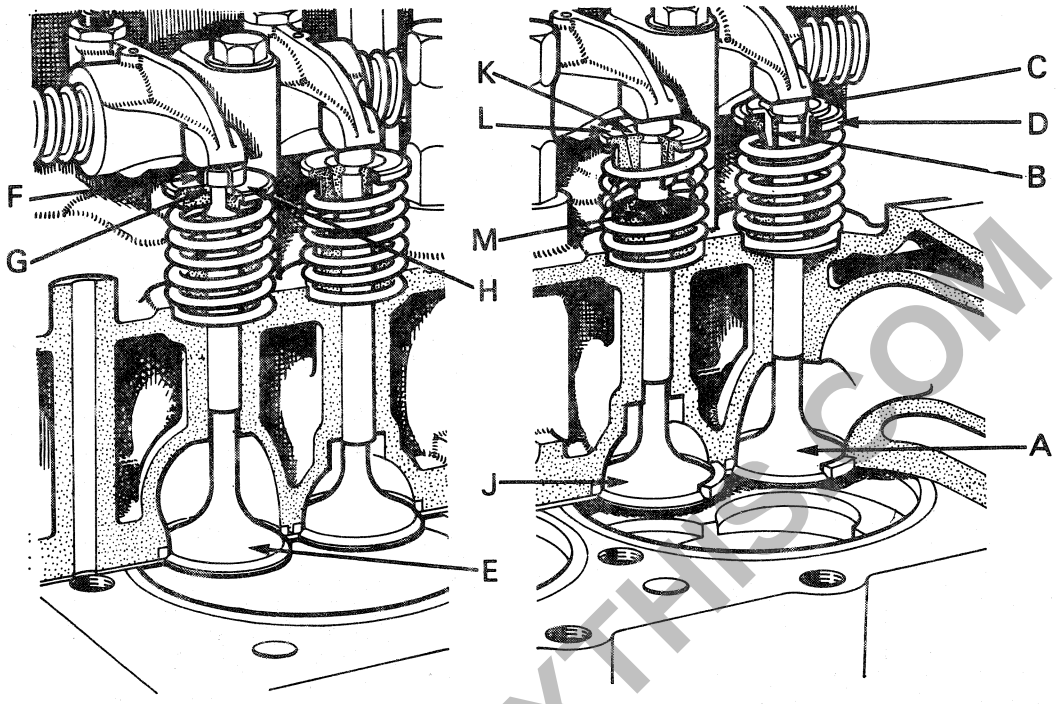


Figure 20. CYLINDER HEAD AND VALVES

A. Exhaust valve	Late type valve	E. Exhaust valve	Early type valve	J. Inlet valve	
B. Cotters		F. Cap—stem		K. Cotters	
C. Collar		G. Cotters		L. Cup	
D. Cup		H. Cup		M. Seal	

● *OPERATION B3d*

Renew any rockers that are excessively worn on the tip. If rocker bushes are worn, these can be renewed. Press out worn bush and press new bush into position, ensuring that oil-holes are aligned. Hone or ream bush after fitting until rocker is free to slide on shaft.

Clean out the rocker shaft, ensuring that all the oilways are clear. Check that rocker bracket faces are completely flat where they seat on the cylinder head. Renew any brackets that are distorted or worn.

Assemble rockers, springs and brackets on shaft in same order as removed. Fit locating screw into rear bracket — oil-holes in shaft are towards bottom of brackets — then lock screw by peening bracket over screw-hole. (Fig. 19.)

Inlet Valve Seals: Having thoroughly cleaned the head and valves, fit new inlet valve stem seals. Ensure there are no burrs in the head chamfer and use Service Tool 961236, or a hollow drift. *Do not use a drift that touches the sharp edge of the seal.* Place seal on tool, smear seal with grease and place in recess, then drive seal home with two or three sharp taps with a copper hammer. Do not use undue force.

Do not fit seals until cylinder head is ready for assembling and do not withdraw a valve once it has been fitted through a seal. Pulling a valve stem through a seal causes the cotter groove to trap and damage the sharp edge of the seal and it is therefore necessary to fit a new seal once a valve is removed.

Assembling Cylinder Head: Smear valve stems with clean oil and fit into their correct positions in cylinder head. Replace springs, collars and cotters, using a suitable tool to compress the valve springs.

Exhaust Valve Caps: If the exhaust valves are fitted with caps, check the stem-end clearance with a Plastigauge. The clearance should be 0·002 to 0·006 in. (0·05 to 0·15 mm) and can be reduced by grinding the cap, provided the cap edge remains square and the sharp corner is removed. (Fig. 20.)

Manifolds: Clean both manifolds, ensuring that the drain-hole and pipe in the exhaust manifold are clear.

Cylinder Block: If the bores are scored, or worn more than 0·010 in. (0·25 mm), they should be rebored to 0·020 in. or 0·040 in. oversize. To maintain balance, always rebore all four cylinders to the same oversize diameter.

Sealing Rings: The sealing rings at the top of the bores have 0·003 in. (0·08 mm) protrusion above the block and it is necessary to remove the rings to rebore the cylinders. New rings, with the appropriate oversize bore, should be fitted after reboring. Ensure the block recesses are clean, smear the rings with

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REPAIR OPERATIONS

● *OPERATION A1*

Engine Tune

If engine becomes difficult to start, or does not develop full power, carry out the following engine tune:

1. **Compression Test:** Use a test gauge as shown in the Service Tool List. Remove all injectors and, using a correct length of extension, fit gauge into No. 1 injector bore. Tighten down with injector nuts to give an airtight seal, and with the stop control in the "stop" position spin engine with starter motor. It is advisable to use a fully-charged battery as the higher the cranking speed the better. Note the gauge reading then repeat the procedure on the remaining cylinders. If the four readings are approximately the same, proceed with the engine tune. If there is a difference of more than 50 lb/sq. in. (3·5 kg/sq. cm) it will be necessary to remove the cylinder head as the loss of performance is due to weak compression and an engine tune will not be fully effective.
2. **Valve Clearance:** Whilst the injectors are out, remove valve rocker cover and check valve clearance (see Page 8). Adjust if necessary, noting that exhaust valves with a cap on the stem end (Fig. 20) should have 0·007 in. (0·18 mm) clearance, but exhaust valves not fitted with caps (Fig. 20) and all inlet valves should have 0·010 in. (0·25 mm) clearance.
3. **Injectors:** Service the injectors (see Page 17) before replacing. Take care to fit copper sealing washers on injector nozzles and tighten nuts down evenly to avoid distortion.
4. **Air Cleaner:** Clean out oil bath and refill to correct level with new oil. Wash wire mesh element, clean out inside of inlet pipe and pre-cleaner. If a paper element pre-cleaner is fitted clean or renew the element (see Page 31).
5. **Fuel Filters:** Clean out fuel sediment bowl and replace fuel filter elements as necessary (see Page 20). Vent fuel system (see Page 21).
6. Start engine, allow to reach working temperature then check idling and maximum speeds. Re-set if necessary (see Page 22).

● *OPERATION A2*

Engine Removal and Replacement

1200 Tractors and 990 6-speed Tractors

Place tractor on firm and reasonably level ground and within reach of suitable lifting equipment.

Remove silencer and bonnet. Drain cooling system and disconnect battery earth lead.

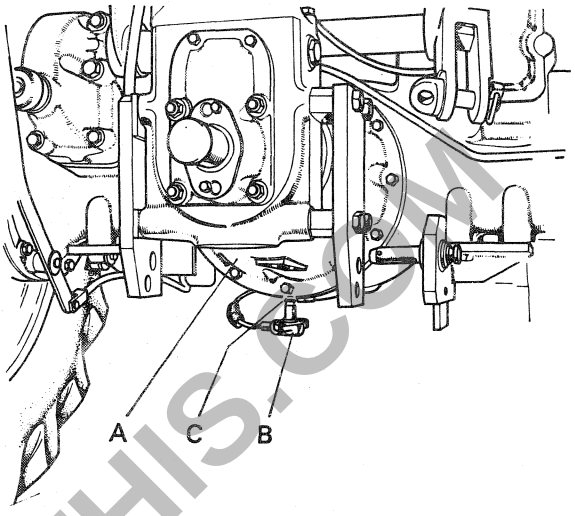


Figure 5. HYDRAULIC FILTER SWITCH — 990 Tractors

A. PTO case B. Adaptor C. 'O' ring—adaptor

Disconnect hoses and remove fan. Remove radiator on 990 Tractors; on 1200 Tractors the radiator and bonnet front need not be removed but the hydraulic pump driveshaft must be disconnected by releasing coupling from crankshaft pulley and removing rubber distance piece.

Disconnect fuel and leak-off pipes from tank; if tank is full it is advisable to drain the fuel to lighten tank. Remove hand throttle lever, disconnect instrument panel wiring and engine speed indicator drive cable. Remove fuel tank mounting bolts and remove tank complete with instrument panel.

Clean gearbox cover, top of rear axle case and adjacent areas to prevent dirt entering main frame when gearbox cover is removed.

Remove steering-box, complete with column and wheel: on 1200 Tractors the box should first be drained of oil. If tractor is fitted with hydrostatic steering, disconnect and drain oil reservoir, then disconnect pipes from servo valve and pump. Remove pump reservoir and servo valve complete with column and mounting bracket. Remove all pipes and *seal all pipe ends and unions* to prevent dirt entering system.

Remove starter and cable from battery to starter. Remove clutch housing — four bolts are positioned inside steering-box cavity — taking care of wedge and shims.

Release seat adjustment and slide seat fully rearwards. Remove gearbox cover bolts and lift off cover.

On Livedrive tractors it is necessary to drain the transmission oil into *clean containers*, remove PTO unit and withdraw cardan shaft clear of clutch. On 990 Tractors the hydraulic filter switch adaptor passes through underside of PTO case and *this adaptor must be removed* before PTO unit is withdrawn. (Fig. 5.)

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LUBRICATION SYSTEM

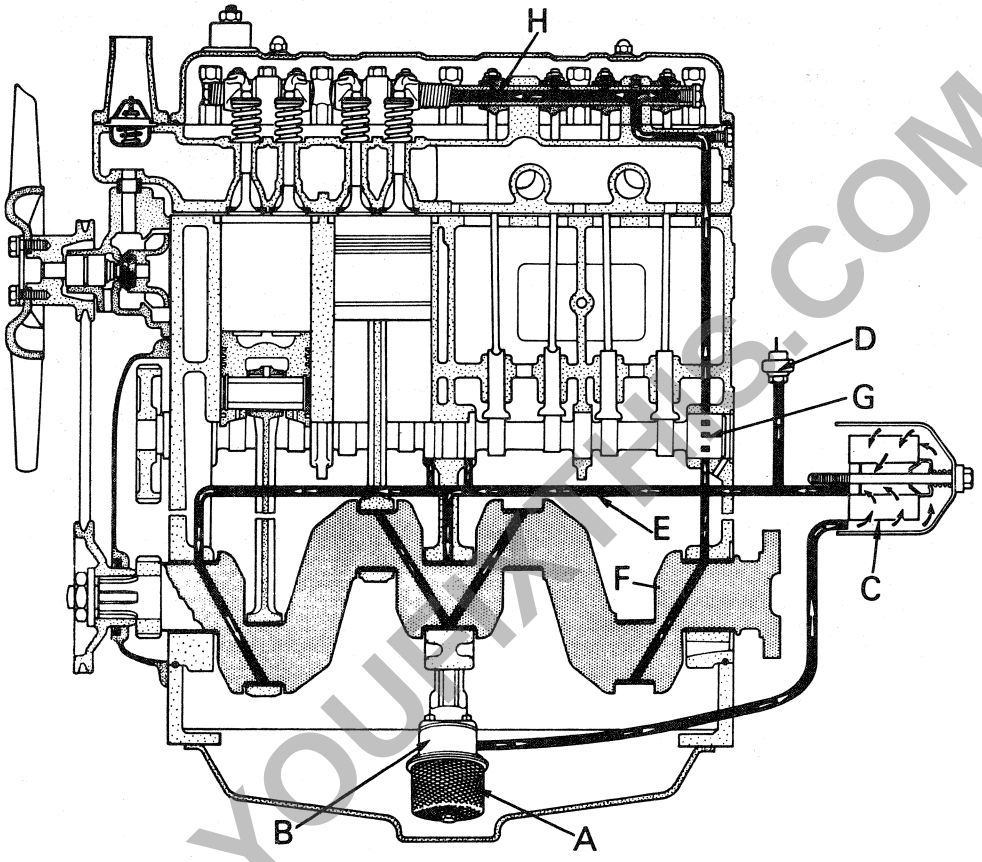


Figure 44. LUBRICATION SYSTEM

A. Inlet gauze
B. Oil pump
C. Filter
D. Warning light switch
E. Oil gallery
F. Crankshaft oil passage
G. Camshaft rear bearing
H. Valve rocker shaft

Engine Lubrication

Oil is drawn from the sump by the gear-driven rotary oil pump and delivered under pressure to the oil filter. After filtration the oil passes to the main oil gallery in the cylinder block and so, via oilways in the block webs, to the crankshaft main journals and then on, through further oilways in the cylinder block, to pressure lubricate the camshaft bearings. The big-end bearings are lubricated by drillings in the crankshaft webs.

The rocker shaft and valve rockers are intermittently fed with oil from the camshaft rear bearing through oilways in block and head and an external connecting pipe. The camshaft is drilled off-centre so that the oilways are connected only once in each revolution. (Fig. 44.) The oil lubricates the tappets and push rods as it returns to the sump.

The intermediate gear is pressure fed via its hollow shaft and an oil-way in the cylinder block. Surplus oil in the timing cover forms an oil bath which splash lubricates the timing gears.

A full-flow oil filter is mounted on the left-hand side of the cylinder block. The filter incorporates a by-pass valve so that if the pressure difference between the filter inlet and outlet exceeds 10 lb/sq in. the valve opens and allows oil to by-pass the element and flow straight into the oil gallery. The engine is not, therefore, starved of oil if the element is allowed to become choked, but it is supplied with unfiltered oil. The replaceable paper element should be renewed at the intervals specified on Page 2. A new element should also be fitted when an engine is overhauled and also if a cylinder head gasket fails. If engine oil and filter element are not changed when a failed cylinder head gasket is replaced, any water which has leaked into sump will cause the paper filter element to swell and fail to pass oil. (Fig. 45.)

Do not attempt to clean a filter element.

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Valve Timing

Inlet opens	8° before top dead centre
Inlet closes	38° after bottom dead centre
Exhaust opens	36° before bottom dead centre
Exhaust closes	10° after top dead centre

Rocker Shaft

Diameter	0·748 — 0·749 in	18·99 — 19·02 mm
Bush bore reamed in position	0·7500 — 0·7505 in	19·05 — 19·06 mm

Crankshaft

Main journal diameter		
Standard size	2·4995 — 2·4990 in	63·487 — 63·474 mm
Undersize 0·010 in (0·254 mm)	2·4895 — 2·4890 in	63·233 — 63·220 mm
Undersize 0·020 in (0·508 mm)	2·4795 — 2·4790 in	62·979 — 62·966 mm
Undersize 0·030 in (0·762 mm)	2·4695 — 2·4690 in	62·725 — 62·712 mm

When regrinding crankshaft it is important that the original journal fillet radius is maintained. It is also important that the surface of the radius is as smooth as the surface of the journal and that the radius is smoothly blended into both surfaces. A fillet that is incorrectly radiused, roughly finished or not smoothly blended, weakens a shaft and may cause fatigue failure during service.

Big-end journal diameter		
Standard size	2·3735 — 2·3730 in	60·29 — 60·28 mm
Undersize 0·010 in	2·3635 — 2·3630 in	60·04 — 60·03 mm
Undersize 0·020 in	2·3535 — 2·3530 in	59·78 — 59·77 mm
Undersize 0·030 in	2·3435 — 2·3430 in	59·52 — 59·51 mm
Centre journal width		
Standard size	2·126 — 2·124 in	54·00 — 53·95 mm
Oversize 0·010 in	2·136 — 2·134 in	54·254 — 54·204 mm
Oversize 0·040 in	2·166 — 2·164 in	55·270 — 55·220 mm
Bearing fillet radius	0·16 — 0·15 in	4·06 — 3·81 mm
Big-end bearing clearance	0·0015 — 0·0025 in	0·038 — 0·063 mm
Main bearing clearance	0·002 — 0·004 in	0·051 — 0·102 mm
End-float of crankshaft	0·002 — 0·010 in	0·051 — 0·258 mm
Thrust washer thickness		
Standard	0·091 — 0·093 in	2·3114 — 2·3622 mm
Oversize 0·005 in (0·127 mm)	0·096 — 0·098 in	2·4384 — 2·4892 mm
Oversize 0·020 in (0·508 mm)	0·111 — 0·113 in	2·8194 — 2·8702 mm

Connecting Rod Alignment

Maximum out of parallel	0·0005 in/in	0·0127 mm/cm
Maximum twist	0·0005 in/in	0·0127 mm/cm
Maximum weight variation in set of four rods	0·25 oz	7·1 gm

Piston Dimensions (new)

Height (990)	4·406 in	111·9 mm
Height (1200)	4·156 in	105·6 mm
Nominal diameter	3 $\frac{15}{16}$ in	100 mm
Piston skirt diameter (at right-angles to gudgeon pin bore)	3·9323 — 3·9315 in	99·9 — 99·8 mm
Piston ring side clearance	0·002 — 0·0035 in	0·050 — 0·088 mm
Piston ring gap	0·011 — 0·016 in	0·28 — 0·41 mm
Gudgeon pin diameter	1·2503 — 1·250 in	31·757 — 31·750 mm

(Push-fit in connecting rod bush, light-drive fit in piston)

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Air-cleaner oil bath (1200)	1½ pints	0·85 litres
Fuel tank (990)	13½ gal	61·4 litres
Fuel tank (1200)	18 gal	81·7 litres
Transmission oil (990)	5 gal	22·7 litres
Transmission oil (1200)	9 gal	41·0 litres

Wear Limits

The following figures are only intended to serve as a guide to determine when a component should be renewed:

Crankshaft big-end journals should be reground if ovality exceeds 0·005 in (0·127 mm).

Crankshaft main-bearing journals should be reground if wear exceeds 0·005 in (0·127 mm).

Crankshaft end-float should not exceed 0·015 in. (0·38 mm).

Piston rings should be replaced if ring gap exceeds 0·060 in (1·524 mm) when checked in unworn part of cylinder.

When there is evidence of ring and slight bore wear causing oil consumption, fit oil control rings. These should control oil consumption if bore wear is not greater than 0·010 in. (0·25 mm) and are available to suit either standard or oversize bores. If oil consumption exists and oil control rings have already been fitted it will be necessary to rebore the cylinder block and fit oversize pistons.

Piston groove clearance should not exceed 0·005 in. (0·13 mm) when checked with a new ring.

Oversize valves should be fitted if bore in cylinder head is worn in excess of 0·006 in. (0·15 mm).

Valve Clearance (set cold)

All inlet valves	0·010 in	0·25 mm
Exhaust valves with stem end caps	0·007 in	0·18 mm
Exhaust valves without stem end caps	0·010 in	0·25 mm

Valve Springs

Inlet (yellow spot)		
Free length	2·127 in	54·02 mm
Length at 77 lb load	1·148 in	
Length at 35 kg load		29·16 mm
Exhaust (blue spot)		
Free length	2·132 in	54·15 mm
Length at 82 lb load	1·180 in	
Length at 37 kg load		29·97 mm

Valve Stem Diameters (inlet and exhaust)

Standard	0·3732 — 0·3722 in	9·479 — 9·454 mm
Oversize 0·010 in. (0·007 mm) ..	0·3832 — 0·3822 in	9·733 — 9·708 mm
Oversize 0·020 in. (0·014 mm) ..	0·3932 — 0·3922 in	9·987 — 9·962 mm
Valve seat angle	45°	45°
Valve guide bore	0·375 — 0·374 in	9·525 — 9·499 mm
Valve tappet diameter	0·624 — 0·623 in	15·850 — 15·824 mm

Valve Seat Insert Counterbore Diameter (inlet and exhaust)

990	1·625 — 1·626 in	41·27 — 41·30 mm
1200 AD4/55A/4913 onward ..	1·625 — 1·626 in	41·27 — 41·30 mm
1200 AD4/55A/1001 to 4912	1·5615 — 1·5635 in	39·66 — 39·71 mm

Seat Insert Interference Fit in Cylinder Head Counterbore

Inlet and exhaust	0·004 — 0·006 in	0·10 — 0·15 mm

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MAINTENANCE

Daily

Engine Oil: Check oil level in engine sump and top up if necessary.

Air Cleaner: Remove filter bowl and examine condition of oil. In dusty conditions the oil should be changed frequently, the detachable wire element removed, washed in diesel fuel, and allowed to stand until all fuel has drained off. (Fig. 1.)

Paper Element Pre-Cleaner: This is an alternative fitting to the centrifugal type pre-cleaner and incorporates a replaceable paper element. Frequency of attention depends on working conditions and in dusty climates the cover should be removed every few hours of use and the element examined. The element can be cleaned by tapping its side to shake off the loose dust. If the element becomes very dirty, or contaminated with oil or water, it should be renewed. *Do not attempt to wash an element.* (Fig. 2.)

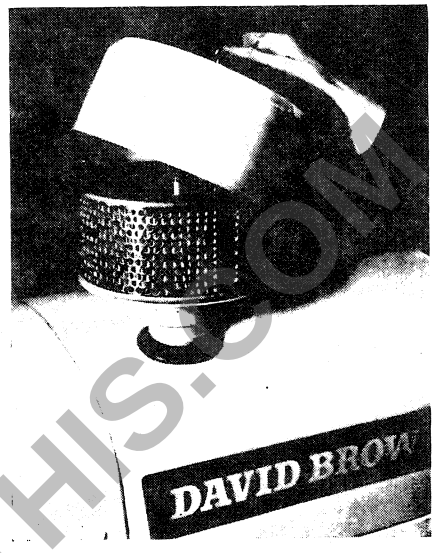


Figure 2. PAPER ELEMENT PRE-CLEANER



Figure 1. AIR CLEANER

A. Oil bowl B. Wire mesh C. Rubber sealing ring
D. Cleaner inlet pipe E. Cleaner body

Air Cleaner: Remove bowl and detachable wire mesh element. Clean out bowl and refill with new, clean oil.

The depth of dust deposit in cleaner bowl must not be allowed to exceed $\frac{1}{4}$ in. (6·3 mm) when checked after standing overnight, otherwise oil pullover into induction manifold will take place due to raised oil level. Oil in the induction manifold, which indicates oil pullover, can be checked through ether plug in manifold. Oil pullover will cause rapid engine wear and must be prevented by adequate cleaner maintenance.

Every 60 Hours

Engine Oil: Check oil level in engine sump and top up to within "safe" range if required.

Cooling System: Check radiator water level and top up to within 1 in. (2·5 cm) from top of filler neck if required. *If engine is hot, remove radiator cap slowly as system is pressurised and may scald hand if opened quickly.*

Sediment Bowl: Visually examine feed pump sediment bowl. Remove and clean if there is any accumulation of dirt or water. (Fig. 3.)

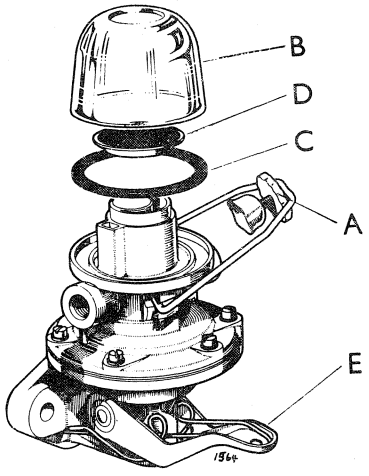


Figure 3. FEED PUMP SEDIMENT BOWL

A. Bowl securing nut B. Sediment bowl
C. Sealing ring D. Filter screen
E. Priming lever

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Position locating hole in bearing in line with screw-hole in pump body, then push bearing into position and fit locating screw. Lock locating screw with tabwasher when tight.

Support impeller end of spindle on a wooden block and press pulley on to spindle until end of pulley bore is level with end of spindle. Do not hammer the pulley on to the spindle and ensure pump is supported under impeller end of spindle and not under pump body.

Turn pump over and place a piece of $\frac{7}{8}$ in. (22 mm) diameter bar inside pulley recess — so that thrust is taken on end of spindle and does not push pulley further on to spindle — then carefully press impeller into place. Ensure gland seal is not damaged when fitting impeller, and press impeller on to spindle until clearance between tips of impeller blades and pump body is reduced to 0·005 in. (0·13 mm). Check that only the slight drag of seal can be felt when pulley is rotated.

DIMENSIONAL DATA

Torque Figures

Big-end bearing nuts	50 lb ft	6·92 kg metres
Breather filter cover nut	10 lb ft	1·38 kg metres
Camshaft gear bolt	40 lb ft	5·53 kg metres
Camshaft locating plate bolts	25 lb ft	3·46 kg metres
Carrier plate to cylinder block bolts	25 lb ft	3·46 kg metres
Clutch housing to main frame bolts	75 lb ft	10·5 kg metres
Crankshaft pulley nut	140 lb ft	19·3 kg metres
Cylinder block to main frame bolts	30 lb ft	4·15 kg metres
Cylinder head nuts and bolts	90 lb ft	12·4 kg metres
Cylinder head studs into block	25 lb ft	3·46 kg metres
Fan blade bolts	25 lb ft	3·46 kg metres
Flywheel nuts	50 lb ft	6·92 kg metres
Front extension to main frame bolts	65 lb ft	8·98 kg metres
Injection pump gear bolts (990)	20 lb ft	2·77 kg metres
Injection pump gear nut (1200)	45 lb ft	6·22 kg metres
Intermediate gear bracket bolts	45 lb ft	6·22 kg metres
Main bearing cap bolts	160 lb ft	22·12 kg metres
Main frame to engine bolts	30 lb ft	4·14 kg metres
Main frame to flywheel housing bolts	75 lb ft	10·5 kg metres
Oil filter bowl bolt	10 lb ft	1·38 kg metres
Sump to main frame bolts	20 lb ft	2·76 kg metres
Valve rocker adjusting nuts	14 lb ft	1·94 kg metres

The following figures apply to bolts of standard material with either coarse (UNC) or fine (UNF) threads and may be used for all bolts and nuts not listed in the previous table.

Thread Diameter	Torque	
$\frac{1}{4}$ in	7 lb ft	0·97 kg metres
$\frac{5}{16}$ in	15 lb ft	2·07 kg metres
$\frac{3}{8}$ in	25 lb ft	3·46 kg metres
$\frac{7}{16}$ in	45 lb ft	6·22 kg metres
$\frac{1}{2}$ in	65 lb ft	8·98 kg metres
$\frac{5}{8}$ in	110 lb ft	15·2 kg metres
$\frac{3}{4}$ in	140 lb ft	19·3 kg metres

Capacities

Cooling system	3 gal	13·6 litres
Engine lubricating oil	13 pints	7·4 litres
Steering-box oil (990)	2 pints	1·1 litres
Steering-box oil (1200)	5 pints	2·8 litres
Air-cleaner oil bath (990)	$1\frac{1}{4}$ pints	0·7 litres

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