THE DIESEL ENGINE

The diesel engine fitted to the Fordson Major range of tractors is a 4 cylinder, direct injection type with a capacity of 3.61 litres. The engine has a bore of 100 mm., a stroke of 115 mm. and a compression ratio of 16 to 1.

The valves are of the overhead type, operated by push rods and rockers from the engine camshaft and operate in replaceable valve guides in the cylinder head, engines after Serial No. 1257972 being fitted with rotator type exhaust valves. A decompressor, operating on the exhaust valves, is available as optional equipment.

The camshaft is gear driven from the front end of the crankshaft which is supported in five replaceable main bearings. End-float of the crankshaft is controlled by replaceable thrust washers fitted at each side of the centre main bearing.

Pistons are manufactured of aluminium alloy and have a combustion chamber machined in the crown. Three compression rings and one oil control ring are fitted above the piston pin, a further oil control ring being fitted below the piston pin. The piston pins are fully floating and are retained by two circlips.

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

The fuel injection pump is driven from the rear end of the auxiliary drive shaft and feeds multi-hole injectors located in the top of the cylinder head. The engine speed is controlled by a governor incorporated in the fuel injection pump. An excess fuel device is also incorporated to assist in cold starting.

The current diesel engine, whilst basically of the same design as when it was introduced, has been modified in certain details to provide increased power, improved efficiency and longer service life.

This section covers complete dismantling and reassembly procedure for a current type Mark III engine. Where different procedures apply to Mark I and II and earlier Mark III engines these are printed in *italics.*

For easy reference the major changes to the engine are given below, together with the effective engine numbers.

For clarity of description reference will be made within the text of this section to Mark I engines (Engine Nos. 1217101 to 1425096), Mark II engines (Engine Nos. 1425097 to 1481090) and Mark III engines (Engine Nos. 1481091 onwards).

Description of Change	*Effective Engine No.*
INTRODUCTION OF "NEW FORDSON MAJOR"	1217101
Rotator type exhaust valves introduced	1257972
Decompressor repositioned from rear to front of engine	1290291
Changes to sizes of fan belt and pulleys	1308977
Chilled camshafts and tappets introduced	1358273
Solid piston pin introduced	1362380
INTRODUCTION OF MARK 11 ENGINE	1425097
'Horseshoe' shaped camshaft thrust washer introduced	1445056
Common length valve guides introduced	1458847
INTRODUCTION OF MARK III ENGINE	1481091
Longer connecting rod bolts	1509598
Redesigned camshaft thrust washer	1511488
New piston together with copper/asbestos permanite gasket and spigoted liners	1518654
Redesigned timing cover breather	1529773
New composition cylinder head gasket and liners with smaller spigot	1565580
Cylinder liners with two seals and larger diameter main bearing bolts	1591023
New exhaust valve, collets, retainers and rotator cap	1594009
New material oil pump drive gear and auxiliary drive shaft gear	1595085
New camshaft, timing gears, front mounting plate, etc.	1599502
New cam form on camshaft and heavier valve springs	1609839
New type lift pump introduced and cylinder block changed	1613500
Cylinder block modified and oil drain hole added to auxiliary drive shaft bore	08B752791
Minimec fuel injection pump introduced	08B756398

TO DISMANTLE THE ENGINE

To Remove the Engine from the Tractor

To prevent the possibility of damage and to facilitate the fitting of the engine stand bracket, the method of removing the engine as described below includes the removal of all external assemblies.

1. Drain the cooling system through the taps on the radiator and cylinder block.

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

3. Remove the primary air cleaner (and vertical exhaust if fitted). Extract the two screws and lockwashers retaining the rear clip of the bonnet hinge and remove the bonnet.

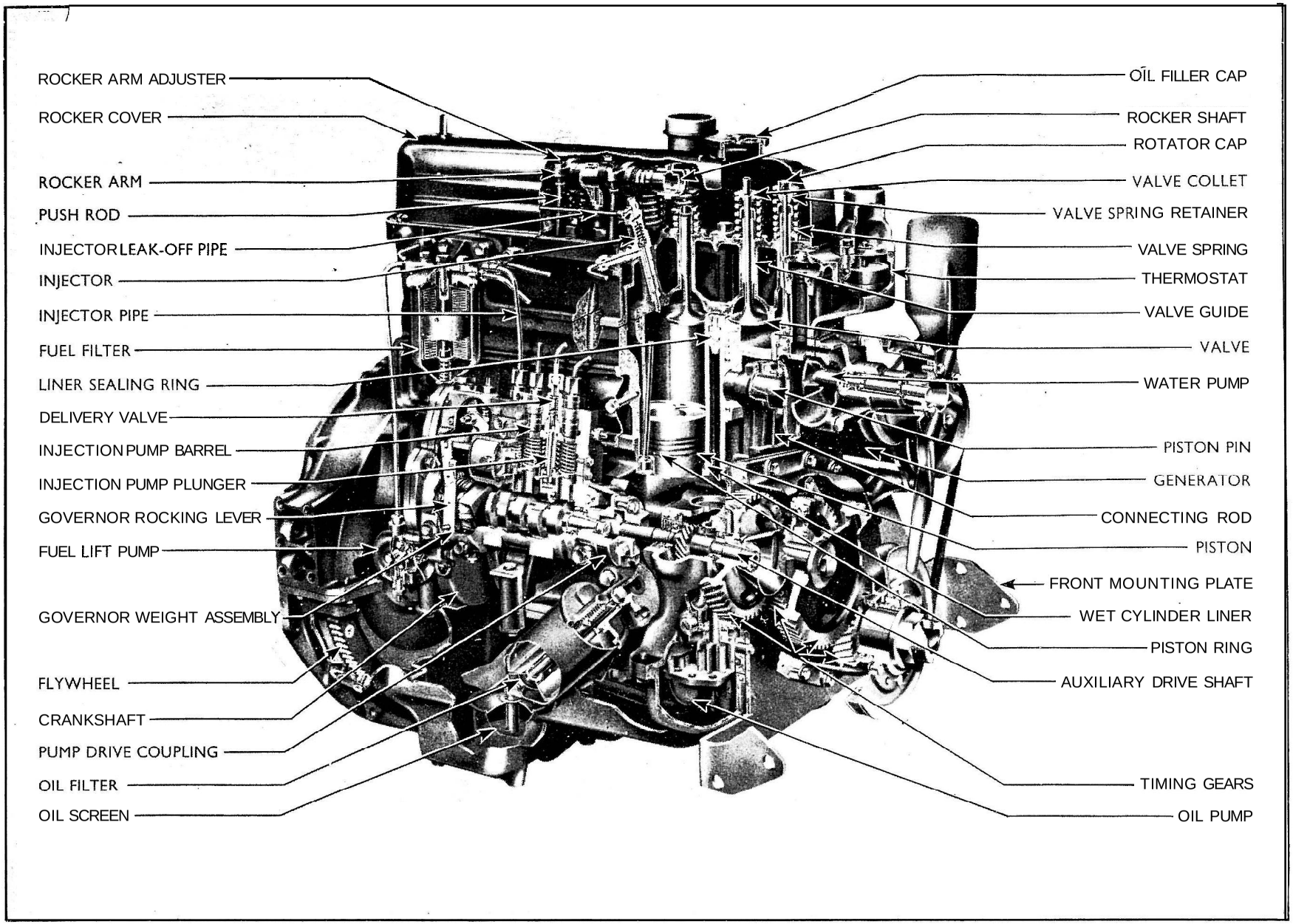

Fig. 1 **Sectioned View of Diesel Engine**

4. Disconnect the battery leads and remove the batteries.

Prior to Engine No. 1408399 a single 12 volt battery was fitted having the same ampere-hour capacity as the two six volt batteries currently used.

Check the battery condition and place on charge if necessary.

5. Remove the tool box.

6. If a downswept exhaust system is fitted, disconnect it at the manifold flange, remove the two brackets, one on the rear axle housing and one on the side channel supporting the tail pipe and silencer, then remove the pipe and silencer complete.

7. Remove the air cleaner to rocker cover breather pipe (Mk. II and III engines).

The Mk. I breather pipe is fitted between the inlet manifold and the side of the rocker cover.

8. Disconnect the starter motor actuating rod at the starter switch clevis.

9. Disconnect the wiring from the starter motor, generator, oil pressure switch, and left-hand headlight snap connectors and coil up the wiring loom so that it does not become damaged (Mk. III engines only).

The wiring loom on the Mk. I and 11 engines is located in clips attached to the tappet cover extension studs on the right-hand side of the cylinder block, extensions from the main loom crossing at the rear of the cylinder block to the starter motor, and across the front of the block to the generator.

Disconnect the wiring from the starter motor and generator on Mk. I and 11 engines, release the loom retaining clips, pull the extension wires from the starter motor and generator through to the right-hand side of the engine, disconnect the headlamp snap connectors and coil back the wiring loom.

10. Remove the starter motor and generator.

11. Disconnect the water temperature gauge bulb from its location in the cylinder head, release the clips holding the capillary tube and carefully coil the capillary tube clear of the engine.

The capillary tube is located in the wiring loom clips on the right-hand side of the Mk. I and 11 engines.

12. Remove the oil pressure warning light switch (Mk. III only).

Disconnect the oil pressure gauge pipe to cylinder block union (Mk. I and 11 engines).

13. Disconnect the mechanical governor control rod from the governor control lever and throttle friction pad lever assembly and remove the rod.

13a. *Remove the vertical operating rod to the throttle butterfly arm (Pneumatic Governor).*

The lower end of this rod on Mk. I engines is connected to the arm of the linkage rod carried in a cross drilling in the cylinder block, between Nos. I and 2 cylinder bores. On Mk. II and III engines the connection is to a relay lever and the linkage passes across the rear of the cylinder block.

13b. *Disconnect the governor suction pipe unions from the inlet manifold venturi and remove the inlet and exhaust manifolds.*

13c. *Remove the throtrle swivel linkage from the cylinder block (Mk. 11 and III engines with pneumatic governor only).*

14. Disconnect the radiator tie bar at the water outlet connection. (Not with current production radiator.)

15. Remove the top and bottom radiator hoses.

16. Disconnect the proofmeter drive cable from the rear of the mechanically governed fuel injection pump.

On all previous models disconnect the proofmeter drive cable and remove the driving gear assembly from the auxiliary drive shaft location.

17. Loosen the pinch bolt on the stop control lever of the fuel injection pump.

Slacken the clamp screw securing the outer cable to the bracket on the injection pump (current production only). Remove the stop control cable.

18. Turn off the fuel tap, disconnect the fuel pipes from the sediment bowl, lift pump and fuel filter and remove the lift pump and sediment bowl.

Engines prior to Serial No. 1613500 were fitted with a lift pump incorporating an integral sediment bowl and this may be removed together with the lift pump.

19. Disconnect the fuel filter to injection pump pipe and remove the fuel filter and pipe.

20. Remove the engine oil filter. The injection pump leak-off pipe is retained by a clip located under the head of the filter front securing screw.

21. Remove the injection pump to injector high pressure pipes.

On tractors fitted with pneumatic governors disconnect and remove governor suction pipes.

22. Suitably seal all the openings on the fuel injection pump and remove the pump from the engine.

22a. *Disconnect the throttle operating rod at the point where the horizontal rod from the hand operating lever connects with the cross linkage at the rear of the cylinder block (Mk. II and previous Mk. 111 engines).*

On Mk. I engines disconnect the horizontal rod where it connects with the cross rod link on the right-hand side of the cylinder block.

23. Disconnect the fuel leak-off pipe banjo connection at the rear of the cylinder head.

24. Disconnect the steering drag link from the spindle steering arm.

25. Support the engine and transmission using the tractor dismantling stand (Tool No. Tr.NMD27). Lay the two rail section under the tractor, place the engine and gearbox trolleys in position and suitably adjust them to support these units during splitting.

26. If the front axle wedge tool, Tool No. T.3007 is available this should be fitted between the front crossmember and the stops on the front axle to prevent movement between the engine and front axle assemblies. If this tool is not available, suitably sized blocks of wood should be used.

27. Remove the four bolts on each side retaining the side channels to the gearbox, and the bolts retaining the engine to the gearbox. Do not forget the two bolts behind the side channels.

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

29. Fit the two engine lifting plates (Tool No. CT. 6003), one to the fuel filter boss at the rear of the cylinder head on the right-hand side of the tractor, and the other under the two front left-hand cylinder head bolts. Take the weight of the engine on a hoist or gantry.

30. Remove the front axle radius rod pin.

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

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

33. 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.

34. Mount the engine on the engine on the engine stand, Tool No. 200A, using the special mounting bracket, Tool No. CT.6006 or, if already in the dealer's possession, mounting bracket, Tool No. CT.6005. The bracket is fitted to the left-hand side of the engine and is secured by two bolts locating in tapped holes provided at the lower forward position on the cylinder block, two bolts at the pneumatic governor throttle bracket location behind the exhaust manifold, and four bolts at the engine side channel rear location.

35. Remove the clutch assembly from the flywheel, taking care to slacken the clutch cover to flywheel bolts evenly.

36. Remove the two engine lifting plates.

To Dismantle the Engine

1. Remove the six screws securing the flange of the valve rocker cover to the cylinder head *(two screws into the intermediate rocker shaft brackets on Mk. I engines)* and remove the cover and gasket.

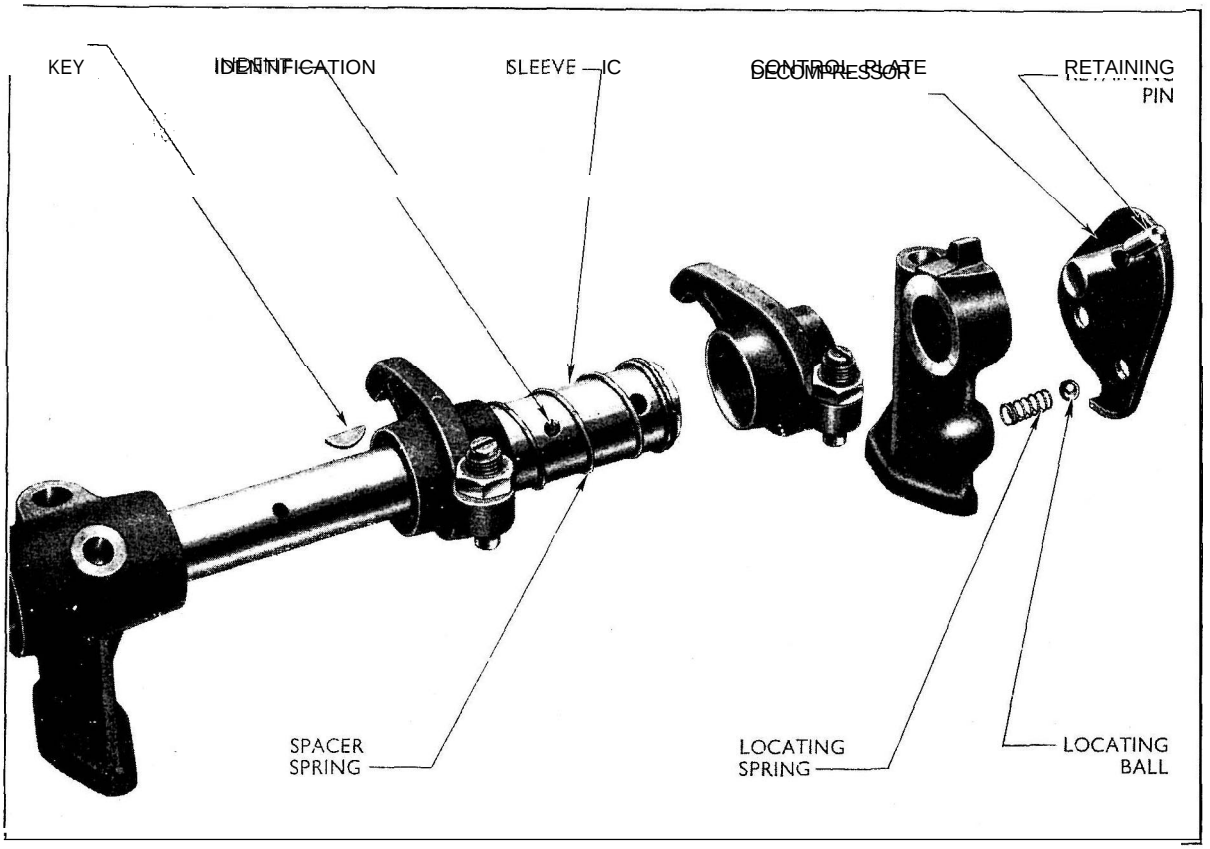

Fig. 2
Rocker Shaft with Front Operated Decompressor

If a decompressor is fitted and it is of the type which has the operating lever at the front of the engine, it will he necessary to extract the retaining screw and detach the lever before the rocker cover can be removed *(prior to Engine No. 1290291 the lever was located in the rear right-hand side of the cylinder head).*

An oil seal is fitted where the tongued boss of the lever? enters the cover and this may be removed, if necessary, and a new seal tapped into position until the flange of the seal is flush with the outside face of the cover.

2. Remove the two screws retaining the water outlet. connection to the cylinder head and remove the outlet connection and the thermostat.

3. Remove the screws retaining the leak-off pipe to the injectors, unscrew the union nut at the rear of the cylinder head and detach the forward portion of the leak-off pipe, then remove the injector retaining screws and extract the injectors from their housings followed by the copper washers from the injector locating bores in the cylinder head.

4. Slide the valve rocker levers sideways to enable the ball ends of the tappet adjusting screws to be disengaged from tne cup ends of the push rods, and remove the push rods keeping them in their correct sequence. It will be necessary to turn the engine using the engine turning bar, Tool-No. CT.6071, to take the load off any rocker lever which may be holding a valve open.

5. Unscrew the rocker shaft support bracket retaining screws evenly and lift off the rocker shaft assembly, then remove the rotator caps from the exhaust valves and keep them in their correct sequence.

To Dismantle the Rocker Shaft Assembly

Three distinct rocker shaft assemblies may be encountered, i.e. without decompressor, with decompressor operating lever at rear of assembly (prior to Engine No. 1290291) and with decompressor operating mechanism at the front of the assembly.

Where the decompressor lever is located at the front of the valve rocker cover, a special decompressor control plate, together with a locating ball and spring, is pinned to the rocker shaft in place of the standard front end plug, the pin hole being offset in the rocker shaft so that it can only be jitted in one position (see Fig. 2).

Where the decompressor is operated by a lever acting through a boss at the rear of the cylinder head the control plate is pinned to the rear end of the rocker shaft (see Fig. **3).**

The rocker arms are " handed " i.e. the valve ends of the levers are offset to the right or left of the centre line of the arm when viewed from the push rod end. Identical right-hand arms are used on Mk. I and II engines but those fitted to Mk. ZII engines are shorter from the centre of the adjusting screw to the centre of the rocker shaft than those fitted to the earlier engines. These arms are not interchangeable.

Similarly, the decompressor sleeves, identified by an indentation in the surface of the sleeve between the two holes, used on Mk. ZII engines (see Fig. 2) differ from, and are not interchangeable with, those used on Mk. I and II engines.

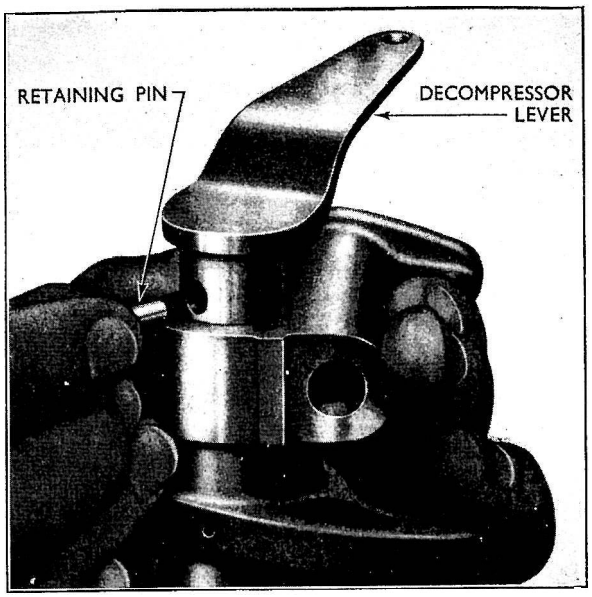

Fig. 3
Rear Operated Decompressor

(a) Stand the rocker shaft assembly on end with the rocker arms for No. 1 cylinder uppermost.

(b) Pull down on the front support bracket until the pin securing the end plug or decompressor locking plate is uncovered.

(c) Remove the pin and end plug (or locking plate, spring and ball where a front operated decompressor is fitted).

(d) Remove the adjacent rocker support bracket, two rocker arms and spacer springs. If a decompressor is fitted, remove the first eccentric sleeve and woodruff key.

(e) Remove the screw securing the intermediate support bracket to the shaft and remove the support bracket. (If a decompressor is fitted, these support brackets are not secured to the shaft.)

(f) Further dismantle the assembly, following a similar sequence, until after removal of the rear support bracket the rear end plug pin *(operating plate retaining pin when a rear operated decompressor is fitted)* is exposed. This pin may then be removed together with the end plug.

To Reassemble the Rocker Shaft

(a) Replace the rear end plug *(or decompressor operating plate and pin if a rear operated decompressor is to be jitted).*

(b) Replace the rear support bracket.

(c) Fit a left-hand rocker arm, i.e. one on which the valve end is set away from the rear support. If a decompressor is fitted assemble a woodruff key to the rear keyway in the shaft and fit an eccentric sleeve.

(d) Fit a spacing spring and a right-hand rocker arm, i.e. one on which the valve end is " set " towards the rear bracket.

(e) Fit an intermediate support bracket and secure it to the shaft with a set screw. (No screw if decompressor is fitted.)

(f) Continue building up the rocker shaft assembly with alternate left- and right-hand arms, springs, sleeves and brackets until the front support bracket is in position.

(g) Fit the front end plug, pull down on the support bracket and fit the plug securing pin.

When a front operated decompressor is being fitted, position the locating pin of the control plate in the end of the rocker shaft, pull down the front support bracket and fit the retaining pin (see Fig. 4). Hold the front support bracket down and fit the decompressor control plate locating spring into the blind hole in the front of the bracket. Place the ball on top of the spring, position the control plate, and release the support bracket so that it abuts the plate with the ball locating in the hole in the plate.

Until the rocker shaft is replaced on the engine and the support brackets are bolted down, care should be taken to ensure that the control plate spring and ball do not become detached and lost.

6. Remove the retaining screws and detach the fan pulley and fan blades from the water pump hub.

7. Remove the four water pump retaining screws and detach the pump and gasket from the cylinder block.

The water pump body used on the Mk. II and III engines incorporates an enlarged water by-pass port, which also necessitates a different gasket from that used on the Mk. I engine.

Instructions for overhauling the water pump are given at the end of this section in "The Cooling System."

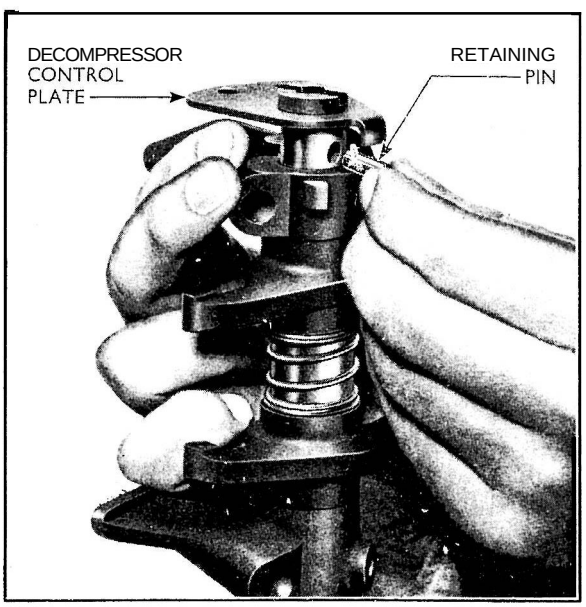

Fig. 4
Front Operated Decompressor

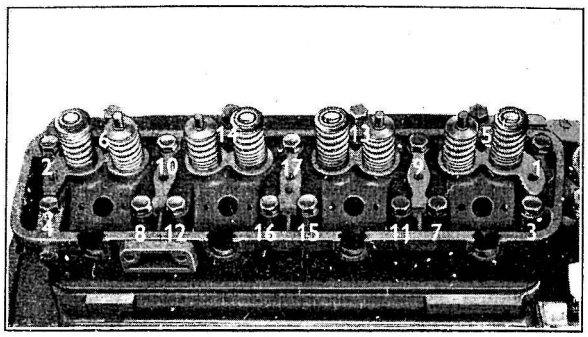

Fig. 5
Correct Sequence for Loosening Cylinder Head Bolts

8. Remove the 17 cylinder head retaining bolts, using the sequence shown in Fig. 5, and remove the cylinder head and gasket, followed by the small rubber washer fitted under the gasket at the rocker oil feed drilling, mid-way along the block.

NOTE.—If further work is to be carried out on the cylinder assembly necessitating inversions of the unit a suitable bolt and large flat washer should be fitted between each pair of cylinder liners to prevent them falling out.

To Dismantle the Cylinder Head

It is possible to change a valve spring without removing the cylinder head providing the piston of the associated cylinder is brought to the top dead centre position (see Fig. 6).

(a) Position the valve spring compressor (either Tool No. CT.6074 or Tool No. T.6118 and adaptor T.6118–3 may be used) over the valve to be removed.

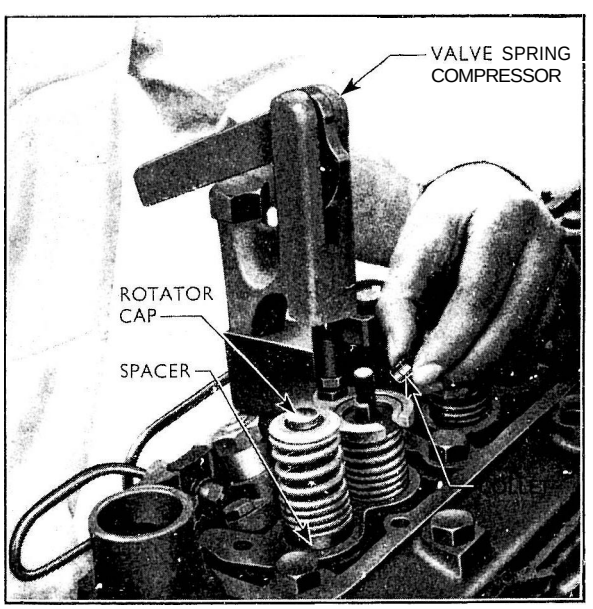

Fig. 6
Valve Spring Compressor

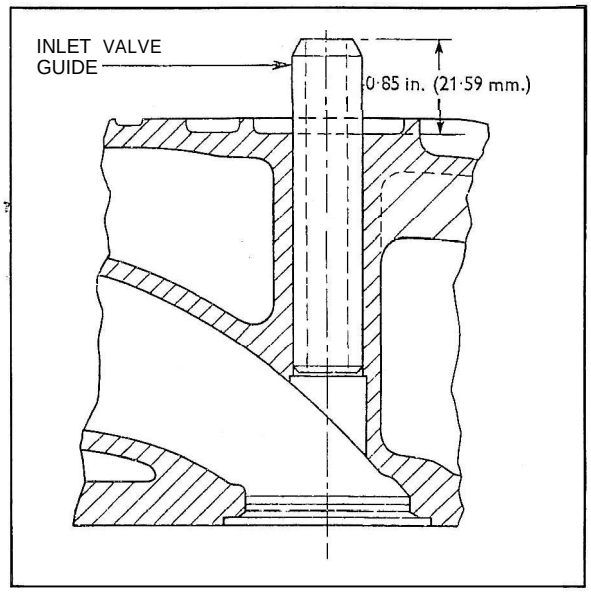

Fig. 7
Inlet Valve Guide Protrusion

(b) Compress the valve spring and extract the split collets. The rotator caps should be removed from the exhaust valves if not previously removed when dismantling the rocker shaft.

(c) Remove the valve spring compressor, spring retainer, spring, rubber sealing ring or cup (also the spring spacer if an exhaust valve is being removed).

(d) Extract the valve from its location in the cylinder head.

(e) Repeat the above operation on the remaining valves, keeping the valve assemblies in their correct order.

(f) Pass the rod of the valve guide remover and replacer, Tool No. CT.6073, through the valve guide so that the angled face of the body abuts the valve seat in the cylinder head.

(g) Fit the spacer and knurled retainer to the rod, and turn the'wing nut of the tool to remove the valve guide from the head.

Repeat the above operation on the remaining valve guides.

To Reassemble the Cylinder Head

If the valve seats in the cylinder head are burnt or pitted they may be reconditioned by using suitable proprietary valve seat grinding equipment with the cutter set at 30'.

If necessary the valves should be ground on a valve refacing machine set to 29½°. The valves should be hand lapped to the valve seats in the normal manner making certain on completion that all traces of the lapping compound are removed.

Prior to Engine No. 1458447 (apart from a few very early engines) the exhaust valve guides were shorter than the inlet guides. A common guide is now used (original inlet type) at both inlet and exhaust locations but at different protrusions (see Figs. 7 and 8) and should it be necessary to renew an exhaust valve guide on any Fordson Major Diesel Engine only the current valve guide should be fitted.

When replacing exhaust valves, collets, spring retainers or rotator caps, it should be noted that various changes have been made to these items since their introduction.

To assist identification of the parts and to ensure their correct usage the changes are summarised in the following notes :—

Effective with approximate Engine No. 1425097 the rotator cap and collets were increased in diameter and the spring retainer was modified to accommodate them. These parts were used in production until Engine No. 1594009 when further changes were made. All diesel engines prior to No. 1594009 must befitted with current parts when the original items require renewal.

The changes to the detail parts can be seen by comparing Figs. 9 and 10, in order to assist identification of the new parts the following points should also be noted :—

The current type exhaust valve has a square lower shoulder to the collet recess as against a taper run-in on the previous valve. The collets used with this type of valve, i.e. after Serial No. 1594009 have a thickness of $\frac{7}{32}$ in. (5.56 mm.) as against the $\frac{5}{32}$ in. 3.97 mm.) thickness of the previous parts.

Further changes have been made to the rotator caps at approximate Serial No. 08B756400 whereby the caps are treated with a black anti-friction compound to improve wear characteristics and only this type of cap will now be supplied. This cap has an outside diameter of 0.610 to 0.614 in. (15.49 to 15.60 mm.) compared with 0.575 to 0.580 in. (14.61 to 14.73 mm.) for the previous type.

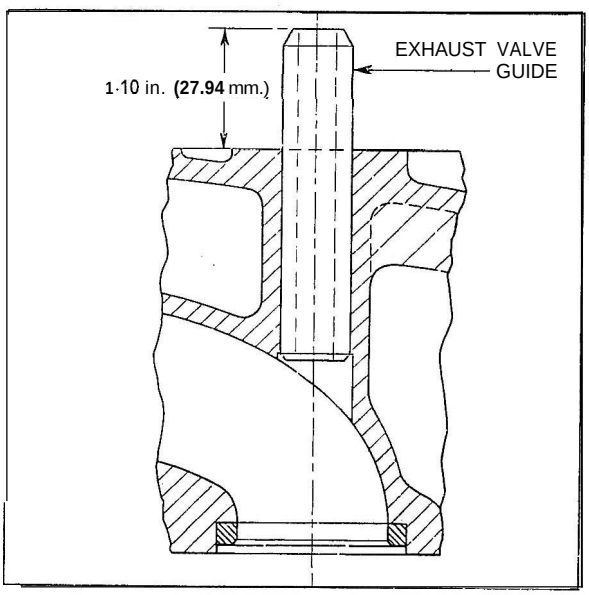

Fig. 8
Exhaust Valve Guide Protrusion

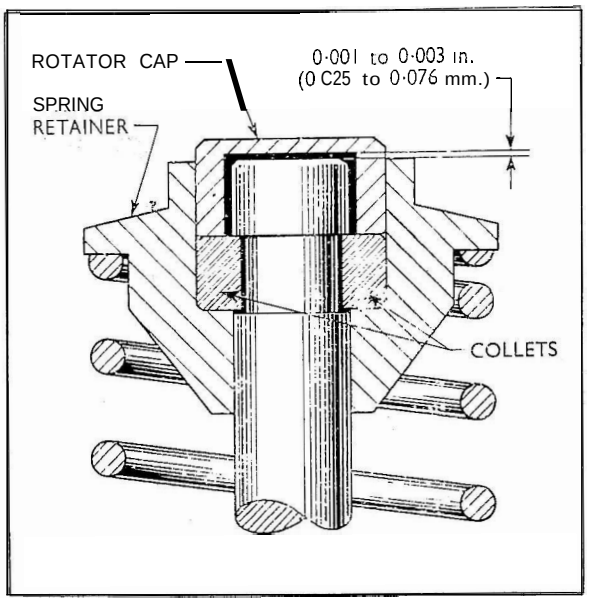

Fig. 9
Current Exhaust Valve Rotator Details

The exhaust valve spring retainer originally used with this type of valve may be identified by its larger overall dimensions and single counterbore (see Fig. 9). Earlier retainers were smaller in size and had a double counterbore (see Fig. 10), the bore for the rotator cap being larger than that for the collets. Effective with Serial No. 1609839 stronger valve springs were introduced and the diameter of the retainer was increased to cater for this change. The latest retainer is not interchangeable with the previous part and is knurled on its outside diameter for identification.

The new springs mentioned above may be identified by their black mottled finish whereas previous parts had a silvery grey appearance. It is essential that the stronger springs are only fitted to tractors after Serial No. 1609839 or to earlier tractors where the latest type of camshaft has been fitted. (See appropriate section.)

Effective with the change to the valve spring the exhaust valve spring spacers were increased in diameter and should only be used with their appropriate spring. Original spacers, Part No. E1-CP-9 had a plain outside diameter. Later parts with the increased outside diameter, Part No. E1ADDN-6515, had a vertical knurling. Effective with Serial No. 08B756400 the spacers were case-hardened and the material changed, the latest parts may be identified either by a diagonal knurling or a machined groove on their outer edge.

Three types of inlet valve spring retainer will be encountered in service, i.e. Original type, used with old type valve springs, identified by plain O.D. Larger type, used with stronger spring, identified by vertical knurling on O.D. Current, case hardened type, to replace previous part, identified by diagonal knurling.

(a) Place a valve guide into its location with the sharp chamfer towards the top of the cylinder head.

(b) Pass the spindle of the special replacer (Tool No. CT.6073) up through the cylinder head and valve guide.

(c) Position the replacer adaptor, Tool No. CT.6073-1/g for inlet valves, Tool No. CT.6073-1/h for exhaust valves, over the spindle of the main tool and secure in position with the knurled nut.

(d) Pull the guide into position by winding on the wing nut of the main tool (see Fig. 12). The adaptor ensures correct depth of the guide in the cylinder head.

(e) Fit the remaining valve guides in the same manner as above.

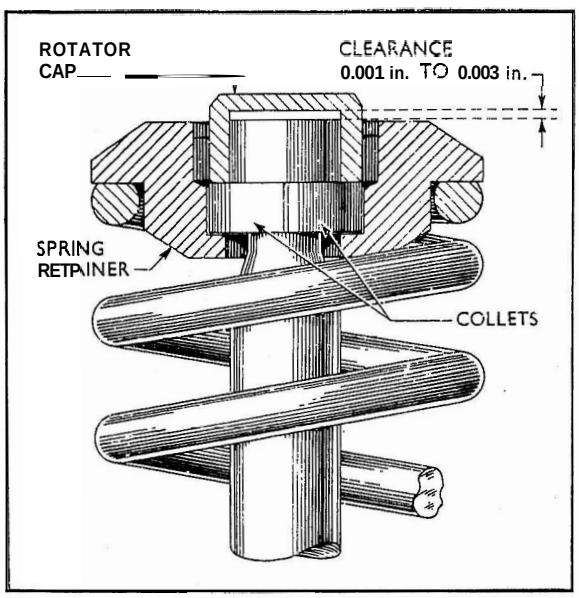

Fig. 10
Previous Exhaust Valve Rotator Cap Details

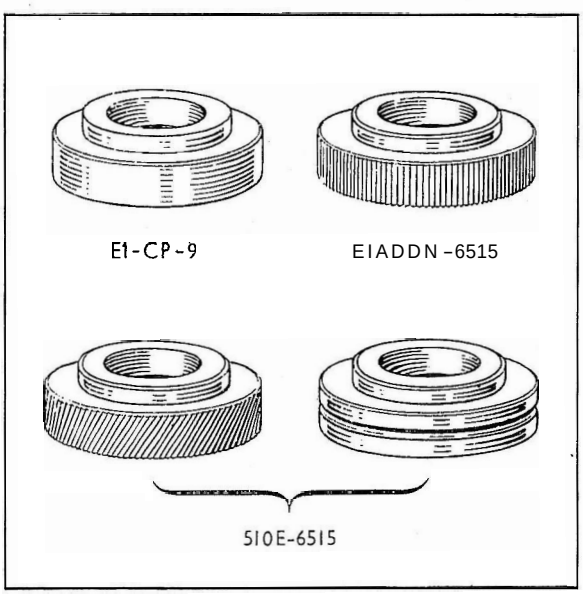

Fig. 11
Exhaust Valve Spring Spacer Identification

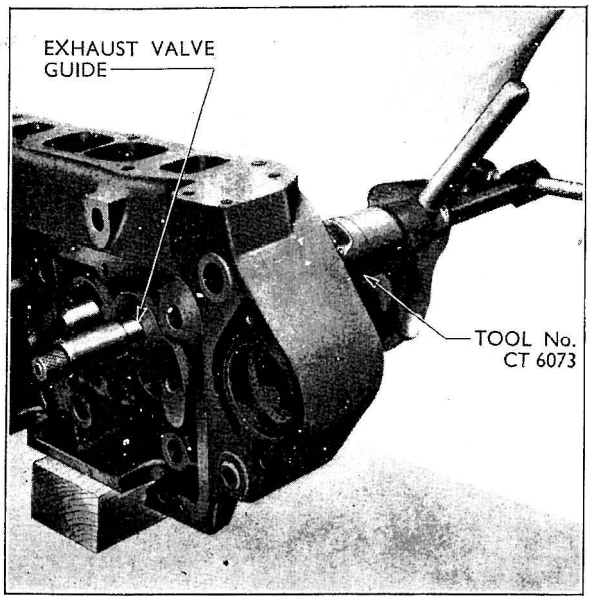

Fig. 12
Replacing a Valve Guide

(f) Lightly lubricate the valve stems and fit the valves into their respective locations.

(g) Lay the cylinder head face down, on a clean bench.

(h) Position the exhaust valve spring spacers over the exhaust valve guides and fit the current type oil seal cups to both inlet and exhaust valve stems.

Prior to Engine No. 1458447 rubber ring seals were fitted to a groove machined in rhe inlet valve stems only. The ring seals should be discarded and the cup type seal used on all valves whether the groove is machined in the valve stem or not.

(i) Assemble the inlet and exhaust valve springs with the close wound coils of the spring nearest the cylinder head.

(j) Place the valve spring retainers in position, compress the springs, using the spring compressor, either Tool No. CT.6074 or Tool No. T.6118 and adaptor T.6118–3, and locate the spring retaining collets. Parallel sided collets are used on exhaust valves, and tapered collets on inlet valves. Only the latest type fully machined inlet valve collets should be used.

(k) Ensure the collets are seating correctly and fit the rotator caps to the exhaust valves.

Mount a dial gauge firmly on the cylinder head so that the plunger touches the top of the rotator cap and set the gauge to zero (see Fig. 13).

Without altering the position of the dial gauge, lift the plunger and reverse the rotator cap so that it touches the inside face of the rotator cap. Note that there is a small machining depression on the inside face of the rotator cap, when taking the reading ensure that the cap is slightly " off centre " so that the dial gauge plunger does not rest in this depression otherwise an inaccurate reading will be obtained. (See Fig. 14.)

A dial gauge and support suitable for making the above measurements is carried under V. L. Churchill Tool No. P.4008, this tool is primarily a passenger car tool and as such it is not listed in tractor service tool lists.

The minus reading from zero shown on the dial gauge will equal the clearance between the valve stem and the rotator cap. If the reading remains at zero then the clearance is too small and the valve stem should be lapped as necessary. If the reading is greater than 0.003 in. (0.076 mm.) then the clearance is too great and the open end of the rotator cap must be lapped.

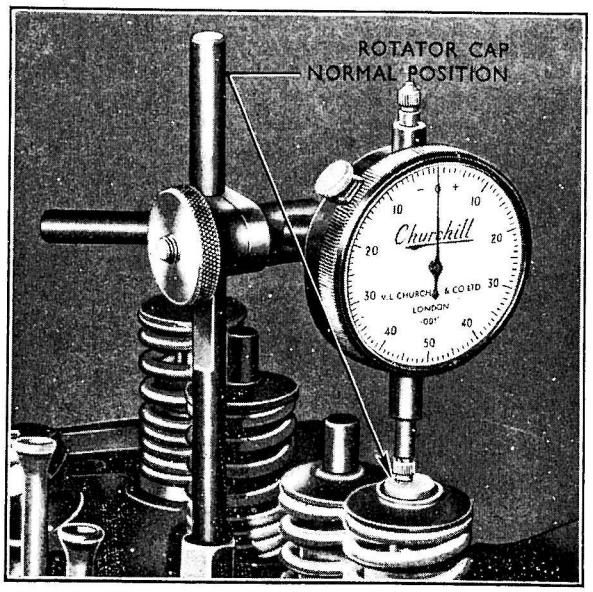

Fig. 13
Rotator Cap in Normal Position

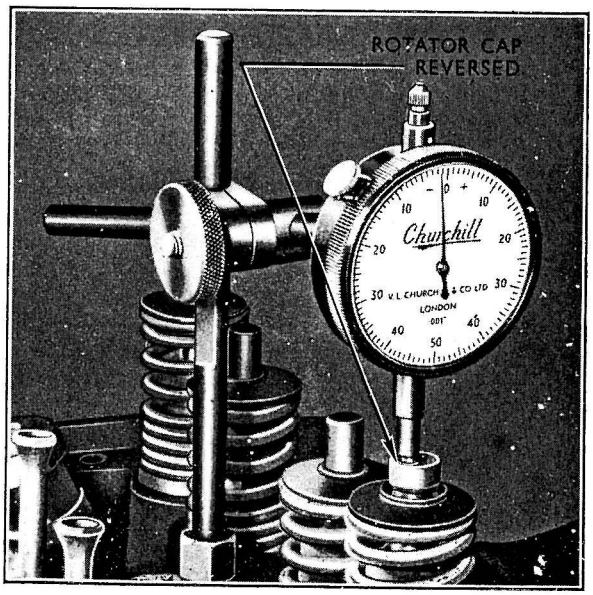

Fig. 14
Rotator Cap in Reversed Position

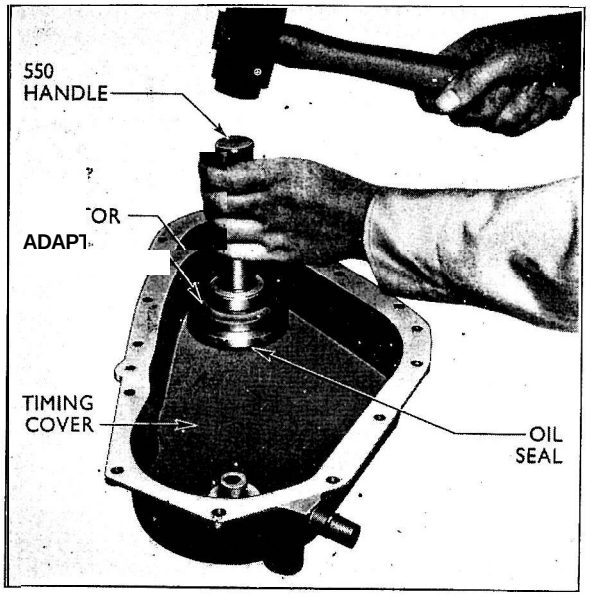

Fig. 15
Fitting Crankshaft Oil Seal in Timing Cover

9. Remove the crankshaft ratchet nut and washer, using the special spanner, Tool No. CT.6071.

10. With the screws of the extractor, Tool No. CT.6070, located in the three tapped holes in the crankshaft pulley boss, tighten the centre screw of the tool and draw the pulley from the crankshaft.

Pulleys fitted to early Mk. I tractors incorporated two puller holes, the same tool is however suitable for either pulley.

11. Remove the oil bath air breather (where fitted) from the front timing cover.

NOTE.—Mk. I engines used a closed circuit breathing system but on Mk. 11 and III engines an open circuit breathing system is used with an air breather mounted on the front timing cover. With the latter system an oil slinger is fitted to the front of the auxiliary drive shaft gear to prevent oil from being thrown out through the breather.

12. Extract the 14 retaining screws and remove the timing cover from its dowelled location on the front mounting plate.

If the timing cover oil seal requires renewal, use a suitable lever to extract the old seal. Use Tool No. 550 with special adaptor, Tool No. CT.6072, to fit a new seal ensuring that the lip of the seal is towards the inside of the cover (see Fig. 15).

13. Remove the auxiliary drive shaft gear retaining nut and oil slinger (where fitted).

14. Remove the camshaft inner and outer gears.

Two methods of fixing the camshaft inner and outer gears have been used on this engine since its introduction.

From the introduction of this engine in 1952 until Engine No. 1599502 the inner and outer gears were located on the camshaft by a dowel pin and secured by three bolts which were locked by a three-hole locking tab.

After Engine No. 1599502 the gears were located on the camshaft by a key and keyways, the method of securing being a single centre bolt locked by an internal tooth lockwasher.

Camshafts with Three-bolt Fixing

Knock back the tabs of the lockwasher and remove the three bolts holding the camshaft inner and outer gears to the camshaft flange. Remove the inner and outer gears from the camshaft spigot and dowel.

Camshaft with Centre Bolt Fixing

Remove the centre securing bolt, using the special Tool No. CT.6124 to prevent any force passing through the gear teeth.

Carefully remove two gears taking care not to use any heavy shock forces as damage to the thrust flange on the camshaft may occur.

NOTE.—When the timing gears have been removed, do not turn the crankshaft until the camshaft has been withdrawn, otherwise if the camshaft moves, the fuel lift pump drive eccentric on the camshaft may foul No. 4 connecting rod big end and cause damage.

15. Withdraw the auxiliary drive shaft gear from.its location on the auxiliary drive shaft.

16. If necessary, remove the crankshaft gear, using the special remover, Tool No. CPT.6040–B as shown in Fig. 16.

NOTE.—It is not necessary to remove the crankshaft gear in order to remove the engine front mounting plate.

17. Unlock the front mounting plate screw locking tab washers, and remove the retaining screws.

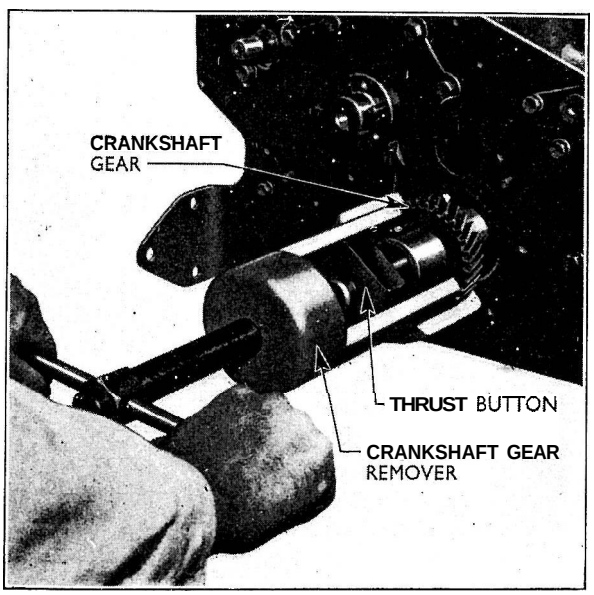

Fig. 16
Removing Crankshaft Gear

mounting plate and gasket from the cylinder block face.

18. Invert the engine, taking care that the camshaft does not drop out, then extract the sump retaining screws and remove the sump and gaskets.

19. Remove the oil pump filter screen, see Fig. 17, straighten the tabs on the suction pipe union locking plate and unscrew the union nut. Remove the suction pipe support bracket screw which is located in the centre main bearing cap, and detach the pipe from the pump.

20. Remove the two screws securing the oil pump to the cylinder block and withdraw the pump.

21. Remove the clamp bolt from the fuel injection pump coupling and tap the coupling rearwards off the shaft.

Three types of coupling will be met in service, i.e. prior to Engine No. 1599502 *where the keyway in the auxiliary drive shaft and coupling was* $\frac{5}{32}$ *in. (3.96 mm.) wide. Effective with Engine No. 1599502 the keyway was increased in width to* $\frac{3}{16}$ *in.* (4.76 *mm.), the clamp slot was moved to an angled position and an Allen screw was used instead of the previous clamp screw and nut.*

Effective with approximate Engine No. 08B746500 the Allen screw was replaced by a pinch bolt and the clamp slot was moved to its original position at right angles to the pinch bolt. Only this type and the original coupling with a $\frac{5}{32}$ *in.* (3.96 *mm.) keyway are now supplied in service.*

22. Remove the woodruff keys from the auxiliary drive shaft and tap the shaft complete with bearings forward out of its location in the cylinder block.

23. Remove the auxiliary drive shaft oil seal by driving it rearwards from its location in the cylinder block.

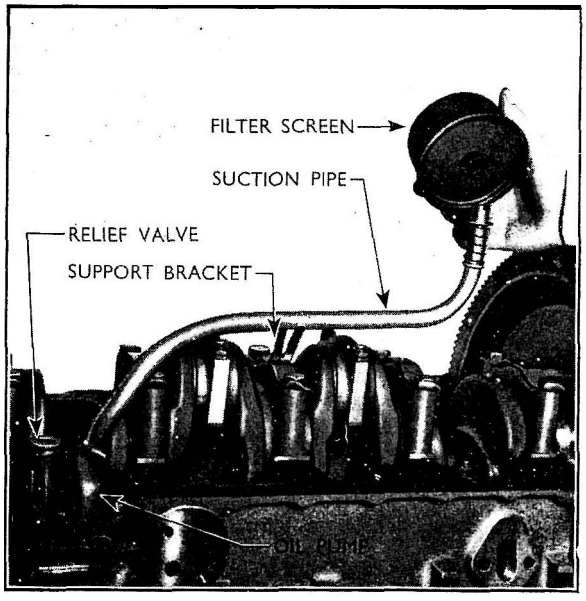

Fig. 17
Removing Sump Oil Filter Screen

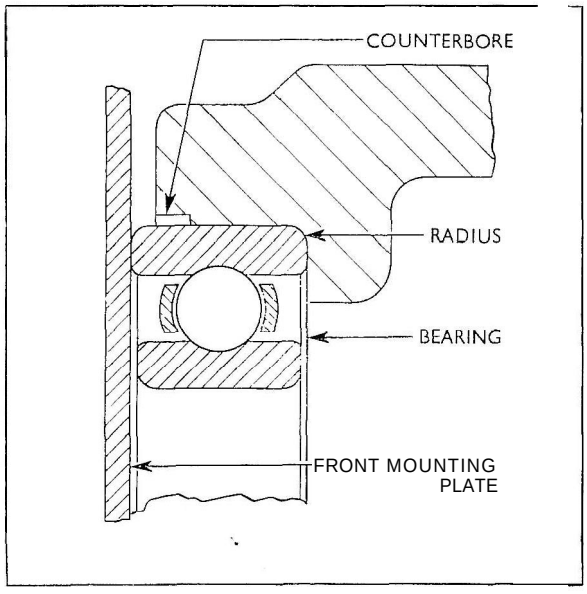

Fig. 18
Auxiliary Drive Shaft Front Bearing Housing

NOTE.—This oil seal may be replaced without removing the shaft by using a suitable lever to remove the old seal and a special protector sleeve, Tool No. CT.6086A, detail e, to ensure that the new seal is replaced undamaged. This tool is used in conjunction with the handle of Tool No. CT.6086 or CT.6086A and the method of use is described in item No. 29 in the section "To Reassemble the Engine."

To Dismantle the Auxiliary Drive Shaft

(a) Clamp the main tool, Tool No. CT.6085, in a vice.

(b) Use the split ring adaptors, Tool No. CT. 6085–3/a, and remove the small bearing.

(c) Use the split ring adaptors and the thrust pad, Tool No. CT.6085–3/d to remove the large bearing.

To Reassemble the Auxiliary Drive Shaft

(a) Place the split ring adaptor, Tool No. CT. 6085–3/a, in position in the main tool with the large bearing positioned in the recess of the ring.

(b) Enter the threaded end of the auxiliary drive shaft into the bearing and press the shaft through the bearing until the shoulder on the shaft abuts the inner face of the bearing.

In order to provide better seating for the bearing slight changes were made to the auxiliary drive shaft front bearing and to the corner radius in the bearing bore. With this change a counterbore was introduced in the front bearing housing in the cylinder block and this may be used as identification of this change, see Fig. 18. A new bearing was introduced with this change and this bearing, carried under Part No. E80–CP–9, *should nor be fitted to cylinder blocks which do not have the counterbore. The earlier bearing, Part No. E1ADKN–*66618–A, *is still available and may be used in either cylinder block.*

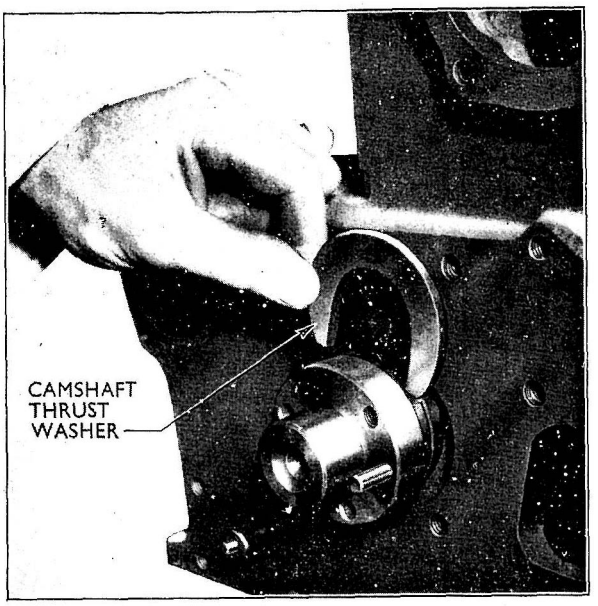

Fig. 19
Previous Camshaft Thrust Washer

(c) Place adaptor, Tool No. CT.6085–3/b, within the split ring adaptor, Tool No. CT.6085–3/a, and position the small bearing in the recess of the ring.

(d) Reverse the auxiliary drive shaft and enter the plain end of the shaft into the bearing.

(e) Using the thrust pad press the shaft through the bearing until the bearing abuts the shoulder on the shaft.

24. Pull the camshaft forward from its location in the cylinder block.

Tractors prior to Engine No. 1599502 have a thrust washer jitted behind the flange on the camshaft and this should be removed. (See Fig. 19.) Completely remove the camshaft.

25. Remove the tappets from their bores in the cylinder block and retain them in their correct sequence.

26. Rotate the crankshaft so that the piston to be removed is at bottom dead centre.

27. Remove the two self-locking nuts from the connecting rod bolts, and remove the bearing cap and bearing liners.

28. Push the piston and connecting rod out through the cylinder bore, and assemble the cap and bearing liners to the rod to retain them in their correct position and order.

29. Repeat on remaining pistons and connecring rod assemblies.

30. Remove the piston rings by using two or three lengths of feeler strip inserted between the rings and the pistons. Slide the rings over the feeler strip and off the pistons.

31. If it is required to replace the piston pins, remove the end circlips from the pistons and push out the pins. This operation may be facilitated by first immersing the piston in boiling water.

32. Straighten the locking tabs, unscrew the flywheel retaining screws and remove the flywheel. The flywheel is located on two dowels in the crankshaft flange and removal may be facilitated by using two puller bolts screwed into the tapped holes provided in the flywheel.

33. Remove the clutch pilot bearing from the flywheel using Tool No. 7600 and adaptor No. CPT.7600–3. Fit the new pilot bearing into position, using clutch pilot bearing replacer, Tool No. CPT. 7061 and 550 handle.

In service two different types of clutch pilot bearings will be encountered; a sintered bronze type and a sealed ball race type, both types can be removed and replaced using the method described above.

It should be noted however, that once a sintered bronze bearing has been removed from a flywheel it should be discarded, under no circumstances should any attempt be made to re-use it for further service. The sealed ball race bearing may be used again providing that it has suffered no damage in being removed. Before fitting the ball race bearing always ensure that it is packed with clean, new, high melting point grease.

34. To remove the flywheel ring gear, remove the six countersunk screws securing the gear to the flywheel, and tap the gear off its register (see Fig. 20).

35. Mark the main bearing caps so that they may be replaced in their original positions. Straighten the main bearing cap screw locking tabs, remove the main bearing cap screws, and remove the caps together with the lower halves of the bearing liners and thrust washers.

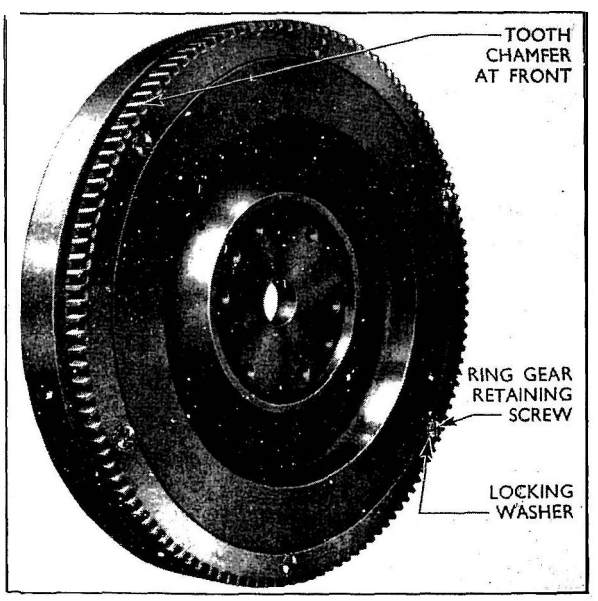

Fig. 20
Flywheel Ring Gear Retaining Screws

36. Carefully lift the crankshaft clear of the cylinder block, taking care to ensure that the upper halves of the bearing liners do not adhere to the crankshaft.

37. Remove the upper halves of the bearing liners—unless they are to be renewed they should be kept with their respective caps. Under no circumstances should the caps be interchanged as the main bearings are line bored in production with the caps in their correct locations.

38. Remove the upper half of the rear main bearing oil seal, then if necessary, extract the three dowel screws and remove the oil seal housing. Normally the latter should not require removal.

39. Revolve the cylinder block on the stand to bring the cylinder block face upwards, remove the temporary screws and washers fitted to retain the cylinder liners in position and withdraw the liners, using special Tool No. CT.6075. If the original liners are to be refitted, they should be numbered and marked for angular position to ensure that they are replaced in their original positions.

NOTE.—There is no necessity to disturb the liners if a cylinder head gasket only is being changed, providing that there is a genuine protrusion of not less than 0.001 in. (0.025 mm.) at any point and that the current type gasket is fitted in the approved manner. (See remarks after Operation 46 of Reassembly Instructions.)

40. Remove the liner sealing rings from their recesses in the cylinder block.

TO REASSEMBLE THE ENGINE

Considerable changes have been made to some of the components since this engine was first introduced and because of these changes problems arise in servicing due to non-interchangeability of some of these parts.

In order to explain the interchangeability position most easily it has been found necessary to refer to various part numbers in the following reassembly instructions.

It should be noted however, that the part numbers quoted are given for guidance only and are correct at the time of going to print. Before ordering replacement parts for any particular tractor engine reference should be made to an up-to-date copy of the Spare Parts List to ensure that parts ordered are in line with current practice at the time when the repair is undertaken.

1. Thoroughly clean and inspect the parts.

Threaded sealing plugs are fitted to the cylinder block at each end of the main oil gallery, and these can be removed so that the oil gallery can be thoroughly cleaned out.

Check the cylinder block top face for flatness and remove any local high spots or burrs by light draw-filing. Check the cylinder liner seats and the liner seal grooves in the block to ensure that they are undamaged and free from dirt or foreign matter. Where cylinder head gasket locating dowels are fitted to the top face of the cylinder block, ensure that they are undamaged, and replace if necessary.

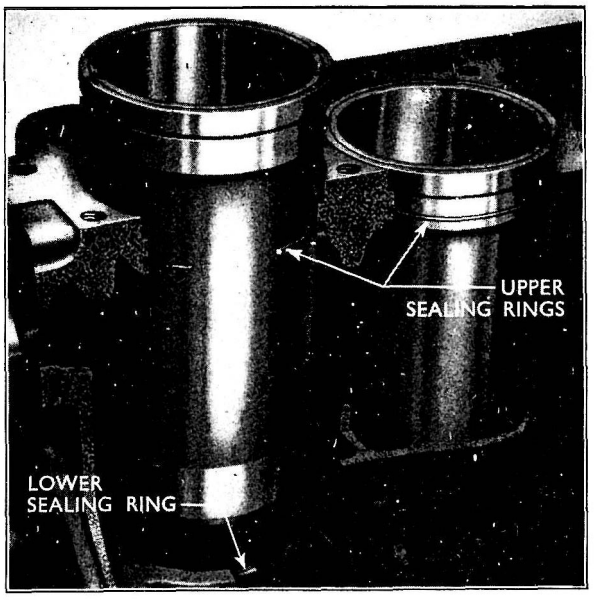

Fig. 21
Current Cylinder Liners and Seals

When reassembling, all normal fitting instructions regarding cleanliness and lubrication of parts should be strictly adhered to.

2. Fit a cylinder liner in position in the cylinder block without any sealing rings in position and retain it in position with bolts and washers spaced equidistant around the liner flange and tighten the bolts to a torque of 20 lb./ft. (2.764 kg.m.) (see Fig. 43). Place the gauge, Tool No. CT.6120, so that the feet rest on diametrically opposite points on the liner flange. Use feeler blades as illustrated in Fig. 48 to measure the gap between the feet of the gauge and the top surface of the cylinder block.

Make a check between each pair of clamping screws that the liner protrusion above the face of the block is within the specified limit of 0.002 to 0.004 in. (0.05 to 0.10 mm.).

If these figures cannot be obtained, loosen the clamping screws and rotate the liner through a series of short arcs re-tightening the screws and checking to establish the best protrusion position for the liner.

On engznes built with cylinder liners having only a lower sealing ring, shims are available for placzng under the flange of the liner to obtain the necessary protrusion. Not more than two of these shims should be used on any one cylinder liner.

Shims cannot be fitted to engines fitted with cylinder liners designed to have an upper and lower sealing ring.

This also applies to some interim engines which were built with the new type liner but which did not have the groove for the upper sealing ring machined in the cylinder block. As a means of identification any cvlinder block which has $\frac{9}{16}$ in. dia. (14.29 mm.) main hearing bolts cannot be fitted with cylinder liner shims.

3. Mark the liner and block to ensure that the same

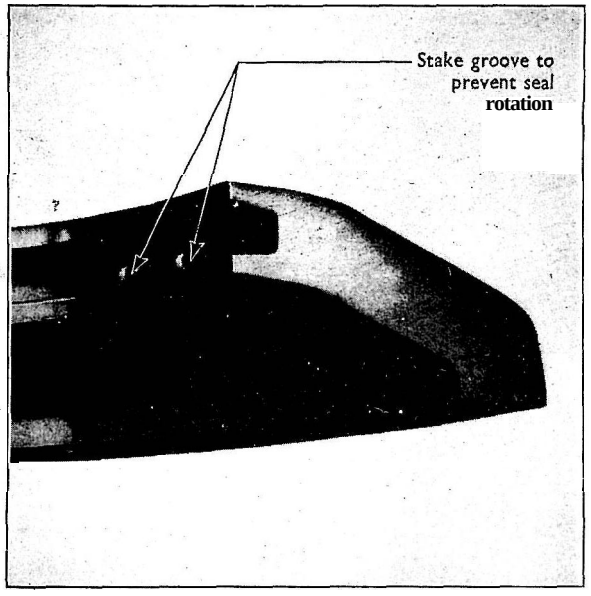

Fig. 22
Crankshaft Rear Oil Seal Retainer Groove Staking

relative position is maintained on final assembly then remove the liner and repeat the protrusion checks on the remaining liners.

Before finally fitting the single sealing ring type liner lightly apply a small quantity of Wellworthy Wellseal, or approved equivalent, under the liner flange, also each side of any shim which is being used. Only a thin film of sealer should be applied and care must be taken that the sealer does not enter the cylinder bores, the water passages or the rubber sealing ring location at the lower end of the liner.

The improvements made to liner sealing by the introduction of the upper sealing ring now means that it is not necessary to apply sealer to the flange of liners fitted with two sealing rings.

4. Select a new set of sealing rings, lubricate them with soft soap and fit them into their recesses in the cylinder block.

The lower sealing ring fitted to liners having upper and lower sealing is very similar to the sealing ring used on single seal liners but they are **not** *interchangeable. To assist identification, the lower sealing ring for the two seal liners is marked with a white paint spot on its surface.*

Replace the cylinder liners and press them into position, ensuring they are fitted in the same bore and in the same angular position as when checked. Retain each pair of liners with screws and washers as before to prevent movement during subsequent assembly operations.

5. Invert the engine on the stand. If the crankshaft rear oil seal packing requires renewal only the current, graphite coated, packing should be used. Whereas the previous packing required soaking in oil, this is not necessary with the current part, the running surface of the packing of the seal should however be lightly oiled.

The current type seal should be trimmed to give a protrusion of 0.015 to 0.025 in. (0.38 to 0.64 mm.)

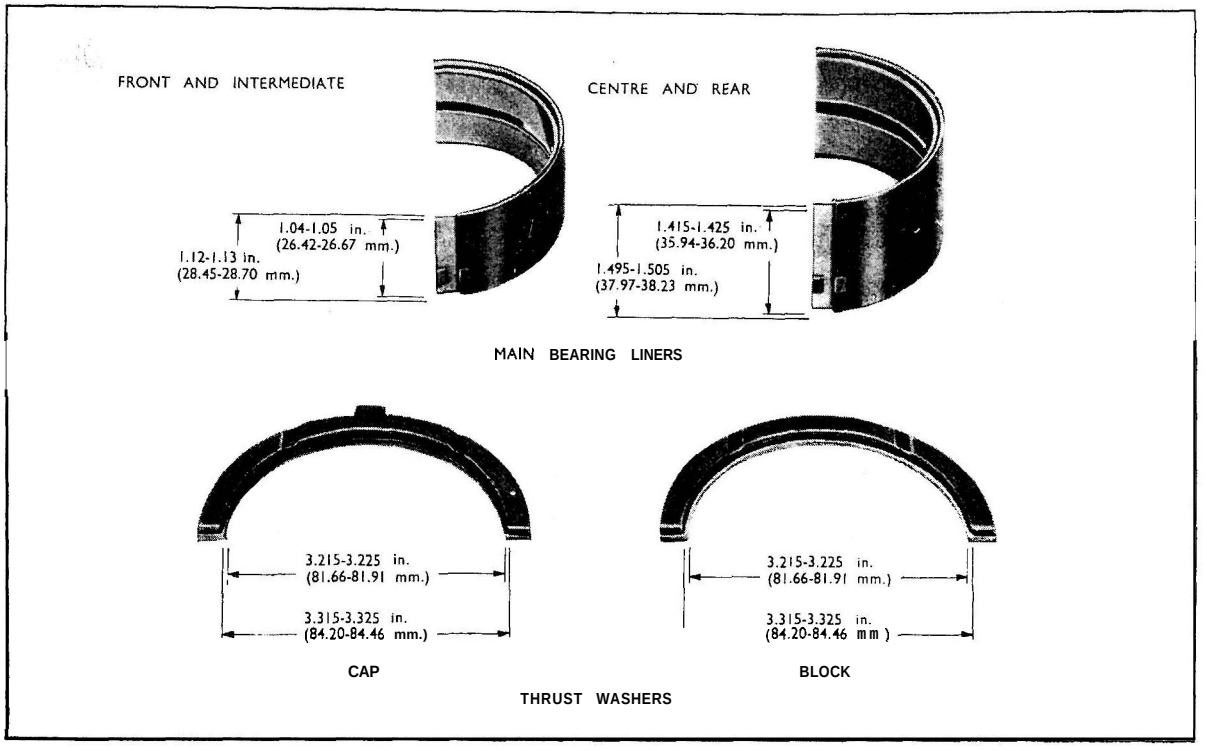

Fig. 23
Main Bearing Liners and Thrust Washers

after fitting. If the oil retainer is not staked at either end as shown in Fig. 22, this operation should be carried out with a suitable punch prior to fitting the packing.

6. Before fitting new bearing liners to the engine the following notes should be studied to ensure that the correct parts are used.

For convenience the instructions to be followed when fitting replacement main bearing caps in service are also given.

Effective with Engine No. 1483140 crankshafts fitted to Power Major engines were modified by increasing the fillet radius between the crankshaft webs and the journals. Providing the correct bearing liners are used, this crankshaft may be fitted to engines built prior to Engine No. 1483140 and there was therefore no change in part number.

To accommodate the change to the crankshaft the overall width of the connecting rod and main bearing liners was reduced by 0.080 in. (1.93 mm.) and the internal diameter of the crankshaft thrust washers increased by 0.1 in. (2.54 mm.).

Normally, where a previous type crankshaft is fitted the original (wide) liners and smaller diameter thrust washers should be used for replacement purposes but these should not be used with the current type crankshaft. To obviate the fitting of incorrect liners and thrust washers it is advisable therefore to note the width of the liners removed and use liners of similar width and corresponding thrust washers as replacements.

If, however, any doubt exists as to the type of crankshaft fitted, or when installing a new crankshaft, only the current (narrow width) liners and large internal diameter thrust washers should be used.

Fig. 23 indicates the dimensional differences between the current and previous type liners and thrust washers. The part number is stamped on the outer surface of the current type liner, but unless this number carries a E1ADDN prefix it should not be used as means of identification between current and previous type parts, as a quantity of current type liners were at one time marked with the part number of the previous type liners. Where the stamped number carried a E1ADKN prefix, identification can only be established by measurement of the width.

To facilitate the use of reground crankshafts a series of 0.010 in. 10.254 mm.), 0.020 in. (0.508 mm.), 0.030 in. (0.762 mm.) and 0.040 in. (1.016 mm.) undersize internal diameter liners are available. Similar considerations apply in respect of wide and narrow liners as with the standard ones.

In addition a similar series of main bearing liners ranging from standard to 0.040 in. (1.016 mm.) undersize internal diameter but 0.015 in. (0.381 mm.) oversize on the outside diameter are available for use with replacement bearing caps.

In service three different types of main bearing liners will be encountered. These three types of liner must be used in pairs, i.e. the top and bottom halves of any one bearing must be of the same type.

Each type of liner has the manufacturers mark, i.e. the letters V.P. entwined and enclosed in a circle indicate one type, the letter G enclosed in a square indicate the second type, and the third type will have the letters AL stamped in the back together with the letter G enclosed in a square. Under no circumstances should the third type of liner described above be intermixed with liners having only the letter G marked upon them i.e., when fitting the third type of liner described, both upper and lower shells should be marked with the letters AL as well as the letter G. Undersize internal diameter and oversize external diameters where applicable were previously marked on the outside diameter. Current production parts however, have only the Part No. and manufacturers identification and where identification of the size is required reference should be made to the Parts List.

It sometimes happens that where a liner fails in service the markings are obliterated and therefore the following points should be noted :—

(*a*) A cylinder block with oversize outside diameter liners may be generally recognised by the marking " O/S " on the sump face of the block. It is possible, however, for new caps to be fitted in service and the block and cap assembly to be bored out to 0.015 in. (0.381 mm.) oversize without the marking being placed on the block.

If any doubt exists, the bore of the cap and block should be physically measured—standard bore size is 3.167 in. (80.435 mm.).

(*b*) The necessity to fit undersize internal diameter liners may be established when the original liner markings are not discernible by measuring the crankshaft journals—size for standard liners is 3.0002 to 3.0010 ins. (76.205 to 76.225 mm.).

There are also two types of crankshaft thrust washers which may be met in service, one type with the letters VP entwined and enclosed in a square and the other type marked with letter *G* enclosed in a square. As with the main bearing liners the thrust washers must also be used in pairs.

In addition to standard thickness thrust washers a series of 0.0025 in. (0.063 mm.), 0.005 in. (0.127 mm.), 0.0075 in. (0.190 mm.), 0.010 in. (0.254 mm.), 0.015 in. (0.381 mm.) and 0.020 in. (0.508 mm.) oversize thickness washers are available for service.

Main Bearing Caps for Service

Semi-finished main bearing caps suitable for line boring 0.015 in. (0.38 mm.) oversize, also bearing liners and thrust washers to be used with these caps, are available for service.

Finishing Operations—Main Bearing Caps and Blocks

When replacing one or more main bearing caps it is essential to line bore the block 0.015 in. (0.38 mm.) oversize, with all caps assembled, to 3.1815 to 3.1820 ins. (80.81 to 80.82 mm.) diameter. If any attempt is made to bore only one new cap, misalignment and crankshaft failure could occur. If the centre bearing cap is replaced, the recess in the block and cap thrust faces must be machined to produce a continuous

bearing surface within the limiting dimensions shown below and illustrated in Fig. 24. Before line boring and machining the thrust faces, mount and secure the cap on the block so that one of its thrust faces is in line with the corresponding face on the block within 0.005 in. (0.13 mm.).

The recesses should be machined square with the centre line of the bearing bore within 0.002 in. (0.05 mm.) total indicator reading and the recess bore concentric with the bearing bore within 0.006 in. (0.15 mm.) total indicator reading. An equal amount should be machined from each face to give an overall distance between thrust faces of 1.589 ins. to 1.591 ins. (40.36 to 40.41 mm.). File back the slots in the cap, which locate the tabs on the thrust washers, to enable the washers to seat on the thrust faces of the cap.

Thrust Washers

Oversize crankshaft upper and lower thrust washers are available in 0.010 in. (0.25 mm.), 0.015 in. (0.38 mm.) and 0.020 in. (0.51 mm.) oversize thicknesses to suit the machining detailed above.

NOTE.—Main bearing caps are line bored in production and caps from one engine should not be interchanged with those from another engine.

7. Fit the crankshaft thrust washer upper halves on either side of the centre main bearing web in the cylinder block, with the oilways in the washers facing outwards.

8. Install the crankshaft in the cylinder block.

9. Fit the lower halves of the bearing liners to the caps and install the caps in their correct locations in the cylinder block.

No. 2 and No. 4 (intermediate) caps are identical and care must therefore be taken to replace them in their correct locations. For identification a single number or letter is stamped on No. 2 cap and block location and a double letter or number on No. 4 cap and block location.

Nos. 2, 3, 4 and 5 caps are marked with the word " Rear " and this should face the rear of the engine when assembled. The front cap must be fitted with the machined face to the front of the engine and this face must be lined up with the front face of the block otherwise oil leakage may occur across the front mounting plate gasket.

Effective from Engine No. 1425097, *the oil return holes in the front main bearing cap were reduced from* $\frac{5}{8}$ *in.* (15.88 *mm.) to* $\frac{5}{16}$ *in.* (7.94 *mm.), these caps should only be used on engines fitted with the current type oil pump, i.e. where the oil pressure relief valve is incorporated in the pump cover.*

At approximate Engine No. 1591023 *the main bearing cap bolts were increased in diameter from* $\frac{1}{2}$ *in. (12.7 mm.) to* $\frac{9}{16}$ *in.* (14.29 *mm.) at the same time new bolt locking tabs were introduced for use with the larger diameter bolts.*

Semi-jnished main bearing caps for use with the larger diameter bolts are .available for service when jtting replacement caps to the latest cylinder block, these caps should not be fitted to engines having the smaller diameter bolts.

A special front main bearing cap is also available for

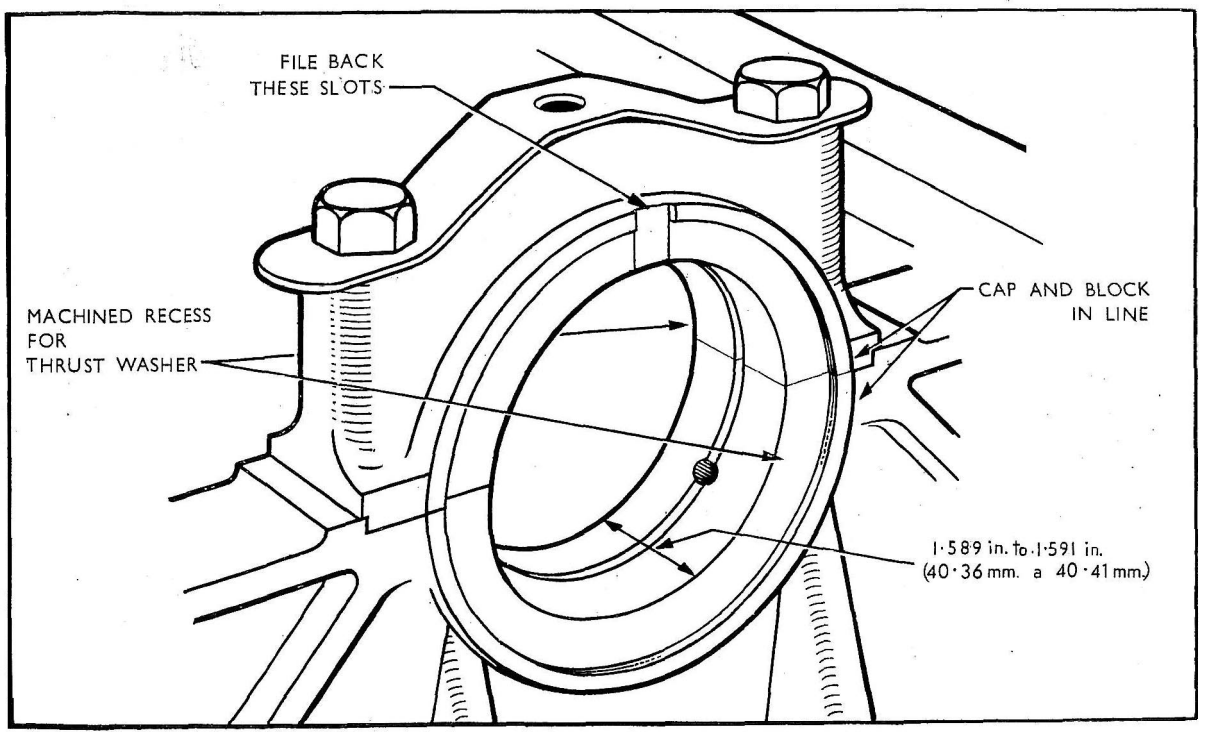

Fig. 24
Centre Main Bearing

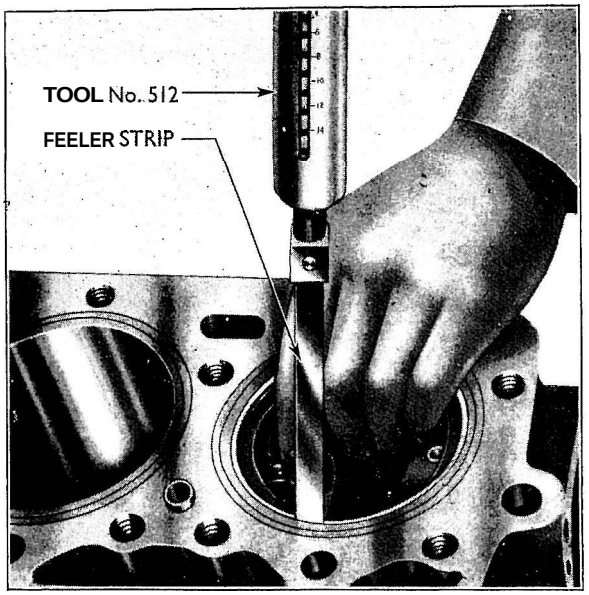

Fig. 25
Checking Piston Fit in Bore

use on engines which have been fitted in service with cylinder blocks having the larger diameter bolt holes and which have the oil pump pressure relief valve fitted in the front mounting plate. These caps can be easily identified as the oil return holes are $\frac{5}{8}$ in. (15.88 mm.) diameter as opposed to the $\frac{5}{16}$ in. (7.94 mm.) diameter holes in the other latest type caps.

10. Fit new locking plates to the main bearing bolts and tighten them to a torque of *70* to 75 lb. ft. *(9.674* to *10.365* kg.m.).

11:' Check that the crankshaft is free to rotate, and that the end-float is between *0.002* and *0.010* in. *(0.051* and *0.254* mm.) measured between the thrust washers on the centre main bearing and the crankshaft, use the oversize washers available to obtain this end-float if necessary. When the end-float is correct and the main bearing bolts have been tightened to the correct torque, bend up the tabs on the locking plates to secure the bolts.

12. Fit the flywheel ring gear to the flywheel with the chamfered edge of the teeth facing towards the front of the flywheel (see Fig. *20).*

Replace the chamfered retaining screws and lock-washers, and tighten the screws evenly and securely.

13. Install the flywheel on the crankshaft flange, having first ensured that the flange is clean and free from burrs. The flywheel can only be fitted in one position on the two different diameter locating dowels. Fit new tab washers to the flywheel securing screws and tighten the screws evenly to the correct torque of *80* to *90* lb. ft. *(11.056* to *12.438* kg.m.).

NOTE.—A special flywheel is required when a double clutch is fitted.

Check the flywheel run-out which should not exceed *0.005* in. *(0.127* mm.) maximum total indicated reading on either the periphery or the clutch driving face. Bend up the tab washers to secure the screws.

14. Reverse the engine on the engine stand, and, if new pistons are being fitted, select the piston to suit the bore by using the poundage pull gauge, Tool No. 512, with a feeler strip 9 ins. *(228.6* mm.) in length, *0.004* in. *(0.102* mm.) thick and *0.5* in. *(12.7* mm.) wide (see Fig. *25).*

The piston should be positioned in the bore with the valve recesses on the head of the piston away from the camshaft side of the engine and the feeler strip between the piston and the cylinder bore on the cam-shaft side. The pull required to remove the feeler strip should be between *2* and 4 lbs. *(0.91* to *1.81* kg.) with the piston fully inserted in the bore.

When selecting replacement pistons for any engine careful note should also be made of the following information and the instructions regarding cylinder liners and cylinder head gaskets given after item No. *47* of this section.

Prior to Engine No. 1425097 the combustion chamber was centrally positioned in the piston crown and the piston pin bore was approximately 1.25 ins. (31.8 mm.) diameter. Subsequent to this engine number a new piston was introduced on which the combustion chamber was placed offset to the centre of piston crown, the piston height (pin to crown, dimension 'X' Fig. 26) was decreased by approximately 0.012 in. (0.305 mm.) to suit a crimped steel cylinder head gasket and the pin bore diameter was increased to approximately 1.375 ins. (34.9 mm.) to suit an increased diameter piston pin which was introduced at this time.

Pistons with 1.375 ins. (34.9 mm.) piston pin bores must not be used on engines prior to Engine No. 142097 (i.e. with the original copper asbestos cylinder head gasket). In service the crimped steel gasket should no longer be used. To determine which type of gasket to use see notes after item number 47 of this section. A special piston, having the off-set combustion chamber but with the original piston height and 1.25 ins. (31.8 mm.) diameter piston pin bore is now serviced to replace the original pistons on engines prior to Engine No. 1425097. (See Figs. 26 and 27.)

Effective with Engine No. 1516654 a further piston was introduced with the piston pin to crown height (dimension 'X' Fig. 26). 0.010 in. (0.25 mm.) higher than that of the piston originally used with the crimped steel cylinder head gasket. An improved type of copper/asbestos/permanite cylinder head gasket was also introduced at this time.

The latest piston should not be used with the crimped steel cylinder head gasket nor on engines fitted with a decompressor if the cylinder block or cylinder head has been refaced.

It is not, however, essential to change the pistons when fitting the latest type copper/asbestos/permanite or thick composition cylinder head gasket as a replacement for a crimped steel type gasket.

Piston usage may be summarised as shown in Figs. 26 and 27.

15. Before fitting the piston rings to the pistons, check the ring gaps by inserting each ring in turn in

the particular bcre to which it is to be fitted, make the check at the lower end of the ring travel in the bore.. Adjust the gap if necessary to between 0.011 and 0.016 in. (0.28 and 0.406 mm.).

16. Check the ring to groove clearance in the piston which should be between 0.002 and 0.004 in. (0.051 and 0.102 mm,), then assemble the rings to the pistons. The top compression ring is marked " H & T TOP " denoting it is hardened and tempered, this marking must face towards the top of the piston when assembled.

The second and third compression rings are tapered and marked " TOP " on one face, and must be fitted this way up in the piston ring groove.

The oil control rings are interchangeable and reversible,

17. Check the connecting rods for alignment on the connecting rod aligning jig, Tool No. 335, using the multi-purpose arbor Tool No. 336, and adaptor as follows :—

Bolt the connecting rod, minus bearing liners, to the arbor adaptor and mount the checking gauge on the piston pin. The connecting rod can be checked for bend or twist by positioning the gauge so that either the vertical or horizontal gauge pins are adjacent to the vertical surface plate.

With the gauge in the horizontal position, clearance at either of the two pins indicates a twisted rod, and in the vertical position clearance indicates a bent rod. When checking, ensure that the piston pin is a good fit in the small end bush.

NOTE.— The following changes have been made to piston pins: Prior to Engine No. 1362380 the piston pin was hollow and of approximately 1.25 ins. (31.75 *mm.) diameter.*

Between Engine No. 1362380 and 1425097, *the pin was made solid but the diameter was unchanged.*

Subsequent to Engine No. 1425097 *a hollow pin was again introduced and the diameter was increased to approximately* 1.375 *ins. (34.9 mm.).*

The solid pin should be used (in sets of four) when fitted as replacement for original hollow type on any engine prior to Engine No. 1425097.

18. To ensure the'correct assembly of the piston to connecting rod, fit the piston so that the recesses for the valve head in the piston crown are on the same side as the machined slots in the big end bore (for the locating tongue of the bearing liner).

With the small end of the connecting rod positioned between the piston pin bosses, press the piston pin into position and retain with end circlips. Assembly may be facilitated by warming the piston in boiling water.

Position the piston ring gaps equally around the pistons, ensuring that no gaps are in line with the piston pin bore.

19. The changes made to the crankshaft described earlier in this section which became effective with Engine No. 1483140 *also effects the choice of connecting rod liners when rebuilding an engine.*

Where the earlier type crankshaft is fitted the wide earlier type connecting rod liners (see Fig. 28) *should be*

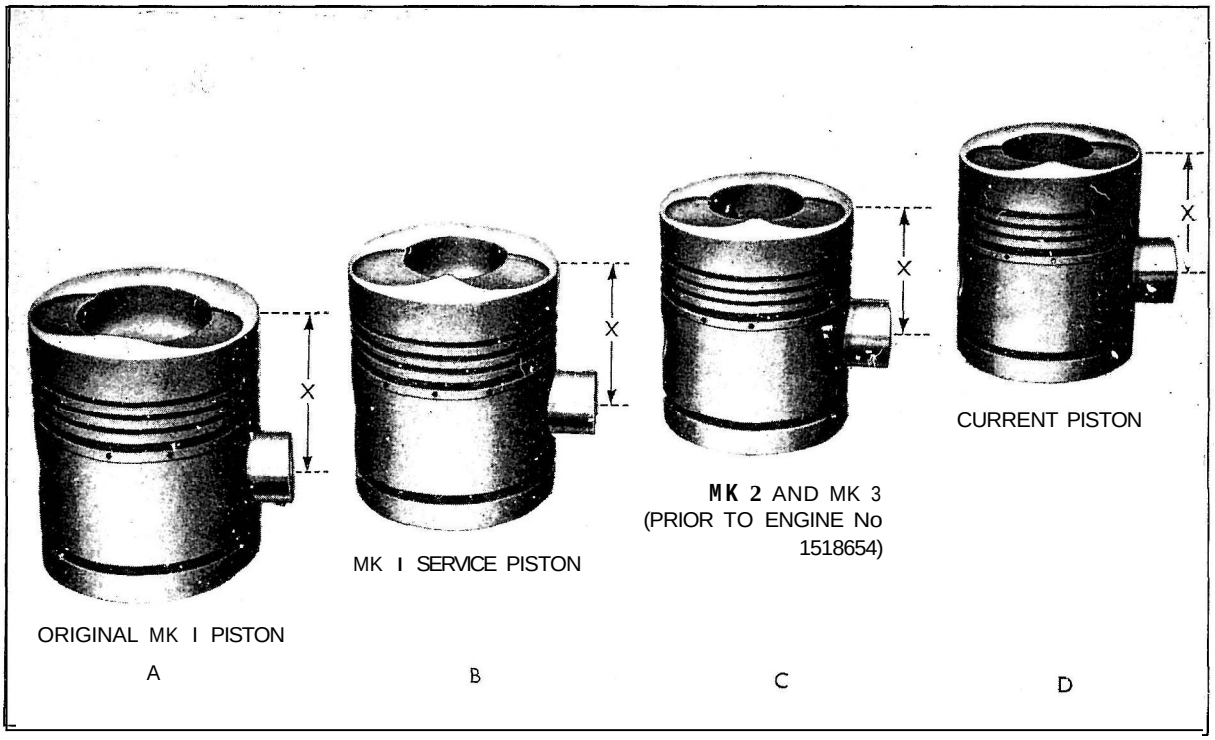

Fig. 26
Piston Identification

used, the wide type liners should not, however, be used with the latest type crankshaft. To avoid the fitting of incorrect liners it is advisable to check the width of liners removed and use liners of similar width for replacement.

If, however, any doubt exists as to which type of liner should be used the current, narrow, liners should be fitted.

As with the main bearing liners there are also three different types of connecting rod liner which may be met in service. These liners can be identified by the same method as used for the main bearing liners and should also only be used in pairs.

20. Replace the piston and connecting rod assemblies in their correct bores with the arrow and the word "FRONT" on the piston crown towards the front of the engine. (In some instances the word FRONT is omitted, being replaced by an arrow head only.)

21. With the corresponding crankpin on the crankshaft at bottom dead centre, insert the pistons from the top of the block, use the piston ring compressing tool, Tool No. CT.6024, to compress the rings (see Fig. 29) and press the piston down the bore through the compressor until the connecting rod big end and liner registers above the crankpin.

22. Ensure that the upper bearing liner and connecting rod bolts are located correctly, then fit the appropriate cap and lower bearing liner to the rod with the mating marks together. Fit new self-locking nuts and tighten to a torque of 55 to 60 lb. ft. (7.601 to 8.292 kg.m.).

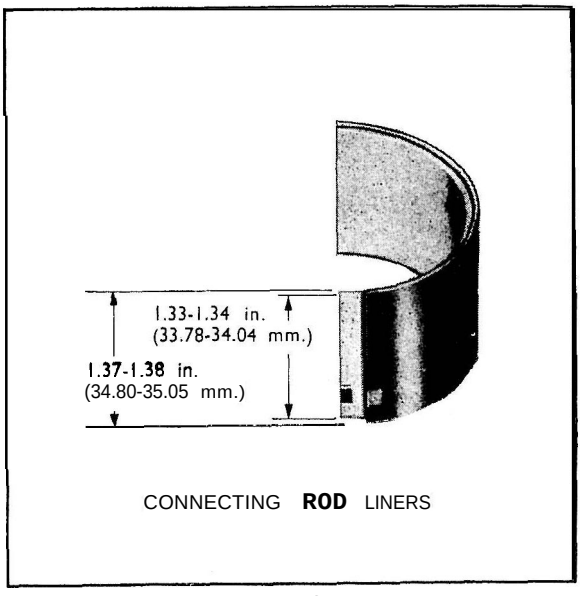

Fig. 28
Connecting Rod Liners

Piston Reference Fig. 26	*Identification*	*Piston Pin Hole Diameter*	*Height, Piston Pin to Piston Crown Dimension 'X' Fig. 26*	*Piston Usage*
A.	Centrally positioned combustion chamber.	1.25 ins. (31.8 mm.)	2.795–2.797 ins. (70.997–71.048 mm.)	No longer serviced.
B.	Offset combustion chamber, and diameter of piston pin hole.	1.25 ins. (31.8 mm.)	2.795–2.797 ins. (70.997–71.048 mm.)	Use in sets of 4 with solid piston pins when replacing original pistons having central combustion chamber, i.e. Type A.
C.	Offset combustion chamber; piston pin height, and piston pin hole diameter. Also Standard—Part No. E1ADDN-6110–E cast inside skirt. 0.0025 in. O/S—Letter F stamped on top of piston.	1.375 ins. (34.9 mm.)	2.783–2.785 ins. (70.686–70.737 mm.)	Use only for individual piston replacement or on any engine after 1425097 which is fitted with a decompressor and on which 0.010 in. (0.254 mm.) has been removed from the top face of the block.
D.	Offset combustion chamber; piston pin height, and piston pin hole diameter. Also: Standard—Letter L stamped on top of piston. 0.0025 in. O/S—Letter M stamped on top of piston.	1.375 ins. (34.9 mm.)	2.793–2.795 ins. (70.946–70.997 mm.)	Use on current production engines with either the latest type copper/asbestos/permanite or thick composition type cylinder head gasket.

Fig. 27
Piston Usage Chart

Fig. 29
Piston Ring Compressor

NOTE:

Three types of connecting rod bolts may be encountered in service. One of these types is a special "waisted" bolt which was specifically introduced for use on connecting rods where the bolt hole in the big end bearing had broken through into the bearing bore. This bolt should only be used for this application.

The other two bolts are of the usual type of connecting rod bolt and for their application these may be identified by their overall length, i.e. 2.87 ins. (72.9 mm.) on engines prior to Engine No. 1509598 and 2.99 ins. (75.9 mm.) on engines subsequent to this number (the engine number quoted is approximate as the change was gradually brought into production).

Nuts for use with the shorter bolt should have a thickness of 0.462 in. (11.7 mm.) and a width across flats of 0.618 in. (15.7 mm.), whereas those for use with the longer bolt have a thickness of 0.530 in. (13.5 mm.) and a width across flats of 0.684 in. (17.3 mm.).

It is permissible to use the longer bolt with connecting rods originally fitted with a shorter type bolt but essential that when so doing the smaller nut only is used as the spot-face on the cap will not allow the larger type to seat correctly.

The shorter bolt must not be used where the connecting rod was originally fitted with the larger bolt.

23. After all the connecting rods and pistons have been fitted, check that the engine is free to rotate and the end-float in the connecting rod big ends is from *0.003* to *0.009* in. *(0.076* to *0.229* [illegible].

24. Fit the tappets into their bores in the cylinder block, ensuring that if the original tappets are to be used they are replaced in their original positions. Ensure that they are all pushed right home in their housings.

NOTE.—Effective from Engine No. 1358273 chilled cast tappets were fitted. These may be identified by the thickness of the tappet foot (approximately 1½ times greater than the previous type) and the fact that the radius between foot and stem is rough cast whereas the original type were machined at this location (see Fig. 30). Only the current type parts should be used as replacements and when fitting to engines prior to Engine No. 1358273 it is advisable to check that in the position of maximum lift the foot of the tappet does not foul the cylinder block.

***At** the same time chilling of the cams on the camshaft*

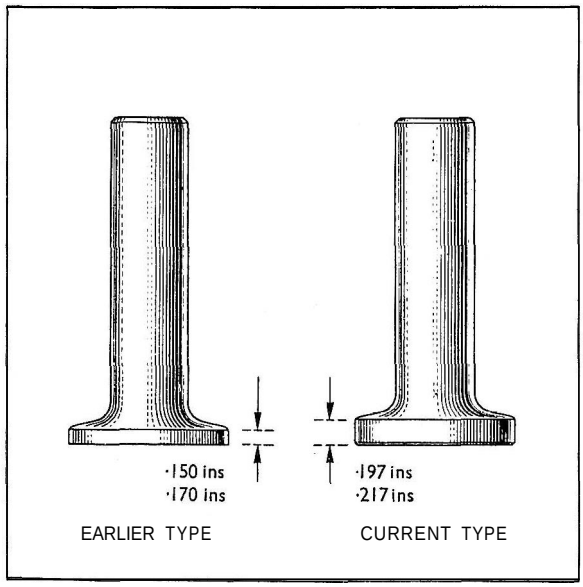

Fig. **30**
Tappet Identification

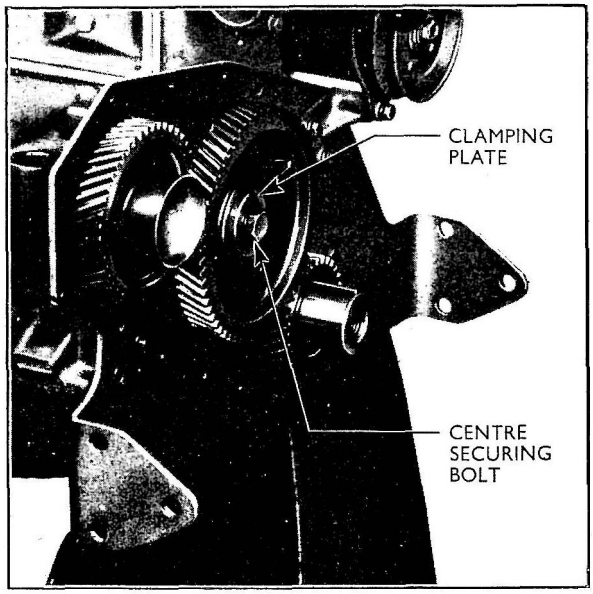

Fig. 31
Current Timing Gears

was introduced. Under no circumstances should these camshafts be used with nor,-chilled tappets.

25. Before fitting the camshaft special note should be made of the following information.

Effective with Engine No. *1599502* a new camshaft was introduced with a single centre bolt to retain the camshaft gears in position (see Figs. *31* and 33), at the same time the camshaft thrust washer was deleted, the thrust being taken on a machined face on the front mounting plate (see Fig. 32). Changes were made at the same time to the timing gears, the auxiliary drive shaft, the fuel injection pump coupling, the front mounting plate gasket and the auxiliary drive shaft oil slinger, these changes are described later in this section.

Instructions follow for fitting procedures tc be followed when fitting either camshaft in service together with any relevant information with regard to interchangeability of the parts involved.

26. Refitting camshafts having dowel pin location for timing gears.

Before fitting this camshaft a check should be made that the camshaft thrust washer protrusion forward of the front face of the cylinder block is between the specified limits of 0.002 *to* 0.005 *in.* (0.05 *to* 0.13 *mm.), see* ***Fig.*** 35. *This may be checked by placing the thrust washer in the recess in the block, without the camshaft, and by means of a straight edge across its front face, measuring the protrusion with suitable feeler gauges.*

If the protrusion is less than that specified, one or more steel shims, available through service, in thickness of 0.003 *and* 0.005 *in.* (0.07 *and* 0.13 *mm.) may be placed behind the thrust washer.*

NOTE.—Prior to Engine No. 1445056 *the camshaft thrust washer consisted of two semi-circular sections; between this engine number and Engine No.* 1511488 *a horseshoe-shaped washer with rounded ends to the jaws was used, after which a redesigned horseshoe type (identified by flat ends to the jaws) (see Fig. 34) was introduced. The current horseshoe-type washer can be used with any camshaft, but the previous types although interchangeable may need easing out on the inside diameter and on the internal edges in order to seat them fully into the groove in the current type camshaft.*

Having checked the protrusion and established which, if any, shims are required, turn the crankshaft until No. 1 *piston is at top dead centre and enter the camshaft into its location in the cylinder block, taking care not to damage the cams or journals. The crankshaft must not be moved from this position until all the timing gears have been refitted, otherwise the fuel lift pump drive eccentric may foul No. 4 connecting rod.*

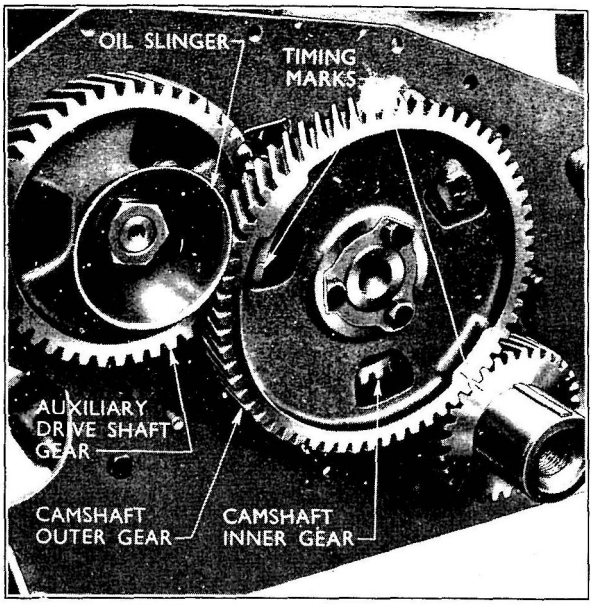

Fig. *33*
Previous Timing Gears

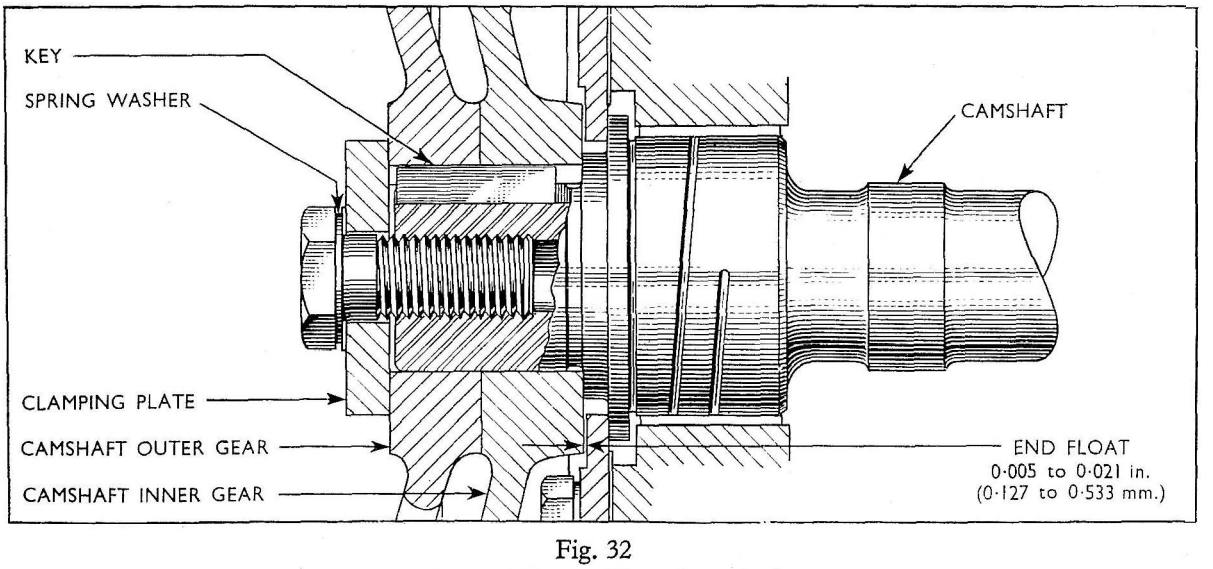

Fig. 32
Current Method of Controlling Camshaft End-float

NOTE.—On early type camshafts the dowel pin was 1.18 ins. (29.97 mm.) long, however, with later camshafts of this type the dowel pin was increased to 1.36 ins. (34.54 mm.) long but the protrusion forward of the front face of the camshaft remained at 0.75 in. (19 mm.)— the locating hole in the camshaft being deepened accordingly.

For service two new camshafts have been introduced, E1ADDN-6251-C for Mk. I and Mk. III engines and 528E-6251-C for Mk. II models. These have the new cam form but retain the three bolt fixing for the timing gears and may therefore be used with either the original narrow width timing gears, if fit for further service, or with the special service gears. These gears are of the increased width but have the three bolt fixing for use with this type of camshaft. (See appropriate section.)

Where a new camshaft is to be installed in an engine in which white metal camshaft liners have been fitted it is important that the phosphate coating on the camshaft journals is removed by lapping prior to installation.

Fit the camshaft thrust washer in position before the camshaft is fully entered, taking care to locate the dowel on the thrust washer with its corresponding hole in the recess at the front of the cylinder block.

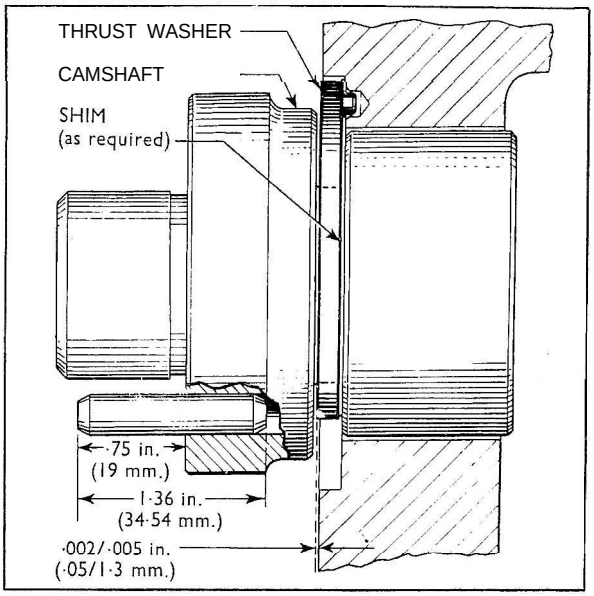

Fig. 35
Previous Camshaft Thrust Washer Protrusion

27. **Fitting Camshafts which have Centre Bolt Fixing for the Timing Gears.**

Because of the changed method of fixing the timing gears (Effective with Engine No. 1599502) changes were made to the front end of the camshaft.

Between Engine Nos. 1599502 and 1609839 the cam form profile of the new camshaft was the same as previously used and in order to identify these camshafts the letters O.F. (meaning Old Form of Cam Profile) were stamped on the front end of the camshaft adjacent to the bolt hole. However, it should be noted that a small quantity of these camshafts were marked with the words " Old Form " 'stamped on the rear end of the camshaft.

This type of camshaft, i.e. with the new centre bolt fixing for the gears and having the earlier type of cam profile ; was never made available in service.

Effective with Engine No. 1609839 a new cam profile was introduced for the camshaft. With this camshaft a new heavier type of valve spring was introduced together with new spring retainers and exhaust valve spacers. These parts which are not individually interchangeable with the previous parts should only be used in conjunction with camshafts having the latest cam profile.

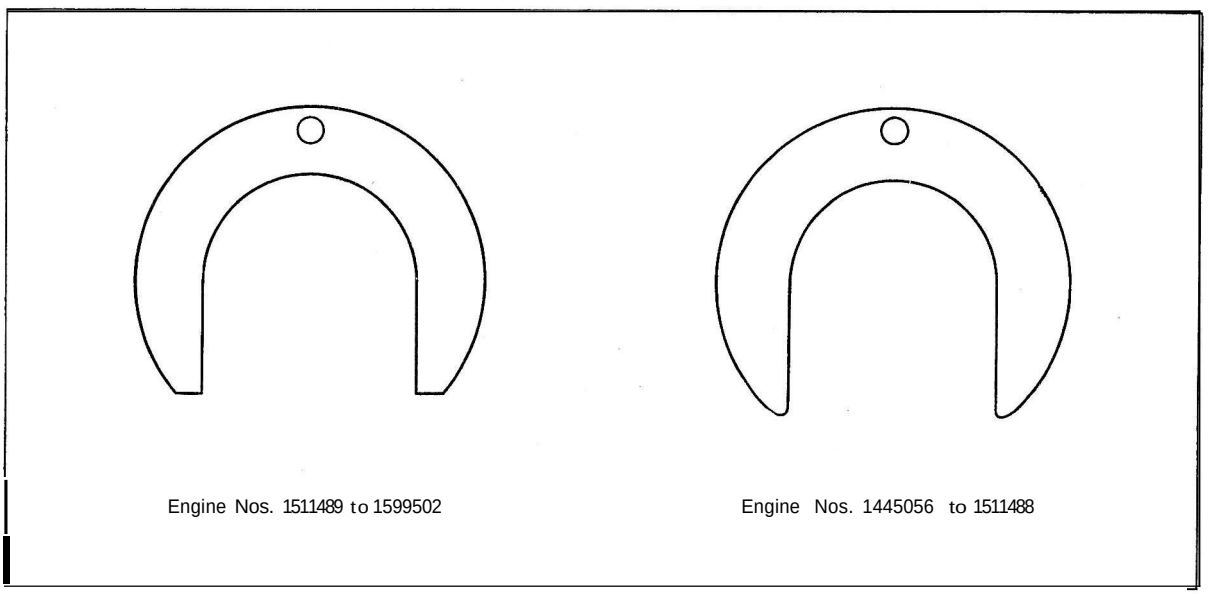

Fig. **34**
Comparison of Camshaft Thrust Washers

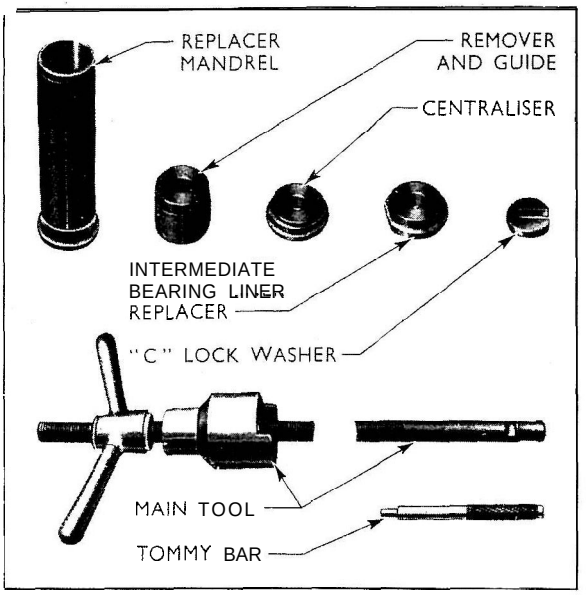

Fig. 36
Camshaft Bearing Liner Remover and Replacer Tool

FITTING CAMSHAFT BEARING LINERS

Normally, pre-sized bearing liners may be fitted only to engines on which the camshaft bearings are already bushed. Pre-sized bearing liners may, however, be fitted to unbushed bearings providing the bearings are first line bored to 2.188 to 2.189 ins. (55.57 to 55.60 mm.) diameter.

The introduction of pre-sized camshaft bearing liners necessitated the development of a special tool for the removal and replacement of these liners and Tool No. CT.6119 and adaptor CT.6119–1 are now available for this purpose (see Fig. 36). Note the white lines marked on the replacer mandrel and on the remover and guide.

It is essential that extreme care should be exercised when fitting pre-sized bearing liners as even slight damage to any part could render them useless for service. It follows, therefore, that the adaptors CT.6119–1 must also be handled with care as any burrs or scores will almost certainly damage the liners during assembly.

To Remove Camshaft Bearing Liners

The centraliser shown in Fig. 37 although not essential, will be found useful when removing the liners from Nos. 2, 3 and 4 bearings.

1. Insert the small diameter of the remover and guide in the rear of the front bearing liner. Pass the centre screw of the main tool through the remover and guide and fit the 'C' washer to the end of the centre screw. Place the tommy bar in the hole at the end of the centre screw and pull the bearing from its location in the cylinder block by turning the wing nut of the main tool.

2. Repeat this procedure for No. 2 and 3 bearing liners. Nos. 4 and 5 bearing liners are removed in a similar manner, but are pulled out towards the rear of the cylinder block after removing the welch plug from No. 5 bearing.

To Replace Camshaft Bearing Liners

(See Figs. 38 and 39)

1. Scrap all worn or damaged camshaft bearing liners and thoroughly clean the bearing bores, ensuring

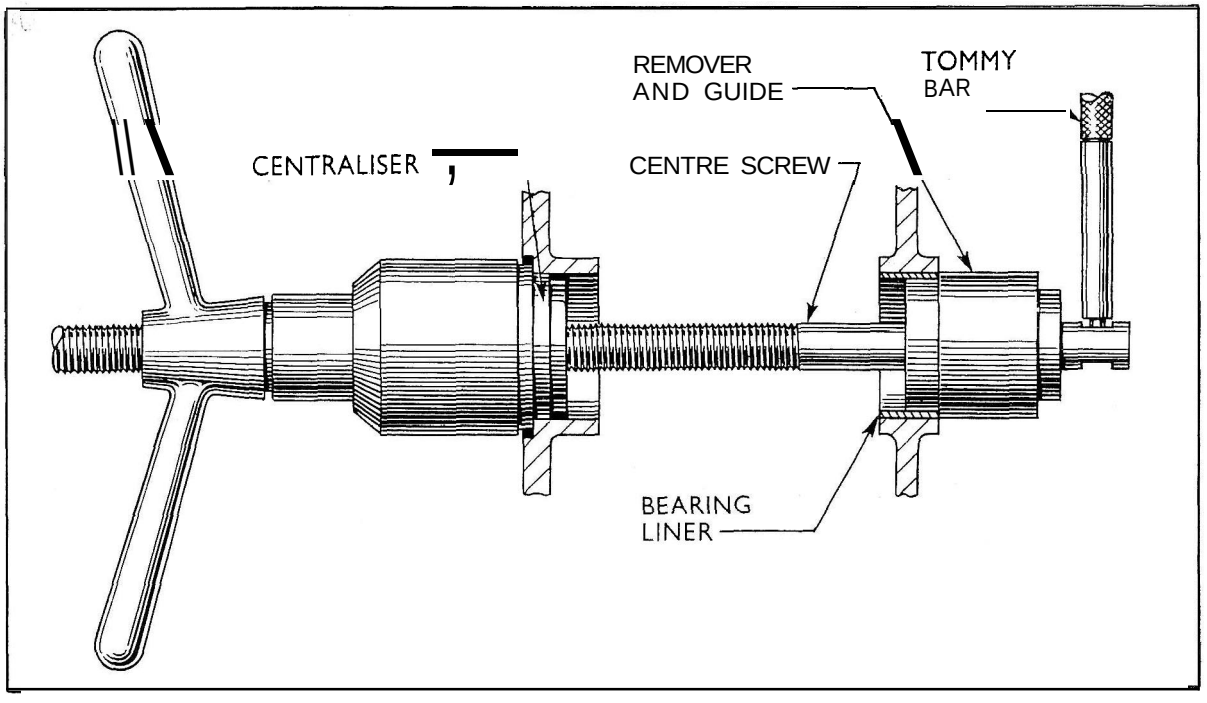

Fig. 37
Removing Camshaft Liners

also that the oil passages leading to and from the camshaft bearings are free from obstruction.

2. Remove the protective wax coating from the new bearing liners by washing with petrol, and lightly coat with oil on the outer surface.

3. Insert the larger diameter of the remover and guide in No. 2 bearing with the small diameter towards the rear of the cylinder block. Place the centraliser in No. 1 bearing with the larger diameter to the outside. Locate the new bearing liner on the smaller diameter of the remover and guide and insert the smaller diameter of the intermediate bearing liner replacer into the liner, ensuring that the flat face of this adaptor is adjacent to the outer wall of the cylinder block. Insert the centre screw of the main tool and fit the 'C' washer.

4. It is essential that the oil holes in the bearing liners and the bearings should coincide, particular attention should therefore be paid to the positioning of the liner before it is drawn into the bearing.

Adjust the position of the liner so that the white line on the remover and guide coincides with the centre line of the oil hole in the liner. Turn the liner, remover and guide until the white line registers with the centre line of the oil drilling between the crankshaft and camshaft bearings. This condition may be checked only after the crankshaft has been removed.

5. When the liner is correctly positioned, fit the tommy bar and draw the liner into position by means of the wing nut of the main tool.

6. Repeat this operation for Nos. 3 and 4 bearing liners. No. 4 liner should be drawn into position with the tool being operated from the rear of the cylinder block.

7. No attempt should be made to fit liners to Nos. 1 and 5 bearings using the method described in paragraph 3. The following procedure is applicable to Nos. 1 and 5 bearings only.

Place a new liner on the replacer mandrel so that it contacts the smaller shoulder and insert the mandrel in No. 5 bearing. Pass the centre screw of the main tool through the mandrel and Nos. 4 and 3 bearings. Insert the intermediate bearing liner replacer in the front of No. 3 bearing so that the centre screw passes through this adaptor. Ensure that the flat face of the adaptor is adjacent to the outer wall of the cylinder block. Fit the 'C' washer and tommy bar to the centre screw.

After ensuring that the oil holes in the bearing liner and the bearing are in line, press the liner into its correct position

8. Repeat this operation for No. 1 bearing liner. Note that No. 1 bearing liner is different from the other liners in that it is wider and has a small cut out portion on the front edge which, after fitting, must line up with the oil-way on the front face of No. 1 bearing.

The alignment of oil holes should be checked after each new lining is fitted.

To test for alignment, insert a $\frac{3}{16}$ in. (4.76 mm.) diameter pin in the drilling between the crankshaft and camshaft bearings. If a pin of this diameter passes through both the drilling and the oil hole in the liner, the position of the liner may be considered to be correct.

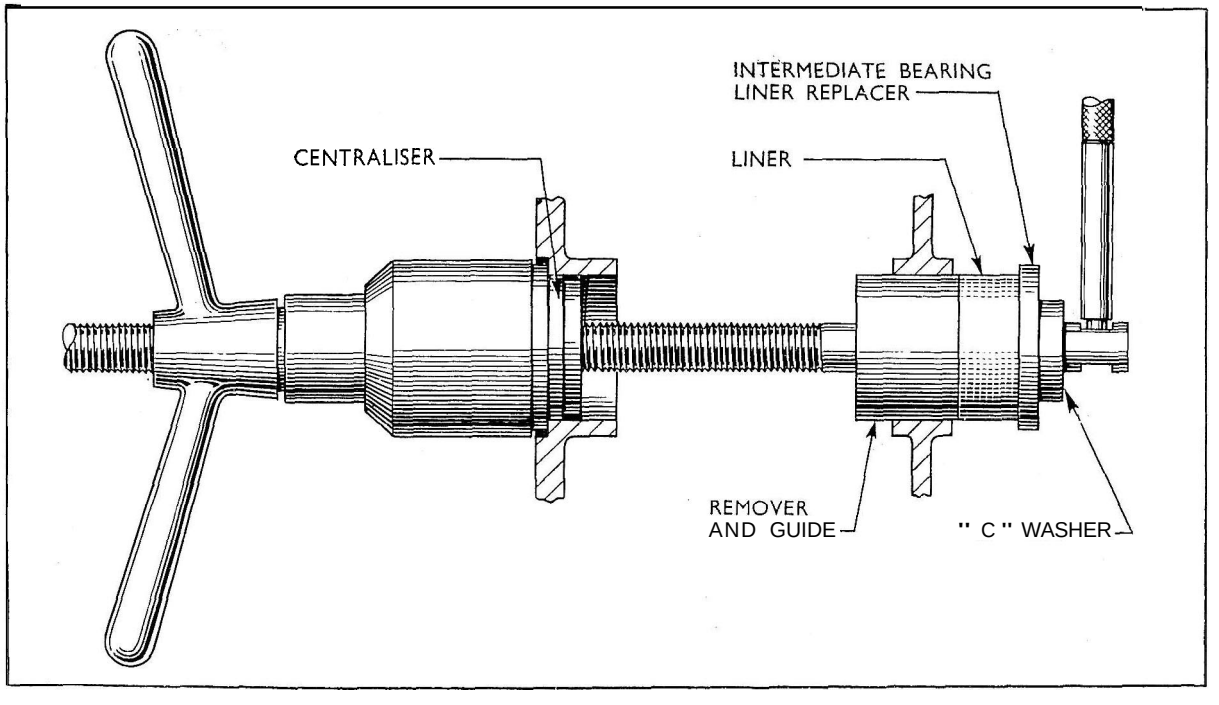

Fig. 38
Replacing Intermediate Bearing Liners

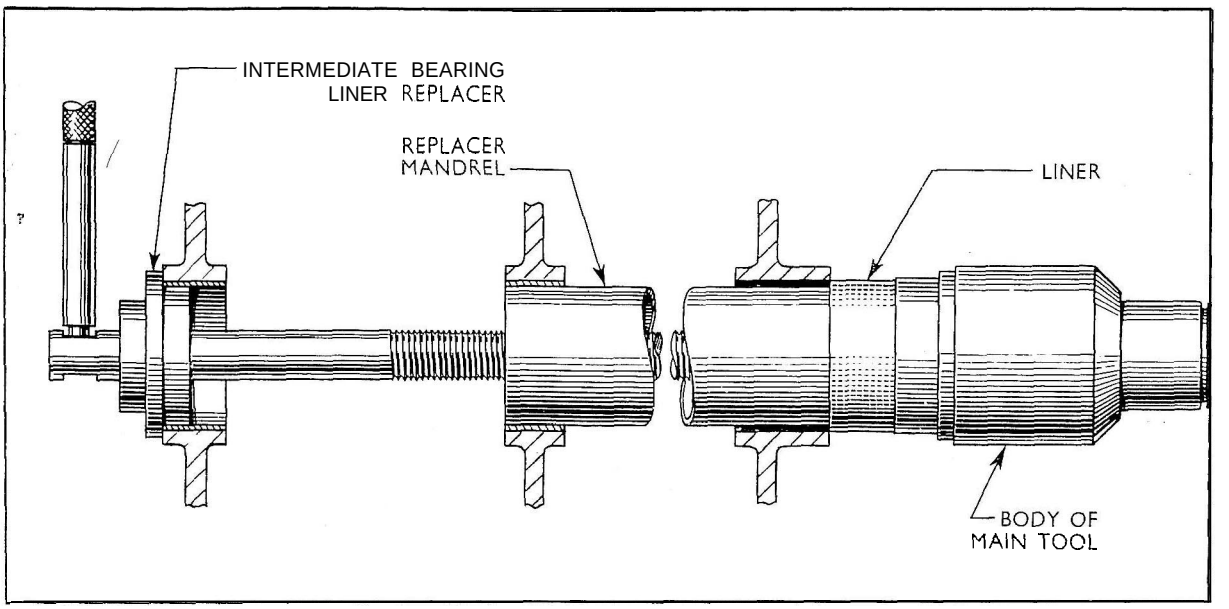

Fig. 39
Replacing Rear Bearing Liner

Particular attention should be paid to the alignment of oil holes in Nos. 3 and 4 bearings which also provide an oil feed to the rocker shaft and, if fitted, the exhauster.

Where a new camshaft is to be installed in an engine to which white metal bearing liners have been fitted it is important that the phosphate coating on the camshaft journals is removed by lapping prior to installation.

To Reassemble the Engine *(continued)*

28. Install the auxiliary drive shaft assembly into its location in the cylinder block, making the assembly from the front end of the block and pressing it into position so that the front bearing seats on the step in the bore.

Refer to the reassembly procedure for the auxiliary drive shaft to ensurc that the correct type of front bearing is being used.

With the changes to the engine timing gears and camshafts, improvements in the asscmbly of the driven gear and injection pump coupling to the auxiliary drive shaft were made.

These changes consisted of a reduction in diameter at the driven gear and injection pump coupling locations on the shaft, also deeper and wider keyways and larger driving keys at each end of the shaft. Because of the larger keyway at the injection pump coupling end of the new shaft, the tapped hole at this point was deleted.

When replacing the auxiliary drive shaft make note of the following information with regard to interchangeability of the parts.

Prior to Engine No. 1599502

Use auxiliay drive shaft assembly E69–CP–9 or E96–CP–9 together with oil pump drive gear E1ADDN-6652, unless the engine camshaft has been changed for one with single bolt gear fixing in which case auxiliary drive shaft assembly E68–CP–9 must be used together with the other parts required when replacing an earlier type camshaft with a camshaft of the latest type.

After Engine No. 1599502

Fit an auxiliary drive shaft assembly of the same type as originally fitted, Part No. E68–CP–9, or an E94–CP–5 assembly.

Engines with Mechanical Governors (Minimec)

Use E92–CP–5 auxiliary drive shaft assembly.

29. Fit a new oil seal to the auxiliary drive shaft rear bearing bore, with the lip towards the front. Use a seal protecting sleeve Tool No. CT.6086A (detail e) to prevent the seal being damaged when passing over the shaft. **Remove** the protecting sleeve from the shaft **before** gently driving the oil seal into position, using seal replacer Tool No. CT.6086 or CT.6086A.

30. Fit a new gasket to the front face of the cylinder block and replace the front mounting plate on its two dowels.

Where a single bolt fixing camshaft is fitted, gasket Part No. E105–CN–9 should be used. For three bolt fixing shafts, gasket Part No. E28–CN–9 should be used. It is essential that the correct type of gasket is used relative to the camshaft fitted.

NOTE.—Prior to fitting the latest type front mounting plate to the front of the engine the camshaft thrust face should be lubricated with engine oil.

In conjunction with the latest type front mounting plate, new high tensile steel bolts, together with new bolt locking plates are being used for retaining the front mounting plate, the front cover plate and the

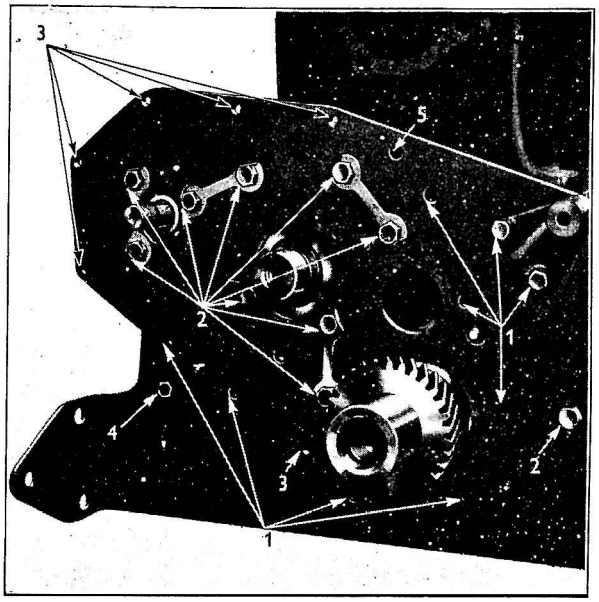

Fig. 40
Front Mounting Plate Bolt Locations

Fig. 40 Ref.	*Length*	*Diameter*	*Thread*	*Tightening Torque*
1	1⅛ in. (28.58 mm.)	5/16 in. (7.9 mm.)	18 UNC 2A	15–17 lb. ft. (2.07–2.35 kg.m.)
2	9 in. (19 mm.)	⅜ in. (9.5 mm.)	16 UNC 2A	22–24 lb. ft. (3.04–3.32 kg.m.)
3	Q in. (19 mm.)	5/16 in. (7.9 mm.)	24 UNF 2A	15–17 lb. ft. (2.07–2.35 kg.m.)
4	Q in. (19 mm.)	5/16 in. (7.9 mm.)	18 UNC 2A	15–17 lb. ft. (2.07–2.35 kg.m.)
5	1½ in. (38.1 mm.)	5/16 in. (7.9 mm.)	18 UNC 2A	15–17 lb. ft. (2.07–2.35 kg.m.)

generator mounting bracket. Fig. 40 shows a current type assembly and the table beside this illustration shows the usage of the various bolts together with the torque which must be applied when tightening.

It should be noted that for service on tractors prior to Engine No. 1425097 where the special service type front mounting plate, EIADDN–6030–B, is fitted, the bolts marked "2" in Fig. 40 are replaced by special shouldered bolts. These special bolts are necessary as the holes in the front mounting plate are the current size to suit ⅜ in. (9.53 mm.) bolts whereas the tapped holes in the cylinder block of an engine prior to No. 1425097 will be 5/16 in. (7.94 mm.) diameter.

Only the current type high tensile steel bolts should be fitted at the mounting plate, front cover plate and generator mounting bracket locations during servicing

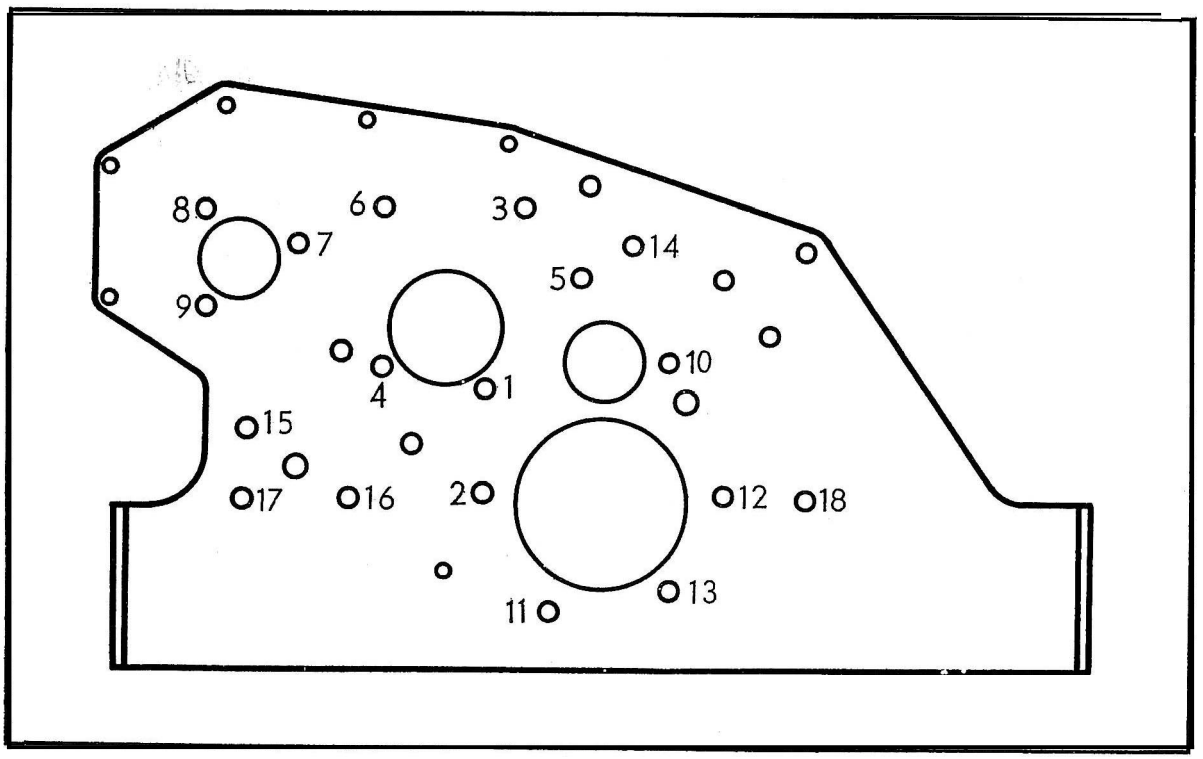

Fig. 41
Front Mounting Plate Bolt Tightening Sequence

operations on any tractor engine. Tightening should be carried out in the sequence shown in Fig. 41. Care should also be taken to ensure that after assembly the bolt locking plates do not foul any of the timing gears or extend over the recessed thrust face of the camshaft inner gear. Fitting instructions are given below for replacing a front mounting plate for any diesel engine built since 1952.

Prior to Engine No. 1425097

When the original camshaft is still fitted, use front mounting plate EIADKN–6030–C.

If the current type single screw gear fixing camshaft is being fitted, use the special service type mounting plate, Part No. EIADDN–6030–B, together with the special shouldered bolts, at locations marked "2" Fig. 40. Tighten these bolts to a torque of 15 to 17 lb. ft. (2.07 to 2.35 kg.m.).

Early type Mk. I cylinder blocks did not have a tapped hole at the location marked "4" in Fig. 40 and under these circumstances it will be necessary to drill and tap a hole at this point to suit a $\frac{5}{16}$ in.—18–NC–2 bolt, using a current type front mounting plate gasket to locate the position of the hole. The hole should be $\frac{7}{8}$ in. (22.23 mm.) deep and should have a thread depth of not less than $\frac{5}{8}$ in. (15.88 mm.).

Between Engine Nos. 1425097 and 1599502

Fit front mounting plate Part No. EIADKN–6030–D, unless the camshaft has been changed to one of the current type, in which case fit the current type mounting plate EIADDN–6030–A. Use the current type retaining bolts and tighten them to the torque shown in the table beside Fig. 40.

After Engine No. 1599502

Fit the current type mounting plate Part No. EIADDN–6030–A, using the current type bolts and tighten to the torque shown in the table following Fig. 40.

Tighten all the bolts using the correct sequence as shown in Fig. 41 to the correct torque also bearing in mind the following information. Bolts numbered 1 to 9 must be tightened prior to the assembly of the front cover and those numbered 10 to 18 after the cover is assembled. The sequence for the remaining bolts is not important.

31. If the crankshaft gear has been removed, replace it, using the crankshaft gear replacer Tool No. CT. 6069. Before refitting the crankshaft gear read special notes following item No. 34 regarding the special usage of timing gears.

32. Fit the woodruff key in the front of the auxiliary drive shaft, and replace the auxiliary drive shaft gear, oil slinger (if fitted), lockwasher and retaining nut. Do not tighten the retaining nut fully until all the timing gears have been replaced.

The increased width of the timing gears (described later in this section) resulted in a decrease in the clearance between the camshaft outer gear and the auxiliary drive shaft oil slinger and as a result a new, smaller slinger was introduced. The new slinger is best identified by its largest diameter which is $2\frac{11}{16}$ in. (68.26 mm.) as against $2\frac{7}{8}$ in. (73.03 mm.) for the previous type.

33. Befcre assembling the camshaft inner gear to the camshaft apply engine oil to the recessed thrust face on the front mounting plate on engines fitted with the current type camshaft.

Fit the camshaft inner gear on the camshaft so that the timing mark on the gear lines up with the timing mark on the auxiliary drive shaft gear.

34. Replace the camshaft outer gear on the camshaft so that the timing mark on this gear and the crankshaft gear coincide. Secure the camshaft gears in position. With all the gears in position, tighten the auxiliary drive shaft gear retaining nut.

Increased width timing gears manufactured from an improved material were introduced with the new camshaft (effective with Engine No. 1599502), and the camshaft gears and auxiliary drive shaft gear were re-designed at this time to accommodate the new methods of retention.

The changes to the widths of the gears are as follows :—

Gear	*Previous Width*	*Current Width*
Crankshaft	0.808/0.818 in. (20.52/20.77 mm.)	0.920/0.930 in. (23.37/23.62 mm.)
Camshaft Inner	0.810/0.815 in. (20.57/20.45 mm.)	0.935/0.940 in. (23.75/23.88 mm.)
Camshaft Outer	0.807/0.817 in. (20.5/20.75 mm.)	0.928/0.938 in. (23.57/23.75 mm.)
Auxiliary Drive Shaft	0.810/0.815 in. (20.57/20.7 mm.)	0.925/0.930 in. (23.5/23.62 mm.)

The current type production gears are in no way individually interchangeable with the earlier type narrow gears and the earlier type narrow width gears are no longer available. However, special service arrangements have been made to facilitate servicing engines built prior to Engine No. 1599502.

To Change a Timing Gear on Engines prior to Engine No. 1599502

To obviate the necessity to fit other parts when only a timing gear requires replacement, special three-bolt fixing camshaft gears and a special service type auxiliary drive shaft driven gear are available for service. These gears are manufactured from the latest material and have the current tooth width.

When fitting these gears it should be noted that each gear must befitted with its corresponding mating gear of the same width, i.e. a service type camshaft outer gear EIADDN–6256–B must be fitted in conjunction with a current type crankshaft gear EIADDN–6306–A or EIADDN–6306–B, depending on which crankshaft, either EIADDN–6303–E or EIADDN–6303–F respectively is fitted and the latest type auxiliary drive

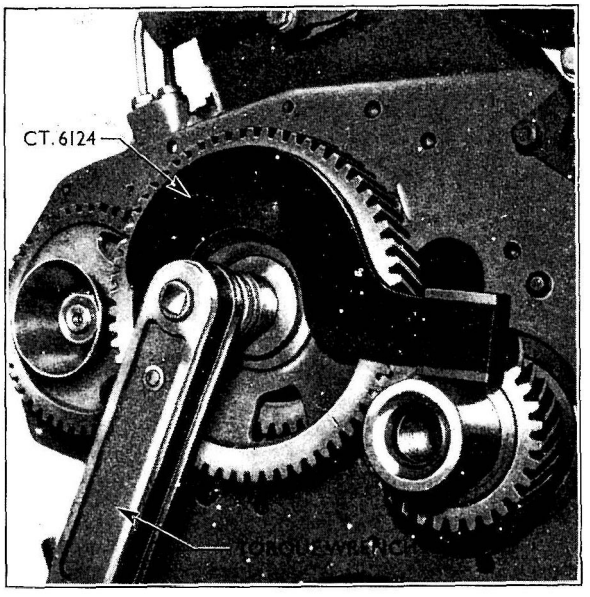

Fig. 42
Tightening Camshaft Centre Bolt

shaft oil slinger must also befitted (see note after item 32 of this section), similarly, a service type camshaft gear E83–CP–9 must be fitted in conjunction with a service type auxiliary drive shaft driven gear E84–CP–9.

A revised method of retaining the service type camshaft gears must be adopted and special parts are available for this purpose. Retaining bolts, 118844–ESB, must be used and the special hardened plate, E1ADDN–6258, without locking tabs, fitted between the camshaft and the bolt heads instead of the previous unhardened locking plate. The retaining bolts should be tightened to a torque of 18 to 21 lb. ft. (2.49 to 2.90 kg.m.) and the heads of the bolts wire locked after tightening.

To Change a Timing Gear on Engines Built after Engine No. 1599502

Fit another gear of the same type as originally fitted. When making the assembly, tighten the centre securing bolt for the camshaft gears to a torque of 95 to 100 lb. ft. (13.13 to 13.82 kg.m.). This torque must **not** be relayed through the gear teeth and therefore the special holding Tool No. CT.6124 is available to take the torque reaction whilst the bolt is being tightened or loosened (see Fig. 42).

35. Fit a new timing cover gasket, and replace the timing cover on the two dowels in the engine mounting plate. Secure in position with the appropriate screws and spring washers, and tighten to the correct torque, following the sequence shown in Fig. 41.

Effective with Engine No. 1308977 the crankshaft pulley hub diameter was changed from 2.5 in. (63.5 mm.) to 2.625 in. (66.67 mm.) and in consequence a change was also made to the oil seal in the front cover. Seals for use with the 2.625 in. diameter hubs should have an approximate sealing diameter (internal) of 2.56 in. (65.02 mm.) as against 2.44 in. (61.98 mm.) for the 2.5 in. diameter hub.

Effective with Engine No. 08B756398 a new crankshaft front oil seal was introduced. This may be recognised by the fact that it is completely rubber cased and has two rubber sealing lips whereas previous seals had a metal casing and had a leather outer lip (see Fig. 43). Only the latest seal, Part No. 510E–6362, is now being supplied and this may be used as a replacement on any engine except these mentioned above for use with the 2.5 in. (61.98 mm.) pulley hub.

Whereas the previous seals require soaking in engine oil for fifteen minutes prior to fitting this is not necessary with the current seal. It is, however, recommended that the outer diameter of the seal is coated with engine oil to facilitate fitting it to the front cover.

Effective with Engine No. 1425097, an oil bath crankcase breather was fitted to the front cover and it will be necessary to suitably seal off the short inlet pipe if this cover is to be fitted to tractors prior to this change. The previous cover is not suitable for use on engines built subsequent to the change.

36. Align the keyway in the crankshaft pulley with the key in the crankshaft, and replace the crankshaft pulley taking care not to damage the oil seal in the timing cover.

37. Replace the flat washer and crankshaft ratchet nut and tighten the ratchet nut, using the special spanner, Tool No. CT.6071.

38. Fit the generator bracket to the mounting plate, and secure it in position with two screws and spring washers.

39. Invert the engine on the stand and fit the lubricating oil pump into its location in the cylinder block, securing it in position with two screws and spring washers. (See also Lubrication Section.)

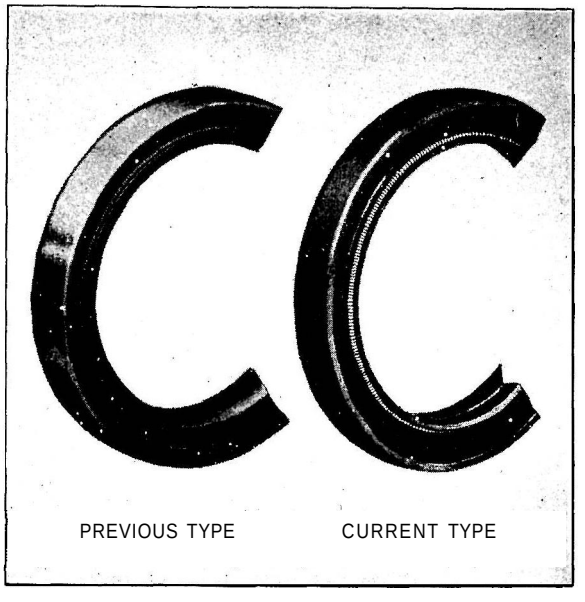

Fig. 43
Current and Previous Crankshaft Front Oil Seal

40. Fit the oil pump suction pipe, securing the union nut to the inlet connection of the pump, and the suction pipe support bracket to the centre main bearing cap. Bend the union nut locking plate so that it is locked against the pump cover and the union nut.

It should be noted that prior to Engine No. 1425097 the sump incorporated a detachable plate which afforded access to the oil pump filter screen, the screen being bowl-shaped and retained inside a pressed steel cover. Subsequent to this engine number the filter screen was changed to a cylindrical type whilst the pressed steel cover and access plate in the sump were deleted. Only the current type sump is now serviced for all tractor engines and when fitting this type of sump as a replacement for a previous type a small modification is necessary to the filter screen cover as detailed below.

Sump EIADKN–6675–F is no longer serviced, and in future all demands for this sump will be met by the modified sump EIADKN–6675–G which is suitable for all tractors up to Engine No. 157886, i.e. pre-Super Major, when the radius rod pin location was modified, which has no inspection cover on the underside. When using this sump on engines prior to Engine No. 1425097 the sump screen assembly will require modification in order to be able to fit the sump and to prevent oil starvation.

It should also be noted that a new sump drain plug EB–6703 and washer EB-6734 are required when using this sump as a replacement for a previous type.

The modification consists of cutting 0.38 in. (9.65 mm.) from the bottom of the cover, opening up the cutaway portion to 2.5 ins. (63.5 mm.) and cutting two 0.5 in. (12.7 mm.) holes as shown in Fig. -14.

A retaining clip, E120–Z–9 is used to hold the screen assembly in position while fitting the sump. This means that when assembling the screen the cover must first be fitted to the pipe, the circlip fixed around the pipe so that it supports the cover, and finally the gauze screen and spring assembled to the cover.

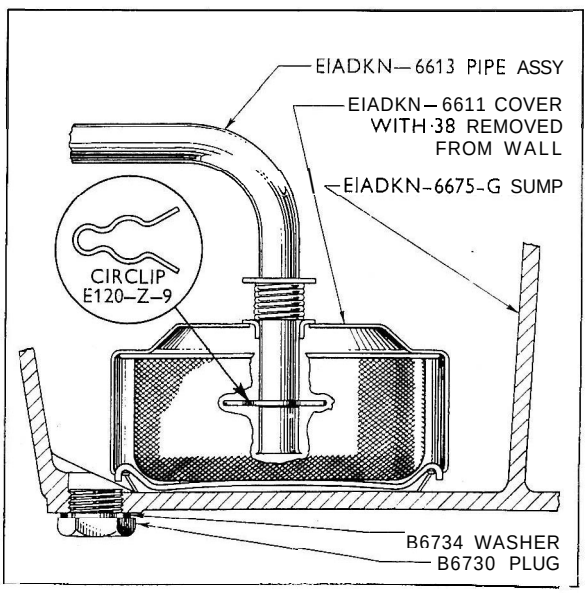

Fig. 44
Sump Screen Cover

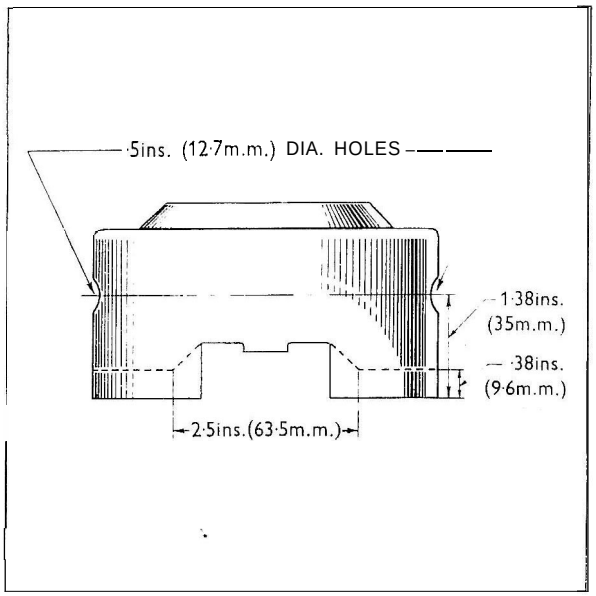

Fig. 45
Sump Screen Assembly

It is absolutely essential that the screen assembly is fitted with the retaining spring along the length of the engine as shown in Fig. 45, otherwise the covey will foul the bevelled face of the sump.

41. Where no access plate is fitted to the sump, position the oil pump filter screen on the suction pipe and rotate it through 90" to retain it in position. If an access plate is fitted the filter screen may be installed after the sump is assembled.

42. Fit the two sump side gaskets ensuring that the front end of the gaskets fit into the grooves in the front main bearing cap and insert the cork strip into the groove of the cap so that it laps over the front ends of the gaskets.

43. Fit a new rear oil seal packing in the groove at the rear of the sump. See notes in paragraph 5 of the Reassembly Instructions regarding previous and current type crankshaft packings.

44. Refit the sump taking care not to damage the gaskets and tighten the retaining screws evenly and securely.

45. Reverse the engine on the stand and remove the cylinder liner retaining screws and washers.

46. Install cylinder head locating studs (Tool No. CT.6076) to diagonally opposite bolt holes at either end of the cylinder block (see Fig. 46) and fit a new rubber seal in the recess at the rocker shaft oil feed drilling in the cylinder block top face.

47. Various detail changes have been made to the pistons, cylinder liners and cylinder head gaskets since this engine was first introduced and these changes have made it necessary to select with care the com-

bination of gaskets, liners and pistons used in service. The usage of pistons is described after item No. *14* of this section, but care must also be taken to ensure that the correct cylinder head gasket is used with each type of piston when reassembling an engine in service.

The changes to the cylinder liners and cylinder head gaskets are given below together with any special instructions with regard to usage.

Prior to Engine No. 1425097 a copper asbestos cylinder head gasket was used with pistons having a piston pin to piston crown height of 2.795 to 2.797 ins. (70.997 to 71.048 mm.) and a piston pin bore diameter of approximately 1.25 ins. (31.8 mm.).

At Engine No. 1425097 a crimped steel cylinder head gasket was introduced for use with new pistons having a piston pin bore diameter of 1.375 ins. (34.9 mm.) and a piston pin to crown height of 2.783 to 2.785 ins. (70.686 to 70.737 mm.).

Effective with Engine No. 1518654 a copper/asbestos/ permanite gasket was introduced together with a new piston having a piston pin to crown height of 2.793 to 2.795 ins. (70.946 to 70.997 mm.). New cylinder liners having a spigot on the top face were also introduced at this time together with two dowels in the cylinder block top face to provide more positive location for the cylinder head gasket.

At Engine No. *1565580* a new composition type cylinder head gasket was introduced together with new cylinder liners with a smaller diameter spigot on the top flange. The new cylinder head gasket can be identified by its thickness which is *0.039* in. *(1.0* mm.).

For service use on Mk. 11 and early Power Major engines a thinner composition type gasket is available which is 0.0236 in, (0.6 mm.) thick. Also for use with this gasket the non-spigoted type cylinder liners originally used were reinstated.

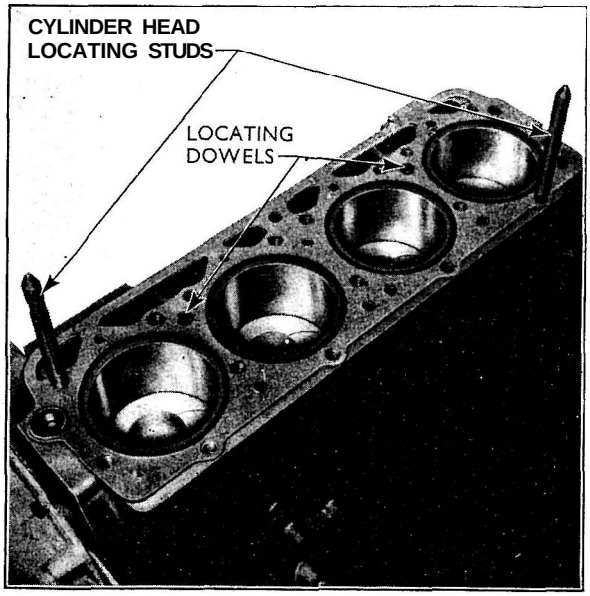

Fig. *46*
Cylinder Head Locating Studs

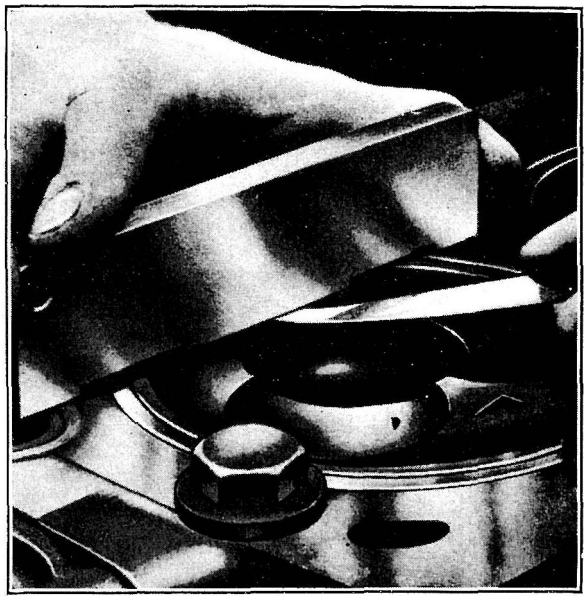

Fig. 47
Checking Piston Height

The usage of the various types of cylinder head gasket now available can be summarized as follows :—

Mk. I Engines (Prior to Engine No. 1425097)

Where the original non-spigoted type of liner is fitted, or if the latest type liner is to be installed use either the copper/asbestos/permanite gasket or the thick composition type gasket.

Where larger diameter spigoted liners have been fitted in service use only the copper/asbestos/permanite gasket.

Mk. 11 and Power Major Engines (Between Engine No. 1425097 and 1518653)

These engines were originally jitted in production with a steel cylinder head gasket and pistons which were lower (piston pin to crown hezght) than either those used on Mk. I or on current Power Major Engines. To maintain correct compression on these engines it is necessary that the thin composition type cylinder head gasket is used, providing that non-spigoted type liners are still fitted.

If spigoted type liners have been fitted in service the thin gasket cannot be used as the height of the spigot is greater than the thickness of the gasket. Under these circumstances it is recommended that when servicing these engines the spigoted liners are replaced by non-spigoted liners to enable the thin composition type of gasket to be used unless the following conditions regarding piston height apply:—

It is known that in some instances the current type pistons have been fitted to Mk. 11 engines. Where this has happened, or if any doubt exists as to which pistons are jitted, it is recommended that the distance be measured between the top of the piston and the cylinder block top face, with the piston concerned in the top dead centre position. If the distance exceeds 0.008 in. (0.203 mm.) the thin composition type gasket may be used (with non-spigoted liners only). If, however, the distance is less than this figure it will be necessary to

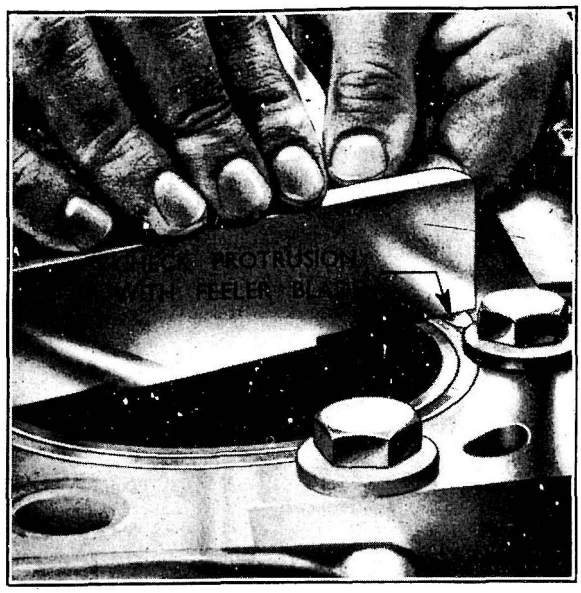

Fig. 48
Checking Cylinder Liner Protrusion

install either the copper/asbestos/permanite gasket (with any liner) or the thick composition type pasket (with any liner excepting the large diameter spigoted type).

The gauge, Tool No. CT.6120, can be used for measuring the piston height with the aid of feeler blades.

" Piston Height " is the distance between the top face of the cylinder block at the top face of the piston. In use the gauge is positioned so that the outer feet straddle the liner flange and rest on the cylinder block top face with the centre portion of the gauge immediately above the piston. With the piston at top dead centre insert feeler blades between the centre portion of the gauge and the top of the piston to obtain a direct figure for the piston height (see Fig. 47).

Power Major Engines between Nos. 1518654 *and* 1565580

Where the larger diameter spigoted type liners are fitted it is recommended that the copper/asbestos/permanite gasket is used.

Where non-spigoted type liners have been fitted in service, or a set of current type liners are to be installed, use either the thick composition gasket or the copper/asbestos/permanite type gasket.

Engines built After Engine No. 1565580

Use the thick composition type gasket, or the copper/asbestos/permanite type gasket.

General Fitting Instructions

The composition type of gasket should be fitted dry but sealing compound of an approved type is recommended for use with the copper/asbestos/permanite gasket.

To avoid any possibility of the sealer used on the copper/asbestos/permanite gasket entering the cylinder bores or the water ports it must not be allowed to come within $\frac{3}{16}$ in. (5 mm.) of the bore and water port holes in the gasket.

It is most important that the cylinder liner protrusion is within the specified limits of 0.002 to 0.004 in. (0.051 to 0.102 mm.).

Check the cylinder liner protrusion with the gauge, Tool No. CT.6120, in the following manner :—

Retain the cylinder liner in position with bolts and washers spaced equidistant around the liner flange and place the gauge over the liner spigot so that the feet rest on diametrically opposite points on the liner flange (see Fig. 48). Use feeler blades to measure the gap between the feet of the gauge and the top surface of the cylinder block.

48. Assemble the cylinder head, remove the locating studs and fit the cylinder head bolts. Tighten the bolts evenly to a torque of 85 to 90 lb. ft. (11.75 to 12.44 kg.m.) in-the correct sequence as shown in Fig. 49.

Effective with Engine No. 1425097 a new cylinder head was introduced on which the exhaust and inlet ports were brought into line horizontally, previously they were offset (see Fig. 50).

With the introduction of the Power Major changes made to the valve rocker arms altered the operating angle of the push rods. This in turn makes it necessary to check, when fitting any cylinder head held in stock prior to August 1958 *to a* Mk. *111 engine that clearance exists at the points where the push rods pass through the cylinder head. Any cylinder heads received after this date will have such clearance and they may therefore be used on any engine subsequent to Engine No.* 1425097.

49. Replace the rocker shaft assembly on the cylinder head, refit the retaining bolts, and tighten the bolts evenly and securely.

Prior to Tractor Engine No. 1607304 tab washers were used to lock the bolts securing the valve rocker brackets to the cylinder head, subsequent to this Engine No. the tab washers were replaced by spring lockwashers. The lockwashers used at this location may be used on previous engines if desired.

50. Insert the lower ends of the push rods in their position in the tappets, slide the rocker lever sideways off the valve stems or caps, and engage the cup ends of

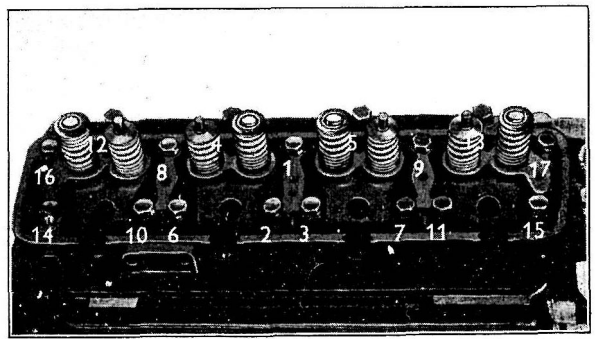

Fig. 49
Cylinder Head Bolt Tightening Sequence