ENGINE

The special tools mentioned herein are obtainable from Messrs. V. L. Churchill & Co., Limited
Great South West Road, Bedfont, Feltham, Middlesex.

THREADS OF THE UNIFIED SERIES ARE EMPLOYED ON THIS ENGINE, AND THE APPROPRIATE SPANNERS MUST BE USED

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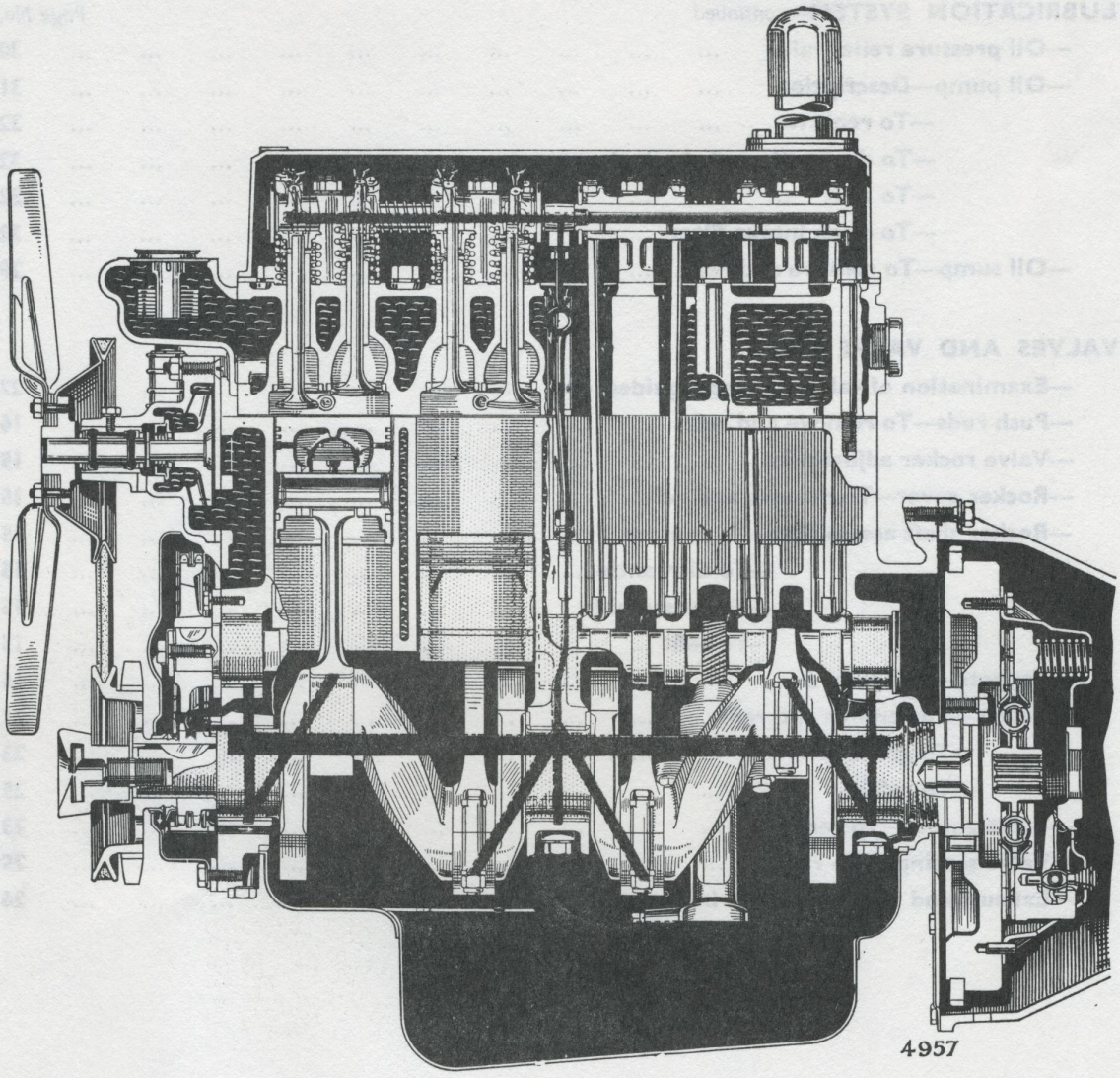


Fig. 1. *Engine—longitudinal section (1494 c.c. engine shown)*

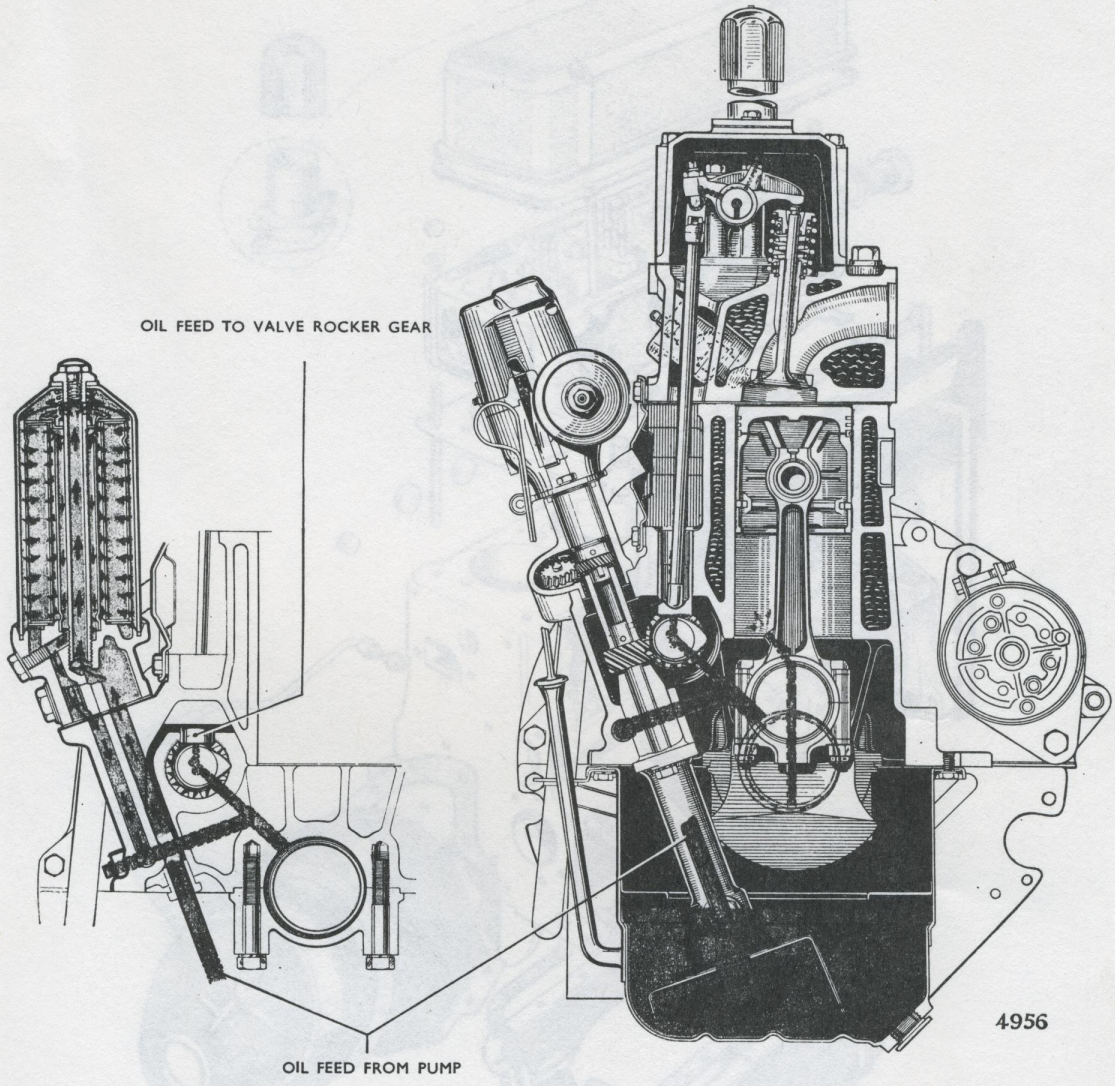


Fig. 2. *Engine—Cross section (1494 c.c. engine shown)*

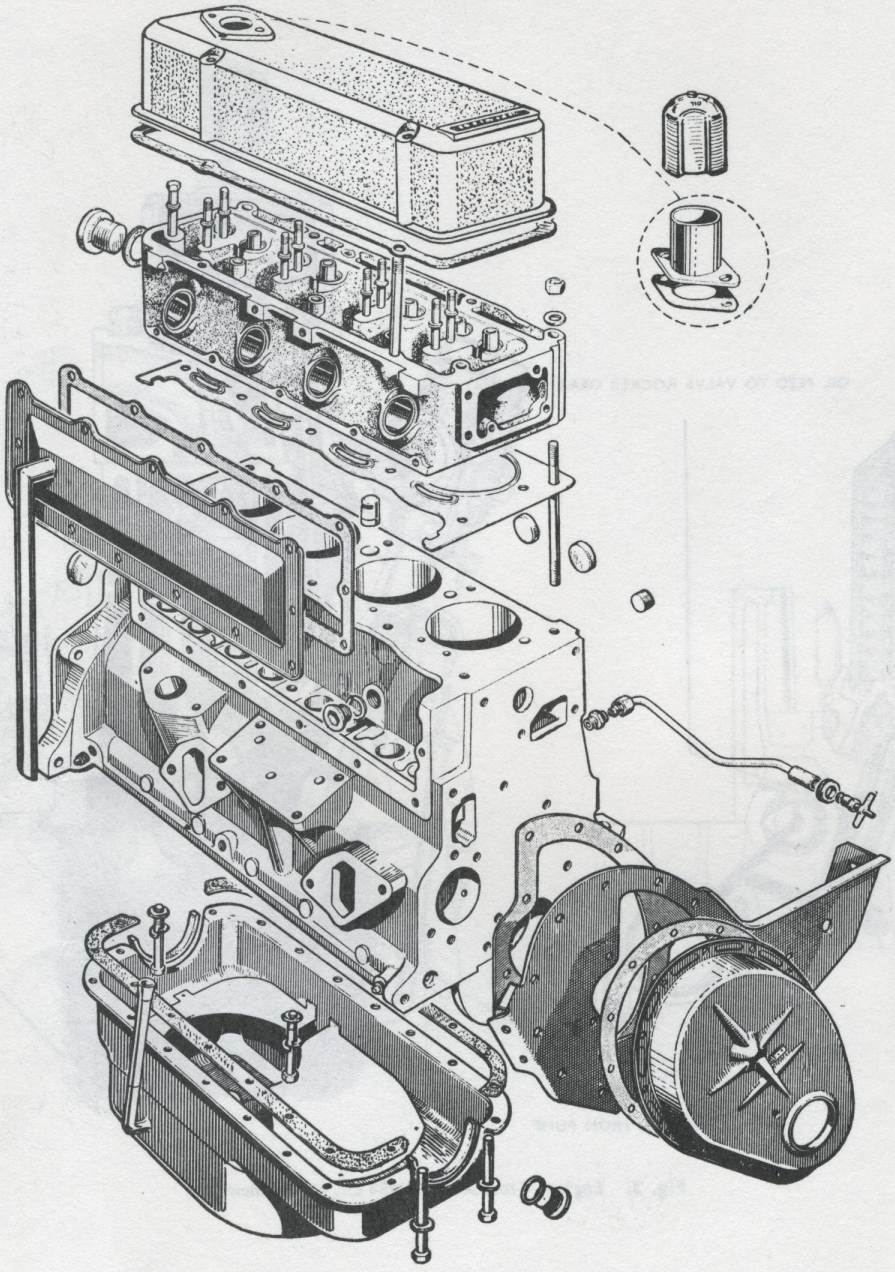


Fig. 3 *Cylinder block and associated parts (1494 c.c. engine shown)*

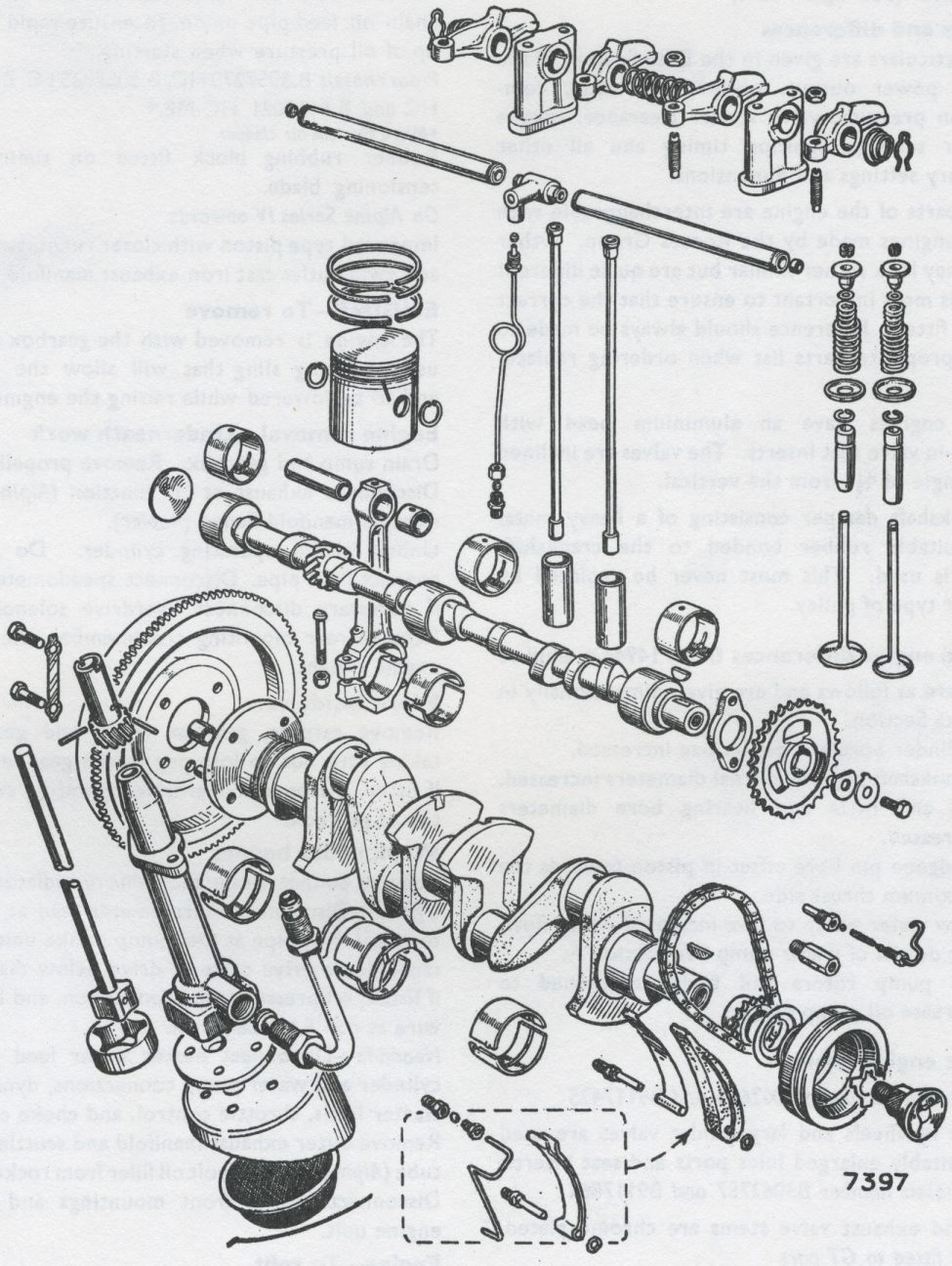


Fig. 4. *Exploded view of working parts (1494 c.c. engine shown)*

ENGINE

ENGINE (See Figs. 1 to 4)

Details and differences

Full particulars are given in the Data Section of the engine power output, compression ratio, compression pressure, valve rocker clearance, torque spanner settings, ignition timing and all other necessary settings and dimensions.

Some parts of the engine are interchangeable with other engines made by the Rootes Group. Other parts may look rather similar but are quite different and it is most important to ensure that the correct part is fitted. Reference should always be made to the appropriate parts list when ordering replacements.

These engines have an aluminium head with shrunk-in valve seat inserts. The valves are inclined at an angle of 4½° from the vertical.

A crankshaft damper consisting of a heavy metal ring suitably rubber bonded to the crankshaft pulley is used. This must never be replaced by another type of pulley.

1592c.c. engine differences from 1494c.c. engine

These are as follows and are given dimensionally in the Data Section.

1. Cylinder bore and piston size increased.
2. Crankshaft big end journal diameters increased.
3. Big and little end bearing bore diameters increased.
4. Gudgeon pin bore offset in piston towards the maximum thrust side.
5. New water pump to give increased water flow. For details of water pump See Section A.
6. Oil pump rotors and body lengthened to increase oil pump output.

1592 cc engine changes

From chassis number B3062665 *and* B9117425

Lighter flywheels and larger inlet valves are used with suitably enlarged inlet ports and seat inserts.
From chassis number B3062757 *and* B9117862

Inlet and exhaust valve stems are chrome plated.
Engines fitted to GT cars

These engines have cast iron exhaust manifolds.
From chassis number B.3053209, B.9106448 HC, B.9107189 LC *and* B.9106535 ME.*

A non return ball valve was fitted in the timing chain oil feed pipe union, to ensure rapid building up of oil pressure when starting.
From chassis B.3057270 HC, B.3057825 LC, B.9110982 HC *and* B.9111021 HC-ME.*
**Micro element air cleaner.*
Rubber rubbing block fitted on timing chain tensioning blade.
On Alpine Series IV onwards
Improved type piston with closer running clearance and twin outlet cast iron exhaust manifold fitted.

ENGINE—To remove

The engine is removed with the gearbox attached using a lifting sling that will allow the gearbox end to be lowered while raising the engine end.

Engine removal—Underneath work

Drain sump and gearbox. Remove propeller shaft. Disconnect exhaust at 'Y' junction (*Alpine*) or at exhaust manifold flange (*Rapier*).
Unbolt clutch operating cylinder. Do not disconnect fluid pipe. Disconnect speedometer cable. If necessary disconnect overdrive solenoid wire. Remove rear mounting crossmember after taking engine weight.

Work inside car

Remove carpets, gearbox cover and gear lever taking care not to lose peg in the gear lever ball. If fitted, disconnect overdrive operating switch on top of gearbox.

Work under bonnet

Remove bonnet, drain and remove radiator.
Offside—Disconnect thermometer lead at element terminal, fuel pipe at fuel pump intake union, tachometer drive cable at drive below distributor if fitted, oil pressure pipe connection, and L.T. feed wire at coil S.W. terminal.
Nearside—Disconnect heater water feed pipes at cylinder and water pump connections, dynamo and starter leads, throttle control, and choke control.
Remove outer exhaust manifold and scuttle bracing tube (*Alpine only*). Unbolt oil filler from rocker cover. Disconnect engine front mountings and lift out engine unit.

Engine—To refit

Refitting is a reversal of the removal procedure. The engine and gearbox should be filled with the correct grade of oil.

GENERATOR

To adjust belt tension

The generator is driven from the crankshaft by a belt which also drives the water pump and fan.
The belt is correctly tensioned when a total of $\frac{5}{8}$" (16 mm.) movement can be obtained on the longest run of the belt.

To adjust the tension, slacken the nuts and bolts at the bottom front and rear of the generator, the link locating bolt and the screw through the slot in the strap. (See Fig. 5). Move the generator about its

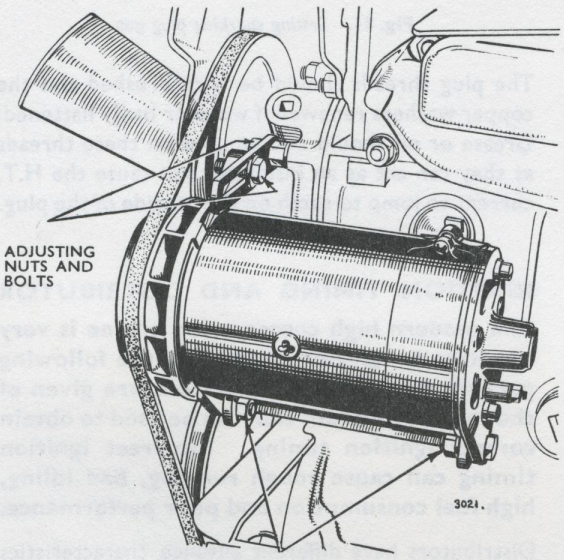


Fig. 5. *Generator belt adjustment*

bottom two fixing bolts until the correct belt tension is obtained, then retighten all bolts.

SPARKING PLUGS

Examination and cleaning

Figs. 6 to 10 illustrate the various conditions in which sparking plugs are found on removal and these are as follows:—

NORMAL CONDITION—look for powdery deposits ranging from brown to greyish tan. Electrodes may be slightly worn. These are signs of sparking plug used under normal conditions of mixed period of high speed and low speed driving. Cleaning and regapping of the sparking plugs is all that is required (see Fig. 6). White to yellowish powdery deposits usually indicate long periods of constant speed service or a lot of slow speed driving. Fig. 7 illustrates this condition. These deposits have no effect on performance if the sparking plugs are cleaned thoroughly at 3,000 mile (4,800 km.) intervals.

OIL FOULING—is usually identified by wet sludge deposits traceable to excessive oil entering the combustion chamber through worn rings and pistons, excessive clearances between intake valve guides and stems or worn and loose bearings, etc. See Fig. 8. Hotter sparking plugs may alleviate oil fouling temporarily but in severe cases engine overhaul is called for.

PETROL FOULING is usually identified by dry black fluffy deposits which result from incomplete combustion (see Fig. 9). Too rich an air-fuel mixture, excessive use of hand choke or faulty choke action can cause incomplete burning. In addition, defective contact breaker points or H.T. cables can reduce voltage supplied to the sparking plug and causes misfiring. If fouling is evident in only a few cylinders, sticking valves may be the cause. Excessive idling, slow speeds or stop-and-go driving can also keep plug temperatures so low that normal combustion deposits are not burned off.

BURNT OR OVERHEATED sparking plugs are usually identified by a white, burnt or blistered insulator nose and badly eroded electrodes (see Fig. 10). Inefficient engine cooling and improper ignition timing can cause general overheating. If only a few sparking plugs are overheated, the cause may be uneven distribution of the coolant. Severe service, such as sustained high speed and heavy loads, can also produce abnormally high temperatures in the combustion chamber, which necessitates use of colder sparking plugs.

Sparking Plugs—To clean and adjust

Plugs should be cleaned with an air blast cleaner and before setting the plug gaps the electrode tips should be filed lightly to remove all traces of burning.

The gap setting of sparking plugs is very important and points should be correctly set by bending the earthing (side) electrode. Never bend the centre electrode as this will crack the insulator tip. A suitable combined setting tool is illustrated in Fig. 11.

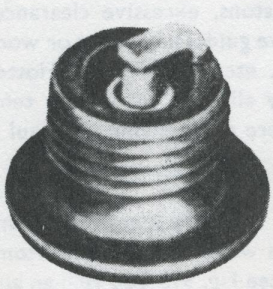


Fig. 6.

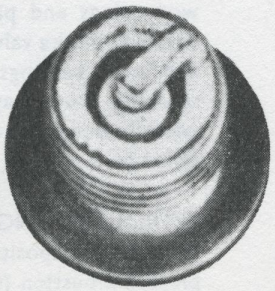


Fig. 7.

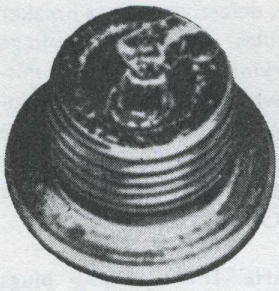


Fig. 8.

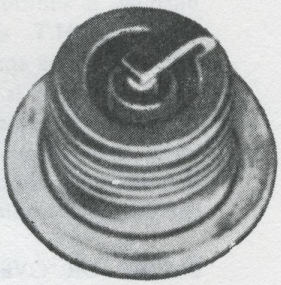


Fig. 9.

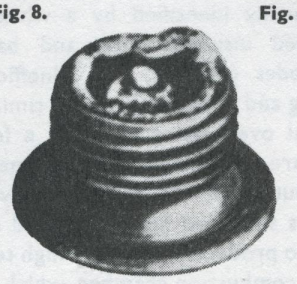


Fig. 10.

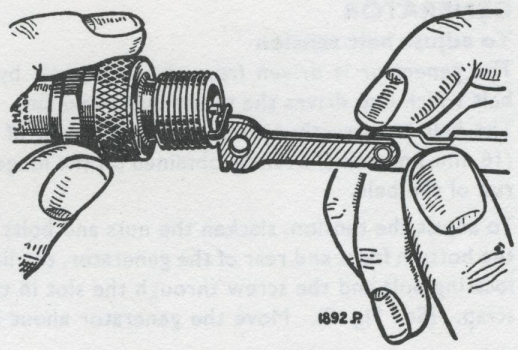


Fig. 11. *Setting sparking plug gap*

The plug threads should be wire brushed and the copper washers renewed if worn or badly flattened. Grease or oil should not be used on these threads as they can act as an insulator, and cause the H.T. current to jump to earth on the outside of the plug.

IGNITION TIMING AND DISTRIBUTOR

The modern high compression engine is very sensitive to ignition timing. In the following paragraphs detailed instructions are given of the various methods that can be used to obtain correct ignition timing. Incorrect ignition timing can cause rough running, bad idling, high fuel consumption and poor performance.

Distributors have different advance characteristics and it is most important that the correct distributor is used when a replacement unit is fitted. The possibility of a wrong unit having been fitted previously in service must not be overlooked.

Distributors may be identified by the despatch number on the plate fitted on the side of the distributor. Correct despatch numbers are given in the Data Section under "Ignition System".

The distributor is mounted on a bracket on the right-hand side of the engine and is driven by an extension of the oil pump spindle, the connection being made by an offset coupling. The rotor revolves in an anti-clockwise direction, viewed from above.

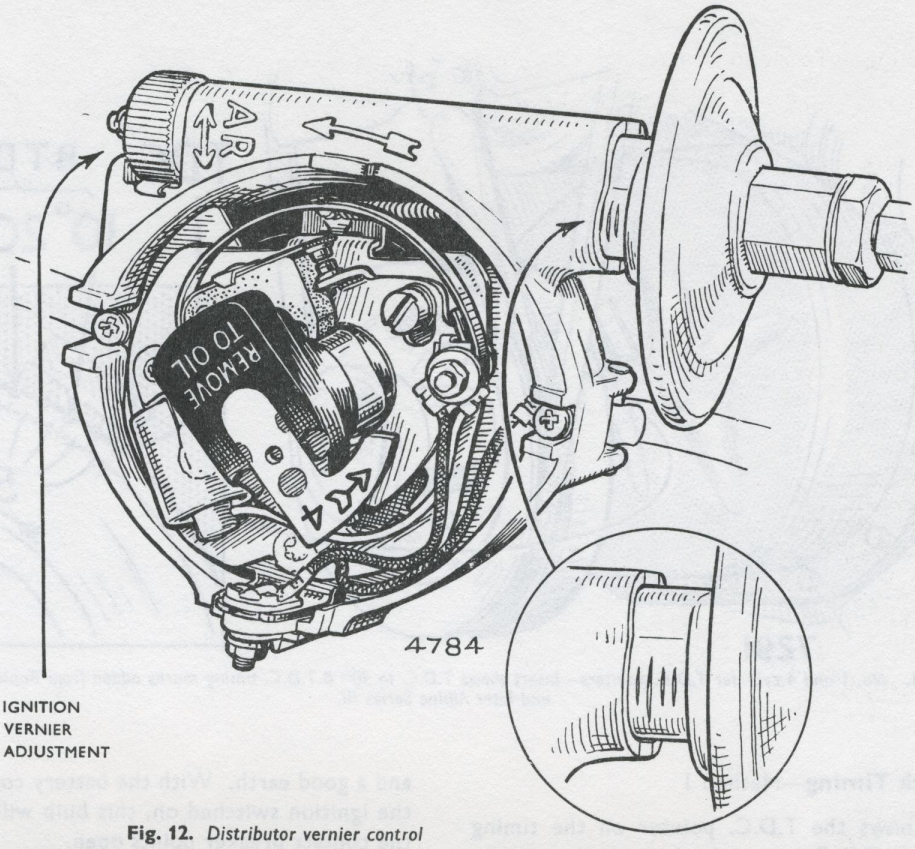


Fig. 12. *Distributor vernier control*

Two adjustments are provided for setting the ignition timing—

(*a*) A clamp screw mounted horizontally below the distributor. This is the main adjustment, and when it is slackened, the body of the distributor can be turned relative to the mounting plate.

(*b*) The vernier control shown in Fig. 12. This provides an easy means of making small adjustments to the ignition timing to give the best performance from a particular fuel, or to eliminate pinking when excessive carbon deposits have formed in the engine. The knurled knob should be turned clockwise to retard and anti-clockwise to advance, one complete turn of the knob being equivalent to three crankshaft degrees, and one vernier division, shown in the inlet of Fig. 12. to four crankshaft degrees.

TO TIME IGNITION

Static ignition settings are given in the Data Section under "Ignition System".

Before checking the ignition timing it is most important to see that the contact breaker point gap is correctly set. This will ensure that the correct ignition timing is obtained each time the contact breaker points are cleaned and adjusted correctly.

Static ignition settings and contact breaker gap are given in the Data Section under "Ignition System".

As the contact breaker point gap decreases, through gradual wear of the moving point heel, the ignition timing becomes retarded. ·004" (·10 mm.) Reduction of contact breaker point gap retards the ignition by approximately 2° of crankshaft movement. This is equal to half a division on the Vernier control which is enough to reduce engine performance.

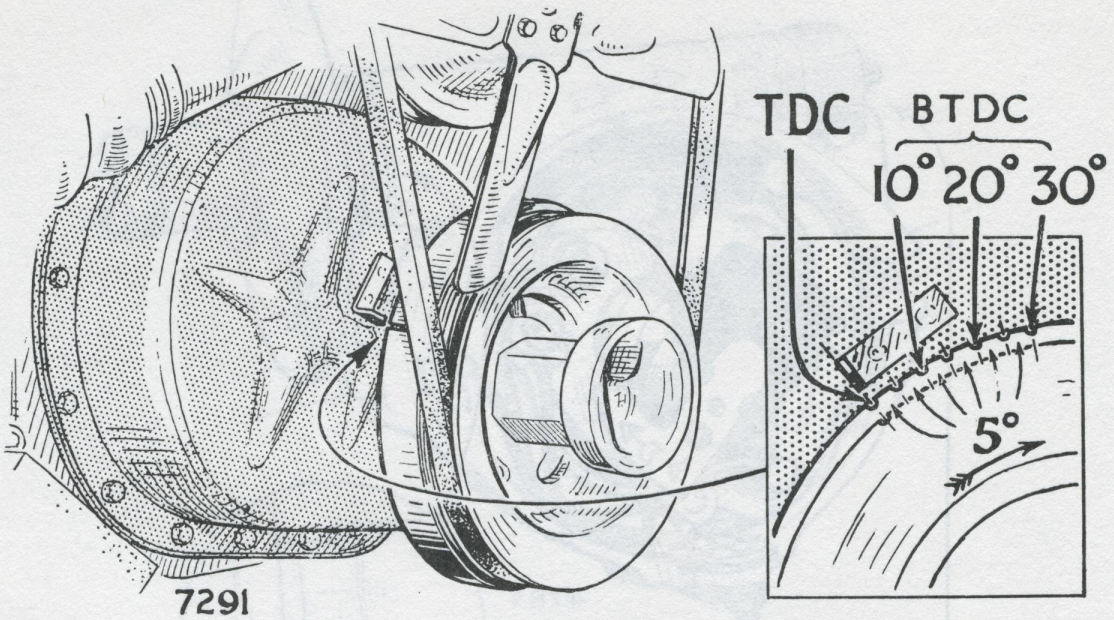


Fig. 13. *No. 1 and 4 cylinder T.D.C. pointers—Insert shows T.D.C. to 30° B.T.D.C. timing marks added from Rapier Series IV and later Alpine Series III.*

To Check Timing—Method 1

Fig. 13 shows the T.D.C. pointer on the timing case and the T.D.C. line on the damper rim opposite to each other.

Rotate the engine in its running direction until the T.D.C. line on the crankshaft damper rim is the required T.D.C. distance before the pointer on the timing case.

This distance, which is given in the Data Section under Ignition, corresponds to the degrees of advance before T.D.C. given for correct ignition timing.

If the 5° spaced timing marks exist, they should be used to set the engine to the static ignition timing angle B.T.D.C. See inset of Fig. 13.

Set the vernier control to the midway position (2 divisions showing on scale). See Fig. 12, top illustration.

Remove the distributor cap and connect a 12 v. bulb between the L.T. terminal of the distributor and a good earth. With the battery connected and the ignition switched on, this bulb will light when the contact breaker points open.

Disconnect the vacuum advance pipe to avoid straining it.

Slacken the distributor clamp screw and rotate the body of the distributor anti-clockwise as far as possible.

Switch on ignition and applying light finger pressure to the rotor in a clockwise direction, return the distributor body clockwise until the bulb just lights.

Tighten the distributor clamp screw.

Check the setting by turning the crankshaft two revolutions clockwise until the bulb again lights, observing the relative positions of the pointers.

The T.D.C. line or the correct timing mark on the crankshaft damper rim must be the required position before the pointer on the timing case.
Switch off ignition, remove bulb, and refit all parts.

STROBOSCOPIC TIMING LIGHT—Uses

The stroboscopic timing light provides a rapid and convenient means of setting the ignition timing and checking the action of the centrifugal and vacuum advance action of the distributor, provided its use is understood.

Correctly connected and with the engine running the timing light gives a high intensity flash every time No. 1 cylinder fires. When this light is directed on to the crankshaft pulley rim, the rim will appear to be stationary. It is this feature that makes it such a useful piece of equipment.

Its advantages are:—

1. It is simple to use and portable.
2. The ignition timing can be quickly checked while the engine is running, provided the engine speed can be set with a tachometer.
3. It enables a quick check to be made of the distributor centrifugal and vacuum advance mechanism, with the distributor in position, while the engine is running.
4. It is possible to set or check ignition timing regardless of any backlash that may exist in the distributor drive gears or camshaft driving chain.

Checking Ignition Timing—with stroboscopic timing light

THIS CANNOT BE DONE WITH THE ENGINE IDLING because at the correct idling speeds given in section C, pages 25 and 51, under slow running adjustment, the distributor centrifugal advance may have begun to operate.

It is therefore necessary to check the ignition timing at an engine speed of 1,000 r.p.m. using a reliable tachometer with the stroboscopic timing light, as explained in the following procedure.

1. Obtain the static ignition setting from the Data section, under ignition, noting that this is given in crankshaft degrees.
2. Add the crankshaft centrifugal advance for a crankshaft speed of 1,000 r.p.m. to the static ignition setting. The centrifugal advance angle for this engine speed on Alpine and Rapier engines is 3 crankshaft degrees BTDC.

   Example—in crankshaft degrees

   3° centrifugal advance BTDC + 8° static advance BTDC = 11° ignition advance BTDC at 1,000 r.p.m.
3. Multiply the total number of degrees found in paragraph 2 by 1·28. This gives 14 mm. which is the number of millimetres before TDC for 11° BTDC on the crankshaft pulley damper rim. Set a pair of dividers to this calculated dimension and mark this distance before TDC on the damper rim. Paint this position with a narrow white line. Also paint the tip of the fixed TDC pointer. Quick drying white paint should be used.

Note: If the damper rim has a number of 5° spaced timing marks as shown in the inset of Fig. 13 it will not be necessary to mark off the metric measurement equivalent for 11° because this angle can be read off directly on the damper rim using the timing marks. The marks are spaced at 5° intervals.

4. Connect a tachometer and stroboscopic timing light to the engine and run it at 1,000 r.p.m. WITH THE VACUUM ADVANCE PIPE DISCONNECTED FROM THE DISTRIBUTOR to prevent any possible vacuum advance action.
5. Project the beam of the stroboscopic timing light on to the TDC pointer on the timing case. The white line on the crankshaft damper rim should appear opposite to the TDC pointer while the engine is running at 1,000 r.p.m. If necessary adjust the distributor to obtain this condition.

Checking the centrifugal advance action—at 2,500 engine r.p.m.

First check that the static ignition timing is correctly set to its average figure of 8° BTDC. Then remove any line painted on the pulley rim to correspond with this position and disconnect the vacuum advance pipe.

On Alpine and Rapier engines the ignition centrifugal advance angle at 2,500 r.p.m. is 24° BTDC.

This is 16° crankshaft centrifugal advance plus 8° static advance timing.

The 16° BTDC crankshaft centrifugal advance angle is twice the distributor centrifugal advance angle. This angle has been obtained by plotting the centrifugal advance figures given under " Ignition " in the Data section.

Mark 24° BTDC on the pulley rim. If the pulley has only a TDC mark this is 30·5 mm. BTDC when marked from TDC with dividers.

Start the engine and increase the speed from idling to 3,000 r.p.m. and then reduce to 2,500 r.p.m. The white line on the pulley rim should approach the fixed pointer on the timing case with increase of engine speed and appear adjacent to the fixed TDC pointer at 2,500 r.p.m., when observed by the stroboscopic timing light.

Jerky movements of the white line, marked on the pulley rim, while increasing or decreasing engine speeds, indicates that the centrifugal advance mechanism is sticking.
The distributor advance tolerance is ± 2 crankshaft degrees.

5. *Checking the vacuum advance action*

The throttle should be opened to give an engine speed of 1,200 to 1,500 r.p.m. With the engine running under these conditions, the vacuum connection on the distributor diaphragm should be alternately disconnected and reconnected whilst observing the line on the crankshaft damper rim. This should retard and advance as the end of the vacuum pipe is removed and refitted. Blockage of the vacuum feed pipe, vacuum feed hole, or jamming of the contact breaker point mounting plate, will prevent correct vacuum advance action.

Ignition timing—Road performance test

After setting the static ignition timing and checking centrifugal and vacuum advance action as previously described, a road performance test can be made by taking stop watch readings of the time taken to accelerate in top gear from 20 to 50 m.p.h. (32 to 80 k.p.h.) under full throttle conditions on a straight level road. Small adjustments are then made with the vernier control on the distributor until the lowest stop watch reading is obtained. Several test runs have to be made ON THE SAME ROAD.

This test requires considerable skill and should only be undertaken by those who have the necessary road testing experience.

It is emphasized that the distributor centrifugal and vacuum advance mechanism must be working correctly and if these are in any way suspect, after checking unit the distributor in position, the distributor should be removed and checked on a reliable test rig or distributor analyser. The use of a Crypton test equipment that allows the ignition advance angle to be read off against engine speeds with the distributor removed is recommended.

Distributor centrifugal and vacuum advance figures are given in the Data Section under "Ignition".

DISTRIBUTOR

To remove and refit

Remove high tension leads from plug terminals, noting their positions. Disconnect high tension lead at coil. Disconnect low tension lead at distributor body. Disconnect vacuum pipe. Remove two setbolts securing aluminium distributor housing to crankcase and withdraw distributor and housing together.

Refitting is a reversal of the above.

A special cranked ring spanner (VLC tool) ½" A/F hexagon is most suitable for removal of the bolts.

To fit replacement Distributor

Before fitting a replacement distributor turn the engine so that the timing mark on the crankshaft pulley (or damper) comes opposite to the pointer on the timing case when the distributor driving slots in oil pump gear are in the position illustrated in Fig. 36.

Install replacement distributor.

The distributor rotor is now adjacent to No. 1 H.T. connection in the distributor cap. No. 1 H.T. lead should be fitted to this connection and No. 1 cylinder spark plug and the other H.T. leads to give the correct firing order of 1, 3, 4, 2. The distributor rotor rotates in an anti-clockwise direction as seen when the distributor cap is removed.
Set the ignition timing by one of the methods previously described.

ROCKER COVER

To remove and refit

Remove four nuts securing rocker cover to cylinder head and lift off cover, taking care not to damage the joint. Refitting is a reversal of the above. The joint should be replaced if damaged.

VALVE ROCKER ADJUSTMENT

(See Figs. 14 and 15)

Remove rocker cover.

Turn the engine until the exhaust valve of No. 4 cylinder is fully open and, starting at this point, adjust valves in the order given below Fig. 15, turning the engine progressively through two revolutions to complete the cycle of adjustment.

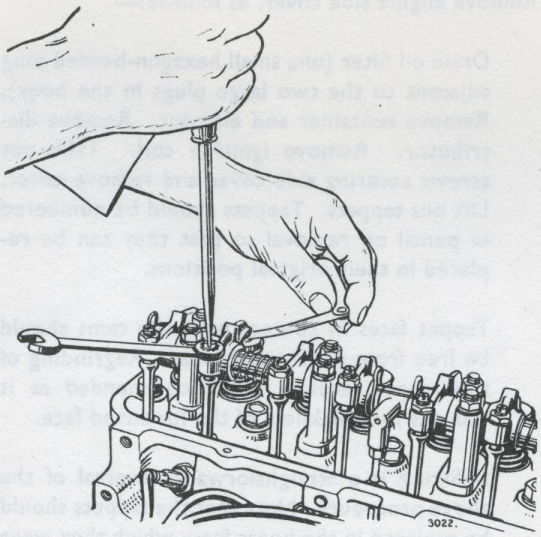


Fig. 14. *Valve rocker adjustment*

To check clearance, insert a feeler gauge of correct thickness between the valve stem and rocker foot. The correct valve clearances are given in the Data Section.

To adjust clearance, slacken lock nut and turn screw with screwdriver until correct clearance is obtained. Tighten lock nut and re-check clearance. Check all valves in this manner, then refit rocker cover.

ROCKER SHAFT ASSEMBLIES

To remove

Remove rocker cover. Undo union nut and disconnect oil pipe to rocker shaft.

Remove eight nuts securing the rocker standards to the cylinder head.

Lift out rocker shafts and upper oil feed complete.

To dismantle

Remove spring clip from one end of each assembly and take off rockers, standard and springs, noting their correct order for reassembly.

Inspect rockers and shaft and replace if worn or scored.

To reassemble

Assemble the components on the rocker shaft in the order shown in Fig. 15, locating the standards on each shaft to allow the oil feed holes to face downwards. Note that the rockers are offset.

To refit (See Fig. 15)

Make sure that each rocker shaft assembly is fitted with its open end towards the oil feed "T" piece, which is then inserted between the two shafts with its elbow facing the push rods.

The other ends of the shafts are plugged.

The rocker shafts are grooved and located by the rocker standard studs nearest to the valves. Upon reassembly the grooves should be located on the side nearest the valves.

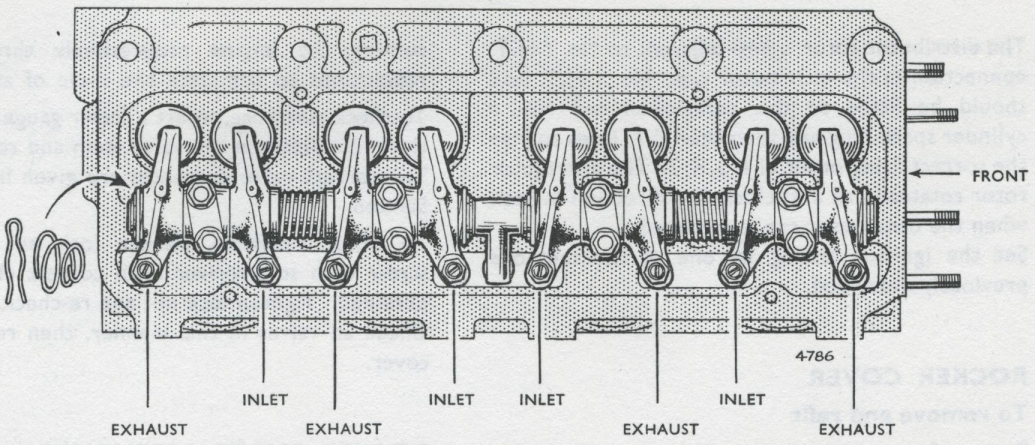


Fig. 15. *Plan view of valve rocker gear*

No. 1 exhaust is adjusted when No. 4 exhaust is fully open.
No. 2 inlet is adjusted when No. 3 inlet is fully open.
No. 3 exhaust is adjusted when No. 2 exhaust is fully open.
No. 1 inlet is adjusted when No. 4 inlet is fully open.

No. 4 exhaust is adjusted when No. 1 exhaust is fully open.
No. 3 inlet is adjusted when No. 2 inlet is fully open.
No. 2 exhaust is adjusted when No. 3 exhaust is fully open.
No. 4 inlet is adjusted when No. 1 inlet is fully open.

PUSH RODS
To remove and refit

The correct push rods for these engines are the tubular type, the diameter of which is given in the Data Section.

Remove rocker cover.

Remove rocker shaft assembly.

When removing push rods make sure that the tappets are not pulled out of their bores. A sharp tap on the side of the push rod will normally break the oil film on the ball end.

When push rods have been replaced, reset the valve clearances and recheck clearance when the engine is HOT.

TAPPETS
To remove

Remove rocker cover, rocker shaft assemblies, and push rods.

Remove engine side cover, as follows:—

Drain oil filter (one small hexagon-headed plug adjacent to the two large plugs in the body). Remove container and element. Remove distributor. Remove ignition coil. Take out screws securing side cover and remove cover. Lift out tappets. Tappets should be numbered in pencil on removal so that they can be replaced in their original positions.

Tappet faces in contact with the cams should be free from pitting and wear. Regrinding of the tappet faces is not recommended as it reduces the thickness of the hardened face.

Refitting is a straightforward reversal of the above procedure. Note that the tappets should be replaced in the bores from which they were removed.

TIMING COVER

To remove

Drain and remove radiator.

Slacken the generator mounting screws and remove fan belt.

Unscrew crankshaft jaw nut and pull off combined crankshaft pulley and damper. (Two tapped holes provided).

Remove all screws and nuts holding cover in position, and withdraw cover.

To refit

Reverse the above operations, taking great care to centralise the cover around the crankshaft pulley, before fully tightening the bolts. A timing cover centraliser (R.G. 89) is supplied by Messrs. V. L. Churchill.

TIMING WHEELS AND CHAIN

To remove

Remove timing cover.

Remove split pin and plain washer from tensioner pivot pin and lift off tensioner blade.

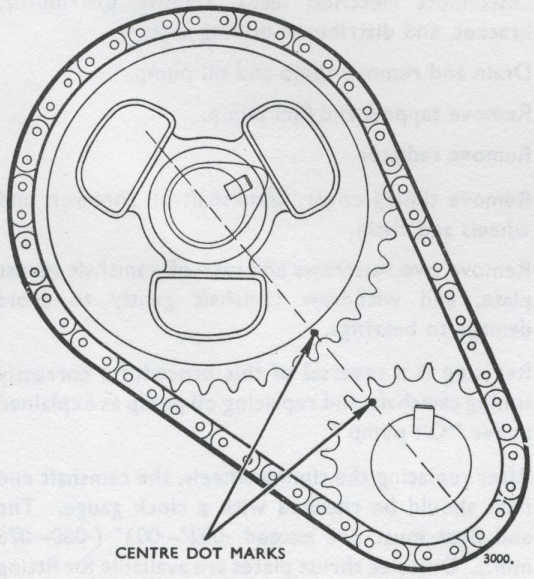


Fig. 16. *Timing wheel alignment*

Remove the setscrew, tab washer, and plain washer from front end of camshaft.

Remove oil thrower in front of crankshaft sprocket.

Pull or lever off both camshaft and crankshaft wheels simultaneously.

To refit

When refitting, set Nos. 1 and 4 pistons to T.D.C. so that the key is to the top of the crankshaft.

Push crankshaft wheel onto crankshaft until it is approximately 1·5″ (38 mm.) from the shaft shoulder.

To obtain the valve timing shown in Fig. 17, fit chain to crankshaft wheel and camshaft wheel so that the dots on the camshaft and crankshaft wheels are in line (See Fig. 16).

Turn camshaft until the key lines up with the key way in the camshaft wheel.

Pull camshaft wheel onto camshaft by means of a washer and bolt screwed into the camshaft end, and drive crankshaft wheel onto crankshaft.

Replace camshaft sprocket fixing bolt and washer Secure bolt with a new lock washer.

Replace crankshaft oil thrower.

Refit chain tensioner and timing cover, making sure that the tensioner blade is correctly fitted.

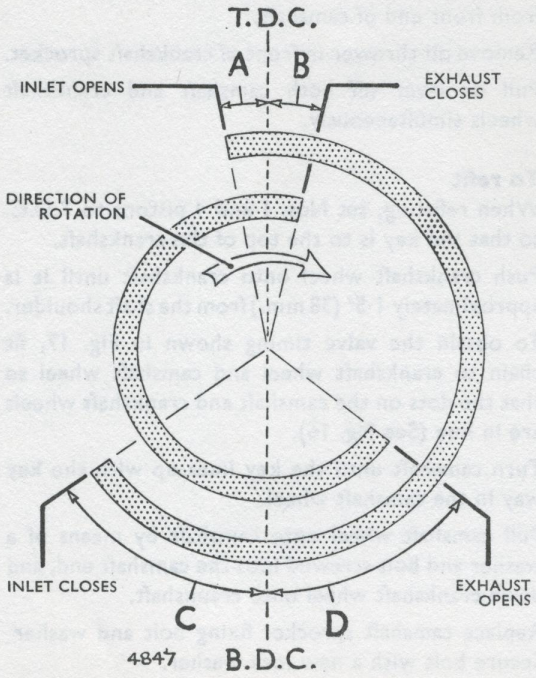
The front face of the timing case is bolted to a pedestal bolt, and the free end of the tensioner blade rests on the inside of the timing case.

Camshaft sprockets used on these engines have a small circular groove machined on the rear face just below the bottom of the sprocket teeth.

Check Valve Timing

THIS IS ONLY NECESSARY WHEN INCORRECT REPLACEMENT OF THE TIMING CHAIN IS SUSPECTED, in which case the following quick check can be made.

1. Remove rocker cover and adjust No. 1 cylinder inlet valve rocker clearance to ·019–·020″ (·48–·50 mm.) when No. 4 cylinder inlet valve is fully open. This is important as valve timing cannot be checked at the normal valve rocker clearances.



Inlet valve open	(A)	14° B.T.D.C.
Inlet valve closes	(C)	52° A.B.D.C.
Exhaust valve opens	(D)	56° B.B.D.C
Exhaust valve closes	(B)	10° A.T.D.C.

Fig. 17. *Valve timing diagram*

2. Turn engine until the line on crankshaft damper rim is about 32 mm. ($1\frac{1}{4}$") before the pointer on the timing case.

3. Set up a clock gauge to show when the inlet valve begins to move. To do this the gauge stylus point must contact the valve spring cap. Set the gauge dial to read zero and turn the engine slowly until the gauge shows ·001" (·025 mm.) downward movement of the valve spring cap. Note the position of the T.D.C. groove in the crankshaft pulley. If the valve timing is correct it should be approximately 17 mm. before the timing cover T.D.C. pointer.

   If the valve timing is one tooth out, the mark on the crankshaft pulley will be a considerably greater distance before T.D.C. or at some distance after T.D.C.

   The valve opening point can also be found with reasonable accuracy by attempting to rotate the valve spring cap with the first finger and thumb. Directly the valve leaves its seat it is possible to slightly twist the valve and this movement will be seen on the spring coils.

   The actual opening point of a valve cannot be determined by noting when a thin feeler is gripped between the rocker and valve stem end or by rotating the push rod to find when load comes onto the push rod.

4. Readjust No. 1 cylinder inlet valve to its normal clearance.

CAMSHAFT

To remove and refit

Disconnect electrical leads, remove distributor, bracket, and distributor driving shaft.

Drain and remove sump and oil pump.

Remove tappets and fuel pump.

Remove radiator.

Remove timing cover, crankshaft oil thrower, and wheels and chain.

Remove two setscrews and take off camshaft thrust plate, and withdraw camshaft gently to avoid damage to bearings.

Refitting is a reversal of this procedure, correctly timing camshaft, and replacing oil pump as explained under "Oil pump".

After replacing the timing wheels, the camshaft end float should be checked with a clock gauge. The end float must not exceed ·002"–·003" (·050–·076 mm.). Oversize thrust plates are available for fitting if required.

CAMSHAFT BEARINGS

To remove

Using special tool (V. L. Churchill RG 32), the front and centre bearings can be withdrawn forwards.

The gearbox, clutch and flywheel, together with rear sealing disc will have to be removed to enable rear bearing to be withdrawn rearwards.

This operation will, in all probability, be carried out on most occasions when an engine is overhauled,

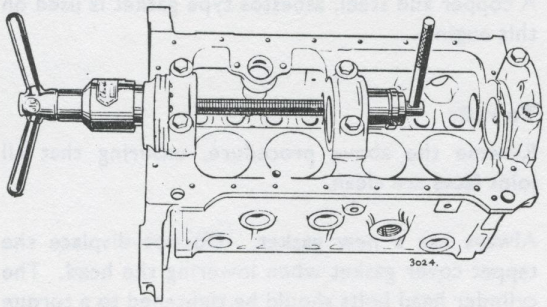


Fig. 18. *Camshaft bearing remover and replacer*

and will be facilitated with the cylinder block in a stripped condition.

Replacement bearing shells require no matching.

Operation of the special tool is shown in Fig. 18.

To refit

Using tool RG 32, draw in the bushes. Ensure that the oil feed holes are correctly aligned, and that the camshaft sealing disc is made oil tight.

INLET AND EXHAUST MANIFOLD

To remove

Drain cooling system as inlet manifold jacket is coupled to cylinder head and water pump.

Remove air cleaner.

Disconnect water hose from the water pump to the inlet manifold water jacket, and the water feed pipe at the rear and of the inlet manifold.

Loosen exhaust pipes from engine at the 'Y' junction in the exhaust pipe (*Alpine only*).

Disconnect exhaust pipe at exhaust manifold flange (*Rapier only*).

Disconnect throttle control rod, choke control and fuel feed pipes.

Remove clamps, long bolt, and nuts holding the manifold assembly to the cylinder head. Lift off manifolds leaving the carburettors on the inlet manifold to save disturbing the throttle synchronization.

To refit

Refitting is a reversal of the removal procedure.

Ensure that the inlet manifold locating rings are in position.

Refill the cooling system and check water connections on the inlet manifold for leaks.

If the carburettors have been removed the throttles should be synchronized and the slow running adjusted as described in Section C.

COMPRESSION PRESSURES

An engine in good condition should give the compression pressures given in the Data Section under "Engine—General". These pressures should be taken at starter cranking speed with the throttle held fully open, all sparking plugs removed and the engine hot. If readings are obtained substantially below these quoted, the engine concerned is in need of attention to the valves or piston rings, or possibly requires reboring.

CYLINDER HEADS

Aluminium alloy cylinder heads are used on these engines. Owing to the high expansion rate of the cylinder head material, valve guides, valve seat inserts, and sparking plug tubes can only be fitted or removed when the cylinder head has been uniformly heated to 200° C. (390°F.).

Valve stem diameters, valve head diameters, valve seat angles, valve stem clearances in the valve guide, and combustion chamber volume are given in the Data Section.

To remove

Drain cooling system.

Remove air cleaner where fitted.

Disconnect header tank to radiator hose, and overflow pipe from header tank.

Remove rocker cover.

Disconnect thermometer lead at bulb by gripping the rubber sleeve at the end of the lead and pulling out the snap connector from the bulb.

Disconnect sparking plug leads and remove coil.

Remove screws securing tappet side cover to cylinder head.

Remove oil feed pipe to rocker shaft.

Disconnect heater pipe (if fitted).

Remove 8 nuts securing rocker shaft to cylinder head.

Remove rocker gear and push rods taking care not to lift out the tappets when lifting out the push rods. The push rods should be placed in a suitable holder so that they can be replaced in the same position as found.

Disconnect fuel pipe connections and throttle control.

Alpine

Disconnect inlet manifold and exhaust manifolds at their cylinder head connections. Slacken off the two exhaust manifold clips at the 'Y' connection at the front end of the exhaust system. Remove inlet manifold complete with carburettors and pull exhaust back pipes clear of the cylinder head.

Rapier

This cylinder head can be lifted off with manifolds and carburettors attached after disconnecting the exhaust pipe at its flange joint.

Remove eight bolts and two nuts and washers securing cylinder head to cylinder block and lift off cylinder head.

Cylinder head gasket

All gaskets are stamped with the word "TOP" and must be fitted with the word uppermost. The gaskets are also stamped with their part number for identification purposes.

A copper and steel, asbestos type gasket is used on this engine.

To refit

Reverse the above procedure, ensuring that all joint faces are clean.

Always use a new gasket. Do not displace the tappet cover gasket when lowering the head. The cylinder head bolts should be tightened to a torque figure given in the Data Section under "Cylinder Head" in the order shown in Fig. 19, before tightening the tappet side cover screws. Adjust valve clearances.

The following procedure should be followed after refitting the cylinder head and fitting a new cylinder head gasket.

1. Run engine until it is thoroughly warmed up.
2. Allow engine to cool down and when COLD retighten the cylinder head.
3. Thoroughly warm up engine and reset the valve clearances.

It is essential to adhere strictly to the torque wrench figures quoted.

It is most important that the cylinder head is aligned so as to correctly position the machined location for the tappet cover in relation to the corresponding machined face on the cylinder block, before tightening the cylinder head bolts.

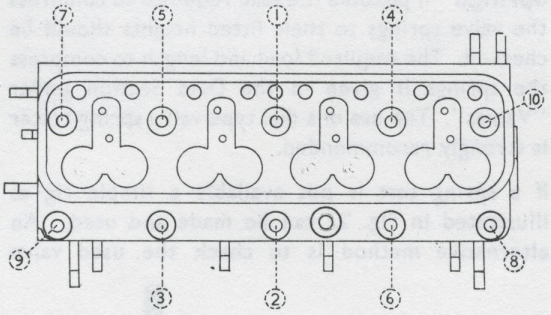


Fig. 19. *Tightening diagram for cylinder head*

DECARBONISING

When the cylinder head has been removed for decarbonising the complete set of valves should be removed for cleaning, inspection and refacing, (detailed instructions for these operations are given elsewhere in this section). The valve guides should also be checked for wear on their internal diameters and in this respect reference should be made to "VALVE GUIDES—TO RENEW".

When removing the carbon from each piston crown, it is always advisable to leave a ring of carbon adjacent to the cylinder bore as this helps to preserve a good seal, and to conserve oil. A convenient method of doing this is to turn the engine until the piston is slightly below the top dead centre position, and insert an old piston ring of correct size in the bore, and press down on the piston. In this way all the carbon within the old piston ring may be removed, leaving a ring of carbon around the piston edge.

Remove carbon from the tops of the pistons, the combustion chambers in the cylinder head and also from the valve ports. With a suitable scraper clean out the inside of the exhaust manifold.

Place clean rag in the exposed area of the tappet chamber, as no carbon should be allowed to enter.

Remove all loosened carbon, preferably by use of a compressed air line.

Care must be taken when decarbonising the tops of the pistons, these being of aluminium alloy. No pointed instrument or emery cloth may be used

Do not on any account use abrasives for removing carbon, or damage will result.

Having attended to the preceding operations and given the valves and seatings any attention that may be required, the engine may be reassembled.

VALVES

To remove

To assist in this operation it is recommended that a valve spring compressor (Churchill Tool D.6513) be used, as shown in Fig. 20.

Remove cylinder head.

Using the valve spring compressor, remove the split coned cotters. When carrying out this

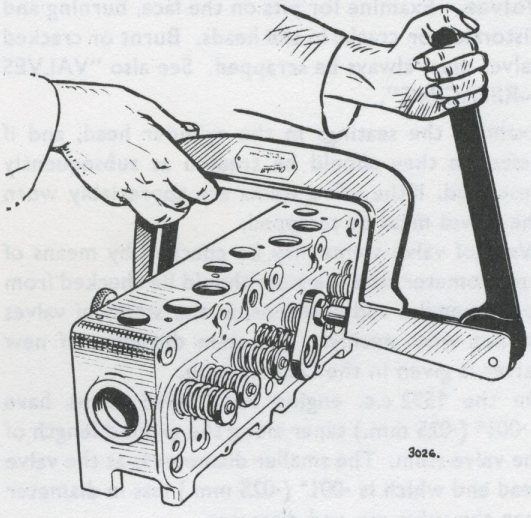


Fig. 20. *Use of valve spring tool*

operation care should be taken to ensure that no damage is caused to the valve stem by the hardened steel cotters and spring cups.

Release valve spring compressor and lift off cups and dual valve springs.

Remove the valves.

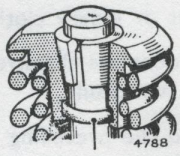


Fig. 21. *Valve spring cup showing sealing ring groove*

To refit

The valve stems should be given a thin coating of oil when the valves are refitted.

The valve spring cups have a sealing ring in the lower end. See Fig. 21. When refitting care should be taken to avoid damage to the sealing ring as damaged rings can cause oiling up of the sparking plugs.

The sealing rings should be renewed if faulty.

EXAMINATION OF VALVES, SPRINGS AND GUIDES, ETC.

Valves. Examine for pits on the face, burning and distortion or cracks in the heads. Burnt or cracked valves must always be scrapped. See also "VALVES —REFACING".

Examine the seatings in the cylinder head, and if defective they should be treated as subsequently described. If the valve stems are appreciably worn the valves must be scrapped.

Wear of valve stems may be checked by means of a micrometer, and the stem should be checked from various angles and positions, as the stems of valves do not wear evenly. The stem diameter of new valves is given in the Data Section.

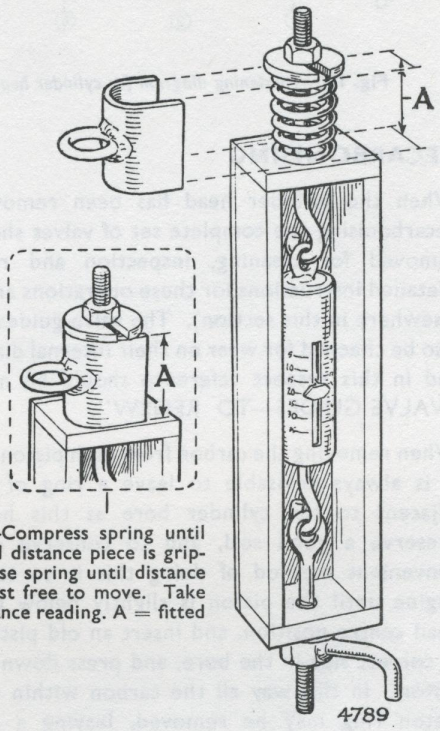
On the 1592 c.c. engine both valve stems have a ·001" (·025 mm.) taper along the ground length of the valve stem. The smaller diameter is at the valve head end which is ·001" (·025 mm.) less in diameter than the valve cap end diameter.

Guides. These may be checked for wear by using a new valve as a gauge. The valve stem should be a free sliding fit in the guide without excessive side play.

In making the foregoing tests both valve stem and valve guide must be free from carbon or burrs and free from oil.

Springs. If possible the load required to compress the valve springs to their fitted heights should be checked. The required load and length to compress the springs is given in the Data Section under "Valves". The use of a dial type valve spring tester is strongly recommended.

If a spring test is not available a simple rig as illustrated in Fig. 22 can be made and used. An alternative method is to check the used valve springs by comparing them with new springs. See Fig. 23. Place them end to end on a long bolt and compress them in a hand press. Any loss will then be apparent as the weaker spring will close up first. If either spring of a pair is weak both inner and outer should be replaced as a pair even though the outer spring in the original pair may appear to be satisfactory when compared with a new spring as



To use.—Compress spring until 'U' shaped distance piece is gripped. Release spring until distance piece is just free to move. Take spring balance reading. A = fitted length.

Fig. 22. *Valve spring testing rig*

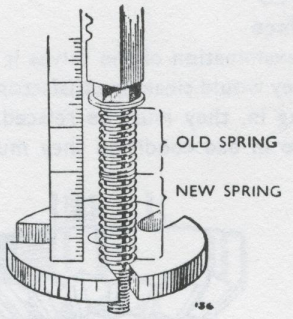


Fig. 23. *Checking valve springs*

described. Inner and outer valve springs are supplied in new pairs only and should not be interchanged.

VALVES

To grind in

This operation will be satisfactory only if the valves and seatings are found to be in good condition after dismantling and examination, and there is no evidence of distortion or burning of the faces and heads of the valves. It is also necessary after new valves have been fitted, or seatings recut. The valve stems must be straight and their guides must be in good condition.

Place a small amount of valve grinding paste (fine) evenly around the face of the valve to be ground, not allowing it to get on the stem or other parts.

Place the valve on its seating and by means of a suction grinding tool, rotate the valve from side to side through a few degrees only, using a light pressure. Frequently raise the valve and move round to a new position on its seating and continue grinding. (On no account should the valve be revolved through complete revolutions when grinding, or rings will be formed on the faces with detrimental effects).

The grinding should be continued in this manner until a continuous but narrow seating has been obtained both on the valve and the seating. The seatings should not be more than ·070″ (1·78 mm.) in width.

After thoroughly cleaning off all traces of grinding paste from the valve and seating with a dry cloth, test by placing a small amount of engineers' marking on the seating and revolving the valve in place not more than about $\frac{1}{8}$″ (3 mm.) in each direction. A complete circle of marking should appear on both valve face and seating, indicating a good seal.

VALVE GUIDES

To renew

Valve guides can only be fitted and removed when the cylinder head has been uniformly heated to a temperature of 200°C. (390°F.).

A suitable size gas or electric cooking stove fitted with a Rototherm or other type of thermometer in the oven door can be used for heating the cylinder head. The oven temperature should be maintained at 200°C. (390°F.) while the cylinder head is left in the oven for about 30 minutes.

A circlip is fitted to both inlet and exhaust valve guides and ensures that the guides are correctly fitted when the circlips come against the cylinder head.

Both valve guides are chamfered on the top ends. The inlet valve guide has a long chamfer at the valve port end and is slightly shorter in length than the exhaust valve guide.

A stand is needed for the cylinder head after it is heated. This consists of a piece of thick hardwood covered on one side with soft asbestos sheet to prevent damage to the cylinder head face. Eight holes should be cut through the board to give ample clearance around the valve guides, when the cylinder head is resting on its top face, to allow the valve guides to be driven out from the valve head ends. As an additional means of retaining heat a fairly close-fitting four-sided wood box, lined with asbestos can be placed around the cylinder head after it has been put on the bottom support board.

This will leave only one face exposed

The valve guides can be driven out with a suitably stepped mild steel drift always provided that the

cylinder head is heated to the proper temperature. THEY CANNOT BE DRIVEN OUT OF A COLD CYLINDER HEAD.

New valve guides must have a proper interference fit and can only be installed when the cylinder head has been heated to the proper fitting temperature. This usually requires the fitting of guides having an outside diameter of ·001" (·025 mm.) larger than the guides that are removed. The correct interference for these valve guides is given in the Data Section under "Valves".

The valve guide depth positioning circlips should be fitted to the valve guides before tapping the valve guides into the cylinder head.

The sharp edge of the top end of the valve guide must not be damaged as this edge is used to scrape excess oil from the valve stem.

After fitting, the valve guides should be reamed with a spiral fluted reamer, to give a valve guide bore diameter of ·3125–·3135 ins. (7·94–7·96 mm.).

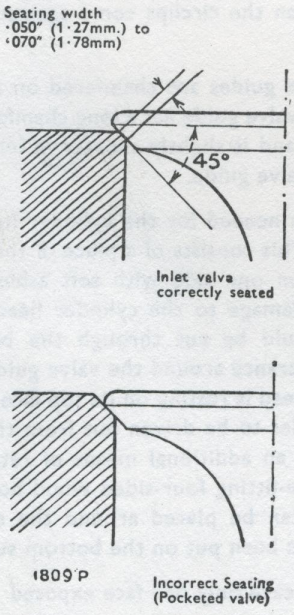


Fig. 24. *Valve seating*

VALVES

To reface

If, on examination of the valves it appears unlikely that they would clean up satisfactorily with ordinary grinding in, they must be refaced. If the seatings are also in bad condition they must be recut, but

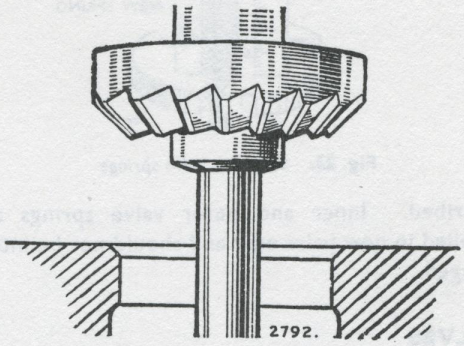


Fig. 25. *Use of 45° valve seat cutter*

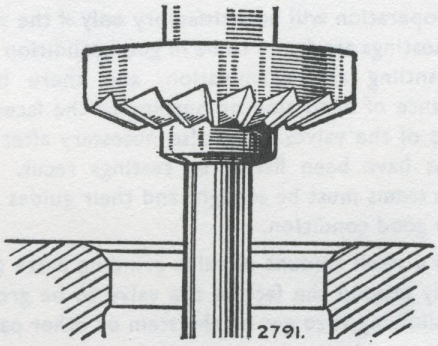


Fig. 26. *Use of 15° valve seat cutter*

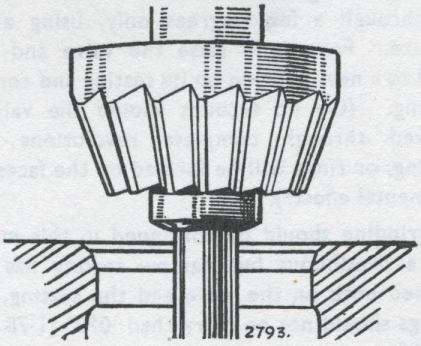


Fig. 27. *Use of 75° valve seat cutter*

generally it will be found that these are better than the valves as regards condition unless the engine has been a very long time in service. It is quite practicable to reface the valves and grind them in on the seatings if the latter are in good order.

It is always better to replace a badly burnt or pitted valve as extended refacing will bring it very low on its seating by reason of the consequent reduction in the effective diameter of the valve face, and "pocketing" will result. (See Fig. 24). This condition is detrimental to the running of the engine and will cause overheating and loss of power. The valve face should be machined only until it is just true and clear of marks, to the standard angle of 45° for inlet and exhaust. These angles are measured from the top face of the valve head. Standard dimensions of valves are given in the Data Section at the beginning of this manual.

The refacing of valves must not leave too thin an edge above the valve head seating. This applies particularly to exhaust valves which must be renewed if much refacing is needed.

A valve which has been refaced as described must also be finally ground in on its seating (see "VALVES—TO GRIND IN"). The seating must be in good condition and the face not more than ·070" (1·78 mm.) in width.

VALVE SEATINGS

To recut

A damaged or slightly burnt seating may be refaced with a 45° seating cutter as illustrated in Fig. 25.

A complete set of valve seat cutters can be obtained from Messrs. V. L. Churchill (Tool No. R.G.316). Individual items may be purchased separately if required. It is most important that the cutter pilot should be a good fit in the valve guide. If necessary the valve guide should be renewed as the highest possible concentricity must exist between the seatings and valve guide bore (See "VALVE GUIDES —TO RENEW).

The seating should be recut with a 45° cutter until all marks have disappeared. NO lubricant is required for this operation.

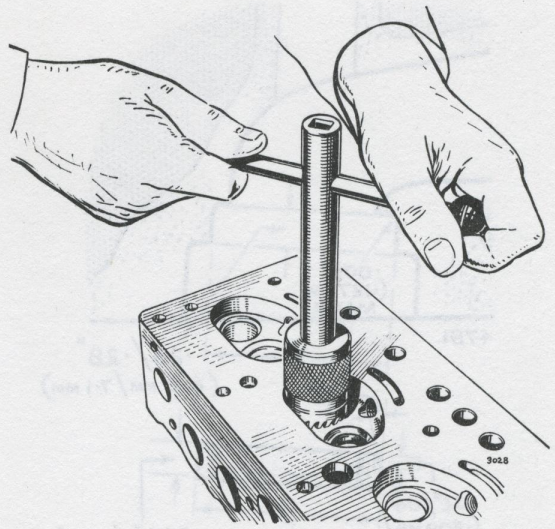


Fig. 28. *Use of valve seat cutting tool*

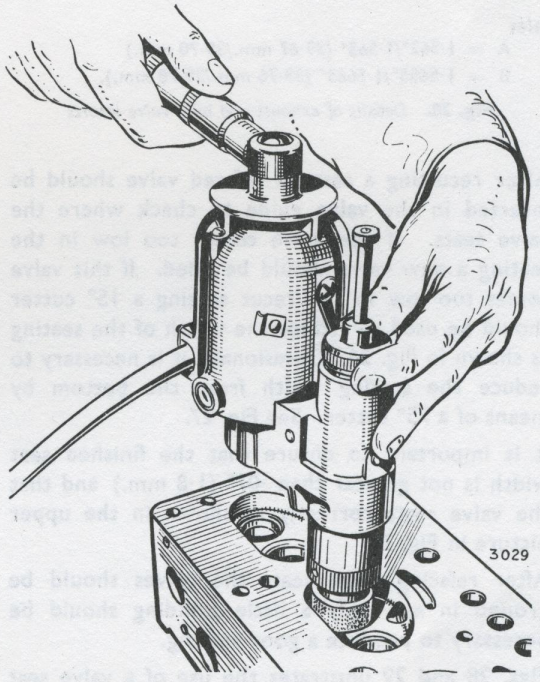
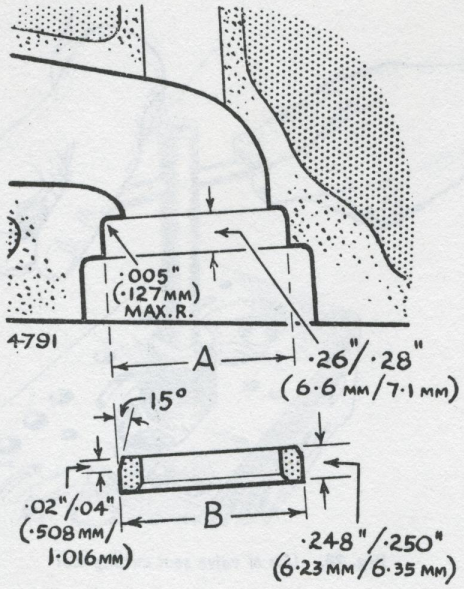


Fig. 29. *Use of valve seat grinder*



Exhaust

A = 1·312″/1·313″ (33·33 mm./33·35 mm.).
B = 1·3155″/1·3165″ (33.42 mm./33·44 mm.).

Inlet

A = 1·562″/1·563″ (39·67 mm./39·70 mm.)
B = 1·5655″/1·5665″ (39·76 mm./39·78 mm.).

Fig. 30. *Details of exhaust and inlet valve inserts*

After recutting a seat its refaced valve should be inserted in the valve guide to check where the valve seats. If the valve comes too low in the seating a new valve should be tried. If this valve comes too low in the recut seating a 15° cutter should be used to reduce the width of the seating as shown in Fig. 26. Occasionally it is necessary to reduce the seating width from the bottom by means of a 75° cutter. See Fig. 27.

It is important to ensure that the finished seat width is not greater than ·07″ (1·8 mm.) and that the valve seats correctly as shown in the upper picture in Fig. 24.

After refacing valve seats the valves should be ground in and only a little grinding should be necessary to produce a good seating.

Figs. 28 and 29 illustrates the use of a valve seat cutting tool and a valve seat grinder. The later is preferable for facing valve seat inserts.

EXHAUST AND INLET VALVE SEAT INSERTS (See Fig. 30)

These inserts can only be fitted when the cylinder head has been uniformly heated to 200°C. (390°F.). The equipment previously described under "VALVE GUIDES—TO RENEW", should be used.

Inserts cannot be extracted from a cold cylinder head as they are fitted ·010″ to ·032″ (·25 mm. to ·81 mm.) below the combustion chamber face which shrinks in above the inserts.

To remove

Old inserts can be removed by boring out until the insert collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the insert recess in the cylinder head.

To replace

From the chassis numbers given in this section on page 8, the inlet valve seat bores, and the inlet ports immediately behind the inlet valve seats, are enlarged by machining after the seats have been fitted to the cylinder head.

If an inlet valve seat is changed from these chassis numbers, it will be necessary to carefully enlarge the inlet valve seat bore, after the insert has been fitted in the cylinder head, so that the bore of the insert blends with the already enlarged inlet post behind the insert.

1. Check the valve recess diameter.
2. Select a suitable oversize valve seat insert and check its outside diameter.
3. Machine the cylinder head recess diameter to the best possible finish concentric to the valve guide centre so that the insert will have the correct interference fit (see Fig. 30).
4. Heat the cylinder head for 30 minutes from cold in an oven maintained at a temperature of 200°C. (390°F.).

5. Fit the insert ensuring that it beds on the bottom face of its recess.

6. The valve seat on the newly fitted insert, should be cut or ground at an angle of 45° to a width of ·05″–0·6″ (1·27 mm.–1·52 mm.). The seat must be concentric to within ·001″ (·025 mm.) of the valve guide bore.

LUBRICATION SYSTEM

General description

The direction of oil flow is shown by arrows in Figs. 1 and 2.

Fig. 31 shows the lubricating system and passages in more detail.

Lubrication of all working parts of the engine is effected by the forced feed system, pressure being generated by a submerged oil pump, mounted in the righthand side of the crankcase, and driven, in tandem with the distributor, through skew gears from the camshaft.

Oil is drawn through a submerged gauze filter and rises through the intake tube and oil pump to an internal delivery pipe, whence it is fed to the full flow filter, before passing to the main oil gallery, situated along the right-hand side of the crankcase.

From there the oil is distributed into the oilways' drilled in the main bearing support webs of the cylinder block, whence the oil is carried to all main and camshaft bearings. Drilled passages in the crankshaft allow oil to flow from the main bearings to the crankpins, where it lubricates the connecting rod big end bearings.

Oil squirt holes drilled through the big end bearings and connecting rod webs project oil on to the cylinder walls at each revolution of the crankshaft, thus ensuring adequate lubrication of the bores.

The timing gears are lubricated by a jet of oil from a small hole drilled in the side wall of a small diameter pipe which is supplied with oil from the front main bearing oil feed. The oil pipe end passes through a hole in the cylinder block, and oil supplied in excess of the chain's requirements is returned direct to the sump.

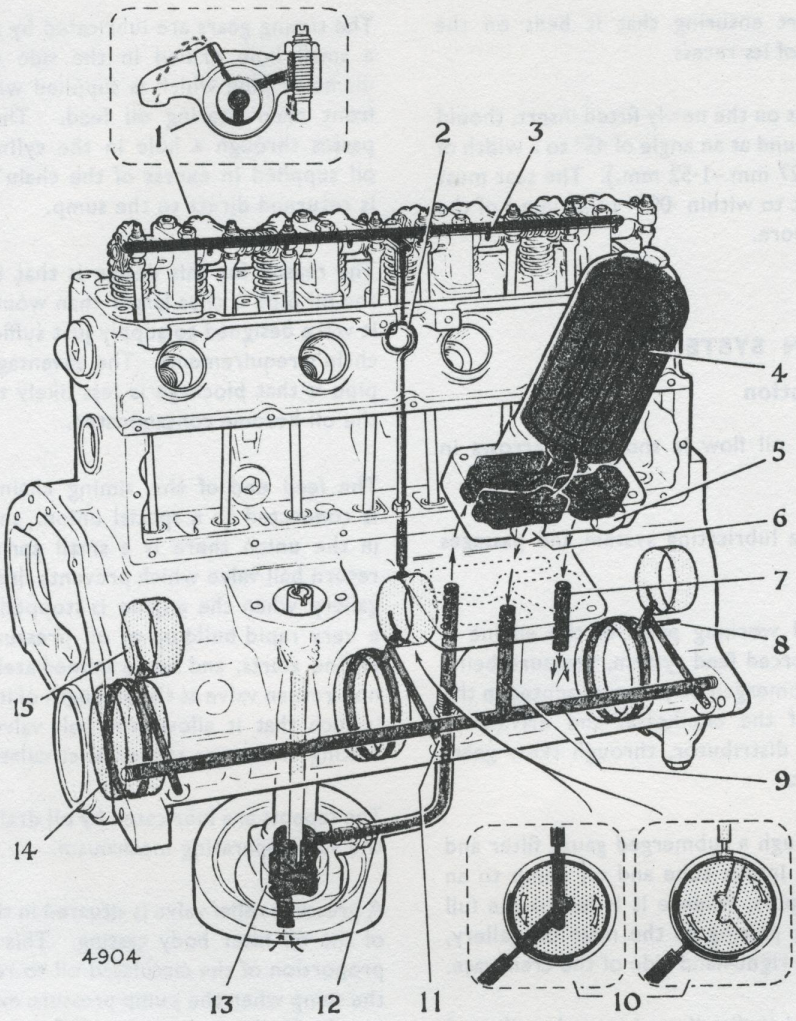
The reason for this design is that the diameter of the oil pipe is thus larger than would be possible if it were designed to supply just sufficient oil for the chain's requirements. The advantage of this larger pipe is that blockage is less likely to occur should the oil become contaminated.

The feed end of the timing chain oil feed pipe is connected to a special union, shown in Fig. 4. In the union there is a small spring-loaded non-return ball valve which prevents draining of the oil gallery when the engine is stopped. This ensures a very rapid build up of oil pressure directly the engine starts, and oil to immediately flow past the non-return valve as the strength of its return spring is such that it allows the ball valve to lift off its seating whenever the oil is circulating.

The tappets are lubricated by oil draining back from the valve-operating mechanism.

A pressure relief valve is situated in the forward end of the oil filter body casting. This valve allows a proportion of the circulated oil to return direct to the sump when the pump pressure exceeds approximately 50 lbs. per sq. in. (3·5 kgs. per sq. cm.). Fitted into the rear end of the oil filter body is a by-pass valve, which opens in the event of the oil filter element becoming choked, thus ensuring a supply of oil to the bearings and other vital parts in such circumstances.

The oil feed to the valve rocker gear is taken from the centre camshaft bearing through a drilling in the centre camshaft journal which acts as a rotary metering device. Oil flow occurs once every camshaft revolution when the drilling connects the



1 Valve Rocker oilways.
2 Oil feed pipe.
3 Oil feed to rocker shaft.
4 Full flow oil filter
5 Oil pressure relief valve.
6 Filter by-pass valve.
7 Oil pressure relief valve discharge hole.
8 Oil feed to timing chain oil feed pipe.
9 Oil gallery and feed from filter.
10 Cross section through camshaft centre journal showing drilling in journal used to control oil feed to rocker gear.
11 Connection point for oil warning light switch or oil pressure gauge.
12 Oil feed from oil pump to filter.
13 Oil pump.
14 Main bearings.
15 Camshaft bearings.

Fig. 31. *Oil passage ways in cylinder block and cylinder head*

centre camshaft bearing oil feed hole, and the oil hole feeding to the valve rocker oil feed pipe. See Fig. 31 and its inset (10). By this means a controlled quantity of oil is fed at a much reduced pressure through an internal pipe to the valve rocker shaft.

Holes in the underside of the rocker shafts feed to each rocker bearing. Grooves in the rocker bearing surface pass oil to drillings in the rockers which feed oil to the push rod cup ends and valve rocker ends that contact the valve stems. Oil from the push rod cup ends overflows and runs down the push rods to lubricate the bottom ends of the push rods in the tappets. Drain holes in each tappet are provided to prevent the tappets from filling with oil.

OIL SUMP (OIL PAN)

To remove and refit

Drain oil from sump by removing drain plug at left side.

Undo eighteen bolts securing sump to lower face of crankcase. It is advisable to leave one centre bolt on each side in place until the weight of the sump can be taken by hand, to avoid distortion of the joint faces.

To refit

As the sump face is in line with the horizontal axis of the crankshaft main bearings, a semi-circular cork joint is used between the front and rear main bearing caps and the sump, in addition to the normal face joints at each side.

The semi-circular cork joints should be fitted to the front and rear main bearing caps after fitting the cylinder block two bottom face side joints.

The thickness of the semi circular cork joint is ·180″ — ·190″ (4·5 — 4·88 mm.) or ·150″ — ·160″ (3·8 — 4·0 mm.). **These joints are not interchangeable.** The thin joint has replaced the thick joint and is recognised by its colour dyed ends. Where the thin joints are used the front and rear main bearing caps have a casting recess, or cast protrusions as shown in Fig. 32, by the letter (C). The identification used on the front main bearing caps can be seen with the sump in position. A small number of these bearing caps are without the casting marks and have rough ground grooves as illustrated.

When the cast identifying marks are seen (or the rough ground grooves) on the front and rear main bearing caps, the thin cork joint MUST be used. Both ends of each semi-circular corks must be square and come up to the ends of the two side joints.

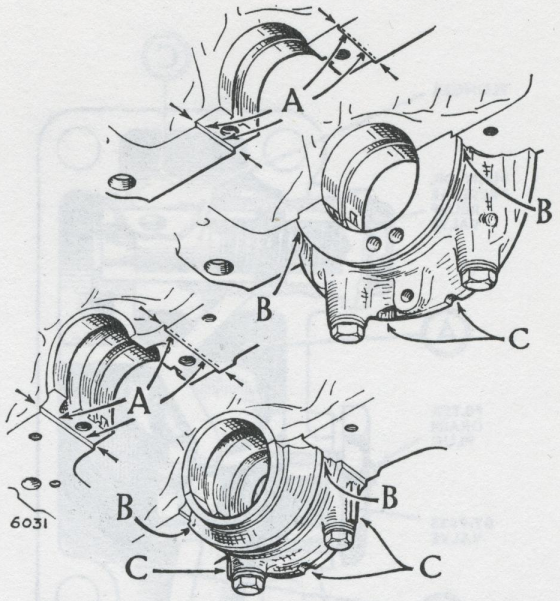


Fig. 32. *Places at which jointing compound is used when replacing sump and identifications used to show when THIN cork joints are fitted.*

All sump joints should be fitted dry, except when working from underneath, when the side joints have to be stuck to the cylinder block bottom face. A small quantity of quick setting compound should be applied to the ends of all joints at the points (B) Fig. 26 to ensure a satisfactory oil seal in the corners. The centre sump bolts should be fitted first and all bolts progressively tightened.

When dealing with difficult cases of oil leakage, the front and rear main bearing caps should be removed and "Wellseal" or other suitable non-setting jointing compound applied along the front and rear main bearing recess vertical locating faces (A) as shown in Fig. 32. The compound must be kept off of the horizontal butting faces. On replacing the main bearing caps the jointing compound is trapped in the small corner clearance between the outside edges of the bearing caps and the corner of the locating recess. This prevents oil leakage along the small clearance that must exist at these points and along which oil sometimes leaks.

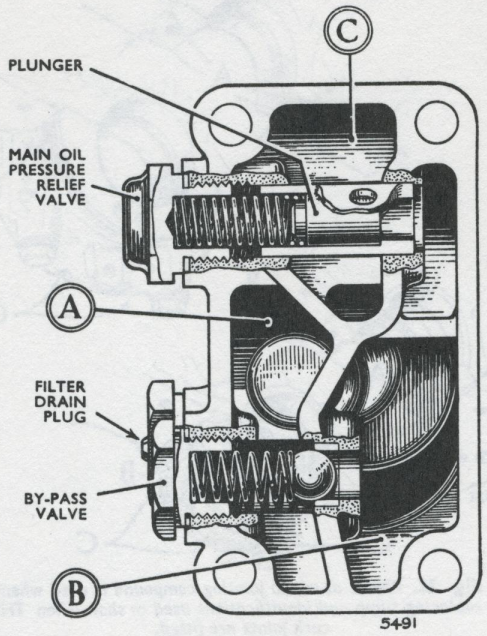


Fig. 33. *Oil filter base details*

FULL FLOW OIL FILTER

The following information applies to the renewable type of oil filter unit. Particulars of the throw away type of oil filter are given on page 45.

The full flow oil filter body is bolted to a flange on the right-hand side of the crankcase, and is divided internally to form three separate compartments (see Figs. 33 and 34).

Oil from the pump flows through a drilling in the crankcase to compartment "B" into which is screwed the hollow bolt retaining the element casing to the filter body. The oil passes through the hollow bolt and via a drilling just below the bolt head, into the filter casing.

The filter element bore is sealed at its ends by two Neoprene rings, the upper ring being fitted into a sleeve passing over the hollow bolt, and spring-loaded away from the top of the element casing. The lower ring is fitted into a groove formed in the top of the filter body.

All oil passing into the element casing flows through the element from its outside surface, through the element, up from the inside of the element and down through the steel tube fixed in the filter base to compartment "A" which feeds to the main oil gallery. See Fig. 34. The steel tube inside the filter prevents the oil draining out of the filter when the engine is not running.

Oil pressure relief valves

A ball or plunger type pressure relief valve is situated in compartment "C" and opens if the oil pressure exceeds approximately 50 lbs. per sq. in. (3·5 kgs. per sq. cm.), allowing a proportion of oil to flow back to the sump.

A by-pass valve normally closes a port connecting compartments "A" and "B" if the filter element is not restricted, as, in this case, pressure in these compartments will be equal.

If, however, the element becomes choked, pressure

On some 1494 c.c. and some 1592c.c. engines the filter drain plug is identified by a "Pip" on its hexagon head.

Later filters have no drain plug.

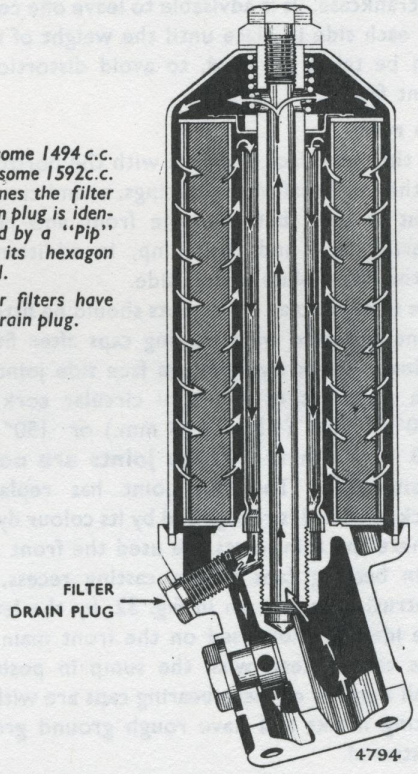


Fig. 34. *Section through oil filter*

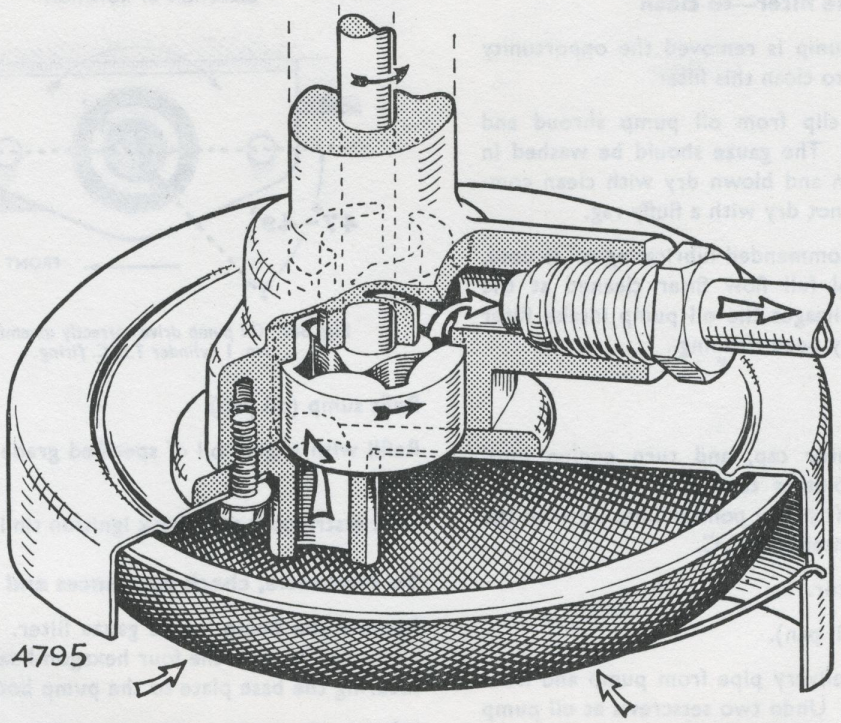


Fig. 35. *Oil pump—cut away view. White arrows show direction of oil flow*

will be appreciably reduced in compartment "A" due to starvation, and this will allow the by-pass valve to open, in turn ensuring a feed to the oil gallery in such conditions.

The oil pressure relief valve has a hexagonal head and is screwed into the front of the filter body casting.

The filter by-pass valve is similar and is screwed into the rear of the filter body casting.

To renew element

Drain filter by removing hexagon-headed plug details of which are given in Fig. 34

Remove centre bolt.

Take out the element and renew.

Run engine and carefully check for oil leaks.

Examine sump level after running engine as one pint of the oil will be taken to fill the filter.

OIL PUMP (See Fig. 35)

A four-lobe rotor mounted on the main spindle drives a ring into which are machined five internal lobes. The outer diameter of the ring rotates in the circular bore of the oil pump body, which is offset from the main spindle.

The action of the four-lobe cam on the five-lobe ring creates a strong pumping force by progressively increasing and reducing the clearance between each set of lobes. The pump itself is driven by skew gears from the camshaft.

Oil pump intake filter—to clean

Whenever the sump is removed the opportunity should be taken to clean this filter.

Remove spring clip from oil pump shroud and withdraw gauze. The gauze should be washed in petrol or paraffin and blown dry with clean compressed air. Do not dry with a fluffy rag.

Provided the recommended lubricating oil is used, and the external full flow filter cleaned at the recommended mileages the oil pump intake filter does not normally need cleaning.

To remove

Remove distributor cap, and turn engine until distributor is pointing to No. 1 firing position, and the crankshaft pulley pointer lines up with the timing cover pointer at T.D.C.

Remove distributor.

Remove sump (oil pan).

Disconnect oil delivery pipe from pump and from inside crankcase. Undo two setscrews at oil pump locating flange and remove pump.

To refit

The ignition distributor takes its drive from the helical gear on the oil pump shaft axially, through an offset tongue and slot type coupling which can only be coupled one way. It is essential that the oil pump helical gear is meshed to the corresponding gear on the camshaft so that the driving slot in the end of the gear is timed in correct relation to the camshaft. In view of this, the pump must be refitted as described below.

Ensure that the engine is at T.D.C. (top dead centre) with piston of No. 1 cylinder in firing position.

Replace the oil pump so that the distributor driving slot in the oil pump gear takes up the position shown in Fig. 36.

No jointing of any kind is required between pump face and cylinder casting.

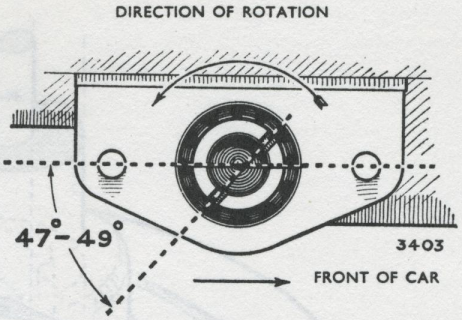


Fig. 36. *Oil pump drive correctly assembled—No. 1 cylinder T.D.C. firing.*

Refit sump (oil pan).

Refill with engine oil of specified grade to correct level.

Refit distributor and check ignition timing.

To dismantle, check clearances and overhaul

Remove the pump intake gauze filter. Invert the pump and remove the four hexagon-headed screws securing the base plate to the pump body.

Lift out the outer rotor ring taking care not to drop it. IF THIS ITEM IS DROPPED IT CAN EASILY CRACK.

Remove all traces of oil from the inside of the pump body and both rotors. Replace outer rotor.

The following clearances should be checked:—

1. End clearance between the inner and outer rotor ring and pump body. The maximum and minimum clearances are ·003″ (·076 mm.) and ·001″ (·025 mm.) when measured with a feeler and straight edge as illustrated in Fig. 37.

2. Side clearance between the top of the lobes on the inner and outer rotor as shown in Fig. 38.

   The maximum and minimum clearances "A" are ·006″ (1·52 mm.) and ·001″ (·025 mm.) New parts should be fitted if the maximum clearance is exceeded.

3. Clearance "B" between the outside of the outer rotor and pump body must not be greater than ·008" (·20 mm.) and not less than ·005" (·127 mm.). Should the clearance found be above the maximum figure a replacement pump should be fitted.

OIL PRESSURE

The normal oil pressure is given in the Data Section under "Lubrication". Tick-over pressure is not critical and the condition of the engine should be judged by its normal running pressure.

REASONS FOR LOW OIL PRESSURE

If abnormally low oil pressure is experienced, it may be due to one of the following reasons:—

Low oil level in sump.

Pressure relief valve not working properly, due to particles of foreign matter lodged between valve and seating.

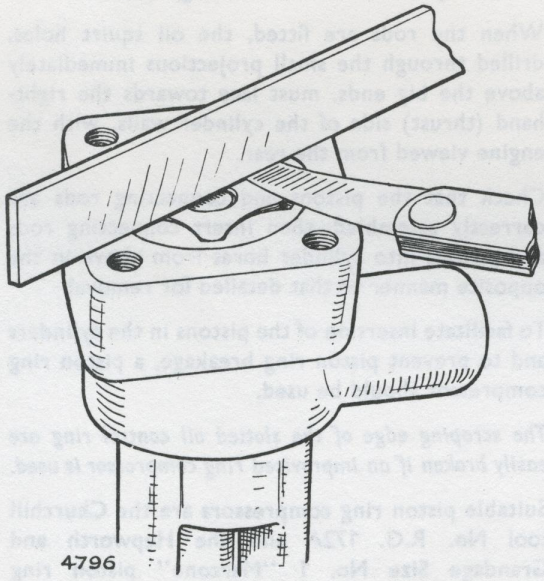


Fig. 37. *Checking pump rotor end clearance*

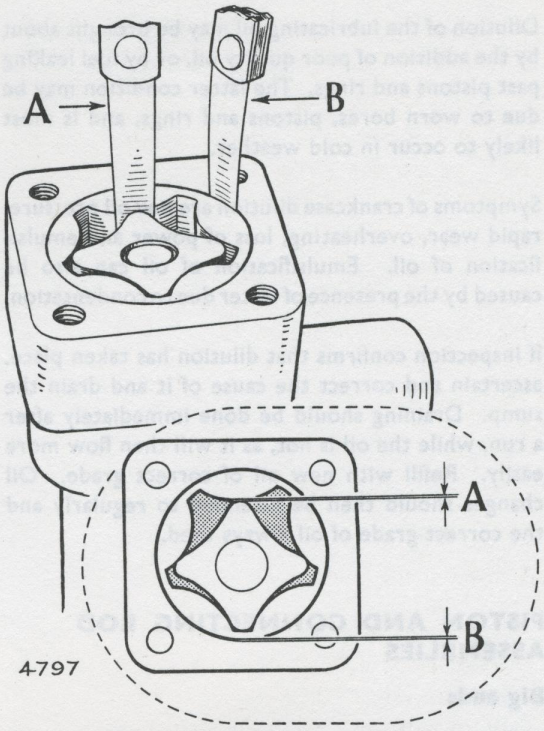


Fig. 38. *Checking rotor lip and outer rotor clearance in the pump body*

Choked oil pump filter.

Oil leaks caused by faulty unions and joints, or by cracked or broken pipes.

Joint between filter base and cylinder block face leaking between pressure compartment "B" and discharge compartment "C". This sometimes causes a lower oil pressure when the engine is cold. See Fig. 33.

Timing chain oil feed pipe loose or damaged.

Dilution of oil in sump (See following paragraphs).

Worn main and big end bearings.

Worn oil pump components.

CRANKCASE DILUTION

Dilution of the lubricating oil may be brought about by the addition of poor quality oil, or by fuel leaking past pistons and rings. The latter condition may be due to worn bores, pistons and rings, and is most likely to occur in cold weather.

Symptoms of crankcase dilution are low oil pressure, rapid wear, overheating, loss of power and emulsification of oil. Emulsification of oil can also be caused by the presence of water due to condensation.

If inspection confirms that dilution has taken place, ascertain and correct the cause of it and drain the sump. Draining should be done immediately after a run, while the oil is hot, as it will then flow more easily. Refill with new oil of correct grade. Oil changes should then be attended to regularly and the correct grade of oil always used.

PISTON AND CONNECTING ROD ASSEMBLIES

Big ends

Indium-coated copper lead bearings are fitted to all new engines and must be used as replacements. These bearings require and have a minimum running clearance of ·0015" (·04 mm.) and are able to carry greater loads than white metal bearings but they are harder and small particles do not bed themselves into the bearing metal. In consequence scoring of the crankshaft big end journals will occur if abrasive particles reach the bearings. Regular oil changing and renewal of the filter element at the recommended mileages are therefore most important.

Pistons

Most engines are fitted with flat top pistons but some engines have hollow crown pistons. The hollow crown pistons give a lower compression ratio which is used in certain export territories where the normal high octane fuels are not available. Fitting clearances are the same for both pistons.

To remove pistons and connecting rods

Remove cylinder head.

Remove sump.

Remove the self-locking nuts securing big end bearing caps.

Remove connecting rod caps with bottom half big end bearings. No identifying numbers are stamped on either the connecting rod or connecting rod cap.

Push pistons up the cylinder bores and withdraw assemblies from above.

If the original parts are to be used again it is essential that the big end caps are reassembled to the same rods from which they were removed. To show correct assembly, a forging flash is left on the oil squirt hole side of the connecting rod. This flash lines up with a similar flash on the connecting rod cap. Each complete connecting rod should be refitted to the same piston and cylinder bore from which it was removed

To refit pistons and connecting rods

When the rods are fitted, the oil squirt holes, drilled through the small projections immediately above the big ends, must face towards the right-hand (thrust) side of the cylinder walls, with the engine viewed from the rear.

Check that the pistons and connecting rods are correctly assembled, then insert connecting rods and pistons into cylinder bores from above in the opposite manner to that detailed for removal.

To facilitate insertion of the pistons in the cylinders and to prevent piston ring breakage, a piston ring compressor should be used.

The scraping edge of the slotted oil control ring are easily broken if an improvised ring compressor is used.

Suitable piston ring compressors are the Churchill tool No. R.G. 172A and the Hepworth and Grandage Size No. 1 "Marcone" piston ring compressor.

Tighten nuts to the correct torque given in the Data Section under "Connecting Rod".

IMPORTANT

These nuts are $\frac{11}{32}$" x 24 T.P.I. UNF. Care is needed to ensure that $\frac{3}{8}$" x 24 T.P.I. UNF nuts, used on other Rootes Group engines, are not fitted when replacement nuts are required. As the larger $\frac{3}{8}$" nuts have the same number of threads per inch they can easily be screwed onto the $\frac{11}{32}$" x 24 T.P.I. big end bolt thread and will strip the threads when tightened to about 12 lbs. ft. torque (1·5 kgm).

The self-locking nuts must not be used again if they can be screwed on with the fingers.

To remove gudgeon pin

Remove circlips retaining gudgeon pin in piston with circlip pliers. Scrape away any carbon which may have accumulated in the outer ends of the piston bosses to facilitate removal of the gudgeon pin.

Warm the assemblies, preferably in oil, and push out the gudgeon pins. Tight fitting gudgeon pins should not be driven out of cold pistons.

To assemble

The original piston, gudgeon pin and small end bush may be used again, if the gudgeon pin is without shake, both in the piston bosses and in the small end bush.

New circlips of the correct size should be fitted. The smaller circlips used on the 1390cc and 1494cc engines must NEVER be fitted to pistons used in 1592cc engines.

Gudgeon Pin Fits

At room temperature of 70°F. (21°C.) the gudgeon pin should be a finger push fit in the piston and only just free in the connecting rod little end bush. It should be possible for the connecting rod to fall by its own weight when the piston and connecting rod assembly is held horizontal.

Gudgeon pins are classified into three grades. Grade diameters are given in the General Data section under Gudgeon Pin.

·003" (·076 mm.) oversize gudgeon pins are available for service use.

Delapena Precision Honing Machine

This honing machine, illustrated in Fig. 39, is recommended for honing new little end bushes to standard size or to + 003" (·076 mm.) oversize. It can also be used to hone out the piston bosses to take the oversize gudgeon pin.

The following equipment is used with this machine:

Mandrel	SL.900
Truing sleeve	ST.900
Roughing stone	EF3J
Finishing stone	EF6J
Polishing stone	EF8J

Delapena connecting rod clamps

Delapena honing fluid. (Standard)

Complete instructions for the operation of this machine are contained in a booklet (Publication No. C.3/55) of which two copies are sent with each machine by the suppliers, Delapena & Sons Ltd., Zona Works, Cheltenham, England.

In using the Delapena honing machine it is stressed that the work must be kept as cool as possible at all times. Only by so doing can an accurate and round bore can be achieved. Heating of the little end boss which can occur due to pressure of the boss, can cause the boss to go "out of round" temporarily. This will not occur if a receptacle containing honing fluid is kept by the machine and the work dipped in it frequently.

Honing Little End Bush (See Fig. 40)

Fit the appropriate Mandrel in the machine with roughing stone and true up stone with truing sleeve; hone out the little end bush until it is ·0005" (·012 mm.) below the finished diameter. To determine this size, useful check gauges can be made by reducing a 1" (25 mm.) length of standard and oversize gudgeon pins to ·0005" (·012 mm.) below their finished diameter. Proceed with the honing, using a finishing stone in the mandrel.

The stone must be trued with the truing sleeve before honing is commenced. In performing this last stage of honing great care is necessary as

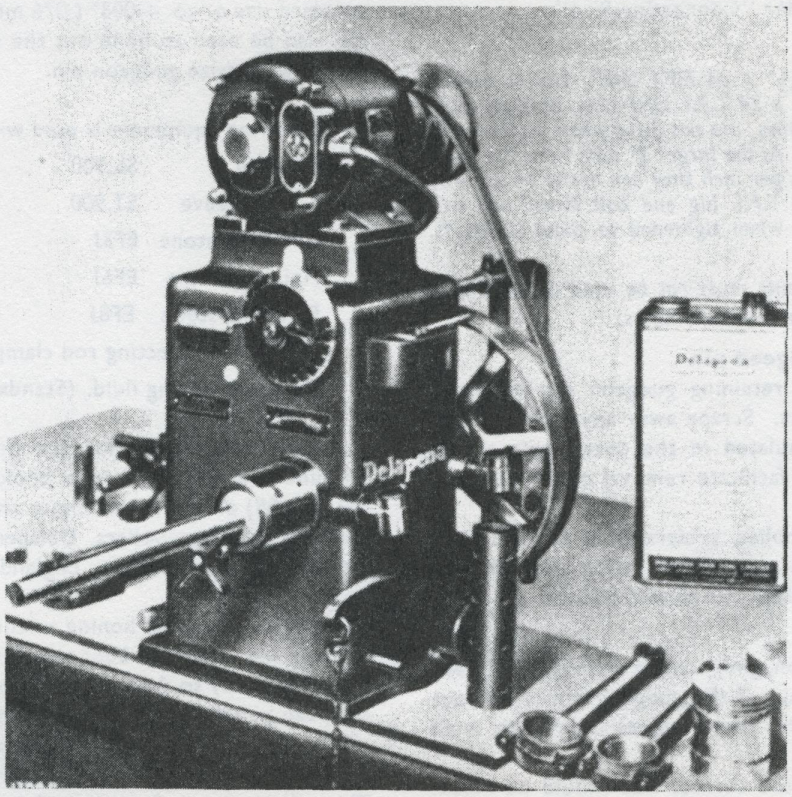


Fig. 39. *Delapena precision honing machine*

only ·0005″ (·012 mm.) of material has to be removed in order to allow the gudgeon pin to enter.

Honing of Piston Bosses (See Fig. 41)

The piston bosses can be honed out to take the ·003″ (·076 mm.) oversize gudgeon pin which should be a finger push fit with the piston at 70°F. (21°C.) The plug gauge, previously described, is used to determine when the boss bores are to within ·0005″ (·012 mm.) of the required size.

Connecting Rod Alignment

After fitting and honing, or reaming a new connecting rod little end bush to size, the connecting rod alignment should be checked. The Churchill tool for this operation is illustrated in Fig. 42. Connecting rod alignment should also be checked when rubbing marking on the front and rear faces of the piston is not even around the piston skirt. Connecting rods can be straightened in a large bench vice using special vice jaws.

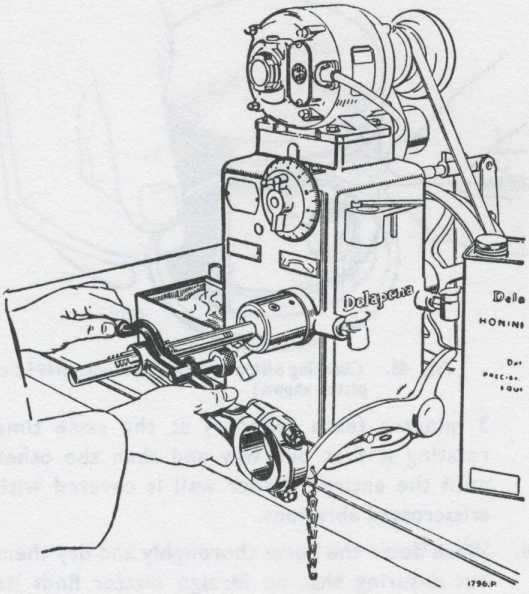


Fig. 40. *Honing connecting rod little end bush*

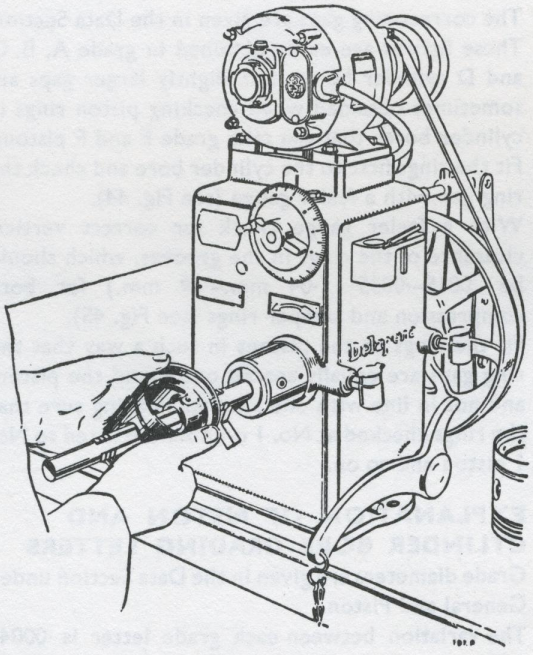


Fig. 41. *Honing piston bosses*

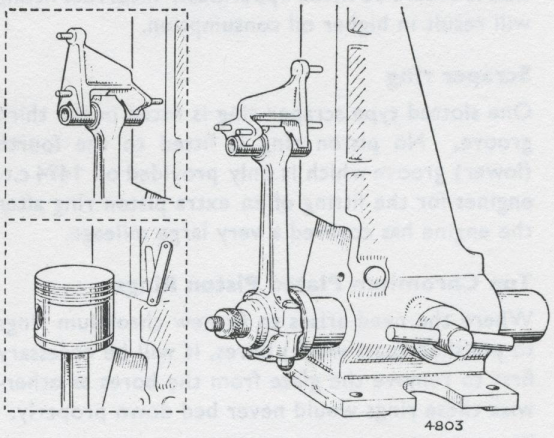


Fig. 42. *Checking connecting rod alignment*

PISTON RINGS

Top Compression Ring

This piston ring is chromium plated with the word "Vacrom" etched on one of its side faces. It may be fitted either way up and is Cargraph treated to assist bedding in. This treatment leaves it a dull grey and faintly red colour.

Second Compression Ring (See Fig. 43)

To provide more rapid running in and also to assist in oil control, a stepped periphery compression ring is fitted in the second groove from the top of both standard and oversize pistons. It is most important that this ring is correctly fitted with the step downwards, that is, with the widest face toward the top of the piston. This face is marked "TOP" to indicate

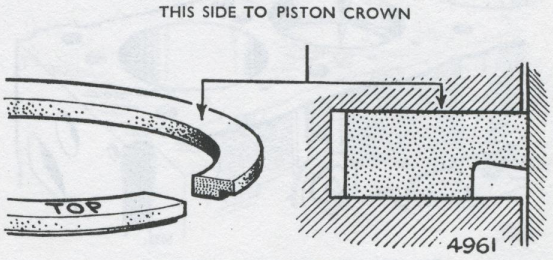


Fig. 43. *Correct method of fitting second compression ring*

that it should be fitted uppermost. Incorrect fitting will result in higher oil consumption.

Scraper ring

One slotted type scraper ring is fitted in the third groove. No piston ring is fitted to the fourth (lower) groove which is only provided on 1494 c.c. engines for the fitting of an extra piston ring after the engine has covered a very large mileage.

Top Chromium Plated Piston Rings

Where the need arises to fit new chromium rings to polished (part worn) bores, it will be necessary first to remove the glaze from the bores as otherwise these rings would never bed down properly.

The procedure to be adopted in such cases is as follows:—

1. Mask off the bottom of the cylinders to prevent any abrasive matter reaching the crankshaft or crankcase.
2. Make up a wooden dummy piston which will fit snugly into the bore with a piece of No. 1 or 1½ grade emery paper wrapped round it.
3. This dummy piston, with the emery round it, should then be inserted into each cylinder in turn and moved up and down the bore for about 3 minutes (each cylinder) at the same time rotating it first one way and then the other until the entire cylinder wall is covered with crisscrossed abrasions.
4. Wash down the bores thoroughly and dry them out ensuring that no foreign matter finds its way into the crankcase.

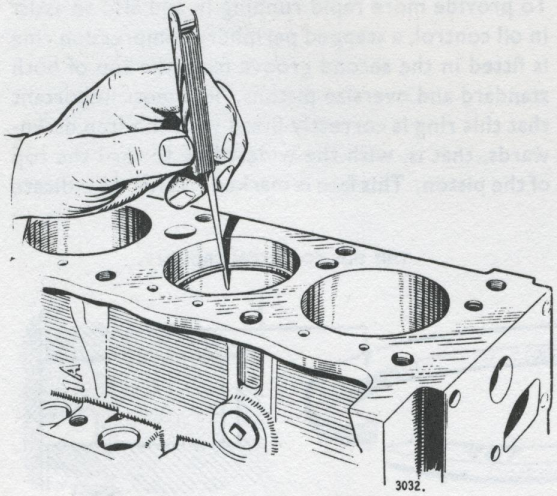


Fig. 44. *Checking piston ring gap*

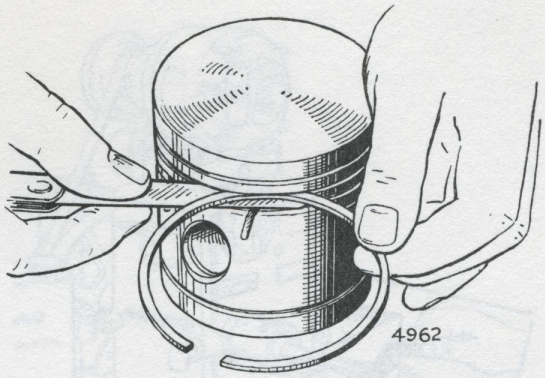


Fig. 45. *Checking piston ring side clearance (1494 c.c. piston shown)*

To fit

The correct ring gaps are given in the Data Section. These figures are easily obtained in grade A, B, C, and D cylinder bores, but slightly larger gaps are sometimes obtained when checking piston rings in cylinder bores that can take grade E and F pistons. Fit the rings first to the cylinder bore and check the ring gap with a feeler gauge (see Fig. 44).

With a feeler gauge check for correct vertical clearance of the rings in the grooves, which should be ·0015–·0035″ (·04 mm.–·19 mm.) for both compression and scraper rings (see Fig. 45).

Fit the rings to the pistons in such a way that the ring gaps are equally spaced out round the piston, and not in line with one another, making sure that the rings checked at No. 1 cylinder are fitted to No. 1 piston and so on.

EXPLANATION OF PISTON AND CYLINDER BORE GRADING LETTERS

Grade diameters are given in the Data Section under General and Piston.

The variation between each grade letter is ·0004″ (·010 mm.) and the total difference between the

highest and lowest cylinder bore limits, in which there are four grades is ·0016″ (·040 mm.). By means of the grading system the correct piston fit is obtained when pistons are fitted to new cylinder bores having similar grade letters as the pistons. The diameter difference between similar grade letters for the cylinder block and piston is the required clearance for the piston.

Example *(1494 c.c. engine dimensions used)*

Cylinder bore grade A		Piston grade A		Piston Clearance
3·1106″	—	3·1084″	=	·0022″
(79·009 mm.)	—	(78·953 mm.)	=	(·056 mm.)
3·1102″	—	3·1088″	=	·0014″
(78·999 mm.)	—	(78·963 mm.)	=	(·036 mm.)

Mean piston clearance is therefore ·0018″ (·046 mm.)

Series IV Alpine and onwards, are fitted with pistons having a bottom skirt clearance of ·0006″ - ·0014″ (·015 mm - ·035mm) which gives a mean clearance of ·001″ (·025 mm). It is therefore necessary to fit these pistons by measurement of the cylinder bore and piston as previously described. Should this be impossible the feeler pull method can be used as given in paragraph 4 provided it is realised that this will give the piston its maximum specified clearance of ·0014″ (·035 mm) rather than the desired mean clearance of ·001″ (·025 mm).

The cylinder grade letters are stamped on two machined bosses at each end of the cylinder block below the level of the cylinder head on the exhaust manifold side, and visible with the cylinder head in place. The piston grade is stamped on the top face of each piston.

FITTING PISTONS TO LOW MILEAGE ENGINES or THE APPLICATION OF PISTON GRADING IN SERVICE

After a new engine has been run for a few hundred miles the cylinder grade letter size no longer applies because the running in process will result in a slight initial increase in piston clearance.

If a piston, or pistons have to be changed under service conditions the following procedure must be followed.

1. Check the cylinder bore diameter with a Mercer, or other dial type bore measuring gauge, after setting its zero reading to a suitable size ring gauge. (see Section S)
2. From the size obtained subtract the correct piston clearance previously given and from this size choose a suitable grade of piston.

Example *(1494 c.c. engine dimensions used)*

Bore size given by clock gauge 3·1116″.

3·1116″ — ·0018″ = 3·1098″

Nearest piston size to 3·1098″ is D grade. Therefore fit a D piston.

3. If the cylinder bore is slightly damaged by seizure or is slightly tapered it should be honed out to take a larger grade, or ·005″ (·127 mm.) oversize piston
4. In the absence of suitable cylinder bore measuring equipment pistons may be fitted by checking their clearance with a feeler gauge and spring balance as shown in Fig. 46.

   To do this invert the piston and insert in the bore with a ·0015″ (·038 mm.) x ½″ (12·7 mm.) wide feeler in line with the thrust face of the piston skirt as shown in Fig. 46.

   A pull of 3-4 lbs. (1·36—1·81 kgs.) is needed to withdraw the feeler with a correctly fitting piston, **when the cylinder bore has been wiped clean from an oiled condition.** If the cylinder has been reborednor honed, it should be well oiled and wiped **clean** with clean lintless cloth.

TO REBORE CYLINDER BLOCK AND FIT OVERSIZE PISTONS

Oversize pistons are supplied for rebored cylinders, and conform to grade B diameter plus the requisite oversize.

When reboring cylinders to suit oversize pistons it is imperative that each bore is machined to the actual diameter of the piston to be fitted, plus the specified clearance in the bore.

For service use with rebored cylinders, oversize pistons will not be supplied to any specific grade, since grading is incidental to manufacture.

The recommended bore finish is a "cross hatched" hone finish of 20–40 micro inches. This is equivalent to that obtained by thoroughly rubbing a used cylinder bore with partly worn number one grade emery cloth.

The cutting tool of the boringmachine should be set

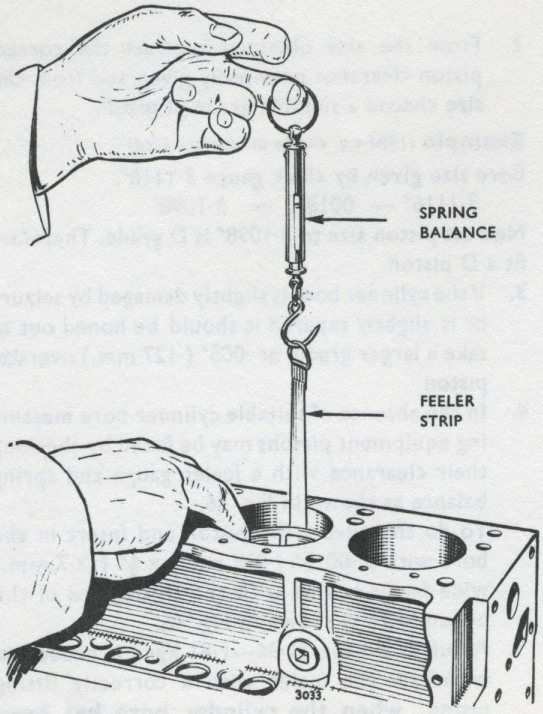


Fig. 46. *Checking piston clearance with feeler and spring balance*

to bore the maximum diameter of the piston plus its prescribed clearance in the cylinder bore less a small amount for honing.

The honing operation allows the bore size to be taken to the size that will allow the piston to be correctly fitted using a feeler to check the clearance as previously described and illustrated in Fig. 46.

it is advisable to regrind and reset the cutter after completing each cylinder bore.

Bores must be parallel and round to within ·0004″ (·01 mm.). The use of a cylinder gauge such as a Mercer is recommended for taking measurements. Top, middle and bottom of each bore should be checked both in line with and at right angles to the gudgeon pin axis.

SERVICE REPLACEMENT CYLINDER BLOCK

It is normal practice to supply cylinder blocks separately, but a set of suitably graded pistons can be supplied to suit any given block. Cylinder blocks complete with pistons are not serviced under one part number.

It is essential to ensure that each new piston is fitted into a bore of appropriate grade.

CYLINDER LINERS

To fit

These instructions apply to engines which are not fitted with liners during initial assembly. Some engines, however, are fitted with liners during production and these should be dealt with as described under "CYLINDER LINERS—To renew".

If the fitting of liners is to prove really successful a high degree of skill on the part of the operator is required, coupled with first-class precision equipment.

If, however, after considerable mileage, it should be decided to install liners, it is absolutely essential that the procedure laid down in the ensuing paragraphs is rigidly adhered to, as otherwise there is every possibility of the operation proving unsatisfactory.

1494 c.c. Engine

The outside diameter of the cylinder liner is 3·257″–3·258″ (82·72–82·75 mm.). Cylinders should be bored to 3·254″–3·255″ (82·65–82·67 mm.).

1592 c.c. Engine

The outside diameter of the cylinder liner is 3·357″–3·358″ (85·267–85·293 mm.). Cylinders should be bored to 3·354″–3·355″ (85·191–85·217 mm.).

Remove engine from chassis and dismantle.

Measure external diameter of liners.

Measure diameter of bores below piston ring travel.

Bore out the cylinders to suit liners, allowing for the prescribed interference fit of ·002″–·004″ (0·051–0·102 mm.). It is imperative that the correct figures are strictly adhered to. Every possible precaution must be taken to ensure concentricity and correct size for the full length of the bore.

Finish boring must not be attempted until all liners have been fitted.

Press in liners. To facilitate fitting, a "lead-in" is provided at the lower end of the liner.

When inserting the liners, the load should be released several times during the first inch or so;

thus allowing the liner to correct any misalignment,

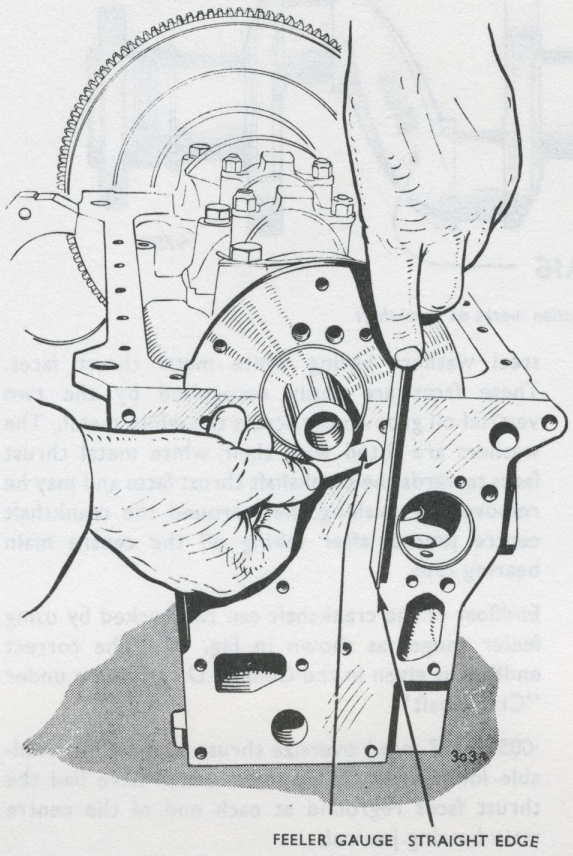


Fig. 47. *Checking front main bearing cap alignment with straight edge and ·0015″ feeler*

Press the liner home flush with the top of the cylinder block.

When each of the liners has been treated as above, the liners may be finish bored and honed to suit the new pistons, allowing for piston clearance as previously described.

Cylinder liners may be rebored only up to ·040″ (1·02 mm.) oversize.

To renew

The method used to remove liners will depend to a great extent on the facilities available. Liners may be drawn or pressed out from the bottom only. Check the cylinder for concentricity and correct size for the full length. If the diameter is in excess of the dimension given on the previous page, the correct interference fit will not be obtained.

Provided the conditions set out above are correct, press in the new liners. Finally, bore and hone the liners to suit the standard pistons.

CRANKSHAFT

Identification

For purposes of identification the letters and figures E.N.16 are embossed on both crank webs connecting No. 1 and No. 2 crankpins, and No. 3 and No. 4 crankpins, see Fig. 48. Crankshafts without this identification must not be used for replacements.

Main Bearings

The main bearing shells for these engines are white metal lined and are interchangeable.

Main bearing shells are available in standard size and undersizes as detailed in the General Data Section under "Crankshaft".

If required the main bearing shells can be removed for inspection, or renewed, provided the crankshaft main bearing journals are not worn or scored, without removing the crankshaft from the engine.

When carrying out this operation the following procedure should be followed:

Drain engine oil.

Remove sump and oil pump.

Slacken all main bearing fixing bolts one to two turns. Starting at one end of the crankshaft remove the bottom main bearing cap, and the corresponding top half bearing by pushing it around the crankshaft journal, with a piece of thin metal from the opposite side to its locating lip. Replace the bottom bearing and cap to support the crankshaft before proceeding to remove the next main bearing cap.

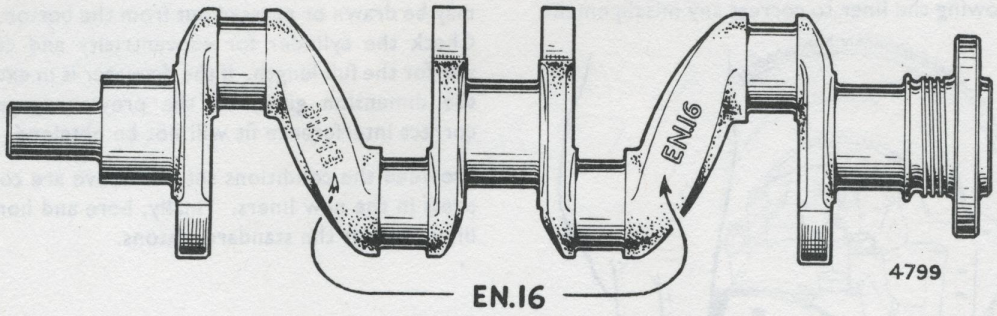


Fig. 48. *EN 16 identification marks on crankshaft*

Top half bearings are replaced in a reverse manner to that described for removal. The following points should be noted:—

(a) Ensure that locating lips engage correctly in their respective recesses.

(b) Bearings are stamped according to their sizes and on renewal the same size must be fitted except when an undersize crankshaft is fitted. In such cases the correct undersize bearings must also be fitted.

(c) When replacing bearing caps particular attention should be given to cleanliness of the mating faces and the oil return thrower recess in the rear main bearing housing.

(d) Before replacing the front and rear main bearing a very small quantity of Wellseal (or other non-setting jointing compound) should be painted onto the sides of the cylinder block recess into which the bearing caps locate. See Fig. 32 under "OIL SUMP—to refit".

(e) Ensure that the front main bearing cap is pulled up against the timing case before fully tightening the front main bearing cap bolts.

As each bearing is tightened up the crankshaft should be turned to ensure that it is free. The correct torque wrench figure for the main bearing bolts is given in the Data Section under "Crankshaft".

Crankshaft end thrust

Crankshaft end thrust is taken by two semi-circular steel washers having white metal thrust faces. These faces are easily recognised by the two vertical oil grooves cut across the white metal. The washers are fitted with their white metal thrust faces towards the crankshaft thrust faces and may be removed by pushing them around the crankshaft centre journal after taking off the centre main bearing caps.

Endfloat of the crankshaft can be checked by using feeler gauges as shown in Fig. 49. The correct endfloat is given in the General Data Section under "Crankshaft".

·005" (·127 mm.) oversize thrust washers are available for use with crankshafts which have had the thrust faces reground at each end of the centre main bearing journal.

Crankshaft—To remove

Remove engine from chassis.
Remove cylinder head, push rods and tappets.
Remove timing wheels and chain.
Remove engine front plate and sump.
Remove connecting rods and pistons.
Remove clutch (See Section D) and flywheel.
Remove main bearing cap bolts, and caps.
Lift out crankshaft.

Crankshafts having oval or scored journals should be replaced by factory reground units. These are available in the undersizes given in the Data Section

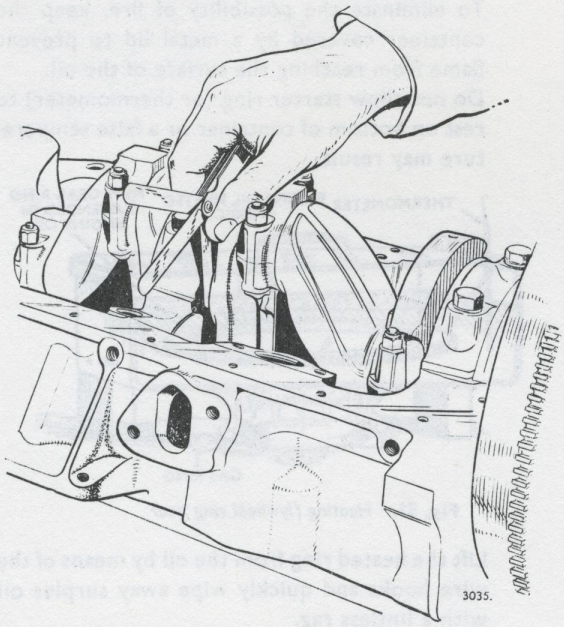


Fig. 49. *Checking crankshaft end float*

under "Crankshaft". Similar dimensioned oversize main and big end bearings can also be obtained.

Crankshaft—To refit

Check that oilways are clear.

Place crankshaft in position, checking that top halves of the main bearings and thrust washers (centre) are correctly fitted into the crankcase. Thrust is taken by two half washers fitted to the side faces of the centre main bearing in the cylinder block.

Fit lower halves of bearings together with main bearing caps.

Replace main bearing cap bolts. Check that the machined front face of the front main bearing cap is in alignment with the machined front surface of the cylinder block (See Fig. 47).

Tighten bolts to the correct torque given in the Data Section under "Crankshaft".

Check endfloat of crankshaft as previously described.

Reassemble engine to instructions given in foregoing section, and refill sump with fresh engine oil.

Crankshafts—Regrinding

The correct, and maximum permissible undersizes are given in the Data Section under "Crankshaft". These must be used when regrinding crankshafts. Not more than ·005″ (·127 mm.) can be removed from each thrust face at the ends of the crankshaft centre journal.

FLYWHEEL

To remove and refit

Remove gearbox and bell-housing. (See Section E).

Remove clutch. (See Section D).

Knock flywheel tabwashers clear of setbolts.

Remove setbolts.

Remove flywheel from crankshaft flange. It will be found expedient to screw a stud of suitable size into the top setbolt hole before levering off flywheel, to prevent the flywheel from falling accidentally with possible damage to the starter ring.

To replace, reverse the above order of operations, observing the following notes:—

It is important that the flywheel fits squarely on crankshaft. Should the dowel have come away with the flywheel when it was removed, tap it out of the flywheel and refit in crankshaft.

Make sure that surface of crankshaft flange and register in the flywheel are perfectly clean and free from burrs, as otherwise the flywheel may not seat properly on the crankshaft.

Tighten set bolts to 37–43 lbs. ft. (5·11–5·94 kg.m.) and check for run-out at outer edge of flywheel clutch facing. A total clock gauge reading of ·003″ (·076 mm.) must not be exceeded.

Lock setbolts with new lockwashers.

STARTER RING GEAR

To renew

The starter ring is shrunk on to the flywheel, and in the event of wear developing on the teeth of the ring the complete flywheel and ring can be renewed (as described above) and the original returned for

reconditioning by the manufacturers. However, if suitable equipment is available, the starter ring may be removed and replaced by adopting the following method.

Place flywheel in a suitable container of clean COLD water, supporting the assembly in the container by placing three or four metal blocks under the starter ring. Arrange the flywheel assembly so that it is partly submerged in water, starter ring uppermost (i.e., the complete starter ring must be *above* the water line, and it is recommended that the ring itself be approximately $\frac{3}{16}$" (5 mm.) clear of the water level, as shown in Fig. 50.

Heat the starter ring evenly round its circumference (using an oxy-acetylene welding torch) thus expanding the ring, which will allow the flywheel itself to drop out. Remove flywheel from the water and thoroughly dry it.

Check height of securing lip by means of straight-edge and feeler gauge. This dimension should be ·008" (·203 mm.). If the height of the lip is greater than ·008" (·203 mm.) it must be reduced by means of a lathe. In carrying out this operation it is most important that the flywheel is located by the dowel holes.

Check the surface of the flywheel on which the clutch driven plate operates. If badly scored, or worn, regrind to restore smooth surface.

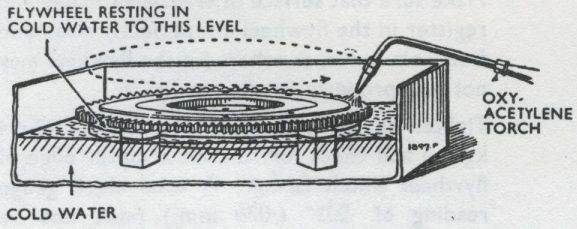


Fig. 50. *Removing worn flywheel ring gear*

Ensure that registering faces of flywheel and starter ring are clean and free from burrs.

To fit a new starter ring after completion of the operations as detailed above, proceed as follows:—

Heat the new gear ring by suspending it from wire hooks in a container of clean engine oil which has been heated to 220°C. (428°F.) until the ring has attained the same temperature as the oil (See Fig. 51).

To eliminate the possibility of fire, keep the container covered by a metal lid to prevent flame from reaching the surface of the oil.

Do not allow starter ring (or thermometer) to rest on bottom of container or a false temperature may result.

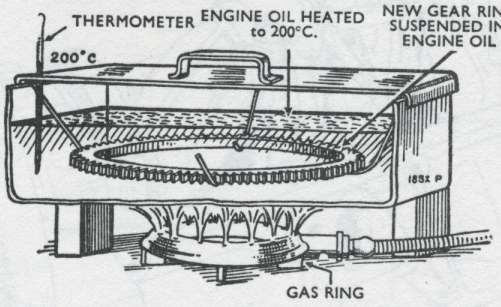


Fig. 51. *Heating flywheel ring gear*

Lift the heated ring from the oil by means of the wire hooks and quickly wipe away surplus oil with a lintless rag.

Place the new ring in position on the flywheel *with chamfered sides of teeth to the clutch side of the flywheel.*

Make sure that the ring is completely over the securing lip and bedding against its locating face. On cooling, the ring will contract and thus firmly grip the flywheel.

FLYWHEEL CENTRE BEARING

To remove and refit

The clutch spigot bearing is of self-lubricating bush type, and a push fit in crankshaft end recess. To remove the bush for replacement, use a small internal type extractor. If the old bush is too tight to remove by this method, thread it with an $\frac{11}{16}$" tap, when it may be removed by screwing in an ordinary $\frac{11}{16}$" bolt. An alternative method of removing an old bush is to fill it with grease, then insert a close fitting piece of steel bar. A hammer blow on the end of the bar will then cause the bush to come out. *It is most essential that the new spigot bush should be soaked in engine oil for 24 hours before fitting, preferably at room temperature.*

The new bush should be pressed into position until flush with the rear face of the crankshaft flange.

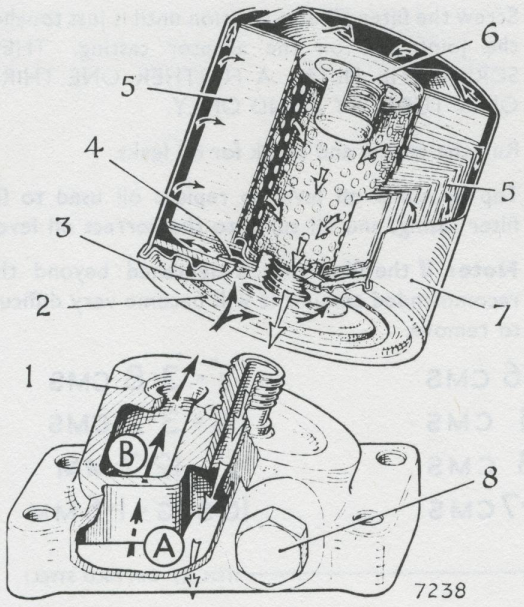


Fig. 52. *Throw away type full flow filter—internal construction*

FULL FLOW OIL FILTER—Throw away type (See Fig. 52)

The throw away type full flow oil filter is screwed to an adaptor casting (1) bolted on the right hand side of the engine Cylinder block.

Oil from the engine oil pump enters compartment "B" in the filter adaptor casting (1) and passes through eight port holes into the filter body. All oil entering the filter passes through the filter cartridge from the outside to the centre as shown in Fig. 52 and thence through the screwed spigot to compartment "A" in the adaptor casting. From here it enters the engine main oil gallery.

The entry ports on the underside of the filter are shrouded by a flexible anti-drain valve (3) and (4) which prevents the filter from draining during standstill periods.

The throw away filter unit must be changed at the recommended periods given in the "Owners Handbook".

Oil pressure relief valve. (See Fig. 53)

A piston type relief valve, situated in compartment "C" in the filter adaptor casting, opens to return all excess oil delivered by the oil pump to compartment "B" when the oil pressure exceeds approximately 60 lbs. sq. in. (4 kg. sq. cm.). The excess oil discharges into compartment "C" from where it drains into the engine sump.

The oil pressure relief valve can be removed as a complete unit with a 13/16 A.F. ring spanner.

By-pass Valve

A by-pass valve (6) is fitted inside the throw away filter unit and forms part of this assembly as shown in Fig. 52.

If the filter element (5) becomes choked, through neglect to change the filter assembly at the servicing periods, the by-pass valve (6) opens and allows oil to pass directly to the engine bearings without being restricted by the blocked element (5).

Opening of the by-pass valve (6) can only occur when there is a pressure difference of over 7 lbs. per sq. in. (0·5 kg. sq. cm.), above and below the by-pass valve.

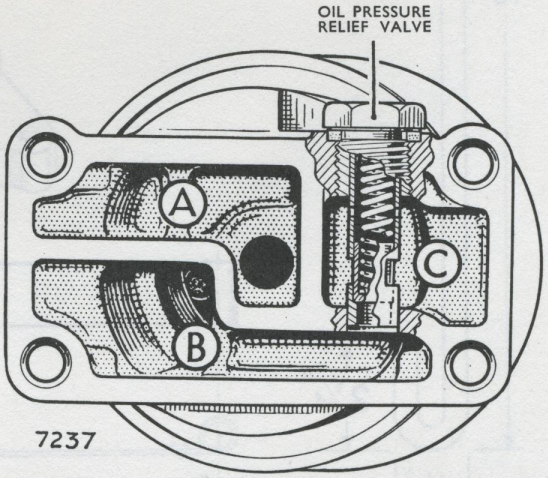


Fig. 53. *Throw away type full flow filter—oil pressure relief valve*

Changing throw away filter unit. (See Fig. 52)

To remove—

The rubber joint ring (2) on the filter base tends to stick to the adaptor casting (1) joint face, and if the filter cannot be removed by hand it can be unscrewed with a strap wrench, which can be made from the particulars given in Fig. 54.

To fit—

Clean the joint face on the adaptor casting (1) and smear the joint ring (2) on the bottom of the filter with clean engine oil.

Screw the filter (7) into position until it just touches the joint face on the adaptor casting. THEN SCREW THE FILTER A FURTHER ONE THIRD OF A TURN BY HAND ONLY.

Run the engine and check for oil leaks.

Top up sump oil level to replace oil used to fill filter casing, and fill sump to the correct oil level.

Note: If the filter unit is tightened beyond the recommended amount it will become very difficult to remove.

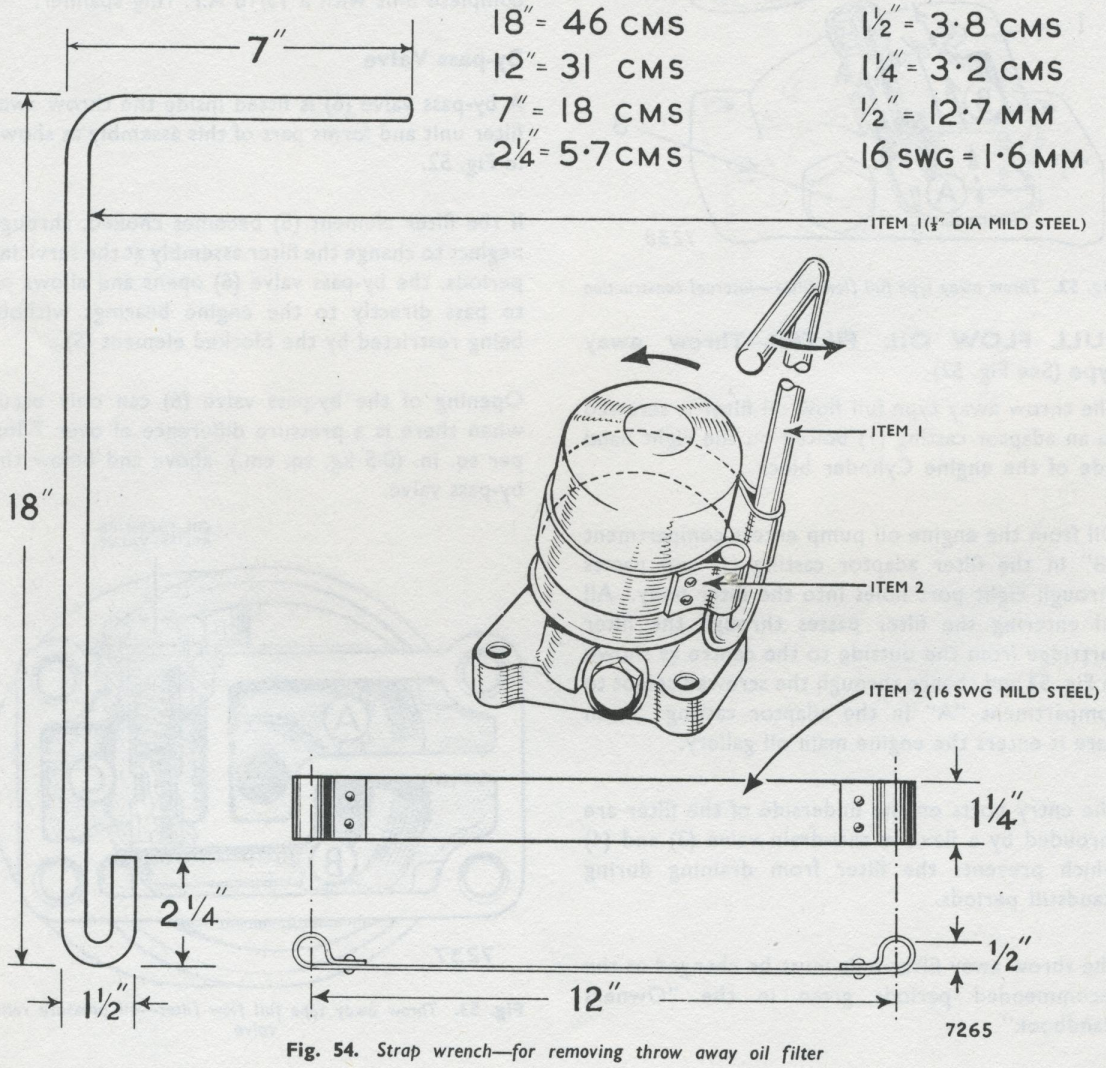


Fig. 54. *Strap wrench—for removing throw away oil filter*

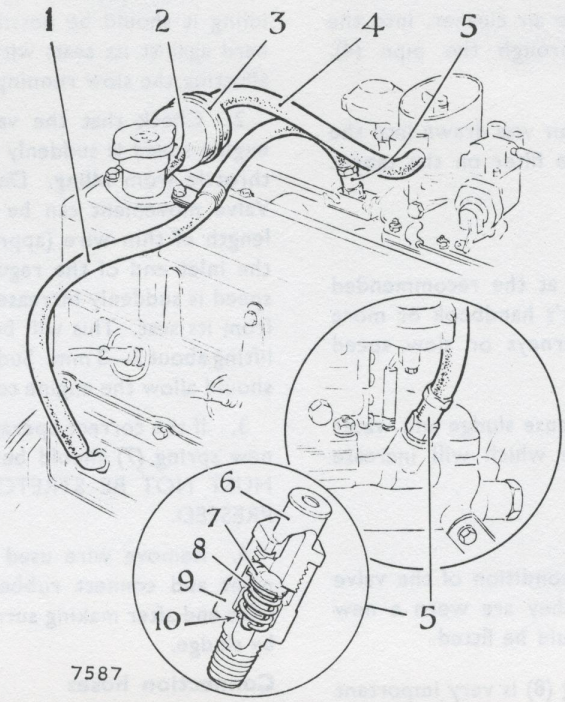


Fig. 55. *Closed crankcase ventilation system.*

CLOSED CRANKCASE VENTILATION SYSTEM

This crankcase ventilation system is fitted to the engines of cars supplied to areas where regulations forbid the discharge of crankcase fumes direct into the atmosphere.

Description See Fig. 55

The system consists of hoses (1) (2) and (4), a flame trap (3), and ventilation regulator (5) the outlet end of which is screwed into the inlet manifold.

Details of the regulator valve are shown in the illustration inset. It consists of an outlet connection (6) screwed into the main body (9) that houses the valve (7) and the valve opening spring (8).

The flame trap (3) *was not fitted to the first arrangement of this system which had a direct hose connection from the oil filter tube on the rocker cover to the ventilation regulator* (5), *and a crankcase air intake gauze filter which screwed into the tappet chamber cover. Particulars of the first type of regulator valve were given in section C page* 59.

Operation

When the engine is idling the inlet manifold depression is high enough to draw the regulator valve (7) onto its seat (10), and under this condition crankcase fumes pass directly into the carburettor through the pipe (2) flame trap (3) and pipe (4).

As the throttle opens the inlet manifold depression decreases and the spring (8) lifts the valve (7) from its seat. This allows the crankcase fumes, and air to be drawn from the tappet cover through

the pipe (1) and for ventilation air to be drawn from the "clean" side of the air cleaner, into the crankcase rocker cover through the pipe (4), flame trap (3) and pipe (2).

On the first arrangement air was drawn into the crankcase through the gauze filter on the tappet cover.

Servicing

This must be carried out at the recommended intervals given in the owner's handbook or more frequently where short journeys or slow speed driving are usual.

Neglect of servicing will cause sludge and water formation inside the engine which will increase engine wear.

Regulator valve—cleaning

Dismantle and check the condition of the valve seat (10) and valve (7). If they are worn a new regulator valve assembly should be fitted.

The condition of the spring (8) is very important as it controls the opening and closing of the valve (7) against inlet manifold vacuum. If damaged or corroded it must be replaced.

When re-assembling, the valve unit make sure that the spring (8) is correctly located in the body (10) and that the valve (7) is not tilted across the body.

Regulator valve—testing

Refit the valve unit to the inlet manifold leaving the connecting hose off of the inlet end. Run the engine and check the valve operation by making the following tests.

1. Check that the engine idles correctly. When idling it should be possible to push the valve (7) hard against its seat; with a suitable rod, without affecting the slow running performance.

2. Check that the valve (7) opens when the engine speed is suddenly increased by opening the throttle from idling. Do not exceed 3,000 RPM. Valve movement can be seen by putting a short length of thin wire (approx. 12 ins.—4 cms.) into the inlet end of the regulator. When the engine speed is suddenly increased the valve (7) should lift from its seat. This will be shown by the test wire lifting about 2—3 mm. Sudden closing of the throttle should allow the engine to idle correctly.

3. If the correct operation cannot be obtained a new spring (7) should be fitted. THESE SPRINGS MUST NOT BE STRETCHED OR FULLY COMPRESSED.

4. Remove wire used to indicate valve movement and connect rubber hose (1) to the valve inlet end after making sure that it is not obstructed by sludge.

Connection hoses

If necessary these should be removed and cleaned internally.

Flame trap—where fitted

The flame trap should be washed in kerosene (paraffin) and inverted so that it drains dry. THE FLAME TRAP MUST BE REFITTED IN THE POSITION SHOWN IN FIG. 55. Incorrect positioning of the flame trap will allow it to gradually fill up with oil and prevent the crankcase ventilation system from operating.

Air intake filter—if fitted.

This filter should be cleaned in the same way as the flame trap.