

SECTION 5, CHAPTER 7

DISMANTLING, CLEANING, ASSEMBLY

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Introduction

1. It will be realized that regular servicing and adjustments are necessary to keep certain essential parts in proper working order, but they cannot stop wear taking place on all the moving parts nor the build-up of deposits such as carbon in the combustion chambers. There are times, therefore, when such parts have to be restored to their original state, and these operations will be described in Chapter 8 of this Section. Before this work can be done to the parts requiring attention, the engine will have to be dismantled to the stage required, all the parts will have to be thoroughly cleaned and, after the work of rectification has been completed, the parts will have to be reassembled. Thus, some of the work required of a General Engineer whose duty it is to service or recondition ground equipment internal combustion engines, will consist of removal, cleaning and refitting of

component parts, and the purpose of this chapter is to give a general outline of these operations.

2. There are many different makes of engines in Service use, so, if detailed information is required about a particular example, it will be found in the relevant Air Publication. If the operator is not conversant with the equipment to be worked upon, he should obtain the relevant A.P. and adhere to the information contained therein; lack of knowledge can quite easily be the basic cause of damaged equipment. Because there are many parts common to both spark ignition and compression ignition engines, the information contained in this chapter can be taken as applicable to either type, except where specifically stated otherwise. The tasks with which this chapter deals may be entailed by periodic servicing requirements, non-periodic servicing tasks that

may well arise, minor repairs, or tasks which require the use of special tools, extractors, etc.

DISMANTLING

General

3. Time spent in consideration and preparation of a task will always be well worth while. Firstly, the engine should be carefully surveyed so that it is known exactly what work is involved; study of the relevant A.P.'s will also help in this respect. All tools, extractors, stands, racks, etc., which will be required should be at hand; drip trays should also be in place, and waste oil containers will also be required if the sump has to be drained. Oil drained from the sump should be examined for signs of metallic particles, the presence of which may give an indication as to the internal condition of the engine. Always use the correct tool for the job, even for the common nut; nuts with rounded corners are a sign of rank bad workmanship, so do not use an open ended spanner where a ring or a box spanner can be employed. Any exterior damage and signs of oil or water leaks should be noted for subsequent rectification.

4. Before dismantling is begun, the exterior of the engine should be cleaned with the aid of kerosine; this makes dismantling easier, for even nuts can be difficult to remove if the threads are choked with foreign matter or are corroded, and it enables tools and

benches to be kept cleaner. The sequence of dismantling as given in the relevant A.P. must always be followed, items as they are removed being safely stowed and labelled if necessary. Used locking devices, e.g. split pins, and such things as unserviceable washers, etc., should not be left lying around but should be discarded immediately. Where necessary, manufacturers usually mark certain components for assembly and timing; if these have been omitted the parts should be marked as required. Marking also helps to prevent parts being mixed, and care must be taken to ensure that they are kept to their original location. By examination of dirty parts as removed, an indication can often be got as to the engine's running condition, e.g. the state of the carbon in combustion chambers may indicate that oil has been getting past the rings, or that the gasoline/air mixture has been weak or rich.

Cylinder Head Removal

5. The usual precautions must be observed to prevent damage to any parts, and extra care is required when removing a cylinder head. Cylinder head nuts must be gradually slackened, working in the reverse order to the tightening sequence; a diagram of the tightening sequence is included in the relevant Air Publication, a typical example being shown in Fig. 1. Each nut or set screw is given only a partial turn at a time, returning to the first nut and repeating the gradual slackening off several times until

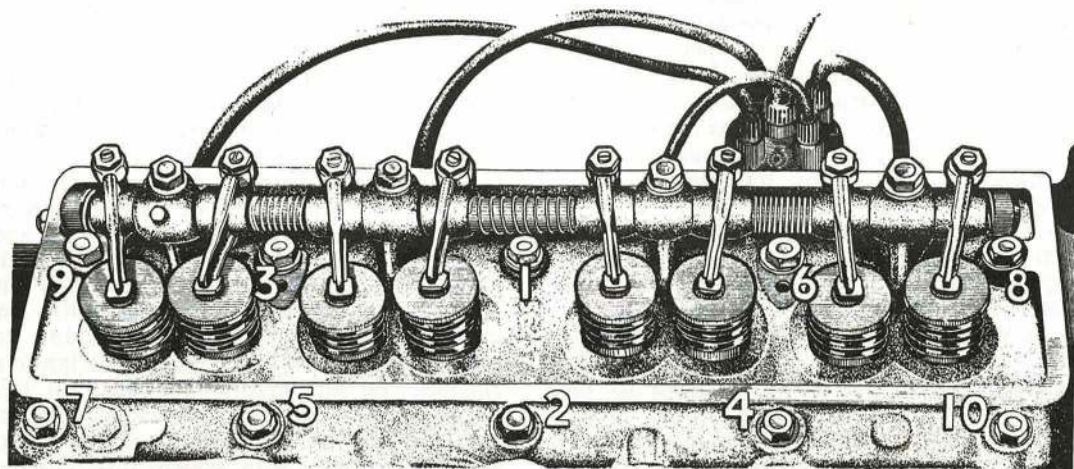


Fig. 1. TIGHTENING CYLINDER HEAD NUTS

all are quite slack, when they can be finally unscrewed. On some engines jack nuts are provided to facilitate the breaking of the cylinder head joint and, in such instances, no attempt must be made to slacken the jack nuts until the cylinder head is definitely ready for removal.

6. Care when slackening cylinder head nuts applies especially to aluminium alloy heads; the head should be quite cold before any slackening of the nuts is attempted. Special devices are sometimes provided to facilitate the lifting of a cylinder head, and useful lifting tools can quite easily be made from the bodies of scrapped sparking plugs. If a head is difficult to remove, never attempt to lever it off or prise it up by driving a tool into the gasket joint, for this will inevitably cause damage. If special lugs are not provided, the joint may be broken and the head loosened by jarring the head with a wooden drift or hide faced hammer; always break the joint and lift evenly (Fig. 2).

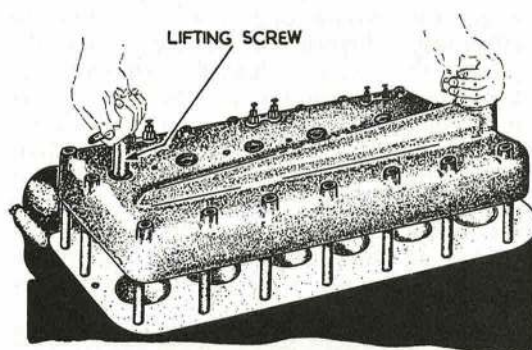


Fig. 2. BREAKING CYLINDER HEAD JOINT

Valve Removal

7. The removal of the valves will necessitate the use of a valve spring compressing tool, the type of tool being dependent upon the type of engine. Fig. 3 shows a valve spring compressing tool in use on an overhead valve cylinder head.

8. **Side Valves.** The valves of side valve engines are not so easily removed as those of overhead valve engines. If the task does not require removal of the sump, it is advisable to plug any apertures in the valve chest with clean rag before commencing

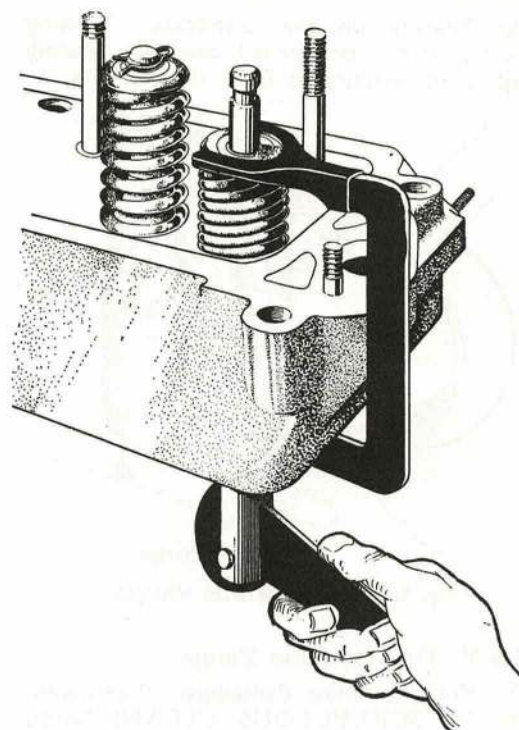


Fig. 3. VALVE SPRING COMPRESSOR

removal of side valves; this is a precaution against dropping valve cotters, or whatever retaining devices are in use, into the sump whilst removing them. Because of the accessibility factor, valves in the centre should be removed first with work then proceeding towards either end. Ensure that the cam of each valve is at its lowest position, i.e. the back of the cam to the valve stem, before inserting the valve spring compressor. When detachable tappet blocks are fitted, it will probably facilitate operations on the valves if these are removed (Fig. 4), but the set screws should be marked to ensure correct replacement as they may be of different lengths.

Crankshaft Removal

9. If it is required to remove the crankshaft an extractor is usually required for the removal of the crankshaft main bearing caps, and Fig. 5 shows an extractor of this type in use. The knurled screw is screwed into the threaded hole in the bearing cap, and the bridge piece is positioned with its

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legs bearing on the crankcase. Turning the nut with a spanner will cause the bearing cap to be withdrawn from the housing.

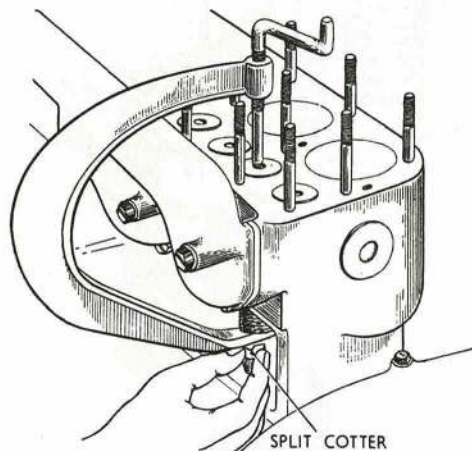


Fig. 4. REMOVING SIDE VALVES

C.A.V. Fuel Injection Pumps

10. Pre-dismantling Procedure. The necessity for **SCRUPULOUS CLEANLINESS** whilst personnel are working on injection equipment cannot be over emphasized. All

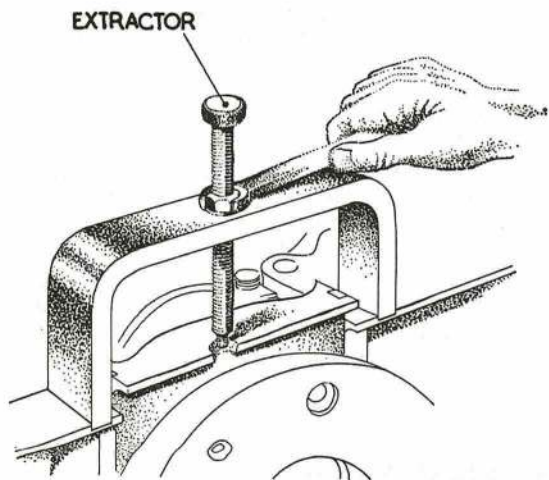


Fig. 5. WITHDRAWING MAIN BEARING CAP

personnel responsible for this work should be able to interpret the type formula as given on the type plate attached to the pump or engraved on the unit. An unserviceable pump should be examined to assess whether

the defect is the result of external controls having been incorrectly adjusted. If this is the case, the pump should be treated as newly assembled and subjected to the test bench routine. Before a pump in this condition is put on the test bench, it must be ensured that the camshaft can be turned in the normal manner. If it is suspected that the camshaft is bent although it is rotatable, this should be checked by running the pump on the test bench with the end cover removed from the governor casing, and observing whether the governor runs eccentrically. Eccentricity is not a definite indication that the camshaft is bent, as the fault may be caused by incorrect mounting of the governor components on the fixing sleeve or of the fixing sleeve on the camshaft. Further checks should be made by running the pump after the governor components have been removed from the sleeve, and again after the sleeve has been removed from the shaft.

11. Before any pump is dismantled, all open fuel connecting points should be effectively plugged or blanked, and the pump thoroughly cleaned externally in kerosine. Dismantling will be made easier if the pump is mounted on a vice as shown in Fig. 6. This also permits the camshaft to be effectively locked (Fig. 7) whilst the governor assembly and driving coupling are being removed. The dismantling sequence as given in Air Publication 1464E or the relevant A.P. should be strictly

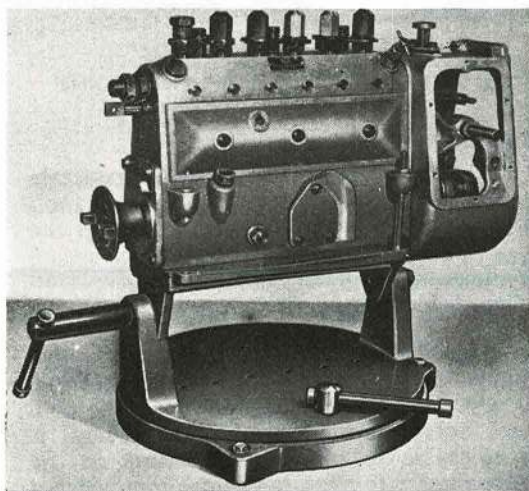


Fig. 6. PUMP MOUNTED ON HARTRIDGE VICE

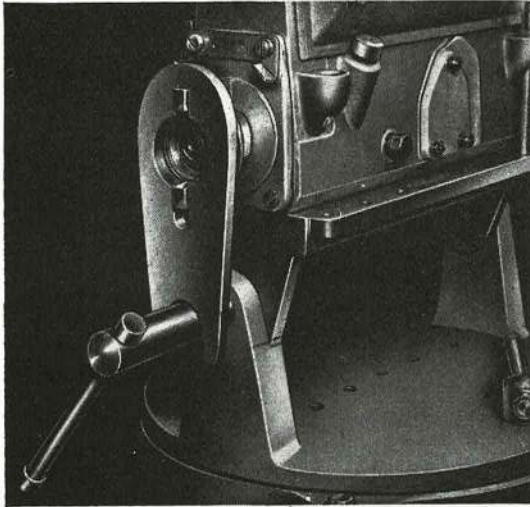


Fig. 7. CAMSHAFT LOCKING PLATE IN POSITION

followed; some of the more important points are reproduced in the following paragraphs.

12. Before the camshaft can be removed, it must be relieved of the pressure exerted by the plunger springs. This is done by turning the camshaft and, as each lobe comes to T.D.C., a special holder is inserted under the head of the tappet adjusting screw (Fig. 8).

13. The sealing plugs in the base of the pump housing must be removed before the tappets, springs and plungers can be removed. These sealing plugs are very tightly

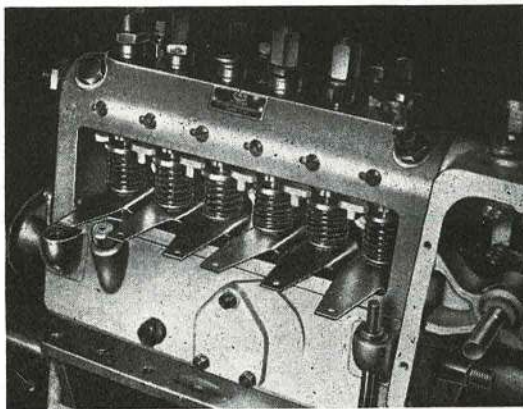


Fig. 8. TAPPET HOLDERS IN POSITION

secured; they are removed by fitting a special tool into the slot of the sealing plug, adjusting the tool until its head is tight against the turntable of the vice, and then using a spanner to turn the tool clockwise (Fig. 9). When the plungers are removed they must be placed apart so that on assembly each plunger can be mated with its original barrel.

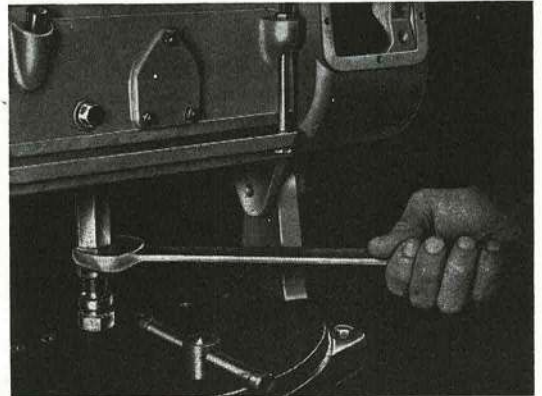


Fig. 9. REMOVING A BASE PLUG

CLEANING

General

14. After dismantling, parts will be cleaned by one of the methods described in the following paragraphs. Care must be taken to prevent damage to joint faces and machined surfaces. It is again emphasized that all mated parts (e.g. pump plungers and barrels, delivery valves and seats) must be kept together, as it is during cleaning operations that parts are most likely to be interchanged. Components fitted with fixed leather or rubber joints or glands must be excluded from any degreasing process, because the leather and rubber would be damaged. Fire fighting equipment must be available, and inflammable solvents must be stored in accordance with the fire regulations in Air Publication 957. Personnel must be provided with approved gloves and aprons, and must not begin cleaning operations until properly protected. Before work is commenced, personnel should apply a barrier cream to the hands and forearms. When the skin is liable to contact oils, kerosine or

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gasoline, Rozalex No. 2 should be applied, but prophylactic ointment should be used against other degreasants.

Kerosine

15. Completely fitted tanks are provided for the cleaning of parts by the use of kerosine. The pressure type kerosine washing tank is provided with a separate pumping unit, which draws off the kerosine from the tank sump and passes it under pressure through a flexible pipe, fitted with a quick acting ON/OFF cock that is controlled by the operator. Small parts can be cleaned in small tanks or trays using bristle brushes; a soft brush should be used for compression ignition equipment parts, which should then be placed in trays to drain. A syringe may be used for cleaning out oil passages or recesses. Compressed air can be used for drying washed parts.

Gasoline

16. Unleaded gasoline is recommended for washing some components, and it may also be used in an emergency when it is not possible to use kerosine or degreasing equipment. At such times, the equipment required consists of small tanks or trays and bristle brushes of a convenient size.

Carbon Removal

17. Although the chemical carbon removers described in this chapter will remove most of the carbon, certain parts of the engine such as piston ring grooves, will have a hard carbon deposit which will have to be removed by careful scraping; a strip of aluminium may be found useful for this purpose. Cylinders heads, valve ports and piston crowns may be cleaned with approved scrapers or with power-driven rotary brushes (Fig. 10). Carbon may be removed from

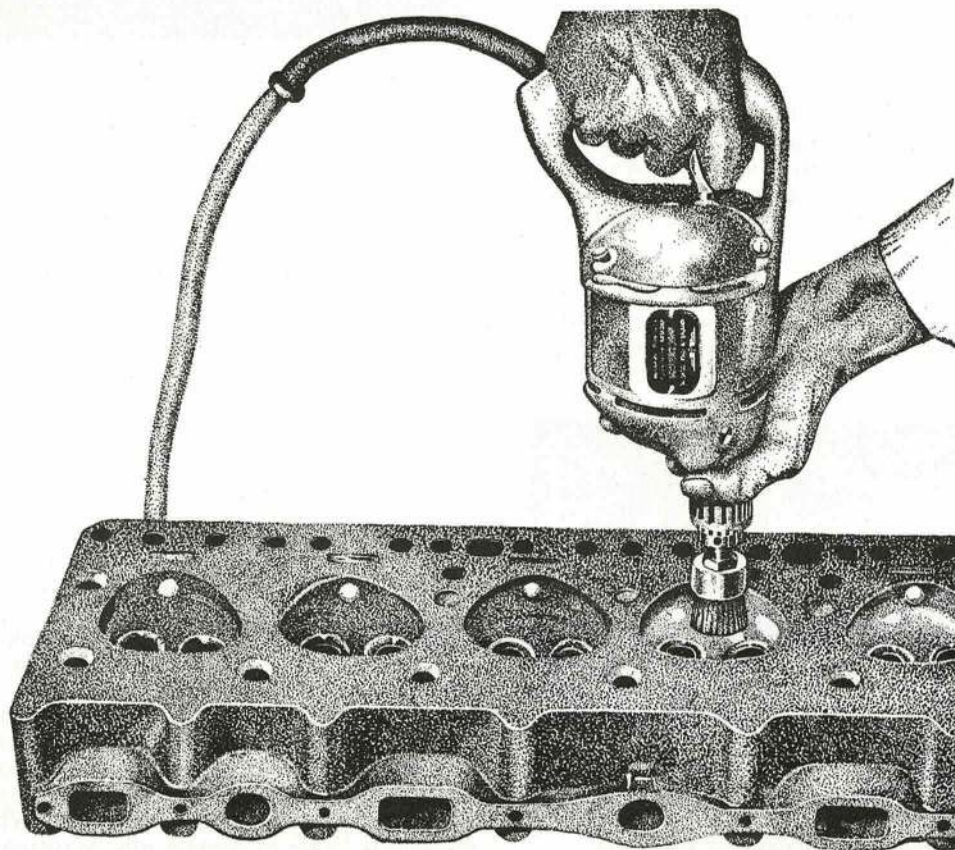


Fig. 10. CLEANING A CYLINDER HEAD

crankcases and similar light alloy castings or forgings with stiff bristle brushes.

Trichlorethylene

18. This is authorized for use in approved degreasers only. There are three main types of trichlorethylene degreasing equipment.

19. **Vapour Type.** When using this process the components are suspended in the vapour from the boiling liquid. The lid of the degreaser should be opened and the components gently lowered until they come to rest on the perforated plate (Fig. 11), the lid then being immediately closed. The cleansing action ceases when the temperature of the components reaches that of the vapour, thus, if further degreasing is necessary the components must be removed, allowed to cool, and the process repeated. In order to prevent corrosion, the parts should be coated with clean thin oil or approved rust preventive as soon as possible after removal from the degreaser. The trichlorethylene will be conserved if all parts are washed in kerosine before being placed in the degreaser, care being taken to remove all traces of kerosine.

20. **Liquid Type.** When this process is used the components are immersed in the

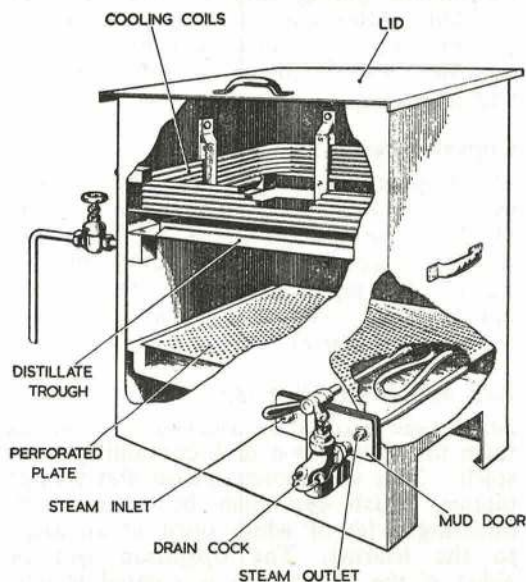


Fig. 11. TYPICAL VAPOUR DEGREASING UNIT (CUT-AWAY)

boiling liquid in three stages, thus obtaining a progressive cleaning action. The parts are usually placed in a metal basket which is lowered into the first compartment and left for a few minutes, the exact period being found by experiment. The basket is then raised above the liquid, drained, and lifted over the dividing plate into the second compartment where it is similarly treated. The basket is then raised, drained, and the parts receive a final washing in the third compartment which contains pure solvent.

21. **Liquid-vapour Type.** With this process the components are first immersed in cold or boiling liquid and then suspended in the vapour. The lid of the degreaser should be opened gently and the components lowered carefully into the liquid compartment. If baskets are used, they should rest on the perforated plate at the bottom of the compartment, but components may be suspended by wire or other means. The length of time that components are left immersed will be found by experience.

22. **Acidity.** Degreasers must be operated so that the trichlorethylene is always alkaline. Small quantities of soda ash are sprinkled evenly over the surface of the solvent twice daily, preferably when the solvent is not boiling. The trichlorethylene is to be checked periodically to verify that it is not acid.

WARNING

Trichlorethylene is non-inflammable but has a narcotic effect and will cause illness or even death if inhaled in large quantities. Personnel should not smoke for at least half an hour after contact with trichlorethylene.

Emulsion Degreasant Compound

23. This method does not require special plant. The solution is made up as required and as recommended by the manufacturers. Provision must be made to heat the water to approximately 70°C. When the water reaches the recommended temperature, the compound should be added and the solution stirred thoroughly. The compound should always be added to the water and not the water to the compound. The drums in which the compound is supplied should be resealed very carefully after use.

24. Throughout the degreasing operations, the temperature of the solution should be

maintained as near as possible to the specified figure, and the solution stirred frequently. Immerse the components in the solution and allow to soak until the grease comes away easily, then clean the components with a bristle brush. After cleaning, drain off the solution and wash the components in clean warm or cold water, afterwards thoroughly drying them before coating with clean thin oil or an approved protective compound against the possibility of corrosion.

Cresol/Soap Process

25. This process is used for the removal of carbon deposits and sludge from components such as crankcases, but it will not remove hard deposits like that found on cylinder heads. All parts except magnesium alloys may be cleaned by this process. The contents of the bath should be periodically checked by A.I.S., and should consist of 5 gallons of cresol, 10 lb. white soap, made up to 100 gallons with water at 90°C.

26. With the solution at a temperature of 65°C. carbon deposits will be loosened; a higher temperature will speed up the process but a maximum temperature of 90°C. must not be exceeded, particularly if the water supply is hard, otherwise the soap content of the solution may become decomposed, in which state it will attack any aluminium alloy components.

27. The time of immersion will depend upon the state of the components. After being cleaned in the solution, the components should be removed and immediately given a thorough washing with kerosine. The operator must wear rubber gloves and avoid splashing the solution.

Alkaline Degreasing Process

28. There are a number of proprietary brands and they can safely be used on any metal, but should not be used if the enamel on a component is in good condition. Always ensure that the bath is maintained at the specified working temperature.

29. **Method.** The method for cleaning components is as follows:—

- (a) Wash the components in clean kerosine to remove any loose carbon, oil or grease.
- (b) Immerse the components in the hot solution and immediately close the lid of the tank. The time taken to loosen

the carbon will vary with the condition of the components, but ensure that components assembled to a shrink fit are not damaged by being left in the solution for an excessive period.

(c) After the parts have soaked for the required period, raise the lid of the tank and lift the components out of the solution. Transfer the components to a tank of clean water maintained at the specified temperature, and wash off the scum.

(d) Wash the components in kerosine to remove any deposits still adhering, then finally re-wash in clean kerosine and dry in an air blast.

Sand Blasting

30. The sand-blast method of removing hard carbon from such components as valves is a suitable alternative to both the chemical and mechanical methods of cleaning. The equipment used is a standard sand-blast machine, the cleaning operation consisting of rotating the component whilst spraying the abrasive grains over the parts to be cleaned. Care must be taken to prevent damage to such parts as valve stems, and these should be protected by suitable sleeves whilst the operation is in progress. Prolonged concentration on any part of the component during sand-blasting must be avoided. After sand-blasting, parts can be polished with a rotary polishing mop if required, and finally washed in kerosine and degreased.

Copper Pipes

31. Copper pipes may be cleaned by dipping them in a bath of commercial nitric acid for 3 to 4 seconds, followed by a thorough washing through in clean cold running water. The pipes should then be dried in hot boxwood sawdust and blown through with compressed air.

Ball and Roller Bearings

32. These should be cleaned by soaking them for a time in a tank containing white spirit. This will loosen grease and foreign matter, which can then be removed by directing a jet of white spirit at an angle to the bearing. The operation will be aided if the outer race is rotated slowly, and then kept moving by the force of the jet. Kerosine under pressure, or other approved cleaning processes, may be used

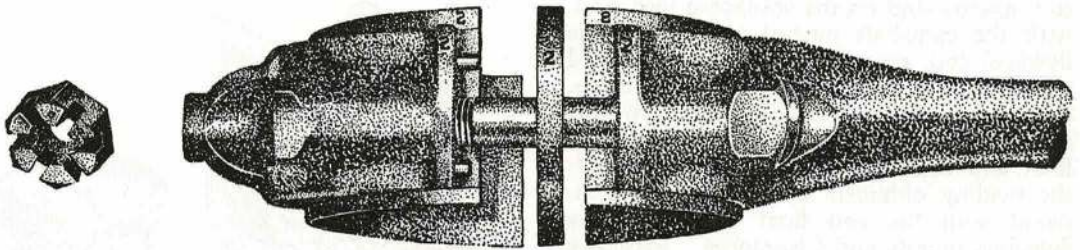


Fig. 12. ASSEMBLY MARKS

for initial cleaning, but the bearings should always be finally washed in gasoline (no lead), in which they should be rotated until quite free. They should then be dried and dipped in warm mineral oil.

ASSEMBLY

Precautions

33. All normal precautions must be observed. Parts must be thoroughly clean and should be visually examined for damage before being fitted. All working parts should be smeared with clean lubricating oil. Observe assembly marks (Fig. 12), and ensure that all parts are fitted in the correct way. Make certain that all locking devices are securely fitted; it is advisable to turn up slightly the tabs of any locking washers before fitting, as this will facilitate final locking. Take care not to overtighten any nuts. When a torque loading is specified, or a special spanner or tool, always adhere to the instructions. Use new gaskets or seals, and only use jointing compound as and when instructed to do so.

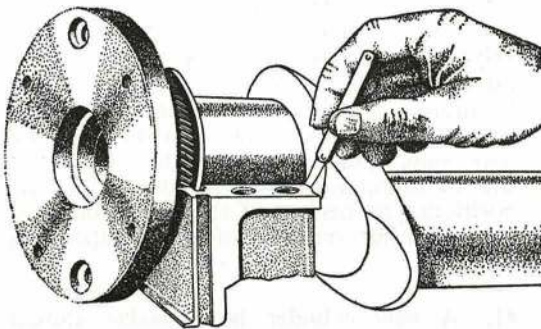


Fig. 13. CHECKING CRANKSHAFT END FLOAT

34. The front and rear bearings on some engines have felt or cork packing washers, and care must always be taken to ensure that these are correctly fitted. Also, at this stage, the end float of the crankshaft will probably be checked and rectified where necessary. Crankshaft end float is sometimes controlled by one of the main bearings, but more frequently by special thrust washers. End float is checked with feeler gauges as shown in Fig. 13. If end float is excessive it may be reduced by selective assembly of new thrust washers, or, by reducing the thickness of washers which are slightly too thick by rubbing them down on emery cloth on a surface plate. If the thrust washers have one side faced with white metal, this side must always be fitted to face the crankshaft. On Rolls Royce B.80 engines new oil seals must be fitted to the side faces of the rear main bearing. These seals are of soft white pine; they should be carefully driven in and the surplus trimmed off flush with the housing face.

35. Piston ring gaps should be spaced at equal distances around the piston, and a piston ring clamp used to retain them in position. When fitting a piston it is usual for the number on the crown of the piston to face the front end of the engine. The connecting rod nuts should be tightened progressively as specified in the relevant Air Publication; the crankshaft should be turned to check that binding does not occur, and then the nuts must be locked in the approved manner.

36. After the camshaft has been fitted, it may be necessary on some engines to proceed with several checks. If the camshaft end float was not checked before assembly commenced, a dial gauge should be attached

to a nearby stud on the crankcase face, and, with the camshaft pushed in towards the flywheel end, the gauge should be adjusted to contact the face of the shaft flange. The dial should then be set to zero, the shaft pulled forward to the limit of its float and the reading on the gauge noted; the reading obtained should then be compared with the end float quoted in the Schedule of Fits and Clearances. Excessive end float is usually rectified by selective assembly, or by rubbing down of thrust washers.

37. To check the backlash between the camshaft and oil pump gears, the oil pump will have to be fitted temporarily in position. The bottom cover of the pump and the idler gear should be removed, and a dial gauge mounted on the crankcase face so that the gauge makes contact with a tooth of the pump driven gear. By holding the camshaft steady and turning the drive shaft, the amount of backlash will be shown on the dial. This reading should then be compared with the backlash quoted in the Schedule of Fits and Clearances.

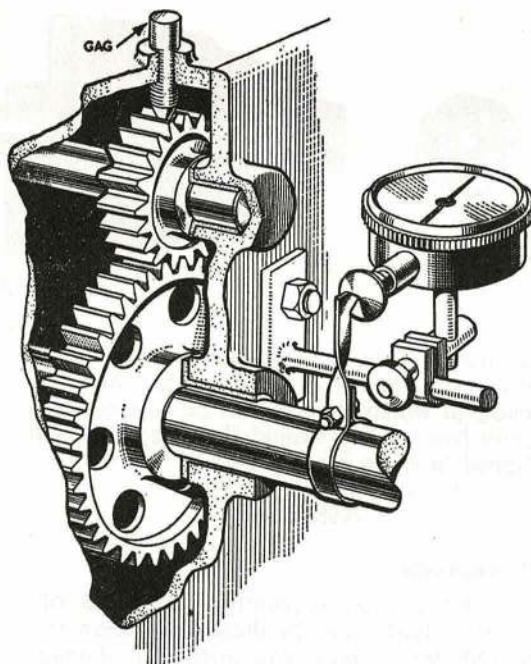


Fig. 14. CHECKING BACKLASH

38. On engines having a gear-driven camshaft it will be necessary to check the backlash between these gears. Sometimes it is possible to measure backlash directly by inserting feeler gauges between the mating teeth, but other methods must be used when the gear teeth are inaccessible; one method is shown at Fig. 14. One of the gear wheels is locked (gagged) by some suitable temporary locking device such as a fibre plug, clamp or wooden wedge. A lever is fixed to the shaft of the mating wheel, its free end bearing on the plunger of a dial test indicator which is fixed to any convenient part of the gear casing. When the second wheel is rocked backwards and forwards, the extent of the movement will be shown on the dial indicator. This movement, corrected if necessary for the length of the lever, will be the amount of backlash. If the length of the lever is equal to the radius of the pitch circle of the wheel, the dial indicator reading will be the actual backlash, but if the length of the lever is twice the radius of the pitch circle the reading must be divided by two, and similarly for other lengths.

39. At this stage it is also usual practice to apply an oil pressure test to the crank-

shaft and its associated components. The test rig will most probably be of local design and manufacture, with provision for heating and supplying the oil at the temperature and pressure stated in the relevant Air Publication. The crankshaft should be turned, and inspection made to see that oil is reaching all bearing surfaces without excessive quantities escaping.

40. When a flywheel has to be refitted, care must be taken to ensure its correct location. A suitable valve spring compressing tool is required for assembling the valves, seating washers, oil seals (where fitted), springs and collets in their original locations. On side valve engines, it will be easier to start with the valves at the front and rear ends and work inwards. A mirror will be useful to check that the cotters are positioned properly, and are not displaced or jammed after removal of the compressing tool.

41. A new cylinder head gasket should always be used, and although it is usual to smear both sides lightly with grease, the relevant Air Publication should be consulted. The reason for this is that

some manufacturers have different ideas, for example, Rolls Royce on B.80 engines recommend lightly smearing both faces of the gasket with jointing compound for approximately 1 inch wide along the edge adjacent to the distributor mounting. On another manufacturer's engines it is recommended that the upper face of the gasket is smeared with grease and the lower face with jointing compound, the use of jointing compound being, in this instance, to minimize the possibility of liner movement when the head is subsequently removed. It is very important that the gasket is the right type, and that it is correctly fitted; many gaskets are marked on their upper face to aid correct fitting.

42. When tightening cylinder head nuts, similar precautions must be observed as for removal. Tighten the nuts progressively in the recommended sequence, and always use the recommended torque or special spanner. When fitting the push rods of overhead valve engines, care should be taken, if they are marked, to fit them in their correct places. Fitting of the rocker shaft assembly will be facilitated if the tappet adjusting screws are screwed back beforehand. The nuts securing the rocker shaft pedestal brackets should be tightened progressively, working from the centre towards each end.

Valve Timing

43. **General.** The method of timing the valves will depend upon the particular engine being worked on. Some engines have marked flywheels, others have their crankshaft and camshaft sprockets marked, and some have no markings at all. An example of each of these methods of timing is explained in the following paragraphs.

44. **Marked Flywheel.** The procedure is as follows:—

- (a) Adjust the tappet clearance of No. 1 cylinder inlet valve to .035-in.
- (b) Temporarily fit the camshaft gear. Turn the crankshaft in the direction of rotation until a .005-in. feeler gauge is just nipped between the rocker and No. 1 inlet valve.
- (c) Carefully remove the camshaft gear and turn the crankshaft until the I.O. mark on the flywheel rim is in line with the

centre line of the cylinders, or, if the flywheel and clutch housing is fitted, in line with the pointer, which can be seen when the cover is removed from the top of the housing.

(d) Check that the feeler gauge is still nipped between No. 1 cylinder inlet valve stem and the rocker.

(e) Assemble the thrust button and spring to the bore of the camshaft gear hub and carefully engage the gear with the crankshaft gear, bearing in mind that the teeth are helical and that a turning movement will occur during engagement. The gear should be positioned with the setscrew holes in alignment, so that the setscrews can be entered without moving the gear. Temporarily secure the gear with at least two setscrews.

(f) Turn the crankshaft back, and then turn it forward until the .005-in. feeler gauge is again nipped between No. 1 inlet valve and the rocker. Check that the flywheel I.O. marking is in alignment with the centre of the cylinder bores or with the timing pointer, as the case may be.

(g) A slight divergence from this position can usually be adjusted by carefully removing the camshaft gear and refitting it to align with a different set of holes.

(h) If the timing is satisfactory, remove the temporary setscrews, fit the locking plate, and fit new lockwashers and setscrews. Tighten the setscrews and bend over the tabs of the lockwashers. Reset No. 1 cylinder inlet valve tappet to its normal operating clearance.

45. **Marked Sprockets.** Using this method the procedure is as follows:—

- (a) Set the engine with Nos. 1 and 4 pistons at T.D.C.—the fan pulley and crankshaft sprocket keyways will be pointing vertically downwards (Fig. 15).
- (b) Rest the camshaft sprocket on the camshaft spigot and line up the scribed lines.
- (c) Turn the camshaft until the centre-punch mark on the camshaft end appears at the punch-marked hole in the camshaft sprocket. The setscrew holes should be exactly aligned with those of the camshaft.
- (d) Fit the chain on to the crankshaft

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sprocket, remove the camshaft sprocket, taking care not to alter the camshaft position and fit it to the chain.

(e) Fit the camshaft sprocket to the camshaft so that the scribed lines on the two sprockets are in line, and the driving side of the chain is tight.

(f) Fit the tabwasher and tighten the setscrews, but do not bend up the locking tabs until after re-checking the position of the markings.

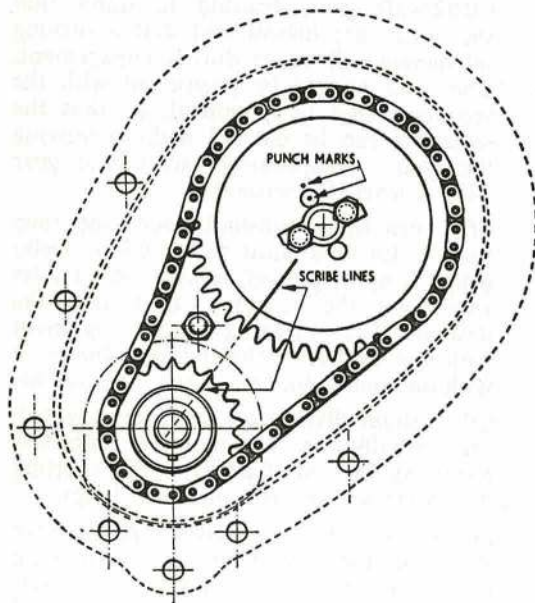


Fig. 15. VALVE TIMING MARKS

46. Valve Overlap. This method can be used when the timing marks have been omitted. The method is based on the assumption that the angles at which the inlet open and the exhaust valves close before and after T.D.C. are equal. The procedure is as follows:—

(a) Connect the crankshaft and camshaft provisionally.

(b) Set No. 1 cylinder valve tappet clearances to the figures specified by the manufacturer.

(c) Turn the engine in the direction of rotation until both inlet and exhaust valves are slightly open, i.e. the inlet valve will be just starting to open and the exhaust valve just about to close.

(d) Disconnect the crankshaft from the camshaft and turn the crankshaft in the

direction of rotation until No. 1 piston is at T.D.C.

(e) Re-connect the crankshaft and camshaft, turn the engine and check the timing. If satisfactory, mark the sprockets in the manner advised in the relevant Air Publication.

Note.—On O.H.V. engines it is advisable to slacken fully all tappet adjusting screws, except those of No. 1 cylinder, before starting to time the valves. The tappets must be re-set to the recommended running clearance after the timing has been checked.

Further Precautions

47. The crankshaft aperture oil seal should be smeared with approved grease (where appropriate), the timing case cover fitted, and the retaining nuts tightened progressively and evenly. When fitting the oil pump, care must be taken to ensure that the oil pump shaft gear is engaged with the camshaft gear in the correct or near correct position for ignition timing. This operation is described in the relevant Air Publication; the following is a typical example. The engine is set with No. 1 cylinder on T.D.C. compression stroke, and the pump drive is

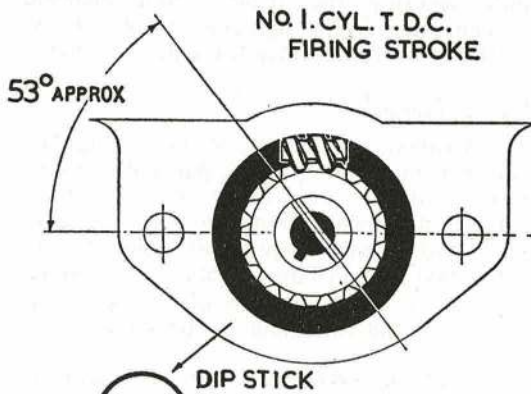


Fig. 16. MESHING OIL PUMP GEAR

correctly engaged as shown (Fig. 16); the slot points rearwards directly towards the exhaust valve pushrod sealing tube, and the keyway in the helical gear is in line with the oil-dipstick.

48. All locking devices for the crankshaft, connecting rods and oil pump should be checked for security, and drain tubes examined for correct fitting. A new gasket should be used for the sump, all nuts being

tightened progressively and evenly. Ensure that the drain plugs, with gaskets, are fitted and tightened.

49. Timing the ignition is very similar for both coil and magneto operation. First check and adjust, if necessary, the gap of the contact breaker points. Set the engine to the figure recommended by the makers on the compression stroke. For coil ignition, fit the distributor and turn the distributor body in the opposite direction to rotation till the points are just about to separate, with the rotor arm opposite No. 1 segment. Tighten the clamp bolt securely but not excessively. For magneto ignition, ensure that it is fully retarded, turn in the direction of rotation until the points are just about to open for No. 1 segment, and offer the magneto to the drive on the engine. Any adjustment required should be obtained by the method provided, and the magneto secured on its mounting. Fit the distributor and contact breaker covers as applicable, and, using new washers, fit the sparking plugs by hand to ensure that the threads are not crossed, finally tightening them with the correct spanner. Connect up the leads in the correct firing order, and if these are of the screened type, tighten the gland nuts securely but not excessively.

50. New gaskets should be used for the manifolds, and again, the securing nuts must be tightened evenly and progressively. Where appropriate, care must be taken when fitting the fuel pump that the operating lever is correctly positioned on the cam or pushrod, and that the correct gasket is used. On some engines it is necessary to prime the oil system, and, if so required, this operation is described in the relevant Air Publication. A final check should be made to ensure that all parts have been refitted and that the engine is complete.

C.I. Engines

51. The assembly of compression ignition engines is very similar to that applied to spark ignition engines, with the exception of the injection equipment. Thus, the following paragraphs describe the timing of the injection pump and injector fitting precautions only.

52. **Timing.** The actual point of injection must be accurately timed, therefore, as

injection timing varies with engine design, the setting is usually marked on the flywheel. The relevant Air Publication should always be consulted if personnel are not familiar with a particular method of timing. The general procedure, which is known as the spill cut-off method, is as follows:—

(a) Fit the fuel pump to the engine and prime the fuel chamber.

(b) Set No. 1 piston at T.D.C. compression stroke.

(c) Turn the flywheel backwards and set the fuel injection advance position mark opposite the fixed mark or pointer on the crankcase.

(d) With the engine drive to the injector pump disconnected, set No. 1 plunger so that it is just commencing to deliver fuel. This is done by disconnecting No. 1 delivery pipe union, and wiping off the surplus fuel with a clean finger so that the remaining fuel has a concave surface. Turn the pump camshaft, by hand, in its correct direction of rotation until the concave surface suddenly flattens. This indicates that the plunger is just commencing to deliver fuel, i.e. that the plunger has just passed the spill point.

(e) At this point, couple the pump camshaft to the engine drive and timing of the pump to the engine is complete.

53. **Injector Fitting Precautions.** When fitting an injector to an engine, care is required to ensure that the injector is fitted squarely, and that a gas-tight joint is made between the injector and the cylinder head. The injector is flange-fitted to the cylinder head in which there is a deep recess to accommodate the portion of the injector below the flange. A seal is made by a copper washer between the lower face of the nozzle cap-nut and a prepared face at the bottom of the recess. Initially, it must be ensured that the injector is a perfectly free fit in the cylinder head recess, that the flange holes fit freely over the studs, and that the copper washer is a free but not loose fit on the cap-nut. These copper sealing washers are specially made for this purpose, and no other type should be used. All surfaces are to be cleaned thoroughly before an injector is finally fitted, and, to avoid damage to the nozzle, the securing nuts must be tightened down evenly.

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