OPERATION AND
MAINTENANCE
INSTRUCTIONS

CATERPILLAR
D343
MARINE ENGINE

SERIAL NUMBERS

Foreword

Caterpillar products are a result of advanced engineering, skilled manufacturing and the finest materials that go into every piece of equipment. Numerous examples of satisfying, economical working years are built into each machine.

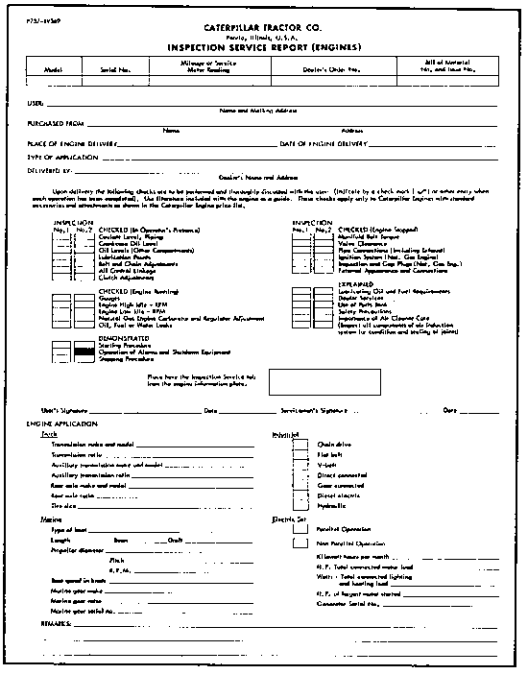
Proper operation of the owner defines the maximum service from its machine depends largely on the care exercised in its operation and maintenance. This book is written to give the operator essential information regarding the day-to-day operation, lubrication and adjustment of the machine. Careful adherence to these instructions will result in assured economy.

More and more Caterpillar owners are depending upon their dealer for service rather than do 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. In all ways they are equipped to render the best of service.

Inspection Service for Engines

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

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



CATERPILLAR TRACTOR CO.
Peoria, Illinois, U.S.A.
INSPECTION SERVICE REPORT (ENGINES)

Model	Serial No.	Mileage or Service Meter Reading	Dealer's Order No.	Bill of Material No. and Issue No.

USER _____
Name and Mailing Address

PURCHASED FROM _____
Name Address

PLACE OF ENGINE DELIVERY _____ DATE OF ENGINE DELIVERY _____

TYPE OF APPLICATION _____

DELIVERED BY _____ Dealer's Name and Address

Upon delivery the following checks are to be performed and thoroughly discussed with the user. (Indicate by a check mark (✓) or when every when each operation has been completed). Use Directions included with the engine as a guide. These checks apply only to Caterpillar Engines with standard accessories and attachments as shown in the Caterpillar Engine price list.

INSPECTION

Req'd	No. 2	CHECKED (Be Operator's Present)
		Coolant Levels, Piping
		Crankcase Oil Level
		Oil Levels (Other Compartments)
		Lubrication Points
		Belt and Chain Adjustments
		All Control Linkage
		Clutch Adjustment

CHECKED (Engine Running)

		Governor
		Engine High Idle - RPM
		Engine Low Idle - RPM
		Natural Gas Engine Carburetor and Regulator Adjustment
		Oil, Fuel or Water Leaks

DEMONSTRATED

		Starting Procedure
		Operation of Alarms and Shutdown Equipment
		Stopping Procedure

INSPECTION

Req'd	No. 2	CHECKED (Engine Support)
		Mounting Bolt Torque
		Valve Clearance
		Pipe Connections (Including Exhaust)
		Ignition System (Nat. Gas Engine)
		Inspection and Gap Plugs (Nat. Gas Eng.)
		Fastened Appearance and Connections

EXPLAINED

		Lubricating Oil and Fuel Requirements
		Dealer Service
		Use of Parts Book
		Safety Precautions
		Importance of Air Cleaner Care (Report if all elements of air induction system in condition and sealing at joints)

Place here the Inspection Service tab from the engine information plate.

User's Signature _____ Date _____ Serviceman's Signature _____ Date _____

ENGINE APPLICATION

Truck
Transmission make and model _____
Transmission ratio _____
Auxiliary transmission make and model _____
Auxiliary transmission ratio _____
Rear axle make and model _____
Rear axle ratio _____
Tire size _____

Marine
Type of boat _____
Length _____ Beam _____ Draft _____
Propeller diameter _____
Pitch _____
R.P.M. _____
Boat speed in knots _____
Marine gear make _____
Marine gear ratio _____
Marine gear serial No. _____

Industrial
- Chain drive
- Flat belt
- V-belt
- Direct connected
- Gear connected
- Direct electric
- Hydraulic

Electric Set
- Parallel Operation
- Non Parallel Operation

Kilowatt hours per month _____
H. P. Total connected motor load _____
Watts - Total connected lighting and heating load _____
H. P. of largest motor started _____
Converter Serial No. _____

REMARKS: _____

INSPECTION SERVICE REPORT

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

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

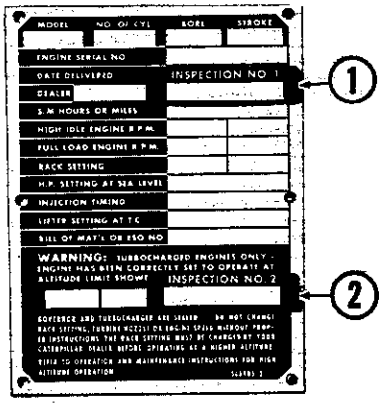
Both inspections are provided free. Any unusual costs, such as travel to an operating location extremely remote from the store of the dealer performing the inspection, however, are subject to charge. These unusual costs, as determined by the Caterpillar Dealer, shall be paid by the party requesting the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

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

ENGINE WARNING AND INFORMATION PLATE

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

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



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Avoid Accidents

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

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

A careful operator is the best insurance against an accident.

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

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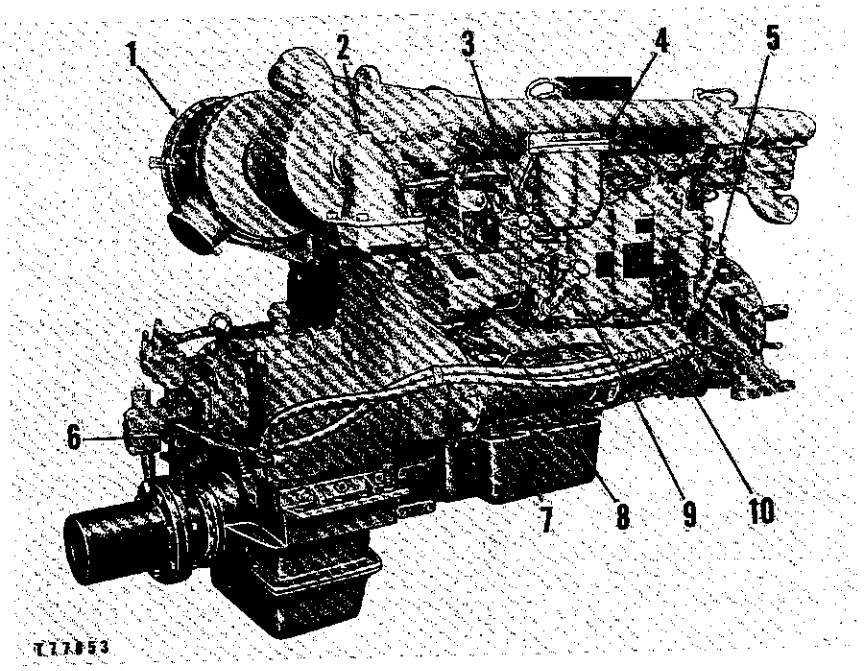
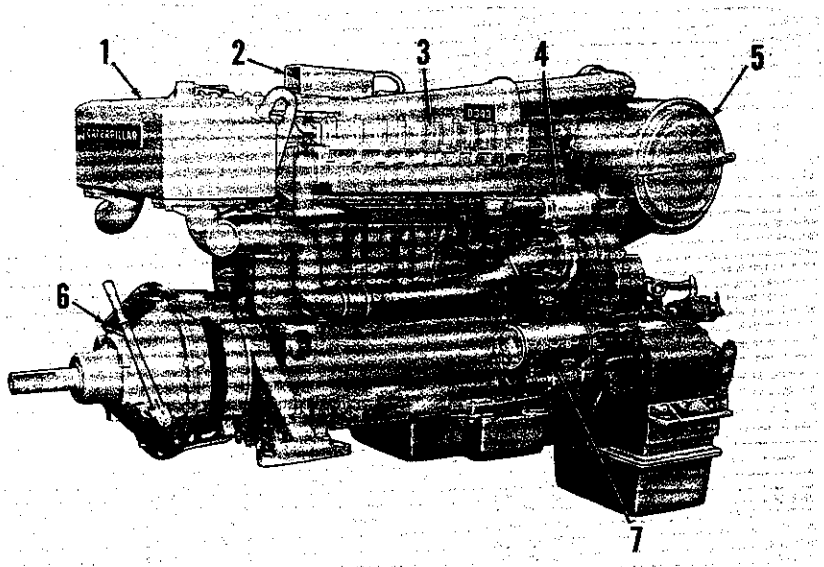


D343 MARINE ENGINE — RIGHT REAR VIEW

1–Air cleaner. 2–Diesel engine exhaust. 3–Diesel fuel vent valve. 4–Diesel fuel filter housing. 5–Diesel engine crankcase filler tube. 6–Marine gear oil level gauge. 7–Crankcase lubricating oil cooler. 8–Crankcase lubricating oil level gauge. 9–Fuel priming pump. 10–Marine gear oil cooler.



D343 MARINE ENGINE — LEFT FRONT VIEW

1–Surge tank. 2–Instrument panel. 3–Aftercooler. 4–Water pump. 5–Air cleaner. 6–Front power take-off. 7–Electric starter.

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 bulkheads and surrounding machinery. Accessibility for adjustment and maintenance should be assured and proper provision made for pumping out 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.

Two types of cooling systems are used in conjunction with marine engines: keel cooling and heat exchanger cooling systems.

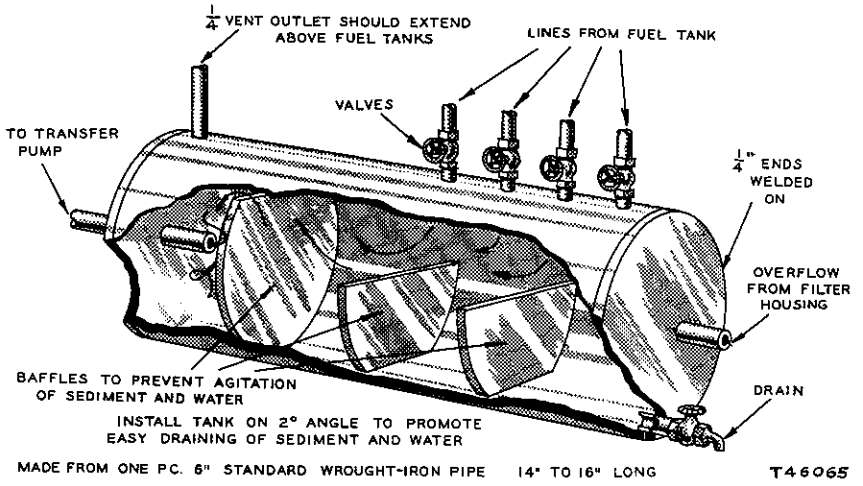
Heat Exchanger: Install a 2" or larger sea water intake suction pipe at a sufficient level below the water line so the opening will not be uncovered by a heavy sea. Care should also be taken not to locate this opening too close to the bottom, as sand and dirt will be drawn into the line in shallow water. A duplex type of basket strainer with 1/16 inch (.157 cm.) openings **must** be installed in the suction line to keep foreign accumulations from reaching the raw water pump and damaging the impeller. Also, install all drain plugs furnished.

Connect a 2 inch (5.08 cm.) or larger sea water overflow pipe to the outlet side of the heat exchanger. This pipe can discharge directly overboard and a portion of the water may be diverted through the exhaust pipe for cooling with a wet exhaust system. In this latter instance the location and design of the exhaust pipe must be such that no water can possibly get back into the engine by flooding through the individual cylinder exhaust valves due to excessive rolling and pitching of the vessel when operating on a heavy sea.

Keel Cooling: In this system the engine coolant is circulated through coils on the hull. The capacity required for this system must be calculated to suit operating conditions, size of coils and horsepower requirements of the engine. An additional expansion tank is normally used. It is recommended that your Caterpillar dealer be consulted when an installation of this type is planned.

DIESEL FUEL TANKS

In many cases the lack of space in small vessels makes it advisable to install several small fuel tanks in convenient locations rather than one large one. When this occurs it is suggested that the fuel lines from all the tanks be connected to a combined fuel manifold and sediment condensation trap as illustrated. Since this forms a common connection for all tanks, it simplifies the supplying of fuel to the engine.



SEDIMENT TRAP

The baffle plates reduce fuel agitation thus trapping sediment and condensation which can be drawn off when necessary through the drain. Fuel by-passed at the fuel filter housing is returned to the trap rather than the individual tanks, thereby eliminating the danger of overflow.

If any of the tanks are so mounted that there is a suction lift required, then it will be essential that all of the other tank connections be tightly closed by the valves shown, or the suction lift of the pump will be broken by air leaks from another tank.

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 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 from engine vibrations, flexible fuel lines are recommended for use between the engine and the diesel fuel tank lines. The flexible lines are available from your Caterpillar Dealer.

EXHAUST LINES

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

ENGINE MOUNTING AND SHAFT ALIGNMENT

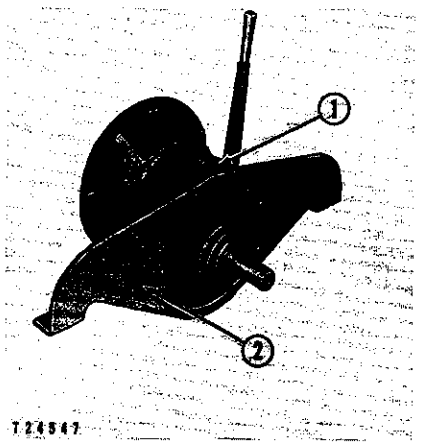
Coupling Alignment: Extreme care should be exercised in the alignment of the engine and propeller shaft. The alignment of the marine gear coupling and the propeller shaft coupling should be checked after the vessel has been launched as hull distortion sometimes takes place after the vessel is in the water. Uncouple the propeller shaft from the marine gear and check the propeller shaft alignment. There are two particular points of alignment that must be considered. These two points are commonly referred to as angular or face alignment and bore alignment. There should be less than .0005 inch (.0126 mm.) per inch of diameter face alignment and .005 inch (.126 mm.) bore alignment. If the variation is greater than this amount, alignment can be restored by adjusting the leveling capscrews. Hold-down bolts or lag screws should be of such diameter as to make a tight fit in the hole of the support bracket. This is necessary to prevent movement of the engine on its supports. At frequent intervals, check this alignment especially in freight boats. Failure to keep the engine and propeller shaft in alignment would cause damage to the various marine gear parts and propeller shaft bearing.

Marine Gear Installation: When a marine gear is not installed at the factory or is removed and reinstalled, care should be taken to insure correct alignment between the marine gear and the engine. Improper alignment will result in undue wear or damage to the marine gear mechanism. It is recommended you consult your Caterpillar dealer for specific information on installing a marine gear on the diesel engine.

CAUTION

The maximum permissible angle of inclination of the engine and marine gear is 19°. The vessel may assume a different angle when it is under way than when in dock. Angle of inclination described here is the angle the marine gear drive shaft (or engine crankshaft) makes with the water level.

Front Power Take-off Installation: When a front power take-off with reduction gear unit **(1)** is installed on the engine it imposes considerable



FRONT POWER TAKE-OFF SUPPORT PLATE

1–Reduction gear unit.
2–Support plate.

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weight and side pull on the adapter flange which is used to mount the unit. Because of the severe strain on the flange in this installation the support plate **(2)** must be used where pilot and bolt holes are provided to insure satisfactory operation. The support plate must also be supported and anchored at the ends in a manner which will eliminate strain on the housing.

DIESEL ENGINE CRANKCASE OIL LEVEL GAUGE MARKING

The engine has had most of the oil drained from the crankcase before shipment from the factory. Before installing the engine prepare for marking the oil level gauge by leveling the engine, removing the crankcase drain plug and draining any oil accumulation. Install the drain plug.

When the engine has been installed in its final location, fill the crankcase with the quantity of oil recommended on the capacity chart on the inside back cover of the Operation and Maintenance Instructions. Then run the engine for a short period of time to distribute oil to all parts of the engine. The oil level should then be checked with the engine running. The oil level indicated by the top of the oil on the gauge should be permanently marked on the gauge for the full "running level." This will vary depending upon the angle at which the engine is mounted in the vessel. It is recommended that the low mark on the gauge be left in its present position.

MARINE GEAR CONTROLS

Remote Controls: The marine gear control should be installed with the neutral position plainly marked in the pilot house to avoid unnecessary slipping of the clutches during the idling periods. The linkages should operate freely without excessive looseness to insure complete engagement of the clutch. Brackets, levers and rods should be of sufficient strength to prevent bending, buckling or breaking. Sufficient travel room should be allowed rod ends and levers to assure complete engagement of the clutch.

To prolong the life of the marine gear clutch, provisions should be made for the time requirement necessary for proper clutch engagement as de-

scribed in the topic, STARTING THE LOAD. If the controls are of the single lever type, adjustment must be made so that the engine remains at low idle speed until the marine gear clutch is fully engaged.

BATTERY LOCATION

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

GENERATOR REGULATOR INSTALLATION

When the unit is equipped with a 12 or 32-volt 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 regulator which might be caused by vibration, or by oil and water from the engine.

ALTERNATOR REGULATOR INSTALLATION

The transistor alternator regulator is an assembly of transistors, resistors, condensers and diodes; and contains no moving parts. These components could be damaged if exposed to temperatures above 140° F. in still air or 170° F. in moving air. It is advisable to mount the alternator regulator away 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. Precleaners are available to provide reasonable service periods and element life. Air inlet extension can be utilized to provide cleaner and cooler air to the air cleaner. Your Caterpillar dealer has additional information.

CRANKCASE BREATHER FUMES DISPOSAL

The crankcase breather fumes disposal tube should be directed or extended to a location that will prevent an oily film from being deposited in the engine room. If oily fumes are 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.

Lubrication Instructions

SERVICE METER

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

COVER ON SERVICE METER RAISED TO OBSERVE DIAL READING

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

GENERAL LUBRICATING INFORMATION

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

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

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

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

DESCRIPTION OF LUBRICANTS

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

Crankcase Lubricating Oils

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

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 temperature use No. 0 or No. 1 grade.

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

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

Water Pump Grease: This lubricant should be insoluble in water to prevent an emulsification of the lubricant. An emulsification of the lubricant could allow water in the bilge to leak by the seal into the marine gear housing.

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 with lower SAE numbers are more fluid and flow more readily than do those with the higher numbers. Crankcase lubricating oils are recommended for use in gear compartments as indicated in the oil specification chart because of their superior oxidation and corrosion inhibitors.

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.

D343 Marine Engine Lubrication

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

SEE DETAILED INSTRUCTIONS UNDER
EACH CORRESPONDING TOPIC NUMBER HEADING

Point	and Identification	Lubri-cant	Approx. Quantity (U.S. Meas.)	No. of Service Points	SERVICE HOURS 10	125	250	1000
1	DIESEL ENGINE CRANKCASE	CO	46 QTS.	1	X	†C		
	OIL COOLER			2		†D		
	OIL FILTER ELEMENTS			2			†C	
	BREATHER			1		†W		
	TURBOCHARGER BREATHER			2		†W		
2	TACHOMETER DRIVE	BR	1 STROKE	1				L

STROKES SHOWN INDICATE AMOUNT OF GREASE FROM A LEVER TYPE GREASE GUN.

Key to Lubricants:

CO CRANKCASE LUBRICATING OIL

BR BALL AND ROLLER BEARING LUBRICANT

Key to Symbols:

X — CHECK, ADD OIL IF NECESSARY

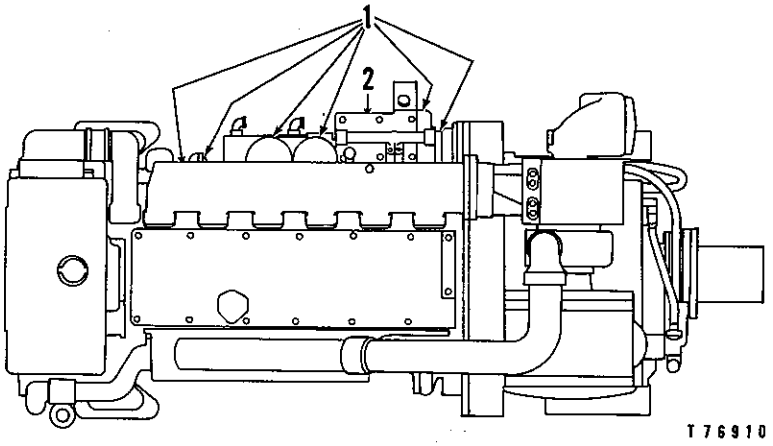
C — CHANGE

CW — CHANGE AND WASH

L — LUBRICATE

† — SEE THE DIESEL ENGINE CRANKCASE LUBRICATING OIL CHANGE PERIOD CHART

Location Of Points Of Lubrication



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	OIL COOLER			2		†D		
	OIL FILTER ELEMENTS			2			†C	
	BREATHER			1		†W		
	TURBOCHARGER BREATHER			2		†W		
2	TACHOMETER DRIVE	BR	1 STROKE	1				L

STROKES SHOWN INDICATE AMOUNT OF GREASE FROM A LEVER TYPE GREASE GUN.

Key to Lubricants:

CO CRANKCASE LUBRICATING OIL

BR BALL AND ROLLER BEARING LUBRICANT

Key to Symbols:

X — CHECK, ADD OIL IF NECESSARY
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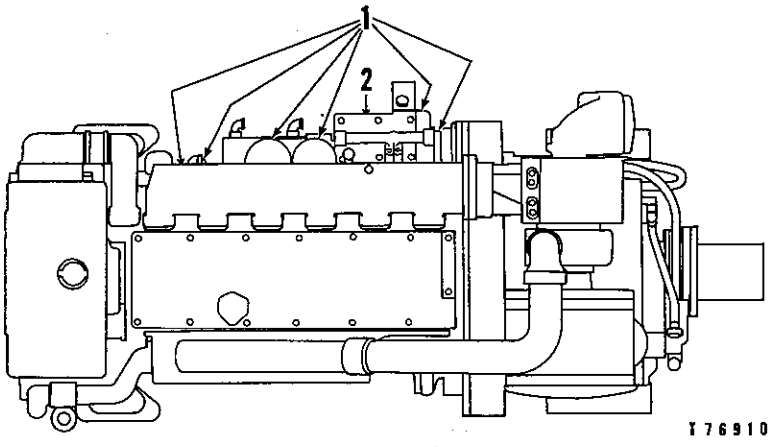
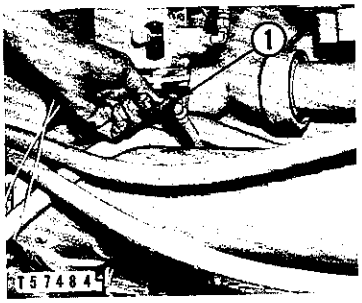
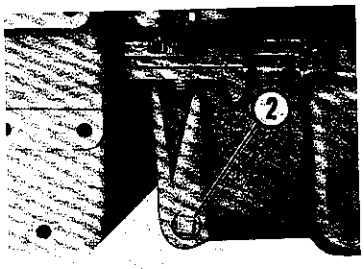
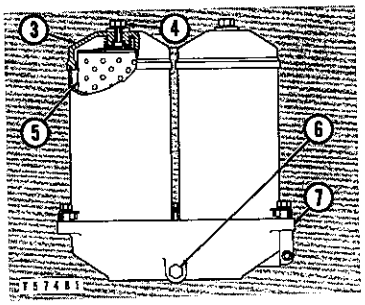
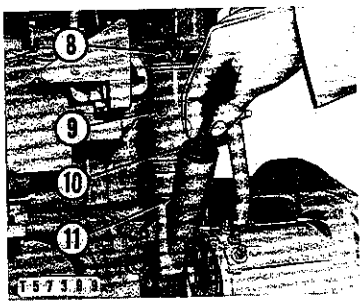


CO Crankcase Lubricating Oil









1
DIESEL ENGINE CRANKCASE LUBRICATING OIL SYSTEM

Use Superior Lubricants (Series 3) only
Check oil level with engine running every 10 service hours. Oil level should be between the "full" and "add oil" marks on gauge (1). The oil level maintained at the "full" mark is more desirable, however, any level above the "add oil" mark is permissible.
The oil level may be considerably higher than the "full" mark on the gauge if the full capacity of crankcase oil is checked after the engine has been stopped for several minutes. See the topic, "Crankcase Lubricating Oils." Also see Note A.
Drain the crankcase at (2) while the engine is hot. See the "Diesel Engine Crankcase Lubricating Oil Change Period Chart." See Note B.

1
DIESEL ENGINE CRANKCASE LUBRICATING OIL FILTER

Remove the plug (6) from the filter base (7) to drain the unfiltered oil from the base. Loosen the bolts (4) on the covers (3) and remove each bolt and cover as a unit. Replace the filter elements (5) with new Caterpillar elements at each oil change period. Install the drain plug and covers and tighten the bolts on the covers. See the "Diesel Engine Crankcase Lubricating Oil Change Period Chart."

1
DIESEL ENGINE CRANKCASE LUBRICATING OIL SYSTEM

Use Superior Lubricants (Series 3) only
After draining the crankcase turn the filler tube cap handle (10) until it is loose, pull the cap from the filler tube (11) and refill the crankcase. Run the engine for two minutes, then add oil to bring oil level to "full" mark on the oil level gauge while the engine is running. See the topic, "Type of Lubricants and SAE Grades to Use." Insert the filler tube cap and turn it until tight.
At each oil change period remove the plug (9) to drain condensation from the breather. Remove the wing nut (8), take off the cover and breather element, wash them in clean kerosene or diesel fuel. Reinstall the element and cover. See "Diesel Engine Crankcase Lubricating Oil Change Period Chart."

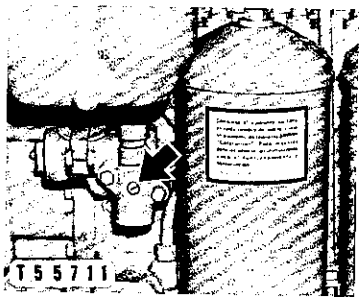
NOTE A: The diesel engine has a guard to protect the gauge from spray so the oil level should be checked when hot with the engine running at low idle speed. Always check the oil level with the engine in a level position.
NOTE B: Caterpillar Diesel Engines are built in a clean modern diesel engine factory and each crankcase is filled with a good quality of new crankcase oil. For these reasons the initial crankcase oil change period for this engine should be at the usual crankcase oil change period. See the "Diesel Engine Crankcase Lubricating Oil Change Period Chart."

BR Ball and Roller Bearing Lubricant

2

TACHOMETER DRIVE

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



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.

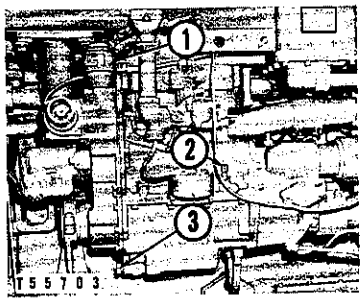
Identification Of Points Of Lubrication, Lubricant To Apply And Interval Of Service

Key to Lubricants:
BR BALL AND ROLLER BEARING LUBRICANT
CO CRANKCASE LUBRICATING OIL
WP WATER PUMP GREASE

Point and Identification		Lubricant	SERVICE HOURS 10	50	125	250	500	2000
A	STARTING ENGINE CRANKCASE	CO	X		†C	†C		
B	ELECTRIC STARTING MOTORS	CO	SEE DETAILED INFORMATION					
C	AIR STARTING MOTOR OILER	CO	X					
D	AIR AND ELECTRIC STARTING MOTOR DRIVE END BEARINGS	CO						L
E	MARINE GEAR CASE	CO					C	
F	FRONT POWER TAKE-OFF GEAR CASE (2.8:1 ANTI-ENGINE ROTATION REDUCTION)	CO						L
G	FRONT POWER TAKE-OFF CONTROL SHAFT BEARINGS	CO		L				
H	FRONT POWER TAKE-OFF CONTROL SHAFT BEARINGS	BR			L			
I	FRONT POWER TAKE-OFF PILOT BEARING CLUTCH THROW-OUT COLLAR SHAFT BEARING	BR BR BR	L	L	L			
J	FRONT POWER TAKE-OFF THROW-OUT COLLAR (2.8:1 ANTI-ENGINE ROTATION REDUCTION)	BR	L					
K	FRONT POWER TAKE-OFF PILOT BEARING (2.8:1 ANTI-ENGINE ROTATION REDUCTION	BR			L			
L	AIR STARTING MOTOR GEAR DRIVE AND PLAIN END	BR	SEE DETAILED INFORMATION					
M	BILGE PUMP CLUTCH THROW-OUT COLLAR	BR					L	
N	CHARGING GENERATOR	BR	SEE DETAILED INFORMATION					
O	CHARGING ALTERNATOR	BR	SEE DETAILED INFORMATION					
P	MARINE GEAR OUTPUT SHAFT SEAL	WP			L			

Key to Symbols:
C — CHANGE
L — LUBRICATE
X — CHECK, ADD OIL IF NECESSARY
† — DEPENDING ON DUSTY CONDITIONS

CO Crankcase Lubricating Oil



A

STARTING ENGINE CRANKCASE

Use Superior Lubricants (Series 3) only

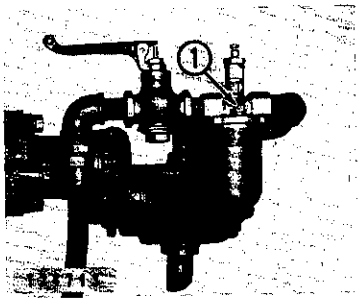
Check the oil level every 10 service hours. Oil should be up to the "full" mark on the gauge (2). Every 125 to 250 service hours, depending on dust conditions, drain the crankcase at (3). When draining, the engine must be as level as possible so all the oil in the starting engine will drain. Wash the crankcase breather at each oil change period. Refill the crankcase at (1) to "full" mark on gauge. See the topic, "Type of Lubricants and SAE Grades to Use."

T7852B

B

ELECTRIC STARTING MOTORS

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



C

AIR STARTING MOTOR OILER

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

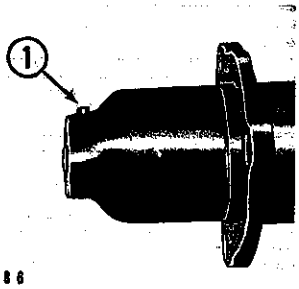
CO Crankcase Lubricating Oil

D

AIR AND ELECTRIC STARTING MOTOR DRIVE END BEARINGS

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

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



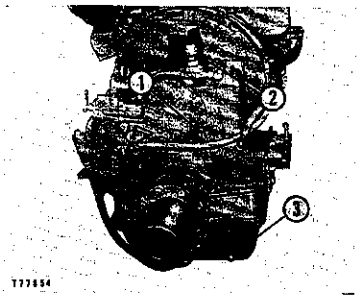
T25286

E

MARINE GEAR CASE

Use Superior Lubricants (Series 3) only.

Drain at (3), wash and oil breather filler cap (2) and fill to full mark on gauge (1) every 500 service hours. Check oil level with engine stopped. See the topic, "Type of Lubricants and SAE Grades to Use."

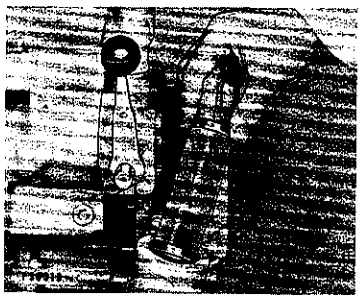


T77454

E

MARINE GEAR CASE

Remove and clean the oil strainer every 500 service hours. When reinstalling the strainer make sure that it is properly seated in its housing.

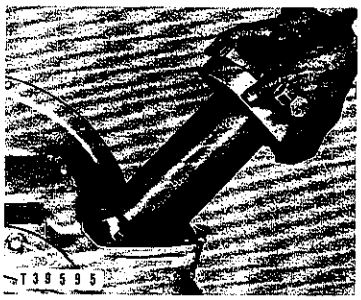


koppeling : filters verwijderen en schoonmaken elke 500 uur

E

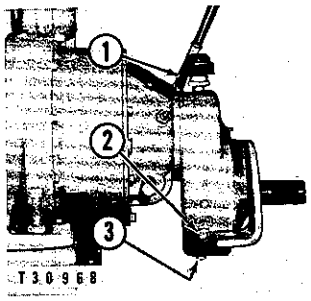
MARINE GEAR CASE

Remove the drain plug from the housing to drain filtered and unfiltered oil from the housing. Remove the filter cover and filter as a unit. Replace the filter element with a new Caterpillar element after every 500 service hours.


T39595

dit filterelement moet vervangen worden elke 500 uur

CO Crankcase Lubricating Oil

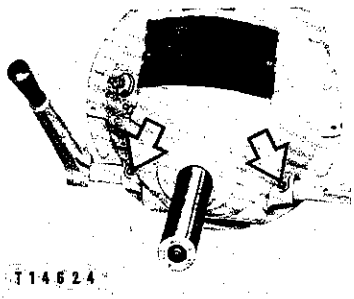


F

FRONT POWER TAKE-OFF GEAR CASE

(2.8:1 anti-engine rotation reduction)

Drain case at (3) and fill at (1) every 2000 service hours. Check level frequently at level plug (2).



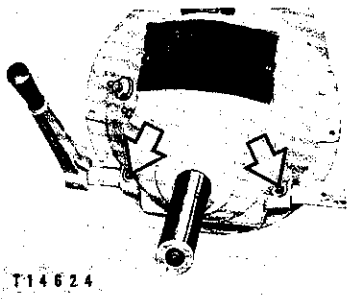
G

FRONT POWER TAKE-OFF CONTROL SHAFT BEARINGS

(1:1 ratio)

Lubricate shift collar control shaft bearings every 50 service if equipped with oil cups. Otherwise see the topic, BALL and ROLLER BEARING LUBRICANT.

BR Ball and Roller Bearing Lubricant

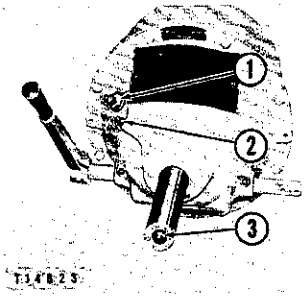


H

FRONT POWER TAKE-OFF CONTROL SHAFT BEARINGS

(1:1 ratio)

Lubricate shift collar control shaft bearings, which are equipped with grease fittings, every 125 service hours. (See same heading above.)



I

FRONT POWER TAKE-OFF PILOT BEARING, CLUTCH THROW-OUT COLLAR AND SHAFT BEARING

(1:1 ratio)

Lubricate clutch throw-out collar at (1) every 10 service hours. Lubricate shaft bearing at (2) every 50 service hours. Lubricate pilot housing bearing at (3) every 125 service hours.

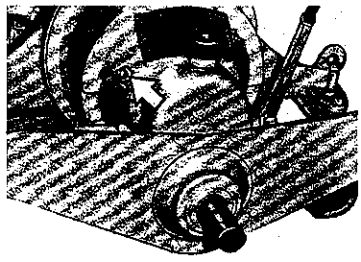
BR Ball and Roller Bearing Lubricant

J

FRONT POWER TAKE-OFF THROW-OUT COLLAR

(2.8:1 anti-engine rotation reduction)

Lubricate clutch throwout collar every 10 service hours before starting the engine.



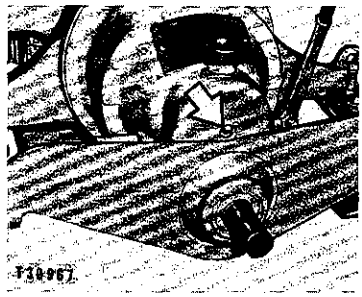
T30966

K

FRONT POWER TAKE-OFF PILOT BEARING

(2.8:1 anti-engine rotation reduction)

Lubricate clutch pilot bearing every 125 service hours of operation.

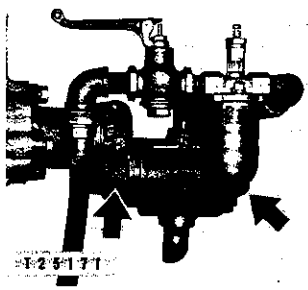


T30967

L

AIR STARTING MOTOR GEAR DRIVE AND PLAIN END

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

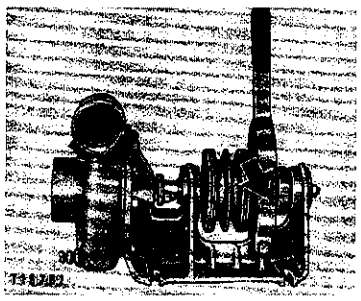


T25171

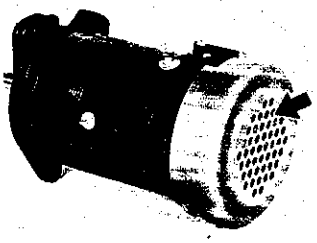
M

BILGE PUMP CLUTCH THROW-OUT COLLAR

Lubricate clutch throw-out collar sparingly every 500 service hours.



BR Ball and Roller Bearing Lubricant

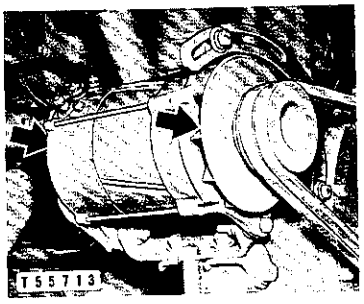


T43142

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.



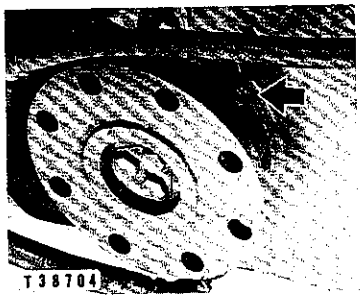
T55713

O

CHARGING ALTERNATOR

Under normal operating conditions the alternator bearings will not require lubrication between reconditioning periods. At the time of overhaul, half-fill the reservoir in each end frame with Ball and Roller Bearing Lubricant.

WP Water Pump Grease



T38704

P

MARINE GEAR OUTPUT SHAFT SEAL

Lubricate output shaft seal every 125 service hours or when vessel is docked, to prevent bilge water from entering gear compartment. Output shaft should be slowly rotating while lubricating the seal.

Operation Instructions

PREPARING THE ENGINE FOR USE

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

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

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

Prime the raw water pump before starting the engine. See the topic, RAW WATER COOLING SYSTEM.

New Engine Recheck: After the first 100 to 125 service hours of operation, tighten the diesel engine inlet manifold stud nuts, exhaust manifold stud nuts and the turbocharger mounting bolts and nuts. If the diesel engine is equipped with a starting engine, tighten the starting engine carburetor elbow nuts.

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

STARTING THE ENGINE

There are four methods available for starting the diesel engine: gasoline starting engine, electric starting, air starting and hydraulic starting. Hydraulic starting instructions are packaged with the Operation and Maintenance Instructions if the diesel engine is so equipped. Gasoline engine, electric and air starting information is covered in the following topics.

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

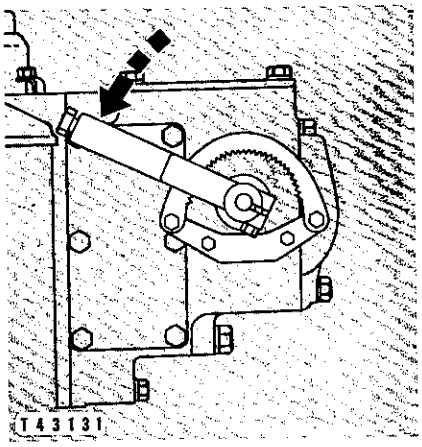
1. See that the marine gear control lever is in the neutral position and remove all other load possible from the engine.
2. Open the diesel fuel tank valve.
3. Open the sea valve to allow raw water to enter the system. When an engine equipped with the earlier model Jabsco pump has had the raw water system drained, it is necessary to prime the pump before starting. See the topic, RAW WATER SYSTEM in the MAINTENANCE INSTRUCTIONS section of this book.
4. Start the engine as described in one of the following topics, whichever applies, GASOLINE STARTING ENGINE, DIRECT ELECTRIC STARTING or AIR STARTING.

Gasoline Starting Engine

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

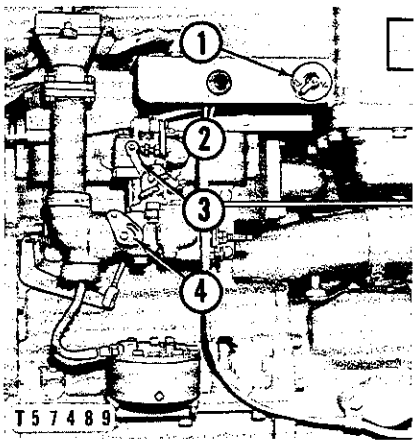
Position Control for Starting: Before attempting to start the starting engine, position the controls of both the diesel and starting engine:

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 downward to the compression released (starting) position.
3. Move the governor control lever to the shut-off position so the fuel injection pumps are closed.
4. See that the starting engine clutch is disengaged by moving the starter pinion and clutch control lever toward the rear of the diesel engine.



GOVERNOR CONTROL LEVER IN SHUT-OFF POSITION

◆



STARTING ENGINE CONTROLS

1–Magneto switch. 2–Idling latch. 3–Throttle control lever. 4–Choke control.

◆

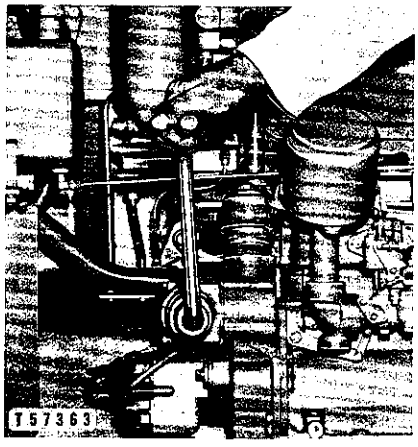
5. Open the starting engine fuel valve by turning the fuel valve control in the counterclockwise direction. The fuel valve and valve control is located on the gasoline fuel line near the gasoline fuel tank.
6. Turn the starting engine choke control knob **(4)** clockwise to the on position.
7. Move the idling latch **(2)** to the hold the throttle control lever **(3)** in the ¼ to ½ engine speed position.
8. Turn ON the magneto switch **(1)**.

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

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

Manual Starting

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



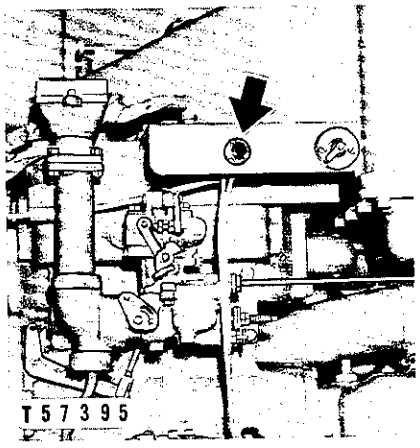
CORRECT POSITION FOR CRANKING STARTING ENGINE

◆

2. Move the choke control counterclockwise when the engine will run with the choke off. Temperature and altitude will vary the length of time it is necessary to have the choke on. Actual experience in starting will determine this interval.
When the engine starts, keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.

Electric Starting

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

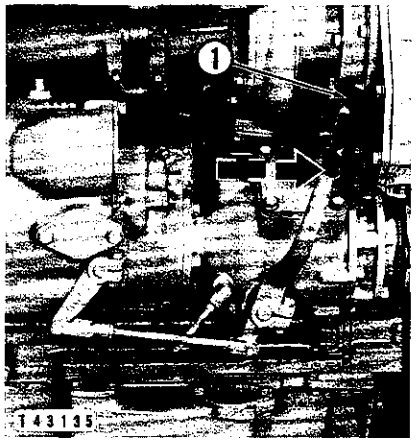


STARTING ENGINE ELECTRIC STARTER SWITCH

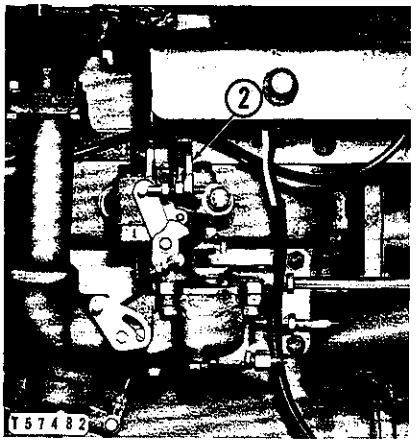
2. Move the choke control counterclockwise when the engine will run with the choke off. Temperature and altitude will vary the length of time it is necessary to have the choke on. Actual experience in starting will determine this interval.
3. **When the engine starts, keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.**

Starting the Diesel Engine: 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.



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



STARTING ENGINE THROTTLE CONTROL
2–Idling latch.

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 and the lever is in the clutch engaged position **(3)**.

CLUTCH AND STARTER PINION CONTROL LEVER
3–Control lever in clutch engaged position.

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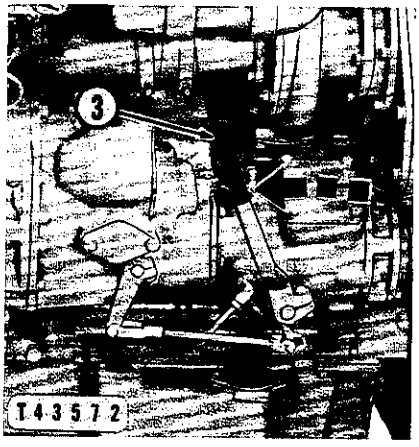


4. If the engine slows to the stalling point when the clutch is engaged, as it might in cold weather, disengage the clutch and let the engine pick up speed again. See the topic, STARTING IN COLD WEATHER.

5. Move the compression release lever upward to the run position when the starting engine is cranking the diesel engine at normal cranking speed.

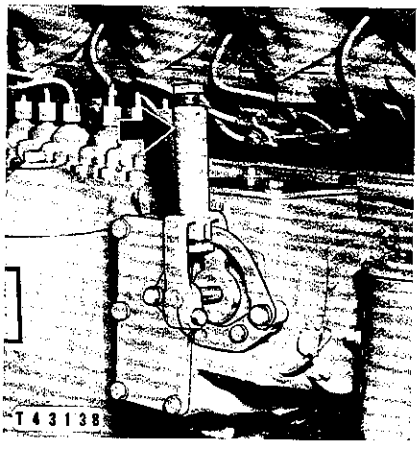
COMPRESSION RELEASE LEVER IN THE RUN POSITION

◆

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

Allow the starting engine to crank the diesel engine against compression for a few minutes to add heat to the diesel engine before starting it. Actual experience will determine the length of time necessary to crank the diesel engine to warm it sufficiently to assure easy starting. Altitude and cold temperature cause a variation in the length of time required to warm the engine before starting. In cold weather the cylinders and precombustion chambers must absorb more heat before reaching starting temperature than in warm weather. Even in warm weather some heat must be added by turning the engine against compression a few minutes before injecting fuel.

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



GOVERNOR CONTROL LEVER IN APPROXIMATE HALF ENGINE SPEED POSITION

◆

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

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

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

If the diesel engine is thoroughly heated but does not start, see that everything is correctly set for starting. If smoke has been coming from the diesel engine exhaust pipe, fuel has been reaching the cylinders. If no smoke is evident when the governor control lever is in the half engine speed position, check the fuel supply. If the diesel fuel tank is empty, or if the valve was closed, it will be necessary to prime the fuel system as outlined under the topic, PRIMING THE FUEL SYSTEM. In case there may be water or dirt in the fuel system, or if the fuel injection equipment is suspected, see the topic, FUEL INJECTION EQUIPMENT.

Direct Electric Starting

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

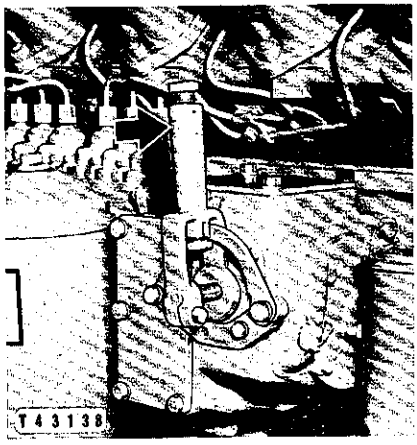
The engine must be kept in the best mechanical condition possible, the batteries kept fully charged and all terminals kept clean and tight for satisfactory performance of the starting system in lower atmospheric or room temperatures. In extremely cold temperatures the use of an engine room heater or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

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

1. Normally the compression release shaft remains in the RUN (counter-clockwise) position unless it is desired to crank the engine for some purpose other than starting.

2. See that the marine gear is in neutral position and remove all other load possible from the engine.

3. Move the governor control lever to approximately half engine speed position.



GOVERNOR CONTROL LEVER IN APPROXIMATE HALF ENGINE SPEED POSITION

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

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

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

2. If the engine does not start in a few seconds, continue to crank the diesel engine but shut off the fuel supply by moving the governor control lever to the shut-off position for about ten seconds to clear the cylinders of raw fuel.

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

4. If the electric starting motor pinion is disengaged for any reason before the engine starts, wait until the electric starting motor stops rotating and the diesel engine stops "rocking" before again pressing the starter switch.

Air Starting

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

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

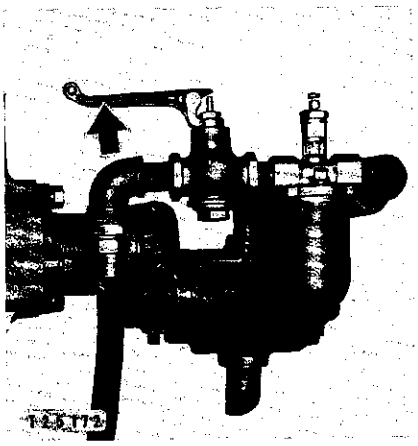
Position Controls for Starting: Before attempting to start the diesel engine the controls should be correctly positioned as follows:

1. Normally the compression release shaft remains in the RUN (counterclockwise) position unless it is desired to crank the engine for some purpose other than starting.
2. See that the marine gear is in neutral position and remove all other load possible from the engine.
3. Move the governor control lever to approximately half engine speed position.

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

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

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



AIR VALVE CONTROL

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2. If the engine does not start in a few seconds, continue to crank the diesel engine but shut off the fuel supply by moving the governor control lever to the shut-off position for about ten seconds to clear the cylinders of raw fuel.

3. If the air starting motor pinion disengages for any reason before the engine starts, release the air valve control and wait until the engine stops "rocking" before again pulling up on the air valve control.

OPERATING STARTING AIDS

Starting the diesel engine at temperatures above 60° F. (16° C.) using the electric starting motor, or 32° F. (0° C.) using the air starting motor, may be accomplished without the use of starting aids as instructed in the preceding topics.

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

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

STARTING AID CHART

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

Do not turn 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** starting motor for more than 30 seconds at a time, then allow 2 minutes intermission before using it again.

Starting Between 60° F. and 32° F.

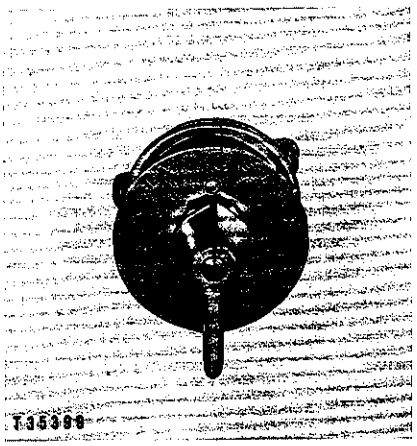
The use of starting aids between these temperatures is needed only when electric starting is used to start the diesel engine.

1. Move the HEAT-START switch to the HEAT position; on earlier engines equipped with a HEAT switch **(1)** and START switch **(2)** move the HEAT switch to the ON position, for the length of time necessary. See the STARTING AID CHART.

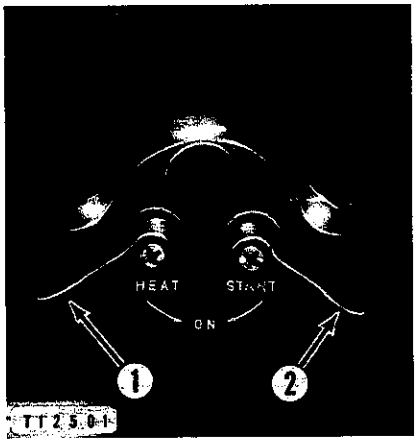
NOTE

Each glow plug uses approximately 5 amperes while the HEAT-START switch is in the HEAT position. This is actually a small amount in comparison to the starting motor load that is imposed on the battery when the switch is in the START position and the engine is cranking.

2. Move the HEAT-START switch to the START position or press the starter switch. If a pressurized ether dispenser is to be used as a starting aid, carefully spray ether toward the air cleaner inlet while the electric starter is turning the diesel engine.



HEAT-START SWITCH
(Later Engines)



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

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

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

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

NOTE

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

Starting Between 32° F. and —10° F.

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

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

NOTE

Each glow plug uses approximately 5 amperes while the switch is in the HEAT position. This is actually a small amount in comparison to the starting motor load imposed on the battery when the switch is in the START position and with the engine cranking.

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

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

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

NOTE

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

Starting Below —10° F.

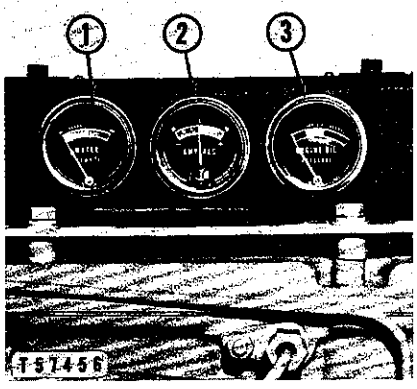
When starting in temperatures below —10° F. (—23° C.), the coolant in the cooling system and possibly the crankcase lubricating oil should be warmed. When heating the cooling system in these lower temperatures, the coolant should be maintained between +15° F. (—9.5° C.) and +30° F. (—1° C.) for easy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

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

GAUGES

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

Oil Pressure Gauge: Immediately after the engine has started, check the crankcase lubricating oil pressure gauge **(3)** to see that it is register-



GAUGES

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

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ing. When the engine is running at rated engine speed the gauge should register in the "OPERATING RANGE." A lower pressure reading is normal at low idling speeds. If no pressure is indicated, investigate at once.

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

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

Ammeter: On engines equipped with a charging generator the ammeter **(2)** should be checked to see that the indicator is registering in the charging range (indicator on the + side of zero). If the indicator registers in the discharging range (indicator on the — side of zero) investigate at once.

STARTING THE LOAD

When the engine has run long enough to warm up, move the governor control lever to the SLOW position to bring the engine to low idle speed. Move the marine gear control lever in the desired direction until it snaps into position. If the lever is not in the fully engaged position when the vessel is traveling, excess heat caused by slippage-friction will cause rapid clutch wear and gear failure. Allow about one second for the clutch to engage fully before moving the throttle. To prolong the life of the clutches and gears reduce the engine speed when reversing the direction of rotation of the reverse gear in normal operation. The marine gear should not be reversed at full engine speed except in an emergency.

MARINE GEAR CONTROL LEVER

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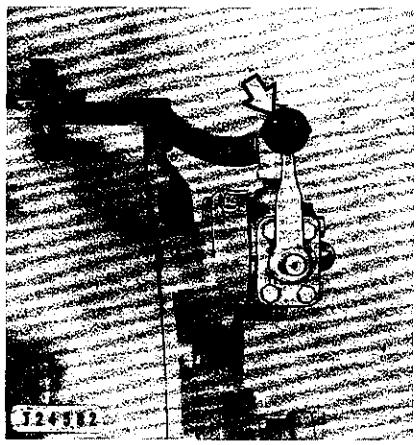

When referring to propeller rotation, it is assumed that a person is standing astern of (behind) the vessel and faces forward (toward the front). Rotation of the propeller is determined by the direction of rotation of the upper part of the propeller when the vessel is traveling forward. Thus, a clockwise rotation would define a right-hand propeller, while counterclockwise refers to a left-hand propeller. Moving the marine gear control lever toward the engine will result in clockwise rotation of the propeller. Moving it away from the engine results in counterclockwise propeller rotation. Whether a given rotation is forward or reverse will depend upon the propeller.

CRUISING SPEED FOR ENGINES WITH PLEASURE CRAFT RATINGS

The maximum cruising speed for this engine, which is that engine speed recommended for continuous operation, is between 1700 to 1800 RPM. However, in some installations the recommended cruising speed may be lowered by physical factors such as marine growth on the hull, and load in the vessel. Slight damage to the propellers, or poor propeller shaft alignment can change the load imposed on the engine. Therefore, it is recommended to check the engine daily for proper cruising speed.

To establish proper cruise speed for any existing condition of a vessel perform the following.

1. Run the vessel under way at maximum speed for about four minutes.
2. Take the tachometer reading. This is the maximum engine speed for the present conditions of the vessel.
3. Reduce the engine speed until the tachometer reading is 200 to 300 RPM less than the maximum engine speed tachometer reading observed in step 2. The engine is now operating at recommended cruising speed.

Operating at recommended cruise speed will give maximum engine service life and most economical operation. Operating at engine speeds

above the recommended cruising speed for periods longer than five minutes at a time may not immediately cause any noticeable change in engine operation but it will contribute to shorter engine life.

STOPPING THE LOAD

When it becomes necessary to stop transmitting power, move the governor control to the reduced speed position and then move the marine gear control lever to the neutral position. Reduce engine speed as described in the topic, STOPPING THE DIESEL ENGINE.

STOPPING THE DIESEL ENGINE

Correctly stopping the diesel engine will allow hot areas in the engine to cool gradually, thus extending engine service life. The correct diesel engine stopping procedure is as follows:

1. 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.
2. Reduce engine speed to low idle speed and allow the engine to run for thirty seconds.
3. While the diesel engine is running at low idle speed, move the governor control lever to the shut-off position. Do not accelerate the engine speed above low idle before stopping the engine.

Close the diesel engine fuel tank valve. Close the sea valve to shut off the raw water supply.

If the temperature is below freezing, or if freezing weather is expected before the engine will be started again, check to see that the system is adequately protected against freezing. See the topic, COOLING SYSTEM, for information about anti-freeze solutions and cooling system draining.

DAILY CARE

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

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

1. Exhaust manifold, inlet manifold and air cleaner connections, inspect for tightness.
2. Fuel pressure gauge, inspect with engine running to see that the indicator is not in the red range.

3. Cooling system, add coolant or anti-freeze if necessary. Be sure the filler cap seal is in good condition and that the cap is installed tightly.

4. Turbocharger, inspect mounting for tighteness. Inspect connections between the air cleaner and turbocharger and between the turbocharger and inlet manifold for tightness. Inspect oil supply tube connection to see that there is no leakage. Check the operation to see that there is no vibration or unusual noise. The "muffled high pitched whine" is the normal sound of the turbocharger.

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

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

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

STARTING IN COLD WEATHER

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

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

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

The liquid in the cooling system may be warmed to make starting easier and quicker. When warming anti-freeze solutions, keep away from flames, as some of these solution 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 damaged by sudden expansion.

Raw Water Cooling System: When the temperature is below freezing, the raw water system should be drained at the low points in the system after each day's run. On engines equipped with a Jabsco pump, the cover must be removed to drain the pump.

Fuel: Fuel must be "free flowing" enough to flow readily through the fuel lines at the lowest temperature at which the engine will be started

and operated. For additional information on this subject, see the topic, FUELS.

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

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

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

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

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

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

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

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

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

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

1. Stop the starting engine after the lubricating oil is thoroughly warm.

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

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

STORAGE

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

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

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

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

Battery: Keep the battery charged by running the engine once a week or by having the battery charged by your Caterpillar dealer.

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.

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

Raw Water System: The raw water system should be completely drained at the low points. Refer to the topic, COOLING SYSTEM.

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

ALTITUDE OPERATION

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

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

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

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

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Maintenance Instructions

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

AIR CLEANERS

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

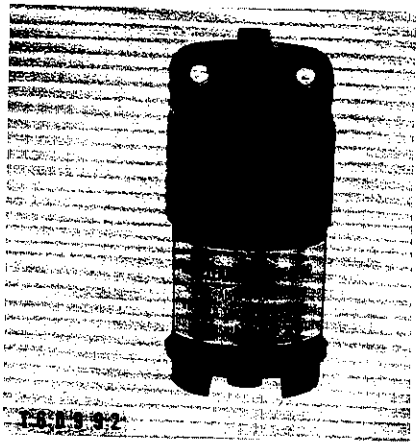
Regular service intervals, along with close visual inspection of the dry type air cleaner, are necessary for proper cleaning of the engine inlet air. The service interval will vary with the weather and working conditions. During dry, dusty months where dust conditions are severe, it will be necessary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

Diesel Engine Dry Type Air Cleaner

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

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

The air cleaner service indicator attachment is connected to the air inlet passage between the air cleaner and the engine. The air cleaner service indicator 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. The piston will re-



AIR CLEANER SERVICE INDICATOR

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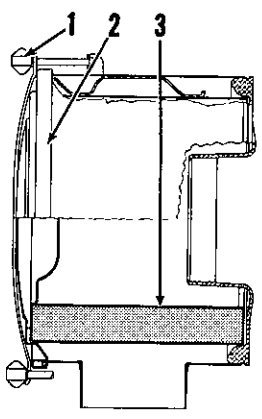
main in this position whether or not the engine is running. After servicing the air cleaner, reset the piston by depressing the plunger in the bottom of the indicator.

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

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.

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. **Never service the air cleaner while the engine is running.**

1. To remove the filter element, loosen the two wing nuts **(1)**, remove the end cover **(2)** and the filter element **(3)**.



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DRY TYPE AIR CLEANER

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

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2. Inspect the element and if it is damaged, install a new element.
3. Remove any dirt which has accumulated on the bottom of the case and clean the filter element using one of the methods covered in the topic, FILTER ELEMENT CLEANING.
4. Thoroughly clean all parts of the air cleaner. Inspect the gaskets and install new ones if they are damaged.
5. Assemble the air cleaner. This air cleaner requires no oil.

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

Replace the filter element at least once a year.

Filter Element Cleaning

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

Clean the filter element using one of the following methods:

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

   Direct air at an angle against the inside (engine side) of the element, holding the nozzle at least one inch away, to loosen any imbedded dirt. Best results can be obtained by moving the air hose so that air is directed at an angle along the complete length of each pleat.

   Blow off loose dirt by directing air against the outside of the element. Repeat this procedure until the element is clean. Make certain that no dirt is inside the element.

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

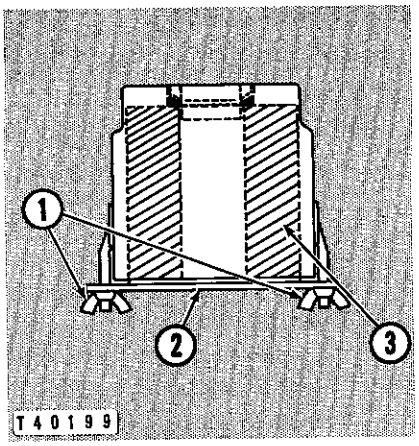
   Direct water at an angle against the inside (engine side) of the element to loosen any imbedded dirt. Best results can be obtained by using a water hose without a nozzle and moving it so that water is directed at an angle along the complete length of each pleat. Wash off loose dirt by directing water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

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

Starting Engine Dry Type Air Cleaner

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

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



AIR CLEANER ASSEMBLY

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

◆

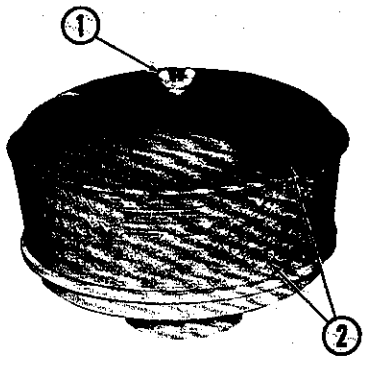
If the element is damaged or if after cleaning, the engine is hard to start and/or loss of power has not been corrected, install a new Caterpillar element.

Replace the filter element at least once a year.

PRECLEANER
(Attachment)

Every 10 to 50 service hours, loosen the wing nut **(1)** that holds the cover and body assembly **(2)** in place. Remove the cover and empty the dust from the body assembly. Inspect the fins in the precleaner and when they are dirty, remove the entire precleaner, and wash it in water.

Machines with transparent precleaner body assemblies have a mark on the body assembly to indicate need of service.



PRECLEANER

1–Wing nut. 2–Cover and body assembly.

◆

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. (—12° 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 points 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

Marine engines are generally refueled at the dock by a commercial dealer. Under these circumstances the problems of supplying **clean** fuel to the engine tank is their responsibility. For those who must store their own fuel, the following recommendations are made.

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 remain in the still.

It is most important to buy clean fuel, and keep it clean. The best fuel can be rendered unsatisfactory by inadequate storage facilities or careless handling. The clearance between the fuel injection pump plunger and the barrel is very small, actually less than .0001 inch (0.00254 mm.), which makes it evident that the invisible particles of dirt which might pass through the filters can damage these finely finished parts.

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

Since natural settling is an effective method of cleaning diesel fuel, the fuel should be allowed to stand at least 24 hours in the 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 tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

CARE OF THE DIESEL FUEL TANK

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

FUEL FILTERING SYSTEM

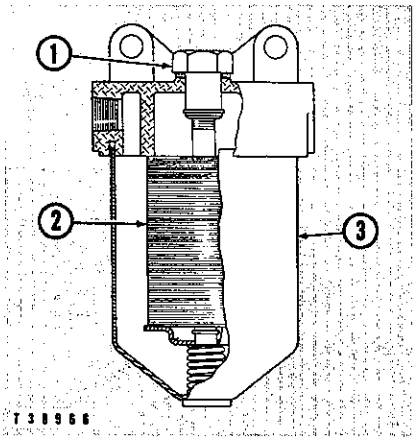
As either the primary filter or the final fuel filter elements become clogged with foreign material, the position of the fuel gauge indicator will gradually work back from the original position in the NORMAL

(green) range into the OUT (red) range. When the indicator shows in the OUT (red) range, the primary metallic filter element should be removed and washed. If the indicator still shows in the OUT (red) range, the resin impregnated cellulose material type fuel filter elements should be replaced.

Primary Fuel Filter Attachment

The purpose of the primary fuel filter is to strain out foreign material from the fuel before it enters the fuel transfer pump. Every 50 service hours remove and wash the metallic filter element in clean kerosene or diesel fuel.

To remove the filter element **(2)**, stop the engine and shut off the diesel fuel tank valve. Loosen the nut **(1)**, on the filter cover and lower the case



PRIMARY FUEL FILTER

1–Nut. 2–Filter element. 3–Filter case.

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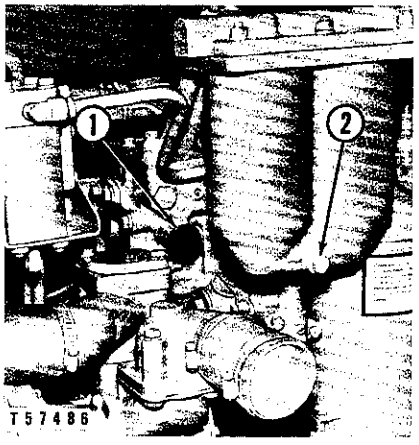
(3). Remove the element and wash in clean kerosene or diesel fuel. Reinstall the element.

Final Fuel Filter

Draining Fuel Filter Housing: Every 50 service hours or even as often as daily during extremely low temperatures, drain the fuel filter housing



DRAINING FUEL FILTER HOUSING

1–Vent valve. 2–Drain plug.

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of sediment and water which settles to the bottom of the compartment. Close the diesel fuel line valve at the fuel tank, remove the filter housing drain plug **(2)** and open the vent valve **(1)** in the housing. Replace the drain plug and prime the system. See the topic, PRIMING THE FUEL SYSTEM.

Fuel Filter Elements: The fuel filter elements are of the resin impregnated cellulose material type. When the pleated elements have collected enough contamination to interfere with engine performance, they must be replaced with new elements. These elements will continue to collect particles until fuel will no longer flow through them at a rate to maintain maximum engine performance. The resin impregnated cellulose material type filter elements collect and hold contaminants and cannot be washed or otherwise restored.

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

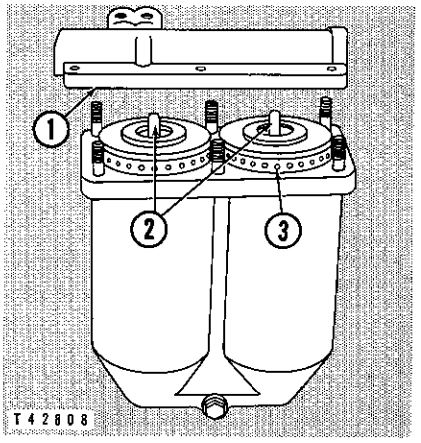
1. Close the diesel fuel line valve.
2. Remove the filter housing drain plug.
3. Open the vent in the filter housing.
4. Thoroughly clean the top of the cover and around the edges of the gasket joint between the filter housing and cover to prevent dirt dropping into the filter housing when it is removed.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

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

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

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

   While inserting the rod in the drilled hole in the bottom of the filter housing, hold the rod and spring with one hand to be sure the spring is held in position on the lower end of the rod.
2. Place the filter elements **(3)** over the rods.
3. Place a new gasket on the filter housing.
4. Install the housing onto the cover **(1)**, making certain that the rods enter the holes for the rods in the cover.
5. Prime the system as outlined in the topic, PRIMING THE FUEL SYSTEM.



INSTALLING FUEL FILTER ELEMENTS

1–Cover. 2–Rods. 3–Filter elements.

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

PRIMING THE FUEL SYSTEM

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

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

1. Check to see that the diesel fuel tank valve is open.

PRIMING THE FUEL SYSTEM

1–Fuel filter vent valve. 2–Vent drain tube.

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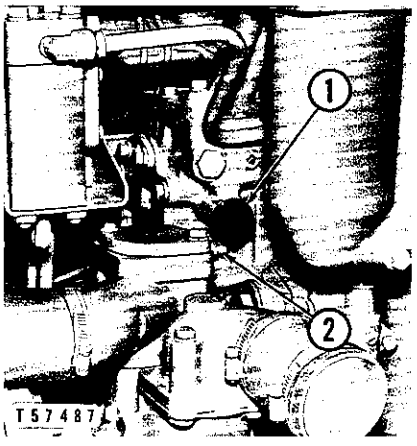
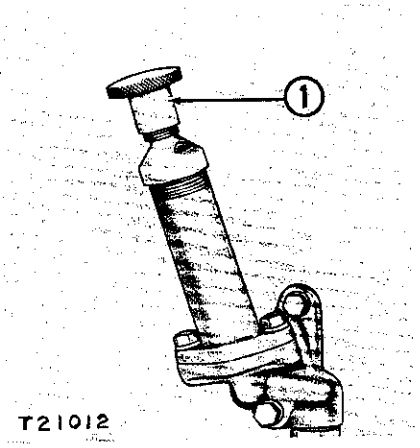


2. Check to see that the governor control lever is in the shut-off position so the fuel injection pumps are closed.
3. See that the compression release lever is in the START position.
4. Start the starting engine, engage the starter pinion and clutch and allow the starting engine to crank the diesel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

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

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



FUEL PRIMING PUMP

1–Knurled top.

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FUEL INJECTION EQUIPMENT

When improper fuel injection is affecting the diesel engine operation, a systematic check should be made to determine the cause. The most likely cause is dirt or water in the fuel. Drain the sediment from the diesel

fuel tank and drain the fuel filter housing. Check the fuel pressure gauge as mentioned in the topic, FUEL FILTERING SYSTEM. Replace the filters if necessary. Then prime the fuel system until clean fuel passes out the fuel vent drain line. If the fuel system is air bound, priming the system will overcome this difficulty.

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

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

Fuel Injection Valves

Testing Fuel Injection Valves: Whenever an engine performs in such a manner that a fuel injection valve is suspected of causing trouble, test all the fuel injection valves. To test the injection valves loosen the fuel injection line nuts at the fuel injection pumps, one at a time, while the engine is running. When a line nut is loosened and the exhaust smoking is completely or partially eliminated and the irregularity in running is not affected, that valve could be defective. A new valve should be installed in that cylinder to definitely determine if the valve removed was defective.

Never wire brush or scrape a fuel injection nozzle as this will damage the finely machined orifice. Your Caterpillar dealer has the proper tools for cleaning and testing fuel injection valves.

LOOSEN FUEL LINE NUTS TO TEST VALVE

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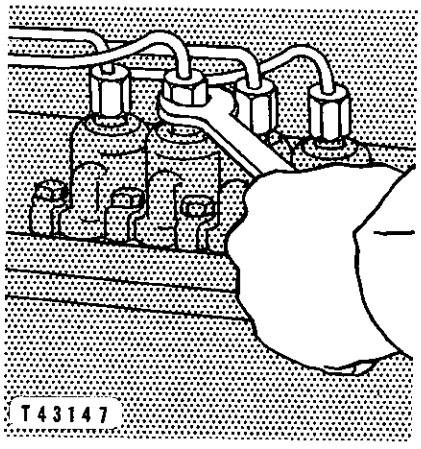
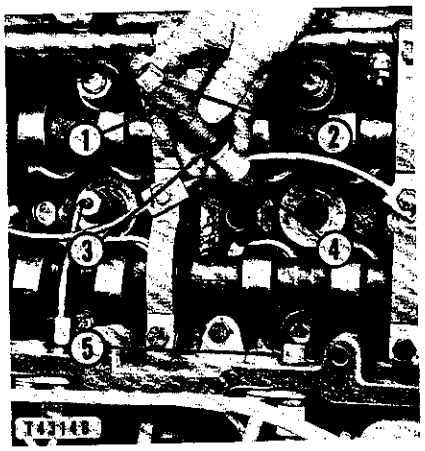


Removing Fuel Injection Valves: Clean around the edge of the camshaft and valve mechanism cover to prevent dirt from entering the valve mechanism when the cover is removed.



REMOVING FUEL INJECTION VALVE

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

◆

1. Remove the valve mechanism cover.
2. Remove the fuel line between the injection valve and camshaft cover base. To prevent dirt from entering the lines, cap the ends of the line and cap the end of the fuel injection line **(5)** which extends through the side of the camshaft cover base.
3. Remove the retainer nut **(1)**.

On engines equipped with direct electric starting systems, the glow plug should first be removed, eliminating the possibility of damaging the glow plug when removing a fuel injection valve. See the topic, GLOW PLUGS.

4. Lift out the fuel injection valve body **(3)** and the fuel injection valve nozzle assembly **(4)** as a unit. If the injection valve will not be immediately installed, cover the body end with a cap **(2)** to prevent dirt from entering the valve body.

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

1. Screw the valve body **(3)** into the fuel injection valve nozzle assembly **(4)** only finger tight. The threads of the body and nozzle assembly are made to fit loosely. The clearance between the threads provides a passage for fuel to enter the nozzle assembly from the body.
2. Insert the nozzle assembly and valve body as a unit into the precombustion chamber opening. Turn the body in a clockwise direction and at the same time press downward to assure alignment of the serrations.
3. Tighten the retainer nut **(1)** to a torque of 100 to 110 pounds feet to prevent leaks between the nozzle assembly and the nozzle assembly seats.
4. Reinstall the fuel injection line and tighten the nuts.

Fuel Injection Pumps

Testing Fuel Injection Pumps: The fuel injection pumps will usually experience the same rate of wear. Worn fuel injection pumps will result in loss of power and hard starting. When loss of power and hard starting are accompanied with a clear exhaust, good compression and no blow-by gases from the crankcase breather, it indicates worn injection pumps. The tools and information required to service and check fuel injection pumps are available at your Caterpillar dealer.

COOLING SYSTEM

Two types of cooling systems are used in conjunction with marine engines; they are keel cooling and heat exchanger cooling systems.

Keel Cooling: In this system, fresh water circulates through the diesel engine block; water cooled exhaust manifold, if engine is so equipped; diesel engine crankcase lubricating oil cooler; marine gear lubricating oil cooler; aftercooler; and is cooled in the keel coils.

Heat Exchanger Cooling: In this system the fresh water circulates within a closed system through the diesel engine block, diesel engine lubricating oil cooler, water cooled exhaust manifold, and the heat exchanger. The fresh water is cooled by the raw water circulating through the heat exchanger.

Fresh Water 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. Add a rust inhibitor to anti-freeze solutions which do not contain inhibitors. Your Caterpillar dealer stocks Caterpillar Rust Inhibitor in convenient one quart cans. Directions for its use are printed on each can.

When the temperature is below freezing sufficient anti-freeze should be used in the fresh water cooling system to prevent freezing. Various anti-freeze mixtures such as ethylene glycol (Prestone, G.M., Permaguard, Zerex, etc.) and glycerine are suitable for use in marine engines. Because Caterpillar Diesel Marine engines are designed to operate at temperatures above the boiling point of alcohol, alcohol should not be used in the fresh water cooling system. **The water temperature regulator should not be removed** to reduce the temperature, as a more desirable engine performance is obtained at a higher temperature.

Filling: Fill the fresh water cooling system by pouring the coolant into the filler opening until the coolant level is even with the bottom of the filler opening pipe. When filling after draining or when excessive coolant has been lost, fill the cooling system, install filler cap, and run the engine

SURGE TANK
FILLER OPENING

◆

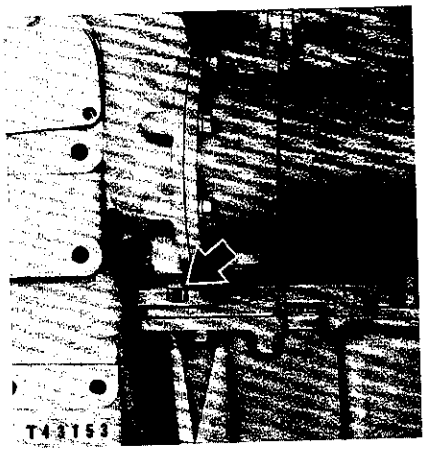
at half speed for a period of 5 to 10 minutes to purge air from the cooling system. Check coolant level and if it has lowered, refill to the bottom of the filler opening pipe.

The cooling system is equipped with an expansion tank designed so as to trap air in the top of the tank when filling. This trapped air compresses as the coolant expands due to heat, or is vented through a sealed pressure overflow valve. Because of this feature, the operator can fill the cooling system to the bottom of the filler opening pipe and automatically allow for coolant expansion.

Draining: The fresh water cooling system should be drained when it is necessary to remove any accumulation of dirt or sediment. This should be done at the end of a run when the foreign material is in suspension and will drain with the water.

The fresh water cooling system can be drained as follows:

1. Remove the drain plug from the diesel engine lubricating oil cooler.



ENGINE OIL COOLER DRAIN PLUG

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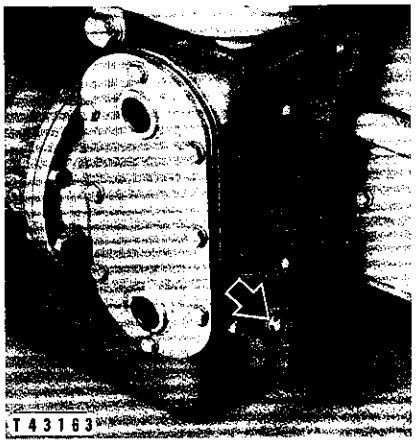
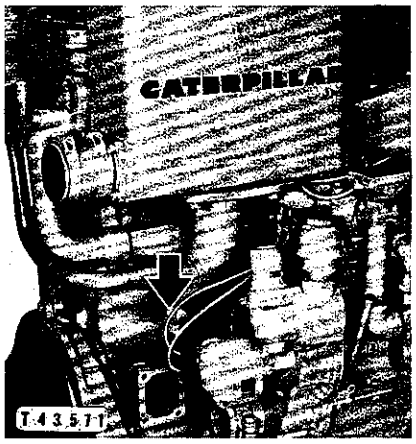
2. On earlier engines, remove the drain plug from the marine gear lubricating oil cooler. On later engines, the water in the marine gear oil cooler will drain from the engine oil cooler.
3. Remove the drain plug in the coolant elbow from the bottom of the surge tank.

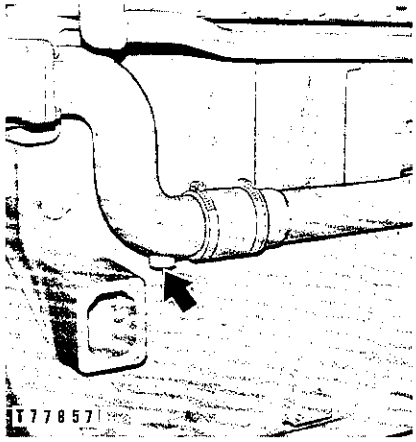


MARINE GEAR OIL COOLER PLUG ON EARLIER ENGINES

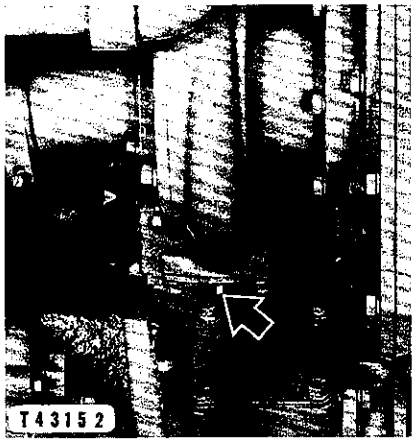


SURGE TANK DRAIN PLUG

4. Remove the drain plug from the cooling system pump.

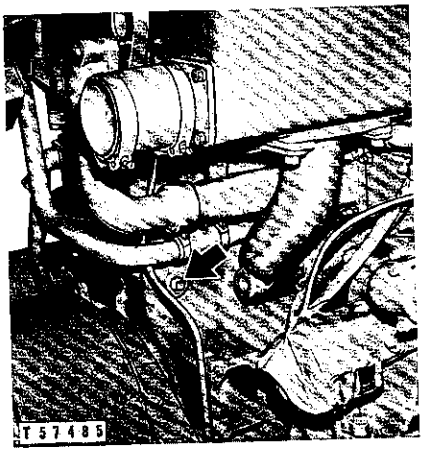


WATER PUMP AND LINES DRAIN PLUG (Later Engines)

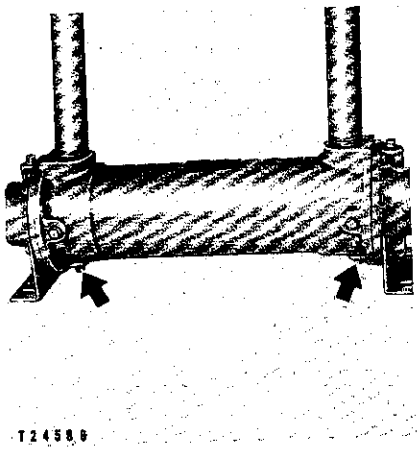


COOLING SYSTEM PUMP DRAIN PLUG

5. On earlier engines, remove the drain plug from the front left side of the diesel engine block.
6. If the engine is equipped with a heat exchanger, remove the drain plugs from the bottom of the heat exchanger body.



ENGINE BLOCK DRAIN PLUG
(Earlier Engines)



HEAT EXCHANGER FRESH WATER DRAIN PLUGS

Cleaning: Wash the cooling system periodically. To wash, stop the engine when it is at normal operating temperature and drain as quickly as possible. Flush thoroughly, then fill with a solution of one pound of Oxalic Acid or Sodium Bisulfate per five gallons of water. Run the engine at operating temperature one-half to one hour, then drain and flush until water is clear. Fill with a solution of one-half pound of Sal Soda per ten gallons of water and run engine for ten minutes. Drain, flush and fill with water, adding corrosion inhibitor or the desired amount of anti-freeze.

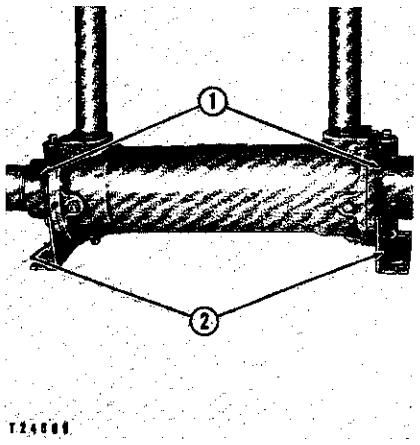
Raw Water System

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

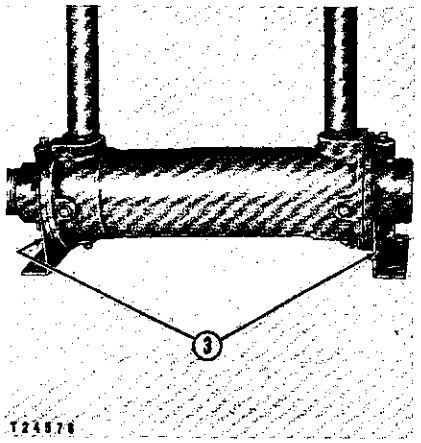
Cleaning The Heat Exchanger: The heat exchanger should be cleaned when the water temperature is continuously 195° to 205° or more during operation.

Close the sea valve and drain the exchanger of raw water by removing the drain plugs **(2)**. Remove the end bonnets **(1)** from each end of the exchanger. A rod not larger than 9/32 inch (7.11 mm.) can be used to push through the tubes of the core to remove accumulations. Reinstall the end bonnets and open the sea valve. When the engine is started, any accumulations which were loosened in the tubes will be flushed out of the core.

Draining: The raw water cooling system should be drained when the vessel is to be left in storage, at the end of a day's run in freezing weather, or when the heat exchanger is to be cleaned. Close the sea valve and remove the raw water pump cover to drain the pump.



CLEANING HEAT EXCHANGER
1–End bonnets. 2–Raw water drain plugs.



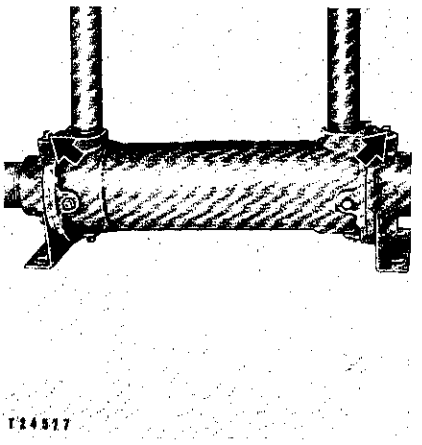
HEAT EXCHANGER DRAINING
3–Drain plugs

Remove the plugs (3) from the bottom of each end bonnet of the heat exchanger.

Also, if there is a low point between the sea valve and the raw water pump, or anywhere else in the line, remove the plug or disconnect the pipe.

The earlier type of raw water pump has to be primed. To prime this raw water pump, remove the priming plug on top of the pump priming chamber and fill with water. Replace the plug and immediately start the engine. Later raw water pumps do not require priming.

Zinc Plugs: Zinc plugs are installed in the raw water circuit for the purpose of localizing any electrolytic action which may be set up. Two zinc plugs are located in the heat exchanger, two zinc plugs are located in the ends of the marine gear oil cooler and in the raw water aftercooler, if the engine is so equipped. They are painted red for identification pur-



HEAT EXCHANGER ZINC PLUGS

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poses and should be inspected every 25 service hours and replaced if deteriorated. The service period may be increased if experience so indicates. To inspect them, close the sea valve, drain the exchanger of raw water and remove the plugs. In draining the water the tubes of the core will be drained because the raw water circulates through the inside of the tube. When inspecting the zinc plugs do not be deceived by their outside appearance but tap them lightly with a small hammer. If they crack or crumble new zinc elements should be installed. If they are not deteriorated and merely appear to be corroded they may be cleaned by scraping away the corrosion.

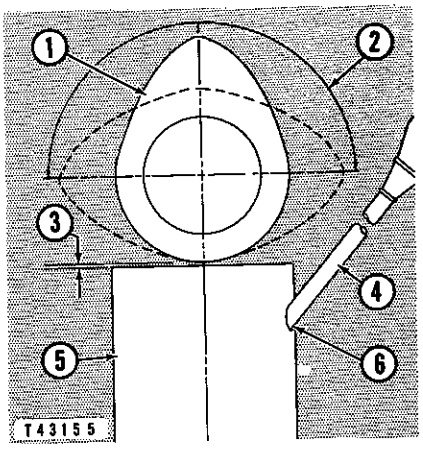
When the heat exchanger end bonnets are removed for the purpose of cleaning the tubes, or the zinc plugs are removed for inspection, it will not be necessary to drain the fresh water system.

DIESEL ENGINE VALVE CLEARANCE ADJUSTMENT

Check the valve clearance, and adjust if necessary, every 1000 service hours with the compression release lever in the RUN position and the engine stopped.

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

1. Rotate the crankshaft in the direction of engine rotation until the valve to be adjusted is closed. The cam **(1)** over the valve to be adjusted will indicate a closed valve when the cam lobe is in any location within the 180° arc **(2)**.
2. Turn the cam follower **(5)** on the valve to be adjusted, until the diagonal hole **(6)** in the follower is toward the center of the engine.



VALVE CLEARANCE ADJUSTMENT

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

◆

3. With a cross point (Phillips) screwdriver **(4)** in the diagonal hole **(6)** in the cam follower, turn the screwdriver clockwise to increase or counterclockwise to decrease the valve clearance at **(3)** enough to allow a thickness gauge of the correct thickness to be passed between the cam follower **(5)** and the cam **(1)**. Valve clearance should be .030 inch (.76 mm.) for exhaust valves and .018 inch (.46 mm.) for inlet valves.

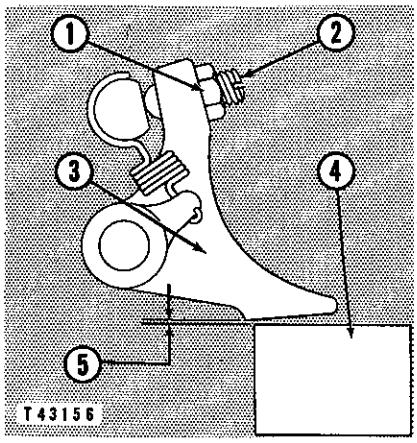
Compression Release Adjustment: Compression release clearance should be adjusted whenever inlet valves have been adjusted. The inlet valve under the compression release lever **(3)** to be adjusted must be closed. To make the adjustment proceed as follows:

1. Loosen the locknut **(1)**.

COMPRESSION RELEASE ADJUSTMENT

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

◆



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

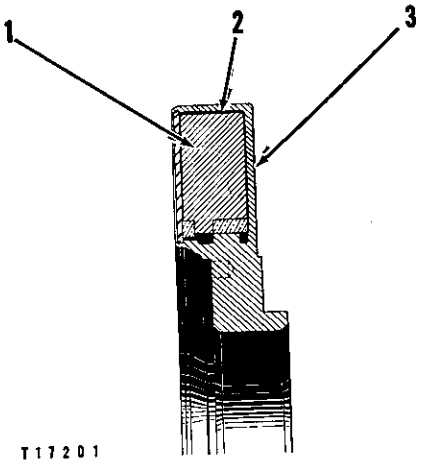
Valve Rotation: Whenever the engine is running the valves slowly rotate. Valve rotation decreases carbon build up and uneven wear, thereby increasing the life of the valves. The cam followers also slowly rotate when the engine is running, but cam follower rotation does not necessarily indicate valve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

VIBRATION DAMPER

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

The damper is constructed of a solid cast iron weight **(1)** enclosed in

VIBRATION DAMPER



VIBRATION DAMPER CROSS SECTION

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

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

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

A viscous type damper that is operating correctly abosrbs energy to damp out torsional vibrations and becomes much warmer than the surrounding engine parts. A damper that is not operating correctly will remain at approximately the same temperature as surrounding engine parts, which is probably 10° to 15° above ambient air temperature. Therefore, by feeling the damper after at least one hour of engine operation, a faulty damper may be detected.

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

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

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

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

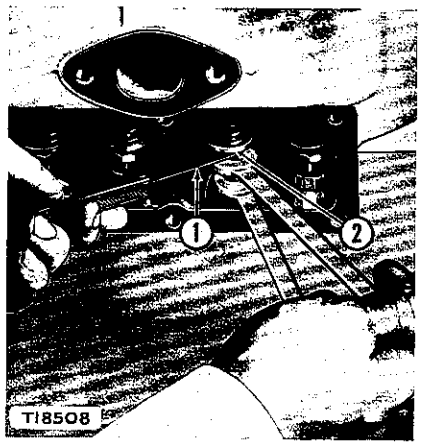
◆

Attachment Instructions

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

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.



STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

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

◆

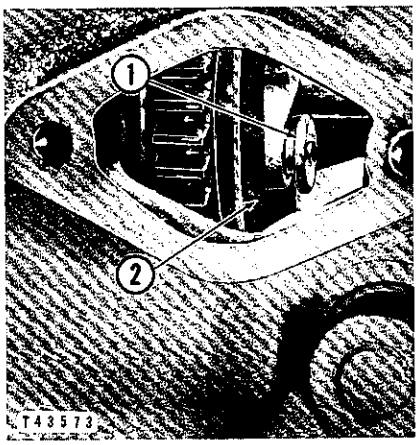
To Adjust: Turn the adjusting screw until there is .008 inch (0.2 mm.) clearance at **(2)** between the adjusting screw and the end of the valve stem. Check this clearance with the thickness gauge **(1)**.

STARTING ENGINE CLUTCH ADJUSTMENT

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

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

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



STARTING ENGINE CLUTCH ADJUSTMENT

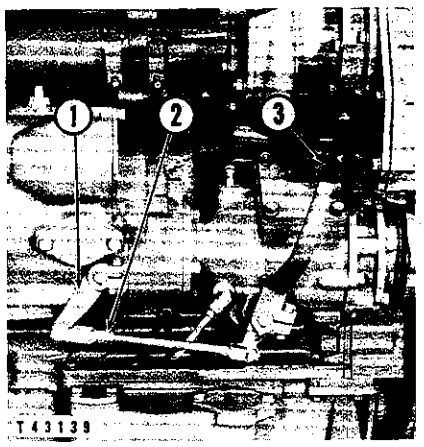
1–Lock pin. 2–Adjusting collar.

◆

STARTING ENGINE CLUTCH AND PINION CONTROL LINKAGE ADJUSTMENT

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

1. Remove the pin from rod end **(2)**.
2. Engage the starting engine clutch by moving clutch lever **(1)** toward the rear of the engine until the clutch snaps into engagement. This engaged position must be maintained throughout the entire adjustment procedure.
3. Engage the pinion by moving clutch and pinion control lever **(3)** toward the front of the engine until the kick-out plunger holds the pinion in engagement. This position must be maintained throughout the entire adjustment procedure.
4. Loosen the locknut, and turn rod end **(2)** until the pin can be inserted into lever **(1)**. Pull the rod so the rear linkage pin is to the extreme front of the slot in control lever **(3)**.



STARTING ENGINE CLUTCH AND PINION LINKAGE

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

◆

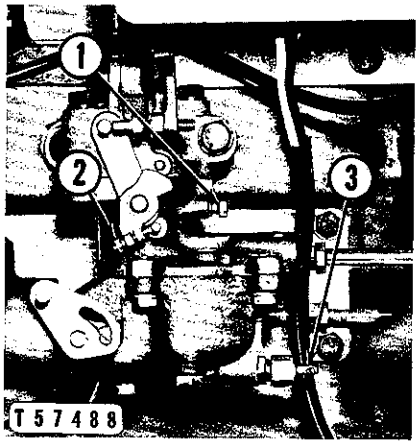
5. Remove the pin and turn the rod end one full turn counterclockwise to lengthen the rod.
6. Reassemble pin and install the cotter.
7. Tighten the locknut of rod end **(2)**.

STARTING ENGINE FUEL SYSTEM

Keeping the starting engine fuel tank filled will prevent condensation in the tank. Periodically drain any water which may have accumulated in the starting engine fuel tank sediment bowl.

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

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



CARBURETOR ADJUSTMENT

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

◆

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

(5) and shake it in kerosene or nonflammable cleaning fluid. When the bowl is replaced see that the gasket (3) is clean, is in the correct position and is not broken.

STARTING ENGINE SEDIMENT BOWL FILTER

1–Sediment bowl. 2–Valve. 3–Gasket. 4–Nut. 5–Edge-type filter element.

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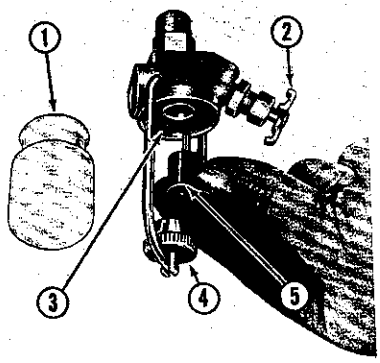

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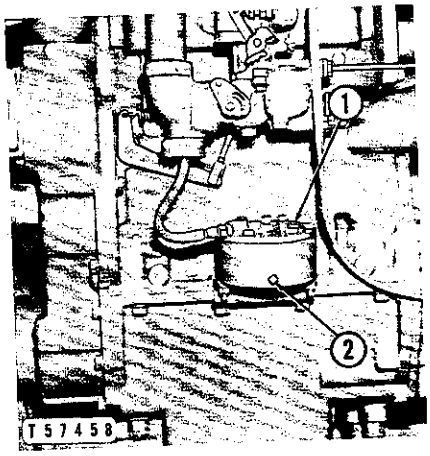
SAFETY DRIP COLLECTOR

Gasoline starting engines are equipped with a safety drip collector. It is located below the carburetor. The safety drip collector is connected to the starting engine carburetor so the collector can catch any excess fuel from the carburetor, thus the hazard from gasoline fumes is cut to a minimum. Remove plug (2) occasionally to drain the collected excess gasoline. Remove bowl (1) and wash occasionally.



SAFETY DRIP COLLECTOR

1–Bowl. 2–Drain plug.

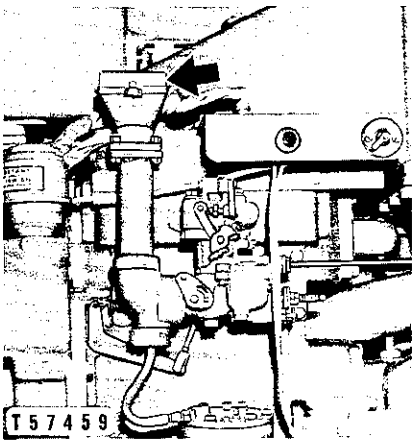
◆

STARTING ENGINE FLAME ARRESTER

On some arrangements the starting engine has a flame arrester on the inlet manifold to reduce fire hazard if the starting engine back-fires.

Remove the flame arrester occasionally to clean the small openings by

removing the fastening screws. Use a wire brush to clean out any dirt or corrosion, then wash it with kerosene or nonflammable cleaning fluid. Replace the flame arrester and tighten the screws.



FLAME ARRESTER

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STARTING ENGINE MAGNETO

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

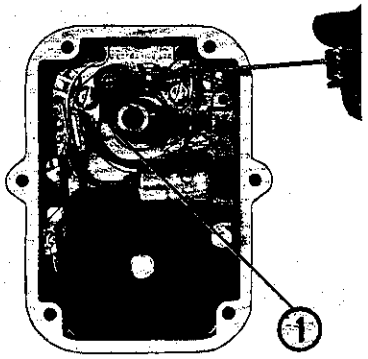
Checking Contact Point Opening: Every 1000 service hours check the contact point opening.

To check, first remove the distributor cap which is held in place by three screws. 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 nonflammable cleaning fluid. Remove the distributor rotor, then turn the engine

CHECKING CONTACT POINT OPENING

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

◆



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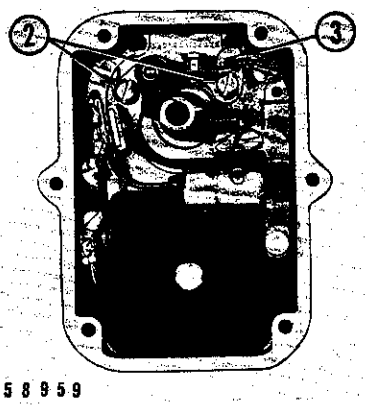
until the contact point bumper block **(1)** is on one of the highest elevations of the cam. Check the clearance with a thickness gauge between the contact point as illustrated. This clearance should be .015 inch (.38 mm.).



ADJUSTING CONTACT POINT OPENING

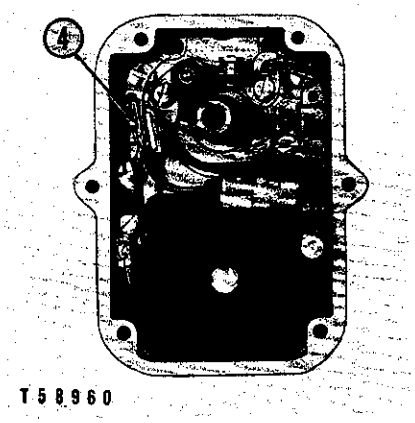
2–Bracket fastening screws.
3–Slot.

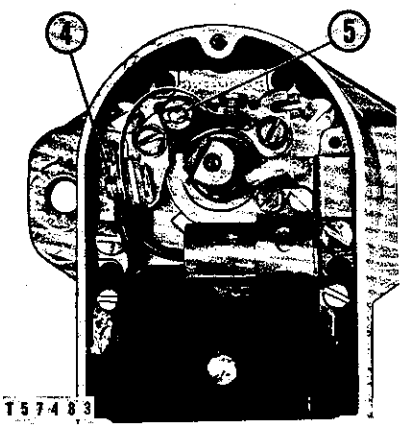
◆

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.

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





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

REMOVING CONTACT POINTS

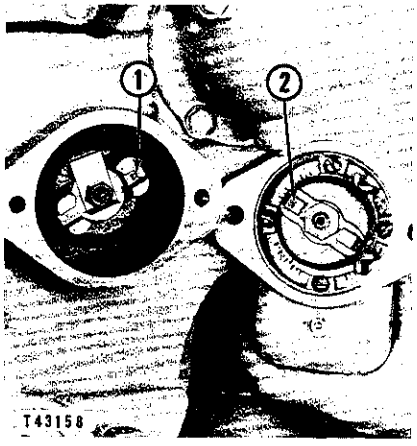
4–Spring clamp screw. 5–Lock and washer.

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

To Remove the Magneto for Testing: Disconnect the cables from the magneto. One of the cables should be tagged or marked in some convenient manner which will designate the proper position of 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 tang is in such a position as to line up with the mark on the magneto drive.
3. Install the magneto with the "X" marks together and tighten the bolts.



TIMING MARKS

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

◆

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

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

SPARK PLUG ADJUSTMENT

The spark plugs should be examined every 1500 service hours. The gap may be kept at approximately .030 inch (.076 mm.). Measure this gap with a thickness gauge. To adjust the gap, bend the outer electrode.

MARINE GEAR

Forward And Reverse Clutches: The clutches are actuated by hydraulic pressure which eliminates the necessity for any adjustments to compensate for wear of the friction surfaces. Thus the clutches must be reconditioned when they wear to the point where slippage occurs.

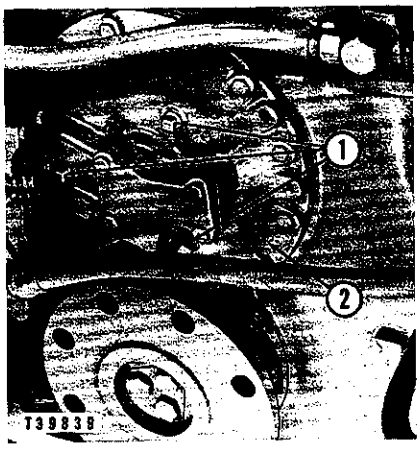
Marine gears should be checked regularly for clutch slippage in both forward and reverse rotation. One sign of slippage is excessive heat. A positive check can be made with a hand tachometer.

1. If possible, check the clutch slippage with the marine gear running at full load.
2. Determine both the engine and propeller shaft speeds with the hand tachometer.
3. The ratio of the engine speed to the propeller shaft speed should be very close to the marine gear reduction ratio.

For example, if the engine is equipped with a 3:1 ratio marine gear it means that the propeller shaft will turn one-third as fast as the engine. If the engine speed is found to be 1600 RPM, the propeller shaft speed should be very close to 533 RPM, or one-third as fast as the engine speed.

Come-home Feature: This feature is incorporated in each clutch. In the event of a failure in the hydraulic system this feature can be used to lock up one clutch mechanically, never both clutches, to enable the vessel to return to port.

If this feature must be used, **stop the diesel engine,** remove only the three access plugs **(1)** from one clutch manifold **(2)**. Rotate the marine gear output shaft until the three hollow hexagon head lock-up screws appear when viewed through the three access plug openings. Use a 3/16 inch (4.76 mm.) hexagonal Allen wrench to tighten the three setscrews (through the access plug openings) alternately until a mechanical lock-up of the clutch is obtained. Replace the access plugs.



MECHANICAL CLUTCH LOCK-UP

1–Access plugs. 2–Clutch manifold.

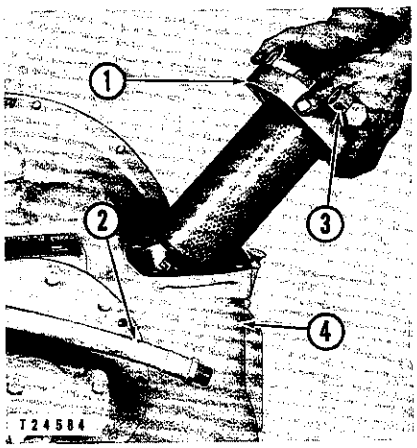
◆

Remote Control Adjustments: Remote controls should be adjusted to give full travel of the clutch control lever. Remote controls that do not move the clutch control lever through full travel may allow only partial engagement of the clutches resulting in rapid wear to the linings due to slippage.

If the controls are of the single lever type, make the adjustment so that the engine remains at the low idle speed until the marine gear clutch is fully engaged. Proper clutch engagement will be assured and result in prolonged clutch life.

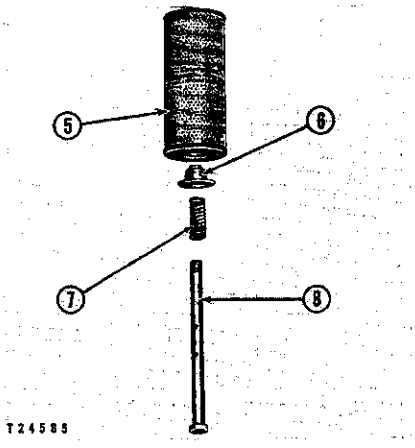
Replacing Oil Filter Element: To replace the oil filter element proceed in the following manner:

1. Disconnect the hose **(2)** from the cover **(1)** by loosening the coupling **(3)**.



COVER REMOVAL

1–Cover. 2–Hose. 3–Coupling. 4–Gear case.



ELEMENT REMOVAL

5–Element. 6–Spring seat. 7–Spring. 8–Tube assembly.

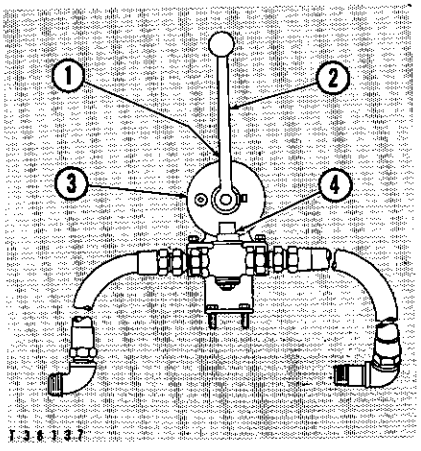
2. Remove the four bolts and lift the cover and element as an assembly from the gear case **(4)**.
3. Unscrew the tube assembly **(8)** from the cover.
4. Remove the element **(5)** from the tube assembly and discard it.
5. See that the spring **(7)** and spring seat **(6)** are in place and install a new Caterpillar element on the tube assembly.
6. Screw the tube assembly into the cover.
7. Replace the cover and element in the gear case.
8. Install the bolts and connect the hose.

Marine Gear Recheck: After the first 10 service hours of operation on a new marine gear or on a marine gear that has been reconditioned, tighten all the bolts on the direction selector valve, both clutch covers and the output shaft bearing retainer.

SUMP PUMP

The lubricating oil sump pump **(3)** may be mounted on the right side of the engine near the flywheel housing, if engine is so equipped. The sump pump provides a convenient method of removing both the diesel engine crankcase lubricating oil and marine gear lubricating oil.

A line or hose connected to the sump pump with a 1/2 inch pipe nipple in place of the plug **(1)** will allow the oil to be pumped into a suitable container instead of the bilge.



SUMP PUMP

1–Outlet plug. 2–Sump pump handle. 3–Sump pump. 4–Selector valve.

◆

To use the pump proceed as follows:

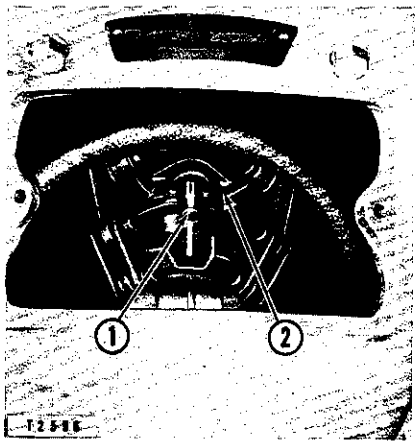
1. Place a selector valve **(4)** to the correct position for draining the desired compartment.
2. With plug **(1)** removed from the outlet and if necessary a hose or pipe connected to the outlet, move the pump handle **(2)** back and forth until all the oil is pumped from the compartment selected.

3. Remove the pipe or hose and reinstall the plug in the sump pump outlet.

FRONT POWER TAKE-OFF

The front power take-off is designed to carry many loads but should not be loaded to take more than 40 horsepower from the output of the engine.

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



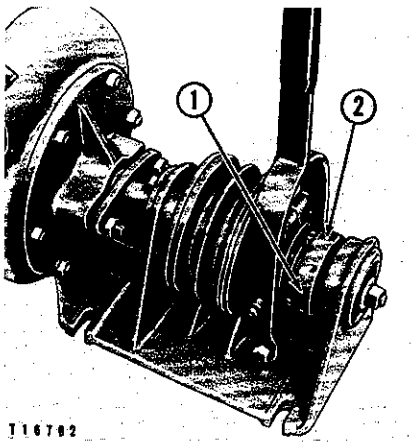
FRONT POWER TAKE-OFF CLUTCH

1–Adjusting lock pin.
2–Adjusting collar.

◆

BILGE PUMP

Clutch Adjustment: The clutch adjustment should be checked by moving the clutch control lever to the engaged position. It should go in with a distinct snap, and should require a reasonably hard push.



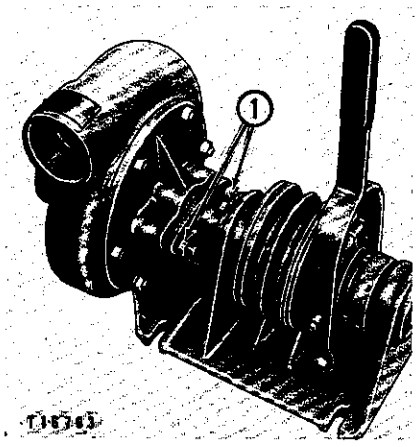
BILGE PUMP CLUTCH ADJUSTMENT

1–Setscrew. 2–Adjusting collar.

◆

To adjust, disengage the clutch and loosen the setscrew **(1)**. Turn the adjusting collar **(2)** a few degrees in a clockwise direction; then tighten the setscrew before testing for correct adjustment.

Packing Adjustment: With the pump in operation tighten the pump shaft packing by tightening the nuts **(1)** until the leak stops. The packing should be only tight enough to stop any leak, but not tight enough to bind the shaft.



PACKING ADJUSTMENT

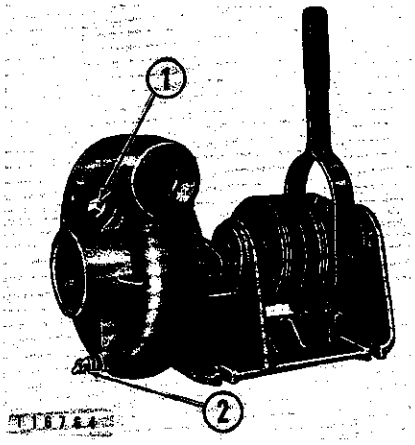
1–Nuts.

◆

Priming and Draining: When it becomes necessary to prime the pump remove the plug **(1)** on the front face of the pump and pour water into the pump with the pump not operating. Replace the filler plug and engage the clutch.

A line with a shut-off cock may be connected to the pump in place of the plug **(1)** and the other end of the line to a water supply for the purpose of priming the pump.

The pump should be drained when the vessel is to be left in storage, or at the end of a day's run in freezing temperatures. To drain the pump open the drain cock **(2)**.



PRIMING AND DRAINING

1–Filler plug. 2–Drain cock.

◆

Open the shut-off cock, if so equipped, to allow the water to drain from the priming line when draining the pump.

ELECTRICAL SYSTEM

The basic electrical system is composed of the following:

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

These components functioning together produce and store 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 state of charge before adding water. A dangerously low point of charge is indicated by a hydrometer reading of 1.150 which will permit the battery to freeze at temperatures only a few degrees below the freezing point of water. A specific gravity of 1.250 will permit the battery to withstand temperatures as low as —60° F. without freezing.

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

Water Addition: Water that escapes by evaporation should be replacd with distilled water or "approved water" (water free from impurities by analysis). The level should be maintained 3/8 inch (9.5 mm.) above the top of the separators or insulators. 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, ALTERNATOR, ALTERNATOR 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 parts replaced that show evidence of being unsatisfactory for reason of wear. It is suggested that this cleaning and reconditioning be entrusted to your Caterpillar dealer.

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

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

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

Polarizing (32V-15 Amp) Generators:

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

CAUTION

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

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

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

Generator Regulator

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

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

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

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

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

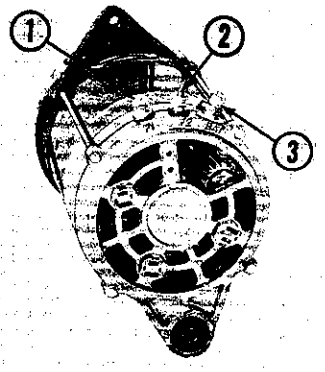
Charging Alternator
30 and 32 Volt Systems

Both the 30 volt and the 32 volt self-rectifying alternators are designed to give long service periods with a minimum amount of maintenance.

The grease reservoirs, for each of the two ball bearings on which the rotor is mounted, eliminate the need for frequent bearing lubrication.

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

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



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CHARGING ALTERNATOR

1–"F-1" terminal. 2–"F-2" terminal. 3–"BAT" terminal.

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CAUTION

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

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

Alternator Regulator

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

The alternator regulator senses the charge condition of the battery as well as electrical system power demand, and controls the alternator out-

put accordingly. As the battery becomes fully charged, the charging rate should drop until the ammeter indicates a rate only perceptibly above zero.

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

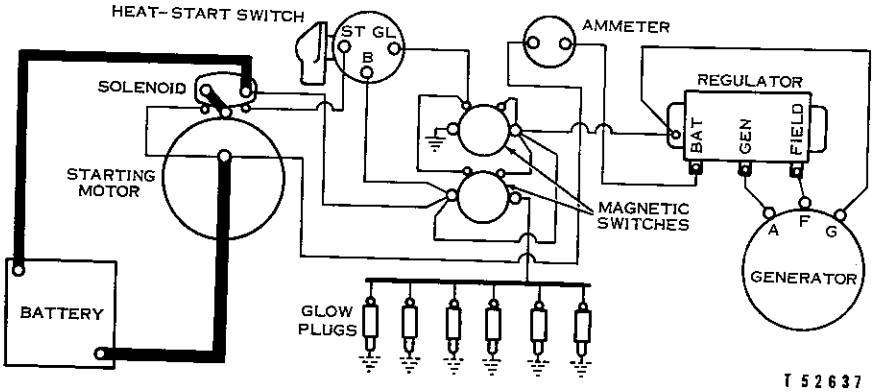
Overcharging of the battery will usually be indicated by the need of frequent additions of make-up water to the battery cells. See the topic, BATTERY; Water Addition. When overcharging occurs, both the alternator and alternator regulator should be checked by your Caterpillar dealer and the alternator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

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

Wiring

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

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

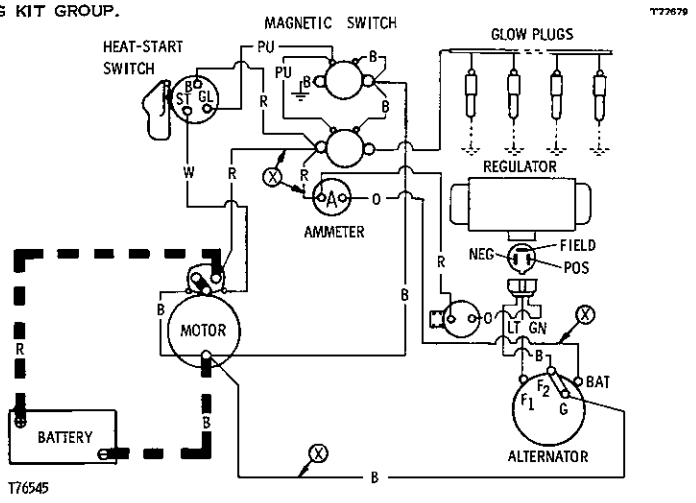


WIRING DIAGRAM FOR 32 VOLT 15 AMPERE ELECTRIC STARTING SYSTEM WITH GLOW PLUGS

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

MAXIMUM RECOMMENDED TOTAL BATTERY CABLE LENGTH		
CABLE SIZE	DIRECT ELECTRIC STARTING	
	12 VOLT	24-32 VOLT
0	4.0 FEET	15.0 FEET
00	5.0 FEET	18.0 FEET
000	6.0 FEET	21.0 FEET
0000	7.5 FEET	27.0 FEET
WIRE AND CABLE SHOWN DOTTED, CUSTOMER FURNISHED.		

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



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

electrical system. See the topics, BATTERY, GENERATOR, GENERATOR REGULATOR, ALTERNATOR and ALTERNATOR REGULATOR.

ELECTRIC STARTER

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

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

General Reconditioning: Approximately every 4,000 service hours, the starter should be removed so that it may be completely disassembled, washed and have all parts replaced that show evidence of being unsat-

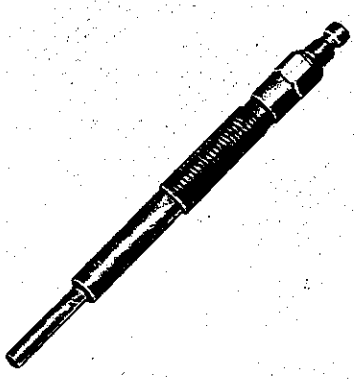
isfactory for reason of wear. Do not use a degreaser or high temperature cleaning method when cleaning parts of the starter or overrunning clutch. If the overrunning clutch turns roughly when rotated in the overrunning direction or slips in the cranking direction, after the clutch has been washed, it must be replaced with a new clutch. It is suggested that cleaning and reconditioning be entrusted to your Caterpillar dealer.

GLOW PLUGS

Maintenance: If it is suspected that the glow plugs are not correctly assisting in starting, the system should be checked for defective glow plugs. When making this check, a properly connected ammeter should show that each glow plug uses approximately 5 amperes.

An ammeter of sufficient capacity should be connected between the glow plug side of the magnetic switch and the lead wire to the glow plug harness. Then move the HEAT-START switch to the HEAT position. A reading on the ammeter should be approximately equal to the number of glow plugs in the system multiplied by 5 amperes. Any reading that varies appreciably from this may indicate one or more defective glow plugs.

GLOW PLUG



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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.

CAUTION

The system should be checked frequently for defective glow plugs. The switch should not be held in the HEAT position over one half minute with a lead disconnected from a glow plug. When a lead is removed from a glow plug and

the switch is moved to the HEAT position, more load is thrown on the remaining plugs in the system, increasing the possibility of burning out additional plugs.

To remove a defective glow plug, disconnect the bus bar lead from the glow plug. Using a thin wall socket, unscrew the glow plug from the precombustion chamber.

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

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

AIR STARTING MOTOR OILER

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

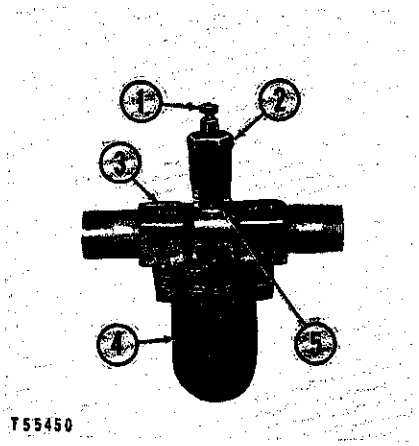
The oiler is designed to operate satisfactorily in a perpendicular position as long as the bowl is kept filled with lubricant. The oiler should be regulated to meter about four drops of oil per minute to the air stream.

Oil drips into the air stream only when air passes through the oiler 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 the 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 suspected 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.



AIR STARTING MOTOR OILER

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

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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 combination can be placed in the circuit so that the operator may 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 information see your Caterpillar dealer.

TYPICAL SAFETY ALARM CIRCUIT

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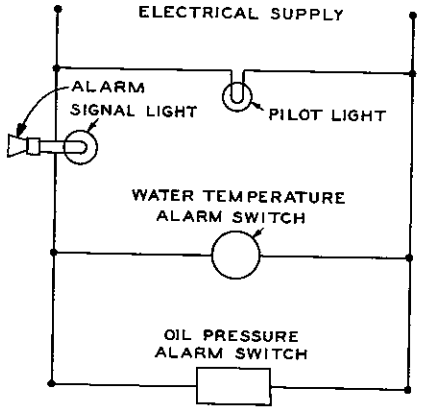
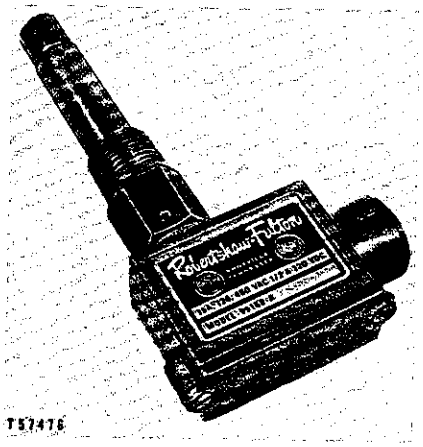


Water Temperature Alarm Switch (Later Type)

The water temperature alarm switch is located at the front of the engine in the water manifold. 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. When excessive temperatures are reached the switch will open or close, depending on how it is wired, and sound the alarm.



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WATER TEMPERATURE ALARM SWITCH

(Later Type Switch)

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(Earlier Type)

The rise in engine water temperature causes the metallic coil inside the water temperature alarm switch 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.

Both types of switches are designed to be installed in series with an alarm switch or relay switch having a rating not to exceed the maximum as follows:

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

5 In circuits of 250 volts, where a direct current relay is employed, .25 ampere.

Oil Pressure Alarm Switch

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

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

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

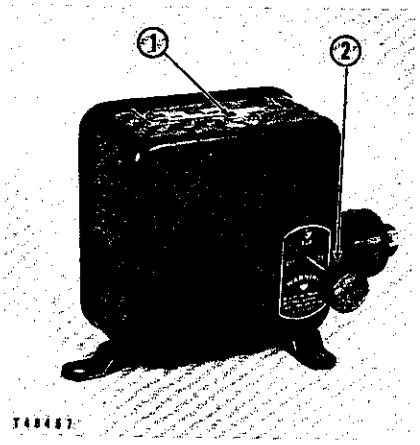
2 — Circuits of 230 volts, alternating current, 15 amperes.

3 — Circuits of 6 to 32 volts, direct current, 15 amperes.

4 — Circuits of 115 volts, direct currect, 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



OIL PRESSURE ALARM SWITCH

1–Adjusting screw. 2–Control knob.

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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.

Turn control knob with arrow pointing toward "ON" or "TEST" position occasionally to test alarm circuit—"ON" or "TEST" position is never used when starting or stopping engine.

Adjustment: 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 the left (counterclockwise).

3—Connect pressure bellows to an air pressure line and apply 8 pounds pressure at which pressure contacts are too close, sounding alarm.

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

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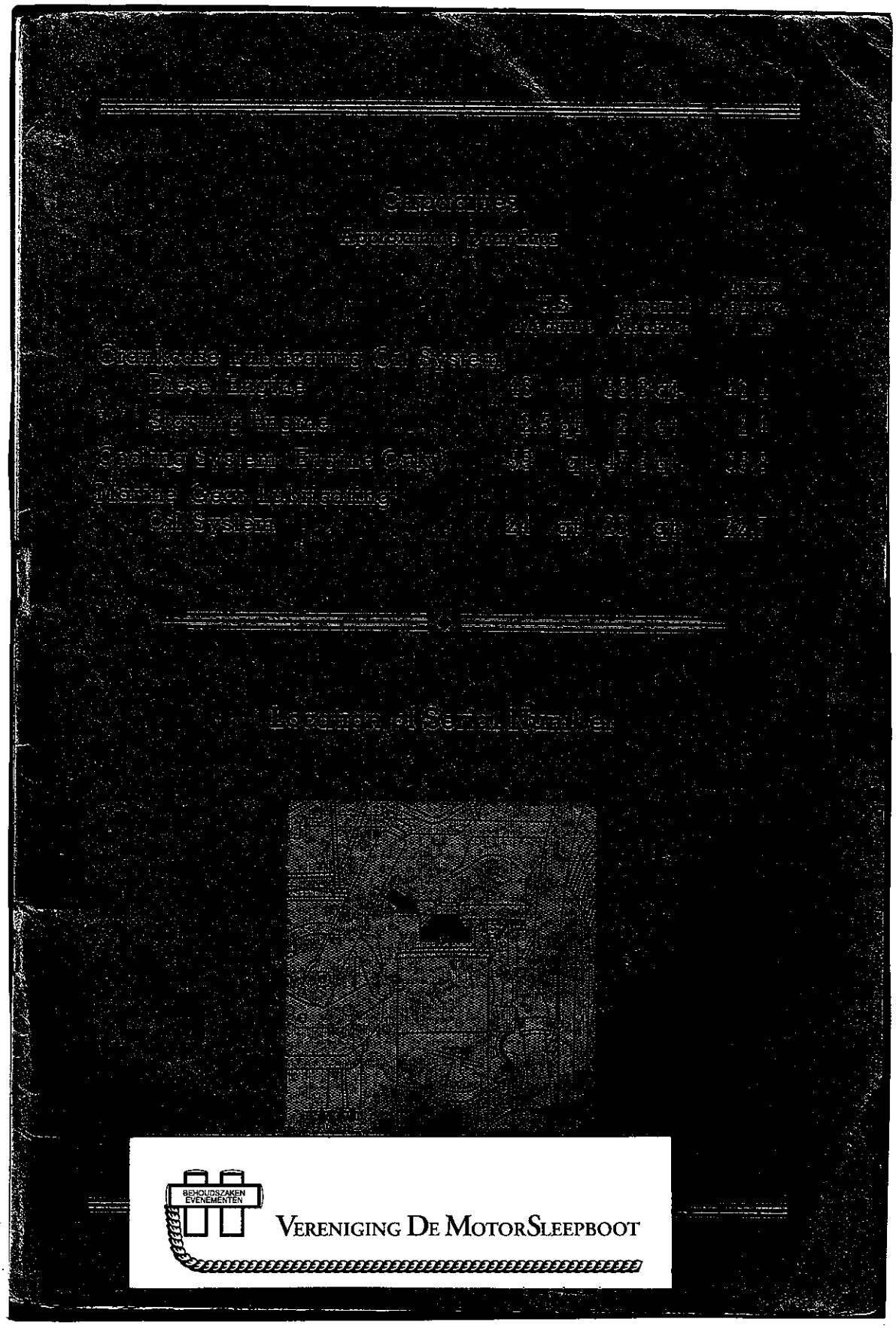

Capacities

Approximate Quantities

	US Gallons	Liters	Imp. Gallons
Crankcase Lubricating Oil System			
Diesel Engine	68 qt	64.3 qt	56.6
Steering Engine	2.5 gal	2.4 qt	2.1
Cooling System Engine Only	58 gal	47.6 gal	38.8
Marine Gear Lubricating Oil System	24 qt	22.7 qt	20.0

Location of Serial Number

BEHOUDSZAKEN EVENEMENTEN

VERENIGING DE MOTORSLEEPBOOT