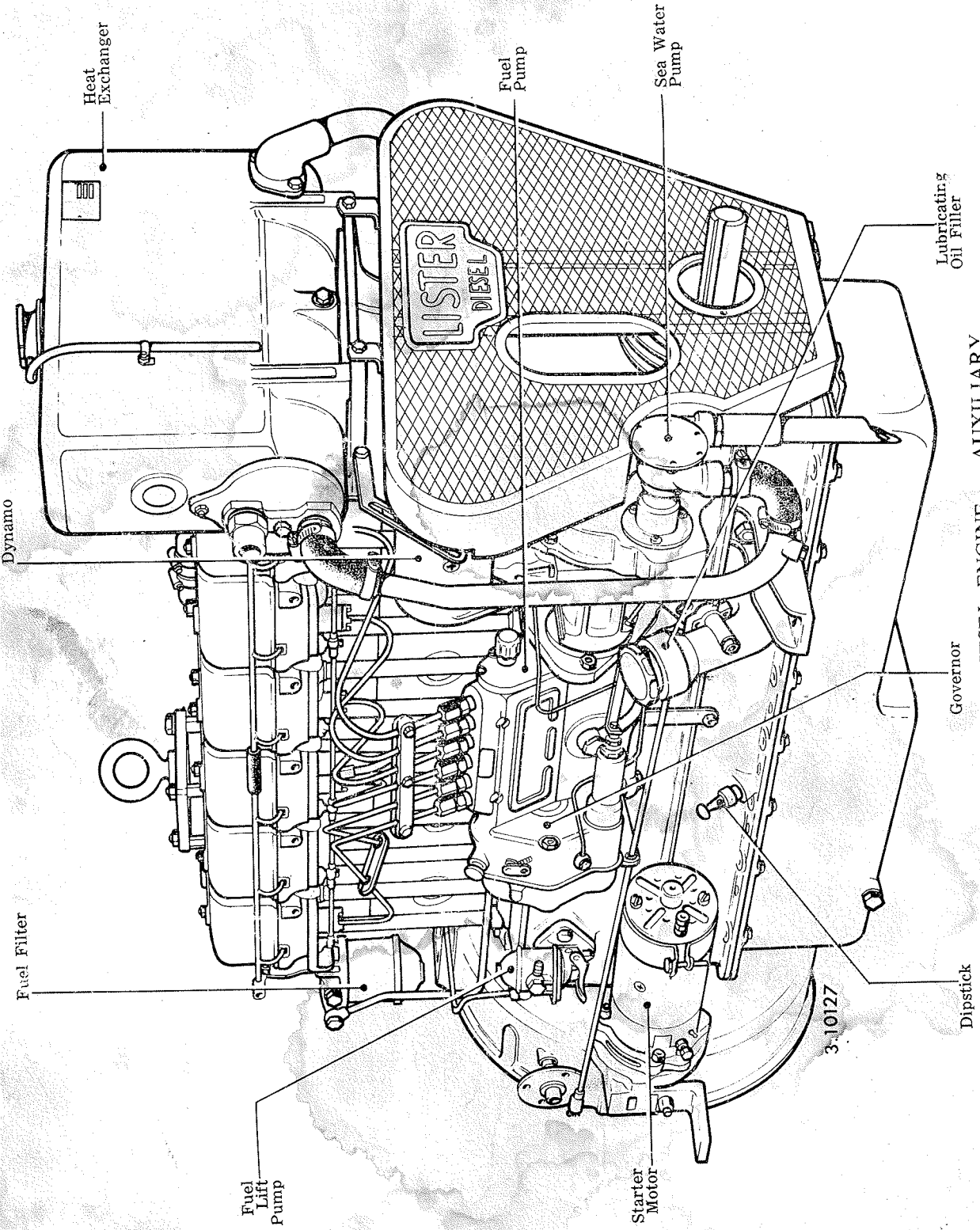


DISCONNECT THE BATTERY POSITIVE LEAD BEFORE MAKING ANY ADJUSTMENT
TO THE ENGINE

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Heat Exchanger

Fuel Pump

Sea Water Pump

Lubricating Oil Filler

HW6 AIR COOLED DIESEL ENGINE — AUXILIARY

Governor

Dipstick

3-10127

Starter Motor

Fuel Lift Pump

Fuel Filter

Dynamo

TYPE HW4/6 MARINE ENGINES

DESCRIPTION

The engine is a four stroke vertical compression ignition unit, engine shaft speed being in the medium/high range of 2000 r.p.m. It is totally enclosed, but easily removed covers make the whole of the valve operating gear and injectors easily available for inspection.

The main bearings are of the steel backed precision type with separate thrust washers, and the crankshaft built to Lloyds' requirements and, when required, to their Classification.

The flywheel is carried at the after end of the engine on the crankshaft taper, and, on propulsion engines the drive is transmitted to the reverse gear through a driving gear secured to the flywheel.

Each cylinder head unit houses its inlet and exhaust valves and fuel injector. Any one head may be removed without disturbing the others.

The cylinder barrels, in single units, are made of high grade cast iron, and are fitted with removable doors to facilitate cleaning of the water spaces.

The pistons are machined from high grade alloy and are fitted with one taper fire ring, two plain compression rings, one scraper ring above the gudgeon pin and one below. The gudgeon pin is fully floating when hot and is retained endwise by circlips.

The steel backed connecting rod small end bushes are bronze lined, and steel backed precision finished big end bearings are used, requiring no fitting.

The camshaft is driven by a gear train at the forward end of the engine and the cylinder head valves are operated by pushrods and rockers.

The lubricating oil pump is mounted internally and driven by the gear train at the forward end of the engine.

The governor is mounted on the outer end of the fuel pump housing and is driven through speed increasing gearing from an extension on the fuel pump camshaft.

The lubricating oil and fuel filters are mounted externally.

Water cooled exhaust manifolds are a standard fitting.

Cooling is by heat exchanger, fresh water circulation is by centrifugal pump vee-belt driven from the crankshaft and raw water circulation by a pump directly driven from the crankshaft at the forward end of the engine.

The heat exchanger is mounted at cylinder head level at the forward end of the engine.

WHEN USING THIS INSTRUCTION MANUAL AND PARTS LIST, PLEASE NOTE THE FOLLOWING:—

1. Instructions and statements contained in this book are given with our best intentions and are correct at the time of going to press. They are subject at any time to alteration.
2. The illustrations are subject to modification and must not be taken as representative of any individual specification.
3. The exploded drawings illustrating the parts are not drawn to scale.

CARE OF YOUR NEW ENGINE

Each engine is carefully tested and inspected before leaving the Maker's Works. This includes full load running for several hours, followed by detailed examination and tightening of all nuts and unions.

Further setting of some joints will occur when the engine is put into service and the valve gear beds down. If the best results are to be obtained from the engine it is therefore important that it should receive regular attention during the first 500 hours of its life. The same applies to an engine which has been completely overhauled.

Initial Attention

It is recommended that the following are attended to after the engine has run 25 hours and again after 250 hours:

1. Adjust tappet clearances (0.015"—0.38 mm. cold).
2. Check water pump belt tension. It is particularly important that the tension be checked after overhaul or after new belts have been fitted. Do not overtighten.
3. Tighten the nuts, bolts and unions making the joints referred to under the heading "Maintenance", (Page 17).
4. Change the lubricating oil for the first time after 100 hours. Thereafter every 250 hours.
5. Clean the engine and keep it clean.
6. Observe the exhaust at the normal full load. The exhaust must be free from soot. A black exhaust means that the engine is overloaded or that the injection equipment is out of order. Do not allow the engine to run with a dirty exhaust without investigating the cause as this may result in an expensive breakdown.

Maintenance Routine

In addition to the Initial Attention to be carried out as above, it is essential to adopt a regular maintenance routine as laid down on page 16.

Lubricating Oil

Always use a heavy duty detergent diesel lubricating oil of the correct detergency and viscosity (see "Lubrication", page 9).

This will ensure easy starting, lowest fuel consumption, minimum wear and longest periods between overhauls.

INSTALLATION OF HW MARINE ENGINES

Before arranging an installation, it is imperative that careful consideration be given to the general layout of the machinery and the guidance notes on the arrangement drawings must be followed.

Cooling. Closed circuit fresh water cooling is standard. The heat exchanger is mounted at the gear end of the engine and a vee belt driven centrifugal pump circulates the fresh water. The raw water pump is directly driven from the camshaft at the forward end of the engine.
Keel cooling can be fitted to special order.

Exhaust. Keep the exhaust pipe as short and straight as possible. Up to 20ft. use 2½" diameter pipe, over 20ft. use 3". Pipes should slope gradually away from the engine down to outlet if this is taken to the ship's side or transom. Swan necks increase back pressure and make cleaning difficult. Wooden structure must be protected from exhaust heat by adequate clearance and lagging.

Alignment. Flexible couplings do not excuse bad alignment of engine to propeller shaft. A solid dummy bobbin should be used when aligning engine to shafting, and afterwards replaced by the flexible coupling. We will supply these solid bobbins on loan to the home market for a nominal charge. Misalignment stresses bearings and may account for a loss of power.

Stern gear. Packing glands should allow free rotation of the tailshaft. Stern tubes should be filled with grease before inserting shaft, except when rubber "cutless" type bushes are used.

Fuel. Clean fuel is essential for any diesel engine. Always fill tank through a clean tundish fitted with a fine gauze strainer.
Injectors should be examined and checked periodically. A faulty injector may reduce engine output by 25%. The fuel tank must be checked or drained periodically to ensure that it does not contain water.

Propellers. Must be permitted to run in adequate apertures and never behind heavy square ended body posts. These should be tapered off to an inclusive angle of about 40°. The distance between the outboard gland and the propeller boss should not be greater than half the diameter of the shaft.

If several of the above defects in installation or operation occur together, even a new engine will lose power, become overloaded, lose revolutions, and may stop altogether.

Rotation

Standard rotation is **anti-clockwise** looking on the flywheel end of the engine.

Bearers

The engine bearers should form an integral part of the boat's structure and where possible should be part of a girder running the majority of her length.

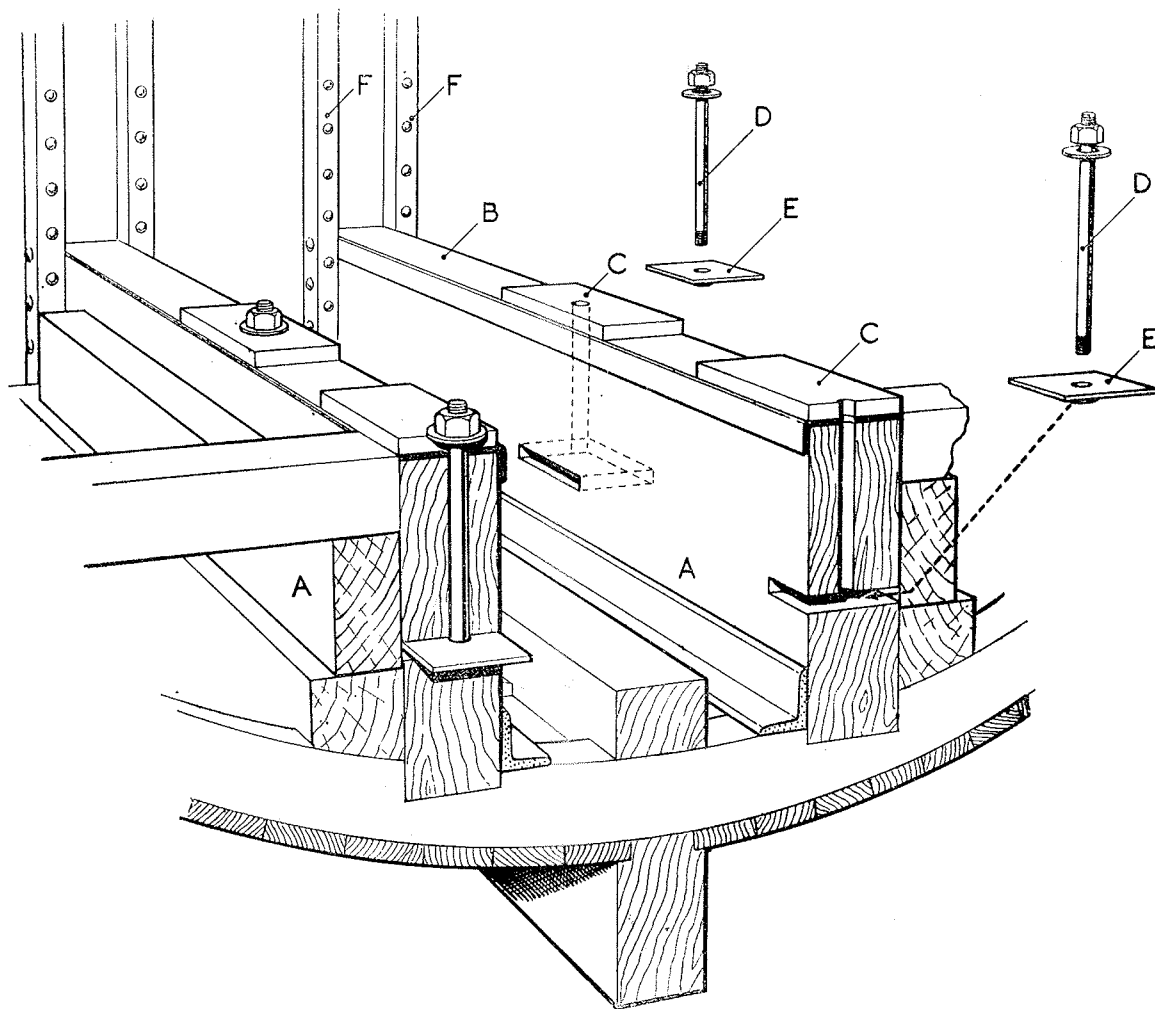
The primary objective, when setting up the bearers for the installation of a marine diesel engine, is to avoid a concentration of stress that would endanger the fastenings and the surrounding structural members.

Therefore it is imperative that all holding down bolts should be "fitted". In wooden vessels, long holding down bolts are required so that a larger bearing surface may be presented to resist the thrust of the propeller. These bolts should be fitted at their lower ends with steel plates, 2in. x 3in. (5 x 8cms.), to which their nuts have been welded, further to spread the load over the bearers.

In all vessels the engine and reverse gear should be seated on a steel grip, or soleplate.

Fuel Tank

The bottom of the fuel tank should be not less than 30ins. (760mm.), and not more than 72ins. (1875mm.) above the crankshaft for gravity feed systems.



A—Engine Bearers.
 B—Soleplate.
 C—Chocks.

D—Holding Down Bolt.
 E—Nut welded to steel plate.
 F—Bulkhead stiffening.

Fig. 1

INSTALLATION IN A WOODEN VESSEL

Alignment (see next page).

The engine may be lined up to the shaft temporarily while the boat is out of the water, but before launching the coupling bolts should be removed and the engine re-aligned when the vessel has taken up her normal shape in the water.

When lining up, steel chocks should be fitted in way of the holding down bolts, between the engine feet and the soleplate. Move the engine into position, with the chocks fitted, and draw the shaft half coupling up to the gearbox half coupling.

If the alignment is correct, feeler gauges inserted at all points between the two half couplings should show no variation. If, however, there is variation, the chocks must be machined to suit, and the couplings checked again. If it is found impossible to obtain a correct alignment by this method, it is probable that the shaft is distorted and requires straightening.

It is good practice to leave the engine uniformly high by 5-10 thousandths of an inch (0.127-0.254mm.) as it will be pulled down about that much when the holding down bolts are pulled down hard, owing to the compression of the packing pieces and the bearers.

After final pulling down of these bolts the coupling faces should be checked again with the feeler gauges before bolting up the coupling. The coupling edges should then be perfectly level.

These engines can, on request, be supplied with flexible couplings, and flexible mountings. These, however, are not designed to take up bad alignment, and if the set is fitted in this way, great care must be taken to ensure that every component is accurately lined up to the next before running it initially.

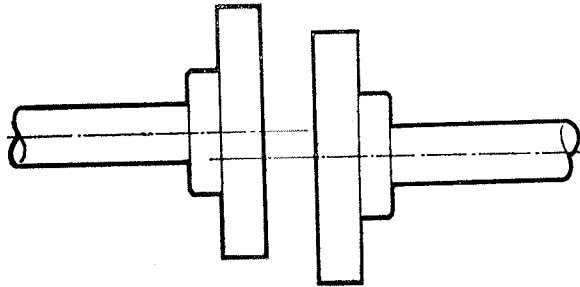
The foregoing limits should be strictly observed during installation.

Alignment

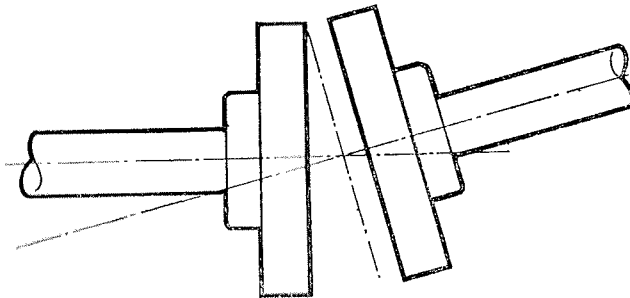
It is often thought that little attention need be paid to accurate alignment when a "flexible coupling" is fitted between the engine and driven unit but such optimism is seldom justified in practice. Irrespective of the type of coupling used, the coupling life will be longer, the chance of coupling or shaft failure will be greatly reduced, and vibration of the combined set will be minimised if proper attention is paid to the alignment problem.

Two principal types of misalignment can occur—parallel misalignment and conical misalignment, or there can be a combination of these two.

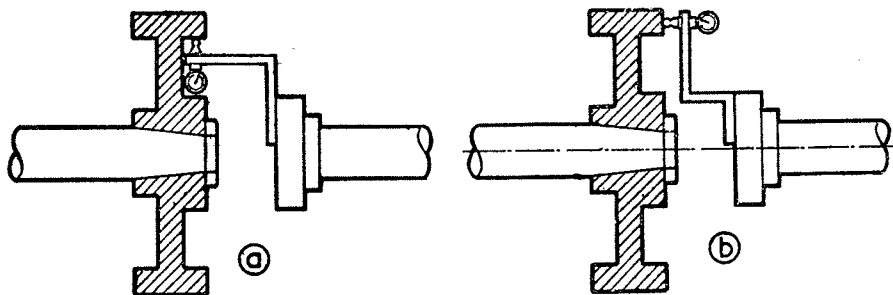
- (a) **Parallel Misalignment**—when the shaft of the driven unit is parallel to, but not in line with, the engine output shaft.



- (b) **Conical Misalignment**—when the axes of the two shafts meet at the correct point, but the shafts are not parallel to each other.



Each type of misalignment is checked individually by having a bracket or clock gauge rigidly bolted to the flange of the driven unit and rotating through 360° to check the clearance to (a) the inside (or outside) of the flywheel rim for parallel misalignment, and (b) the clearance to the flywheel face for conical misalignment. Readings should not vary by more than 0.005" throughout one revolution.



KEY

- A—Tail Housing.
- B—Stern Tube.
- C—For'd. Bracket.
- D—For'd. Gland.
- E—Water and Sand Seal.
- F—Spring Ring.
- G—Aft Bearing.
- H—Locating Screw.
- I—Packing.
- K—Stauffer Grease Cup.
- L—Annular Grease Space.
- M—Grease Gun Height: Empty 12", Full 19½".
- N—Grease Gun—¾ pt. cap.—optional (Part No. 501-723).

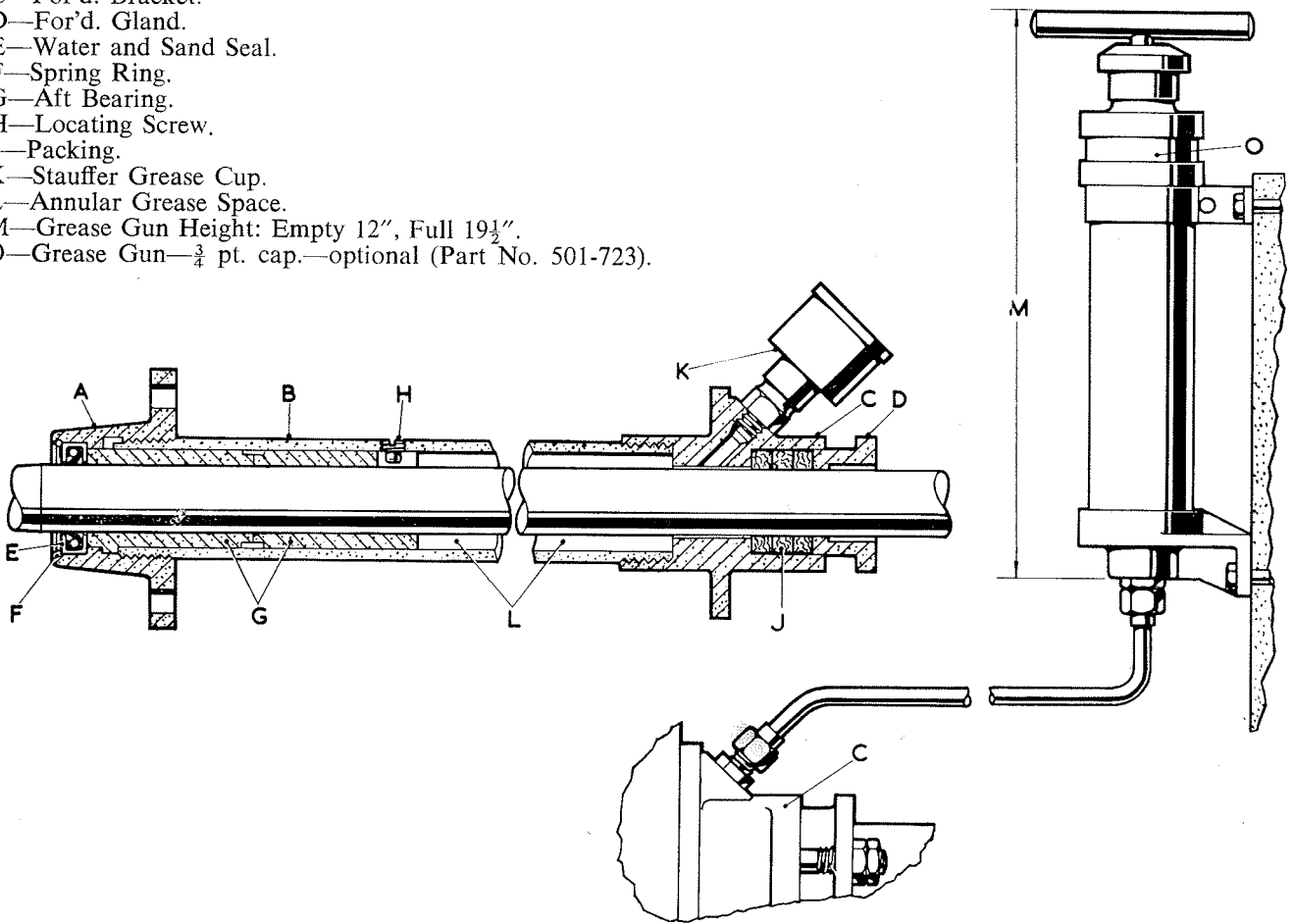


Fig. 2—Stern Gear

IMPORTANT — PROPULSION ENGINES

The sterntube **MUST** be filled with a suitable grease, such as Vickers "NEOX DT" immediately after installation. To ensure complete filling of the tube it is imperative that a grease gun be used for the initial filling. For service use regular attention to the grease cup provided should be sufficient to make up any loss incurred.

Tailshaft Size ENGINE	1½"—38.1mm. HW4MG	1⅝"—16.03mm. HW6MG	2"—50.8mm. HW4MGR2	2¼"—57.15mm. HW4MGR3 HW6MGR2	2½"—63.5mm. HW6MGR3
Sterntube Grease capacity - pints	.96	.46	1.03	.57	1.9
litres	.54	.26	.59	.33	1.08

LUBRICATION

Specification

HW engines must be run on good quality diesel engine heavy duty detergent lubricating oil.

In temperate climates (up to 85°F (30°C) oils complying with BS1905 or DEF2101C or MIL-L-2104A must be used when load and servicing conditions are favourable but for arduous duties in temperate climates, and for all applications in tropical climates (above 85°F (30°C)) the use of oils to supplement 1 level of detergency is recommended. Supplement 1 oils must also be used if the sulphur content of the fuel is of 1% or more. Multigrade oils must have a degree of detergency equivalent to Supplement 1 level and **must not** be used for heavy duty applications.

Viscosity

The viscosity of the lubricating oil must be as follows:—

For starting temperatures—

up to 32°F (0°C)	...	...	...	...	...	SAE.10W
between 32°F and 85°F (0°C—30°C)	...	...	...	...	...	SAE.20/20W
above 85°F (30°C)	...	...	...	...	...	SAE.30

Branded Oils

To assist engine users, a list of brands of oil which meet the above requirements and which are normally available on the world markets is given on pages 11 and 12.

Do not mix two different brands of oil. Thoroughly drain off oil of one brand before changing to another. Lubricating oil additives are not considered necessary and some can harm the engine.

Lubricating Oil System

Oil is drawn through a wire mesh strainer in the lowest part of the engine sump and is circulated by a rotary pump driven through an idler gear from the crankshaft. Before passing to the main bearing manifold, oil passes through a full flow lubricating oil filter which incorporates a by-pass valve designed to open should the filter element become choked owing to lack of maintenance. A relief valve regulates the delivery pressure to 45 lbs./sq.in.

All main, big end and camshaft bearings are pressure lubricated, a feed also being taken to the camshaft locating bearing, the idler gear bearing, valve rockers, governor and fuel pump. Other parts are lubricated by splash and by spray.

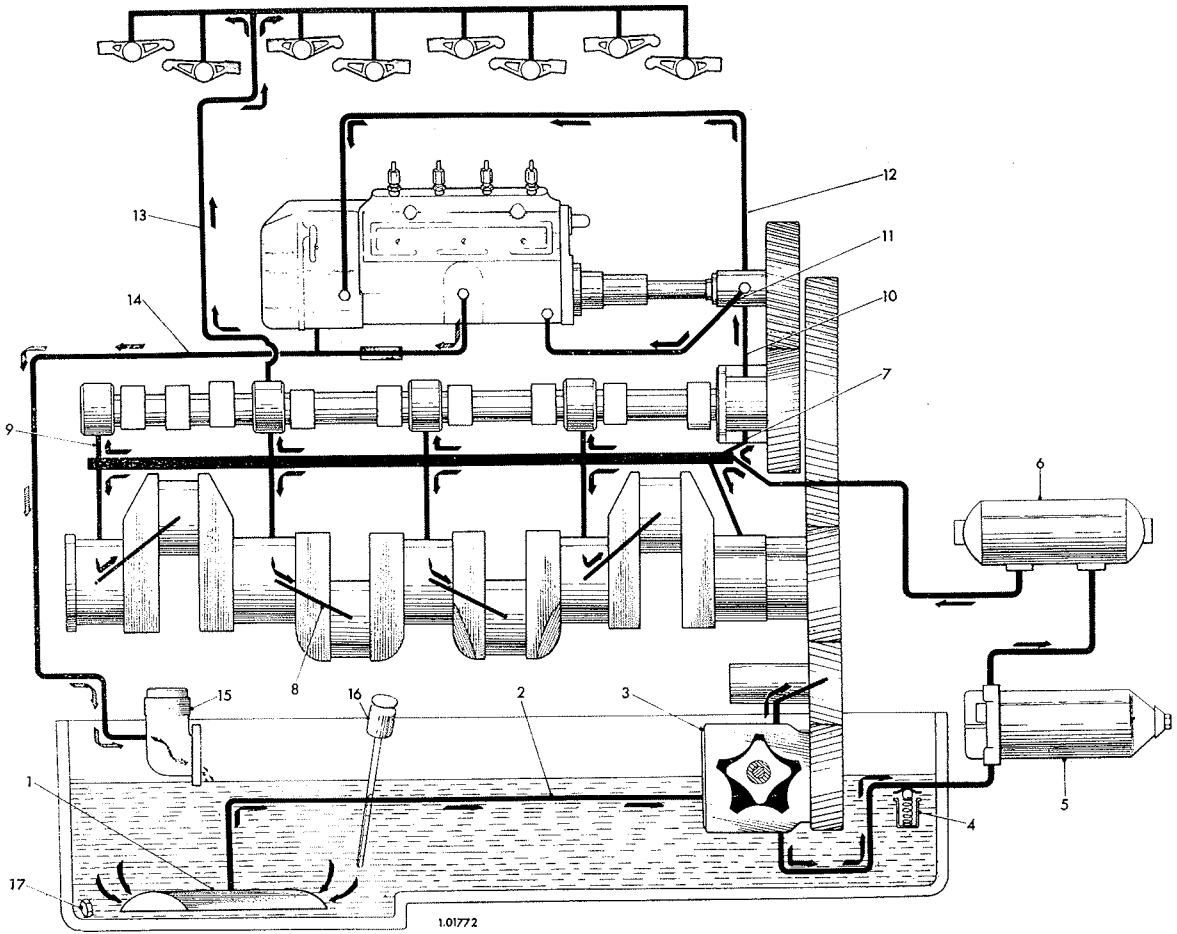
After draining the crankcase through the plug provided, or by sump pump (when fitted), the engine sump can be easily detached for cleaning purposes or for obtaining access to the big end bearings.

Before Initial Starting or After Overhaul, or if the engine has been idle for several months.

Remove the cylinder head covers and well lubricate the valve gear and push rod cups but do not spill oil over the sides of the cylinder heads.

Fill the engine sump to the 'MAX' mark on the dipstick, using an appropriate oil as specified above.

Sump Capacities :	4 cylinder engines	...	25 imp. pints (14 litres)
	6 cylinder engines	...	32 imp. pints (18 litres)



- | | |
|---------------------------------|---|
| 1. Strainer. | 10. Supply to fuel pump drive. |
| 2. Suction pipe. | 11. Supply to fuel pump. |
| 3. Pressure pump. | 12. Supply to governor. |
| 4. Relief valve. | 13. Supply to valve rockers. |
| 5. Filter. | 14. Return from fuel pump and governor. |
| 6. Cooler. | 15. Oil filler. |
| 7. Main oil gallery. | 16. Dipstick. |
| 8. Supply to big end bearings. | 17. Sump drain plug. |
| 9. Supply to camshaft bearings. | |

Fig. 3.—Engine Lubricating Oil System.

TABLE I

LIST OF LUBRICANTS COMPLYING WITH SUPPLEMENT 1 REQUIREMENTS U.S. ARMY SPECIFICATION MIL-L-2104A and MINISTRY OF DEFENCE SPECIFICATION DEF 2101C

Heavy Duty Application — Temperate Climates. All Applications — Tropical Climates

OIL COMPANY	SAE 10W	BRAND	SAE 30
Castrol Ltd.	Castrol CR 10 Deusol CR 10/1	SAE 20 or 20W Castrol CR 20 Deusol CR 20/1	SAE 30 Castrol CR 30 Deusol CR 30/1
Esso Petroleum Co. Ltd.		Estor HD X 20	Estor HD X 30
A. Duckham & Co. Ltd.	Duckhams HD 10/1	Duckhams HD 20/1	Duckhams HD 30/1
Germ Lubricants Ltd.	Germol D10/S1	Germol D20/S1	Germol D30/S1
Gulf Oil (Gt. Britain) Ltd.	Gulflube Motor Oil HD 10W	Gulflube Motor Oil HD 20/20W	Gulflube Motor Oil HD 30
Filtrate Ltd.	Diesel "Filtrate" 10W	Diesel "Filtrate" 20	Diesel "Filtrate" 30
Mobil Oil Co. Ltd.	Delvac Oil 1110	Delvac Oil 1120	Delvac Oil 1130
Petrofina (Gt. Britain) Ltd.	Motortomic Delta SAE 10W Solna S1 SAE 10W	Motortomic Delta SAE 20/20W Solna S1. SAE 20/20W	Motortomic Delta SAE 30 Solna S1. SAE 30
Power Petroleum Co. Ltd. (U.K.)	BP Energol DS1/10W	BP Energol DS1 20W	BP Energol DS1 30
B.P. Companies (Overseas)			
Regent Oil Co.	Super RPM Delo Special SAE 10W	Super RPM Delo Special SAE 20/20W	Super RPM Delo Special SAE 30
Shell Group of Companies	Shell Rotella T Oil 10W	Shell Rotella T Oil 20/20W	Shell Rotella T Oil 30
Snowdrift Lubricants Ltd.	Alpine SAE 10	Alpine SAE 20	Alpine SAE 30
Valvoline Oil Co.	Super HPO S1 10	Super HPO S1 20	Super HPO S1 30
Vigzol Oil Co. Ltd.	New Ace 10 Sup 1	New Ace 20 Sup 1	New Ace 30 Sup 1

TABLE II
LIST OF LUBRICANTS COMPLYING WITH SPECIFICATIONS BSS.1905 : 1952, MINISTRY OF DEFENCE
DEF. 2101C AND U.S. ARMY MIL - L - 2104A
Favourable Applications — Temperate Climates only

OIL COMPANY	SAE 10W	BRAND	SAE 30
Castrol Ltd.	SAE 10W Agricastrol HD 10 Deusol CR 10	SAE 20 or 20W Agricastrol HD 20 Deusol CR 20	SAE 30 Agricastrol HD 30 Deusol CR 30
Esso Petroleum Co. Ltd.	Essolube HD 10 Estor HD 10	Essolube HD 20 Estor HD 20	Essolube HD 30 Estor HD 30
A. Duckham & Co. Ltd.	Duckhams HD 10/MIL	Duckhams HD 20/MIL	Duckhams HD 30/MIL
Germ Lubricants Ltd.	Germil 101	—	Germil 303
Gulf Oil (Gt. Britain) Ltd.	Gulf Dieselube HD 10W (GB)	Gulf Dieselube HD 20/20W (GB)	Gulf Dieselube HD 30 (GB)
Filtrate Ltd.	Diesel "Filtrate" 10W	Diesel "Filtrate" 20	Diesel "Filtrate" 30
Mobil Oil Co. Ltd.	Delvac Oil 910 Mobiloil 10W (Overseas)	Delvac Oil 920 Mobiland Diesel 20	Delvac Oil 930 Mobiland Diesel 30
Petrofina (Gt. Britain) Ltd.	Motortonic SAE 10W Solna HD SAE 10W Solco HD SAE 10W	Motortonic SAE 20/20W Solna HD SAE 20/20W Solco HD SAE 20/20W	Motortonic SAE 30 Solna HD SAE 30 Solco HD SAE 30
Power Petroleum Co. Ltd. (U.K.)	BP Energol DD 10W BP Energol IC-D10	BP Energol DD 20W BP Energol IC-D 20	BP Energol DD 30 BP Energol IC-D 30
B.P. Companies (Overseas)	RPM Delo Special SAE 10W	RPM Delo Special SAE 20/20W	RPM Delo Special SAE 30
Regent Oil Co.	Shell Rotella Oil 10W Shell Talona Oil 10W	Shell Rotella Oil 20/20W Shell Talona Oil 20	Shell Rotella Oil 30 Shell Talona Oil 30
Shell Group of Companies	Apennine SAE 10	Apennine SAE 20	Apennine SAE 30
Snowdrift Lubricants Ltd.	Super HPO 10	Super HPO 20	Super HPO 30
Valvoline Oil Co.	New Ace 10	New Ace 20	New Ace 30
Vigzol Oil Co. Ltd.			

FUEL OIL

Fuel Oil System

The feed to the fuel injection pumps is by means of a mechanically operated fuel lift pump. A cartridge type filter is always included in the pumps to the injectors. The injector leak-off must be led from the leak-off manifold direct to the fuel tank NOT to the suction line.

Fuel is delivered under pressure from the fuel pumps to the injectors.

Specification

HW engines must be used only with distillate fuels conforming to, or equivalent to, British Standard Specification 2869 : 1957, Class A.

Item	Min.	Max.
Cetane number	45	—
Viscosity : centistokes @ 100°F	1.6	7.5
Redwood No. 1 @ 100°F	31	45
Conradson carbon % by weight	—	0.1
Distillation % by volume recovered @ 357°C (675°F)...	90	—
Flash Point (closed) °F	130	—
Water % by volume	—	0.1
Ash % by weight	—	0.01
Sediment % by weight	—	0.01
Sulphur % by weight	—	1.3
Sulphur, corrosive	Not more than slight tarnish	
Strong acid number	Nil	Nil

Specification Limits

Variations occur throughout the world in the quality of oils marketed under a given name. It is therefore recommended that the Lister Blackstone dealer, or the agent of a reputable oil company, be consulted regarding the type of oil locally obtainable which conforms to the specification given above. In cases of doubt, Lister Blackstone Marine Ltd. will be pleased to advise on the suitability of a particular oil on receipt of a detailed analysis and specification.

As a general guide the following is a list of some fuel oils which meet BS2869:1957 Class A:-

Shell Gas Oil "C.I."	Regent Gas Oil
Esso Diesel Medium	Regent Derv.
Esso Marine Diesel Medium	

Vaporising oils are NOT suitable as fuels for Lister Blackstone diesel engines.

- Note:**
1. The purchaser must satisfy himself that his fuel storage arrangements are such that the oil will remain fluid at the lowest temperature to which it may be exposed.
 2. Some fuels, and fuel additives, are unsuitable owing to excessive pressures resulting from their use, or to excessive carbon and ash formation, or to corrosive action, or to premature clogging of the fuel filters. The operator is cautioned that although the engine may appear to run satisfactorily for a short time, permanent damage will be caused.
 3. CLEAN FUEL IS OF THE UTMOST IMPORTANCE IN ENSURING RELIABLE PERFORMANCE.

STARTING AND STOPPING

Initial Starting

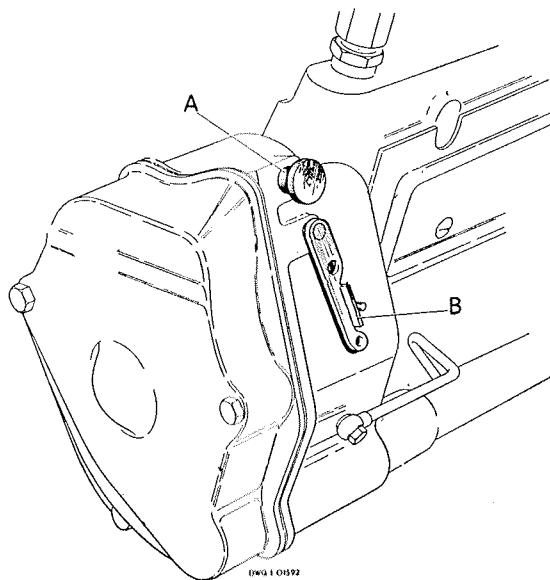
- (a) Fill the cooling system through the filler on top of heat exchanger.
- (b) Check that the engine is free to turn without obstruction.
- (c) Check that the starter batteries are correctly filled, charged and connected.
- (d) Fill the sump to the 'MAX' mark on the dipstick using oil complying with the recommended specification (page 9).
- (e) Check that the fuel tank and piping are scrupulously clean, and fill up with fuel oil complying with the recommended specification (page 13).
- (f) Thoroughly prime the system by manually operating the fuel lift pump. Should the pump appear not to function, turn the crankshaft one revolution and repeat. Loosen the two vent screws on top of the fuel oil filter and operate the lift pump until fuel flows freely and without bubbles from the vents. Tighten these vent screws and repeat the priming process by slackening the two further vent screws at the back of the fuel pump which permit air to be expelled from the top of the fuel oil gallery in the pump itself. Re-tighten the screws.
- (g) To vent the fuel pump elements, if necessary, loosen the delivery connections at each injector and disconnect one delivery pipe from the pump. Remove the delivery valve holder and spring, and slightly raise the valve off its seat. With the engine control lever in the 'stop' position, and manually operating the fuel lift pump, fuel will flow from the valve. Continue until all air has been expelled. Replace the spring and delivery valve holder and tighten the delivery pipe connection. Repeat for each cylinder in turn.
- (h) To vent the fuel pipes, if necessary, with the delivery pipe connections loosened at the injectors and the engine control lever in the normal running position, motor the engine for a few seconds until the air has been expelled from the delivery pipes to injectors. Tighten all connections firmly, and ensure that the injector clamp nuts are secure (15 lb.ft. torque).
- (j) Lift the overload trip only in cold weather to allow the pump to deliver excess fuel.
- (k) Press the starter button firmly, and release immediately the engine fires. Do not motor the engine continuously for more than 10 seconds.
- (l) If a lubricating oil pressure gauge is fitted check the pressure.
- (m) Check that the overload trip, if raised, has moved 'in' to the normal running position.

Note: On propulsion engines carry out instructions as above but before "j" ensure that reverse gear lever is in "Neutral" position (vertical).

Set engine speed control lever to "FULL".

As soon as engine runs up to speed return engine speed control lever to "SLOW".

ALWAYS return engine speed control lever to "SLOW" before using reverse gear.



A Overload Stop. B Stopping Lever.

Fig. 4—Engine Controls.

Daily Starting

- (a) Check the fuel and lubricating oil levels.
- (b) Lift the overload trip "A" **only in cold weather.**
- (c) Press the starter button firmly and release immediately the engine fires.
- (d) Check that the overload trip "A", if raised, has moved 'in' to the normal running position. See Note p. 14 on propulsion engines.

To Stop the Engine

Move the control lever to the left and hold in this position until the engine stops.

Speed Adjustment (constant speed)

A slight adjustment of speed may be made by increasing or reducing the tension of the speeder spring located in the tubular extension to the governor case. The locknut must be loosened and the rod screwed clockwise to reduce speed—anti-clockwise to increase speed. Re-tighten the locknut.

DO NOT INCREASE SPEED ABOVE 2½% WITHOUT CONSULTING
LISTER BLACKSTONE MARINE LTD.

ROUTINE MAINTENANCE

When the engine is in regular use:—

Daily

Check supply of fuel oil.
Check level and condition of lubricating oil (also in gearbox if fitted) with the engine stopped.
Check water level in heat exchanger header tank (radiator or water tank as applicable).
Drain condensate trap in exhaust pipe, if applicable.

Every 100 hours

Clean air cleaner if necessary.
Check for fuel and lubricating oil leaks. Tighten nuts and fittings as necessary.
Wipe engine and baseplate clean.
Check the level of the battery electrolyte.

Every 250 hours

Drain lubricating oil, flush out system and refill with the correct grade and type of oil.
Clean the fuel injector nozzles if the exhaust is dirty.
Check water pump belt tension (also after 25 hours when new belts are fitted). Do not reset unless belts are slack — do not overtighten — see page 18.

Every 500 hours

Decarbonise if engine shows loss of compression or blow-by past the piston, but do not disturb otherwise.
Adjust tappet clearances.
Wash engine down with paraffin or fuel oil.
Renew lubricating oil filter element.
Lubricate dynamo bearing.

Every 1000 hours

Clean air filter.
Clean heat exchanger or radiator (if fitted).*

Every 1500 hours

Decarbonise — if engine shows signs of loss of compression or piston blow by.
Clean inlet manifold and exhaust system (if decarbonised).
Check water space in cylinder blocks for sludge etc., remove doors and clean if necessary.
Examine fan blades and clean. (Radiator cooled engines only).
Check free working of governor linkage.
Drain and clean fuel tank.
Renew fuel filter element.
Clean injector nozzles or replace with serviced ones, and adjust pressure settings.
Check injector pressure setting.
Check fuel pump timing and balancing.

Every 3000 hours

Check fan bearings and grease. (Radiator only).

Every 5000 hours

Check big end and main bearings.
Inspect camshaft bearings and tappets.
Renew valve springs.

The frequency of servicing will depend to a large extent upon installation conditions, engine duty and the quality of the fuel and lubricating oil used. The above servicing periods must therefore be taken as a guide and may be varied by operators according to experience obtained with individual installations.

*If anti-freeze has been used in the radiator it should be thoroughly flushed out when danger of frost is past.

MAINTENANCE

Note:— Every effort must be made to maintain the engine in a clean condition and oil leaks must be dealt with as soon as they appear. With a new or overhauled engine the joints settle during the first few hours running, and their tightness must subsequently be checked. This includes the following:

- Gearcase end cover.
- Cylinder head cover joints.
- Lubricating oil pipes.
- Fuel system pipe unions.
- Injector pipe nuts.
- Injection pump delivery unions (first slacken injector pipe nut).
- Injection pump vent.
- Crankcase sump.
- Fuel pump and governor joints.

Note:— All joints, other than rubber, are to be coated on both sides with Wellseal jointing compound or an equivalent non-hardening product. Rubber joints are to be cemented to the covers with Bostik 772 compound, no cement being used on the other side of the joint.

Note:— For assembly use SAE.10W heavy duty detergent lubricating oil with 5% colloidal graphite added. All bearing surfaces must be well lubricated including the cups of the push rods and the valve stems.

Note:— Where torque spanners are available, the following tightening torques must be maintained:

Size	Torque		Component
	lb.ft.	kg.m.	
$\frac{1}{4}$ " UNF	10	1.38	Injector clamp nut, valve rocker nuts.
$\frac{5}{16}$ " UNF	15	2.07	
$\frac{3}{8}$ " UNF	32	4.4	
$\frac{7}{16}$ " UNF	60	8.3	Flywheel setscrews. Dynamo shaft nut (hold pulley in vice).
$\frac{1}{2}$ " UNF	68	9.4	Connecting rod bolt nuts.
$\frac{9}{16}$ " UNF	100	13.8	Cylinder head nuts.
$\frac{3}{4}$ " BSP	100	13.8	Main bearing cap nuts.
	65	9.0	Injector top cap nut and lock nut.

Air Cleaners

The frequency with which the air cleaner requires servicing varies greatly according to the amount of foreign matter in the air. It is recommended, however, that the element receives attention at least every 1000 hours, even when operating in substantially dust-free conditions; under less favourable conditions more frequent servicing will be necessary—even daily.

With oil bath cleaners, after dismantling the filter, the element should be thoroughly washed in paraffin or fuel oil and the filter bowl cleaned out. On reassembly the filter must be filled with oil exactly up to the mark indicated on the filter bowl, using the same grade and viscosity of oil as for the engine.

The restriction caused by the air cleaner measured at the inlet end of the manifold must not exceed 10" (25 cm.) water gauge at full load and speed or 11" (28 cm.) at no load and full speed.

Air cleaners with paper elements must have the elements **replaced** when the above restrictions are reached, and the rest of the air cleaner cleaned internally if necessary. When reassembling air cleaners it must be ensured that all joints and connections on the cleaned air side are air tight so that no particles of dust can enter the engine.

Bearings

Big End Bearings: These are steel backed precision bearings which require no fitting. Under no circumstances should they be scraped or 'touched up' in any way.

If the big end has been dismantled because of failure of the metal through lack of oil, or dirt in the system, the oil passage in the crankshaft must be examined for obstruction or fragments of metal. After cleaning out, it is advisable to crank the engine over by hand to see that oil reaches the main bearings and to flush out the oilways.

When re-fitting bearing shells it is essential to ensure that the connecting rods and the backs of the shells are scrupulously clean and free from burrs, so that the shells fit perfectly into the rods. Also no dirt or burrs must prevent the cap half of the connecting rod from mating squarely with the rod half, otherwise distortion, slackness and bearing failures may occur.

Double cylinder numbers '11', '22', etc., on the big end of the connecting rod must be towards the camshaft side of the engine. Connecting rod bolt tightening torque should be 68 lb.ft. (9.4 kg.m.) but before finally tightening down ensure that the bolts are seating squarely with the flat on the head correctly located in relation to the milled form of the rods.

Main Bearings: These are steel backed precision bearings, fitting instructions for which are similar to those quoted under 'Big End Bearings' above.

On either side of the flywheel end bearing a pair of ring bearings provide crankshaft location. Care must be taken when fitting these bearings to ensure that the bronze surfaces face outwards to take the bearing load. End float should be checked with a dial type indicator, and must be between 0.003"-0.012" (0.076-0.36 mm.).

Main bearing caps must be refitted in their original positions with the number on the cap facing towards the same side as the corresponding number stamped on the crankcase. Tightening torque for main bearing cap nuts is 100 lb.ft. (13.8 kg.m.).

Belts: The dynamo/water pump driving belts are of special materials and construction and no belts other than those supplied as genuine spares should be used for replacements.

Belt tension initially must be such that when a weight of 5 lb. is rested on top of the two belts half way between the dynamo and pump a deflection of $\frac{1}{2}$ " is procured. This is approximately equivalent to a deflection of 11 mm. for a load of 2 kg.

It is particularly important that the belt tension be checked after overhaul (initially 25 hours) or after new belts have been fitted. DO NOT overtighten the belts or keep on resetting the tension at short intervals.

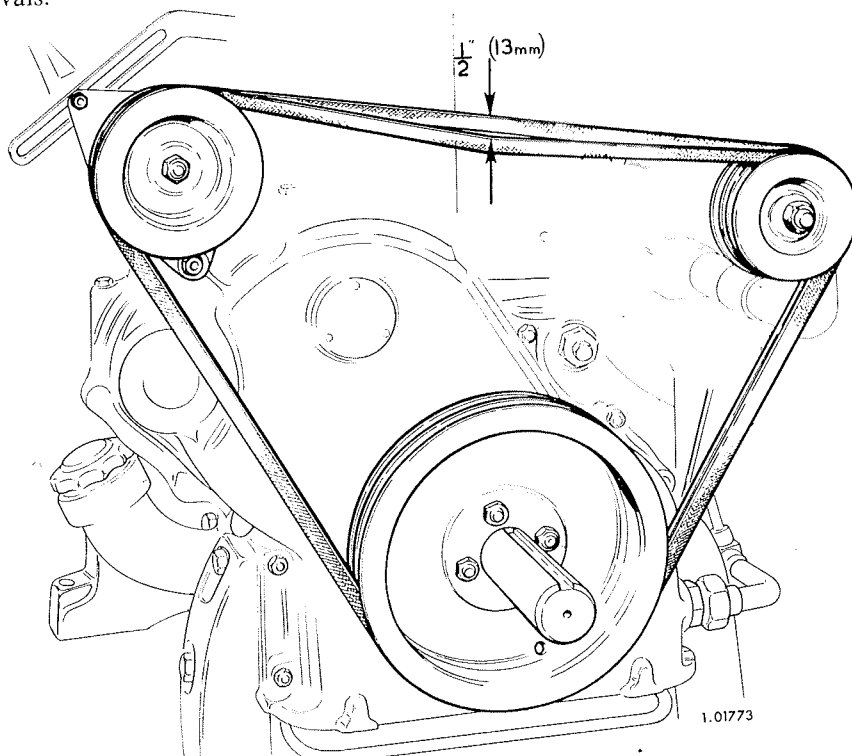


Fig. 5.—Belt Tension.

Breather

The crankcase breathers are in the form of a pipe screwed into the top of each cylinder head and connecting with the respective inlet ports. The oil laden vapour is thus drawn into the inlet ports and a partial vacuum is maintained in the crankcase preventing leakage at seals and joints.

Camshaft

The camshaft runs in bearings machined in the crankcase, with the exception of the cast iron locating bearing at the gearcase end which is a separate bush retained in position by a dowel. All bearings are pressure lubricated through drillings in the crankcase from the main oil gallery.

The centre camshaft journal is cross-drilled to provide a metered feed of lubricating oil to the rocker gear.

To Remove the Camshaft

- (a) Remove auxiliaries and their drives from the gearcase end of the engine.
- (b) Remove the cylinder heads (see page 22).
- (c) Remove push rods and tubes.
- (d) Remove guide clamps and guides complete with tappets.
- (e) Remove the fuel lift pump and operating plunger.
- (f) Remove the gearcase end cover.
- (g) Remove the end plate secured by three setscrews to the top face of the cylinder housing ('A', Fig. 6).
- (h) Withdraw the camshaft locating bush dowel exposed by removal of the end plate. The dowel is tapped $\frac{1}{4}$ " UNF to facilitate removal.
- (j) Withdraw the camshaft and gearwheel from the engine, taking care not to damage the cams.

Before reassembling check that the oilways between main oil gallery and camshaft bearings are clean.

Reassemble in the reverse order using new joints to prevent oil leakage.

Timing the Camshaft: The camshaft is timed correctly when the 'O' mark on the gearwheel coincides with the 'O' mark on the crankshaft pinion (keyway of the crankshaft extension towards the top). It must be checked at the same time that the fuel pump timing gears are correctly meshed with the camshaft gears (see 'Fuel Pump Timing', page 27).

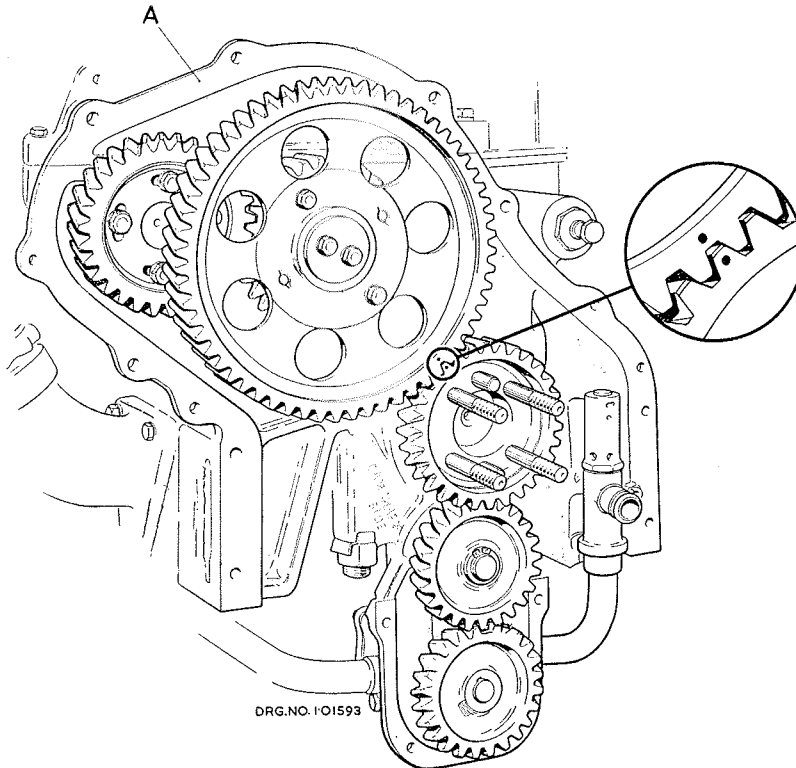


Fig. 6.—Timing marks.

Crankshaft

Individual main bearings between each crank throw carry the crankshaft under the crankcase. On each side of the flywheel end bearing there are two pairs of ring bearings which locate the crankshaft axially.

To Remove the Crankshaft:

- (a) Disconnect all driven equipment.
- (b) Remove the cylinder heads (see page 22).
- (c) Remove push rods and tubes.
- (d) Remove the gearcase end cover (retain two dowels).
- (e) Remove the crankshaft pinion and shaft extension at the gearcase end of the engine (retain two dowels).
- (f) Drain and remove sump (see page 33).
- (g) Remove the oil strainer, piping, relief valve and oil pressure pump if not dismantled in the course of (f).
- (h) Remove the big end nuts on one cylinder at a time and withdraw pistons and barrels complete. Do not inter-mix bearing caps or bearing shells.
- (j) Remove the starter and flywheel.
- (k) Remove the flywheel housing, if fitted, complete with oil seal; or if a crankcase end plate is fitted, remove this complete with the oil seal housing. Leave the oil thrower in position in both cases.
- (l) Remove the main bearing caps and 'drop' the crankshaft out of the crankcase. Do not damage the ring-type thrust bearings located at each side of the main bearing at the flywheel end.

All oilways and bearing surfaces must be scrupulously clean on assembly.

Each bearing cap is separately numbered. Ensure that caps are fitted to the correct bearings and that the identification number on the cap is to the same side as the corresponding number on the crankcase. Tightening torque for main bearing cap nuts on assembly is 100 lb.ft. (13.8 kg.m.). Use new locking washers.

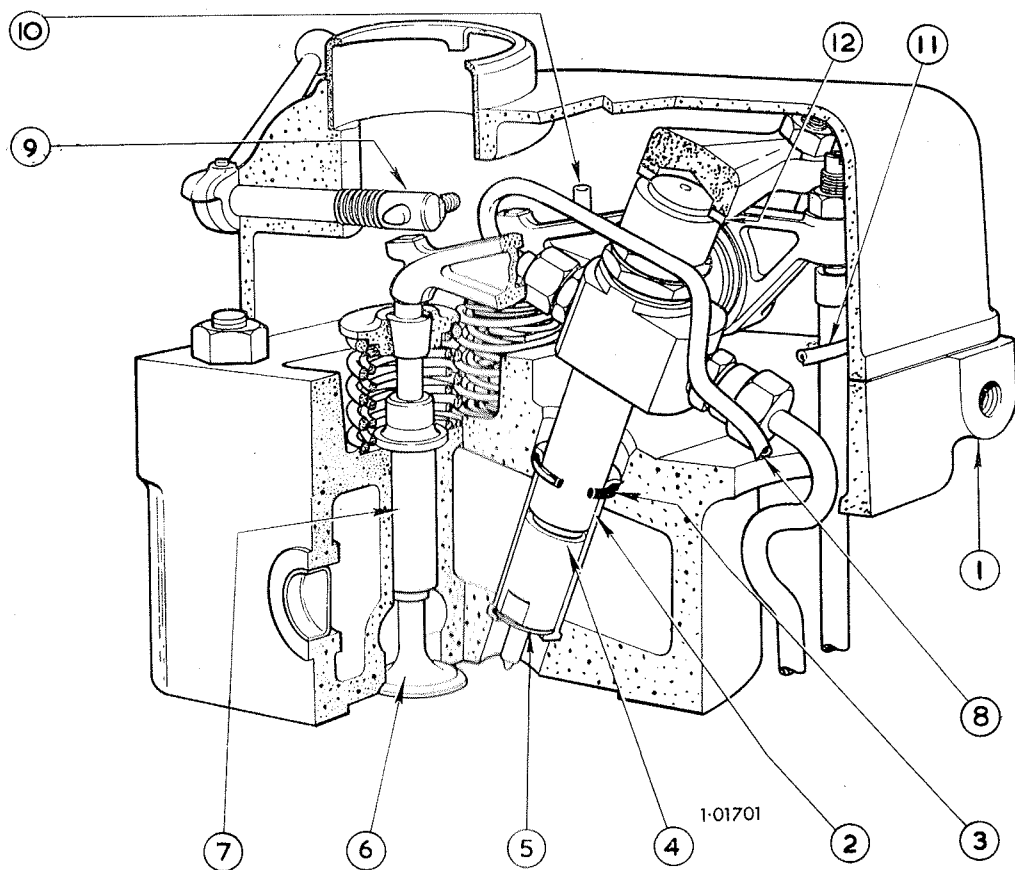


Fig. 7.—Cylinder Head

Key

- | | |
|-----------------------|--|
| 1. Cylinder Head. | 7. Exhaust Valve Guide. |
| 2. Injector Sleeve. | 8. Fuel Leak-off Pipe. |
| 3. Rubber Ring. | 9. Decompressor Shaft. |
| 4. Injector. | 10. Breather. |
| 5. Copper Ring Joint. | 11. Valve Rocker Lubricating Oil Pipe. |
| 6. Exhaust Valve. | 12. Injector Distance Piece. |

Valve Guides

The valve guides are a press fit into the cylinder head. The inlet valve guide is fitted with a rubber sealing ring, the exhaust valve guide has no joint ring.

To Remove Cylinder Heads

- (a) Drain cooling system.
- (b) Remove lifting plate.
- (c) Remove cylinder head covers.
- (d) Disconnect thermostat at water outlet manifold and exhaust manifold.
- (e) Remove pipe between water inlet manifold and exhaust manifold.
- (f) Remove air inlet manifold.
- (g) Remove exhaust manifold.
- (h) Remove water outlet manifold.
- (j) Remove all lubricating oil pipes to valve rockers.
- (k) Remove fuel pipes to injectors, also fuel leak-off pipes.
- (l) Release fuel filter at bracket. Where an instrument panel is fitted, it will have to be removed to allow access to the filter bracket.
- (m) Remove fuel injector clamps and injectors.
- (n) Remove cylinder head nuts (four to each head).
- (o) Remove cylinder head, be careful in keeping each gasket and shims for its own head. The shims are used to adjust cylinder head clearance.

To Remove Valves

Having carried out above instructions proceed as follows:—

- (a) Lay head upright on bench and place a circular block of wood about 4½" in diameter under the valve heads.
- (b) Depress valve spring carrier.
- (c) Remove valve stem cone (in two halves).
- (d) Remove valve spring carrier, and valve springs.
- (e) Turn cylinder head over, and remove valves. Clean and regrind valves, and reverse above process to replace. Valve heads must be between 0.040"/0.045" for inlet valve and 0.025"/0.030" for exhaust valve, below the face of the cylinder head.

To Replace Cylinder Head

Ensure that the gasket and shims are correct as removed with each head.

Fit the cylinder heads to their respective cylinders and fit one manifold before tightening the cylinder head nuts. The fitting of a manifold will give accurate alignment of the joint faces on each cylinder head relative to its neighbour and prevent the possibility of distortion or damage to the manifolds. The cylinder head nuts should be tightened to a torque of 100 lb.ft. (13.8 kg.m.).

Cylinder Head—Valves

The valve rocker operates directly on to the valve stem.

For adjusting instructions see page 35.

Inlet valve—Opens 25° B.T.D.C.; Closes 35° A.B.D.C.

Exhaust valve—Opens 40° B.B.D.C.; Closes 20° A.T.D.C.

Valve heads must be between 0.040" and 0.045" for the inlet valve and between 0.025" and 0.030" for the exhaust valve below the face of the cylinder head.

The width of the valve seats must be 0.120" - 0.140". This width can be maintained by increasing the depth of the recess in the head.

To Check Cylinder Head Clearance

Place a piece of lead wire 0.048" x $\frac{1}{8}$ " on top of the piston clear of the valve recesses and the combustion chamber in the top of the piston.

Tighten down cylinder head and turn the piston past T.D.C.

Remove the cylinder head and measure the thickness of lead. This should be between 0.032" (0.81 mm.) and 0.035" (0.89 mm.) and may be adjusted by steel shims 0.003" (0.075 mm.) thick placed between the cylinder head and the gasket. Only one copper joint must be used between the crankcase and the cylinder block and it must be jointed with compound.

To Remove Piston

- (a) Drain sump—by means of plug (directly underneath starter motor) or by sump pump (if fitted).
- (b) Remove cylinder heads (see page 22).
- (c) Remove water pipe from heat exchanger to cooler.
- (d) Slacken hose clip on cooler outlet to pump at pump end.
- (e) Remove cooler oil pipes.
- (f) Remove cooler clip bolt and remove cooler.
- (g) Remove water inlet manifold.
- (h) Remove sump (see pages 32-33).
- (i) Disconnect big end bearings one at a time.
- (k) Cylinder block with piston and connecting rod can now be removed.

When the piston has been withdrawn from the cylinder block the gudgeon pin can be removed easily by immersing the piston in hot water after removal of gudgeon pin circlips.

Heating of the piston in the same way should be done for refitting gudgeon pins. A piston ring expanding tool is recommended for removing the piston rings. As an alternative strips of thin metal inserted between the ring and the piston will simplify its removal.

To Replace Piston Rings

Ring grooves and oil holes must be thoroughly cleaned, care being taken not to scratch the side faces of the grooves. A check to ensure that the ring is free can be made by rolling each ring (except the top one) round its own groove.

The top ring is taper sided and chromium plated; the second and third rings have slightly tapered peripheries in contact with the cylinder wall and must be fitted with the larger diameter of the taper at the bottom; the fourth, the oil control ring, must be replaced in its own groove, above the gudgeon pin, the same way up as before stripping. New rings are marked TOP on the top side and must be fitted accordingly. Minimum piston ring gaps, measured with feelers with the ring square in the lower part of the cylinder bore, are as follows:—

top ring	...	...	...	...	...	0.010"
compression rings	...	...	...	...	...	0.016"
scraper ring	...	...	...	...	...	0.012"

To Replace Piston and Connecting Rod

Always check the clearance between the piston and the cylinder which must not be less than 0.004" (0.101 mm.) measured with a $\frac{1}{2}$ " wide feeler inserted between the two and requiring a force of 4-8 lb. to pull it out.

Invert the cylinder block, oil and insert piston and connecting rod in the cylinder block, using a ring compressor tool. Place one 0.005" copper joint at the base of the cylinder block.

Turn the piston with wording 'CAMSHAFTSIDE' on top towards the camshaft (fuel pump housing side).

Turn crankshaft to T.D.C., lower into position cylinder complete with piston and connecting rod, and when the connecting rod bolts have passed over the crankpin, turn crank to camshaft side as the piston is pressed down.

Lightly oil the bearing surfaces before assembly and ensure scrupulous cleanliness. Assemble the big end bearing according to the identification marks and secure with the self locking nuts. Correct tightening torque is 68 lb.ft. (9.4 kg.m.)

Decarbonising

Decarbonising may be necessary after about 1500 running hours, but this figure will vary with different installations and depends upon the engine duty and upon the quality of maintenance, fuel and lubricating oil. To dismantle the engine for decarbonising completely:—

- (a) Remove the cylinder heads (page 22).
- (b) Remove the sump (page 33) disconnect the connecting rod bolts, and withdraw the connecting rods, pistons and cylinder blocks as complete assemblies.

Should it be necessary to decarbonise the pistons but access to the engine sump is exceptionally difficult, the cylinder heads may be removed as above and the pistons then cleaned in position after removing the cylinder blocks in turn. Great care must then be taken in removing and replacing the piston rings, to avoid scratching or damaging the pistons, and in **preventing dirt from falling into the crankcase**. In any case it is advisable to flush out the sump thoroughly with fuel oil before putting the engine into service again.

All parts must be thoroughly cleaned and washed in paraffin or fuel oil, particular attention being paid to:—

- (a) Valve ports.
- (b) Piston rings and grooves (ensure that the grooves are thoroughly clean but do not scratch the groove faces).
- (c) Combustion chambers in top of the pistons.
- (d) Inside the pistons.
- (e) Clean out water spaces in each cylinder block.
- (f) Clean out the exhaust piping and silencer.
- (g) Regrind the valve seats.

- Note :** (i) Valve seat width should be maintained within the limits 0.120"-0.140" (3.05-3.56 mm.).
- (ii) When fitting new valves it must be checked that the valve head is below the face of the cylinder head at least 0.040" (1.02 mm.) for the inlet valve and 0.025" (0.64 mm.) for the exhaust.

Dynamo

In addition to its normal function the dynamo acts as the tensioning pulley for the water pump 'vee' belt drive. It is therefore particularly important that the dynamo bearings be maintained in good condition, and that attention be paid to the dynamo to ensure that any irregularity — such as excessive noise or bearing play — is not allowed to pass unrectified.

Normal maintenance involves removing the rubber plug from the end of the dynamo casing every 250 hours and injecting a few drops of oil to lubricate the plain bearing, and stripping the dynamo every 5000 hours to examine the ball bearing at the drive end. Re-pack the bearing with Shell Alvania No. 2 or an equivalent high melting point grease.

Flywheel

The flywheel is bolted to a flange on the crankshaft and is located in position by two dowels.

When assembling the flywheel to the crankshaft care must be taken to ensure that all surfaces are perfectly clean, that the locking washers are in good condition and that the setscrews are tightened to a torque of 60 lb.ft. (8.3 kg.m.). Bend over the tabs of the locking washers to fasten the setscrews securely.

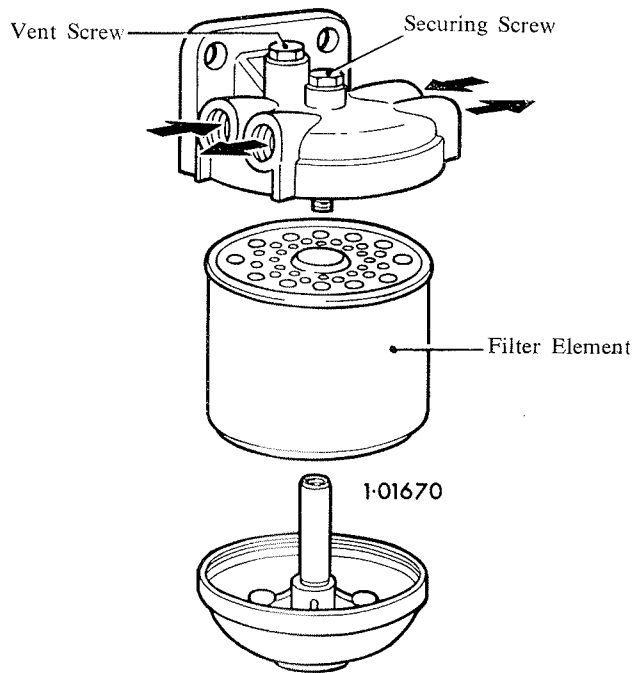


Fig. 8.— Fuel Filter

Fuel Filter

The fuel filter is an essential component of a diesel engine and must not be removed or used without a filter element.

Renew the element every 1,500 hours if clean fuel is used. If fuel is dirty attend to the filter more often taking care to prevent dirt reaching the inside of the element or delivery pipes. Clean inside the bowl.

Assemble carefully and prime the fuel system by slackening the vent screw until all air is removed and then tightening again.

If the engine runs erratically it should be further primed at the fuel pump vent screws which are accessible after removing the fuel pump housing door.

On engines fitted with a self priming fuel system the fuel pump vent screws mentioned above are replaced by pipes with swivel unions. With this system the venting procedure should not be necessary but in extreme cases slackening of the swivel union screws would release any air in the system.

Fuel Injector: The injector nozzle has four spray holes 0.010" diameter. The release pressure should be set at 180 atmospheres (2,650 lbs./sq.in.) which allows for settling to the normal pressure of 170 atmospheres (2,500 lb./sq.in.).

The injection equipment and piping must be absolutely clean as one particle of dirt in the system can easily block a hole in the nozzle and produce a dirty exhaust. The greatest possible care must therefore be taken not to permit dirt to enter the system when any part of it is dismantled for servicing—this applies to the fuel pump, the fuel injector, and to all pipes and unions between the fuel filter and the fuel pump and between the pump and injector.

Testing Fuel Injector: To check that the injector spray is satisfactory the injector must be removed from the engine and reconnected externally to the fuel pump so that the spray can be observed. (Direct the spray AWAY from the operator). This involves removing the injector pipe and using a spare one as the standard pipe must NEVER be bent for this purpose.

The engine must then be turned at about 60 r.p.m. and after a few revolutions the nozzle will begin to function and the sprays can be observed. These should be in the form of a very fine mist, not streaky or dribbly. All four sprays should have the same appearance and the same length of penetration in the air. If one spray is shorter or weaker than the others this means that the corresponding hole is partially blocked and the best results will not be obtained.

If one hole is totally blocked or if there are signs of dribbling, the nozzle must be replaced or sent for reconditioning to an accredited service depot.

If the nozzle only is replaced the injector spring pressure must be reset with a special test rig consisting of a hand operated fuel pump and a pressure gauge. This equipment is normally carried by service engineers, but if it is not available, a complete injector either new or serviced must be fitted and the faulty unit returned to a service depot, Lister agent, or to the works for reconditioning.

When fitting a new injector the following instructions must be observed:—

1. The injector nozzle cap nut must be dead tight.
2. The injector spring locknut must be dead tight to the injector body and the outer cap then screwed on and locked dead tight against the thin locking nut. Use a spanner on the thin locking nut and not the injector body to take the reaction when tightening the outer cap.
3. The injector copper sleeve should be examined and if there is any doubt about it it should be replaced together with a new rubber ring.
4. A new copper ring should be fitted between the injector and the bottom of the sleeve.
5. The injector clamp nuts must be tightened to a torque of 15 lb.ft.

Important. ALL work on the fuel injection equipment must be carried out by an accredited Service Depot, with the exception of the attention given to the fuel pump delivery valve and seat and the changing of defective injector nozzles.

Fuel Pump Timing: Injection is timed to commence 28° before top dead centre. To assemble the drive and to ensure that this setting is correct proceed as follows:—

- (a) Bolt the driving gear to the fuel pump drive shaft with the bolts in the centre of the gear slots. Only one bolt 'B' to be tightened (see Fig. 9).
- (b) Assemble drive shaft sleeve and thrust washer and check clearance between flange and washer. This should be between 0.005" and 0.0135". If in excess of 0.0135" the longer sleeve Part No. 354-19571 should be fitted.
- (c) Position the fuel pump drive shaft so that tightened bolt 'B' appears in the centre of the access hole when the gearcase end cover is located in position (view 'A', Fig. 9).

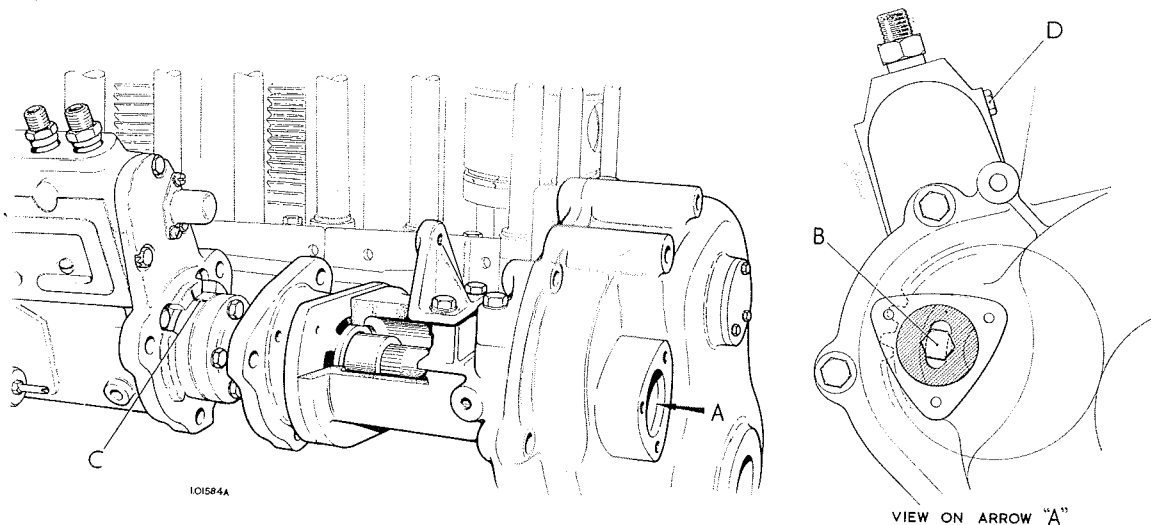


Fig. 9.—Fuel Pump Timing

- (d) Turn the crankshaft to No. 1 cylinder T.D.C. (see Fig. 6, page 19), and assemble the camshaft compound gear so that timing marks 'O' coincide, also retaining setting (b).
- (e) Turn the flywheel (in the correct direction of rotation) to the firing position for No. 1 cylinder (nearest gearcase end). This is when the firing mark FP on the flywheel coincides with the pointer on the engine crankcase, and both valves on cylinder No. 1 are closed. When a flywheel housing is fitted the timing mark can be observed after removing a plug in the top of the housing.
- (f) Assemble the fuel pump coupling to the pump and rotate the pump shaft to line up the timing marks 'C' on the pump spigot and the coupling flange.
- (g) Engage the pump coupling with the driving serrations on the shaft and bolt the fuel pump to its mounting flange, maintaining as closely as possible the setting (e). Ensure paper joint and jointing compound are used.
- (h) Disconnect No. 1 fuel delivery pipe from the fuel pump, unscrew the delivery valve holder and remove the spring and valve. If fuel flows from the pump, turn the flywheel a few degrees forward to stop the flow, and replace the valve holder.
- (i) Turn the flywheel backwards until, with the lift pump manually operated and the stopping lever in the normal running position, fuel starts to flow, then turn the flywheel in the normal direction of rotation until the flow is again interrupted. Blow fuel from the top of the valve holder to make sure it has stopped.

Note: To avoid having to operate the fuel lift pump when checking the timing, a small container can be used with a banjo union fitting straight onto the fuel pump inlet connection. Fuel can then be gravity fed through the pump.

- (k) At this point the firing mark on the flywheel should coincide with the pointer on the engine crankcase. Any correction must be made by turning the crankshaft back to T.D.C. position, No. 1 cylinder, slackening the single tight setscrew 'B' securing the driving gear to the fuel pump drive shaft, and advancing or retarding (turning clockwise or anti-clockwise respectively, viewed from the gear case end) by means of the slot adjustment. When the timing is correct all four setscrews must be securely tightened, and the setting finally re-checked.
- (l) Wash the fuel pump delivery valve, spring and pipe in clean fuel oil, and reassemble.

To Prime Fuel System: See "Initial Starting", page 14.

Gear Drives

Fuel Pump Drive: Access to the camshaft and fuel pump drive gears is obtained by removing the gearcase end cover. Any burrs should first be removed from the shaft extension keyway, and the keyway turned to face downwards so as not to damage the oil seal in the cover.

The crankshaft pinion, oil thrower and extension shaft are all carried on four studs and are located by two off-set dowels. A similar dowel arrangement ensures that the camshaft gear and the fuel pump drive gear are correctly located relative to each other and to the camshaft.

There is a drilling across the end of the crankcase which feeds oil under pressure to the serrations of the fuel pump drive shaft via a hole through the centre of the shaft. Oil passing the serrations then feeds back to lubricate the pump drive shaft bearings.

Lubricating Oil Pump Drive: If it is required to examine or dismantle the complete gear drive to the lubricating oil pump, the gearcase end cover must be removed and the sump either removed (if space is available) or lowered and drawn forward as far as possible (see page 32). Removal of the oil pump gear cover will then expose the oil pump driving gear.

The idler between the crankshaft pinion and oil pump gear is carried on a hollow spindle which also serves as a dowel locating the oil pump housing to the crankcase. The idler bearing is lubricated by oil fed through the centre of this spindle via a hole drilled through the housing from the delivery side of the oil pump.

When reassembling, the gearcase end cover should be fitted before the sump, using a new paper joint coated on both sides with Wellseal or similar non-hardening jointing compound to prevent leakage.

Governor

The governor is flange mounted to the fuel pump housing and is driven through speed increasing gears from an extension of the fuel pump camshaft. The driving gear incorporates a rubber disc-type resilient coupling, and should this require renewal after a long period of service, the gear and coupling assembly should be renewed complete. At the same time the pinion assembly should be checked for wear and renewed if necessary.

Gear and pinion assemblies should not be dismantled when they are inspected in the course of routine engine servicing.

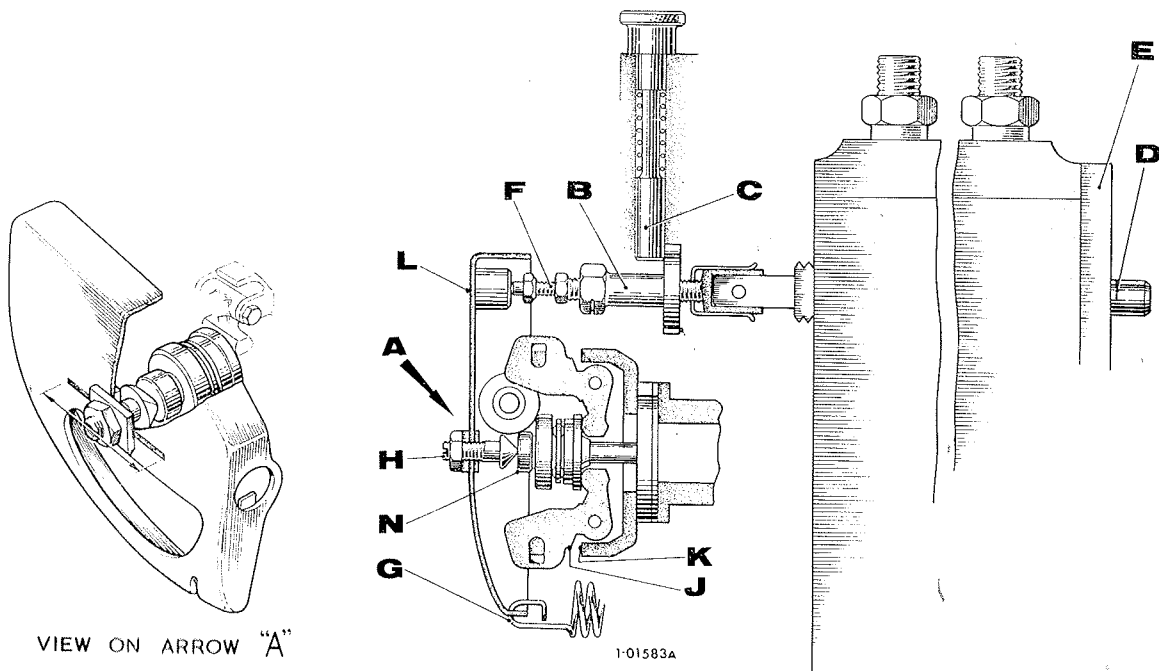


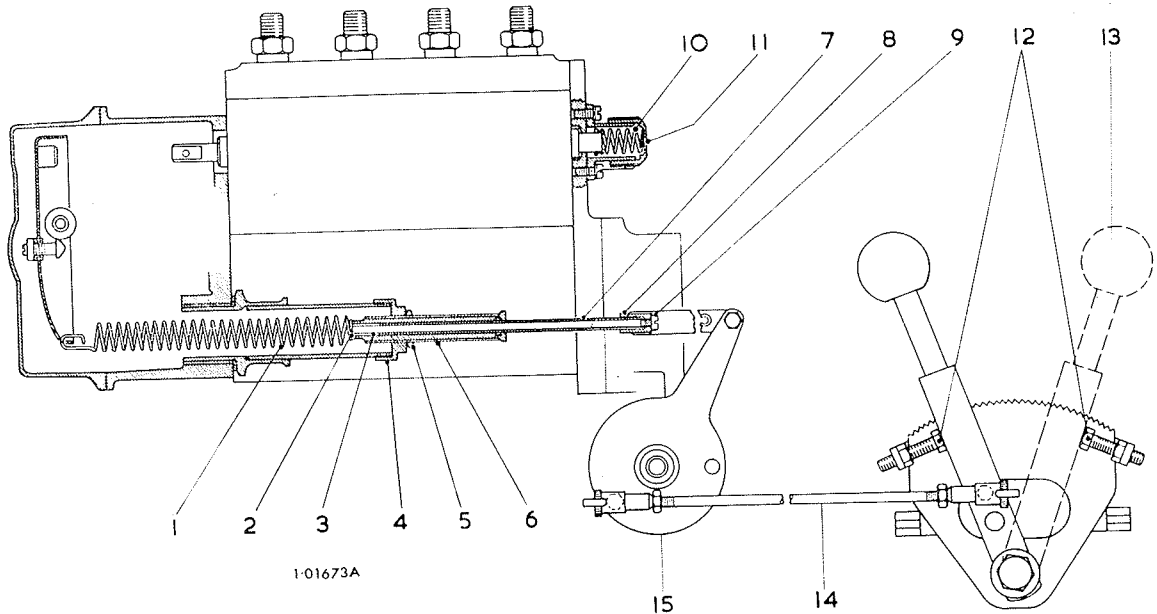
Fig. 10.—Setting Governor and Fuel Pump.

Governor Setting:

To set the governor linkage in the correct relationship to the fuel pump rack proceed as follows (see Fig. 10):—

Constant Speed

- (a) Adjust the overload stop 'B' so that it just touches the overload trip plunger 'C' when the pump calibration mark 'D' is exactly in line with the fuel pump and cover 'E' at the input coupling end.
- (b) Adjust the length of the linkage 'F' between the overload stop 'B' and the pressed steel governor lever 'L' so that the governor lever is vertical with the overload stop just touching the overload trip plunger 'C'.
- (c) With a piece of wire locked through the end of the speeder spring, disconnect the spring from the governor lever at 'G' and allow it to withdraw into the speeder spring tube.
- (d) Set the fuel pump so that the calibration mark 'D' projects 0.394"-0.433" (10-11 mm.) from the end cover 'E'. With this setting maintained, adjust pivot pad 'H' so that the weights "open" stops "J" abut against the carrier stops "K" when the pivot pad 'H' is against the sleeve thrust pad 'N'. The screwdriver slot in pivot pad 'H' **must** be dead in line with the alignment marks stamped on the lever, see left hand figure above, in order to ensure correct operation of the pivot pad knife edge. Tighten locknut.
- (e) Re-connect the speeder spring to the governor lever.



- | | |
|---------------------------------------|--------------------------------|
| 1. Speeder Spring. | 9. Slide Assembly Screw. |
| 2. Speeder Spring Backing Washer. | 10. Idling Spring. |
| 3. Speeder Spring Connecting Spindle. | 11. Idling Adjustment Cap. |
| 4. Speeder Tube Cap. | 12. Speed Control Lever Stops. |
| 5. Adjuster Lock Nut. | 13. Speed Control Lever. |
| 6. Speeder Spring Idling Stop. | 14. Connecting Rod. |
| 7. Slide Assembly. | 15. Intermediate Lever. |
| 8. Slide Assembly End Piece. | |

Fig. 11.—Setting Variable Speed Governor

Variable Speed Governor Setting:

Carry out setting for constant speed and continue as follows:—

- (a) Slacken off stops (12) for the speed control lever (13) so that the full extent of lever movement is available.
 - (b) Screw in speeder spring idling stop (6) to the full extent.
 - (c) Screw up idling adjusting cap (11) to within a few threads of being fully tightened.
 - (d) Run the engine at half speed on no load then move slide (7) to the left until slide end piece (8) is in contact with speeder spring idling stop (6).
 - (e) Slacken off idling adjustment cap (11) until correct idling speed is obtained.
- Note:**— Engine speed will fluctuate at this stage and adjustment must be made so that the mean of these fluctuations corresponds to the idling speed required.
- (f) Unscrew the speeder spring idling stop (6) until the idling speed just begins to rise and hunting is eliminated. Tighten locknut (5).
 - (g) Set full speed adjuster so that full rated speed and power can be obtained.
 - (h) Centralize control lever movement over detent plate by adjusting connecting rod between control and intermediate levers. Recheck full and idling speeds and then set speed control lever stops (12) to correspond with the final settings.

Note:- If a combined stop and speed control is fitted instead of that shown in fig. 11, the idling stop is fixed. The connecting rod between the control lever and the intermediate lever must be adjusted so that the end piece abuts against the speeder spring idling stop when the control lever comes up against the gate stop.

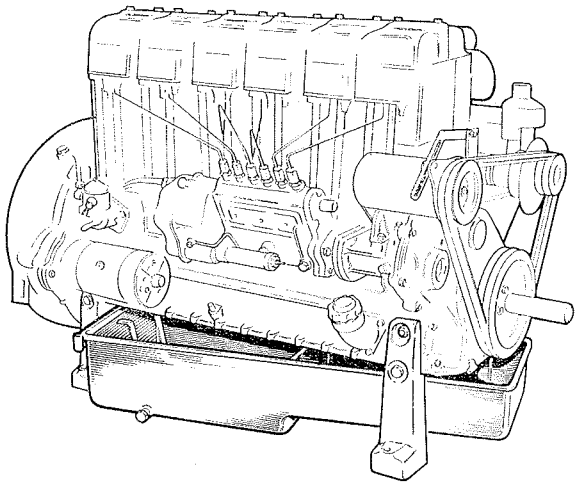
Governor Weights and Springs: The weights and springs normally fitted for a given range are as set out in the table below:—

CONSTANT SPEED (B.S. 649:1958 CLASS 'A' GOVERNING)

Engine Speed r.p.m.	GOVERNOR WEIGHT		GOVERNOR WEIGHT SPRING			SPEEDER SPRING			Speeder Spring Link
	Part No.	No. per Set	Part No.	Colour	No. per Set	Part No.	Colour	No. per Set	
1000	354-28350	2	354-22910	Blue	2	354-22860	Blue	1	354-26871
1200	354-11500	2	354-22910	Blue	2	354-22860	Blue	1	—
1500	354-11500	2	354-22910	Blue	2	354-25941	Green	1	—
1800	354-11501	2	354-22910	Blue	2	354-25941	Green	1	—
2000	354-21560	2	354-22910	Blue	2	354-25941	Green	1	—

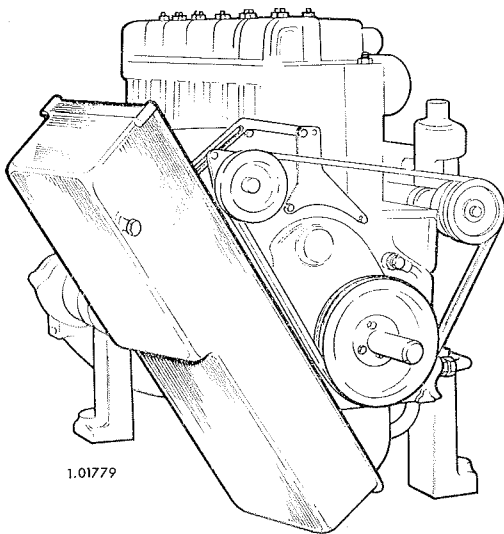
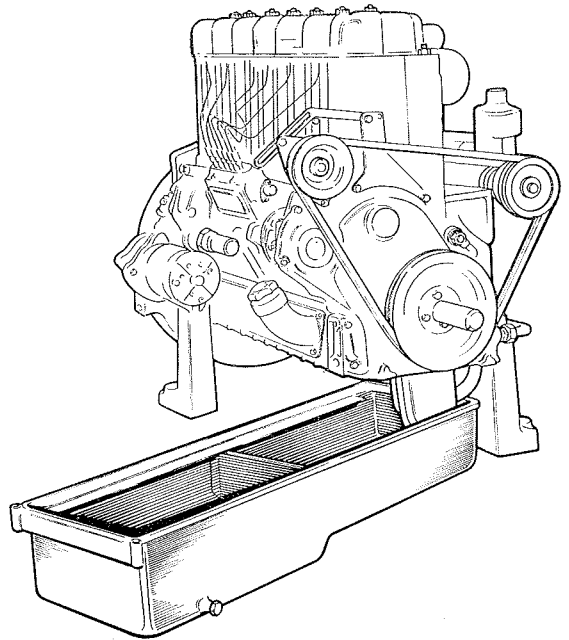
VARIABLE SPEED (B.S. 649:1958 CLASS 'B' GOVERNING)

Engine Speed Range—r.p.m.	GOVERNOR WEIGHT		SPEEDER SPRING			IDLING SPRING		
	Part No.	No. per Set	Part No.	Colour	No. per Set	Part No.	Colour	No. per Set
500-2000	354-21561	2	354-26850	Orange	1	354-24260	—	1



1. Sump drawn out as far as possible between support feet.

2. Support foot removal at gearcase end, camshaft side and sump turned through 120° .



3. End of sump raised 45° .

1.01779

Fig. 12.—Removing Lubricating Oil Sump (Auxiliary Engine)

Sump

The engine sump is separate from the crankcase and is held in position by a number of clamps secured by setscrews. Two long setscrews on either side at the flywheel end locate the sump in correct relation to the crankcase.

The joint between the sump and crankcase is made by a rubber 'O' ring which must be in good condition and properly seated during assembly. It is advisable for the seal to be stuck to the recess round the lip of the sump using Bostik 772 or similar jointing compound, but adhesive should not be used between the joint ring and the crankcase.

To Remove Sump: After draining the oil the sump is most conveniently removed, where space is available under the engine (approx. 8" (20 cm.) clear), by unscrewing the clamps and locating setscrews and lowering it clear of the strainer. This gives access to the oil strainer, lubricating oil pump and big end bearings without further dismantling.

Where this procedure cannot be adopted, two other methods of sump removal are possible, depending upon the installation.

1)—requiring 3ft. (1 metre) clear at the gearcase end:

- (a) Drain the sump when the engine is warm.
- (b) Remove the belt guard, belts and dynamo.
- (c) Remove the pulley and extension shaft.
- (d) Disconnect the filter lubricating oil pipe from the gearcase end cover and remove the cover.
- (e) Remove the two sump setscrews at the flywheel end, remove the remaining clamps, and lower the sump. Withdraw it towards the gearcase end until it fouls the oil strainer.
- (f) Remove the lubricating oil pump cover.
- (g) Remove the idler circlip and withdraw the idler gear. Slacken the screw securing the idler shaft and remove the shaft.
- (h) Remove the screw connecting the strainer pipe to the lubricating oil pump and also the corresponding screw retaining the relief valve pipe.
- (j) Remove the two setscrews securing the strainer to two main bearing studs and moving the strainer if necessary, withdraw the suction pipe from the pump (push fit). Retain the two sealing rings on the end of the pipe.
- (k) Remove the relief valve and pipe as one assembly.
- (l) Remove the lubricating oil pump.
- (m) Withdraw the sump.

2)—requiring 3 ft. (1 metre) clear radius from the dynamo:

- (a) Remove the sump setscrews and clamps and lower the sump.
- (b) Remove the belt guard and draw the sump forward until it fouls the oil strainer.
- (c) Remove the strainer setscrews and also the single setscrew securing the lubricating oil suction pipe to the oil pump.
- (d) Withdraw the suction pipe from the oil pump, retaining the two sealing rings on the end of the pipe, and allow the strainer and pipe to rest in the sump.

By drawing the flywheel end of the sump out as far as possible between the engine support feet on the camshaft side it is now possible to remove the strainer and pipe for cleaning. If the sump is to be removed completely from the engine continue as follows:—

- (e) After ensuring that the engine is adequately supported, remove the engine support foot at the gearcase end, camshaft side, and swing the flywheel end of the sump through 120° towards the gearcase end of the engine.
- (f) Raise the end of the sump 45° so that it can be removed from under the lubricating oil pump.

Lubricating Oil Pump: The pump is of the rotary type and is submerged below the level of the oil in the crankcase. It should require little attention, but should the spindle and impeller require renewal the eccentric ring must be renewed at the same time.

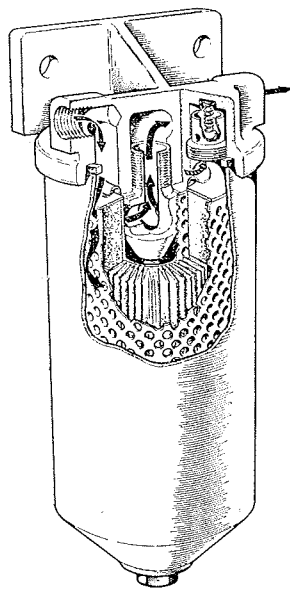


Fig. 13—
Lubricating Oil Filter

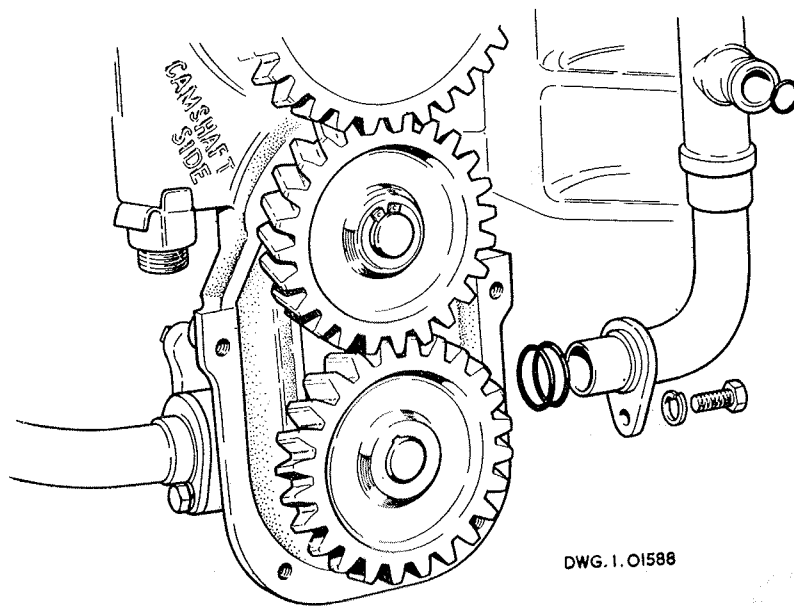


Fig. 14—Removing Lubricating Oil Pump

To Remove the Lubricating Oil Pump

- (a) Drain the sump.
- (b) Remove the gearcase end cover.
- (c) Remove the sump completely if space is available, or lower and draw forward as far as possible. See illustrations on page 32.
- (d) Slacken the strainer setscrews and disconnect the oil suction pipe flange at the pump by removing the single retaining setscrew and withdrawing the pipe from pump (retain the two rubber sealing rings on the end of the pipe).

Note: When reassembling, locate the suction pipe flange squarely to the pump and tighten the single setscrew before finally retightening the strainer setscrews.

- (e) Disconnect the relief valve pipe from the pump, remove the nut securing the relief valve to the crankcase, and withdraw the valve and pipe from the lubricating oil pump as one assembly. Retain the two rubber sealing rings on the end of the pipe.
- (f) Remove the pump gearwheel cover.
- (g) Unscrew the two setscrews securing the pump housing to the crankcase.
- (h) Slacken the setscrew retaining the idler gear spindle in position and withdraw the spindle and idler gear. The pump can then be removed.

Lubricating Oil

Change oil every 250 hours: The plug should be removed from the sump and the oil drained when the engine is warm, alternatively the engine may have a sump pump fitted. Fuel oil should be used for flushing out the sump if this is necessary—not paraffin—and a brush should be used for wiping out the engine—not a cloth.

When the sump is removed for overhaul purposes the strainer must be cleaned.

Lubricating Oil Filter. The filter assembly consists of a detachable sump containing the filter element which is secured by a through bolt to a filter head incorporating a by-pass valve which opens should the element become choked through neglect.

Renewing the Element (every 500 hours):

- (a) Clean the outside of the filter before removing the sump.
- (b) Unscrew the centre bolt and withdraw the sump and filter element from the head. Remove the element from the sump.
- (c) Thoroughly clean inside the sump and ensure that the sealing ring is in good condition and correctly seated in its groove in the filter head.
- (d) Place the new element in the sump so that it rests centrally on the lower element support plate and offer up the sump and element to the filter head ensuring that the former seats squarely.
- (e) Screw the retaining bolt into the centre tube and tighten sufficiently to prevent leakage past the seals.

Dismantling: To dismantle the filter, remove the element as above, then extract the circlip on the centre bolt and remove the lower element support plate, the rubber washer, steel washer, and spring. The bolt can then be withdrawn from the sump and the rubber sealing ring and reinforcing plate taken off the bolt.

Assembling: Assemble in the reverse order, ensuring that all seals are in good condition and correctly located.

Valves

Adjustment. It is important that the correct valve-to-rocker clearances are maintained otherwise serious damage to the valve gear can result. With new engines or engines which have just been overhauled the valve gear beds down rapidly during the first 500 hours running; it is therefore essential to check clearances at 25 hours and 250 hours, and thereafter every 500 hours.

If it is found, and confirmed, that the valve clearances remain constant after 500 hours the adjustment periods may be extended to 1500 hours.

Valve-to-rocker clearances are 0.015" (0.38 mm.) cold for inlet and exhaust.

To adjust the clearance:

- (a) Remove the cylinder head covers and slacken the injectors to decompress the engine.
- (b) Turn the engine in the direction of rotation until the inlet valve of the cylinder concerned opens and then closes. Continue turning until the appropriate 'top dead centre' mark on the flywheel coincides with the pointer on the crankcase.

Note: Where provision is not made for a cranking handle, the decompressed engine may be turned over by means of the flywheel or by the cooling fan driving belts.

- (c) As a further check before adjusting the clearance, oscillate the flywheel backwards and forwards about 8" (20 cm.) and observe that both rockers remain motionless.
- (d) Slacken the locknut and turn the adjusting screw until the correct clearance between rocker pad and valve stem is obtained. Measure with feelers. Tighten the locknut and re-check the clearance.

Note: The tappet must be in its lowest position and the rocker pressed down firmly on the push rod.

- (e) Repeat the procedure for all cylinders.

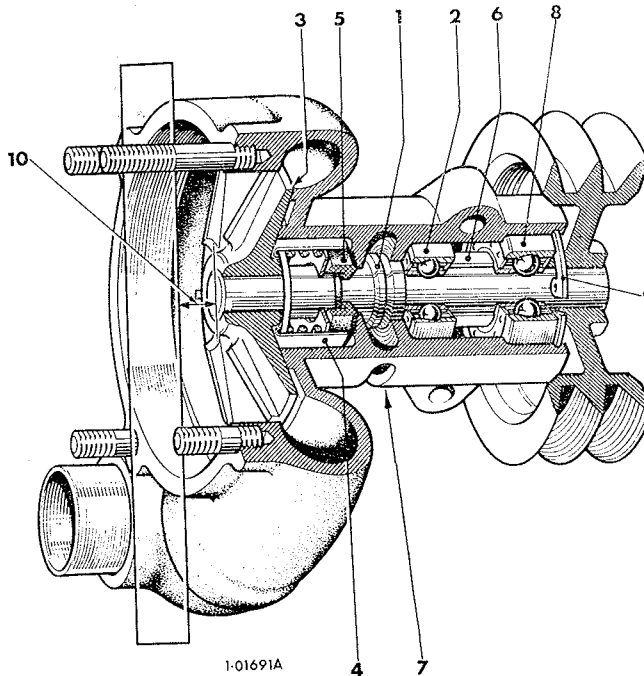


Fig. 15—Fresh water Pump

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Impeller Shaft. 2. Ball Bearing (Small). 3. Impeller. 4. Carbon Ring Driver. 5. Carbon Ring. 6. Bearing Spacer. | <ol style="list-style-type: none"> 7. Drain Hole in Pump Body. 8. Ball Bearing (Large). 9. Circlip. 10. Clearance between impeller and cover —
0.4105" to 0.4385". |
|---|--|

Failure of the carbon seal is indicated by leakage from the drain hole (7).

To fit a new carbon seal proceed as follows:—

- (a) Remove belt pulley.
- (b) Remove circlip (9).
- (c) Remove pump end cover.
- (d) Using a brass drift tap the impeller shaft (1) out through the impeller and pump body.
- (e) Check ball bearings (2 and 8).
- (f) Fit shaft (1) and inner bearing (2) into pump body.
- (g) Replace bearing spacer (6).
- (h) Fit outer bearing and circlip (9).
- (i) Fit pulley—end of shaft should be flush with face of pulley boss.
- (k) Lightly grease the seal seating, smear rubber ring with soft soap and fit seal assembly to shaft.
- (l) Place pump upright on bench, resting on the pulley, and fit the impeller (3). Care must be taken to ensure that the lugs on the carbon ring driver (4) enter the carbon ring (5) correctly.
- (m) Before fitting the cover check that the face of the impeller boss is between 0.4105" and 0.4385" below the level of the body joint face as shown at (10).
- (n) Fit new joint to cover and fit cover.

When the pump is fitted to the engine the drain hole (7) must be downwards.

LISTER REVERSE GEAR

The reverse gear is built integral with the engine, incorporating a multiple plate ahead clutch, and an epicyclic reverse gear. Lubrication is from the engine system.

As the ahead clutch is of the metal to Ferodo plate type, it is most important that no "slip" should occur, as this involves loss of power and undue wear and tear of the plates. Slipping causes heat to be generated so that on the first sign of excessive heat while going ahead the boat should be stopped and the clutch adjusted. After adjustment a well defined neutral position must exist.

The thrust bearing is situated at the extreme after end of the reverse gearbox and is lubricated from the main oil circulating system. When a reduction gear is fitted the thrust races are mounted in the reduction gearbox.

Operation—Neutral

Drive from the engine is passed initially from the crankshaft spur gear (1) to the two stepped pinions (2). These in turn drive the two spur pinions (3), thus driving the clutch shaft spur gear (4). This latter is keyed to the clutch spider (5). The clutch shaft spur gear (4) is keyed to the clutch shaft (6), and while in neutral this gear remains at rest and the two sets of pinions revolve around it, carrying around with them the clutch body (7).

Operation—Ahead

Five clutch plates (large) (8) have teeth on their outer periphery meshing with internal teeth on the clutch body (7), and four clutch plates (small) (9) are keyed to the clutch spider (5). Pushing the control lever forward rotates the cross shaft (10), throwing forward the sliding sleeve (11), and forcing the toggle levers (12) outward and forward. The adjusting screws (13) mounted in the toggle levers (12) then press upon the clutch gripping plate (14) which, although keyed to the clutch spider (5), can slide forward pressing the clutch plates (8 and 9) together. Referring to the paragraph above (neutral), as long as the engine is running the larger clutch plates (8) are being driven round by the clutch body (7). When the control lever is pushed forward, and the toggle levers (12) press all the clutch plates together friction then drives the four smaller ones, keyed to the clutch spider (5), which is keyed also to the clutch shaft spur gear (4) and the clutch shaft (6) itself, giving forward drive to the gear box half coupling (15). The sliding sleeve (11) is keyed to the clutch shaft (6) and so the toggle levers (12) and gripping plate (14) revolve at the same time, eliminating wear at these points.

Operation—Astern

When the control lever is pulled aft, the brake band roller lever (16), operating through the brake band lever (17) closes the brake band (18) around the clutch body (7) and holds it at rest. The drive from the engine then passes through the stepped pinions (2), and the spur pinions (3) and thus drives the clutch shaft gear (4) in the astern direction of rotation. There is no applied pressure on to the clutch gripping plate (14) so that the clutch spider (5) and the two clutch plates (small) (9) drive round without transferring any drive to other components.

ADJUSTING THE LISTER REVERSE GEAR

Ahead

With the reverse control gear lever in neutral, remove the inspection cover, and turn the sliding sleeve, carrying the toggle lever round, until one toggle lever is at the top. Slack off the adjusting screw locknut slightly and screw in the adjusting screw one quarter turn. Without losing this setting, set up the locknut hard. Turn the sliding sleeve until the other toggle lever comes on top, and repeat the adjustment, being careful to obtain equal adjustment on both toggle lever screws. Engage ahead clutch. There should be an appreciable effort required to get it in, (68-80 lbs. on the end of the reverse lever), but once in, there must be no tendency to jump out. It is important that there should be as little movement possible between the operating die and control sleeve with the gear fully engaged. With the Ferodo plates, 'bedding in' of these takes place during the first few hours of operation, and it is most important that the adjustment be followed up, until the clutch is fully 'bedded in'.

REVERSE GEAR

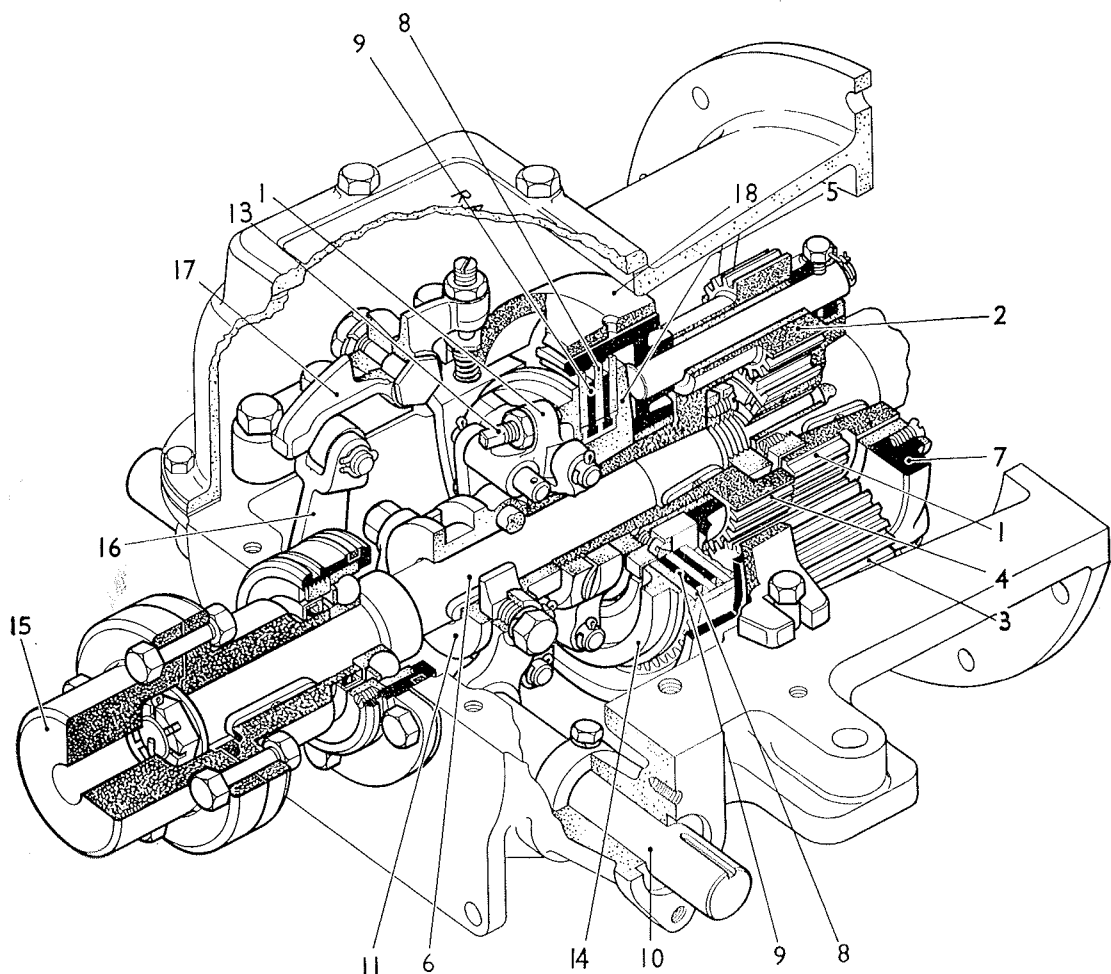


Fig. 16—Reverse Gear

Astern

Should there be any wear on the brake band the gear will slip when engaged in astern. On the port side of the gear, under the inspection cover, an adjusting screw will be found on the brake band lever over the tongue of the brake band. Put hand lever into neutral position, slacken the brake band lever adjusting screw locknut and adjust screw one $\frac{1}{4}$ turn in a clockwise direction and secure locknut. Put hand lever into astern position. When gear is now engaged astern the same effect should be required to engage the gear as felt after adjusting the ahead clutch. Should the lever tend to jump out of engagement, ease the brake band adjustment when the gear is in the neutral position. Should the gear still slip in astern, tighten the brake band lever screw to suit.

Note.— Before adjustments are made to the reverse gear for ahead or astern running, the stop screws and locknuts on the locating plunger must be slackened off, and then secured when all adjustments have been made.

REDUCTION GEAR

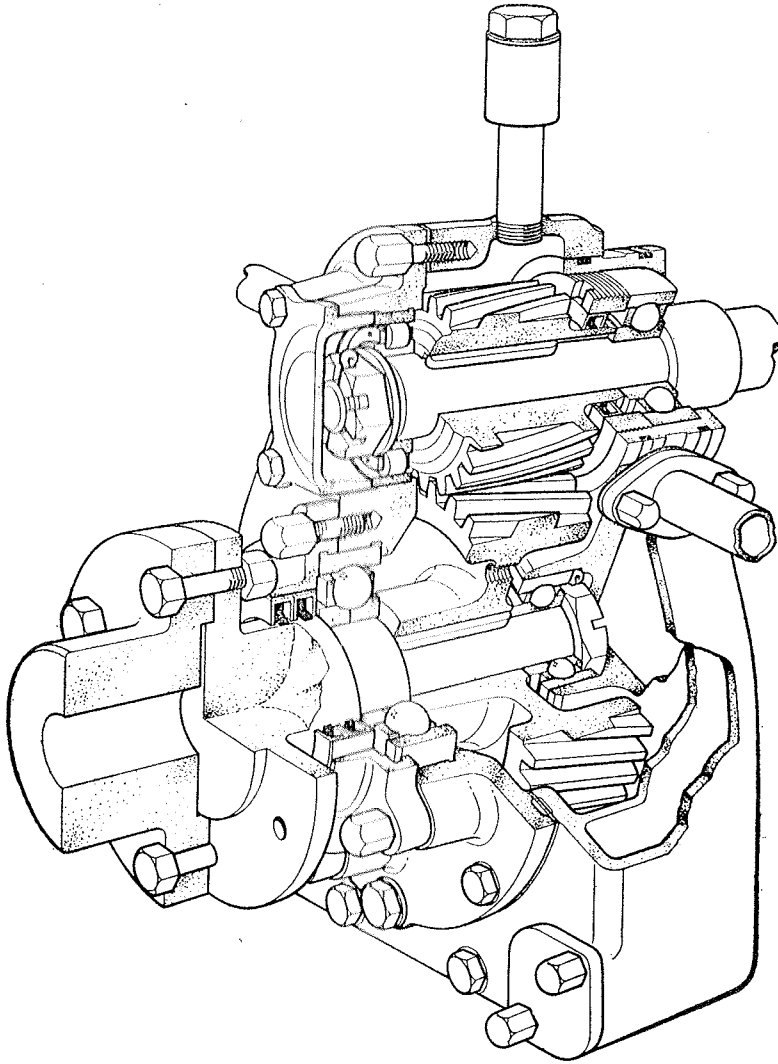


Fig. 17—Reduction Gear

Reduction Gear

It is important to see that the correct lubricating oil is used in the reduction gear box, i.e., SAE90 Oil when working in an air temperature below 85°F., and SAE 140 in tropical climates.

The level of oil in the casing should be examined daily at the same time as that in the lubricating oil tank, and the oil changed after every 450 hours running, the casing being thoroughly flushed out.

When an engine with reduction gear is to be laid up for any length of time, be careful to see that all cooling water is drained out of the reduction gear cooling jacket.

STARTING AND RUNNING FAULTS

Possible Cause of Trouble

Action to be taken

Difficult Starting

(1) Overload trip not lifted	...	...	...	Lift to give extra fuel for starting in cold weather.
(2) Unsuitable lubricating oil (too heavy)	...	...	...	Drain sump and refill with correct grade.
(3) Incorrect grade of fuel	...	...	...	Drain system, refill with correct fuel and prime.
(4) No fuel in tank	...	...	...	Fill tank and prime system.
(5) Choked fuel filter	...	...	...	Clean and prime system.
(6) Air lock in fuel system	...	...	...	Prime system.
(7) Injector nozzle valve stuck open	...	...	...	Clean or replace nozzle or injector complete.
(8) Fuel pump delivery valve scored	...	...	...	Replace valve and guide.
(9) Injector loose on seat	...	...	...	Tighten clamp evenly to 15 lb.ft. torque.
(10) Leaking valves	...	...	...	Regrind.
(11) Sticking rings	...	...	...	Decarbonise and check oil.
(12) Exhaust valve sticking	...	...	...	Clean stem and guide. Check oil and lubrication of valve gear.
(13) Worn cylinder	...	...	...	Renew or rebore.
(14) Sticking fuel pump rack	...	...	...	Inspect and rectify.

Knocking

(1) Valve, probably exhaust, sticking in guide and touching piston	...	...	...	Clean stems and guides.
(2) Slack bearing	...	...	...	Fit new shells if crankshaft is not worn.
(3) Worn gudgeon pin or small end bearing	...	...	...	Renew.
(4) Insufficient clearance between piston and cylinder head	...	...	...	Check and adjust shims to give 0.032"-0.035".
(5) Injection too early	...	...	...	Check timing.
(6) Flywheel coupling or pulley loose	...	...	...	Inspect and rectify.
(7) Too much crankshaft end float	...	...	...	Renew locating bearing rings.
(8) Excessive carbon deposit on piston	...	...	...	Decarbonise.
(9) Excessive clearance between piston and cylinder	...	...	...	Fit new pistons and cylinders or rebore.

Excessive Carbon Deposits

(1) Choked air filter	...	...	...	Clean.
(2) Choked exhaust system	...	...	...	Dismantle and clean.
(3) Unsuitable fuel oil	...	...	...	Drain system, fill with correct fuel and prime.
(4) Unsuitable lubricating oil	...	...	...	Drain sump and refill with correct grade of oil.
(5) Continuous idling	...	...	...	Increase engine load or stop engine.
(6) Defective spraying	...	...	...	Check nozzles. Clean or replace.
(7) Late injection of fuel	...	...	...	Check timing.
(8) Too much side play on valve rockers	...	...	...	Shim to 0.004" max.

Smoky Exhaust. Black smoke due to incomplete combustion of fuel can be caused by:

(1) Overload	...	...	...	Check setting of overload stop.
(2) Choked air filter	...	...	...	Clean.
(3) Defective spraying	...	...	...	Check nozzles. Clean or replace.
(4) Unsuitable fuel oil or water in fuel	...	...	...	Drain system, fill with correct fuel and prime.

Note: Faint blue smoke is generally the result of light load. Heavy blue smoke is due to lubricating oil passing the piston rings and is attributable to stuck, worn or broken piston rings, or to a worn cylinder barrel.

Engine Stops

- | | | | | |
|--|-----|-----|-----|---|
| (1) Lack of fuel | ... | ... | ... | Fill tank and prime system. |
| (2) Air or water in fuel system | ... | ... | ... | Drain off water and vent system . |
| (3) Choked fuel filter or blocked nozzle | ... | ... | ... | Inspect and rectify. |
| (4) Overload | ... | ... | ... | Allow engine to cool slowly. Turn by hand to ensure freedom of moving parts. Start, and check load. |
| (5) Loss of compression | ... | ... | ... | Check valves, rings and cylinder wear. |

Loss of Power

- | | | | | |
|--|-----|-----|-----|--|
| (1) Loss of compression | ... | ... | ... | Check valves, rings and cylinder wear. Check cylinder head gasket. |
| (2) Incorrect tappet clearance | ... | ... | ... | Set to 0.015" cold, inlet and exhaust. |
| (3) Choked air filter | ... | ... | ... | Clean. |
| (4) Choked exhaust system | ... | ... | ... | Dismantle and clean. |
| (5) Fuel injector or pump out of order | ... | ... | ... | Inspect and renew defective components. |
| (6) Choked fuel filter | ... | ... | ... | Clean and vent fuel system. |

Failure to Attain Normal Speed

- | | | | | |
|-------------------------------------|-----|-----|-----|--|
| (1) Engine started on overload | ... | ... | ... | Modify load. |
| (2) Fuel system not properly primed | ... | ... | ... | Check and rectify. |
| (3) Insufficient fuel | ... | ... | ... | Check fuel pump/governor linkage for sticking and correct adjustment. Clean fuel filter. |
| (4) Injection retarded | ... | ... | ... | Check and rectify. |

Loss of Oil Pressure

- | | | | | |
|---------------------------------------|-----|-----|-----|--------------------------------------|
| (1) Low oil level | ... | ... | ... | Check on dipstick and rectify. |
| (2) Strainer choked | ... | ... | ... | Clean. |
| (3) Fractured pipe or leaking joint | ... | ... | ... | Inspect and rectify. |
| (4) Badly worn bearings | ... | ... | ... | Renew shells if crankshaft not worn. |
| (5) Relief valve not seating | ... | ... | ... | Inspect and clean. |
| (6) Oil pump worn or drive failed | ... | ... | ... | Inspect and rectify. |
| (7) Oil cooler choked (by-pass lifts) | ... | ... | ... | Clean. |

Note: Lubricating oil filter element must be regularly changed.

Overheating

- | | | | | |
|---|-----|-----|-----|-------------------------------------|
| (1) Thermostat faulty | ... | ... | ... | Examine and rectify or replace. |
| (2) Header tank on heat exchanger empty | ... | ... | ... | Allow engine to cool and fill tank. |
| (3) Raw water circulation faulty | ... | ... | ... | Check pump, sea cock and strainer. |
| (4) Heat exchanger silted up | ... | ... | ... | Dismantle and clean. |
| (5) Faulty injection timing | ... | ... | ... | Check and reset. |

Reverse Gearbox Overheating

- | | | | | |
|--------------------------------|-----|-----|-----|--------------------|
| (1) Choked oil supply | ... | ... | ... | Check and rectify. |
| (2) Clutch slipping | ... | ... | ... | Adjust or replace. |
| (3) Astern brake band slipping | ... | ... | ... | Adjust or replace. |
| (4) Astern brake band binding | ... | ... | ... | Adjust or replace. |

LAYING-UP PROCEDURE

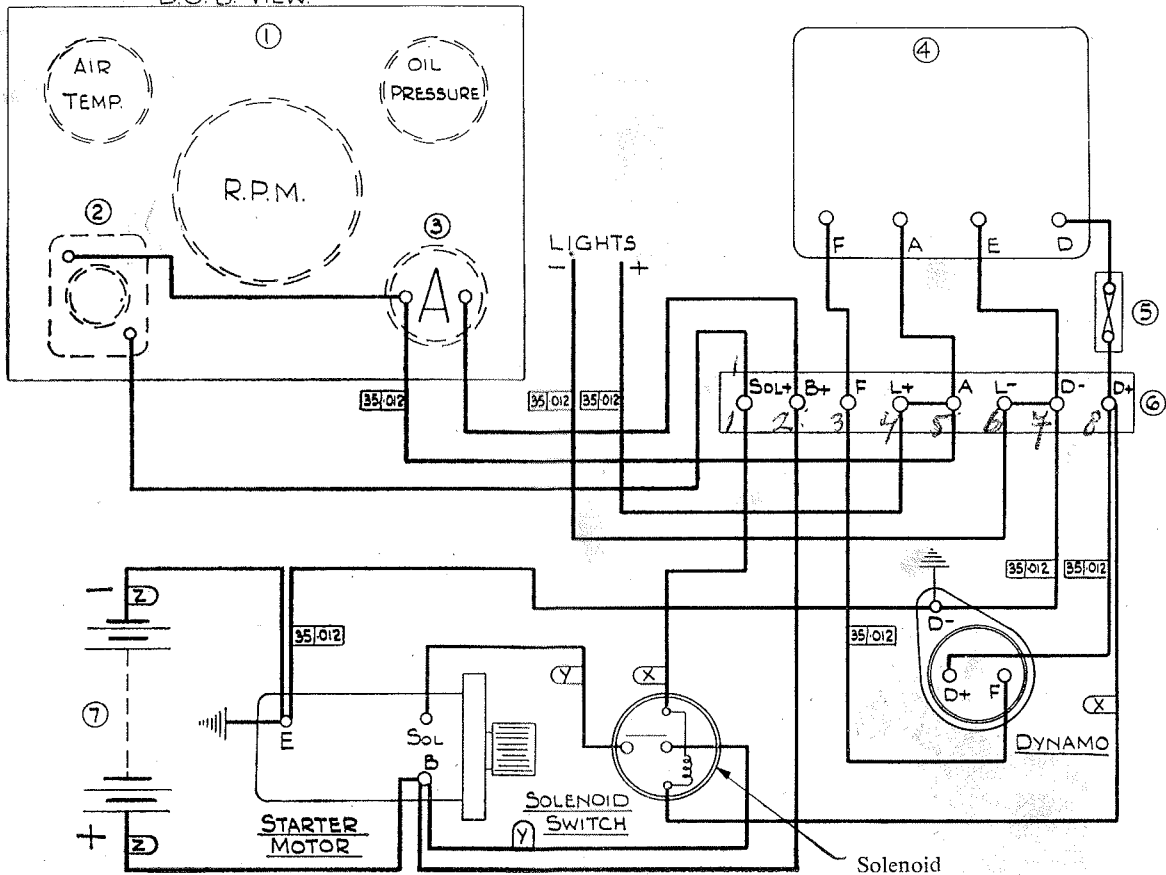
The following routine should be carried out when it is known that the engine will not be required for some months.

1. Replace fuel with a small supply of Shell Fusus oil A or equivalent.
2. Drain lubricating oil from sump and refill with Shell Ensis 453 oil or equivalent.
3. Run the engine for a period to circulate the Ensis oil through the system and to ensure the Fusus oil is passed through the fuel pumps and injectors.
4. Stop the engine and drain off the Ensis lubricating oil from the sump, after which the crankshaft should NOT be turned until the engine is again required for service. The Fusus oil should be left in the fuel system.
5. Drain all water from engine (and drain gearbox).
6. Seal all openings on the engine with tape.
7. Remove batteries from engine and store fully charged with terminals coated with Vaseline (petroleum jelly).
8. Grease all external bright parts and control linkage, etc.
9. Tie labels on the unit clearly stating its condition.

If the above is not complied with the engine should be run for a minimum of 15 minutes every month.

Before returning the engine to service it should be turned by hand to ensure free movement of all working parts — See "Initial Starting" Page 14.

B.O.B. VIEW.



Connection Diagram of Electric Start

ED9305

CONNECTION DIAGRAM OF HWM MARINE ELECTRIC START

- 1 Panel on Engine
- 2 Starter Push Button
- 3 Centre Zero Ammeter
- 4 Automatic Cut-out & Controller (supplied loose)
- 5 Dynamo Fuse (supplied loose)
- 6 Terminal Box (mounted on engine)
- 7 Starter Battery

Solenoid Switch should be free from vibration and terminals pointing down.

RECOMMENDED CABLES		
CIRCUIT	Total Length of Lead	Cable Size
Starter to Solenoid Switch Cables Shown [Y]	0-2 yards	65/.012
Solenoid Switch to Start Panel Cables shown [X]	0-1 yard	9/.012
	1-2 yards	14/.012
	2-4 yards	28/.012

Main Starter Cables [Z] Supplied 6ft. 0in. long in T.R.S. 163/.018 or P.V.C. 37/.036.

NOTE: Connecting D & F gives the dynamo full field and it should only be run for a short while. If the polarity is incorrect it is only necessary to "flash" the field using 6 volts of the starter battery as follows:

1. Lift dynamo brushes.
2. Connect battery *negative* to frame of dynamo. *Touch* battery *positive* on the field terminal "F".
3. Replace brushes and run up engine. Should dynamo voltage fail to build up repeat above procedure.

IMPORTANT

Spare Parts — Directions for Ordering

1. Always quote the **ENGINE No.**, **PART No.** and **DESCRIPTION OF PART** when ordering spare parts. The Engine No. will be found on the plate and on the engine flywheel.
2. Unified Threads are used where applicable throughout the engine.
3. Undersize/Oversize parts—Main bearings and connecting rod big end bearings can be supplied 0.014", 0.020" and 0.040" undersize.

Nominal journal diameter 2.9990—2.9995 ins. (76.175—76.187 mm.).

Nominal crankpin diameter 2.6235—2.6240 ins. (66.637—66.650 mm.).

Cylinder barrels, pistons and rings can be supplied 0.010", 0.020" and 0.040" oversize.

Nominal bore diameter 4.002—4.003 ins. (101.651—101.676 mm.).

INDEX TO PARTS LIST

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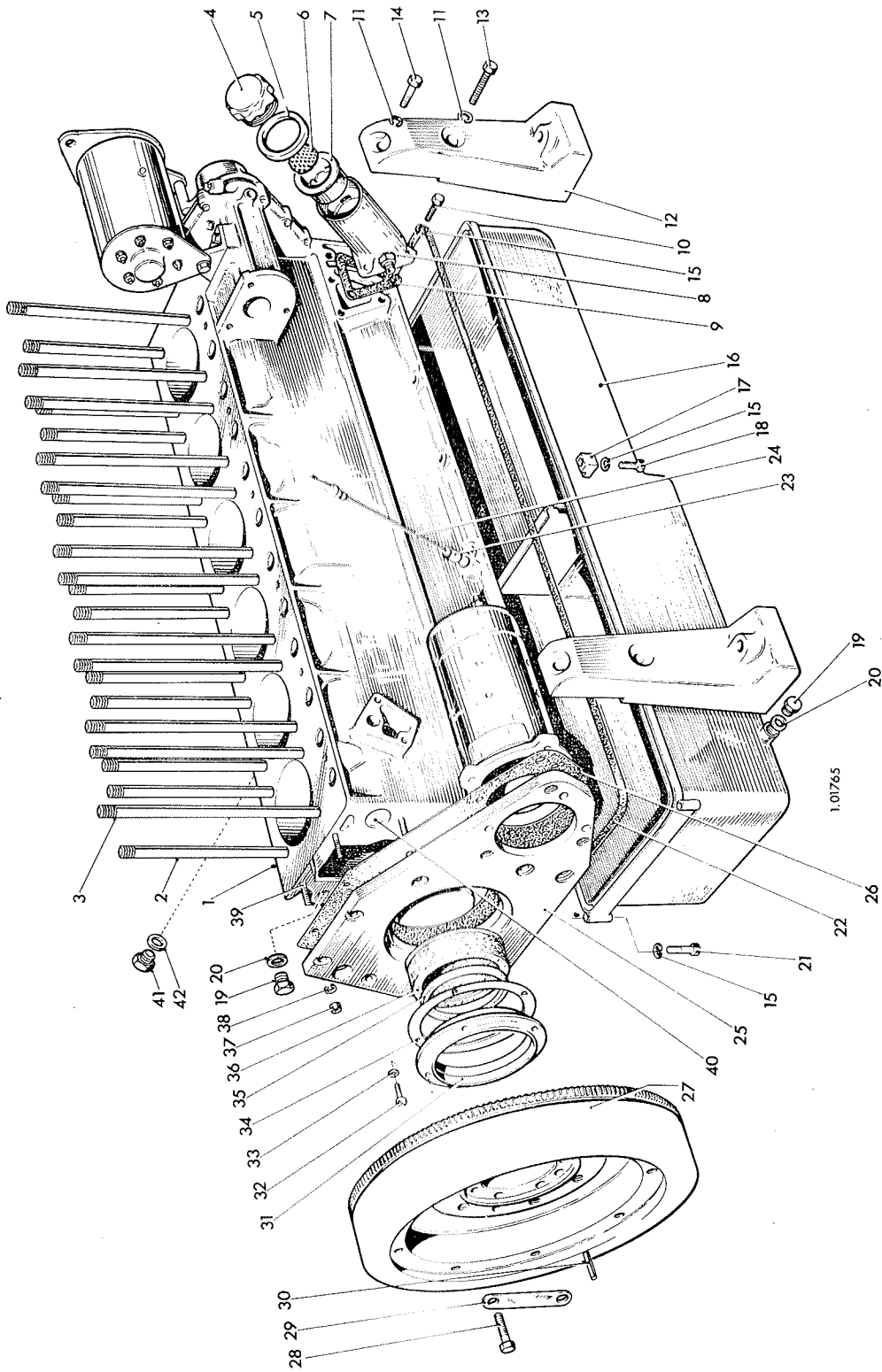
PARTS LIST

See directions for ordering Page 44

PLATE 1. CRANKCASE

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
		356-10011	—	1
1	Crankcase	354-10011	1	—
	Crankcase	351-10240	8	12
2	Cylinder Head Stud —short	351-10250	8	12
3	Cylinder Head Stud —long	27-3824	1	1
4	Oil Filler Cap	303-253	1	1
5	Joint for filler cap	291-23751	1	1
6	Strainer Plate for oil filler	27-3821	1	1
7	Oil Filler Pressing	354-19622	1	1
8	Oil Filler	354-19630	1	1
9	Joint for filler	270-25	3	3
10	Setscrew for filler $\frac{5}{16}$ " UNF x $1\frac{1}{8}$ "	27-394	8	8
11	Spring Washer for bracket	354-19641	4	4
12	* Support Bracket	270-344	4	4
13	* Bolt for bracket $\frac{1}{2}$ " UNF x $2\frac{1}{2}$ "	270-252	4	4
14	* Bolt for bracket $\frac{1}{2}$ " UNF x $1\frac{1}{2}$ "	27-413	22	25
15	* Spring Washer	356-18000	—	1
16	Oil Sump Assembly	354-18000	1	—
	Oil Sump Assembly	351-11401	11	14
17	Clamp for sump	270-182	11	15
18	Setscrew for clamp $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	27-1815	2	2
19	Plug for drain and oil gallery (1 for each)	291-3063	2	2
20	Joint for plugs	270-65	2	2
21	Setscrew $\frac{5}{16}$ " UNF x 2"	356-18120	—	1
22	Joint for sump	354-18120	1	—
	Joint for sump	27-4344	1	1
23	Dipstick Adaptor	572-10220	1	1
24	Dipstick —includes Rubber Ring 201-13120	354-19450	1	1
25	Crankcase End Plate	354-19270	1	1
26	Joint for end plate	572-10315	1	1
27	Flywheel and Gear Ring Assembly —up to 2000 rpm			
	Flywheel and Gear Ring Assembly —over 2000 rpm—CAV starter motor—heavy	572-10822	1	1
	Flywheel and Gear Ring Assembly —up to 2000 rpm—Auto-lite Starter Motor	572-10316	1	1
	Flywheel and Gear Ring Assembly —over 2000 rpm—heavy	572-10823	1	1
28	Setscrew for flywheel	354-32480	6	6
29	Locking Plate	354-19290	3	3
30	Dowel	294-2659	2	2
31	Housing for retaining ring	354-19460	1	1
32	Setscrew $\frac{5}{16}$ " UNF x $\frac{5}{8}$ "	270-59	4	4
33	Copper Washer	616-1608	4	4
34	Joint	354-19470	1	1
35	Felt Washer	354-19420	1	1
36	Oil Retaining Ring	354-19280	1	1
37	Nut $\frac{3}{8}$ " UNF	270-4	8	8
38	Spring Washer	27-393	8	8
39	Stud for flywheel housing $\frac{3}{8}$ " UNF x $1\frac{3}{8}$ "	270-334	8	8
40	Expansion Plug for camshaft bore	27-1833	1	1
41	Plug for oil gallery $\frac{3}{8}$ " BSP	8-3-19	5	7
42	Joint	600-106	5	7
	TDC Indicator	354-26890	1	1
	Screw for indicator	270-501	1	1
	Spring Washer	27-413	1	1
	Plug for oil hole—fuel pump drive	270-189		

*These parts are for auxiliary engines—see page 82 for propulsion engines.



CRANKCASE, CYLINDERS AND AIR SHIELDS

PLATE I

PLATE 2. CRANKCASE END COVER AND EXTENSION PLATE

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
1	End Cover	354-18296	1	1
2	Joint	354-18340	1	1
3	Crankcase Extension Plate	354-18330	1	1
4	Joint for extension plate	354-19400	1	1
5	Setscrew—extension plate to end cover— $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-182	2	2
6	Setscrew for extension plate— $\frac{5}{16}$ " UNF x $3\frac{1}{4}$ "	270-176	1	1
7	Setscrew for end cover— $\frac{5}{16}$ " UNF x 1"	270-61	5	5
8	Spring Washer	27-413	14	14
9	Oil Retaining Ring	291-23542	1	1
10	Felt Washer	291-24142	1	1
11	Timing Cover Plate	354-18941	1	1
12	Joint	354-18951	1	1
13	Setscrew— $\frac{1}{4}$ " UNF x $\frac{5}{8}$ "	270-23	3	3
14	Spring Washer	27-451	3	3
15	Blanking Plate—when tachometer not fitted	351-18960	1	1
16	Setscrew for end cover $\frac{5}{16}$ " UNF x $3\frac{1}{2}$ "	270-69	2	2
17	Setscrew for end cover $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-182	2	2
18	Joint for blanking plate	294-3642	1	1
19	Setscrew for blanking plate	351-13720	3	3
20	Spring Washer	64-2582/1	3	3
21	Dowel	351-13660	2	2
22	Guard	354-43250	1	1
23	Bolt $\frac{5}{16}$ " UNC x $\frac{5}{8}$ "—top bracket	270-404	2	2
24	Bolt $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "—bottom bracket	270-182	2	2
25	Spring Washer	27-413	4	4
26	Clamp	351-11401	2	2
27	Capscrew for end cover $\frac{5}{16}$ " UNF x $1\frac{3}{4}$ "	270-49	1	1
28	Setscrew for end cover	270-65	1	1
	Cover	351-28000	1	1
	Joint	354-23840	1	1
	Bolt $\frac{1}{4}$ " UNF x $\frac{5}{8}$ "	270-23	4	4
	Spring Washer	27-451	4	4

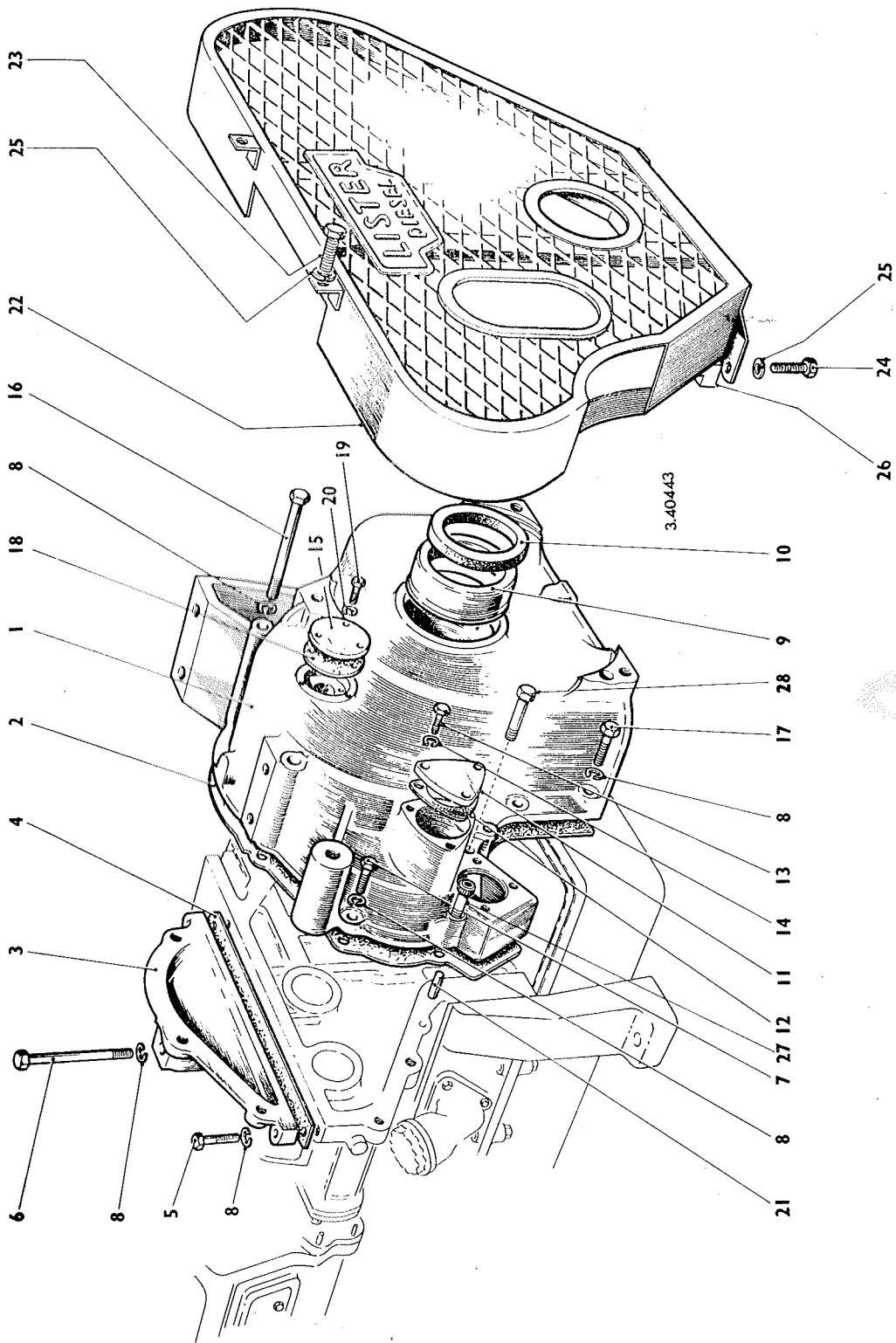
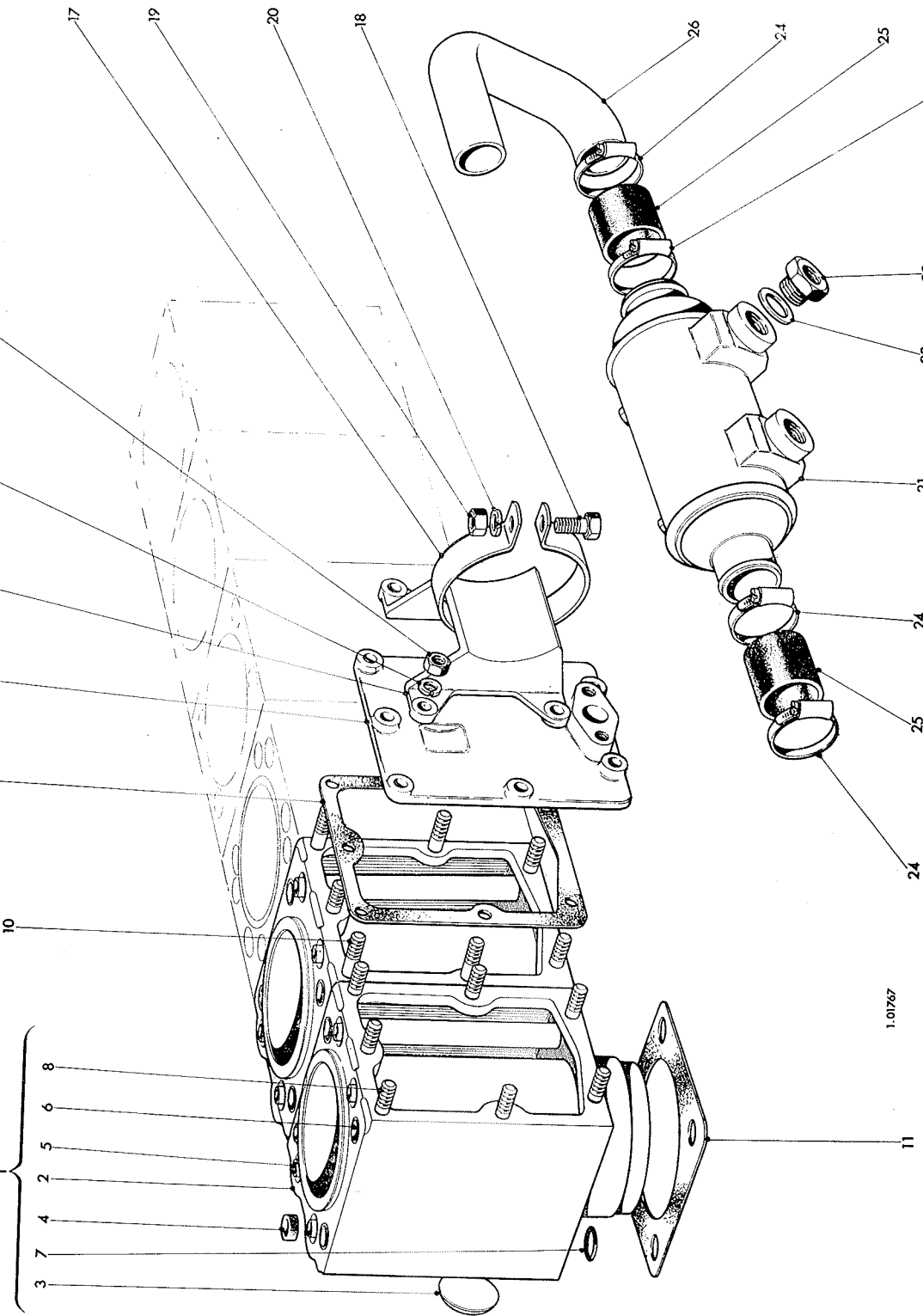


PLATE 2

CRANKCASE END COVER AND EXTENSION PLATE

PLATE 3—CYLINDER BLOCK AND FITTINGS

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
1	Cylinder Block Assembly comprising:	572-40001	3	5
2	Cylinder Block	351-40001	3	5
3	Cylinder Block Plug	351-40190	6	10
4	Ferrule Joint Ring	351-40130	12	20
5	Ferrule	351-40120	12	20
6	Sleeve	351-40110	12	20
7	"O" Ring for sleeve	201-14640	12	20
8	Stud for water jacket door $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-81	28	35
9	Cylinder Block Assembly —items 2-7	572-40003	1	1
8	Stud for water jacket door $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-81	3	3
10	Stud for mounting oil cooler $\frac{5}{16}$ " UNF x $1\frac{1}{2}$ "	270-83	4	4
11	Joint for cylinder block	351-40080	4	6
12	Joint for water jacket door	351-40070	4	6
13	Door for water jacket	351-42870	4	6
14	Bracket for oil cooler	354-42970	1	1
15	Spring Washer	27-413	28	42
16	Nut $\frac{5}{16}$ " UNF	270-3	28	42
17	Strap for oil cooler	354-43220	1	1
18	Bolt $\frac{5}{16}$ " UNF x $1\frac{3}{4}$ "	270-64	1	1
19	Nut $\frac{5}{16}$ " UNF	270-3	1	1
20	Spring Washer	27-413	1	1
21	Oil Cooler	364-1677	1	1
22	Reducing Bush in oil cooler	27-517	2	2
23	Joint for bush	291-3064	2	2
24	Hose Clip	27-4233	4	4
25	Rubber Hose	370-12280	2	2



CYLINDER BLOCK & FITTINGS

1.01767

PLATE 3

PLATE 4—CYLINDER HEAD AND FITTINGS

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
—	Cylinder Head Assembly comprising *	...		
—	Cylinder Head Assembly comprising †	...		
1	† Cylinder Head	572-40091		
—	† Expansion Plug	351-40012	4	6
—	† Expansion Plug	351-40190	8	12
2	† Valve Guide —exhaust	351-41510	4	6
3	† Valve Guide —inlet	291-50800	4	6
4	† Oil Seal for inlet valve guide	351-10400	4	6
5	† Injector Sleeve	351-10341	4	6
6	† O' Ring for sleeve	351-40100	4	6
7	Stud for manifold $\frac{5}{16}$ " UNF x $1\frac{3}{4}$ "	351-40200	4	6
8	Stud for manifold $\frac{5}{16}$ " UNF x 3"	270-84	8	12
9	† Exhaust Valve	270-123	4	6
10	† Inlet Valve	291-50150	4	6
11	† Valve Spring —outer } up to 1800 rpm—	351-10361	4	6
12	† Valve Spring —inner } Supplied in	291-20641	8	12
13	† Valve Spring Carrier } pairs only	291-20651	8	12
14	† Valve Collets	291-50160	8	12
—	Valve Spring } above 1800 rpm	291-20661	8 prs.	12 prs.
—	Valve Spring Carrier }	351-21400	8	12
15	Cylinder Head Gasket	351-21430	8	12
16	Cylinder Head Shim	351-10380	4	6
17	Cylinder Head Nut $\frac{9}{16}$ " UNF	351-10370		as reqd.
18	† Breather Pipe Assembly	270-7	5	9
19	Sealing Plate	351-40140	4	6
20	Sealing Plate for fuel filter mounting	354-18811	3	5
21	Joint for sealing plate	354-43340	1	1
22	Retaining Sleeve	351-10480	4	6
23	O' Ring on oil pipe to valve rocker } see also	354-19820	8	12
24	Stud for sealing plate $\frac{1}{4}$ " UNF x $2\frac{1}{4}$ "	520-7648	8	12
25	Dome Nut	270-490	8	12
26	Copper Washer	270-268	8	12
27	Rubber Cups	291-2609	8	12
28	Sealing Tubes	354-18830	16	24
29	Tappet Guide	354-18820	8	12
30	Joint for guide	354-18850	8	12
31	Push Rod	354-19480	8	12
32	Tappet	354-10311	8	12
33	Clamp for tappet	351-10210	8	12
34	Setscrew for clamp— $\frac{5}{16}$ " UNF x $1\frac{1}{2}$ "	354-18840	4	6
35	Spring Washer	270-63	4	6
	Rocker Bracket Assembly L.H. comprising †	27-413	4	6
	Rocker Bracket Assembly R.H. comprising §	572-40050	4	6
36	† Rocker Bracket L.H.	572-40060	4	6
37	§ Rocker Bracket R.H.	351-10530	4	6
38	Joint for bracket	351-10520	4	6
39	§† Dowel for valve rocker	351-10560	8	12
40	§† Rocker Lever	351-10530	8	12
41	§† Bush for rocker lever	351-10290	8	12
42	§† Circlip	291-20701	8	12
43	§† Adjusting Screw	201-11630	8	12
44	§† Nut $\frac{5}{16}$ " UNF	292-167	8	12
45	Setscrew for rocker bracket $\frac{5}{16}$ " UNF x 1"	270-3	8	12
		270-61	8	12

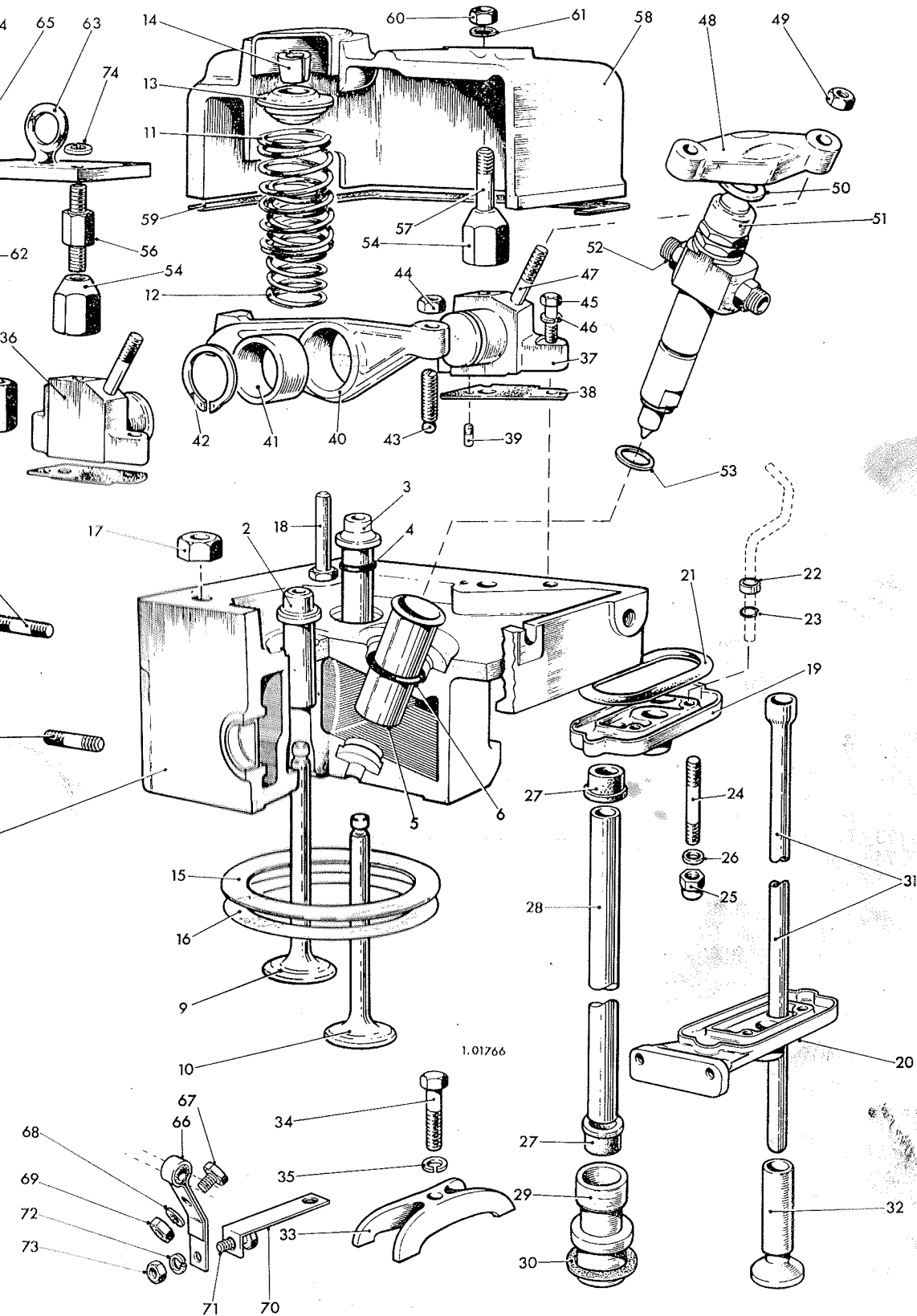
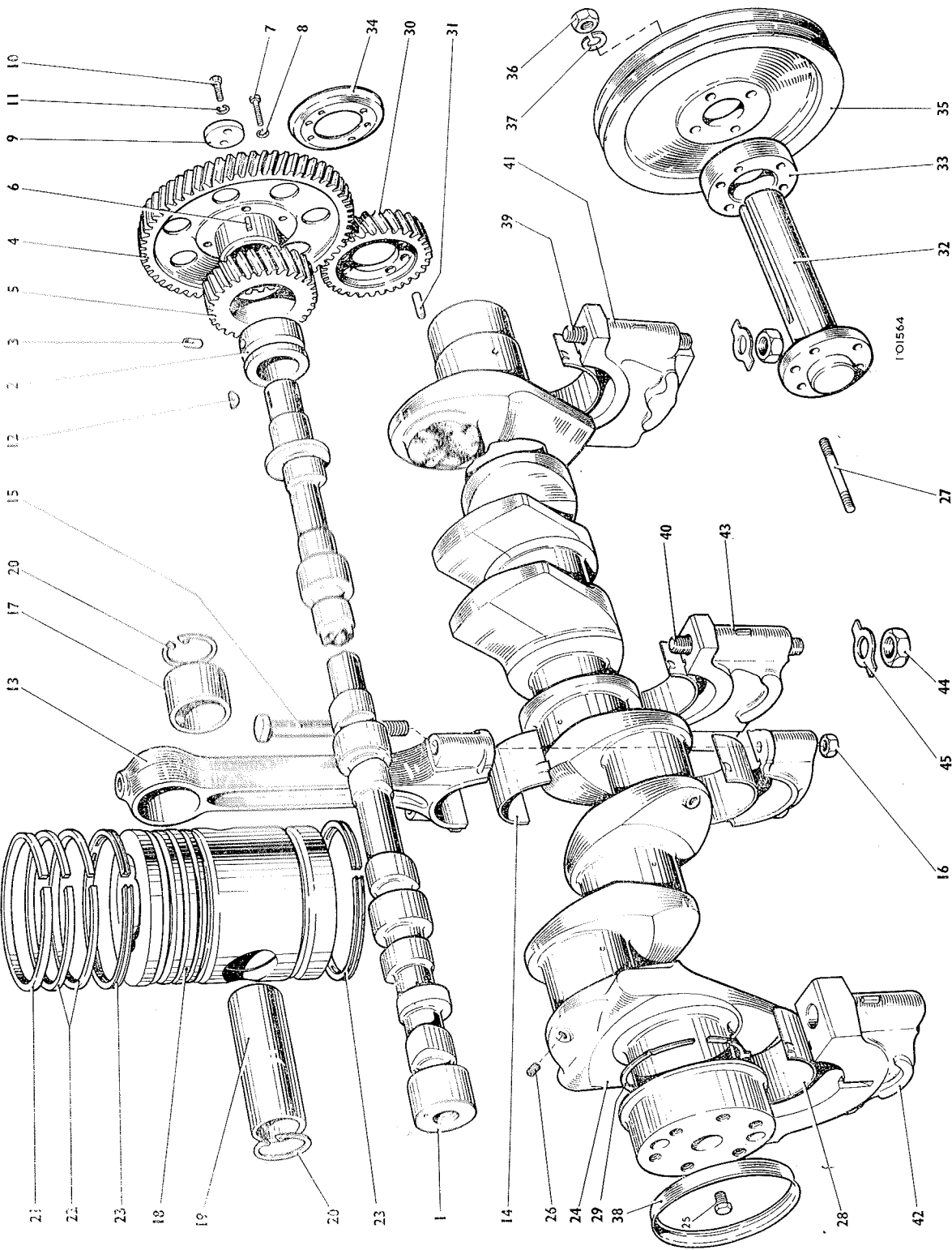


PLATE 4. CYLINDER HEAD & FITTINGS (contd.)

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
46	Spring Washer	27-413	8	12
47	Stud for injector clamp	354-26920	8	12
48	Injector Clamp	351-10580	4	6
49	Nut $\frac{5}{16}$ " UNF	270-3	8	12
50	Distance Piece for injector	354-26910	4	6
51	Fuel Injector complete comprising:—	351-40091	4	6
	Nozzle Holder	—		
	Nozzle	351-21451	4	6
	Edge Filter Assembly	572-10590	4	6
	Joint for edge filter	352-29960	4	6
52	Leak-off Union	201-11690	4	6
53	Joint for injector	351-40230	4	6
54	Cylinder Head Nut	351-10220	8	12
55	Cylinder Head Nut	351-13860	1	1
56	Stud for lifting plate	354-24600	2	2
57	Stud for cylinder head cover— $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-81	6	10
58	Cylinder Head Cover Assembly	354-10550	4	6
59	Joint for cover	351-10510	4	6
60	Nut for cover	270-3	8	12
61	Copper Washer	616-1608	8	12
62	Lifting Plate Distance Piece	354-24590	2	2
63	Lifting Plate	354-24570	1	1
64	Bolt for plate— $\frac{9}{16}$ " UNF x $1\frac{1}{4}$ "	270-487	2	2
65	Spring Washer	27-2061	2	2
66	Fuel Pipe Clip	354-26190	1	1
—	Rubber Bush for clip	354-26890	1	1
67	Setscrew	270-151	1	1
68	Spring Washer	27-717	1	1
69	Nut	270-1	1	1
70	Bracket for fuel pipe clip	356-44150	1	1
71	Setscrew $\frac{1}{4}$ " UNF x $\frac{5}{8}$ "	270-23	1	1
72	Spring Washer	27-451	1	1
73	Nut $\frac{1}{4}$ " UNF	270-2	1	1
74	Spring Washer for lifting plate	27-413	2	2

PLATE 5. CAMSHAFT, CRANKSHAFT, CONNECTING ROD & PISTON

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
1	Camshaft	356-10160	—	1
	Camshaft	354-10160	1	—
2	Camshaft Bush	354-10170	1	1
3	Camshaft Bush Dowel	354-19030	1	1
4	Camshaft Gear	354-10721	1	1
5	Fuel Pump Driving Gear	354-18432	1	1
6	Dowel	354-19040	2	2
7	Set Screw	270-24	4	4
8	Spring Washer	27-413	4	4
9	Locating Plate	351-10180	1	1
10	Locating Plate Set Screw	270-60	2	2
11	Spring Washer	27-413	2	2
12	Key for Camshaft	27-105	1	1
	Connecting Rod Assembly comprising:—	572-10200	4	6
13	Connecting Rod	291-50030	4	6
14	Connecting Rod Bearing —pairs	291-50040	4	6
15	Connecting Rod Bolt	291-50050	8	12
16	Connecting Rod Nut —self locking	270-236	8	12
17	Connecting Rod Bush	291-50080	4	6
	Piston complete with Rings and Gudgeon Pin	572-10192	4	6
18	Piston	351-19252	4	6
19	Gudgeon Pin —not supplied separately	291-50090	4	6
20	Gudgeon Pin Circlip	291-50100	8	12
21	Piston Ring —Top (Tapered)	351-10112	4	6
22	Piston Ring	291-50190	8	12
23	Piston Ring Scraper	291-50210	8	12
24	Crankshaft	356-10001	—	1
—	Crankshaft	354-10001	1	—
25	Crankshaft Plug	291-2167	1	1
26	Plug	270-51	4	6
27	Stud for Vee Pulley	270-583	4	4
28	Crankshaft Bearing	352-12672	5	7
29	Thrust Washer —in two halves	351-10871	2	2
30	Crankshaft Pinion	354-10710	1	1
31	Dowel	354-10300	2	2
32	Extension Shaft	354-10230	1	1
33	Boss	354-19320	1	1
34	Oil Thrower (Gear End)	354-19311	1	1
35	Vee Pulley	356-19303	1	1
36	Nut	270-159	4	4
37	Disc Washer	202-24060	4	4
38	Oil Thrower (Flywheel End)	356-21750	1	1
39	Stud for main bearing cap	291-2012	8	12
40	Stud for Main Bearing Cap (between 4 & 5 Cyl.)	354-18180	2	2
41	Main Bearing Cap (Gear End)	354-17520	1	1
42	Main Bearing Cap (Flywheel End)	354-17530	1	1
43	Main Bearing Cap (Intermediate)	354-17540	3	5
44	Nut	291-3376	10	14
45	Tab Washer	291-3377	10	14



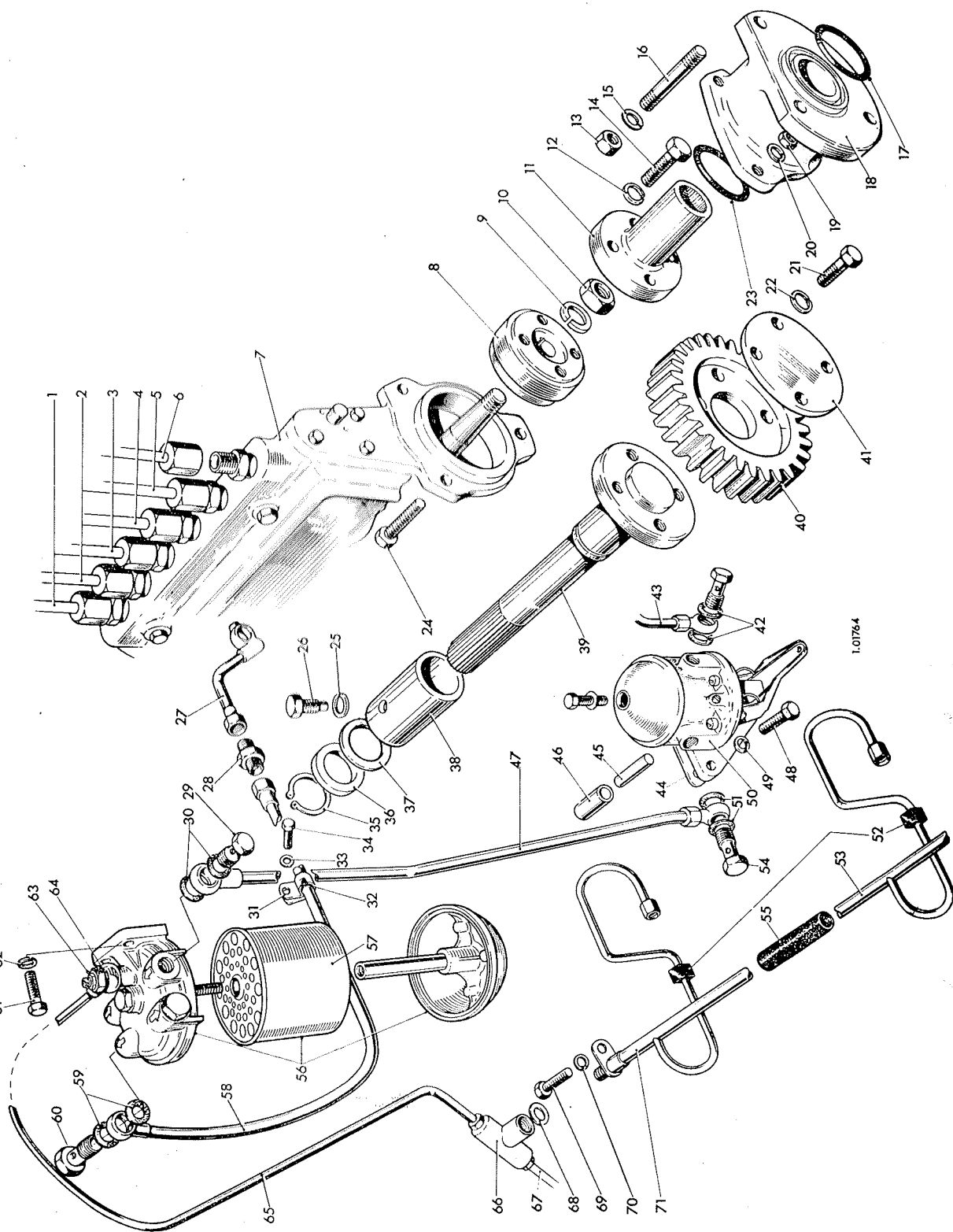
CAMSHAFT, CRANKSHAFT, CONNECTING ROD & PISTON

PLATE 5

PLATE 6. FUEL FILTER, FUEL LIFT PUMP, FUEL PUMP & DRIVE, AND FUEL INJECTOR PIPES

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
1	Fuel Pipe —pump to No. 6 injector	356-24201	—	1
2	Fuel Pipe—pump to No. 5 injector	356-24191	—	1
3	Fuel Pipe—pump to No. 4 injector	356-24181	1	1
4	Fuel Pipe—pump to No. 3 injector	356-24171	1	1
5	Fuel Pipe—pump to No. 2 injector	356-24161	1	1
6	Fuel Pipe—pump to No. 1 injector	356-24151	1	1
7	Fuel Pump—AAR6C/D75/153	356-22531	—	1
	Fuel Pump—AAR4C/D75/153	354-22531	1	—
	End Cap for fuel pump rack	354-26150	1	1
	Setscrew	270-287	2	2
	Spring Washer	27-717	2	2
8	Coupling —fuel pump half	354-22600	1	1
9	Spring Washer	660-10590	1	1
10	Coupling Nut	354-22620	1	1
11	Coupling —drive half	354-22590	1	1
12	Spring Washer	27-451	4	4
13	Adaptor Nut	270-3	3	3
14	Coupling Bolt	270-56	4	4
15	Adaptor Spring Washer	27-413	3	3
16	Adaptor Stud	270-98	3	3
17	Adaptor Joint	616-1895	1	1
18	Adaptor	354-22652	1	1
19	Fuel Pump Nut	270-4	3	3
20	Fuel Pump Spring Washer	27-393	3	3
21	Locking Plate Setscrew	270-60	4	4
22	Spring Washer	27-413	4	4
23	Fuel Pump Joint	354-31850	1	1
24	Fuel Pump Bolt	270-75	3	3
25	Locating Pin Copper Washer	600-106	1	1
26	Locating Pin	354-19581	1	1
27	Fuel Pipe —union to fuel pump	354-24140	1	1
28	Union	291-3683	1	1
29	Swivel Union Screw	354-28380	1	1
30	Joint	13-22-350	2	2
31	Pipe Clip			
32	Rubber Bush	} See page 54		
33	Spring Washer			
34	Setscrew			
35	Circlip	201-10670	1	1
36	Shaft Locating Washer	354-22510	1	1
37	*Thrust Washer	354-19591	1	1
38	*Drive Shaft Sleeve ($1\frac{7}{8}'' + 0.002 - 0$ long)	354-19561	1	1
or	*Drive Shaft Sleeve ($1\frac{7}{8}'' + 0.0045 + 0.0065$ long)	354-19571	1	1
39	*Drive Shaft	354-22611	1	1
40	Gear	354-18442	1	1
41	Locking Plate	354-18930	1	1
42	Swivel Union Joint	351-21620	2	2
43	Fuel Pipe —tank to lift pump—to suit installation			
44	Joint	354-19350	1	1
45	Lift Pump Push Rod	354-19340	1	1
46	Bearing Bush	354-19330	1	1
47	Fuel Pipe —lift pump to filter	354-28450	1	1

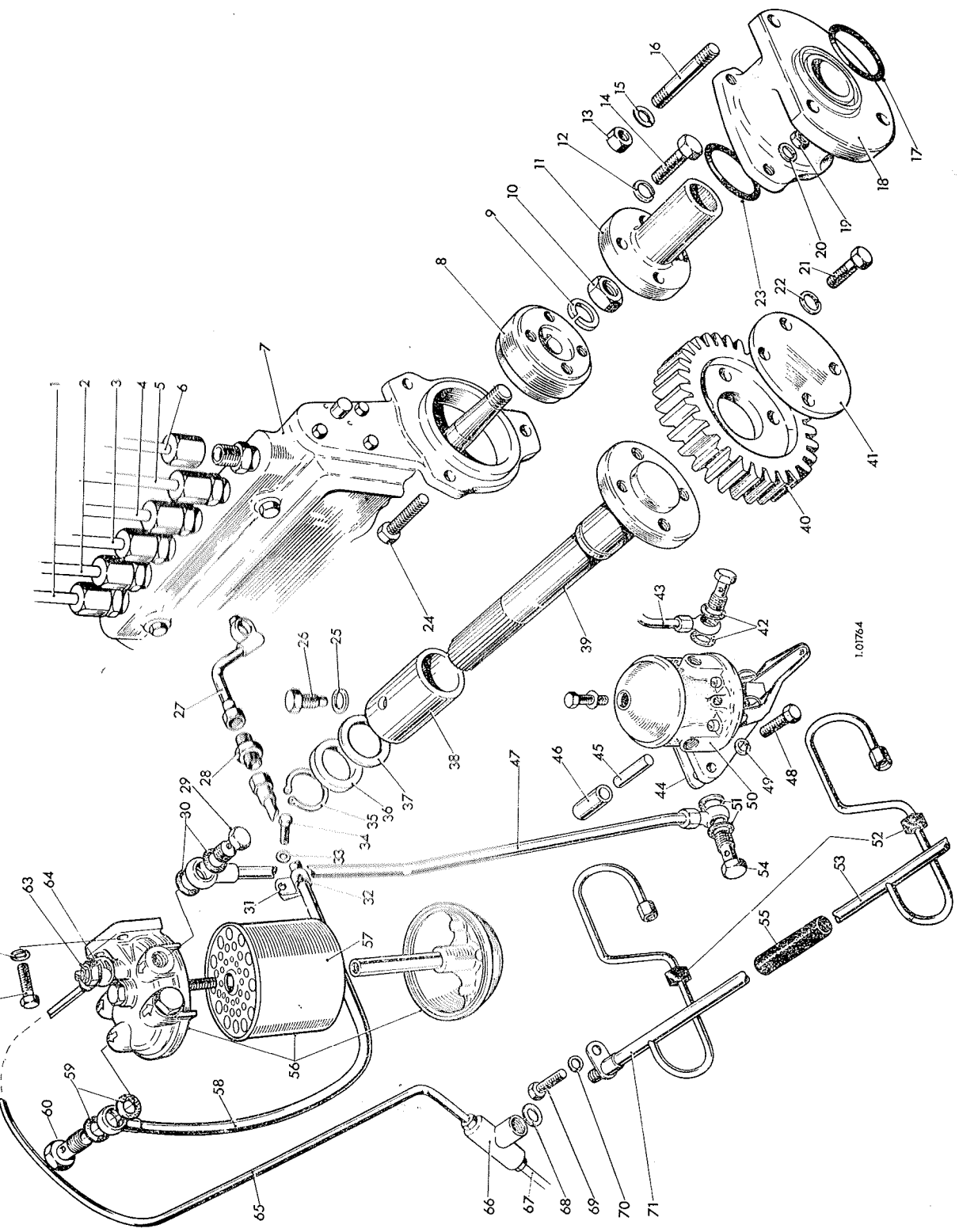
*These parts only available supplied together.



FUEL FILTER, FUEL LIFT PUMP, FUEL PUMP & DRIVE

PLATE 6. FUEL FILTER, FUEL LIFT PUMP, FUEL PUMP & DRIVE, AND FUEL INJECTOR PIPES (contd.)

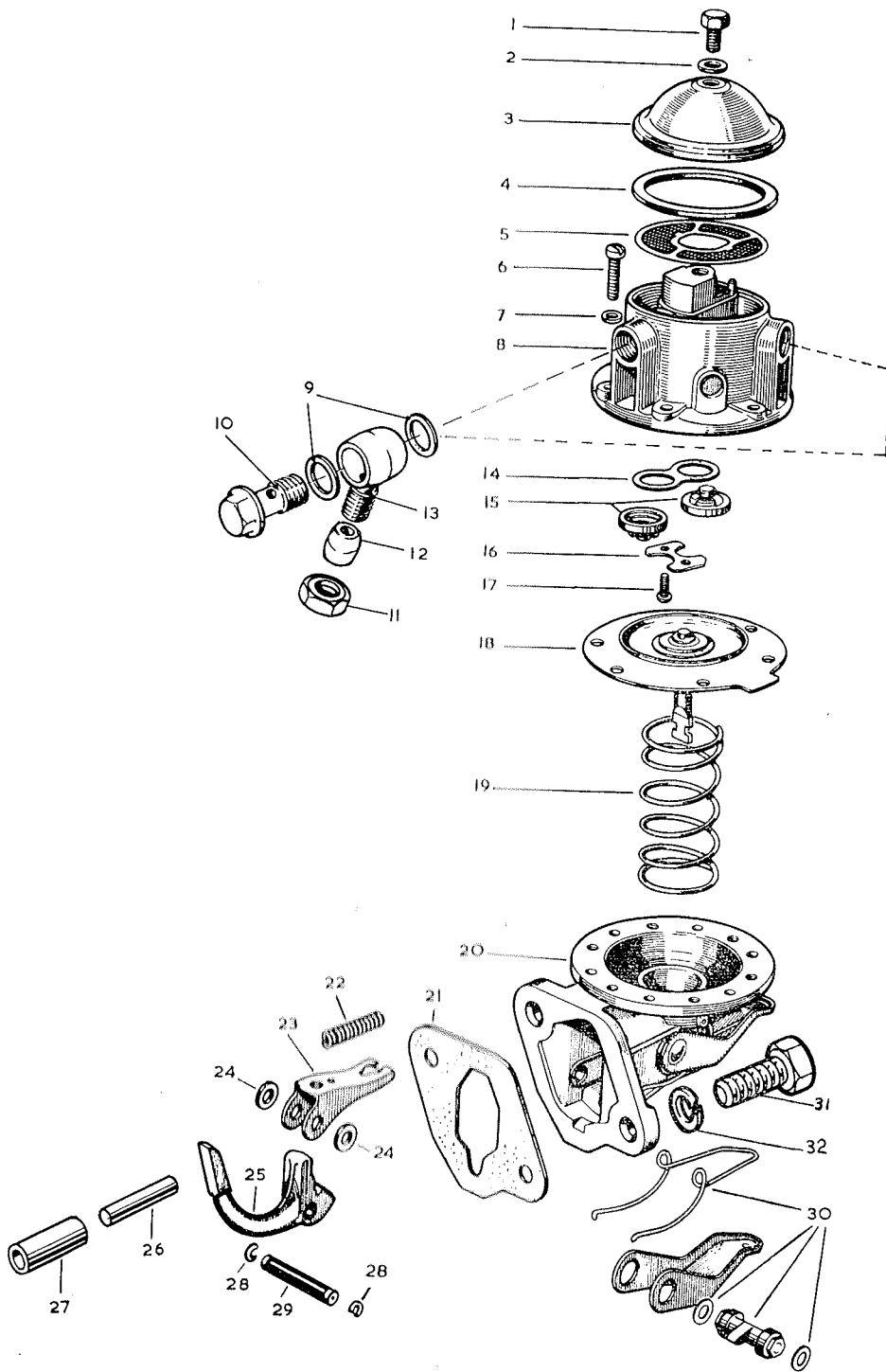
Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
		270-24	2	2
48	Setscrew	27-413	2	2
49	Spring Washer	291-3688	1	1
50	Fuel Lift Pump —see also page 62	351-21620	2	2
51	Swivel Union Joint	201-11090	4	6
52	Rubber Bush	356-20480	1	—
53	Leak-off Pipe —gear end	354-20480	1	—
	Leak-off Pipe	351-21610	1	1
54	Swivel Union Plug	356-20500	—	1
55	Rubber Hose	354-28360	1	1
56	Fuel Filter —complete	351-29760	1	1
57	Fuel Filter Element	356-28610	—	1
58	Fuel Pipe —filter to union	354-28610	1	—
—	Fuel Pipe —filter to union	13-22-350	6	6
59	Swivel Union Joint	354-28630	1	1
60	Swivel Union Plug	354-28530	2	2
—	Blank Plug	13-22-350	2	2
—	Joint	270-24	2	2
61	Setscrew $\frac{5}{16}$ " UNF x $\frac{5}{8}$ "	27-413	2	2
62	Spring Washer	27-82	2	2
—	Plain Washer	572-10611	1	1
63	Non-return Valve	354-26310	2	2
64	Joint for non-return valve	354-28440	1	1
65	Leak-off Pipe —filter to tee	201-17211	1	1
66	Tee-piece			
67	Leak-off Pipe —tee to tank—to suit installation	600-106	1	1
68	Tee-piece Copper Washer	270-189	1	1
69	Setscrew $\frac{1}{4}$ " UNF x $\frac{3}{8}$ "	27-451	1	1
70	Spring Washer	356-20490	—	1
71	Leak-off Pipe —flywheel end	354-31600	1	1
	Vent Screw —on pipe 354-24140	291-2609	1	1
	Joint	354-26790	2 halves	—
	Injector Pipe Clamp	356-26790	—	2 halves
	Injector Pipe Clamp	270-366	3	3
	Bolt for clamp	27-618	3	3
	Plain Washer	27-451	3	3
	Spring Washer	270-2	3	3
	Nut	572-10781	—	1
	Fuel Pipe Clip Assembly comprising:—	354-31030	—	2
	Clamp	356-32410	—	2
	Rubber Bush	270-122	—	1
	Bolt	270-153	—	1
	Nut —self-locking	660-10070	1	1
	Injector Cleaning Kit —optional			



FUEL FILTER, FUEL LIFT PUMP, FUEL PUMP & DRIVE

PLATE 7. FUEL SYSTEM—FUEL LIFT PUMP

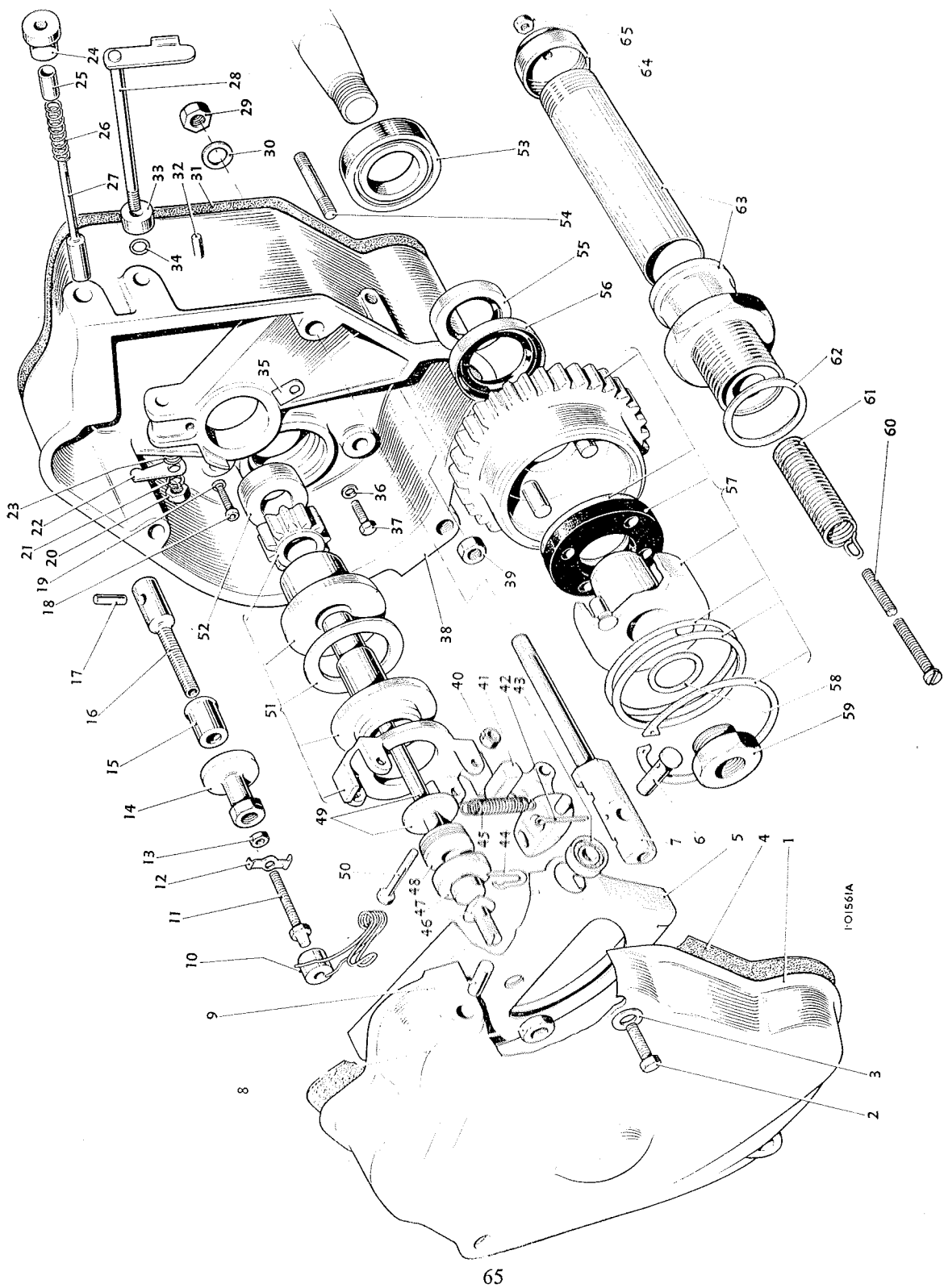
Illus. No.	Description of Part	Part No.	No. per Set
—	Fuel Lift Pump complete	291-3688	1
1	Filter Cover Screw	662-10240	1
2	Washer	662-10250	1
3	Filter Cover	662-10260	1
4	Gasket	662-10270	1
5	Filter Screen	662-10280	1
6	Pump Cover Screw	662-10050	6
7	Washer	662-10010	6
8	Upper Casting	662-10290	1
9	Swivel Union Joint	351-21620	4
10	Swivel Union Plug	351-21610	2
11	Fuel Pipe—Tank to Lift Pump—To suit installation		
12	Olive	351-21640	2
13	Swivel Union	351-21600	2
14	Valve Gasket	662-10080	1
15	Valve Assembly	662-10090	2
16	Valve Retaining Plate	662-10100	1
17	Valve Retaining Screw	662-10110	2
18	Diaphragm Assembly	662-10300	1
19	Diaphragm Spring	662-10310	1
20	Body	662-10320	1
21	Joint	354-19350	1
22	Rocker Arm Spring	662-10330	1
23	Link	662-10340	1
24	Rocker Arm Pin Washer	662-10350	2
25	Rocker Arm	662-10360	1
26	Push Rod	354-19340	1
27	Bearing Bush	354-19330	1
28	Rocker Arm Pin Clip	662-10180	2
29	Rocker Arm Pin Assembly	662-10370	1
30	Primer Parts Set (Spring—662-10390)	662-10380	1
31	Setscrew—$\frac{5}{16}$" UNF x $\frac{7}{8}$"	270-24	2
32	Spring Washer	27-413	2
	Fuel Pipe—Lift Pump to Filter	354-28450	1



2-0961A

PLATE 8. GOVERNOR—CONSTANT SPEED

Illus. No.	Description of Part	Part No.	No. per Set
—	Governor Casing Assembly —parts marked *	572-10420	1
1	Governor Cover	354-22670	1
2	Governor Cover Bolt — $\frac{1}{4}$ " UNC x $\frac{3}{4}$ "	270-294	3
3	Copper Washer	291-2609	3
4	Governor Cover Joint	354-23100	1
5	Governor Lever Assembly —includes item 10	354-24040	1
6	Governor Lever Pivot Pin	354-23050	2
7	* Pillar	354-23040	2
8	Locknut for adjustable pad— $\frac{1}{4}$ " UNF	270-340	1
9	Dowel	27-1604	1
10	Governor Lever Spring	354-22800	1
11	Adjusting Screw	354-22950	1
12	Stopping Lever Spring Saddle	354-23230	1
13	Locknut — $\frac{3}{16}$ " UNF	270-1	1
14	Stopping Nut	354-22920	1
15	Governor Link Sleeve	354-24290	1
16	Governor Link	354-22931	1
17	Governor Link Pin	354-23221	1
18	Cap Head Screw	354-23250	1
19	Washer	291-2609	5
20	Nut — $\frac{1}{4}$ " UNF	270-2	1
21	Spring Washer	27-451	1
22	Control Lever	201-12320	1
23	Spring	201-12330	1
24	Knob	351-11100	1
25	* Bush	351-11090	1
26	* Spring	351-11080	1
27	* Plunger	351-11070	1
28	Stopping Lever Assembly	354-22970	1
29	* Pillar Nut — $\frac{5}{16}$ " UNF	270-3	2
30	* Pillar Washer	616-1608	2
31	Governor Case Joint	354-23060	1
32	* Dowel	354-30770	1
33	Distance Piece	351-11140	1
34	Joint Ring	201-13120	1
35	Bearing Retaining Plate	354-23120	1
36	Spring Washer	27-451	1
37	Bolt — $\frac{1}{4}$ " UNC x $\frac{1}{2}$ "	270-376	1
38	* Governor Case	354-22660	1
39	Nut — $\frac{1}{4}$ " UNF	270-340	4
40	Governor Weight Pin Nut	27-4683	2
41	Governor Weight —1000 rpm	354-28350	2
	Governor Weight —1200 and 1500 rpm	354-11500	2
	Governor Weight —1800 rpm	354-11501	2
	Governor Weight —2000 rpm	354-21560	2
	Governor Weight —2200 rpm	354-21564	2
42	Split Pin for item 7	27-913	2
43	Ball Race	351-11480	2
44	Thrust Cap Circlip	351-10820	1
45	Governor Weight Spring —all speeds	354-22910	2
46	Adjustable Pad	354-23791	1
	Thrust Bearing and Shaft Assy. includes item 44	572-10003	1
47	Thrust Cap	354-10800	1
48	Thrust Race	354-10810	1
49	Shaft Assembly	354-10770	1

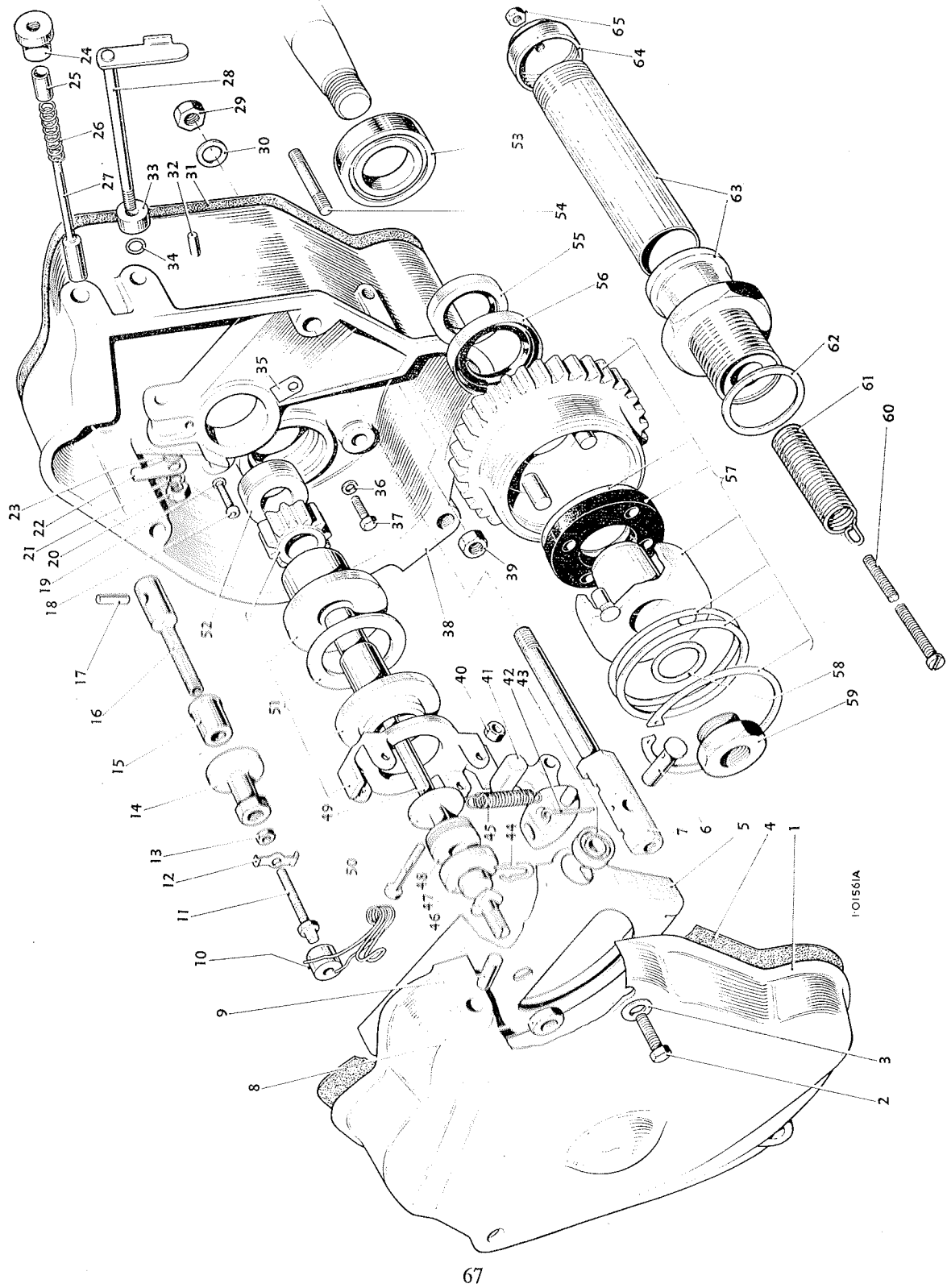


GOVERNOR—CONSTANT SPEED

PLATE 8

PLATE 8. GOVERNOR—CONSTANT SPEED (contd.)

Illus. No.	Description of Part	Part No.	No. per Set
50	Governor Weight Pin	354-23260	2
51	Hub and Gear Assembly	572-10410	1
52	*Bush	354-23020	1
53	Ball Bearing	660-11080	1
54	Stud	354-23030	4
55	Oil Seal	660-11090	1
56	*Oil Seal	354-23240	1
57	Governor Driving Gear Assembly	572-10520	1
58	Washer	291-2265	1
59	Driving Member Nut	354-22760	1
60	Screw — $\frac{3}{16}$ " UNF x $\frac{3}{4}$ "	270-112	1
61	Speeder Spring —1000-1200 rpm	354-22860	1
	Speeder Spring —1500-2000 rpm	354-25941	1
	Speeder Spring Link —1000 rpm only	354-26871	1
62	Joint	616-1524	1
63	Speeder Spring Tube Assembly	354-24011	1
64	Cap for Spring Tube	354-23082	1
65	Locknut	354-23470	1

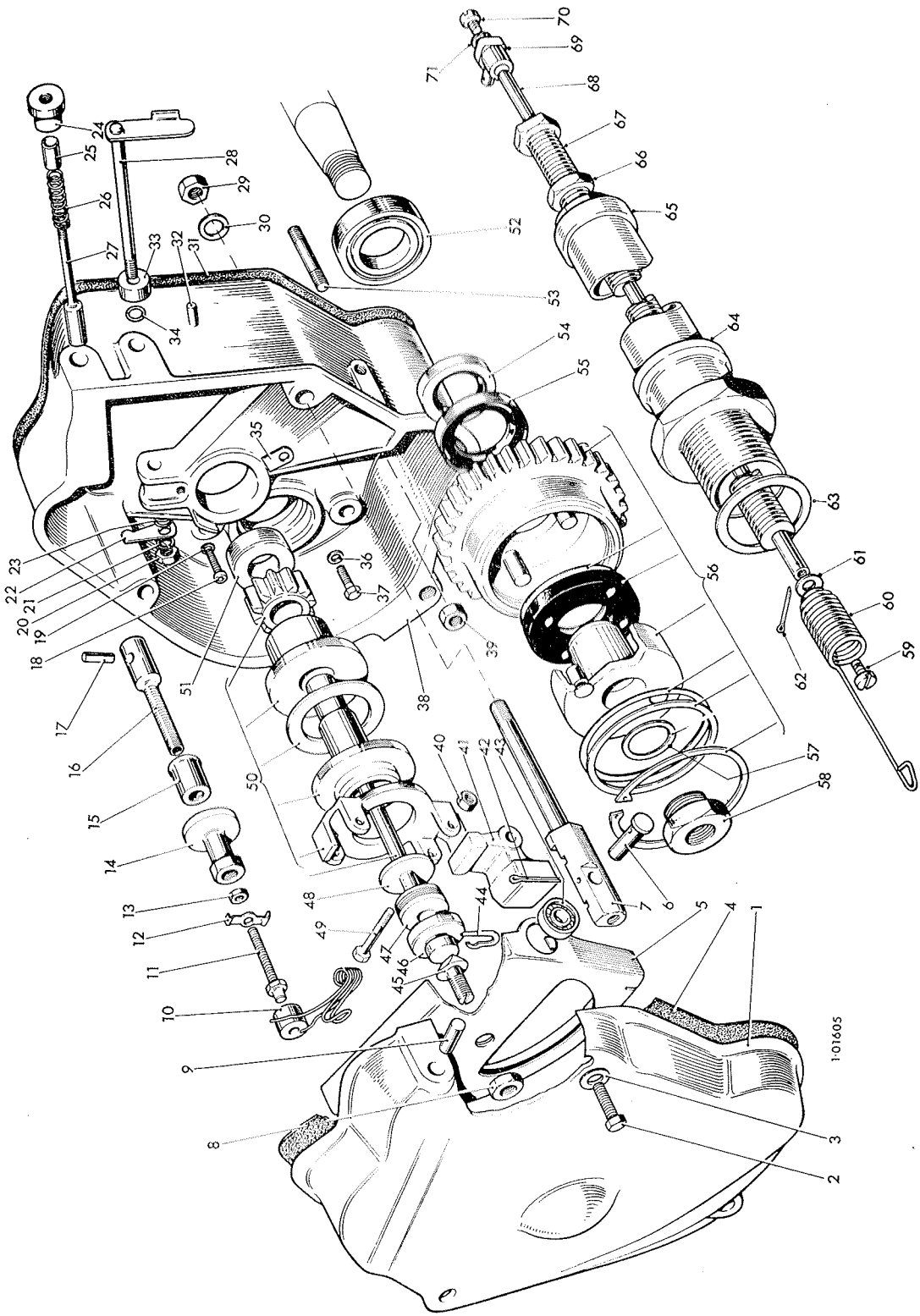


GOVERNOR—CONSTANT SPEED

PLATE 8

PLATE 9. GOVERNOR—VARIABLE SPEED

Illus. No.	Description of Part	Part No.	No. per Set
—	Governor Casing Assembly —parts marked *	572-10420	1
1	Governor Cover	354-22670	1
2	Governor Cover Bolt — $\frac{1}{4}$ " UNC x $\frac{3}{4}$ "	270-294	3
3	Copper Washer	291-2609	3
4	Governor Cover Joint	354-23100	1
5	Governor Lever Assembly —includes item 10	354-24040	1
6	Governor Lever Pivot Pin	354-23050	2
7	* Pillar	354-23040	2
8	Locknut for adjustable pad— $\frac{1}{4}$ " UNF	270-340	1
9	Dowel	27-1604	1
10	Governor Lever Spring	354-22800	1
11	Adjusting Screw	354-22950	1
12	Stopping Lever Spring Saddle	354-23230	1
13	Locknut — $\frac{3}{16}$ " UNF	270-1	1
14	Stopping Nut	354-22920	1
15	Governor Link Sleeve	354-24290	1
16	Governor Link	354-22931	1
17	Governor Link Pin	354-23221	1
18	Cap Head Screw	354-23250	1
19	Washer	291-2609	5
20	Nut — $\frac{1}{4}$ " UNF	270-2	1
21	Spring Washer	27-451	1
22	Control Lever	201-12320	1
23	Spring	201-12330	1
24	Knob	351-11100	1
25	* Bush	351-11090	1
26	* Spring	351-11080	1
27	* Plunger	351-11070	1
28	Stopping Lever Assembly	354-22970	1
29	* Pillar Nut — $\frac{5}{16}$ " UNF	270-3	2
30	* Pillar Washer	616-1608	2
31	Governor Case Joint	354-23060	1
32	* Dowel	354-30770	1
33	Distance Piece	351-11140	1
34	Joint Ring	201-13120	1
35	Bearing Retaining Plate	354-23120	1
36	Spring Washer	27-451	1
37	Bolt — $\frac{1}{4}$ " UNC x $\frac{1}{2}$ "	270-376	1
38	* Governor Case	354-22660	1
39	Nut — $\frac{1}{4}$ " UNF	270-340	4
40	Governor Weight Pin Nut	27-4683	2
41	Governor Weight —700-2000 rpm	354-21561	2
	Governor Weight —750-2200	354-23214	2
42	Split Pin	27-913	2
43	Ball Race	351-11480	2
44	Thrust Cap Circlip	351-10820	1
45	Adjustable Pad	354-23791	1
	Thrust Bearing and Shaft Assy. includes item 44	572-10003	1
46	Thrust Cap	354-10800	1
47	Thrust Race	354-10810	1
48	Shaft Assembly	354-10770	1
49	Governor Weight Pin	354-23260	2
50	Hub and Gear Assembly	572-10410	1
51	* Bush	354-23020	1



VARIABLE SPEED GOVERNOR

PLATE 9

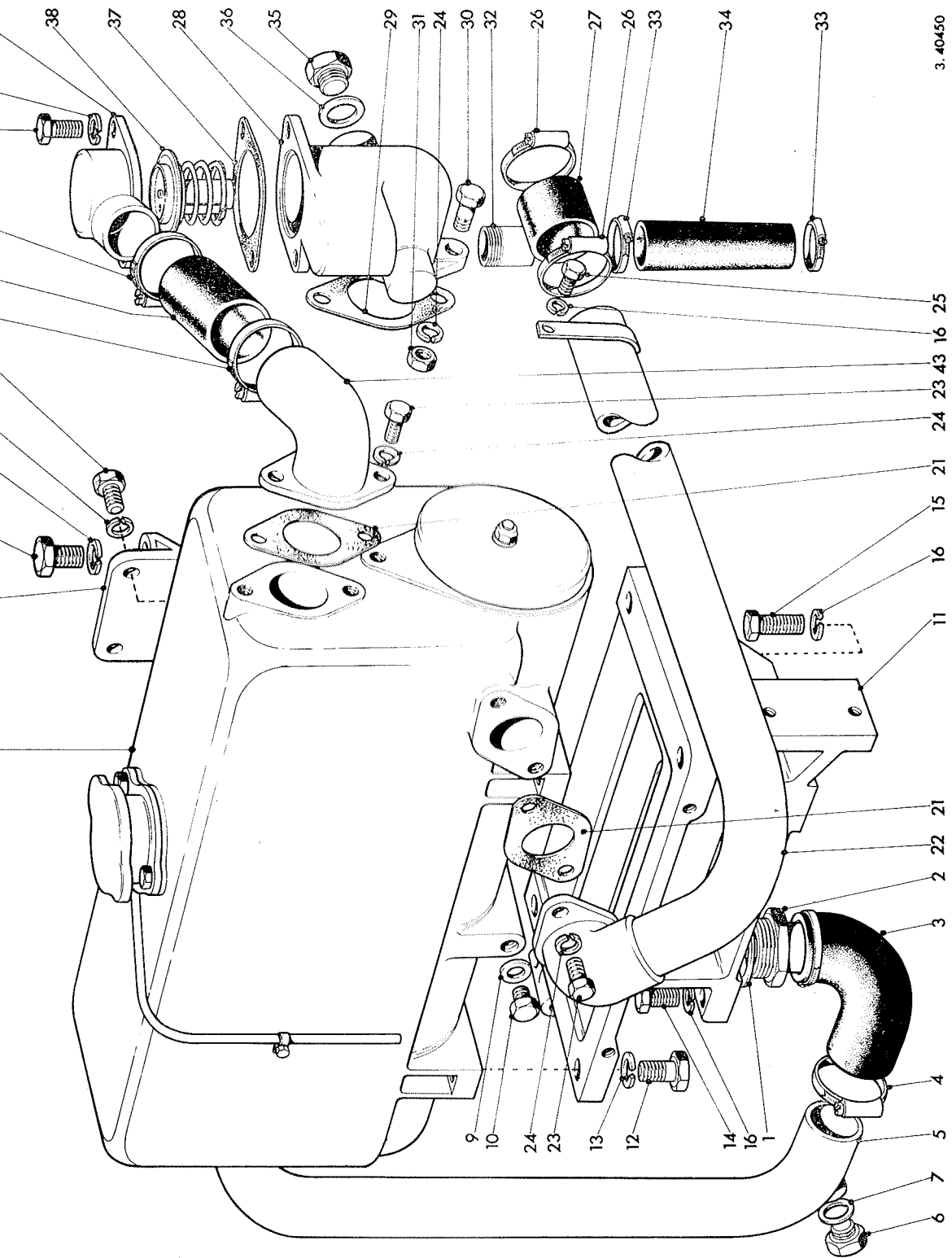
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PLATE 9. GOVERNOR—VARIABLE SPEED (contd.)

Illus. No.	Description of Part	Part No.	No. per Set
52	Ball Bearing	660-11080	1
53	Stud	354-23030	4
54	Oil Seal	660-11090	1
55	* Oil Seal	354-23240	1
56	Governor Driving Gear Assembly	572-10520	1
57	Washer	291-2265	1
58	Driving Member Nut	354-22760	1
59	Screw for speeder spring	354-26880	1
60	Speeder Spring	354-26850	1
61	Speeder Spring Backing Washer	27-1698	1
62	Split Pin —for speeder spring screw	27-2255	1
63	Joint	616-1524	1
64	Speeder Spring Tube Assembly	354-24011	1
65	Cap for Spring Tube	354-23083	1
66	Locknut	354-23470	1
67	Adjusting Screw	354-23461	1
	Slide Assembly comprising	354-23502	1
68	Slide	354-26860	1
69	Slide End Piece	354-23492	1
70	Screw — $\frac{3}{16}$ " UNF x $\frac{3}{4}$ "	270-183	1
71	Spring Washer	27-717	1

PLATE 10. HEAT EXCHANGER, THERMOSTAT AND PIPING

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
1	Joint	291-3064	3	3
2	Union for hose	354-43530	2	2
3	Rubber Hose Bend	354-43580	2	2
4	Clip	27-4688	6	6
5	Pipe —Jabsco pump to heat exchanger includes:	354-43470	1	1
6	Drain Plug	211-540	1	1
7	Joint	600-106	1	1
8	Heat Exchanger	354-40750	1	1
9	Joint for drain plug	13-22-350	1	1
10	Drain Plug	11-13-693	1	1
11	Bracket —for heat exchanger, water pump and dynamo	354-43230	1	1
12	Bolt $\frac{1}{2}$ " UNF x $1\frac{1}{4}$ "	270-198	4	4
13	Spring Washer	27-394	4	4
14	Bolt $\frac{3}{8}$ " UNF x $1\frac{1}{8}$ "	270-305	3	3
15	Bolt $\frac{3}{8}$ " UNF x 2"	270-307	1	1
16	Spring Washer	27-393	6	6
17	Steady Bracket for heat exchanger	354-43240	1	1
18	Bolt $\frac{3}{8}$ " UNC x 1"	270-288	2	2
19	Bolt $\frac{9}{16}$ " UNF x $1\frac{1}{4}$ "	270-487	1	1
20	Spring Washer	27-2061	1	1
21	Joint	354-43210	2	2
22	Water Pipe —heat exchanger to oil cooler	354-43070	1	1
23	Setscrew — $\frac{5}{16}$ " UNC x $\frac{7}{8}$ "	270-405	4	4
24	Spring Washer	27-413	8	8
25	Bolt —stay to air manifold $\frac{3}{8}$ " UNC x $\frac{1}{2}$ "	270-457	1	1
26	Clip	27-4233	2	2
27	Rubber Hose	27-2212	1	1
28	Thermostat Body	354-43120	1	1
29	Joint	3-309	1	1
30	Bolt $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-182	2	2
31	Nut $\frac{5}{16}$ " UNF	270-3	2	2
32	Bypass Pipe	27-712	1	1
33	Clip	27-4230	2	2
34	Rubber Hose —to water pump	27-2353	1	1
35	Plug	11-13-198	1	1
36	Joint	13-21-778	1	1
37	Joint	291-2751	1	1
38	Thermostat Unit	354-44070	1	1
39	Thermostat Cover	354-43150	1	1
40	Setscrew $\frac{5}{16}$ " UNF x $\frac{3}{4}$ "	270-60	2	2
41	Clip	27-4231	2	2
42	Rubber Hose	351-40640	1	1
43	Water Pipe —thermostat to heat exchanger	354-43140	1	1



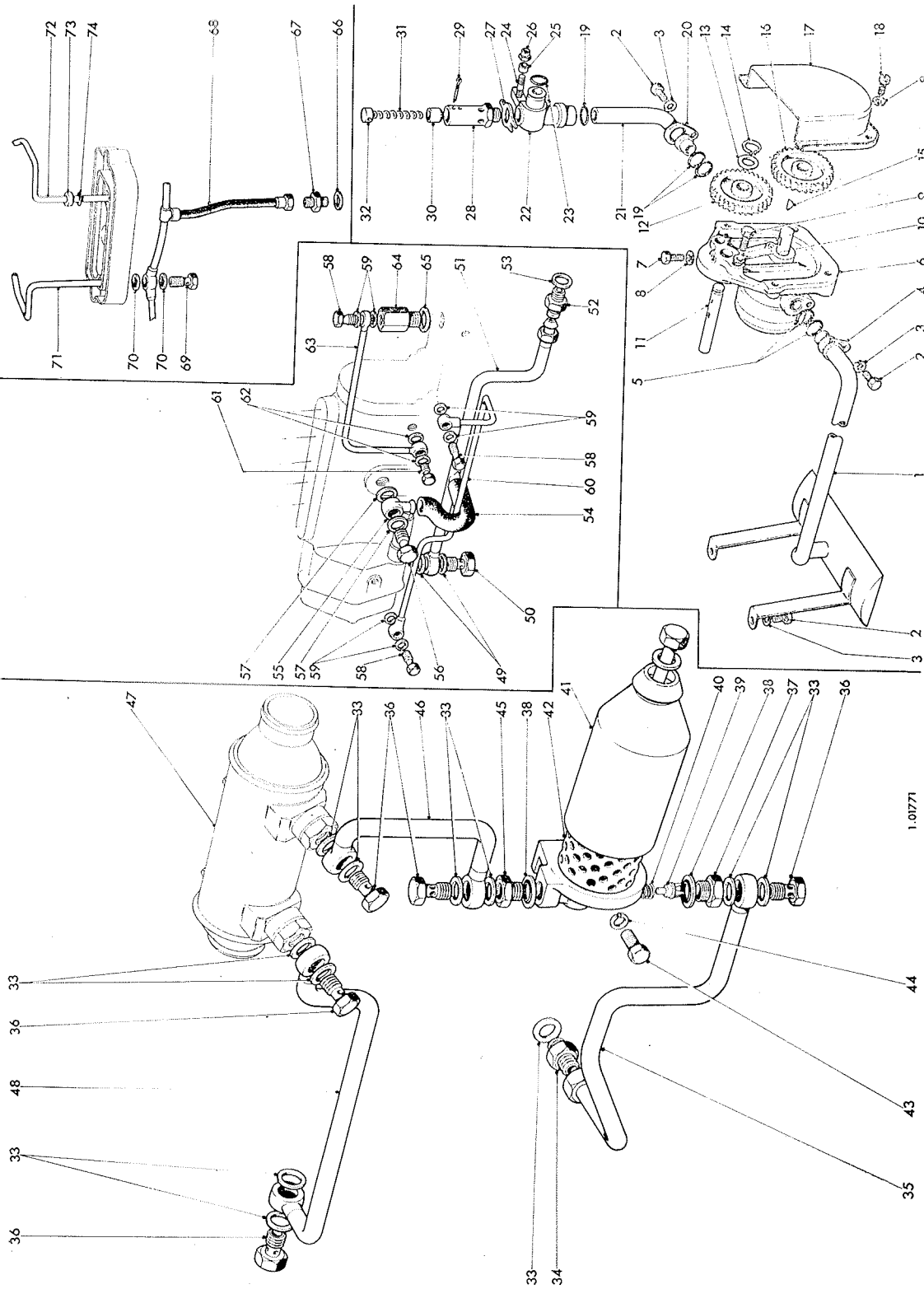
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HEAT EXCHANGER & THERMOSTAT

PLATE 10

PLATE 11—LUBRICATING OIL SYSTEM

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
1	Oil Strainer Assembly	356-28891	—	1
	Oil Strainer Assembly	354-18131	1	—
2	Setscrew $\frac{1}{4}$ " UNF x $\frac{1}{2}$ "	270-54	4	4
3	Spring Washer	27-451	4	4
4	Retaining Plate for oil pipe	356-28930	—	1
	'O' Ring —suction pipe	354-31640	1	—
5	'O' Ring —suction pipe	354-31650	—	1
6	Lubricating Oil Pump	356-11820	—	1
	Lubricating Oil Pump	354-11820	1	—
7	Locking Screw	354-19060	1	1
8	Spring Washer	27-451	5	5
9	Setscrew $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-182	2	2
10	Spring Washer	27-413	2	2
11	Shaft for idler gear	354-19021	1	1
12	Idler Gear and Bearing Assembly comprising:	354-19011	1	1
	Gear			
	Bearing			
13	Thrust Washer	354-19050	1	1
14	Circlip—no longer used—replaced by:—			
—	Thrust Collar	354-32870	1	1
—	Pin	354-32880	1	1
—	Spring Ring	354-32890	1	1
	} replaces circlip 291-2311			
15	Key for oil pump gear	27-107	1	1
16	Gear for oil pump	354-18201	1	1
17	Trough	354-19140	1	1
18	Screw for trough $\frac{1}{4}$ " UNF x $\frac{1}{2}$ "	270-162	4	4
19	'O' Ring for delivery pipe	354-31640	3	3
20	Retaining Plate for delivery pipe	354-18170	1	1
21	Oil Delivery Pipe	354-19851	1	1
22	Union	354-19841	1	1
23	'O' Ring for union	351-10341	1	1
24	Stud $\frac{5}{16}$ " UNF x $1\frac{1}{4}$ "	270-98	1	1
25	Distance Piece	354-20430	1	1
26	Nut —self locking $\frac{5}{16}$ " UNF	270-154	1	1
27	Tabwasher	351-32860	1	1
28	Relief Valve Body	354-11791	1	1
29	Split Pin	27-2252	1	1
30	Relief Valve	354-29860	1	1
31	Spring for relief valve	354-11811	1	1
32	Spring Cap	201-12570	1	1
33	Copper Washers for unions	13-21-778	11	11
34	Union in end cover	10-2-85	1	1
35	Oil Pipe —end cover to filter	354-30640	1	1
36	Swivel Union Plug	23-2308	5	5
37	Check Valve Body	354-30570	1	1
38	Dowty Washer	31-66806	2	2
39	Check Valve	354-30580	1	1
40	Spring for check valve	354-30590	1	1
41	Oil Filter —Purolator	291-3719	1	1
42	Element for filter (MF43A)	291-40910	1	1
43	Setscrew $\frac{7}{16}$ " UNF x $1\frac{1}{8}$ "	270-526	2	2
44	Spring Washer	27-394	2	2
45	Reducing Bush	354-19880	1	1
46	Lubricating Oil Pipe —filter to cooler	354-43160	1	1



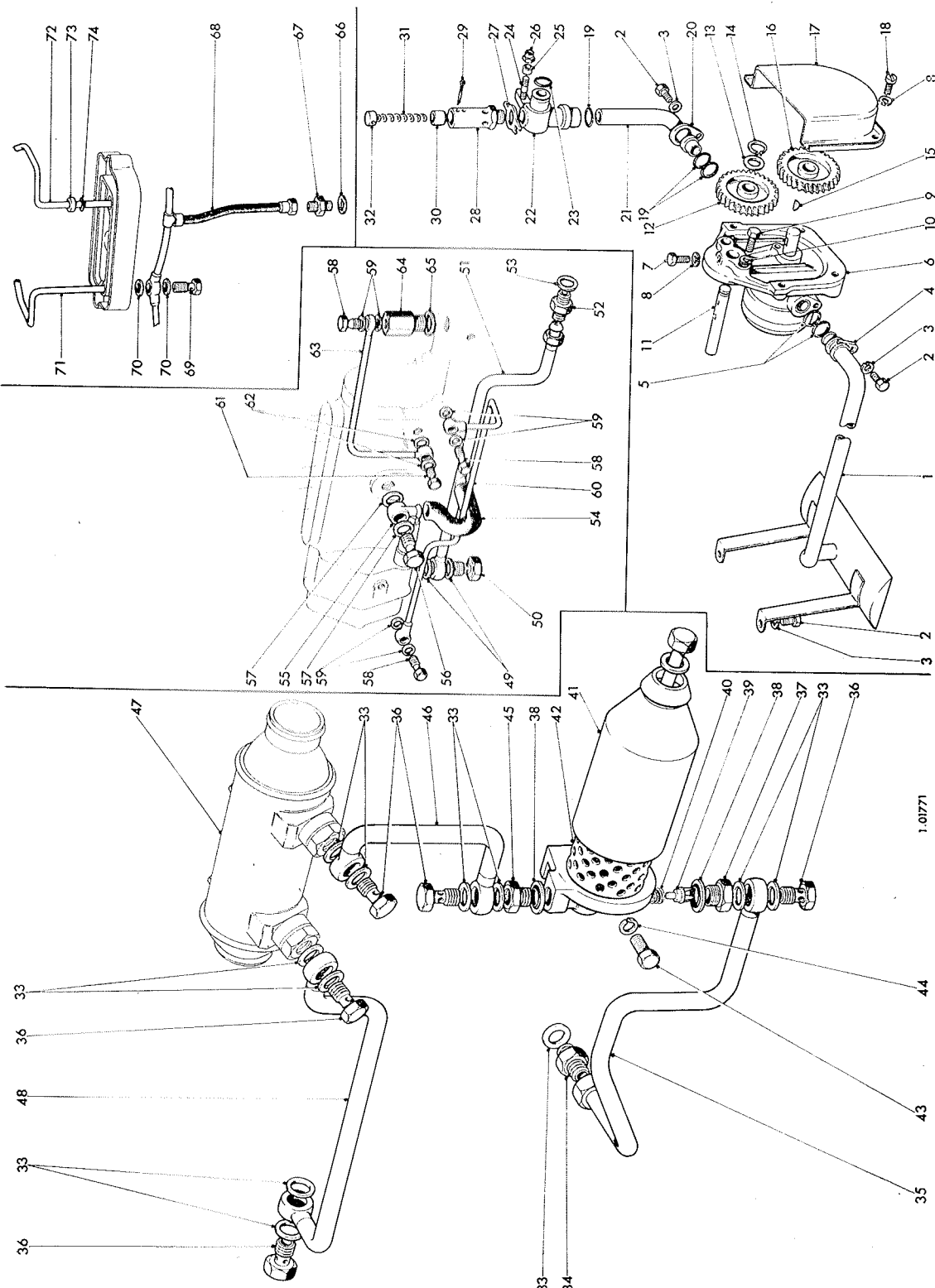
LUBRICATING OIL SYSTEM

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PLATE II

PLATE 11—LUBRICATING OIL SYSTEM (contd.)

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
47	Oil Cooler	364-1677	1	1
48	Lubricating Oil Pipe —cooler to crankcase	354-43170	1	1
49	Joint	291-3063	2	2
50	Swivel Union Plug	204-20320	1	1
51	Oil Return Pipe	356-23522	—	1
—	Oil Return Pipe	354-23522	1	—
52	Union	354-28570	1	1
53	Joint	291-3063	1	1
54	Rubber Hose —union to drain pipe	356-20500	1	1
55	Swivel Union —pump drain	354-26230	1	1
56	Swivel Union Plug	354-26220	1	1
57	Joint	291-3062	2	2
58	Swivel Union Plug	354-23280	3	3
59	Joint	291-2609	6	6
60	Oil Pipe to governor	356-23270	—	1
—	Oil Pipe to governor	354-23270	1	—
61	Swivel Union Plug	354-26260	1	1
62	Joint	354-26310	2	2
63	Oil Pipe to fuel pump	354-26270	1	1
64	Locating Pin	354-19581	1	1
65	Washer	600-106	1	1
66	Joint	13-22-350	1	1
67	Union —oil feed to valve rockers	103-106	1	1
68	Lubricating Oil Pipe —crankcase to cylinder head	356-19801	—	1
—	Lubricating Oil Pipe —crankcase to cylinder head	354-19802	1	—
69	Swivel Union Plug	354-19810	4	6
70	Joint	616-1414	8	12
71	Lubricating Oil Pipe —sealing plate to rocker L.H.	354-29180	4	6
72	Lubricating Oil Pipe —sealing plate to rocker R.H.	354-29190	4	6
73	Retaining Plug for 'O' ring	354-19820	8	12
74	'O' Ring	520-7648	8	12



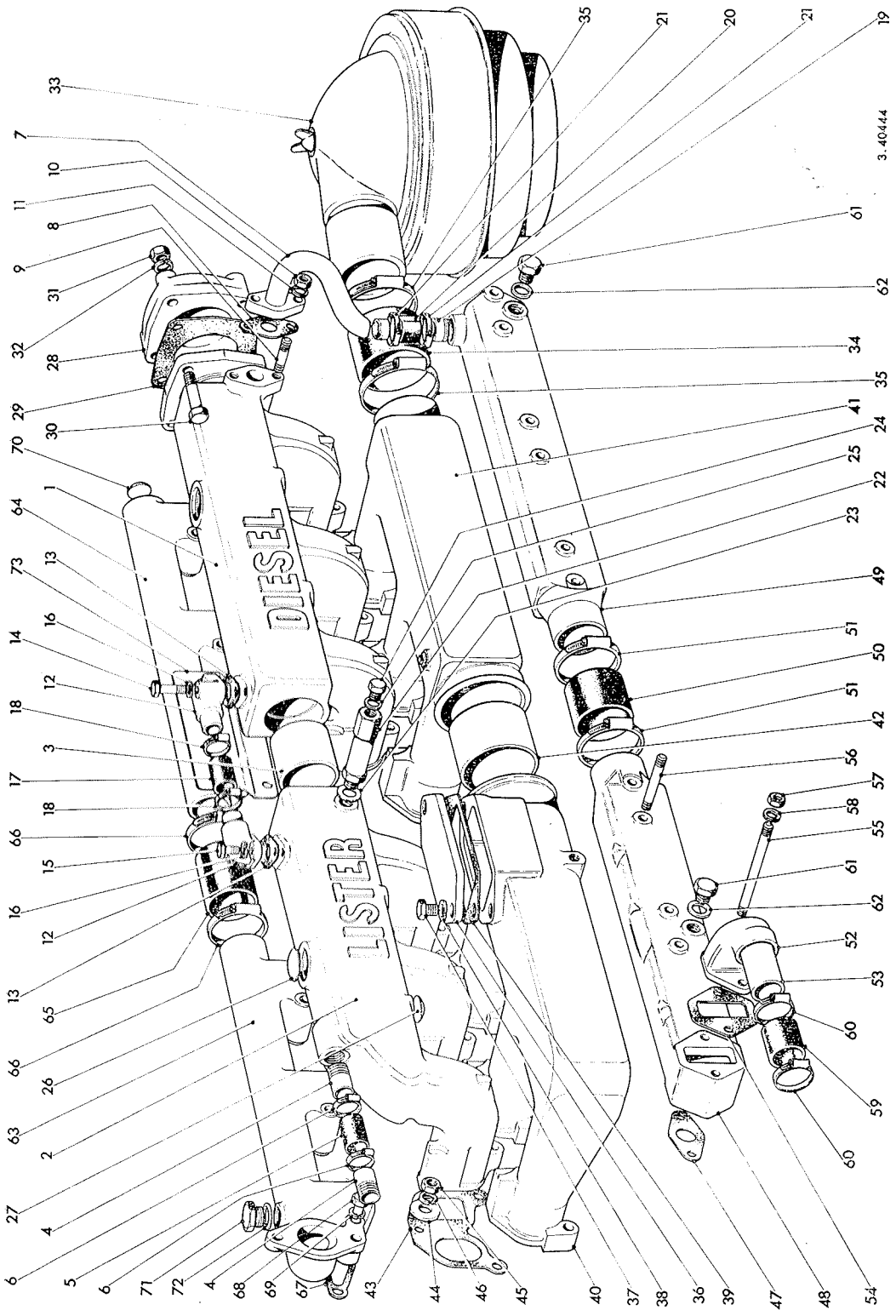
LUBRICATING OIL SYSTEM

PLATE 11

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PLATE 12. MANIFOLDS—WATER COOLED EXHAUST—AIR—WATER

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
1	Exhaust Manifold—flywheel end	356-42521	—	1
2	Exhaust Manifold—gear end	356-42511	—	1
—	Exhaust Manifold	354-42521	1	—
3	Connecting Sleeve	354-19382	—	1
4	Connection—to thermostat	27-4599	2	2
5	Rubber Hose	351-40631	1	1
6	Clip	27-4687	2	2
7	Pipe—water inlet manifold to exhaust manifold	354-43380	1	1
8	Joint	356-26010	1	1
9	Stud $\frac{1}{4}$ " UNF x $1\frac{1}{8}$ "	270-79	2	2
10	Nut $\frac{1}{4}$ " UNF	270-2	2	2
11	Spring Washer	27-451	2	2
12	Transfer Flange	356-25960	—	2
13	Joint	356-26010	—	2
14	Bolt $\frac{1}{4}$ " UNC x $1\frac{1}{2}$ "	270-293	—	2
15	Bolt $\frac{1}{4}$ " UNC x $\frac{3}{4}$ "	270-294	—	2
16	Spring Washer	27-451	—	4
17	Rubber Hose	356-25990	—	1
18	Clip	27-4687	—	2
19	Connection—in water inlet manifold	27-4599	1	1
20	Rubber Hose	351-40631	1	1
21	Clip	27-4687	2	2
22	Drain Extension	351-27810	—	1
23	Joint	13-22-350	—	1
24	Plug	211-540	—	1
25	Joint	600-106	—	1
26	Expansion Plug— $1\frac{1}{4}$ "	27-768	—	1
27	Expansion Plug— $\frac{3}{4}$ "	27-1549	—	2
—	Expansion Plug	27-3905	2	—
—	Expansion Plug	27-4605	3	—
28	Exhaust Flange	354-19360	1	1
29	Joint	354-19370	1	1
30	Bolt— $\frac{5}{16}$ " UNF x $2\frac{1}{4}$ "	270-66	4	4
31	Nut— $\frac{5}{16}$ " UNF—brass	270-14	4	4
32	Spring Washer	27-413	4	4
33	Air Cleaner	356-26431	1	1
34	Rubber Hose	27-4739	1	1
35	Clip	27-4696	2	2
36	Blind Flange	354-44080	1	1
37	Setscrew— $\frac{5}{16}$ " UNC x $\frac{3}{4}$ "	270-231	2	2
38	Spring Washer	27-413	2	2
39	Joint	356-43860	1	1
40	Air Manifold—gear end	356-42491	—	1
41	Air Manifold—flywheel end	356-43401	—	1
—	Air Manifold	354-43401	1	—
42	Connecting Tube	354-19390	—	1
43	Joint	351-40311	4	6
44	Clamp Washer	351-11630	4	6
45	Nut $\frac{5}{16}$ " UNF brass	270-14	12	18
46	Spring Washer	27-413	12	18
47	Joint	351-42890	4	6
48	Water Inlet Manifold—gear end	356-42950	—	1
49	Water Inlet Manifold—flywheel end	356-42960	—	1
—	Water Inlet Manifold	354-42880	1	—



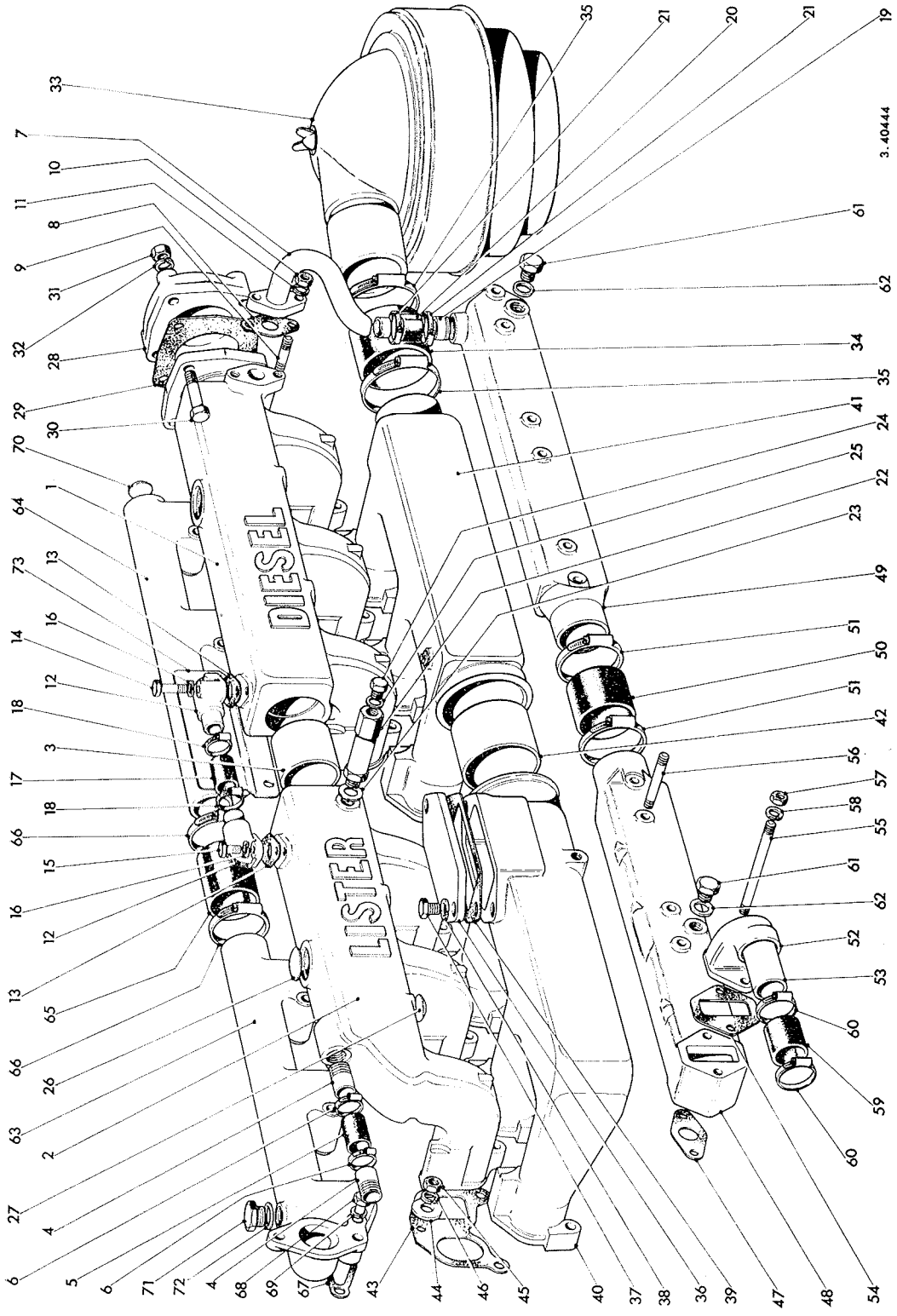
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MANIFOLDS

PLATE 12

PLATE 12. MANIFOLDS—WATER COOLED EXHAUST—AIR—WATER (Contd.)

Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
50	Rubber Hose	27-4740	—	1
51	Clip	27-4234	—	2
52	Pipe—Elbow	354-42900	1	1
53	Connection	351-40061	1	1
54	Joint	354-42920	1	1
55	Stud $\frac{5}{16}$ " UNF x $3\frac{1}{4}$ "	270-85	2	2
56	Stud $\frac{5}{16}$ " UNF x $2\frac{3}{4}$ "	270-481	6	10
57	Nut $\frac{5}{16}$ " UNF	270-3	8	12
58	Spring Washer	27-413	8	12
59	Rubber Hose	351-40810	1	1
60	Clip	27-4231	2	2
61	Drain Plug	11-13-693	2	2
62	Joint	13-22-350	2	2
63	Water Outlet Manifold—gear end	356-42470	—	1
64	Water Outlet Manifold—flywheel end	356-42480	—	1
—	Water Outlet Manifold	354-42470	1	—
65	Rubber Hose	27-2212	—	1
66	Clip	27-4233	—	2
67	Joint	351-40170	4	6
68	Bolt $\frac{5}{16}$ " UNF x $2\frac{1}{4}$ "	270-66	8	12
69	Spring Washer	27-413	8	12
70	Expansion Plug	27-4605	1	1
71	Plug—not required when temp. gauge is fitted	27-1815	1	1
72	Joint	291-3063	1	1
73	Heat Shield	356-43880	—	1
—	Plug for air inlet manifold	27-1993	1	1
—	Air Cleaner Maintenance Transfer	351-31730	1	1



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MANIFOLDS

PLATE 12

PLATE 13. FRESH WATER PUMP

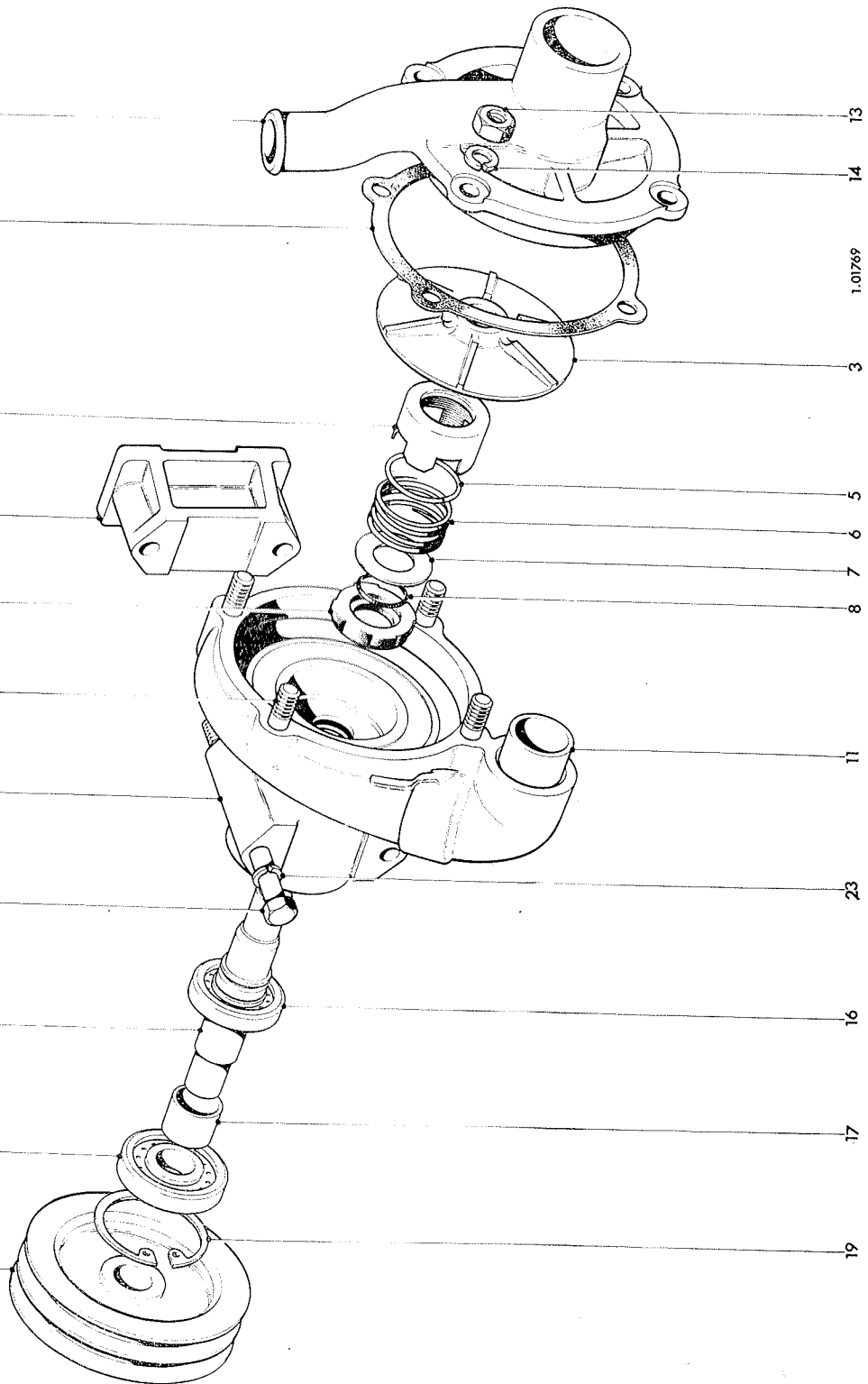
Illus. No.	Description of Part	Part No.	No. per Engine	
			4 cyl.	6 cyl.
—	Water Pump complete	572-40140	1	1
1	Pump Cover	354-40330	1	1
2	Joint	351-40340	1	1
—	Impeller Assembly comprising:—	572-40022	1	1
3	Impeller	351-40382	1	1
4	Carbon Driver	291-38850	1	1
5	Distance Piece	291-3035	1	1
6	Seal Spring	291-21524	1	1
7	Backing Plate	291-38860	1	1
8	Sealing Ring	291-25271	1	1
9	Carbon Seal	291-21502	1	1
—	Pump Body Assembly comprising:—	351-43930	1	1
10	Pump Body	351-43910	1	1
11	Connection	351-40061	1	1
12	Stud $\frac{5}{16}$ " UNF x 1"	270-131	4	4
13	Nut $\frac{5}{16}$ " UNF	270-3	4	4
14	Spring Washer	27-413	4	4
15	Impeller Shaft	351-43980	1	1
16	Ball Bearing —small	351-43940	1	1
17	Spacer	351-43970	1	1
18	Ball Bearing —large	351-43950	1	1
19	Circlip	351-43960	1	1
20	Pump Pulley	354-43110	1	1
21	Pedestal	351-44000	1	1
22	Bolt $\frac{5}{16}$ " UNC x $4\frac{1}{2}$ "	270-611	2	2
23	Spring Washer	27-413	2	2

HIGH LEVEL BEARERS — FLEXIBLE

	Part No.	No. per Set
Engine Support Bracket	354-23970	2
Stud $\frac{1}{2}$ " UNF x $2\frac{1}{4}$ "	270-96	4
Nut $\frac{1}{2}$ " UNF	270-6	4
Spring Washer	27-394	4
Flywheel Housing Bracket	354-23980	2
Flywheel Housing Stud $\frac{1}{2}$ " UNF x $1\frac{3}{4}$ "	270-544	4
Nut $\frac{1}{2}$ " UNF	270-6	4
Spring Washer	27-394	4
Reverse Gear Bracket	294-29501	2
Stud $\frac{3}{8}$ " UNF-UNC x $1\frac{1}{2}$ "	270-260	8
Nut $\frac{3}{8}$ " UNF	270-4	8
Spring Washer	27-393	8
Anti-Vibration Mounting	294-2951	6
Setscrews $\frac{5}{16}$ " UNF x $\frac{1}{2}$ "	270-58	12
Spring Washer	27-413	12

HIGH LEVEL BEARERS — SOLID

Engine Support Bracket	354-23940	2
Stud $\frac{1}{2}$ " UNF x $2\frac{1}{4}$ "	270-96	4
Nut $\frac{1}{2}$ " UNF	270-6	4
Spring Washer	27-394	4
Flywheel Housing Bracket	354-23960	2
Stud $\frac{1}{2}$ " UNF x $1\frac{3}{4}$ "	270-544	4
Nut $\frac{1}{2}$ " UNF	270-6	4
Spring Washer	27-394	4
Reverse Gear Bracket	354-23950	2
Stud $\frac{3}{8}$ " UNF-UNC x $1\frac{1}{2}$ "	270-260	8
Nut $\frac{3}{8}$ " UNF	270-4	8
Spring Washer	27-393	8
Engine Bearer Plate	354-23990	6



FRESH WATER PUMP

PLATE 13

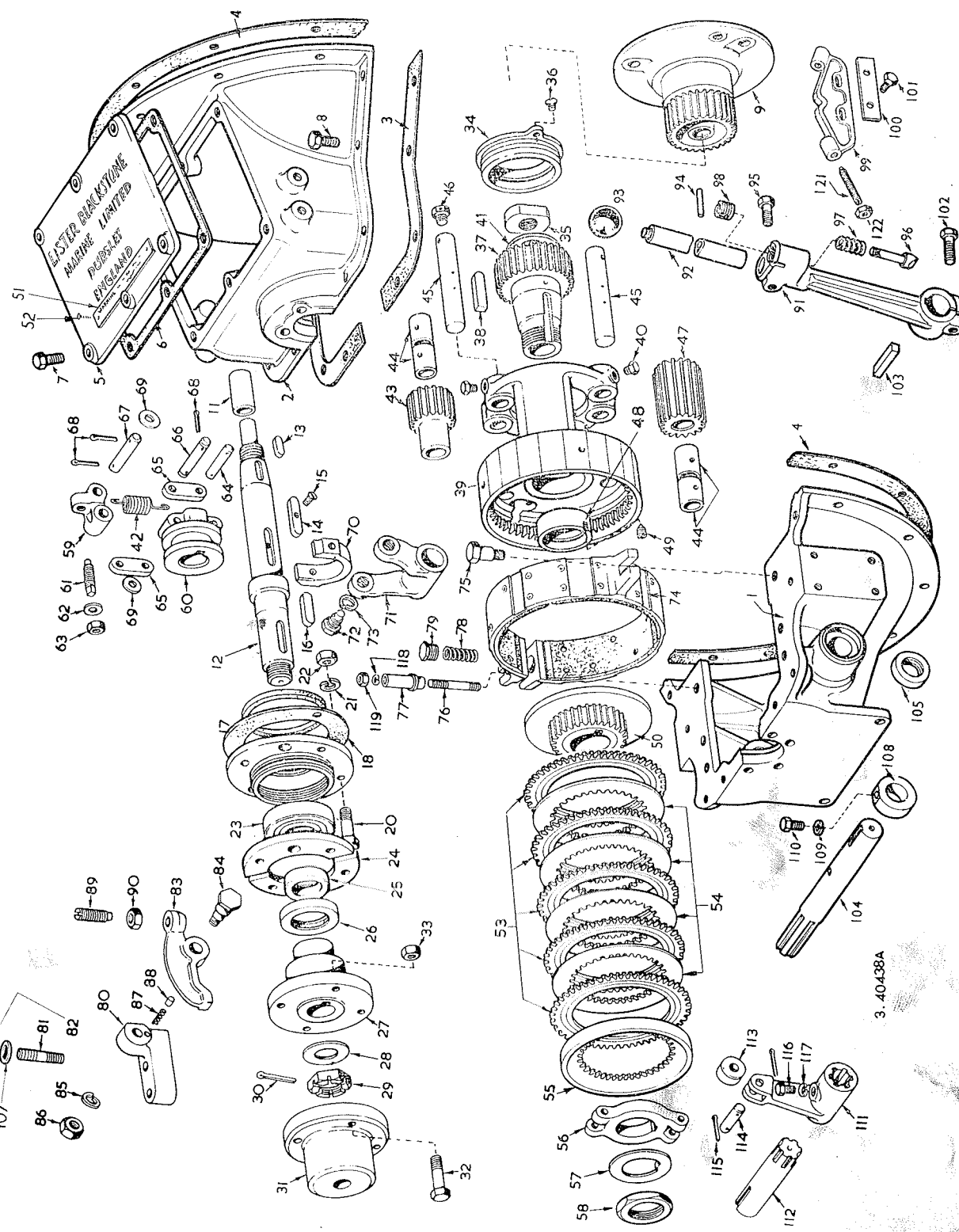
PLATE 14. REVERSE GEAR

Illus.

No.	Description of Part	Part No.	No. per Set
	Casing Top and Bottom Halves complete—comprising *		
1	* Casing Bottom Half	354-14041	1
2	* Casing Top Half	354-13971	1
3	* Casing Top to Bottom Joint	354-13961	1
4	Casing to Flywheel Housing Joint	354-14020	2
5	Casing Inspection Cover	354-14010	1
6	Inspection Cover Joint	294-2652	1
7	Setscrew $\frac{3}{8}$ " UNC x 1"	294-2653	1
—	Copper Washer	270-288	6
—	* Setscrew — when sump is fitted — $\frac{3}{8}$ " UNC x 3"	600-106	6
—	* Setscrew — sump pump bracket — $\frac{3}{8}$ " UNC x 1 $\frac{5}{8}$ "	270-373	2
8	* Setscrew — 5 only when sump pump is fitted	270-393	1
—	* Spring Washer	270-288	6
9	Crankshaft Spur Gear	27-393	8
—	Crankshaft Spur Gear Dowel	354-13980	1
—	Crankshaft Spur Gear Stud	294-2659	2
—	Nut for above — $\frac{5}{8}$ " UNF	354-30500	3
—	Split Pin	270-42	3
—	Crankshaft Oil Restrictor	27-121	3
11	Crankshaft Bush	354-28280	1
12	Clutch Shaft	502-11910	1
13	Reverse Shaft Spur Gear Key	354-24050	1
14	Sliding Sleeve Key	503-3288	1
15	Countersunk Head Screw , $\frac{1}{4}$ " BSF	503-2327	1
16	Half Coupling or Pinion Key	503-8997	1
17	Joint Ring	503-3856	1
18	Shim —.002"	354-24090	1
—	Shim —.010"	354-24120	as required
19	Ball Bearing Housing	354-24121	as required
20	Bolt — $\frac{1}{2}$ " UNF x 2 $\frac{3}{4}$ "	354-18320	1
21	Spring Washer	270-474	2
22	Nut — $\frac{1}{2}$ " UNF	27-1477	2
—	Spring Washer	270-6	2
—	"O" Ring	27-394	2
—	Bolt — $\frac{3}{8}$ " UNF x 2 $\frac{1}{4}$ "	616-1742	2
—	Stud — $\frac{3}{8}$ " UNF x 2 $\frac{5}{8}$ "	270-187	2
—	Nut — $\frac{3}{8}$ " UNF	270-543	2
—	Spring Washer	270-4	2
23	Ball Bearing (Direct Drive only)	27-393	4
24	Ball Bearing Retaining Plate	354-24070	1
25	Distance Piece	354-24080	1
26	Weston Seal	354-24060	1
27	Half Coupling (Direct Drive only)	503-2331	1
28	Pinion Retaining Nut Washer	502-11101	1
29	Pinion or Coupling Retaining Nut	354-30800	1
30	Split Pin	502-11980	1
31	Tail Shaft Half Coupling (Direct Drive only)	503-2673	1
32	Coupling Bolt (Direct Drive only)	502-11861	1
33	Coupling Bolt Nut	502-19330	4
34	Clutch Body Bush (large)	503-5358	4
35	Clutch Shaft Nut	502-11110	1
36	Countersunk Head Screw — $\frac{5}{16}$ " BSF	354-29220	1
37	Clutch Shaft Spur Gear	503-2640	3
38	Clutch Spider Spur Gear Key (Inner)	354-23860	1
		503-2389	1

PLATE 14. REVERSE GEAR (contd.)

Illus. No.	Description of Part	Part No.	No. per Set
39	Clutch Body	294-40300	4
40	Spur Pinion Shaft Locking Screw	502-14521	1
41	Tab Washer	354-29210	1
42	Spring for toggle lever	294-3028	2
43	Spur Pinion —Stepped	354-31780	2
44	Spur Pinion Bush	354-31760	4
45	Spur Pinion Shaft	354-31770	4
46	Spur Pinion Shaft Oil Hole Plug	502-11181	4
47	Spur Pinion	354-31790	2
48	Clutch Body Bush (small)	502-11090	1
49	Clutch Body Bush Joint Screw $\frac{3}{16}$ " BSF	503-4131	1
50	Clutch Spider	354-13510	1
51	Warning Plate	27-4518	1
52	Screw for warning plate	64-7175/1	2
53	Clutch Plate (large)	354-13530	5
54	Clutch Plate (small)	354-13500	4
55	Clutch Gripping Plate	354-13520	1
56	Toggle Lever Plate	354-31800	1
57	Toggle Lever Plate Nut Locking Plate	502-11270	1
58	Toggle Lever Plate Nut	502-11260	1
59	Toggle Lever	502-11291	2
60	Sliding Sleeve	502-11341	1
61	Toggle Lever Screw	502-11311	2
62	Toggle Lever Screw Washer	503-2577	2
63	Locknut — $\frac{7}{16}$ " BSF	503-2467	2
64	Sliding Sleeve Link Pin	502-11332	2
65	Sliding Sleeve Link	502-11322	4
66	Toggle Lever Link Pin	294-3029	2
67	Toggle Lever Fulcrum Pin	502-11282	2
68	Split Pin	503-2454	12
69	Link Pin Washer	503-1704	12
70	Sliding Sleeve Fork Lever Die	502-11371	1
71	Sliding Sleeve Fork Lever	502-11383	1
72	Sliding Sleeve Die Screw	502-11362	2
73	Spring Washer	503-2577	2
74	Brake Band and Lining Assembly, complete	294-40241	1
	Brake Band	294-39812	1
	Brake Band Lining	294-39820	3
	Brake Band Lining Rivet	294-40250	21
75	Brake Band Position Screw	351-16170	1
76	Brake Band Position Stud — $\frac{7}{16}$ " UNF-UNC x 4"	270-306	1
	Brake Band Position Spring Washer	27-984	1
	Brake Band Position Nut — $\frac{7}{16}$ " UNF	270-5	1
77	Brake Band Position Sleeve	294-39850	1
78	Brake Band Spring	2-1864	1
79	Brake Band Spring Cap	294-39860	1
80	Brake Band Lever Bracket (Standard rotation)	354-28950	1
	Brake Band Lever Bracket (Rev. rotation)	502-11723	1
	Bracket Packing	354-28960	As required
81	Brake Band Lever Bracket Stud — $\frac{1}{2}$ " UNC-UNF x $2\frac{3}{4}$ "	270-289	2
82	Brake Band Lever Bracket Spring Washer	27-394	2
83	Brake Band Lever (Standard rotation)	294-39870	1
	Brake Band Lever (Reverse rotation)	294-39880	1
84	Brake Band Lever Fulcrum Pin	502-11521	1



REVERSE GEAR

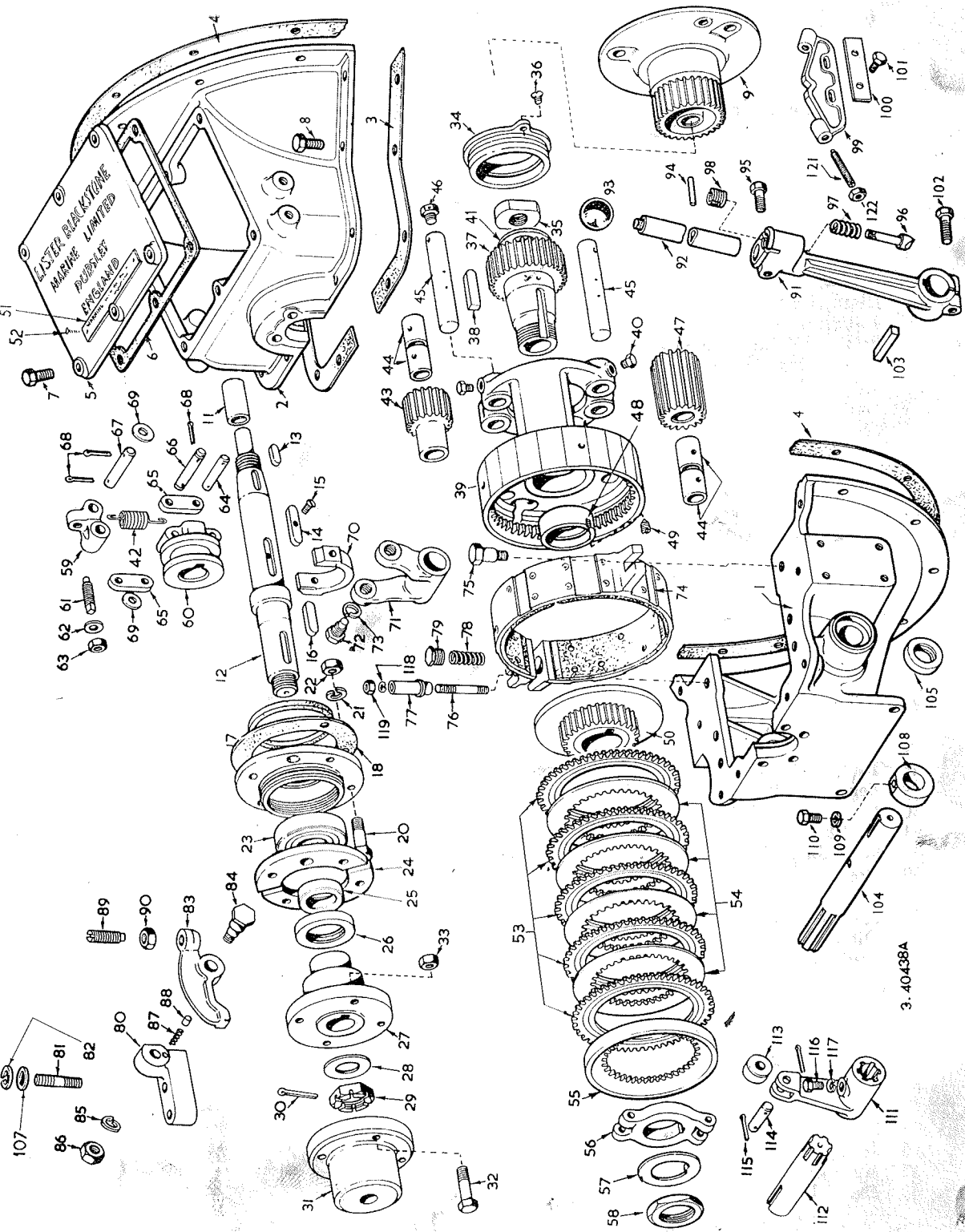
PLATE 14

PLATE 14. REVERSE GEAR (contd.)

Illus. No.	Description of Part	Part No.	No. per Set
85	Brake Band Lever Fulcrum Pin Washer	503-2577	1
86	Brake Band Lever Fulcrum Pin Locknut	503-2470	1
87	Locking Plunger Spring	502-11760	1
88	Lever Bracket Plunger	502-11750	1
89	Lever Adjusting Screw	502-11512	1
90	Lever Adjusting Screw Locknut $\frac{1}{2}$ " BSF	503-2468	1
91	Reverse Lever Socket	502-11663	1
92	Reverse Lever Tube	291-3052	1
—	Tube Adaptor	291-3053	1
93	Reverse Lever Locating Plunger Pin	502-14680	1
94	Reverse Lever Knob	291-3019	1
95	Reverse Lever Setscrew— $\frac{3}{8}$ " BSF	27-894	1
96	Reverse Lever Locating Plunger	502-14670	1
97	Reverse Lever Locating Plunger Spring	503-5871	1
98	Reverse Lever Locating Plunger Guide	502-11970	1
99	Reverse Lever Locating Plate	291-30311	1
—	Reverse Lever Locating Plate Dowel Pin	10-2-110	1
100	Locating Plate Locking Plate	24-5131	1
101	Locking Plate Setscrew— $\frac{3}{8}$ " UNC x 1"	270-288	2
102	Reverse Lever Setscrew— $\frac{3}{8}$ " BSF	503-3815	1
103	Reverse Lever Key	502-11790	1
104	Fork Lever Cross Shafts	502-11392	1
105	Cross Shaft Oil Seal	294-2660	2
106	Brake Band Lever Bracket Nut— $\frac{1}{2}$ " UNF	270-6	2
107	Plain Washer	27-698	2
108	Cross Shaft Collar	502-11411	1
109	Cross Shaft Collar Spring Washer	503-2573	1
110	Cross Shaft Collar Setscrew— $\frac{3}{8}$ " UNF	502-11451	1
111	Brake Band Roller Lever (Standard rotation)	502-11431	1
	Brake Band Roller Lever (Reverse rotation)	502-11441	1
112	Lever Cross Shaft	502-11422	1
113	Brake Band Lever Roller	502-11460	1
114	Lever Roller Pin	502-11472	1
115	Split Pin	503-2454	2
116	Cross Shaft Locating Screw	502-11451	1
117	Spring Washer	503-2573	1
	No. 6 Drive Pins	503-1612	2
	Reverse Gear Number Plate	502-11890	1
118	Brake Band Position Stud Nut	270-5	1
119	Brake Band Spring Washer	27-984	1
121	Adjusting Screw for Reverse Lever Stop	291-3034	1
122	Adjusting Screw Lock Nut— $\frac{7}{16}$ " UNF	270-5	1

FLYWHEEL HOUSING

	Flywheel Housing	354-12963	1
	Timing Hole Plug	3-140	1
	Joint	13-21-787	1
	Drain Plug— $\frac{5}{16}$ " UNF x $\frac{1}{2}$ "	270-58	1
	Joint	616-1608	1
	Dowel—gearcase to housing	291-2586	2
	Setscrew—gearcase to housing— $\frac{3}{8}$ " UNF x $\frac{7}{8}$ "	270-72	12
	Spring Washer	27-393	12
	SPECIAL TOOLS		
	Clutch Shaft Nut Spanner	502-11920	1
	Spanner Tommy Bar	502-11930	1
	Toggle Lever Plate Nut Spanner	317-175	1

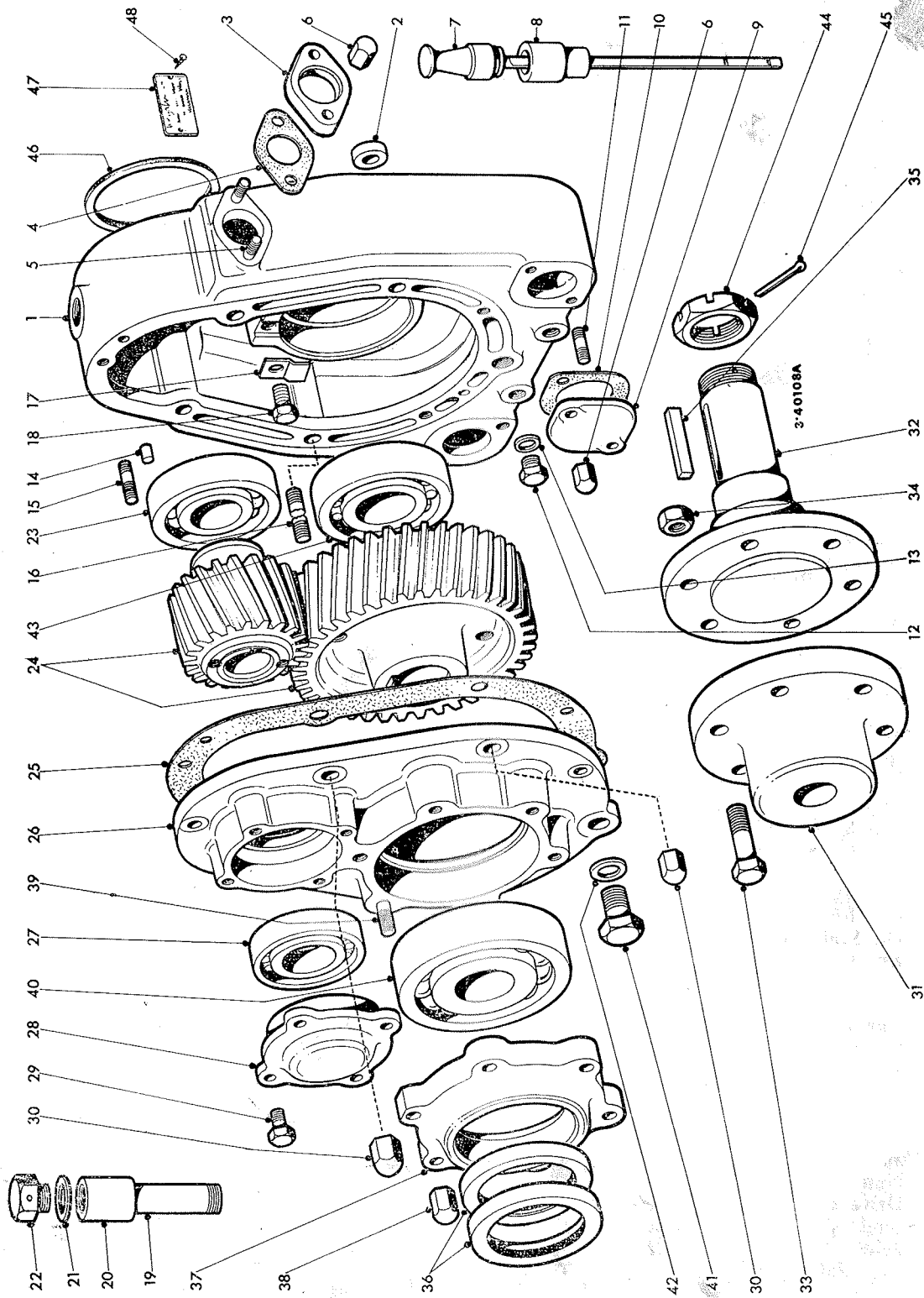


REVERSE GEAR

PLATE 14

PLATE 15. REDUCTION GEAR—2 : 1

Illus. No.	Description of Part	Part No.	No. per Set
—	Reduction Gear complete		
1	Gear Case	502-17004	
2	Distance Piece	502-17013	1
3	Flange	354-24101	2
4	Joint	502-10280	2
5	Stud — $\frac{5}{16}$ " BSF x $1\frac{1}{8}$ "	502-10290	2
6	Cap Nut — $\frac{5}{16}$ " BSF	503-1850	4
7	Dipstick —includes rubber ring 201-13120	503-2194	8
8	Dipstick Adaptor	570-10390	1
9	Blank Flange	27-4344	1
10	Joint for flange	502-10190	2
11	Stud — $\frac{5}{16}$ " BSF x 1"	503-2214	2
12	Drain Plug	503-1884	4
13	Joint for plug	503-5844	2
14	Dowel	13-22-350	2
15	Stud for gearcase cover — $\frac{3}{8}$ " BSF x $1\frac{1}{4}$ "	503-3567	2
16	Stud for gearcase cover — $\frac{1}{2}$ " UNF x 7"	503-2042	3
—	Stud for gearcase cover — $\frac{1}{2}$ " UNF x 6"	270-476	2
—	Stud for gearcase cover — $\frac{1}{2}$ " UNF x 6"	270-477	2
17	Retaining Bracket for outer race	354-23800	1
18	Setscrew for bracket — $\frac{1}{4}$ " BSF x $\frac{1}{2}$ "	27-899	1
—	Spring Washer	27-451	1
19	Breather Pipe	502-10320	1
20	Socket for pipe	503-1376	1
21	Joint for pipe plug	503-5845	1
22	Breather Plug	503-5843	1
23	Ball Bearing —40 mm. x 110 mm. x 27 mm.	354-24110	1
24	Pinion } Supplied in	294-38480	1
24	Gearwheel } pairs only	294-38490	1
25	Joint for end cover	503-2215	1
26	Gear Case Cover	502-17020	1
27	Roller Bearing — $1\frac{1}{2}$ " x $3\frac{1}{4}$ " x $\frac{3}{4}$ "	503-3985	1
28	Reverse Shaft End Cover	502-17050	1
29	Setscrew for end cover — $\frac{5}{16}$ " BSF x $1\frac{3}{16}$ "	503-3224	4
30	Cap Nut $\frac{1}{2}$ " UNF	270-47	6
31	Tailshaft Half Coupling	502-11870	1
32	Secondary Shaft	502-17120	1
33	Bolt for coupling	502-11880	6
34	Nut — $\frac{1}{2}$ " BSF	503-5358	6
35	Key for gearwheel	503-3884	1
36	Oil Seal —Weston	503-1749	2
37	End Cover for secondary shaft	502-17170	1
38	Cap Nut $\frac{3}{8}$ " BSF	503-2195	9
39	Stud for secondary shaft cover	503-1752	6
40	Double Purpose Bearing — $2\frac{1}{4}$ " x 5" x $1\frac{1}{4}$ "	503-3984	1
41	Oil Drain Plug	502-10180	1
42	Joint for plug	291-3063	1
43	Roller Bearing	27-4523	1
44	Nut for secondary shaft	502-10141	1
45	Split Pin	503-2663	1
46	Joint Ring for register bracket	12-15-483	1
47	Number Plate	502-10310	1
48	Drive Pin for plate	503-1612	2



2:1 REDUCTION GEAR

PLATE 15

PLATE 16—REDUCTION GEAR 3:1

Illus. No.	Description of Part	Part No.	No. per Set
—	Gear Case Assembly comprising *	294-3747	
1	* Gear Case	294-37481	1
2	Spacer	354-24101	2
3	Flange	502-10280	2
4	Joint for flange	502-10290	2
5	Stud — $\frac{5}{16}$ " BSF x $1\frac{1}{8}$ "	503-1850	4
6	Cap Nut $\frac{5}{16}$ " BSF	503-2194	8
7	Dipstick —includes 'O' ring 201-13120	572-10240	1
8	Dipstick Adaptor	27-4344	1
9	Blank Flange	502-10190	2
10	Joint for flange	503-2214	2
11	Stud — $\frac{5}{16}$ " BSF x 1"	503-1884	4
12	Drain Plug	503-5884	2
13	Joint for plug	13-22-350	2
14	Dowel	291-2586	2
15	Stud —gear case to reverse gear— $\frac{1}{2}$ " UNF x 7"	270-476	2
16	Stud —gear case to cover— $\frac{3}{8}$ " BSF x $1\frac{1}{4}$ "	503-2042	5
17	Circlip	294-3764	1
18	Breather Pipe	502-10320	1
19	Socket	503-1376	1
20	Joint for breather plug	13-21-778	1
21	Breather Plug	503-5843	1
22	Ball Bearing —40 mm. x 110 mm. x 27 mm.	354-24110	1
23	Pinion } Supplied in	294-3756	1
23	Gearwheel } pairs only	294-3754	1
24	Paper Joint	502-11820	1
25	* End Cover for gear case	294-3749	1
26	Roller Bearing — $1\frac{1}{2}$ " x $3\frac{3}{4}$ " x $\frac{15}{16}$ "	294-3758	1
27	Joint for bearing housing cap	294-3759	1
28	Bearing Housing Cap	294-3760	1
29	Setscrew — $\frac{5}{16}$ " BSF x $\frac{7}{8}$ "	503-4455	4
30	Cap Nut — $\frac{1}{2}$ " UNF	270-47	2
31	Tail Shaft Half Coupling	502-19340	1
32	Secondary Shaft	294-3750	1
33	Coupling Bolt	502-19330	6
34	Nut — $\frac{1}{2}$ " BSF	503-5358	6
35	Key for gearwheel	503-3884	1
36	Oil Seal —Weston	503-4129	2
37	End Cover for secondary shaft	294-3753	1
38	Cap Nut — $\frac{3}{8}$ " BSF	503-2195	11
39	Stud — $\frac{3}{8}$ " BSF x $1\frac{3}{8}$ "	503-1752	6
40	Thrust Bearing —60 mm. x 150 mm. x 35 mm.	503-4113	1
41	Oil Drain Plug	502-10180	1
42	Joint for plug	291-3063	1
43	Roller Bearing —2" x $4\frac{1}{2}$ " x $1\frac{1}{16}$ "	294-3763	1
44	Nut for secondary shaft	294-3766	1
45	Split Pin	27-4040	1
46	Joint for register bracket	12-15-483	1
47	Number Plate	502-10310	1
48	Drive Pin	503-1612	2
49	Stud —gear case to reverse gear— $\frac{1}{2}$ " BSF x $2\frac{1}{8}$ "	27-4449	2
50	Joint	13-22-350	2
51	Cap Nut — $\frac{1}{2}$ " BSF	503-2197	2

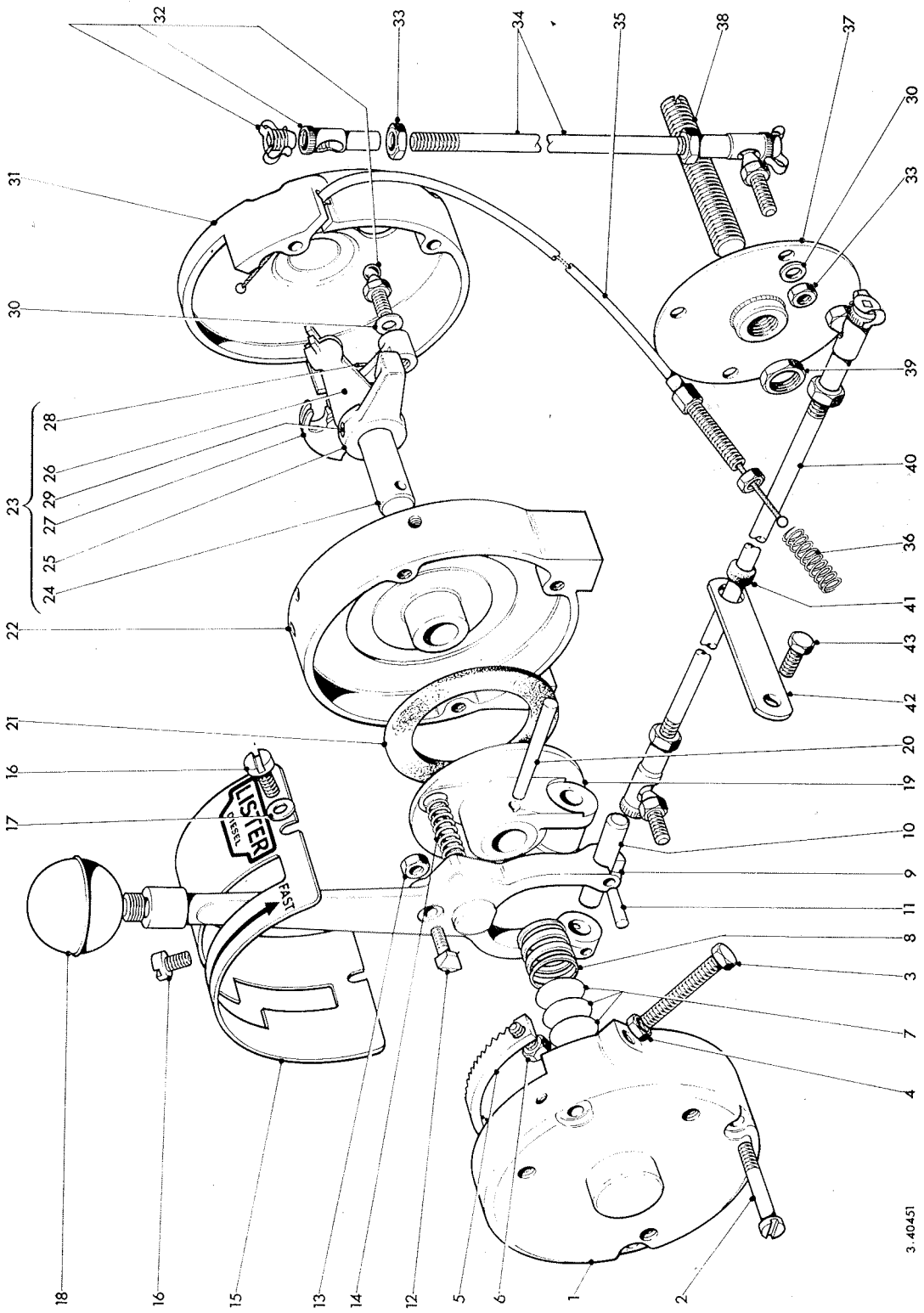
PLATE 17—COMBINED SPEED AND STOP CONTROL

Illus. No.	Description of Part	Part No.	No. per Set
—	Complete Control comprising *	572-10430	1
1	* Hand Lever Cover	351-15252	1
2	* Setscrew for cover—No. 10 UNC x 1 $\frac{1}{4}$ "	270-360	6
3	* Adjusting Screw for lever stop— $\frac{1}{4}$ " UNF x 2 $\frac{1}{4}$ "—brass	270-494	1
4	* Locknut — $\frac{1}{4}$ " UNF—brass	270-13	1
5	* Detent Plate	351-15400	1
6	* Setscrew for detent plate No. 10 UNC x $\frac{7}{8}$ "—brass	270-359	2
7	* Shim for spring	351-15420	as reqd.
8	* Spring	351-15410	1
9	* Control Lever	351-15374	1
10	* Pivot Pin for control lever	351-18231	1
11	* Locking Pin for pivot pin	351-18240	2
12	* Detent Peg	351-15390	1
13	* Nut	270-12	1
14	* Spring	351-15381	1
15	* Cover Plate	351-15271	1
16	* Setscrew for cover plate—No. 10 UNC x $\frac{3}{8}$ " ch. hd.	270-399	3
17	* Washer	64-6618/5	2
18	* Lever Knob	291-3019	1
19	* Pressure Plate	351-15362	1
20	* Locking Pin	351-15340	1
21	* Friction Disc	351-15350	1
22	* Body	351-15241	1
23	*† Lever Assembly —items 24 to 29 inclusive	572-10130	1
30	Copper Washer	616-1414	4
31	* Control Cover	351-15261	1
32	Ball End Joint	351-16500	4
33	Locknut for joint	27-907	7
34	Connecting Rod —lever to coupling plate	354-24720	1
35	Stopping Control Cable —3ft.	351-16350	1
—	Stopping Control Cable —6ft.	351-16351	1
36	Return Spring	351-24650	1
37	Coupling Plate	366-1205	1
38	Pivot Screw	354-24740	1
39	Locknut for pivot screw	270-483	1
40	Connecting Rod —coupling plate to interim lever—HW6	354-24721	1
—	Connecting Rod —coupling plate to interim lever—HW4	354-24722	1
41	Grommet for guide plate—HW6 only	636-14140	1
42	Guide Plate —HW6 only	354-28020	1
43	Setscrew — $\frac{1}{4}$ " UNC x $\frac{7}{8}$ "	270-556	1
44	Copper Washer	291-2609	1
—	Guide Plate —HW4 only	354-28022	1
—	Guide Block —HW4 only	354-30040	1
—	Bolt — $\frac{1}{4}$ " UNF x 1"—HW4 only	270-56	1
—	Spring Washer —HW4 only	27-451	1
—	Nut — $\frac{1}{4}$ " UNF—HW4 only	270-2	1

BRACKET AND CONTROL RUN FOR COMBINED STOP AND SPEED CONTROL

(Engine Mounted Only)

Mounting Bracket	354-24661	1
Setscrew — $\frac{3}{8}$ " UNF x $\frac{3}{4}$ "	270-71	4
Spring Washer	27-393	4
Setscrew — $\frac{5}{16}$ " UNC x $\frac{5}{8}$ "	270-404	2
Spring Washer	27-413	2
Nut — $\frac{5}{16}$ " UNF	270-3	2
Spring Washer	27-413	2
Plain Washer	27-82	2
Nut — $\frac{1}{4}$ " UNF	270-2	2
Steady Bracket	354-28880	1
Bolt	270-502	1
Lock Washer	27-2061	1
Nut	351-13860	1



VARIABLE SPEED AND STOP CONTROL

3.40451
PLATE 17

VARIABLE SPEED CONTROL—ROD OPERATED

Description of Part	Part No.	No. per Set
Operating Lever Assembly —comprising items marked *	572-10360	1
* Detent Plate	351-15911	1
* Fulcrum Pin	351-15991	1
* Fulcrum Pin Key	351-19490	1
* Fulcrum Pin Dished Washer	351-19530	2
* Fulcrum Pin Plain Washer	351-19500	1
* Self Locking Nut — $\frac{1}{2}$ " UNF	270-236	1
* Knob	291-3019	1
* Lever Assembly	351-15961	1
* Ratchet	351-16021	1
* Ratchet Spring	351-19510	1
* Split Pin	27-4336	1
* Stop Screw (over 1500 rpm)— $\frac{1}{4}$ " UNF x $1\frac{1}{4}$ "—Brass	270-200	2
Stop Screw (under 1500 rpm)— $\frac{1}{4}$ " UNF x $1\frac{1}{4}$ "—Brass	270-200	1
Stop Screw (under 1500 rpm)— $\frac{1}{4}$ " UNF x $2\frac{1}{4}$ "—Brass	270-491	1
* Stop Screw Nut — $\frac{1}{4}$ " UNF—Brass	270-13	2
* Rod Connector	351-16011	4
* Ball Joint	351-16500	4
* Ball Joint Copper Washer	616-1414	4
Ball Joint Nut	27-907	4
Intermediate Lever Assembly	354-24301	1
Link for Intermediate Lever —HW4	354-24350	1
Link for Intermediate Lever—HW6	356-24350	1
Washer	64-2580/11	1
Split Pin	27-4363	1
Link Pin	354-24340	1
Nut —self locking	270-445	1
Spring for Lever	354-24330	1
Swivel Stop Block	354-26820	1
Spring Washer	27-451	1
Nut — $\frac{1}{2}$ " UNF	270-2	1
Pivot Screw for Lever	354-24320	1
Locknut — $\frac{7}{16}$ " UNC	270-483	1
Lubricating Oil Filler and Inter. Lever Bracket	354-19623	1
† Idling Adjustment Body	354-24230	1
† Setscrew —No. 10 UNF x $\frac{1}{2}$ "	270-287	2
† Spring Washer	27-717	2
† Adjustment Cap Locking Spring	354-24270	1
† Pump Rack Spring Cap	354-24250	1
† Idling Spring	354-24260	1
† Idling Adjustment Cap	354-24240	1

†These parts are fitted on fuel pump over the end of the control rod—see page 30.

ROD CONNECTIONS FOR SPEED CONTROL

Description of Part	Part No.	4 cyl.	6 cyl.
Rod Coupling Plate Assembly	366-1205	1	1
Pivot Screw	354-24740	1	1
Locknut	270-483	1	1
Connecting Rod	354-24720	1	1
Connecting Rod	354-24721	—	1
Connecting Rod	354-24722	1	—
Guide Plate	354-28022	1	—
Guide Block	354-30040	1	—
Bolt	270-56	1	—
Spring Washer	27-451	1	—
Nut	270-2	1	—
Copper Washer	291-2609	1	—
Bolt	270-556	1	1
Guide Plate	354-28020	—	1
Grommet	636-14140	—	1

VARIABLE SPEED CONTROL — CABLE OPERATED

Description of Part	Part No.	No. per Set
Operating Lever Assembly	572-10360	1
Anchor Bracket	354-26840	1
Setscrew — $\frac{1}{4}$ " UNC x $\frac{5}{8}$ "	270-285	2
Spring Washer	27-451	2
Swivel Block	354-26810	1
Spring Washer	27-413	2
Nut — $\frac{5}{16}$ " UNF	270-3	2
Swivel Block	354-26830	1
Bolt	270-553	1
Nut — $\frac{1}{4}$ " UNF	270-2	1
Speed Control Cable 3' 0" long	354-24410	1
or Speed Control Cable 6' 0" long	354-24411	1
Cable Nipple for Intermediate Lever	354-24390	1
Washer	354-24400	1
Nut —self-locking—No. 10 UNF	270-445	1
Securing Screw for Control Wire—No. 10 UNF x $\frac{3}{8}$ "	270-239	1
Split Pin	27-4363	1
Cable Nipple	351-16001	1

STOPPING CONTROL CABLE AND LEVER

Governor Cover and Cable Anchor	354-24920	1
Stopping Control Nipple Seating	354-24900	1
Plain Washer	27-618	2
Spring Washer	27-451	1
Nut — $\frac{1}{4}$ " UNF	270-2	1
Return Spring	351-24650	1
Cable, Wire and Lever Assembly 3' 0" long	351-16350	1
Cable, Wire and Lever Assembly 6' 0" long	351-16351	1

ELECTRIC STARTING EQUIPMENT

Description of Part	Part No.	No. per Set
12 VOLT ELECTRIC STARTER MOTOR (CAV)		
Starter Motor CA. 4512-4	351-31460	1
Starter Motor Solenoid	351-31480	1
Starter Motor Distance Piece	354-10880	1
Starter Motor Stud	270-336	3
Starter Motor Nut	270-4	3
Spring Washer	27-393	3
12 VOLT DYNAMO		
Dynamo	354-26490	1
Dynamo Pulley	356-18861	1
Dynamo Hinge Bracket	354-18901	1
Hinge Bracket Setscrew	270-60	2
Spring Washer	27-413	2
Distance Piece for Dynamo	351-14970	1
Dynamo Setscrew	270-61	1
Dynamo Setscrew	270-182	1
Spring Washer	27-413	2
Bracket for Adjusting Link	354-18910	1
Adjusting Link	354-18920	1
Adjusting Link Bolt	270-60	1
Spring Washer	27-413	1
Nut	270-3	1
Clamp Screw	291-3694	1
Plain Washer	27-85	1
Spring Washer	27-413	1
12 VOLT (HIGH OUTPUT) OR 24 VOLT DYNAMO		
Dynamo (24 Volt) or	352-32020	1
Dynamo (12 Volt High Output)	352-32010	1
Dynamo Pulley	354-24871	1
Dynamo Hinge Bracket	354-24861	1
Hinge Bracket Setscrew	270-60	2
Dynamo Setscrew	270-62	1
Bracket for Adjusting Link	354-18910	1
Extension for Adjusting Link	354-24881	1
Adjusting Link	354-18920	1
Adjusting Link Extension Bolt	270-60	2
Bolt for Fan Drive Guard	270-60	1
Clamp Screw	291-3694	1
Plain Washer	27-85	1
Packing Washer	354-24890	1
Spring Washer	27-413	7
Nut	270-3	3
Dynamo Spacer	616-2747	1
Dynamo Belt	356-19723	2
CONTROLLER & BATTERY (CAV—LUCAS 12 & 24 VOLT EQUIPMENT)		
Press Button	12-8-364	1
Ammeter	291-3705	1
Controller for 12 Volt Standard Dynamo—RB108	64-19099	1
Bracket for controller	64-12447	2
Blade Connector	64-19161/1	3
Blade Connector	64-19161/2	3
Insulator Cover	64-19162/1	3
Insulator Cover	64-19162/2	3
Blade Connector	64-19161/1	2
Blade Connector	64-19162/1	2
Battery for 12 Volt Engines, 115 ampere-hour	294-40020	2
Battery for 24 Volt Engines	294-40020	4
Blade Adaptor	64-23391	2

ELECTRIC STARTING EQUIPMENT (contd.)

Description of Part	Part No.	No. per Set
24 VOLT ELECTRIC STARTER MOTOR (CAV)		
Starter Motor CA.45—24 Volt	351-31970	1
Starter Motor Solenoid	351-31990	1
Starter Motor Distance Piece	354-10880	1
Starter Motor Stud	270-336	3
Starter Motor Nut	270-4	3
Spring Washer	27-393	3

AUTO-LITE ELECTRIC EQUIPMENT—NORTH AMERICA ONLY

AUTO-LITE STARTER MOTOR

Starter Motor MCK-4004	294-3401	1
Starter Motor Distance Piece	354-10881	1
Starter Motor Stud	270-431	3
Starter Motor Nut	270-8	3
Spring Washer	27-395	3

12 VOLT AUTO-LITE DYNAMO

Dynamo	201-15110	1
Dynamo Hinge Bracket	354-24930	1
Dynamo Pulley	354-24940	1
Hinge Bracket Set Screw	270-60	2
Dynamo Set Screw	270-61	1
Dynamo Bolt	270-62	1
Bracket for Adjusting Link	354-18910	1
Adjusting Link	354-18920	1
Adjusting Link Set Screw	270-60	1
Clamp Screw	291-3694	1
Plain Washer	27-85	1
Packing Washer	354-24890	1
Spring Washer	27-413	6
Nut	270-3	2

AMMETER & PUSH BUTTON "AUTO-LITE" ELECTRIC STARTING

Push Button	201-15100	1	
Ammeter	291-3705	1	
Battery Lug Positive	Optional Extras	64-6922	1
Battery Lug Negative		64-6923	1
Battery Cables			2

INSTRUMENT PANEL

Description of Part	Part No.	No. per Set
Instrument Panel Bracket	354-24691	1
Bolt— $\frac{1}{4}$ " UNF x $\frac{3}{4}$ "	270-55	3
Spring Washer	27-451	5
Bolt— $\frac{1}{4}$ " UNF x $\frac{7}{8}$ "	270-114	2
Nut— $\frac{1}{4}$ " UNF	270-2	5
Flexible Mounting	351-16431	2
Spring Washer	27-393	2
Hinge Plate	351-16420	2
Setscrew— $\frac{1}{4}$ " UNC x $\frac{5}{16}$ "	270-374	4
"Cross" Wire Insert— $\frac{1}{4}$ " UNF	270-375	4
Panel	351-15880	1
Starter Push Button	12-8-364	1
Push Button Plate	351-16410	1
Screw	64-2576/11	4
Ammeter	291-3705	1
Tachometer	370-12982	1
Tachometer Drive Cable—6ft. long	291-36249	1
Oil Pressure Gauge	370-12970	1
Adaptor—for flexible oil pipe	291-37920	1
Flexible Oil Pipe	291-3012	1
Union	291-21141	1
Oil Pressure Gauge Pipe—HW4	354-28030	1
Oil Pressure Gauge Pipe—HW6	356-28030	1
Swivel Union Plug	842-359	1
Copper Joint	600-106	2
Swivel Union Plug	291-2835	1
Clipping Strip—tachometer cable to pressure gauge pipe	354-28040	3
Rubber Packing Strip	354-28060	3
Water Temperature Gauge—4' 6" capillary	616-1558	1
Clip for temperature gauge capillary—HW4	351-32600	3
Clip for temperature gauge capillary—HW6	351-32600	4

TACHOMETER ANGLE DRIVE

Tachometer Driving Gear	354-20010	1
Bolt— $\frac{5}{16}$ " UNF x $1\frac{1}{8}$ "	270-25	2
Driven Gear	354-20000	1
Bush	354-20020	2
Retaining Washer	354-20030	1
Circlip	616-1586	1
Tachometer Angle Drive	351-18450	1
Grease Trap	354-23650	1