FORM 31603-7

OPERATION AND MAINTENANCE INSTRUCTIONS

CATERPILLAR

D342 ENGINE

SERIAL NUMBERS

31B1-UP

Caterpillar Tractor Co., General Offices, Peoria, Illinois. • Caterpillar Americas Co., Peoria, Illinois. • Caterpillar Overseas S.A., Geneva. • Caterpillar of Australia Pty. Ltd., Melbourne. • Caterpillar Brasil S.A., São Paulo. • Caterpillar Tractor Co. Ltd., Glasgow. • Caterpillar of Canada Ltd., Toronto. • Caterpillar France S.A., Grenoble. • Caterpillar (Africa) (Pty.) Ltd., Johannesburg. • Caterpillar Mexicana S.A. de C.V., Monterrey.

Warranty

Caterpillar Tractor Co. warrants products sold by it for six (6) months after date of delivery to the initial user, subject to the succeeding provisions hereof. This warranty is limited to the repair or replacement, as Caterpillar Tractor Co. may elect, at one of its factories designated by it, of such parts as shall appear to it, upon inspection, to have been defective in material or workmanship, but does not include any installation or transportation costs. No warranty is made with respect to items made by others (except items made by direct or indirect subsidiaries of Caterpillar Tractor Co.) when such items are warranted by their respective makers or when they are supplied by Caterpillar Tractor Co. on special order. No other warranty of any kind is made or authorized by Caterpillar Tractor Co., and no recommendation of items made by others shall imply or constitute any warranty with respect to such items.

T54255

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

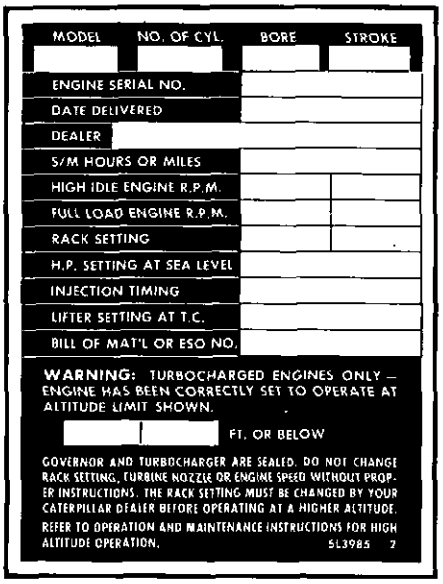
Avoid Accidents

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."



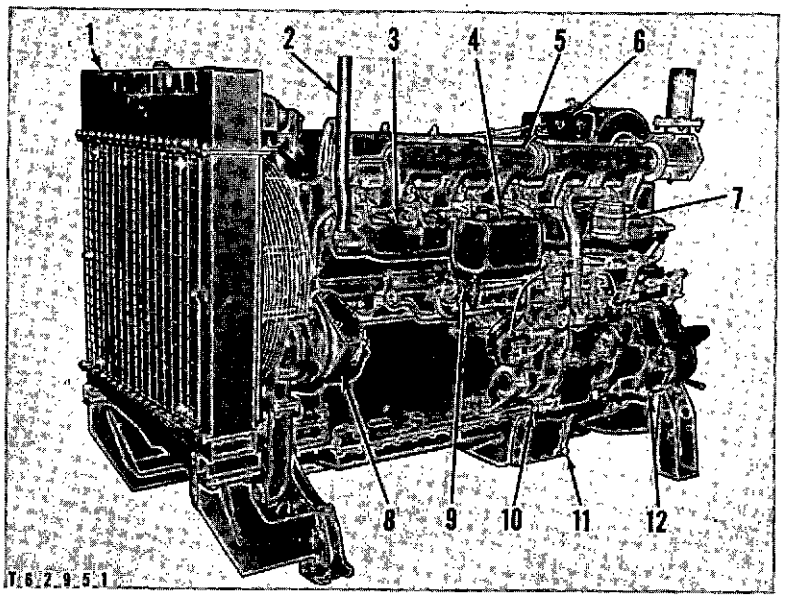
Altitude Operation Warning Plate

THIS PLATE IS MOUNTED ON THE ENGINE. A SIMILAR ALTITUDE WARNING PLATE SHOULD BE MOUNTED SO AS TO BE IN FULL VIEW OF THE OPERATOR.

For additional information concerning safe altitude operation, see the topic, ALTITUDE OPERATION.

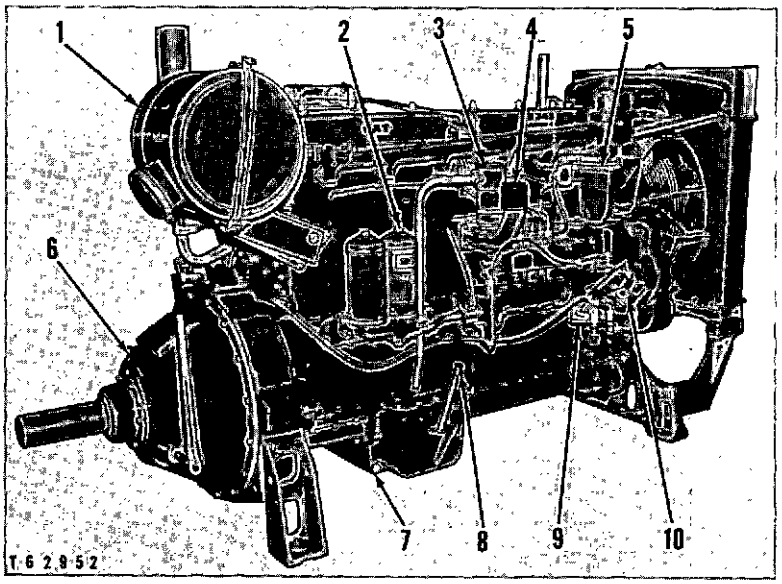
T63404

Table of Contents



D342 ENGINE — WITH GASOLINE START — LEFT FRONT VIEW

1–Radiator. 2–Starting engine exhaust pipe. 3–Diesel engine air inlet manifold. 4–Starting engine fuel tank. 5–Diesel engine exhaust manifold. 6–Gauge panel. 7–Starting engine air cleaner. 8–Water pump. 9–Starting engine fuel tank shut-off valve. 10–Starting engine crankcase drain plug. 11–Diesel engine crankcase drain plug. 12–Starting engine transmission drain valve.



D342 ENGINE — WITH GASOLINE START — RIGHT REAR VIEW

1–Diesel engine dry type air cleaner. 2–Crankcase lubricating oil filter housings. 3–Crankcase breather. 4–Crankcase oil filler cover. 5–Fuel filter housing. 6–Enclosed flywheel clutch. 7–Diesel engine crankcase drain plug. 8–Crankcase oil level gauge. 9–Fuel transfer pump. 10–Service meter.

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. With any type of installation a water cooled oil cooler is recommended. 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 line 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 shipping straps, brackets, bolts, skids and coverings to be sure they have all been removed before operation of the engine.

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.

AIR SUPPLY

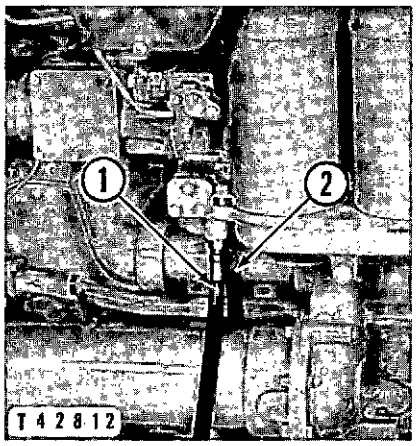
It is advisable to use a special precleaner or air inlet pipe extension on engines operating in extremely dusty conditions to keep the air precleaner up out of the dust and to prevent dust and lint entering the air cleaner.

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 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.

◆

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)** 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.

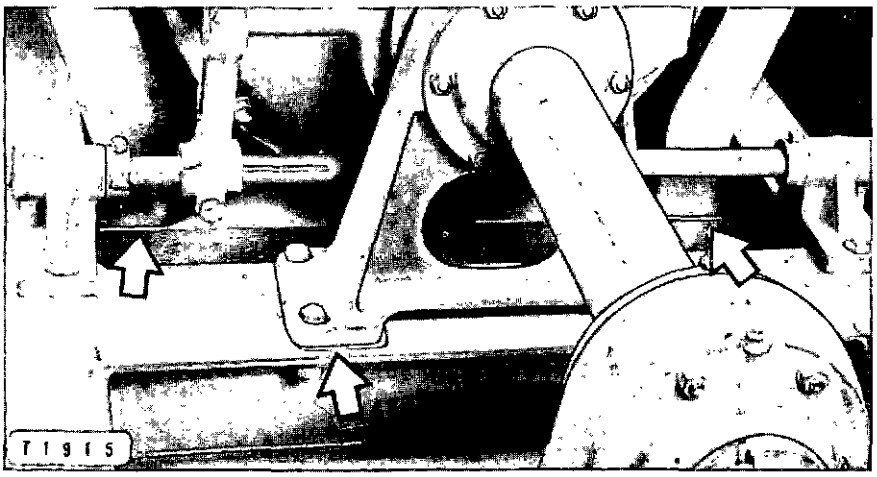
BASE

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.

ENGINE AND CLUTCH ALIGNMENT

After an engine equipped with an open type clutch has been secured to the foundation, the engine should be aligned with the clutch and clutch shaft by removing or adding shims under the engine rear support brackets and clutch shaft front bearing pillow block. Additional shims for this purpose are furnished with the open type clutch.



SHIMS FOR ALIGNING OPEN TYPE CLUTCH

The standard engine, with a flywheel clutch, has the flywheel clutch control lever located on the left side of the unit. If the installation of the unit makes it desirable, this control may be shifted to the right side.

GENERATOR REGULATOR INSTALLATION

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

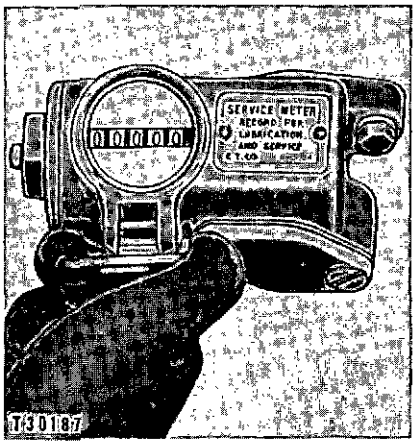
◆

Lubrication Instructions

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

SERVICE METER

The Service Meter is located on the right side of the engine near the bottom of the governor housing. It is geared to the engine, and when the crankshaft turns as many revolutions as are made in an hour at average speed, or 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.



COVER ON SERVICE METER RAISED TO OBSERVE DIAL READING

◆

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 LUBRICATION INFORMATION

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 hourly intervals of servicing according to service hours.

Drain oil, check oil levels and refill compartments with the engine level. It is best to drain oil when it is warm, after the engine has run for some time. Then, most of the sediment will be in suspension, and therefore will readily drain.

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

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 and contribute to quicker starting.

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.

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 bushings, ball bearings and roller bearings — where equipped with hydraulic pressure fittings or when bearings are hand packed.

Use only a high grade Ball and Roller Bearing Grease of short fiber. 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. Oils assigned lower SAE numbers are more fluid and flow more readily than do those with the 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.

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.

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.

Diesel Engine Crankcase Lubricating Oil Change Periods

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

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

DIESEL ENGINE CRANKCASE LUBRICATING OIL CHANGE PERIOD CHART USE ONLY SUPERIOR LUBRICANTS (Series 3).

FUEL SULPHUR CONTENT	OIL CHANGE PERIOD*	FILTER CHANGE PERIOD
0 .4% or less	300 Service Hrs.	300 Service Hrs.
0.4% to 1.0%**	150 Service Hrs.	150 Service Hrs.

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

****Reduce change period one half when sulphur content is greater than 1%.**

T26986

LUBRICATION CHART
CATERPILLAR
DIESEL D342 ENGINE

The folded page is arranged to serve 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 lubricating and service information.

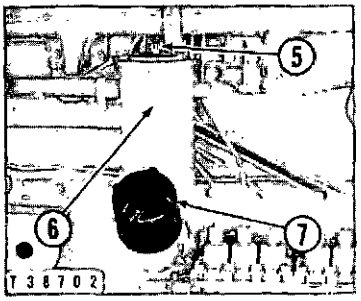
CO Crankcase Lubricating Oil

1

DIESEL ENGINE CRANKCASE

After draining crankcase refill at (5) and start the diesel engine. Run engine for two minutes then add oil to bring level to "full" mark on gauge, while engine is running.

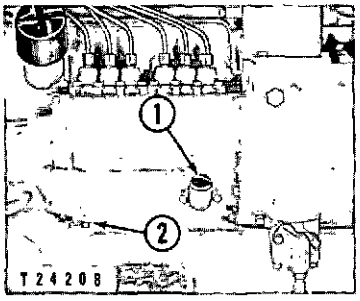
Wash breather element (6) each time crankcase oil is drained. Pour 1/4 pint (0.12 liter) oil through element and install.



FUEL INJECTION PUMP HOUSING

(Engines before 31B2478)

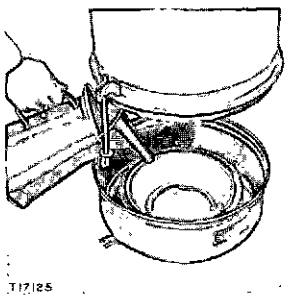
Check level every 125 service hours. Keep filled to top of filler elbow (1). Drain at (2) and refill every 250 service hours.



DIESEL ENGINE AIR CLEANER CUP

Inspect the oil in the air cleaner cup every 10 to 50 service hours depending upon dust conditions. Wash and fill both the inner and outer cups to the flat face of the inner cup *either when the oil will not flow freely, the* sediment in the cup is 1/2 inch deep, or every 50 service hours, whichever occurs first. See the topic, "Air Cleaners".

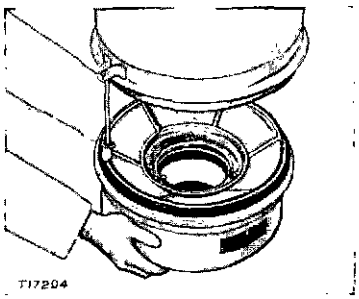
Refill the cup with the same S.A.E. grade of oil as is used in the diesel engine crankcase and the same type of oil may also be used. However, it is permissible to use clean, undiluted reclaimed oil or the most inexpensive straight mineral oil. See the topic, "Crankcase Lubricating Oil".



DIESEL ENGINE AIR CLEANER TRAY ASSEMBLY

When the oil cup is removed for inspection, remove the air cleaner separable tray screens from the cup, inspect and wash them if dirty. Inspect the inside of the air cleaner inlet pipe and clean if necessary.

Clean the inside of the air cleaner inlet pipe every 50 service hours. See the topic, "Air Cleaners".



Lubrication of Attachments

The following list of identifying letters, names of attachments requiring lubrication, and types of lubricant required will help in lubrication of attachments.

Identification Of Points Of Lubrication, Lubricant To Apply And Interval Of Service

Point	and Identification	Lubricant	SERVICE HOURS 10	50	125	250	500	1000
A	Starting Engine Crankcase	CO	X		C	C		
B	Starting Engine Air Cleaner	CO		X				
C	Starting Engine Transmission	CO				X		C
D	Enclosed Clutch Shift Collar Shaft	CO		L				
E	Enclosed Clutch Shift Collar and Shaft Bearings	BR	L	L				
F	Enclosed Clutch Pilot Bearing	BR			L			
G	Open Clutch Driving Plate Bearing	BR	L					
H	Open Clutch Pillow Block Bearings	BR				L		
I	Open Clutch Sliding Collar	CO	L					
J	Air Starting Motor Oiler	CO	X					
K	Air Starting Motor Gear Drive and Plain End†	BR						
L	Tachometer Drive and Cable	BR						L
M	Fan Bearings	BR				L		
N	Charging Generator*	BR						
O	Electric Starting Motors**	CO						
P	Woodward Governor	CO	X				CW	

*See detailed information on page 20.
**See detailed information on page 18.
†See detailed information on page 20.

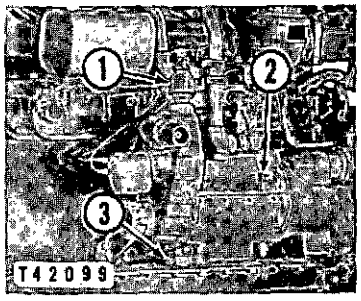
Key to Symbols:
X — Check, add oil if necessary
C — Change
CW — Change and wash
L — Lubricate

CO Crankcase Lubricating Oil

A

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 the crankcase breather at each oil change period. On earlier engines the breather is located on the flywheel clutch inspection cover. 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 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 "SAE Grade of Oil."

CO Crankcase Lubricating Oil

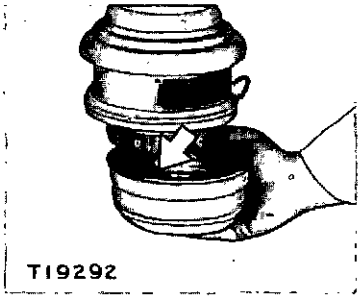
B

STARTING ENGINE AIR CLEANER

Inspect the oil in the air cleaner cup every 50 service hours. Wash and refill cup to oil level bead when oil will not flow freely or if the sediment in the cup is ¼ inch deep. See the topic, "Air Cleaners".

Refill the cup with the same S.A.E. grade of oil as is used in the diesel engine crankcase and the same type of oil may also be used. However, it is permissible to use clean, undiluted reclaimed oil or the most inexpensive straight mineral oil.

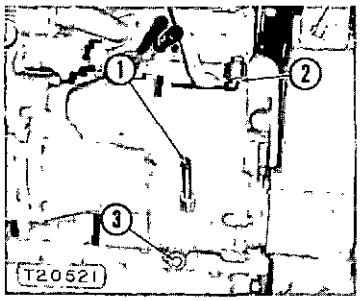
See the topic, "Crankcase Lubricating Oil".



C

STARTING ENGINE TRANSMISSION

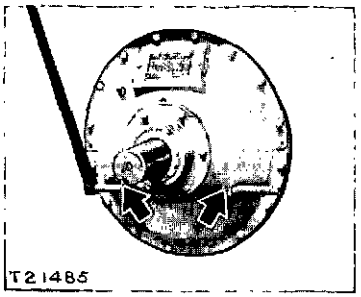
Every 250 service hours check oil level at (1). Oil should be up to "full" mark on gauge. Every 250 service hours remove, wash and oil the breather. Drain at (3), wash, and refill at (2), every 1000 service hours. See topic, "Washing Gear Compartments".



D

ENCLOSED CLUTCH SHIFT COLLAR SHAFT

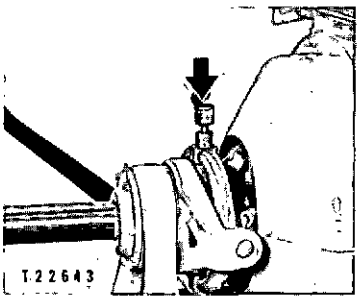
Lubricate shift collar shaft bearings every 50 service hours.



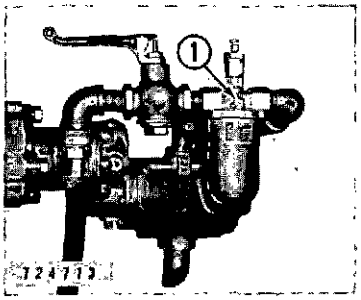
I

OPEN CLUTCH SLIDING COLLAR

Fill sliding collar oil cup every 10 service hours.



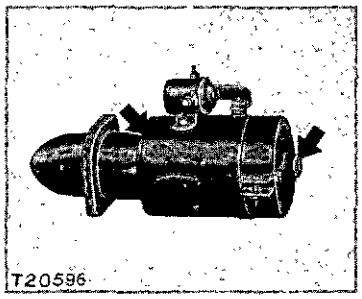
CO Crankcase Lubricating Oil



J

AIR STARTING MOTOR OILER

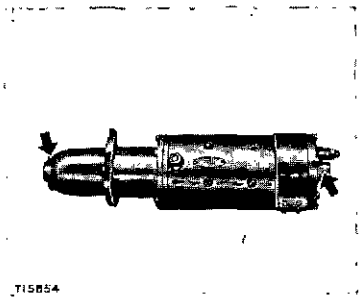
Every 10 service hours check oil level in oiler by removing plug (1). Keep oiler filled at all times.



O

ELECTRIC STARTING MOTORS

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



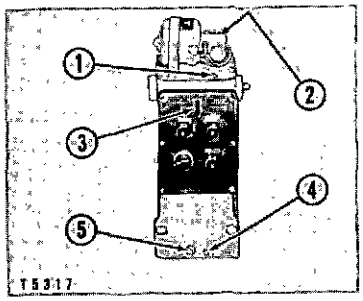
P

WOODWARD UG8 GOVERNOR

Check oil level every 10 service hours. Oil level should be visible in gauge and up to full mark (3). Replenish with STRAIGHT MINERAL lubricating oil at (2) to bring the *oil level to full mark. Use the same viscosity* oil as is recommended in the topic, "Crankcase Lubricating Oil," except in extremely hot weather use S.A.E. 50 oil.

Every 500 service hours drain, wash and refill governor housing. To do this, remove drain plug (4) and needle valve plug (5). Unscrew the needle valve three turns and fill the governor housing with clean kerosene or diesel fuel. Run engine thirty seconds then drain and refill with STRAIGHT MINERAL lubricating oil. Start the engine then screw the needle valve in three turns and install the needle valve plug (5).

Every six months, regardless of service hours operated, remove top cover (1) from governor and governor from engine then drain by turning the governor upside down. Fill and flush the governor with clean kerosene or diesel fuel. The friction cover may fall out, if loose, but no other governor parts will be dislocated by turning the governor upside down. Reinstall the governor and fill with STRAIGHT MINERAL lubricating oil. Replace the friction cover and top cover.

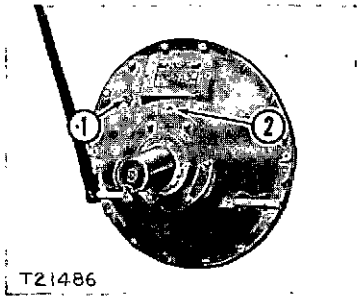


BR Ball And Roller Bearing Lubricant

E

ENCLOSED CLUTCH SHIFT COLLAR AND SHAFT BEARINGS

Lubricate the shift collar through fitting (1) every 10 service hours. Lubricate the shaft bearing through fitting (2) every 50 service hours.

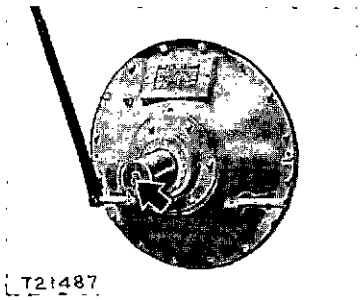


F

ENCLOSED CLUTCH PILOT BEARING

Lubricate the clutch pilot bearing every 125 service hours.

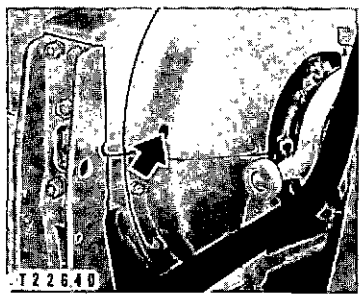
When the fitting cannot be lubricated as shown above, remove plate on the top right side of the flywheel housing and turn the flywheel until fitting appears. Lubricate sparingly every 125 service hours.



G

OPEN CLUTCH DRIVING PLATE BEARING

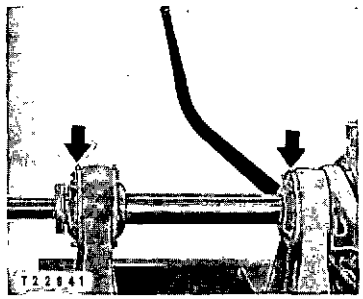
Lubricate the bearing sparingly every 10 service hours.



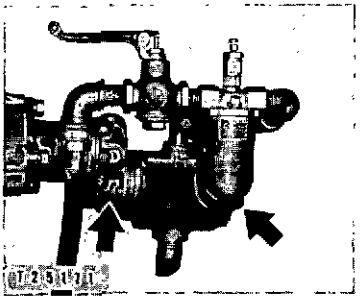
H

OPEN CLUTCH PILLOW BLOCK BEARING

Lubricate the pillow block bearings sparingly through fittings every 250 service hours.



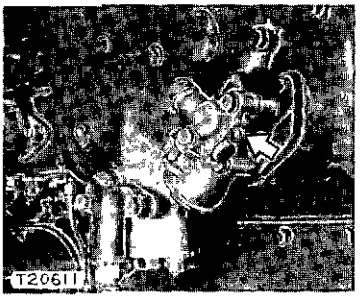
BR Ball And Roller Bearing Lubricant



K

AIR STARTING MOTOR GEAR DRIVE AND PLAIN END

Air starting motor gear drive 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.

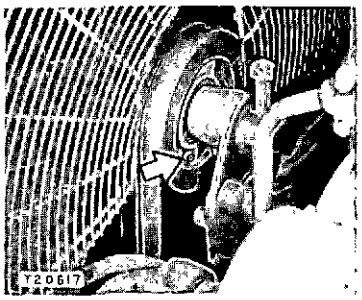


L

TACHOMETER DRIVE AND CABLE

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

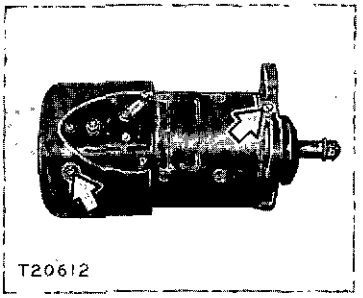
Remove the tachometer core, wipe old grease from the core, and lubricate with one teaspoon of No. 00 Grade of Ball and Roller Bearing Lubricant every 1000 service hours. Lubricate only the lower three quarters of the core to eliminate grease from entering the tachometer.



M

FAN BEARING

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



N

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.

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, including a check to see that all shipping straps, brackets, bolts and skids are removed, 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.

Fill the cooling system with clean soft water, or with the correct antifreeze 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 cylinder head stud nuts, inlet manifold stud nuts, and the exhaust manifold stud nuts. If the diesel engine is equipped with a starting engine, tighten the starting engine cylinder head bolts and the carburetor elbow nuts.

When the diesel engine cylinder head nuts are tightened and the valve mechanism cover is removed, check the diesel engine valve clearance and adjust if necessary as described in the topic, DIESEL ENGINE VALVE CLEARANCE ADJUSTMENT.

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 crankcase oil level in the diesel engine to make sure the oil is above the "add oil" mark on the gauge.

When the engine is equipped with an oil pressure shut-off, a Woodward governor, and oil pressure alarm switch or other attachments, see one of the topics, SAFETY SHUT-OFF CONTROLS, WOODWARD GOVERNOR, VERNIER GOVERNOR CONTROL or OIL PRESSURE ALARM SWITCH for further starting instructions.

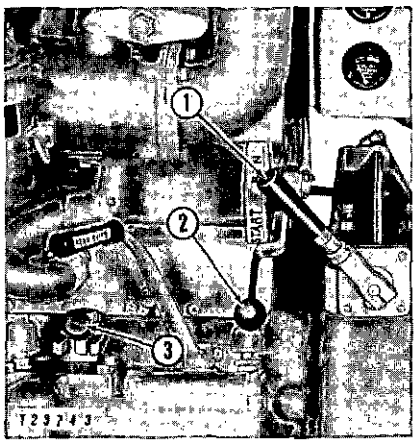
Disengage the flywheel clutch or remove any load possible from the engine, then start the engine as described in one of the following topics, whichever applies, GASOLINE STARTING ENGINE, ELECTRIC STARTING MOTOR OR AIR STARTING MOTOR.

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.

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 **(2)** to the START position.
3. Move the governor control lever **(1)** to the shut-off position so the fuel injection pumps are closed.
4. See that the starting engine clutch is disengaged by moving the clutch control lever **(3)** toward the rear of the diesel engine.

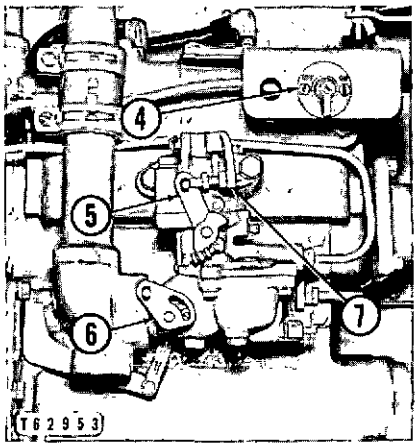


CONTROLS POSITIONED FOR STARTING

1–Governor control lever in shut-off position. 2–Compression release lever in START position. 3–Starting engine clutch and starter pinion control lever in disengaged position.

◆

5. Open the starting engine fuel valve which is located near the starting engine gasoline tank, by turning the fuel valve control in the counterclockwise direction.
6. Turn the starting engine choke control knob **(6)** clockwise to the on position.



STARTING ENGINE CONTROLS

4–Magneto switch. 5–Throttle control lever. 6–Choke control. 7–Idling latch.

7. Move the idle latch **(7)** to hold the throttle control lever **(5)** in the 1/4 to 1/2 engine speed position.

8. Turn ON the magneto switch **(4)**.

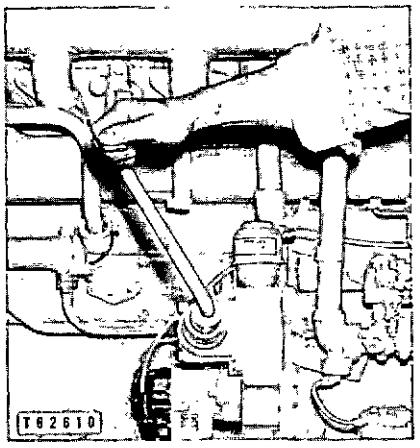
Starting The Starting Engine: The starting engine may be started manually or by means of the starting engine electric starter if so equipped.

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.**

2. Move the choke control counterclockwise when the engine will run without choking. Temperature and altitude will vary the length of



CORRECT POSITION FOR CRANKING STARTING ENGINE

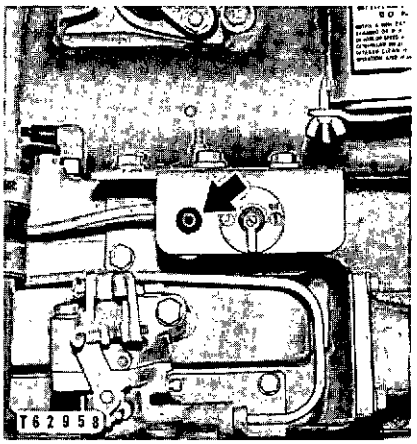
◆

time it is necessary to have the choke on. Actual experience in starting will determine this interval.

3. Sometimes the starting engine can be started more quickly by leaving the idling latch free of the throttle control lever. **When the engine starts, lock the throttle control lever with the idling latch to 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 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.
2. See the instructions given in paragraphs 2 and 3 in the preceding topic, MANUAL STARTING.

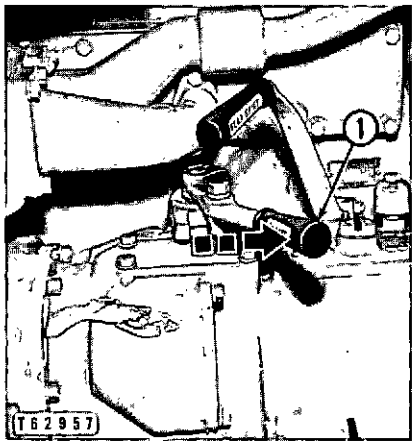


STARTING ENGINE ELECTRIC STARTER SWITCH

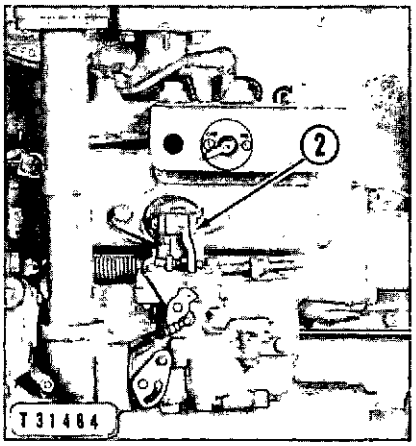
◆

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 lever toward the front of the diesel engine until the clutch snaps over center.



APPLYING CLUTCH BRAKE
1–Clutch and starter pinion control lever.



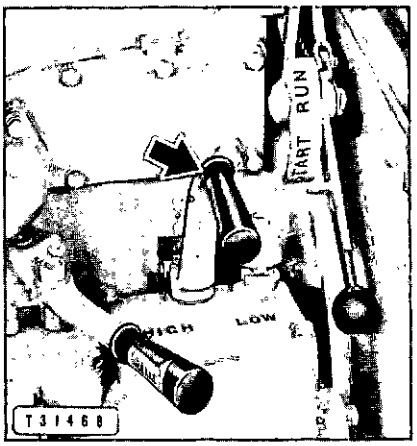
STARTING ENGINE THROTTLE CONTROL
2–Idling latch.

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.

During cold weather, or whenever the normal cranking speed cannot be reached with the transmission control lever in HIGH position, the starting engine transmission will be found quite beneficial.

To use the starting engine transmission for starting a cold engine proceed as follows:

1. Disengage the starting engine clutch.
2. Shift the starting engine transmission into LOW.
3. Engage the starting engine clutch and after the cranking effort required is reduced, move the compression release lever to the RUN position.

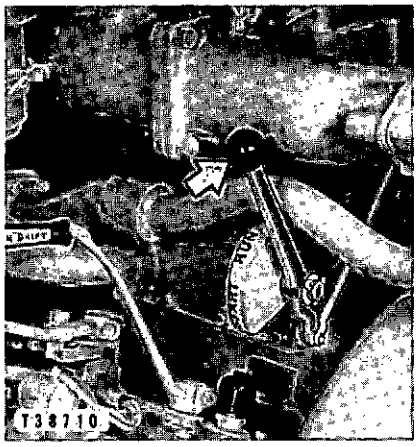


STARTING ENGINE TRANSMISSION CONTROL LEVER IN LOW SPEED POSITION

◆

4. Allow the starting engine to turn the diesel engine for several minutes as the heat of compression will assure easy starting.
5. Move the compression release lever to the START position, disengage the starting engine clutch, shift the starting engine transmission to HIGH.

If the engine is equipped with glow plug starting aid attachment for quicker starting in lower temperatures, press the glow plug switch at this point in the starting operation. See the topic, OPERATING STARTING AIDS.



COMPRESSION RELEASE LEVER IN RUN POSITION

◆

6. Engage the clutch and move the compression release lever to the RUN position when the starting engine is cranking the diesel engine at normal cranking speed.

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 temperatures.

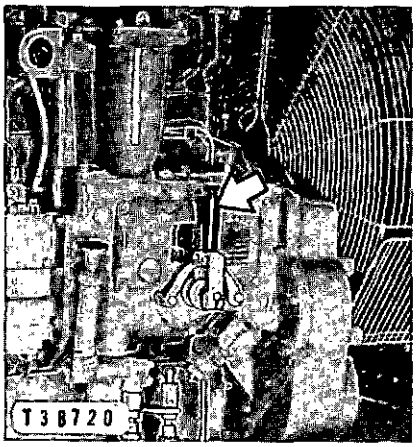
Allow the starting engine to crank the diesel engine against compression for a few minutes to add heat to the diesel engine before starting it. Actual experience will determine the length of time necessary to crank the diesel engine to warm it sufficiently to assure easy starting. Cold temperatures will require longer periods of cranking against compression before injecting fuel.

7. 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. See the topic, GAUGES.

If the engine is equipped with ether starting aid attachment for quicker starting in lower temperatures, discharge ether into the manifold of the diesel engine at this point in the starting operations. See the topic, OPERATING STARTING AIDS.

GOVERNOR CONTROL LEVER IN APPROXIMATE HALF ENGINE SPEED POSITION FOR STARTING

◆



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.

8. 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.

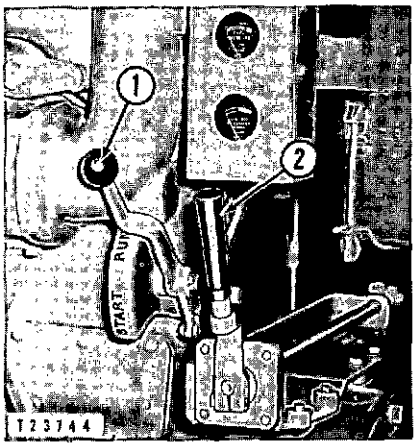
Direct Electric Starting

The diesel engine electric starter **can** be used successfully in atmospheric or engine room temperatures of 50°F. (10°C.) or above **without** the use of a starting aid. **It is not advisable** to use the diesel engine electric starter in temperatures below 50°F. (10°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, CRANKCASE LUBRICATING OIL.

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 **(1)** remains in the RUN position 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 **(2)** to approximately half engine speed position.



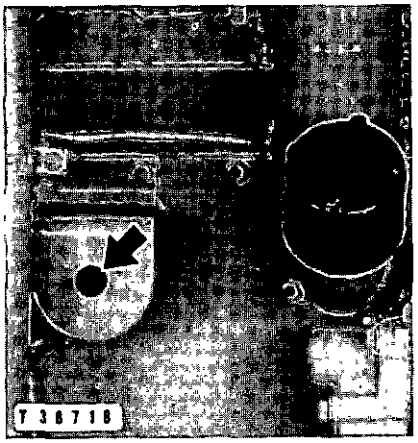
CONTROLS POSITIONED FOR STARTING

1–Compression release lever in RUN position. 2–Governor control lever in approximately 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.
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



DIESEL ENGINE ELECTRIC STARTER BUTTON

◆

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 starter to cool before using it again.
4. If the electric starter pinion disengages for any reason before the engine starts, release the starter switch and wait until the electric starter stops rotating and the diesel engine stops "rocking" before again pressing the starter switch.

When the engine starts, see the topic, GAUGES.

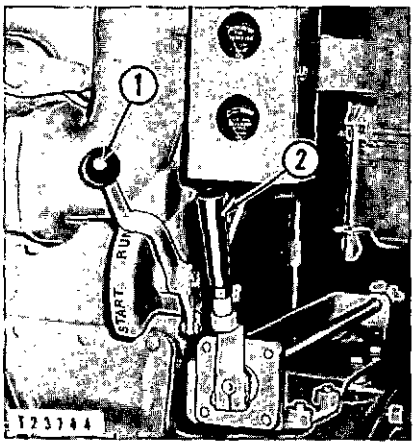
Air Starting

The diesel engine air starter **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 starter 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, CRANKCASE LUBRICATING OIL.

An installation having a 25 cubic feet air receiver with 250 pounds air pressure should provide an adequate volume of air for starting the diesel engine. The air pressure should be regulated to 100 pounds 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 **(1)** remains in the RUN position unless it is desired to crank the engine for some purpose other than starting.



CONTROLS POSITIONED FOR STARTING

1–Compression release lever in RUN position. 2–Governor control lever in approximately half engine speed position.

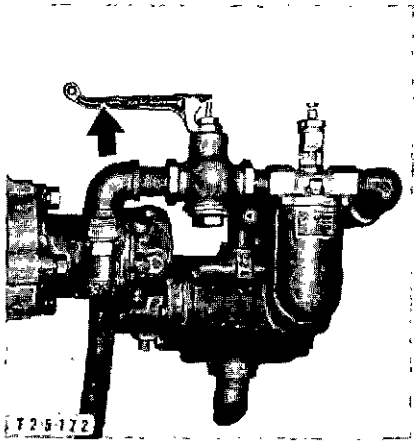
◆

2. Disengage the flywheel clutch or remove any load possible from the engine.

3. Move the governor control lever **(2)** 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.



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.

   When the engine starts, see the topic, GAUGES.

OPERATING STARTING AIDS

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

When using the electric or air starting motor in lower temperatures, the glow plug starting aid, the ether starting aid, or both should be used. Starting aids may also be used with the gasoline starting engine method of starting, however, 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 air or electric 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 voltage 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 until the engine is running smoothly.

Do not move the HEAT-START 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** starter for more than 30 seconds at a time, then allow 2 minutes intermission before using it again.

STARTING AID CHART

STARTING TEMPERATURE	STARTING METHOD	STARTING AID	HEATING TIME OR CAPSULES TO USE
Above 50°F.	Electric	None	None
	Air or Gasoline	None	None
Between 50°F. and 32°F.	Electric	Glow Plugs	1 Minute
		Ether	1 Capsule
	Air or Gasoline	None	None
Between 32°F. and 15°F.	Electric	Ether	1 or 2 Capsules
		Glow Plugs and Ether	1 to 2 Minutes and 1 Capsule
	Air or Gasoline	Ether	1 Capsule
		Glow Plugs and Ether	1 to 2 Minutes and 1 Capsule
Between 15°F. and −10°F.	Electric, Air or Gasoline	Ether	2 Capsules
		Glow Plugs and Ether	3 to 5 Minutes and 2 Capsules
Below −10°F.	Air or Gasoline	Glow Plugs or Ether, or Both	Heat cooling system and crankcase oil

Starting Between 50°F. And 32°F.

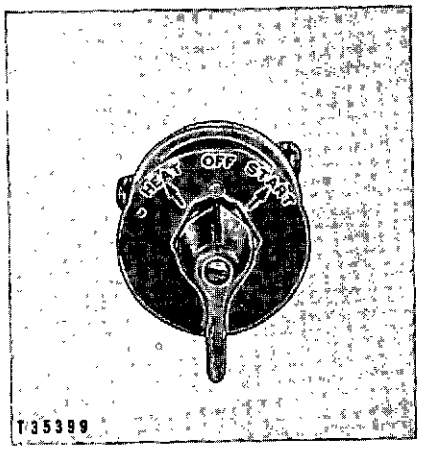
The use of starting aids between these temperatures is needed only when electric starting is used to start the diesel engine.

1. Move the HEAT-START switch to the HEAT position for the length of time necessary **or** discharge one ether capsule. See the STARTING AID CHART. On earlier engines, move the HEAT switch **(1)** to the ON position.

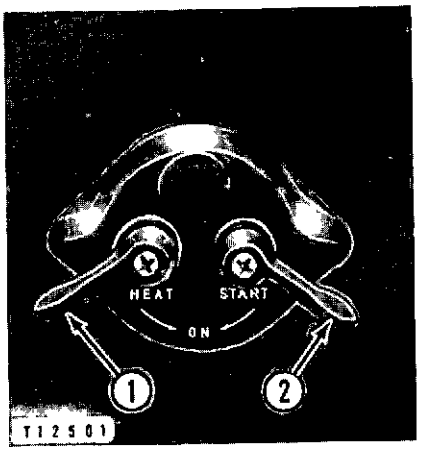
NOTE

Each glow plug uses approximately 7 amperes while the HEAT-START switch is in the HEAT position. This is actually a small amount in comparison to the starter load that is imposed on the battery when the HEAT-START switch is in the START position with the diesel engine cranking.

2. Move the HEAT-START switch to the START position or press the starter switch. On earlier engines move the START switch **(2)** to the ON position.



HEAT-START SWITCH
(Later Engines)



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

Starting Between 32°F. and −10°F.

Starting between 32°F. and 15°F., 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 or discharge ether, or both, as indicated in the STARTING AID CHART.

NOTE

Each glow plug uses approximately 7 amperes while the HEAT-START switch is in the HEAT position. This is actually a small amount in comparison to the starter load that is imposed on the battery when the HEAT-START switch is in the START position with the diesel engine cranking.

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

Starting Below −10°F.

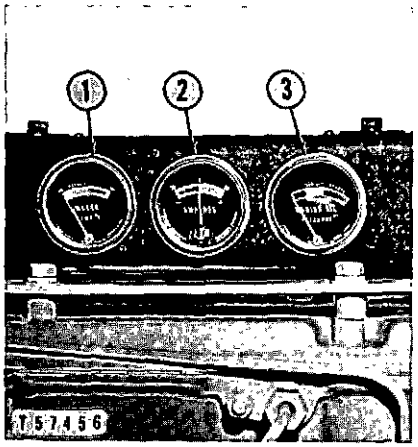
When starting in temperatures below −10°F., the coolant in the cooling system and the crankcase lubricating oil should be warmed. When heat-

ing the cooling system in these lower temperatures, the coolant should be maintained between +15°F. and +30°F. 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:



GAUGES

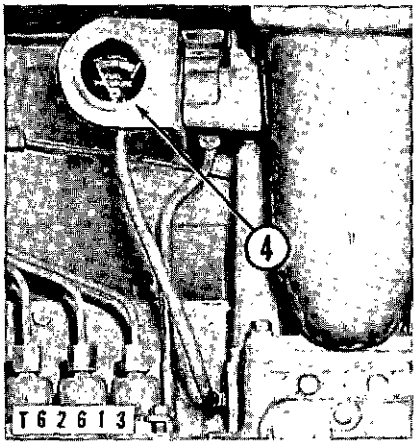
1–Water temperature gauge. 2–Ammeter. 3–Crankcase lubricating oil pressure gauge.

◆

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 NORMAL range. A lower pressure reading is normal at low idling speeds. If no pressure is indicated, investigate at once.

Water Temperature Gauge: The indicator on the water temperature gauge **(1)** should register in the NORMAL 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 very according to the air temperature and load factor, but should never exceed boiling temperature at the prevailing altitude.

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 (green area or + side of zero). If the indicator registers in the discharging range (red area or — 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 voltage regulator is not functioning properly. See the topic, GENERATOR REGULATOR.



GAUGES

4–Fuel pressure gauge.

◆

Fuel Pressure Gauge: The indicator on the fuel pressure gauge **(4)** should register in the NORMAL (green) range. See the topic, CARE OF THE FUEL FILTER.

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.

STOPPING THE LOAD

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

STOPPING THE DIESEL ENGINE

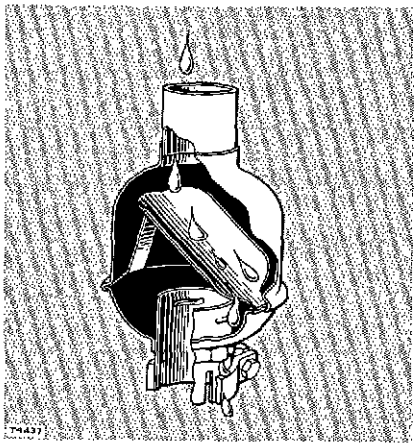
After the normal load is removed from the engine allow it to idle five minutes with the governor control lever at half engine speed position before stopping.

Move the governor control lever to the shut-off position. Leave the diesel fuel tank valve open.

If the engine must stand without shelter, cover the exhaust pipe to exclude rain or snow. A rain trap for this purpose may be obtained from your Caterpillar dealer. 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.

RAIN TRAP EXHAUST PIPES

◆



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, capscrews, or parts worn to such an extent that they are no longer serviceable. If corrective steps are taken immediately on discovery of loose or worn parts, fewer forced stops and more economical operation will result. Points to be checked daily, or every 10 service hours, are as follows:

1. Exhaust and 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 indicator is not in red range.
4. Diesel engine air cleaner cup, inspect for dirt in cleaner cup when operating in extremely dusty conditions.

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

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, lubrication and maintenance.

The Service Meter which is located on the left side of the engine near the bottom of the governor and fuel injection pump drive housing, should be read daily. From the daily readings, the lubricating time of all parts as directed under the topic, LUBRICATION CHART, can be determined. The Service Meter readings should also be used in determining maintenance service periods.

STARTING IN COLD WEATHER

If the starting engine and the diesel engine are both in good mechanical condition, and precautions necessary for cold weather operations 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 LUBRICATION INSTRUCTIONS section of this book.

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, 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 the diesel engine crankcase and starting engine crankcase to provide proper lubrication when starting. Refer to the topic, CRANKCASE LUBRICATING OIL.

Crank the starting engine several revolutions with the magneto switch OFF, the choke off, the throttle closed and the starting engine clutch disengaged. This will 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.

Avoid over-choking and over-priming the starting engine when attempting to start it.

Sometimes the starting engine can be started more quickly by pulling out the throttle control. **When the engine starts push in the throttle control to keep the engine speed low until the crankcase lubricating oil has a chance to warm up 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.

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

Battery: Periods of two weeks or more when the engine is not operated necessitates provisions being made to keep the battery charged. This may be done 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.

◆

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 CLEANER

Later machines are equipped with dry type air cleaners and earlier machines with oil bath air cleaners. Maintenance of both types is described in the following pages.

Diesel Engine Dry Type Air Cleaner

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

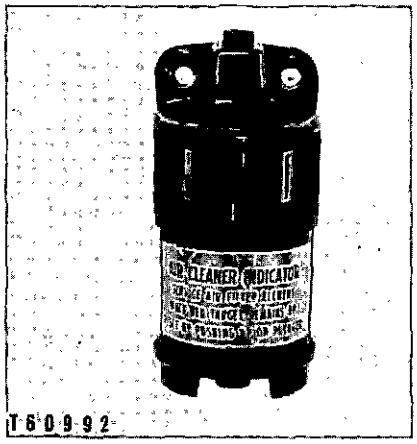
Regular service intervals, along with close visual inspection of the dry type air cleaner, are necessary for proper cleaning of the engine inlet air. The service intervals will vary with the weather and working conditions. During dry, dusty months where dust conditions are severe, it will be necessary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

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.

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.

AIR CLEANER
SERVICE INDICATOR

◆

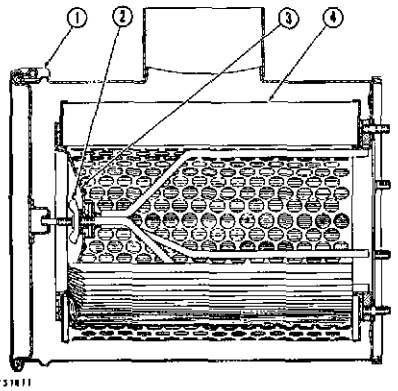


The Air Cleaner Service Indicator is located on the air inlet pipe. It contains a red marked piston, which gradually rises with restriction to the air flow. When the entire piston is visible it will lock in this position. This indicates a need for air cleaner service. This piston will remain in this position whether or not the engine is running. 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. **Never service the air cleaner while the engine is running.**

Filter Element: Every 50 to 250 service hours in average operating conditions, 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 wing screw **(1)** and remove the end of the filter case.
2. Remove the wing nut **(2)** and the sealing plate assembly **(3)**, which hold the element in position.
3. Remove the filter element **(4)**.



DRY TYPE AIR CLEANER

1–Wing screw. 2–Wing nut. 3–Plate assembly. 4–Element.

◆

Cleaning Filter Elements:

The ends of a filter element can be damaged 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.

1. Clean the filter element using one of the following methods.
   a. Using clean, dry air, at a pressure not to exceed 100 PSI, proceed as follows:

      Direct air against the inside of the element to loosen any imbedded dirt. Best results can be obtained by moving the air hose so that air is directed 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 inside the element.

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

Direct water against the inside 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 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 inside the element and that the element is thoroughly dry before installing it.

c. 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 as in "b" above.

2. Thoroughly clean all parts of the air cleaner. Visual inspection of the gaskets is important in keeping dust from by-passing the air cleaner filter element. Air leakage can upset proper air cleaner action. If the condition of the gaskets is questionable, replace them. If the sealing ends of the filter element or the element pleats are damaged, replace the element.

3. 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, replace with a new element.

Replace the filter element at least once a year.

Diesel Engine Oil Bath Type Air Cleaner

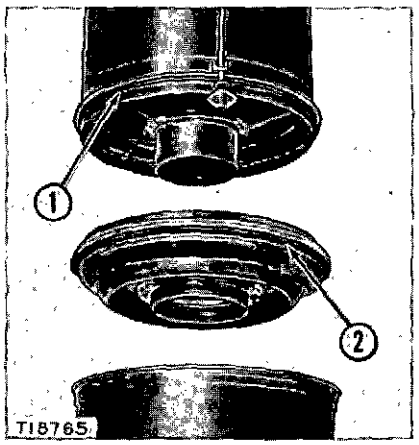
The air cleaners do their work efficiently only as long as the oil in the cups is thin enough to flow freely, so it will spray into the filter section and wash back the dirt collecting there. For this reason, air cleaners should be inspected frequently and serviced according to the following instructions.

Inspect the Oil in the Diesel and Starting Engine Air Cleaner Cups: Every 10 to 50 service hours, depending upon operating conditions, inspect the oil in the diesel engine air cleaner cup. The air cleaner cup should be washed and refilled every 50 service hours or when the oil in the cup will not flow freely at operating temperature, or if the sediment in the cup is 1/2 inch deep (1/4 inch in a starting engine air cleaner), whichever occurs first. It may be necessary to inspect the oil in the starting engine air cleaner cup every 50 service hours.

1. Loosen the wing nuts and take off the diesel engine air cleaner cup and separable tray.
   a. On starting engine air cleaners the oil cup is removed by loosening the screw clamp.

Some thickening of the oil in the cup should be no cause for alarm, actually it can be considerably thicker than the SAE grade that was last put in the cup; as long as the oil at operating temperatures will flow freely. For a check to determine if the oil will flow freely, dip into the oil with a finger and if the oil on it will flow off, the oil is fluid enough to flow freely.

2. Service other parts of the air cleaner while the oil cup is removed, as indicated in the following topics.
3. When refilling the oil cup, care should be taken to see that both the inner and outer cups are filled to the flat face of the inner cup and to the oil level bead on the starting engine air cleaner cup. In temperatures above freezing SAE 30 oil should be used. In temperatures below freezing use SAE 10W oil. Do not dilute SAE 10W oil.
4. Seals between the cup, separable tray and body prevent oil running out of the cup during angular operations. Air leakage at this point can possibly upset proper air cleaner action. When replacing the oil cup and separable tray on air cleaners, check to see that the seal **(2)** between the air cleaner cup and separable tray and the seal **(1)** between the separable tray and body are in place and in good condition.



AIR CLEANER SEALS

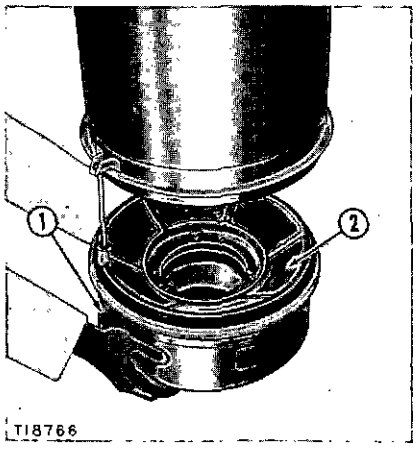
1–Seal. 2–Seal.

◆

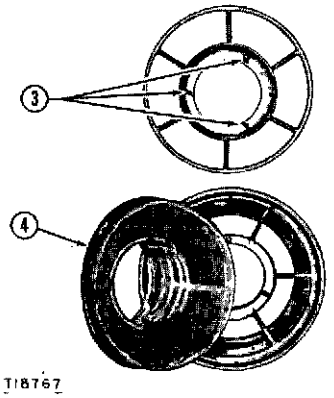
Never attempt to change the oil in the air cleaner cup when the engine is running. This will cause dirty oil to be held in the filter section by intake action. The dirty oil held in the filter section will contaminate the fresh oil and also cause an abnormally high oil level which may allow oil in the screens to be carried into the engine resulting in overspeeding.

Wash Air Cleaner Lower Filter Section: At every air cleaner cup service period, between 10 and 50 service hours depending on operating conditions, wash the separable tray screens.

1. Remove the separable tray **(2)** and cup **(1)** by loosening the wing nuts that hold them in place.



REMOVING AIR CLEANER CUP AND SEPARABLE TRAY
1–Cup. 2–Separable tray.



AIR CLEANER SEPARABLE TRAY DISASSEMBLED
3–Thumb screws. 4–Screens.

2. Turn the cup slightly and remove it with the tray from the air cleaner body.
3. Disassemble the separable tray by loosening the thumb screws **(3)** and lift out the screens.
4. Wash the separable tray screens with a brush in kerosene or non-flammable cleaning fluid.
5. Assemble the separable tray by placing the screens **(4)** in the tray, and tightening the thumb screws.
6. Assemble the separable tray and cup to the air cleaner body.
7. Make sure all connections are tight.

Inspect the Inside of the Air Cleaner Inlet Pipe: Every 10 to 50 service hours, depending on operating conditions, when the air cleaner cup is removed to clean the separable tray screens, inspect the inside of the air cleaner inlet pipe by reaching up from the bottom of the pipe. If a heavy accumulation of dirt is noticed, clean the pipe.

Inspect the Air Cleaner Upper Filter Section: Inspect the bottom screen of the air cleaner upper filter section whenever chaff, lint, leaves or other such material shows up in the oil or in the separable tray. This material must be cleaned out to maintain proper air cleaner performance.

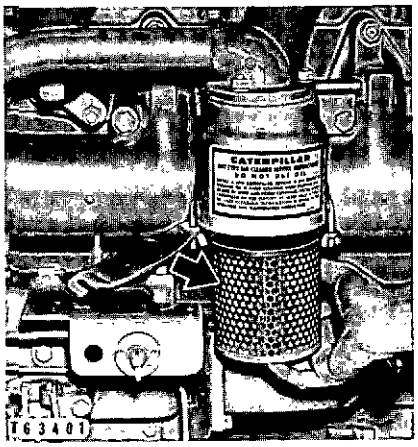
Wash the Entire Air Cleaner: Every 2000 service hours — more often in dusty conditions — wash the entire air cleaner.

1. The entire air cleaner should be removed from its support in order to thoroughly clean the upper filter section in the cleaner body.
2. Remove the oil cup and separable tray.
3. Immerse the entire cleaner in kerosene or some non-inflammable cleaning fluid. Steam cleaning is not recommended because some forms of dust rolls into small balls when steam is applied, and these balls cannot be washed out of the screens.
4. *Wash the oil cup and separable tray as outlined in the preceding* topics.
5. Dry the air cleaner parts thoroughly and reassemble them, making certain all connections are air tight.

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 which retain the assembly.
2. Remove the air cleaner retaining plate and the filter element.



REMOVING STARTING ENGINE DRY TYPE AIR CLEANER

◆

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

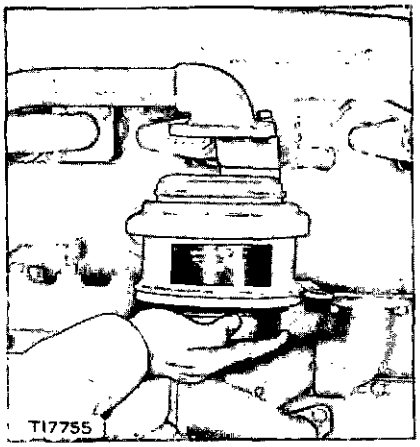
If the element is damaged or if after cleaning, the engine is hard to start and/or loss of power has not been corrected, install a new Caterpillar element.

Replace the filter element at least once a year.

Starting Engine Oil Type Air Cleaner

Wash Starting Engine Air Cleaner: Every 1000 service hours wash the starting engine air cleaner.

1. Loosen the screw clamp and remove the oil cup.
2. Remove the cleaner body by taking out the capscrews at the top of the cleaner.
3. Wash the filter by shaking the air cleaner body in a pan of kerosene or some non-inflammable cleaning fluid.
4. Wash and refill the oil cup.



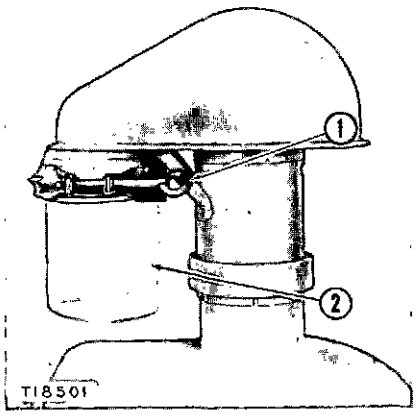
REMOVING STARTING ENGINE OIL BATH TYPE AIR CLEANER

◆

5. Assemble and install the air cleaner, but be sure the mating faces of the air cleaner and the cleaner pipe are clean, the gasket between them is in place and all connections are air tight.

Air Cleaner Attachments

Precleaner Care: The precleaner is recommended to lengthen air cleaner service periods because it removes some of the dirt from the inlet air. For this reason, always install the jar **(2)** correctly and replace



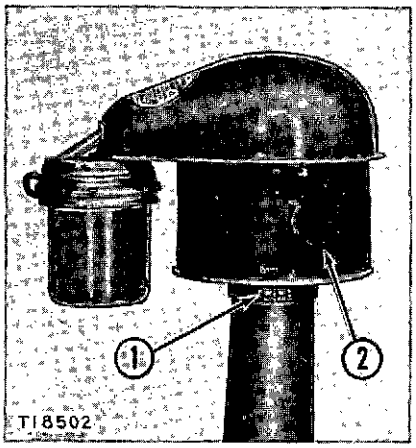
PRECLEANER

1–Clamp bolt. 2–Jar.

◆

either a broken jar or gasket immediately, because the precleaner will not work properly without them. Remove and empty the jar before it becomes three-fourths full by loosening the clamp bolt **(1)** that holds it in place. Inspect the fins in the precleaner regularly and when they are dirty remove the entire precleaner and wash it in water.

Prescreener Care: Where the air contains objectionable foreign material, such as, cotton lint, small leaves or other particles the special prescreener should be used to prevent these materials entering the air cleaner. When the prescreener is used, inspect the screen **(2)** regularly and when it is dirty remove by loosening the clamp bolt **(1)** which holds it in place. Clean the screen with a dry brush or wash it in water.



PRESCREENER

1–Clamp bolt. 2–Screen.

◆

Air Inlet Pipe Extension: Where dust conditions are severe, dust and abrasives may be carried in a heavy cloud rising to the height of the air inlet. In these conditions an air inlet pipe extension will put the precleaner up where the air is cleaner, reducing engine wear and the frequency of air cleaner service.

WASHING THE CRANKCSAE

Whenever the diesel or starting engine oil pan is removed for any reason it should be thoroughly cleaned before it is reinstalled. The oil pump screen should also be cleaned while the oil pan is off the engine.

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. 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 remains in the still.

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. Important steps are to use clean containers and funnels and to reduce the number of times the fuel must be handled. When the fuel can be delivered by the distributor to storage tanks and then pumped from the storage tank to the diesel 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 20 hours in the storage tank after it 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 storage tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

CARE OF THE DIESEL FUEL TANK

The fuel level in the diesel fuel tank may be checked with the plunger gauge in the filler opening.

Fill the diesel fuel tank at the end of the day, because the 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 diesel fuel tank filler opening should be removed and cleaned regularly. Remove the retainer ring and lift out the strainer.

Diesel Fuel Tank Filler Cap: The diesel fuel tank filler cap elements should be washed every 50 to 250 service hours depending upon the amount of dust in the air. To do this, remove the capscrew and take out the baffle plate and gaskets. Wash the cap and elements in a pan of kerosene or nonflammable cleaning fluid. After the cap is washed pour a small amount of crankcase lubricating oil on the filter elements.

FUEL SYSTEM

The fuel flows from the diesel fuel tank through the fuel line to the fuel transfer pump. The fuel transfer pump supplies the fuel under pressure to the fuel filter housing, the filter removes the dirt and other

foreign particles. From here the fuel is supplied to the fuel pump manifold for the individual fuel injection pumps. The fuel injection pumps meter and force the fuel through the fuel injection lines and the fuel injection valves in the cylinder head, into the precombustion chamber where it is ignited and passed into the main combustion chamber or cylinder..

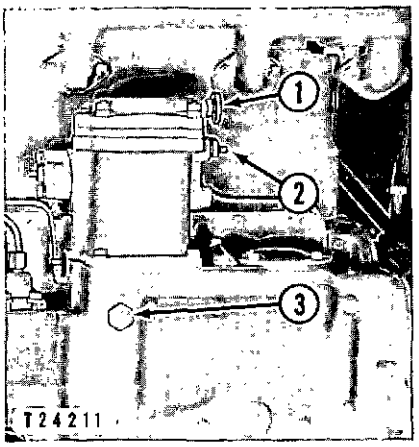
CARE OF THE FUEL FILTER

Draining Fuel Filter Housing: Every 50 service hours or even as often as daily in 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, remove the filter housing drain plug **(3)** and open the lower vent **(2)** and then the upper vent **(1)** in the housing. Replace the drain plug and prime the system. See the topic, PRIMING THE FUEL SYSTEM.

DRAINING FILTER HOUSING

1–Upper vent. 2–Lower vent. 3–Drain plug.

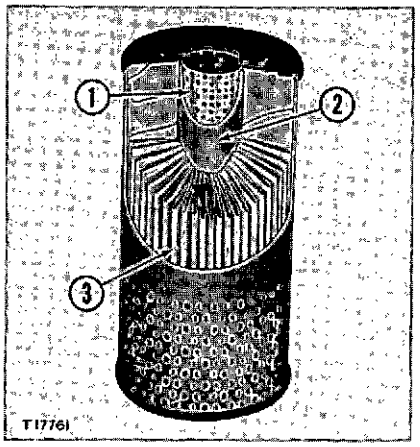
◆



Fuel Filter Element: The fuel filter element is of the plastic impregnated paper type. When the pleated, plastic impregnated paper **(3)** or the fine grade filter paper **(2)** has collected enough contamination to interfere with engine performance, it must be replaced with a new element. This element will continue to collect particles until fuel will no longer flow through it at a rate to maintain maximum engine performance. It will not discharge its burden into the clean fuel; this is prevented by the fine grade filter paper around the perforated metal core **(1)**.

The plastic impregnated paper type filter element collects and holds contaminants, and cannot be washed or otherwise restored.

As the filter 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 filter should be changed and a new filter element installed.



FUEL FILTER ELEMENT

1–Perforated metal core. 2–Fine grade filter paper. 3–Impregnated paper.

◆

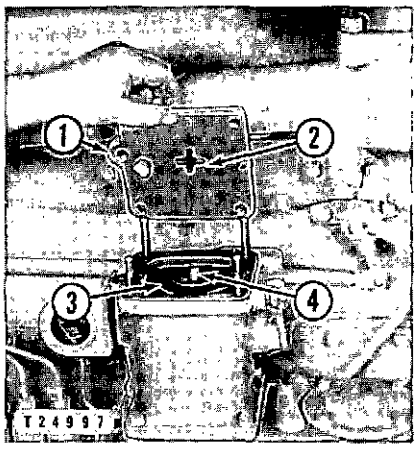
Removing Used Filter Element: To remove the used filter element, proceed as follows:

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

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

Installing Filter Element In Housing: To install the element in the housing proceed as follows:

1. Replace the rod and spring 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 a new Caterpillar element **(3)** over the rod **(4)**.
3. Place a new gasket on the filter housing.
4. Place the retainer plate **(1)** on the housing making certain that the rod enters the center hole **(2)** in the plate.
5. Install a new gasket on the retainer plate.



INSTALLING FUEL FILTER ELEMENT

1–Retainer plate. 2–Center hole. 3–Filter element. 4–Rod.

◆

6. Replace the filter cover and drain plug.
7. Prime the system as outlined in the topic, PRIMING THE FUEL SYSTEM.

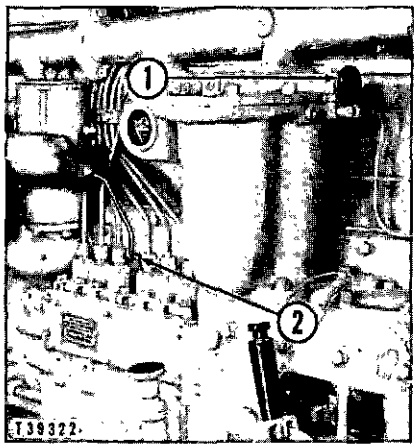
Keep a New Filter Element On Hand: An extra filter element should be kept on hand for replacement. Always keep the element wrapped in its original carton to insure against dust and dirt accumulations which will shorten the life of the element if it gets on the outside or may cause damage to the fuel 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 mis-firing of one or more cylinders.

When Equipped With Gasoline Starting Engine

1. Check to see that the diesel fuel tank valve is open.
2. Move the governor control lever to the shut-off position, so the fuel injection pumps are closed.
3. Move the compression release lever to the START position.
4. Start the starting engine, engage the starter pinion and clutch. Allow the starting engine to crank the diesel engine at starting engine low idle speed.
5. Open the fuel filter vent valve **(1)** and fuel injection pump vents **(2)**. When the flow of fuel from the vent is continuous and contains no air bubbles, close the vent valves.
6. Open and close the vent valves several times in succession to be sure all air is bled from the system.



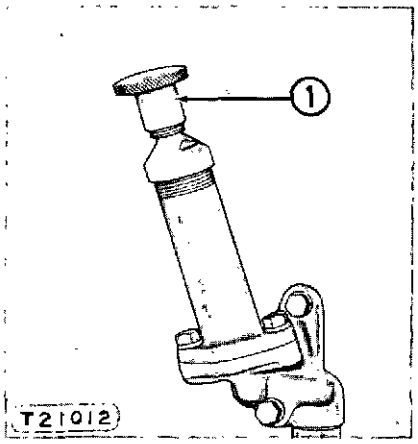
PRIMING THE FUEL SYSTEM

1–Fuel filter vent valve. 2–Fuel injection pump vents.

◆

When Equipped With Electric Or Air Starting Motor

1. Check to see that the diesel fuel tank valve is open.
2. Move the governor control to the shut-off position so the fuel injection pumps are closed.
3. Open the fuel filter vent valves.
4. Loosen the knurled top **(1)** of the fuel priming pump and operate the pump plunger up and down until fuel flows from the top vent of the fuel filter.



FUEL PRIMING PUMP

1–Knurled top.

◆

5. Close the filter vents and open the fuel injection pump vents.
6. Continue to operate the fuel priming pump until the flow of fuel through the fuel injection pump vents becomes continuous and contains no air bubbles, close the vents.
7. Open and close the vents several times in succession to be sure all of the air is bled from the system.

8. 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, CARE OF THE FUEL FILTER. Replace the filter element if necessary. Then prime the fuel system until clean fuel passes through the events on the fuel injection pumps. If the fuel system is air bound, priming the system will overcome the difficulty.

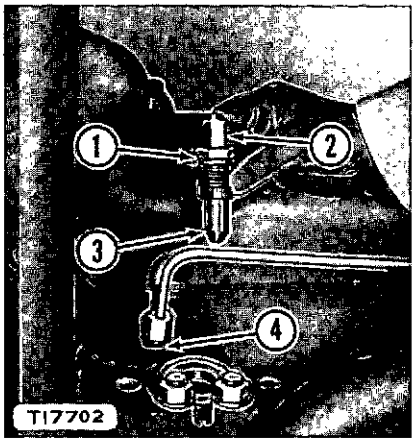
When the engine is running irregularly, and smoking, a fuel injection valve may not be spraying the fuel properly.

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 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.

Removing Fuel Injection Valves: Before removing a valve, clean the dirt from around the valve and connections and remove the glow plugs if so equipped. See the topic, GLOW PLUGS.



REMOVING FUEL INJECTION VALVE

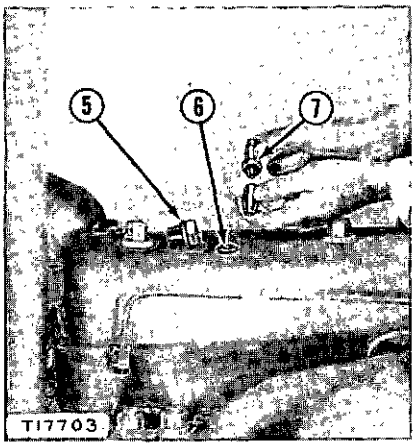
1–Retainer nut. 2–Cover. 3–Fuel injection valve nozzle assembly. 4–Plug.

◆

Disconnect the fuel injection line from the injection valve. Install plug **(4)** in the fuel injection line. Remove the valve retainer nut **(1)** and install the cover **(2)** on the valve body. Lift out the nozzle assembly **(3)** and body as a unit.

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 **(7)** into the fuel injection valve nozzle assembly only finger tight. The threads of the body and nozzle assemble 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. Install a new large seal **(5)** on the retainer nut. A light coating of lubricant on the seal will permit it to seat properly.
4. Tighten the retainer nut 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 nut.



INSTALLING FUEL INJECTION VALVE

5–Large seal. 6–Small seal. 7–Injection valve body.

◆

5. Place a new small seal **(6)** over the threads on the top of the valve body and on the retainer nut.
6. Connect 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 unless all the pumps are worn. Worn fuel injection pumps will result in loss of power and hard starting. When loss of

power and hard starting is 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.

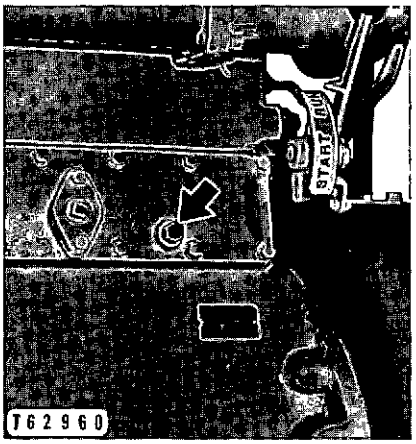
COOLING SYSTEM

Coolants: Water used in the cooling system should be soft, or as free as possible from scale forming minerals. If it is impossible to obtain soft water it is advisable to 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, therefore, it is not necessary to use rust inhibitors with those anti-freeze solutions which do 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 regulators 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.

Filling: Fill the starting and diesel engine cooling system by pouring the coolant into the radiator filler opening.

Draining: Every 1000 service hours drain and refill the cooling system. The cooling system is drained by removing the radiator cap, opening the



CYLINDER BLOCK DRAIN PLUG

◆

valve on the radiator water outlet on the left side and by removing the diesel cylinder block drain plug at the left rear of the diesel engine block. This should be done at the end of the day's run when all the material is in suspension and will drain with the liquid.

Cleaning The Radiator: Every 1000 service hours clean dirt and trash from in between the tubes of the radiator which may cause excessively high operating temperature. This dirt may be easily removed by removing the capscrews which hold the perforated guard in place. Then wash, brush or blow the dirt out with whichever method is available and most effective.

Cleaning The Cooling System: The cooling system should be drained occasionally to remove dirt and sediment which accumulates. The draining should be done at the end of the day's run, when the foreign material is in suspension and will easily drain with the liquid.

The cooling system should be washed out occasionally. To do this, 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 in 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.

If the above treatment does not prove effective, an acid solution may be used. Acid must be used with extreme care and only after other means have proved ineffective. Immediately after the system has been washed with the soda solution described, fill the cooling system with a solution of five parts hydrochloric (commercial muriatic) acid, one part formaldehyde and forty-eight parts water and allow it to remain in the system for a few hours at operating temperature. The formaldehyde should first be mixed with the water, then the acid added to the solution. Drain immediately after stopping the engine and thoroughly flush the system with clean water to which has been added a handful of washing soda which acts as a neutralizing agent.

After using the acid treatment, the cooling system should be drained and flushed with clean water the second time at the end of the day's run.

CAUTION

The acid solution is also a solvent of the metals of which radiators are made, therefore, great care must be exercised to avoid continuing the operation beyond the point where the scale is dissolved. It is highly important that no trace of the acid be left in the cooling system.

SEALED PRESSURE OVERFLOW UNIT

The sealed pressure overflow unit 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, disassemble by removing the screws which hold the cover in position. Lift off the cover, then remove the seal assembly and brush the parts thoroughly until all of the foreign matter has been removed.

CAUTION

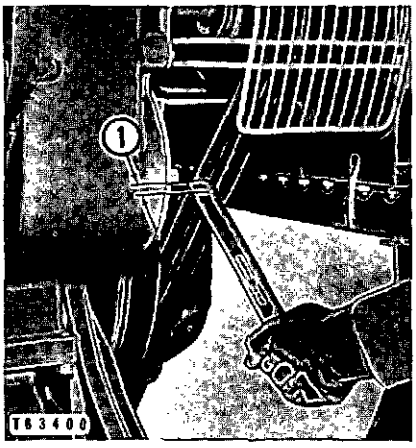
Do not wash the unit in any kind of cleaning solution because so doing may damage the seal.

FAN BELT ADJUSTMENT

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

If the fan belts are operated too loose, they will slap against the pulleys, causing unnecessary wear to the belts and possibly slipping to the extent that the engine will overheat. If the belts are too tight, unnecessary stresses are placed upon the fan bearings and belts, which might shorten the life of both. Correct adjustment exists when the belts can be pushed inward 3/4 to 1 inch (1.91 to 2.54 cm.) with approximately 25 pounds pressure exerted midway between the pulleys as shown at **(1)**.

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



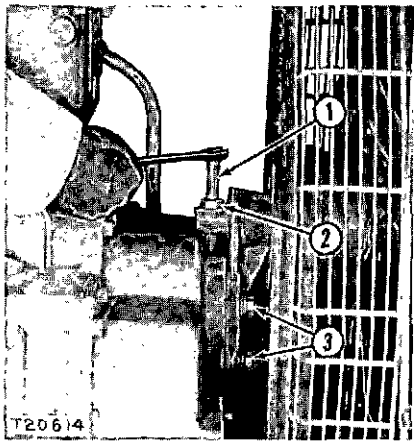
CHECKING FAN BELT TENSION

1–Correct adjustment allows 3/4 to 1 inch (1.91 to 2.54 cm.) slack at this point.

◆

Adjusting Belts: Loosen the three retaining nuts **(3)** which hold the fan hub bracket to the timing gear cover. Loosen the locknut **(2)** on the

adjusting screw **(1)** and turn the screw until the belts can be pushed inward ¾ to 1 inch (1.91 to 2.54 cm.) with approximately 25 pounds pressure exerted midway between the pulleys. Recheck the adjustment after tightening the locknut and retaining nuts.



FAN BELT ADJUSTMENT

1–Adjusting screw. 2–Locknut. 3–Retaining nuts.

◆

VALVE CLEARANCE ADJUSTMENT

The initial valve clearance adjustment should be made after the first 250 service hours of operation. Thereafter, the clearances should be checked and adjusted if necessary after every 500 service hour operating interval.

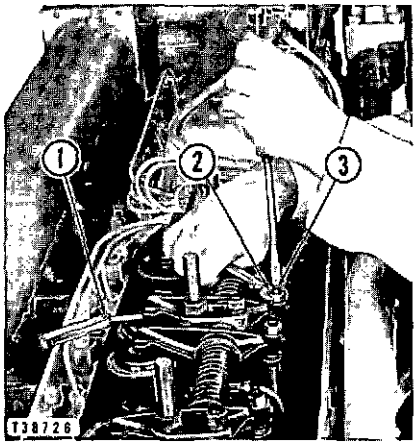
The valve clearance adjustment should be made while the engine is hot, either while the engine is running or before it has been stopped twenty minutes after having run long enough to thoroughly warm up. If the adjustment is made with the engine stopped and is not completed during this twenty minute interval, start the engine and allow it to warm up. The valve clearance adjustment and the compression release clearance adjustment must be made, or the clearances checked, with the compression release lever in the RUN position.

To Adjust: Loosen the valve adjusting screw locknut **(2)**, turn the adjusting screw **(3)** to allow the thickness gauge **(1)** to pass between the top of the valve sleeve and the end of the valve rocker at the correct clearance. Set the clearance for the inlet and exhaust valves at .016 inch (0.41 mm.). Tighten the adjusting screw locknut and check the adjustment.

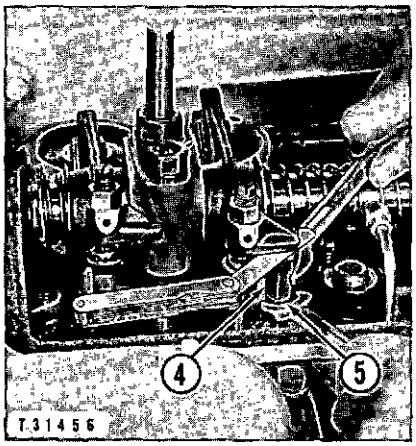
If adjustment is made with the engine stopped, turn the engine until the valve closes and the push rod is at its lowest point.

After adjusting the clearance on the valves, and while the compression release lever is still in the RUN position, with the engine stopped, check the clearance between the upper end of the compression release push

rod and the end of the valve rocker. This clearance should be .025 to .030 inch (0.64 to 0.76 mm.). To adjust, loosen the adjusting screw locknut **(5)** on the compression release push rod and turn the adjusting nut **(4)** *until the correct clearance is obtained. If the compression release push* rod turns when adjusting, hold the push rod with a wrench on the two flat surfaces below the locknut. Recheck the adjustment after the locknut is tightened. Check this clearance every time the valve clearances are changed or checked.



VALVE CLEARANCE ADJUSTMENT
1–Thickness gauge. 2–Locknut. 3–Adjusting screw.



COMPRESSION RELEASE PUSH ROD ADJUSTMENT
4–Adjusting nut. 5–Locknut.

Check Valve Rotators: *Check the valve rotators with the engine running,* after the valve clearance adjustment check has been made, to see if the valves rotate. The rotating of valves decreases carbon build up and uneven wear, thereby increasing the life of the valves. To check the rotation of the valves, observe the lines on the spring retainer through one of the three holes in the valve sleeve. If the valves do not turn the valve rotators should be replaced. See your Caterpillar dealer.

◆

Attachment Instructions

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

STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

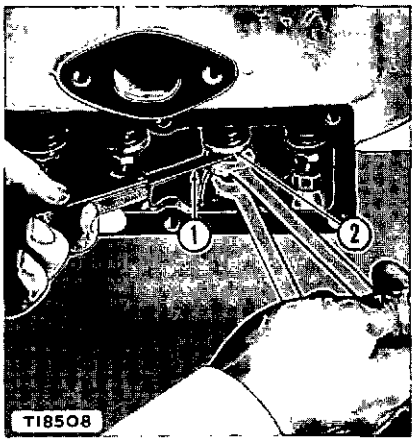
The valve clearance adjustment should be checked every 2000 service hours. To check the adjustment remove the carburetor and valve cover. The valve clearance check or adjustment should be made when the engine is hot. To check, crank the engine until the valve closes and the valve lifter is at its lowest 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 a thickness gauge **(1)**.

STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

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

◆



SPARK PLUG ADJUSTMENT

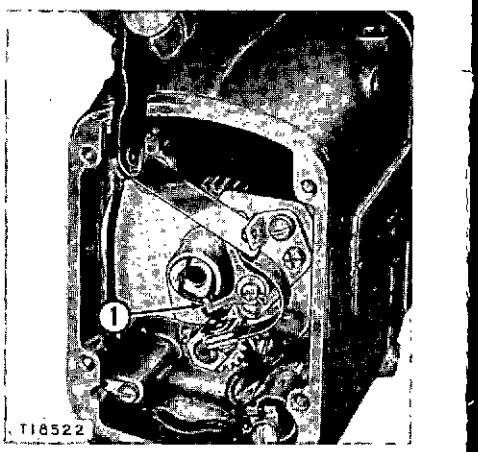
The spark plugs should be examined every 1000 service hours. The gap should be kept at approximately .030 inch (.076 mm.). Measure this gap with a thickness gauge. To adjust the gap, bend the outer electrode.

STARTING ENGINE MAGNETO

American Bosch 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.



CHECKING CONTACT POINT OPENING

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

◆

To check, first remove the distributor plate which is held in place by four screws. Care should be taken in removing the plate not to damage the gasket. Clean any carbon dust from the inside of the plate using a soft cloth, dampened with a non-inflammable cleaning fluid. Remove the distributor rotor, then turn the engine until the contact point bumper block **(1)** is on one of the highest elevations of the cam. Check the clearance with a thickness gauge between the contact points as illustrated. This clearance should be .014 to .018 inch (.35 to 46 mm.).

Adjusting Contact Point Opening: Loosen the screws **(2)** which hold the adjustable contact point bracket and move the bracket by inserting a screw driver in the eccentric slotted-head screw **(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–Eccentric slotted-head screw.

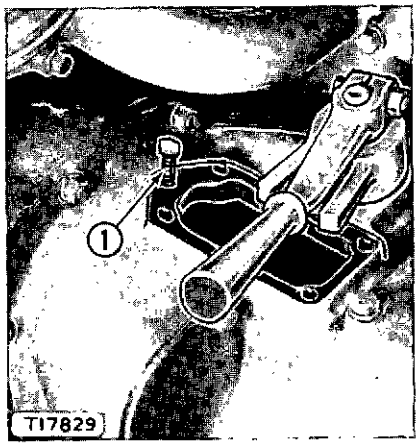
◆

Testing: A magneto may be tested when coupled to the engine by turning the switch, ON, removing the cable from a spark plug, and hold-

ing the terminal 1/8 inch (3.17 mm.) away from the metal base of the plug while cranking the engine. If no spark passes from the terminal to the metal base, disconnect the magneto switch wire from the magneto where it is connected to the terminal on the top of the magneto housing and test again. If a spark passes from the terminal to the base with the switch wire removed, the wire running 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 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 these cables. Remove the two capscrews that hold the magneto to the timing gear cover and lift off the magneto. Do not remove the magneto mounting trunnion when lifting the magneto from the engine.

To Time The Magneto To The Engine: Check the adjustment of the contact points. Locate the firing point of No. 1 cylinder by removing the cover from the top of the starting engine clutch housing and the spark plug from No. 1 cylinder. Crank the engine slowly until the air is forced from the spark plug opening. This indicates the piston is coming up on the compression stroke. Place a 3/8 inch by 2 inch bolt **(1)** in the hole in the flywheel housing. Continue to turn the crank slowly until the bolt drops into the hole in the flywheel. Remove the bolt and replace the cover.

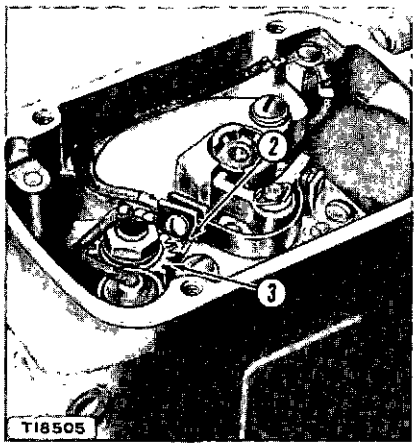


LOCATING CORRECT POSITION OF FLYWHEEL FOR TIMING MAGNETO TO ENGINE

1–Bolt.

◆

Remove the plate at the end of the magneto by taking out the four small fastening screws. Turn the magneto shaft backwards (to prevent the impulse from catching) until the mark "A" on the distributor gear **(2)** lines up with the red line on the magnet rotor shaft gear **(3)**. At this point if the distributor rotor is installed the distributor rotor contact **(4)**

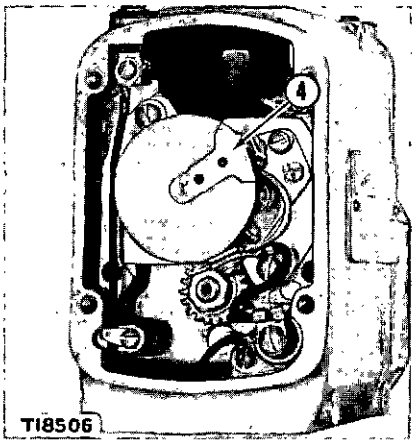


TIMING MARKS ON MAGNETO

2–Mark "A" on distributor gear.
3–Magneto rotor shaft gear.

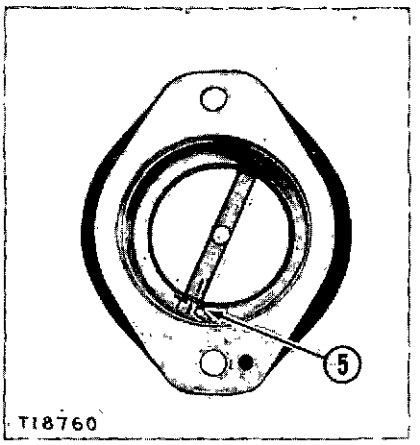
◆

should be in the position shown. When the distributor plate is installed the No. 1 cylinder spark plug wire conductor in the plate will contact the rotor contact **(4)**.



ROTOR POSITION TO TIME MAGNETO TO ENGINE

4–Rotor contact.



TIMING MARKS ON MAGNETO MOUNTING TRUNNION

5–Mark "TC" in magneto mounting trunnion.

Place the magneto into position, making sure the mark on the impulse lug lines up with the mark "TC" **(5)** in the magneto mounting trunnion, and bolt the magneto into place. Check the location of the rotor before replacing the plate to be sure it has not changed its position and then replace the plate on the magneto.

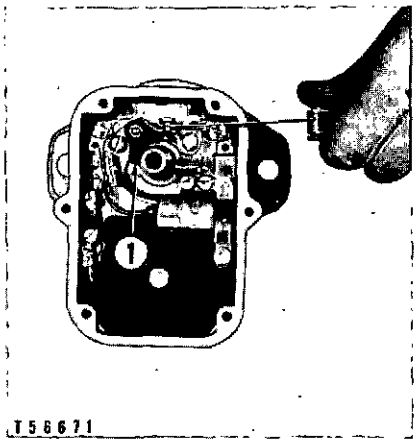
Wico Magneto

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.

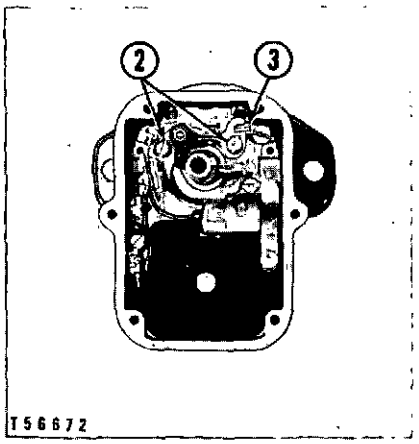
Checking Contact Point Opening: Every 1000 service hours check the contact point opening.

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 non-inflammable cleaning fluid. Remove the distributor rotor, then turn the engine until the contact point bumper block **(1)** is on one of the highest elevations of the cam. Check the clearance with a thickness gauge between the contact points 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.

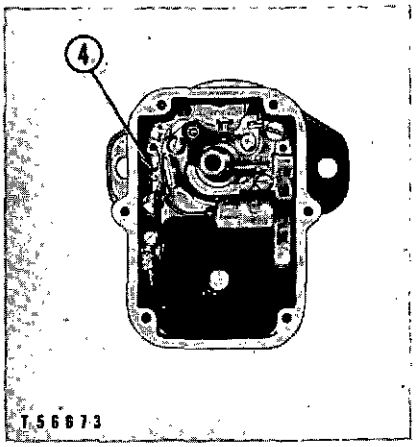


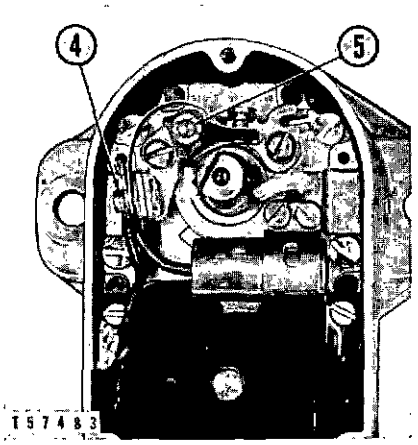
ADJUSTING CONTACT POINT OPENING

2–Bracket fastening screws.
3–Slot.

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.

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.





REMOVING CONTACT POINTS

(Later Magneto)
4–Spring clamp screw.

(Earlier Magneto)
4–Lock and washer. 5–Spring clamp screw.

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

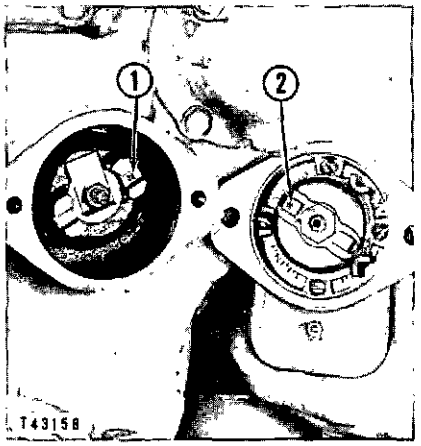
Testing: A magneto can be tested when coupled to the engine. Remove the cable from a spark plug (rotate the terminal to facilitate removal), *insert a 1/4 inch (6 mm.) bolt or similar metal object into the terminal* to contact the wire, and hold the terminal so the end of the bolt is 1/8 inch (3.17 mm.) 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 instruct*ed 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 these 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:

1. Locate the "X" mark **(1)** on the starting engine magneto drive.

2. Turn the magneto impulse coupling until the "X" mark **(2)** on the



TIMING MARKS

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

◆

*tang is in such a position as to line up with the mark on the mag-*neto drive.

3. Install the magneto with the "X" marks together and tighten the bolts.

STARTING ENGINE CLUTCH

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

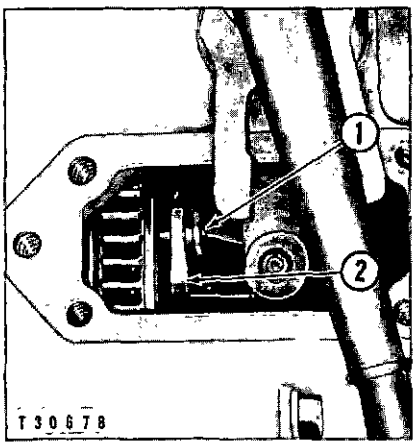
To Adjust: Remove the plate from the top of the clutch compartment. Turn the clutch adjusting collar **(2)** until the lock pin **(1)** is accessible. Pull the lock pin out and turn the collar to the right until the lock pin drops into the next hole.

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.

◆

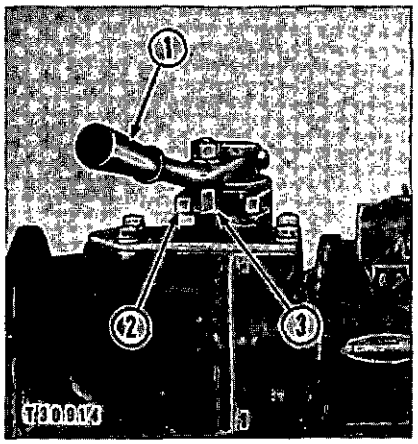


STARTING ENGINE CLUTCH AND STARTER PINION CONTROL LEVER ADJUSTMENT

The clutch and starter pinion control lever should be checked every 500 service hours for proper engagement of the starting engine clutch and starter pinion. Failure to check this adjustment may result in the clutch being engaged before the starter pinion is engaged with the flywheel ring gear or excessive clutch slippage. After the starting engine clutch has been tested for proper adjustment the control lever adjustment may be checked by grasping the control lever **(1)** and engaging the clutch and starter pinion. With control lever and lever **(2)** held as far toward the front of the engine as it will go, measure the gap between the flat on the block **(3)** and the finished flat, nearest the front of the engine, on the lever **(2)**. The clearance should be 1/64 to 1/32 inch (.40 - .80 mm.) for correct adjustment.

If the clearance is greater or less than 1/64 to 1/32 inch (.40 - .80 mm.) the correct clearance should be obtained as follows:

1. Move the clutch lever **(2)** toward the front of the engine until the clutch snaps into engagement.
2. Remove the nut and block **(3)** from the starter pinion control lever **(1)**.
3. Engage the starter pinion by moving the lever **(1)** toward the front of the engine until the latches hold the starter pinion in engagement.
4. Assemble the nut and block to the lever and rotate the block until a flat on the block has 1/64 to 1/32 inch (.40 - .80 mm.) gap between it and the finished flat nearest the front of the engine on the clutch lever, when both the clutch and starter pinion control levers are as far toward the front of the engine as they will go.



STARTING ENGINE CLUTCH AND STARTER PINION CONTROL LEVER

1–Starting engine pinion control lever.
2–Clutch control lever.
3–Block and nut.

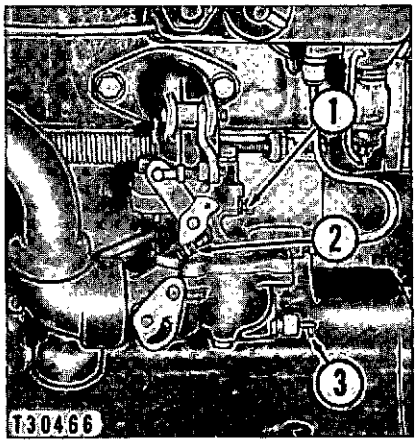
◆

STARTING ENGINE FUEL SYSTEM

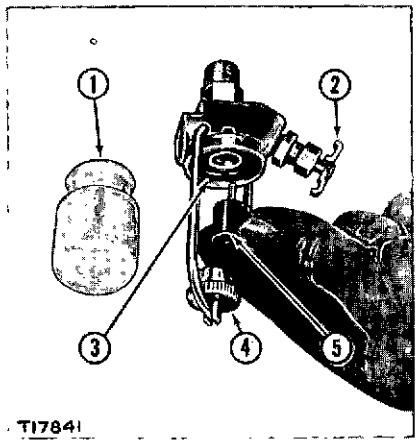
Keeping the starting engine fuel tank filled will prevent condensation in the tank. Periodically drain any water which may have accumulated in the starting engine fuel tank sediment bowl. Occasionally remove the drain filter on the bottom of the starting engine air inlet tube and inspect the filter element. If it is deteriorated, replace it. 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 screw **(3)** one turn from the closed position and the idling speed adjusting screw **(1)** one-half turn from the closed position.

A more accurate adjustment can be made with the engine running at full governed speed by turning the high speed 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 idling speed 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 richer or in to make it leaner. 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–Idling speed 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.

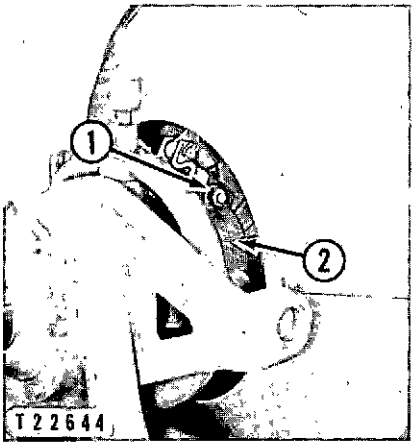
Sediment Bowl Filter: The sediment bowl **(1)** collects water and sediment that may be in the fuel. To remove the collected water and sediment, close valve **(2)** and remove the bowl by unscrewing nut **(4)** that clamps it to the body of the valve. Unscrew the edge-type filter element **(5)** and 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.

FLYWHEEL CLUTCH

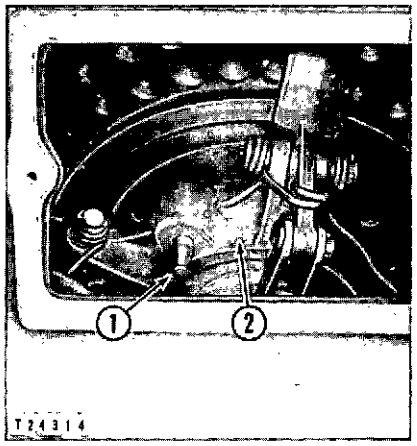
To Test The Flywheel Clutch Adjustment: Pull the clutch lever to the engaged position. For a desirable adjustment the lever should go into the engaged position with a distinct snap, and should require a reasonably hard pull.

Open Type Clutch

To Adjust Open Type Clutch: Disengage the clutch and loosen the nut **(1)** on the adjusting collar clamp bolt. Turn the collar **(2)** a few degrees in a clockwise direction; then tighten the clamp bolt before testing for correct adjustment. Repeat this adjustment until the desired clutch snap is obtained.



OPEN TYPE CLUTCH
1–Clamp bolt. 2–Adjusting collar.



ENCLOSED TYPE CLUTCH
1–Adjusting lock pin. 2–Adjusting collar.

Enclosed Type Clutch

Twin Disc Clutch Adjustment: Remove the inspection cover and turn the adjusting collar **(2)** until the lock pin **(1)** can be reached. Pull out the lock pin and tighten the clutch by turning the collar 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.

Draining The Flywheel Clutch Housing: The clutch plates are designed to operate dry. The drain plug in 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. Lubricants for these points should not be allowed to accumulate in the housing.

ELECTRICAL SYSTEM

The basic electrical system is composed of the following:

1. Battery.
2. Generator.
3. Generator regulator.
4. Wiring.

These components functioning together produce the electricity necessary for operating 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 more often when continuous operation without the use of the battery is encountered, 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 degree of charge before adding water. The specific gravity between the cells should be within .025. A dangerously low point of charge is indicated by a hydrometer reading of 1.150 which will permit the battery to freeze. A specific gravity of 1.250 will permit the battery to withstand temperatures as low as −60°F. without freezing.

Water Addition: The water 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 bicarbonate 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 and the commutator and brushes checked for glaze or darkening. At the same time the generator should be completely disassembled, washed and have all worn parts replaced. 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 connected correctly 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 Delco-Remy Generators: With the disconnect switch ON, if so equipped, connect a jumper wire momentarily between the regulator terminals marked BAT and GEN. Make sure all connections are clean and tight. See the topics, BATTERY, GENERATOR REGULATOR and WIRING.

Polarizing American-Bosch Generators:

1. Disconnect the wire from the generator regulator terminal marked FIELD.
2. Touch this wire 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.

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 degree of charge in the battery. As the battery becomes fully charged, the charging rate should drop 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.

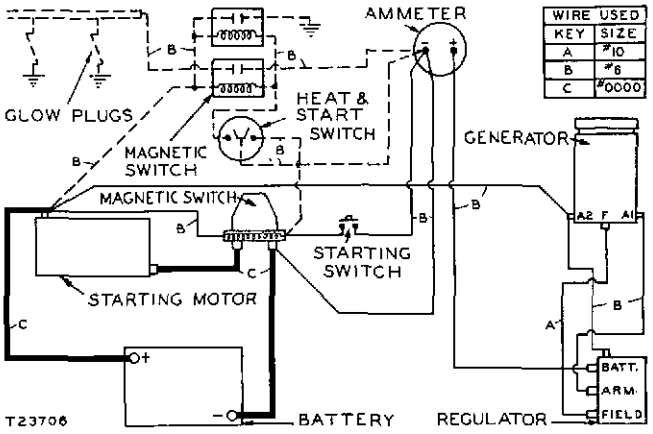
Polarity: Electrical systems may have either the positive or negative battery terminal grounded. When connecting the battery, be sure to ground the same battery terminal that was originally grounded. On new installations or where the battery grounding is questioned, check the generator regulator to determine 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: "12 VOLTS - NEGATIVE GROUND," "12V - NEG.," or "12V N." Similar marks are used for other voltages and for POSITIVE ground systems.

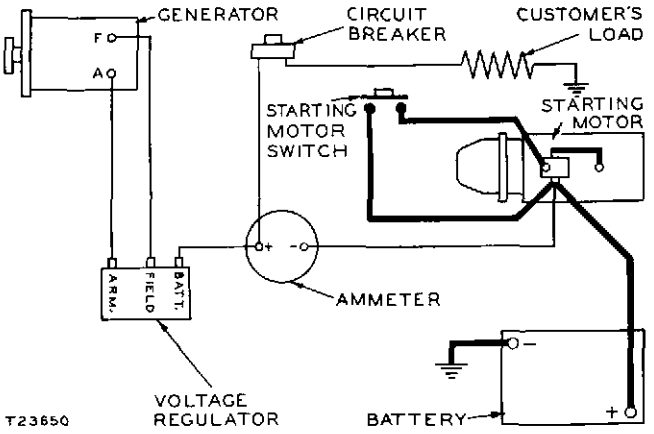
Wiring

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 and GENERATOR REGULATOR.

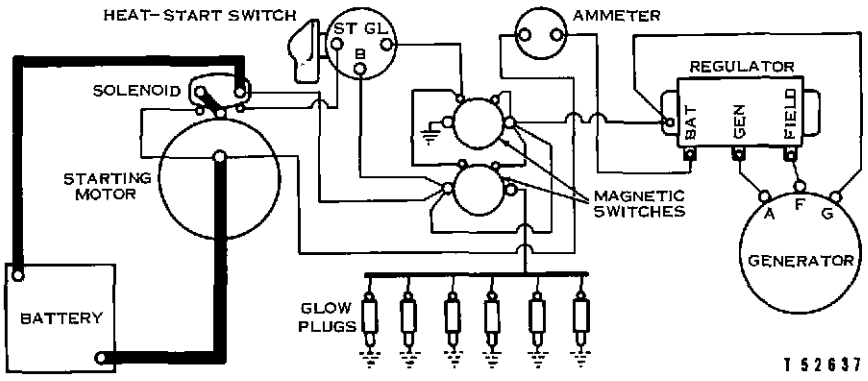
Wiring Diagrams: The diagrams are furnished so that when it becomes necessary to disturb the electrical equipment for purpose of reconditioning or parts replacement, reassembling may be accomplished without difficulty. The battery terminal to be grounded is determined by the generator regulator. See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



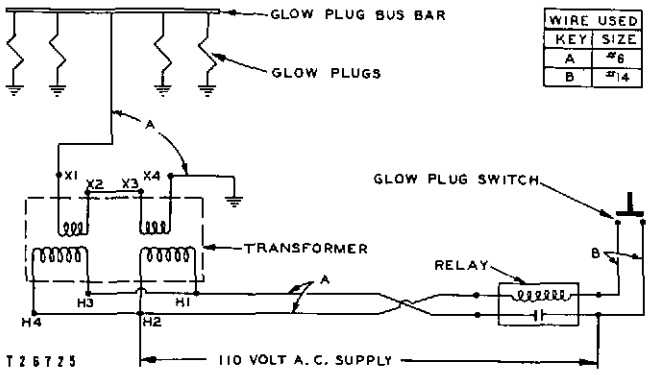
WIRING DIAGRAM FOR 24 VOLT ELECTRICAL SYSTEM WHEN EQUIPPED WITH GLOW PLUGS
(Positive ground)



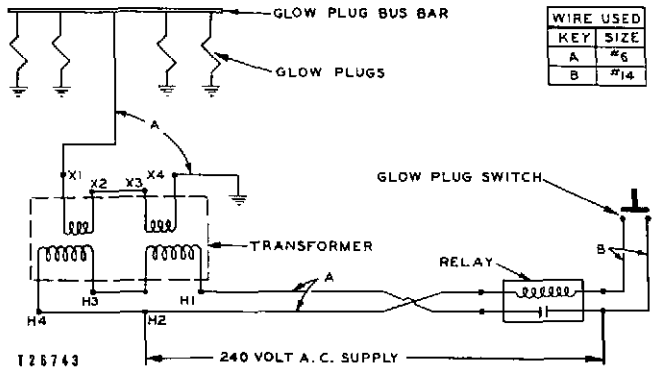
WIRING DIAGRAM FOR ENGINES EQUIPPED WITH 6 OR 12 VOLT GENERATOR AND STARTER FOR STARTING ENGINE



WIRING DIAGRAM FOR 24 VOLT ELECTRICAL SYSTEM WHEN EQUIPPED WITH GLOW PLUGS
(Negative ground)



WIRING DIAGRAM FOR ENGINES EQUIPPED WITH GLOW PLUGS FOR USE WITH 120 VOLT A.C.



WIRING DIAGRAM FOR ENGINES EQUIPPED WITH GLOW PLUGS FOR USE WITH 240 VOLT A.C.

ELECTRIC STARTER
(12 and 24 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. The 24 volt electric starter commutator end and drive end bearings are equipped with wicks for lubrication purposes. The wicks should be saturated with oil whenever the electric starter is removed or disassembled.

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.

AIR STARTING MOTOR OILER

The air starting motor oiler automatically meters oil into the air stream 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.

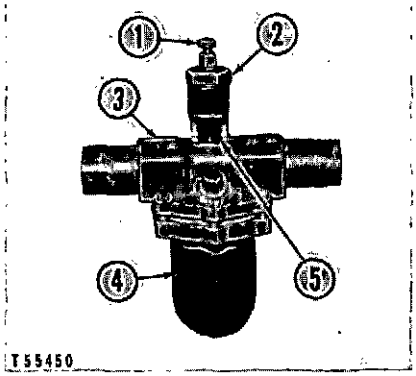
The oiler is designed to operate satisfactorily in a perpendicular position as long as the bowl is kept filled with lubricant. The oiler should be regulated to meter about four drops of oil per minute to the air stream.

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 nonflammable cleaning fluid. Be sure the oil passage is open in both the body and drip gland before reinstalling the top plug. If it is sus-



AIR STARTING MOTOR OILER

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

◆

pected that dirt or sludge has accumulated in bowl **(4)** remove the bowl and clean it thoroughly in kerosene or nonflammable cleaning fluid and blow out the passages in the body with compressed air.

WOODWARD UG8 GOVERNOR OPERATION

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)** indicator 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. Crank the engine and allow it to run at about half normal engine speed for five minutes. 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 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 rated 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 line shafts, the speed droop knob **(1)** indicator should be left at "0" then proceed with step 7.

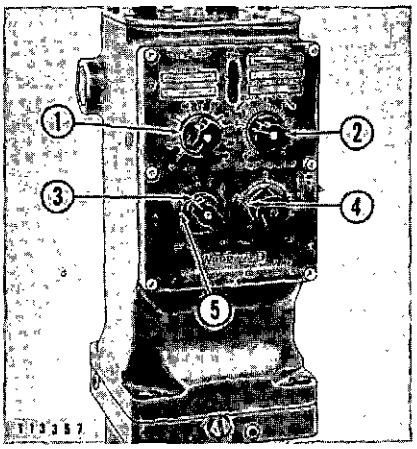
   B—Solid Line Shaft Compounding:

   If the engine is to be compounded on solid line shafting, set the speed droop knob indicator between "30" and "70", then proceed with step 7.

   C—Fluid Coupling And Other Compound Applications:

   If the engine is operating an application 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. Re-adjust 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.



WOODWARD UG8 GOVERNOR

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

◆

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 adjustments to the governor after the load is on the engine have the effects as follows:

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 assure more of the continuous load, turn the synchronizer knob clockwise. When the engines are paralleled on solid line shafting, etc., individual engine outputs are adjusted by turning the synchronizer knobs.

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

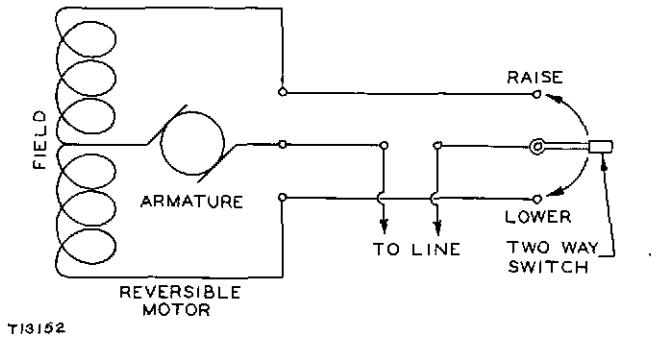
To Stop The Engine

1. Remove the load and turn the synchronizer knob to allow the engine to idle at about half engine speed 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 to protect it with an anti-freeze solution. See the topic, COOLING SYSTEM.

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 speed of an engine driven unit with that of other units, or a system, before synchronizing and to change load distribution after synchronizing.

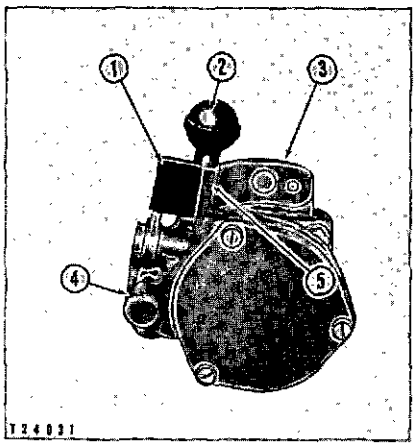
The motor used is of the split field, series wound, reversible type. It can be used on either direct current or alternating current at its specified voltage. It should be wired as shown.



GOVERNOR SYNCHRONIZING MOTOR WIRING DIAGRAM

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. The control also can be used to quickly raise or lower engine



VERNIER GOVERNOR CONTROL

1–Plunger lever. 2–Control lever knob. 3–Adapter quadrant. 4–Plunger. 5–Control mechanism lever.

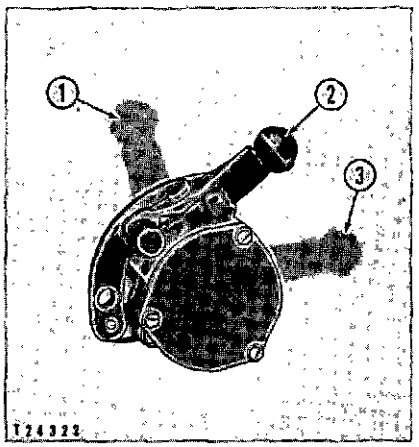
◆

speed between low idle and full load settings. The control may be located on either the left or right side of the engine.

Pressing the plunger lever **(1)** *moves the spring loaded plunger* **(4)** out of either hole in the adapter quadrant **(3)**, thus permitting free movement of the control mechanism lever **(5)** to any position between low idle and full engine speed positions.

The spring loaded plunger **(4)** will lock the control in high speed range when the plunger is engaged in one of the holes in the adapter quadrant **(3)**.

The control lever knob **(2)** is provided to allow minute speed changes. *This is done by turning the control knob in either direction.*

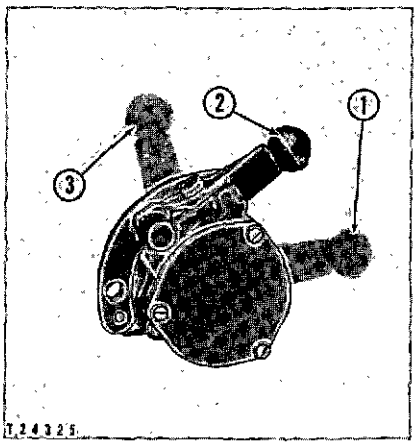


LEFT HAND CONTROL

1–Full speed position. 2–Starting position. 3–Shut-off position.

◆

Position Control For Starting: If necessary, press the plunger lever and rotate the control mechanism lever to a position approximately half way between the shut-off and full speed positions as shown at **(2)**.



RIGHT HAND CONTROL

1–Full speed position. 2–Starting position. 3–Shut-off position.

◆

Position Control For Full Speed: Rotate the control mechanism in such a manner that the top of the control mechanism moves toward the front of the engine until the plunger drops into the hole in the adapter quadrant and the control lever is in the position shown at **(1)**. Adjust for desired speed by turning the control lever knob.

Position Control For Shut-off: If necessary, press the plunger lever and rotate the control mechanism lever toward the rear of the engine as far as possible as shown at **(3)** and hold in this position until the engine stops. The control may be locked in the shut-off position if so desired. This is done by rotating the control mechanism toward the rear of the engine until the plunger drops into the hole in the adapter quadrant and the control lever is in the position shown at **(2)**, and then turning the control lever knob until the engine stops.

STARTING AIDS

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. An ammeter should be used when making this check to show that each glow plug uses approximately 7 amperes.

An ammeter of sufficient capacity should be connected to the glow plug side of the magnetic switch and the HEAT-START switch moved to the HEAT position. A reading on the ammeter should be approximately equal to the number of glow plugs in the system multiplied by 7. Any reading that varies appreciably from this may indicate one or more defective glow plugs.

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, it can be assumed that the glow plug is defective and should be replaced. Remove the ammeter from the magnetic switch.

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.

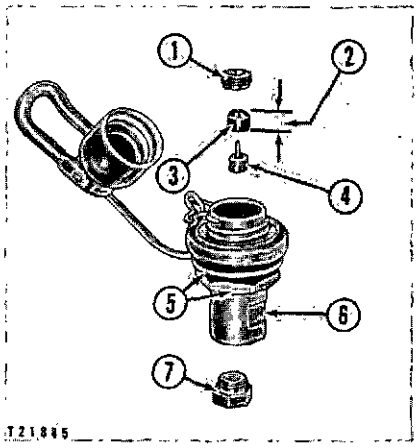
The glow plug should first be removed before removing and replacing a fuel injection valve to eliminate the possibility of damaging the glow plug.

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

Ether Starting Aid

Maintenance: If it is suspected that the ether starting aid is not functioning properly to assist in starting, disassemble the ether discharger **(6)**.

1. Disconnect the tubing from the bottom of the discharger.
2. Remove the screen assembly **(7)** and wash the screen.



ETHER DISCHARGER

1–Screw. 2–Free length measurement of 3/8 inch. 3–Rubber washer. 4–Pin. 5–Nut and washer. 6–Ether discharger. 7–Screen assembly.

◆

3. Remove the nut and washer **(5)** to remove the discharger.
4. Remove the screw **(1)**, rubber washer **(3)** and pin **(4)**.
5. Inspect the pin **(4)** to see that it is sharp. If the pin is not sharp, replace it.
6. Check the small hole through the pin to see that it is clean.
7. Inspect the rubber washer **(3)**. The rubber washer should have a free length measurement of approximately 3/8 inch as shown at **(2)** and should not be distorted, otherwise replace it.
8. Assemble the discharger and replace it.

SAFETY SHUT-OFF CONTROLS

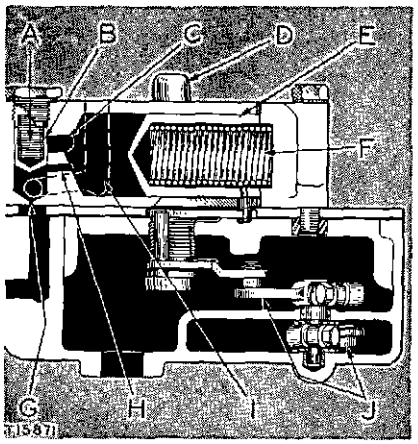
The purpose of the safety shut-off controls are to provide means of automatically stopping the engine to prevent damage when the lubricating oil pressure becomes dangerously low or excessively high cooling system temperatures occur.

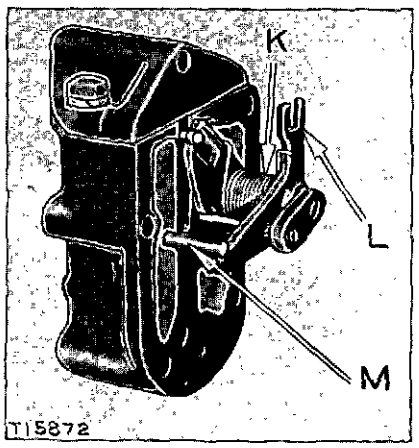
The oil pressure shut-off is mounted on the side of the fuel injection pump housing. Oil pressure lines between the oil pressure shut-off and

water temperature shut-off and oil return lines from the oil pressure and water temperature shut-offs to the diesel engine crankcase constitute the oil pressure arrangement of the safety shut-off controls.

Oil Pressure Shut-Off: When the engine is running and the lubricating oil pressure is normal, oil is forced by the crankcase lubricating oil pump through a passage in the oil pressure shut-off mounting housing and enters the shut-off mechanism at opening **(G)**, causing the pilot piston valve **(B)** to move thus opening passage **(H)** to allow oil to move the shut-off piston **(E)** against pressure of spring **(F)**. When pilot piston valve **(B)** is forced against spring **(A)** the passage **(C)** is closed to prevent oil returning to the crankcase. When the shut-off piston is compressing spring **(F)** the shut-off lever **(L)** is held against stop **(M)** by spring **(K)** permitting the fuel pump rack to be moved by governor action.

Should the oil pressure become dangerously low the oil pressure exerted on the pilot piston valve **(B)** will diminish, allowing spring **(A)** to force the pilot valve toward oil inlet opening **(G)**, opening passage **(C)**





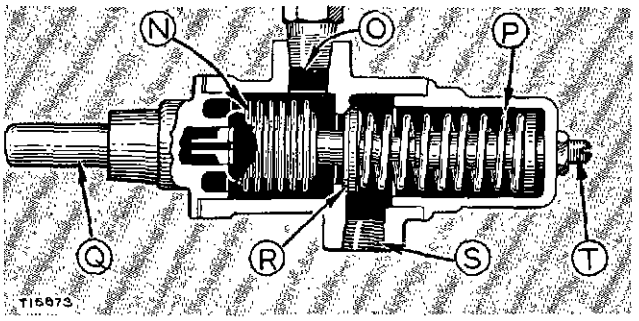
OIL PRESSURE SHUT-OFF

A–Pilot valve spring. B–Pilot piston valve. C–Oil exhaust passage from shut-off piston chamber. D–Reset button. E–Shut-off piston. F–Shut-off piston spring. G–Oil inlet opening. H–Oil supply passage to shut-off piston chamber. I–Oil supply passage to the water temperature shut-off if so equipped. J–Lever arrangement. K–Shut-off lever return spring. L–Shut-off lever. M–Shut-off lever stop.

and releasing the oil pressure in the chamber thus allowing spring **(F)** to force the shut-off piston **(E)** toward the pilot piston valve **(B)**. This causes the shut-off lever **(L)** to be forced against lever arrangement **(J)** which in turn causes the fuel pump rack to move to the shut-off position.

Water Temperature Shut-Off: The water temperature shut-off in itself is a control valve for the oil pressure shut-off, as it is actually the oil pressure shut-off that functions to stop the engine. The water temperature shut-off is used only with the oil pressure shut-off.

When the water temperature is normal, spring **(P)** holds valve **(R)** on its seat which prevents oil flowing from the oil pressure shut-off through opening **(O)** of the water temperature shut-off and on into the



WATER TEMPERATURE SHUT-OFF CONTROL
N–Bellows. O–Inlet opening. P–Spring. Q–Temperature bulb. R–Valve. S–Outlet opening. T–Adjusting screw.

engine crankcase through outlet opening **(S)**. This allows oil pressure to build up in the safety shut-off system with the result that the oil pressure shut-off functions to permit the governor to control the engine speed in the manner already described.

Occurrence of abnormally high engine water temperature, heats temperature bulb **(Q)** which is immersed in the engine water at the water temperature regulator housing. As heat on the temperature bulb increases, bellows assembly **(N)** expands, unseating valve **(R)** allowing oil held under pressure in the safety shut-off control system to return to the engine crankcase through passage **(I)** and outlet opening **(S)**. A drop in the oil pressure, on the pilot piston valve side of inlet opening **(G)** then causes the oil pressure shut-off to stop the engine.

The temperature at which the water temperature shut-off operates is adjusted by use of screw **(T)**.

Reset Button: The reset button **(D)** is provided to disengage the shut-off lever so the engine can be started after the engine has stopped for any reason. Pushing the reset button releases shut-off lever **(L)** from shut-off position, allowing the rack to be moved by governor action. When sufficient oil pressure is developed to move shut-off piston **(E)** the shut-off lever is re-engaged so that the shut-off mechanism can function properly. This re-engagement is evident when the reset button snaps out to its original position.

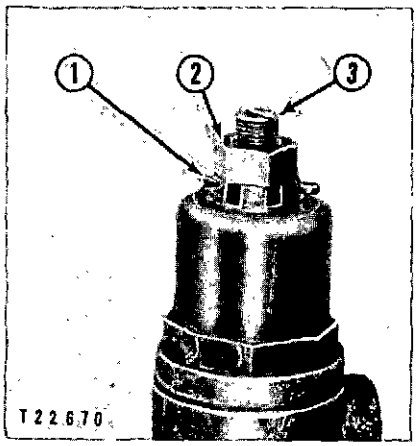
CAUTION

After starting, if sufficient oil pressure is not developed, it is possible for the engine to run but the safety shut-off mechanism will be inoperative. Therefore, **check the oil pressure immediately** after starting either by observing that the oil

pressure gauge indicator is in the operating range or by watching the reset button snap out to the engaged position.

Water Temperature Shut-Off Adjustment: The water temperature adjustment should be made when the engine is operating without load. The shut-off has an adjustable range from 188°F. to 208°F. (87°C. to 98°C.) when there is no load on the engine. However, an engine operating under load may cause a variation of approximately 5°F. (3°C.) in the point at which the water temperature shut-off will open. This should be considered when adjusting the water temperature shut-off.

To Adjust: To raise the temperature at which the shut-off valve operates, remove the cotter pin **(1)**, loosen the locknut **(2)** and turn the adjusting screw **(3)** counterclockwise. This applies more tension on the pressure control spring, making a higher water temperature necessary to create sufficient pressure in the bellows to unseat the control valve. To lower the temperature, turn the adjusting screw clockwise. Always tighten the locknut and replace the cotter pin after making an adjustment.



WATER TEMPERATURE SHUT-OFF ADJUSTMENT

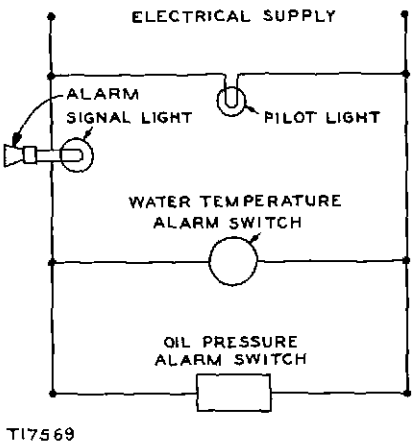
1–Cotter pin. 2–Locknut. 3–Adjusting screw.

◆

The most practical method of making the adjustment is as follows: Turn the adjusting screw counterclockwise about three turns; then cover the radiator and operate the diesel engine at no load until the water temperature reaches that selected for shutdown under the particular operating temperature. Then, slowly turn the adjusting screw clockwise until the engine stops after which the locknut should be tightened. Check the correctness of adjustment by operating the diesel engine without the radiator covered; then again cover the radiator to determine whether shut-down occurs at the desired temperature. If not, repeat this procedure until proper results are obtained.

SAFETY ALARM SWITCHES

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 combi-



TYPICAL SAFETY ALARM CIRCUIT

◆

nation can be placed in the circuit so that the operator will be warned in case the water temperature or oil pressure reach dangerous levels. The operator can then shut-down the engine and correct the difficulty. For further in formation see your Caterpillar dealer.

Water Temperature Alarm Switch (Later Type)

The single pole double throw switch can be wired so that it is either normally open or normally closed. The switch operates due to expansion and contraction of the liquid in the element which is submerged in the engine coolant. The switch operating temperature is stamped on the copper element.

WATER TEMPERATURE ALARM SWITCH

(Later Type Switch)

◆

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.*

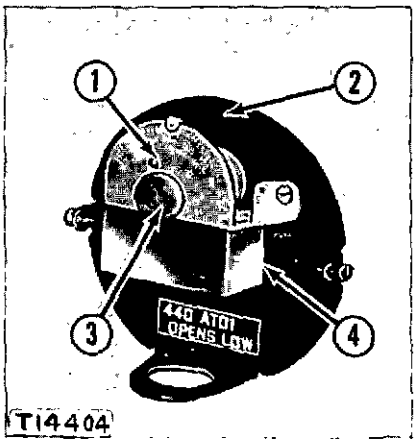
2. In circuits of single phase, 230 volts alternating current, connected directly to the relay, 2.5 amperes.
3. In circuits up to 600 volts alternating current, where another switch (relay) is operated, 1 ampere.
4. In circuits of 125 volts, where a direct current relay is employed, .5 ampere.
5. In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

(Earlier Type)

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. The rise in engine water temperature causes the metallic coil to expand, operating a single throw, snap-acting, magnetic switch. This switch is open during cold and normal water temperature ranges. When excessive temperatures are reached the switch is closed thus sounding the alarm.

The switch **(4)** can be adjusted to operate the alarm at any temperature, ±7°, between 50° and 350°F. For practical use on Caterpillar Diesel Engines a stop screw **(1)** limits the highest temperature adjustment to the boiling point area.

Adjustment: Remove the cover, loosen the knurled nut **(3)** and move the pointer **(2)** to the desired calibrated temperature. Hold the pointer in position and tighten the knurled nut securely.



EARLIER WATER TEMPERATURE ALARM SWITCH

1–Stop screw. 2–Pointer. 3–Knurled nut. 4–Switch.

◆

Oil Pressure Alarm Switch

The oil pressure alarm switch may be mounted on the right side of the engine on a bracket fastened to the water manifold mounting studs. 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 alarm or relay switch having a rating not to exceed the maximum as follows:

1—Circuits of 115 volts, alternating current, 15 amperes.

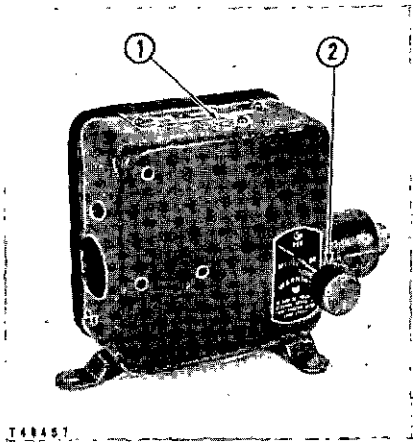
2—Circuits of 230 volts, alternating current, 14 amperes.

3—Circuits of 6 to 32 volts, direct current, 14 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 after each start, as this indicates that alarm contactor is ready to function in case of no oil pressure.



OIL PRESSURE ALARM SWITCH

1–Adjusting screw. 2–Control knob.

◆

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.

◆

Index

INDEX—Continued

FORM 31603-7

6-63
PRINTED IN U.S.A.

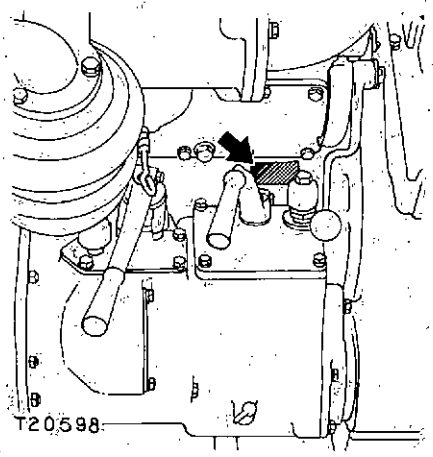
Capacities

Approximate quantities

	U.S. MEASURE	IMP. MEASURE	METRIC MEASURE
rankcase Lubricating Oil System, Diesel Engine	35 qt.	29.2 qt.	33,12 lit.
Starting Engine	2 ¾ qt.	2.3 qt.	2,6 lit.
uel Injection Pump Housing	1 ¼ qt.	1.1 qt.	1,2 lit.
ir Cleaner, Diesel Engine	5 qt.	4.1 qt.	4,73 lit.
ir Cleaner, Starting Engine	¾ qt.	.6 qt.	,71 lit.
arting Engine Transmission	1 ⅜ qt.	1.1 qt.	1,3 lit.
iel Tank, Starting Engine	8 qt.	6.7 qt.	7,57 lit.
ooling System (Without Radiator)	16 ½ gal.	13.7 gal.	62,5 lit.
(With Radiator)	26 gal.	21.7 gal.	98,4 lit.

◆

Location of Serial Number



CATERPILLAR

Diesel Engines - - - - Tractors - - - - Motor Graders
- - - - - - - Earthmoving Equipment - - - - - -

THERE IS A CATERPILLAR DEALER NEAR YOU

FORM 31603-7

PRINTED IN U.S.A.