Instruction Manual for

SOUTHERN CROSS

3½ h.p. DIESEL ENGINE
MARK EF-D

MANUFACTURED IN AUSTRALIA

BY

TOOWOOMBA FOUNDRY PTY. LTD.

AND MARKETED BY

SOUTHERN CROSS MACHINERY COMPANIES

★ **Read through this Instruction Manual carefully before Installing or Operating your Engine.**

★ **Hang this Instruction Manual in the Engine Room for Future Reference.**

Foreword . . .

Remember that this Engine has been carefully built, and has been run under exacting tests before it left the Works. All adjustments are correct and should not be altered.

A new Engine requires more careful attention during the first few days than after the parts have become thoroughly worked in.

It will take a few days for the various working parts to get into nice working condition. Consequently any Engine that has been properly and carefully treated at first will run more smoothly, and generally give more satisfactory results over a longer period than one which has been overloaded at first.

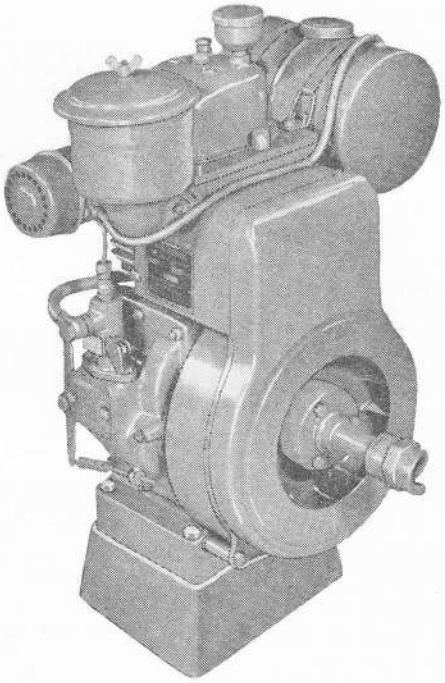
★ **This Instruction Manual has been prepared to assist in the Installation, Operation, and Maintenance of the Engine, and should be read carefully before proceeding with the Installation.**

Installation — Operation

and

Maintenance Instructions

for



SOUTHERN CROSS

3½ H.P. DIESEL ENGINE
MARK EF-D

1457A|1250
9|64 McD&R.

INSTALLATION

The Foundation

The engine should be set up on a firm foundation. The recommended foundation is a block of concrete as shown in the illustration, "General Arrangement of 3½ h.p. Diesel Engine, Mark EF-D", on page 3. The four foundation bolts supplied with the engine should be set in the concrete block when it is made.

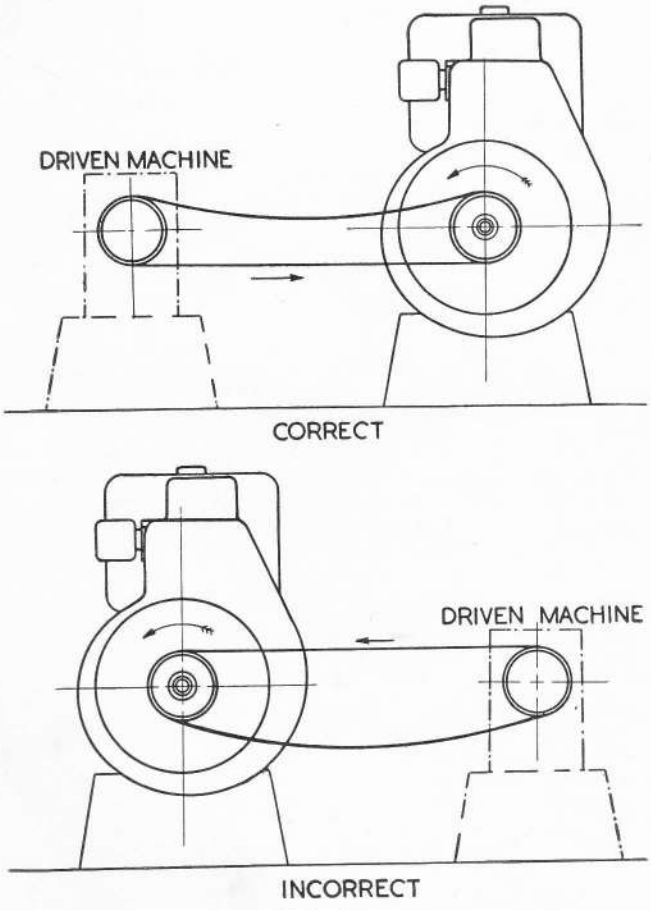
The illustration on page 3 also shows the overall sizes of the engine and the positions of the foundation bolts.

Engine Drive

Engines are supplied for the following types of drives:—

(a) Belt driving from drive end of Crankshaft (either flat or V-Belt Pulley).
(b) Belt driving from extension shaft at flywheel end (V-Belt Pulley).
(c) Direct coupling to driven machine by means of a flexible coupling.
(d) Belt driving from 2 : 1 reduction box mounted on engine (either flat or V-Belt Pulley). **Pulley runs in reverse direction of rotation to engine crankshaft.**
(e) Direct coupling by means of a flexible coupling from 2 : 1 reduction box mounted on engine.

Flexible coupling runs in reverse direction of rotation to engine crankshaft.



Belt Drives

Where a belt drive is being used, the engine will give you the best service if you arrange the drive as follows:—

The engine should be placed so it will drive with the tight side of the belt on the bottom side and the slack side on top of the pulleys. See illustration, "Belt Drives", below.

The reason for this is to allow the slack side of the belt to wrap around the pulleys due to the sag of the belt, and obtain a more efficient drive by greater belt contact.

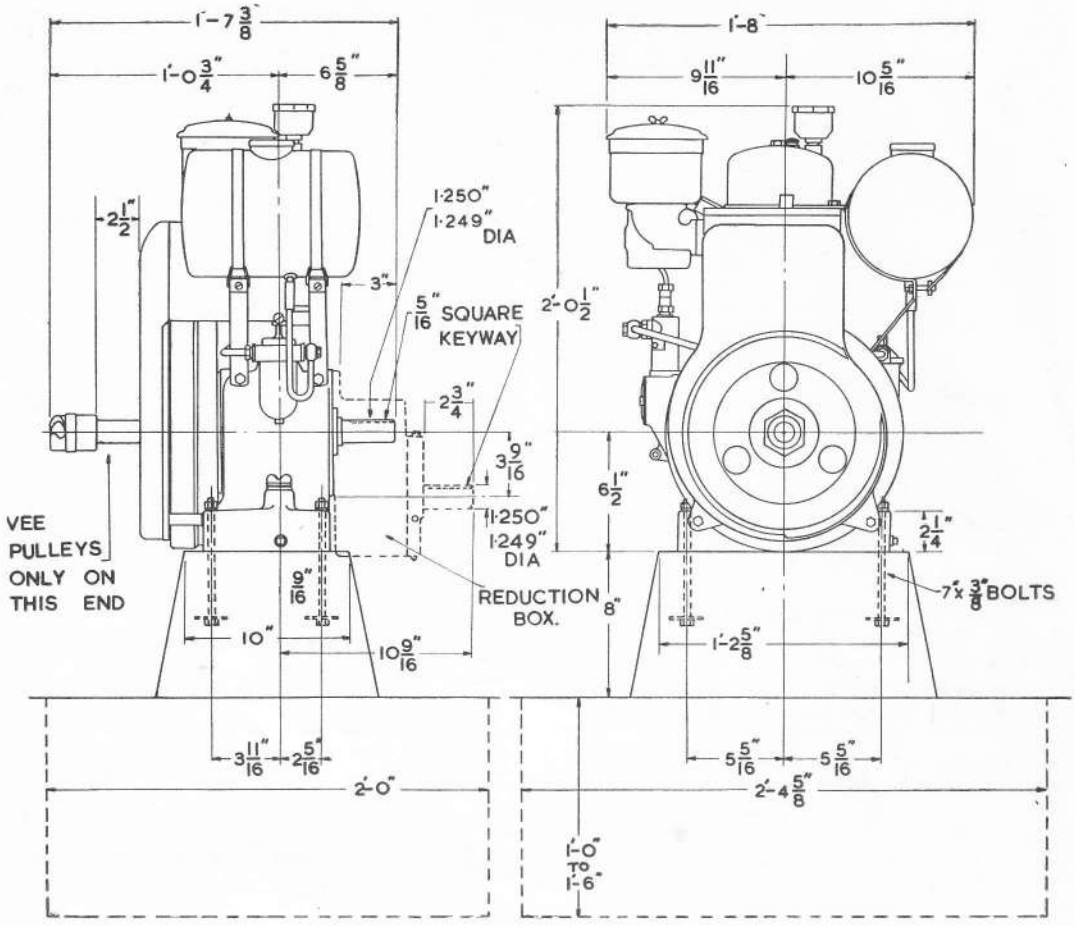
WITH FLAT BELT DRIVES ON TO FAST AND LOOSE PULLEYS, THE BELT, WHEN DRIVING, SHOULD BE NEAREST THE ENGINE.

Also by use of fast and loose pulleys, or a clutch, or a water by-pass in the case of pumps, or similar arrangement, arrange for the engine to be started free of load. This will assist starting and enable the engine to attain its correct working speed quickly.

To Make a Concrete Base

The following instructions are for a concrete base which is suitable for any of the five types of drives set out in section "Engine Drive", opposite.

1. Construct a suitable wooden mould. The recommended sizes for the concrete base are shown on Page 3.
2. Nail two pieces of timber across the top of the mould and then mark on them the positions for the foundation bolts. The engine sits centrally on the block. **Check the distance between the centres of the bolts diagonally from corner to corner. If the marking out is correct, the centres should be 12 13/64 inches apart (i.e., 12 3/16in. plus 1/64in.).**
3. Drill ⅝ inch holes at the positions marked. Put the large washers on the foundation bolts and hang them from these drilled holes. **The nuts have to be screwed on so the tops of the bolts will be 2⅝ inches above the top of the concrete block.** It probably will be necessary to fit small wooden blocks under the nuts to act as distance pieces.
4. Nail two pieces of timber along the ends of the mould to support it over the foundation hole.
5. After deciding on the position for the engine, sink a hole 12 inches to 18 inches deep in the ground and about 6 inches larger all round than the mould. The depth of the hole depends on the type of soil—light soil requiring a deeper hole than hard, well-packed soil. However, always make the block larger for preference.
6. Set the mould in position over the hole and check its position in relation to the machinery it is to drive.
7. **Make sure that the engine will be level by trying a spirit level across the top of the mould both ways.** If the mould is not level on the top, pack under the edge until it is.
   Arrange some steel bars in the bottom of the hole to act as reinforcement.
8. Mix up a batch of concrete, using 4 parts of stone or rubble, 2 parts of sand, and one part of cement. Fill the hole to ground level, and then stand a few more bars in the concrete so they project into the mould. These will act as reinforcement for the section of the block above ground level.



General Arrangement of 3½ H.P. Diesel Engine, Mark EF-D.

When filling the mould, ram it well, being careful not to disturb it, and making sure that the mixture is well packed under the timber crosspieces. Fill to the top of the mould.

When the mould is full, smooth off the top with a mixture of two parts sand and one part cement. Allow the concrete to stand for **at least 24 hours** before removing the mould. Then dampen the block and smooth off the sides with a mixture of two parts sand and one part cement.

9. Lift the engine on to the block and fit a nut and spring washer on each foundation bolt, but don't tighten the nuts too tightly until the concrete has set properly. If the engine does not sit flat on the block, put thin flat washers in the space before tightening the nuts.

IT IS IMPORTANT THAT THE BLOCK BE ALLOWED TO SET FOR AT LEAST THREE DAYS BEFORE STARTING THE ENGINE.

Fitting Extension Shaft

Take the extension shaft supplied and fit it to the flywheel, after seeing that the mating faces are clean. Fit spring washers under the heads of the 3 — 2in. x ⅜in. — 24 U.N.F. setscrews and bolt up tightly.

Fit starting handle clutch spacing collar on to extension shaft and screw on the starting handle clutch and check for position in relation to the compression, with the starting handle. By varying the thickness of washers behind the starting clutch, adjust starting handle position so compression is met on the pull up.

Belt Drive from Crankshaft Pulley

The pulley is supplied in a separate package from the engine. Fit the key in position and slide the pulley on. Tighten the pulley locking screw securely.

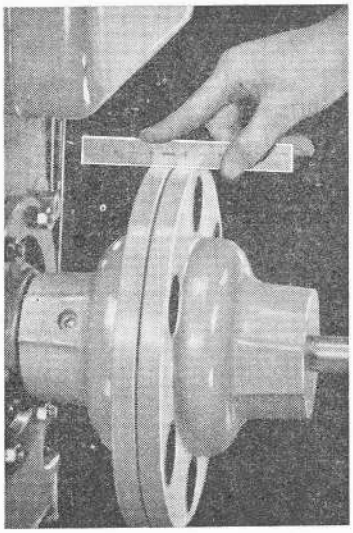
Belt Drive from Extension Shaft at Flywheel End

Fit the key in position in the extension shaft and slide the Pulley on. Tighten the pulley locking screw securely. Screw on the starting handle clutch and proceed as in section "Fitting Extension Shaft".

Flexible Coupling Drive from Crankshaft

Where a flexible coupling drive is being used, it is most important that the coupling be very accurately lined up as its life depends entirely upon the accuracy of the alignment. The more accurate the alignment, the longer the life of the coupling will be; but if it is not in line, the coupling rubbers will wear out very quickly, and may also cause damage to the engine or driven machine.

1. While the engine block is being made, a suitable block for the driven machine should be made.
2. Clean the bore of the driving half of the flexible coupling, and shaft and keyway.



Lining up Flexible Coupling

3. Fit the key in place and slide on the driving half of the coupling until the face of the coupling half is about 1/16 inch out from the end of the shaft. Tighten the locking screws.
   NOTE: Two locking screws are fitted in each coupling half, one on top of the other.
   Make sure that the bottom locking screw is tightened firmly in place before fitting and tightening the top locking screw.
4. Fit the driven half of the coupling to the driven machine. Lift the machine on to the block.
5. With wooden wedges, adjust driven machine until it is approximately level, and at the same time see that it is in line with the engine.
6. The two halves of the Coupling are the same diameter. Using a metal straight edge across the coupling halves, check if the diameters coincide on top, underneath, and on either side. Shift the driven machine and recheck with the straight edge at these four points until correct.
7. Then, using a set of feeler gauges, check the gap between the Coupling halves at the top, underneath, and on either side. Shift the driven machine until the gap is the same all round the coupling, and, at the same time, check that the diameters coincide, using the straight edge as in (6) above. The driven machine must be adjusted until the maximum misalignment on the outside of the coupling is less than .005 inch and the maximum variation in the gap between the coupling halves is less than .010 inch.
8. When the alignment is correct, proceed to grout in the bolts of the driven machine with a mixture of two parts of clean sand and one of cement. When the holes are full, work the grouting under the machine base so that it will sit on a firm, level foundation. This must be very carefully done to prevent the machine from getting out of alignment.
9. Next day, remove the wedges, tighten the foundation bolts, check the alignment, and, with the same grouting mixture, clean up and surface the block.
10. Next day, shift the driven half of the coupling along the shaft to leave about 1/32 inch gap between the halves, and lock it in this position. Fit the rubbers and pins to the coupling, fit locking nuts with spring washers under them, and tighten.
11. The engine can now be started, but not before, as it is essential that the block be allowed to set for at least three days before the engine is started.

Fitting 2:1 Reduction Box—Mark KF-J

1. Take the Pinion supplied with the Reduction Box and slide it on until it is hard up against the Shoulder on the Crankshaft. **The Pinion Locking Screw must be nearest the end of the Crankshaft,** and it is important to see that the Pinion is not put on the wrong way. Slide the key into place and tighten the locking screw with the spanner supplied.
2. Fit the studs supplied with the reduction box into the Crankcase. Use two nuts locked together to screw in the studs.
3. Clean the paint from the spigot on the crankcase. Fit the gearbox gasket on to the studs and then put the box in position, fitting spring washers under the nuts. The reduction box may be mounted in any of six different positions by altering it on the studs, but it is preferable to keep the drive shaft level with, or below, the Crankshaft level.
4. Undo the nuts around the drive shaft bearing housing, and remove the housing, drive shaft, and bearings. With these parts removed, the nuts can be fitted to the two studs which pass through the back of the box.
5. When replacing the housing, position it so the filling plug is at the 12 o'clock position, and the oil level plug is at the 8 o'clock position.
6. Remove the oil level plug and the filling plug and pour Southern Cross Drive Gear Oil—E.P. S.A.E. 90—into the box until it runs from the oil level hole. Replace both plugs.

Drives from Reduction Drive Box

1. **Belt Drive.**
   For a belt drive, make sure the key is in position in the drive shaft, then slide on the pulley and tighten the locking screw.
   Fit the starting handle clutch spacing collar on to the drive shaft, and screw on the starting handle clutch. Check for position in relation to compression with the starting handle. By varying the thickness of washers behind the starting handle clutch, adjust the starting handle position, so compression is met on the pull up.
2. **Flexible Coupling Drive.**
   For a Flexible Coupling Drive, fit the parallel key in the keyway in the crankshaft and slide on the driving half of the coupling until the face of the coupling half is about 1/16 inch out from the end of the shaft. Tighten the locking screws.
   The remainder of the installation of the flexible coupling and the lining up are done in a similar manner to that described in section "Flexible Coupling Drive from Crankshaft", on Page 3.

Exhaust System

1. If an exhaust pipe is fitted, always turn the end of the pipe downwards, so that any moisture which may collect in the pipe will run away from the engine.
2. If a long exhaust pipe is fitted, over 12 feet, use 1½ inch pipe and keep it as free from bends as possible.

Lubricating System

Unscrew the oil filler plug and fill crankcase to the bottom thread in the filler hole with Southern Cross Engine Oil—Series 3—D.S. Service (S.A.E. 20). The sump capacity is 4½ pints.

Fitting Oil Bath Air Cleaner

The Oil Bath Air Cleaner Assembly is to be fitted to the engine before starting. To do this, fit the Oil Bath Air Cleaner Adaptor to the studs in the Cylinder Head, and tighten the nuts. Unscrew the Wing Nut and remove the Cover. Fill Oil Bath up to the oil level mark with clean engine oil and refit the element and cover.

Fuel System

Fill the fuel tank with fuel which is clean and free from water. (See page 7 for "Fuel Recommendations".) If in doubt about cleanliness of fuel, strain it through a fine gauze strainer before filling into tank.

18 Gallon Fuel Tank (Supplied as an Extra)

1. Disconnect the fuel tank to filter tube and injector overflow tube and remove, taking care not to lose the washers from either side of the banjos.
2. Remove fuel tank and fuel tank brackets from the engine.
3. Remove banjo and collar from the injector overflow tube by holding them in boiling water for about ½ minute and then withdrawing and removing them. The banjo and collar are to be fitted to the end of the longer injector overflow tube, supplied with the engine. Cut this tube to the correct length, and fit the double banjo and collar supplied with the tank to the other end. To do this, slide the collar back about 6 inches along the tube and then immerse about 1 inch of the tube in boiling water for about ½ minute. Quickly withdraw the tube, slide the collar to about ¼ inch from the end, and push the tube on to the banjo.
4. Using the brackets provided, mount the 18 gallon fuel tank on a convenient wall with the bottom of the tank at least 12 inches above the level of the pump inlet.
5. Fit the fibre washer provided on the adaptor fitting and screw it into the bottom of the tank.
6. Fit the fibre washer provided to the fuel stop cock and screw it into the adaptor.
7. Cut the fuel tank to filter tube to length and fit it to the double banjo on the injector overflow tube, and the fuel stop cock, using the same procedure as above. Connect the banjo fittings to the filter and injector, fitting fibre washers on either side of each banjo.
8. Fill the fuel tank with **distillate fuel,** which is clean and free from water (see Page 7 for fuel recommendations). Never fill the tank without pouring the fuel through the strainer provided in the top of the tank.

THE INSTALLATION OF THE ENGINE IS NOW COMPLETE.

RUNNING INSTRUCTIONS

Preparing the Engine For Running

To start the engine for the first time, or after an overhaul, or any operation during which the lubricating oil has been drained from the sump, or after the fuel tank has been allowed to run dry, the following instructions must be carried out in the order given, otherwise the engine may not start, or, if it does, it may be damaged.

Check the following (see Pages 4 and 5):—

1. Fuel in fuel tank.
2. Oil level in Engine Sump.
3. Oil in Oil Bath Air Cleaner.

Retarding Injection Timing

(Export Engines Only)

Diesel fuels obtainable outside Australia vary considerably. To assist in starting the engine the injection timing may be retarded up to 5° from the factory setting. Degree markings on the flywheel alongside the "Pump" mark are provided to assist in this adjustment.

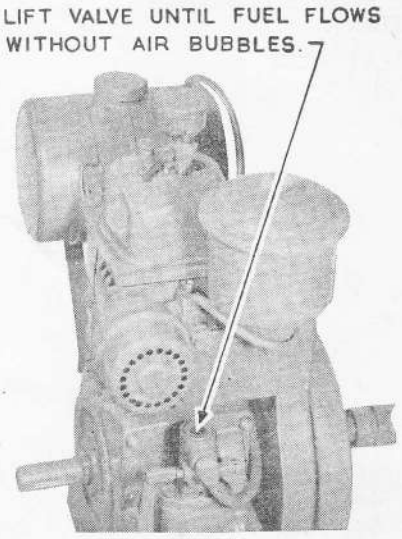
At the factory, the injection timing is set so that the fuel ceases to flow when the "pump" mark on the flywheel is opposite the mark on the fuel pump mounting plate. (See illustration, "Checking Fuel Pump Timing", on Page Twelve.)

To retard the injection timing, adjust the fuel pump rocker adjusting screw. Read Section (5), "Check Fuel Pump Timing", on Page Twelve. Under no circumstances is the fuel pump timing to be retarded beyond the 5° marking.

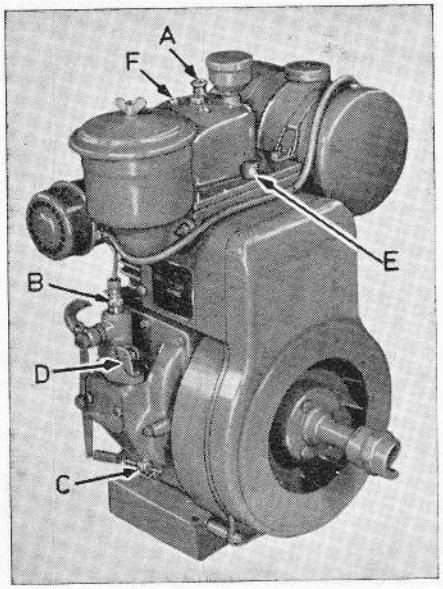
Priming Fuel System

IMPORTANT—If you don't follow these instructions the engine won't start, as the fuel system must be absolutely full of fuel and free from air.

1. Shift fuel stop cock to "on" position by gripping the knurled sleeve and sliding it downwards as far as it will go.
2. Disconnect high pressure tube from pump and then remove delivery valve connection ("B" on illustration) and lift the delivery valve off its seat. Replace valve and connection as soon as fuel flows without air bubbles, and be sure the spring is in position.
   If the fuel does not flow after the valve has been removed, rotate the engine about one turn.
3. See that the control rod stop on the fuel pump control rod is in the running position as shown at "D" on illustration (page 6).
4. Rotate engine until fuel is pumped from the top of the fuel pump. Then fit the high pressure pipe and tighten nut at the fuel pump end. Leave the other end of the pipe undone.
5. Rotate the engine until the fuel is pumped from the end of the pipe without air bubbles. Then tighten nut.
   It is important to see that no air is imprisoned in the fuel line, as it will prevent the engine from starting.
6. Crank the engine, and, if the fuel is being injected properly, a decided vibration can be heard and felt on the high pressure pipe, but if air is still in the fuel pipe, the fuel will not be injected, and it will be necessary to further bleed the system.
   The engine is now ready to start.



Priming Fuel System

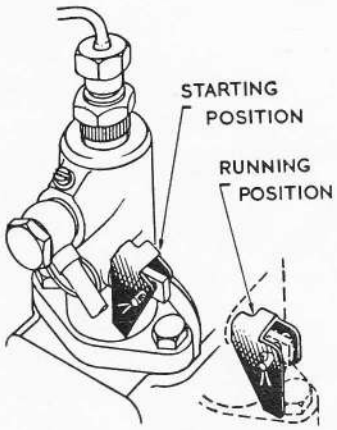


3½ H.P. Diesel Engine, Mark EF-D.

To Start Engine

Check that, when cranking, the compression is met on the pull-up. If not, adjust the position of the starting handle clutch by the method described in the installation instructions, "Fitting Extension Shaft", on page 3.

1. Oil Valve Rockers.
2. Check Engine Nuts. (Read Section 9, Page 8.)
3. **Set belt, clutch, etc., so that engine can be started up without its load.**
4. Set fuel pump control rod so that fuel will not be injected.
5. Diesel engines rely on the heat generated by compression of the air charge for ignition. The faster the engine is cranked, the more readily it will start. Practise swinging engine over compression so that the knack of maintaining speed at the point of maximum compression can be acquired.
6. See that the fuel cock is "on". The knurled sleeve should be pushed down as far as it will go.
7. Shift the control rod stop to the "STARTING POSITION", as shown in the illustration below. When the engine has been started, and reaches running speed, the control rod stop will drop back to the "RUNNING POSITION".



8. Pour sufficient lubricating oil into the priming plug ("E" on illustration) to fill it, then put into cylinder head plate. Up to four fillings may be necessary in cold weather, but never use more than four fillings of oil, or pour oil in while the engine is running, otherwise it may be damaged.

   NOTE: Use only sufficient oil in the priming plug to give easy starting. After some experience with starting it may be found that it is only necessary to partly fill the priming plug.
9. Raise the valve lift handle on the cylinder head cover (at "A" on illustration) to the vertical position. This will release the compression.
10. Crank the engine rapidly for about two or three turns, shift valve lift handle to the horizontal position, and continue to crank the engine, giving a little extra effort on the compression stroke until the engine fires. The engine should start providing the speed is maintained.
11. If the engine does not start now you have not followed the above instructions carefully. In very cold weather the above procedure may not be sufficient to start the engine, and, in this case, hold a petrol soaked rag around the air filter while starting. NEVER POUR PETROL DIRECTLY INTO THE ENGINE.

To Stop Engine

1. Push the fuel pump control rod towards the starting end of the engine, and lift the control rod stop to hold the control rod in this position.
2. As soon as the engine has stopped, release the control rod stop so the fuel pump control rod will be in the correct position for the next starting of the engine.
3. Do not shut off fuel cock after stopping as this may cause air to collect in the pipes and cause an air lock.

   IMPORTANT: Never stop the engine by means of the valve lift.

Engine Speed

The engine as supplied is set to run at 2,100 R.P.M. on full load, which equals about 2,180 R.P.M. on no load. The engine must not be run at a greater speed than this.

To reduce the engine speed, unscrew the governor screw adjusting nut ("C" on illustration). If this nut is tightened, the speed will be increased.

Where the engine speed is altered from the factory setting, a tachometer should be used to check the new setting.

Rated Output of Engine

2 B.H.P. at 1,200 R.P.M.
2.5 B.H.P. at 1,500 R.P.M.
3 B.H.P. at 1,800 R.P.M.
3.5 B.H.P. at 2,100 R.P.M.

This engine is rated in accordance with British Standard Specification 649/1958, that is, it will develop its rated output continuously up to altitudes of 500 feet above sea level at temperatures not exceeding 85° F. A de-rating of 3½% must be made for every 1,000 feet over 500 feet above sea level; plus a de-rating of 2% for every 10° F. above 85° F.; plus a de-rating of up to 6% for humidity in accordance with B.S.S. Table for Humidity.

Do not vary the speed on load above 2,100 R.P.M. or below 1,200 R.P.M.

FUEL AND LUBRICATING OIL RECOMMENDATIONS

Fuel

All engines are tested in the Factory with Diesel Fuel, and the warranted horsepower and fuel consumption have been produced with it.

The performance of the engine will, however, be even better if a distillate fuel is used. Less frequent cleaning of the fuel filter will be necessary and the engine will give cleaner and smoother running. We recommend, therefore, that **distillate** fuel, as supplied by any reputable oil company, be used.

The fuel pump and injector nozzle will be damaged beyond repair if power kerosene is used as fuel. In an emergency, mixing ¼ pint of lubricating oil per gallon of power kerosene will provide a temporary substitute for the correct fuel.

DO NOT ON ANY ACCOUNT USE MOTOR CAR SUMP OIL AS FUEL.

Lubricating Oil

The following lubricating oils are recommended for use in the Diesel Engine, Mark EF-D:—
Southern Cross Engine Oil Series 3—DS Service—S.A.E. 20—(Obtainable from the nearest Southern Cross Distributor).
Or—
If Southern Cross Oil is not available, any other Heavy Duty Detergent Lubricating Oil, S.A.E. 20, which is recommended by a reputable oil company for service conditions classified by the American Petroleum Institute as **Service DS.**

The lubricating oils specified have been scientifically blended to satisfy the requirements of the engine. Engine life and performance will not be improved by the introduction of additional additives to the lubricating oil.

WARRANTY NULL AND VOID—
If oil other than that recommended for **Service DS.** is used, the warranty on the Engine is rendered null and void.

NOTE: It is recommended that with a new engine the first lubricating oil change should be made after 50 hours' running. After this, the oil changes should be made in accordance with the routine as set out in the next section, "Running Maintenance".

RUNNING MAINTENANCE

In order to ensure the satisfactory operation of this engine, certain maintenance routine is advisable. The accompanying notes indicate the approximate intervals between the different inspection operations. These will probably vary according to site conditions, but these notes may be used as a guide when the engine is first operated until the user is able to form his own time table.

This section of the manual does not deal with overhaul and maintenance of a major nature. Reference should be made to the next section of the manual, "Overhaul Maintenance", where the routine for work of a major character is set out.

Summary of Procedure

Every Day—
1. Oil valve rockers.
2. Check oil level in crankcase.
3. Clean outside of engine.

Every 100 Hours—
4. Drain crankcase and refill with fresh oil (use correct grade as specified).
5. Check oil level in reduction gearbox (if fitted).
6. Clean air breather valve assembly.

Every 200 Hours—
7. Clean Oil Bath Air Cleaner.

Every 400 Hours—
8. Check valve clearance.
9. Check engine nuts.

Every 500 Hours—
10. Drain oil from reduction box and refill with fresh oil.

Every 1000 Hours—
11. Fit new element to Fuel Filter.

Dealing with each of the above points in more detail:—

1. **Oil Valve Rockers:**
   Every day put a small quantity of oil into the two oilers in the cylinder head covers. Do not use an excessive quantity of oil. About half a teaspoonful in each oiler is sufficient. (Refer "F" in illustration, Page 6.)

2. **Check Oil Level in Crankcase:**
   The oil level should be checked daily before the engine is started up. Do not remove the filling plug while the engine is running. Keep the oil level up to the bottom thread in the filling plug hole. Lubricating oil recommendations are given above. Never use lubricating oil of an unknown brand.

3. **Clean Outside of Engine:**
   After every run, or at least once a week, the engine should be wiped down and closely inspected.
   The cooling fins on the cylinder and cylinder head must always be kept clean. Any oil or dust on these fins will hinder the cooling and may result in the engine being damaged due to overheating.

4. **Drain Crankcase and Refill with Fresh Oil:**
   Refer above for lubricating oil recommendations. Good clean oil increases the life of the engine and to get the best results it is necessary to drain the crankcase and refill with fresh oil every 100 hours.

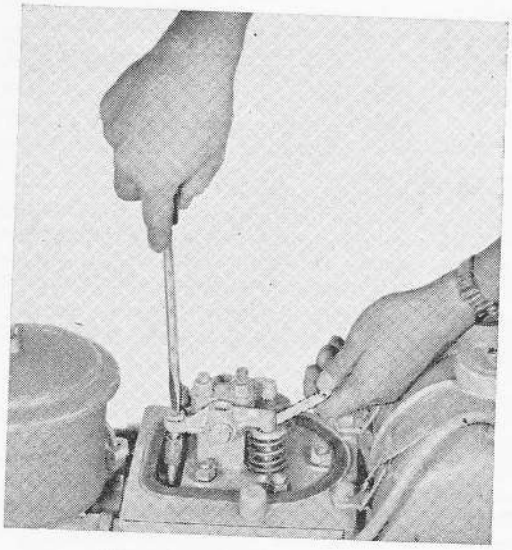
The oil is to be drained when the engine is hot; i.e., after it has been running for at least ½ hour.
To drain the crankcase, remove the drain plug and the oil will flow out. When the oil stops flowing, replace drain plug.
Then refill crankcase with fresh oil up to the bottom thread in the filling plug hole.

5. **Check Oil Level in Reduction Gearbox:**
Remove both the oil level plug and the filling plug and pour in Southern Cross Drive Gear Oil—E.P. S.A.E. 90—until it runs from the oil level hole. Then replace both plugs.

6. **Clean Air Breather Valve Assembly:**
Unscrew the air breather valve assembly from the cylinder head cover and immerse it in clean kerosene. Remove assembly momentarily, allowing dirty kerosene to drain, and then immerse again. Repeat this procedure several times and then allow all kerosene to drain from the assembly and replace it in the cylinder head cover.

7. **Clean Oil Bath Air Cleaner:**
Remove cover and element and lift off oil bath and empty out dirty oil. Wash element and inside of oil bath with clean petrol or kerosene and allow to dry. Refit oil bath in position and refill to oil level mark with clean engine oil before fitting element and cover.
NOTE: In dusty conditions, carry out this procedure every few days.

8. **Check Valve Clearance:**
Check the clearance between the valve rocker and the top of the valve stems. The valves should have the following clearances when the engine is cold:



Checking Valve Clearance

Inlet, .012in.; Exhaust, .014in. Crank the engine very slowly until the compression is felt. Release the compression and turn the flywheel slowly until the top dead centre mark on the flywheel is opposite the mark on the fuel pump mounting plate. Check the clearance. If the clearance is not correct, adjust by loosening the locknut under the other end of the rocker and then adjusting the screw until the clearance is correct. Then tighten the locknut. Recheck clearance after tightening the locknut.

9. **Check Engine Nuts:**
Before starting engine for the first time, or after an overhaul, check all nuts on the outside of the engine, paying particular attention to cylinder head stud nuts and nuts round the Flywheel End Bearing Housing. Repeat this procedure after the first 20 hours' running, and thereafter, each 400 hours.

10. **Drain Oil from Reduction Gearbox and Refill with Fresh Oil:**
Remove the drain plug and allow all the oil to drain. Replace plug. Remove both the oil level plug and the filling plug and pour in Southern Cross Drive Gear Oil—E.P. S.A.E. 90—until it runs from the oil level hole. Then replace both plugs.

11. **Fit New Paper Element to Fuel Filter:**
The fuel filter has an element which is not intended to be cleaned and must be discarded when choked.
The period at which it will be found necessary to change the filter element will vary according to the type of fuel being used, settling or pre-filtering before filling the fuel tank, and the conditions under which the engine is working.
The fitting of a new element at approximately every 1000 hours may be premature in some cases but it should prevent any trouble due to the filter not flowing sufficient fuel. However, if it is desired to obtain the maximum life from each element, a spare element should be kept on hand to prevent unnecessary delay when a change has to be made.
New elements are obtainable from the nearest Southern Cross Sales Office. When ordering, specify that the element is for a C.A.V. FS 5836020 Fuel Filter.
To fit a new element to the filter, proceed as follows:
(a) Thoroughly clean the outside of the filter with a cloth.
(b) Unscrew the central cap nut to release filter element and sediment bowl.
(c) Remove the dirty element and throw it away. **No attempt should be made to clean the element.** Remove any sludge and wash out the sediment bowl with petrol and allow to dry.
(d) See that the top and bottom sealing rings are in position and in good order.
(e) Reassemble the filter with the new element and screw up cap nut tightly. Undue force should not be used in an attempt to stop leakage.
(f) Proceed to bleed all air from the fuel system as in "Priming Fuel System", Page 5.

OVERHAUL MAINTENANCE

This section of the manual deals with the major overhaul of the engine, and the summary of procedure below indicates the approximate intervals between the various overhaul operations. These intervals may vary according to conditions, and are given only as a guide when the engine is first operated until the user is able to form his own time table.

Summary of Procedure

Every 500 Hours—

1. Remove Injector Nozzle and Clean.

Every 1,000 Hours—

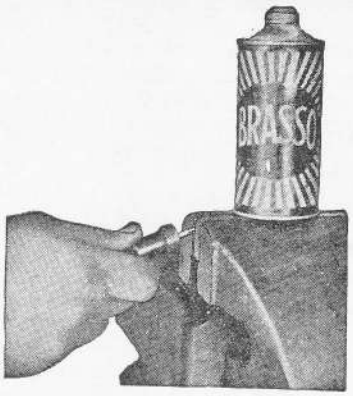
2. Grind Valves and Decarbonise.

Every 4,000 Hours—

3. Inspect Piston and Cylinder.
4. Inspect Bearings.
5. Check Fuel Pump Timing.
6. Clean Exhaust System.
7. Check Governor Adjustment.

Dealing with each of the above points in detail:—

1. **Remove Injector Nozzle and Clean:**
   First read section on "Fuel Injection Equipment" on page 14.
   Remove the injector and fuel pump to injector tube and refit the tube to the fuel pump so the injector can be connected outside the engine.
   If the injector is difficult to remove, screw nuts loosely on to the injector studs and then fill starter plug with lubricating oil and put into cylinder head plate. Crank engine and the injector will be freed. Crank the engine, and it may be found that the fuel comes out of the injector nozzle in almost a solid stream, and does not atomise. The fuel should be delivered in a finely atomized spray, and there should be a distinct snap at the commencement and finish of the discharge.
   If atomization is satisfactory it is only necessary to clean the carbon from around the injector nozzle with a wire brush, after which it can be replaced in the engine. If it is not, proceed as follows:—
   (a) Arrange to have a clean bench to work on, and have a small tin of clean diesel fuel or kerosene available. Absolute dust free cleanliness is essential.
   (b) Remove cap nut which holds the injector nozzle to the injector body with the spanner provided, and examine the nozzle.
   The small plunger should work freely in the nozzle, and to test it, lift the plunger in the body 1/16th inch and then it should fall back on its own weight.
   (c) If it does not, remove it and clean it and the body carefully, and then test again. Very fine particles of grit will prevent this working, and it is essential to see that the parts are perfectly clean before testing. When re-assembling, hold the parts in clean diesel fuel to exclude all dust and grit.
   (d) If the plunger is still tight, inspect it, and it is probable that a small bright spot will show at some point. This is due to the injector nozzle warping and binding the plunger. Sometimes it is possible to correct this by carefully freeing the plunger in the body. Use a liquid polish, such as "Brasso", and proceed as follows:—
   (e) Hold the plunger carefully in a vice by the stem at the top. Then pour the polish into the nozzle and work it up and down on the plunger, spinning it at the same time.
   (f) Then thoroughly wash in kerosene and apply test as to whether the valve will fall freely in the nozzle.
   (g) Reassemble the parts, making sure that the face of the injector nozzle and the injector body where they join, is perfectly clean. Tighten the nut so that it is reasonably tight.
   (h) Connect the injector to the high pressure tube again and test before putting in engine.
   NOTE: Fit the copper washer on the injector before replacing it in the engine.
   After a considerable amount of running the injector nozzle will finally become so worn that it will not function properly, as too much fuel will leak past the valve. The only remedy for this is to replace the nozzle.



Freeing Injector Nozzle

2. **Grind Valves and Decarbonise:**
   To remove cylinder head, grind valves and decarbonise, proceed as follows:—
   (a) Disconnect the fuel pump to injector tube and put protecting plugs in the ends of the tube. Put protecting caps on the injector and fuel pump.
   (b) Unscrew the injector leak-off connection stud and remove the injector overflow pipe. Remove the injector.
   (c) Disconnect the exhaust pipe from the cylinder head and remove the air cleaner and adaptor.
   (d) Remove the two screws holding the fuel tank brackets to the cylinder head plate. Then loosen the screws at the bottom of the brackets enough to allow the top of the brackets to sit clear of the cylinder head plate.
   (e) Undo the cylinder head cover nut and remove the cylinder head cover and gasket.
   (f) Undo the valve rocker support nuts and remove rocker gear.
   (g) Undo cylinder head nuts and the cylinder head and plate can be lifted off.

(h) Depress valve springs and remove valve collets, after which the valves can be withdrawn from the head.

(i) Clean away all carbon from the cylinder head, piston, and inside the combustion chamber.

(j) **To Grind Valves:** Light grinding can be done by the use of grinding paste, but if the seats in the head show any pitting the only satisfactory way to correct this is to have the seats reground by the use of a high-speed valve resurfacing machine, such as a Vibro-Centric. The seats are so hard that the average grinding paste does not make much impression upon the surface, and the result is that the valve is ground and not the seat. If the seating is reground, see that the total width of the seat does not exceed 3/32 inch. If it does, by the use of 15 degree and 70 degree grinding wheels reduce the width of the seat so that it is within the desired dimensions. The seat must not be less than 1/16 inch.

NOTE: If the inlet valve seat in the head has to be reground, use care, as an insert is not fitted.

If, when the valves require attention, the seating face of the valve is shouldered so that the shoulder is sitting on top of the valve seat, the valve should be refaced to present a flat seating face at 45 degrees.

(k) After regrinding the valves, thoroughly clean the cylinder head, valves, valve guides, etc., to remove all traces of grinding paste, and then replace valves, valve springs, washers, and collets.

(l) See that the cylinder head gasket is in good condition and then replace cylinder head and plate, putting nuts on loosely.

(m) Now tighten the nuts which are diametrically opposite and not those adjacent, as this is likely to distort the cylinder head or cylinder. If a Torque Wrench is being used, set it at 47 ft. lbs.

(n) Replace valve rockers.

(o) After replacing the valve rockers, and before the cylinder head cover is put in position, check the clearance between the rockers and valve stems as set out on page 8, "Check Valve Clearance".

(p) Replace rest of parts, reversing the order in which they were removed.

(q) See that the fuel is being injected properly after the fuel pump to injector tube has been fitted, by cranking the engine and listening for the decided vibration which can be heard if the fuel is being injected correctly.

3. **Inspect Piston and Cylinder:**

(a) To withdraw the piston, first remove the cylinder head cover and cylinder head as described above.

(b) Shift the fuel stop cock to the "off" position and disconnect the fuel filter to fuel pump tube at the pump. Also, remove the fuel pump to injector tube and put protecting plugs in the ends of the tube and protecting caps on the injector and fuel pump.

(c) Remove the fuel pump tappet cover, and slowly turn the flywheel in the normal direction of rotation. The fuel pump end of the fuel pump rocker will move up, and then down. When the fuel pump end of the rocker is at the bottom of the stroke, turn the flywheel another half a turn, and leave it in this position. Replace fuel pump tappet cover.

(d) Undo the nuts around the fuel pump mounting plate and remove it, being careful not to damage the gasket.

(e) Undo the connecting rod setscrews and remove the big end bearing cap.

(f) Using a sharp knife, clean away all carbon deposits from the top of the cylinder. Then remove the ridge from the top of the cylinder with a sharp bearing scraper or a special ridge cutting tool, if available. Remove all of the ridge but **do not cut down into ring travel.**

(g) Withdraw the piston and connecting rod.

(h) **Cylinder:** The cylinder will probably give good service until it is worn .012 inch oversize. It may be used until it is .015 inch oversize if new piston rings are carefully fitted, but it is recommended that it be rebored to suit an .020 inch oversize piston when worn .012 inch oversize. The bore of the cylinder when new is 2.750 inches, and it should be rebored to 2.770 inches to suit a .020 inch oversize piston.

After a rebore, run the engine very carefully for a few days until it is properly run in. Do not put it on load for at least four hours after starting up.

(i) **Care of Piston:** The piston and rings may be cleaned with soft soap and washed with hot soda and water, that is, if they are not very dirty.

If there is much carbon deposit, or if the rings are stuck, they must be removed and cleaned. To remove the gudgeon pin from the piston and rod it is necessary to first remove the circlips. In some instances, it may be necessary to immerse the whole assembly in boiling water to expand the piston sufficiently to allow the gudgeon pin to be removed.

The pin must fit the piston tightly in this manner, otherwise it would be too slack when the engine is hot, because of the difference in expansion between the alloy piston and the steel gudgeon pin.

(j) **To Remove Piston Rings:**

The piston is fitted with the following rings — a "Torsional Chromol" compression ring in the top groove, a plain "Torsional" compression ring in the second groove, four segments of "Cords" rings in the third groove, and an oil ring, consisting of an expander and two segments, in the fourth groove. To remove the two compression rings, work them loose and then spring one ring open and push narrow strips of thin sheet metal between ring and piston at four different points. Work ring off along the strips of metal—do not force ring or it will break. Repeat this procedure with the other compression ring.

To remove the "Cords" Segments, push a finger nail under one end of the top segment at the gap. Lift end of segment and it will unwind off piston. Repeat this procedure with the remaining "Cords" segments.

When removing the oil ring from the fourth groove, push a finger nail under one segment at the gap. Lift the end of the segment and it will unwind off the piston. Repeat this procedure with the other segment. Lift out the expander.

(k) **Testing Piston Rings and Fitting New Piston Rings:**

It is recommended that piston rings be replaced as a full set when sufficient wear in any one of the rings in the engine warrants its replacement. Clean the top portion of the cylinder to remove all traces of carbon.

Put a piston ring in place in the top of cylinder. By inserting bottom of piston into cylinder, move ring down about 1 inch. This will square the ring in the cylinder.

Examine gap in ring. If it is more than 1/16 inch, renew ring. Repeat this procedure with each compression ring, and each "Cords" ring segment.

To fit new rings to the worn cylinder, proceed as follows:—

Fit one of the compression rings into the cylinder and then insert bottom of piston and shift ring down into the **unworn** portion at the **bottom** of the cylinder; i.e., about 1 inch from the bottom. Check the gap, and, if it is less than .008 inch, file joint to obtain this gap. Repeat this procedure with the other compression ring. For the "Cords" Segments, use the same procedure, but make the gap .011 inch with the ring in the unworn portion at the bottom of the cylinder.

To hold "Cords" Segments while filing, make a hacksaw cut in the edge of a piece of timber, and use this cut to steady segment while it is being filed.

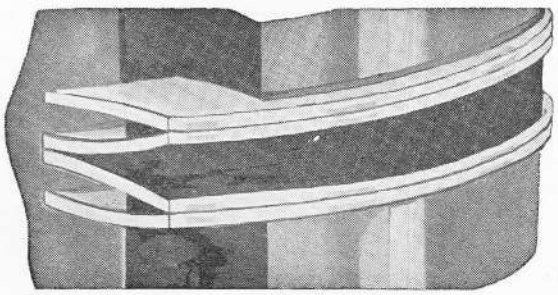
Check segments of the fourth groove oil ring in the unworn portion of the cylinder to ensure a gap of at least .014 inch.

Test compression rings in their respective piston grooves by rolling them around in the grooves to see that they do not pinch anywhere.

Piston rings must be fitted to the piston in the correct order, as follows:—

Fourth Groove:

Place the expander in the fourth ring groove, making sure the coloured ends butt together, and do not overlap, that is, so that both colours are visible. Insert one end of a segment into the ring groove and wind it into the groove. Repeat this procedure with the other segment, on the other side of the expander. Position the gaps in the segments so that they are on the same side of the piston, but opposite the join in the expander. Before replacing the piston in the cylinder, check that both ends of the expander are visible, and, if they are overlapped, rectify by separating the ends with a small screwdriver or similar tool.



"Cords" Segments in Piston Groove

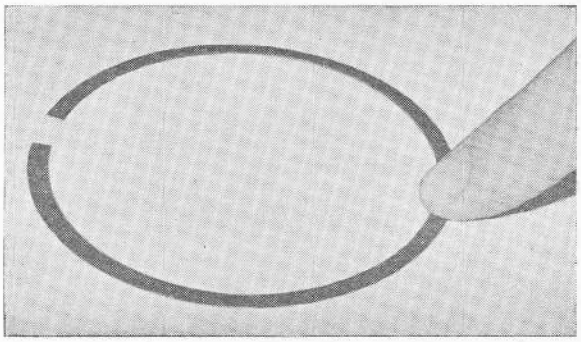
Third Groove:

Special care must be taken to see the segments are fitted correctly. Each segment is "dished" or "cupped", and, to determine which is the "cupped" side, place segment on a flat surface and press a finger on it at one point. If segment remains flat, the "cupped" side is facing downwards, but if the free part of segment rises, the "cupped" side is facing upwards. (Refer illustration, "Cupped Side of Cords Segments".)

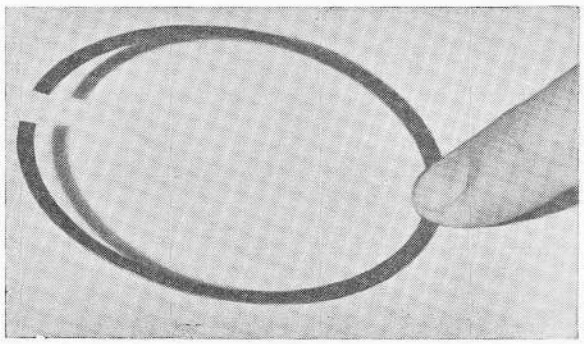
The first segment is put on with the cupping upwards, the second with the cupping downwards, the third upwards and the fourth downwards. (Refer illustration, " Cords' Segments in Piston Groove", which shows a sectional view.)

To fit "Cords" Segments to the piston, do not spring them open and slide them on using metal strips as for the other rings. Insert one end of the segment into the groove, allowing the remainder of segment to lie naturally. Then simply "wind" segment into groove. Repeat this procedure with each segment, taking care not to cross segments, and also see that the cupping is correct. All gaps in the segments should be in line with gudgeon pin ends. Place gap in first segment over the end of pin. Place gap in second segment over opposite end of pin, and alternate each succeeding gap in this manner.

Cupped Sides of "Cords" Segments



Cupped Side Downwards



Cupped Side Upwards

Second and Top Grooves:
After the "Cords" segments have been fitted, examine the two compression rings and it will be noticed that the outer surface is more highly polished on one ring. **The highly polished one is the "Torsional Chromol" ring and must be fitted in the top groove.** Also it will be noticed that one of the corners on the inside of each ring is chamfered. **The rings must be fitted with this chamfered corner at the top.**
Using metal strips, slide the two compression rings on to the piston.

(l) **Checking Piston:** A new piston should be fitted if the wear on the piston skirt exceeds .015 inch, or if the side clearance on a new piston ring exceeds .005 inch. The diameter of the piston skirt when new is between 2.743in. and 2.742in. at the bottom. When fitting a new piston, test the rings in the piston grooves to see they do not pinch.

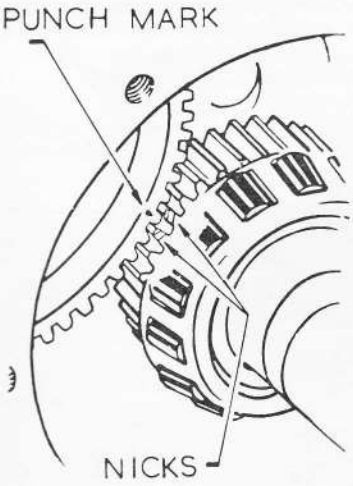
(m) **To Replace Piston:**
First make sure the gudgeon pin circlips are carefully fitted, otherwise the gudgeon pin will work along and score the cylinder.
Turn the compression rings so the gaps are on opposite sides of the piston and not in line, and coat piston and rings with lubricating oil.
NOTE: Check that the gap in alternate "Cords" segments are in line with opposite ends of the gudgeon pin, and that the ends of the expander in the fourth groove are not overlapped.
Use a piston ring compressor to compress the rings when replacing the piston in the cylinder. One side of the connecting rod is marked "Flywheel Side", and should be fitted nearest the flywheel.
When refitting the big end of the connecting rod, make sure the plain half of the bearing is in the cap and grooved half is in the rod. Fit the dipper in place on the bottom of the rod and **make sure the numbers on the cap and rod are on the same side.**
When the big end setscrews are tightened up, turn up the edges of the tab washer to prevent the setscrews coming loose. If a Torque Wrench is used to tighten the big end setscrews, set it at 20 ft. lbs.
To reassemble the rest of the engine, reverse the order in which the parts were removed.
NOTE: When refitting the fuel pump mounting plate, make sure the cap is in position on the fuel pump rocker adjusting screw.

4. **Inspect Bearings:**
The main bearings on the crankshaft are tapered roller bearings. Unless it is considered that these bearings are badly worn and need close inspection, it is sufficient to try them by pushing the crankshaft back and forth. When the bearings are properly adjusted it should be just possible to detect end play.
If the movement is very noticeable, then adjust as follows:—
Remove the flywheel end bearing housing from the crankcase and remove one packing and refit housing. Check again for end play, making sure that when finally adjusted the crankshaft can be easily turned by hand.

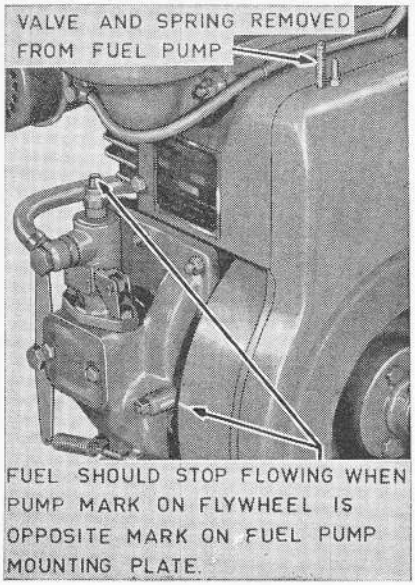
Connecting Rod Big End Bearing:
This bearing is bolted together without any shims. **It must not be filed or adjusted in any way.**
After many hours' running the bearing may wear and need replacing. In this case, fit a new standard bearing or a .002 inch undersize bearing; or, if necessary, have the crankpin reground to suit a .010 inch undersize bearing. To check if the crankpin should be reground, check its diameter with a micrometer and if it is less than 1.6225 inches, have it reground to 1.615 inches diameter and fit a .010 inch undersize bearing.
IMPORTANT: When fitting the bearing into the connecting rod, make sure that the grooved half is fitted into the rod and the plain half into the cap.

Connecting Rod Small End Bush:
The inside diameter of this bush is machined to special limits after it is pressed into the connecting rod, and, if a new bush is required, it is recommended that a replacement rod be installed with a new bush already fitted. This may be done by procuring a new connecting rod or a "service" rod which has previously been fitted with a new small end bush. The connecting rod with the worn bush may be returned for inspection, freight prepaid, to the Southern Cross Sales Office from which the engine was obtained and, if they find it suitable for repair, they will make an allowance for it.
Where a customer decides that a local engineering workshop or garage has equipment suitable for pressing in a new small end bush and boring it to precision limits, a new small end bush will be supplied rough bored on the inside diameter together with a sheet detailing the finish boring size.

Timing Camshaft:
If the crankshaft is removed for any reason, make sure the valve timing is correct when it is replaced. **The marked tooth on the camshaft gear should mesh between the marked teeth on the crankshaft pinion.** See illustration, "Timing Camshaft".



Timing Camshaft



Checking Fuel Pump Timing

5. **Check Fuel Pump Timing:**
Read this before altering pump tappet setscrew otherwise pump will be damaged.
It is not necessary to alter this setting under ordinary circumstances, but it is advisable to check the pump timing whenever a major overhaul is in progress, so that any wear may be adjusted.
Proceed as follows:—
   (a) Crank the engine until the compression stroke is felt, then release the compression with the valve lifter and turn the flywheel until the "pump" mark is nearly opposite the mark on the fuel pump mounting plate. Make sure the control rod stop is released so that the fuel pump control rod is in the running position.
   (b) Remove the fuel pump to injector tube. Then remove the delivery valve, delivery valve spring, and delivery valve connection from the pump. The Delivery Valve Connection should then be screwed back in and tightened. Fuel will now flow freely from the pump.
   (c) Now turn the flywheel in the normal direction of rotation until the fuel stops flowing. It will be necessary to turn the flywheel very slowly to find this point and recheck the position several times by turning the flywheel backwards and then slowly forwards to the point where the cut-off takes place. The mark on the flywheel marked "pump" should be opposite the mark on the fuel pump mounting plate when the fuel stops flowing.
   (d) If it is necessary to adjust the pump timing to take up wear, then remove the fuel pump tappet cover, No. 62.
   (e) With the pump mark on the flywheel opposite the mark on the fuel pump mounting plate, if the injection is retarded, undo the locknut on the fuel pump rocker adjusting screw and screw out very slowly until the fuel just ceases to flow. If timing is advanced, screw in very slowly until fuel ceases to flow.
   (f) Retighten locknut and recheck timing as before.
   (g) After the setting is correct, wash the delivery valve and spring in clean diesel fuel or kerosene and replace. Then connect the fuel pump to injector tube to the fuel pump and pump all air from the tube before connecting the other end to the injector.
   Do not put a gasket between the fuel pump and the machined face on which it sits.
   Do not attempt to take the pump to pieces. If it requires adjustment, return it to the Southern Cross Sales Office from which the engine was purchased, or a recognised Fuel Injection Equipment Service Agent.

6. **Clean Exhaust System:**
Periodic cleaning of the exhaust pipe, if fitted, and silencer is necessary. If the exhaust pipe is clogged the engine will appear overloaded, and will not perform well. An engine running on light loads for long periods may clog up the exhaust pipe or silencer. To clean the silencer it should be removed from the exhaust pipe and tapped sharply on the outside with a hammer. Then shake the loosened deposit from it.

7. **Check Governor Adjustment:**
The governor lever adjusting screw in the governor lever is adjusted at the Factory and does not normally require further adjustment, but when a major overhaul is being carried out it is a good idea to check the adjustment.
To do this, proceed as follows:—
   (a) Set fuel pump control rod stop in the "starting" position.
   (b) Loosen the locknut on the governor lever adjusting screw.
   (c) Examine the fuel pump control rod stop and, if it is not already touching the fuel pump, screw out the governor lever adjusting screw until it does touch.
   (d) Then very slowly screw the adjusting screw in until the control rod stop is just starting to move away from the fuel pump. Leave the adjusting screw in this position and tighten locking nut.

WARNING: Do not alter the setting of the governor lever adjusting screw to alter the engine speed as the governing of the engine will be affected.

FUEL INJECTION EQUIPMENT

Extreme care must be taken when handling any of the injection pump and nozzle parts.

They are very accurately made, and if any dirt or foreign matter gets amongst the working parts, they will quickly give trouble.

No attempt should be made by the operator to make any adjustments to the fuel injection equipment beyond those set out in this instruction manual.

If at any time the pump or injector does require any further adjustment, it should be returned to the nearest Southern Cross Sales Office or a recognised Fuel Injection Equipment Service Agent.

Fuel Pump

The fuel pump forces the fuel under very high pressure to the injector, which discharges the fuel in a spray through a fine hole into the combustion chamber.

The fuel pump does not require any adjustment other than an occasional drop of oil on the control rod.

Injector

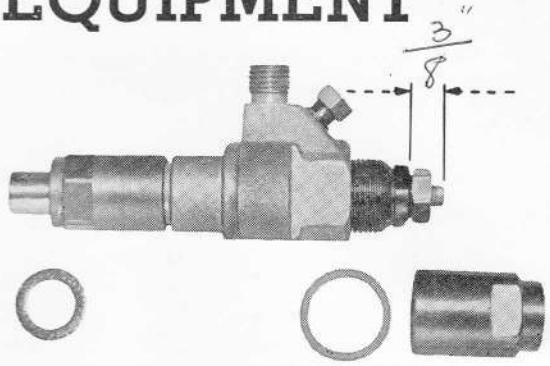
The injector is set correctly, and should not be interfered with in any way, beyond occasionally cleaning the nozzle, if necessary.

When making any adjustments to a nozzle, always have a tin of clean diesel fuel handy to wash the parts in.

Injector Setting

The correct injection pressure is 125 atmospheres.

If the injection pressure is tested at any time, and it is found that the pressure has risen above the correct setting, the rise is probably due to a partially or wholly stuck plunger in the nozzle. The nozzle should be freed as set out in the section, "Remove Injector Nozzle and Clean", on page 9, and the injection pressure retested. If the pressure is still incorrect, the setting may be altered, but it is important that no alteration be made to the setting until a check has been made to see that the plunger is free in the nozzle.



Setting Injector in an Emergency

If at any time the setting of the adjusting screw at the back of the nozzle holder is altered by mistake, or if a new nozzle is fitted, the nozzle holder with nozzle should be sent to the nearest Southern Cross Sales Office or recognised Fuel Injection Equipment Service Agent to have the injector reset to 125 atmospheres.

In an emergency, an approximate setting can be made by adjusting the screw on the back of the nozzle to the dimension shown in the illustration.

However an exact setting can only be obtained by using special equipment, and an engine fitted with an injector which has been set by the approximate method shown above, will not run as well or efficiently as one with an exact setting.

The above approximate setting should therefore only be used until such time as it is possible to have the injector set by a Service Agent.

Cleanliness of Fuel

Remember that the life of the fuel pump and injector depends upon the quality and cleanliness of the fuel used.

Never use fuel of an unknown quality.

Never run an engine without the fuel filter in position.

Never replace the fuel filter with any type other than that originally fitted without first seeking the advice of your Southern Cross Service Agent.

TROUBLES AND THEIR REMEDIES

Compression ignition engines depend entirely on the heat generated by process of compressing the air to a very high pressure, and it is this heat only which ignites the fuel when it is injected into the combustion chamber.

When tracing any troubles, the essential points to remember are:

(1) Is the compression satisfactory?

(2) Is the fuel being injected properly? (Refer to Nos. 1, 2, 3, 6, 8 under "Failure to Start" below).

To test the compression, attempt to crank the engine over the compression stroke, and unless it takes quite an effort to do this the compression is not satisfactory, and the reason for the loss of compression can be located from the faults set out under "Failure to Start," Nos. 4, 5 and 7.

Failure to Start

1. Fuel Tank Empty.
2. Failure to Inject.
3. Injector stuck or worn.
4. Exhaust Valve sticking.
5. Exhaust or Inlet Valve leaking.
6. Filter clogged.
7. Piston Rings stuck in grooves.
8. Broken High Pressure Fuel Pipe.

The above may be traced as follows:

(1) Fuel Tank Empty: If the fuel tank is run dry the fuel system will become air locked, and on refilling the tank it will be necessary to prime the fuel system in the same manner as in starting for the first time. (Refer page 5, "Priming Fuel System") and remove all air bubbles from the pipes.

(2) Failure to Inject: This may be caused by:— (a) air in fuel pipe; (b) leaking high pressure fuel pipe; or (c) leaking delivery valve on fuel pump.

(a) Air in the fuel pipe will sometimes allow the engine to fire several times and then it will stop. The air acts as a cushion and prevents the fuel from being pumped through the pipe. Refer to page 5—"Priming Fuel System"—and correct. If the fuel cock is shut off overnight, it may cause air to collect in the pipes and produce an air lock.

(b) A leaking high pressure pipe will prevent satisfactory injection. The leak should be repaired or a new pipe fitted. Also, before starting the engine again, make sure there is no blockage in the injector to have caused the breakage of the pipe.

(c) If the delivery valve on the fuel pump is leaking, no fuel will be injected. To correct, remove the delivery valve, clean it and inspect.

(3) Injector Stuck or Worn: To locate a stuck or faulty injector, first remove the injector and injector sleeve, reverse the injector on its studs, and connect it to the high pressure fuel tube outside the engine. Now crank the engine and it may be found that the fuel is not being sprayed properly or is being sprayed erratically. If this is the case, the injector requires attention. This applies providing the fuel is being pumped to the injector. Refer to page 9 to correct.

(4) Exhaust Valve Sticking: Where an engine is lightly loaded or overloaded, or where the lubricating oil leaks past the piston rings, the exhaust valve will get a gummy deposit on the stem and it will stick to the guide, preventing the valve from seating properly, with a resulting loss of compression.
This can usually be freed by pouring kerosene around the stem and giving the end of the rocker over the valve a few light blows with a hammer, and at the same time rotating the engine. In an obstinate case, turn the flywheel until the "pump" mark lines up with the mark on the fuel pump mounting plate, remove the rockers and the collets, washer and spring, and work the valve up and down while adding kerosene. To replace valve springs, etc., turn flywheel so "Top Dead Centre" is opposite mark on plate. This will hold valve in position for reassembly.

(5) Exhaust or Inlet Valve Leaking: Leaking Valves can be detected by the sound of air leaking from either, but before removing the head to grind the faulty valve, it is possible sometimes to correct the trouble, which may only be due to a small particle of carbon lodging between the valve and the seat.
To remove this, crank the engine, and, at the same time lightly strike the end of the rocker over the faulty valve with a hammer.
This should blow the obstruction away and restore the compression, but if this fails, it will be necessary to remove the head and grind the valves (pages 9 and 10).

(6) Filter Clogged: The symptoms of a clogged filter will be as follows:
The engine will start and fire several times, and then stop. After a few minutes it can be started and will stop again.
This happens because the filter will not pass sufficient fuel to feed the pump. While the engine is stopped it will fill the pipe line and for the first few revolutions the pump will get sufficient fuel, then the fuel will be used, and the filter will not supply fuel quickly enough and the engine will stop. (Refer to page 8 to fit new paper element.)

(7) Piston Rings Stuck in Grooves: Loss of compression may be caused by the piston rings sticking in the grooves of the piston and not sealing the compression properly.
To check for this, remove the crankcase cover plate, crank the engine and the leakage past the rings can be heard.
A further check is to remove the cylinder head (refer to pages 9 and 10) and inspect the cylinder walls. If any of the rings are stuck, there will be a brown mark on the cylinder wall where the blow-by has occurred.
The remedy is to remove the piston and free the rings, and if necessary, replace with new rings. (Refer to page 10—"Testing Piston Rings and Fitting New Piston Rings."

Engine Stops

If the engine stops suddenly it will be due to one of the following:

(1) Fuel Tank Empty (refer to No. 1, page 15).
(2) Air in Fuel Pipe (refer to No. 2, page 15).
(3) Stuck Injector (refer to No. 3, page 15).
(4) Clogged Filter (refer to No. 6, page 15).

Knocking

With a diesel engine there is always a certain amount of compression knock which must not be associated with a bearing knock. Knocking may be caused by:

(1) Exhaust Valve Sticking in Guide: This will be a very severe hammering, and may sometimes be heard when the engine is starting, stopping, or after it has been running on an overload.
What happens is that the piston strikes the exhaust valve before it has time to close.
To free it, pour some kerosene down the exhaust valve stem while the engine is running (refer "Exhaust Valve Sticking", page 15).
A sticking exhaust valve is caused through dirty running due to the engine running on an overload, or the engine being out of adjustment; and this must be corrected otherwise the effect of the kerosene will only be temporary.

(2) Too Early Injection: If the timing is altered or the Camshaft is replaced with the timing in advance, the pump will inject the fuel too soon, and this will produce a severe knock which will be very sharp and distinct.
Refer to page 13, "Check Fuel Pump Timing", and correct.

(3) Stuck Injector: If the engine runs unevenly and occasionally a sharp knock is heard, it is generally caused by a stuck injector (refer to page 9, No. 1, to correct).

(4) Carbon on Injector Nozzle: If, after the engine has warmed up, a knock which sounds like, but proves not to be early injection, is heard, it is generally due to a carbon deposit forming at the point where fuel is injected from the nozzle. This carbon gets red hot and ignites the fuel as it enters the combustion chamber, and produces an early combustion. Remove injector nozzle and clean carbon off the end of the nozzle and replace in the engine. This carbon is usually the result of using diesel fuel with the engine on very light loads, and the remedy is to change to a Blended Distillate (refer to page 7).

(5) Loose Flywheel: Occasionally a loose flywheel will produce a very severe knock, which can be quickly stopped by tightening the flywheel nut. The flywheel fits on a taper on the end of the crankshaft and the nut must be tightened very tightly. Hammer the spanner round with a hammer.

(6) Loose Bearings: A knock from a loose bearing will be exactly the same on a light load as on full load, and can be recognised as it is a dull knock, not sharp and distinct.
The connecting rod big end bearing can be tested by removing the crankcase cover and testing the connecting rod for up and down movement. If any up and down play can be felt, the bearing should be checked for wear (refer to page 12, "Inspect Bearings.")

Overload and Dirty Exhaust

White or grey smoke from the exhaust is caused by lubricating oil getting up past the pistons due to badly fitting rings or overfilling the crankcase with lubricating oil.

If the engine shows black smoke from the exhaust, it is a sure sign that it is overloaded. Do not continue to run the engine but correct the cause of the overload.

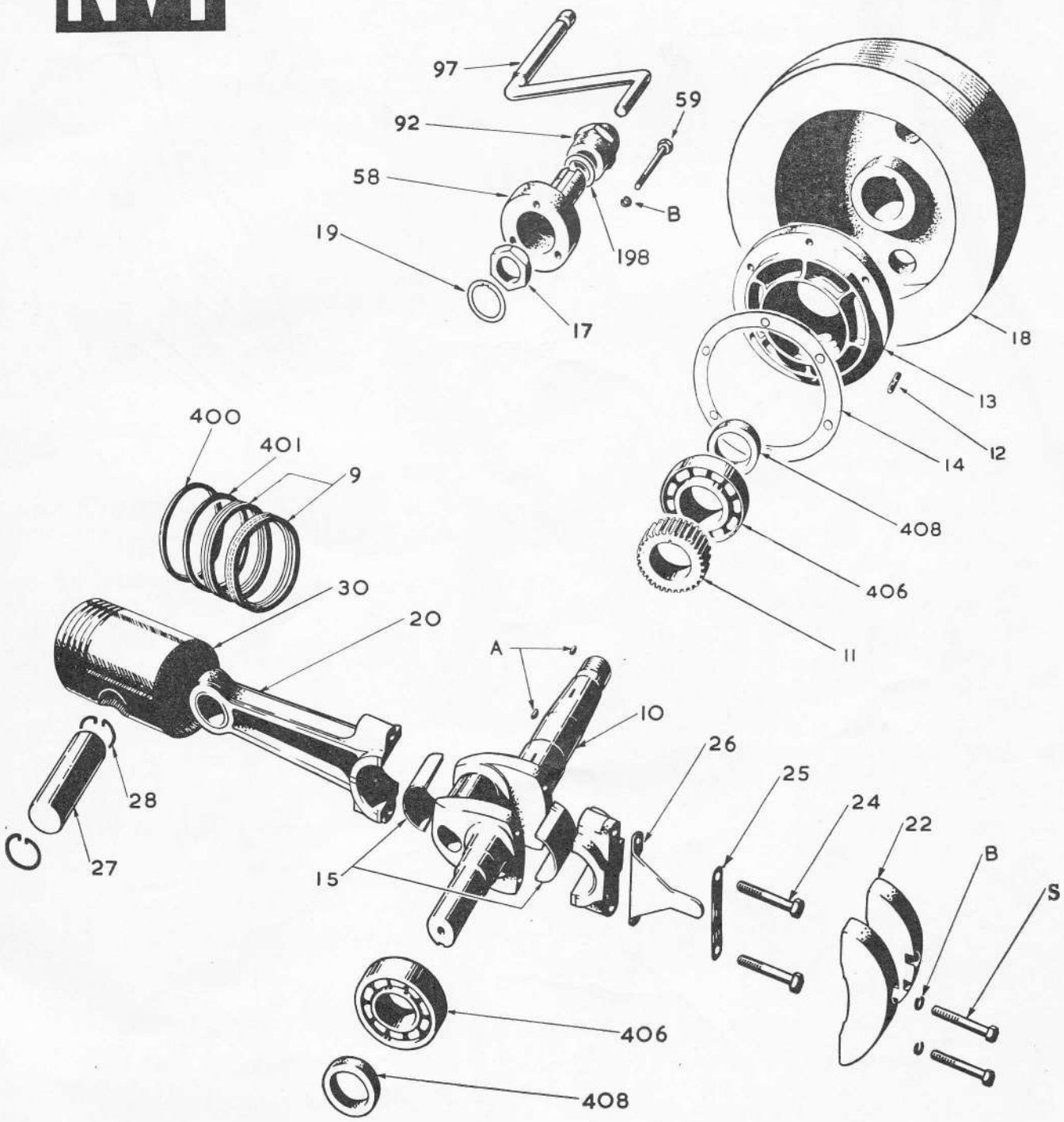
Overloading may be caused by:

(a) A load greater than the rated output of the engine. In this case, reduce the load. An increased load could be the result of a fault in the driven machine.

(b) A fault in the engine which is limiting its performance. In this case the engine can be overloaded on loads less than its rated output.
This may be caused by: (1) Fuel not being injected properly in the cylinder; (2) Leaking Valves; (3) Stuck Piston Rings, or (4) General Wear. For causes 1, 2 and 3, refer to section, "Failure to Start" on page 15. However, if the overload of the engine is caused by poor performance due to general wear, a major overhaul should be carried out.

The performance of an engine which is run on an overload will become progressively worse, so do not continue to run the engine but correct the cause of the overload.

No 1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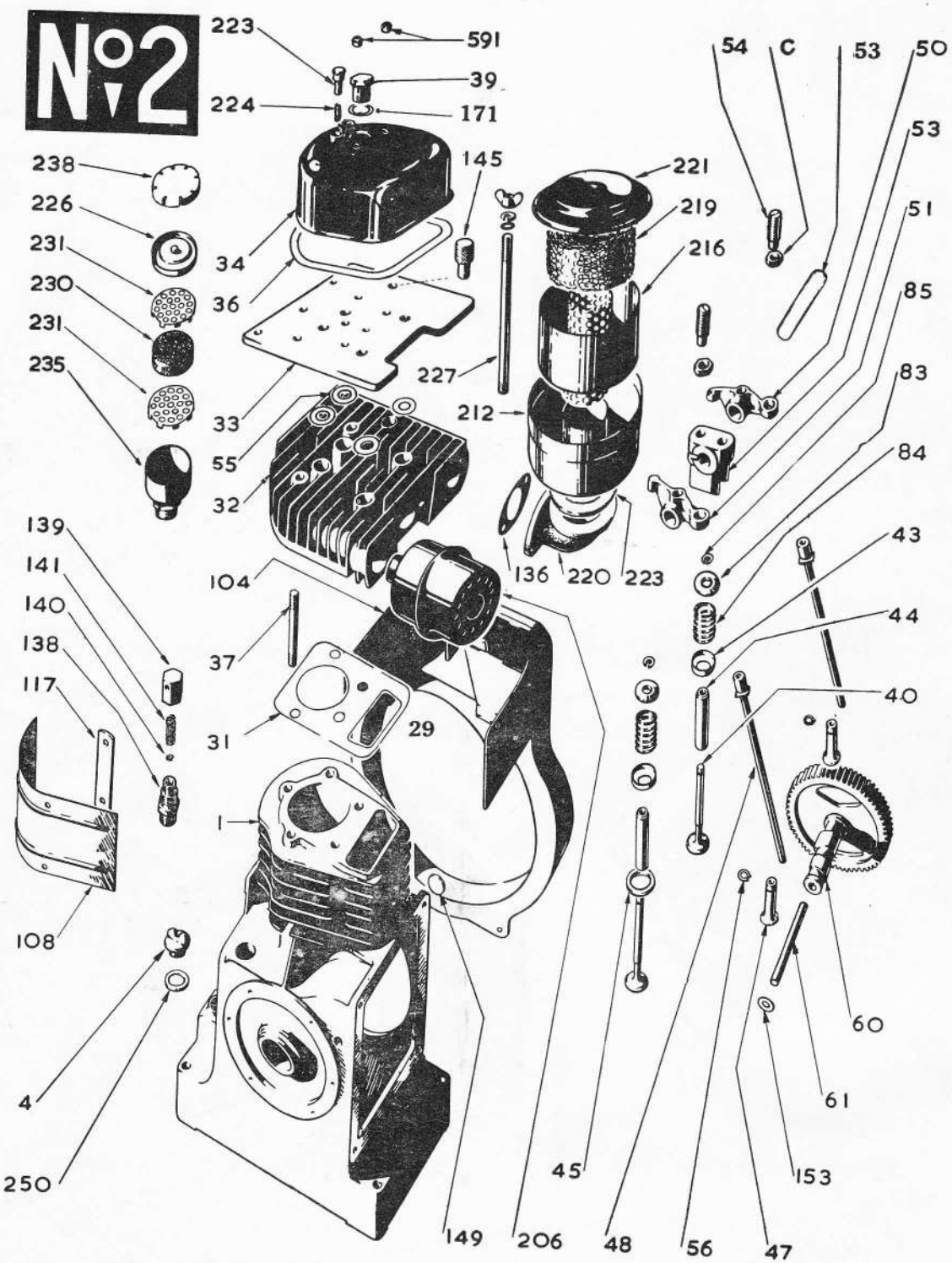
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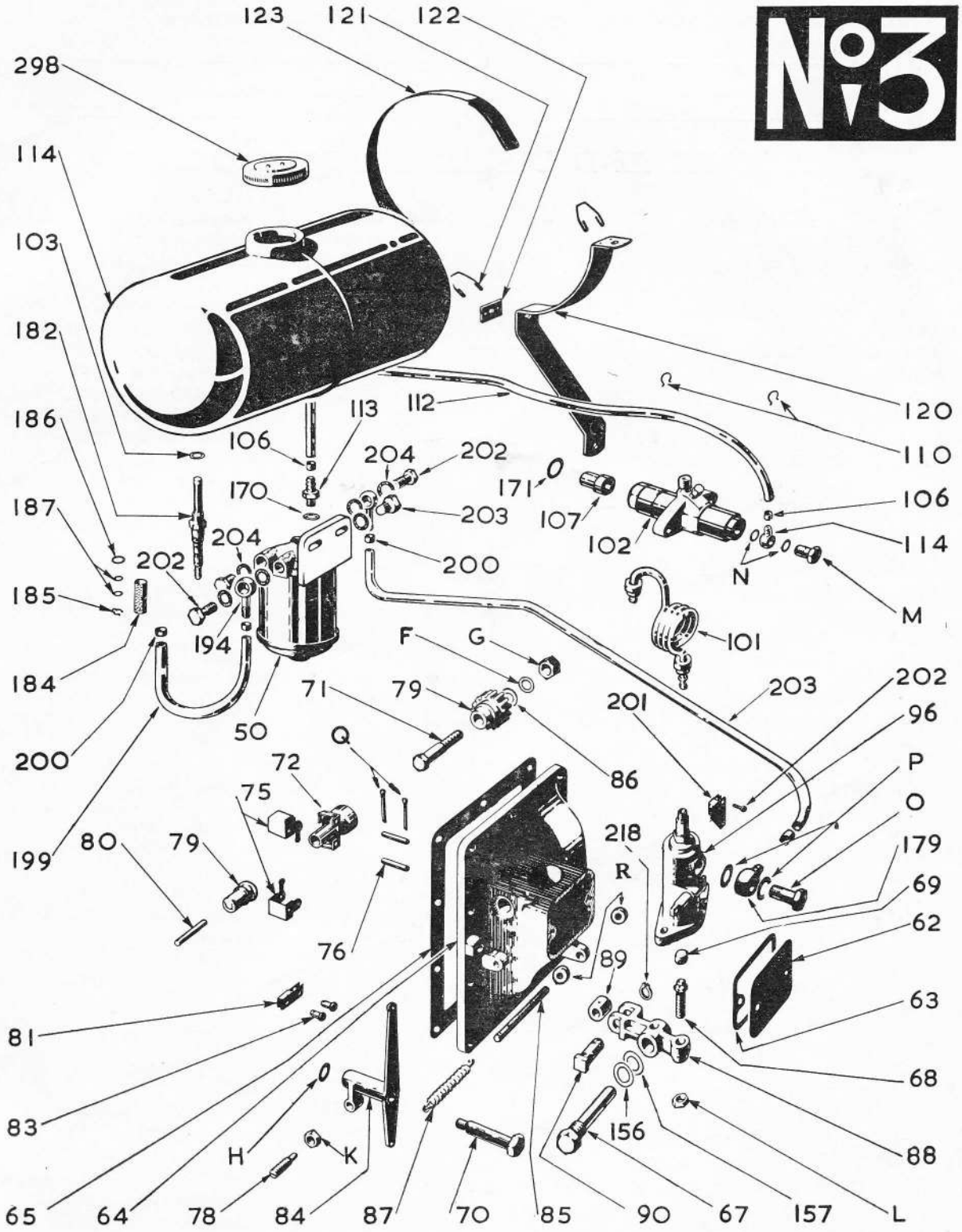
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PARTS LIST

IMPORTANT

It is important when ordering a part for an engine to give the following information:—

(1) Mark .....

(2) Engine No. .....

(3) Date Supplied .....

(4) Name and Symbol No. of Part .....

1. MARK EF-D DIESEL ENGINE PARTS

No. per Engine	Symbol No.	Name of Part	Parts List Illustration No.
1	EF-D 1B	Crankcase	2
1	EF-C 4	Oil Filler Plug	2
4	ET-B 9	"Cords" Rings for Third Groove Segments	1
1	EF-D 9	Fourth Groove Oil Ring	1
1	EY-D 10	Crankshaft	1
1	EE-D 11	Crankshaft Pinion	1
6	EY-D 12	Crankshaft Bearing Housing Stud	1
1	EF-D 13	Crankshaft Bearing Housing	1
As reqd.	EE-D 14	Crankshaft Bearing Housing Gasket	1
1	EE-D 15	Connecting Rod Big End Bearing	1
1	EF-D 17	Flywheel Nut	1
1	EF-D 18B	Flywheel	1
1	EF-D 19	Flywheel Nut Tab Washer	1
1	EF-D 20	Connecting Rod	1
2	EE-D 22	Balance Weight	1
2	EE-D 24	Connecting Rod Setscrew	1
1	EE-D 25	Connecting Rod Setscrew Tab-washer	1
1	EE-D 26	Connecting Rod Dipper	1
1	EF-C 27	Gudgeon Pin	1
2	EE-D 28	Gudgeon Pin Circlip	1
1	EF-D 29	Pushrod Housing Gasket	2
1	EF-D 30B	Piston	1
1	EF-D 31	Cylinder Head Gasket	2
1	EF-D 32	Cylinder Head	2
1	EF-C 33	Cylinder Head Top Plate	2
1	EF-C 34B	Cylinder Head Cover Assembly	2
1	EF-C 36	Cylinder Head Cover Gasket	2
5	EF-C 37	Cylinder Head Stud	2
1	EF-C 39	Cylinder Head Cover Nut	2
2	EF-D 40	Valve	2
2	EF-D 43	Valve Spring Retaining Washer	2
2	EE-D 44	Valve Guide	2
1	EF-C 45	Exhaust Valve Seat Insert	2
2	EF-D 47	Valve Tappet	2
2	EF-D 48	Push Rod	2
1	EF-D 50B	Inlet Valve Rocker and Bush	2
1	ED-G 50	Fuel Oil Filter	3
1	EF-D 51B	Exhaust Valve Rocker and Bush	2
1	EF-D 53	Valve Rocker Support	2
1	EF-E 53B	Valve Rocker Spindle	2
2	EF-D 54	Valve Rocker Adjusting Screw	2
4	EF-C 55	Cylinder Head to Cylinder Head Top Plate Sealing Washers	2
2	EF-E 56	Valve Tappet Retaining Circlip	2
2	EF-D 57	Valve Rocker Bush (not illus.)	
1	EF-D 58	Extension Shaft	1
3	EF-D 59	Extension Shaft Setscrew	1
1	EF-D 60	Camshaft	2
1	EE-D 61	Camshaft Spindle	2
1	EF-C 62	Fuel Pump Tappet Cover	3
1	EF-C 63	Fuel Pump Tappet Cover Gasket	3
1	EF-C 64	Fuel Pump Mounting Plate	3
As reqd.	EF-C 65	Fuel Pump Mounting Plate Gasket—1/64in., 1/32in. and 1/16in. Thicknesses	3
1	EF-D 67	Fuel Pump Rocker Spindle	3
1	EF-C 68	Fuel Pump Rocker Adjusting Screw	3
1	EF-C 69	Fuel Pump Rocker Adjusting Screw Cap	3
1	EF-C 70	Governor Lever Spindle	3
1	EF-C 71	Governor Spindle	3
1	EF-D 72	Governor Sleeve Spindle Assembly	3
2	EE-D 75	Governor Weight	3
2	EF-D 76	Governor Weight Spindle	3
1	AX-C 78	Governor Lever Adjusting Screw	3
2	EC-B 79	Valve Rocker Retaining Circlip (not illus.)	
1	EE-D 79	Governor Sleeve	3
1	EF-C 79	Governor Pinion	3
1	EF-C 80	Governor Thrust Pin	3
1	EF-D 81	Governor Connecting Link	3
1	EF-D 82	Fuel Pump Rocker Bush (not illus.)	
2	EF-D 83B	Valve Spring Washer	2
2	EF-C 83	Governor Connecting Link Pin	3
1	EF-C 84	Governor Lever	3
2	EF-E 84	Valve Spring	2
1	EE-D 85	Governor Spring Adjusting Screw	3
2	EF-D 85B	Valve Collet	2
1	EF-C 86	Governor Spindle Washer	3
1	EF-C 87	Governor Spring	3
1	EF-D 88	Fuel Pump Rocker	3
1	EF-D 89	Fuel Pump Rocker Roller	3
1	EF-D 90	Fuel Pump Rocker Roller Spindle	3
1	EF-C 92	Starting Handle Clutch	1
1	EF-D 93	Starting Handle Clutch Spacing Collar (not illustrated)	
1	EF-D 96	Fuel Pump	3
1	EF-C 97	Starting Handle Assembly	1
1	EF-D101	Fuel Pump to Injector Tube	3
1	EF-D102	Injector Nozzle Holder	3
1	AK-B103	Fuel Stop Cock Washer	3

No. per Engine	Symbol No.	Name of Part	Parts List Illustration No.
1	EF-D104	Fan Cowl	2
2	EU-C106	Injector Overflow Pipe Collar	3
1	EF-D107	Injector Nozzle	3
1	EE-D108	Cylinder Cowl	2
2	EF-C110	Injector Overflow Pipe Clip	3
1	EF-D111B	Injector Overflow Pipe Assembly (not illustrated)	
1	EF-C112	Injector Overflow Pipe	3
1	EF-D113	Injector Overflow to Fuel Filter Connection	3
1	EE-D114	Fuel Tank	3
1	ED-E114	Injector Overflow Pipe Banjo	3
1	EF-D117	Cylinder Cowl Clamp Plate	2
2	EF-D118	Flywheel Cowl Mounting Stud Collar (not illustrated)	
2	EF-D120	Fuel Tank Support	3
4	EF-C121	Fuel Tank Strap Anchor	3
2	EF-C122	Fuel Tank Strap Clamp Plate	3
2	EF-C123	Fuel Tank Strap	3
1	EF-C136	Air Cleaner Adaptor Gasket	2
1	EF-C138	Crankcase Vent Body	2
1	EF-C139	Crankcase Vent Cap	2
1	EF-C140	Crankcase Vent Gauze	2
1	EF-C141	Crankcase Vent Filter	2
1	EU-C145	Priming Plug	2
1	AX-C149	Camshaft Hole Plug	2
As reqd.	EU-C153	Camshaft Spindle Washer	2
1	EF-E156	Fuel Pump Rocker Spindle Washer (Copper)	3
As reqd.	EF-E157	Fuel Pump Rocker Spindle Washer (M.S.)	3
1	YC170	Injector Overflow to Fuel Filter Connection Washer	3
3	YC171	Injector Nozzle Holder Gasket	

AMMENDMENT TO PARTS LIST:

If any of the parts shown on this list are required for replacements, quote symbol number and name of part from this list when ordering.

No. Off.	Symbol No.	Name of Part.
1	EF-D 34	Cylinder Head Cover Assembly.
1	ED-E218	Valve Lift Cam Retaining Circlip.
1	ED-E221	Valve Lift Assembly.
1	ED-E222	Valve Lift Cam Bearing.
1	ED-E223	Valve Lift Plunger.
1	ED-E224	Valve Lift Plunger Spring.
1	ED-E225	Valve Lift Cam Bearing Locknut.
1	EF-D269	Governor Assembly.

As reqd.	YB198	Starting Handle Clutch Washer	1
1	EF-D199B	Fuel Tank to Fuel Filter Tube	3
4	EF-E200B	Fuel Filter to Fuel Pump Tube Collar (2)	3
		Fuel Tank to Fuel Filter Tube Collar (2)	3
1	EF-C201	Governor Control Rod Stop	3
1	EF-C202	Governor Control Rod Stop Pin	3
2	ED-G202	Fuel Filter Banjo Connection	3
1	EF-D203B	Fuel Filter to Fuel Pump Tube	3
2	ED-G203	Fuel Filter Plug	3
6	ED-G204	Fuel Filter Banjo Connection and Plug Washer	3
1	EF-D204D	Fuel Filter to Fuel Pump Assembly (not illustrated)	

No. per Engine	Symbol No.	Name of Part	Parts List Illustration No.
1	EU-C206	Silencer	2
1	EF-D212	Air Cleaner Oil Bath	2
1	EY-D216	Oil Bath Air Cleaner Element Housing	2
1	ED-E218	Fuel Pump Rocker Roller Spindle Retaining Circlip	3
1	EY-D219	Oil Bath Air Cleaner Element	2
1	EF-D220	Oil Bath Air Cleaner Adaptor	2
1	EY-D221	Oil Bath Air Cleaner Cover	2
1	EY-D223	Oil Bath Air Cleaner Gasket	2
1	EU-C223	Valve Lift Plunger	2
1	ET-B224	Valve Lift Plunger Spring	2
1	ET-B226	Breather Valve Seat	2
1	EF-E227	Oil Bath Air Cleaner Cover Stud	2
1	ET-B230	Breather Valve Filter Pad	2
2	ET-B231	Breather Valve Filter Plate	2
1	EE-D235	Breather Valve Cup	2
1	ET-B238	Breather Valve Cup Cap	2
1	YB250	Crankcase Oil Filler Plug Washer	2
1	EF-E263	Flywheel Nut Spanner (not illustrated)	
1	EU-C298	Fuel Tank Cap	3
1	EF-C400	Piston Compression Ring—Top Groove	1
1	EF-C401	Piston Compression Ring—Second Groove	1
2	EE-D406	Crankshaft Bearing	1
2	EE-D408	Crankshaft Oil Seal	1
1 As reqd.	EE-D504	Con Rod Big End Bearing (.002in. Undersize)	
1 As reqd.	EE-D505	Con Rod Big End Bearing (.010in. Undersize)	
1 As reqd.	EE-D506	Con. Rod Big End Bearing (.020in. undersize)	
1 As reqd.	EF-D550B	Piston (.020in. Oversize)	
1 As reqd.	EF-C551	Top Compression Ring (.020in. Oversize)	
1 As reqd.	EF-C552	Second Compression Ring (.020in. Oversize)	
4 Segments	EF-C553	3rd Groove Oil Ring (.020in. Oversize) (as reqd.)	
1 As Reqd.	EF-D554	Fourth Groove Oil Ring (.020in. Oversize)	
2	BD-C591	Rocker Spindle Ball Oiler Assembly	2
As Reqd.	EF-D900	Gasket Set for Valve Grind	
As Reqd.	EF-D901	Gasket Set for Complete Overhaul	
8		Fuel Pump Mounting Plate Stud — Short (1¼in. x 5/16in. — 18 U.N.C.)	
1		Fuel Pump Mounting Plate Stud — Long (3½in. x 5/16in. — 18 U.N.C.)	
2		Air Cleaner Adaptor Stud (1¼in. x 5/16in. — 18 U.N.C.)	
2		Cylinder Cowl Stud (1¾in. x 5/16in. — 18 U.N.C.)	
2		Flywheel Cowl Mounting Stud (2½in. x 5/16in. — 18 U.N.C.)	
4		Injector Stud (2), Fuel Filter to Crankcase Stud (2) (1½in. x ⅜in. — 16 U.N.C.)	

No. per Engine	Symbol No.	Name of Part
4	S	Balance Weight Setscrew (2¼in. x ⅜in. — 16 U.N.C. H. Tensile)
1		Valve Rocker Support Stud — Short (3¼in. x ⅜in. — 16 U.N.C.)
1		Valve Rocker Support Stud — Long 3½in. x ⅜in. — 16 U.N.C.)
2		Fuel Tank Strap Anchor Setscrew (1½in. x ¼in. Whit. Cheesehead)
2		Cylinder Head Cowl Setscrew (½in. x 5/16in. — 18 U.N.C.)
2		Fuel Pump Tappet Cover Setscrew ½in. x 5/16in. — 18 U.N.C.)
4		Fuel Tank Mounting Bracket Setscrew (⅝in. x 5/16in. — 18 U.N.C.)
2		Fuel Pump Setscrew (¾in. x 5/16in. — 18 U.N.C.)
2		Fuel Tank Strap Anchor Setscrew Nut (¼in. Whit.)
9		Fuel Pump Mounting Plate Stud Nut (5/16in. — 18 U.N.C.)
2		Flywheel Cowl Mounting Stud Nut (5/16in. — 18 U.N.C.)
6		Crankshaft Bearing Housing Stud Nut (5/16in. — 24 U.N.F.)
2		Air Cleaner Adaptor Stud Nut (5/16in. — 18 U.N.C.)
2		Cylinder Cowl Stud Nut (5/16in. — 18 U.N.C.)
2		Injector Stud Nut (⅜in. — 16 U.N.C.)
2		Valve Rocker Support Stud Nut (⅜in. — 16 U.N.C.)
2		Fuel Filter to Crankcase Stud Nut (⅜in. — 16 U.N.C.)
1	G	Governor Spindle Nut (⅜in. — 16 U.N.C. Nyloc Nut) **Parts List Illustration No. 3.**
5		Cylinder Head Stud Nut (7/16in. — 20 U.N.F.)
1	L	Fuel Pump Rocker Adjusting Screw Nut (⅜in. — 24 U.N.F.) **Parts List Illustration No. 3.**
1	K	Governor Lever Adjusting Screw Nut (5/16in. — 24 U.N.F.) **Parts List Illustration No. 3.**
2	C	Valve Rocker Adjusting Screw Nut (5/16in. — 24 U.N.F.) **Parts List Illustration No. 2.**
2	R	Governor Adjusting Screw Nut (3/16in. Whit. Wingnut)
1		Oil Bath Air Cleaner Cover Stud Nut (5/16in. Whit. Wingnut)
9		Fuel Pump Mounting Plate Stud Washer (5/16in. x 3/32in. x 3/32in. Spring)
6		Flywheel End Bearing Housing Stud Washer (5/16in. x 3/32in. x 3/32in. Spring)
2		Air Cleaner Adaptor Stud Washer (5/16in. x 3/32in. x 3/32in. Spring)
4		Fuel Tank Mounting Bracket Setscrew Washer (5/16in. x 3/32in. x 3/32in. Spring)
2		Cylinder Head Cowl Setscrew Washer (5/16in. x 3/32in. x 3/32in. Spring)
2		Cylinder Cowl Stud Washer (5/16in. x 3/32in. x 3/32in. Spring)
2		Flywheel Cowl Mounting Stud Washer (5/16in. x 3/32in. x 3/32in. Spring)
2		Fuel Filter to Crankcase Stud Spring Washer (⅜in. x 3/32in. x 3/32in. Spring)
2		Valve Rocker Support Stud Washer (⅜in. x 3/32in. x 3/32in. Spring)
4		Foundation Bolt Washer (⅜in. x 3/32in. x 3/32in. Spring)
4	B	Balance Weight Setscrew Washer (⅜in. x 3/32in. x 3/32in. Spring) **Parts List Illustration No. 1.**
3	B	Extension Shaft Washers (⅜in. x 3/32in. x 3/32in. Spring) **Parts List Illustration No. 1.**
1		Cylinder Cowl Plain Washer (5/16in. Plain)
1		Oil Bath Air Cleaner Cover Stud Washer (5/16in. Plain)
1	H	Governor Lever Washer (⅜in. Plain) **Parts List Illustration No. 3.**
2		Fuel Filter to Crankcase Stud Washer (⅜in. Plain)
1	F	Governor Spindle Sealing Washer (⅜in. Brass Plain) **Parts List Illustration No. 3**
1		Governor Control Rod Stop Pin Cotter Pin (⅜in. x 3/32in.)
1		Valve Lift Plunger Cotter Pin (⅜in. x 3/32in.)
2		Governor Connecting Link Pin Cotter Pin (⅜in. x 1/16in.)
2	Q	Governor Weight Spindle Retaining Pin (1¾in. x 3/32in. Cotter Pin) **Parts List Illustration No. 3.**
4		Foundation Bolt (7in. x ⅜in. Whit.)
1		Oil Drain Plug (⅜in. B.S.P.)
1	A	Crankshaft Pinion Key (⅝in. x 5/32in. Woodruff) **Parts List Illustration No. 1.**
1	A	Flywheel Key (⅝in. x 5/32in. Woodruff) **Parts List Illustration No. 1.**
1		Extension Shaft Key (1½in. x 5/16in. Square Plain Parallel Key)
1		Crankshaft Key (2in. x 5/16in. Square Plain Parallel Key)
1	M	Injector Leak-off Connection Stud (Bosch Part No. NSR5299/IX313) **Parts List Illustration No. 3.**
2	N	Injector Leak-off Connection Washer (Bosch Part No. NMR49/2X) **Parts List Illustration No. 3.**
1	O	Fuel Pump Inlet Connection Stud (Bosch Part No. NSR5302/IX313) **Parts List Illustration No. 3.**
2	P	Fuel Pump Inlet Connection Washer (Bosch Part No. NMR49/5X) **Parts List Illustration No. 3.**
1		8in. Adjustable Spanner
1		Screw Driver
1		Injector Nozzle Nut Spanner (⅞in. A/F)

2. MARK KF-J REDUCTION BOX PARTS

No. Off	Symbol No.	Name of Part
1	KF-J 1	Gearbox
1	KF-J 2	Gearbox to Engine Gasket
1	KF-J 3	Pinion
1	KF-J 4	Drive Shaft Collar
1	KF-J 5B	Drive Shaft
1	KF-J 6	Drive Gear
1	KF-J 7	Drive Shaft Bearing Plate
1	KF-H 8	Drive Shaft Bearing Plate Gasket
1	KF-J 10	Starting Handle Clutch Spacing Collar
1	ET-B 17	Drive Shaft Oil Seal (Gaco MIS 112)
1	IZ-A 42B	Pinion Locking Screw
1	IZ-A 43B	Pinion Locking Screw Spanner
1	EF-C 92	Starting Handle Clutch
1	ET-B156	Drive Shaft Front Bearing (S.K.F. 6307)
As reqd.	YB198	Starting Handle Clutch Washer
1	EC-B405	Drive Shaft Rear Bearing (S.K.F. 6205)
6		Gearbox to Engine Stud (1⅛in. x 5/16in. — 18 U.N.C.)
6		Drive Shaft Bearing Plate to Gearbox Stud (1⅛in. x 5/16in.—18 U.N.C.)
6		Gearbox to Engine Stud Nut (5/16in. — 18 U.N.C.)
6		Drive Shaft Bearing Plate to Gearbox Stud Nut (5/16in. — 18 U.N.C.)
6		Gearbox to Engine Stud Washer (5/16in. x 3/32in. x 3/32in. Spring)
6		Drive Shaft Bearing Plate to Gearbox Stud Washer (5/16in. x 3/32in. x 3/32in. Spring)
1		Oil Filler Plug (⅜in. B.S.P.)
1		Oil Level Plug (⅛in. B.S.P.)
2		Drain Plug (⅛in. B.S.P.)
1		Pulley Key (2in. x 5/16in. Square Plain Parallel Key)
1		Drive Gear Key (1in. x 5/16in. Woodruff)

3. FLAT BELT PULLEYS FOR ENGINE AND REDUCTION BOX

Symbol No.	Name of Part
* KF-H 12	4in. Dia. Flat Belt Pulley
* KF-H 13	4½in. Dia. Flat Belt Pulley
* KF-H 14	5in. Dia. Flat Belt Pulley
* KF-H 15	5½in. Dia. Flat Belt Pulley
* KF-H 16	6in. Dia. Flat Belt Pulley
* KF-H 18	7in. Dia. Flat Belt Pulley
IZ-B 42B	Pulley Locking Screw
IZ-B 43C	Pulley Locking Screw Spanner
EY-D600	3in. Dia. Flat Belt Pulley
EY-D601	3½in. Dia. Flat Belt Pulley
EY-D609	8in. Dia. Flat Belt Pulley

* Reduction Box Pulley — 4in. to 7in. inclusive only.

4. VEE BELT PULLEYS FOR ENGINE AND REDUCTION BOX

Symbol No.	Name of Part
IZ-A 42B	Pulley Locking Screw
IZ-A 43B	Pulley Locking Screw Spanner
EY-D612	3in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D613	3½in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D614	4in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D615	4½in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D616	5in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D617	5½in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D618	6in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D619	7in. Dia. P.C.D. x 4 "A" Groove Vee Pulley
EY-D620	8in. Dia. P.C.D. x 4 "A" Groove Vee Pulley

5. MARK KS-B FLEXIBLE COUPLING PARTS

No. Off	Symbol No.	Name of Part
1	KS-B 1	Flexible Coupling — Driving Half
5	BQ-D 2	Flexible Coupling Pin
as ord.	KS-B 2	Flexible Coupling — Driven Half — ¾in. Dia. Bore
as ord.	KS-B 4	Flexible Coupling — Driven Half — 1in. Dia. Bore
as ord.	KS-B 6	Flexible Coupling — Driven Half — 1⅛in. Dia. Bore
as ord.	KS-B 7	Flexible Coupling — Driven Half — Bored and Keywayed to order
4	IZ-A 42B	Flexible Coupling — Driving and Driven Half Locking Screw
1	IZ-A 43B	Flexible Coupling Driving and Driven Half Locking Screw Spanner.
5	YC400	Flexible Coupling Rubber Bush
5		Flexible Coupling Pin Nut (½in. Whit.)
5		Flexible Coupling Pin Washer (½in. x ⅛in. x ⅛in. Spring)

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