Lister

DIESELS

`ST´ range

Workshop Manual

ST-W

SAFETY PRECAUTIONS

GENERAL

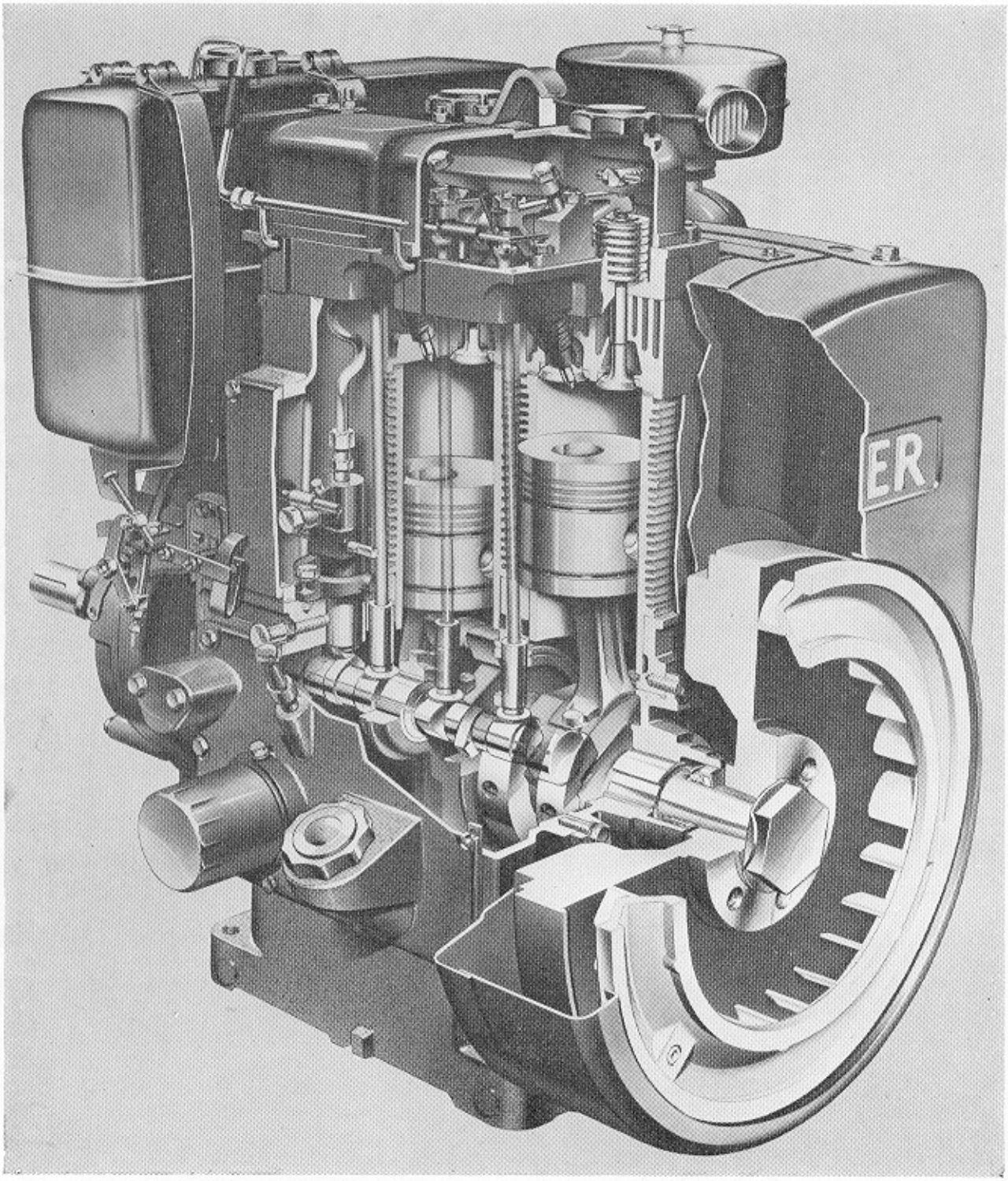
- Ensure the engine is securely mounted.
- Ensure that a generous supply of fresh air is available to the engine house.
- Ensure that the engine is clean.
- Ensure that all necessary safety guards are fitted.
- Never place the hands or any other part of the body near rotating parts of the engine such as fan impeller or flywheel.
- Never allow any unprotected skin to come into contact with high pressure fuel oil, for example when testing fuel injection equipment.
- Thoroughly clean any diesel fuel oil from the skin as soon as practicable after contact.
- Always rectify any fuel oil or lubricating oil leaks as soon as practicable.
- Always clean up any fuel or lubricating oil or lubricating oil spillage lying near the engine.
- Never smoke or use naked lights in the proximity of electric batteries.
- The lifting plates and eyes supplied by RAL are designed to carry the engine plus RAL supplied accessories. They must not be used to lift complete assemblies such as a complete power plant.

STARTING

- Always ensure that oil levels (including gear boxes), coolant levels and fuel oil levels are correct prior to starting.
- Ensure that the engine is free to turn without obstruction.
- Use the CORRECT Lister handle. Ensure there are no burrs on starting shaft and lightly oil before fitting handle. Do not attempt to start an engine if the starting handle is damaged and always check the arrow on the handle boss for direction of rotation.
- ON ST, HL and HR/W engines, a clutch pin (pawl) on the starting handle engages with a keyway on the starting shaft. After fitting handle, turn in opposite direction to that required to start the engine in order to check that the clutch pin will disengage from the keyway, and does not bind on the starting shaft, before attempting to start the engine.
- Do not allow the starting handle to rotate on the running shaft when the engine is firing.
- Hand starting any diesel engine can be dangerous in the hands of inexperienced people. Engine operators must be instructed in correct procedures before attempting to start an engine, if these conditions cannot be met electric starting should be used.

ST & STW Diesel Engines

FOR
INDUSTRIAL
MARINE AUXILIARY
AND
MARINE PROPULSION
APPLICATIONS
AND
MOISTURE EXTRACTION UNITS



A Sectioned Lister ST2 Diesel Engine

Lister
DIESELS

PUBLICATION 2001
SIXTH EDITION

ST & STW Diesel Engines

Workshop Manual

Publications for ST and STW Engines

Workshop Manual

Industrial, Marine and Moisture Extraction Units	Book 2001

Operators Handbooks

Industrial Engines	Book 2010
Marine Engines	Book 2011

Parts List

Industrial	Book 1705PL
Marine—ST	Book 1704PL(ST)
Marine Propulsion—STW	Book 1704PL(STW)

Operators Handbook & Parts List

Moisture Extraction Unit	Book 1207

Generating Sets

A list of books containing information and parts list for generating sets which may be fitted to ST engines can be found in Section Eight.

Note: Every engine supplied by R. A. Lister is consigned with the appropriate Handbook and Parts List.

ENQUIRIES

Industrial Engines — R. A. Lister and Co. Ltd.

DURSLEY, GLOUCESTERSHIRE, GL11 4HS, ENGLAND

Telephone: DURSLEY (0453) 4141. Telex: 43261

Telegrams & Cables: Machinery, Dursley.

Marine Auxiliary and Marine Propulsion — Hawker Siddeley Marine Ltd.

GOODRIDGE AVENUE, BRISTOL ROAD, GLOUCESTER, GL2 6XX, ENGLAND

Telephone: GLOUCESTER (0452) 21401 Telex: 43330

Generating Sets supplied by Lister — Hawker Siddeley Power Plant Ltd.

THRUPP, GLOUCESTERSHIRE, GL5 2BW, ENGLAND

Telephone: BRIMSCOMBE (0453-88) 5166 Telex: 43559

OR YOUR NEAREST LISTER DISTRIBUTOR

FOREWORD

This Manual covers the operation and servicing of Lister ST Engines used in Industrial and Marine applications, Moisture Extraction Units, and STW Engines used in Marine applications.

The Manual is divided into sections as listed in the Index which are arranged to show the complete strip and assembly sequence for each component part of the engine and its accessories. Section Four, which deals with the basic engine, is in two parts. Part 1 covers the servicing of the air cooled engines (ST) and Part 2 the servicing of water cooled engines (STW). All the salient external features of the basic engine can be identified by reference to the photographs on pages 46/48 ST and page 66 STW.

ST engines are now manufactured in a range of standard Builds, each incorporating certain features to allow engines to be adapted for various applications by the addition of a range of easily fitted accessories. An Appendix at the end of the book gives a brief description, speed setting etc. for each Build and compatibility charts showing which accessories may be fitted to each Build.

The use of genuine Lister replacement parts will assure the correct material, dimension and high standard of quality associated with the original engine components. When ordering replacement parts, always quote the engine serial number which will be found on the plate on the fuel pump housing door. On Moisture Extraction Units, the unit number—which can be found on a plate attached to the main frame—should also be quoted.

The information, specifications and illustrations in this publication are correct at the time of going to print. Our policy is one of continued development and we therefore reserve the right to amend any of the information contained in this book without prior notice.

IMPORTANT

When purchasing parts or giving instructions for repairs, customers should in their own interest, always specify :

GENUINE LISTER PARTS

Parts that have not been supplied by the Lister organisation cannot be relied upon for correct material, dimensions or finish. R. A. LISTER & CO. LTD. cannot therefore be responsible for any damage arising from the use of such parts and the guarantee will be invalidated.

In your own interest, therefore, specify

GENUINE LISTER PARTS

INDEX

INDEX—(Cont.)

TECHNICAL DATA—ST1 ENGINE

Engine

Type	Four stroke, vertical single cylinder with direct injection Diesel engine.
Bore and Stroke	95.25 mm. x 88.9 mm. (3.75 x 3.5 in.)
Cylinder Capacity	0.63 litres (38.7 $in.^3$)
*BHP/kW (to BS649 or BS5514‡) continuous	10.5/7.8 at 3000 rev/min. 10.0/7.5 at 2600 rev/min. 8.1/6.0 at 2000 rev/min. 7.3/5.4 at 1800 rev/min. 6.0/4.5 at 1500 rev/min. 4.7/3.5 at 1200 rev/min.
B.M.E.P.	5.73 bar (83.1 $lbf./in.^2$) at 1800 rev/min.
Weight (Basic engine)	107 kg. (236 lb.) approx.

‡BS5514 is the equivalent of ISO 3046

Lubricating System

Oil Pressure	1.0/1.4 bar (15/20 $lbf/in.^2$) at 1500 rev/min. 0.34 bar (5 $lbf/in.^2$) at 750 rev/min.
Oil Pump	Self regulating plunger pump.
Oil Filter	Screw on, cartridge type.
Oil Consumption	Less than 0.75% of full load fuel consumption.
Sump Capacity (engine level)	2 litre (3.5 pint)

Fuel System

Fuel Pump	Bryce Berger
Fuel Filter	A.C. Delco
Injector	Bryce Berger
Injector Pressure	190 Atmospheres
†Fuel Consumption lb/bhp/h—g/bhp/h (at full load subject to 5% B.S. tolerance)	0.474—215 at 3000 rev/min. 0.445—202 at 2600 rev/min. 0.410—186 at 2000 rev/min. 0.405—184 at 1800 and 1200 rev/min. 0.400—181 at 1500 rev/min.

***Rating**

This is the bhp which the engine is capable of de livering continuously at a stated crankshaft speed in accordance with the conditions specified in British Standard 649:1958. The engine shall be capable of satisfactorily providing an output 10% in excess of the BS rating at the same speed for one hour in any period of twelve hours consecutive running unless driving centrifugal water pumps, fans and other similar equipment.

†Fuel Consumption

The fuel consumption figures apply to fully run-in, non-derated, bare engines without power absorbing optional accessories, transmissions or marine gearboxes, etc.

Rotation either clockwise or anti-clockwise looking on flywheel

TECHNICAL DATA ST2—AIR COOLED ENGINE
STW2—WATER COOLED ENGINE (see also page 7)

Engine

Type		Four stroke, vertical two cylinder with direct injection Diesel engine.
Bore and Stroke		95.25 mm. x 88.9 mm. (3.75 in. x 3.5 in.)
Cylinder Capacity (2 cyls.)		1.27 litres (77.3 in.^{3})
*BHP/kW (to BS649 or BS5514‡) continuous		21.0 (15.7) at 3000 rev/min. (not STW) 20.0/14.9 at 2600 rev/min. 16.2/12.1 at 2000 rev/min. 14.6/10.9 at 1800 rev/min. 12.0/8.9 at 1500 rev/min. 9.4/7.0 at 1200 rev/min.
B.M.E.P.		5.73 bar (83.1 lbf/in.^{2}) at 1800 rev/min.
Weight (Basic engine)	ST	170 kg. (375 lb.) approx.
	STW	220 kg. (485 lb.) approx.

No. 1 Cylinder is at opposite end to Flywheel.

‡BS5514 is the equivalent of ISO 3046

Lubricating System

Oil Pressure	1.0/1.4 bar (15/20 lbf/in.^{2}) at 1500 rev/min. 0.34 bar (5 lbf/in.^{2}) at 750 rev/min.
Oil Pump	Self regulating plunger pump.
Oil Filter	Screw on cartridge type.
Oil Consumption	Less than 0.75% of full load fuel consumption.
Sump Capacity (engine level)	5.4 litre (9.5 pints).

Fuel System

Fuel Pumps	Bryce Berger (2)
Fuel Filter	A.C. Delco
Injectors	Bryce Berger (2)
Injector Pressure	190 Atmospheres
†Fuel Consumption (approx.) lb/bhp/h—g/bhp/h (at full load subject to 5% B.S. tolerance)	0.474—215 at 3000 rev/min. 0.445—202 at 2600 rev/min. 0.410—186 at 2000 rev/min. 0.405—184 at 1800 and 1200 rev/min. 0.400—181 at 1500 rev/min.

***Rating**

This is the bhp which the engine is capable of delivering continuously at a stated crankshaft speed in accordance with the conditions specified in British Standard 649:1958. The engine shall be capable of satisfactorily providing an output 10% in excess of the BS rating at the same speed for one hour in any period of twelve hours consecutive running unless driving centrifugal water pumps, fans and other similar equipment.

†Fuel Consumption

The fuel consumption figures apply to fully run-in, non-derated, bare engines without power absorbing optional accessories, transmissions or marine gearboxes, etc.

Rotation either clockwise or anti-clockwise looking on flywheel

TECHNICAL DATA ST3—AIR COOLED ENGINE
STW3—WATER COOLED ENGINE (see also page 8)

Engine

Type		Four stroke, vertical three cylinder with direct injection Diesel engine.
Bore and Stroke		95.25 mm. x 88.9 mm. (3.75 in. x 3.5 in.)
Cylinder Capacity (3 cyls.)		1.90 litres (116.0 in.^{3})
*BHP/kW (to BS649 or		31.5/23.5 at 3000 rev/min. (not STW)
BS5514‡)		30.0/22.4 at 2600 rev/min.
continuous		24.3/18.1 at 2000 rev/min.
		21.9/16.3 at 1800 rev/min.
		18.0/13.4 at 1500 rev/min.
		14.1/10.5 at 1200 rev/min.
B.M.E.P.		5.73 bar (83.1 lbf/in.^{2}) at 1800 rev/min.
Weight (Basic engine)	ST	215 kg. (474 lb.) approx.
	STW	260 kg. (573 lb.) approx.
Firing Order		1—3—2 clockwise. 1—2—3 anti-clockwise.

No. 1 Cylinder is at opposite end to Flywheel.

‡BS5514 is the equivalent of ISO 3046

Lubricating System

Oil Pressure	1.0/1.4 bar (15/20 lbf/in.^{2}) at 1500 rev/min.
	0.34 bar (5 lbf/in.^{2}) at 750 rev/min.
Oil Pump	Self regulating plunger pump.
Oil Filter	Screw on cartridge type.
Oil Consumption	Less than 0.75% of full load fuel consumption.
Sump Capacity (engine level)	9.1 litre (16.0 pint.) See also page 25.

Fuel System

Fuel Pumps	Bryce Berger (3)
Fuel Filter	C.A.V.
Injectors	Bryce Berger (3)
Injector Pressure	190 Atmospheres
†Fuel Consumption	
lb/bhp/h—g/bhp/h	0.467—212 at 3000 rev/min.
(at full load subject to 5% B.S.	0.438—199 at 2600 rev/min.
tolerance)	0.400—181 at 2000 rev/min.
	0.396—180 at 1800 rev/min.
	0.398—180 at 1500 rev/min.
	0.405—184 at 1200 rev/min.

***Rating**

This is the bhp which the engine is capable of delivering continuously at a stated crankshaft speed in accordance with the conditions specified in British Standard 649:1958. The engine shall be capable of satisfactorily providing an output 10% in excess of the BS rating at the same speed for one hour in any period of twelve hours consecutive running unless driving centrifugal water pumps, fans and other similar equipment.

†Fuel Consumption

The fuel consumption figures apply to fully run-in, non-derated, bare engines without power absorbing optional accessories, transmissions or marine gearboxes, etc.

Rotation either clockwise or anti-clockwise looking on flywheel

TECHNICAL DATA STW2M—WATER COOLED ENGINE—MARINE PROPULSION

Engine

Type	Four stroke, vertical two cylinder with direct injection Diesel engine.
Bore and Stroke	95.25 mm x 88.9 mm (3.75 in. x 3.5 in.)
Cylinder Capacity (2 cyls.)	1.27 litres (77.3 in.^{3})
*BHP/kW (to BS649 or	20.0/14.9 at 2300 rev/min.
BS5514‡)	17.8/13.3 at 2000 rev/min.
continuous	16.0/11.9 at 1800 rev/min.
	13.0/9.7 at 1500 rev/min.
	10.0/7.5 at 1200 rev/min.
B.M.E.P.	6.28 bar (91.06 lbf./in.^{2}) at 1800 rev/min.
Weight (Engine and LM100 Gearbox)	278 kg. (613 lb.) approx.

No. 1 Cylinder is at opposite end to Flywheel

‡BS5514 is the equivalent of ISO 3046

Lubricating System

Oil Pressure	1.0/1.4 bar (15/20 lbf./in.^{2}) at 1500 rev/min.
	0.34 bar (5 lbf./in.^{2}) at 750 rev/min.
Oil Pump	Self regulating plunger pump.
Oil Filter	Screw on cartridge type.
Oil Consumption	Less than 0.75% of full load fuel consumption.
Sump Capacity (engine level)	5.4 litre (9.5 pints).

Fuel System

Fuel Pumps	Bryce Berger (2)
Fuel Filter	A.C. Delco
Injectors	Bryce Berger (2)
Injector Pressure	190 Atmospheres
†Fuel Consumption (approx.)	
lb/bhp/h—g/bhp/h	0.441—200 at 2300 rev/min.
(at full load subject to	0.436—198 at 2000 and 1800 rev/min.
5% B.S. tolerance)	0.445—202 at 1500 rev/min.
	0.467—212 at 1200 rev/min.

***Rating**

This is the bhp which the engine is capable of delivering continuously at a stated crankshaft speed in accordance with the conditions specified in British Standard 649:1958. The engine shall be capable of satisfactorily providing an output 10% in excess of the BS rating at the same speed for one hour in any period of twelve hours consecutive running unless driving centrifugal water pumps, fans and other similar equipment.

†Fuel Consumption

The fuel consumption figures apply to fully run-in, non-derated, bare engines without power absorbing optional accessories, transmissions, marine gearboxes etc.

Rotation is clockwise looking on flywheel

TECHNICAL DATA STW3M—WATER COOLED ENGINE—MARINE PROPULSION

Engine

Type	Four stroke, vertical three cylinder with direct injection Diesel engine.
Bore and Stroke	95.25 mm x 88.9 mm (3.75 in. x 3.5 in.)
Cylinder Capacity (3 cyls.)	1.9 litres (116.0 in.^{3})
*BHP/kW (to BS649 or BS5514‡)	30.0/22.4 at 2300 rev/min.
continuous	26.7/19.9 at 2000 rev/min.
	24.0/17.9 at 1800 rev/min.
	19.5/14.5 at 1500 rev/min.
	15.0/11.2 at 1200 rev/min.
B.M.E.P.	6.28 bar (91.06 lbf./in.^{2}) at 1800 rev/min.
Weight (Engine and LM100 Gearbox)	323 kg. (712 lb.)
Firing Order	1—3—2

No. 1 Cylinder is at opposite end to Flywheel

‡BS5514 is the equivalent of ISO 3046

Lubricating System

Oil Pressure	1.0/1.4 bar (15/20 lbf/in.^{2}) at 1500 rev/min.
	0.34 bar (5 lbf./in.^{2}) at 750 rev/min.
Oil Pump	Self regulating plunger pump.
Oil Filter	Screw on cartridge type.
Oil Consumption	Less than 0.75% of full load fuel consumption.
Sump Capacity (engine level)	6.6 litre (11.6 pints). See also page 25.

Fuel System

Fuel Pumps	Bryce Berger (3)
Fuel Filter	C.A.V.
Injectors	Bryce Berger (3)
Injector Pressure	190 Atmospheres
†Fuel Consumption (approx.)	
lb/bhp/h—g/bhp/h	0.441—200 at 2300 rev/min.
(at full load subject to	0.436—198 at 2000 and 1800 rev/min.
5% B.S. tolerance)	0.445—202 at 1500 rev/min.
	0.467—212 at 1200 rev/min.

***Rating**

This is the bhp which the engine is capable of delivering continuously at a stated crankshaft speed in accordance with the conditions specified in British Standard 649:1958. The engine shall be capable of satisfactorily providing an output 10% in excess of the BS rating at the same speed for one hour in any period of twelve hours consecutive running unless driving centrifugal water pumps, fans and other similar equipment.

†Fuel Consumption

The fuel consumption figures apply to fully run-in, non-derated, bare engines without power absorbing optional accessories, transmissions, marine gearboxes etc.

Rotation is clockwise looking on flywheel

INSTALLATION INFORMATION—INDUSTRIAL ENGINES

The engine should be bolted down to a rigid bed to ensure there is no excessive vibration and installed where a generous supply of fresh air is assured. (see COOLING AIR CONSIDERATIONS)

DISTORTION

Customers installing engines in their own equipment must ensure that no strain is imposed on the engine feet either by distortion during installation (feet not correctly shimmed) or by deflection of the structure during operation.

COOLING

The engine is cooled by air. A fan impeller is secured to the flywheel. Air is drawn into the impeller and discharged through trunking and shrouding to the fins of the cylinder and cylinder head.

Arrangements must be made to ensure the cooling air is not re-circulated or restricted.

HAND STARTING

Normally the engine will be hand started from the camshaft, but in cases where the final drive is from the camshaft, starting can be effected from the flywheel end through geared-up starting.

BELT DRIVE

Driving belts must be run as close to the engine as possible to avoid undue strain on the bearings.

EXHAUST SYSTEM

In general the exhaust pipe run should be kept as short and straight as possible. A silencer, or expansion chamber, should be fitted near the engine. The tail pipe beyond the silencer should be about 30 times the pipe diameter in length. When long tail pipes have to be fitted the bore of the pipe must be increased as shown in the accompanying table. When the larger diameter pipes are fitted they should be fitted from the silencer onward.

A back pressure of about 1½ lbf/in.² (40" water gauge) (3" mercury) at the point where the exhaust pipe joins the exhaust manifold must not be exceeded.

Bends should have a radius of not less than 4 diameters at the centre line of the pipe. When reckoning the total effective length of the pipe an allowance of 1 foot to the total centre line length must be made for each bend in the system. If the bends are sharper than 4 diameters then the allowance must be increased to 2 feet per bend.

Where pipes must be led upwards from the engine a suitable drain cock, or drain trap with cock, should be fitted at the lowest point to prevent the condensate running into the engine.

Normal Pipe bore-ins.	Maximum total length of exhaust pipe in metres (feet)	
	ST1—2	ST3
1¼	4.5 (15)	
1½	9.5 (31)	4.5 (15)
2	30.0 (99)	14.6 (48)
2½	72.8 (240)	36.8 (121)
3		72.8 (240)

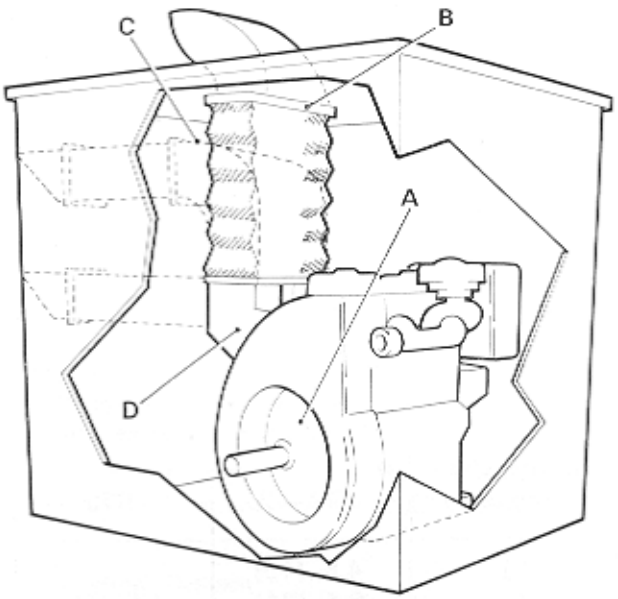
Example:—In an exhaust system which measures 28 feet, 1½" pipe would be required for ST2 but, if there were five simple bends in the system then the total effective length would be 28+5=33 feet and the pipe size would have to be increased to 2".

TEMPERATURES

From the aspect of engine performance, the temperature of the air entering the engine is the only criterion of ambient temperature. The power developed by the engine depends on the temperature of the combustion air, measured at the air manifold inlet (or the air cleaner), and the temperature of the cooling air as measured at the fan inlet. The higher of these two temperatures is taken as being the "Ambient Temperature" as far as engine ratings are concerned.

The engines are able to run satisfactorily at Ambient temperatures up to 29.4°C (85°F) without derating. Above this temperature the rated brake horsepower must be reduced by 1% for every 2.78°C (5°F). The maximum temperature is 52°C (125°F), and if it is desired to run at higher temperatures, R. A. Lister & Co. Ltd., or their Distributors must be consulted.

COOLING AIR CONSIDERATIONS



Diag. 1 Method of leading out the hot cooling air in small enclosed compartments.

A It is absolutely essential that the hot cooling air discharge does not find its way to the cooling inlet and become recirculated.

B Flexible trunking of canvas, rubberized canvas or heat resisting rubber.

C One of these alternative methods must be used if engine is flexibly mounted.

D Ducting as shown can be supplied if ordered. Ducting is fully detachable for servicing and priming fuel pump and the trunking must be attached so that it does not impair the quick removal of the ducting.

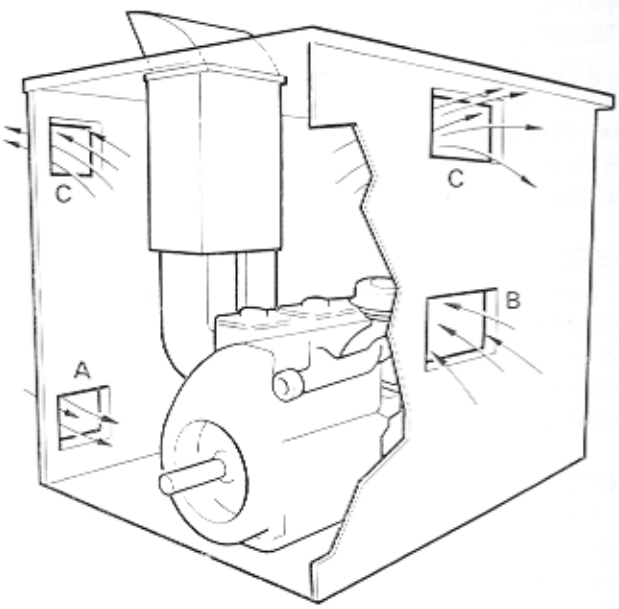
The extension of the ducting, the trunking and the cowl are to be supplied by the customer. For lengths up to 1.5 m. (5 ft.) the minimum inside area to be:—

195 cm.^{2} (30 in.^{2}) for ST1
390 cm.^{2} (60 in.^{2}) for ST2
580 cm.^{2} (90 in.^{2}) for ST3

For 1.525 m. to 3.05 m. (5-10 ft.) multiply by 1.4.

For 3.05 m. to 7.625 m. (10-25 ft.) multiply by 2.25.

For 7.625 m. to 15.25 m. (25-50 ft.) multiply by 3.5.

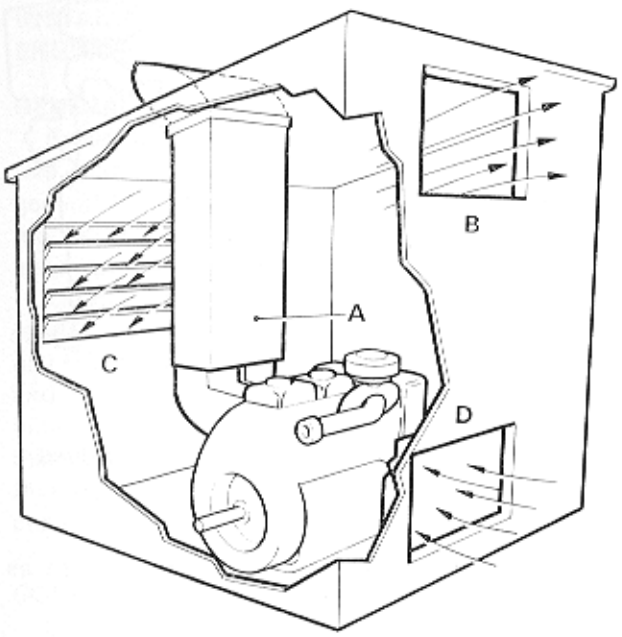


Diag. 2 Notes on Air Intakes

A One of the cooling air intake holes must be near the bottom of engine room to bring cool air in and also to strike the engine sump to assist cooling the lubricating oil.

B Another intake hole must be opposite the air filter to ensure a good supply of cool combustion air.

C One or two cooling air holes must be near the top of the engine room to prevent an accumulation of hot air above the engine. Generally it is not desirable to place an air hole opposite the engine cooling fan, because the rest of the engine room will not be ventilated (except where the ambient temperature exceeds 49°C (120°F) when it is essential for the engine to be as cool as possible under these conditions).



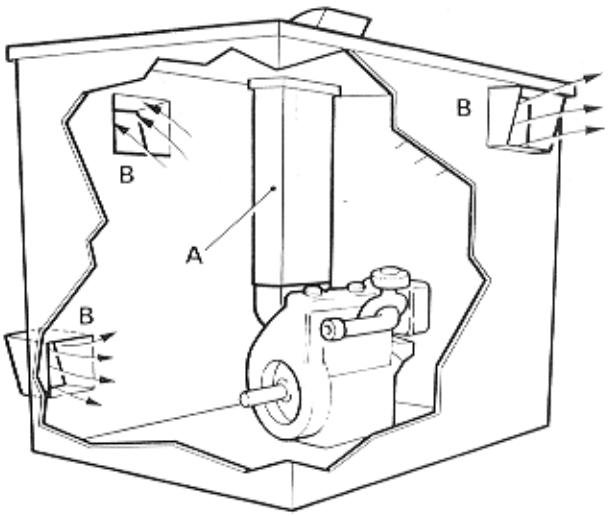
Diag. 3 Installation in moderate size engine house. 3.05 m. x 1.83 m. (10 ft. x 6 ft.)

A Engine ducting, trunking and cowl to be used in tropical climates and in other climates when a cool engine house is required.

B Window 62 x 62 cm. (2 ft. x 2 ft.) near the roof and opposite the main window capable of being fully opened.

C Large window opposite the engine air outlet, capable of being fully opened (or if louvred, slots to be 102 mm. (4") apart).

D Window 62 x 62 cm. (2 ft. x 2 ft.) near the floor and opposite main window or in the wall nearest the engine fuel filter, capable of being fully opened.



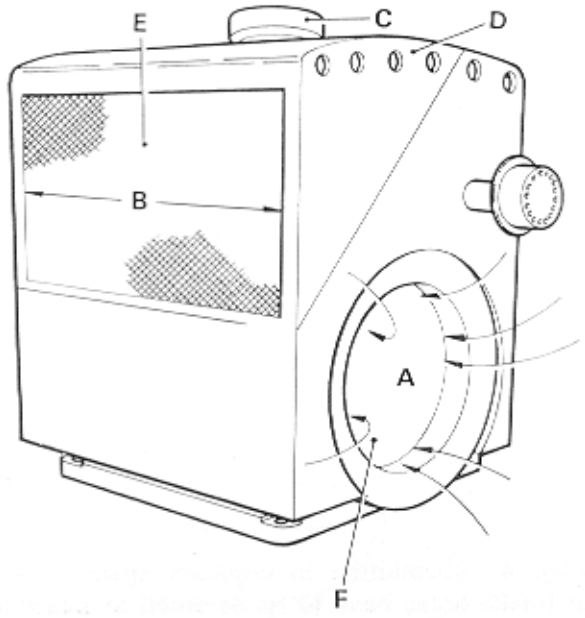
Diag. 4 Installation in confined space where air intake holes have to be as small as possible

A Area of trunk and cowl to be as given in Diag. 1.

B Air intake holes to be in positions shown and all the same size to ensure even air distribution. For area of intakes consult with RAL.

WARNING: THE EXHAUST SYSTEM MUST ALWAYS BE TAKEN TO THE OUTSIDE OF THE ENGINE ROOM.

NOTE: The air supply to the engine room must be at least 30% greater than the air required for cooling to allow for combustion air consumption.



Diag. 5 Engine installed in a housing which itself is in the open with unobstructed air all round. (2 and 3 cylinder engines only).

A 381 mm. (15 in.) minimum diameter hole opposite flywheel air intake.

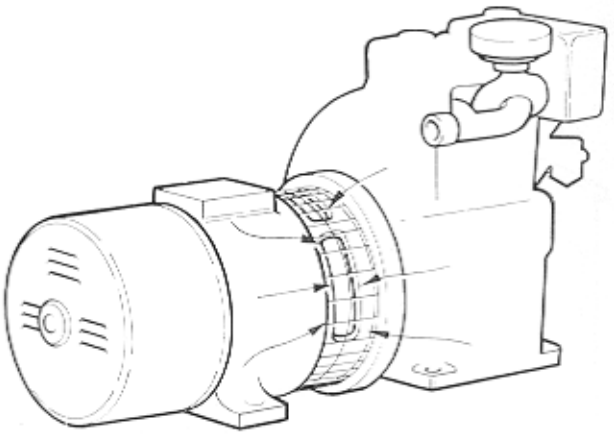
B 533.4 mm. (21 in.) for two cylinder engine: 660.4 mm. (26 in.) for three cylinder engine.

C Combustion air intake brought outside.

D At least 6 ventilating holes each end 25.4 mm. (1 in.) dia.

E Open mesh grille opposite hot air side of engine. Free area through grille, 450 cm.² (70 in.²) (minimum) for two cylinder engine; 970 cm.² (105 in.²) (minimum) for three cylinder engine.

F Flywheel air intake to be against this end.



Diag. 6 Engine close coupled to a driven machine

Typical air intake areas in the adaptors are as follows:

291 cm.² (45 in.²) for ST1.
396 cm.² (61 in.²) for ST2/3.

Larger areas are preferred. The coupling or clutch driving member at the flywheel end must not obstruct the air flow to the fan, and the areas above must be maintained at this point and through to the fan.

Note: Information on alignment and air flow through louvres or grille can be found on pages 15 and 16.

INSTALLATION INFORMATION—MARINE ENGINES

GENERAL

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

Careful consideration should be given to ensure accessibility and ease of maintenance, any housing must be constructed so that the sides and forward portion can be dismantled for servicing without disturbing the controls or instruments. The housing should not be connected directly to the engine bearers but fastened to a coaming on the deck or cockpit floor.

COOLING

Unless an adequate supply of air is allowed to circulate around the engine and means are taken to prevent the same air re-circulating, the engine will lose power due to overheating.

Provision is made on the engine to take the customer's air outlet ducting. Sizes of air inlets and outlets as specified are minimum and must not be obstructed in any way. If wooden slats, or wire mesh having not less than $\frac{1}{4}$" x $\frac{1}{4}$" mesh between the wires, are fitted as protective measures over openings, the area of the openings must be increased to compensate for same thus maintaining the net specified area.

It is recommended that the portion of ducting which attaches to the outlet port on the engine should be made of fire resistant material and be made readily detachable. When engines are flexibly mounted due allowance must be made in the length of ducting between engine and fixed ducting.

An unrestricted flow of cold air to the engine fan must be maintained, inlets for cooling air should be designed to give not less, and preferably more, than the sectional area specified.

To ensure efficient engine operation the combustion air filter must receive an adequate supply of cold air. To ensure this the filter may, if found necessary, be removed from the engine and fitted in a protected position on deck or at engine bearer level, the connection between engine and filter being by flexible pipe.

Where hot air is led away by trunking, this hot air can be utilised to heat accommodation and ventilate cupboards, etc., but the recirculation of this air back to the engine compartment must be prevented and, further shutters or similar fittings used to control the air to the accommodation must operate in the heating trunk—not in the engine discharge trunking.

Heat radiated from the engine must be expelled from the engine case or compartment. Where an engine is installed in a case, a series of one inch diameter holes near the top will give adequate top ventilation. When fitted in a compartment, cowl ventilators opening just below the top of the compartment, will dispel the heat; extractor fans installed in the ventilators will obviously improve this arrangement.

On STWM engines, the standard cooling system is of the raw water type. A Jabsco pump, mounted on the fuel pump side at the flywheel end and driven by a worm gear from the camshaft, supplies water to the blocks, cylinder heads and exhaust manifold. The system is controlled by a thermostat.

EXHAUST SYSTEM

Pipes should slope gradually away from the engine down to the outlet on ship's side or transom and be kept as straight and short as possible, the minimum radius in any bend being not less than 4 times the pipe bore. Adjacent wood structure must be protected from exhaust heat by adequate clearance and lagging.

If it is found necessary to fit a swan neck in the exhaust pipe to prevent the ingress of water, a small (1/32" diameter) hole must be drilled in the top of same to break the vacuum and a drain plug or cock should be fitted at the lowest point in the pipe.

CASINGS OR COMPARTMENTS

These can be constructed of $\frac{3}{8}$" bonded marine plywood to BSS 1080 on substantial framing and have portable panels secured by cuphead screws for ease of servicing. The noise level can be effectively reduced by lining the box or compartment with resin impregnated glass fibre type 425 secured in position by 25 gauge perforated zinc plate having 51-3/32" dia. holes per square inch. Glass fibre can be obtained in varying thicknesses but for pleasure craft or vessels operating

in confined waters a thickness of 2" is recommended.

Where large openings in the casing cannot be avoided, the noise level can be further reduced by fitting plywood baffle plates faced with glass fibre and perforated zinc but it is essential that the area between the casing and the baffle is not below the specified requirement.

ENGINE MOUNTING (Diag. 7)

To provide a rigid bed free from alignment troubles it is essential in the case of wooden hulls to ensure that the engine bearers extend as far forward and aft as possible, and are made of well seasoned wood of liberal size so arranged that they are an integral part of the ship's hull. In addition a steel plate should be placed along the top of the bearer the length of the engine base to prevent the engine feet biting into the bearers. Bearers must be adequately supported by athwartship members secured to the hull structure. See also page 17.

Since NO PROVISION is made in the engine design to take END THRUST, a thrust block must be provided for all propulsion installations.

LISTER reverse and reverse/reduction gears are provided with thrust bearings.

On propulsion units when a flexible coupling is fitted, a plummer block must be fitted to the tailshaft if the stern tube forward bearing is more than 9" from the edge of the tailshaft coupling.

Propellers must 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 the diameter of the shaft.

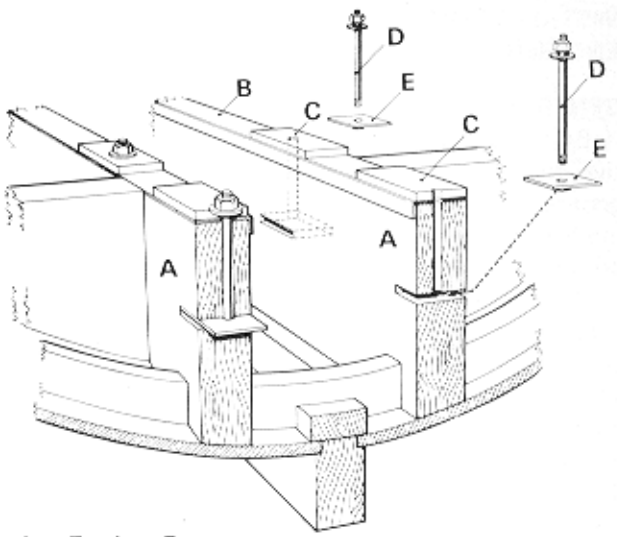
FLEXIBLE MOUNTINGS

Allowance must be made for the engine to clear bearers by at least ½", and to clear any casing, including air ducts or deflectors which might be fitted, by 1" to allow for engine movement.

INCLINATION

The maximum angle of inclination at which engines may be run is 15° flywheel up or down.

See page 25



A—Engine Bearers.
B—Soleplate.
C—Chocks.
D—Holding Down Bolt.
E—Nut welded to steel plate.

Diag. 7 Installation in a wooden vessel

ROTATION

Engine rotation is clockwise when looking on flywheel end of engine. When reverse/reduction gear is fitted rotation of the output coupling is anti-clockwise.

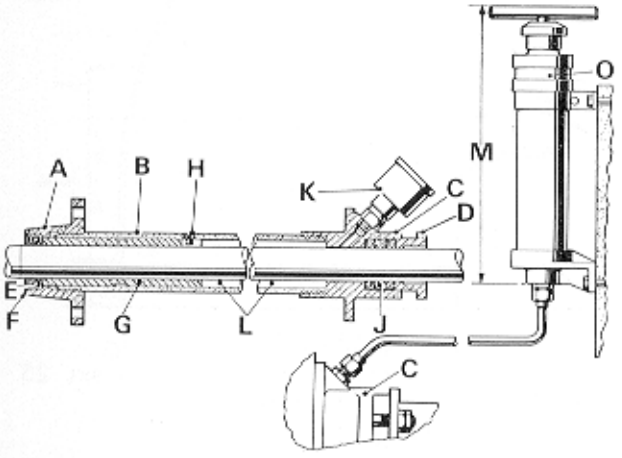
TEMPERATURES

From the aspect of engine performance, the temperature of the air entering the engine is the only criterion of ambient temperature. The power developed by the engine depends on the temperature of the combustion air, measured at the air manifold inlet (or the air cleaner), and the temperature of the cooling air measured at the fan inlet. The higher of these two temperatures is taken as being the "Ambient Temperature" as far as engine ratings are concerned.

The engines are able to run satisfactorily at Ambient temperatures (as defined above) up to 29.4°C (85°F) without derating. Above this temperature, the rated brake horsepower must be reduced by 1 per cent for every 2.78°C (5°F). The maximum temperature is 52°C (125°F), and if it is desired to run at higher temperature Hawker Siddeley Marine or their Distributors must be consulted.

STERNGEAR (Diag. 8)

Packing glands should allow free rotation of the tailshaft. Stern tubes should be filled with grease before inserting shaft. Before launching, run engine to ensure that packing glands do not overheat. If necessary slacken back gland. Long lengths of unsupported shafting must be avoided by the use of plummer blocks.



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.
J—Packing.
K—Stauffer Grease Cup.
L—Annular Grease Space.
M—Grease Gun Height: Empty 12", Full 19½".
O—Grease Gun—¾ pt. cap—optional.

Diag. 8. Stern Gear

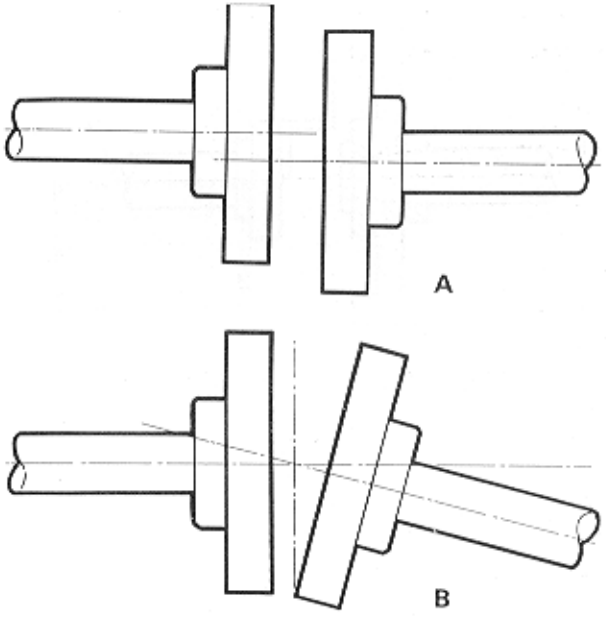
IMPORTANT

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, regular attention to the grease cup provided should be sufficient to make up any loss incurred.

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.



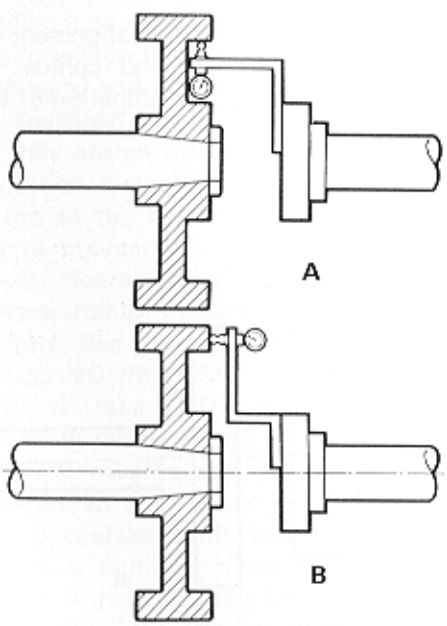
Diag. 9. Misalignment

(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.

CHECKING FOR MISALIGNMENT (Diag. 10)

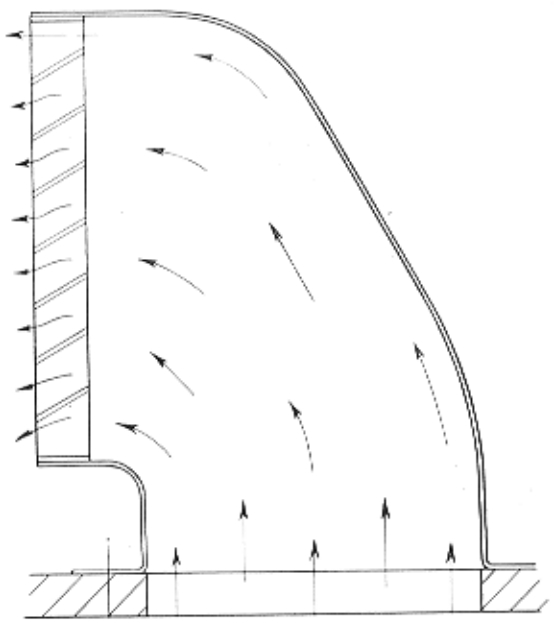
Each type of misalignment is checked individually by having a bracket or clock gauge rigidly bolted to the flange of the driven unit, when suitable, and rotating through 360° to check the clearance to (a) the inside (or outside) of the flywheel rim for parallel misalignment, and (b) the clearance to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



Diag. 10. Checking Alignment

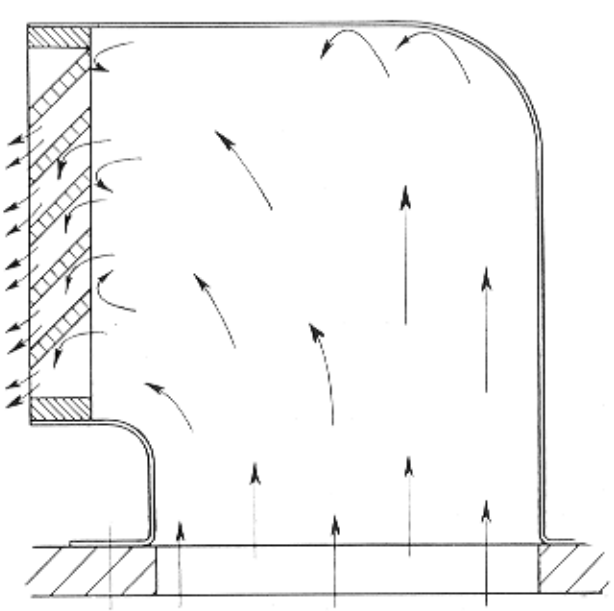
AIR FLOW

Grilles, wire mesh or louvres placed in the air stream are obstructions and allowance must be made for them. The free flow area of these must be calculated to ensure that it is at least 25 per cent greater than that specified for the inlet and outlet passages.



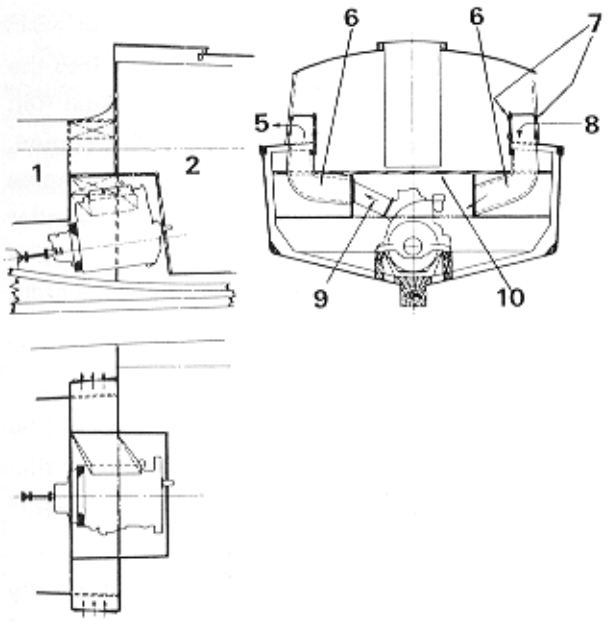
CORRECT—
Area through louvres or grille is at least 25 per cent greater than area of ducting.

Diag. 11. Cowl



WRONG—
Louvres or grille obstructs air flow. Area through louvres is smaller than area of ducting.

Diag. 12. Cowl



Diag. 13. Installation below deck

Key to Diag. 13

1—Cockpit.

2—Cabin.

5—Outlet.

6—Inlet & Outlet Trunks lined internally with 1" thick fibre glass faced with perforated zinc.

7—In bad weather shutters may be fitted to outboard inlets and inboard inlets used, P & S.

8—Inlet.

9—Portable Ducting of plywood or heavy canvas expanding from engine duct size to area of duct given in table.

10—Hot air to be vented from top of engine to atmosphere.

COOLING AIR INLET AND OUTLET DUCTS

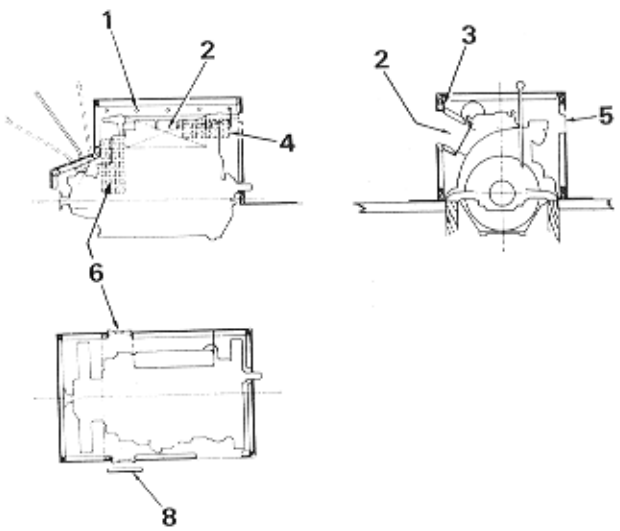
Engine Type	Hot Air Outlet Duct		Cooling Air Inlet Duct	
	sq.cm.	sq.ins.	sq.cm.	sq.ins.
ST1M	194	30	252	39
ST2M	390	60	503	78
ST3M	580	90	780	120

The above are the minimum areas required for trunking up to 1.8 m. (6' 0") in length and free from any obstruction such as protective wooden slats or wire mesh. If either of these protective measures are used then the area of trunking must be increased to allow the free area to comply with the table above. Where the trunking is more than 1.8 m. (6' 0") long the above areas must be increased as follows:—

1.8 to 3.05 metres (6' to 10') multiply by 1.4

3.05 to 7.625 metres (10' to 25') multiply by 2.25

7.625 to 15.25 metres (25' to 50') multiply by 3.50



Diag. 14. Installation in open boat

Key to Diag. 14

1—1" dia. holes near top to expel radiated heat.

2—Hot air outlet duct of sheet steel lined with 1" fibre glass. Minimum area of duct to be as given in table.

3—Outlet duct to be a close fit but not secured to engine box.

4—Combustion Air Inlet.

5—Combustion Air Inlet covered with wire mesh.

6—Air Inlet each side giving a total unobstructed area as shown in table.

8—To further reduce the noise, plywood baffles faced with fibre glass may be fitted in way of inlets, but inlet area between baffle and box must not be less than that specified.

Note—Engine Box may be constructed of ⅜" resin bonded marine plywood to BSS 1088 on substantial framing. To reduce the noise level, the inside of the box can be lined with resin impregnated fibre-glass of a minimum thickness of 1" (2" thick preferred).

MOISTURE EXTRACTION UNIT

TRANSPORTATION

The Lister MEU must not be towed on a public road as it is not equipped to comply with The Road Traffic Acts and Regulations made thereunder (UK only).

When towing ensure that the jack is clamped in its highest position.

Tyre pressure on mobile units 2.07 bar (30 lbf./in.^{2}).

NOISE PREVENTION

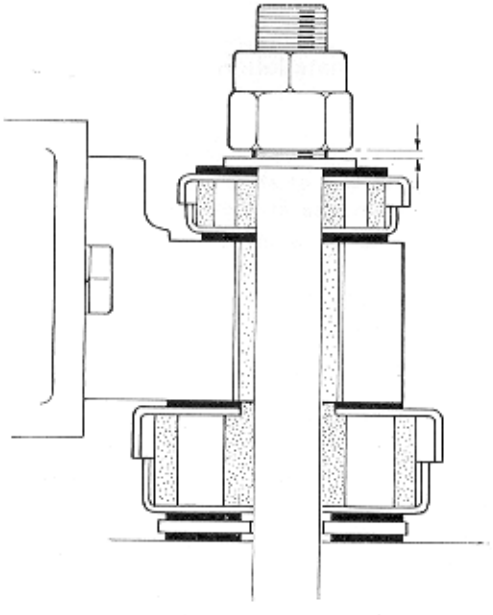
Point the unit away from inhabited buildings. If it is necessary to build a baffle of bales to reduce noise, site the baffle so that the distance from the baffle to the MEU is 0.6 m (2 ft.) more than the height of the baffle.

FOUNDATIONS

The unit must stand on firm level ground, or on a vibration free rigid platform or foundation.

LISTATEX ANTI-VIBRATION MOUNTING

The adjusting nut must NOT be secured dead tight. A 1.00 mm. (0.040 in.) gap is left between the adjusting nut and top washer.



Diag. 15. Anti-Vibration Mounting

ENGINE COOLING

The engine is air cooled. Air is drawn into the flywheel cowling inlets by the centrifugal fan mounted between the flywheel and the engine. The cooling air is then blown along the engine cowling to the fins of the cylinder and cylinder head. Warm air discharged from the engine joins the air flow through the axial flow fan to the crop.

MEU INSTALLED IN A BUILDING

Air flow to the MEU must not be restricted by placing it in a building with insufficient ventilation. A minimum air intake hole of 0.93m^2 (10 ft^2) must be provided.

The air intake hole should be placed centrally in front of the engine to ensure a good supply of combustion air to the air filter and flow of air past the sump to assist cooling the lubricating oil.

ENGINE EXHAUST

A 1.5 m. (5 ft.) exhaust extension pipe is provided to prevent exhaust fumes contaminating the drying air, the securing nuts must always be kept fully tightened.

When the unit is operated in a building and a longer exhaust pipe is required, a larger bore pipe must be used to prevent excessive back pressure. Up to 5.5 m. (18 ft.) of 51 mm. (2 in.) diameter exhaust extension may be fitted in place of the standard exhaust extension pipe. (Exhaust extensions are available from R. A. Lister, Farm Equipment Ltd.)

Extensions should be kept as short and straight as possible. Ensure that rain water cannot enter the exhaust outlet.

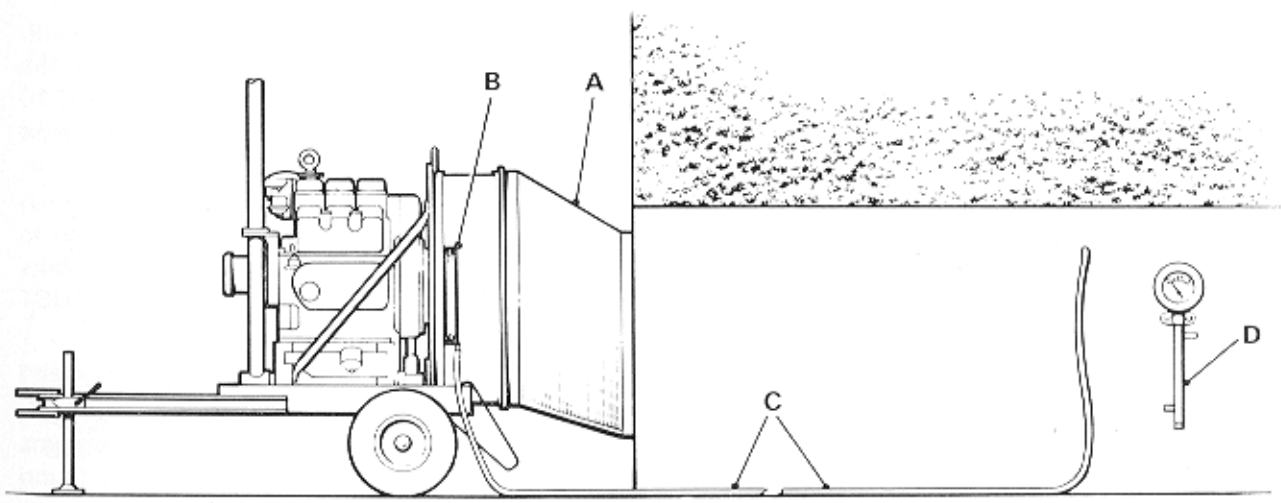
To avoid recirculation of damp air, the MEU must be housed in a building separate from the crop store. Air flow to the MEU must not be restricted, the building must be provided with a minimum air intake hole of 0,93m^2 (10 ft.^{2}).

FLEXIBLE CONNECTING DUCT (Diag. 16)

To avoid wasteful loss of air from the fan, and ensure more even air distribution through the crop, connect the MEU to the main air duct with a flexible connecting duct. Do not back the MEU straight into the crop.

MANOMETER

The level of the fluid in the gauge tube should read '0' when the unit is stopped. If it is below this level top up the manometer reservoir with coloured water. Static pressure in the air ducting is measured in inches water gauge, by the level of fluid in the manometer gauge tube.



A. Connecting Duct
B. Manometer
C. Manometer Tube
D. Hygrometer

Diag. 16. Flexible Connecting Duct

STATIC PRESSURE AND HUMIDITY

The air pressure (static pressure) attained in the air ducting is measured with the manometer. The humidity of this air is measured with a hygrometer. These measurements are normally taken from the main air duct. Static pressure will vary, depending on the following factors:—

1. Total floor area of crop being ventilated. The smaller the floor area, the higher the static pressure.
2. Depth of Crop. The greater the depth of crop, the greater the static pressure.
3. Number of bins or venta floors. In multi bin or multi venta floor installations it will vary with the number of bins or venta floors being ventilated at any time. The greater the number of bins or venta floors being ventilated, the smaller will be the static pressure.
4. If long air ducts of too small cross section area are used the static pressure will increase. A further increase in static pressure will occur if the openings between the air duct and venta floor are too small.

MANOMETER PROBE

The manometer probe is connected to the manometer by a 3 mm. (10 ft.) length of plastic tubing. Insert the probe into the main duct, connecting duct or area under the venta floor at a point as far as possible from the fan, so the readings will not be affected by turbulence.

When the unit is connected directly to a venta floor via a flexible connecting duct, insert the probe at an angle into the blanked off section of the venta floor. Holes drilled to receive the manometer probe should be made with the smallest possible clearance around the probe, so there is minimum escape of air.

OPERATING INSTRUCTIONS

To Start Engine (Fig. 1) Hand Starting

(a) Check fuel and lubricating oil levels.

(b) Ensure the fuel and lubricating oil systems are primed.

(c) If the engine is fitted with a fuel lift pump, prime the fuel filter by using the priming level on the lift pump.

(d) Move the decompressor lever(s) over towards the flywheel.

(e) Pull the control lever outwards and allow it to rotate anticlockwise so that it abuts against the top stop and is in a vertical position. See Fig. 2.
Note: On engines fitted with speed control the control lever should be set at "Fast".

(f) **Important.**—Lightly oil the end of the camshaft extension or raised hand starting shaft and fit the correct and fully serviceable starting handle. Check the arrow on the handle for correct rotation and turn the handle in the opposite direction to that required to start the engine, in order to check that the clutch pin will disengage from the keyway, and does not bind on the starting shaft.

Ensure there are no burrs on shaft.

(g) **Important.**—Turn the engine slowly from 3 to 20 turns on the camshaft according to the temperature and period of standing unused, in order to prime the combustion chamber(s) and the lubricating oil system.

(h) Turn the engine in the correct rotation and when maximum cranking speed is reached operate decompressors. Retain grip on starting handle until the engine is firing and remove handle from shaft.

Warning IT IS DANGEROUS TO ALLOW THE HANDLE TO ROTATE ON THE RUNNING SHAFT.

(j) As soon as the engine reaches normal speed, **turn the control lever clockwise to the horizontal position so that it abuts against the horizontal stop**—THIS IS MOST IMPORTANT.

When speed control is fitted reduce speed as required.

To Start Engine (Electric Starting)

Carry out items (a) to (c) as Hand Starting.

(d) Pull the control lever outwards and allow it to rotate anticlockwise so that it abuts against the top stop and is in a vertical position. See Fig. 2. Note: On engines fitted with speed control the control lever should be set at FAST.

(e) Press starter button and release immediately the engine fires. Do not motor the engine continuously for more than 10 seconds. (See page 124a for information on key switch).

(f) As soon as the engine reaches normal speed, turn the control lever clockwise to the horizontal position so that it abuts against the horizontal stop—THIS IS MOST IMPORTANT.

When speed control is fitted reduce speed as required.

Note: Further information and wiring diagrams for electric starting systems can be found in Section 8.

COLD STARTING (Below–10°C)

A cup and plunger is fitted on the combustion air intake port of each cylinder on ST engines. To operate, withdraw plungers and fill one third

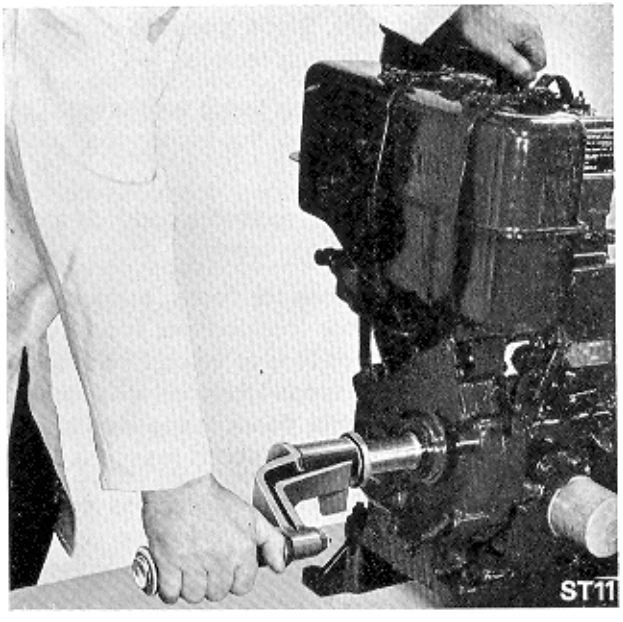


Fig. 1. Starting Engine

of the cups with the same type of lubricating oil as used in the engine. Replace plungers and inject the oil just before starting. The device must not be used more than three times in succession. When hand starting, turn the engine 20 revolutions with the fuel on after injecting the oil, before attempting to start.

TO STOP ENGINE

Turn the stopping lever clockwise and fix in clip. When remote control is fitted, move lever to STOP position.

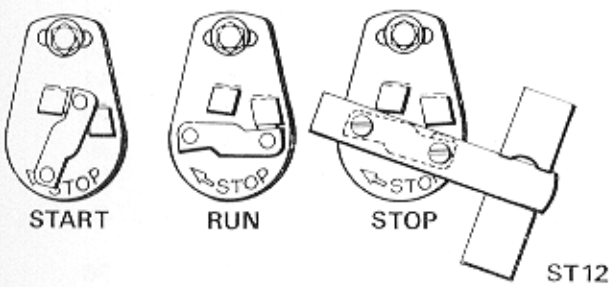


Fig. 2. Stopping Control

VARIABLE SPEED CONTROL

On all engines, in place of the standard fixed speed control, a variable speed control can be fitted with a range of 750 to maximum rev/min. This arrangement is detailed in Section 5.

CARE OF YOUR NEW ENGINE

Before leaving the makers' works, each engine is carefully tested and inspected; this includes full load running, followed by detailed examination and tightening of all nuts and unions.

When the engine is put into service, further setting of some joints will occur and the valve gear beds down. For these reasons, if the best results are to be obtained from the engine, it is important that it should receive regular attention, particularly during the first 500 hours of its life. The same applies to an engine which has been completely overhauled.

INITIAL ATTENTION

To ensure that the top cups of the push rods are full of oil and that the valve springs are lubricated, pour 300cm^3 ($\frac{1}{2}$ pt.) of lubricating oil per cylinder over the valve gear.

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

1. Adjust tappet clearances (see pages 50 or 68).
2. Check, and tighten, the nuts on the following joints: end cover, cylinder head covers, fuel pipes, fuel pump housing door, lubricating and fuel oil pipe joints.

In addition to the above the following should also be carried out.

a. Change the lubricating oil for the first time after 100 hours. Thereafter every 250 hours.

b. Clean the engine and keep it clean.

c. 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 well result in an expensive breakdown.

ROUTINE MAINTENANCE

Following the initial attention, the normal routine maintenance must be carried out as laid down on next page.

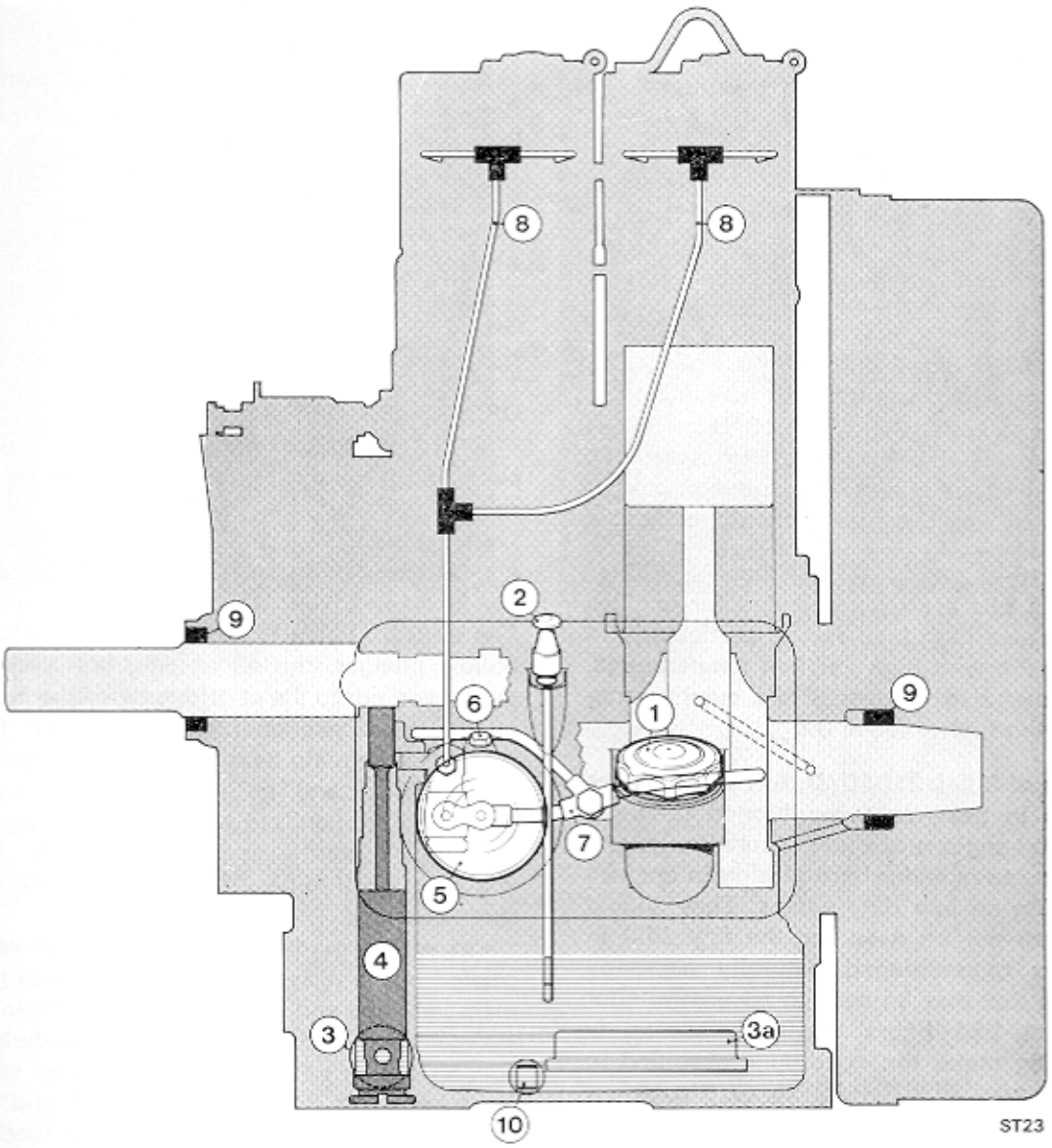
LUBRICATING OIL

Always use oils of the correct viscosity and type Heavy Duty diesel engine detergent lubrication oil. (See Section 2.)

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

ROUTINE MAINTENANCE	Page No. ST	STW
Daily		
Check supply of fuel oil.	33	33
Check the level and condition of lubricating oil (also in gearbox if fitted).	25	25
Clean the air cleaner under very dusty conditions.	49	67
Drain the moisture trap in the exhaust pipe if fitted.	9	9
Every 125 Hours		
Clean the air cleaner under moderately dusty conditions. (Renew the element if necessary).	49	67
Check for oil and fuel leaks—tighten nuts and fittings if necessary.	—	—
Change the lubricating oil if it is thick and black.	24	24
Check electrolyte level in batteries.		
Every 250 Hours		
Drain the lubricating oil and refill with the correct grade and type.	24	24
Renew the lubricating oil filter element (if fitted).	26	26
Clean the fuel injector nozzle if the exhaust is dirty.	41	41
Clean the fan blades and examine for damage (M.E.U.).	59	59
Renew the fuel filter element if the fuel used is not perfectly clean.	36	36
Check belt tension	116	116
Every 500 Hours		
Renew the fuel filter element.	36	36
Every 1000 Hours		
Decarbonise if the engine shows loss of compression, or blow-by past the piston. Do not disturb otherwise.	62	62
Adjust valve clearances.	50	68
Every 2000 Hours		
Decarbonise.	62	62
Clean the inlet manifold and exhaust system.	49	67
Examine the fan blades and clean.	59	59
Check for free working of the governor linkage.	42	42
Drain and clean the fuel tank.	34	34
Renew the air cleaner element.	49	67
Clean or replace the fuel injector nozzle and check the pressure settings.	41	41
Check the fuel pump timing and balancing.	40	40
Check lubricating oil pressure.	23	23
Clean the cylinder, cylinder head and injector finning under normal conditions. (ST).	63	—
Check the lubricating oil pump valve assemblies.	27	27
Check water space in cylinder blocks for sludge etc. Remove doors and clean if necessary (STW).	—	73
Every 6000 Hours		
Give the engine a major overhaul if necessary.	60	60

A reasonable amount of time spent in checking over the details as described above is the user's best insurance against loss of valuable time and costly repairs.



1. Oil Filler Cap
2. Dipstick
3. Strainer
3A. Strainer (3 cyl. engines)
4. Oil Pump
5. Lubricating Oil Filter
6. Tapping for Oil Pressure Gauge
7. Oil Pipe to Main Bearings
8. Oil Pipe to Valve Gear
9. Oil Seals
10. Drain Plug

Fig. 3. Lubricating Oil System

SPECIFICATION

1. The Temperatures mentioned in the table are the ambient temperatures at the time when the engine is started. However if the running ambient temperatures are much higher than the starting temperatures, a compromise must be struck and a higher viscosity oil used, provided starting is satisfactory; multigrade oils overcome the problems provided they have a suitable specification. See note 5.

2. ST and STW diesel engines must be run on H.D. Diesel lubricating oils to specifications equal to or better than DEF2101D or MIL-L-2104B or MIL-L-46152A/B or API CC. Straight mineral oils are not suitable, neither are oils of less detergency than specified.

3. MIL-L-2104C or MIL-L-2104D or API CD or Series III oils are recommended for engines running at a high load factor, particularly in conjunction with high ambient temperatures. They must also be used if the sulphur content of the fuel exceeds 0.5%.

4. **The use of MIL-L-2104C/D, API CD or Series III oils in new, or reconditioned naturally aspirated engines can inhibit running-in, and give rise to cylinder bore glazing in engines operating on low duty cycles. They should therefore not be used for the first 'fill' in new or reconditioned naturally aspirated engines, but may be used to advantage after the first 250 hours when an engine is operating under the conditions specified in para 3.**

5. Multigrade oils must meet the specifications listed in Para 2.

6. The oil should be suitable for oil changes every 250 hours without undue oxidisation, with sump temperatures reaching 150°C in tropical climates under extremely severe applications, and 120°C under normal applications.

7. Marine gearboxes of Lister manufacture with separate lubrication from the engine, and all marine reduction gears of Lister manufacture, must use "Mild type EP gear lubricants" or "Multi-purpose gear lubricants" (as used in the majority of motor car differentials).

VISCOSITY

For starting temperatures:-

	Monograde	Multigrade
Below −15°C	SAE 5W	5W/20
Between −15°C and 4°C	SAE 10W	10W/30
Between 4°C and 30°C	SAE 20/20W	15W/40
Above 30°C	SAE 30	15W/40 20W/40

OPERATION (Fig. 3)

Oil is supplied under pressure from a plunger pump to all crankshaft bearings and to the valve rockers.

The oil is drawn through a wire gauze strainer and ball suction valve. The suction valve assembly is screwed into the base of the crankcase. The delivery valve is carried in the bottom of a hollow plunger, the oil passing into the hollow tappet and out to the cartridge type filter mounted on the crankcase door. From the filter the oil passes to the main bearing pipes on single cylinder engines, and on two and three cylinder engines, to a manifold which supplies the centre bearing(s) and the end main bearings. On all engines, small pipes supply oil to the rocker shaft bearings.

On earlier model engines, the relief valve is carried in the plug securing the oil pipes for the main bearings and incorporates a reservoir which maintains oil pressure on the bearing during the suction stroke of the pump. The relief valve is set to open at 3.4 bar (50 lbf.in.^{2}) and is not adjustable. On engines fitted with a lubricating oil pressure gauge, a recorded pressure of 1.0/1.4 bar (15/20 lbf./in.^{2}) as 1500 rev/min. is adequate and 0.34 bar (5 lbf./in.^{2}) at 750 rev/min.

Later model engines using the self regulating oil pump have no relief valve but maintain the oil pressure quoted above.

The oil system is filled through the oil filler cap on the cylinder head cover or through the filler cap on the crankcase door, depending on installation. The oil is drained through the drain plug fitted in the crankcase on the manifold side of the engine.

A dipstick is fitted in the crankcase door.

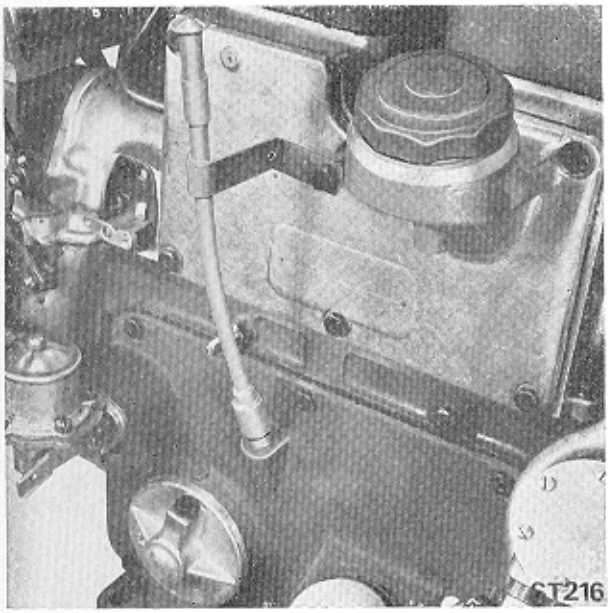


Fig. 4. Dipstick Oil Filler and Adaptor Plate—STW

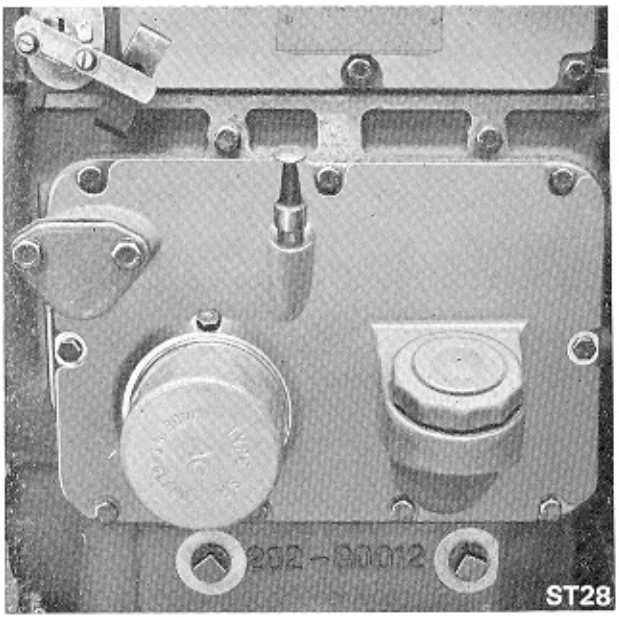


Fig. 5. Crankcase Door with Dipstick and Filler Cap—ST

Engine	Industrial and Marine Auxiliary	Marine Propulsion	Dipstick Identification No.	Max. angle of inclination at which the engine may be run		Approx. oil capacity with engine level	Dipstick type
				Flywheel down	Flywheel up		
ST1	*		17	10°	10°	2 litres (3½ pints)	Solid
ST2	*		19	15°	15°	5.4 litres (9½ pints)	Solid
ST3	*		19	15°	10°	9.1 litres (16 pints)	Solid
STW2	*		19	15°	15°	5.4 litres (9½ pints)	Solid
STW3	*		19	15°	10°	9.1 litres (16 pints)	Solid
ST1		*	3	10°	10°	2 litres (3½ pints)	Flexible
ST2		*	8	15°	15°	5.4 litres (9½ pints)	Flexible
ST3		*	15	12°	6°	6.6 litres (11.6 pints)	Flexible
STW2		*	13	15°	15°	5.4 litres (9½ pints)	Flexible
STW3		*	13	12°	6°	6.6 litres (11.6 pints)	Flexible

Note: Maximum side tilt, manifold up 15°, down 8° continuous operation.

BEFORE STARTING OF AFTER OVERHAUL

Fill the engine crankcase through the oil filler to the mark "max" on the dipstick. Top up when the engine has been stopped after the initial run.

OIL FILTER (Fig. 6)

The standard oil filter is a screw on cartridge type located on the crankcase door. A by-pass valve is incorporated in the filter to prevent oil starvation in the unlikely event of the element clogging. A special band gripping tool is required to remove the filter from the engine. When fitting a new filter, the face of the rubber joint must be lightly greased to facilitate assembly and removal. The filter must be screwed until the rubber joint just makes contact with the crankcase door facing and then screwed on clockwise $\frac{1}{2}$ to $\frac{3}{4}$ of a turn.

The element should be renewed every 250 hours. (See ROUTINE MAINTENANCE).

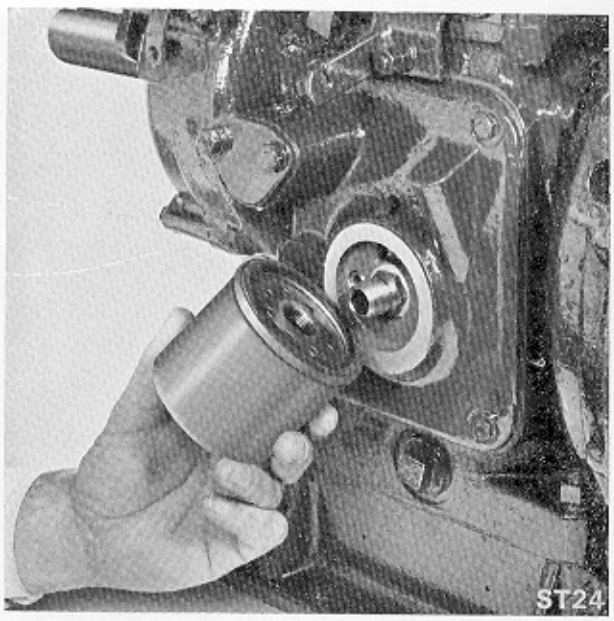


Fig. 6 Changing Oil Filter

Marine Propulsion Engines

In place of the oil filter described above, on marine propulsion engines an adaptor plate is fitted to blank off the filter position.

Note. Remote mounted oil filters are available for all engines; details can be found in Section 5.

WIRE GAUZE STRAINERS (Fig. 7)

Access to the strainer is gained by removing the crankcase door.

On one and two cylinder engines a tubular strainer is fitted (A). The open end of the strainer locates into the oil pump (or suction valve) housing, the other being spring loaded against the crankcase wall. When refitting, ensure spring loaded pin is in positive contact with recess in crankcase wall.

On three cylinder engines (B) the strainer assembly is held in position by a bracket bolted to the dividing wall in the crankcase and a metal pipe located in the oil pump (or suction valve) housing.

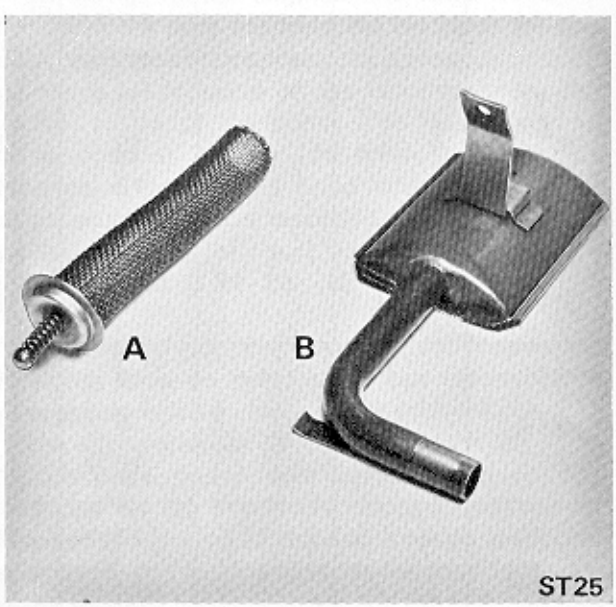


Fig. 7 Oil Strainers

OIL PUMP AND SUCTION VALVE (Fig. 8)

Access to the oil pump plunger is through the crankcase door; the suction valve is screwed into the base of the crankcase.

To Remove:—

(a) Drain oil—the oil drain plug is located on the manifold side of the crankcase.

(b) Compress pump return spring to relieve pressure on the circlip; remove circlip and release pump spring.

(c) Gain access to the underside of the crankcase; loosen and remove suction valve assembly.

(d) Slide out pump plunger and tappet; remove return spring and circlip from the inside of the crankcase.

SERVICING

Clean assembly and examine for damage or wear; change 'O' rings on tappet and suction valve if necessary. Ensure copper washer on suction valve is serviceable. **Under no circumstances dismantle valve assemblies.**

To Refit:—

(a) Compress pump return spring and tie with fine string. (This will enable circlip to be inserted more easily).

(b) Fit tappet with hollow end and oil seal nearest the pump plunger.

(c) Fit tappet and pump plunger through bottom of crankcase; locate return spring and circlip around pump plunger from inside the crankcase.

(d) Screw suction valve in position (with copper washer).

(e) Fit circlip to the top of pump plunger; release tension on spring. (Remove string if used).

(f) Replace drain plug after coating threads with Hylomar PL32M.

(g) Fill sump with correct grade and quantity of oil.

A. Suction Valve
B. Oil Pump Plunger
C. Tappet

Fig. 8. Oil Pump

LUBRICATING OIL PUMPS (Fig. 8A)

The illustration shows the two types of oil pumps which may be fitted to ST and STW engines.

The self regulating pump illustrated on the left was introduced in ST1 engines from May 1978. By the end of 1978 all multi-cylinder engines were fitted with the self regulating pump.

Instructions for removing and refitting the old type pump and suction valve can be found on page 27.

SELF REGULATING PUMP

To Remove :

(a) Drain oil — the oil drain plug is located on the manifold side of the crankcase.

(b) Remove crankcase door and run engine until oil pump push rod is at its highest point (cam lobe not operating pump).

(c) Gain access to the underside of the crankcase; loosen and remove oil pump plug.
Note: The pump assembly is under spring tension and care should be taken to prevent components of the pump being misplaced or damaged.

SERVICING — MAJOR OVERHAUL

Clean assembly and examine for damage or wear; change 'O' ring on plug. Fit new plug joint washer and coat with Hylomar PL 32M.

To Refit :

Note: It will greatly ease assembly if engine is placed on its side.

(a) Insert push rod A.

(b) Assemble plunger cap B with ball valve C into plunger D; place spring E over shank of plunger and insert complete assembly into crankcase.

(c) Place ball valve F into plug J and place retaining plate G centrally over end of plug (ensure serviceable jointing washer H is fitted).

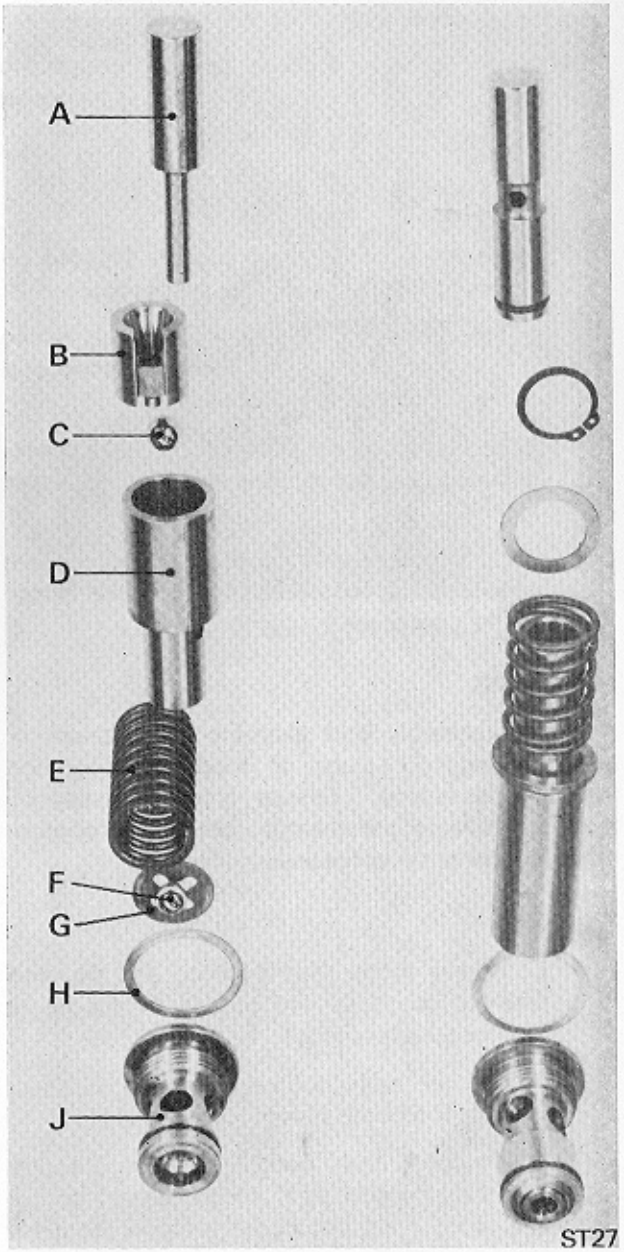


Fig. 8A. Lubricating Oil Pumps

OIL PIPES

The variations in the oil system layout for all engines can be seen in Figs. 10, 11 and 12.

Please note, a blanking plug is fitted in place of the relief valve on engines fitted with a self regulating oil pump.

The oil pipe into the flywheel end main bearing housing and the crankcase at the gear end main bearing must be a very close sliding fit. When refitting, Hylomar PL32M should be applied to the last 16mm ($\frac{5}{8}$") of pipe taking care not to coat the very end of the pipe, otherwise jointing compound will be fed into the oil stream.

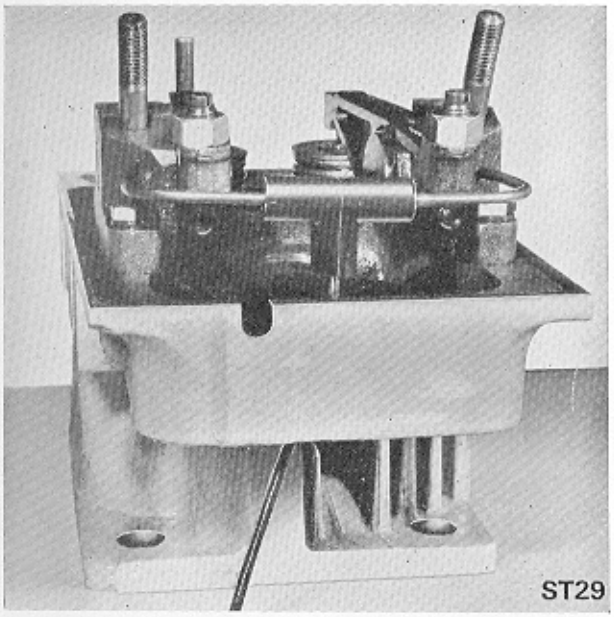


Fig. 9. Oil Pipes to Cylinder Head

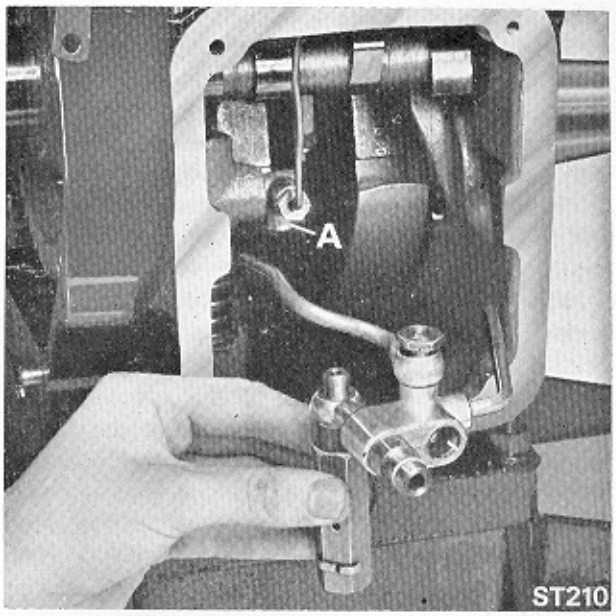


Fig. 10. ST1—Oil Pipes (Old type oil pump)

Oil Feed Pipes to Rockers

The oil feed to cylinder head rocker levers is reduced by restricting the bore of the vertical oil feed pipe by means of a wire inserted inside the pipe. This reduces splash in the rocker box. Under no circumstances should these restrictor wires be removed.

When refitting the rubber tee pieces on the rocker feed pipes, ensure that the pipes are not pushed in beyond the internal counterbores. If they are forced beyond the counterbores the oil feed can be blocked (Fig. 9). When fitting rocker feed pipe into relief valve adaptor, ensure pipe is pushed firmly into packing seal before tightening gland nut. (See item A Fig. 10).

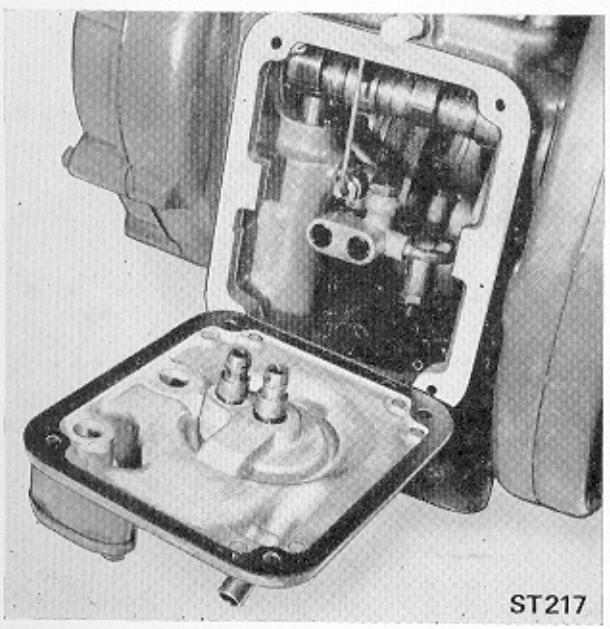


Fig. 11. ST1—Oil pipes (Self regulating oil pump)

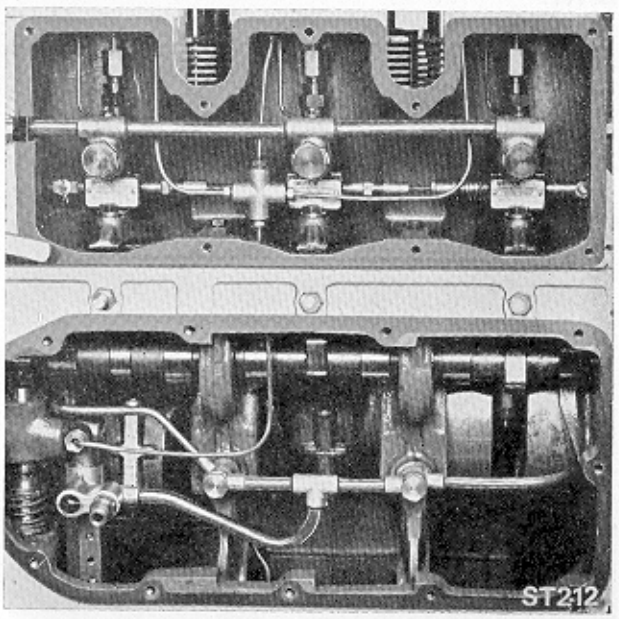


Fig. 12. ST/STW3—Oil Pipes (Old type oil pump)

OIL SEALS (Fig. 13)

The crankcase is sealed at the crankshaft by a screw type oil seal (A) and a felt ring (B). The screw seal must be concentric with the shaft, the maximum permissible variation of gap being 0.075 mm. (0.003"). A ring type oil thrower (C) is fitted over the crankshaft at the flywheel end and must be fitted before the main bearing housing.

When an oil seal is replaced, the outside diameter of the seal should have a little Hylomar PL23M applied. When fitting a new crankshaft felt seal, coat the inside of the grooves with Wellseal before inserting felt. Ensure the felt is not distorted during fitting, and lightly oil before fitting assembly to the crankshaft.

Ensure that the correct seal assembly is fitted for the direction of the engine rotation. An arrow marked on the seal shows the direction or rotation.

A Gits seal and oil thrower ring in the end cover seals the camshaft extension (Fig. 13A). A service tool should be used when fitting the end cover to prevent damage to this seal. See Section 7.

When fitting a new end cover seal, fit oil thrower ring before inserting Gits seal assembly. Seal assembly should be pushed in until outside edge of assembly is flush with outside of end cover.

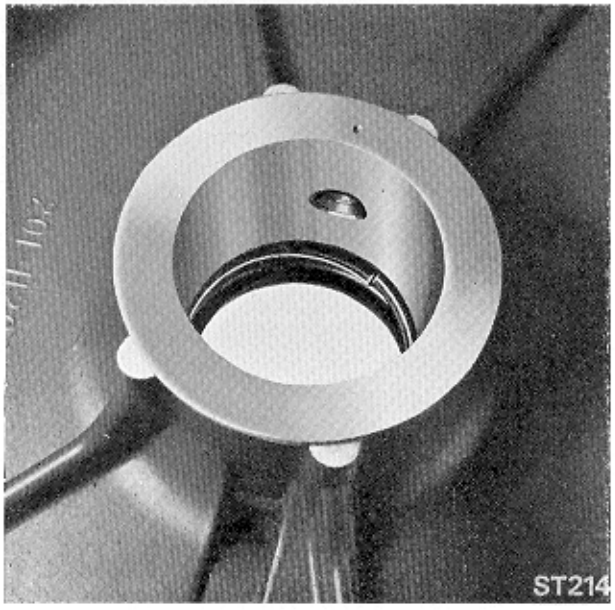


Fig. 13A. Camshaft Oil Seal

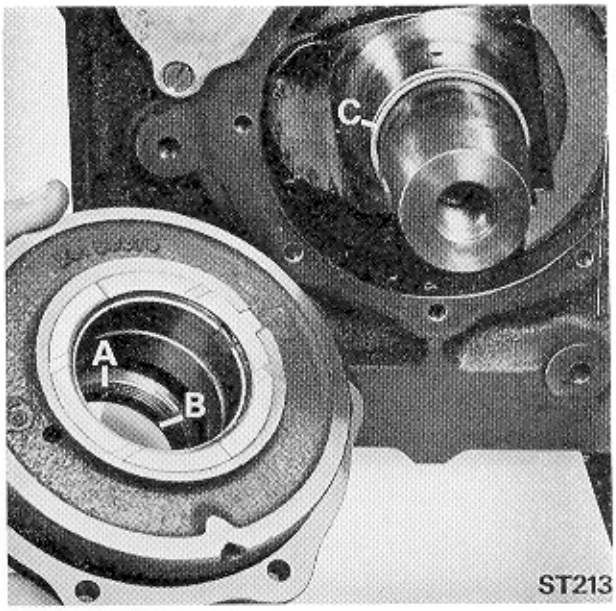


Fig. 13. Crankshaft Oil Seals

NOTE: The camshaft oil seal should be installed without applying a jointing compound in order to eliminate the possibility of jointing compound getting on the sealing lip of the seal.

OIL FEED TO JABSCO PUMP (Fig. 14)

On STW engines, an oil feed pick up is fitted in the fuel pump housing and feeds oil—via a rubber hose—to the pump drive housing.

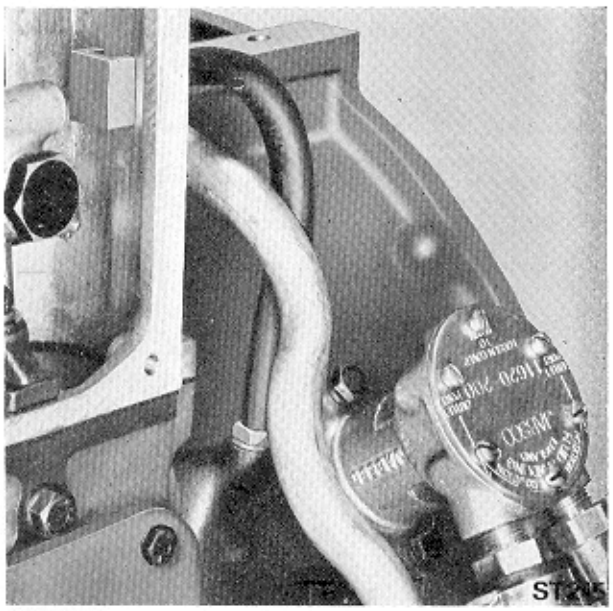


Fig. 14. **Oil Feed to Jabsco Pump**

LUBRICATING OIL PRESSURE GAUGE

See Section Five — Accessories.

DIRECT DRIVE CLUTCH

The Lister clutch housing is filled to the level of the side plug with light engine oil (SAE 10). The capacity is approximately 0.36 litre ($\frac{5}{8}$ imp. pint). An even lighter grade of oil may be used in cold weather to reduce oil drag of driven shaft. (See Section Five.)

REDUCTION GEAR

Where reduction gears are fitted, fill the gear case to the maximum mark on the dipstick with a mild type EP gear lubricant.

REVERSE GEAR

Lubricating instructions for marine reverse gear fitted to STM and STWM engines can be found in Section 5.

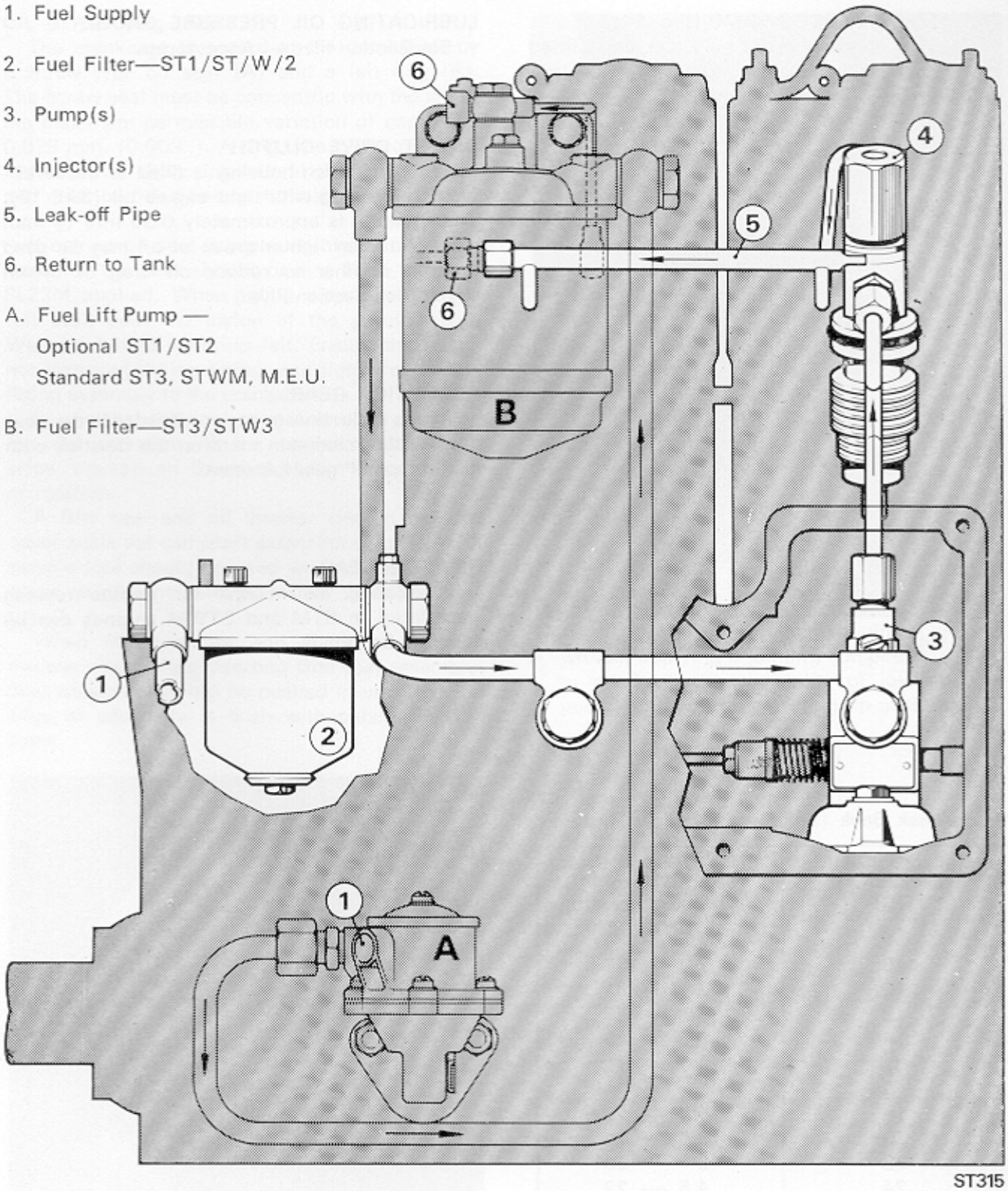
Nozzle Leak Back (See Page 42 'Fuel System')

Calibration fluid temperature (°C)	Back leakage time (secs) 170 to 140 Atms pressure drop
6	7.5 — 34
8	7 — 33
10	7 — 31
12	6.5 — 29
14	6.5 — 28
15.5	6 — 27
18	5.5 — 25.5
20	5.5 — 24
22	5 — 23
24	4.5 — 22
26	4.5 — 21
28	4 — 20
30	4 — 19.5

1. Fuel Supply
2. Fuel Filter—ST1/ST/W/2
3. Pump(s)
4. Injector(s)
5. Leak-off Pipe
6. Return to Tank

A. Fuel Lift Pump —
Optional ST1/ST2
Standard ST3, STWM, M.E.U.

B. Fuel Filter—ST3/STW3



ST315

Fig. 15. Fuel System

(See page 35 for M.E.U. fuel system)

SPECIFICATION

It has not been found practicable to recommend any particular fuel for universal use, but the fuel must be a distillate and not a residual oil or a blend thereof.

It should have a Specification conforming to British Standard No. 2869: 1970, Class A1 or A2.

Fuels to USA Specifications ASTM D-975-77 Grades No. 1-D and No. 2-D are also acceptable.

SPECIFICATION LIMITS

Item	Class A1	Class A2
Viscosity, Kinematic at 37.8°C		
centistokes, Min.	1.6	1.6
centistokes, Max.	6.0	6.0
Cetane number, min.	50	45
Carbon residue, Conradson on 10% residue, % by weight, max.	0.2	0.2
Distillation, recovery at 357°C% by volume, min.	90	90
Flash point, closed, Pensky-Martens, min.	55°C	55°C
Water content, % by volume, max.	0.05	0.05
Sediment % by weight, max.	0.01	0.01
Ash% by weight, max.	0.01	0.01
Sulphur Content % by weight, max.	0.5	1.0
Copper corrosion test, max.	1	1
Cloud point °C, maximum Summer	0	0
Winter	−7	−7

In some cases Summer grade oil is unsuitable for use in Winter because it becomes cloudy and rapidly clogs the fuel filters on the engine.

In general the fuel must be free from foreign matter and water otherwise excessive wear may take place, particularly in the fuel injection system. Certain fuels are unsuitable owing to the excessive temperatures, pressures, deposits and corrosion resulting from their use.

The user is cautioned that although the engine may run satisfactorily for a short time on some fuel, excessive wear and damage will ultimately be suffered by the engine and its life materially shortened. For these reasons we can accept no responsibility for such damage or wear caused by the use of unsuitable or dirty fuels.

When in doubt as to the suitability of a fuel oil, the local dealer should be consulted.

Clean fuel is of the utmost importance in ensuring reliable performance.

Vaporising oils are unsuitable as fuel for Lister diesel engines.

*DESCRIPTION (Fig. 15)

The fuel system comprises a fuel tank, filter and a fuel pump and injector for each cylinder. A pressed steel fuel tank is mounted on the gear end of the engine and feeds fuel by gravity through a Delco or C.A.V. filter. The top casting of the filter assembly contains two vent screws for bleeding the air. From the filter, fuel flows via a metal pipe and banjo unions to each of the fuel pumps which are located in a housing on the side of the engine; each pump is secured in position by a clamp bolted to the crankcase. The pump(s) feed fuel to the injector(s) which are located in the cylinder head(s). A leak-off pipe from the injector(s) carries surplus fuel back to the tank.

*(See page 35 for M.E.U. fuel system)

SERVICING—GENERAL

When priming or checking the fuel pump timing, care must be taken to wipe spilled fuel from the outside of the engine.

Always fit a NEW joint when a joint has been broken.

Special care must be taken to see that there is no leakage from the joints of the fuel pipe connection to the pump.

When tightening or loosening the fuel pump delivery connections, use two spanners to prevent the pump from twisting on its seating and causing misalignment and possibly jamming o the fuel pump rack.

When refitting the fuel pipe from pump to injector the connection to the injector must be tightened before the connection to the fuel pump. This procedure will ensure that there is no leakage from these joints. It is most important that all fuel joints are tight and leakproof.

Always fill the fuel tank through a fine strainer, preferably at the end of a run. If any sediment is stirred up during the process this has time to settle before the engine is used again. If cans are used, avoid tipping out the last few drops.

Funnels are very difficult to keep clean in dusty conditions. Wash them before and after use and wrap them up when not required, or fill service tank direct from a small mouthed screw capped can such as a 2 gallon fuel can.

Fuel Tank Capacities (not M.E.U.)

The basic engine mounted fuel tank offered for all ST engines is 11.4 litres (2½ gal.). Larger capacity tanks are also available, see Section 5. Fuel tanks for STW engines can be found in Section 5.

FUEL TANK (Fig. 17)

The engine mounted tank is held in position by two straps secured to the casting of the end cover. The tank would normally be removed with the end cover. Should it be necessary to remove the tank only, proceed as follows:—

(a) Drain fuel.
(b) Disconnect tank support strap to cylinder head cover; remove leak-off pipe from top of tank.
(c) Disconnect main fuel pipe from the base of tank.
(d) Unscrew fuel tank straps and remove tank; note position of pads at base of tank for refitting.

Refitting the tank is carried out in the reverse order. After filling tank with the correct grade of fuel the system should be primed. See page 36.

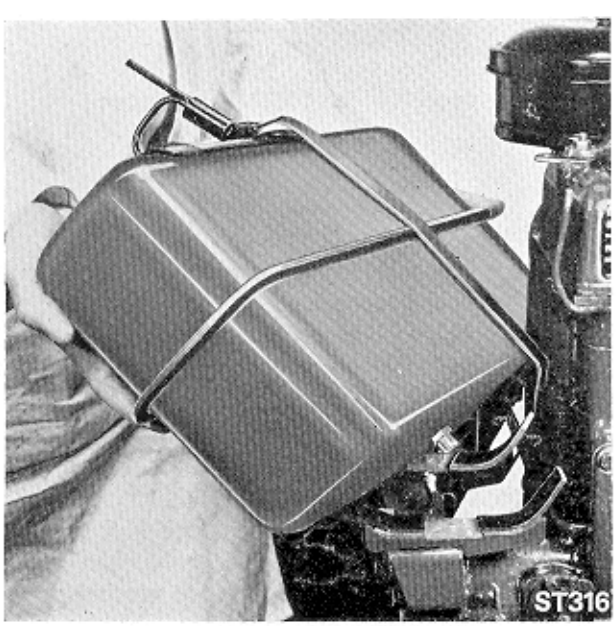


Fig. 16. Removing Fuel Tank Only

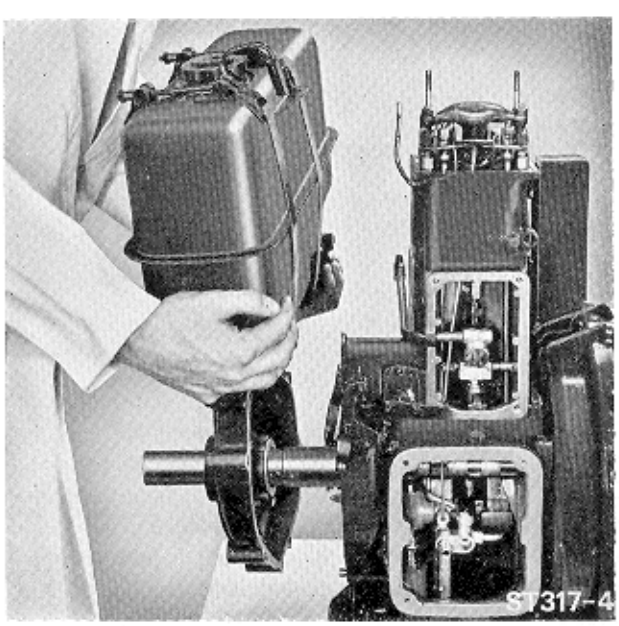


Fig. 17. Removing Tank and End Cover

FUEL TANK—MOISTURE EXTRACTION UNIT

Fuel may be stored in 180 litre (40 gallon) drums or bulk fuel tanks. Fuel is drawn from the fuel drum through the fuel probe. The probe supplied with the unit is suitable for drums with an end opening, drums with a side opening require a shorter fuel probe.

To prevent air entering the fuel system keep the end of the probe submerged in fuel; stop the engine before changing the probe to another fuel drum. A NEW DRUM SHOULD STAND IN POSITION FOR 12 HOURS BEFORE USE. A freshly transported drum of fuel may contain sediment in suspension and by doing this small particles have time to settle to the bottom. Tilt drums with end opening so that rainwater cannot enter the drum.

BULK FUEL TANK

If the tank is situated to gravity feed fuel to the unit (the bottom of the tank should not be more than 2.3 m (7 ft. 6 in.) above the engine crankshaft) the fuel suction probe and flexible fuel pipes can be removed from the unit. The supply pipe from the gravity fuel tank must be connected to the right hand connection on the fuel connection block. The fuel leak-off pipe is taken from the left hand connection to the top of the tank.

The fuel outlet from the gravity tank should be at least 51 mm (2 in.) above the bottom of the tank and a suitable plug fitted at the lowest point for draining.

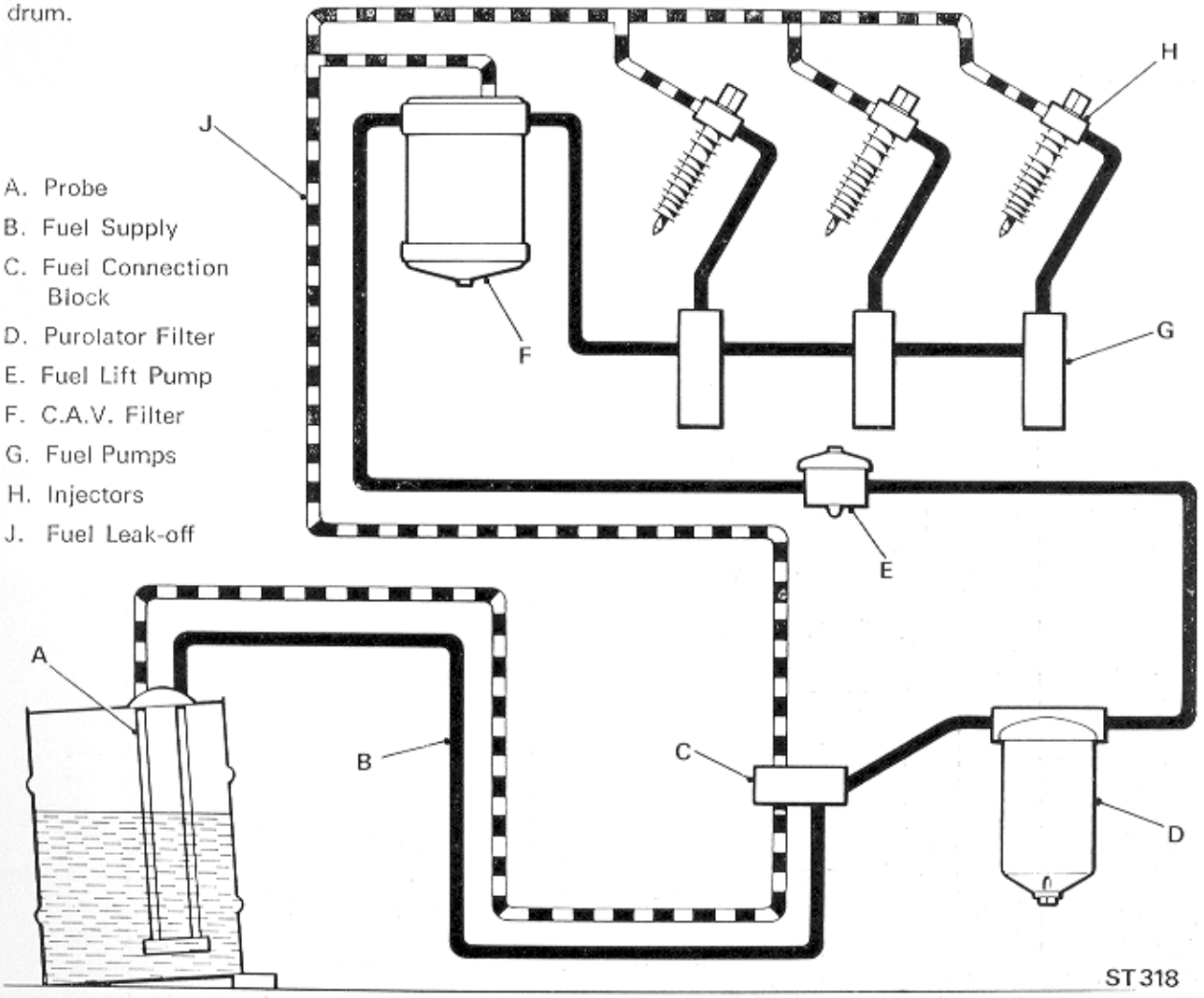


Fig. 18. Moisture Extraction Unit—Fuel System

FUEL FILTER (Fig. 19)

The fuel filter is an essential part of a diesel engine. It must not be removed from the engine or used without a filter element. The element should be renewed every 1000 hours, more frequently if for any reason the fuel is known to be dirty. The filter is located on a bracket at the gear end of the engine, a larger capacity C.A.V. filter being fitted to 3 cylinder engines. On STW3 engines the filter is located by the fuel pump housing door. To remove, drain fuel tank and unscrew bolt in the base of the filter assembly. Clean the inside of the filter bowl before fitting a new element and renewing any joints or seals. When the filter assembly has been refitted to the engine, fill fuel tank and prime system. On Moisture Extraction Units, an additional fuel filter is fitted to the main frame and is connected between the fuel supply and the lift pump, see Fig. 18. It is serviced similarly to the main filter.

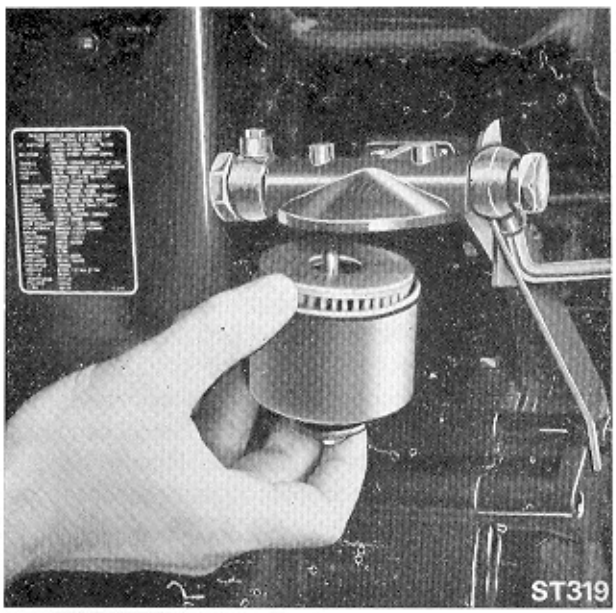


Fig. 19. Changing Fuel Filter

PRIMING FUEL SYSTEM (Fig. 20)

(a) Fill fuel tank.

(b) Slacken each bleed screw on top of the filter body and in the outlet banjo union. Tighten each bleed screw when a full air free flow of fuel is obtained working from the fuel tank.

(c) Slacken bleed screw on fuel pump(s) nearest the tank first; tighten when all air has been displaced from fuel at each pump.

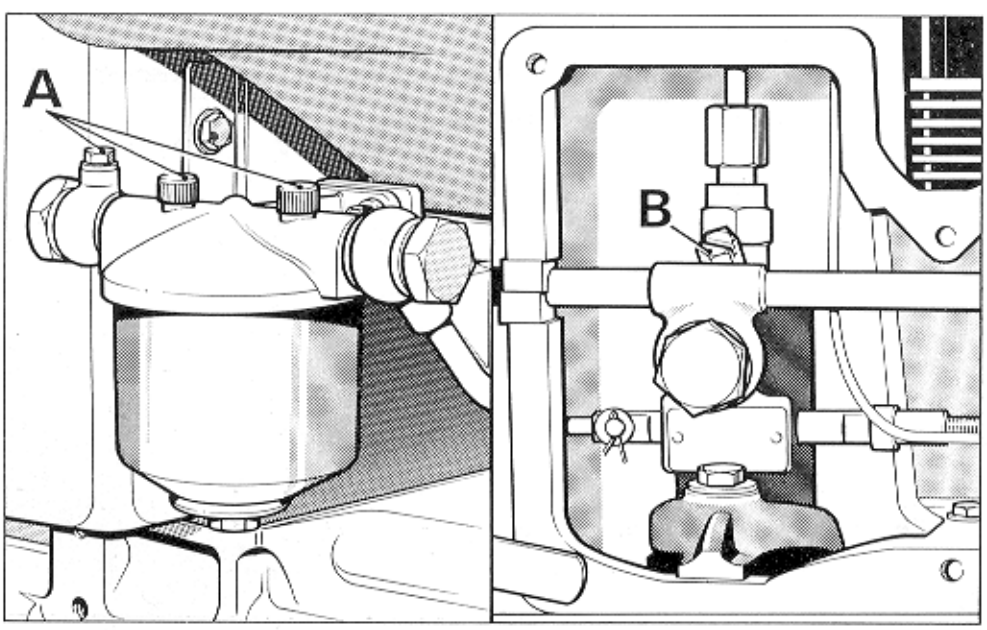


Fig. 20. Priming Fuel System

FUEL PUMP

A separate Bryce Berger fuel pump is fitted for each cylinder. The pump(s) are located in a housing which is bolted to the top of the crankcase. All servicing operations can be carried out without removing the housing.

Removing Fuel Pump

(a) Drain fuel.

(b) Remove fuel pump housing door and spring clip for stopping control.

(c) Disconnect fuel feed pipe at fuel pump(s) (Fig. 21). Note: A copper washer is fitted each side of the banjo union to the filter and a Dowty washer with a hard rubber insert each side of the connections to the pumps. A rubber bush locates the pipe in a recess in the fuel pump housing.

(d) Disconnect fuel pipe to injector(s).

(e) Disconnect governor link; unhook governor speeder spring.

(f) Remove gear case end cover; this is to check governor setting if required. If an engine mounted fuel tank is fitted, remove leak-off pipe to top of tank, disconnect strap to cylinder head cover and remove fuel feed pipe at base of tank. With keyway on camshaft extension at the bottom position, remove tank, filter and end cover complete (Fig. 17).

(g) Disconnect the linkage between pumps on multi cylinder engines, slide spring clip away from pump and push fulcrum pin out of the fuel pump shackle—do not let pin fall into sump.
Note: Every effort should be made not to disturb the fuel pump setting when disconnecting the linkage. The amount of linkage disconnected is left to the operator's discretion depending on the reason for removing the pump(s). On a two cylinder engine it is possible to lift out pumps with the linkage undisturbed.

(h) Remove fuel pump clamp setscrew and clamp (Fig. 22). Lift out pump(s) taking care to retain adjusting shims with their respective pumps to avoid affecting the timing. (Spill timing must be checked when refitting pumps.)

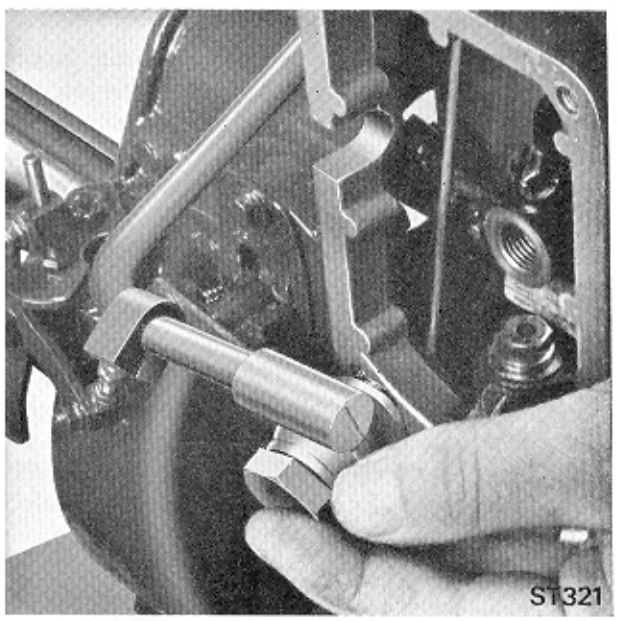


Fig. 21 Fuel Connection to Pump

Servicing

It is recommended that all servicing on the fuel pumps is carried out by accredited Service Depots. For operators wishing to carry out their own maintenance, see Bryce Berger Publication F158.

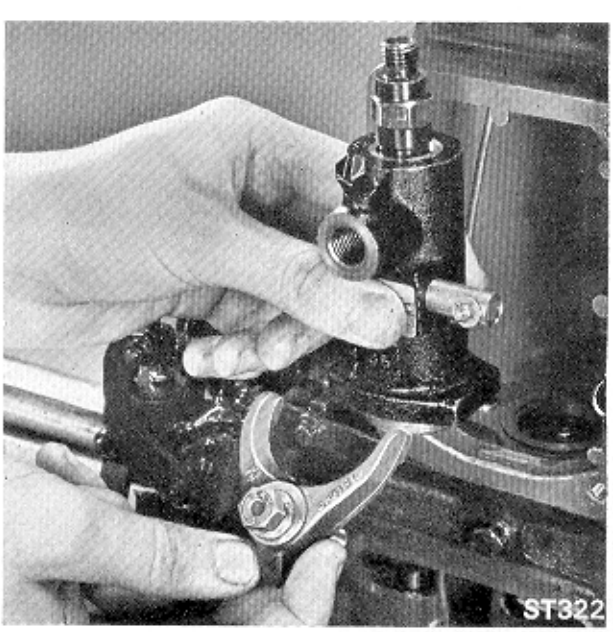


Fig. 22 Removing Fuel Pump

Refitting Fuel Pump

Refitting the fuel pump is carried out in the reverse order to removal. When tightening the fuel delivery connection, use two spanners to prevent the pump being twisted on its seat. The fuel injector pipe nuts should be torque loaded to 28.48 Nm (21 lbf.ft.). Ensure the pump rack(s) move freely otherwise erratic running or hunting will occur. Check fuel pump and governor setting and fuel pump timing; refit fuel pump housing door after coating jointing face with Hylomar PL32M and fitting a new joint. A special tapered sleeve should be used when re-fitting end cover to prevent damage to the oil seal. See Section 7, Service Tools. A new end cover joint should be used and Wellseal applied to the joint face and to the joint.

FUEL PUMP AND GOVERNOR SETTING (Fig. 23)

(a) Set the engine control to RUN position.

(b) Adjust linkage so that all the calibration marks A coincide with the sides of the fuel pumps within 0.13 mm (0.005"). The fuel pump racks must move freely after this adjustment.

(c) Adjust the governor lever fulcrum B so that when the calibration mark(s) A are against the outside of the pump(s) the distance C between the inside of the governor sleeve and the outside of the governor weight carrier is 12.7 mm (½").

(d) *Set the clearance G to the correct figure for the application and speed of engine. See table "Values of G". Maintain the correct clearance and rotate the locating plate until the calibration mark(s) A coincide with the sides of the fuel pump(s). The full width of each calibration mark must be visible. When mark(s) coincide and clearance is correct, secure locating plate with screw.

(e) After making adjustments, check that fuel pump racks and linkage move freely.

*On automatic control engines, this clearance is established by the distance between a mark on the **left** hand side of the pump and the fuel pump body. See Table G, third column.

VALUES OF G

Engine Speed rev/min.	Clearance mm. (inches)	Movement of Rack corresponding to clearance mm. (inches)
1200—2199	††0.38 (0.015)	1.22 (0.048)
2200—2699	0.69 (0.027)	2.18 (0.086)
2700—3000	0.91 (0.036)	2.92 (0.115)
For engines driving fans, centrifugal pumps and marine engines other than STW 2/3 marine propulsion engines, set as follows:—		
1200—2199	†0.076 (0.003)	0.254 (0.010)
2200—2699	0.127 (0.005)	0.406 (0.016)
2700—3000	0.279 (0.011)	0.89 (0.035)
For STW2/3 marine propulsion engines only, set as follows:—		
1200—2300 Continuous duty	0.203 (0.008)	0.66 (0.026)
1200—2600 Light duty	0.254 (0.010)	0.813 (0.032)

†All Moisture Extraction Units should be set to this clearance.

Note

To assist in the stopping of exhaust smoke from engines used in variable speed applications where the engine could be stalled, the following 'G' setting may be used—

General applications ††0.38 (0.015).

Fans, centrifugal pumps and marine auxiliary applications †0.076 (0.003).

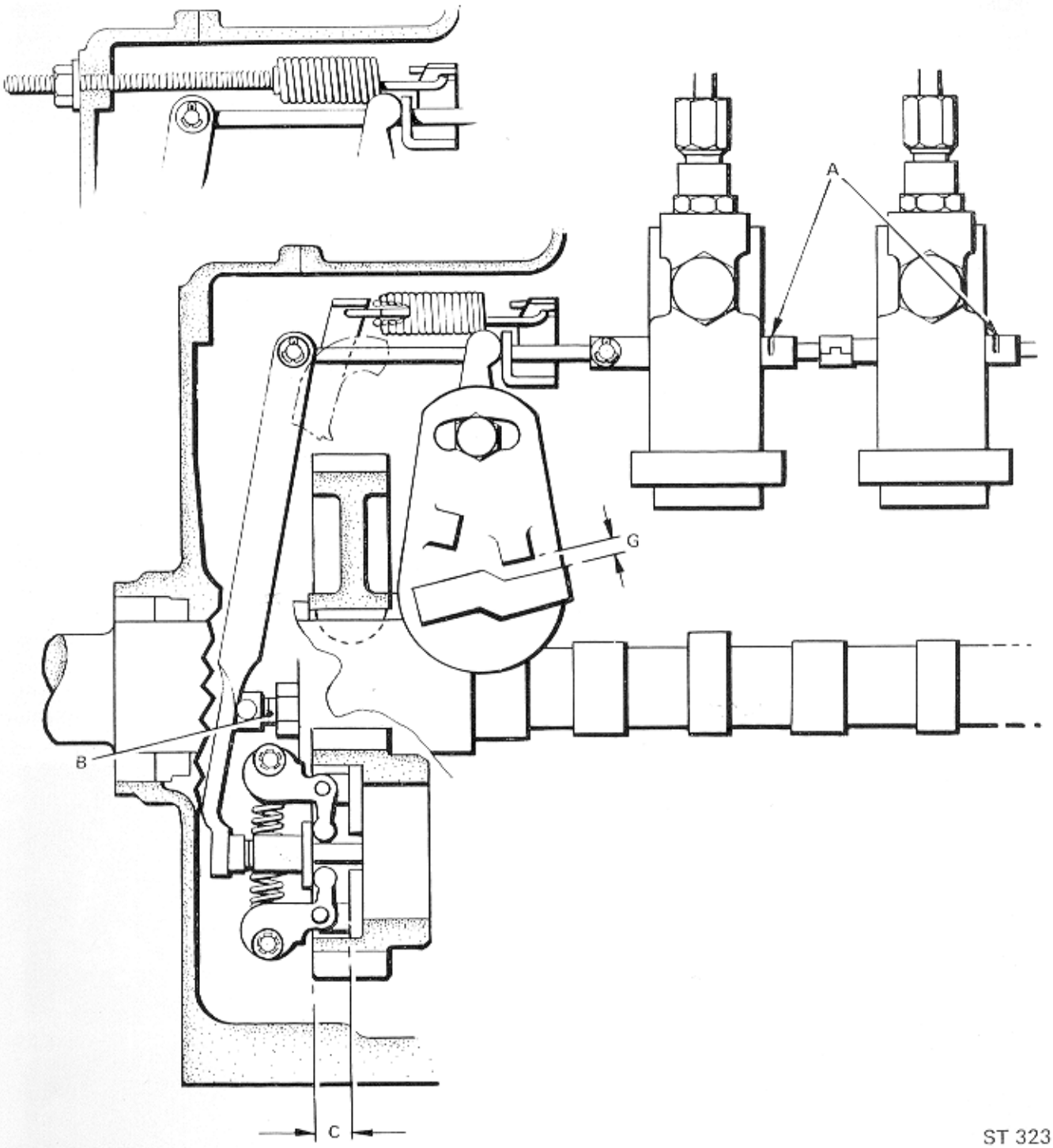


Fig. 23. Fuel Pump and Governor Setting

FUEL PUMP TIMING (Fig. 24)

(a) Set the control lever to START.

(b) Turn the flywheel to the firing position.
ST1 Engines. (Fig. 25A) (and M.E.U.)
Set the mark Z on the flywheel opposite the timing mark on the fan shroud with both valves closed.
Multi Cylinder Engines (Fig. 25B)
Set the mark Z opposite the arrow at the back of the fan shroud with both valves closed.

(c) Remove the fuel pipe from the pump to the injector.

(d) Remove the delivery valve holder A, delivery valve B and spring C. If fuel flows from the pump, turn the crankshaft in the direction of rotation until the flow ceases.

(e) Replace the delivery valve holder without the valve and spring.
Note: A spill pipe, fitted to the top of the delivery valve holder will give a more accurate indication of fuel flow cut off.

(f) Turn the crankshaft backwards until fuel commences to flow and turn in direction of rotation until flow ceases. Blow fuel from the top of the holder—or spill pipe—to make sure flow has ceased. At this position the firing mark on the rim of the flywheel should be opposite the centre mark on the fan shroud. If it is not, the shims below the pump body must be adjusted.

Remove shims to advance.

Add shims to retard.

Shims 0.13 mm. and 0.25 mm. (0.005" and 0.010") thick to a total of approximately 0.89 mm. (0.035") are normally inserted below the fuel pump. One shim 0.13 mm. (0.005") thick is equivalent to a timing adjustment of 4.76 mm (3/16") measured round the rim of a flywheel 35.56 cm. (14") diameter, or 5.16 mm. (13/64") for a flywheel 38 cm. (15") diameter.

When timing is correct, replace delivery valve and spring.

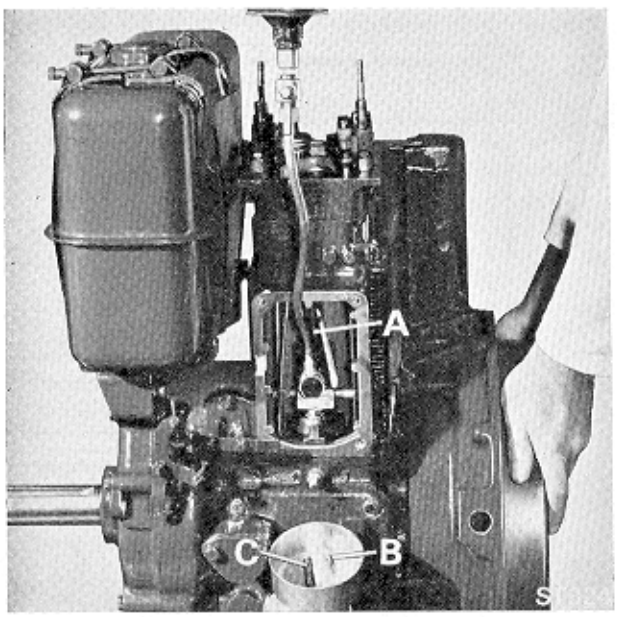


Fig. 24. Fuel Pump Timing

A thoroughly cleaned container holding a supply of clean, fresh fuel oil should be available for washing dismantled parts. Components should be assembled wet although it is permissible to use non-fluffing paper during cleaning processes. Never use paraffin and never use woven cloths. The components of each individual pump should be kept together during dismantling.

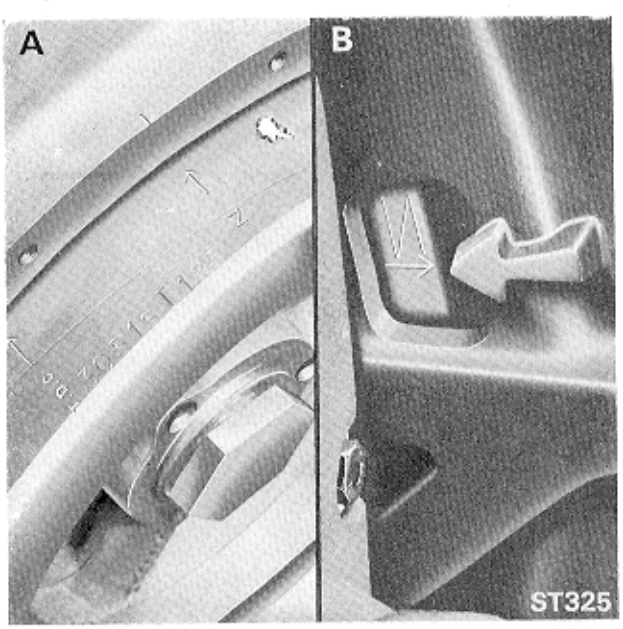


Fig. 25. Timing Marks

Fuel Pump Timing (cont.)

The speed ranges below are the 100% load setting revs/min. The measurements B.T.D.C. on flywheel rims are given for guidance only.

	Speed Ranges rev/min.	Deg. BTDC	mm (inches) BTDC on flywheel rims				
			324 (12¾")	343 (13½")	356 (14")	381 (15")	406 (16")
Engines ST/W/1/2/3	Up to 2000	19	53.59 (2.11)	56.90 (2.24)	58.93 (2.32)	63.25 (2.49)	67.31 (2.65)
	2001 to 2600	22	62.23 (2.45)	65.79 (2.59)	68.33 (2.69)	73.15 (2.88)	77.98 (3.07)
	Over 2600	25	70.61 (2.78)	74.68 (2.94)	77.47 (3.05)	83.06 (3.27)	88.65 (3.49)

FUEL INJECTOR

The injection equipment, and the pipes and unions between the fuel filter and the fuel pump, and between the fuel pump and the injector must be absolutely clean; one particle of dirt can easily block one hole in the nozzle and produce a dirty exhaust. Every care is taken before the engine leaves the Works to ensure that this equipment is scrupulously clean, and after the engine is run in on test these injectors are checked and replaced if necessary, as sometimes particles of dirt get dislodged from the system when all the equipment is new. Therefore it is recommended that great care be taken not to introduce dirt into the system in any subsequent dismantling after the engine leaves the Works. This applies to the fuel pump, the fuel injector and all the pipes and unions between the fuel filter and the fuel pump and between the fuel pump and the injector.

REMOVING INJECTOR (Fig. 26)

(a) Remove cylinder head cover.
(b) Disconnect leak-off pipe to tank and fuel feed pipe from pump.
(c) Remove injector clamp.
(d) Remove injector complete with oil seal ring and injector joint.

The injector is set to 200 atmospheres; full instructions for testing injector can be found on next page.

SERVICING

Examine oil seal ring for damage or cuts, replace if necessary.

Ensure the seatings in the cylinder head and the injector finned nut are clean and smooth. Fit new copper joint.

Check that the finning is clean.

Check that the injector nozzle cap nut and outer cap are dead tight 88.16 Nm (65 lbf.ft.) A rubber plug in the nozzle cap nut gives access to the adjuster.

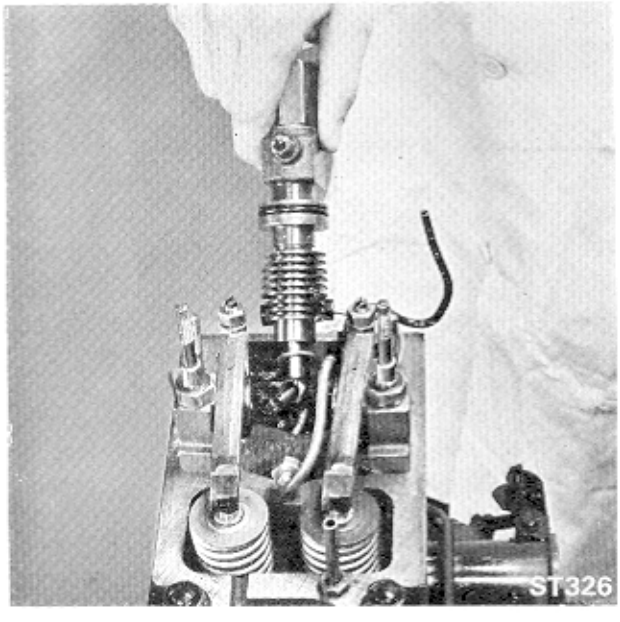


Fig. 26. Removing Injector

Refitting is carried out in the reverse order to removal. The clamp nuts must be tightened evenly to 20.34 Nm (15 lbf.ft.) ST and 43.40 Nm (32 lbf.ft.) STW torque ensuring that the clamp is level and bears evenly on the injector. The pipe from the pump to the injector must not be tightened until the clamp is correctly secured.

FUEL INJECTOR—TESTING INSTRUCTIONS

The injector nozzle has four spray holes each **0.25 mm. diameter.** The setting pressure of the injector spring is **200 atmospheres;** this allows for settling to the normal pressure of 190 atmospheres.

To ascertain if the injector spray is in good condition, the injector is removed from the engine and reconnected to the fuel injection pump externally, so that the spray can be observed. This requires removing the injection pipe and using a spare one (the standard injection pipe must never be bent for this purpose otherwise it will be impossible to refit). The engine is turned at about 60 rev/min and after a few turns the nozzle will begin to function and the sprays can be observed. **Ensure sprays are directed away from the operator.** These should be in the form of a very fine mist, not streaky or dribbly.

All 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 best results will not be obtained.

If one hole is totally blocked or the nozzle dribbles it must be replaced or sent to be cleaned and reclaimed by an accredited Service Depot.

If the nozzle only is replaced, the injector spring pressure must be reset and this cannot be done without a special test rig consisting of a hand operated fuel pump and a pressure gauge. This rig is normally carried by Service Engineers but if it is not available it becomes necessary to replace the complete injector by a new or a serviced one which has a clean nozzle and has been properly set to the correct pressure; in this case the complete faulty injector should be sent to the Service Depot or returned to the Lister Works or Agents for reconditioning.

The back leakage measured with a hand pump and gauge must be such that the time for the setting pressure to drop from 170 to 140 atmospheres must be within **6 to 27** seconds at 15.5°C calibration fluid temperature. See Page 32 for comprehensive table.

GOVERNOR

The engine governor is carried within the crankshaft pinion at the gear case end of the engine; access is gained by removing the end cover.

The governor lever (Fig. 27) operating the fuel pump(s) is carried on a fulcrum bearing secured to the crankcase above the pinion (Fig. 28). This bearing is fitted so that the centre line of the bearing is approximately 19.05 mm. (0.75") from the facing on the crankcase and is adjusted in accordance with the instructions given on page 38. The lever is curved to pass over the camshaft gearwheel and is joined to the fuel pump by a link arm.

A pad on the bottom of the lever makes contact with a thrust sleeve (Fig. 29) carried in the centre of the crankshaft pinion. The thrust sleeve movement is controlled by two governor weights secured by pins to a carrier (Fig. 30), which is bolted in the recess of the crankshaft pinion.

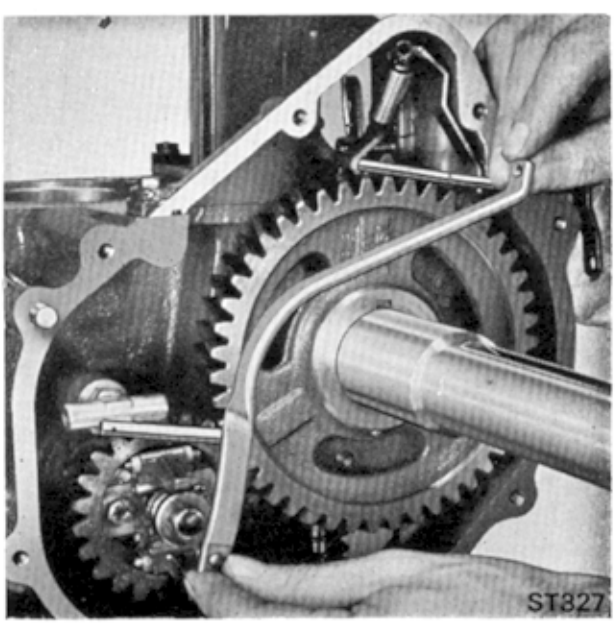
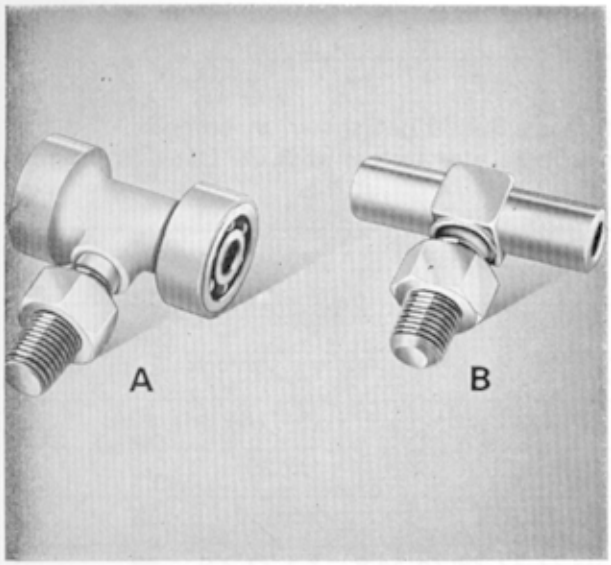


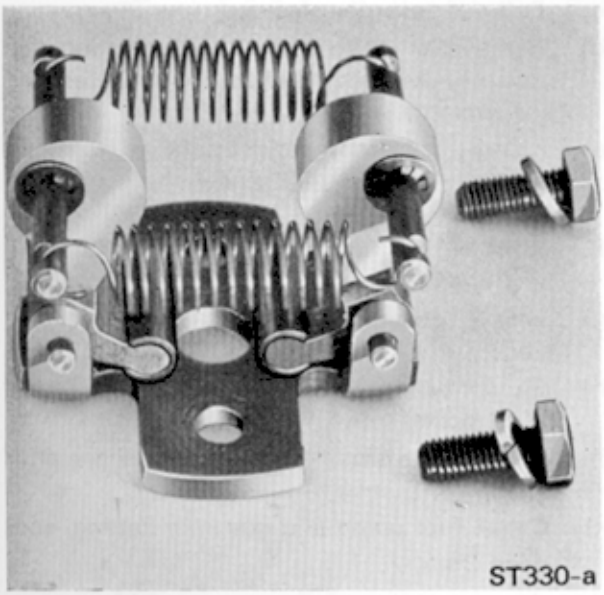
Fig. 27. Governor Lever



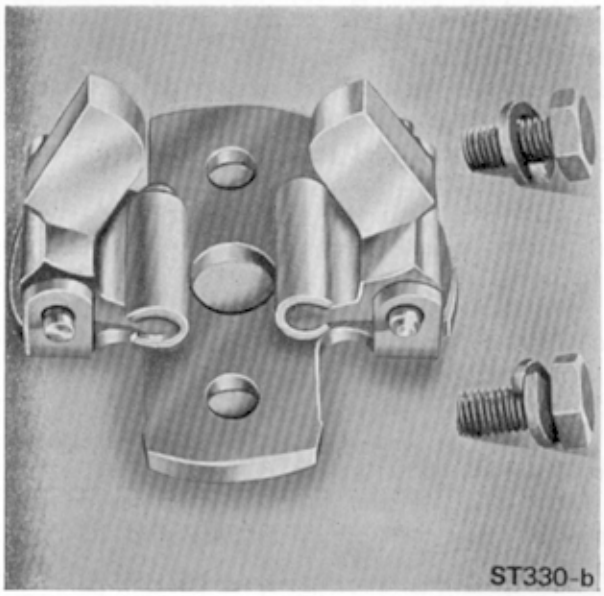
A. 3 Cylinder Engines.
B. 1 & 2 Cylinder Engines.

Fig. 28. Governor Lever Fulcrums

Fig. 29. Governor Sleeve



A. Constant Speed



B. Variable Speed

Fig. 30 Governor Weights

NOTE:- The side mounted speed control lever and associated parts are replaced by an end cover speeder spring adjusting screw on generating set builds.

MANUFACTURERS SPEED SETTING

Each engine is tested and the speed control lever of those Builds not shown in brackets, and the speeder spring adjusting screw of those Builds shown in brackets, are set at R. A. Lister to the following figure:-

R/min 100% load	ST1 Builds	ST2 Builds	ST3 Builds
1200			28
1500	(6),(7),(8),(22)	(4),(5),(6),27,(31)	(3),(4),(21),(27)
1800	(9),(10),(15),(24),(31)	(7),(8),(12),(29)	(5), (6), (9), (24)
2000	1,4,5,11,14,25,26,30	1,9,11,23,32,33	1,8,29
2350	—	25	25
2600	2,3,12,13,21,23,29	2,3,10,21,22,24,28,34, 35	2,7,22,23
3000	20,27,28	20,30	20,26

Note. See Appendix for governor range for each build.

CHANGING GOVERNOR WEIGHTS SPEEDER SPRING AND GOVERNOR WEIGHT SPRINGS

Note. See table on next page for the weights and springs required for various engine speeds.

To Obtain Access

(a) Drain fuel.
(b) Remove fuel pump housing door; disconnect speeder spring.
(c) Disconnect fuel pipe from filter to pump at fuel filter.
(d) Remove strap, tank to cylinder head cover.
(e) Remove end cover complete with tank and filter.

To Change Governor Weight Springs

Unhook governor weight springs, fit new springs (consult table).

To Change Speeder Spring

Disconnect speeder spring from governor link assembly and wire link; remove and fit new spring.

To Change Governor Weights

(a) Remove split pins and washers from the governor lever fulcrum and from the connection to the governor link assembly.
(b) Remove the governor lever.
(c) Pull out governor sleeve.
(d) Remove the two set screws securing the governor weight carrier; remove carrier and weights.
(e) Remove governor weight fulcrum pins, fit new weights and refit pins—check pins for wear.
(f) Refit carrier complete with weights and pins and secure with the two setscrews.
(g) Ensure governor sleeve is clean and replace.
(h) Fit correct governor weight springs (constant speed only).
(j) Replace governor lever with washers and split pins.
(k) Check fuel pump and governor setting, see page 38.

ENGINE CONTROLS

Information on engine controls including variable speed, two speed, remote stopping etc., can be found in Section Five.

Schedule of Governor Weight and Spring Combinations

Combination Code	Number of Cylinders	Governor Weight Part Number (Ident. No.) 2 per set	Governor Weight Spring Part Number (Colour) 2 per Set	Speeder Spring Part Number (Colour) 1 per Set	Idling Spring Part Number (Colour) 1 per Set	REV/MIN RANGE Full Load Range Within 4½%	Full Load Range Within 8%	Full Load Range Outside 8%	Idling Limits
2 GRZ	ST 1—2—3	(2) 572-11380	(Red) 201-10820	(Green) 201-83170	—	1480-2200	1300-2200	—	—
11 GRZ	ST 1—2—3	(11) 572-11640	(Red) 201-10820	(Green) 201-83170	—	1800-2100	1500-2100	—	—
15 GZZ	ST 1	(15) 572-11662	—	(Green) 201-83170	—	2500-3000	2000-3000	1100-2000	800-900
15 GZY	ST 2—3	(15) 572-11662	—	(Green) 201-83170	(Yellow) 204-21491	—	2400-3000	1200-2400	750-850
17 GZY	ST 2—3	(17) 572-11664	—	(Green) 201-83170	(Yellow) 204-21491	2600	2100-2600	1200-2100	750-850
2 GDZ	ST 3	(2) 572-11380	Red/Green 201-10821	(Green) 201-81370	—	1500-1700	1200-1700	—	—
17 GZY	STWM 2—3 Marine Propulsion	(17) 572-11664	—	(Green) 201-83170	(Yellow) 204-21491	—	2100-2600	1200-2100	750-850
2 GRZ	STWMA 2—3	(2) 572-11380	(Red) 201-10820	(Green) 201-83170	—	1500-1790	—	—	—
11 GRZ	STWMA 2—3	(11) 572-11640	(Red) 201-10820	(Green) 201-83170	—	1800-1890	—	—	—
17 GZY	STWMA 2—3	(17) 572-11664	—	(Green) 201-83170	(Yellow) 204-21491	—	2100-2600	1200-2100	750-850
6 GRZ	STWMA 2—3	(6) 572-11590	(Red) 201-10820	(Green) 201-83170	—	1900-2190	—	—	—
5 GRWZ	STWMA 2—3	(5) 572-11580	Red/White 203-10824	(Green) 201-83170	—	2200-2600	—	—	—

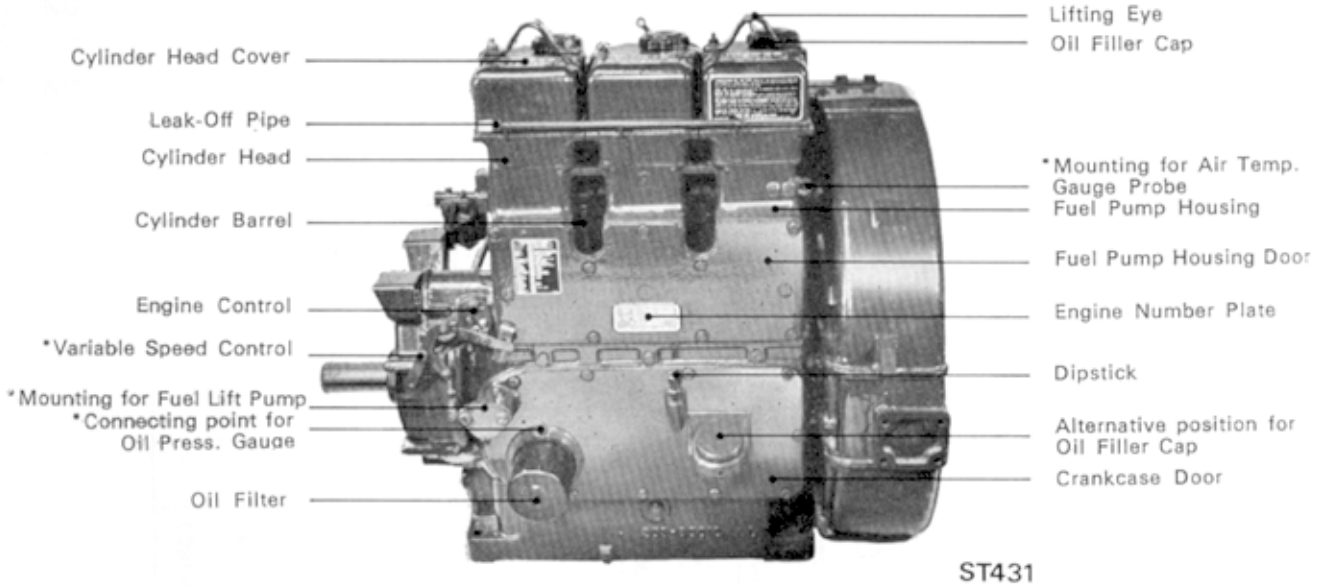


Fig. 31. Features of an ST3 Engine—Fuel Pump Side

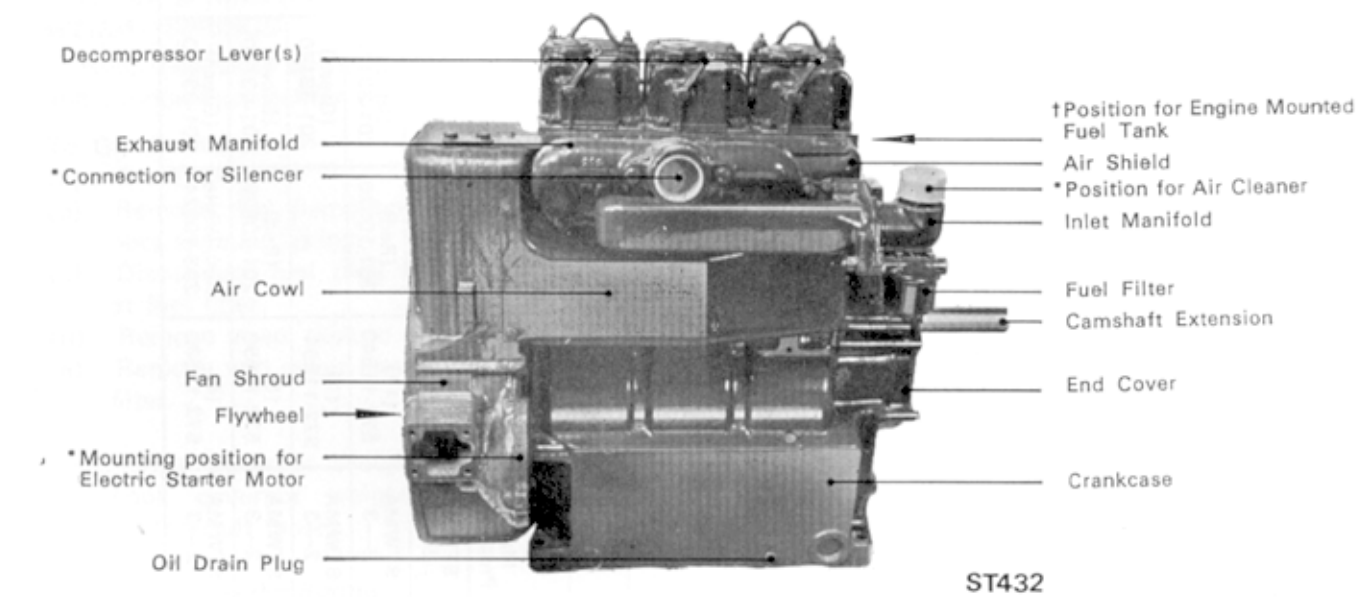


Fig. 32. Features of an ST3 Engine—Manifold Side

*Information on accessories that may be fitted in these positions, can be found in Sections Five and Eight.
†See Section Three.

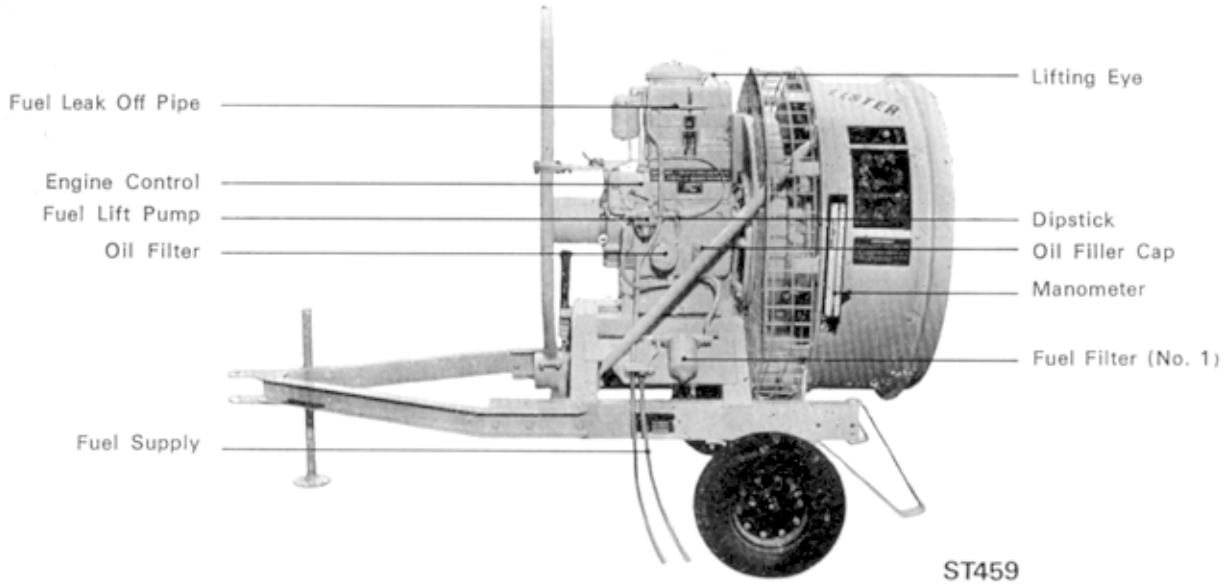


Fig. 33. Features of an ST2 Moisture Extraction Unit—Fuel Pump Side

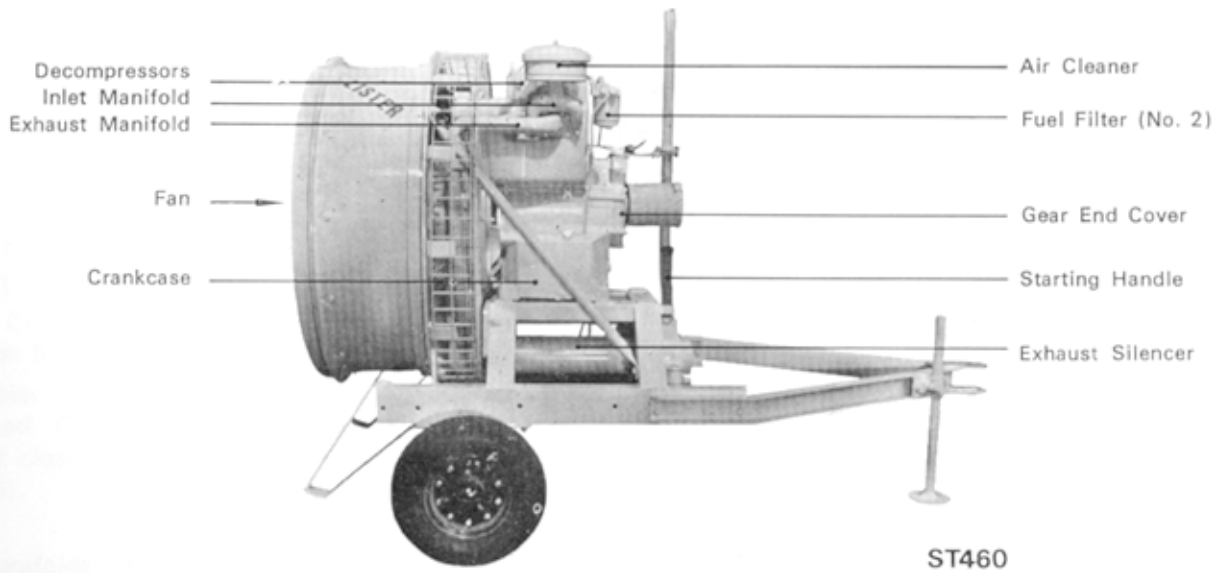


Fig. 34. Features of an ST2 Moisture Extraction Unit—Manifold Side

The illustrations show a mobile unit. Although the engine and fan assembly are basically the same, on a static unit anti-vibration mountings are fitted.

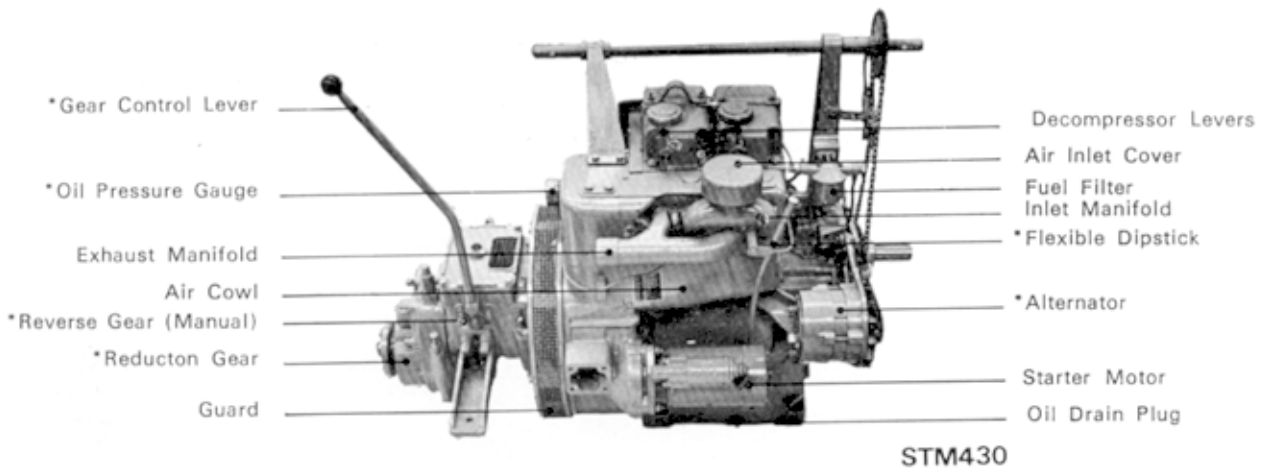


Fig. 35. Features of an ST2M with LM100 Reverse Gear—Manifold Side

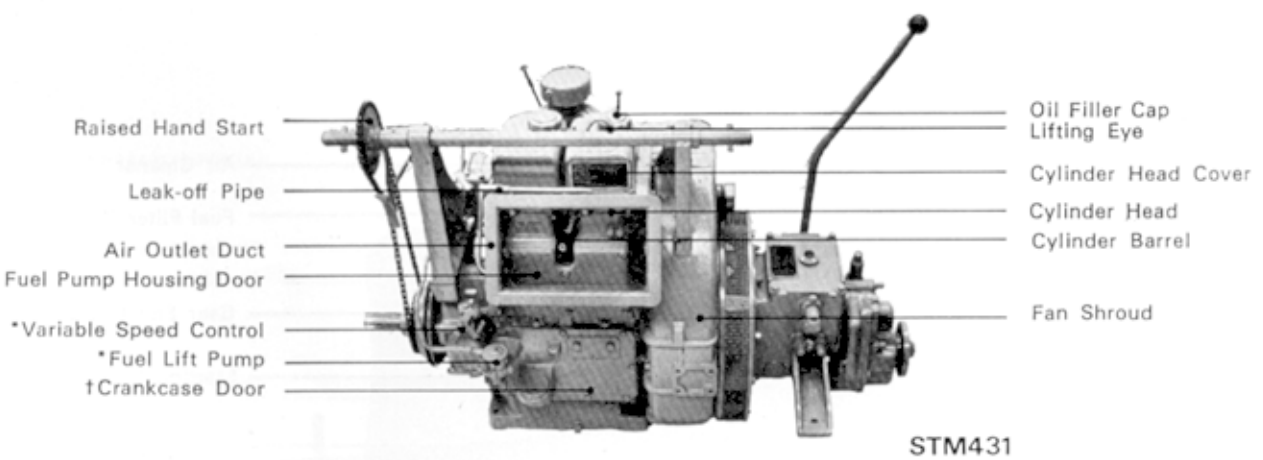


Fig. 36. Features of an ST2M—Fuel Pump Side

*Alternative fittings and further information on these items can be found in Sections Five and Eight.

†The crankcase door may be fitted with dipstick, filler cap and oil filter. See Section Two, Fig. 5.

Note. On later model engines, the lubricating oil dipstick is fitted in the crankcase door, see Section 2. The air intake cover may be replaced by the Lister dry air cleaner, see next page.

INTRODUCTION

Every effort must be made to maintain the engine in a clean condition and oil leaks must be dealt with as soon as they occur. With a new or overhauled engine the joints settle during the first few hours running and their tightness must be subsequently checked. A table showing recommended jointing compounds and how to use them is given on page 64.

LUBRICATION ON ASSEMBLY

When assembling the engine, use a mixture of 2.5% colloidal molybdenum disulphide (Acheson's Hi Load additive or equivalent) and normal engine lubricating oil.

All bearing surfaces must be well lubricated including the valve stems and the cups of the push rods.

New camshaft bushes should be immersed in clean engine lubricating oil for four hours before fitting.

AIR CLEANER, MANIFOLD AND SILENCER

Air Cleaner

Three types of air cleaner may be fitted to ST engines:—

(a) A Lister dry air cleaner fitted directly on to the inlet manifold.

(b) A Lister foam element air cleaner (ST1).

(c) A Cyclopac heavy duty air cleaner.

Details of air cleaners can be found in Section 5.

Note: On ST3 engines, two dry air cleaners are used. On ST3M Marine Propulsion engines an air cleaner/silencer is fitted (see page 67, Fig. 65).

Manifolds and Silencer

The cast iron manifolds with asbestos joints are located on studs in the side of the cylinder head. On single and two cylinder engines the silencer is screwed into the end of the exhaust manifold; on three cylinder engines the silencer is screwed via a socket to the side of the manifold. Remote mounted silencers and air cleaners must be connected by means of flexible pipe or hose with no solid extensions between the manifolds and the flexible element. See Installation Information in Section 1. The various silencers and exhaust pipes that may be fitted are detailed in Section Five.

A cold start oil injector device is mounted on the inlet manifold to assist starting under frosty conditions.

CYLINDER HEAD COVER (Fig. 37)

The cylinder head cover carries the decompressor lever, oil filler cap* and on some cylinders, an engine lifting eye.

*On some engines the oil filler cap is in the crankcase door.

Fig. 37. Cylinder Head Cover

Removing Cover

(a) Remove decompressor coupling rod(s)—if fitted.

(b) Remove cover holding down nuts.

(c) If fitted: Remove support strap to fuel tank; remove lifting eye.
Note: Where a support strap and lifting eye are connected to the same cylinder, a distance piece is fitted under the lifting eye on the stud nearest the tank to compensate for the support strap.

(d) Lift off cover—mark cover with cylinder number.

Breather

A crankcase breather pipe is screwed into the top of each cylinder head and connects with the inlet port. Vapour is drawn into the inlet manifold and a partial vacuum is thus maintained in the crankcase preventing oil leakage through joints and bearings.

Valve Clearance

The valve clearance for both inlet and exhaust set with the engine cold is:—

0.15 mm. (0.006") GO

0.20 mm. (0.008") NOT GO

To Adjust (Fig. 38)

(a) Turn the engine until the piston is on the T.D.C. position firing stroke (both valves closed).

(b) Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.

(c) Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that clearance is correct.

Repeat the procedure for all valves.

Fig. 38. Adjusting Valve Clearance

Refitting Cylinder Head Cover

(a) Apply Hylomar PL32M to cover jointing face and stick joint to it.

(b) Replace cover and fit fuel tank support strap and lifting eye (if applicable).

(c) Refit decompressor coupling rod(s) if removed.

Decompressor Adjustment (Fig. 39)

For engines provided with an oil hole filler in each cylinder head cover, access to the decompressors is through these holes.

(a) Turn the engine until the piston is on T.D.C. firing stroke (both valves closed).

(b) Move the decompressor lever towards the flywheel.

(c) Slacken the locknut and turn the decompressor screw down (clockwise) until the exhaust valve touches the piston.

(d) Turn the screw back half turn and tighten the locknut.

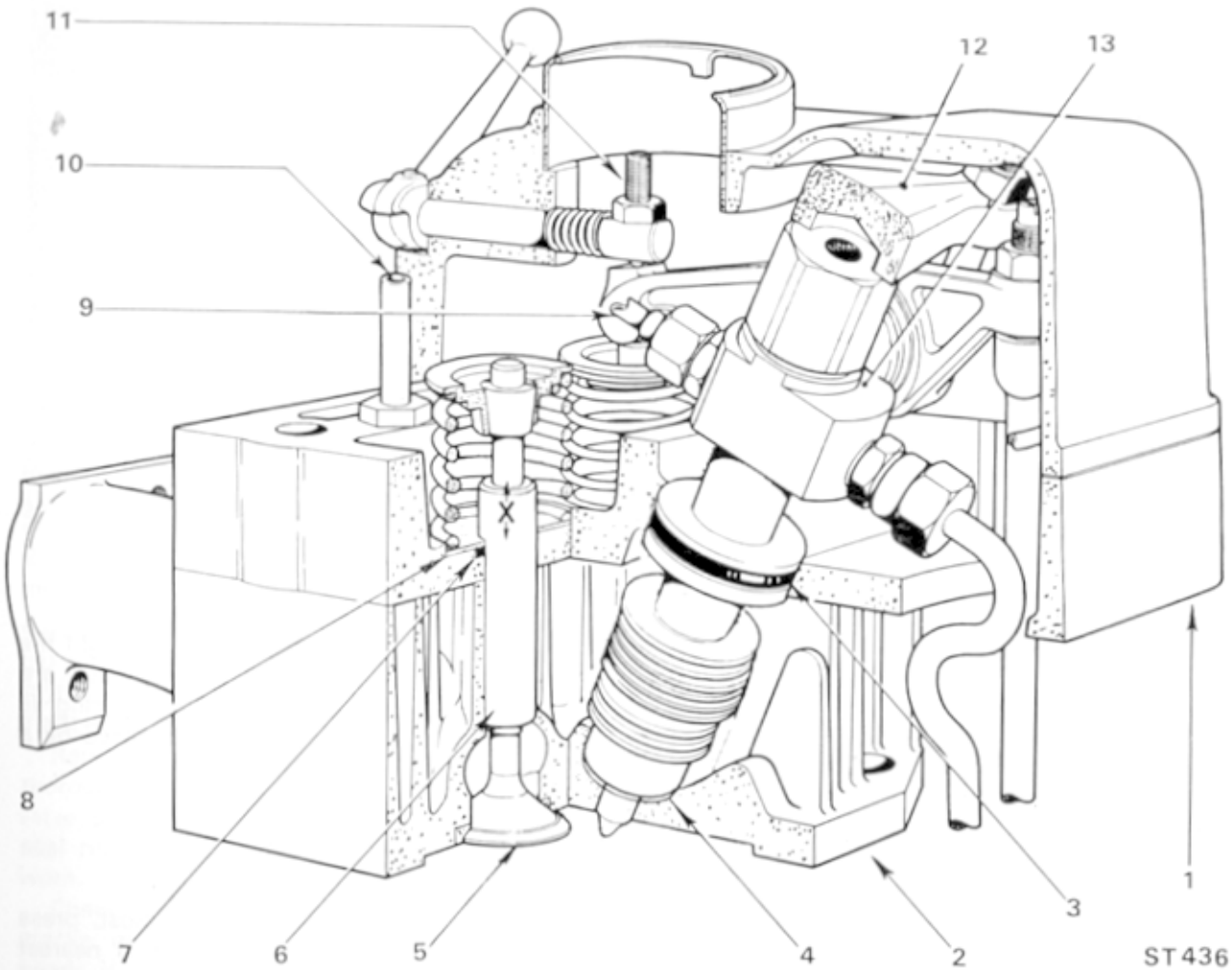
When no oil filler hole is provided in the cylinder head cover, the decompressor should be adjusted so that when the cover is tightened down in position the adjusting screw just touches the valve rocker when operated. The adjusting screw should then be screwed down (clockwise) $\frac{3}{4}$ turn and locked in position. Repeat the procedure for all cylinders.

Fig. 39. Adjusting the Decompressor

CYLINDER HEAD (Fig. 40)

The cylinder head consists of two parts. The top half (top plate) is cast iron and contains the valve gear and breather tube. The lower half (cylinder head) is aluminium alloy in which are fitted the valve seat inserts. The valve guides which are a press fit, hold the two halves together.

Provision is made for a cold start device which is screwed into the machined face above the inlet port.



1. Top plate.
2. Cylinder head.
3. Injector oil seal ring.
4. Injector joint.
5. Inlet valve.
6. Inlet valve guide.
7. Valve guide seal ring.
8. Seal ring retaining plate.
9. Leak-off pipe.
10. Breather.
11. Decompressor.
12. Fuel injector clamp.
13. Fuel injector.

"X" 12.60-13.00 mm. (0.495-0.515 in.)

Fig. 40. Cylinder Head

Removing the Cylinder Head (Fig. 41)

Remove:—

(a) Cylinder head cover. See page 49.
(b) Fuel pump housing door.
(c) Lubricating oil pipe to rockers. (Do not remove restrictor wire from pipes.)
(d) Fuel leak-off pipe—injector to tank. On engines fitted with a self-venting system, disconnect pipe from base of pump(s).
(e) Fuel pipe—fuel pump to injector.
(f) Fuel injector. See Fuel System, Section 3.
(g) Inlet and exhaust manifolds.
(h) Unscrew and remove cold starting device.
(j) Cowling assembly on manifold side.
(k) Four holding down nuts. Two are located on the centre of the rocker brackets and two on the manifold side.
(l) Lift of cylinder head—mark with cylinder number.
(m) Lift out push rods.

Fig. 41. Removing the Cylinder Head

To Remove Valves (Fig. 42)

Depress valve spring and remove collets; release spring and lift off valve spring carrier and spring.

If it is necessary to change rocker lever bush, remove setscrew and spring washer securing valve rocker bracket to head, lift off assembly

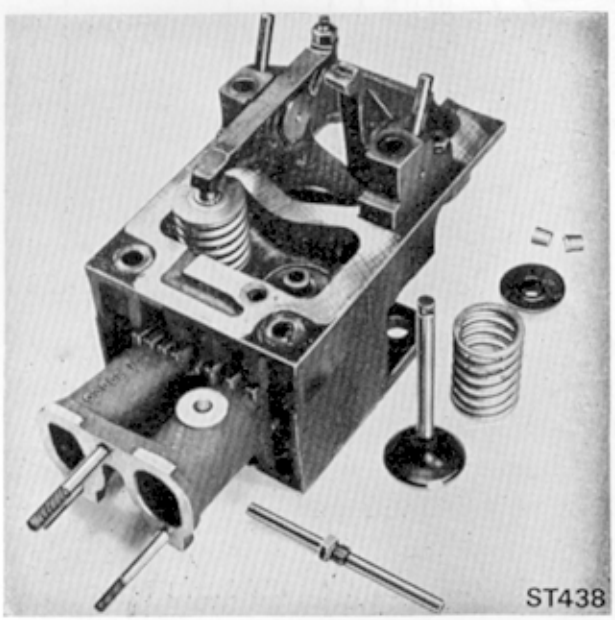


Fig. 42. Removing Valves

When removed, release circlip and slide off rocker lever. Use new joint when refitting assembly (Fig. 43). To prevent damage to the breather tube it is advisable to remove it when servicing the valve gear.

Valve Guides

The valve guides are a press fit and hold the two parts of the cylinder head together, they are not interchangeable. A rubber sealing ring is fitted to the inlet guide and held in place by a retaining plate. See Fig. 40.

Fitting New Guides

(a) Fit rubber ring into recess (inlet).
(b) With lettering IN or EX uppermost, press guides into place. (Inlet valve is nearest breather tube). The guides should project 12.60-13.00 mm. (0.495"-0.515") above the surface of the casting. See X on Fig. 40.
(c) Place retaining plate in position (inlet). Note: A gauge 8.70712 mm (0.3428") diameter must pass through the exhaust valve guide after it is assembled in the head. If it does not go, the guide must be reamed square 8.707/8.727 mm (0.3428"/0.3436") diameter.

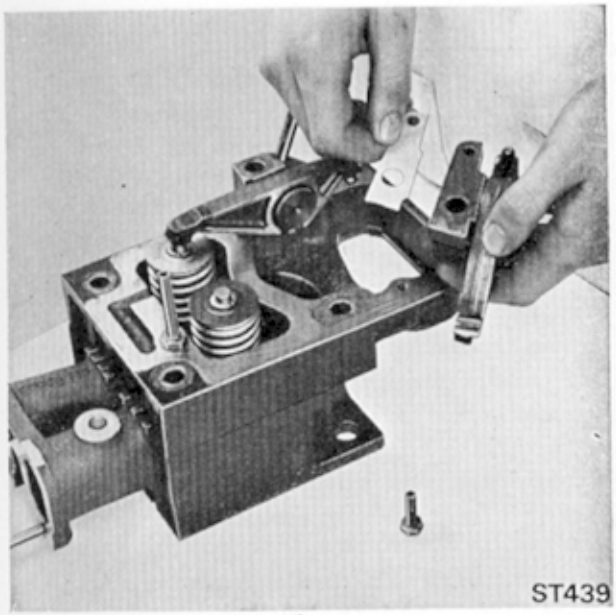


Fig. 43. Valve Rocker Bracket

Valve Seats

The inlet valve is 0.96-1.27 mm. (0.038"-0.050") and the exhaust valve is 0.84-1.14 mm. (0.033"-0.045") below the combustion surface of the head. Width of valve seats: Inlet 1.65-2.29 mm. (0.065"-0.090"); Exhaust 1.35-1.78 mm. (0.053"-0.070").

Servicing

INFORMATION ON WEAR LIMITS CAN BE FOUND ON PAGE 125.

TABLE OF CLEARANCES

Remove carbon from combustion area; thoroughly clean and inspect for cracks. Clean valve guides and check for wear; examine oil seal ring on inlet guide, replace if damaged or worn.

Check valve seats and inspect for nicks cracks or pitting. Reface or change cylinder heads if not within limits. Check valve springs for free length. Examine rocker arms for cracks, damage and wear. Inspect push rods for bends and examine ball and cup ends for wear or cracks.

Refitting the Cylinder Head

Examine the gasket, renew if necessary. Fit the necessary shims—see Checking Cylinder Head Clearance—nearest the head followed by the gasket; these are retained in position with High Melting Point grease (see page 65). The sequence for fitting the head is the reverse to removal. The cylinder head nuts and top threads of the studs should have Wellseal applied.

On multi cylinder engines the inlet and exhaust flanges of all cylinder heads must be lined up with a straight edge, or alternatively fit a manifold before finally tightening down head. Ensure holding down nuts are pulled down evenly and torque loaded to 67.82 Nm (50 lbf.ft.). It is essential that these nuts be tightened before securing the injector. After fitting head(s), reset valve clearance and check decompressor adjustment.

Checking Cylinder Head Clearance (Fig. 44)

Place two pieces of lead wire 1.2 mm. (0.048") thick on the cylinder head, clear of valve recesses and the combustion chamber in the top of the piston; retain in position with grease. Space widely and as near as possible in line with the gudgeon pin. Tighten down the cylinder head to the correct torque loading (see previous paragraph) and turn the piston twice past T.D.C. Remove the cylinder head and measure the thickness of the lead. This should be between 0.89 and 0.97 mm. (0.035 and 0.038"). The clearance is adjusted by 0.076 mm (0.003") and 0.254 mm (0.010") thick shims. The gasket must be placed next to the

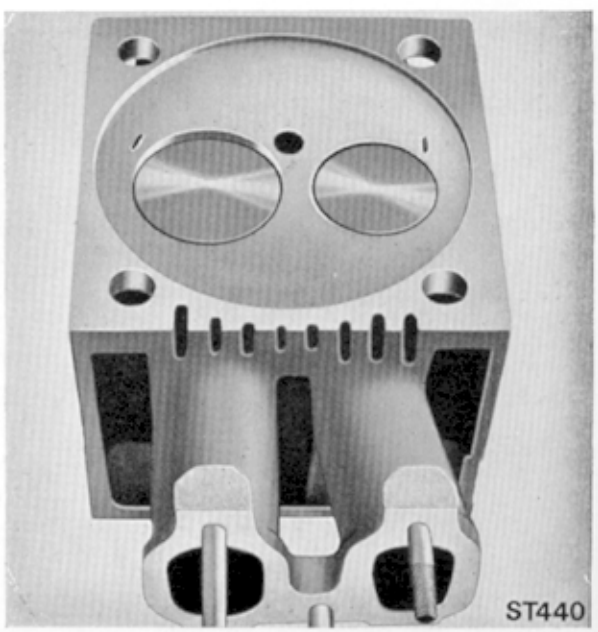


Fig. 44. Checking Cylinder Head Clearance

cylinder; a minimum number of 0.076 thick shims must be used, and placed between the gasket and the 0.254 shims. Great care must be taken not to trap the thin shims on the spigot. If necessary the shims and gaskets may be smeared with a thin film of clean high melting point grease and stuck to the head recess, placing the gasket last.

PISTON, PISTON RINGS AND CONNECTING ROD (Fig. 45)

Piston and Gudgeon Pin

The piston is made of low expansion alloy with a machine recessed combustion chamber in the crown. The gudgeon pin is a clearance fit in the piston and is retained by two circlips. It runs in a copper faced steel backed bush in the small end of the connecting rod.

Piston Rings

Five piston rings are fitted:—

Firing Ring

A barrel lapped chrome ring is situated at the top of the piston and is tapered on the sides to prevent sticking in the groove.

Fig. 46. Side Shield—Gear End

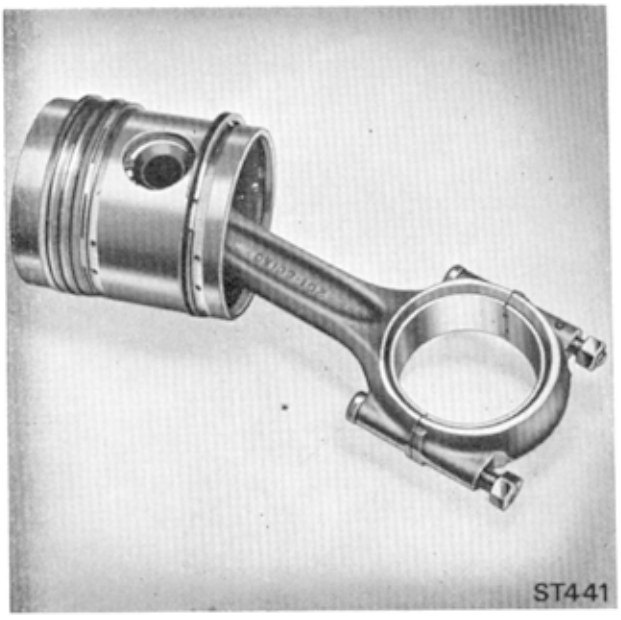


Fig. 45. Piston and Connecting Rod

Compression Rings

Two compression rings are fitted. Each has a tapered face in contact with the barrel. One surface on each is marked TOP and the rings must be fitted the correct way up.

Scraper Rings

One conformable type—with spring expander—is fitted above and a slotted scraper ring fitted below the gudgeon pin.

Connecting Rod and Big End Bearing

The forged steel connecting rod is connected to the crankpin by a conventional big end bearing, the cap held in position by two bolts and nuts. The two halves of the big end bearing are steel backed copper lead. They are precision finished and should not be scraped or touched up in any way.

To Remove Piston, Connecting Rod and Barrel

Note : On multi cylinder engines mark the cylinder number on each assembly removed. No. 1 cylinder is the opposite end to the flywheel.

(a) Remove cylinder head. See page 52.

(b) Remove side shield assembly at the gear end; (Fig. 46) remove air deflector plates between cylinders (on multi cylinder engines).
Note: The side shield on the cylinder barrel at the flywheel end can only be removed with the barrel. Mark positions for refitting.

(c) Remove crankcase door complete with oil filter or adaptor plate.

(d) Remove lubricating oil pipes, distributor block and relief valve. (This will vary according to the number of cylinders; see Section 2).

(e) Remove connecting rod nuts and cap—fit thread protectors (Fig. 47).

(f) Rotate piston to T.D.C.

(g) Mark position of barrel for refitting and remove piston, connecting rod and barrel as a complete unit (Fig. 48).

(h) Withdraw piston from barrel.

(j) Gudgeon pin may be removed by releasing one spring clip and pushing out pin.

(k) Using a standard ring expander, remove piston rings.

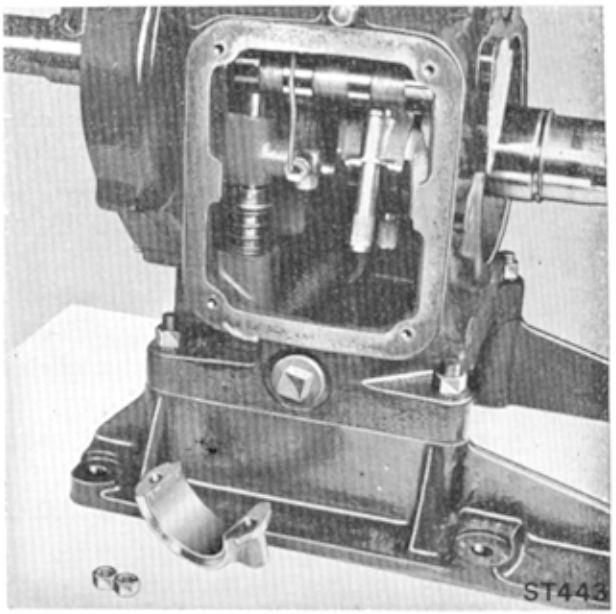


Fig. 47. Big End Bearing

Fig. 48. Removing Cylinder Barrel

Servicing (see page 125, Table of Clearances)

Thoroughly clean the barrel and check for scoring and wear.

Clean the piston, remove all carbon from both upper and underside of head, ring grooves and oil holes.

Check all piston rings in the cylinder barrel for correct gap clearance.

Clean connecting rod and examine for bending and twisting—examine small end bush for wear.

Check the connecting rod bearings and crankpin for signs of wear.

If the big end has been dismantled because of metal failure, the oil passages in the crankshaft must also be examined for obstruction and fragments of metal.

Refitting Piston, Connecting Rod and Barrel:

(a) Fit piston to connecting rod with the wording CAMSHAFT SIDE on piston to the same side as machining numbers on connecting rod. Insert gudgeon pin and circlips.

(b) Fit piston rings as detailed on page 54. (Fig. 49.)

(c) Stagger piston ring gaps and fit piston into barrel.

(d) Ensure bearing shells are correctly located in connecting rod and cap.

(e) Fit joint to bottom of the cylinder using Hylomar PL32M.

(f) Position crankshaft with crankpin to T.D.C.

(g) With the flat sided cylinder fins facing the flywheel and gearwheel ends and the wording CAMSHAFT SIDE on the piston correctly positioned, lower the cylinder, piston and connecting rod assembly into position. Ensure side shield is fitted with barrel on cylinder nearest flywheel.

(h) Push down on piston and turn crankshaft until access is gained to connecting rod bolts; fit cap with bearing shell and torque nuts to 43.40 Nm (32 lbf. ft.).

(k) Refit lubricating oil pipes, distributor block and relief valve (see Section 2).

(l) Coat groove in crankcase door with Bostik 772 and stick joint to it; refit crankcase door.

(m) Replace air deflector plates and side shield, at gear end; refit cylinder head.

Fig. 49. Fitting Piston Rings

CAMSHAFT

The steel camshaft is carried in porous bronze bushes, located in the end cover and the crankcase. Cams actuate the tappets for the oil pump, fuel pump(s) and valves. A gearwheel is keyed on to the camshaft and held in position with a locating pin. The camshaft is extended beyond the end cover and is the same diameter as the crankshaft extension providing a second position for power take off at half engine speed. An oil seal and oil thrower ring in the end cover prevents oil leaks around the camshaft extension.

Engines driving a hydraulic pump from the gear end have a camshaft fitted with two gearwheels, the pump drive being driven by the second gearwheel. See Section Five.

Information on removing and servicing all camshafts is on the following pages.

To Remove Camshaft

(a) Drain fuel.

(b) Remove cylinder head cover and cylinder head. See pages 49 and 52.

(c) Remove fuel pump housing door and crankcase door; disconnect speeder spring.

(d) Turn camshaft keyway to bottom and remove end cover. If an engine mounted fuel tank is fitted, disconnect fuel feed from filter to pump(s), remove leak-off pipe to top of tank, lift off end cover, tank and filter complete (Fig. 50).

(e) Remove fuel pump(s). See page 37.

(f) Remove fuel pump tappet(s); remove tappet guide locating pin and remove guide(s) (Fig. 51).
Note: On variable speed engines the guide locating pin on No. 1 cylinder secures the variable speed control bracket. Ensures it is refitted in the same position.

(g) Remove Jabsco pump (STW only).

(h) Set oil pump to the bottom of its travel and depress the lubricating oil pump return spring until pump tappet is below the level of camshaft bearing (Fig. 52).
For engines fitted with a self regulating pump see page 28.

(j) Hold up valve tappets and remove camshaft; collect tappets. Ensure hands are protected from the edges of keyway on shaft extension when removing camshaft.

Fig. 51. Fuel Pump Tappet and Guide

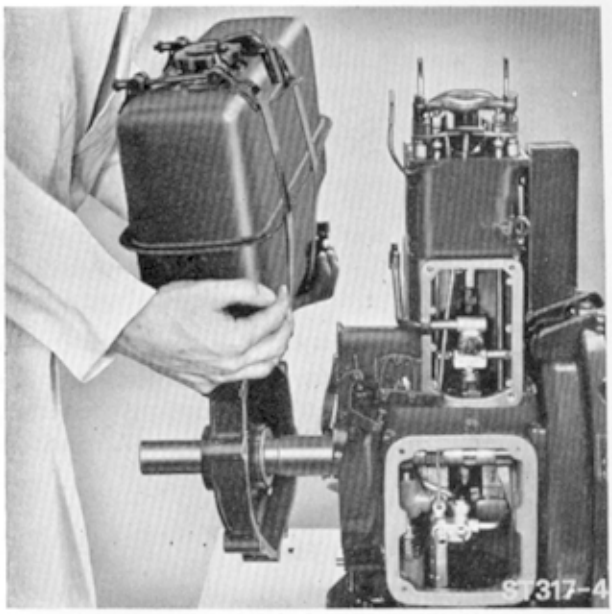


Fig. 50. Removing End Cover and Fuel Tank

Inspection (see page 125. Table of Clearances)
Examine camshaft bushes for scars or wear. Check the camshaft gearwheel and crankshaft pinion teeth for chipping or wear. Ensure cams are not chipped or damaged.
Check the tappets for scars or damage to the contact face.
Examine oil seal in end cover for damage or wear.

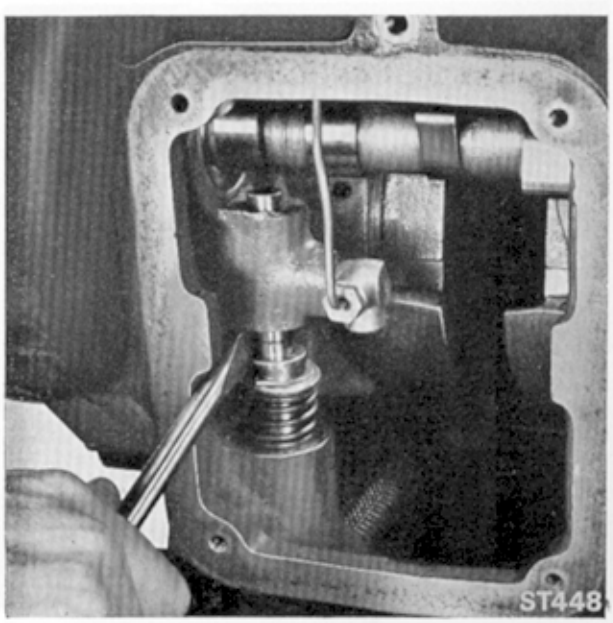


Fig. 52. Depressing Lubricating Oil Pump Spring

Changing Camshaft Bushes

New bushes should be immersed in engine lubricating oil for four hours before fitting. They should be fitted with the thinnest part of the bearing wall towards the top (marked 'O').

A plain bush is fitted at the flywheel end and on multi cylinder engines, plain bushes are fitted in the crankcase dividing walls. A flanged bush is fitted in the end cover and in the crankcase at the gear end.

A service tool is required for fitting and removing the bushes. Full instructions for this operation can be found in Section 7, Service Tools.

Refitting Camshaft and Timing

Refitting the camshaft is carried out in the reverse order to removal. When fitting camshaft ensure 'O' mark on gearwheel coincides with 'O' on crankshaft pinion (Fig. 53).

Fuel pumps are timed in accordance with instructions on page 40. When fitting end cover, use a new joint with Wellseal jointing compound; a tapered sleeve should be fitted to the end cover to prevent damage to the oil seal. See Section 7.

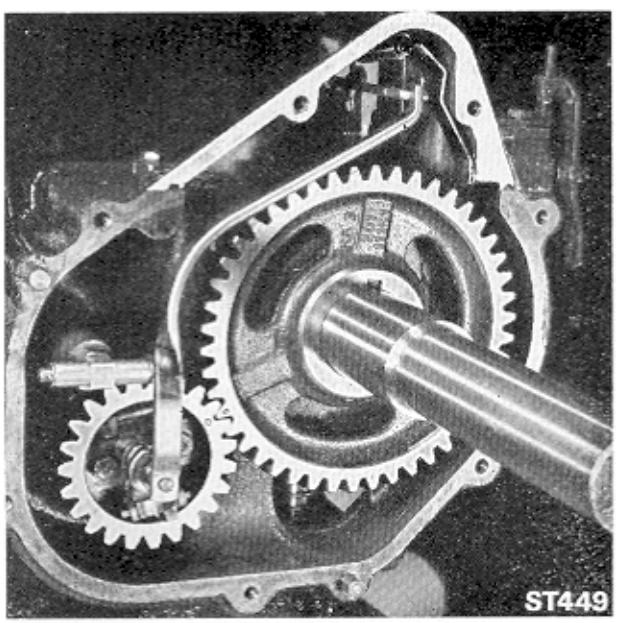


Fig. 53. Camshaft Timing

FLYWHEEL AND FANSHROUD

The type and size of flywheel, and the type of fanshroud—either sheet metal or cast iron—is dependent on the engine build and application. Part numbers, with ordering instructions, for all flywheels and fanshrouds can be found in the appropriate engine Parts List. Should it be necessary to change the application of the engine, R. A. Lister or their Distributors should be consulted.

Flywheel

The cast iron flywheel is mounted on a tapered shaft and secured with a $\frac{7}{8}$" UNF setscrew.

ST1 Engines. An etched line on the rim of the flywheel indicates the T.D.C. position and a Z mark gives the firing position when lined up with the timing mark on the fan shroud.

Multi Cylinder Engines. An etched line for T.D.C. and a Z mark for the firing position are etched on the rear face of the flywheel. They show the respective positions when lined up with an arrow viewed on the rear face of the fan shroud adjacent to the fuel pumps. (Timing information can be found in Section 3.)

To Remove Flywheel

(a) Remove any accessories that may be fitted.

(b) Slacken flywheel retaining screw not more than two turns.

(c) Using service tool—see Section 7—withdraw flywheel.

Refitting is carried out in reverse order. The tapered shaft and the coned bore of the flywheel must be perfectly clean and should be smeared with clean lubricating oil before assembly.

After fitting lockwasher, tighten flywheel retaining screw to a final torque of 406.89 Nm. (300 lbf.ft.); secure screw with lock washer.

Fan Shroud/Flywheel Housing (Fig. 56)

The fan shroud is removed by disconnecting air cowlings and retaining straps from the rear of shroud and removing bolts securing shroud to crankcase. On engines fitted with electric starting, remove starter motor.

Refit in reverse order.

FAN ROTOR AND FLYWHEEL ASSEMBLY—MOISTURE EXTRACTION UNIT (Figs. 54 & 55)

Fan rotor blades of similar weight are selected for each rotor assembly. The complete fan rotor and flywheel assembly is then carefully balanced before being fitted to the unit. If a fan rotor blade is damaged the complete fan rotor and flywheel assembly must be replaced—NOT individual fan blades.

To Remove the Fan Rotor and Flywheel Assembly

(a) Disconnect the fan guard.

(b) Remove the fan casing complete with the stator assembly.

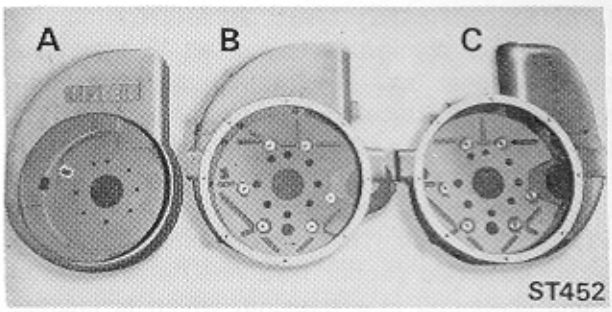
(c) Slacken flywheel retaining screw not more than two turns. Using service tool—see Section Seven—remove flywheel.

Refitting Fan Rotor and Flywheel Assembly

(a) Fit the flywheel assembly and torque load retaining screw to 406.89 Nm. (300 lbf.ft.); secure tab washer.

(b) Fit the fan casing dowel with the fan casing.

(c) Check the distance between the tips of the blades and the inside of the casing—this is adjusted by shims placed under the engine between the crankcase and the main frame. A rod of 2.5 mm. (0.1 in.) diameter must pass between the tip of any blade and the casing.



A. Sheet Metal—Clockwise
B. Cast Iron—Clockwise
C. Cast Iron—Anti-clockwise

Fig. 56. Fan Shrouds

Fig. 54. Casing and Stator (M.E.U.)

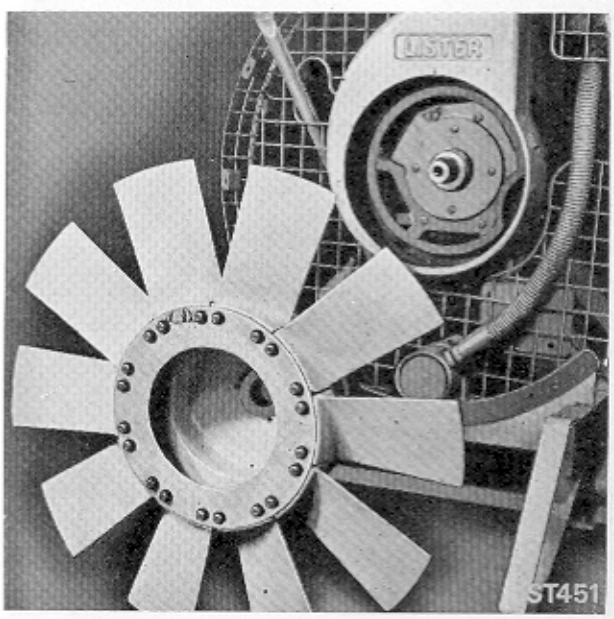


Fig. 55. Fan Rotor and Flywheel (M.E.U.)

CRANKSHAFT AND MAIN BEARINGS

The steel crankshaft is carried in two steel backed copper lead lined split bush main bearings which are located in the crankcase at the gear end and in a housing at the flywheel end. Intermediate main bearings are fitted in multi cylinder engines, one in ST/STW2 and two in the ST/STW3 engine. The intermediate main bearing(s) comprise copper lead lined steel backed shells contained in a housing, which is located in the crankcase by a plain hollow dowel tapped at one end.

End thrust is taken on steel backed copper based split thrust washers fitted inside the crankcase at the gear and flywheel ends. A pinion is keyed on to the end of the crankshaft and engages with the camshaft gearwheel. Shims are fitted between the main bearing housing and the crankcase to provide crankshaft end float adjustment. An oil thrower ring which fits over the crankshaft is held in position by the main bearing and a screw type oil seal and a felt ring seal the crankcase at the flywheel end.

Key to Fig. 57
A. Screw type oil seal.
B. Felt ring
C. Oil thrower ring

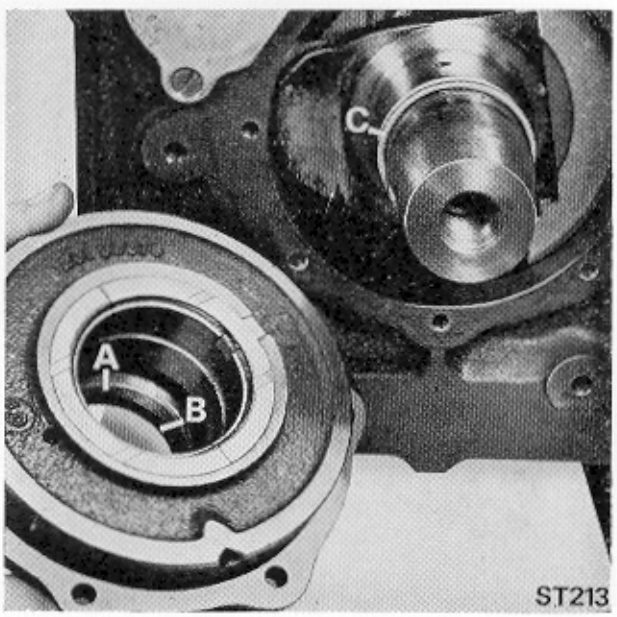


Fig. 57. Main Bearing Housing

To Remove Crankshaft

(a) Drain fuel tank and lubricating oil sump.
(b) Remove:—
Cylinder Head (page 52—page 71 STW).
Piston and Barrel (page 54—page 73 STW).
Camshaft (page 57).
Flywheel and Fanshroud (page 58).
(c) Remove governor lever; unscrew governor lever fulcrum; remove governor assembly complete from inside crankshaft pinion.
(d) Remove crankshaft pinion—keyed—using withdrawal tool. See Section 7.
(e) On ST1 engines fitted with heavy balance weights: remove capscrews and weights. (See Engine Parts List.)
(f) Remove main bearing housing taking care to retain any shims which may be fitted; remove split thrust washer; slide off oil thrower ring.
(g) Multi cylinder engines. Insert a $\frac{1}{4}$" UNF bolt into the end of the centre bearing(s) locating dowel and remove (Fig. 58).
(h) Withdraw crankshaft through the housing bore; remove split thrust washer (gear end).
(j) Note the position of intermediate bearings for refitting. Unscrew and remove the two capscrews; separate the two halves of the bearing housing (dowelled).

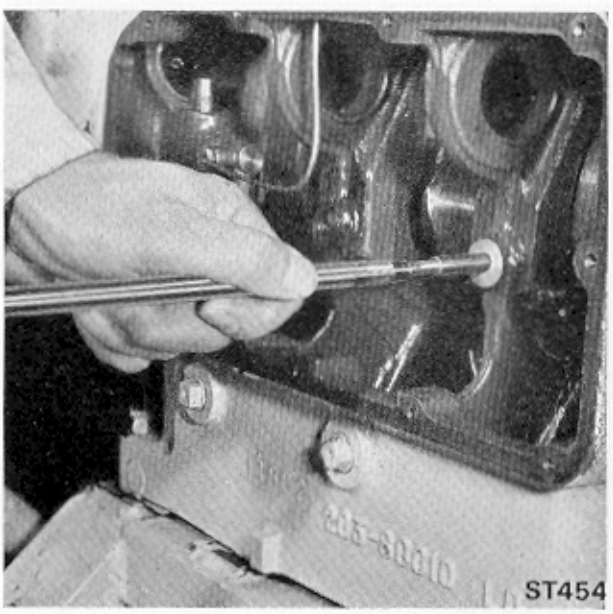


Fig. 58. Removing Bearing Locating Dowel

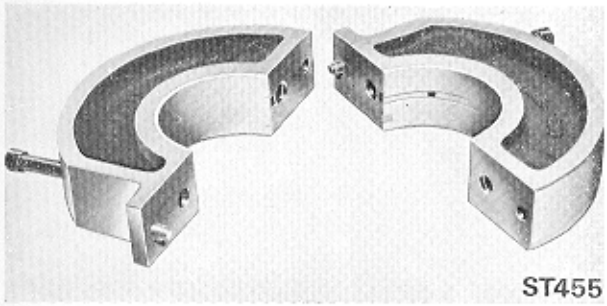


Fig. 59. Intermediate Bearing

Servicing. See Table of Clearances, page 125

Inspect main bearings for scoring or wear, replace bearings if necessary. See Section 7. Check clearance between crankshaft journals and main bearings and crankpin and connecting rod bearing(s).

Examine crankshaft for scoring or wear. If a standard set of bearings will not fit with the required clearance, regrind and fit undersize bearings.

Replace split thrust washers if damaged or worn.

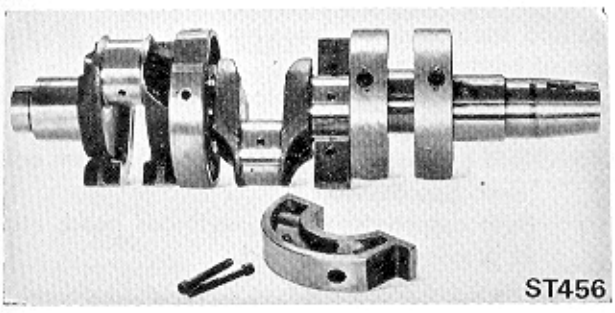


Fig. 60. Crankshaft ST/STW3

Fig. 61. Bearings in Crankcase (ST1)

To Refit Crankshaft.

Note: Intermediate bearings are marked on one side FLYWHEEL END and should be fitted correctly. On three cylinder engines the bearings are in matched pairs and can be identified by the machining numbers stamped on the side.

(a) If required, fit new bearings in crankcase and main bearing housing with grooved shell to the top and oil holes lined up.

(b) Fit split thrust washer at gear end with tabbed piece to the top, copper face towards crankshaft. Grease may be used to retain thrust washer in position while offering up crankshaft.

(c) Multi cylinder engines. Fit two halves of intermediate bearing on correct crankshaft journal. Note, when crankshaft is refitted, the locating dowel must line up with hole on fuel pump side of crankcase.

(d) Insert crankshaft. On multi cylinder engines, locate intermediate bearing(s). Fit dowel(s) with the threaded portion to the outside.

(e) Fit split thrust washers—flywheel end—position oil thrower ring on crankshaft.

(f) Fit main bearing housing and shims after coating one side of each jointing face with Wellseal. Ensure housing is fitted with oil drain hole to the bottom.

(g) On ST1 engines with heavy balance weights—refit weights using new capscrews. Torque load to 43.40 Nm (32 lbf.ft.); lock capscrews in position.

(h) Check crankshaft end float (Fig. 62).

(i) Set a dial test indicator so that the actuating plunger makes contact with the flywheel end face of the crankshaft.

(ii) Push crankshaft firmly towards gear end of engine and zero indicator.

(iii) Push crankshaft firmly towards the flywheel end of engine and note reading.

End float should be:—

ST1

0.179-0.254 mm. (0.007"-0.010")

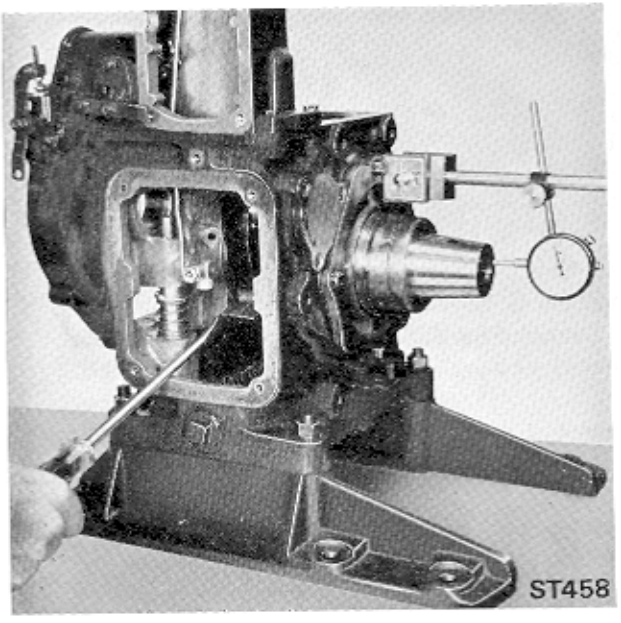


Fig. 62. Checking Crankshaft End Float

ST/STW2 & 3

0.229-0.305 mm. (0.009"-0.012")

This can be adjusted by 0.08, 0.13 or 0.25 mm. (0.003", 0.005", 0.010") metal shims, fitted behind main bearing housing. See page 64 for use of jointing compound.

(j) Heat crankshaft pinion and refit; ensure timing mark 'O' faces outwards.

(k) Refit governor weights, sleeve, fulcrum and lever. See Section 3.

(l) Refit camshaft, piston, cylinder head, etc. as previously described.

NOTE. **After a complete overhaul, the Initial Attention instructions on page 21 should be observed.**

DECARBONISING

Decarbonising should be carried out after 2000 hours running or if the engine shows loss of compression or blow-by past the piston. To gain access, remove the cylinder barrel, piston and rings. See page 54.

Thoroughly clean and examine for damage or wear:—

1. Piston.
2. Piston rings and grooves.
3. Combustion chamber in the top of the piston.

4. Valve ports, valves and valve seats.
5. Exhaust manifold, piping and silencer.
6. Fins on cylinder, cylinder head and injector (ST).
7. Check cylinder blocks and heads for sludge deposits (STW).
8. Regrind the valves.

Renew any defective parts as necessary, reassemble as detailed on previous pages.

CLEANING COOLING FINS (ST only)

The cylinder, cylinder head and injector cooling fins must be kept reasonably clean if the engine runs at high loads and speeds, otherwise seizure of various components can occur due to overheating.

Cleaning frequency depends on the nature and concentration of the substances contained in the cooling air. For example, fluff, hair, vegetable fibre, etc., have a greater clogging effect than dry dust.

The fins should always be cleaned when the engine is decarbonised but can also be cleaned by removing the manifold and air cowl and raking the dust off the fins with a hooked piece of wire.

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 in tank with a small supply of calibration fluid or equivalent.
2. Drain lubricating oil from sump and refill with Shell Ensis 20 or equivalent.
3. Run the engine for a period to circulate the Ensis oil through the system and to ensure the calibration fluid 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 calibration fluid should be left in the fuel system.
5. Drain water from engine (STW).
6. Seal all openings on the engine with tape.
7. Remove batteries, when applicable, and store fully charged with the terminals coated with Vaseline (petroleum jelly).
8. Grease all external bright parts and control linkage, etc.
9. Tie labels on the engine clearly stating what steps have been taken to inhibit the engine during storage, as above.

If the above is not carried out then the engine should be run about 15 minutes once a month —preferably on load.

SPANNER TORQUES

Thread Size	Torque Nm.	Torque (lb.ft.)	Location
$\frac{1}{4}$" UNF	11.53	(8.5)	
$\frac{5}{16}$" UNF	20.34	(15)	Injector clamp nuts (ST). Rocker adjusting screws.
$\frac{3}{8}$" UNF	54.25	(40)	Balance weight setscrews.
$\frac{3}{8}$" UNF	43.40	(32)	Injector clamp screw (STW) Connecting rod nuts.
	10.85	(8)	Flexible couplings.
$\frac{7}{16}$" UNF	39.38	(29)	C40 Dynamo and 11 AC Alternator
$\frac{7}{16}$" UNF	67.82	(50)	Cylinder head holding down nuts.
$\frac{1}{2}$" UNF	92.23	(68)	
$\frac{7}{8}$" UNF	406.89	(300)	Flywheel retaining screw.
M12 x 1.5	28.48	(21)	Fuel injector pipe nuts.
M21 x 1.5	88.16	(65)	Injector cap nut and lock nut.
M18 x 1.5	54.25	(40)	Fuel pump delivery valve holder.
M14 x 1.5	44.76	(33)	15 ACR and 17 ACR Alternator.
$\frac{9}{16}$" UNF	135.63	(100)	
$\frac{5}{8}$" UNF	54.25	(40)	AC5 Alternator.
$\frac{5}{8}$" UNF	203.44	(150)	

JOINTING COMPOUNDS

JOINT DESCRIPTION	JOINTING COMPOUND TO BE USED	INSTRUCTION FOR APPLYING COMPOUND
Valve gear cover	Hylomar PL32M	Coat valve gear cover jointing face and stick joint to it.
Fuel pump housing door and crankcase door	Hylomar PL32M	Coat door jointing face and stick joint to it.
Fuel pump housing to crankcase, rubber joint	Bostik 772	Coat housing groove and stick joint to it.
Fuel pump housing to crankcase, flat joint	Hylomar PL32M	Coat housing on jointing face, stick joint to it and coat joint.
Fuel pump housing top rubber joint ring	Bostik 772	Coat housing groove and stick joint to it.
Crankcase door (pressed steel)	Bostik 772	Coat door groove and stick joint to it.
Gear case cover	Wellseal	Coat gear case on joint face, stick joint to it and coat joint.
Crankshaft bearing housing shims	Wellseal	Coat all joint surfaces on one side—tighten bolts and re-tighten after about 10 mins.
Bottom of cylinders	Hylomar PL32M	Coat cylinder on jointing face, stick joint to it and coat joint.
Camshaft cover in crankcase	Hylomar PL32M	Apply a little compound to ring recess in cover.
Oil seals — Crankshaft	Hylomar PL32M	Apply a little compound to outside diameter of seal.
Oil pump suction plug	Hylomar PL32M	Coat plug threads and both sides of joint.
Leak off connection at leak off manifold	Hylomar PL32M	Coat threads lightly before screwing connection.
Cylinder head nuts and top thread of cylinder studs	Wellseal	Dip nuts and coat stud threads and area of cylinder head or rocker bracket in contact with nuts.

JOINTING COMPOUNDS—cont.

JOINT DESCRIPTION	JOINTING COMPOUND TO BE USED	INSTRUCTION FOR APPLYING COMPOUND
Crankshaft felts	Wellseal	Coat inside of groove for felt before inserting felt. Ensure felt is not distorted during fitting.
Internal lubricating oil pipes pushed into holes in the crankcase and end bearing housing	Hylomar PL32M	Coat the last 15 mm ($\frac{5}{8}$") of pipe, taking care not to coat the very end of the pipe as otherwise jointing compound will be fed into the oil stream.
Water cooled cylinder holding down stud tubes	Hylomar PL32M	Lightly smear the inside of the hole and the outside of the tube at the press fit end. Do not use any compound at the 'O' ring end—the ring may be kept in position with a little Shell Alvania 2 grease.
Cylinder shims and gasket—water cooled engines (STW)	Wellseal	Lightly coat the recess on the head where the joints seat and the side of the counter bore. Place each shim in the recess and coat it in turn and finally place the thick gasket and coat it. The top of the cylinder is not coated. Use very little compound or grease.
Cylinder shims and gasket—air cooled engines (ST)	High Melting Point Grease	
Sump drain plug	Hylomar PL32M	Coat threads.
Fuel lift pump pipes with solderless unions	Wellseal	Place the nut on the pipe; coat the end of the pipe and assemble the olive to the pipe. Keep the jointing compound from the inside of the pipe.
Taper sump pump drain	Wellseal	Coat threads.

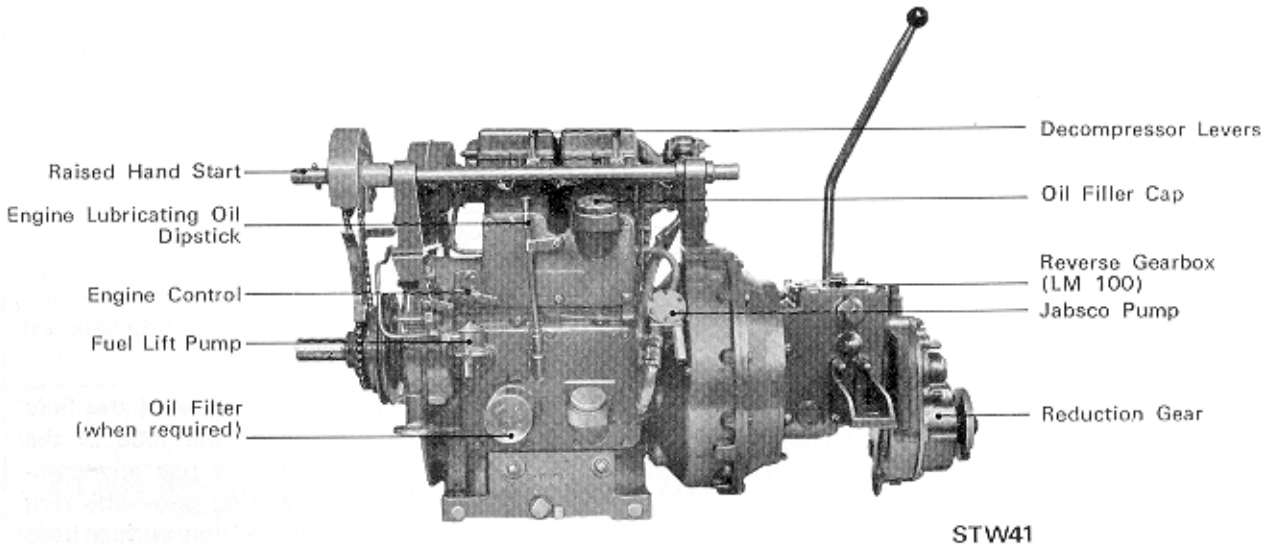


Fig. 63. Features of an STW2M—Fuel Pump Side

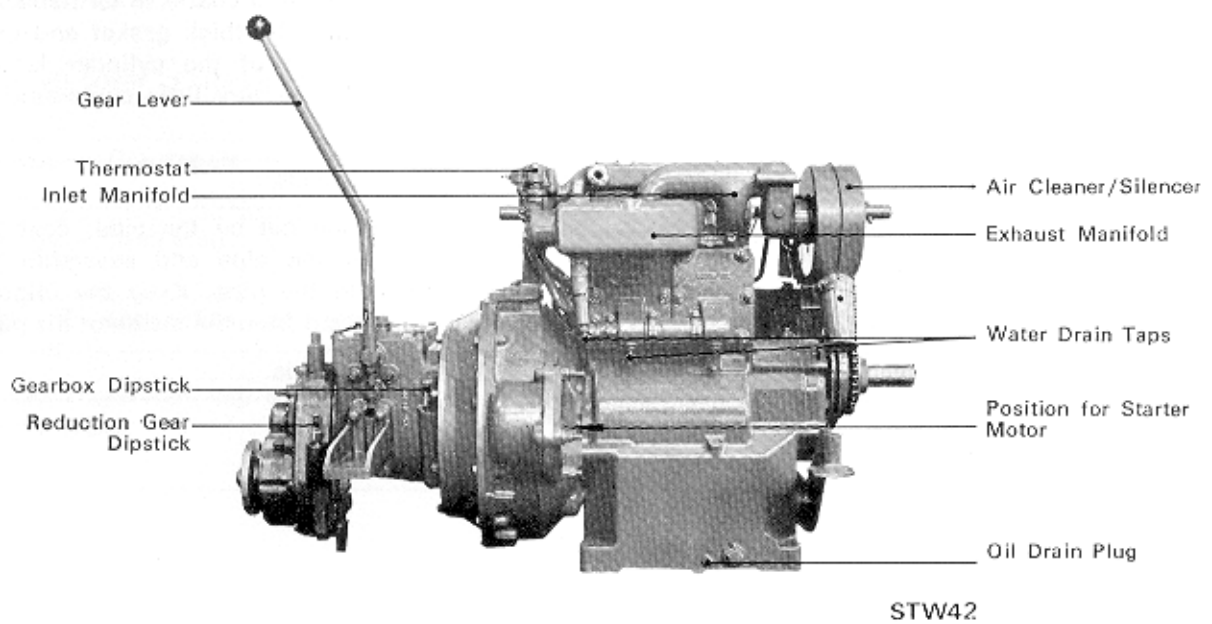


Fig. 64. Features of an STW2M—Manifold Side

INTRODUCTION

Every effort must be made to maintain the engine in a clean condition and oil leaks must be dealt with as soon as they occur. With a new or overhauled engine, the joints settle during the first few hours running and their tightness must be subsequently checked. A table showing recommended jointing compounds and how to use them is given on page 64.

LUBRICATION ON ASSEMBLY

When assembling the engine, use a mixture of 2.5% colloidal molybdenum disulphide (Acheson's Hi Load additive or equivalent) and normal engine lubricating oil.

All bearing surfaces must be well lubricated including the valve stems and the cups of the push rods.

New camshaft bushes should be immersed in clean engine lubricating oil for four hours before fitting.

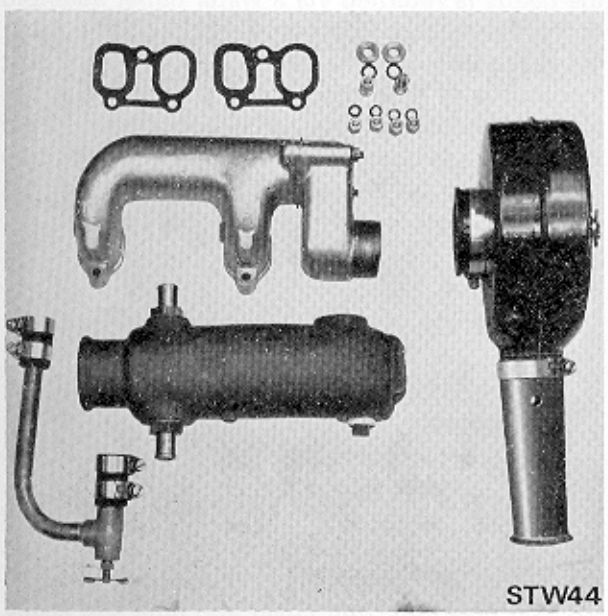


Fig. 66. Manifolds and Fittings

AIR CLEANER/SILENCER AND MANIFOLDS

An air cleaner/silencer (Fig. 65) is secured by clips to the inlet manifold and the cast iron manifolds with asbestos joints are secured by brass nuts to studs on the side of the cylinder heads. Before removing manifolds, drain water and remove pipe between thermostat and exhaust manifold. On marine propulsion engines a flexible exhaust system is fitted and consideration should be given to the Installation Information on pages 9 and 13.

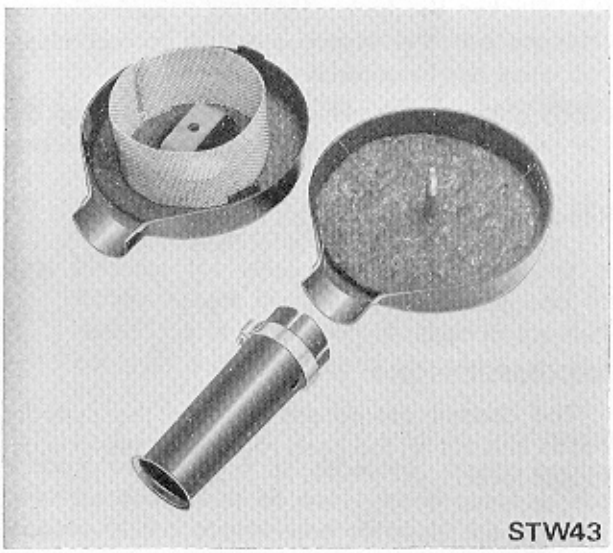


Fig. 65. Air Cleaner/Silencer

CYLINDER HEAD COVER

The cylinder head cover is retained in position by three screws, the longer being fitted on the manifold side; Hylomar PL32M is used between cover and cover joint. The lifting eye is secured to two of the water outlet manifold studs—with distance pieces—and to two studs on the fuel pump side of the cylinder head cover.

Breather

A crankcase breather pipe is screwed into the top of each cylinder head and connects with the inlet port. Vapour is drawn into the inlet manifold and a partial vacuum is thus maintained in the crankcase preventing oil leakage through joints and bearings.

Valve Clearance

The valve clearance for both inlet and exhaust set with the engine cold is:-

0.56 mm (0.022") GO

0.61 mm (0.024") NOT GO

To Adjust (Fig. 67)

(a) Turn the engine until the piston is at the T:D.C. position firing stroke (both valves closed).

(b) Slacken the locknut on the adjusting screw and turn the screw until the correct clearance has been obtained.

(c) Tighten the locknut whilst restraining the adjusting screw and re-check to ensure that clearance is correct.

Repeat the procedure for all valves.

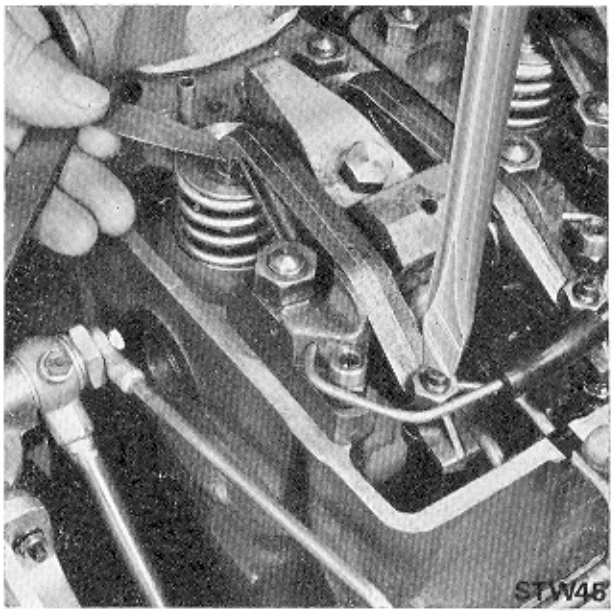


Fig. 67. Adjusting Valve Clearance

DECOMPRESSORS

The decompressors are fitted in the cylinder heads and act on the push rod end of the exhaust rocker lever.

To Adjust

Turn the engine until the piston of the cylinder being adjusted is at T.D.C. firing stroke and turn the decompressor screw until it just begins to lift the valve when the decompressor lever is operated; the screw should then be given one turn clockwise and locked. Repeat the procedure for all cylinders.

COOLING SYSTEM

The cooling system consists of a Jabsco pump, driven by a helical gear from the camshaft, which supplies water through a copper pipe to the cylinder blocks. The water is circulated through the blocks and cylinder heads and from the heads is returned via a water outlet manifold to the thermostat. From the thermostat, the water is passed through an external pipe to the exhaust manifold and then discharged through an outlet pipe. When the engine is cold, the water from the Jabsco pump goes directly through the thermostat to be discharged through the exhaust manifold.

Thermostat (Fig. 69)

To change the thermostat unit:-

(a) Drain water.

(b) Remove pipe from thermostat to exhaust manifold.

(c) Remove screws and lift off thermostat cover.

(d) Fit new unit; refit cover and pipe and check for leaks.

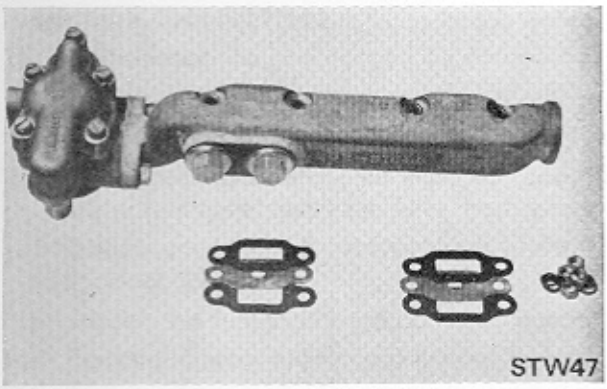


Fig. 68. Water Outlet Manifold with Thermostat

Water Outlet Manifold (Fig. 68)

To remove:-

(a) Drain water.
(b) Disconnect all pipes to thermostat.
(c) Remove inlet and exhaust manifolds.
(d) Remove nuts securing water outlet manifold to cylinder heads and remove lifting eye; lift off manifold and thermostat complete.

Note: A metal restrictor plate is fitted between two rubber joints between the outlet on each cylinder head and the manifold. Ensure the rubber joints are in good condition—replace if necessary.

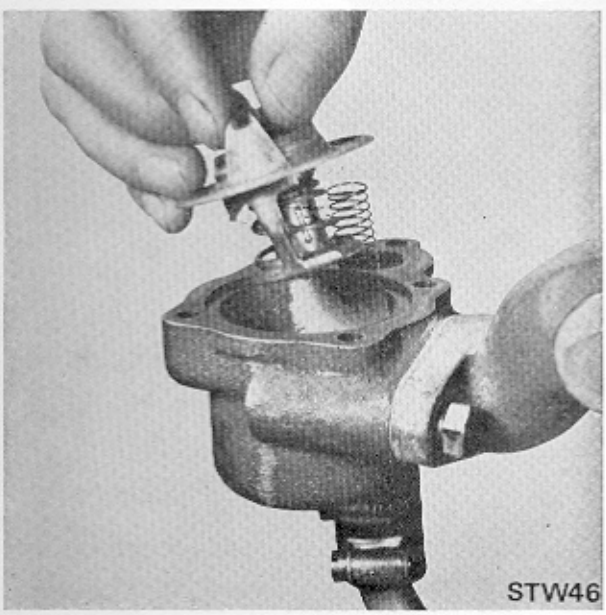


Fig. 69. Thermostat

JABSCO PUMP (Fig. 70)

To remove the impeller:-

(a) Drain water.
(b) Remove pump end cover (6 screws) and joint.
(c) Using thin nose pliers, pull out impeller.

To refit:-

(a) Fit impeller screw into impeller.
(b) Apply a coating of soft grease to impeller bore.
(c) Start impeller into bore of pump using a rotary motion until the screw engages in the slot in the shaft.
(d) Fit new joint and refit end cover (two when engine is keel cooled).
(e) Reconnect water pipes and check for leaks.

To remove pump complete:-

(a) Drain water.
(b) Disconnect water supply to pump and pipe from pump to engine.
(c) Remove the two bolts securing pump to flange, rotate pump anti-clockwise and lift out. (This is to prevent damage to the helical gear with the camshaft, see inset Fig. 70).

Fitting is carried out in the reverse procedure; ensure paper joint is renewed, check helical gear for wear, and fill water pump gearbox with engine oil to overflowing through the breather pipe.

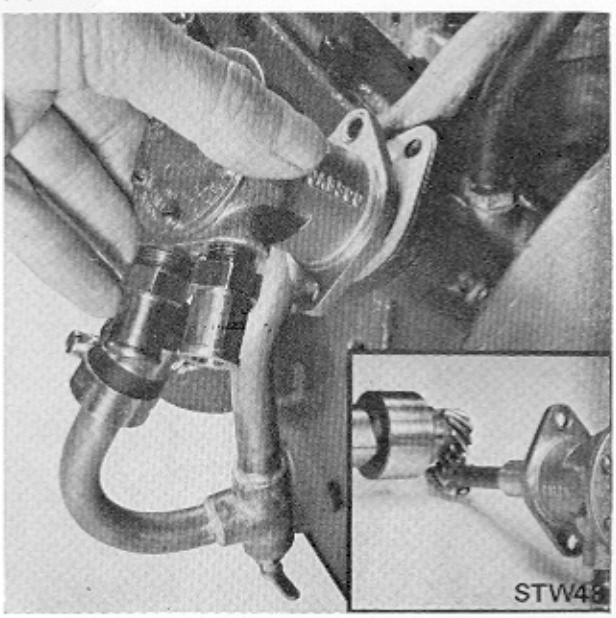
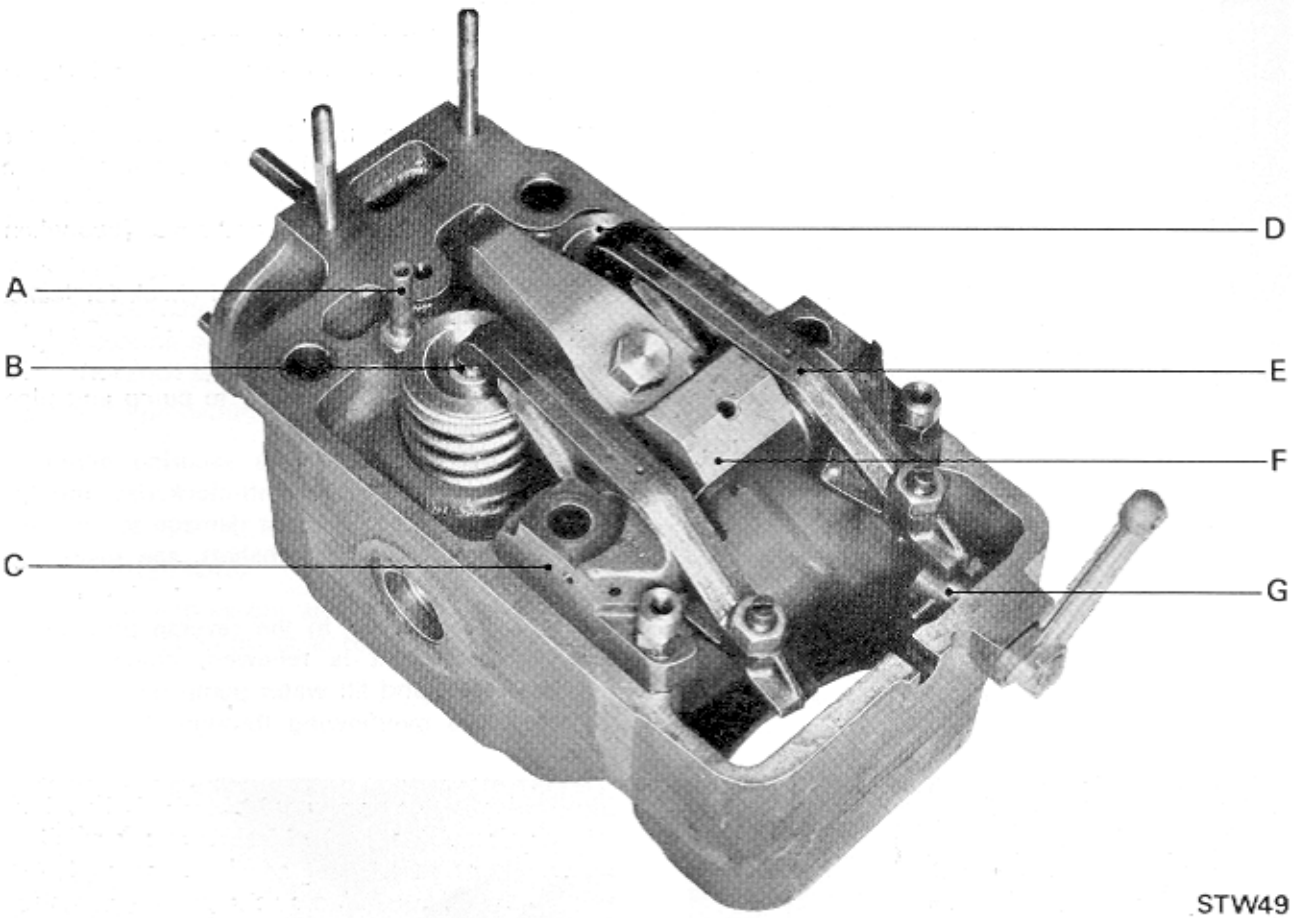


Fig. 70. Jabsco Pump

CYLINDER HEAD (Fig. 71)

The cast iron cylinder head is made in one piece and contains the valve gear, injector and breather tube. The valve guides are a press fit into the head and are not interchangeable.



A. Breather
B. Inlet Valve
C. Rocker Lever Bracket
D. Exhaust Valve
E. Rocker Lever
F. Injector Clamp
G. Decompressor

Fig. 71. Cylinder Head

Removing a Cylinder Head

(a) Drain water.

(b) Remove cylinder head cover and lifting eye.

(c) Remove fuel pump housing door.

(d) Disconnect lubricating oil pipe to rockers. Do not remove restrictor wire from pipe.

(e) Disconnect fuel leak-off pipe from injectors and fuel filter.

(f) Disconnect fuel pipe from pump to injector.

(g) Remove injector clamp and lift out injector.

(h) Remove inlet and exhaust manifolds and water outlet manifold with thermostat—see page 69.

(j) Remove circlips retaining valve rocker levers and move rocker levers to enable a socket to be fitted on cylinder head holding down nuts. (Fig. 72.)

(k) Remove the four holding down nuts; lift off head (Fig. 73). Mark cylinder number for refitting and keep shims and gasket with head.

(l) Lift out push rods.

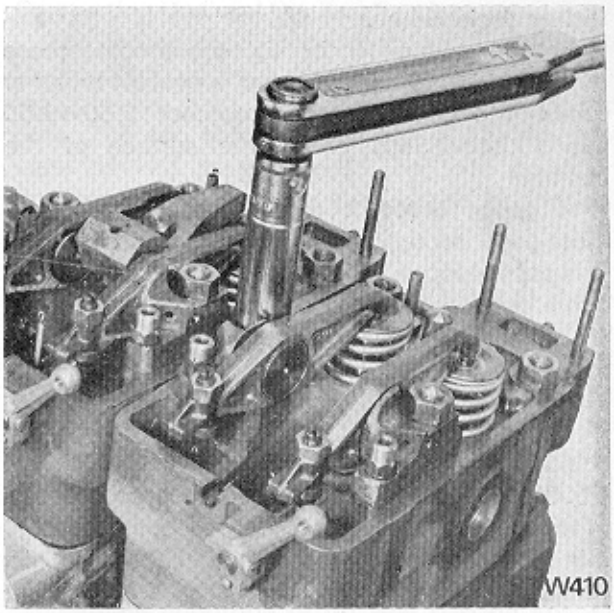


Fig. 72. Removing Cylinder Head Nuts

To Remove Valves (Fig. 74)

Depress valve spring and remove collets; release spring and lift off valve spring carrier and spring.

The rocker lever may be removed by releasing circlip and sliding lever off shaft.

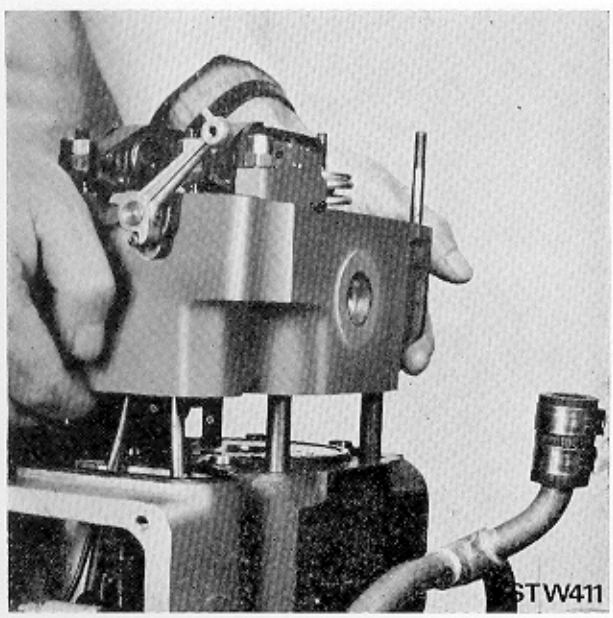


Fig. 73. Removing a Cylinder Head

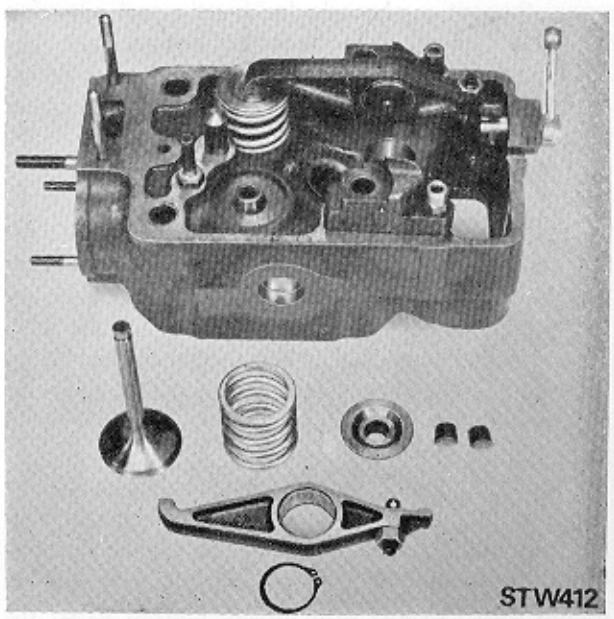


Fig. 74. Removing Valves

Fitting New Guides

With lettering IN or EX uppermost, press guides into place. (Inlet valve is nearest breather tube.) The guides should project 12.60-13.00 mm (0.340-0.360) above the surface of the casting.

A gauge 8.70712 mm (0.3428") diameter must pass through the exhaust valve guide after it is assembled in the head. If it does not go, the guide must be reamed square 8.707/8.727 mm (0.3428"/0.3436") diameter.

Valve Seats

The inlet valve is 1.02-1.27 mm (0.040"-0.050") and the exhaust valve is 0.89-1.14 mm (0.035"-0.045") below the combustion surface of the head. Width of valve seats: Inlet 1.65-2.29 mm (0.065"-0.090"); Exhaust 1.35-1.78 mm (0.053"-0.070").

Servicing

INFORMATION ON WEAR LIMITS CAN BE FOUND ON PAGE 125, TABLE OF CLEARANCES

Remove carbon from combustion area; thoroughly clean and inspect for cracks. Clean valve guides and check for wear.

Check valve seats and inspect for nicks, cracks or pitting. Reface or change cylinder heads if not within limits. Check valve springs for free length. Examine rocker arms for cracks, damage and wear. Inspect push rods for bends and examine ball and cup ends for wear or cracks.

Ensure a serviceable ferrule joint ring is located in each of the four holes to the water jacket in the cylinder block (Fig. 78A).

Refitting the Cylinder Head

Examine the gasket, renew if necessary. Fit the necessary shims—see Checking Cylinder Head Clearance—nearest the head followed by the gasket; these are retained in position with Wellseal (see page 65). The sequence for fitting the head is the reverse to removal. The cylinder head nuts and top threads of the studs should have Wellseal applied.

The inlet and exhaust flanges of all cylinder heads must be lined up with a straight edge, or alternatively fit a manifold before finally tightening down head. Ensure holding down nuts are pulled down evenly and torque loaded to 67.82 Nm (50 lbf.ft.). It is essenttial that these nuts be tightened before securing the injector. Refit circlips securing rocker levers. After fitting head(s), reset valve clearance and check decompressor adjustment.

Checking Cylinder Head Clearance (Fig. 75)

Place two pieces of lead wire 1.2 mm (0.048") thick on the cylinder head, clear of valve recesses and the combustion chamber in the top of the piston; retain in position with grease. Space widely and as near as possible in line with the gudgeon pin. Tighten down the cylinder head to the correct torque loading (see previous paragraph) and turn the piston twice past T.D.C. Remove the cylinder head and measure the thickness of the lead. This should be between 0.89 and 0.97 mm (0.035" and 0.038"). The clearance is adjusted by 0.076 mm (0.003") and 0.254 mm (0.010") thick shims. The gasket must be placed next to the cylinder; a minimum number of 0.076 thick shims must be used, and placed between the gasket and the 0.254 shims. Great care must be taken not to trap the thin shims on the spigot. If necessary the shims and gaskets may be smeared with a thin film of clean high melting point grease and stuck to the head recess, placing the gasket last.

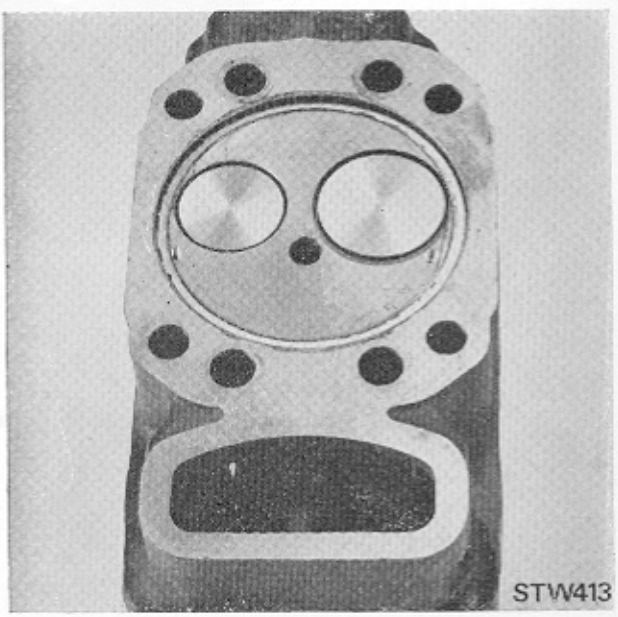


Fig. 75. Checking Cylinder Head Clearance

PISTON, PISTON RINGS AND CONNECTING ROD (Fig. 76)

Piston and Gudgeon Pin

The piston is made of low expansion alloy with a machine recessed combustion chamber in the crown. The gudgeon pin is a clearance fit in the piston and is retained by two circlips. It runs in a copper faced steel backed bush in the small end of the connecting rod.

Piston Rings

Five piston rings are fitted:-

Firing Ring

A barrel lapped chrome ring is situated at the top of the piston and is tapered on the sides to prevent sticking in the groove.

Compression Rings

Two compression rings are fitted. Each has a tapered face in contact with the barrel. One surface on each is marked TOP and the rings must be fitted the correct way up.

Scraper Rings

One conformable type—with spring expander —is fitted above and a slotted scraper ring fitted below the gudgeon pin.

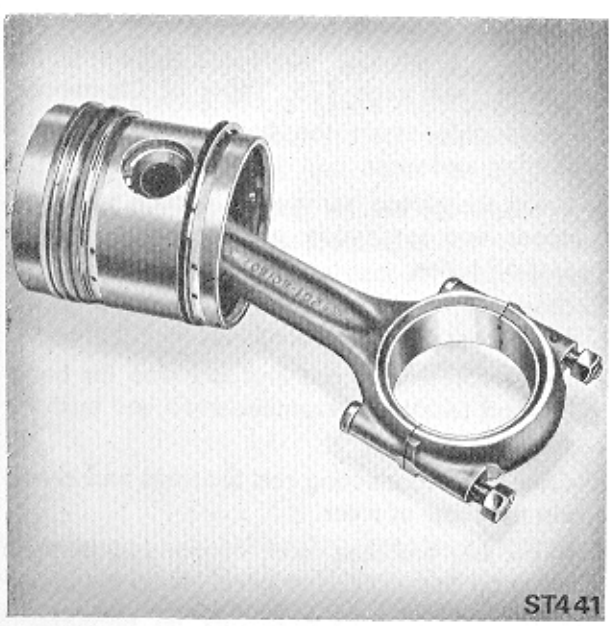


Fig. 76. Piston and Connecting Rod

Connecting Rod and Big End Bearing

The forged steel connecting rod is connected to the crankpin by a conventional big end bearing, the cap held in position by two bolts and nuts. The two halves of the big end bearing are steel backed copper lead. They are precision finished and should not be scraped or touched up in any way.

To Remove Piston, Connecting Rod and Barrel

Note: Mark the cylinder number on each assembly removed. No. 1 cylinder is the opposite end to the flywheel.

(a) Drain water; remove cylinder head. See page 71.

(b) Disconnect water supply pipe from Jabsco pump at block door. Remove block doors and connecting hose(s) complete.

(c) Remove dipstick and lift off dipstick tube. (Note condition of oil seal ring on adaptor when refitting.)

(d) Disconnect fuel pipes to fuel lift pump and remove crankcase door.

(e) Remove lubricating oil pipes, distributor block and relief valve. (This will vary according to the number of cylinders; see Section 2.)

(f) Remove connecting rod nuts and caps—fit thread protectors.

(cont.)

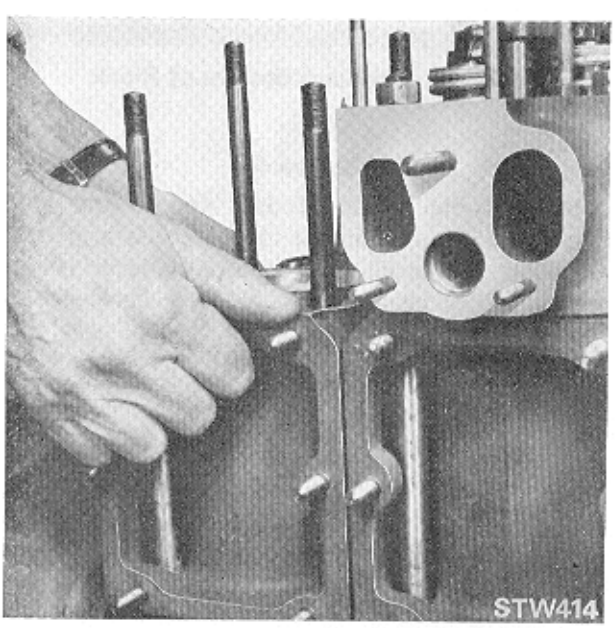


Fig. 77. Removing Cylinder Block

To Remove Piston and Barrel (cont.)

(g) Rotate piston to T.D.C.

(h) Note position of barrel for refitting and remove piston, connecting rod and barrel as a complete unit (Fig. 77).

(j) Withdraw piston from barrel.

(k) Gudgeon pin may be removed by releasing one spring clip and pushing out pin.

(l) Using a standard ring expander, remove piston rings.

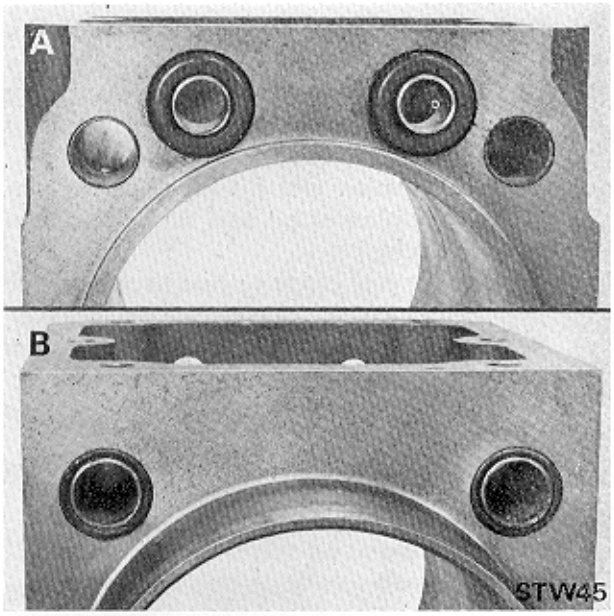


Fig. 78. Top and Bottom of Block

Cylinder Block Stud Sleeves

When removing the block, should the stud sleeves become attached to the studs and thus remain on the studs when the block is removed, the following procedure should be carried out.

(a) Replace studs.

(b) Examine block and sleeves and if in good condition carefully clean the bores in the block taking care not to increase the diameters.

(c) Coat both ends of sleeves with Hylomar PL32M.

(d) Insert the ground outside diameter of the sleeve from the bottom of block and push up until it just enters the top bore.

(e) From the top of the block, pull the sleeve into position until the top face is flush with the top face of the block.

(f) Fit 'O' ring to each sleeve at the bottom of block (Fig. 78B).

(g) Pressure test water jacket to 1.4 bar (20 lbf/in.^{2}) if facilities available.

Fig. 79. Fitting Piston Rings

Servicing (see page 125, Table of Clearances)

Thoroughly clean the barrel and check for scoring and wear.

Clean the piston, remove all carbon from both upper and underside of head, ring grooves and oil holes.

Check all piston rings in the cylinder barrel for correct gap clearance.

Clean connecting rod and examine for bending and twisting—examine small end bush for wear.

Check the connecting rod bearings and crankpin for signs of wear.

If the big end has been dismantled because of metal failure, the oil passages in the crankshaft must also be examined for obstruction and fragments of metal.

Refitting Piston, Connecting Rod and Barrel

(a) Fit piston to connecting rod with the wording CAMSHAFT SIDE on piston to the same side as machining numbers on connecting rod. Insert gudgeon pin and circlips.

(b) Fit piston rings as detailed on page 73 (Fig. 79).

(c) Stagger piston ring gaps and fit piston into barrel.

(d) Ensure bearing shells are correctly located in connecting rod and cap.

(e) Fit joint to bottom of the cylinder using Hylomar PL32M.

(f) Ensure that a serviceable 'O' ring is fitted on each of the four sleeves at the base of the block (Fig. 78B). A ferrule joint should be located in each of the four holes to the water jacket in the top of the block (Fig. 78A).

(g) Position crankshaft with crankpin at T.D.C.

(h) With the wording CAMSHAFT SIDE on the piston correctly positioned, lower the cylinder block, piston and connecting rod assembly into position.

(j) Push down on piston and turn crankshaft until access is gained to connecting rod bolts; fit cap with bearing shell and torque nuts to 43.4 Nm. (32 lbf.ft.).

(k) Refit lubricating oil pipes, distributor block and relief valve (see Section 2).

(l) Coat groove in crankcase door with Bostik 772 and stick joint to it; refit crankcase door and connect fuel pipes to lift pump.

(m) Refit cylinder head; ensure all water pipe connections are secure and check for leaks. If sump has been drained, fill with correct quantity and grade of oil—see Section 2; prime fuel system.

RAISED HAND STARTING (Fig. 80)

The raised hand starting assembly on STW engines is secured to the fan shroud and to a bracket on the gearcase end cover. Before either of these components can be removed it is first necessary to remove the raised hand starting complete—see also Section 5.

When refitting this assembly, ensure brackets are correctly aligned and that shaft turns easily.

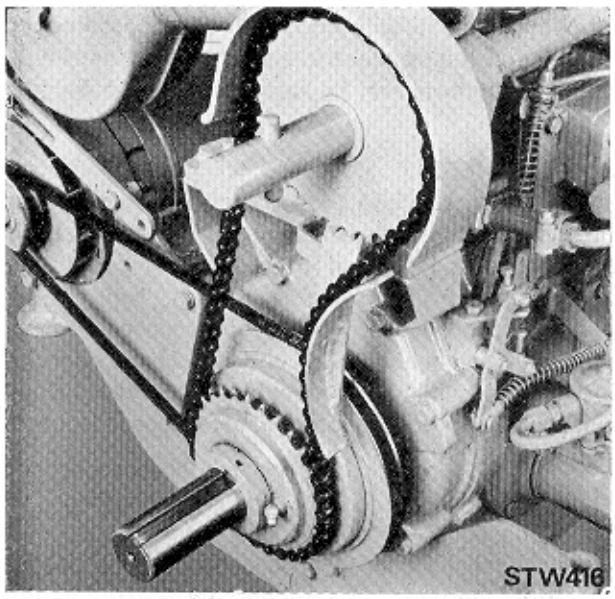


Fig. 80. Raised Hand Start—STW

Information on **CAMSHAFTS, CRANKSHAFTS and** FLYWHEELS is the same as air cooled engines and can be found in Section 4, Part 1.

Information on **DECARBONISING, LAYING-UP PROCEDURES and SPANNER TORQUES** can be found at the end of Section 4, Part 1.

Section Five
ACCESSORIES

INTRODUCTION

This section contains information on some of the accessories which may be fitted to ST and STW engines. An Appendix at the end of the book gives a comprehensive list of all the accessories that are currently available with "Compatibility Charts" listing which accessory may be fitted to each Build of engine.

Part numbers, with ordering instructions, may be obtained from the appropriate engine parts list and each accessory is consigned with a drawing and fitting instructions where applicable.

Information on electric starting equipment with wiring diagrams can be found in Section 8.

AIR CLEANERS

The correct fitting and maintenance of air cleaners cannot be over-emphasised. The air cleaner must be fitted to ensure no possibility of air entering the engine except through the cleaner. Loose or incorrect fittings will leave gaps through which dust will be drawn. Servicing periods will vary according to the conditions under which the engine is run, see Routine Maintenance.

Lister Dry Air Cleaner (Fig. 81)

The Lister dry air cleaner, which may be fitted to all ST engines, is removed by loosening the clip to the manifold and lifting off the assembly. Remove the top half by releasing the centre bolt and lift out the element. Check that the rubber adaptor and clip are in good condition and clean the inside of the assembly. The paper element should be changed if found to be damaged or dirty. When refitting; ensure the two halves of assembly are correctly lined up and that the assembly is securely attached to the engine air intake.

Cyclopac Air Cleaner (Fig. 82)

The dust cap on the end of the cleaner should be emptied daily.

To service cleaner, remove element and clean the outside with a soft brush or by tapping. If compressed air is available this can be used by blowing from the inside of the element only. Maximum pressure 100 lbf.in.^{2}. If air is blown on to the outside of the element it will force the dust through the element leaving holes and it will then be useless. These elements are renewable but if carefully maintained they can be reused. To check if the element is still serviceable, clean and then insert an unshaded light inside the element in a darkened room. The light will show through any small holes which may be in the element and this will indicate that the ele-

Fig. 81. Lister Dry Air Cleaner

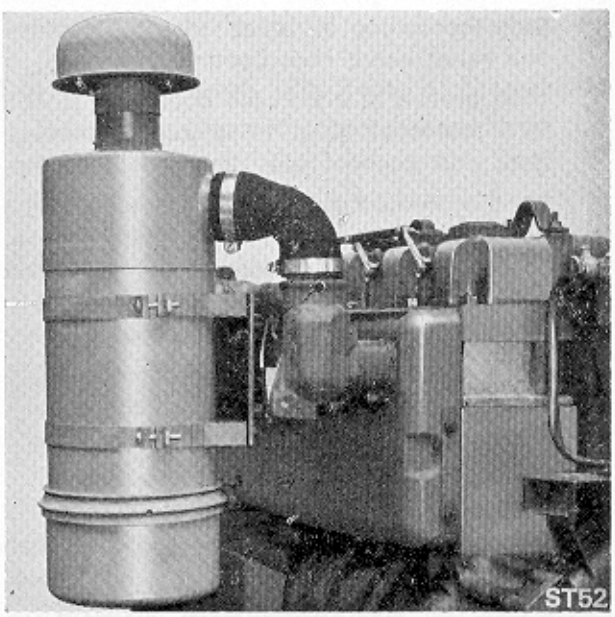


Fig. 82. Cyclopac Air Cleaner—ST3

ment is no longer serviceable. A new element must then be used.

Clean the element container thoroughly, refit the element and ensure that all joints are in good condition and well made. Refit the complete unit to the engine and again ensure that all the fittings are tight and that there are no gaps through which unfiltered air can be drawn.

Oil Bath Air Cleaner

On engines still fitted with an oil bath air cleaner, remove the cleaner from the engine by loosening the clip to the manifold and lifting off.

Keep the unit level to avoid spilling oil from the container.

Remove the cleaner top cover, lift out the element and immerse in a container of kerosene. Drain the oil from the container and thoroughly clean out. Agitate the element in the container of kerosene and when clean, remove and allow to drain. If compressed air is available this can be used to blow out the kerosene from the element. When dry immerse the element in clean engine lubricating oil, allow to drain for a few minutes before replacing in air cleaner container. Fill the container with clean engine oil up to the mark on the container—do not over-fill—replace cover and refit to engine ensuring that all clips and joints are tight and that the rubber adaptor is in good condition.

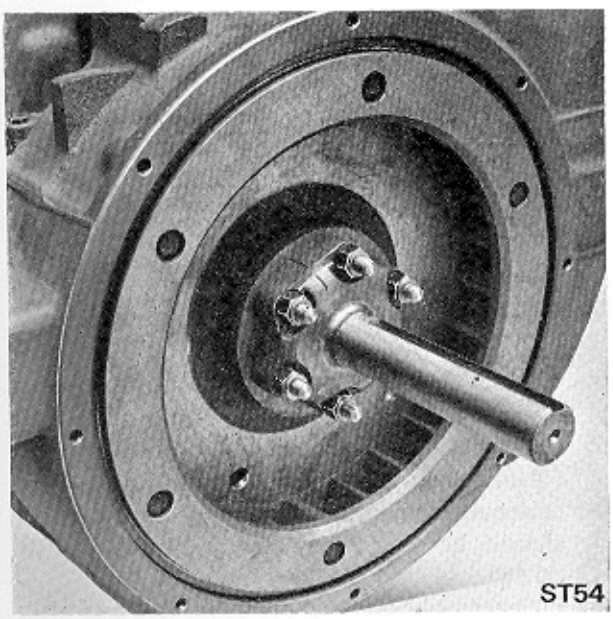


Fig. 83. Flywheel Shaft Extension

HOURMETER

A vibration type hourmeter is available and may be fitted to the top of the cylinder head cover.

Note. When this accessory is fitted to a single cylinder engine, the lifting eye must be removed.

FOAM ELEMENT AIR CLEANER (ST1)

A foam element may be used on the ST1 engine in place of the Lister dry element. The foam element should be treated before initial fitting and subsequently cleaned as follows:

1. Remove the inner and outer perforated reinforcements.
2. Wash the element in a mixture of fuel oil and 5% lubricating oil and wring dry.
3. Fit the reinforcements back ensuring that approximately 6 mm ($\frac{1}{4}$") of foam element protrudes from beyond the reinforcements on both ends for sealing purposes.

FLYWHEEL SHAFT EXTENSIONS (Fig. 83)

Three hole and six hole type shaft extensions may be fitted to the flywheel. Shaft extensions fitted to ST1 engines are secured by three $\frac{7}{16}$" UNF studs, spring washers and nuts on both three hole and six hole extensions. When fitting a shaft extension ensure all nuts are tightened evenly and there are no burrs on keyway. Nuts should be tightened to 67.82 Nm (50 lbf.ft.).

FLEXIBLE HALF COUPLING—ST1 (Fig. 84)

Fitting Instructions

1. Fit equally spaced studs (A) with tab washers into flywheel, torque to 67.82 Nm (50 lbf.ft.); lock into position with tab washers.
2. Assemble three equally spaced bolts (B); each bolt through a spring disc washer, coupling disc spacer and half coupling; fit locknut.
3. Fit assembly over studs and secure with nuts (C) and dished washers.
   Note: Spring disc washers should be fitted with concave side against coupling disc. Torque load all nuts to 10.85 Nm (8 lb.ft.).

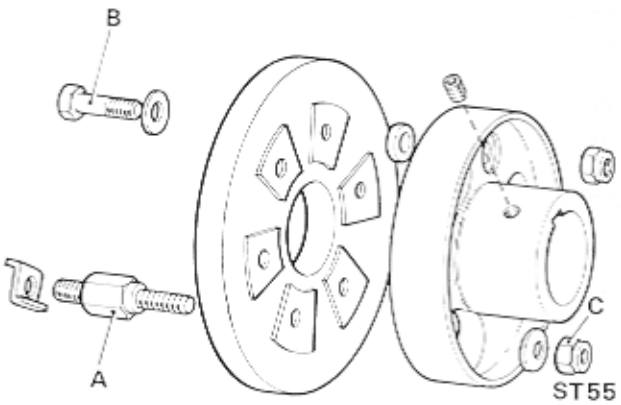


Fig. 84. Flexible Half Coupling—ST1

Note: When fitting flexible couplings ensure that drive shafts are not touching.

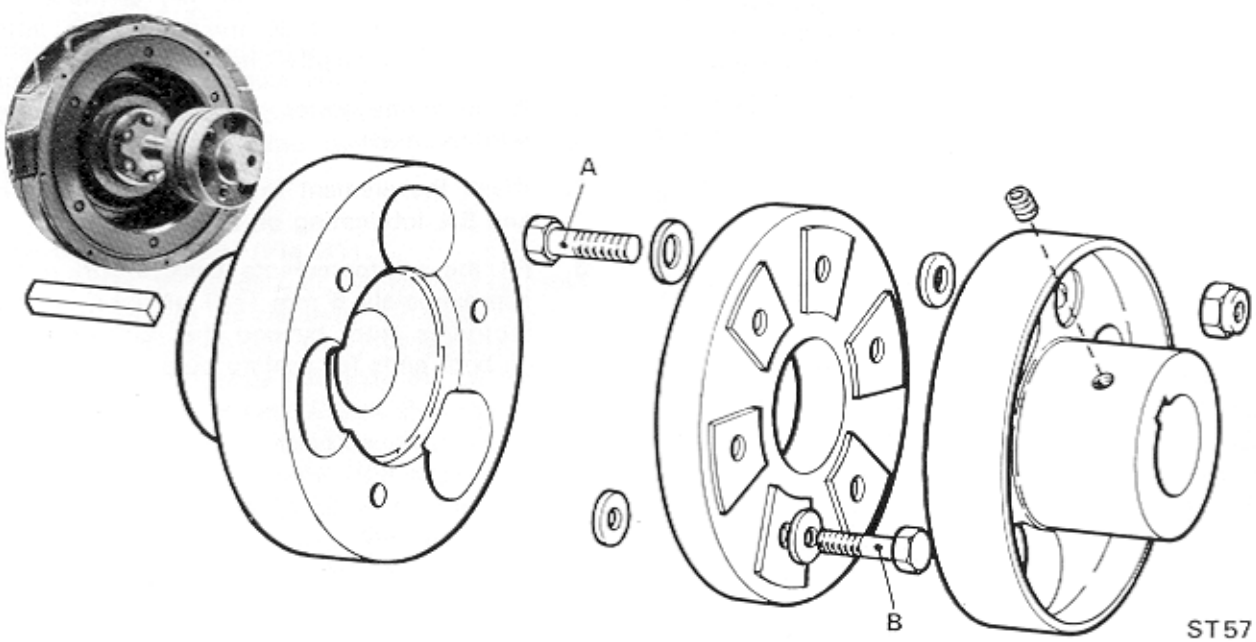


Fig. 85. Flexible Whole Coupling

FLEXIBLE WHOLE COUPLING (Fig. 85)

Fitting Instructions

1. Assemble three equally spaced bolts (A); each bolt through a spring disc washer, coupling disc, spacer, and half coupling; fit locknut.
2. Assemble three equally spaced bolts (B) with spring disc washers and spacers to the other half of coupling in the same manner. Note. All spring disc washers should have concave face against coupling disc. All nuts should be torque loaded to 10.85 Nm (8 lbf.ft.).
3. Fit assembly on to shaft using key and grub screw.

FLEXIBLE HALF COUPLING (Fig. 86)

Fitting Instructions

1. Fit three equally spaced studs (A) into flywheel. Torque to 67.82 Nm (50 lbf.ft.).
2. Secure coupling plate (B) to studs using washers and locknuts.
3. Fit three studs (C) with tab washers into coupling plates; lock into position with tab washers.
4. Assemble three equally spaced bolts (D); each through a spring disc washer, coupling disc, spacer and half coupling; fit locknut.
5. Fit assembly over studs and secure with locknuts.

   Note: Spring disc washers should be fitted with concave side against coupling disc. Torque load all nuts to 10.85 Nm (8 lbf.ft.).

SPLIT BOSS COUPLING (Fig. 86, Item F)

Split boss couplings are assembled by the same method as described in the previous paragraph. Where reference is made to half coupling, substitute split boss coupling.

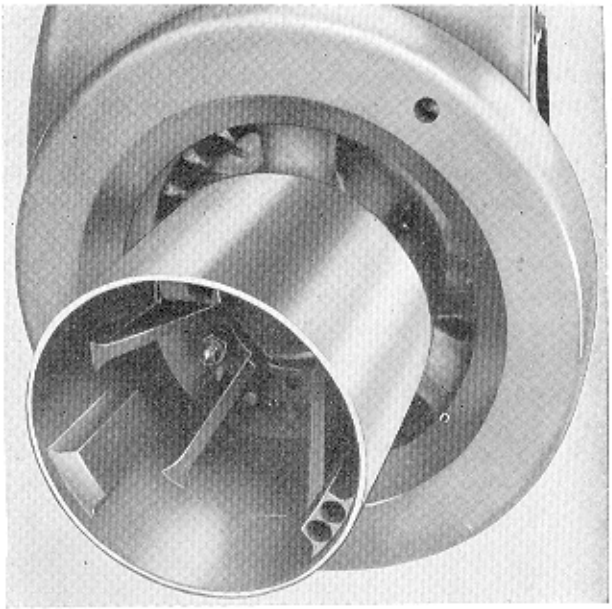


Fig. 87. Bolt-on Pulley

PULLEYS (Fig. 87)

If no other component is attached to the flywheel, a bolt-on pulley as illustrated may be fitted. Nuts should be tightened to 67.82 Nm (50 lbf.ft.).

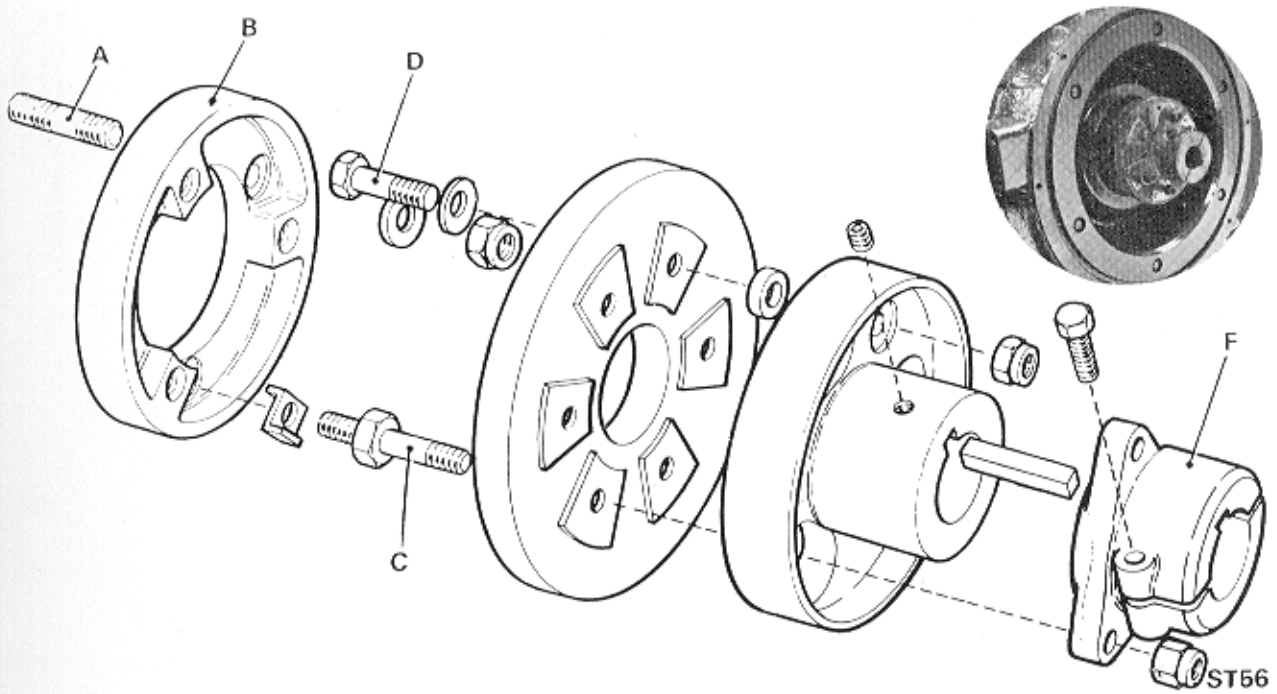


Fig. 86. Flexible Half and Split Boss Couplings—ST2/3

DIRECT DRIVE CLUTCH (Fig. 88)

The clutch, fitted to the crankshaft, is of the multi plate type running in oil. It is toggle operated and is therefore self locking in either the engaged or disengaged position. Tension should be felt throughout the movement of the lever to engage the clutch and it should be released on completion of the movement.

The clutch housing is filled to the level of the side plug with light engine oil (SAE10). The capacity is approximately 0.36 litre ($\frac{5}{8}$ imp. pint). An even lighter grade of oil may be used in cold weather to reduce oil drag of driven shaft.

REDUCTION GEAR—INDUSTRIAL ENGINES

A 3 : 1 reduction gear may be fitted to the flywheel end on ST2 and 3 cylinder engines. The reduction gear assembly is secured to the fan shroud and a splined drive engages with a shaft extension which is bolted to the flywheel.

The oil is replenished by removing the breather in the top of the gear box and the level should be maintained to the full mark on the dipstick with a mild type E.P. gear lubricant.

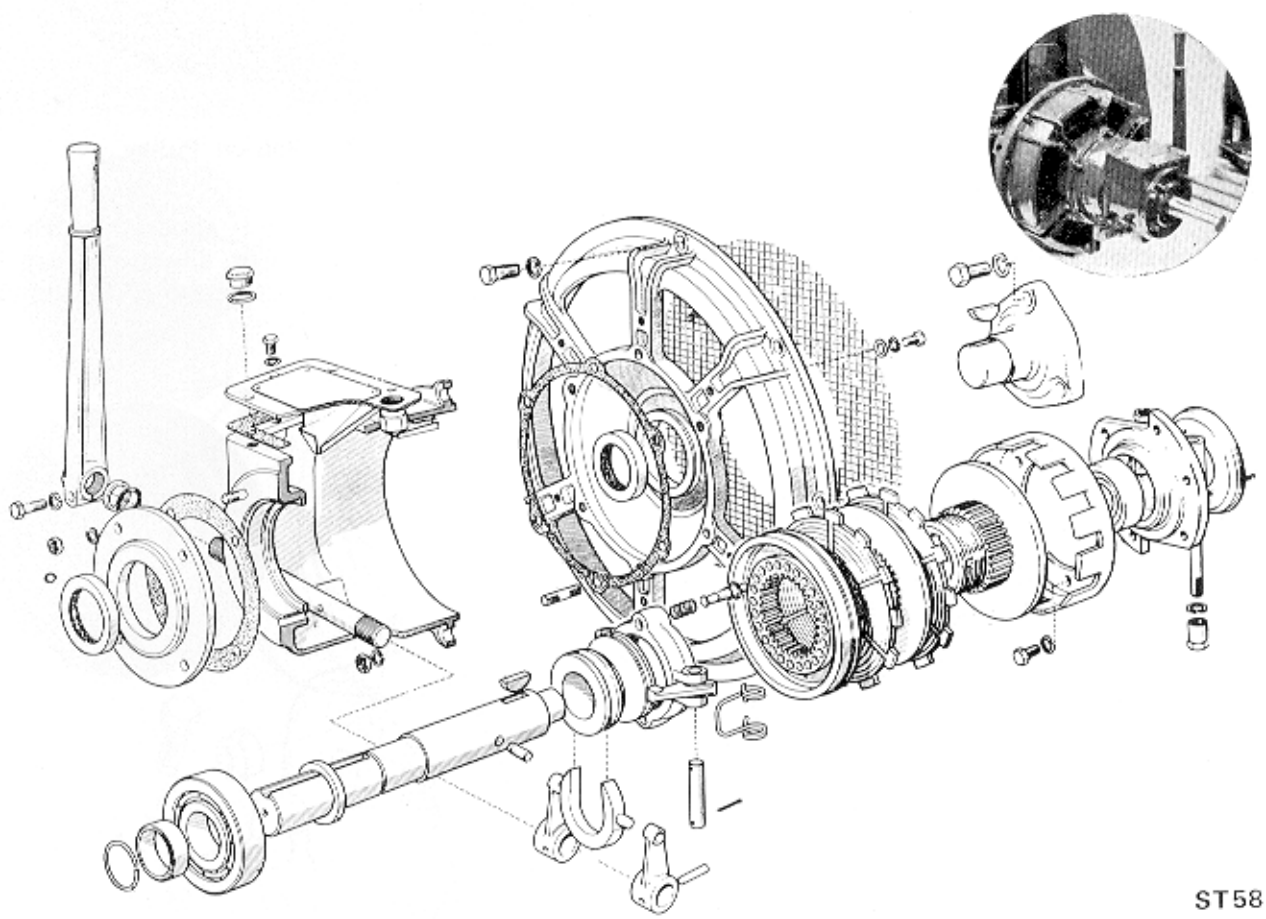


Fig. 88. Lister Clutch

ANDERTON CLUTCH

When an Anderton clutch is fitted, the manufacturers instructions supplied with each engine should be consulted, for adjusting and servicing.

Clutch Adjustment—see Fig. 89

The clutch plates are held between pressure plates when fully engaged. It is essential there should be no slip when fully engaged. If the full power is not being transmitted, the clutch should be adjusted as follows:—

(a) Stop the engine.

(b) Remove the inspection cover on top of the clutch casing.

(c) With the lever in the "neutral" position, revolve the clutch until the adjusting ring locking plate is accessible.

(d) Pull plunger C out of engagement and rotate adjusting ring clockwise 1 to 3 holes, re-engage plunger C and then check "feel" of the clutch operating lever. Alter the adjustment until the full power is transmitted without slip.

(e) Do not adjust more tightly than is necessary to transmit the full power without slip.

(f) Ensure the clutch runs freely in the "neutral" position.

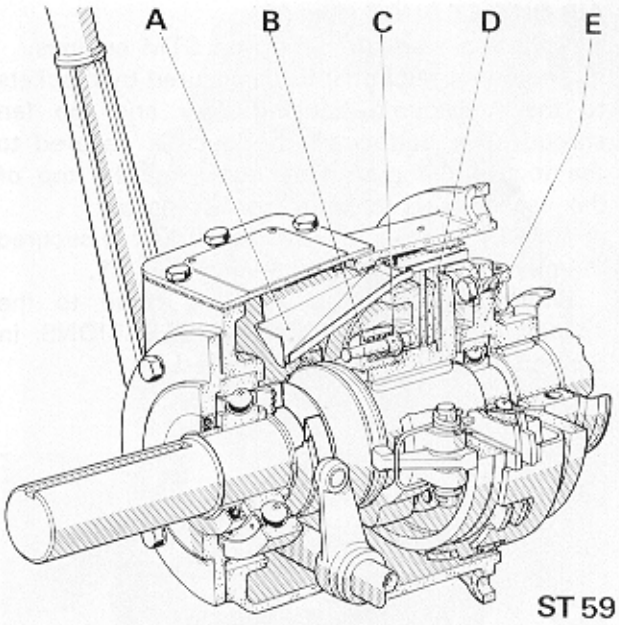


Fig. 89. Clutch Adjustment

A. Lubricating oil return trough
B. Adjusting ring
C. Adjusting plunger
D. Clutch plates
E. Clutch driving member

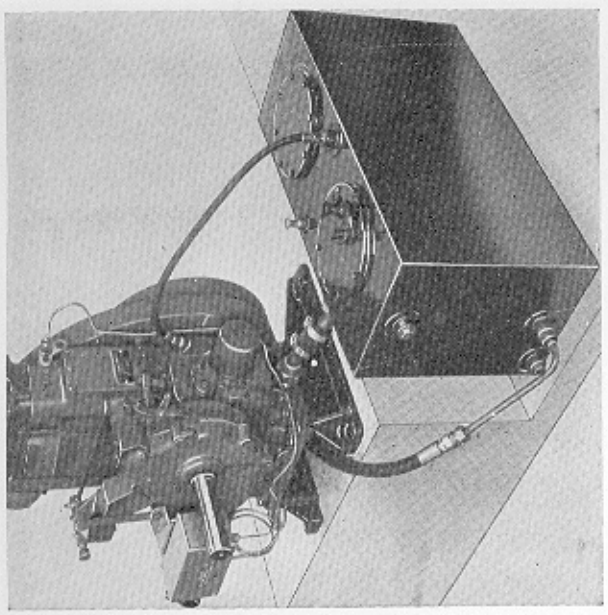


Fig. 90. Dry Sump Arrangement—ST1

DRY SUMP (Fig. 90)

A dry sump arrangement is available to allow the engine to be run for long periods without replenishing the oil system.* A large capacity oil tank is connected to a modified suction plug in the base of the engine, the oil being returned to the tank by gravity after circulating through the engine. A breather pipe is fitted between the engine dipstick hole and top of the tank. The tank contains its own dipstick and filter—no oil strainer being used in the engine.

The illustration shows a dry sump arrangement on an ST1 engine. On multi-cylinder engines the tank is connected to the engine from the manifold side.

Note: A special crankcase is used for this arrangement on multi-cylinder engines and all engines must be mounted with enough clearance below the crankcase to enable the inlet pipe to be connected to the suction plug. The tank must be sited lower than the engine to enable the oil to be returned by gravity.

*A number of considerations must be taken into account when installing long running engines. Consult R. A. Lister or the nearest Lister Distributor.

AIR OUTLET DUCT (Fig. 92)

This is a standard fitting on STM engines.

The outlet duct adaptor is secured by brackets to the fuel pump housing door and the fan shroud. The bottom of the duct is secured to the top of the crankcase door and the top of the assembly is located on felt pads.

On ST1 engines, the air outlet duct is secured directly to the fan shroud—see Fig. 91.

When ducting or trunking is fitted to the adaptor, COOLING AIR CONSIDERATIONS in Section One should be consulted.

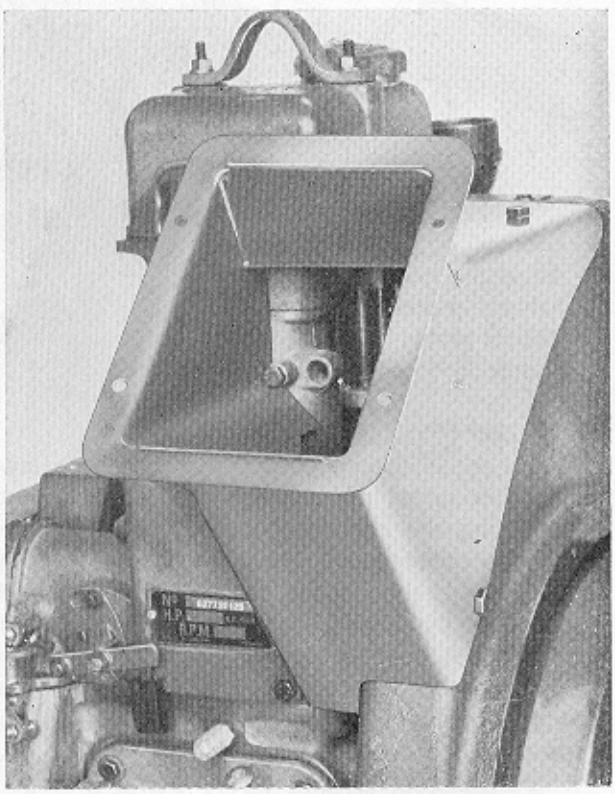


Fig. 91. Air Outlet Duct—ST1

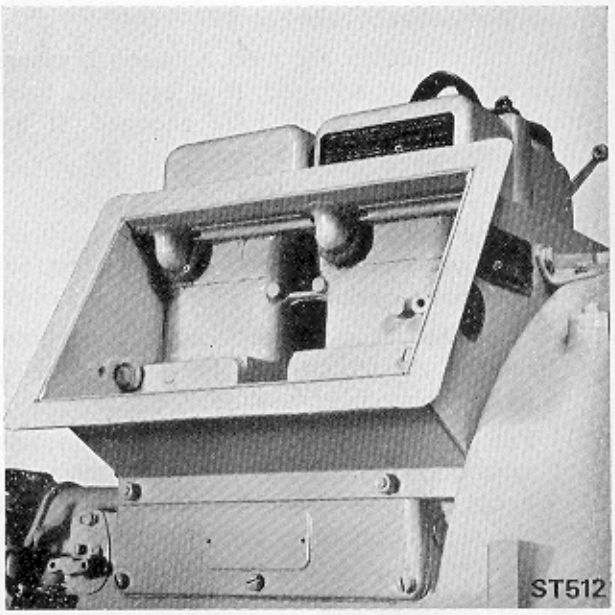


Fig. 92. Air Outlet Duct—ST2

COUPLED DECOMPRESSORS (Fig. 93)

Coupled decompressors are available for multi cylinder engines. Adjustment is detailed on pages 50 and 68. When reconnecting coupling rods, coupling rod screws should not be secured dead tight. This is to allow free movement between pin centres when operating decompressors.

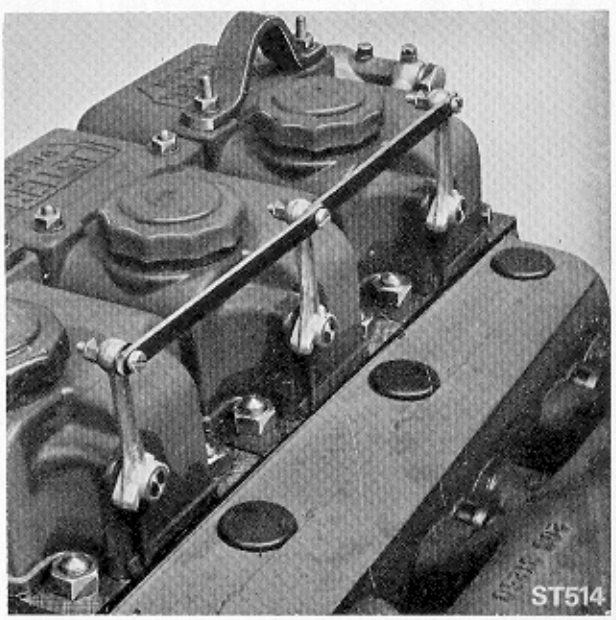


Fig. 93. Coupled Decompressors

GEARED HAND STARTING (Fig. 95)

When required, a geared hand start may be fitted at the flywheel end of the engine. It is essential to have the correct assembly for the rotation of the engine.

A starting dog plate is bolted to the flywheel and the complete assembly is secured in three positions to the fan shroud with the centre arm of the assembly in the top central position on multi-cylinder engines and in four positions, as shown in Fig. 94 on single engines. The gearbox should contain normal engine oil—to the level of the filler plug—and be checked periodically depending on usage.

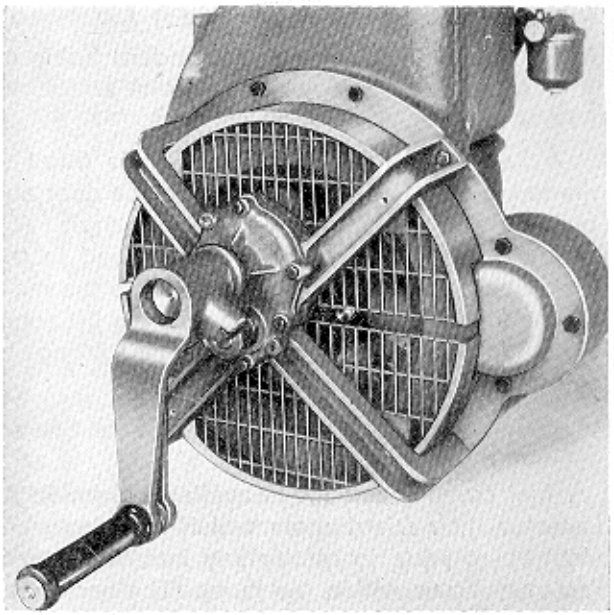


Fig. 94. Geared Hand Starting Fitted to ST1

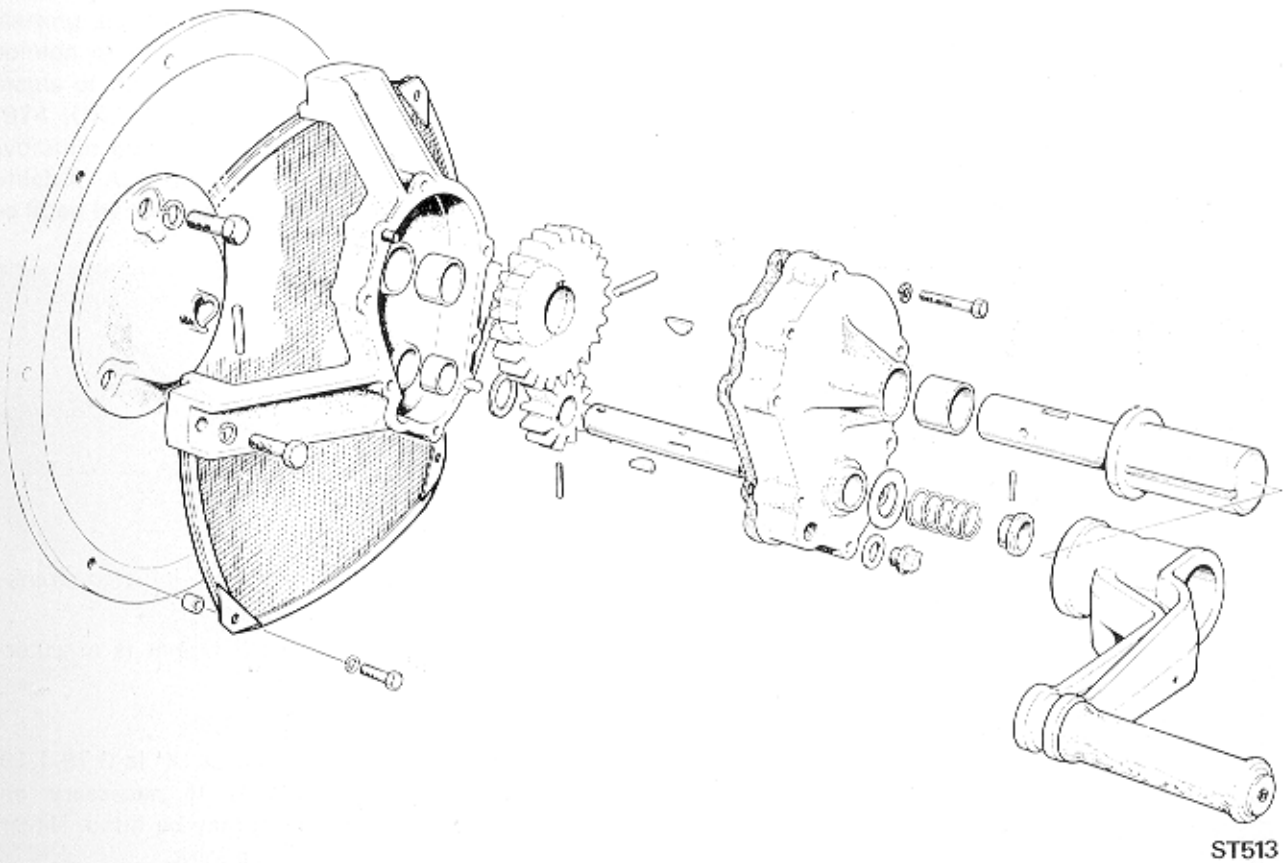


Fig. 95. Components of Geared Hand Starting (ST2/3)

FUEL LIFT PUMP (Fig. 96)

Note: The fuel lift pump is a standard fitting on ST3 engines, all Moisture Extraction Units and STWM engines.

A fuel lift pump, when required, is fitted to the top left hand side of the crankcase door and operated by a tappet from the camshaft. The inlet side of the lift pump is connected to the fuel supply and the outlet feeds fuel to the main engine fuel filter. All connections to the lift pump are made by solderless (nut and olive) fittings to suit $\frac{5}{16}$" O.D. pipe.

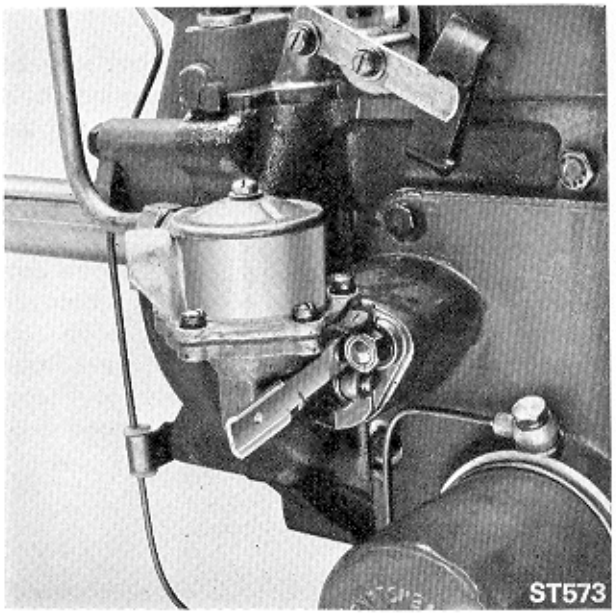
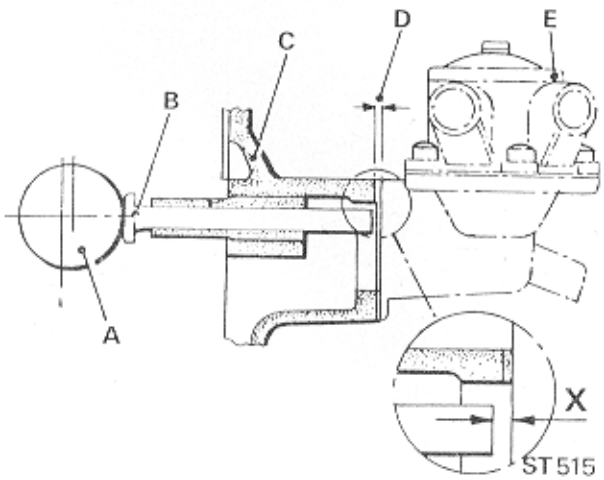


Fig. 96. Fuel Lift Pump

Servicing

A fuel pump repair kit is available from R. A. Lister or their Distributors which contains sufficient spare parts to rectify any internal defects that may occur within the pump. The part number, with ordering instructions can be found in the engine parts list.



A. Camshaft
B. Lift Pump Tappet
C. Crankcase Door
D. Lift Pump Joint
E. Fuel Lift Pump

Fig. 97. Checking Lift Pump Tappet Setting

Checking Tappet Setting (Fig. 97)

Note: When fitting the pump tappet bush, ensure oil hole is to the top.

(a) Insert lift pump tappet.

(b) Fit crankcase door and joint to crankcase—bolt door firmly.

(c) Turn crankshaft until tappet is at outermost point of travel.

(d) Fit lift pump joint to door.

(e) Check that clearance at 'X' is 0.79-1.19 mm (1/32"-3/64"). If necessary an extra lift pump joint may be fitted. Never fit lift pump without a joint.

(f) Tighten nuts to 20.34 Nm (15 lbf.ft.).

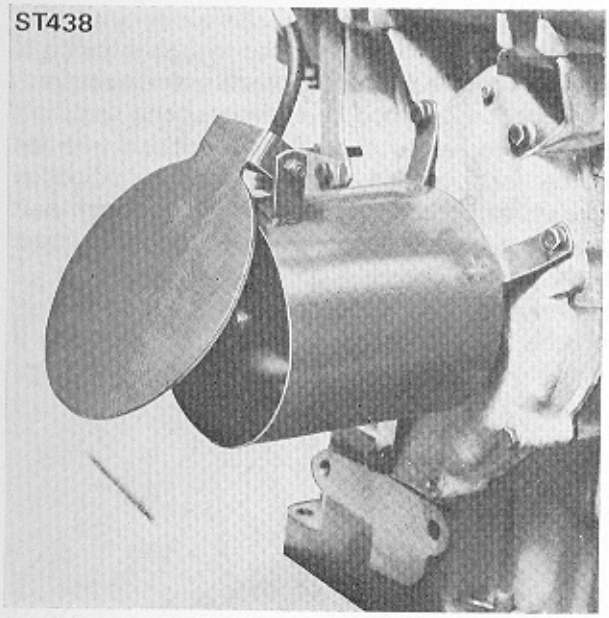


Fig. 98. Camshaft Guard

For basic hand start and electric start engines starting shaft guards are available which in the opinion of R. A. Lister comply with the requirements of the Health and Safety at work etc. Act 1974 (UK). Additional accessories e.g. gear end hydraulic pump adaptors require special guards which R. A. Lister do not supply and which must be fitted by the purchaser.

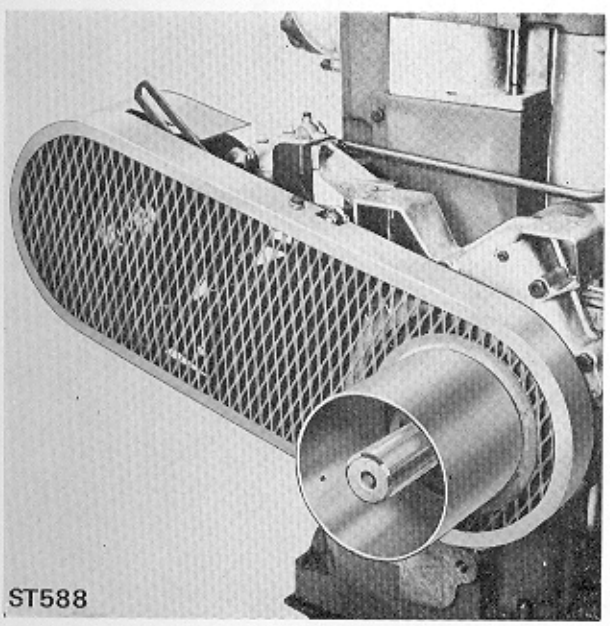


Fig. 99. Alternator Guard

ADAPTORS (Fig. 100)

The following flywheel housing adaptors may be fitted:—

ST1:— SAE 5
ST2/3:— SAE 4, SAE 5 and SAE6.

GUARDS

A number of wire mesh guards may be fitted to ST engines.

Camshaft Guard (Fig. 98)

This is fitted over the camshaft extension at the gear end and secured by three brackets to the end cover.

Flywheel Guard (Fig. 95)

A guard may be fitted with geared hand start arrangement on multi cylinder engines. This is a flat mesh screen fitted with the curved edge to the bottom of the engine. It is secured by four bolts, spring washers and distance pieces to the flange on the fan shroud.

Dynamo/Alternator Guard (Fig. 99)

A number of configurations of dynamo/alternator guards may be used depending on the engine build and application.

Note: It is mandatory to guard all pulley take on/take off points on agricultural machinery. (U.K.).

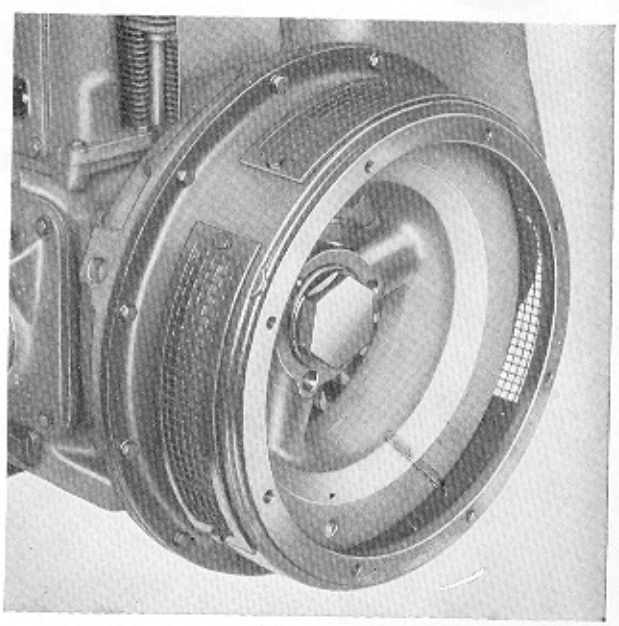


Fig. 100. An SAE 5 Adaptor

HYDRAULIC PUMP MOUNTINGS

ST engines can be supplied to drive a hydraulic pump from either the flywheel or gear end. R. A. Lister do not supply the pumps.

Hydraulic Pump Mounting—Gear End (Fig. 101)

A modified camshaft, end cover with pump mounting flange and modified camshaft bush are fitted to the standard engine. The hydraulic pump is secured to the engine on four studs with a joint and adaptor plate. The pump drive gear, which is supplied by R. A. Lister, is keyed on to the drive shaft of the pump and retained in position by a lockwasher and nut.

Servicing

It is recommended that the hydraulic pump is serviced by the pump manufacturer or an accredited Service Depot. The end cover and camshaft are removed and serviced in accordance with the instructions for the standard engine in Section Four. Instructions for fitting a new camshaft bush can be found in Section 7. Ensure correct bush is fitted.

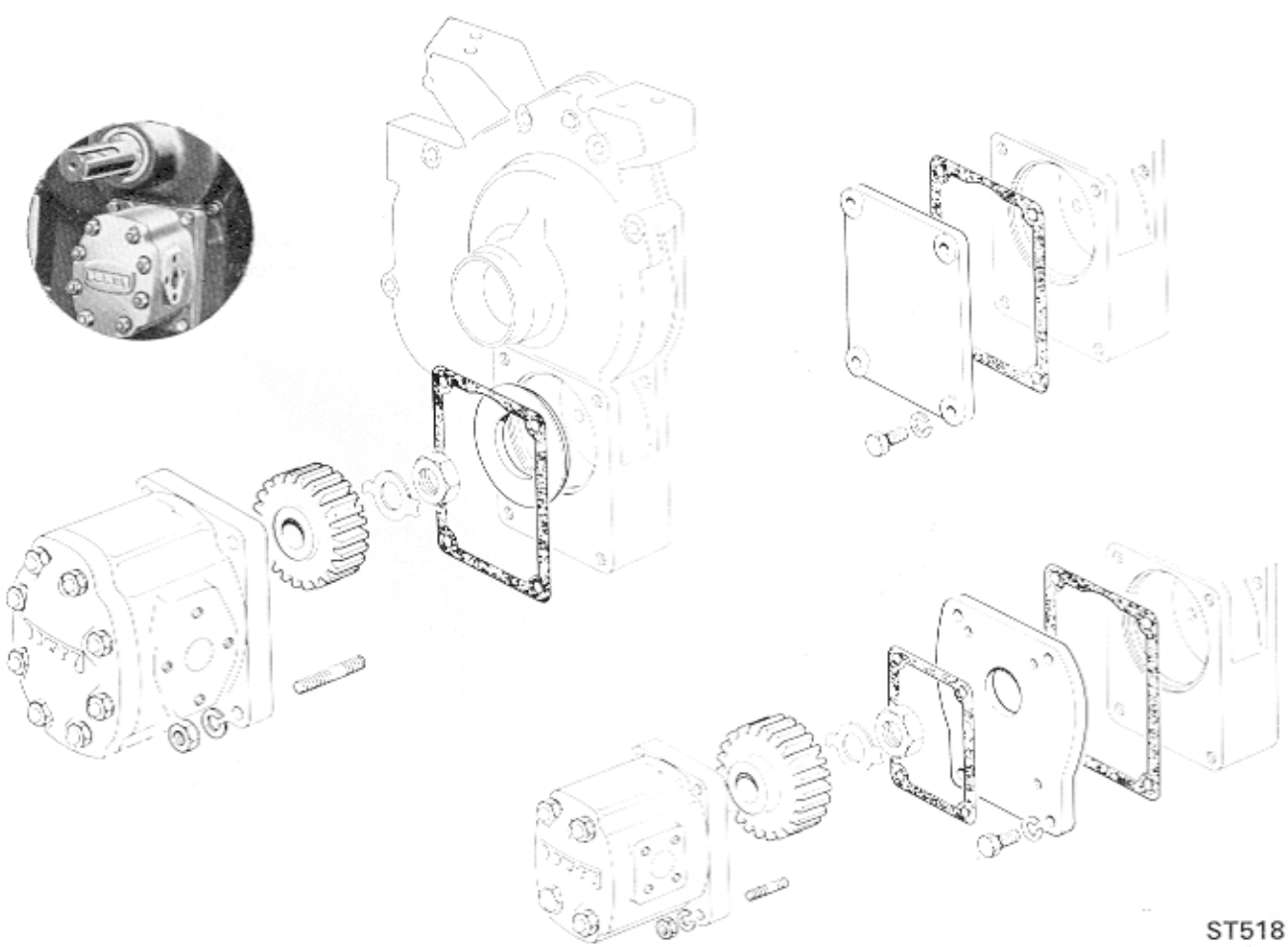


Fig. 101. Hydraulic Pump Mounting — Gear End

Hydraulic Pump Mounting—Flywheel End (Fig. 102)

Although the adaptor fitted to the engine and the size of pump and type of drive may vary, the same fitting procedure is used throughout. A driving member is bolted to the centre of the flywheel and engages with a coupling disc. A half coupling, supplied by R. A. Lister, is secured to the pump drive and is driven through the coupling disc. The hydraulic pump is bolted to a mounting plate which is carried on the adaptor attached to the fan shroud.

Servicing

It is recommended that the hydraulic pump is serviced by the pump manufacturer or an accredited Service Depot.

IMPORTANT: When refitting a new or serviced pump, a clearance of 0.8-3.2 mm (1/32"-1/8") must be maintained between the driving member and the coupling disc (item A, Fig. 102). This can be obtained by shims fitted between the adaptor and the mounting plate (item B. Fig. 102).

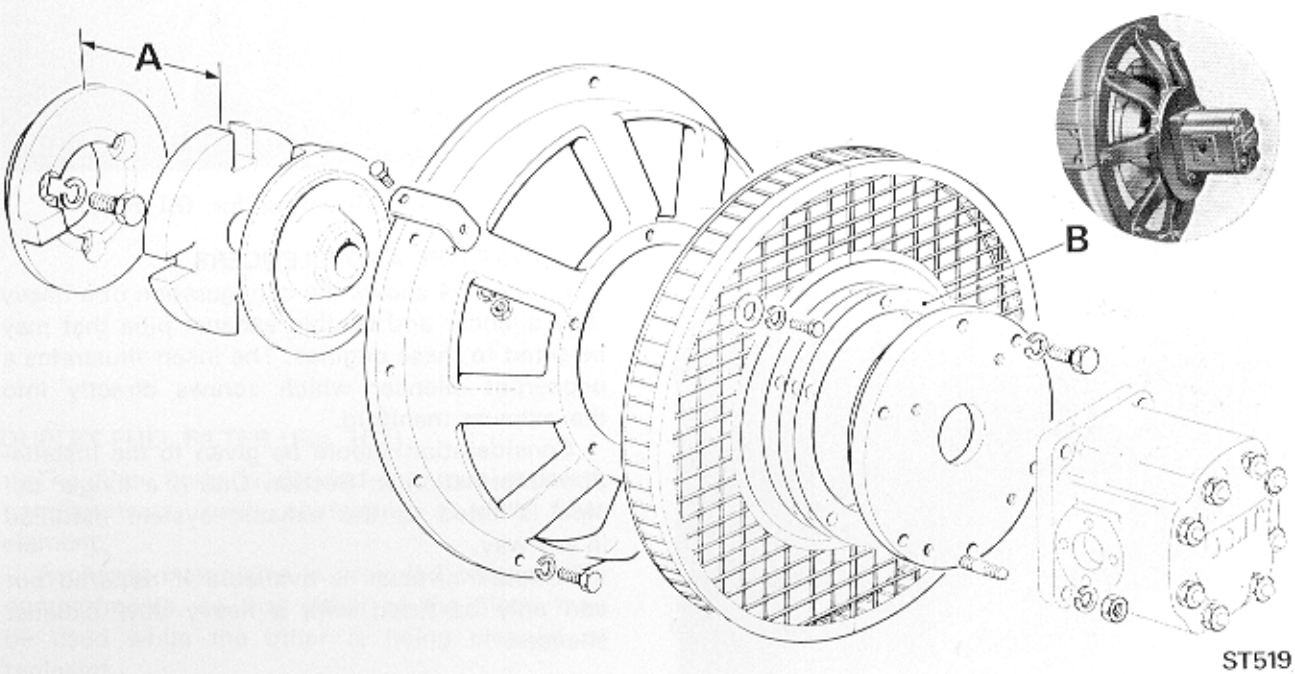


Fig. 102. Hydraulic Pump Mounting—Flywheel End

REMOTE MOUNTING FOR LUBRICATING OIL FILTER (Fig. 103)

In place of the standard cartridge filter, a pipe connector and union connect with an adaptor fitted to the crankcase door. Another adaptor holding a standard cartridge filter is secured where required by the user.

When connecting pipes please note the OUTLET of the adaptor fitted to the engine connects to the INLET of the adaptor holding the oil filter.

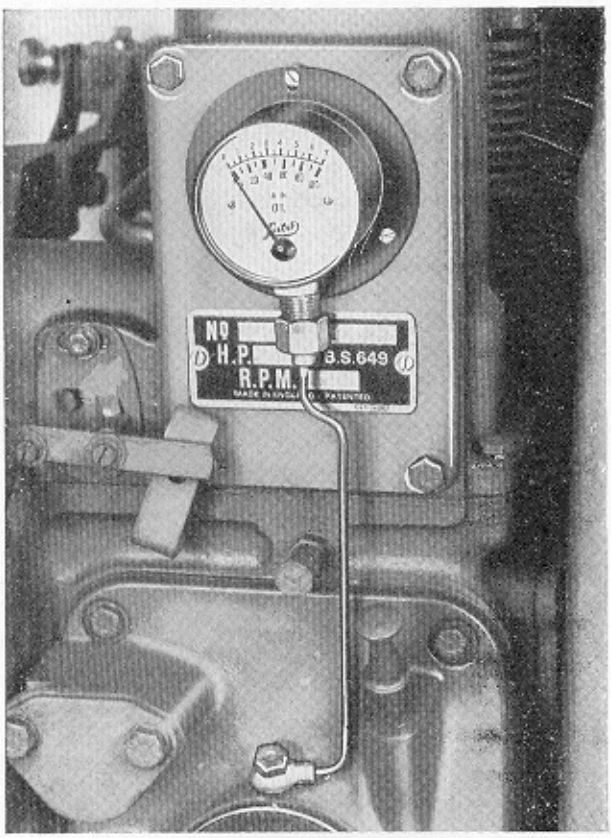


Fig. 105. Oil Pressure Gauge—ST1

LUBRICATING OIL PRESSURE GAUGE (Fig 105)

A tapped hole, immediately above the oil filter position on the crankcase door, provides a fitting for the pipe to the lubricating oil pressure gauge. The gauge is mounted on the fuel pump door, gauge panel or where required for the particular application of the engine. See Section 2 for oil pressures. On later engines the position of the oil pressure gauge and engine number plate is transposed to enable the number plate to be more easily read.

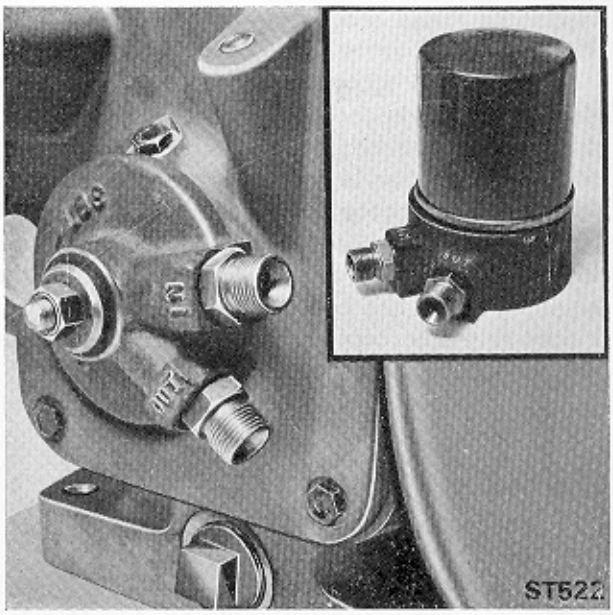


Fig. 103. Mounting for Oil Filter

EXHAUST PIPE AND SILENCERS

Figure 104 shows the configuration of a heavy duty silencer and flexible exhaust pipe that may be fitted to these engines. The insert illustrates a pepperpot silencer which screws directly into the exhaust manifold.

Consideration should be given to the Installation Information in Section One if a longer tail pipe is fitted or the exhaust system modified in any way.

A spark arrestor is available if required but can only be fitted with a heavy duty exhaust silencer.

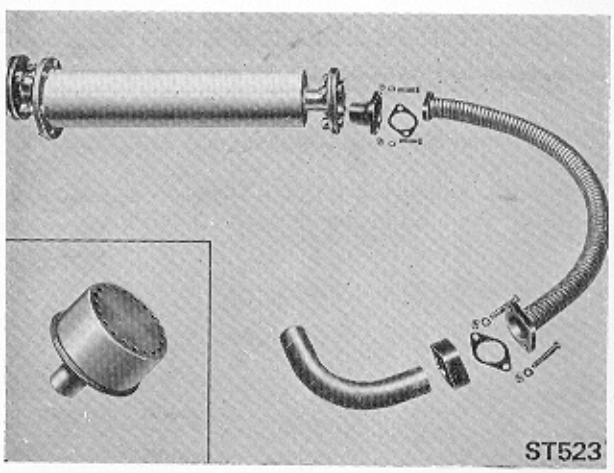


Fig. 104. Silencers and Flexible Exhaust Pipe

AIR TEMPERATURE GAUGE (Fig. 106)

A probe is secured through a casting in the fuel pump housing and is connected to an air temperature gauge, mounted where required.

Figure 106 shows a multi gauge panel, fitted to the gear end of the engine containing both a Lubricating Oil Pressure and an Air Temperature Gauge. Please note that where an outlet duct is fitted—as illustrated—the connection from the probe to gauge is routed through a drilling in the side of the duct.

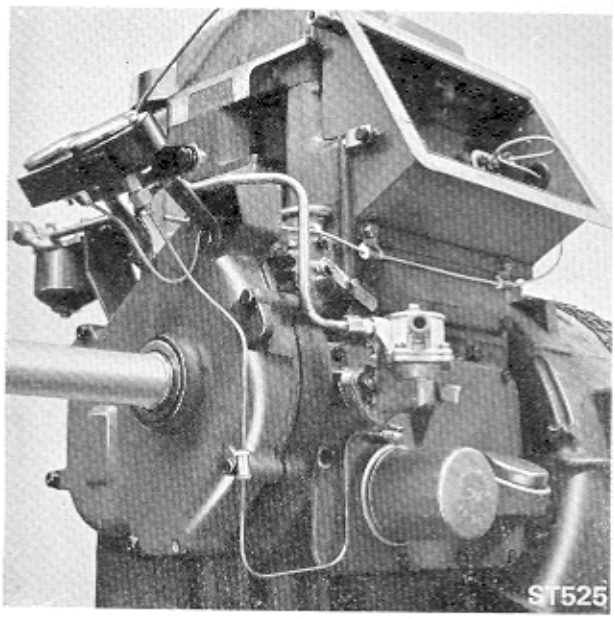


Fig. 106. Air Temperature Gauge

DUPLEX FUEL FILTER (Fig. 107)

The filter body is divided into two separate compartments, each containing a wick filter element.

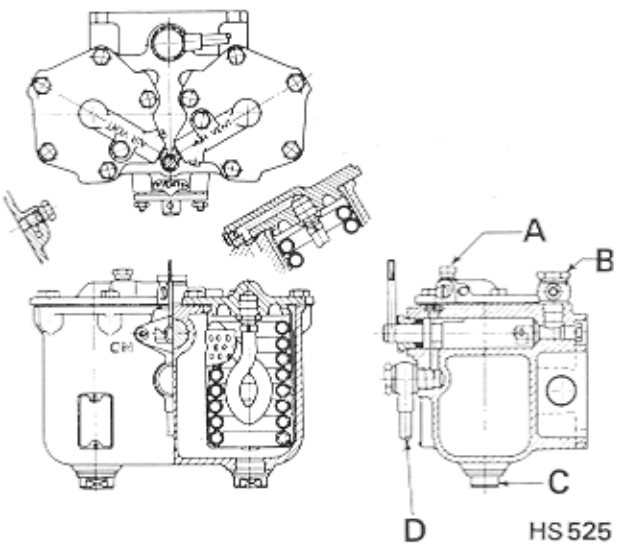
A change-over valve is provided between the compartments, so that either of the filters may be used while the other is being cleaned or replaced.

The wick has a screwed connection at one end, which is attached to the cover.

A jacket is provided on the back of the filter body so that hot water (or exhaust gases) may be used to warm the fuel oil under very cold climatic conditions.

Special vent screws are arranged in the covers so that all air may escape from the filter body and passages.

If both compartments of the filter have been properly vented, it is possible to change over from one filter to the other directly, while engine is running. Otherwise it will be necessary to move the change-over lever to the central position so that fuel may flow through both filters for venting purposes.



A. Vent screw.
B. Fuel Inlet.
C. Drain Plug.
D. Outlet to Fuel Pump.

Fig. 107. Duplex Fuel Filters

VARIABLE SPEED CONTROL

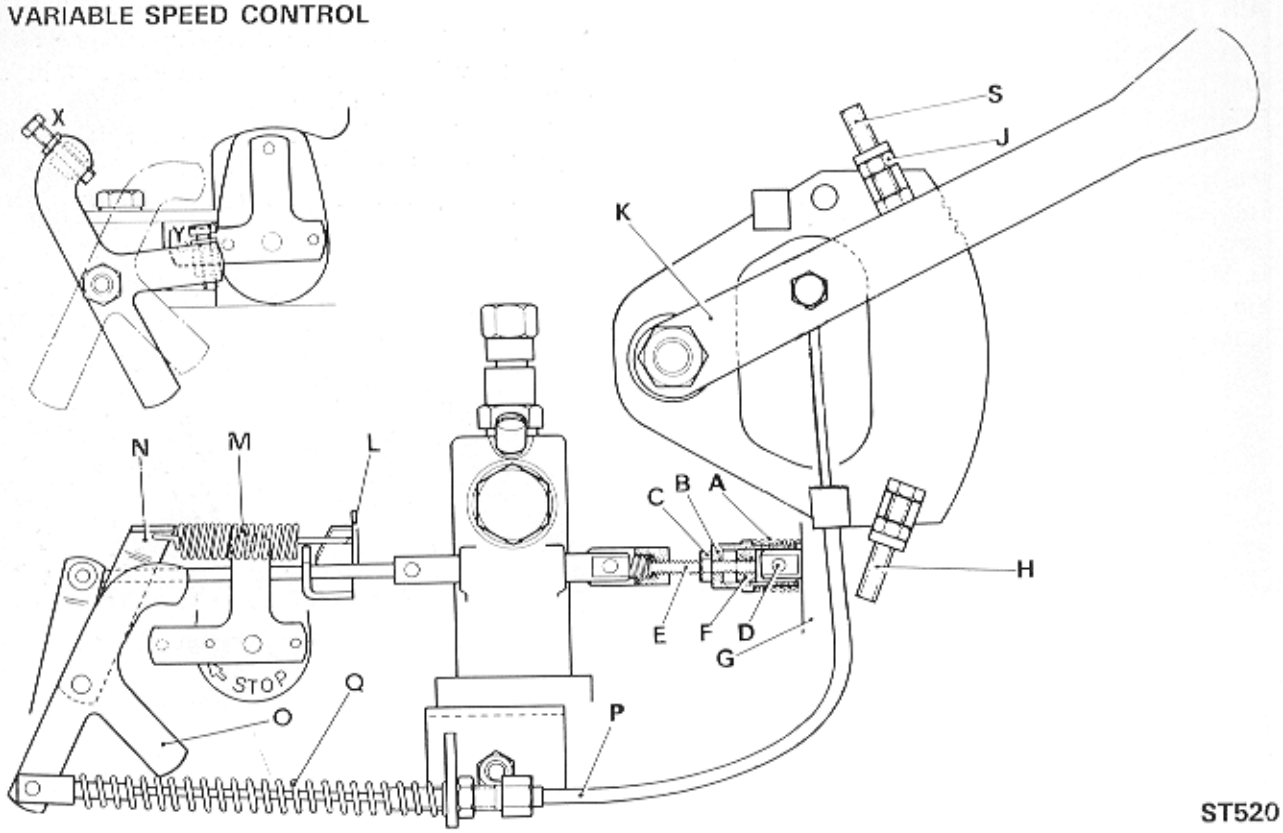


Fig. 108. Variable Speed Control (Cable Operated)

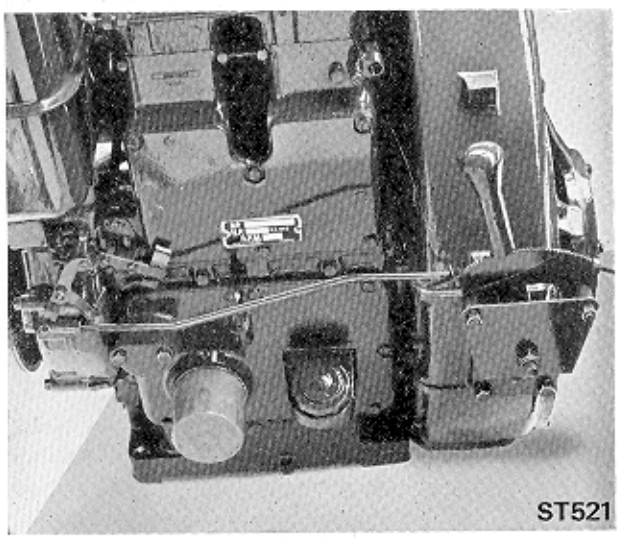


Fig. 109. Variable Speed Control (Rod Operated)

A Idling spring
B Adjusting sleeve
C Locknut
D Shackle pin
E Connecting rod
F Fuel pump shackle
G Fuel pump body
H Stop screw—hand lever
J Stop screw locknut
K Speed control lever
L Governor link
M Speeder spring
N Internal lever
O External lever
P Cable control
Q Pull-off spring (cable control)
S Stop screw—hand lever
X Stop screw—engine lever
Y Stop screw—engine lever

VARIABLE SPEED CONTROL

A speed control may be fitted to all engines, Figure 109 shows an engine mounted rod operated control; Figure 108 shows a cable operated control.

Adjusting Variable Speed Control (Fig. 108)

ST1 Engines. With the control lever in SLOW position adjust screw X until idling speed is 750 rev/min and tighten locknut.

Multi Cylinder Engines. The idling device consists of a spring A which is mounted over the left hand shackle F of the flywheel end fuel pump and exerts a force on the fuel pump rack by abutting against the pump body.

The fuel pump shackle F is fitted with a link stud E which has a long thread on which is screwed the idling spring adjusting sleeve B. This sleeve when rotated controls the spring force and is locked in position by the lock nut C.

To adjust the idling spring A, the main speeder spring at the gear end of the engine is completely slackened and the adjusting sleeve B is rotated in the desired direction until a steady idling of about one third of the rated engine speed is obtained and then locked by the nut C. Care must be taken to ensure that shackle pin D is at least partially covered by adjusting sleeve B.

The speed control on the engine has an idling adjusting screw X which should now be adjusted so that the main speeder spring just begins to increase the engine speed; this will eliminate hunting.

All Engines. With control lever still in SLOW position adjust screw H until it just touches the operating lever and lock the nut.

Move the control lever to FAST position, adjust screw Y until full revs are obtained and tighten the locknut. With the lever still in FAST position, adjust screw S until it just touches the lever and tighten locknut.

Note:—Ensure that the ratchet is engaged between two teeth in the FAST position. Adjust the length of the connecting rod or cable to suit.

A speed difference of 8% is found between engines on full load at maximum speed and engines on no load.

Fig. 110. Remote Stopping Control

A Remote Stopping Control (Fig. 110) and a Two Speed Control (Fig. 111) are available and may be fitted to all ST engines. Contact R. A. Lister or the nearest Distributor for further information.

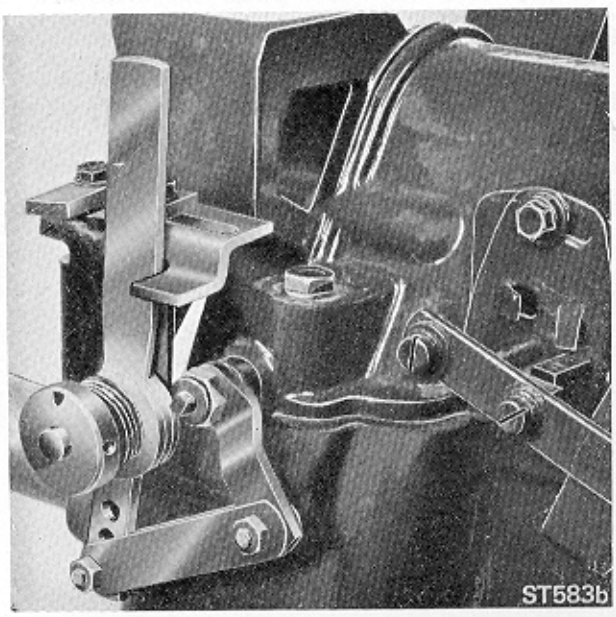


Fig. 111. Two Speed Control

SPEED CONTROL LEVER PLATE (Fig. 112)

In engine builds set at 2000 and 2600 rev/min (100% load), the speed control lever plate is marked on factory test while the engine is hot with three marks, as shown in the illustration, to indicate position of the speed control lever corresponding to the three engine speeds.

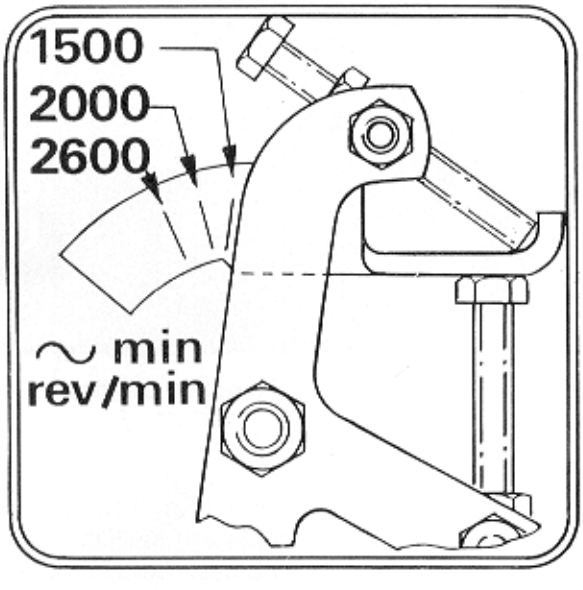


Fig. 112. Speed Control Lever Plate

Extended Stop Control

A simple rod arrangement may be fitted to the fuel pump housing door operating directly on to a modified stopping lever.

MARINE PROPULSION ENGINES

Single Lever Speed and Stop Control Adjustment (Fig. 113)

Engine idling at 750/850 rev/min: Adjust the connecting rod to the hand control so that the hand lever is in the bottom notch of the ratchet in the speed sector.

Engine at full speed 2000/2600 rev/min. With the hand lever held in the full speed position (on load), set adjustable stop X so that it just touches the hand lever. Tighten the lock nut.

Stopping Control: Adjust cable so that the engine stops when the hand lever is at the limit of its travel in the stopping sector.

Note: The above settings are made after setting X and Y, Fig. 108.

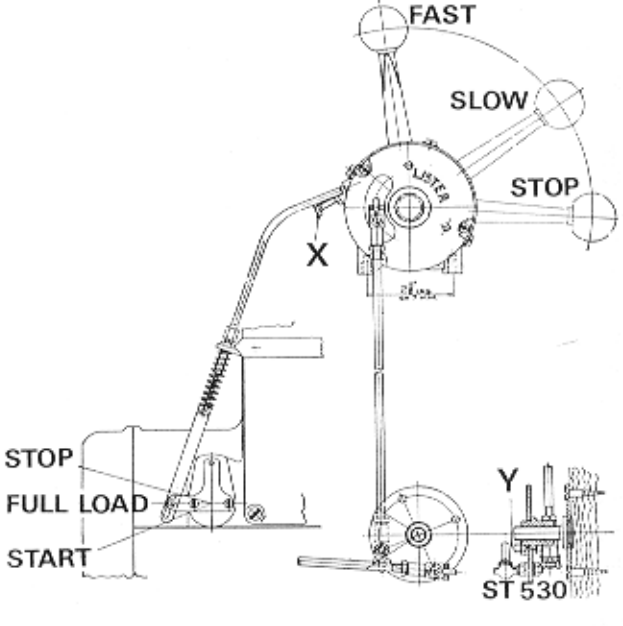


Fig. 113. Single Lever Speed and Stop Control

Morse Single Lever Control

A Morse single lever control is available on request for engines fitted with an hydraulic gearbox. As the fitting will depend on the installation, reference should be made to the instructions supplied with each kit.

PROTECTION DEVICES AND SOLENOIDS

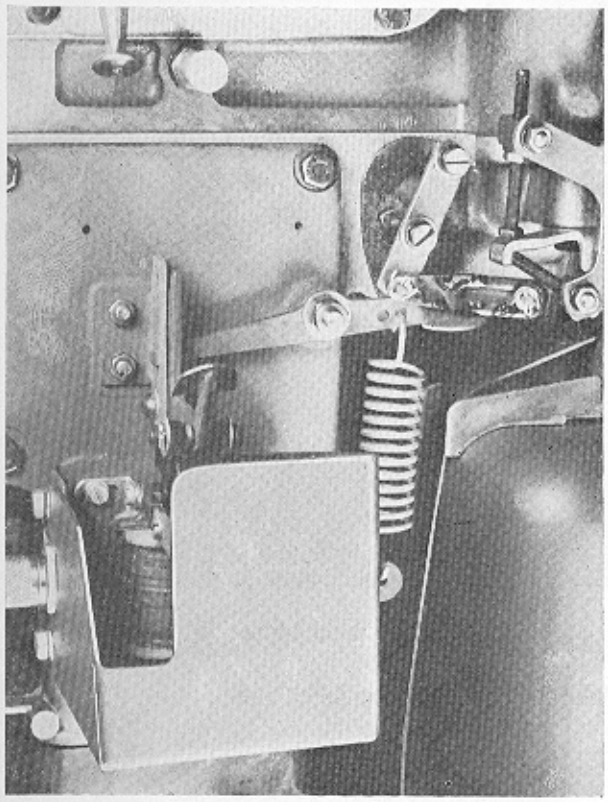


Fig. 114. Trip Type Fuel Control Soleniod

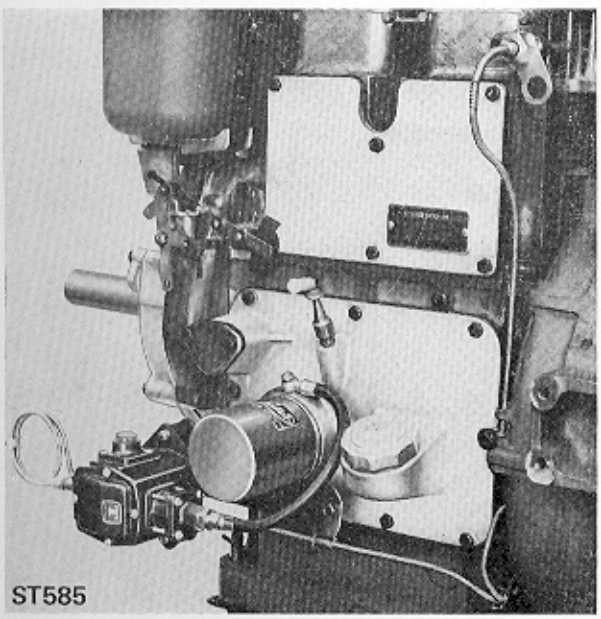
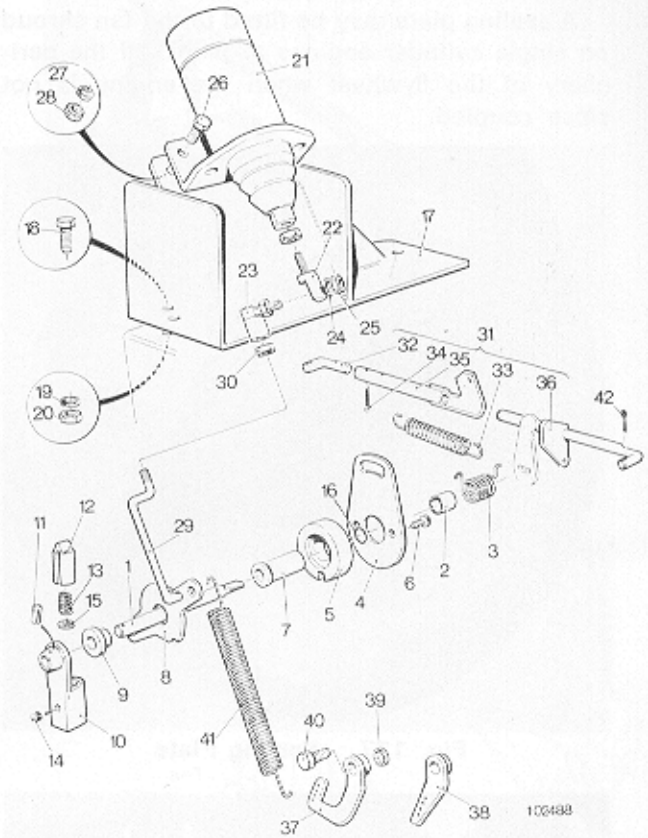


Fig. 116. Combined Air Temperature and Oil Pressure Switch



1	Spindle	23	Ball Joint
2	Movement Limit Spacer	24	Spring Washer
3	Overload Control Spring	25	Nut—0.19" UNF
4	Adjustment Plate	26	Setscrew—M6 x 14mm
5	Locking Disc	27	Spring Washer
6	Screw	28	Nut—M6
7	Spacer Bush	29	Solenoid Link
8	Cam Control Lever	30	Nut—0.19" UNF
9	Cam Bush	31—36	Governor Link Assembly
10	Plunger Barrel	37	Spring Anchor Bracket Assembly—ST1/2
11	Spring Pin	38	Spring Anchor Bracket Assembly—ST3
12	Control Plunger	39	Copper Washer
13	Plunger Spring	40	Bolt—¼" UNF
14	Plunger Locating Dowel	41	Solenoid Return Spring
15	Shim	42	Split Pin
16	'O' Ring		
17	Solenoid Bracket Assembly		
18	Screw—M6 x 14mm		
19	Spring Washer		
20	Nut—M6		
21	12V Solenoid		
22	Connector		

Fig. 115. 12V Synchro Fuel Control Solenoid©

SEALING PLATE (Fig. 117)

A sealing plate may be fitted to the fan shroud on single cylinder engines to blank off the periphery of the flywheel when the engine is not close coupled.

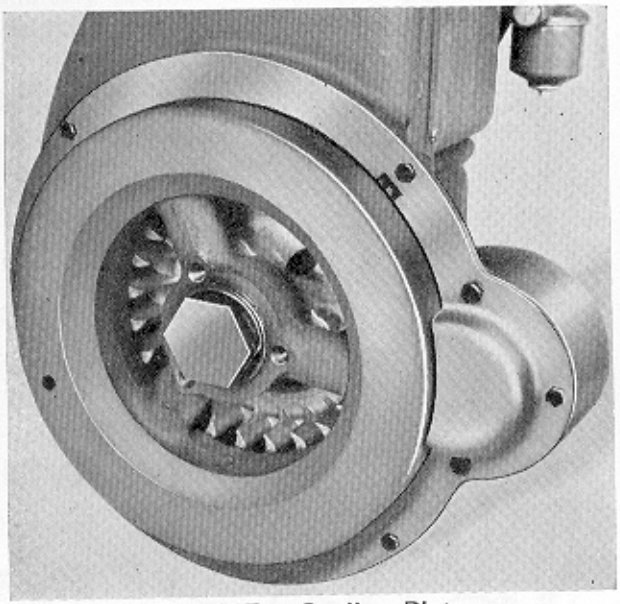


Fig. 117. Sealing Plate

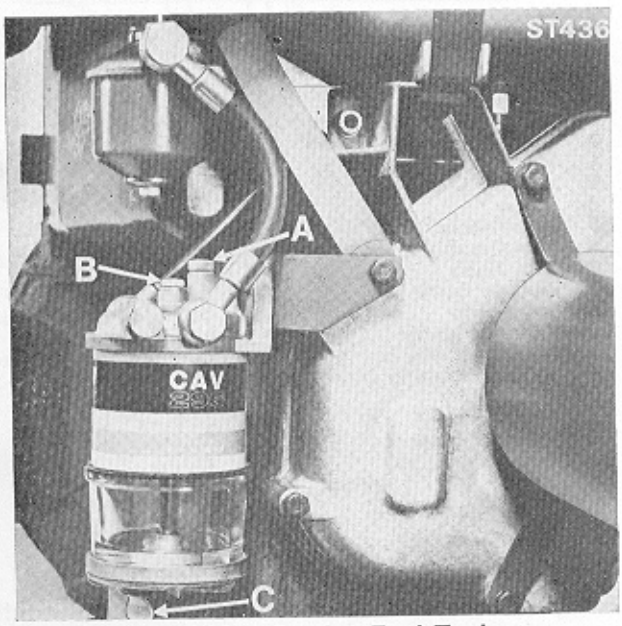


Fig. 119. Marine Fuel Tanks

Marine Fuel Tanks (Fig. 119)

Three tanks are available for marine applications:-

A. 27.3 litre (6 gall)
B. 45.5 litre (10 gall)
C. 113.5 litre (25 gall)

FUEL TANKS

Engine Mounted

An 11 litre (2½ gall) engine mounted tank is available for most applications. Information on fitting and removal can be found in Section 3.

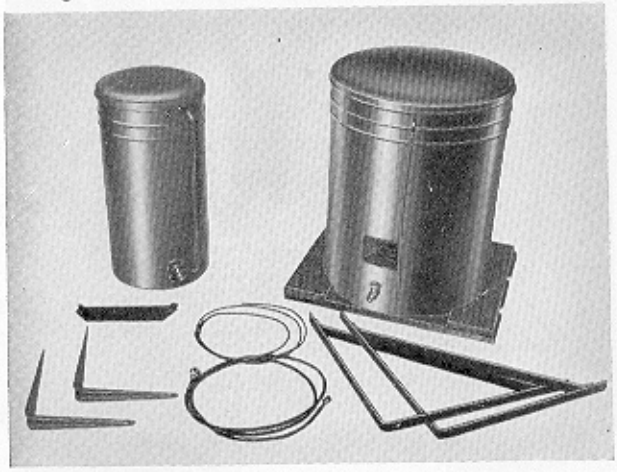


Fig. 118 Wall Mounted Tanks

Wall Mounted Tanks (Fig. 118)

Two sizes are available:-

32 litre (7 gall)
90 litre (20 gall)

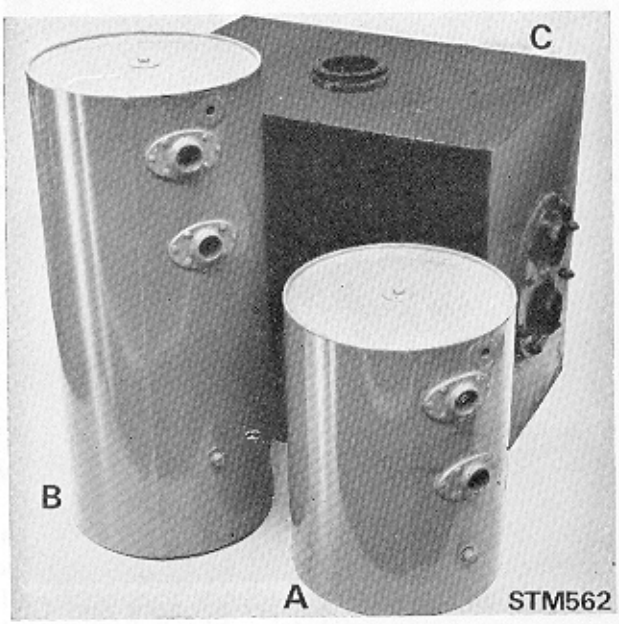


Fig. 119A. Fuel Filter/Agglomerator

RAISED HAND START

The raised hand start assembly is secured to the engine by brackets to the fan shroud and the gear end. The fittings will vary according to the application and type of accessories used on the engine.

Figures 121 and 122 show the components of R.H.S. on ST and STW engines respectively. Figure 120 illustrates the complete assembly fitted to an ST engine.

A dynamo pulley containing ratchet pawls, a ratchet wheel and bearing assembly, is keyed on to the camshaft extension and secured by a socket screw in the bearing collar.

A chain connects the raised hand start chain wheel to the ratchet wheel on the camshaft extension, one side of the chain being fitted inside a chain tensioner.

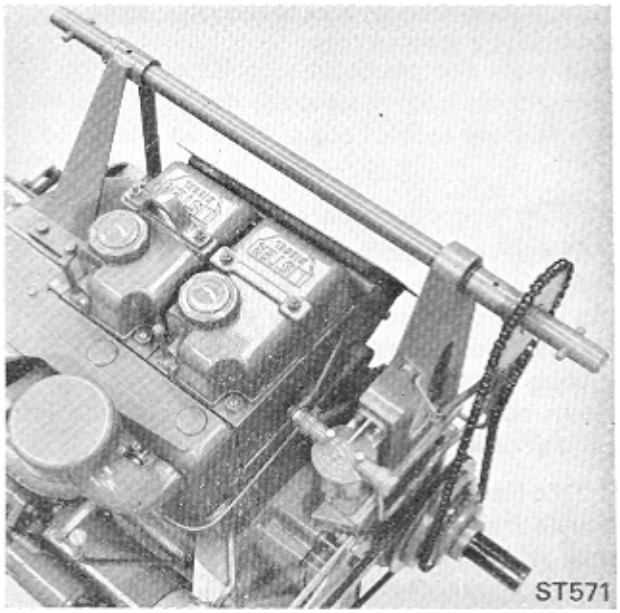


Fig. 120. Raised Hand Start

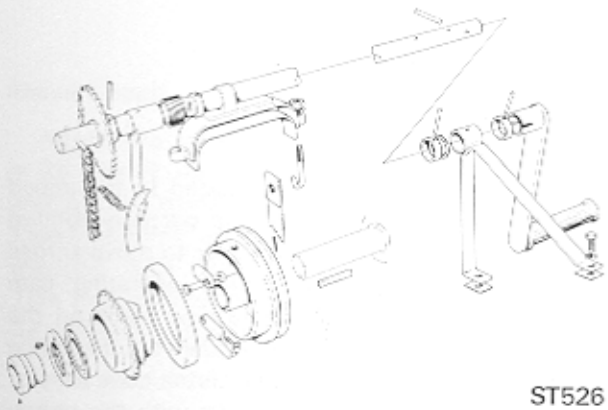


Fig. 121. Components (ST)

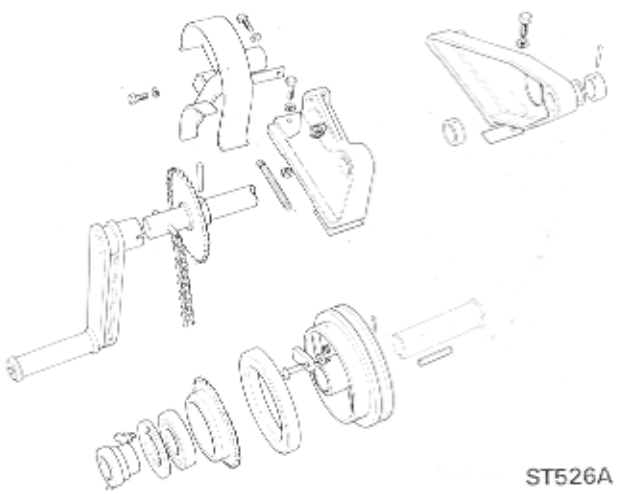


Fig. 122. Components (STW)

FUEL FILTER/AGGLOMERATOR (Fig. 119A)

The fuel filter/agglomerator may be fitted to ST1 or 2 engines provided the engine is fitted with an engine mounted fuel tank. The accessory acts as a primary filter and is in series with the basic engine filter.

With the fuel turned off the unit can be drained through drain plug 'C' and the element may be removed by unscrewing bolt 'B'.

Bleeding System

1. Check fuel tank is full.
2. Loosen vent screw 'A' on agglomerator until the bowl is free of any air bubbles.
3. Tighten vent screw.
4. Loosen vent screws at the top of main filter (Fig. 20A) until air free fuel is seen to flow.
5. Tighten vent screws.

LISTER REVERSE GEAR LM100 (Fig. 123) MANUALLY OPERATED

General

The reverse gear is mounted on an adaptor which is attached to the engine fan shroud and two bearers situated at the aft end of the unit. The gear box incorporates an epicyclic gear with a cone clutch for ahead and a brake band for astern operations with thrust bearings built into the unit capable of absorbing the propeller thrust.

This box is robust and designed to give a long trouble free life. Abuse and/or lack of maintenance will, however, affect this life and the following points should be watched.

1. Before changing gear, reduce engine speed.
2. Move the gear lever firmly and steadily to change gear.
3. Never run with the reverse band or cone clutch slipping.
4. Check oil level in the reverse gear and also in the reduction gear (if fitted) every 24 running hours or weekly.
5. If the gear lever is moved to the port side of gearbox, a locating bolt should be fitted through the hole in the operating shaft to limit travel of lever.

Flexible Coupling

A flexible coupling capable of taking the full thrust of the propeller is supplied, to accommodate the movements of resiliently mounted engines. Should any other type of flexible coupling be fitted it must be capable of absorbing this thrust.

If the stern tube inboard gland is more than 228 mm (9") from the flexible coupling a bearing or plummer block must be fitted and positioned as near the coupling as practicable. If an intermediate shaft is installed, this bearing must be fitted close to the coupling.

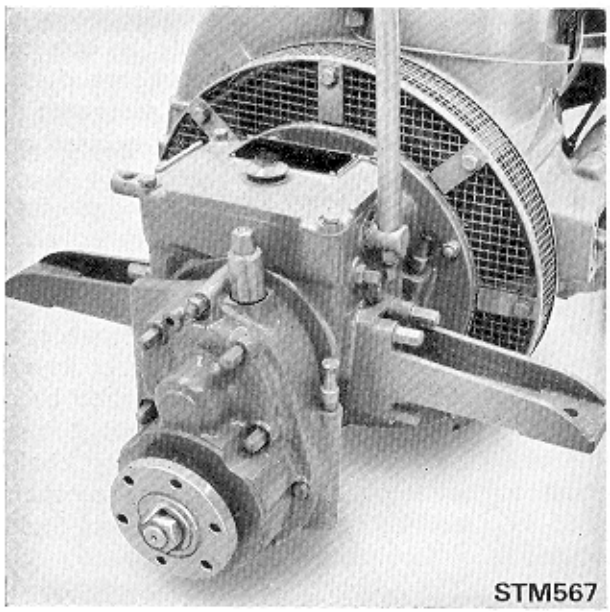


Fig. 123. Manually Operated Reverse Gear with Reduction Gear

Operation—Ahead

When the gear lever is engaged in the ahead position, the operating shaft is partially rotated allowing the forward facing roller to move across the formed face of the clutch operating cam lever. This removes the restraining force on the clutch operating yoke and under the influence of the clutch springs the inner clutch cone assembly moves forward and engages with the clutch body. As the inner clutch cone assembly is splined to the clutch shaft, a direct through drive is obtained.

Operation—Neutral

Drive from the engine is passed initially from the crankshaft spur gear to the short reverse pinions. These in turn drive the two reverse pinions thus driving the clutch shaft spur gear. The latter is situated forward of clutch and is integral with the clutch shaft. When in neutral this gear remains at rest and the two sets of pinions revolve round it, carrying with them the clutch body.

Operation—Astern

When the gear lever is put in the astern position the operating shaft causes the aft facing roller to move the brake band lever. This tightens the brake band on to the clutch body and the latter ceases to revolve. The drive then passes through the short reverse pinions and the spur pinions thus rotating the clutch shaft spur gear and the clutch shaft in the astern direction.

Adjustment

Remove the gear box cover, and the retaining screw at the port side end of the operating shaft. This will enable the shaft to be withdrawn sufficiently for the two rollers to clear their respective levers when the reverse lever is selected to the ahead position.

Ahead Clutch

Adjust the forward facing roller so that there is 25 mm (1 in.) of free movement at the knob end of the hand lever when it is fully in the ahead position and the forward facing roller is engaged with the clutch operating cam lever. This free movement is important and should not be allowed to become less than 12 mm. ($\frac{1}{2}$ in.).

Reverse Band

The aft facing roller should be adjusted so that the full astern power can be taken without the clutch body or brake band slipping. It is very important, however, that the band is not over adjusted otherwise considerable damage may be caused. The force required to engage the hand lever from the neutral to the astern position, should be about 40.69 Nm (30 lbf.). When in the OFF position, the band rests on a lug in the bottom of the gear case, and it should be clear of the clutch body drum, although very light rubbing is permissible.

Lubrication—Gear Box and Reduction Gear

A mild type EP gear lubricant or a multi purpose gear lubricant (as used in most car differentials) should be used in the reverse gearbox and reduction gear.

Fill the reverse gear and reduction gear (if fitted) to the marks on the respective dipsticks. Do not overfill.

Capacities:—

Reverse Gear	**0.85 litre (1.5 pt.)**
Reduction Gear	**0.3 litre (0.5 pt.)**

Change the oil every 1000 hours and clean magnetic drain plug.

The external ends of the reverse gear operating shaft must be oiled frequently to prevent rust formation which may stiffen the shaft. To lubricate the port side of the shaft, the locating screw should be removed and a few drops of oil poured down the hole.

MISCELLANEOUS MARINE ACCESSORIES

For information on marine accessories not described in this section, i.e. Propellers, Bilge Pumps, Sump Pumps etc., contact Lister Marine.

Notes on fitting and servicing sterngear can be found in the installation information on page 15.

Identification of all parts, part numbers and ordering instructions can be found in the engine Parts List, Book 1704PL.

Dismantling Lister LM100 Reverse Gear

(a) Drain the oil through the drain plug and replace drain plug.

(b) Disconnect reverse gear bearer holding down bolts.

(c) Disconnect propeller shaft from half coupling.

(d) If required and space is available, remove reduction gear. First drain the oil and then remove one steel nut at the top and two to the rear of the casing, plus four brass dome nuts on the front casing.

(e) Remove reverse gear case securing nuts leaving the top two until last (on reassembly it is advisable to start the top two nuts on the studs prior to the gear casing being pushed fully into position).

(f) If no other obstacles are apparent the reverse gear can be withdrawn from the engine.

(g) Place one gear case bearer in a vice and allow the case to rest on the bench.

(h) Remove the inspection cover taking care not to damage the joint.

(j) Remove operating shaft by selecting ahead position, removing locating set screw, and lightly tapping operating shaft to clear roller adjusters from brake band and cam lever.

(k) Loosen locknuts and remove roller adjusters from operating shaft. The operating shaft may be removed from the reverse gear casing, and if desired the two 'O' rings on the shaft may be changed.

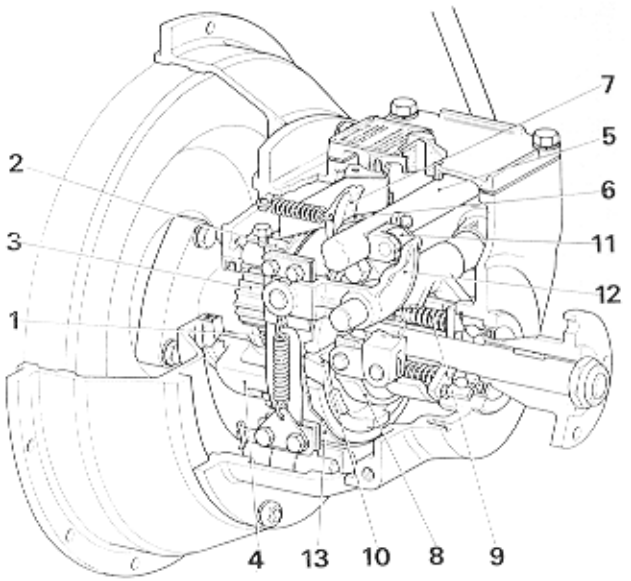
(i) Remove clutch operating cam spring, and clutch operating cam bolt and nut, which connects clutch operating cam lever and clutch operating lever.

(m) Remove fulcrum shaft retaining plug on side of gear case and screwing a suitable set screw into threaded hole provided, withdraw the fulcrum shaft.

(n) Remove brake band anchor pin after withdrawing the retaining split pin.

(o) Remove split pin, securing nut, half coupling and key, or if reduction gear used remove pinion nut, inner race of roller bearing, pinion and key and oil trap.

(p) Gently drive out reverse gear by tapping reverse shaft with suitable lead or copper hammer.



ST 533

1. Crankshaft spur gear.
2. Short reverse pinion.
3. Reverse pinions.
4. Clutch body.
5. Operating shaft.
6. Forward facing roller.
7. Clutch operating cam lever.
8. Clutch operating yoke.
9. Clutch springs.
10. Inner clutch cone assembly.
11. Aft facing roller.
12. Brake band lever.
13. Brake band.

Fig. 124. Lister LM100 Reverse Gear

(q) Remove brake band assembly from gear casing and if it is necessary to change brake band, remove brake band spring, split pin and brake band pin, brake band lever, four brake band clamping bolts, two brake band end plates and lower anchor plates. Renew brake lining assembly and assemble in reverse order.

To Remove Cone Clutch

(r) Remove distance piece, retaining plate, clutch springs and housing, and clutch spring housing sleeve. Note position of clutch spring spacing discs—if fitted.

(s) If the casing bearing needs renewing, remove circlip and drift out oil seal bush from the outside of the gear case. This will

take the casing bearing with it and with care the casing oil seal will remain undamaged. Removing the oil seal bush through the casing will certainly destroy the oil seal. Replace the casing bearing and re-assemble. Renew seal if damaged or worn.

(t) Remove clutch cone assembly reverse shaft, and if the thrust race needs renewing, remove circlip and distance piece, clutch operating yoke and bearing. At this point renew inner clutch cone assembly if necessary. **If replacing thrust race ensure that closed or thrust face of bearing is facing towards the clutch cone.**

(u) Remove locking wire and screws (older boxes) or circlips (newer boxes) from reverse pinion shafts, remove pinion shafts and pinions marking location of pinions.

(v) Remove circlip and 2 clutch body retainers, gently drive out reverse shaft taking with it the large clutch body bush, free running small clutch body bush and two thrust washers.

Assembly

During assembly freely lubricate all parts with a mixture of SAE 80 EP gear oil and 2% concentrated collodial graphite.

Cementing of Joints

All jointed must be cemented with Hylomar PL32M jointing compound.

NOTE: When fitting reduction gear assembly to a reverse gearbox already fitted to the engine, place operating lever in reverse position prior to removing propeller shaft coupling and assembly of reduction gear components.

Assembly (cont.)

It is recommended that all joints and seals should be renewed.

On reassembly place copper thrust washer next to the reverse shaft gear. Proceed in reverse order until reaching para (o). in order to compress the clutch springs which in turn will permit the fitting of the reduction gear drive pinion, etc. proceed as follows:—

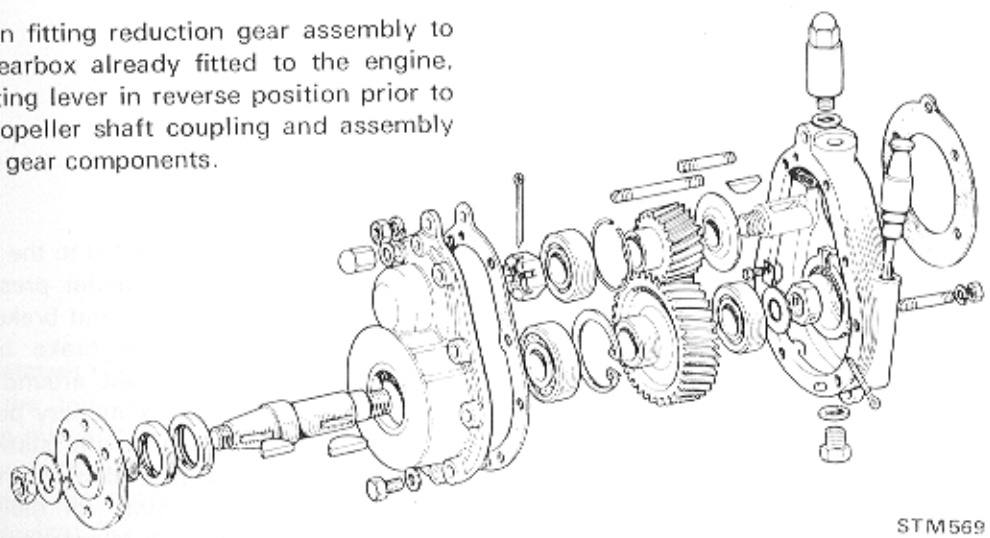
(a) Prevent the rotation of the epicyclic gears and clutch housing by using hard wood wedges between the gears and the gear box casing.

(b) Using the oil trap and reduction gear pinion (less key) as distance pieces use the nut to draw the reverse gear assembly fully into the casing. Should the pinion be tight on the shaft it would be advisable to use a suitable loose fitting sleeve in place of the pinion.

(c) When both roller adjusters are in position against their respective operating levers remove securing nut and reduction gear pinion. The springs will remain compressed.

(d) Refit oil trap, pinion and key, inner race of roller, nut and split pin in their correct order.

(e) Continue with assembly remembering to fill to correct level with oil both the reverse gear and reduction gear.



STM569

Fig. 125. Components of Reduction Gear

LISTER REVERSE GEAR LH150 (Fig. 126) HYDRAULIC OPERATED

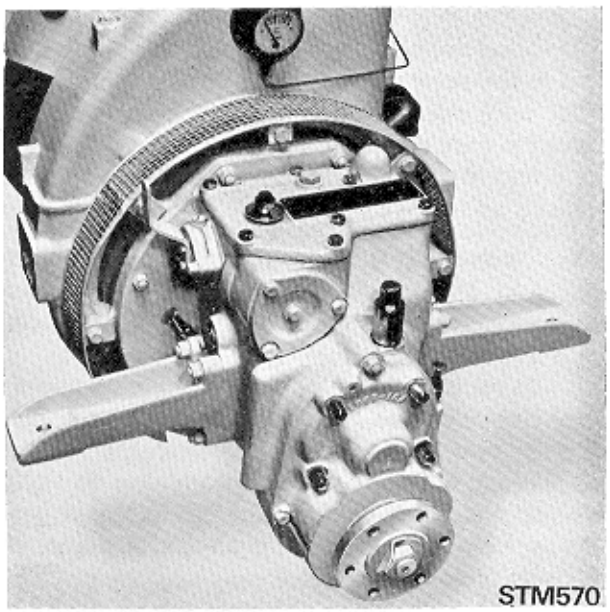


Fig. 126. Hydraulic Reverse Gear with Reduction Gear

General

Hydraulic pressure is used only to obtain 'neutral' and 'astern' positions. There is no high oil pressure in the ahead position and therefore the power loss in this position is small. If this hydraulic system fails the clutch remains engaged in the ahead position. The propeller shaft remains engaged with the crankshaft until the engine is started when it disengages in 2-3 seconds if the control is in neutral position. If it is decided to free the ahead clutch with the engine stopped, as for example, for lining up the engine coupling during installation, the screw (A) is removed, replaced by screw (B) and screwed carefully until the clutch just disengages and no more. The screws must be replaced before starting the engine (see Fig. 126A).

N.B.—Prior to replacing screw (A) with screw (B) it is necessary to check correct gap of 2.4 mm (0.094").

Operation Ahead

On the forward movement of the selector valve into the ahead position, pressurised oil to the clutch operating piston is vented back into the sump. The resultant action is that the cone clutch travels forward under spring pressure locking the driving gear to the clutch body which prevents the planetary gears rotating, so locking the driving gear to the output shaft causing the whole mass to rotate as one.

Operation Neutral

On the movement of the selector valve to the central position, oil under pressure will flow to the clutch operating piston moving it forward to draw the cone clutch out of engagement through a pivoted lever. This will allow the planetary gears to rotate on their own axis free of the output shaft, causing an interruption of the drive.

Operation Astern

The selector valve is moved to the astern position to allow oil to flow under pressure to the pistons for the cone clutch and brake band. The upward movement of the brake band piston draws the brake band tight around the clutch body and brings it to a stationary position.

With the clutch body in the stationary position and the driving gear rotating, the planetary pinions will start to rotate on their own axis and reverse the direction of rotation to the output shaft.

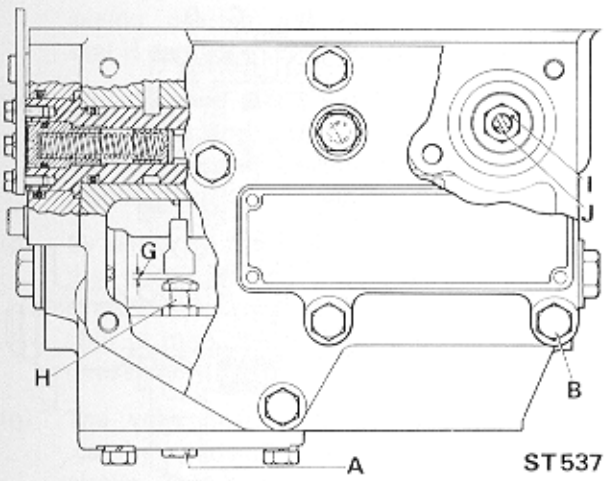


Fig. 126A. Adjusting Hydraulic Reverse Gear

Ahead Adjustment (Fig. 126A)

Remove the top cover and adjust screw (H) until the dimension (G) is 2.4 mm (0.094") with the piston pushed right back. After adjustment place spanner on piston flats whilst tightening locknut.

Astern Adjustment (Fig. 126A)

Remove the top cover and slacken nut (I) then holding nut with a spanner, turn adjusting screw (J) anticlockwise until the brake band is felt to be tight on the drum, then slacken the screw (clockwise) 3 complete turns on the self locking nut. (J).

Lubrication

A mild type EP gear lubricant or a multi purpose gear lubricant (as used in most car differentials) should be used in the reverse gearbox and reduction gear.

Fill the reverse gear and reduction gear (if fitted) to the marks on the respective dipsticks. Do not overfill.

Capacities:—

Reverse Gear	**1.2 litre (2 pt.)**
Reduction Gear	**0.3 litre (0.5 pt.)**

Change the oil every 1000 hours and clean magnetic drain plug.

Identification of all parts, part numbers and ordering instructions, can be found in the engine Parts List, Book 1704PL.

Dismantling the LH150 Reverse Gear

To Remove Reverse Brake Band

(a) Drain oil through magnetic drain plug, clean and replace plug.

(b) Remove propeller shaft from half coupling, and holding down bolts from reverse gear bearers.

(c) If required and space is available drain reduction gear and remove. Remove one steel nut from the stud at the top and two nuts to the rear of the casing, and four brass dome nuts on the front casing.

(d) Remove gear case securing nuts leaving the top two until last (on re-assembly it is necessary to start the top two nuts on the studs prior to the gear casing being pushed fully into position).

(e) After disconnecting the control to the hydraulic selector lever the reverse gear can be withdrawn from the engine.

(f) Securing one engine bearer in a vice and allowing the gear casing to rest on the bench, remove the 9 securing screws from the inspection cover. Remove the inspection cover and joint.

(g) Remove the oil pump complete with driving gear, joint and oil pipe, by removing two set screws on the oil pump flanges and disconnecting the banjo union of the oil pipe at the selector valve.

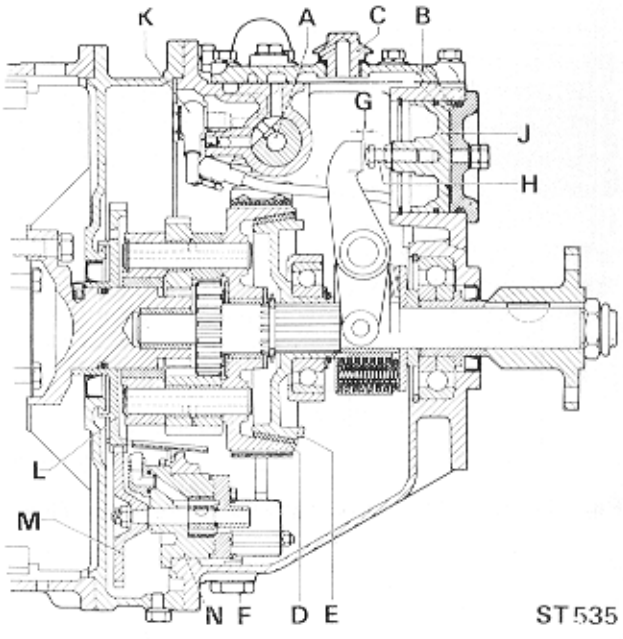
(h) Remove splash guard by removing the two set screws.

(j) Slacken self locking nut and washer from brake band operating piston.

(k) Separate and remove clamping piece by removing the three nuts and bolts. Remove the split pin and lower anchor pin, this will allow the removal of the brake band and push off spring.

To Remove Ahead Clutch

(l) Remove the two brass retaining plugs in the side of the gear casing, this will permit the screwing of suitable set screws into the threaded holes provided, and thus allow the two pivot pins to be withdrawn. (On re-assembly ensure that the threaded hole in the pivot pins are facing outwards).



A—Selector Valve
B—Inspection Cover
C—Oil Filler and Breather Plug
D—Clutch Body
E—Clutch Cone
F—Magnetic Drain Plug
G—Clearance of 2.38 mm ($\frac{3}{32}$").
H—Adjusting Screw
J —Astern Piston
K—Oil Feed Pipe to Selector Valve
L—Oil Pump Driving Wheel
M—Oil Pump Driven Wheel
N—Oil Pump

Fig. 127 Lister LH150 Reverse Gear

(m) Remove half coupling nut and remove coupling and key, or if reduction gear fitted, remove split pin and reduction pinion nut, inner race of the reduction gear roller bearing, reduction pinion, key and oil thrower.

(n) Tap out reverse gear assembly. If the casing bearing needs renewing, remove circlip and drift out oil seal bush from the outside of the gear case. This will take the casing bearing with it, and with care the housing oil seal will remain undamaged. Removing the gear through the casing will certainly destroy the oil seal. Replace the

casing bearing and re-assemble. Renew seal if damaged or worn.

(o) The distance piece, retaining plate, housing sleeve and clutch spring housing can all be removed carefully noting order of dismantling.

(p) By removing the four circlips and washers the short pinions, spacers, and reverse shaft pinions may be removed. It is advisable to mark the pinions to ensure correct re-assembly.

(q) The yoke bearing clutch operating yoke can be removed by removing the retaining circlip. **This bearing is a thrust bearing in one direction only and should be re-assembled with closed or thrust face into the cone.**

(r) The removal of a further circlip will permit the removal of the two halves of the clutch body retainer, locating washer and free running small clutch body bush.

(s) Tapping out the reverse shaft from the clutch body will drive the large clutch body bush from its housing and release the two thrust washers. (On re-assembly the bronze thrust washer fits nearest the clutch shaft gear.)

Assembly

During assembly freely lubricate all parts with a mixture of SAE80 EP gear oil and 2% concentrated collodial graphite.

Cementing of Joints

All joints must be cemented with Hylomar PL32M jointing compound. It is recommended that all joints and seals should be renewed.

Proceed in reverse order until reaching para (n). In order to compress the clutch spring which in turn will permit the fitting of the reduction gear drive pinion, etc., proceed as follows:—

(a) Prevent the rotation of the epicyclic gears and clutch housing by using hard wood wedges between the gears and the gear box casing.

(b) Using the oil trap, reduction gear pinion (less key) and inner race as distance pieces use the nut to draw the reverse gear assembly fully into the casing. (Should the pinion be tight on the shaft it would be advisable to use a suitable loose fitting sleeve in place of the pinion.)

(c) Leaving the springs compressed, continue to assemble the clutch operating lever assembly by inserting the two pivot pins.

(d) Take up any clearance using the adjusting screw on the clutch lever operating piston, and remove the nut and reduction gear pinion.

(e) Refit pinion and key, inner race of roller, nut and split pin in their correct order. Continue with assembly procedure.

(f) When offering up the reverse gear to the engine ensure that reverse gear oil pump driving and driven gears are correctly meshed by gently rotating the engine with a hand start crank handle. If these gears are not correctly meshed serious damage may occur to the oil pump drive shaft.

(g) Fill reverse gear and reduction gear with correct oil.

Hydraulic Servicing

(a) To remove clutch lever operating piston, remove the piston cover and withdraw the piston. The piston cover 'O' ring and/or piston ring on the piston can be replaced. If the piston is withdrawn a piston ring clamp will be needed to refit the piston.

(b) The brake band operating piston may also be removed to fit a new piston ring, once again using a piston ring clamp to replace piston. The brake band actuating spindle may be withdrawn and the two 'O' rings replaced; the piston shoulder is fitted uppermost.

(c) The selector valve may be withdrawn by removing the two Allen Screws securing the valve retaining cover to the gearbox case in order to change the 'O' rings.

FAULT	PROBABLE CAUSE	RECTIFICATION	PAGE REFERENCE	
			ST	STW
Engine Difficult to Turn (Decompressed)	Lubricating oil too heavy	Drain sump and refill with correct oil	25	25
	Incorrect decompressor clearance	Re-adjust	50	68
	Load not disconnected from the engine	Investigate	—	—
Engine Difficult to Start	Lack of fuel	Fill tank and bleed system	36	36
	Air in fuel system	Check and tighten all connections and bleed system	36	36
	Defective fuel pump	Overhaul or replace	37	37
	Faulty injector	Test or replace	41	41
	Low compression	See "Low Compression"	—	—
	Stopping control incorrectly positioned	Set in correct starting position	20	20
	Air cleaner or exhaust blocked	Clean	49	67
Failure to Obtain Normal Speed	Engine started under overload	Reduce load on engine until normal speed obtained.	—	—
	Fuel system not primed	Bleed and prime	36	36
	Injection retarded	Retime fuel pump	40	40
Loss of Power	Incorrect fuel	Drain and refill tank with correct fuel	33	33
	Choked air cleaner	Change element	49	67
	Choked fuel filter	Change	36	36
	Fuel injector not fuctioning properly	Test injector, replace if necessary	41	41
	Fuel pump not operating correctly	Replace	37	37
	Incorrect tappet clearance	Adjust	50	68
	Choked exhaust	Remove restriction	49	67
Erratic or Uneven Running	Air in fuel system	Check all fuel lines and connectors, bleed system	36	36
	Incorrect fuel pump timing	Retime	40	40
	Faulty injector	Test and/or replace	41	41

FAULT	PROBABLE CAUSE	RECTIFICATION	PAGE REFERENCE ST	PAGE REFERENCE STW
Knocking	Incorrect timing.	Retime fuel pump.	40	40
	Air in fuel system.	Check connections and bleed system.	36	36
	Incorrect fuel.	Change.	33	33
	Worn bearings.	Replace.	54/60	54/60
	Insufficient clearance between piston and cylinder head.	Adjust.	53	72
	Flywheel loose.	Tighten.	58	58
	Excessive carbon deposit on piston.	Remove Carbon.	54	73
	Engine loose on its mountings.	Tighten.	—	—
	Valve sticking in guide.	Clean stems and guides.	52	71
	Slack bearing.	Fit new bearing if crankshaft is not worn.	54	54
Low Compression	Injector loose on its seat.	Check clamp is secure.	41	41
	Piston rings worn or broken.	Fit new rings.	54	73
	Leaking inlet or exhaust valves.	Regrind valve and seat.	52	71
	Cylinder head gasket leaking.	Check head is correctly torque loaded, replace gasket if necessary.	53	72
Low Oil Pressure	Insufficient oil.	Maintain correct oil level.	26	26
	Oil seals leaking.	Check and change defective seal.	30	30
	Worn bearings.	Change.	54/60	54/60
	Fractured pipe.	Change.	28	28
	Oil pump defective.	Change.	28	28
	Oil diluted.	Drain and refill with correct oil.	25	25
	Strainer choked.	Remove and clean.	27	27
	Relief valve not seating.	Renew if worn out.	29	29
	Oil pump plunger and valves worn or dirty.	Clean and renew as necessary.	28	28
Smoky Exhaust (BLACK)	Engine running on overload.	Check stopping control setting.	21	21
	Air cleaner choked.	Renew element.	49	67
	Injector nozzle dirty.	Clean or replace.	41	41
	Incorrect fuel.	Drain and refill with correct fuel.	33	33

FAULT	PROBABLE CAUSE	RECTIFICATION	PAGE REFERENCE	
			ST	STW
Smoky Exhaust (BLUE)	Piston rings worn.	Renew.	54	73
	Cylinder bore worn.	Rebore and fit oversize rings.	54	73
Engine Stops	Insufficient fuel	Fill tank and bleed system	36	36
	Loss of Compression	See "Low Compression"	—	—
	Dirt in injector or fuel system	Investigate and clear	41	41
	Air in fuel system	Bleed system	36	36
	Water in fuel system	Drain, flush, fill with correct fuel and bleed system	36	36
High Oil Consumption	Valve Guides worn	Change guides or fit new cylinder head	52	71
Engine Overheating ST Engines	Cooling air recirculating	Check that cooling air inlet and outlet are not obstructed	10	
	Air cleaner or exhaust choked	Clean	49	
	Injection retarded	Retime fuel pump	40	
	Insufficient lubricating oil	Check level	26	
	Engine overloaded	Reduce load	—	
Engine Overheating STW Engines	Thermostat faulty	Replace		68
	Injection timing faulty	Check and adjust		40
	Jabsco pump faulty	Change impellor or replace pump		69
	Blockage in water cooling system	Check and renew all hoses and remove cylinder block inspection doors		73
		Clean out water channels in block and cylinder head		

Note:—Electrical system fault diagnosis can be found in Section Eight.

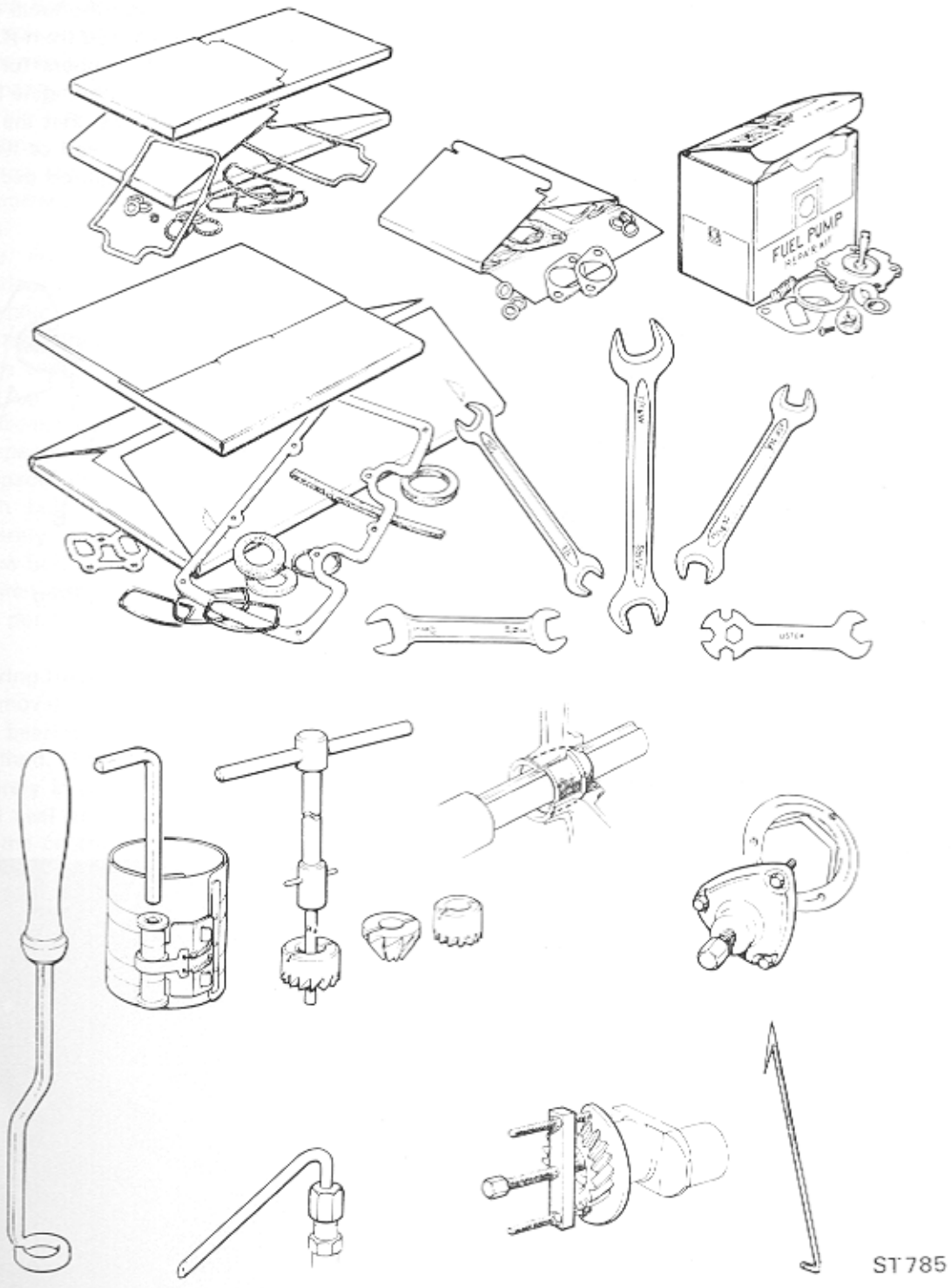


Fig. 128. Tools and Joints Sets
(See Engine Parts List for details)

INTRODUCTION

Five spanners are supplied with each engine. This section describes the special service tools that are available for particular servicing operations on these engines.

MAIN BEARING AND CAMSHAFT BUSH WITHDRAWAL AND ASSEMBLY TOOL

Replacement spanners and the tools described in this section can be purchased from R. A. Lister or their Distributors. Part numbers for all tools can be found in the appropriate Engine Parts List.

Note: Experience has shown that the positioning of a ball race under the head of item 8 will reduce the torsional effort required to remove or replace bearings.

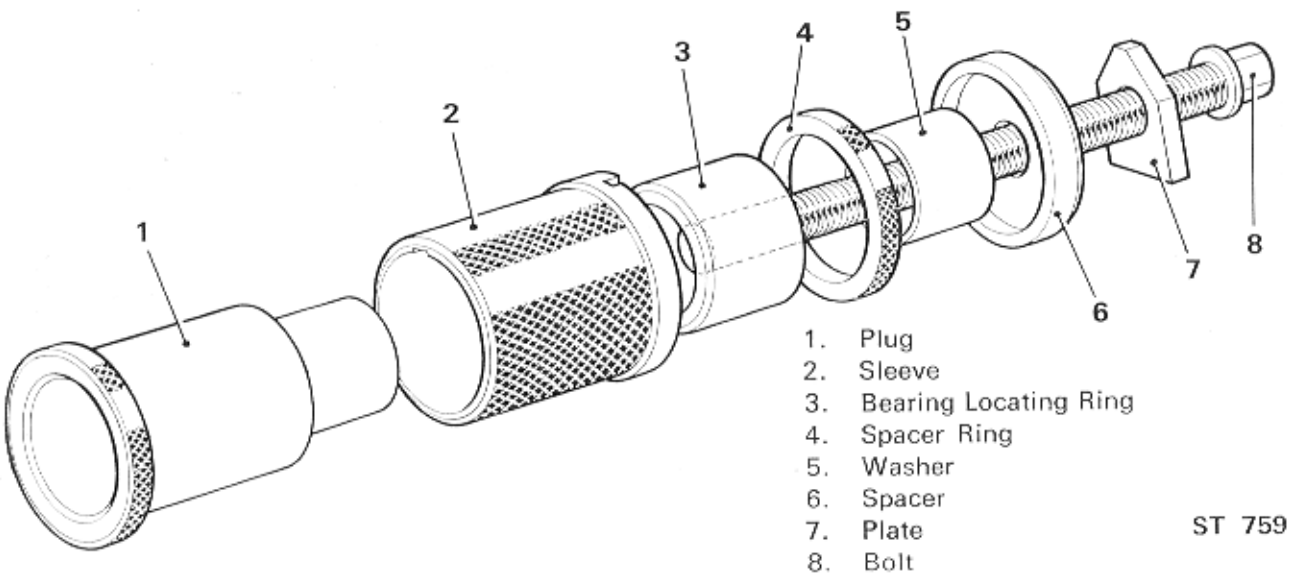


Fig. 129. Components of Main Bearing and Camshaft Bush Tool

Removing Main Bearing (Fig. 130)

(a) Fit correct bearing locating ring (3) on to plug (1).
Note: Four bearing rings are available for standard and undersize bearings.

(b) Insert plug with bearing ring into main bearing shells until bearing ring is located completely in the bearing shells.

(c) Fit sleeve (2) inside crankcase with the locating lug positioned in the thrust washer locating groove in crankcase.

(d) Push bolt (8) through centre of spacer (6) with recessed face of spacer nearest the head of bolt.

(e) Fit bolt from inside of crankcase through sleeve and screw into plug.

(f) Maintain a grip on knurled flange of plug and tighten bolt until main bearing shells are pushed fully into sleeve of tool.

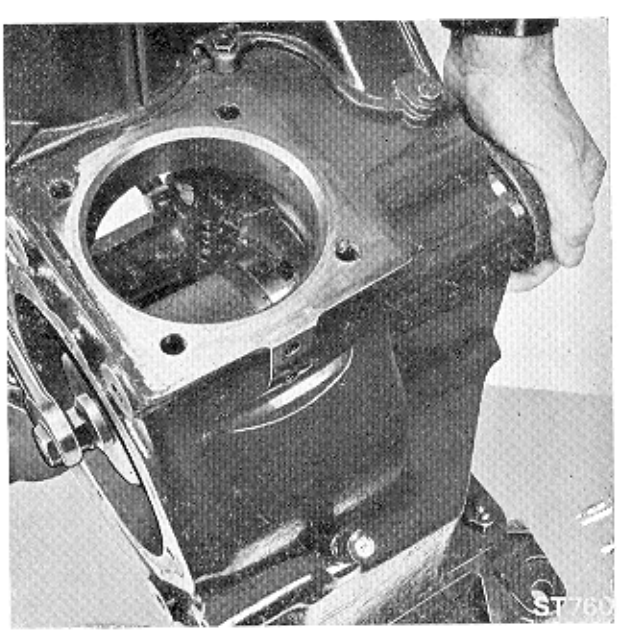


Fig. 130. Removing Main Bearing

Fitting Main Bearing (Fig. 131)

(a) Position sleeve (2) with locating lug facing downwards—on a bench or in the palm of the hand—slide the two halves of the new bearing into the top of the sleeve with the locating tag of the bearing uppermost; engage tag in slot in the sleeve.

(b) Fit correct bearing locating ring (3) on to plug.
Note: Four bearing rings are available for standard and undersize bearings.

(c) Fit plug into sleeve with bearing ring located completely in the bearing shells.

(d) Place assembly into crankcase with locating lug on sleeve positioned in slot in crankcase.

(e) Fit spacer (6) on to bolt (8) with plain face of spacer nearest head of bolt.

(f) Push bolt into crankcase, locate spacer squarely against outside of crankcase; screw bolt into plug.

(g) Tighten bolt until bearing shells are drawn into position.

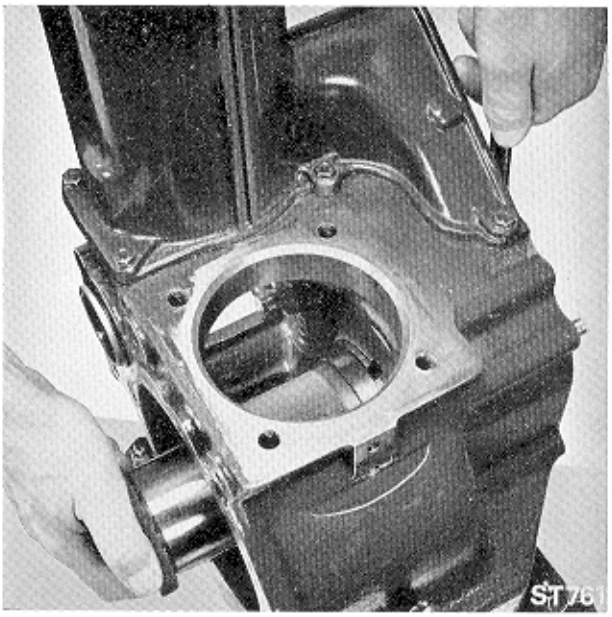


Fig. 131. Fitting Main Bearing

Main Bearing Housing

The removal and fitting of bearing shells in the main bearing housing is carried out by the same method. The bearing housing should be held securely in a vice or refitted to the engine.

The oil seal assembly should first be pushed out from the centre of the housing; new oil seal refitting instructions can be found on page 30.

Intermediate Main Bearings

Instructions for the removal and fitting of intermediate main bearing(s) can be found on page 60.

MAIN BEARING AND CAMSHAFT BUSH WITHDRAWAL AND ASSEMBLY TOOL (cont.)

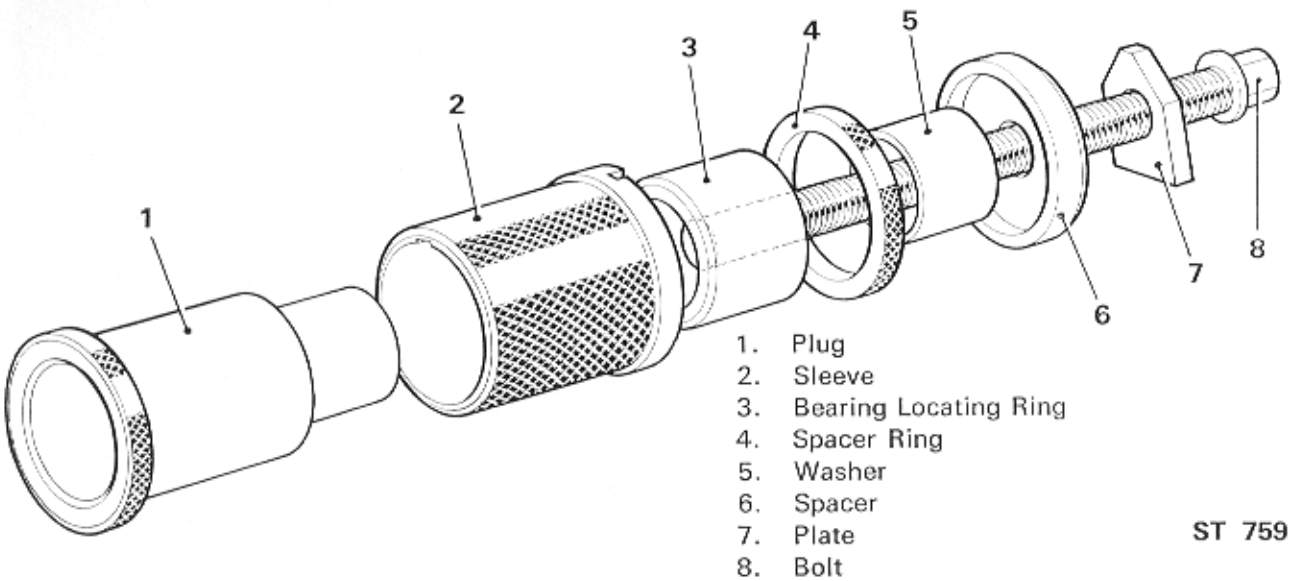


Fig. 129. Components of Main Bearing and Camshaft Bush Tool

Removing Camshaft Bushes

Note: On multi cylinder engines, centre bushes must be removed first.

All Engines Outer Bushes (Fig. 132)

To obtain access to flywheel end bush, remove camshaft end cover and rubber ring on bush.

(a) Place plug (1) into the camshaft bush that is to be removed.

(b) Fit bolt (8) into washer (5) with recessed side of washer nearest head of bolt.

(c) Insert bolt, with washer, into crankcase; line up washer with bush and screw bolt into plug.

(d) Using a soft drift on the head of bolt, tap the bush out.

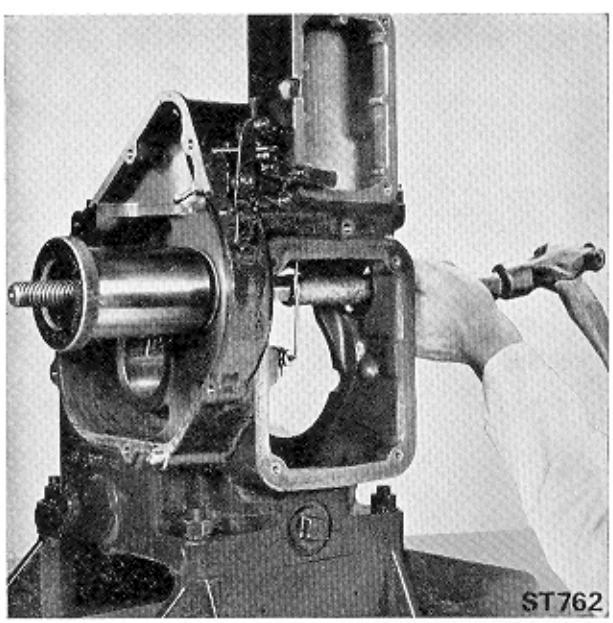


Fig. 132. Removing Outer Bush

ST2 and ST3 Engines

Removing Centre Bush—Gear End (Fig. 133)

Figure 133 shows the removal of centre bush at the flywheel end on a multi cylinder engine. The same method is used for centre bush at the gear end but item (4) ring is not required.

(a) Place plug (1) into bush.

(b) Fit bolt (8) through washer (5) with recessed side of washer nearest head of bolt.

(c) Insert bolt through centre bush and line up washer with bush; screw bolt into plug.

(d) Using a 7/16" Whit. socket on a standard 1/2" square extension, tighten bolt until centre bush is pushed out.

Removing Centre Bush—Flywheel End (Fig. 133)

(a) Remove camshaft end cover and rubber ring from projection on bush.

(b) Fit ring (4) over projection and insert plug (1). Continue with operations (c) and (d) above.

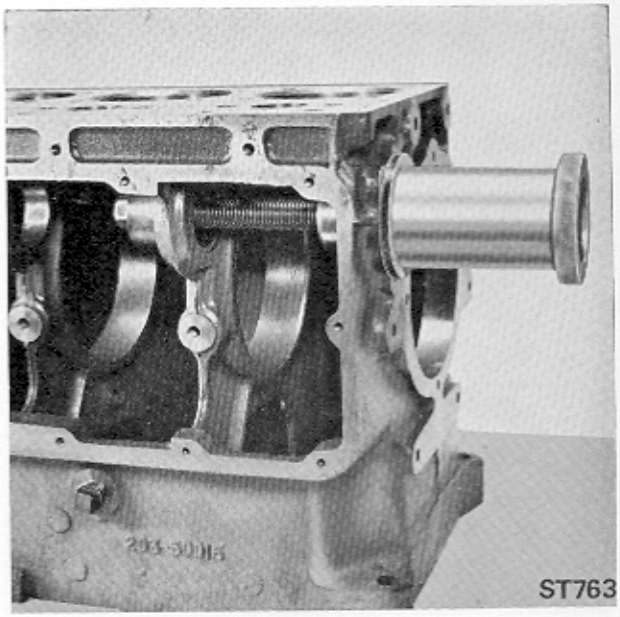


Fig. 133. Removing Centre Bush

Fitting Camshaft Bushes

New bushes should be immersed in engine lubricating oil for four hours before fitting. They should be fitted with the thinnest part of the bearing wall towards the top—marked 'o'.

Note: On multi cylinder engines, outer bushes must be fitted first.

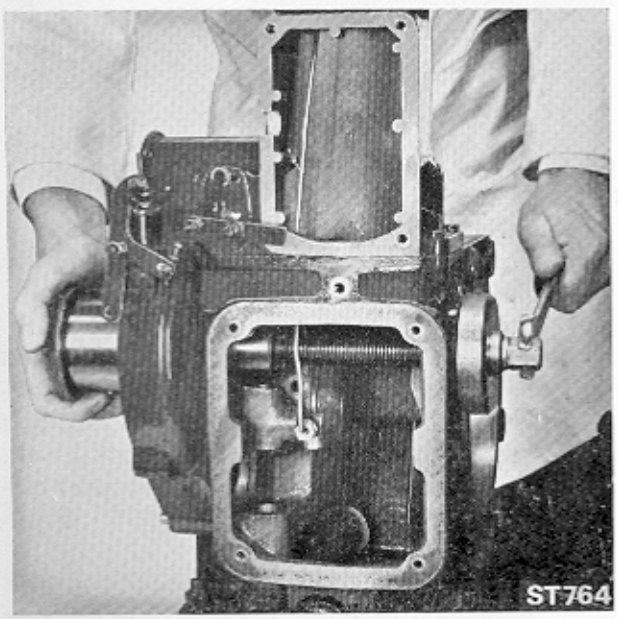


Fig. 134. Fitting Gear End Bush—ST1

ST1 Engines—Gear End (Fig. 134)

(a) Place new flanged bush on to plug (1).

(b) Insert plug—with bush—into crankcase.

(c) Fit bolt through spacer (6) with recessed side of spacer nearest head of bolt.

(d) Place bolt through gear end of crankcase and screw into plug.

(e) Ensure tool assembly is square and secure; tighten bolt until camshaft bush is pulled into crankcase.

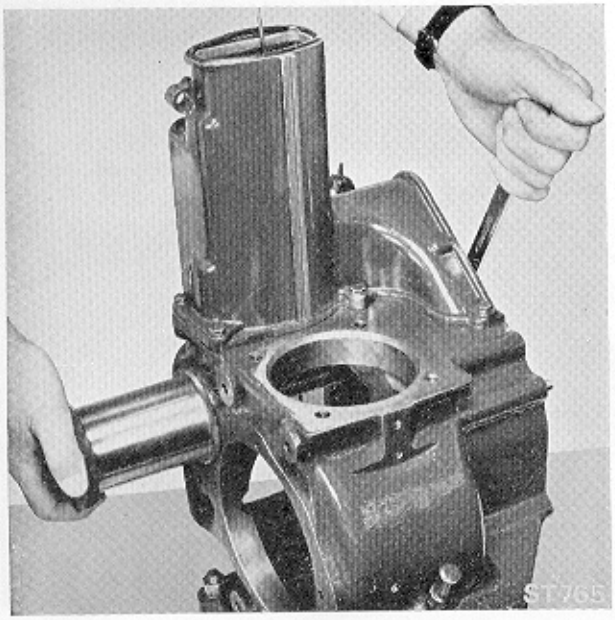


Fig. 135. Fitting Flywheel End Bush—ST1

ST1 Engines—Flywheel End (Fig. 135)

(a) Place ring (4) on to plug; fit new plain camshaft bush on to plug.

(b) Insert plug—with bush—into crankcase. Continue with operations (c), (d) and (e) on previous page.

(c) Remove tool and fit new rubber ring over projection of bush. Apply a little Hylomar PL32M compound to ring recess in camshaft cover and refit cover with flat edge to the right.

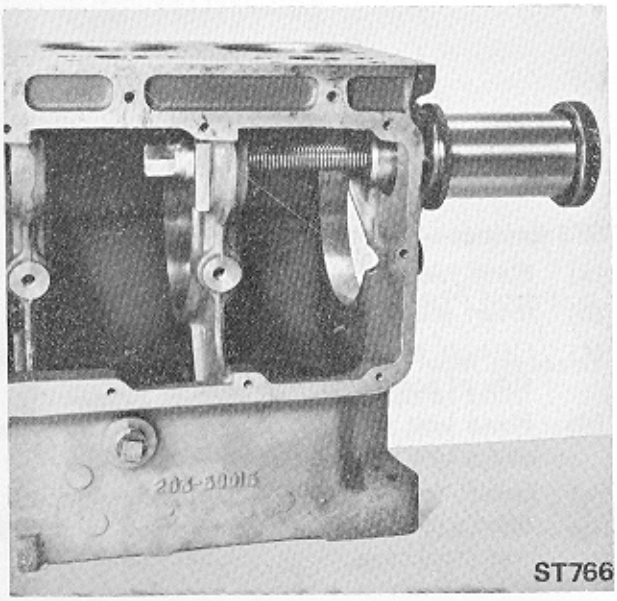


Fig. 136. Fitting Outer Bush—Flywheel End

ST2 and ST3 Engines

Fitting Outer Bush—Gear End (Fig. 137)

(a) Place new flanged bush on to plug (1); fit washer (5) with recessed side over plug.

(b) Insert plug—with bush and washer—into crankcase.

(c) Fit bolt through plate (7) and insert bolt through centre bush bore nearest gear end. Ensure plate is centralised and secured square to crankcase dividing wall.

(d) Tighten bolt until flange on bush just touches outside of crankcase. DO NOT OVERTIGHTEN.

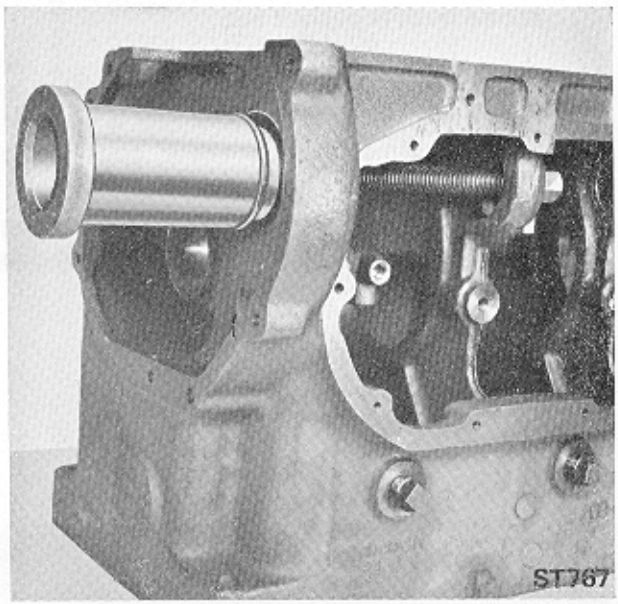


Fig. 137. Fitting Outer Bush—Gear End

ST2 AND ST3 ENGINES

Fitting Outer Bush—Flywheel End (Fig. 136)

(a) Place ring (4) over plug (1). Fit new plain bush on to plug.

(b) Insert plug—with bush—into crankcase.

(c) Fit bolt (8) through plate (7) and insert bolt through centre bush bore nearest flywheel end. Ensure plate is centralised and secured square to crankcase dividing wall.

(d) Tighten bolt until ring (4) just touches outside of crankcase. DO NOT OVERTIGHTEN.

(e) Remove tool and fit new rubber ring over projection of bush. Apply a little Hylomar PL32M compound to ring recess in camshaft cover and fit cover with flat edge to the right.

Fitting Centre Bushes (Figs. 138 and 139)

(a) Fit plug (1) from outside of crankcase, into outer bush. At flywheel end only, fit ring (4) over outer bush to maintain projection.
(b) Place washer (5) on to bolt (8); fit new centre bush over bolt.
(c) Fit bolt, with washer and bush through crankcase wall and screw bolt into plug.
(d) Locate bush centrally into crankcase wall and tighten on bolt until bush is pushed into position.
(e) Remove tool and fit new rubber ring over projection of bush at flywheel end. Apply a little Hylomar PL32M compound to ring recess in camshaft cover and fit cover with flat edge to the right.

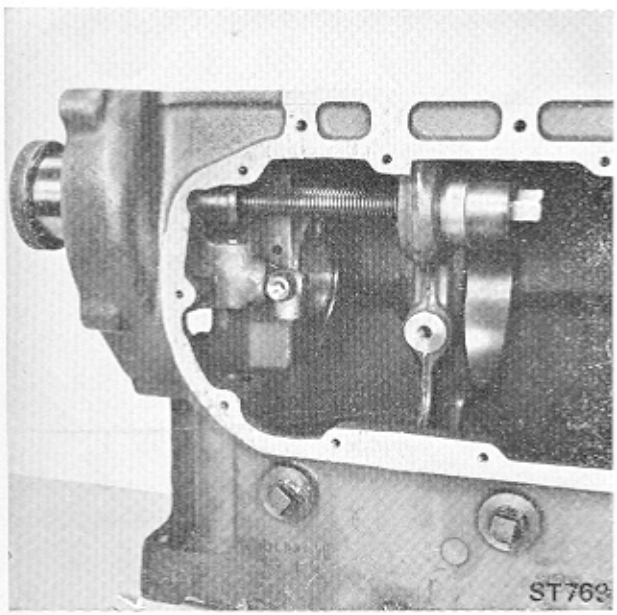


Fig. 139. Fitting Centre Bush—Gear End

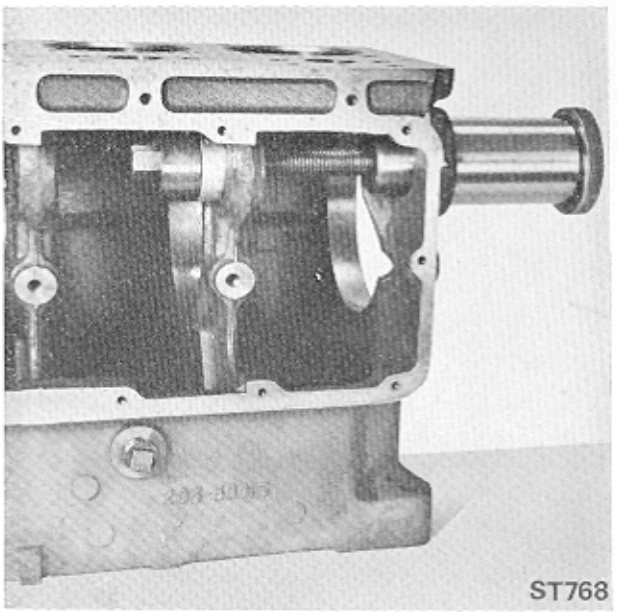


Fig. 138. Fitting Centre Bush—Flywheel End

Camshaft Bush in End Cover

The removal and fitting of camshaft bush in the end cover can be carried out by the same method as removing and fitting gear end bushes in single cylinder engines.

The oil seal and thrower ring must first be removed and when bush has been changed a new seal and thrower ring fitted in accordance with instructions on page 30.

Fig. 140. Flywheel Withdrawal Tool

FLYWHEEL WITHDRAWAL TOOL (Fig. 140)

(a) Slacken flywheel retaining screw two turns.
(b) Bolt withdrawal tool to face of flywheel.
(c) Tighten centre bolt until flywheel is loosened on tapered shaft.
(d) Remove tool and support flywheel whilst removing retaining screw.

Fig. 142. End Cover Oil Seal Assembly Tool

CRANKSHAFT PINION WITHDRAWAL TOOL (Fig. 141)

(a) Fit tool as illustrated with curved bar behind crankshaft pinion; secure in position.
(b) Tighten on centre bolt until pinion is pulled off; remove and retain key.

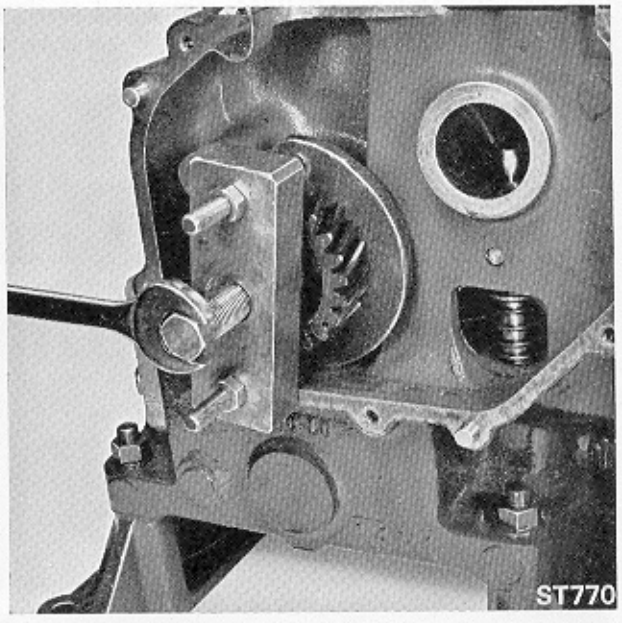


Fig. 141. Crankshaft Pinion Withdrawal Tool

END COVER OIL SEAL ASSEMBLY TOOL (Fig. 142)

When refitting the end cover, a special tapered sleeve, as illustrated, should be inserted from inside the end cover through the oil thrower ring into the Gits seal. This will centralise the thrower ring and prevent damage to the oil seal when fitting end cover. Ensure tool is removed when end cover is in position.

Fig. 143 Removing Injector Sleeve

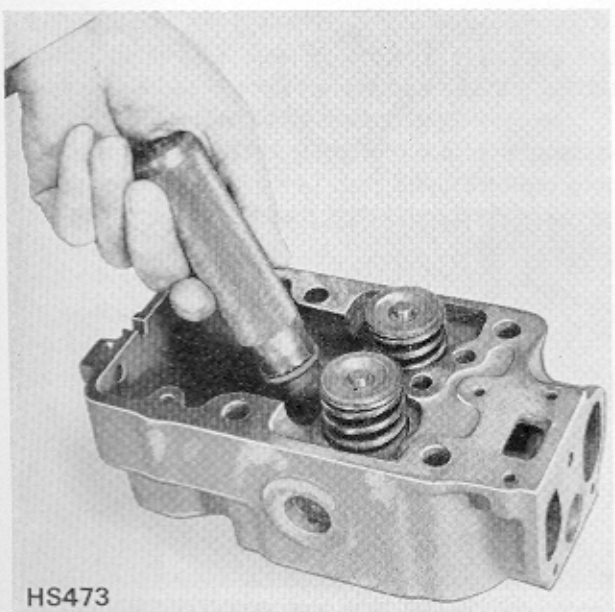


Fig. 143a Fitting Injector Sleeve

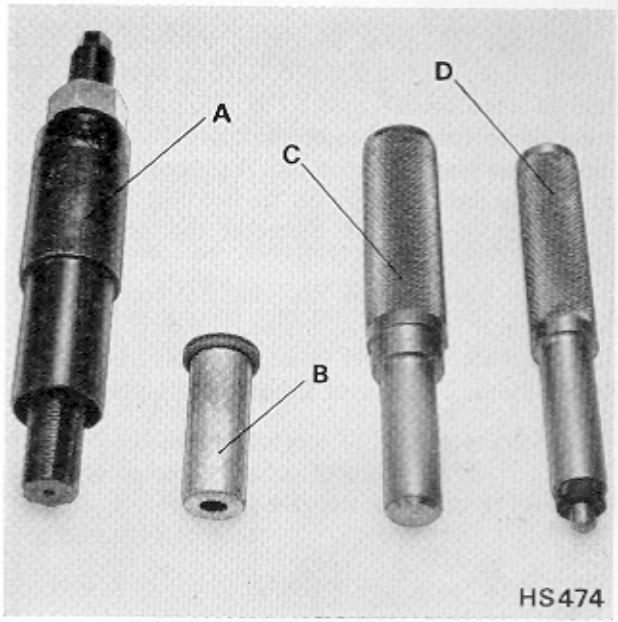


Fig. 143b Injector Sleeve Tools

A. Injector Sleeve Extractor Tool

B. Injector Sleeve

C. Injector Sleeve Fitting Tool

D. Injector Sleeve Belling Tool

The Injector Sleeve on water cooled engines can be changed as follows:-

(a) Screw extractor tool into sleeve and remove sleeve (Fig. 143).

(b) Fit new sleeve using fitting tool (Fig. 143a).

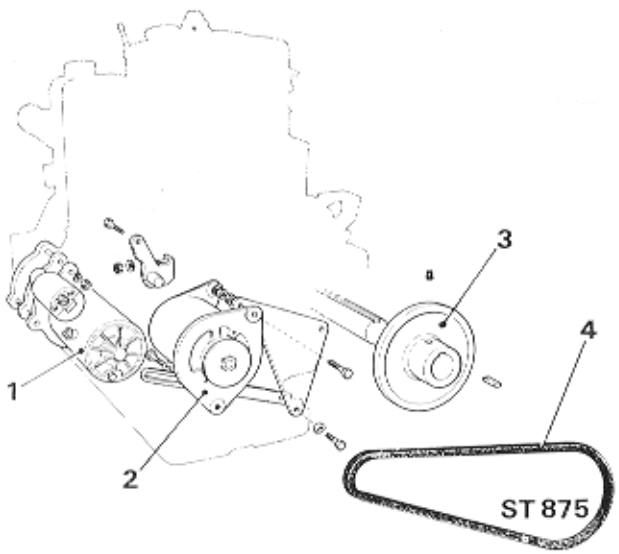
(c) When the sleeve is fully home insert belling tool and tap with a copper hammer to secure sleeve.

Section Eight
ELECTRICAL EQUIPMENT

INTRODUCTION

This section gives servicing information and wiring diagrams for electric starting systems that can be used on ST and STW engines. Replacement parts for this equipment are listed in the appropriate engines parts list. A glossary of books containing information on generating sets used with these engines is given at the end of the section.

Further information on electric starting can be obtained from R. A. Lister, Dursley; information on generating sets fitted by Lister from Lister Power Plant, Thrupp; or the nearest Lister Distributor.



1. Starter Motor
2. Dynamo
3. Pulley
4. Driving Belt

Fig. 144. Components of Electric Starting System

LOCATION OF COMPONENTS (Fig. 144)

Starter Motor

On all engines except M.E.U.s the starter motor is located on three studs at the rear of the fan shroud. On M.E.U.s the motor is mounted on a bracket attached to the main frame. Depending on installation, a distance piece is fitted between the starter motor and the mounting point.

Dynamo or Alternator

The dynamo or alternator is secured to a bracket and adjusting link mounted on the gear end of the engine. The type of bracket will depend on installation and other accessories which may be fitted to the engine.

Pulley and Driving Belt

A pulley is keyed on to the camshaft extension and secured in position with a grub screw. The fan belt is adjusted by moving the dynamo or alternator on its adjusting link to give sufficient tension only, to drive without slipping.

Note:—To comply with agriculture safety regulations in the United Kingdom, a dynamo guard must be fitted to Moisture Extraction Units.

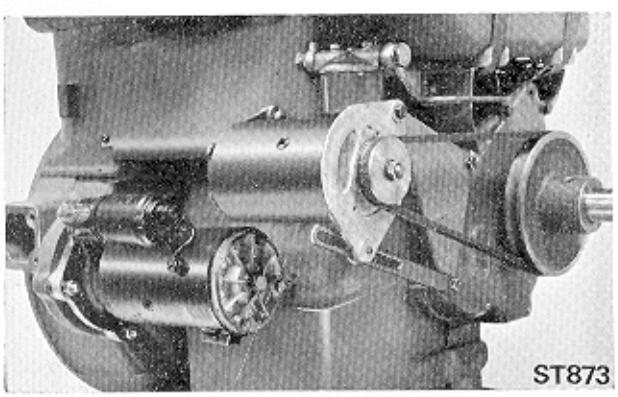


Fig. 145. Typical Electric Start Arrangement —Dynamo

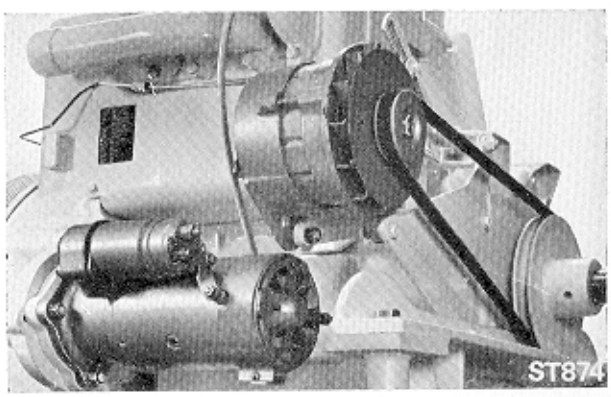


Fig. 146. Typical Electric Start Arrangement —Alternator

INSTRUCTIONS FOR 'LUCAS' COMPENSATED VOLTAGE CONTROLLED DYNAMO

THE EQUIPMENT

The equipment consists of a specially designed dynamo and a separate regulator unit. The regulator unit also incorporates the automatic battery cut-out.

HOW IT WORKS—A COMPLETELY AUTOMATIC CONTROL

The regulator causes the dynamo to give an output which varies according to load on the battery and its state of charge. When the battery is discharged the dynamo gives high output, so that the battery receives a quick recharge which brings it back to its normal state in the minimum time. On the other hand, if the battery is fully charged, the dynamo is arranged to give only a trickle charge which is sufficient to keep it in good condition without any possibility of causing damage to the battery by overcharging.

MAINTENANCE IN SERVICE

The compensated voltage control equipment requires very little attention in service.

BATTERY

For details of how to prepare a battery with factory sealed charge for service see the instruction card supplied with the battery.

Care of the battery cannot be overstressed. Keep exterior clean and dry. Ensure filling plugs and connections are tight. Keep terminals and connections free from corrosion and coated with pure 'Vaseline' or Petroleum Jelly.

Regularly inspect level of acid in each cell and add distilled water (NOT ACID) so as to cover the plates by ½". The specific gravity of the acid is the best indication of the state of charge or discharge in the cells.

DYNAMO

After every 2000 hours running, examine the brushgear and commutator to see that the brushes move freely and that the commutator is clean.

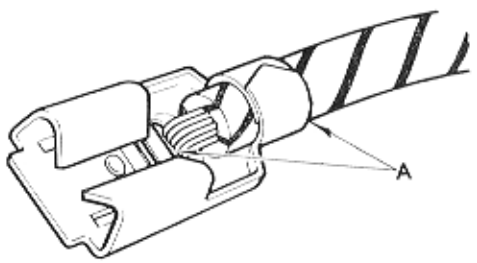
Occasionally inspect the dynamo driving belt taking up any undue slackness by turning the dynamo on its mounting. Do not over-tighten the belt which should have sufficient tension only to drive without slipping.

LUBRICATION

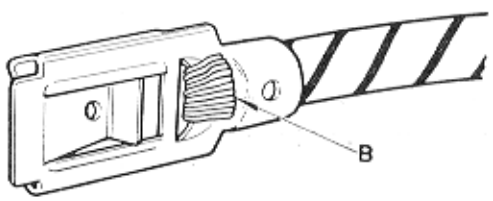
Every 400 hours inject a few drops of lubricating oil into the commutator end bearing of the charging dynamo. Use same lubricating oil SAE20 as engine **and on no account over oil** as this will lead to trouble with the brush gear.

REGULATOR UNITS

Cut-out and regulator units are accurately set during assembly and do not require any adjustment in service. The cover protecting these units is therefore sealed.



A. Feed Conductors through aperture and grip cable firmly in tags.



B. Splay conductors back towards cable and solder securely. Do not allow solder to run through aperture.

Fig. 147. Instructions for Making Connections

FAULT DIAGNOSIS
VOLTAGE CONTROLLED DYNAMO EQUIPMENT

SYMPTOMS	PROBABLE FAULT	REMEDY
No dynamo output.	Dynamo not charging due to broken or loose connection in dynamo circuit, or control box not functioning correctly.	Examine charging and field circuit wiring. Tighten loose connection or replace broken cable. Particularly examine battery connections. If trouble persists, have equipment examined by a Lucas Service Depot, or Agent.
Battery in low state of charge. Shown by lack of power when starting and hydrometer reading below 1.200.	Dynamo giving low or intermittent output, due to:—	
	(a) Loose or broken connection in dynamo circuit.	Examine dynamo wiring. Tighten loose connections or replace broken cable. Particularly examine battery connections.
	(b) Dirty commutator or brushgear.	Clean with petrol moistened cloth.
	(c) Worn brushes.	Worn brushes must be replaced and properly bedded by a Lucas Service Depot or Agent.
	(d) Slipping dynamo driving belt.	Adjust if necessary.
	(e) Control box not functioning	Have equipment examined by a Lucas Service Depot or Agent.
Battery overcharged, shown by frequent need for topping up.	Dynamo giving high output. Due to: Control box not functioning correctly.	Have equipment examined by Lucas Service Depot or Agent.

Cold Cranking Battery Performance Table (See BS3911: 1982)

This table defines the recommended minimum cold cranking performance required from lead-acid batteries, when tested at an ambient temperature of −18°C. For temperatures below −18°C, high discharge, low resistance Arctic or Alkaline batteries must be used.

Refer to the table and select engine type, system voltage and ambient temperature band. Read off value in amps. e.g. an ST2 with a 12V system at −6°C would require a battery with a minimum cold cranking rating of 239A. Should that same engine have a 24V system it would require a minimum rating of 210A.

Engine Type	System Voltage	Engine Operating Ambient Temperature °C			
		27 min	26 to 1	0 to −8	−9 to −18
ST1	12	70A	113A	162A	315A
ST/W2	12	104A	151A	239A	400A
ST/W2	24	118A	158A	210A	372A
ST/W3	12	125A	181A	258A	415A
ST/W3	24	139A	170A	239A	393A

Starter Motor Cranking Current Current Requirements (See BS3911: 1982)

This table defines the current required by the engine starter motor to crank an engine at the stated temperature.

Engine Type	System Voltage	Engine Operating Ambient Temperature °C			
		27 min	26 to 1	0 to −8	−9 to −18
ST1	12	100A	150A	170A	220A
ST/W2	12	150A	200A	250A	280A
ST/W2	24	170A	210A	220A	260A
ST/W3	12	180A	240A	270A	290A
ST/W3	24	200A	225A	250A	275A

NOTES ON WIRING DIAGRAMS

The number given in brackets under each illustration is for the manufacturers wiring diagram, obtainable from R. A. Lister. Information on 24 v. and automatic control systems can also be obtained from R. A. Lister.

ELECTRIC STARTING INCORPORATING LUCAS ALTERNATORS

The following points must be strictly observed when an alternator is fitted otherwise serious damage can be done.

(a) NEVER disconnect the battery whilst the alternator is running.

(b) NEVER disconnect a lead unless the alternator is stopped and all switches are in the "OFF" position.

(c) ALWAYS ensure that leads are fitted to their correct terminals. A short circuit or reversal of polarity will ruin the diodes or transistors.

(d) NEVER connect a battery into the system without checking that voltage and polarity are correct.

(e) NEVER "flash" the connections to check current flow.

(f) NEVER experiment with adjustment or repairs to the system.

GENERATING SETS

General information and parts lists for generating sets which may be fitted to ST Engines can be found in the following publication, available from Hawker Siddeley Power Plant:—

Book GS165 ... Nova II Generating Sets, Hand and Electric Start.

Book GS224 ... Nova II Automatic Remote Control.

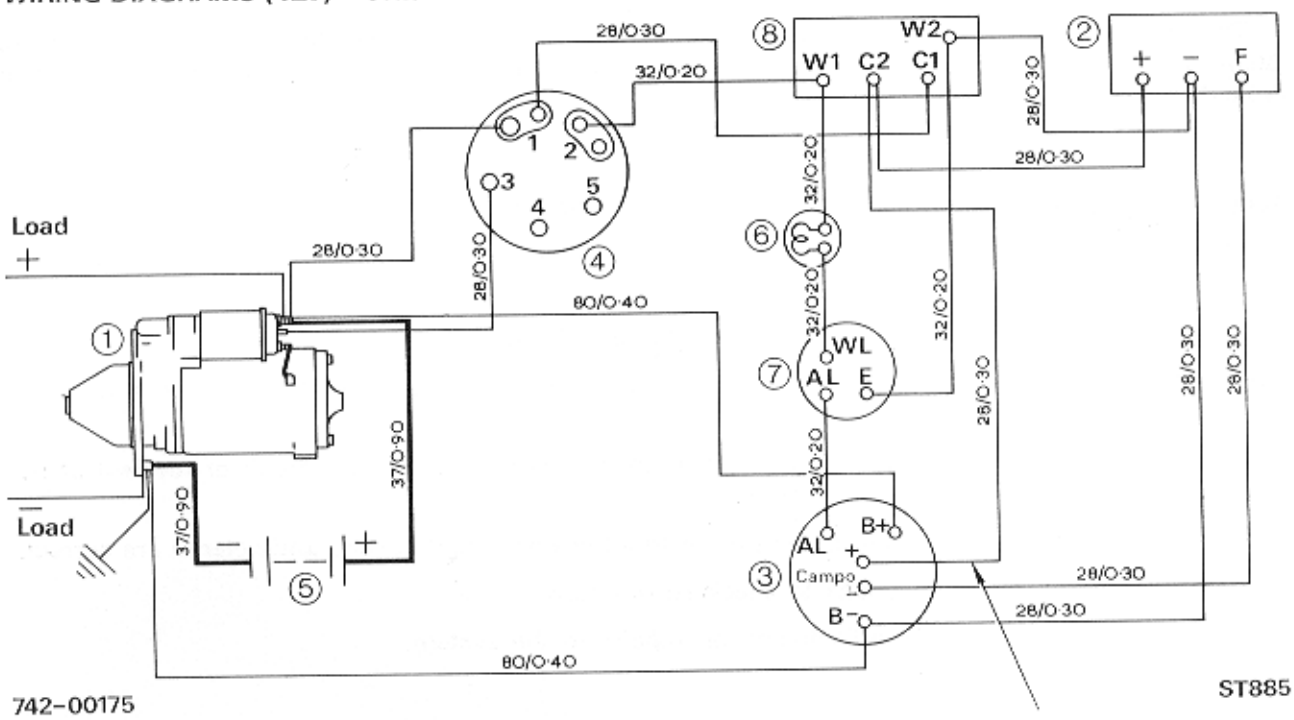
Book GS60 ... Start-O-Matic Air Cooled Diesel Generating Sets.

Book GS196 ... Nova II Automatic Stand-By to Mains (Series Starting Scheme) (Replaces 1930).

Publication HB445-T ... SDA and SDT Generators (Self Excited—Self Regulated).

Publication 510/10/71 ... GP AC Generators (Self Excited—Self Regulated).

WIRING DIAGRAMS (12v)—cont.



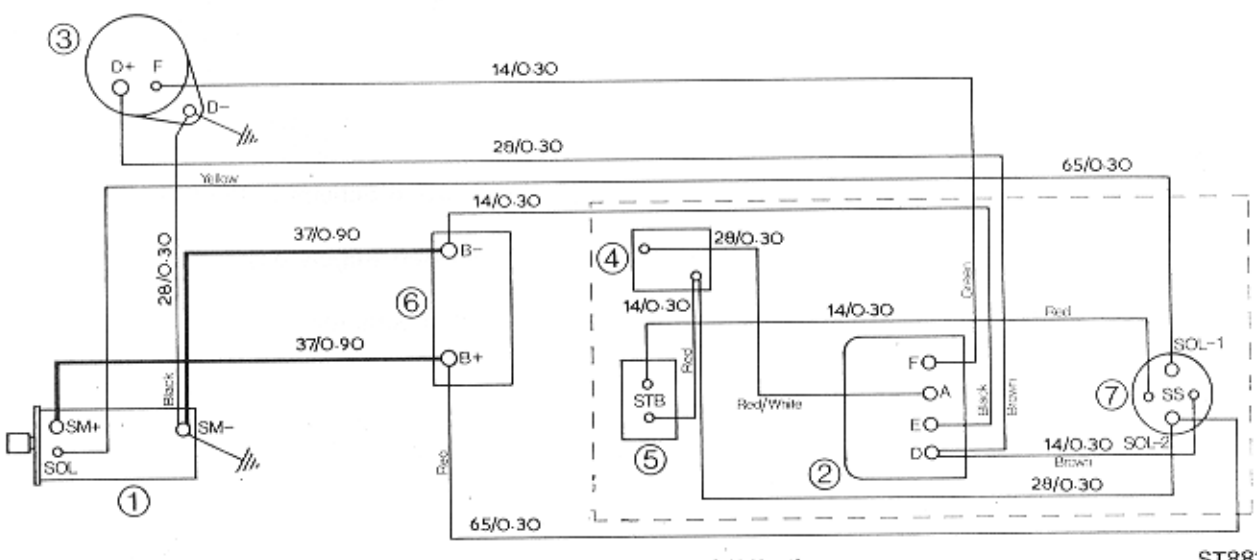
742-00175

(Wiring to be Black P.V.C. cable to BS6862. Sizes relate to cables between components and engine being Max. length of 2 metres)

This connection must be taken to excitation relay C2 before going to alternator control unit Field+

1. Starter Motor
2. Alternator Control Unit
3. Alternator
4. Control Key Switch
5. Battery
6. Warning Light
7. Warning Light Control
8. Excitation Relay

Fig. 148. 11 AC Alternator, ST2/3—Rationalised Panel (742-00175)



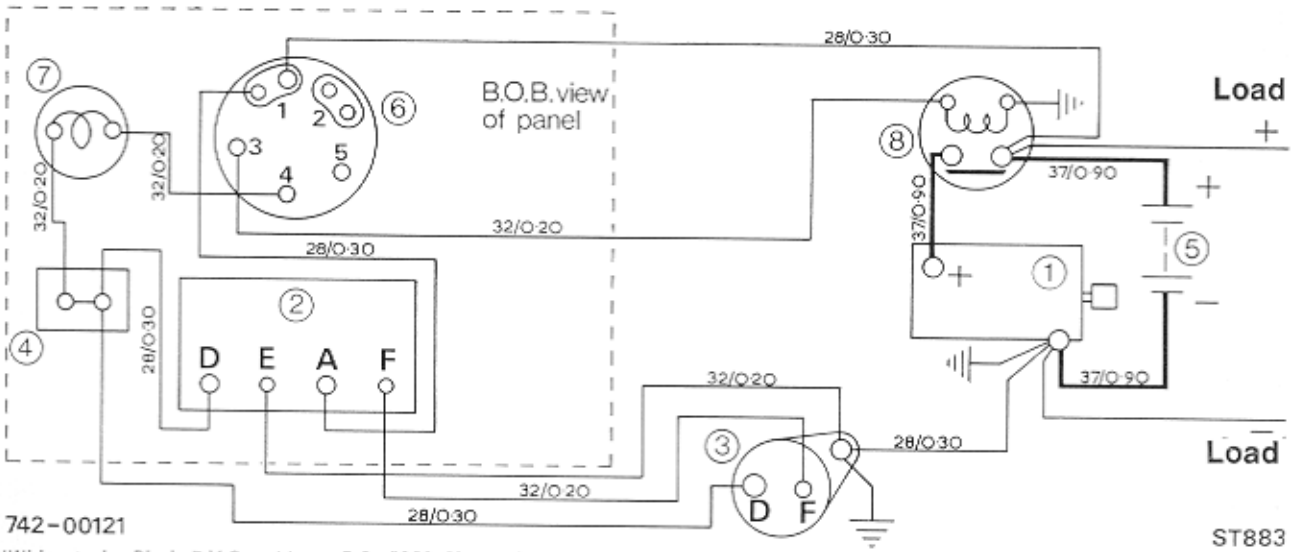
ED 9396

(All cables to be P.V.C. insulated to B.S.6862 pt.1)

1. Starter Motor
2. Cut-out and Controller
3. Dynamo
4. Charge Resistance
5. Push-button
6. Battery
7. Solenoid

Fig. 148A Dynamo, M.E.U.—ST2/3 (ED 9396)

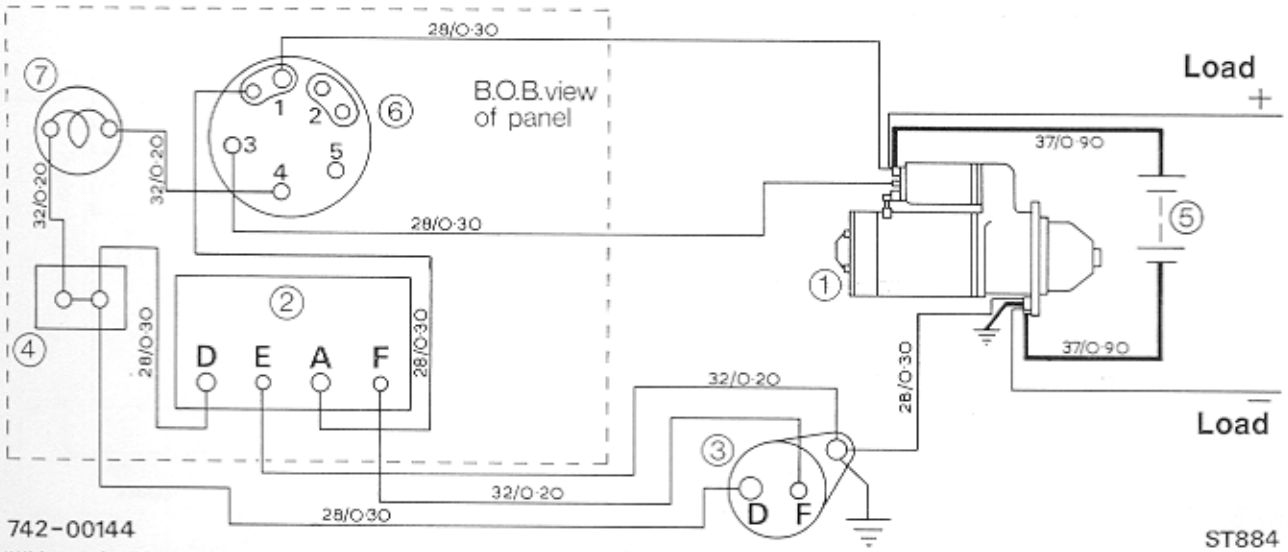
WIRING DIAGRAMS (12 V) cont.



(Wiring to be Black P.V.C. cable to B.S. 6862 Sizes relate to cables between panel & engine being Max. length of 2 metres.)

1. Starter Motor
2. Battery Charging Controller
3. Dynamo
4. Terminal Block
5. Battery
6. Control Key Switch
7. Warning Light
8. Starter Motor Solenoid

Fig. 149. Dynamo (ST1—Rationalised Panel (742-00121)

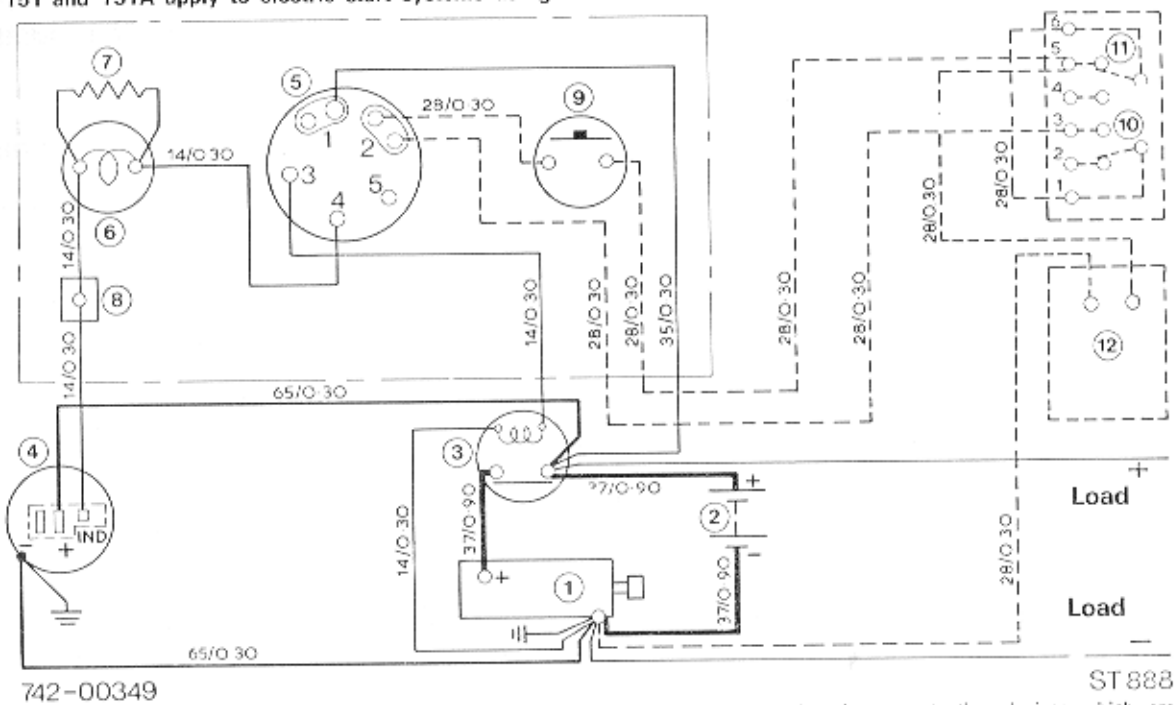


(Wiring to be Black P.V.C. cable to B.S. 6862. Sizes relate to cables between panels & engine being Max. length of 2 metres).

1. Starter Motor
2. Battery Charging Controller
3. Dynamo
4. Terminal Block
5. Battery
6. Control Key Switch
7. Warning Light

Fig. 150. Dynamo, ST2/3—Rationalised Panel (742-00144)

Figs. 151 and 151A apply to electric start systems using the derated 15 ACR and the A115-28 alternators.

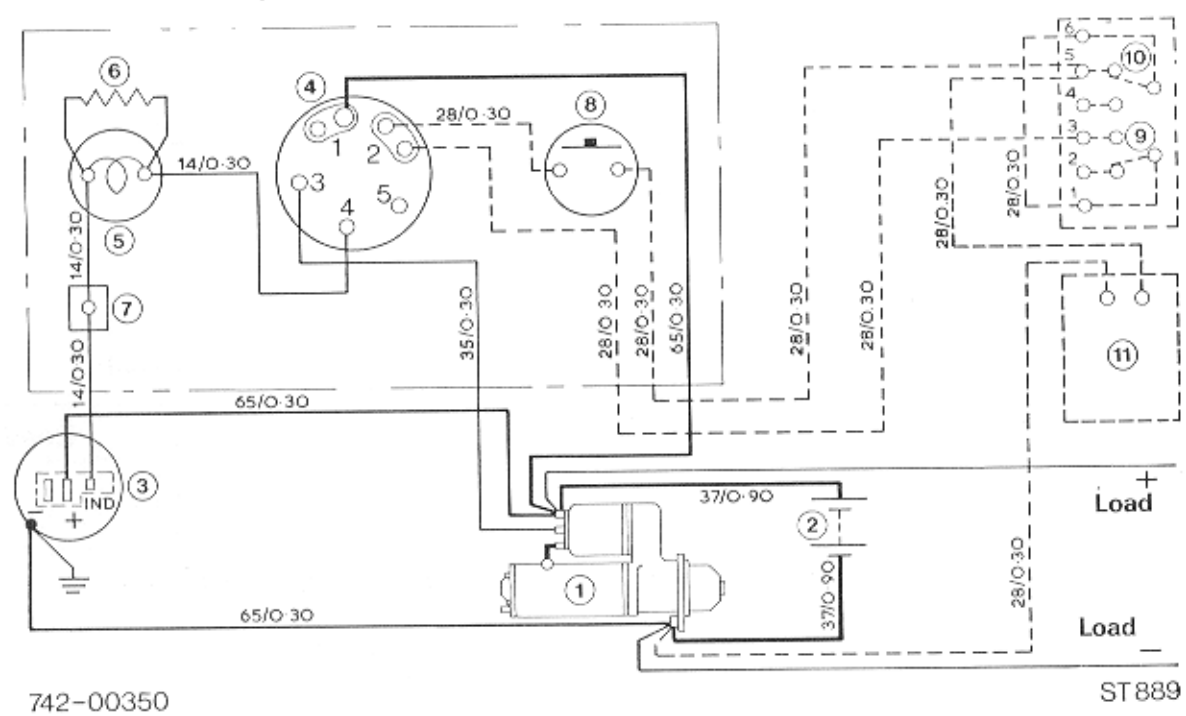


(Wiring to be Black P.V.C. cable to B.S. 6862. Sizes relate to cables between components and engine being Max. length of 2 metres)

Items shown dotted are protective devices which are optional accessories and only fitted when specially ordered.

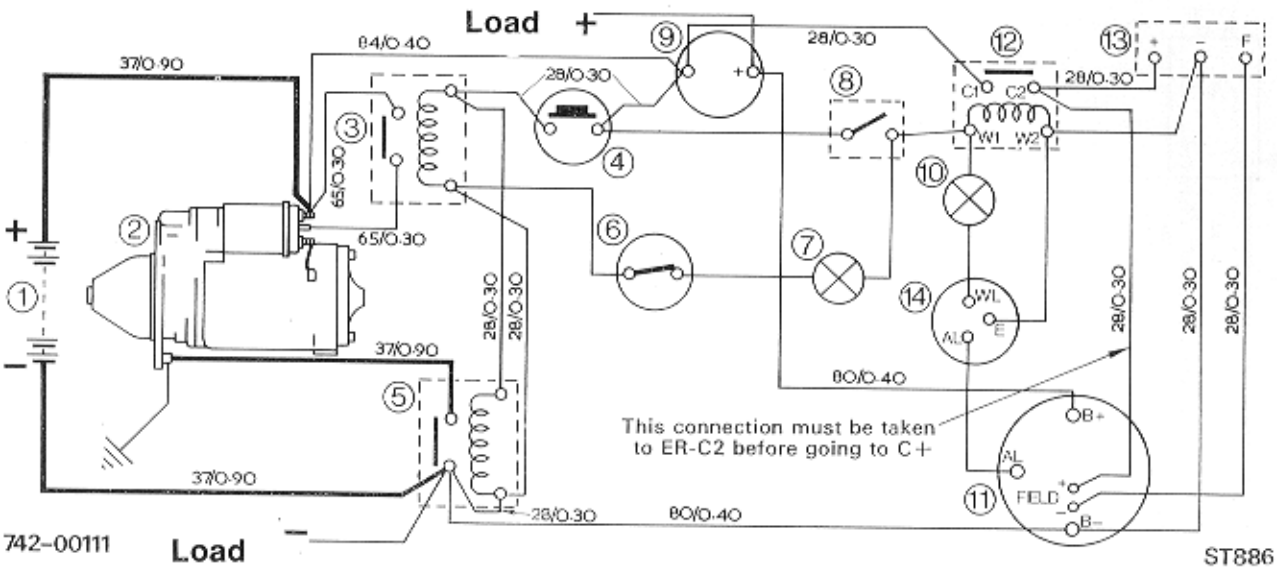
1. Starter Motor
2. Starter Battery
3. Starter Motor Solenoid
4. Derated 15 ACR Alternator
5. Control Key Switch
6. Warning Light
7. Excitation Resistor
8. Terminal Block
9. Oil Pressure Override Button
10. Oil Pressure Switch
11. Engine Temperature Switch
12. Fuel Control Solenoid

Fig. 151 Connection Diagram for ST1 Electric Start with Alternator



1. Starter Motor
2. Starter Battery
3. Derated 15 ACR Alternator
4. Control Key Switch
5. Warning Light
6. Excitation Resistor
7. Terminal Block
8. Oil Pressure Override Button
9. Oil Pressure Switch
10. Engine Temperature Switch
11. Fuel Control Solenoid

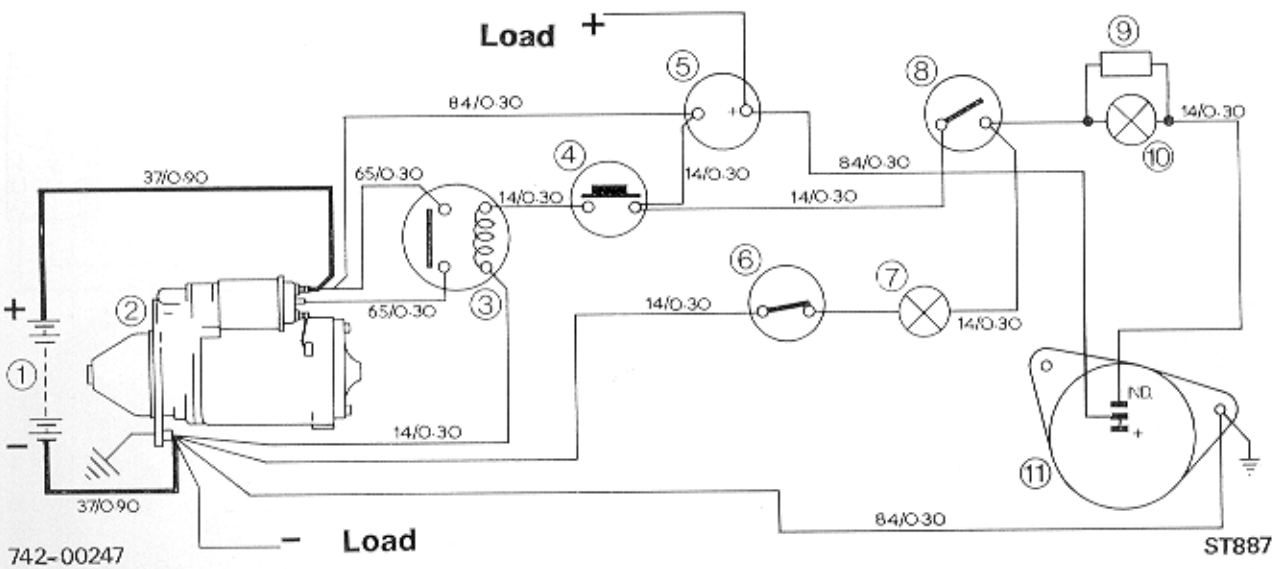
Fig. 151A Connection Diagram for ST2/3 Electric Start with Alternator



(All cables to be Black P.V.C. insulated to BS6862pt. 114/0.30 unless otherwise stated. Sizes relate to Max. cable length of 2 metres between engine and loose components. The control switch 8 must be set to the OFF position whilst engine is stationary to prevent discharge of the battery.)

1. Battery
2. Starter Motor
3. Solenoid
4. Push-button
5. Earthing Solenoid
6. Oil Pressure Switch
7. Oil Pressure Lamp
8. Control Switch
9. Ammeter
10. Excitation Warning Light
11. Alternator
12. Excitation Relay
13. Alternator Controller
14. Excitation Warning Control

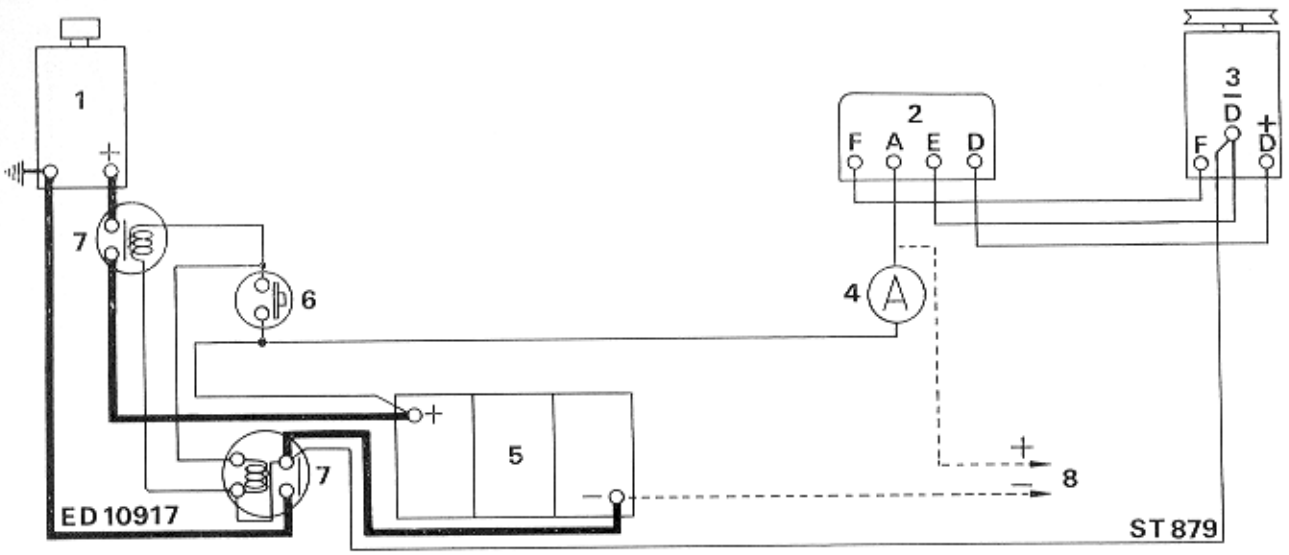
Fig. 152. Connection Diagram, Insulated Electric Start for ST2/3 and STW2/3 Engines with 11 AC Alternator.



(All cables to be Black P.V.C. automobile cable to BS6862 pt. 1. Sizes given relate to cables between engine and loose components being a Max. length of 2 metres. Control switch 8, must be set to the OFF position whilst the engine is stationary to prevent discharge of the battery).

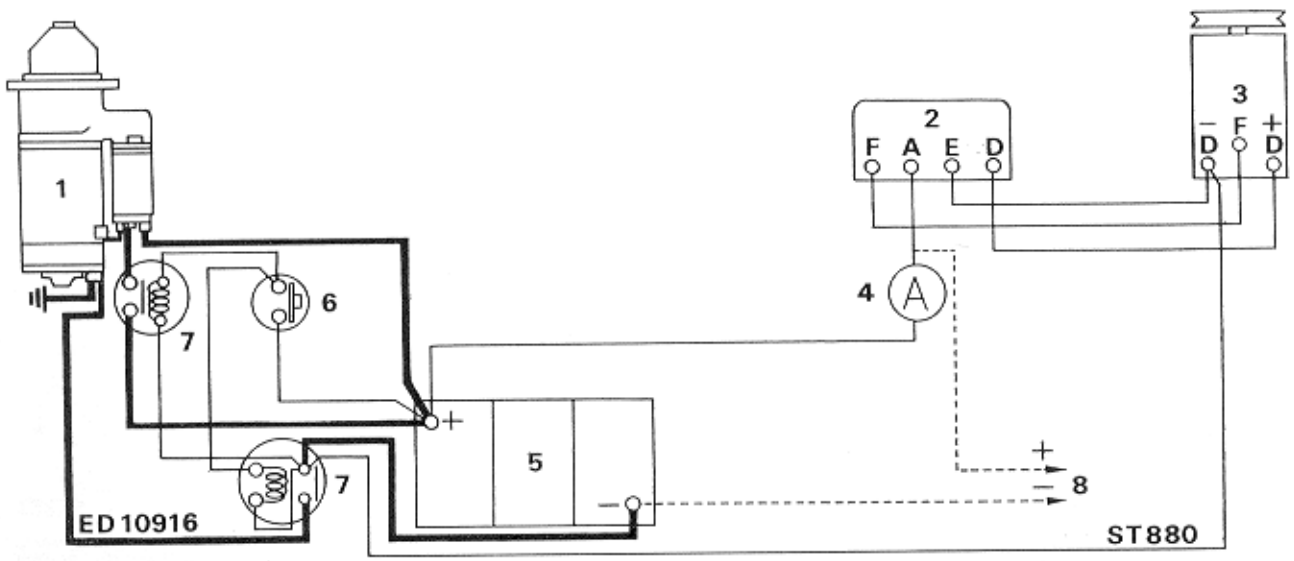
1. Battery
2. Starter Motor
3. Solenoid
4. Push-button
5. Ammeter
6. Oil Pressure Switch
7. Oil Pressure Lamp
8. Control Switch
9. Excitation Resistor
10. Excitation Warning Lamp
11. Alternator

Fig. 153. Connection Diagram for Marine Electric Start 17 ACR Earth Return ST/W/2-3



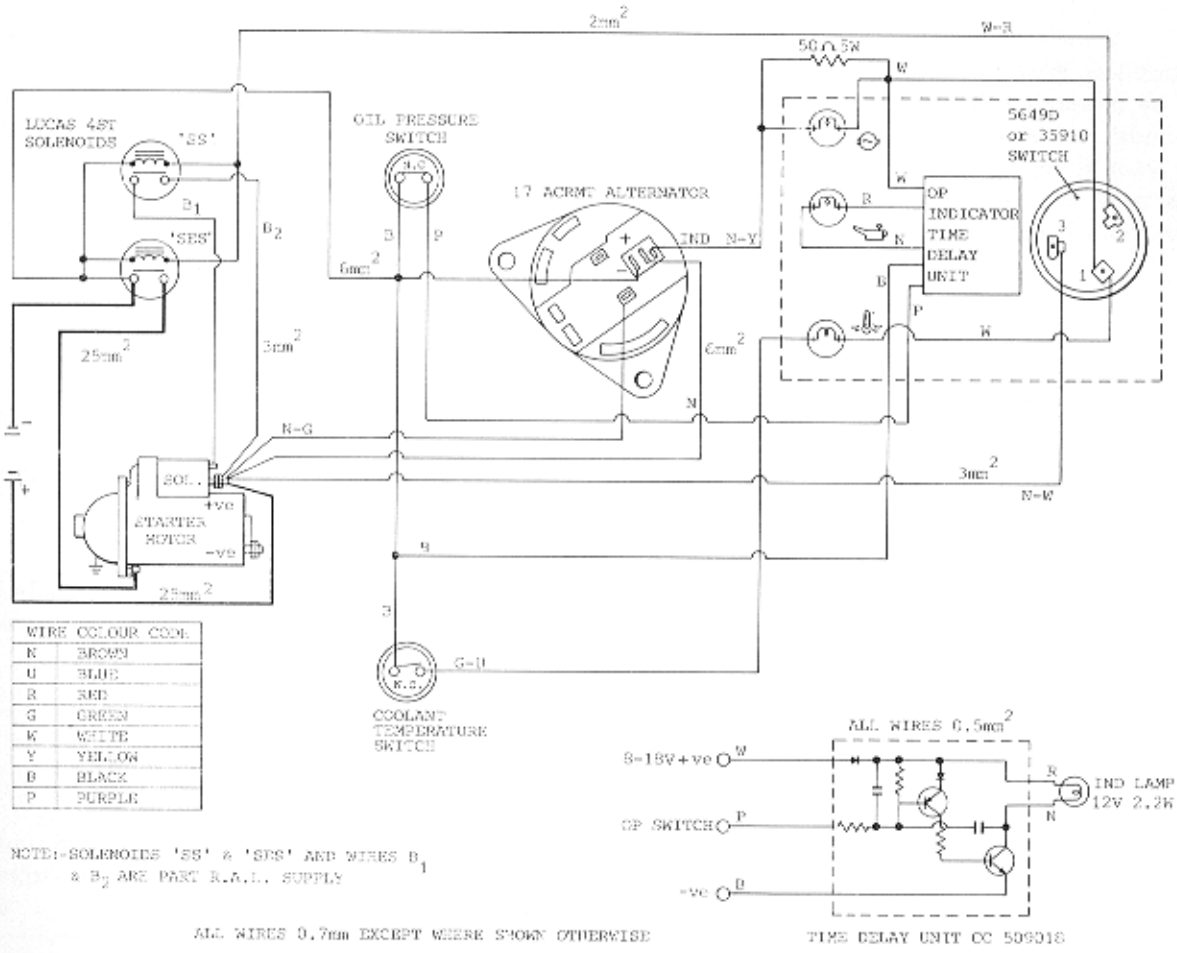
1. Starter Motor
2. Cut-out and Controller
3. Dynamo
4. Ammeter
5. Battery
6. Push-button
7. Solenoid
8. Lighting Circuit

Fig. 154. Insulated Return—STM1 (ED 10917)



1. Starter Motor
2. Cut-out and Controller
3. Dynamo
4. Ammeter
5. Battery
6. Push-button
7. Solenoid
8. Lighting Circuit

Fig. 155. Dynamo, Insulated Return—STM2/3 (ED 10916)



WIRE COLOUR CODE	
N	BROWN
U	BLUE
R	RED
G	GREEN
W	WHITE
Y	YELLOW
B	BLACK
P	PURPLE

NOTE:-SOLENOIDS 'SS' & 'SRS' AND WIRES B_1 & B_2 ARE PART R.A.I. SUPPLY

WIRING DIAGRAM FOR 17ACRMT ALTERNATOR (UNSUPPRESSED) ELECTRIC START PANEL

Fig. 155a Key Switch

Key Switch Positions

OFF

1. Warning light on—No charge.
2. Cold start—if fitted.
3. Energise starter.

Note: After stopping the engine ensure electric start switch 'OFF' otherwise warning light will remain on.

Table of Clearances and Dimensions of Wearing Parts

ENGINE WEAR

The following information is given as a guide to the extent by which components may reasonably be expected to wear, without appreciable loss of performance. To maintain the engine in good running order it is therefore recommended that when the "maximum advisable clearance" figure is reached, one or more components affecting the clearance be replaced.

The wear to be allowed in parts re-fitted to an engine depends on the life required to the next overhaul and the relative costs of labour to materials. If labour costs are high it may pay to replace parts before the maximum wear condition is reached, in order to avoid further work before the next scheduled overhaul.

COMPONENT	INITIAL DIMENSION		INITIAL CLEARANCE		MAXIMUM ADVISABLE CLEARANCE	
	in.	mm.	in.	mm.	in.	mm.
Cylinder bore (See note 1)	3.752	95.30	0.0103	0.262		
	ST		ST		ST	
	3.751	95.27	0.0083	0.211	0.014	0.35
	3.75	95.25	0.0083	0.211		
	STW		STW			
	3.749	95.225	0.0063	0.16	STW 0.012	0.30
Piston dia. at bottom of skirt—across thrust face	3.7427	95.065				
	ST/W					
	3.7417	95.039				
Fire ring gap			0.028	0.70		
			ST		ST	
	0.022	0.55	0.016	0.41	0.039	0.98
	ST/W					
	0.014	0.35	0.022	0.55		
			STW		STW	
			0.011	0.27	0.033	0.83
Compression ring gap			0.022	0.55		
			ST		ST	
	0.016	0.40	0.010	0.26	0.033	0.85
	ST/W					
	0.008	0.20	0.016	0.40		
			STW		STW	
			0.005	0.12	0.028	0.70
Scraper ring gap			0.026	0.65		
			ST		ST	
	0.020	0.50	0.014	0.36	0.033	0.85
	ST/W					
	0.012	0.30	0.020	0.50		
			STW		STW	
			0.009	0.22	0.027	0.69

Note 1.
The maximum advisable piston to cylinder clearance given, is the clearance between the bottom of the piston skirt (across thrust faces) and the cylinder bore measured in the region of travel of that part of the piston, i.e. NOT at the top of the bore.

Note 2.
Initial dimensions given for piston ring gaps assume the use of a gauge exactly equal to the nominal cylinder bore. The gaps given under "initial clearance" are those to be anticipated when checking rings in a new bore. For every 0.001" (0.02 mm.) by which the actual bore size exceeds the "as new" dimension, the ring gap will increase by approximately 0.003" (0.06 mm.).

COMPONENT	INITIAL DIMENSION		INITIAL CLEARANCE		MAXIMUM ADVISABLE CLEARANCE	
	in.	mm.	in.	mm.	in.	mm.
Small End Bearing dia.	1.3142 1.3147	33.381 33.393	0.00238	0.0606	0.0033	0.085
Gudgeon Pin dia.	1.31230 1.31250	33.3324 33.3375	0.00171	0.0435		
Big End Bore (in rod)	2.6465 2.646	67.221 67.208				
Bearing shell thickness	0.0719 0.07225	1.826 1.835	0.0032 0.0015	0.08 0.04	0.0055	0.14
Crankpin dia.	2.500 2.4995	63.500 63.487				
Main bearing housing bore	2.6465 2.6455	67.221 67.195				
Bearing shell thickness	0.07225 0.0719	1.835 1.826	0.0037 0.0015	0.09 0.04	0.0055	0.16
Crankshaft journal dia.	2.4995 2.499	63.50 63.47				
Thrust bearing Thickness	0.093 0.091	2.36 2.31	ST1 ST2/3	0.007 0.179 0.010 0.254 0.009 0.229 0.012 0.305	0.010 0.012	0.254 0.305
			CRANKSHAFT END FLOAT — ADJUSTABLE			
Camshaft bush bore gear end (inner and outer) and centre	1.7545 1.753	44.56 44.53	0.009	0.23	0.011	0.28
dia Camshaft journal	1.746 1.7455	44.35 44.34	0.007	0.18		

Note: A mandrel of 1.7487" dia. and the length of the crankcase must just pass through all camshaft bearings, but a mandrel of 1.74825" dia. must fall through freely when the crankcase is inclined at an angle of 45°.

COMPONENT	INITIAL DIMENSION		INITIAL CLEARANCE		MAXIMUM ADVISABLE CLEARANCE	
	in.	mm.	in.	mm.	in.	mm.
Camshaft bush bore flywheel end	1.7525 1.7515	44.51 44.49				
Camshaft journal dia.	1.746 1.7455	44.35 44.34	0.006 0.0055	0.15 0.14	0.009	0.23
Camshaft bush length, gear end (inner)	1.089 1.099	27.91 27.66				
Camshaft bush length gear end (outer)	1.599 1.589	40.61 40.36	0.020 0.005	0.51 0.13	0.025	0.63
Camshaft gear hub width	1.0625 1.0605	26.99 26.94	END FLOAT		END FLOAT	
Fuel pump tappet dia.	0.96825 0.96725	24.593 24.568	0.0025	0.06	0.004	0.1
Tappet guide bore	0.96975 0.96875	24.632 24.606	0.0005	0.01		
Oil pump tappet dia.	0.6235 0.6225	15.837 15.811	0.0035	0.089		
Crankcase bore **Self regulating pump**	0.6250 0.6260	15.875 15.900	0.0015	0.038	0.0055	0.14
Oil pump plunger dia.	1.124 1.123	28.550 28.525	0.003	0.08		
Crankcase bore **Self regulating pump**	1.126 1.125	28.605 28.575	0.001	0.025	0.004	0.11
Oil pump tappet dia.	0.6235 0.6225	15.837 15.811	0.0035	0.089		
Crankcase bore **PRE self regulating pump**	0.6250 0.6260	15.875 15.900	0.0015	0.038	0.0055	0.14

COMPONENT	INITIAL DIMENSION		INITIAL CLEARANCE		MAXIMUM ADVISABLE CLEARANCE	
	in.	mm.	in.	mm.	in.	mm.
Oil pump plunger dia.	0.8738 0.8735	22.194 22.187	0.0025	0.06		
Crankcase bore **PRE self regulating pump**	0.876 0.875	22.25 22.22	0.0015	0.04	0.0035	0.09
Valve spring free length	2.324 **ST** 2.244 **STW** 1.738	59.03 57.00 44.15 approx	—	—	**ST/W** 3% SET.	
Valve guide bore (inlet and exhaust)*	0.34455 0.34375	8.751 8.731	0.004	0.10	0.005	0.13
Valve stem dia.	0.34105 0.34055	8.663 8.650	0.0027	0.07		
Valve rocker bush bore	1.0025 1.002	25.46 25.45	0.004	0.10	0.005	0.13
Valve rocker shaft dia.	0.999 0.9985	25.37 25.36	0.003	0.08		
Backlash between gears	— —	— —	0.005 0.001	0.13 0.02	0.008	0.20

*Exhaust guides are counterbored.

OVERSIZE/UNDERSIZE ITEMS

Oversize pistons and piston rings, and undersize big end and main bearing shells are available. Reference should be made to an up to date Parts List for accurate numbers. The variations from standard dimensions are as follows:—

.010" (0.254mm), .020" (0.508mm), .030" (0.762mm), .040" (1.016mm)

RAL does not undertake the reboring of cylinders or the regrinding of crankshafts.

Non-standard sizes are marked as a suffix to the part number and in the following locations:—

a. Piston rings—201-80410 0.010", stamped on the face of the ring.

b. Pistons—201-80157 0.010", stamped on the top surface.

c. Bearings—202-80600 US 0.010", stamped on the steel outside surface of the bearing.

When cylinders are rebored the lower skirt should be etched or painted with the amount of oversize.

The standard initial dimensions are given in the 'Table of Clearances.'

Appendix A
ST1 BUILDS AND ACCESSORIES

BUILDS

Build No. 01

General purpose model—not close coupling. Clockwise rotation. Sheet metal fan shroud 356mm (14") dia x 67mm (2 5/8") flywheel. Fuel pump set to 'no overload'.
Governor set at 2000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 02

Close coupling general purpose model. Clockwise rotation. Close coupling fan shroud with starter motor blanking plate 356mm (14") dia x 67 mm (2 5/8") flywheel. Fuel pump set 'no overload'.
Governor set to 2600 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 03

Close coupling model with ring gear on flywheel. Clockwise rotation. Close coupling fan shroud with starter motor blanking plate. 356mm (14") dia x 67mm (2 5/8") flywheel with ring gear. Fuel pump set 'no overload'. Governor set to 2600 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 04

For gear end hydraulic Pump. Clockwise rotation. Sheet metal fan shroud. 356 mm (14") dia x 67 mm (2 5/8") flywheel. End cover suitable for hydraulic pump adaptor. (refer to accessories for adaptors and gears etc.)
Governor set to 2000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 05

For high inertia applications. Clockwise rotation. Sheet metal fan shroud. 356mm (14") dia x 89mm (3½") heavy industrial flywheel.
Governor set to 2000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 06

Hand start 50 Hz gen. set build. Clockwise rotation. Close coupling fan shroud with starter motor blanking plate. 50 Hz gen. set flywheel 356mm (14") dia x 127mm (5").
Governor set to 1500 rev/min. Class A2. End cover speed adjustment.

Build No. 07

'Auto' 50 Hz gen. set build. As Build 06 with 'auto' type fuel control operating lever, and sprung governing link.

Build No. 08

Hand start 50 Hz gen. set build (for use with SAE5 adaptor). Clockwise rotation. Close coupling fan shroud with starter motor blanking plate. Heavy industrial flywheel 356mm (14") dia x 89mm (3½") with ring gear. End cover speed adjustment.
Governor set to 1500 rev/min Class A2

Build No. 09

Hand start 60 Hz gen. set build. Clockwise rotation. Close coupling fan shroud with starter motor blanking plate. Heavy industrial flywheel with 356mm (14") dia x 89mm (3½") with ring gear. End cover speed adjustment.
Governor set to 1800 rev/min. Class A2

Build No. 10

'Auto' 60 Hz gen. set build. As build 09 but with 'auto' type fuel operating lever, and sprung governing link.

BUILDS—continued

Build No. 11
General purpose build. Anticlockwise rotation. Cast alloy fan shroud. 356mm (14") dia x 67mm (2 5/8") flywheel. Fuel pump set to 'no overload.'
Governor set at 2000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 12
Close coupling general build. Anticlockwise rotation. Close coupling fan shroud with starter motor blanking plate. 356mm (14") dia x 67mm (2 5/8") flywheel. Fuel pump set to 'no overload'.
Governor set at 2600 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 13
Close coupling build with ring gear on flywheel. Anticlockwise rotation. Close coupling fan shroud with starter motor blanking plate. 356mm (14") dia x 67 mm (2 5/8") flywheel with ring gear. Fuel pump set to 'no overload'.
Governor set to 2600 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 14
For high inertia applications. (Basic dumper build). Anticlockwise rotation. Close coupling fan shroud with starter motor blanking plate. 356mm (14") dia x 89mm (3½") flywheel.
Governor set to 2000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 15
60 Hz gen. set build. Anticlockwise rotation. Close coupling fan shroud with starter motor blanking plate. 356mm (14") dia x 89mm (3½") flywheel with ring gear. End cover speed adjustment.
Governor set to 1800 rev/min. Class A2

Build No. 20
3000 rev/min. build. Clockwise rotation. Close coupling fan shroud with starter motor blanking plate. High speed flywheel 356mm (14") x 67mm (2 5/8") with ring gear. Fuel pump set to 'no overload'
Governor set to 3000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—3000 (within 8% governing limits)

Build No. 21
'Flush' type starting. Clockwise rotation. Sheet metal fan shroud. 356mm (14") dia. x 67mm (2 5/8") flywheel.
Governor set at 2600 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 22
50 Hz gen. set build with ring gear on flywheel. Clockwise rotation. Close coupling fan shroud with starter motor blanking plate. 356mm (14") x 127mm (5") 50 Hz gen. set flywheel. End cover speed adjustment.
Governor set to 1500 rev/min. Class A2

BUILDS—continued

Build No. 23

Marine triple survey for propulsion and pumps. Clockwise rotation.
Close coupled fan shroud fitted with starter blanking plate, 14" (356mm) x 2⅝" (67mm) flywheel, starter ring. Fuel pump set to 'no overload'. Special crankcase.
Governor set to 2600 rev/min.
Governor range 1100-2000 (Outside 8% governing limits)
2000-2600 (within 8% governing limits)

Build No. 24

Marine auxiliary triple survey for 60 Hz gen set. Clockwise rotation. Close coupled fanshroud with starter blanking plate. 14" (356mm) x 5" (127mm) flywheel, starter ring. End cover speed adjustment.
Governor set to 1800 rev/min. Class A2.

Build No. 25

High inertia applications with gearend hydraulic pump adaptor (Dumper unit with hydraulics). Anticlockwise rotation. End cover suitable for hydraulic pump adaptor (refer to accessories for adaptors and gears etc.). Close coupling fan shroud with starter motor blanking plate. 356mm (14") dia x 89mm (3½)") flywheel.
Governor set at 2000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 26

High inertia applications. Anticlockwise rotation. Cast alloy fan shroud. 356mm (14") dia x 89mm (3½") flywheel.
Governor set at 2000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—2600 (within 8% governing limits)

Build No. 27

3000 rev/min build. Anticlockwise rotation. Close coupling fan shroud with starter motor blanking plate. High speed flywheel 356mm (14") dia x 67mm (2 5/8") with ring gear. Fuel pump set to 'no overload'.
Governor set to 3000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—3000 (within 8% governing limits)

Build No. 28

'Flush' type starting. Anticlockwise rotation. Cast alloy fan shroud. High speed flywheel 356mm (14") dia x 67mm (2 5/8")
Governor set at 3000 rev/min.
Governor range 1100—2000 (outside 8% governing limits)
2000—3000 (within 8% governing limits)

Build No. 29

Special for 'Simplite' pump, anti clockwise rotation, standard camshaft, close coupled fan shroud with starter blanking plate. End cover for close coupling.
Governor set at 2600 rev/min
Governing range 1100-2000 (outside 8% governing limits)
2000-2600 (within 8% governing limits)

Build No. 30

High inertia applications with gear end hydraulics, clockwise rotation, close coupled fan shroud with starter blanking plate. 14"' (356mm) x 2⅝" (67mm) flywheel, ring gear.
Governor set to 2000 rev/min
Governing range 1100-2000 (outside 8% governing limits)
2000-2600 (within 8% governing limits)

Build No. 31

Identical to Build 15 but with high capacity flywheel fan.
Governor set to 1800 rev/min. Class A2

ACCESSORIES

Coding Rotation Clock	Coding Rotation Anti Clock	DESCRIPTION
		A. AIR CLEANERS
AA	AA	Medium Duty Dry Air Cleaner
AB	AB	Heavy Duty Cyclopac Air Cleaner
AC	AC	Rubber Air Intake Elbow
AD	AD	Medium Duty Air Cleaner (Foam Element)
		B. FLYWHEEL END DRIVES
BA	BA	Shaft Extension—short
BB	BB	Shaft Extension—long
BC	BC	Shaft Extension—long unmachined shank
		Flexible half couplings:
BD	BD	17.5 mm (11/16") pilot bore
BE	BE	Split Boss 17.5 mm (11/16") pilot bore
BF	BF	Split Boss 25.4 mm (1") finish bore
BG	BG	Split Boss 31.7 mm (1¼") finish bore
BH	BH	Split Boss 35 mm (1 3/8") finish bore
BJ	BJ	Split Boss 38.1 mm (1½") finish bore
BK	BK	Split Boss 32 mm finish bore
BL	BL	Flexible whole coupling
BN	BN	Bolt-on pulley 203 mm (8") x 165 mm (6½")
BP	BP	Industrial overcentre clutch
BQ	BQ	Drive member for Newage gear boxes
	BR	Newage 40m 43 gearbox with 8" clutch including BQ and CA
BT	BT	Flat Face Pulley (replaces BM and BS)
		C. CLOSE COUPLING ADAPTORS
CA	CA	SAE5 Adaptor
CB	CB	Sealing Plate
CC	CC	Starter pinion Cover Plate (for customers' close coupling adaptors)
		D. AIR DUCT ADAPTORS
DA	DB	Angled air duct adaptor
		E. STARTING EQUIPMENT
EA	EB	Starting handle—short
EC	ED	Starting handle—long
EE	EF	Geared hand start with loose handle EA/EB
EG	EH	12 volt electric start with charging equipment and loose control panel
EJ	EK	12 volt electric starter motor only with Keyswitch loose
EL	EM	12 volt charging equipment and drive
EN	EU	12 volt charging equipment and drive (gear end hydraulics)
EQ	EQ	12 volt battery—dry charged
ER	ER	Battery leads 0.9m (3')
ES	ET	Flush type starting handle
		F. FUEL SUPPLY EQUIPMENT
FA	FA	11 litre (2½ gall) engine mounted fuel tank
FB	FB	31 litre (7 gall) fuel tank supplied loose
FC	FC	90 litre (20 gall) fuel tank supplied loose
FD	FD	Fuel lift pump
FE	FE	Fuel pipes 2.4 m (8') to suit FD and FB or FC
FF	FF	Filter/Agglomerator
		G. GUARDS
GA	GA	Camshaft guards
GB	GB	Charging equipment drive guard
		H. HYDRAULIC PUMP ADAPTORS
		Gear End (Builds 4 and 25 only)
HC	HC	To suit Dowty 2P3000 pump or equivalent } Starting Handle EC
HD	HD	To suit Dowty 1P3000 pump or equivalent } Required

ACCESSORIES—continued

Coding Rotation Clock	Coding Rotation Anti Clock	DESCRIPTION
HE	HE	Blanking plate
		Flywheel End
HF	HF	To suit Dowty 2P3000 Pump including guard
HG	HG	To suit Dowty 1P3000 Pump including guard
HH	HH	Pilot bore 12.7 mm (½") dia half coupling with 36.5 mm ,1.7/16") dia pilot bore mounting plate
		J. PROTECTION DEVICES AND SOLENOIDS
JB	JB	Air temp and oil pressure switch combined
JC	JC	Fuel control solenoid—12 volt trip type
JH	JH	12v Synchro start fuel control solenoid (energised to run)
JP	JP	Auto lever and link
		K. CONTROLS
KA	KA	Variable speed control lever and 1.8m cable (6')
KB	KB	2-speed control
KC	KC	Remote stop control lever and 1.8 m cable (6')
KD	KD	Extended stop control
		L. LUBRICATION EQUIPMENT
LA	LA	Remote filter mounting adaptor
LB	LB	Long running equipment (dry sump)
		N. EXHAUST EQUIPMENT
NA	NA	Lister silencer
NB	NB	Heavy duty exhaust silencer
NC	NC	Flexible exhaust pipe
ND	ND	Spark arrestor (can only be used with NB)
		P. GAUGES
PA	PA	Ammeter (loose)
PB	PB	Lub oil pressure gauge—on engine door
PC	PC	Lub oil pressure gauge and engine air temp gauge in dual panel
PD	PD	Hourmeter—vibration type supplied loose
		Q. MOUNTINGS
QA	QA	Wide support feet
QB	QB	Holding down bolts
		R. RECOMMENDED SPARES (supplied with engines only)
RA	RA	2500 hours
RB	RB	5000 hours
RC	RC	7500 hours
RD	RD	12500 hours
		S. SUNDRIES
SA	SA	Paint finish—primer
SB	SB	Paint finish—Lister green
SC	SC	Transfers: English, Spanish, Italian, French, Portuguese
SD	SD	Manuals: Operators Handbook — English, French, Spanish, [Portuguese, German
		Parts Book—English only
SE	SE	Engine instruction plate supplied loose
SF	SF	Packing—Export plywood case
SG	SG	Packing—Export soft-wood case (certain markets only)
SH	SH	Packing—Export skid base
SJ	SJ	Packing—U.K. road base
SK	SK	Toolkit
SL	SL	Paint finish—dolphin blue

COMPATIBILITY OF ACCESSORIES TO BUILDS

● Indicates non-compatible

		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	20	21	22	23	24	25	26	27	28	29	30
MEDIUM DUTY DRY AIR CLEANER	AA																										
HEAVY DUTY CYCLOPAC AIR CLEANER	AB																										
RUBBER AIR INTAKE ELBOW	AC																										
MEDIUM DUTY AIR CLEANER (FOAM ELEMENT)	AD																										
SHAFT EXTENSION (SHORT)	BA																										
SHAFT EXTENSION (LONG)	BB																										
SHAFT EXTENSION (UN-MACHINED SHANK)	BC																										
FLEXIBLE HALF COUPLING (17.5 PILOT BORE)	BD																										
SPLIT BOSS HALF COUPLING (17.5 PILOT BORE)	BE																										
SPLIT BOSS HALF COUPLING (25.4 FINISH BORE)	BF																										
SPLIT BOSS HALF COUPLING (31.7 FINISH BORE)	BG																										
SPLIT BOSS HALF COUPLING (35 FINISH BORE)	BH																										
SPLIT BOSS HALF COUPLING (38.1 FINISH BORE)	BJ																										
SPLIT BOSS HALF COUPLING (32 FINISH BORE)	BK																										
FLEXIBLE WHOLE COUPLING	BL																										
BOLT ON PULLEY 203mm (8") DIA.	BN						●	●											●		●						
INDUSTRIAL OVER CENTRE CLUTCH	BP	●			●	●	●	●	●	●	●	●			●	●		●	●		●	●	●		●		
DRIVE MEMBER FOR NEWAGE GEARBOX	BQ	●			●	●	●	●	●	●	●	●				●		●	●		●		●		●		●
40 M 43 GEARBOX AND CLUTCH	BR	●			●	●	●	●	●	●	●	●				●		●	●		●		●		●		●
FLAT FACE BELT PULLEY (REPLACES BSI	BT																										
SAE 5 ADAPTOR	CA	●			●	●	●	●				●						●	●		●		●		●		
SEALING PLATE	CB	●			●	●						●						●					●		●		
COVER PLATE	CC	●			●	●						●						●					●		●		
AIR DUCT ADAPTOR (CLOCKWISE ROTATION)	DA	●			●	●						●	●	●	●	●		●				●	●	●	●	●	
AIR DUCT ADAPTOR (ANTI-CLOCKWISE ROTATION)	DB	●	●	●	●	●	●	●	●	●	●	●					●	●	●	●	●		●		●		●
STARTING HANDLE (SHORT, CLOCKWISE)	EA				●							●	●	●	●	●		●				●	●	●	●	●	●
STARTING HANDLE (SHORT, ANTI-CLOCKWISE)	EB	●	●	●	●	●	●	●	●	●	●						●	●	●	●	●	●			●		●
STARTING HANDLE (LONG, CLOCKWISE)	EC											●	●	●	●	●		●				●	●	●	●	●	
STARTING HANDLE (LONG, ANTI-CLOCKWISE)	ED	●	●	●	●	●	●	●	●	●	●						●	●	●	●	●				●		●
GEARED HAND START (CLOCKWISE) WITH EB & CB	EE	●			●	●						●	●	●	●	●		●	●		●	●	●	●	●	●	
GEARED HAND START (ANTI-CLOCKWISE) WITH EA & CB	EF	●	●	●	●	●	●	●	●	●	●							●	●	●	●		●		●		●
12 VOLT ELECTRIC STARTING (CLOCKWISE)	EG	●	●		●	●	●	●				●	●	●	●	●		●				●	●	●	●	●	●
12 VOLT ELECTRIC STARTING (ANTI-CLOCKWISE)	EH	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●	●		●	●	●
12 VOLT STARTER MOTOR (CLOCKWISE)	EJ	●	●		●	●	●	●				●	●	●	●	●		●				●	●	●	●	●	●
12 VOLT STARTER (ANTI-CLOCKWISE)	EK	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●	●		●	●	●
12 VOLT CHARGING EQUIPMENT AND DRIVE (CLOCKWISE)	EL				●							●	●	●	●	●		●				●	●	●	●	●	●
12 VOLT CHARGING EQUIPMENT AND DRIVE (ANTI-CLOCKWISE)	EM	●	●	●	●	●	●	●	●	●	●						●	●	●	●	●				●		●
12 VOLT CHARGING EQUIPMENT AND DRIVE-GEAR END HYDRAULICS	EN	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
BATTERY	EQ	●	●		●	●	●	●	●	●	●	●			●			●				●	●		●	●	
BATTERY LEADS	ER	●	●		●	●	●	●	●	●	●	●			●			●				●	●		●	●	
FLUSH TYPE STARTING HANDLE (CLOCKWISE)	ES	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
FLUSH TYPE STARTING HANDLE (ANTI-CLOCKWISE)	ET	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	
12 VOLT ALTERNATOR AND DRIVE-GEAR END HYDRAULICS (A/CW. ROT)	EU	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
ENGINE MOUNTED FUEL TANK 11 LITRE	FA							●			●																
31 LITRE FUEL TANK-LOOSE	FB																										
90 LITRE FUEL TANK-LOOSE	FC																										
FUEL LIFT PUMP	FD																										
FUEL PIPES	FE																										
FILTER AGGLOMERATOR	FF				●		●			●											●					
CAMSHAFT GUARD	GA				●													●			●				●		●
CHARGING EQUIPMENT DRIVE GUARD	GB				●													●			●				●		●
HYD. PUMP ADAPTOR-GEAR END (DOWTY 2P3000)	HC	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	
HYD. PUMP ADAPTOR-GEAR END (DOWTY 1P3000)	HD	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	
BLANKING PLATE	HE	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	
HYD. PUMP ADAPTOR-FLYWHEEL END (DOWTY 2P3000)	HF	●			●	●	●	●	●	●	●	●			●	●		●	●		●	●	●		●		●
HYD. PUMP ADAPTOR-FLYWHEEL END (DOWTY 1P3000)	HG	●			●	●	●	●	●	●	●	●			●	●		●	●		●	●	●		●		●
PILOT BORED HALF COUPLING AND MOUNTING PLATE	HH	●			●	●	●	●	●	●	●				●	●		●	●		●	●	●		●		●
AIR TEMP AND OIL PRESSURE SWITCHES	JB																	●							●		
*12 VOLT FUEL CONTROL SOLENOID-TRIP TYPE	JC							●			●																
12V SYNCHRO FUEL CONTROL SOLENOID (ENERGISED TO RUN)	JH							●			●																
AUTO LEVER AND LINK	JP							●			●																

COMPATIBILITY OF ACCESSORIES TO BUILDS

● Indicates non-compatible

		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	20	21	22	23	24	25	26	27	28	29	30
VARIABLE SPEED CONTROL	KA						●	●	●	●	●					●			●		●						
TWO SPEED CONTROL	KB						●	●	●	●	●					●			●		●						
REMOTE STOP LEVER	KC							●			●																
EXTENDED STOP CONTROL	KD							●			●																
REMOTE FILTER ARRANGEMENT	LA																										
DRY SUMP WITH QA AND MLA	LB																										
LISTER SILENCER	NA																										
HEAVY DUTY SILENCER	NB																										
FLEXIBLE EXHAUST PIPE	NC																										
SPARK ARRESTOR	ND																										
AMMETER	PA	●	●		●	●	●	●	●	●	●	●	●		●			●				●	●		●		
LUB. OIL PRESSURE GAUGE ON DOOR	PB																										
OIL PRESSURE GAUGE & ENGINE TEMP GAUGE IN DUAL PANEL	PC																	●							○		
VIBRATION HOUR METER	PD																										
WIDE SUPPORT FEET	QA																										
HOLDING DOWN BOLTS	QB																										
2500 HOUR SPARES	RA																										
5000 HOUR SPARES	RB																										
7500 HOUR SPARES	RC																										
12500 HOUR SPARES	RD																										
PAINT FINISH-PRIMER	SA																										
PAINT FINISH-LISTER GREEN	SB																										
TRANSFERS	SC																										
MANUALS	SD																										
DUMPER ENGINE INSTRUCTION PLATE	SE						●	●	●	●	●					●			○	○	○						
PACKING-PLYWOOD CASE-EXPORT	SF																										
PACKING-SOFTWOOD CASE	SG																										
PACKING-EXPORT-SKID BASE	SH																										
PACKING-HOME ROAD BASE	SJ																										
TOOL KIT	SK																										

Appendix B
ST2 BUILDS AND ACCESSORIES

BUILDS

Build No. 01
General purpose model—not close coupling, clockwise rotation, sheet metal flywheel housing, standard flywheel. Fuel pump set to 'no overload'.
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 02
Close coupling general purpose build, clockwise rotation, close coupling flywheel housing with starter blanking plate, standard flywheel, fuel pumps set to 'no overload'.
Governor set to 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 03
Close coupling build with ring gear on flywheel, clockwise rotation, close coupling flywheel housing with starter blanking plate. Standard flywheel with ring gear.
Standard fuel pump setting.
Governor set to 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governining limits)

Build No. 04
Hand start 50 Hz Gen set build, clockwise rotation, close coupling flywheel housing with starter blanking plate. 50 Hz Gen set flywheel. End cover speed adjustment.
Standard fuel pump setting.
Governor set to 1500 rev/min Class A2

Build No. 05
'Auto' 50 Hz Gen set build. As Build 04 but with 'Auto' Type fuel control operating lever, and sprung governor link.

Build No. 06
50 Hz Gen set build with ring gear on flywheel. As build 04 but with ring gear on flywheel.

Build No. 07
Hand start 60 Hz Gen set build. Clockwise rotation, close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear, standard fuel pump setting. End cover speed adjustment.
Governor set to 1800 rev/min Class A2

Build No. 08
'Auto' 60 Hz Gen set build as Build 07 with 'Auto' type fuel control operating lever, and sprung governor link.

Build No. 09
General purpose build anticlockwise rotation, close coupling flywheel housing with starter blanking plate. Standard flywheel, standard fuel pump setting.
Governor set to 2000 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits

Build No. 10
Close coupling build with ring gear on flywheel, anticlockwise rotation ,close coupling flywheel housing with starter blanking plate. Standard flywheel with ring gear.
Standard fuel pump setting. Fuel pump set to 'no overload'.
Governor set to 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

BUILDS—continued

Build No. 11

Close coupling build with ring gear on flywheel and gear end hydraulics, anticlockwise rotation, close coupling flywheel housing with starter blanking plate. Standard flywheel with ring gear end cover suitable for hydraulic pump adaptors (refer to accessories for adaptors).
Standard fuel pump setting.
Governor set to 2000 rev/min
Governor range 1300—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 12

60 Hz Gen set build, anticlockwise rotation, close coupling flywheel housing with starter blanking plate.
Standard fuel pump setting.
Standard flywheel with ring gear.
Governor set to 1800 rev/min Class A2

Build No. 20

3000 rev/min build clockwise rotation, close coupling flywheel housing with starter blanking plate, high speed flywheel with ring gear, fuel pump set to 'no overload'.
Governor set to 3000 rev/min
Governor range 1200—2400 (outside 8% governing limits)
2400—3000 (within 8% governing limits)

Build No. 21

Flush type starting clockwise rotation, close coupling flywheel housing, standard flywheel and ring gear.
Standard fuel pump setting.
Governor set at 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 22

Close coupling build for gear end hydraulics, clockwise rotation, close coupling flywheel housing with starter blanking plate. Standard flywheel with ring gear end cover suitable for hydraulic pump adaptor (refer to accessories) standard fuel pump setting.
Governor set to 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 23

Marine build with close coupled fan shroud for R.H.S. and starter blanking plate. Standard flywheel with starter gear ring. Fuel pump set to 'no overload'.
Governor set at 2000 rev/min.
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 24

Marine with close coupled fan shroud for raised hand starting and starter blanking plate. Standard flywheel and starter ring. Fuel pumps set to no overload. Clockwise rotation.
Governor set at 2600 rev/min.
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

BUILDS—continued

Build No. 25

MEU engine, clockwise rotation, with special flywheel and fan assembly, fan shroud, cowling, camshaft end cover and cylinder head cover. Includes fuel filter, fuel lift pump and dipstick in crankcase door.
Governor set at 2350 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 27

For extended running applications and with provision for sump heaters. Close coupling fan shroud, heavy flywheel for 50 Hz Gen set with ring gear and starter blanking plate.
Standard fuel pump setting.
Governor set to 1500 rev/min Class A2

Build No. 28

Marine auxiliary triple survey, clockwise rotation, close coupled fan shroud for raised hand starting and with starter blanking plate. Long running/sump heater crankcase. Standard flywheel with starter ring. Fuel pumps set to no overload.
Governor set to 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 29

Marine auxiliary triple survey, clockwise rotation, close coupled fan shroud with starter blanking plate, 60 Hz gen. set flywheel with starter ring. End cover speed adjustment.
Governor set at 1800 rev/min Class A2

Build No. 30

3000 rev/min build anticlockwise rotation, close coupling flywheel housing with starter blanking plate, high speed flywheel with ring gear, fuel pump set to 'no overload'.
Governor set to 3000 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 31

50 Hz 'Auto' Gen set build anticlockwise rotation, close coupling flywheel housing with starter blanking plate, heavy flywheel with ring gear.
Standard fuel pump setting. 'Auto' Type fuel control lever and sprung governor link. End cover speed adjustment.
Governor set to 1500 rev/min Class A2

Build No. 32

'Benford' build, anti clockwise rotation, close coupled fan shroud with starter blanking plate, standard flywheel with anti clockwise fan and special exhaust manifold.
Governor set at 2000 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 33

Concrete mixer, anti clockwise rotation, close coupled fan shroud with starter blanking plate, short camshaft, standard flywheel with anti clockwise fan.
Governor set at 2000 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

BUILDS—continued

Build No. 34
Piling winch, anti clockwise rotation, close coupled fan shroud with starter blanking plate. Flywheel and anti clockwise heavy fan and starter ring.
Governor set at 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

Build No. 35
Marine fire pumps triple survey, anti clockwise rotation, close coupled fan shroud with starter blanking plate. Standard flywheel with anti clockwise fan and with starter ring.
Governor set at 2600 rev/min
Governor range 1200—2100 (outside 8% governing limits)
2100—2600 (within 8% governing limits)

ACCESSORIES

Coding		DESCRIPTION
Rotation		
Clock	Anti-Clock	
		A. AIR CLEANERS
AA	AA	Medium Duty Dry Air Cleaner
AB	AB	Heavy Duty Cyclopac Air Cleaner (Mounted)
AC	AC	Heavy Duty Cyclopac Air Cleaner (Loose)
AD	AD	Rubber Air Intake Elbow
		B. FLYWHEEL END DRIVES
BA	BA	Shaft Extension (Short)
BB	BB	Shaft Extension (Long)
BC	BC	Shaft Extension (Long unmachined shank)
		Flexible half couplings:
BD	BD	17.5mm (11/16") Pilot Bore
BE	BE	Split Boss 17.5mm (11/16") Pilot Bore
BF	BF	Split Boss 25.4mm (1") Finish Bore
BG	BG	Split Boss 31.7mm (1¼") Finish Bore
BH	BH	Split Boss 35.0mm (1⅜") Finish Bore
BJ	BJ	Split Boss 38.1mm (1½") Finish Bore
BK	BK	Split Boss 32.0mm Finish Bore
BL	BL	Flexible whole coupling
BM	BM	Bolt on Pulley 203mm (8") x 165mm (6½")
BN	BN	Bolt on Pulley 229mm (9") x 165mm (6½")
BP	BP	Bolt on Pulley 254mm (10") x 165mm (6½")
BQ	BQ	Industrial Overcentre Clutch
BR	BR	3 : 1 Reduction Gear
BS	BS	Drive Member for Newage Gearbox
	BU	Newage 40m43 Gearbox with 8" Clutch includes BS & CB
	BY	Newage 40m42 Gearbox with 8" Clutch includes BS & CB
		C. CLOSE COUPLING ADAPTORS
CA	CA	SAE 4 Adaptor
CB	CB	SAE 5 Adaptor
	CC	SAE Adaptor (Benford)
CD	CD	SAE 6 Adaptor
		D. AIR DUCT ADAPTOR
DA	DB	Angled Air Duct Adaptor
		E. STARTING EQUIPMENT
EA	EB	Starting Handle—Short
EC	ED	Starting Handle—Long
EE	EF	Geared Hand Start with Loose Handle EA/EB
EG	EG	Coupled Decompressors
EH	EI	12 Volt Electric Start with Charging Equipment and Control Panel
EL	EM	12 Volt Charging Equipment and Drive with Gear End Hydraulics
EN	EO	12 Volt Electric Starter Motor only includes Key switch Loose
EP	EQ	12 Volt Charging Equipment and Drive
ER	ER	12 Volt Battery (Dry Charged)
ES	ES	Battery Leads 0.91m Long
ET	EU	24 Volt Starter Motor includes Keyswitch (Loose)
EV	EW	Starter Gear Ring
EX	EX	Sump Heater and Thermostat
EY	—	Flush type Starting Handle
EZ	EZ	24 Volt Battery Dry Charged

ACCESSORIES — continued

Coding		DESCRIPTION
Rotation		
Clock	Anti-Clock	
		F. FUEL SUPPLY EQUIPMENT
FA	FA	11 Litre (2½ Gall) Engine Mounted Fuel Tank
FB	FB	31 Litre (7 Gall) Fuel Tank Supplied Loose
FC	FC	90 Litre (20 Gall) Fuel Tank Supplied Loose
FD	FD	Fuel Lift Pump
FE	FE	Fuel Pipes 24 m (8') to suit FB, FC or FD
FF	FF	Filter/Agglomerator
		G. GUARDS
GA	GA	Camshaft Guard
GB	GB	Drive Guard—charging equipment
		H. HYDRAULIC PUMP ADAPTORS
		Gear End (Builds 11 & 22 only)
HC	HC	To suit Dowty 2P3000 Pump } Requires Starting
HD	HD	To suit Dowty 1P3000 Pump } Handle EC or ED
HE	HE	Blanking Plate
		Flywheel End
HF	HF	To suit Dowty 2P3000 Pump
HG	HG	To suit Dowty 1P3000 Pump
HH	HH	Pilot Bored 12.7 mm (½") Half Coupling with 36.5 mm (1 7/16") Dia. Bore Mounting Plate
		J. PROTECTION DEVICES AND SOLENOIDS
JB	JB	Air Temp and Oil Pressure Switch Combined
JC	JC	Fuel Control Solenoid—Trip Type 12 Volt (energised to stop)
JD	JD	Fuel Control Solenoid—Trip Type 220/240 Volt 50 Hz
JO	JO	12V Synchro Start Fuel Control Solenoid (energized to run)
JP	JP	Auto Lever and Link
JT	JT	24V Synchro Start Fuel Control Solenoid (energized to run)
		K. CONTROLS
KA	KA	Variable Speed Control Lever and 1.8m Cable (6')
KB	KB	2-Speed Control
KC	KC	Variable Speed Control Engine Mtd. Rod Operated
KE	KE	Remote Stop Control Lever and 1.8m Cable (6')
KF	KF	Extended Stop Control
		L. LUBRICATION EQUIPMENT
LA	LA	Remove Filter Less Pipes
LB		Long Running Equipment (Dry Sump)
LC	LC	Extended Flexible Dipstick

ACCESSORIES — continued

Coding		DESCRIPTION
Rotation		
Clock	Anti-Clock	
		N. EXHAUST EQUIPMENT
NA	NA	Lister Silencer
NB	NB	Heavy Duty Exhaust Silencer
NC	NC	Flexible Exhaust Pipe
ND	ND	Spark Arrestor (can only be used with NB)
NF	NF	Exhaust Manifold Flange—90° Bend
		P. GAUGES
PA	PA	Ammeter 12 Volt—Alternator
PC	PC	Lub. Oil Pressure Gauge on Engine Door
PD	PD	Lub. Oil Pressure and Eng. Air Temp. Gauges in Dual Panel
PE	PE	Hourmeter—Vibration Type Supplied Loose
		Q. MOUNTINGS
QA	QA	Holding Down Bolts
		R. RECOMMENDED SPARES
RA	RA	2500 Hours
RB	RB	5000 Hours
RC	RC	7500 Hours
RD	RD	12500 Hours
		S. SUNDRIES
SA	SA	Paint Finish—Primer
SB	SB	Paint Finish—Lister Green
SC	SC	Transfers: English, French, Spanish, Italian, German, Portuguese
SD	SD	Manuals: Operators Handbook, English, French, Spanish, Portuguese [German
		Parts Book—English Only
SE	SE	Engine Instruction Plate
SF	SF	Packing—Export Plywood Case
SG	SG	Packing—Export Softwood Case
SH	SH	Packing—Export Skid Base
SJ	SJ	Packing—U.K. Road Base
SK	SK	Toolkit
SL	SL	Paint Finish—Dolphin Blue

COMPATIBILITY OF ACCESSORIES TO BUILDS

● Indicates non-compatible

		01	02	03	04	05	06	07	08	09	10	11	12	20	21	22	27	30	31	32	33	34	35
DRY AIR CLEANER	AA																						
HEAVY DUTY CYCLOPAC AIR CLEANER—ENGINE MOUNTED	AB	●																					
HEAVY DUTY CYCLOPAC AIR CLEANER—LOOSE (LESS BKTS. INCL. CONNECTIONS)	AC																						
RUBBER AIR INTAKE ELBOW	AD																						
SHAFT EXTENSION—SHORT (APPROVED APPLICATIONS ONLY)	BA																						
SHAFT EXTENSION—LONG	BB																						
SHAFT EXTENSION—LONG (UNMACHINED SHANK)	BC																						
FLEXIBLE HALF COUPLINGS 11/16" (17.5mm) PILOT BORE	BD																						
FLEXIBLE HALF COUPLINGS—SPLIT BOSS 11/16" (17.5mm) PILOT BORE	BE																						
FLEXIBLE HALF COUPLING—SPLIT BOSS 1" (25.4mm) FINISH BORE	BF																						
FLEXIBLE HALF COUPLING—SPLIT BOSS 1 1/4" (31.7mm) FINISH BORE	BG																						
FLEXIBLE HALF COUPLING—SPLIT BOSS 1 3/8" (35mm) FINISH BORE	BH																						
FLEXIBLE HALF COUPLING—SPLIT BOSS 1 1/2" (38.1mm) FINISH BORE	BJ																						
FLEXIBLE HALF COUPLING—SPLIT BOSS 32mm FINISH BORE	BK																						
FLEXIBLE WHOLE COUPLING	BL																						
BOLT ON PULLEY 8" (203mm) x 6 1/2" (165mm)	BM																						
BOLT ON PULLEY 9" (229mm) x 6 1/2" (165mm)	BN																						
BOLT ON PULLEY 10" (254mm) x 6 1/2" (165mm)	BP																						
CLUTCH	BQ	●			●	●	●								●		●		●			●	
3:1 REDUCTION GEAR	BR	●			●	●	●								●		●		●			●	
DRIVE MEMBER FOR NEWAGE GEARBOXES	BS	●			●	●	●	●	●				●		●		●		●			●	●
NEWAGE 40M43 GEARBOX WITH 8" CLUTCH (ANTI-CLOCKWISE) INCL. BS & C8	BU	●	●	●	●	●	●	●	●				●	●	●	●	●		●			●	●
NEWAGE 40M42 GEARBOX WITH 8" CLUTCH (ANTI-CLOCKWISE) INCL. BS & C8	BY	●	●	●	●	●	●	●	●				●	●	●	●	●		●			●	●
SAE 4 ADAPTOR	CA	●													●								
SAE 5 ADAPTOR	CB	●													●								
SAE 6 ADAPTOR	CD	●													●								
AIR DUCT ADAPTOR (CLOCKWISE)	DA	●								●	●	●	●		●			●	●	●	●	●	
AIR DUCT ADAPTOR (ANTI-CLOCKWISE)	DB	●	●	●	●	●	●	●	●					●	●	●	●						●
STARTING HANDLE—SHORT (CLOCKWISE)	EA									●	●	●	●		●	●		●	●	●	●	●	
STARTING HANDLE—SHORT (ANTI-CLOCKWISE)	EB	●	●	●	●	●	●	●	●			●		●	●	●	●						●
STARTING HANDLE—LONG (CLOCKWISE)	EC									●	●	●	●		●			●	●	●	●	●	
STARTING HANDLE—LONG (ANTI-CLOCKWISE)	ED	●	●	●	●	●	●	●	●					●	●	●	●						●
GEARED HAND START WITH LOOSE HANDLE EA (CLOCKWISE)	EE	●			●	●	●			●	●	●	●		●		●	●	●	●	●	●	●
GEARED HAND START WITH LOOSE HANDLE EB (ANTI-CLOCKWISE)	EF	●	●	●	●	●	●	●	●					●	●	●	●		●			●	●
COUPLED DECOMPRESSORS	EG					●			●										●				
12V ELECTRIC START-CHARGING EQUIPMENT & START PANEL (CLOCKWISE)	EH	●	●		●	●				●	●	●	●					●	●	●	●	●	●
12V ELECTRIC START-CHARGING EQUIPMENT & START PANEL (ANTI-CLOCKWISE)	EI	●	●	●	●	●	●	●	●	●				●	●	●	●						●
ELECTRIC START (WITH GEAREND HYDRAULICS) REQUIRES EC	EL	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
12V ELECTRIC START-WITH PANEL (SUIT GEAR END HYD. PUMP ANTI-CLOCKWISE)	EM	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
12V ELECTRIC STARTER MOTOR WITH KEY SWITCH (CLOCKWISE)	EN	●	●		●	●				●	●	●	●					●	●	●	●	●	●
12V ELECTRIC STARTER MOTOR WITH KEY SWITCH (ANTI-CLOCKWISE)	EO	●	●	●	●	●	●	●	●	●			●		●	●				●		●	
12V CHARGING EQUIPMENT & DRIVE (CLOCKWISE)	EP									●	●	●	●		○	●		●	●	●	●	●	
12V CHARGING EQUIPMENT & DRIVE (ANTI-CLOCKWISE)	EQ	●	●	●	●	●	●	●	●			●		●	●	●	●				●		●
12V BATTERY (DRY CHARGED)	ER																						
BATTERY LEADS—0.91m	ES																						
24V ELECTRIC STARTER MOTOR WITH KEY SWITCH (CLOCKWISE)	ET	●	●		●	●		●	●	●	●	●	●					●	●	●	●	●	●
24V ELECTRIC STARTER MOTOR WITH KEY SWITCH (ANTI-CLOCKWISE)	EU	●	●	●	●	●	●	●	●	●				●	●	○	●				●		●
STARTER GEAR RING (CLOCKWISE)	EV	●		●			●			●	●	●	●	●	●	●	●	●	●	●	●	●	●
STARTER GEAR RING (ANTI-CLOCKWISE)	EW	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●			●	●
SUMP HEATER AND THERMOSTAT 240V. 50 Hz	EX	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
FLUSH TYPE STARTING HANDLE	EY	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●
24V BATTERY (DRY CHARGE)	EZ																						
11 LITRE (2 1/2 GALLON) ENGINE MOUNTED FUEL TANK	FA					●			●											●			
31 LITRE (7 GALLON) FUEL TANK-LOOSE	FB																						

COMPATIBILITY OF ACCESSORIES TO BUILDS

● Indicates non-compatible

		01	02	03	04	05	06	07	08	09	10	11	12	20	21	22	27	30	31	32	33	34	35
90 LITRE (20 GALLON) FUEL TANK-LOOSE	FC																						
FUEL LIFT PUMP	FD																						
FUEL PIPES 2.4m (8') I SUIT FB, FC & FD	FE																						
FILTER AGGLOMERATOR	FF					●			●			●				●			●				
CAMSHAFT GUARD	GA											●			●	●					●		
DRIVE GUARD	GB											●		●	●					●			
HYD. PUMP ADAPTOR: GEAR END – DOWTY 2P3000 PUMP	HC	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●	●	●
HYD. PUMP ADAPTOR: GEAR END – DOWTY 1P3000 PUMP	HD	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●	●	●
BLANKING PLATE	HE	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●	●	●
HYD. PUMP ADAPTOR: FLYWHEEL – DOWTY 2P3000 PUMP	HF	●			●	●	●								●		●		●			●	
HYD. PUMP ADAPTOR: FLYWHEEL – DOWTY 1P3000 PUMP	HG	●			●	●	●								●		●		●			●	
PILOT BORED 1/2" (12.7mm) HALF COUPLING WITH 1 7/16" (36.5mm) BORE mounting plate	HH	●			●	●	●								●		●		●			●	
COMBINED AIR TEMP. AND OIL PRESS. SWITCH (SUITABLE 12V & 24V)	JB														●								
12V FUEL CONTROL SOLENOID – TRIP TYPE (ENERGISED TO STOP) *	JC					●			●										●				
220 – 240V FUEL CONTROL SOLENOID – TRIP TYPE (ENERGISED TO TRIP) *	JD					●			●				●						●				
SYNCHRO START FCS (ENERGISED TO RUN) – 12V	JO					●			●										●				
SYNCHRO START FCS (ENERGISED TO RUN) – 24V	JT					●			●										●				
AUTO LEVER LINK	JP					●			●										●				
110/115 HZ TRIP TYPE SOLENOID	JQ				●	●			●								●						
VARIABLE SPEED CONTROL C/W OPERATING LEVER & 6' (1.82m) CABLE	KA				●	●	●	●	●				●				●		●				
TWO SPEED CONTROL	KB				●	●	●	●	●				●				●		●				
VARIABLE SPEED CONTROL – ENG. MTD. ROD OPERATED	KC	●			●	●	●	●	●				●		●		●		●				
REMOTE STOP CONTROL C/W OPERATING LEVER AND 6' (1.82m) CABLE	KE					●			●										●				
EXTENDED STOP CONTROL	KF					●			●										●				
REMOTE FILTER ARRANGEMENT – LESS PIPES	LA																						
LONG RUNNING EQUIPMENT	LB	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
EXTENDED FLEXIBLE DIPSTICK	LC																						
LISTER SILENCER	NA																						
HEAVY DUTY EXHAUST SILENCER	NB																						
FLEXIBLE EXHAUST PIPE	NC																				●		
SPARK ARRESTOR (CAN ONLY BE USED WITH NB)	ND																						
90° BEND EXHAUST MANIFOLD FLANGE	NF																				●		
12V AMMETER – LOOSE	PA																						
LUB. OIL PRESSURE GAUGE – ENGINE DOOR	PC																						
LUB. OIL PRESSURE GAUGE & ENGINE AIR TEMP. GAUGE IN PANEL	PD														●								
VIBRATION TYPE HOUR RECORDER – LOOSE	PE																						
HOLDING DOWN BOLTS	QA																						
RECOMMENDED SPARES – 2500 HOURS (NOT ACCESSORY LB)	RA																						
RECOMMENDED SPARES – 5000 HOURS (NOT ACCESSORY LB)	RB																						
RECOMMENDED SPARES – 7500 HOURS (NOT ACCESSORY LB)	RC																						
RECOMMENDED SPARES – 12500 HOURS (NOT ACCESSORY LB)	RD																						
PAINT FINISH – PRIMER	SA																						
PAINT FINISH – LISTER GREEN	SB																						
TRANSFERS	SC																						
MANUALS	SD																						
ENGINE INSTRUCTION PLATE	SE																						
EXPORT – PLYWOOD PACKING CASE	SF																						
EXPORT – SOFTWOOD PACKING CASE	SG																						
PACKING – EXPORT SKID BASE	SH																						
PACKING – HOME ROAD BASE	SJ																						
TOOL KIT	SK																						

Appendix C
ST3 BUILDS AND ACCESSORIES

BUILDS

Build No. 01

General purpose model—not close coupling, clockwise rotation, sheet metal flywheel housing, standard flywheel, fuel pump to 'no overload.'
Governor set at 2000 rev/min.
Governor range 1200—2100 (outside 8% governing limit)
2100—2600 (within 8% governing limit)

Build No. 02

Close coupling general purpose build, clockwise rotation, close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear.
Fuel pump set to 'no overload.'
Governor set to 2600 rev/min.
Governor range 1200—2100 (outside 8% governing limit)
2100—2600 (within 8% governing limit)

Build No. 03

Standard 50 Hz Gen set build clockwise rotation close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear, standard fuel pump setting. End cover speed adjustment.
Governor set to 1500 rev/min Class A2.

Build No. 04

'Auto' 50 Hz Gen set build.
As Build 03 but with 'Auto' type fuel.
control operating lever and sprung governor link.

Build No. 05

Standard 60 Hz Gen Set build clockwise rotation, close coupling flywheel housing, starter blanking plate, standard flywheel with ring gear. Standard fuel pump setting. End cover speed adjustment.
Governor set to 1800 rev/min Class A2.

Build No. 06

60 Hz Auto Gen Set build. As build 05 but with 'Auto' type fuel control operating lever and sprung governor link.

Build No. 07

General purpose build, anticlockwise rotation, close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear, fuel pump set to 'no overload.'
Governor set to 2600 rev/min.
Governor range 1200—2400 (outside 8% governing limit)
2400—2600 (within 8% governing limit)

Build No. 08

Close coupling build with gear end hydraulics, anticlockwise rotation, close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear end cover suitable for hydraulic pump adaptors. Standard fuel pump setting.
Governor set to 2000 rev/min.
Governor range 1200—2100 (outside 8% governing limit)
2100—2600 (within 8% governing limit)

Build No. 09

60 Hz Gen set build, anticlockwise rotation, close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear, standard fuel pump setting.
Governor set to 1800 rev/min. Class A2

Build No. 20

3000 rev/min. build clockwise rotation, close coupling flywheel housing with starter blanking plate, high speed flywheel with ring gear, lubricating oil cooler. Fuel pump set to 'no overload.'
Governor set to 3000 rev/min.
Governor range 1200—2400 (outside 8% governing limit)
2400—3000 (within 8% governing limit)

BUILD—continued

Build No. 21

For extended running applications and with provision for sump heaters, close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear. End cover speed adjustment. Standard fuel pump setting.
Governor set to 1500 rev/min Class A2.

Build No. 22

Marine with close coupled fan shroud for raised hand starting and starter blanking plate. Marine inlet manifold adaptor. Standard flywheel with starter ring. Pumps set to 'no overload'. Clockwise rotation
Governor set to 2600 rev/min.
Governor range 1200—2100 (outside 8% governing limit)
2100—2600 (within 8% governing limit)

Build No. 23

Marine auxiliary triple survey, Clockwise rotation. Close coupled fan shroud for raised hand starting and with blanking plate. Long running/sump heater crankcase. Standard flywheel with starter ring. Pumps set to 'no overload'.
Governor set to 2600 rev/min Class A2

Build No. 24

Marine auxiliary triple survey for 60 Hz gen. set. Close coupled fan shroud with starter blanking plate. Standard flywheel with starter ring. End cover speed adjustment.
Governor set to 1800 rev/min Class A2

Build No. 25

MEU engine, clockwise rotation, Special flywheel with starter ring and fan, cowling and fan shroud. Special camshaft end cover, cylinder head covers. Fuel filter and fuel lift pump. Dipstick in crankcase door.
Governor set to 2350 rev/min.
Governor range 1200—2100 (outside 8% governing limit)
2100—2600 (within 8% governing limit)

Build No. 26

3000 rev/min. build anticlockwise rotation, close coupling flywheel housing with starter blanking plate and lubricating oil cooler, high speed flywheel with ring gear. Fuel pump set to 'no overload'.
Governor set to 3000 rev/min.
Governor range 1200—2400 (outside 8% governing limit)
2400—3000 (within 8% governing limit)

Build No. 27

50 Hz 'Auto' Gen set build anticlockwise rotation, close coupling flywheel housing with starter blanking plate, standard flywheel with ring gear, standard fuel pump setting, 'Auto' type fuel control lever, and sprung governor link. End cover speed adjustment.
Governor set to 1500 rev/min. Class A2.

Build No. 28

Long running or sump heating. As Build 01 except for, close coupled fan shroud with starter blanking plate. Standard flywheel with starter gear ring and special crankcase.
Governor set to 1200 rev/min. Class A2.

Build No. 29

Marine build. As Build 01 except for, close coupled fan shroud for raised hand starting with starter blanking plate, standard flywheel with starter gear ring. Fuel pump set to 'no overload'.
Governor set at 2000 rev/min.
Governor range 1200—2100 (outside 8% governing limit)
2100—2600 (within 8% governing limit)

ACCESSORIES—continued

Coding		DESCRIPTION
Rotation		
Clock	Anti-Clock	
		G. GUARDS
GA	GA	Camshaft guard
GB	GB	Drive guard—charging equipment
		H. HYDRUALIC PUMP ADAPTORS
		Gear End
	HC	To suit Dowty 2P3000 pump or equivalent
	HD	To suit Dowty 1P3000 pump or equivalent
	HE	Blanking plate
		Flywheel End
HF	HF	To suit Dowty 2P3000 pump or equivalent
HG	HG	To suit Dowty 1P3000 pump or equivalent
HH	HH	Pilot bored 12.7 mm ($\frac{1}{2}$") half coupling with 36.5 mm (1 7/16") dia bore mounting plate
		J. PROTECTION DEVICES AND SOLENOIDS
JB	JB	Air temperature and oil pressure switches combined
JC	JC	Fuel control solenoid—trip type 12 volt (energised to stop)
JD	JD	Fuel control solenoid—trip type 220-240 volt 50 Hz (energised to stop)
JP	JP	Auto Lever and Link
JS	JS	12 V Synchro start fuel control solenoid (energized to run)
JT	JT	24 V Synchro start fuel control solenoid (energized to run)
		K. CONTROLS
KA	KA	Variable speed control lever and 1.8 m cable (6')
KB	KB	2-speed control
KC	KC	Variable speed control engine mounted rod operated
KE	KE	Remote stop control lever and 1.8 m cable (6')
KF	KF	Extended stop control
		L. LUBRICATION EQUIPMENT
LA	LA	Remote filter less pipes
LB	LB	Long running equipment (dry sump)
LC	LC	Extended Flexible Dipstick
		N. EXHAUST EQUIPMENT
NA	NA	Lister silencer
NB	NB	Heavy duty exhaust silencer
NC	NC	Flexible exhaust pipe
ND	ND	Spark arrestor (can only be used with NB)
NF	NF	Exhaust manifold flange 90° bend

ACCESSORIES—continued

Coding		DESCRIPTION
Rotation		
Clock	Anti-Clock	
		P. GAUGES
PA	PA	Ammeter 12 volt
PC	PC	Lub. oil pressure gauge on engine door
PD	PD	Lub. oil pressure and engine temp. gauges in dual panel
PE	PE	Hourmeter—vibration type, supplied loose
		Q. MOUNTINGS
QA	QA	Holding down bolts
		R. RECOMMENDED SPARES
RA	RA	2500 hours
RB	RB	5000 hours
RC	RC	7500 hours
RD	RD	12500 hours
		S. SUNDRIES
SA	SA	Paint finish—primer
SB	SB	Paint finish—Lister green
SC	SC	Transfers: English, French, Norwegian, Spanish, Italian, Dutch, German, Portuguese
SD	SD	Manuals: Operators Handbook, English, French, Spanish, Portuguese [German
		Parts Book—English only
SE	SE	Engine instruction plate
SF	SF	Packing—export plywood case
SG	SG	Packing—export softwood case
SH	SH	Packing—export skid base
SJ	SJ	Packing—U.K. road base
SK	SK	Tool kit
SL	SL	Paint finish— Dolphin blue

COMPATIBILITY OF ACCESSORIES TO BUILDS

[•] Indicates non-compatible

		01	02	03	04	05	06	07	08	09	20	21	22	23	24	25	26	27
DRY AIR CLEANERS STANDARD	AA																	
DRY AIR CLEANERS FOR USE WITH ENGINE MOUNTED FUEL TANK	AB																	
HEAVY DUTY CYCLOPAC AIR CLEANER, ENGINE MOUNTED	AC																	
HEAVY DUTY CYCLOPAC AIR CLEANER, LOOSE LESS BRACKETS	AD																	
ADAPTOR FOR REMOTE MOUNTED AIR CLEANER	AE																	
RUBBER AIR INTAKE ELBOW	AF																	
SHAFT EXTENSION – SHORT – FOR APPROVED APPLICATIONS ONLY	BA																	
SHAFT EXTENSION – LONG	BB																	
SHAFT EXTENSION – LONG UNMACHINED SHANK	BC																	
FLEXIBLE HALF COUPLING – 17.5 PILOT BORE	BD																	
FLEXIBLE SPLIT BOSS HALF COUPLING – 17.5 PILOT BORE	BE																	
FLEXIBLE SPLIT BOSS HALF COUPLING – 25.4 FINISH BORE	BF																	
FLEXIBLE SPLIT BOSS HALF COUPLING – 31.7 FINISH BORE	BG																	
FLEXIBLE SPLIT BOSS HALF COUPLING – 35 FINISH BORE	BH																	
FLEXIBLE SPLIT BOSS HALF COUPLING – 38.1 FINISH BORE	BJ																	
FLEXIBLE SPLIT BOSS HALF COUPLING – 32 FINISH BORE	BK																	
FLEXIBLE WHOLE COUPLING	BL																	
BOLT ON PULLEY – 254 DIA X 165 FACE	BP																	
CLUTCH	BQ	•																
3:1 REDUCTION GEAR	BR	•																
DRIVE MEMBER FOR NEWAGE GEARBOXES	BS	•																
SAE 4 ADAPTOR	CA	•																
SAE 5 ADAPTOR	CB	•																
SAE 6 ADAPTOR	CC	•																
AIR DUCT ADAPTOR – CLOCKWISE	DA							•	•	•							•	•
AIR DUCT ADAPTOR – ANTI-CLOCKWISE	DB	•	•	•	•	•	•				•	•	•	•	•			
STARTING HANDLE – LONG CLOCKWISE	EC							•	•	•							•	•
STARTING HANDLE – LONG ANTI-CLOCKWISE	ED	•	•	•	•	•	•				•	•	•	•	•			
GEARED HAND START WITH LOOSE HANDLE (SHORT) CLOCKWISE	EE	•						•	•	•							•	•
GEARED HAND START WITH LOOSE HANDLE (SHORT) ANTI-CLOCKWISE	EF	•	•	•	•	•	•				•	•	•	•	•			
12 VOLT ELECTRIC START – CHARGING EQUIPMENT & START PANEL – CLOCKWISE	EH	•						•	•	•							•	•
12 VOLT ELECTRIC START – CHARGING EQUIPMENT & START PANEL – ANTI-CLOCKWISE	EI	•	•	•	•	•	•		•		•	•	•	•	•			
12V ELECTRIC START – ANTI-CLOCKWISE (Gear End Hyd)	EM	•	•	•	•	•	•	•		•	•	•	•	•	•		•	•
12 VOLT STARTER MOTOR WITH KEY SWITCH – CLOCKWISE	EN	•						•	•	•							•	•
12 VOLT STARTER MOTOR WITH KEY SWITCH – ANTI-CLOCKWISE	EO	•	•	•	•	•	•				•	•	•	•	•			
12 VOLT ALTERNATOR AND DRIVE – CLOCKWISE	EP							•	•	•							•	•
12 VOLT ALTERNATOR AND DRIVE – ANTI-CLOCKWISE	EQ	•	•	•	•	•	•		•		•	•	•	•	•			
12 VOLT DRY CHARGED BATTERY	ER																	
BATTERY LEADS 0.9m LONG	ES																	
24 VOLT STARTER MOTOR WITH KEY SWITCH – CLOCKWISE	ET	•						•	•	•							•	•
24 VOLT STARTER MOTOR WITH KEY SWITCH – ANTI-CLOCKWISE	EU	•	•	•	•	•	•				•	•	•	•	•			
24 VOLT DRY CHARGED BATTERY	EZ	•																
SUMP HEATER AND THERMOSTAT – 240 VOLT	EX	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•
11 LITRE ENGINE MOUNTED FUEL TANK	FA				•		•											•
41 LITRE INDUSTRIAL FUEL TANK – SUPPLIED LOOSE	FB																	
31 LITRE FUEL TANK SUPPLIED LOOSE FOR WALL MOUNTING	FC																	
90 LITRE FUEL TANK SUPPLIED LOOSE FOR WALL MOUNTING	FD																	
FUEL PIPES 2.4m LONG TO SUIT FB, FC AND FD	FE																	
CAMSHAFT GUARD	GA								•									
DRIVE GUARD – ALTERNATOR	GB								•									
HYDRAULIC PUMP ADAPTOR – TO SUIT DOWTY 2P3000 PUMP – GEAR END	HC	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•
HYDRAULIC PUMP ADAPTOR – TO SUIT DOWTY 1P3000 PUMP – GEAR END	HD	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•
HYDRAULIC PUMP BLANKING PLATE – GEAR END	HE	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•
HYD. PUMP ADAPTOR – TO SUIT DOWTY 2P3000 PUMP – FLYWHEEL END	HF	•																
HYD. PUMP ADAPTOR – TO SUIT DOWTY 1P3000 PUMP – FLYWHEEL END	HG	•																
12.7 DIA PILOT BORED HALF COUPLING WITH 36.5 DIA BORE MOUNT. PLATE	HH	•																
COMBINED OIL PRESSURE AND ENGINE TEMPERATURE SWITCHES	JB																	
12 VOLT TRIP TYPE FUEL CONTROL SOLENOID ENERGISED TO STOP	JC				•		•											•
220/240V 50HZ TRIP TYPE FUEL CONTROL SOLENOID ENERGISED TO STOP	JD				•		•			•								•

COMPATIBILITY OF ACCESSORIES TO BUILDS

● Indicates non-compatible

		01	02	03	04	05	06	07	08	09	20	21	22	23	24	25	26	27
12V SYNCHRO START FUEL CONTROL SOLENOID (ENERGISED TO RUN)	JS				●													●
24V SYNCHRO START FUEL CONTROL SOLENOID (ENERGISED TO RUN)	JT				●		●											●
AUTO LEVER AND LINK	JP				●		●											●
VARIABLE SPEED CONTROL WITH OPERATING LEVER & 1.82m LONG CABLE	KA			●	●	●	●			●		●			●			●
TWO SPEED CONTROL	KB			●	●	●	●			●		●			●			●
ENGINE MOUNTED ROD OPERATED VARIABLE SPEED CONTROL	KC	●		●	●	●	●			●		●			●			●
REMOTE STOP CONTROL WITH OPERATING LEVER & 1.82m LONG CABLE	KE				●		●											●
EXTENDED STOP CONTROL	KF				●		●											●
REMOTE OIL FILTER – LESS PIPES	LA										●	●					●	
LONG RUNNING EQUIPMENT WITH 45 LITRE LUB. OIL TANK	LB	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
EXTENDED FLEXIBLE DIPSTICK	LC																	
LISTER SILENCER	NA																	
HEAVY DUTY EXHAUST SILENCER	NB																	
FLEXIBLE EXHAUST PIPE	NC																	
SPARK ARRESTOR (CAN ONLY BE USED WITH NB)	ND																	
EXHAUST MANIFOLD FLANGE ADAPTOR – 90° BEND	NF																	
AMMETER – 12 VOLT	PA																	
LUB. OIL PRESSURE GAUGE ON FUEL PUMP HOUSING DOOR	PC																	
LUB. OIL PRESSURE GAUGE AND ENGINE TEMPERATURE GAUGE IN PANEL	PD																	
VIBRATION TYPE HOURMETER	PE																	
HOLDING DOWN BOLTS	QA																	
RECOMMENDED SPARES 2500 HOURS	RA																	
RECOMMENDED SPARES 5000 HOURS	RB																	
RECOMMENDED SPARES 7500 HOURS	RC																	
RECOMMENDED SPARES 12500 HOURS	RD																	
PAINT FINISH – PRIMER	SA																	
PAINT FINISH – LISTER GREEN	SB																	
TRANSFERS	SC																	
MANUALS	SD																	
ENGINE INSTRUCTION PLATE	SE																	
PACKING – EXPORT PLYWOOD CASE	SF																	
PACKING – EXPORT SOFTWOOD CASE	SG																	
PACKING – EXPORT SKID BASE	SH																	
PACKING – HOME ROAD BASE	SJ																	
TOOL KIT	SK																	
PAINT FINISH – DOLPHIN BLUE	SI																	

IMPORTANT

The information in these Appendices was correct at the time of going to print. The builds and accessories for these engines are constantly under review and R.A. Lister therefore reserve the right to amend any of this information without prior notice. The latest information on the availability and price of all builds and accessories can be obtained from your nearest Lister Diesels Distributor.

ACCESSORIES—Marine

CODE	DESCRIPTION
	MA AIR CLEANERS
MAA	Air Cleaner—(paper)
MAB	—(gauze)
	MB & MC FLYWHEEL END AND AUXILIARY DRIVES
MBH	Tailshaft Coupling—Solid—Pilot Bored
MBJ	Jabsco Bilge Pump—with Clutch and Drive
MBK	—Piping
MBL	Drive Pulley
MBM	Jabsco Pump and Drive—Water Injected Exhaust
MBO	Forward End Drive FD. 107
MCB	Gearbox—Hurth HBW 100—2L 2:1 Reduction
MCC	—Hurth HBW 220—3L 3:1 Reduction
	ME STARTING AND BATTERY CHARGING EQUIPMENT
MEA	Starting Handle—Short Grip
MEB	—Long Grip
MEC	Driving Pulley
MEE	Raised Hand Start including Driving Pulley
MEN	Starter Motor—12V
MEW	Battery—12V
MEY	Battery Leads—0.9m (3') long
	MF FUEL SUPPLY EQUIPMENT
MFB	Fuel Tank—45 litre/10 gall.
MFJ	Fuel Pipe—2.4 m (8')—with Lift Pump
MFK	—without Lift Pump
MFL	Fuel Connections—Flexible—with Lift Pump
MFM	—without Lift Pump
MFN	Duplex Fuel Filter
MFP	Fuel Connections—Flexible—with Duplex and Fuel Lift Pump
MFQ	—with Duplex without Fuel Lift Pump
	MG GUARDS
MGA	Camshaft Guard
MGB	—With R.H.S.
MGG	Drive Guard—Charging Equipment

ACCESSORIES—Marine

CODE	DESCRIPTION
	MJ PROTECTION DEVICES AND SOLENOIDS
MJH	Magnetic Perception Head
	MK CONTROLS
MKA	Variable Speed Control—Rod Operated
MKB	—Cable Operated
MKC	Single Lever Speed and Gearbox Control
MKD	Morse Control Cable—2.13m (7')
MKE	—3.05m (10')
MKF	—3.96m (13')
MKG	Remote Stop-Cable Operated 1.82m (6')
MKH	Control Lever and Stopping Link only
	ML LUBRICATION EQUIPMENT
MLA	Blanking Plate—Oil Filter
MLB	Sump Drain Pump
MLC	Flexible Dipstick
	MN EXHAUST EQUIPMENT
MNA	Exhaust Silencer—Dry
MNB	Exhaust Pipe—Flexible
MNC	Exhaust Skin Fitting
MND	Spark Arrester Silencer
	MP GAUGES
MPA	ET and OP Gauges in Panel—1.82m (6') connections
MPE	OP Gauge
	MQ MOUNTINGS
MQA	High Level Bearers—Solid—LM100/LM150
MQC	Tico Pads—Solid Mounting
MQD	Heavy Listatex Mountings
MQE	High Level Bearers—Hurth—Solid

ACCESSORIES—Marine

CODE	DESCRIPTION
	MS SUNDRIES
MSA	Marine Paint Finish
MSB	Primer Finish
MSC	Operator's Hand book and Parts List—Auxiliary
MSD	—Propulsion
MSE	Transfers—Various Languages
MSF	Workshop Manual
MSG	Lister Bronze Plaque
MSH	Lifeboat Engine Instruction Card
MSI	Special Cylinder Head Cover
MSJ	Toolkit
MSK	Packing Case—Plywood
MSL	—Softwood
MSM	Road Base—Home
MSN	—Export
MSP	Sterngear Case
MSR	Treated Packing Case
MSQ	Propeller Case
	MT STERNGEAR
MTA	Sterngear—1¼" dia. MGR3 (4' 6" long)
MTB	—1¼" dia. MGR3 (6' 0" long)
MTC	Sterngear Fittings—1", 1¼"
MTN	Sterngear—1" dia. MGR2 (4' 6" long)
MTP	—1" dia. MGR2 (6' 0" long)

ACCESSORIES—Marine

CODE	DESCRIPTION
	MA AIR CLEANERS
MAA	Air Cleaner—Paper
MAB	—Gauze
MAC	—For use with Engine Mounted Fuel Tank (ST3 only)
	MB & MC FLYWHEEL END AND AUXILIARY DRIVES
MBA	Gearbox—Hurth HBW 10—2L 2:1 Reduction
MBD	—Hurth HBW—220—3L 3:1 Reduction (ST3 only)
MBH	Tailshaft Coupling—Pilot Bored Solid
MBJ	Jabsco Bilge Pump—with Clutch and Drive
MBK	—Piping
MBL	Drive Pulley
MBM	Jabsco Pump and Drive—Water Injected Exhaust
MBN	Water Injected Exhaust Piping
MBO	Forward End Drive—
MBP	—with clutch
MCA	Gearbox—Hurth HBW 100— 2:1 Reduction (ST2)
MCB	Gearbox—Hurth HBW 220—2L 2:1 Reduction (ST2)
MCC	—Hurth HBW 220—3L 3:1 Reduction (ST2 only)
	ME STARTING AND BATTERY CHARGING EQUIPMENT
MEA	Starting Handle—Short (ST2 only)
MEB	—Long
MEC	Driving Pulley—Alternator
MEE	Raised Hand Starting—With Alternator Pulley
MEG	12V Electric Start 17 ACR MT
MEH	12V AC5
MEJ	24V AC5
MEK	Start Panel—12V 17 ACR
MEN	Starter Motor—12V
MEP	Starter Motor—24V
MES	Bosch Starter Motor Fittings
MET	Bosch Hydrostart
MEU	Delco-Remy Starter Motor—Parts for fitting only
MEW	Battery—12V
MEX	—24V
MEY	Battery Leads—0.91m (3')

CODE	DESCRIPTION
	MF FUEL SUPPLY EQUIPMENT
MFB	Fuel Tank—45 litre/10 gall.
MFJ	Fuel Pipe—2.4 m (8')—with lift pump
MFK	—without lift pump
MFL	Fuel Connections—Flexible—with lift pump
MFM	—without lift pump
MFN	Duplex Fuel Filter*
MFP	Fuel Connection—Flexible—with Duplex and lift pump
MFQ	—with Duplex without lift pump
	MG GUARDS
MGA	Camshaft Guard
MGB	—With R.H.S.
MGC	Alternator Drive Guard—with R.H.S.
MGD	—without R.H.S.
	MJ PROTECTION DEVICES AND SOLENOIDS
MJH	Magnetic Perception Head
	MK CONTROLS
MKA	Variable Speed Control—Rod Operated
MKB	—Cable Operated
MKC	Single Lever Speed and Gearbox Control
MKD	Morse Control Cable—2.13m (7')
MKE	—3.05m (10')
MKF	—3.96m (13')
MKG	Cable Operated Remote Stop—1.82m (6')
MKH	Control Lever and Stopping Link only
	ML LUBRICATION EQUIPMENT
MLA	Blanking Plate—Oil Filter
MLB	Sump Drain Pump
	MN EXHAUST EQUIPMENT
MNA	Exhaust Silencer—Dry
MNB	Exhaust Pipe—Flexible
MNC	Exhaust Skin Fitting
MND	Spark Arrestor Silencer
MNE	Water Injection Bend
MNF	Wet Exhaust Kit

ACCESSORIES—Marine

CODE	DESCRIPTION
	MP GAUGES
MPA	ET and OP Gauges in Panel
MPB	Ammeter—12V
MPC	—24V
MPD	OP and ET Gauge in Panel
	MQ MOUNTINGS
MQA	High Level Bearers LM 100/LH 150—Solid (Loose Bushes)
MQB	—Flexible (Loose Mountings)
MQC	Tico Pads—Solid Mountings
MQD	Heavy Listatex Mountings
MQE	High Level Bearers—Hurth Gearbox—Solid (Loose Bushes)
MQF	—Flexible (Loose Mountings)
	MR RECOMMENDED ON BOARD SPARES
MRA	D.O.T. Spares List
MRB	2500 Hrs Unrestricted Service Spares List
MRC	5000 Hrs Unrestricted Service Spares List
MRD	Restricted Service Spares
	MS SUNDRIES
MSA	Marine Paint Finish
MSB	Primer Paint Finish
MSC	Operators Parts List and Hand Book—Auxiliary
MSD	—Propulsion
MSE	Transfers—State Language
MSF	Workshop Manual
MSG	Lister Bronze Plaque
MSH	Lifeboat Engine Instruction
MSI	Special Cylinder Head Covers
MSJ	Toolkit
MSK	Packing Case—Plywood
MSL	—Softwood
MSM	Road Base—Home
MSN	—Export
MSP	Sterngear Case
MSQ	Propeller Case
	MT STERNGEAR
MTA	Sterngear—$1\frac{1}{4}$" dia. MGR2 (4' 6" long)
MTB	—$1\frac{1}{4}$" dia. MGR2 (6' 0" long) (ST2 only)
MTC	Sterngear Fittings—$1\frac{1}{4}$"
MTD	Sterngear—$1\frac{1}{2}$" dia. MGR3 (4' 6" long) (MGR2 on ST3)
MTE	—$1\frac{1}{2}$" dia. MGR3 (6' 0" long)
MTF	—$1\frac{3}{4}$" dia. MGR3 (4' 6" long) (ST3 only)
MTG	—$1\frac{3}{4}$" dia. MGR3 (6' 0" long)
MTH	Sterngear Fittings—$1\frac{1}{2}$", $1\frac{3}{4}$"
MTJ	Standard Propeller—MGR2
MTK	—MGR3
MTL	Weedless Propeller—MGR2 LM100/LH150
MTM	Standard Propeller—MGR2 Pilot Bored

Appendix 1
STW BUILDS AND ACCESSORIES
(Clockwise Rotation)

Governor ranges—see Page 45

BUILDS

Build No. 01

Basic engine general purpose for pumps or propulsion unit. Hand start, Flywheel with starter ring, close coupled fan shroud with starter blanking plate, fuel lift pump but no lub. oil filter. Fuel pumps set to 'No overload.' Variable speed at 2300 rev/min Class 'B'.

Build No. 02

50 Hz gen. set. As Build 01 but includes oil filter. Standard fuel pump setting, 1500 rev/min Class A2.

Build No. 03

60 Hz gen. set. As Build 02 but governor set at 1800 rev/min Class A2.

Build No. 04

Lloyds survey, otherwise as Build 01.

Build No. 05

50 Hz gen. set. Lloyds survey, otherwise as Build 02 (STW2 has heavy flywheel)

Build No. 06

60 Hz gen. set. Lloyds survey, otherwise as Build 03 (STW2 has heavy flywheel).

ACCESSORIES—Marine

	DESCRIPTION
	MB & MC FLYWHEEL END AND AUXILIARY DRIVES
MBA	Gearbox—Hurth HBW 10—2:1 Reduction (for STW2)
MBD	—Hurth HBW220—3L 3:1 Reduction (for STW3)
MBH	Tailshaft Coupling—Pilot Bored Solid
MBJ	Jabsco Bilge Pump—with Clutch and Drive
MBK	—Piping
MBL	Drive Pulley
MBO	Forward End Drive—FD107
MBP	—FD109
MBQ	Shaft Extension—Short
MBR	—Long
MBS	—Long Unmachined Shank
MBT	Flexible Half Coupling—11/16" (17.5mm) Pilot Bore
MBU	Split Boss Half Coupling—11/16" (17.5mm) Pilot Bore
MBV	—1" (25.4mm) Finish Bore
MBW	—1 ¼" (31.7mm) Finish Bore
MBX	—1 3/8" (35mm) Finish Bore
MBY	—1 ½" (38.1mm) Finish Bore
MBZ	—32mm Finish Bore
MCA	Gearbox—HBW100—2L 2:1 Reduction
MCB	—HBW220—2L 2:1 Reduction (for STW3)
MCC	—HBW 220—3L 3:1 Reduction (for STW2)
MCE	Flexible Whole Coupling
	MD COOLING
MDA	Water Inlet Kit
MDB	Water Discharge Kit
MDC	Header Tank for Keel Cooling
	ME STARTING AND BATTERY CHARGING EQUIPMENT
MEA	Starting Handle—Short (STW2 only)
MEB	—Long
MEC	Driving Pulley — Alternator
MEE	Raised Hand Starting—With Alternator Pulley
MEG	12V Elect Start—17 ACR MT
MEH	Alternator—12 V AC5
MEJ	—24V AC5
MEK	—Start Panel 12V 17 ACR MT
MEL	Extra High R.H.S.
MEM	As above with Alternator Pulley
MEN	Starter Motor—12V
MEP	—24V
MES	Bosch Starter Motor Fittings
MET	Bosch Hydrostart
MEU	Delco—Remy Starter Motor—Parts for fitting only
MEW	Battery—12V
MEX	—24V
MEY	Battery Leads—0.91m (3')

ACCESSORIES—Marine

CODE	DESCRIPTION
	MF FUEL SUPPLY EQUIPMENT
MFB	Fuel Tank—45 litre/10 gall
MFJ	Fuel Pipes—2.4 m (8')
MFL	—Flexible
MFN	Duplex Fuel Filter
MFP	Flexible Fuel Connections—Engines with Duplex
	MG GUARDS
MGA	Camshaft Guard
MGB	—With R.H.S.
MGC	Alternator Drive Guard—with R.H.S.—AC5) STW3 only
MGD	—without R.H.S.—AC5) STW3 only
MGH	—with R.H.S.—17 ACR MT
MGI	—without R.H.S.—17 ACR MT
	MJ PROTECTION DEVICES AND SOLENOIDS
MJA	OP and ET Switches—Single Stage
MJH	Magnetic Perception Head
	MK CONTROLS
MKA	Variable Speed Control—Rod Operated
MKB	—Cable Operated
MKC	Single Lever Speed and Gearbox Control
MKD	Morse Control Cable—2.13m (7 ft.)
MKE	—3.05m (10 ft.)
MKF	—3.96m (13 ft.)
MKG	Cable Operated Remote Stop—1.82m (6 ft.)
MKH	Control Lever and Stopping Link only
	ML LUBRICATION EQUIPMENT
MLB	Sump Drain Pump
MLD	Oil Filter
	MN EXHAUST EQUPIMENT
MNA	Exhaust Silencer—Dry
MNB	Exhaust Pipe—Flexible
MNC	Exhaust Skin Fitting
MND	Spark Arrestor Silencer
MNE	Water Injection Bend
MNF	Wet Exhaust Kit
	MP GAUGES
MPA	ET and OP Gauges in Panel
MPD	ET and OP Gauges in Panel

ACCESSORIES—Marine

CODE	DESCRIPTION
	MQ MOUNTINGS
MQC	Tico Pads—Solid Mountings
MQE	High Level Bearers—Hurth Gearbox—Solid (Loose Bushes)
MQF	—Flexible (Loose Mountings)
	MS SUNDRIES
MSA	Marine Paint Finish
MSB	Primer Paint Finish
MSC	Operators Parts List and Hand Book (Aux)
MSD	Operators Parts List and Hand Book (Prop)
MSE	Transfers—State Language
MSF	Workshop Manual
MSG	Lister Bronze Plaque
MSH	Lifeboat Engine Instruction
MSI	Special Cylinder Head Covers
MSJ	Toolkit
MSK	Packing Case—Plywood
MSL	—Softwood
MSM	Road Base—Home
MSN	—Export
MSP	Sterngear Case
MSQ	Propeller Case
MSR	Treated Packing Case
MSS	Cold Starting Oil Cups
MST	Decompressor—Push Lever
	MT STERNGEAR
MTA	Sterngear—$1\frac{1}{4}$" dia. MGR2 (4' 6" long)
MTB	—$1\frac{1}{4}$" dia. MGR2 (6' 0" long) (STW 2 only)
MTC	Sterngear Fittings—$1\frac{1}{4}$"
MTD	Sterngear—$1\frac{1}{2}$" dia. MGR3 (4'6" long)
MTE	—$1\frac{1}{2}$" dia. MGR3 (6'0" long) (MGR2 on STW3)
MTF	—$1\frac{3}{4}$" dia. MGR3 (4' 6" long)
MTG	—$1\frac{3}{4}$" dia. MGR3 (6' 0" long) (STW 3 only)
MTH	Sterngear Fittings—$1\frac{1}{2}$", $1\frac{3}{4}$"

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