



SEBU5810

Replaces
SEBU5741 and
SEBU5774

operation & maintenance

**3208
Industrial Engine**

**90N1 - Up
3Z1 - Up**

Foreword

This Operation and Maintenance Guide contains operation instructions, and lubrication and maintenance information. Application of this information should maximize performance and life of the engine; and minimize the costs of engine operation.

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

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

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

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

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

Excessive Oil Consumption? It Could Be Your Oil Level Gauge...

All 3208 Engines

There are several causes for excessive oil consumption. One cause is overfilling.

To prevent overfilling, make sure that the oil level gauge gives a correct indication of the volume of oil in your engine.

Follow this procedure at the next scheduled oil change to make sure the full mark on your oil level gauge is in the correct position.

1. Drain the oil (this takes at

least 15 minutes). Remove the oil filters.

2. Install new filters.

3. Add the volume of oil shown in Column A of the following chart. Remember to add additional oil, as necessary, to engines equipped with the auxiliary filters.

4. Start the engine and operate it long enough to fill the internal passages and filters with oil.

5. Stop the engine and let the oil drain back into the oil pan for at

least 15 minutes. Check the oil level on the gauge. If the gauge is correct, the oil will be at the "add" mark. If it is not, scribe a new "add" mark at the level of the oil on the gauge.

6. Add the volume of oil shown in Column B of the chart. Again, check the oil level shown on the gauge. The oil level should be at the "full" mark. If it is not, scribe a new "full" mark at the oil level shown on the gauge.

Model	Serial No.	Column A Volume To "Add" Mark-liters (qts)	Column B Difference Between "Add" and "Full" Marks-liters (qts)	Total Volume liters (qts)
3208 Vehicular Engines	79V1-6965	*8.5 (9) or 11.4 (12)	2.8 (3)	*11.4 (12) or 13.2 (14)
	79V6966-Up	11.4 (12)	1.9 (2)	13.2 (14)
3208 Truck Engines	32Y1-32180	*8.5 (9) or 11.4 (12)	2.8 (3)	*11.4 (12) or 13.2 (14)
	32Y32181-68440	11.4 (12)	1.9 (2)	13.2 (14)
	32Y68441-Up	13.2 (14)	3.8 (4)	17.0 (18)
	40S1-Up	*8.5 (9) or 11.4 (12)	2.8 (3)	*11.4 (12) or 13.2 (14)
	22Z1-Up below 225 hp	13.2 (14)	3.8 (4)	17.0 (18)
	22Z1-UP 225 hp and above	15.1 (16)	3.8 (4)	18.9 (20)
3208 Industrial Engines	90N1-44127	*8.5 (9) or 11.4 (12)	2.8 (3)	*11.4 (12) or 13.2 (14)
	90N44128-Up	11.4 (12)	1.9 (2)	13.2 (14)
	32Z1-Up	15.1 (16)	3.8 (4)	18.9 (20)
3208 Marine Engines	75V1-5532	*8.5 (9) or 11.4 (12)	2.8 (3)	*11.4 (12) or 13.2 (14)
	75V5533-7389	11.4 (12)	1.9 (2)	13.2 (14)
	75V7390-Up	12.3 (13)	1.9 (2)	14.2 (15)
	12Z1-Up	15.1 (16)	1.9 (2)	17.0 (18)
3208 Generator Set Engines	29A225-Up	13.2 (14)	3.8 (4)	17.0 (18)
	30A210-Up 125 kW Standby 60 Hz	13.2 (14)	3.8 (4)	18.9 (20)
	30A210-Up 150 kW Standby 60 Hz	15.1 (16)	3.8 (4)	18.9 (20)

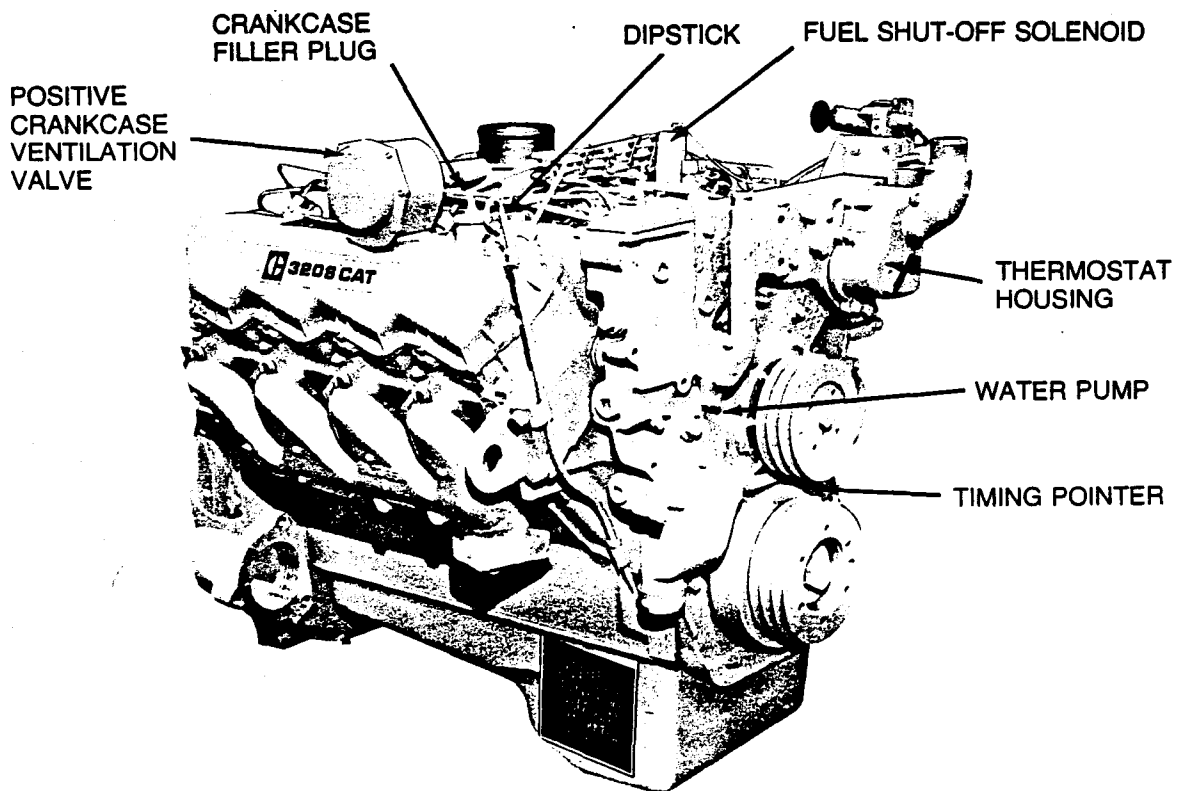
*These engines originally had an 11.4 liter (12 qt) system. Service Magazine articles on Pages 6 and 7 of the December 24, 1979 and Pages 2-4 of the April 21, 1980 issues told how to change them to a 13.2 liter (14 qt) system. Either capacity can be used for these engines.

Use this chart to find the correct oil level for your 3208 Engine.

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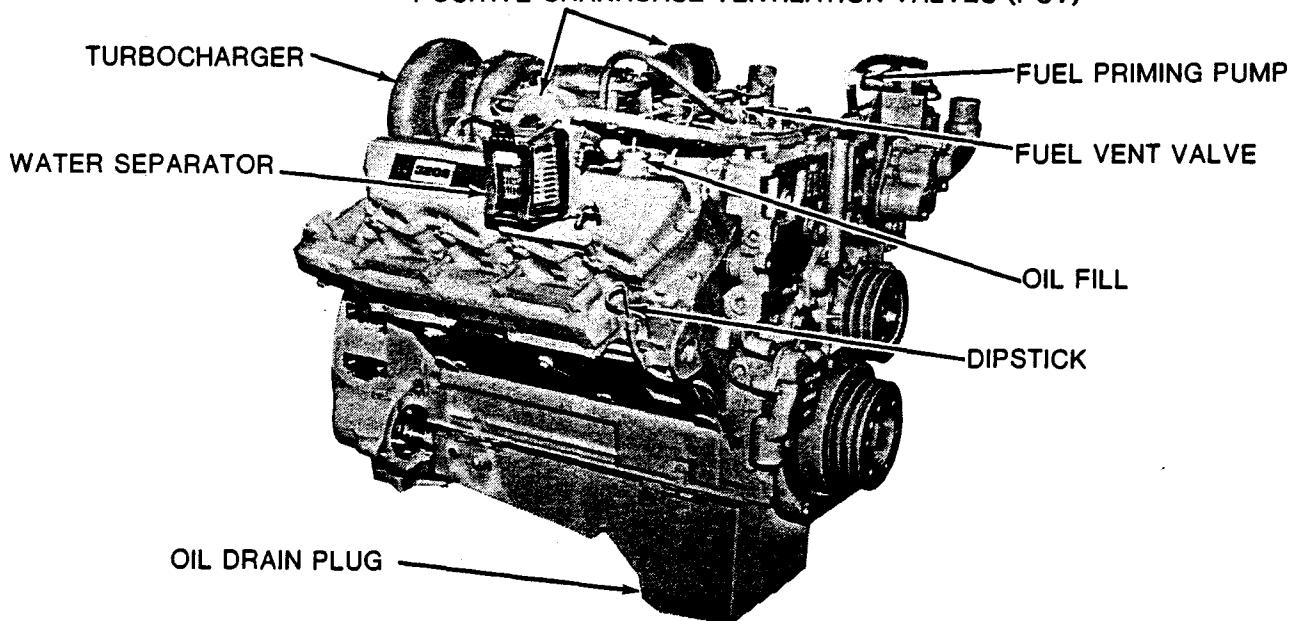
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Model Views



3208 NATURALLY ASPIRATED ENGINE

POSITIVE CRANKCASE VENTILATION VALVES (PCV)



3208 TURBOCHARGED ENGINE

Safety



THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY

To prevent personal injury, install guards over all exposed rotating parts.

Stop engine before adjusting or repairing engine or driven equipment.

Do not wear loose clothing whenever working around engines or machinery.

To prevent hearing damage, wear ear protective devices if working inside an enclosed engine room with engine running.

Wear protective glasses, clothing, hat, respirator or other protective items when necessary.

When using pressure air, wear protective face shield and clothing. Use 205 kPa (30 psi) maximum air for cleaning purposes.

Always inspect cooling system with engine stopped and cool.

If equipped with jacket water cooling system, remove filler cap slowly to relieve pressure. Steam may cause personal injury.

Cooling system conditioner contains alkali, avoid contact with skin and eyes to prevent personal injury.

Do not smoke while refueling. Fumes from fuel are flammable.

Do not smoke when observing battery electrolyte level. Batteries give off flammable fumes.

Be sure engine room is properly ventilated.

Do not allow electrolyte solution to contact skin or eyes. Electrolyte solution is an acid.

Do not attempt repairs you do not understand. Follow instructions.

Replace or repair broken or damaged servicing equipment. Use proper tools.

Remove all tools, electrical cords and other loose items from the engine before starting.

Wipe up spilled oil, fuel or coolant.

Provide adequate and safe waste oil disposal.

Store oily rags in fireproof containers. DO NOT leave rags on engine.

Never store flammable liquids near the engine.

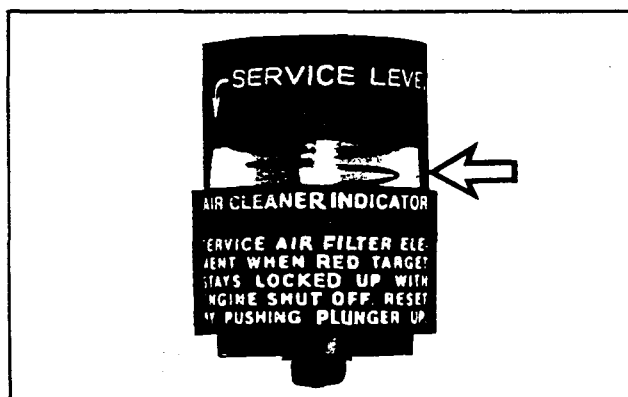
Disconnect and tape the battery ground lead before working on an engine to prevent accidental starting.

Never start an engine with the governor linkage disconnected.

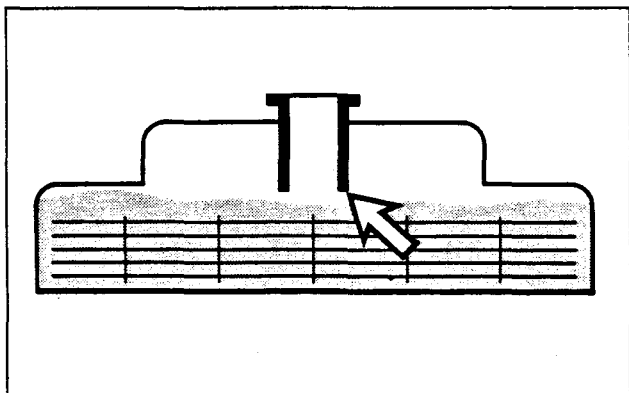
When starting an engine after repair, make provisions for shutting off air supply, to stop engine, in case there is an overspeed on start up.

Before Starting

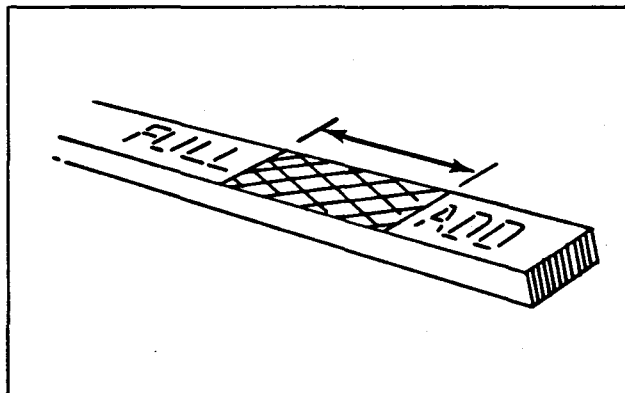
Perform required periodic maintenance before starting the engine. Make a "walk-around" inspection of the installation. It only takes a few minutes to correct minor discrepancies. This can prevent major repairs at a later date.



1. Inspect the air cleaner service indicator. If the red piston is locked in the raised position, service the air cleaner.



2. Inspect the coolant level. The level must be to the bottom of the radiator filler neck.



3. Measure the crankcase oil level. The oil level must be between the ADD and FULL marks on the dipstick.

4. Disconnect any battery chargers that are not protected against the starter current drain.

5. All guards must be in place. Repair or replace all guards that are damaged.

Starting the Engine

The 3208 Industrial Engine is designed to start at temperatures above 10°F (-12°C) without using starting aids. If the temperature is below 10°F (-12°C), a starting aid may be necessary and/or crankcase oil may need to be heated. Jacket water heaters are often used to assist starting in cold temperatures.

1. Place the transmission in NEUTRAL (and disengage the flywheel clutch, if so equipped).
2. Move the throttle to half engine speed position when starting the engine.
3. Turn the ON/OFF switch to the ON position.
4. Turn the starter switch to START. (If the engine fails to start within 30 seconds, release the starter

switch and wait 2 minutes to allow the starter motor to cool before using it again.)

5. As soon as the engine starts, allow the engine to idle for 3 to 5 minutes; or until the water temperature gauge has begun to rise.
6. Do not apply load to the engine or increase engine speed until the oil pressure gauge indicates normal. (Oil pressure should raise within 15 seconds after the engine starts.)
7. Operate the engine at low load until all systems reach operating temperatures. Check all gauges during the warm-up period.

When Starting Fluid is Required

WARNING

Use starting fluid sparingly. Follow manufacturer's instructions carefully.

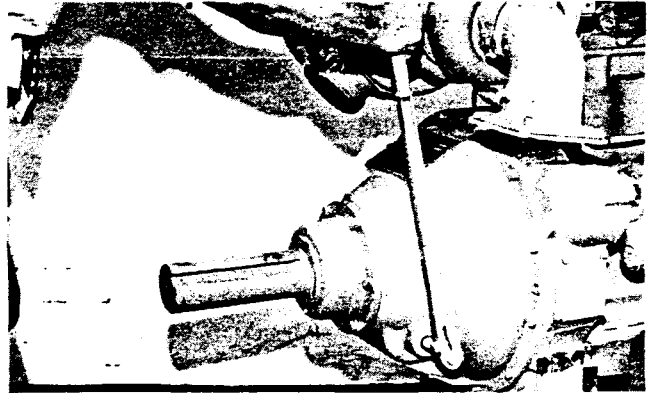
1. Turn the ON/OFF switch to the ON position.
2. Move starter switch to START.
3. Spray starting fluid for 1 second, into precleaner, while cranking engine. Wait at least 2 seconds before spraying starting fluid again.
4. When engine starts release the starter switch.

CAUTION

If engine does not start, let starter cool for 2 minutes, then repeat starting procedure.

Operating the Engine

1. Move the governor control to half engine speed.



2. Engage the driven equipment.

3. Check the engine gauges and equipment.

4. Move the governor control to high idle (full load) position.

5. Apply the load to the driven equipment.

Stopping the Engine



5 MINUTES

LOW LOAD

Before stopping the engine, operate it at low load for 5 minutes, then at low idle for 30 seconds. (This procedure allows hot areas in the engine to cool gradually, extending the engine life.)



30 SECONDS

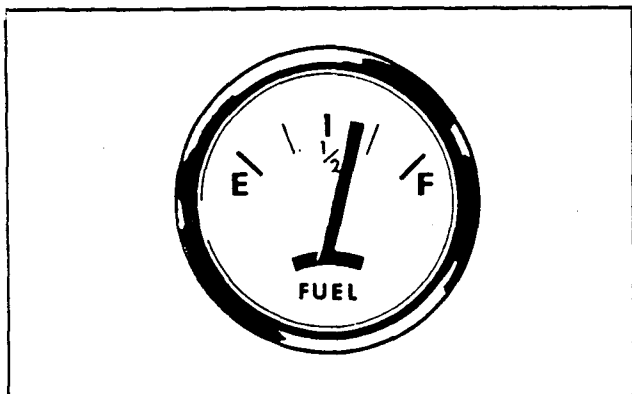
LOW IDLE

1. Remove the load from the engine.
2. Move the governor control to the OFF position.
3. Turn the ON/OFF switch to the OFF position.

Attachments Gauges

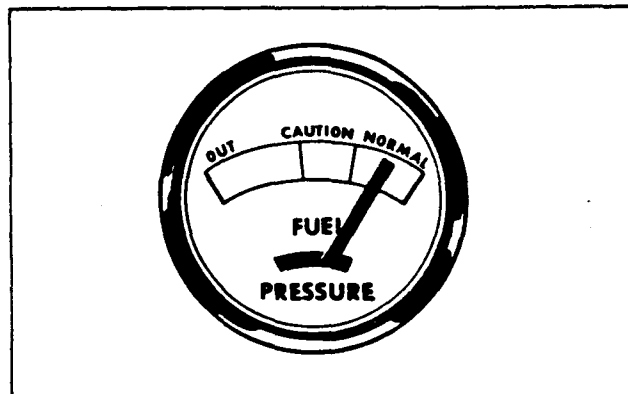
Gauges provide a "look" inside the engine. Be sure they are in good working order. You can determine what is "normal" operating range by observing the

gauges over a period of time. The cause of any sudden or significant change in the readings should be determined and corrected.



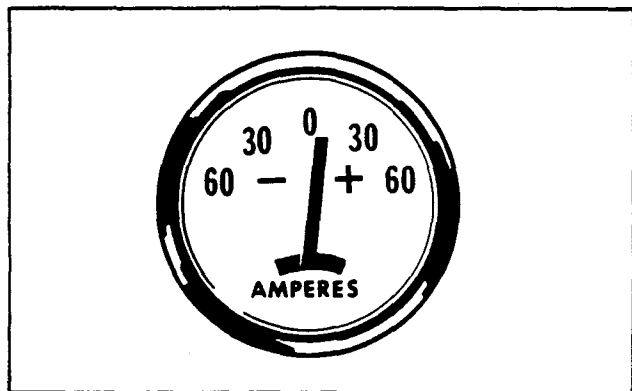
Fuel

Indicates the level of fuel in the tank. Electrically operated, it registers only when the key switch is ON.



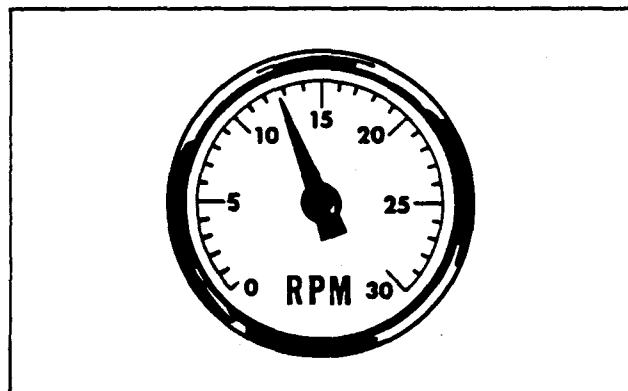
Fuel Pressure

Indicator should register in the NORMAL (green) range. When the filter element becomes clogged, the indicator moves to OUT. When indicator registers below 20 psi (140 kPa), wash the primary fuel filter and replace the secondary fuel filter element.



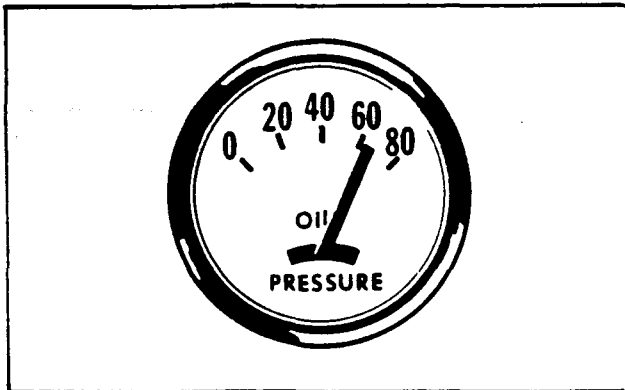
Ammeter

Indicates the rate of battery charge or discharge.



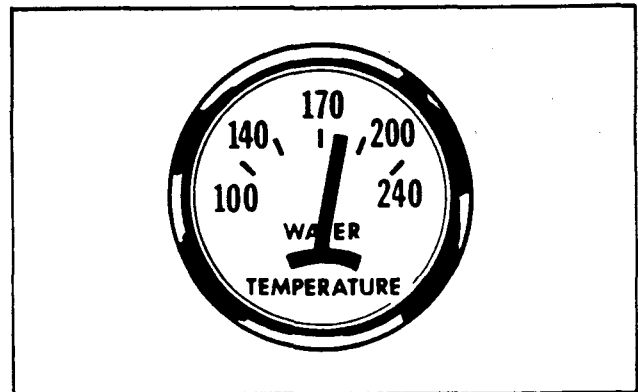
Tachometer

Indicates engine RPM.



Oil Pressure

Registers between 35 and 70 psi (240 and 480 kPa) when the engine is running at rated engine speed, with SAE 10W/30 oil, at operating temperature. A lower pressure is normal at low idling speeds. If no pressure is indicated, stop the engine immediately.



Water Temperature

Normally registers between 170° F and 195° F (77° C and 90° C). Somewhat higher temperatures may occur under certain conditions.

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. It 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. This 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, a 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, and will not allow 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 closes the fuel supply valve and the engine stops. The locking relay insures that the circuit to the safety relay is complete, even if the remote contacts open.

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

Maintenance Recommendations

Cooling

CAUTION

Never add coolant to an overheated engine; allow the engine to cool first.

Check specific gravity of antifreeze solution frequently in cold weather to assure adequate protection.

Coolant should be drained and replaced "Every 2000 Service Meter Units." With additions of Caterpillar Cooling System Conditioner or the use of Caterpillar Coolant Conditioner Elements as recommended, the drain period can be extended to "Every 4000 Service Meter Units".

All water is corrosive at engine operating temperature. The cooling system should be protected with conditioner at all times regardless of concentration of antifreeze. This can be done by maintaining a 3% concentration of liquid Caterpillar Cooling System Conditioner or by using Caterpillar Coolant Conditioner Elements.

Never use both the liquid cooling system conditioner and coolant conditioner elements at the same time.

Do not use Caterpillar Cooling System Conditioner or Coolant Conditioner Elements with Dowtherm 209 Full-Fill coolant.

If the engine is to be stored in an area with below freezing temperatures, the cooling system must be protected to the lowest expected ambient temperature.

Operate with a thermostat in the cooling system all year-round. Cooling system problems can arise without a thermostat.

Use clean water that is low in scale forming minerals, not softened water. Add Caterpillar Cooling System Conditioner, Caterpillar Coolant Conditioner Elements, or equivalent, to the water to provide corrosion protection.

Run the engine with the radiator cap off when warming the engine up to check coolant level.

Always recheck the coolant level when the engine reaches normal operating temperature. Add coolant as necessary to bring up to proper level.

Filling at over 5 U.S. gallons (19 liters) per minute can cause air pockets in the cooling system. Run with radiator cap off until warm and level stabilizes. Refill if necessary.

Premix antifreeze solution to provide protection to the lowest expected ambient temperature. Pure undiluted antifreeze will freeze at -10°F (-23°C).

Electrical

CAUTION

When using jumper cables to start the engine, be sure to connect in parallel: POSITIVE (+) to POSITIVE (+) and NEGATIVE (-) to NEGATIVE (-).

When using external electrical source to start the engine, turn the disconnect switch off and remove the key before attaching jumper cables.

Scheduled Oil Sampling

Use Scheduled Oil Sampling to monitor engine condition and maintenance requirements. Each oil sample should be taken when the oil is hot and well mixed to insure a sample which is representative of the oil in the engine. Samples should be taken at each engine oil change. Consult your authorized Caterpillar engine dealer for complete information and assistance in establishing a scheduled oil sampling program for your engine.

Fuel

CAUTION

Fill the fuel tank at the end of each day of operation to drive out moisture laden air and to prevent condensation. Do not fill the tank completely full. The fuel expands when it gets warm and may overflow.

Water and sediment should be drained from the fuel tank and the water separator at the start of each shift, or after the fuel tank has been filled and allowed to stand for 5 to 10 minutes. Drain the fuel tank of moisture and sediment as required by prevailing conditions.

After changing the fuel filters, always bleed the fuel system to remove air bubbles.

General

CAUTION


Accumulated grease and oil on the engine is a fire hazard. Remove this debris with steam cleaning or high pressure water, at least "Every 1000 Service Meter Units" or each time any significant quantity of oil is spilled on the engine.

Wipe all fittings, caps and plugs before servicing.

GENERAL TIGHTENING TORQUE FOR BOLTS AND NUTS

The following charts give the standard torque values for bolts and nuts of SAE Grade 5 or better quality.



Standard thread		Use these torques for bolts and nuts with standard threads (conversions are approximate).	
			
THREAD DIAMETER		STANDARD TORQUE	
inches	millimeters	lb. ft.	N-m
1/4	6.35	9 ± 3	12 ± 4
5/16	7.94	18 ± 5	25 ± 7
3/8	9.53	32 ± 5	45 ± 7
7/16	11.11	50 ± 10	70 ± 15
1/2	12.70	75 ± 10	100 ± 15
9/16	14.29	110 ± 15	150 ± 20
5/8	15.88	150 ± 20	200 ± 25
3/4	19.05	265 ± 35	360 ± 50
7/8	22.23	420 ± 60	570 ± 80
1	25.40	640 ± 80	875 ± 100
1-1/8	28.58	800 ± 100	1000 ± 150
1-1/4	31.75	1000 ± 120	1350 ± 175
1-3/8	34.93	1200 ± 150	1600 ± 200
1-1/2	38.10	1500 ± 200	2000 ± 275

Lubricants—Fuels—Coolants

Lubricant Specifications

The abbreviations listed below follow S.A.E. J754 nomenclature. The classifications follow S.A.E. J183 classifications. The MIL specifications are U.S.A. Military Specifications. These definitions will be of assistance in purchasing.

Engine Oils (EO)

Use oils that meet Engine Service Classification CD (MIL-L-2104C) or oils that meet Engine Service Classification SE/CC (MIL-L-2104B) or (MIL-L-46152). Recommended change period is dependent on oil classification used—See chart below.

Engine Oil Viscosity Range

°C	AMBIENT TEMPERATURES													
	-23	-18	-12	-7	-1	+4	+10	+16	+21	+27	+32	+38	+43	+49
°F	-10	0	+10	+20	+30	+40	+50	+60	+70	+80	+90	+100	+110	+120
RECOMMENDED SAE VISCOSITY FOR CD QUALITY OILS	SAE 10W-30													
	SAE 10W-40													
	SAE 15W-40													

At temperatures below -10°F (-23°C) it may be necessary to warm the oil so the engine can be cranked and allow the oil to circulate freely. For operation in cold temperatures, see your Caterpillar dealer for cold weather operation instructions.

Oil and Filter Change Intervals

Oil Classification	Fuel Sulphur Content	Service Hours	50	75	100	150	200	300
CD	Less Than 0.4%	Turbocharged						
		Non-Turbocharged						
	0.4% to 1.0%	Turbocharged						
		Non-Turbocharged						
	1.0% to 1.5%	Turbocharged						
		Non-Turbocharged						
SE/CC	Less Than 0.4%	Turbocharged						
		Non-Turbocharged						
	Over 0.4%	Use CD Oil						

Turbocharged engines have longer oil change intervals due to larger crankcase capacity.

Lubricating Grease (MPG)

Use Multipurpose-type Grease (MPG). NLGI No. 2 Grade is suitable for most temperatures. Use NLGI No. 1 or 0 Grade for extremely low temperatures.

Lubricants—Fuels—Coolants

Fuel Specifications

Types of Fuel

Caterpillar engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups, Preferred and Permissible.

The Preferred Fuels provide maximum engine service life and performance. These are distillate fuels. They are commonly called fuel oil, furnace oil, diesel fuel, gas oil, or kerosene.

The Permissible Fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and reduced engine service life.

See Caterpillar Form Number SEHS7067 for a detailed summary of Preferred and Permissible Fuels and their specifications.

Cetane Requirement

The minimum number recommended for this engine is: 40 Cetane.

Fuel Cloud Point

Fuel waxing can plug the fuel filters in cold weather. The fuel cloud point must be below the temperature of the surrounding air to prevent filter waxing and power loss. Diesel fuel heaters are available, which will permit the use of fuel with a higher cloud point.

Fuel Sulphur Content

The percent of fuel sulphur content will effect the engine oil and filters change interval. See chart in the "Lubrication Specifications" on Oil and Filters Change Interval.

Lubricants-Fuels-Coolants

Coolant Specifications

Engine Coolant (EC)

Use a mixture of fill water, antifreeze and conditioner.

Caterpillar Form Number SEBD0518 entitled, "Know Your Cooling System" can provide more detailed specifications.

Fill Water

Always add conditioner to water. Never use plain water. Conditioner can be liquid additions or coolant conditioner elements.

Acceptable water for use in the ethylene glycol-type antifreeze and water mixture is shown on the chart below:

ACCEPTABLE WATER		
WATER CONTENTS	50% OR MORE ANTIFREEZE	LESS THAN 50% ANTIFREEZE
Chlorides	100 ppm or less	50 ppm or less
Sulfates	100 ppm or less	50 ppm or less
Hardness as Ca CO ₃	200 ppm or less	100 ppm or less
Dissolved Solids	500 ppm or less	250 ppm or less
PH	6.5 or higher	6.5 or higher

ppm = parts per million

Use ethylene glycol-type antifreeze. Use the correct amount to provide freeze protection to the lowest expected temperature.

Conditioner

Use Caterpillar Cooling System Conditioner or equivalent. Add enough conditioner to provide a 3% to 6% concentration in the coolant. Conditioner is available in quart containers Part No. 3P2044.

3% = approximately 1 pint per 4 U.S. gal. (1 liter per 33 liters).

6% = approximately 1 pint per 2 U.S. gal. (1 liter per 16 liters).

Caterpillar Coolant Conditioner Elements

On the initial fill, or after cleaning the cooling system, install the correct precharge element. The correct precharge element is determined by the cooling system capacity.

Every oil change thereafter install the correct maintenance element.

Cooling System Capacity			
Gallons	Liters	Precharge Element Part No.	Maintenance Element Part No.
9 To 12	34 To 40	9N6123	9N3717
12 To 16	45 To 61	9N3366	9N3717

CAUTION

Use either Caterpillar Coolant Conditioner Elements or Caterpillar Cooling System Conditioner. Do NOT use both.

Do NOT use Caterpillar Cooling System Conditioner or Caterpillar Coolant Conditioner Elements with Dowtherm 209 Full-Fill coolant.

Engine Specifications

Bore	4.5 in. (114 mm).
Stroke	5.0 in. (127 mm).
Displacement	636 cu. in. (10.4 liters)
Firing Order	1, 2, 7, 3, 4, 5, 6, 8
Rotation (viewed from flywheel)	Counterclockwise
Weight (net-dry-approximate)	1200 lbs (545 kg).

Rated HP Without Fan at 2800 RPM	175	210	225	250
Low Idle RPM	650	650	650	650
High Idle RPM	2980	3020	2520	2815

Refill Capacities (approximate)

Item	U.S.	Metric	Imperial
Turbocharged Crankcase and Filters	20 qts.	19 liters	16.5 qts.
Non-Turbocharged Crankcase and Filters ²	14 qts.	13 liters	11.7 qts.
Clutch Rear Bearing	1 qt.	1 liter	1 qt.
Cooling System Engine Only	26 qts.	24.5 liters	21.5 qts.
Cooling System Standard Radiator	38.75 qts.	37.5 liters	32.5 qts.
Cooling System High Capacity Radiator	40 qts.	38 liters	33.5 qts.

¹NOTE — Earlier engines were only filled 12 qts. (11.4 liters). The dipsticks on these engines should be re-marked for 14 qts. (13 liters) capacity. Consult your Caterpillar dealer for details.

²NOTE — If Naturally Aspirated engines are equipped with 20 qt. (19 liters) oil sumps, use the same oil change intervals as for the turbocharged engines.

Lubrication and Maintenance Chart

Item	Service	Lubricant	Page No.
Every 10 Service Meter Units			
① Engine Crankcase	Measure the oil level—add oil as required	EO	18
② Fuel Tank	Drain water and sediment		18
③ Cooling System	Inspect coolant level	EC	18
④ Clutch Adjustment	Should engage with a distinct snap		19
⑤ Water Separator	Drain water and sediment		19
Every 50 Service Meter Units			
⑥ Batteries	Observe electrolyte level		20
Every 100 Service Meter Units			
⑦ Clutch Control Lever	Lubricate 2 fittings	MPG	21
⑧ Pilot Bearing	Lubricate 1 fitting	MPG	21
Do item ⑮ on a new or reconditioned engine			
Every 150 Service Meter Units			
⑨ Air Intake System ¹	Install a new or cleaned element		22
⑩ Pulley Belts	Maintain proper adjustment		24
⑪ Flywheel Clutch	Maintain at proper level on heavy duty clutch or lubricate 1 fitting on standard clutch	EO/MPG	25
Oil and Filters Change Intervals			
⑫ Engine Crankcase	Change oil and filters	EO	26
Oil Classification	Fuel Sulphur Content	Service Hours	5075100150200300
CD	Less Than 0.4%	Turbocharged	
		Non-Turbocharged	
	0.4% to 1.0%	Turbocharged	
		Non-Turbocharged	
	1.0% to 1.5%	Turbocharged	
		Non-Turbocharged	
SE/CC	Less Than 0.4%	Turbocharged	
		Non-Turbocharged	
	Over 0.4%	Use CD Oil	

Turbocharged engines have longer oil change intervals due to larger crankcase capacity.

Lubrication and Maintenance Chart

Item	Service	Lubricant	Page No.
Every 250 Service Meter Units			
⑬ Cooling System	Add cooling system conditioner		27
Every 500 Service Meter Units			
⑭ Fuel Tank	Clean filler cap and screen		28
⑮ Engine Valve Lash	Measure—adjust if necessary		28
⑯ Flywheel Clutch (Heavy Duty)	Change oil	EO	30
Every 1000 Service Meter Units			
⑰ Engine Protective Alarms	Check by authorized personnel only		31
⑱ Fuel System	Change final filter—clean primary filter if equipped		31
Every 2000 Service Meter Units			
⑲ PCV Valve(s)	Replace diaphragm(s)		33
⑳ Cooling System	Change antifreeze solution	EC	34
When Required			
㉑ Water Separator	Replace element		35
㉒ Cooling System	Drain and clean when engine overheats or solution is dirty	EC	35

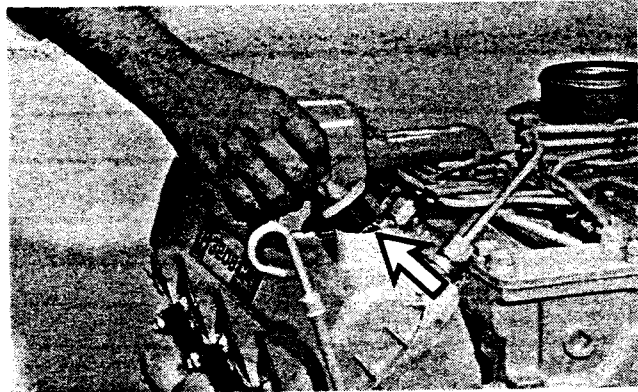
(1) Service the air cleaner more often in dusty conditions. If after servicing the air cleaner, the exhaust smoke and/or loss of power continues, discard that element and install a new element at least once a year.

Every 10 Service Meter Units

① Engine Crankcase

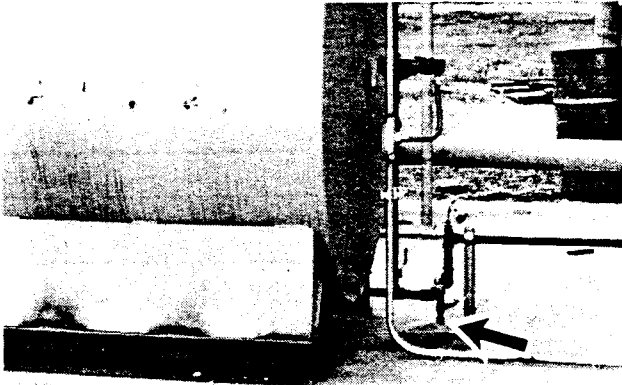


1. Measure oil level. Oil should be between the FULL and ADD marks on the dipstick.



2. Add oil if necessary.

② Fuel Tank



Drain water and sediment.

③ Cooling System

WARNING

At Operating Temperature, engine coolant is hot and under pressure.

Steam can cause personal injury.

Check coolant level ONLY when engine is stopped and radiator cap is cool enough to touch with your hand.

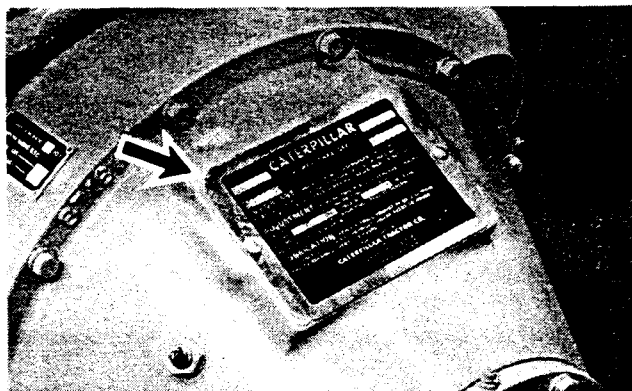
Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.

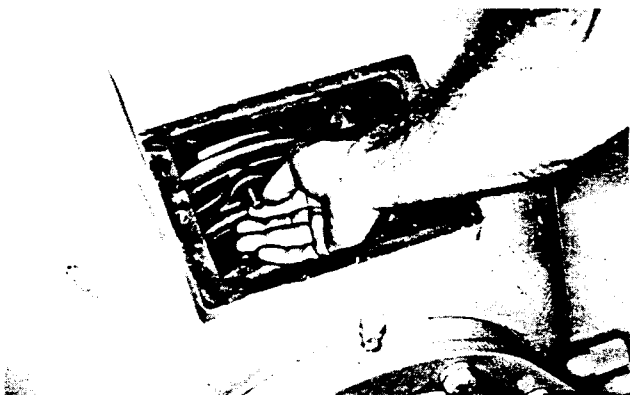
If it is necessary to add coolant daily, inspect the cooling system for leaks.

④ Clutch-Adjustment

The clutch should engage with a hard push and a distinct snap. If the engagement is "soft", adjust the clutch.



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



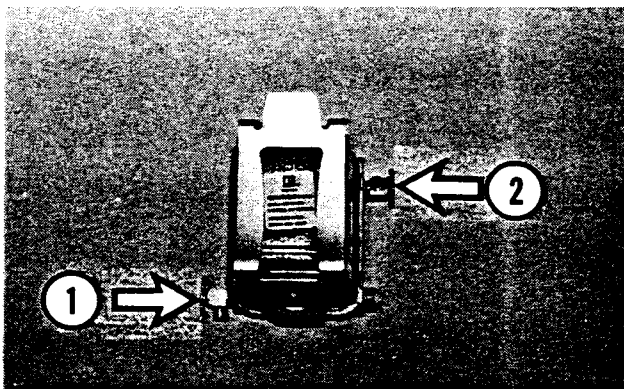
2. Turn the clutch until the lock pin, engaged in the locking ring, is visible.

3. Pull the lock pin out and rotate the locking ring clockwise until the lock pin pops into the next notch.

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.

⑤ Water Separator



CAUTION

The engine should never be allowed to run with the water level in the element more than 1/2 full or engine damage may result.

1. Close the fuel supply valve, if equipped.

2. Open the separator drain valve ①.

3. Open the separator vent valve ②.

4. After water is drained, close the vent valve and drain valve, and then open the fuel supply line valve.

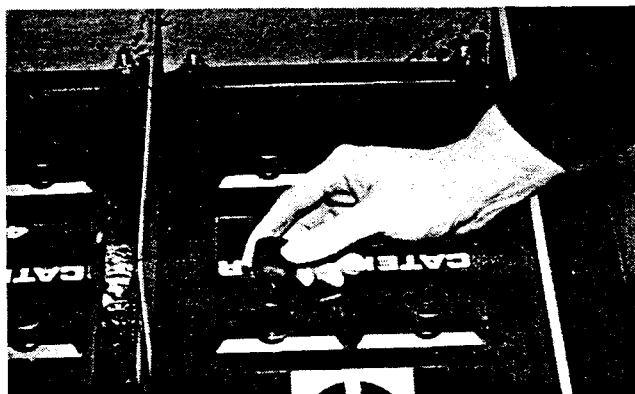
Every 50 Service Meter Units

⑥ Batteries

WARNING

Do not smoke when observing battery electrolyte level. Batteries give off fumes that can explode.

Electrolyte is an acid and can cause personal injury if it contacts skin or eyes.



1. Clean the tops of the batteries. Keep the terminals and clamps clean and covered with a light coat of grease.

2. Remove all fill caps. Observe the electrolyte level.

3. Maintain the electrolyte level to the bottom of the filler openings.

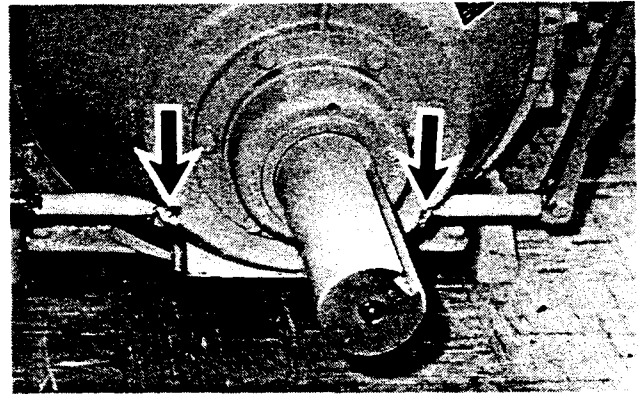
If water is necessary, use distilled water if it is available. Otherwise, use clean water that is low in minerals, not artificially softened water.

4. Install the fill caps.

Every 100 Service Meter Units

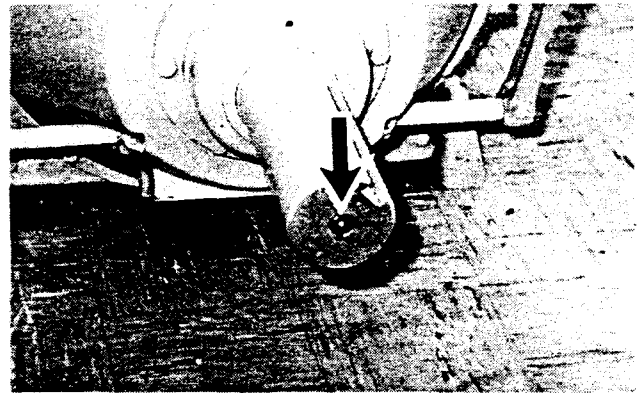
⑦ Clutch Control Lever

Lubricate 2 fittings; 1 fitting on each side of the clutch housing.



⑧ Pilot Bearing—Standard Clutch

Some clutches are furnished with a pre-lube pilot bearing, therefore no lubrication will be required.

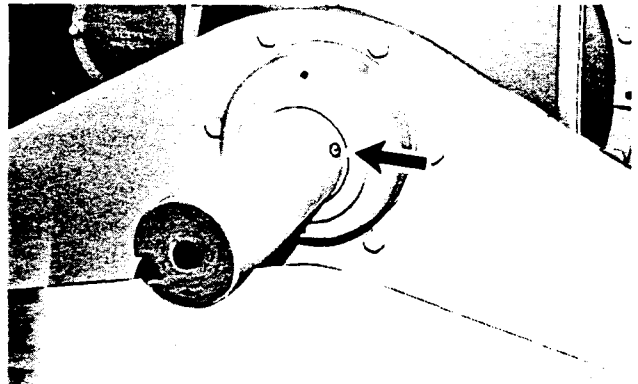


Lubricate 1 fitting at the end of shaft.

Heavy Duty Clutch

Some clutches are furnished with a pre-lube pilot bearing, therefore no lubrication will be required.

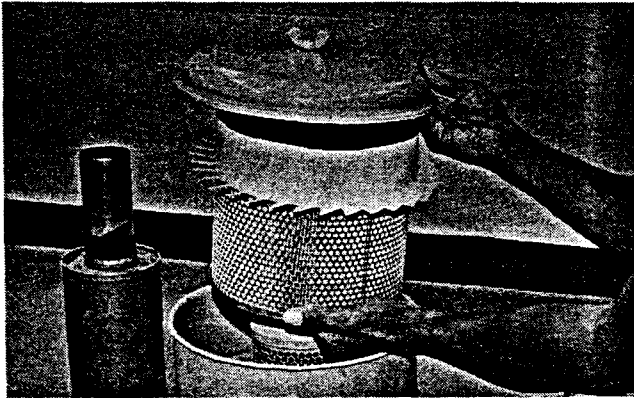
1. Remove plug from main shaft.
2. Insert grease zerk and lubricate bearing.



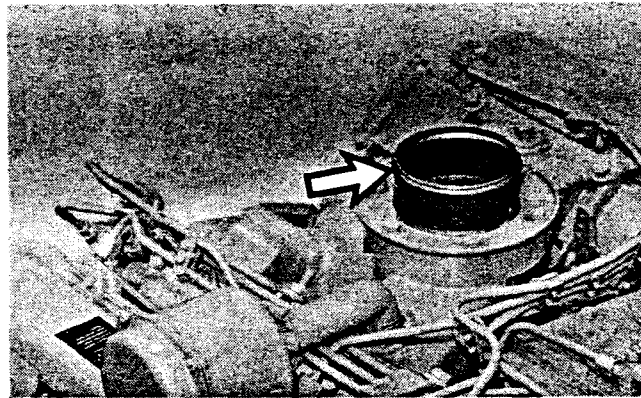
3. Remove grease zerk and install plug.

Every 150 Service Meter Units

⑨ Engine Air Intake System—Clean or Replace Filter

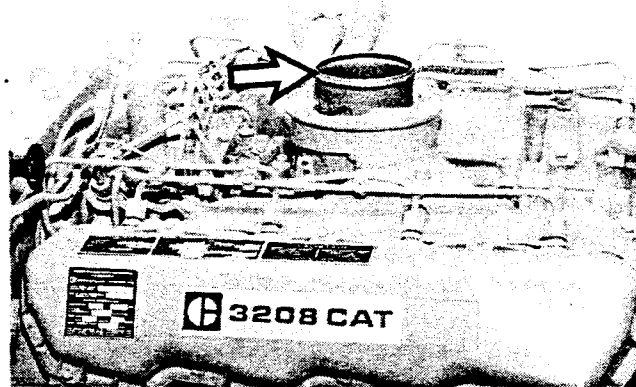


1. Remove the wing nut, cover and the element.

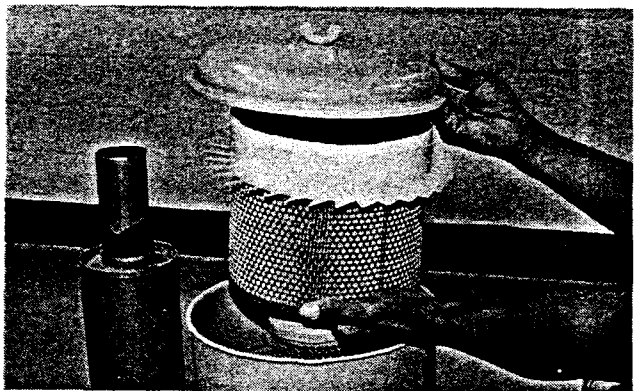


2. Cover the air inlet opening with tape to keep the dirt out.

3. Clean the inside of the cover.



4. Remove the tape covering the air inlet opening. Install either a new or cleaned filter element with the larger gasket on top.



5. Install the air cleaner cover and tighten the wing nut.

Cleaning Air Cleaner Elements

⚠ WARNING

When using pressure air, wear protective face shield and protective clothing. Use 30 psi (205 kPa) maximum pressure air for cleaning purposes.

CAUTION

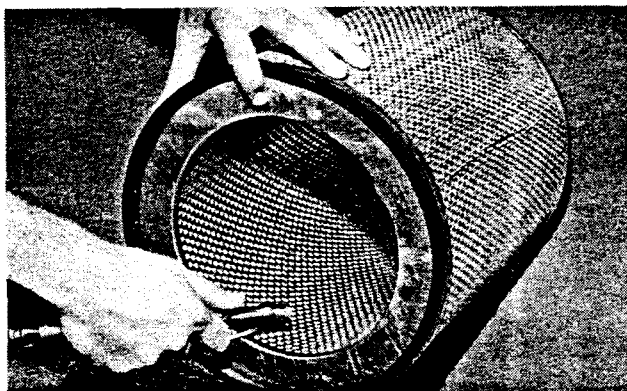
Do not clean element by bumping or tapping.

Do not use elements with damaged pleats, gaskets or seals.

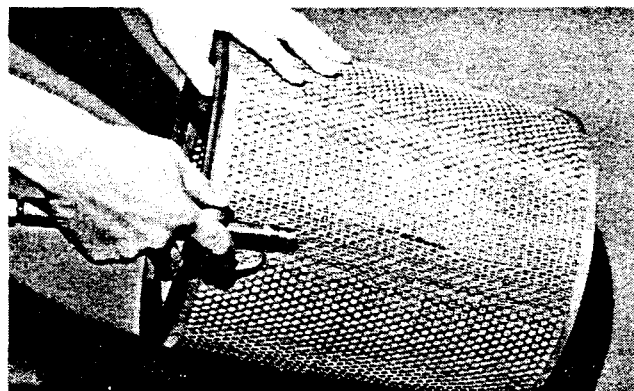
Dry type air cleaner elements can be cleaned with either Pressure Air, Water or Detergent.

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

Pressure Air—30 psi (205 kPa) Maximum

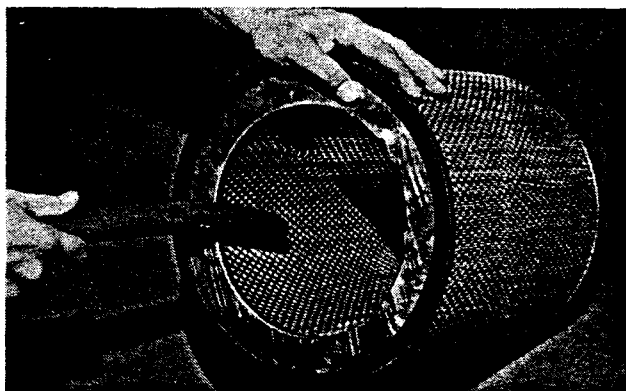


1. Direct air inside the element along the length of the pleats.

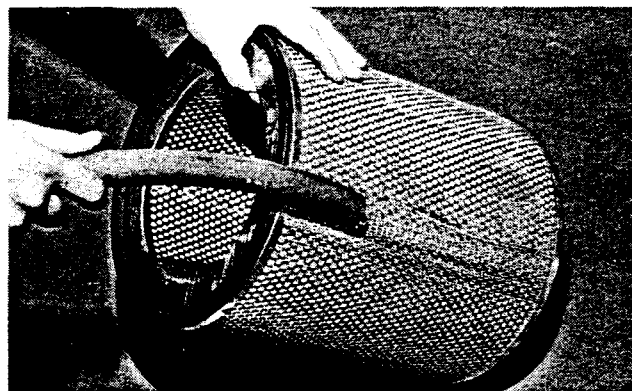


2. Direct air outside the element along the length of the pleats. Direct air inside the element along the length of the pleats. Inspect the element.

Water—40 psi (280 kPa) Maximum



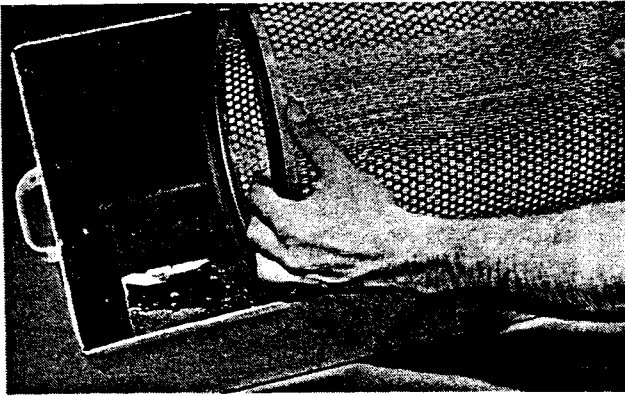
1. Direct water inside the element and along the length of the pleats.



2. Direct the water outside the element along the length of the pleats. Rinse, air dry thoroughly and inspect it.

Every 150 Service Meter Units

Detergent

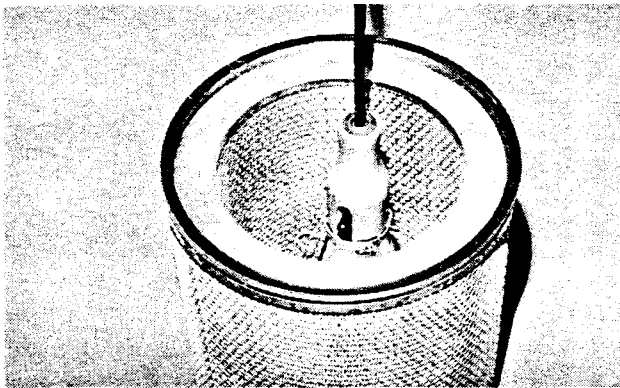


1. Wash the element in warm water and detergent.

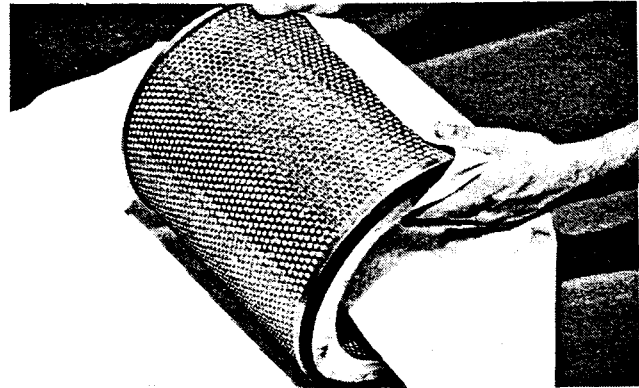
2. Rinse the element with clean water.

3. Air dry the element thoroughly and inspect it.

Inspecting Element



1. Insert a light inside of the clean and dry element, and inspect it. Discard the element if rips or tears are found.

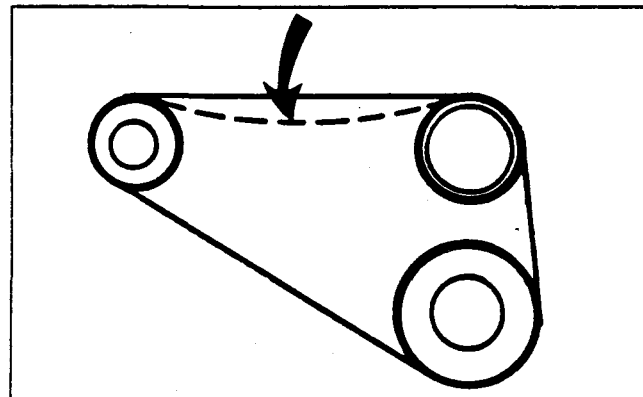


2. Wrap and store good elements in a clean, dry place.

⑩ Pulley Belts—Check Adjustment

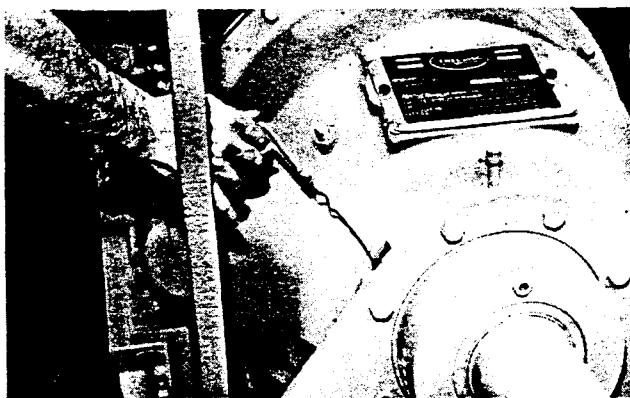
To test belt tension, apply 25 lbs. (110 N) force midway between pulleys. Correctly adjusted belts will deflect 1/2 to 3/4 inch (13 to 19 mm).

If necessary, adjust belts.

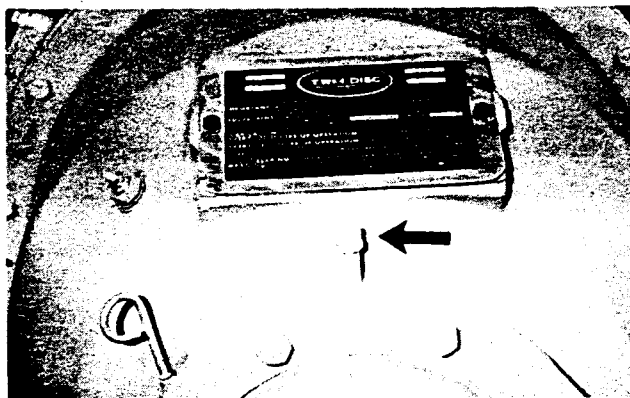


Typical pulley/belt arrangement shown.

⑪ Main Shaft Bearing—Check Oil Level (Heavy Duty Clutch)



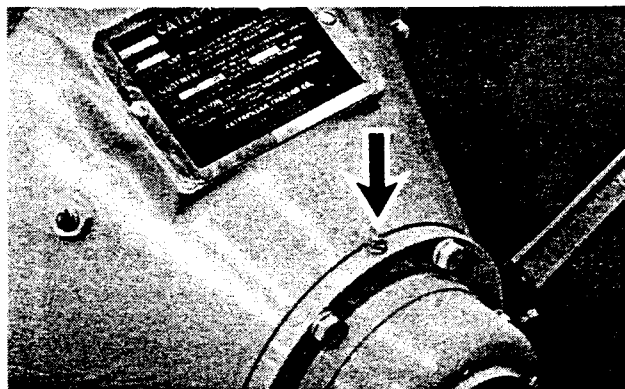
1. With the engine stopped, check the oil level. Maintain oil between the ADD and FULL marks on the dipstick.



2. Add oil if necessary. Do not overfill.

Grease Bearing (Standard Clutch)

Lubricate 1 fitting on top-rear of housing.



Oil and Filters Change Interval

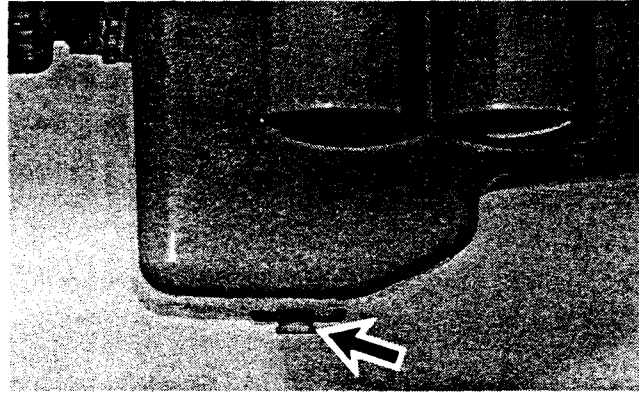
⑫ Engine Crankcase—Change Oil and Filter

WARNING

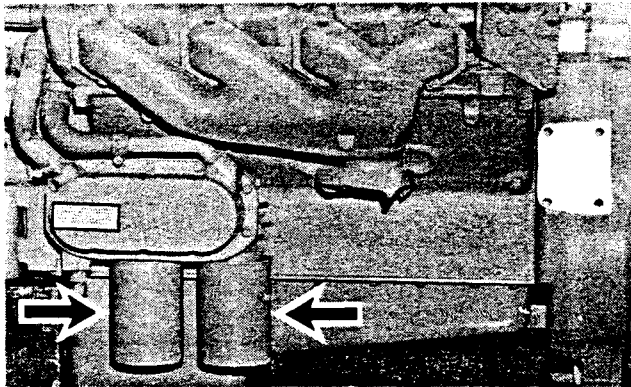
Use caution when draining oil or changing filters.

Hot oil or components can cause burns if they contact skin.

Drain the crankcase with oil warm and the engine stopped.



1. Remove the crankcase drain plug and allow the engine oil to drain.



2. Unscrew and remove the oil filters.

3. Wipe the filter base housing. Be sure all of old seals are removed.

4. Lubricate the entire sealing surface of the seals with clean engine oil.

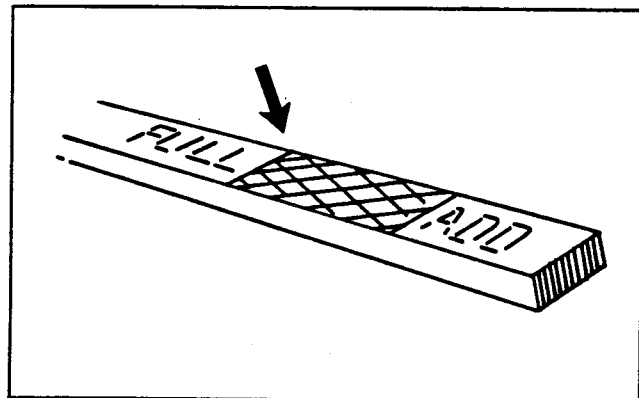
5. Tighten the oil filters by hand until the gasket contacts the base, then tighten 3/4 turn more using a filter wrench, if necessary.

6. Clean and install the drain plug. Fill the crankcase with clean oil.

CAUTION

If equipped with auxiliary oil filter, extra oil must be added when filling the crankcase.

If the extra oil is not added, the auxiliary oil filter will take priority and the engine will be starved for oil.



7. Check oil level before starting. Oil level should be at the FULL mark on the dipstick.

8. Start and run the engine. Inspect for any oil leaks.

Every 250 Service Meter Units

⑬ Cooling System—Add Cooling System Conditioner

⚠ WARNING

At Operating Temperature, engine coolant is hot and under pressure.

Steam can cause personal injury.

Check coolant level ONLY when engine is stopped and radiator cap is cool enough to touch with your hand.

Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.

On a new or reconditioned engine: Add enough Caterpillar Cooling System Conditioner, or equivalent, so that the cooling system will have a 3% concentration of conditioner. Add 1 pint (.50 liters) for each 4 gal. (15 liters) of coolant.

Every 250 Service Meter Units thereafter: Add 1 pint (.50 liters) for each 20 gal. (75.5 liters) of coolant in the system. This will maintain the required 3% concentration of conditioner.

CAUTION

Do not add conditioner monthly unless the engine has actually operated 250 Service Hours. Adding conditioner before 250 Service Hours will result in an excessive concentration of conditioner

CAUTION

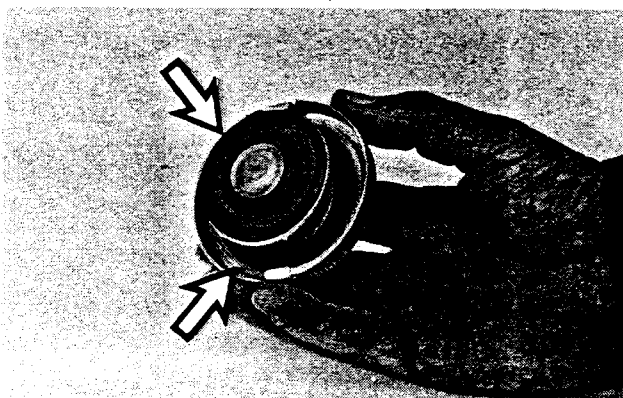
All water is corrosive at engine operating temperature. Use either Caterpillar Cooling System Conditioner liquid, or the coolant conditioner element to treat either plain water or ethylene glycol anti-freeze solution. NEVER use both the liquid cooling system conditioner and the coolant conditioner element at the same time.

Do not use Caterpillar Cooling System Conditioner or Coolant Conditioner Elements with Dowtherm 209 Full-Fill coolant.

1. Loosen the radiator cap slowly to relieve pressure, and remove radiator cap.

It may be necessary to drain enough coolant to allow for the addition of conditioner.

2. Add Caterpillar Cooling System Conditioner.

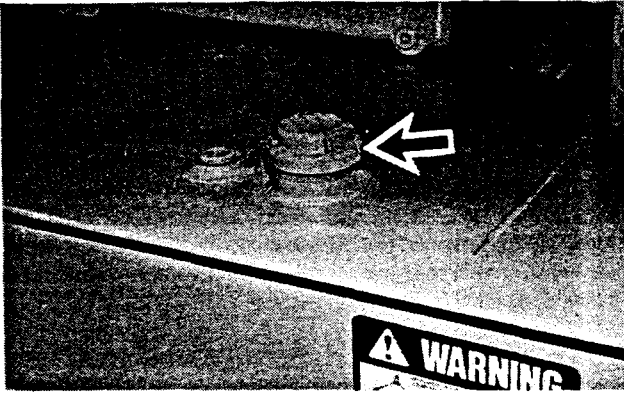


3. Inspect the radiator cap gaskets. Replace the cap if the gaskets are damaged.

4. Install the radiator cap.

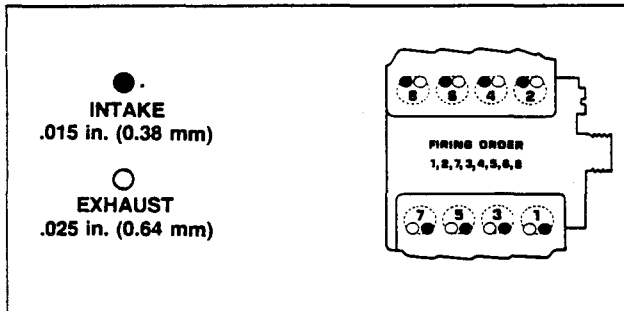
Every 500 Service Meter Units

⑭ Fuel Tank



1. Clean the filler cap.
2. Clean the screen in the fuel tank filler inlet.

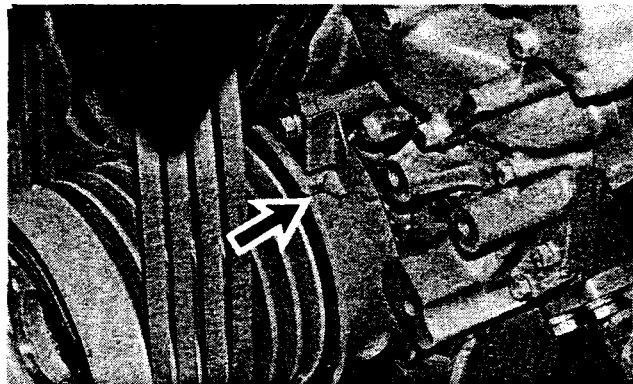
⑮ Engine Valve Lash – Check Adjustment



The valve clearance for the 3208 Engine is $.015 \pm .003$ " (0.38 ± 0.07 mm) for inlet valves and $.025 \pm .003$ " (0.64 ± 0.07 mm) for exhaust valves. With this specification, no adjustment of the inlet valve clearance is needed unless it measures less than $.012$ " (0.30 mm) or more than $.018$ " (0.46 mm). Similarly, no adjustment of the exhaust valve clearance is needed unless it measures less than $.022$ " (0.56 mm) or more than $.028$ " (0.71 mm).

To Check Valve Lash

1. Stop the engine.
2. Clean around the valve covers.
3. Remove both valve covers.
4. Turn the crankshaft until No. 1 cylinder is on Top Dead Center (TC1) compression stroke.

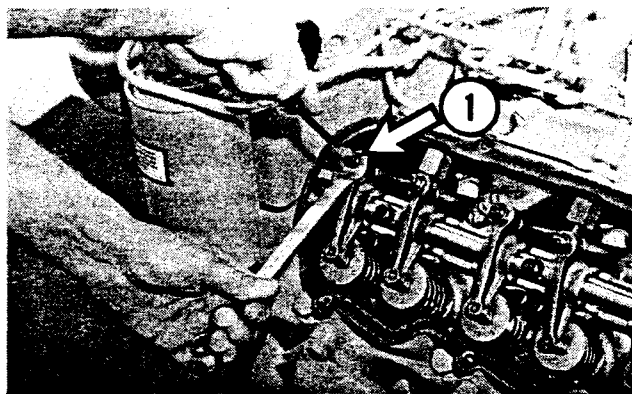


5. Align the (TC1) timing mark on the damper with the timing pointer located on the front of the engine block.

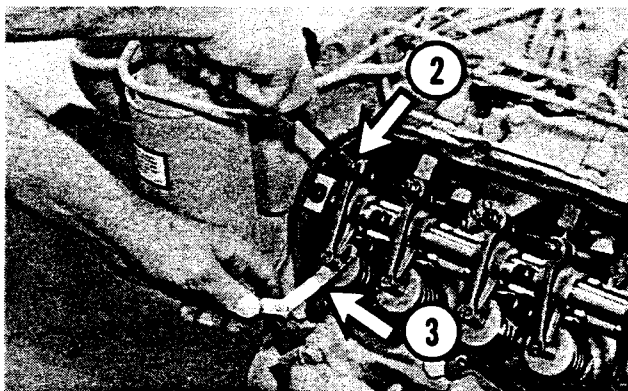
Both the exhaust and inlet valves for No. 1 and No. 2 cylinders will be closed. The four rocker arms will rotate with finger pressure. If both valves for No. 1 are not closed, rotate the engine 360° to obtain TDC No. 1 compression.

Adjusting Valve Lash

With the engine on Top Dead Center No. 1 compression, adjust the inlet and exhaust valve lash for No. 1 and No. 2 cylinders.



1. Loosen the valve adjusting screw locknut ①.



2. Turn the adjusting screw ② to allow the correct clearance gauge ③ to pass between the top of the valve stem and the valve rocker arm with a slight drag.

3. Tighten the adjusting screw locknut.

4. Check valve lash clearance.

5. 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.

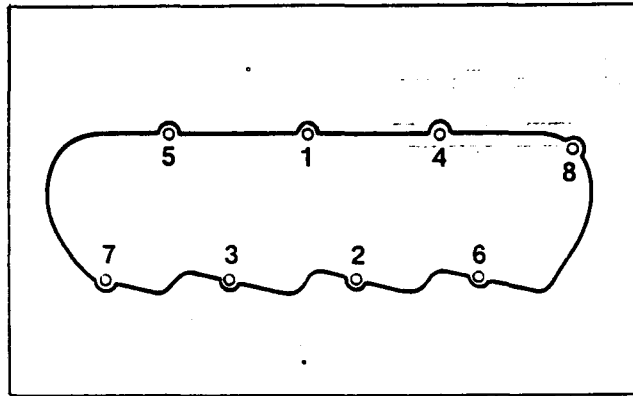
6. Turn crankshaft 180° clockwise (viewed from front of engine), and align (TC1) timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 4 and No. 5 cylinders.

Every 500 Service Meter Units

7. 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.

8. Inspect the valve cover gaskets. Install new gaskets if necessary.

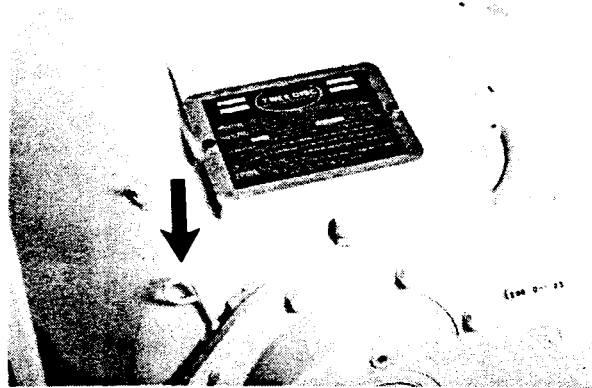
9. Install valve covers. Tighten bolts, in the sequence shown, to a torque of 10 ± 2 lb. ft. (14 ± 3 N·m).



⑩ Flywheel Clutch—Change Oil

WARNING

Hot oil or components can cause personal injury if they contact skin. Use caution when draining oil or changing filters.



1. Remove the drain plug and allow the oil to drain.

2. Install drain plug.

3. Add oil. See "Refill Capacities".

4. Check oil level. Level should be to FULL mark on dipstick.

Every 1000 Service Meter Units

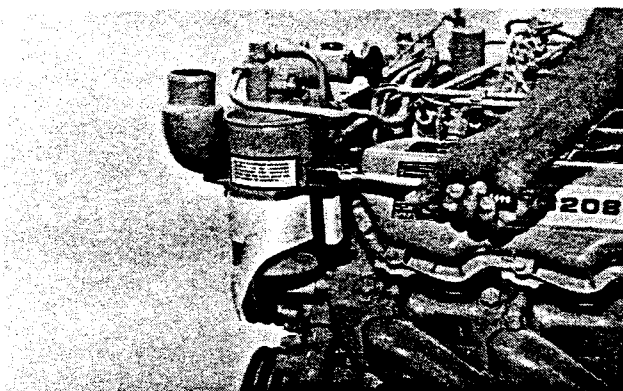
⑰ Engine Protective Switches (If Equipped)

It is important that the shut-off switches be in good working order because they operate only in time of a mechanical emergency, it is impossible to tell if they are in good working order through normal operation.

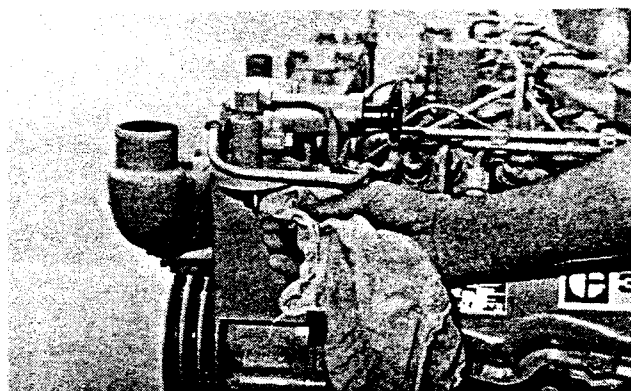
Have them checked at regular intervals by your Caterpillar dealer.

⑱ Fuel System—Change Filters

Final Fuel Filters



1. Remove and discard the filter (right hand thread).



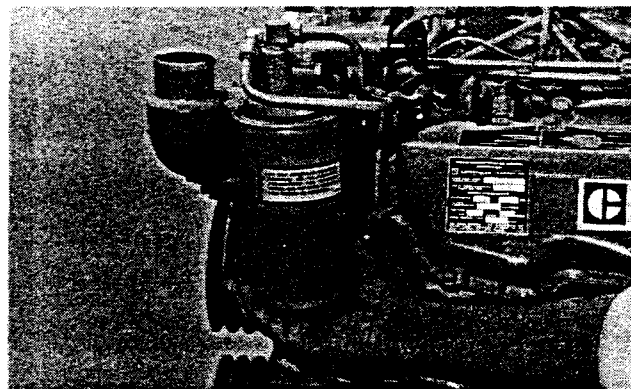
2. Clean the gasket sealing surface of the filter base.

CAUTION

Be sure all of old gasket is removed.



3. Lubricate the gasket of the new filter with clean fuel.

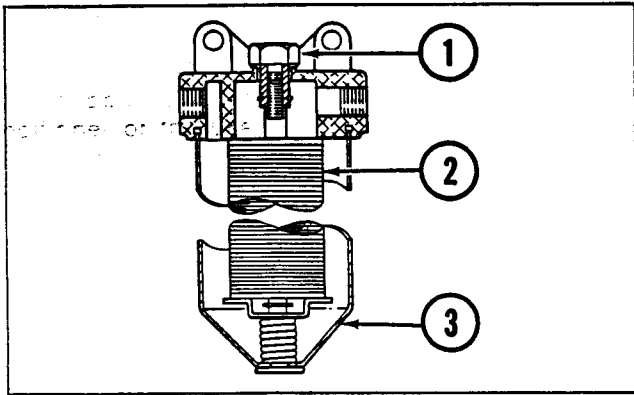


4. Install the filter and tighten it by hand until gasket contacts base, then tighten 1/2 to 3/4 turn more.

5. Prime the system.

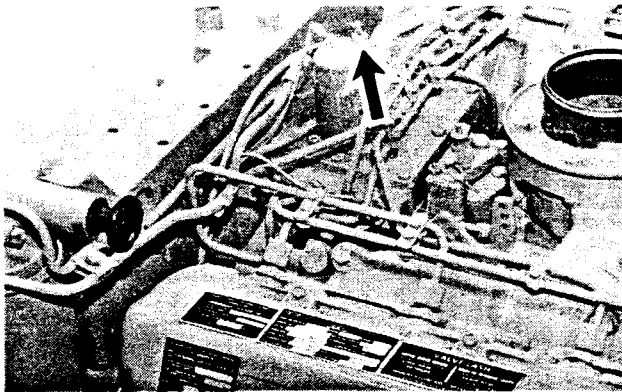
Every 1000 Service Meter Units

Primary Filter—If Equipped



1. Stop the engine
2. Shut off the fuel-tank supply valve.
and under pressure
3. Loosen the nut ① on the filter cover and lower the filter case ③.
4. Remove the element ② and wash in clean non-flammable solvent.
5. Reinstall the element.

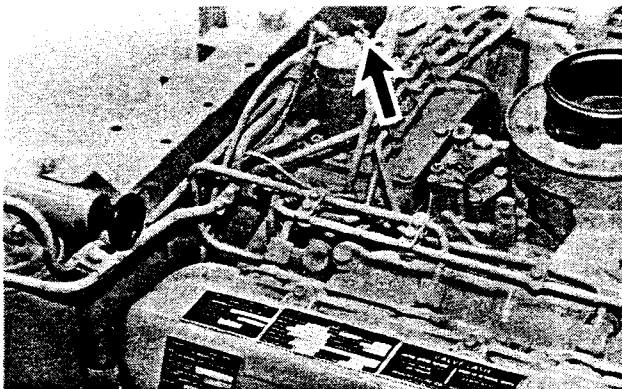
To Prime the System:



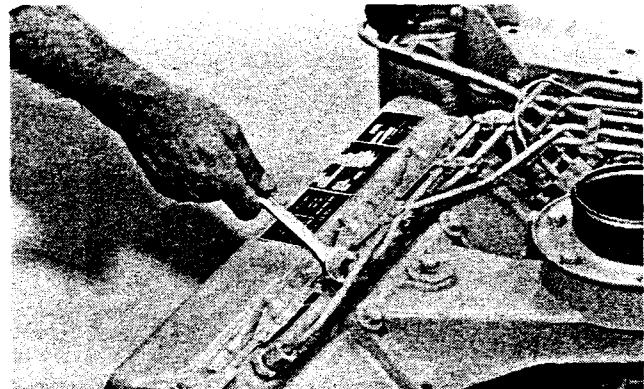
1. Open the vent valve on the fuel injection pump housing.



2. Operate the priming pump until the flow of fuel from the vent valve is continuous, and free of air bubbles.



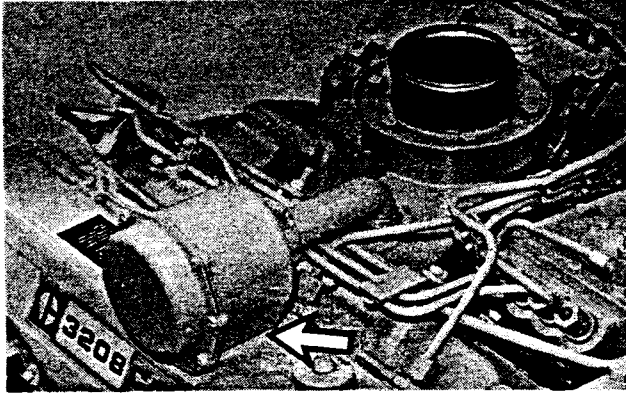
3. Close the vent valve and lock the fuel priming pump.
4. Start the engine. If the engine continues to misfire or smoke, further bleeding is necessary.



5. With the engine running, loosen the fuel lines at the cylinder head, one at a time, and allow the fuel to run until free of air bubbles.
6. Tighten the fuel line nuts.

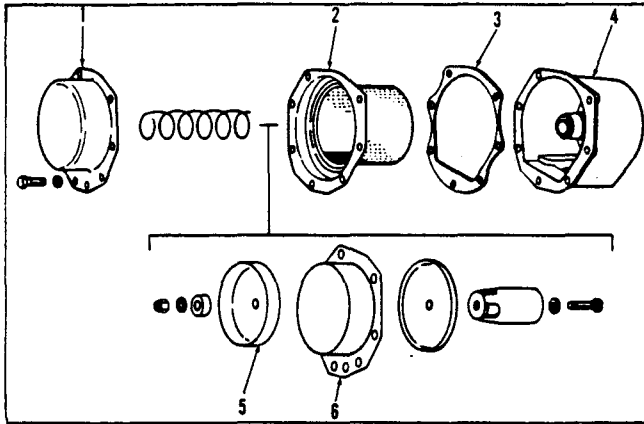
Every 2000 Service Meter Units

①⑨ PCV Valve



1. Clean the area around the PCV valve.

2. Remove the bolts holding the cover ① in place on the housing ④.



3. Clean and inspect all parts. Replace any part that is worn or damaged. Always install new gaskets and diaphragm when the valve is disassembled.

4. When installing the gasket, coat both sides of it ③ with gasket cement. Install it against the rear face of the inner sleeve ②.

5. To prevent the diaphragm ⑥ from distorting and tearing during assembly, coat both flange sides of the diaphragm with gasket cement and install it with the face marked "piston side" facing the piston ⑤.

Every 2000 Service Meter Units

② Cooling System—Changing Antifreeze Solution

⚠ WARNING

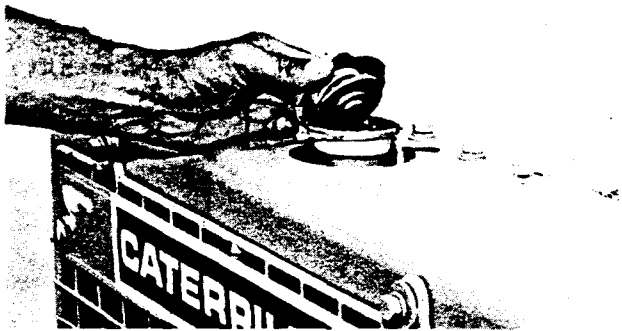
At Operating Temperature, engine coolant is hot and under pressure.

Steam can cause personal injury.

Check coolant level ONLY when engine is stopped and radiator cap is cool enough to touch with your hand.

Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.



1. Loosen the filler cap slowly to release pressure, and remove the cap.

3. Install the drain plugs.

4. Mix antifreeze and water solution to provide protection to lowest expected ambient temperature.

CAUTION

To help avoid air locks, add coolant slowly, at 5 U.S. gallons (19 liters) per minute or less, to within 1/2 inch (1 cm) of the bottom of the fill pipe.

5. Add antifreeze solution.

CAUTION

Coolant should be drained and replaced "Every 2000 Service Meter Units." With additions of Caterpillar Cooling System Conditioner or the use of Caterpillar Coolant Conditioner Elements as recommended, the drain period can be "Every 4000 Service Meter Units".

Do not use Caterpillar Cooling System Conditioner or Coolant Conditioner Elements with Dowtherm 209 Full-Fill coolant.

If the engine is to be stored in, or shipped to, an area with below freezing temperatures; the cooling system must either be protected to the lowest expected ambient temperature, or drained completely to prevent damage.

2. Remove the cooling system drain plugs. Allow coolant to drain.

Do not completely fill the cooling system. Allow for the addition of Caterpillar Cooling System Conditioner, or equivalent.

6. Add the correct amount of Caterpillar Cooling System Conditioner, the correct Caterpillar Coolant Conditioner precharge element, or equivalent, so that this cooling system will have a 3% concentration of conditioner.

7. Start and run the engine with the filler cap removed. Allow the coolant to warm and the level to stabilize. Add coolant, if necessary, to bring the level to within 1/2 inch (1 cm) of filler pipe. Stop the engine.

8. Inspect the filler cap gasket. Replace it if it is damaged. Install the filler cap.

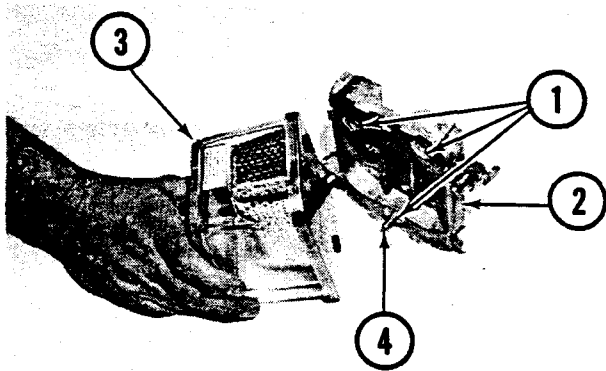
When Required

②① Water Separator—Replace Element

Change element anytime water separator becomes contaminated enough that water level cannot be seen through the transparent cover.

1. Shut off the engine and close the fuel supply valve, if equipped.

2. Clean all dirt from the separator and surrounding area.



4. Pull the old element from the base and discard it.

5. Clean the three sealing surfaces ① on the base ② with a clean cloth.

②② Cooling System—Cleaning

⚠ WARNING

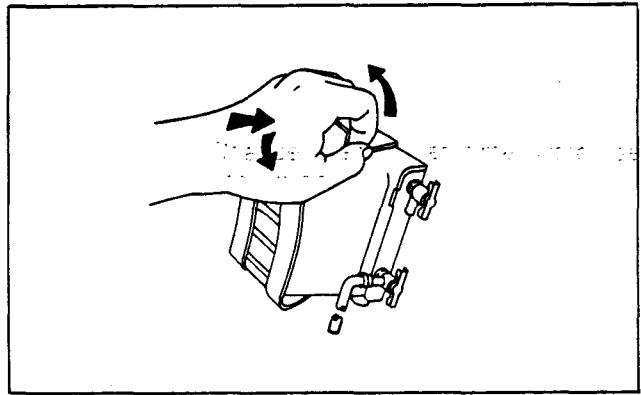
At Operating Temperature, engine coolant is hot and under pressure.

Steam can cause personal injury.

Check coolant level ONLY when engine is stopped and radiator cap is cool enough to touch with your hand.

Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.



3. To remove the element, depress the extended tab with the heel of the hand. Then lift the slotted tab from the locking slot, at the top of the base, with the fingers.

6. Install the new element ③ to the base by first inserting the roll pin ④ into the outlet passage at the bottom of the base. Align the filter holes with the base holes, and push the element into place.

7. Place the lower tab of the clamp in the bottom locking slot of the base. Push the upper tab of the clamp in the bottom locking slot of the base. Push the upper tab into the locking slot at the top of the base. Make sure clamp is securely engaged in the top and bottom locking slots.

8. Open the fuel valve and start the engine. It may be necessary to prime the fuel system if the engine does not start. Inspect for fuel leaks.

CAUTION

If the engine is to be stored in, or shipped to, an area with below freezing temperatures, the cooling system must either be protected to the lowest expected ambient temperature, or drained completely.

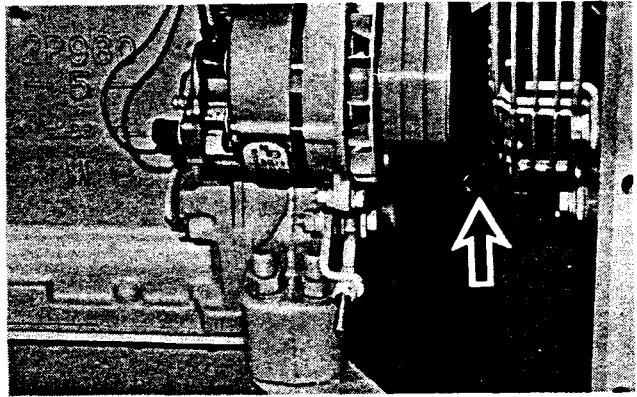
Never add coolant to an overheated engine, allow engine to cool first.

Do not use Caterpillar Cooling System Conditioner or Coolant Conditioner Elements with Dowtherm 209 Full-Fill coolant.

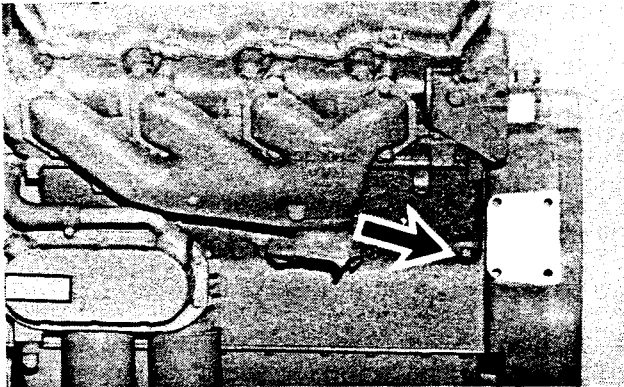
When Required



1. Loosen radiator cap slowly to release pressure and remove filler cap.



2. Remove radiator drain plug.



3. Remove engine block drain plugs.

WARNING

Use all cleaning solutions with care.

Most commercial cooling system cleaners may be used.

4. Install drain plugs. Fill system with cleaning solution.⁽¹⁾

5. Start and run engine for 1/2 hour. Stop engine and drain cleaning solution.

6. Flush system with clean water until draining water is clean. Do not run engine while flushing.

7. Install all drain plugs. Fill system with neutralizing solution.⁽²⁾

8. Start and run engine for 10 minutes. Stop engine and drain neutralizing solution.

9. Flush system with clean water, until draining water is clean. Do not run engine while flushing.

10. Install all drain plugs.

11. Add 1 quart (1 liter) of Caterpillar Cooling System Conditioner, or equivalent, for each 8 gallons (30.28 liters) of cooling capacity of the radiator so that this cooling system will have a 3% concentration of conditioner, or add the correct Caterpillar Coolant Conditioner precharge element.

12. Mix antifreeze and water to provide protection to the lowest expected ambient temperature.

13. To help avoid air locks, add coolant slowly, at 5 U.S. gallons (19 liters) per minute or less.

⁽¹⁾2 lb. Sodium Bisulfate (NaHSO_4) per 10 U.S. gallons (1 kilogram per 40 liters) water.

⁽²⁾1/2 lb. Sodium Carbonate Crystals ($\text{Na}_2\text{CO}_3 \bullet 10 \text{ H}_2\text{O}$) per 10 U.S. gallons (250 grams per 40 liters) water.

Caterpillar Warranty

NEW INDUSTRIAL, AGRICULTURAL, AND MARINE ENGINES, MARINE TRANSMISSIONS AND ELECTRICAL POWER GENERATION PRODUCTS

This warranty applies to the following products delivered to the first user on or after April 1, 1980.

Caterpillar warrants new industrial, agricultural, and marine engines, marine transmissions and electrical power generation products ("products") sold by it (except products installed in on-highway vehicles, in machines manufactured by Caterpillar or in marine pleasure craft sold in the United States of America, to which different warranties apply) to be free from defects in material and workmanship subject to the following provisions:

Warranty Period

The warranty period is 12 months (24 months for standby electric generators) starting from date of delivery to the first user.

Caterpillar Responsibilities

If a defect in material or workmanship is found during the warranty period Caterpillar will provide through a Caterpillar dealer or other source approved by Caterpillar:

- New or repaired parts at Caterpillar's choice.
- Labor needed to make the repair during normal working hours including reasonable labor to remove and reinstall the product if necessary and customary.
- Reasonable travel expenses if Caterpillar chooses to perform the repair in the field.
- Usual and customary parts shipping charges to the approved source.
- Lubricating oil, filters, antifreeze and other service items made unusable by the warranty failure.

User Responsibilities

User is responsible for:

- All costs for transporting the product or equipment in which the product is installed.
- Travel expenses for field repair of products in remote places.
- Premium or overtime labor costs.
- Parts shipping charges in excess of those which are usual and customary.
- Costs to investigate performance complaints unless the problem is caused by a defect in Caterpillar material or workmanship.
- Giving timely notice of a warrantable failure and promptly making the product available for repair.

Limitations

Caterpillar is not responsible for failures resulting from:

- Any use or installation which Caterpillar judges improper.
- Attachments, accessory items and parts not sold or approved by Caterpillar.
- Abuse, neglect and improper repair.
- User's unreasonable delay in making the product available after notice for product improvements ordered by Caterpillar.
- Caterpillar does not warrant items sold by it which are warranted by another maker.

This warranty is expressly in lieu of any other warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose. Remedies under this warranty are limited to the provision of materials and services, as specified above. Caterpillar is not responsible for incidental or consequential damages.

As used in this warranty the term "Caterpillar" means Caterpillar Tractor Co or one of its subsidiaries whichever last sold the product involved.