OPERATION GUIDE

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ENGINE OPERATION

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LUBRICATION AND MAINTENANCE PROCEDURES

3100 SERIES INDUSTRIAL ENGINES

98M1-UP 97M1-UP 96M1-UP

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COMPLETE GUIDE
GEG00228–01 (5–73)

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ENGINE OPERATION

GENERAL

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

Before starting the engine, familiarize yourself with these procedures and apply the principles to your particular installation.

SAFETY PRECAUTIONS

Safety is basically common sense. There are standard safety rules but each situation has its own peculiarities which cannot always be covered by rules. Therefore with your experience and common sense, you are in a position to do something about safety. Lack of attention to safety can result in: accidents, personal injury, reduction of efficiency and worst of all – loss of life. Watch for safety hazards. Correct deficiencies promptly.

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

1. Never adjust or repair a machine while it is in operation.
2. Remove all tools and electrical cords before starting.
3. Keep the engine room and floor area clean.
4. Store oily rags in containers.
5. Never store flammable liquids near the engine.
6. Observe NO SMOKING signs.
7. Do not smoke around batteries. Hydrogen gas generated by charging is explosive. Keep batteries in a well ventilated area.
8. Do not wear loose clothing around machinery.
9. Be sure the engine room is properly ventilated.
10. Always disconnect and tape the ground battery lead before working on the elctrical system.
11. All electrical equipment must be grounded according to local building ordinances.
12. Be sure an automatic start-stop system is inoperative when the engine or generator is being worked on. Disconnect and tape the ground battery lead.

Remember, safety is everyone's business.

INSTALL GUARDS ON ALL EXPOSED ROTATING COMPONENTS

PERIODS OF LIMITED USE

A prolonged period without use is not good for any piece of machinery. Engines should be started and cycled every week. Load the engine every two weeks to the extent that it would be in normal operation. This is particularly important for standby power. Prolonged idling or running under a reduced load may cause oil consumption and carboning in the combustion chamber and result in poor performance and a loss of power. If long periods of idling are necessary, run the engine under load every four hours to clear carbon from the combustion chambers.

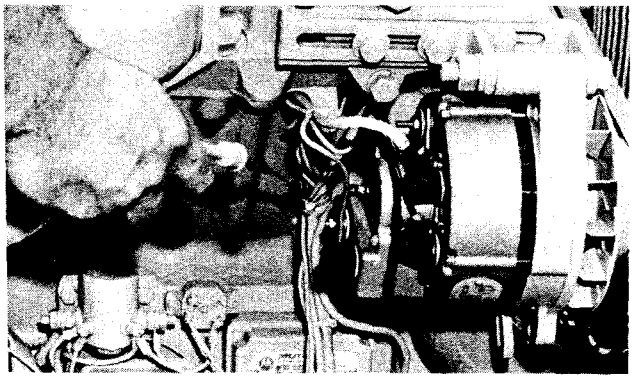
If an engine is going to be put in storage see your Caterpillar dealer for storage instructions.

STARTING

Perform required periodic maintenance before starting the engine. Make a "walk-around" check of the installation. It takes only a few minutes to correct minor discrepancies that can develop into major repair jobs.

PRE-START CHECKS

1. Correct any leaks, loose bolts or covers, and obstructions. The fan and radiator must be clear of restrictions.
2. Check the coolant level. The radiator must be full to the bottom of the filler neck.



)IL LEVEL

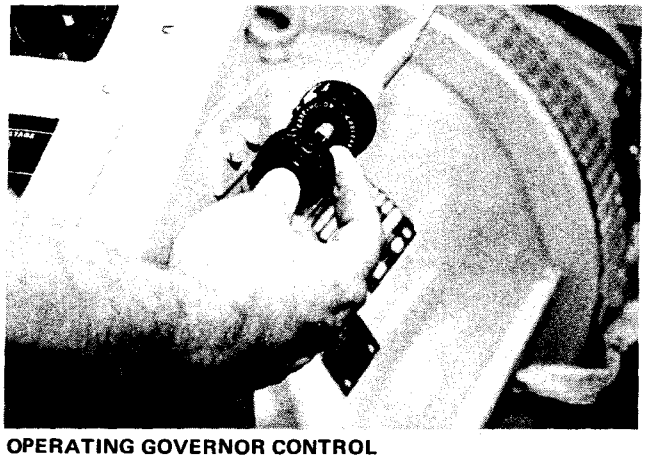
3. The crankcase oil level must be above the ADD mark on the dipstick.
4. Disconnect any battery chargers that are not protected against the starter current drain.
5. All guards must be in place. If guards are inadequate or in need of repair, notify your supervisor.

If an engine has not been run for several weeks, fuel may have drained from or air accumulated in the filter housing. When fuel filters have been changed, some air space will be left in the housing. In these instances, prime the fuel system until pressure registers on the gauge.

STARTING PROCEDURE

LECTRIC START

1. Open the fuel supply valve. The fuel return line must be open to prevent engine damage.
2. Disengage the clutch or open the circuit breaker. Do not start an engine under load.
3. Move the controls to half engine speed position or to limiter stop. Push in on the center knob and simultaneously pull back the control knob.



OPERATING GOVERNOR CONTROL

4. Turn the start switch to START position. Start the engine using starting aids as necessary.

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

CAUTION

Do not engage the starter when the flywheel is moving.

5. As the engine starts, release the start switch. It will return to the RUN position.

Clearances and tolerances are designed for operating conditions — including operating temperature. After the engine is started it takes several minutes to establish the lubricating oil film and allow the moving parts to heat up and expand. Loading a cold engine will cause shortened service life; i.e., broken rings, seized pistons, etc. This warm up period allows time for another "walk-around" check for leaks, etc.

WARNING

Do not attempt repairs or adjustments while the engine is running.

COLD WEATHER STARTING

Caterpillar 3100 Series Engines are designed to start at temperatures above 10°F without using starting aids. If temperature is below 10°F, a starting aid may be necessary and/or crankcase oil may need to be heated.

ETHER — Ether is much more volatile than diesel fuel and is used to start combustion of the fuel-air mixture.

WARNING

Ether is volatile and must be stored away from heat and direct sunlight. See the instructions on the container.

Engine mounted either dispensers are available commercially. Aerosol cans can also be used. Point the can opening at the air inlet and give a quick spray while cranking the engine. Too much ether will cause excessively high pressure and detonation. Liquid ether can be used by pouring a small amount on a cloth and holding the cloth in front of the air cleaner while the engine is cranking. Be sure the cloth is outside the air cleaner and cannot be drawn into the engine.

WARNING

DO NOT use ether after the engine has started. DO NOT inhale ether fumes.

In extremely cold climates, additional aids such as water heaters and battery heaters may be used. Contact your Caterpillar dealer before installing submersible crankcase oil heaters.

STOPPING

1. Remove the load from the engine.
2. Allow the engine to run at about half speed for five minutes. This allows internal temperatures to reduce gradually and prevents the loss of coolant by "afterboil".
3. Reduce speed to low idle for about 30 seconds.
4. Stop the engine by turning the START switch to OFF. The governor control will not stop the engine.

If an engine is going to be put in storage see your Caterpillar dealer for storage instructions.

ATTACHMENTS

GAUGES

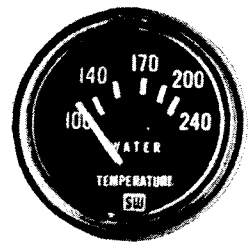
Gauges provide a "look" inside the engine. Be sure they are in good working order. You can determine what is "normal" operating range by observing the gauges over a period of time. The cause of any sudden or significant change in the readings should be determined and corrected.

OIL PRESSURE — Oil pressure is normally greatest after starting a cold engine. As the oil warms up the pressure drops. Oil pressure is greater at operating speeds than at low idle. Fluctuating readings can mean air in the oil or a sticking pressure relief valve. Stop the engine immediately if a sudden loss of oil pressure occurs.

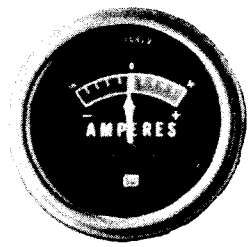
WATER TEMPERATURE — The operating temperature is maintained by the water temperature regulator. High coolant temperatures mean the cooling system is not dissipating enough engine heat.

The minimum operating temperature should not be below 175°. If the temperature gauge continues to indicate below 175° while operating, have the gauge checked for accuracy and the thermostats checked for proper operation.

OIL PRESSURE



WATER TEMPERATURE



AMMETER

In cold weather the temperature gauge may fluctuate in or near the cold range. This indicates the engine is being overcooled. In these instances the use of radiator louvers is suggested.

AMMETER – The ammeter should register in the charging range when the engine is running above low idle. If the gauge still registers a discharge as the engine speed is increased, determine the cause.

AUTOMATIC START-STOP

An automatic start-stop system ensures that power is supplied to a load when the normal power source is interrupted. The cranking panel is the heart of the system and consists of the failure warning system and relays to start and stop the engine. When a power failure occurs the system senses the failure, starts the engine and transfers the load to standby. When power is restored, it senses power restoration, transfers the load from standby and stops the engine. The major use of automatic start-stop systems is standby electric sets. This discussion is limited to that application.

The remote contacts close when a power failure occurs and completes the circuit to the cranking timer and the start slave relay. The start slave relay completes the circuit to the starter motor and the engine begins cranking.

As the engine starts and increases in speed, the frequency sensing relay turns off the cranking timer and starts the slave relay. This disconnects the starter motor circuit and protects the starter from overspeed damage. If the engine fails to start, the cranking timer will time out and lock the start circuit open, preventing the batteries from being discharged.

During the cranking cycle, the safety shutoffs are inoperative to prevent a low oil pressure shut down. When oil pressure reaches a safe level the safety circuit is armed by the arming relay. High water temperature or low oil pressure will now stop the engine and prevent major damage.

If an unsafe engine condition exists, a sending unit completes the circuit to the safety relay and locking relay. The safety relay de-energizes the fuel solenoid and stops the engine. The locking relay insures that the circuit to the safety relay is complete even if the remote contacts open.

The safety circuit must be reset by moving the start selector switch to the OFF position. Before restarting any unit which has been shut down by the safety circuit, the cause must be determined and corrected.

DETERMINING THE CAUSE OF SHUTDOWN

Anytime an engine is shut down by its safety circuit, the cause must be determined. In some cases the cause will be obvious but often an investigation will have to be made. Do not put the engine back into service without determining and correcting the cause of the shutdown.

HIGH WATER TEMPERATURE

Look for the obvious first.

1. Check for water on the floor from spilled or leaking coolant.
2. Check the water temperature gauge for accuracy.
3. Check air flow through the radiator.

WARNING

DO NOT remove the pressure cap of an overheated unit. The coolant is under pressure and relieving this pressure will cause the coolant to flash into steam. Serious burns and engine damage can result from the escaping coolant. Pressure in a radiator or surge tank may be reduced by pouring warm water on the top tank to condense the steam.

CAUTION

NEVER add cold water to an overheated engine.

4. Check air temperature to radiator. Few radiators can adequately cool a fully loaded engine with 125°F (52°C) ambient air.

5. Check for recirculating air currents.

6. Check fan and water pump belts for proper tension.

7. See that engine room vents and louvers are open.

8. Check water hoses for leaks. Is the water pump inlet hose collapsed. Hoses have been known to peel off internally and restrict water flow.

9. If the engine is overloaded, overheating can result.

Overheating can cause seals and gaskets to relax and fuel nozzles to change their operating characteristics. If severe or prolonged overheating has occurred, have the engine checked.

LOW OIL PRESSURE

Look for the obvious first.

1. Check the oil level.
2. Check floor for oil from leaks.
3. To determine if low oil pressure was the cause of the shut down, crank the engine with the fuel valve disconnected. If unusual noises come from the engine, discontinue cranking. If oil pressure fails to build up, and no external leaks are found, the problem is probably internal.

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Engine Operation

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LUBRICATION AND MAINTENANCE CHART

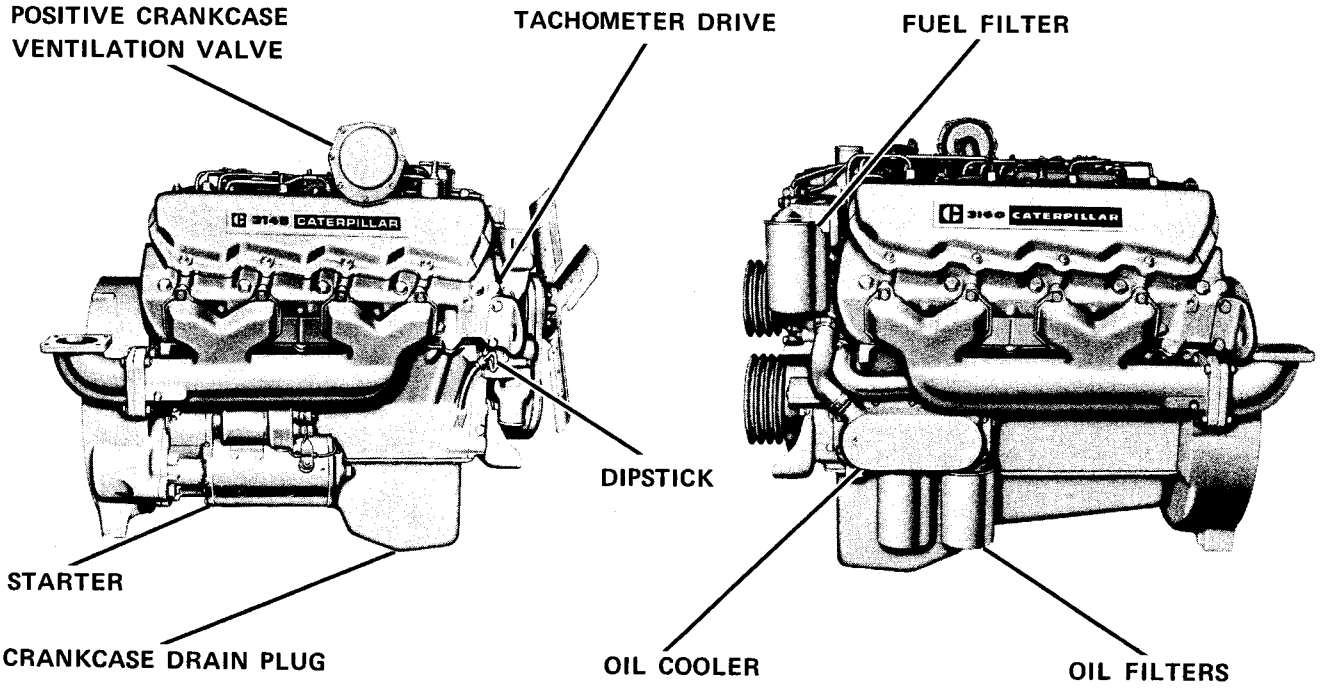
The LUBRICATION AND MAINTENANCE CHART lists all serviceable items which are either standard equipment or attachments commonly ordered on your model of engine.

Items needing periodic maintenance are grouped according to frequency of service. Items needing service as required are grouped according to the general system of which they are a part, and follow the periodic interval items.

The page letter and number in the right hand column of the chart is the reference page for the detailed instructions in the LUBRICATION AND MAINTENANCE PROCEDURES. These procedures are grouped according to the various engine systems, e.g., the Diesel Engine Lubrication System is A, the Air Induction and Exhaust System is B, etc.

The number following the letter indicates the page number within that system, e.g., B-2 is the second page in the Air Induction and Exhaust System.

Items which do not pertain to your engine may be lined out to customize your charts.



3100 SERIES INDUSTRIAL ENGINES

98M1-UP 97M1-UP 96M1-UP

Service Intervals

The service meter is the most reliable method of determining service intervals. If your engine does not have a service meter, use the following figures. These figures are based on a 10 hour day and a 2000 hour year. If your operation differs from these limits, base your service intervals on actual running time. Keep an accurate record of operating time.

Do not use these figures as an optional service interval for engines with service meters.

10 hours – One day
50 hours – One week
100 hours – Two weeks
200 hours – One month

ITEM	PROCEDURE	Lubricant	Section and Page
FREQUENTLY DURING OPERATION			
Crankcase lube oil pressure	Check oil pressure gauge		A-1
Water temperature	Check water temperature gauge		D-1
Battery charge rate	Check ammeter reading		F-1
EVERY 10 SERVICE HOURS OR DAILY			
Crankcase lube oil	Check oil level	CD/CC	A-1
Fuel tank	Check fuel supply		C-1
Day tank	Check fuel supply		C-1
Cooling system	Check coolant level		D-1
Clutch	Check clutch adjustment		G-1
EVERY 50 SERVICE HOURS OR WEEKLY			
Battery	Check electrolyte level		F-1
EVERY 100 SERVICE HOURS OR 2 WEEKS			
Enclosed clutch	Lubricate	MPGM	G-1
EVERY 200 SERVICE HOURS OR MONTHLY			
Crankcase lube oil (See Note 1)	Change oil	CD/CC	A-1
Crankcase oil filters	Change filter elements		A-1
Air cleaner (See Note 2)	Change air cleaner elements		B-1
Fan and drive belts	Check adjustments and wear		H-1
Clutch housing	Check oil level	CD/CC	G-1
EVERY 500 SERVICE HOURS OR 3 MONTHS			
Intake and exhaust valves	Check adjustment (See Note 3)		A-1
Clutch housing	Change oil in rear bearing	CD/CC	G-1
EVERY 1000 SERVICE HOURS OR 6 MONTHS			
Safety shut-off	Check operation		H-1
Fuel tank	Drain water and sediment		C-1
Primary fuel filter	Clean element		C-1
EVERY 2000 SERVICE HOURS OR 1 YEAR			
Fuel filters	Change filter elements		C-1

Note 1. Normal change interval when fuel sulphur is 0.4% or less.

When sulphur content is 0.4% to 1.0% reduce oil change interval one-half.

When sulphur content is above 1% reduce oil change to one-fourth the normal interval.

Regardless of hours, change oil and filters every six months.

Note 2. More often in dusty conditions. If after servicing the air cleaner, the exhaust smoke and/or loss of power continues, discard that element and install a new element at least once a year.

Note 3. Check valve lash after the first 80-100 hours of operation and then at least every 6 months regardless of service hours.

KEY TO LUBRICANTS AND FUELS

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

CC – Use oils which meet Engine Service Classification CC, MIL–L–2104B or MIL–L–46152 in Caterpillar 3100 Diesel Engine crankcases and/or gear compartments.

MPGM – Use Multipurpose-type Grease which contains both 3 to 5% molybdenum disulfide conforming to MIL–M–7866, and a suitable corrosion inhibitor. NLGI No. 2 Grade is suitable for most temperatures. NLGI No. 1 or No. 0 are suitable for extremely low temperatures.

Fuel – Use only distillate fuels (ASTM No. 1 or No. 2 Fuel Oil, or No. 1D or No. 2D Diesel Fuel Oil for examples) with a minimum cetane number of 40. Heavier oil is generally preferable because of its higher energy content.

COMPONENT	ABOVE 32°F (ABOVE 0°C)	BELOW 32°F (BELOW 0°C)
Diesel engine crankcase	SAE 30 SAE10W-30	SAE 10W SAE10W-30
Flywheel clutch rear bearing	SAE 30	SAE 10W

REFILL CAPACITIES (Approximately)

	U.S. Qts.	Imp. Qts.	Liters
Diesel engine lubrication system	12	10	11.5
Flywheel clutch rear bearing	1	1	1
Cooling system			
Engine only	26.0	21.5	24.5
High capacity radiator	40.0	33.5	38
Standard radiator	38.75	32.5	37.5

VALVE LASH

Exhaust valves	.025 inch (0,63 mm)
Inlet valves	.015 inch (0,38 mm)

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LUBRICATION AND MAINTENANCE PROCEDURES

ENGINE LUBRICATION SYSTEM

CHECKING OIL PRESSURE GAUGE READING

Observe the oil pressure gauge frequently. If the indicator registers below NORMAL, or fluctuates, determine the cause and take the necessary corrective measures.

CHECKING OIL LEVEL

Check the oil level before starting. Maintain the oil level between the ADD and FULL marks on the dipstick. See the Lubrication and Maintenance Chart for proper oil.

CHECKING THE OIL LEVEL

CHANGING CRANKCASE OIL AND FILTERS

Drain the crankcase with the engine stopped and oil warm.

1. Remove the crankcase drain plug.
2. Unscrew and remove the filters. Be sure the old filter gasket does not remain attached to the filter base: Leaking between the new and old filter gaskets will result.
3. Wipe the filter base.

WIPING THE FILTER BASE

4. Apply a thin coat of clean oil to the gasket of each new filter.
5. Install new filters. Hand tighten the filter 1/2 turn after the gasket contacts the filter base.
6. Install the drain plug. Fill the crankcase with clean oil. See the Lubrication and Maintenance Chart for refill capacity and proper oil to use.
7. Check oil level before starting.
8. Start and run the engine until it is warm; check for oil leaks.

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AIR INDUCTION AND EXHAUST SYSTEM

AIR CLEANER

1. Remove the wing nut, cover and element.
2. Clean the inside of the cover. The base should be clean. If the base is dusty, the air cleaner gasket leaked; discard the element.
3. Inspect the new element for damage and dirt.

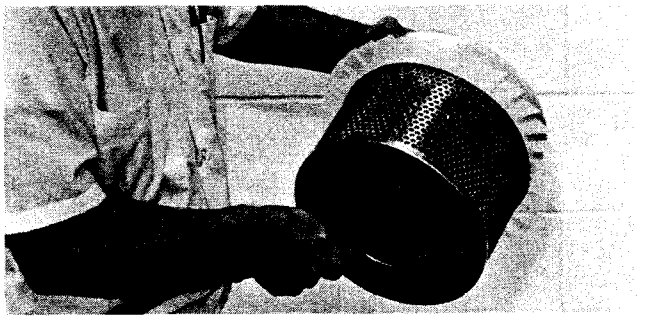
REMOVING THE ELEMENT

4. Install the new element and cover.

The element removed may be cleaned or discarded, depending upon the apparent condition of the pleats. If a cleaned element is installed, and the exhaust smoke and/or loss of power continues, remove and discard that element and install a new element. Install a new element at least once a year.

CLEANING WITH PRESSURE AIR

1. Use clean, dry air - 30 PSI maximum. Hold the nozzle at least one inch from the element and at a slight angle. (A direct blast can rip the pleating.)
2. Direct the air stream along the complete length of each pleat on the CLEANEST side of the element. (This will loosen the dirt from the dirtier side.)
3. Blow the loosened dirt from the DIRTY side.
4. Direct the air from the CLEAN side through to the DIRTY side to remove any dirt blown into the pleats.



CLEANING THE ELEMENT WITH PRESSURE AIR

CLEANING WITH WATER

1. Use clean water - 40 PSI maximum. Do not use a nozzle.
2. Direct the water stream along the complete length of each pleat on the CLEAN side of the element.
3. Direct water along the complete length of each pleat on the DIRTY side of the element.
4. Rinse the CLEAN side of the element.
5. Allow the cleaned element to dry thoroughly.

CLEANING WITH DETERGENT

1. Wash both sides of the element in a solution of warm water and non-sudsing household detergent.
2. Rinse the CLEANEST side of the element with clean water (40 PSI maximum) along the complete length of each pleat.
3. Rinse the opposite side of the element along the complete length of each pleat.
4. Rinse the first side again to remove all loosened dirt.
5. Allow the cleaned element to dry thoroughly.

CHECKING CLEANED ELEMENT

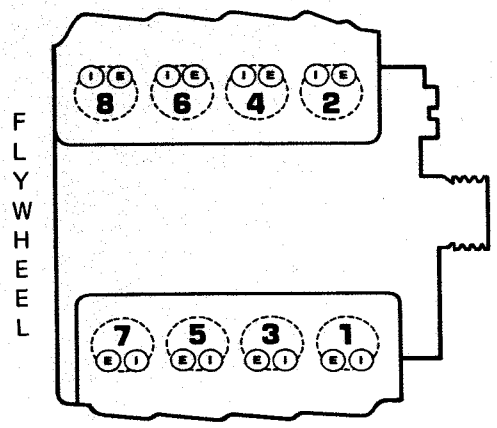
Hold the dried element in front of a lighted electric bulb. Carefully inspect the element for tiny, pin-points of light. Any light showing indicates a pleat has ruptured and will tear with further use. Discard the element.

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

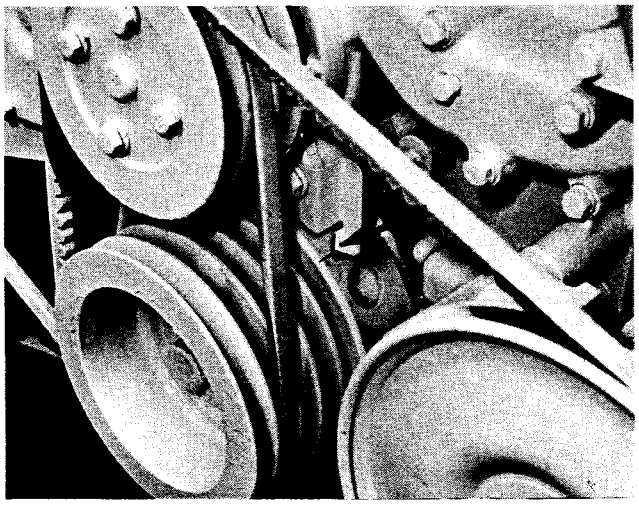
VALVE LASH

PREPARING TO CHECK ADJUSTMENT

TDC of the No. 1 piston on the compression stroke is the reference point. The No. 1 piston is at TDC compression stroke when the timing mark on the damper or the pulley is aligned with the timing pointer, and No. 1 and No. 2 exhaust and inlet valves are closed. (The rocker arms are free and the push rod is at its lowest point.)



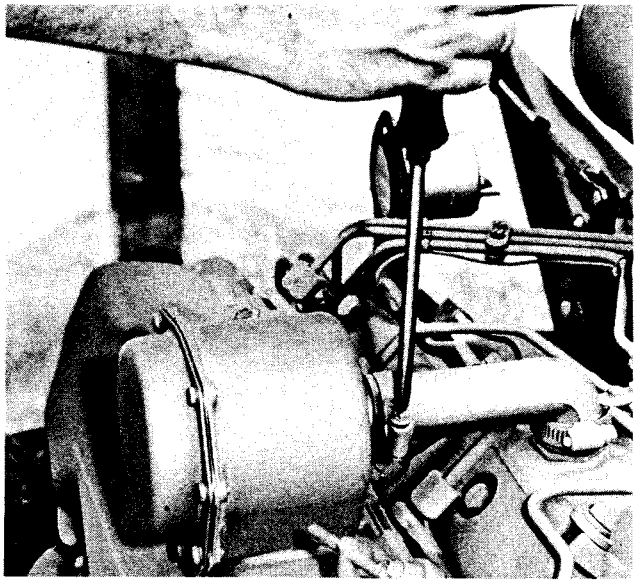
NUMBERING OF CYLINDERS AND VALVE LOCATION



TIMING MARK AND POINTER

TO CHECK VALVE LASH

1. Stop the engine.
2. Clean around the valve covers.
3. Remove the crankcase ventilation valve.
4. Remove both valve covers.



REMOVING CRANKCASE VENTILATION VALVE

5. Turn the crankshaft until No. 1 cylinder is on top dead center ("TC1") compression stroke.

   Align the ("TC1") timing mark on the damper with the timing pointer located on the front of the engine block.

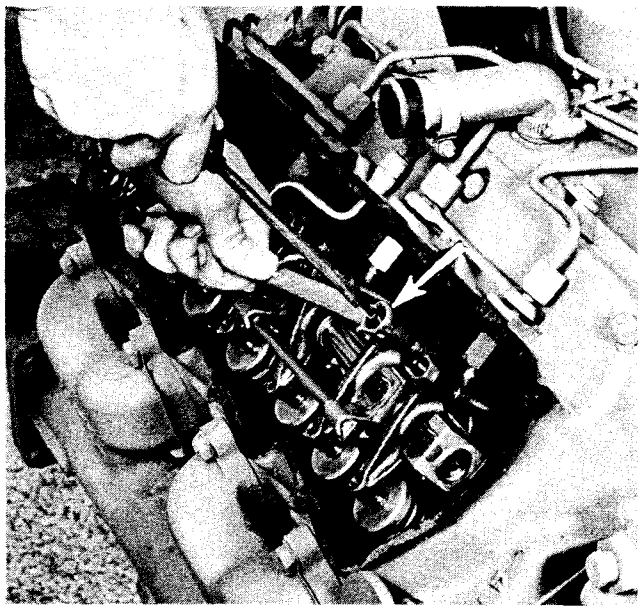
   Both the exhaust and inlet valves for No. 1 and No. 2 cylinders will be closed: The four rocker arms will rotate with finger pressure.

ROTATING ROCKERS

ADJUSTING VALVE LASH

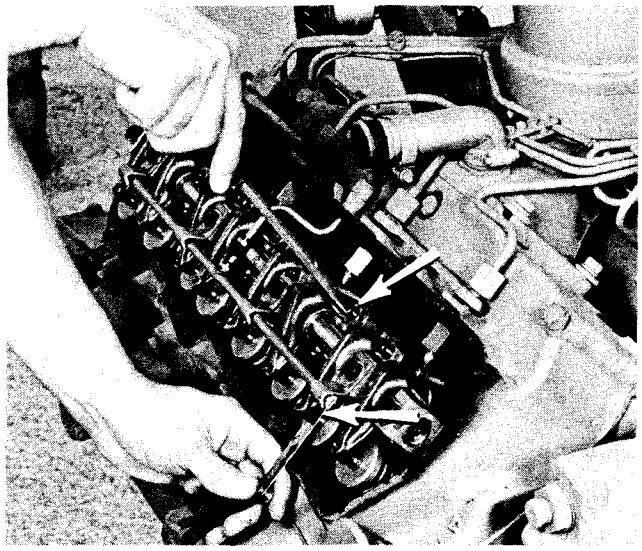
1. Adjust the inlet and exhaust valve lash for No. 1 and No. 2 cylinders:

   a. Loosen the valve adjusting screw locknut.



LOOSENING LOCKNUT

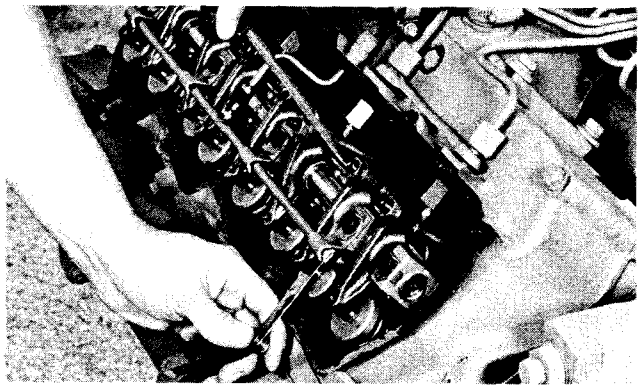
b. Turn the adjusting screw to allow a clearance gauge to pass between the top of the valve stem and the valve rocker arm. See the LUBRICATION AND MAINTENANCE CHART for correct lash measurement.



ADJUSTING VALVE LASH

c. Tighten the adjusting screw locknut.

d. Check valve lash clearance.



CHECK VALVE LASH CLEARANCE

2. Turn the crankshaft 180° clockwise (viewed from the front of the engine). On later engines, align the "VS" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 3 and No. 7 cylinders.

3. Turn crankshaft 180° clockwise (viewed from front of engine), and align "TC1" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 4 and No. 5 cylinders.

4. Turn crankshaft 180° clockwise (viewed from front of engine); align "VS" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 6 and No. 8 cylinders.

5. Inspect the valve cover gaskets. Install new gaskets if necessary. Install the valve covers and crankcase ventilation valve. The crankcase ventilation valve does not require servicing.

FUEL SYSTEM

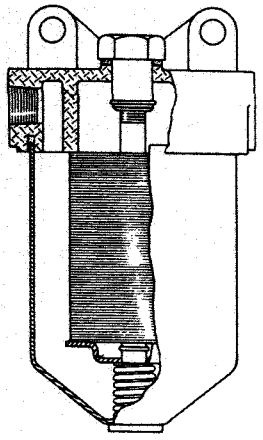
FUEL TANK

Open the fuel tank drain valve to drain water and sediment from the fuel tank. To minimize water contamination, fill the fuel tank in the late afternoon: As the fuel is consumed, air with some humidity must replace the fuel in the tank. By filling the tank in the late afternoon, this humid air is expelled before the moisture can condense on the cool inside walls of the fuel tank.

FUEL FILTERS

CLEANING PRIMARY FILTER ELEMENT

1. Stop the engine.
2. Close the diesel fuel supply valve.
3. Loosen the nut on the cover and remove the case and filter.
4. Clean the element and case in clean kerosene or diesel fuel.
5. Before installing the filter, inspect the gaskets. Install new gaskets if necessary.
6. Install the cleaned filter element and case.
7. Prime the fuel system.



PRIMARY FUEL FILTER

INSTALLING NEW FINAL FUEL FILTER ELEMENTS

1. Unscrew and remove the filter. Be sure the old filter gasket does not remain attached to the filter base: Leaking between the new and old filter gaskets will result.

REMOVING THE FUEL FILTER

2. Clean the gasket sealing surface of the filter base.
3. Lubricate the new filter gasket with clean diesel fuel.
4. Fill the new filter with clean diesel fuel.
5. Tighten filter by hand until gasket contacts base; then tighten 1/2 turn more.
6. Prime the fuel system.

PRIMING THE FUEL SYSTEM

If air is trapped in the fuel system, the diesel engine will either not start, or will misfire.

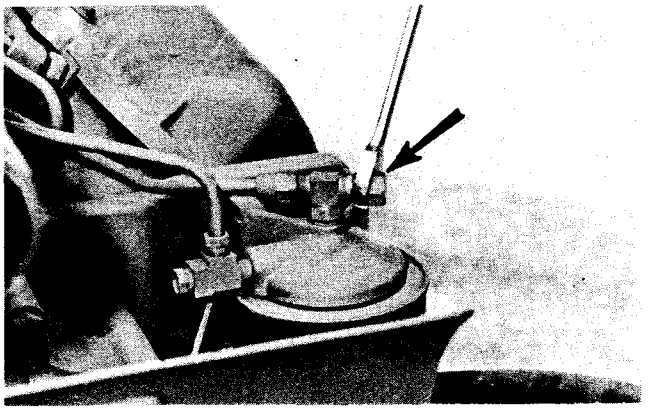
To prime the system:

1. Stop the engine.
2. Loosen the vent cap on the filter base.

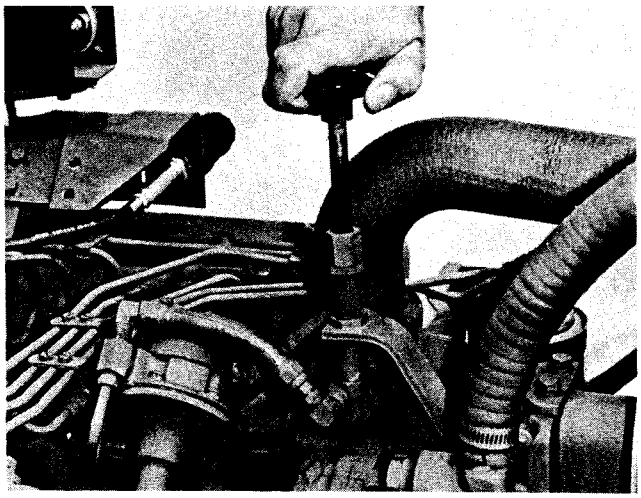
CAUTION

Operate the priming pump only when the bleed valve is open. Avoid bleeding excessive fuel.

3. Operate the electric starter, or the hand priming pump if so equipped, until the flow of fuel from the filter is continuous and free of bubbles.

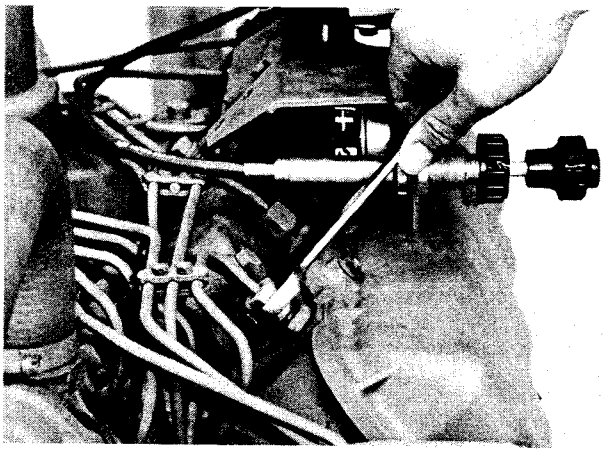


VENT CAP



OPERATING THE PRIMING PUMP

4. Tighten the vent cap.
5. Start the engine. If the engine misfires or smokes, loosen a fuel injection line nut; allow the fuel to flow until free of air bubbles. Tighten the line nut, open the next line nut and continue priming each successive line.



BLEEDING THE FUEL LINE

COOLING SYSTEM

ENGINE JACKET WATER

CHECKING COOLANT LEVEL

With the engine warm and stopped:

1. Slowly loosen the filler cap and release pressure.

WARNING

Be careful; steam may spray. Avoid being burned.

2. Push downward and turn the cap until it is released.
3. Maintain coolant level to within 1/2 inch (1 cm) below bottom of fill pipe. The coolant will expand as it is heated.
4. Make-up coolant must be one of the following:
   a. Permanent anti-freeze and water solution.
   b. Drinkable water and rust inhibitor solution.

   For emergencies, and only as a "temporary fix" until the cooling system can be returned to either (a) or (b), use either:

   c. Drinkable water.
   d. Any available water.

"Drinkable water" is clean water that is low in scale forming minerals — not softened water. Never add coolant to an overheated engine; allow it to cool first.

Check specific gravity of anti-freeze solution frequently in cold weather to assure adequate protection.

DRAINING RADIATOR

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

1. Remove the filler cap.
2. Open the drain valve for the radiator.

DRAINING COMPLETE COOLING SYSTEM

1. Drain the radiator; see the topics above.
2. Remove the thermostat housing drain plug.
3. Remove both engine block drain plugs.
4. Remove the coolant; then install all drain plugs.

FLUSHING COOLING SYSTEM

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

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

1. Fill the cooling system with a solution consisting of one pound of oxalic acid or sodium bisulphate ($NaHSO_4$) with every 5 gallons of water (mix 0,24 kg. with every 10 liters of water).
2. Start the engine and operate at operating temperatures for 1/2 to 1 hour.
3. Stop the engine and drain the cooling system.
4. Flush the system with clean water until the draining water is clear.
5. Install all drain plugs.
6. Fill with a solution consisting of 1/2 pound of sodium carbonate crystals (Na_2CO_3, $10H_2O$) with every 10 gallons of water (mix 0,06 kg with every 10 liters of water).
7. Start and run the engine for 10 minutes.
8. Stop the engine and drain the cooling system.
9. Flush the cooling system with clean water.
10. Install all drain plugs.

FILLING COOLING SYSTEM

1. Add anti-freeze, if required.
2. Fill to correct level with water which is free as possible from scale forming minerals.
3. Start and run engine for 10 minutes.
4. Remove the radiator cap and check the coolant level.
5. Add coolant, if needed, until coolant level is to the bottom of the filler tube.
6. Install the radiator cap.

ELECTRICAL SYSTEM

BATTERY INSTALLATION

PREPARING DRY CHARGE BATTERIES

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

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

CAUTION

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

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

NOTE

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

PREPARING WET CHARGE BATTERIES

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

USING A BATTERY CHARGER

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

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

WARNING

Never smoke near the area where batteries are being charged.

INSTALLING BATTERY

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

CAUTION

Always connect the "hot" terminal first.

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

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

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

BATTERY MAINTENANCE

TESTING THE ELECTROLYTE SOLUTION

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

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

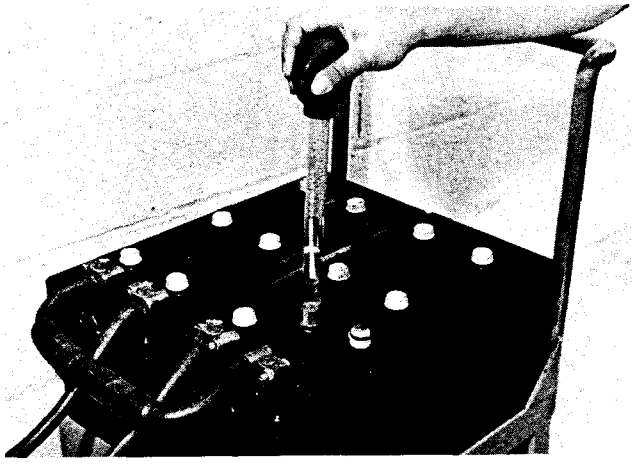
   1.250 or above - fully charged battery cell

   1.250-1.225 - full to half charged battery cell

   1.225-1.150 - half to low charged battery cell

   Below 1.150 - dead cell

   1.000 - water
3. Test each cell in the same manner.



MEASURING SPECIFIC GRAVITY

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

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

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

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

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

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

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

ADDING MAKE-UP WATER

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

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

WARNING

Never add acid or electrolyte.

READING THE AMMETER

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

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

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

CLEANING BATTERY

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

CLEANING BATTERY TERMINALS

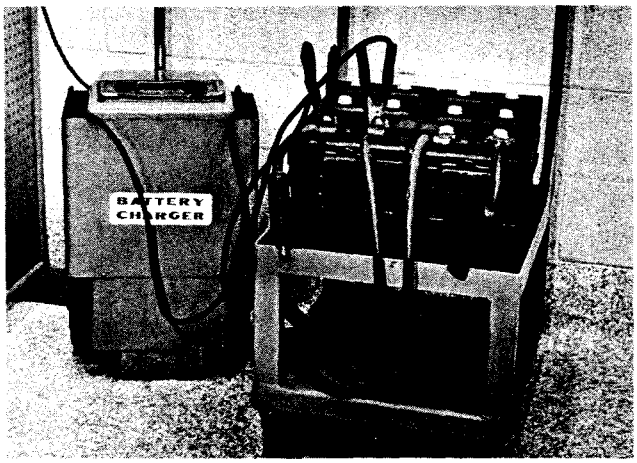
2. Thoroughly rinse the battery and battery tray with clean water.
3. Apply grease to the battery cable clamps and terminals and to all threads.

COLD WEATHER BATTERY MAINTENANCE

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

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

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



CHARGING THE BATTERY

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

CAUTION

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

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

CONNECTING A BOOSTER BATTERY

1. Using a pair of jumper cables, connect the red jumper cable to the "hot" terminal of the 12 Volt booster battery.
2. Connect the black jumper cable to the ground terminal of the booster battery.

CAUTION

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

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

REMOVING JUMPER CABLES

As soon as the engine starts:

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

POWER COUPLING SYSTEM

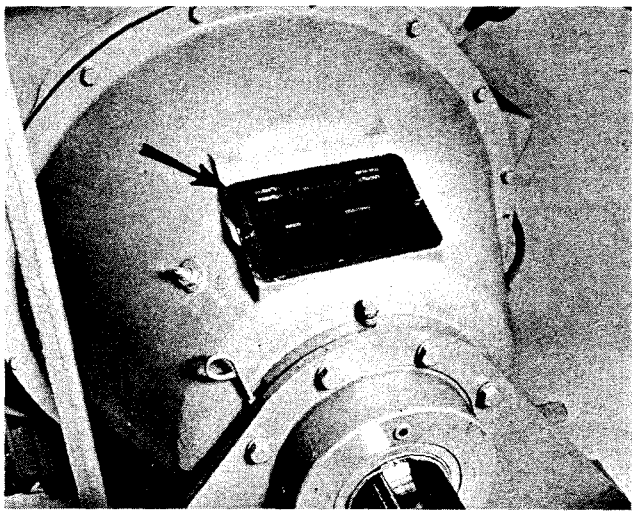
ENCLOSED CLUTCHES AND/OR FRONT POWER TAKE-OFF

CHECKING CLUTCH ADJUSTMENT

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

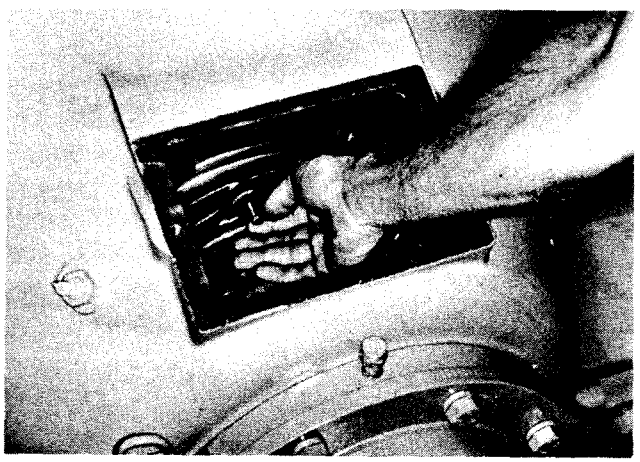
ADJUSTING CLUTCH

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



CLUTCH INSPECTION COVER

2. Turn the clutch until the lock pin, engaged in the locking ring, is visible.
3. Pull the lock pin out and rotate the locking ring clockwise until the lock pin pops into the next notch.



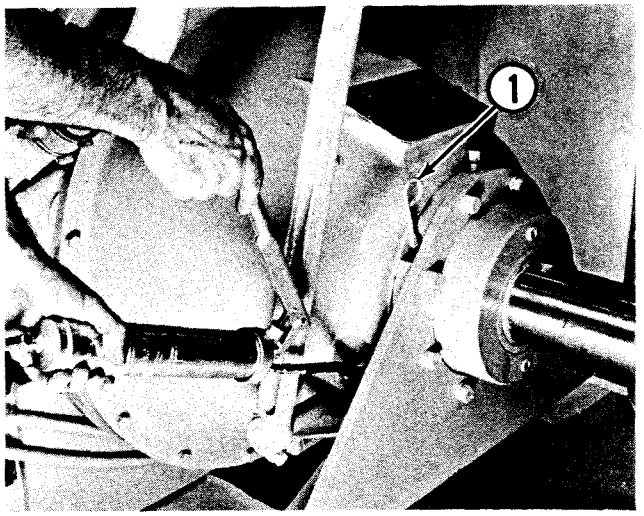
DISENGAGING LOCKING PIN

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

LUBRICATING FLYWHEEL CLUTCH

The flywheel clutch bearings are grease lubricated, except the main shaft bearing. The main shaft bearing is oil lubricated.

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



LUBRICATING SHIFT LEVER BEARINGS

1. Oil level gauge

2. Lubricate the pilot bearing; 1 fitting at the end of shaft. If this fitting is not accessible, remove the plug located on the circumference of the shaft near the rear of the housing, and install a fitting.
3. Lubricate the shift-collar bearings; 1 fitting at top - left of center.
4. Check the main shaft bearing oil reservoir level with engine stopped. Maintain the oil level at the FULL mark on the oil level gauge. Add oil through the filler tube on top of the bearing cage housing. See the Lubrication and Maintenance Chart for proper oil.
5. To drain the reservoir: Remove the drain plug located on the lower right side of the shaft bearing reservoir. Drain and install the drain plug. Fill to the FULL mark on the oil level gauge. Install filler cap.

ELECTRIC SET GENERATOR

The single bearing used on this generator is sealed and does not require periodic lubrication. The generator is of the brushless design, and therefore requires no maintenance. However, it is important that a preventive maintenance program be practiced.

With engine running:

1. Check meters for correct adjustment and operation.
2. Observe if any unusual noises or vibrations exist.

Stop the engine and remove the rear panel:

1. Inspect wiring for cracked insulation or loose terminal connections.
2. Inspect for dust accumulation or moisture. Clean and/or dry the inside of the generator assembly.
3. Clean the outside of the electric set, and the generator ventilating screens.
4. Inspect the controls for looseness. Tighten hardware when needed.
5. Install the rear panel after completing preventive maintenance. Always have the rear panel installed before placing the generator in service.

MISCELLANEOUS MAINTENANCE

VEE BELTS

CHECKING BELTS

1. Check belt wear.
2. Check tension of each belt.

If one belt in a set requires replacement, always install a new matched set of belts—never replace just the worn belt. If only the worn belt is replaced, the new belt will be carrying all of the load—as it will not be stretched as much as the older belts—and all of the belts will fail in rapid succession.

In the following illustrations the pulley marked X is the adjusting pulley. The pulley marked C is the crankshaft. Force is applied at the arrow. See the chart for the force and belt deflection.

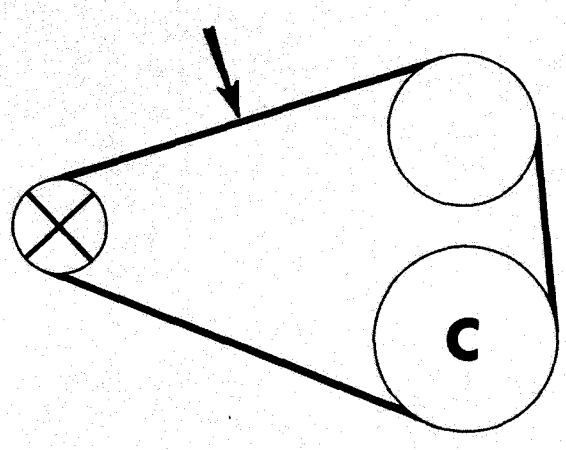


FIG. A ALTERNATOR DRIVE AND WATER PUMP DRIVE

ADJUSTING BELT TENSION

Alternator Drive (Fig. A)

1. Loosen the bolts on the alternator.
2. Move the alternator until the belt is properly adjusted. Tighten the adjustment bolt.
3. Check the adjustment.
4. Tighten the bolt.

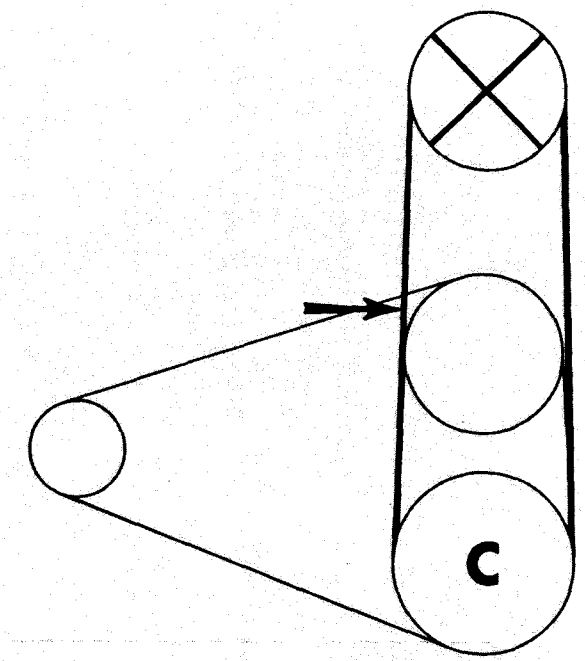


FIG. B HIGH MOUNT FAN DRIVE

ATTACHMENT	FORCE		BELT DEFLECTION		FOR SCHEMATIC SEE:
Alternator Drive	5 lbs.	227 gms.	0.25 in.	6.5 mm	FIG. A
Water Pump-Fan Drive	5 lbs.	227 gms.	0.25 in.	6,5 mm	FIG. A
High Mount Fan Drive	5 lbs.	227 gms.	0.25 in.	6,5 mm	FIG. B
Air Compressor Drive	6 lbs.	272 gms.	0.25 in.	6,5 mm	FIG. C
Air Compressor Drive w/high mount fan	4 lbs.	182 gms.	0.12 in.	3,0 mm	FIG. D

Water Pump-Fan Drive (Fig. A), and Air Compressor Drive (Fig. C & D):

1. Loosen the adjusting bolt and pivot bolt on the idler.
2. Move the idler outward until the belt is properly adjusted. Tighten the adjustment bolt.
3. Check the adjustment.
4. Tighten the pivot bolt.

High-Mount Fan Drive (Fig. B)

1. Loosen the four bolts holding the adjustment plate.
2. Loosen the adjustment bolt locknut.
3. Turn the adjustment bolt to obtain correct bolt adjustment.
4. Tighten the four bolts holding the adjustment plate.
5. Tighten the adjustment bolt locknut.

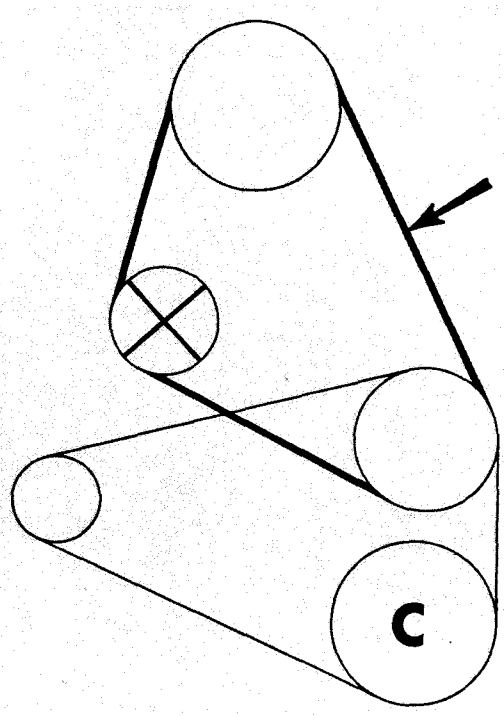


FIG. C AIR COMPRESSOR DRIVE

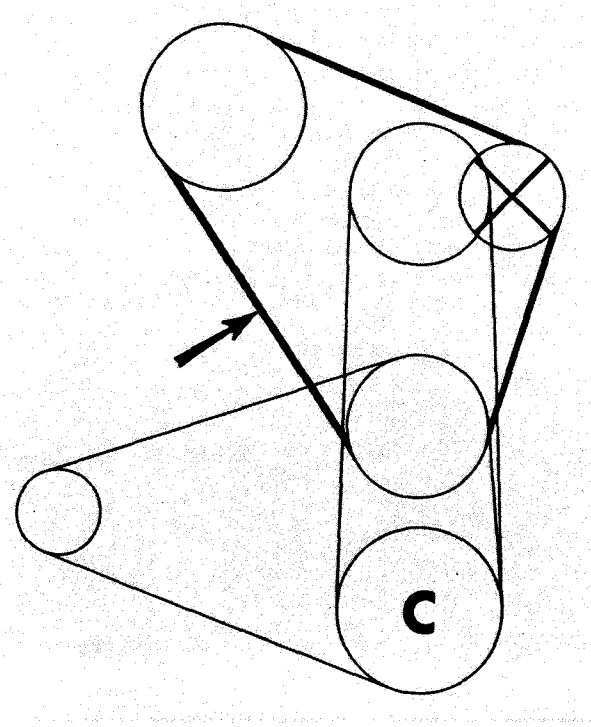


FIG. D AIR COMPRESSOR DRIVE WITH HIGH MOUNT FAN DRIVE

SAFETY SHUT-OFF CONTROLS

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

INDEX

Lubrication and Maintenance Procedures

GEG00229-02 (9-71)

PRINTED IN U.S.A.

IMPORTANT

The Warranty Service Registration form **must** be completed by the **delivering** dealer. Delivering dealer **must** send to the nearest Caterpillar dealer the "FACTORY COPY" and "CATERPILLAR DEALER COPY". Caterpillar dealer **must** send factory copy to the Service Engineering Department of the Caterpillar administrating company to which they normally submit warranty claims.

IMPORTANTE

El formulario de Registro de Garantía debe llenarlo el Distribuidor que hace la entrega. La copia para la fábrica y la copia para el Distribuidor de Caterpillar debe enviarlas al Distribuidor de Caterpillar más cercano. El Distribuidor de Caterpillar debe enviar la copia para la fábrica a "Service Engineering Department" de la subsidiaria de Caterpillar a la cual presenta reclamos cubiertos por la garantía.

IMPORTANT

La fiche d'inscription pour l'application de la garantie **doit** être remplie par le concessionnaire qui **effectue la livraison.** Ce dernier **devra** faire parvenir au concessionnaire Caterpillar le plus proche l'exemplaire destiné aux usines **et** la copie destinée au concessionnaire Caterpillar. Ce dernier **adressera** l'exemplaire destiné aux usines au département "Service Engineering" de la filiale Caterpillar à laquelle il soumet normalement les réclamations en garantie.

WICHTIG

Die Garantieanmeldung **muß** vom **Lieferhändler** ausgefüllt werden. Lieferhändler **muß** Werkskopie und Kopie für den Caterpillar-Händler an den nächsten Caterpillar-Händler einreichen. Caterpillar-Händler **muß** Werkskopie an die Kundendienstabteilung der für seine Garantieansprüche zuständigen Caterpillar-Verwaltung einreichen.

CATERPILLAR

WARRANTY SERVICE REGISTRATION

REGISTRO DE GARANTIA GARANTIEANMELDUNG
FICHE D'INSCRIPTION POUR L'APPLICATION DE LA GARANTIE

Engine Model Modelo de motor Modèle du moteur Motormodell	Engine Serial No. No. de Serie del Motor N° de série Seriennummer	Bill of Material or Arrgt. No. Lista de materiales o No. de orden de embarque del motor Bon de fabrication ou N° d'ensemble (Arrangement) Ausführungsnummer	Service Meter Reading Lectura del medidor de servicio Compteur d'entretien Wartungsmesseranzeige

Driven Equipment Equipo accionado Appareil entraîné Getriebenes Gerät	Make Marca Marque Hersteller	Model Modelo Modèle Modell	Serial Number No. de Serie N° de série Seriennummer

Application code no. / No. de Código de Aplicación _____ (see reverse side) (ver respaldo)

N° de code d'utilisation / Einsatz-Kennziffer _____ (voir au verso) (siehe Rückseite)

Sold to: _____
Vendido a / Vendu à / Verkauft an:
Name Nombre Nom Name

Address Dirección Adresse Adresse

City Ciudad Ville Postleitzahl | State Estado Zone postale Ort Kreis | Zip País Pays ou province Land

SERVICE AT DELIVERY Durante la entrega A la livraison : Auslieferungsdienst

☐ 1. Check if proper literature included.
Se verificó que el material impreso correspondiente venía incluido.
La littérature technique appropriée a-t-elle été fournie?
Zugehörige Anleitungen prüfen.

☐ 2. Check fluid levels in all compartments.
Se verificó el nivel de fluidos en todos los compartimientos.
Vérifier les niveaux de liquide de tous les circuits.
Flüssigkeitsstand in allen Gehäusen prüfen.

☐ 3. Review safe start, stop and operating procedures with user.
Se revistó con el propietario los procedimientos de arranque, parada y funcionamiento.
Revoir avec le client les instructions exactes pour le départ, l'arrêt et le fonctionnement.
Sichere Start-, Abstell- und Bedienungsmethoden mit dem Kunden besprechen.

☐ 4. Review maintenance service and adjustments with user.
Se revistó con el propietario el servicio de conservación y ajustes.
Revoir avec le client les réglages et l'entretien.
Wartung und Einstellungen mit dem Kunden besprechen.

This engine inspected and started. Este motor se inspeccionó y se le hizo arrancar. Ce moteur a été vérifié et mis en marche. Dieser Motor wurde geprüft und angelassen.

Customer's signature _____
Firma del dueño Signature du client Unterschrift des Kunden

Delivered by: _____
Entregado por: / Livré par : / Geliefert durch:
Name Nombre Nom Name

Address Dirección Adresse (rue, N°) Adresse

City Ciudad Ville Postleitzahl | State Estado Zone postale Ort Kreis | Zip País Pays ou province Land

Sold by: _____
Vendido por: / Vendu par : / Verkauft durch:
Name Nombre Nom Name

Address Dirección Adresse (rue, N°) Adresse

City Ciudad Ville Postleitzahl | State Estado Zone postale Ort Kreis | Zip País Pays ou province Land

Delivery Date Fecha de entrega Date de livraison Lieferdatum Signature Firma Signature Unterschrift

Please Complete Reverse Side of This Copy
Tenga a bien completar el respaldo de esta copia Prière de remplir au verso Bitte Rückseite ausfüllen

FOR FACTORY USE ONLY PARA USO DE LA FABRICA SOLAMENTE RÉSERVÉ AUX USINES NUR FÜR WERKSEINTRAGUNGEN

DLR	JCI	STATUS	FACTORY COPY Copia para la fábrica Copie destinée aux usines Werkskopie

NOTE: Use ballpoint pen and press firmly. Use un bolígrafo y escriba con fuerza. Écrire au stylo à bille en appuyant fortement. Mit Kugelschreiber fest aufdrücken.

GEG02128–02 (2–73)

PRINTED IN U.S.A.

APPLICATION CODE

CODIGO DE APLICACIONES
CODES D'UTILISATION
EINSATZKENNZIFFER

(Circle applicable code hereunder and enter on front side)
(Circunscriba el código correspondiente y éntrelo en el otro lado de la tarjeta)
(Cercler le N° de code correspondant à l'utilisation et l'inscrire au recto)
(Zutreffendes ankreuzen und Kennziffer auf der Vorderseite eintragen)

Marine

Marina
Marin
Schiffahrt

A11 Fish Boat
Barcos de pesca
Bateau de pêche
Fischerei

A12 Work Boat
Remolcadores
Remorquage ou poussage
Lastkahn

A13 Cargo/Transport
Carga/Transporte
Cargo/Transport
Fracht-/Passagierdienst

A20 Pleasure
Embarcación de placer
Plaisance
Privatyachten

A30 Naval
Marina de guerra
Marine (militaire)
Marine

Petroleum

Petróleo
Pétrole
Erdöl

B11 Work Over Rig
Perforación (pozos viejos)
Reforage
Verarbeitung

B12 Drill Rig
Perforación (pozos nuevos)
Forage
Bohren

B13 Auxiliary
Auxiliar
Auxiliaire de forage
Hilfsgerät

B20 Servicing
Servicio
Auxiliaire d'exploitation
Wartung

B30 Secondary Recovery
Sistema de reforzador
Extraction par déplacement secondaire
Nebenförderung

B40 Gas Transmission
Compresión de gas
Conduites de gaz
Gasfernleitungen

B50 Crude Oil Transmission
Bombeado de oleoductos
Conduites de pétrole brut
Rohölfernleitungen

Building Service

Edificios
Services pour immeubles
Versorgungseinrichtungen

C11 Water/Sewage Utility
Agua/Alcantarillado
Eau/Égout
Wasserversorgung/Kanalisation

C12 Gas/Electric
Gas/Electricidad
Gaz/Électricité
Gas-/E-Werke

C13 Telephone
Teléfono
(Téléphone)
(Telefon)

C20 Military/Government
Militar/Gubernamental
Armée/Administration
Militär-/Regierungsstellen

C30 Institution
Instituciones
Hôpitaux; éts. publics
Öffentliche Anstalten

C40 Manufacturing
Fabricación (prod. metálicos)
Fabrications métalliques
Herstellung

C50 Processing
Fabricación (prod. no metálicos)
Fabrications non métalliques
Verarbeitung

C60 Commercial Building
Edificios comerciales
Immeubles commerciaux
Gebäudeversorgung

On-Highway Trucks

Camiones para carretera
Camions routiers
Lkw im Straßenverkehr

For on-highway truck engines use Form GEG02040.

Para los motores de camión para carretera debe usarse el formulario GEG02040.

Pour les camions routiers n'utiliser que le formulaire GEG02040.

Für Lkw-Motoren im Straßenverkehr Form GEG02040 verwenden.

Agriculture

Agricultura
Agriculture
Landwirtschaft

E11 Tractor
Tractor
Tracteur
Traktoren

E12 Agriculture Stationary
Agrícola-estacionario
Moteur stationnaire
Landw. - ortsfest

E13 Other Agriculture Vehicle
Otros vehículos agrícolas
Autres véhicules agricoles
Landw. Fahrzeuge

E21 Wheel Skidder
Arrastradores de ruedas
Débardeurs à roues
Forstschlepper

E22 Forestry Stationary
Forestal-estacionario
Moteur stationnaire (bois)
Forstw. - ortsfest

E23 Other Forestry Vehicle
Otros vehículos forestales
Autres véhicules forestiers
Forstw. Fahrzeuge

Material Handling

Manejo de Materiales
Manutention
Materialumschlag

F11 Off-Highway Truck
Camiones para fuera de camino
Camion de chantier
Muldenkipper

F12 Construction Stationary
Estacionario para construcción
Mot. stationnaire T.P.
Bau - ortsfest

F13 Dredge
Dragas
Drague
Schwimmbagger

F14 Crane/Excavator
Grúa-Excavador
Grues/Excavateurs
Krane/Bagger

F15 Other Construction Vehicle
Otros vehículos de construcción
Autres véhicules T.P.
Sonst. Baumaschinen

F20 Industrial Vehicle
Vehículos industriales
Véhicule industriel
Industriefahrzeuge

F31 Locomotive
Locomotoras
Locomotive (propulsion)
Lokomotiven

F32 Other Rail
Otras aplicaciones ferroviarias
Autres applications ferroviaires
Sonst. Schienenfahrzeuge