FORD LRG 425 ENGINES

GASOLINE CARBURETOR
GASOLINE ELECTRONIC FUEL INJECTION (EFI)
LIQUEFIED PETROLEUM GAS (LPG)
NATURAL GAS (NG)

Ford Power Products policy is one of continuous improvement and while every effort is made to ensure that this publication is up to date and correct in all respects, the right to change prices, specifications and equipment at any time without notice is reserved. Accordingly this publication is not to be regarded as a final description of any individual engine.

VCA REGISTERED FIRM BS EN ISO 9001:1994

EUROPE

Q1 ISO 9001

USA

CONTENTS

HEALTH & SAFETY

WARNING: THE FOLLOWING HEALTH AND SAFETY RECOMMENDATIONS SHOULD BE CAREFULLY OBSERVED.

Carrying out certain operations and handling some substances can be dangerous or harmful to the operator if the correct safety precautions are not observed. Some such precautions are recommended at the appropriate points in this book.

While it is important that these recommended safety precautions are observed, care near machinery is always necessary, and no list can be exhaustive. ALWAYS BE CAUTIOUS TO AVIOD POTENTIAL SAFETY RISKS.

The following recommendations are for general guidance:

1. Always wear correctly fitting protective clothing which should be laundered regularly. Loose or baggy clothing can be extremely dangerous when working on running engines or machinery. Clothing which becomes impregnated with oil or other substances can constitute a health hazard due to prolonged contact with the skin even through underclothing.

2. So far as practicable, work on or close to engines or machinery only when they are stopped. If this is not practicable, remember to keep tools, test equipment and all parts of the body well away from the moving parts of the engine or equipment—fans, drive belts and pulleys are particularly dangerous. The electric cooling fan used on some installations is actuated automatically when the coolant reaches a specified temperature. For this reason, care should be taken to ensure that the ignition/isolating switch is OFF when working in the vicinity of the fan as an increase in coolant temperature may cause the fan suddenly to operate.

3. Avoid contact with exhaust pipes, exhaust manifolds and silencers when an engine is, or has recently been running; these can be very hot and can cause severe burns.

4. *Many liquids used in engines or vehicles are harmful if taken internally or splashed* into the eyes. In the event of accidentally swallowing gasoline (petrol), oil, diesel fuel, antifreeze, battery acid etc, DO NOT ENCOURAGE VOMITING AND OBTAIN QUALIFIED MEDICAL ASSISTANCE IMMEDIATELY.

Wear protective goggles when handling liquids which are harmful to the eyes; these include ammonia and battery acid. If any of these substances are splashed in the eyes, wash out thoroughly with clean water and OBTAIN QUALIFIED MEDICAL ASSISTANCE IMMEDIATELY.

WARNING:

CALIFORNIA
Proposition 65 Warning

WARNING: ENGINE EXHAUST AND SOME OF ITS CONSTITUENTS CONTAIN CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER OR BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all industrial engines as well as the personal safety of the individual doing the work. This Service Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools and parts for servicing equipment, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that neither personal safety nor equipment integrity are compromised by the choice of methods, tools or parts.

NOTES, CAUTIONS, AND WARNINGS

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES gives you added information that will help you to complete a particuar procedure. CAUTIONS are given to prevent you from making an error that could damage the equipment. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on the equipment.

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GENERAL WARNINGS:

To help avoid injury:

- **Always wear safety glasses for eye protection.**
- **Use safety stands whenever a procedure requires you to be under the equipment.**
- **Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.**
- **Set the parking brake (if equipped) when working on the equipment. If you have an automatic transmission, set it in PARK REVERSE (engine off) or NEUTRAL (engine on) unless instructed otherwise for a specific operation. Place wood blocks (4"x 4" or larger) to the front and rear surfaces of the tires to provide further restraint from inadvertent equipment movement.**
- **Operate the engine only in a well ventilated area to avoid the danger of carbon monoxide.**
- **Keep yourself and your clothing away from moving parts when the engine is running, especially the fan belts.**
- **To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.**
- **Do not smoke while working on the equipment.**
- **Always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on the equipment. Tie long hair securely behind the head.**
- **Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.**

Battery Handling and Charging

The handling and correct use of lead acid batteries is not as hazardous provided that sensible precautions are observed and that operatives have been trained in their use and are adequately supervised.

It is important that all labelling on the battery is carefully read, understood and complied with. The format of the following symbols and labels is common to most brands of lead acid battery.

Fig. 1—Typical Battery Labelling

1. *Explosive gases*
2. *Eye protection must be WORN*
3. *No smoking or naked flames*
4. *Corrosive acid*
5. *Flush eyes immediately when contacted with acid*
6. *Caution/important notice*
7. *Read relevant instructions*
8. *Keep away from children*
9. *Do not dispose of as household waste*
10. *Recycle (via recognized disposal system)*
11. *Electrical current may cause injury to personnel.*

NOTE: Observe all manufacturers' instructions when using charging equipment.

CAUTION: **Batteries should not be charged in the vehicle.**

FOREWORD

This book contains operating and maintenance instructions for the engine(s) listed on the title page.

The life of your engine unit and the delivery of the high performance built into it will depend on the care it receives throughout its life. It is the operator's responsibility to ensure that the engine is correctly operated and that the maintenance operations outlined in this book are carried out regularly after the specified hours of operation have been reached. We consider it to be in your interests to enlist the aid of an authorized Ford Dealer (Europe) or Ford Power Products Distributor (USA) not only when repairs are required but also for regular maintenance. Distributors are listed at the back of this handbook.

Regular maintenance will result in minimal operating costs.

Engines manufactured by Ford Motor Company are available through Ford Power Products Dealers or Distributors. When in need of parts or service, contact your local Authorized Dealer or Distributor. In overseas territories, in the event of difficulties, communicate directly with the supervising Ford affiliated Company in your area whose address appears at the end of this book.

Where the terms "Right" or "Left" occur in this publication, they refer to the respective sides of the engine when viewed from the rear or flywheel end.

Pistons and valves are numbered from the front or timing cover end of the engine commencing at No. 1.

You may find that your engine assembly includes optional equipment not specifically covered in the following text. Nevertheless, the maintenance procedures outlined in this book still apply to your engine.

ENGINE IDENTIFICATION

Because Ford Power Products Operations markets such a wide range of industrial gasoline and diesel engines – manufactured both in the U.S. and overseas – it is important that you have as complete identification of the engine as possible in order to provide the correct replacement parts. New engines being shipped include a standard parts listing describing the parts which does not tell the owner the part number. It remains a distributor function to identify the part number. The key to identifying the engine is the identification decal mounted on the engine rocker cover. That decal provides not only the engine serial number, but also the exact model or type, options and S.O. (Special Order). The combination of that data permits you to isolate the precise engine, build level and customer so you can determine the correct replacement parts.

EUROPEAN SERVICE IDENTIFICATION PLATE

This plate (Fig. 2) is fixed to the engine in a prominent position. Panels 1 to 11 on the plate refer to various engine details as listed here.

Detail Title

1. Engine model identification.

2. Engine capacity.

3. Serial No: This identifies the engine as supplied by Power Products Engineering.

   Date: The two letters following the serial No. indicate the year and month in which the specified build components were assembled - refer to the chart, Fig 3.

   NOTE: These markings should not be confused with any that may be stamped or etched into the crankcase of the basic engine.

4. Selective Build Number indicates the complete specification. The digit to the extreme right hand side is the build chart issue number.

5. Engine operating rpm. An asterisk denotes speed set by customer.

6. Not applicable.

7. Not applicable.

8. 9. 10. — Applicable to diesel engines only.

11. This box is provided for Equipment Manufacturers' use when extra equipment is fitted outside of the Ford Motor Company. Reference should be made to the Equipment Manufacturer for any information or parts required.

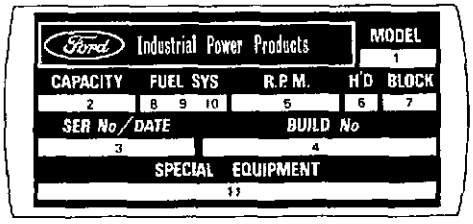


Fig. 2 – Service Identification Plate

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1991	M	L	Y	S	T	J	U	M	P	B	R	A	G
1992	N	C	K	D	E	L	Y	S	T	J	U	M	P
1993	P	B	R	A	G	C	K	D	E	L	Y	S	T
1994	R	J	U	M	P	B	R	A	G	C	K	D	E
1995	S	L	Y	S	T	J	U	M	P	B	R	A	G
1996	T	C	K	D	E	L	Y	S	T	J	U	M	P
1997	U	B	R	A	G	C	K	D	E	L	Y	S	T
1998	V	J	U	M	P	B	R	A	G	C	K	D	E
1999	W	L	Y	S	T	J	U	M	P	B	R	A	G
2000	X	C	K	D	E	L	Y	S	T	J	U	M	P

Fig. 3 – Build Date Chart

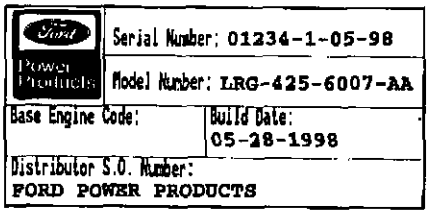
NOTES: The letters I, O and Q are not used in the year column. The letter representing the month repeats every five years.

U.S.A. ENGINE IDENTIFICATION DECAL

An identification Decal is affixed to the valve cover of the engine. The decal contains the engine serial number which identifies this unit from all others. Use all numbers when seeking information or ordering replacement parts for this engine.

01 - Serial Number: Has a total of 10 numbers.

02 - Model Number



For a handy reference, this information is recorded on your Ford Power Products Operations Engine Registration copy (Form #194-103-D).

PARTS AND SERVICE

Replacement parts can be obtained through your local Ford Power Products Distributors or Dealers listed in the back portion of this handbook. They also may be found in the yellow pages under "Engines" or contact Ford Power Products: 1-800 833-4773 U.S.A., 49221-94700551 Europe, or 441708-858415 Great Britain.

Ford Power Products Distributors and Dealers are equipped to perform major and minor repairs. They are anxious to see that all of your maintenance and service needs are quickly and courteously completed.

SERVICE LITERATURE

A service manual can be purchased from your distributor or dealer. This publication will provide the necessary servicing and overhaul information for your Ford Industrial Engine.

SERVICE MANUAL FPP 194-303

PART LIST FPP 194-301-A

WARRANTY REGISTRATION

The Warranty Registration form must be completed by the consumer or final purchaser and returned to Ford Power Products to establish an in-service date or warranty start date. When an in-service date is not established by a Warranty Registration form, the warranty start date for your new Ford Engine is calculated from the time a Ford Power Products Distributor or Dealer purchased the engine. The Warranty Registration form is supplied with all Ford Power Products engines and has a postage paid and addressed return envelope. Please complete this form when you receive your new Ford engine or product powered by a Ford engine. Retain the purchaser's copy and mail the remainder of the form using the pre-paid postage and addressed envelope. For more information or assistance please call your nearest Ford Power Products Distributor or Dealer listed in the back of this manual, or contact Ford Power Products:

USA:	1-800-833-4773
Europe:	492-219-4700551
Great Britain:	441-708-858415

BEFORE OPERATING THE ENGINE

1. Before operating a new engine it should be thoroughly inspected to ensure that during transit and installation it has not suffered damage likely to affect its subsequent operation. Controls and instruments should be studied carefully in order that their functions are thoroughly understood .

2. Check that the radiator (where applicable) is full and top off as necessary — refer to page 24 for recommended coolant mixtures

In the case of marine engines ensure that there is coolant in the degas/expansion tank.

CAUTION: Under no circumstances may the engine be started without liquid in the cooling system.

3. Check the engine oil level and top up or fill as necessary— refer to page 19. For the correct type and grade of oil. Refer to page 18.

4. Ensure that the battery is fully charged and, if necessary, top up with distilled water.

NOTE: Ensure that ALL wiring earth connections are properly made to a clean point on the chassis/frame of the vehicle/ installation.

5. The engine must be started in accordance with the starting instructions given on page 14.

OPERATING CONTROLS

Ignition or isolation switch
An isolating switch is usually fitted which connects the engine starter motor and other electrical equipment to the battery; Fig. 4 shows a typical example. The switch can be moved to any of the four positions shown by rotating the key. These positions are:

1. Auxiliary Circuits - When moved to this position the auxiliary electrical equipment such as radios and heater fans, can be operated without also connecting the starting circuit with the battery.

2. Off - When set to this position, the switch disconnects the auxiliary electrical equipment and the starting circuit from the battery. The key can be removed from the switch when it is in this position; this will help to prevent unauthorized operation of the engine.

3. Run - This switch position connects the auxiliary circuits as described previously, and the alternator is given initial excitation via the battery.

4. Start - In this position, the starter solenoid is energized and the starter motor cranks the engine. The switch, when released, automatically returns to position 3.

Safety Switch (where fitted)
A low pressure/high water temperature safety switch may be fitted. This automatically shuts off the ignition when the oil pressure drops below a pre-set value, or when the water temperature rises above a pre-set value. A button on the instrument panel is used to override the safety switch when starting the engine. The safety switch override button must be depressed to start the engine.

Power Take-off (where fitted)
The power take-off control handle allows engagement and disengagement of the power take-off clutch. Moving the lever towards the engine engages the clutch and moving the lever away from the engine disengages the clutch.

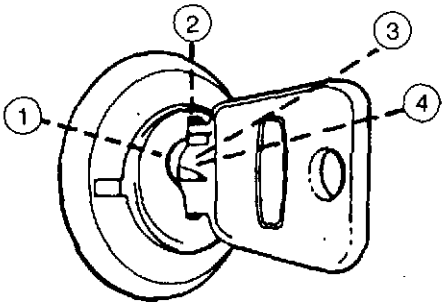


Fig. 4 - Typical Ignition Switch or Isolating Switch

1. *Auxiliary Circuits*
2. *Off*
3. *Run*
4. *Start*

When moving the handle to engage the clutch and pick up the load, do so in a smooth manner. Moving the clutch handle too slowly will cause slippage and wear, while moving it too fast will cause quick engagement and possible damage to the power take-off, engine or driven equipment. The normal force required to engage the clutch is 55 lbf (245 N) for the over-centre type and 25 lbf (110 N) for the spring loaded type.

Throttle Control (where fitted)
The throttle control adjusts engine speed. Initial engine speed adjustment is obtained by pressing the throttle control release button while pulling the throttle knob out to increase the engine speed or pushing it in to decrease the engine speed.

A final fine speed adjustment is obtained by turning the throttle control counterclockwise to increase engine speed or clockwise to decrease engine speed.

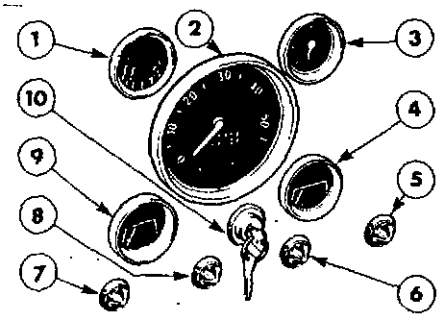


Fig. 5 — Typical Instrument Panel

1. *Ammeter*
2. *Combined tachometer/hour meter*
3. *Oil pressure gauge*
4. *Temperature gauge*
5. *Water-in-fuel warning light*
6. *Fast Flame Start Plug/Warning light*
7. *Engine management system warning light/Malfunction Indicator Lamp (MIL)*
8. *Charge indicator light*
9. *Fuel gauge*
10. *Ignition or Isolating switch*

INSTRUMENTS

Your Ford Powered Equipment will have been fitted with instruments selected by the manufacturer. The types of instruments most likely to be encountered are detailed here. A typical instrument panel is shown in Fig. 5.

1. Ammeter
This instrument registers the charging current which is being passed to the battery from the alternator. It also registers a discharge equivalent to the amount of current being used by the electrical equipment when the alternator is not charging.

Battery Condition Indicator
This is sometimes fitted instead of an ammeter and measures the battery voltage thus indicating the state of charge of the battery.

2. Tachometer
The tachometer indicates the actual engine running speed in crankshaft revolutions per minute.

2. Hourmeter
This instrument records the number of hours of operation which the engine has completed at the rated rpm. It is frequently combined with the tachometer and is used to determine when an engine service operation is required. If no hourmeter is fitted, a log should be kept.

3. Oil Pressure Gauge
The oil pressure gauge registers the lubricating system pressure in bar (kgf/cm^2 or lbf/in^2) and should be frequently observed to ensure that the system is functioning correctly.

4. Temperature Gauge
The temperature gauge enables a close check to be kept on the coolant temperatures.

5. Water In Fuel Light
This light indicates when water is present in fuel and proper service should be complete to eliminate the water.

7. Malfunction Indicator Light (EFI only)
Used on engines equipped with gasoline electronic fuel injection systems. This light will illuminate whenever there is an engine malfunction such as low oil pressure, high engine temperature, fuel injection system fault. The engine can be programmed to shut down in the event of a malfunction.

8. Charge Indicator Light
If an alternator is fitted to your engine, a charge indicator light will also be fitted. The light will glow when the isolating switch is in position 3 (Fig. 4) with the engine stationary and will therefore serve as a reminder either to turn the isolating switch to the OFF position or to start the engine. Once the engine has started, the charge indicator light should cease glowing.

Safety Switch Override Button
This must be depressed when starting the engine, as the safety switch operates when the oil pressure falls due to the engine stopping - refer to page 12.

9. Fuel Gauge
This instrument indicates the quantity of fuel in the tank.

10. Ignition or Isolation Switch - refer to page 12.

STARTING THE ENGINE

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WARNING: ALL INTERNAL COMBUSTION ENGINES GIVE OFF VARIOUS FUMES AND GASES WHILE RUNNING. DO NOT START OR RUN THE ENGINE IN A CLOSED OR POORLY VENTILATED BUILDING WHERE THE EXHAUST GASES CAN ACCUMULATE. AVOID BREATHING THESE GASES AS THEY MAY CONTAIN POISONOUS CARBON MONOXIDE WHICH CAN ENDANGER YOUR HEALTH OR LIFE IF INHALED STEADILY FOR EVEN A FEW MINUTES.

Initial start-up
On initial start-up follow the daily regular *maintenance schedule illustration page* 17.

To start from cold
1. Where possible, disconnect the driven equipment, eg, fully depress the clutch where a manual transmission is fitted.

If your unit is equipped with the engine warning light system, always turn the ignition switch to the ON position to make sure that each warning light is operating before starting engine.

2. Switch on the ignition and operate the starter motor until the engine fires.

NOTE: Where a safety switch is fitted, the override button must be depressed whilst the engine is being cranked.

3. Set the throttle to give a fast idle speed until normal operating temperature is reached.

NOTE: For EFI Governor application *there is no throttle cable. Turn key to* crank to start engine. When engine starts release key to run position. *The ECM will* adjust speed for cold start and altitude automatically.

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CAUTION: If the engine stalls or falters in starting, wait 3-4 seconds before re-engaging starter. This will prevent possible damage to the starter or *engine. The starter should not* **operate for periods longer than 30** ***seconds at a time. An interval of at*** **least two minutes should be observed between such cranking periods to protect the starter from overheating.**

To Re-start When Warm
1. Open the throttle slightly.
   a. For EFI engines, the ECM automatically controls fuel.

2. *Switch on the ignition and operate the* starter motor until the engine fires.

NOTE: Where a safety switch is fitted, the override button must be depressed whilst the engine is being cranked.

Engine Flooded (EFI Only)
Contact your nearest dealer (Europe) or industrial applications distributor (USA) located in the back section of this manual.

STOPPING THE ENGINE

AUTOMOTIVE APPLICATIONS
1. Switch off the engine by means of the ignition key.

INDUSTRIAL APPLICATIONS
Normal Conditions
Following normal operating conditions, *lower the engine speed to idle,* disengage the clutch, and then turn the ignition switch to the OFF position. If the engine has been running under high power, let it run at fast idle speed a few minutes to cool the engine down.

Abnormal Conditions
Under abnormally overheated conditions, the engine may continue to run after the ignition switch is turned off. *If this case is ever encountered, turn on* the ignition switch immediately and *allow the engine to idle until it has* cooled enough to stop. If the engine is overheated due to loss of coolant, *it is* best to stop the engine immediately, if necessary by applying the load. Add engine oil if necessary, then after the engine has returned to a normal temperature, add coolant slowly until the radiator is full.

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WARNING: AVOID INJURY WHEN CHECKING A HOT ENGINE. COVER THE RADIATOR CAP IN A THICK CLOTH AND TURN IT SLOWLY COUNTERCLOCKWISE TO THE FIRST STOP. AFTER THE PRESSURE HAS BEEN COMPLETELY RELEASED, PRESS THE CAP DOWNWARD AND FINISH REMOVING THE CAP.

The above instructions also apply to engines that stop due to operation of the low oil pressure/high water temperature safety switch. However, if the engine stops due to low oil pressure, do not restart until the cause has been determined and corrected, after the correction has been completed and the appropriate amount of oil added. Refer to page 19.

RUNNING-IN PROCEDURE

A new or reconditioned engine must not be run at high speeds or on full load for the first 25 hours. The load and speed may be increased to a maximum over this period. After the first 50 hours running, carry out the maintenance operations listed on page 17.

Check the instruments frequently and keep the coolant and oil filled to their recommended levels.

FUEL RECOMMENDATION

This engine is designed to operate on unleaded 87 or 89 octane gasoline. The engine, with the proper fuel equipment, can also operate on dry fuel such as LPG and NG.

NOTE: It is highly recommended that a Fuel Stabilizer, Ford Part Number E8AZ-19C544-A or an equivalent additive be used for any length of storage. It is imperative in any application where the fuel will not be consumed within thirty days. Refer to "STORAGE" in this section for further information.

LPG fuel specifications must meet or exceed EN 589 (European) HD-5 (USA).

NG fuel specification must meet or exceed 38.7 MJ/m^3 (UK) 39.0 MJ/m^3 (USA) (1050 BTU/ft^3).

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CAUTION: Use of fuels rated lower than the grades specified above may cause persistent, heavy spark knock, which can lead to engine damage. If your engine knocks heavily when using unleaded gasoline with 87 octane or higher, or if you hear continuous spark knock while maintaining constant operating speeds, consult your distributor or another qualified technician.

FUEL QUALITY

Using a high quality gasoline will help maintain the power, fuel economy and emissions performance of your engine. A properly formulated gasoline will be comprised of well refined hydrocarbons and chemical additives and will perform the following functions:

- Minimize varnish, lacquer, and other induction system deposits.
- Prevent gum formation or other deterioration during storage.
- Protect fuel tank and other fuel system components from corrosion or degradation.
- Provide the correct seasonally and geographically adjusted volatility. This will provide easy starting in the winter and avoid vapor lock in the summer.
- Avoid fuel system icing.

In addition, the fuel will be free of water, debris, and other impurities.

We also recommend that the fuel supply be kept fresh; when the equipment is in storage (especially in hot weather), the fuel tank should be kept at least 3/4 full.

If you anticipate storage of your engine in excess of two months, consult your distributor or other qualified technician. Also refer to the information on storage

in the "Maintenance Instructions" section of this manual.

ALCOHOL GASOLINE BLENDS (GASOHOL)

Gasohol is a mixture of gasoline and ethanol or methanol.

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CAUTION: If not properly formulated with appropriate cosolvents and corrosion inhibitors, such blends may cause performance problems or damage emissions and fuel system materials. Discontinue use if performance problems occure. To avoid jeopardizing the engine warranty and incurring unnecessary repair cost, do not use blends containing more than 10% ethanol by volume or 5% methanol by volume, or blends that do not contain cosolvents and corrosion inhibitors. Do not use such fuels unless they are unleaded.

Ethanol (C8H16) is an alchohol based fuel. There are basically two ways to produce ethanol. One way is the fermentative method. This method is based on the fermentation of ethanol from corn, sugar cane, cellulose, and other alternative crops. The other way is the catalytic hydrolysis of ethylene, a petroleum product, is the primary synthetic method. Compared to gasoline the energy content of ethanol is 66%. Ford engines should operate satisfactory on gasohol blends using unleaded gasoline and containing no more than 10% ethanol by volume. Cosolvents and corrosion inhibitors must also be added. The blend must also have an octane (anti-knock) index of 87 or 89, reference to engine specification section.

Methanol (CH30H) is also an alcohol based fuel. It can be produced in several ways. One is from natural gas. This process is an inefficient nonviable method of production. Another method is from coal. The problem with methanol produced from coal it yields a higher carbon dioxide emission. However coal reserves are much greater than oil or natural gas. A long-term supply of methanol can also be produced from biomass and urban refuse. The biomass process to methanol is prohibitive due to the amount of nonrenewable energy input required for conversion. Compared to gasoline the energy content of methanol is only 49%. Ford engines should operate satisfactory on gasohol blends using unleaded gasoline and containing no more than 5% methanol by volume. Cosolvents and corrosion inhibitors must also be added. The blend must also have an octane (anti-knock) index of 87 or 89, reference to engine specification section.

LUBRICATION AND MAINTENANCE

The importance of correct lubrication, periodic inspection and adjustment cannot be over-emphasized. It will determine, to a very large extent, the service the engine will give. Detailed instructions regarding this maintenance are given in the following pages. Your Authorized Ford Power Products Distributor/Dealer listed in the back section of this manual, will be pleased to carry out this regular maintenance for you. The various maintenance operations are listed under the heading 'Regular Maintenance Schedules' on page 17.

REGULAR MAINTENANCE SCHEDULES

When carrying out any of the following operations, any fault or malfunction should be reported immediately to the supervisor or person responsible for engine overhaul or repair.

	Daily or when refueling	After the 1st 50 hrs. (2500 km or 1500 miles) running	Every 100 hrs. (5000 km or 3000 miles) running	Every 200 hrs. (10,000 km or 6000 miles) running	Every 400 hrs. (20,000 km or 12,000 miles) running	Every 800 hrs. (40,000 km or 24,000 miles) running	Every 4 years maximum	Details on Page Number
Check engine oil level and top up if necessary	✓	✓						17
Check engine coolant level and top up if necessary with correct mixture	✓	✓	✓	✓	✓	✓		22
Check visually for oil, fuel, or coolant leaks	✓	✓	✓	✓	✓	✓		
Lubricate PTO release bearing	✓	✓	✓	✓	✓	✓		
Check coolant, oil, fuel, exhaust and vacuum hoses/pipes for leaks, damage, deterioration and correct routing. Check all visible electrical wiring for security, correct routing and evidence of chafing or heat damage		✓	✓	✓	✓	✓		
Check condition and adjust tension of drive belt(s)				✓	✓	✓		19
Change engine oil and renew engine oil filter			✓	✓	✓	✓		16
Renew air cleaner element					✓	✓		20
Renew spark plugs					✓	✓		18
*Check fuel filter element and renew as necessary				✓	✓	✓		18
Check all instruments, controls and warning lights. Check hot and cold starting functions	✓							
Clean coolant filler cap. Renew cap if seal has deteriorated							✓	
Lubricate PTO bearings			✓	✓	✓	✓		
Renew PCV valve						✓		21
Clean PCV hoses, tubes and fittings						✓		21
Check all nuts & bolts for tightness*					✓			
Adjust PTO clutch release & shaft bearings*					✓			

NOTE: The above Maintenance Schedules give the maximum recommended service periods. Since operating conditions can vary, it may be found advisable to carry out some operations, for example, changing the engine oil, at an interim period. Your operating experience is the best guide for determining this time.

*For EFI it is recommended that this operation is carried out by an authorized Ford Dealer. Depending upon the quality of the fuel used, it may be necessary to renew the filter element more frequently.

REGULAR MAINTENANCE OPERATIONS

Recommended Lubricants (Automotive)
Use Ford/Motorcraft 'Formula E' SAE 5W-30 engine oil or an equivalent oil which meets the requirements of ACEA A1-96, B1-96 and Ford Specification WSS- M2C9 12-A1.

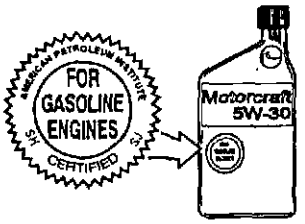
Other viscosity oils meeting these requirements or meeting ACEA A2-96 and B2-96 or ACEA A3-96 and B3-96 may be used according to the prevailing ambient temperature - refer to the viscosity chart (Fig. 6). If these recommended oils are not available, then oils meeting the requirements of API SH may be used. Use of these alternative oils may result in reduced performance for fuel economy and emissions. Do not use API SC, SD, SE or SF oils.

CAUTION: Do not use supplemental oil additives or other engine treatments. They are unnecessary and could, under certain conditions, lead to engine damage which is not covered by Ford warranty.

Lubricating oil cleanliness is vital for the successful operation of your engine. The oil should be stored under the cleanest possible conditions.

When changing or topping-up engine oil use only clean receptacles. Do not allow the oil to come into contact with rubber hoses on the engine.

Recommended Lubricants (Industrial)
Use Ford or Motorcraft oil or equivalent that meets Ford Specification **WSS-M2C153-G** (API Classification – SJ). If SJ oils are not available, SH oils are acceptable. Use only engine oil displaying the American Petroleum Institute Certification Mark on the front of the container, or API specification SH, or SJ.



NOTE: Ford Power Products industrial engines are designed to perform with engine oils that are licensed by the American Petroleum Institute (API), and oils carrying the most current API classification should be used. API classifications are broken into two categories, gasoline and diesel engines. API's classification is designated by a two letter system. The first letter, the prefix, designates gasoline or diesel. An "S" designates gasoline and a "C" designates diesel. The second letter in the system designates the level of the classification. It should be noted that alternative fuel engines fall into the "gasoline" API category.

Gasoline engines that are converted for LPG or Natural Gas applications must use oils labeled SH and/or SJ. Do not use oils that are specifically formulated for Diesel Engines only. CC or CD classification, even when labeled Heavy Duty or for Natural Gas Engines, are not acceptable. The use of SAE 5W~30 is preferred for all temperatures.

Used Engine Oils

WARNING: PROLONGED AND REPEATED CONTACT MAY CAUSE SERIOUS SKIN DISORDERS INCLUDING DERMATITIS AND SKIN CANCER.

AVOID EXCESSIVE CONTACT—WASH THOROUGHLY AFTER CONTACT. KEEP OUT OF THE REACH OF CHILDREN.

PROTECT THE ENVIRONMENT: IT IS ILLEGAL TO POLLUTE DRAINS, WATER COURSES OR SOIL. USE AUTHORIZED FACILITIES FOR DISPOSAL. IF IN DOUBT, CONTACT YOUR LOCAL AUTHORITY FOR ADVICE.

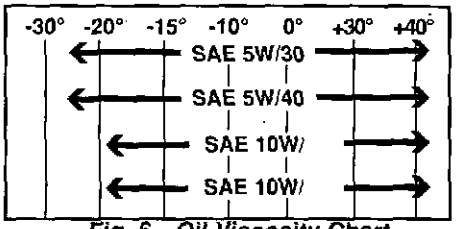


Fig. 6—Oil Viscosity Chart

WARNING: DO NOT HANDLE A HOT OIL FILTER WITH BARE HANDS. CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. PROTECT YOUR SKIN BY WASHING WITH SOAP AND WATER IMMEDIATELY AFTER CONTACT.

Change Engine Oil

1. Warm the engine to normal operating.

2. Make sure that the equipment is standing level and that the engine is stopped.

3. Obtain a sufficiently large draining pan to accommodate the engine oil (see 'Service Oil Fill Capacity' in General Specifications).

4. Remove the oil filler cap from the rocker cover, remove the drain plug from the oil pan and drain the oil into the draining pan.

NOTE: Modern high performance oils have a cleaning action on the engine which may turn the oil dark, but does not necessarily indicate inadequate oil changes.

5. Replace and tighten the drain plug, then fill the engine via the filler neck in the rocker cover with the correct quantity of oil (see 'General Specifications').

6. Replace the oil filler cap and run the engine for no more than 30 seconds.

7. Check the oil level as described in the following section.

Check Engine Oil Level

1. Make sure the equipment is standing level and that the engine is stopped.

2. Pull out the dipstick and wipe it with a clean rag.

3. Insert the dipstick fully and again remove it. At no time should the level of the oil fall below the lower mark on the dipstick.

4. If necessary, top up to the dipstick higher mark with an approved type and grade of oil.

5. Replace the dipstick, ensuring that it is fully inserted into its tube to maintain a sealed crankcase condition.

Renew Engine Oil Filter

Your engine is equipped with a Motorcraft oil filter. A filter of this quality should be used throughout the life of the engine. It is designed to protect your engine by filtering harmful abrasive and sludgy particles without clogging up or blocking the flow of the oil to vital engine parts. This filter is especially designed for use in engines built by Ford to give successful operation with the recommended oil filter change intervals. Contact your nearest Ford Power Product Distributor/Dealer listed in the back section to obtain the correct filter.

Before commencing, place a drain pan beneath the filter to catch any spilt oil.

1. Using a suitable strap wrench, unscrew the oil filter canister.

2. Thoroughly clean oil filter housing face.

3. Partly pre-fill the new filter with clean engine oil of the correct type and grade. Apply a thin film of clean engine oil to the oil filter sealing ring.

4. Screw on new oil filter canister until sealing ring abuts the filter head and tighten a further 1/2 turn. Do NOT use a strap wrench or similar tool to tighten the filter canister.

5. Run engine and check for any leaks from oil filter.

6. Stop engine, allow oil to settle and top up as necessary.

FUEL SYSTEMS

EFI

In the event that your engine is equipped with an EFI (Electronic Fuel Injection) system follow normal maintenance service. Any necessary service repairs should be made by your Ford Power Products Distributor or Dealer. The adjusting procedure requires the use of tools which are not readily available to consumers. Please contact Ford Power Products Dealers or Distributors listed in the back section of this manual.

FUEL FILTER - EFI (Industrial)

The fuel filter is located between the fuel tank and the fuel pump, and is not mounted on the engine.

WARNING: WHEN REMOVING THE FUEL FILTER, USE CAUTION SINCE THERE MAY BE FUEL PRESSURE PRESENT.

The fuel filter should be replaced according to the maintenance schedule on page 17, or more often if needed.

1. Block fuel flow by crimping fuel feed line with appropriate tool between fuel tank and filter.

2. Place suitable container beneath filter to collect spilt fuel.

3. Remove fuel line clamps and hose at each end of filter.

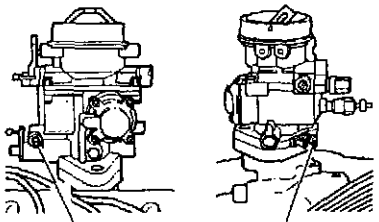
4. Replace fuel filter using Ford Power Products fuel filter number F8JL-9A011-AA.

5. Dispose of fuel filter properly.

PROTECT THE ENVIRONMENT. It is illegal to pollute drains, water courses or soil. Use authorized facilities for disposal. If in doubt, contact your Local Authority for advice.

CARBURETOR

Adjustments/Zenith



The idle speed adjustment screw, and the idl fuel mixture adjustment needle are accessible on the exterior of the carburetor.

There are three factors that control conversion of the fuel and air mixture into the engine power. These factors are engine compression, ignition and correct carburetor air/fuel adjustment. Correct carburetor adjustment cannot be obtained, however, unless engine compression and ignition meet specifications.

To make the adjustments, start the engine and operate it until it has reached normal operating temperature. Be sure the choke and throttle controls are pushed all the way in.

Start the adjustments by setting the idle speed screw to obtain an engine speed of 750 rpm. Then turn the idle fuel mixture adjustment needle in (clockwise) until the engine begins to roll. Then, back it out

slowly until the engine is running smoothly. Reset the idle speed to 750 rpm.

Fuel Filter At Carburetor

The disposable filter is located at the carburetor fuel inlet line.

1. Backup filter using an 11/16" open end wrench while removing fuel inlet line using a 1/2" line wrench.

CAUTION: Do not use open end wrench on a fuel line fitting. This may cause damage to the fitting.

2. Unscrew fuel filter from carburetor and discard.

3. Install new filter being careful not to overtighten.

4. Backup filter while tightening inlet line.

5. Cycle the ignition switch to charge fuel system and check for leaks.

Fuel Filter Before Fuel Pump

The disposable filter is located on the inlet side of the electric fuel pump.

1. Backup filter using an open end wrench while removing fuel inlet line using a line wrench.

2. Disconnect hose clamp and remove filter from hose and discard.

3. Install new filter being careful not to overtighten.

4. Backup filter while tightening line.

5. Cycle ignition switch and check for leaks.

IGNITION SYSTEM - DIS

The Distributorless Ignition System (DIS) used on this engine does not have a distributor or vacuum advance mechanism. Ignition timing is set by design and cannot be readily changed. In the event that the engine is converted to alternative fuels, the timing can be re-set by trained technicians. Please contact a Ford Dealer or Distributor listed at the back of this manual.

Renew Spark Plugs

WARNING: THE DIS IGNITION SYSTEM COMMONLY CARRIES VOLTAGES IN EXCESS OF 60,000 VOLTS. PLEASE USE CAUTION.

1. Remove the lead from each spark plug by grasping, twisting and then pulling the moulded boot on the end of the lead.

CAUTION: Do not pull directly on the lead as this could cause the wire connection inside the boot to become separated.

2. After loosening each spark plug one or two turns with a proper spark plug spanner, clean the area around each spark plug port with compressed air then remove the spark plugs.

WARNING: PROTECTIVE GOGGLES MUST BE WORN TO PROTECT THE EYES WHEN USING COMPRESSED AIR.

3. Check the gaps of the new spark plugs with feeler gauges, and, where necessary, bend the outer ground extension to achieve the specified gap.

4. Use a proper spark plug spanner to avoid damaging the insulators, screw the new spark plugs into the cylinder head and tighten them to the specified torque value listed under specification of this manual.

CAUTION: Do not over tighten spark plugs as the gap may change considerably due to the distortion of the plug outer shell.

5. Coat the inside of each spark plug boot with silicone dielectric compound D7AZ-1 9A33 1-A (USA) or equivalent, using a small screwdriver blade.

6. Re-connect each high tension lead to the correct spark plug (Fig. 10).

NOTE: The plug numbers are printed on the leads to aid correct re-assembly.

Be sure each lead is fully pressed onto each plug and that the moulded boot is firmly in place.

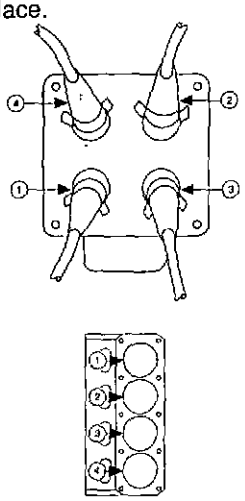


Fig. 10

GOVERNORS - ELECTRONIC

In the event that your engine is equipped with an electronic governor, any necessary adjustment should be made by your Power Products Distributor or Dealer listed at the back of this manual. The adjusting procedure requires the use of tools which are not readily available to consumers.

GOVERNORS - MECHANICAL

WARNING: BEFORE PERFORMING ANY SERVICE OR MAINTENANCE TO THE MECHANICAL GOVERNOR THE ENGINE MUST BE TURNED OFF AND HAVE COME TO A COMPLETE STOP: ANY REMOTE START MUST BE DISABLED AND LOCKED OUT.

Lubrication

Clean the body of the governor in the area of the fill plug. Check the oil level by slowly removing the oil level plug. If oil drips out, the oil level is full. If oil doesn't drip out, slowly add engine oil into the oil fill hole. As soon as it begins dripping out the oil level hole, insert the plug.

At the specified intervals, apply an appropriate lubricant, such as Lubriplate (C0AZ-19584-A) at the pivot points of the throttle, governor and choke linkage.

NOTE: Before making any governor adjustments, check the governor drive belt tension with a belt tension gauge. Refer to Anciliary Drive Belt section, page 23.

Linkage Adjustment

The first adjustment is the governor-to-carburetor control rod adjustment. With the control rod connected, manually move the governor throttle lever to the maximum open throttle position. Check that the carburetor throttle shaft lever is set from 1/32 to 1/16 of an inch from its maximum open position stop. If necessary adjust length of the control rod to obtain the setting.

High Speed Adjustment

1. Attach a tachometer to the engine suitable for Distributorless Ignition System.

2. Disengage any engine load and run the engine until it reaches normal operating temperature.

3. Slowly increase the throttle to maximum no load engine speed.

4. Check engine RPM to determine if RPM is low or high.

5. Decrease throttle back to idle.

6. Turn engine ignition off and wait for engine to come to complete stop. Disable and lock out any remote start.

7. Loosent the lock nut on the high-speed stop screw.

8. Turn the high-speed stop screw counterclockwise a 1/4 of a turn to increase the speed or turn the high-speed screw clockwise a 1/4 of a turn to decrease the speed.

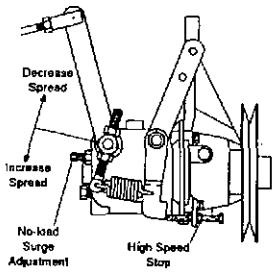
9. Restart the engine. Slowly increase the throttle to maximum no load engine speed.

NOTE: Do not exceed maximum RPM recommended by the equipment manufacture.

10. Check RPM. If not at desired speed, repeat steps 5 through 10.

Spread Adjustment

The next adjustment is for spread. Proper governor operation requires a difference between full-load and no-load governor speed. Too small an rpm spread between the two speeds will cause govenror hunting and surging. Too large a spread will cause the low response. For this governor, normal rpm spread is approximately 250 rpm within the full load speed range of 2000-2800 rpm.



To increase the rpm spread, adjust the screw to move the spring away from the lever hub. To decrease the rpm spread, adjust the screw to move the spring closer to the lever hub.

No-Load Surge Adjustment

The no-load surge adjustment is set at the factory and rarely requires adjustment. If necessary, this adjustment can be used to prevent hunting and surging at no-load speeds only, provided the rpm spread adjustment is set properly. Make the adjustment with the tachometer installed. Increase the engine speed with the hand throttle to 75 rpm lower than the maximum no-load desired control rpm.

NOTE: At this point if the engine continues to surge, apply light pressure to governor throttle lever. If the surges are dampened then loosen the no-load surge adjustment screw locknut and turn the screw inward until the rpm increases to the desired control rpm. Reset high speed adjustment screw and tighten locknuts.

⚠

CAUTION: Do not turn the no-load surge screw in all the way. It will interfere with proper governor operation and prevent the governor from returning the engine to idle speed.

ANCILLIARY DRIVE BELT

Serpentine Belt

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WARNING: ENGINE SHOULD BE STOPPED AND ANY REMOTE START DISABLED BEFORE CHECKING BELT.

The serpentine ancilliary belt used to drive the alternator and water pump, is tensioned automatically and does not require adjustment.

However, the belt should be visually inspected for signs of wear or damage. It should be renewed if necessary.

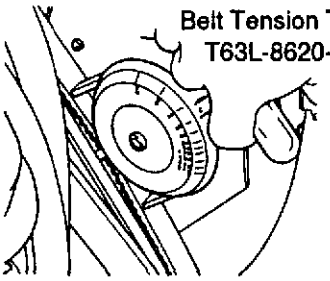
V-Belt

The V-belt should be properly adjusted at all times. A loose V-belt can cause improper operation, in addition to overheating. Overtightening the belt may result in excessive bearing wear, as well as premature wear on the belt itself.

V-Belt Tension

A belt tension gauge should be used to

check V-belt tension. Refer to specification section for the proper tension at the back of the book.



To adjust V-drive belt tension:

1. Shut off engine, disable and lockout any remote start.

2. Loosen the mounting bolts.

3. Move the driven component until the correct tension is obtained (see "Belt Tension" in the Specifications Section).

4. Remove the gauge.

5. Tighten the mounting bolts.

6. Recheck belt tension with tension gauge.

Check Engine Coolant Level

⚠

WARNING: AVOID INJURY FROM HOT COOLANT WHEN CHECKING A HOT ENGINE.

NOTE: Cover the radiator cap with a thick cloth and turn it slowly counter-wise to the first stop. After the pressure has been completely released, press downward and finish removing cap.

⚠

CAUTION: Do not add coolant to an engine that has become overheated until the engine cools. Adding coolant to an extremely hot engine can result in a cracked block or cylinder head.

⚠

WARNING: FAILURE TO FOLLOW THE INSTRUCTIONS BELOW COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY.

1. Allow the engine to cool down to 110°F.

2. Turn the radiator expansion/degas tank filler cap through 90° in an counter-clockwise direction. Pause to allow any pressure to drop, then turn cap fully anti-clockwise and remove it.

3. The quantity of coolant in the expansion/degas tank is a direct indication of the coolant level in the complete system. The acceptable level of coolant in the expansion/degas tank is shown by the level indicators moulded into the tank wall. Top up as necessary with a mixture of plain water and antifreeze — refer to page 25 for information on mixing antifreeze solutions.

NOTE: It is essential that only the correct type of antifreeze is used — refer to page 25

4. Replace the filter cap and turn down tightly.

Renew Air Cleaner Element

Your air cleaner filters air entering the engine induction system and acts as a silencer and a flame arrester. Air that contains dirt and grit produces an abrasive fuel mixture, and can cause severe damage to the cylinder walls and piston rings. Damage to the cylinder walls and piston rings will cause high oil consumption and short engine life. A restricted or dirty air cleaner will also cause a rich fuel mixture. Thus, it is extremely important that the air cleaner be serviced at recommended intervals.

CAUTION: Service the air cleaner more frequently under severe dust conditions.

1. Release the air cleaner lid retaining hardware.

2. Lift the air cleaner lid clear of the air cleaner body, then remove the air cleaner element and discard it.

3. Wipe the inside of the air cleaner body and lid clean, using a non-fluffy rag.

4. Insert the new element, ensuring that it is seated correctly.

5. Replace the air cleaner lid and secure it with the retaining hardware.

Renew PCV Valve

1. Detach the hose (1) Fig. 12, from the top of the PCV valve located at the top of the oil deflector just below the first and second leg of the inlet manifold (2) and from the inlet manifold.

2. Withdraw the PCV valve from the valve cover (2).

3. Discard the PCV valve.

4. Thoroughly clean the inside and outside of the hose.

5. Insert the new PCV valve.

6. Re-connect the hose to the PCV valve and to the inlet manifold.

GENERAL MAINTENANCE INFORMATION

The following section outlines some aspects of general maintenance which will be of value to the operator.

Cooling System

To obtain maximum engine service life, its operating temperature must be maintained by an efficient cooling system.

CAUTION: Under no circumstances may the engine be started without liquid in the cooling system may cause permanent damage to the engine.

Inspect the exterior of the radiator for obstructions, Remove all bugs, dirt or foreign material with a soft brush or cloth. Use care to avoid damaging the fins. If available, use low pressure compressed air or a stream of water in the opposite direction to normal airflow. Check all hoses and connections for leaks. If any of the hoses are cracked, frayed, or feel spongy, they should be replaced.

CAUTION: Never use a cold coolant mixture to top-up the radiator or degas tank of a hot engine if the coolant level is very low; this could cause serious damage to the engine.

The radiator or degas tank is normally equipped with a pressure cap. It is dangerous to remove this when the system is very hot.

WARNING: AVOID INJURY FROM HOT COOLANT WHEN ENGINE IS HOT.

If the cooling system is hot, cover the pressure cap with a thick cloth to prevent coolant from scalding the hand, then turn cap to the safety position (first stop) to relieve system pressure. When pressure has been relieved, remove cap completely.

In territories where freezing conditions may occur, the coolant should consist of a mixture of 50% plain water and 50% Motorcraft Super Plus 2000 coolant. This antifreeze contains additional corrosion inhibitors designed to provide lasting protection for the engine.

Only this antifreeze, or proprietary antifreeze meeting Ford Specification WSS-M97B44-D or Ford specification ESE-M97B44-A should be used when

topping-up or re-filling the cooling system.

Motorcraft Super Plus 2000 coolant has long life characteristics and if the concentration is kept to a maximum of 50% it will provide adequate frost protection and inhibiting for the life of the engine.

NOTE: If a major component of the cooling system is renewed such as the radiator, water pump etc., the system should be flushed and re-filled with a 50% solution of Motorcraft Super Plus 2000 coolant and clean water.

In territories where the ambient temperature is such that no protection against freezing is required, it is recommended that a 25% concentration of Motorcraft Super Plus 2000 coolant is used. This will protect water pumps, core plugs, thermostat housings and radiators against corrosion for the life of the engine when used at this concentration. See previous Note on renewing cooling system components.

The antifreeze concentration in a cooling system can be determined by using a suitable hydrometer.

A reading of 1080 represents a 50% antifreeze concentration.

A reading of 1040 represents a 25% antifreeze concentration.

A reading of 1000 represents plain water.

WARNING: ANTIFREEZE CONTAINS MONOETHYLENE GLYCOL AND OTHER CONSTITUENTS WHICH ARE TOXIC IF TAKEN INTERNALLY AND CAN BE ABSORBED IN TOXIC AMOUNTS ON REPEATED OR PROLONGED SKIN CONTACT. PERSONS USING ANTIFREEZE ARE RECOMMENDED TO ADHERE TO THE FOLLOWING PRECAUTIONS:

1. ANTIFREEZE MUST NEVER BE TAKEN INTERNALLY. IF ANTIFREEZE IS SWALLOWED ACCIDENTALLY, MEDICAL ADVICE SHOULD BE SOUGHT IMMEDIATELY.

2. PRECAUTIONS SHOULD BE TAKEN TO AVOID SKIN CONTACT WITH ANTIFREEZE. IN THE EVENT OF ACCIDENTAL SPILLAGE ONTO THE SKIN, ANTIFREEZE SHOULD BE WASHED OFF AS SOON AS PRACTICABLE. IF CLOTHING IS SPLASHED WITH ANTIFREEZE, IT SHOULD BE REMOVED AND WASHED BEFORE BEING WORN AGAIN, TO AVOID PROLONGED SKIN CONTACT.

3. FOR REGULAR AND FREQUENT HANDLING OF ANTIFREEZE, PROTECTIVE CLOTHING (PLASTIC OR RUBBER GLOVES, BOOTS AND IMPERVIOUS OVERALLS OR APRONS) MUST BE USED TO MINIMIZE SKIN CONTACT.

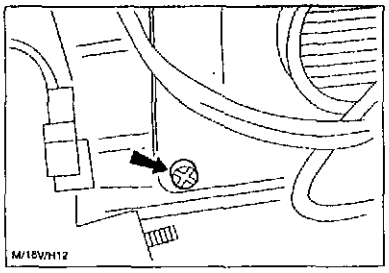


Fig. 14 — Radiator Drain Cock (Typical Ford Vehicle Type shown)

Draining, flushing and filling the cooling system

WARNING: AVOID INJURY FROM HOT COOLANT WHEN ENGINE IS HOT.

1. Allow the engine to cool down until the coolant has lowered in temperature to below 110°F.

2. Remove the radiator expansion/ degas tank filler cap, then open the radiator drain cock (Fig. 14), where fitted, or detach the bottom radiator hose.

3. Flush the system through with a hose until clean water emerges and allow all water to drain out. Close the drain cock (or replace the bottom radiator hose). Recover all old antifreeze and dispose of properly. Contact your local municiple government for the proper disposal.

4. Fill the system with the correct coolant mixture via the expansion/degas tank filler neck. Fill the system slowly, to avoid air locks, up to the 'maximum' mark on the degas tank.

5. Run engine and check hose connections for leaks. Check, and, if necessary, top up the coolant in the radiator or degas tank.

Engine Lubrication System

The lubrication system should be maintained regularly (page 17) with the correct grade of lubricant as specified in the maintenance summary (page 18). The system is of the force feed type, the lubricating oil being circulated to the engine bearings under pressure by an oil pump driven from the camshaft drive belt.

The dipstick provides some guide to the condition of the oil. An additive type of oil keeps soot in suspension, and even a small amount of soot causes the oil to darken rapidly.

However, if the dipstick is found to be heavily coated with sludge, then obviously the oil should be changed.

Electrical System

A NEGATIVE EARTH SYSTEM IS USED. (Negative ground).

Battery

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WARNING: BATTERIES NORMALLY PRODUCE EXPLOSIVE GASES WHICH CAN CAUSE PERSONAL INJURY. THEREFORE, DO NOT ALLOW FLAMES, SPARKS OR ANY IGNITED OBJECT TO COME NEAR THE BATTERY. WHEN CHARGING OR WORKING NEAR A BATTERY, ALWAYS SHIELD YOUR EYES. ALWAYS PROVIDE VENTILATION.

⚠

WARNING: WHEN LIFTING A BATTERY, ALWAYS LIFT WITH A BATTERY CARRIER OR WITH YOUR HANDS ON OPPOSITE CORNERS. EXCESSIVE PRESSURE ON THE END WALLS COULD CAUSE ACID TO SPEW THROUGH THE VENT CAPS, RESULTING IN PERSONAL INJURY.

NOTE: Please refer to page 6 for additonal warnings.

Ensure that the correct battery terminal is connected to a good earth on the framework of the equipment.

⚠

WARNING: GOGGLES MUST BE WORN WHEN CARRYING OUT THE FOLLOWING OPERATIONS.

If there is any corrosion on the cables and terminals remove it with a wire brush and neutralize the acid with a solution of baking soda with water.

After cleaning, flush the top of the battery with clean water, install the terminal clamps on the battery posts, and coat the parts with petroleum jelly to retard further corrosion.

The electrolyte level should be 6 to 9 mm (0.25 to 0.38 in) above the top of the plates. If the electrolyte is below the correct level, add the required amount of distilled water.

NOTE: When a battery becomes discharged, it is important to recharge it as soon as possible to avoid permanent damage.

Distilled water for battery use should be kept in clean, covered, non-corrodible vessels. In cold weather, add water only immediately before running the engine, so that the charging will mix the water and electrolyte and prevent freezing.

If the battery is allowed to stand at low temperatures in a partially discharged condition there is a possibility that it may freeze, causing damage to the container. Take care, therefore, to keep the battery as fully charged as possible.

Battery condition and charge level can be determined by the use of a suitable proprietary battery test meter. To ensure accurate readings, follow the manufacturer's recommended test procedure exactly.

In addition to the battery test meter, charge level can also be determined using a calibrated digital voltmeter. This test provides a useful alternative to the test meter to establish battery charge, but provides no indication of battery condition .

NOTE: In the event of a conflict of results between the battery test meter and the digital volt meter, the battery test meter results should be used.

Battery State of Charge Measurement *using a Calibrated Digital Volt Meter*

NOTE: Before taking a voltage reading the battery must in a stabilized condition.

The battery can be considered stabilized if it has stood for six hours without being charged or discharged (includes charging by the engine's alternator or discharging by the vehicle/installation loads). Otherwise *the battery can be stabilized by carrying out* the following operations 1 to 4 inclusive.

1. Switch on the headlamps (main/high beam) or similar load for 30 seconds. In the case of headlamps, the ignition must usually be switched on to activate the main/ high beam.

2. Switch off the headlamps and all other electrical loads; in the case of vehicles, close all doors and the tailgate/luggage compartment lid to switch off any internal lights.

3. Wait for at least five minutes to allow the battery voltage to recover before taking a reading.

4. Clean the battery terminals and measure the voltage.

The stabilized voltage can be interpreted as shown in the following table:

Stabilized Voltage (V)	% Charge	Notes
Up to 11,6	0	Recharge immediately to avoid permanent damage
11,6 to 11.9	0 - 25	
11,9 to 12,2	25 - 50	
12,2 to 12,4	50 - 75	
12,4 to 12,7	75 - 100	Battery is adequately charged
12,8 +	100	Caution – Battery may not be fully stabilized

Using 'Jumper' Cables

WARNING: SINCE EXPLOSIVE HYDROGEN GAS IS ALWAYS PRESENT, SPARKS OR FLAMES SHOULD NOT BE ALLOWED NEAR THE BATTERY.

CAUTION: Only connect batteries with the same nominal voltage (12V). Use jumper leads with shrouded clamps and wires of sufficient thickness to carry the required current. Do not disconnect either battery from its electrical system.

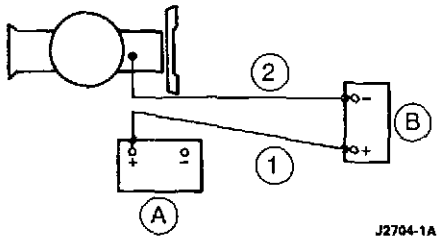

Fig. 16 — Correct Connections of Vehicle Booster Battery

A. *Flat battery*
B. *Booster battery*
1. *Jumper lead connecting positive (+) terminals* (red leads).
2. *Jumper lead connecting negative (-) terminal of booster battery to earth of vehicle with flat battery (black leads).*

NOTE: Use Fig. 16 for all applications. Vehicle and industrial use.

1. Position both vehicles close to but not touching one another so that the batteries are near each other (Fig. 16).

2. Switch off all unnecessary electrical equipment on both vehicles.

3. With both vehicle engines switched off, connect the positive (+) terminal of the booster battery to the positive (+) terminal of the flat battery with the red jumper lead (1) in Fig. 16.

4. Connect one end of the jumper lead #2 (black lead) to the negative (-) terminal of the booster battery . Connect the second end of the #2 jumper lead (black lead) to a clean, bare metal part of the engine to be started with the black jumper lead (2) in Fig. 16.

NOTE: Connect the black lead to a part of the engine as far from the flat battery as possible.

5. Ensure that both jumper leads are well clear of any moving parts of the engines, then start the booster battery vehicle engine.

6. With the engine of the booster battery vehicle running at a medium speed, start the engine of the vehicle with the flat battery.

7. Once the engine has started, leave both engines running for approximately 3 minutes.

8. To reduce voltage peaks, switch on the heater blower and the heated rear screen of the vehicle with the flat battery, then disconnect lead (2) first then lead (1).

CAUTION: Do NOT switch on the headlamps instead of the heated rear window as the peak voltage could blow the bulbs.

NOTE: When using 'jumper' cables, the cables should always be attached to the booster battery first.

Alternator

This is mounted on a bracket at the front of the engine and is driven from the crankshaft by a serpentine belt.

The charging rate is adjusted automatically by the built-in regulator to provide sufficient electric current to keep the battery fully charged under normal operating conditions.

The alternator requires no lubrication or maintenance.

WARNING: IT IS ESSENTIAL THAT THE WIRING CONNECTIONS TO THE ALTERNATOR ARE NOT REMOVED WHILE THE ENGINE IS RUNNING, AS THIS WILL RESULT IN DAMAGE TO THE REGULATOR OR PERSONAL INJURY.

STORAGE (Industrial Applications, Gasoline (Petrol) Only)

NOTE: It is highly recommended that a Fuel Stabilizer, Ford Part Number E8AZ-19C544-A or an equivalent additive be used for any length of storage. It is imperative in any application where the fuel will not be consumed within thirty days. Ford Fuel stabilizer comes in an 8 fl. oz. bottle for consumer use and should be available through all Power Products Distributors. The correct ratio is 2 oz. Stabilizer to 5 gallons of gasoline. Without the use of an additive, the unused fuel in your fuel tank can and will go sour in a very short period of time, causing varnish and contaminants to form. This causes problems in fuel delivery by clogging fuel injectors.

STORAGE - ONE MONTH

- Add fuel stabilizer (see previous note).
- While the engine is running, treat upper cylinders by spraying engine fogging agent (from your local aftermarket supplier), recommended engine oil (SAE 10) or equivalent into the air intake for about two minutes. Open throttle for short burst of speed, shut-off engine and allow it to come to a stop while continuing to spray into air intake.
- Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs and cover all openings into engine with dust proof caps or shields (suitable non-hygroscopic material).
- If engine is less transmission, spray flywheel and ring gear with mixture of one part recommended engine oil, and one part Stoddard Solvent or equivalent.
- Check coolant protection. Store indoors in dry area.

STORAGE - INDEFINITE PERIOD

- Add fuel stabilizer (see previous note).
- Drain crankcase completely and refill with recommended engine oil, (SAE 10) or equivalent.
- Run engine until completely out of gasoline, then restart and run on unleaded gasoline, mixed with stabilizer, for at least 10 minutes. While engine is still running and at completion of above run, treat upper cylinders by spraying fogging agent or recommended engine oil into the air intake for about two minutes. Open throttle for short burst of speed, shut off engine and allow it to come to a stop while continuing to spray into air intake.
- Check coolant protection.
- Disconnect and remove battery.
- Clean exterior surface of engine.
- Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs.
- Seal all openings in engine and accessories with non-hydroscopic material. Mask off all areas to be used for electrical contacts.
- Make sure all surfaces are dry, then spray all taped openings, all engine accessories including ignition wiring, and all exterior surfaces of engine with Insulation Compound.
- If engines are equipped with automotive type clutch, block clutch in slightly disengaged position so that lining and pressure plates are not in contact.

ENGINE FAULT FINDING

Engine will not start

Starter does not crank engine	Battery run down. Lead disconnected or corroded. Faulty starter switch. Starter drive dirty. Faulty starter motor.
Starter cranks engine slowly	Battery partly run down. Terminal(s) loose. Connections dirty. Wrong grade of oil. Faulty starter motor.
Starter cranks engine normally	**Fuel** Lack of fuel. Fuel shut-off valve not opening.* Faulty vacuum switch.* Blockage in fuel line. Air leak in inlet manifold. Blocked fuel filter. Faulty converter/regulator.* Faulty fuel pump.
	Electrical IGNITION – NO SPARK AT PLUG GAPS Spark plugs oiled up. Spark plug insulators cracked. COIL – NO SPARK AT HIGH TENSION LEAD Coil(s) burnt out. High tension lead loose or broken. Faulty ignition switch or low tension wiring to coil. Faulty wiring to fuel shut-off valve or vacuum switch*. Faulty ECM. Faulty ICM. Faulty crank position sensor. Faulty fuel pump relay.

*Applicable to LPG & Natural Gas engines only.

Engine runs incorrectly

	IGNITION	FUEL	MECHANICAL
Engine misfires	High tension leads to spark plugs shorting. Incorrect spark plug gaps. Cracked spark plug insulator.	Fuel line partly chocked. Shortage of fuel. Faulty regulator.* Vacuum leaks at mixer.*	Valves sticking. Valves burnt. Valve spring broken.
Engine starts and stops.	Faulty ignition switch contact.	Fuel line blocked. No fuel. Air leaks.	
Engine runs on full throttle only		Faulty electronic governor.	Valve sticking. Valve burnt. Valve spring broken.
Engine does not give full power	Ignition retarded. High tension lead shorting. Engine running in Limp-in mode.	Fuel supply faulty. Air leaks in inlet manifold.	Valve burnt or bad seating.
Engine runs imperfectly	Faulty EFI system.	Fuel feed faulty.	Inlet valve(s) not closing.
Engine knocks	Plug leads crossed.		Excessive carbon deposits. Loose bearings or piston.

	COOLING SYSTEM	MECHANICAL	FUEL
Engine runs too hot	Low coolant level. Inoperative thermostat. Dirty cooling system. Running engine with frozen coolant. Ambient temperatures 50°C or higher.	Loose or broken fan belt. Radiator fins restricted with leaves, dirt, etc. Prolonged idling. Leaky head gasket. Overloading, especially during hot weather.	Gasoline running lean LPG & NG running rich.

*Applicable to LPG & Natural Gas engines only.

GENERAL SPECIFICATIONS

Engine Type: I-4 cylinder 4 stroke spark ignition.

Liter/CID:	2.5 / 153
Bore: mm (inch)	96 (3.0)
Stroke: mm (inch)	86.4 (3.4)
Compression Ratio:	9.37:1
Firing Order:	1-3-4-2

Fuel System

Liquefied Petroleum Gas (LPG)

Type:	2 stage
Fuel Specification:	EN589 (European) HD-6 (USA)

Natural Gas

Type:	Butterfly plate
Fuel Specification:	38.7 MJ/m³ (UK) 39.0 MJ/m³ (USA)

Gasoline (Petrol)

Type:	Electronic Fuel Injection or Carburetor
Fuel Specification:	Unleaded 87 or 89 Octane (Gasoline blends not to exceed 10% Ethanol by volume Octane Index of 87 or 89).

Fuel Pump Pressure

Normal:	EFI: 63 (PSI)	Carb: 3.5-5.0 (PSI)
Max:	EFI: 100 (PSI)	Carb: 6.0 (PSI)

Lubrication System

Maximum Oil Pressure

Hot at 2500 rpm –	275.79-413.69 kPa (40-60 psi)

Service Oil Fill Capacity

(including filter):	4.26L (4.5 quarts)

Cooling System

Thermostat Type:	Wax element
Commences opening:	88.9°C
Fully Open:	100°C

Electrical System

Polarity:	Negative to earth (ground)
Battery Size:	Cold start/reserve capacity 550Z/105RC

Alternator

Drive BeltTension:	Tension is witin specification if the tensioner is within the indicator markings

GENERAL SPECIFICATIONS (Continued)

Ignition System

Spark Plug Type	Gasoline	Dual Fuel	Dedicated LPG & NG
Motorcraft	AWSF-52-C	AWSF-52-C	AWSF-52-C
Gap	1.12mm (.044 in)	1.12mm (.044 in)	1.12mm (.044 in)

Mechanical Governor Belt Tension

New 3.1138N (70 lbs.)
Used 222.41 N (50 lbs.)
(A used belt is one that has been in operation for 10 minutes or more.

TIGHTENING TORQUES

	Nm	lbf ft
Oil Pan Draing Plug:	20 to 34	15 to 25
Spark Plugs:	9 to 20	7 to 15

Conversion Tables

To Convert From To	To From	Multiply By Divide By
Inches	**mm**	**25.4**
inches	m	0.0254
feet	**mm**	**304.8**
feet	m	0.3048
yards	**m**	**0.9144**
mile	km	1.609
	AREA	
In^2	**mm^2**	**645.16**
ft^2	m^2	0.0929
yds^2	**m^2**	**0.8361**
	VOLUME	
In^2	**cm^2**	**16.3871**
in^2	1 (dm^3)	0.016387
pint (US)	**1 (dm^3)**	**0.47318**
pint (UK)	1 (dm^3)	0.56826
gallon (US)	**1 (dm^3)**	**3.7854**
gallon (UK)	1 (dm^3)	4.5461
ft^3	**1 (dm^3)**	**28.3168**
ft^3	m^3	0.02832
	MASS	
oz	**g**	**28.3495**
lb	kg	0.45359
ton (US)	**tonne**	**0.90718**
ton (UK)	tonne	1.01605
	DENSITY	
oz/in^3	**g/cm^3**	
lb/ft^3	kg/m^3	
	FORCE	
lfb	**Nm**	**4.44822**
	PRESSURE & STRESS	
1000 Kpa	**Bar**	**1000**
lbf/in^2 (psi)	N/M^2	6894.76
lbf/in^2 (psi)	**Bar**	**0.0689**
lbf/in^2 (psi)	N/mm^2	0.00689
lbf/m^2 (psi)	**mmHg**	**51.715**
"H2O	mmH20	25.4
"Hg	**mmHG**	**25.4**
ton (US)/in^2	N/mm^2	13.7894
ton (UK)/in^2	**N/mm^2**	**15.4443**
	VELOCITY	
ft/sec	**m/s**	**0.3048**
ft/sec	km/h	1.09728
mph	**m/s**	**0.44694**
mph	km/h	1.609
	ACCELERATION	
ft/sec^2	**m/s^2**	**0.3048**
	ENERGY	
Btu	**J**	**1055.06**
Kcal	J	4186.8
HP.h	**kW.h**	**0.7457**
PS.h	kW.h	0.7355
	TORQUE	
ft.lbf	**Nm**	**1.35582**
	POWER	
HP	**kW**	**0.7457**
PS	kW	0.7355
HP	**PS**	**1.01387**
	SPECIFIC FUEL CONSUMPTION	
lbs/hp.h	**g/kW.h**	**608.277**

Dealers/Distributors

Africa

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
SOUTH AFRICA	**Samcor (Pty) Ltd.**	P.O. Box 411 Pretoria	Tel: 27 12842 2616 Fax: 27 12842 2635

Australia

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
AUSTRALIA (Automotive)	**Ford Motor Company of Australia Ltd.**	Private Bag 2 1743 Sydney Road Campbellfield, Victoria 3061	Tel: 61 3 9359 8060 Fax: 61 3 9359 8276
AUSTRALIA (Industrial)	**Lees Industries Group**	P.O. Box 71 Papakura, Auckland, New Zealand	Tel: 64 9 299 6019 Fax: 64 9 298 9986

Europe

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
EUROPE - HEADQUARTERS	**Ford Power Products**	Stolbergerstr. 1316, D-50933 Koln	Tel: 49 221 947 00551 Fax: 49 221 947 00560
FINLAND, NORWAY, SWEDEN	**Masino OY**	Tillitie 3, FIN-01720 Vantaa	Tel: 358 9476 800 Fax: 358 9476 80300
FRANCE	**Fomaut SA**	45, Rue Charles Nodier, BP21 F93310 Le Pre' St. Gervais	Tel: 33 1 48 450394 Fax: 33 1 48 457504
GERMANY	**IMA GmbH**	Westring 41 D-33818 Leopoldshohe	Tel: 00495292 8765-11 Fax: 00495202 9875-15
	Sauer & Sohn	Gross Zimmemer Str. 51 D-64807 Dieburg	Tel: 49 6071 206 330 Fax: 49 6071 206 219
GREAT BRITAIN	**Bellshill Engine Sales Ltd.**	Advance Factory No. 6, Rosehall Road Bellshill Industrial Estate Strathclyde MC43JA	Tel: 44 1698 747528 Fax: 44 1698 841715
	Dalton Power Products Ltd.	Unit 6, Autumn Park Industrial Estate Dysart Road, Grantham Lincolnshire NG31 7DD	Tel: 44 1476 576666 Fax: 44 1476 577127
	Ford Power Products (sales office)	20/586 Arisdale Avenue, South Ockendon Essex RM15 5TJ	Tel: 44 1708 676415 Fax: 44 1708 678815
	Hendy Lennox Power Products Ltd.	Chandlers Ford, Eastleigh, Hampshire S053 4DG	Tel: 44 1703 242666 Fax: 44 1703 242656
	Perrys Engineering	79-81 Stadium Way Benfleet Essex SS7 3BN	Tel: 44 1268 773227 Fax: 44 1268 773185
	Power Torque Eng. Ltd.	Herald Way, Binley, Coventry Warwickshire CV3 2RQ	Tel: Fax:
ITALY	**CTM SpA**	Via C Colombo 41, 1-20090 Trezzano sul Naviglio, (Milano)	Tel: 39 02 445 5141 Fax: 39 02 484 01771
NETHERLANDS	**Neldalo BV**	Rendementsweg 4 NL-3641 SK Mijdrecht	Tel: 31 297 293242 Fax: 31 297 285930
SPAIN	**Equimovil SA**	P°de Yeserias, 11 E-28005 Madrid	Tel: 34 91 474 4211 Fax: 34 91 474 3342
SWITZERLAND	**Minelli AG**	Mattenstr. 3, CH-8330 Pfaffikon (ZH)	Tel: 41 1 950 1720 Fax: 41 1 950 1132

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Dealers/Distributors

New Zealand

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
NEW ZEALAND	**Lees Industries Group**	345 Gt South Road, Takaninin, Papakura, Auckland, New Zealand	Tel: 64 9 299 6019 Fax: 64 9 298 9986
NEW ZEALAND	**Ford Motor Company of New Zealand Ltd.**	Privatge Bag Manakau Cith	Tel: 69 9 277 8554 Fax: 64 9 278 2548

North America – Canada

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
WORLD HEADQUARTERS	**Industrial Power Power Products LLC.**	28333 Telegraph Road, Suite 300 Southfield, MI 48034 USA	Tel: 1 248 945 4500 Fax: 1 248 945 4431
BRITISH COLUMBIA, ALBERTA, SASKATCHEWAN	**Industrial Engines Ltd.**	1020 Cliveden Ave. Delta, Annacis Island, British Columbia Canada, V3M 5R5	Tel: 1 604 525 8529 Fax: 1 604 525 0974 Parts: 1 604 525 9153
NOVA SCOTIA, NEW BRUNSWICK	**Lundenberg Industrial Foundry**	53 Falkland Street Lunenberg, Nova Scotia, Canada, *BOJ2CO*	Tel: 1 902 634 8827 Fax: 1 902 634 8886 Engine Dept. Fax: 1 902 634 8889
ONTARIO, QUEBEC, MANITOBA	**M-K Power Products Corp.**	5641 McAdam Road Mississauga, Ontario Canada, L4Z-1N9	Tel: 1 905 890 5323 CAN: 1 800 263 5011 Fax: 1 905 890 6660

Dealers/Distributors

North America – United States

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
WORLD HEADQUARTERS	**Industrial Power Products, LLC**	28333 Telegraph Road, Suite 300 Southfield, MI 48034 USA	Tel: 1 248 945 4500 Fax: 1 248 945 4531
ALABAMA	**M&I Engine Company, Inc.**	30762 State Highway 181 Daphne, AL 36526	Tel: 1 334 626 8080 1 800 633 1834 Fax: 1 334 626 2744
ARIZONA	**EC Power Systems**	8360 E. Via de Ventura, Suite L-200 Scottsdale, AZ 85258	Tel: 1 480 905 5500 Fax: 1 503 224 3907
ARKANSAS (Northwestern)	**Dealers Industrial Power** **OK Ford Power Products**	3871 Old Getwell Road, P.O. Box 18635 Memphis, TN 38118 400 N. Ann Arbor Oklahoma City, OK 73127	Tel: 1 901 794 8584 Fax: 1 901 360 9844 Tel: 1 405 945 7525 1 800 645 3673 Fax: 1 405 945 7532
CALIFORNIA	**Powertech Engines Inc.**	2933 E. Hamilton Avenue Fresno, CA 93721	Tel: 1 559 264 1776 1 800 750 1776 Fax: 1 559 264 2933
	Powertech Engines Inc. (corp. admin.)	2003 Leghorn Street Mountainview, CA 94043	Tel: 1 650 968 2424 Fax: 1 650 969 1267
	Powertech Engines Inc. (branch)	1410B South Acacia Avenue Fullerton, CA 92831	Tel: 1 714 635 1774 1 800 784 1776 Fax: 1 714 635 1771
COLORADO	**Industrial Power Systems**	3233 Oakland Street Aurora, CO 80010	Tel: 1 303 360 7110 1 800 678 3673 Fax: 1 303 360 9579
CONNECTICUT	**Engine Distributors, Inc. (branch)**	56 Mitchell Road Ipswich, MA 01938	Tel: 1 978 356 2114 US: 1 800 446 1026 MA: 1 800 325 4228 Fax: 1 978 356 9602
DELAWARE	**Engine Distributors, Inc. (main office)**	332 South 17th Street Camden, NJ 08105-1798	Tel: 1 856 365 8631 1 800 220 2700 Fax: 1 856 338 0606
DISTRICT OF COLUMBIA	**Engine Distributors, Inc. (main office)**	332 South 17th Street Camden, NJ 08105-1798	Tel: 1 856 365 8631 1 800 220 2700 Fax: 1 856 338 0606
FLORIDA	**Highway Equipment & Supply Co.**	P.O. Box 547189 Orlando, FL 32854 (ship to 1017 West Jackson St. Orlando, FL 32805)	Tel: 1 407 843 6310 1 800 827 6495 Fax: 1 407 849 0740
	Highway Equipment & Supply Co. (branch)	4850 Collins Rd. Unit 103, P.O. Box 440367, Jacksonville, FL 32222-0367	Tel: 1 904 215 6356 Fax: 1 904 215 7109
	Highway Equipment & Supply Co. (branch)	6015 U.S. Highway 301 North Tampa, FL 33610	Tel: 1 813 621 9634 1 800 827 9092 Fax: 1 813 621 6873
(Panhandle)	**M&I Engine Company, Inc.**	30762 State Highway 181 Daphne, AL 36526	Tel: 1 334 626 8080 1 800 633 1834 Fax: 1 334 626 2744
GEORGIA – (Southeastern)	**Engine Distributors, Inc II** **Highway Equipment & Supply Co.**	303 Interstate Drive Archdale, NC 27263-4539 P.O. Box 547189 Orlando, FL 32854 (ship to: 1017 West Jackson St. Orlando, FL 32805)	Tel: 1 336 434 6616 1 800 220 7080 Fax: 1 336 434 6612 Tel: 1 407 843 6310 1 800 827 6495 Fax: 1 407 849 0740
HAWAII	**Powertech Engines Inc.**	2933 E. Hamilton Avenue Fresno, CA 93721	Tel: 1 559 264 1776 1 800 750 1776 Fax: 1 559 264 2933
IDAHO	**E.C. Power Systems**	4499 Market Street Boise, ID 83705-5428	Tel: 1 208 342 6541 1 800 354 6767 Fax: 1 208 345 4308
ILLINOIS – (Central & North Central)	**University Power Products**	2100 West Pioneer Parkway Peoria, IL 61615	Tel: 1 309 693 2525 1 800 322 4582 Fax: 1 309 693 6796

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Dealers/Distributors

North America – United States (Continued)

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
ILLINOIS – (Northeastern)	**Engine Power, Inc.**	1830 Executive Drive, P.O. Box 66 Oconomowic, WI 53066-0066	Tel: 1 414 567 8575 WI: 1 800 242 2289 Fax: 1 414 567 2556
– (Southern)	**Kansas City Power Products**	80 South James Kansas City, KS 66118	Tel: 1 913 321 7040 1 800 486 5277 Fax: 1 913 321 7341
– (Western)	**Midwestern Power Division (branch)**	7820 42nd Street Rock Island, IL 61204	Tel: 1 309 787 4300 Fax: 1 309 787 4397
INDIANA – (Northern)	**Engine Power, Inc.**	1830 Executive Drive, P.O. Box 66 Oconomowic, WI 53066-0066	Tel: 1 414 567 8575 WI: 1 800 242 2289 Fax: 1 414 567 2556
– (Southern)	**Power Unlimited, Inc.**	P.O. Box 3008, Louisville, KY 40201 (ship to: 830 South Ninth St. Louisville, KY 40210)	Tel: 1 502 581 0916 1 800 634 7912 Fax: 1 502 584 4544
IOWA	**Midwestern Power Division (branch)**	Cummins Great Plains 5194 NE 17th Street Des Moines, IA 50313	Tel: 1 515 264 1650 1 800 367 8503 Fax: 1 515 264 1651
	Midwestern Power Division (branch)	625 33rd Avenue, S.W. P.O. Box 1107 Cedar Rapids, IA 52406	Tel: 1 319 366 7537 Fax: 1 319 366 7562
– (Western)	**Anderson Industrial Engines**	5532 Center Street Omaha, NE 68106	Tel: 1 402 558 8700 1 800 747 1438 Fax: 1 402 558 8249
KANSAS	**Kansas City Power Products**	80 South James Kansas City, KS 66118	Tel: 1 913 321 7040 1 800 486 5277 Fax: 1 913 321 7341
KENTUCKY	**Power Unlimited, Inc.**	P.O. Box 3008, Louisville, KY 40201-3008 (ship to: 830 South Ninth St. Louisville, KY 40210)	Tel: 1 502 581 0916 1 800 634 7912 Fax: 1 502 584 4544
LOUISIANA – (Northern)	**Lightbourn Equipment Co.**	P.O. Box 801870, Dallas, TX 75380-1870 (ship to: 13649 Beta Rd., Dallas TX 75244)	Tel: 1 972 233 5151 1 800 729 3131 Fax: 1 972 661 0738
– (Southern)	**Lightbourn Equipment Co.**	8272 El Rio, Suite 110, Houston, TX 77054	Tel: 1 713 741 2003 1 800 827 1717 Fax: 1 713 741 1909
MAINE	***Branch Engine* Distributors, Inc.**	56 Mitchell Road Ipswich, MA 01938	Tel: 1 978 356 2114 US: 1 800 446 1026 MA: 1 800 325 4228 Fax: 1 978 356 9602
MARYLAND	**Engine Distributors, Inc. (main office)**	332 South 17th Street Camden, NJ 08105-1798	Tel: 1 609 365 8631 1 800 220 2700 Fax: 1 609 338 0606
MASSACHUSETTS	**Engine Distributors, Inc. (branch)**	56 Mitchell Road Ipswich, MA 01938	Tel: 1 978 356 2114 US: 1 800 446 1026 MA: 1 800 325 4228 Fax: 1 978 356 9602
MICHIGAN – (Lower Peninsula)	**Engine Center, Inc.**	2351 Hilton Road Ferndale, MI 48220	Tel: 1 248 399 0002 1 800 726 8870 Fax: 1 248 399 3142
– (Upper Peninsula)	**Engine Power, Inc.**	1830 Executive Drive P.O. Box 78764 Oconomowoc, WI 53066-4831	Tel: 1 414 567 8575 WI: 1 800 242 2289 Fax: 1 414 567 2556
MINNESOTA	**Northern Power Products, Inc.**	2815 Eagandale Blvd. P.O. Box 21348 Eagan, MN 55121-0348	Tel: 1 651 452 8900 1 800 284 6247 Fax: 1 651 452 9182
MISSISSIPPI	**Dealers Industrial Power**	3871 Old Getwell Road, P.O. Box 18635 Memphis, TN 38118	Tel: 1 901 794 8584 Fax: 1 901 360 9844
– (Panhandle)	**Lightbourn Equipment Co.**	8272 El Rio, Suite 110, Houston, TX 77054	Tel: 1 713 741 2003 1 800 827 1717 Fax: 1 713 741 1909

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Dealers/Distributors

North America – United States (Continued)

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
MISSOURI	**Kansas City Power Products**	80 South James Kansas City, KS 66118	Tel: 1 913 321 7040 1 800 486 5277 Fax: 1 913 321 7341
– (Boot Heel)	**Dealers Industrial Power**	3871 Old Getwell Road, P.O. Box 18635 Memphis, TN 38118	Tel: 1 901 794 8584 Fax: 1 901 360 9844
MONTANA – (Eastern & Central)	**Industrial Power Systems**	3233 Oakland Street Aurora, CO 80010	Tel: 1 303 360 7110 Fax: 1 303 360 9579
– (Western)	**E.C. Power Systems**	4499 Market Street Boise, ID 83705-5428	Tel: 1 208 342 6541 1 800 354 6767 Fax: 1 208 345 4308
NEBRASKA	**Anderson Industrial Engines**	5532 Center Street Omaha, NE 68106	Tel: 1 402 558 8700 1 800 747 1438 Fax: 1 402 558 8249
NEVADA	**Powertech Engines Inc.**	2933 E. Hamilton Avenue Fresno, CA 93721	Tel: 1 559 264 1776 1 800 750 1776 Fax: 1 559 264 2933
NEW HAMPSHIRE	**Engine Distributors, Inc. (branch)**	56 Mitchell Road Ipswich, MA 01938	Tel: 1 978 356 2114 US: 1 800 446 1026 MA: 1 800 325 4228 Fax: 1 978 356 9602
NEW JERSEY	**Engine Distributors, Inc. (main office)**	332 South 17th Street Camden, NJ 08105-1798	Tel: 1 856 365 8631 1 800 220 2700 Fax: 1 856 338 0606
NEW MEXICO – (Central & Southern)	**EC Power Systems**	8360 E. Via de Ventura, Suite L-200 Scottsdale, AZ 85258	Tel: 1 800 480 5500
– (Northern)	**Industrial Power Systems**	3233 Oakland Street Aurora, CO 80010	Tel: 1 303 360 7110 1 800 678 3673 Fax: 1 303 360 7519
NEW YORK – (New York City & Nassau County)	**Engine Distributors, Inc. (main office)**	332 South 17th Street Camden, NJ 08105-1798	Tel: 1 856 365 8631 1 800 220 2700 Fax: 1 856 338 0606
– (Upstate & Hudson Valley)	**Pitt Auto Electric Co. Industrial Engine Division**	2900 Stayton Street Pittsburgh, PA 15212-2698	Tel: 1 412 766 9112 US: 1 800 245 0711 Fax: 1 412 766 5508 1 800 551 5908
NORTH CAROLINA	**Engine Distributors, Inc. II**	303 Interstate Drive Archdale, NC 27263-4539	Tel: 1 336 434 6616 1 800 220 7080 Fax: 1 336 434 6612
NORTH DAKOTA	**Northern Power Products, Inc.**	2815 Eagandale Blvd. P.O. Box 21348 Eagan, MN 55121	Tel: 1 651 452 8900 1 800 284 6247 Fax: 1 651 452 9182
OHIO – (Central)	**Graham Ford, Inc.**	P.O. Box 789 Columbus, OH 43216-0789 (ship to: 707 W. Broad Street Columbus, OH 43222)	Tel: 1 614 464 6006 1 800 837 0001, ext. 6006 Fax: 1 614 464 6013
– (Northern)	**North Coast Ford Industrial, Inc.**	11885 Bellaire Road Cleveland, OH 44135	Tel: 1 216 251 5800 OH: 1 800 423 1316 Fax: 1 216 251 8675
– (Southeastern)	**Pitt Auto Electric Co. Industrial Engine Division**	2900 Stayton Street Pittsburgh, PA 15212	Tel: 1 412 766 9112 US: 1 800 245 0711 Fax: 1 412 766 3229 1 800 551 5908
– (Southern)	**Power Unlimited, Inc.**	P.O. Box 3008, Louisville, KY 40201 (ship to: 830 South Ninth St. Louisville, KY 40210)	Tel: 1 502 581 0916 1 800 634 7912 Fax: 1 502 584 4544
OKLAHOMA – (Except Panhandle)	**OK Ford Power Products**	P.O. Box 270836 Oklahoma City, OK 73127 (ship to: 400 N. Ann Arbor, Oklahoma City, OK 73127)	Tel: 1 405 945 7525 1 800 654 3673 Fax: 1 405 945 7532
– (Panhandle)	**Lighbourn Equipment Co.**	P.O. Box 801870 Dallas, TX 75380 (ship to: 13649 Beta Road, Dallas, TX 75244)	Tel: 1 972 233 5151 Fax: 1 972 661 0738

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Dealers/Distributors

North America – United States (Continued)

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
OREGON – (Pacific Northwest)	**E.C. Power Systems**	1805 N.W. 21st Avenue P.O. Box 10286 Portland, OR 97210-0286	Tel: 1 503 224 3623 1 800 452 1511 Fax: 1 503 241 3907
PENNSYLVANIA – (Eastern)	**Engine Distributors, Inc. (main office)**	332 South 17th Street Camden, NJ 08105-1798	Tel: 1 856 365 8631 1 800 220 2700 Fax: 1 856 338 0606
– (Western)	**Pitt Auto Electric Co. Industrial Engine Division**	2900 Stayton Street Pittsburgh, PA 15212	Tel: 1 412 766 9112 US: 1 800 245 0711 Fax: 1 412 766 3229 1 800 551 5908
RHODE ISLAND	**Engine Distributors, Inc. (branch)**	56 Mitchell Road Ipswich, MA 01938	Tel: 1 978 356 2114 US: 1 800 446 1026 MA: 1 800 325 4228 Fax: 1 978 356 9602
SOUTH CAROLINA	**Engine Distributors, Inc. II**	303 Interstate Drive Archdale, NC 27263-4539	Tel: 1 336 434 6616 1 800 220 7080 Fax: 1 336 434 6612
TENNESSEE	**Power Unlimited, Inc. (branch)**	1401 Galway Knoxville, TN 37917	Tel: 1 423 525 1193 1 800 251 9318 Fax: 1 423 637 2448
– (Central & Eastern)	**Power Unlimited, Inc.**	P.O. Box 3008 Louisville, KY 40201 (ship to: 830 South Ninth St., Louisville, KY 40210)	Tel: 1 502 581 0916 1 800 634 7912 Fax: 1 502 584 4544
– (Western)	**Dealers Industrial Power**	3871 Old Getwell Road, P.O. Box 18635 Memphis, TN 38118	Tel: 1 901 794 8584 Fax: 1 901 360 9844
TEXAS	**Lightbourn Equipment Co.**	P.O. Box 801870 Dallas, TX 75380 (ship to: 13649 Beta Road, Dallas, TX 75244)	Tel: 1 972 233 5151 Fax: 1 972 661 0738
	Lightbourn Equipment Co. (branch)	8272 El Rio Suite 110 Houston, TX 77054	Tel: 1 713 741 2003 1 800 827 1717 Fax: 1 713 741 1909
UTAH – (Central & Northern)	**Industrial Power Systems, Inc. (branch)**	2492 W. Custer Road Salt Lake City, UT 84104	Tel: 1 801 908 8099 US: 1 800 705 3699 Fax: 1 801 908 0898
– (Southern)	**Industrial Parts Systems**	2492 W. Custer Road Salt Lake City, UT 84104	Tel: 1 800 705 3699 1 801 908 8099 Fax: 1 801 908 0898
VERMONT	**Engine Distributors, Inc. (branch)**	56 Mitchell Road Ipswich, MA 01938	Tel: 1 978 356 2114 US: 1 800 446 1026 Fax: 1 978 356 9602
VIRGINIA	**Engine Distributors, Inc. (main office)**	332 South 17th Street Camden, NJ 08105-1798	Tel: 1 856 365 8631 1 800 220 2700 Fax: 1 856 338 0606
– (Southwestern)	**Power Unlimited, Inc.**	P.O. Box 3008, Louisville, KY 40201 (ship to: 830 South Ninth St. Louisville, KY 40210)	Tel: 1 502 581 0916 1 800 634 7912 Fax: 1 502 584 4544
WASHINGTON	**E.C. Power Systems**	6051 S. 194th Street Kent, WA 98032-1169	Tel: 1 253 872 7011 1 800 247 5899 Fax: 1 243 872 6947
WEST VIRGINIA	**Pitt Auto Electric Co. Industrial Engine Division**	2900 Stayton Street Pittsburgh, PA 15212	Tel: 1 412 766 9112 US: 1 800 245 0711 Fax: 1 412 766 3229 1 800 551 5908
WISCONSIN – (Eastern)	**Engine Power, Inc.**	1830 Executive Drive P.O. Box 66 Oconomowoc, WI 53066-0066	Tel: 1 414 567 8575 WI: 1 800 242 2289 Fax: 1 414 567 2556
– (Northwestern)	**Northern Power Products, Inc.**	2815 Eagandale Blvd. P.O. Box 21348 Eagan, MN 55121-0348	Tel: 1 651 452 8900 1 800 284 6247 Fax: 1 651 452 9182
WYOMING	**Industrial Power Systems, Inc.**	3233 Oakland Street Aurora, OH 80010	Tel: 1 303 360 7110 Fax: 1 303 360 9579

Dealers/Distributors

Oceania

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
OCEANIA	Lees Industries Group	P.O. Box 71 Papakura, Auckland, New Zealand	Tel: 64 9 299 6019 Fax: 64 9 298 9986

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