# GIPSY MAJOR

1, 1C, 1D, 1F, 1G, HC, AND 7

# DESCRIPTION, OPERATION, MAINTENANCE AND OVERHAUL

THIS MANUAL HAS BEEN PREPARED IN ACCORDANCE WITH CHAPTER A6-2 OF BRITISH CIVIL AIRWORTHINESS REQUIREMENTS AND IS ISSUED WITH THE APPROVAL OF THE AIR REGISTRATION BOARD. AMENDMENTS TO THIS PUBLICATION INVADIDATE THE APPROVAL UNLESS ISSUED BY THE MANUEACTURERS BY ARRANGEMENT WITH THE AIR REGISTRATION BOARD.



DECEMBER 1958 EDITION
(See overleaf)

THIS PUBLICATION SUPERSEDES THE PREVIOUS EDITIONS OF THE GIPSY MAJOR CARE AND MAINTENANCE MANUAL, AND CANCELS AMENDMENT NO. 13 TO THE GIPSY MAJOR SERIES II MANUAL

Issued by Rolls-Royce Limited, Small Engine Division
Leavesden Watford WD2 7BZ England

K 4221 A

The following minor revisions should be made to this handbook. It is suggested that holders either make the alterations, or insert a reference to this list on the relevant pages.

Page 15, para. 21, last line, add:-

Crankshaft (Modification 2495)

Modification 2495 supplements Modification 2094, by adding three magnaflux crack detection tests which are applied to the crankshaft during the fitting of the sleeve. The test is made three times: when the crankshaft has been removed from the engine, after the existing thread has been removed, and after the sleeve has been fitted.

Crankshaft (Modification 2385)

This modification is an alternative to Modification 2495. It introduces a crankshaft with a parallel-splined front end, a suitable propeller boss, and, unless Modification 1049 has been embodied, a new crankcase assembly. Engines in which Modification 2385 is embodied have the suffix Z added to their type number, i.e. Gipsy Major 1Z.

Page 56, para. 7, Op. 1, add:-

Where Modification 2197 is embodied the plugs should be type AGS1622.

Page 110, para. 78, Op. 5, 3rd line, amend to read:-

stems with a thin film of an approved anti-fretting grease, insert the

Page 145, para. 22, Op. 1, 2nd line, amend to read:-

an approved anti-fretting grease, and insert each

Page 146, para. 23, Op. 4, last line, add:-

Check the valve loading as described on page 280.

Page 146, para. 24, Op. 2, Note; and page 164, para. 12, Op. 7, Note; add:-

The instruction regarding the letter "C" applies to gas ring 34635. When using gas rings 1900-29A and 1900-6A (1 and 1F only), ring 1900-29A is fitted to the top groove with the "C" towards the crown of the piston; ring 1900-6A is fitted to the second groove and is not marked with the letter "C".

Page 165, para. 13, Op. 1, alter part number to 42427.

Page 166, para. 18, Op. 4, last line, add:-

Two types of shim are required, a 0·020 in. steel shim, Part No. 1301-26, which must always be fitted immediately under the front cover, and a 0·002 in. bronze shim, Part No. 1301-25. Adjustment for the correct bearing nip is obtained by selecting the required number of bronze shims.

Page 182, para. 61, alter part number of joint ring for "cylinder to crankcase joint" to Part No. 42427.

Page 185, amend last line to read:-

A new synthetic rubber gasket should be fitted whenever the filter bowl has been removed.

Page 200, Check 4, Op. 1, sentence beginning "Remove the propeller and hub", add:-

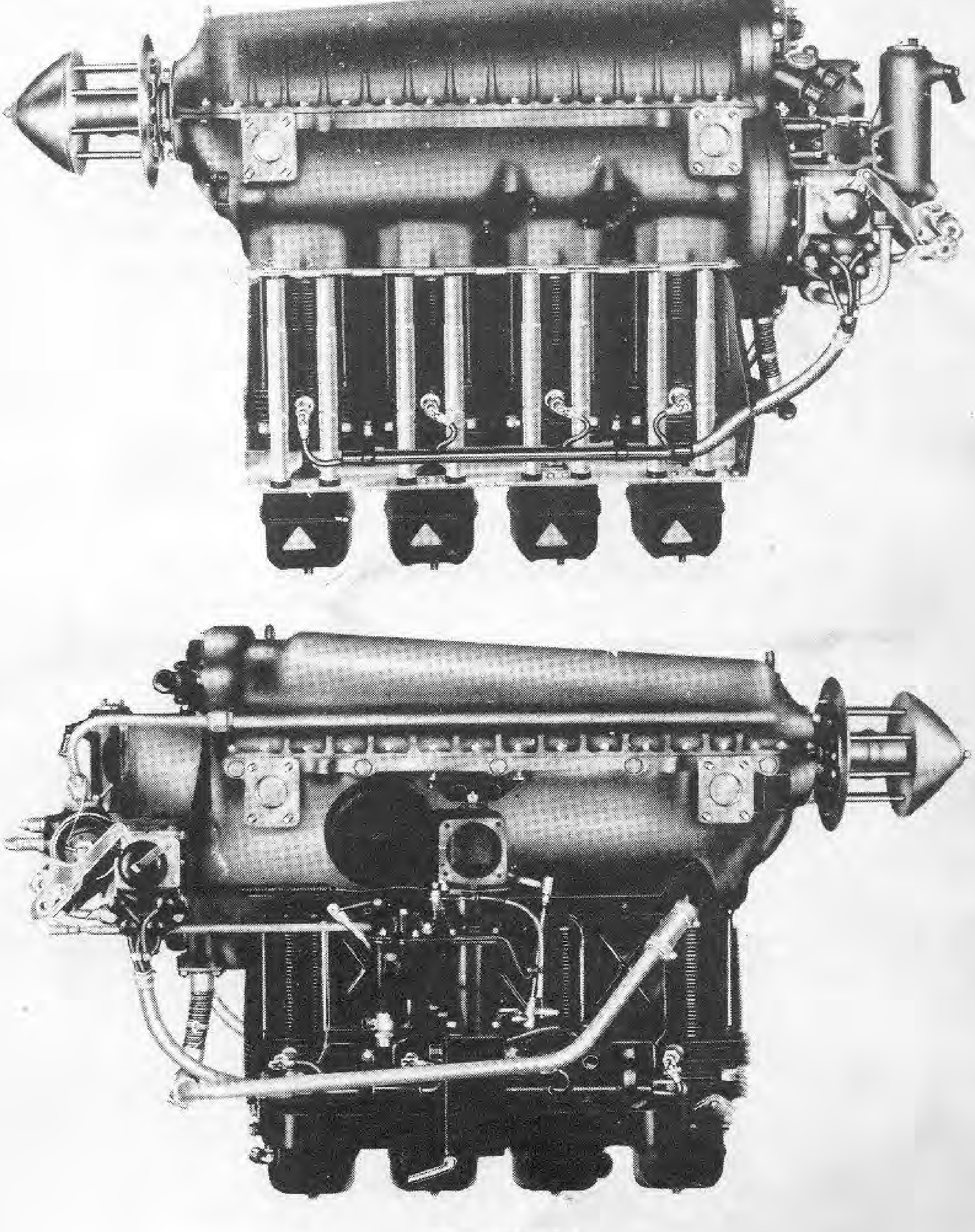
as described on page 87.

Page 231, table of Components to be Tested by Electro-Magnetic Methods; column headed Alternating Current Amps.

Delete 3,000 and insert 1,000

# CONTENTS AND LIST OF CHAPTERS

NOTE: A list of its contents and illustrations appears at the beginning of each chapter



**GIPSY MAJOR 1**

# SERVICE

Operators are strongly advised to consult the Service Department of Rolls-Royce Limited in all cases of difficulty or uncertainty, and are reminded that the Company's service engineers are always at their disposal should they require assistance. Maintenance, repair and complete overhaul services are also available and estimates for these services will be supplied on request. All enquiries should be addressed to:

THE SERVICE DEPARTMENT,
ROLLS-ROYCE LIMITED, SMALL ENGINE DIVISION,
LEAVESDEN, WATFORD, WD2 7BZ, ENGLAND.
Telephone GARSTON 74000
Telegrams ROLLSED WATFORD Telex 23206

Enquiries regarding spares and modification sets should be addressed to:

ORDER CONTROL, MARKETING SERVICES DEPARTMENT,
ROLLS ROYCE LIMITED, SMALL ENGINE DIVISION,
LEAVESDEN, WATFORD, WD2 7BZ, ENGLAND.

NOTE

Where the name "de Havilland", or Bristol Siddeley", appears in this publication it should be read as "Rolls-Royce Limited".

December 1969

# INTRODUCTION

**1.** The Gipsy Major 1, 1C, 1F, and 7 are developments of the original Gipsy engines. They are unsupercharged, four-cylinder, inverted, in-line, air-cooled direct drive engines and have push-rod operated poppet valves.

**2.** The bore, stroke, and capacity are the same in each case but the Mk. 1C and 7 have a 6 to 1 compression ratio compared to the Mk. 1 and 1F which have 5¼ to 1. The Mk. 1C has a higher power output than either the Mk. 1 or the Mk. 1F, and the Mk. 7 has a higher power output than the Mk. 1C.

**3.** The Mk. 1F is virtually identical with the Mk. 1 except for the cylinder heads, valves, and cooling baffle assemblies. Aluminium-bronze cylinder heads on which the valves operate direct are fitted to the Mk. 1, but to enable the use of leaded fuel, aluminium alloy heads with separate valve seat inserts are fitted to the Mk. 1F and Mk. 1C. In addition to aluminium alloy cylinder heads the Mk. 1C and Mk. 7 also have different connecting rods and pistons which together with a 6 to 1 compression ratio are necessary for the higher power output of these engines

**4.** Carburation is by a single Hobson A.I.48H down-draught, float-chamber carburettor which has a mechanically-operated enrichment valve arranged to come into operation at large throttle openings, and a manually-operated mixture (or altitude) valve. Mk. 1 and 1F engines are fitted with a Hobson A.I.48 H1M carburettor, and the Mk. 1C and 7 with an A.I.48 H3M; apart from jet sizes, which vary between individual engines, even though they are of the same mark number, the principal difference between the A.I.48 H1M and H3M is that the latter has a larger choke.

**5.** Two rotating-armature type B.T.H. magnetos, each fitted with an integral distributor and supplying an individual set of sparking plugs, provide full dual ignition. An impulse starter is fitted to the starboard magneto only. The ignition system of the Mk. 1 variants is unscreened but the Mk. 7 has screened magnetos, ignition harness, and sparking plugs.

**6.** Lubrication is on the dry-sump principle, by a gear-type pressure pump through an Auto-Klean filter. One pressure only is employed throughout. In the Mk. 1 variants scavenge oil is returned from the crankcase to the oil tank by gravity, but the Mk. 7 is fitted with duplicate gear-type scavenge pumps to ensure that all the oil supplied by the pressure pump is returned positively regardless of the angle of flight.

**7.** A mounting face for an electric starter is machined on the rear cover of all engines. This face is normally blanked off as an electric starter is only fitted to the Mk. 7. The drive from the electric starter is taken through an extension shaft, integral with which is a three-jaw starter dog, bolted to the gear at the rear end of the crankshaft.

**8.** The Mk. 1C is installed in Tiger Moth Trainer aircraft and the Mk. 7 in the Auster T.7 aircraft. The Mk. 1 and the Mk. 1F are installed in Magister aircraft and the Tiger Moth Trainer, and except for the differences described in para. 2 and 3 and the addition of engine-driven, diaphragm-type fuel pumps, driven by eccentrics formed on the camshaft, fitted to the engines installed in Magister aircraft, the engines are practically identical. The Mk. 7 is also fitted with engine-driven fuel pumps.

**9.** This publication deals primarily with the Royal Air Force versions of the Gipsy Major 1 and 7 but most of the information is equally applicable to the civil versions of the Gipsy Major 1. Information in this handbook stated to apply to "Mk. 7" engines will, in many instances, be applicable to those civil versions of the Major 1 which have scavenge pump lubrication and screened ignition.

## GIPSY MAJOR 7 ENGINES RECATEGORIZED AS GIPSY MAJOR 10 Mk.1-1

Gipsy Major 7 engines are approved for use in civil aircraft subject to the following conditions.

1. The military Log Card/Book, or a certified extract therefrom, must be available.

2. The crankshaft must be removed from the engine and sent to an organisation approved for the following work.

   (a) Crankshaft without bearing locating sleeve

   The crankshaft must be subjected to a Magnaflux crack detection test, and a new bearing locating sleeve of Modification 2495 standard must be fitted.

   (b) Crankshaft with bearing locating sleeve (of either Modification 2094 or 2495 standard)

   The sleeve must be removed, a Magnaflux crack detection test carried out on the crank-shaft, and a new bearing locating sleeve of Modification 2495 standard must be fitted.

   Instructions for the embodiment of Modification 2495 may be obtained on request from the Service Department at the address given on page 2.

3. The engine must meet the requirements of Notice to Licensed Aircraft Engineers No. 16.

4. A civil type log book must be raised, and all relevant entries made.

5. The engine type, on the nameplate or on the left front side of the crankcase top cover joint face, must be altered to 10 Mk.1-1 and a corresponding entry made in the log book.

These engines should be operated to the Operating Limitations given on page 10, and maintained in accordance with the instructions given for the Gipsy Major Mk.7 in this handbook.

Based on A.R.B. Technical Certificates Major 1 (Auster 111), No. 2, issue 4, 12.1.56; 1D, No. 12, issue 3, 4.5.53; HC, 1C and 1G, No. 17, issue 5, 30.3.53; 1 and 1F, No. 21, issue 3, 30.3.53; and M.O.S. Technical Certificate No. M.50, issue No. 3, 10.3.50, (Amendment No. 1, 6.7.51).

## GENERAL

| | |
|---|---|
| Type of engine | Inverted, air-cooled, four-stroke, O.H.V., normally aspirated |
| Number of cylinders | Four |
| Arrangement of cylinders | In-line |
| Cylinder numbering | 1, 2, 3, 4 (commencing from the propeller end of the engine) |
| Bore | 118 mm. (4·646 in.) |
| Stroke | 140 mm. (5·512 in.) |
| Swept volume | 6·124 litres (373·7 cu. in.) |
| Compression ratio | |
| Mk. 1, 1 (Auster 111) and 1F | 5·25 to 1 |
| Mk. 1C, HC, 1D and 1G and 7 | 6 to 1 |
| Big-end and main bearings | Plain, split |
| Main bearing numbering | 1, 2, 3, 4, 5 (commencing from the propeller end of the engine) |
| Direction of rotation | Counter-clockwise (viewed from the rear of the engine) |
| Propeller drive | Direct |
| Weight (nett dry) | |
| Mk. 1 and 1 (Auster 111) | 310 lb. plus 2½ per cent |
| Mk. 1D | 322 lb. plus 2½ per cent |
| Mk. 1C, HC and 1G | 312 lb. plus 2½ per cent |
| Mk. 1F | 300 lb. plus 2½ per cent |
| Mk. 7 | 316 lb. plus 2½ per cent |

## IGNITION

| | |
|---|---|
| Magnetos | |
| Mk. 1, 1C, HC, 1F and 1G | Two, unscreened, B.T.H. AG4-6 or AG4-6/1 |
| Mk. 1 (Auster 111), 1D and 7 | Two, screened, B.T.H. AG4-8, AG4-10, AG4-8/1 or AG4-10/1 |
| Direction of rotation | Port magneto: counter-clockwise<br>Starboard magneto: clockwise<br>(viewed from their driving ends) |
| Speed of rotation | Crankshaft speed |
| Impulse starter coupling | B.T.H. Z1-1 on starboard magneto |
| Distributors | Integral with magnetos |
| Sparking plugs | Eight |
| Type | See page 9 |
| Firing order | 1, 3, 4, 2 |
| Timing | 30 deg. before T.D.C. when fully advanced |

## VALVES

Type ... Poppet, 1 exhaust and 1 inlet per cylinder

| Timing | Mk. 1 | Mk. 1C, HC, 1D, 1F, 1G and 7 |
|---|---|---|
| Inlet opens | 16½ deg. before T.D.C. | 20 deg. before T.D.C. |
| Inlet closes | 67½ deg. after B.D.C. | 71 deg. after B.D.C. |
| Exhaust opens | 62 deg. before B.D.C. | 62 deg. before B.D.C. |
| Exhaust closes | 29 deg. after T.D.C. | 29 deg. after T.D.C. |

| Tappet clearance (cold) | Inlet | Exhaust |
|---|---|---|
| With aluminium-bronze cylinder heads | 0·010 in. | 0·005 in. |
| With aluminium alloy cylinder heads | 0·005 in. | 0·005 in. |

*Type of carburettor*

| | |
|---|---|
| *Mk. I HC, ID, IF and IG* ... ... | *Float chamber type, Hobson A.I.48 HIM* |
| *Mk. IC and 7* ... ... ... ... | *Float chamber type, Hobson A.I.48 H3M* |

*Choke*

| | |
|---|---|
| *A.I.48 HIM, Mk. I HC, ID, IF and IG* ... | ... *41 mm.* |
| *A.I.48 H3M, Mk. IC and 7* ... | ... *43 mm.* |

*Main jet*

| | |
|---|---|
| *A.I.48 HIM, Mk. I HC, ID, IF and IG* ... | *690, 705, 720, 740, 760, 780 cc.* |
| *A.I.48 H3M, Mk. IC and 7* ... | *790, 820, 850 cc.* |

*Power jet*

| | |
|---|---|
| *A.I.48 HIM, Mk. I HC, ID, IF and IG* ... | *40, 60, 70, 80 cc.* |
| *A.I.48 H3M, Mk. IC and 7* ... | *60, 80, 100 cc.* |
| *Slow-running jet* ... | ... *160 cc.* |
| *Number of carburettors* ... | *One* |
| *Fuel pressure at carburettor* ... | *1·5 to 2·5 lb. per sq. in.* |
| *Mixture control* ... | *Manual (may be locked in rich position on some installations)* |

*Fuel pumps*

*2 DH AC diaphragm type, except on gravity feed Tiger Moth installation when no pumps are required.*

## POWER RATING (Sea Level)

| | *International power rating* | | *Maximum power rating* | | *Maximum take-off power* | |
|---|---|---|---|---|---|---|
| | *B.H.P.* | *R.P.M.* | *B.H.P.* | *R.P.M.* | *B.H.P.* | *R.P.M.* |
| *Mk. I, I (Auster III) and IF* ... | *122* | *2100* | *132* | *2400* | *122* | *2100* |
| *Mk. IC, HC and IG* ... ... | *130* | *2100* | *142* | *2400* | *130* | *2100* |
| *Mk. ID and 7* ... ... ... | *142* | *2400* | *145* | *2550* | *145* | *2550* |

## FUEL

| | *Minimum grade* | *Maximum lead content T.E.L. mls./Imp. gall.* |
|---|---|---|
| *Mk. I* ... ... ... | *69* | *Nil* |
| *Mk. I (Auster III) and IF* ... | *69* | *4·0* |
| *Mk. IC, HC and IG* ... | *77* | *4·0* |
| *Mk. ID and 7* ... | *80* | *4·0* |

## OIL

| | |
|---|---|
| *Type* ... ... ... | *see page 7* |

*Consumption at maximum cruising conditions*

| | |
|---|---|
| *Mk. I and IF* ... | ... *1 to 2 pints per hour* |
| *Mk. IC, HC and IG* ... | ... *1½ to 3 pints per hour* |
| *Mk. ID* ... | ... *1½ to 4 pints per hour* |
| *Mk. 7* ... | ... *1 to 3½ pints per hour* |

*Pressure*

| | |
|---|---|
| *Normal in flight* ... | *40 to 45 lb. per sq. in.* |
| *Emergency minimum* ... | *30 lb. per sq. in.* |
| *Temperatures* ... | *Refer to Operating Limitations* |

## STARTING SYSTEM

| | |
|---|---|
| *Mk. I, IC and IF* ... | *By swinging the propeller* |
| *Mk. 7* ... | *Electric starter, Rotax type N3-EY* |

## PROPELLER

| | |
|---|---|
| *Type* ... ... ... | *Fixed-pitch* |

## LUBRICATING OIL FOR GIPSY ENGINES

The Gipsy range of piston engines is approved for operation in Arctic and Temperate conditions on lubricants complying with British Ministry of Supply Specification D.Eng.R.D.2472, and in Tropical conditions on lubricants complying with Specification DHE.227.

The appropriate grade of oil must be used according to the prevailing conditions and the following grades of oil, certified as complying with these requirements, are, until further notice, suitable for use in Gipsy engines in appropriate climatic and operating conditions.

| Conditions of Operation | " Arctic " (Below 0 deg. C.) | " Temperate " (0—30 deg. C.) | " Tropical " (Above 30 deg. C.) |
|---|---|---|---|
| Specification | D.Eng.R.D.2472.A/O | D.Eng.R.D.2472.B/O | de Havilland DHE.227 |

The following grades comply with the above specifications.

| | | | |
|---|---|---|---|
| Esso Petroleum Co. | Esso Aviation Oil 80 | Esso Aviation Oil 100 | Esso Aviation Oil 120 |
| Shell-Mex Ltd. | Aeroshell 80 | Aeroshell 100 | Aeroshell 120 |
| Regent Oil Co. | Caltex Aircraft Engine Oil 80 | Caltex Aircraft Engine Oil 100 | Caltex Aircraft Engine Oil 120 |
| Vacuum Oil Co. | Mobiloil Aero, grey band | Mobiloil Aero, red band | Mobiloil Aero, green band |
| C. C. Wakefield & Co. | Castrolaero " A " | Castrolaero " B " | Castrolaero " C " |

The conditions of operation given above can, of course, act only as a general guide, for, as will be readily appreciated, the wide variations of temperature that may occur in one locality even during a single day would make impossible a literal application of the recommendations. In general, however, if it is expected that the temperatures specified for the use of tropical or arctic grades of oil will be met at ground level during the normal course of operation of the aircraft at that particular time, then the appropriate grade of oil should be used.

# SUMMARY OF CIVIL VARIANTS

The main differences between the civil variants of the Gipsy Major 1 engine are given below :—

**The Gipsy Major 1** has bronze cylinder heads and must **not** be operated on fuels containing Tetra-ethyl Lead (T.E.L.).

**The 1F** differs from the 1 in that it has aluminium cylinder heads. The use of fuels containing up to a maximum of 4 m.l. T.E.L. per Imperial gallon is permitted, but the limiting cylinder temperatures are adjusted in consequence.

Variants of the above engine introduced to suit the Tiger Moth Trainer and the Magister aircraft are identified by the addition of " Trainer " or " Magister " after the engine mark number, and differ in detail as described in the introduction to this handbook.

**The 1 (Auster III)** is similar to the 1F but incorporates a screened ignition system. The mixture control is locked in the rich position so that it is not possible to compensate for the effect of altitude on mixture strength and a higher maximum cruising oil inlet temperature is permitted.

**The 1C and HC** have aluminium cylinder heads permitting the use of fuel containing up to a maximum of 4 m.l. T.E.L. per Imperial gallon. The 1C engine is built to a later modification standard.

**The 1G** is similar to the 1C but incorporates the Gipsy Major 10 Mk. 1–3 accessory drives which are illustrated on page 71.

**The 1D** is similar to the 1C but incorporates fuel pumps, screened ignition with B.T.H. AG4–8 magnetos, induction system priming, and double scavenge oil pumps. The mixture control is locked in the rich position and the ratings are increased. There are various installational differences.

The 1, 1F, 1C, 1G and HC engines all have a manual mixture control which should be used only to maintain " weakest mixture for maximum power " conditions when cruising at altitudes greater than 3,000 feet, and to avoid rough running due to over-richness at other conditions of flight.

OPERATING LIMITATIONS

For oil pressures see Leading Particulars

## GIPSY MAJOR 1, 1F, AND 1 (AUSTER 111)

Based on A.R.B. Technical Certificates No. 2 (issue 4, 12.1.56) and No. 21 (issue 4, 23.1.56)

| Flying condition | Time limitation | R.P.M. | Boost pressure lb. per sq. in. | Oil temp. deg. C. 1 and 1F (Auster 111) | Cyl. temp. deg.C. 1 | Cyl. temp. deg.C. 1F and 1 (Auster 111) |
|---|---|---|---|---|---|---|
| Maximum take-off, climb, and emergency cruising | 60 minutes | 2,100 | Full throttle | 80 maximum 15 minimum | 270 | 230 |
| Minimum for take-off at maximum take-off boost | | 1,825 | | | | |
| Maximum emergency | 5 minutes | 2,400 | Full throttle | 90 | 280 | 240 |
| Maximum cruising | Continuous | 2,100 | Minus 2 | 80 | 250 | 210 |
| Maximum diving | | 2,400 | Full throttle | | | |

## GIPSY MAJOR 1C, 1D, 1G, AND HC

Based on A.R.B. Technical Certificates No. 12 (issue 3, 4-5-53) and No. 17 (issue 5, 30-3-53)

| Flying condition | Time Limitation | R.P.M. 1C, 1G, HC | R.P.M. 1D | Boost pressure lb. per sq. in. 1C, 1G, HC / 1D | Oil Temp. deg.C. | Cyl. Temp. deg.C. |
|---|---|---|---|---|---|---|
| Maximum take-off, climb, and emergency cruising | 60 minutes | 2,100 | 2,400 | Full throttle | 80 maximum 15 minimum | 230 |
| Minimum for take-off at Maximum take-off Boost | | 1,995 | unrestricted | | | |
| Maximum emergency | 5 minutes | 2,400 | 2,550 | Full throttle | 90 | 240 |
| Maximum cruising | Continuous | 2,100 | 2,300 | Minus 2 / Minus 1·5 | 70 | 210 |
| Maximum overspeed | 20 seconds | 2,400<br>2,550 1C and 1G engines with Mod. G.1145 | 2,675 | Full throttle | | |

## SPARKING PLUGS

| Sparking plug make | Unscreened Ignition Cables Type | Unscreened Ignition Cables Gap | Screened Ignition Cables Type | Screened Ignition Cables Gap |
|---|---|---|---|---|
| 12 mm. sparking plugs for use on engines pre-Mod. 2197 | | | | |
| K.L.G. | V.12/2<br>- | 0·012 in. to 0·015 in.<br>- | RC.50 RH<br>RV.12/3 | 0·012 in. to 0.015 in.<br>0·012 in. to 0·015 in. |
| LODGE | S 50/1<br>A 55/4 | 0·012 in. to 0·015 in.<br>0·012 in. to 0·015 in. | RS 50R<br>RS 50/1R | 0·012 in. to 0.015 in.<br>0·015 in. to 0·018 in. |
| 14 mm. sparking plugs for use on engines Mod. 2197 | | | | |
| K.L.G. | RC. 5/4H | 0·012 in. to 0·015 in. | RC. 5/4H | 0·012 in. to 0·015 in. |
| LODGE | RS 5/7R<br>LH 1 | 0·012 in. to 0.015 in.<br>0·015 in. to 0·018 in. | RS 5/7R<br>LH 1 | 0·012 in. to 0·015 in.<br>0·015 in. to 0·018 in. |

## OPERATING LIMITATIONS

*For oil pressures see Leading Particulars*

**Gipsy Major Mk. 7**

*Based on M.O.S. Technical Certificate No. M50 (issue 3, 10-3-50) (Amendment No. 1, 6-7-51)*

*This engine is, in effect, the military version of the Gipsy Major 10, Mk. 1-1 ; the civil engine is covered fully in the Gipsy Major Series 10 Handbook.*

| *Flying Condition* | *Time Limitation* | *R.P.M.* | *Boost pressure lb. per sq. in.* | *Oil Temp. deg. C.* | *Cyl. Temp. deg. C.* |
|---|---|---|---|---|---|
| Take-Off and Operational Necessity | 5 minutes | 2,550 | Full throttle | 100 maximum<br>15 minimum | 240 |
| Minimum for Take-Off at Maximum Take-Off Boost | | 2,000 | | | |
| Intermediate | 60 minutes | 2,400 | Full throttle | 85 | 230 |
| Maximum Continuous-Rich Mixture | Continuous | 2,300 | Minus $\frac{3}{4}$ | 85 | 210 |
| Maximum Continuous-Weak Mixture | Continuous | 2,300 | Minus 2 | 85 | 210 |
| Maximum Diving | 20 seconds | 2,675 | Full throttle | | |

## TORQUE LOADING TABLE

To ensure that the correct loading is applied when tightening certain nuts, the table below lists the respective torque loading values. These values are subject to the threads being lubricated and to the nut being able to run freely down the thread without binding. These values are applicable to the nuts only and are not the loadings to be used when inserting studs.

| Nut Part No. | Description | Torque loading pound inches, and recommended tools |
|---|---|---|
| 800-CN-1 | Nut, intermediate and rear main bearing | 500 to 600<br>MSW 208, TQ.50A |
| 800-CN-2 | Nut, front main bearing | 300 to 400<br>MSW 207, TQ.50A |
| N.372 or N.376 | Nut, rocker bracket (pre-Mod. 2197) | 300<br>MSW 205, TQ.50A |
| N.6542 | Nut, rocker bracket (Mods. 2197 and 2282) | Tighten to 360, slacken completely and then re-tighten to 275<br>MSW 205, TQ.50A |
| 1900/3 | Nut, connecting rod | 180 to 270<br>MSW 204, TQ.50A |
| 801/16B | Nut, cylinder, holding down | 350 to 400 (Mod. 2329)<br>T.79017, T.79013, T.86451 |

# Chapter 1

# ENGINE

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



### PRELIMINARY

**1.** The Gipsy Major Mk. 1 is a development of the original Gipsy engines, and the Mk. 1C, 1F, and 7 are developments of the basic Mk. 1.

**2.** A very brief general description of these engines, with an indication of the principal differences between the marks, is given in the Introduction at the beginning of this Publication. These differences are also summarized on page 8.

**3.** For the purposes of this chapter the engine is divided into four groups:—the crankcase, timing gear cover and drives, the cylinder group, and miscellaneous. Controls, air-intake, and induction pipe are dealt with in Chapter 3, oil pumps, filters and sump in Chapter 2, and ignition equipment in Chapter 4.

**4.** The crankcase group includes the crankcase proper with the main and the camshaft bearings, the top cover, the crankshaft, the camshaft, and the tappets and guides.

**5.** The timing gear cover and drives group contains descriptions of the timing gear and of the magneto, tachometer, and oil pump drives. Although some of the gears are actually mounted on the crankcase rear wall, they have been included in this part of the chapter to preserve continuity in the description of the gear trains.

**6.** There are four identical cylinder assemblies, each including a cylinder barrel and cylinder head, piston and piston rings, and a gudgeon pin and connecting rod. Each cylinder head carries a pair of valves and their rockers. For convenience the push-rods and push-rod covers have been included in the cylinder group.

**7.** The cooling system, of airscoop and baffles, and the propeller hub are described in the miscellaneous group which concludes this chapter.

## CRANKCASE GROUP

**Crankcase** (*fig. 1*)

**8.** The crankcase is divided in the horizontal plane on the crankshaft centre line. The term crankcase is generally used to indicate the lower and larger component (*fig.* 2), the upper and smaller component being called the top cover (*fig.* 4).

**9.** The crankcase is a light-alloy casting supporting the bearing and mounting loads, and containing the crankshaft, camshaft, and tappets. The four cylinder assemblies are attached to its lower face, and the upper edge of the airscoop and cooling baffle are attached to its sides. The carburettor air-intake is also attached to the starboard side of the crankcase. The engine bearer arms, which are not supplied with the complete engine although they are engine parts, are bolted to its side walls. In Mk. 7 engines, the front scavenge filter is accommodated on the starboard wall, and, where engine-driven fuel pumps are fitted, the fuel pumps are mounted on the port wall.

**10.** The crankcase, which is stiffened by transverse webs, forms a rigid box-girder foundation for the engine. The intermediate webs and the crankcase rear wall are pierced so that oil can drain freely to either end of the crankcase, according to the attitude of the aircraft; holes in the port sides of these webs accommodate the intermediate camshaft bearings.

**11.** The lower face of the crankcase is flat and has four apertures to accommodate the cylinder barrels. Steel studs are screwed into this face, four around each aperture, to secure the four cylinder assemblies to the crankcase. Along the port side are the eight light-alloy tappet guides, each held in place by a pair of studs and nuts.

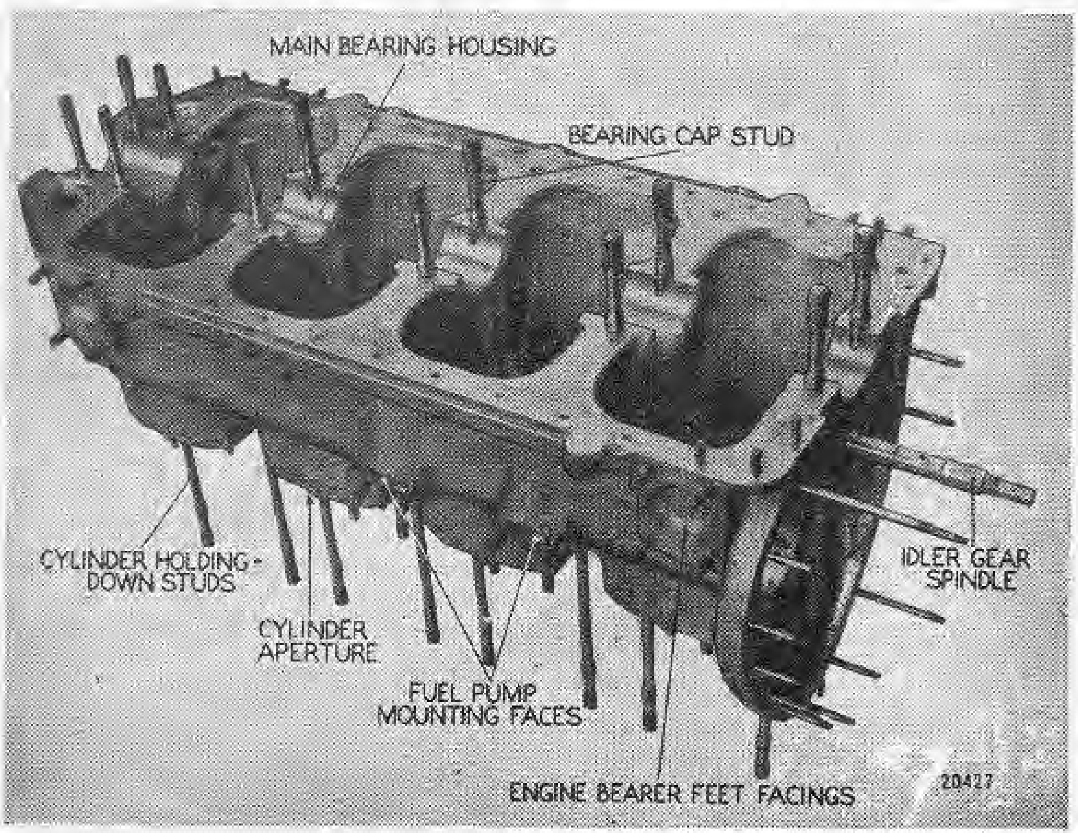



**Fig. 1. Crankcase (Pre-mod. 1876)**

**12.** At the front of the crankcase a face is machined concentric with the crankshaft centre line, and three studs which secure the front cover are screwed into this face; two further studs which also secure the front cover are in a similar face machined on the top cover.

**13.** On both side walls of the crankcase are two rectangular faces, each having four studs for the attachment of the engine bearer arms. A recess is bored in the centre of each rectangular face to receive a matching spigot on the bearer arms. An accurate spigot fit is provided to ensure that the fixing studs are not loaded in shear. Other tapped bosses and studs are provided for attachment of the airscoop mountings, cooling baffle, and the carburettor air-intake, etc. Two faces on the port side of the crankcase adjacent to No. 3 cylinder position provide mountings for engine-driven fuel pumps when fitted. These facings are in the same plane as the camshaft on which are formed two eccentrics by which the pumps are actuated. On Mk. 1 variants where gravity feed is employed, these two faces are permanently blanked off.

**14.** The crankcase rear wall projects downwards below the cylinder mounting face, and in conjunction with the timing gear cover provides the casing in which the timing gear magneto, oil pump, and tachometer drives are situated. On Mk. 1 variants, an oil drain pipe, through which oil returns to the tank by gravity, is attached to the bottom of the timing gear cover. On Mk. 7 engines, a sump, referred to as the settling tank, is attached to the bottom of the timing gear cover and the majority of the drain oil collects in this via a rectangular opening in the starboard side of the crankcase rear wall. The periphery of the rear wall is provided with studs for the attachment of the timing gear cover. When Mod No. 1876 is embodied, a reamed hole is provided in the timing cover mounting face just below the centre line on the port side which aligns with a corresponding reamed hole in the cover. A fitting bolt is assembled in this position to afford improved location for the cover.

**15.** Each transverse web is drilled to form oil ducts through which oil is fed under pressure from a gallery in the top cover to the main bearings.

#### Main bearings (*fig.* 2)

**16.** Five split main bearings, which are numbered 1 to 5 from the front, support the crankshaft. A ball thrust bearing, which locates the crankshaft axially, is housed in the crankcase and top cover and retained by the front cover as described in para. 22. The main bearings are carried in housings, the

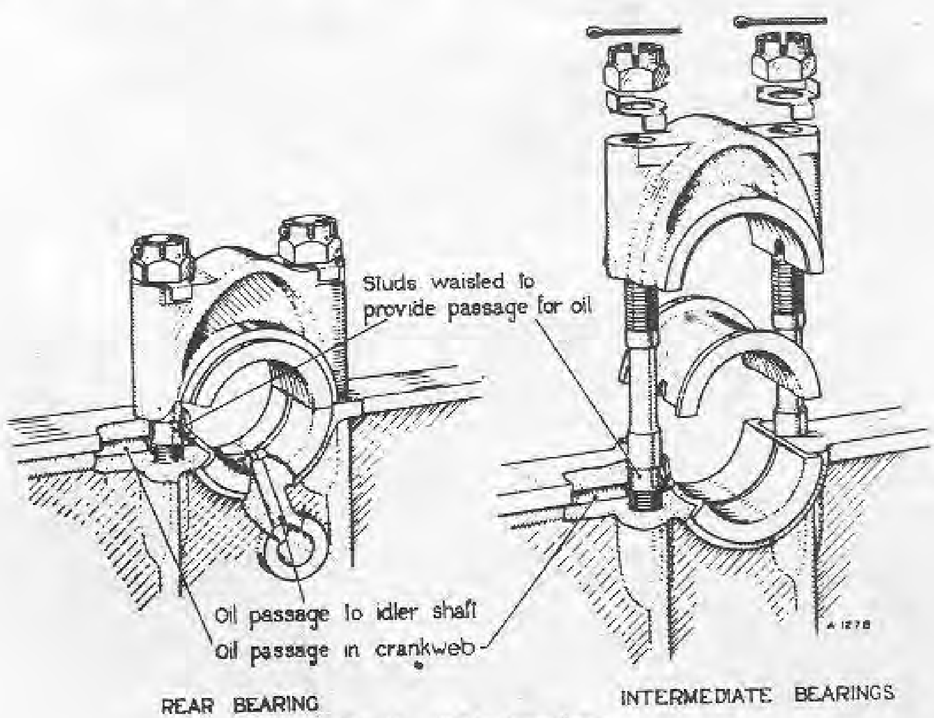



**Fig. 2. Main bearings**

lower halves being machined out of bosses integral with the transverse webs and the rear wall of the crankcase. The foremost housing boss is extended forwards and joined to the front wall of the crankcase, where it is machined to form the lower half of the housing for the thrust bearing; the upper half of this housing is in the top cover.

**17.** Each bearing cap is secured by studs and nuts. The caps for No. 2, 3, 4, and 5 bearings are each secured by two studs. As the studs pass through the oil duct drilled in the crankcase webs they are waisted to permit the passage of oil to the bearings. The front bearing cap, which is longer than any of the others, is secured by four studs.

**18.** Except in very early Mk. 1 variants, which had die-cast white-metal bearings with, in certain engines, a steel-backed centre bearing, the main bearing housings are lined with flanged steel shells. Each steel shell is coated with white-metal on the bearing surface. Rotation of the bearing shells in their housing is prevented by a dowel in the bearing cap. The lower half bearing shells contain oil holes and grooves; the oil holes align with the oil ducts in the crankcase when the shells are in position and permit the oil to reach the crankshaft journals.

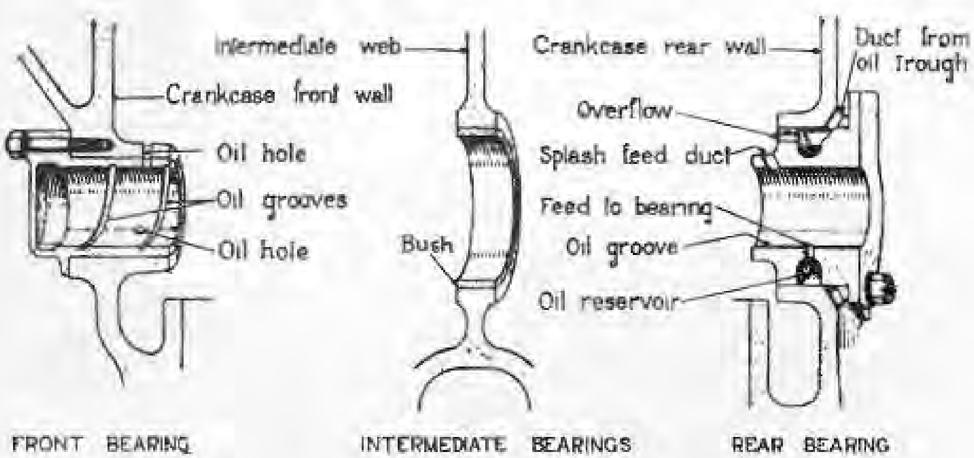



**Fig. 3. Camshaft bearings**

**Camshaft bearings** (*fig.* 3)

**19.** The camshaft is carried within the port side of crankcase in five plain bearings. The front bearing consists of a blind light-alloy bush, also serving as an end cover for the camshaft, which is secured to the front wall of the crankcase by an integral flange and three studs and nuts. The three intermediate bearings are carried in the transverse webs and are of larger bore than the two end bearings so that the camshaft can be threaded through them for purposes of assembly and dismantling. Each intermediate bearing is identical and consists of a phosphor-bronze bush locked in position by a set-screw through the port wall of the crankcase. The rear bearing consists of a flanged light-alloy bush secured to the crankcase rear wall by two studs and nuts.

**Top cover** (*fig.* 4)

**20.** As stated in para. 8, the crankcase is divided in the horizontal plane on the crankshaft centre line and the upper component is called the top cover. In effect this component is a lid closing the open top of the crankcase, and it is secured by twenty-seven bolts and nuts, and eight studs. The timing gear cover is fastened to the rear of the top cover by eight set-bolts. Two lifting eyes are provided on the upper surfaces of the top cover for use when slinging the engine. At the front end the cover is machined to accommodate the upper half of the thrust bearing and two studs in the front face, in conjunction with the three studs mentioned in para. 12, secure the front cover to the crankcase/top cover assembly. At the rear it is flanged to mate with the upper portion of the rear cover. The top cover is a magnesium alloy casting stiffened by internal webs and contains the main oil gallery. This oil gallery consists of a duct cored in the casting along the starboard side with branch ducts drilled into it from the top cover/crankcase joint face. These ducts align with corresponding ducts drilled in the crankcase and feed oil from the gallery to the main bearings. To enable the oil ducts to be cleaned efficiently, later engines are provided with detachable blanking plugs.

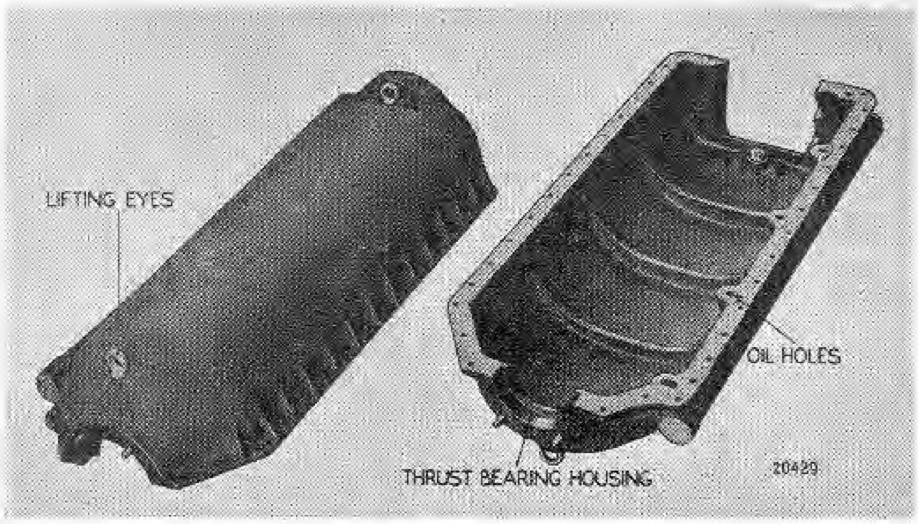



**Fig. 4. Top cover**

**Crankshaft** (*fig.* 5)

**21.** The crankshaft extends forward to form an integral propeller shaft, which is machined with a standard one-in-ten taper and fitted with a round-ended feather key to locate the fixed-pitch propeller hub. The extreme forward end is threaded for the propeller hub retaining nut, and its hollow core is plugged to prevent the ingress of foreign matter or the leakage of oil. The crankshaft is machined from a nickel-chromium steel forging and has four cranks, or throws, with cranks No. 1 and 4 at 180 deg. to No. 2 and 3. Both journals and crankpins are hollow, both for lightness and to act as oilways, their open ends are closed by discs and sealing washers secured in pairs by axial bolts. Holes drilled in the crankwebs connect the bore of each crankpin to its adjacent journal. Oil enters the crankshaft at journals No. 2 and 4 which are drilled radially and passes through the drilled passages in the crankwebs to the crankpins to lubricate the big-end bearings via a hole drilled radially in each crankpin. Female splines in the rearmost journal engage male splines on the integral shaft of the first timing gear, which is secured by a retaining bolt and dished end cap at the front of the journal, in a similar manner to the sealing arrangements of the hollow journals and crankpins. On Mk. 7 engines, where an electric starter is fitted, the starter dog, which transmits the torque from the starter to the crankshaft, is bolted to a flange on the rear face of the timing gear.

**Thrust bearing** (*Pre-mod. 2094*) *

**22.** The thrust bearing is a single-row deep-groove type of ball bearing capable of dealing with thrust in either direction. In addition to locating the crankshaft endwise it transmits the propeller thrust through the crank-

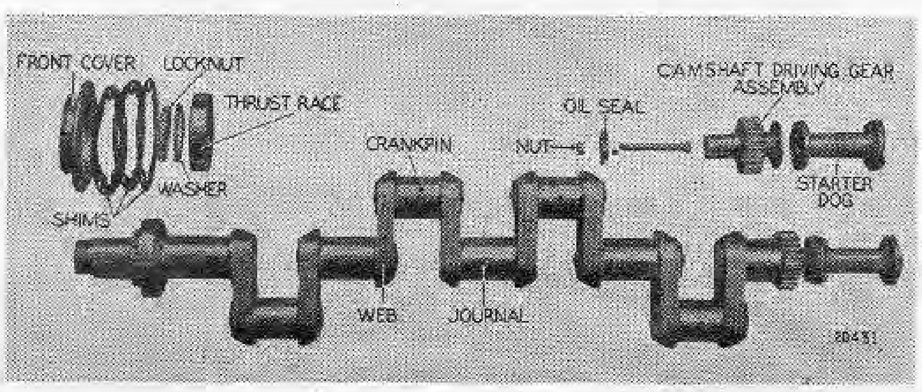



**Fig. 5. Crankshaft**

* *On engines embodying Mod. 2094, the thrust bearing has a split inner race and is located on a sleeve shrunk on the crankshaft, the forward end of the sleeve is threaded to receive the bearing retaining nut, and a distance-piece is fitted between the rear face of the outer race and the bearing housing.*

case and the engine mountings. Forward of the front main bearing, the crankshaft is formed with a narrow collar, against the front face of which is located the inner race of the thrust bearing. The race is held in position by a retaining nut which is locked by a tab-washer. The tab-washer is formed with an additional inwardly-projecting tab, which is bent up to lie parallel with the axis of the washer and is inserted within the bore of the inner race; a flat is milled on the crankshaft to accommodate this tab. The outer race of the thrust bearing is housed in the forward end of the crankcase and the top cover, and is secured in its housing by the front cover, which is attached to the front of the crankcase and top cover by five studs. The outer race of the thrust bearing must be nipped by the front cover as specified in the Schedule of Fits and Clearances and Repair Tolerances, and packing shims are selected and fitted between the front cover and the crankcase to obtain the correct nip.

**Front cover**

**23.** The crankcase front cover is in effect a retaining plate for the thrust bearing and is secured both to the crankcase and the top cover by studs which pass through the flange of the cover.

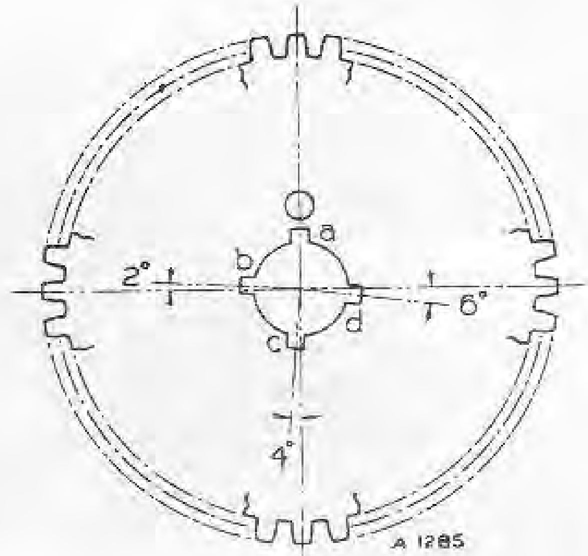



**Fig. 7. Camshaft adjustment**

Axial movement of the camshaft rearwards is prevented by an integral flange bearing against the front face of the rear bearing. Forward movement is prevented by the front face of the camshaft timing gear rotating against the rear face of this bearing. The camshaft timing gear is located on the rear end of the camshaft by a Woodruff key and is secured by a tabwasher and nut. Four alternative keyways in the gear provide

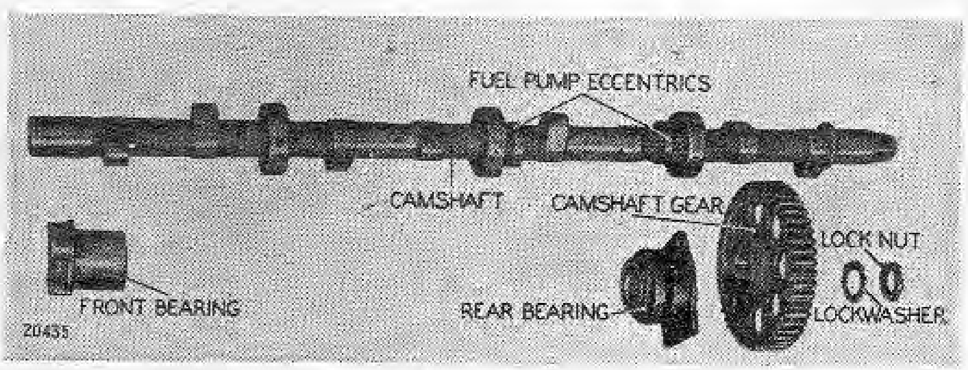



**Fig. 6. Camshaft**

**Camshaft** (*fig.* 6)

**24.** The camshaft is a one-piece hollow shaft with five bearing journals, four inlet and four exhaust cams, and two fuel pump eccentrics. It is carried in five plain bearings situated in the lower port side of the crankcase as described in para. 19. Prior to the introduction of Gipsy modification G1619, six holes drilled diagonally through each intermediate journal assisted the splash lubrication to reach the bearing surfaces, but these holes are deleted by the modification.

alternative positions of assembly to the camshaft and enable the timing to be set accurately within one degree. Referring to fig. 7, the keyway *a* is cut radially in line with a tabwasher hole drilled in the gear wheel. The camshaft gear has 48 teeth so that the alternative keyways *b*, *c* and *d* provide variations of 2, 4, and 6 deg. within each tooth space of $7\frac{1}{2}$ deg. By trying the four keyways in turn, the most nearly correct is chosen at first assembly and should be marked for future reference.

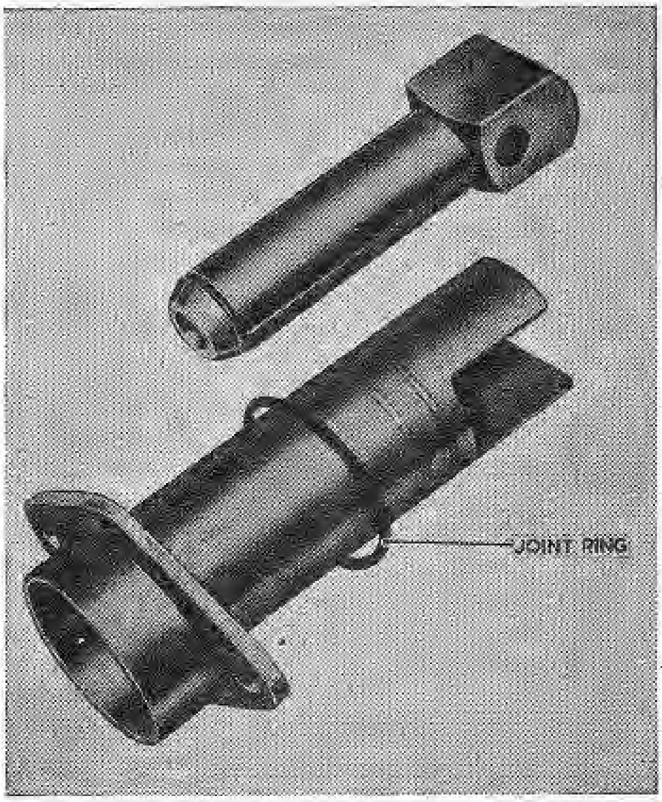



Fig. 8. Tappet and guide

**Tappets and guides** (*fig.* 8)

**25.** Four pairs of steel tappets act as cam followers to transmit the motion of the cams to the valves via push-rods and rockers. The upper end of each hollow cylindrical tappet body is machined with a rectangular foot curved on the cam-following face, the lower end being fitted with a replaceable hardened steel cup, to provide a working surface for a hardened steel ball fitted at the upper end of the push rod. The aluminium alloy guides are flanged, each being secured to the crankcase by two studs and nuts. A moulded joint ring interposed between the flange and the crankcase, and two oil-retaining grooves turned in each guide towards its upper end, prevents the leakage of oil from the engine. A slot in each guide engages the rectangular foot of the tappet and prevents it from rotating.

## TIMING GEAR COVER AND DRIVES

**Timing gear cover** (*fig.* 9)

**26.** The magnesium alloy rear cover bolted on the back of the crankcase and top cover encloses the timing gear and the drives, and provides mounting faces for the magnetos, the oil pump, the tachometer drive, and the engine breather connection. Mod. No. 1876 introduces a fitting bolt in place of the stud shown at the eight o'clock position in fig. 9. On Mk. 7 engines the sump and the electric starter are also mounted on the timing gear cover.

**27.** The magnetos are secured by set-bolts to two horizontal inverted platforms on either side of the timing gear cover. The two magneto drives project to port and starboard from a narrow section of the cover situated below, and slightly to port of the centre of the two platforms. Displacement to port is necessitated by the impluse starter coupling, which is situated between the starboard magneto and its drive.

**28.** The oil pump mounting face is situated below the magneto drives. On Mk. 1 variants, an oil drain pipe is bolted to an opening at the

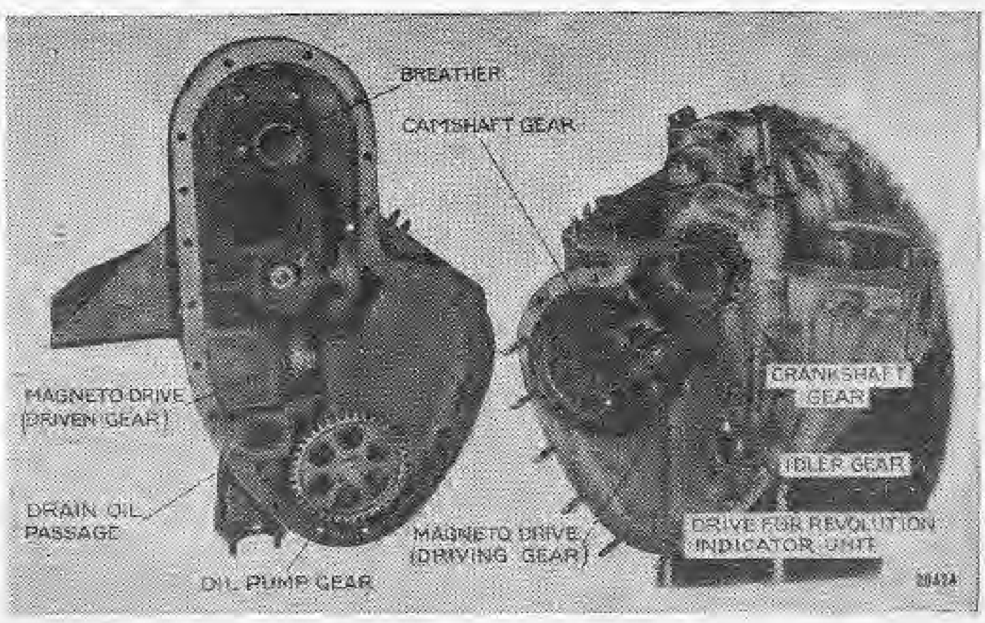
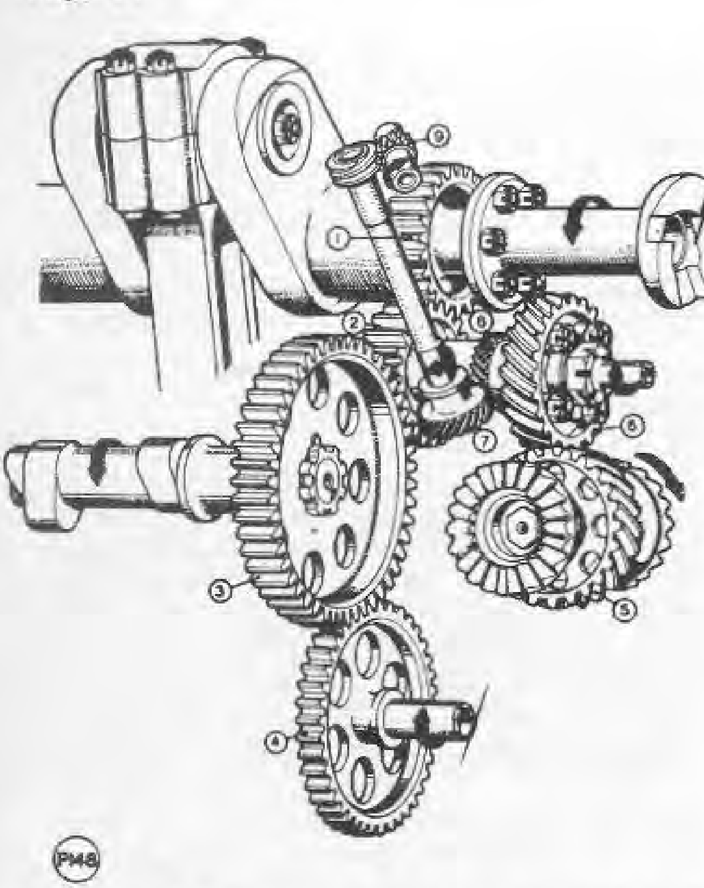



Fig. 9. Timing cover and timing gear (Pre-mod. 1876)




1 FIRST TIMING GEAR
2 INTERMEDIATE GEAR
3 CAMSHAFT TIMING GEAR
4 OIL PUMP DRIVING GEAR
5 MAGNETO DRIVEN GEAR
6 MAGNETO DRIVING GEAR
7 TACHOMETER DRIVING GEAR
8 TACHOMETER SPIRAL GEAR ON INTERMEDIATE GEAR
9 TACHOMETER DRIVEN GEAR

**Fig. 10. Timing gear, magneto, tachometer and oil pump drives**

lowest point of the timing gear cover, and on Mk. 7 engines the settling tank is bolted to this opening.

**29.** The mounting for the electric starter is situated in the centre of the cover in line with the crankshaft. On Mk. 1 variants, this mounting face is permanently blanked off, but on Mk. 7 engines a starter adapter is secured to the timing gear cover and the electric starter is mounted on the rear face of this adapter.

**30.** The tachometer drive components are carried in the timing gear cover with the drive connection(s) situated to port, and the engine breather connection consists of an elbow secured by studs to the upper part of the cover.

**Timing gear, magneto, tachometer, and oil pump drives** *(fig. 9 and 10)*

**31.** For the purpose of this description the numbers quoted in parenthesis in para. 32 to 44 refer to the annotations in fig. 10, although additional illustrations of the separate drive assemblies are also given.

*First timing gear*

**32.** The first timing gear (1), which is secured to the rear end of the crankshaft, is the first driving gear for the whole of the drives group. This gear, together with the starter dog on Mk. 7 engines, and its method of attachment to the crankshaft are described in para. 21.

*Magneto drive (fig. 10 and 11)*

**33.** The magneto drive is taken from an intermediate gear (2) between the first

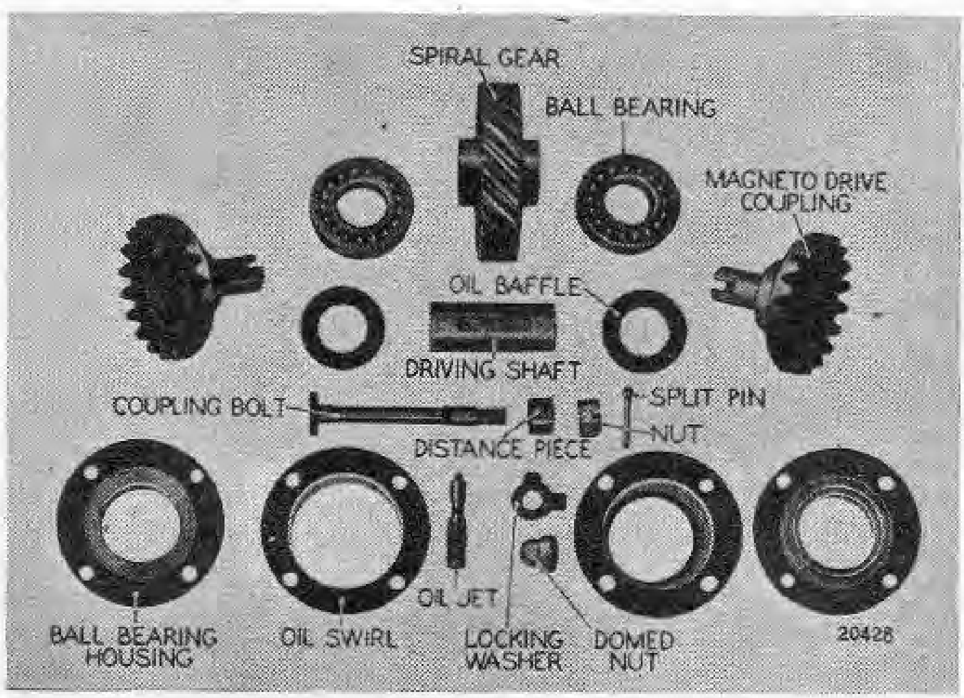


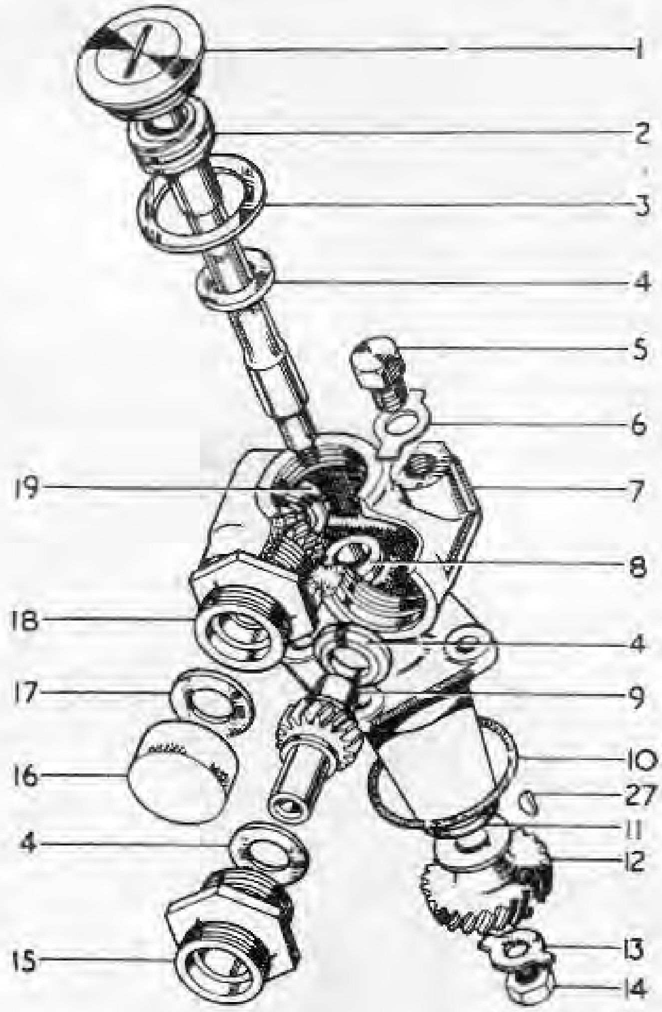

**Fig. 11. Magneto drive**

timing gear and the camshaft timing gear (3). A hollow shaft, integral with the intermediate gear, is fitted internally with two plain bearings which rotate on a stationary spindle secured to the rear of the crankcase. The other end of the spindle is supported in a bushed hole in the timing gear cover. The magneto driving gear (6) is bolted to a flange at the rear end of the hollow shaft. At the front of the shaft, between the intermediate gear and the crankcase, is a ball thrust bearing which takes the end thrust from the spiral gear. The final magneto drive is provided by the magneto driven gear (5), which is mounted below, and at right angles to, the driving gear. The driven gear is situated in the centre of a hollow integral cross-shaft, which is keyed to a second hollow shaft, the latter being supported across the narrow section of the timing gear cover by two ball bearings. Two Simms couplings, one at either end of the cross-shaft, transmit the drive to the magnetos, positive radial location being ensured by keyways in the coupling hubs engaging the key already mentioned. The assembly is secured by a through-bolt, which also clamps the inner races of the ball bearings between the driven gear shaft and the back of the couplings. The hub of each coupling rotates in an oil retaining plate which is machined internally with a helical groove, for the purpose of returning escaping oil to the inside of the timing gear cover.

*Tachometer drive (fig. 12 and 13 and fig. 7 of chapter 14)*

**34.** Mk. 1 variants are fitted with either dual quarter-engine-speed, or dual engine-speed tachometer drives according to the requirements of the installation. The Mk. 7 engine is fitted with the dual quarter-engine-speed tachometer drive but one drive outlet is permanently blanked off so that in effect the Mk. 7 has a single quarter-engine-speed tachometer drive. In all cases, the drive is taken off a spiral gear (8) which is integral with the intermediate gear.

**35.** The quarter-engine-speed tachometer drive (*fig.* 12) consists of an encased driving shaft, the lower end of which projects inside the timing gear cover and is driven through spiral gears by the intermediate gear, whilst another spiral gear, formed integrally with the shaft at its upper end, drives the two tachometer driving gears at right angles.

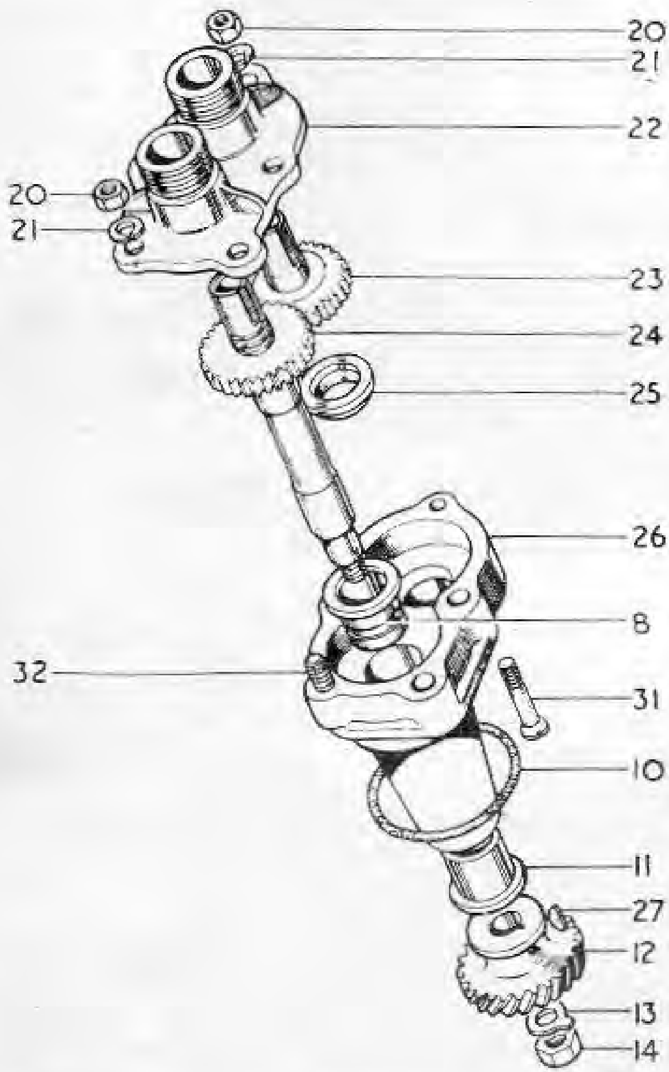



1 HOUSING CAP
2 DRIVING SHAFT
3 WASHER FOR HOUSING CAP
4 ADJUSTING WASHER
5 CASING PLUG
6 TAB WASHER FOR PLUG
7 CASING
8 OUTER BUSH
9 DRIVEN GEAR
10 JOINT WASHER
11 INNER BUSH
12 DRIVING GEAR
13 LOCK WASHER
14 PLAIN NUT
15 BEARING
16 BLANKING CAP (MK. 7 ONLY)
17 WASHER (MK. 7 ONLY)
18 BEARING
19 SHORT BUSH
27 KEY

**Fig. 12. Dual tachometer drive—quarter engine speed**

**36.** The magnesium alloy casing is in the form of a long barrel, bored centrally, with a flange and spigot at the middle. The casing encloses the driving shaft, and is surmounted by an upper housing for the two tachometer driving gears. The steel driving shaft, which is hollow for most of its length, rotates in bronze bushes which are pressed into the bore from each end of the casing, the requisite end float being obtained by an adjusting washer at the top end of the shaft. The spiral driving gear is keyed to the shaft and retained by a tab-washered nut.

**37.** The inner end of each of the tachometer driving gears is carried in a flanged phosphor-bronze bush which is pressed into a recess in the upper part of the casing, whilst the outer end works in an aluminium bush. The latter is screwed into the casing and is formed with a screwed adapter to take the flexible drive connection. Adjusting washers which permit the requisite amount of end float are fitted between collars on the tachometer driving gears and the inner end of the bushes. Spiral oil grooves are cut within these bushes to oppose the outward flow of oil, and the bushes are identical in all respects except the handing of the spiral oil grooves.




| | | | |
|---|---|---|---|
| 8 | OUTER BUSH | 22 | COVER |
| 10 | JOINT WASHER | 23 | AUXILIARY GEAR |
| 11 | INNER BUSH | 24 | DRIVING SHAFT |
| 12 | DRIVING GEAR | 25 | SHORT BUSH |
| 13 | LOCK WASHER | 26 | HOUSING |
| 14 | PLAIN NUT | 27 | KEY |
| 20 | PLAIN NUT | 31 | COUNTERSUNK SCREW |
| 21 | SPRING WASHER | 32 | STUD |

**Fig. 13. Dual tachometer drive—engine speed**

**38.** The engine-speed tachometer drive (*fig.* 13) which is of the straight type, also enables two tachometers to be driven. The casing encloses the driving shaft and gears, and is provided with a cover in which the upper ends of the shafts are located. The spiral driving gear at the lower end of the driving shaft is fitted in the manner already described. Screwed bosses are provided on the cover for the attachment of the flexible drive connections. The complete unit is retained on the timing gear cover by studs which pass through both the casing and its cover.

**39.** The driving shaft rotates in bronze bushes which are pressed into the bore of the casing, the shaft being located by the inner face of the spiral driving gear at the lower end, the lower face of the integral gear at the upper end. The lower end of the auxiliary gear also rotates in a bronze bush, whilst the upper ends of both driving shafts and auxiliary gear rotate in plain bearings formed within the cover. Spiral oil grooves are provided around the upper ends of both shaft and gear to prevent oil from working up the flexible drive casing and reaching the instruments in the cockpit.

*Oil pump driving gear*

**40.** The oil pump driving gear (4) is attached directly to the oil pump shaft and meshes with the camshaft timing gear. The shaft is adequately supported inside the pumps and no additional bearings are required.

## CYLINDER GROUP

**Cylinder barrels** (*fig.* 14 *and* 15)

**41.** The four cylinder barrels are machined from carbon steel forgings and are identical. The external surface is closely finned over the greater part of the cylinder, to provide rapid heat dissipation. Four semi-circular grooves are cut along the length of the cylinder fins to accommodate the holding-down studs. A spigot, to enter the aperture in the crankcase facing, is formed at the upper end; a machined collar on the cylinder limits the depth of entry into the aperture. The spigot diameter is stepped up immediately adjacent to the collar, and is ground to size so as to locate the cylinder within the crankcase aperture. The joint between the collar and the facing is made with a moulded synthetic rubber ring. The inwardly projecting length of the spigot forms an oil dam

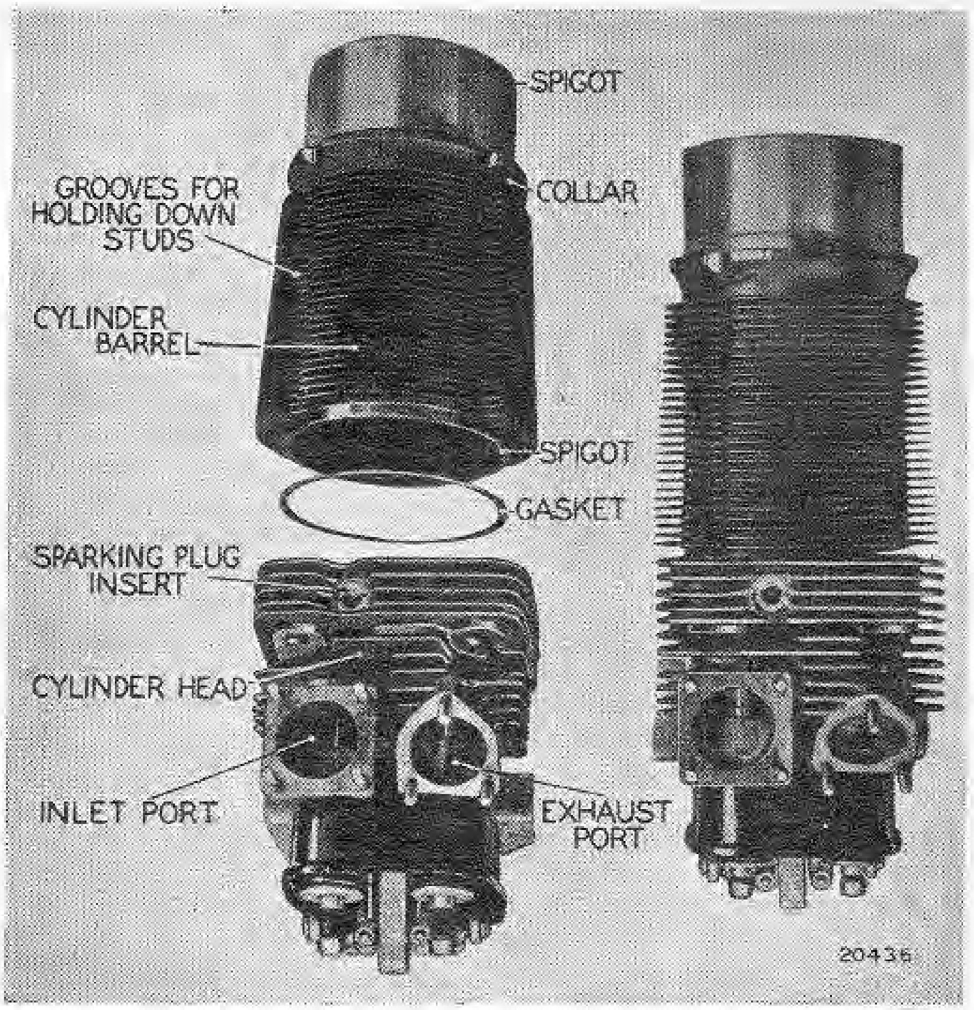



**Fig. 14. Cylinder barrel and aluminium alloy cylinder head**

which prevents oil from flooding the cylinder. Each barrel is securely clamped between its cylinder head and the crankcase by four high-tensile steel studs, the head being located by a spigot on the barrel. A copper-asbestos washer is employed between the barrel and the head to ensure a gas-tight joint.

#### Cylinder heads (*fig.* 14, 15 *and* 17)

**42.** The cylinder heads are also finned externally for cooling purposes. The cylinder heads of the Mk. 1 engine are machined from aluminium bronze castings and may be easily recognised by their bronze colour. The cylinder heads of Mk. 1C, 1F, and 7 engines are machined from aluminium alloy castings and the fins on the outside of the head are extended to envelop both the inlet and exhaust ports, those on the Mk. 1 aluminium bronze head envelop the exhaust port only. The valve seats are cut directly in the aluminium bronze of the Mk. 1 cylinder heads, but in the Mk. 1C, 1F, and 7 aluminium alloy cylinder heads, two valve seat inserts of high thermal expansion steel are shrunk into the valve pockets. The exhaust insert is also screwed into position. The valves are on the longitudinal centre line, with the inlet valve behind the exhaust. The conical valve seats are machined at an included angle of 120 deg. The valve pockets terminate in faced flanges on the starboard side of the engine, the inlet flanges being vertical and the exhaust flanges facing downwards at an angle of 45 deg. Both flanges are fitted with studs for securing the manifolds and copper-asbestos gaskets are used to ensure gas-tight joints. A horizontal platform cast on the head across the two ports is bored to receive the phosphor-bronze valve guides and holes are drilled in the platform for attachment of the rocker bracket. In the aluminium alloy heads fitted to Mk. 1C, 1F, and 7 engines, brass sparking plug adapters are screwed and shrunk into the sides of the combustion chamber. Immediately below each starboard sparking plug aperture a 4 B.A. stud is fitted between the fins for the attachment of a thermocouple.

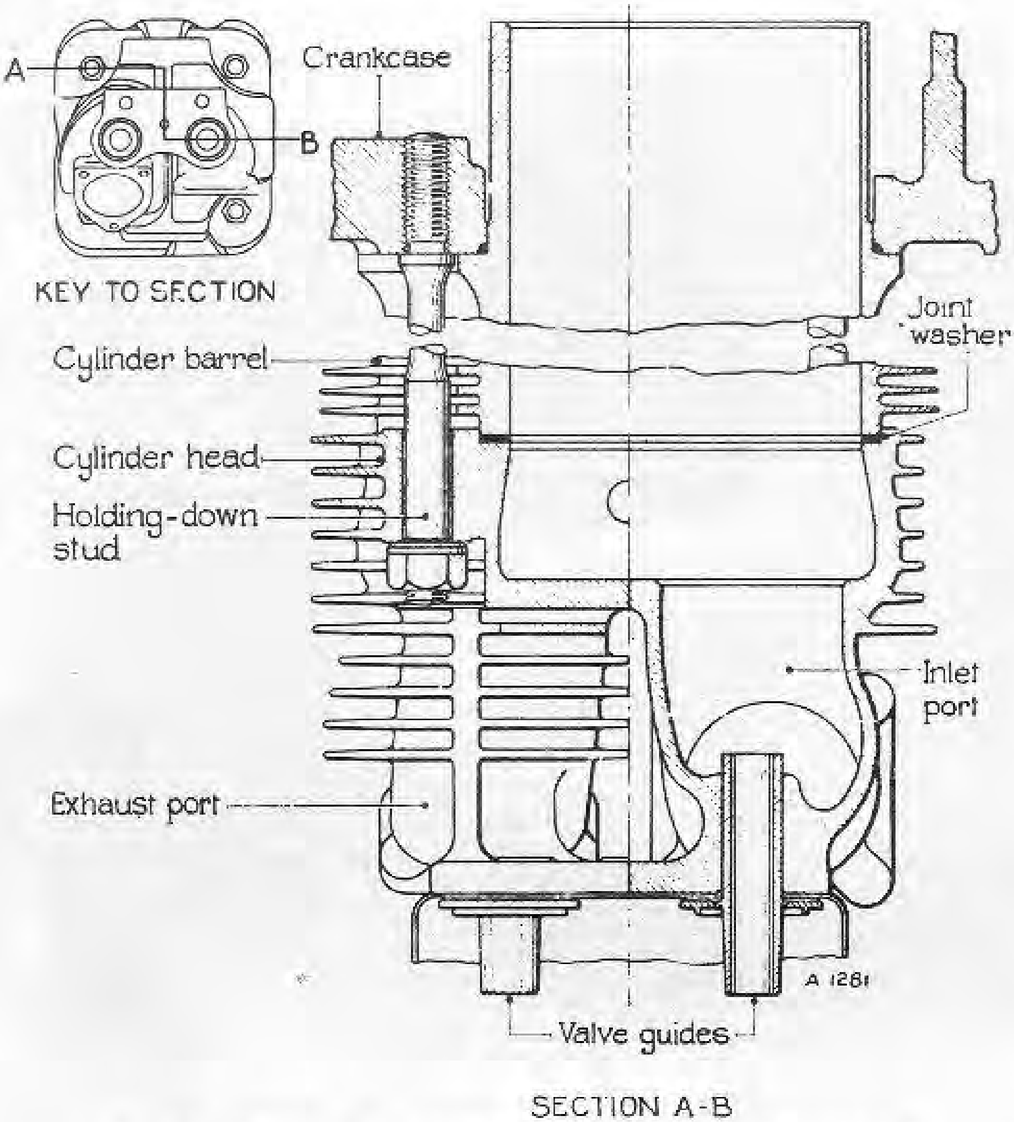



**Fig. 15. Section through cylinder head/cylinder barrel joint**

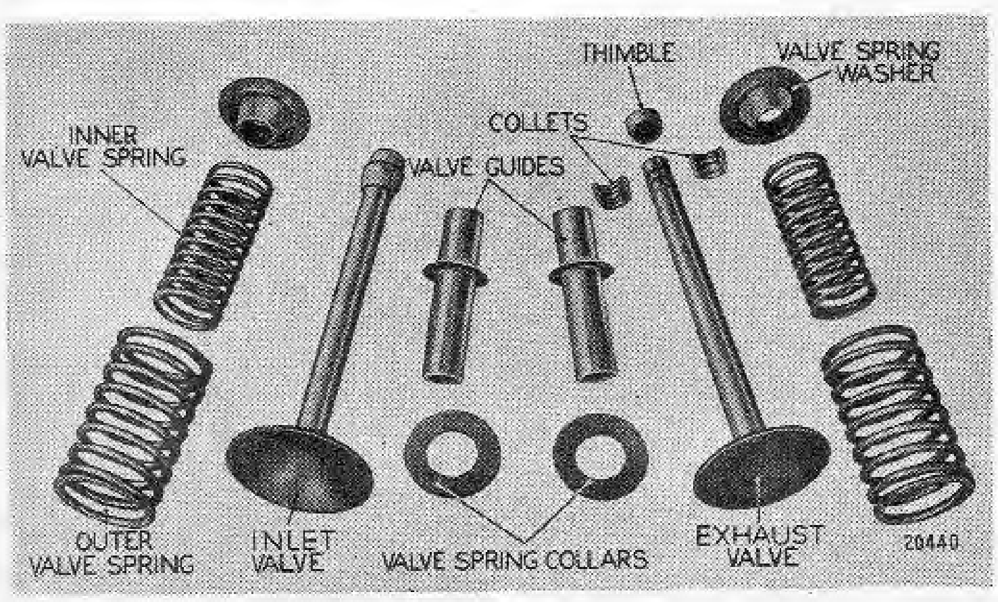



**Fig. 16. Valves, valve guides and springs**

#### Valves and valve springs (*fig. 16 and 17*)

**43.** One inlet and one exhaust valve is fitted to each cylinder head. Both valves are made with an included face angle of 120 deg. The inlet valves are distinguishable from the exhaust by the formation of the valve head which, for inlet valves, is hollowed out to a depth of about ⅛ in., whereas in early engines the exhaust valve head is solid and in later type engines only slightly hollowed. The latest type exhaust valves are stellited on the seating face. The valve stems are capped with thimbles made of hardened nickel-chrome steel which provide the working surface for the valve rocker pads. The valves work in flanged phosphor-bronze guides which are a light driving fit in the housings bored in the cylinder head. In early-type engines, each guide, when driven into its housing, imprisons between its flange and the cylinder head facing an aluminium joint washer and the base of the rocker gear casing; the opposite surface of the flange is stepped to locate the inner ends of the two concentric valve springs. Later engines are fitted with modified guides having very small flanges which rest directly on the cylinder head. Suitable apertures are cut in the rocker gear casing to clear the guide flanges, the base of the casing resting on the cylinder head platform, and a separate flanged collar is fitted over the guides to accommodate the inner ends of the two concentric valve springs.

**44.** Two concentric valve springs are used to close each valve, the inner ends of the springs bearing on a steel collar (except on early type engines as mentioned in para. 43) which is fitted over the valve guides, the outer ends being located by a flanged collar secured to the end of the valve stem with a pair of conical split collets. Grooves which engage corresponding grooves in the valve stem are formed in the bore of the collets.

#### Valve rockers (*fig. 18 and 19*)

**45.** The two valve rockers, together with the push rods, transmit the motion of the cams to the valves. The rockers are forged steel levers pivoted in the centre and supported in pairs on a single bracket secured to the cylinder head by three bolts, which pass through the rocker platform. Originally these bolts were secured by slotted nuts

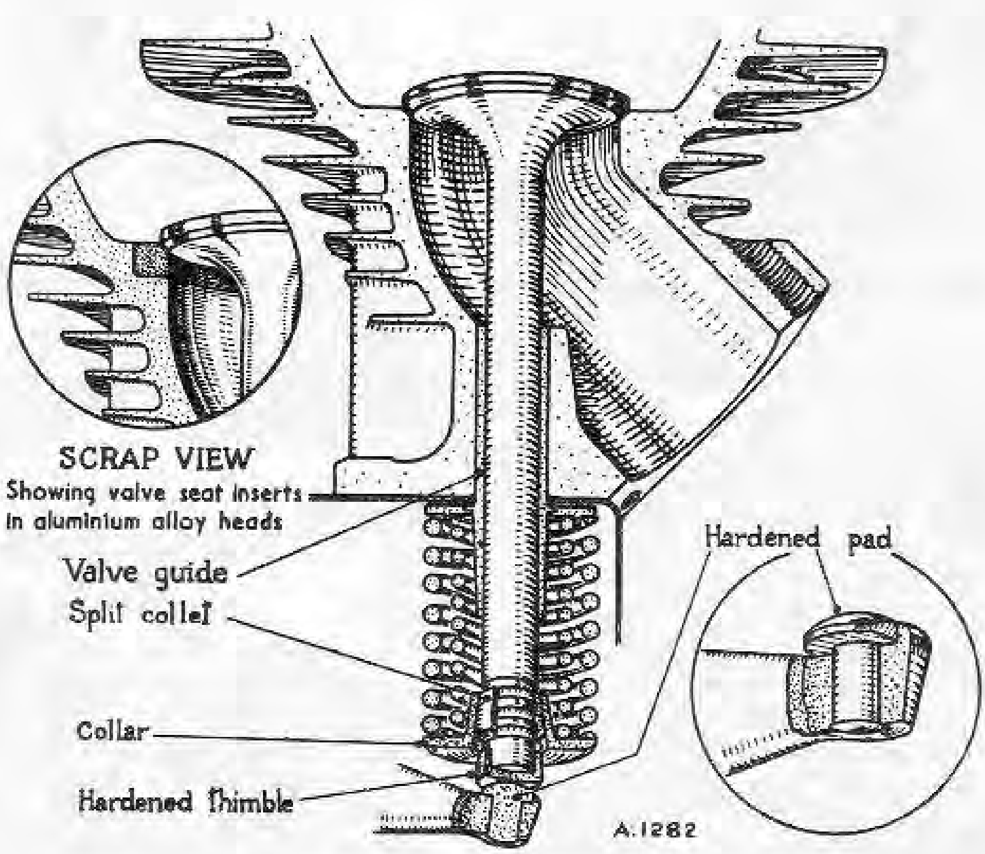



**Fig. 17. Assembly of valve in cylinder head**

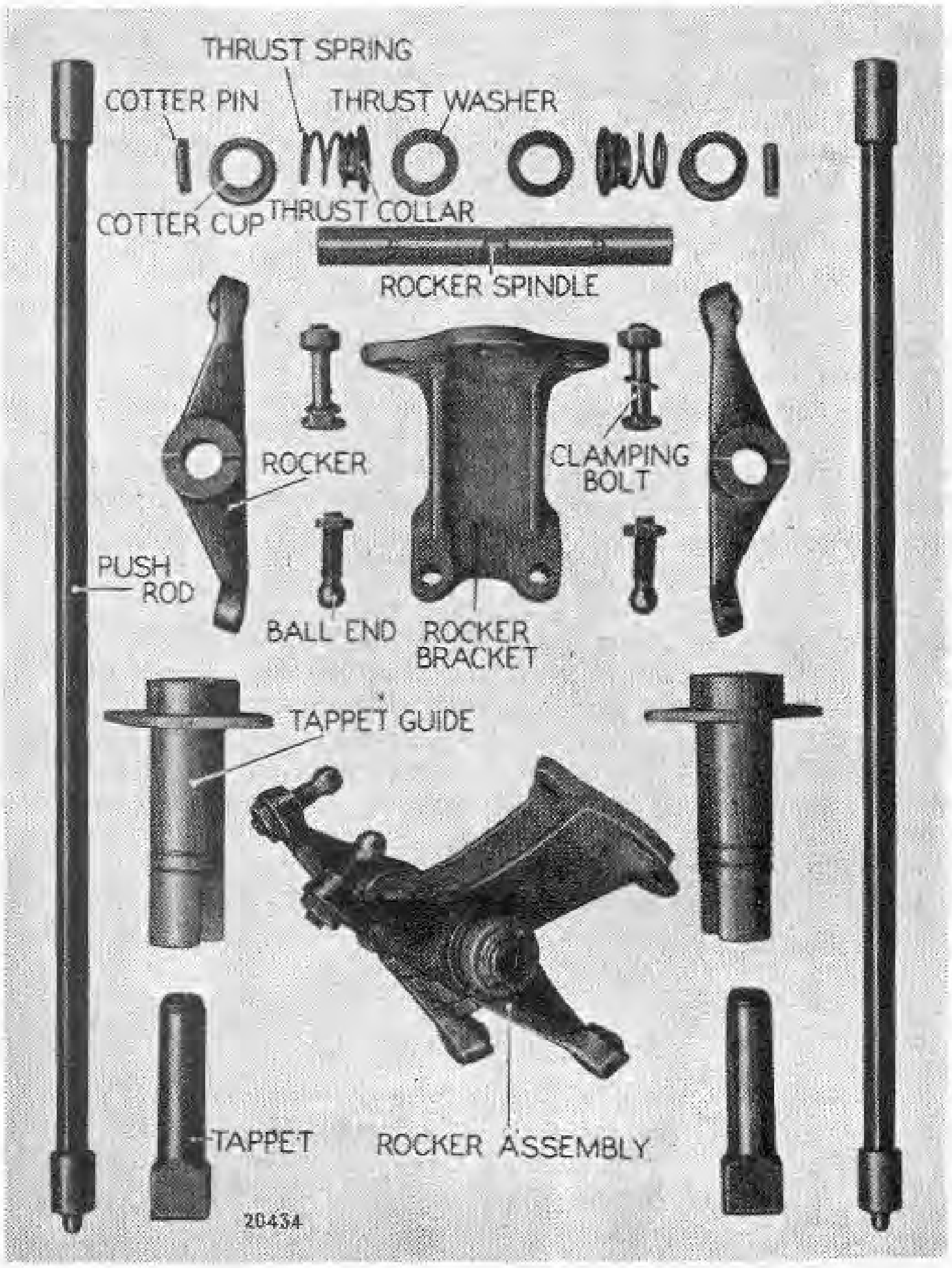



**Fig. 18. Old-type steel push-rods, tappets and guides, and rocker mechanism**

locked with split pins, but later they screwed into a tapped plate and were locked by tab-washers under their heads; in current practice, tab-washers lock the heads of these bolts, and plain nuts locked by a single locking plate secure them. A rocker pivot spindle is clamped in the lower end of the bracket and the two rockers are supported on phosphor-bronze bearings, one at each end of the spindle. Each rocker is held by a thrust spring and cup-washer, the assembly being retained by a cotter pin at each end of the spindle. One end of each rocker is fitted with an adjustable ball-ended hardened steel set-screw, which locates in the cup-end of the push rod. A small domed steel pad, which contacts the thimble on the end of the valve stem, is peened in the other end of the rocker arm. This pad is hardened to reduce wear.

**46.** A pressed steel casing and cover enclose the whole valve operating gear, the casing being secured to the cylinder head by the rocker bracket bolts. The cover is secured to the casing by one central captive screw. Leakage of oil at the cover joint and from the screw aperture is prevented by a synthetic rubber ring and an oil seal washer respectively. Protruding from the bottom of the cover and welded to it is a vertical vent pipe to which is attached a small collar for indicating the oil level required to lubricate the valve operating components.

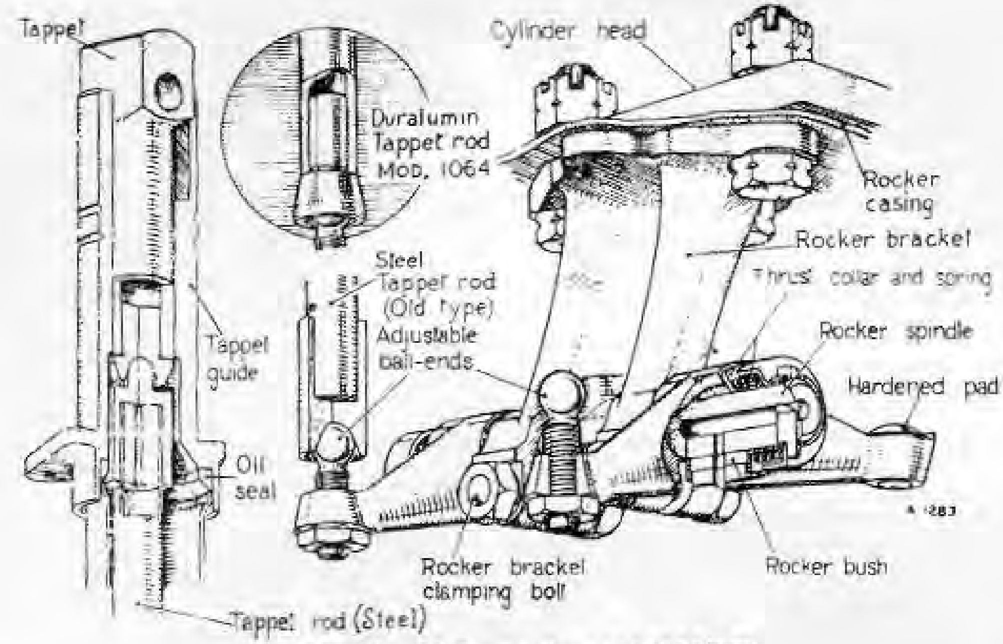



**Fig. 19. Valve rocker mechanism**

**Push rods** (*fig.* 18 *and* 19)

**47.** The push rods, prior to Gipsy Mod. G1064, consisted of steel tubes with plugged ends. Mod. G1064 introduced aluminium alloy push rods which may be identified by the ball and cup ends fitting *into* instead of *over* the rods (*fig.* 19). In both instances the tips are of case-hardened steel. The upper tip is spherical to engage the cup in the end of the tappet, the lower tip being cupped to receive the ball-end of the rocker adjusting screw. The push rods are enclosed in separate covers, each consisting of three aluminium tubes. The outer ends of the upper and lower tubes are belled, the upper to locate in a recess in the tappet guide, and the lower in a ferrule welded to the rocker casing. Synthetic rubber rings are used to prevent the escape of oil at these points. The cover assembly is completed by a centre tube of larger diameter, housing a coil spring, into which the inner ends of the upper and lower tubes are inserted to butt against the spring, forming an oil-tight telescopic casing for the push rod.

**Pistons, piston rings, and gudgeon pins** (*fig.* 20 *and* 21)

**48.** The four slipper-type, flat-crowned pistons of the Mk. 1 and Mk. 1F engines are machined from heat-treated aluminium alloy castings. The pistons of the Mk. 1C and 7 are machined from aluminium alloy forgings and have a higher piston crown to provide the higher compression ratio employed in these Marks. To withstand the increased operating loads, the Mk. 1C and 7 pistons are considerably strengthened, particularly in the region of the gudgeon-pin bosses, and the gudgeon-pin is similarly strengthened by a thickening in the bore. These differences are clearly illustrated in fig. 20 and 21. The gudgeon-pin is supported by two substantial webs which transmit the thrust directly from the crown of the piston to the gudgeon-pin. The latter is made of high-tensile steel and located endwise in the gudgeon-pin bore by a thrust washer and circlip at each end. Three piston rings of rectangular section, two of which are compression rings and the third a scraper ring, are all situated in grooves between the gudgeon pin and the piston crown, the scraper ring being nearest the gudgeon pin. A recess in which oil collects is formed between the stepped-down portion of the scraper ring, which must face the gudgeon pin, and a similar step in the ring groove. The oil then drains to the inside of the piston through two rows of holes drilled radially in the stepped portion of the piston ring groove.

**Connecting-rods** (*fig.* 22)

**49.** The connecting-rods are machined from aluminium alloy forgings, the shank being of a substantial "I" section. The big-end is split in the plane of the crankpin centre line, the cap being held to the rod by four bolts and nuts locked with split pins. Except in early engines which had white metal-lined phosphor-bronze big-end bearings, a split, steel-backed, white-metal lined bearing is fitted in each big-end and is prevented from rotating by a dowel in the connecting-rod half of the bearing. End float is prevented by flanges round the edges of the bearing shells. With each crankshaft revolution, two oil holes drilled in the bearing shells and big end align with a radial hole in the crankpins and allow the escape of pressure oil into the crankcase to provide splash lubrication for the cylinder walls and the camshaft. The small end of the connecting rod is unbushed and is provided with a drilled hole to lubricate the gudgeon-pin. This oil hole is drilled on the centre axis of the connecting-rod, but on later type rods, introduced by Mod. No. 1607, this single hole is replaced by two slightly smaller holes drilled at 45 deg. to the centre axis.

### MISCELLANEOUS

**Cooling system** (*fig.* 23)

**50.** An engine cooling system, consisting of an airscoop and an arrangement of baffles, is employed to direct air round the finned cylinder barrels and heads and so utilize for cooling purposes the air entering the engine cowling during flight. An airscoop is fitted along the port side of the cylinders into which air enters through the open front end, which is aligned with an opening in the engine nose cowl. A back-plate closes the rear end of the

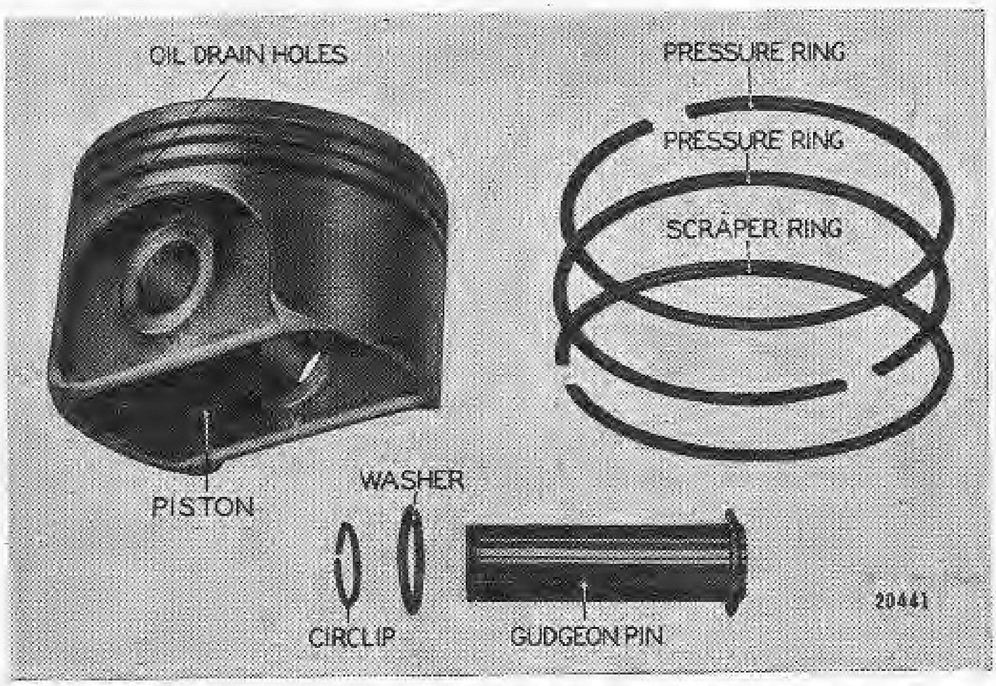



**Fig. 20. Piston, gudgeon pin and piston rings, Mk. I and Mk. IF**

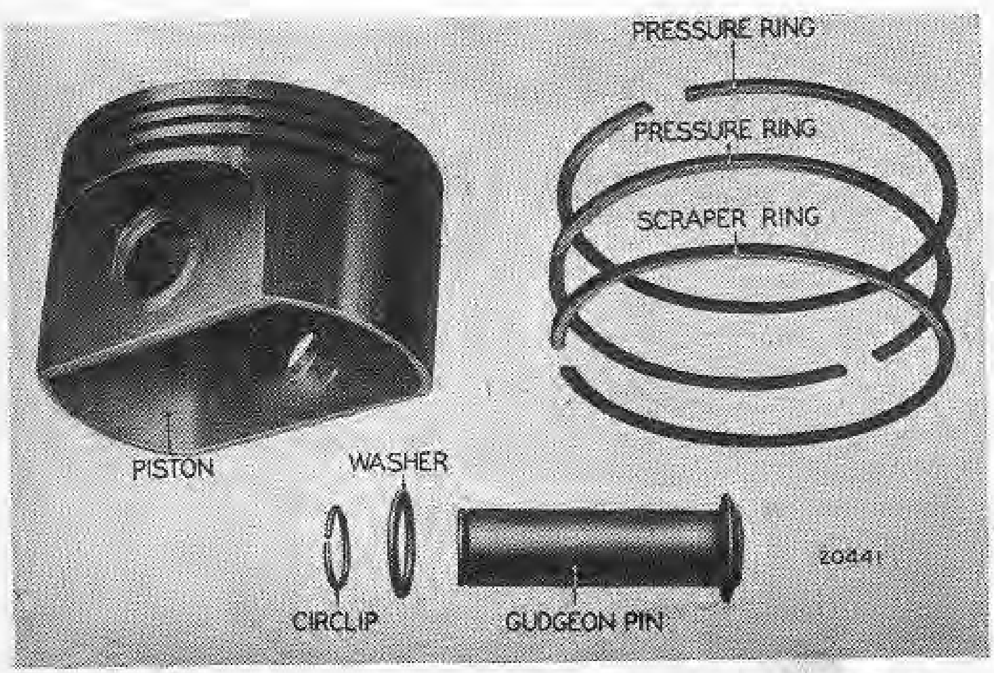



**Fig. 21. Piston, gudgeon pin, and piston rings, Mk. IC and Mk. 7**

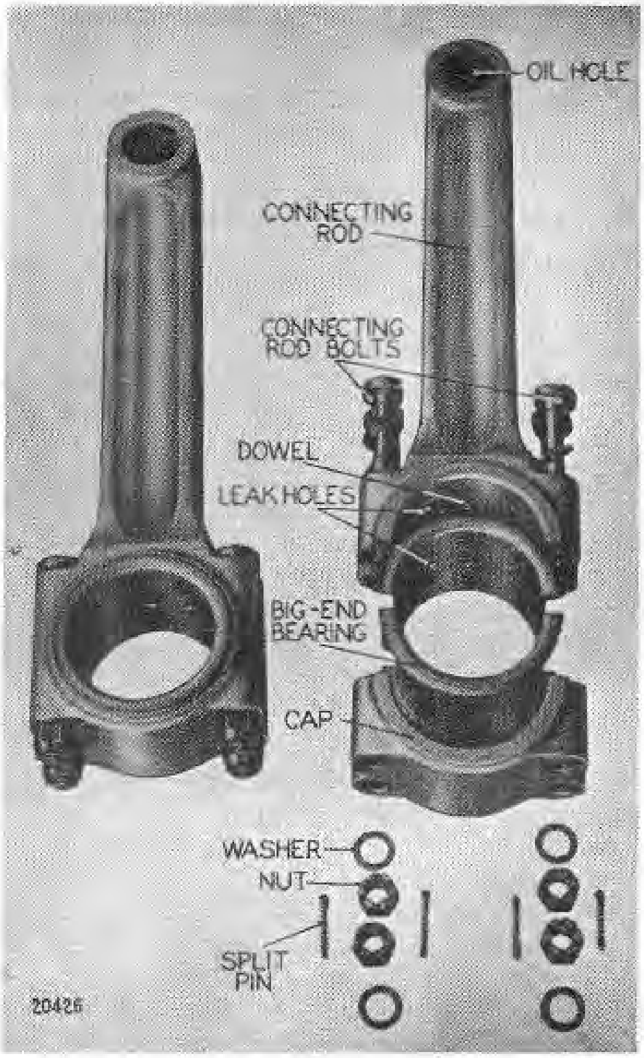



**Fig. 22. Connecting-rods**

airscoop and causes a pressure to be built up. The air then flows across the engine through gaps between the cylinders to the region of low pressure on the starboard side of the engine. Inter-cylinder baffles across the starboard side of the gaps prevent the immediate escape of air until it has flowed completely round each cylinder. It then escapes between the baffles and leaves the engine cowling through suitably placed exits at the rear.

**Airscoop** (*fig* 24 *and* 25)

**51.** The airscoop, which is made in two parts from aluminium sheet, is secured to upper and lower support plates by long draw-wires. The upper support plate is bolted to the underside of the crankcase and the lower support plate takes the form of four cylinder head baffles* bolted one to each of the four rocker casings. The draw-wires pass through hinges rolled on the edge of the airscoop and support plates and are secured by locking pins attached to brackets riveted to the assembly. Mod. No. 1727 introduces an improved type of airscoop for the Mk. 7 engine which is secured to studs in the crankcase at its upper location, and to supporting plates on the cylinder heads at its lower location. It is divided horizontally to facilitate easy removal of the lower portion which is secured both to the cylinder head support plates, and to the upper portion by

** On Mk. 7 engines, Mod. 2017 introduces improved cylinder head baffles using a thinner gauge sheet steel in place of aluminium alloy, and fitted with single swivel clips in place of swivel bolt brackets.*

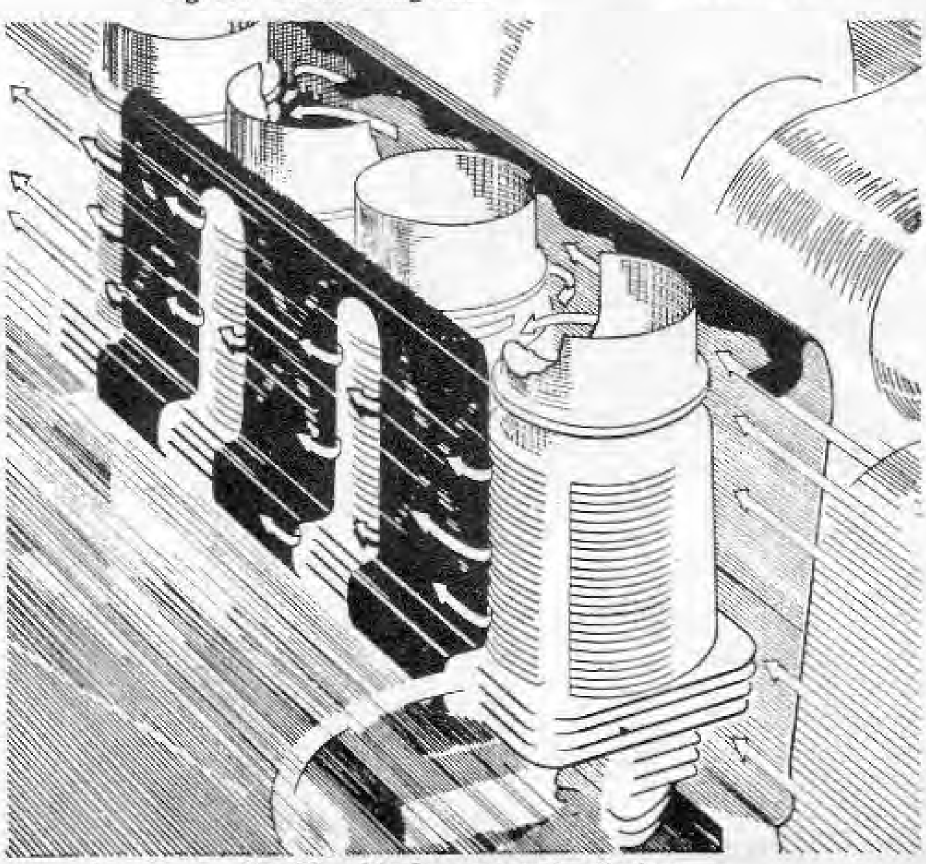


**Fig. 23. Air flow around cylinders**

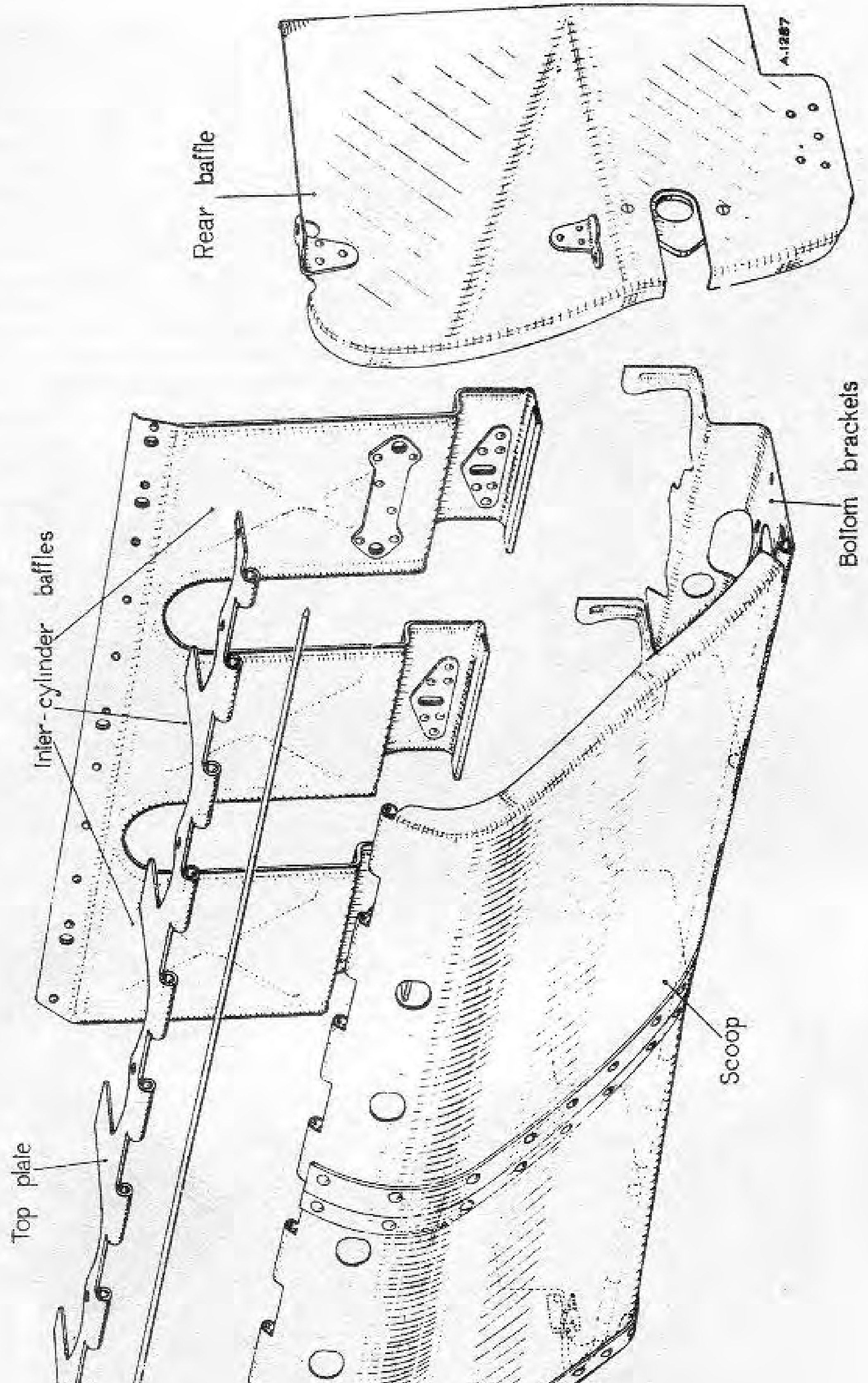



**Fig. 24. Airscoop and baffles, Mk.**

wing nuts to provide a quickly detachable panel for access to the cylinder heads and sparking plugs.

**Back-plate**

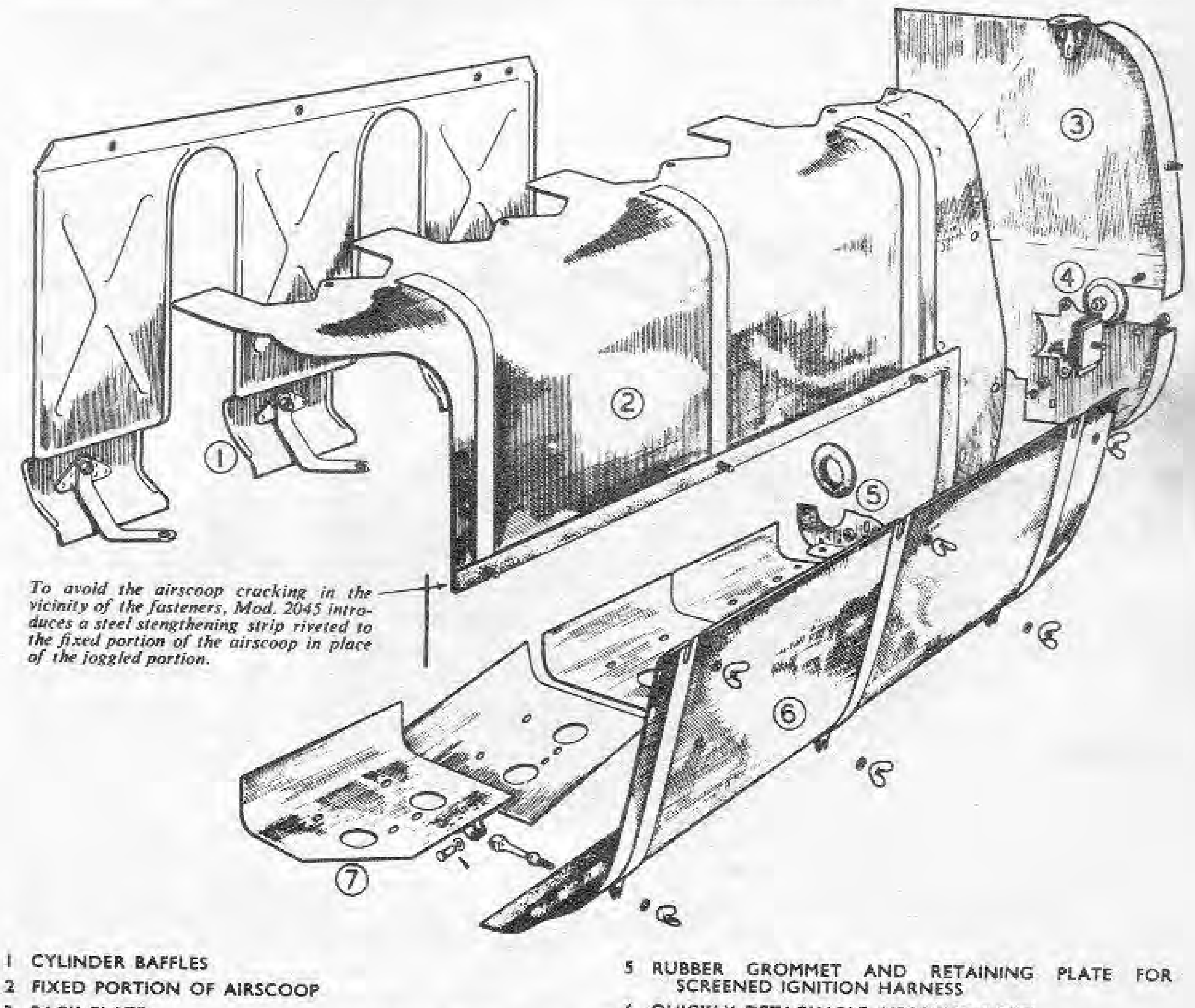
**52.** The back-plate is bolted to the upper airscoop support plate and to the rear cylinder head baffle by two brackets riveted to the back-plate. A lip around the edge of the airscoop fits over the outer edge of the back-plate to support it against the pressure of air. When Mod. No. 1727 is embodied, the airscoop back-plate on the Mk. 7 engine is secured to the crankcase and to the fixed portion of the airscoop. It contains apertures for the ignition harness, either screened or unscreened, the redundant aperture being blanked by a small metal disc and rubber grommet.

**Cooling baffle**

**53.** The three cylinder baffles are made from a single sheet of aluminium and are so constructed that they are joined along the top edge by which they are bolted to the side of the crankcase immediately above the cylinders. The bottom edges of the baffles are anchored to the cylinder heads by brackets.

**Propeller hub** (*fig.* 25)

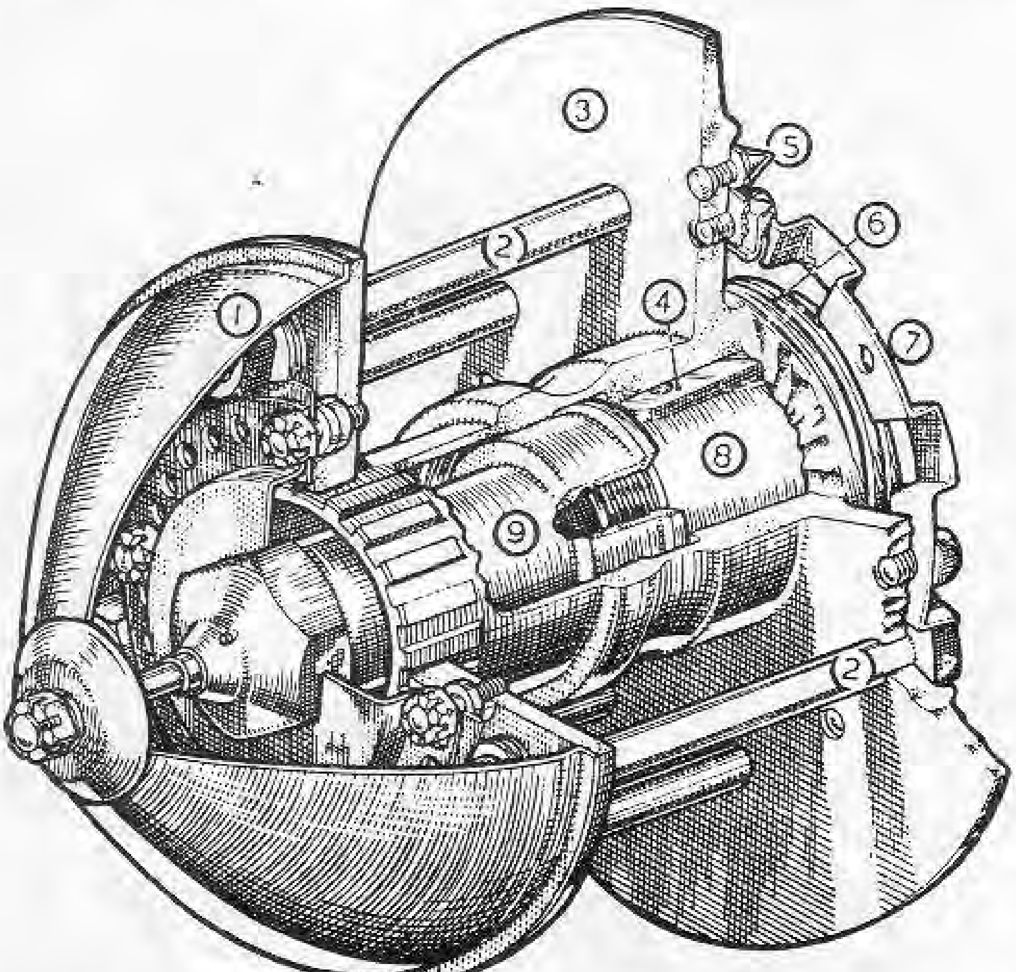
**54.** The propeller hub, which is mounted on the front end of the crankshaft, consists of three main components, the hub, the nave plate, and the nose cap or spinner. As already stated, the hub is keyed to the tapered extension of the crankshaft front end and is retained by a nut. Internally, the hub




1 CYLINDER BAFFLES
2 FIXED PORTION OF AIRSCOOP
3 BACK PLATE
4 REDUNDANT APERTURE FOR UNSCREENED IGNITION HARNESS BLANKED OFF
5 RUBBER GROMMET AND RETAINING PLATE FOR SCREENED IGNITION HARNESS
6 QUICKLY DETACHABLE AIRSCOOP PANEL
7 AIRSCOOP SUPPORT PLATES (pre-mod. 2017)

**Fig. 25. Airscoop and baffles Mk. 7 (Mod. 1727 and pre-mod. 2045)**

is machined with a taper slightly smaller than the crankshaft taper, the difference in the taper angle being of the order of two minutes. A maximum grip of the hub on the crankshaft is thus obtained at the large end of the hub taper. A large diameter flange, formed towards the rear end of the hub, is drilled for the reception of the eight hub bolts which are inserted from the rear of the flange. The bolts are prevented from turning by a channelled lock-plate of pressed steel which fits over the heads of the bolts and is secured to the flange of the hub by eight set-bolts, the set-bolts being locked by tab washers. The rear end of the hub enters the front cover and an oil-retaining groove, cut on the outside diameter of the hub, working in conjunction with the bore in the front cover prevents the escape of oil. A screwed-in and riveted timing pointer is fitted on the rear face of the hub flange to register with timing markings on the rim of the front cover. Female splines in the nave plate engage male splines on the hub and relieve the hub bolts of any torsional load. Four studs and split-pinned slotted nuts secure two locking plates, which lock the hub-bolt nuts at the retaining nut, to the nave plate. The retaining nut carries a stud to which the spinner is attached. To prevent crushing of the wooden propeller by overtightening of the hub bolts, Mod. No. 2085 introduces on Mk. 7 engines, two friction discs which are assembled one between the front face of the hub and the rear face of the propeller and the other between the front face of the hub and the nave plate.




1 NOSE CAP OR SPINNER
2 HUB BOLT
3 HUB
4 CRANKSHAFT KEY
5 TIMING POINTER
6 OIL RETURN GROOVE
7 HUB BOLT LOCK PLATE
8 TAPERED END OF CRANKSHAFT
9 HUB RETAINING NUT

**Fig. 25. Sectioned propeller hub (pre-mod. 2085)**