MF 50 B

TRACTOR/BACKHOE/ LOADER

SPECIFICATIONS

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LIST OF ILLUSTRATIONS

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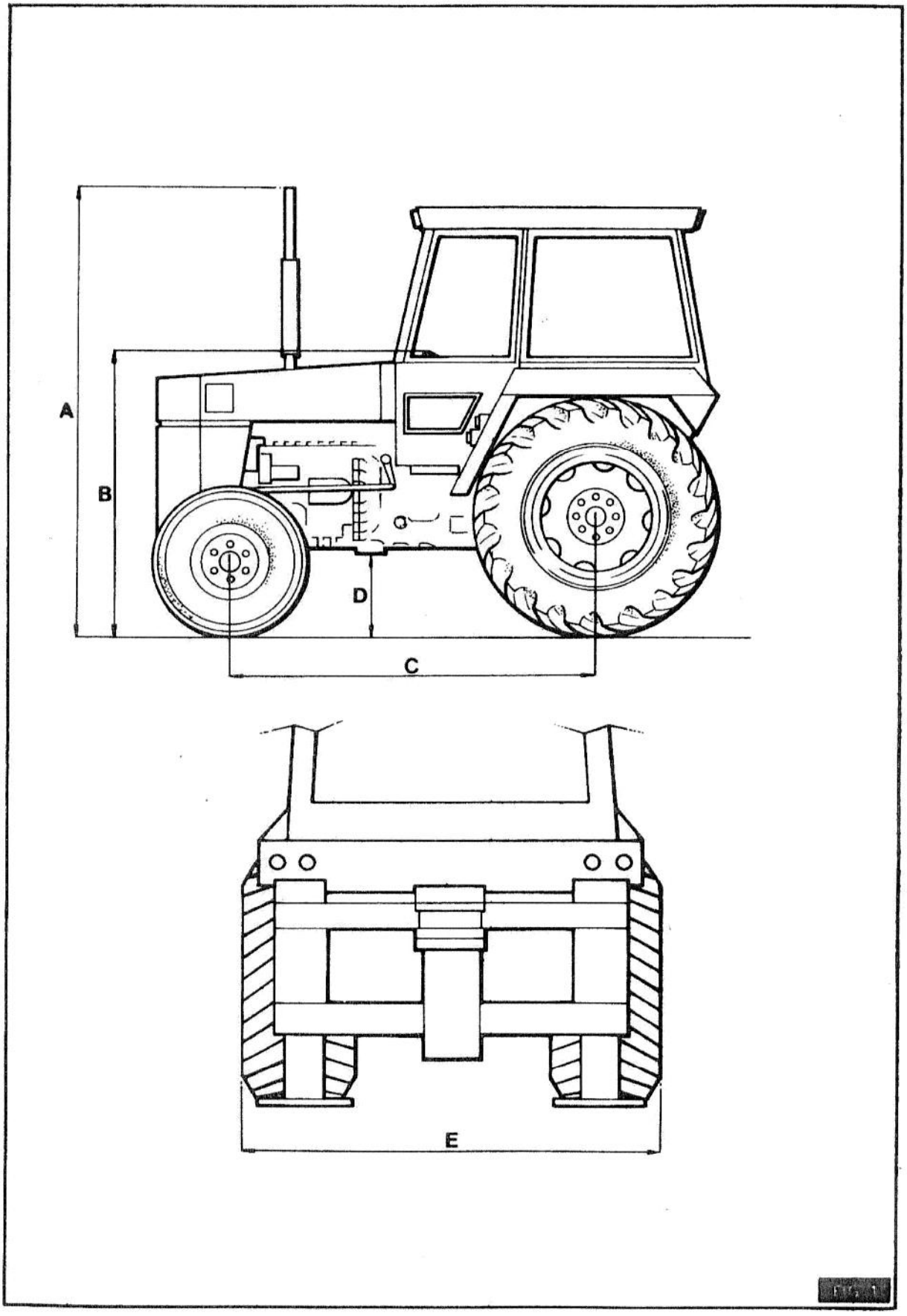
A
B
D
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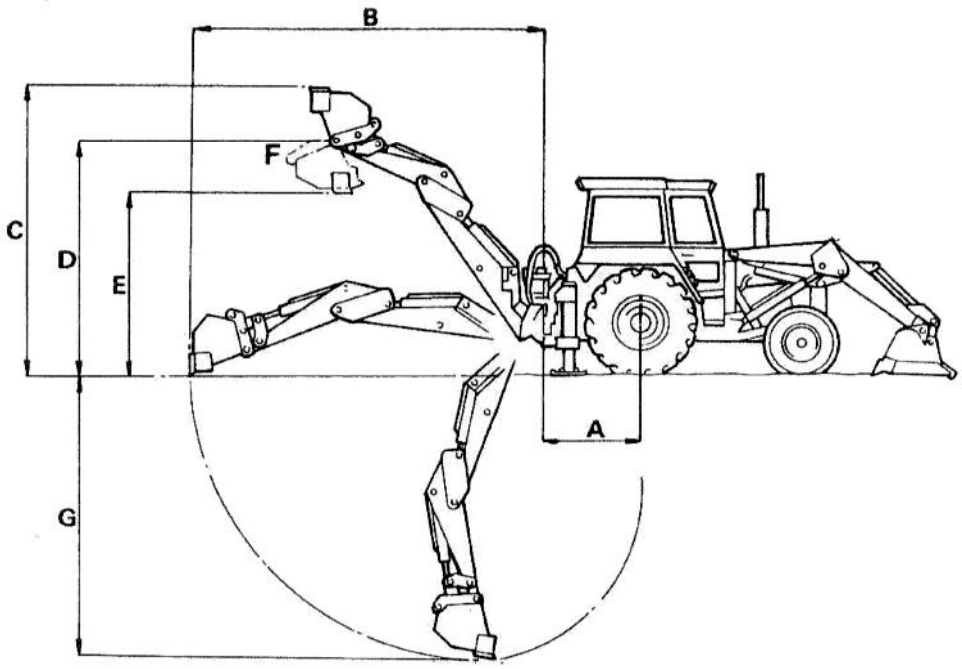
E



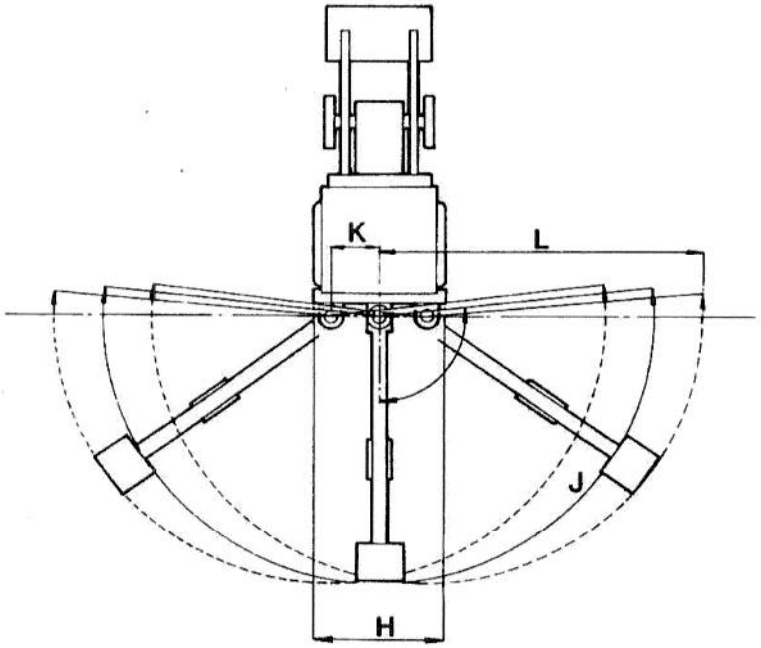


FIG. 2

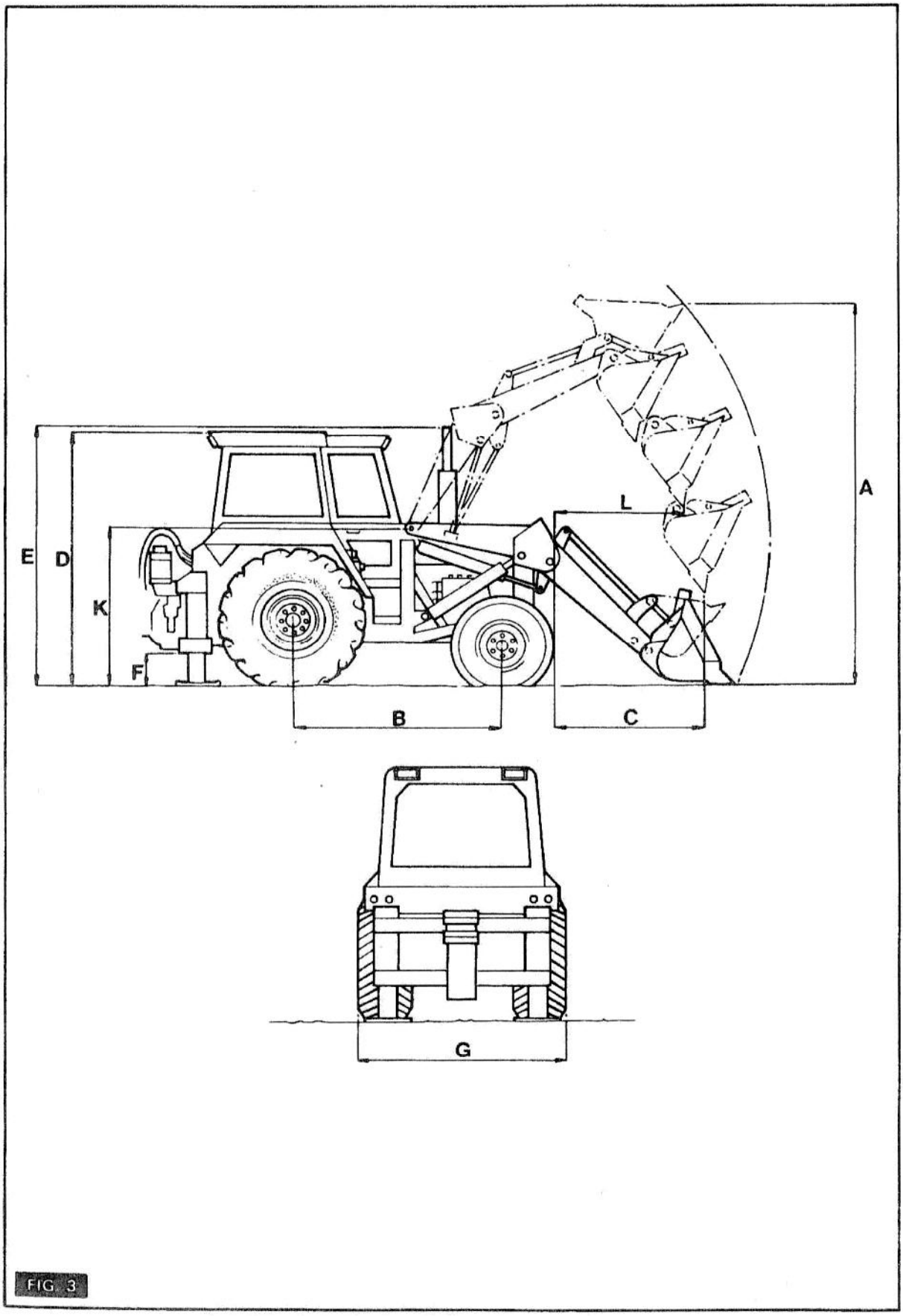


FIG. 3

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.
Valves	Overhead type
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.
Easy Starting Aid	C.A.V. Thermostart Mark IIIC.
Air Cleaner	Dry element, removable for cleaning.

GENERAL . . . Cont'd

COOLING SYSTEM

System Pressure	10 p.s.i. (0.703 kg/cm^2). 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
Cab	Front windscreen wiper Rear wiper optional
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 10.86:1
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.
Final Drive	Bevel drive with epicyclic final hub reduction giving a ratio of 10.9:1.

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 × 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 :– 10½ pints (1.575 U.S. Gallons; 5.96 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). Reversomatic 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)	5¼ 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.)	190	234	345	387	432	398
(kgs.)	86	106	156	175	195	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.

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	Grand 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)	6¾ 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

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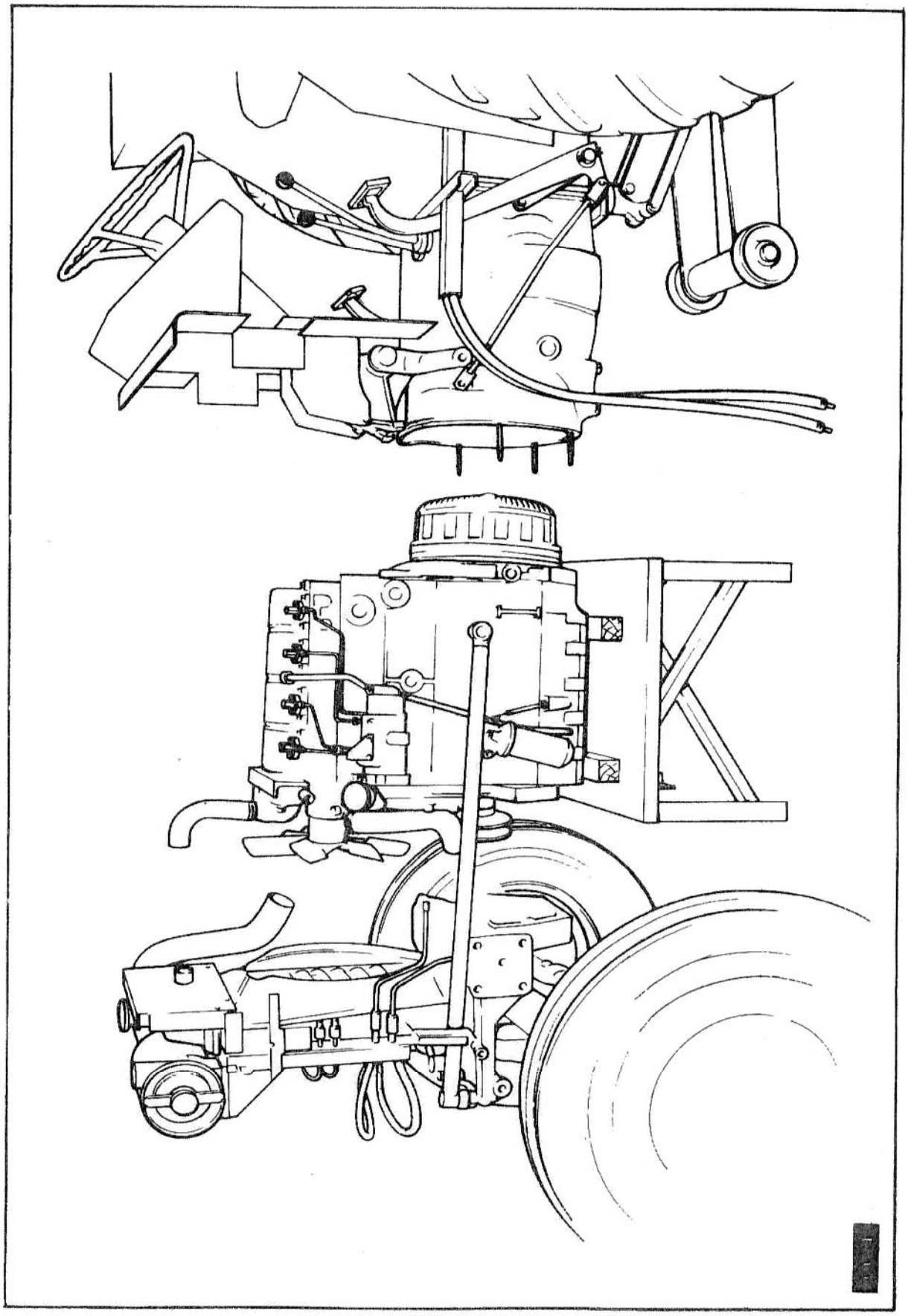
LIST OF ILLUSTRATIONS



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

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Technical Data—Engine Manufacturing Data and Dimensions

Timing Gears

Cooling System

Fuel System

Contents . . . . Cont'd

General Data

TECHNICAL DATA

Bore	3.875 in (98,43 mm)
Stroke	4.5 in (114,3 mm)
No. of Cylinders	Four
Cubic Capacity	212 in³ (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)
Idler Gear hub nuts	21–24 lb ft (2,9–3,32 kg m)
Flywheel setscrews	80 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)	3.9625/3.9635 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 (5,80/50,83 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	4.0655/4.0665 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 (38,99/39,03 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 (40,06/40,11 mm)
Connecting Rod End float on Crankpin	0.0095/0.0145 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.	2.499/2.4995 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 (46,98/47,00mm)
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 ± 0.15 in (103,20 mm ± 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/in² (2.11 kgf/cm²)
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 ± 2lb (7 kg ± 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 ± 2 lb (18,1 kg ± 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 (34,93/34.96 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	63
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/in² (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/in² (3,52/4,22 kgf/cm²)
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/in² (0,91/1,2 kgf/cm²) 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)
Vaive 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	1.656/1.718 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	2¾—4¼ lb/in² (0,19/0,30 kg/cm²)
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 0.205 in (5,21 mm)	Static Timing 22°

Atomisers

Working Pressure 170	Setting Pressure 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 reboring 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)
Idler Gear End Float	0.010 in (0,25 mm)

GENERAL DATA

Cooling System

System Pressure	10 p.s.i. (0,703 kg/cm²)
Thermostat Opening Temperature	180°F (82°C)
Fan Belt Deflection	¾ 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	45–50 lb ft (6,22–6,91 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 (10,5–11,1kg 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/in² (210,9 kg m)
Shock Relief Valve—Bucket Ram Rod side set at	5000 lbs/in² (351,5 kg m)
Shock Relief Valve— Lift Ram Head side set at	3500 lbs/in² (246,kg m)
Shock Relief Valve—Lift Ram Rod side set at	5000 lbs/in² (351,5 kg m)

Seven Spool Control Valve

Boom Direct Operated Relief Valve Pressures	3000 lbs/in² (211,0 kg/cm²) 2750 lbs/in² (193,3 kg/cm²)
Slew Spool Operated Relief Valve Pressure—Circuit Relief Valve	2000 lbs/in² (140,6 kg/cm²)
Dipperstick Ram Operated Relief Valve Pressures	3000 lbs/in² (211,0 kg/cm²) 2750 lbs/in² (193,3 kg/cm²)
Bucket Ram Operated Relief Valve Pressures	2750 lbs/in² (193,3 kg/cm²) 2750 lbs/in² (193,3 kg/cm²)

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.	100 lb/in² (7 kg f/cm²)
Relief Valve Torque	55/60 lb ft (7,6/8,3 kg m)
Check Valve Torque	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	50–55
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

CONTENTS . . . Cont'd

LIST OF ILLUSTRATIONS

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

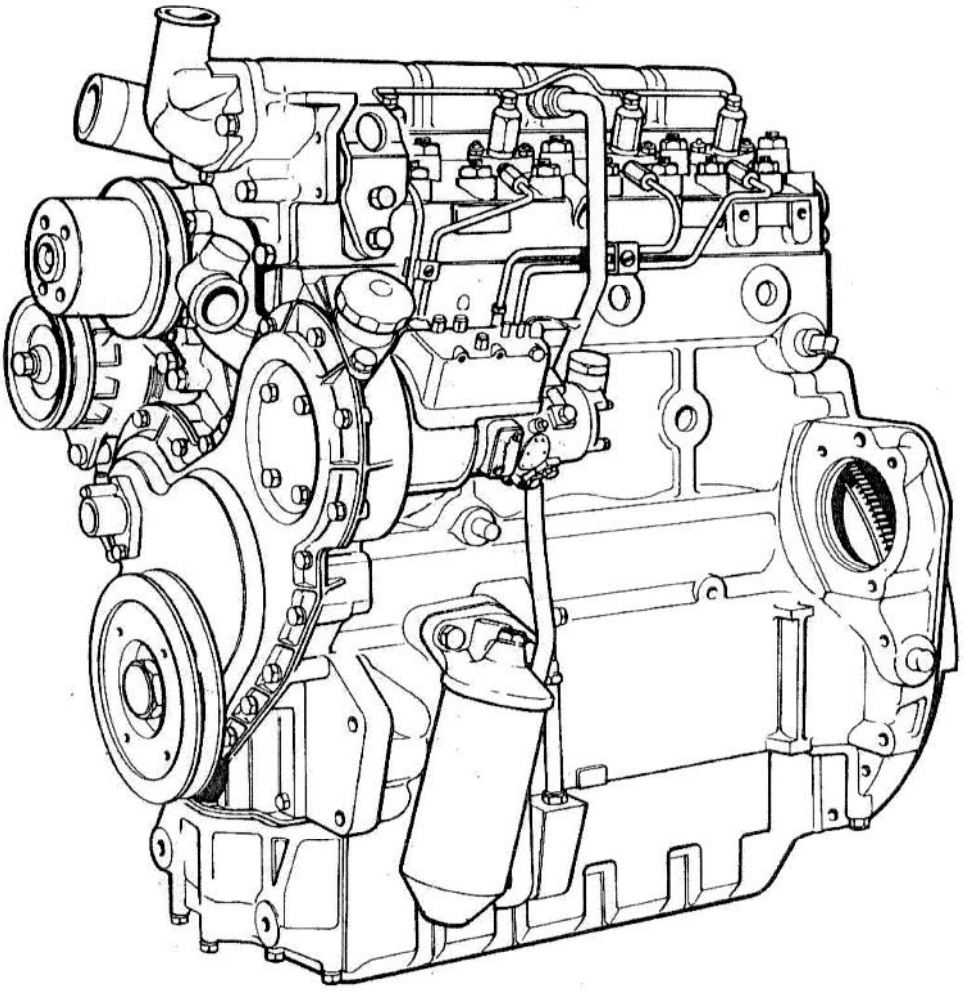

FIG 1A

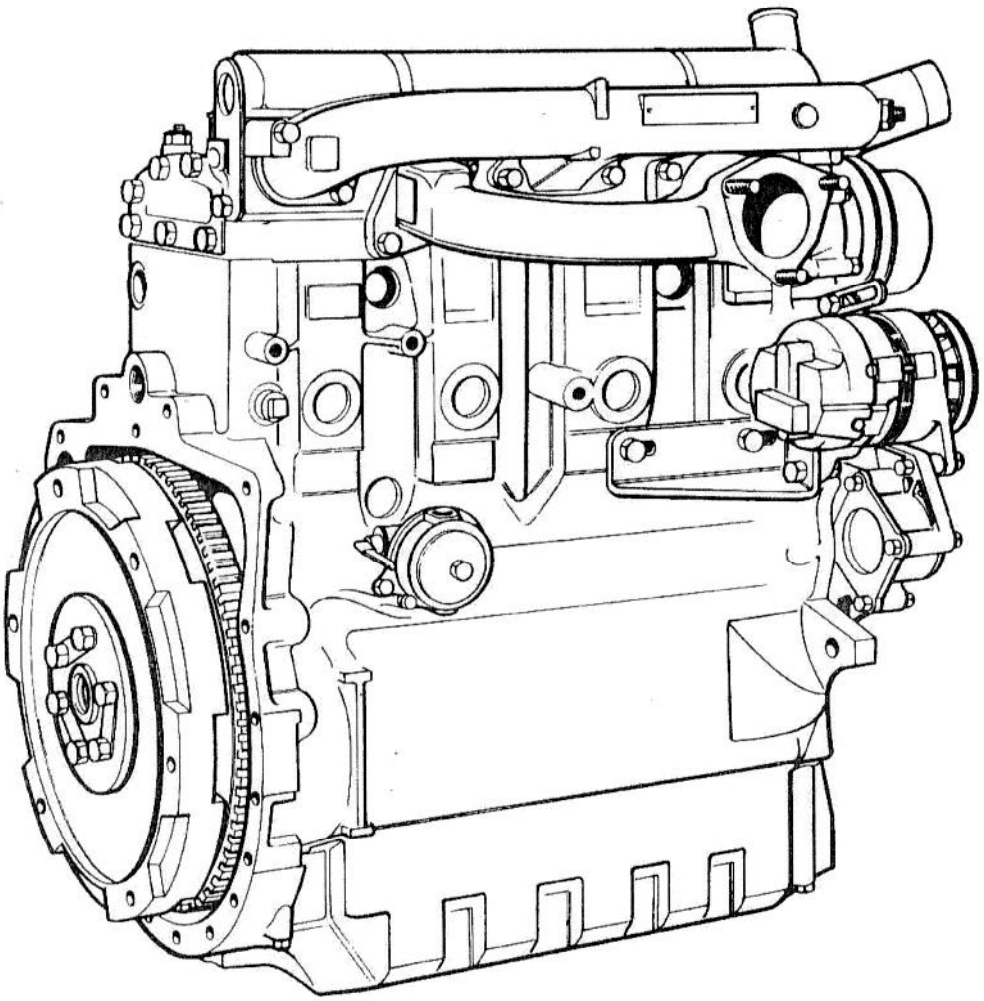

FIG. 1B

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 pressures 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 ±0,91 kg) for the outer springs and 1,5625 in. (39.69 mm.) at a load of 15.4 lb ±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 replacable 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 strained 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

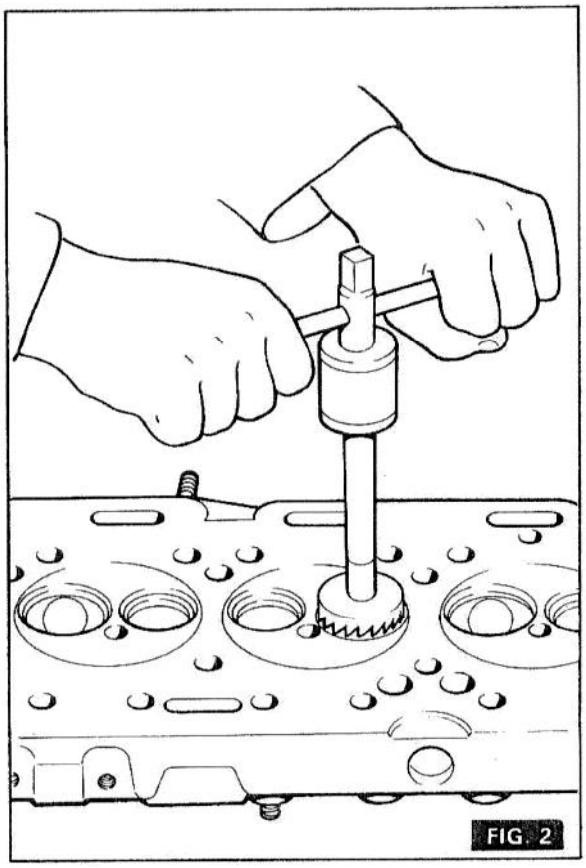

FIG. 2

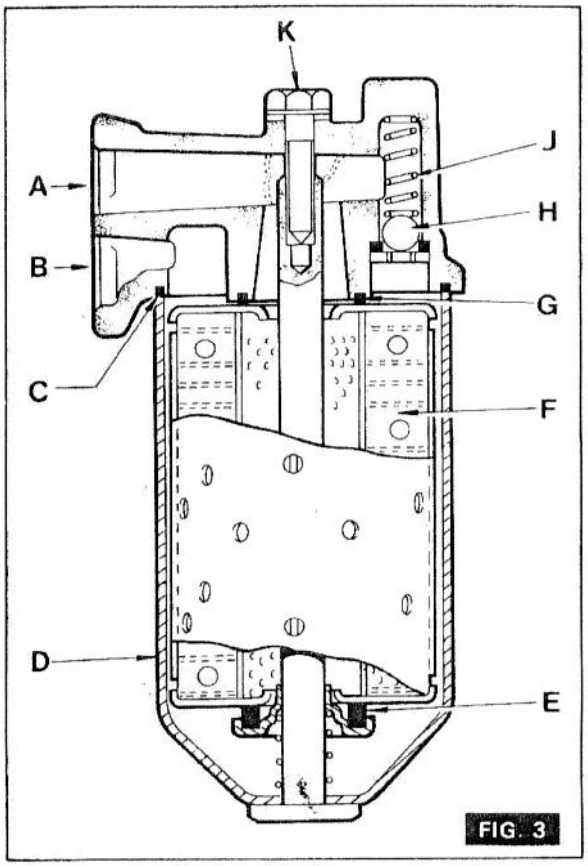

FIG. 3

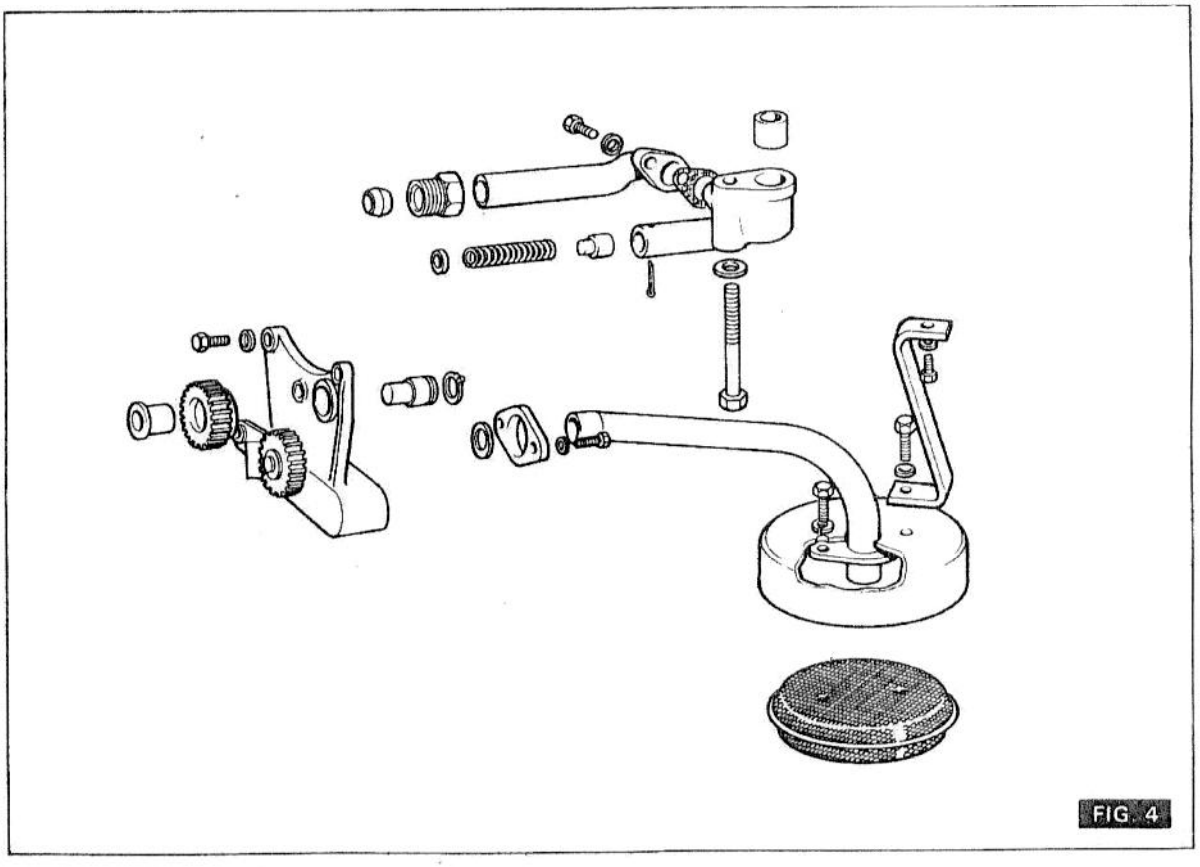

FIG. 4

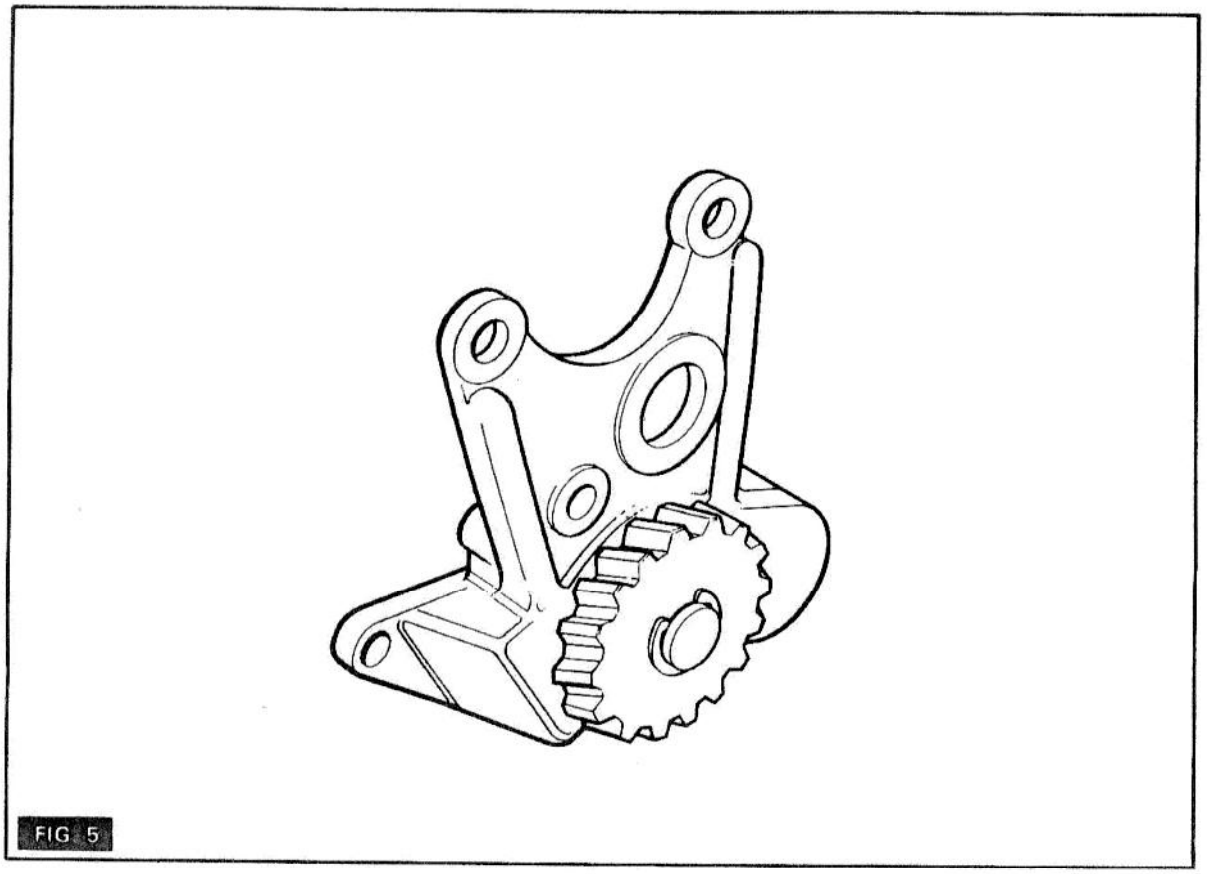

FIG 5

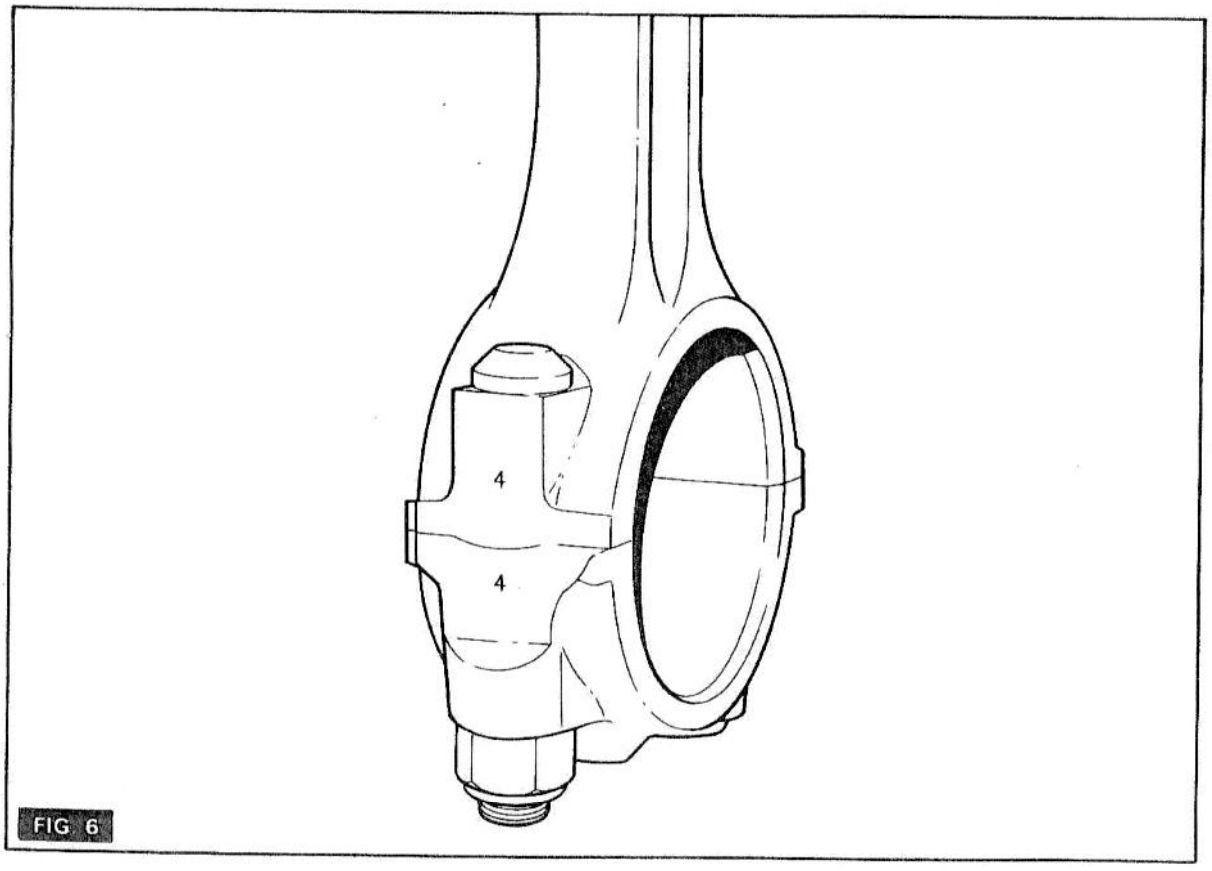

FIG 6

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.

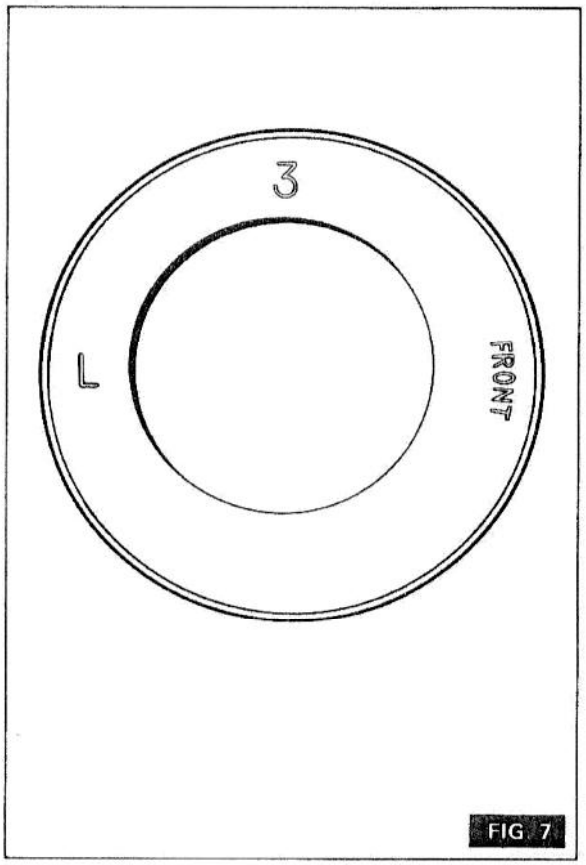

FIG. 7

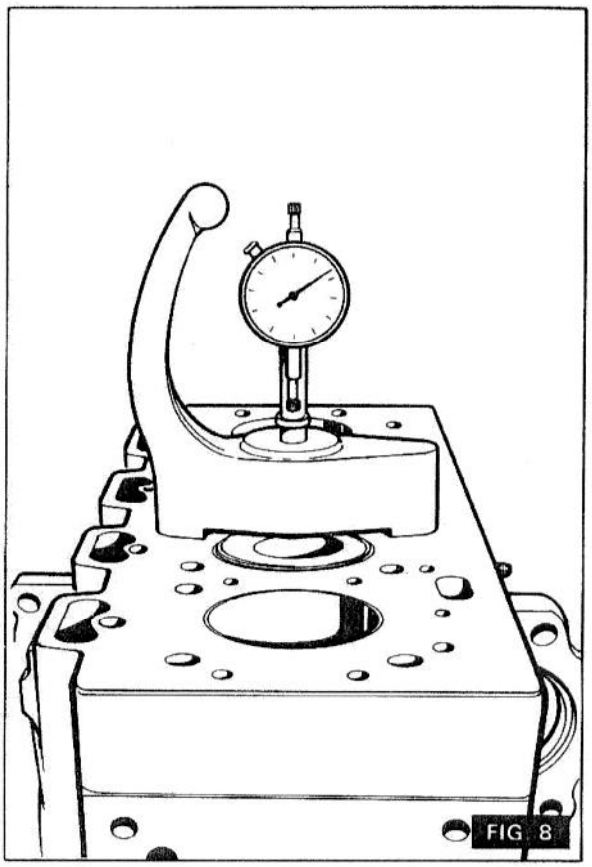
FIG. 8

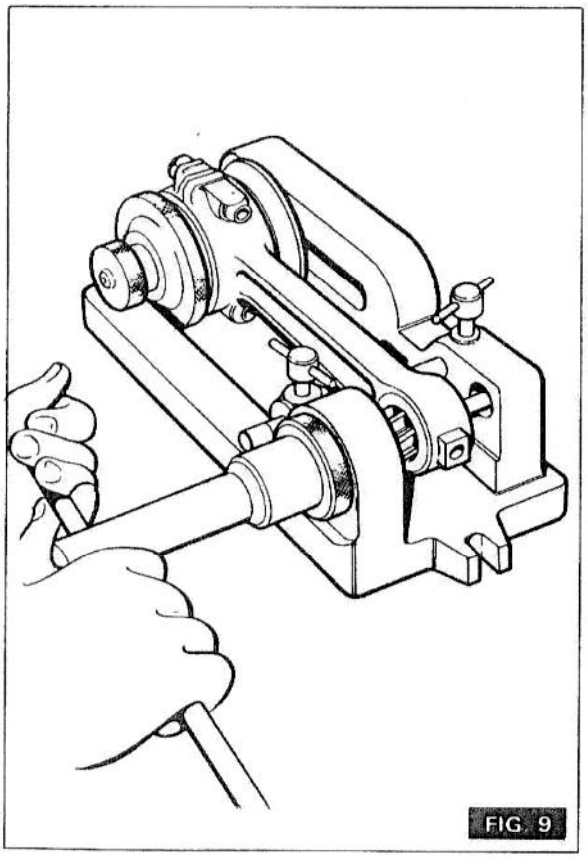
FIG. 9

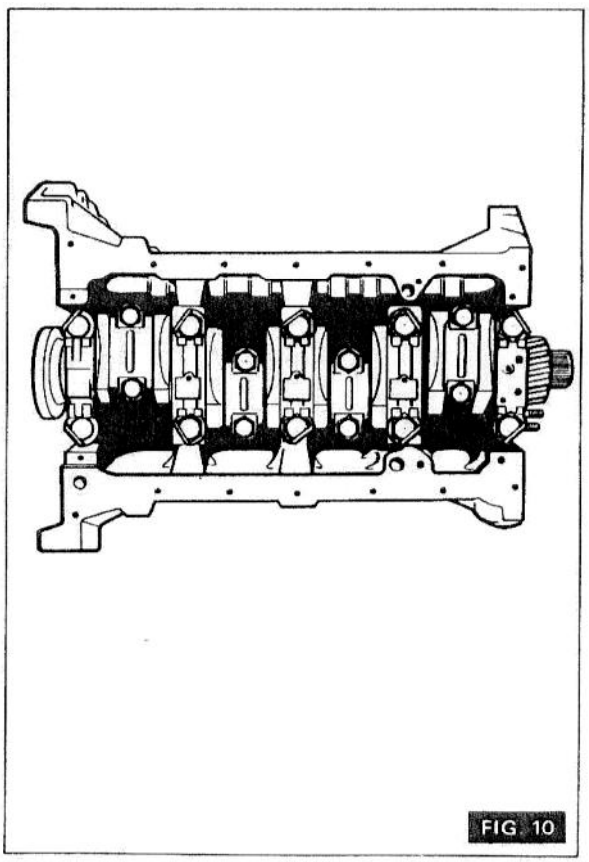
FIG. 10

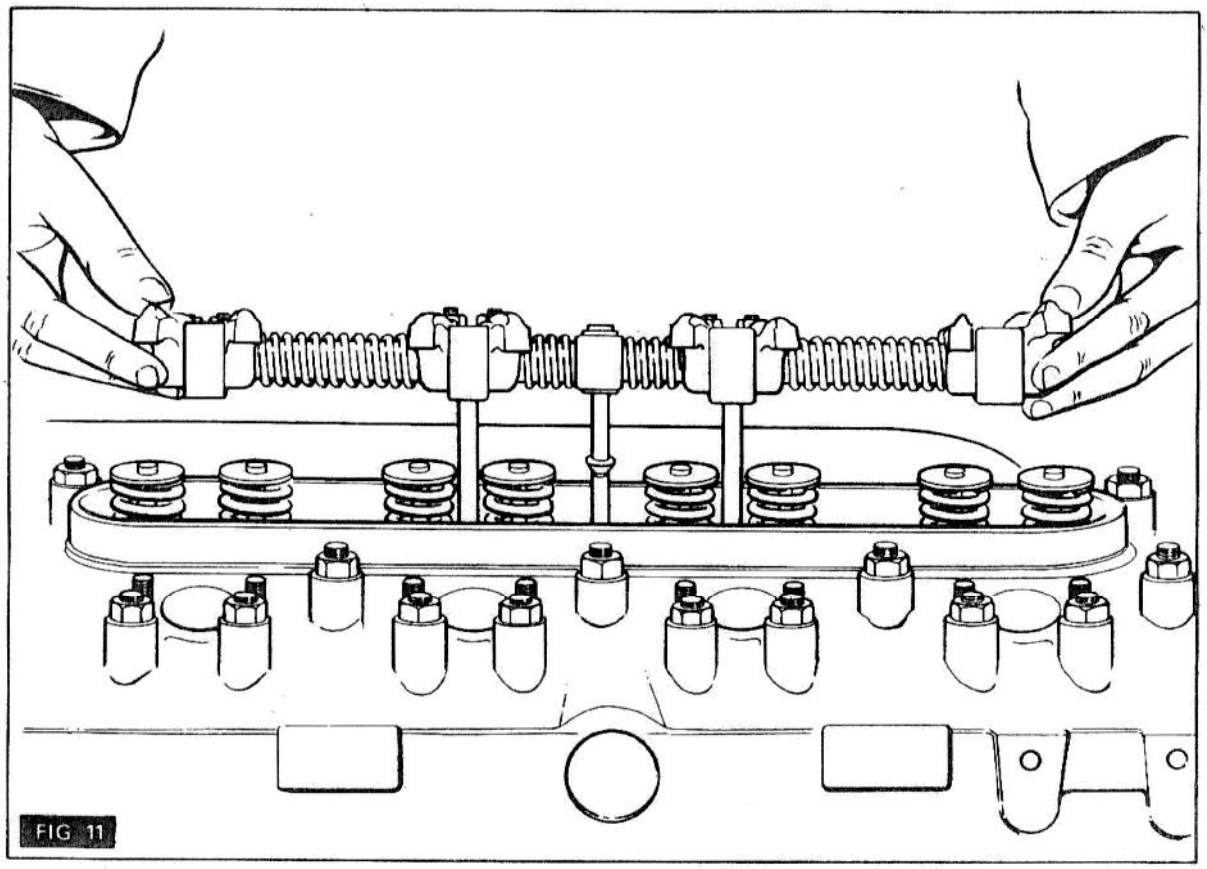

FIG 11

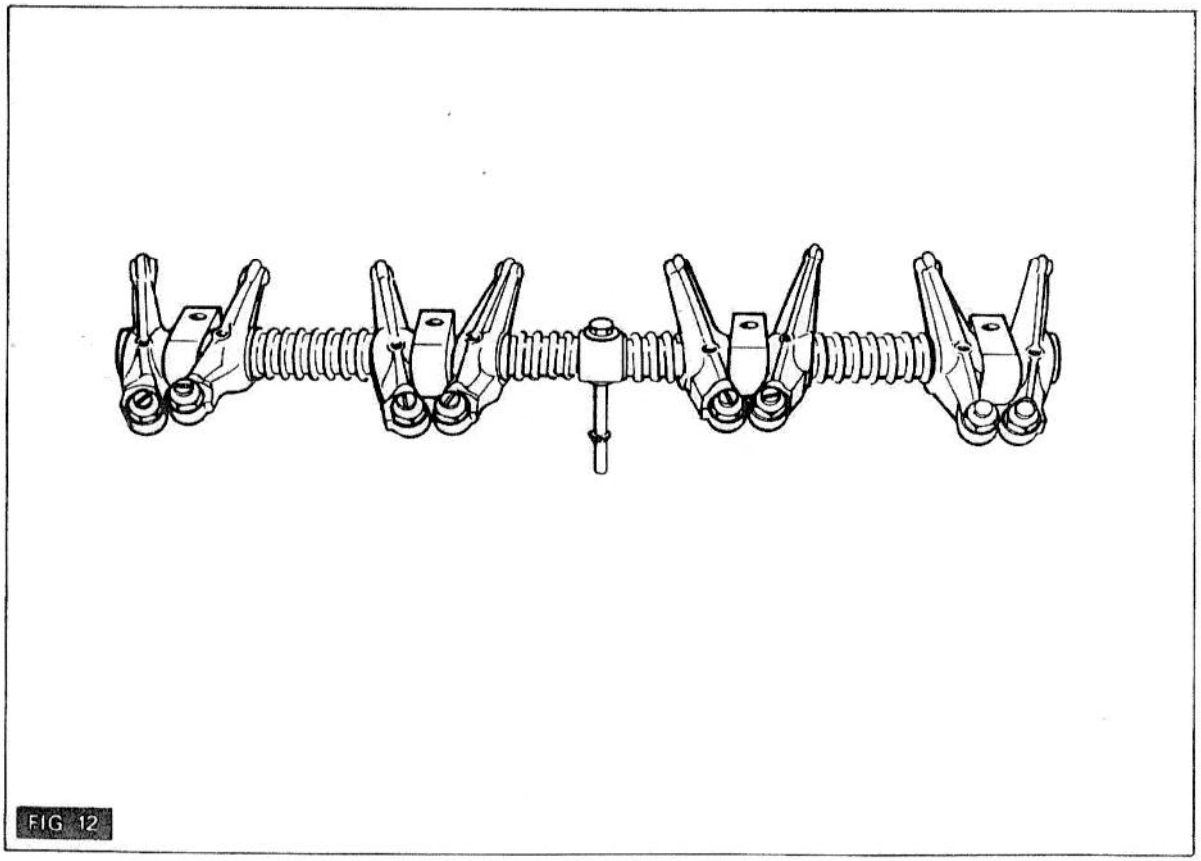

FIG 12

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 Valve.

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 collets 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 to 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.)

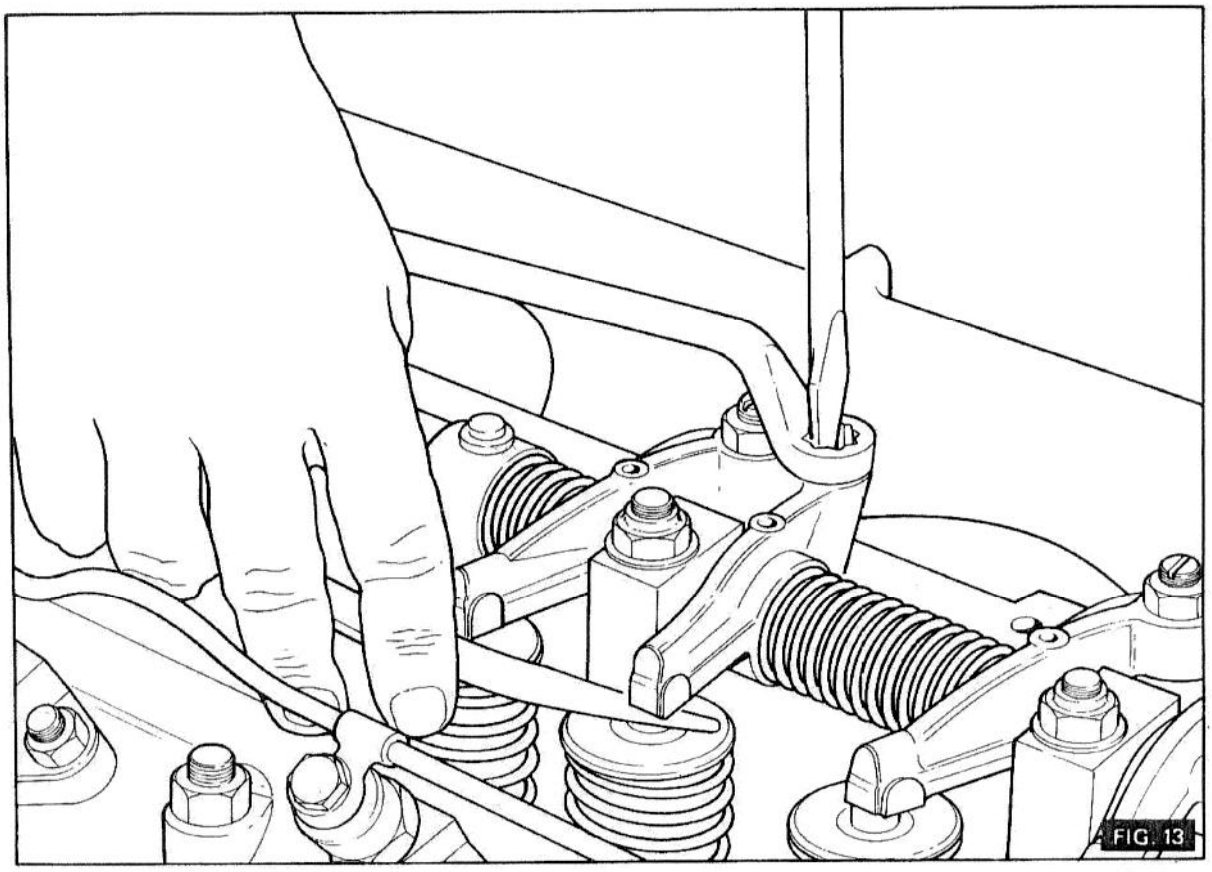

FIG. 13

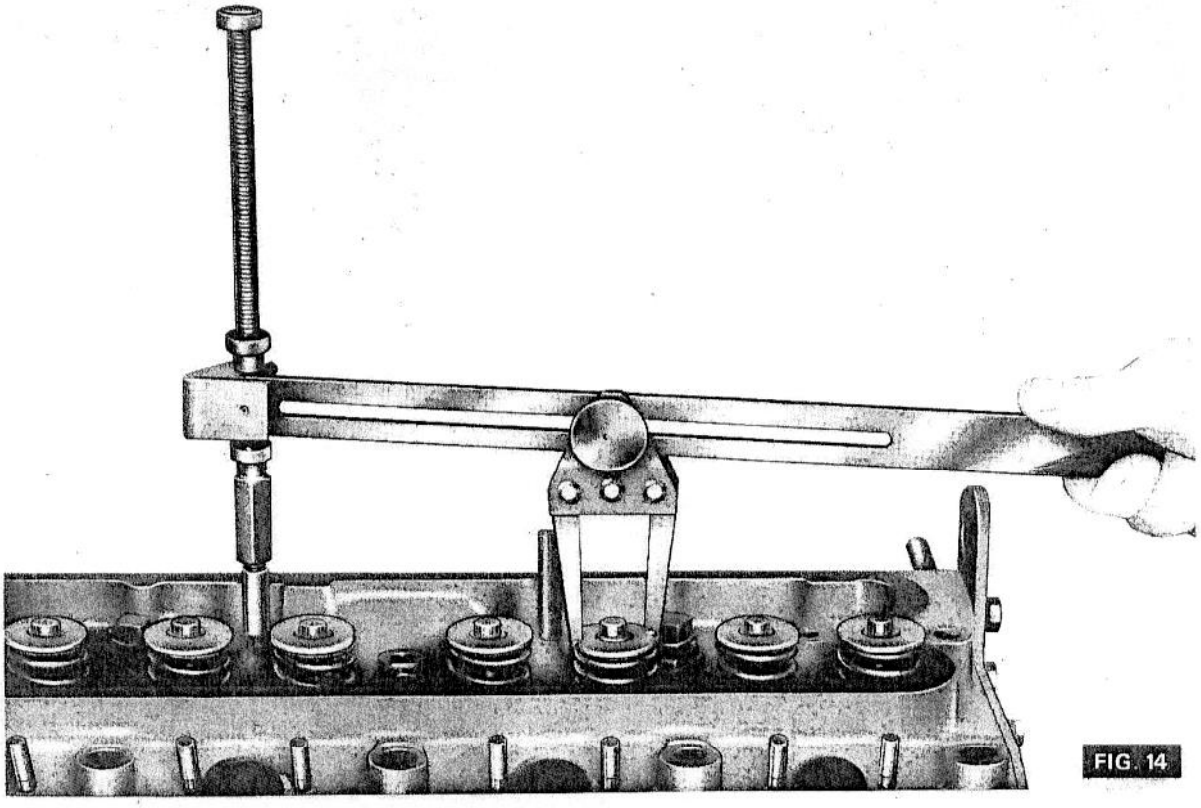

FIG. 14

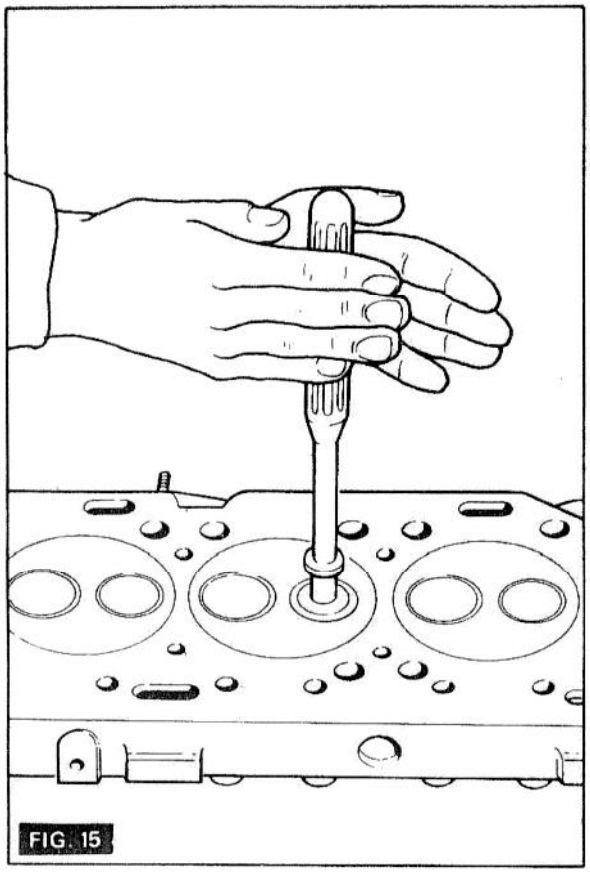

FIG. 15

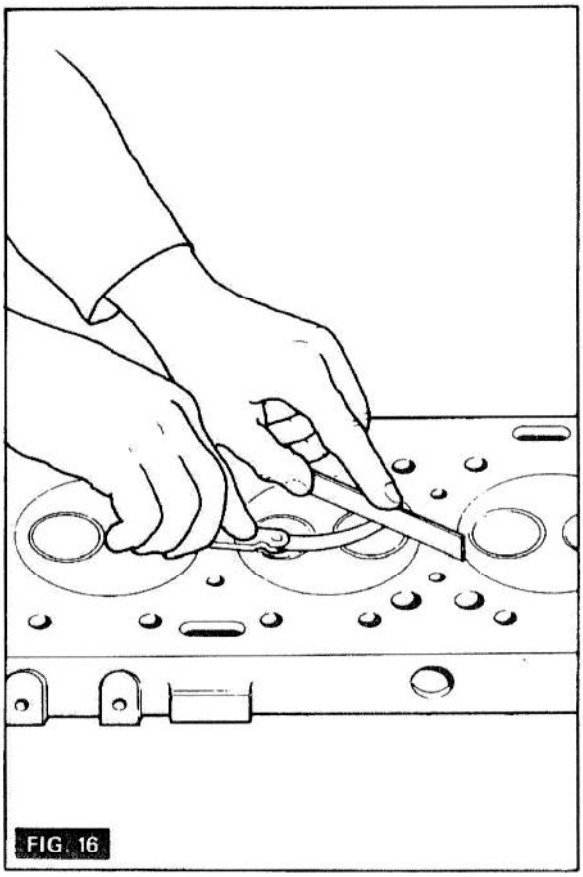

FIG. 16

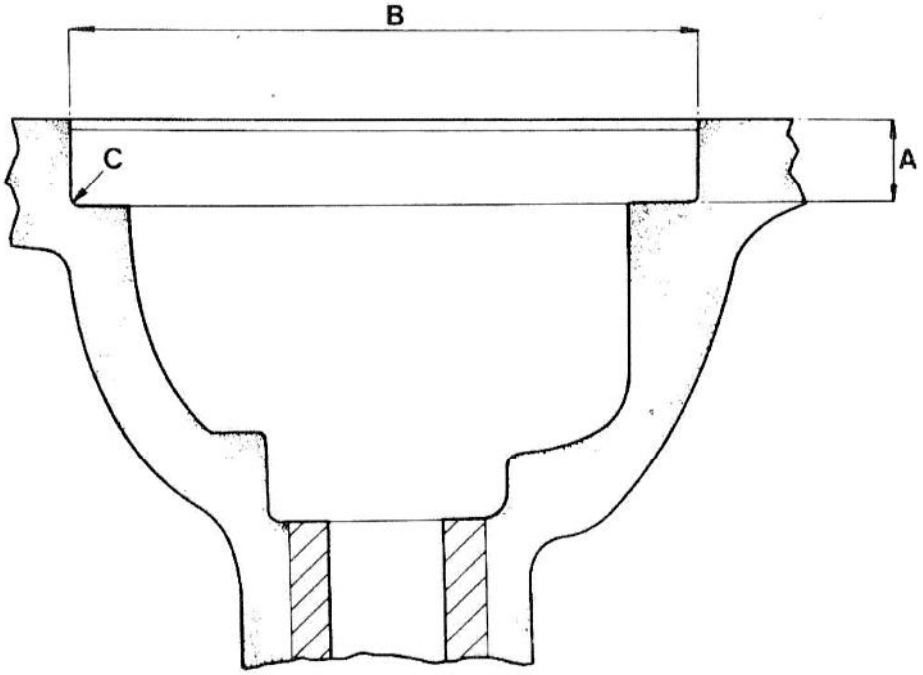

FIG. 17

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.)

2. 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.
3. Using the valve stem bore as a pilot, machine the "flare" to the dimensions given in Fig. 19.
4. Remove all machining swarf and any burrs which may be present.
5. 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 4.0355 in. (102.51 mm.).

KEY TO FIGURE 18

A -	3"		(76. 20 mm.)
B -	.250"	Inlet	(6. 35 mm.)
	.312"	Exhaust	(7.925 mm.)
C -	3/4"		(19. 05 mm.)
D -	.372"		(9.449 mm.)
	.373"		(9.474 mm.)
E -	1.582")	Inlet	(40.183 mm.)
	1.583")		(40.208 mm.)
	1.248")	Exhaust	(31.699 mm.)
	1.249")		(31.725 mm.)
F -	2.009")	Inlet	(51.029 mm.)
	2.019")		(51.283 mm.)
	1.670")	Exhaust	(42.418 mm.)
	1.680")		(42.672 mm.)
G -	Grind	(where indicated)	
H -	1/16" rad.		(1.587 mm.)
J -	1/32" rad.		(0.794 mm.)
K -	1/16" (1.587 mm.) at 45°		

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.

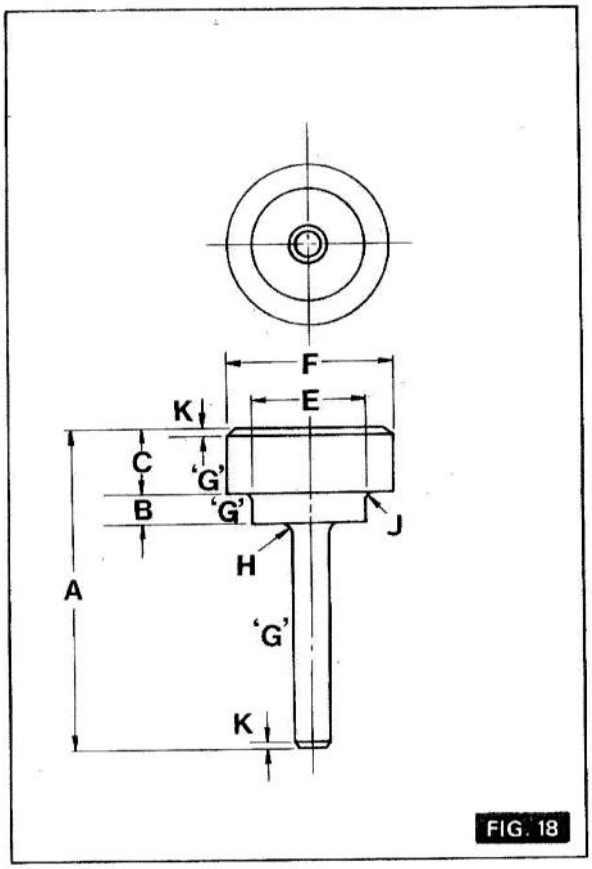

FIG. 18

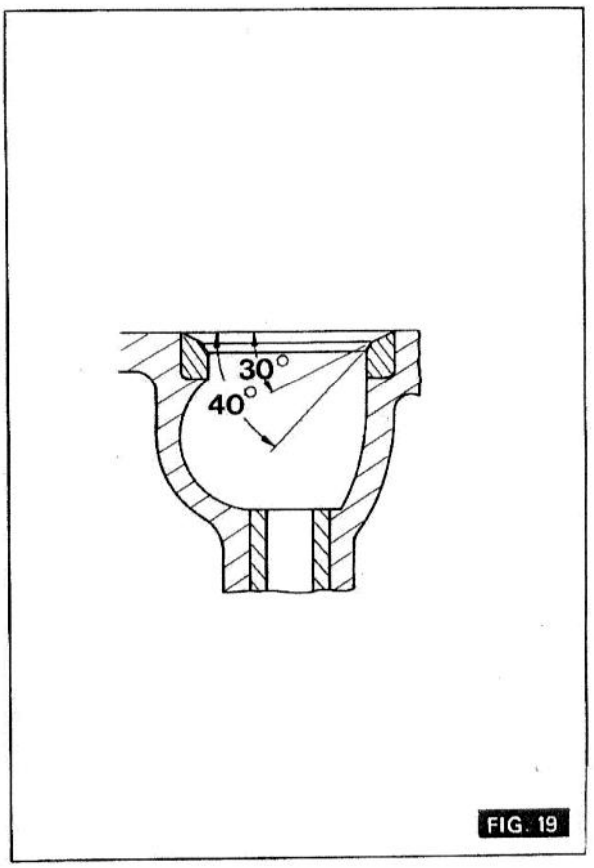

FIG. 19

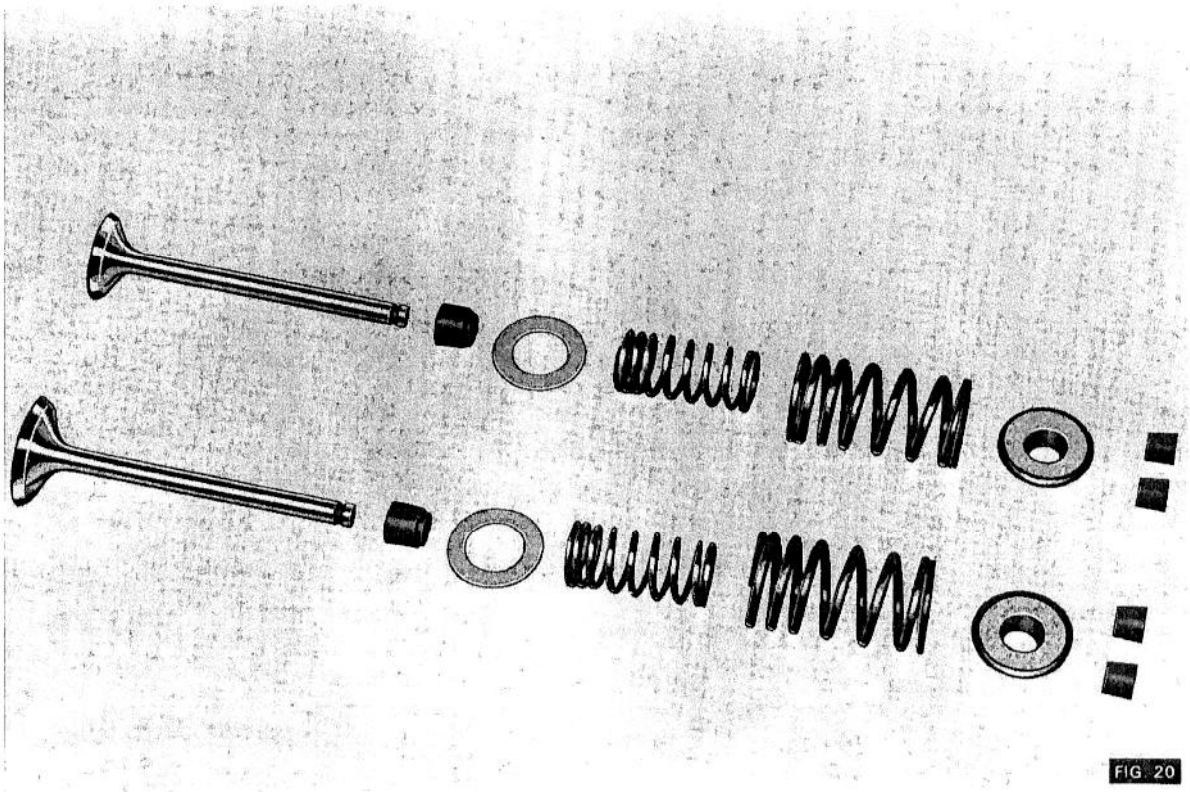
FIG. 20

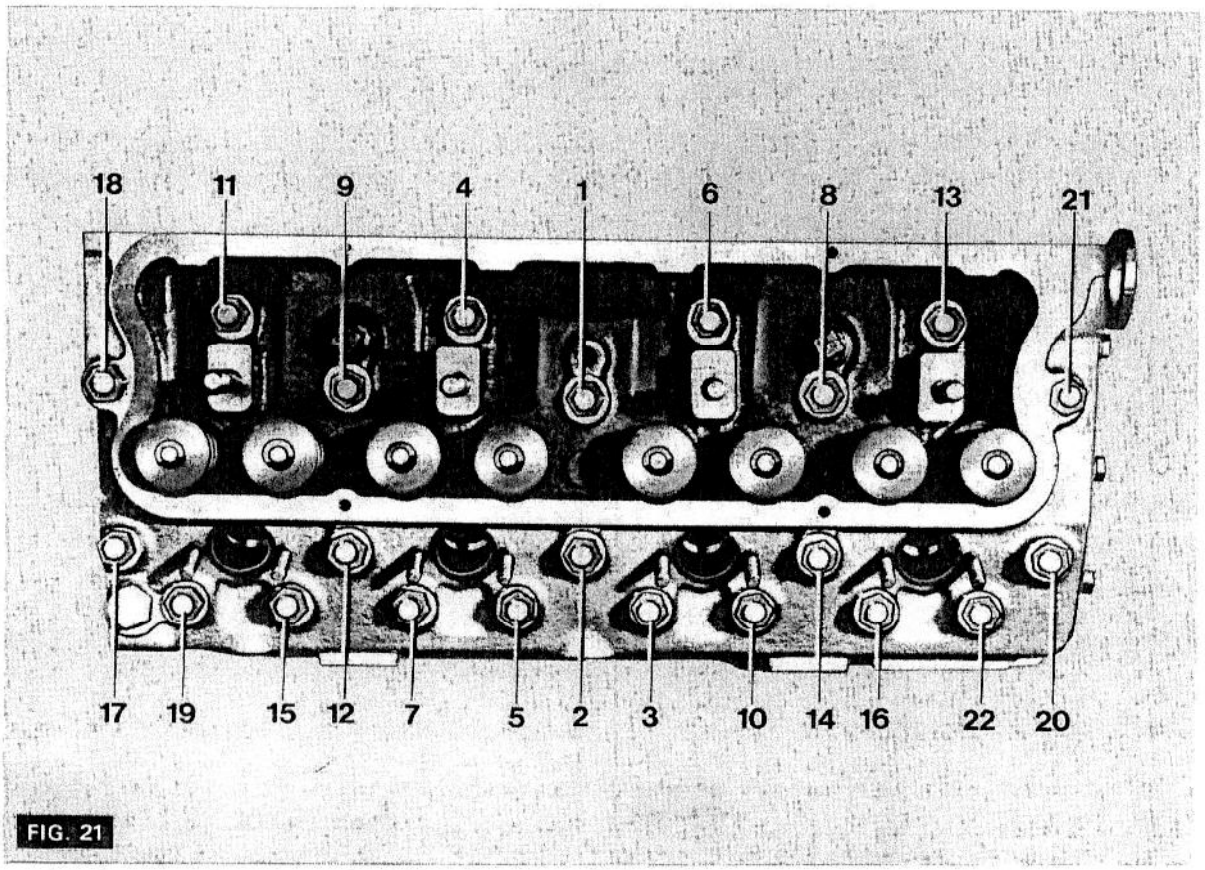

FIG. 21

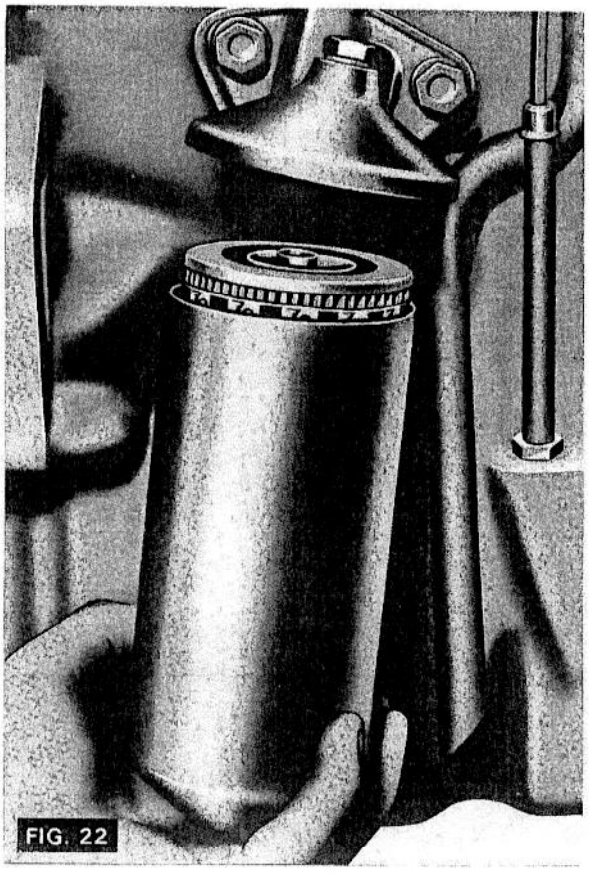
FIG. 22

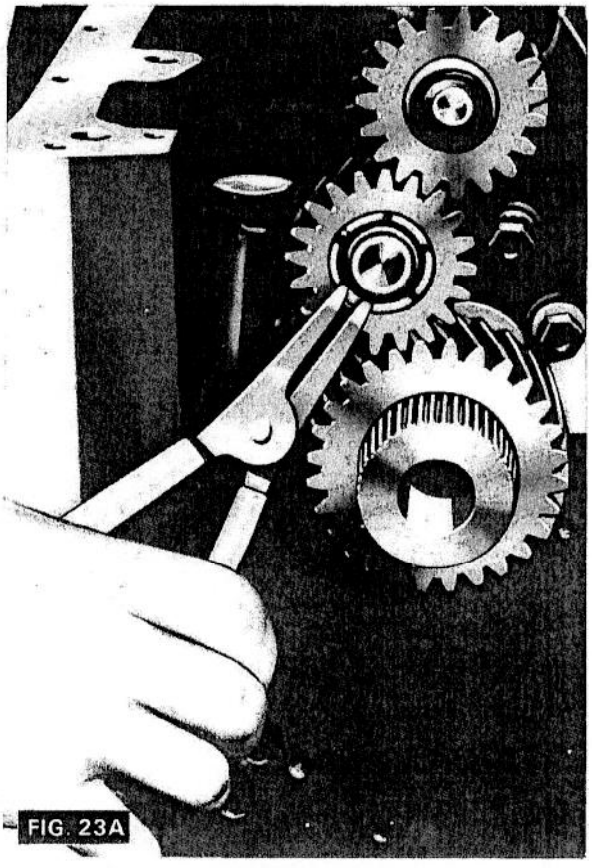
FIG. 23A

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.

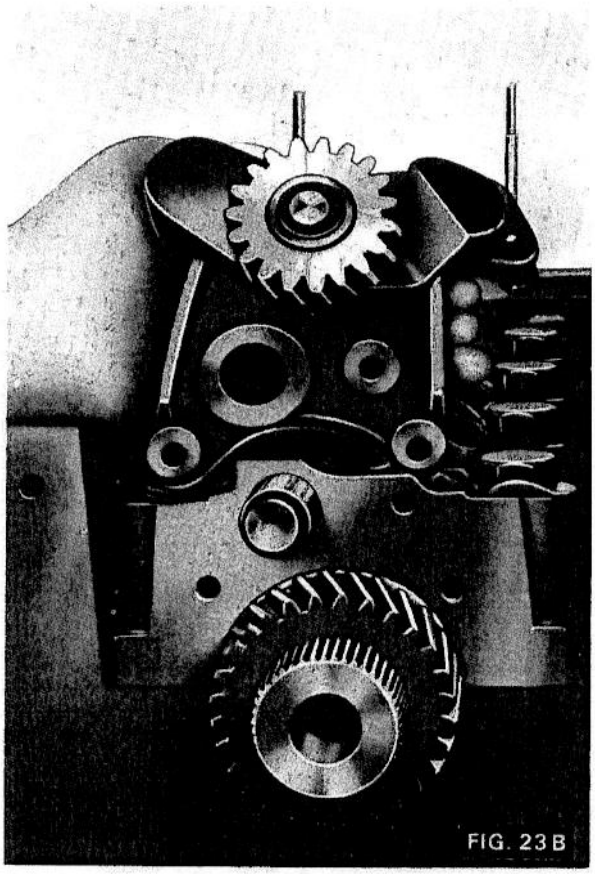

FIG. 23B

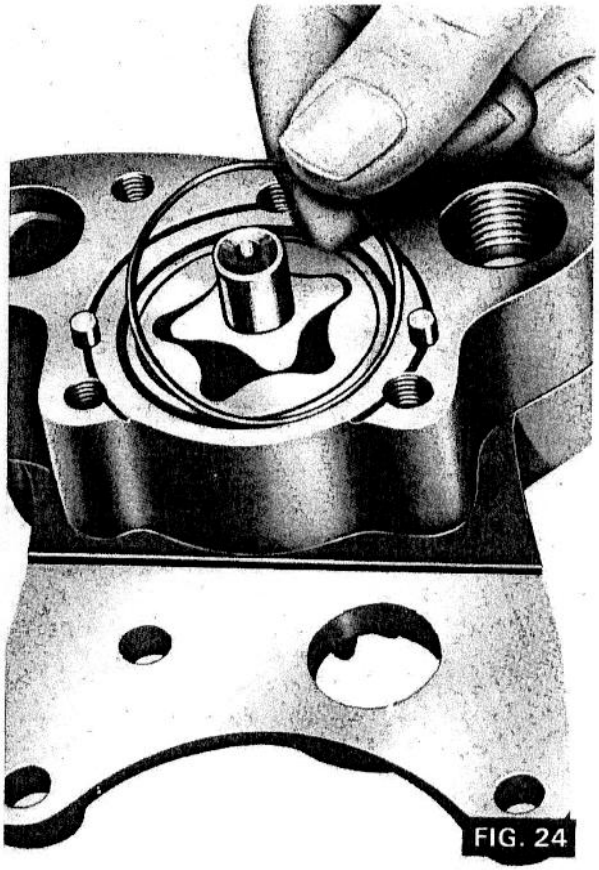

FIG. 24

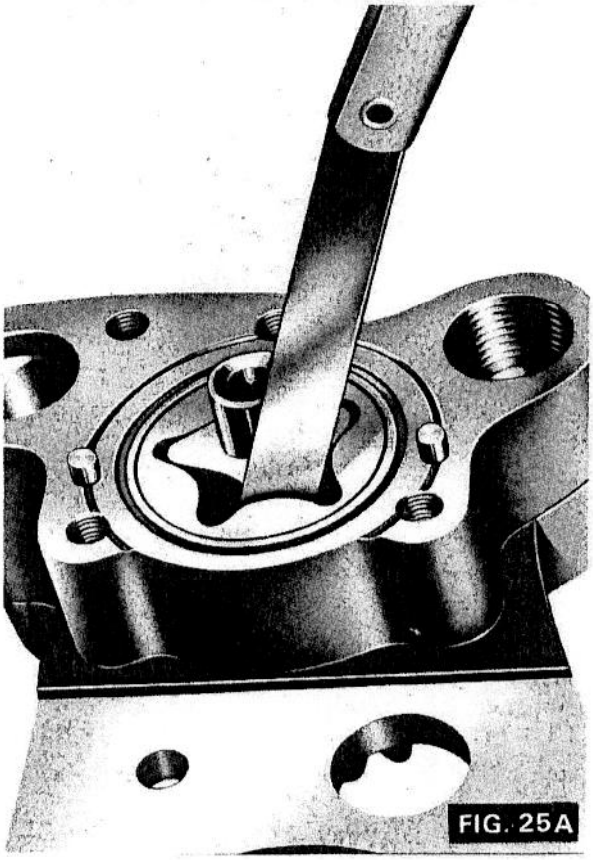

FIG. 25A

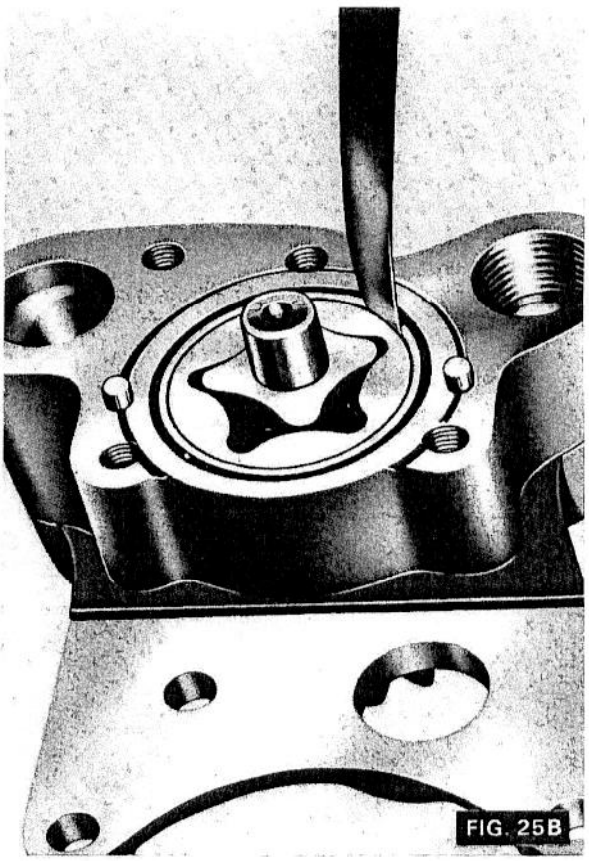

FIG. 25B

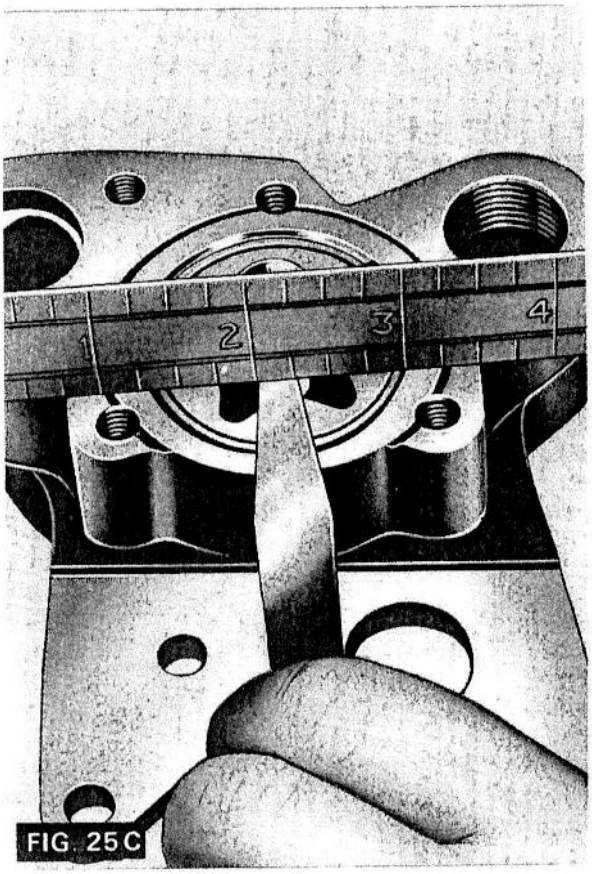

FIG. 25C

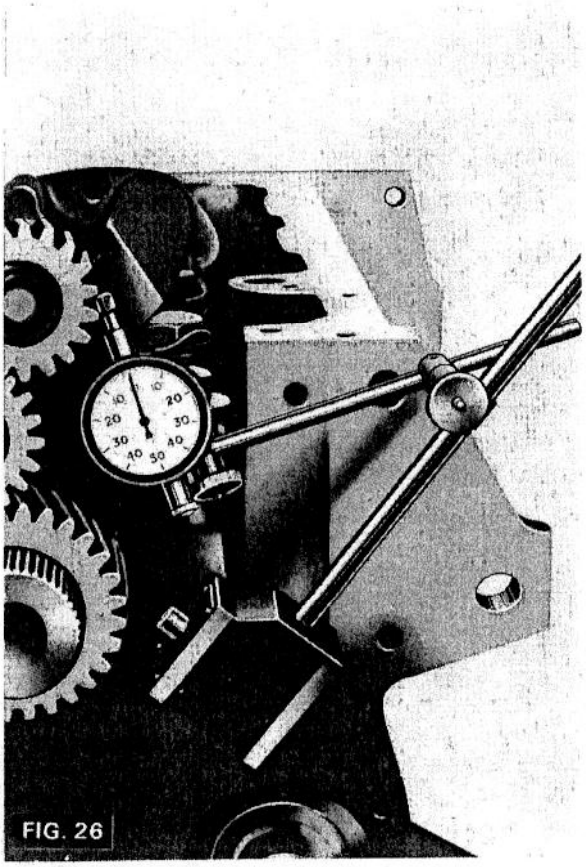

FIG. 26

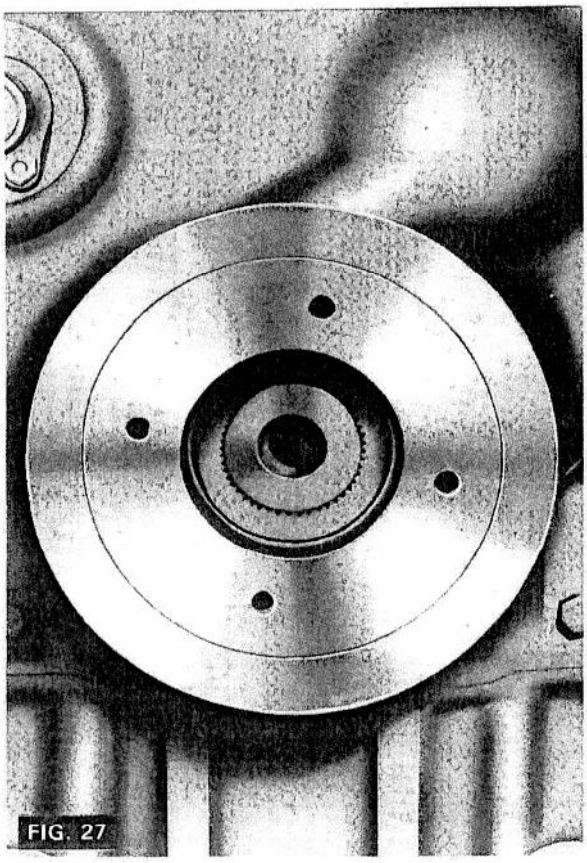
FIG. 27

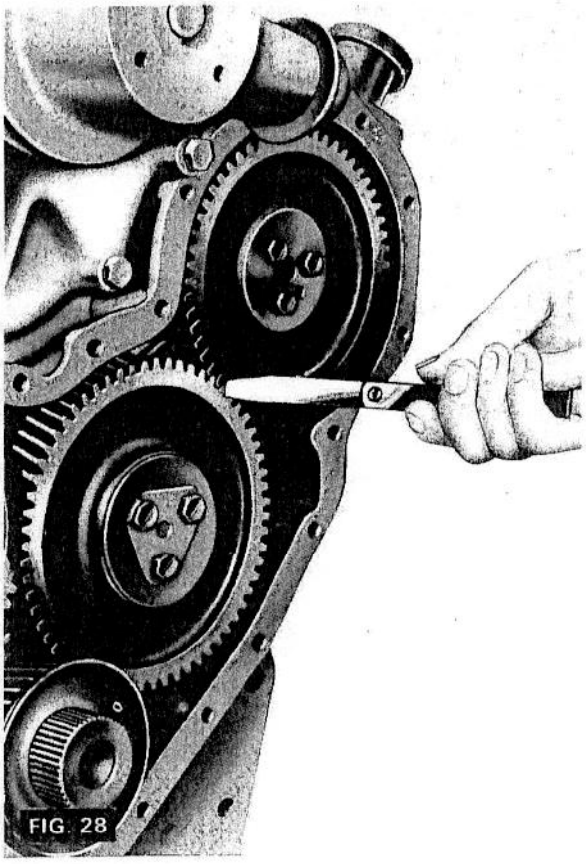
FIG. 28

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. ie. 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 the 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.

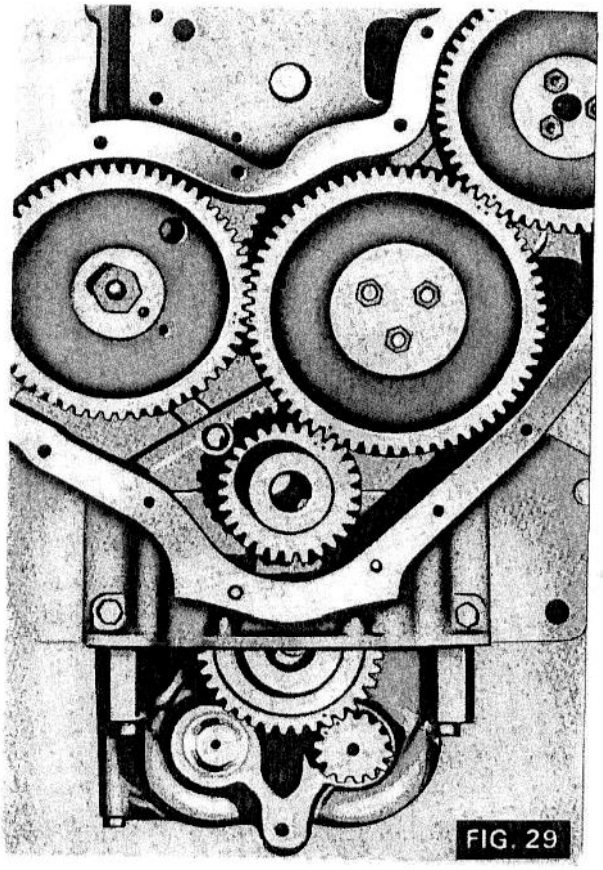

FIG. 29

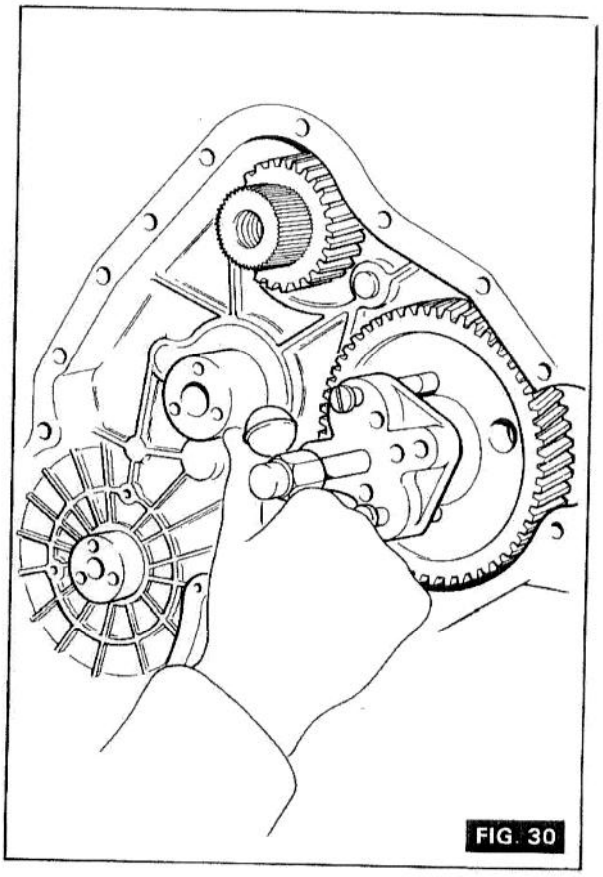

FIG. 30

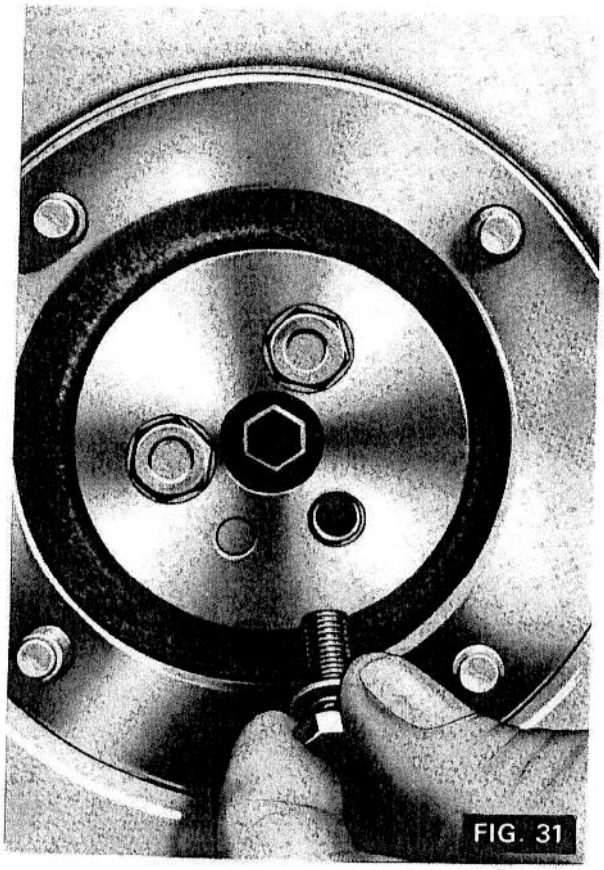

FIG. 31

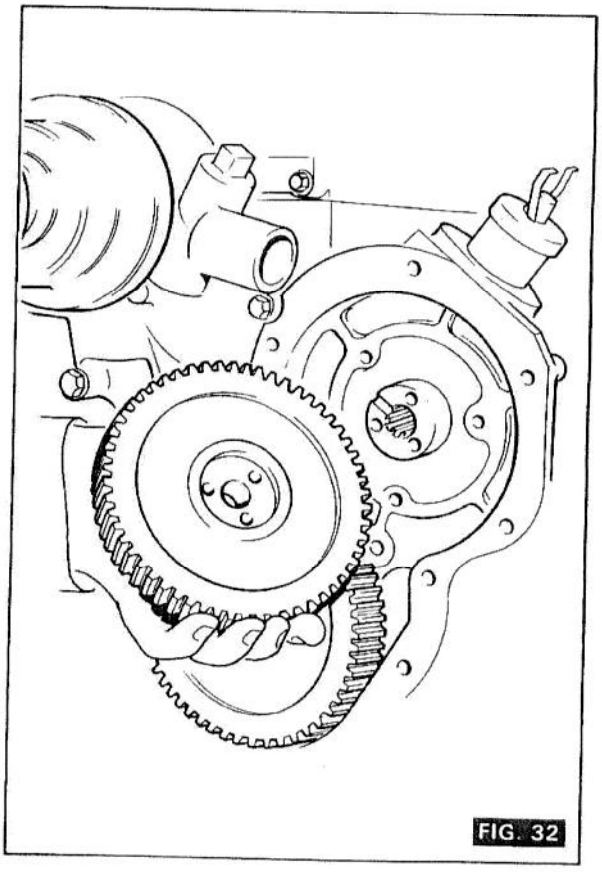

FIG. 32

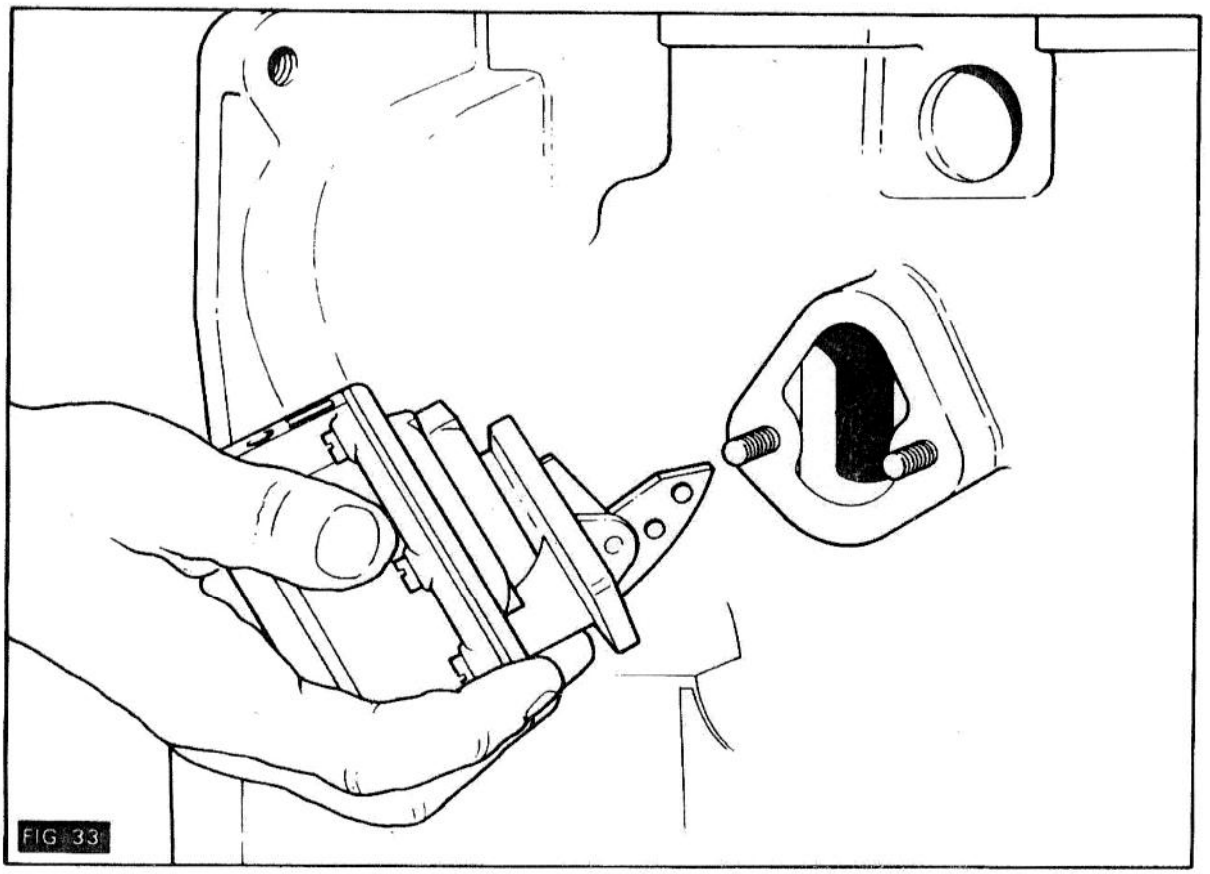

FIG 33

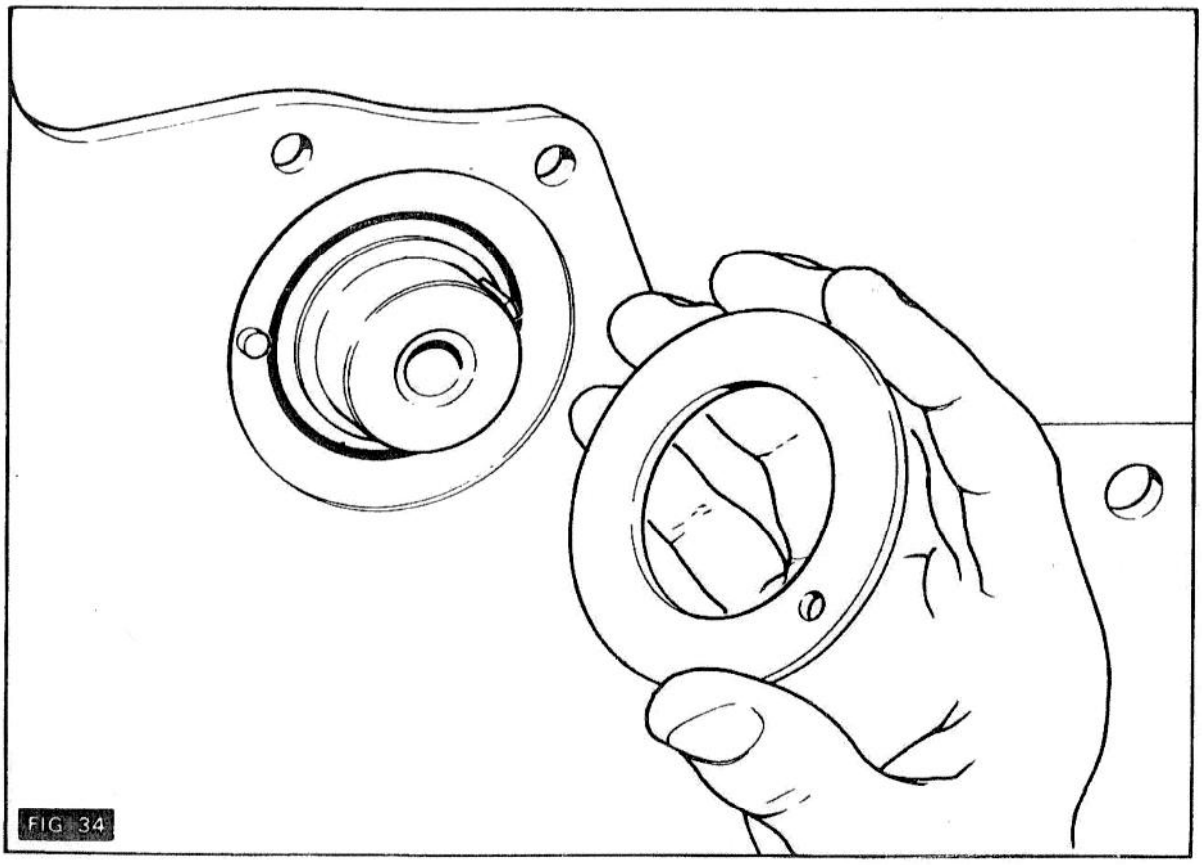

FIG 34

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. ± 2.1/2°. 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.

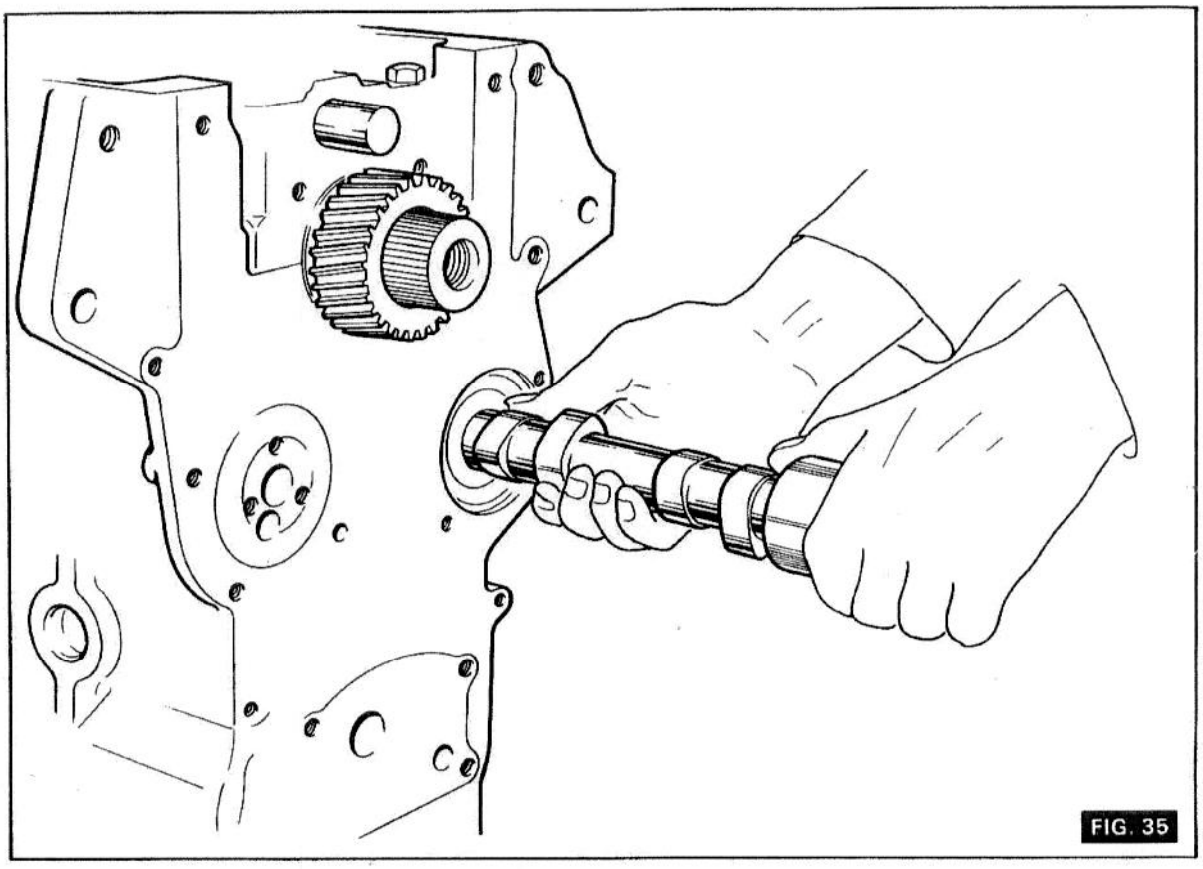

FIG. 35

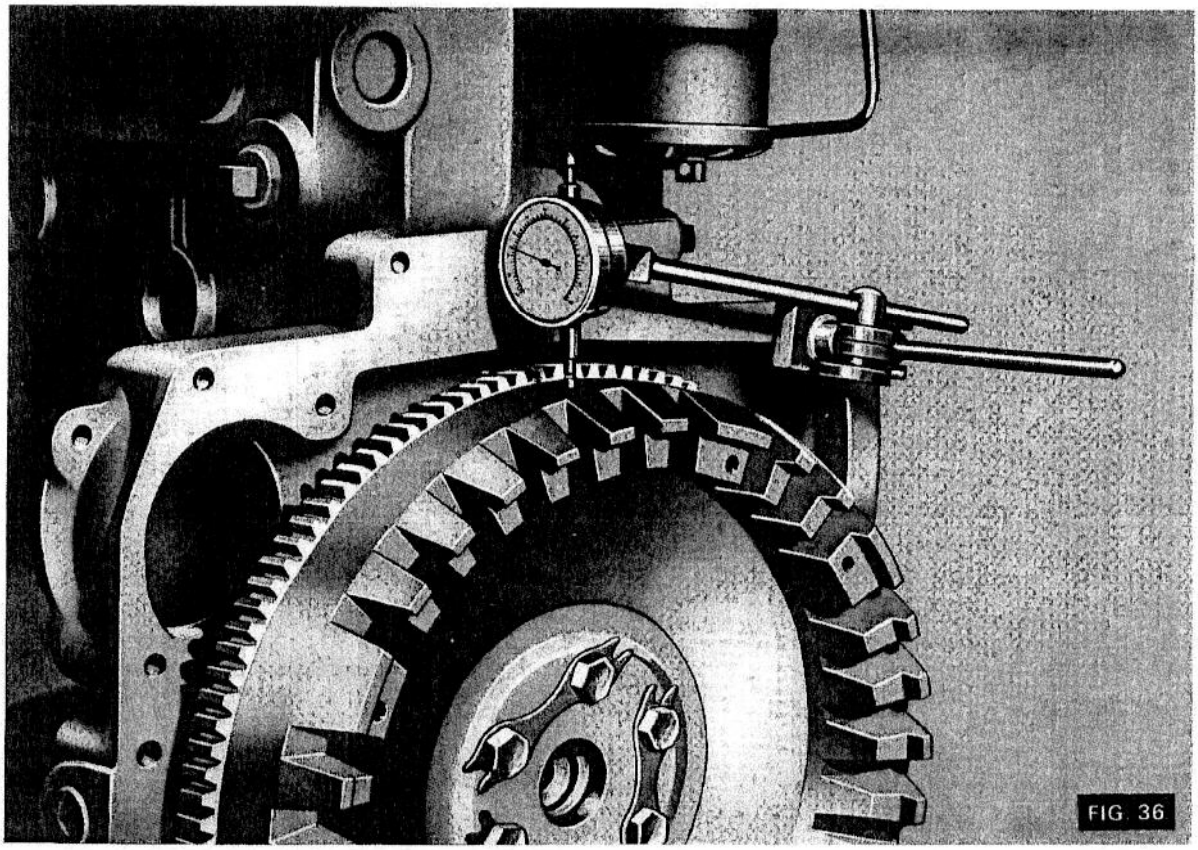

FIG. 36

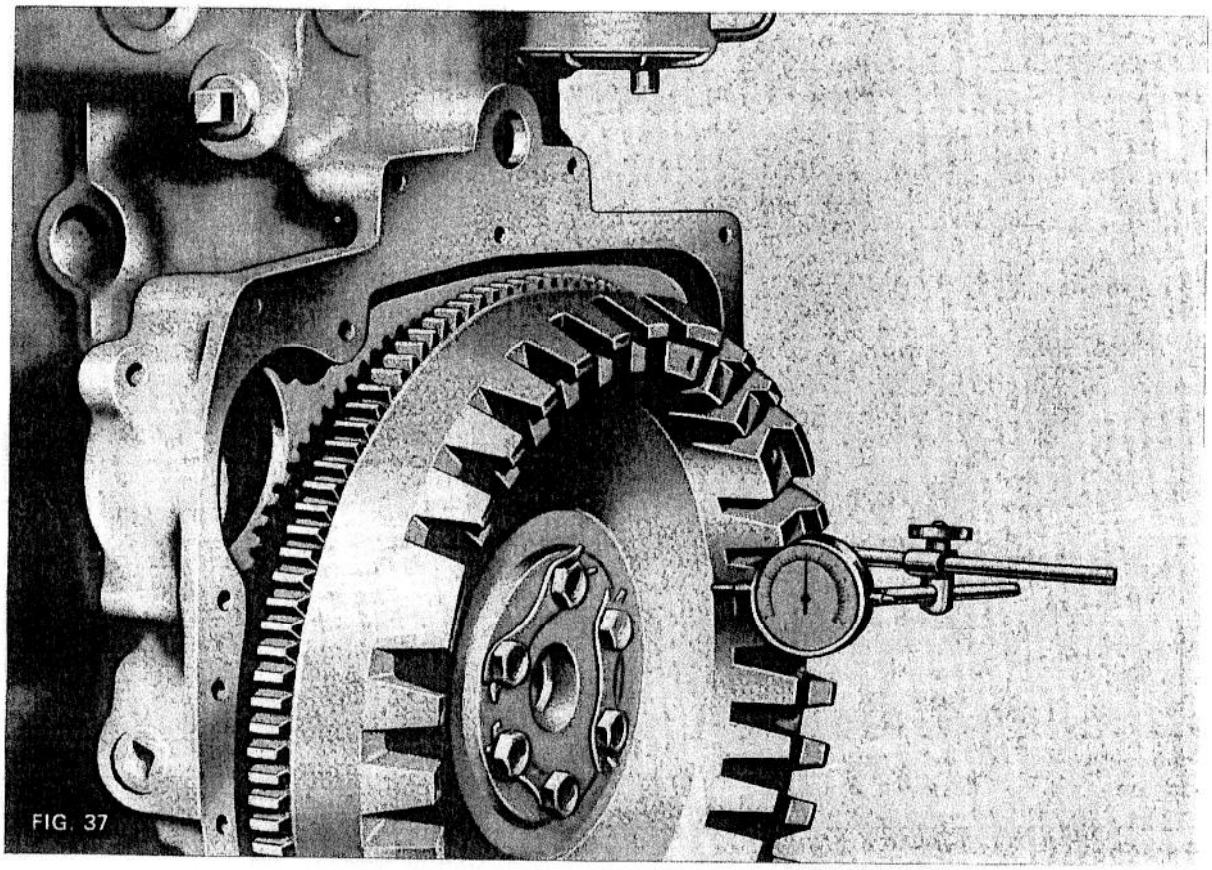

FIG. 37

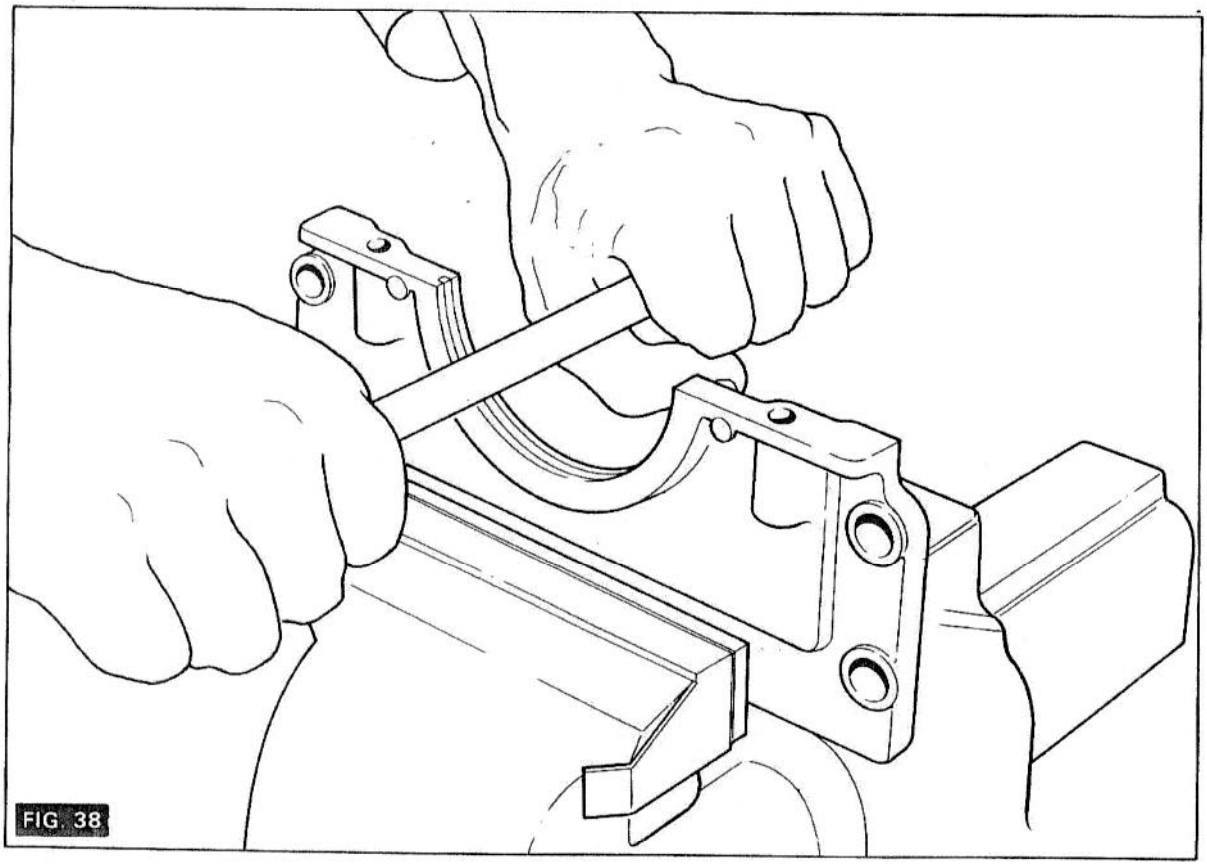

FIG. 38

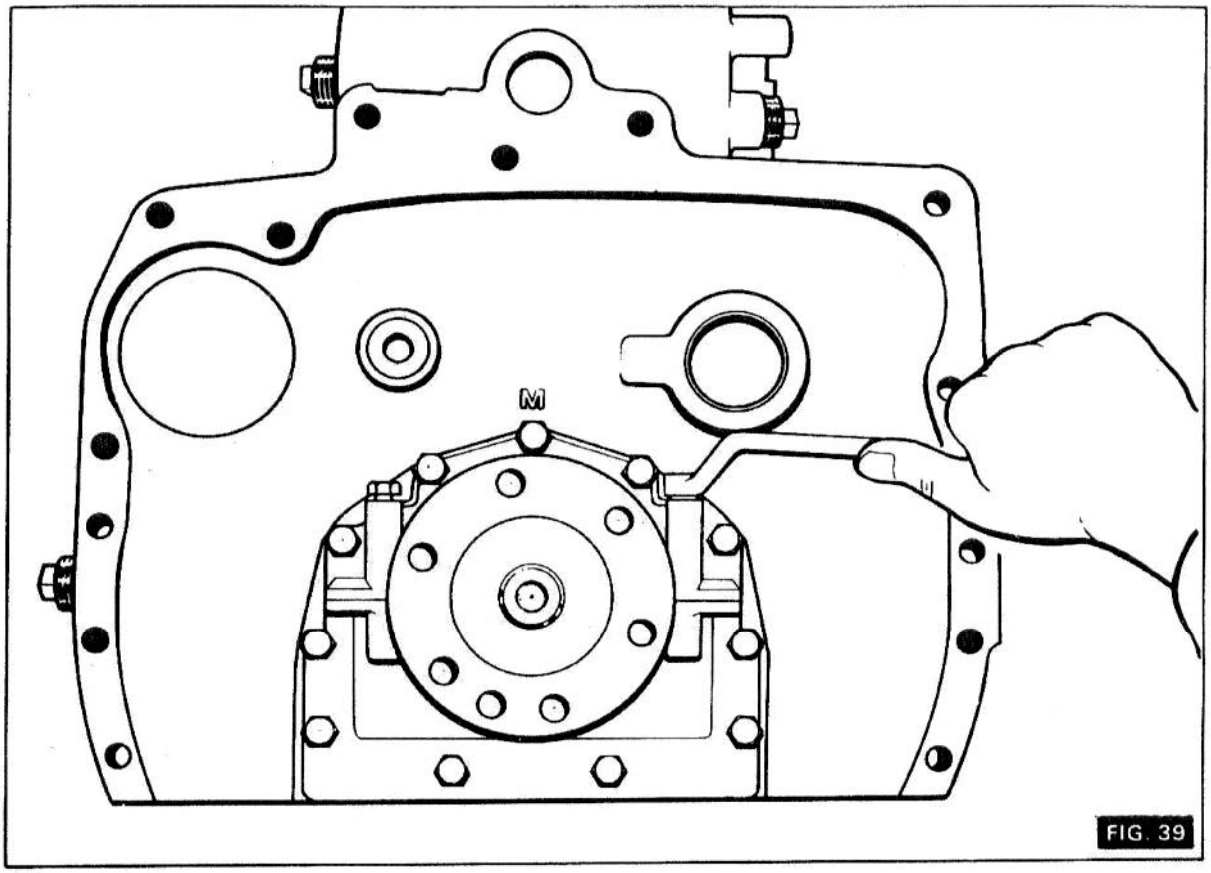

FIG. 39

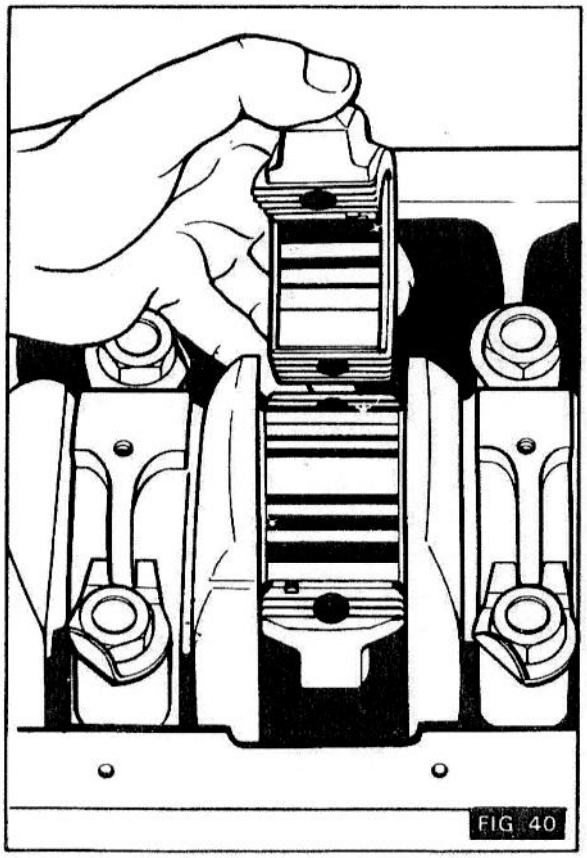
FIG. 40

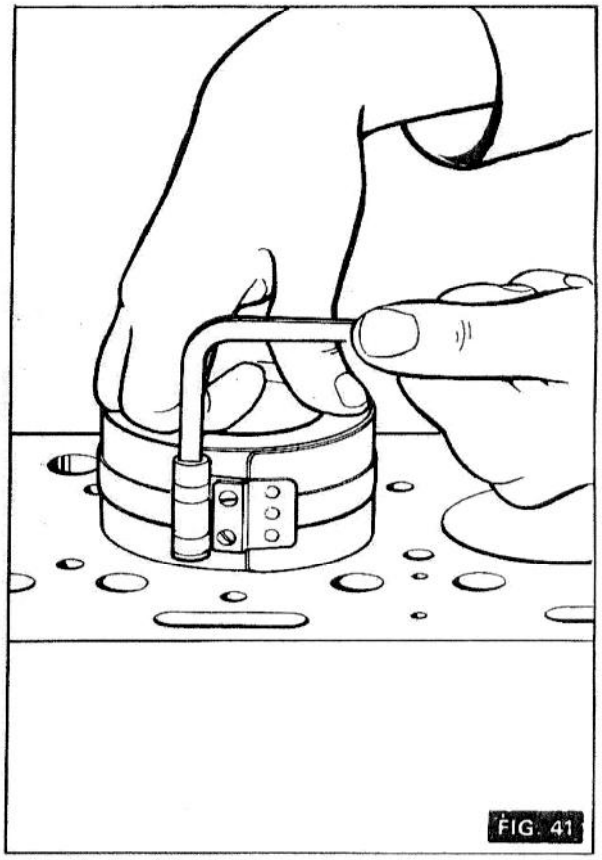
FIG. 41

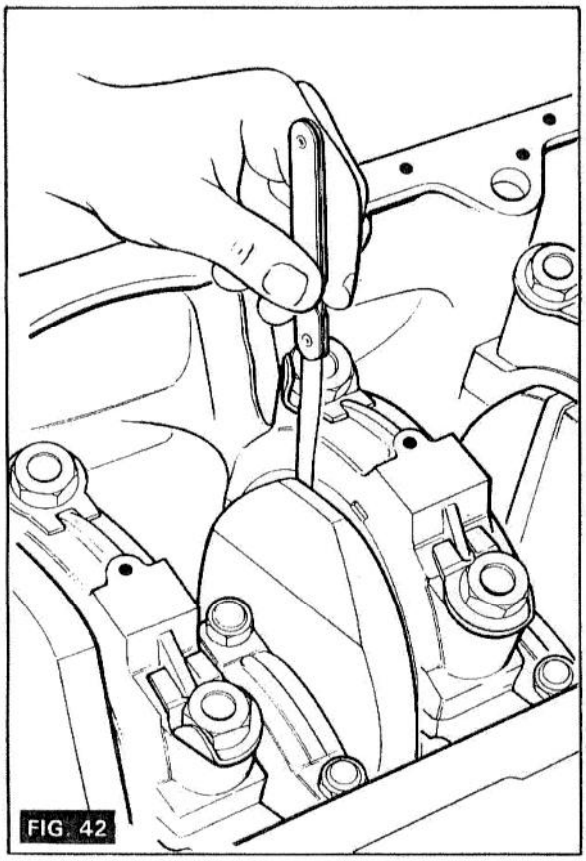

FIG. 42

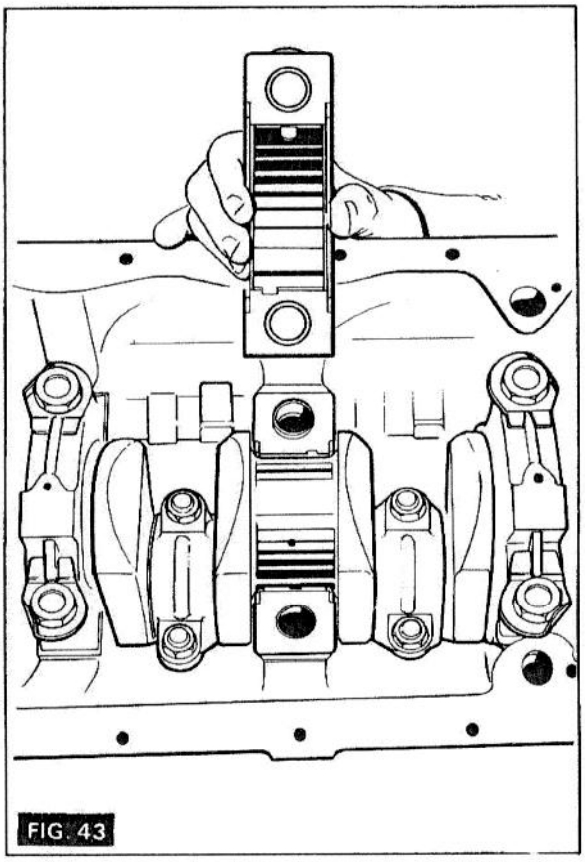

FIG. 43

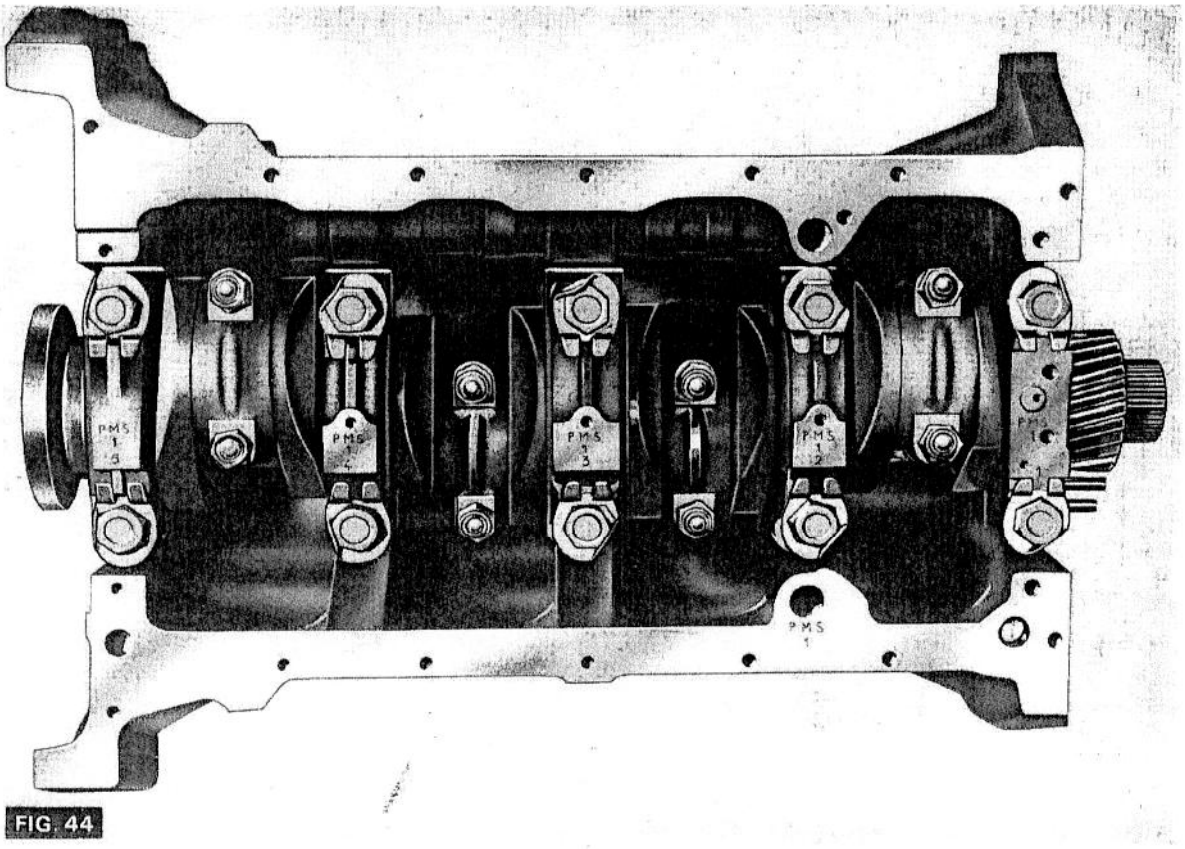

FIG. 44

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OPERATING INSTRUCTIONS - PD 145A H/B/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.

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TO REMOVE CONNECTING ROD AND PISTON ASSEMBLIES (2B/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 (2B'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 (2B/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 65/70 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 POSTION (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 lo 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.

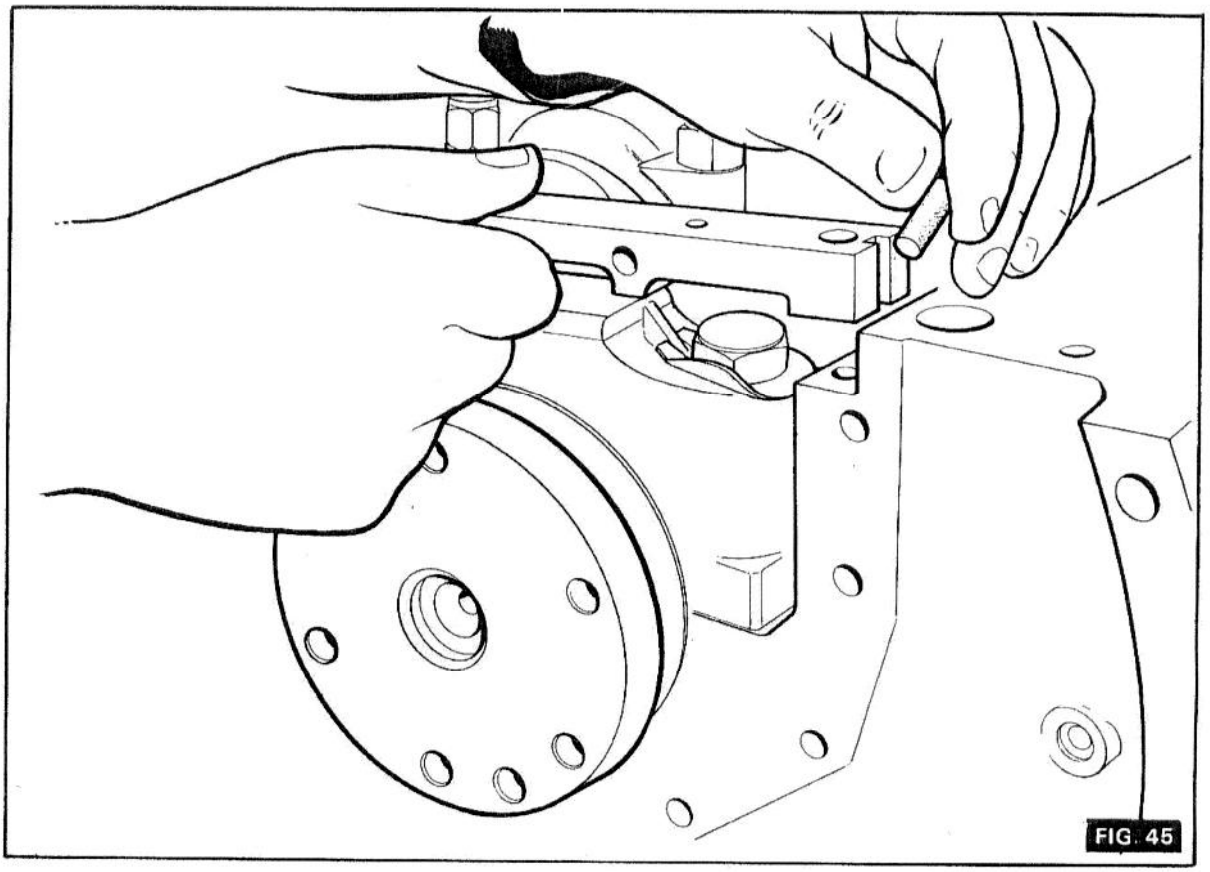

FIG. 45

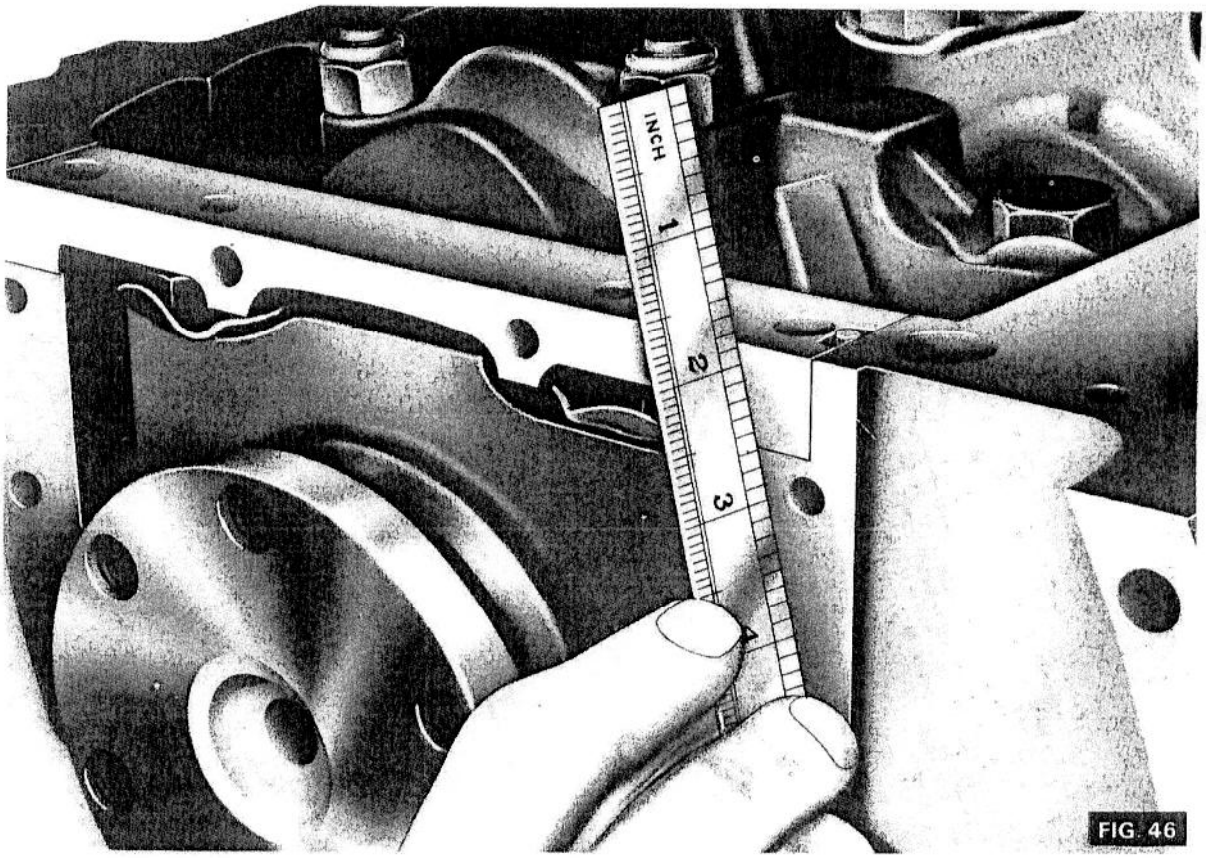

FIG. 46

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 $\frac{2.9990}{2.9985}$ 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	103.26	.001 in.	Interference
			4.0645	103.24	.003 in.	Fit
Cylinder Block	4.0625	103.19			.076 mm	
Bore	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 Bore	3.877 3.878	98.48 98.50				
Total Height Cylinder Block	17.375 17.367	441.33 441.12				
Height of Liner above Cylinder Block	0.030 0.035	0.76 0.89	Below block top face			
Cylinder Block No. 1 Camshaft Bearing	2.1875 2.1885	55.56 55.59			.0058 in. .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	3.116 3.117	80.42 80.44				
Crankshaft End Float					.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			4.098 4.088	104.09 103.83	.000 in. .018 in.	Clearance
Cylinder Block recess For Thrust Washer	4.098 4.106	104.09 104.29			.00 mm .46 mm	
Conn. Rod Big End Bore	2.6460 2.6465	67.21 67.22				
Crank Pin Diameter			2.4995 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			1.579 1.577	40.11 40.06	.0095 in. .013 in.	End Float Clearance
Crankpin Width	1.5885 1.5915	40.35 40.42			.24 mm .37 mm	
Bush Conn. Rod Small End Diameter			1.5365 1.535	39.13 38.99	.00525 in .00272 in.	Interference Fit
Conn. Rod Small End Bore	1.531 1.532	38.89 38.92			.13 mm .07 mm	
Gudgeon Pin Diameter			1.3750 1.3748	34.925 34.92	.00075 in. .0017 in.	Clearance
Bush Conn. Rod	1.37575 1.3765	34.94 34.96			.02 mm .04 mm	
Gudgeon Pin			1.3750 1.3748	34.925 34.92	.00015 in. .00025 in.	Transition Fit

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			0.0938	2.38	.0019 in.	Clearance
Rings Width			0.0928	2.36	.0039 in.	
Compression Ring	0.0957	2.43			.05 mm	
Groove Width	0.0967	2.46			.10 mm	
Compression Ring					.021 in.	At 3.876 in.
Gap (Chrome)					.016 in.	Bore
					0.53 mm	
					0.41 mm	
Compression Ring					.019 in.	At 3.876 in.
Gap (Cast Iron)					.015 in	bore
					0.38 mm	
					0.48 mm	
Compression Ring Gap					0.011/0.016 in.	
(Cast Iron Internally Stepped)					0.28 /0.41 mm	
Scraper Ring			0.251	6.38	.0015 in.	Clearance
Width			0.249	6.32	.0045 in.	
Scraper Ring	0.2525	6.41			.04 mm	
Groove Width	0.2535	6.44			.11 mm	
Crankshaft Diameter			1.8755	47.64	.0005 in.	Transition
for Gear			1.8750	47.62	.0001 in.	Fit
Crankshaft Gear	1.8750	47.62			.01 mm	
Bore	1.8755	47.64			.02 mm	
Crankshaft Pulley			2.380	60.45		
Seal Diameter			2.375	60.32		
Crankshaft Rear			3.125	79.37		
Seal Diameter			3.124	79.35		
Width of Crankshaft	1.741	44.22				
Centre Main Journal	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			0.7485	19.01	.0015 in.	Clearance
Diameter			0.7475	18.99	.00375 in.	
Cylinder Block	0.7500	19.05			.04 mm	
Tappet Bore	0.75125	19.08			.09 mm	
Valve Inlet			0.3735	9.49	0.0008 in.	Clearance
Stem Diameter			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	0.37425	9.506			0.02 mm	
Bore	0.37525	9.531			0.07 mm	
Valve Exhaust			0.373	9.47	0.0013 in.	Clearance
Stem Diameter			0.372	9.45	0.0035 in.	
Cylinder Head	0.37425	9.506			0.03 mm	
Bore	0.37525	9.531			0.09 mm	
Valve Head Depth					.029 in.	
Below Head Face					.039 in.	
(Exhaust)					.74 mm	
					.99 mm	
(Inlet)					0.035/0.045 in.	
					0.89 /1.14 mm	
Water Pump Shaft			0.6267	15.92	.0018 in.	Interference
Dia.			0.6262	15.91	.0005 in.	Fit
Water Pump	0.6249	15.87			.05 mm	
Impeller Bore	0.6257	15.89			.01 mm	
Water Pump Shaft			0.7506	19.07		Transition
Dia.			0.7501	19.05		Fit
Water Pump	0.7500	19.05			.015 mm	
Pulley Bore	0.7508	19.07			.017 mm	
Water Pump Body	1.8494	46.97			0013 in.	Interference
Bore	1.8504	47.00			.0000 in.	Fit
Water Pump			1.8504	47.00	.03 mm	
Bearing			1.8507	47.01	.00 mm	
Water Pump Shaft			0.7877	20.01	.0007 in.	Interference
Diameter			0.7874	20.00	.0000 in.	Fit
Water Pump	0.7870	19.99			.003 mm	
Bearing	0.7874	20.00			.000 mm	
Impeller Running Clearance					.010 in. .035 in. .25 mm .89 mm	Measured between impeller vanes and water pump body (front half)
Lubricating Oil Pump						
Inner Rotor End Clearance					0.015 in. 0.003 in. 0.38 mm 0.08 mm	Clearance Fit
Gear—L.O.P. Drive					0.006 in.	
Gear—L.O.P. Idler					0.009 in.	
Backlash at					0.15 mm	
2.0608 in CRS					0.23 mm	

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	1.5000	38.10			.001 in.	Clearance
Bore	1.5016	38.14			.0032 in.	
Hub Idler Gear			1.4990	38.07	.02 mm	
			1.4984	38.06	.08 mm	
Idler Gear Bore	1.6563	42.07				
	1.6573	42.09				
Idler Gear			1.007	25.58	.008 in.	End Float
Length			1.005	25.53	.014 in.	
Hub Idler	1.015	25.78			.20 mm	
Gear Length	1.019	25.88			.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)

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. (8,99–9,68 kg m)
Main Bearing Setscrews	140–150 lb. ft. (19,35–20,74 kg m)
Flywheel Setscrews	75 lb. ft. (10,37 kg m)
Idler 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)
Atomiser Securing Nuts	10–12 lb. ft. (1,3–1,7 kg m)

ENGINE COOLING SYSTEM

CONTENTS

LIST OF ILLUSTRATIONS

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./cm^2) 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 filler 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.

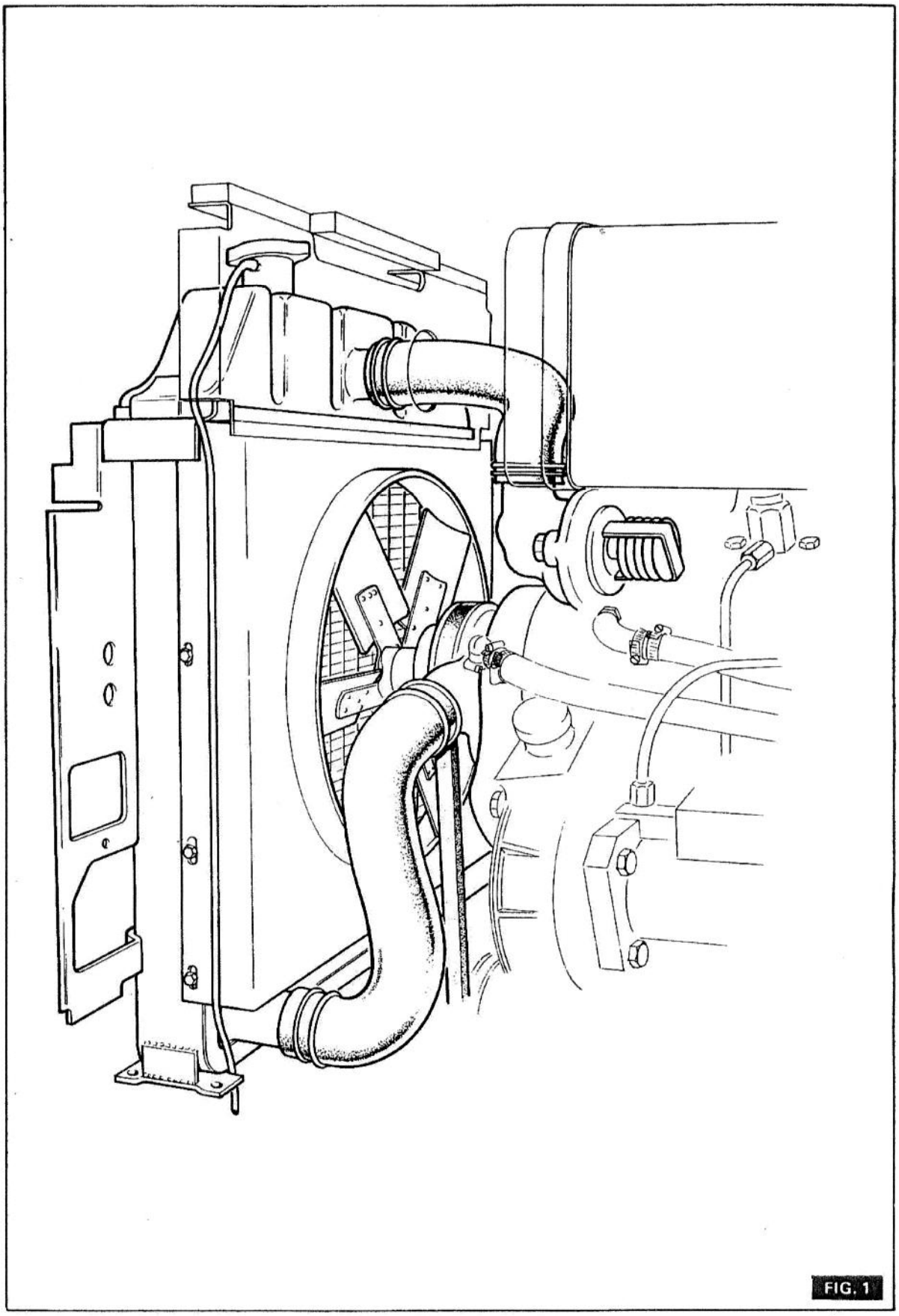

FIG. 1

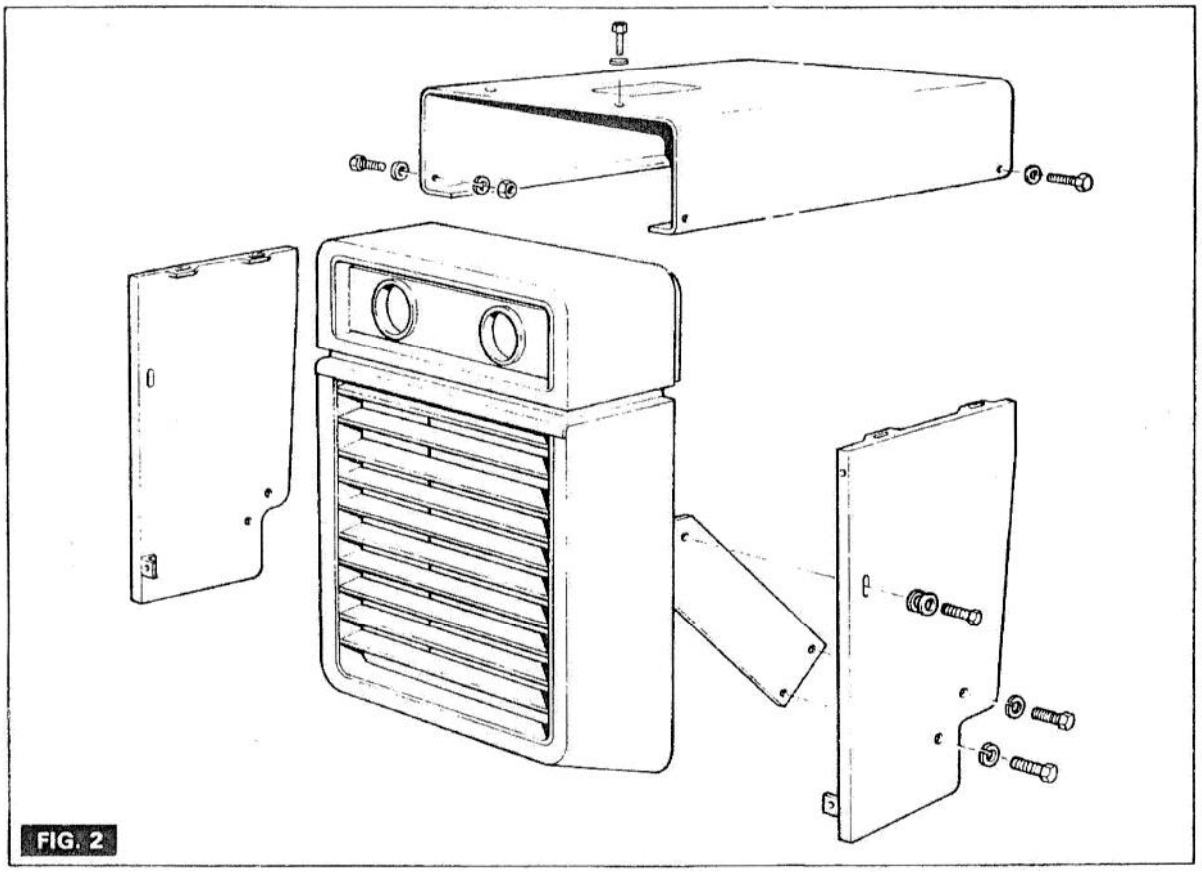

FIG. 2

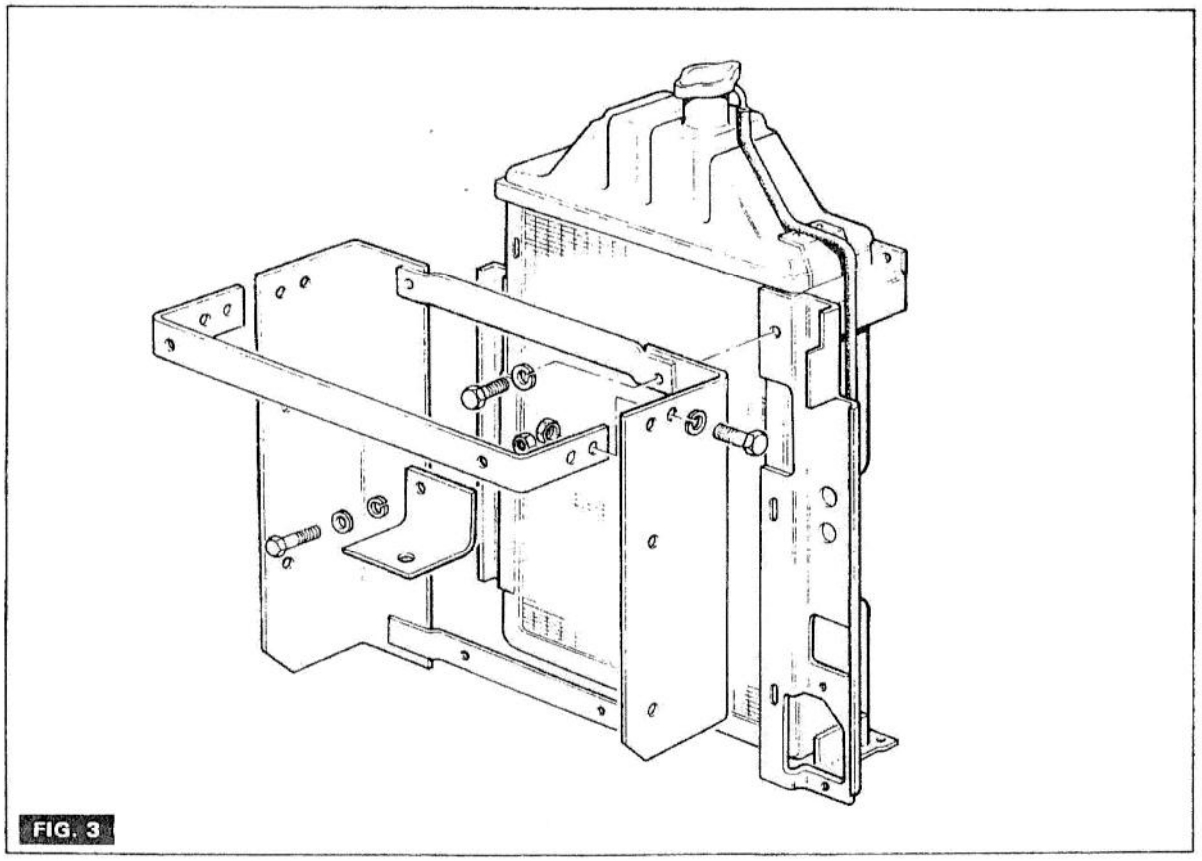

FIG. 3

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.

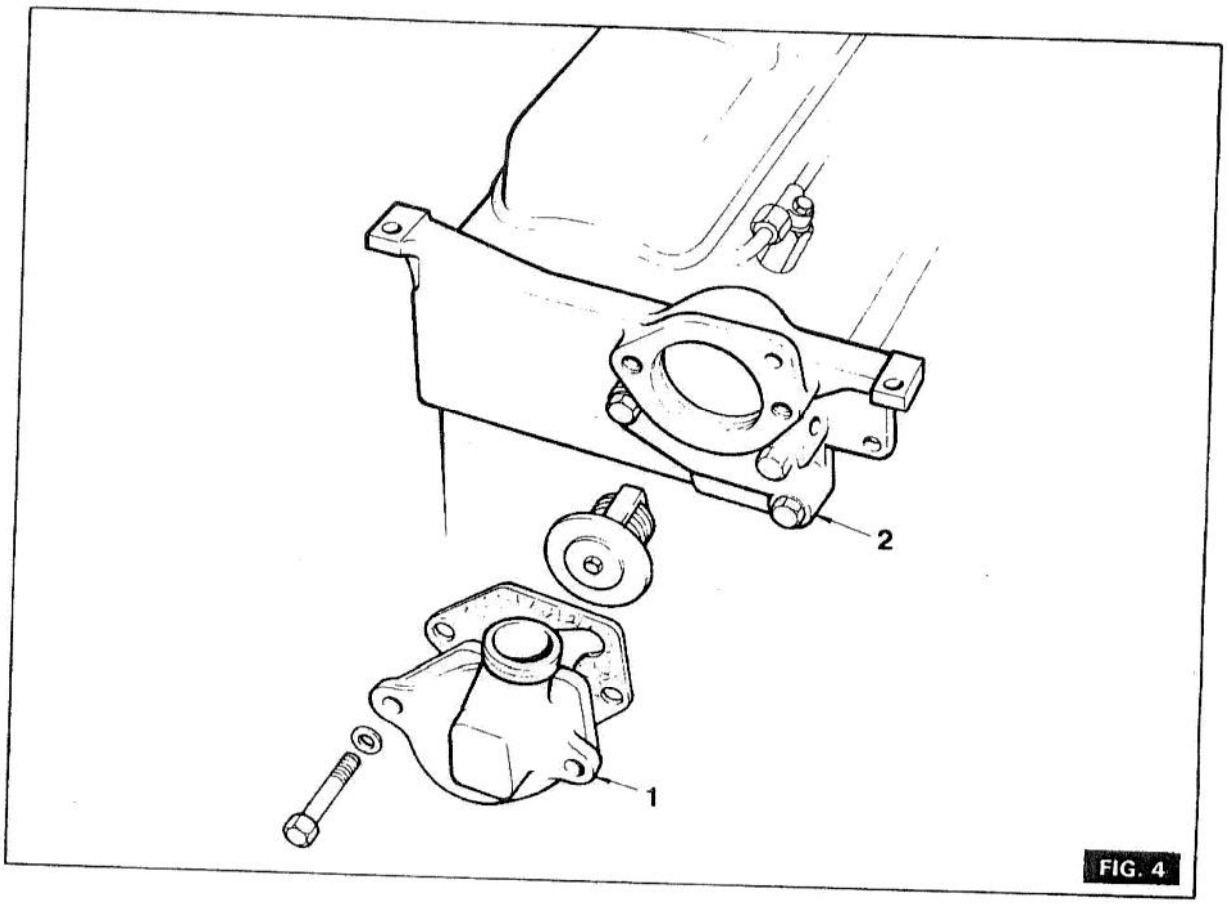

FIG. 4

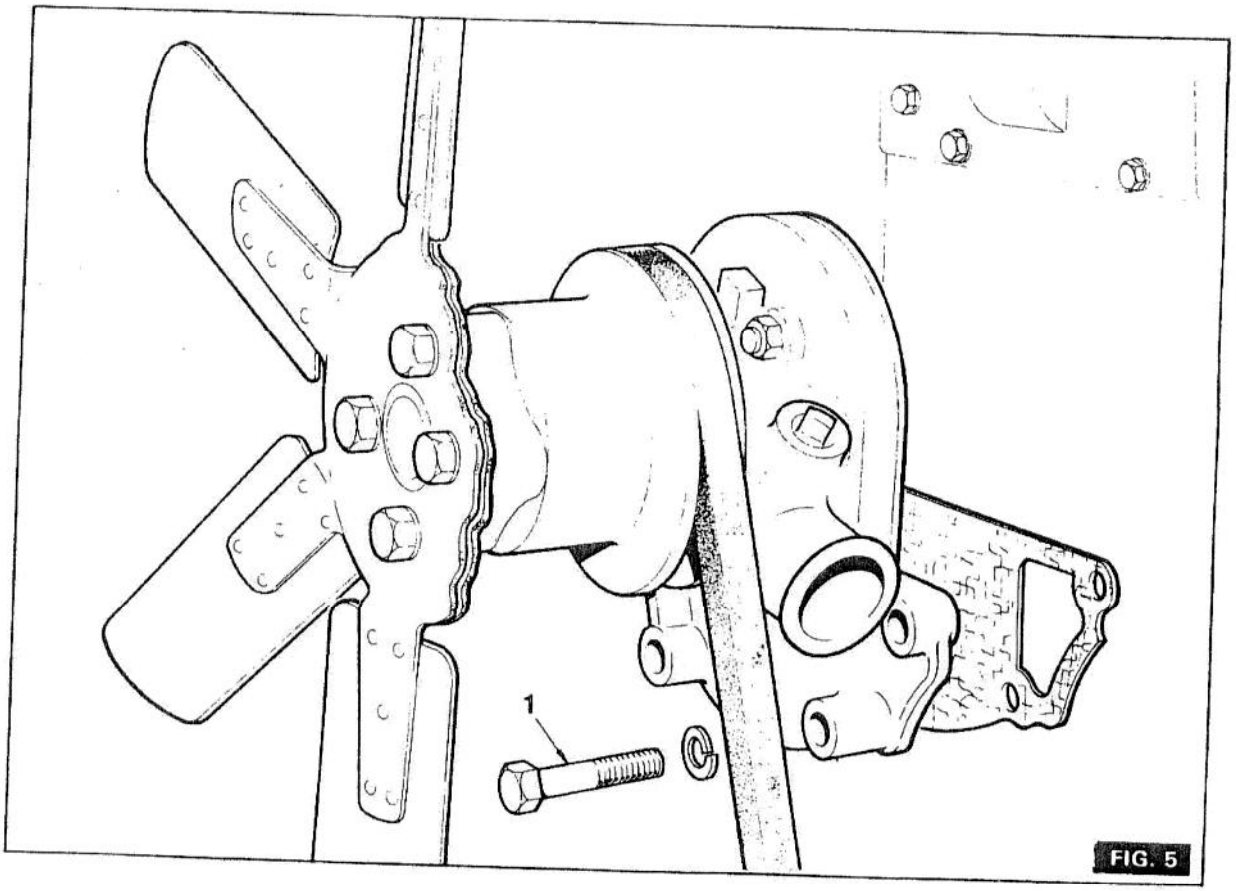

FIG. 5

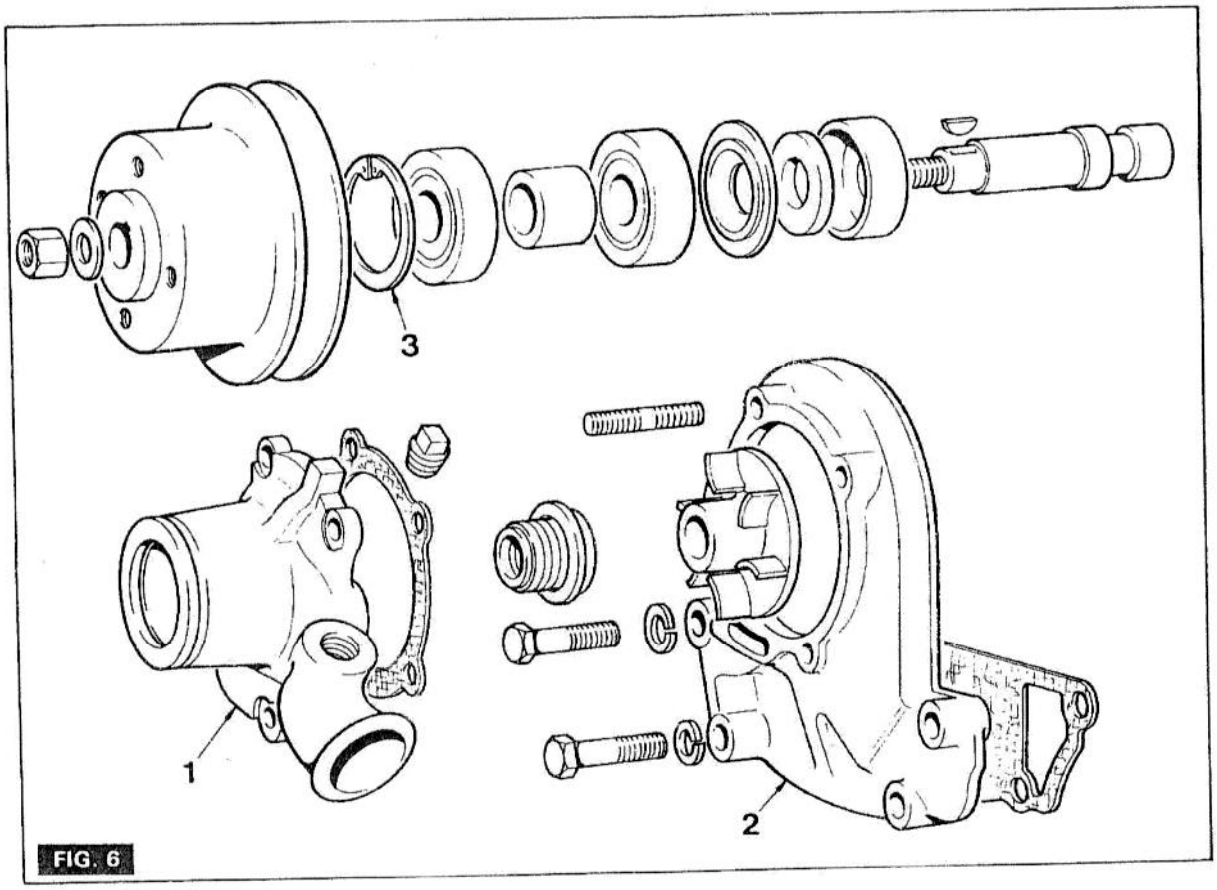

FIG. 6

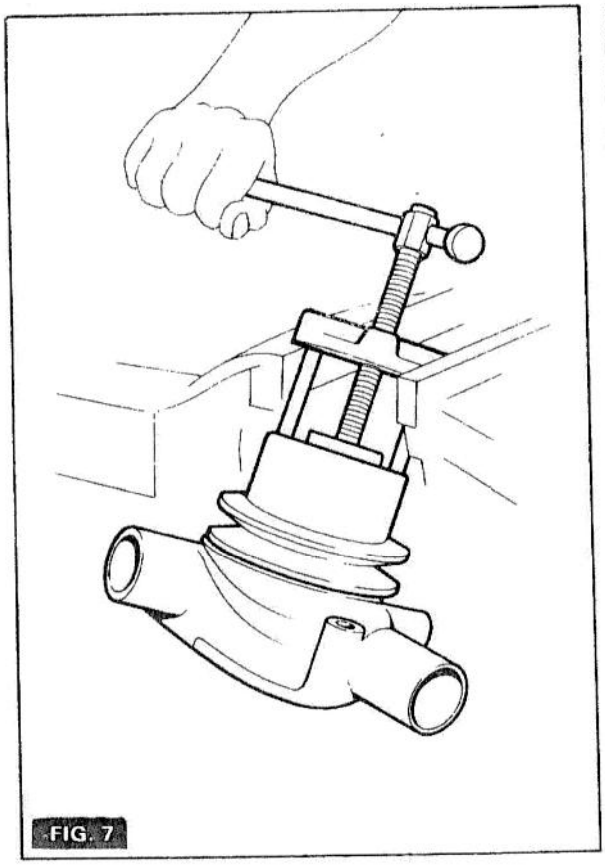
FIG. 7

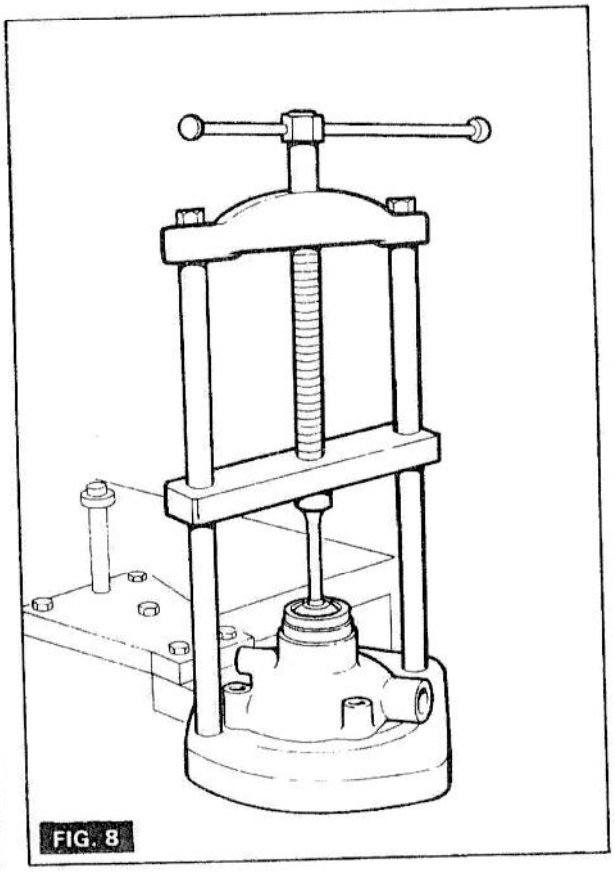
FIG. 8

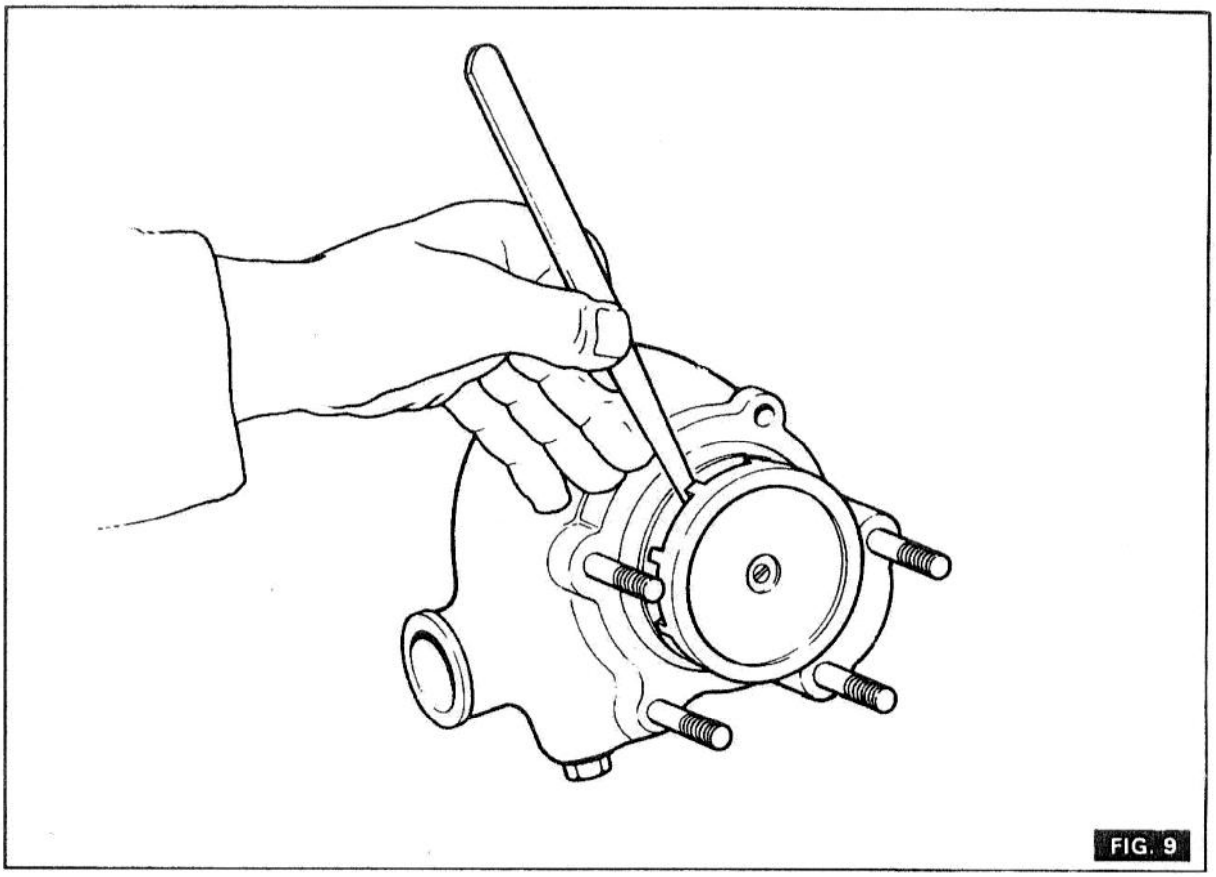

FIG. 9

FUEL SYSTEM

CONTENTS