Chapter 21

CLEANING

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LIST OF ILLUSTRATIONS

General

1. The chapter details the methods to be used when cleaning the component parts of the engine after dismantling. The instructions assume that the engine has completed the full time since reconditioning and that the condition of the components is, therefore, consistent with a time expired engine. If the engine has not run the full permitted period it may not be necessary to carry out the full cleaning processes specified, but always the components must be cleaned to an extent that renders them suitable for efficient detail inspection.

2. Standard cleaning methods applicable to piston engines can, in general, be applied to these engines as instructed in the following paragraphs. A component cleaning chart, which lists the main component parts of the engine and the type of cleaning processes to which each may be submitted, is given at the end of this chapter. Although the time of immersion in the cleaning solutions must necessarily depend on the state of the components and the strength of the solution, experience in the use of the solution with components of a like nature will determine largely the length of time best suited to any particular operation.

Precautions

3. Special care should be taken to keep component parts of sub-assemblies together during cleaning and all large components should be clearly labelled by means of wire-attached metal discs in such a way that they can be readily identified. Small components should be placed in similarly labelled strongly constructed wire baskets so that immersion in and removal from the de-greasing or cleaning process tanks is facilitated. Shims and packing washers should be wired to their respective components.

4. To ensure that the de-greasing or cleaning medium penetrates and acts fully on any component, it is essential that the component is stripped to the fullest permissible standard before it is placed into the process tank.

5. To prevent damage to joint faces, care must be taken when packing the smaller components into wire baskets or when placing larger components into the process tanks. Strips of wood positioned along the top edges of the tanks will help in this latter respect. Where lifting tackle is provided it should be used always to hoist the heavier components into the tanks, and levering or sliding larger components about in the tanks must be avoided.

6. To prevent unnecessary fouling of the degreasing and cleaning solutions, all loose carbon, superfluous oil and grease should be removed from components by kerosine washing and the components wiped dry before they are immersed in the process tanks.

7. Precautionary notices and warnings issued by the manufacturers, and also general orders regarding the use of solvents and degreasing and cleaning agents must be heeded, and any special instructions likewise given must be adhered to strictly at all times.

Ball bearings

8. To prevent corrosion, ball bearings should not be cleaned until immediately before inspection, and as soon as possible after the satisfactory completion of inspection they should be dipped in clean warm engine oil then wrapped in wax impregnated paper and stored until required for reassembly to the engine. As clean dry bearings tarnish readily if touched by bare hands, and as corrosion thus started may spread rapidly, gloves should be worn when handling bearings after cleaning.

9. Ball bearings should first be washed in a kerosine tank, then transferred to a washing tank equipped with an integral pump and there soaked with filtered white spirit (R.A.F. Ref. 34A/246) in order to remove hardened grease and included foreign matter that may be lodged in the cage. A jet of white spirit should be directed on to the balls and the cage, thus causing them to rotate continuously, while the outer race is held stationary. Cleaning must be continued until the bearing is free of all deposits.

10. If white spirit washing equipment is not available, clean kerosine may be used, but in this instance it will be necessary to degrease the bearings in trichlorethylene after the cleaning operation has been completed.

Flexible pipes

11. Flexible pipes should be washed in kerosine and cleaned internally under pressure. Clean kerosine should be flushed through the pipe from each end in turn to ensure that no foreign matter is lodged adjacent to the end fittings. A clean blanking cap must be secured to both ends of each pipe immediately after flushing.

Rigid pipes

12. Rigid pipes should be degreased in a trichlorethylene tank and then flushed thoroughly with clean kerosine under pressure as described in para. 11. A clean blanking cap must be secured to both ends of each pipe after the cleaning process has been completed.

Rubber and non-metallic parts

13. Non-metallic parts, including those made of natural or synthetic rubber, are normally discarded at overhaul and new parts are used at reassembly. Such parts however, consumable or otherwise, must not be subjected to degreasing treatment because of the adverse effect the solution has upon them. Washing in kerosine is the only permissible method of cleaning these parts.

Steel components

14. Steel components should first be degreased in the trichlorethylene tank. After degreasing, baked-on enamel, stains, and other hard deposits should be removed either by immersion in a cresol-type detergent solution or by immersion in a solution of 10 per cent caustic soda in water; this latter solution should be maintained at a temperature of approximately 80 deg. C.

15. After cleaning in caustic soda, components must be washed thoroughly in hot water to remove all traces of the caustic soda, and must then be dried by means of a compressed air jet. Any component that is not to be inspected or used immediately must then be coated lightly with a thin mineral oil to prevent corrosion.

16. Immediately after removal from the cresol-type solution, components must be transferred to a kerosine washing tank and thoroughly washed to remove all traces of the solution.

Light alloy components

17. With the exception of the magnesium alloy components, which must not be immersed in the degreasing vapour or in any of the cleaning solutions, all light alloy components must first be degreased in a trichlorethylene tank.

18. After degreasing, baked-on enamel, stains and other hard deposits should be removed by immersion in a cresol-type detergent solution. Light alloy components must not be immersed in caustic soda solution.

19. Magnesium alloy components should be immersed in a kerosine bath and scrubbed thoroughly first with a fine wire or stiff bristle brush and then with a soft brush to remove carbon deposits, and then those components from which enamel is to be removed should be treated with paint remover such as R.A.F. Ref. 33B/147 and cleaned down to base metal by means of suitable wire brushes.

20. All light alloy components must finally be washed by a kerosine jet to remove any deposits that may still be adhering. It is important at this stage that all oilways and passages are checked for freedom from sludge and other foreign matter; if necessary clean kerosine must be forced through passages by means of a syringe. Finally the components must be thoroughly dried by means of a compressed air jet.

Pistons

21. After the kerosine wash following removal from the cresol-type solution, any hard carbon deposits must be removed from the pistons by prunus blasting. The bearing faces of the piston must be protected during this operation; a suitable mask for this purpose may be readily manufactured from local resources to the design indicated in fig. 1.

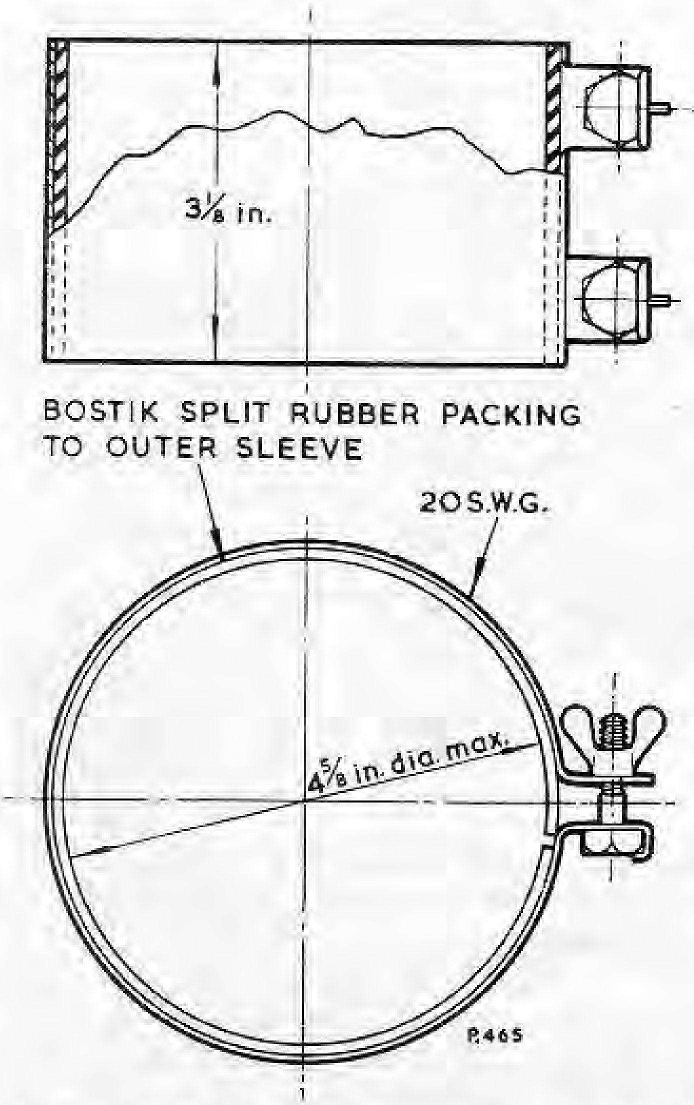

Fig. 1. Mask for use when prunus blasting pistons

22. On removal from the blasting cabinet all traces of the prunus powder must be removed by means of a compressed air jet and the pistons must be polished externally and internally.

23. Wire brushing may be used on the inside of pistons to remove any stubborn deposits and similar deposits may be removed from the ring grooves by means of locally manufactured aluminium scrapers. Finally pistons must be washed thoroughly in clean kerosine and dried by means of a compressed air jet.

Cylinder heads

24. After degreasing, cylinder heads must be cleaned by shot blasting. All machined faces must be suitably masked to protect them during the blasting operation; sets of masks, T85980 are contained in the Major Tool Kit. On removal from the shot blasting cabinet the masks must be removed and the cylinder heads washed thoroughly in clean kerosine to remove all traces of the blasting medium, and then dried by means of a compressed air jet. Valve seats must be cleaned by use of suitable hand polishing equipment.

Valves

25. After degreasing and cleaning, valves must be finally polished by use of any standard bench polishing fixture equipped with a suitable chuck.

Crankshaft

26. The inside of the crankshaft main journals and crankpins must be cleaned thoroughly, after degreasing and immersion in the cleaning solution, by means of a portable flexible shaft machine equipped with suitable wire brushes and polishing mops. The journals and crankpins must be cleared after this operation by a jet of compressed air.

Engine accessories

27. Surplus oil must be drained from accessories and the accessories cleaned externally by kerosine washing, and then thoroughly dried before they are dispatched to their respective bays for individual inspection.

Component cleaning chart

28. The following chart details the processes that may be used when cleaning the larger components of Gipsy Major engines. It is intended as a quick means of reference and should be used only after the whole chapter has been read and understood.

COMPONENT CLEANING CHART

Component	Material specification	Trichlor-ethylene degreasing	Cresol-type solution	Caustic solution	Kerosine	Remarks
Crankcase	R.R.50	Yes	Yes	—	Yes	
Top cover	D.T.D.59 *or* D.T.D.136	—	—	—	Yes	
Timing gear cover	D.T.D.281	—	—	—	Yes	
Oil pump casing	D.T.D.281	—	—	—	Yes	
Suction and scavenge oil filter housings and settling tank	D.T.D.281	—	—	—	Yes	Use approved paint remover and suitable wire brushes to remove enamel from these components
Pressure oil filter housing (Auto-klean)	D.T.D.281	—	—	—	Yes	
Air-intake and flame trap housing	D.T.D.281	—	—	—	Yes	
Crankshaft	S.11	Yes	Yes	Yes	Yes	
Camshaft	S.14	Yes	Yes	Yes	Yes	
Cylinder barrels	S.70	Yes	Yes	Yes	Yes	
Cylinder heads	L.11	Yes	—	—	Yes	Masked and shot blasted
Pistons	L.42	Yes	Yes	—	Yes	Masked and prunus blasted if Ardrox 670 or similar solution not available.
Connecting-rods	D.T.D.130	Yes	Yes	—	Yes	
Valves	S.111	Yes	Yes	Yes	Yes	Finally polished
Valve rocker covers	C.R.C.A. steel	Yes	Yes	Yes	Yes	
Tappet rod casings	T.9	Yes	Yes	—	Yes	
Tappet rods	S.20	Yes	Yes	Yes	Yes	
Induction manifold	S.84	Yes	Yes	Yes	Yes	
Propeller hub	S.76	Yes	Yes	Yes	Yes	
Airscoop and baffle assembly	D.T.D.610 and Alum. sheet	Yes	Yes	—	Yes	

Note :- Among the proprietary brands of degreasants and cleaning agents that may be used on Gipsy Major engine components are :-

Degreasants (emulsion type) .... Ardrox 606 and 610
Cresol-type cleaners .... Hysone 160, Magnus 755 Stripolene, Turco Fusee
(pistons only) ..... Ardrox 670
Paint removers .... Ardrox 20, Quicker-stryp 32

When using these agents, reference must be made to the 'Component Cleaning Chart' above, and any special instructions and recommendations of the manufacturers must be closely followed.

Chapter 22

CRACK DETECTION

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LIST OF ILLUSTRATIONS

1. This chapter contains instructions on examining stressed steel or light alloy components for cracks, and arranges each component in one of two groups, depending on which method of test is appropriate, i.e., electro-magnetic, or hot oil and chalk. The electro-magnetic method is suitable for testing all magnetic steel components; the hot oil and chalk is suitable for light alloy and non-magnetic steel components. If there is no equipment for either electro-magnetic or hot oil and chalk crack detection, the parts must be carefully examined by using a high-powered magnifying glass under strong artificial light. The methods of applying the general principles of crack detection must be employed, and any specific instructions issued by the equipment manufacturer must be closely followed.

ELECTRO-MAGNETIC TESTS

General

2. Electro-magnetic tests which should be applied to the principal magnetic steel components listed in the table at the end of this chapter includes the magnetic flow, contact current flow, and the threading bar and coil method. The table indicates the magnitude and direction of the current or magnetic flux to be applied to each component, but alternatives to these may have to be adopted depending on the test equipment available. Current flow machines have meters reading in amperes; magnetic flow machine meters read in units related to the oersted and indicate the flux density obtained across a 2 in. air gap of the equipment being used. Where magnetic flow machines are not calibrated, they should be tested at a machine strength which is just NOT sufficient to cause furring round the component. Before testing, each component must be de-magnetized in a standard demagnetizer. It must then be degreased, descaled and, if necessary, stripped of paint. After testing, the component must again be demagnetized and cleaned.

3. Components requiring electro-magnetic crack detection are included in the categories listed below and can be readily identified by the stamp (M) or (MT) on the actual components.

(1) All gears.

(2) All surface-hardened parts.

(3) Components made from high tensile magnetic steel having an ultimate tensile strength exceeding 55 tons per sq. in.

(4) Major welded components.

Magnetic flow tests

4. In the magnetic flow method the component is inserted between the poles of a powerful electro-magnet, or permanent magnet. Provision is made in the standard equipment to adjust the field strength and to vary the working strength to suit various sizes of components; laminated pole pieces as illustrated in fig. 1, are provided to ensure good contact with the component. This testing method is suitable for detecting both surface and subcutaneous defects if they occur either directly transverse, or within a 50 degree angle of the transverse, to the normal direction of flow of the magnetic lines of force between the two poles of the electro-magnet. Components should be turned through 180 deg. and retested to ensure that the whole surface of the component is inked and inspected.

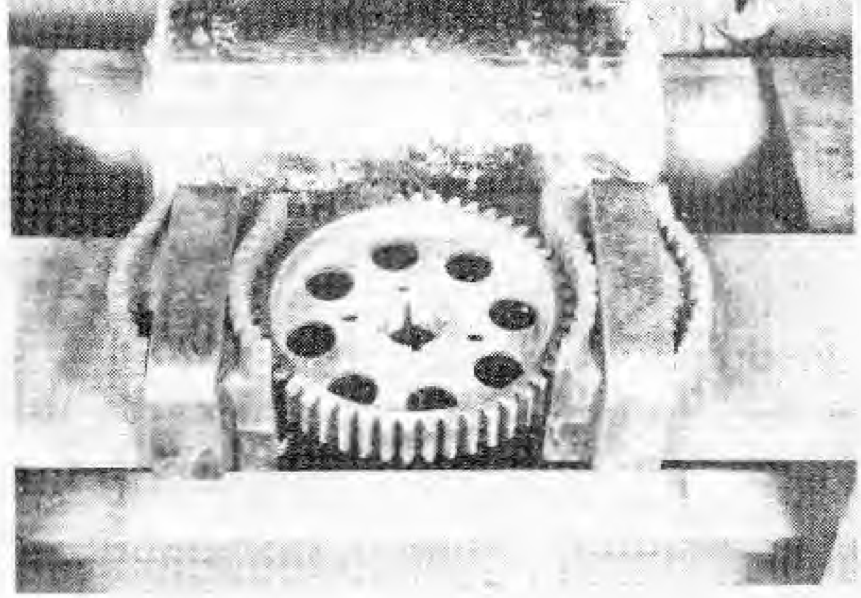

Fig. 1. Testing a component by the magnetic flow method

Contact current flow tests

5. In the contact current flow method the component is clamped firmly at the extreme ends between the contact heads with copper gauze pads interposed, as illustrated in fig. 2, and a current of suitable intensity is passed through. In every test the component must be turned about its longitudinal axis through an angle of 180 deg. and retested to ensure that inking and inspection are adequate over the whole surface. It is emphasised that copper gauze must always be used to ensure good contact and to prevent local burning. The contact current flow method of test is suitable for revealing defects which are longitudinal to the direction of test, and within 50 deg. of this direction.

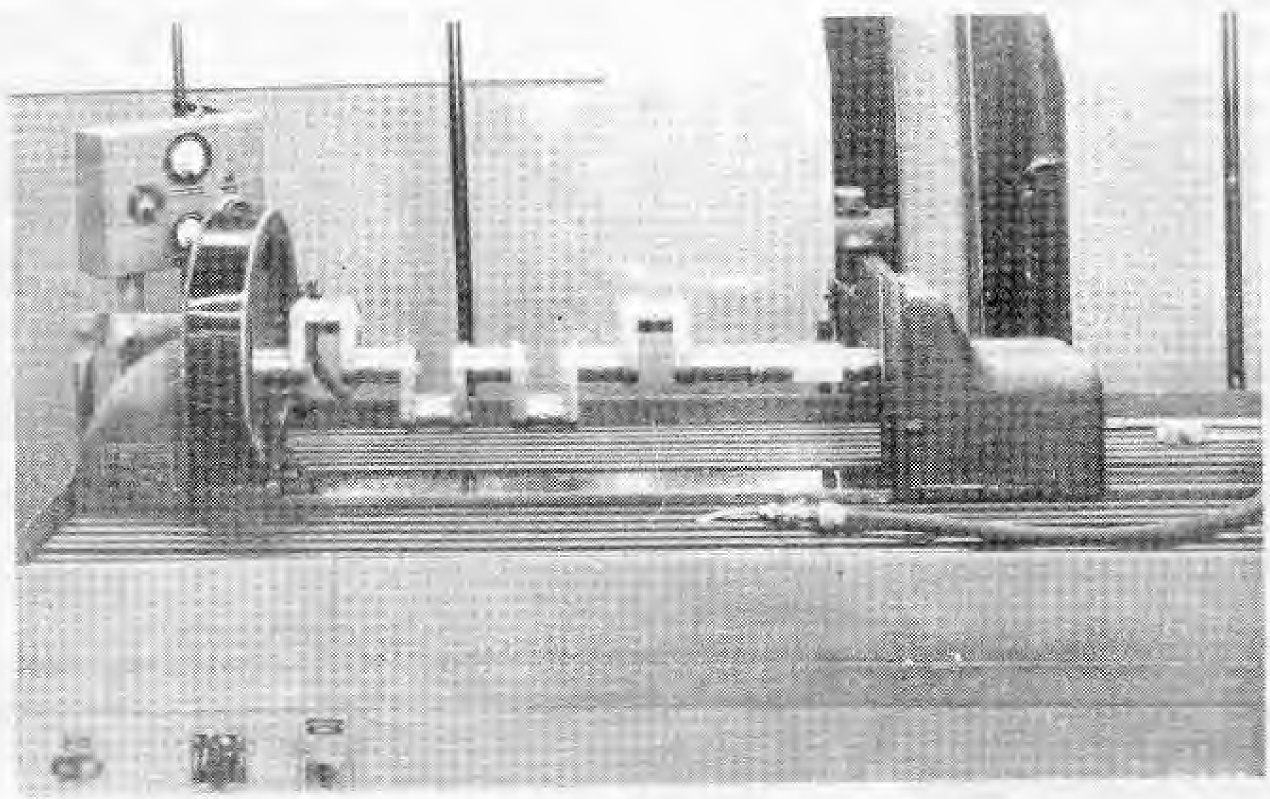

Fig. 2. Testing a component by the contact current flow method
(The crankshaft illustrated is from a later type Gipsy Major engine)

Threading bar tests

6. The threading bar method is suitable for those components which can be threaded on a bar supported by the contact heads of the testing machine, as illustrated in fig. 3. For greatest efficiency the bar should be as large in diameter as possible. Owing to the difficulty of adequately inking and viewing the underside of circular parts the test must be repeated after rotating the components through 180 deg. about their longitudinal axis. This method is most suitable for revealing defects in a longitudinal direction, or within 50 deg. of this direction: as the magnetic effect on a specimen is not complete throughout its section, deep-seated defects cannot be revealed.

Coil tests

7. In the coil method illustrated in fig. 4, the component under investigation is placed inside a helix of stiff copper cable or rod through which the high amperage low voltage current is passed (a piece of thin insulating material must cover the bottom half of the helix bore to prevent accidental shorting). The design of the coil to be used is very important, a suitable coil is illustrated in fig. 5. The coil should be energised with a current of not less than 1000 amp A.C. or 1400 amp D.C. Components should be turned through 180 deg. and then retested. The defects revealed will comprise those in a transverse direction and within 50 deg. of this direction. Only that portion of a component which is inside the coil is tested, therefore where a long component is involved it may be necessary to test it section by section.

HOT OIL AND CHALK TESTS

8. The hot oil and chalk method of testing can be used for the detection of flaws in non-ferrous alloy components. In this method the component must first be cleaned and then immersed in a tank (fig. 6) containing a solution of 25-30 per cent lard oil in paraffin at 80 deg. C. until the component attains the same temperature as the bath. Allow the surface oil to drain off the component, and then wipe off all traces of residual oil while still hot. Suspend the component in a cabinet and spray with finely powdered french chalk using a standard paint spray gun; the cabinet (fig. 6) should be provided with an extractor fan. The component should

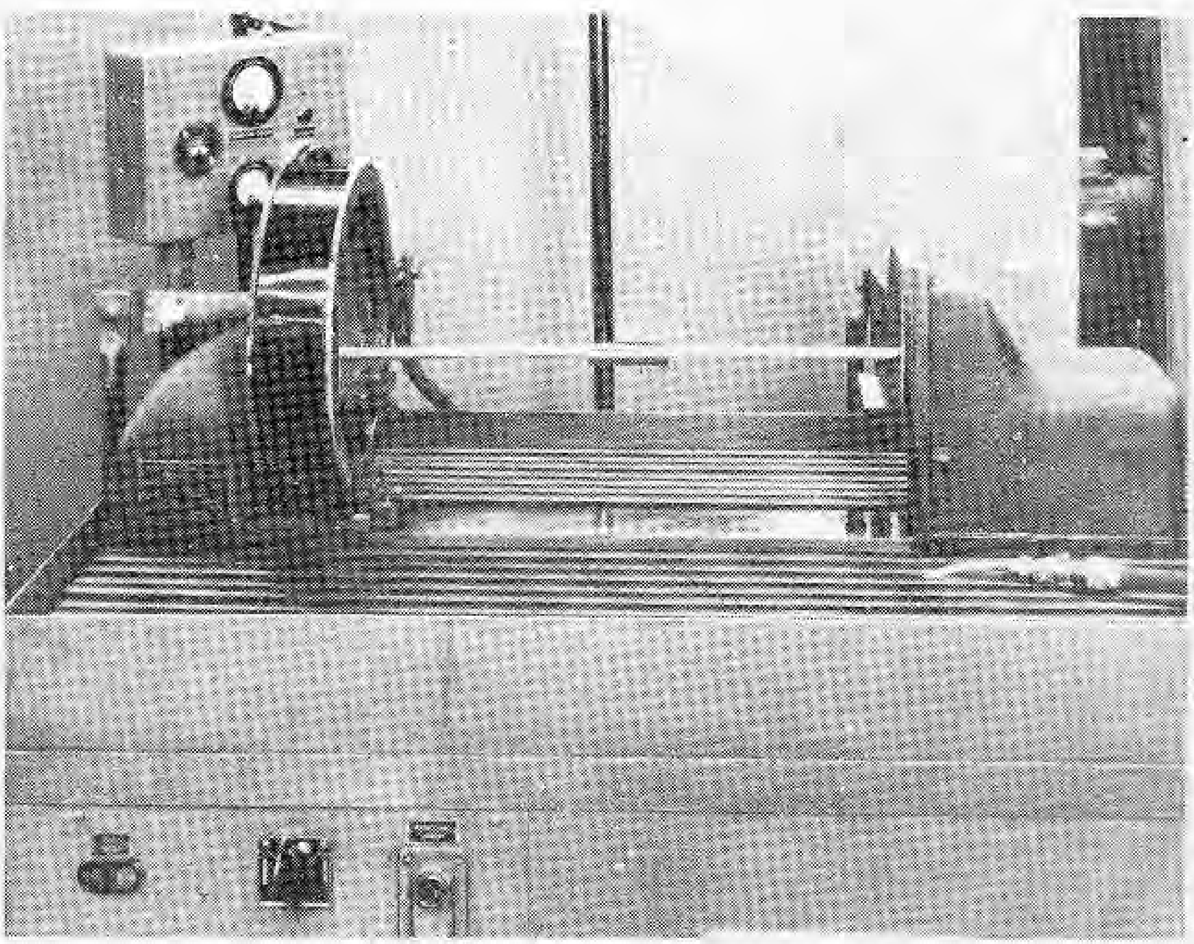

Fig. 3. Testing a component by the threading bar method

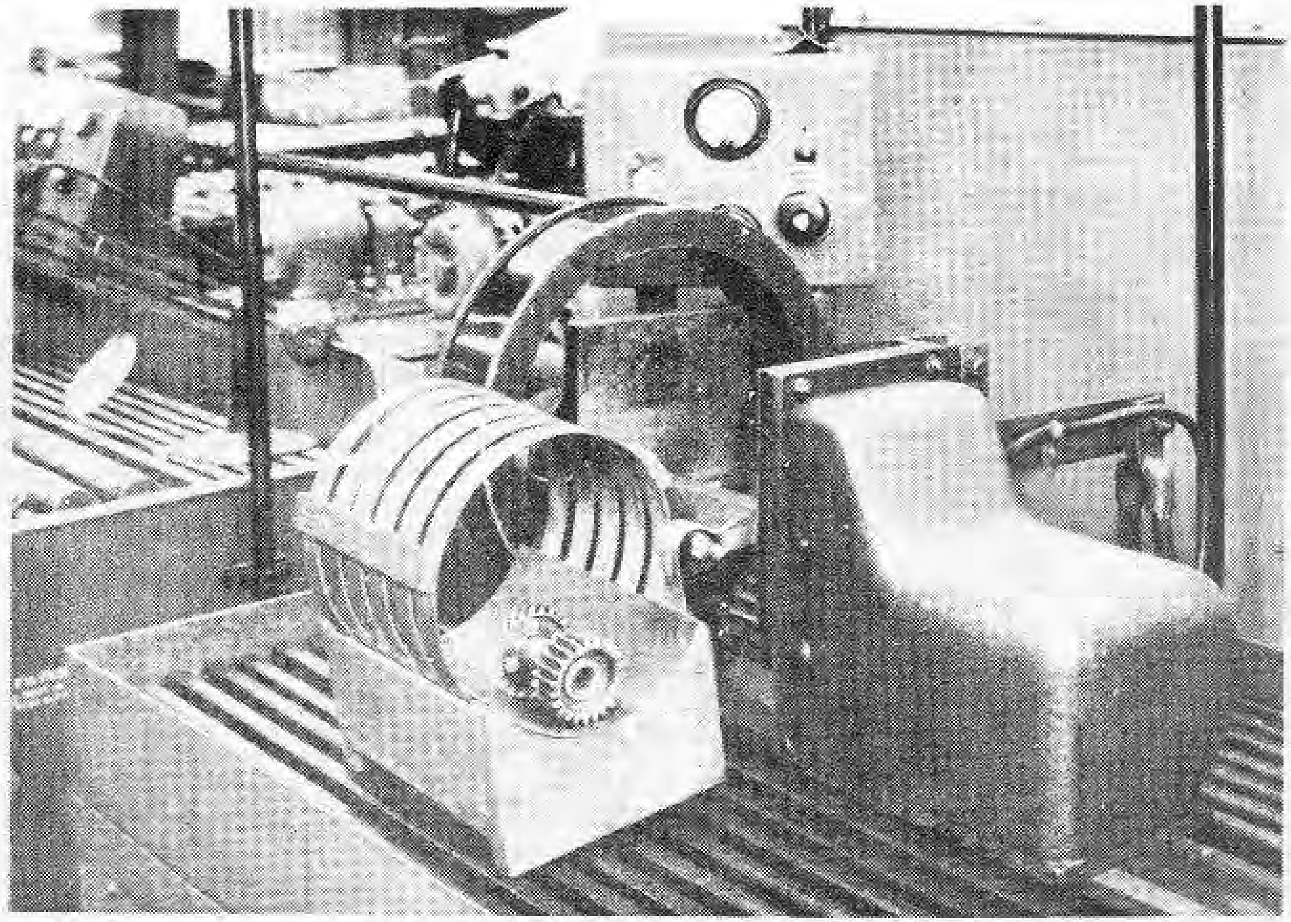

Fig. 4. Testing a component by the coil method

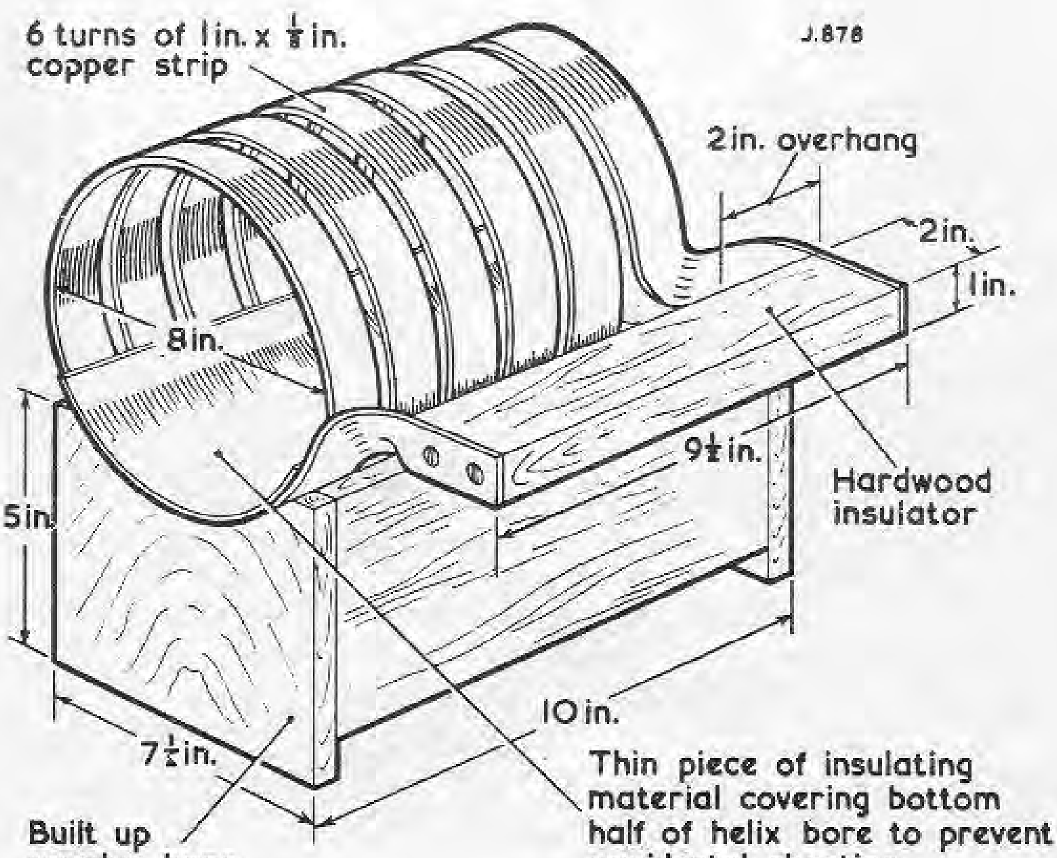

Fig. 5. Details of testing coil

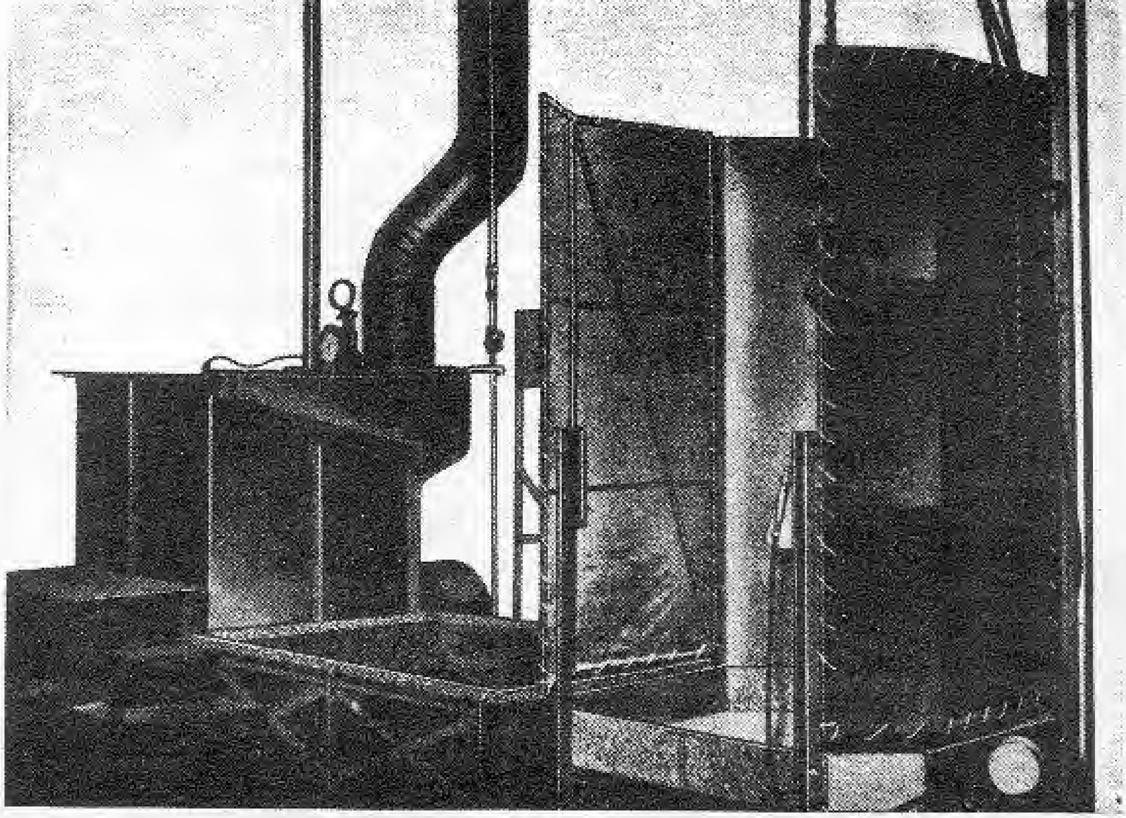

Fig. 6. Equipment for hot oil and chalk method of crack detection

be transferred to a viewing bench and when cool examined under a good light; while the component is cooling contraction will cause oil to be squeezed out of any cracks; defects will be revealed by a dark stain on the surface of the chalk. Components which should be tested by this method are as follows:—

(1) Crankcase
(2) Top cover
(3) Timing gear cover
(4) Main bearing caps
(5) Settling tank
(6) Suction filter body
(7) Auto-Klean filter body
(8) Oil pump bodies
(9) Pistons
(10) Connecting-rods

COMPONENTS TO BE TESTED BY ELECTRO-MAGNETIC METHODS

Note.—*When using D.C. as source of current the A.C. values indicated below should be increased by 50 per cent*

Assembly	Components	Method of test	Alternating Current amps.	Magnetic units
CRANKSHAFT	Crankshaft	Contact current flow through length	3,000	—
	First timing gear	Magnetic flow across faces	—	300
		Threading bar through length	2,000	—
	Starter extension shaft	Threading bar through length	1,500	—
		Inserted in 8 inch diameter coil	2,000	—
	Oil seals	Threading bar through length	750	—
	Oil seal bolts	Contact current flow	300	—

Components to be tested by electro-magnetic methods *(continued)*

Assembly	Components	Method of test	Alternating current amps.	Magnetic units
CAMSHAFT	Camshaft	Contact current flow through length	1,500	—
	Camshaft gear	Magnetic flow across faces		300
		Threading bar through length	2,000	—
	Tappets	Contact current flow through length	300	—
		Inserted in 8 inch diameter coil	2,000	—
VALVE ROCKERS AND PUSH RODS	Valve rockers	Magnetic flow through length	—	200
		Inserted in 8 inch diameter coil	2,000	—
	Rocker spindles	Contact current flow through length	250	—
		Inserted in 8 inch diameter coil	2,000	—
	Push rods ball-ends	Contact current flow through length*	250	—
		Magnetic flow through length	—	200
GUDGEON-PIN	Gudgeon-pins	Threading bar through length	600	—
		Magnetic flow through length	—	200
GENERATOR AND VACUUM PUMP (Mk. 1G only)	Generator and vacuum pump intermediate gear	Threading bar through length	1,500	—
		Magnetic flow across face	—	200
	Generator driving gear	Threading bar through length	1,500	—
		Magnetic flow across face	—	200
	Generator drive idler gear and pinion	Contact current flow through length	500	—
		Inserted in 8 inch diameter coil	2,000	—
	Generator driven gear and pinion	Contact current flow through length	750	—
		Inserted in 8 inch diameter coil	2,000	—
	Generator drive torsion bar and coupling	Contact current flow through length	500	—
	Vacuum pump driving bevel gear and pinion	Contact current flow through length	1,000	—
		Inserted in 8 inch diameter coil	2,000	—
	Vacuum pump driven bevel gear and pinion	Contact current flow through length	1,000	—
		Inserted in 8 inch diameter coil	2,000	—

*As the ball-end only is hardened and as this end fouls the machine poles, the examination should be supplemented by using the residual magnetism.

Components to be tested by electro-magnetic methods *(continued)*

Assembly	Components	Method of test	Alternating current amps.	Magnetic units
TACHOMETER QUARTER ENGINE SPEED	Tachometer driving gear	Threading bar through length	1,250	—
		Magnetic flow across faces	—	300
	Tachometer driven gear and pinion	Threading bar through length	750	—
		Inserted in 8 inch diameter coil	2,000	—
	Tachometer second driven gear	Threading bar through length	750	—
		Magnetic flow across faces	—	200
	Tachometer driving shaft	Contact current flow through length	500	—
		Inserted in 8 inch diameter coil	2,000	—
TACHOMETER ENGINE SPEED	Tachometer driving gear	Threading bar through length	1,250	—
		Magnetic flow across faces	—	300
	Tachometer driving shaft assembly	Contact current flow through length	750	—
		Inserted in 8 inch diameter coil	2,000	—
	Tachometer auxiliary gear and pinion	Threading bar through length	750	—
		Inserted in 8 inch diameter coil	2,000	—
MAGNETO DRIVE ASSEMBLY	Magneto drive intermediate gear and pinion	Contact current flow through length	1,500	—
		Threading bar through length	1,500	—
	Magneto driving spiral gear	Threading bar through length	1,500	—
		Magnetic flow across faces	—	200
	Magneto driven spiral gear	Threading bar through length	1,500	—
		Magnetic flow across faces	—	200
OIL PUMP ASSEMBLY	Oil pump driving gear	Threading bar through length	2,000	—
		Magnetic flow across faces	—	300
	Oil pump driver and driven gear and pinions	Contact current flow through length	750	—
		Inserted in 8 inch diameter coil	2,000	—
	Oil pump auxiliary gears	Threading bar through length	750	—
		Contact current flow through length	750	—
	Oil pump dividing plates	Threading bar through length	2,000	—
		Magnetic flow through length	—	300

Chapter 23

VIEWING

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LIST OF ILLUSTRATIONS

General

1. The viewing of detail parts described in this chapter includes visual inspection, distortion checks, dimensional checks, hardness tests and the checking of modification standards. Inspectional checks to be made during reassembly of sub-assemblies, and during reassembly of the engine are given in Chapter 15 and Chapter 16. As hardness test will not be required unless there are indications of overheating, notes on these tests are contained under a separate heading at the end of this chapter.

2. Inspection of ball bearings should be in accordance with local approved procedure: see also para. 16. Ball bearings should be cleaned, oiled and wrapped pending inspection.

3. Methods of crack detection are described in Chapter 22. All gears, shafts, and bolts must be tested for cracks by electro-magnetic methods; the crankcase, top cover, and all other non-ferrous components must be tested by the hot oil and chalk method.

4. Components subject to wear must be checked in accordance with the Schedule of Fits, Clearances in Chapter 20, and throughout this chapter the expression "within the limits" refers to the Schedule.

5. When dealing with surface damage such as scores, pitting, etc., it is difficult to lay down precise standards of acceptance, as this would vary according to prevailing conditions; it is therefore recommended that previous experience of similar conditions is utilized, and wherever possible reference made to practical examples.

6. Components which become redundant due to incorporating essential modifications in the subsequent rebuild of the engine, tab-washers and rubber glands, must be rejected at each appropriate stage of the viewing process; a list of consumable stores is given at the end of chapters 15 and 16 which cover reassembly of the engine.

7. Standard items such as bolts and nuts should be examined for distortion, stretching, and thread condition; special fitting bolts and dowel bolts should be examined for scores and burrs.

8. The examination of components for dimensional accuracy, truth and concentricity will in certain instances require special tools and equipment; tools are referred to as they are used and are also listed at the end of the Chapter.

9. In addition to these special tools the following standard tools are required. A set of Mercer bore indicators 50 mm. to 300 mm., a set of micrometers up to 100 mm., a set of feeler gauges, a dial indicator set, a four foot straight edge and a pair of V-blocks.

10. During inspection of the engine reference should be made to the log book and to any previous inspection records. The embodiment of all essential modifications noted in these records should be verified by visual inspection.

Crankcase

11. Thoroughly examine the crankcase for cracks, paying particular attention to those areas mentioned in para. 12, sub-para. (1). Where possible it is recommended that the crankcase should be subjected to the hot oil and chalk method of crack detection, as described in Chapter 22 and in accordance with local approved procedure.

12. Great care must be exercised in differentiating between surface defects and cracks. Such surface defects that can be removed by filing, or scraping and blended by the use of fine grade emery paper without seriously affecting strength or wall thickness, can, as a general rule, be accepted.

(1) Examine for cracks round the mounting feet, all flanges or bosses, internal webs, stud and bolt holes, bearing housings,

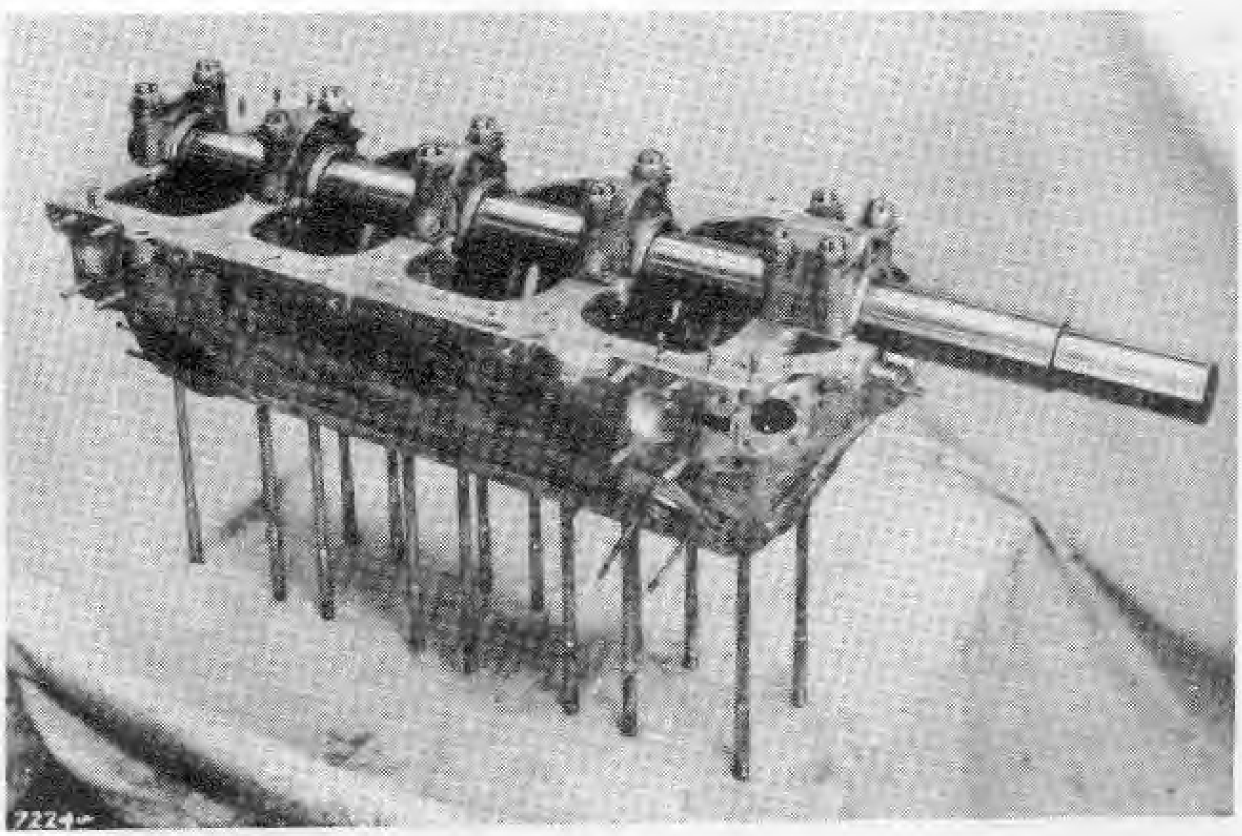


Fig. 1. Checking alignment of the main bearing housings

cylinder barrel apertures, the vicinity of cylinder holding down studs, and all other studs.

(2) Examine all studs for tightness, and their threads for damage and signs of over-stress; trial fit the nuts. Using a square check all studs for bending; bent studs must be renewed. Do not reject the crankcase because of loose studs; it is usually possible to replace such studs by oversize replacements.

(3) Examine all bearing housings for signs of scoring. Fit the main bearings and caps: tighten the nuts to the correct torque as described in Chapter 16. Check the internal diameter of the bores with a Mercer gauge, and the appropriate setting ring as described in para. 15.

(4) Check the alignment of the main bearing housings using the alignment bar Pt. No. T1900-78 for standard bores or the appropriate mandrel specified in the list of tools for non-standard bores.

(5) Check the bores of the camshaft intermediate bearings with the plug gauge T85922, and the camshaft front and rear bearings with the plug gauge T85921. If they are worn beyond the permissible limits, new bushes must be fitted. Check the oil ways of the camshaft bearings for obstructions.

(6) Examine all oil ways to ensure that they are free from foreign matter; if possible blow through with a compressed air jet.

(7) Examine the joint faces for distortion and fretting; high spots must be removed by hand-scraping until satisfactory contact is obtained. Special attention should be given to areas around studs and dowels.

Top cover and timing gear cover

13. Inspect both the top cover and timing gear cover for general condition, as described previously for the crankcase.

14. Make the following checks on the timing gear cover with the appropriate plug gauges:—

(1) With the plug gauge T85957, check the tachometer driving spindle bush bores

(2) Using the length gauge T85985, check the overall length over the tachometer driving shaft bush flanges

1. DIAL INDICATOR ON STAND.

2. STEEL PLATE. V-SHAPED OPENING ENABLES VARIOUS SIZES OF BEARINGS TO BE ACCOMMODATED.

3. ROLLED-STEEL CHANNEL.

4. LIGHT COIL SPRINGS.

5. BOLTS AND WING NUTS TO CLAMP OUTER RACE OF BEARING BETWEEN ITEMS 2 AND 3.

6. OUTER RACE OF BEARING CLAMPED BETWEEN ITEMS 2 AND 3.

7. BOLT NUTTED TO INNER RACE OF BEARING USING SUITABLE WASHERS. END FLOAT IS MEASURED BY MOVING THE BOLT UP AND DOWN AND OBSERVING THE DIAL INDICATOR READINGS. A REFINEMENT WOULD BE A SIMPLE GUIDE TO ENSURE THAT THE BOLT CAN MOVE IN THE VERTICAL PLANE ONLY.

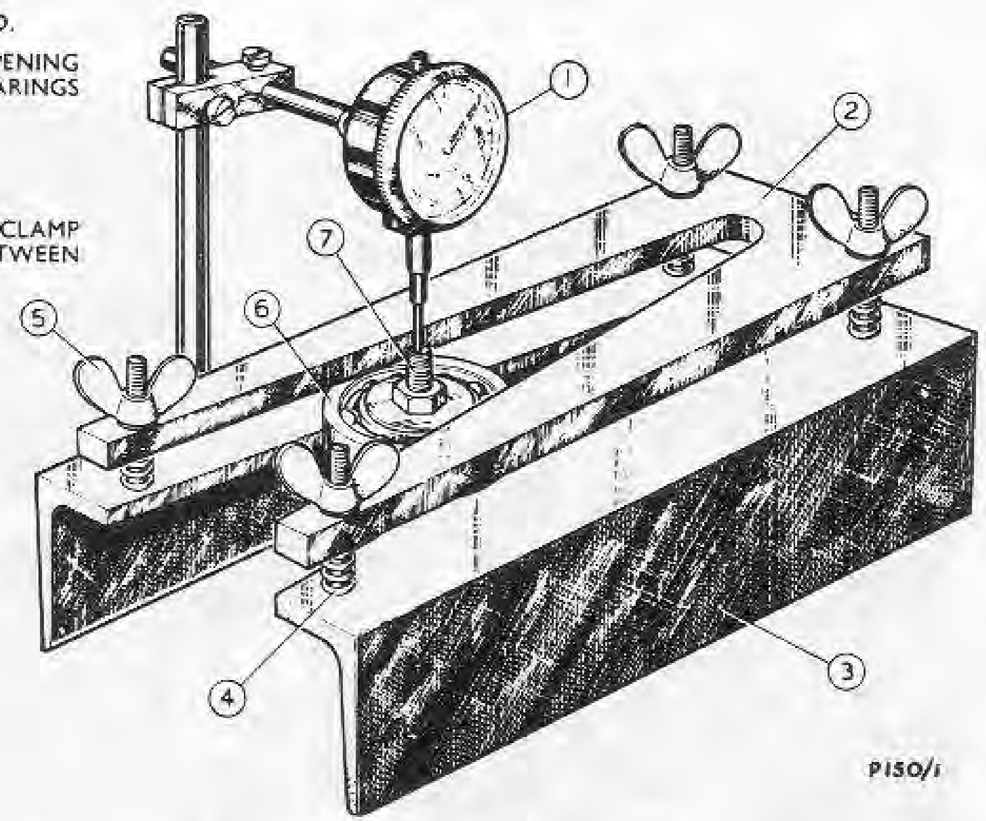


Fig. 2. A suggested simple rig for checking the end of float of ball bearings

(3) With the plug gauge T85961, check the vacuum pump driving bevel shaft housing bore **(Mk. 1G only)**.

(4) Using the plug gauge T85992, check the generator drive gear and idler gear bush bores, fig. 3 **(Mk. 1G only)**.

(5) With the length gauge T85984, check the overall length of the generator drive idler gear bush (Mk. 1G only).

(6) Check the vacuum pump bevel pinion housing bore, using the plug gauge T85993 (Mk. 1G only).

If any dimension is not within the tolerance determined by the gauge, the component should not be rejected before it has been ensured that a Repair Scheme is not applicable.

Main bearing caps and shells

15. Inspect the main bearing caps for cracks by the hot oil and chalk method, as described in Chapter 22, page 229. Generally inspect the Hoyt type white metal bearings for cracks, corrosion, deep score marks, and flaking; slight marks of damage may be carefully blended out. In all cases of doubt, new bearings should be fitted. To check the internal diameter of the main bearings proceed as follows:—

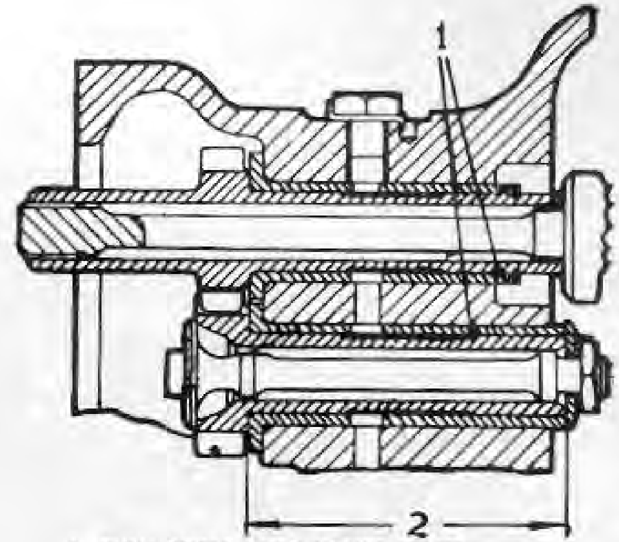
(1) Assemble the bearings to the crankcase and fit the main bearing caps, tighten the twelve retaining nuts to the correct torque (torque loading figures are given in Chapter 16).

(2) Using a Mercer gauge and the setting rings T85890 for standard bores or the appropriate setting rings for undersize bores, check that the internal diameter of the bearings is within the figure laid down in the Schedule of Fits and Clearances.

(3) Check the running clearance of the crankshaft in the bearings by measuring the diameter of the journals with a micrometer and subtracting this figure from the figure arrived at in OP. 2.

Inspection of ball bearings *(See page 283)*

16. The bearings should be visually examined for signs of flaking at the bearing surfaces of the race track grooves, and the cage should be checked for signs of abrasion, burring and general wear. Loose cage rivets may be detected by attempting to move them; bearings with loose rivets must be rejected. Bearings which have been overheated to an extent that they are unserviceable, will show discolouration of the balls and inner race tracks; temperature discolouration, which has a graded appearance, should not be confused with oil staining which has a uniform appearance. Where the races have turned straw colour the bearings are suspect; they should be thoroughly cleaned with a paraffin rag before a final decision is made. If the stain cannot be removed, the bearing must in every instance be rejected. After the visual examination of the bearing is complete, the general condition of the balls and tracks should be tested by spinning. A small quantity of clean approved engine oil should be introduced and distributed over the surface of the outer race track by holding the inner race and rotating the outer race slowly. While continuing to turn the outer race slowly and feeling for any slackness, catching or roughness, the axis of rotation should be slowly changed from the horizontal to the vertical. A regular catching of the bearing at each revolution would indicate track damage, an intermittent catching would indicate ball damage, and general roughness would indicate wear of the tracks. The diametral slackness of the bearing should be tried, and in cases of doubt compared with a new bearing. The end-float between the inner and outer races of all ball bearings must be determined to ensure that they are within the limits, see fig. 2.



1 BUSH BORES, PLUG GAUGE T85992
2 LENGTH OVER IDLER GEAR BUSH T85984

Fig. 3. Generator drive (Mk. 1G only)

Crankshaft

17. The crankshaft should have been tested for cracks by the magnetic crack detection method, as described in Chapter 22, page 227. In addition the following checks should be carried out:—

(1) Check the diameters of the journals and crankpins for size and ovality.

(2) Mount the crankshaft upon a pair of V-blocks and check for bow and parallelism by taking readings on each

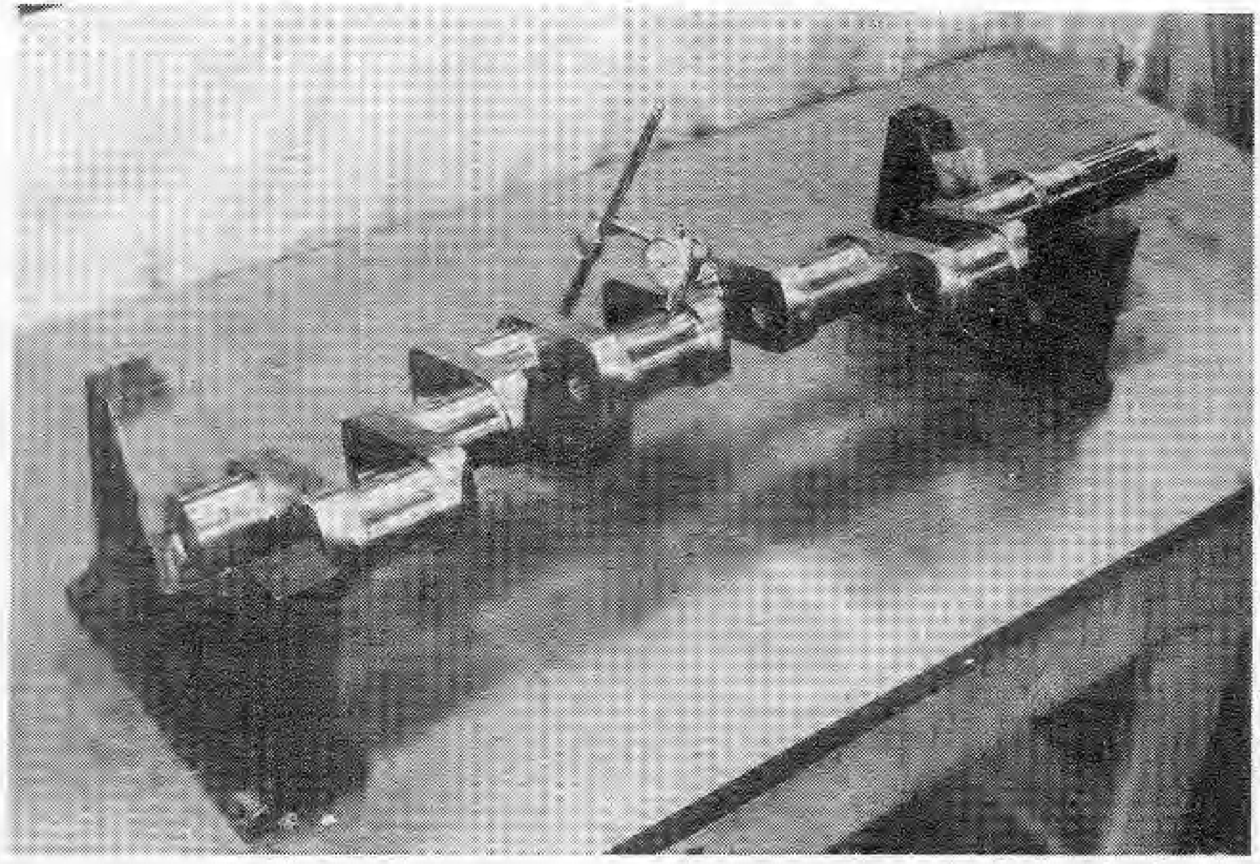


Fig. 4. Checking crankshaft for bow and parallelism
(The crankshaft illustrated is from a later type Gipsy Major engine)

journal and pin when their crankwebs are respectively parallel to, and at right-angles to, the surface table (*fig.* 4).

(3) Examine the tapered forward end of the crankshaft for wear, cracks, and corrosion, paying particular attention to the area around the keyways as this is the most likely area in which cracks appear. In the absence of the magnaflux test equipment described in Chapter 22, examination of the crankshaft may be carried out with the aid of a suitable magnifying glass, or the area around the key-way may be etched using a 5 per cent aqueous solution of nitric acid; if the latter method is employed, the etched areas must be thoroughly washed off with plain water after the operation. Carefully examine the threads at the forward tip of the shaft.

(4) If the first timing gear is still in position on the crankshaft, this also must be examined carefully for signs of wear, corrosion, etc. If the gear has been removed, inspect the female splines in the rearmost journal of the crankshaft.

(5) Check the oil-seal discs for distortion and cracks, particularly the faces which abut the copper sealing washers. Any irregularity will be a cause for replacement.

(6) Examine the oil seal bolts for elongation and damaged threads.

(7) Where applicable, visually inspect the starter extension shaft for general condition; the shaft should have been tested for cracks by the magnetic crack detection method as described in Chapter 22.

Connecting-rods

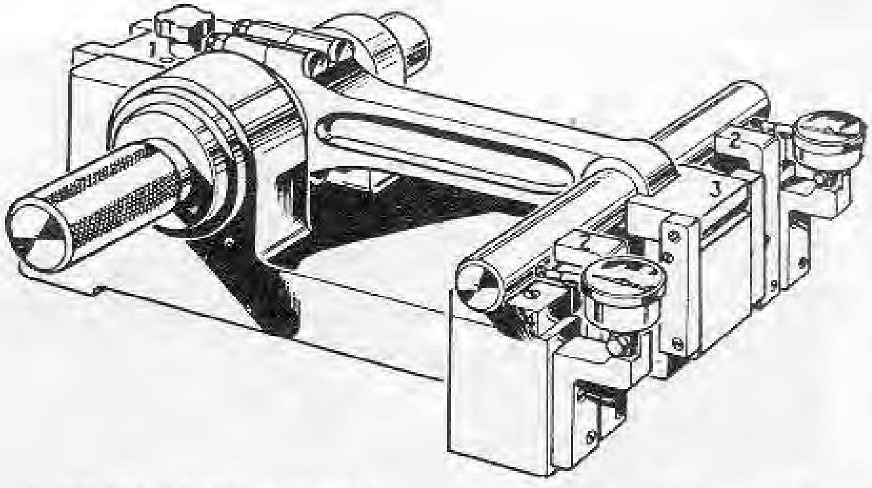
18. Inspect the rods and big-end caps for cracks and other surface defects by the hot oil and chalk method detailed in Chapter 22, page 229, the Hoyt type big-end bearings should be inspected as described under the main bearings in para. 15.

(1) Fit the connecting-rod shells and caps and tighten to the correct torque. Check the internal diameter of the big-end bearing bores using the setting ring T85890 and a Mercer gauge: refer to Repair drawing R-1 if crankpins have been re-ground.

(2) Check the small-end bores using the plug gauge T85896.

(3) Check the big and small-end bores for ovality and running marks; light running marks in the small-end bore may be polished out.

(4) Check the rod for parallelism and twist in the checking fixture T85970 (*fig.* 5) as follows. Turn the big-end positioning piece so that the appropriate end—according to whether the connecting rod is being checked with, or without, its big-end bearing shells—is towards the body of the fixture. Locate the small-end mandrel against the setting pieces and set both dial indicators to zero. Place the big-end between the main lugs of the fixture and locate with the mandrel. Swing the small-end eye into position and support with the small-end mandrel. Swing over the small-end positioning piece and check the lateral alignment by inserting feelers on either side of the small end. Note the dial readings to ascertain parallelism, and check against the figures given in the Schedule of Fits and Clearances. Twist will be indicated by the small-end mandrel making contact with one of the alignment pads only, and may be measured with feelers. If this fixture is not available the following method should be adopted. Assemble a mandrel in the big-end, mount the rod on V-blocks and test for parallelism to the surface table. Insert a mandrel in the gudgeon-pin bearing and rotate until the rod is vertical, allowing the small-end of the rod to rest against a support as shown in fig. 6. Take a dial reading and then, without disturbing the indicator setting, repeat the operation at approximately the same point on the opposite side of the rod. Note the two readings and the exact position where they were taken. If the readings agree the rod is parallel, i.e. the distance between the extremities of the axes of the big-end and small-end are equal. If the readings do not agree, calculate the amount of difference per inch length of mandrel which is the error due to lack of parallelism; check with the Schedule of Fits and Clearances whether the rod is within the permissible tolerance.



1 BIG-END POSITIONING PIECE
2 SETTING PIECE
3 SMALL-END POSITIONING PIECE
4 ALIGNMENT PAD

Fig. 5. Checking connecting-rod for parallelism and twist

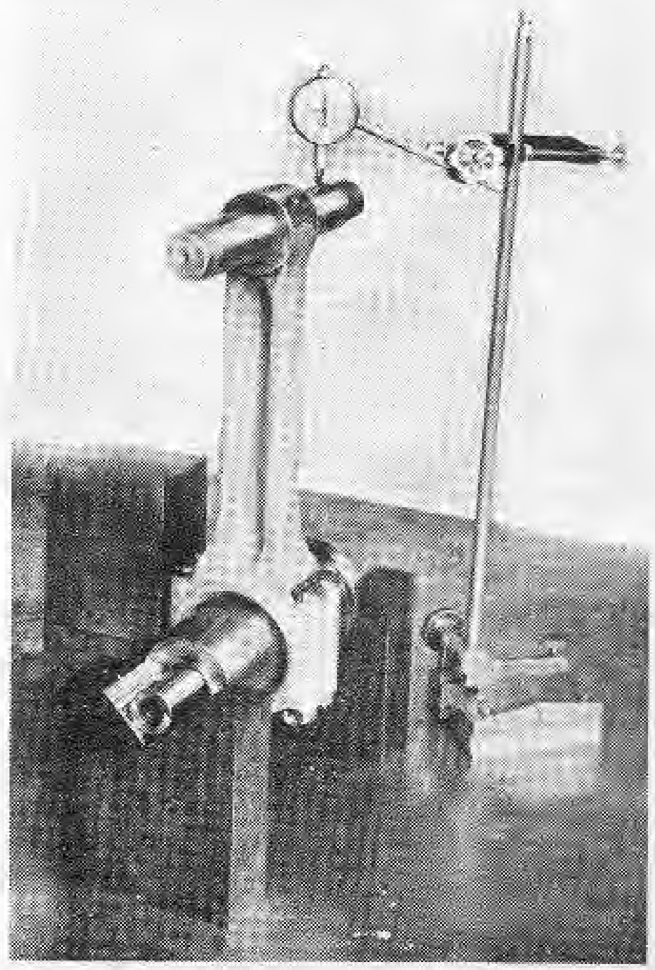


Fig. 6. Checking connecting-rod for parallelism and twist on V-blocks

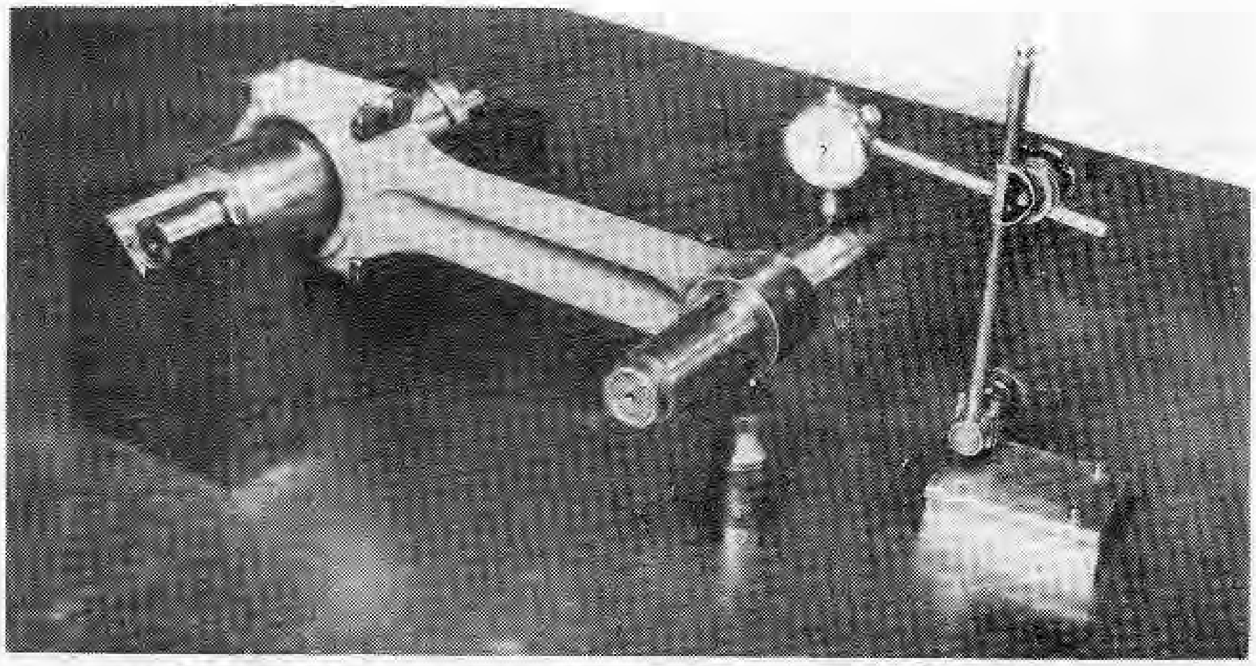


Fig. 7. Checking connecting-rod for parallelism and twist on V-blocks

(5) Rotate the rod until it is in a horizontal position (*fig.* 7) approximately parallel to the table; support the small-end and check the rod for twist. Take dial readings at either end of the mandrel, make a note of the readings obtained per inch length of mandrel, the difference in the readings denotes the amount of twist present in the rod. Check that any discrepancy thus shown is within the permissible limits.

(6) Check the connecting-rod bolts for elongation, and the bolts and nuts for general condition of threads and hexagons.

Gudgeon-pins

19. Inspect for longitudinal fractures and cracks, paying particular attention to the areas around the circlip grooves and slots, and the inside of the taper.

(1) Inspect generally for wear, scores and signs of overheating; slight running marks can be eased by polishing with superfine emery cloth.

(2) Check the pins for size and ovality, and ensure that they are a good sliding fit in the small-end of the connecting-rod.

Pistons and piston-rings

20. Inspect the pistons generally for blemishes and scores; slight marks on the skirt can be eased by careful use of a superfine file.

(1) Inspect all oil holes for cleanliness, examine for flaws in the vicinity of the holes.

(2) Examine the gudgeon-pin bores for wear, paying particular attention to the adjacent surface of the piston. Check the bores using the plug gauge T85902.

(3) Check with a micrometer the diameter of the piston skirt and lands.

(4) Examine all ring grooves for wear, check the scraper ring grooves with the slip gauge T85904, and the two compression ring grooves with the slip gauge T85903.

(5) Normally all piston rings will be renewed, but if this is not practical, inspect the ring faces for signs of blowing and scuffing.

(6) Measure the width of the rings with a micrometer, and the side clearance of each ring in its groove, and the ring gap with feeler gauges, to ensure that they are within the limits laid down in the Schedule of Fits and Clearances.

Cylinders

21. Examine the cylinder wall for wear, corrosion, signs of overheating, pitting and scoring, which if not too deep may be blended out by polishing, provided that the cleaned up dimensions of the bore remain within the permissible limits, otherwise the barrel must be rejected, and the worn barrel submitted for reconditioning.

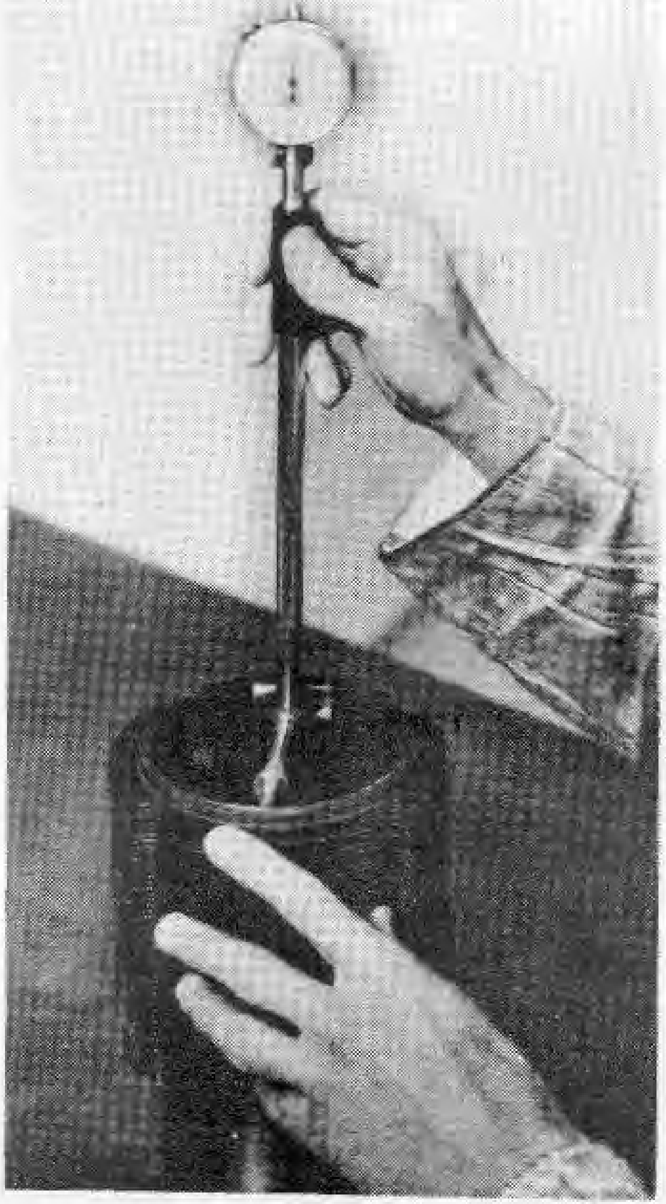


Fig. 8. Checking cylinder barrel for wear

22. When checking cylinder barrels for wear and ovality by use of a Mercer gauge and the appropriate setting ring (*fig.* 8), readings should be taken in line with the crankshaft and at right-angles to it, at the top, centre and bottom of the piston travel.

Cylinder head assembly

23. Before cleaning the cylinder head, examine the valve seats for indications of burning and looseness, especially where general conditions show that the head has been subjected to high temperatures. Should definite signs of looseness or leakage be visible, an oversize seat must be fitted. After the preliminary examination, remove all burnt oil, carbon and other foreign matter both from the inside and outside of the head. Further inspection should then be made as follows:—

(1) Examine all valve seats for uneven wear, ridges, pitting, surface cracks, and burning. Pitting or burning of the valve seats or faces should be ground off and the valves subsequently re-lapped. Check both the inlet and exhaust valve seats with the appropriate plug gauges.

(2) Check the security of the sparking plug adapters in the leads; indications of looseness will necessitate oversize replacements being fitted. Inspect the threads of the adapter for wear and stripping.

(3) Inspect the valve guides for wear, signs of scoring and cracks, and check the inlet and exhaust guides with the plug gauge, ensuring that the guide-ends are free from burrs that could cause misreading; the plug gauge T85190 should be used for both the inlet and the exhaust guide; the guides should not be removed from the heads unless they are faulty.

(4) Examine the valve stems for discolouration, distortion, corrosion and scores, and the valve faces for ridges, pitting, heating, surface cracks, and bright or discontinuous markings indicating distortion. Smooth over any roughness with superfine emery cloth. The valve face should be checked for distortion, using a dial test indicator and securing the valve stem in a lathe chuck or bench grinder chuck.

(5) Check the diameter of the valve stems for wear and check for clearance in the valve guides.

(6) Examine the valve springs for "draw" marks, distortion, excessive or uneven butting between coils, broken ends, wear from contact with other parts, and surface defects such as corrosion. Any of these defects must involve rejection of the spring.

(7) Using the fixture T85947 check the valve spring for length and load to the figures given in the Schedule of Fits and Clearances. A spring must be rejected if found to have a permanent set, or to bulge out on one side when under test, as this indicates that it is below the desired strength.

(8) Examine the valve rockers paying particular attention to the area in contact with the top of the valve stem; slight wear can be stoned into a smooth contour, but care must be taken to keep the face square with the end of the valve

stem. Inspect the adjustable cup end for looseness, corrosion and wear. Check that the rocker bush is firm in its bore.

(9) Examine the rocker brackets for excessive wear, corrosion, cracks, traces of pitting, and security on the head. Check the fit of the fulcrum bushes in their respective rockers.

(10) Check the cylinder head fins for cracks and flaws; if the area of broken fin does not exceed 2 sq. in. the head may be considered serviceable, and the broken edge should be cleaned up. A head on which the broken fin exceeds the given figure must be scrapped.

(11) Examine the rocker covers for general condition.

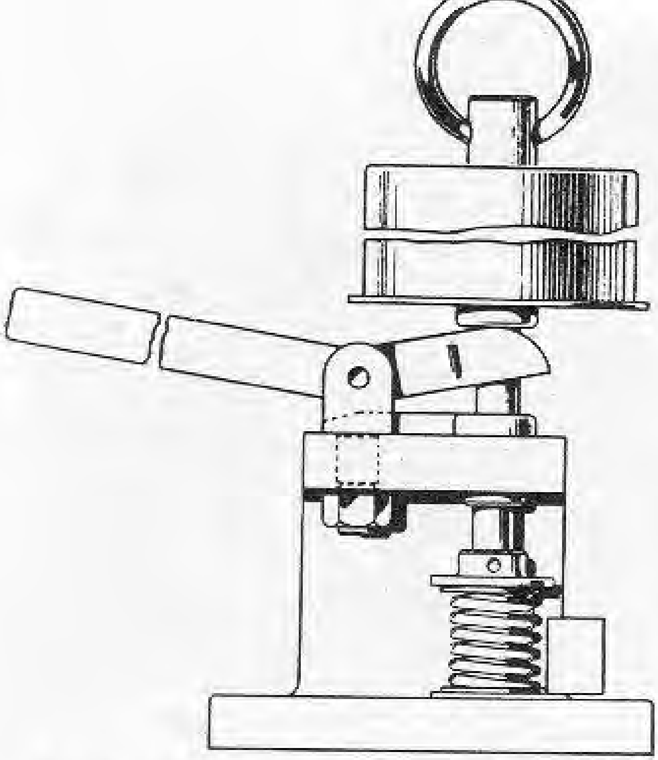


Fig. 9. Checking valve spring for length and load

Camshaft

24. Examine the camshaft for cracks paying particular attention to the areas adjacent to

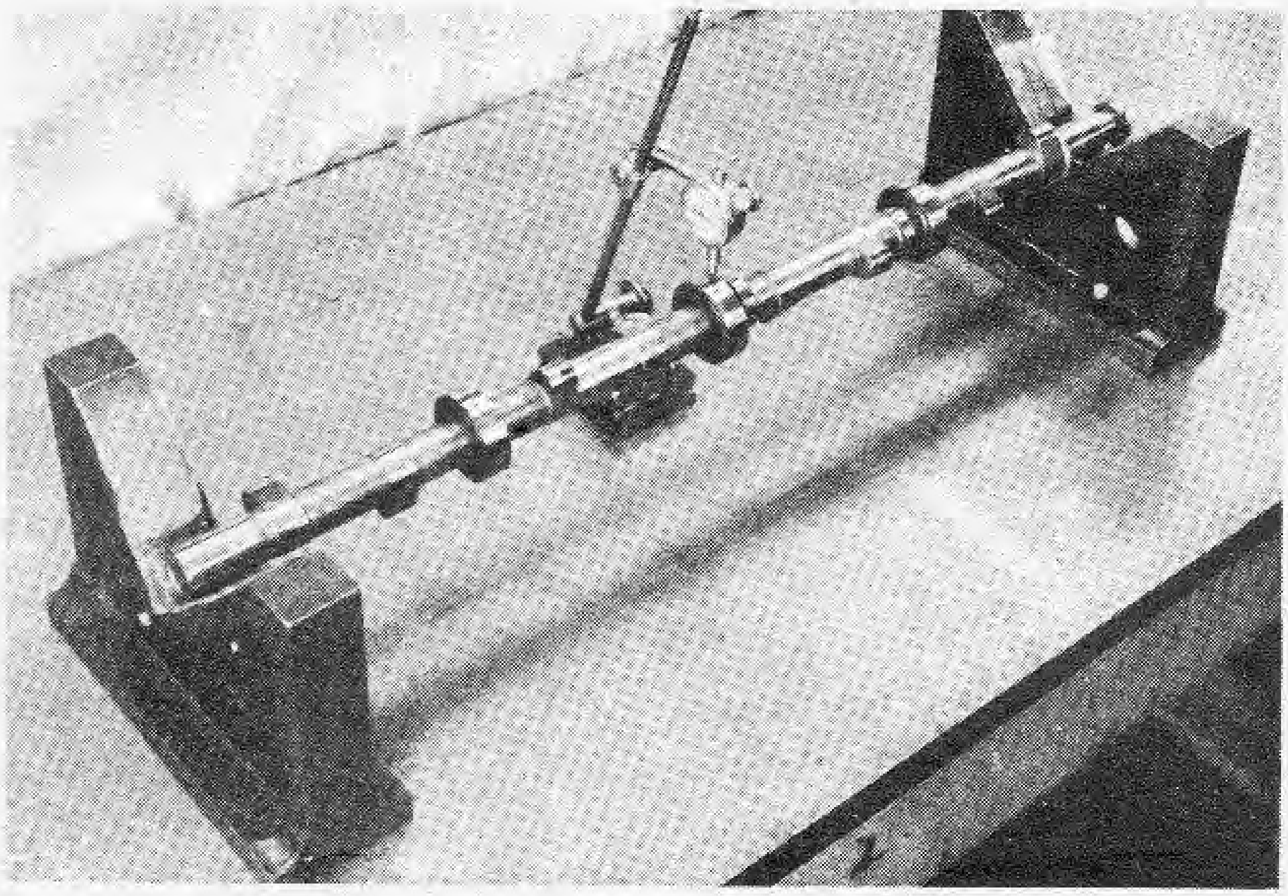


Fig. 10. Checking camshaft for alignment errors due to bowing

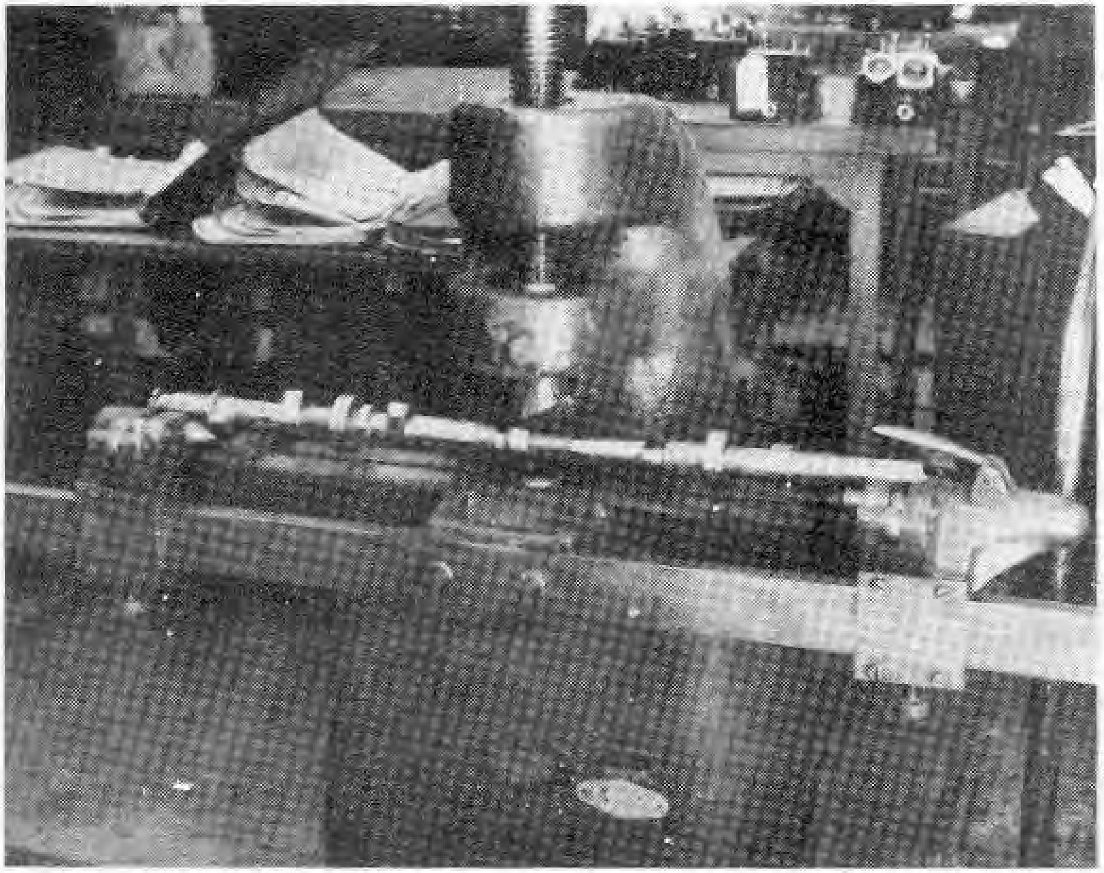


Fig. 11. Straightening a bowed camshaft

the cams. Any roughness noted on the camshaft when making the following checks should be smoothed over with a fine stone:—

(1) Check the diameter of the journals for ovality and size.

(2) Examine the journals for discolouration, wear, pitting, and scoring.

(3) Inspect the cams for wear and pitting. If the cams are badly worn the shaft should be rejected.

(4) Test the camshaft for alignment errors due to bowing. Mount the shaft on a pair of V-blocks placed under the end journals, and check these journals to ensure that their axes are parallel to the table. Rotate the shaft and take dial readings at each end of the centre journal. The direction of any high points on the journals should be marked with an indelible pencil. Reposition the V-blocks under No. 2 and 3 intermediate journals, and take readings on the end journals, marking any high spots as before. If the results of these tests show that the camshaft is outside the permissible limits, it must be rejected; if, however, it is within the limits it can be straightened in an ordinary fly press (*fig.* 11).

(5) Inspect the key way at the end of the shaft for cracks.

Tappets

25. To inspect the tappets carry out the following operations:—

(1) Inspect for corrosion, score or damage marks, and excessive wear in the cup end or tappet head. Stone any roughness present on the heel of the tappet until a smooth contour is obtained.

(2) Examine the tappet guides for cracks and any obvious damage marks; the faces of the guide slot are the most usual place in which excessive wear and score marks may be found.

(3) Dimensionally check each tappet and guide, and test for smooth operation. Using the plug gauge T85923, and the slip gauge T85924, check the tappet guide bores and the tappet guide slots respectively.

Push rods

26. Check the cup and ball-ends for security in the rods, and the push rod stems for longitudinal cracks and corrosion. Check the rods for alignment by rolling them on a flat surface.

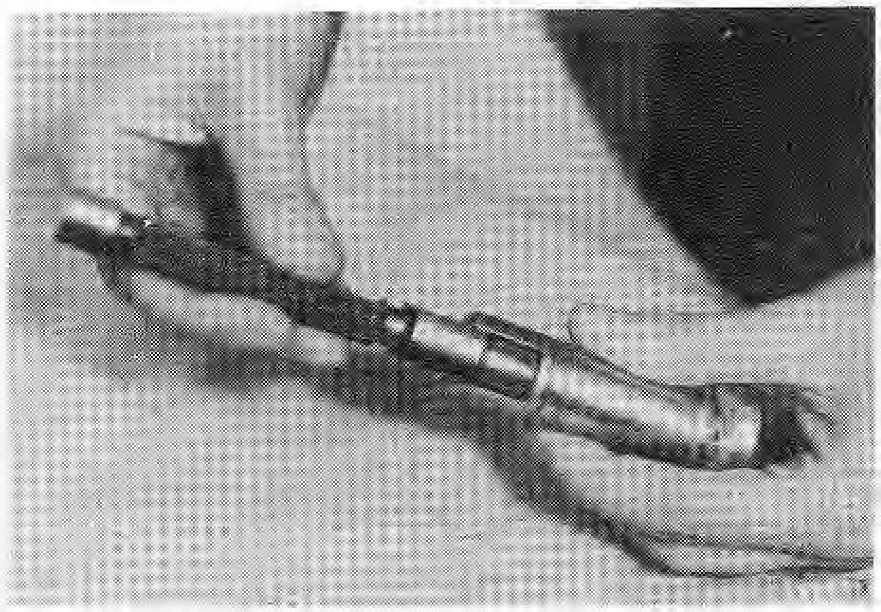


Fig. 12. Checking the tappet guide bore with plug gauge

27. Inspect the push rod covers for cracks and dents; unless the dents are deep the cover can be considered serviceable.

Oil pump

28. The inspection of the oil pump should be made as follows: —

(1) Inspect the casing for cracks, especially in the vicinity of stud and bolt holes; brush any suspected area with a thin mixture of methylated spirit and French chalk.

(2) Inspect studs for looseness, and all bolts, nuts, and studs for condition of visible threads.

(3) Inspect the gears with a powerful magnifying glass for signs of wear; any score marks and blemishes, if not severe, should be stoned out.

(4) Inspect the gear spindles for wear, particularly the surfaces that run in the bushes.

(5) Inspect all bushes and journals for ovality and wear, and for signs of scoring. Check the driving and driven spindle bushes with the plug gauge T85995.

(6) Where applicable, inspect the dividing plates for scoring which if only slight may be cleaned up.

(7) Check the radial clearance between the gear wheels and the walls of the casing, using the plug gauge T85972 and narrow feeler gauges.

(8) Visually inspect the pressure relief valve and its seating in the pump casing for damage, and check the relief valve spring in a similar manner to that given for the valve spring in para. 22, sub-para. (6).

(9) Inspect the keyway on the tapered end of the oil pump driving shaft for cracks, and the extreme end of the shaft for damage to the threads.

Gears and shafts

29. Inspect the hub and teeth of all gear wheels for cracks and wear at the contact faces. Wear will be shown by a hard bearing line on the pitch circle, or a rough surface on the tooth. Slight wear on the surface of the teeth should be eased by careful stoning. Check the wheels for distortion by placing them on a suitable mandrel, mounting the assembly on a pair of V-blocks, and using a dial test indicator in contact with the side of the wheel.

30. Check all spindles and shafts dimensionally and for any obvious damage marks. Compound gears separated during dismantling should be examined for elongation of the bolt holes, or wear in the keyways as applicable, check the keys for stepping. Using the plug gauge T85960, check the camshaft idler gear bush bore.

Propeller boss

31. Examine the propeller boss assembly generally for wear, corrosion, and cracks, paying particular attention to the condition of the various threads throughout the assembly.

Crankshaft thrust bearing assembly

32. Examine the various components of the crankshaft thrust bearing assembly for general condition, paying particular attention to the condition of the bearing housing, in addition the actual thrust bearing should be inspected in accordance with current procedure; see also paras. 4 and 16 of this chapter.

Filters

33. Examine the front and rear scavenge filters, where applicable, and the suction filter for damage to the gauze and general condition; slight breaks in the gauze may be soldered. The Auto Klean pressure filter should be carefully examined for general condition and any obvious signs of damage.

34. Inspect the filter casings for cracks and all studs for looseness, also examine the bolts, nuts, and studs for the condition of the visible threads.

Rigid oil and fuel pipes

35. Check all pipes for obstruction and inspect them for damage; dents should be restored to the proper contour where this will not reduce the wall thickness of the pipe. Examine the threads and conical seatings of all unions. Generally examine each pipe in accordance with current approved procedure.

Flexible pipe

36. The fuel pump flexible pipe should be given a careful inspection for surface damage, fractures and frayed and distorted outer casings. Examine the union nuts for thread, spanner flat and locking hole condition. The instructions for pressure testing flexible pipes issued by the pipe manufacturers should be closely followed.

Induction manifold assembly

37. Make a careful visual inspection paying particular attention to the welding at the junction of flanges and pipes. Test the flanges for alignment on a surface plate; it should not be possible to insert a 0·005 in. feeler gauge between any one of the flanges and the plate; a certain amount of rectification can be done by filing. The manifold should then be given a pressure test; the following operations give a method of doing this:—

(1) Blank off the four flanged openings on the manifold with steel plates and sheet rubber jointings; with suitable plugs blank off the drains, primer connections, and the induction manifold heater muff inlet and outlet connections. Short lengths of tubing can be used for banjo pillars.

(2) Provide an air connection by fitting a standard tyre valve in one of the blanking plates.

(3) Apply an air pressure of about 25 to 30 lb. per sq. in. and submerge the manifold in water heated to about 80 or 90 deg. C. The heat expanding the metal will cause any minute cracks to open slightly and reveal their position by bubbles of escaping air.

(4) Repair any cracks by welding and repeat the pressure test.

Main control unit assembly

38. Inspect the control rods generally for condition of threads, distortion, cracks and any obvious damage. Examine all the ball joints in the lever arms for tightness and wear, check the ball-ends for wear, and also visually examine the condition of the springs. In addition to these general checks the following inspections must be performed:—

(1) With the plug gauge T86235 check that the diameter of the bores in the control bracket bushes is within the limits.

(2) Using a micrometer check that the diameter of the cross-shaft is within the limits.

Airscoop and cylinder baffles

39. Examine the airscoop and cylinder baffles carefully for cracks, corrosion, dents and any other serious damage marks.

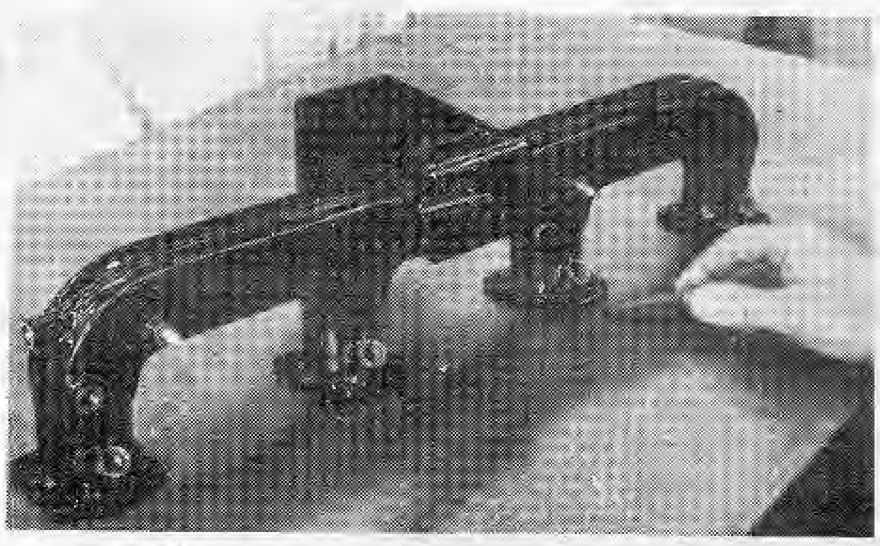


Fig. 13. Checking induction manifold flanges for alignment on surface plate

Flame trap assembly

40. Inspect the flame trap assembly generally for cracks, paying particular attention to the mating faces. Visually examine the flame trap valve and element; any serious signs of damage will necessitate replacement of the assembly.

Hardness testing

41. Where components are suspected of being subjected to overheating during running a hardness check must be made to establish their serviceability. The two classes of steel components considered in these notes are case-hardened components, and heat-treated nickel-chromium steel.

42. Table 1 contains a short list of typical case-hardened components and the corresponding minimum specification hardness numbers. As the temperature limitation beyond which the hardness is affected is 150 deg. C. for these components, the case-hardness of a component showing any temperature discolouration other than oil staining must be checked. Components showing signs of wear should also be checked. Oil carbonisation stains can be distinguished from temper discolouration by their uniformity, compared with the gradient effect of the latter.

43. It is unlikely that a hardness test will be required on many heat-treated nickel-chromium steel components, as temperatures which would soften these components would also produce other manifestations of unserviceability such as distortion. However, Table 2, which contains a short list of typical heat-treated nickel-steel components and their corresponding minimum specification hardness numbers, will provide a guide should there be any doubt concerning the serviceability of a component made of these materials. As the temperature limitation of air-hardening steel such as S.28 is 200 deg. C., any air-hardened component which shows signs of temperature discolouration must be checked for hardness.

44. It is recommended that the hardness of parts should be checked on a Vickers' machine with a load 30 kg. A drop of 5 per cent in the V.P.N. hardness figure below the bottom limit of the drawing or specification can normally be tolerated.

45. If any doubt exists, steps should be taken to ascertain the specification of a component.

TABLE 1

Component	Material	Minimum specification Hardness figure V.P.N.
Gudgeon-pin	S.90	700
Generator drive driving gear	S.15	700
Vacuum pump drive driving gear	S.15	700
Generator idler gear	S.15	700
Camshaft	S.14	700
Tappet	S.14	700
Generator pinion	S.15	700
Magneto driven gear	S.14	700
Magneto driving gear	S.14	700
Magneto idler gear	S.15	700

TABLE 2

Component	Material	Minimum specification Hardness figure V.P.N.
Crankshaft	S.11	275
Oil pump driven gear	S.11	275
Oil pump auxiliary gears	S.11	275
Tachometer intermediate gear	S.11	275
Tachometer driving gear	S.11	275
Tachometer driving pinion	S.11	275

TABLE 2 (*continued*)

Component	Material	Minimum specification Hardness figure V.P.N.
Tachometer driven shaft	S.11	275
Tachometer driving shaft	S.28	460
Tachometer driven gear adapter	S.28	460
Oil pump driving gear	S.28	460
Camshaft gear	S.28	460
Generator driving shaft	S.28	460
Starter gear	S.28	460
Starter extension shaft	S.28	460
Vacuum pump bevel pinion	S.28	460

LIST OF TOOLS

46. The following tools are required for the viewing of detail parts:—

Description	Part No.
Crankcase gauges	—
Front and rear camshaft bearings plug gauge	T.85921
Camshaft intermediate bearing plug gauge	T.85922
Tappet guide bores plug gauge	T.85923
Tappet guide slot slip gauge	T.85924
Main bearing alignment mandrel for standard bores (Mk. 1 variants and Mk. 7)	T.1900–78
Main bearing alignment mandrel 0·005 in. undersize bores (use with 1st undersize replacement bearings)	T.1900–313
Main bearing alignment mandrel 0·010 in. undersize bores (use with 2nd undersize replacement bearings)	T.1900–314
Main bearing alignment mandrel 0·015 in. undersize bores (use with 3rd undersize replacement bearings)	T.1900–315
Main bearing alignment mandrel 0·020 in. undersize bores (use with 4th undersize replacement bearings)	T.1900–316
Main bearing bores setting ring standard (Mk. 1 variants and Mk. 7)	T.85890
Main bearing bores setting ring 0·005 in. undersize	T.85930
Main bearing bores setting ring 0·010 in. undersize	T.85931
Main bearing bores setting ring 0·015 in. undersize	T.85932
Main bearing bores setting ring 0·020 in. undersize	T.85933
Timing gear and accessory drives gauges	—
Tachometer drive bushes plug gauge	T.85957
Tachometer bush flanges length gauge	T.85985
Tachometer adapter bore plug gauge	T.85959
Camshaft idler gear bush bore plug gauge	T.85960
Vacuum pump drive bevel gear housing bore plug gauge	T.85961
Generator drive shaft splines concentricity gauge	T.85891
Generator drive gear and idler bushes plug gauge	T.85992
Generator drive bush length gauge	T.85984
Bevel pinion housing plug gauge	T.85993
Connecting-rod gauges	—
Small-end bore plug gauge	T.85896
Connecting-rod alignment and twist fixture	T.85970
Setting ring big-end bearing bores	T.85890
Mercer gauge	Standard
Piston gauges	—
Gudgeon-pin boss bore plug gauge	T.85902
Compression ring grooves slip gauge	T.85903
Scraper ring groove	T.85904
Feeler gauge set, 0·0015 in. to 0·025 in. checking ring gap	—

LIST OF TOOLS *(continued)*

Description	Part No.
Cylinder gauges	—
Setting ring standard bore	T.85889
Setting ring 1st oversize	T.85830
Setting ring 2nd oversize	T.85831
Mercer cylinder bore gauge	Standard
Cylinder head gauges	—
Inlet valve guide bore plug gauge	T.85190
Exhaust valve guide bore plug gauge	T.85897
Valve spring length and load fixture	T.85947
Valve spring length gauge	T.85940
Outer valve spring weight testing	T.85942
Inner valve spring weight testing	T.85943
Inlet valve seat gauge, standard seat	T.85963
Inlet valve seat gauge, 1st replacement	T.85964
Exhaust valve seat gauge, standard seat	T.85965
Exhaust valve seat gauge, 1st replacement	T.85966
Driving and driven spindle bushes plug gauge	T.85995
Pump casing pockets plug gauge	T.85972
General gauges	—
Mercer bore gauge 50 mm. to 300 mm.	Standard
Micrometer 0–25 mm.	Standard
Micrometer 25–50 mm.	Standard
Micrometer 50–75 mm.	Standard
Micrometer 75–100 mm.	Standard
Feeler gauge 0·001½ in. to 0·025 in.	Standard
Universal dial indicator gauge	Standard

Chapter 24

TESTING

LIST OF CONTENTS

Note.— The above tables are repeated, with the exception of B, for the respective engine Marks and are entitled accordingly

TABLE A

GIPSY MAJOR Mk. I, IC, and IF ENGINES RUNNING CONDITIONS AND ACCEPTANCE LIMITATIONS MAXIMUM OPERATING CONDITIONS

Condition	r.p.m.	Boost lb. per sq. in.	Oil inlet temp. deg. C.	Cyl. head temp. deg. C. Mk. I	Mk. IC	Mk. IF
Maximum with weak mixture	2,100	—	70	210	210	210
Maximum continuous	2,100	—	70	250	210	230
Maximum intermediate (60 minutes limit)	2,100	Full throttle	80	270	230	230
Maximum take-off (5 minutes limit)	2,100	Full throttle	80 (maximum) 15 (minimum)	270	230	230
Maximum emergency	2,350 2,400 (Mk. 1C)	Full throttle	90	240	240	240

Note . . .

With a fixed pitch test fan the throttle lever can be used only to select either r.p.m. or boost, but cannot control both simultaneously. All test running, therefore, will be to values either of r.p.m. or of manifold pressure. Because of this the boost pressures quoted in this chapter for specific engine speeds must be regarded only as examples; the actual values will depend upon the conditions prevailing at the time of test.

FUEL

Mk. I ... ... *Mk. IC* ... ... *Mk. IF*	*See page 6, for permissible minimum grade and maximum lead content.*
Pressure at carburettor	*1·5 to 2·5 lb. per sq. in.*

OIL

Type		*Specification D.Eng.R.D.2472 A/O or B/O, see page 7 for list of approved oils.*
Pressure ...	*Normal*	*40 to 45 lb. per sq. in. at 2,100 r.p.m. with an inlet temperature of 70 ± 2 deg. C.*
	Minimum at slow-running	*20 lb. per sq. in. with an inlet temperature of 65 deg. C.*

Note . . . *The emergency minimum oil pressure below which the engine must not be run at other than slow-running speed is 30 lb. per sq. in.*

Consumption	
Mk. I and IF	*To be within the limits 1 to 2½ pints per hour at 2,100 r.p.m. with an inlet temperature of 70 deg. C.*
Mk. IC	*To be within the limits 1½ to 3 pints per hour at 2,100 r.p.m. with an inlet temperature of 70 deg. C.*
Circulation	*To be within the limits 50 to 75 gallons per hour at 2,100 r.p.m. with an inlet temperature of 70 deg. C.*

TABLE A (cont.)

IGNITION

Sparking plugs	*Screened ignition, KLG. RV12/3 or RC50R, or Lodge RS50R or RS50/1R. Unscreened ignition, KLG. V12/2 or Lodge A55-4 or S50/1.*
Drop on single ignition	*Not to exceed 105 r.p.m.*

R.P.M.

Note . . . *The observed r.p.m. obtained during power performance check test and during full throttle run of final test, when corrected for atmospheric temperature by standard methods must not be less than 98 per cent of the standard r.p.m. established for the particular test fan being used.*

TABLE B

TEST OBSERVATION CODE (FOR ALL MARKS)

Ref. No.	Observation	Standard Units
1	Crankshaft rotational speed	R.P.M.
2	Induction manifold pressure (absolute)	Inches of mercury
3	Main oil pressure	lb. per sq. in.
6	Fuel pressure at inlet to carburettor	lb. per sq. in.
11	Oil inlet temperature	Degrees centigrade
12	Oil outlet temperature	Degrees centigrade
15	Cylinder head temperature	Degrees centigrade
16	Cooling air temperature (in front of engine)	Degrees centigrade
17	Cooling air speed (pressure difference)	Miles per hour or inches of water
20	Oil circulation rate	Gallons per min.
21	Oil consumption	Pints per hour
22	Fuel consumption	Pints per hour
23	Air intake temperature	Degrees centigrade
26	Test house barometer	Inches of mercury
28	Temperature of air passing test fan	Degrees centigrade

SUMMARY OF TESTS

This summary is provided as a quick reference *and should be used only after the complete chapter has been read and understood*, otherwise important details of the requirements of individual tests may be overlooked. Reference must be made to the Running Conditions and Acceptance Limitations (Table A), and also to the Test Observation Code (Table B) which is the key to the code used in the test running procedure tables of this summary.

TABLE C

GIPSY MAJOR Mk. I, IC, and IF ENGINES

Running-in and tuning

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position. Prime engine with oil at 60 to 70 deg. C. and start-up. Run-in the engine under its own power as follows:—			
15 mins.	850	Running light	Check for leaks
15 mins.	1,500	Running light	
15 mins.	1,800	Running light	
15 mins.	1,800 increasing to 2,100	Open-up in incremental stages	
	2,100	Adjust oil pressure relief valve as necessary	3
	2,100	Tune engine to give a fuel consumption of 60-67 pints/hour.	22
Throttle back and check slow-running; adjust as necessary. Shut down engine and examine for fuel and oil leaks.			

TABLE D

GIPSY MAJOR Mk. I, IC, and IF ENGINES

Endurance test at maximum continuous r.p.m.

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position. Start engine, accelerate smoothly to 2,100 r.p.m., adjust throttle to maintain this speed and make following checks and observations:—			
Start of test	2,100	Single ignition check; drop on single ignition not to exceed 105 r.p.m.	1
	2,100	Oil inlet temperature throughout test 70 $\pm$ 3 deg. C.	1, 2, 3, 11, 12, 15, 17, 22, 23
15 mins.	2,100		2nd record of above
15 mins.	2,100		3rd record of above
15 mins.	2,100		4th record of above
15 mins.	2,100		5th record of above
15 mins.	2,100		6th record of above
15 mins.	2,100		7th record of above
15 mins.	2,100		8th record of above
15 mins.	2,100		9th record of above
During the above 2-hour run	2,100	The mean of five readings to be taken as actual flow	16, 20, 21, 26
End of test	2,100	Single ignition check; drop on single ignition not to exceed 105 r.p.m.	1
Proceed to endurance test at maximum weak-mixture manifold pressure.			

TABLE E
GIPSY MAJOR Mk. I, IC, and IF ENGINES
Endurance test at maximum weak-mixture manifold pressure

Period	Manifold pressure (absolute)	Remarks	Observations (Table B)
Mixture control in fully rich position			
	26 in. Hg.	Oil inlet temperature throughout test 70 ± 3 deg. C.	1, 2, 3, 11, 12, 15, 17, 22, 23
10 mins.	26 in. Hg.		2nd record of above
10 mins.	26 in. Hg.		3rd record of above
10 mins.	26 in. Hg.		4th record of above
Proceed to power performance check			

TABLE F
GIPSY MAJOR Mk. I, IC, and IF ENGINES
Power performance check test

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position			
5 mins.	Full throttle	When steady throttle conditions have been attained record one set of observations as indicated	1, 2, 3, 11, 16, 17, 22, 23, 26
Correct observed r.p.m. for atmospheric temperature; the corrected r.p.m. must not be less than 98 per cent of the standard r.p.m. as established on the fan calibration test. Proceed to slow-running and acceleration test.			

TABLE G
GIPSY MAJOR Mk. I, IC, and IF ENGINES
Slow-running and acceleration test

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position.			
5 mins.	550	Minimum oil pressure at slow-running 20 lb. per sq. in. with 65 deg. C. oil inlet temperature	1, 3, 11
Accelerate Decelerate	Full throttle 550	Engine to be accelerated rapidly to full throttle SIX TIMES. Time taken for each acceleration not to exceed 5 seconds	Time for each acceleration
Shut down engine; carry out three hot starts. Remove engine from test bench and pass it to strip examination.			

TABLE H
GIPSY MAJOR Mk. I, IC, and IF ENGINES
Final test (after strip examination)

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position except for mixture control range check. Prime engine with oil at 60 to 70 deg. C. Carry out three starts, one from cold.			
5 mins.	850	Running light	Check for leaks
10 mins.	850 increasing to	Open-up in incremental stages	
	2,100	Check tuning	22
	2,100	Single ignition check; drop on single ignition not to exceed 105 r.p.m. Oil inlet temperature 70 $\pm$ 3 deg. C.	1, 2, 3, 11, 12, 15, 17, 22, 23
10 mins.	2,100		2nd record of above
10 mins.	2,100		3rd record of above
10 mins.	2,100	Single ignition check; (see above)	4th record of above
During the above 30 mins.	2,100		16, 20, 21, 26
5 mins.	550	Minimum oil pressure at slow-running 20 lb. per sq. in. with 65 deg. C. oil inlet temperature	1, 3, 11
Accelerate Decelerate	Full throttle 550	Engine to be accelerated rapidly to full throttle THREE TIMES. Time taken for each acceleration not to exceed 5 seconds.	Time for each acceleration
5 mins.	Full throttle	When steady throttle conditions have been attained, record one set of observations as indicated	1, 2, 3, 11, 16, 17, 22, 23, 26
Correct observed r.p.m. for atmospheric temperature; the corrected r.p.m. must not be less than 98 per cent of the standard r.p.m. as established on the fan calibration.			
As required	2,100	Check the range of mixture control available. Percentage weakening of 27 to 30 per cent with mixture control in "To 15,000 feet" position and a minimum of 40 per cent with control in "Over 15,000 feet" should be obtained. Inject supplementary fuel into induction system to prevent excessive weakening during check	22 over mixture control range. Record mixture control movement
Shut down engine. Remove, examine, clean and reassemble all oil filters.			

TABLE J

GIPSY MAJOR Mk. I, IC, and IF ENGINES

Check run (not required if anti-corrosion run is made)

Period	r.p.m.	Remarks	Observations
Mixture control in fully rich position. Prime engine with oil at 60 to 70 deg. C. and start up.			
As required	2,000		Check for leaks at oil filters

TABLE K

GIPSY MAJOR Mk. I, IC, and IF ENGINES

Anti-corrosion run

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position. Change over fuel supply to unleaded fuel to specification D.Eng.R.D.2485 (R.A.F.Ref. 34A/135). Prime engine with oil at 60 to 70 deg. C. and start up.			
15 mins.	2,000	If entire test run has been made on unleaded fuel this run may be omitted.	Check for leaks at oil filters
Shut down engine. Remove and clean filters; allow surplus oil to drain. Reassemble filters.			
Change oil supply to storage oil to specification D.E.F.2181. Prime engine with storage oil and start up.			
10 mins.	1,500	Maintain oil temperature as low as possible. Oil outlet temperature not to exceed 60 deg. C. Initial return of storage oil will be contaminated with engine oil and must be run to waste	Check for leaks at oil filters 11, 12

Note . . .

The delay between changing from normal oil to the storage oil supply and commencing the final running must be as short as possible. On no account must the engine be left overnight between these stages.

Shut down engine.

After the engine is removed from the test bench, complete the inhibiting procedure in accordance with the instructions given in Chapter 18.

TABLE A

GIPSY MAJOR Mk. 7 ENGINE
RUNNING CONDITIONS AND ACCEPTANCE LIMITATIONS
MAXIMUM OPERATING CONDITIONS

Condition	R.p.m.	Boost lb. per sq. in.	Oil inlet temp. deg. C.	Cyl. head temp. deg. C.
Maximum with weak mixture	2,300	minus 2	85	210
Maximum continuous	2,300	minus $\frac{3}{4}$	85	210
Maximum intermediate (60 minutes limit)	2,400	Full throttle	85	230
Maximum take-off and operational necessity (5 minutes limit)	2,550	Full throttle	100 (maximum) 15 (minimum)	240

Note . . .

With a fixed pitch test fan the throttle lever can be used only to select either r.p.m. or boost, but cannot control both simultaneously. All test running, therefore, will be to values either of r.p.m. or of manifold pressure. Because of this, the boost pressures quoted in this chapter for specific engine speeds must be regarded only as examples; the actual values will depend upon the conditions prevailing at the time of test.

FUEL

Type	*See page 6, for permissible minimum grade and maximum lead content.*
Pressure at carburettor	*1·5 to 2·5 lb. per sq. in.*

OIL

Type	*Specification D.Eng.R.D.2472 A/O or B/O, see page 7 for list of approved oils.*
Pressure	
Normal	*40 to 45 lb. per sq. in. at 2,300 r.p.m. with an oil inlet temperature of 80 ± 2 deg. C.*
Minimum at slow-running	*20 lb. per sq. in. at 65 deg. C. oil inlet temperature*

Note . . . *The emergency minimum oil pressure below which the engine must not be run at other than slow-running speed is 30 lb. per sq. in.*

Consumption	*To be within the limits 1 to 3½ pints per hour at 2,300 r.p.m. with an inlet temperature of 85 deg. C.*
Circulation	*To be within the limits 90 to 130 gallons per hour at 2,300 r.p.m. with an inlet temperature of 85 deg. C.*

IGNITION

Sparking plugs	*KLG. RV12/3 or RC50R, or Lodge RS50R or RS50/1R.*
Drop on single ignition	*Not to exceed 105 r.p.m.*

R.P.M.

Note . . . *The observed r.p.m. obtained during power performance check test and during full throttle run of final test, when corrected for atmospheric temperature by standard methods must not be less than 98 per cent of the standard r.p.m. established for the particular test fan being used.*

SUMMARY OF TESTS

This summary is provided as a quick reference *and should be used only after the complete chapter has been read and understood,* otherwise important details of the requirements of individual tests may be overlooked. Reference must be made to the Running Conditions and Acceptance Limitations (Table A) and also to the Test Observation Code (Table B) which is the key to the code used in the test running procedure tables of this summary.

TABLE C
GIPSY MAJOR Mk. 7 ENGINE
Running-in and tuning

Period	r.p.m.	Remarks	Observations (Table B)
Electric starter assembled to engine. Mixture control in fully rich position. Prime engine with oil at 60 to 70 deg. C. and start up. Run-in the engine under its own power as follows:—			
15 mins.	850	Running light	Check for leaks
15 mins.	1,500	Running light	
15 mins.	1,800	Running light	
15 mins.	1,800 increasing to 2,300	Open-up in incremental stages	
	2,300	Adjust oil pressure relief valve as necessary	3
	2,300	Tune engine to give fuel consumption of 74-80 pints/hour.	22
Throttle back and check slow-running; adjust as necessary. Shut down engine and examine for fuel and oil leaks.			

TABLE D
GIPSY MAJOR Mk. 7 ENGINE
Endurance test at maximum continuous r.p.m.

Period	r.p.m.	Remarks	Observations (Table B)
Electric starter assembled to engine. Mixture control in fully rich position. Start engine, accelerate smoothly to 2,300 r.p.m., adjust throttle to maintain this speed and make following checks and observations.			
Start of test	2,300	Single ignition check; drop on single ignition not to exceed 115 r.p.m.	1
	2,300	Oil inlet temperature throughout test 85 $\pm$ 3 deg. C.	1, 2, 3, 11, 12, 15, 17, 22, 23
15 mins.	2,300		2nd record of above
15 mins.	2,300		3rd record of above
15 mins.	2,300		4th record of above
15 mins.	2,300		5th record of above
15 mins.	2,300		6th record of above
15 mins.	2,300		7th record of above
15 mins.	2,300		8th record of above
15 mins.	2,300		9th record of above
During the above 2-hour run	2,300	The mean of five readings to be taken as actual oil flow	16, 20, 21, 26
End of test	2,300	Single ignition check; drop on single ignition not to exceed 115 r.p.m.	1
Proceed to endurance test at maximum weak-mixture manifold pressure			

TABLE E
GIPSY MAJOR Mk. 7 ENGINE
Endurance test at maximum weak-mixture manifold pressure

Period	Manifold pressure (absolute)	Remarks	Observations (Table B)
Mixture control in fully rich position.			
	26 in. Hg.	Oil inlet temperature throughout test 85 ± 3 deg. C.	1, 2, 3, 11, 12, 15, 17, 22, 23
10 mins.	26 in. Hg.		2nd record of above
10 mins.	26 in. Hg.		3rd record of above
10 mins.	26 in. Hg.		4th record of above
Proceed to power performance check			

TABLE F
GIPSY MAJOR Mk. 7 ENGINE
Power performance check test

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position.			
5 mins.	Full throttle	When steady throttle conditions have been attained, record one set of observations as indicated	1, 2, 3, 11, 16, 17, 22, 23, 26

Correct observed r.p.m. for atmospheric temperature; the corrected r.p.m. must not be less than 98 per cent of the standard r.p.m. as established on the fan calibration test. Proceed to slow-running and acceleration test.

TABLE G
GIPSY MAJOR Mk. 7 ENGINE
Slow-running and acceleration test

Period	r.p.m.	Remarks	Observations (Table B)
Mixture control in fully rich position.			
5 mins	550	Minimum oil pressure at slow-running 20 lb. per sq. in. with 65 deg. C. oil inlet temperature	1, 3, 11
Accelerate Decelerate	Full throttle 550	Engine to be accelerated rapidly to full throttle SIX TIMES. Time taken for each acceleration not to exceed 5 seconds	Time for each acceleration

Shut down engine. Carry out three starts by means of the electric starter while the engine is still hot. Shut down engine, remove it from test bench and pass it to strip examination.

TABLE H
GIPSY MAJOR Mk. 7 ENGINE
Final test (after strip examination)

Period	r.p.m.	Remarks	Observations (Table B)
Electric starter assembled to engine. Mixture control in fully rich position except for mixture control range check. Prime the engine with oil at 60 to 70 deg. C. Carry out three starts, one from cold.			
5 mins.	850	Running light	Check for leaks
10 mins.	850 increasing to 2,300	Open-up in incremental stages. Check tuning	22
	2,300	Single ignition check; drop on single ignition not to exceed 115 r.p.m. Oil inlet temperature 85 ± 3 deg. C.	1, 2, 3, 11, 12, 15, 17, 22, 23
10 mins.	2,300		2nd record of above
10 mins.	2,300		3rd record of above
10 mins.	2,300	Single ignition check; (see above)	4th record of above
During the above 30 mins.	2,300		16, 20, 21, 26
5 mins.	550	Minimum oil pressure at slow-running 20 lb. per sq. in. with 65 deg. C. oil inlet temperature	1, 3, 11
Accelerate Decelerate	Full throttle 550	Engine to be accelerated rapidly to full throttle THREE TIMES Time taken for each acceleration not to exceed 5 seconds.	Time for each acceleration
5 mins.	Full throttle	When steady throttle conditions have been attained, record one set of observations as indicated	1, 2, 3, 11, 16, 17, 22, 23, 26
Correct observed r.p.m. for atmospheric temperature; the corrected r.p.m. must not be less than 98 per cent of the standard r.p.m. as established on the fan calibration.			
As required	2,400	Check the range of mixture control available. Percentage weakening of 27 to 30 per cent should be obtained. Inject supplementary fuel into induction system to prevent excessive weakening	22 over mixture control range
Shut down engine. Remove, examine, clean and reassemble all oil filters.			

TABLE J

GIPSY MAJOR Mk. 7 ENGINE

Check run (not required if anti-corrosion run is made)

Period	r.p.m.	Remarks	Observations
Electric starter assembled to engine. Mixture control in fully rich position. Prime engine with oil at 60 to 70 deg. C. and start up.			
As required	2,000		Check for leaks at oil filters

TABLE K

GIPSY MAJOR Mk. 7 ENGINE

Anti-corrosion run

Period	r.p.m.	Remarks	Observations (Table B)
Electric starter assembled to engine. Mixture control in fully rich position. Change over fuel supply to unleaded fuel to specification D.Eng.R.D.2485 (R.A.F. Ref. 34A/135). Prime the engine with oil at 60 to 70 deg. C. and start up.			
15 mins.	2,000	If entire test run has been made on unleaded fuel this run may be omitted	Check for leaks at oil filters
Shut down engine. Remove and clean oil filters; allow surplus oil to drain. Reassemble filters. Change oil supply to storage oil to specification D.E.F.2181. Prime engine with storage oil and start up.			
10 mins.	1,500	Maintain oil temperature as low as possible. Oil outlet temperature not to exceed 60 deg. C. Initial return of storage oil will be contaminated with engine oil and must be run to waste	Check for leaks at oil filters 11, 12

Note . . .

The delay between changing from normal oil to the storage oil supply and commencing the final running must be as short as possible. On no account must the engine be left overnight between these stages.

Shut down engine.

After the engine is removed from the test bench, complete the inhibiting procedure in accordance wih the instructions given in Chapter 18.

Shut down engine.