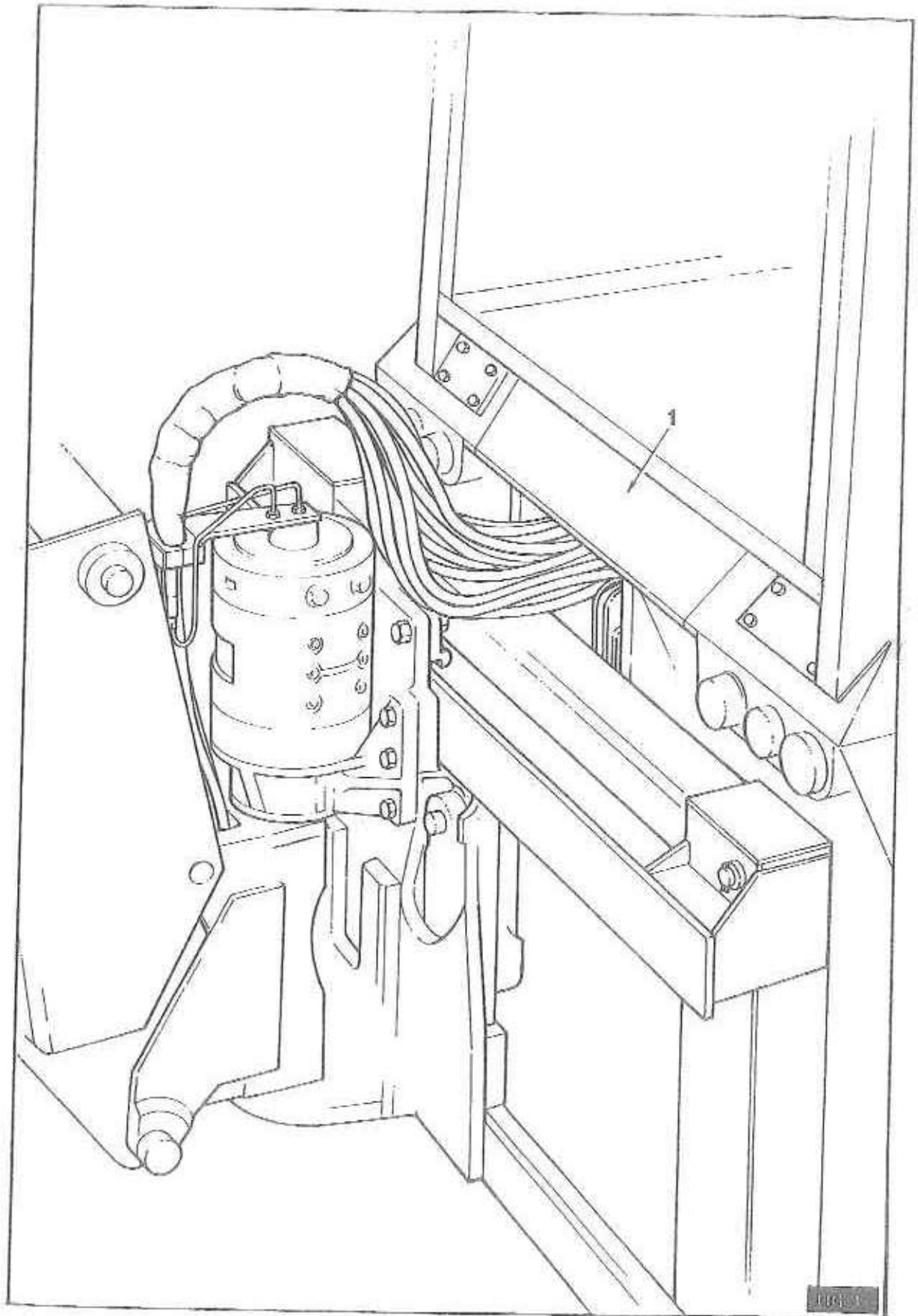
FRAME

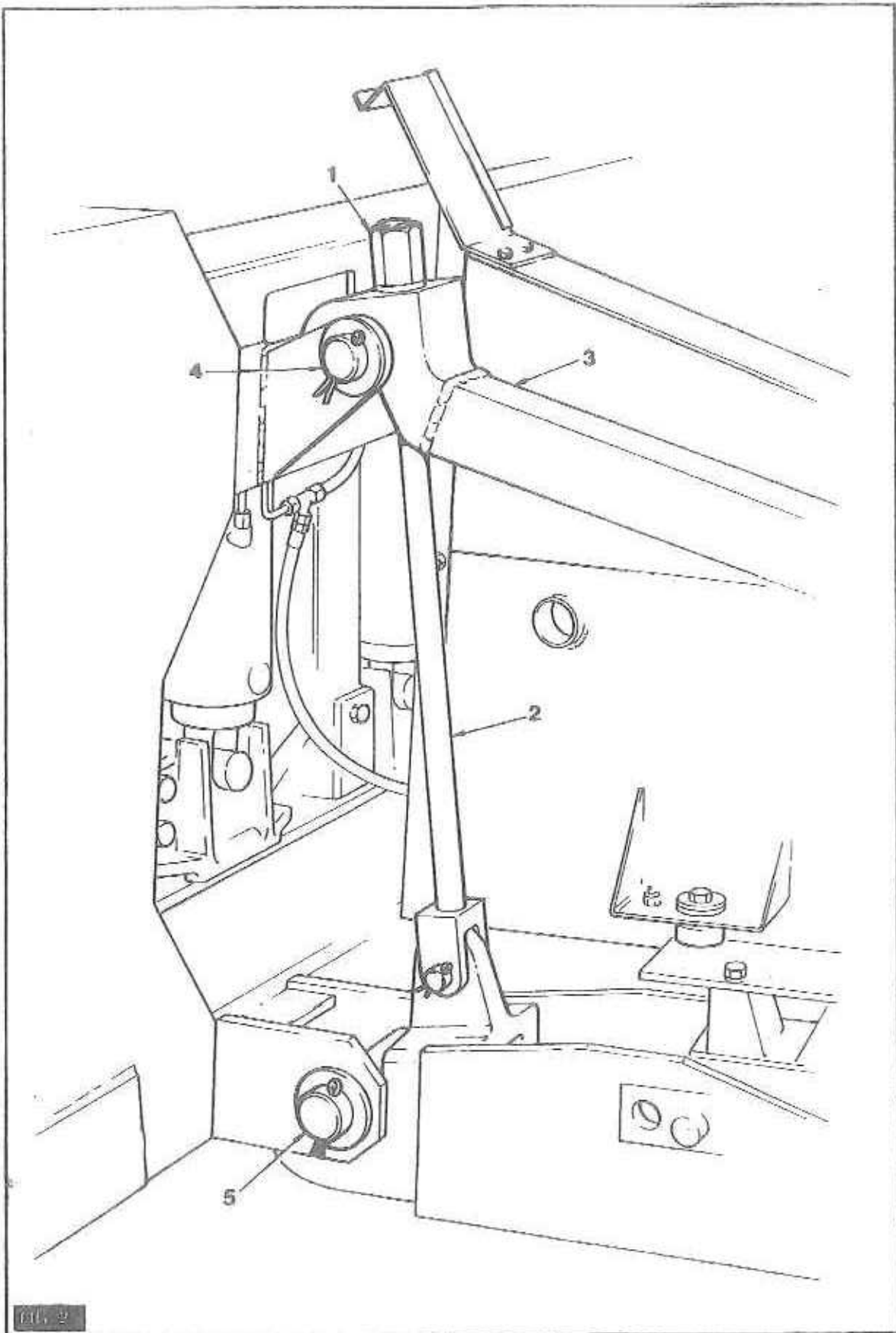
Removal and Replacement

11A/1

1. (Fig. 1) Remove the rear panel (1) from the cab.
2. Extend the stabilizer legs far enough to take the weight of the digger rear frame.
3. Centralise the digger unit on the frame and position the bucket centrally on the ground.
4. (Fig. 2) Unscrew the nuts (1) from the tie links (2) and lift the arms (3) from off the pin (4).
5. Carefully raise the frame by using the stabilizers until it is clear of the lower link (5) then move the tractor a few inches forward to clear the frame.
6. Lower the frame far enough to allow the seven spool valve control levers to come clear of the cab frame.
7. Disconnect the oil return pipe from the seven spool valve.
8. Disconnect the oil pressure pipe at the union under the left hand wheel arch then quickly connect the return pipe to the pressure pipe thus isolating the digger.
9. To replace the digger reverse the above procedure.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100





LOADER MECHANICAL COMPONENTS

CONTENTS

	PAGE
GENERAL	4
BUCKET, Removal and Replacement 12A/1	4
LIFT ARMS, Removal and Replacement 12A/2	4
SIDE FRAMES, Removal and Replacement 12A/3	4

LIST OF ILLUSTRATIONS

Figure	Facing Page
1. LIFT ARMS, Removal and Replacement	4
2. SIDE FRAME, Removal and Replacement	4
3. CROSS PIPES, Removal and Replacement	5

LOADER FRAME AND LIFT ARMS

GENERAL

The main movable component of the loader is the lift arms which, pivoted from the vertical pivot posts, is actuated by a pair of hydraulic rams and carries the bucket and its associated linkage.

BUCKET

Removal and Replacement

12A/1

1. Lower the bucket to the floor and switch off the engine.
2. Disconnect the loader lift arms and the bucket arms from the bucket by removing the split pins and pivot pins from each lift arm and bucket arm attachment points.
3. The bucket can now be moved clear.
4. Replace in reverse order of the above procedure.

LIFT ARMS

Removal and Replacement

12A/2

1. Remove the bucket as stated in operation 12A/1.
2. (Fig. 1) Remove the split pins and pivot pins (1) which secure the short transfer arms (2) to the counter arms (3) and remove the transfer arms.
3. Remove the split pins and pivot pins (4) securing the long transfer arms (5) to the counter arms and remove the transfer arms.
4. Remove the split pins and pivot pins (6) which secure the front counter lever (3) to the lift arms and remove the levers.
5. Remove the pivot pins and split pins (7) securing the bucket rams to the counter levers.
6. Remove the split pins and pivot pins (8) securing the rear counter levers to the lift arms and remove the levers.
7. Disconnect the lift rams from the lift arms.
8. Start the engine and fully contract the bucket and lift arms.
9. Support the loader lift arms on a suitable gantry and remove the split pins and pivot pins (9) which secure the loader arms to the side frames.
10. Reverse the machine from the loader lift arms and lower the arms to the ground.
11. Replace in reverse order of the above procedure.

SIDE FRAMES

Removal and Replacement

12A/3

The following instructions assume that the cab and digger unit have been removed.

1. Completely drain the hydraulic system.
2. Remove the lift arms as stated in operation 12A/2.
3. Remove the lift rams as stated in operation 9G/1.
4. Remove the bucket ram as stated in operation 9G/4.
5. Disconnect all hydraulic pipes from the two spool valve (L.H. frame only).

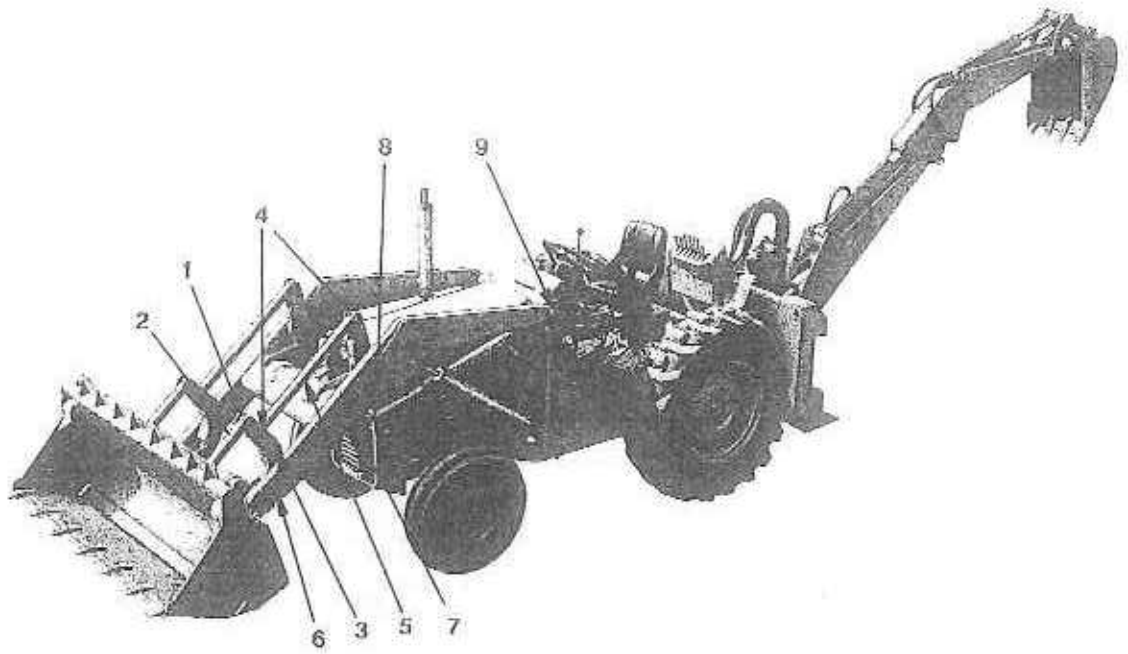


FIG 1

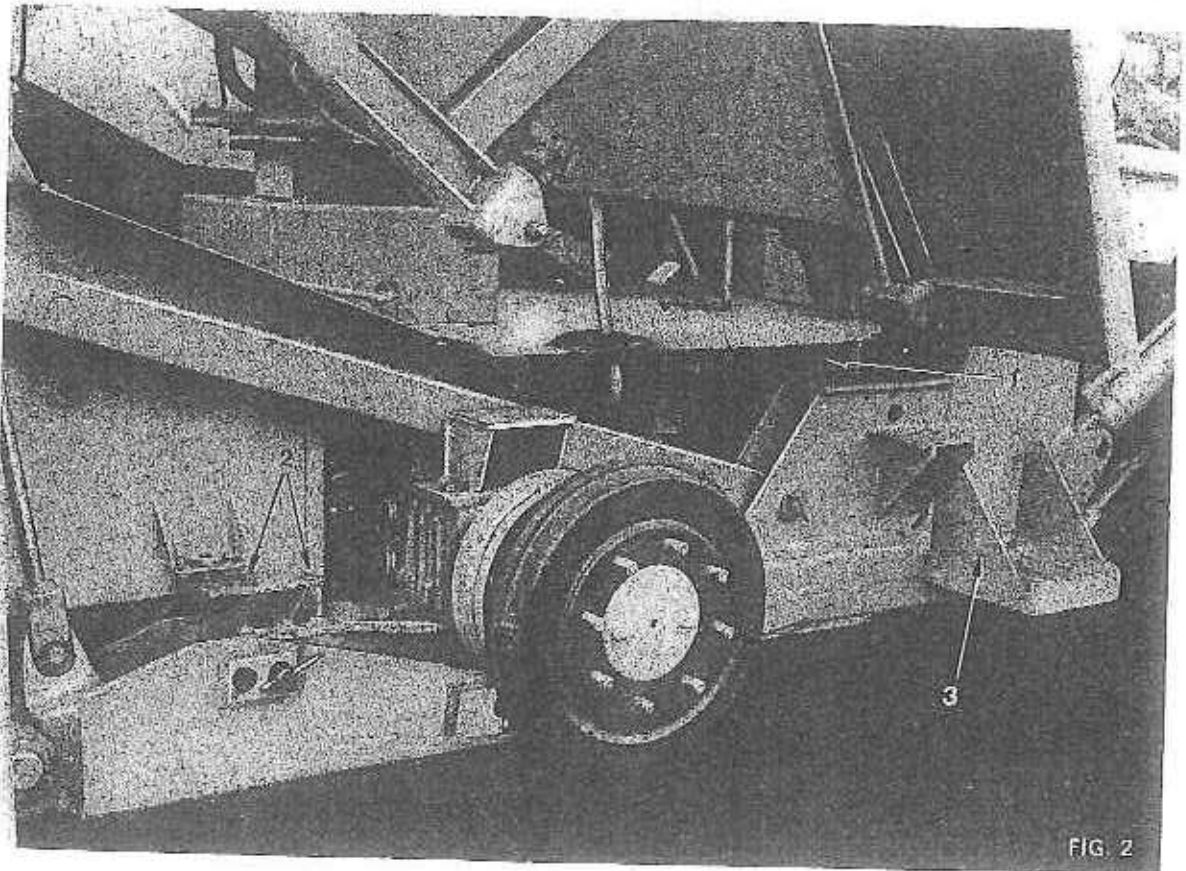


FIG. 2

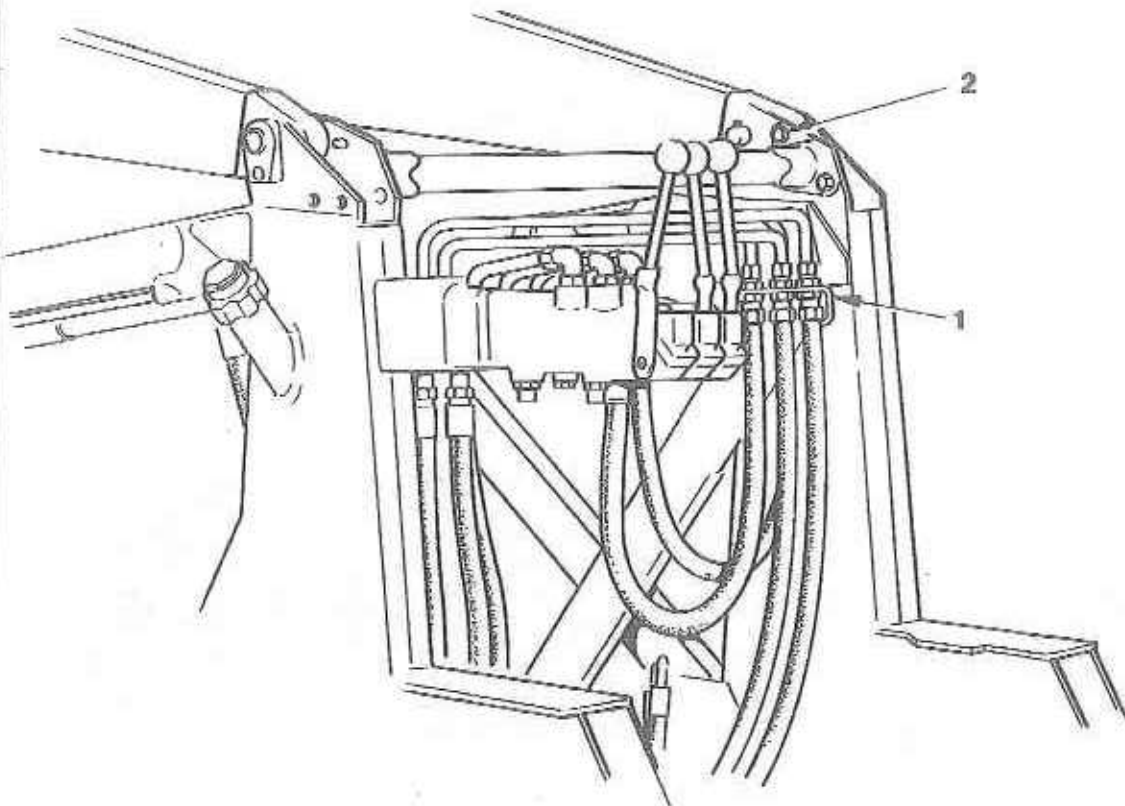


FIG 3

SIDE FRAMES

Removal and Replacement Cont'd

6. Remove the oil filter and main hydraulic hoses from the side frame (L.H. frame only).
7. (Fig. 2) Remove the bolt (1) which secures the platform to the side frame.
8. Remove the two bolts (2) which secure the rear well to the side frame.
9. Remove the footstep unit (3) by unscrewing the four securing bolts (R.H. frame only).
10. (Fig. 3) Release the cross pipe securing bracket (1) from the inside face of the side frame.
11. Remove the cross member retaining bolts (2).
12. Place a trolley jack under the centre of the side frame and set the jack just in tension.
13. Remove the four frame/rear axle retaining bolts.
14. Remove the three front retaining bolts.
15. Lower the frame and remove it from under the machine.
16. Replacement is a reversal of the above procedure.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

TOOLS

CONTENTS

	PAGE
ENGINE	4
COOLING SYSTEM	4
FRONT AXLE	4
POWER STEERING	4
STANDARD TRANSMISSION	4
CLUTCH	5
REVERSOMATIC TRANSMISSION	5
TORQUE CONVERTER	5
REAR AXLE AND WET BRAKES	5
HYDRAULIC PUMP	5
TWO SPOOL VALVE	6
ROTARY ACTUATOR	6

100

100

100

TOOLS

APPROVED SERVICE TOOLS

ENGINE

38 UX	Piston Ring Compressor
PD 42 B	Gudgeon Pin Bush Remover
PD 42 B/4	Adaptor
PD 137	Valve Guide Reamer
PD 138	Valve Guide Reamer
PD 150	Cylinder Liner Remover/Replacer
PD 150/2	Cylinder Liner Remover/Replacer Adaptor
MF 155	Small Adjustable Puller
MF 200	Hand Press
MF 200/4	Hand Press Adaptor
316 X	Valve Seat Cutter Handle
316/12	Valve Seat Cutter Pilot
316/13	Valve Seat Cutter Pilot +.030 in.
316/125	Valve Seat Cutter Pilot +.015 in.
317/30	Inlet Valve Seat Cutter
335	Con. Rod Alignment Jig
336	Multi-Purpose Arbor
6118 A	Valve Spring Compressor
6118/4	Valve Spring Adaptor
6200	Reaming Fixture
PD 6200/3	Reamer Set

COOLING SYSTEM

MF 155	Small Adjustable Puller
MF 200	Hand Press
MF 200/4	Hand Press Adaptor

FRONT AXLE

MF 263/3	King Pin Bush Remover
MF 264/7	King Pin Bush Reamer

POWER STEERING

MF 148	Hydraulic Pressure Test Equipment
MF 148/7	Power Steering Adaptor
MF 203 A/1	Oil Seal Driver Adaptor
MF 263	Front Axle and Steering Bush Remover
MF 263/2	Front Axle and Steering Bush Remover/ Replacer Adaptor
MF 264	Front Axle and Steering Bush Reamer
MF 264/2	Reamer and Pilot
MF 550	Driver Handle

STANDARD TRANSMISSION

MF 177	Transmission Main Drive Shaft Oil Seal Pilot
MF 179	Transmission Pinion Oil Seal Replacer
MF 220/25	Multi Purpose Bearing Remover/Replacer



CLUTCH

MF 159 A
MF 314

Clutch Centraliser
Lever Fulcrum Height Setting

REVERSOMATIC TRANSMISSION

MF 244

Instant Reverse Clutch Spring Compressor

TORQUE CONVERTER

MF 246
MF 260
MF 260/2

Torque Converter Checking Gauge
Low Pressure Hydraulic Test Set
Hydraulic Test Adaptor

REAR AXLE WET BRAKES

MF 197
MF 197/2
MF 200
MF 200/3
MF 200/23
MF 200/24
MF 200/25
MF 245 D
MF 257
MF 265 A
MF 266
MF 550
MF 555
MF 555-2 A
MF 1105
MF 1105/1
MF 1105/2 A/1
MF 1105/2 A/4
MF 1105/7A/1
MF 1105/7A/2
MF 1105/7A/3
MF 1105/B
CP 4030

Wheel Axle Outer Bearing Cone and
Differential Cone Replacer
Differential Carrier Plate Bearing Cone
Replacer Adaptor
Hand Press

Differential Carrier Plate Bearing Cone
Remover Adaptor
Drive Pinion Bearing and Pilot
Bearing Remover/Replacer Adaptor
Epicyclic Hub Inner Bearing Cone
Remover Adaptor
Multi Purpose Bearing Remover
Rear Axle Pre Load Gauge
Differential Bearing Cone Replacer
Planetary Carrier Remover
Planetary Carrier Bush Inner Oil Seal
Bearing Cone and Unit Replacer
Handle
Three-Legged Adjustable Puller
Differential Coupling Bearing
Cone Remover
Adaptor
Adaptor
Adaptor
Differential Bearing Cup Remover/
Replacer Adaptor
Differential Bearing Cup Removal/
Replacer Adaptor
Differential Bearing Cup Removal/
Replacer Adaptor
Epicyclic Hub Inner Bearing Cup
Remover/Replacer Adaptor
Drive Pinion Pre-Load Gauge

HYDRAULIC PUMP

MF 341

Drive Shaft Extractor

PART 13 SECTION A

MF WORKSHOP SERVICE MANUAL 1457 087 M1

TWO SPOOL VALVE

MF 148

Hydraulic Pressure Test Equipment

ROTARY ACTUATOR

MF 342

Peening Punch—Rotary Actuator
Locking Column

MF 343

Peening Punch—Rotary Actuator
Sleeve Retainer

MF 344

Tee Wrench—Rotary Actuator Sleeve
Retainer and Locking Column