# DAVID BROWN

## FOUR-CYLINDER DIESEL ENGINE
(SERIES AD4/47)

# REPAIR MANUAL

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# Introduction

The engine fitted to 990 Agricultural Tractors is designated AD4/47 and is a four-cylinder unit of $3\frac{5}{8}$ in. bore and $4\frac{1}{2}$ in. stroke, fitted with wet cylinder sleeves. As the engine must have a flywheel suitable for the clutch (Livedrive or Non-Livedrive) the suffix A or B is included in the designation to indicate the type of flywheel fitted and therefore the tractor model on which the engine is used.

The engine fitted to 990 Industrial Tractors is designated ID4/47 and is basically identical to the AD4/47 engine, the only difference being that the ID4/47 engine is fitted with a flywheel suitable for the twin-plate clutch and has a splined coupling flange attached to the longer flywheel bolts.

## Engine Designation and Tractor Models

| *Engine Series* | *Tractor Model* | *Tractor Number* |
|---|---|---|
| **AD4/47A** | **990 Implematic Livedrive** | **440001 to 481999** |
| | **990 Selectamatic Livedrive** | **482001 onwards** |
| **AD4/47B** | **990 Implematic Non-Livedrive** | **440001 to 481999** |
| | **990 Selectamatic Non-Livedrive** | **482001 onwards** |
| **ID4/47** | **990 Industrial Models** | **440001 onwards** |

# MAINTENANCE

## Daily

Check engine oil level. Top up if necessary.

Check air cleaner. Remove filter bowl and examine the oil. In dusty conditions the air cleaner oil should be changed frequently, the detachable wire mesh element removed, washed in diesel fuel, and allowed to stand until all fuel has drained off. (See note regarding air cleaner maintenance.)

If a paper element pre-cleaner is fitted, remove the cover and examine the element. If it is dirty, remove the element and tap it on the side to shake off dust. **Do not attempt to wash a paper element.** Examine for any water, fuel or lubricating oil leaks.

## Every 60 hours

Check engine oil level. Top up to the "full" mark on dipstick if required.

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

Visually check the feed pump sediment bowl. Remove and clean if there is any accumulation of dirt or water.

## Air Cleaner

**Air Cleaner Oil:** Air cleaner oil should be changed and the detachable wire mesh element removed and in dusty conditions washed frequently. The maximum dust deposit in the cleaner bowl should never be allowed to exceed $\frac{1}{4}$ in., checked after standing overnight, otherwise oil pullover into the induction manifold will take place, due to the raised oil level.

Oil in the induction manifold, which indicates oil pullover, can be easily checked through the ether plug aperture in the inlet manifold. This pullover will cause rapid engine wear and must be prevented by adequate cleaner maintenance. An SAE 30 grade of straight mineral oil is less susceptible to frothing, and usually cheaper, than the detergent oils used in the engine. In climates where the ambient temperature often exceeds 32° C (90° F) an SAE 50 grade oil may be used. Care should be taken not to overfill the bowl. Only fill to the level mark — not above or below it.

Before assembling the air cleaner thoroughly clean the inside of the pre-cleaner and the inside of the pipe through the centre of the air cleaner. Ensure that the 'O' rings between the cleaner body, lower element and oil bowl are correctly fitted to ensure an air-tight seal. The fit of these 'O' rings is particularly important, as the upper ring may be easily displaced when the oil bowl and lower element are being fitted. The 'O' ring should not be twisted and should fit securely on the small notched register on the lower edge of the air cleaner body. If the 'O' rings are damaged during assembly new rings must be fitted.

## Paper Element Pre-cleaner

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

## Every 125 Hours

**Engine Oil:** Drain the oil, while it is still warm, through the sump plug on the underside of the sump plate. Refill with approved oil to within the safe marks on the dipstick. For list of approved lubricants see Page 39. In dusty conditions clean or replace engine breather (see Engine Breather, Page 2).

## Every 250 Hours

**Engine Oil and Filter:** Drain the oil when warm and remove filter bowl. Discard the old element and clean bowl out with clean diesel fuel, using a brush to make sure that the by-pass valve is perfectly clean. Fit a new element and check the sealing ring in the cylinder block groove; fit a new ring if it is damaged or distorted. Do not overtighten the bowl securing bolt — 10 lb ft (1·4 kg metres) is sufficient.

Refill the sump with new oil, start engine to fill the filter then recheck the oil level.

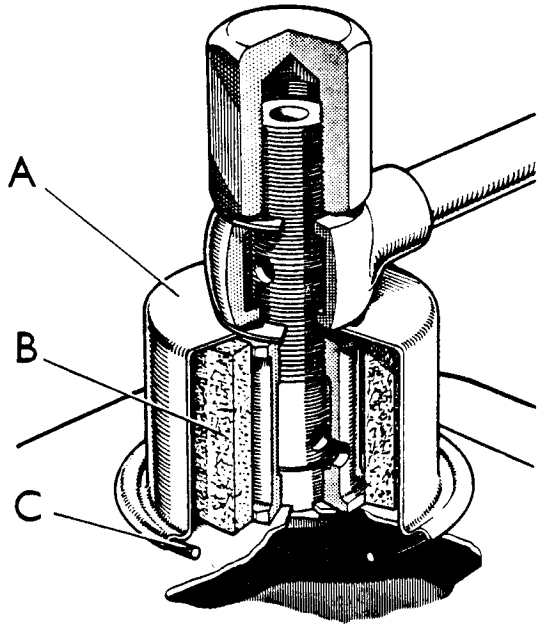


Figure 1. ENGINE BREATHER

A. Cover B. Element
C. Sealing ring

**Engine Breather:** Remove the domed nut from top and remove the pipe. Lift the cover off and remove breather element. Clean the top of rocker cover and fit a new element. Replace breather cover, ensuring that the 'O' ring is correctly located in the cover lip and replace pipe and nut. Failure to change the breather element could cause excessive pressure to build up in the crankcase with resulting oil leakage from the crankshaft seals. (Fig. 1.)

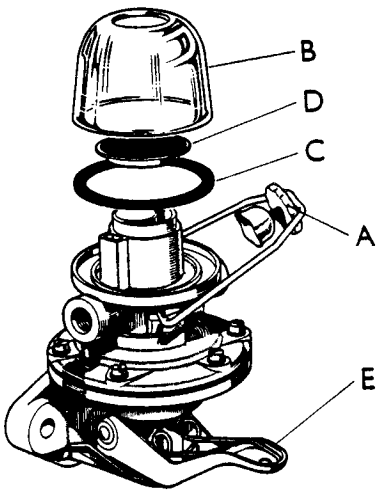


Figure 2. FUEL FEED PUMP SEDIMENT BOWL

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

## Every 500 Hours

Remove sediment bowl and filter, as shown in Fig. 2, and wash in diesel fuel.

Injectors: Remove injectors for cleaning (see Page 7).

Procedure for removal of injectors:

1. Thoroughly clean off all external dirt.
2. Disconnect and remove leak-off pipe.
3. Disconnect high-pressure pipes at injector unions.
4. Slacken nuts holding down the injectors in stages, to prevent distortion.
5. Withdraw injectors carefully. Blank off inlet unions with caps. A protection sleeve should be fitted to nozzle tip.
6. Clean injector bores and remove copper washers. Plug the bores with clean rag to prevent dirt entering engine.

When replacing injectors refit copper washers — new ones if old ones were damaged — and tighten the injector down evenly. Reconnect leak-off pipe and high-pressure pipes leaving the injector unions slack. Turn engine, with stop control in the "run" position and throttle lever full open, until all air is expelled from high-pressure pipes, then tighten the unions. Start engine and check for any leaks.

## Valve Clearance

Remove valve rocker cover and check valve clearances when engine is cold. The valve clearance should be set cold to the dimensions on Page 33, Dimensional Data. The clearance between the tip of rocker arm and the end of valve stem should be checked with a feeler gauge as shown on Fig. 3 and adjusted, if necessary, to the correct clearance. Adjustment is made by slackening the locknut and turning the adjusting screw until correct clearance is obtained. When tightening the locknut hold adjusting screw firmly with a screwdriver, then recheck the clearance.

Relative position of valves is as follows:

| No. 1 Cylinder (Front) | | No. 2 Cylinder | | No. 3 Cylinder | | No. 4 Cylinder (Rear) | |
|---|---|---|---|---|---|---|---|
| Exhaust | Inlet | Inlet | Exhaust | Exhaust | Inlet | Inlet | Exhaust |
| No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 |

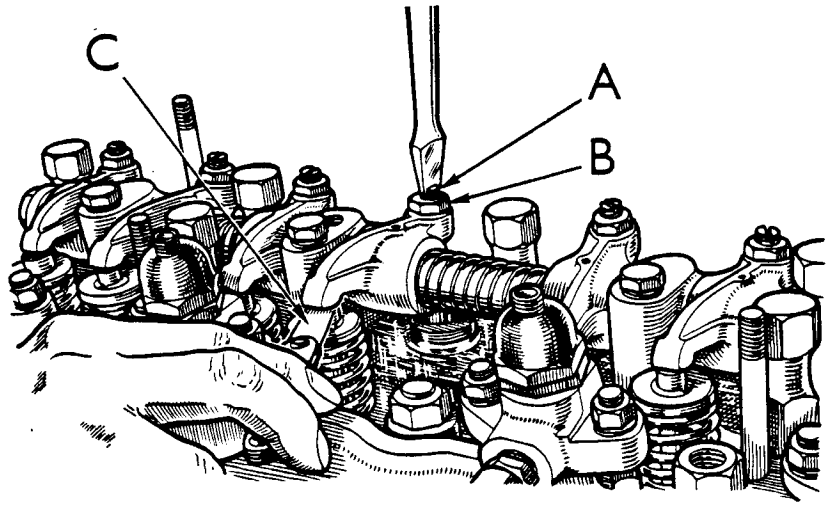


Figure 3. SETTING THE VALVE CLEARANCE

A. Adjusting screw B. Locknut C. Feeler gauge

Valve adjustment is easier if carried out when the injectors have been removed for servicing as the engine can then be turned by means of the fan. If the injectors are not removed, or the holding-down nuts released, it will be necessary to use a box-spanner (Service Tool 960995) on the crankshaft nut to turn the engine.

To ensure the valve tappets are at the base of the cam, adjust the valves in the following order:

Adjust No. 1 valve when No. 8 valve is fully open
Adjust No. 6 valve when No. 3 valve is fully open
Adjust No. 4 valve when No. 5 valve is fully open
Adjust No. 2 valve when No. 7 valve is fully open
Adjust No. 8 valve when No. 1 valve is fully open
Adjust No. 3 valve when No. 6 valve is fully open
Adjust No. 5 valve when No. 4 valve is fully open
Adjust No. 7 valve when No. 2 valve is fully open

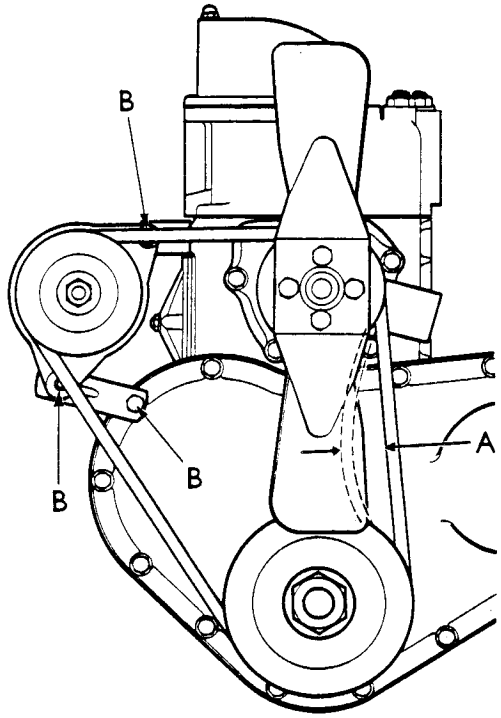


Figure 4. FAN BELT ADJUSTMENT
A. Deflection B. mounting bolts

## Fan Belt

Check tension by deflecting belt midway between the fan and crankshaft pulleys. It should deflect approximately 1 in. (25 mm) and if necessary may be adjusted by releasing the three dynamo mounting bolts and swinging dynamo on the two upper bolts. Tighten lower bolt first, as this will hold dynamo in position whilst the upper bolts are tightened. Do not overtighten the belt. A taut belt will place excessive load on the dynamo and water pump bearings and cause rapid belt wear. If the belt has insufficient tension when dynamo has been adjusted so that the lower mounting bolt is at end of arm slot, the belt should be renewed. (Fig. 4.)

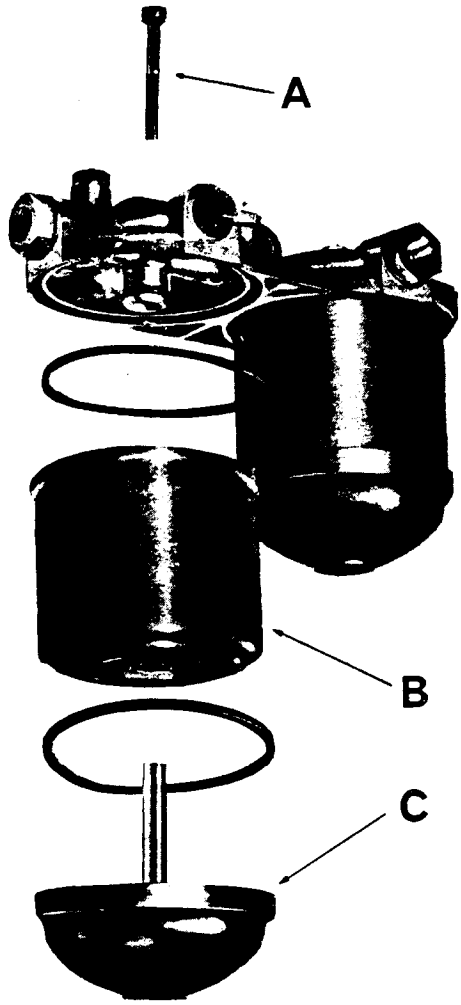


Figure 5. FUEL FILTER
A. Element securing bolt B. Element
C. Filter base

## Fuel Filter

Fit a new element in the first fuel filter but do not disturb the second filter. Clean the outside of filter then remove the bolt securing base of first filter to filter head, whilst holding base and element with the other hand. Remove base and discard element. Flush out base and fit a new element, ensuring that it seats correctly on the sealing rings in base and head. Fit a new sealing washer on to the retaining bolt. Replace the bolt and tighten firmly, but not excessively.

Do not attempt to clean fuel filter elements and do not change elements from one filter to another.

Remove and flush out fuel feed pump sediment bowl. As the fuel pump is lower than the tank it will be necessary to turn fuel tap off or, if a fuel tap is not fitted, slacken outlet union on fuel tank, so that fuel will not siphon out. Clean filter gauze with an air blast, or wash in clean fuel. Replace gauze and bowl, ensuring that it seats correctly on the sealing ring. After refitting sediment bowl and tightening the tank outlet union, or turning on fuel tap, vent system to remove air. (See Page 5.) (Fig. 5.)

## Water Pump

Apply high-melting-point grease sparingly to the pump grease nipple. A few strokes of the grease-gun are all that is required. Over-greasing will damage the seals and cause eventual bearing failure.

## Dynamo

Remove small rubber plug from the centre of dynamo rear end-plate, inject a few drops of engine oil through the hole and replace the plug.

## Every 1000 Hours

**Engine Oil Pump**: Drain the oil and remove sump cover. Remove setscrew attaching gauze to pump. Remove and clean the wire gauze with diesel oil. Do not use a cloth. Refit gauze, sump cover and plug; fill with correct oil (see Page 39).

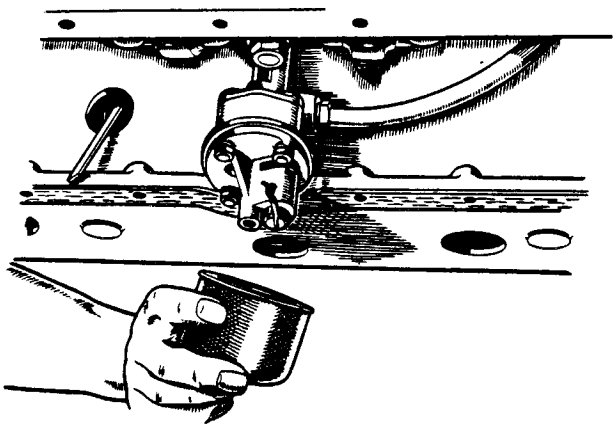

Figure 6. REMOVING THE OIL PUMP GAUZE FILTER

**Fuel Filter**: Using the same procedure as in 500 hours service, fit new elements in both first and second filters. Do not attempt to clean or interchange the filter elements.

# FUEL SYSTEM

## Introduction

A thoroughly clean fuel system is essential. Too much emphasis cannot be made on this point and the necessity for correct storage of fuel, proper attention to filter renewal, cleaning the exterior of the tractor before slackening any connections on the fuel system, and care when filling the fuel tank not to allow dirt to enter, must be impressed upon the user. Cotton waste or cloths must not in any circumstances be used in conjunction with fuel injection equipment.

Every care should also be exercised in the workshop. The bench used for servicing of fuel equipment should be situated in a well-lit and separate part of the workshop. If it is possible, an insulated dust-proof room should be provided in which the equipment can be permanently installed.

Some of the tools and test gear necessary for servicing injectors are shown in Category 'C' Tool Leaflets. The minimum essentials consist of the following: Two Safety Containers — one filled with petrol for soaking dirty nozzles and the other filled with test oil (see Page 40), or clean diesel fuel, for assembly of the cleaned components. A nozzle bench plate should be screwed to the bench with the jig end overhanging so that an injector can be located on it while the dome nut and lockwasher are slackened or tightened. A Nozzle Setting Outfit should also be securely bolted to the bench with a suitable canister to collect the spray and protect the operator against accidental contact with the spray.

The Flushing device used in conjunction with the Nozzle Setting Outfit is essential. The Nozzle Cleaning Kit (Fig. 13) includes a probing tool but not needles; correct diameter needles can be obtained separately as required. Although the above items are an essential minimum for injector servicing, more complex apparatus or additional items are available where the volume of work makes their purchase worthwhile.

## Venting the System

Venting the system is necessary to remove air, as the system cannot operate correctly if air is present. If the system is allowed to run dry, or if any components are disturbed, venting should be carried out as follows:

1. Fill tank to a minimum of 2 gallons — 9 litres of fuel.
2. Clean sediment bowl and filter on lift pump before venting the system to prevent carry over of sludge or water, noting that if a fuel tap is not fitted it will be necessary to release the fuel tank outlet union to prevent fuel siphoning out. Ensure that no air is trapped in the bowl when refitting by filling it to the top with clean fuel.
3. Clean the outside of the fuel filters. Remove the plug G and slacken the connection H. Operate the feed pump priming lever and tighten in the order G then H as fuel appears at each point.

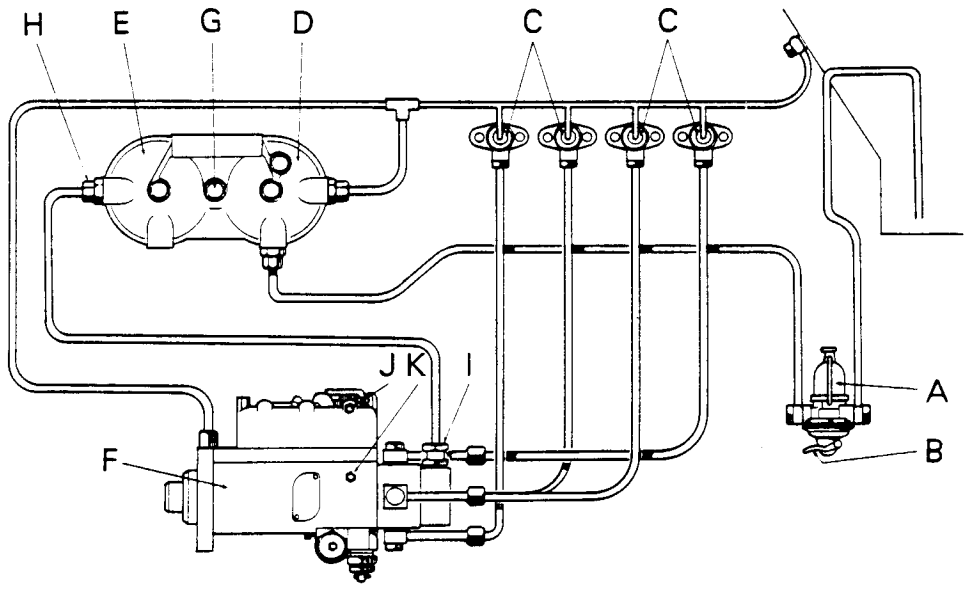


Figure 7. DIAGRAM OF FUEL SYSTEM

A. Fuel sediment bowl
B. Feed pump priming lever
C. Injectors
D. First fuel filter
E. Second fuel filter
F. Injection pump
G. Filter vent plug
H. Filter leak-off union
I. Pump inlet union
J. Pump vent plug
K. Pump vent plug

4. Slacken the injection pump plug J and prime until all air is expelled then tighten the plug and repeat the operation with plug K.

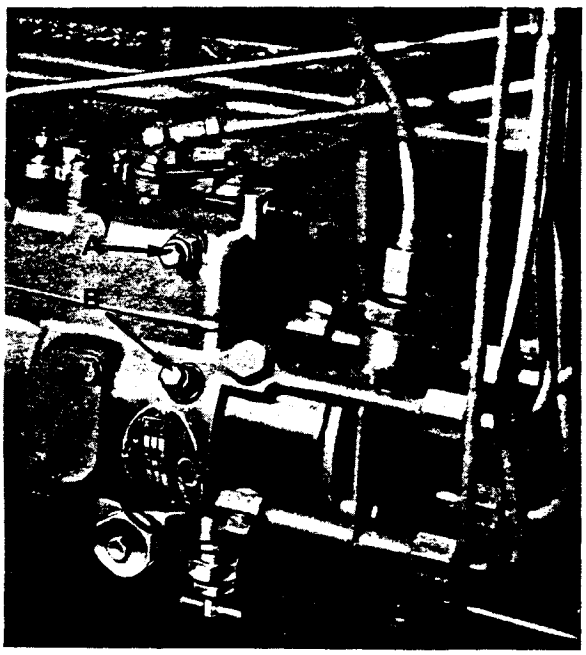

Figure 8. FUEL INJECTION PUMP VENT PLUGS
A. Governor housing vent plug
B. Pump barrel vent plug

5. Slacken the union I and prime until free from air then tighten.
6. Slacken the high-pressure pipes at the nozzle end then, with the engine stop control in the "run" position and the throttle fully open, turn the engine with the starter until fuel is ejected. Tighten the pipe unions and operate the starter: the engine should then start.
7. Having started the engine, check tightness of all the connections, check for any fuel leaks and wipe clean all spilt fuel.

## Fuel Feed Pump

The fuel feed pump is mounted on the right-hand side of the engine crankcase and is actuated by a push rod from an eccentric formed on the camshaft.

To remove the fuel feed pump, disconnect fuel pipes at the pump and release the two bolts securing the pump to the engine crankcase. When the pump is removed the push rod may be withdrawn from crankcase.

**Renewal of Diaphragm:** Clean exterior of the pump and mark top and bottom halves so that they can be replaced in the same position. Remove six cheese-headed screws securing the upper half of the pump to the base and lift off the pump top.

Remove diaphragm complete with pull-rod by turning these through an angle of 90° which should release the pull-rod from the connecting link. Fit new diaphragm and pull-rod over the spring with the tab in the position shown in Fig. 10. Press the centre down until the "T" of pull-rod enters slot in connecting link and turn diaphragm through 90° as shown in Fig. 10 so that they lock together. The upper housing may then be replaced. Press priming lever and keep it pressed whilst the cheese-headed screws securing the housing are tightened. This ensures the diaphragm is not taut.

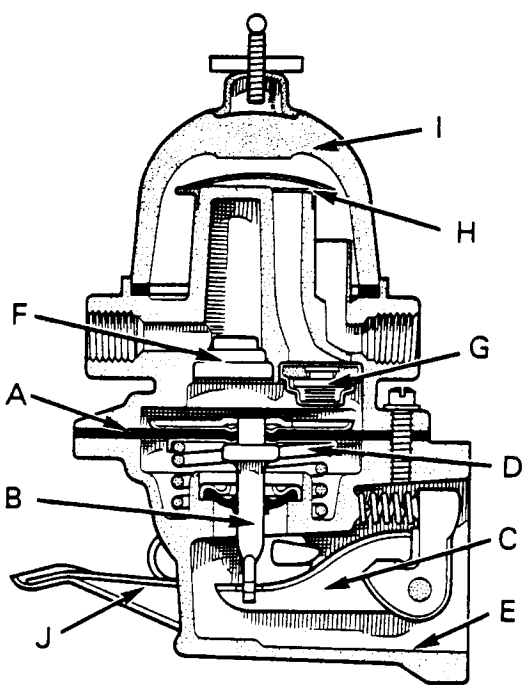


Figure 9. FUEL FEED PUMP
A. Diaphragm
B. Diaphragm pull-rod
C. Connecting link
D. Diaphragm spring
E. Body
F. Outlet valve
G. Inlet valve
H. Filter gauze
I. Sediment bowl
J. Hand primer

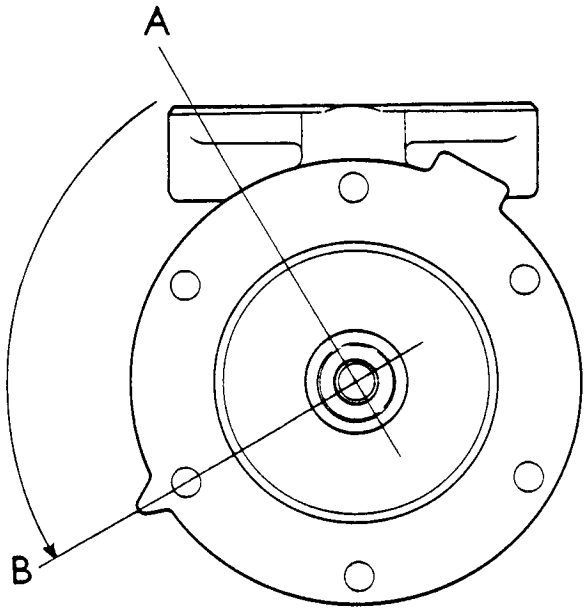


Figure 10. REFITTING FEED PUMP DIAPHRAGM

With the diaphragm tab at position A, fit the diaphragm on to the pump body until the pull-rod enters the link slot, then turn the diaphragm 90°, so that the tab is at position B, to lock the pull-rod in the link slot.

## Injector Servicing

**Nozzle Testing:** The hand tester shown in Fig. 11 is adequate for testing and pressure setting injectors.

Attach the injector to the spray tester and place a canister round the nozzle to ensure that spray does not contact the body. The force of the spray is such that it will easily penetrate the skin, even through clothing. The resultant oil under the skin is very difficult to treat and can be a very uncomfortable wound. The canister will also help to condense the very fine spray which forms an objectionable atmosphere. If regular nozzle testing is contemplated a totally enclosed test chamber with exhauster is advocated.

**Pressure Test:** With injector mounted in the test outfit, depress hand lever several times to fill the injector and expel any air. Depress lever very slowly and observe highest pressure reading that is obtained before needle on pressure gauge flicks. This is the pressure at which injection takes place. The correct pressure for new injectors is 185 atmospheres, and for used injectors 175 atmospheres.

If the pressure is incorrect but the nozzle is clean and otherwise satisfactory, it should be set to the correct figure as follows: Remove dome cap and slacken locknut, and using a large screwdriver in the pressure adjusting screw D (Fig. 12) adjust the pressure. Only a very small movement will be required unless the nozzle has only just been assembled and the pressure not previously set. When the screw has been adjusted, tighten locknut and recheck pressure.

**Back Leakage Test:** Operate hand pump until pressure is about 170 atmospheres. Release the handle quickly and measure, with a stop-watch, the time taken between pressure gauge pointer passing the marks for 150 and 100 atmospheres as it gradually falls. For a satisfactory nozzle the time taken should be between 6 and 25 seconds.

**Dry Seat Test:** Carefully wipe nozzle dry. Build up pressure to 10 atmospheres below the injection pressure. Examine nozzle whilst under this pressure. It should be dry and free from leakage. If the nozzle is inadvertently caused to inject, the tip should be re-wiped dry and tested again.

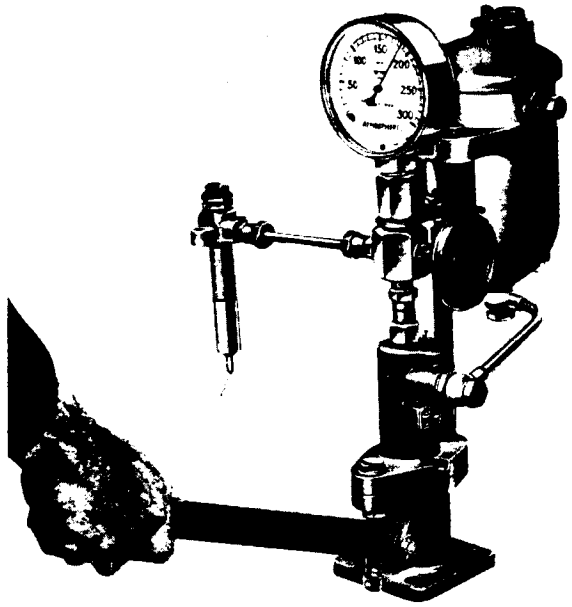

Figure 11. INJECTOR TESTING
Using Service Tool 7044/122FF

**Atomisation Test:** Isolate pressure gauge by closing valve. Apply eight quick jerks and examine the spray quality. The sprays should be free from coarse or solid streaks and the tip should remain dry. There should be four sprays equally spaced at an inclusive angle of 140°. They are offset 10° to allow for the tilt of the injector in the cylinder head.

Examine injector for signs of leakage at nozzle cap nut, spring adjusting nut, and copper sealing washers.

**Nozzle Cleaning:** If the injector fails to pass any of the above tests it must be dismantled, cleaned and retested. Note the spring pressure must be released before removing a nozzle. Unscrew the nozzle cap (Fig. 12), using a close-fitting spanner on the flats provided, and remove nozzle, noting that it will only fit in one position because of the locating dowels. Remove needle valve and place in petrol to soften the carbon. Examine nozzle and needle for damage, overheating or scratch marks on the lapped working surfaces. If excessive overheating has occurred, denoted by a dark blue colour of the needle, or if the seat or working surfaces are damaged, re-conditioning will be required and a new nozzle should be fitted.

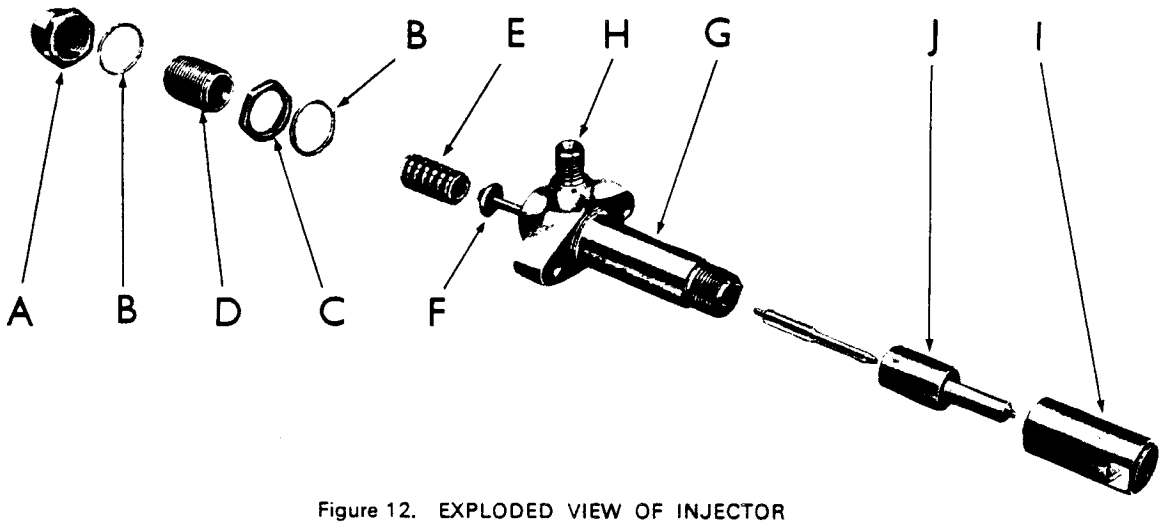


Figure 12. EXPLODED VIEW OF INJECTOR

A. Cap B. Sealing washer C. Locknut D. Adjusting screw
E. Spring F. Plunger G. Holder H. Fuel inlet connection
I. Nozzle nut J. Nozzle

If the nozzle is not damaged it should be cleaned using the special tools provided in the nozzle cleaning kit shown in Fig. 13 and Tool Leaflet C2. Firstly clean fuel oil channels and bores in the nozzle. Scrape carbon from valve seat with the brass scraper.

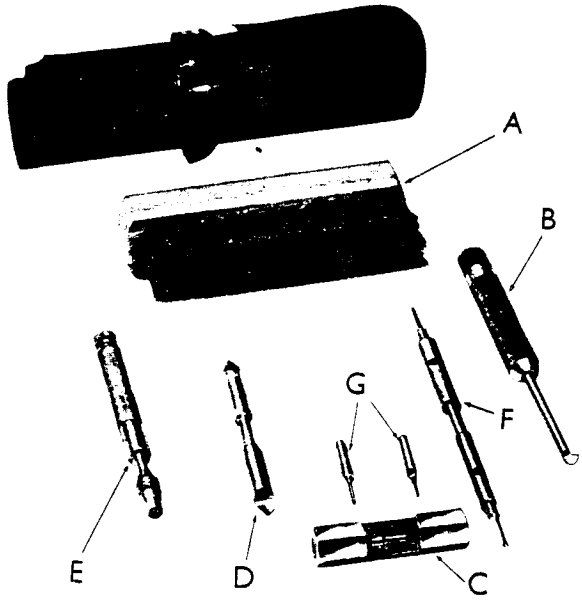


Figure 13. C.A.V. NOZZLE CLEANING KIT

A. Brass wire brush B. Nozzle body groove scraper
C. Nozzle plunger cleaner D. Nozzle body seat scraper
E. Holder—probing needle F. *Pintle hole cleaner
G. *Probes—pintle hole cleaner

* Not required for D.B. nozzles.

Using the special groove scraper clear carbon deposits from oil gallery. Clean spray holes with probing tool fitted with a probing wire of the correct diameter.

If a wire is broken off in the hole it is often impossible to remove it, and the nozzle is then useless. Great care should be exercised when using the probing wires. After clearing the holes scrape carbon from valve seat with the V-tipped brass tool. Next use the tool with the thin blade radiused at its tip to clean carbon out of the sac. After cleaning with the tools, the nozzle should be thoroughly cleaned with fuel. This should be done by placing the nozzle, without needle, in the reverse flushing attachment and connecting to the nozzle pressure tester in place of an injector. Operation of the tester will then thoroughly flush all particles of loose carbon from the nozzle.

With the brass wire brush, gently clean needle valve, paying particular attention to valve seat and needle tip. Brush carbon from nozzle stem and tip.

**Reassembly**: The needle valve should be fitted to nozzle whilst both are under the surface of clean fuel oil or test oil. Only in this way can dust be excluded from assembly. The needle should slide smoothly in the nozzle and this should be tried several times whilst under the surface of fluid. Needle and nozzle are assembled as a pair and under no account should they be interchanged.

The nozzle should then be assembled on to injector body. In order to avoid distorting needle or plunger the pressure on pressure spring should be released. Remove dome cap, slacken locknut and slacken pressure adjusting screw right back until there is no pressure on spring. Make sure that mating surfaces between nozzle and injector body are perfectly clean. Place nozzle on body with the dowels in correct engagement so that the two faces are in perfect contact, i.e., not held apart by spring pressure. Place the cap over nozzle and tighten adequately but not overtight. Retighten pressure adjusting screw and reset the pressure on spray tester. Test the spray, leak back, etc. If the injector is not required for immediate use it should be stored in a sealed plastic bag or similar container. (Fig. 14.)

It is essential that the copper washer be used under

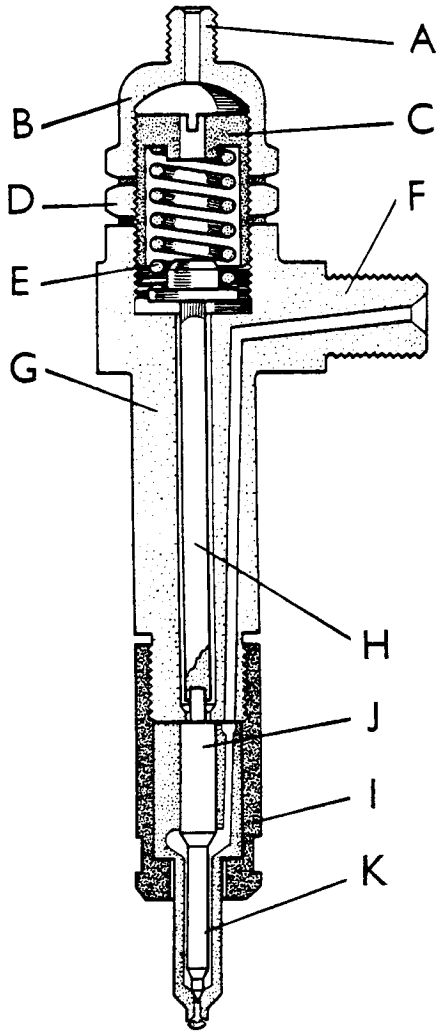


Figure 14. SECTIONED INJECTOR

A. Leak-off connection B. Cap C. Adjusting screw
D. Locknut E. Spring F. Fuel inlet connection
G. Holder H. Plunger I. Nozzle nut
J. Needle K. Nozzle

injector when refitting to engine. Check that the seat in head is clean and that the old washer has not been left in the recess. The use of two washers will raise nozzle tip so that the spray impinges on cylinder head. This causes a loss of efficiency and excessive exhaust smoke.

## Injection Pump

The injection pump is attached by three studs on the engine carrier plate, and the pump mounting holes are slotted to permit pump body to be turned for injection timing adjustment. To assist in obtaining the correct timing position the pump flange is marked with a groove and when the timing is set during assembly a mark is made on the carrier flange in line with the mark on pump. Any pump can thus be fitted and the original timing obtained by placing the two marks in alignment. (See Fig. 15.)

The pump is driven from the camshaft by means of an intermediate gear and correct timing of the injection pump can only be obtained if all the timing gears are meshed correctly (see Fig. 44).

## Removing the Pump

1. Disconnect all fuel pipes from pump.
2. Disconnect throttle and stop control cables from pump.
3. Check that timing-mark on pump drive housing is visible. If not, scribe a new line in line with the mark on pump.
4. Unscrew holding-down nuts on pump flange.
5. Lift pump away from housing. The quill shaft will probably remain in the pump and should be withdrawn and retained until required.

## Refitting the Pump

1. Before refitting the pump check the position of the master spline in the driving gear then fit the quill shaft into the pump (chamfered end of shaft towards pump) and turn the pump so that the master spline on the quill shaft is in line with the gear spline.
2. Fit pump to housing.
3. Rotate pump body until timing marks line up (see Fig. 15) and tighten the three holding nuts.
4. Reconnect all fuel pipes and control cables. Vent fuel system (see Page 5).

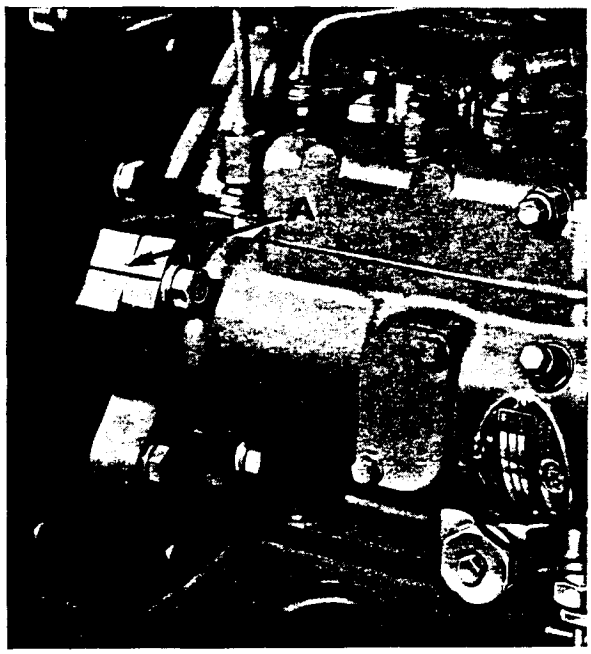


Figure 15. INJECTION PUMP TIMING-MARKS

A. Pump body mark aligned with engine flange

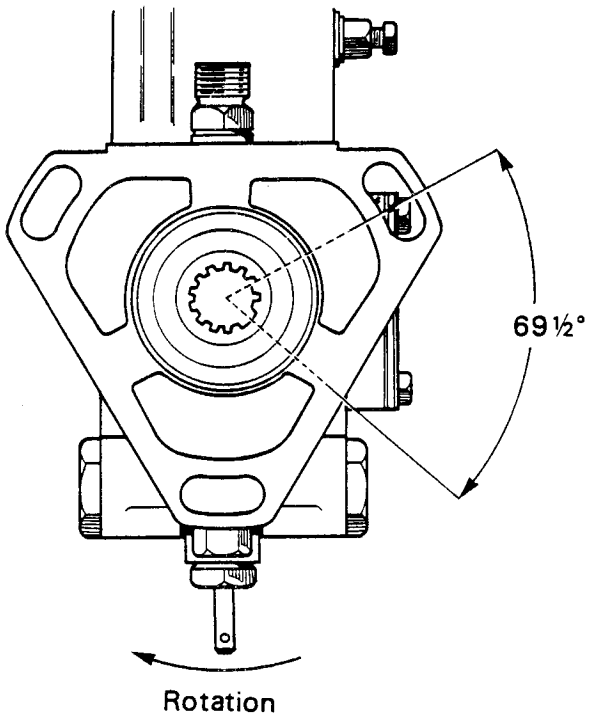


Figure 16. SETTING THE INJECTION PUMP

## Retiming the Injection Pump

If the timing-line on pump becomes obliterated the pump can be retimed to the engine as follows:

1. Attach stirrup pipe, Service Tool CAV 7144/262, to Nos. 1 and 4 injector pipe connections and connect the pipe to an injector tester. Set the pump so that the master spline is towards the top of the pump then operate the tester handle to build up a pressure of 30 atmospheres.
2. Fit Service Tool CAV 7144/112U on to the pump quill shaft and turn the pump until it becomes rigid. This will be the point at which injection commences on No. 1 cylinder.
3. Measure 69½° from the blank spline by means of the scale on the tool and mark the pump flange (Fig. 16).
4. Remove the tool, disconnect the tester and refit the pump on the engine, aligning the timing-marks before tightening the mounting nuts.

## Fuel Setting

Once the fuel setting has been set for an engine it is most unlikely that it requires adjustment. If adjustment is required then the pump should be removed from the engine and tested for delivery on a Hartridge Test Bench. For details of injection pump fuel setting see Page 34.

## Injection Pump Controls

The front lever on injection pump operates the fuel cut-off to stop the engine. The rear lever operates the governor to give required engine speed and is fitted with two adjustable stops. The front stop is for setting idling speed and this should be set so that the engine runs at 650–700 rev/min with throttle lever in shut-off position. The rear stop is for setting maximum speed and should be set at: 2350 rev/min no load to give 2200 rev/min full load.

## Fuel Filters

The double fuel filter mounted on the left-hand side of the engine contains two replaceable paper elements. These are connected in series, so that all fuel must pass through both elements before it is fed to the injection pump. Always wipe the outside of filter clean before removing the elements and fit new elements at the time specified. New elements should also be fitted whenever a new, or reconditioned, fuel injection pump is fitted. Do not attempt to clean elements and do not change elements from one filter to another.

## Fuel Tank Removal

The easiest way of removing the fuel tank is to remove the tank complete with instrument panel, then remove instrument panel from tank.

First drain tank by unscrewing union nut on fuel tap outlet and allowing fuel to flow by gravity into a suitable, **clean** container. If tractor is not fitted with a fuel tap, remove union from fuel feed pump inlet and allow the fuel to siphon through pipe into a suitable, clean container. Do not release the union at the tank end of pipe as this will allow air into pipe and prevent the siphon action from taking place. Disconnect tractormeter drive cable and wiring. Some of the wires are fitted with snap connectors, but others, such as oil warning switch wire, will have to be disconnected at their terminals.

Remove fuel tank mounting bolts and fuel cut-off control-rod spring bracket, unscrew fuel outlet and leak-off pipes from tank and lift tank assembly from its support.

Replace the tank in reverse order of removal ensuring that seating pads are in position and wires are replaced in their correct connectors.

# STARTING AIDS

## For use in cold weather

**Manual retard device on injection pump:** The wing-nut on the under-side of pump should be screwed in **before** trying to start engine. As soon as engine is running the wing-nut must be screwed out, otherwise erratic running with black exhaust smoke and loss of power will occur. Do not screw manual retard nut in immediately after an unsuccessful attempt to start engine. If you attempt to start engine prior to screwing in manual retard, wait 15 to 20 seconds to allow pressure inside

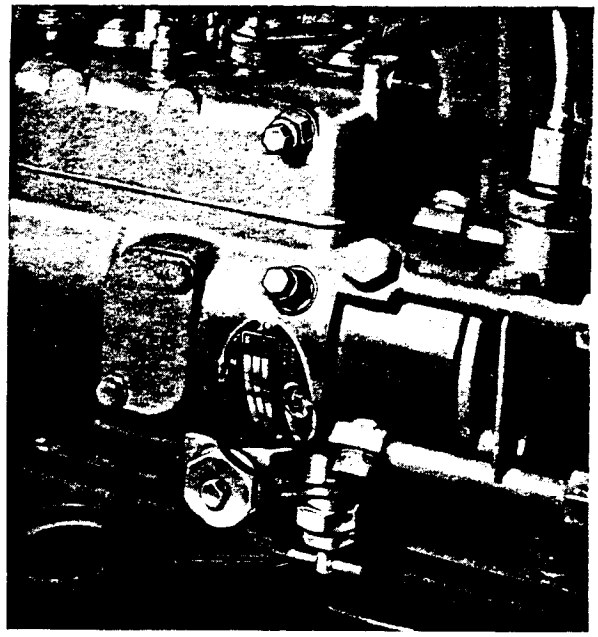

Figure 17. INJECTION PUMP RETARD CONTROL
A. Wing nut

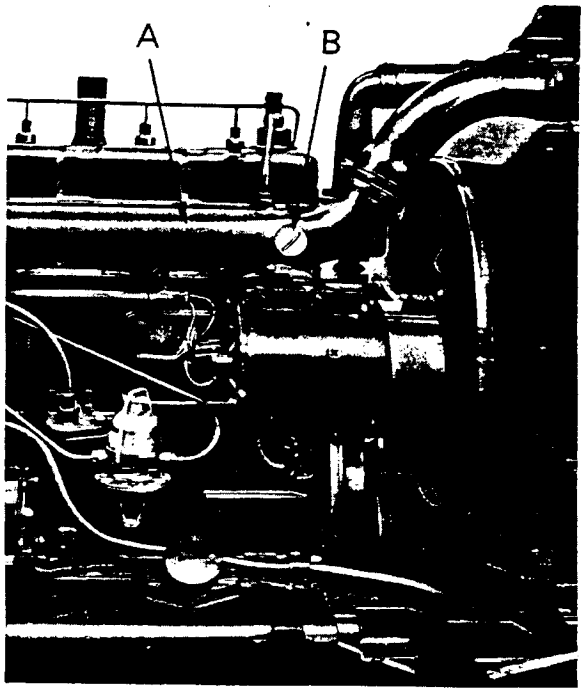


Figure 18. ETHER STARTING PLUG
A. Inlet manifold B. Plug

pump to fall; otherwise pump will be locked in the advanced position and engine will not start. It is advisable to screw the wing-nut in **before** attempting to start engine. (Fig. 17.)

## For use in sub-zero temperatures

**Ether plug** : In the inlet manifold there is a plastic plug with a felt pad on the end. Unscrew plug and dip felt pad into ether or a proprietary starting fluid, replace plug in manifold and start engine immediately. (Fig. 18.)

## Warning

Serious damage can be caused to an engine by the use of an excessive amount of ether. The plug should be removed, the felt soaked in ether and then replaced. **Ether in excess of the quantity absorbed by the felt must not be added.**

It must be noted that other aids do exist, namely that correct oil should be used (see Page 39) and the battery should be kept charged by running the engine for adequate periods of time.

# LUBRICATION SYSTEM

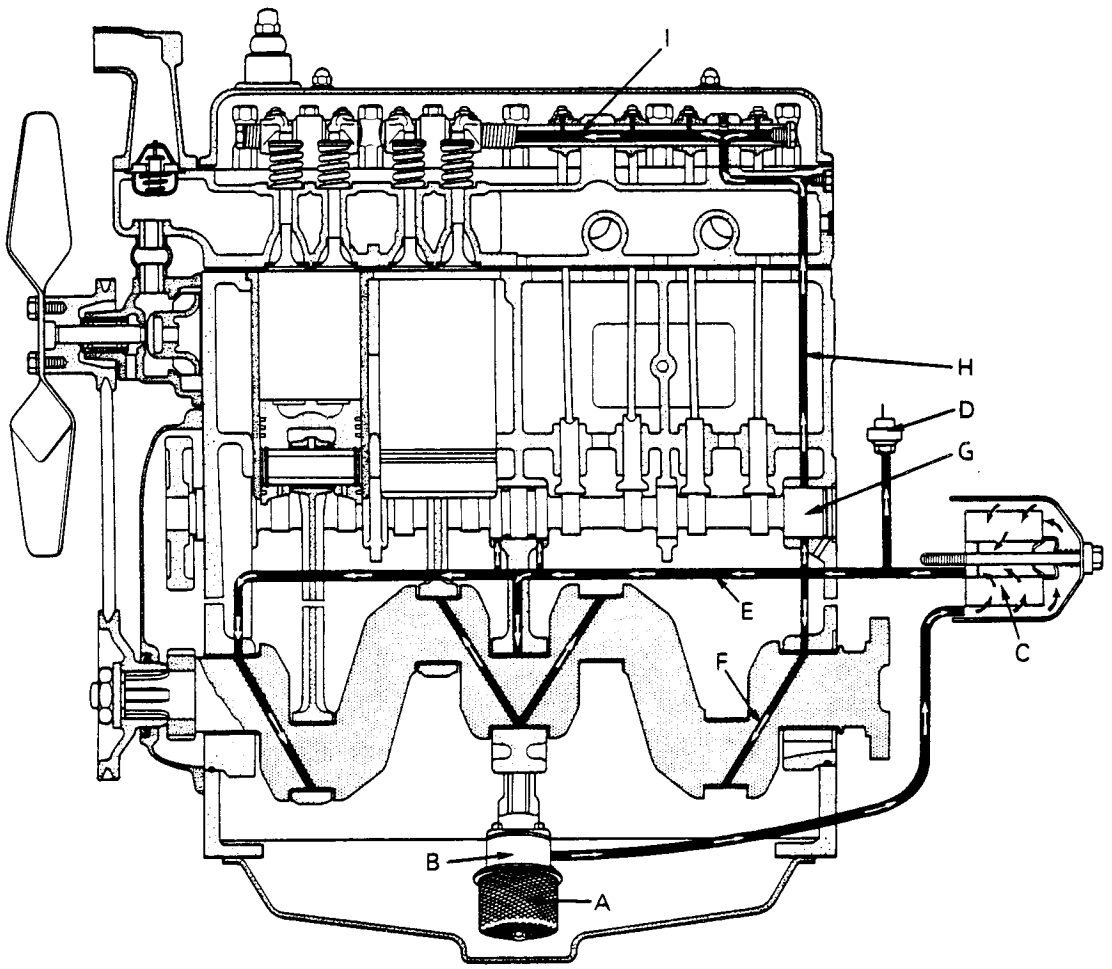


Figure 19. LUBRICATION SYSTEM

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

## Engine Lubrication

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

The rocker shaft and valve rockers are intermittently fed with oil from the camshaft rear bearing through oilways in block and head and an external connecting pipe. The camshaft is drilled off-centre so that the oilways are connected only once in each revolution. (See Fig. 20.) The oil lubricates the tappets and push rods as it returns to the sump.

The intermediate gear is pressure fed via its hollow shaft and an oil-way in the cylinder block. A connection at the front end of the main oil gallery supplies a reduced flow of oil to the injection pump drive gear. Surplus oil in the timing cover forms an oil bath which splash lubricates the timing gears.

A full-flow oil filter is mounted on the left-hand side of the cylinder block. The filter incorporates a by-pass valve so that if the pressure difference between the filter inlet and outlet exceeds 10 lb/sq in. the valve opens and allows oil to by-pass the element and flow straight into the oil gallery. The engine is not, therefore, starved of oil if the element is allowed to become choked, but it is supplied with unfiltered oil. The replaceable paper element should be renewed at the intervals specified on Page 1. A new element should also be fitted when an engine is overhauled and also if a cylinder head gasket fails.

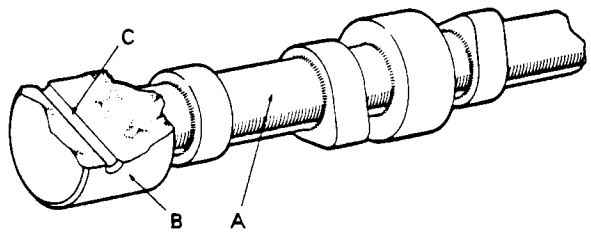


Figure 20. VALVE GEAR OIL FEED

A. Camshaft B. Rear journal C. Oil passage

If engine oil and filter element are not changed when a failed cylinder head gasket is replaced, any water which has leaked into sump will cause the paper filter element to swell and fail to pass oil. (Fig. 21.)

Do not attempt to clean a filter element.

## Oil Warning Light

The oil warning light on the instrument panel is earthed by a switch in the cylinder block and when the switch opens the light is extinguished. The switch is connected into the main oil gallery and should open at 9 to 13 lb/sq. in. (0·6 to 0·9 kg/sq. cm) but if not, it must be replaced because no adjustment is possible. If incorrect oil pressure is suspected the oil switch can be removed and a pressure gauge connected into the cylinder block, which is threaded $\frac{1}{8}$ BSP, so that the actual oil pressure will be shown when the engine is started.

## Oil Pump

The gear type oil pump is located in the engine sump and contains a relief valve which is set to open at 40 lb/sq. in. (2·8 kg/sq cm).

## To Remove the Pump

1. Drain engine oil and remove sump.
2. Disconnect outlet pipe from pump to cylinder block.
3. Disconnect the tractormeter cable.
4. Release locknut and remove pump locating screw, which is situated on the right-hand side of block, and withdraw pump downwards.

The oil pump must be dismantled to check gear wear, gear end-float, and the condition of the upper bearing.

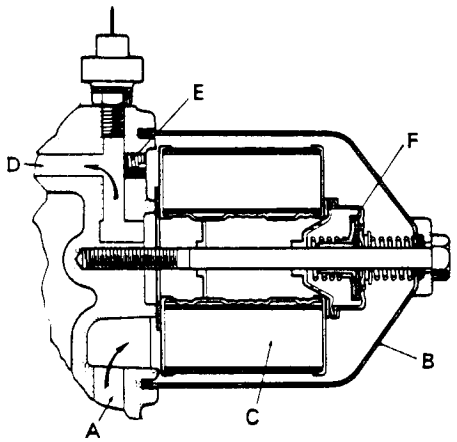


Figure 21. SECTION THROUGH OIL FILTER

A. Oil feed from pump B. Bowl C. Element
D. Outlet to oil gallery E. Plug F. By-pass valve

## To Dismantle Pump

1. Remove the two setscrews and two bolts securing pump cover, noting that the two bolts are special locating bolts and must be fitted in their correct places when re-assembling.
2. Remove cover, complete with relief valve, and filter.
3. Check backlash between gears — this should be 0·020 to 0·026 in. (0·51 to 0·66 mm).

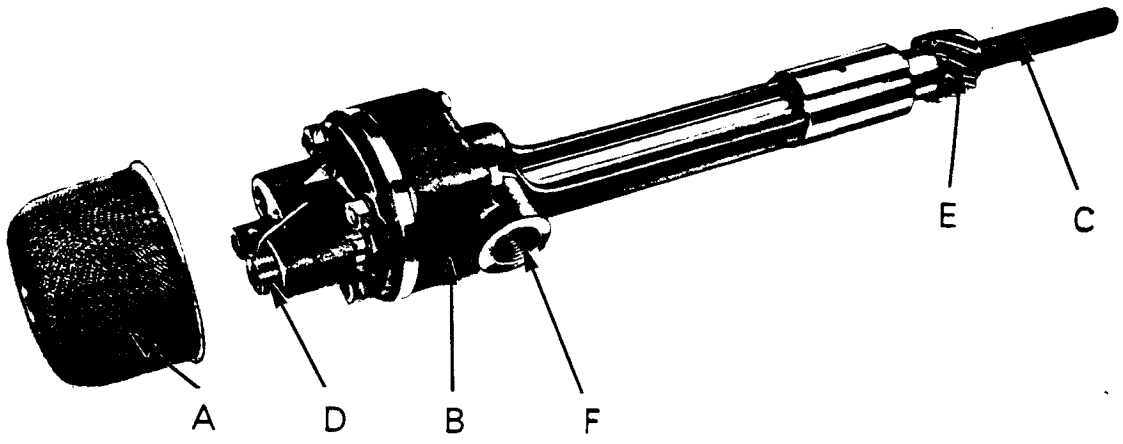


Figure 22. LUBRICATING OIL PUMP

A. Oil inlet gauze B. Pump body C. Driveshaft
D. Relief valve screw E. Spiral pinion F. Oil outlet connection

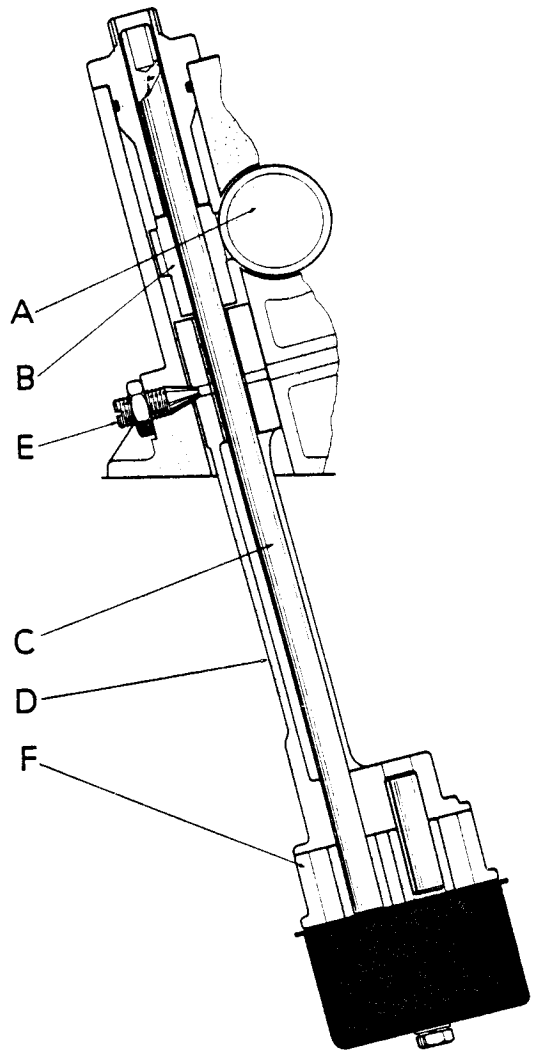


Figure 23. OIL PUMP DRIVE

A. Camshaft B. Spiral pinion C. Driveshaft
D. Pump bracket E. Locating screw F. Pump body

4. Remove driven gear and shaft.
5. Use a drift to force driving shaft from driving gear.
6. Check rotor and housing dimensions.
   Rotor width: 1·1865 – 1·1855 in. (30·13 – 30·11 mm)
   Housing depth: 1·1890 – 1·1875 in. (30·19 – 30·16 mm)
   Rotor side clearance: 0·001 – 0·0035 in. (0·025 – 0·089 mm)
   If end-float is excessive but backlash is within limits and the gears are not worn, it is permissible to grind the face of the housing to reduce end-float. If the gears are damaged, both gears should be replaced. Never replace one gear only.
7. Check the upper bearing for wear.
   Bush internal diameter: 0·4905 – 0·4925 in. (12·46 – 12·51 mm)
   Shaft diameter: 0·4895 – 0·490 in. (12·43 – 12·45 mm)

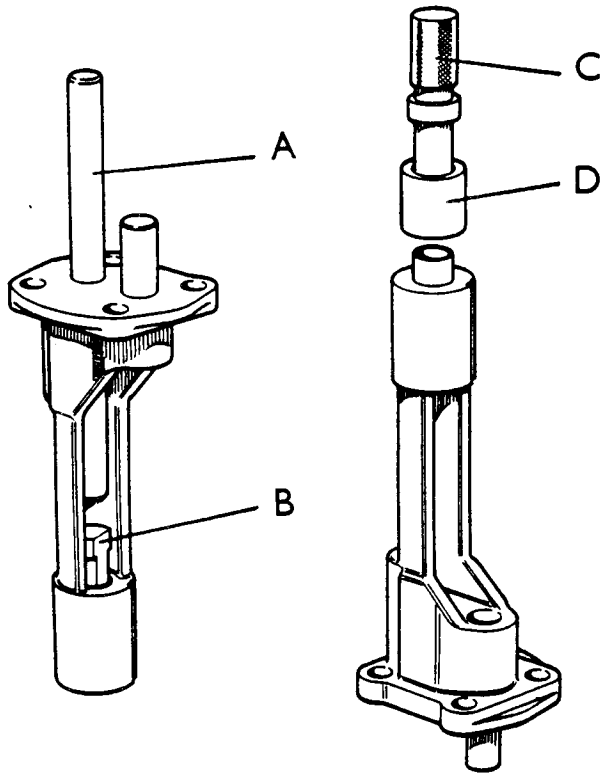


Figure 24. REPLACING OIL PUMP BRACKET BUSH
(Using Service Tool 901701)

A. Long drift B. Pilot C. Replacer drift
D. Centraliser guide

   Clearance: 0·0005 – 0·003 in. (0·02 – 0·08 mm)

If wear is excessive, remove the bush and replace using Service Tool 901701 as detailed below:

1. Slip special pilot bush B through slot in pump bracket to locate in driveshaft bush.
2. Stand pump bracket on a suitable hollow anvil or press base.
3. Place drift A in position.
4. Drive or press out pump bracket bush.

To replace the new bush:

1. Place new bush on the replacer drift C.
2. Push centraliser D over new bush and drift C until oil-hole in bush just shows at bottom edge of centraliser, ensuring that the oil-holes in bush and bracket are in line.
3. Start new bush in pump bracket and slide of centraliser, ensuring that the oil-holes in bush and bracket are in line.
4. Stand the pump bracket on a flat anvil or press base; drive or press C until it butts firmly against D. The bush is now in its correct position in pump bracket. The driven rotor shaft may be removed using drift A.

## Relief Valve

If the valve is to be removed for cleaning purposes take note how many threads are showing above the

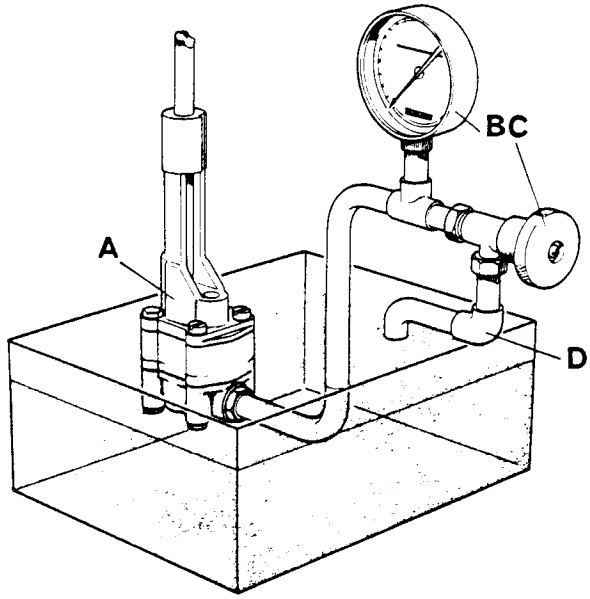


Figure 25. OIL PUMP TEST RIG

A. Oil pump B. Pressure gauge C. Shut-off valve
D. Swivelling outlet

locknut before removal. This is necessary so that the valve may be set in its original setting if a test rig is not available.

Approximate figures to use as a guide when setting the valve are: four threads showing above locknut give approximately 40 lb/in.$^2$; one full turn produces a 6 lb/in.$^2$ variation in pressure.

To check the pressure, the oil pressure warning switch should be removed and a gauge fitted into the $\frac{1}{8}$ BSP hole in the cylinder block.

If a test rig is available the following procedure should be adopted:

1. Use Shell Fortisal 5W at room temperature of 20°C (68°F) or 20/20W at 46°C (115°F), which is equivalent to hot engine oil.
2. Pump to be driven at 750 rev/min or 330 rev/min.
3. Relief valve set to open at 40 lb/sq. in. (2·8 kg/sq. cm).
4. Pump flow at 20 lb/sq. in. should be 19·2 pints/min (10·9 litres/min) at 750 rev/min and 8·4 pints/min (4·7 litres/min) at 330 rev/min. Delivery in pints/min $= \frac{480}{\text{time in seconds for one gallon to flow.}}$

Maximum time for one gallon should be:

25 seconds at 750 rev/min.

57 seconds at 330 rev/min.

## To Replace the Pump

Reverse the removal procedure. Coat the locating screw with Wellseal, or a similar jointing compound, screw tightly into the cylinder block then tighten locknut.

# COOLING SYSTEM

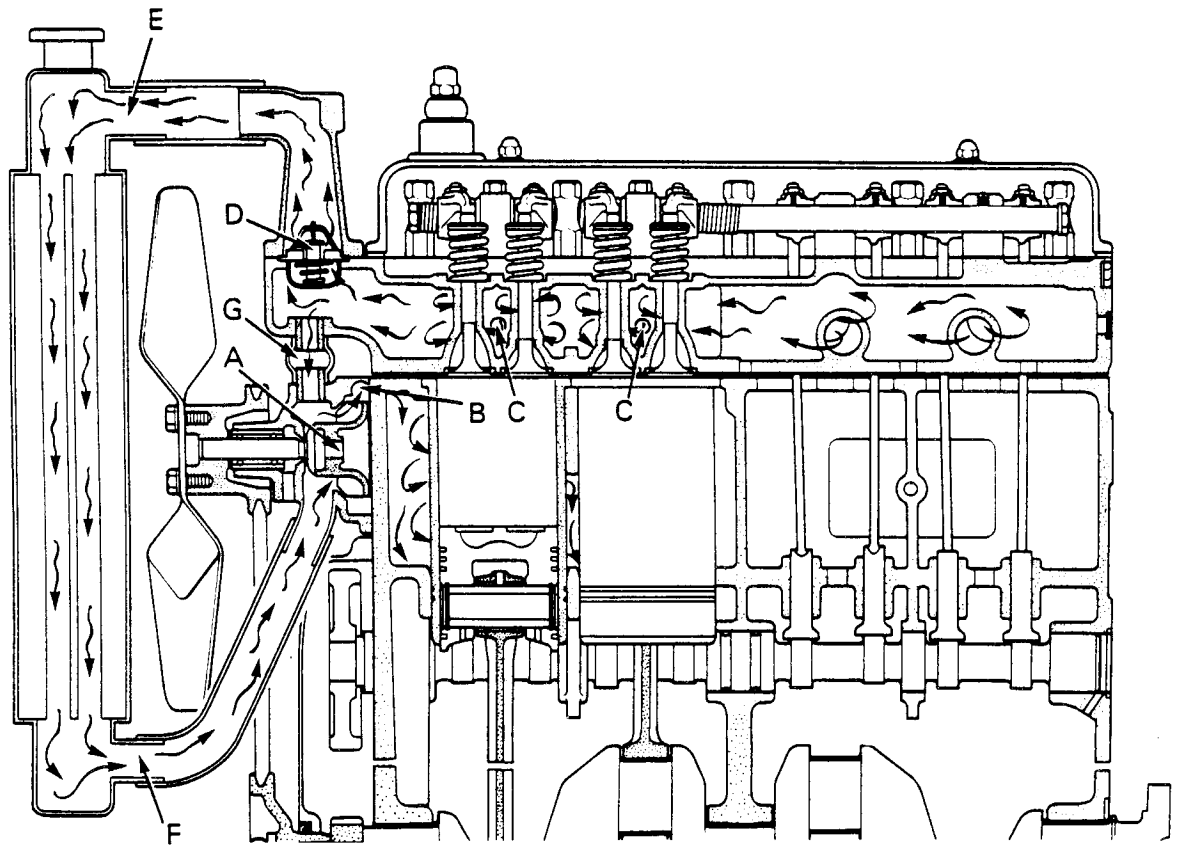


Figure 26. COOLING SYSTEM

A. Pump impeller
B. Passage into cylinder head
C. Jets on to valve ports
D. Thermostat
E. Radiator inlet
F. Radiator outlet
G. By-pass connection

## Path of Water

Cold water is drawn into the water pump from the bottom of the radiator and is then pumped through a passage in the cylinder block to the cylinder head, where it is directed, in the form of jets, on to the injector bosses and integral valve guides. The water is able to pass, by thermo-siphon, into the block through the mating passages in the cylinder head and block to cool the cylinders. The hot water returns from the head to the top of the radiator through a thermostat which is only fully open when the engine reaches its working temperature.

When the thermostat is closed the water passing out of the cylinder head cannot pass into the radiator and therefore circulates through the by-pass into the inlet side of the water pump, thus ensuring that working temperature is reached as quickly as possible.

The system is pressurised by a spring plunger in the radiator cap, which allows steam to escape through the overflow pipe if the pressure exceeds 4 lb/sq. in. (0·28 kg/sq. cm).

The fan is mounted on the same spindle as the water impeller and is driven by a 'V' belt from the crankshaft at $1\frac{1}{2}$ times engine speed. (Fig. 26.)

## Removal of Water Pump

This operation can be accomplished, without removing the radiator, in the following manner:

1. Drain the water from radiator and cylinder block.
2. Remove waste pipe from radiator to pump.
3. Remove fan belt.
4. Remove fan blades (ensuring that they are marked in such a way that they can be refitted in the same position, thus safeguarding against the possibility of them getting out of balance).
5. Slacken clip securing by-pass hose. Unscrew the five bolts fixing pump to cylinder block and remove pump.

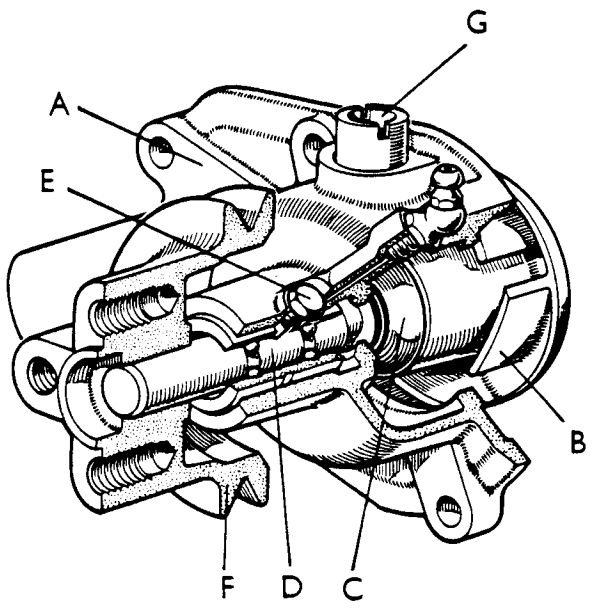


Figure 27. ARRANGEMENT OF WATER PUMP

A. Body B. Impeller C. Gland seal
D. Bearing and shaft E. Bearing locating screw
F. Pulley G. By-pass connection

## Fitting a New Seal or Bearing

Remove bearing location screw E (Fig. 27) from pump body. Place pump, impeller upwards, on the bed of a press and suitably support it with packing. Press spindle and bearing assembly out, taking care not to damage impeller or pump body.

After spindle and bearing assembly has been removed the impeller may be lifted out and the seal prised out of end of impeller. The seal is supplied as a self-contained assembly and no attempt should be made to dismantle it. A new seal should be carefully pressed into impeller bore using a little Pressoline No. 2 compound (one part Pressoline to three parts water) as a lubricant. Press the seal in until the shoulder touches the end of the impeller, taking care not to cut or damage the seal. Coat the contact face of the seal with anti-scuffing paste to prevent the seal sticking to the pump body.

Examine the spindle and bearing assembly and, if this is to be renewed, remove pulley with a suitable extractor or press.

As gland seals are affected by light they should be stored in a light-tight drawer or box. The wax wrapping paper is not sufficient and seals will deteriorate if exposed to light during storage.

## Reassembly of Water Pump

Position bearing-locating hole so that it is in line with the screw-hole in pump body then push bearing into the body and fit the locating screw. After tightening locating screw, lock the screw with the tabwasher.

Press pulley on to spindle until the end of spindle is level with the end of pulley bore. Do not fit pulley by hammering it on to spindle but press the spindle into pulley by pressing against the impeller end of spindle.

Press impeller on to spindle until the sides of impeller blades are 0·005 in. (0·13 mm) clear of the pump body. Ensure that the seal is not damaged when fitting the impeller and do not support the pump on the pulley when pressing impeller into position. Support pulley end of spindle on a short piece of $\frac{7}{8}$ in. (22 mm) diameter bar, so that the thrust is taken on the end of spindle and does not tend to push the pulley further on to spindle.

Before replacing water pump, check the condition of by-pass hose ; if this is at all suspect it is advisable to renew it, as renewal is more difficult when both pump and cylinder head are in place.

A new gasket should always be used when refitting the pump and plain washers fitted on the fan blade setscrews, to avoid any possibility of blade failure due to fatigue.

## Thermostat

To test the thermostat, remove it and place it in cold water together with an accurate thermometer. Heat the water and as the temperature rises note at what stage the thermostat begins to open. This should be at between 174°F and 183°F (79°C – 84°C). At 200°F (94°C) it should be fully open. If placed in boiling water the thermostat should be fully open within 60 to 90 seconds.

On the base of the thermostat the figure 180 signifies the temperature at which it should start to open.

# REPAIR OPERATIONS

## Engine Tune

1. **Compression:** To check the compression use a Test Gauge such as is shown in the Service Tools List. Remove all injectors and, using the correct length of extension, fit the gauge into No. 1 injector bore. Tighten down with injector nuts to give an airtight seal and with the stop control in the "stop" position turn engine with starter. It is advisable to use a fully charged battery. Note the compression reading and repeat the procedure for the remaining cylinders. If the four readings are approximately the same then proceed with the engine tune. If there is an appreciable difference in readings then it will be necessary to decarbonise cylinder head, as the loss of compression is probably due to faulty valves or valve seats.

## Compression Figures

Compression ratio 17:1. Air temperature 68°F (20°C)

| Crankshaft Speed | Pressure lb/in² | Pressure kg/cm² |
|---|---|---|
| 150 rev/min | 380 – 400 | 26·6 – 28·0 |
| 250 rev/min | 415 – 435 | 29·0 – 30·5 |

2. **Injectors:** Service and set before replacing. (See Page 7.) Take care to fit copper sealing washers and tighten nuts down evenly to avoid distortion.
3. **Fuel:** Clean fuel sediment bowl and replace fuel filter elements as necessary. (See Page 3.) Vent the system, finishing with tightening the injector unions (as in Fuel System, Page 5).
4. **Breather:** Fit a new breather element as instructed under Maintenance, Page 2.
5. **Valves:** Check valve clearances, taking care to follow instructions on Page 2.
6. **Timing:** Check timing marks on pump and pump drive housing. If necessary loosen the mounting nuts and rotate the pump to align the marks.

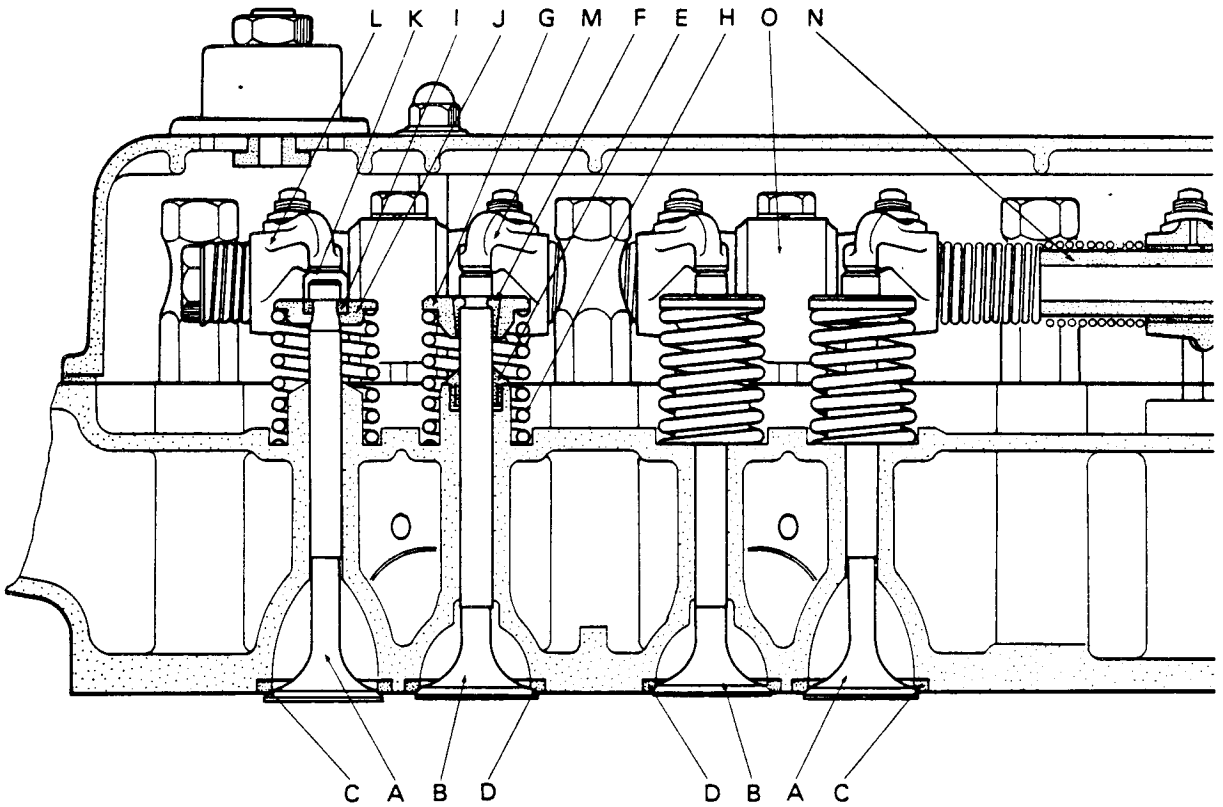


Figure 28. ARRANGEMENT OF VALVES

A. Exhaust valves
B. Inlet valves
C. Exhaust seat inserts
D. Inlet valve seats
E. Inlet valve stem seal
F. Inlet valve cotters
G. Inlet valve cup
H. Springs
I. Exhaust valve cotters
J. Exhaust valve cup
K. Stem end-cap
L. Exhaust valve rocker
M. Inlet valve rocker
N. Rocker shaft
O. Bracket

7. **Air Cleaner**: Clean out oil bath and replenish with the correct oil. Wash out gauze filter and clean tube and pre-cleaner. If a paper pre-cleaner is fitted, clean or renew the element. (See Page 1.)

## Decarbonising the Engine

When compression is low or engine is down in power due to an accumulation of carbon inside combustion chamber, the cylinder head should be removed, cleaned of carbon deposits and the valves re-seated.

## To Remove Cylinder Head

1. Remove the bonnet, disconnect the battery and drain the cylinder block.
2. Remove injector leak-off pipe and four high-pressure injector pipes.
3. Remove injectors and copper sealing washers. Before refitting, injectors will require servicing and testing. (See Page 7.)
4. Remove breather pipe from air cleaner and unscrew the four domed nuts and remove rocker cover and gasket.
5. Slacken clips on by-pass hose.
6. Remove rocker shaft oil-feed pipe.
7. Remove rocker shaft assembly and push-rods.
8. Remove the ten nuts, seven bolts and two lifting nuts, holding the head to cylinder block, in reverse order to tightening procedure, to prevent distortion of head.
9. Lift off cylinder head and place on the bench.
10. Remove gasket, clean cylinder-block face and oil the bores before covering over with a cloth or sheet of paper for protection.

## Dismantling the Cylinder Head and Cleaning

1. Remove inlet and exhaust manifolds, scraping out ports in exhaust manifold and washing to clean away carbon.
2. Mark all valves on head with a number to ensure re-assembly in same order.
3. Remove valve springs, cotters, collars and inlet valve seals and wash in paraffin.
4. Clean the head, scraping all carbon from valve ports, then wash and clean with an air jet.

## Valves and Seats

The valve stems operate direct in micro-finished bores in the cylinder head (no separate guides). The inlet valves are fitted with taper cotters which grip the valve stem and prevent it from rotating, but the exhaust valve cotters are parallel and the valve has a loose cap on the end of the stem. The valve rocker does not, therefore, operate directly on the valve stem but operates against the cap so that the valve is free of pressure at the beginning and end of each opening period. This allows the valve to rotate, keeping it free of carbon and prolonging seat life.

Clean the valves and reface if necessary, using a suitable valve grinder. The valve faces should be ground at 45° and care must be taken not to remove too much metal as the exhaust valves will overheat if heads are ground to a knife-edge finish.

Examine the ends of the inlet valve stems and if worn, lightly skim on a valve refacing machine, using the V-support guide to ensure that the end is ground square with the valve stem.

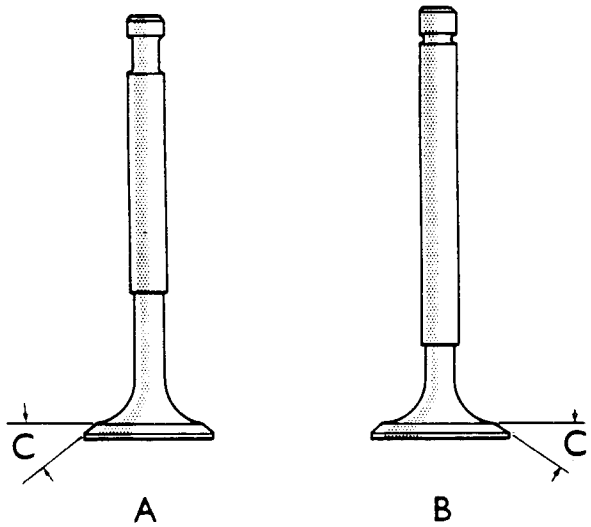


Figure 29. INLET AND EXHAUST VALVES
A. Exhaust valve B. Inlet valve
C. Seat angle 45°

Examine valve seats. If seats are in good condition but only discoloured, lapping-in the valves will be sufficient to obtain a good seat, but if seats are pitted it may be necessary to recut them before lapping-in the valves. Use a valve seat cutter, or grinder, with a pilot of the correct diameter, to ensure an accurate seat (see Tool Leaflet B9). Do not remove more metal than is necessary. If valve seat becomes wider than 0·065 in. (1·65 mm), the seat insert should be removed and a new insert fitted. To remove the insert, weaken by drilling almost through then crack it with a sharp chisel, taking care not to damage cylinder head, and covering insert with a piece of cloth, to prevent injury from flying particles. Clean the head counterbore and after cooling new insert with dry ice (solid carbon dioxide) quickly tap it into position using Service Tool 960602. The seat must be fitted with its chamfered edge into the head counterbore and then ground flush with the head face before the seat is cut.

## Oversize Valves

The valve guides are cast integral with cylinder head and if excessive wear takes place the guide can be reamed true and new valves with oversize stems fitted. Valves with 0·010 in. and 0·020 in. oversize stems are available and the appropriate size reamer

should be used (see Service Tool Leaflet A28) to obtain an accurate bore. It is also important that the bore has a good surface finish and special care should be taken when reaming; use a liberal quantity of cutting fluid and a very slow-running pillar drill. When bore has been reamed to the correct size, fit new valve and check valve seat with marking blue. If valve head touches seat all the way round, lapping-in will be sufficient, but if valve head only touches seat at one side the seat is not concentric with guide bore and will require cutting before lapping-in.

## Valve Springs

If suitable equipment is available, check spring lengths when under load, but if such equipment is not available check the free length. (See Page 33.)

If any spring is weak, broken or corroded, and engine has run for a large number of hours it is advisable to fit a complete set of new springs.

## Cylinder Head Face

The face of cylinder head should be smooth and free from distortion and damage, otherwise the cylinder head gasket may be unable to provide an effective seal.

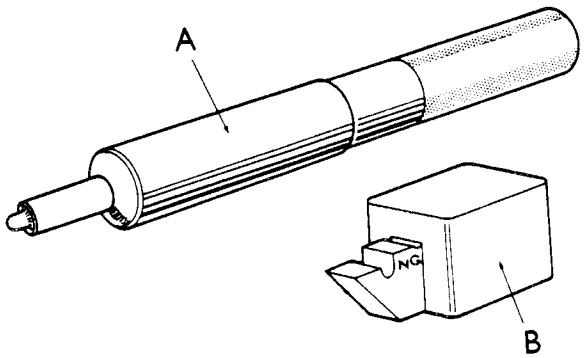


Figure 30. CYLINDER HEAD FACE GAUGES
A. Depth gauge (960938) B. Slip gauge (960940)

If the cylinder head face is reground care must be taken to obtain a smooth finish: a fine stone should be used with a slow feed. Before surface grinding check how much metal can be removed by using Service Tools 960938 and 960940. Insert depth gauge into injector recess, ensuring that both recess and tool are clean, then check protrusion of depth gauge above head face with slip gauge. If face G of slip gauge beak fouls end of depth gauge the cylinder head face has been previously ground to the limit and no further grinding is permissible. If beak face G passes over end of depth gauge the head face can be ground and the thickness of feeler gauge which can be fitted between tip of depth gauge and face G will indicate the maximum amount of metal that should be removed.

## Valve Lapping

Using a suitable tool to hold the valves and rough grinding paste, lap-in all the valves to obtain full-circle contact between valve and seat, then lap-in again with smooth grinding paste, and wipe clean.

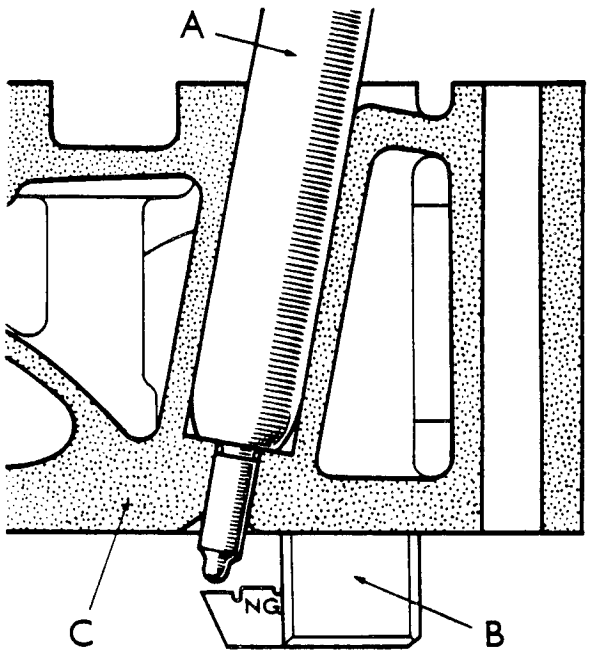


Figure 31. CHECKING THE CYLINDER HEAD BEFORE REFACING
A. Depth gauge B. Slip gauge C. Cylinder head

## To Reassemble and Replace the Cylinder Head

1. Renew inlet valve seals (see Fig. 28) using Service Tool 961236, making sure there are no burrs on the chamfer in cylinder head recess. Put seal on to the tool, smear with grease and place tool in the recess. Two or three sharp taps with a copper hammer are sufficient to drive seal home. Do not fit seals until cylinder head is ready for assembling and do not withdraw a valve once it has been fitted through a seal. As pulling valve stem through seal causes the cotter groove to trap and damage the sharp edge of the seal, it is necessary to fit a new seal whenever a valve is removed.
2. Smear valve stems with a little oil and reassemble with the springs, collars and cotters, using a suitable tool to compress springs and ensuring that valves are fitted in their correct positions.
3. Refit inlet and exhaust manifolds using new gaskets.
4. If the new gasket is copper and asbestos, coat both sides evenly with Wellseal. Allow gasket to dry for five minutes, keeping clear of dirt, then fit on to cylinder block with beaded side of gasket towards cylinder head. If the new gasket is graphite-finished asbestos with tin-plate inserts do not use Wellseal but fit the gasket dry (side marked "Top" towards cylinder head), after ensuring that block and head face are clean.

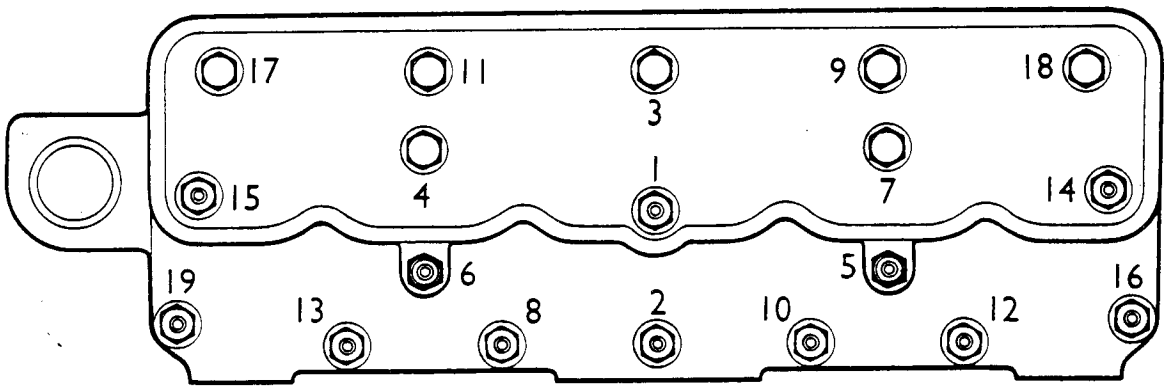


Figure 32. CYLINDER HEAD TIGHTENING SEQUENCE

Tighten the bolts in the order shown and in three stages of 30, 60 and 90 lb ft (4, 8 and 12·5 kg metres)

5. Fit a new by-pass hose and lower cylinder head on to block. Following the tightening sequence shown in Fig. 32, progressively tighten down all head bolts and nuts in stages of 30, 60 and 90 lb ft (4, 8 and 12·5 kg metres).
6. Tighten by-pass hose clips and replace push-rods in their original positions. Ensure that the push-rods are not bent and check that they are correctly seated in the tappets.
7. Refit rocker shaft assembly and rocker lubrication pipe.
8. Oil the rockers liberally and then proceed to set valve clearances. (See Page 2.)
9. Replace injectors, fitting new copper sealing washers. Replace high-pressure injector pipes and leak-off pipe.
10. Replace gasket and rocker cover and then refit breather pipe.
11. Refill radiator, start engine and check for any fuel, oil or water leaks. It is advisable to check tightness of cylinder head bolts and check valve clearances after the engine has been run for half-an-hour.

## Pistons and Connecting Rods

The pistons cannot be removed through sump when crankshaft is in position, but by removing cylinder head and bearing caps they can be withdrawn through the top of bores.

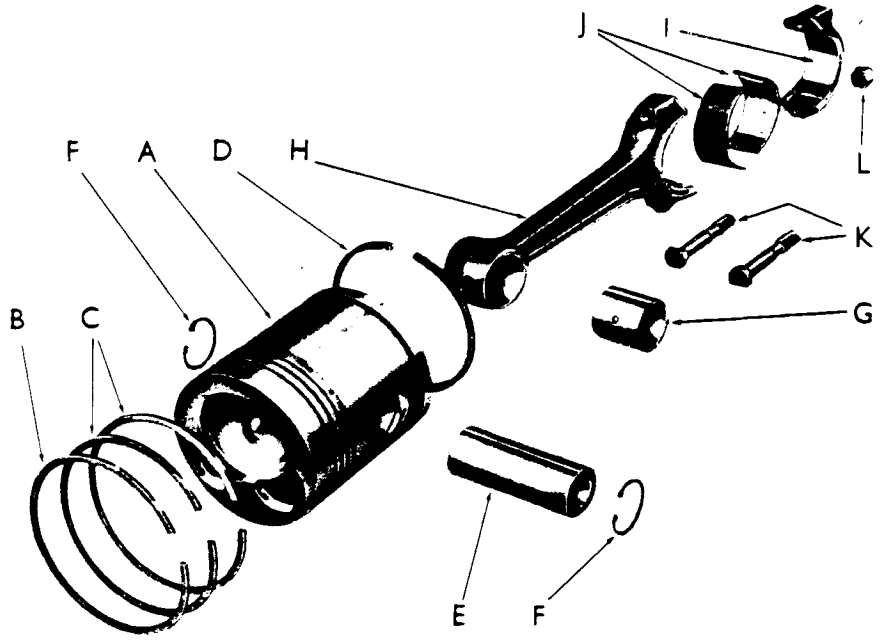


Figure 33. PISTON AND CONNECTING ROD

A. Piston
B. Top compression ring
C. Nos. 2 and 3 compression rings
D. Oil scraper ring
E. Gudgeon pin
F. Circlips
G. Bush — connecting rod
H. Connecting rod
I. Connecting rod cap
J. Big-end bearing shells
K. Connecting rod bolts
L. Self-locking nut

## Removing the Pistons

The bearing cap bolts must be removed to prevent possible damage to the bore as the connecting rod is pulled up through the bore. Having removed piston, check that connecting rod and bearing caps are marked and mark piston so that it can be replaced in same cylinder.

## Gudgeon Pins

The fully floating gudgeon pins are retained by two circlips, one at each end of the pin, and to remove the gudgeon pin remove both circlips, then immerse piston in hot oil. This will cause piston to expand and allow the pin to be pushed out. Refit pin in same manner using hot oil, then replace circlips, ensuring that they are fully seated in their grooves. When the gudgeon pin has been refitted check that the piston has been replaced in its original position by noting that the valve recesses in the piston crown are towards the same side as the identification mark on the connecting rod.

## Connecting Rods

The small end of connecting rod is bushed and this can be replaced if worn. Press out worn bush, using a suitable sized mandrel, and press in new bush, ensuring that oil hole in the bush is opposite hole in the end of connecting rod. Hone, or ream, new bush after fitting until gudgeon pin is a light push-fit.

Connecting rods should always be checked for alignment whenever they are removed and especially if the piston skirt marking is not even. The easiest way of checking connecting rods is by means of a proprietary aligning tool such as is shown in Service Tool Leaflet B5, but if such a tool is not available, mandrels and 'V' blocks can be used.

If connecting rods are not more than 0·010 in./in. (0·1 mm/cm) out of alignment they should be straightened to bring them within the limits shown on Page 35. If a rod is more than 0·010 in./in. (0·1 mm/cm) out of alignment it should not be straightened but must be renewed.

When replacing pistons check that the ring gaps are spaced round piston so that no two are in line, i.e., one above the other. Check that piston is the right way round: valve recesses to camshaft side of cylinder block. Replace piston through top of the bore, using a ring clamp to compress piston rings.

Smear oil on bearing surfaces and replace cap and bolts. Fit new nuts if self-locking ring in nuts can be screwed on to bolts with the fingers, and tighten to specified torque. (See Page 32.)

## Pistons and Rings

There are three compression rings and one oil scraper ring on each piston. The top compression ring is plain on early engines, but is chromed on later engines. Numbers 2 and 3 compression rings are of the stepped type; these help to return oil back down the bore as well as acting as compression rings, and must be fitted correctly, i.e., cut-away section uppermost, otherwise oil will be pumped up the cylinder.

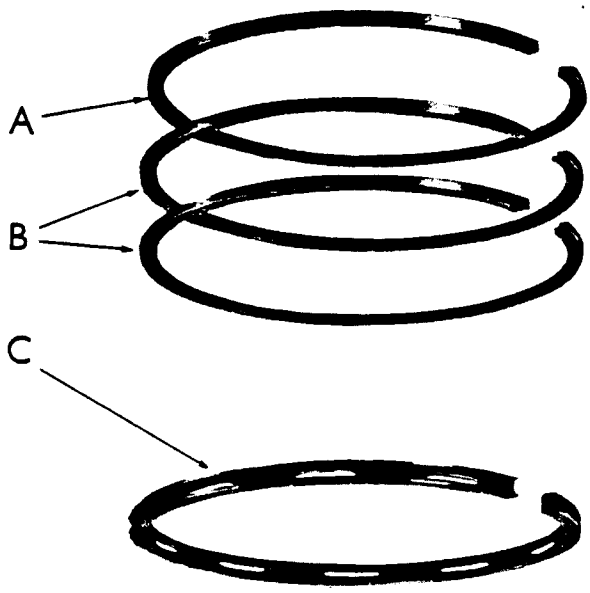


Figure 34. PISTON RINGS
A. Top ring with chrome insert
B. Nos. 2 and 3 stepped compression rings
C. Oil scraper ring

(See Fig. 34.) Number 4 ring is a single-piece cast iron scraper ring. This ring's function is purely to scrape oil down the bore, and the piston is drilled behind the ring to allow oil to pass through the piston skirt and back down to the sump.

After removing carbon from the top, unworn part of the bore, place the rings in position and check piston ring gaps. New rings will be required if the gaps exceed 0·060 in. (1·5 mm). For further guidance on bore wear see Guidance of Wear Limits on

Figure 35. CHECKING PISTON RING GROOVE CLEARANCE

Page 32. Excessive top ring wear may be attributed to the ingress of dusty air, due to lack of air cleaner maintenance, and excessive lower ring wear may be attributed to dirty engine oil, due to infrequent oil and filter changes.

If the cylinder sleeves are worn, but not sufficiently for renewing, oil control rings can be fitted. These sets include special top rings, which have a shoulder at the top so that the rings do not foul the ridge at the top of the bores, and spring-loaded steel scraper rings.

Pistons used with high-lift camshafts have slightly deeper valve recesses and pistons with shallower recesses must not be fitted to engines having a high-lift camshaft as the valve heads would foul the piston.

High-lift camshafts were fitted to engines from

AD4/47A/60390 AD/47B/40725

When fitting new pistons to AD4/47 engines subsequent to the above serial numbers ensure that they are of the later type, otherwise the pistons will foul the valve heads.

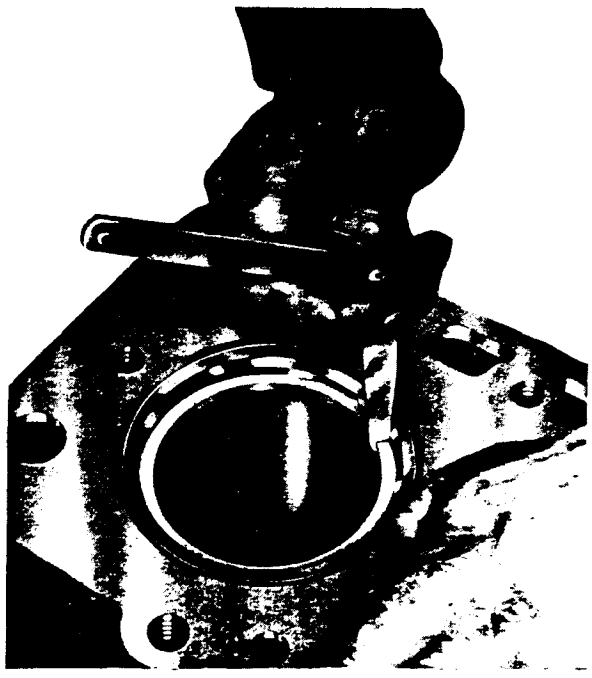

Figure 36. CHECKING PISTON RING GAP

## Crankshaft and Bearings

**Crankshaft Bearings**: The shell type crankshaft bearings are steel backed and faced with a thin coating of soft, anti-friction material. The upper and lower big-end shells and the lower main bearing shells are faced with aluminium-tin, but the upper main bearing shells are faced with white metal.

Bearing shells are not interchangeable once they have been fitted and if not renewed must be replaced in their original position.

The bearing caps and shells are very accurately machined and no attempt should be made to file a bearing cap or scrape a bearing. Connecting-rod caps must only be used with their original connecting rods and main bearing caps must only be fitted to their original cylinder blocks.

## Crankshaft Regrinding

If crankshaft journals are worn, or scored, the shaft should be reground and suitable undersize bearings fitted. Regrind the shaft journals to the appropriate undersize (see Page 35) and ensure that the correct fillet radii is maintained. A fillet that is incorrectly radiused, roughly finished or not smoothly blended weakens a shaft and may cause fatigue failure during service.

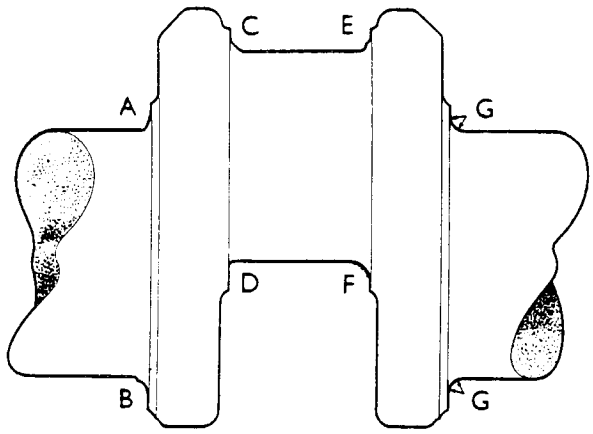


Figure 37. EXAMPLES OF REGROUND FILLET RADII

Incorrect
- A. No radius
- B. Radius not smoothly blended
- C. Radius too large
- D. Radius too small
- E. Radius too small
- F. Radius roughly finished

Correct
- G. Correct radius smoothly finished and correctly blended

## Crankshaft Rear Oil Seal

Oil leaks from the rear of the engine are prevented by an oil flinger on the crankshaft and a removable aluminium oil retainer incorporating a scroll. This retainer, which is in two halves — one half bolted to the block and the other half to the main bearing cap — is now fitted with paper gaskets. The gaskets are slightly oversize and should be trimmed on fitting. It is advisable to apply a gasket sealing compound. The two cap-head screws clamping the two halves of the retainer together and the four setscrews which hold the retainer to the cylinder block should be tightened together to ensure an oil-tight seal.

There is 0·008–0·012 in. (0·20–0·30 mm) clearance between scroll and crankshaft. The scroll must not touch the crankshaft, otherwise oil leakage will take place.

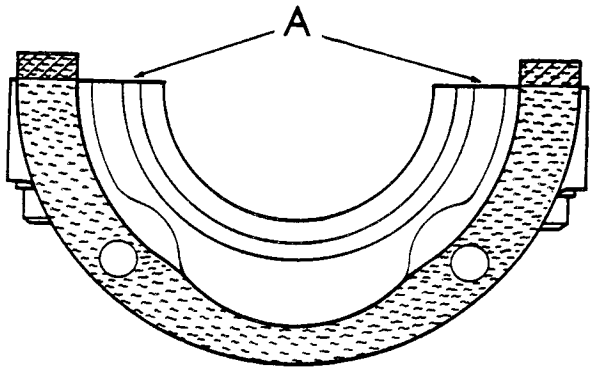


Figure 38. OIL RETAINER GASKET

Temporarily fit the gasket to the retainer and trim each half flush with the retainer face "A", so that when installed the two halves of the gasket will touch but not overlap.

## Cylinder Sleeves

The wet cylinder sleeves are sealed at their lower ends by two rubber rings and at their upper ends by the cylinder head gasket. The upper ends of the sleeves have a shoulder which is firmly clamped into a recess in the cylinder block when the cylinder head is bolted in position. The sleeves are a light press-fit in the cylinder block but as the outsides of the sleeves are immersed in the cooling water any build-up of deposit round the lower end of a sleeve will tend to "cement" the sleeve in position. The force required to remove the sleeve may, therefore, be quite high and it is essential that correct equipment is used when removing tight sleeves, otherwise damage to the sleeve or cylinder block may occur.

If the sleeves are worn, or the lower seals are leaking and allowing water to pass into the engine sump, withdraw the sleeves using the sleeve remover (Service Tool 901729). With the extractor pad attached to the centre screw so that the $3\frac{5}{8}$ in. diameter shoulder (the $3\frac{1}{2}$ in. diameter shoulder is for the $3\frac{1}{2}$ in. bore sleeves fitted on AD4/25 engines) is uppermost, tilt the pad on one side and lower the bore until the pad is positioned squarely underneath the sleeve (Fig. 39). Whilst holding extractor pad firmly against lower end of sleeve, lower the centralizer pad — larger diameter shoulder downwards against the sleeve — and tighten the butterfly-nut until sleeve is clamped between thrust pad and centralizer pad. After checking that the thrust pad is held squarely against lower end of sleeve, lower the bridge piece down until side-rod feet rest firmly on cylinder block and run the ratchet down until it comes up against bridge piece. Holding the centre screw stationary with the tommy-bar, operate ratchet handle to pull sleeve out of block.

After removing sleeve, clean all traces of deposit from upper and lower cylinder block registers. If sleeve has been removed with the engine in position clean off any dirt which has fallen on to crankshaft.

Always fit new rubber sealing rings when replacing sleeves and ensure that the sleeve and cylinder block are clean. Thoroughly clean cylinder block recess and

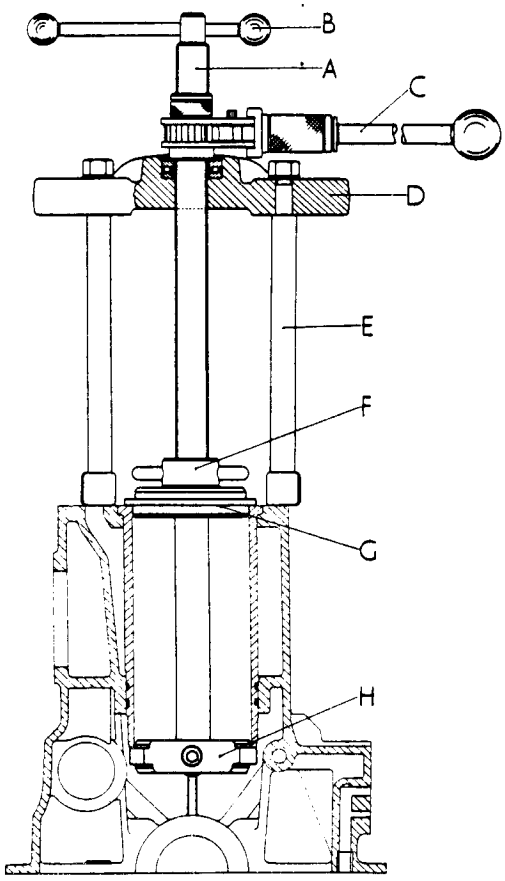


Figure 39. CYLINDER SLEEVE REMOVAL

A. Centre screw
B. Tommy bar
C. Ratchet handle
D. Bridge piece
E. Side rod
F. Butterfly nut
G. Centralizer pad
H. Extractor pad

} Service Tool 901729

carefully fit the rubber seals into sleeve grooves, taking care that the seals are not twisted. Smear underside of sleeve shoulder with Wellseal and apply an even coating of Pressoline No. 2 compound — one part Pressoline (Part No. 900185) mixed with three parts of water — on the seals and lower end of the sleeve.

Push the sleeve into block as far as possible by hand, positioning sleeve so that the flat in the shoulder is in line with the flat in adjacent sleeve. Using sleeve protrusion checking tool (Service Tool 902169), fit the replacer pad on top of sleeve, positioning the pad with the larger diameter recess against the sleeve and the flats in the pad aligned with the sleeve flats.

Attach the press body to cylinder block, using the original cylinder head studs and bolts. Fit the three distance pieces between the body and block and place a flat washer under each nut and bolt. After centring the body so that the ball in the end of pad rests in the dimple at pad centre, tighten the nut and bolts to 90 lb ft (12·5 kg metres).

Tightening the centre screw will push sleeve into block and when the screw has been tightened to a torque of 35 lb ft (4·8 kg metres) check the sleeve

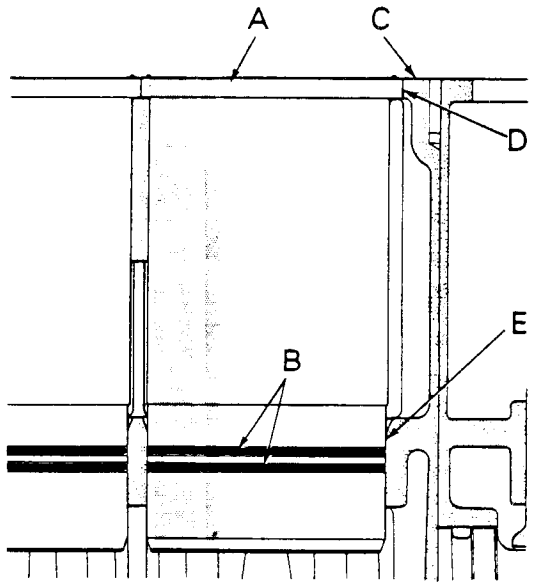


Figure 40. CYLINDER BLOCK AND SLEEVE

A. Sleeve shoulder
B. Sleeve seals
C. Cylinder block face
D. Cylinder block upper register
E. Cylinder block lower register

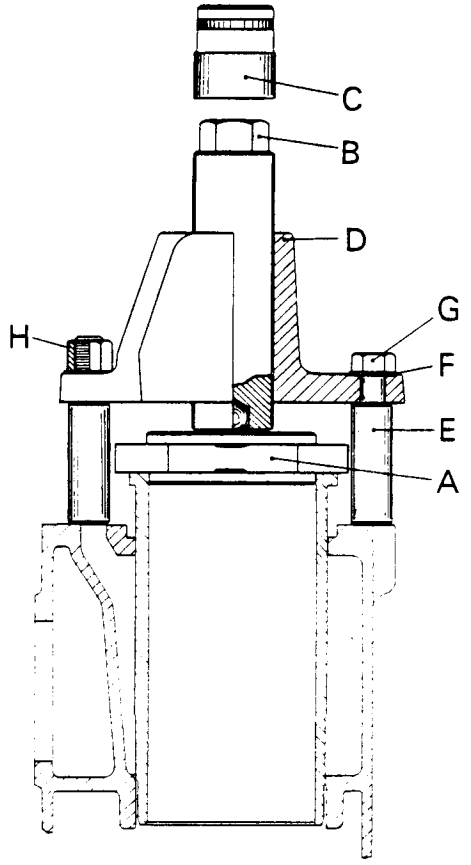


Figure 41. REPLACING CYLINDER SLEEVE

A. Replacer pad
B. Centre screw
C. Socket
D. Body
E. Distance piece
F. Flat washer
G. Cylinder head bolt
H. Cylinder head nut

} Service Tool 902169

protrusion above block face by inserting a feeler gauge between pad and block face. The sleeve and block are machined to give a protrusion of 0·002–0·005 in. (0·05–0·13 mm) and if the protrusion is greater than this the sleeve should be removed and the block recess cleaned as dirt, or carbon, must be preventing the sleeve shoulder from being fully seated.

Remove the tool from block, clean the sleeve and check that the ridge on the top edge of the sleeve has not been damaged during fitting.

## Cylinder Block

After stripping the cylinder block, clean out all the oil passages and check that they are clear by blowing through with compressed air. Ensure that the plugs from rear of oil gallery and the oil filter mounting boss are replaced. If the plug is omitted from the oil filter boss (Fig. 21) unfiltered oil will pass into the oil gallery.

## Timing Gear

To remove timing-gear cover with engine *in situ* it is advisable to remove the radiator to provide sufficient room for working at the front end of the engine.

Disconnect dynamo mounting and remove fan belt. Before removing crankshaft-pulley bolt, remove valve-rocker cover and turn the engine, using Service Tool 960995, until the valves on No. 4 cylinder are "rocking"; this will assist re-assembly by aligning the gear markings. Remove crankshaft pulley; this is splined on to the shaft and should not be very tight. Withdraw timing case, after removing the bolts. A small quantity of oil will be released when the cover joint is "broken".

Cut the locking wire and remove camshaft-gear bolt: do not allow camshaft to turn when releasing the bolt as a valve head may foul against a piston. Do not remove the three bolts visible through the holes in camshaft gear. These bolts attach the locating plate and if removed will allow the camshaft to move forward and jam against the tappets. The gear is keyed on to a parallel shaft and if tight may be withdrawn by using an extractor such as Service Tool 960901. Do not attempt to remove the gear by striking the end of camshaft with a hammer.

Remove the four bolts from the intermediate gear shaft support bracket, taking care of the shims fitted between bracket and carrier plate. The gear may be slid off the shaft, but the shaft is a push-fit in cylinder block and may be tight. If shaft is too tight to be pulled out by hand it may be extracted by cutting the head off a $\frac{5}{16}$ UNC bolt and threading the bolt shank $\frac{5}{16}$ BSF. The UNC thread can then be screwed into the shaft plug-hole and the BSF thread screwed into the slide hammer, Service Tool 4235A.

Cut the locking wire on injection-pump drive gear and remove the three coupling bolts. Mark position of the coupling and gear then remove the coupling; this will expose the split thrust washer and allow the washer and gear to be removed.

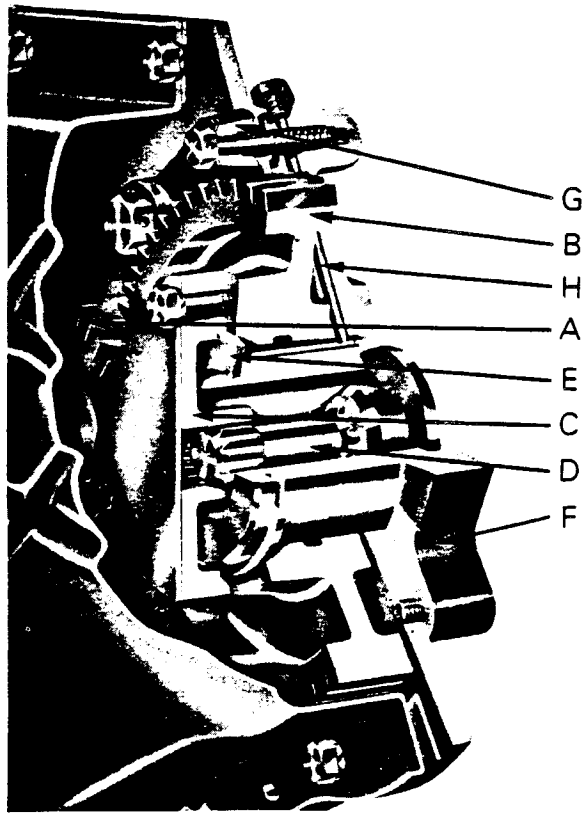


Figure 42.
INJECTION PUMP DRIVE

A. Intermediate gear
B. Drive gear
C. Coupling
D. Quill shaft
E. Thrust washer
F. Support flange
G. Connector
H. Oil feed

The injection pump gear support flange is fitted on the injection pump mounting studs and is attached by two bolts. The upper bolt is fitted on front of carrier plate and passes through a connector which receives oil from the main gallery and lubricates the gear bore through the drillings in the support flange. The bolt attaching the connector to oil gallery incorporates a restricting tube, so that a reduced flow of oil is supplied to the injection pump gear and it is advisable to remove this bolt to ensure that the restrictor is clear and not choked with sludge. Ensure the connector is refitted with the groove against the carrier plate and both bolts are firmly tightened before being wired together.

The crankshaft gear is keyed on the shaft and should not be removed unless it is to be renewed. Using Service Tool 960604, unscrew the extractor bolt so that when the tool is placed over the end of crankshaft the extractor body touches the face of gear. Place the two halves of split ring over the gear and, whilst holding split ring against the body until it is gripped by the chamfer on body shoulder, tighten extractor bolt to draw the gear off shaft.

Replace the gears in reverse order of removal, meshing the gears so that the teeth marks are aligned as shown in Fig. 44.

Smear injection pump gear with anti-scuffing paste before fitting in position. Replace the two halves of thrust washer and refit coupling : note that quill shaft is in position and the two marks on coupling are towards the mark on gear. Fit retaining plate and replace the bolts. Tighten the bolts to 20 lb ft (2·76 kg metres) and wire together. (Fig. 42.)

Smear plugs with Loctite and screw tightly into each end of the intermediate gear before pushing the grooved end of the shaft into cylinder block. Smear the intermediate gear bore with anti-scuffing paste and fit the gear on the shaft — teeth marks aligned and longest side of gear boss to carrier plate. Fit support bracket on to gear shaft and bolt in position, replacing the shims between carrier plate and bracket before fitting the bolts. With the bolts fully tightened insert a feeler gauge between bracket and gear to check the clearance. The gear should have 0·002–0·004 in. (0·05–0·010 mm) end-float and if necessary the bracket should be removed and shims added, or removed, as required.

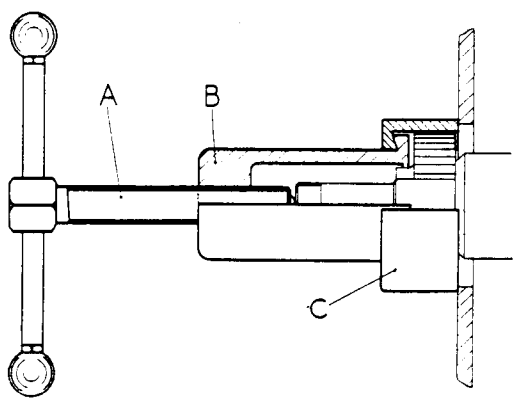


Figure 43. CRANKSHAFT GEAR REMOVER
A. Extractor screw B. Body C. Split ring
(Service Tool 960604)

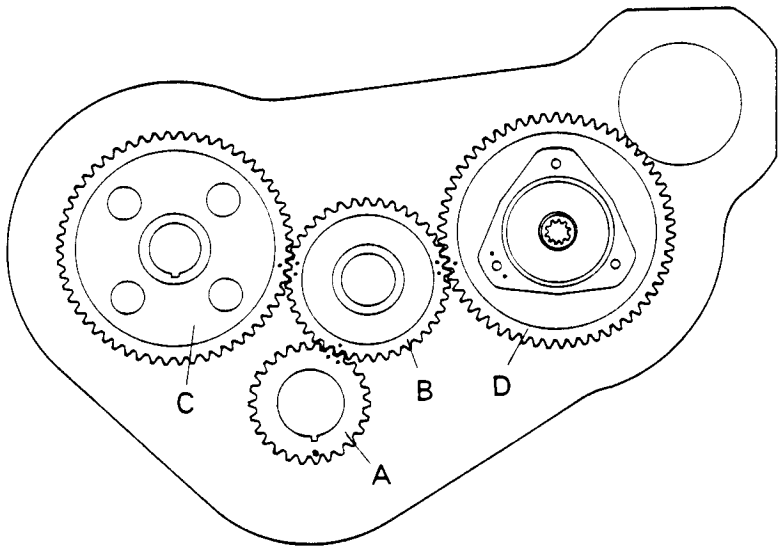


Figure 44.
TIMING GEAR MARKINGS

A. Crankshaft gear
B. Intermediate gear
C. Camshaft gear
D. Injector pump drive gear

Before replacing timing cover, check that gear marks are all correctly aligned and the crankshaft oil flinger, if originally fitted, is replaced. When the face width of crankshaft gear was increased to 1 in. (25·4 mm) the fitting of an oil flinger was discontinued.

Lever the oil seal out of timing case and carefully press in a new seal. Position the seal so that the seal lip points towards inside of case and take care not to distort the seal. Use Service Tools 901700 and 900211.

Fit timing cover in position, using a new gasket, and after screwing the bolts loosely into position fit crankshaft pulley. This will position oil seal centrally over pulley land before the bolts are tightened. Replace crankshaft pulley washer and nut. Refit dynamo and replace fan belt.

## Valve Mechanism

The camshaft is fitted from the front of the cylinder block and is retained in position by means of the locating plate behind the gear. As the tappets will fall and jam against the shaft journals when the shaft is moved forward it is necessary to invert the cylinder block or, if the engine is *in situ,* to hold the tappets up with 'O' rings, or spring clips, when removing the shaft. The shaft bearings are pressure fed from the oil gallery and the journals run directly in the cylinder block, the rear journal being drilled to supply a reduced flow of oil to the valve rocker shaft.

High-lift camshaft, Part No. 914673, is fitted to all engines from Nos. A/60390 and B/40725 and may be identified by the part number cast on the shaft between No. 1 cylinder cam lobes. When fitting a new camshaft ensure that this is the same number as originally fitted. A 902050 shaft must not be replaced by a 914673 shaft unless later type pistons (915308) are also fitted, otherwise the valve heads may foul the pistons.

## To Rebush Valve Rockers

Remove rocker shaft assembly and place on the bench. Unscrew the brass plugs from the ends of shaft and remove springs, rockers and shaft brackets, placing them in order on the bench.

Press out worn bush and fit new bush, ensuring that oil-hole is opposite hole in rocker. Hone or ream the bush until rocker is free to slide on the shaft.

If rocker end faces are worn, lightly skim on a smooth grindstone, taking care to maintain the original profile. Do not remove more metal than necessary: grind only until the wear mark is almost, but not fully, removed.

Assemble rockers, springs and brackets on to shaft. Fit locating screw into rear bracket, noting that the shaft is positioned with oil-feed holes towards the bottom, then peen the bracket over screw-hole to retain the screw.

## Engine Removal

On twelve-speed tractors the engine cannot be lifted out of the frame and the tractor must, therefore, first be "split" so that the clutch is clear of the driveshaft.

On six-speed gearboxes the engine can be lifted from main frame if the muff coupling can be slid far enough forward on clutch driveshaft to clear the gearbox. This is possible on all tractors fitted with the friction-pad type clutch stop and on tractors fitted with the band-type clutch stop from Serial No. 487807. Commencing at this number the width of the clutch-stop drum was reduced to allow sufficient clearance for sliding the muff coupling forward on the driveshaft, but on Livedrive tractors from Nos. 479539 to 487806 the width of the clutch-stop drum prevents the muff coupling from sliding far enough forward to clear the gearbox.

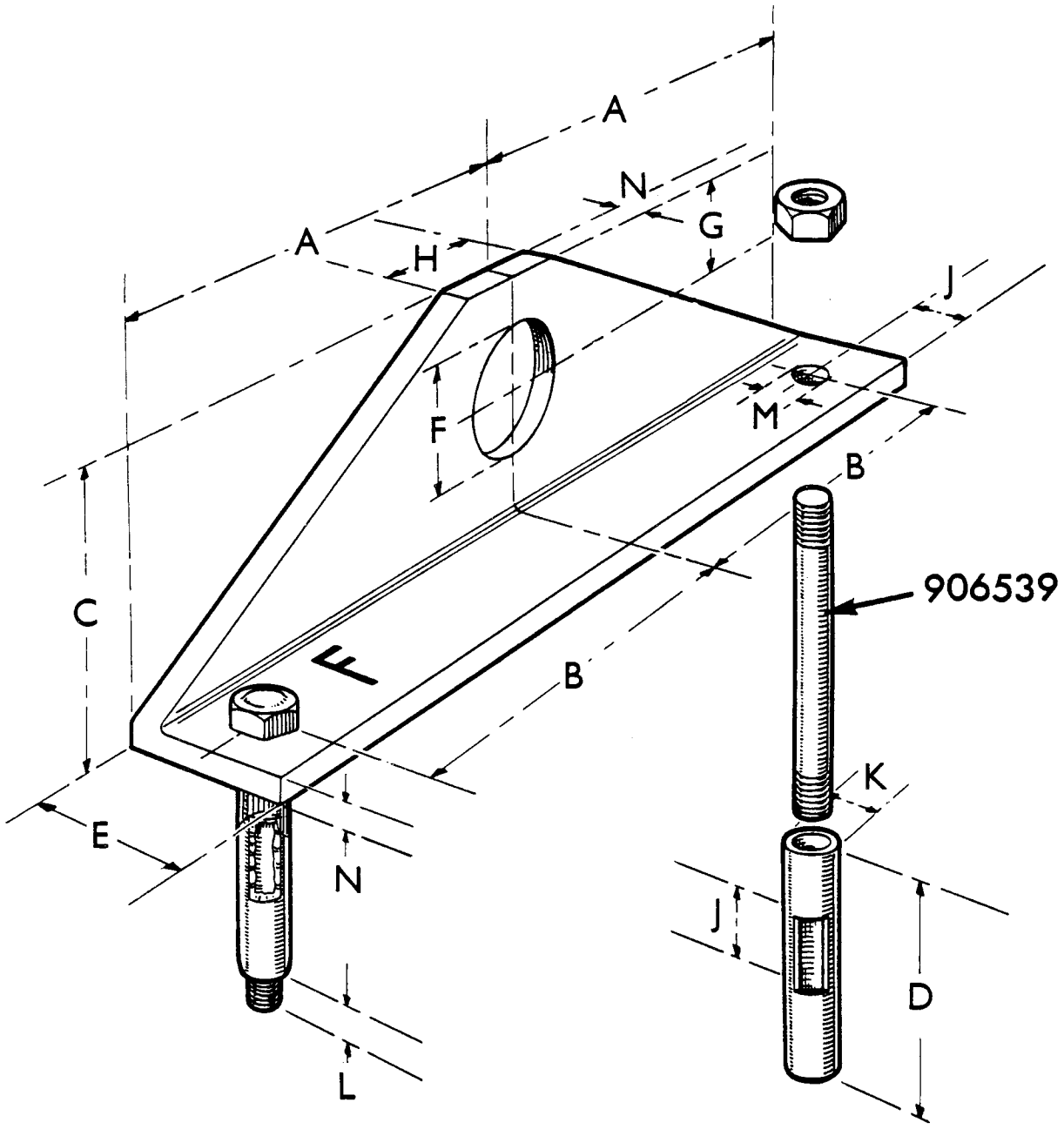


Figure 45. ENGINE LIFTING BRACKET

Nut and distance piece to be welded to stud allowing $\frac{1}{16}$ in. (0·158 cm) clearance between nut and angle bracket

A. 6 in. (15·24 cm)
B. $5\frac{1}{16}$ in. (12·86 cm)
C. 4 in. (10·16 cm)
D. $3\frac{11}{16}$ in. (9·366 cm)
E. $2\frac{1}{2}$ in. (6·350 cm)
F. 2 in. (5·080 cm)
G. $1\frac{3}{4}$ in. (4·445 cm)
H. $1\frac{1}{2}$ in. (3·810 cm)
J. 1 in. (2·54 cm)
K. $\frac{7}{8}$ in. (2·222 cm)
L. $\frac{5}{8}$ in. (1·587 cm)
M. $\frac{9}{16}$ in. (1·428 cm)
N. $\frac{3}{8}$ in. (0·952 cm)

Engine removal procedures may be summarised as follows:

**Non-Livedrive Models**
All numbers — Lift engine (Method 'A').

**Livedrive Models — Six-Speed**
Nos. 440001 to 479538 — Lift engine (Method 'A').

Nos. 479539 to 487806 — "Split" tractor (Method 'B').

Nos. 487807 onward — Lift engine (Method 'A').

**Livedrive Models — Twelve-Speed**
All numbers — "Split" tractor (Method 'B').

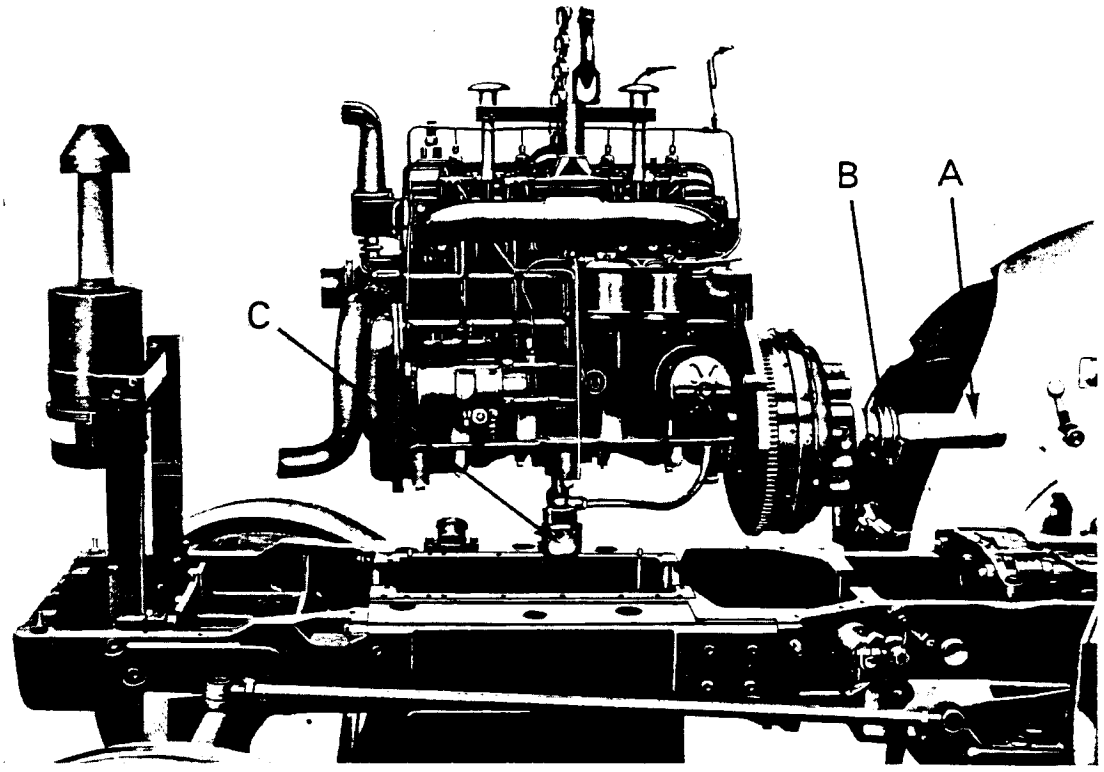


Figure 46. TRACTOR WITH ENGINE REMOVED

A. Muff coupling B. Support snout C. Engine oil pump

## Engine Removal — Method 'A'

Remove pre-cleaner, silencer and bonnet. Disconnect battery terminals and main lead to starter. Drain radiator and cylinder block, disconnect hoses and remove radiator. Disconnect throttle and stop-control linkage from injection pump. Remove the fuel pipe from tank to fuel feed pump and remove the short pipe connecting the leak-off to tank.

Disconnect the wiring and tractormeter cable. Remove fuel-tank mounting nuts and remove tank complete with instrument panel.

Remove steering drop-arm from its shaft and remove the steering-box, complete with column and wheel. This will expose the clutch-housing bolts inside the steering-box and enable gearbox cover and clutch housing to be removed.

On Livedrive tractors it is necessary to drain the transmission oil and remove the power take-off unit so that the cardan shaft can be withdrawn clear of clutch driveshaft.

If the tractor is fitted with a band-type clutch-stop remove the pins from each end of the band so that the band can be removed. Release the circlips on clutch driveshaft so that the drum and muff coupling can be slid far enough forward on the shaft to clear the gearbox.

If the tractor is not fitted with a band-type clutch-stop, release the circlip at the front of the muff coupling and slide the coupling fully forwards.

Remove the three bolts attaching the support snout to the axle case and remove the clutch-stop bracket, if fitted. Remove the two figure-of-eight spring clips from clutch fork so that the release bearing can be lifted clear of the fork.

Remove the cylinder-block-to-main-frame bolts (four of these are long bolts fitted from the underside of the main frame) and remove valve rocker cover. Fit a lifting bar (Fig. 45) on to the two cylinder-head lifting nuts, or place suitable slings round the engine, and lift the engine complete with clutch and clutch driveshaft vertically out of the frame. Ensure that the support snout is lifted clear of frame and lift the engine carefully until oil pump is clear of frame.

Replace engine in the reverse order to removal, using new gaskets and seals. Clean main frame and cylinder block faces, ensuring that all traces of the old gasket are removed. Smear main frame face with jointing compound, also both sides of the gaskets before placing them in position. A rubberised jointing compound such as Hylomar (962184) should be used. Fit new bearing-cap seals, pushing ends of seals into holes in block so that seals fit closely in bearing cap grooves.

Two $\frac{3}{8}$ UNC studs temporarily screwed into main frame at opposite points will assist in locating the engine and allow it to be lowered into position without disturbing the gaskets. Note that the clutch shaft is inserted in the clutch, and the support snout and muff coupling are in position on the shaft, before lowering the engine into position.

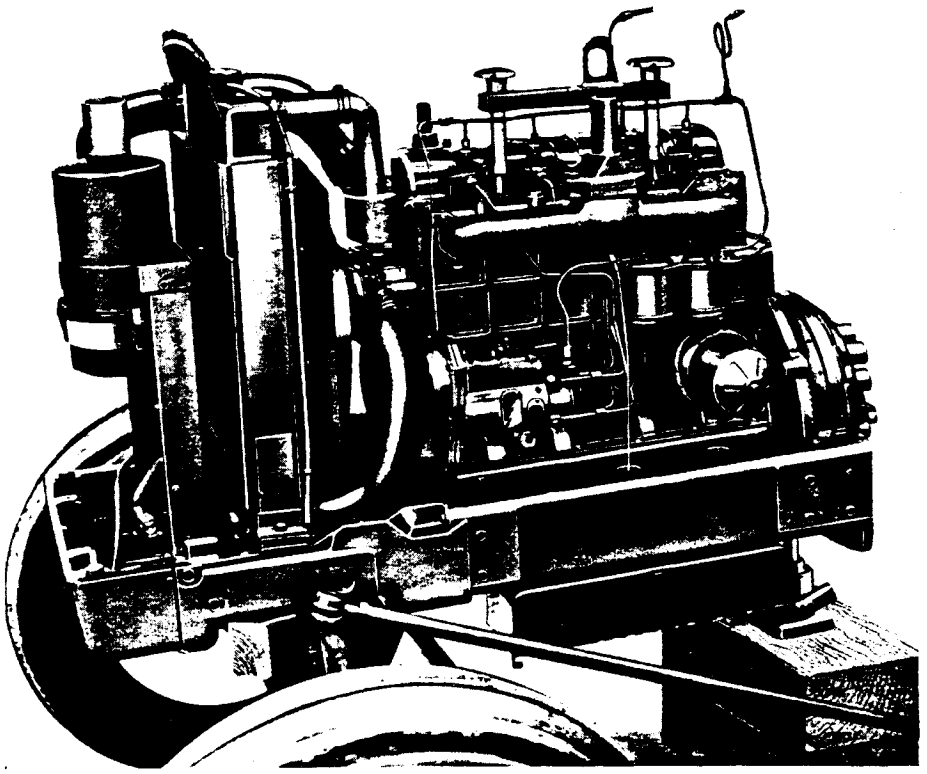

Figure 47. TRACTOR SPLIT FOR ENGINE REMOVAL

When refitting the steering drop-arm on to its shaft ensure that it is fitted on its correct spline, otherwise the steering lock will be restricted on one side. Shafts and arms are marked during assembly and should be refitted so that the centre-punch mark on the arm is opposite the mark on the end of the shaft.

## Engine Removal — Method 'B'

As the two halves of the tractor are heavy and require to be maintained in alignment during assembly, this operation should be carried out with the tractor standing on firm and reasonably level ground.

Place a trolley-jack under rear of tractor so that it can support the rear half of tractor when the main frame is "split". Place the jack-pad immediately behind the clutch-pit cover and raise the jack so that it takes weight but does not lift the frame. Drive wooden wedges between each side of the front extension and axle beam so that the engine unit will remain upright when it is not attached to the rear half of tractor. The wedges should be of hard wood and approximately 5 in. (12 cm) long so that they can be driven firmly into position without any possibility of becoming dislodged. Chock the front wheels so that they cannot move either way and place a jack under the front main frame positioned just in front of the rear flange. Extend the jack so that it takes weight but does not lift the frame.

Remove the bonnet and drain radiator and cylinder block. Disconnect throttle and stop-control linkage. Disconnect instrument panel and wiring and tractor-meter cable.

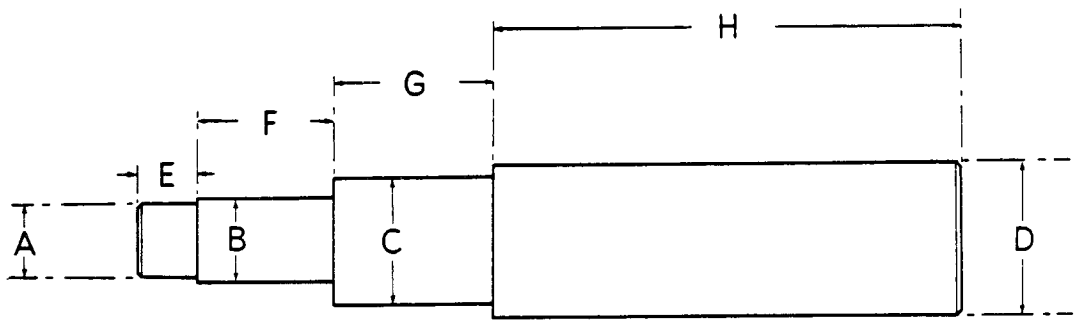


Figure 48. CLUTCH PLATE PILOT

A. 0·874 in. (22·20 mm) B. 0·915 in. (23·24 mm) C. 1·420 in. (36·07 mm) D. 1·771 in. (44·98 mm)
E. $\frac{5}{8}$ in. (15·88 mm) F. $1\frac{1}{2}$ in. (38·10 mm) G. $1\frac{3}{4}$ in. (44·45 mm) H. 5 in. (127 mm)

Remove fuel pipe from tank to feed pump and remove the pipe connecting the leak-off to tank.

Remove steering drop-arm from its shaft. Remove starter and remove bolts attaching the main frame and clutch housing to front half of tractor. Using the two jacks to support the two halves of frame in alignment, draw the rear half away until PTO cardan shaft is clear of the clutch.

Having separated the two halves of tractor, remove the radiator and the cylinder-block-to-main-frame bolts — four of which are on the underside of the main frame. Attach a lifting bar (Fig. 45) to the two cylinder head lifting nuts, or place suitable slings round the engine, and lift the engine vertically until the oil pump is clear of the frame.

Replace engine in reverse order of removal, using new gaskets and seals. Clean main frame and cylinder block faces, ensuring that all traces of the old gasket are removed. Smear main frame face and both sides of the gaskets with jointing compound before placing the gaskets in position. A rubberised jointing compound such as Hylomar (962184) may be used. Fit new bearing-cap seals, pushing ends of seals into holes in cylinder block so that seals fit closely in bearing-cap grooves.

Two $\frac{3}{8}$ UNC studs temporarily screwed into main frame at opposite points will assist in locating the engine and allow it to be lowered into position without disturbing the gaskets.

If the clutch assembly has been removed from flywheel it will be necessary for the clutch plates to be centralised so that the clutch shafts can be entered. When fitting clutch assembly on to flywheel a pilot shaft (Fig. 48) should be used to hold the plates central until the cover bolts are fully tightened.

When refitting the steering drop-arm on to its shaft ensure that this is on the correct spline, otherwise the steering lock will be restricted on one side. Shafts and arms are marked during assembly and should be refitted so that the centre-punch mark on the arm is opposite the mark on end of the shaft.

# DIMENSIONAL DATA

## Torque Figures

| | | |
|---|---|---|
| Big-end bearing nuts | 50 lb ft | 6·92 kg metres |
| Breather filter cover nut | 10 lb ft | 1·38 kg metres |
| Camshaft gear bolt | 40 lb ft | 5·53 kg metres |
| Cylinder head nuts and bolts | 90 lb ft | 12·4 kg metres |
| Cylinder head studs into block | 35 lb ft | 4·84 kg metres |
| Flywheel housing to engine bolts | 30 lb ft | 4·14 kg metres |
| Flywheel nuts | 50 lb ft | 6·92 kg metres |
| Front extension to main frame bolts | 50 lb ft | 6·92 kg metres |
| Fuel Injection Pump: | | |
| Automatic retard fixing bolt | 120 lb in | 1·38 kg metres |
| Governor housing nuts (Permanite gasket) | 40 lb in | 0·46 kg metres |
| Governor housing nuts (cork gasket) | 30 lb in | 0·35 kg metres |
| Head-side fixing bolts | 170 lb in | 1·96 kg metres |
| Inspection cover nuts | 30 lb in | 0·35 kg metres |
| Inspection pipe banjo bolts | 270 lb in | 3·11 kg metres |
| Manual lock fixing bolt | 350 lb in | 4·02 kg metres |
| Throttle and stop lever nuts | 30 lb in | 0·35 kg metres |
| Main bearing cap bolts | 140 lb ft | 19·3 kg metres |
| Main frame to engine bolts | 30 lb ft | 4·14 kg metres |
| Main frame to flywheel housing bolts | 50 lb ft | 6·92 kg metres |
| Oil filter bowl bolt | 10 lb ft | 1·38 kg metres |
| Sump to main frame bolts | 20 lb ft | 2·76 kg metres |
| Valve rocker adjusting nuts | 14 lb ft | 1·94 kg metres |

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

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

## Capacities

| | | |
|---|---|---|
| Cooling system | 3 gal | 12·6 litres |
| Engine lubricating oil | 13 pints | 7·4 litres |
| Steering-box oil | 2 pints | 1·1 litres |
| Air-cleaner oil bath | $1\frac{1}{4}$ pints | 0·7 litres |
| Fuel tank | $13\frac{1}{2}$ gal | 61·4 litres |

## Wear Limits

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

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

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

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

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

Piston groove clearance should not exceed 0·010 in. (0·25 mm) when checked with a new ring.

Oversize valves should be fitted if the bore in the cylinder head is worn in excess of 0·006 in. (0·15 mm). For details of oversize reamers and seat cutter pilots see Service Tool Leaflet A28.

## Piston Dimensions (new)

| | | |
|---|---|---|
| Nominal diameter | 3⅝ in | 92·075 mm |
| Piston skirt diameter (at right-angles to gudgeon pin bore) | 3·619 — 3·618 in | 91·93 — 91·91 mm |
| Piston weight variation (maximum in one set) | ½ oz | 14 gm |
| Piston ring side clearance | 0·002 — 0·0035 in | 0·050 — 0·088 mm |
| Piston ring gap | 0·010 — 0·015 in | 0·254 — 0·374 mm |
| Gudgeon pin diameter | 1·2503 — 1·250 in | 31·757 — 31·750 mm |

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

## Sleeve Dimensions (new)

| | | | |
|---|---|---|---|
| Bore | 3·6255 — 3·6250 in | 92·088 — 92·076 mm |
| Taper (maximum) | 0·0005 in | 0·0127 mm |
| Ovality (maximum) | 0·0005 in | 0·0127 mm |
| Protrusion (excluding ridge) | 0·002 — 0·005 in | 0·0508 — 0·127 mm |

## Valve Clearance (set cold)

| | | | |
|---|---|---|---|
| Inlet | to AD4/47A 60389 | 0·015 in | 0·35 mm |
| Exhaust | and AD4/47B 40724 | 0·012 in | 0·30 mm |
| Inlet | from AD4/47A 60390 | 0·010 in | 0·25 mm |
| Exhaust | and AD4/47B 40725 | 0·007 in | 0·18 mm |

## Valve Springs (inlet and exhaust)

| | | |
|---|---|---|
| Free length | 1·970 in | 5·0 cm |
| Length at 40 lb load | 1·530 in | |
| Length at 80 lb load | 1·102 in | |
| Length at 15 kg load | | 4·08 cm |
| Length at 30 kg load | | 3·15 cm |

## Valve Stem Diameters (inlet and exhaust)

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

## Valve Timing

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

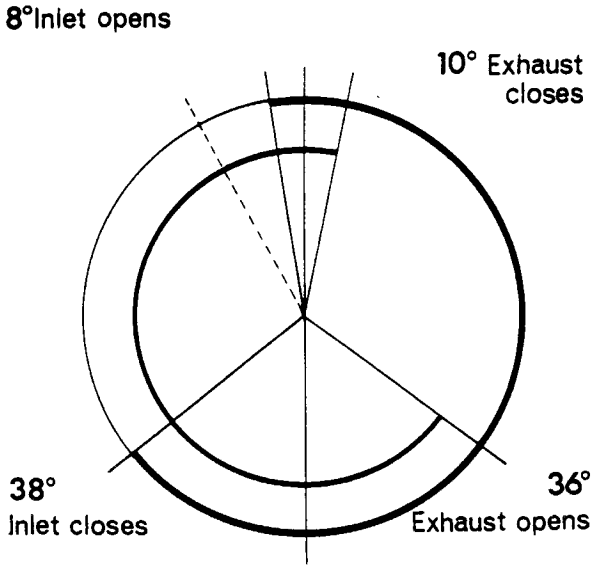


Figure 49. VALVE TIMING DIAGRAM

## Fuel System

Injector setting pressure .. .. .. .. 175 atmospheres (1810 kg/cm²)
Spill timing (static) .. .. .. .. .. 11° before top dead centre

Spill timing mark: Pump flange and engine mounting flange are marked, and correct pump timing is obtained when these marks are in alignment.

Spill timing adjustment: Elongated holes in the injection pump mounting flange permit the pump body to be rotated when the three securing nuts are released.

## Injection Pump Flange Mounting

AD4/47 .. .. .. .. 69½° from blank spline when at point of injection

## Injection Pump Fuel Setting

AD4/47 .. .. .. .. 10·4 — 10·6 cc per 200 shots at 850 rev/min

## Injector Nozzle Hole Diameter

AD4/47 .. .. .. .. .. .. .. .. 0·28 — 0·30 mm

## Injection Pump and Injectors

| Pumps | | Injectors | | |
|---|---|---|---|---|
| DB No. | CAV No. | DB No. | Holder | Nozzle |
| 906899<br>909458 | 3243090<br>3243860 | 904442 | BKBL 97S5152 | BDLL 140S6276 |
| 910521<br>910521<br>918912 | 3243960<br>3248260<br>3248680 | 910530 | BKBL 97S5152 | BDLL 140S6417 |

## Oil Pump

| | | |
|---|---|---|
| Spindle diameter .. .. .. | 0·4895 — 0·490 in | 12·43 — 12·45 mm |
| Spindle bush bore .. .. .. | 0·4905 — 0·4925 in | 12·458 — 12·509 mm |
| Rotor width .. .. .. | 1·1865 — 1·1855 in | 30·137 — 30·112 mm |
| Housing depth .. .. .. | 1·1890 — 1·1875 in | 30·191 — 30·162 mm |
| End float .. .. .. .. | 0·001 — 0·0035 in | 0·025 — 0·088 mm |
| Pump rotor backlash .. .. | 0·020 — 0·026 in | 0·511 — 0·66 mm |

## Crankshaft

Main journal diameter

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

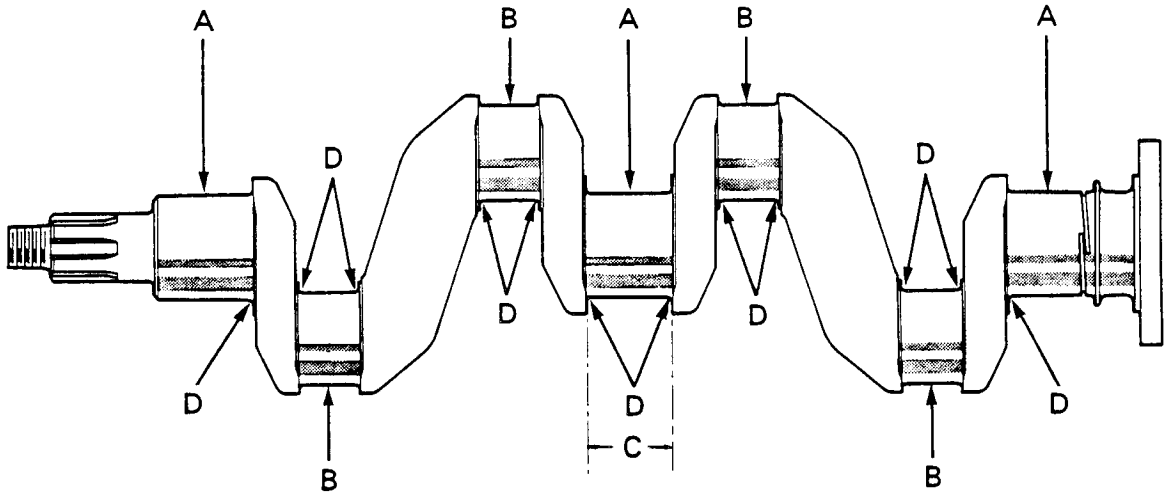


Figure 50. CRANKSHAFT DIMENSIONS

A. Main journal diameters
B. Big end journal diameter
C. Centre journal width
D. Fillet radius

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

Big-end journal diameter

| | | |
|---|---|---|
| Standard size .. .. .. | 2·2485 — 2·2480 in | 57·111 — 57·099 mm |
| Undersize 0·010 in. .. .. | 2·2385 — 2·2380 in | 56·848 — 56·845 mm |
| Undersize 0·020 in. .. .. | 2·2285 — 2·2280 in | 56·604 — 56·591 mm |
| Undersize 0·030 in. .. .. | 2·2185 — 2·2180 in | 56·350 — 56·337 mm |

Centre journal width

| | | |
|---|---|---|
| Standard size .. .. .. | 2·126 — 2·124 in | 54·00 — 53·95 mm |
| Oversize 0·010 in. .. .. | 2·136 — 2·134 in | 54·254 — 54·204 mm |
| Oversize 0·040 in. .. .. | 2·176 — 2·174 in | 55·270 — 55·220 mm |

| | | |
|---|---|---|
| Bearing fillet radius .. .. | 0·16 — 0·15 in | 4·06 — 3·81 mm |
| Big-end bearing clearance .. .. | 0·0015 — 0·0025 in | 0·038 — 0·063 mm |
| Main bearing clearance .. .. | 0·002 — 0·004 in | 0·051 — 0·102 mm |
| End-float of crankshaft .. .. | 0·002 — 0·010 in | 0·051 — 0·258 mm |

Thrust Washer thickness

| | | |
|---|---|---|
| Standard .. .. .. | 0·091 — 0·093 in | 2·3114 — 2·3622 mm |
| Oversize 0·005 in. (0·127 mm) | 0·096 — 0·098 in | 2·4384 — 2·4892 mm |
| Oversize 0·020 in. (0·508 mm) | 0·111 — 0·113 in | 2·8194 — 2·8702 mm |

## Connecting Rod Alignment

| | | |
|---|---|---|
| Maximum out of parallel .. .. .. .. | 0·001 in/in | 0·01 mm/cm |
| Maximum twist .. .. .. .. | 0·001 in/in | 0·01 mm/cm |
| Maximum weight variation in set of three rods .. | 0·25 oz | 7·1 gm |

## Rocker Shaft

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

## Compression Pressures

Average pressure obtained when the engine is cranked, by means of the starter motor, with all injectors removed and at an ambient temperature of 20°C (68°F).

| Cranking Speed rev/min | Pressure lb/in² | kg/cm² |
|---|---|---|
| 150 | 380 — 400 | 26·6 — 28·0 |
| 250 | 415 — 435 | 29·0 — 30·5 |

## Camshaft Journal Diameters

| | | | | | |
|---|---|---|---|---|---|
| Front | 1·872 — 1·870 | in | 47·55 | — 47·50 | mm |
| No. 2 | 1·827 — 1·825 | in | 46·41 | — 46·35 | mm |
| Nos. 3 and 4 | 1·811 — 1·810 | in | 46·00 | — 45·97 | mm |
| No. 5 | 1·765 — 1·763 | in | 44·83 | — 44·78 | mm |
| No. 6 | 1·749 — 1·747 | in | 44·42 | — 44·37 | mm |
| Camshaft thrust washer thickness | 0·245 — 0·240 | in | 6·223 | — 6·096 | mm |
| Camshaft end-float | 0·010 — 0·020 | in | 0·254 | — 0·508 | mm |

# SUMMARY OF DESIGN CHANGES

| Details of change | When introduced |
|---|---|
| Across-flats dimension of crankshaft nut reduced from 1·670–1·658 in. (42·42–42·11 mm) to 1·500–1·488 in. (38·10–37·80 mm). Part No. 623300 unchanged. | AD4/47A/32776<br>AD4/47B/31181<br>(July 1962) |
| Exhaust valve spring (907895) also fitted on inlet valve. The previous inlet-valve spring (905215), which is marked with red paint, is weaker than the 907895 spring and should not be used for replacements. | AD4/47A/31773<br>AD4/47B/32002<br>(July 1962) |
| Length of thread on injection-pump coupling bolts reduced to $\frac{1}{2}$ in. (12·5 mm). Part No. of bolts, 600353, unchanged. | AD4/47A/34476<br>AD4/47B/31901<br>(July 1962) |
| Changes to reduce amount of oil leakage down valve guides. Rocker shaft oil-holes reduced. Part No. of shaft changed from 904192 to 909622, and 30° chamfer machined at top of exhaust valve stem bore. | AD4/47A/34932<br>AD4/47B/32082<br>(August 1962) |
| Position of injection cut-off lever turned through 180° and control rod changed so that operation of engine control stop is reversed, i.e., the engine being stopped when the control is in the forward position. Part No. of pump unchanged but Part No. of stop control rod changed from 908221 to 908524. | AD4/47A/34065<br>AD4/47B/31734<br>(September 1962) |
| Injection pump changed from 906899 (CAV 3243090) to 909458 (CAV 3243860). As the new pump has a slightly different internal timing the pump drive gear marking has been retarded one tooth. Part No. of gear changed from 902006 to 909457. Pumps and gears are interchangeable if the gears are meshed one tooth advanced, or retarded, in order to obtain the correct timing. | AD4/47A/35277<br>AD4/47B/32248<br>(September 1962) |
| Drain-hole drilled in water pump body (902029) to prevent any water which leaks past the gland seal from damaging the bearing and provide a visible indication that the seal is leaking. | AD4/47A/32074<br>AD4/47B/30917<br>(January 1963) |
| Dynamo 35521 (Lucas C39-2) replaced by dynamo 908882 (Lucas C40A). The new dynamo, which is fitted with Lucar connectors, is interchangeable with the previous dynamo if suitable connectors are used. | AD4/47A/36228<br>AD4/47B/32834<br>(January 1963) |
| Fitting of injection pump 909458 (CAV 3243860) discontinued and 906899 (CAV 3243090) re-introduced. Pump drive gear 909457 also changed back to previous gear 902006. | AD4/47A/36230<br>AD4/47B/32832<br>(January 1963) |
| Crankshaft breather changed so that overtightening the nut does not compress the breather element and cause pressure build-up in the crankcase. Parts not interchangeable unless fitted complete. | AD4/47A/37593<br>AD4/47B/33527<br>(February 1963) |
| Injection pump 906899 (CAV 3243090) changed to 910521 (CAV 3243960) and injectors changed from 904442 to 910530. | AD4/47A/43672<br>AD4/47B/36677<br>(January 1964) |
| Timing gear cover changed from cast iron to pressed steel. Part No. of cover changed from 904056 to 910057. Covers interchangeable if the appropriate bolts are used. | AD4/47A/44311<br>AD4/47B/37572<br>(July 1964) |
| Distance piece, Part No. 912812, fitted between water-pump pulley (900476) and fan in order to comply with U.K. safety requirements. | AD4/47A/46417<br>AD4/47B/37384<br>(July 1964) |

| Details of change | When introduced |
|---|---|
| Oil flinger, Part No. 913369, fitted between the crankshaft gear and pulley. | AD4/47A/46481<br>AD4/47B/37378<br>(July 1964) |
| Gasket, Part No. 914404, fitted between crankshaft oil retainer and cylinder block. | AD4/47A/49989<br>AD4/47B/37876<br>(September 1964) |
| Two $\frac{5}{16}$ in. (7·8 mm) diameter holes drilled through rear main-bearing cap to assist oil drainage into sump when operating on severe gradients. | AD4/47A/51137<br>AD4/47B/38316<br>(October 1964) |
| Length of water-pump pulley-hub increased to make the fitting of distance piece (912812) unnecessary. Part No. of pulley changed from 900476 to 914335. | AD4/47A/57582<br>AD4/47B/40057<br>(October 1964) |
| Injection pump changed from CAV 3243960 to CAV 3248260. Part No. of pump, 910521, unchanged. | (November 1964) |
| Water pump pulley, Part No. 914335, changed back to 900476. Distance piece 912812 re-introduced on U.K. tractors only. | AD4/47A/60986<br>AD4/47B/40825<br>(November 1965) |
| Camshaft, Part No. 902050, replaced by camshaft 914673, which has higher lift inlet cams. To accommodate the increased valve opening the valve recess in the pistons has been made deeper, the valve heads slightly thinner, and stronger valve springs fitted. With the exception of the camshaft, which must not be fitted unless the other parts are also fitted, the new parts may be used as replacements for earlier engines. The introduction of this change has required a reduction in valve clearances to inlet — 0·010 in. (0·25 mm) — and exhaust — 0·007 in. (0·18 mm). | AD4/47A/60390<br>AD4/47B/40725<br>(November 1965) |
| Retaining plate, Part No. 919660, fitted on fan bolts and bolt-holes in fan blade repositioned, to prevent any possibility of blade fracture. | AD4/47A/68495<br>AD4/47B/41696<br>(October 1966) |
| Face width of crankshaft gear (901989) and intermediate gear (904074) increased to 1 in. (25·4 mm). Part No. of gears changed to 917898 and 917904 respectively. Fitting of a crankshaft oil flinger discontinued. | AD4/47A/69515<br>AD4/47B/41792<br>(September 1966) |
| Injection pump 918912 (CAV 3248680), with direct mounted gear used as an alternative pump to quill-shaft driven pump 910521 (CAV 3248260) on a number of tractors not fitted with power-assisted steering. | AD4/47A/69515 and<br>AD4/47B/41792 to<br>AD4/47A/71241 and<br>AD4/47B/42115<br>(November 1966) |
| Tappet cover studs (608206) changed to bolts (600408) and material of tappet cover gaskets (10030) changed from cork/aluminium to cork only. | AD4/47A/71160<br>AD4/47B/42116<br>(December 1966) |
| Material of cylinder head gasket (902040) changed from copper and asbestos sandwich to graphite-surfaced asbestos. Part No. of gasket unchanged. Wellseal should not be used when fitting gaskets of the later material. | AD4/47A/74181<br>AD4/47B/42612<br>(January 1967) |
| Cap nut, Part No. 607516, fitted on the oil pump locating screw (900748) in place of the locknut (607053) fitted previously. | AD4/47A/76496<br>AD4/47B/42941<br>(April 1967) |

Under this service classification, the factors of operating conditions, fuel character, especially sulphur content, and design features combine in various ways to make the service and hence the lubrication requirements less severe than for Service DS. Some designs are critical with respect to lubricating oil residues; for these designs some oils suitable for Service DS are not satisfactory.

**Footnote:** The characteristics of oil in this rating are similar to Supplement 1 oils I.C.E.I. (Internal Combustion Engine Institute) rating.

### (c). Service DS — Extreme Conditions — Diesel

**Service typical of Diesel Engines operating under very severe conditions, or having design characteristics, or using fuel tending to produce excessive wear or deposits.**

The service requirements in this classification are the most severe encountered in the operation of diesel engines. High-load operation at high temperatures, design factors, especially supercharging or engine installation details causing unusually high temperatures within the engine, constitute severe service, as does intermittent operation at low temperatures, since both promote wear and deposit formation. Cooling system and crankcase ventilating system design, also exhaust line arrangement, can aggravate or minimise the severity in either case. The use of high-sulphur content fuels increases service severity with respect to wear and deposits, depending upon design, maintenance and operating conditions. Hence, frequently their use is considered to constitute severe service, especially in low temperature operation.

**Note:** The characteristics of oil in this rating are similar to Supplement 3 I.C.E.I. rating or Series 3 "Caterpillar rating" oil.

### (d). Service ML — Least Severe Conditions — Petrol

**Service typical of Gasoline and other Spark Ignition Engines used under light and favourable operating conditions, the engines having no special lubrication requirements and having no design characteristic sensitive to deposit formation.**

This is the least severe condition. It includes moderate speed driving or moderate load operation most of the time, with no severe low or high engine temperature operation. It also includes operation of engines insensitive to sludge, deposit formation, bearing corrosion, wear or fuel characteristics.

### (e). Service MM — Moderate Conditions — Petrol

**Service typical of Gasoline and other Spark Ignition Engines used under moderate to severe operating conditions, but presenting problems of deposit or bearing corrosion control when crankcase oil temperatures are high.**

This is a more moderate service requirement than Service MS. Vehicles powered by engines which are relatively insensitive to deposit formation or wear when operated at high speeds or under heavy loads are included in this service, particularly when using fuels of suitable characteristics. It does not include extensive operation under the severe type of low engine temperature service such as start-and-stop driving or prolonged idling described under Service MS.

### (f). Service MS — Severe Conditions — Petrol

**Service typical of Gasoline and other Spark Ignition Engines used under unfavourable or severe types of operating conditions, and where there are special lubrication requirements for deposit, wear or bearing corrosion control, due to operating conditions or to engine design or fuel characteristics.**

This class of oil also covers operation in extremes of temperature, stop/start or prolonged idling conditions and the resulting crankcase condensation and dilution which causes the formation of sludge, being taken into consideration.

# APPROVED LUBRICANTS

## OVERSEAS

## Lubricants

| Application | A.P.I. Classn. | Air Temp. | GRADE Recomm. | GRADE Alternative | AMOCO | B.P. | CASTROL | ESSO | MOBIL | SHELL |
|---|---|---|---|---|---|---|---|---|---|---|
| Engine and Air Cleaner | DG, MS, DM | Below —7°C (20°F) | Multi-purpose 10W/30 | 10W Diesel (SAE 10W) | AMERICAN HD – M Motor Oil 10W – 30 | Tractor Oil Universal | Agricastrol Multi-use 10W/30 | Esso Tractorlube Universal 10W/30 | Mobiland Universal 10W/30 | Rotella Multigrade 10W/30 |
| | DG, MS, DM | —7°C to 32°C (20°F to 90°F) | Multi-purpose 20W/30 or 20W/40 | 20/20W Diesel (SAE 20W) | AMERICAN HD – M Motor Oil 20W – 30 or 20W – 40 | Tractor Oil Universal | Agricastrol Multi-use 20W/30 or 20W/40 | Esso Tractorlube Universal 20W/30 | Mobiland Universal 20W/30 or 20W/40 | Rotella Multigrade 20W/40 |
| | DG, MS, DM | Above 32°C (90°F) | Multi-purpose 20W/30 or 20W/40 | 30 Diesel (SAE 30) | | | | | | |
| Details of Alternative Grade Oils | | | 10W Diesel (SAE 10W) | | AMERICAN HD – M Motor Oil SAE 10W | Energol Diesel D SAE 10W | Castrol CR10 or Agricastrol HD10 | Essolube HD 10W | Mobiloil 10W or Delvac Oil 1110 | Rotella 10W |
| | | | 20/20W Diesel (SAE 20W) | | AMERICAN HD – M Motor Oil SAE 20-20W | Energol Diesel D SAE 20W | Castrol CR20 or Agricastrol HD20 | Essolube HD20 | Mobiloil Arctic or Delvac Oil 1120 | Rotella 20/20W |
| | | | 30 Diesel (SAE 30) | | AMERICAN HD – M Motor Oil SAE 30 | Energol Diesel D SAE 30 | Castrol CR30 or Agricastrol HD30 | Essolube HD30 | Mobiloil A or Delvac Oil 1130 | Rotella 30 |

**Engine oil:** Under normal operating conditions the engine oils should be marked with viscosity grade and API classification as shown in the above table. Oils marked with service classification DM are recommended when one or more of the following conditions is present:—abnormally high operating temperatures, intermittent operation at low temperatures or fuel contains more than 1% sulphur. Service DS (Series 3) oil is not listed as it has super-detergent qualities which are not considered essential for D.B. tractor engines operating in normal field conditions.

**Air cleaner:** All M and D classifications with the exception of DS are recommended for use in oil-washed air cleaners fitted to D.B. tractors. DS is not recommended due to its frothing characteristics. Where possible a straight mineral oil should be used as an alternative to engine oil to avoid frothing.

## Fuel, Grease and Anti-freeze

**Diesel fuel: For temperature above 0°C (32°F)** use No. 2D fuel (ASTMD 975) with a minimum cetane rating of 45.

**For temperature below 0°C (32°F)** use No. 1D fuel (ASTMD 975) with a minimum cetane rating of 50.

**Note:** For low temperature operation a fuel with a pour point 6°C (10°F) below lowest starting temperature should be specified. Fuels with not more than 0·5% by weight sulphur should be used when available. A high sulphur content fuel requires an engine lubricating oil with high detergent characteristics to prevent carbon build up in the nozzles and combustion chambers and to neutralise the acid created by sulphur.

**Greasing points:** A good quality multi-purpose grease should be applied to all grease fittings (except water pump which requires a high-melting-point grease applied sparingly every 500 hours). High-melting-point grease may be used for all fittings except those which require oil.

**Anti-freeze solutions for engine coolant:** Use only a brand formulated for use in diesel engines to British Standard 3151 (1959) type B (or equivalent) which specifies a corrosion inhibited ethanediol anti-freeze. (Sodium benzoate and sodium nitrite inhibited.)

# BRITISH ISLES

## Lubricants

| APPLICATION | GRADE Recommended | Alternative | AMOCO | B.P. | CASTROL | ESSO | MOBIL | SHELL |
|---|---|---|---|---|---|---|---|---|
| Engine & Air Cleaner | Multi-purpose Oil | 20/20W | Vitamatic Tractor Oil | Tractor Oil Universal | Agricastrol Multi-use | Esso Tractorlube (Universal) | Mobiland Universal | Tractor Oil Universal |
| Alternative Grade Oils | 20/20W | | New Ace 20/20W | Energol DD 20W | Castrol CR20 or Agricastrol HD20 | Essolube HD20 | Mobiloil Arctic or Delvac Oil 1120 | Rotella 20/20W |

## Fuel, Grease and Anti-freeze

**Diesel fuel**: Farm diesel fuel of high quality is recommended for use in David Brown engines. Fuels with not more than 0·5% by weight sulphur should be used when available. A high sulphur content fuel requires an engine lubricating oil with high detergent characteristics, to prevent carbon build up in the nozzles and combustion chambers, and to neutralise the acid created by sulphur.

**Greasing points**: A good quality multi-purpose grease should be applied to all grease fittings (except water pump which requires a high-melting-point grease applied very sparingly every 500 hours). A high-melting-point grease may be used for all fittings except those which require oil.

**Anti-freeze solution for engine coolant**: Use only a brand formulated for use in diesel engines to British Standard 3151 (1959) type B (or equivalent) which specifies a corrosion inhibited ethanediol anti-freeze. (Sodium benzoate and sodium nitrite inhibited.)

## Fuel Injection Equipment Test Oils

New oils made from a refined mineral oil with the addition of oxidation and corrosion inhibitors have recently been introduced for use when testing fuel injection equipment.

The oils previously approved have therefore been superseded by the new oils as follows:

| Previously Approved | New Recommendation |
|---|---|
| Shell — Fusus 'A' Oil | Shell Calibration Fluid 'C' (obtainable in the U.K.)<br>Shell Calibration Fluid 'B' (obtainable overseas) |
| Esso — TSD Oil 815 | Esso — Calibration Fluid IL/1838 |
| Wakefield — Calibration Oil 8327 | Castrol — Calibration Oil 'C' |

**Note**: As Shell Fusus 'A' Oil does not now include a viscosity control but will still be available for other industries, e.g., for use as a burning or drying oil, **it is important that Fusus 'A' Oil is not now used as a test oil.**
The two Shell grades 'B' and 'C' are interchangeable.



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