



## FOREWORD

This Operation Guide contains both operation instructions, and lubrication and maintenance information. Application of this information should give maximum performance and life of the engine, and minimize the costs of engine operation.

Caterpillar engines are found in many applications. Therefore, the illustrations in this Guide are typical and may not be of your specific engine or application.

Familiarize yourself with the components installed on your engine as described in the instructions. Some components described in the instructions may not be on your engine or installation.

Continuing improvement and advancement of product design may cause changes to your engine which may not be included in this publication. Each publication is reviewed and revised, as required, to update and include these changes in later editions.

Whenever a question arises regarding your Caterpillar product, or this publication, please consult your Caterpillar dealer for the latest available information.

The services of authorized Caterpillar dealers are recommended. Your dealer is staffed with trained personnel who are equipped with proper tools, necessary Caterpillar parts, and are trained in the latest service procedures.

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# NOTICE!

## TO THE DELIVERING DEALER —

### THE WARRANTY COVERAGE ON CATERPILLAR ENGINES VARIES BY APPLICATION

To ensure the proper warranty coverage is extended to the owner of this engine, fill out the attached card COMPLETELY and ACCURATELY and return to CATERPILLAR.

**The warranty period will start on the DELIVERY DATE entered below.**

An Engine Warranty Information Card must be prepared by the OEM or Caterpillar dealer when delivering the engine to the user.

A card must be prepared for each new or remanufactured Caterpillar engine except for new engines installed in new on-highway trucks.

#### USER'S REFERENCE INFORMATION

DELIVERY DATE \_\_\_\_\_

ENGINE SERIAL NO. \_\_\_\_\_

DELIVERING DEALER'S NAME AND ADDRESS:

ARRANGEMENT NO. \_\_\_\_\_

\_\_\_\_\_

MODIFICATION NO. \_\_\_\_\_

\_\_\_\_\_

REMANUFACTURED ENGINE  
REFERENCE SERIAL NO. \_\_\_\_\_

\_\_\_\_\_

VEHICLE MILES \_\_\_\_\_

OR

HOURS \_\_\_\_\_

SIGNATURE OF DELIVERING DEALER'S REPRESENTATIVE

FOLD AND DETACH HERE.



## CATERPILLAR

### ENGINE WARRANTY INFORMATION CARD

ENGINE MODEL	ENGINE SERIAL NUMBER	DELIVERY DATE
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IF ELECTRIC SET, IS IT  L PRIME OR  M STAND-BY?

DID THIS ENGINE REPLACE ANOTHER ENGINE? YES <input type="checkbox"/> NO <input type="checkbox"/>	CURRENT VEHICLE MILES _____ OR HOURS _____
-----------------------------------------------------------------------------------------------------	-----------------------------------------------------

**APPLICATION (check PRIMARY application only)**

- A MARINE
- B DREDGE
- C POWERING AGRICULTURAL VEHICLE
- D AGRICULTURAL — OTHER
- E POWERING ON-HIGHWAY VEHICLE
- F PETROLEUM — DRILL RIG
- G PETROLEUM — OTHER
- H LOCOMOTIVE
- J POWERING OFF-HIGHWAY TRUCK
- K OTHER: \_\_\_\_\_

PLEASE SPECIFY

(PLEASE TYPE OR PRINT)

**SOLD TO:** \_\_\_\_\_

NAME

\_\_\_\_\_

ADDRESS

\_\_\_\_\_

CITY                      STATE                      ZIP

**SOLD BY:**  1. CATERPILLAR DEALER  
 2. OEM DEALER

\_\_\_\_\_

DEALER'S NAME

**MANUFACTURER'S EQUIPMENT IDENTIFICATION**

\_\_\_\_\_

TYPE MACHINE

\_\_\_\_\_

MODEL                      SERIAL NUMBER

SIGNATURE OF DELIVERING DEALER'S REPRESENTATIVE

## NOTE

When mailing from locations in the U.S.A., use the card below which requires no postage.

When mailing from other locations, use the similar card, attached to Form 83996, and mail it to the appropriate address listed above that card.

### In the United States —

All OEM's, except those who manufacture on-highway trucks, should include the foreign version of the Engine Warranty Information Card with their equipment shipped overseas. The foreign version of the Engine Warranty Information Card, Form 83996, may be obtained through your Caterpillar dealer or by written request to Caterpillar at the address shown below.

Additional copies of the domestic Engine Warranty Information Card, Form 83995, may be obtained through your Caterpillar dealer or by written request to:

**CATERPILLAR TRACTOR CO.**  
Miscellaneous Orders, AB5C  
100 NE Adams Street  
Peoria, IL 61629

Please be sure to reference the appropriate form number.

FIRST CLASS  
PERMIT NO. 385  
PEORIA, ILLINOIS

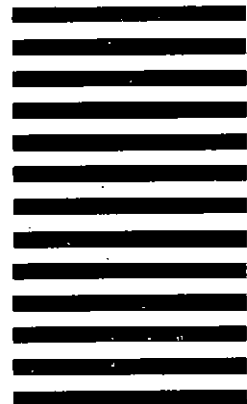
**BUSINESS REPLY MAIL**  
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

 **CATERPILLAR TRACTOR CO.**

100 N.E. Adams Street  
Peoria, Illinois 61602, U. S. A.

ATTN: Warranty & Data Div.  
AB5A



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#### USER'S REFERENCE INFORMATION

DELIVERY DATE _____	ENGINE SERIAL NO. _____
DELIVERING DEALER'S NAME AND ADDRESS: _____ _____ _____	ARRANGEMENT NO. _____
	MODIFICATION NO. _____
	REMANUFACTURED ENGINE REFERENCE SERIAL NO. _____
	VEHICLE MILES _____ OR HOURS _____
SIGNATURE OF DELIVERING DEALER'S REPRESENTATIVE _____	

FOLD AND DETACH HERE.



### ENGINE WARRANTY INFORMATION CARD

ENGINE MODEL	ENGINE SERIAL NUMBER	DELIVERY DATE

**SOLD TO:** \_\_\_\_\_  
NAME

\_\_\_\_\_

ADDRESS

\_\_\_\_\_

CITY STATE ZIP

IF ELECTRIC SET, IS IT  L PRIME OR  M STAND-BY?

DID THIS ENGINE REPLACE ANOTHER ENGINE?	CURRENT VEHICLE MILES _____
YES <input type="checkbox"/> NO <input type="checkbox"/>	OR HOURS _____

**SOLD BY:**  1. CATERPILLAR DEALER  
 2. OEM DEALER

\_\_\_\_\_

DEALER'S NAME

**MANUFACTURER'S EQUIPMENT IDENTIFICATION**

\_\_\_\_\_

TYPE MACHINE

\_\_\_\_\_

MODEL SERIAL NUMBER

**APPLICATION (check PRIMARY application only)**

- A MARINE
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- C POWERING AGRICULTURAL VEHICLE
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- F PETROLEUM — DRILL RIG
- G PETROLEUM — OTHER
- H LOCOMOTIVE
- J POWERING OFF-HIGHWAY TRUCK
- K OTHER: \_\_\_\_\_

SIGNATURE OF DELIVERING DEALER'S REPRESENTATIVE \_\_\_\_\_

PLEASE SPECIFY

(PLEASE TYPE OR PRINT)

**WHEN MAILING FROM THIS COUNTRY  
OR AREA** 

**ADDRESS TO THIS CATERPILLAR  
LOCATION** 

UNITED STATES (use postage paid card in Engine Operation Guide)	CATERPILLAR TRACTOR CO. 100 N.E. ADAMS STREET PEORIA, ILL. 61629
EUROPE AFRICA NEAR EAST	CATERPILLAR OVERSEAS S.A. POST OFFICE BOX 408 1211 GENEVA 3 SWITZERLAND
AUSTRALIA PAPUA NEW GUINEA NEW ZEALAND NEW CALEDONIA - FIJI	CATERPILLAR OF AUSTRALIA LTD. POST OFFICE BOX 35 NIDDRIE VICTORIA, AUSTRALIA 3042
FAR EAST (EXCEPT JAPAN)	CATERPILLAR FAR EAST LTD. 31ST FLOOR, GAMMON HOUSE 12, HARCOURT ROAD HONG KONG, B.C.C.
JAPAN	CATERPILLAR MITSUBISHI LTD. 3700, TANA SAGAMIHARA-SHI, KANAGAWA-KEN 229 JAPAN
BRASIL	CATERPILLAR BRASIL S.A. CAIXA POSTAL 8239 SAO PAULO BRAZIL
CANADA CENTRAL AMERICA MEXICO SOUTH AMERICA (EXCEPT BRASIL)	CATERPILLAR AMERICAS CO. 100 N.E. ADAMS STREET PEORIA, ILL. 61629 U.S.A.

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# INDUSTRIAL ENGINE OPERATION INSTRUCTIONS

## GENERAL

Proper engine operation and maintenance are essential for long engine life and maximum performance. The basic operation and periodic maintenance procedures are outlined in this OPERATION GUIDE. Before starting the engine, familiarize yourself with these procedures.

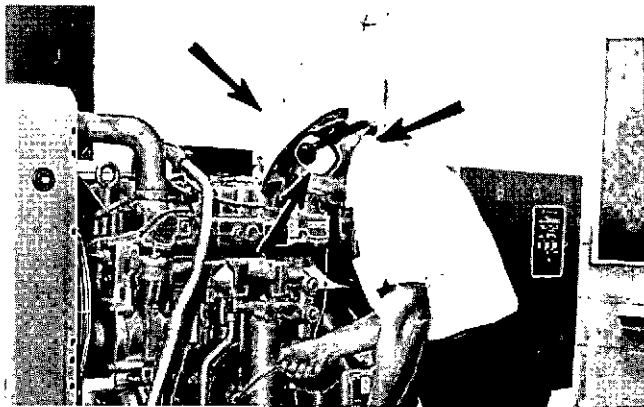
Your Caterpillar dealer is available for troubleshooting, testing and servicing when required.

## SAFETY PRECAUTIONS

Safety is basically common sense. A general guide of safety precautions may be listed, but each installation has its own peculiarities which cannot always be predicted and covered by rules. Past experience and common sense are needed for the necessary safety measures. Lack of attention to safety can result in serious accidents. Be alert. Watch for hazards. Use preventive measures. Correct deficiencies promptly.

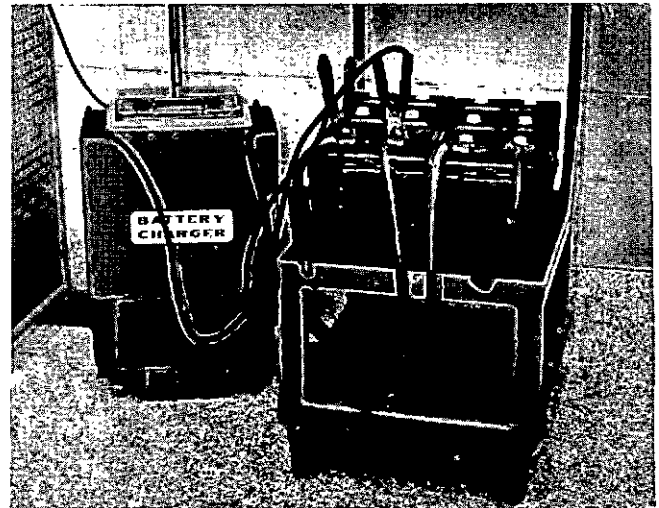
The following safety precautions are a guide to safe operation:

1. Install guards over all exposed rotating parts. If guards are missing, inadequate or in need of repair, repair or replace them.
2. Wear ear protective devices if working inside an enclosed engine room with engine running.



3. Wear a safety hat when working in the area of overhead equipment.
4. Do not wear loose clothing whenever working around engines or machinery.

5. Keep the engine room and floor clean. Wipe up spilled oil or fuel.
6. Keep batteries in a well ventilated area.

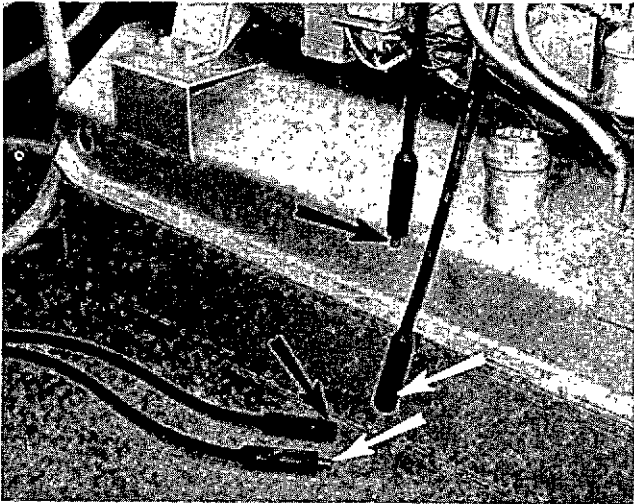


Hydrogen gas, which is present in the area of the batteries, is highly explosive. Do not smoke around batteries.

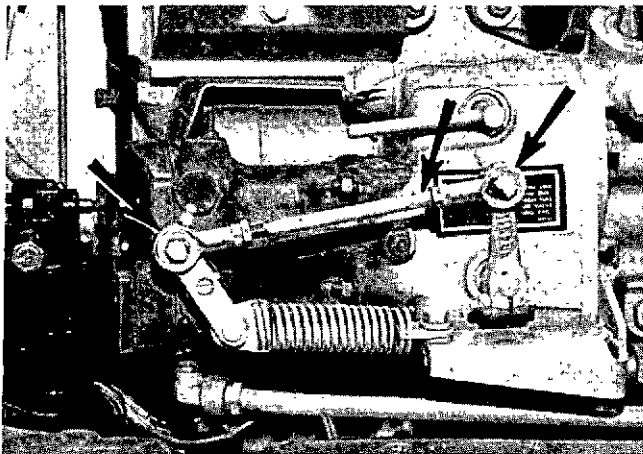


7. Provide adequate waste oil disposal.
8. Store oily rags in containers. Don't leave rags on an engine.
9. Remove all tools and electrical cords from the engine before starting.
10. Disconnect and tape the battery ground lead before working on an engine. Be sure an automatic start-

stop system cannot operate and start the engine while working on it.



11. Never start, nor attempt to run, an engine with the governor linkage disconnected.



12. Never try adjusting or repairing either the engine, or the driven equipment, while the engine is running.

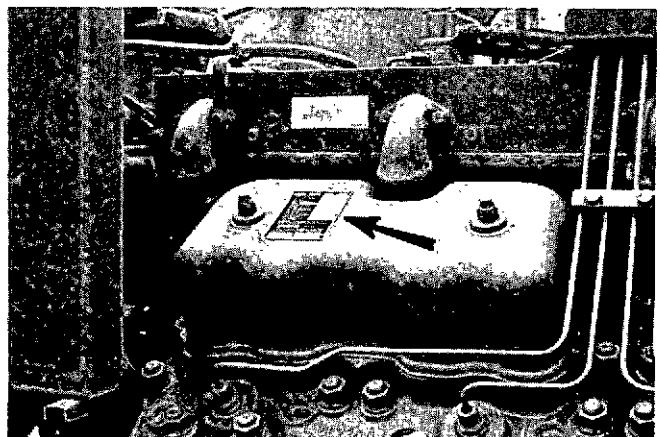
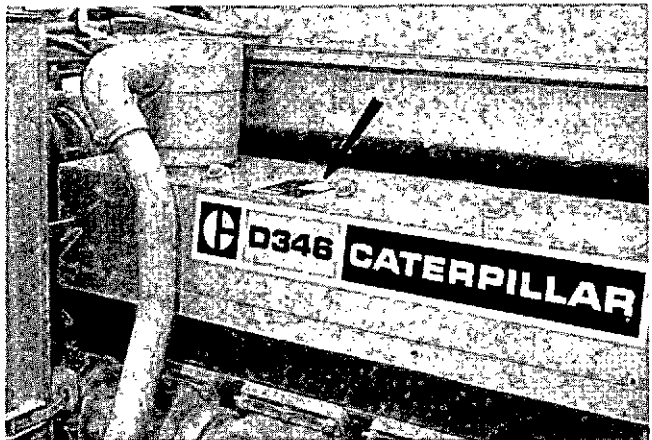
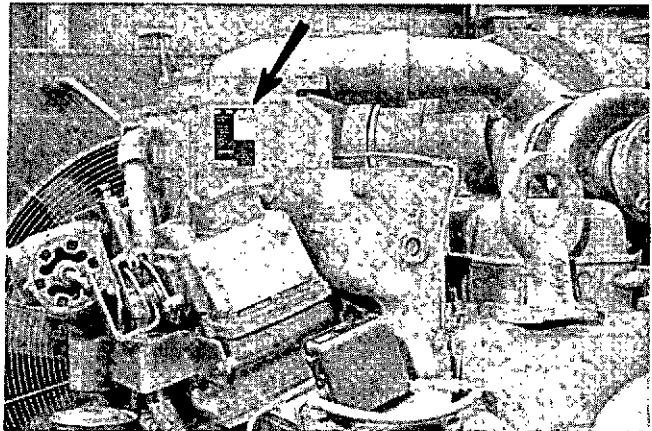
Safety is EVERYONE'S Business!!

## ALTITUDE OPERATION

The fuel system settings and altitude limits are stamped on the engine information plate. When an engine is moved to a higher altitude, these settings must be changed by your Caterpillar dealer in order to prevent damaging the turbo-charger, and to provide maximum engine efficiency.

If the engine is moved to a lower altitude than that which is stamped on the engine information plate, the engine can be operated safely, but it will deliver less than rated horsepower.

- Typical warning plate locations on several engines are shown below.



## COLD WEATHER STARTING

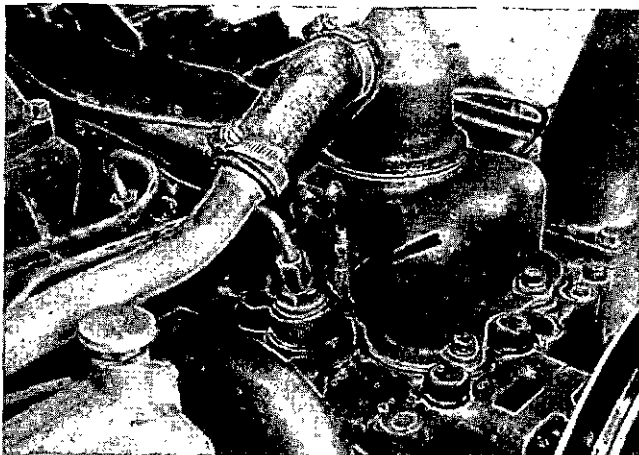
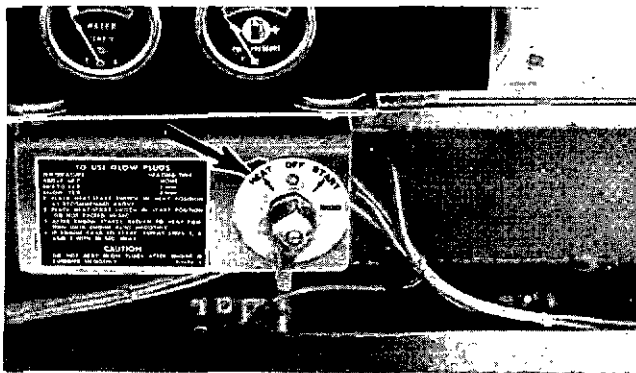
STARTING TEMP.	STARTING AID	HEATING TIME
Above 60°F (15°C)	None	None
60°F to 32°F (15°C to 0°C)	Glow Plugs	1 Minute
32°F to 0°F (0°C to -20°C)	Glow Plugs	2 Minutes
Below 0°F (-20°C)*	Glow Plugs & Starting Fluid	3 Minutes

\*Heating of jacket water and/or crankcase oil; and/or use of extra battery capacity may be required.

Many variables can affect cold weather starting. Use the above chart as a guide, but actual experience will determine when aids are necessary and how they should be used. The following starting aids are available:

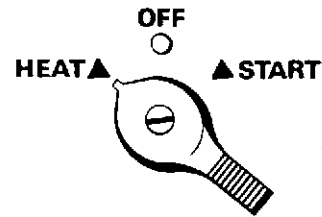
### Glow Plugs (Attachment)

Use glow plugs before cranking the engine, immediately after the engine has started, and until the engine is running smoothly.

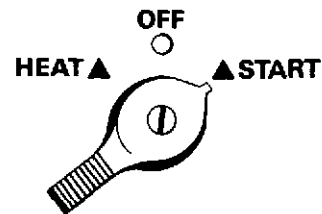


### Operation:

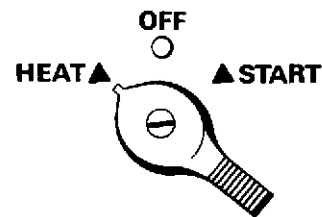
1. Push in and turn the HEAT-START switch to the HEAT position and hold for the approximate heating time shown in the Cold Weather Starting Chart.



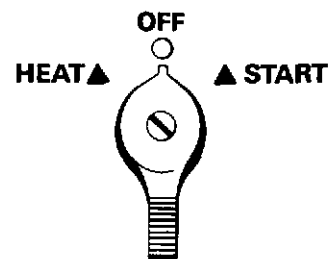
2. Turn the HEAT-START switch to the START position.



3. As soon as the engine starts, turn the HEAT-START switch to the HEAT position. Hold the switch in this position until the engine is running smoothly.



4. Release the switch.



### CAUTION

NEVER use glow plugs when the engine is warm and running.

## Starting Fluid

### CAUTION

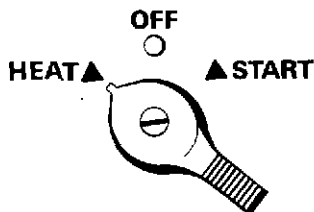
Spray starting fluid only while cranking the engine.

If starting fluid is sprayed into an engine that is running, the fluid would cause severe preignition in all cylinders until the fluid is consumed.

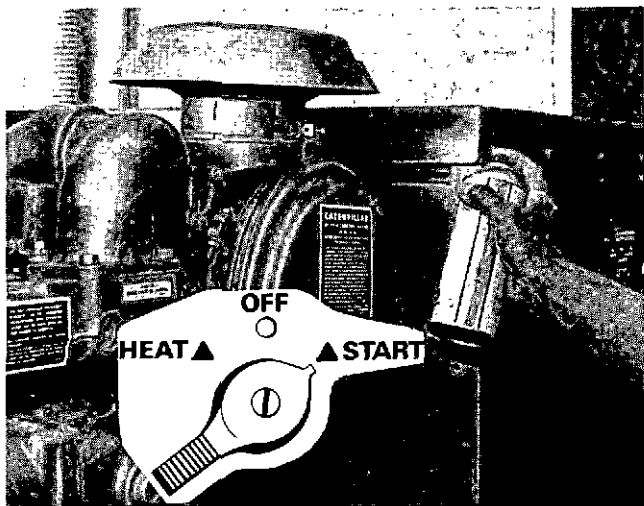
### WARNING

Starting fluid is volatile and must be stored away from heat and direct sunlight. If an aerosol container is used, follow the instructions on the container.

1. Heat the glow plugs for the approximate heating time shown in the Cold Weather Starting Chart.



2. Turn the HEAT-START switch to the START position. While cranking, discharge a quick spray of starting fluid into the air inlet or air cleaner.



3. If necessary, repeat the procedure.
4. After the engine starts, it may be necessary to return the HEAT-START switch to the HEAT position until the engine runs smoothly. Then release the switch.

## Jacket Water Heater (Attachment)

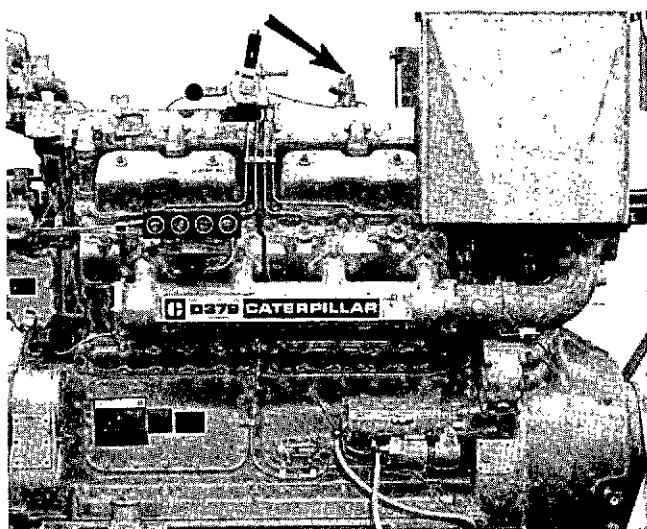
In very low temperatures, the lubricating oil must be warmed to allow starting. A jacket water heater can maintain the jacket water temperature at approximately 90°F (32°C). The warm jacket water will keep the oil in the upper part of the engine block warm enough to flow when starting.

## Dipstick Oil Heater

Contact your Caterpillar dealer before installing a dipstick crankcase oil heater.

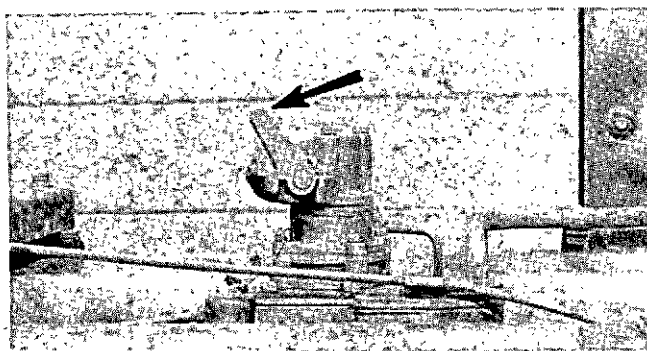
## Air/Fuel Ratio Control With Over-Ride

The large V-type engines are equipped with an air/fuel ratio control which has an over-ride lever. During extremely cold weather, more fuel and a richer fuel mixture may be necessary when starting.



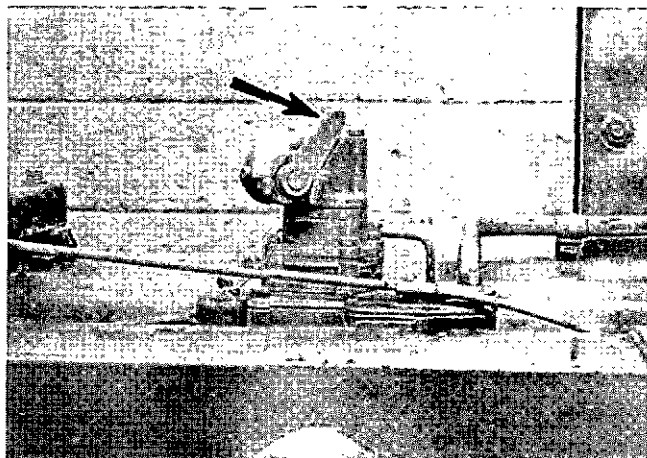
If the engine is blowing white smoke, but will not start:

1. Release the start switch.
2. Move the over-ride lever to the START position.



3. Use starting aids and crank the engine.

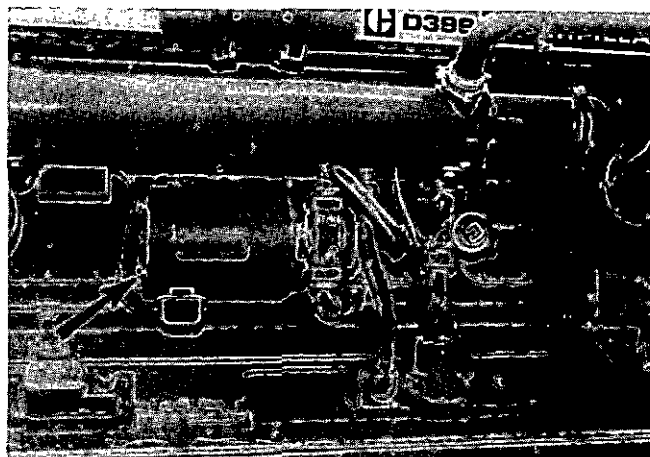
As soon as the engine starts and runs, the lever will return to the RUN position.



## AUTOMATIC START-STOP

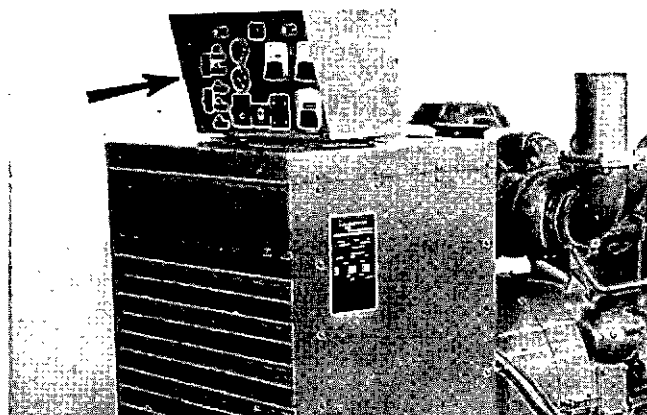
An automatic start-stop system is used when an engine must start when a specific condition occurs and with no one in attendance. The engine will start, increase speed, pick-up the load, operate the load until a second condition occurs, remove the load, cool and stop. The following conditions must exist for the engine to start unattended:

1. Either the ambient (engine room) temperature must be at least 70°F (20°C); or, the engine jacket water temperature must be at least 90°F (32°C). A jacket water heater can maintain this temperature.
2. If a prelube oil pump is used (large bore engines), the pump must operate before the starting motor(s) are energized, and stop when the engine starts and oil pressure increases.



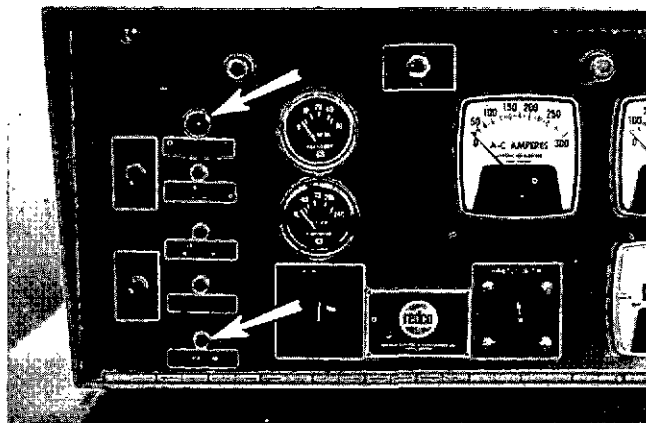
## PROTECTION DEVICES

The engine's control panel may be equipped with protection devices to protect the engine while cranking,



### Batteries:

Lights can indicate if a fault has occurred in the battery charging system causing the battery to be either undercharged or overcharged.



### Overcranking:

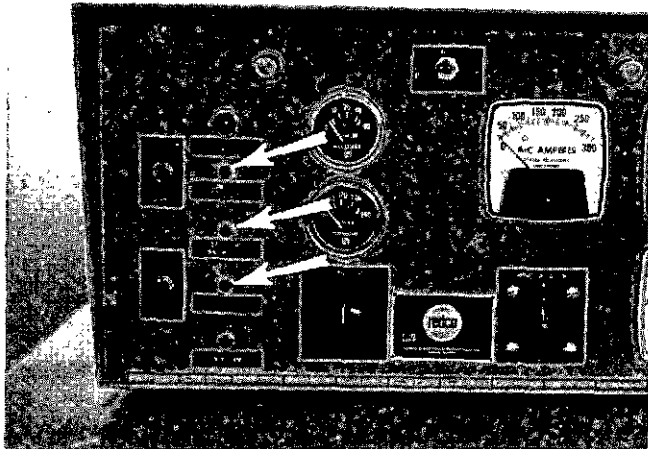
A timer allows the engine to crank either once for 30 seconds, or to crank through 5 ten-second cranking cycles (depending upon the device used) while unattended. If the engine does not start before the time elapsed, the fuel system will be shutoff and a light will indicate a starting failure.

### Engine Operation:

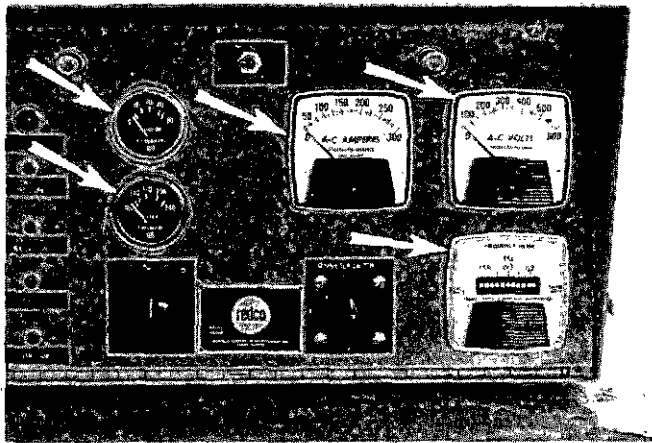
Prealarm systems provide an audible and/or a visual indication for low oil pressure, high water temperature, low

fuel supply or low jacket water temperature before the condition becomes critical. These alarms are self resetting when the condition is corrected.

The engine may also be equipped with shutdown devices. If low oil pressure, high jacket water temperature or an engine overspeed condition occurs, the engine will be shutdown and a corresponding light will indicate the cause of the shutdown. These devices must be reset after repairs have been made and before starting. See the topic, EMERGENCY SHUTOFF DEVICES AND ALARMS.



If the engine is equipped with an electric set, the control panel should be equipped with an ammeter, a frequency meter and a voltmeter. Depending upon the type of operation, the panel may also be equipped with other meters and lights. Know these instruments and their normal readings. They will indicate how the engine is performing.



### Shutting Down:

A timer allows the engine to remove or transfer the load, and to continue running for up to 2 minutes for cooling purposes before stopping.

### Engine Exerciser:

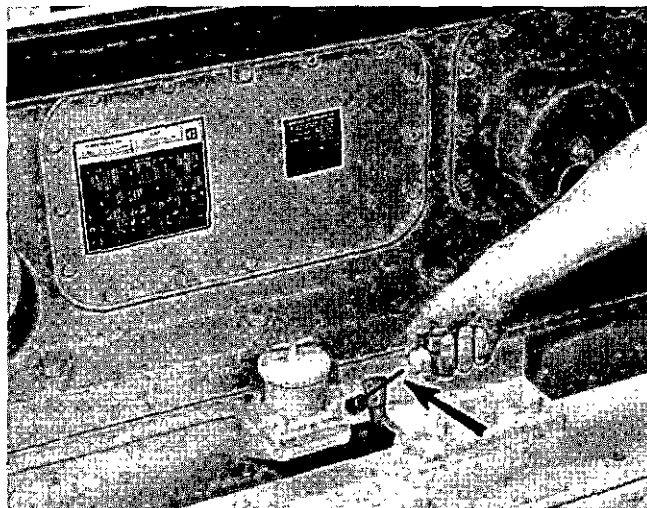
At preset times, the exerciser will start, run and stop the engine in order to ensure both proper lubrication of all engine parts and proper equipment operation if and when the standby unit is needed.

Become familiar with all instructions included with the equipment.

## ENGINE OPERATION

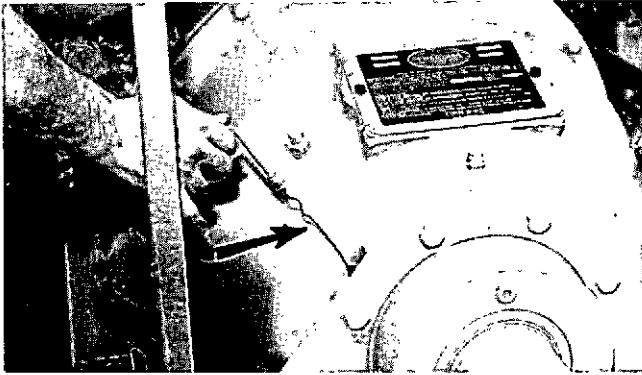
### PRE-START CHECKS AND PROCEDURES

1. Make a "walk-around" check of the engine and components. Correct minor adjustments before they develop into major repair jobs.
2. Check the crankcase oil level. Maintain the oil level between the ADD and FULL marks on the dipstick. See the LUBRICATION AND MAINTENANCE CHART for proper type and viscosity of oil to use.

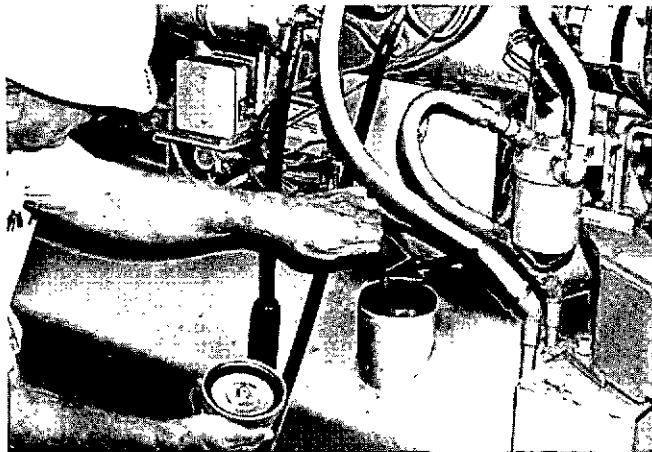


D346, D348, D379 and D398 Engines are equipped with a combination sump pump and prelube hand pump. After a long shut down or after a filter and oil change, operate the hand pump to fill the oil passages in the lube system before starting. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Oil Filter Elements, before starting any one of these models of engines.

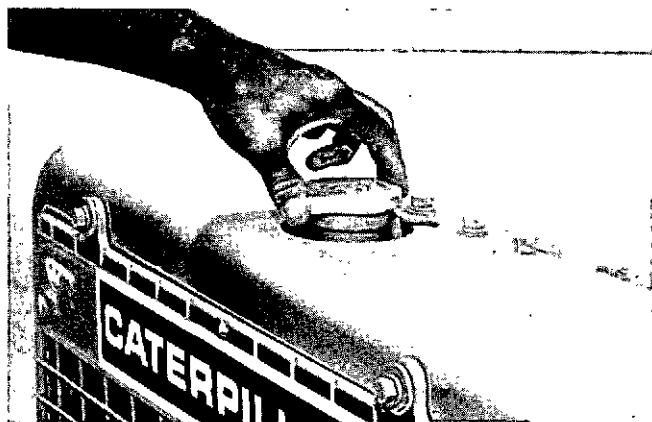
3. Check oil level(s) on driven equipment.



4. Check the fuel tank level. See the LUBRICATION AND MAINTENANCE CHART for proper fuel to use.

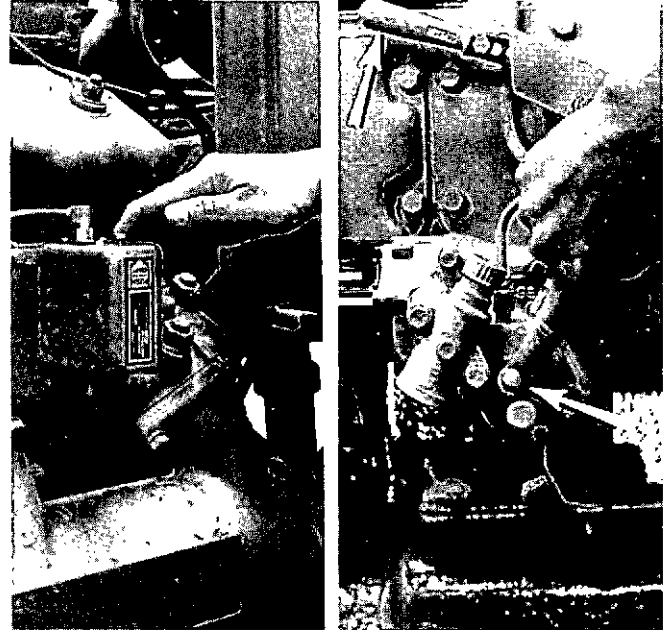


5. Check the engine jacket coolant level. Maintain coolant level to the base of the fill pipe. See the LUBRICATION AND MAINTENANCE CHART for proper make-up coolant to use.



6. Open the raw water valve (if so equipped) on the engine jacket heat exchanger system.

7. Reset shutoff devices. See the topic, ATTACHMENTS, Emergency Shutoff Devices and Alarms.

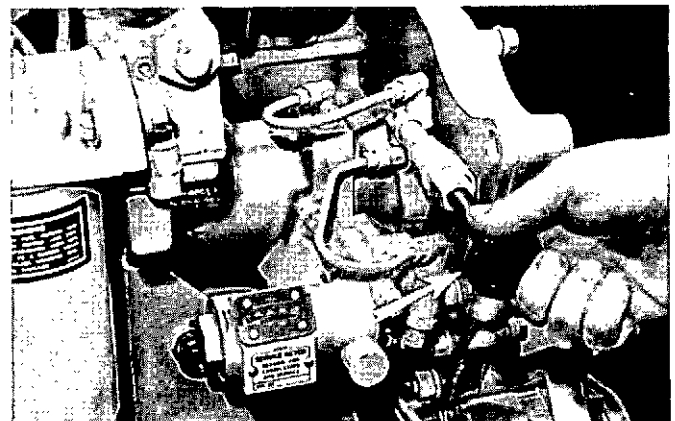


8. Open the fuel supply valve.

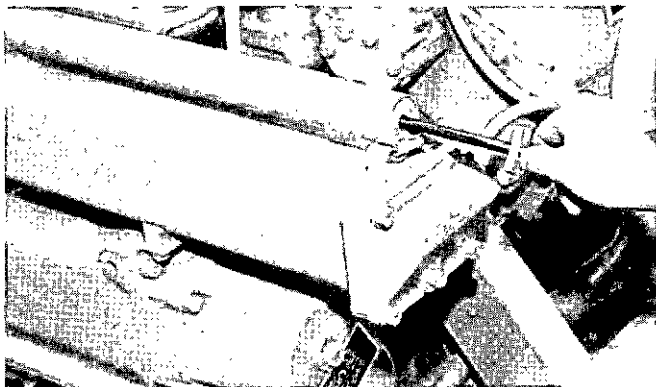
#### CAUTION

The fuel return line must be open to prevent engine damage.

9. If air has entered the fuel system, prime the fuel system. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Priming the Fuel System.

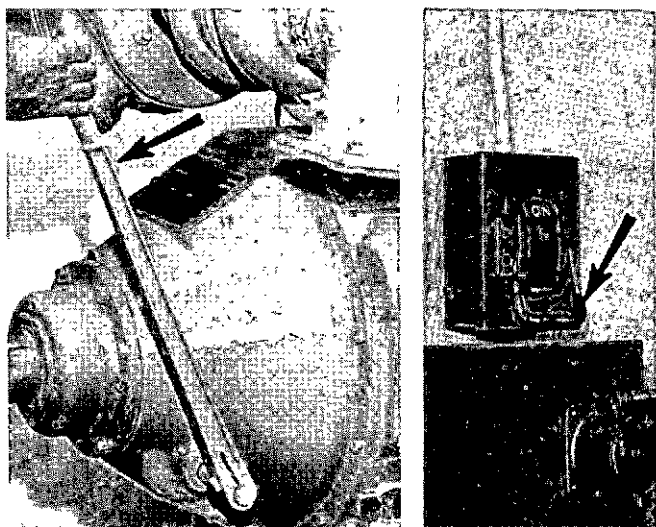


PRIMING PUMP ON 6 CYLINDER ENGINE



PRIMING PUMP ON V-ENGINE

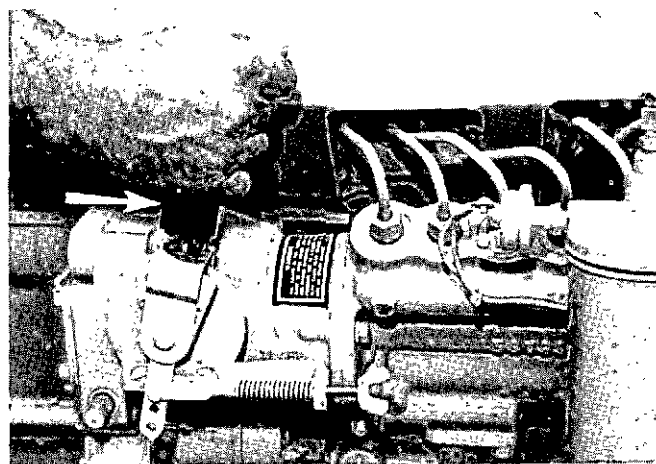
10. Disconnect any battery charger which is not protected against starting motor drain.
11. Disengage the clutch, or open the circuit breaker on an electric set.



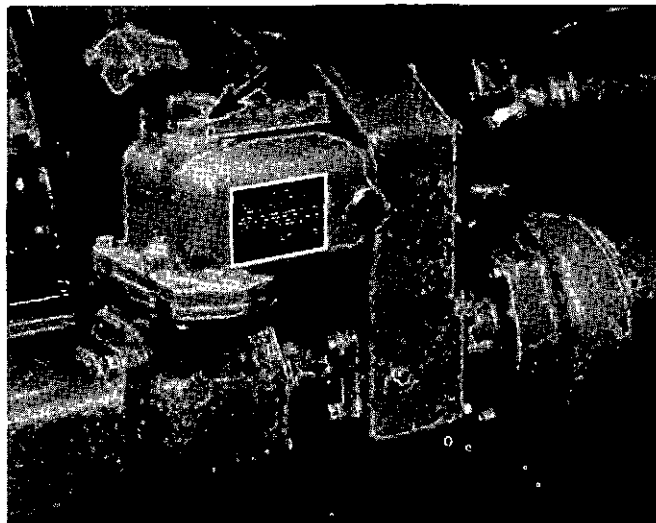
**CAUTION**

Do not start an engine under load.

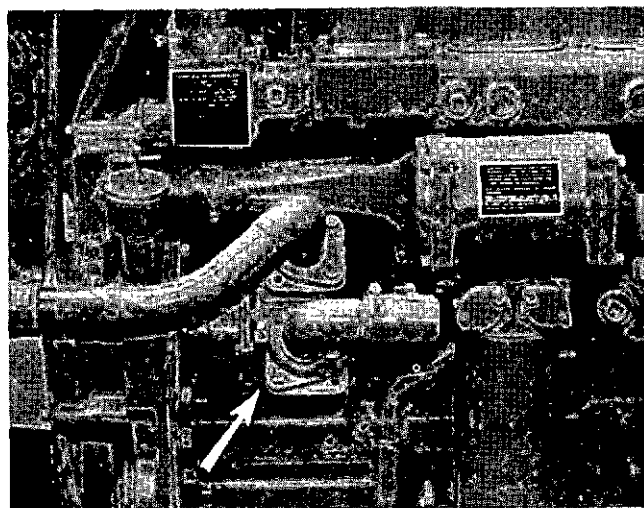
12. Move the governor control lever to half engine speed position or to speed limiter stop.



13. Prime the raw water pump if necessary. (Only water pumps equipped with a water reservoir and fill plug require priming.)



If the raw water pump is of the type shown below, the pump is a self priming pump. This pump does not have a priming chamber or fill plug.



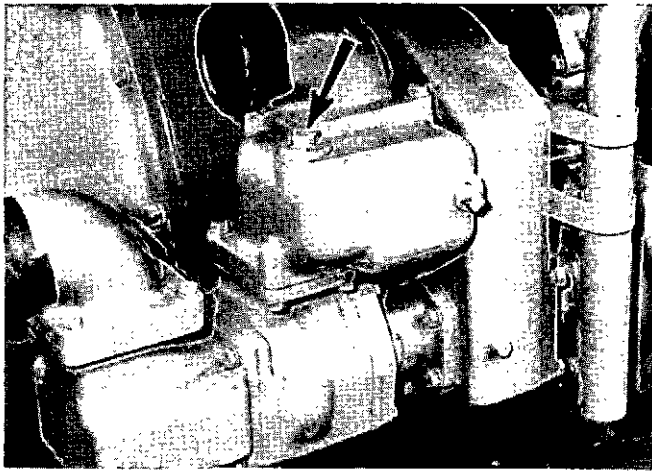
SELF PRIMING RAW WATER PUMP

**Priming The Raw Water Pump:**

**CAUTION**

The priming chamber must be filled with water before starting the engine to prevent pump or engine damage. After the engine is started, increase engine speed immediately to obtain and maintain system flow.

1. Carefully loosen the fill plug. If water is present immediately tighten the plug; the pump is full.
2. If water is not present, pour approximately two gallons (7.5 liters) (1.5 Imp. Gals.), or until overflow occurs, into the fill hole.
3. Install the fill plug.



FILL PLUG

4. Start the engine at fast enough speed to obtain the normal water flow from the overboard raw water discharge or water cooled exhaust pipe.

If the proper flow is not observed, stop the engine and repeat this procedure. If the pump does not hold water in the priming chamber, the water pump seals should be replaced.

## STARTING THE ENGINE

### CAUTION

Do not engage the starter when the flywheel is moving.

### Electric Starting:

1. Use starting aids if required. See the topic, GENERAL, Cold Weather Starting.

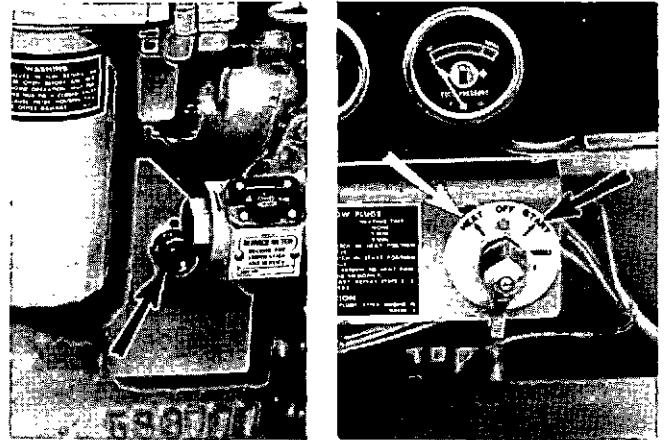
### NOTE

#### D349 and D399 Engines:

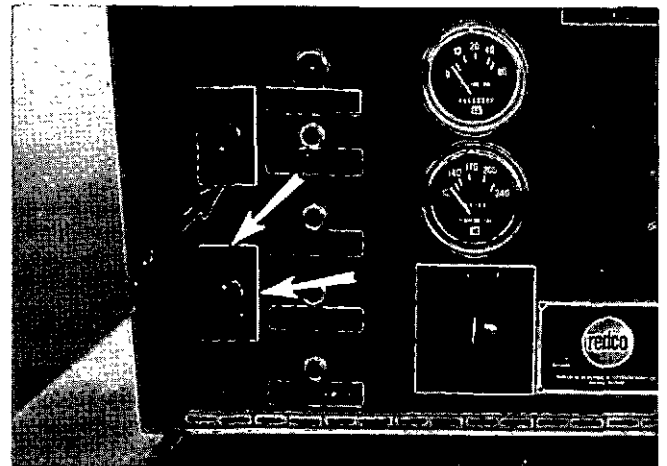
When the START switch is turned to the START position, a prelube pump driven by an electric motor will pressurize the engine lubrication system with oil. The crankcase oil will develop sufficient pressure before closing a switch which will energize the starting motor(s). The starting motor(s) will then crank the engine. After the engine starts, the starter switch is released, the prelube pump stops and the engine oil pump continues lubricating the lube system.

Prelube time will vary with the temperature of the oil. Hot oil will require more time to attain oil pressure before the engine can crank than will cold oil.

2. Push the START button; or turn the HEAT-START switch to the START position, depending upon the control the engine has. Release the control as soon as the engine starts.



For electric sets, place the AUTO-MAN switch in the MAN position; place the ON-OFF-STOP switch in the ON position to crank the engine. As soon as the engine starts, move the switch to the OFF position. (The STOP position is used to stop the diesel engine.)

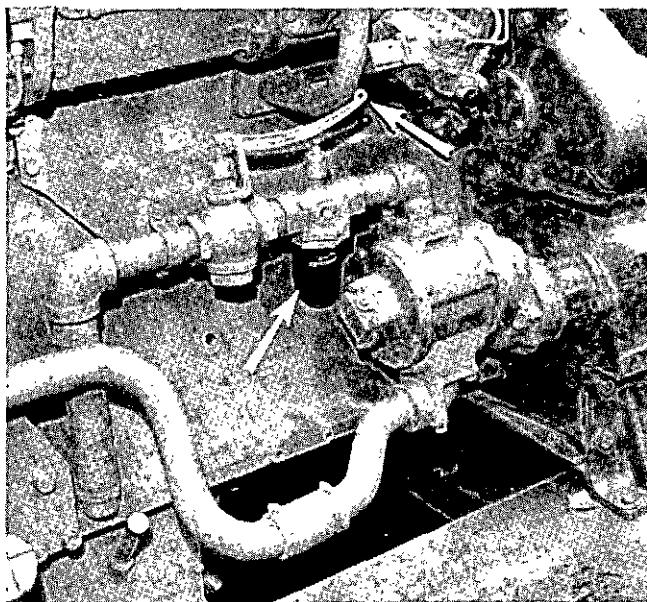
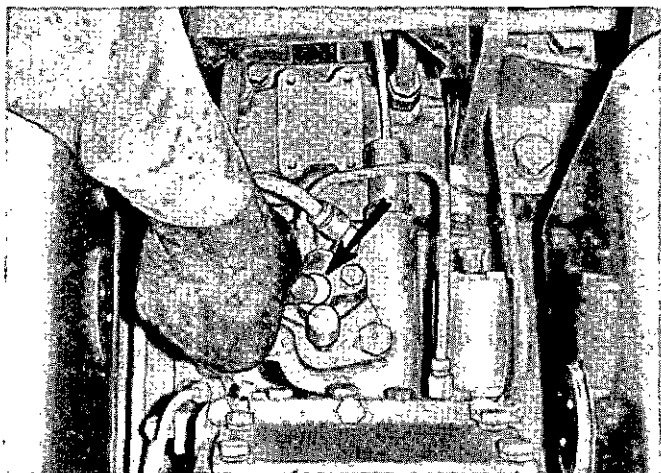


If the engine fails to start in a few seconds, move the governor control lever to the fuel off position, then continue to crank for 10 seconds. This will clear the cylinders of unburned fuel.

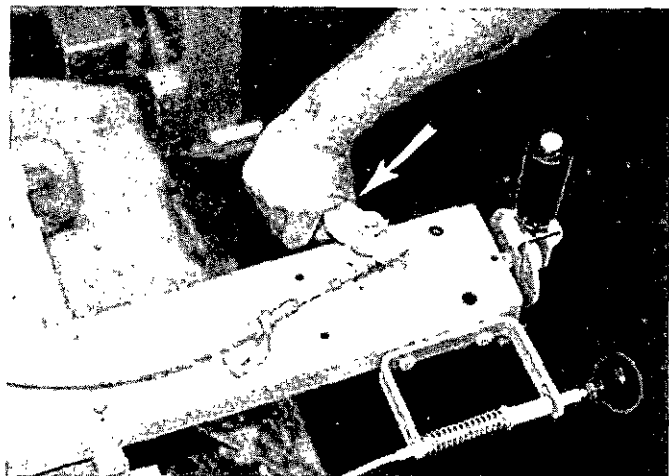
If the engine fails to start after 30 seconds of cranking, allow the starter to cool for 2 minutes before repeating the starting procedure.

### CAUTION

Prolonged cranking at low oil pressure can energize the mechanical safety shutoff which is used on 5.4" bore and larger engines. If the reset lever is in the shutoff position, reset the mechanical shutoff control.



The engine governor may be controlled by an air regulator valve. One control panel can regulate several synchronous operating engines.



RESETTING MECHANICAL SHUTOFF CONTROL

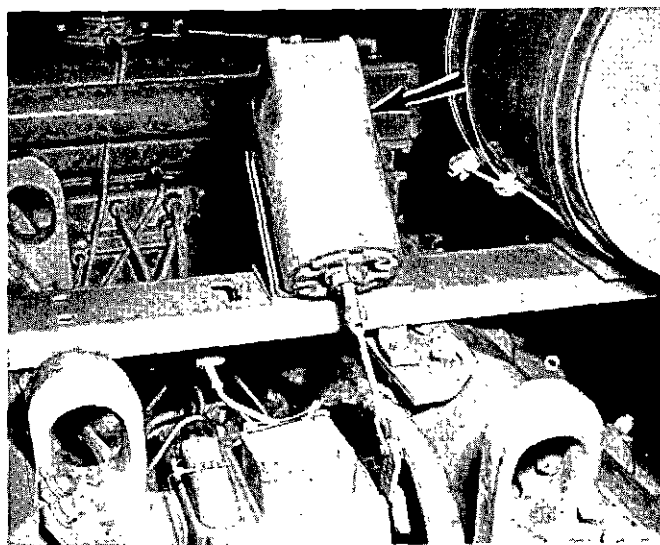
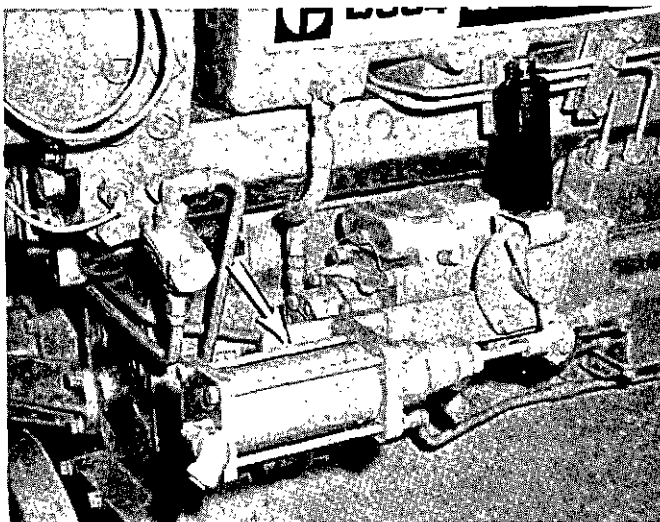
#### CAUTION

**NEVER** use starting aids when the engine is warm and running.

If the engine is equipped with either a Woodward PSG or UGB Governor, see the topic, **WOODWARD GOVERNORS** for the governor operation instructions.

#### Air Starting:

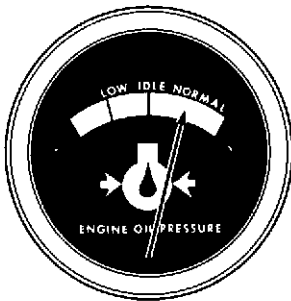
1. Open and close the bleed valve on the bottom of the air tank to drain condensation and oil carryover.
2. Check the air supply pressure. The air start must have 100 PSI (7 kg/cm<sup>2</sup>) to operate properly.
3. Check the oil level in the oiler jar. Keep jar at least half full. Add oil if necessary. See the **LUBRICATION AND MAINTENANCE CHART** for the proper oil to use.
4. Pull the air valve upward to crank the engine. As soon as the engine starts, release the valve.



GOVERNOR AIR REGULATOR VALVES

## AFTER ENGINE STARTS

1. Observe the oil pressure gauge immediately after starting.



### CAUTION

If oil pressure is not indicated, stop the engine and have necessary repairs made.



### WARNING

Stop the engine if any repairs or adjustments are required. Do not work on machinery while the engine is running.

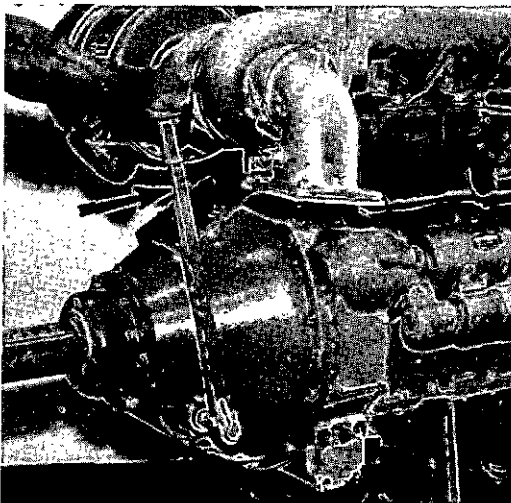
2. Move the governor control to low idle, allow the engine to warm (usually several minutes). Make another "walk-around" inspection for leaks, etc.

## STARTING THE LOAD

### Driven Equipment Without Load:

To engage the driven equipment before applying load:

1. Move the governor control to half engine speed.
2. Engage the driven equipment without load.



3. Check the engine gauges and equipment.
4. Move the governor control to high idle (full load) position.
5. Apply the load to the driven equipment.

### Driven Equipment With Load:

1. Move the governor control to half engine speed. Check the engine gauges.
2. Move the governor control to high idle (full load) position.
3. Engage the load.

## ENGINE OPERATION

### INSTRUMENT PANEL GAUGES

After the engine starts, and at frequent intervals while the engine is operating, the gauges should be observed. Determine the normal reading for each gauge. Investigate the cause whenever there is a significant change in the reading.

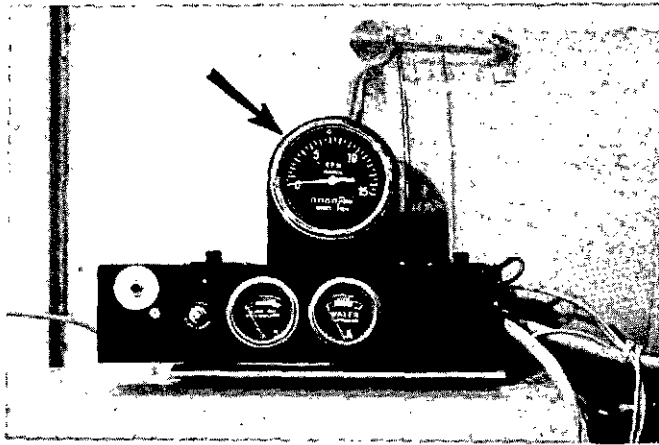
Your engine may be equipped with calibrated gauges. Periodic monitoring and recording of the gauge readings will provide a history of the engine's performance. As certain conditions develop, a change in the readings will indicate a problem is developing. The necessary repairs can be scheduled before the failure and the resulting unexpected downtime occurs.

### CAUTION

If a large quantity of oil or water is lost in a short period of time — as when the line ruptures — manually shut down the engine immediately. If the oil or water levels are allowed to go below the ADD levels, the safety shutoff devices will not protect your engine.

### Tachometer:

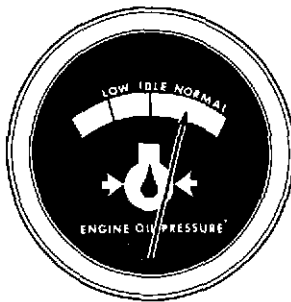
The tachometer indicates engine RPM. When the governor control lever is moved to the full speed position without load, the engine is running at high idle. When the governor control lever is moved to the full speed position and load is applied, the engine will slow slightly to full load speed. The high idle RPM and the full load RPM are stamped on the engine's altitude information plate. The engine can be operated between these two speed limits for long periods of time without shortening engine life.



If the engine speed drops below full load speed with the governor control lever positioned in the full load position, the engine will be operating in a lug condition; see the topic, LUGGING.

### Engine Oil Pressure:

Oil pressure will be greatest after starting a cold engine. Oil pressure will decrease as the engine warms while idling. As the engine speed is increased to full load speed, oil pressure will increase into the NORMAL range and stabilize.



If the gauge reading fluctuates:

1. Remove the load.
2. Reduce engine speed to low idle.
3. Check the oil level. Maintain the oil level between the ADD and FULL mark on the dipstick. If the reading continues to fluctuate, call your Caterpillar dealer.

### Engine Jacket Water Temperature:

The water temperature reading may vary according to load, but should never exceed the boiling temperature for the pressurized system being used.



If the engine operates with the indicator in the HOT range and steam becomes apparent:

1. Reduce the load and speed.
2. Inspect for pressure steam or water leaks. Determine if the engine must be shut down immediately; or if the engine can be safely cooled by reducing the load.

### CAUTION

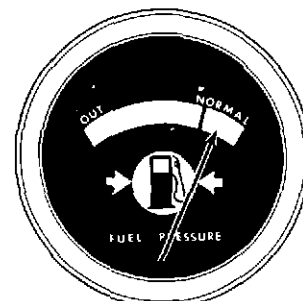
**Do not add cold water to a hot engine: Cracking of engine components may occur. Allow the engine to cool, then add coolant.**

The engine operating temperature should be approximately 200°F (95°C). If the temperature gauge reading registers in, or near, the cold range — approximately 170°F (75°C):

1. Check the temperature regulators for proper temperature range; and replace if necessary.
2. Check the water temperature gauge for accuracy.
3. Determine if the radiator is overcooled, and if radiator louvers are required.

### Fuel Pressure:

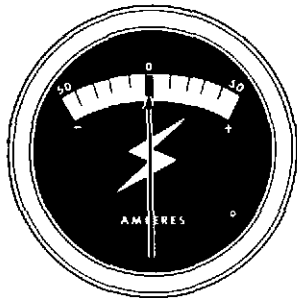
The fuel filter gauge indicates pressure of the filtered fuel. If the fuel filter gauge registers in the OUT range, clean the primary fuel filter if so equipped, and install new fuel filter elements. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Fuel Filters.



In cold weather, paraffin crystals can form in the fuel and plug the fuel filter. If this occurs, a fuel that has a lower CLOUD POINT must be used. See your fuel distributor.

### Ammeter:

The ammeter should indicate just to the right of zero (in the "+" range) when the engine is warm and running at rated speed. If the gauge registers to the left (in the "-" range) as the engine speed is increased, determine and correct the cause.



### Engine Oil Temperature:

The purpose of the oil is to lubricate all moving parts inside the engine, and to cool (remove the heat from) the pistons, liners and bearings. The lube oil cooler transfers the heat in the oil to the engine water. If the radiator cannot expel the necessary heat from the water, the engine oil cannot be properly cooled. Above normal oil temperature indicates a heat problem has occurred with the cooling system and/or engine, and a problem can occur with cylinder heads, liners, pistons or bearings.

### Exhaust Temperature Gauge:

This gauge measures exhaust gas temperature. On V-engines, temperature readings are taken from both the left and right banks. If the exhaust temperature increases:

1. Check the load on the engine. Running the engine below rated full speed RPM at full load causes excessive exhaust temperatures, overheating of the engine's cooling system, and possible engine damage. See the topic, LUGGING. Reduce the load if necessary.
2. Check the air cleaner service indicator or air cleaner pressure gauge; the air cleaner element may be plugged. Stop the engine and service the air cleaner if necessary.
3. After the engine has been stopped, check the tightness of the inlet and exhaust manifold bolts. These bolts must be tight to prevent air leakage.

### Inlet Air Temperature Gauge:

As the inlet air increases in temperature, the inlet air expands. As the air expands, less fuel is burned in the cylinders; and less horsepower is developed. As a result, at full load position with a normal load, the engine may be overloaded.

If excessive air inlet temperature occurs:

1. Check the water temperature gauge. Determine if the engine jacket water system is able to cool the engine properly.
2. Listen for unusual water pump noises. Be sure the V-belts are properly operating the water pump. Check belt adjustment when the engine is stopped.
3. Reduce the load if necessary.
4. Determine if there is an adequate supply of cool air to the engine air inlet. Be sure hot air from another engine or exhaust system isn't being drawn into the air cleaner or radiator.

### Air Cleaner Service Indicator:

This gauge measures the difference of air pressure between the inlet side (dirty side) and the engine side (clean side) of the air filter element. As the element becomes plugged, the gauge indicator reading will increase when the gauge indicates the filter element is dirty, service the air cleaner when the engine is stopped; see the LUBRICATION AND MAINTENANCE PROCEDURES topic, Air Cleaner Service Indicator.

### Oil Filter Service Indicator:

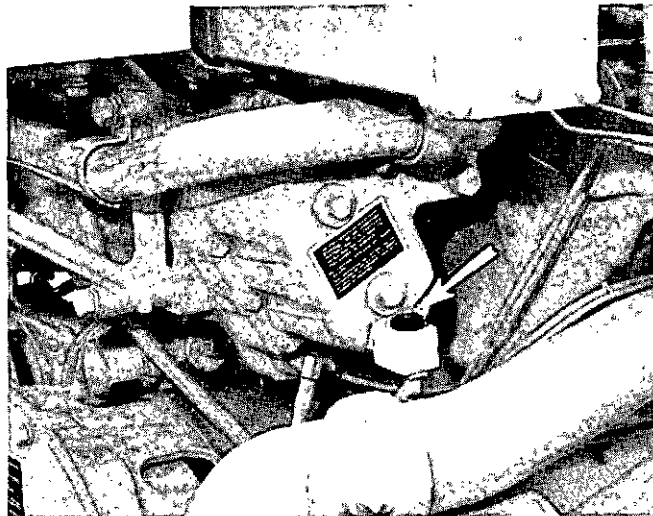
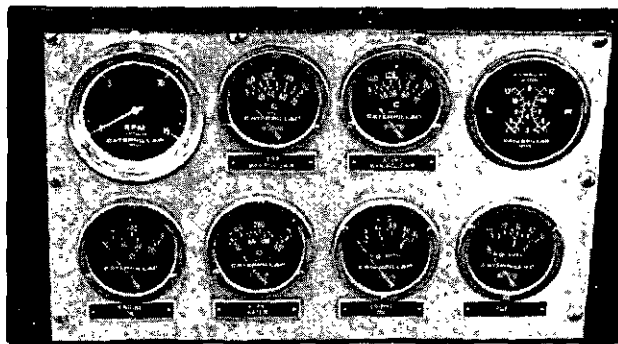
This gauge measures the difference of oil pressure between the inlet side (dirty outer side) and the outlet side (inner diameter side) of the oil filter elements. As the element becomes plugged, the difference of pressure between the inner and outer sides of the element will increase. Then the gauge reading indicates the filter element is almost plugged, change filter elements when the engine is stopped. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Oil Filter Service Indicator.



**WARNING**

Shut the engine down if work on, or around, the engine is required.

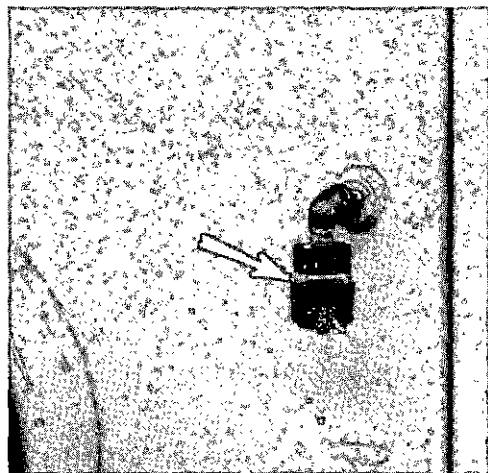
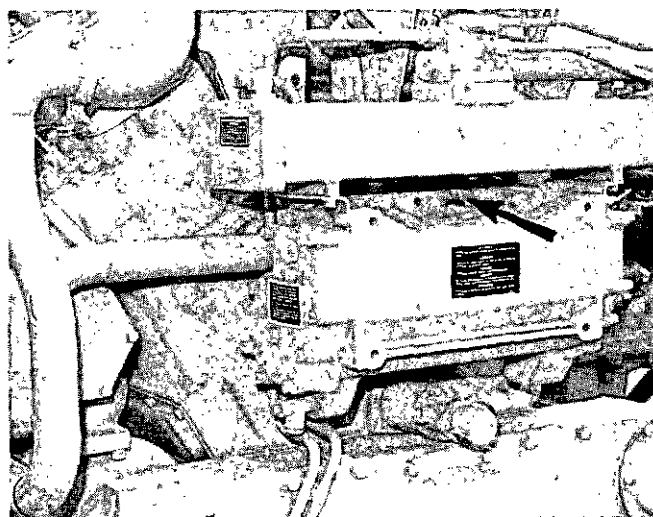
Observe all gauge readings periodically. Know the normal indication of each gauge. If there is a sudden change, investigate the cause immediately, and make repairs if needed.



## INDICATORS

### Air Cleaner Service Indicator:

Periodically check the air cleaner service indicator. If the red piston remains in the visible position, the air cleaner element requires servicing. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Air Cleaner Service Indicator.



## ENGINE HORSEPOWER RATINGS

There are two general horsepower ratings for industrial engines and two for electric set engines. They are: intermittent or continuous; standby or prime. These ratings are the recommended engine horsepower settings based upon load requirements and type of operation.

### Continuous and Prime Ratings:

Horsepower settings for these two ratings allow the engine to operate a constant load at full speed for long periods of time without shortening engine life.

### Intermittent Rating:

Horsepower settings for this rating requires the engine to be operated at full load and speed for periods up to an hour, followed by an equal time of operation at reduced load and speed.

### Oil Filter Change Indicator:

On Vee engines, periodically check the oil filter change indicator. When the red piston has raised half way in the clear plastic window, change the oil filter elements.

#### NOTE

The engine is shipped with an opaque covering over the clear plastic window. Be sure this covering is removed.

### CAUTION

If an engine is set for an intermittent rating and is operated for long periods of time at constant full load, the engine life will be shortened.

### Standby Rating:

Horsepower settings for this rating allows the electric set to supply rated power for a period of time, after which the engine is stopped.

Contact your Caterpillar dealer if there is doubt as to which rating the engine has.

### CAUTION

Horsepower settings should only be done by authorized personnel.

### Full Load Operation:

The governor control lever should remain in the full governed position while powering full load.

### Reduced Load Operation:

If the load varies, or is cyclic, the governor usually will adjust the engine speed as required. If a slower constant speed is desired, move the governor control lever to desired speed position.

### CAUTION

Be sure to increase engine speed before increasing the load.

### No Load Operation:

If the load is temporarily removed, engine speed may be reduced by manually moving the governor control. However, the engine may be operated at high idle without causing shortened engine life.

### CAUTION

Never operate an electric set below 2/3 full load RPM: Overheating and possible damage could occur to the generator below this RPM.

### Lugging:

Lugging can occur at any engine speed and with most applications. Lugging occurs whenever engine speed decreases below full load speed with the governor control at

full load speed position; or when an increase in governor control setting will not increase engine speed.

Lugging can damage an engine: Maximum fuel is injected at reduced engine speed; and the water pump, oil pump and fan run slower than required to cool the engine. Certain engine areas will become extremely hot and failure of parts could occur.

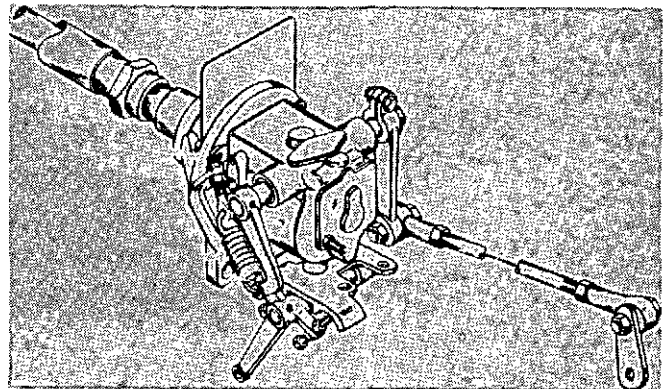
Because maximum engine torque is developed, lugging — if properly used — can be useful. Lugging will not cause damage if the lugging period is short in duration, and if the engine is allowed to cool.

An example of lugging could be a shovel digging through rock and clay. As the bucket is raised, the governor increases engine speed. If the bucket becomes lodged on a rock, the engine speed will drop, but the fuel consumption rate, exhaust temperatures and torque will increase. The operator must determine if either the rock can be loosened in a short period of time, or the bucket should be repositioned and the load reduced. If the rock is to be loosened while in lug condition, the engine must be able to cool in the time it takes to finish the cut, swing and dump the load, and return to the next load.

The temperature gauges for the engine should be closely watched during periods of lugging. If the temperature readings increase, the load must be reduced.

### Output Shaft Governor Operation:

When the load can overspeed the torque converter output shaft, an output shaft governor should be installed. The output shaft governor is a speed limiting device which eliminates having to frequently change engine speed by using the engine governor control lever.



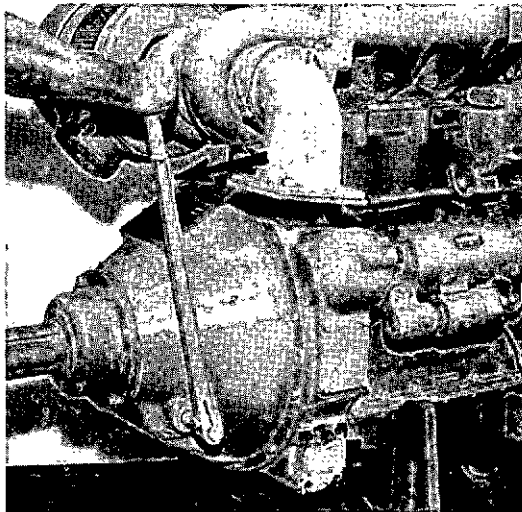
The output shaft governor is installed on the torque converter output shaft and is connected to the engine governor through a hydraulic servo mechanism. When under load, the engine governor regulates engine speed. If the load is removed and the torque converter output shaft speed exceeds desired operating speed, the output shaft governor will operate the engine governor so as to reduce the speed of the engine. When the output shaft speed returns to normal operating speed, the engine governor maintains full load engine speed.

## ELECTRIC SET OPERATION

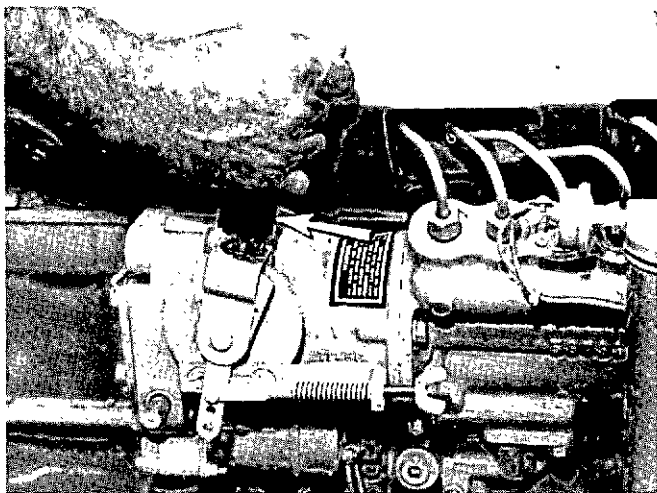
See the ELECTRIC SET OPERATION INSTRUCTIONS.

### STOPPING

1. Flywheel clutch operation: Quickly pull the clutch lever to the released position. For electric set operation, see the ELECTRIC SET OPERATION instructions. For Woodward Governor operation, see the topic, WOODWARD GOVERNORS, Stopping the Engine.

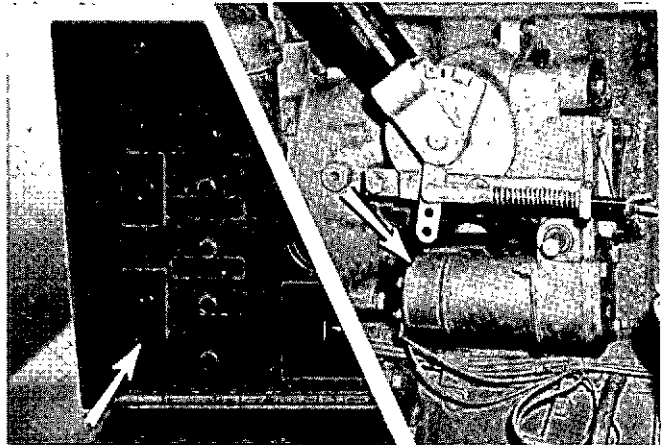


2. Reduce engine speed to half speed. Run for 5 minutes to cool engine.



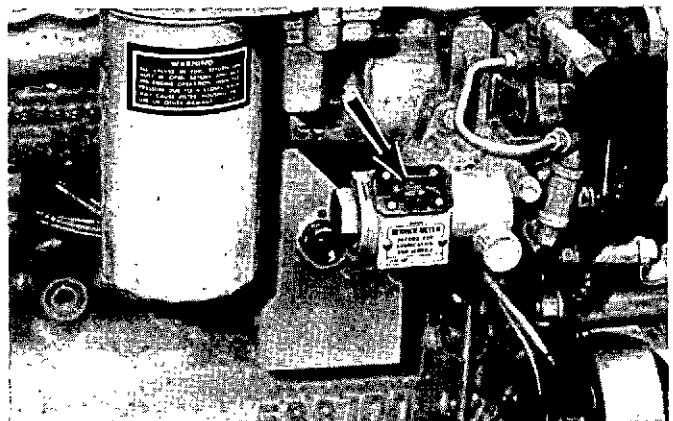
3. Reduce engine speed to low idle.
4. Check the crankcase oil level while the engine is idling. Maintain the oil level between the ADD and FULL marks on the side of the dipstick stamped CHECK WITH ENGINE RUNNING. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Diesel Engine Lube Oil.

5. Stop the engine by either moving the engine governor control to the shutoff position, or by pushing and holding the ON-OFF-STOP switch until the engine stops; depending upon how your engine is equipped.

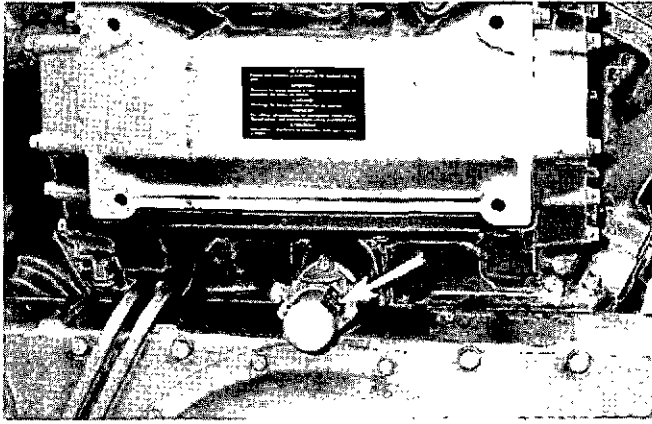


### AFTER STOPPING CHECKS AND PROCEDURES

1. Fill the fuel tank. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Fuel Tank.
2. Drain the raw water system if below freezing temperatures are expected; see Section D: Draining Raw Water System.
3. If below freezing temperatures are expected, allow the engine jacket water expansion tank to cool; then check the coolant for proper antifreeze protection. Add permanent type antifreeze if required. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Cooling System.
4. Repair any leaks, correct major adjustments, tighten loose bolts, etc.
5. Observe the Service Meter reading. Perform the periodic maintenance as instructed in the LUBRICATION AND MAINTENANCE CHART.



SERVICE METER ON 6 CYLINDER ENGINE



SERVICE METER ON V-ENGINE

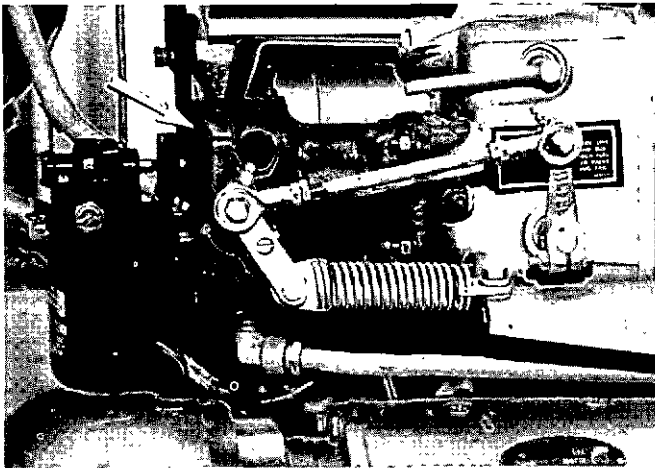
6. Perform the required maintenance on all other equipment; see the equipment manufacturer's instructions.

## WOODWARD GOVERNORS

Woodward Governors are usually electrically operated from a control panel.

### STARTING THE ENGINE

#### Woodward PSG Governor:



1. Perform all pre-start checks outlined previously. In addition, be sure the alternator and alternator belt are properly installed and adjusted.
2. Push the START-STOP switch to the START position.
3. When the engine starts, release the START-STOP switch.

On some installations, low alternator output frequency will operate a relay to stop the starter. The alternator belts on these arrangements must be inspected regularly for proper belt tension and conditions.

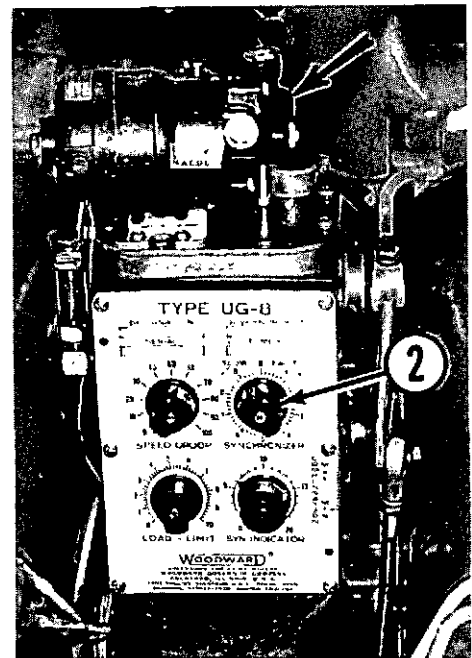
4. Start the load.
5. Regulate the engine speed with the RAISE-LOWER switch to attain the required instrument panel gauge readings.

#### Woodward UG8 Governor:

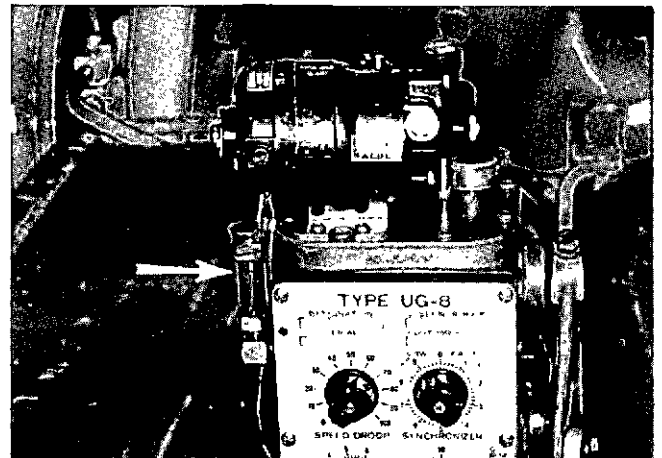
Start the engine as follows:

#### NOTE

If the governor is equipped with an electric motor, operate synchronizer knob (2) by using the RAISE-LOWER switch on the control panel.

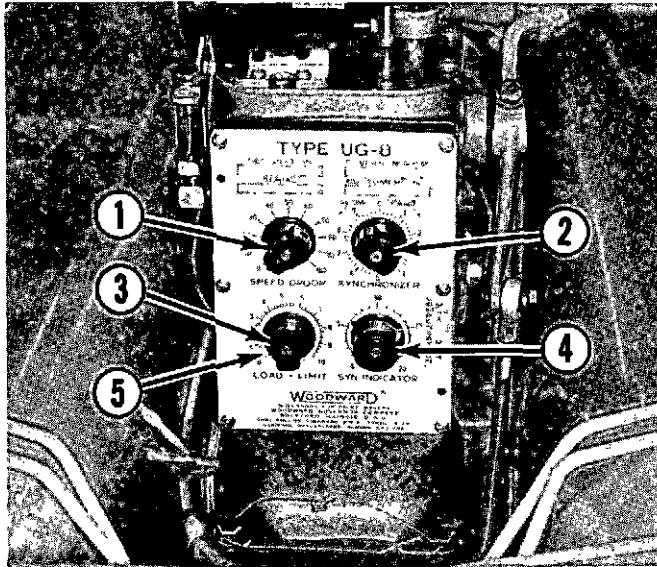


1. Perform all pre-start checks outlined previously.
2. Check the oil level in the sight level gauge with the engine stopped. Oil level should be near the top of



the sight level gauge. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Woodward UG8 Governor.

3. Turn the load limit knob (3) until the indicator is between "5" and "7".



1—Droop knob. 2—Synchronizer knob.  
3—Load limit knob. 4—Synchronizer Indicator.  
5—Load pointer.

4. Turn the synchronizer knob (2) clockwise until the indicator (4) is at "8".
5. Move the START-STOP switch to the START position; start the engine.
6. Run the engine at low idle for 5 minutes.
7. Turn the load limit knob (3) to "10".
8. Turn synchronizer knob (2) clockwise until the engine runs at full governed speed.
9. Turn speed droop knob (1) to obtain proper droop for the operation:
  - a. For single unit operation, set knob (1) at "0".
  - b. For parallel operation: See Parallel Operation Droop Adjustment in the ELECTRIC SET OPERATION instructions. Speed droop knob (1) on the first unit on the line may be set at "0" droop, and the remaining units set between "30" and "70". These settings should provide constant speed or frequency. If constant speed is not re-

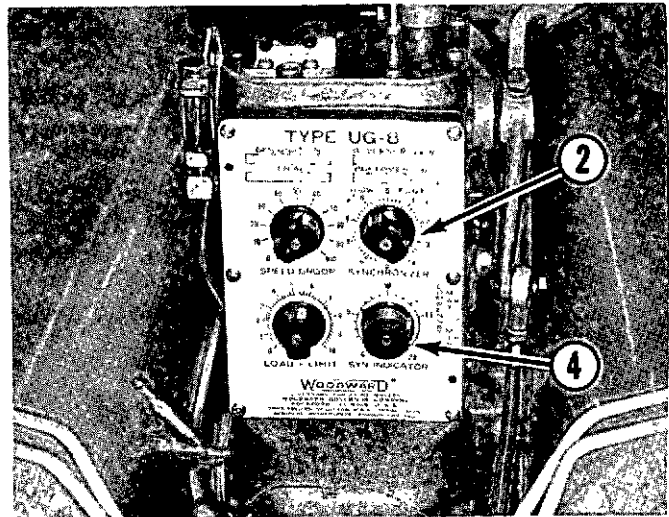
quired, set droop knob (1) on all units between "30" and "70".

10. Apply the load and readjust the synchronizer knob (2) to obtain the desired load division. Load pointer (5) indicates the relative load.

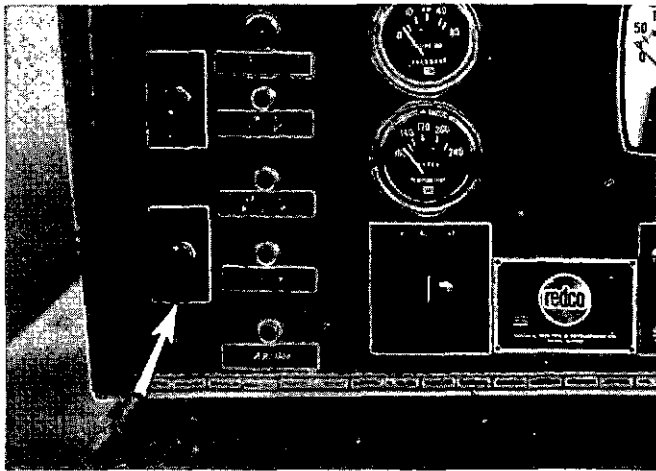
## STOPPING THE ENGINE

1. Remove the load. See ELECTRIC SET OPERATION instructions if equipped with an electric set generator.
2. Reduce engine speed to low idle: Push down and hold the RAISE-LOWER switch until the engine low idle speed is reached.

When manually operating a UG8 Governor, move the synchronizer knob until the synchronizer indicator points to "8", or the low idle stop is reached.

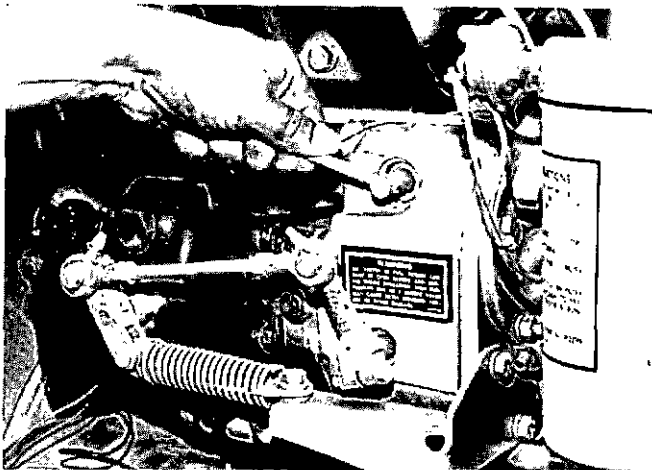


3. While the engine is idling, check the engine oil level. Oil level must be maintained between the ADD and FULL mark on the side of the dipstick marked "CHECK WITH ENGINE RUNNING".
4. Stop the engine.
  - a. **Solenoid Shutoff:** Move the ON-OFF-STOP switch to the STOP position. Hold the switch until the engine stops. (Do not confuse this with the "RAISE-LOWER" switch.)

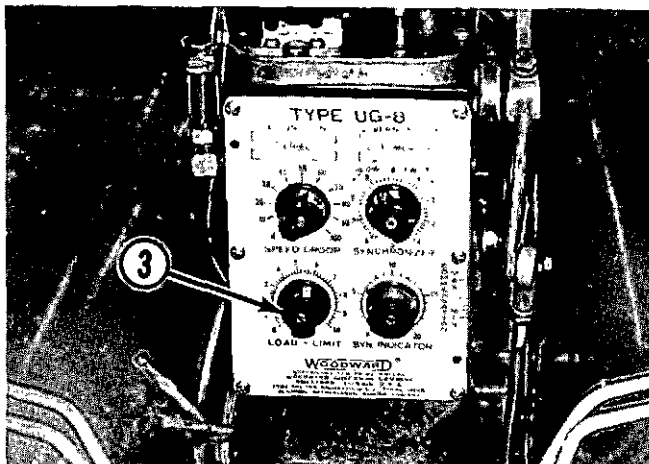


**ON-OFF-STOP SWITCH**

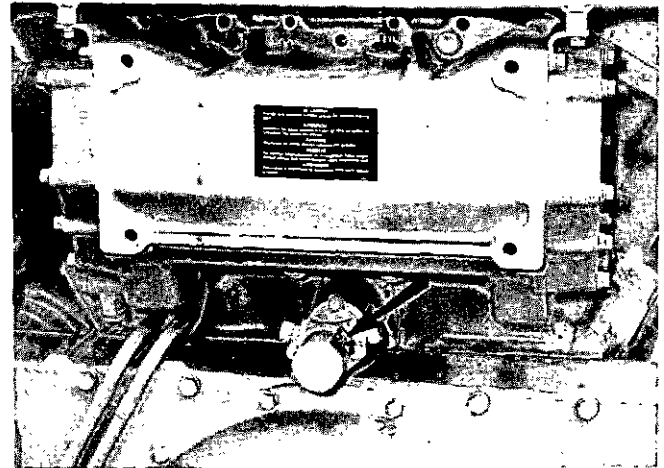
- b. **PSG Governor:** Move the shutoff lever forward, or hold the lever up, depending upon installation. Hold the lever in this position until the engine stops.



- c. **UG8 Governor:** Turn the load limit knob to "0".



- 5. Fill the the fuel tank. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Fuel Tank.
- 6. Drain the raw water system if below freezing temperatures are expected.
- 7. Observe the Service Meter reading. Perform the periodic maintenance as instructed in the LUBRICATION AND MAINTENANCE CHART.

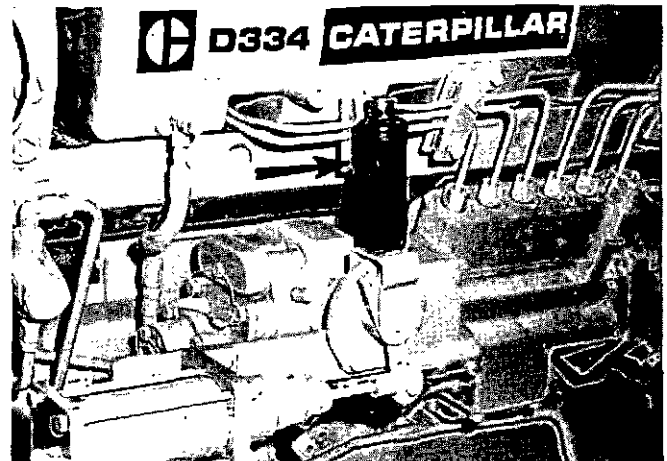


## EMERGENCY STOPPING

To stop in an emergency:

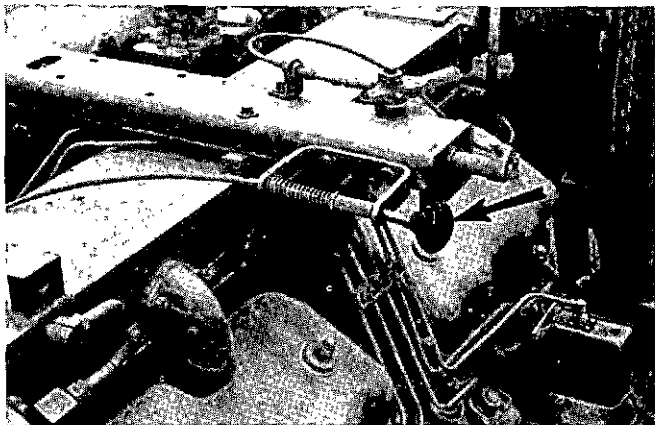
### Mechanical Governor Control:

Pull upward on the hand grip, and move the control to the shutoff position.



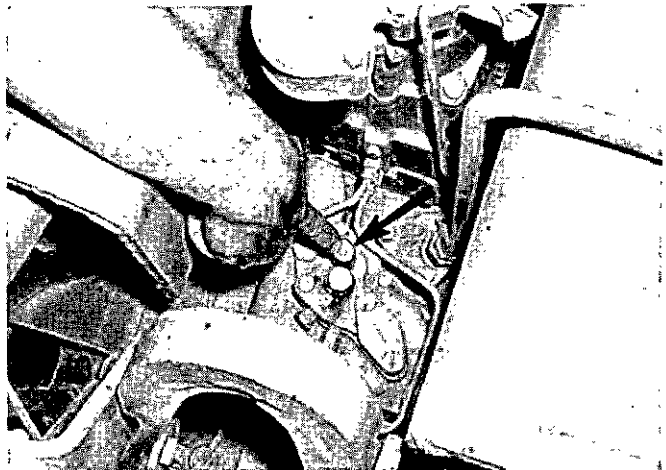
### Manual Shutoff Control:

Push and hold the control handle until the engine stops.



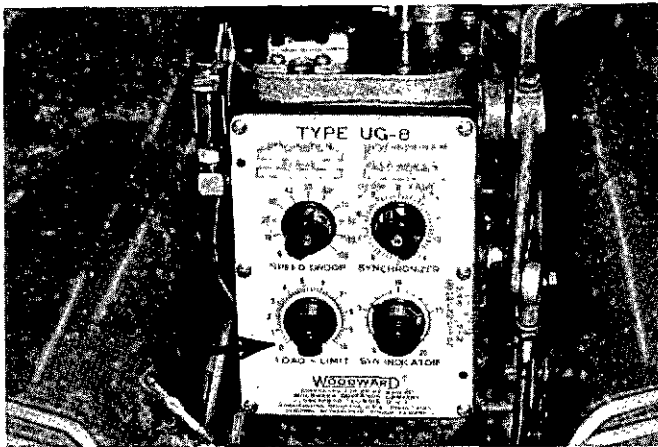
### Mechanical Safety Shutoff Control:

Push and hold the emergency stop button momentarily to allow the overspeed mechanism to trip and start slowing the engine.



### Woodward UG8 Governor:

Turn the load limit knob to "0".



### CAUTION

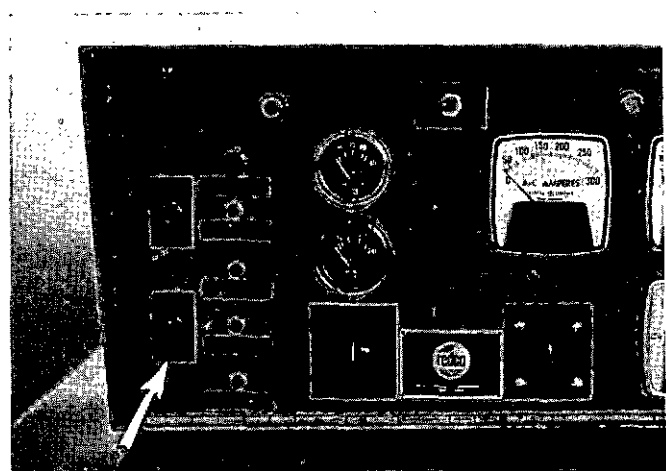
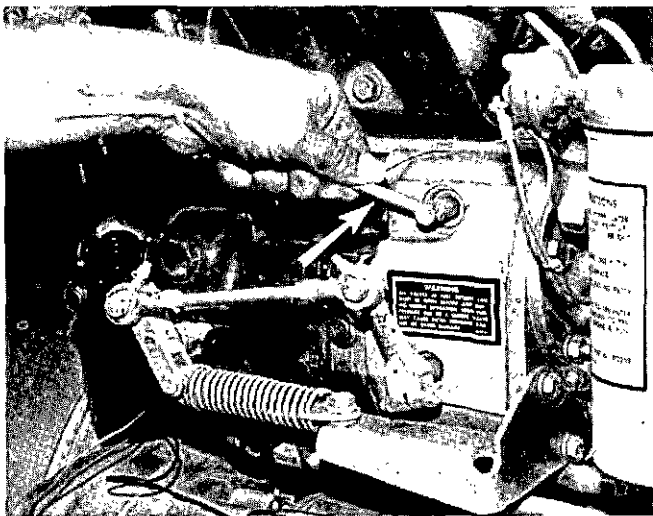
This button has a skirt. Do not confuse it with the reset button which is flat. Use this mechanical shutoff button for emergencies only. Do not use it for normal stopping.

### Electric Shutoff Solenoid:

Push and hold the ON-OFF-STOP switch in the STOP position until the engine stops.

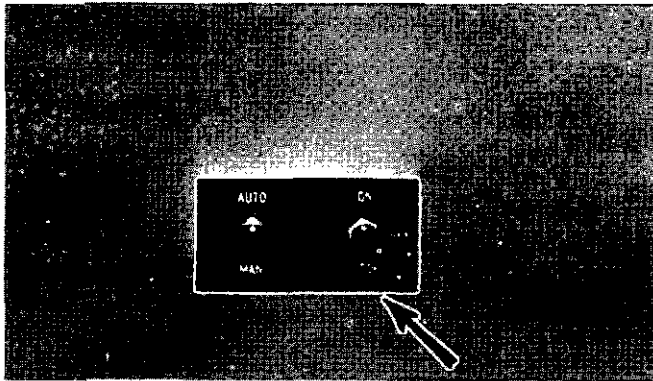
### Woodward PSG Governor:

Move the lever forward against the stop; hold the lever until the engine is stopped.



### Air Controls:

Push and hold the ON-OFF-STOP switch in the STOP position until the engine stops.



## EMERGENCY SHUTOFF DEVICES AND ALARMS

Emergency shutoff devices are either electrically, mechanically or hydraulically operated. Familiarize yourself with the types and locations of the shutoff devices, the conditions which cause each control to function, and the resetting procedure required to start your engine.

### CAUTION

Always determine the cause of the shutdown, and have the necessary repairs made before restarting the engine.

Emergency shutoff controls are for emergency use only. Do not use an emergency shutoff device for a normal stopping procedure.

## ELECTRIC SHUTOFF CONTROLS

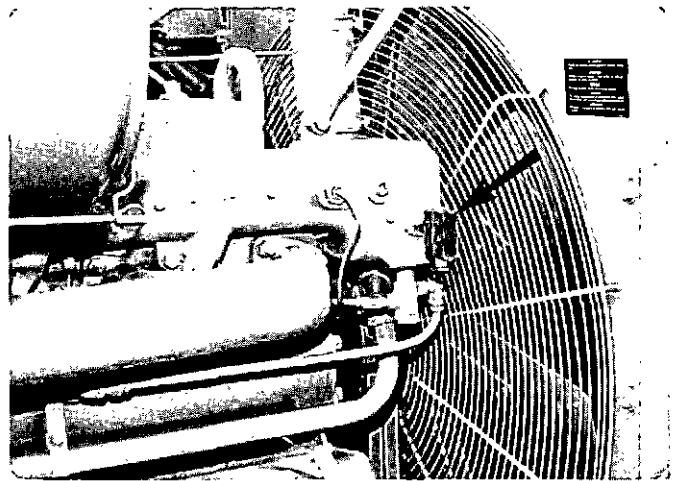
The operation of all electric shutoff controls is similar: A critical operating condition actuates a switch in the sensing unit. The switch closes the circuit to the shutoff solenoid which moves linkage to bypass the fuel to the cylinders; thus stopping the engine. The shutoff control may require resetting before the engine can start.

### High Water Temperature Shutoff:

The shutoff switch is located in the water temperature regulator housing. Excessive water temperature closes the switch. No resetting procedure is required: As the coolant cools, the switch opens.

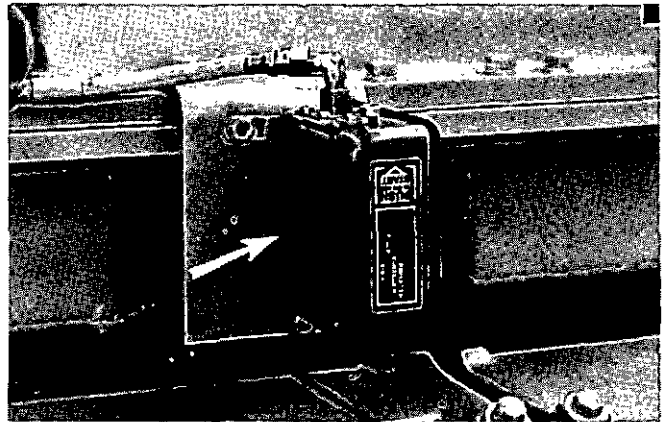
### CAUTION

The sensing element must be submerged in the coolant to operate. A low coolant level cannot actuate the shutoff.



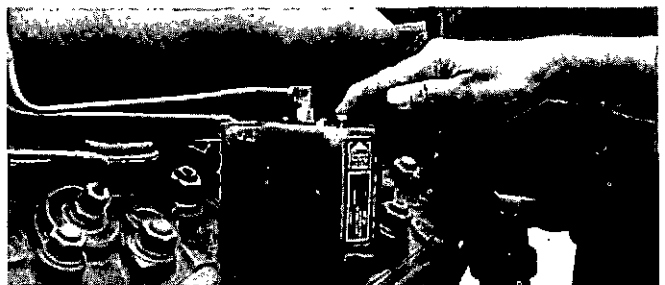
### Low Oil Pressure Shutoff Switch:

This device is usually mounted on the side of the engine with oil lines connected to the switch. Low oil pressure closes the switch.



Manually operated systems require resetting of this switch before starting. Automatic start-stop systems use a pressure switch which resets itself.

To reset the switch, push the button until it latches. After the engine starts and develops oil pressure, the oil pressure will push the button to the extended running position.



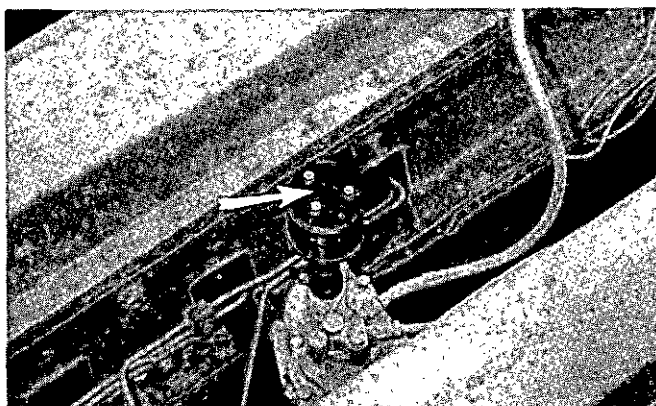
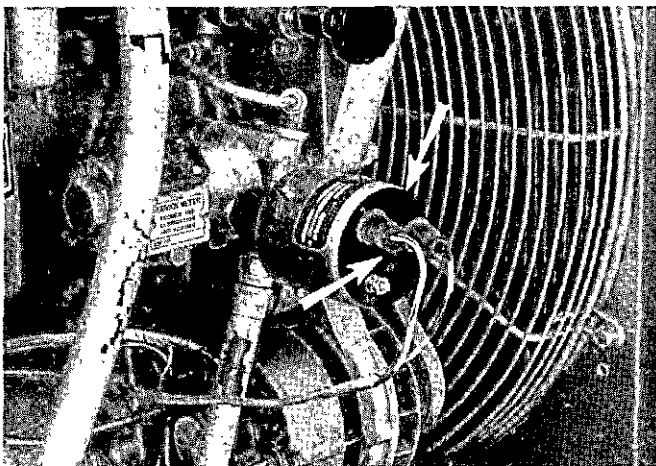
### CAUTION

The engine will not be protected if the engine is operated with the button latched in the START position.

If the button remains in the reset position, the engine oil pump is not developing normal oil pressure and a check should be made.

### Overspeed Shutoff Switch (Electro-Mechanical):

This switch is mounted either on the tachometer drive or on the governor. Excessive engine speed closes a switch by centrifugal force.



TWO INSTALLATIONS OF OVERSPEED SWITCH

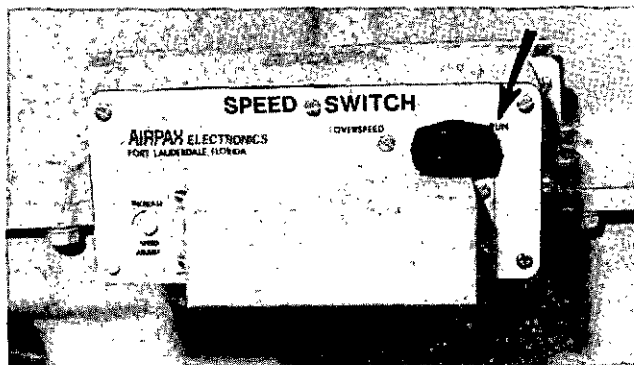
To reset the switch, push the button marked RESET. The knob will remain down until the engine overspeeds.

### Overspeed Shutoff Switch (Electronic):

This switch is a magnetic pick-up which is mounted on the flywheel housing and senses engine speed. The control box is mounted on the engine block. Excessive engine speed closes a circuit breaker. To reset the switch, push arm of breaker to the run position.

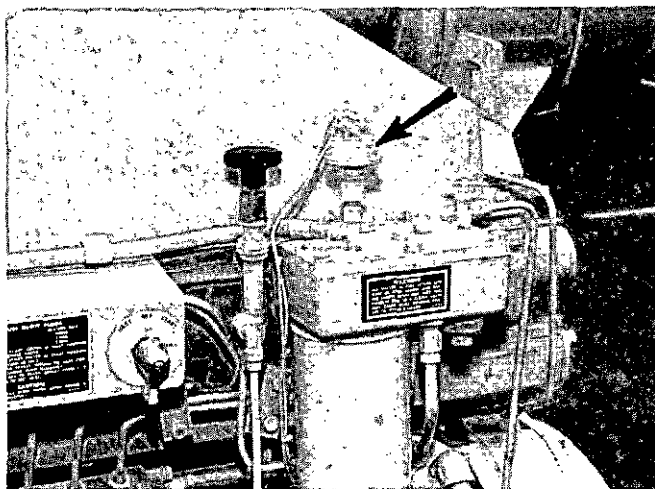
#### CAUTION

This switch will not provide overspeed protection if there is no power to the control box.

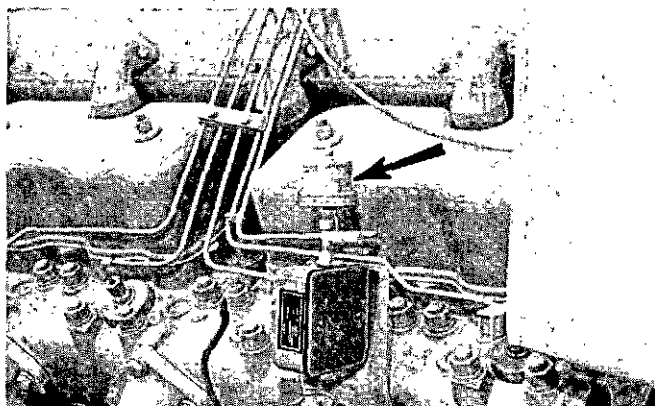


### Fuel/Oil Pressure Switch:

This switch is mounted in the fuel manifold between the clean side of the fuel filter and the fuel injection pump housing. Low fuel pressure (below 3 psi) opens the switch and the electrical circuit to either the shut off solenoid or the circuit between the alternator and the alternator regulator. Opening of these circuits prevents the battery from becoming discharged while the engine is stopped.



This switch can also be used with an electric governor. In this application, oil pressure closes the switch to allow the electric governor to control engine speed.

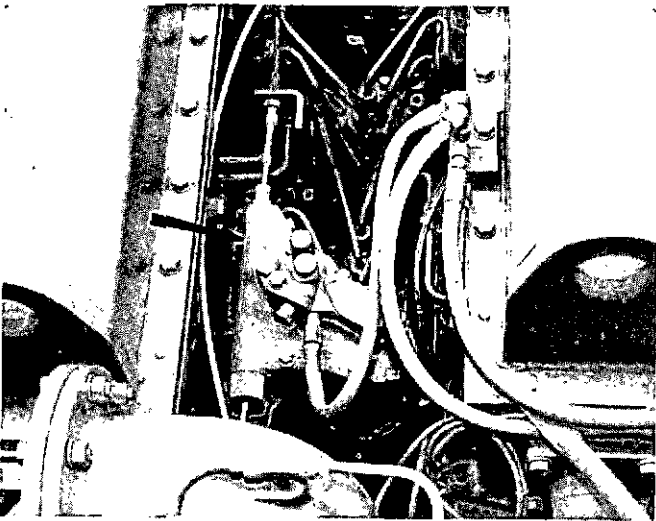
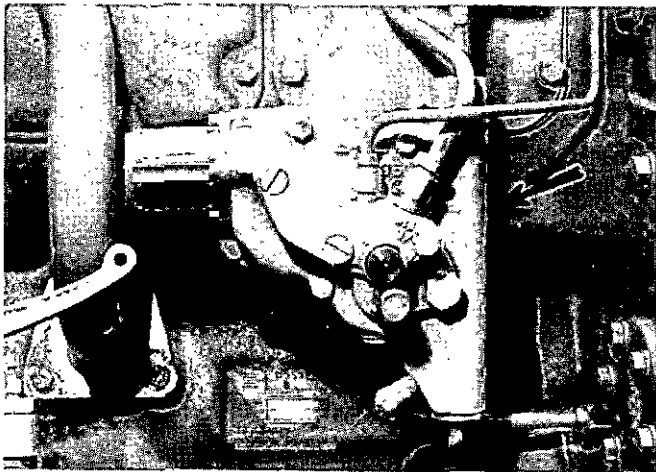


This switch does not require resetting.

## MECHANICAL SAFETY SHUTOFF CONTROL

The mechanical safety shutoff is both a low oil pressure and an overspeed shutoff device. A high water temperature shutoff can be installed which uses the low oil pressure shutoff device to stop the engine.

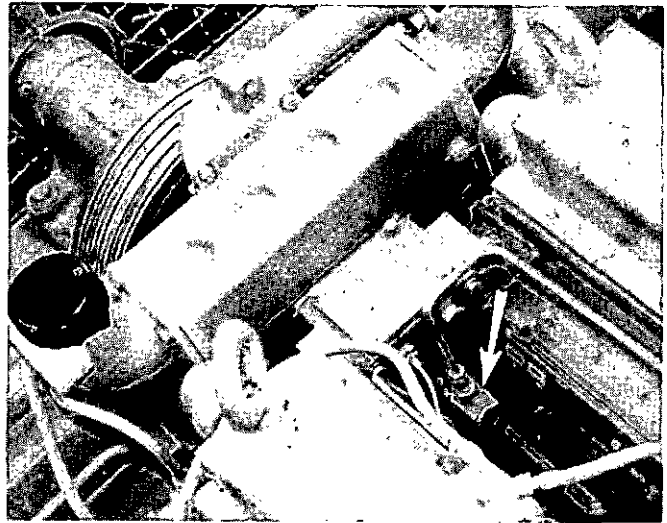
On 6 cylinder engines, the mechanical shutoff is mounted on the side of the engine. On vee engines, the shutoff is mounted in the vee of the engine between the two banks of cylinders.



The high water temperature shutoff is installed in the temperature regulator housing of all engines.

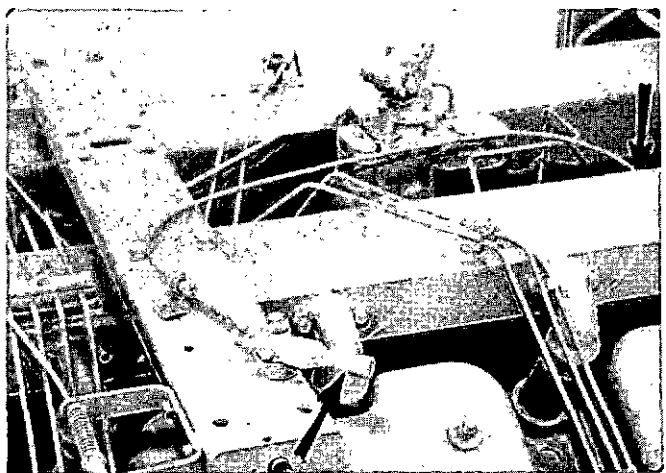
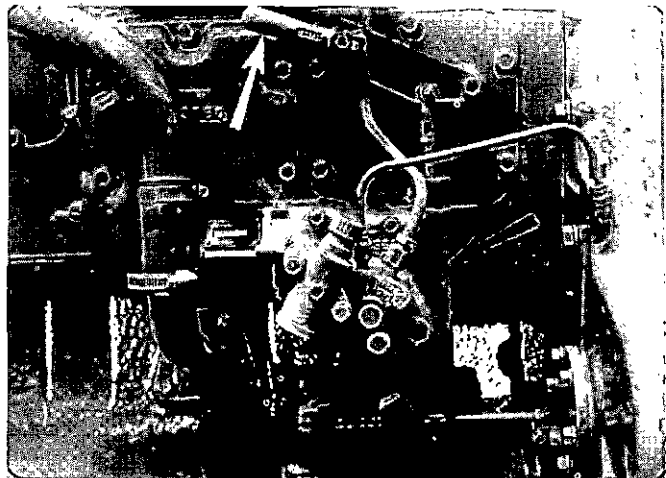
If an overspeed, low oil pressure, or high water condition occurs, a spring loaded rod is mechanically tripped internally, which moves and holds the rack in the shutoff position.

Difficult starting with long periods of cranking can trip the low oil pressure shutoff. The reset lever must be moved and latched in the run position before starting can be accomplished. Normal stopping of the engine will not trip the shutoff device.



The basic cause for the shutdown can be determined by the manner in which the shutoff must be reset:

1. Push the reset lever (or handle).

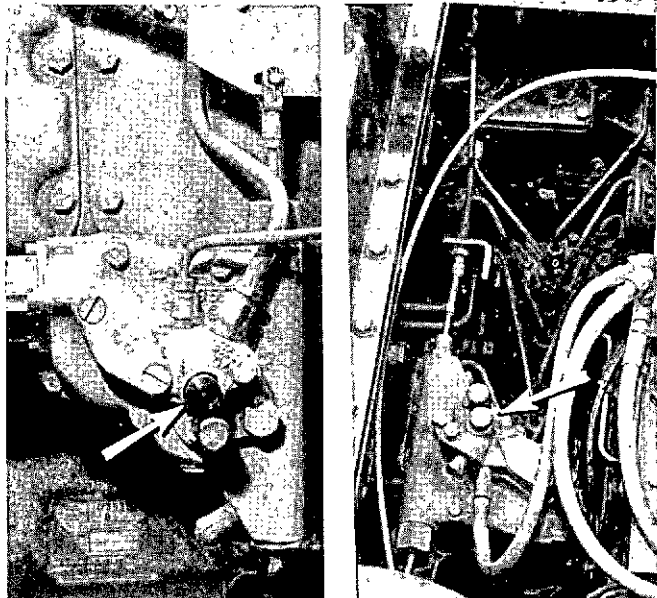


If the rod latches, an overspeed condition stopped the engine. Investigate the cause for overspeed condition.

If the rod does not latch, the engine was stopped because of a low oil supply to the shutoff control. This could

be caused by either low engine oil pressure, or by the high water temperature shutoff bypassing the oil to the mechanical shutoff. Therefore, perform checks for both low oil supply and high water temperature. Reset the control by the following steps:

1. Push the reset button firmly.

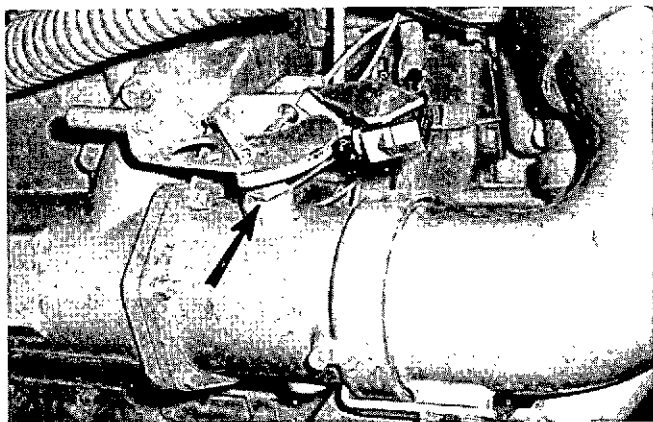


2. Push the reset lever (or handle) until the rod latches.

If the reset lever does not move freely, check the reset cable for kinks, binds, or lack of lubrication. Make needed repairs or adjustments.

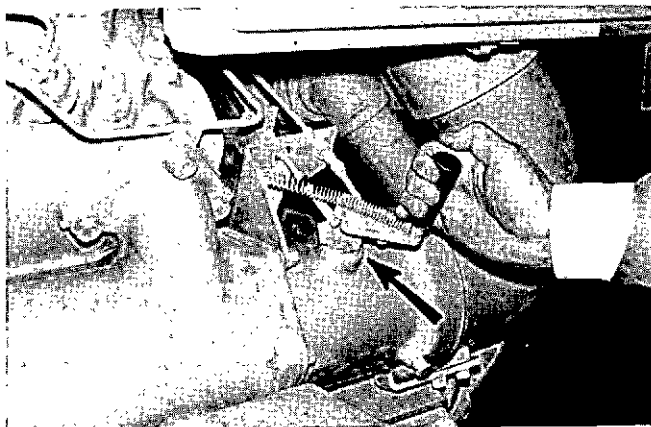
### AIR SAFETY SHUTOFF CONTROL

The air shutoff control is an attachment to the mechanical safety shutoff device installed on large bore vee type engines. When an emergency condition occurs, the mechanical shutoff pushes the rack into the shutoff position and pulls a butterfly valve, located in each inlet manifold, to the closed position. The air safety shutoff control must be reset before starting.



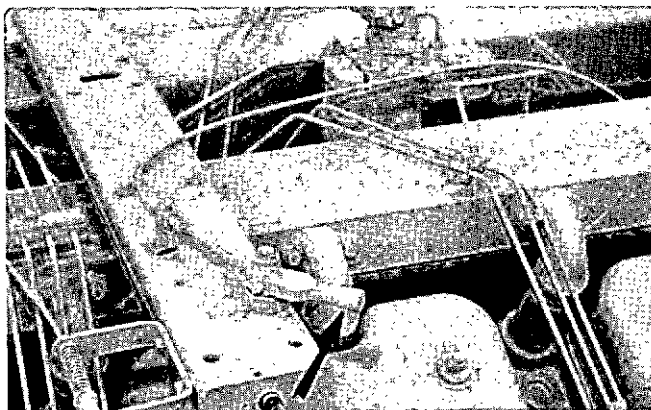
If an overspeed condition shut the engine down:

1. Pull the air shutoff reset lever on the air inlet manifold to the RESET position.



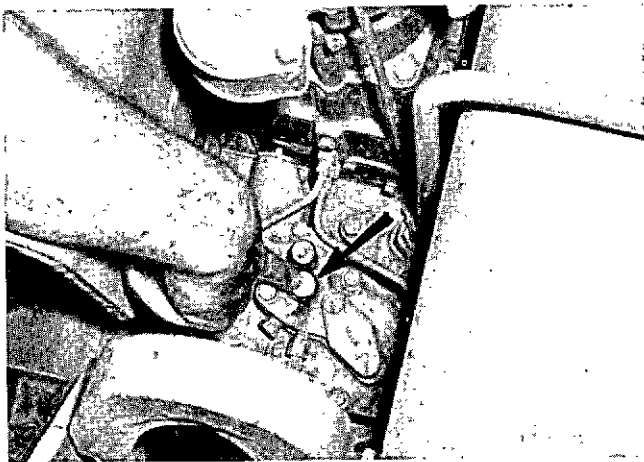
2. Release the lever. The lever should move slightly and then latch in the RUN position.

3. Push the mechanical shutoff reset lever until the rod latches.

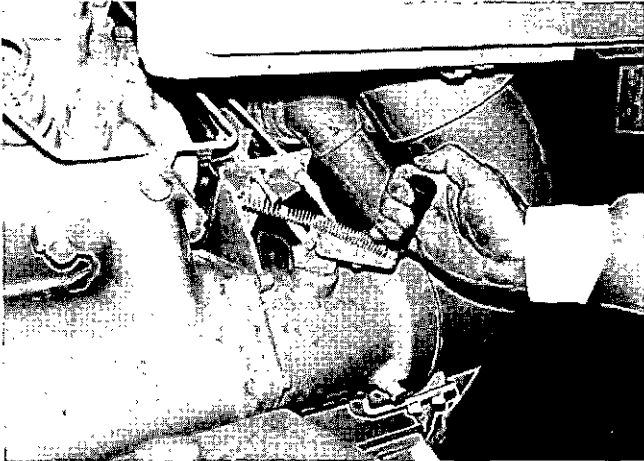


If a low oil pressure or high water temperature condition shut the engine down:

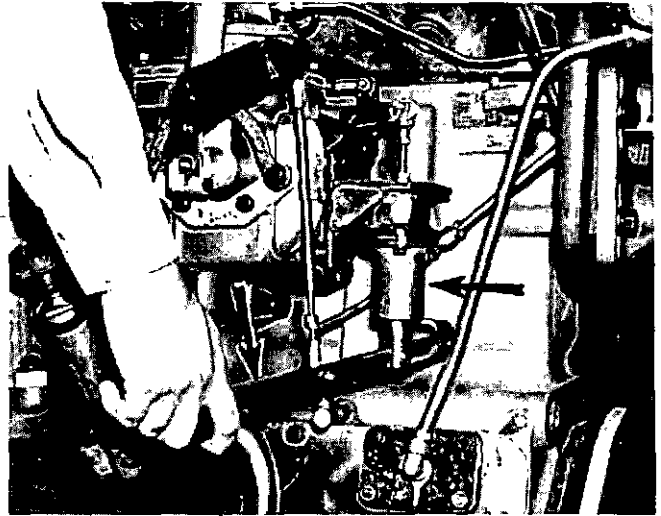
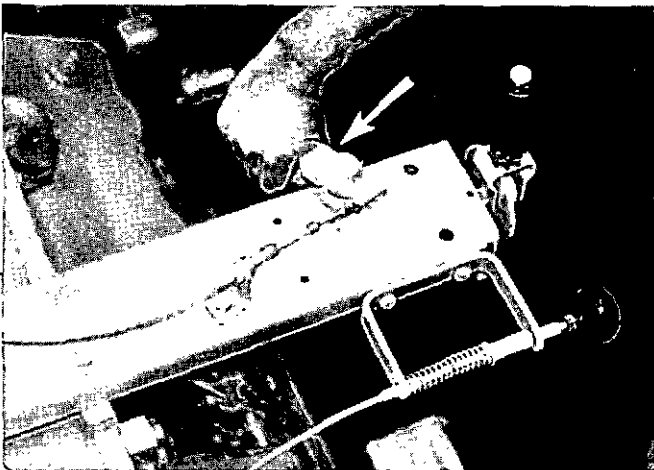
1. Firmly push the reset button in the vee of the engine.



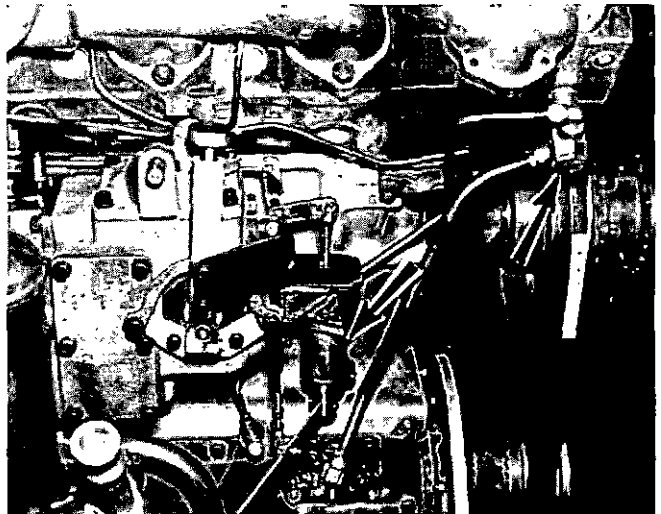
2. Pull the air shutoff reset handle on the air inlet manifold to the RESET position.



3. Release the lever. The lever should move slightly and latch in the RUN position.
4. Push the mechanical shutoff reset lever until the rod latches.



A high water temperature shutoff can be used with this shutoff control. Excessive coolant temperature causes the temperature sensor to open a dump valve which empties the pressure oil from the low oil pressure shut off device. The low oil pressure shutoff control shuts down the engine.



Reset the oil pressure control as instructed above. Allow the water sensor to cool: No resetting of the water temperature shutoff switch is required.

#### CAUTION

The water temperature sensor must be submerged in the coolant to operate. A low coolant level, or a failed water pump cannot actuate the shutoff.

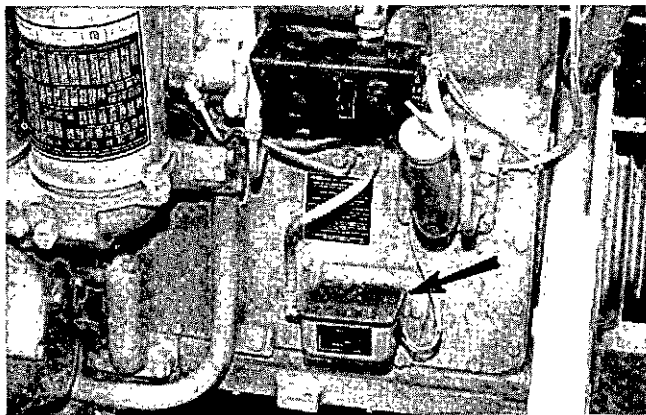
### HYDRAULIC SHUTOFF CONTROLS

The hydraulic shutoff control is mounted on (or near) the governor. When oil pressure drops below 8 PSI, the fuel injection pumps bypass the fuel to the cylinders.

To start the engine, move and hold the reset lever against the stop while cranking the engine. After the engine starts, the lever will stay in the running position. Manually reset the control each time the engine is stopped.

### ALARM SWITCHES

Alarm switches are set at a less critical temperature, pressure, or level limit than the comparable shutoff control. The purpose of the alarm switch is to warn the operator an unsafe operating condition is starting to occur, and that corrective measures should be taken to avoid possible damage to the engine and/or a possible shutdown of the engine.



**LOW OIL PRESSURE ALARM SWITCH**

**CAUTION**

It could be hazardous to have the engine stop unexpectedly when engine power is needed. However, if the engine overspeeds, the engine should be stopped immediately.

When the preset temperature, pressure or fluid level occurs, the sensor of the alarm switch will move and close an electrical circuit. Either a light or an audible alarm will be energized. The light or alarm will continue to operate until the condition is corrected. When the condition is corrected the alarm will automatically reset and the light will turn off.

**CAUTION**

The cause of the shutdown must be investigated and corrected before starting and operating the engine.

**Alarm Shutoff Switch:**

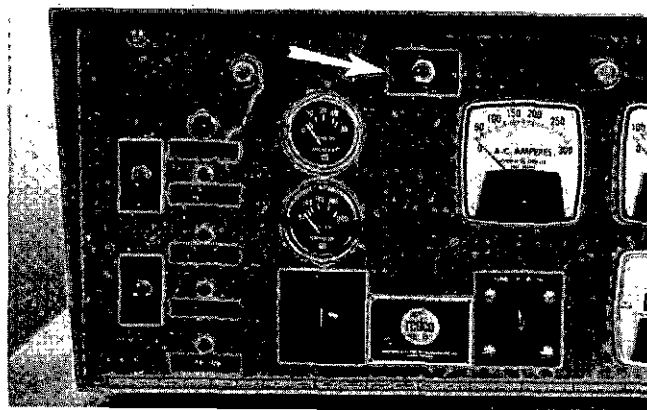
A switch may be installed in the alarm circuit for silencing the alarm while the engine is stopped for repairs. Be sure the switch is moved to the closed (ON) position and the warning lights are lit before starting.

**CAUTION**

If the switch is left in the open (OFF) position when the engine is started, the engine will not be protected.

**Testing Indicator Lights:**

Most control panels are equipped with a test switch. By turning the switch ON, all of the indicator lights can be checked for proper operation. Test the indicator lights periodically, replace burned out light bulbs immediately.



**TESTING SHUTOFF DEVICES AND ALARMS**

Have all shutoff controls and alarms on the engine checked twice a year by your Caterpillar dealer.

It is important that these controls function properly. Their operating condition can only be checked by simulating extreme operating conditions under controlled testing procedures. To avoid damage to the engine, only authorized personnel should conduct these checks.

**DETERMINING CAUSE OF SHUTDOWN**

**CAUTION**

If the engine has been shutdown by a safety device, do not start the engine and place it into service without having the cause of the shutdown investigated and corrected.

**Low Oil Pressure Checks:**

If the low oil pressure shutoff control has stopped the engine, make the following checks:

1. Check the water temperature gauge. Determine if the engine was overheated. Check for external water leaks.



**WARNING**

Beware of steam or scalding water. Do not attempt to loosen the radiator cap until the temperature gauge indicates the coolant has sufficiently cooled. Then, loosen the cap slowly.

2. Check the oil level. Oil level must be between the ADD and FULL marks on the side of the dipstick stamped CHECK WITH ENGINE STOPPED.
3. If the oil level is below the ADD mark, check for oil

spray and/or oil accumulations. If any are found, have the necessary repairs made. Before starting, add oil to the FULL mark.

4. Reset the shutoff control.
5. Remove the load and start the engine at its slowest speed. Be prepared to shut the engine down manually.
6. Be alert for unusual sounds or noises. If the engine knocks, stop the engine immediately and call your Caterpillar dealer.
7. If the engine blows excessive black exhaust or has excessive crankcase blow-by, the engine may need reconditioning. Stop the engine and call your Caterpillar dealer.
8. If the engine runs satisfactorily, observe the oil pressure gauge. If satisfactory pressure is not indicated, shut the engine down; call your Caterpillar dealer.
9. If proper oil pressure is registered, check to see if the reset knob has moved to the run position. If the knob does not move, stop the engine. Check the shutoff control, the oil line, and the oil pressure gauge. Have necessary repairs made.
10. If the oil pressure gauge registers normal oil pressure, if the knob on the shutoff control moves to the run position, and if the engine operation is otherwise satisfactory, determine if the high water temperature shutoff may have shut down the engine.

#### High Water Temperature Checks — Engine Running:

1. Determine if the load was too great for the engine: Reduce the load and allow the engine to cool while running.
2. If pressure steam or water leaks are visible, remove the load and stop the engine. Have necessary repairs made.
3. Check for collapsing or deteriorated water hoses. Have repairs made.
4. Check for noisy water pump operation. Have necessary repairs made.
5. Refill the cooling system with a solution of water and permanent type antifreeze if below freezing temperatures are expected; or with a solution of approved

water and Caterpillar Corrosion Inhibitor. Follow the instructions on the container.

#### WARNING

**DO NOT** remove the pressure cap on an overheated engine. The coolant is under pressure and relieving the pressure will cause the coolant to flash into steam. Serious flash burns and engine damage can result. If necessary, reduce pressure in a surge tank by pouring warm water on top of the tank. Never add cold water to a hot engine.

#### NOTE

If there is adequate coolant in the cooling system, gradual cooling is preferred by running the engine at half speed. This eliminates hot spots in the engine, and possible failure.

#### High Water Temperature Checks — Engine Stopped and Cold:

1. Check coolant level. Determine if the coolant has proper antifreeze protection. A 50-50 solution of permanent type antifreeze and approved water will give protection below  $-20^{\circ}\text{F}$  ( $-29^{\circ}\text{C}$ ).
2. Check to be sure the raw water valve has been opened.
3. Check water pump drive belts for proper tension; see the LUBRICATION AND MAINTENANCE PROCEDURES topic, Fan Belts.
4. Check engine room vents and/or louvers. Be sure the engine is receiving sufficient air.
5. Be sure temperature regulators are operating at proper temperature range.
6. Inspect all water hoses carefully for collapsing, external and internal failures. Replace hoses as required.
7. Have the cooling system cleaned.

#### CAUTION

If severe or prolonged overheating has occurred, contact your Caterpillar dealer to have your engine checked for possible damage.

# STORAGE

If the engine is not started for several weeks, the lubricating oil drains from the cylinder walls and piston rings. This lack of oil permits the piston rings to rust; and causes metal-to-metal contact between the piston rings, the pistons and the cylinder liners when the engine is started. This metal-to-metal contact will result in shorter engine life. To prevent excessive engine wear:

1. Be sure all lubrication points mentioned in the LUBRICATION AND MAINTENANCE CHART are serviced.
2. Once a week, start and run the engine until it is

thoroughly warm. For unattended automatic start-stop systems, an engine exerciser can be installed for this purpose.

3. Stop the engine, perform required servicing.
4. Check the cooling system for adequate protection against freezing if freezing temperatures can be expected. A 50-50 solution of permanent type anti-freeze and approved water will give protection below -20°F (-29°C).

If it will be impossible to start the engine every week, see your Caterpillar dealer for instructions to prepare your engine for further storage.

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# ELECTRIC SET OPERATION INSTRUCTIONS

## GENERAL

Proper engine operation and maintenance are essential to long engine life and maximum performance. The essentials for proper operation and normal periodic maintenance are outlined in this guide. However, your Caterpillar dealer is available for troubleshooting and/or repairs when required.

Before starting the engine, familiarize yourself with these procedures. Even though your engine may not be equipped with the exact attachment illustrated, the operating procedures will be similar.

This guide contains information for Caterpillar Statically Regulated Controlled Rectifier (SRCR) and SR 4 generators. Caterpillar SR 4 refers to the brushless type generators. Study the guide carefully and apply the principles to your particular installation.

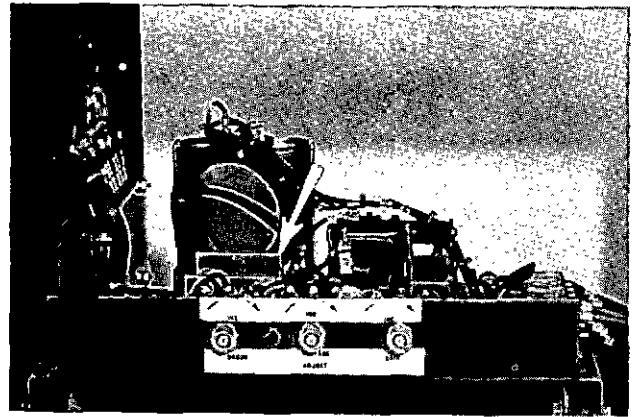
### SAFETY PRECAUTIONS

You can do something about safety. Lack of attention to safety can result in: accidents, personal injury, reduction of efficiency and worst of all—loss of life.

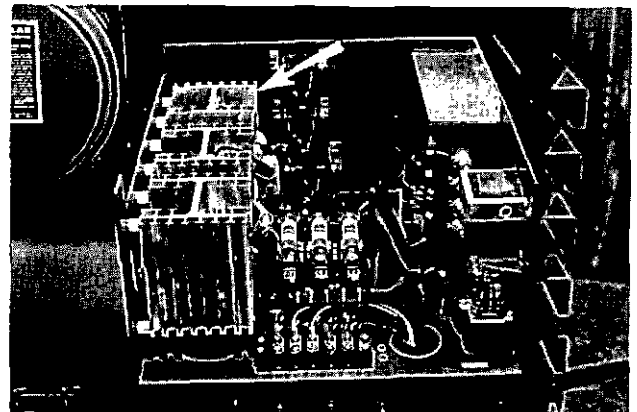
Safety is basically common sense. There are standard safety rules but each situation has its own peculiarities which cannot always be covered by rules. Therefore, your experience and common sense will be your best guides to safety. Watch for safety hazards. Correct deficiencies promptly.

Use the following safety precautions as a general guide to safe operation.

1. Observe NO SMOKING signs.
2. Do not wear loose clothing around machinery.
3. Be sure the engine room is properly ventilated.
4. Do not smoke around batteries. Hydrogen gas generated by charging batteries is explosive. Keep batteries in a well ventilated area.
5. All electrical equipment must be grounded according to local building codes.
6. Remove tools and electrical cords from the engine before starting.
7. All fans, shafts, pulleys, etc. must have guards.
8. Check all connections periodically for tightness and insulation.
9. Never adjust or repair a machine while in operation.
10. Never operate a diesel engine with the governor linkage disconnected. Human reactions are not fast enough to control the fuel rack.
11. Do not touch the heat sink on the generator regulator when the generator is running. It is electrically "hot".
12. Always disconnect and tape the ground battery lead before working on the electrical system.
13. Be sure the remote starting system is inoperative when the engine is being worked on. Disconnect the starter from the start switch.
14. Always disconnect the engine starter circuit when working on the generator.
15. Keep the engine room and floor area clean.
16. Store oily rags in metal covered containers.
17. Never store flammable liquids near the engine.



HEAT SINK (SR 4)



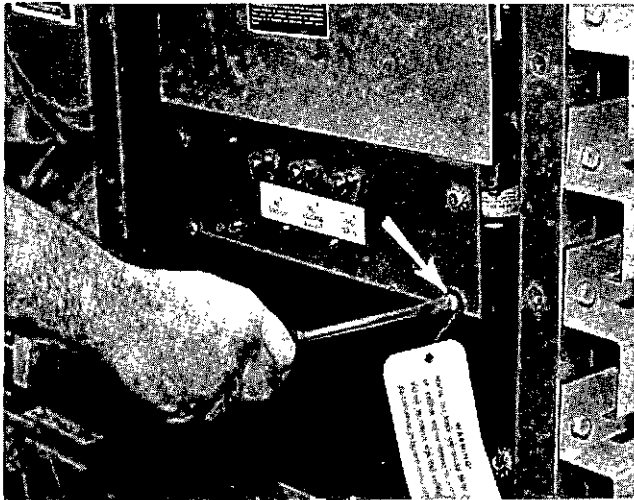
HEAT SINK (SRCR)

- 18. Insulate all connections and disconnected wires.
- 19. Do not use carbon tetrachloride fire extinguishers. Fumes are toxic and the liquid has a deteriorating effect on insulation.
- 20. Do not work on electrically "hot" equipment.

### Generator Serial Number

The engine serial number is stamped on the engine information plate and on a plate on the left side of the block toward the rear. The generator serial number is stamped on the generator nameplate and on the right side of the generator frame forward of the terminal box. Requests for information and orders for parts should be accompanied by the engine and generator serial numbers.

1. The group of numbers before the letters indicates generator frame size. The letter T may appear before the first group of numbers. This indicates a "tropicalized" generator, that has been dipped in epoxy to prevent moisture entrapment in windings.
2. The letter T is the symbol for Caterpillar Statically Regulated Controlled Rectifier generators. The letter B is the symbol for Caterpillar Statically Regulated Brushless Excited generators.
3. The next letter indicates the voltage rating of the generator as follows:



REMOVE SHIPPING SCREWS BEFORE STARTING (SRCR ONLY)

## IDENTIFICATION

### Voltage Setting

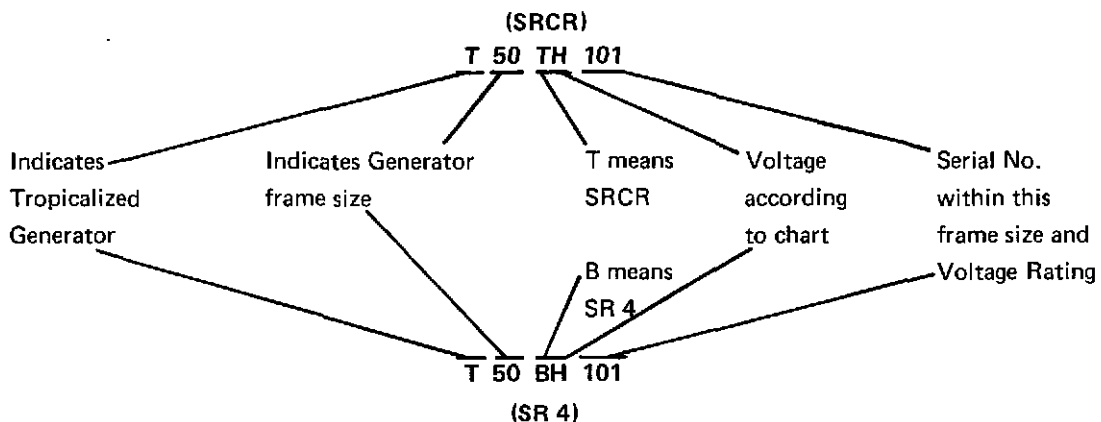
Generators are set at the factory for the voltage and type of operation specified. Voltage control initial adjustment instructions are located inside the generator exciter and regulator access cover. These instructions are for adjusting the generator output to nameplate ratings. For further adjustments, see page 5 for single and parallel unit operation.

#### SRCR

L	115-230 volts	60 Hz
	125-250 volts—Single Phase	60 Hz
H	230-460 volts	60 Hz or
	125-216 volts	60 Hz or
	200-400 volts	50 Hz
G	287-575 volts	60 Hz or
	230-460 volts	50 Hz
N	2400 volts	60 Hz

#### SR 4

L	120-240 volts	60 Hz or
	125-250 volts—Single Phase	60 Hz
S	208-416 volts	60 Hz
H	240-480 volts	60 Hz or
	200-400 volts	50 Hz
G	300-600 volts	60 Hz or
	240-480 volts	50 Hz

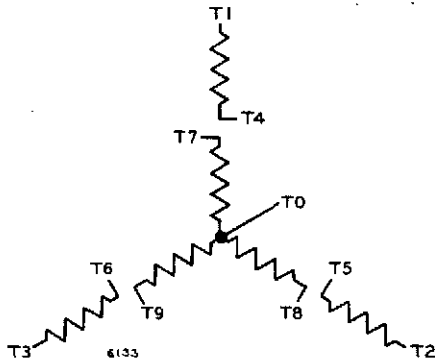


- The last group of numbers are the actual serial numbers of the generator in the frame size and voltage rating. Always use the complete serial number.

### Generator Lead Numbering

Each coil lead is marked according to the following diagram.

Numbering is clockwise from the top and from the outside in. Terminal **T0** is the neutral lead on all high voltage connections. On low voltage connections **T0** is connected with **T4**, **T5**, and **T6** to form the neutral terminal. The standard generator diagram and the terminal connections are on the nameplate of each generator.



### THREE PHASE NEUTRAL CONNECTIONS

#### Single Units

**Three Wire:** In a three phase, three wire system, the generator should normally be grounded according to local wiring codes. In some cases, however, it is undesirable to ground the neutral wire. For example, on boats a grounded neutral may increase the problem of electrolysis. In applications where definite measures are taken to prevent grounds to the load leads, an ungrounded neutral can be used. Be sure to check your local wiring codes.

**Four Wire:** In a three phase, four wire system, the neutral wire should be grounded according to local wiring codes. For only single unit operation, there should never be a need for a disconnect switch, or device, in the neutral line.

### Multiple Units

Operation of multiple generators in parallel, having all neutrals grounded, may result in current circulating through the neutral connections. To eliminate the possibility of circulating currents, ground the neutral of only one generator. If multiple generators are alternated on line, a single pole single throw knife switch should be installed in the neutral ground circuit of each generator, so all but one neutral ground circuit can be opened. Be sure one neutral ground circuit is closed.

### VOLTAGE CONNECTIONS

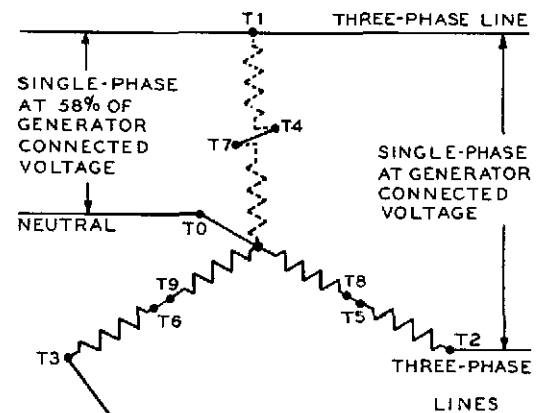
#### Three Phase

The connections for both high and low voltage are given in the following chart.

The terminals must be connected securely and insulated with a good quality electrical tape.

REQUIRED VOLTAGE	CONNECT LINE LEADS TO			NEUTRAL	CONNECT
	T1	T2	T3		
3 Phase High Voltage	T1	T2	T3	T0	T4 to T7 T5 to T8 T6 to T9
3 Phase Low Voltage	T1 & T7	T2 & T8	T3 & T9	T4, T5, T6 & T0	T4, T5, T6 & T0 For Neutral

#### Single Phase Current From A Three-Phase Generator



Three phase and single phase current can be taken simultaneously from a generator connected for three phase service. Connecting any two of the three phase leads will provide single phase current at the same voltage as three phase power. Connecting a three phase lead to neutral will produce current at 58% of the three phase voltage. DO NOT exceed the nameplate current rating for any one phase.

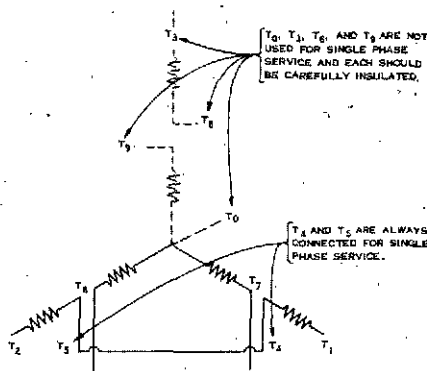
### Single Phase

When a generator is connected for single phase operation, do not exceed these limits:

1. The nameplate amperage limits.
2. Fifty-eight percent of the KVA and KW ratings. (The engine will only work about half as hard.)

Three phase (230-460V and 115-230V for SRCR) and (240-460V, 125-250V and 208-416V for SR 4) generators can be connected for two or three wire service at either voltage. When generators are connected for three wire ser-

vice both high and low voltages may be obtained simultaneously without reconnecting the leads. In this case DO NOT ground T0. Generator neutral is not T0 but a point in the windings electrically half way between T1 and T8. This point is not wired to a terminal.



To reconnect the generator for single phase voltage follow the chart. Wrap all connections and unused terminals with a good grade of insulation.

REQUIRED VOLTAGE	CONNECT LINE LEADS TO			CONNECT	TAPE INDIVIDUALLY
Single-Phase 2 Wire Low Voltage	T2&T8		T1&T7	T4&T5	T3 T6 T9 T0
Single-Phase 3 Wire Low/High Voltage	T2	T1 & T8 Neutral	T7	T4&T5	T3 T6 T9 T0
Single-Phase 2 Wire High Voltage	T2		T7	T1&T8 T4&T5	T3 T6 T9 T0

## ELECTRIC SET OPERATION

### Generator Loading

A three phase load is usually balanced and presents no problem when kept within the amperage limits. However, single phase power taken from a three phase source can be a problem unless the single phase loading is equally distributed.

When a generator is installed or reconnected, be sure the total current in one phase does not exceed the nameplate rating. Each phase should carry the same load, allowing the engine to work at its rated capacity. An electrical unbalance can result in an electrical overload and overheating if one phase exceeds the nameplate amperage.

## Power Factor

Power factor may be thought of as the efficiency of the load — the ratio of apparent power to total power. Power factor is expressed as a decimal and denotes that portion of current supplied to a system doing useful work. The portion of current not doing useful work is absorbed in maintaining the magnetic field in motors. This current, although it is called the reactive load, does not require engine horsepower to maintain it. The only horsepower consumed in a reactive load is used to start motors. This is the inrush or starting current.

In most applications electric motors and transformers determine the power factor of the system. Induction motors usually have a .8 power factor. Incandescent lighting is a resistive load of about 1.0 power factor, or unity.

The power factor of a system may be determined by a power factor meter or by calculations. Determine the power requirement in KW by multiplying the power factor by the KVA supplied to the system. As the power factor goes up the total current supplied to a constant power demand will go down. A 100 KW load at .8 power factor will draw more current than a 100 KW load at .9 power factor. A higher power factor increases the possibility of overloading the engine. A lower power factor increases the possibility of overloading the generator.

## Low Idle Adjustment

Electric sets require higher low idle setting than do industrial engines. Low idle must not be below 2/3 the full load speed of 60 Hz units (4/5 full load speed of 50 Hz units).

### CAUTION

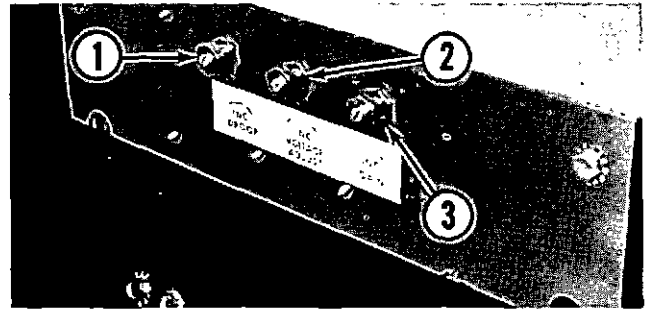
Disconnect the exciter circuit by removing fuses F1 and F2 (on SRCR) or Fuse F1 (on SR 4) before operating the engine below the low idle rating. Failure to do this will result in generator damage.

On electric sets with Woodward governors, there is no low idle stop. On electric sets with mechanical governors and natural gas electric sets, the low idle is set at the factory, and should only be adjusted by your Caterpillar dealer if adjustment is required.

## SINGLE UNIT OPERATION

Final adjustments for a new installation are given here.

1. Remove the exciter regulator cover and loosen the locknuts on the voltage level, voltage droop and regulator gain controls.
2. Turn the voltage droop control counterclockwise to zero droop and tighten the locknut.



### VOLTAGE ADJUSTMENT CONTROLS

1. Voltage Droop 2. Voltage Level 3. Voltage Gain

3. Run the engine at full governed speed.
4. Using the voltage level control, adjust the open circuit (no load) voltage to equal nameplate voltage.
5. Apply rated load and adjust the governor control for rated speed.
6. Adjust the regulator gain control until the line voltage is equal to rated voltage at rated load.
7. Allow the electric set to operate about one hour until temperature in the generator has stabilized.
8. Repeat steps 4, 5 and 6.
9. Tighten the locknuts on the voltage level and regulator gain controls, and install the exciter-regulator assembly access cover.

The electric set is now properly adjusted for single unit operation.

## PARALLEL OPERATION

Preparing a generator for parallel operation requires special attention. Before attempting to parallel units for the first time, all units must be checked to be sure the following three conditions are met:

1. Same phase rotation.
2. Same speed capabilities.
3. Same voltage characteristics.

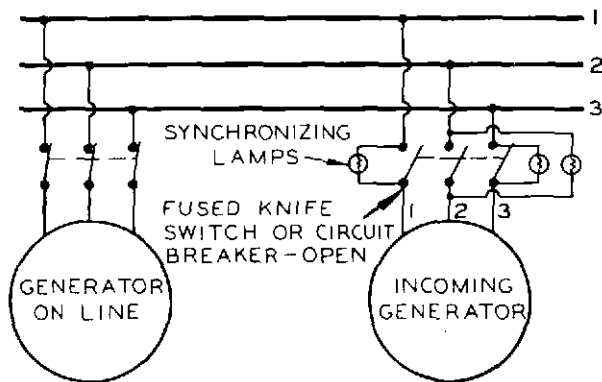
These three conditions may be compared to similar conditions required for engagement of two gears. To mesh as smoothly as possible, two gears must meet the following three conditions:

1. Correct rotation.
2. Same rotation speed.
3. The tooth of one segment must fit the root of the engaging segment.

### Phase Rotation

The phase rotation must be the same. A set of three light bulbs is used to determine whether the phase rotation of the incoming unit and the phase rotation of the line are the same.

1. Connect the light bulbs between the generator leads and the corresponding line phase, i.e. terminal 1 to line 1 across the open circuit breaker.
2. Start the units to be paralleled and bring them up to speed. As they approach the same speed the lights will start to blink.



SYNCHRONIZING LIGHTS

- a. If the lights blink in sequence one of the units is connected backward. To correct this remove generator leads 1 and 3 at the circuit breaker and exchange them. This reverses the direction of phase rotation. Line 2 should always be connected to line 2.

### WARNING

Never attempt to work on electrically hot wiring. Stop the electric set before rewiring generator leads. Open circuit breakers before working on the equipment which they control.

- b. If lights blink in unison the phase rotation of both engines is the same, and condition 1 has been met.

### Engine Speed

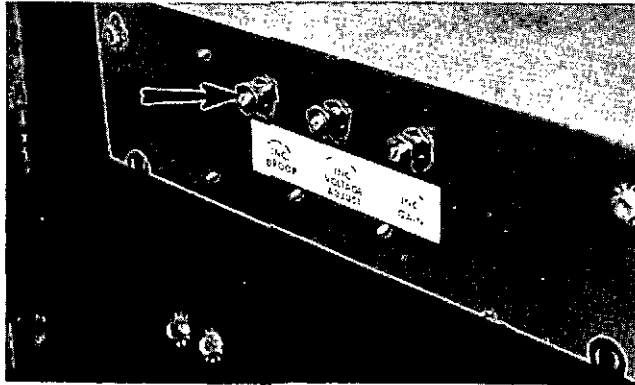
The speed of units to be paralleled must be the same. Speed refers to the alternating current frequency.

1. Allow each electric set to run under load long enough for the internal temperatures to stabilize (about one hour).
2. Adjust the governor control to give rated frequency at full load.
3. Remove the load and check the high idle speed; it should be approximately 3% above full load speed. If these speeds can not be obtained, contact your Caterpillar dealer.
4. For the most consistent results repeat steps 2 and 3. Condition 2 has been met.

### Voltage Adjustment

The voltage level and voltage droop adjustments determine the amount of circulating currents between generators. Carefully matched voltage regulator adjustments will reduce the circulating currents. Adjustments to the voltage droop control should be made to give a 2% droop for load of unity power factor (load composed primarily of lighting). Loads of .8 power factor (primarily motors) require a generator voltage droop of about 5%. Voltage droop is expressed as the percentage of voltage change from no load to full load.

1. Remove the exciter-regulator access cover and loosen the locknuts of the voltage level and droop controls and the regulator gain control.
2. Turn the droop control counterclockwise to zero.
3. Run the engine at high idle.
4. Adjust the open circuit voltage level to equal nameplate rated voltage.



#### DROOP ADJUSTMENT

5. Apply full load and adjust the governor control to the rated full load speed.
6. Adjust the regulator gain control to equal nameplate rated voltage at full speed.
7. Run the electric set at full load until internal temperatures have stabilized (about 1 hour) remove the load and repeat steps 4, 5, and 6.
8. Tighten the locknut on the regulator gain control.
9. With the engine running at high idle, turn the voltage droop clockwise about 1/4 of full range.
10. Readjust the voltage level control until the voltage is about 5% above rated voltage.
11. Apply full load at .8 power factor.

#### NOTE

If a generator is paralleled with other generators, the voltage droop of each generator must be the same to satisfactorily divide reactive load.

12. Readjust the voltage droop control to get rated voltage with full load at .8 power factor.
13. Repeat steps 10, 11 and 12 until line voltage is equal to nameplate rating at .8 power factor and open circuit voltage is approximately 5% above rated voltage.
14. Tighten the locknuts on all controls and install the access cover. Condition 3 has been met.

#### Starting Single Unit Operation

1. Make all preliminary engine starting checks.
2. Be sure the main or line circuit breaker is open.
3. Start the engine and allow it to warm up.
4. Close the main circuit breaker.
5. Apply the load. Do not try to apply full load in one move, rather apply the load in increments to maintain system frequency at a constant level.

#### Stopping

1. Remove the load in increments.
2. Open the circuit breaker.
3. Allow the engine to run for 5 minutes to cool.
4. Stop the engine.

#### Standby Electric Sets

Most standby units are automatic. They start, pickup the load, run and stop without an operator in attendance. Standby units can not change the governor control setting automatically. The throttle must be preset for the proper operation of that unit. Whenever the set is exercised or operated manually, be sure the throttle setting is correct for automatic operation. Check all switches to see they are properly set: Start Selector Switch in AUTOMATIC position and any Emergency Stop Switches in RUN position.

#### MULTIPLE UNITS

STARTING — Units are started the same as single units. See page 5, steps 1 — 3.

## Paralleling

Units may be paralleled at no load or paralleled with units under load. To parallel two or more units the following conditions must be met:

1. Same phase rotation.
2. Same voltage level.
3. Same voltage droop.
4. Same frequency.
5. Voltages must be in phase.

The first three conditions have been met in the parallel operation. See page 5.

1. Start the unit to be paralleled according to the procedure in the engine operation section.
2. Turn the synchronizer lights on.
3. After the engine has run long enough to warm up, bring it up to synchronous speed (the same frequency as the unit on the line). The synchronizing lights will begin to blink.
4. Using the governor control adjust the speed until the lights blink very slowly.
5. The lights are off when the voltages of the two units are in phase. At this point very quickly close the breaker while the lights are out.

### NOTE

The frequency of the incoming unit should be slightly greater than the line frequency. This will allow the incoming unit to assume some of the load rather than add to the system load.

## Circulating Currents

When two units are paralleled there will be circulating currents. These currents are not doing useful work, but are flowing between the generators. By determining the total generator amperage and subtracting the amperage going to the load, the amount of circulating current can be determined.

Circulating currents are caused by voltage differences between the two units. As the oncoming generator warms up the circulating current will be reduced.

In a cold unit, circulating current may be as high as 25% of rated amperes without being considered harmful. Circulating current is part of the total generator current which must not exceed the rated amperage.

## Load Division

Once two units have been paralleled their share of the load is determined by the governor control setting. If two units of the same capacity and the same governor characteristics have the same governor control settings they will share the load equally.

To transfer the load from one engine to the other follow this procedure:

### NOTE

The total load must not exceed the capacity of the engine, or the engine will be overloaded.

1. Increase the governor speed control of the unit to the high idle position to assume the load.
2. Reduce the governor speed control of the outgoing unit until the generator amperage is at a minimum. (The amperage may never be zero due to circulating currents.) At this point transfer the load.

## Stopping

To remove a generator from the line do the following:

1. Check the load. It must be less than the rated capacity of remaining units.
2. Be sure the neutral of one of the remaining units is grounded.
3. Remove the load from the outgoing unit as described in LOAD DIVISION.
4. Open the circuit breaker.
5. Allow the engine to cool for 5 minutes.
6. Stop the engine.

## GENERATOR STORAGE

When a generator is stored for any length of time moisture condenses in the windings. Minimize the condensation by providing a dry storage space.

To remove moisture caused by high humidity or dampness, dry the generator by one of the following methods:

1. Place the generator in an oven and bake at a temperature not above 185°F (85°C) for four hours.

### CAUTION

If an oven is used for drying, use a forced air type rather than a radiant type. Radiant ovens can cause localized overheating.

2. Enclose the generator and heating lamps in canvas to raise the temperature. Leave an opening in the top for the moisture to escape.

3. Pass a low voltage current through the windings to raise the temperature of the windings to 185°F (85°C).

If there is a possibility the insulation resistance has deteriorated to a dangerously low level, contact your Caterpillar Dealer.

If a brush type generator (SRCR) is to be stored for a prolonged time, lift the brushes off the slip ring to prevent chemical action from damaging the slip ring.

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# LUBRICATION AND MAINTENANCE CHART

## D353

# INDUSTRIAL ENGINE

### 46B2437-UP

The LUBRICATION AND MAINTENANCE CHART lists all serviceable items commonly ordered on this engine. The items are listed according to their frequency of maintenance, followed by those items needing only "As Required" maintenance.

The maintenance time intervals are expressed in Service Meter Units. The Service Meter on your engine shows the total number of units your engine has run. Use the Service Meter readings for determining your maintenance schedules. Perform the maintenance at multiple intervals of the units shown. For example, when the Service Meter shows "100" on the dial, all items listed under "EVERY 10 SERVICE METER UNITS" should be serviced now for the tenth time, and all items under "EVERY 50 SERVICE METER UNITS" should be serviced for the second time.

Diesel fuels, "CD" and "MPGM" lubricants, and the types of battery and coolant make-up water to use are explained in the topic "Key to Fuels, Lubricants and Water" which follows this chart.

Page numbers refer to the LUBRICATION AND MAINTENANCE PROCEDURES where the detailed service instruction for that item can be found.

SERVICE ITEMS AND PROCEDURES		LUBE	PAGE
<b>FREQUENTLY DURING OPERATION</b>			
Check oil pressure gauge reading.	Observe all gauge readings. Note any change from the NORMAL reading and determine the cause. Have necessary repairs made.	—	D-1
Check fuel pressure gauge reading.		—	F-1
Check water temperature gauge reading.		—	G-1
Check ammeter reading.		—	J-2
<b>EVERY 10 SERVICE METER UNITS OR DAILY</b>			
Check crankcase oil level.	Maintain at FULL mark on dipstick.	CD	D-1
Check piston in air cleaner indicator.	If locked "up", replace element.	—	E-1
Check fuel supply level after running.	See "Key to Fuels, Lube & Water", Pg. 3.	—	F-1
Check Woodward UG8 Governor oil level.	Level must be between ADD and FULL.	CD	F-4
Check engine coolant level.	Maintain level 1/2" below fill pipe.	—	G-1
Lubricate clutch, or front power take-off, shift collar and shaft.	1 fitting — 2 strokes.	MPG	K-1
<b>EVERY 50 SERVICE METER UNITS</b>			
Empty dust collector cup of two stage air cleaner.	Shorter interval may be necessary under severe dusty conditions.	—	E-2
Inspect raw water zinc rods.	Replace rods if zinc is deteriorated.	—	G-3
Check electrolyte level of battery cells.	Fill only with make-up water, See "Key to Fuels, Lubricants and Water", Page 3.	—	J-2

## SERVICE ITEMS AND PROCEDURES

**LUBE**
**PAGE**

### EVERY 125 SERVICE METER UNITS

Lubricate clutch, or front power take-off:			
Main shaft bearing,	1 fitting — 2 strokes.	MPG	K-1
Pilot bearing,	1 fitting — 2 strokes.	MPG	K-1
Shift lever bearings.	2 fittings — 2 strokes.	MPG	K-1

### EVERY 250 SERVICE METER UNITS

Check fan/alternator belt tension and wear.	Belt should deflect 9/16 — 13/16" (15-20 mm) @ 25 lbs. (11 kg).	—	G-2
		—	J-4

### EVERY 250 SERVICE HOURS OR MONTHLY — 10 Gal. Crankcase See 500 Service Hours for 22½ Gal. Crankcase

Change engine oil and oil filter (Note A).	Cap.: 10 Gals. 38 Liters 8 Imp. Gals.	CD	D-1
Clean engine breather.	Wash breather in clean solvent.	—	D-2

### EVERY 500 SERVICE HOURS OR 3 MONTHS

Lubricate fan drive.	1 fitting — 2 strokes.	MPG	G-3
Inspect slip rings (2) and brushes (4).	SRCR Generator.	—	K-2

### EVERY 500 SERVICE HOURS OR 3 MONTHS — 22½ Gal. Crankcase

Change engine oil and oil filter (Note A).	Cap.: 22.5 Gals. 85 Liters 19 Imp. Gals.	CD	D-1
Clean engine breather.	Wash breather in clean solvent.	—	D-2

### EVERY 1000 SERVICE METER UNITS OR 6 MONTHS

Drain water and sediment from fuel tank.	Open drain valve momentarily, then close.	—	F-1
Change Woodward UG8 governor oil supply.	Turn governor upside down, drain, flush, fill.	CD	F-4
Lubricate UG8 governor synchronizing motor.	Fill cup on top of motor with clean oil.	CD	F-5
Lubricate tachometer angle adapter.	1 fitting — 2 strokes.	MPG	L-1
Have safety shutoff controls checked.	Contact your Caterpillar dealer.	—	L-1

### EVERY 2000 SERVICE METER UNITS OR 1 YEAR

Install new air cleaner element.	Shorter interval may be necessary under dusty conditions.	—	E-1
Check inlet and exhaust valve lash: engine cold.	Exhaust valves: 0.030 in. (0.8 mm). Inlet valves: 0.018 in. (0.5 mm).	—	E-4
Check rotation of valves.	Watch valve retainers while engine idles.	—	E-6
Lubricate rear bearing of SRCR Generator.	Remove 2 plugs, install 1 fitting at top. Lubricate until grease appears at bottom hole.	MPG	K-3

### AS REQUIRED      Air Induction and Exhaust System

Service air cleaner element.	See Note B.	—	E-1
Clean precleaner for air cleaner.	Remove and wash when ¾ full.	—	E-4

SERVICE ITEMS AND PROCEDURES		LUBE	PAGE
<b>Fuel System</b>			
Clean primary fuel filter element.	When fuel gauge registers OUT.	—	F-1
Install new fuel filter.	When fuel gauge registers OUT.	—	F-2
Prime the fuel system.	After servicing any part of fuel system.	—	F-3
Bleed the Woodward UG8 governor.	After servicing governor, or if surging occurs.	—	F-4
<b>Cooling System</b>			
Maintain coolant level in cooling system.	Level should be at base of fill tube.	—	G-1
Check level when engine is cold.	See the topic KEYS TO FUELS, LUBE AND WATER, Engine Coolant, C-4.		
<b>Starting System</b>			
Fill the oiler jar when jar is half empty.	Use only clean, unused oil.	CD	H-1
Empty the collector jar when half full.	Do not reuse this oil.	—	H-1
Adjust the oiler feed:	Approximately 4 drops per minute.	—	H-1
<b>Electrical System</b>			
Clean the battery case.	Use baking soda and water solution.	—	J-2
Connect battery charger.	Remove all vent well caps. Connect positive to positive, negative to negative.	—	J-3
Connect booster batteries.			
Test and install glow plugs.	When ammeter reading is less than usual with HEAT switch "ON".	—	J-5
<b>Power Coupling System</b>			
Check clutch adjustment.	See clutch name-plate for details.	—	K-1
Adjust clutch adjustment.	When engagement is soft.	—	K-1
Install brushes in SRCR Generator.	When brush length is less than minimum required.	—	K-3

### NOTES

**NOTE A:** This is the normal change interval to use when fuel sulphur content is 0.4% or less. When sulphur content is 0.4% to 1.0%, reduce oil change interval one half. When sulphur content is above 1.0%, reduce oil change interval to one-fourth the normal interval. Regardless of hours, change oil filters every 6 months.

**NOTE B:** If the exhaust smoke and/or loss of power continues after servicing the air cleaner, install a new element. Install a new element at least once a year.

### KEY TO FUELS, LUBRICANTS AND WATER

**FUEL:** Use only distillate fuels (ASTM No. 1 or No. 2 Fuel Oil, or No. 1D or No. 2D Diesel Fuel Oil are examples) with a minimum cetane number of 35. Heavier oil is generally preferable because of its higher energy content.

**CD:** Use oils which meet Engine Service Classification CD, or MIL-L-2104C, in Caterpillar diesel engine crankcases and gear compartments.

(Continued on Next Page)

**MPG:** Use Multipurpose-type Grease (MPG). Multipurpose-type Grease which contains 3 to 5% molybdenum disulfide is also acceptable, and preferred. NLGI No. 2 Grade is suitable for most temperatures. NLGI No. 1 or No. 0 are suitable for extremely low temperatures.

**BATTERY WATER:** Use either distilled water; or, odorless, tasteless drinking water. Do not use mineral water, water containing iron, salt water or softened water.

**ENGINE COOLANT:** Use clean water that is low in scale forming minerals, not softened water. When the temperature is below 32° F (0° C), a sufficient amount of permanent type anti-freeze must be added to adequately protect your engine against freezing. Add enough Caterpillar Corrosion Inhibitor, or equivalent, so that the cooling system will have a 3% concentration of inhibitor at initial fill (one pint/4 gallons). Every 500 Service Meter Units, add 1 pint per 16 gallons of coolant capacity.

### RECOMMENDED VISCOSITIES AT VARIOUS STARTING TEMPERATURES

COMPONENT	ABOVE 32° F (ABOVE 0° C)	32° F TO 10° F (0° C TO -12° C)	10° F TO -10° F (-12° C TO -23° C)	BELOW -10° F (BELOW -23° C)
Air starting motor oiler jar	SAE 10W	SAE 10W	SAE 10W	SAE 10W
Diesel engine crankcase	SAE 30	SAE 10W <sup>(1)</sup>	SAE 10W	SAE 10W <sup>(2)</sup>
Governor, Woodward UG8 and synchronizing motor	SAE 30	SAE 10W <sup>(1)</sup>	SAE 10W	SAE 10W

<sup>(1)</sup>SAE 10W oil may be used even if daytime ambient temperatures rise to 70° F (21° C).

<sup>(2)</sup>It may be necessary to warm the oil so the engine can be cranked and the oil will circulate freely.

### REFILL CAPACITIES

	U.S. Gals.	Imp. Gal.	Liters
Diesel engine lubrication system: 23° maximum tilt oil pan	10	8	38
17° maximum tilt oil pan	22.5	19	85
Cooling system (engine only):	25	21	95
Cooling system (with radiator):	36	30	136



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# LUBRICATION AND MAINTENANCE PROCEDURES

## ENGINE LUBRICATION SYSTEM

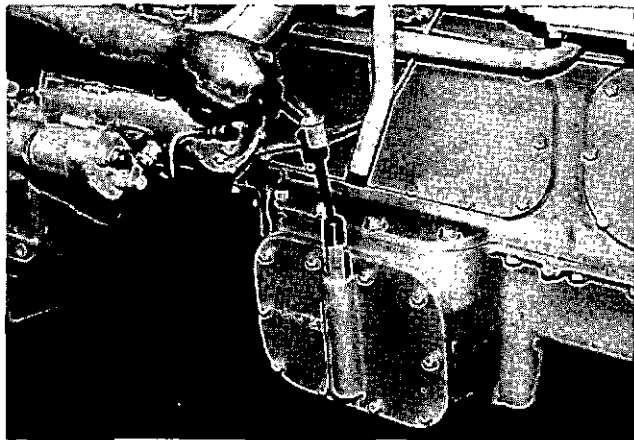
### DIESEL ENGINE LUBE OIL

#### CHECKING OIL PRESSURE GAUGE READING

After starting and during operation, frequently observe the oil pressure gauge. If the gauge indicator registers below "NORMAL", or if the indicator fluctuates, check the oil level and take corrective measures.

#### CHECKING OIL LEVEL

Check the oil level with the engine idling. Oil level must be between the ADD and FULL marks on the oil level gauge. Add oil as required. See Lubrication and Maintenance Chart for proper oil.

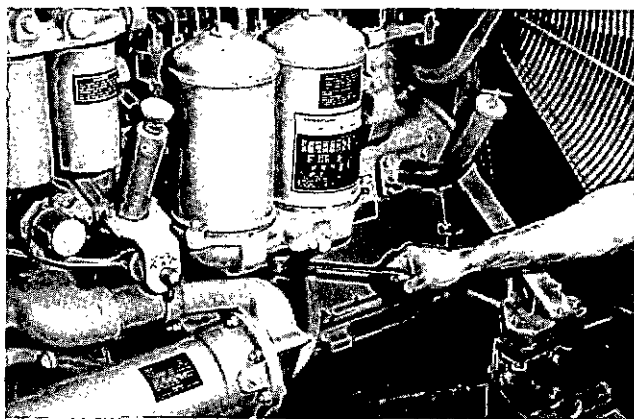


CHECKING CRANKCASE OIL LEVEL

#### DRAINING CRANKCASE LUBE OIL

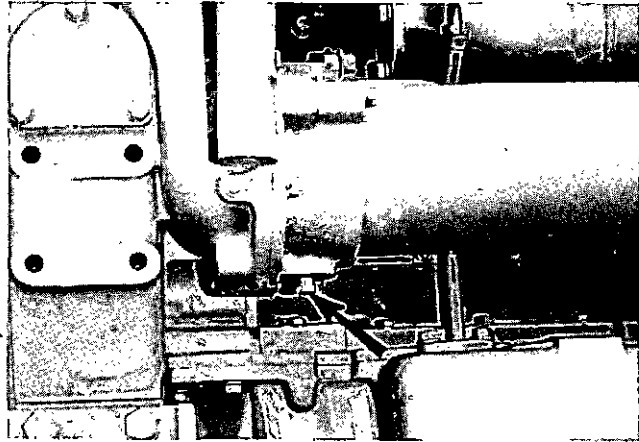
With engine stopped and oil warm:

1. Wipe dirt from each oil filter housing.
2. Remove the oil filter housing drain plug(s).



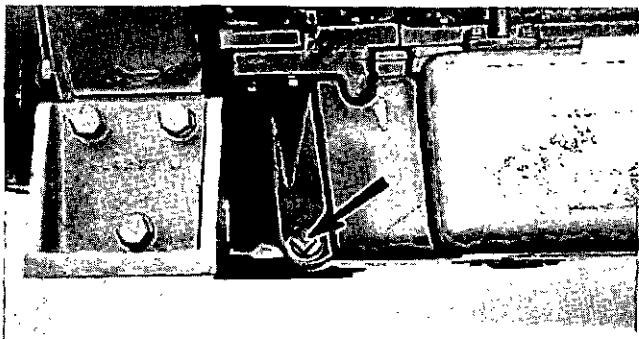
REMOVING OIL FILTER DRAIN PLUG

3. Remove the oil cooler drain plug.



OIL COOLER DRAIN PLUG

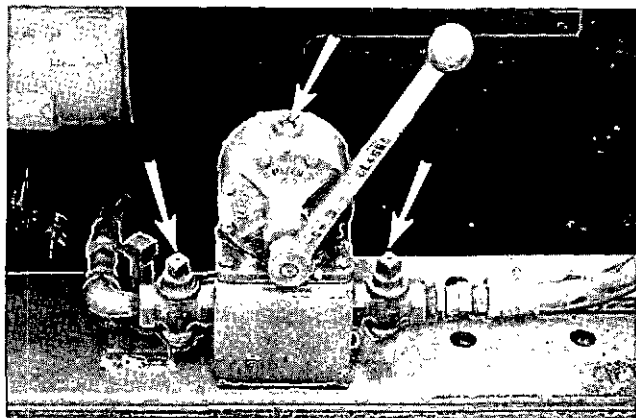
4. Remove the crankcase oil plug.



REMOVING CRANKCASE DRAIN PLUG

OR If a sump pump is used

- a. Connect a suitable drain to the pump outlet.
- b. Open the valve to the engine crankcase.

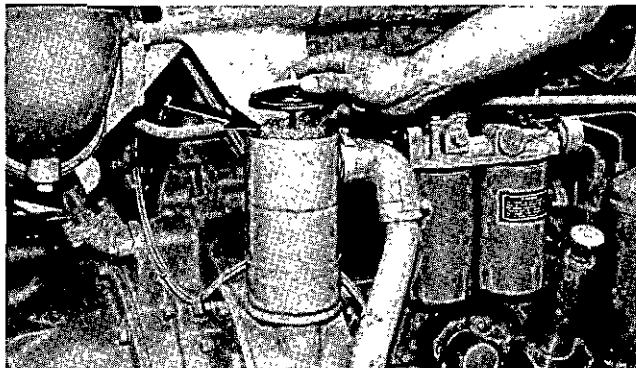


SUMP PUMP VALVES AND PUMP OUTLET

- c. Close the valve to the marine gear housing.
- d. Operate the sump pump handle until the crankcase is empty.
- e. Close the valve to the engine crankcase.

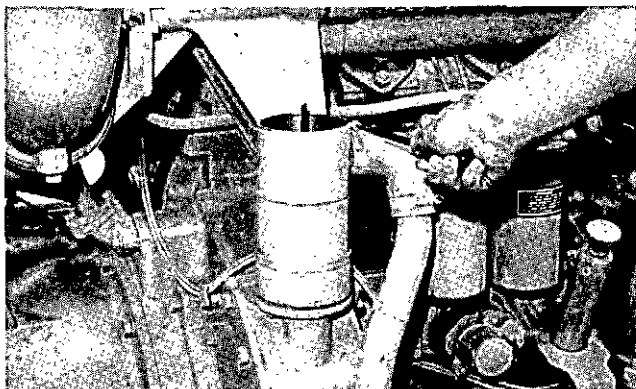
#### CLEANING BREATHER (S)

1. Remove the breather cover and breather element.



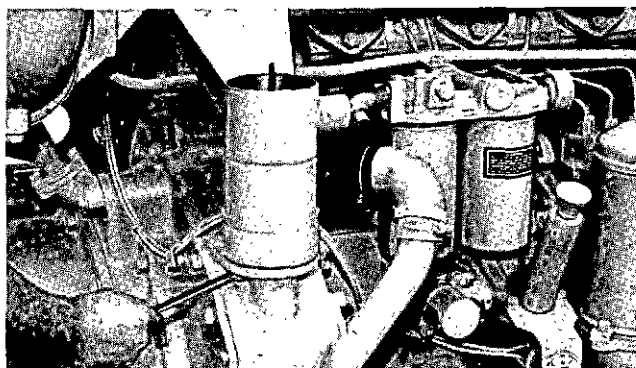
#### REMOVING COVER AND ELEMENT

2. Loosen the hose clamp and remove the fumes disposal tube.



#### LOOSENING HOSE CLAMP

3. Remove the breather assembly.

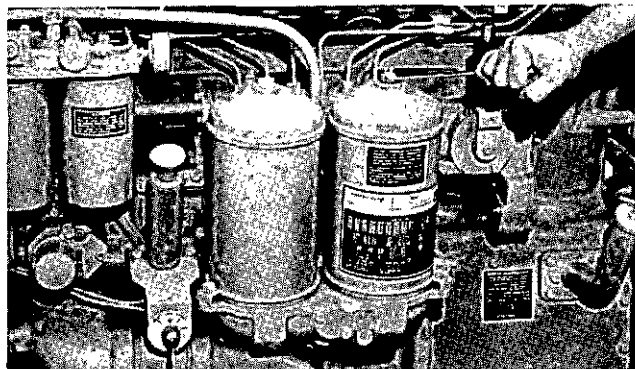


#### REMOVING BREATHER ASSEMBLY

4. Wash the breather and elements in clean diesel fuel or solvent.
5. Install the breather, breather element and cover.

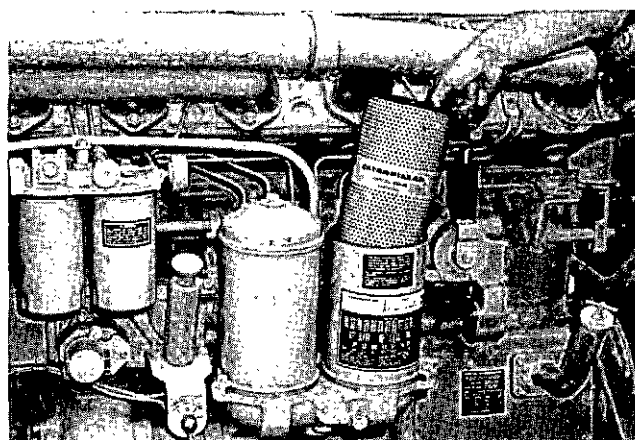
#### INSTALLING NEW OIL FILTER ELEMENTS

1. Drain the oil filter housing.
2. Remove both covers.



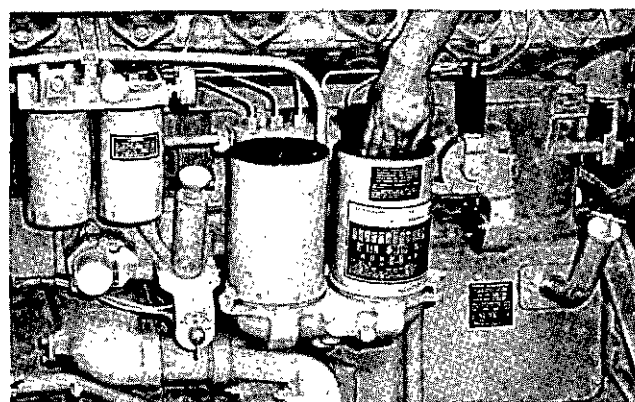
#### REMOVING FILTER COVER

3. Remove both filter elements.



#### REMOVING OIL FILTER COVER

4. Wipe both filter housings.



#### WIPING FILTER HOUSING

5. Install new filter elements and covers.
6. Install drain plugs which were removed.
7. Fill the crankcase to the FULL mark on the oil level gauge.

8. Start the engine and reduce engine speed to low idle.
9. Observe the oil pressure gauge. Oil pressure must be indicated, or shut the engine down and investigate the cause.
10. Move the governor control lever to half engine speed position and allow the engine to warm five minutes before applying any load.
11. Check the oil level gauge. Add oil as required.

# AIR INDUCTION AND EXHAUST SYSTEM

## AIR CLEANER SERVICE INDICATOR

### CHECKING AIR CLEANER SERVICE INDICATOR

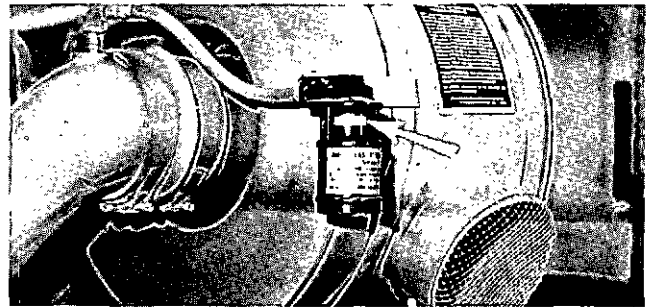
Before starting, check the window of the indicator. If the red piston is locked in the raised position, service the air cleaner as outlined.

#### NOTE

Have spare elements on hand to install while cleaning used elements.

#### CAUTION

Service the air cleaner with the engine STOPPED.

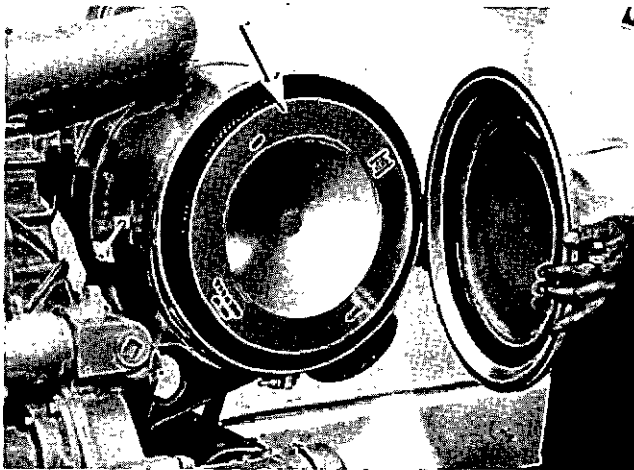


PISTON LOCKED IN RAISED POSITION

## SINGLE STAGE AIR CLEANER

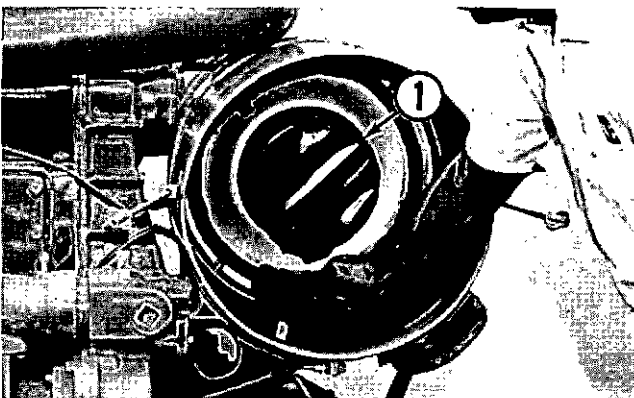
### SERVICING SINGLE STAGE AIR CLEANER

1. Remove the air cleaner cover and element.



REMOVING COVER AND FILTER ELEMENT

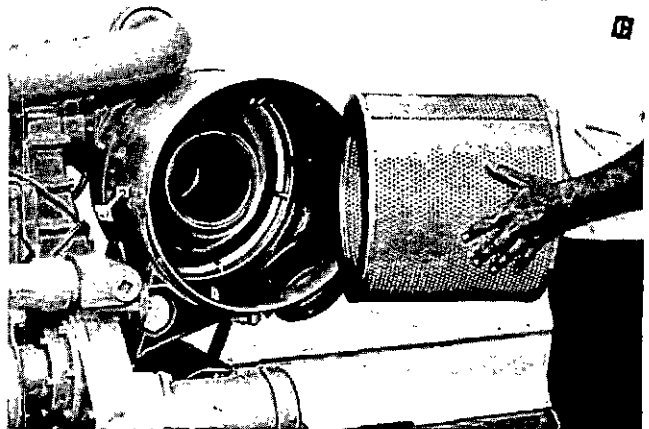
2. Cover the air inlet opening to prevent dirt from entering the engine.
3. Clean the inside of the air cleaner cover and the air cleaner body.



CLEANING INSIDE OF AIR CLEANER

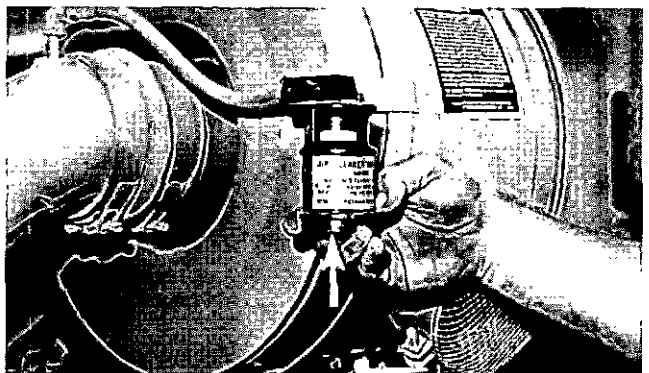
1. Air Inlet Cover

4. Inspect the replacement element for damage and dirt.
5. Remove the covering from the air inlet opening.
6. Install the element.



INSTALLING AIR CLEANER ELEMENT

7. Install the air cleaner cover.
8. Reset the service indicator piston by pushing the reset button. (See the instructions for air cleaner element cleaning).

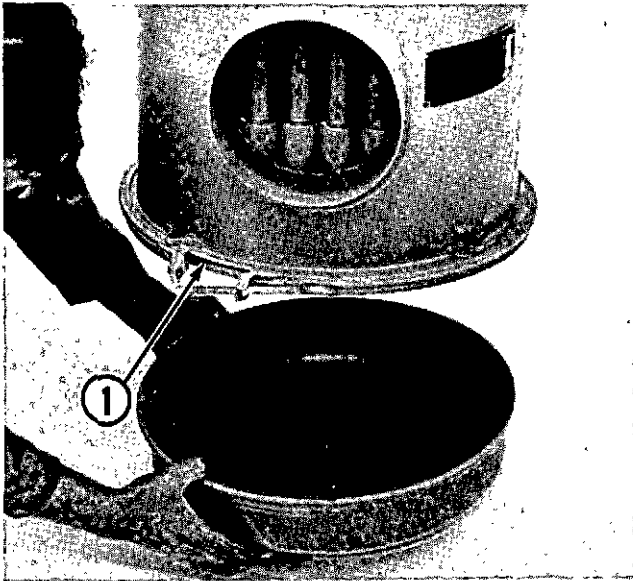


RESETTING AIR INDICATOR PISTON

## TWO STAGE AIR CLEANER

### EMPTYING DUST COLLECTOR CUP

1. Loosen the clamping bolt on the lower body.
2. Remove and empty the dust collector cup.
3. Inspect and install the seal; install a new seal if necessary.

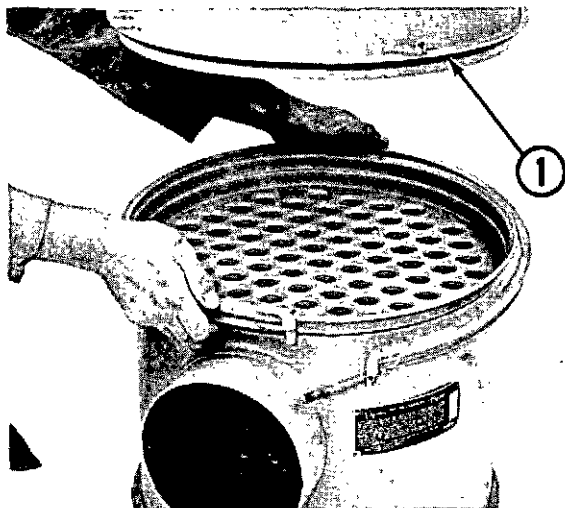


### REMOVING DUST CUP

1. Seal
4. Inspect the tubes in the lower body. If dirty, clean the tubes with a round bottle brush.
5. Install the dust collector cup.

### CLEANING THE LOWER BODY

1. Remove the dust collector cup.
2. Loosen the clamping bolt on the upper body.



### REMOVING LOWER BODY

1. Seal

3. Remove the lower body. Clean the tubes from both ends.
4. Inspect and install the upper body seal. Install a new seal if it is damaged.

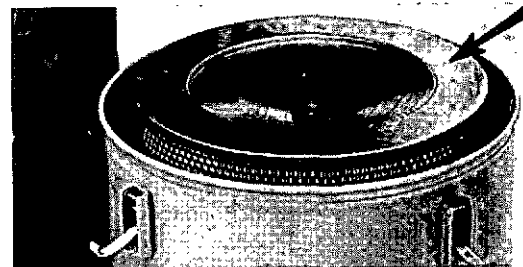
### INSTALLING REPLACEMENT FILTER ELEMENT

1. Remove the cover.



### REMOVING COVER AND INNER COVER

2. Remove the inner cover and filter element. In cold weather, a stuck inner cover may be removed by warming the air cleaner cover to 70-75°F (21-24°C).



### REMOVE ELEMENT

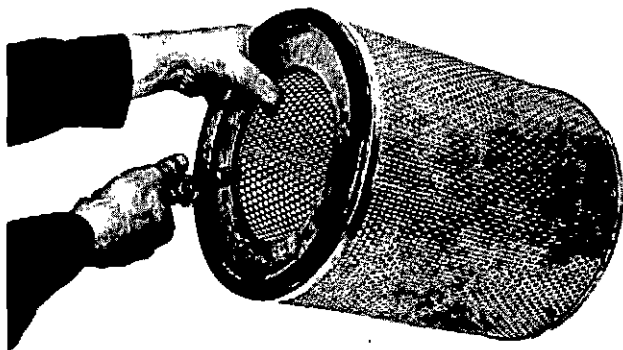
3. Clean all parts of the air cleaner.
4. Inspect the replacement element for damage and cleanliness.
5. Install the element, inner cover, and wing nut. Tighten the wing nut to prevent dust from bypassing the filter element.
6. Install the cover.

If, after servicing the air cleaner, the exhaust smoke and/or loss of power continues; or the service indicator locks in the raised position, discard that element and install a new element. Install a new element at least once a year.

## CLEANING USED AIR CLEANER ELEMENTS

### CLEANING WITH PRESSURE AIR

1. Use clean, dry air—100 PSI maximum. Hold the nozzle at least one inch from the element and at a slight angle. (A direct blast can rip the pleating.)

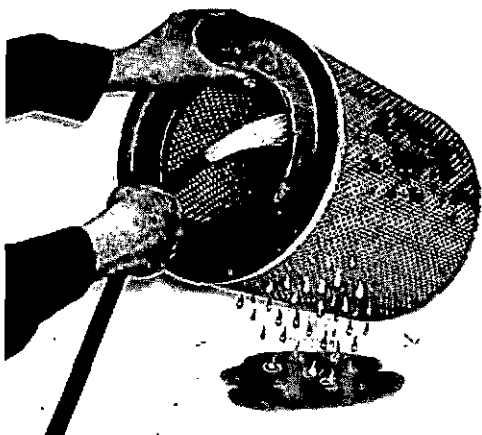


### CLEANING ELEMENT WITH AIR

2. Direct the air stream along the complete length of each pleat on the CLEANEST side of the element. (This will loosen the dirt from the dirtier side.)
3. Blow the loosened dirt from the DIRTY side.
4. Direct the air from the CLEAN side through to the DIRTY side to remove dirt blown into the pleating.

### CLEANING WITH WATER

1. Use clean water at no more than 40 PSI. Do not use a nozzle.
2. Direct the water stream along the complete length of each pleat on the CLEAN side of the element.

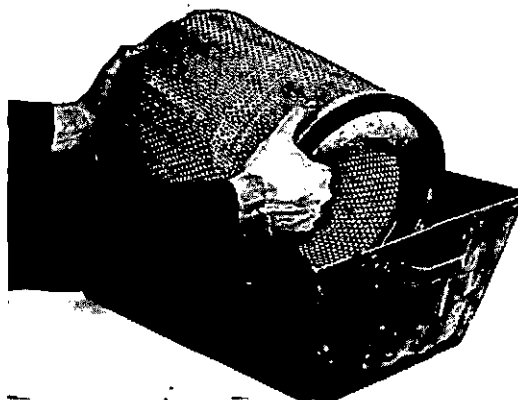


### CLEANING ELEMENT WITH WATER

3. Direct water along the complete length of each pleat on the DIRTY side of the element.
4. Rinse the CLEAN side of the element.
5. Allow the cleaned element to dry thoroughly.

### CLEANING WITH DETERGENT

1. Wash both sides of the element in a solution of warm water and non-sudsing household detergent.
2. Rinse the CLEANEST side of the element with clean water (40 PSI maximum) along the complete length of each pleat.

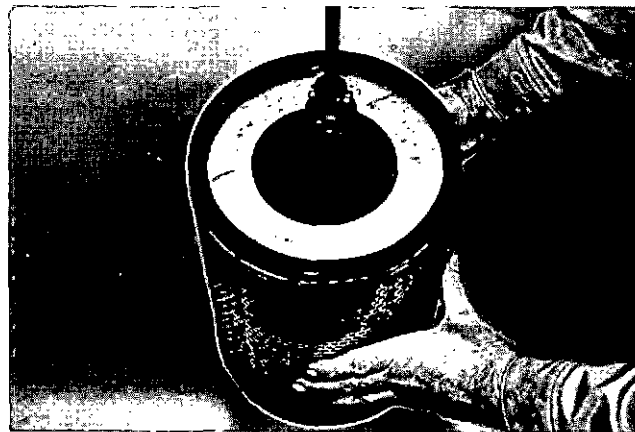


### WASHING ELEMENT WITH DETERGENT

3. Rinse the opposite side of the element along the complete length of each pleat.
4. Rinse the first side again to remove all loosened dirt.
5. Allow the cleaned element to dry thoroughly.

### STORING CLEANED ELEMENTS

1. Hold the dried element in front of a lighted electric bulb. Carefully inspect the element for tiny, pin-points of light. Any light showing indicates a pleat has ruptured and will tear with further use. Discard the element.



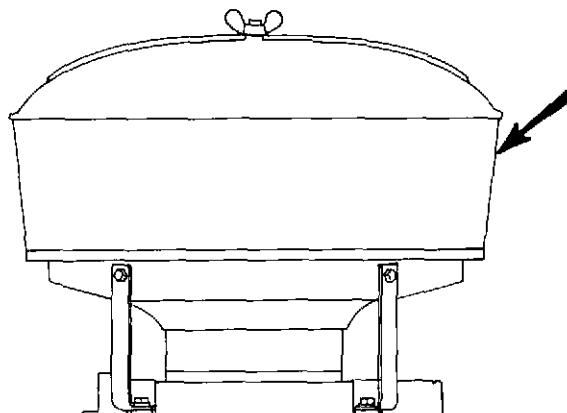
### INSPECTING ELEMENT

2. Wrap usable elements in heavy paper.
3. Store the wrapped element in a dry, clean place.

## PRECLEANER

### SERVICING

When the precleaner body is 3/4 full, remove and empty the precleaner. Wash the precleaner in water.



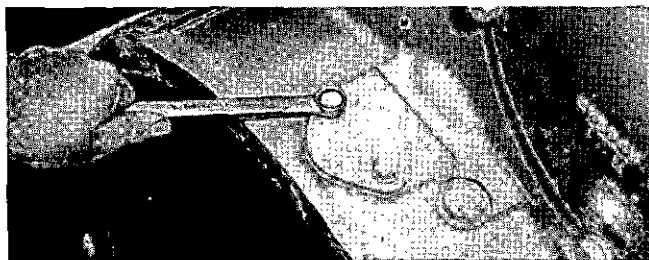
AIR CLEANER PRECLEANER

## ENGINE VALVES

### VALVE LASH

#### PREPARING TO CHECK ADJUSTMENT

1. Stop the engine.
2. Remove the flywheel housing timing cover(s).



REMOVING TIMING COVER(S)

3. Wipe the base of the valve cover(s) to keep dirt from getting into the valve mechanism.
4. Remove the valve cover(s).
5. Move the compression release lever to the START position, if engine is so equipped.



COMPRESSION RELEASE LEVER

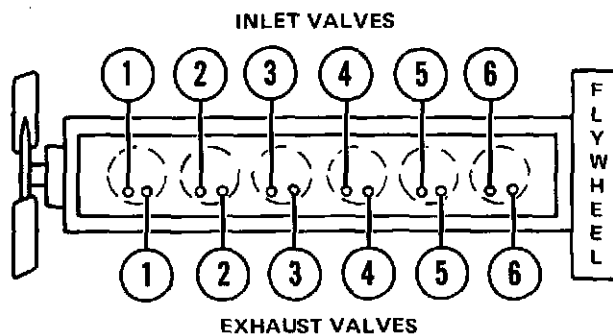
6. Bar the flywheel counterclockwise. Align the "TC 1" timing mark on the flywheel with the timing pointer on the flywheel housing.

7. Observe the rockers for cylinder No. 1. Determine if the piston is on COMPRESSION or EXHAUST stroke:

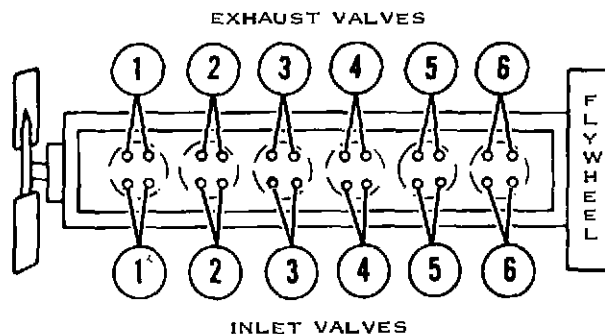
COMPRESSION STROKE: Both inlet and exhaust valve rockers can be moved freely.

EXHAUST STROKE: Only inlet valve rocker(s) can be moved freely.

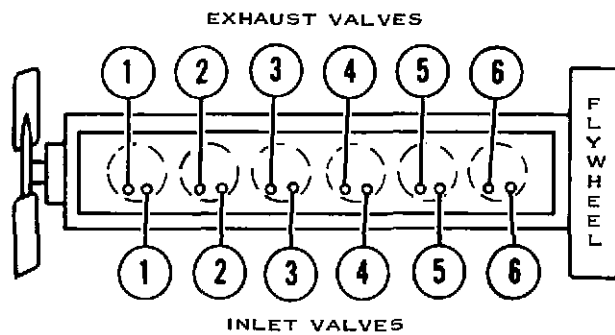
#### NUMBERING OF CYLINDERS AND VALVE LOCATION



D342 ENGINES



D343 ENGINES ONLY



#### D353 ENGINES

- With NO. 1 CYLINDER ON COMPRESSION STROKE, check the lash of the following valves; adjust if necessary.

##### NO. 1 CYLINDER ON COMPRESSION STROKE

VALVES	CYLINDERS	VALVE LASH (Inches)		
		D342	D343	D353
Exhaust	1-3-5	.020	.030	.030
Inlet	1-2-4	.016	.018	.018

.020 Inch = 0,51 mm. .030 Inch = 0,76 mm.  
.016 Inch = 0,41 mm. .018 Inch = 0,46 mm.

- With NO. 1 CYLINDER ON EXHAUST STROKE, check the lash of the following valves; adjust if necessary.

##### NO. 1. CYLINDER ON EXHAUST STROKE

VALVES	CYLINDERS	VALVE LASH (Inches)		
		D342	D343	D353
Exhaust	2-4-6	.020	.030	.030
Inlet	3-5-6	.016	.018	.018

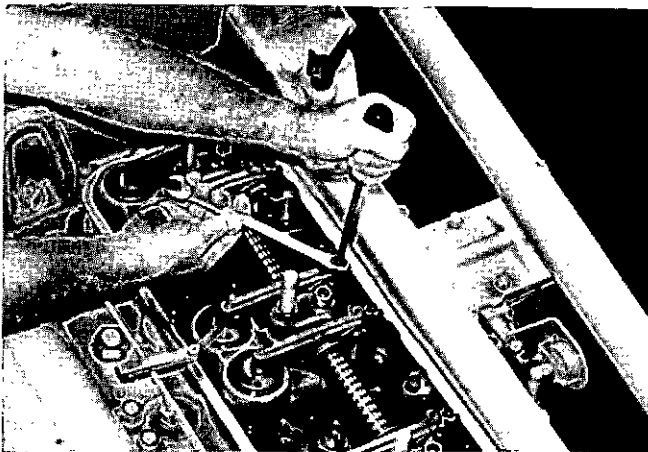
.020 inch = 0,51 mm. .030 inch = 0,76 mm.  
.016 inch = 0,41 mm. .018 inch = 0,46 mm.

- Bar the flywheel one revolution in the direction of normal rotation and align the flywheel "TC 1" timing mark with the timing pointer.
- Set the remaining valves as specified in the remaining chart.

## ADJUSTING VALVE LASH

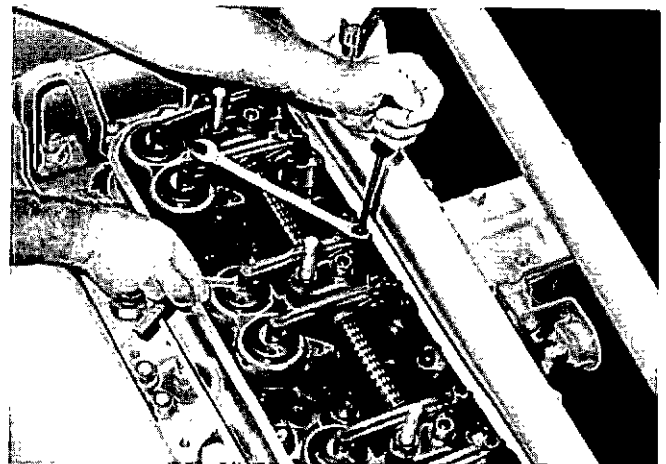
### D342 and D353 Engines

- Loosen the locknut on the adjusting screw.



LOOSENING LOCKNUT

- Hold the locknut and turn the adjusting screw to obtain the proper lash.



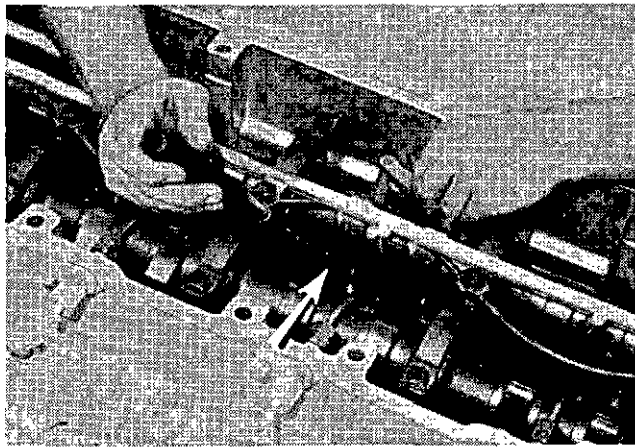
ADJUSTING VALVE LASH

- Hold the adjusting screw and tighten the locknut.
- Recheck the lash.

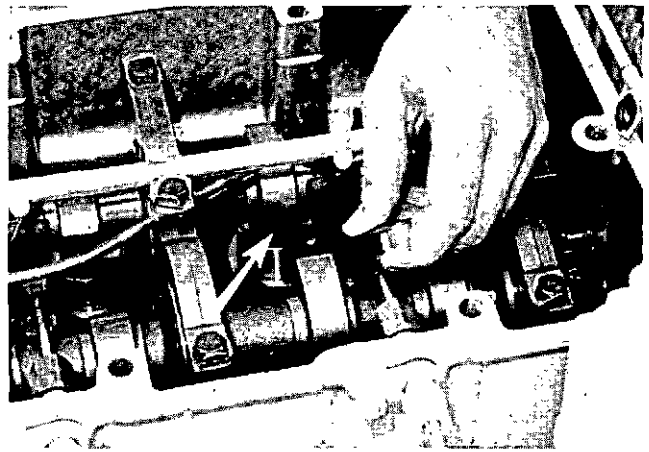
### D343 Engines

- Insert a cross point (Phillips) screwdriver in the hole in the side of the cam follower and engage the cam follower adjuster gear.

- Turn the screwdriver clockwise to increase lash or counterclockwise to decrease lash.
- Recheck the lash.



**ADJUSTING VALVE LASH (D343 Engine only)**



**CHECKING VALVE LASH**

## VALVE ROTATORS

### CHECKING ROTATION

After checking all valve clearances, and before installing the valve covers:

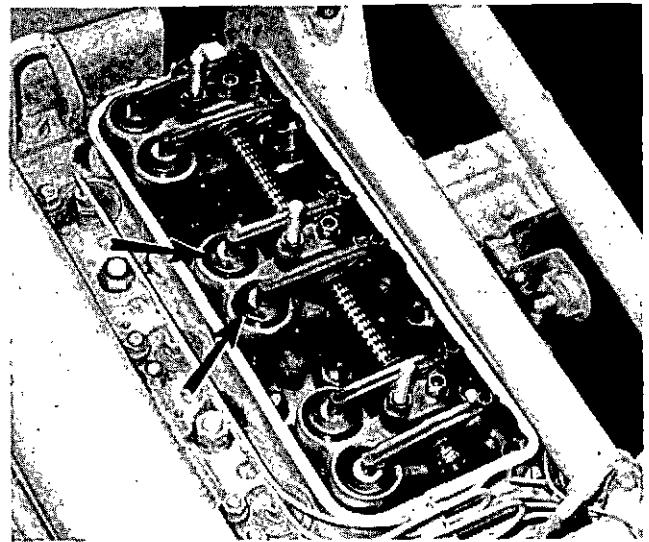
1. Start the engine.
2. Move the governor control to low idle position.
3. D342 and D353 Engines: Watch the serrations on each valve retainer. Each valve retainer should turn slightly each time the valve closes.

D343 Engines: Watch the cam followers. Each cam follower should slowly rotate while the engine is running. However, cam follower rotation does not necessarily indicate valve rotation.

If it is suspected a valve is not rotating, contact your Caterpillar dealer. Repairs must be made to prevent burning the valve.

If all valves rotate, proceed as follows:

4. Stop the engine.
5. Inspect and install valve cover gaskets. Install new gaskets if necessary.



**CHECK VALVES FOR ROTATION (D342 shown)**

6. Install the valve covers.
7. Install the flywheel housing timing cover(s).

# FUEL SYSTEM

## FUEL

Check the fuel supply. Order fuel as required. See Lubrication and Maintenance Chart for fuel recommendations.

## FUEL TANK

### FILLING

Fill the day tank at the end of each day's operation. This helps prevent moisture in the air from condensing on the inside walls of the tank and contaminating the fuel with water.

### DRAINING WATER AND SEDIMENT

1. Open the fuel tank drain valve and drain water and sediment from fuel tank.
2. Close the drain valve.

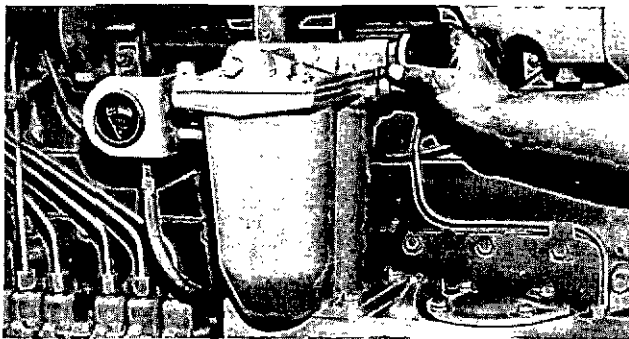
## FUEL FILTERS

### CHECKING FUEL PRESSURE GAUGE

With engine running, the fuel pressure gauge should register in the NORMAL range. If the gauge registers in the OUT range, service the fuel filter elements.

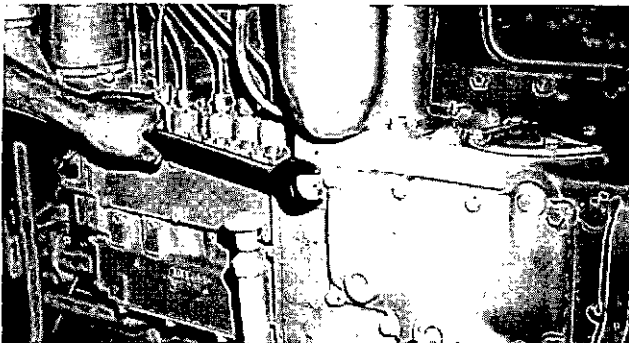
### DRAINING WATER AND SEDIMENT – All D342 and Early D353 Engines:

1. Close the fuel supply valve.
2. Open the fuel vent valve, located on top of the fuel filter housing.

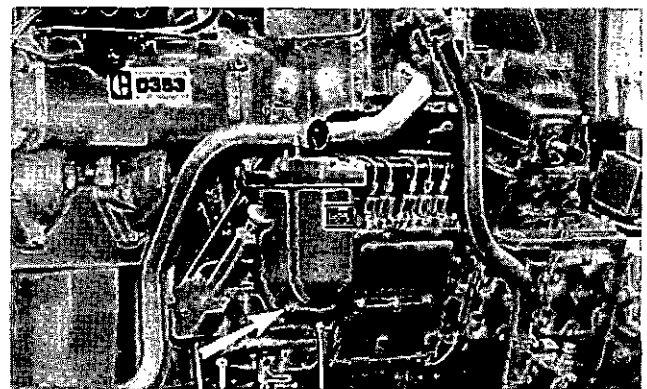


FUEL VENT VALVE

3. Remove the fuel drain plug. Drain water and sediment from filter.



REMOVING FUEL FILTER HOUSING DRAIN PLUG – D342 Engine shown

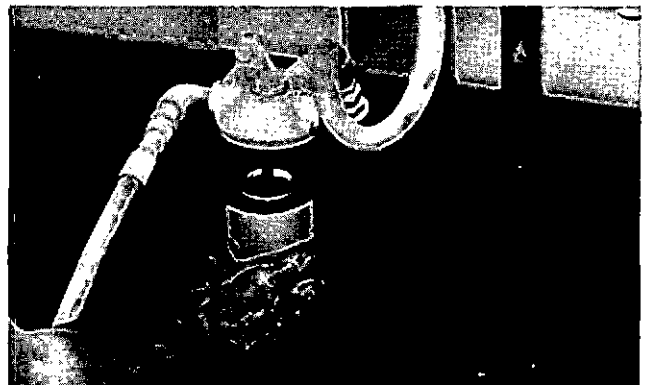


REMOVING FUEL FILTER HOUSING DRAIN PLUG – D353 Engine shown

4. Install the drain plug.
5. Close fuel vent valve.
6. Prime the fuel system.

### CLEANING PRIMARY FILTER ELEMENT

1. Stop the engine.
2. Close the diesel fuel supply line valve.
3. Loosen the nut on the cover and remove the case.



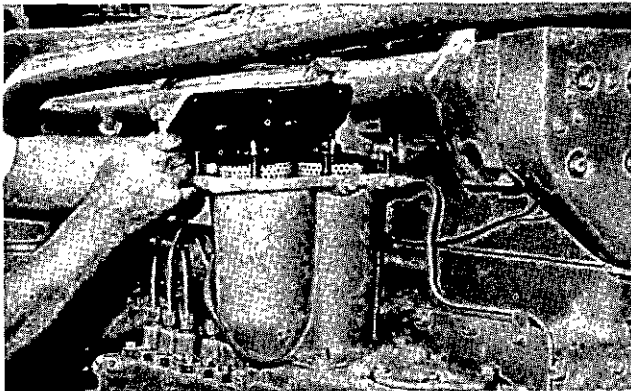
REMOVING PRIMARY FUEL FILTER

4. Remove the filter element. Clean the element and case in clean diesel fuel or solvent.
5. Inspect and install the upper and lower cover gaskets. Install new gaskets if necessary.
6. Install the cleaned filter element and case.
7. Open fuel supply line valve.
8. Prime the fuel system.

#### INSTALLING NEW FINAL FUEL FILTER ELEMENTS

##### D342 Engines:

1. Close the fuel supply line valve.
2. Open the fuel vent valve located on top of the fuel filter housing.
3. Remove the drain plug and drain the fuel filter housing.
4. Remove the filter housing cover.



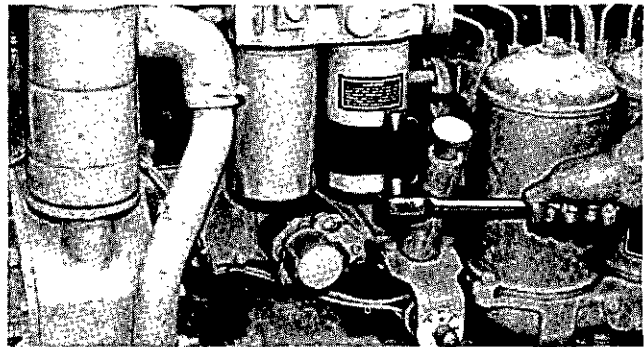
##### REMOVING FILTER HOUSING COVER

5. Remove the filter elements.
6. Wipe sediment from inside the housings.
7. Install the drain plug.
8. Install the new elements.
9. Inspect and install the cover gasket. Install a new gasket if necessary.
10. Install the cover.
11. Open fuel supply line valve.
12. Prime the fuel system.

##### D343 and Later D353 Engines:

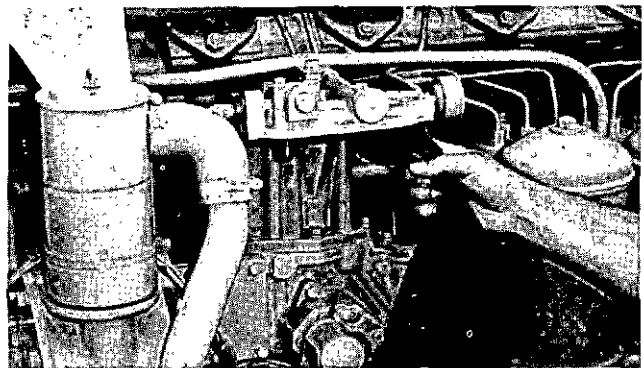
1. Close the fuel supply line valve.
2. Open the fuel vent valve located on top of the fuel filter housing.
3. Use a strap wrench to remove the filters. Be sure the old filter gasket does not remain attached to the filter

base: Leaking between the new and old filter gaskets will result.



##### REMOVING FUEL FILTERS

4. Wipe the filter base.



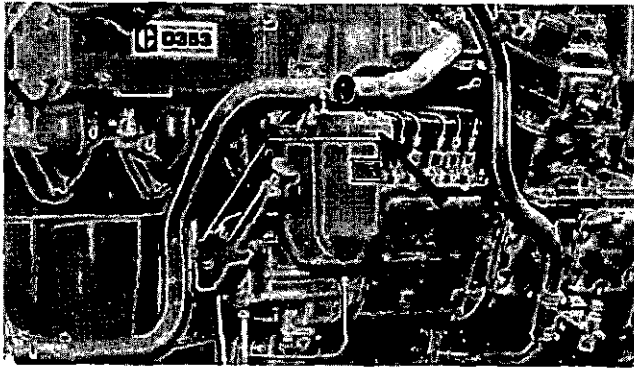
##### WIPING FILTER BASE

5. Apply a few drops of clean fuel to the new filter gasket. Fill the new filter with clean diesel fuel.
6. Tighten the filter by hand until the gasket contacts the base; then tighten the filter 1/2 turn more.
7. Open the fuel supply line valve.
8. Prime the fuel system.

##### Earlier D353 Engines:

Check the governor oil level by observing the oil level in the sight gauge. Add oil as necessary through the filler hole on top of the governor. See the Lubrication and Maintenance Chart for proper oil to use.

1. Close the fuel supply line valve.
2. Open the fuel vent valve located on top of the fuel filter housing.
3. Remove the drain plug and drain the fuel filter housing.
4. Remove the fuel filter housing.

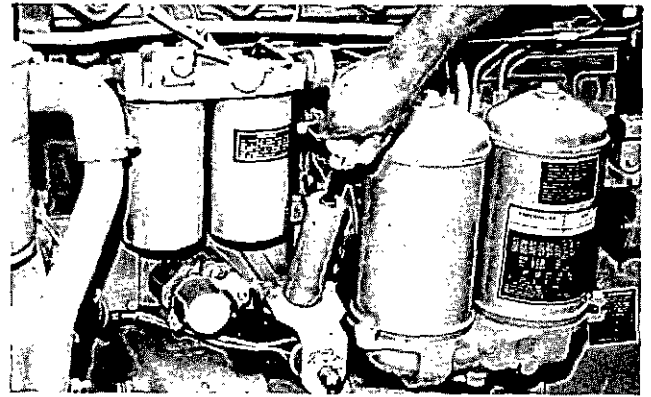


#### REMOVE FUEL FILTER HOUSING

5. Remove the filter elements.
6. Wipe sediment from inside the housing.
7. Install the drain plug.
8. Install new elements.
9. Inspect and install the cover gasket. Install a new gasket if necessary.
10. Install the filter housing.
11. Open fuel supply line valve.
12. Prime the fuel system.

#### PRIMING THE FUEL SYSTEM

1. Open the fuel supply line valve.
2. Move the governor control lever to the shut-off position.
3. Be sure the fuel vent valve, located on top of the fuel filter housing is open.
4. Turn and unlock the priming pump knob. Operate the pump until a solid stream of fuel flows from the drain tube.



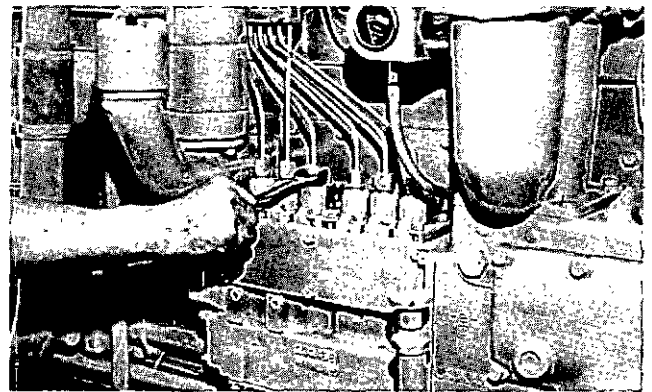
#### OPERATING FUEL PRIMING PUMP

5. Turn the pump knob to the locked position.
6. Close the vent valve.
7. Start the engine.

#### IF THE ENGINE RUNS ROUGH, RELEASE TRAPPED AIR FROM FUEL LINES

With the engine running:

1. Loosen a fuel line—loosen either the line nut at the fuel injection pump, or the line nut at the nozzle.



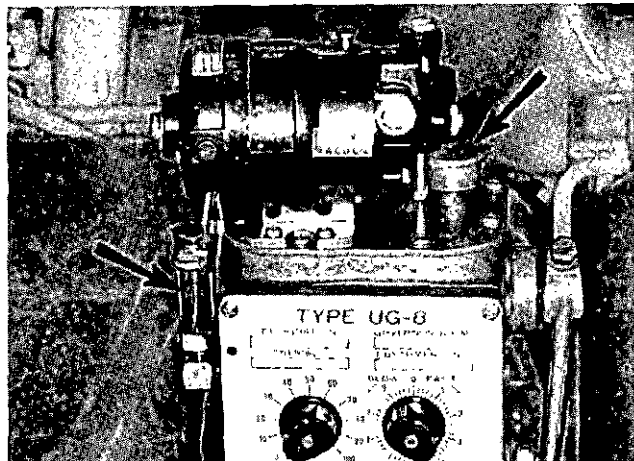
#### LOOSENING FUEL LINE NUT

2. Allow the fuel to spurt until the fuel stream is free of air bubbles.
3. Tighten the line nut. Proceed to the next fuel line and repeat the procedure.
4. Continue this procedure for all fuel lines.

## WOODWARD UG8 GOVERNOR

### CHECKING GOVERNOR OIL LEVEL

1. Before starting the engine, the oil level should be at, or slightly above, the FULL mark.
2. With the engine running, the oil level must be between the ADD and FULL marks. Do not overfill. See the Lubrication and Maintenance Chart for proper oil.



### CHECKING OIL LEVEL

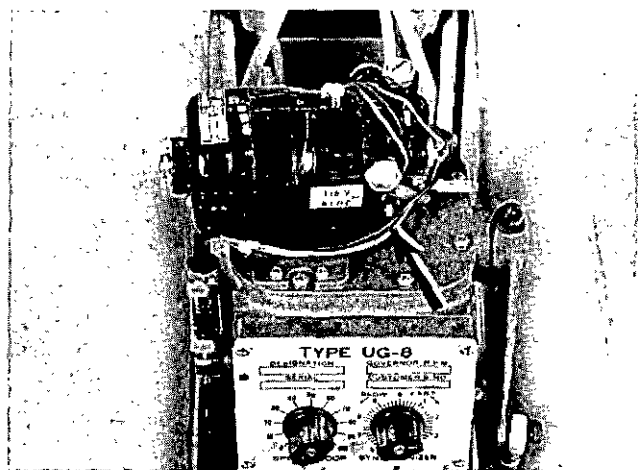
### CHANGING GOVERNOR OIL

1. Move the governor control lever to the shut-off position.
2. Shut off the fuel tank fuel supply valve.
3. Disconnect the ground cable from the battery.

### WARNING

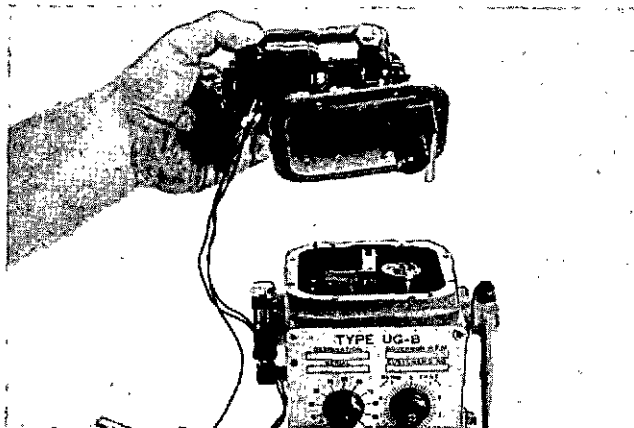
*Be sure the engine cannot be started while work is being done. This is very important when the engine is equipped with an Automatic Start-Stop System.*

4. Disconnect the governor linkage from the governor.
5. Disconnect the governor synchronizing motor wires.



### DISCONNECT SYNCHRONIZING MOTOR

6. Remove the governor from the engine.
7. Remove the governor cover.



### REMOVING GOVERNOR COVER

8. Turn the governor upside down and drain the oil.
9. Flush the governor with clean diesel fuel or solvent.
10. Install the governor on the engine.
11. Fill the governor, with clean oil, to the FULL mark on the sight gauge. See Lubrication and Maintenance Chart for proper oil.
12. Connect the governor linkage.

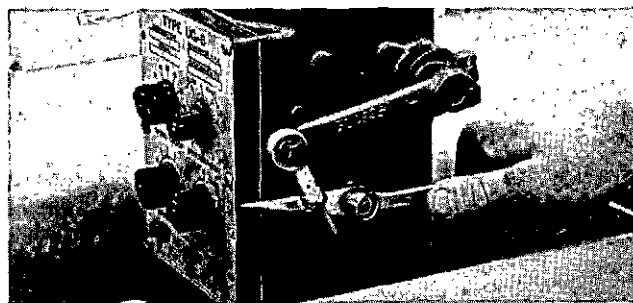
### WARNING

*Before starting the engine, check to be sure the governor linkage has been connected to the governor.*

13. Connect the ground cable to the battery.

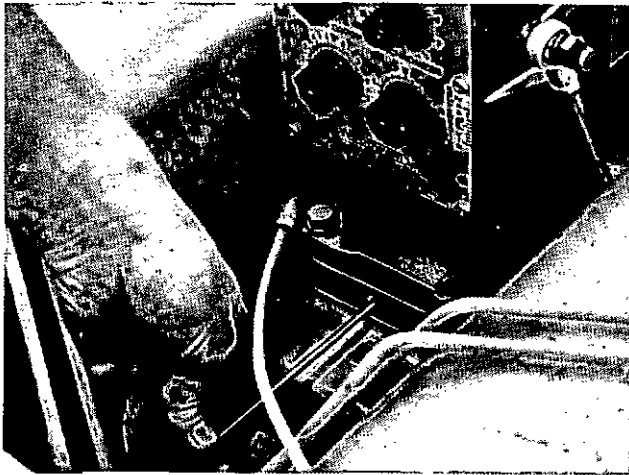
### BLEEDING GOVERNOR

1. Start the engine and allow the engine to reach normal operating temperature.
2. Loosen the nut on the side of the governor which holds the compensation adjusting pointer.
3. Manually move the pointer to the extreme upper position and tighten the nut. This will allow the governor to be purged of air.



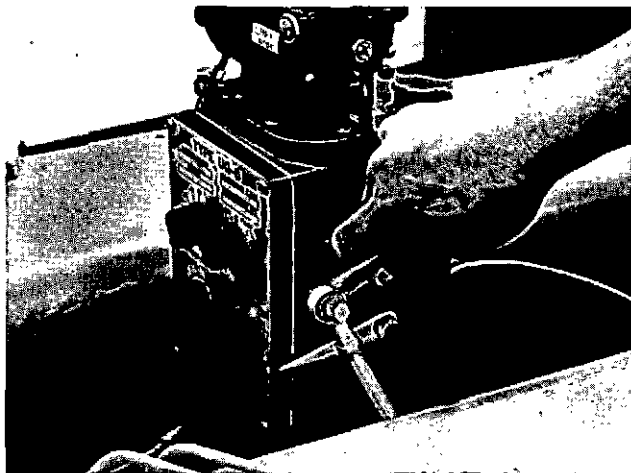
### SETTING POINTER AT UPPER POSITION

4. Remove the plug from the base of the governor.
5. Engage the shallow screwdriver slot and open the needle valve (turn counterclockwise) 3 or more turns.



**OPENING NEEDLE VALVE**

6. Allow the engine to surge for approximately 30 seconds.
7. Loosen the nut and move the compensation adjusting pointer to the extreme downward position. Tighten the nut.
8. Slowly close the needle valve (turn clockwise) until the surging stops.
9. It should now take less than one turn from this point to close the valve completely.
10. Open the valve to the same position where the surging had stopped.
11. Manually move the governor linkage to disturb the engine speed.



**MANUALLY CHANGING ENGINE SPEED**

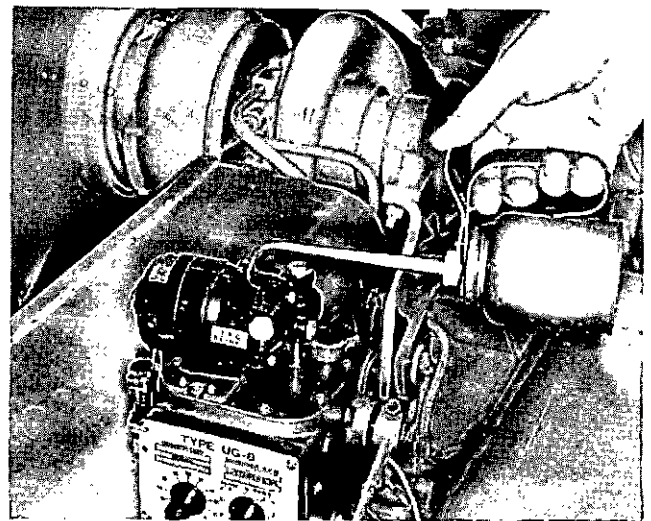
If the engine speed stabilizes, and the needle valve requires 1/2 to 3/4 turn to close, the governor is properly adjusted. Install the base plug.

If the needle valve requires less than 3/8 turn to close, proceed with the following steps:

12. Raise the pointer two divisions on the pointer scale.
13. Engage the wide shallow slot and turn the needle valve counterclockwise 3 or more turns.
14. Allow the engine to surge approximately 30 seconds.
15. Gradually turn the needle valve clockwise until surging just stops.
16. Note the portion of a turn required to close the needle valve.
17. Open the valve exactly to the same position surging stopped.
18. Manually move the governor linkage to disturb the engine speed. The engine speed should stabilize with the needle valve opened 1/2 to 3/4 turn.
19. A valve opened less than 1/2 of a turn produces a slow response to load changes. A valve opened more than 3/4 of a turn produces excessive speed response to load change. If the engine does not stabilize between 1/2 to 3/4 turn open, raise the pointer two divisions and repeat steps 12 through 19.
20. When the engine speed stabilizes, install the base plug.

#### LUBRICATING THE GOVERNOR SYNCHRONIZING MOTOR

Fill the cup on top of the motor with clean oil. See Lubrication and Maintenance Chart for proper oil.



**LUBRICATING ELECTRIC MOTOR**

# COOLING SYSTEM

## ENGINE JACKET WATER

### CHECKING COOLANT LEVEL

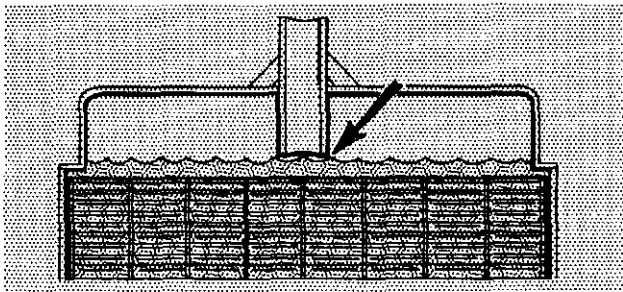
With the engine stopped:

1. Slowly turn the filler cap to the first stop and release pressure.

#### WARNING

**Be careful. If the engine is warm—steam may spray outward under high pressure.**

2. Push the cap down; turn until the cap is released.
3. Maintain level to base of fill pipe. The coolant requires expansion space as it is heated.



### PROPER COOLANT LEVEL

4. Make-up coolant should be one of the following, in the order of preference:
  - a. Permanent anti-freeze and water solution.
  - b. Drinkable water and rust inhibitor solution.
  - c. Drinkable water.
  - d. Any available fresh water.

(a) Must be used if engine is to be shut down in below freezing weather without draining the coolant. (b) Can only be used when the coolant temperature is above freezing, or if the coolant will be immediately drained after shut down during below freezing temperatures.

(c) or (d) Should only be used as a "temporary fix". As soon as possible, return the system to either (a) or (b).

### CHECKING WATER TEMPERATURE GAUGE READING

The water temperature gauge should normally register in the NORMAL range when operating. However, with some systems, as long as the coolant does not boil the cooling system is functioning properly.

1. If the water temperature gauge continually registers near—or in the "HOT" range—without boiling, have the system checked to determine if the cooling system is functioning properly.
2. Frequently observe the water temperature gauge indicator while operating. Be sure to note any deviation from the normal reading.

3. Whenever the reading changes, investigate the cause and have necessary repairs made.

### DRAINING RADIATOR OR EXPANSION TANK

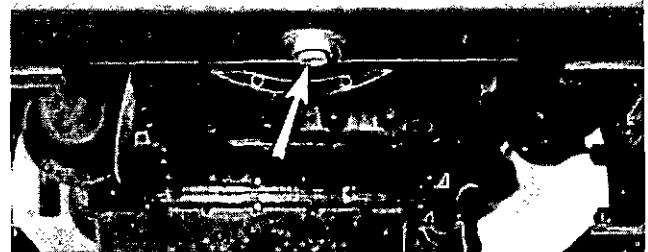
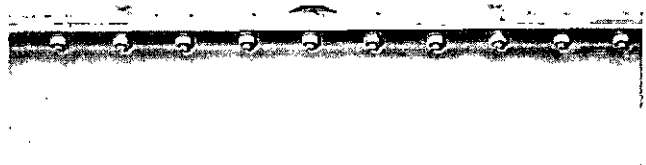
Whenever it is necessary to drain the cooling system for repairs:

1. Shut the engine off.
2. Slowly turn the pressure cap to the first stop and release pressure.

#### WARNING

**Be careful. If the engine is warm—steam may spray outward under high pressure.**

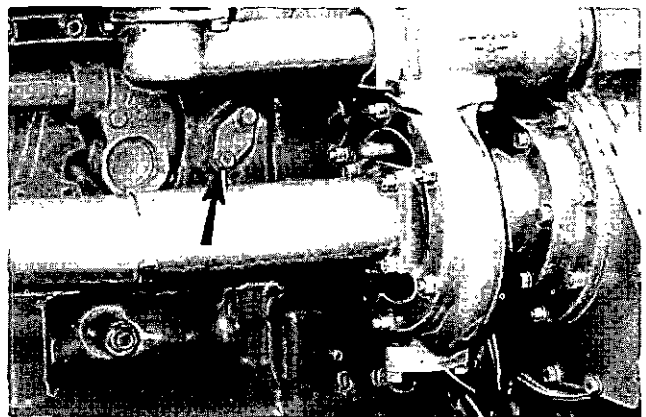
3. Push the cap down and turn until the cap is released.
4. Open the drain valve on the radiator, if so equipped.



### COOLANT DRAIN

### DRAINING COMPLETE COOLING SYSTEM

1. Remove the engine block drain cover; rear left side.
2. Remove the water pump drain plug.



### COOLANT DRAINS

3. Remove the oil cooler bonnet drain plug.

4. Remove the water shield drain plugs if equipped with a water cooled manifold.
5. Remove aftercooler drain plugs if so equipped.
6. Allow the coolant to drain.
7. Install all drain covers and plugs.
8. Close the radiator drain valve.

#### FLUSHING COOLING SYSTEM

To clean the cooling system, any good commercial radiator cleaning solution can be used. Follow the instructions included with the cleaner.

The cooling system can be cleaned using oxalic acid and sodium carbonate as follows:

1. Fill the cooling system with a solution consisting of two pounds of oxalic acid or sodium bisulphate ( $\text{NaHSO}_4$ ) with every 10 gallons of water (mix 0,24 kg with every 10 liters of water).
2. Start the engine and operate at operating temperatures for 1/2 to 1 hour.
3. Stop the engine and drain the cooling system.
4. Flush the system with clean water until the draining water is clear.
5. Install all drain plugs.

6. Fill with a solution consisting of 1/2 pound of sodium carbonate crystals ( $\text{Na}_2\text{CO}_3, 10 \text{ H}_2\text{O}$ ) with every 10 gallons of water (mix 0,06 kg with every 10 liters of water).
7. Start and run the engine for 10 minutes.
8. Stop the engine and drain the cooling system.
9. Flush the cooling system with clean water.
10. Install all drain plugs.

#### FILLING COOLING SYSTEM

1. Add either rust inhibitor or permanent type anti-freeze. Do not add both.
2. Fill to correct level with water which is free as possible from scale forming minerals.
3. Open the raw water valve.
4. Start and run engine for 10 minutes.
5. Remove the radiator cap and check the coolant level.
6. Add coolant, if needed, until coolant is to the bottom of the filler tube.
7. Install the radiator or expansion tank cap.

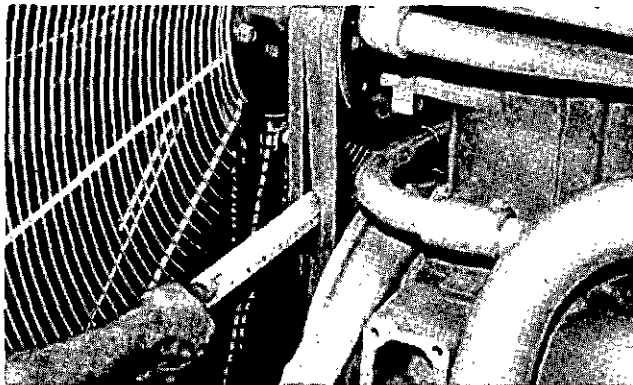
### FAN BELTS AND DRIVE

1. Check belt wear.
2. Apply a 25 pound (10 kg) force, perpendicular to the belt, midway between the driver and driven pulley and measure the belt deflection.
3. Proper belt deflection is 9/16 to 13/16" (14 to 20 mm). Adjust the belt tension as required.

new belt will be carrying all of the load—as it will not be stretched as much as the older belts—and all of the belts will fail in rapid succession.

#### ADJUSTING FAN BELTS

1. Loosen the four nuts holding the fan plate to the engine block.



MEASURING BELT DEFLECTION

4. If one belt in a set requires replacement, always install a new matched set of belts—never replace just the worn belt. If only the worn belt is replaced, the

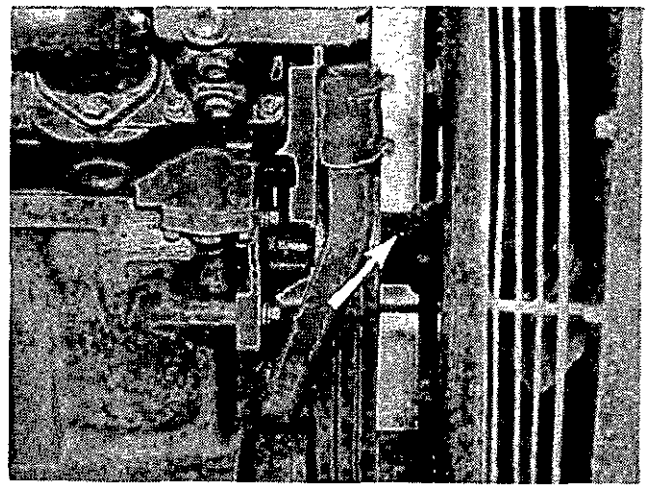


ADJUSTING FAN BELT TENSION

2. Loosen locknut. Turn the adjusting screw until belt is adjusted properly.
3. Tighten the four nuts and locknut.
4. Check the belt adjustment.

#### LUBRICATING FAN DRIVE

Lubricate the fan drive bearing with grease; 1 or 2 strokes, 1 fitting.



FAN DRIVE BEARING

### RAW WATER

Salt water has a highly corrosive reaction with metal by a chemical action called "electrolysis". To prevent this chemical action taking place, with parts used in the raw water system, zinc plugs are placed in the raw water piping. Zinc is a relatively soft metal which reacts quite readily with the salt water. Thus, by the deterioration of the zinc, the raw water system parts are protected from corrosion.

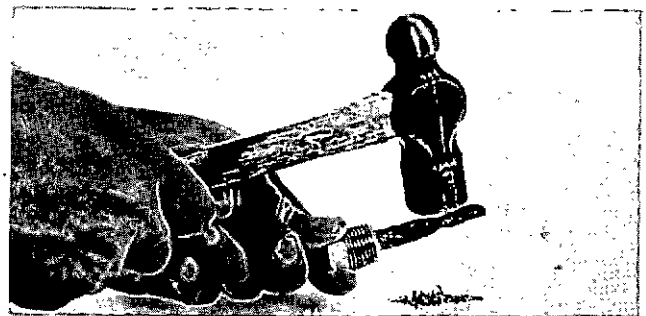
The zinc rods must be inspected regularly and be replaced as they become deteriorated. The zinc rod plugs are painted red for easy identification.

#### INSPECTING ZINC RODS

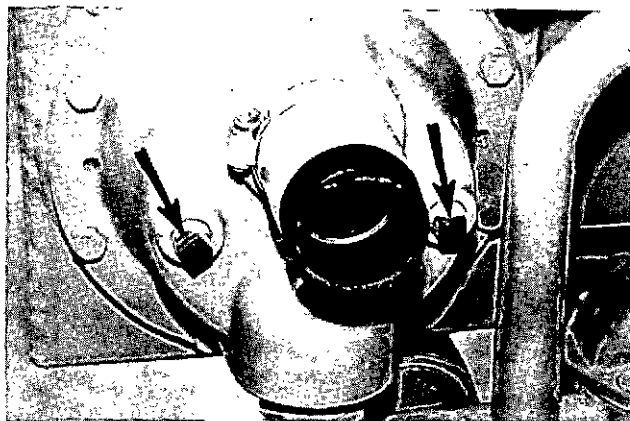
1. Move the governor control lever to the shut-off position.
2. Remove and inspect all of the zinc plugs. They are painted red for easy identification. Depending upon

the engine, their location may be in the oil cooler heat exchanger bonnet, raw water heat exchanger bonnet, aftercooler lines, raw water pump, or in the raw water lines.

3. Tap the zinc rods lightly with a hammer.



INSPECTING ZINC ROD



ZINC PLUGS

4. Inspect the rods. If a rod has deteriorated, or flakes apart when tapped, install a new zinc rod.

#### INSTALLING NEW ZINC ROD

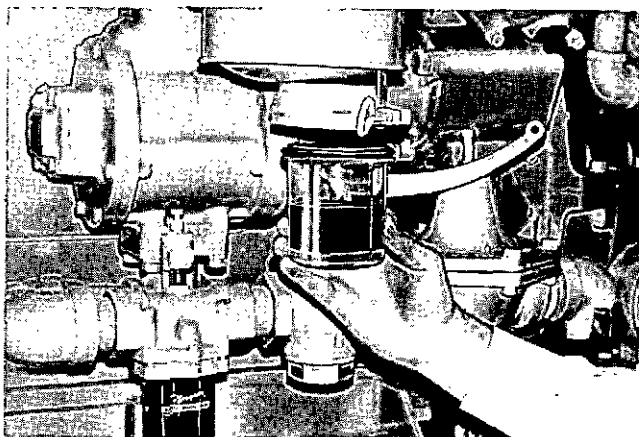
1. Unscrew or drill the existing rod from the plug base.
2. Install a new rod in the plug base.
3. Install the plug.

# STARTING SYSTEM

## AIR STARTING

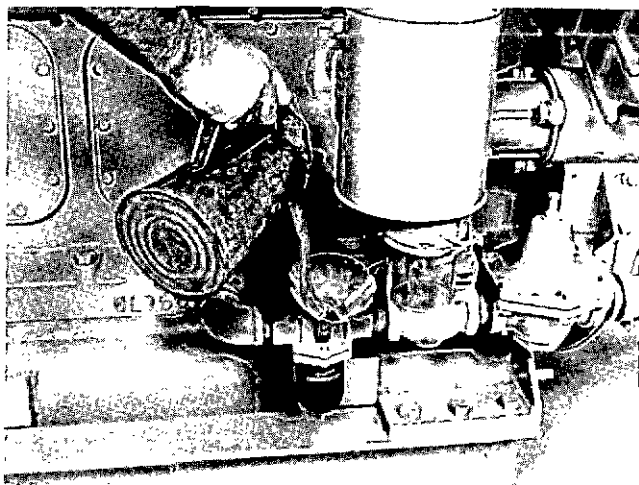
The motor oiler lubricates the vanes of the starting motor with a fine oil mist as the motor is operating.

The collector jar collects both the oil after it has lubricated the starting motor vanes, and the moisture condensation from the compressed air. Empty the collector jar whenever the jar becomes half full.



REMOVING OIL COLLECTOR JAR

When the oiler jar becomes half empty, remove the oil filler plug and fill the jar with clean oil. Refer to Lubrication and Maintenance Chart for proper oil.



ADDING OIL TO MOTOR OILER

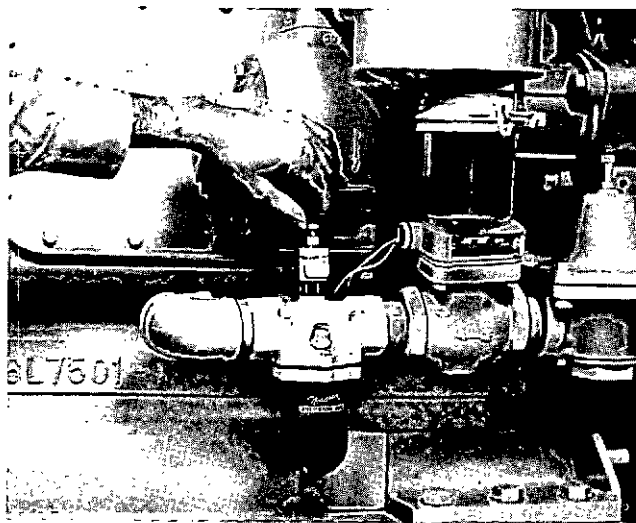
### CAUTION

Never allow the jar to become empty. The starting motor will be damaged by lack of proper lubrication.

### ADJUSTING THE AIR STARTING MOTOR OILER FEED

If necessary, adjust the oiler to release approximately four drops of oil per minute into the starting motor air stream.

1. Move the compression release lever to the START position, and move the governor control lever to the SHUT-OFF position.
2. Pull up on the air start control lever and crank the engine.
3. Count the drops of oil released per minute into the air stream.
  - a. Turn the valve needle (the uppermost knob on the oiler) counterclockwise to increase the number of drops.
  - b. Turn the valve needle clockwise to decrease the number of drops.



ADJUSTING MOTOR OILER

# ELECTRICAL SYSTEM

## BATTERY INSTALLATION

### PREPARING DRY CHARGE BATTERIES

One day before installing a new dry charge battery, add the electrolyte solution to each cell.

1. Fill each cell to the bottom of the vent with electrolyte solution.

#### CAUTION

If the battery is initially filled with water by mistake, the battery is ruined and must be replaced.

2. Allow the battery to sit for several minutes to permit the battery plates to absorb the electrolyte.
3. Add make-up electrolyte solution until the level stabilizes. Once the level stabilizes, never add anything but water.
4. Install the vent caps.
5. Remove the tape covering the vent hole in each cap.
6. Slowly charge the battery on a battery charger until the specific gravity of the solution is at least 1.240 at a temperature of 80°F (27°C).

#### NOTE

If the electrolyte solution temperature nears 125°F (53°C) reduce the charging rate. Temperature in excess of 125°F (53°C) will ruin the battery.

### PREPARING WET CHARGE BATTERIES

The electrolyte solution was added by the manufacturer. Make-up solution must be water; never add electrolyte or acid to a wet charge battery. If necessary, slowly charge the battery before using.

### USING A BATTERY CHARGER

A desirable charging rate can be calculated by multiplying the amp-hour rating of the battery by .07 (7%).

## BATTERY MAINTENANCE

### TESTING THE ELECTROLYTE SOLUTION

The general condition of a battery can be determined by measuring the specific gravity of the electrolyte solution and adjusting the reading to 80°F (27°C). If the electrolyte level is too low to allow taking a hydrometer reading, add make-up water to the correct level and then charge the battery 2 to 4 hours before taking a reading.

1. Insert the hydrometer into a cell. Fill the hydrometer barrel while holding it vertically. The float must not drag on the wall of the barrel.

Shut off the battery charger before disconnecting the booster charger clamps from the battery terminals. While the battery is charging, hydrogen gas is being given off through each vent cap. When hydrogen gas is mixed with air, the mixture is highly explosive and will explode in the presence of a spark or small flame.

#### WARNING

Never smoke near the area where batteries are being charged.

### INSTALLING BATTERY

1. Be sure the tray is free of objects which may puncture the battery case when the hold down straps are tightened.
2. Be sure terminal posts and cable clamps are clean.
3. Place the battery in the tray. Tighten the hold downs evenly until the battery is snug. Do not over-tighten.
4. Connect the "hot" terminal first.
5. Connect the ground terminal last.

#### CAUTION

Always connect the "hot" terminal first.

When the "hot" terminal is connected first, no arcing can occur if the wrench accidentally contacts both the terminal and the frame or tray. The part that is contacted will take the same polarity as the battery terminal.

By connecting the ground terminal first, the frame or tray is connected to ground. Then, if the wrench accidentally contacts the frame while connecting the "hot" terminal, a circuit is completed through the wrench. A hot spark will occur which could burn the person holding the wrench, or possibly explode the battery if an excess of hydrogen gas is present at any one of the vent holes.

After connecting both cables, apply a thin coating of grease over the cable clamps, terminals and hold down fasteners.

2. Read the hydrometer:

1.250 or above - fully charged battery cell

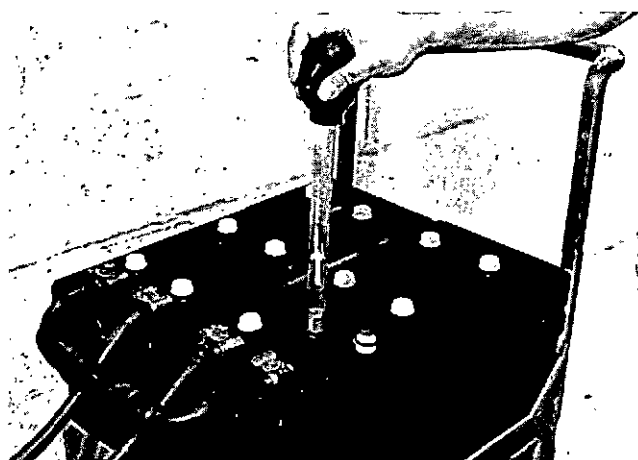
1.250-1.225 - full to half charged battery cell

1.225-1.150 - half to low charged battery cell

Below 1.150 - dead cell

1.000 - water

3. Test each cell in the same manner.



#### MEASURING SPECIFIC GRAVITY

4. If there is more than .050 (50 gravity points) variation between the highest and lowest reading, the battery should be replaced.
5. Adjust the readings to 80°F (27°C).
  - a. For every 10F° (5.5C°) the electrolyte temperature is above 80°F (27°C), add .004 (4 gravity points) to the specific gravity reading.

Example: Electrolyte temperature = 100°F; 38°C  
 Corrected temperature = 80°F; 27°C  
 Difference: = 20°F; 11°C  
 Increments: 10; 5.5  
 $20 \div 10 = 2$ ;  $11 \div 5.5 = 2$   
 $2 \times 4$  gravity points = 8 gravity points

Add 8 gravity points to your hydrometer reading to obtain the adjusted reading at 100°F. If the uncorrected hydrometer is 1.240 the corrected reading would be: 1.240 + 8, or 1.248

- b. For every 10F° (5.5C°) the electrolyte temperature is below 80°F (27°C), subtract .004 (4 gravity points) from the specific gravity reading.

Example: Electrolyte Temperature = 10°F; -13°C  
 Corrected temperature = 80°F; 27°C  
 Difference = 70°F; 40°C  
 Increments: 10; 5.5  
 $70 \div 10 = 7$ ;  $40 \div 5.5 = 7$   
 $7 \times 4$  gravity points = 28 gravity points

If the uncorrected hydrometer reading is 1.210 the corrected reading would be  $1.210 - 28 = 1.182$

The corrected reading is of most importance during cold weather when the hydrometer reading is always corrected to a lower specific gravity reading. A low reading signifies the battery has less available power to crank the engine and that booster batteries may be required.

#### CHECKING ELECTROLYTE LEVEL

Check the electrolyte level of each cell and the general condition of the battery.

1. Maintain the electrolyte level to the base of each vent well.
2. The make-up water must be one of the following (in order of preference):
  - a. Distilled water.
  - b. Odorless, tasteless drinking water.
  - c. Iron free fresh water.
  - d. Any available fresh water.

#### WARNING

Never add acid or electrolyte.

#### READING THE AMMETER

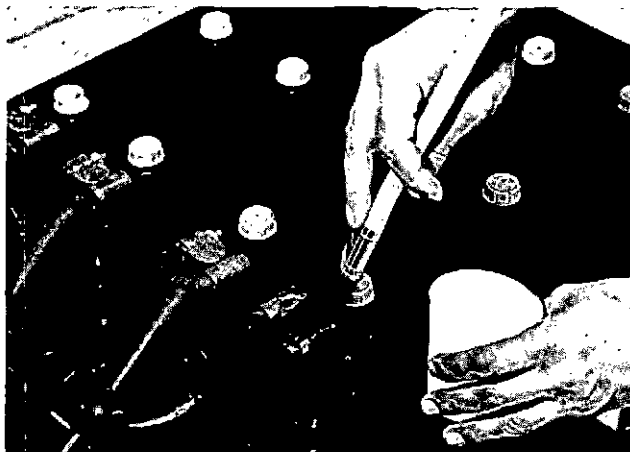
1. After starting the engine, the ammeter indicator should register to the right of zero, but should never be "pegged".
2. After the engine has been running, the indicator should be just to the right of zero.

If the indicator either "pegs" to the right, or remains to the left of zero with an increase of engine speed, have the electrical charging system checked.

The alternator charging rate maintains the battery's electrolyte specific gravity reading, and the battery's performance. An undercharge rate cannot maintain a desired 1.250 specific gravity reading. An overcharge rate will boil the water from the electrolyte solution. A proper charging rate should require no more than one ounce (30 cc) of water per cell per week to maintain a fully charged battery.

#### CLEANING BATTERY

1. Mix a weak solution of baking soda and water. Apply the solution with a bristle brush.



#### CLEANING BATTERY TERMINALS

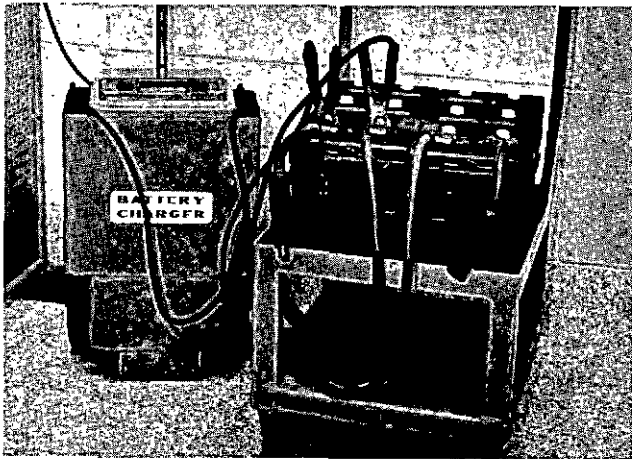
2. Thoroughly rinse the battery and battery tray with clean water.
3. Apply grease to the battery cable clamps and terminals and to all threads.

## COLD WEATHER BATTERY MAINTENANCE

The following instructions aid in obtaining maximum performance in cold weather:

1. After adding make-up water, charge the battery.

The added water will dilute the electrolyte. This will lower the specific gravity of the solution, raise the freezing point of the solution and lower the charge of the battery.



**CHARGING A BATTERY**

2. Keep the batteries fully charged either by operating the charging system or by using a battery charger.
3. Keep the electrolyte warm when the battery is not in use. The heat from an electric light bulb usually is sufficient.

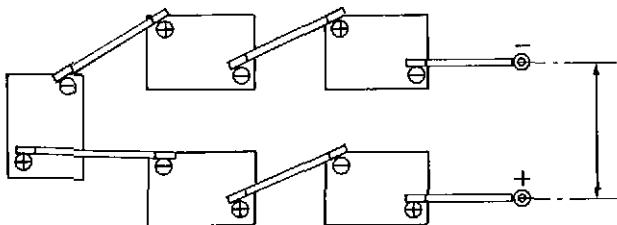
### CAUTION

Do not lay cloth or any flammable material in contact with a lighted bulb. Charring, or fire, can result.

4. Use starting aids as instructed when starting.
5. Use booster batteries as required. Connect as instructed below.

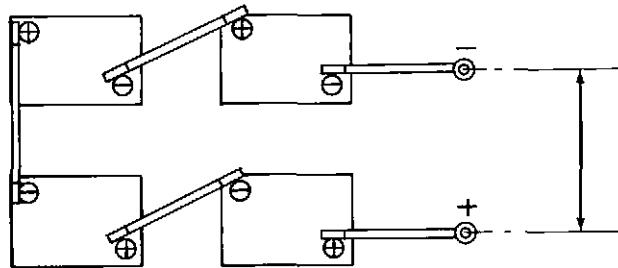
### CONNECTING LOWER VOLTAGE BATTERIES IN SERIES FOR BOOSTER STARTING

To obtain 30 volt starting, connect five 6 volt batteries in series as illustrated below.



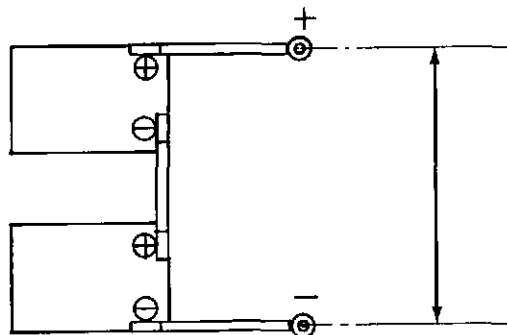
**30 VOLT STARTING USING 6 VOLT BATTERIES**

To obtain 24 volt starting, connect four 6 volt batteries in series as illustrated below.



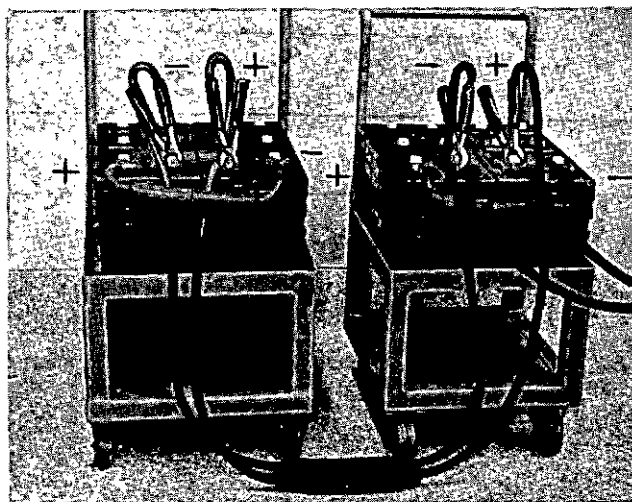
**24 VOLT STARTING USING 6 VOLT BATTERIES**

To obtain 24 volt starting, connect two 12 volt batteries in series as illustrated below:



**24 VOLT STARTING USING 12 VOLT BATTERIES**

1. Using jumper cables, connect fully charged batteries in series: Connect the positive terminal of one battery to the negative terminal of a second battery.



**SERIES CONNECTED BOOSTER BATTERIES CONNECTED IN PARALLEL**

2. Using a pair of jumper cables, connect the red

jumper cable to the "hot" terminal of the booster batteries.

3. Connect the black jumper cable to the ground terminal of the booster batteries.

#### CAUTION

Keep the red and black cable terminals from touching each other.

4. Connect the other end of the red jumper cable to the "hot" terminal of the engine batteries.
5. Connect the other end of the black jumper cable to the ground terminal of the engine batteries.
6. Start the engine using starting aids as instructed.

## REMOVING JUMPER CABLES

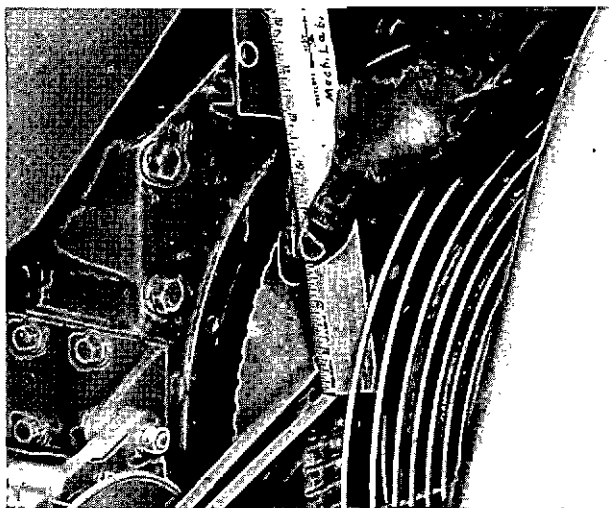
As soon as the engine starts:

1. Disconnect the black jumper cable from the engine battery ground terminal.
2. Disconnect the red jumper cable from the engine battery "hot" terminal.
3. Disconnect the black jumper cable from the booster batteries.
4. Disconnect the red jumper cable from the booster batteries.
5. Disconnect the booster batteries. Charge them to full capacity with a battery charger.

## CHARGING ALTERNATOR

### CHECKING ALTERNATOR BELTS

1. Check belt wear.
2. Apply a 25 pound (11,34 kg) force, perpendicular to the belt, midway between the driver and driven pulleys. Measure the belt deflection.



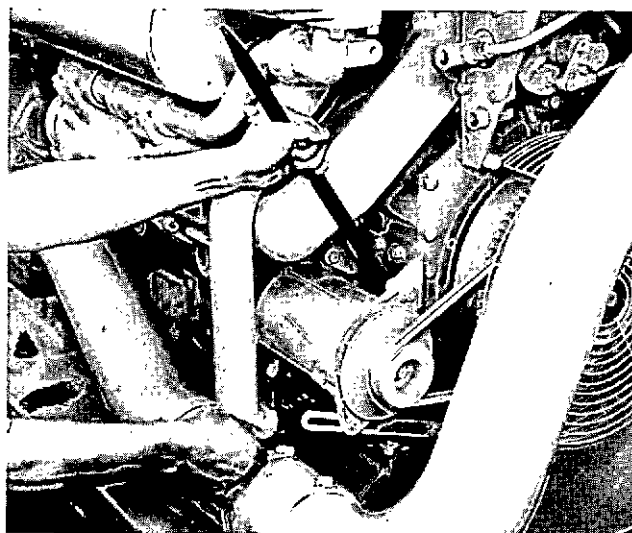
MEASURING BELT DEFLECTION

3. Proper belt deflection is  $9/16$  to  $13/16$ " (14 to 20 mm). Adjust the belt tension as required.
4. If one belt in a set requires replacement, always install a new matched set of belts—never replace just the worn belt. If only the worn belt is replaced, the

new belt will be carrying all of the load—as it will not be stretched as much as the older belts—and all of the belts will fail in rapid succession.

### ADJUSTING ALTERNATOR BELTS

1. Remove the belt guard.
2. Loosen the alternator mounting bolts.
3. Push the alternator outward until the belt is properly adjusted.
4. Tighten the mounting bolts.
5. Check the belt adjustment.
6. Install the belt guard.



ADJUSTING BELT TENSION

## GLOW PLUGS

### TESTING GLOW PLUGS

1. Stop the engine.
2. Disconnect the lead harness wire from the magnetic switch.
3. Connect an ammeter of sufficient capacity between the magnetic switch terminal and the lead harness wire.
4. Push in, turn and hold the HEAT-START switch in the HEAT position.
5. The ammeter reading should equal the number of glow plugs multiplied by the amperage of each glow plug.

Calculate the amperage of each glow plug by dividing its wattage by its voltage. These values are stamped on each glow plug. The amperage should be 3.5 amperes to 7 amperes per glow plug, depending upon the engine.

A deviation from the calculated reading will indicate one or more defective glow plugs.

### LOCATING DEFECTIVE GLOW PLUGS

1. Push in, turn and hold the HEAT-START switch in the HEAT position. Observe the ammeter reading.
2. Pull the lead from a glow plug. Observe the ammeter reading.

### NOTE

If the ammeter reading does not change, the glow plug was not drawing current when connected and can be assumed to be defective. If the ammeter reading decreases, the glow plug is working properly.

3. Release the HEAT-START switch.
4. Connect the lead to the glow plug.
5. Test each glow plug individually.

### INSTALLING GLOW PLUGS

1. Disconnect the lead wire at the defective glow plug.
2. Remove the defective glow plug.
3. Apply anti-seize compound to the threads of the new glow plug.
4. Install the new glow plug and tighten to a torque of 10 to 12 pounds feet.
5. Turn the HEAT-START switch to the HEAT position and observe the ammeter reading.
6. Release the switch.
7. Install the lead wire.
8. Turn the HEAT-START switch to the HEAT position. The reading should be increased. If the reading is the same, check the glow plug wiring.
9. Disconnect the ammeter.

# POWER COUPLING SYSTEM

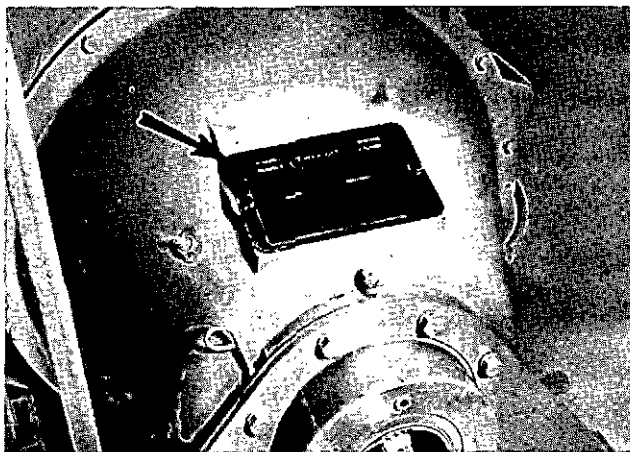
## FLYWHEEL AND/OR FRONT POWER TAKE-OFF CLUTCHES

### CHECKING CLUTCH ADJUSTMENT

While engaging the clutch to pick up the load, check the clutch adjustment. The clutch should engage with a hard push and distinct snap. If engagement is "soft", adjust the clutch.

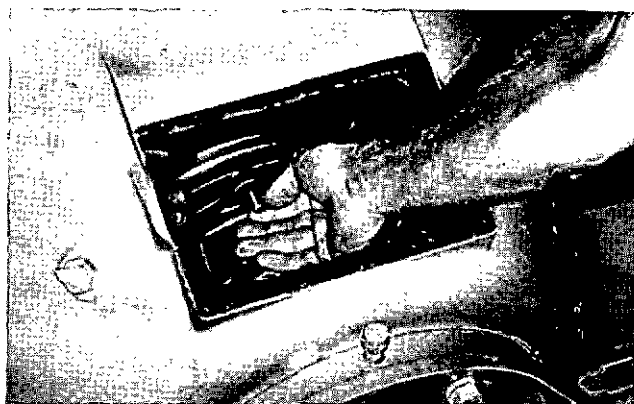
### ADJUSTING CLUTCH

1. Stop the engine and remove the clutch inspection cover.



**CLUTCH INSPECTION COVER**

2. Turn the clutch until the lock pin, engaged in the locking ring, is visible.
3. Disengage the lock pin and rotate the locking ring clockwise until the lock pin engages the next notch.



**PULLING LOCKING PIN**

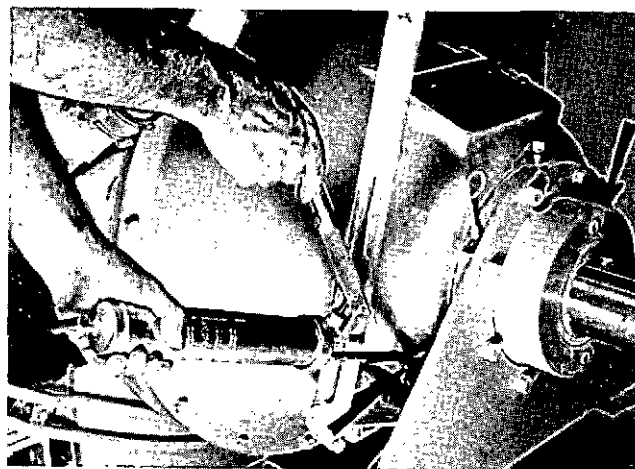
4. Test the clutch adjustment. If still too "soft", rotate the ring to the next notch. If the adjustment is too tight—turn the ring back one notch.
5. Install the cover.

### LUBRICATING FLYWHEEL CLUTCHES AND FRONT POWER TAKE-OFF CLUTCHES

(All except D343 oil lubricated clutch)

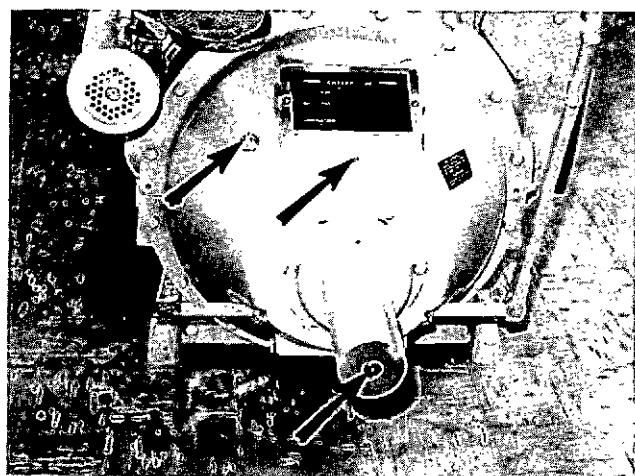
Lubricate the clutch bearings with grease, 1 or 2 strokes each fitting.

1. Lubricate the shift lever bearings; 1 fitting on each side of the clutch housing.



**LUBRICATING SHIFT LEVER BEARINGS**

2. Lubricate shift-collar and shaft; 1 fitting at top-left of center.



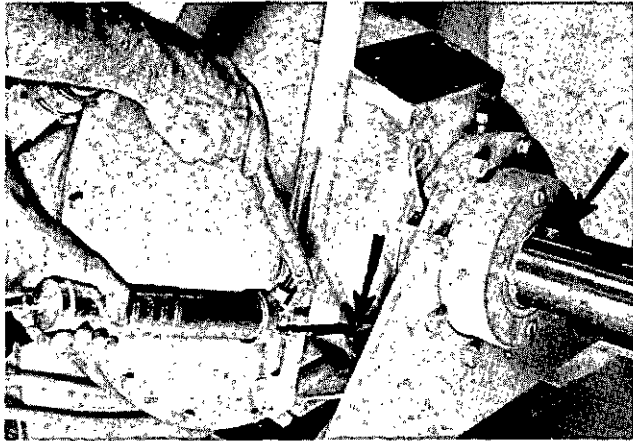
**SHIFT COLLAR, SHAFT AND PILOT BEARINGS**

3. Lubricate the shaft bearing; 1 fitting on top-rear of housing.
4. Lubricate pilot bearing; 1 fitting at the end of shaft. If this fitting is not accessible, remove the plug located on the circumference of the shaft near the rear of the housing, and install a fitting.

## LUBRICATING D343 ENGINE FLYWHEEL CLUTCH

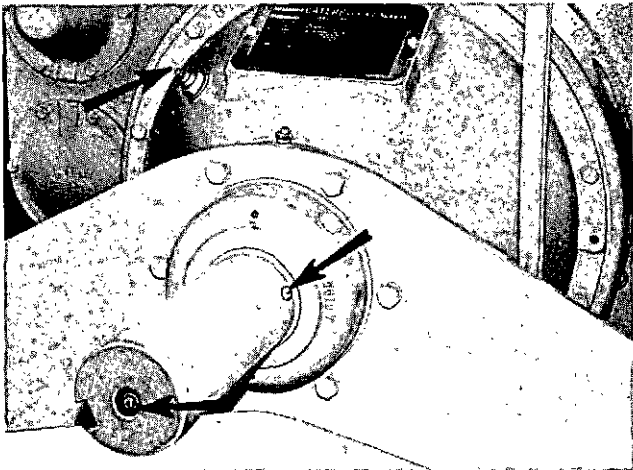
The D343 flywheel clutch main shaft bearing is oil lubricated. The remaining bearings are lubricated with grease.

1. Lubricate the shift lever bearings; 1 fitting on each side of clutch housing.



SHIFT LEVER BEARING

2. Lubricate the pilot bearing; 1 fitting at the end of shaft. If this fitting is not accessible, remove the plug located on the circumference of the shaft near the rear of the housing, and install a fitting.



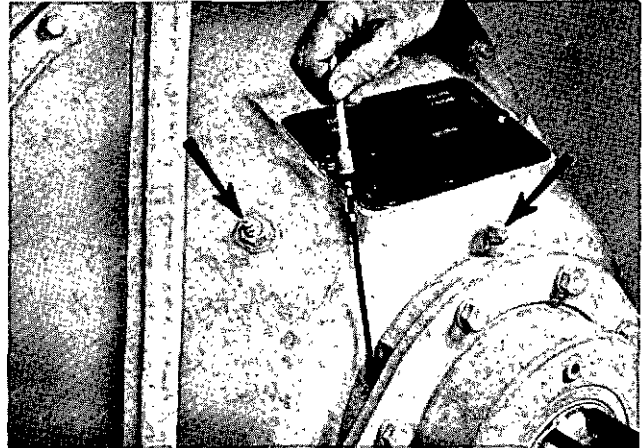
PILOT AND SHIFT COLLAR BEARINGS

3. Lubricate the shift-collar bearing; 1 fitting at top-left of center.

There are two types of Generators: SR4 and SRCR. To determine which generator you have, see the serial number stamped on the generator nameplate. The first group of numbers will be followed by either a "B", or a "T"; "B" designates a SR4 Generator, "T" designates a SRCR Generator. For a complete explanation of the serial number, see the ELECTRIC SET OPERATION INSTRUCTIONS.

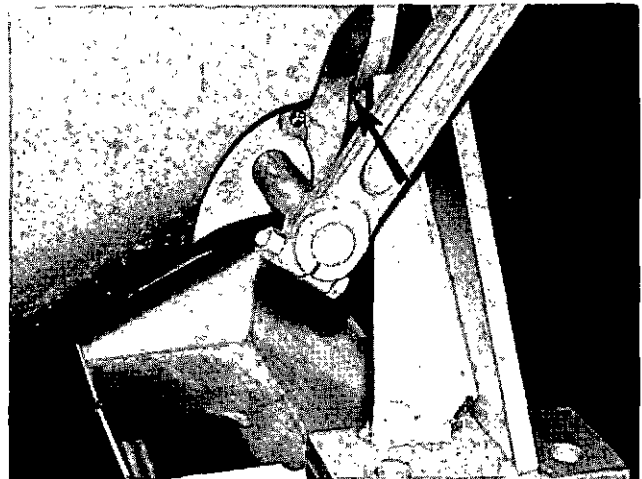
The SR4 Generator is a brushless type generator. The SRCR Generator uses slip rings and brushes. Periodically

4. Check the main shaft bearing oil reservoir level with engine stopped. Maintain the oil level at the FULL mark on the oil level gauge. Add oil through the filler tube on top of the bearing cage housing. Refer to Lubrication and Maintenance Chart for proper oil.



CHECKING OIL LEVEL

5. To drain the reservoir: Remove the drain plug located on the lower left side of the shaft bearing reservoir. Drain and install the drain plug. Fill to the FULL mark on the oil level gauge. Install the filler cap.



CLUTCH SHAFT BEARING DRAIN PLUG

## ELECTRIC SET GENERATOR

inspect the brushes and/or slip rings for wear and appearance.

If the electric set generator is not of Caterpillar design, see the manufacturer's instructions for the required lubrication and maintenance procedures.

### INSPECTING SLIP RING

1. Remove the two lower panels from the rear of the generator housing.
2. Inspect the slip ring color. The slip ring color may be

shiny copper to straw, or chocolate to black, but the color must be uniform to indicate satisfactory operation.

If the ring is basically one of the above shades, but contains blotches of green, blue or black, clean the ring with an electrical cleaning solvent.

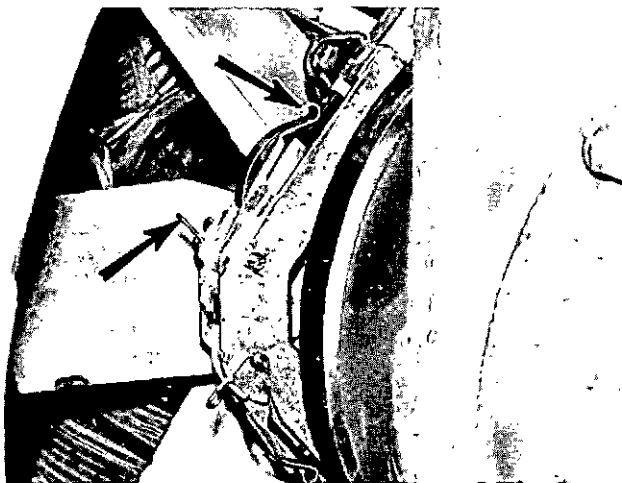
**CAUTION**

**Do not use gasoline or carbon tetrachloride. Both solvents will dissolve insulation. The vapors from carbon tetrachloride can be harmful when inhaled.**

3. Inspect the slip ring for pitting. If the slip rings are rough, pitted, or worn eccentric, contact your Caterpillar dealer. The rings must be reconditioned.
4. Check the following to determine the cause for pitting:
  - a. Check the generator nameplate rating. The generator load must be within this rating.
  - b. Check brush tension (SRCR Generators only).

**INSPECTING BRUSHES (SRCR Generators only)**

The brush must move freely within the holder, but with enough spring tension to prevent brush flotation during operation.



**INSPECT BRUSH SPRING TENSION**

BRUSH CONTACT AREA		SPRING TENSION	
in.	mm	ounces	grams
5/8 x 5/16	(16 x 8)	14	400
7/8 x 5/16	(22 x 8)	20	550
1 1/8 x 1/2	(29 x 13)	40	1100

New brush length measures 1 1/8 inch (29 mm). Replace the brushes when brush length measures 9/16 (15 mm).

If brush tension is weak, push the spring forward into the next notch. If the spring is in the front notch, remove the brush and check the brush length. If the brush length is less than the minimum required, install a new brush.

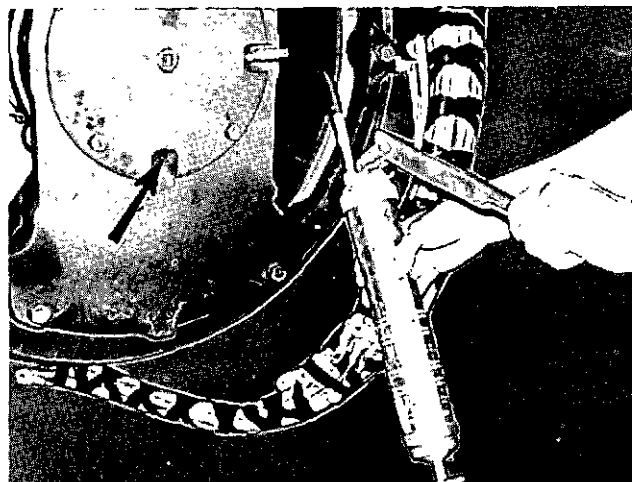
If the spring is moved forward and the brush tension is greater than chart specifications, release the spring one notch. Excessive spring tension will cause excessive brush wear.

**INSTALLING NEW BRUSHES**

1. Release spring tension.
2. Disconnect the lead wire from the brush and pull the brush from the brush holder.
3. Insert a new brush. Be sure it moves freely in the brush holder. Connect the lead wire.
4. Place a narrow piece of "00" sandpaper between the brush and slip ring with the abrasive surface against the brush. (Never use emery cloth as the emery contains small metallic particles which will damage the copper.)
5. Engage the spring in the middle notch.
6. Slowly pull the sandpaper from beneath the brush.
7. Remove all dust with a suction hose. If suction is not available, use a very low pressure blower. Do not use metal hose tips.
8. Check brush tension.
9. Install the two panels.

**LUBRICATING THE REAR BEARING (All Generators)**

1. Remove the two lower panels from the rear of the generator housing.
2. Remove the upper and lower grease fitting plugs.
3. Install the grease fitting in the upper threaded hole.
4. Lubricate with grease until clean lubricant appears at the lower threaded hole.



**LUBRICATING BEARING**

5. Wipe off the excess grease. Install the lower plug.

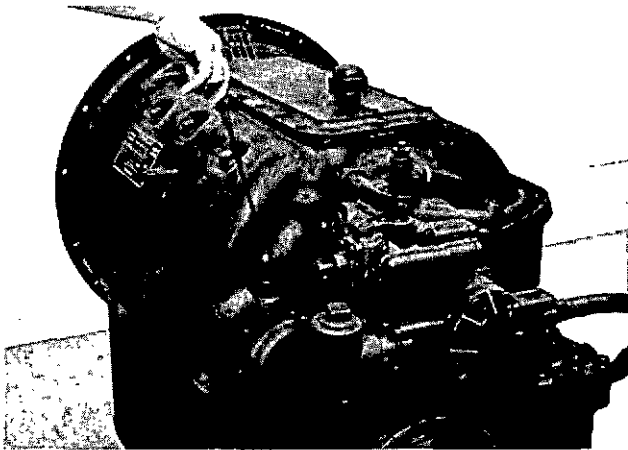
6. Remove the fitting from the upper threaded hole.
7. Start the engine and allow the grease to expand from the upper hole.

8. Stop the engine. Install the plug in the upper hole and wipe off excess grease.
9. Install the two panels.

## MARINE GEAR

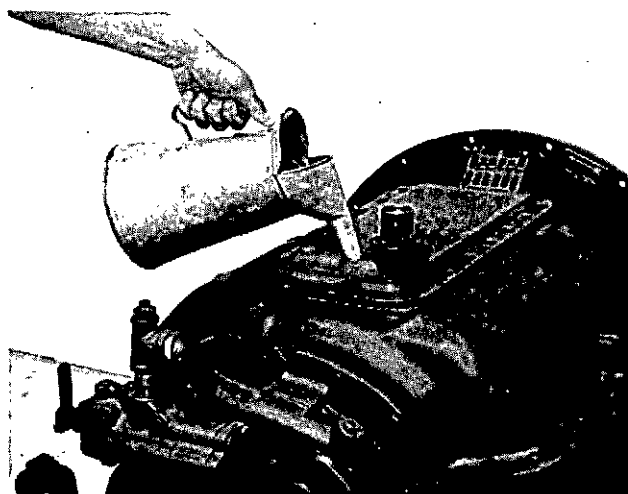
### CHECKING OIL LEVEL

1. Check the oil level with the engine warm, idling, and the clutch engaged.



### CHECKING OIL LEVEL

2. Maintain oil level at the FULL mark on the oil level gauge. Add oil through the breather tube on top of the marine gear housing. Refer to Lubrication and Maintenance Chart for proper oil to use.

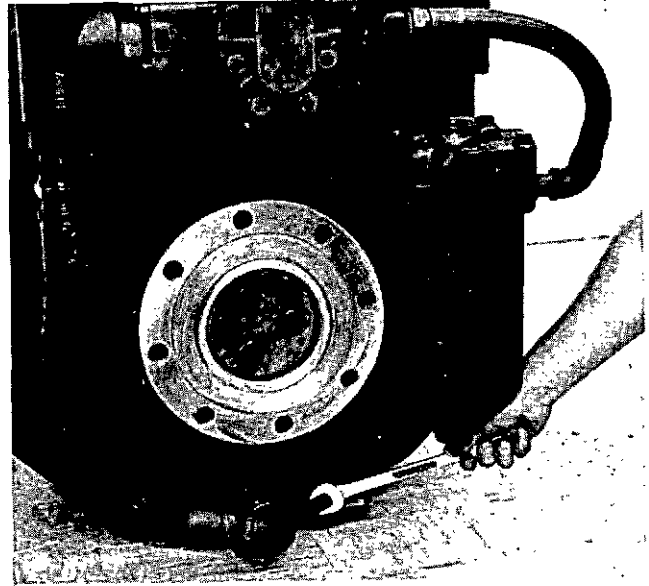


ADDING OIL

### MG521 Marine Gear only:

#### DRAINING LUBRICATING OIL

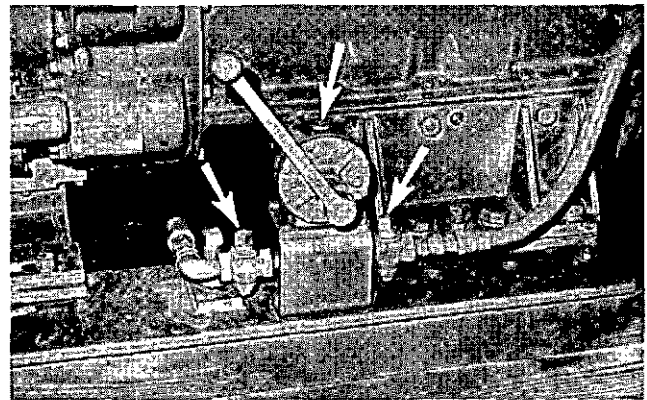
1. Remove the marine gear drain plug.



### REMOVING DRAIN PLUG

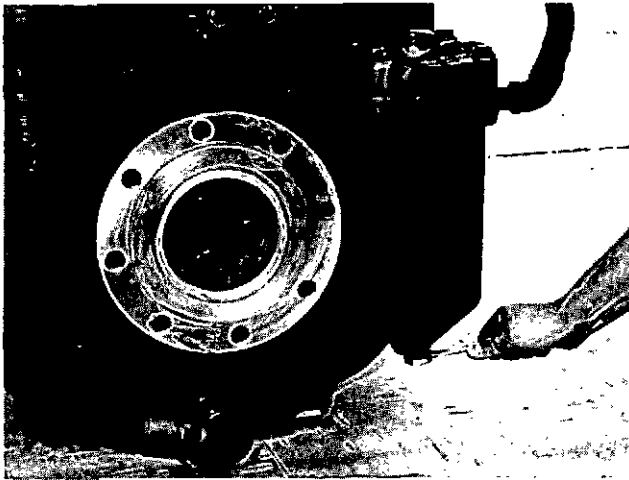
If a sump pump is used:

- a. Connect a drain line to the top outlet of the sump pump.



### SUMP PUMP VALVES AND PUMP OUTLET

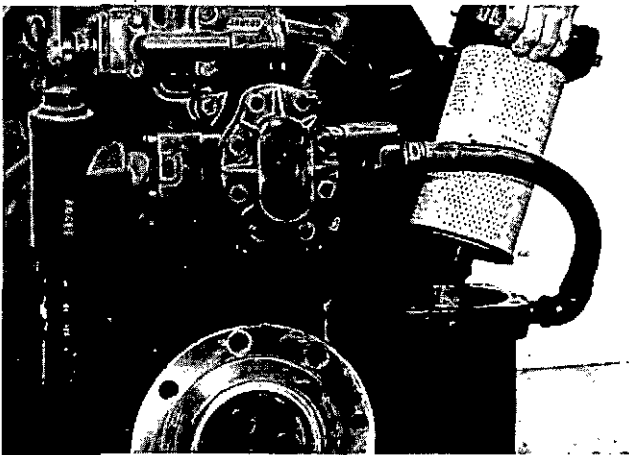
- b. Be sure the valve on the engine oil pan line is closed. Marks on the valve must be turned at right angles to the direction of the oil line.
  - c. Open the valve on the marine gear oil line.
  - d. Operate the sump pump handle until the oil is drained.
2. Remove the marine gear oil filter housing drain plug.



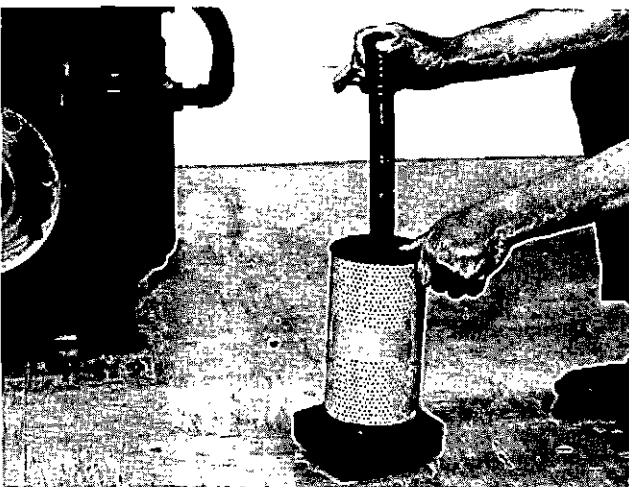
**OIL DRAIN**

**INSTALLING MARINE GEAR OIL FILTER ELEMENT**

1. Drain the lubricating oil.
2. Remove the cover, spring, bypass valve and filter element.



**REMOVING COVER AND FILTER ELEMENT**



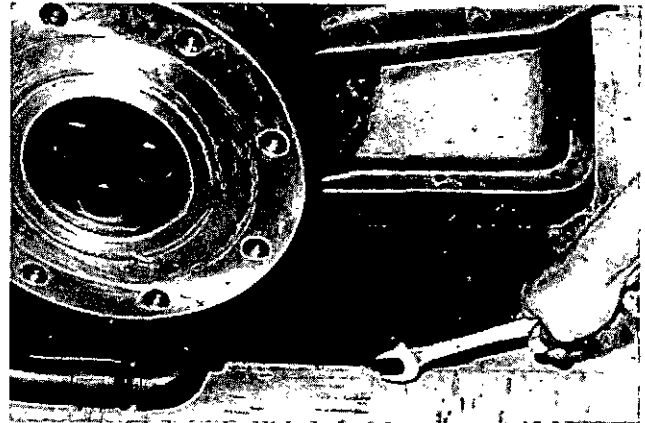
**REMOVING BOLT**

3. Wash the inside of the housing and the cover.
4. Install the housing drain plug.
5. Inspect and install the cover gasket; install a new gasket if necessary.
6. Place the spring and retainer plate on the bolt. Insert the bolt thru the filter and into the cover. Tighten the bolt securely.

**MG512 and MG514 Marine Gears:**

**DRAINING LUBRICATING OIL**

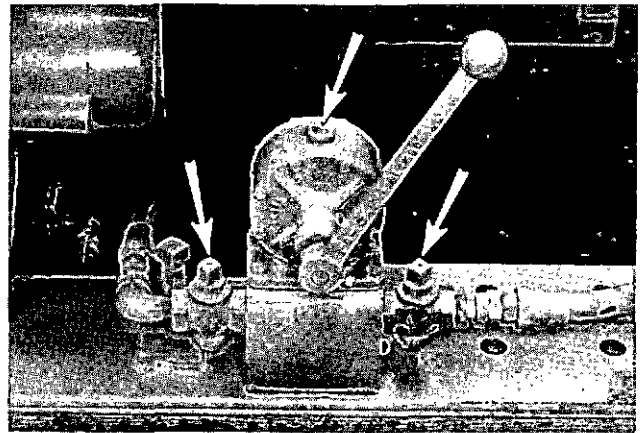
1. Remove the marine gear drain plug.



**REMOVING DRAIN PLUG**

If a sump pump is used:

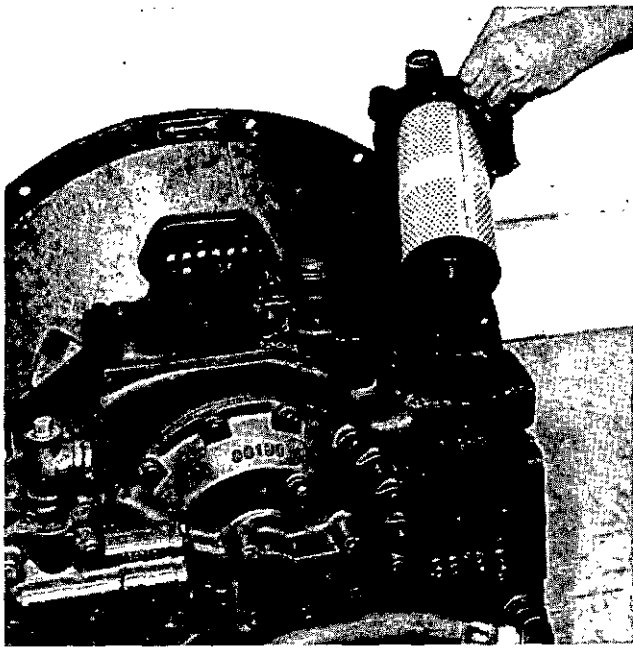
- a. Connect a drain line to the top outlet of the sump pump.



**SUMP PUMP VALVES AND PUMP OUTLET**

- b. Be sure the valve on the engine oil pan line is closed. Marks on the valve must be turned at right angles to the direction of the oil line.
- c. Open the valve on the marine gear oil line.
- d. Operate the sump pump handle until the oil is drained.

2. Remove the oil filter cover and filter element.



#### REMOVING COVER AND FILTER ELEMENT

3. Reach down thru the oil and locate the filter housing drain plug. Remove the plug. The oil will drain into the marine gear sump.
4. Wash the cover and inside the filter housing.
5. Install the drain plug in the bottom of the filter housing.
6. Inspect and install the cover gasket. Install a new gasket if necessary.
7. Place the spring and retainer plate on the bolt. Insert the bolt thru the filter into the cover. Tighten the bolt securely.
8. Install the marine gear drain plug.

#### CLEANING MARINE GEAR OIL STRAINER

1. Remove the strainer plug and strainer.



REMOVING PLUG AND STRAINER

2. Wash the strainer in clean diesel fuel or solvent.
3. *Inspect the strainer. Install the strainer; or replace it if necessary.*
4. Install the plug.

#### All Marine Gears:

##### FILLING THE MARINE GEAR LUBE SYSTEM

1. Install the marine gear drain plug, or close the sump pump valve on the oil line to the marine gear.

##### CAUTION

Be sure both valves (one to the marine gear and one to the engine oil pan) are closed. Otherwise a transfer of oil during operation may occur and damage could result.

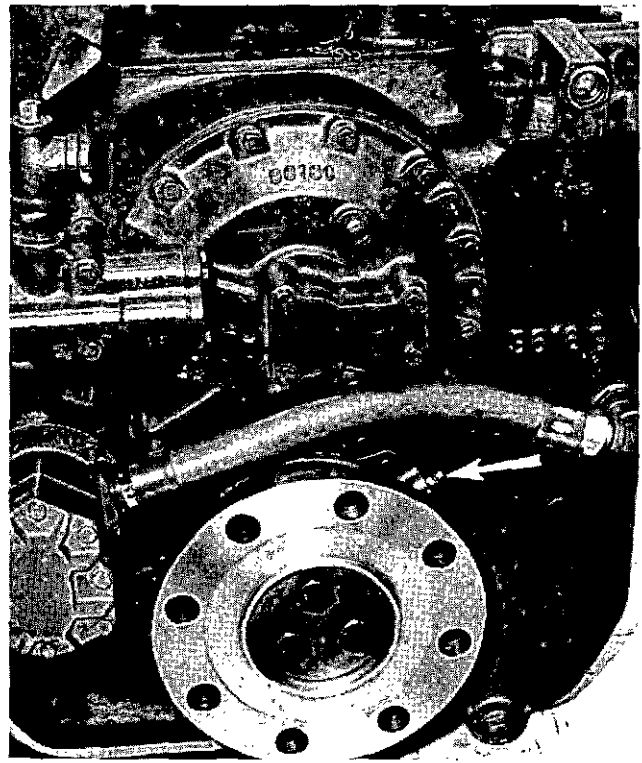
2. Fill the marine gear to the FULL mark on the oil level gauge. Refer to Lubrication and Maintenance Chart for proper oil.

#### CLEANING THE BREATHER

1. Remove the breather.
2. Wash the breather in clean diesel fuel or solvent.
3. Install the breather.

#### OUTPUT SHAFT SEAL

Lubricate the output shaft seal, 1 fitting at top rear of marine gear. Slowly rotate the output shaft while lubricating the seal.



LUBRICATING OUTPUT SHAFT SEAL

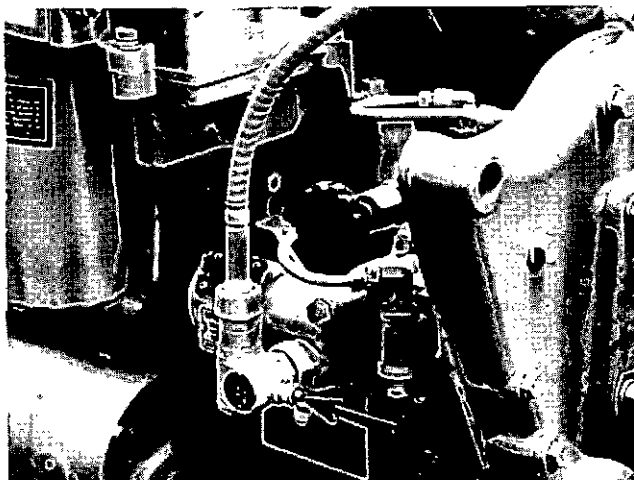
## MISCELLANEOUS MAINTENANCE

### LUBRICATING TACHOMETER DRIVE

Lubricate the tachometer drive bearing with grease; 1 or 2 strokes, 1 fitting.

### SAFETY SHUT-OFF CONTROLS

The shut-off controls must be checked to insure proper functioning if and when needed. To prevent damage to your engine while making the required tests, only authorized personnel should perform the checks. Contact your Caterpillar dealer.



TACHOMETER LUBRICATION FITTING

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