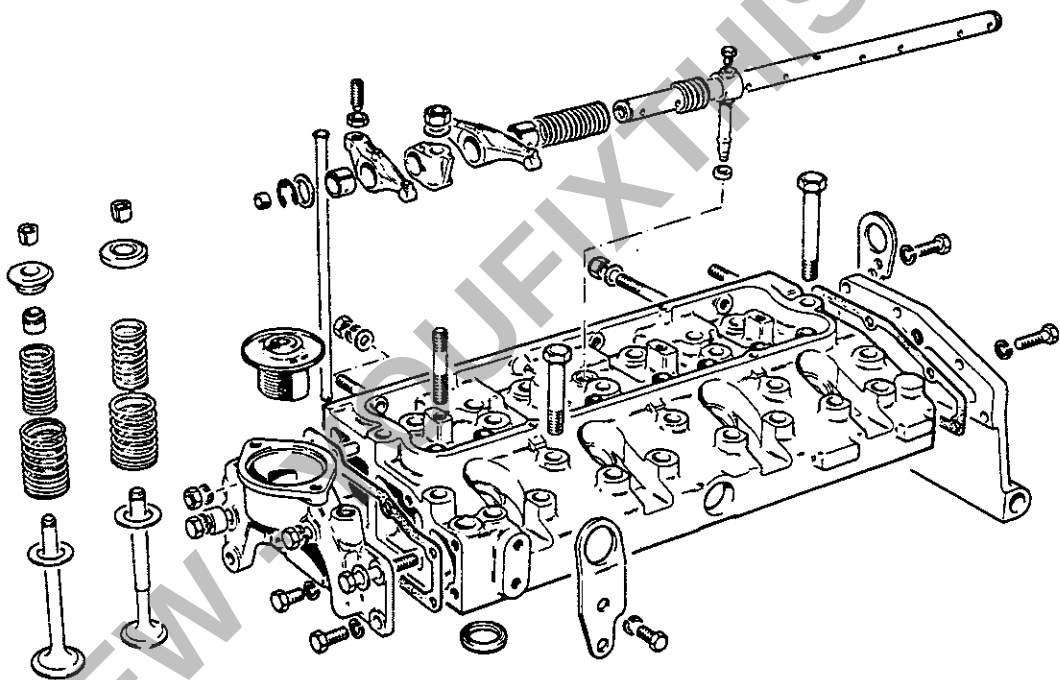


# INDEX

|                                  |     |                                     |          |
|----------------------------------|-----|-------------------------------------|----------|
| Alternator,                      |     | Periodical Attention                | C2       |
| Data                             | S10 | Refitting                           | L3       |
| Fault Finding                    | S2  | Foreword                            | 4        |
| Maintenance                      | S2  | Flywheel, Refitting                 | P2       |
| Precautions                      | S2  | Frost Precautions                   | C3       |
|                                  |     | Fuel Specification                  | B2       |
| Balancer Unit                    | H7  | Fuel System, Description            | N2       |
| Bearing, Connecting Rod, Data    | F5  |                                     |          |
| Bearing, Main                    |     |                                     |          |
| Assembly                         | H2  | Gasket, Cylinder Head, Refitting    | E3       |
| Data                             | H6  | Gear, Camshaft,                     |          |
| Belt, Fan,                       |     | Data                                | J6       |
| Adjustment                       | M4  | To Refit                            | J3       |
| Periodical Attention             | C2  | Gear, Crankshaft, Data              | J6       |
| Block, Cylinder, Data            | G3  | Gear, Lubricating Oil Pump Drive,   |          |
| Bush, Connecting Rod, Small End, |     | Data                                | L6       |
| Data                             | F4  | To Refit                            | L4       |
| To Renew                         | F2  | Gear, Lubricating Oil Pump Idler,   |          |
| Bush, Rocker Lever,              |     | Data                                | L6       |
| Data                             | E5  | To Refit                            | L5       |
|                                  |     | Gear, Upper Idler,                  |          |
| Camshaft,                        |     | Data                                | J6       |
| Data                             | J6  | To Refit                            | J3       |
| To Refit                         | J4  | Governor and Distributor Drive,     |          |
| To Remove                        | J4  | Housing, Assembly                   | Q2       |
| Carburettor,                     |     | Housing, Data                       | Q4       |
| Assembly                         | N4  | Housing, Dismantling                | Q2       |
| Data                             | N8  | Housing, Removal                    | Q2       |
| Dismantling                      | N3  | Governor, Setting                   | Q2       |
| Float Level                      | N4  |                                     |          |
| Case, Timing, To Remove          | J4  |                                     |          |
| Case, Timing, Cover, To Remove   | J2  |                                     |          |
| Companies, Overseas              | 2   | Head, Cylinder,                     |          |
| Cooling System,                  |     | Data                                | E5       |
| Data                             | M4  | Overhaul                            | E2       |
| Description                      | M2  | Removal                             | E2       |
| Crankshaft,                      |     | Replacement                         | E3       |
| Assembly                         | H2  | Housing, Flywheel, Alignment Limits | P3       |
| Data                             | H5  | Hub, Upper Idler Gear,              |          |
| Overhaul                         | H3  | Data                                | J6       |
| Removal                          | H3  | To Refit                            | J3       |
|                                  |     |                                     |          |
| Data, Engine                     | B2  | Laying-Up, Engine Preservation      | C3       |
| Distributor                      |     | Liner, Cylinder                     |          |
| Condenser                        | R2  | Data                                | G3       |
| Data                             | R3  | To Refit                            | G2       |
| Description                      | R2  | Lubricating Oil,                    |          |
| Setting contact breaker points   | R2  | Approved Grades                     | Appendix |
| Fault Finding (Electronic)       | R5  | High Pressure, Fault Finding        | D2       |
| Dynamo,                          |     | Level, Periodical Attention         | C2       |
| Data                             | S11 | Low Pressure, Fault Finding         | D2       |
| Maintenance                      | S7  | Operating Pressure                  | B2       |
|                                  |     | Renewal, Periodical Attention       | C2       |
|                                  |     | System                              | L2       |
| Electrical Equipment, Data       | S11 |                                     |          |
| End Float, Crankshaft            | H2  | Marks, Gear Timing                  | K2       |
|                                  |     | Misfire, Engine, Fault Finding      | D2       |
| Fault Finding (General)          | D2  | Number, Engine, Location            | B2       |
| Filter, Fuel,                    |     |                                     |          |
| Periodical Attention             | C2  | Oil Cooler                          | L3       |
| Filter, Lubricating Oil,         |     | Overheating, Engine, Fault Finding  | D2       |
| Data                             | L6  |                                     |          |

# SECTION E

## Cylinder Head



## FAULT FINDING—D.2

### Fault Finding Chart.

#### Fault

|                              |     |     |     |     |
|------------------------------|-----|-----|-----|-----|
| Low cranking speed           | ... | ... | ... | ... |
| Will not start               | ... | ... | ... | ... |
| Stalls                       | ... | ... | ... | ... |
| Misfiring at idling speed    | ... | ... | ... | ... |
| Misfiring at high speed      | ... | ... | ... | ... |
| Misfiring on acceleration    | ... | ... | ... | ... |
| Loss of power                | ... | ... | ... | ... |
| Overheating                  | ... | ... | ... | ... |
| Low oil pressure             | ... | ... | ... | ... |
| High oil pressure            | ... | ... | ... | ... |
| Excessive crankcase pressure | ... | ... | ... | ... |
| Starts but stops             | ... | ... | ... | ... |
| Races on no load condition   | ... | ... | ... | ... |
| Erratic performance          | ... | ... | ... | ... |
| Noisy                        | ... | ... | ... | ... |
| High oil consumption         | ... | ... | ... | ... |
| Knocking                     | ... | ... | ... | ... |

#### Possible Cause

|                                                                                 |
|---------------------------------------------------------------------------------|
| 22, 31, 35, 38.                                                                 |
| 1, 5, 30, 31, 32, 35, 38, 39, 40, 41, 42, 43, 54, 55.                           |
| 1, 5, 28, 29, 37, 40, 41, 42, 44, 47, 48, 51, 52.                               |
| 1, 5, 28, 29, 34, 35, 36, 37, 39, 40, 41, 42, 43, 48, 52.                       |
| 1, 27, 28, 32, 34, 36, 37, 40, 41, 42, 46, 47, 50.                              |
| 1, 29, 32, 40, 42, 46, 50.                                                      |
| 1, 5, 6, 9, 10, 24, 28, 29, 30, 32, 33, 36, 37, 40, 41, 42, 46, 47, 50, 52, 54. |
| 9, 11, 12, 13, 14, 22, 30, 32, 46, 47, 49.                                      |
| 15, 16, 17, 19, 20, 21, 22, 23, 25.                                             |
| 18, 21, 22.                                                                     |
| 7, 8, 9, 24.                                                                    |
| 45, 53.                                                                         |
| 10.                                                                             |
| 36.                                                                             |
| 2, 25, 28.                                                                      |
| 3, 4, 7, 15, 18, 22, 24.                                                        |
| 25, 26, 27, 46.                                                                 |

### Key to Fault Finding Chart

- |                                                |                                                      |
|------------------------------------------------|------------------------------------------------------|
| 1. Dirty or incorrectly gapped sparking plugs. | 29. Worn, burned or pitted valves.                   |
| 2. Piston slap.                                | 30. Incorrect valve timing.                          |
| 3. Worn valve guides.                          | 31. Starter motor unserviceable.                     |
| 4. Sump overfilled.                            | 32. Incorrect ignition timing.                       |
| 5. Carburettor float setting incorrect.        | 33. Incorrect automatic advance.                     |
| 6. Exhaust system restricted.                  | 34. Unserviceable rotor arm.                         |
| 7. Partially choked breather pipe.             | 35. Battery not fully charged.                       |
| 8. Worn or sticking piston rings.              | 36. Distributor drive shaft worn.                    |
| 9. Cylinder head gasket blown.                 | 37. Distributor cam worn.                            |
| 10. Governor faulty or set wrongly.            | 38. Poor electrical connections.                     |
| 11. Thermostat stuck.                          | 39. Cracked distributor head.                        |
| 12. Fan belt slipping.                         | 40. Unserviceable H.T. coil or condenser.            |
| 13. Radiator or system partially blocked.      | 41. Unserviceable H.T. heads.                        |
| 14. Coolant level in system too low.           | 42. C.B. points dirty, pitted or incorrectly gapped. |
| 15. External oil leak.                         | 43. Damp H.T. leads.                                 |
| 16. Loose or restricted lubricating oil pipes. | 44. Air leak in induction manifold.                  |
| 17. Pressure relief valve sticking open.       | 45. Fuel tank vent blocked.                          |
| 18. Pressure relief valve sticking closed.     | 46. Incorrect grade fuel.                            |
| 19. Oil pump suction pipe faulty.              | 47. Dirt or water in carburettor.                    |
| 20. Oil pump worn.                             | 48. Idling speed incorrect.                          |
| 21. Pressure gauge incorrect.                  | 49. Weak carburettor mixture.                        |
| 22. Incorrect grade of lubricating oil.        | 50. Carburettor jets dirty or partially blocked.     |
| 23. Insufficient oil in sump.                  | 51. Choke adjustment incorrect.                      |
| 24. Worn bores.                                | 52. Idling mixture incorrect.                        |
| 25. Worn or damaged bearings.                  | 53. Vapour lock.                                     |
| 26. Piston striking a valve.                   | 54. Dirty or blocked fuel feed pipe.                 |
| 27. Broken valve spring.                       | 55. Carburettor flooded.                             |
| 28. Valve clearances incorrect.                |                                                      |

## GENERAL INFORMATION—B.2

### DATA

|                                                     |     |     |     |     |                                                                                                                      |
|-----------------------------------------------------|-----|-----|-----|-----|----------------------------------------------------------------------------------------------------------------------|
| Type                                                | ... | ... | ... | ... | Four cylinder. Four stroke                                                                                           |
| Bore                                                | ... | ... | ... | ... | 3.875 in (98,4 mm) — Nominal                                                                                         |
| Stroke                                              | ... | ... | ... | ... | 5 in (127 mm)                                                                                                        |
| Compression Ratio                                   | ... | ... | ... | ... | 7.5 : 1 Gasolene and LPG engines                                                                                     |
| Compression Ratio                                   | ... | ... | ... | ... | 11.5 : 1 (Natural gas engines)                                                                                       |
| Cubic Capacity                                      | ... | ... | ... | ... | 235.9 in <sup>3</sup> (3,86 litre)                                                                                   |
| Firing Order                                        | ... | ... | ... | ... | 1, 3, 4, 2.                                                                                                          |
| Tappet Clearance                                    | ... | ... | ... | ... | Inlet (cold) 0.012 in (0,30 mm)<br>Exhaust (cold) 0.015 in (0,38 mm)                                                 |
| Oil Pressure                                        | ... | ... | ... | ... | 30/60 lbf/in <sup>2</sup> (2,1/4,2 kgf/cm <sup>2</sup> ) at maximum engine speed<br>and normal operating temperature |
| Lubricating Oil Sump Capacity (less filter)         | ... | ... | ... | ... | High Level 14 U.K. pints 16.8 U.S. pints 7,9 litre                                                                   |
| Ignition Timing (A.C. Delco Distributor)            | ... | ... | ... | ... | 2 1/2° B.T.D.C. (Static)<br>12° B.T.D.C. at 1250 rev/min (Dynamic)                                                   |
| Ignition Timing (Lucas Distributor)                 | ... | ... | ... | ... | 3° B.T.D.C. (Static)<br>15° B.T.D.C. at 1400 rev/min (Dynamic)                                                       |
| Ignition Timing (Lucas Electronic Distributor)      | ... | ... | ... | ... | 24° B.T.D.C. at 1400 rev/min<br>(Static and Dynamic)                                                                 |
| Sparking Plug                                       | ... | ... | ... | ... | Champion N11Y 14 mm                                                                                                  |
| Sparking Plug Gap                                   | ... | ... | ... | ... | 0.025 in (0,64 mm)                                                                                                   |
| Sparking Plug Gap (Natural Gas Engines)             | ... | ... | ... | ... | Champion N180B 14 mm                                                                                                 |
| Sparking Plug Gap                                   | ... | ... | ... | ... | Not adjustable (Twin electrode)                                                                                      |
| Contact Breaker Points Gap (A.C. Delco Distributor) | ... | ... | ... | ... | 0.019/0.021 in (0,48/0,53 mm)                                                                                        |
| Contact Breaker Points Gap (Lucas Distributor)      | ... | ... | ... | ... | 0.014/0.016 in (0,35/0,40 mm)                                                                                        |
| Reluctor Gap (Lucas Electronic Distributor)         | ... | ... | ... | ... | 0.006/0.008 in (0,15/0,20 mm)                                                                                        |
| Fuel Specification (Gasolene Engines)               | ... | ... | ... | ... | 91 octane                                                                                                            |
| Fuel Specification (Natural Gas Engines)            | ... | ... | ... | ... | Methane gas at 15° and 101,3 kPa, 34,82 MJ/m <sup>3</sup> nett                                                       |

### Rating Details (Gasolene Engines)

|                      |     |     |     |                                     |
|----------------------|-----|-----|-----|-------------------------------------|
| Maximum Gross Output | ... | ... | ... | 78 bhp (58 kW) at 2600 rev/min      |
| Maximum Torque       | ... | ... | ... | 202 lbf ft (273 Nm) at 1250 rev/min |

### Rating Details (Natural Gas Engines)

|                      |     |     |     |                                     |
|----------------------|-----|-----|-----|-------------------------------------|
| Maximum Gross Output | ... | ... | ... | 74 bhp (55 kW) at 2000 rev/min      |
| Maximum Torque       | ... | ... | ... | 206 lbf ft (280 Nm) at 1400 rev/min |

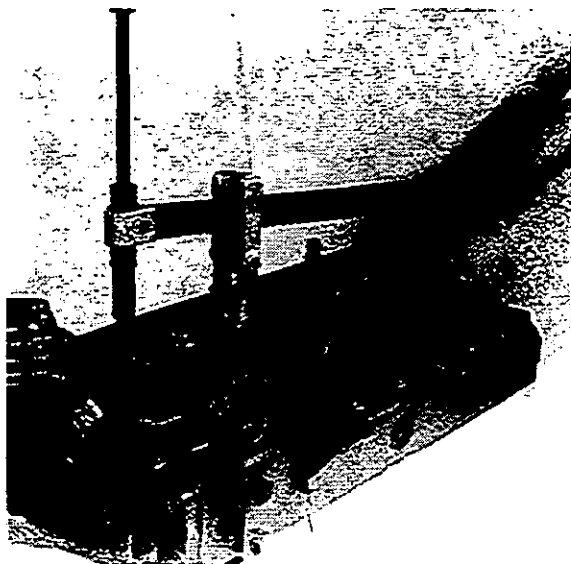
### Recommended Torque Tensions

| Component                                             | Screw<br>Size UNF | lbf ft | kgf m | Nm  |
|-------------------------------------------------------|-------------------|--------|-------|-----|
| Cylinder head nuts and setscrews                      | 1/2               | 96     | 13,2  | 130 |
| Big end nuts* (Cadmium plated)                        | 1/2               | 72     | 9,9   | 98  |
| Big end nuts† (Phosphated)                            | 1/2               | 92     | 12,6  | 125 |
| Main bearing setscrews**                              | 5/8               | 145    | 20,0  | 196 |
| Main bearing setscrews††                              | 5/8               | 171    | 23,5  | 232 |
| Camshaft gear retaining setscrew                      | 1/2               | 48     | 6,6   | 65  |
| Rockershaft Support Brackets (Aluminium)              | 7/16              | 30     | 4,1   | 41  |
| Rockershaft Support Brackets (Cast Iron)              | 7/16              | 54     | 7,4   | 74  |
| Idler Gear Hub to Block setscrews                     | 3/8               | 27     | 3,7   | 37  |
| Upper Idler Gear Hub nut (Plain)                      | 7/16              | 37     | 5,1   | 50  |
| Upper Idler Gear Hub nut (Cadmium plated)             | 7/16              | 42     | 5,7   | 57  |
| Crankshaft Pulley Retaining setscrew (Plain)          | 3/8               | 287    | 39,6  | 390 |
| Crankshaft Pulley Retaining setscrew (Cadmium plated) | 3/8               | 230    | 31,7  | 312 |
| Crankshaft Pulley Retaining setscrew (Phosphated)     | 3/8               | 276    | 38,0  | 375 |
| Crankshaft Pulley Retaining setscrews (3)             | 7/16              | 70     | 9,7   | 95  |
| Flywheel setscrews                                    | 1/2               | 77     | 10,6  | 105 |
| Governor Drive Gear Retaining Nut                     | 3/8               | 24     | 3,3   | 32  |
| Lubricating Oil Filter Setscrews                      | 7/16              | 28     | 3,8   | 38  |
| Sparking Plug                                         | 14mm              | 25     | 3,4   | 34  |

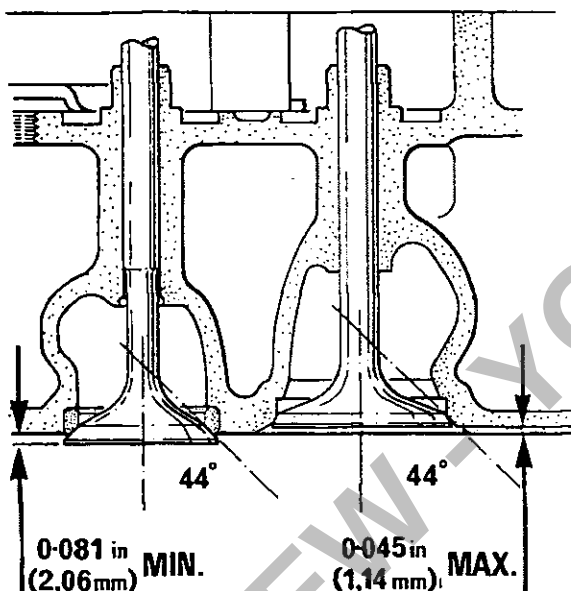
\*For engines preceding the following engine number.  
†For engines commencing at the following engine  
number 236UA1660A

\*\*For engines preceding the following engine number.  
††For engines commencing at the following engine  
number 236U671A.

## CYLINDER HEAD—E.2



E1



E2



E3

### To Remove Head

Drain water from radiator and cylinder block.  
Detach hose connections to water pump.  
Remove carburettor; vacuum advance pipe (where fitted) throttle linkage, fuel pipes, rear end plate assembly, alternator adjusting link, induction and exhaust manifolds.  
Remove H.T. leads, sparking plugs and breather pipe.  
Remove cylinder head cover and remove rocker shaft assembly.  
Remove cylinder head nuts and setscrews and remove head.

### To Remove Valves

Depress the spring cap and springs using a valve spring compressor and remove the two half conical collets (See fig. E.1).  
Remove the spring caps, rotators and on later engines, the seal (on exhaust valves).  
Remove inner and outer springs and inlet valve seals.  
Remove valves.

Valve faces and seats can be reconditioned using grinding compound. The valve face and seat angle is  $45^\circ$ . Do not unnecessarily grind valve seats. The maximum clearance between the head of the valve and the cylinder head face should not exceed 0.045 in (1.143 mm) below for the inlet valves and 0.081 in (2.06 mm) minimum above for the exhaust valves. Fig. E.2.

The inlet valve seat has a  $31^\circ 30'$  "flare" machined between the seat and the cylinder head.

Inserts are fitted to exhaust valve seats.

Mark all valves with a corresponding mark on the cylinder head to ensure that valves are refitted to their original positions unless replaced with new ones. Earlier engines had their valves and heads numbered during assembly as illustrated in Fig. E.3.

### Rocker Levers

Examine the rocker bush bores for wear. They should be an easy fit on the shaft without excessive side play. If the rocker bores are worn new rocker lever bushes must be fitted.

When dismantling rocker shaft assemblies note the order of assembly to facilitate re-build in the correct component order.

### Valve Bores

If valve bores are worn, valves with oversize stems should be fitted. Three service valves are available for both inlet and exhaust, with oversize stems of 0.003, 0.015 and 0.030 in (0.08, 0.38 and 0.76 mm) respectively. To fit oversize valves, the bores in the cylinder head must be reamed with a piloted reamer.

Where detachable valve guides are fitted, these can be replaced.

To fit new guides; clean the parent bore, smear the outer surface of the guide with clean oil and press home the guide until 0.594 in (15.10 mm) is protruding above the cylinder head. The guides are manufactured from cast iron and are brittle.

### Testing the 15ACR, 17ACR, 18ACR, 23ACR, A115/45, A133/55 LR and 9AR series in Position

First check the driving belt for condition and tension.

The nominal hot outputs at 6,000 rev/min (alternator speed) are given on Page S.11. These figures may be exceeded slightly when the alternator is running cold. To avoid misleading results, the following test procedure should therefore be carried out with the alternator running as near as possible to its normal operating temperature.

Fig. S.1. illustrates a Test Circuit for 15ACR and 17ACR alternators with standard terminations, battery-sensed.

Fig. S.2. illustrates a Test Circuit for 15ACR and 17ACR alternators with standard terminals and two piece connection plug (machine-sensed).

Fig. S.3 illustrates a Test Circuit for 15ACR, 17ACR, 18ACR, 23ACR, A115/45, A133/55 and LR series alternators with European terminations and single 3 terminal connector plug (machine-sensed). Broken line cable connection applies to battery-sensed, in which case, the connections between the two '+' terminals will not apply and the broken line terminal will be marked "S" instead of '+'.  
S.4 shows a test circuit for Motorola 9AR.

Value of components in Figs. S.1, S.2, S.3 and S.4 are as follows:—

1. 12 volt 2.2 watt bulb.
2. 0 — 60 ammeter
3. 12 volt battery
4. 0 — 20 moving coil voltmeter.
5. 0 — 15 ohm 50 amp variable resistor.

S.4 shows a test circuit for Motorola 9AR.

### Alternator Output Test with Regulator Inoperative

Withdraw the cable connector(s) from the alternator, remove the moulded cover (secured by two screws) and earth the regulator green lead or connector strip to frame.

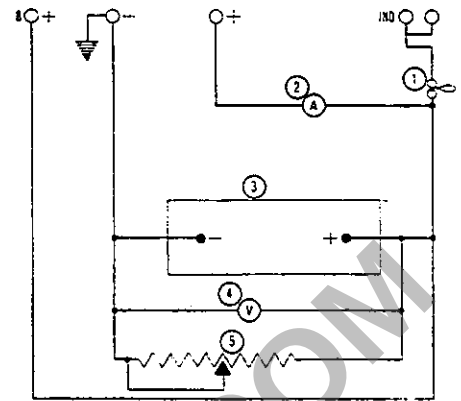
Connect an external test circuit to the alternator output terminals as shown in Figs. S.1, S.2, S.3 or S.4.

Observe carefully the polarity of battery and alternator terminals — reversed connections will damage the alternator diodes.

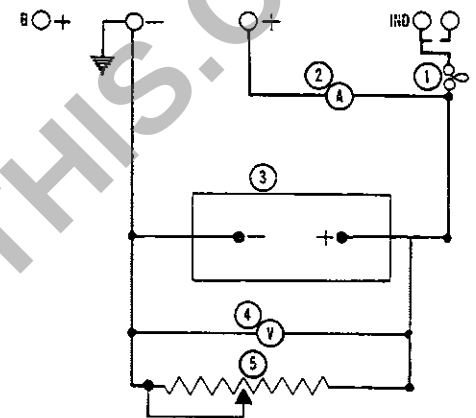
The variable resistor across the battery terminals must not be left connected for longer than is necessary to carry out the following test.

Start the engine. At 1,500 rev/min (alternator speed), the test circuit bulb should be extinguished. Increase engine speed until the alternator is running at 6,000 rev/min approximately, and adjust the variable resistance until the voltmeter reads 13.6 volts. The ammeter reading should then be approximately equal to the rated output (see previous heading). Any appreciable deviation from this figure will necessitate the alternator being removed from the engine for further examination. Failure of one or more of the diodes will be indicated in the above test by effect on alternator output, and also in some instances by abnormally high alternator temperature and noise level.

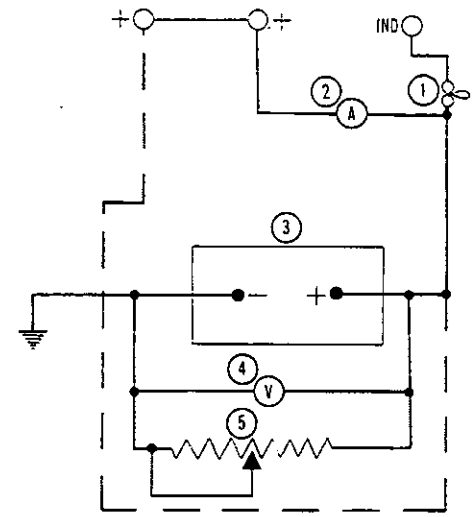
S1



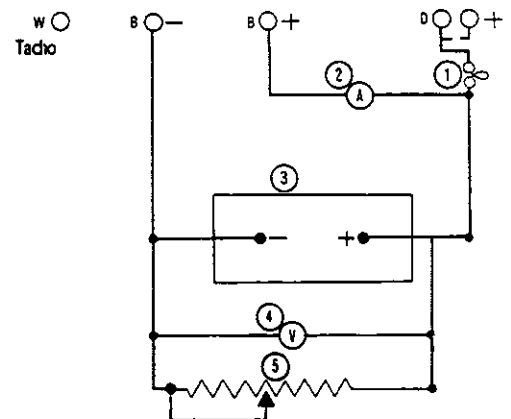
S2



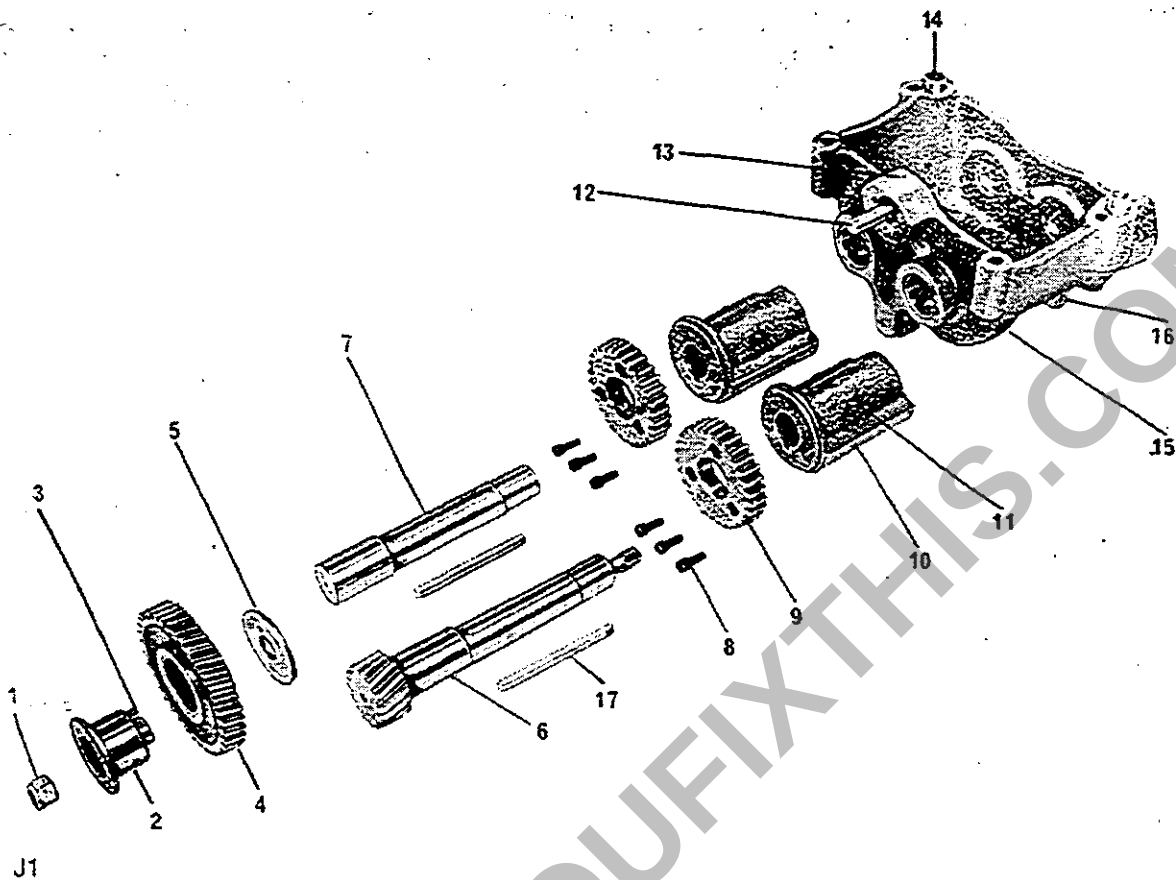
S3



S4



## CRANKSHAFT, MAIN BEARINGS AND BALANCER UNIT-H.8



|                                                              |   |                                           |   |
|--------------------------------------------------------------|---|-------------------------------------------|---|
| 1. Idler Gear Hub Retaining Nut or setscrews (later engines) | 1 | 10. Balance Weight                        | 2 |
| 2. Idler Gear Hub                                            | 1 | 11. Balance Weight Locating Screw         | 4 |
| 3. Idler Gear Hub Dowel                                      | 1 | 12. Idler Gear Hub Stud                   | 1 |
| 4. Idler Gear Assembly (complete with bush)                  | 1 | 13. Balance Weight Frame Plug             | 5 |
| 5. Idler Gear Thrust Plate                                   | 1 | 14. Frame to Cylinder Block Thimble       | 2 |
| 6. Driving Shaft                                             | 1 | 15. Frame Assembly (complete with bushes) | 1 |
| 7. Driven Shaft                                              | 1 | 16. Balance Weight Frame Plug             | 2 |
| 8. Balance Weight Gear Retaining Screws                      | 6 | 17. Balance Weight Locating Key           | 2 |
| 9. Balance Weight Gear                                       | 2 |                                           |   |

### Note:

Current engines have reversed balance weights where the gears are fitted to the rear of the weights.

Replacement bushes are not serviced separately for the idler gear. A replacement idler gear, complete with pre-finished bush must be fitted.

The stud which secures the idler gear and hub to the balancer frame is available as a spare part but need not be removed from the balancer frame unless it requires replacing.

# FOREWORD

This Workshop Manual has been compiled for use in conjunction with normal workshop practice. Mention of certain accepted practices, therefore, has been purposely omitted in order to avoid repetition.

Reference to renewing joints and cleaning off joint faces, has to a great extent been omitted from the text, it being understood that this will be carried out where applicable.

Similarly, it is understood that in reassembly and inspection, all parts are to be thoroughly cleaned, and where present, burrs and scale are to be removed.

It follows that any open ports etc. exposed by dismantling, will be blanked off until reassembled, to prevent the ingress of foreign matter.

To give improved sealing, later engines are built with controlled swell type joints which are fitted dry.

When fitting setscrews into "through" holes into the interior of the engine, a suitable sealant should be used.

**Note:** Some setscrews may already have sealant coated threads. These can be identified by the colour of the threads which will be red or blue etc. Ensure that where these setscrews are fitted, there are no sharp edges to the holes as this could remove the sealant.

Engines built for Massey Ferguson applications are designated AG4.236. Where information specific to these engines is referred to, the appropriate designation is given, otherwise the information is the same as listed under standard engine types.

Throughout this manual, whenever the "left" or "right" hand side of the engine is referred to, it is that side of the engine when viewed from the flywheel end.

This publication is produced by the Technical Publications Department of Perkins Engines Ltd. and every endeavour is made to ensure that the information contained in this manual is correct at the date of publication, but due to continuous development, the manufacturers reserve the right to alter this specification without notice.

### Tappets

The running clearance between the valve stem tip and the rocker arm should be 0.012 in (0,30 mm) for the inlet valve and 0.015 in (0,38 mm) for the exhaust valve (cold). When adjusting this clearance, tighten lock nut effectively, so that it does not slacken in service. (Figs. E.4 and E.5).

### General

All studs on the cylinder head and top face of the cylinder block should be examined for looseness or damage. The cylinder head nuts and setscrews should also be checked for thread damage.

### Re-assembly

Replace valves, washers, rotators, seals, collars, springs and collets. Valves should always be refitted to their original seats and any new valve fitted should be suitably marked to identify its position if removed at a later date. Refer to Fig. E.3 for illustration of valve numbering on assembly of earlier engines. Ensure that the spring damper coils are fitted towards the cylinder head (Fig. E.6).

Fit a new cylinder head gasket DRY. Jointing compound must not be used.

Lower head into position on its studs and torque nuts and setscrews down to the correct value (See 'General Information') and sequence. (Fig. E.7). Fit push rods and refit rocker shaft assembly ensuring that the rocker oil feed pipe rubber olive is fitted in the recess in the head before fitting the rocker shaft assembly. (Fig. E.8).

Adjust valve tip clearance as follows:—

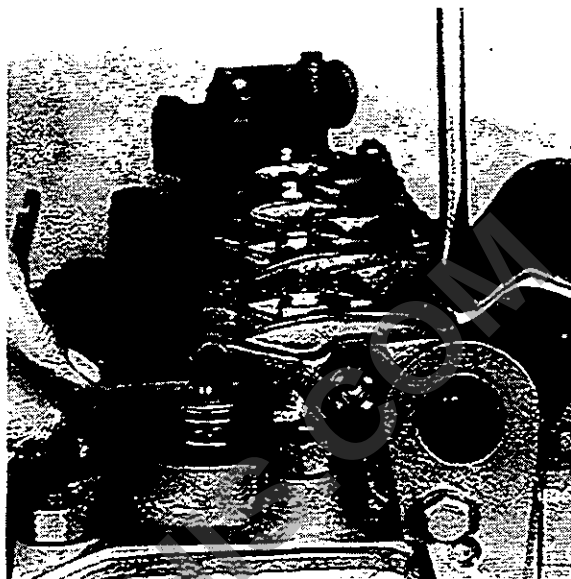
With valves rocking on No. 4 cylinder (i.e. the period between the opening of the inlet valve and the closing of the exhaust valve), set the valve clearances on No. 1 cylinder.

With valves rocking on No. 2 cylinder set the valve clearances on No. 3 cylinder.

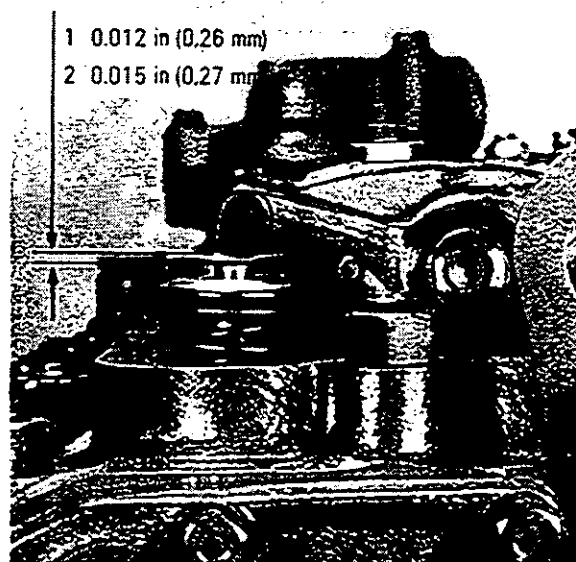
With valves rocking on No. 1 cylinder set the valve clearances on No. 4 cylinder.

With valves rocking on No. 3 cylinder set the valve clearances on No. 2 cylinder.

Valve tip clearances are (cold) inlet 0.012 in (0,30 mm), exhaust 0.015 in (0,38 mm). Rebuild head in the reverse order to disassembly.



E4

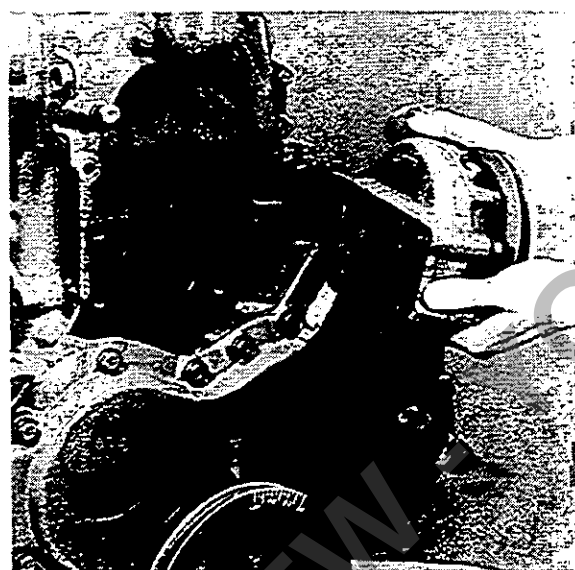


E5 1. Inlet Clearance  
2. Exhaust Clearance

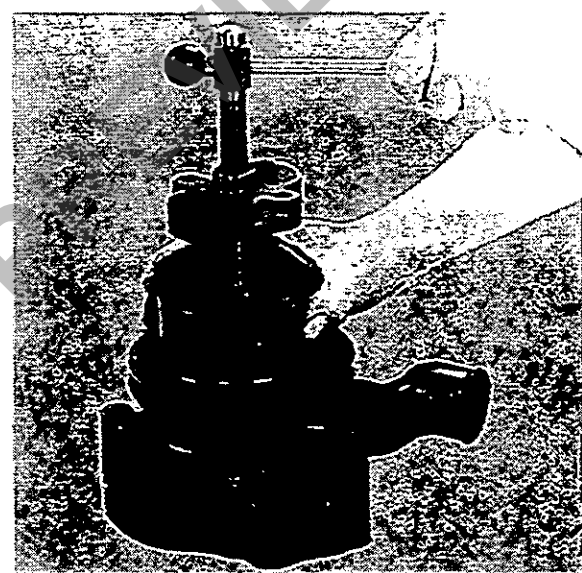
## COOLING SYSTEM—M.2



M1



M2



M3

The cooling water is circulated by a centrifugal type pump which is mounted on the front of the cylinder block. It is driven by a vee-belt from the engine crankshaft and provision is made for fitting a fan on the front end of the water pump pulley.

The pump does not require greasing as the bearings are treated with a special quality grease before assembly.

### To Remove Water Pump

Drain cooling system.

Remove fan.

Slacken generator securing setscrews and remove fan belt.

Remove water pump inlet hose connection.

Unscrew nuts securing the water pump to the water pump rear body and remove water pump. Fig. M.1.

The water pump rear body can be removed by unscrewing the four holding setscrews. Fig. M.2.

**Note:** With later pumps which are secured directly to the cylinder block, the lower fixing setscrew and corresponding drilled boss on the water pump body has been deleted and the joint and cylinder block modified accordingly.

The later type water pump is interchangeable with its predecessor providing the later joint is used and the lower setscrew discarded.

### To Dismantle Water Pump—Earlier Type

Remove self locking nut and plain washer securing water pump pulley.

Remove the water pump pulley using a suitable puller. The tapped holes in the pulley can be utilised for this purpose. Fig. M.3.

Press the water pump shaft from the water pump body. remove impeller and seal.

Remove bearing retaining circlip and press out the two bearings and distance piece. Remove front grease seal, seal retainer and flange.

### To Re-Assemble Water Pump—Earlier Type

Press rear bearing onto shaft, fit distance piece and press on front bearing.

Ensure that the shielded faces of the bearings face outward towards the front and rear ends of the shaft. Fit grease seal retaining plate in position against back face of rear bearing.

This retaining plate is 'dished' and, when in position, the centre of the plate must not be in contact with the bearing.

Fit felt seal and seal retainer housing so that these bear on the retaining plate.

Half fill space between the two bearings with high melting point grease and press complete bearing and shaft assembly into pump housing from the front end. Position the retaining circlip in the recess of the pump housing immediately forward of the front bearing.

Fit water seal with carbon face towards rear. At this stage the shaft should be turned to check for undue resistance.

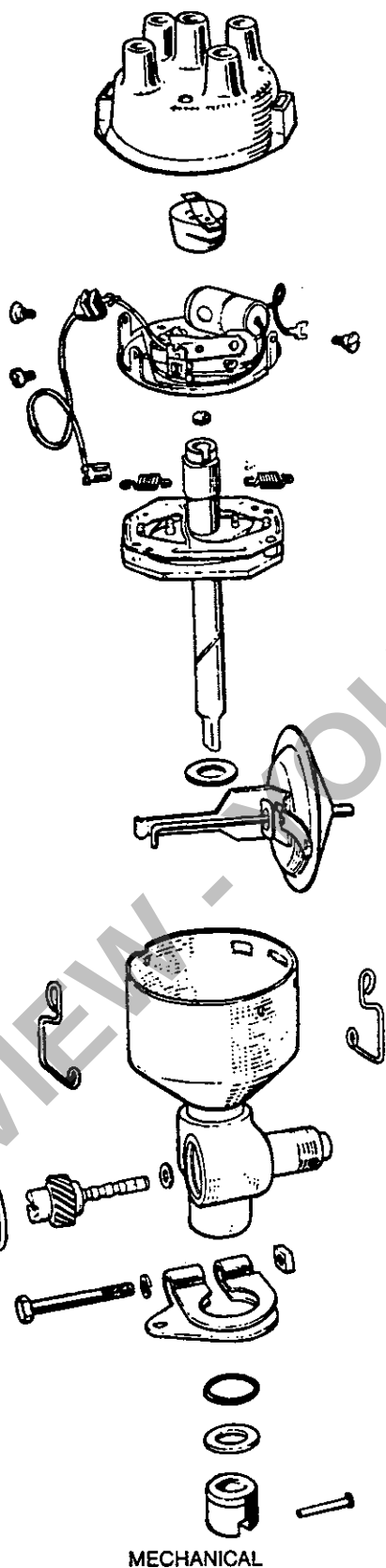
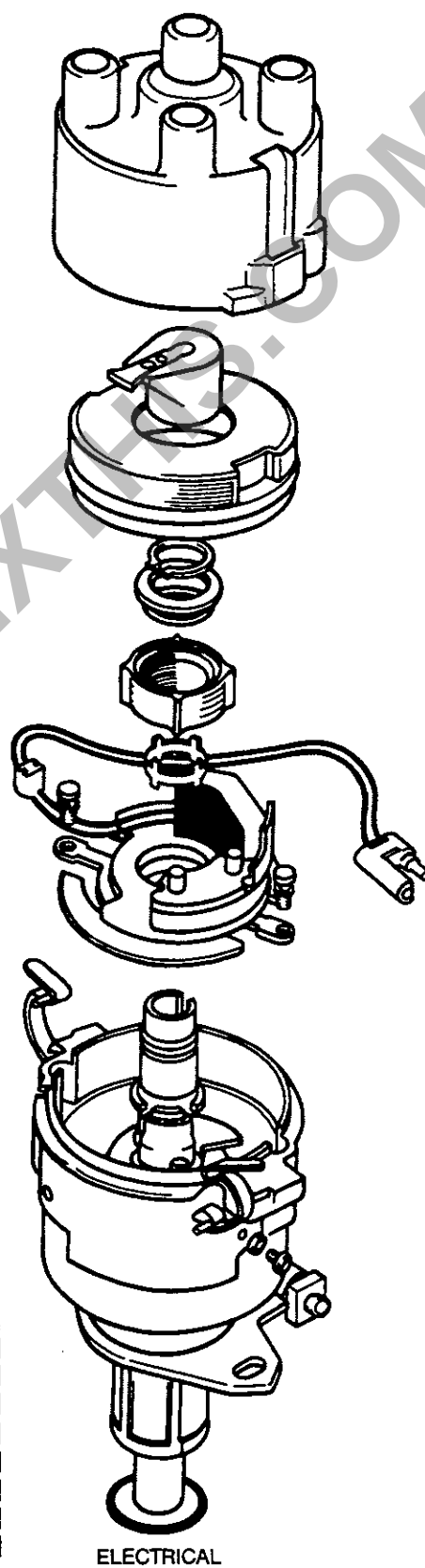
Fit pulley key and press on pulley.

Press impeller onto shaft so that a clearance of 0.010/0.035 in (0.25/0.89 mm) is maintained between impeller vanes and pump body. Fig. M6.

Refit plain washer and self locking nut, tightening to a torque of 50/55 lbf ft (6.9/7.6 kgf m).

# SECTION R

## Distributor



G4.236 Series Workshop Manual, June 1984

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