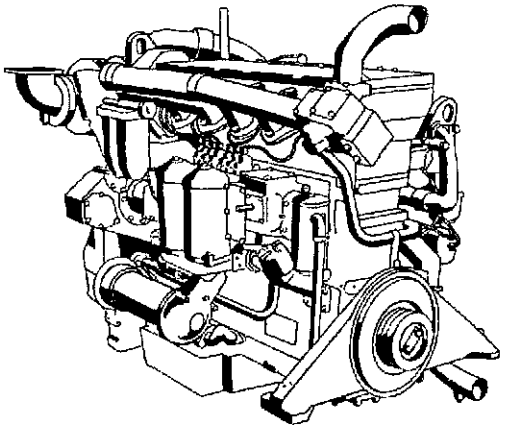
FORM FE033743-05

OPERATION AND MAINTENANCE INSTRUCTIONS

CATERPILLAR
D343 ENGINE



SERIAL NUMBERS

62B1-UP

Foreword

Caterpillar products are a result of advanced engineering, skilled manufacturing, and the finest materials metallurgical science can select. Thousands of satisfying, economical working hours are built into each machine.

Whether or not the owner derives the maximum service from his machine depends largely on the care exercised in its operation and maintenance. This book is written to give the operator essential information regarding the day-to-day operation, lubrication and adjustment of the machine. Careful adherence to these instructions will result in assured economy.

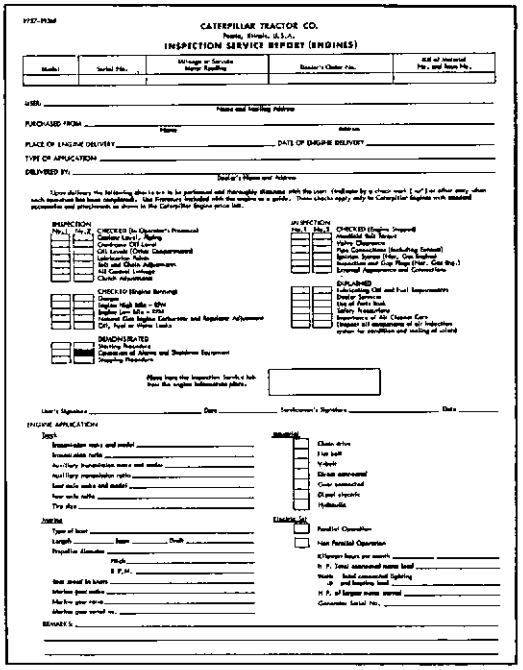
More and more Caterpillar owners are depending upon their dealer for service other than the care and adjustments described in this book. This practice is recommended because Caterpillar dealers have stocks of genuine Caterpillar parts and are equipped with tools designed and built by Caterpillar. Their servicemen are factory-trained and are kept closely informed by the factory regarding advanced methods of servicing Caterpillar products — thus, in all ways they are equipped to render the best of service.

T20841

Inspection Service for Engines

Caterpillar Engines, installed in Original Equipment Manufacturers' (OEM) machines, are entitled to two free inspections. The inspections are made by the nearest Caterpillar dealer, only at request of the OEM or the user.

Inspections consist of thorough operational and procedural checks for which this Operation and Maintenance Instruction book is the guide. The Inspection Service Report, reprinted here, indicates the details covered in each inspection.



CATERPILLAR TRACTOR CO.

INSPECTION SERVICE REPORT (ENGINES)

INSPECTION SERVICE REPORT

The **first** inspection normally should be requested so it can be performed when the machine is ready to be started by the initial user. However, it may be requested by the OEM or his dealer at anytime during construction, testing or running of the equipment.

The **second** inspection should be made after the first thirty (30) days of operation but not later than six (6) months after initial use.

Both inspections are provided free. Any unusual costs, such as travel to an operating location extremely remote from the store of the dealer performing the inspection, however, are subject to charge. These unusual costs, as determined by the Caterpillar Dealer, shall be paid by the party requesting the service.

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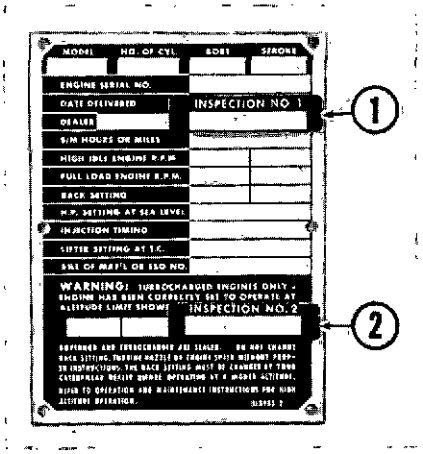
Inspections service tabs **(1)** and **(2)** are attached to the Engine Warning and Information plate of each engine. The serviceman performing the inspection will remove a tab after each inspection. In addition, the serviceman will complete a report of his inspection which is to be signed by the OEM machine owner or his representative. The Inspection Service Report is then sent to Caterpillar to become a part of the engine history record.

ENGINE WARNING AND INFORMATION PLATE

This plate is mounted on the engine. A similar plate should be mounted so as to be in the full view of the operator.

1–Inspection No. 1 tab.
2–Inspection No. 2 tab.



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Avoid Accidents

Most accidents, whether they occur in the air, in industry, on the farm, at home, on the highways, or at sea, are caused by someone's failure to follow simple and fundamental safety rules or precautions. For this reason most accidents can be prevented by recognizing the real cause and doing something about it before the accident occurs.

Regardless of the care used in the design and construction of any type of equipment, there are many conditions that cannot be completely safeguarded against without interfering with reasonable accessibility and efficient operation.

A careful operator is the best insurance against an accident.

The complete observance of one simple rule would prevent many thousands of serious injuries each year. That rule is: "Never attempt to clean, oil or adjust a machine while it is in motion."

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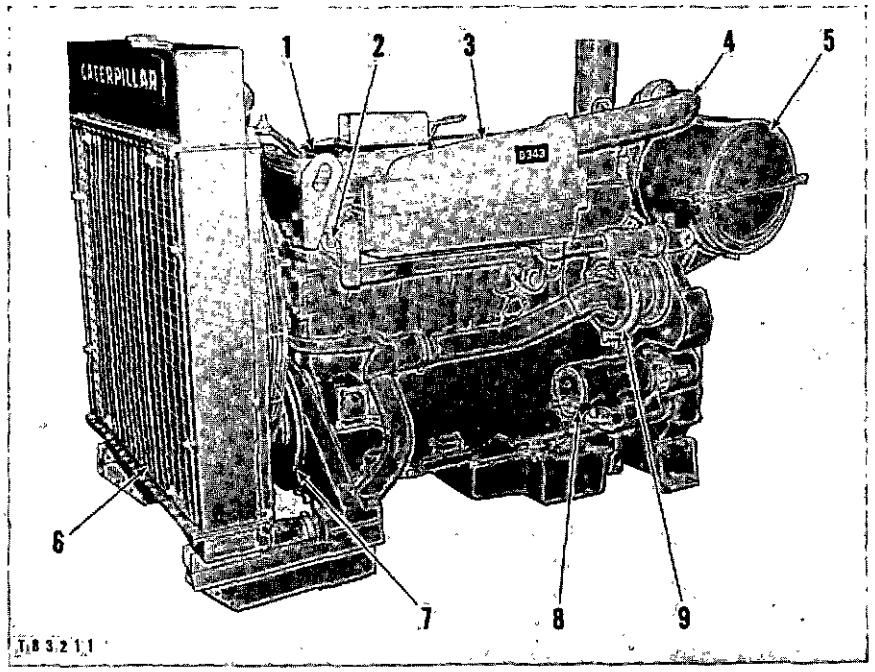
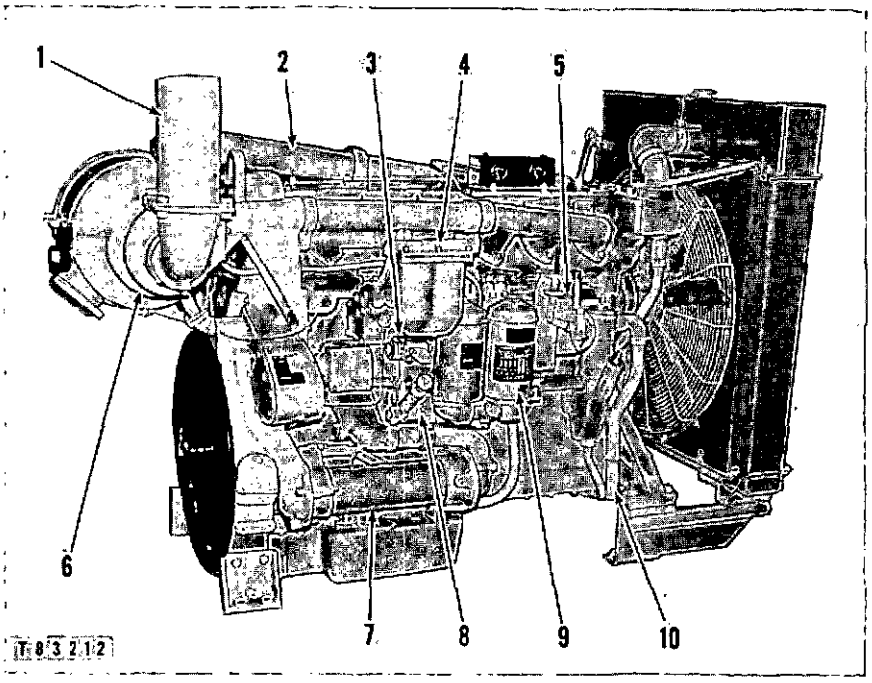


D343 ENGINE—LEFT FRONT VIEW

1–*Camshaft cover.* 2–*Cylinder head.* 3–Aftercooler. 4–Air inlet from turbocharger. 5–Dry type air cleaner. 6–Radiator. 7–Vibration damper. 8–Electric starting motor. 9–Cooling system pump.



D343 ENGINE — RIGHT REAR VIEW

1–Diesel engine exhaust. 2–Exhaust manifold. 3–Service meter. 4–Diesel fuel filter. 5–Governor housing. 6–Turbocharger. 7–Oil cooler. 8–Diesel fuel transfer pump. 9–Crankcase lubricating oil filter. 10–Crankcase breather fumes disposal tube.

Installation Instructions

There are a number of factors that warrant careful consideration when installing an engine. Careful thought and planning on installation details can pay dividends in increased engine life and successful operation Attention should be given to installation details that will make operation and maintenance easy, such as ample clearance around walls and surrounding machinery, accessibility for adjustment and maintenance, and proper provision for draining crankcase oil. The following comments will touch briefly on some of the more important factors, but for more specific recommendations, it is suggested that your Caterpillar dealer be consulted.

COOLING

Probably the most important consideration is that of making sure the engine will cool properly. Various types of cooling may be used successfully, the choice being governed by the type of engine application and local conditions. Cooling, however, is a complete subject within itself and is not covered in this book. Contact your Caterpillar dealer to obtain complete installation details. Following are certain fundamentals which can be mentioned.

In the initial planning of the installation, it is assumed that the most satisfactory cooling system was selected. If it is to be a permanent installation, a heat exchanger or cooling tower was probably chosen. Normally, a permanent installation in a building would be cooled by means other than a radiator. If it is a portable unit, a radiator system may be used.

On heat exchanger and cooling tower installations, it is important to be sure that there is a sufficient flow of raw water at low enough temperatures to properly cool the engine. The piping should be carefully checked to be sure there are no air pockets that will restrict the flow of water and, if necessary, vents should be installed. It should be kept in mind, however, that very few vents will be needed if the piping is properly installed. Where necessary, flexible connections should be used to keep engine vibrations from being transmitted to the cooling water piping.

On radiator-cooled installations, the engine should always be placed so that the flow of air through the radiator is in the same direction as the prevailing wind. Strong cross winds materially reduce the cooling capacity by cutting down the amount of air the fan can force through the radiator. On installations where the engine powers a machine that stirs up quantities of dust, such as rock crushers, it is advisable to locate the engine so that air passing through the radiator will be as free of dust as possible. Any accumulation of dust, dirt or lime on the radiator reduces cooling capacity.

Two or more radiator-cooled engines operated together should be so arranged that the discharged hot air from one engine does not pass through the radiator of the other. Each engine should be able to pass unheated air through its radiator.

CAUTION

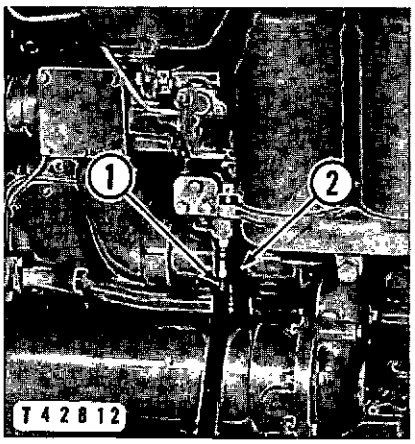
Various packaging materials must be removed before operating the engine. Inspect the engine for other shipping straps, brackets, bolts, skids and coverings to be sure they have all been removed before operation of the engine.

EXHAUST LINES

Flexible connections should be used to prevent transmission of engine vibrations to exhaust piping. Flexible metal tubing is generally recommended for the exhaust connections at the engine. The weight of the exhaust lines must be supported so that no weight is imposed on the turbocharger. The exhaust outlet should be protected from the weather so that rain and snow cannot enter the line and get into the engine. The exhaust lines should be as short as possible. Long exhaust lines or lines with several bends should be of increased diameter so as not to create excessive back pressure. The back pressure should never exceed 15 inches (38.1 cm.) of water on a new installation when measured with a manometer at the exhaust connection of the engine. Exhaust from the starting engine should be carried in a separate line and not connected into the diesel exhaust line.

FUEL LINES

On power units, where the fuel tank is not installed at the factory, remove the corks from the fuel transfer pump and the fuel filter housing. Connect a fuel supply line from the fuel transfer pump to the fuel tank, and a fuel return line from the fuel filter housing to the fuel tank. The fuel transfer pump will lift fuel the height of 12 feet (3.7 meters) through



FLEXIBLE FUEL LINES

1–Flexible fuel supply line. 2–Flexible fuel return line.

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no more than 50 feet (15.24 meters) of pipe. It is essential that there be no air leaks in the suction system. Even a small leak will destroy the suction lift of the transfer pump. To prevent leaks caused by engine vibrations, flexible fuel lines **(1)** and **(2)** are recommended for use between the engine and the diesel fuel tank lines. The flexible lines are available from your Caterpillar Dealer.

CAUTION

Do not connect line **(2)** to the fuel inlet line **(1)** to the fuel transfer pump as this may cause the system to become air bound. If a pipe plug is installed in place of the return line or if the return tube is too small, fuel pressure can burst the filter housing.

BASE

A chart is available that gives the necessary dimensions for making an engine installation. A concrete base may be constructed which will be satisfactory for all average conditions. Where the soil is sandy or extremely wet, the concrete base should be proportionately increased in size both in length and width, to secure a firm and solid foundation. Reinforcing bars should be used to strengthen the walls especially at the corners.

Provisions should be made for draining the crankcase, either by providing a small pit for a container near the drain plug, or by extending the pipe and installing a shut-off valve close to the engine.

CORRECT AIR CLEANING IS NECESSARY

Caterpillar air cleaners are designed to remove all harmful elements from the air entering the engine. Dusty atmospheric conditions will cause frequent servicing and short element life. Precleaners are available to provide reasonable service periods and element life. Air inlet extension can be utilized to provide cleaner and cooler air to the air cleaner. Your Caterpillar dealer has additional information.

CRANKCASE BREATHER FUMES DISPOSAL

The crankcase breather fumes disposal tube should be directed or extended to a location that will prevent an oily film from being deposited in the engine room. If oily fumes were allowed to be drawn into the engine dry type air cleaner, frequent air cleaner filter element servicing will result. A 1 inch (2.54 cm.) tube not to exceed 25 feet (7.6 meters) in length connected to the crankcase breather fumes disposal tube and piped to the atmosphere is recommended. Greater lengths will cause excessive crankcase back pressure. Also in order to keep crankcase pressure low, the number of bends should be kept to a minimum. Loops and low spots in the tube should be avoided or improper crankcase breathing will result from trapped condensate in the loops and low spots.

ELECTRICAL EQUIPMENT

Generator Regulator: When the engine is equipped with a 24 volt charging system it is advisable to mount the generator regulator at some location other than on the engine. This will reduce to a minimum, any damage or irregular operation of the generator regulator which might be caused by vibration or oil and water from the engine.

The transistor alternator regulator is an assembly of transistors, resistors, condensers and diodes; and contains no moving parts. These components could be damaged if exposed to temperatures above 140° F. in still air of 170° F. in moving air. It is advisable to mount the alternator regulator away from the engine.

Battery Installation: Storage batteries should not be placed on the floor. A rack high enough to place them in a comfortable position for maintenance should be built of wood or metal and heavily painted with an acid-resistant paint. The batteries should be located where heat from the engine or other source will not reach them and cause their temperature to become excessive. Storage battery ratings are based on a battery temperature of 77° F. If the area where the batteries are installed can be kept near or below this temperature, it will help in obtaining good engine cranking and good service life. Batteries should not be stored in a discharged state.

Lubrication Instructions

SERVICE METER

The Service Meter is located on the right side of the engine below fuel filter housing. It is geared to the engine, and when the crankshaft turns as many revolutions as are made in an hour at average operating speed on an average job application, the dial advances one number. There are some applications that will result in either a lower or higher than normal average engine speed. Under this condition, the advance in *the Service Meter reading will differ from the number of clock hours of* operation.

SERVICE METER

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The purpose of the Service Meter is to indicate when to perform the recommended maintenance and lubrication operations. The established intervals in the lubrication chart and maintenance instructions are given in service hours, so daily readings will tell when to service the engine. Rely on the Service Meter and not on the clock to measure service intervals.

GENERAL LUBRICATING INFORMATION

Naturally, any precautions taken during cold weather to house the engine, cover it with a tarpaulin, or warm it before starting, will cause more rapid oil distribution.

Lubricate all miscellaneous points not equipped with fittings, with crankcase lubricating oil every 50 service hours.

It is extremely important in handling the oil to keep it clean. Every precaution should be taken to use only clean filler cans and to be sure that all dirt is removed from the filler cap before it is taken off for filling. The operator should take every precaution to prevent dirt from getting into any system to extend the life of the engine.

Careful attention to the following information on lubricants and their proper selection will add much to performance, economy and long life of your engine. The lubrication chart specifies the lubricants to be used, the points to be serviced and the intervals of servicing according to service hours.

DESCRIPTION OF LUBRICANTS

The lubricants recommended for use in this engine can be identified by the sub-headings preceding their descriptions that follow. The proper selection of one of these types of crankcase lubricating oils, and SAE grade of oils can be made from the information in the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

Crankcase Lubricating Oils

Superior Lubricants (Series 3): *These are additive-type oils that have* been identified as meeting a rigid, high quality standard and certified for use in all Caterpillar Diesel Engines. See your Caterpillar dealer for brand names of products conforming to this specification.

MIL-L-2104A Specification Oils: These oils are additive-type but are milder than Superior Lubricants (Series 3) Oils. They can be used as specified for various compartments satisfactorily. Your oil supplier is familiar with those oils meeting the MIL-L-2104A Specification.

Lubricating Grease

Ball and Roller Bearing Lubricant: This lubricant is a mixture of mineral oil and metallic soaps. Use No. 2 grade for most temperatures. For extremely low temperatures use No. 0 or No. 1 grade.

This grease can be applied to all bearing points — plain bearings, ball bearings and roller bearings — where equipped with hydraulic pressure fittings or when bearings are hand packed.

Use only a high grade short fiber grease. This grease must be satisfactory in anti-friction bearings at speeds up to 3000 RPM at a maximum temperature of 300° F. It is a grease with sufficient adhesive qualities to cling to the bearings in all extremes of high and low operating temperatures.

Type of Lubricants and SAE Grades to Use

The grade of oil is classified in terms of viscosity (fluidity or flow ability) and is identified with numbers called SAE numbers.

Oil assigned lower SAE numbers are more fluid and flow more readily than do those oils with higher numbers within the same series.

To determine if the oil in the compartments will flow in cold weather, remove the oil level gauge or dip a finger into the oil before starting and if the oil will flow off, the oil is fluid enough to circulate properly.

The oil that has been diluted for cold weather starting should be drained and replaced with undiluted oil at the end of the cold season when dilution is no longer required.

OIL SPECIFICATION CHART

Compartment	SAE GRADE OF OIL TO USE AT STARTING ATMOSPHERIC TEMPERATURE			
	Above +32°F.	+32°F. to +10°F.	+10°F. to −10°F.	−10°F. and Lower
Diesel Engine Crankcase	Superior Lubricants (Series 3)			
	*SAE 30	*SAE 10W	SAE 10W	**Dilute SAE 10W
†Starting Engine Crankcase	Superior Lubricants (Series 3) or MIL-L-2104A Oils			
	SAE 10W	SAE 10W	SAE 10W	**Dilute SAE 10W

*In seasons or locations where starting atmospheric temperatures are below 32°F., SAE 10W oil should be used to insure free circulation, even though daytime atmospheric temperatures may rise as high as 70°F.

**In lower temperatures it may be necessary to dilute oil with kerosene so it will be fluid enough to insure free circulation. This should be done before stopping, then operate the engine for a few minutes to mix the kerosene and oil. Evaporation in the engine crankcase under steady operation may make it necessary to again add kerosene to maintain proper fluidity.

†Disregard the starting engine SAE grade of oil recommendations if the starting engine lubricating oil system is interconnected with the diesel engine lubricating oil system.

The oil specification chart will aid in the proper oil grade selection for the various compartments. The proper SAE grade of oil to select is determined by the atmospheric temperature at which the machine **is started.** However, during **operation** SAE 10W oil can be used successfully in the diesel engine crankcase when atmospheric temperatures are as high as 70° F.

Diesel Engine Crankcase Lubricating Oil Change Periods

The crankcase lubricating oil change periods for these engines have been carefully established for the purpose of protecting the service life of the engine as economically as possible.

Change the oil and filter elements after the first 10 service hours of operation of a reconditioned engine.

DIESEL ENGINE CRANKCASE LUBRICATING OIL CHANGE PERIOD CHART
Use Only Superior Lubricants (Series 3)

FUEL SULPHUR CONTENT	OIL CHANGE PERIOD*	FILTER ELEMENT CHANGE PERIOD*
0.4% or less	125 Service Hrs.	125 Service Hrs.
0.4% to 1.0%	50 Service Hrs.**	50 Service Hrs.

*Regardless of time operated, the crankcase oil and filter elements should be changed at least every six months.

**Reduce crankcase oil change periods one half when sulphur content is greater than 1.0%.

T81545

LUBRICATION CHART
CATERPILLAR
DIESEL D343 ENGINE

The folded page is arranged for two purposes:

First, it is a complete outline of all the information required to lubricate the engine.

Second, the illustration and identification of points of lubrication can be used with the detailed illustrations and information on the pages following the chart as a reference for lubrication and service information.

Topic and Identification	Lubricant	Quantity (U.S. Measure)	No. Service Points	SERVICE HOURS 10	50	125	250	100
1 DIESEL ENGINE CRANKCASE	CO	46 QUARTS	1	X		†C		
OIL FILTER ELEMENTS			2			†C		
BREATHER			1			†W		
Attachments								
A CHARGING GENERATOR	BR		2					
B ELECTRIC STARTING MOTORS	CO		3					
ELECTRIC AND AIR STARTING MOTOR DRIVE END BEARINGS	CO		1					
C AIR STARTING MOTOR OILER	CO	KEEP FILLED	1	X				
MOTOR DRIVE END BEARING	CO		1	SEE TOPIC B				
GEAR DRIVE AND PLAIN END	BR		2					
D STARTING ENGINE CRANKCASE	CO	2.5 QTS.	1	X			††C	
BREATHER			1				††W	
E FAN PULLEY BEARING	BR		1				L	
F CHARGING ALTERNATOR	*		2					
G TACHOMETER DRIVE	BR		1					L*
H ENCLOSED CLUTCH SHIFT COLLAR SHAFT	CO		2		L			
SHIFT COLLAR SHAFT	BR		2			L		
SHAFT BEARING	CO		3			C		
SHIFT COLLAR	BR		1	L**				
PILOT BEARINGS	BR		1			L**		

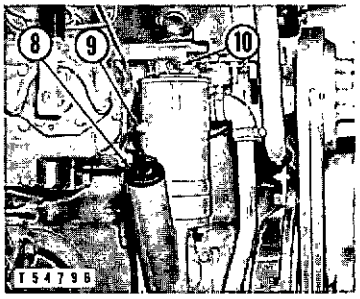
Key to Lubricants:

CO CRANKCASE OIL
BR BALL AND ROLLER BEARING LUBRICANT

Key to Symbols:

C — CHANGE
L — LUBRICATE
W — WA
X — CH
WH

CO Crankcase Lubricating Oil



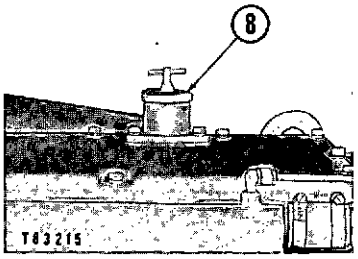
1

DIESEL ENGINE CRANKCASE LUBRICATING OIL SYSTEM

Use Superior Lubricants (Series 3) only

After draining crankcase, refill at (8). The oil filler tube may also be located on top of the valve cover plate. Start the diesel engine. Run the engine for two minutes, then add oil to bring level to "full" mark on the gauge while the engine is running. See the topic, "Type of Lubricants and SAE Grades to Use".

At each oil change period remove the plug (9) to drain condensation from the breather. Remove the wing nut (10), take off the cover and breather element, wash them in clean kerosene or diesel fuel. Reinstall the element and cover. See "Diesel Engine Crankcase Lubricating Oil Change Period Chart."

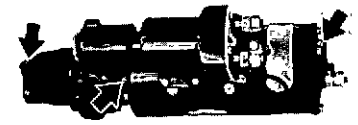


Lubrication of Attachments

B

ELECTRIC STARTING MOTORS

Electric starting motors for the starting engine and diesel engine are equipped with bearings of a type that make lubrication necessary only when the starter is disassembled for cleaning or reconditioning. Two or three drops of oil for each bearing is sufficient.

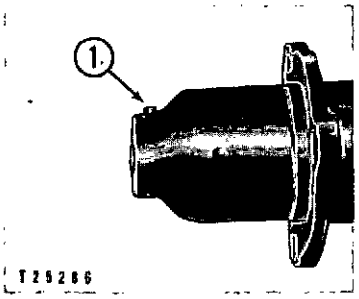


B-C

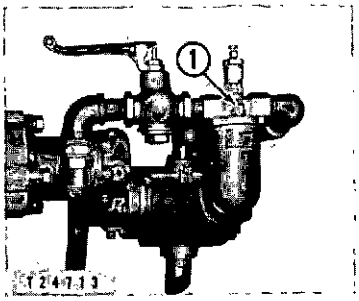
ELECTRIC AND AIR STARTING MOTOR DRIVE END BEARINGS

Both air and electric starting motors for the diesel engine have bearings in the drive end that require lubrication every 2000 service hours, or whenever the motor is removed for any reason.

To lubricate remove the starting motor and the plug (1). Saturate the wick with CRANKCASE LUBRICATING OIL. Reinstall the plug and starting motor.



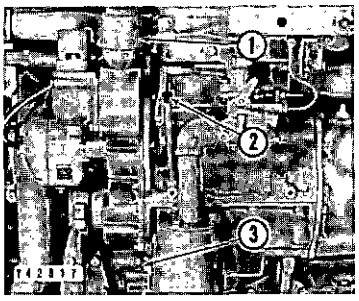
CO Crankcase Lubricating Oil



C

AIR STARTING MOTOR OILER

Every 10 service hours check oil level in oiler by removing plug (1). Keep oiler filled at all times.



D

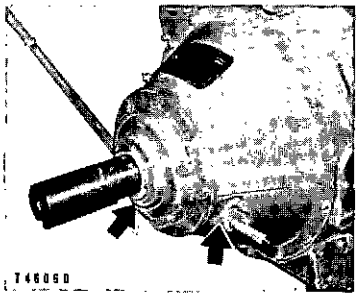
STARTING ENGINE CRANKCASE

Use Superior Lubricants (Series 3) only

Check the oil level every 10 service hours. Oil should be up to the "full" mark on the gauge (2). Every 125 to 250 service hours, depending on dust conditions, drain the crankcase at (3). When draining, the engine must be level so the oil in the starting engine clutch compartment will drain. Wash and oil the crankcase breather at each oil change period. Refill the crankcase at (1).

Fill slightly above the "full" mark on the gauge. Start and run the starting engine at least one minute to equalize the oil level in the crankcase and clutch compartment. Stop the engine and check the oil level, the oil level should be up to the "full" mark on the gauge.

If the starting engine has an oil system interconnected with the diesel engine lubricating oil system, the crankcase should be drained at each diesel engine oil change period. The starting engine crankcase, equipped with interconnected system, must be filled to the "full" mark on the gauge with the same type and SAE grade oil used in the diesel engine crankcase before starting the starting engine. See the topic, "Type of Lubricants and SAE Grades to Use."



H

ENCLOSED CLUTCH SHIFT COLLAR SHAFT

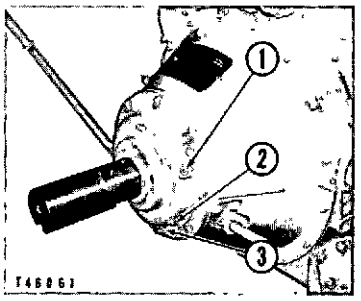
Lubricate shift collar shaft bearings every 50 service hours if equipped with oil cups. If the shaft has grease fittings, see the topic BALL AND ROLLER BEARING LUBRICANT.

CO Crankcase Lubricating Oil

H

ENCLOSED CLUTCH SHAFT BEARING

Every 125 service hours, drain oil from clutch shaft bearing carrier. Remove drain plug (3), filler plug (1) and oil level plug (2). After oil has drained, install drain plug and add enough oil to be visible at the oil level opening. Install oil level and filler plugs.

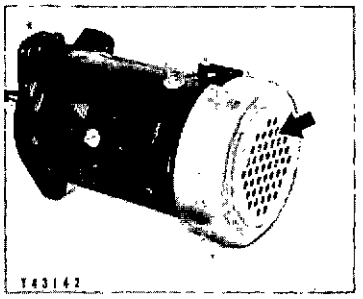


BR Ball and Roller Bearing Lubricant

A

CHARGING GENERATOR

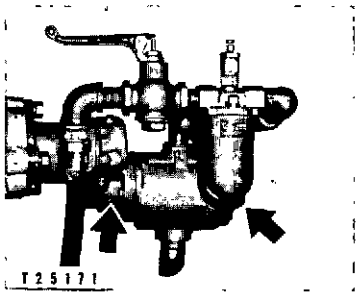
Generators have bearings packed with BALL AND ROLLER BEARING LUBRICANT making lubrication necessary only when the generator is disassembled for cleaning or servicing.



C

AIR STARTING MOTOR GEAR DRIVE AND PLAIN END

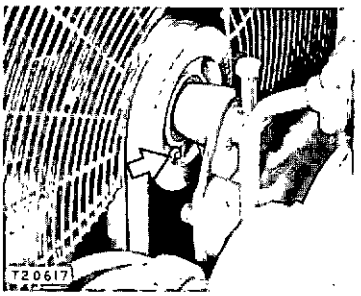
Air starting motor drive gear and plain end bearing compartments are packed at the time of assembly and require no periodic lubrication. If the motor is disassembled for any reason, No. 1 BALL AND ROLLER BEARING LUBRICANT should be used to fill the compartments.



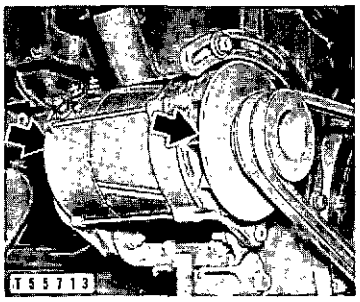
E

FAN BEARING

Every 250 service hours, lubricate the fan bearings through the fitting until grease appears at the relief valve.



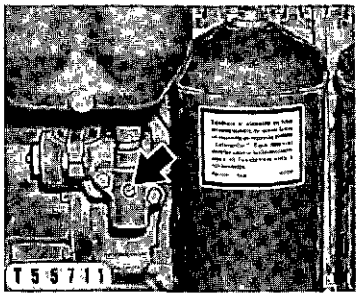
BR Ball and Roller Bearing Lubricant



F

CHARGING ALTERNATOR

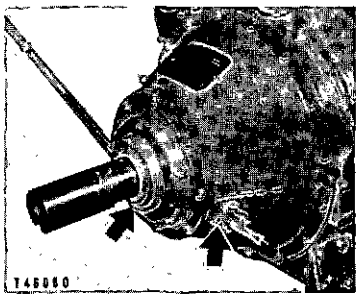
Under normal operating conditions the alternator bearings will not require lubrication between reconditioning periods. At the time of reconditioning, half-fill the reservoir in each end frame with a special lubricant available from your Caterpillar dealer.



G

TACHOMETER DRIVE

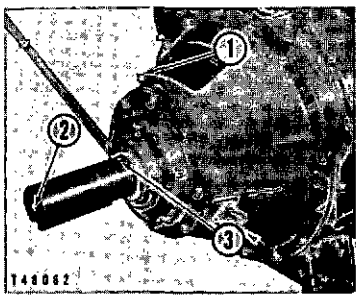
Remove pipe plug, insert 1/8 inch hydraulic fitting and lubricate sparingly every 1000 service hours.



H

ENCLOSED CLUTCH SHIFT COLLAR SHAFT

Lubricate shift collar shaft bearings which are equipped with grease fittings every 125 service hours.



H

ENCLOSED CLUTCH SHIFT COLLAR AND PILOT BEARINGS

Lubricate shift collar sparingly through fitting (1) every 10 service hours.

Lubricate pilot bearing sparingly through fitting at (2) every 125 service hours. When fitting (2) cannot be lubricated, remove plug (3), install a fitting and lubricate the pilot bearing.

Operation Instructions

Electric set generator information is covered in the Operation and Maintenance Instruction Book for the generator.

PREPARING THE ENGINE FOR USE

New Engine Initial Service: The first duty of anyone charged with the care and operation of an engine is to give it a detailed inspection, and to lubricate all parts as directed in the LUBRICATION INSTRUCTIONS section of this book.

Fill the diesel fuel tank, taking care no dirt, water, or other foreign substances are admitted with the fuel. Give particular attention to the details of fuel handling as outlined under the topic, CARE OF THE FUEL SUPPLY. Fill the starting engine fuel tank with gasoline if so equipped.

Fill the cooling system with clean soft water and rust inhibitor, or with the correct anti-freeze solution if temperatures below freezing are likely to be encountered. See the topic, COOLING SYSTEM.

New Engine Recheck: After the first 100 to 125 service hours of operation, tighten the diesel engine inlet manifold stud nuts, exhaust manifold stud nuts and the turbocharger mounting bolts and nuts.

If the diesel engine is equipped with a starting engine, tighten the starting engine carburetor elbow nuts.

New Operator's Responsibility: The operator who is given the responsibility of care and operation of an engine already in service, should first, check it for necessary lubrication, fuel supply and coolant in the cooling system.

Second, the engine should have any necessary adjustments made to obtain satisfactory performance.

STARTING THE ENGINE

There are three methods available for starting the diesel engine: gasoline starting engine, electric starting motor and air starting motor. The three methods are covered in these instructions. The following topic covers the starting information required, regardless of the starting method involved.

Before Starting: Be sure to check the oil level in the diesel engine crankcase to make sure the oil is considerably above the "add oil" mark on the gauge.

When the engine is equipped with an oil pressure shut-off, or an oil pressure alarm switch, see one of the topics, SAFETY SHUT-OFF CONTROLS, or OIL PRESSURE ALARM SWITCH for further starting instructions.

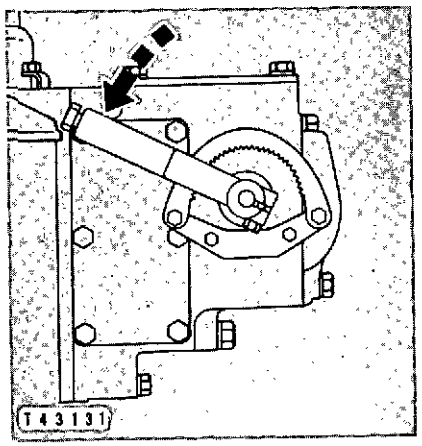
Disengage the flywheel clutch or remove any load possible from the engine, then start the engine as described in one of the following topics, whichever applies, GASOLINE STARTING ENGINE, ELECTRIC STARTING MOTOR OR AIR STARTING MOTOR.

Gasoline Starting Engine

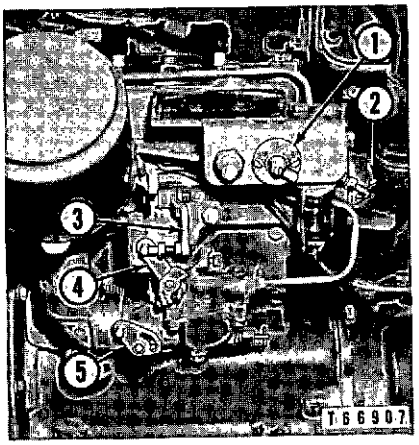
The gasoline engine may be used to start the diesel engine without the use of starting aids. However, starting aids may be used in lower temperatures to obtain quicker starts if desired. See the STARTING AID CHART.

Position Controls For Starting: Before attempting to start the starting engine, position the controls of both the diesel and starting engine:

1. Check the crankcase oil level in the starting engine to make certain the oil is up to the "full" mark on the gauge.
2. Move the compression release lever to the START position as indicated by the arrow on the compression release lever.
3. Move the governor control lever to the shut-off position so the fuel injection pumps are closed.
4. See that the starting engine clutch is disengaged by moving the starter pinion and clutch control lever toward the rear of the diesel engine.
5. Open the starting engine fuel valve by turning the fuel valve control **(2)** in the counterclockwise direction.



GOVERNOR CONTROL LEVER IN SHUT-OFF POSITION



STARTING ENGINE CONTROLS

1–Magneto switch. 2–Fuel valve control. 3–Idling latch. 4–Throttle control. 5–Choke control.

6. Turn the starting engine choke control knob **(5)** clockwise to the on position.
7. Move the idling latch **(3)** to hold the throttle control **(4)** in the 1/4 to 1/2 engine speed position.
8. Turn ON the magneto switch **(1)**.

Starting The Starting Engine: The starting engine may be started manually or by means of the starting engine electric starter if so equipped.

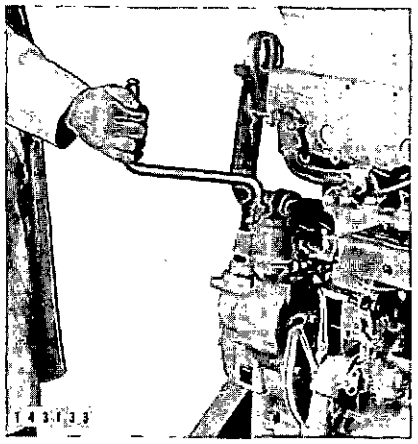
Helpful suggestions for starting the starting engine in cold weather are in the topic, STARTING IN COLD WEATHER.

Manual Starting

1. Insert the crank into position and crank until the engine starts. **Pull the crank through a compression stroke. DO NOT attempt in any manner to spin or push the crank through a cranking arc.**

CORRECT POSITION FOR CRANKING STARTING ENGINE

◆

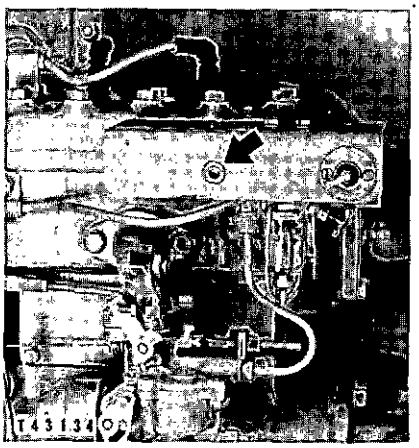


2. Move the choke control counterclockwise when the engine will run with the choke off. Temperature and altitude will vary the length of time it is necessary to have the choke on. Actual experience in starting will determine this interval.

   When the engine starts, keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.

Electric Starting

1. Press the electric starter switch to crank the engine. **Do not run the starter for more than thirty seconds at a time. Then, allow two minutes intermission for cooling before using it again.** If the electric starter pinion disengages for any reason before the engine starts, release the starter switch and wait until the starting motor stops turning and the starting engine stops "rocking" before again pressing the starter switch.



STARTING ENGINE ELECTRIC STARTER SWITCH

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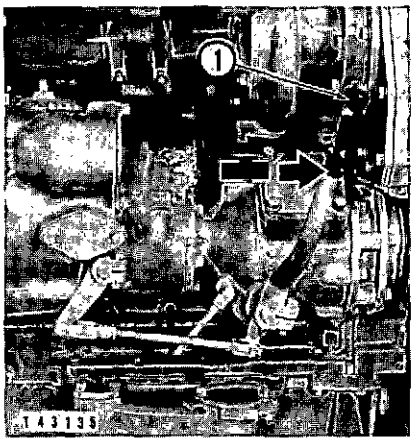
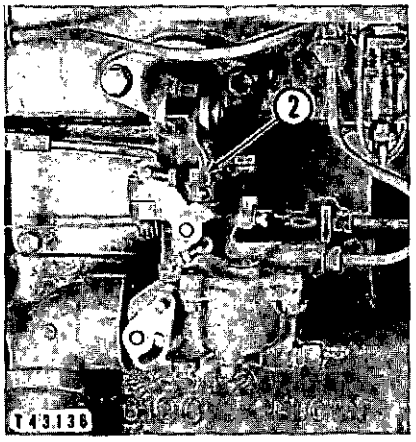
See the instructions given in paragraph 2 in the preceding topic, MANUAL STARTING.

Starting The Diesel Engine: When using the gasoline starting engine, the steps to start the diesel engine **should be carefully followed to prevent damage to the starter pinion or the flywheel ring gear.**

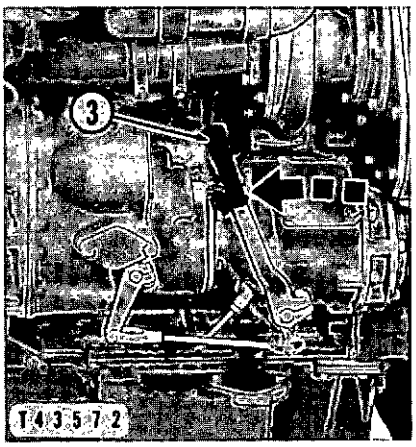
1. *Move the idling latch* **(2)** *up to allow the starting engine to run at* high idle speed.
2. Apply sufficient pressure to the starting engine clutch brake to **stop the starter pinion from rotating** by pushing the clutch and starter *pinion control lever* **(1)** *all the way toward the rear of the diesel* engine and hold it in the brake applied position for at least 5 seconds.
3. Engage the starter pinion with the flywheel ring gear and engage the clutch by **quickly** pulling the clutch and starter pinion control



CLUTCH AND STARTER PINION CONTROL LEVER
1–Control lever in brake applied position.



STARTING ENGINE THROTTLE CONTROL
2–Idling latch.



CLUTCH AND STARTER PINION CONTROL LEVER

3–Control lever in clutch engaged position.

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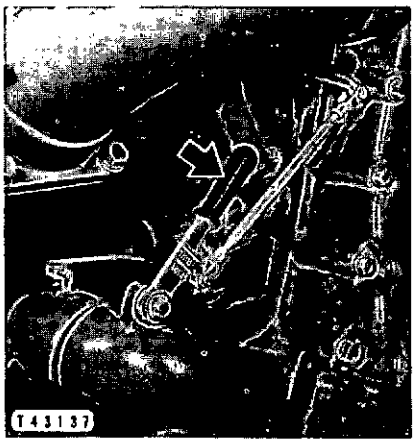
lever toward the front of the diesel engine until the clutch snaps over center and the control lever is in the clutch engaged position **(3)**.

4. If the engine slows to the stalling point when the clutch is engaged, as it might in cold weather, disengage the clutch and let the engine pick up speed again. See the topic, STARTING IN COLD WEATHER.

5. Move the compression release lever to the RUN position, as indicated by the arrow on the compression release lever, when the starting engine is cranking the diesel engine at normal cranking speed.

COMPRESSION RELEASE LEVER IN THE RUN POSITION

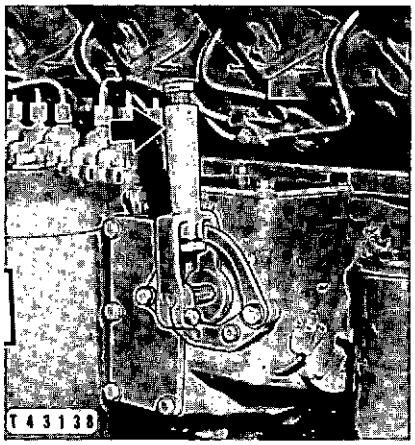
◆



The heat generated when the starting engine is cranking the diesel engine against compression, and the circulation of the starting engine exhaust through the tube in the diesel engine air inlet pipe warms the cylinders, pistons, and combustion chambers to the starting temperature.

Allow the starting engine to crank the diesel engine against compression for a few minutes to add heat to the diesel engine before starting it. Actual experience will determine the length of time necessary to crank

the diesel engine to warm it sufficiently to assure easy starting. Altitude and cold temperature cause a variation in the length of time required to warm the engine before starting. In cold weather the cylinders and pre-combustion chambers must absorb more heat before reaching starting temperature than in warm weather. Even in warm weather some heat must be added by turning the engine against compression a few minutes before injecting fuel.



GOVERNOR CONTROL LEVER IN APPROXIMATE HALF ENGINE SPEED POSTION

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6. Move the governor control lever to approximately half engine speed position. When the diesel engine begins to run the starting engine clutch and starter pinion automatically disengage.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

An ether aid can be used for quicker starting in lower temperatures, spray ether into the air cleaner inlet of the diesel engine at this point in the starting operations. See the topic, OPERATING STARTING AIDS.

7. Move the idling latch to hold the starting engine throttle control lever in the idling position. Stop the starting engine by closing the fuel valve control, allowing the engine to burn all the fuel in the carburetor, then turn OFF the magneto switch.

If the diesel engine is thoroughly heated but does not start, see that everything is correctly set for starting. If smoke has been coming from the diesel engine exhaust pipe, fuel has been reaching the cylinders. If no smoke is evident when the governor control lever is in the half engine speed position, check the fuel supply. If the diesel fuel tank is empty, or

if the valve was closed, it will be necessary to prime the fuel system as outlined under the topic, PRIMING THE FUEL SYSTEM. In case there may be water or dirt in the fuel system, or if the fuel injection equipment is suspected, see the topic, FUEL INJECTION EQUIPMENT.

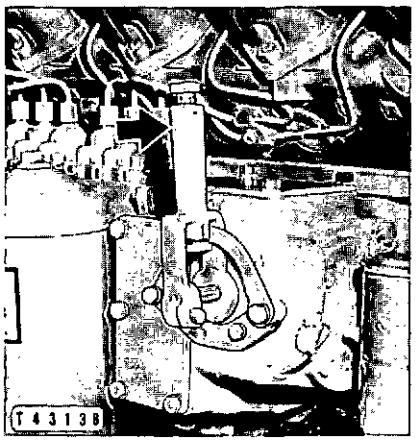
Direct Electric Starting

The diesel engine electric starting motor can be used successfully in atmospheric or engine room temperatures of 60° F. (16° C.) or above **without** the use of a starting aid. **It is not advisable** to use the diesel engine electric starting motor in temperatures below 60° F. (16° C.) without the use of a starting aid. See the topic, OPERATING STARTING AIDS. Even when a starting aid is used in temperatures below 32° F. (0° C.), it is advisable to use crankcase lubricating oil of a lower viscosity in the engine crankcase to reduce the cranking effort required. See the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

The engine must be kept in the best mechanical condition possible, the batteries kept fully charged and all terminals kept clean and tight for satisfactory performance of the starting system in lower atmospheric or room temperatures. In extremely cold temperatures the use of an engine room heater or cooling system auxiliary heater will make starting easier.

Position Controls for Starting: Before attempting to start the diesel engine the controls should be correctly positioned as follows:

1. Normally the compression release lever remains in the RUN position, as indicated by the arrow on the compression release lever, unless it is desired to crank the engine for some purpose other than starting.
2. Disengage the flywheel clutch or remove any load possible from the engine.
3. Move the governor control lever to approximately half engine speed position.



GOVERNOR CONTROL LEVER IN APPROXIMATE HALF ENGINE SPEED POSITION

◆

Starting The Diesel Engine: After positioning the controls correctly, the diesel engine may be started as follows:

1. Press the starter switch to crank the engine against compression.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

2. If the engine does not start in a few seconds, continue to crank the diesel engine but shut off the fuel supply by moving the governor control lever to the shut-off position for about ten seconds to clear the cylinders of raw fuel.
3. If the diesel engine fails to start within **thirty seconds,** release the starter switch and wait **two minutes** to allow the electric starting motor to cool before using it again.
4. If the electric starting motor pinion is disengaged for any reason before the engine starts, wait until the electric starting motor stops rotating and the diesel engine stops "rocking" before again pressing the starter switch.

Air Starting

The diesel engine air starting motor **can** be used successfully in atmospheric or engine room temperatures of 32° F. (0° C.) or above without the use of a starting aid. **It is not advisable** to use the diesel engine air starting motor in temperatures below 32° F. (0° C.) without the use of a starting aid. See the topic, OPERATING STARTING AIDS. Even when a starting aid is used in temperatures below 32° F. (0° C.), it is advisable to use crankcase lubricating oil of a lower viscosity in the engine crankcase to reduce the cranking effort required. See the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

An installation with 250 pounds air pressure in a 25 cubic feet (706 liters) air receiver should provide an adequate volume of air for starting the diesel engine. The air pressure should be regulated to 100 pounds pressure before the air enters the control valve.

Position Controls For Starting: Before attempting to start the diesel engine the controls should be correctly positioned as follows.

1. Normally the compression release lever remains in the RUN position, as indicated by the arrow on the compression release lever, unless it is desired to crank the engine for some purpose other than starting..

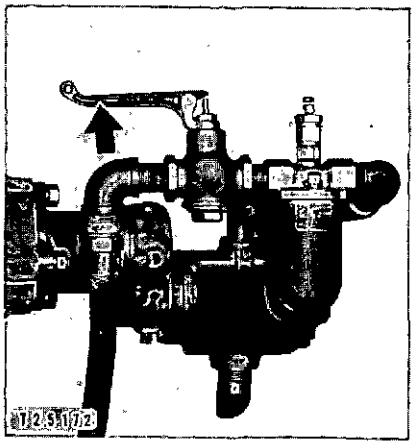
2. Disengage the flywheel clutch or remove any load possible from the engine.
3. Move the governor control lever to approximately half engine speed position.

Starting The Diesel Engine: After positioning the controls correctly, the diesel engine may be started as follows.

1. Pull up on the air valve control to crank the engine against compression.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

AIR VALVE CONTROL



2. If the engine does not start in a few seconds, continue to crank the diesel engine but shut off the fuel supply by moving the governor control lever to the shut-off position for about ten seconds to clear the cylinders of raw fuel.
3. If the air starting motor pinion disengages for any reason before the engine starts, release the air valve control and wait until the engine stops "rocking" before again pulling up on the air valve control.

OPERATING STARTING AIDS

Starting the diesel engine at temperatures above 50° F. (10° C.) using the electric starting motor, or 32° F. (0° C.) using the air starting motor, may be accomplished without the use of starting aids as instructed in the preceding topics.

STARTING AID CHART

STARTING TEMPERATURE	STARTING METHOD	STARTING AID	HEATING TIME TO USE AND/OR ETHER AID
Above 60°F.	Electric	None	None
	Air or Gasoline	None	None
Bewteen 60°F. and 32°F.	Electric	Glow Plugs	1 Minute
		Ether	Ether Aid
	Air or Gasoline	None	None
Between 32°F. and 0°F.	Electric	Ether	Ether Aid
		Glow Plugs and Ether	1 to 2 Minutes and Ether Aid
	Air or Gasoline	Glow Plugs	1 to 3 Minutes
		Ether	Ether Aid
		Glow Plugs and Ether	1 to 2 Minutes and Ether Aid
Between 0°F. and −10°F.	Electric, Air or Gasoline	Ether	Ether Aid
		Glow Plugs and Ether	3 to 5 Minutes and Ether Aid
Below −10°F.	Air or Gasoline	Glow Plugs or Ether, or Both	Heat cooling system and crankcase oil

When using the electric or air starting motor in lower temperatures, the glow plug starting aid, an ether aid, or both should be used. Pressure ether dispensers and commercially available, engine mounted ether dispensers are available and can be used as an aid in low temperature starting. Only experience can determine the temperatures at which the starting aid should be used. The controls should be positioned as instructed in the topic covering the method of starting to be used, and the following additional instructions should be carefully followed. This will permit the quickest possible start and conserve the battery or air supply. See the STARTING AID CHART.

When using glow plugs with either electric or air starting, and the engine fails to start after 10 seconds of cranking, the air valve control should be released, but turn and hold the HEAT-START switch in the HEAT position for about 30 seconds before cranking the engine again. When the starting motor is cranking, the battery efficiency is reduced and the glow plugs cool. Reheating them after 10 seconds of cranking makes the glow plugs more effective and conserves the battery or air supply.

When the engine starts, turn and hold the HEAT-START switch in the HEAT position for a few seconds, or a period long enough to assure that the engine will continue to run.

Do not turn the switch to the HEAT position while the engine is warm and running.

When using ether for starting, continue cranking until the engine starts. However, do not run the **electric** starting motor for more than 30 seconds at a time, then allow 2 minutes intermission before using it again.

Starting Between 60°F. and 32° F.

The use of starting aids between these temperatures is needed only when electric starting is used to start the diesel engine.

1. Move the HEAT-START switch to the HEAT position for the length of time necessary. See the STARTING AID CHART.

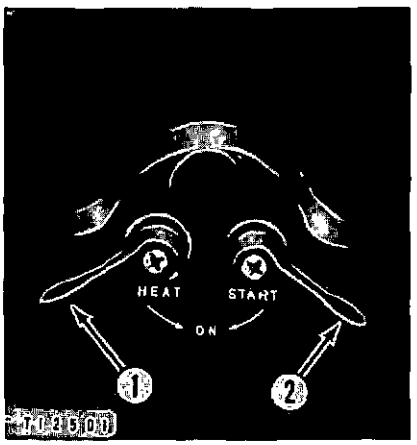
NOTE

Each glow plug uses approximately 5 amperes while the switch is in the HEAT position. This is actually a small amount in comparison to the starting motor load of possibly as many as 800 amperes that is imposed on the battery when the switch is in the START position.

2. Move the HEAT-START switch to the HEAT position or press the starter switch.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

HEAT-START SWITCH
(Later Engines)



CONTROL SWITCHES
(Earlier Engines)
1–HEAT switch. 2–START switch.

3. If the diesel engine fails to start within **thirty seconds,** release the starter switch and wait **two minutes** to allow the electric starting motor to cool before using it again.

4. If the electric starter pinion is disengaged for any reason before the engine starts, wait until the electric starter stops rotating and the diesel engine stops "rocking" before again turning the switch to the START position.

If a pressurized ether dispenser is to be used as a starting aid, move the switch to the START position or press the starter switch. While the electric starter is turning the diesel engine, carefully spray ether toward the air cleaner inlet until the engine starts. If the diesel engine fails to start within **thirty seconds,** release the starter switch and wait **two minutes** to allow the electric starter to cool before using it again.

NOTE

Use only enough ether to start the diesel engine or keep it running if the engine starts to stall.

Starting Between 32° F. and −10° F.

Starting between 32° F. (0° C.) and −10° F. (−23° C.) using either the electric or air starting motor, may be accomplished with the use of starting aids in the following manner.

1. Move the HEAT-START switch to the HEAT position for the length of time necessary. See the STARTING AID CHART.

NOTE

Each glow plug uses approximately 5 amperes while the switch is in the HEAT position. This is actually a small amount in comparison to the starting motor load of possibly as many as 800 amperes that is imposed on the battery when the switch is in the START position.

2. Move the switch to the START position; press the starter switch or pull up on the air valve control to crank the engine.

While the starter is turning the diesel engine, carefully spray ether toward the air cleaner inlet until the engine starts. If the electric starter is being used to start the diesel engine and the engine fails to start in thirty seconds, release the starter switch and wait two minutes to allow the electric starter to cool before using it again.

After the diesel engine starts, reduce engine speed to low idle with no load. Do not apply any load to the engine or increase engine speed until normal oil pressure is indicated on the gauge. Avoid unnecessary accelerating of the engine before operating temperatures are obtained. When the gauge indicates normal oil pressure, the engine should be allowed to run for five minutes with the governor control lever at approximately half speed position before applying the load. During this period the engine gauges should be observed for proper readings as explained in the topic, GAUGES.

NOTE

Use only enough ether to start the diesel engine or keep it running if the engine starts to stall.

Starting Below −10° F.

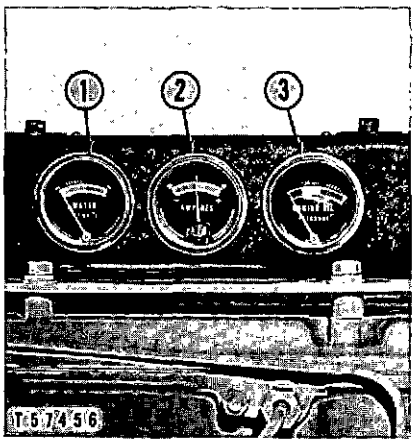
When starting in temperatures below −10°F. (−23°C.), the coolant in the cooling system and possibly the crankcase lubricating oil should be warmed. When heating the cooling system in these lower temperatures, the coolant should be maintained between +15°F. (−9.5°C.) and +30°F. (−1°C.) for easy cranking, quicker starting and rapid oil distribution.

When electric starting is used, an oversize or paralleled battery may be required to maintain cranking speeds.

GAUGES

After the engine starts, and at frequent intervals while the engine is operating, the engine gauges should be observed for proper readings as explained in the following paragraphs:

Oil Pressure Gauge: Immediately after the engine has started, check the crankcase lubricating oil pressure gauge **(3)** to see that it is registering. When the engine is running at rated engine speed the gauge should register in the "OPERATING RANGE". A lower pressure reading is normal at low idling speeds. If no pressure is indicated, investigate at once.



GAUGES

1–Water temperature gauge. 2–Ammeter. 3–Crankcase lubricating oil pressure gauge.

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Water Temperature Gauge: The indicator on the water temperature gauge **(1)** should register in the "OPERATING RANGE". The water temperature regulators within the diesel engine cooling system are designed to give an approximate minimum coolant temperature of 160°F. (71°C.). The maximum operating temperature will vary according to the air temperature and load factor, but should never exceed boiling temperature at the prevailing altitude.

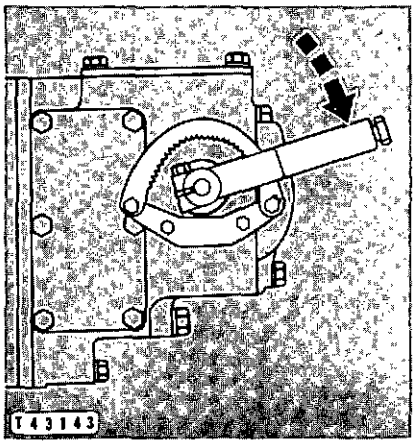
Fuel Pressure Gauge: The indicator on the fuel pressure gauge should register in the NORMAL (white) range. See the topic, FUEL SYSTEM.

Ammeter: On engines equipped with a charging generator the ammeter **(2)** should be checked to see that the indicator is registering in

the charging range (indicator on the + side of zero). If the indicator registers in the discharging range (indicator on the — side of zero) investigate at once. If the ammeter shows no charge it may be that the circuit breaker in the junction box is open. To close the circuit breaker press the reset button on the junction box and again check the ammeter to see if it is registering in the charging range. When it is necessary to close the circuit breaker after each start, it indicates the generator regulator is not functioning properly. See the topic, GENERATOR REGULATOR.

STARTING THE LOAD

When the engine has run long enough to warm up, move the governor control lever to the full governed speed position to bring the engine to operating speed. Move the flywheel clutch lever forward slowly, and after the load has started, push the clutch lever firmly until it snaps over center.



GOVERNOR CONTROL LEVER IN FULL GOVERNED SPEED POSITION

STOPPING THE LOAD

For a temporary stop — that is, when it becomes necessary to stop transmitting power — disengage the flywheel clutch and move the governor control lever to reduce the engine speed.

STOPPING THE DIESEL ENGINE

For a temporary stop — that is, when it becomes necessary to stop transmitting power — disengage the flywheel clutch and move the governor control lever to reduce the engine speed. Allow the diesel engine to run at half engine speed for five minutes, then reduce engine speed to low idle speed for at least thirty seconds before stopping it.

2. Reduce engine speed to low idle speed and allow the engine to run for thirty seconds.
3. Stop the diesel engine while it is running at low idle speed by moving the governor control lever to the shut-off position. Do not accelerate the engine speed above low idle before stopping the engine.

If the temperature is below freezing or if freezing weather is expected before the engine will be started again, drain the cooling system or protect it with anti-freeze solution. See the topic, COOLING SYSTEM.

DAILY CARE

Attention should be given to the operations mentioned in this topic, every 10 service hours or daily, whichever occurs first.

A daily check of the engine should be made to see if there are any loose nuts, bolts, or parts worn to such an extent that they are no longer serviceable. If corrective steps are taken immediately upon discovery of loose or worn parts, fewer enforced stops and more economical operation will result. Points to be checked daily, or every 10 service hours, are as follows:

1. Exhaust manifold, inlet manifold and air cleaner connections, inspect for tightness.
2. Cooling system, clean trash from radiator core and add coolant or anti-freeze if necessary. Be sure the filler cap seal is in good condition and that the cap is installed tightly.
3. Fuel pressure gauge, inspect with engine running to see that the indicator is not in the red range.
4. Diesel engine air cleaner, with the engine stopped, inspect for dirt in cleaner body when operating in extremely dusty conditions.
5. Turbocharger, inspect mounting for tightness. Inspect connections between the air cleaner and turbocharger and between the turbocharger and inlet manifold for tightness. Inspect oil supply tube connection to see that there is no oil leakage. Check the operation to see that there is no vibration or unusual noise. The "muffled high pitched whine" is the normal sound of the turbocharger.

Dirt should not be allowed to accumulate on the engine. A few minutes spent daily in keeping it clean are well repaid in improved appearance, and greater ease and safety in operation and maintenance.

Fill the diesel fuel tank at the end of the day's run. See the topic, CARE OF THE DIESEL FUEL TANK for other periodic care.

When the diesel engine is operating continuously, the starting engine should be run for a few minutes each day to dissipate condensation and renew the oil film on the bearing surfaces and cylinder walls.

STARTING IN COLD WEATHER

If the electrical system, starting engine and the diesel engine are all in good condition, and the precautions necessary for cold weather operation are taken, ordinary cold weather will not cause difficulty in starting or loss of efficiency.

Lubricants: As the starting atmospheric temperatures become lower, where warm housing facilities are not available, lubricants of lower viscosity should be used. See the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

Coolant: When the temperature is below freezing, sufficient anti-freeze solution should be used in the cooling system to prevent freezing. See the topic, COOLING SYSTEM.

The liquid in the cooling system may be warmed to make starting easier and quicker. When warming anti-freeze solutions, keep away from flames, as some of these solutions may be inflammable. Avoid getting the solution hot, and even a warm solution should be poured very slowly into a cold cooling system to prevent damage by sudden expansion.

Fuel: Fuel must be "free flowing" enough to flow readily through the fuel lines at the lowest temperature at which the engine will be started and operated. For additional information on this subject, see the topic, FUELS.

Electrical Equipment: During cold weather, more attention should be given the condition of the battery. It should be tested frequently and charged as often as necessary to insure sufficient power for starting. All switches and connections in the electrical system should be inspected and kept in good condition to prevent losses through improper contacts. See the topic, BATTERY.

Starting The Starting Engine: If the engine has been standing without shelter in extremely cold weather, the following suggestions will materially assist starting.

It is very important to keep low viscosity crankcase lubricating oil up to the full mark on the gauges in both the diesel engine and starting engine to provide proper lubrication when starting. Refer to the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

Crank the starting engine several revolutions with the magneto switch OFF, the choke ON, the throttle slightly open and the starting engine clutch disengaged. This will prime the engine and better distribute oil to the bearings and cylinder walls.

Sometimes moisture, or fuel which has not vaporized, collects on the starting engine spark plugs. They may be dried out by removing them and pouring gasoline over the electrodes. Ignite the gasoline and allow it to burn. **Use care to prevent fire.**

Pouring a small amount of gasoline on the electrodes before they are replaced in the engine is more effective in promoting combustion than priming the cylinders with gasoline. A small amount of gasoline in the cylinders will remove the film of oil from the cylinder walls and interfere with compression.

Follow the starting procedure covered in the topics, GASOLINE STARTING and either MANUAL STARTING or ELECTRIC STARTING whichever applies.

Sometimes the starting engine can be started more quickly by leaving the idling latch free of the throttle control lever. **When the engine starts keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.**

Starting the Diesel Engine: It is very important to keep low viscosity crankcase lubricating oil up to the full mark on the gauge in the diesel engine crankcase to provide proper lubrication when starting. Refer to the topic, TYPE OF LUBRICANTS AND SAE GRADES TO USE.

In cold weather, if the pinion clashes and will not engage with the ring gear, proceed as follows:

1. Stop the starting engine after the lubricating oil is thoroughly warm.
2. Engage the starter pinion and starting engine clutch. (It may be necessary to rotate the starter pinion by the use of the electric starter or hand crank.)
3. Disengage the starting engine clutch by pushing the control lever to the rear.
4. Restart the starting engine.
5. With the starting engine running at high idle speed, engage the starting engine clutch to start the diesel engine.

When the engine starts, keep the engine speed low until the crankcase lubricating oil has a chance to get warm and better lubricate the engine.

STORAGE

Lubricate all points mentioned in the lubrication chart if the engine is to be stored or left standing for any length of time. This will protect against rusting.

Diesel Engine: If the engine is to be stored or left standing for a long period of time, the lubricating oil may drain away from the cylinder walls and piston rings. This lack of lubricant permits the rings and liners to rust. It also permits unnecessary wear caused by metal-to-metal contact between the pistons, rings and liners when the engine is started before fresh oil has reached these surfaces. The lack of lubricant may not cause any noticeable change in engine operation after it has been started but it does contribute to shorter engine life.

On the diesel engine the oil film should be renewed by running the engine once a week until it is thoroughly warm. This will circulate the oil and prevent rusting from condensation.

Starting Engine: The oil film should be renewed in the starting engine by running the engine once a week until it is thoroughly warm.

Battery: Keep the battery charged by running the engine once a week or taking the battery to your Caterpillar dealer for charging.

When replacing a battery that has been removed, make certain the correct battery post is connected to the ground cable. Failure to connect the battery terminal to the correct post will damage the voltage regulator. See the topic, WIRING DIAGRAMS.

Cooling System: If the temperature will be below freezing, the cooling system should be drained if it has not been serviced as indicated in the topic, COOLING SYSTEM.

Fuel Tank: If the engine is to be stored or left standing longer than a normal work day, fill the tank with clean fuel to drive out moisture laden air. This will prevent condensation and rust from forming inside the tank. If the machine is to be stored with the fuel tank empty or partially filled, commercially available rust preventive vapor phase inhibitor crystals should be placed in a cloth bag and hung inside the tank filler opening to prevent moisture and rust from collecting. Crystals should not be dropped into the fuel as they will not function when saturated with fuel. Remove the crystals before the fuel tank is to be refilled with fuel.

ALTITUDE OPERATION

The maximum turbocharger speed is determined by the fuel rack setting, the high idle speed, the turbine nozzle and the altitude at which the engine is operated. The rack and high idle speed settings have been set to permit the engine to be operated at the altitude marked on the warning plate located on the right side of the flywheel housing. The turbine nozzle is the same for all altitudes, but the engine fuel rack setting and high idle speed vary with altitude. If the fuel rack setting is greater than specified for the altitude at which the engine is being operated or the high idle speed is too high, **serious damage due to turbocharger overspeeding may result.**

The maximum altitude at which the engine may be operated at the present setting is marked on the warning plate located on the right side of the flywheel housing. The governor housing and turbocharger are sealed for your protection. **Changes to the turbocharger, fuel rack setting, or high idle speed should be made only by your Caterpillar dealer.**

The engine can be operated at a lower altitude than marked on the warning plate without danger of turbocharger overspeeding, but with slightly less than maximum performance, however the fuel rack setting must be changed when operated at a lower altitude to get full power. **When operated at a higher altitude, the fuel rack setting must be changed by your Caterpillar dealer.** After making any changes, the new altitude limit will marked on the warning plate and the governor housing will be re-sealed for your protection. This will assure you correct settings have been made.

IMPORTANT: Consult your Caterpillar dealer before operating at a higher altitude than is marked on the warning plate.

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Maintenance Instructions

Electric set generator information is covered in the Operation and Maintenance Instruction Book for the generator.

The foregoing paragraphs have been devoted to instructions which are necessary for day-to-day operation of the engine. The following topics give detailed instructions regarding the care and adjustment of the various parts.

AIR CLEANERS

This dry type air cleaner is to be used without oil.

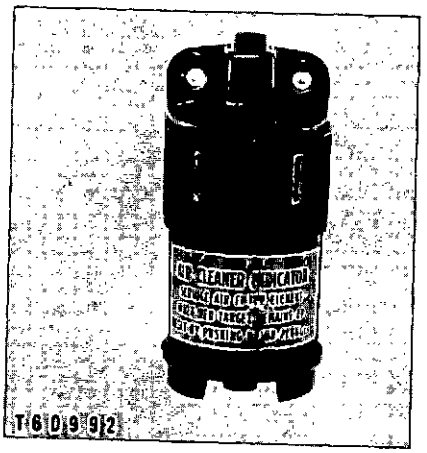
Regular service intervals, along with close visual inspection of the dry type air cleaner, are necessary for proper cleaning of the engine inlet air. The service interval will vary with the weather and working conditions. During dry, dusty months where dust conditions are severe, it will be necessary to service the air cleaner frequently. In damp weather and other conditions of little or no dust, the service interval can be extended.

Diesel Engine Dry Type Air Cleaner

To extend the service life of the element, the exhaust and air cleaner inlet pipes should be arranged so that exhaust and/or oil fumes do not enter the engine air cleaner.

The Air Cleaner Service Indicator is connected to the air inlet passage. It contains a red marked piston which moves up and down due to engine demands, and when the entire piston is visible, it will lock in the raised position. The piston will remain in this position whether the engine is running or stopped; thus indicating a need for air cleaner service. After servicing the air cleaner, reset the piston by depressing the plunger in the bottom of the indicator.

Excessive engine exhaust smoke and/or loss of power may indicate the need for servicing the air cleaner.



AIR CLEANER SERVICE INDICATOR

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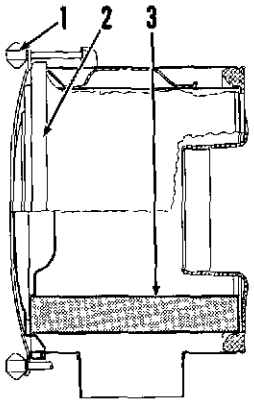
Single Stage Air Cleaner

Filter Element: Every 50 to 250 service hours in average operating conditions, or whenever the red piston in the air cleaner service indicator locks in the visible position remove the filter element for inspection and cleaning. The service hour interval may be extended in clean atmosphere and can only be determined by experience. **Never service the air cleaner while the engine is running.**



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SINGLE STAGE AIR CLEANER

1–Wing nut. 2–End cover.
3–Filter element.

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1. To remove the filter element **(3)**, loosen the two wing nuts **(1)**, remove end cover **(2)** and the filter element.
2. Inspect the element and if it is damaged, install a new element.
3. Remove any dirt which has accumulated on the bottom of the case and clean the filter element using one of the methods covered in the topic, FILTER ELEMENT CLEANING.
4. Inspect the filter element. If either the filter element seal or the pleats in the filter element is damaged, replace it with a new filter element.
5. Assemble the air cleaner. This air cleaner requires no oil.

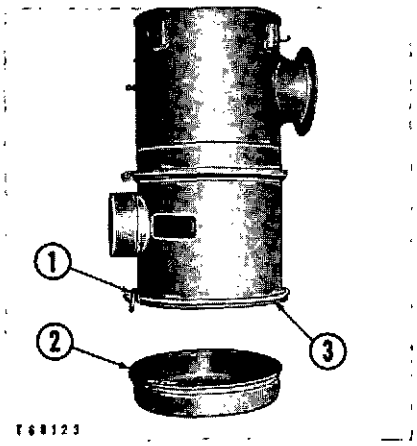
If after cleaning, the engine exhaust smoking and/or loss of power has not been corrected, or the restriction has not been reduced, install a new Caterpillar element.

Replace the filter element at least once a year.

Two Stage Air Cleaner (Attachment)

Dust Collector Cup: Every 10 to 50 service hours, depending on dust conditions, remove the dust collector cup.

1. Loosen clamping bolt **(1)** and remove dust collector cup **(2)**.
2. Empty the dust from the dust collector cup.
3. Inspect lower body seal **(3)**, replace if necessary, and install the dust collector cup. Use no oil in the dust collector cup.



REMOVING DUST COLLECTOR CUP

1–Clamping bolt. 2–Dust collector cup. 3–Lower body seal.

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Lower Body: Inspect the lower body when the dust collector cup is removed. If an accumulation of dirt is found in the tubes, they should be cleaned by pushing a round bottle brush, through the tubes from the bottom. It is not necessary to remove the lower body except when thorough cleaning is desired.

1. Loosen the clamping bolt **(4)** and remove the lower body **(5)**.
2. Thoroughly clean the tubes.
3. Inspect the air cleaner inlet tube and remove any accumulation of dust.
4. Inspect the upper body seal **(6)** and replace if it is damaged.

REMOVING LOWER BODY

4–Clamping bolt. 5–Lower body. 6–Upper body seal.

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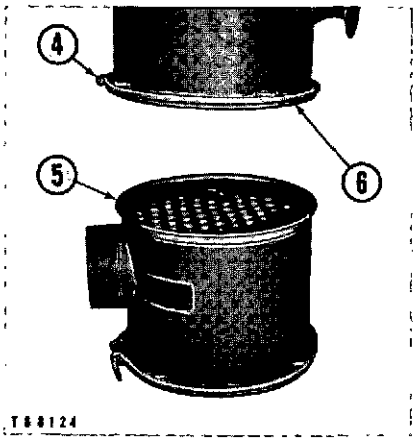
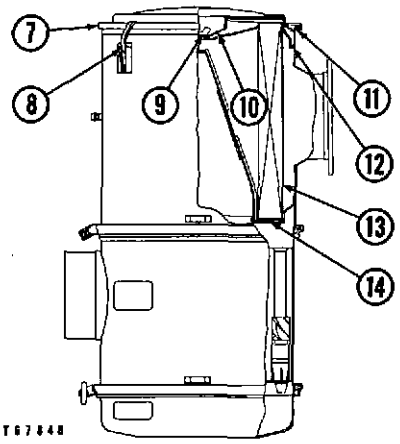
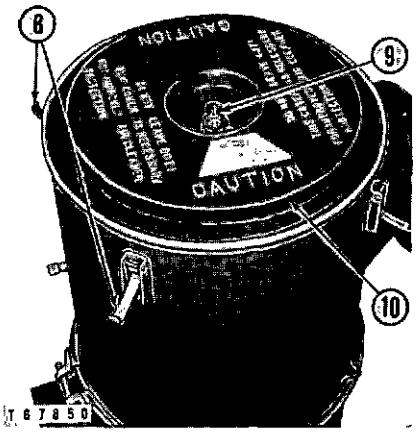


Filter Element: Every 125 to 250 service hours in average operating conditions, or whenever the red piston in the air cleaner service indicator locks in the visible position, remove the filter element for inspection and cleaning. This period may be extended in clean atmosphere and can only be determined by experience.

1. Loosen the four cover clamps **(8)** and remove cover **(7)**.
2. Remove the wing nut **(9)**, inner cover **(10)**, and the filter element **(13)**.



DRY TYPE TWO STAGE AIR CLEANER
7–Cover. 8–Clamps. 9–Wing nut. 10–Inner cover. 11–Cover seal. 12–Inner cover seal. 13–Filter element. 14–Filter element gasket.



REMOVING FILTER ELEMENT
8–Two of four clamps. 9–Wing nut. 10–Inner cover.

3. Clean the filter element by using one of the methods in the topic FILTER ELEMENT CLEANING.
4. Inspect the element. If the element is damaged install a new filter element.
5. Thoroughly clean all parts of the air cleaner. Inspect all replaceable seals **(11)** and **(12)** and gasket **(14)** and replace with new ones if damaged.
6. Install the filter element, inner cover, and the filter element retaining wing nut. Tighten the wing nut securely to prevent dust from by-passing the air cleaner filter element.
7. Place the cover in position and secure it with the four clamps.

If after cleaning, the engine exhaust smoking and/or loss of power has not been corrected, or the restriction has not been reduced, replace with a new Caterpillar element.

Replace the filter element at least once a year.

Filter Element Cleaning

An extra filter element should be kept on hand for replacement or for use in the air cleaner while the element that was removed is being cleaned.

The ends of a filter element can be damagd by bumping or tapping. Bent and/or dented ends cannot seal properly and will allow unfiltered air to enter the engine cylinders, thus causing premature engine wear.

Clean the filter element using one of the following methods:

1. Using clean, dry air, at a pressure not to exceed 100 PSI, proceed as follows:

Direct air at an angle against the inside (engine side) of the element to loosen any imbedded dirt. Best results can be obtained by moving the air hose so that air is directed at an angle along the complete length of each pleat. Blow off loose dirt by directing air against the outside of the element. Repeat this procedure until the element is clean. Make certain that no dirt is on the engine side of the element.

2. Using clean water, at a pressure not to exceed 40 PSI, proceed as follows:

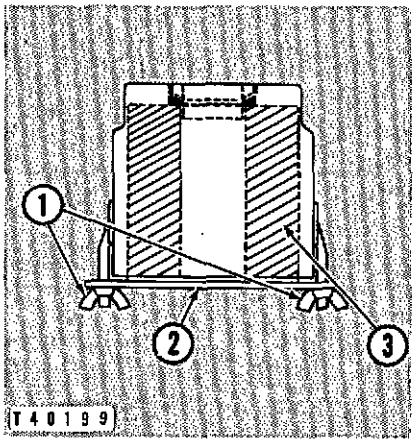
   Direct water at an angle against the inside (engine side) of the element to loosen any imbedded dirt. Best results can be obtained by using a water hose without a nozzle and moving it so that water is directed at an angle along the complete length of each pleat. Wash off loose dirt by directing water against the outside of the element. Repeat this procedure until the element is clean. Make certain that no dirt is on the engine side of the element, and thoroughly dry the element before installing it.

3. Some oily and/or sooty deposits can be removed by washing the element in a solution of warm water and a good household non-sudsing detergent. Rinse with clean water and thoroughly dry the element before installing it.

Starting Engine Dry Type Air Cleaner

Every 250 service hours clean the filter element. The element may have to be cleaned oftener under dusty conditions or whenever hard starting and/or loss of speed and power is observed. To service the element proceed as follows:

1. Unscrew the wing nuts **(1)** which retain the assembly.
2. Remove the air cleaner cover plate **(2)** and the filter element **(3)**.
3. Clean the element by directing clean dry air under pressure (not to exceed 100 PSI) against the inside of the element forcing air through the element to the outside. Do not let dust collect on the inside of the element.



AIR CLEANER ASSEMBLY

1–Wing nuts. 2–Cover plate. 3–Filter element.

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4. While the filter is removed inspect and clean all parts of the cleaner before assembly.

If the element is damaged or if after cleaning, the engine is hard to start and/or loss of power has not been corrected, install a new Caterpillar element.

Replace the filter element at least once a year.

WASHING THE CRANKCASE

Whenever the diesel engine or starting engine oil pan is removed, thoroughly clean both the oil pan and the oil pump screen.

FUELS

As a source of power the diesel engine has two outstanding advantages over the gasoline engine. The first is its lower rate of fuel consumption and second, its ability to use less expensive fuels. In selecting a fuel, it should be pointed out that distillates are especially desirable because, in refining, they are heated to a vaporous state and condensed in another container; thus, all the sediment and residue remain in the still. Always buy the **lowest priced distillate fuel giving satisfactory operation.**

In the United States and Canada, there are two general classes of fuel available for diesel engines. The American Society for Testing Materials (ASTM) has established these classes in their specifications. One class is that group of fuels marketed as fuel oil (domestic furnace oil); the other is that marketed as diesel fuel oil. No. 2 fuel oil and No. 2D diesel fuel oil *are recommended for use in Caterpillar Diesel Engines. More expensive* "premium" fuels such as No. 1 fuel oil and No. 1D diesel fuel oil are not necessary or recommended for normal operating conditions.

There is considerable variation in the composition of fuels distributed under the No. 2 grade classifications. For desirable engine service, it is most important to give special attention to pour point, cloud point, filterability, sulphur content and cetane number of the fuel.

Pour Point: The pour point of the fuel has no effect on engine performance, as long as the fuel is fluid enough to flow from the diesel fuel tank to the engine fuel transfer pump. The pour point of the fuel should be at least 10° F. (6° C.) below the lowest atmospheric temperature at which the engine must start and operate. This will generally provide a fuel that will flow readily from the fuel tank to the engine fuel transfer pump. In subzero (—18°C.) weather it may be necessary to use No. 1 fuel oil or No. 1D diesel fuel oil to obtain unusually low pour point fuels.

Cloud Point: Cloud point is a low temperature property frequently not reported in fuel characteristics. It is the temperature at which wax crystals

become visible, and it is generally above the pour point of the fuel. The cloud point should be below the lowest atmospheric temperature at which the engine will be operated so the filter will not be plugged with the wax formation.

Filterability: A good clean fuel should contain no more than .1% sediment and water. Dirty fuels lead to early filter plugging and in addition, with some fuels, fuel stability and fuel compatibility can result in the formation of gums and resins which will also reduce filter life.

Sulphur Content: As the sulphur content of the fuel increases, the oil change periods should be reduced as indicated in the topic, DIESEL ENGINE CRANKCASE LUBRICATING OIL CHANGE PERIODS.

Cetane Number: This is an indication of a fuel's ignition quality and should never be less than 35 for Caterpillar Engines. A higher cetane number is required at higher altitudes and for easier starting at low temperatures.

There is no world-wide standardization of diesel fuels and the ASTM classifications are not used in many export territories. Therefore, for best results, consult your Caterpillar dealer because he is familiar with fuels that are marketed in his particular area. He will be glad to advise you.

CARE OF THE FUEL SUPPLY

Keep The Fuel Clean: Too much emphasis cannot be placed on the importance of using only clean diesel fuel. It is important to buy clean fuel, and keep it clean. The best fuel can be rendered unsatisfactory by inadequate storage facilities or careless handling. The clearance between the fuel injection pump plunger and the barrel is very small, actually less than .0001 inch (0.00254 mm.), which makes it evident that the invisible particles of dirt which might pass through the filters can damage these finely finished parts.

Effort should be constantly expended to prevent contamination of the fuel. An important step is to reduce the number of times the fuel must be handled. When the fuel can be delivered by the distributor to fuel storage tanks and then pumped from the fuel storage tank to the engine fuel tank, the handling is reduced to a minimum.

Since natural settling is an effective method of cleaning diesel fuel, the fuel should be allowed to stand at least 24 hours in the fuel storage tank after the tank has been filled before fuel is transferred to the diesel fuel tank. Be sure to drain all water and sediment that has settled to the bottom of the tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

CARE OF THE DIESEL FUEL TANK

Fill the diesel fuel tank at the end of the day, because incoming fuel will drive out the moisture-laden air and prevent condensation. Every 125 service hours, before starting the engine, open the drain cock under the diesel fuel tank and drain off any sediment or water which may have accumulated. The strainer in the fuel tank filler opening should be removed and cleaned regularly. Remove the snap ring and lift out the strainer.

FUEL FILTERING SYSTEM

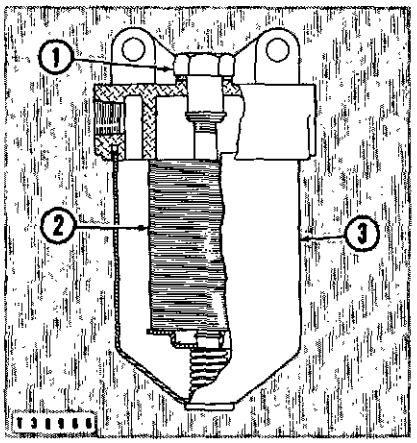
The primary fuel filter in the fuel system is for the purpose of straining out foreign material from the fuel before it enters the fuel transfer pump.

As either the filter element in the primary filter or the fuel filter elements in the final fuel filter housing gradually becomes clogged with foreign material, the position of the fuel gauge indicator will work back from the original position in the NORMAL (green) range, to the CAUTION (white) range and later into the OUT (red) range. When the indicator shows in the OUT (red) range, the primary filter element should be removed and washed. If the indicator still shows in the OUT (red) range, the final fuel filter elements should be replaced.

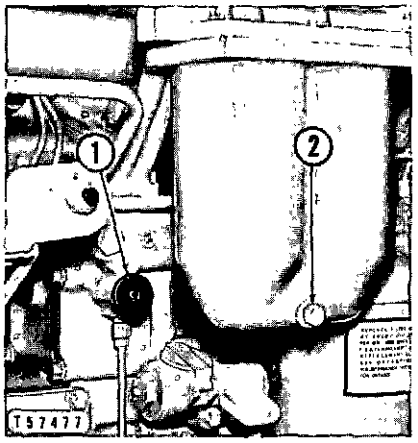
Primary Fuel Filter (Attachment)

Every 50 service hours remove and clean the filter element.

To remove the filter element **(2)**, stop the engine and shut off the diesel fuel tank valve. Loosen the nut **(1)**, on the filter cover and lower the filter case **(3)**. Remove the element and wash in clean kerosene or diesel fuel. Reinstall the element.



PRIMARY FUEL FILTER
1–Nut. 2–Filter element. 3–Filter case.



FINAL FUEL FILTER
1–Vent valve. 2–Drain plug.

Final Fuel Filter

Draining Fuel Filter Housing: Every 50 service hours or even as often as daily during extremely low temperatures, drain the filter housing of sediment and water which settles to the bottom of the compartment. Close the diesel fuel line valve at the fuel tank, remove the filter housing drain plug **(2)** and open the vent valve **(1)** in the housing. Replace the drain plug and prime the system. See the topic, PRIMING THE FUEL SYSTEM.

Fuel Filter Elements: The fuel filter elements are of the resin impregnated cellulose material type. When the pleated elements have collected enough contamination to interfere with engine performance, they must be replaced with new elements. These elements will continue to collect particles until fuel will no longer flow through them at a rate to maintain maximum engine performance. They will not discharge their burden into the clean fuel; this is prevented by the fine grade filter paper around the perforated metal core.

The resin impregnated cellulose material type filter elements collect and hold contaminants and cannot be washed or otherwise restored.

Removing Used Filter Elements: To remove the used filter elements, proceed as follows:

1. Close the diesel fuel line valve.
2. Remove the filter housing drain plug.
3. Open the vent in the filter housing.
4. Thoroughly clean the top of the cover and around the edges of the gasket joint between the filter housing and cover to prevent dirt dropping into the filter housing when it is removed.
5. Remove the filter housing from the cover.
6. Lift the filter elements out of the housing.

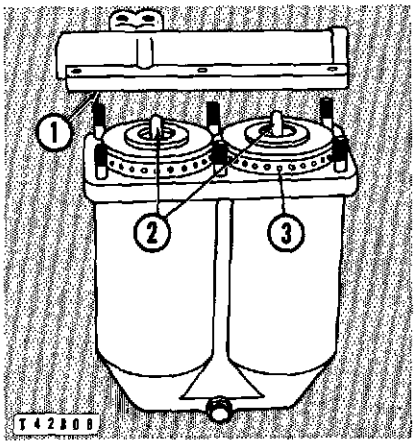
The rods and rod springs may be lifted out of the housing to permit the inside of the housing to be thoroughly cleaned if so desired.

Installing Filter Elements In Housing: To install the elements in the housing proceed as follows:

1. Replace the rods **(2)** and springs in the housing if they have been removed.

   While inserting the rod in the drilled hole in the bottom of the filter housing, hold the rod and spring with one hand to be sure the spring is held in position on the lower end of the rod.

2. Place the filter elements **(3)** over the rods.



INSTALLING FUEL FILTER ELEMENTS
1–Cover. 2–Rods. 3–Filter elements.

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3. Place a new gasket on the filter housing.
4. Install the housing onto the cover (1), making certain that the rods enter the holes for the rods in the cover.
5. Prime the system as outlined in the topic, PRIMING THE FUEL SYSTEM.

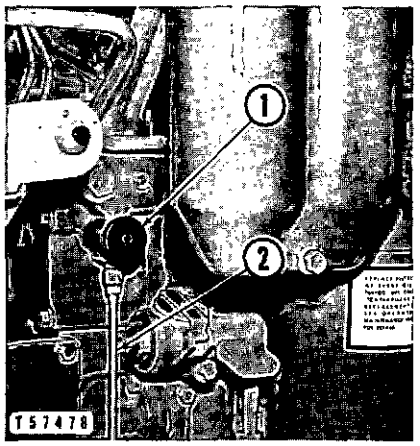
Keep New Filter Elements On Hand: An extra set of filter elements should be kept on hand for replacement. Always keep the elements wrapped in their original cartons to insure against dust and dirt accumulation which will shorten the life of the elements if it gets on the outside or may cause damage to the fuel injection equipment if it gets on the inside.

PRIMING THE FUEL SYSTEM

Any time the fuel flow is broken and air is allowed to get into the fuel system, the fuel system must be primed. If air is left in the lines, the fuel system may become air bound, resulting in inability to start the diesel engine or the misfiring of one or more cylinders.

Priming When Equipped With Gasoline Starting Engine: Priming the fuel system will allow the fuel transfer pump to force air and fuel through the fuel filters and the fuel injection pump vents if the engine is level. Prime the system as follows:

1. Check to see that the diesel fuel tank valve is open.
2. Check to see that the governor control lever is in the shut-off position so the fuel injection pumps are closed.
3. See that the compression release lever is in the START position.
4. Start the starting engine, engage the starter pinion and clutch and allow the starting engine to crank the diesel engine at starting engine low idle speed.



PRIMING THE FUEL SYSTEM

1–Vent valve. 2–Vent drain tube.

◆

5. Open the vent valve **(1)**. When the flow of fuel from the fuel vent drain tube **(2)** is continuous and contains no air bubbles, close the vent valve. Open and close the vent valve several times in succession to be sure all air is bled from the system.

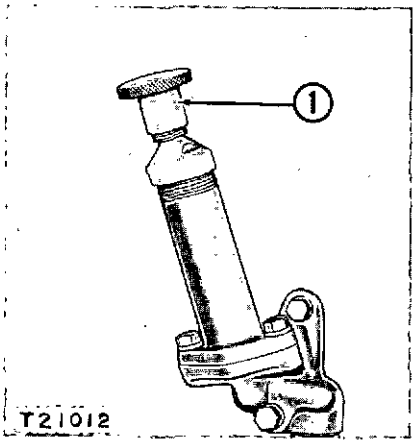
Priming When Equipped With Diesel Engine Electric Or Air Starter: When the engine is equipped with direct electric or air starting, a fuel priming pump is used to prime the system. To prime the system proceed as follows:

1. Check to see that the diesel fuel line valve is open.
2. Open the vent valve.
3. Loosen the knurled top **(1)** of the fuel priming pump.
4. Operate the pump plunger up and down until the flow of fuel from the vent drain tube becomes continuous and contains no air bubbles.
5. Close the vent valve.

FUEL PRIMING PUMP

1–Knurled top.

◆



6. Tighten the knurled top of the fuel priming pump to its original position.

FUEL INJECTION EQUIPMENT

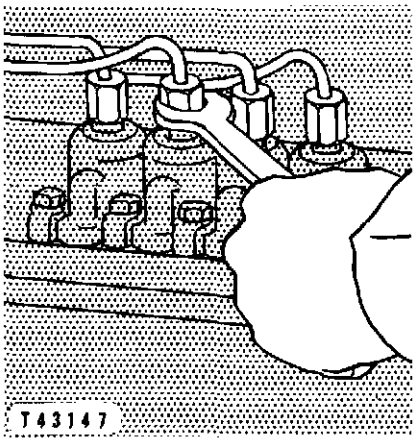
When improper fuel injection is affecting the diesel engine operation, a systematic check should be made to determine the cause. The most likely cause is dirt or water in the fuel. Drain the sediment from the diesel fuel tank and drain the fuel filter housing. Check the fuel pressure gauge as mentioned in the topic, FUEL FILTERING SYSTEM. Replace the filters if necessary. Then prime the fuel system until clean fuel passes out the fuel vent drain line. If the fuel system is air bound, priming the system will overcome this difficulty.

When the engine is running irregularly and smoking, a fuel injection *valve may not be spraying the fuel properly.*

As the clearance between the plunger and the barrel of a fuel injection pump increases, due to wear, fuel leakage occurs. When the leakage increases to the point where insufficient fuel is injected into the cylinder, a loss of power is noticeable. With the loss of power, hard starting is also encountered.

Fuel Injection Valves

Testing Fuel Injection Valves: Whenever an engine performs in such a manner that a fuel injection valve is suspected of causing trouble, test all the fuel injection valves. To test the injection valves loosen the fuel injection line nuts at the fuel injection pumps, one at a time, while the engine is running. When a nut is loosened and the exhaust smoking is completely or partially eliminated and the irregularity in running is not affected, this identifies the defective valve and a new one should be installed in that cylinder. These valves can be checked by your Caterpillar dealer.



LOOSEN FUEL LINE NUTS TO TEST VALVE

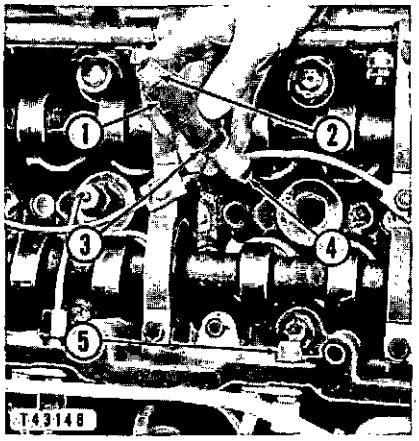
Removing Fuel Injection Valves: Clean around the edge of the camshaft and valve mechanism cover to prevent dirt from entering the valve mechanism when the cover is removed.

1. Remove the valve mechanism cover.
2. Remove the fuel line between the injection valve and camshaft cover base. Install a cap on each end of this line and a cap **(5)** on the fuel injection line, which extends through the cover base, to prevent dirt from entering the lines.
3. Remove the retainer nut **(1)**. If the engine is equipped with glow plug starting aids the glow plug should first be removed before removing and replacing a fuel injection valve to eliminate the possibility of damaging the glow plug. See the topic, GLOW PLUGS.
4. Lift out the fuel injection valve body **(3)** and the fuel injection valve nozzle assembly **(4)** as a unit. If the injection valve will not be installed immediately, cover the body end with a cap **(2)** to prevent dirt from entering the valve body.

REMOVING FUEL INJECTION VALVE

1–Retainer nut. 2–Cap. 3–Fuel injection valve body. 4–Fuel injection valve nozzle assembly. 5–Cap on fuel injection line extending through the camshaft cover base.

◆



Installing Fuel Injection Valves: Before installation of a fuel injection valve, be sure the wrench is clean. Put the dust cover on the valve body as soon as possible to prevent dirt entering the fuel passage. Install the fuel injection valve in the following manner:

1. Screw the valve body **(3)** into the fuel injection valve nozzle assembly **(4)** only finger tight. The threads of the body and nozzle assembly are made to fit loosely. The clearance between the threads provides a passage for fuel to enter the nozzle assembly from the body.
2. Insert the nozzle assembly and valve body as a unit into the precombustion chamber opening. Turning the body in a clockwise direction and at the same time pressing down will assure alignment of the serrations.

3. Tighten the retainer nut **(1)** to prevent leaks between the nozzle assembly and the nozzle assembly seats. A torque of 100 to 110 pounds feet is adequate to tighten the retainer nuts.

4. Reinstall the fuel injection line and tighten the nuts.

Fuel Injection Pumps

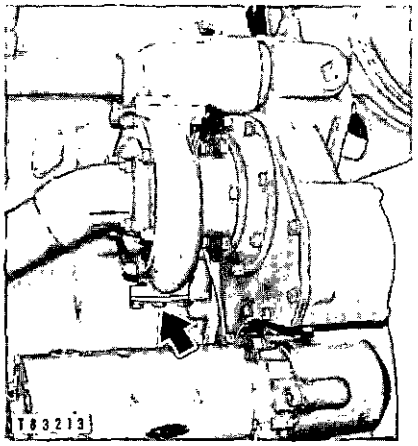
Testing Fuel Injection Pumps: It is not usual for one pump on an engine to require replacement; usually all of the pumps are worn. Worn fuel injection pumps will result in loss of power and hard starting. When loss of power and hard starting are accompanied with a clear exhaust, good compression and no blow-by gases from the crankcase breather, it indicates worn injection pumps. The tools and information required to service and check fuel injection pumps are available at your Caterpillar dealer.

FRESH WATER COOLING SYSTEM

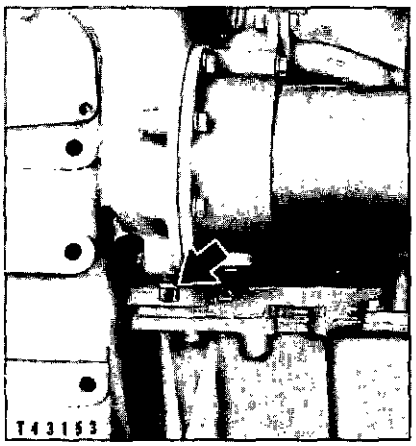
Coolants: Water used in the cooling system should be soft, or as free as possible from scale forming minerals. Treat the available water with Caterpillar Rust Inhibitor. The use of this rust inhibitor in the cooling system will prevent the formation of rust. It will also retard, and in some cases completely eliminate mineral deposits within the engine. Most commercial anti-freeze solutions contain rust inhibitors. Add rust inhibitors to anti-freeze solutions which do not contain inhibitors. Your Caterpillar dealer stocks Caterpillar Rust Inhibitor in convenient one quart cans. Directions for its use are printed on each can.

When the temperature is below freezing sufficient anti-freeze should be used in the cooling system to prevent freezing. Various anti-freeze mixtures such as ethylene glycol (Prestone, G.M., Permaguard, Zerex, etc.), denatured ethyl alcohol, methanol (synthetic wood or methyl alcohol) and glycerine are all suitable for use. Alcohol can be used successfully but, because it readily evaporates at the normal operating temperature of the diesel engine the solution should be tested frequently—even daily—and kept up to correct strength. This loss by evaporation is objectionable **but the temperature regulator should not be removed.** Doing so might make the solution run cooler and save the alcohol, but is not desirable for good performance. It is essential, therefore, that the coolant be tested frequently to assure adequate protection.

Draining: The cooling system is drained by removing the radiator cap, removing the drain plug below the radiator, removing the plug in the bottom of the water pump and removing the plug from the bottom of the oil cooler. This will drain the entire cooling system of the diesel and starting engines if the engine is level. This should be done at the end of the day's run when all the foreign material is in suspension and will drain with the liquid.



WATER PUMP DRAIN PLUG



OIL COOLER DRAIN PLUG

Cleaning the Radiator: Every 10 service hours clean dirt and trash from in between the tubes of the radiator which may cause excessively high operating temperature. Wash, brush or blow the dirt out with whichever method is available and most effective.

Cleaning The Cooling System: An occasional washing of the cooling system may be necessary to remove the dirt and sediment which accumulates. The frequency of washing will depend on the amount of foreign material present in the water used in the system.

To wash the system, run the engine until the liquid in the cooling system is at operating temperature, and the loose foreign material is stirred up. Then stop the engine and drain as quickly as possible before the sediment has time to settle. Close the drain and pour kerosene equal to about one-tenth the capacity of the cooling system and fill the remainder with a solution of one-half pound (226.8 grams) of washing soda to each gallon (3.8 liters or .8 Imp. Gal.) of water. Run the engine for about one-half hour, and again drain and flush the system with clean water. Commercially available cooling system cleaners can be used.

Filling: To fill the cooling system, pour the coolant into the filler opening until the coolant level is even with the bottom of the filler opening pipe. When filling after draining or when excessive coolant has been lost, fill the cooling system, install filler cap, and run the engine at half speed for a period of 5 to 10 minutes to purge air from the cooling system. Check coolant level and if it has lowered, refill to the bottom of filler opening pipe.

The cooling system is equipped with an expansion tank or a radiator top tank designed so as to trap air in the top of the tank when filling. This trapped air compresses, as the coolant expands due to heat, or is vented

through a sealed pressure overflow valve. Because of this feature, the operator can fill the cooling system to the bottom of the filler opening pipe and automatically allow for coolant expansion.

SEALED PRESSURE RADIATOR CAP

The sealed pressure radiator cap should be cleaned every 1000 service hours to remove lime deposits and other accumulations which might hold the valve in the "open" position. Such deposits are not so noticeable where inhibitors are used in the cooling system, but, even so, regular cleaning of the unit should be encouraged.

To clean the unit, remove the cap assembly and brush the parts thoroughly until all of the foreign matter has been removed. **Caution: Do not wash the unit in any kind of cleaning solution because so doing may damage the seal.**

RAW WATER HEAT EXCHANGER COOLING

Engines operating in the vicinity of an abundant raw water supply may use the raw water for cooling the engine water. The raw water cooling system will include a raw water pump and a heat exchanger of a calculated size which will permit maintaining the proper temperature of the fresh water system.

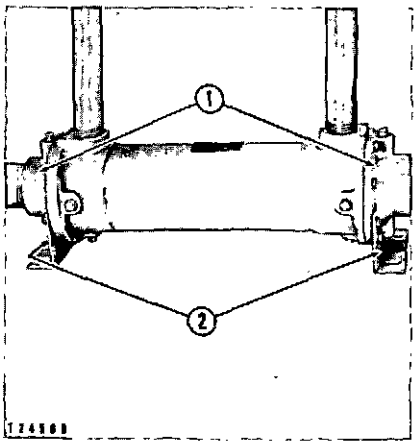
In certain waters the heat exchanger may become less efficient due to marine growths and possible accumulations of sediment. As such materials accumulate, the fresh water temperature indicator will show a gradual day-to-day increase. Before the indicator approaches the boiling point, the accumulated material should be removed.

Draining: The raw water cooling system should be drained when the engine is to be left in storage, or at the end of a day's operation when freezing temperatures can be expected, or when the heat exchanger is to be cleaned.

To drain the cooling system, remove the raw water pump drain plug and the two heat exchanger bonnet drain plugs. If there is a low point in the piping, disconnect the pipe or drain it if a provision is made. Before starting, be sure the inside of the raw water inlet pipe has not frozen shut at the surface of the water level.

Cleaning the Heat Exchanger: The heat exchanger should be cleaned when the water temperature is continuously 195° F. to 205° F. (91° C. to 96° F.) or more during operation.

Close the sea valve and drain the exchanger of raw water by removing the drain plugs **(2)**. Remove the end bonnets **(1)** from each end of the



CLEANING HEAT EXCHANGER

1–End bonnets. 2–Raw water drain plugs.

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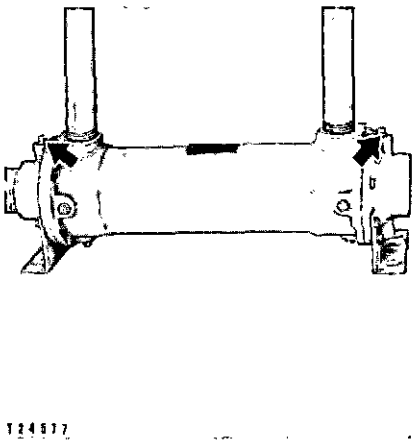
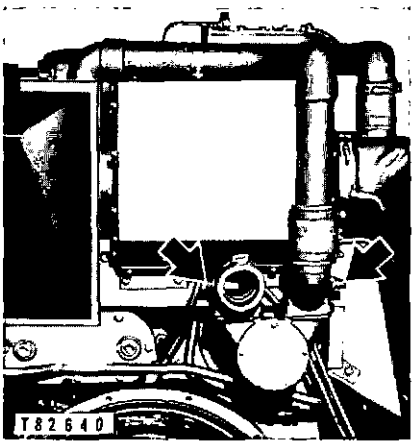
exchanger. A rod not larger than 9/32 inch (7.11 mm.) can be used to push through the tubes of the core to remove accumulations. Reinstall the end bonnets and open the sea valve. When the engine is started, any accumulations which were loosened in the tubes will be flushed out of the core.

Zinc Plugs: Zinc plugs are installed in the raw water circuit for the purpose of localizing any electrolytic action which may be set up. Two zinc plugs are located in the heat exchanger and two are in the raw water pump. They are painted red for identification purposes. They should be inspected every 25 service hours to determine the amount of corrosion. To inspect them drain the exchanger of raw water and remove the plugs. When draining the water, the core tubes will be drained. When inspecting the zinc plugs, do not be deceived by their outside appearance, but tap them lightly with a small hammer. If they crack or crumble,



HEAT EXCHANGER ZINC PLUGS



RAW WATER PUMP ZINC PLUGS

new zinc elements should be installed. If they are not deteriorated and merely appear to be corroded, they may be cleaned by scraping away the corrosion.

When the heat exchanger end bonnets are removed for the purpose of cleaning the tubes, or the zinc plugs are removed for inspection, it will not be necessary to drain the fresh water system.

DIESEL ENGINE VALVE CLEARANCE ADJUSTMENT

The valve clearance adjustment should be checked after every 500 service hour interval and adjusted if necessary.

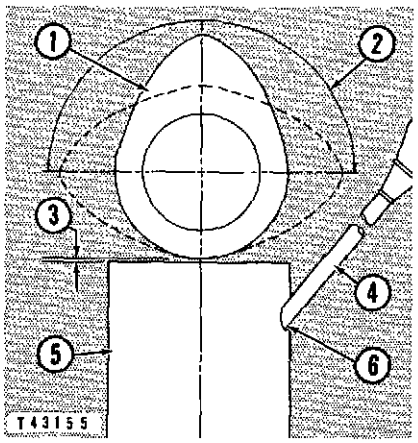
The valve clearance adjustment can be made on a cold engine or on an engine that has been shut-down long enough for the heat in the engine to dissipate. The compression release lever must be in the RUN position whenever valve clearance and compression release clearance is being check or adjusted.

To Adjust: With the camshaft cover removed, proceed as follows:

1. Rotate the crankshaft in the direction of engine rotation until the valve to be adjusted is closed. The cam **(1)** over the valve to be adjusted will indicate a closed valve when the cam lobe is in any location within the 180° arc **(2)**.

2. Turn the cam follower **(5)** on the valve to be adjusted, until the diagonal hole **(6)** in the follower is toward the center of the engine.

3. With a cross point (Phillips) screwdriver **(4)** in the diagonal hole **(6)** in the cam follower, turn the screwdriver clockwise to increase or counterclockwise to decrease the valve clearance at **(3)** enough to allow a thickness gauge of the correct thickness to be passed between the cam follower **(5)** and the cam **(1)**. Valve clearance on a cold engine should be .030 inch (.76 mm.) for exhaust valves and .018



VALVE CLEARANCE ADJUSTMENT

1–Cam. 2–Valve is closed when cam lobe is in any location within this 180° arc. 3–Valve clearance on a cold engine should be, exhaust valve .030 inch (.76 mm.), inlet valve .018 inch (.46 mm.). 4–Cross point (Phillips) screwdriver. 5–Cam follower. 6–Diagonal hole in follower.

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inch (.46 mm.) for inlet valves. An engine that is close to operating temperature should have a clearance of .025 inch (.64 mm.) for exhaust valves and .015 inch (.38 mm.) for inlet valves.

Compression Release Adjustment: Compression release clearance should be adjusted whenever inlet valves have been adjusted. The inlet valve under the compression release lever **(3)** to be adjusted must be closed. To make the adjustment proceed as follows:

COMPRESSION RELEASE ADJUSTMENT

1–Locknut. 2–Adjusting screw. 3–Compression release lever. 4–Cam follower. 5–Compression release clearance .030 inch (.76 mm.).

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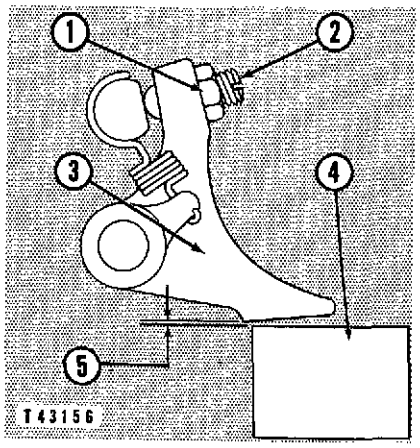


1. Loosen the locknut **(1)**.
2. Turn the adjusting screw **(2)** and adjust the clearance **(5)** to allow a thickness gauge of .030 inch (.76 mm.) to pass between the compression release lever **(3)** and the cam follower **(4)**.
3. Tighten the locknut **(1)** and recheck the clearance.

Valve Rotation: Whenever the engine is running the valves slowly rotate. Valve rotation decreases carbon build up and uneven wear, thereby increasing the life of the valves. The cam followers also slowly rotate when the engine is running, but cam follower rotation does not necessarily indicate valve rotation. If it is suspected that a valve is not rotating, see your Caterpillar dealer.

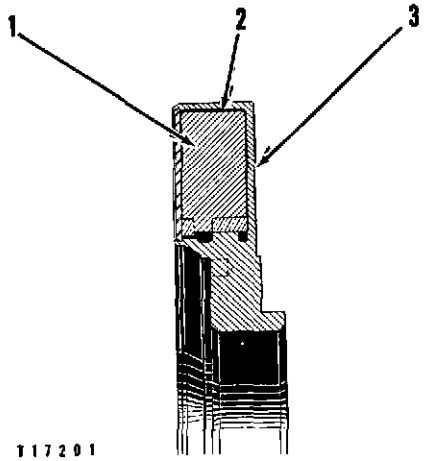
VIBRATION DAMPER

The viscous type vibration damper, mounted on the front of the crankshaft, reduces crankshaft vibration and gear train noise.

The damper is constructed of a solid cast iron weight **(1)** enclosed in a metal case **(3)**. The small space **(2)** between the case and weight is filled with a viscous fluid that permits the iron weight to move in such a manner within the case as to dampen the vibrations of the crankshaft.

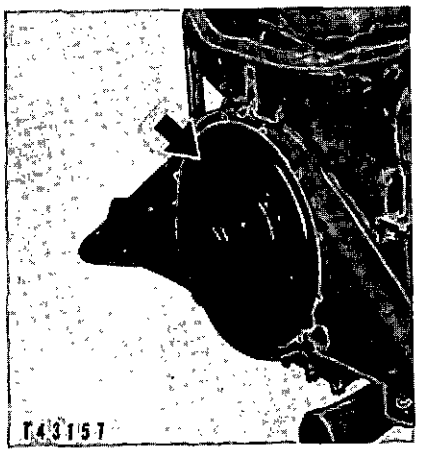
If the case becomes dented the viscous fluid may partially solidify, or the case and iron weight may actually rub against each other. In either instance it will restrict the movement of the iron weight, and instead of dampening crankshaft vibrations and reducing gear train noise, it may actually increase vibrations that could result in crankshaft failure. It will, in most cases, cause excessive gear train noises.

A viscous type damper that is operating correctly absorbs energy to damp out torsional vibrations and becomes much warmer than the surrounding engine parts. A damper that is not operating correctly will remain at approximately the same temperature as surrounding engine



VIBRATION DAMPER CROSS SECTION

1–Solid cast iron weight. 2–Space between case and weight. 3–Case.



VIBRATION DAMPER

parts, which is probably 10° to 15° above ambient air temperature. Therefore, by feeling the damper after at least one hour of engine operation, a faulty damper may be detected.

Avoid welding, hammering or prying on the damper case. A damper that has the mounting holes worked oblong should be replaced.

Excessive heat can also damage a viscous damper. It is therefore necessary that adequate ventilation be provided around the damper to eliminate excessive heat. Complete enclosure of a viscous type damper should be avoided.

The damper should be checked occasionally for dents or bulges in the damper case. A dented or bulged case requires that the damper be replaced. Damage can occur to the damper, the hub, and to the crankshaft if the engine is operated with the damper loose.

Whenever a damper is found to be defective it should be replaced.

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Attachment Instructions

Attachments are available from your Caterpillar dealer. Many of these attachments will add to operator convenience as well as increase the usefulness of your engine.

PRECLEANER

Precleaner Care: A precleaner is available from your Caterpillar dealer and will permit lengthening air cleaner service periods because it removes some of the dirt from the inlet air.

PRECLEANER

1–Body. 2–Tubes. 3–Collector cup. 4–Body seal.

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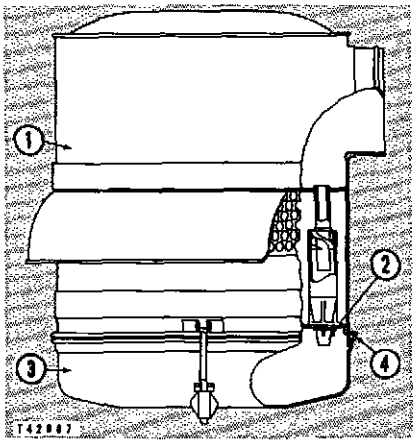

Every 10 to 50 service hours remove the collector cup.

1. Loosen the wing nuts and remove the collector cup **(3)**.
2. Empty the dust from the collector cup.
3. Inspect the lower bottom of the body **(1)** after the collector cup is removed. If an accumulation of dirt is found in the tubes **(2)**, they should be cleaned by pushing a round bottle brush through the tubes from the bottom.
4. Inspect the body seal **(4)**, replace if necessary. A good seal is important in keeping dust from by-passing the precleaner.
5. Install the collector cup **(3)**.

STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

The valve clearance adjustment should be checked every 2000 service hours. To check the adjustment remove the carburetor and valve cover. The valve clearance check or adjustment should be made when the engine is hot. To check, crank the engine until the valve closes and the valve lifter is at its lowest position.

To Adjust: Turn the adjusting screw until there is .008 inch (0.2 mm.) clearance at **(2)** between the adjusting screw and the end of the valve stem. Check this clearance with the thickness gauge **(1)**.

STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

1—Thickness gauge. 2—There should be .008 inch (0.2 mm.) clearance at this point.

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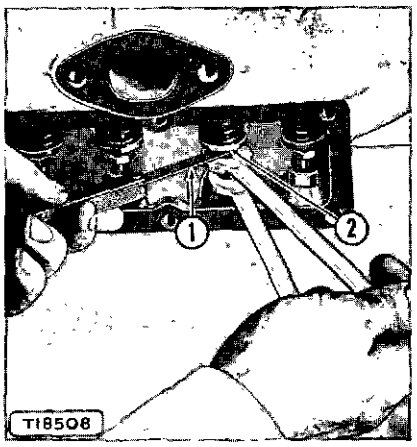
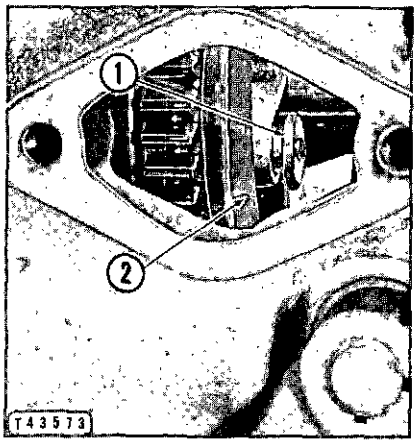


STARTING ENGINE CLUTCH

To Test The Adjustment: Pull the clutch and starter pinion control lever to the engaged position. The lever should go into position with a distinct snap, and should require a reasonably hard pull. The clutch should be checked every 500 service hours for proper adjustment.

To Adjust: Remove the plate from the side of the clutch compartment. Turn the adjusting collar **(2)** until the lock pin **(1)** is accessible. Pull the lock pin out and turn the collar to the right until the lock pin drops into the next hole.

Test the adjustment by engaging the clutch. If one hole gives a slightly loose adjustment and the next gives too tight an adjustment, use the looser adjustment.



STARTING ENGINE CLUTCH ADJUSTMENT

1–Lock pin. 2–Adjusting collar.

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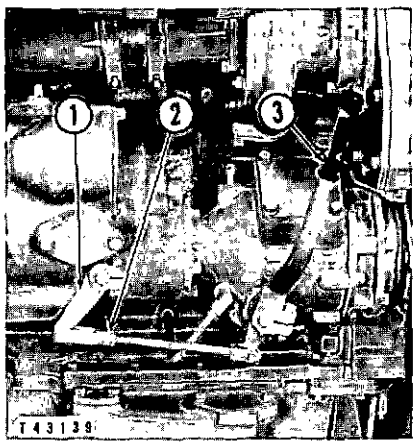
STARTING ENGINE CLUTCH AND PINION CONTROL LINKAGE ADJUSTMENT

If the starting engine clutch brake will not stop the pinion from turning when the clutch is properly adjusted, an adjustment of this linkage should be made with the starting engine stopped.

1. Remove the pin from the rod end **(2)**.
2. Engage the starting engine clutch by moving clutch lever **(1)** toward the rear of the engine until the clutch snaps into engagement. This engaged position must be maintained throughout the entire adjustment procedure.



STARTING ENGINE CLUTCH AND PINION LINKAGE

1–Clutch lever. 2–Rod end. 3–Clutch and pinion control lever.

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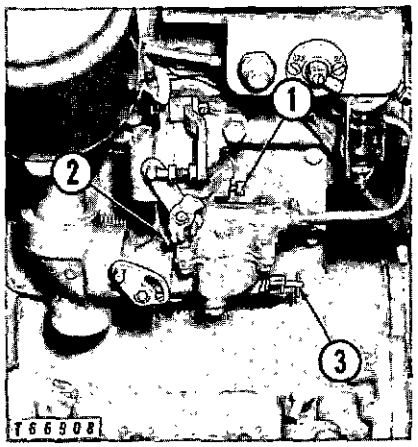
3. Engage the pinion by moving the clutch and pinion control lever **(3)** toward the front of the engine until the kickout plunger holds the pinion in engagement. This position must be maintained throughout the entire adjustment procedure.
4. Loosen the locknut and turn the rod end **(2)** until the pin can be inserted in lever **(1)**. Pull the rod so the rear linkage pin is to the extreme front of the slot in control lever **(3)**.
5. Remove the pin and turn the rod end one full turn counterclockwise to lengthen the rod.
6. Reassemble the pin and install the cotter.
7. Tighten the locknut of rod end **(2)**.

STARTING ENGINE FUEL SYSTEM

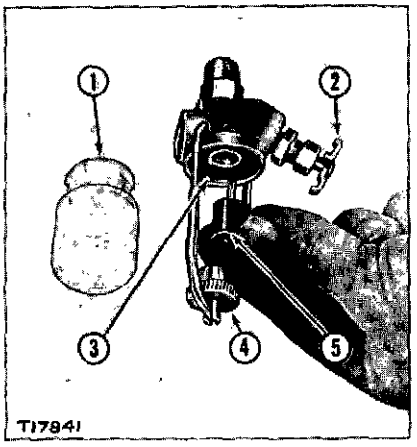
Keeping the starting engine fuel tank filled will prevent condensation in the tank. Periodically drain any water which may have accumulated in the starting engine fuel tank sediment bowl. Check the carburetor for proper adjustment every 500 service hours.

Carburetor Adjustment: To obtain an approximate carburetor adjustment, turn the adjusting screws gently against their seats. Then back off the high speed mixture adjusting screw **(3)** one turn from the closed position and the low idle speed mixture adjusting screw **(1)** one-half turn from the closed position.

A more accurate adjustment can be obtained while the engine is running at full governed speed by turning the high speed mixture adjusting screw out to make the mixture richer or in to make it leaner. Adjust this screw to a point that will give the greatest amount of power with a clear exhaust. Turn the low idle mixture adjusting screw until the engine will idle regularly at slow speed without emitting black smoke from the exhaust. Turn this screw out to make the mixture leaner or in to make it richer. Turn the idling speed control screw **(2)** to the left (out) to decrease idling speed or to the right (in) to increase the speed.



CARBURETOR ADJUSTMENT
1–Low idle mixture adjusting screw. 2–Idling speed control screw. 3–High speed mixture adjusting screw.



STARTING ENGINE SEDIMENT BOWL FILTER
1–Sediment bowl. 2–Valve. 3–Gasket. 4–Nut. 5–Edge-type filter element.

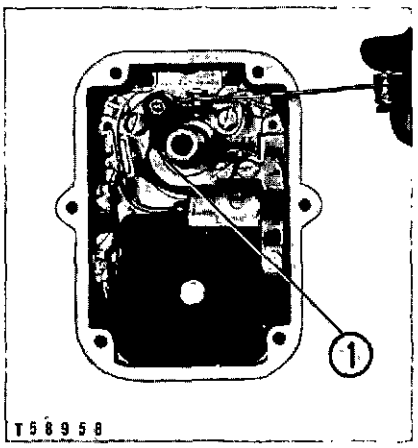
Sediment Bowl Filter: The sediment bowl **(1)** collects water and sediment that may be in the fuel. To remove the collected water and sediment, close the valve **(2)** and remove the bowl by unscrewing the nut **(4)** that clamps it to the body of the valve. Unscrew the edge-type filter element **(5)** and shake it in kerosene or nonflammable cleaning fluid. When the bowl is replaced see that the gasket **(3)** is clean, is in the correct position and is not broken.

STARTING ENGINE MAGNETO

Do Not Lubricate The Magneto At Any Point: The bearings are packed with a ball and roller bearing grease when assembled, and this should be replaced only when the magneto is taken to your Caterpillar dealer for checking or reconditioning.

Checking Contact Point Opening: Every 1000 service hours check the contact point opening.

To check, first remove the distributor cap. Care should be taken in removing the cap not to damage the gasket. Clean any carbon dust from inside the cap and any carbon track from the rotor by using a soft cloth dampened with a noninflammable cleaning fluid. Remove the distributor rotor, then turn the engine until the contact point bumper **(1)** is on one of the highest elevations of the cam. Check the clearance with a thickness gauge beween the contact point as illustrated. This clearance should be .015 inch (.38 mm.).



CHECKING CONTACT POINT OPENING

1–Contact point bumper block on one of the highest elevations of the cam.

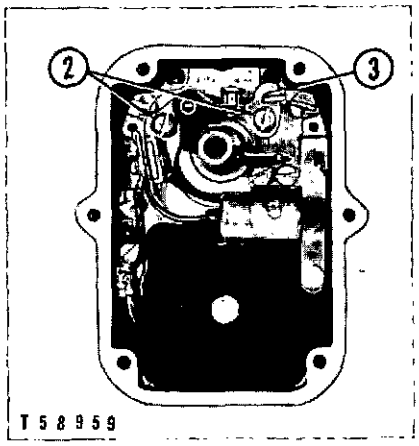
◆

Adjusting Contact Point Opening: Loosen the screws **(2)** which hold the adjustable contact point bracket and move the bracket by inserting a screwdriver in the slot **(3)** and turn either clockwise or counterclockwise until the correct point opening is obtained. Then tighten the fastening screws and recheck the adjustment.

ADJUSTING CONTACT POINT OPENING

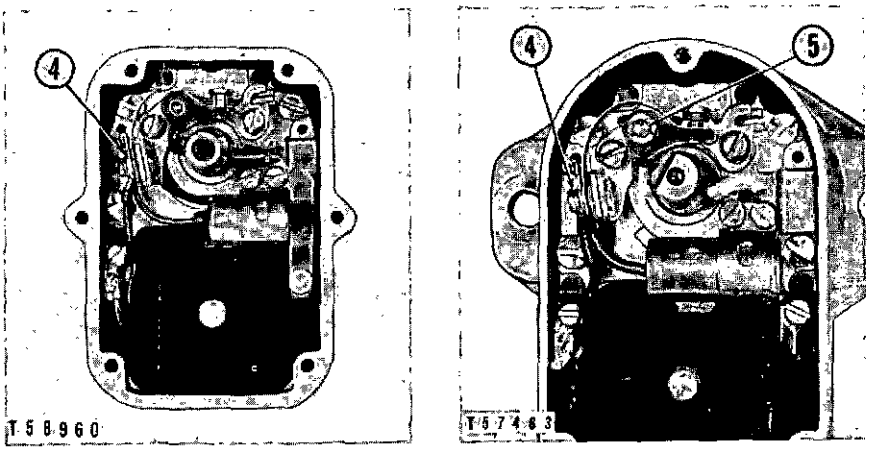
2–Bracket fastening screws.
3–Slot.

◆



To Remove the Contact Points: To remove the contact points on later magnetos remove spring clamp screw **(4)**. Remove the two screws **(2)** used in adjusting contact point opening.

To remove the contact points on earlier magnetos, remove spring clamp screw **(4)**, lock and washer **(5)** and the two screws **(2)** used in adjusting contact point opening.



REMOVING CONTACT POINTS

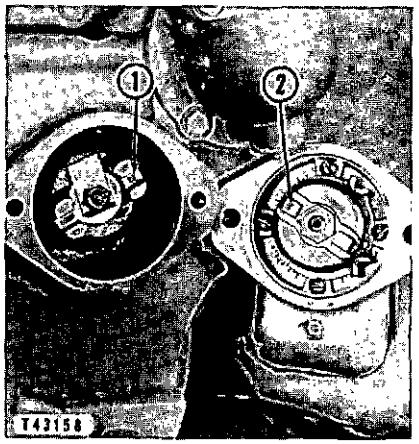
(Later Magneto) **(Earlier Magneto)**

4–Spring clamp screw. 5–Lock and washer.

Testing: A magneto can be tested when coupled to the engine. Remove the cable from a spark plug (rotate the terminal to facilitate removal), insert a 1/4 inch (6 mm.) bolt or similar metal object into the terminal to contact the wire, and hold the terminal so the end of the bolt is 1/8 inch (3.17 mm.) away from the metal base of the spark plug. Turn the magneto switch ON and crank the engine. If no spark occurs between the bolt and the spark plug base, disconnect the switch wire from the terminal on the magneto and test again. If a spark now occurs with the switch wire removed, the wire from the magneto to the switch has become grounded or the switch requires replacement. If, with the switch wire off, the magneto still does not fire, remove the magneto as instructed in the next paragraph and take it to your Caterpillar dealer for testing.

To Remove the Magneto for Testing: Disconnect the cables from the magneto. (One of the cables should be tagged or marked in some convenient manner which will designate the proper position of the cables.) *Remove the two bolts that hold the magneto to the timing gear cover and* lift off the magneto.

To Time the Magneto to the Engine: To time the magneto to the engine, *proceed as follows:*



TIMING MARKS

1–Mark "X" on magneto drive. 2–Mark "X" on the impulse coupling tang.

◆

1. Locate the "X" mark **(1)** on the starting engine magneto drive.
2. Turn the magneto impuse coupling until the "X" mark **(2)** on the tang is in such a position as to line up with the mark on the magneto drive.
3. Install the magneto with the "X" marks together and tighten the bolts.

To Reinstall Magneto Wires: To reconnect the magneto wires proceed as follows:

1. Place the spark plug wire from number 1 cylinder (the cylinder farthest away from the flywheel) into the top wire receptacle of the magneto cap.
2. Install the other spark plug wire.
3. Reconnect ground wire.

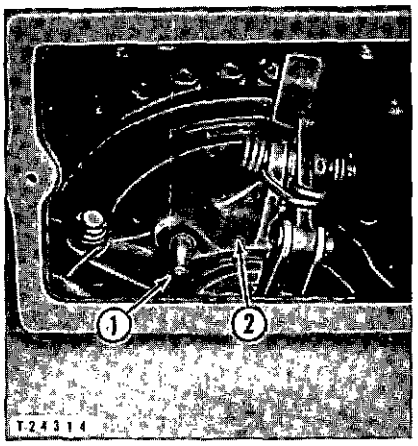
SPARK PLUG ADJUSTMENT

The spark plugs should be examined every 1000 service hours. The gap may be kept at approximately .030 inch (0.76 mm.). Measure this gap with a thickness gauge. To adjust the gap, bend the outer electrode.

ENCLOSED CLUTCHES

To Test The Adjustment: Pull the clutch lever to the engaged position. For a desirable adjustment the lever should engage with a distinct snap, and should require a reasonably hard pull.

Clutch Adjustment: Remove the inspection cover and turn the adjusting ring **(2)** until the lock pin **(1)** can be reached. Pull out the lock pin and tighten the clutch by turning the ring to the right or clockwise until the lock pin drops into the next hole. Test the adjustment by engaging the clutch. If one hole gives too tight an adjustment, and the other gives a slightly loose adjustment, use the looser adjustment. Replace the inspection cover.



CLUTCH ADJUSTMENT

1–Adjusting lock pin. 2–Adjusting ring.

◆

Draining The Flywheel Clutch Housing: The clutch plates are designed to operate dry. The drain plug on the bottom of the flywheel housing, should be removed every 50 service hours to drain any lubricant that may have seeped into the compartment from the engine, or clutch bearings. If lubricant from these points is allowed to accumulate the clutch discs may become sticky and cause difficult operation of the clutch.

BELT ADJUSTMENT
(Fan and Alternator Belts)

The belts should be checked for proper adjustment every 250 service hours.

If the belts are operated too loose, they will slap against the pulleys and cause unnecessary belt wear. The fan belts could possibly slip to the extent the engine might overheat. If the belts are too tight, unnecessary stresses are placed upon the pulley bearings and belts, which may shorten the life of both.

When a vee belt (or belts) needs replacing, a matched set which is available from your Caterpillar dealer should be used. Always install a matched set—never only one.

Checking Belt Adjustment

Fan Belt: Correct adjustment exists when the belts can be pushed inward 9/16 to 13/16 inch (1.4 to 2.0 cm.) with approximately 25 pounds pressure exerted at point **(2)** midway between the fan pulley **(1)** and the crankshaft pulley **(3)**.

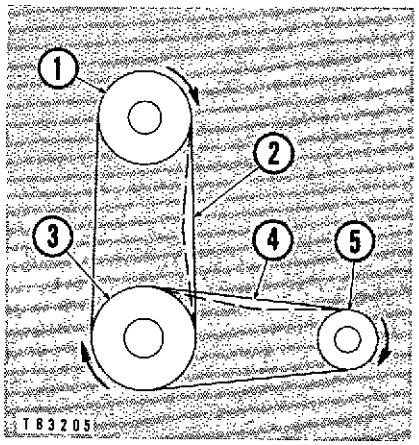
Alternator Belt: Correct adjustment exists when the belt can be pushed inward 9/16 to 13/16 inch (1.4 to 2.0 cm.) with a force of 25 pounds exerted at point **(4)** midway between the alternator pulley **(5)** and the auxiliary drive pulley **(3)**.

CHECKING FAN BELT ADJUSTMENT

(Arrows Beside Each Pulley Indicate Direction of Rotation as Viewed from Front of Engine)

1–Fan pulley. 2–Point where correct fan belt adjustment should be checked. 3–Crankshaft pulley and auxiliary drive pulley. 4–Point where correct alternator belt adjustment should be checked. 5–Alternator pulley.

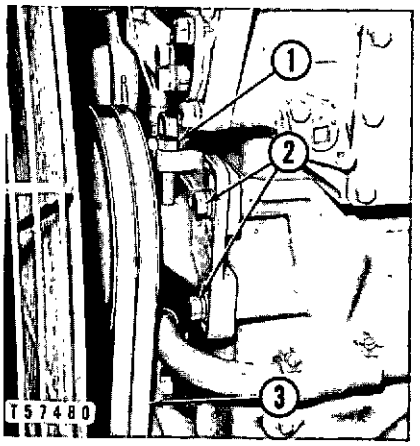
◆



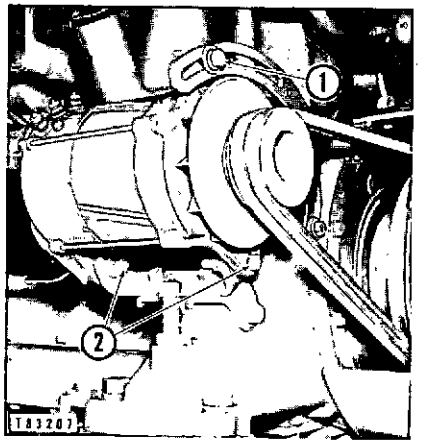
Adjusting Belts

Fan Belts: Loosen the four retaining nuts **(2)** and turn the adjusting screw **(1)** until the belts can be pushed inward approximately 9/16 to 3/16 inch (1.4 to 2.0 cm.) with a force of approximately 25 pounds exerted at a point **(3)** midway between the two pulleys. Check the adjustment after tightening the screw and retaining nuts.

Alternator Belt: Loosen the hinge bolts **(2)** and adjustment bolt **(1)**. Move the alternator up until the belt can be pushed inward 9/16 to 13/16 (1.4 to 2.0 cm.) with a force of approximately 25 pounds exerted midway between the two pulleys. Check the adjustment after tightening the hinge bolts and adjustment bolt.



FAN BELT ADJUSTMENT
1–Adjusting screw. 2–Retaining nuts. 3–Point midway between the two pulleys.



ALTERNATOR BELT ADJUSTMENT
1–Adjustment bolt. 2–Hinge bolt.

ELECTRICAL SYSTEM

The basic electrical system is composed of the following:

Battery.
Generator or charging alternator.
Generator or alternator regulator.
Wiring.

These components functioning together produce the electricity necessary for the electrical equipment on the machine and each is dependent upon the others for satisfactory operation. In the event of failure or improper operation it is essential to check the entire electrical system, as a defect in one component can cause damage to another.

The topics which follow describe the proper maintenance of the components to assure satisfactory operation of the electrical system.

Battery

Every 50 service hours, or whenever ammeter readings indicate a condition of over or under charging, the following attention should be given to the battery to insure high efficiency and maximum operating life.

Testing: The battery should be tested with a hydrometer and kept to a specific gravity of 1.250 or above. Always test a battery for state of charge before adding water. A dangerously low point of charge is indicated by a hydrometer reading of 1.150 which will permit the battery to freeze at temperatures only a few degrees below the freezing point of water. A specific gravity of 1.250 will permit the battery to withstand temperatures as low as —60°F. without freezing.

When the specific gravity difference between cells of the battery exceeds .025, it indicates the battery may soon need replacing.

Water Addition: The electrolyte level should be maintained 3/8 inch (9.5 mm.) above the separators or insulators by addition of distilled water or "approved water" (water free from impurities by analysis). Do not overfill or underfill the cells of the battery as either has a detrimental effect on battery life.

Charging: The charging rate is correct when the battery maintains a minimum specific gravity of 1.250 and does not require the addition of more than 1 ounce of water per cell per week or 50 service hours.

When there is evidence of either overcharging or undercharging, the cause should be found and corrected as soon as possible to protect the service life of the battery. See the topics, GENERATOR, GENERATOR REGULATOR and WIRING.

Cleanliness: Keep the top of the battery clean and dry to prevent current losses and keep the terminals clean and tight. To clean corrosion from the battery terminals, scrub them with a weak solution of bicar-

bonate of soda (baking soda) and water. Dry the battery thoroughly, then coat the terminals with lubricant to prevent corrosion. Keep the battery securely fastened in its compartment at all times.

Installation: When installing a battery in its compartment, fasten it securely and be sure to attach the cables to the correct battery terminals. Incorrect grounding of the battery will reverse the polarity of the electrical system and cause damage to the generator regulator. See the topic, GENERATOR REGULATOR.

Generator

Never operate a generator with an open circuit between it and the battery.

General Reconditioning: Every 2000 service hours, the generator should be removed, the bearings repacked and the commutator and brushes checked for glaze or darkening. At the same time the generator should be completely disassembled, washed and have all parts replaced that show evidence of being unsatisfactory for reason of wear. It is suggested that this cleaning and reconditioning be entrusted to your Caterpillar dealer.

Generator Removal: Remove all wires from the generator and tag them so that they may be correctly connected when the generator is reinstalled. Remove the bolts or stud nuts that hold the generator in position and lift off the generator.

Generator Installation: Whenever a generator is installed, or reconnected to the generator regulator, it must be polarized **before** starting the engine. Follow the instructions carefully to prevent damage to the generator, generator regulator, or both, due to incorrect polarizing.

1. Place the generator in position and install the bolts or stud nuts.
2. Connect all wires to the generator, regulator and battery. See the topic, WIRING.
3. Polarize the generator.

Polarizing (32V-15 Amp) Generators:

1. Disconnect the wire from the generator regulator terminal marked FIELD.
2. Touch the wire which was removed from the FIELD terminal momentarily to the generator regulator terminal marked BAT.
3. Reconnect the wire to the generator regulator terminal marked FIELD.

CAUTION

Always disconnect the wire from the generator regulator terminal marked FIELD. **Never** use a jumper wire between the terminals on the generator regulator or generator marked FIELD, ARM or BAT.

Make sure all connections are tight. See the topics, BATTERY, GENERATOR REGULATOR and WIRING.

Polarizing (12V and 24V) Generators: Connect a jumper momentarily between the regulator terminals marked BAT and GEN.

Generator Regulator

The generator regulator is adjusted at the factory for average operating conditions. The regulator may have to be readjusted to provide the proper charging rate for the particular operating conditions of the machine. In case of failure of either the regulator or generator, both units should be taken to your Caterpillar dealer, where the output of the generator can be checked and the regulator adjusted accordingly.

Charging Rate: The normal function of the generator regulator is to adjust the generator charging rate by sensing the state of charge in the battery. As the battery becomes fully charged, the charging rate should be reduced until the ammeter indicates a rate only perceptibly above zero.

When improper charging of the battery is encountered, the entire electrical system should be carefully checked. Loose or dirty connections, worn or broken wires, or a faulty generator can prevent a good regulator from functioning properly. See the topics, BATTERY, GENERATOR, and WIRING.

Polarity: Electrical systems may have either the positive or negative terminals grounded. When connecting the battery, be sure to ground the same battery terminal that was originally grounded. In new installations or where the battery grounding is questioned, check the generator regulator to determine the polarity of the system. The battery must be grounded as indicated on the regulator or damage will result.

The voltage and polarity of the electrical system are marked either on the cover or on the base of the regulator near a mounting hole. These marks may appear in any of the following forms: "24 VOLTS - NEGATIVE GROUND," "24V - NEG," or "24 V N." Similar marks are used for other voltages and for POSITIVE ground systems.

Charging Alternator

The self-rectifying charging alternator is designed to give long service periods with a minimum amount of maintenance. The grease reservoirs, for each of the two ball bearings on which the rotor is mounted,

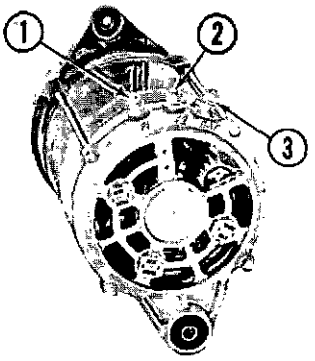
eliminate the need for frequent bearing lubrication. Six rectifier diodes change A. C. power to D. C. power.

Alternator Removal: Remove all wires from the alternator and tag them so that they may be connected correctly when the alternator is reinstalled. Remove the bolts or stud nuts that hold the alternator in position and lift off the alternator.

Charging Alternator Installation: Remove the power supply to the electrical system by disconnecting the positive and negative battery cables. Install the alternator. Connect the tagged wires to the correct alternator terminals and the battery cables to their respective battery terminals.

CAUTION

Do not attempt to polarize the alternator. If an accidental connection is made between the "BAT" terminal **(3)** and either of the "F" terminals, **(1)** or **(2)**, on the alternator, the rectifiers in the alternator and the transistors in the regulators will be damaged.



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CHARGING ALTERNATOR

1–"F1" terminal. 2–"F2" terminal. 3–"BAT" terminal.

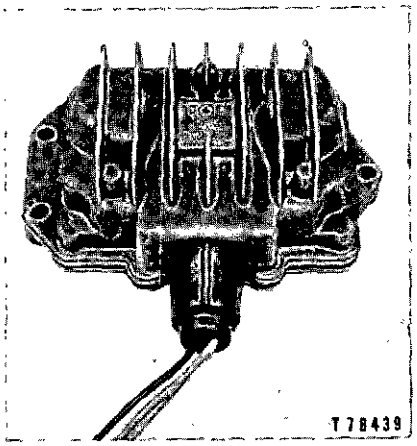
◆

Do not make or break any alternator connections with the alternator operating. Making or breaking an alternator connection with a heavy load on the circuit could result in damage to the voltage regulator. Never operate the alternator without the battery connected in the circuit. When recharging the battery from an external source disconnect the battery from the alternator to prevent damage to the alternator rectifiers. Before using booster cables to start the engine, be sure of the lead polarity and connect the batteries correctly. Do not operate the alternator simultaneously with a DC generator on a common battery circuit.

Alternator Regulator

The alternator regulator should be mounted where the ambient temperatures will not exceed 170° F. in moving air, or 140° F. in still air.

The alternator regulator senses the charge condition of the battery as well as electrical system power demand, and controls the alternator output accordingly. As the battery becomes fully charged, the charging rate should drop until the ammeter indicates a rate only perceptibly above zero.



FULL TRANSISTOR ALTERNATOR REGULATOR

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Charging rate: The alternator regulator is adjusted at the factory for average operating conditions. This voltage setting should maintain the batteries in a fully charged condition and not require more than 1 ounce of water be added per cell per 50 service hours. The regulator may require adjusting to provide the proper charging rate for the particular ambient temperature in which the engine is being operated.

Overcharging of the battery will usually be indicated by the need of frequent additions of make-up water to the battery cells. See the topic, BATTERY; Water Addition. When overcharging occurs, both the alternator and alternator regulator should be checked by your Caterpillar dealer and the alternator output decreased to prevent damage to the battery.

If the battery is undercharged, or continually in a low state of charge, first check the entire electrical system and battery for loose or dirty connections, worn or broken wires, or corroded terminals. Then have the output of the alternator checked and adjusted by your Caterpillar dealer.

Fuel Pressure Switch

An engine equipped with an alternator uses a fuel pressure switch to prevent electrical current from flowing to the alternator and damaging it when the engine is not running. The switch will operate with 3 to 4 PSI fuel pressure.

When the engine is stopped, the switch will open and de-energize the field relay, thus opening the field circuit between the ammeter and battery. When the engine is running, fuel pressure will hold the switch

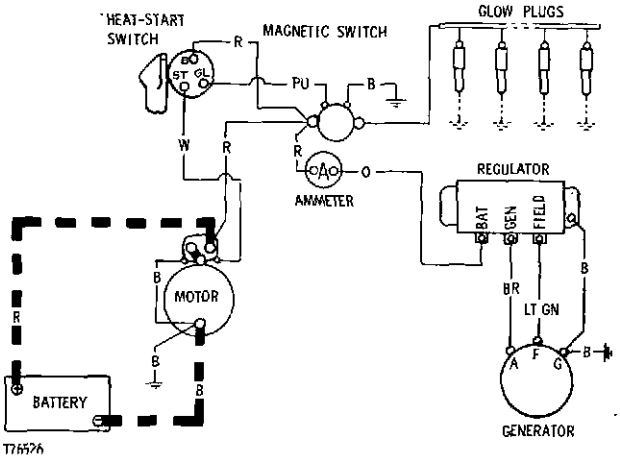
closed, permitting electrical current to flow from the alternator to charge the battery.

The fuel pressure switch is located in the (clean fuel) side of the fuel filter housing. If it is suspected that the switch is malfunctioning, replace the switch.

Wiring

The wiring forms an important part of the electrical system and care should be used to protect it from damage. When the electrical system is being serviced, check the wiring for loose or dirty connections, worn insulation or broken wires. Inspect the battery terminals and cables. Poor connections or wiring can cause trouble or damage in other parts of the electrical system. See the topics, BATTERY, GENERATOR, GENERATOR REGULATOR, ALTERNATOR and ALTERNATOR REGULATOR.

Wiring Diagrams: The diagrams are furnished so that when it becomes necessary to disturb the electrical equipment for purpose of reconditioning or parts replacement, reassembling may be accomplished without difficulty. The battery terminal to be grounded is determined by the generator regulator. See the topic, POLARITY.



WIRING DIAGRAM FOR ELECTRIC STARTING SYSTEM WITH EITHER 12, 24 OR 32 VOLT CHARGING GENERATOR AND GLOW PLUGS

COLOR CODE	
B	BLACK
W	WHITE
R	RED
O	ORANGE
BR	BROWN
LT GN	LIGHT GREEN
PU	PURPLE
W/B	WHITE WITH BLACK STRIPE

MAXIMUM RECOMMENDED TOTAL BATTERY CABLE LENGTH		
CABLE SIZE	DIRECT ELECTRIC STARTING	
	12 VOLT	24-32 VOLT
0	4.0 FEET	15.0 FEET
00	5.0 FEET	18.0 FEET
000	6.0 FEET	21.0 FEET
0000	7.5 FEET	27.0 FEET

WIRE AND CABLE SHOWN DOTTED, CUSTOMER FURNISHED.

IF ALTERNATOR RATED OUTPUT IS GREATER THAN 45 AMPERES, THE WIRES MARKED ⊗ ARE TO BE WIRED WITH THE HEAVY GAUGE WIRE SUPPLIED IN THE WIRING KIT GROUP.

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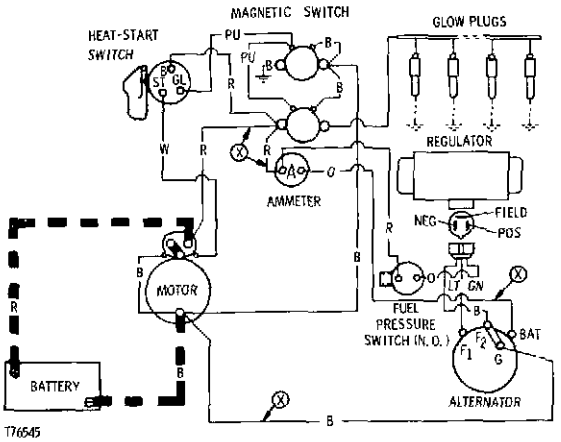

WIRING DIAGRAM FOR ELECTRIC STARTING SYSTEM WITH 32 VOLT 60 AMPERE CHARGING ALTERNATOR AND GLOW PLUGS

ELECTRIC STARTER
(12 and 32 volt systems)

No periodic service is indicated for the electric starter brushes between general reconditioning periods. The brushes should only be inspected *after removal of the starter from the engine and removal of the commutator* end bearing frame. Replace worn brushes.

Most starting motors have three bearings which should be lubricated *with crankcase lubricating oil. When plugs and wicks are* provided, remove the plugs and saturate the wicks with oil when the starting motor is reconditioned or removed. When wicks are not provided apply two or three drops of oil to the bearings when the starter motor is disassembled for reconditioning. Over lubrication of the commutator end bearing may cause gum to build up on the commutator and cause poor commutation.

General Reconditioning: Approximately every 4,000 service hours, the starter should be removed so that it may be completely disassembled, washed and have all parts replaced that show evidence of being unsatisfactory for reason of wear. Do not use a degreaser or high temperature cleaning method when cleaning parts of the starter or overrunning clutch. If the overrunning clutch turns roughly when rotated in the overrunning direction or slips in the cranking direction, after the clutch has been washed, it must be replaced with a new clutch. It is suggested that cleaning *and reconditioning be entrusted to your Caterpillar dealer.*

GLOW PLUGS

Maintenance: If it is suspected that the glow plugs are not correctly assisting in starting, the system should be checked for defective glow plugs with the engine stopped.

Disconnect the glow plug lead wire from the magnetic switch. Connect an ammeter of sufficient capacity between the glow plug side of the magnetic switch and the lead wire to the glow plug harness. Then turn the HEAT-START switch to the HEAT position. The ammeter reading should be approximately equal to the number of glow plugs in the system multiplied by the amperes used by each glow plug. A reading that varies appreciably from this may indicate one or more defective glow plugs.

Each glow plug will use approximately 5 amperes.

To locate the defective glow plug or plugs, check each glow plug separately by removing the leads from the glow plugs, one at a time, with the HEAT-START switch in the HEAT position. **Reconnect the lead to the glow plug before removing the lead from the next glow plug to be checked.** When a lead is removed from a glow plug with no variation shown on the ammeter, is can be assumed that the glow plug is defective and should be replaced.

GLOW PLUG

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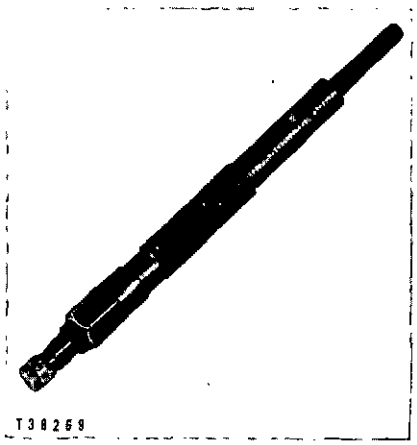


CAUTION

When checking the system for defective glow plugs, the HEAT-START switch should not be held in the HEAT position over one half minute with a lead disconnected from a glow plug. When a lead is removed from a glow plug and the switch moved to the HEAT position, more load is thrown on the remaining plugs in the system, increasing the possibility of burning out additional plugs.

To remove a defective glow plug, disconnect the lead from the glow plug and unscrew the glow plug from the precombustion chamber.

Apply anti-seizure compound to the thread of new glow plug and install the glow plug into the precombustion chamber tightening it to torque of 10 to 12 pounds feet.

The glow plug should first be removed before removing and replacing a fuel injection valve to eliminate the possibility of damaging the glow plug.

AIR STARTING MOTOR OILER

The air starting motor oiler automatically meters oil into the air system in the form of a fine fog to lubricate the air motor vanes when the air control valve is opened. An air director tube (venturi tube) located in the air passage of the oiler body **(3)** delivers air pressure above the oil in bowl **(4)**. Oil flows from the bowl through a tube and drilled passage in oiler body **(3)** into the air stream and then to the motor.

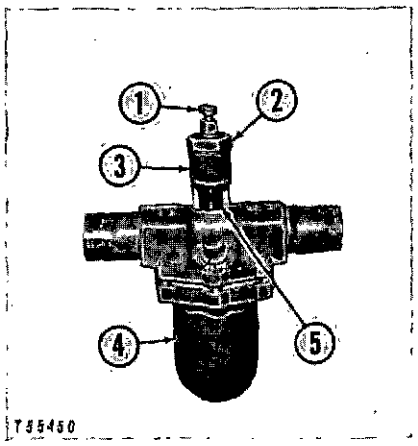
The oiler is designed to operate satisfactorily in a perpendicular position as long as the bowl is kept filled with lubricant. The oiler should be regulated to meter about four drops of oil per minute to the air stream.

Oil drips into the air stream only when air passes through the oil to the air motor.

To regulate the drops of oil from the oiler.

1. Crank the engine with the compression release lever in the start position and the governor control in the shut-off position.
2. Turn valve needle **(1)** counterclockwise to increase or clockwise to decrease the amount of oil.
3. While cranking the engine watch the sight feed glass **(5)** to see the oil dripping.

If the oiler becomes clogged or cannot be adjusted to deliver the proper quantity of oil, remove top plug **(2)** and valve needle **(1)** from the plug. Lift the oil drip gland out of the body and wash it in kerosene or some nonflammable cleaning fluid. Be sure the oil passage is open



AIR STARTING MOTOR OILER

1–Valve needle. 2–Top plug. 3–Oiler body. 4–Bowl. 5–Sight feed glass.

◆

in both the body and drip gland before reinstalling the top plug. If it is suspected that dirt or sludge has accumulated in bowl **(4)** remove the bowl and clean it thoroughly in kerosene or some nonflammable cleaning fluid and blow out the passages in the body with compressed air.

SAFETY SHUT-OFF CONTROLS

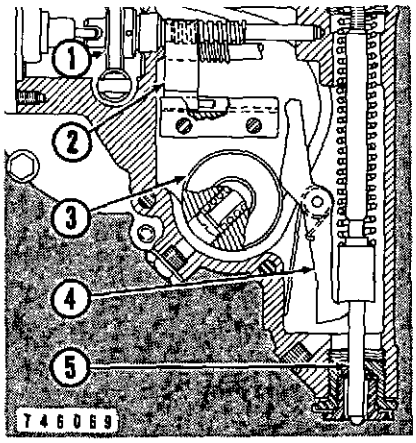
The purpose of safety shut-off controls is to provide a means of automatically stopping the engine to prevent damage when the oil pressure becomes dangerously low or when the cooling system temperature becomes excessively high or the engine overspeeds.

The high water temperature shut-off is a safety control that is used only with the oil pressure shut-off control, in that it is a valve that lowers the oil pressure in the safety shut-off control when high water temperature occurs. Actually it is the low oil pressure shut-off control that functions and stops the engine when high water temperatures occur.

In the event that the safety shut-off has stopped the engine because of overspeed, low oil pressure or high water temperature, the reason for the shut-off must be determined and corrected before attempting to restart the engine.

Overspeed and Oil Pressure Shut-Off

Operation: The safety shut-off control is geared to the diesel engine. The overspeed carrier **(3)** and worm shaft **(1)** are always turning whenever the diesel engine crankshaft is rotating. The latch **(4)**, when latched as shown, holds the spring loaded rod **(5)** away from the diesel engine fuel injection pump rack. Slide **(2)** has a rack that can mesh with worm shaft **(1)**. Diesel engine lubricating oil pressure holds the slide away from the worm shaft. If the lubricating oil pressure drops and stays below safe operating limits, slide **(2)** meshes with and moves along worm shaft **(1)**. In seven seconds, at engine operating speed, the slide contacts latch



SAFETY SHUT-OFF CONTROL

1–Worm shaft. 2–Slide. 3–Overspeed carrier. 4–Latch. 5–Rod.

◆

(4) and unlatches rod (5). The spring loaded rod when unlatched, moves and holds the fuel injection pump rack in the shut-off position thus stopping the diesel engine. *If the diesel engine overspeeds, a spring controlled* weight in overspeed carrier (3) moves out by centrifugal force, strikes latch (4) and unlatches rod (5) stopping the diesel engine as previously explained.

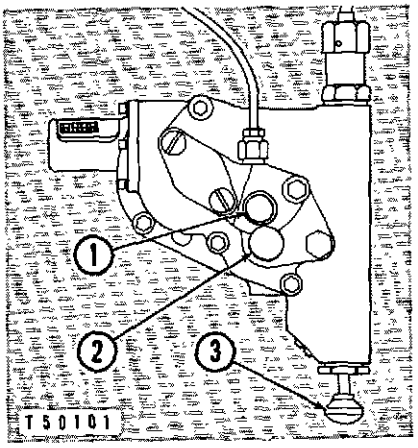
The safety shut-off control must be reset by pulling on the safety shut-off control reset knob before the diesel engine fuel injection pump rack can be moved from the shut-off position.

The diesel engine can be stopped by pushing the manual shut-off button (2). The shut-off button, when pushed, simulates an overspeed engine condition by mechanically moving the spring controlled weight far enough out of the overspeed carrier until the weight strikes the latch and releases the spring loaded rod. The rod, when released moves and holds the fuel injection pump rack in the shut-off position, thus stopping the engine.

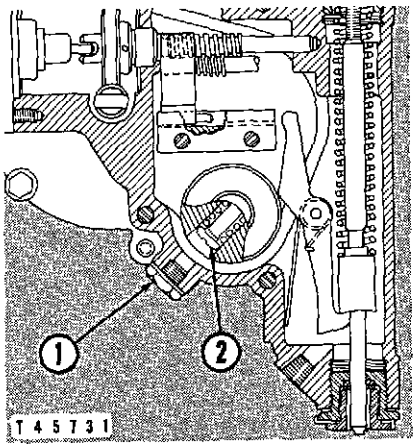
Resetting the Safety Shut-off Control: Before the engine can be started because the safety shut-off stopped the engine, push in the reset button (1) and push up the reset knob (3) until the safety shut-off mechanism latches. The knob will remain up when the control is correctly set.

CAUTION

After starting, if sufficient oil pressure has not developed, the safety shut-off control will stop the engine again after running approximately seven seconds. Therefore, **check the oil pressure *immediately*** *after starting by observing the oil* pressure gauge indicator to see that it is in the operating range.



SAFETY SHUT-OFF CONTROL
1–Reset button. 2–Manual shut-off button. 3–Reset knob.



SAFETY SHUT-OFF CONTROL ADJUSTMENT
1–Plug. 2–Weight adjusting screw.

Safety Shut-off Control Adjustment: The only adjustment is for maximum RPM shut-off. Whenever the control has been disassembled or the adjustment disturbed, adjust the maximum RPM shut-off as follows:

1. Remove the plug **(1)** from the bottom of the shut-off control housing.
2. Turn the weight adjusting screw **(2)** in (clockwise) to raise and out (counterclockwise) to lower the maximum RPM shut-off. One complete turn will change the maximum limit 45 to 50 RPM.

NOTE

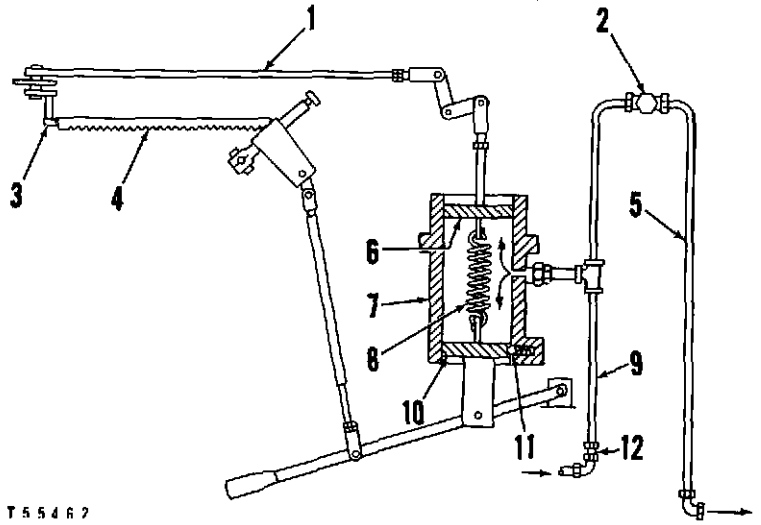
It may be necessary to rotate the engine flywheel until the adjusting screw can be reached with a screwdriver.

There is no low oil pressure or high water temperature shut-off adjustment.

Oil Pressure Shut-Off

Operation: When the engine is operating with normal lubricating oil pressure, the oil is forced by the crankcase lubricating oil pump through orifice **(12)** and oil pressure line **(9)**, into the oil pressure shut-off housing **(7)** and between piston **(6)** and **(10)**, and up to the water temperature shut-off valve **(2)**. The water temperature valve **(2)** blocks the flow of oil through oil dump line **(5)** when the engine water temperature does not exceed the normal operating temperature.

The oil pressure inside the housing **(7)** pushes against and separates reset piston **(10)** from control piston **(6)**. Piston **(10)** moves downward to a



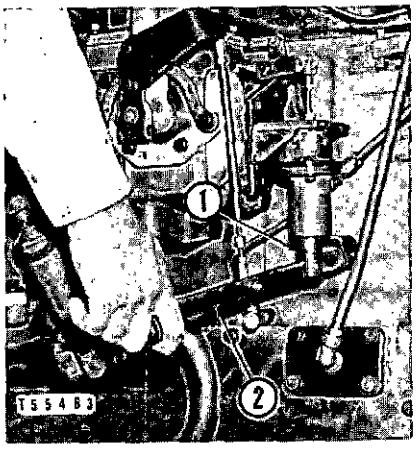
OIL PRESSURE SHUT-OFF CONTROL

1–Control rod.
2–Water temperature shut-off.
3–Rack shut-down lever.
4–Fuel rack.
5–Oil dump line.
6–Control piston.
7–Oil pressure shut-off housing.
8–Spring.
9–Oil pressure line.
10–Reset piston
11–Detent.
12–Orifice.

position where detent **(11)** engages and holds the piston. Piston **(6)** moves upward; and by means of linkage and control rod **(1)**, rack shut down lever **(3)** moves out of contact with fuel rack **(4)**.

If the oil pressure drops below a safe operating pressure with piston **(10)** latched in the detent, spring **(8)** will pull piston **(6)** down. As piston **(6)** moves down, the connected linkage and rod **(1)** causes lever **(3)** to contact the end of the fuel rack and moves it to the shut-off position, stopping the engine.

Starting the Engine: After the engine has been stopped for any reason, and before restarting, the rack shut-down lever must be released from the



RESET POSITION OF PISTON

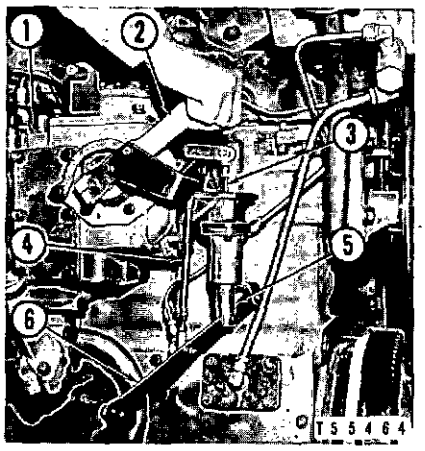
1–Reset piston. 2–Reset control lever.

◆

fuel rack. Otherwise, the shut-off control will keep the rack in the shut-off position until normal operating oil pressure is built up by overworking the starting system. Release the shut-off control by raising the reset control lever **(2)** to the upper position. This will release piston **(1)** from the detent. Place the governor control lever in low idle to 1/3 open position and start the diesel engine according to the Operation and Maintenance Instructions.

After Starting: After the engine starts, operate the engine near low idle speed until the oil pressure gauge indicates normal oil pressure. At this time, piston **(5)** will move down to engage with the detent and piston **(3)** will move up to position the control linkage so that the fuel rack can move freely while running at full governed speed.

If proper oil pressure is not developed, pistons **(3)** and **(5)** will remain in a neutral position pulled together by the spring; the shut-off mechanism will not function automatically; and the engine will continue to run at low idle speed. As soon as an attempt is made to move the governor control



SAFETY CONTROL LEVERS

1–Control rod. 2–Governor control lever. 3–Control piston. 4–Tube. 5–Reset piston. 6–Reset control lever.

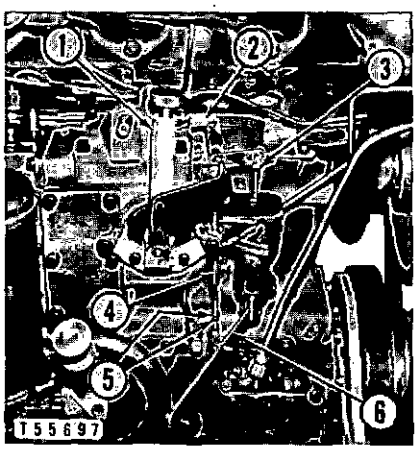
◆

lever **(2)** into an operating range, tube **(4)** telescopes to permit the forward motion of lever **(2)** to push reset lever **(6)** downward which in turn pulls piston **(5)** downward. Absence of oil pressure permits the spring to pull control piston **(3)** down from its normal position, control rod **(1)** will engage and move the rack forward to shut off the injection pumps; stopping the engine.

Adjustment: With the governor control lever **(1)** at low idle stop, remove and install the governor control lever in a vertical or slightly clockwise from vertical position.

Move the governor control lever **(1)** to the shut-off position. Push oil pressure reset control lever **(6)** down until the reset piston engages the detent inside the shut-off housing. Adjust the length of the shut-down linkage at rod ends **(3)** and **(2)** until the rack shut-down lever just touches the end of the rack. Tighten all nuts and install cotter pins.

With the engine shut down, adjust the length of the telescoping linkage between the governor control lever **(1)** and reset control lever **(6)**. Move



ADJUSTMENT

1–Governor control lever. 2–Rod end. 3–Rod end. 4–Tube. 5–Locknuts. 6–Reset control lever.

◆

the governor control lever to full load position and move lever **(6)** to the upper position. Adjust locknuts **(5)** by running the nuts against tube **(4)** and then backing them off 1/4 to 1/2 turn.

Start the engine and make sure the shut-down lever does not contact the fuel rack when the rack is in the full load position.

CAUTION

The rack travel must not be restricted at any time, otherwise the engine will not develop full power.

Water Temperature Shut-Off

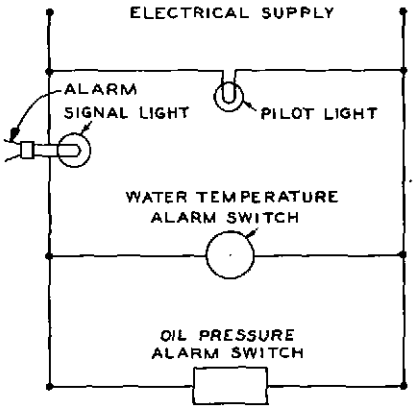
WATER TEMPERATURE SHUT-OFF

1–Water temperature shut-off.
2–Dump line.

◆

The water temperature shut-off **(1)** is used only with an oil pressure shut-off. In the event the engine water temperature becomes excessively high, the valve opens permitting the pressurized oil to return to the crankcase through dump line **(2)**. This reduction in oil line pressure simulates a loss of lubricating oil pressure to the low oil pressure safety shut-off which then operates to stop the engine.

SAFETY ALARM SWITCHES



TYPICAL SAFETY ALARM CIRCUIT

◆

The engine may be equipped with a water temperature alarm switch and an oil pressure alarm switch. A signal light, horn or bell or a combination can be placed in the circuit so that the operator will be warned in case the water temperature or oil pressure reaches dangerous levels. The operator can then shut down the engine and correct the difficulty. For further information see your Caterpillar dealer.

Water Temperature Alarm Switch

The water temperature alarm switch is located either in the cover above the water temperature regulator housing or in the regulator housing if not equipped with safety shut-off arrangement. Earlier switches are single throw, snap-acting, magnetic switches. They remain open during cold and normal water temperature ranges, and they close to sound the alarm when excessive temperatures are reached. Later switches are single pole — double throw switches and can be connected to be either normally open or normally closed.

The switch is designed to be installed in series with an alarm switch or relay switch having a rating not to exceed the maximum as follows:

1. In circuits of single phase, 115 volts alternating current, connected directly to the alarm, 5 amperes.
2. In circuits of single phase, 230 volts alternating current, connected directly to the relay, 2.5 amperes.
3. In circuits up to 600 volts alternating current, where another switch (relay) is operated, 1 ampere.
4. In circuits of 125 volts, where a direct current relay is employed, .5 ampere.
5. In circuits of 250 volts, where a direct current relay is employed, .25 ampere.

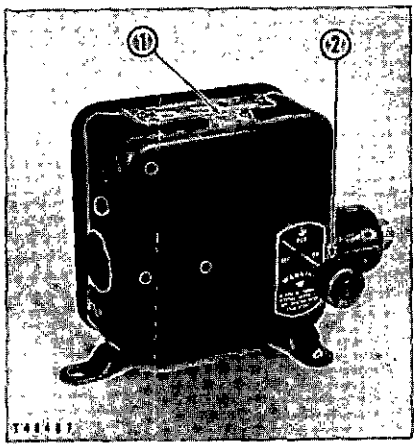
Oil Pressure Alarm Switch

The oil pressure alarm switch may be mounted on a bracket between the flywheel housing and the fuel filter housing. When the engine oil pressure drops to the danger point a diaphragm actuates the contact points thus closing the circuit to sound the alarm.

The switch is designed to be installed in series with an alarm or relay switch having a rating not to exceed the maximum as follows:

1—Circuits of 115 volts, alternating current, 15 amperes.
2—Circuits of 230 volts, alternating current, 15 amperes.
3—Circuits of 6 to 32 volts, direct current, 15 amperes.
4—Circuits of 115 volts, direct current, 6.5 amperes.
5—Circuits of 230 volts, direct current, 3.3 amperes.

Oil Pressure Alarm Switch Operation: When the engine is stopped the oil pressure drops closing the switch and causing the alarm to sound. A control knob **(2)** is provided to stop the alarm when the arrow on the knob is turned to the START or OFF position. When the pressure builds up, the knob automatically flips to RUN position. Watch to be sure it does change



OIL PRESSURE ALARM SWITCH
1–Adjusting screw. 2–Control knob.

◆

after each start, as this indicates that alarm contactor is ready to function in case of no oil pressure.

Adjustments: This control was originally set at factory but if it is necessary to change factory setting, proceed as follows:

1—Set manual control knob with arrow pointing to RUN. This places the control in the running position.

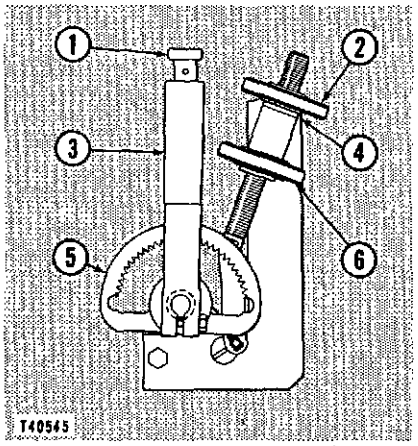
2—Decrease all tension on main spring by turning adjusting screw **(1)** to left (counterclockwise).

3—Connect pressure bellows to air pressure line and apply pressure at which contacts are to close, sounding alarm.

4—Hold pressure on bellows constant and turn adjusting screw to right (clockwise) just to point where contacts open.

VERNIER GOVERNOR CONTROL

The vernier type governor control provides a means of adjusting engine speed to the exact speed desired. This is particularly desirable when paralleling electric sets and when loading engines that are operating in parallel. To move the governor control lever **(3)** to a position on quadrant **(5)** for the approximate engine speed required, push in knob **(1)** on control lever **(3)** and move the lever to that approximate position. To make slight engine speed changes, turn the adjusting nuts to unlock the adjustment. Turn the lower adjusting nut **(6)** clockwise to increase speed and counterclockwise to decrease engine speed. Lock the adjustment when



VERNIER GOVERNOR CONTROL

1–Knob. 2–Upper adjusting nut. 3–Governor control lever. 4–Yoke. 5–Quadrant. 6–Lower adjusting nut.

◆

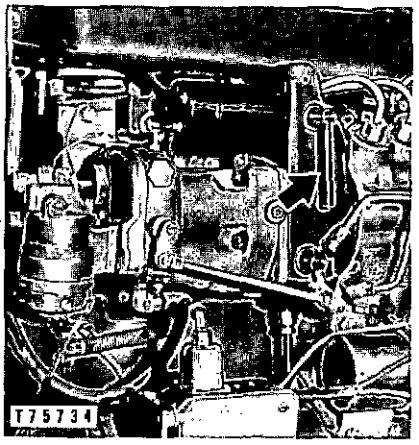
the diesel engine is running at the desired speed by turning the upper adjusting nut **(2)** against the yoke **(4)** locking the adjustment. To stop the diesel engine, push in the knob on the governor control lever and move the lever all the way forward to shut off the fuel injection pumps, stopping the engine.

WOODWARD GOVERNOR

If the engine is equipped with a Woodward PSG governor, stop the engine after all load has been removed from it by pulling the lever back from its run position. After the engine has stopped, move the lever forward to the run position so the engine is ready to start.

MANUAL SHUT-OFF LEVER IN RUN POSITION

◆



ELECTRIC SET WOODWARD UG8 GOVERNOR

Starting the Engine

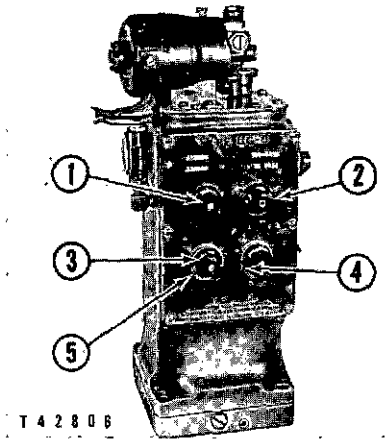
Make the usual checks of lubricant, coolant, fuel supply, cranking capacity (if air starting is used) and disengage the flywheel clutch or remove any load from the engine then perform the following steps:

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

2. Turn the synchronizer knob **(2)** clockwise or in "fast" direction until the synchronizer indicator **(4)** registers "8" on the dial. This setting is for an initial start, and experience will determine the correct setting for individual engines. The synchronizer knob controls engine speed the same as a governor control lever or throttle.

3. Start the engine and allow it to run at about half normal engine speed for five minutes before applying the load. Do not allow the engine to run below 900 RPM. To adjust the engine speed, turn the synchronizer knob.

4. Turn the load limit knob indicator to "10" which will allow the engine to carry the load as it is applied in step 7. This can be done without



WOODWARD UG8 GOVERNOR

1–Speed droop knob. 2–Synchronizer knob. 3–Load limit knob. 4–Synchronizer indicator. 5–Load indicator pointer.

◆

overloading of the engine as the load is applied in step 7 because all Caterpillar engines have a separate rack stop to prevent engine overloading.

5. Turn the synchronizer knob clockwise until the engine runs at full governed speed.

6. Three general groups of applications have different speed droop knob settings preliminary to applying the load in step 7 as follows:

   A—Single Unit Application:

   If the engine is to operate as a single unit, that is, not compounded with other electric sets or line shafts, the speed droop knob **(1)** indicator should be left at "0" then proceed with step 7.

   B—A. C. Generator Paralleling Application Or Solid Line Shaft Compounding:

If the engine is operating on an A.C. generator which is to be paralleled with other A.C. generators, or is to be compounded on solid line shafting, set the speed droop knob indicator between "30" and "70", then proceed with step 7.

C—D. C. Generator, Fluid Coupling And Other Compound Applications:

If the engine is operating a D.C. generator or applications other than an A.C. generator which is to be compounded with units with similar drives, the speed droop knob indicator should be set at the lowest value which will give a satisfactory load division when the load is applied in step 7. Experience will determine this setting.

7. Apply the load. Readjust synchronizer knob and/or speed droop knob if necessary to secure load division if the unit is paralleled or compounded. The load indicator pointer **(5)** behind the load limit knob indicates the relative position of the fuel rack and indicates relatively the load on the engine.

The above steps are basically what should be done to start and run the engine when equipped with Woodward UG8 Governor. There are differences in installation and applications, particularly compounded applications, which require adjustments so varied that specific instructions cannot be given in this book. However, the adjustment to the governor after the load is on the engine have the following effects:

The engine with the lowest speed droop setting will be the engine which will respond to and carry load increases. The speed droop may have to be adjusted on one or both engines to give speed droops which will result in stable operation and yet provide for load division as the amount of load increases.

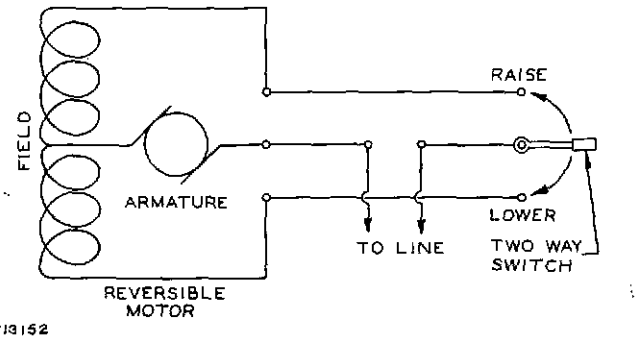
To cause an engine to assume more of the continuous load, turn the synchronizer knob clockwise. When the engines are paralleled on A.C. generators or solid line shafting etc., individual engine outputs are adjusted by turning the synchronizer knob.

The synchronizer indicator **(4)** merely indicates how many turns of the synchronizer knob have been made.

To Stop the Engine

1. Remove the load and turn the synchronizer knob to allow the engine to idle at about half normal engine speed (a minimum of 900 RPM on an electric set) for five minutes before stopping. (If the knob is left in this position, step 2 of starting need not be observed at the next start).

2. Stop the engine by turning the load limit knob to "0". If the temperature is below freezing, or if freezing weather is expected before the engine will be started again, drain the cooling system or protect it with an anti-freeze solution. See the topic, COOLING SYSTEM.



GOVERNOR SYNCHRONIZER MOTOR WIRING DIAGRAM

Synchronizing Motor: A synchronizing motor may be mounted on a special cover for the UG8 governor to provide remote speed control. Its use enables the switchboard operator to match the frequency of an engine driven alternator with that of other units, or a system, before synchronizing and to change load distribution after synchronizing.

The motor used is of the split field, series wound, reversible type. It can be used on either direct current or alternating current at its specified voltage. It should be wired as shown.

◆

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FORM FE033743-05

1-67
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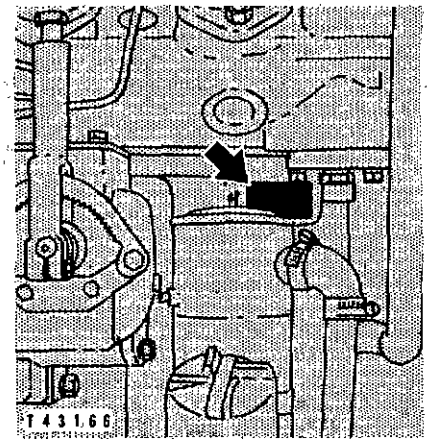
Capacities

Approximate Quantities

	U.S. Measure	Imperial Measure	Metric Measure Liters
Crankcase Lubricating Oil System,			
Diesel Engine	46 qt.	38.2 qt.	43,4
Starting Engine	2.5 qt.	2.1 qt.	2,4
Fuel Tank, Starting Engine	8 qt.	6.4 qt.	7,57
Cooling System (Engine Only)	12 gal.	10 gal.	45,2
Engine With Radiator (Standard)	20.5 gal.	17.1 gal.	77,6
Engine With Radiator (High Capacity)	24 gal.	20 gal.	90,8

Location Of Serial Number



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