THE PETROL AND VAPORISING OIL ENGINES

The four-cylinder petrol and vaporising oil engines fitted to the New Fordson Major Tractors have capacities of 3.26 and 3.61 litres, the bore diameters being 95 and 100 mm. respectively, with a stroke in each case of 115 mm.

Overhead valves are employed operated by push rods from a gear driven camshaft located in the right-hand side of the cylinder block. The compression ratio of the petrol engine is 5.5 to 1 and the vaporising oil engine 4.62 to 1. (Early type 4.35 to 1.) The valves are inclined at an angle of 13" in the cylinder head, the inlet valve head is larger than the exhaust. The valve guides are replaceable.

Identification of the Cylinder Heads

Petrol 5.5 –1	E1ADN-6050-B cast between Nos. 2 and 3 exhaust ports.
Vap. Oil 4.62–1	E1ADKN-6050-B cast between Nos. 2 and 3 exhaust ports and letter 'H' embossed between Nos. *2* and 3 spark plugs.
Vap. Oil 4.35–1	E1ADKN-6050 cast between Nos. 2 and **3** exhaust ports.

Aluminium alloy pistons are employed. The vaporising oil engine piston has three compression rings and the petrol engine piston has two compression rings. Both have one oil control ring above and one below the piston pin. The piston pins are fully floating and are retained in position by two circlips.

Detachable wet cylinder liners are fitted, flange-mounted in the top face of the cylinder block and retained in position by the cylinder head.

The crankshaft is supported in five large diameter main bearings. These bearings and the connecting rod big end bearings are of the detachable steel-backed lead-bronze type. Crankshaft end float is controlled by detachable thrust washers fitted at each side of the centre main bearing.

The distributor is fitted with both mechanical and vacuum advance mechanisms.

A centrifugal ball type governor controls the engine speed.

The operations described in the following pages are each complete in themselves and used in conjunction with the instructions from page 54 onwards give detailed information for a complete engine strip down.

These instructions have been prepared in order that the operations may be completed in the quickest time, involving the removal of the least number of component parts.

A guide as to whether a part is fit for re-use or not is given in the form of wear limits tabulated at the end of the section. In the case of a complete overhaul of the engine, discretion must be exercised when re-fitting parts which, although within the limits, may be subject to arduous service when reassembled.

THE ROCKER SHAFT ASSEMBLY

To Remove

1 Undo the adaptor nut securing the ventilation pipe from the rocker cover to the inlet manifold.

2 Unscrew the two securing bolts and remove the rocker cover and gasket.

3 Release the tab washers on the five rocker shaft bolts. Gradually unscrew the bolts and lift off the rocker shaft.

4 Lift out the push rods from their block locations, keeping them in their correct order.

To Dismantle

1 Remove the locating screws from No. **2** and No. 4 support bracket.

2 Stand the assembly on one end, push the rocker levers, springs, and support brackets downwards until the pin retaining the end plug is revealed. Remove the pin and withdraw the end plug. (See Fig. 46.)

3 Withdraw the rocker levers, springs and brackets from the shaft. The pin at the other end is then revealed.

4 Remove the front plug after withdrawing the retaining pin.

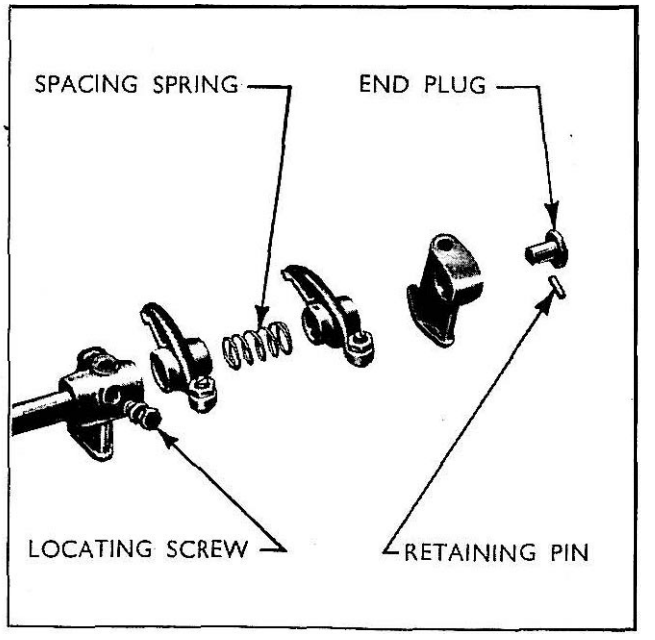


Fig. **46**
Rocker Shaft

To Reassemble

1 Fit a plug to one end of the shaft, securing it with a retaining pin. Replace the brackets, rocker levers and springs. Fit the locating screws to Nos. 2 and 4 brackets and the other end plug and retaining pin. Ensure that the support bracket bolt holes are to the right when viewing the shaft from the front end, with each pair of rocker levers inclined towards each other at the valve ends.

2 Fit the push rods in their original positions and mount the rocker shaft to the cylinder head, entering the adjusting screw ball ends in the push rod cups.

3 Fit and tighten down evenly the five rocker shaft support bracket bolts and lock with the tab washers.

4 Adjust the valve clearances initially to 0.015 in. for inlet and exhaust valves. Ensure that all locknuts are tightened, and after the engine has been run the valve clearances should be readjusted to 0.015 in. with the engine running.

5 Fit the rocker cover and gasket and tighten down the two securing bolts which are fitted with folded copper sealing washers.

6 Fit the ventilation suction pipe between the rocker cover and the carburettor.

CYLINDER HEAD ASSEMBLY AND GASKET

To Remove

1 Disconnect the negative cable from the battery terminal post.

2 Remove the radiator cap and drain the water from the cooling system through the two taps, one on the radiator and one on the left-hand side of the cylinder block.

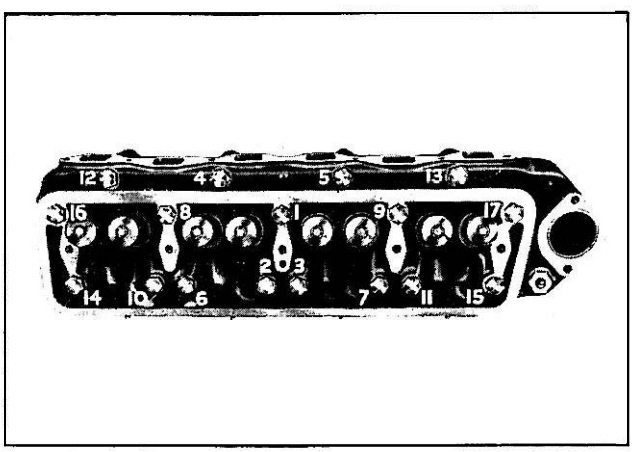


Fig. 47
Correct Sequence for Tightening Cylinder Head Bolts

3 Disconnect the radiator tie bar, remove the water outlet connection and lift out the thermostat,

4 Remove the temperature gauge thermometer bulb from the front of the cylinder head.

5 Remove the rocker cover, gasket, rocker shaft and push rods as described on page 35.

6 Disconnect the inlet and exhaust manifolds.

7 Unscrew the 17 bolts retaining the cylinder head to the cylinder block, lift off the cylinder head and remove the gasket and rocker shaft oil feed seal.

To Replace

1 Thoroughly clean off all dirt, carbon, etc., from the cylinder block, cylinder head faces and the recess in the cylinder block for the rocker shaft oil feed seal.

2 Fit a new oil seal in the recess in the cylinder block face and screw the cylinder head locating studs (tool No. TTr/MD 6050) in opposite corners of the cylinder block face and locate the new cylinder head gasket in position.

3 Replace the cylinder head and screw in the 17 bolts and tighten in the order shown in Fig. 47, to the correct torque.

4 Replace the inlet and exhaust manifolds as described below.

5 Replace the push rods, rocker shaft, rocker cover and gasket as described on this page.

6 Replace the temperature gauge thermometer bulb in the front of the cylinder head.

7 Refit the thermostat, water outlet connection and the radiator tie bar.

8 Refill the cooling system

9 Reconnect the battery lead to the battery terminal

THE INLET AND EXHAUST MANIFOLDS

To Remove

1 Lift out the vertical type exhaust pipe and remove the elbow adaptor. If the horizontal type is fitted, disconnect the pipe at the manifold.

2 Unscrew the clips at either end of the rubber hose between the carburettor and the air cleaner and remove the hose.

3 Disconnect the carburetror vertical control rod, also all pipes. Remove the carburettor if necessary (two bolts).

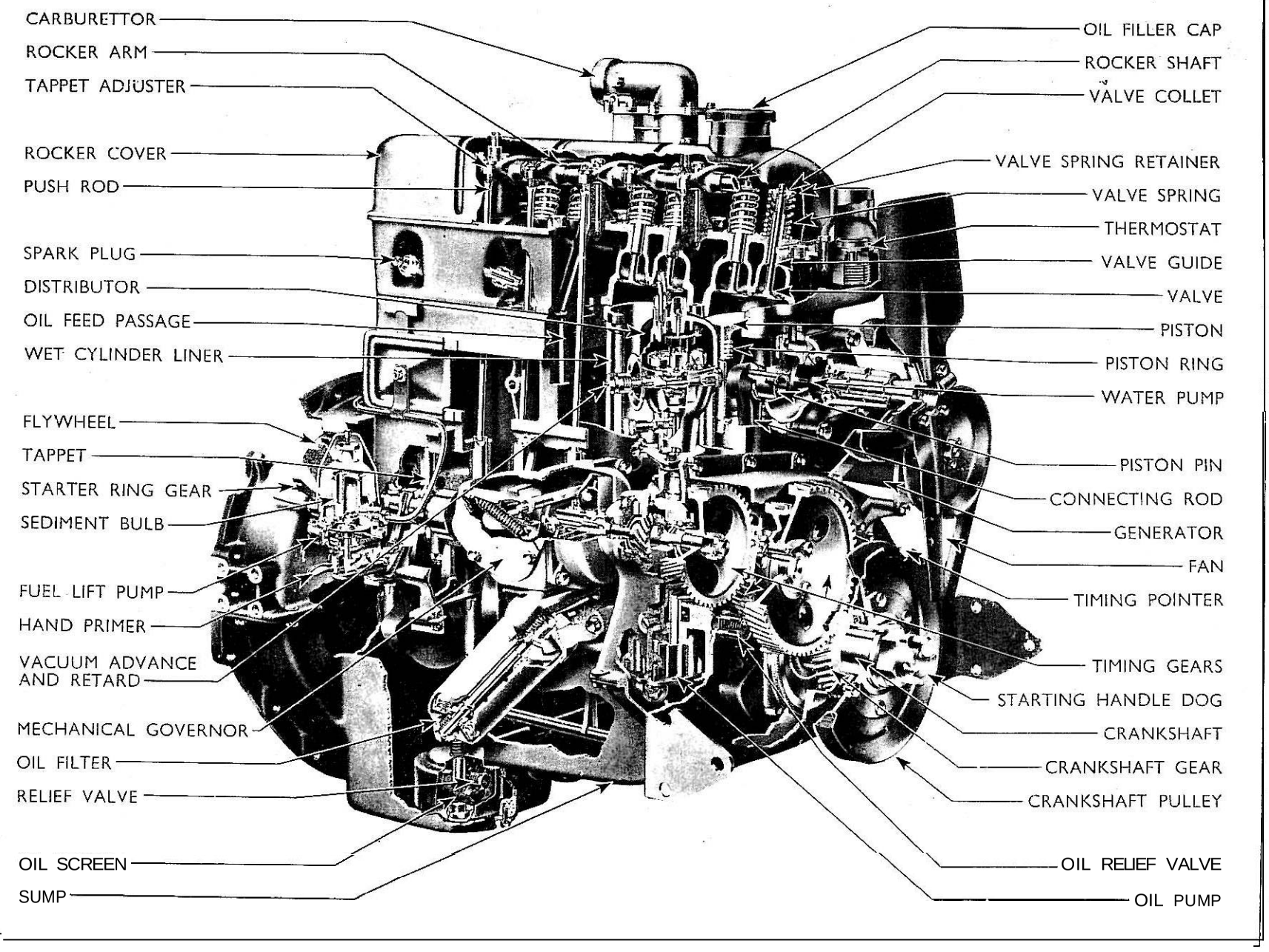


Fig. **48** **Sectioned View of Vaporising Oil Engine**

4 Disconnect the control wire and petrol pipe from the starter carburettor (if fitted) and remove the carburettor and gasket.

5 Unscrew the six bolts retaining the adaptor to the manifold and lift out the heat control flap. On early tractors a drain valve was fitted in place of the upper centre bolt.

6 Unscrew the manifold to head bolts and lift away the manifolds. On petrol engines the inlet manifold may be separated at the hot spot from the exhaust manifold by removing the four bolts.

To Replace

1 Fit the manifold using new gaskets and screw in the retaining bolts evenly, making sure that the clamping washers are correctly positioned in their recesses.

Note—For vaporising oil engines use the steel-faced gaskets, positioning the steel face towards the manifold and for petrol engines use copper asbestos gaskets.

2 Fit the main and petrol starting carburettors (if removed), pipes and controls.

3 Refit the rubber hose between the carburettor and the air cleaner.

4 If vertical exhaust, refit the elbow adaptor and position the pipe. IF horizontal exhaust, secure the pipe to the manifold.

VALVES, GUIDES AND SPRINGS

The valves are inclined at an angle of 13" in the cylinder head and are operated by push rods and rocker arms from the camshaft. The inlet valves are larger, on the diameter of the head, than the exhaust to ensure maximum intake of air on the induction stroke.

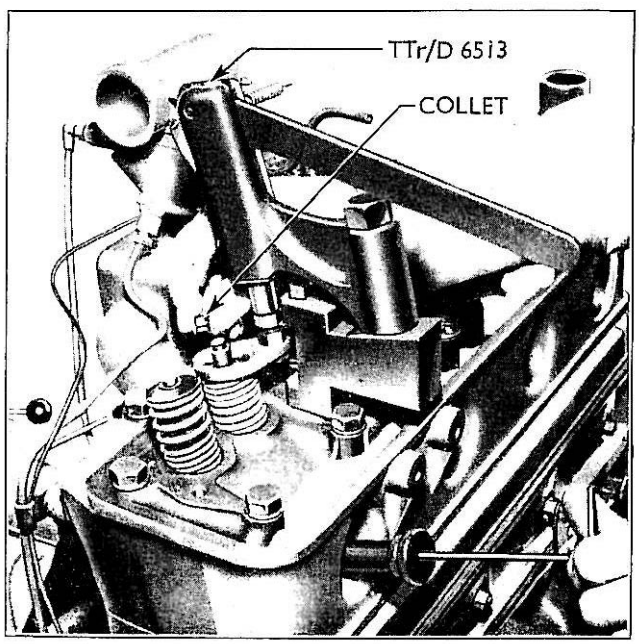


Fig. 49
Valve Spring Compressor

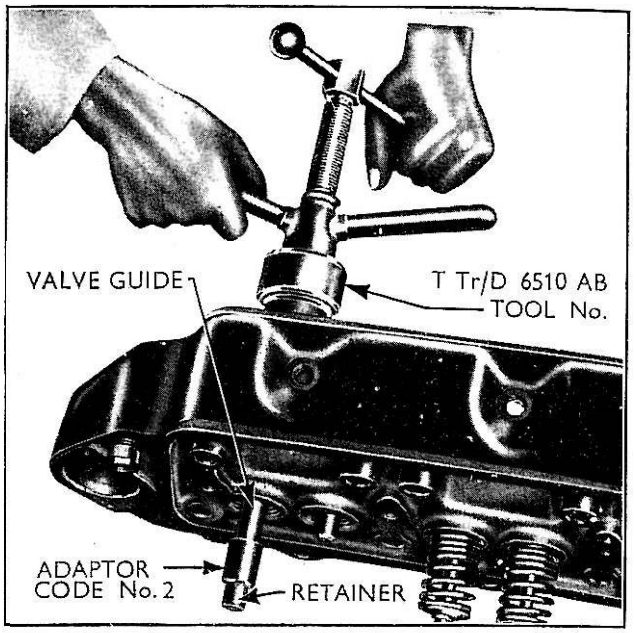


Fig. 50
Replacing Valve Guides

To **Renew** a Valve Spring (without removing **the** cylinder head)

1 Remove the rocker cover, rocker shaft assembly and push rods as described on page 35.

2 Remove the sparking plug from the cylinder concerned and screw the adaptor, part of the valve spring compressor tool (TTr/D 6513), in the sparking plug hole and turn the handle until the inner end contacts the valve to keep it in the closed position.

3 Fit the valve spring compressor (tool No. TTr/D 6513) under the appropriate rocker shaft support bolt and tighten the bolt.

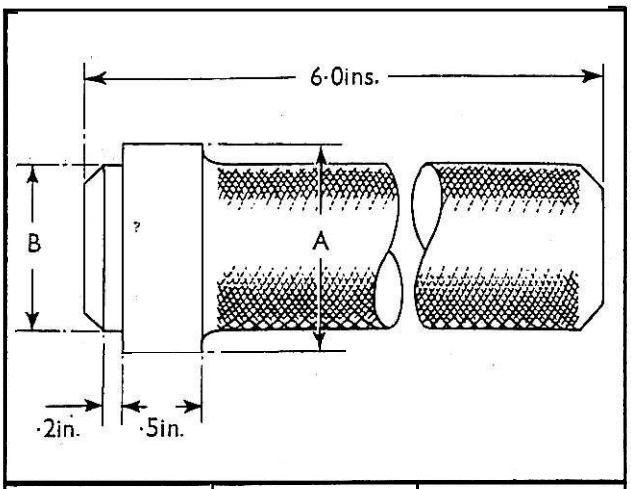
4 Locate the foot of the tool over the valve and pull down the cam handle to compress the valve spring and extract the taper cotters (see Fig. 49). Release the cam handle and remove the spring retainer, valve spring and rubber sealing ring.

5 Fit a new valve spring with the close-coiled end to the cylinder head and replace the spring retainer. Compress the valve spring and fit a new rubber sealing ring into the lower groove of the valve stem. Locate the cotters in the top groove of the valve stem with the tapers engaging in the taper of the spring retainer.

6 Remove the tool and replace the push rods, rocker shaft assembly and rocker cover, as described on page 36. Readjust the valve clearances.

To Remove Valves

1 Remove the rocker shaft assembly, push rods and cylinder head, see pages 35 and 36.



VALVE	A	B
INLET	1·88ins.	1·5ins.
EXHAUST	1·69ins.	1·3ins.

Fig. 51
Valve Seat Insert Driver

2 Lay the cylinder head on the base provided with the tool TTr/D 6513 to support the valves.

3 Mount the valve spring compressor (tool No. TTr/D 6513) on the cylinder head and secure it with the rocker shaft support bolt (see Fig. 49) nearest the valve to be removed.

4 Locate the foot of the tool over the valve, compress the spring, extract the collets and remove the retainer, spring and rubber seal. Repeat for all valves.

5 Turn the head on its side and remove the valves.

Note — Do not stamp the heads of the valves with a centre punch, but place them with their components in a suitable container so that they may be refitted to the port from which they were removed.

VALVE GUIDES

Valve guides are serviced for both inlet and exhaust valves, and may be removed and replaced, using tool No. TTr/D 6510-AB. Similar valve guides are used in the petrol and vaporising oil engines.

To Remove

1 Pass the rod of the valve guide remover and replacer (tool No. Tr/D 6510–AB) through the guide to be withdrawn so that the tool body abuts the valve seat, enter the spacer on the rod and screw on the retainer.

2 Turn the wing nut and pull the guide from the cylinder head.

The valves, springs, guides and retainers should he cleaned and the valve faces and valve seatings in the cylinder head examined for signs of pitting, burning or distortion.

To **Replace**

If worn beyond the limits specified at the end of this section, the valve guides should be renewed.

1 Pass the rod of the valve guide remover and replacer (tool No. TTr/D 6510–AB) through the valve guide housing so that the tool body abuts the valve seat.

2 Locate the guide, then the adaptor. The use of the correct adaptor, code No. 2 (see Fig. 50) will ensure that the guide is correctly positioned, i.e., with a protrusion of 1.045 ins. to 1,105 ins. above the spring seat.

3 Turn the wing nut to pull the guide into its housing and continue to do so until the adaptor abuts the face of the valve spring seat on the cylinder head.

VALVE SEAT INSERTS

Where replaceable valve inserts are fitted in the cylinder head, they can be renewed, if necessary, by following the instructions given below.

The first operation is to remove the original insert and the utmost care must be taken to avoid damage to the cylinder head. The easiest method for removal is to position a bar through the insert so that the end locates under its lower inside edge, suitably protecting the edge of the head on which the fulcrum point of the bar rests. A smart tap on the outer end of the bar will force the insert out of the cylinder head.

A new insert should be placed in the recess in the cylinder head, chamfered edge first. It can then be fitted with the aid of a driver, tool No. 6057–D/19 (inlet) and 6057–D/20 (exhaust) rings with 316–12 pilot. If not available suitable drivers can be made locally from the details given in Fig. 51 Great care should he taken to ensure that the insert is entered squarely in its recess and an extension to the driver to locate in the valve guide may be found advantageous.

The dimensions of standard and oversize inserts can be obtained from Fig. 52.

Insert	*Valve*	*I.D. of Recess in Head*	*Approx. Depth of Recess in Head*
Standard	Inlet	1.887–1.888 in.	0.218 in.
	Exhaust	1.699–1.700 in.	0.218 in.
ia. Std. Depth		1.897–1.898 in.	0.218 in.
0.010 in. o/s dia. and Depth	Exhaust	1.709–1.710 in.	0.228 in.
0.020 in. o/s dia. and Depth	Exhaust	1.719–1.720 in.	0.238 in.

Fig. 52
Valve Insert Data

Peening or rolling the surrounding metal of the cylinder head cover over the edge of the insert is unnecessary, as the interference fit is such that the insert will be firmly retained in the cylinder head without these aids.

Suitable cutters are marketed to enable the cylinder head to be machined to accept an insert where not previously fitted and also to permit an oversize insert to be fitted, should the original for any reason need renewing.

VALVE SEATS

If it should be necessary at any time to re-cut the valve seats in the cylinder head, a 30" cutter, or one of the proprietary portable valve seat grinding machines with the stone faced to 30°, should be used.

Care should be taken when re-cutting the valve seats to ensure that too much metal is not removed. As narrow a valve seat as possible should always he maintained.

If the valve seats in the cylinder head are badly damaged, valve seat inserts should be fitted (see page 39).

VALVE GRINDING

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 29½°. Fig. 53 shows a valve mounted in such a machine. The grinding should continue only until the face is true and free of pits, as the removal of an excessive amount of metal may thin the edge of the valve head to a degree where it will "curl" and overheat under operating conditions. For a similar reason the valve will be unduly lowered in its seating in the cylinder head and "pocketing" will result. If a valve tends towards thinness at the edge, particularly after refacing, it is more satisfactory to renew it.

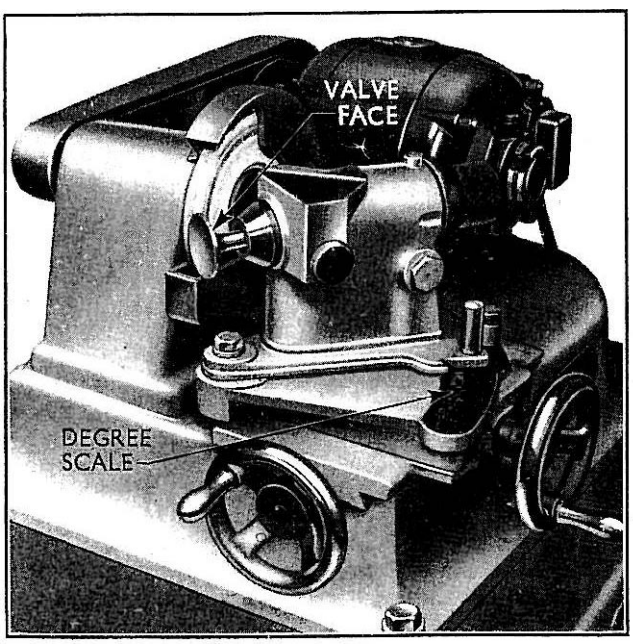


Fig. **53**
Grinding the Valve Face

If the valve seats show signs of pining, burning or other evidence of gas leakage, they should be machined or hand ground according to their condition. Remember that hand grinding is a finishing process and on no account should excessive hand grinding be attempted, otherwise the seat angles may be altered and the seat width increased excessively. Valves which are badly burned, distorted or which have been previously ground to the limits should be discarded and new parts fitted as replacements. Always grind a replacement valve into its seating.

1 With the valve removed, apply a small amount of medium or fine grinding paste to the valve face and replace in correct port.

2 Rotate the valve lightly, using a suitable suction grinding tool, first in one direction then in the other, raising the valve off its seat from time to time and turning it approximately one-quarter of a turn to ensure a concentric seat.

3 Add more fine grinding paste if necessary and continue the operation until an even, clean, matt-grey finish has been obtained on a seating no wider than $\frac{3}{32}$ in. If the condition cannot be reached, it will he necessary to re-face or re-cut the valves and/or seats.

After grinding-in the valves, carefully clean all paste and foreign matter from the seats and valves.

VALVE SPRINGS

Similar valve springs are used for the inlet and exhaust valves. They are "close-coiled" at one end to increase their efficiency and, when assembling, this end must be positioned against the valve spring seat on the cylinder head.

Before re-use all the valve springs should be carefully examined, with particular attention to squareness of ends and pressure developed at the compressed lengths.

PUSH RODS AND TAPPETS

Push rods should be checked for straightness before fitting to the engine. The tappets can only be removed from the crankcase locations after the camshaft has been withdrawn.

Note — Vaporising oil and petrol engine push rods are not interchangeable. (See Specification.)

To Replace the Valves

1 Remove all traces of grinding paste and foreign matter from the valve heads and stems and from the seats and guides in the cylinder head.

2 Oil the valve stems and guides to provide initial lubrication.

3 Insert each valve in its correct port.

4 With the base plate provided with the tool TTr/D 6573 fitted in place to support the valves, locate the valve springs in the spring retainers with the closed coils to the cylinder head.

5 Using the valve spring compressor (tool No. TTr/D 6513) as for dismantling, compress each valve spring in turn and fit a new rubber seal in the lower groove in the valve stem and position the valve collets.

6 Replace the cylinder head as described on page 36.

Adjusting the Valve Clearances

After replacing the rocker shaft assembly and push rods it will be necessary to readjust the valve clearances. With the tappet foot on the heel of the cam the clearance between the end of the valve stem and the rocker arm should be approximately 0.015 in. measured initially. (Sec Fig. 54.)

After the engine has been started up the tappets should be readjusted to 0.015 in. when the engine is running at its normal working temperature.

DECARBONISING

It is difficult to lay down any set period when it will be necessary to decarbonise petrol or vaporising oil engines. The usual indications are a deterioration in performance, accompanied by a loss of power, loss of compression or a light tapping or knocking sound (pinking) produced by the engine when pulling hard or accelerating under load. As a somewhat similar sound can be produced if the "ignition" is too far advanced, check this point before making a final decision. (See Electrical section.)

Carbon Removal

It is essential that absolute cleanliness is observed throughout the following operations to prevent any possibility of consequential damage resulting from particles of carbon falling into the engine and causing scoring of the cylinder bores, pistons, bearings, etc.

1 Remove the cylinder head and dismantle the valves. Clean all the carbon from the face of the cylinder head, combustion chambers and all ports. Ensure that no burrs are made on the machined face of the cylinder head.

2 Apply a smear of grease inside the tops of the cylinders and rotate the engine until numbers 1 and 4 pistons are at the top of their strokes. This causes the grease to fill up the gap between the piston crown and the cylinder wall and prevents carbon particles from reaching the ring grooves and subsequently causing wear.

3 Cover up numbers 2 and 3 bores and all water and oil ways, using clean rag, to prevent the entry of carbon and dirt.

4 With a suitable scraper remove all the carbon from the piston crowns, taking care not to scratch the aluminium alloy pistons.

5 When numbers 1 and 4 piston crowns are completely free of carbon, repeat the process of greasing on numbers 2 and 3, turn these pistons to the top of their strokes and cover up numbers 1 and 4 bores.

Note — Leave the piston crowns absolutely clean and smooth, as carbon will not deposit so fast on a smooth surface, but do not use any form of abrasive, as particles may find their way into the working parts of the engine.

6 Clean all piston crowns and cylinder bores with a paraffin moistened non-fluffy rag, lubricate with engine oil and cover for protection until the cylinder head assembly is to be replaced.

7 Reassemble the valves and replace the cylinder head assembly as described on page 36.

SUMP AND GASKETS

To Remove

1 Remove the sump drain plug and drain off the engine oil. Replace the drain plug.

2 Remove the retaiuing bolts from the front ends of the radius rod.

3 Remove the split pin retaiuing the radius rod rear pin in its location and remove the radius rod rear pin.

4 Carefully tap the radius rod across the axle sideways until clear of the sump and then lift it away.

5 Disconnect the track rod end on the left-hand side of the tractor.

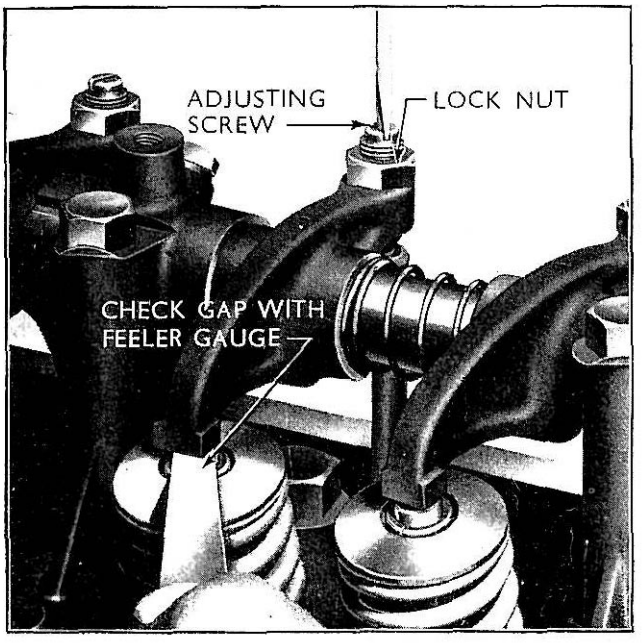


Fig. 54
Adjusting Valve Clearances

6 Remove the sump cover and the oil pump screen (six bolts).

7 Unscrew the bolts retaining the sump to the cylinder block and the flywheel housing. It will he necessary to support the weight of the sump as it must be lowered squarely during removal.

To Replace

1 Clean off the gasket faces on the sump and cylinder block.

2 Smear with grease and locate the new gaskets on the cylinder block faces.

3 Fit a cork strip to the front main bearing cap so that its ends are over the gaskets already fitted.

4 Fit a new lower half rear oil seal. This should be previously soaked in engine oii for one hour and when fitted should protrude at its ends $\frac{1}{32}$ in. above the sump face in a similar manner to the upper half seal in the block. (See Fig. 55.)

5 Replace the sump ensuring that all gaskets are correctly aligned, screw in and tighten all bolts evenly.

6 Reposition the radius rod and fit the two bolts in the front ends and a pin in the rear end. Do not forget the split pin.

7 Reconnect the track rod end on the left-hand side of the tractor.

8 Replace the oil pump screen, sump cover plate, gasket and drain plug.

9 Refill the sump with the apptoved grade of oil to the correct level.

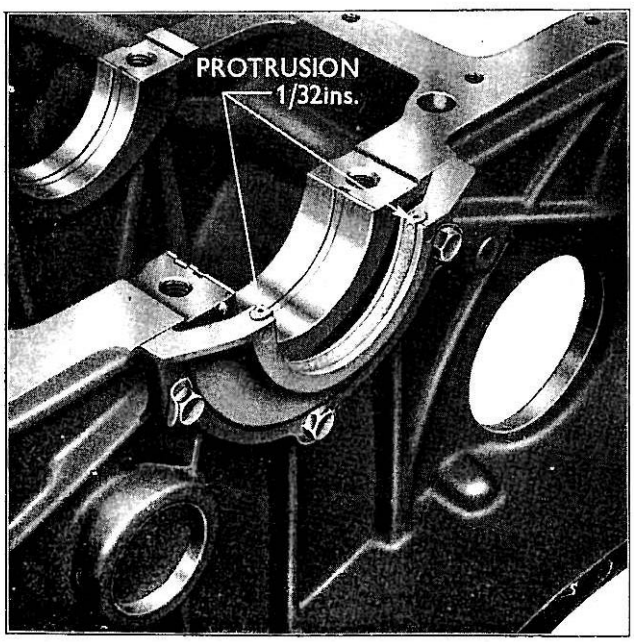


Fig. 55
Rear Main Bearing Oil Seal

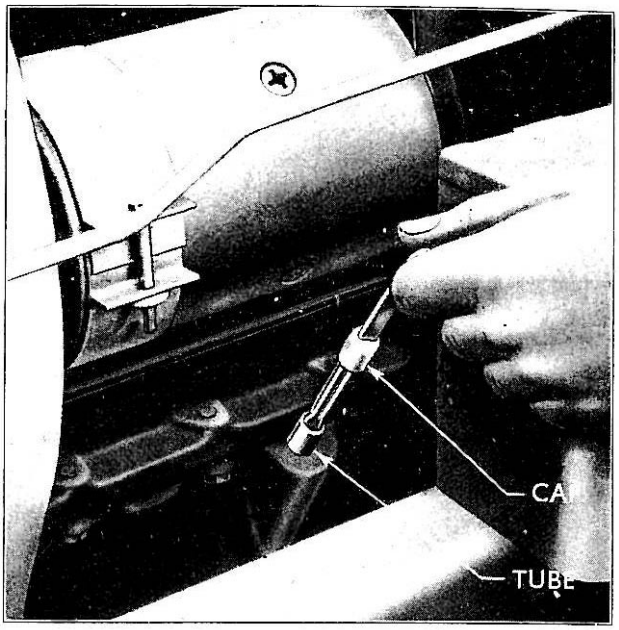


Fig. 56
Engine Oil Indicator

ENGINE OIL INDICATOR

On current tractors the engine air indicator is used in conjunction with a steel tube pressed into the sump. It has a metal cap brazed to the shank which is located over the top of the tube. **A** rubber seal is fitted inside the cap to exclude all foreign matter (see Fig. 56).

In cases where early type tractors are operating under adverse conditions and it is desired to convert to the latest lype indicator, the following method can be adopted with the sump in *situ.*

1 Drain the sump and remove the cover plate and oil screen.

2 Ream out the full length of the oil indicator bore in the sump to a diameter of 0.499 in.–0.500 in. (The outside diameter of the tube is 0.5005 in.–0.5015 in.)

3 Press the tube into the bore, taking care not to damage its upper end, until it protrudes 0.6875 in.

4 Clean all swarf thoroughly from inside the sump, replace the screen, cover plate and gasket. Refill with clean oil of approved grade.

Note — The latest type oil indicator is not suitable for use on engines without the indicator tube.

THE OIL PUMP

To Clean the Filter Screen

1 Drain the sump and remove the sump cover plate (six bolts) and take out the screen.

2 Remove the spring clip from the screen cover and lift out the screen.

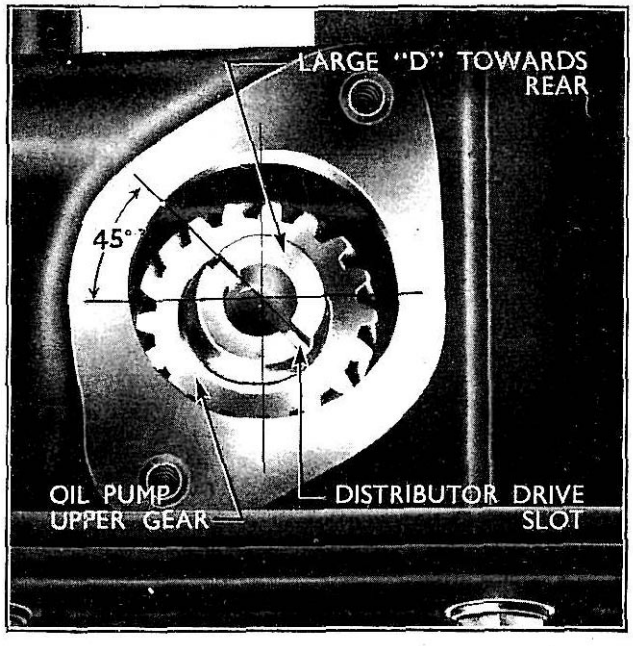


Fig. 57
Assembly of Oil Pump *to* Block

3 Wash all parrs thoroughly in petrol or paraffin.

4 Check that the relief valve in the screen is operating freely and reassemble the screen in the cover.

5 Refit the oil pump screen and replace the sump cover plate and gasket. Refill the sump with clean oil of an approved grade.

To Remove the Oil Pump

1 Remove the sump as described on page 41.

2 Remove the suction pipe by removing the bolt from the support bracket on the centre main bearing cap and unscrewing the union nut after releasing the locking plate.

3 Unscrew rhe two bolts securing the oil pump to the cylinder block.

Note — For Dismantling, Reassembling and Testing the Pump, refer to Engine Lubrication Section on pages 60 and 61.

To **Replace** the Oil Pump

1 With No. 1 piston at T.D.C. compression stroke enter the oil pump in its block location ensuring that the oil pump gear engages with the auxiliary drive shsft gear in such a manner that when the pump is fully home the large " D " formed by the offset distributor drive slot, points towards No. 2 cylinder and the slot assumes the position shown in Fig. 57. Replace the two bolts to secure the oil pump to the cylinder block.

2 Thread the suction pipe through the locking plate, screw in the union nut and secure with the tabs on the plate.

3 Replace the sump as described on page **42.**

4 Replace the screen and sump cover plate and gasket.

PISTONS AND CONNECTING RODS

Numbering Connecting Rods

Connecting rods are numbered on rod and cap when installed in the engine to facilitate correct reassembly, should they be dismantled in service. (See Fig. 58.)

The numbers are stamped on the camshaft side of the big end so that a cap replaced with numbers together must be in the original position. Never reassemble the cap to the connecting rod incorrectly, otherwise a true bearing surface cannot he assured.

It is advisable, before removing connecting rods from an engine, to ascertain that they have been numbered, as they may have been installed at some time after the engine left the factory, in which case the numbering may not have been carried out. Such connecting rods should be suitable stamped.

To Remove a Connecting Rod and Piston Assembly

1 Remove the cylinder head as described on page 36.

2 Remove the sump as described on page 41.

3 Remove the carbon from the top of the cylinder liner with a suitable scraper.

4 Turn the crankshaft so that the piston to be removed is at the bottom of its stroke.

5 Remove the self-locking nuts from the connecting rod bolts and remove the cap and the bottom half of the big end bearing liner. (See Fig. 58.)

6 Push the piston and connecting rod assembly up and out of the bore, taking care not to dislodge the top half of the bearing liner. Keep the two halves of the big end liners in their respective positions in the rod and cap.

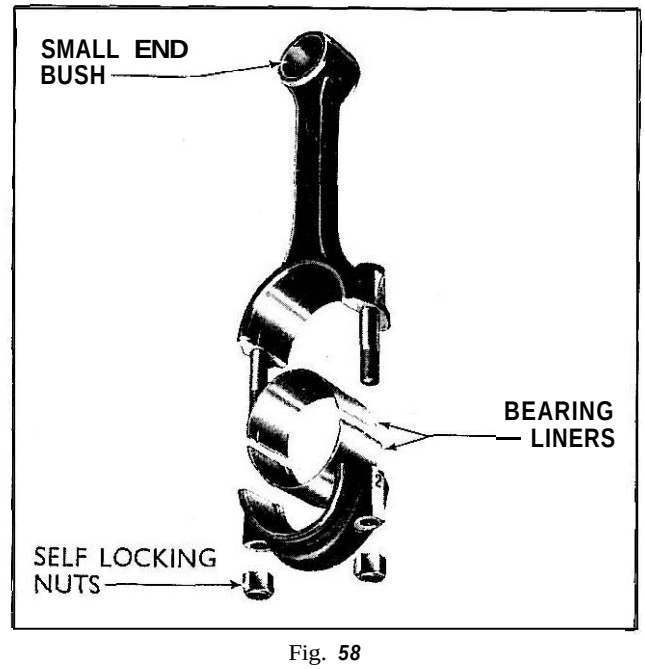


Fig. *58*
Exploded View of Connecting Rod

To Replace **a** Piston and Connecting Rod Assembly

1 Thoroughly clean out the cylinder liner with a clean dry rag.

2 Clean the piston, preferably using a compressed air line. Oil the cylinder liner, piston and rings lightly.

3 Position the rings so that the gaps are equally spaced around the piston and no gap is in line with the piston pin bore.

4 Fit the top half of the bearing liner in the connecting rod, ensuring that the tongue in tlie liner engages in the machined recess in the big end bore. Smear freely with clean oil to provide initial lubrication.

5 Compress the rings, using the ring compressor (tool No. Tr/DDK 6153) and insert the piston and connecting rod assembly into the bore, ensuring that the split in the skirt is on the opposite side to the camshaft with the word "Front" stamped on the piston crown pointing towards the front of the engine, also check the numbers on the connecting rod are on tlie same side as the camshaft.

6 Push the piston down the bore through the compressor.

7 Locate the lower half of the big end bearing liner in the cap with the tongue registering in the machined recess and refit the cap with the stamped numbers together and the liner smeared freely with clean oil.

8 Fit new self-locking nuts to the connecting rod bolts and tighten with a torque wrench to the current specification.

9 Instal the sump and cylinder head as described previously.

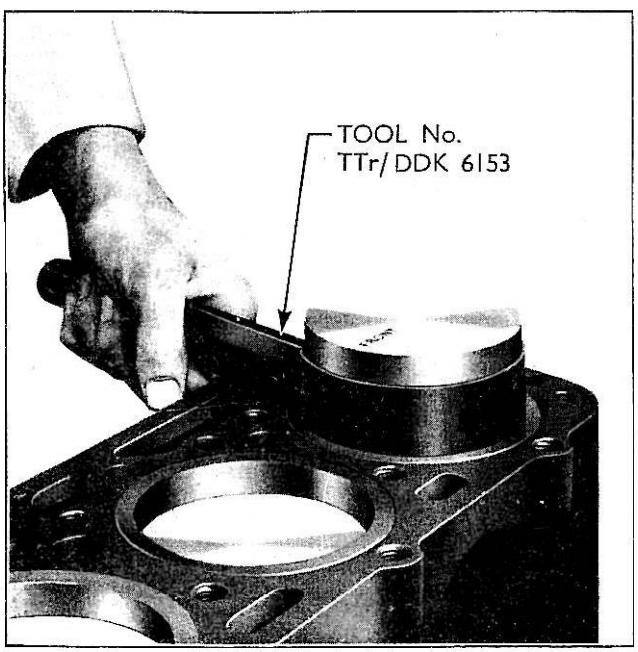


Fig. **59**
Fitting Pistons

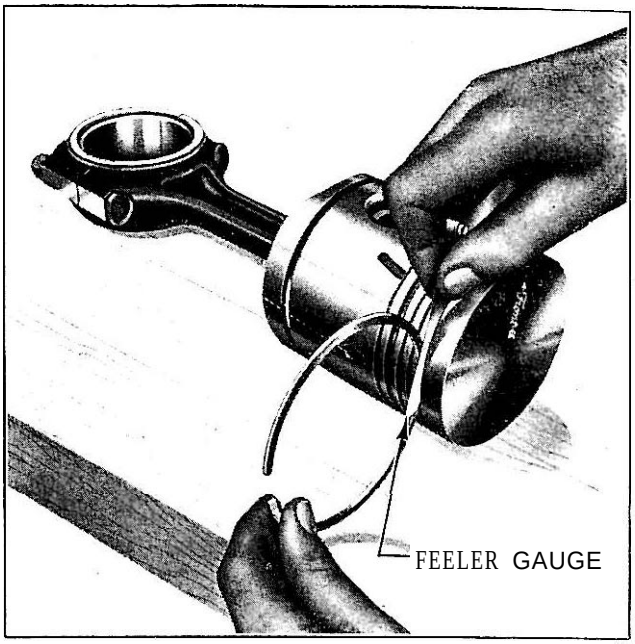


Fig. **60**
Checking Ring to Groove Clearance

PISTON RINGS

The current production vaporising oil engine ring layout is a hardened and tempered, parallel compression ring in the top groove. Two tapered compression rings are fitted in the next two grooves and it is essential that these rings are installed with the word "Top," marked on the top face of the ring, upperniost, otherwise oil pumping may result.

Two normal, slotted type, oil control rings are fitted in the two grooves, one immediately above and one below the piston pin.

Only this ring combination should be used in service.

Note — On the petrol engine, only one tapered compression ring is fitted below the top hardened and tempered parallel ring.

To Remove

1 Remove the connecting rod and piston assembly as described previously, and turn the piston rings in their grooves until the five gaps are in line.

2 With the piston laid ona flatsurface, rings downwards, push three metal strips (0.020 in. feeler strip not more than ½ in. wide is suitablc) through the gaps between the piston and ring. Work two of the strips sideways until the three strips are equally spaced around the piston. The rings can then be eased over the metal strips.

Checking Piston Ring **Gap**

I Insert the piston ring in the cylinder bore, centralising it by means of a piston until the ring is on an unworn part of the bore. The gap should then be checked by means of a feeler gauge to ensure that it is within the specified limits.

2 Check that the piston ring grooves are clean, especially the oil control ring grooves, and ensure that the oil return holes are clear.

With the piston ring inserted in its groove (see Fig. 60), check that the piston ring to groove clearance is within the specified limits.

Insufficientclearance may cause piston ring seizure, resulting in loss of compression. Excessive clearance will contribute to oil pumping.

To Replace

1 Replace the piston rings, oil control rings first, in their respective piston grooves. The hardened and tempered parallel faced compression ring **must** be fitted **in** the top groove and the lower taper faced compression ring with the word " TOP " uppermost.

2 Position the piston ring gaps so that they are evenly spaced. Lubricate the piston and rings and replace the piston and connecting rod assembly as described on page 44.

PISTONS

The flat top pistons are of aluminium alloy with a split skirt to ensure closer fitting. The diameter of the vaporising oil engine piston is 100 mm. and the petrol engine piston 95 mm.

If new pistons are being installed they should be selected to fit in the cylinder liners, using a poundage pull gauge in conjunction with a strip of feeler steel, having a width and thickness specified. The feeler should be inserted into the cylinder liners the whole length of the piston opposite the split in the skirt and a pull of between four and seven pounds should be required to remove it. (See Fig. 61.)

The only oversize pistons available for service are plus 0.0025 in.

To Remove a Piston from a Connecting Rod

1 Remove the connecting rod and piston assembly as described on page **43.**

2 Remove the two circlips, retaining the pin in the piston. To assist in removing the pin the piston may be warmed by insertion in boiling water.

3 Push out the piston pin.

To Replace Piston on Connecting Rod

1 Heat the piston in boiling water to allow easy assembly of the piston pin.

2 Insert the connecting rod between the piston bosses so that the numbers on the connecting rod are on the opposite side to the split in the skirt.

3 Insert the piston pin and fit the circlip retainers in the grooves at each end.

4 Oil the parts and reassemble as described on page 44.

PISTON PINS

The piston pin is a case hardened seamless steel tube, ground to very fine limits, so that when fitted to the piston it is selected to give the clearance as shown in the specification at the end of this section.

It is advisable, therefore, to warm the piston before removing or replacing the piston pin which is retained by means of a circlip installed in a groove at each end of the piston pin

Piston pins are not interchangeable in the diesel, petrol or vaporising oil engines. (See Specification.)

CONNECTING RODS

The connecting rods are forgings of " H section having steel backed, lead bronze, indium plated big end bearing liners and separate cap bolts and self-locking nuts. The piston pins are fully floating and the small end of the connecting rod is bronze bushed.

As the connecting rods in the petrol and vaporising oil engine differ from those in the diesel engine, they can he distinguished by the words "Petrol & Vap Oil" embossed on the centre web.

The small end bushes are not serviced independently.

Renewing Connecting Rod Liners

Liners may be changed without removing the piston and connecting rod assembly from the engine.

Connecting rod liners are available in standard and 0.010 in., 0.020 in., 0.030 in. and 0.040 in. undersize.

1 Remove the sump as described on page 41

2 Remove the oil pump suction pipe as described on page 43.

3 Turn the crankshaft to bring the affected big end to bottom dead centre. Remove the self-locking nuts and detach the cap.

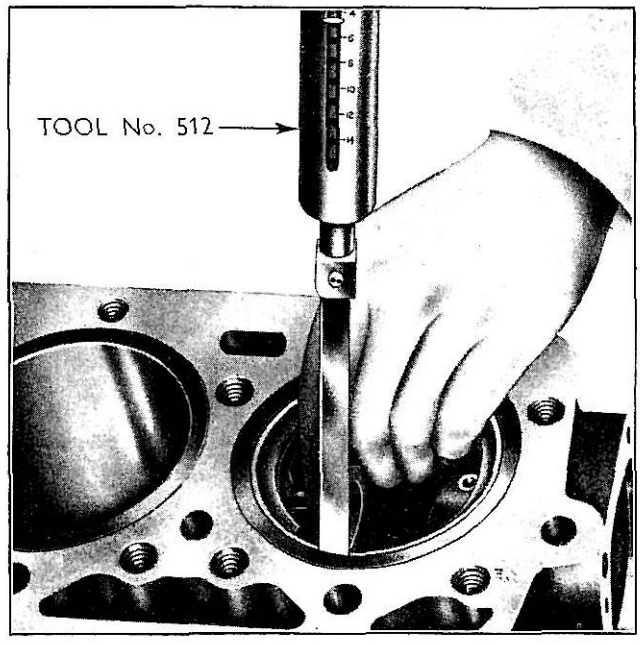


Fig. *61*
Checking Fir of Piston in Bore

4 Push up the connecting rod sufficiently to clear the crankpin and move the big end to one side. The upper half of the liner may now be extracted from the rod and a new one inserted with the tongue in the liner engaging the machined recess in the big end bore.

5 The lower half of the liner may now be extracted from the cap and a new one inserted as described overleaf for the upper half (paragraph 4).

6 Lubricate the liner and refit the big end to the crankpin, taking care that the upper half of the liner is not dislodged.

7 Replace the big end cap with the stamped numbers together (ensure that the cap bolts are right down with the bolt heads locating against the sides of the rod).

8 Fit new locknuts and tighten to the specified torque and check the end float by means of a feeler gauge as shown in Fig. 62.

9 Replace oil pump suction pipe, sump, oil pump screen, sump cover plate and gasket, and radius rod, etc., as described in the appropriate sections.

CONNECTING ROD ALIGNMENT

Connecting rod alignment can be checked by using the connecting rod alignment jig, tool No. 335 and arbor No. 335-F1. This indicates bent or twisted connectingrods, see Fig. 63. The method of testing is described below.

Checking for Twisted Connecting Rods

1 Remove the piston as described on page 45. Insert the piston pin in the small end of the connecting rod, in which it must he a good fit, otherwise misleading results will occur.

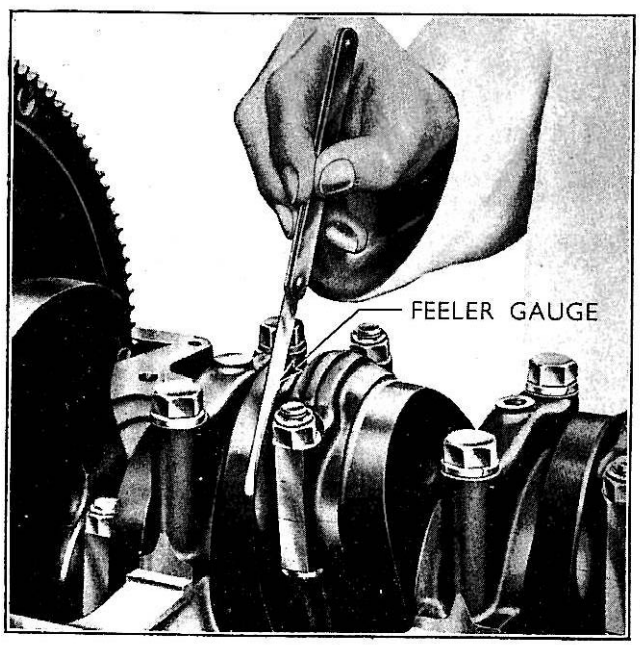


Fig. 62
Checking Connecting Rod End-float

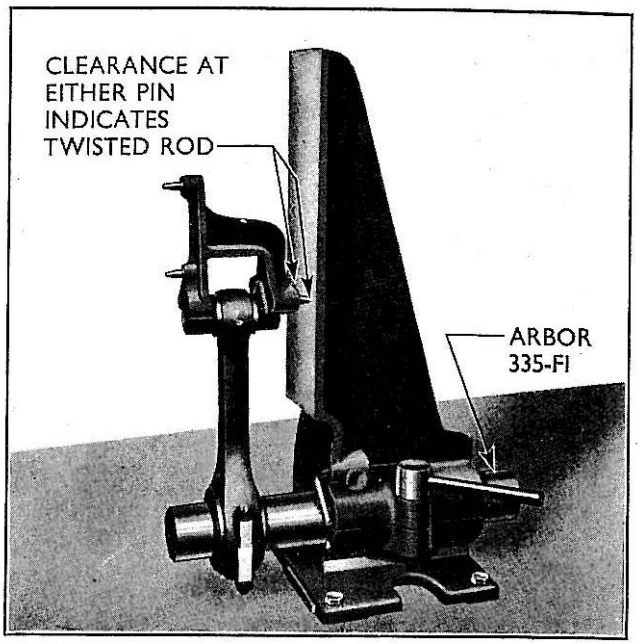


Fig. 63
Checking for Twisted Connecting Rods

2 Bolt the connecting rod, without cylinder liners, to the arbor and with the gauge mounted on the piston pin with the two horizontal pins towards the jig, move the arbor along until the pins touch the machined surface. Clamp the arbor in this position. Clearance between the face of the jig and one of the pins indicates a twist in the connecting rod. (See Fig. 63.)

Checking for Bent Connecting Rods

The procedure is the same as for checking for twisted connecting rods, except that the vemcal pins of the gauge are brought into contact with the machined surface. Clearance between one of the pins and the machined face of the jig indicates small and big end bores are out of parallel an3 the connecting rod is bent.

Where any connecting rods are found to be either twisted or bent, they should be replaced by a new part. No attempt should be made to straighten these connecting rods.

CYLINDER **LINERS'**

The diesel engine is fitted with detachable wet cylinder liners, flange-mounted in the top face of the cylinder block and retained in position by the cylinder head. The liners used on the vaporising oil engine have a bore diameter of 100 mm. and those on the petrol engine 95 mm.

A rubber seal is situated around the bottom of the cylinder liner to make a water-tight joint.

When fitting new liners to a block, it is essential that the liner protrusion above the block face is between 0.002 in. and 0.004 in. The most satisfactory method of checking this protrusion is by using a straight edge and feelers. In the unlikely event of difficulty in obtaining this protrusion, it is possible to use shims under the liner flange to bring it within the above limits.

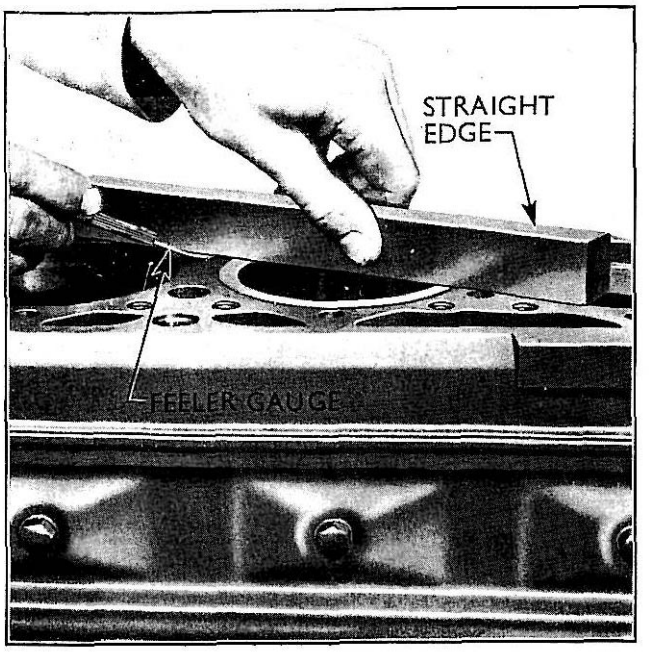


Fig. 64
Checking Liner Protrusion

These shims are supplied for service in 0.002 in. and 0.003 in. thicknesses.

When checking this protrusion it is also necessary to carry out the check in more than one position to ensure that the top flange of the cylinder liner is parallel with the top face of the cylinder block. Should the flange be more than 0.002 in. out of parallel with the top face of the cylinder block it is advisable to turn the cylinder liner and recheck to see if an improvement can be made. Failing this it is advisable to interchange the cylinder liners with the cylinder block location until it is possible to get all four liners within the 0.002 in. limit. (See Fig. 64.)

To Remove the Cylinder Liners

1 Remove the cylinder head as described on page 36.

2 Remove the sump as described on page 41.

3 Remove the connecting rods and piston assemblies as described on page 44.

4 Withdraw the liners, using the extractor (tool No. TTr/D 6055–A). (See Fig. 65.) If the original liners are to be fitted, number and mark them for angular position. Do not make this mark on the top face.

To Replace Cylinder Liners

1 Ensure that the recesses for the seal in the cylinder block and the liner flange location are clean and free from loose particles of dirt.

2 Fit the liners in their location *without the* rubber *seals* and check that the liner protrusion above the top face of the cylinder block is between 0.002 in. and 0.004 in. and that they are parallel within 0.002 in. Carry out this test in more than one positionof the straight edge.

3 Remove the liners after this check. Lubricate the rubber seals with soft soap and fit them in their recesses in the block.

4 Fit the cylinder liners by hand, rotating them in a short arc and making sure that the liner seal is not disturbed from its location.

5 Refit the connecting rod and piston assemblies as described on page 44.

6 Refit the sump, radius rod and the cylinder head as described in the appropriate sections.

THE TIMING COVER AND OIL SEAL

To Remove

1 Drain the cooling system through the two taps, one on the radiator and one on the side of the cylinder block.

2 Remove the engine bonnet by unscrewing the two screws from the rear clip.

3 Disconnect the top and bottom water hoses by unscrewing the clips at the radiator end of the hoses.

4 Disconnect the headlamp wiring by pulling out the snap connectors on the right-hand side of the tractor, near the radiator.

5 Remove the radiator tie bar clip from the water outlet connection bolt.

6 Disconnect the radiator shutter operating rod at the radiator end behind the grille:

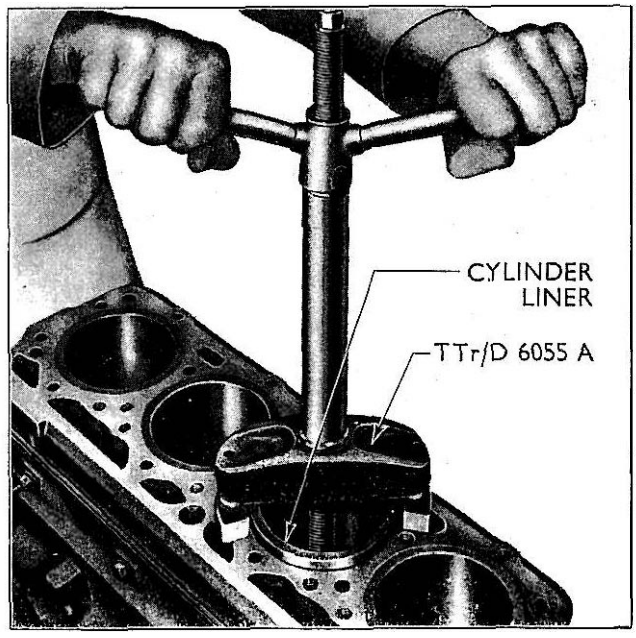


Fig. 65
Removing a Cylinder Liner

7 Where a horizontal exhaust system is fitted, remove the bolt securing the silencer to the side channel.

8 Mount the Front Axle Wedge Tool No. Tr/2 NMD 3004.

9 Remove the cotter pin from the radius rod rear pin and pull out the pin.

10 Remove the two bolts from the fork ends of the radius rod.

11 Carefully tap the radius rod sideways across the front axle until clear of the sump and lift it away.

12 Disconnect the steering drag link by unlocking the drag link front ball plug and unscrewing the plug.

13 If the Tractor Dismantling Stand is not available suitably support the engine.

14 Remove the four bolts from each side channel where the side channel is bolted to the gearbox.

15 Remove the three bolts from each side channel, securing the front mounting plate to the side channel.

16 Support the radiator and front axle assembly by the side channels and wheel the assembly forward until clear of the tractor.

17 Slacken off and remove the generator and the fan belt.

18 Remove the crankshaft ratchet and pulley using the turning bar (tool No. TTr/D 6319) to undo the crankshaft ratchet and puller (tool No. TTr/D 6312–A) to withdraw the pulley (see Fig. 66).

19 Remove the timing cover (fourteen bolts). Take care not to damage the seal when the cover is withdrawn.

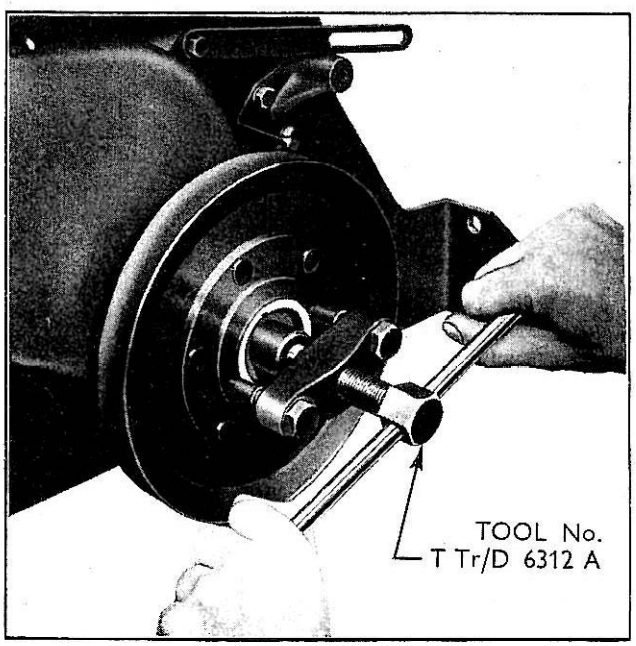


Fig. 66
Removing the Crankshaft **Pulley**

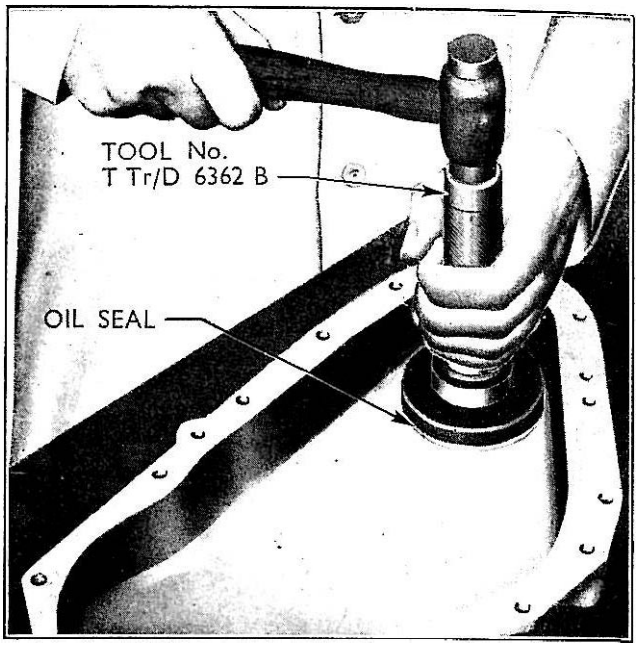


Fig. 67
Fitting Crankshaft **Oil** Seal in Timing **Cover**

To Renew the Crankshaft Front Oil Seal

1 Carefully extract the old seal with a suitable lever.

2 Locate a new seal in the front cover with the lip of the seal towards the inside of the cover.

3 Tap the new seal gently into position using the tool No. TTr/D 6362-B and a suitable mallet (see Fig. 67).

To Replace the Timing Cover

1 Locate the cover and new gasket on the front face of the mounting plate. On earlier tractors where the front mounting plate is not dowelled, fit the crankshaft pulley to align the timing cover oil seal with the crankshaft.

2 Screw in the fourteen holts to secure the cover. Make sure that the coarse threaded bolts are screwed into the block, and the fine threaded ones into the front mounting plate and tighten evenly to the specified torque.

3 Fit the crankshaft pulley and ratchet.

4 Replace the generator and fan belt, adjust to give a free movement of ½ in. (12.6 mm.) midway between water pump and generator pulleys, and tighten up the generator mounting bolts.

5 Support the radiator and front axle assembly by the side channels and wheel it towards the tractor, positioning the front mounting plate in each side channel, until the holes in the end of each side channel are located opposite their gearbox mounting positions. Refit four bolts securing each side channel to the gearbox mountings and replace the six bolts retaining the front mounting plate to the channels.

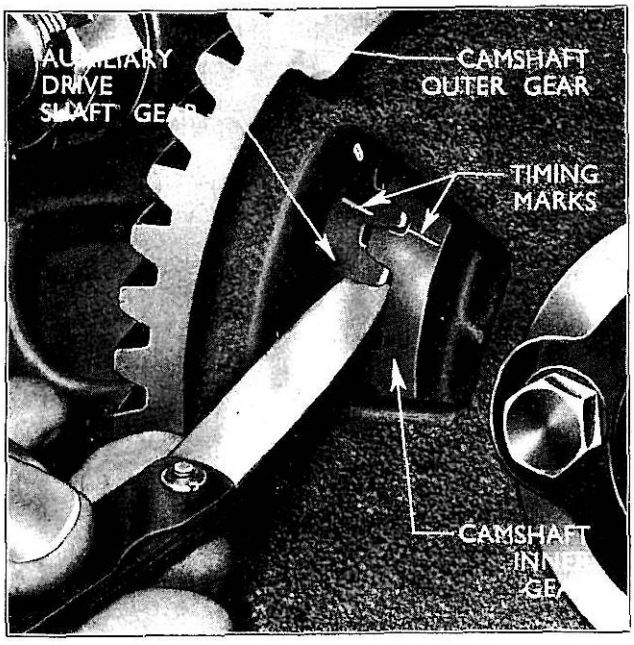


Fig. 68
Checking Timing Gear Backlash

6 Release the weight of the engine from the lifting equipment.

7 Reconnect the steering drag link.

8 Position the radius rod with the fork ends on the front axle to the right-hand side of their location holes and gently tap the radius rod across the front axle, at the same time locating its rear end in the sump bracket.

9 Replace the two bolts in the fork ends of the radius rod.

10 Refit the radius rod rear pin and secure it with the cotter pin and remove the front axle wedge tool No. Tr2/NMD 3004.

11 If a horizontal exhaust system is fitted, replace the bolts securing the silencer to the left-hand side channel.

12 Reconnect the radiator shutter operating rod at the radiator end.

13 Refit the radiator tie-bar clip to the water outlet connection bolt.

14 Reconnect the headlamp wiring by pushing in the snap connectors on the right-hand side of the tractor near the radiator.

15 Replace the top and bottom radiator water hoses and tighten up the clips.

16 Replace the engine bonnet and secure it by screwing in the two screws in the rear clip. If a vertical primary air cleaner is fitted, replace this now.

17 Refill the cooling system.

TIMING GEARS

The camshaft and auxiliary drive shaft are driven from the crankshaft by helical gears. Should they at any time be disturbed, the timing gears are suitably marked to facilitate re-timing, and the marks are all relative to top dead centre compression stroke, No. 1 cylinder. (See Fig. 70.)

To Check the **Timing** Gear Backlash

1 Remove the timing cover as described on page 47.

2 Check the backlash between all gears using a suitable feeler gauge. This should be between 0.003 in. and 0.004 in. (See Fig. 68.)

3 Replace the timing cover as described on page 48.

To Remove the **Timing** Gears

1 Remove the timing cover as described on page 47.

2 Turn the crankshaft until the marked teeth on the crankshaft gear and camshaft outer gear are in line.

3 Remove the split pin from the auxiliary drive shaft castellated nut, unscrew the nut.

4 Bend back the locking tabs of the three bolts securing the camshaft gears to the camshaft, remove the three bolts then the camshaft outer gear, auxiliary drive shaft gear and camshaft inner gear.

5 Remove the crankshaft gear, using the puller (tool No. ATTr/NVMD 6306–A) with the thrust button inserted in the threaded end of the crankshaft (see Fig. 69). Once the gears have been removed do not turn the engine over otherwise interference may occur between the fuel lift pump eccentric on the camshaft and a big end nut on No. 4 connecting rod.

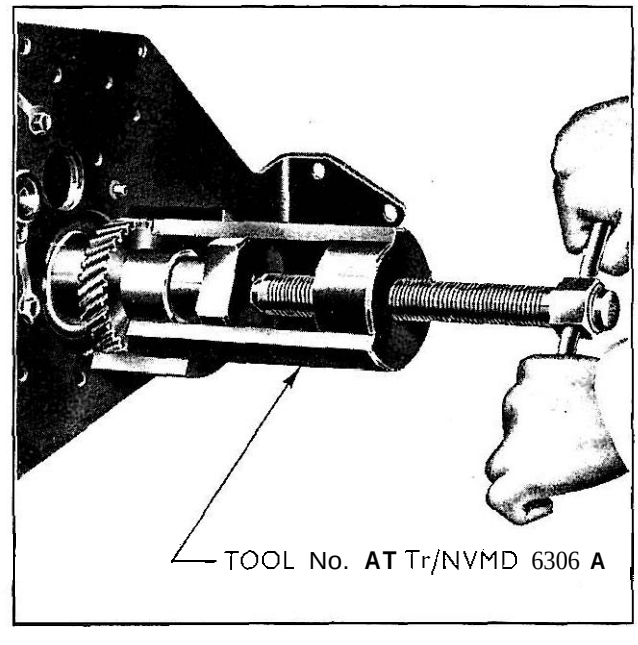


Fig. G9
Removing Crankshaft Gear

To Replace the **Timing** Gears

1 Refit the crankshaft gear using tool No. TTr. D 6306–B. Take care that the marked side of the gear is to the front and that the keyway is located over the crankshaft key (see Fig. 70). On current engines a long single key is fitted.

2 Refit the camshaft inner gear making sure that the camshaft dowel is in position.

3 Replace the auxiliary drive shaft gear making sure that its timing mark is in line with that on the camshaft inner gear. Fit the auxiliary drive shaft castellated nut and lock by means of a new split pin.

4 Fit the camshaft outer gear with its timing mark in line with the mark on the crankshaft gear. Fit the lock plate and replace the three bolts. Bend up the corners of the lock plare to secure the bolts.

5 Replace the timing cover, etc., as described on page 48

FRONT MOUNTING PLATE

Current production tractors are now fitted with a modified engine front mounting plate incorporating two stepped dowels and one extra bolt as shown in Fig. 71.

In service the extra bolt can he easily installed, in engines not so equipped, by drilling and tapping a $\frac{5}{16}$ m. 18NC2 hole in the block. The hole must he $\frac{7}{8}$ in. deep and the thread $\frac{5}{8}$ in. deep. **A** suitable template to locate the position of the hole can be provided by using a current type engine front mounting plate gasket.

It is not considered practicable to modify in service the block and mounting plate to accommodate the two stepped dowels on tractors not so equipped.

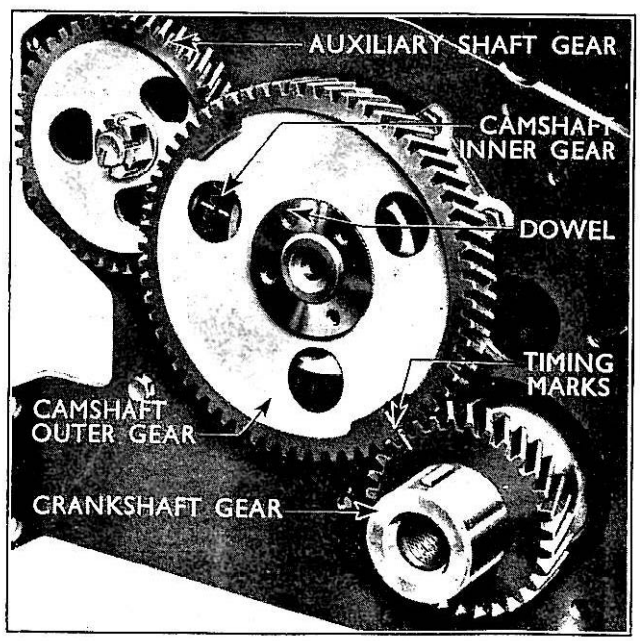


Fig. 70
Timing Gears

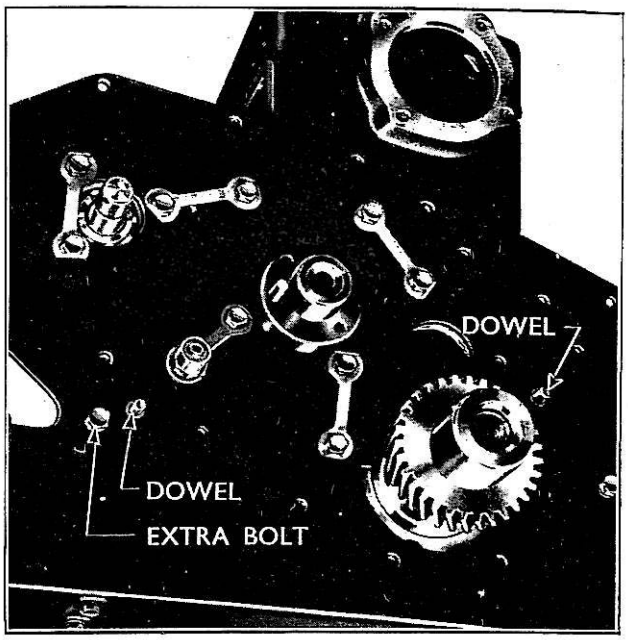


Fig. 71
Modified Front Mounting Plate

Where the original mounting plate is not drilled to accommodate the bolt, it can he reworked using the latest type mounting plate gasket as a template.

Current type mounting plates and engine timing covers can be used on earlier type engines, drilling the extra bolt hole in the block, if necessary.

Current type blocks (with dowels) can he used with earlier type mounting plates and front covers by removing the dowels from the blocks, although if a new cylinder block is supplied, it is preferable to fit the latest type mounting plare and timing cover.

To Remove

1 Remove the riming cover and timing gears as described on page 49.

2 Bend hack the locking tabs and remove the retaining screws. Remove the screws to release the generator bracket and timing pointer, and then lift off the front mounting plate and gasket. The oil relief valve may now be removed, if necessary. See Engine Lubrication Section.

To Replace

1 If the oil relief valve has been removed, refit it to the mounting plare. Instal the mounting plate, gasket, generator bracket and timing pointer. Bend up the locking tabs of the retaining bolts.

2 Instal the timing cover and timing gears as described above.

THE AUXILIARY DRIVE SHAFT

The auxiliary drive shaft is driven from the camshaft by helical gears and is used in the petrol and vaporising oil engines to drive the governor, distributor or magneto where fitted as alternarive equipment.

To Remove the Auxiliary Drive Shaft

1 Drain the cooling system and remove a battery lead.

2 Remove the radiator and front axle assembly as described in the appropriate sections.

3 Drain the engine oil and remove the sump gaskets and oil pump.

4 Remove the mechanical governor and distributor, or magneto, as described in the appropriate sections.

5 Remove the engine timing cover and gasket as described on page 49.

6 Remove the camshaft and auxiliary drive gears as described in the section on this subject. It is not necessary to remove the crankshaft gear.

7 Remove the front mounting plate and gasket by unscrewing the retaining bolts (see previous page).

8 Tap the shaft and bearings forward out of its block location. Withdraw the bearings, using the tool TTr/D 66608–AB.

To Replace the Auxiliary Drive Shaft

1 Refit the bearings to the auxiliary drive shaft, using tool No. TTr/D 66608–AB.

2 Enter the shaft from the front of the block and tap it rearwards until the front bearing is flush with the front face of the block (see Fig. 72).

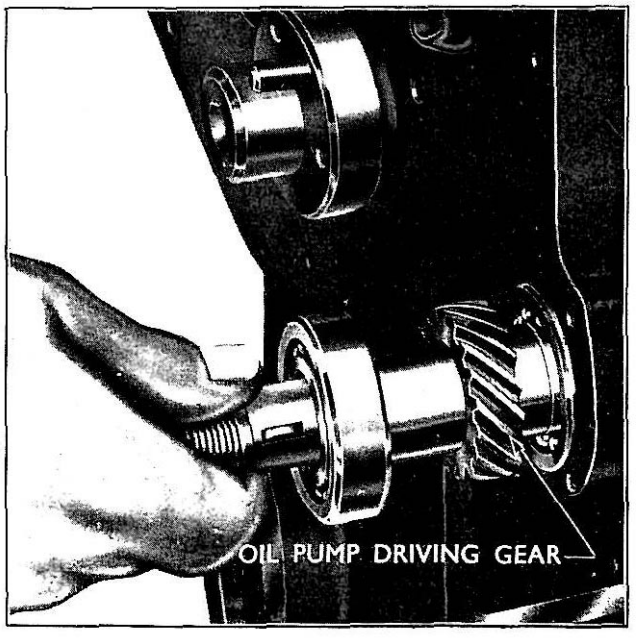


Fig. 72
Replacing Auxiliary Drive Shaft

3 Fit the camshaft inner gear, auxiliary drive shaft gear and camshaft outer gear, making sure that all rhe timing marks are in line.

4 Refit the timing cover and gasket as described on page 48.

5 Refit the crankshaft pulley and ratchet.

6 Mount the mechanical governor in position as described in the Fuel Sysrem Section.

7 Replace the oil pump and suction pipe.

8 Refit the engine sump and gaskets.

9 Refit the radiator and front axle assembly as described in the appropriate Sections.

10 Refit the distributor, or magneto. (See Electrical Section.)

11 Reconnect the battery lead and fill the cooling system.

12 Refill the engine sump with the approved grade of oil to the correct level.

THE CAMSHAFT AND TAPPETS

Camshaft end-float is controlled by a split thrust plate located in a groove machined in the hub of the camshaft and a recess in the front face of the block. The top half of this plate is dowelled to prevent rotation and held in position by the front mounting plate.

The camshaft runs in bearings machined directly in the block and fed with oil from the adjacent main bearings.

To Remove

1 Drain the cooling system through the two taps provided.

2 Drain the sump, remove the rocker cover, rocker shaft and push rods as described previously.

3 Remove the front axle and radiator assembly and timing cover as described in the appropriate sections.

4 Disconnect the fuel pipes and remove the fuel lift pump as described in the Fuel Sysrem Section.

5 Remove the timing cover as described on page 47.

6 Remove the camshaft and ausiliary drive gears as described on page 49.

7 Remove the tappet side cover and hold up the tappets in their locations using suitable clips.

8 Bend back the locking plates and remove the front mounting plate complete with the oil pressure relief valve and remove the mounting plate gasket. See opposite page.

9 Pull the camshaft forward slightly, lift out the nvo halves of the thrust plate.

10 Carefully withdraw the camshaft. Rotating it slowly will assist this operation.

11 If desired the rappers may now be extracted from underneath after the sump has been removed.

To Replace

1 Lubricate the tappets and refit them in their locations. Use suitable clips to hold the tappets up while the camshaft is replaced.

2 Check the camshaft end-float, using a feeler gauge, by fitting the thrust plate into its groove in the camshaft before the camshaft is fitted to the engine. The clearance should be between the limits specified.

3 Lubricate the camshaft journals and carefully slide the camshaft into its bearings, being careful not to damage the edges of the cams or bearings.

4 Before the camshaft is pushed fully home, fit the camshaft thrust plate in its groove and as the camshaft is pushed home, ensure that the dowel in the upper half of the thrust plate enters the hole in the block. (See Fig. **73.)**

5 Fit a new front mounting plate and gasket and refit the timing pointer and generator mounting bracket.

6 Replace the timing gears and the timing cover as described previously.

7 Replace the push rods, rocker shaft and rocker cover as described on page **36.**

8 Refit the fuel lift pump and reconnect the fuel pipes.

9 Replace the generator as described in the appropriate section.

10 Refit the sump, if removed, and replace the tadiator and front axle assembly as described in the appropriate section.

11 Refill the cooling system with clean soft water.

12 Refill the engine sump with the approved grade of oil to the correct level if the original was drained.

Fig. **73**
Camshaft Thrust Washers

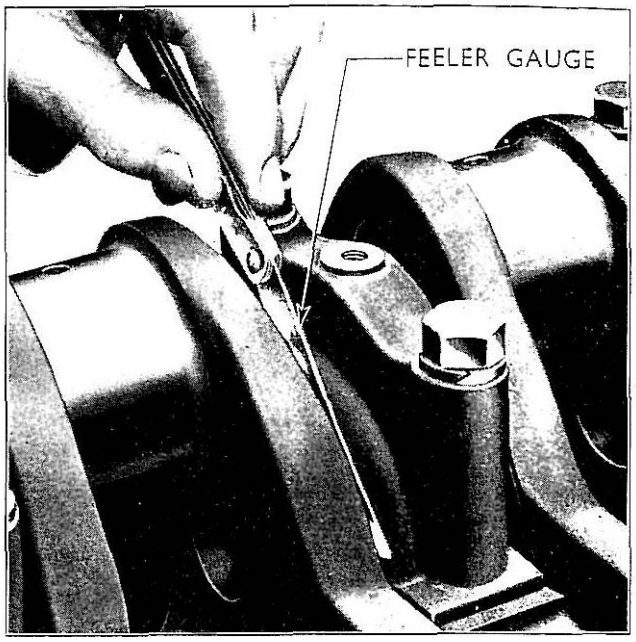


Fig. **74**
Checking Crankshaft End-float

MAIN BEARING LINERS

The main bearings are steel backed, lead bronze, indium plated liners and these may he easily replaced without the necessity for removing the engine.

They are held in position by tongues which register with suitably cut locations in the cylinder block and cap, to prevent them from turning or moving out of position.

In service liners are supplied 0.010 in., 0.020 in., 0.030 in and 0.040 in. undersize in the bore.

Should it be necessary to renew crankshaft main bearings following failure due to oil shortage, it is imperative that ail oilways and the oil pump are thoroughly cleaned, otherwise mere replacement of liners may lead to repeated failure. In this event the engine must be removed.

Crankshaft End-Flo'at

The crankshaft end-float is controlled by detachable thrust washers at each side of the centre main bearing. The bottom halves of these thrust washers have suitable locating lugs to prevent them from turning out of position. Fit the crankshaft thrust washers in the recesses at each side of the cenrre msin bearing with their oil grooves outwards.

The thrust washers are available in service in 0.0025 in.. 0.005 in., 0.0075 in, and 0.010 in. oversize in thickness.

To check the crankshaft end float, carefully push the crankshaft forward as far as it will go and test with a feeler gauge the gap between the machined shoulder on the crankshaft web and the front half of the crankshaft thrust washers. (See Fig. 74.)

End-float should be within the specified limits. If the end-float is too grear the cenrre main bearing cap should be removed and the appropriate oversize thrust washers fitted.

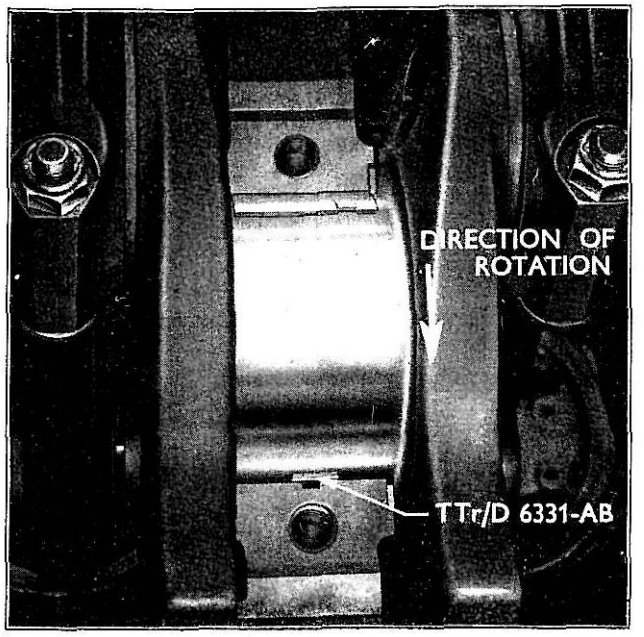


Fig. 75
Removing Main Bearing Liner

To Renew Main Bearing Liners

1 Remove the sump and oil pump suction pipe as described on page 41. Even if it a necessary to renew all the main bearing liners, remove only one bearing cap at a time.

2 Remove the cap from the bearing affected or, if all bearing liners are to be changed, commence at No. 1 main bearing, taking carc not to disturb the front mounting plate gasket when removing the cap. Turn the crankshaft until the oil hole in the exposed journal is near the end of the liner opposite the tongued side.

3 Insert the special liner pin, tool No. TTr D 6331–AB in the hole in the crankshaft so that the head of the pin lies flat against the crankshaft journal.

4 Carefully turn the crankshaft against the normal direction of rotation until the upper half of the liner is brought to such a position rhat it may be removed (see Fig. 75).

5 To instal the new upper half liner, lightly oil the crankshaft journal and position the liner on the journal so that its tongue is on the opposite ride to the machined recess it is intended to fit in the block.

6 Hold the liner tightly against the journal and by turning the crankshaft in the normal direction of rotation, enter the liner into its location as far as it will go. If it is found rhat the liner is not fully home insert the special pin TTr D 6331–AB in the oil hole in the crankshaft journal and continue to rotate the crankshaft until the liner is correctly positioned with both ends Rush with the cylinder block. Remove the liner pin.

7 Clean both the cap and the new lower half liner, insert the liner in the cap so rhat rhe tongue enters the machined recess provided. Apply a film of oil to the liner bearing surface and replace the cap and the liner with the word " Rear" towards the rear of the engine. Always use new spring washers on the main bearing cap bolts. For complete details of the marking of main bearing caps refer ro the following section.

MAIN BEARING CAPS

In manufacture, the main bearing liner bores in thecylinder block and caps are machined in-line, with the caps fitted in their correct locations. If the caps are interchanged or replaced the wrong way round, they will not then match up and possibly lead to bearing failure with consequential damage to the engine.

It is for this reason that great care must be taken when the engine is dismantled to keep its own bearing caps separare from any others and refitted in exactly the same position From which removed. For identification purposes there is a single number or letter stamped on No. 2 cap and block location and a double letter or number on No. 4 cap and block location. These letters or numbers are on the opposite side to the engine camshaft.

No. 1 main bearing cap must be fitted with the machined face ro the front and before the bolts are tightened this face must be lined up, with the aid of a straight edge, with the front face of rhe block. Failure to do this may give rise to oil leakage across the front mounting plate gasket.

Nos. 2, 3, 4 and 5 caps are marked with the word " Rear" on the casting and should be replaced with this word towards the rear of the engine.

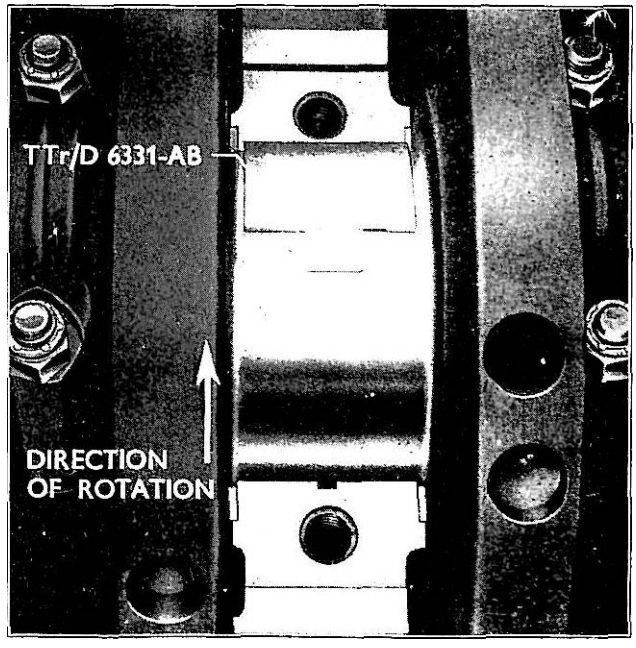


Fig. 76
Replacing Main Bearing Liner

MAIN BEARING BOLTS

The cusrent type main bearing bolt used in production can be identified by the figures "100" marked on the head and should be tightened to the torque shown in the specification.

Bolts marked "BEES" "NEWALL HIGH TENSILE or "RIBE" should only be used as individual replacements to a complete set of similar bolts. The tightening torque figures for these are also shown in the specification.

Should it become necessary to use the current bolts as individual replacements when stocks of the earlier bolts are exhausted, they should be tightened to the torque being used on the original bolts.

THE FLYWHEEL AND RING GEAR

To remove the flywheel it will be necessary to separate the engine from the gearbox.

To Remove

1 Separate the engine from the gearbox as described in the Section dealing with this subject on page 115.

2 Unscrew evenly the six bolts and spring washers securing the clutch pressure plate assembly to the flywheel and detach the clutch assembly and disc.

3 The flywhcel is secured by six bolts with three locking plates. Bend back the locking tabs and unscrew the flywheel bolts.

4 Carefully ease the flywheel off the crankshaft spigot and the two locating dowels.

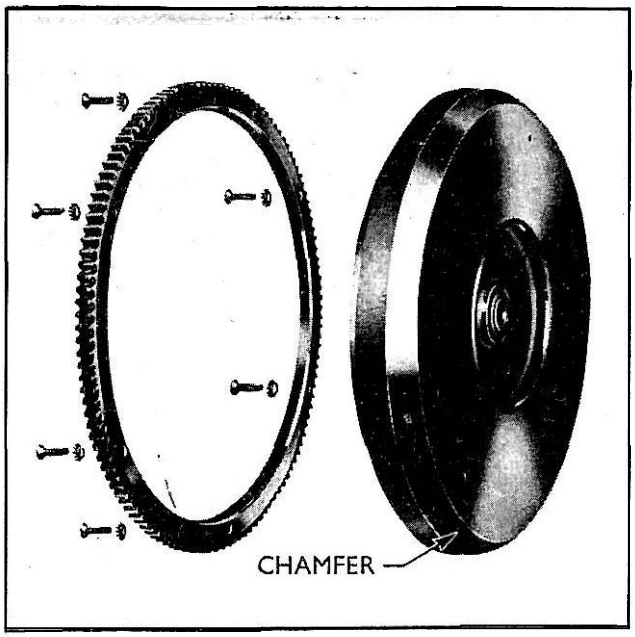


Fig. 77
Flywheel and Ring Gear

Note — For details of the clutch pilot bearing, refer to the clutch section.

To Renew the Flywheel **Ring** Gear

1 Unscrew the six countersunk headed screws retaining the ring gear to the flywheel and remove them and their lockwashers.

2 Tap off the ring gear. *There is no necessity to apply heat to remove or refit the gear.*

3 Fit a new ring gear with the countersunk holes to the front of the flywheel and retain in position by using six new screws and lockwashers.

Note — The lighter flywheel fitted to the petrol and vaporising oil engine is not interchangeable with that of the diesel. It may be identified by the chamfer machined on its rear edge (see Fig. 77). The ring gear is also not interchangeable and may be identified by the fact that the chamfer on the teeth are on the opposite end to the countersinking for the retaining screws.

To Replace the Flywheel

1 Carefully clean the crankshaft flange and the mating flange on the flywheel.

2 Ensure that the flywheel dowels are installed in the crankshaft rear flange.

3 Mount the flywheel on the flange ensuring that the dowel holes are lined up with the crankshaft dowels.

Fit the six bolts and the three locking plates and tighten up the bolts.

4 It is essential that the flywheel runs true, as dirt, etc., between the mating flange faces could cause it to run out of balance, with consequent difficulties. The clutch thrust face and flywheel rim should be tested with a dial indicator, when the "run-our" (total indicator reading) should not exceed .005 in. (See Fig. 78.)

If the run-out exceeds this figure, remove the flywheel and check the mating flanges for burrs, etc. Refit to the crankshaft and recheck the "run-out" as above. Turn up the tabs of the locking plates against the flat on the bolts.

5 Replace the clutch assembly and engine as described in their appropriate sections.

MAJOR REPAIR OPERATIONS

Most operations of dismantling and repair can be carried out without removing the engine from the tractor, but should removal be necessary the following procedure should be adopted :—

To Remove the Engine

1 Drain the cooling system through the tap un the radiator and the cylinder block.

2 Remove the sump drain plug and drain off the engine oil. Remove engine oil indicator.

3 Turn the fuel tap to the "off" position and remove the fuel lift pump.

4 Remove the two screws on the rear clip of the engine bonnet and lift off (if a vertical extension pipe and primary air cleaner are fitted, remove these first).

5 Disconnect the battery leads and remove the battery.

6 Disconnect the cables and remove the starter motor, fan belt, generator assembly, and fan blades. Coil up the wiring so that it does not become damaged.

7 Disconnect the temperature gauge bulb from the adaptor in the cylinder head and release the capillary tubing from its clips.

8 Disconnect the governor control rod at each end and slide the rod clear of the engine. Remove the vertical operating rod and withdraw the throttle relay spindle running across the block.

9 Lift off the vertical exhaust pipe. On the horizontal exhaust remove the two bolts and one nut from the manifold adaptor and the two bolts, one securing the silencer bracket to the side channel and the other securing the outlet pipe bracket to the rear axle housing.

10 Remove the pipe between the air cleaner and the carburettor.

11 Remove the manifolds complete with carburettor after disconnecting the pipes.

12 Remove'the radiator shutter operating rod and the tool box (two bolts).

13 Pull out the snap connectors of the headlamp wiring on the right-hand side of the tractor, near the radiator, and release the wiring.

14 Disconnect the leads and remove the distributor or magneto. (See Electrical Section.)

15 Disconnect the steering drag link by removing the split pin and unscrewing the drag link front ball plug.

16 Support the engine and transmission using the tractor dismantling stand (tool No. Tr/NMD 27). Place the two rail sections under the tractor and position the engine and gearbox trolleys.

17 Place the front axle wedge (tool No. Tr2/NMD 3004) in position to prevent movement between the engine and the front axle.

18 Lock the track rod by means of the front axle clamp (tool No. Tr/ND 3000).

19 Remove the four bolts on each side retaining the side channels to the gearboxand the bolts retaining the engine to the gearbox.

Note — Do not forget the two bolts behind the side channels.

20 Withdraw the engine, radiator and front axle assembly. Move the assembly forward until the engine is clear of the gearbox.

21 Fit the two engine lifting plates (tool No. TTr D 6004), one on the boss at the offside rear of the cylinder head and the other under the two front near-side cylinder head bolts. Take the weight of the engine on a hoist or gantry.

22 Disconnect the radiator hoses and free the radiator tie-bar from the engine.

23 Remove the front axle radius rod rear pin after removing the split pin.

24 Remove the four bolts from the front of the side channel on the left-hand side and the radiator shell bolt.

25 Remove the three bolts from the engine front mounting to each side channel, and remove the side channel from the left-hand side.

26 Remove the engine by lifting it slightly and pushing it carefully towards the left-hand side so that the radius rod slides sideways out of its sump location and the front mounting plate clears the right-hand side channel. Lift the engine a little higher, then wheel away the front axle and radiator assembly.

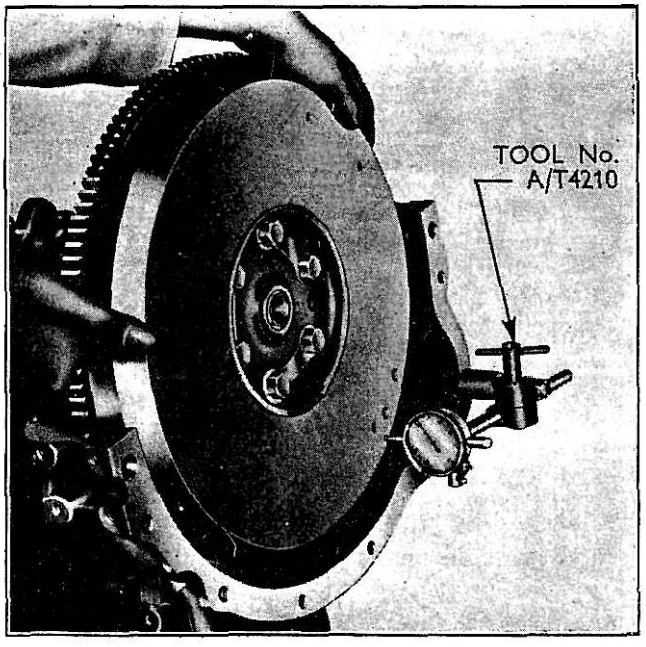


Fig. 78
Testing Flywheel Run-out

SEQUENCE FOR DISMANTLING THE ENGINE

Note — The following sequence is given as a guide and, where necessary, reference can be made to the appropriate sections for detailed instructions covering the dismantling and reassembling of any particular sub-assembly.

1 Mount the engine on the engine stand (tool No. 200) in the normal manner, using the special bracket TTr/D 6005, which is available for this purpose.

2 Remove the water pump and cylinder block drain tap.

3 Remove the generator mounting brackets.

4 Remove the mechanical governor (see Fuel Section).

5 Unscrew the crankshaft ratchet using the tool TTr/D 6319 and withdraw the crankshaft pulley using the remover tool TTr/D 6312–A.

6 Remove the two bolts retaining the rocker cover and lift off the cover and gasket.

7 Remove the rocker shaft support bolts, and detach the rocker shaft assembly. Lift out the push rods.

8 Remove the sparking plugs.

9 Unscrew the cylinder head bolts and lift off the cylinder head and gasket. To dismantle the cylinder head assembly refer to page 36.

10 Remove the tappet chamber cover screws and detach the cover and gasket.

11 Invert the engine on the stand and remove the external oil filter, sump cover plate, gasket and oil screen. Unscrew the bolts retaining the sump to the cylinder block and lift off the sump and gaskets.

12 Remove the suction pipe and oil pump.

13 Remove the connecting rods and pistons as described in the appropriate section.

14 Remove the clutch assembly taking care to slacken the pressure plate to flywheel bolts evenly.

15 Unscrew the bolts securing the flywheel to the crankshaft flange and ease off the flywheel, after removing the clutch pilot bearing (if necessary) using the tool TTr/D 7600–A. Remove the six screws retaining the ring gear to the flywheel and tap off the ring gear. There is no necessity to apply heat.

Note — The flywheel locates on the crankshaft spigot and two dowels.

16 Remove the timing cover, gasket and gears.

17 Withdraw the crankshaft gear using the tool ATTr/NVMD 6036–A, and extract both Woodruff keys from the front of the crankshaft. On current engines a long single key is fitted.

18 Remove the front mounting plate and gasket, and detach the oil relief valve.

19 Remove the auxiliary drive shaft.

20 Remove the main bearing bolts, caps, liners and crankshaft thrust washers. Carefully lift out the crankshaft and extract the upper halves of the thrust washers and main bearing liners. Remove the rear oil seal retainer and extract the seal.

21 Ease the camshaft out sufficiently to permit removal of the thrust washers and then carefully remove the camshaft, taking care not to damage the cams and bores. Lift out the tappets.

22 Using the tool TTr/D 6055–A withdraw the cylinder liners and remove the seals from their recesses in the block.

23 Remove the plug from each end of the main oil gallery, and unscrew the block connection for the oil gauge pressure pipe. Remove any loose scale or deposit from the water jacket and thoroughly clean the block oil passages and tapped holes for the main bearing cap bolts on the oil gallery side before carrying out any further work.

Note — It is most important that the cylinder block is carefully and thoroughly cleaned in all respects and this operation not neglected in any way.

SEQUENCE FOR REASSEMBLING THE ENGINE

Before reassembling the engine, all parts will require checking dimensionally against the general specification and new parts selected where necessary. Lubricate all bearing surfaces and moving pans before assembly and soak the new rear oil seal in oil for one hour before fitting.

1 Refit the blanking plugs at each rear end of the main oil gallery. Mount the oil seal retainer and seal and instal the oil pressure gauge union in the block.

Note — Oversize oil gallery blanking plugs are available, and when fitting the plugs a sealing compound should be used sparingly and the front plug fitted just below flush.

2 Instal the new water seals for the liners in the recesses in the cylinder block and fit the cylinder liners after checking for protrusion as described in the appropriate section.

3 Fit the tappets and camshaft after checking the end-float.

4 Fit the top halves of the main bearing liners and thrust washers, instal the crankshaft and fit the main bearing caps, bottom half liners and thrust washers. Check the crankshaft end-float.

5 Instal the auxiliary drive shaft.

6 Refit the mounting plate and gasket. Instal the oil relief valve. Fit the Woodruff keys in the crankshaft spigot and reassemble the timing gears. On current engines a long single key is fitted. Refit the timing cover and gasket, crankshaft pulley and ratchet and the generator mounting brackets.

7 Refit the ring gear to the flywheel, mount the flywheel on the crankshaft spigot and instal the clutch pilot bearing using the tool Tr2/D 7600-B.

8 Locate the piston and connecting rod assemblies in the appropriate bores with the word "Front" stamped on each piston crown pointing to the front of the engine. 'Compress the piston rings, using the squeezer TTr/DDK 6153 and push the pistons down the cylinder bores and reassemble the big ends to the crankshaft. Always use new self-locking nuts. Check the end-float of each connecting rod.

9 Mount the oil yumy in the base of the block and fit the sucrion pipe. Instal the sump and gaskets, tightening the bolts evenly. Replace the oil pump screen, cover plate and gasket.

10 Turn the engine over on the mounting stand and fit the rocker feed oil seal. Replace the cylinder head and gasket, using the locating studs TTr/6050 and tighten the cylinder head bolts in correct sequence. Do not forget to refit the lifting plates TTr/D 6004.

11 Instal the push rods and rocker shaft assembly. Reset the valve clearances and fit the sparking plugs.

12 Refit the tappet chamber cover and gasket.

13 Instal the rocker cover and gasket.

14 Mount the water pump and gasket in position. Refit the drain tap.

15 Refit the mechanical governor

16 Refit the external oil filter.

17 Mount the clutch and pressure plate assembly into position, using the clutch plate locator Tr/D 7563.

18 Remove the engine from the mounting stand.

To **Replace** the Engine

1 Support the radiator and front axle assembly by using a suitable block or jack under the right-hand side channel and place blocks at either side of the wheels.

2 Lift the engine, using an overhead sling, and position it so that the radius rod location is to the left-hand side and just above the level of the radius rod eye.

3 Push the engine sideways towards the right-hand side and at the same time gently lower it, guiding the right-hand side of the front mounting plate into its side channel and the radius rod eye in its correct location.

4 Fit the radius rod pin and split pin

5 Secure the front mounting foot to the right-hand side channel, using the three bolts.

6 Fit the left-hand side channel, bolting it to the front mounting foot, using three bolts, and replace the radiator shell bolt. Instal the engine trolley part of the dismantling stand and remove the sling.

7 Wheel the front axle and engine assembly towards the transmission and engage the drive shaft in the clutch disc splines and pilot bearing.

8 Replace the bolts retaining the engine to the gearbox and the four bolts holding each side channel to the gearbox. Reconnect the steering drag link.

9 Refit the starter motor, generator assembly, fan belt and fan blades and connect uv the cables. (See Electrical Section,)

10 Instal the distributor, or magneto, and check timing. (See Electrical Section.)

11 Refit the two radiator hoses and the radiator tie-bar to the engine.

12 Remove the engine lifting plate and tighten the cylinder head bolts to the specified torque.

13 Refit the manifolds and carburettor assembly.

14 Replace the air intake pipe between the air cleaner and tighten up the two clips.

15 Reconnect the headlamp wiring by joining the snap connectors and refit the wiring clips.

16 Replace the radiator shutter uperating rod and the tool box.

17 Refit the governor control rod, throttle relay spindle and the vertical operating rod.

18 Replace the temperature gauge bulb and refit the clips holding the capillary tubing.

19 Instal the fuel lift pump and reconnect the pipes.

20 Replace the battery and refit the battery leads.

21 Replace theengine bonnet and secure by screwing in the two screws on the rear clip. (If a vertical primary air cleaner is fitted, replace this at this stage.)

22 Refit the vertical exhaust pipe. If a horizontal exhaust system is fitted, replace the two bolts securing the silencer bracket to the side channel and the outlet clamp to the axle housing.

23 Turn the petrol tap to the " on " position.

24 Refill the engine with clean oil of an approved grade to the correct level and replace the oil indicator.

25 Refill the cooling system.

THE CRANKSHAFT

The cast-steel crankshaft is statically and dynamically balanced. It should be ring tested for cracks. before replacing by suspending the crankshaft suitably by one end and lightly tapping with a hand hammer.

The crankshaft should always be thoroughly checked before replacement to ensure that all oil passages are clear and perfectly clean in all respects.

Reference to the specification will indicate the dimensions of parts available for service.

To Remove

1 Remove the engine from the tractor as described on page **54.**

2 Remove the clutch assembly.

3 Remove the crankshaft pulley.

4 Remove the timing cover and gasket.

5 Remove the timing gears as described on page 49.

6 Remove the front mounting plate and gasket.

7 Remove the sump arid gaskets.

8 Remove the oil pump.

9 Unscrew the connecting rod big end cap nuts, detach the caps and push the pistons up the cylinder bores. Take care not to dislodge the big end bearing liners in the rods and caps.

10 Remove the flywheel. (See page 54.)

11 Unscrew the main bearing cap bolts and detach the caps. When removing the centre main bearing cap take care not to lose the crankshaft thrust washers from either side of the cap.

12 Lift the crankshaft carefully out of the cylinder block.

13 Extract the upper halves of the main bearing liners and thrust washers from the cylinder block, and the halves of the crankshaft rear oil seals from the sump and the oil seal retainer.

14 Thoroughly clean all the oil passages in the block after removing the plugs at each end of the main oil gallery and the oil gauge adaptor in the block. The crankshaft must also be cleaned. This operation is most important and must be carried out in detail.

To Replace

1 Locate the upper halves of the main bearing liners in their block locations. Ensure that all oilways and passages are clear, and lightly lubricate the liners.

2 Fit the new crankshaft rear oil seal, upper half, in the oil seal retainer and the lower half in the rear of the sump. This oil seal should be previously soaked in engine oil for at least one hour.

3 Locate the upper halves of the crankshaft end-float thrust washers on either side of the centre main bearing with the oil grooves outwards. The upper halves of these washers do not have locating tabs.

Check that the ends of the thrust washers are level with the cylinder block face, otherwise they may be distorted when fitting the bearing cap. A light coating of oil will assist in holding the washers in place until the crankshaft is fitted.

4 Insert new keys at the front end of the crankshaft, lubricate the bearing liners and lay the crankshaft in the hearings.

5 Check that the liners are seating correctly in the caps with the tongues engaging in the machined recesses and that the end-float thrust washers are located on either side of the centre main bearing.

The washers must be fitted with the oil grooves away from the bearing and the locating tabs in the recesses of the cap.

6 Refit the main bearing caps with the cast word "Rear" to the rear of the engine.

7 Push the crankshaft fully forward and check the end-float as shown in Fig. 74, which should be within the limits specified. If this limit is exceeded, fit thicker thrust washers.

8 Refit the connecting rods to the crankpins, ensuring that the liners are correctly positioned with the tongues engaging in the machined recesses. Connecting rod caps must be fitted with the stamped numbers together and on the same side as the camshaft.

9 Use new self-locking nuts on the bearing bolts and tighten to the specified torque.

10 Replace the oil pump and suction pipe.

11 Refit front mounting plate and gasket.

12 Replace the timing gears as described on page 50

13 Replace the timing cover, gasket, and crankshaft pulley.

14 Refit the sump and gaskets, see page **42.**

15 Replace the flywheel and clutch assembly, checking the "run-out" as described on page **54.**

16 Refit the engine to the tractor as described on page 57.

THE ENGINE LUBRICATION SYSTEM

The lubrication system is of the forced feed type, the oil being circulated, under pressure, by a gear type pump driven from the auxiliary drive shaft by helical gears. The oil pump is housed in the base of the block and the oil is drawn through a sump filter screen and a suction pipe before entering the pump itself. It is then pumped up the pump drive shaft body and via oil passages in the cylinder block, to a relief valve and to a full flow filter, fitted externally and having a renewable element.

After passing through the filter which is located low down on the right-hand side of the engine, the oil passes through a transverse passage to the main oil gallery on the other side of the cylinder block lubricating No. 2 main and camshaft bearing on the way.

From the main oil gallery the oil is fed through oilways in the block to Nos. 1, **3,** 4 and 5 main bearings and then from each of these to adjacent camshaft bearings. (See Fig. 79.) Nos. 1, 2, **3** and 4 main bearings also supply oil, under pressure, through oilways in the crank webs to the corresponding big end bearings.

The camshaft centre bearing supplies a vertical controlled feed of oil m the overhead valve rocker gear. This controlled feed is obtained by allowing oil under pressure to be forced to the rocker gear only when the passages in the camshaft journal and camshaft centre bearing are in line, this occurring once per camshaft revolution. Oil from the rocker shaft lubricates the valves and guides via a small hole in each rocker lever.

The pistons, cylinder liners, and connecting rod small end bearings are lubricated by splash and oil mist, likewise the cams and tappets of the valve mechanism.

The timing gears are fed by oil spill from the relief valve located on the front mounting plate. After lubricating the timing gears the oil returns to the sump through passages in the front main bearing cap. **A** seal is fitted in the timing cover to prevent the ingress of dirt and any leakage of oil.

Oil is prevented from leaking into the dutch housing by an oil thrower on the crankshaft and a suitable oil seal fined to the rear of No. 5 main bearing.

THE OIL PUMP

The gear type oil pump consists of two meshing gears rotating in a closely fitting body. They are driven by a

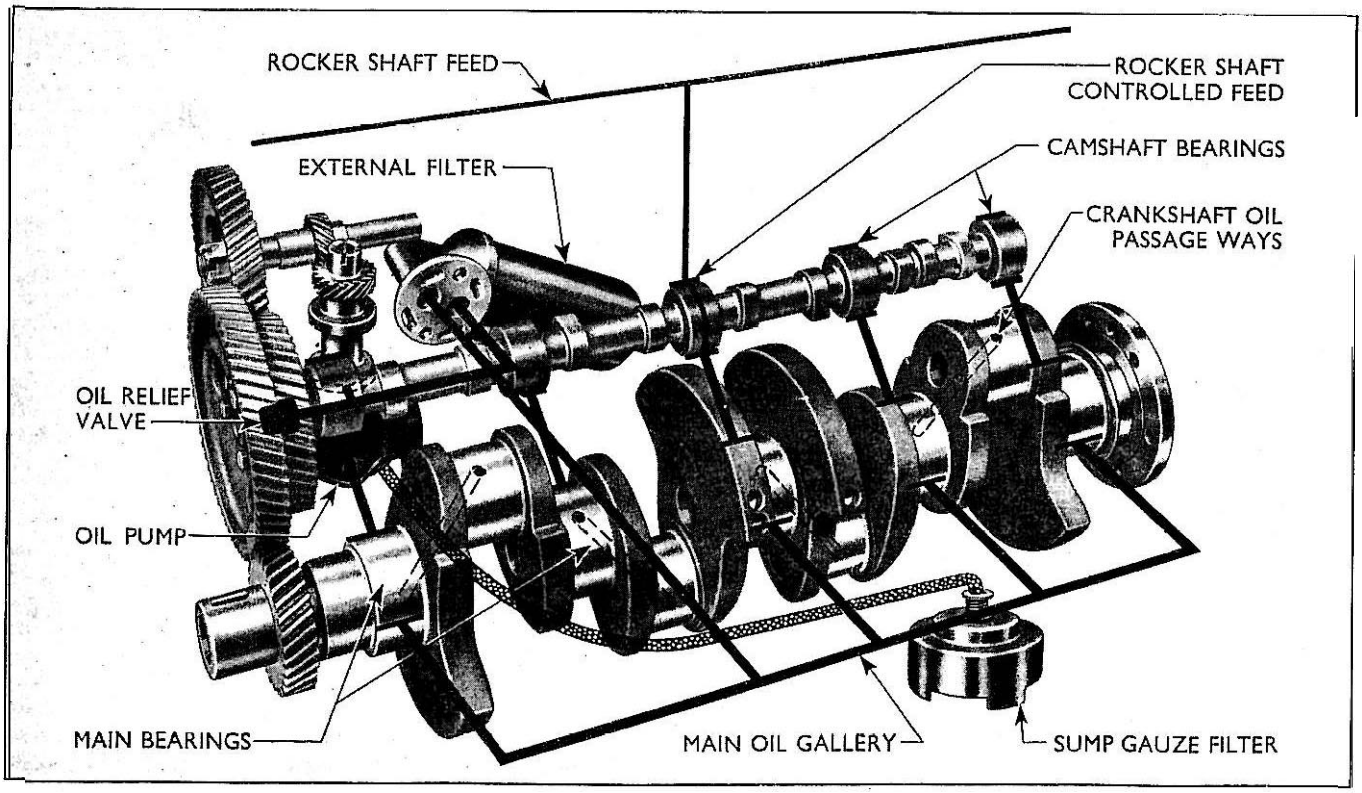


Fig. 79
Lubrication System

vertical pump shaft on the upper end of which is a helical gear engaging the gear on the auxiliary drive shaft. One of the oil pump gears is an interference fit on the lower end of the shaft, whilst the other is driven from it and rotates on the idler gear shaft in the pump body. (See Fig. 80.)

The inlet port, into which the suction pipe is screwed, is incorporated in the pump cover plate. The outlet port is on the deeper of the two pump body locating spigots and the lubricating oil is fed, under pressure, through oil passages in the cylinder block, via the external oil filter, to the main oil gallery.

To Dismantle the **Oil** Pump

1 Remove the sump as described in the appropriate section.

2 Remove the oil pump suction pipe union lock plate, unscrew the union nut, release the support bracket on the centre main bearing and lift away the pipe.

3 Remove the oil pump by unscrewing the two bolts securing the oil pump to the cylinder block. Clean the pump externally.

4 Remove the four bolts securing the pump cover plate to the pump body, lift away the cover plate which will permit removal of the gear from the idler gear shaft.

5 Withdraw the helical gear from the upper end of the pump shaft and remove the shaft and lower gear from the pump body. Normally it should not be necessary to remove the lower gear from the pump shaft.

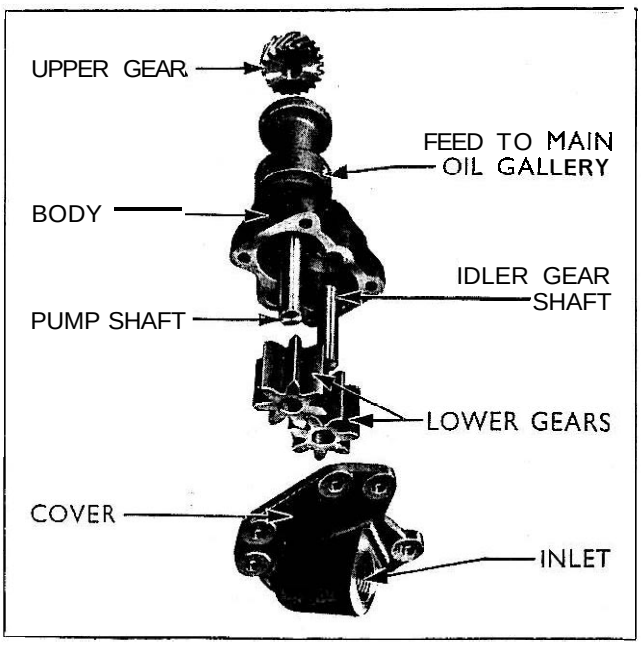


Fig. *80*
Exploded View of Oil Pump

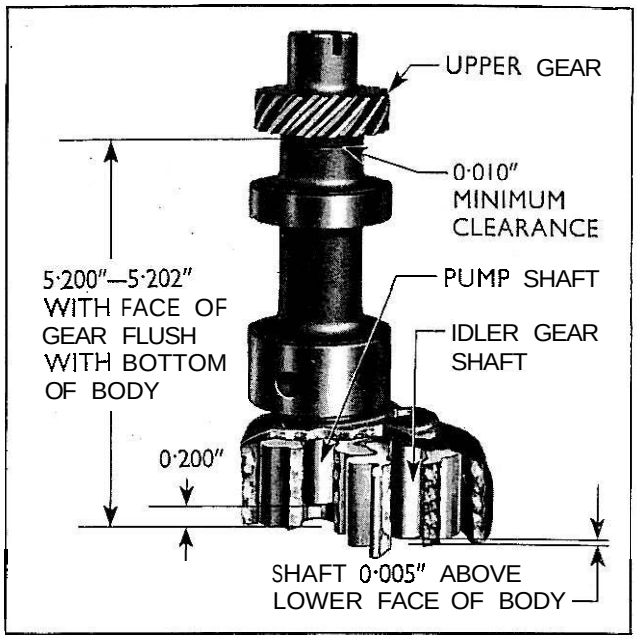


Fig. 81
Fitting the Shafts and Gears

6 Press the idler gear shaft out of the pump body if necessary.

To Reassemble the Oil Pump

Note — Check all parts, especially the two lower gears and the pump shaft and body, and ensure that there is no excessive wear present.

1 Press the idler gear shaft (if removed) into the body so that there is 0.005 in. clearance between the end of the shaft and the face of the pump body, using a straight edge and feeler gauge to check this clearance. (See Fig. 81.)

2 Press the lower gear on to the pump shaft so that the end of the shaft is 0.2 in. from the lower face of the gear as shown in Fig. 81. **A** suitable distance piece 0.2 in. thick and approximately 0.4 in. diameter can be used for this purpose.

3 Enter the gear and shaft in the pump body and stand the assembly on a flat surface, inserting the 0.2 in. thick distance piece in the centre of the gear to maintain the clearance. Press the upper gear onto the shaft until its lower face *(not* ***hub)*** is between 5.200 ins. and 5.202 ins. above the lower face of the pump body (see Fig. 81). This will give a minimum clearance of 0.010 in. between the lower face of the upper gear hub and the top of the pump body.

4 Replace the other lower gear on the idler gear shaft and instal the pump cover plate and test the pump.

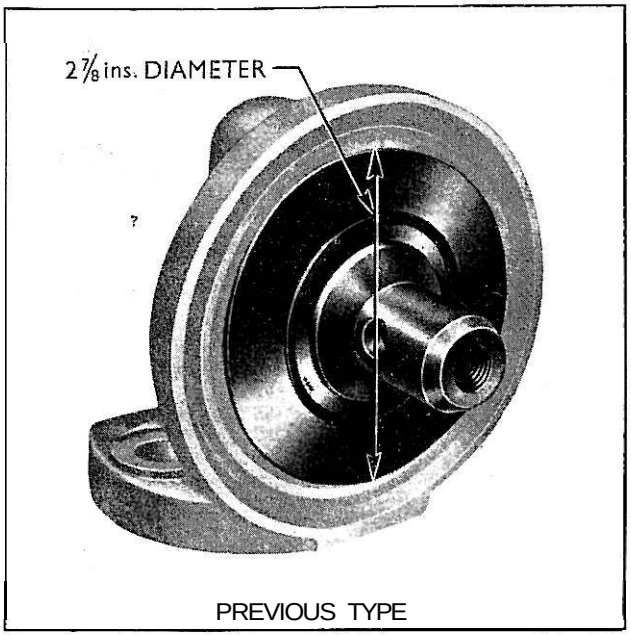


Fig. S2
Previous Type Oil Filter Washer

5 In the case of petrol and vaporising oil engines with No. 1 piston at T.D.C. compression stroke enter the pump in its block location, ensuring that the oil pump upper gear engages with the auxiliary drive shaft gear in such a manner that when the pump is fully home, the large ' D ' formed by the distributor drive slot, points towards No. 2 cylinder and the slot assumes the position shown in Fig. 57. On the diesel engine the gears may be engaged in any position. Secure by means of the two bolts and lockwashers. (See Engine Section.)

6 Refit the sump, oil suction pipe and screen, and cover plate and gasket as described in the appropriate section.

Oil Pump Test

The oil pump may be tested when removed from the engine by carrying out the following check. Instal the suction pipe and immerse its lower end in a mixture of three parts of kerosene to one part of S.A.E. 30 engine oil and rotate the pump by hand in a clockwise direction when at approximately 60 R.P.M. a copious supply of fluid from the outlet should be evident.

Engine Oil

The engine oil should be changed every 200 hours in the diesel and the petrol engines, and 100 hours in the vaporising oil engine. The sump capacity of the engine is 12 imp. pints (6.816 litres) in addition 1 pint (0.568 litre) for dry oil filter. The engine oil indicator is located on the nearside of the engine. Refer to pages 16 and 17 for full details of the current type oil indicator modification. See Specification for correct grades of lubricant. (Refer to page 63.)

In the case of the diesel engine it is important that only H.D. oils are used, otherwise ring gumming, sludging and premature engine wear may result.

ENGINE OIL FILTER

Two types of filter assemblies are in use and as the elements are not interchangeable, ensure that the correct replacement is fitted

These filters are easily identified by the manufacturer's name which is cast on the top of the filter head. The element should be changed every 200 hours in all engines.

On the Fram type filter in current production, to obviate the possibility of any blockage in the oil supply due to foreign matter building up between the disc washer and the filter head, the washer has been reduced from 2⅞ ins. diameter to 2 ins. diameter as shown in Figs. 82 and 83.

In service, rhe 2⅞ ins. diameter washer originally fitted may be modified to conform with the current washer by removing the surplus metal, taking care not to distort the washer. It is not permissible to drill holes as an alternative to reducing the diameter.

When refitting the washer, ensure it iscorrectly positioned with the "ridge" towards the filter element.

Renewing the Oil Filter Element

1 Unscrew the centre retaining bolt and withdraw the filter body and element.

2 Clean out the bodv thoroughly and ensure that the ring groove in the top casting is clean.

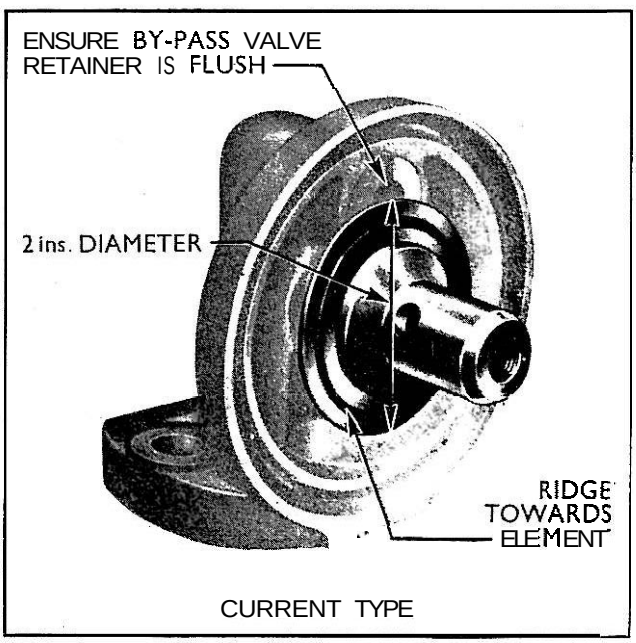


Fig. S3
Current Type Oil Filter Washer

3 Fit a new element in the body and a New Rubber Sealing Ring. Tighten the centre bolt to 10 lbs. ft. torque.

Removing and Dismantling the Oil Filter

1 Unscrew rhe two bolts securing the filter to the cylinder block and remove the filter unit and gasket.

2 Unscrew the central retaining bolt and withdraw the filter body and the element. Clean out the body thoroughly.

3 Remove the by-pass valve retaining plug and extract the spring and ball.

Note — In the case of the "Fram" type filter (see overleaf) the washer retainer must be unscrewed from the filter head and the washer removed before the by-pass valve seating can be unscrewed. The diameter of the washer must be reduced, if necessary, to 2 ins.

4 Thoroughly clean all parts.

Reassembly

1 Instal the by-pass valve ball, spring and plug. On the "Fram" type the 2 in. diameter washer and retainer must now be fitted.

2 Fit a new correct type element in the body and a new sealing ring, mount in position and tighten the centre bolt to 10 lbs. ft. torque.

3 Mount the assembly, with a new gasket, to the cylinder block and tighten the two retaining bolts and lockwashers.

OIL RELIEF VALVE

The oil relief valve located behind the timing gears on the front mounting plate is of the non-adjustable type.

To Remove

1 Remove the front timing cover and camshaft gears to expose the oil relief valve as described in the Engine Section.

2 Bend back the tab of the locking plate and unscrew the oil relief valve from the mounting plate. (See Fig. 84.)

3 To dismantle the oil relief valve remove the circlip at the outer end of the valve and extract the spring seat, spring and valve plate. Thoroughly clean all parts.

To Replace

1 Instal the valve plate in the body and fit the spring, spring seat and retaining circlip.

2 Screw the oil relief valve on the mounting plate and bend up the tab of the locking plate.

3 Refit the camshaft gears and timing cover as described in the Engine Section.

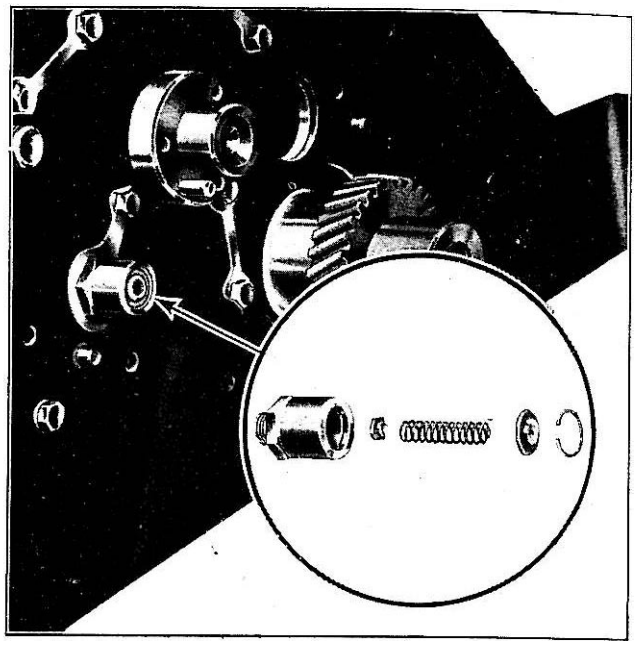


Fig. 84
Oil Relief Valve

ENGINE OIL INDICATOR

Engine Oil Indicator

In current production the engine oil indicator is used in conjunction with a steel tube pressed into the sump. A metal cap, with a rubber seal incorporated, is located on the shank of the indicator.

To convert previous type sumps in line with the above refer to pages 16 or 42.

OIL PRESSURE GAUGE

The oil pressure gauge is mounted on the left-hand side of the instrument panel and connected to the main oil gallery on the left-hand side of the engine through suitable piping and adaptors. With the engine hot and running at normal speed the oil pressure should be between 30 and 40 lbs. per sq. inch.

Testing the Oil Pressure Gauge

The oil pressure gauge can be tested by locating a master gauge at the block union when the pressure recorded should be as previously obtained with the original gauge.

To Remove

1 Disconnect the negative terminal of the batter!.

2 Disconnect the oil feed pipe from the block to the gauge at the union nut located at the rear of the Instrument Box. Remove the locknut from the union.

Note — On early type engines an elbow type adaptor was used to connect the oil pipe to the main oil gallery in the cylinder block. Current production engines use an adaptor and a banjo type union secured by a special grooved bolt. Do not remove the adaptor.

3 Release the coil of the temperature gauge capillary tube adjacent to the fuel tank tap and disconnect the starter controls (Petrol and Vaporising Oil) or stop control (Diesel).

4 Remove the two top screws at each side of the Instrument Box and ease the top half forward. Unscrew the two screws retaining the pressure gauge to the panel and lift out the gauge.

To **Replace**

1 Mount the oil pressure gauge on the top half of the Instrument Box (left-hand side). Retain by means of the two screws and lock the short oil pipe union nut at the rear of the panel using an internal tooth lockwasher each side of the panel.

2 Instal the top half of the Instrument Box to the base and tighten the two retaining screws each side.

3 Connect the oil feed pipe from the block to the gauge using a fibre washer each side of the banjo union and tighten the grooved bolt thoroughly.

4 Connect the starter and choke controls (Petrol and Vaporising Oil) or stop control (Diesel) and restore the coil in the capillary tube adjacent to the fuel tank tap.

5 Connect the negative battery cable.

FOR CORRECT GRADE OF LUBRICANT REFER TO THE OPERATORS INSTRUCTION BOOK

CAPACITY	12 Imp. Pints (6.816 Litres), in addition 1 Pint (0.568 Litre) for dry oil filter.

Fig. *85*

SPECIFICATIONS and REPAIR DATA

NOTE.—Unless otherwise indicated the following information applies to the Diesel, Petrol and Vaporising Oil engine,.

ENGINE

	Diesel	*Petrol*	*Vaporising Oil*
Bore	3.937"–3.938" (100 mm.)	3.740"–3.741" (95 mm.)	3.937"–3.938" (100 mm.)
W/L taper	0.007" (0.178 mm.)	0.007" (0.178 mm.)	0.007" (0.178 mm.)
W/L out of round	0.003" (0.008 mm.)	0.0003" (0.008 mm.)	0.0003" (0.008 mm.)
Stroke	4.520"–4.528" (115 mm.)	4.520"–4.528" (115 mm.)	4.520"–4.528" (115 mm.)
Cubic capacity	3610 c.c. (220 cu. ins.)	3260 c.c. (199 cu. ins.)	3610 c.c. (220 cu. ins.)
B.H.P. (max.) at 1,600 r.p.m.	40.5	39.5	38.5
Compression ratio	16: 1	5.5 : 1	4.62 : 1
Injection system	Direct	—	
No. of cylinders	4	4	4
Firing order	1, 2, 4, 3	1, 2, 4, 3	1, 2, 4, 3

Cylinder Liners

Retention of liner	Pressure of cylinder head exerted through gasket
Liner protrusion above top face of block	.002" to .004" proud (.0254 to .0762 mm.)

Oil Filter

Type	Full flow pressure relief replaceable element

Oil *Pump*

Pump shaft diameter	.5045"–.5050" (12.81–12.83 mm.)
Shaft bearing internal diameter	.506"–.508" (12.85–12.90 mm.)
Shaft clearance	.001"–.0035" (.025–.0889 mm.)
Idler gear internal diameter	.5025"–.5035" (12.76–12.79 mm.)
Idler gear shaft to housing interference	.0005"–.002" (.0127–.050 mm.)
Idler gear shaft diameter	.501"–.5015" (12.725–12.738 mm.)
Idler gear shaft to gear clearance	.001"–.0025" (.025–.0635 mm.)
Idler gear shaft length	1.67" (42.418 mm.)
Idler gear end-float	.001"–.0045" (.025–.1143 mm.)
Oil pump gear, driver, I.D.	.5025"–.5035" (12.76–12.79 mm.)
Interference fit of driver gear on drive shaft	.001"–.0025" (.025–.0635 mm.)
Length of drive shaft	5.90" (149.9 mm.)
Interference fit of ton gear on drive shaft	.001"–.0025" (.025–.0635 mm.)
Clearance between top gear face and pump body	.010" min. (.254 mm.)
Relief valve spring—fitted length	1" (25.4 mm.)
Relief valve spring—fined load	3.09–3.42 lbs.

Oil *Pump—continued*

Oil pump pressures	40–50 lbs. sq. in. (2812–3515 gm. sq. cm.) approx. at 1500 r.p.m.

Camshaft

Camshaft drive		Gear
Camshaft gear clearance fit on spigot		.000"–.001" (.0254 mm.)
Max. cam lift		.259" (3.6553 mm.)
Max. valve lift	*P. & D.*	.354"
	V.O.	.360"
Journal diameter		2.0595"–2.0600" (52.3115–52.324 mm.)
	Wear limit	2.0585"–(52.286 mm.)
Bearing internal diameter		2.062"–2.063" (52.375–52.4 mm.)
	Wear limit	2.065" (52.451 mm.)
Bearing clearance		.002"–.0035" (.051–.0889 mm.)
	Wear limit	0.006" (0.152 mm.)
Backlash—crankshaft to camshaft gears at 5.204 centres		.003"–.004" (.0762–.1016 mm.)
End-float of camshaft		.003"–.008" (.0762–.2032 mm.)
Thickness of camshaft thrust pad		.175"–.177" (4.446–4.495 mm.)
No. of teeth on camshaft inner gear		45
No. of teeth on camshaft outer gear		62
No. of teeth on aux. drive shaft gear		45

Crankshaft and *Main* Bearings

Crankpin journal length	1.660"–1.664" (42.2–42.3 mm.)
Crankpin journal diameter	2.4997"–2.5005" (63.492–63.5 mm.)
Crankpin journal clearance	0.001"–,0028" (.025–.071 mm.)
Wear limit taper	0.001" (0.25 mm.)
Out of round	0.0015" (0.0375 mm.)

Crankshaft and Main Bearings — continued

Crankshaft end-float	.002 –.010" (.050–.254 mm.)
Wear limit	0.013" (0.33 mm.)
Main bearing liner thickness (standard)	.082"–.08225" (2.083–2.088 mm.)
Undersizes	.01" (.254 mm.) .03" (.762 mm.) .02" (.508 mm.) .04" (1.016 mm.)
Main bearing journal diameter	3.0002"–3.0010" (76.205–76.225 mm.)
Wear limit taper	0.001" (0.025 mm.)
Out of round	0.0015" (0.0375 mm.)
Main bearing journal clearance	.001"–.0028" (.025–.071 mm.)
Main bearing journal length (front)	1.295"–1.305" (32.89–33.15 mm.)
Main bearing journal length (centre)	1.799"–1.801" (45.67–45.72 mm.)
Main bearing journal length (intermediates (2))	1.395"–1.405" (35.43–35.69 mm.)
Main bearing journal length (rear)	1.831"–1.841" (46.507–46.76 mm.)
Centre main thrust washer thickness (standard)	.091"–.093" (2.31–2.36 mm.)
Wear limit	0.0895" (2.273 mm.)
Effective length of front and intermediate main bearing shells	0.905" (22.987 mm.)
Effective length of centre and rear main bearing shells	1.28" (32.512 mm.)
No. of teeth on crankshaft gear	31
Crankshaft pulley diameter	9" (228.6 mm.)
Crank pulley fit	.0005" interference to .0015" clearance

Connecting Rod

Interchangeability	Diesel — Diesel only Petrol & V.O. — Interchangeable
Length — centre to centre	7.998"–8.002" (203.149–203.251 mm.)
Small end bore (with bush)	1.2501"–1.2504" (31.7525–31.761 mm.)
W/L	1.270 (32.258 mm.)
Wear limit	1.2515" (31.788 mm.)
Big end bore (with liners)	2.5015"–2,5025" (63.533–63.563 mm.)
Wear limit	2.5035" (63.589 mm.)
Big end bore (without liner)	2.6460"–2.6465" (67.2–67.23 mm.)
Undersizes of liner	.01" (.254 mm.) .03" (.762 mm.) .02" (.508 mm.) .04 (1.016 mm.)
Connecting rod big end width	1.655"–1.657" (42.03–42.08 mm.)
Liner thickness (standard)	.072"–.07225" (1.82–1.84 mm.)
Clearance on crankpin	.001"–.0028" (.025–.071 mm.)
End-float on crankpin	.003"–.009" (.076–.229 mm.)
Wear limit	0.005" (0.127 mm.)
Clearance between small end and piston pin	.0001"–.0007" (.0025–.01778 mm.)
Wear limit	0.0014 (0.0355 mm.)

Piston Pin

Type		Fully floating
Length	D.	3.384"–3.392" (85.95–86.15 mm.)
	P.	3.084–3.092" (78.33–78.54 mm).
	V.O.	3.284"–3.292" (83.41–83.62 mm.)
Outside diameter		1.2497"–1,2500" (31.742–31.750 mm.)
Wall thickness	D.	,3125" (7.94 mm.)
	P.	.1875" (4.76 mm.)
	V.O.	.1875" (4.76 mm.)
Fit in piston at 70°F.	D.	.0001" free to .0001" interference (.0025–.0025 mm.)
	P.	.0002" free tc .0000" interference (.00568 mm.)
	V.O.	,0002" free to .0000" interference (.00568 mm.)
Method of retention		End circlips

Piston

Type	D.	100 mm. dia. Combustion chamber (machined in top)
	P.	95 mm. dia. Flat top
	V.O.	100 mm. dia Flat top
Piston fit, i.e. poundage pull on feeler blade	D.	P 7 Ibs. with .004" × .5' feeler (1.8–3.2 kgs. with .127 x 12.7 mm. feeler)
	P. & V.O.	P 7 lbs. with .002" x .5" feeler (1.8–3.2 kgs. with .07 x 12.7 mm. feeler)
Piston diameter (at bottom of skirt) (standard)	D.	3.9326"–3.9336" (100.888–100.913 mm.)
	P.	3.7383"–3.7397" (94.953–94.978 mm.)
	V.O.	3.9351"–3.9361" (99.949–99.977 mm.)
Piston length overall		4.65" (118.11 mm.)
Piston oversizes		.0025" (.0635 mm.)
Diameter of piston pin bore boss		1.2497"–1.2500" (31.745–31.75 mm.)

Piston Rings

Piston ring gap — compression		.011"–.016" (.2794–.406 mm.)
— oil control		.011"–.016" (.2794–.406 mm.)
No. of compression rings	D.	3
	P.	2
	V.O.	3
No. of oil control rings	D. & *V.O.*	2
Width of piston ring groove — Top compression	D.	,0952"–,0962" (2.418–2.443 mm.)
	P. & *V.O.*	.0952"–.0962" (2.418–2.443 mm.)

Piston Rings—conrinued

2nd compression	D.	.0952″–.0962″ (2.418–2.443 mm.)
	P. & *V.O.*	.0952″–.0962″ (2.418–2.443 mm.)
3rd compression ..	D.	.0952″–.0962″ (2.418–2.443 mm.)
	P. & *V.O.*	.0952″–.0962″ (2.418–2.443 mm.)
1st oil control	D.	.189″–.190″ (4.800–4.826 mm.)
	P. & V.O.	.189″–.190″ (4.800–4.826 mm.)
2nd oil control	D.	.189″–.190″ (4.800–4.826 mm.)
	P. & V.O.	.189″–.190″ (4.800–4.826 mm.)

Width of Piston Ring

Top compression	.0928″–.0938″ (2.357–2.38 mm.)
2nd compression	.0928″–.0938″ (2.357–2.38 mm.)
3rd compression (D. and V.O. only)	.0928″–.0938″ (2.357–2.38 mm.)
1st oil control	.1865″–.1875″ (4.737–4.762 mm.)
2nd oil control	.1865″–.1875″ (4.737–4.762 mm.)

Ring to Groove Clearance

Compression Rings ..	D.	.0014″–.0034″ (.035–.086 mm.)
Wear limit ..		0.005" (0.127 mm.)
	P.	.0012″–.0032″ (.031–.0812 mm.)
Wear limit ..		0.005″ (0.127 mm.)
	V.O.	.0014″–.0034″ (.03556–.086 mm.)
Wear limit ..		0.005″ (0.127 mm.)
Oil control rings	*D.*	.0025″.–0045″ (.0635–.1143 mm.)
Wear limit ..		0.005" (0.127 mm.)
	P.	.0015″–.0035″ (.038–.0889 mm.)
Wear limit ..		0.005" (0.127 mm.)
	V.O.	.0015″–.0035″ (.038–.0889 mm.)
Wear limit ..		0.005" (0.127 mm.)

Valves and Guides

Valve clearance—inlet ..	D.	.015″ (.381 mm.) set idling (hot)
—exhaust (rotator)	D.	.012″ (.305 mm.)
—inlet and exhaust	P.	.015″ set idling (hot) (.381 mm.)
—inlet and exhaust	*V.O.*	.015″ set idling (hot) (.381 mm.)
Valve head diameter—inlet ..		1.720"–1.730" (43.688–43.94 mm.)
--exhaust ..		1.535"–1.543" (38.938–39.19 mm.)
Valve stem diameter—inlet ..		.3731″–.3742″ (9.474–9.486 mm.)
Wear limit ..		0.372" (9.449 mm.)
Valve stem diameter—exhaust ..		.3723″–.3733″ (9.449–10.061 mm.)
Wear limit ..		0.3713" (9.430 mm.)
Length of valves—inlet ..	D.	6.218″–6.248″ (157.9–158.7 mm.)
—exhaust ..	D.	6.154″–6.176″ (156.312–157.870 mm,)
—inlet and exhaust	P.	4.818″–4.848″ (122.4123.1 mm.)
—inlet and exhaust	*V.O.*	4.818″–4.848″ (122.P123.1 mm.)
Angle of valve head		29" **30'**
Angle of valve seat in head ..		30"
Length of valve guide—inlet	D.	3.00" (76.2 mm.)
--exhaust	D.	2.62" (66.55 mm.)
—inlet and exhaust	P.	2.22" (56.388 mm.)
—inlet and exhaust	*V.O.*	2.22" (56.388 mm.)
		2.22" (56.388 mm.)
		2.22" (56.388 mm.)
Valve guide—internal diameter inlet		.375″–.376″ (9.525–9.550 mm.)
internal diameter exhaust		.375″–.376″ (9.525–9.550 mm).
Wear limit ..		.378″ (9.60 mm.)
--outside diameter ..		.6260″–.6265″ (15 900–15.913 mm.)
Stem to guide clearance—inlet ..		.0008″–.0029″ (.020–.074 mm.)
Wear limit ..		0.006″ (0.152 mm.)
—exhaust		.0017″–.0037″ (.043–.094 mm.)
Wear limit ..		0.008" (0.203 mm.)
Amount valve guide is to be proud of head above spring seat—inlet	D.	0.820"–0.880" (21.47 mm.)
--exhaust	D.	0.690"–0.750" (18.28 mm.)
—inlet and exhaust	P.	1.045″–1.105″ (26.543–28.067 mm.)
—inlet and exhaust	*V.O.*	1.045″–1.105″ (26.543–28.067 mm.)
External diameter of valve insert—inlet (where fitted)		1.8900″–1.8905″ (48.006–48.019 mm.)
External diameter of valve insert—exhaust		1.702″–1.7025″ (43.2308–43.2435 mm.)
Internal diameter of valve insert—inlet (where fitted)		1.560"–1.565" (39.624–39.751 mm.)
Internal diameter of valve insert—exhaust		1.372"–1.377" (34.849–34.916 mm.)
Thickness of valve inserts ..		.2175″–.2195″ (5.525–5.550 mm.)
Interference fit of inserts to head. .		.002″–.0035″ (.05–.0085 mm.)
Decompressor (Early type Diesel)		Eccentric rocker opens each valve .025″ (.425 mm.)

Valve Springs and Collet

Number of coils on valve spring	8.8 total coils : 7 free coils
Free length of valve spring	2.48" (62.99 mm.)
Compressed length and load	1.98" @ 45–50 lb. (50.3 mm. @ 20.4–22.7 Kilogrammes)

Push Rods and Tappets

Length of push rods	D.	11.9" (302.26 mm.)
	P.	11.9" (302.26 mm.)
	V.O.	12.28"
Diameter of push rods		.280"–.284" 17.11–7.21 mm.)
Diameter of tappet stem		.6080"–.6085" (15.443–15.455 mm.)
Overall length of tappet		2.50" (63.5 mm.)
Tappet to block clearance		.0005"–.002" (.012–.050 mm.)
Wear limit		0.005" (0.127 mm.)

Rocker Shaft and Rockers

Rocker shaft diameter	.743"–.744" (18.872–18.897 mm.)
Rocker shaft length	20.26"–20.32" (514.6–516.128 mm.)
Interchangeability of rocker shafts	Diesel—Diesel only Petrol & V.O.—Interchangeable
Interchangeability of rocker shaft springs	Diesel—Diesel only Petrol & V.O.—Interchangeable
No. of rocker shaft springs	4
No. of coils per spring	6
Compressed length and load of springs	1.06" @ P 5 lb. (26.92 mm. @ 1.81–2.3 kilogrammes)
Free length of rocker shaft springs D.	1.89" (48.01 mm.)
P.	1.51" (38.35 mm.)
V.O.	1.51" (38.35 mm.)
Clearance between rocker arm and eccentric D.	.0007"–.0029" (.018–.074 mm.)
Clearance between shaft and eccentrics D.	.0005"–.0035" (.0127–.0889 mm.)
Clearance between rocker arm and shaft P.	.001"–.003"
V.O.	(.0254–.076 mm.) .001"–.003" (.0254–.076 mm.)

Valve Timing at .021" Valve Clearance

Inlet opens	8" before T.D.C.
Inlet closes	31" 52' 16" after B.D.C.
Exhaust opens	34° 52' 16" before B.D.C.
Exhaust closes	5" after T.D.C.

FLYWHEEL

Flywheel interchangeability		Diesel—Diesel only Petrol & V.O.—Interchangeable
Flywheel outside diameter	D.	16.25" (412.75 mm.)
	P.	15.50" (393.7 mm.)
	V.O.	15.50" (393.7 mm.)
Flywheel run-out clutch face (T.I.R. Max.)		.005" (.127 mm.)
Interchangeability of ring gears		Diesel—Diesel only Petrol & V.O.—Interchangeable
Identification	D.	Chamfer Same Side as Countersink
	P. & V.O.	Ring Gear Chamfer on Opposite Side to Mounting Bolt Countersink
No. of teeth on ring gear		128
Method of flywheel retention		Dowel and bolts
Method of flywheel ring gear retention		Six screws

TORQUE TIGHTENING FIGURES (lbs. ft.)

	Diesel	*Petrol*	*Vap. Oil*
*Cylinder head bolts (marked 100)	‡85–90	‡75–80	‡75–80
Cylinder head bolts marked " Bees " " Newall high tensile " or " Ribe "	‡75–80	‡75–80	‡75–80
Main bearing cap bolts (marked 100)	70–75	70–75	70–75
Front mounting plate bolts	12–15	12–15	12–15
Timing cover bolts	12–15	12–15	12–15
Big end cap nuts	55–60	55–60	55–60
Flywheel bolts	80–90	80–90	80–90
Flywheel ring gear screws	12–15	12–15	12–15
Clutch to flywheel bolts	12–15	12–15	12–15
Sparking plugs	—	25–30	25–30
Injector holding down bolts	12–15	—	—
Delivery valve holder (injection pump)	30	—	—
Sump bolts	12–15	12–15	12–15
Engine Oil Filter	10	10	10

* Plain head bolts should not be used as replacements.

‡ Maintain at higher figure.