

Fig. 3-16. Checking fuel manifold pressure

2. Adjust manifold pressure by adding or removing shims from under nylon fuel adjusting plunger in the by-pass valve plunger. Do not lose small lock-washer which fits between fuel adjusting plunger and plunger cap.

3. Make checks on a hot engine. Operate engine five minutes between checks to clear system of air.

### CHANGE HYDRAULIC GOVERNOR OIL:

If fuel pump has a hydraulic governor, maintain oil level between marks on dipstick gauge.

Change governor oil at each "E" check. Use same grade oil in hydraulic governor as used in engine.

NOTE: In extremely low temperature governor oil may be diluted with fuel oil or special fluid to assure normal governor action.

## FUEL OIL SPECIFICATIONS

Fuel oil should be a neutral distillate petroleum oil, free from suspended matter, and not a mixture of light oil and heavy residue.

Physical and chemical properties should meet the following requirements:

### Viscosity @ 100° F.:

Centistokes: 2.4 to 5.0, or  
Saybolt Universal: 34 to 42.

### Gravity:

30 to 42 Degrees A.P.I. at 60° F.

### Cetane Number:

40 minimum except that in warm weather and where no starting difficulties are encountered, the cetane number may be lower.

### Pour Point:

10° F. below lowest temperature expected.

### Bottom Sediment and Water:

Not to exceed .05% of weight.

### Distillation:

At least 10% should distill below 460° F.

At least 90% should distill below 675° F.

End point should not exceed 725° F.

Minimum recovery 98%.

### Conradson Carbon Residue:

Not to exceed .25% on 10% bottoms.

### Ash:

Not to exceed .02% of weight.

### Sulphur:

Not to exceed 1% of weight.

### Copper Strip Corrosion:

Must pass test 3 hours @ 122° F.

## COOLING SYSTEM MAINTENANCE

	OPERATION	✓	A	B	C	D	E
COOLING SYSTEM	Fill Cooling System		●	●	●	●	●
	Check Leaks and Correct		●	●	●	●	●
	Check and Adjust Belt Tension				●	●	●
	Check Corrosion Resistor				●	●	●
	Check Thermal Controls					●	●
	Check Engine Coolant					●	●
	Check Fan Hub and Drive Pulley					●	●
	Check Sea Water Pump				*	●	●
	Clean Cooling System		SPRING & FALL				

Perform the operations at the intervals shown in the chart above. The instructions follow the same order as listed in the chart.

### FILL COOLING SYSTEM:

Keep the cooling system completely filled. *Check the coolant level daily or at each fuel stop. Investigate for cause of coolant loss.* Recheck the level after the engine reaches normal operating temperature. At operating temperature the thermostat is open and water is free to circulate to all parts of the system and fill all air pockets.

### CHECK LEAKS AND CORRECT:

Check for evidence of external coolant leakage. Tighten capscrews, hose clamps, fittings, and connections, or replace gaskets or hoses as necessary to correct.

### CHECK AND ADJUST BELT TENSION:

Belt life can be greatly extended by proper installation, adjustment and maintenance procedures. Neglect or improper procedures may lead to short belt life, cooling problems, or bearing failure.

#### Installation:

1. Shorten distance between pulley centers and install belt without force. Do not roll or pry belt over pulley.
2. Maximum pulley misalignment must not exceed 1/16 inch for each foot of belt free span.
3. Belt riding depth should not vary over 1/16 inch on matched belt sets.
4. Do not allow belt to bottom on pulley groove or rub against adjacent parts. The top belt edge should

not protrude over 1/16 inch above top edge of pulley groove.

#### Adjustment:

##### Water Pump

1. Remove capscrews from water pump pulley sheaves.
2. Place a pry bar between front pulley sheave lugs. Turn front pulley sheave to loosen or tighten belt tension as necessary.
3. Replace pulley sheave capscrews.

##### Fan Hub

1. Loosen fan hub locknut.
2. Raise or lower hub with adjusting screw on top of bracket to obtain desired belt tension.
3. Tighten bracket locknut to 400 ft. lbs.

Generator and vacuum pump drive belts may be adjusted by loosening adjusting link or mounting pad capscrews and adjusting distance between pulley centers to obtain desired belt tension. Make sure adjusting link or mounting pad capscrews are tightened securely after belt adjustments are made.

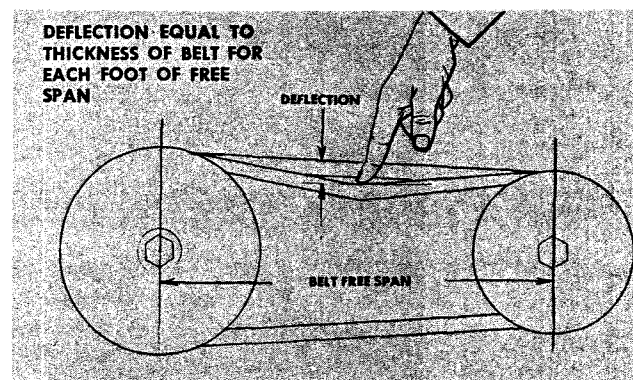


Fig. 3-17. Fan belt tension

### Belt Tension:

A good quality commercial gauge may be used to check belt tension.

As an alternate method, tighten belts so pressure of index finger extended straight down will depress the belt to the value shown in the table below. Force applied will be approximately 13 pounds. Fig. 3-17.

**TABLE**  
**Belt Tension**

Belt Width	Deflection per ft. of Span
1/2"	13/32"
11/16"	13/32"
3/4"	7/16"
7/8"	1/2"
1"	9/16"

### Re-tensioning New Belts:

All new belts will loosen after running for an hour or more and they must be re-tensioned. If the belt can be pushed down 1/16 inch more than the recommended depression, re-tension as described above.

### Belt Care or Maintenance:

Belts often slip or squeak because of the glaze which forms due to dirt or steam cleaning.

To clean a belt, wipe it off with hydraulic brake fluid. Cleaning in this manner will eliminate most cases of squeaking.

Do not tighten belt beyond figures given to eliminate belt squeak. A squeak does not necessarily mean belt slippage. Tightening to excess may damage bearings as well as the belts.

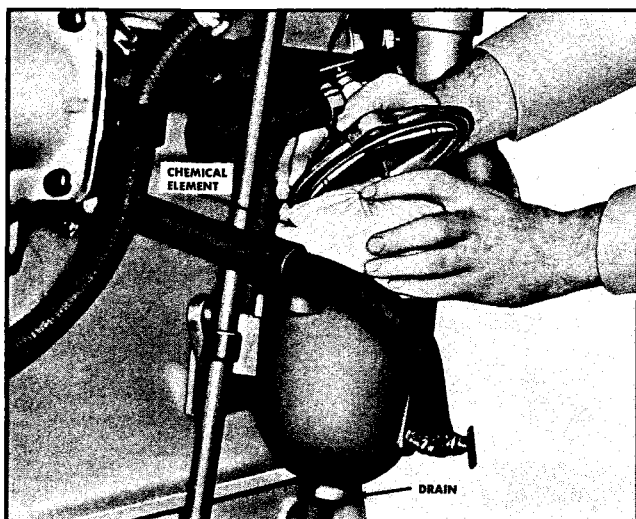


Fig. 3-18. Installing corrosion resistor element

### CHECK CORROSION RESISTOR:

Check coolant chromate concentration at each "C" check to determine if corrosion resistor element should be changed. See "Testing Engine Coolant," Page 3-17. Change element when concentration drops below 1700 parts per million. To change element:

1. Close shut-off valves on inlet and drain lines. Unscrew drain-cock at bottom of housing.
2. Remove cover capscrews and cover.
3. Remove plate securing element and lift element from housing. Remove plate below element.
4. Lift spring from housing.
5. Polish plates. If less than half of metal plate can be exposed by polishing, install new plate.
6. Replace spring and lower plate.
7. Remove transparent bag from corrosion resistor element; install element in housing.

NOTE: Do not damage *cloth* bag containing chemicals.

8. Place upper plate on top of element.
9. Install new gasket and replace cover. Tighten cover capscrews securely.
10. Close drain cock at bottom of housing and open shut-off valves.

### CHECK THERMAL CONTROLS:

Low-range thermostats start to open at 160° F. and are fully open at 175° F. High-range thermostats start to open at 170° F. and are fully open at 185° F. Check stamping on thermostat; install same range new thermostat as that removed.

The opening and closing of thermostats can be checked against a thermometer while immersed in water as the water is brought up to temperature by heating. Fig. 3-19.

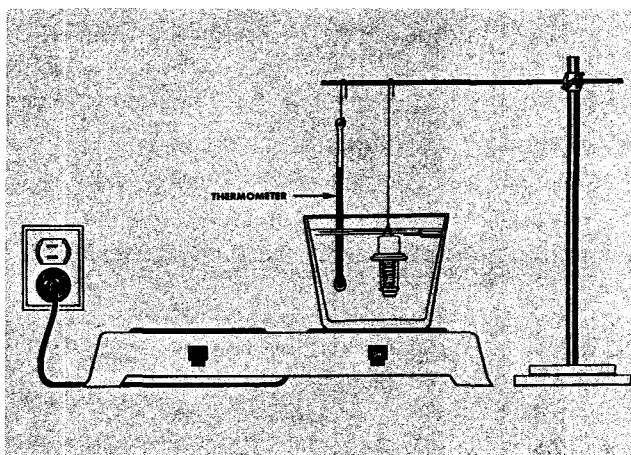


Fig. 3-19. Test thermostat

Shutterstats, *when used with standard thermostats and without thermatic fans*, should be set to open at 180° F. and to close at 172° F.

Thermatic fans, where used, should start at 185° F. and shut off at 170° F.

Shutterstats, *when used with thermatic fan*, should open at 170° F. and close at 162° F.

### CHECK ENGINE COOLANT:

Diligent maintenance of the engine cooling system is necessary to enable the system to cool the engine, and to prevent corrosion within the water jacket. Maintenance involves mechanical corrections for loose belts, etc., and water testing and treatment to prevent rust and corrosion.

### Requirements of a Good Coolant:

Water should be clean and free of any corrosive chemicals, such as, chlorides, sulphates and acids. It should be kept slightly alkaline with pH value in range of 8.5 to 10.5.

Any water which is suitable for drinking can be treated as described in the following paragraphs to make it suitable for use in an engine.

### Coolant Treatment:

Following are two effective methods of treating engine coolant to prevent corrosion:

1. Install and maintain a Cummins Corrosion Resistor. This is a unit which by-passes a small amount of coolant from the system through a filtering and treating device. It softens water, neutralizes acidity and protects against corrosion by the use of a replaceable chemically-activated filtering element. In addition the unit contains a sacrificial metal plate which arrests pitting of metals in the system by electro-chemical action. It can be used with or without anti-freeze.

2. The second best method of treating coolant to prevent corrosion requires a summer and winter treatment as follows:

**In summer:** Use one ounce of chromate compound for every two to three gallons of water. This is equivalent to 1700 to 2500 parts per million.

**In winter:** Use ethylene-glycol base anti-freeze in the percentage required for winter protection. You can use anti-freeze with Cummins Corrosion Resistor.

### Testing Engine Coolant:

If the cooling system in your engine is being protected by either one of the two methods recommended, it should be tested regularly for each of the following conditions:

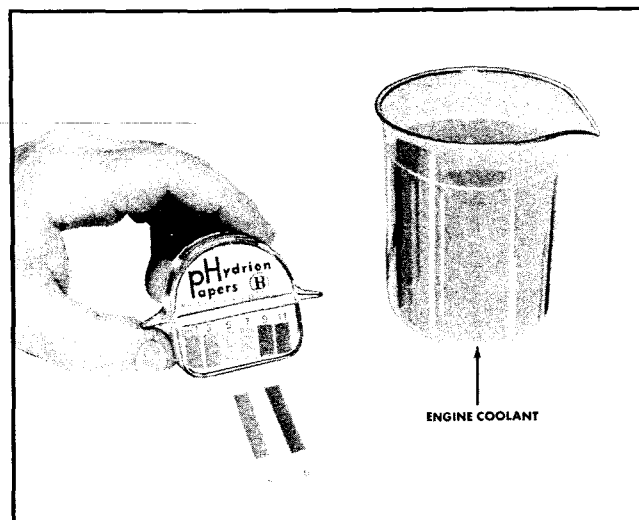


Fig. 3-20. pHydron test paper

**pH Value:** The test kit is pHydron wide range test paper and dispenser (ABpH 1-11). The kit can be purchased from the Harshaw Scientific Company which has branches in Cleveland, Cincinnati, Detroit, Houston, Los Angeles, and Philadelphia, or from other companies furnishing chemical supplies. The cost is nominal (approximately \$1.50) for a plastic dispenser and two 15-foot rolls of test paper. Check the engine coolant following the manufacturer's directions supplied with the kit.

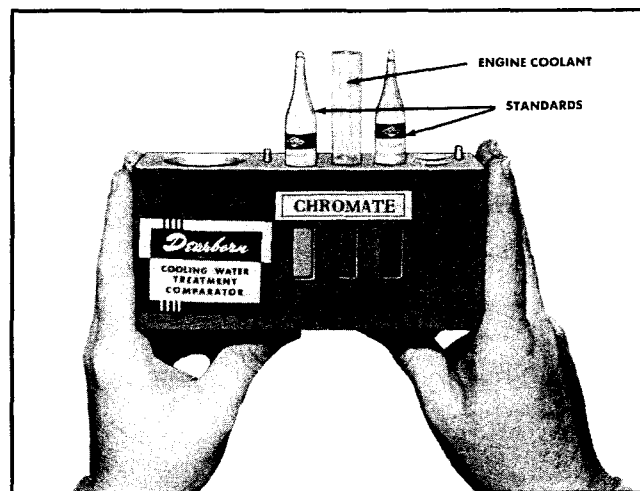


Fig. 3-21. Checking chromate concentration

**Chromate Concentration:** A color comparator kit provides an easy and accurate check of chromate concentration in any cooling system protected by Cummins Corrosion Resistor, or by chromate compounds. A good comparator, called "The Dearborn Cooling Water Treatment Comparator," is manufactured and sold by Dearborn Chemical Company, Merchandise Mart Plaza, Chicago 54, Illinois.

Testing is accomplished by comparing the color of a sample with standards supplied in the kit. Chromate concentration should be kept between 1700 and 2500 parts per million.

### **Adjusting Coolant To Specifications:**

If the tests indicate that the coolant has a pH value below 8.5 or that the chromate concentration is below 1700 parts per million, an adjustment should be made immediately to prevent corrosion. The correction necessary depends upon which method of protection is being used in the cooling system.

If the Cummins Corrosion Resistor is used, change the element, run the engine four to six hours; then, check again.

If chromate compounds are used, add enough compound to bring the concentration between 1700 and 2500 parts per million.

### **CHECK FAN HUB AND DRIVE PULLEY:**

Check fan hub and drive pulley to be sure that they are securely mounted.

Tighten the fan capscrews each "D" check. Check drive pulley for looseness or wobble, and, if necessary, remove fan and hub and tighten the shaft nut. Tighten the four bracket capscrews.

### **SEA WATER PUMP:**

Maintenance and service periods for the sea water pump must necessarily be adjusted to agree with the type of application to which it is subjected.

If coolant being pumped through the sea water pump is relatively free of sediment, corrosive chemicals, foreign material and abrasives such as sand or mud, normal maintenance periods are sufficient.

Accelerated maintenance periods are necessary to compensate for undesirable operating conditions.

1. Check all pipes and fittings for leaks. Tighten as necessary.

2. Remove cover plate to drain pump.

3. Lift out rubber impeller and check for cracks, breaks, or damage. Install new impeller if necessary.

NOTE: If impeller is subjected to extreme temper-

atures, either hot or cold, impeller life is shortened and inspection periods must be adjusted accordingly.

4. Clean out all sediment.

5. Install new cover plate gasket and install cover on pump. A .015 inch gasket should be used to maintain proper impeller-to-cover clearance.

6. The sea water pump is self-priming.

7. No lubrication is necessary as sealed bearings are used.

### **CLEAN COOLING SYSTEM—SPRING AND FALL:**

The cooling system must be clean to do its work well. Scale in the system slows down heat absorption from water jackets and heat rejection from the radiator. Use clean water which will not clog any of the hundreds of small passages in the radiator or the water passages in the block.

Clean out radiator cores, heater cores and block passages which have become clogged with scale and sediment by chemical cleaning, neutralizing and flushing.

### **Chemical Cleaning:**

The best way to insure an efficient cooling system is to prevent formation of rust and scale by using Cummins Corrosion Resistor, but if they have collected, the system must be chemically cleaned. Use a good cooling system cleaner such as sodium bisulphate or oxalic acid followed by neutralizer and flushing.

### **Pressure Flushing:**

The radiator and block should be flushed when anti-freeze is added or removed, or before installing a corrosion resistor on a used engine.

When you pressure flush the radiator, open the upper and lower hose connections, and screw the radiator cap on tight. Use hose connections on both upper and lower connections to make the operation easier. Attach the flushing gun nozzle to the lower hose connection and let the water run until the radiator is full. When full, apply air pressure gradually to avoid damage to the core. Shut off air and allow the radiator to refill, then apply air pressure. Repeat until the water coming from the radiator is clean.

Sediment and dirt settles into pockets in the block as well as in the radiator core. Remove thermostats from housing and flush the block with water. The lower opening should be partially restricted until the block fills up. Apply air pressure and force the water through the lower opening to flush water out top of engine. Repeat the process until the stream of water coming from the block is clean.

## AIR SYSTEM MAINTENANCE

	OPERATION	✓	A	B	C	D	E
AIR SYSTEM	Check Air Cleaner Oil Level		●	●	●	●	●
	Clean Pre-Cleaner		●	●	●	●	●
	Check Air and Vapor Line Connections		●	●	●	●	●
	Clean Composite-Type Air Cleaner		*	●	●	●	●
	Clean Dry-Type Cleaner Element			●	●	●	●
	Change Air Cleaner Oil			●	●	●	●
	Clean Crankcase Breather (Oil-Bath Type)		*	●	●	●	●
	Clean Crankcase Breather (Horsehair Element)		*	●	●	●	●
	Change Crankcase Breather (Paper Element)		*	●	●	●	●
	Clean Air Compressor Breather		*	*	●	●	●
	Clean Tray Screen			*	●	●	●
	Check Air Piping			*	●	●	●
	Check for Supercharger/Turbocharger Oil Leaks					●	●
	Tighten Turbocharger Mounting Nuts					●	●
	Check Inlet Air Restriction				*	●	●
	Replace Composite-Type Cleaner Element				*	●	●
	Replace Dry-Type Cleaner Element				*	●	●
	Clean Oil-Bath Air Cleaner				*	●	●
	Clean Aneroid Air Filter				*	●	●
	Tighten Manifold Nuts or Cap Screws						●
	Clean Turbocharger Compressor Wheel & Diffuser					*	●
	Check Turbocharger Bearing Clearances						●

When the engines operate under extremely dusty conditions, the operations followed by asterisks in the chart above should be performed at the more frequent intervals as indicated.

### CHECK AIR CLEANER OIL LEVEL:

Daily or at each trip, check oil level in the oil bath air cleaner to be sure that level is at indicated mark. Add oil if necessary. This is especially important if the oil bath cleaner is the only cleaner on the engine.

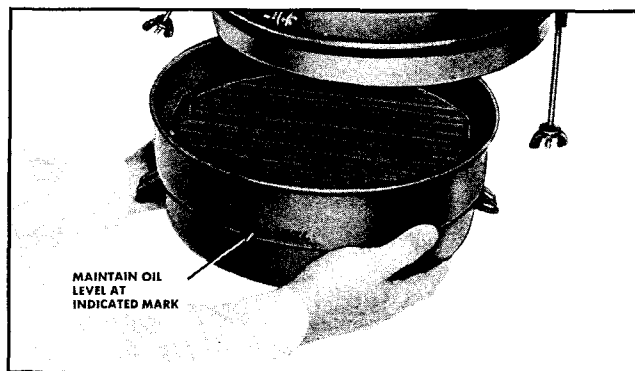


Fig. 3-22. Oil level in air cleaner

When dirt build-up reaches 1 inch, change oil as described under "Change Air Cleaner Oil".

### CLEAN PRE-CLEANER:

Some engines working under extremely dirty conditions use an air pre-cleaner. Clean daily or oftener as necessary depending on operating conditions.

### CHECK AIR AND VAPOR LINE CONNECTIONS:

All air and vapor lines and connections from compressor, supercharger, rocker housing cover, and cylinder heads should be checked and corrected as needed.

In cold weather, the condensed moisture in air tanks and lines may freeze and make brakes useless. Air tanks should be drained and all water must be kept out of the brake system.

### CLEAN COMPOSITE-TYPE CLEANER ELEMENT:

Composite-type air cleaners feature two stage air cleaning. In the first stage, centrifugal cleaning action deposits dust into a dust cup or bin at the bottom of the cleaner. The second stage is a dry-type paper element which catches remaining dust particles.

Empty the dust cup or bin daily or at each trip, as necessary.

Clean the paper element with compressed air when air restriction exceeds maximum permissible limits.

NOTE: This maintenance operation must be ad-

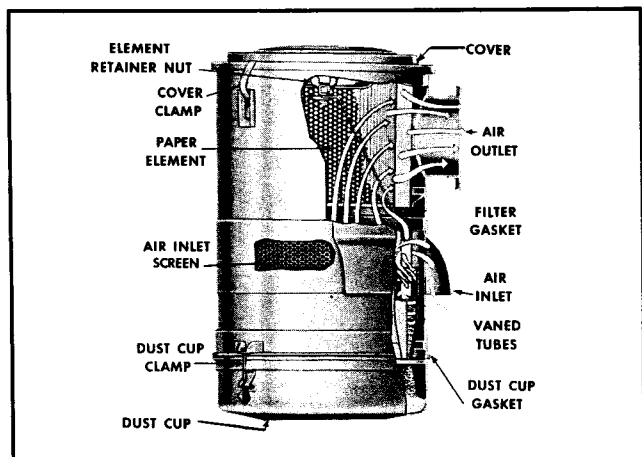
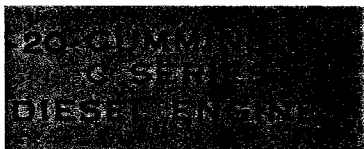


Fig. 3-23. Composite-type air cleaner

justed to suit each engine application according to degree of dust concentration.

**CAUTION:** DO NOT DAMAGE PAPER ELEMENT WHILE CLEANING. BREAKS, REGARDLESS OF SIZE, RENDER ELEMENT USELESS.

#### CLEAN DRY-TYPE CLEANER ELEMENT:

The paper element in a dry-type air cleaner may be cleaned several times by using a compressed air jet to blow off dirt. Do not hold jet too close to paper element.

When installing element, make sure it seats on gasket at air cleaner outlet end.

**CAUTION:** HOLES IN THE ELEMENT OF A DRY-TYPE AIR CLEANER RENDER CLEANER INOPERATIVE AND DAMAGE TO THE ENGINE WILL RESULT.

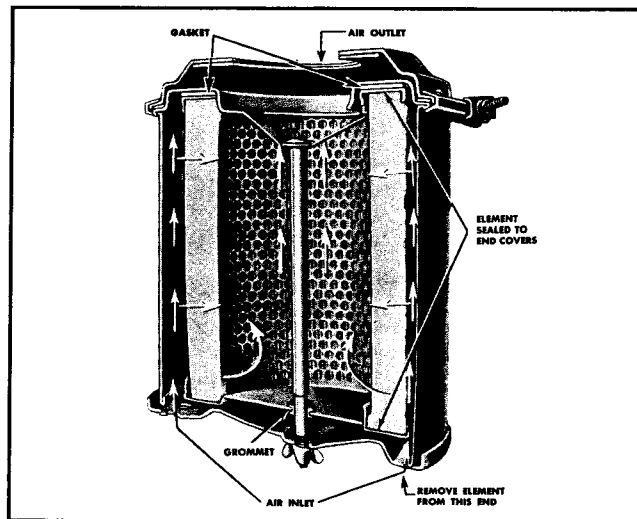


Fig. 3-24. Cross section of dry-type air cleaner

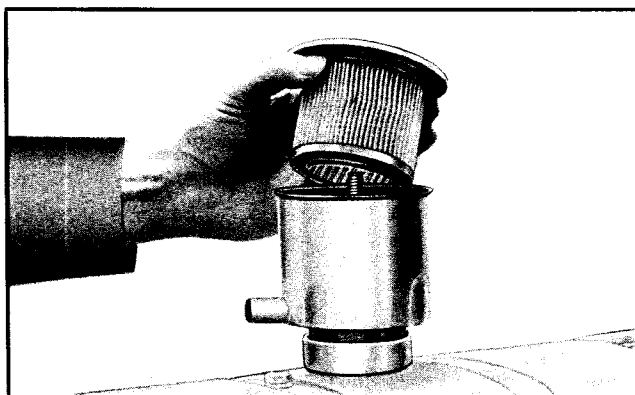


Fig. 3-25. Crankcase breather—dry type

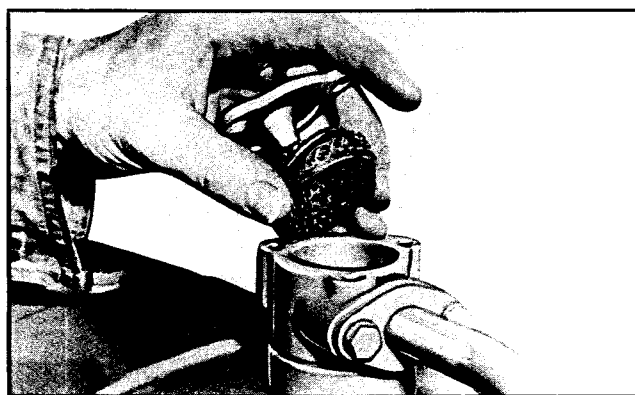


Fig. 3-26. Crankcase breather—horsehair element

#### CHANGE AIR CLEANER OIL:

When dirt build-up reaches 1 inch, remove oil cup from cleaner. Discard oil and wash cup in cleaning solvent or fuel oil.

Fill oil cup to level indicated by bead with clean oil; assemble cleaner. Use oil of same grade as used in crankcase. In extremely cold weather a lighter grade may be used. As some detergent, or additive, oils tend to foam in air cleaners, use a straight mineral oil.

**CAUTION:** NEVER USE CRANKCASE DRAININGS.

#### CLEAN CRANKCASE BREATHER:

##### Horsehair Element:

Crankcase breather with horsehair elements are used on turbocharged engines. Clean element by washing in cleaning solvent and drying with compressed air.

##### Oil Bath:

Immerse breather in kerosene or cleaning solvent. Wash thoroughly. Dry with compressed air. Fill breather oil cup to level indicated with same grade oil used in crankcase.

## CHANGE CRANKCASE BREATHER:

### Paper Element:

Dry-type crankcase breathers containing a chemically-treated paper element are used on naturally-aspirated engines. **DO NOT ATTEMPT TO CLEAN ELEMENT OR TO USE ON ENGINES WITH PRESSURIZED SYSTEMS. INSTALL NEW ELEMENT.** Fig. 3-25.

## CLEAN AIR COMPRESSOR BREATHER:

Some air compressors used on Cummins engines utilize a breather to provide clean air for the air compressor. Clean breather at each oil change period as follows.

### Mesh Type:

Remove breather from air compressor. Disassemble breather completely and wash all parts in solvent. Dry with compressed air, reassemble, and install on com-

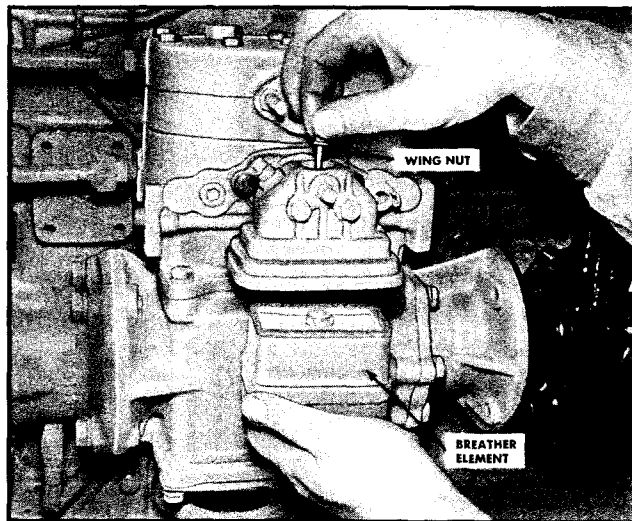


Fig. 3-27. Air compressor breather

pressor. Oil mesh element lightly with SAE 20 oil to aid in capturing dirt particles.

### Oil Bath Type:

Unsnap spring clips and remove oil cup. Wash in solvent, dry, fill to oil level mark and reassemble. Use clean oil, the same grade as used in crankcase.

Every other service period, unscrew wing nut on top and remove filter element. Wash in solvent, dry, and reassemble to cover.

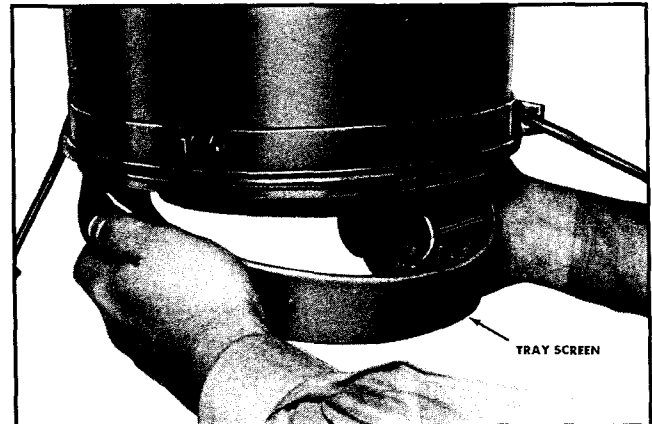


Fig. 3-28. Tray screen in oil bath cleaner

## CLEAN TRAY SCREEN:

Wash tray screen in kerosene or cleaning solvent. Dry thoroughly with compressed air, and reassemble to air cleaner.

**NOTE:** If tray screen is extremely dirty or coated with varnish, it may be necessary to singe the screen with a flame. Be careful not to melt the tin plate on the screens.

## CHECK AIR PIPING:

Check air intake piping from air cleaner to intake manifold for loose clamps, connections, cracks, punctures, or tears in hoses or tubing, collapsing hoses, or other damage. Tighten clamps or replace parts as necessary to insure an airtight air intake system. *Make sure that all air goes through the air cleaner.*

When hose clamps are installed over rubber hose, lubricate the clamp inside diameter and sliding points of contact under the tee-bolt joints with Lubriplate or similar lubricant.

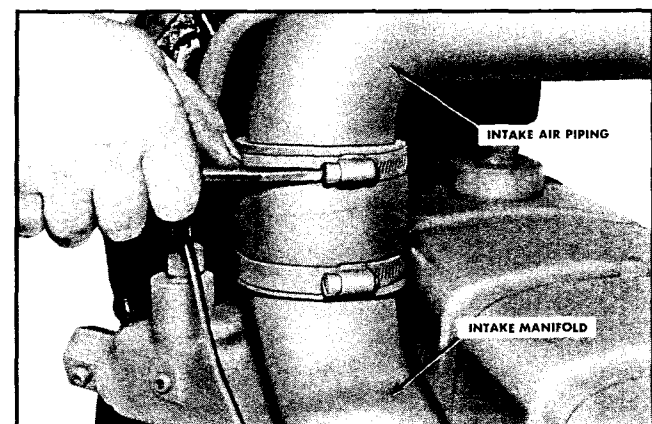


Fig. 3-29. Air inlet piping

## CHECK FOR OIL LEAKS AT SUPERCHARGER OR TURBOCHARGER:

### Supercharger:

Remove supercharger outlet connection. Check ends of rotors and case for evidence of oil leakage from supercharger seals. Rotors will always show some oil from vapor tube which is connected to rocker housing cover. "Wet" oil at ends of rotors, and excessive oil consumption are cause for changing supercharger seals.

Check supercharger lubricating oil lines and connections for leaks. Correct as needed.

### Turbocharger:

Check for wet oil in intake and exhaust sides of turbocharger. If oil is present, be sure that it is not caused by worn rings or an oil-over-condition from the air cleaner. Check hoses, tubing and connections for leaks, and tighten or replace as necessary to correct.

## TIGHTEN TURBOCHARGER MOUNTING NUTS:

Tighten all turbocharger mounting capscrews and nuts securely. Tighten mounting bolts and brace rods so vibration will be at minimum.

## CHECK INLET AIR RESTRICTION:

The best method for determining air cleaner maintenance periods is through air restriction checks. To check air restriction:

1. Attach a vacuum gauge or water manometer in the middle of the intake manifold. On turbocharged or supercharged engines, attach the checking fixture 4 to 8 inches upstream from the supercharger or turbocharger in a straight section of tubing.
2. Idle the engine until normal operating temperature is reached.
3. Operate engine at rated speed, no-load and take reading from vacuum gauge or manometer. Air restriction must not exceed 25 inches of water.

NOTE: Operate turbocharged engines at rated speed and full-load to make check.

4. If air restriction exceeds 25 inches of water:
  - a. Clean or replace dry-type cleaner element.
  - b. Replace damaged air piping, rain shield or housing.
  - c. Remove excessive bends or other source of restriction in air piping.

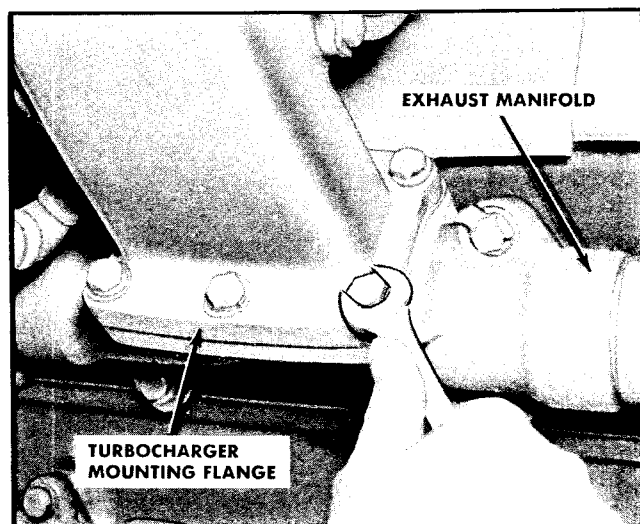


Fig. 3-30. Turbocharger mounting nuts

Vacuum switches are available which actuate a warning light on the instrument panel when air restriction becomes excessive.

Air restriction checks should not be used to determine maintenance periods for oil-bath air cleaners. When dirt build-up reaches 1 inch level in oil cup perform maintenance as described under "Change Air Cleaner Oil".

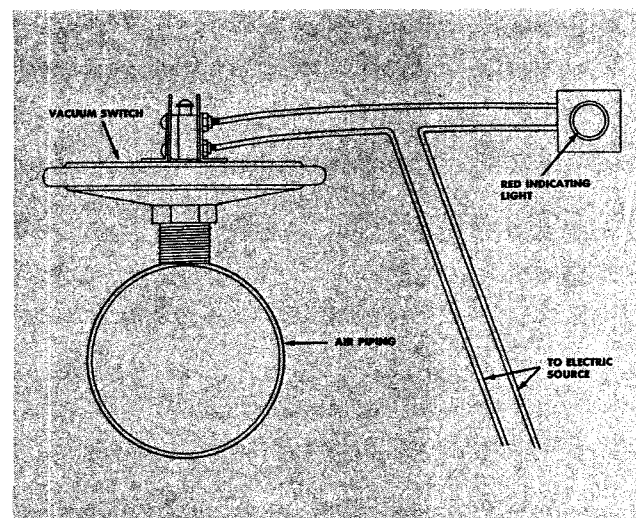


Fig. 3-31. Vacuum switch to check inlet air restriction

### **REPLACE COMPOSITE-TYPE CLEANER ELEMENT:**

Replace the paper element in composite-type air cleaners when breaks appear or if air restriction is still excessive after element has been cleaned. To change element:

1. Remove cover; lift out element. Do not allow dust from element to fall back into air cleaner. Discard element.
2. Inspect "O" rings or gaskets. Replace as needed.
3. Insert new element and tighten cover securely.

### **REPLACE DRY-TYPE CLEANER ELEMENT:**

Dry-type elements that have been cleaned several times will finally clog, restricting air flow to the engine. After cleaning, check restriction as previously described and replace if necessary.

Holes, loose end seals, dented sealing surfaces, or other damage requires immediate element replacement.

### **CLEAN OIL-BATH AIR CLEANER:**

#### **Steam Cleaning:**

Steam clean oil-bath air cleaner main body screens. Direct steam jet from air outlet side of cleaner to wash dirt out in opposite direction of air flow.

If screens cannot be thoroughly cleaned in this manner or if body has been damaged, replace air cleaner.

#### **Solvent-Air Cleaning:**

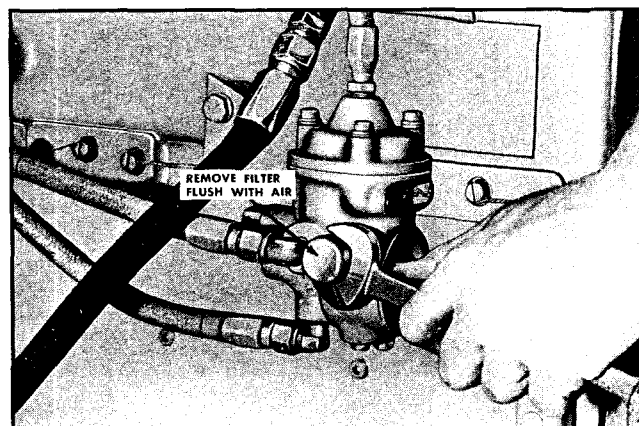
This method of cleaning requires a 55 gallon drum and a source of air pressure. Any good commercial solvent may be used.

1. Steam clean exterior of cleaner.
2. Remove air cleaner oil cup.
3. Clamp hose with air line adapter to air cleaner outlet.
4. Submerge air cleaner in solvent.
5. Introduce air into unit at 3/5 psi and leave in washer 10 to 20 minutes.
6. Remove cleaner from solvent and steam clean thoroughly to remove all traces of solvent.

**CAUTION: FAILURE TO REMOVE SOLVENT MAY CAUSE ENGINE TO RUN-AWAY UNTIL ALL SOLVENT IS SUCKED FROM CLEANER.**

7. If air cleaner is to be stored, dip in lubricating oil to prevent rusting of screens.

If the screens cannot be thoroughly cleaned or if body is pierced or otherwise damaged, replace with new air cleaner.



*Fig. 3-32. Aneroid control air filter*

### **CLEAN ANEROID AIR FILTER:**

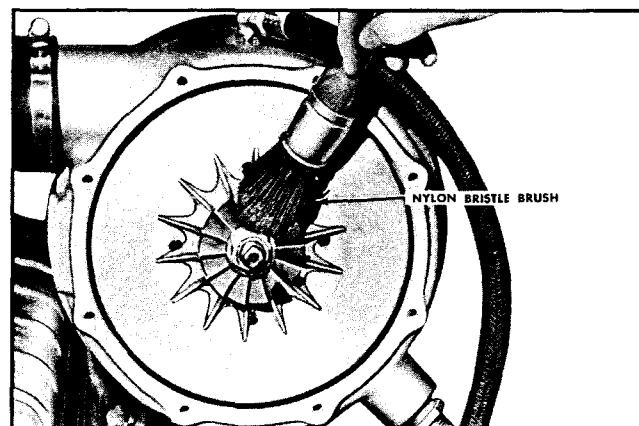
Clean aneroid air filter at each "E" check by reverse flushing with compressed air; it is not necessary to disassemble filter.

### **TIGHTEN MANIFOLD NUTS OR CAPSCREWS:**

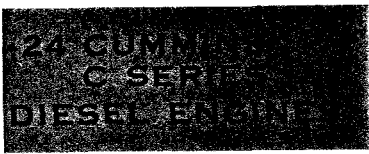
Check exhaust, intake and water manifolds for tightness; correct as required.

### **CLEAN TURBOCHARGER COMPRESSOR WHEEL AND DIFFUSER:**

Keep compressor wheel and diffuser clean for best turbocharger performance. Dirt build up on the com-



*Fig. 3-33. Cleaning turbocharger compressor wheel*



pressor wheel chokes air flow causing rotor imbalance.

Clean compressor wheel and diffuser each "E" check.

1. Remove piping and support bracket from turbocharger.

2. Loosen capscrews; remove front plate to expose compressor wheel and diffuser.

3. Brush carbon from compressor wheel and diffuser with a nylon bristle brush. *Never use wire brushes or scraper.*

4. If unit is badly carboned, remove turbocharger from engine and immerse compressor wheel end in carbon solvent to diffuser plate. Allow to soak. *Do not use caustic solution or solvent that will attack aluminum.* Do not rest turbocharger weight on compressor wheel or end of shaft.

5. Dry unit with compressed air and reassemble front plate.

#### CHECK TURBOCHARGER BEARING CLEARANCES:

Check bearing clearance by checking rotor shaft side

and end-play at each "E" check. Without removing turbocharger from engine, check as follows:

1. Remove turbocharger intake and exhaust piping.

2. Attach dial indicator to turbine casing with indicator point against turbine wheel hub.

3. Force turbine wheel up and down and note total indicator reading.

4. Remove one front plate capscrew and replace with long capscrew.

5. Attach indicator to long capscrew and register point against flat on end of rotor shaft.

6. Push shaft sideways; note total indicator reading.

7. Move indicator point to end of shaft; check rotor assembly end play.

	Min.	Max.
<b>Radial Clearance</b>		
(Total Indicator Reading)	.008	.013
<b>Rotor End-Play</b>	.004	.010

If radial or end clearance exceeds maximum, replace turbocharger.

## OTHER MAINTENANCE

	OPERATION	✓	A	B	C	D	E
OTHER	Check Operator's Report		●	●	●	●	●
	Retighten Cylinder Head Capscrews (1st "B" Only)			●			
	Blow Dust from Generator and Cranking Motor			*	*	●	●
	Clean and Tighten Electric Connections					●	●
	Check Generator Brushes and Commutator					●	●
	Steam Clean Engine					●	●
	Tighten Mounting Bolts and Nuts					●	●
	Check Engine Blow-By					●	●
	Check Crankshaft End Clearance						●

Perform the operations at the intervals shown in the chart above. The instructions follow the same order as listed in the chart.

### CHECK OPERATOR'S REPORT:

Check the operator's daily or trip reports, and investigate and correct reported cases of:

1. Low lubricating oil pressure.
2. Low fuel pressures.
3. Abnormal water or oil temperature.
4. Unusual engines noises.
5. Excessive smoke.

### RETIGHTEN CYLINDER HEAD CAPSCREWS:

Retighten cylinder head capscrews at the first "B" check. This procedure applies both to new engines

or engines from which the cylinder head has been removed.

NOTE: If steel-type head gasket is used, this maintenance operation is not necessary.

To retighten cylinder head capscrews or stud nuts:

1. Bring engine oil temperature to 140°/160° F.
2. Remove rocker lever cover.
3. Tighten all cylinder head capscrews or stud nuts in sequence (Fig. 3-34) to torque values shown below.

NOTE: This is *not* cylinder head *installation* procedure. For installation procedure see Page 4-10.

11/16"

280/300 Ft. Lbs.

3/4"

380/400 Ft. Lbs.

CAUTION: DO NOT OVERTIGHTEN CYLINDER HEAD CAPSCREWS.

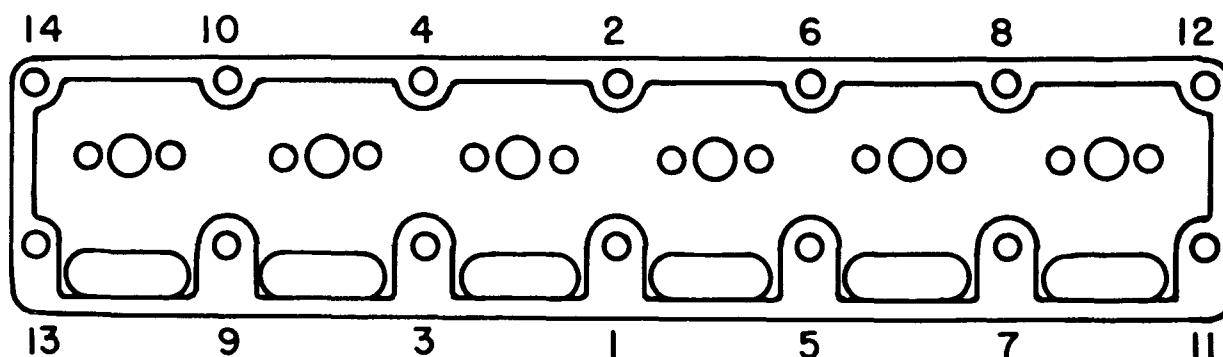


Fig. 3-34. Sequence for tightening cylinder head capscrews

## BLOW DUST FROM GENERATOR AND CRANKING MOTOR:

Dust and dirt, if allowed to accumulate in the generator and cranking motor, will cause excessive wear of bearings, brushes and commutator.

Remove cover band and blow out dust and dirt with compressed air.

## CLEAN AND TIGHTEN ELECTRIC CONNECTIONS:

Poor starting conditions are often traceable to loose or corroded battery connections. A loose connection will overwork the generator and regulator and shorten their life.

1. Add water to battery cells to keep tops of plate covered.
2. Remove corrosion from and around terminals, then coat with petroleum jelly.
3. Keep connections clean and tight. Prevent wire and lugs from touching each other or any metal except screw terminals to which they are attached.
4. Replace broken or worn out wires and their terminals.
5. Have battery tested periodically for any faults by competent agency. Follow battery manufacturer's instructions for maintenance.

## CHECK GENERATOR BRUSHES AND COMMUTATOR:

Generator failure will cause unit down-time and result in expensive replacement.

Clean commutators with No. 00 sandpaper; *never with emery cloth.*

Replace worn brushes. If brushes wear rapidly, check for incorrect brush spring tension or high mica on commutator. Check generator output and action of ammeter indicator after brush replacement.

Shorts and incorrect polarization can be detected at the ammeter. Incorrect polarization is indicated by minus reading when generator is turned. Take unit to electric service station for correction.

## STEAM CLEAN ENGINE:

Steam cleaning is the most satisfactory method to clean the engine and prevent surface dirt from entering fuel and lubricating oil systems. If steam is not available, use mineral spirits or equivalent.

When cleaning the engine, protect cranking motor openings, wiring, generator, belts, etc., from full force

of steam jet. If belts squeak after steam cleaning, wipe thoroughly with brake fluid.

## TIGHTEN MOUNTING BOLTS AND NUTS:

Mounting bolts occasionally work loose and cause supports and brackets to wear rapidly. Tighten all mounting bolts or nuts. Replace broken or lost bolts and capscrews.

## CHECK ENGINE BLOW-BY:

To check for blow-by, bring engine to normal operating temperature and remove oil filler tube cap. Watch for distinct puffs of exhaust gas escaping from tube.

There will always be some exhaust gas escaping from tube due to heat and piston movement. Distinct puffs, however, indicate blow-by. To check extent of blow-by.

1. *On naturally aspirated engines only:* Remove rocker covers and plug cylinder head vent holes.
2. Remove crankcase breather.
3. Attach ST-487 to crankcase breather opening.
4. Attach manometer to ST-487.

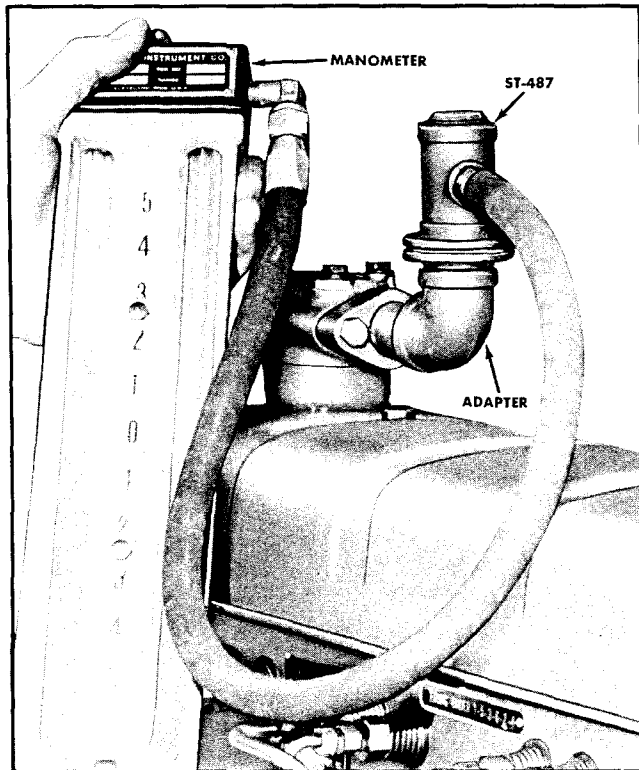
NOTE: Turbocharged and supercharged engines are equipped with low-silhouette, horsehair-type breathers. If this type breather is used, remove cover, horsehair element, baffles and vent tube and attach ST-487 to vent tube opening with adapter. Replace cover. Fig. 3-35.

5. Bring engine temperature to 140°/160° F.
6. Run engine at maximum rpm and full load.
7. Take reading from manometer and compare with table below.
8. *On naturally aspirated engines only:* Remove plugs from cylinder head vent holes after checking blow-by.

TABLE — MAXIMUM CRANKCASE PRESSURE

Values Shown are Inches of Water

Model	Pressure
C-90	1.7
C-105	1.8
C-140	4.5
C-160	2.5
C-175	8.0
C-180	3.0
C-200	8.5



*Fig. 3-35. Checking blow-by*

Excessive blow-by is accompanied by excessive oil consumption and is caused when the seal between piston rings and cylinder liner is broken. Excessive blow-by can be corrected only by installing new rings, pistons or liners as needed. See C Series Shop Manual for instruction.

### **CHECK CRANKSHAFT END CLEARANCE:**

The crankshaft of a new or newly rebuilt engine should have .004" to .011" end clearance. A worn engine should not be operated with more than .030" crankshaft end clearance.

The check can be made by attaching a dial indicator gauge so the point will rest against the end of the vibration damper as the crankshaft is pried back and forth. You can pry against the vibration damper flange, but do not pry against the damper itself because any dent or damage to the damper may cause a crankshaft failure. End clearance must be present with the engine mounted to its driven unit.

Insufficient end clearance will cause excessive wear of the crankshaft flange and thrust bearings. It often results in bearing and engine failure.

Excessive thrust bearing or flange wear is generally caused by poor mounting of driven unit or by riding the clutch or other poor operating practices. End clearance in excess of .030" may result in bossing of connecting rods in pistons.

### **MAJOR INSPECTION**

After 18,000 gallons fuel consumption, the engine should have a major inspection to determine whether it is in condition for another service period, or whether it should be overhauled. Oil consumption, oil pressure at idling, dilution and other signs of wear should be considered as part of the inspection.

Since the major inspection requires partial disassembly of the engine, it should be done in a well-equipped shop by mechanics who are thoroughly familiar with worn-replacement limits and with disassembly and assembly procedures. This information is available in the C Series Shop Manual, which can be purchased from any Cummins Distributor.

The items which should be inspected at this period are the following:

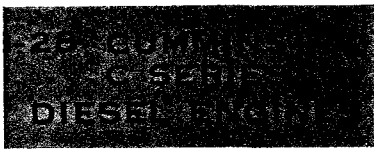
- Main and Connecting Rod Bearing Shells
- Crankshaft Journals
- Camshaft Lobes
- Cylinder Heads (Grind Valves)
- Cylinder Liners
- Pistons and Rings
- Fuel Pump (Calibrate)
- Injectors (Clean)
- Supercharger Seals and Bearings
- Turbocharger Bearing Clearances
- Air Compressor or Vacuum Pump
- Generator and Cranking Motor
- Intake and Exhaust System (Clean and Correct Leaks)

Parts which are worn beyond worn replacement limits at this inspection should be replaced with new or rebuilt parts or units.

### **ENGINE REBUILD**

If during the major inspection it is determined that crankshaft journals or many of the other engine parts are worn beyond the worn replacement limits, the engine should be removed from the equipment and be completely rebuilt.

The overhaul or complete rebuild must be performed in a well-equipped shop by well-trained mechanics. Your Cummins Distributor has the special tools and



the up-to-date information necessary to rebuild the engine to factory specifications.

After an engine has been rebuilt it is essentially a new engine and should be treated as such. By treating

the rebuilt engine like a new engine and by following the protective maintenance schedule, the same dependable service can be expected from the engine that it gave during its first service period.

Each space under "B", "C", "B", "D", etc., represents check interval of 200 operating hours or equivalent. Insert date or hour meter reading in proper space and due date in following column at each maintenance check. Perform next maintenance at due date or hour meter reading indicated for this unit.

UNIT NUMBER OR DESCRIPTION	MAINTENANCE CHECK	B	C	C	B	D	B	B	C	C	B	E	B	C	D	B	C	C	B	E	B	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B	D	B	C	C	B
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NOTE: INCLUDE SUMMARY OF DAILY AND WEEKLY REPORTS PERFORMED BETWEEN 15 OPERATIONS IN THE REPORT.

~~CONFIDENTIAL~~



## C SERIES DIESEL ENGINES

### Section IV

#### ENGINE UNIT REPLACEMENTS

The design of Cummins engines makes it possible to replace worn units with new or rebuilt units in a few hours so you can get the engine back on the job quickly.

For all unit rebuilding and installation of other units and parts see your nearest Cummins Distributor. He is equipped to rebuild your engine or engine units. If you are equipped to do your own overhaul work he can supply you with the complete instructions contained in the C Series Shop Manual. Through the use of the Shop Manual, factory approved service tools and trained mechanics you should get the same as new engine performance from your rebuilt engine.

Use only genuine Cummins parts in Cummins engines. Years have been spent in developing and testing these parts—each one in relation to its mating parts. Your Cummins engine deserves the best replacement parts and *these are genuine Cummins parts.*

Always provide a clean place to work and clean the outside of the engine before you remove any units. More engine failures are caused by dirt than from any other cause.

Use the proper tools for the job. Good work is impossible with poor or improper tools.

Protect all machined surfaces from contact with other rough parts. Protect parts which are to be stored with an oil or grease film.

## CLEAN ENGINE EXTERIOR

After removal of generator, cranking motor and other electric equipment, but before removal of remaining units, clean engine thoroughly with steam. Time spent in cleaning will be made up quickly during disassembly.

A portable fuel-oil or electric-heated steam cleaner is satisfactory for general use. This type cleaner can be used either in the cleaning room or yard.

## GENERATOR REMOVAL:

1. Disconnect wiring leads from terminals.
2. Disconnect capscrews securing generator to mounting bracket.
3. Loosen belt tension and remove belt from generator pulley. Lift generator from engine.

NOTE: On some applications, it may be easier to remove generator and bracket as a unit or No. 1 cylinder injector inlet and drain manifolds may have to be disconnected.

## INSTALLATION:

Make sure generator is same type and rating as that removed.

1. Mount generator to bracket and install belt. Tighten capscrews and adjust belt tension as described on Page 3-18.
2. Install fuel manifolds if disconnected and replace wiring leads to proper terminals.

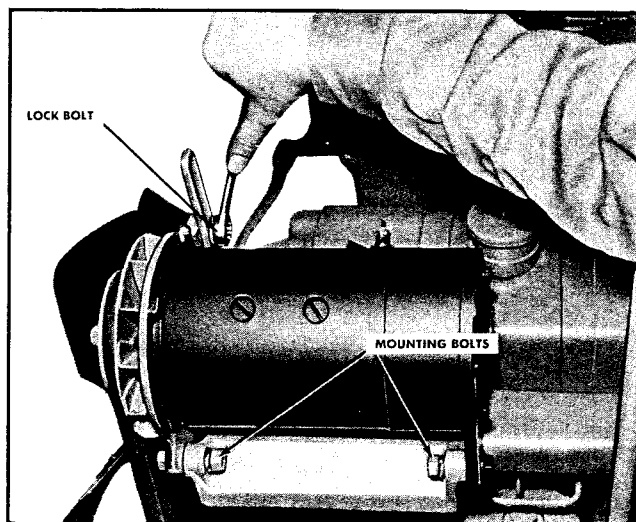


Fig. 4-1. Installing generator

## CRANKING MOTOR

### Removal:

The cranking motor is mounted on the flywheel housing with three capscrews; by removing them, the motor may be pulled from the housing. Fig. 4-2.

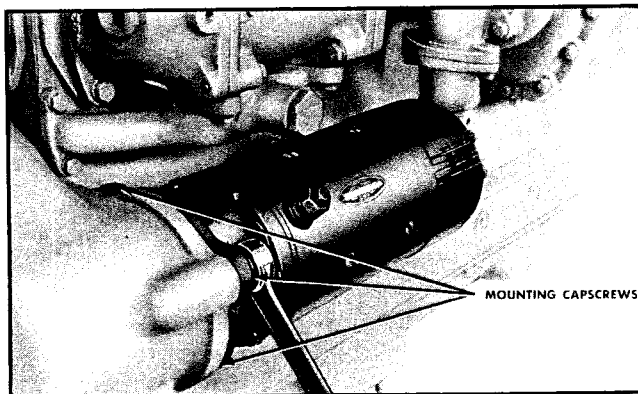


Fig. 4-2. Cranking motor removal

### Installation:

Lift the cranking motor in place in the flywheel housing and tighten securely with three capscrews and lockwashers.

## CORROSION RESISTOR REMOVAL:

1. Close shut-off valves in inlet and outlet lines; remove drain plug in resistor housing and drain coolant.
2. Disconnect inlet and outlet lines.
3. Remove capscrews securing corrosion resistor to engine block or mounting bracket.

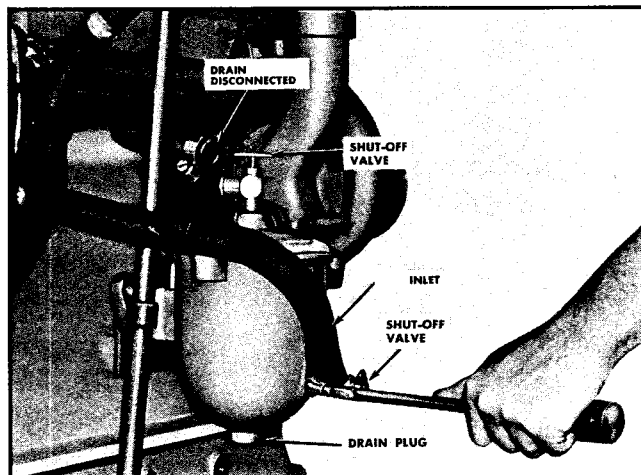


Fig. 4-3. Installing corrosion resistor

## INSTALLATION:

1. Select location so resistor will be grounded and inlet line less than 18 inches long.
2. Secure resistor to engine or mounting bracket with capscrews.
3. Attach 5/8 inch heater hose inlet and outlet lines. Fig. 4-3. Inlet line connects resistor to pressure side of water pump. Outlet line connects to suction side of water pump.
4. Open shut-off valves; start engine and check for leaks.
5. After a few minutes, check resistor head temperature to see if coolant is circulating. If resistor head is cold, disconnect outlet line to bleed off air. Recheck for circulation.
6. For service instructions, see Page 3-16.

## THERMOSTAT

### Removal:

1. Disconnect hose from water outlet connection on thermostat housing.
2. Disconnect air compressor water lines and turbo-charger water outlet line, if used.
3. Remove capscrews securing thermostat housing to cylinder head water outlet connections. Separate housing from cylinder head.

**NOTE:** If water-cooled turbocharger is used, lift housing from water by-pass coupling.

4. Remove thermostat and gasket. Discard gasket.
5. See Page 3-16 for thermostat testing procedure.

### Installation:

1. Using new gasket, install new or tested thermostat in thermostat housing. Fig. 4-4.

**NOTE:** If thermostat with "V" notch is used, plug vent hole in thermostat housing.

2. If water-cooled turbocharger is used, install new O-ring on water by-pass coupling.

**CAUTION:** INSTALL THERMOSTAT WITH VENT HOLE AT TOP. FAILURE TO DO SO MAY RESULT IN AIR LOCK AND INCOMPLETE COOLANT CIRCULATION.

3. Install thermostat housing with washers and cap-screws. Tighten securely.

4. Connect air compressor and turbocharger water outlet lines, if used.

5. Connect water outlet hose; tighten clamp.

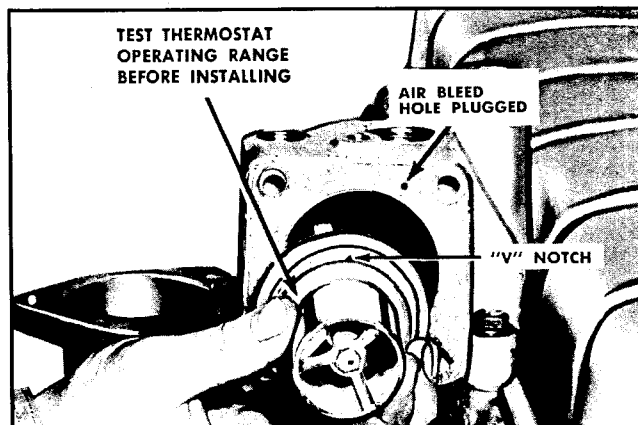


Fig. 4-4. Thermostat installation

## WATER PUMP (Belt Driven)

### REMOVAL:

Loosen clamp and disconnect hose at water pump inlet connection. Loosen tension on the water pump belt and slip belt from sheaves of pulley. Remove the capscrews holding pump to the gear housing, and remove pump from engine by separating it from water by-pass coupling and oil cooler connection.

### INSTALLATION:

Install new rubber O-rings on oil cooler connection and on water by-pass coupling. Lift pump into posi-



Fig. 4-5. Water pump — belt driven

tion and install capscrews and lockwashers holding pump to gear housing. Adjust water pump belt tension as described on Page 3-15.

## WATER PUMP (Supercharger Driven) REMOVAL:

Loosen clamp and disconnect hose at water pump inlet connection. Disconnect and remove oil cooler as described on Page 4-5. Remove four capscrews holding pump to supercharger. Disconnect pump from water by-pass coupling and remove pump from engine. Remove capscrew holding oil cooler connection to water pump and remove connection.

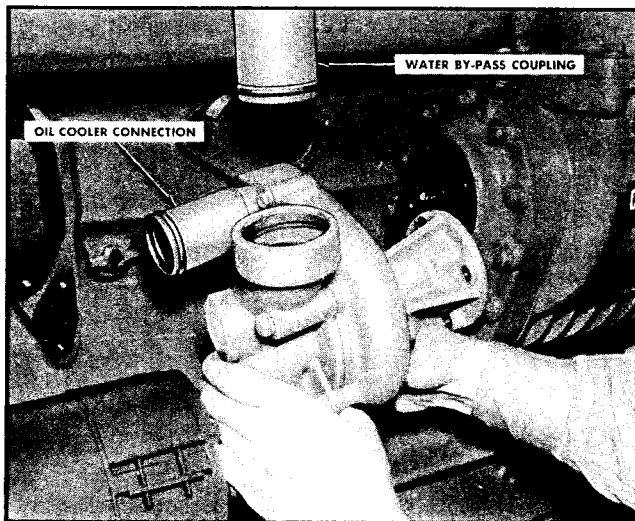


Fig. 4-6. Water pump — supercharger driven

## INSTALLATION:

Assemble new rubber O-ring on oil cooler connection and attach to water pump with capscrew and lockwasher. Install a new rubber O-ring on water by-pass coupling. Attach pump to coupling and to supercharger using a new gasket. Install four capscrews and lockwashers and tighten securely. Install oil cooler as described on Page 4-5.

## SUPERCHARGER

### REMOVAL:

1. Disconnect and remove water pump as described on Page 4-3. Loosen hose clamp; remove four capscrews holding inlet connection to supercharger, and remove connection and gasket. Discard gasket. On engines that do not have the pressurizing valve, dis-

connect the vapor suction tube at the inlet connection. Tape the inlet connection opening on the supercharger to prevent entry of foreign objects.

2. At intake manifold connection, loosen hose clamp and drop out of position. Remove retainer ring; then roll rubber O-ring over supercharger flange.

3. Remove seven capscrews holding supercharger to gear housing cover. Grasp supercharger firmly, slide to rear to disengage from drive gear and remove from engine. Remove gasket and discard.

### INSTALLATION:

1. At all times before final assembly of the outlet and inlet connections to the supercharger, the ports should be kept covered. Masking tape may be used. Do not stuff rags into the inlet or outlet ports at any time as they might be left there on assembly to the engine.

2. Make sure the supercharger locating dowels are in the gear case.

3. Close to the lower dowel is a lubricating oil ferrule or feed tube; make sure it is in place. The supercharger and water pump drive are lubricated under pressure through this connection. A counterbore is provided in the gear housing for a rubber O-ring that fits over the oil supply ferrule. Fig. 4-7.

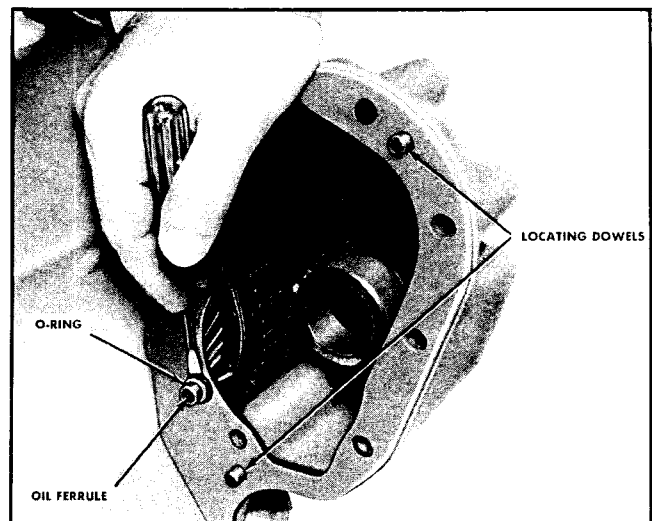


Fig. 4-7. Supercharger locating dowels and oil ferrule

4. Slip a new rubber O-ring over the flange on the intake manifold.

5. Shellac a new gasket to the supercharger and lift the supercharger to the back of the gear housing. Mesh the drive gear with the idler driven gear and assemble supercharger to gear housing cover.

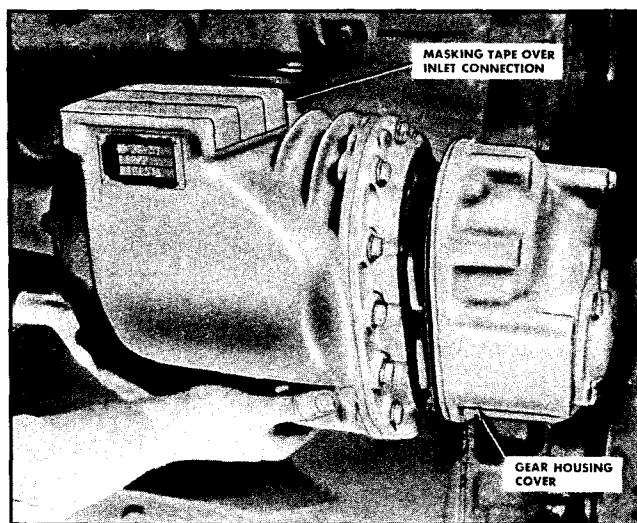


Fig. 4-8. Installing supercharger

6. Insert the seven capscrews through the front of the gear housing cover and tighten the supercharger securely to the gear housing.

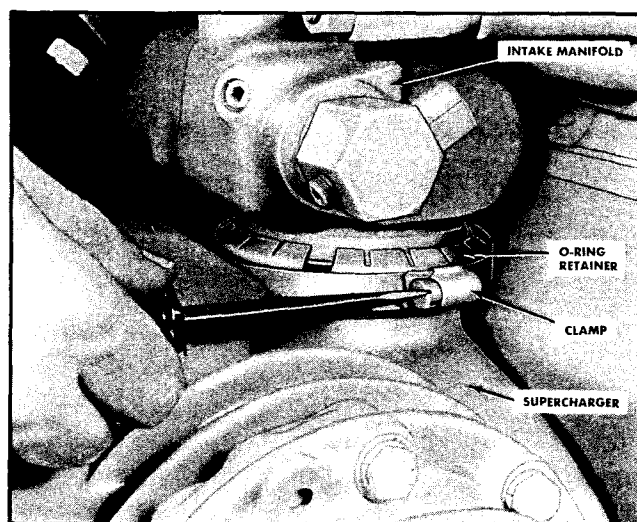


Fig. 4-9. Clamp on O-ring retainer

7. Roll rubber O-ring into position at intake manifold. Install retaining ring and secure in position with airplane clamp. Install water pump as described on Page 4-3. Remove tape and install air inlet connection to supercharger with four capscrews and lockwashers, using a new gasket. Tighten rubber hose connections securely.

## FAN AND PULLEY

### REMOVAL:

1. Remove fan from fan pulley.
2. Loosen fan hub nut; turn adjusting screw to loosen belt. Remove capscrews; lift fan hub and bracket from engine.

### INSTALLATION:

1. Assemble bracket and pulley to block with lockwashers and capscrews.
2. Install fan pulley V-belts; loosen large hex nut and bring belts to proper tension with pulley adjusting screw. See Page 3-15. Tighten hex nut.
3. On engines with water pump driven from fan hub, proceed as follows:
  - a. Before tightening fan drive belts, loosen water pump belt by separating water pump pulley sheaves.
  - b. Tighten fan drive belts to proper tension as described in Paragraph 2.

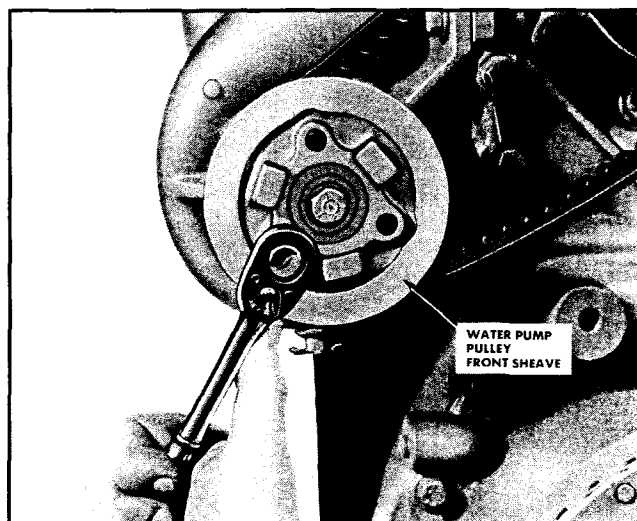


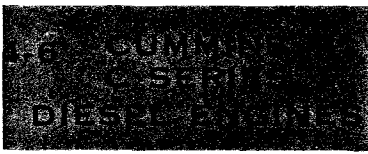
Fig. 4-10. Adjusting water pump pulley sheaves

- c. Tighten water pump belt by adjusting water pump pulley sheaves. Fig. 4-10.

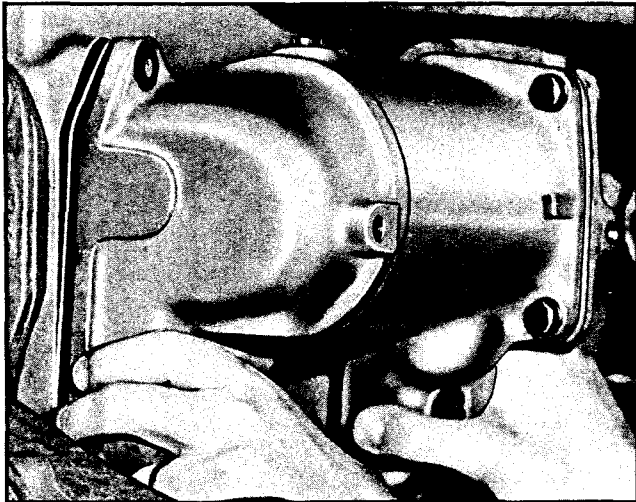
## OIL COOLER

### REMOVAL:

1. Disconnect oil and water lines and electric units. Remove capscrews holding oil cooler to cylinder block.
2. Remove and discard gaskets and O-ring on water connection.



3. Insert capscrews in holes in cooler element. Pull element from housing.



*Fig. 4-11. Remove oil cooler*

#### **Cleaning:**

1. Clean element in approved solvent.

**CAUTION:** DO NOT USE SOLVENT THAT WILL HARM COPPER. DO NOT USE MECHANICAL CLEANING METHOD SUCH AS SCRAPING.

2. Finish cleaning with compressed air.
3. Clean housing with solvent and compressed air.

#### **INSTALLATION:**

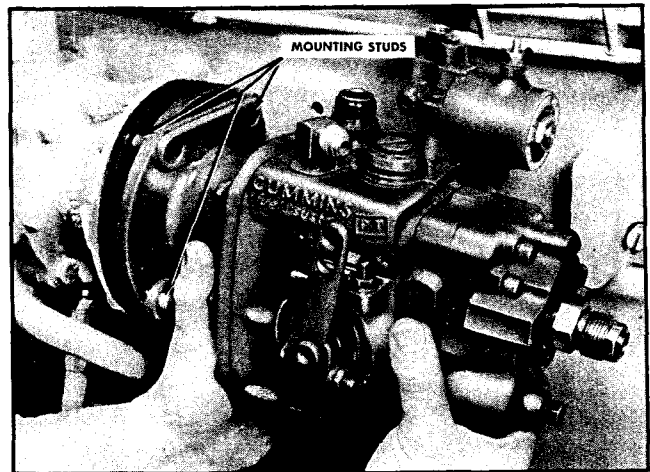
1. Position oil cooler on cylinder block; secure with lockwashers and capscrews. Use new gaskets and O-ring on water pump connection.
2. Connect water and oil lines and electric units removed from cooler.

#### **FUEL PUMP**

##### **REMOVAL:**

The fuel pump is flange-mounted to accessory drive on gear housing or rear of air compressor.

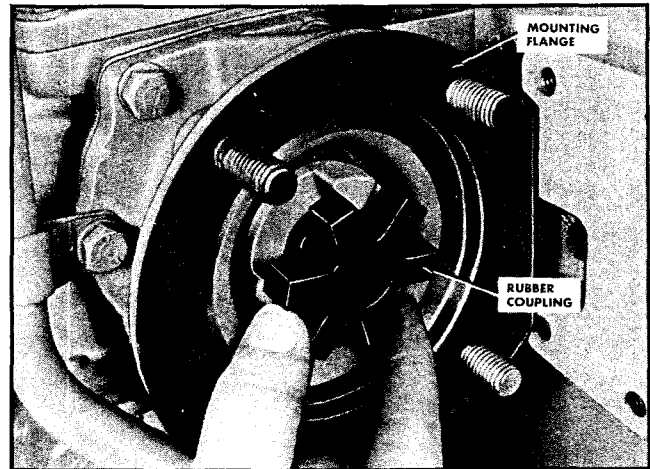
1. Disconnect throttle linkage, shut down valve wiring and fuel inlet and drain lines.
2. Disconnect tachometer cable, if used.
3. Remove stud nuts or capscrews holding fuel pump to accessory drive or air compressor.
4. Lift fuel pump from engine.
5. Remove rubber coupling from drive unit.



*Fig. 4-12. Remove fuel pump*

#### **INSTALLATION:**

1. Install rubber coupling to fuel pump drive unit.
2. Install new gasket and assemble fuel pump to accessory drive or air compressor.



*Fig. 4-13. Fuel pump drive rubber coupling*

3. Install flat washer, lockwasher, then nut or cap-screw. Tighten securely.

**NOTE:** See that flat washers are next to fuel pump.

4. Attach fuel inlet and drain lines, electric connections, linkage and cables.

#### **AIR COMPRESSOR**

Two types of air compressors are used on Cummins engines. Following are removal and installation instructions for each type.

## **CUMMINS:**

### **Removal:**

The Cummins air compressor is flange mounted to the gear case and gear-driven off the camshaft.

1. Remove capscrew, lockwasher and washer securing accessory drive pulley to compressor crankshaft.
2. Remove pulley from crankshaft with puller.

**CAUTION:** REPLACE CAPSCREW IN END OF CRANKSHAFT TO PREVENT DAMAGE TO THREADS.

3. Remove accessory drive pulley key.
4. Remove fuel pump as described on Page 4-6. Discard gasket.
5. Disconnect air, water and oil lines from compressor.
6. Remove capscrews and lockwashers mounting compressor support to gear case. If compressor is bracket mounted, remove capscrews and lockwashers securing compressor to bracket.
7. Lift compressor from engine; discard gasket.

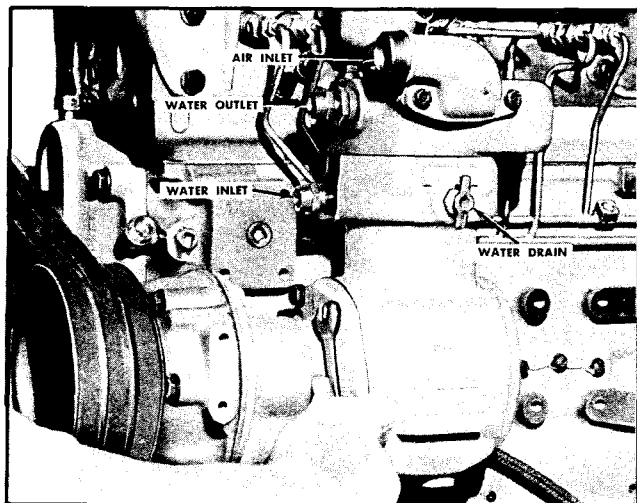
**CAUTION:** DO NOT LOSE COUPLING RETAINER PLATE AND RUBBER BUFFER FROM FUEL PUMP END OF CRANKSHAFT.

### **Installation:**

1. Using a new gasket, install compressor to gear case. Secure with lockwashers and capscrews. Fig. 4-14.

**CAUTION:** INDEX TIMING MARKS ON COMPRESSOR DRIVE GEAR AND CAMSHAFT GEAR.

2. Connect air, water and oil lines to compressor.
3. If removed, install coupling retainer plate and rubber buffer on fuel pump end of crankshaft.



*Fig. 4-14. Install air compressor — Cummins*

4. Using a new gasket, install fuel pump. See Page 4-6.

5. Install accessory drive pulley key in crankshaft by tapping in place with plastic mallet.

6. Remove large capscrew from end of crankshaft.

7. Install accessory drive pulley on crankshaft with puller. Secure with washer, lockwasher and capscrew.

## **BENDIX-WESTINGHOUSE:**

### **Removal:**

The Bendix air compressor is flange mounted to accessory drive and driven by a splined-sleeve type drive coupling from accessory drive shaft.

1. Remove fuel pump. See Page 4-6. Disconnect oil inlet line from air compressor drive.

2. Remove oil drain tube from bottom of compressor. Disconnect water and air tubing from compressor.

3. Remove capscrews holding compressor support to cylinder block and capscrews holding air compressor to accessory drive.

4. Remove compressor and splined coupling. Discard gasket.

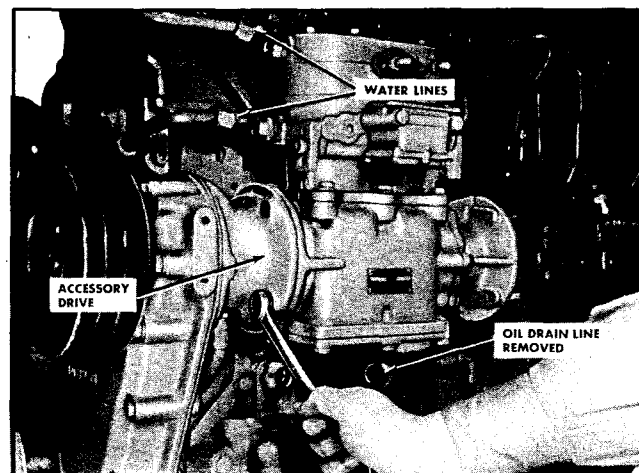
### **Installation:**

1. Assemble splined coupling to compressor. Fig. 4-16. Assemble air compressor to accessory drive using new gasket. Install capscrews and lockwashers.

2. Attach compressor support to block with flatwashers, lockwashers and capscrews.

3. Connect water, air and oil lines.

4. Install fuel pump. See Page 4-6.



*Fig. 4-15. Install air compressor — Bendix-Westinghouse*

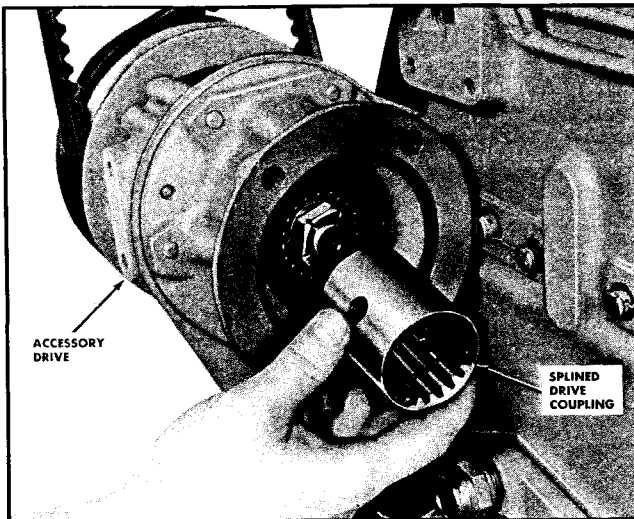
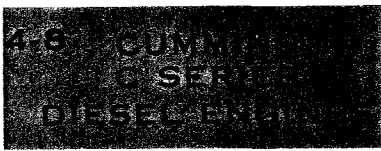


Fig. 4-16. Installing splined coupling

## TURBOCHARGER

### REMOVAL:

1. Remove water lines connecting turbocharger to thermostat housing and oil cooler, if used.
2. Remove oil lines connecting turbocharger to gear case cover or oil cooler and crankcase.
3. Disconnect hose connection from turbocharger to intake manifold.
4. Loosen and remove mounting capscrews; lift turbocharger from exhaust manifold mounting flange.

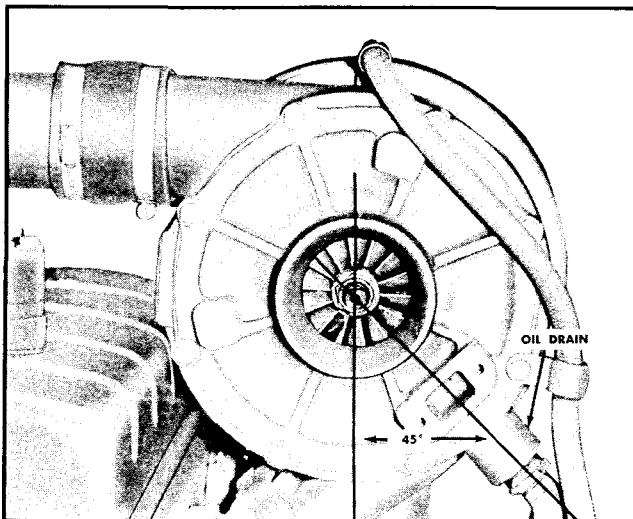


Fig. 4-17. Oil drain position

### INSTALLATION:

The following instructions apply specifically to top-mount and rear-mount applications; however, the same general principles must be followed when mounting Cummins turbochargers in other positions:

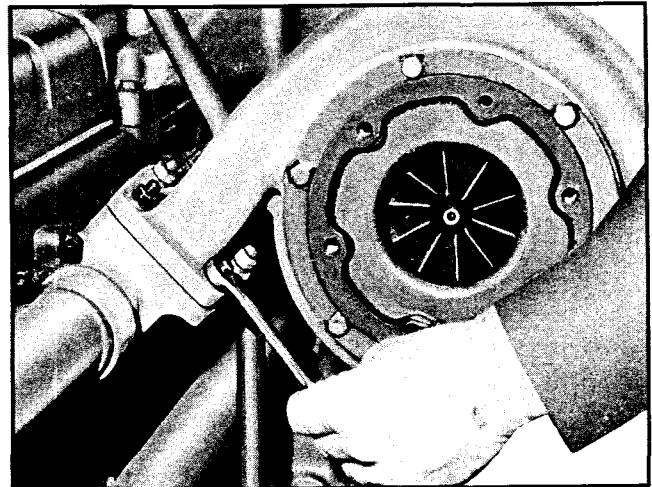


Fig. 4-18. Mounting turbocharger

1. Check position of lubricating oil drain (large boss). Oil drain must always be down or within 45° of that position when turbocharger is mounted on engine. Fig. 4-17.
2. Install gasket.
3. Coat turbocharger mounting capscrews with anti-seize compound such as Never-Seez, or equivalent.
4. Lift turbocharger into position and secure with capscrews. Fig. 4-18.

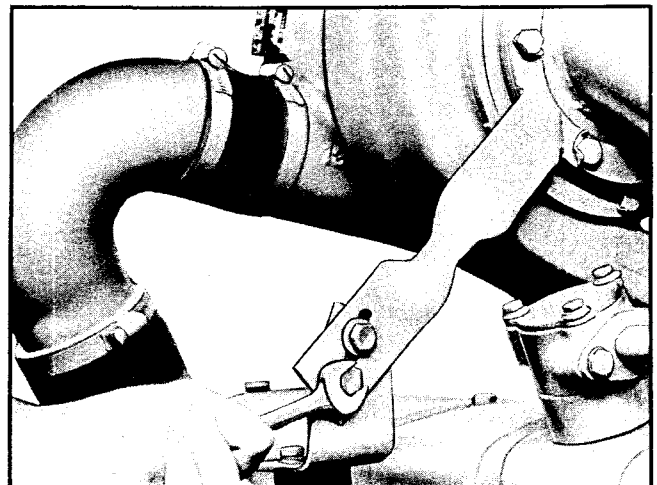


Fig. 4-19. Turbocharger support bracket

5. Secure turbocharger support bracket, if used. (Rear-mount fastens to clutch housing). Fig. 4-19.

6. Assemble water inlet line, if used, from bottom of turbocharger to oil cooler.

7. If turbocharger is water cooled, assemble water outlet line from top of turbocharger to thermostat housing and install oil flow regulator valve in oil cooler. With rear mount turbocharger, regulator is installed in elbow in oil transfer connection.

NOTE: Oil cooled turbochargers do not have oil regulator valves.

8. Connect oil supply and drain lines. Fig. 4-20.

9. Assemble and tighten air inlet and outlet piping to turbocharger. *Do not carry the exhaust piping weight on the turbocharger.*

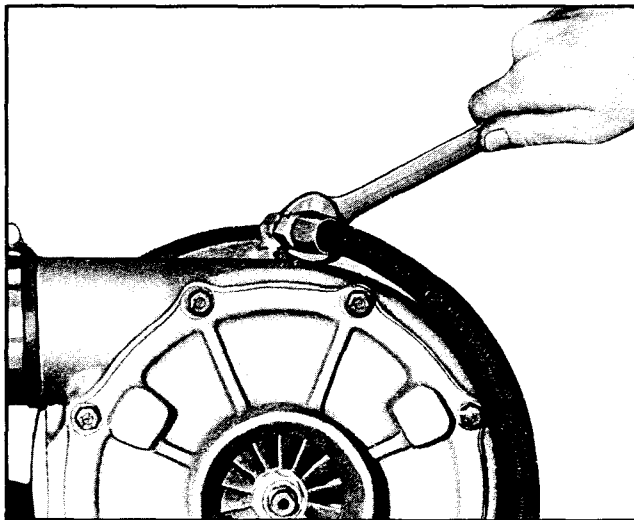


Fig. 4-20. Connect turbocharger oil inlet line

#### TURBOCHARGER LINE SIZES

Oil Inlet 5/16 I.D.

Oil Drain 1/2 I.D.

### INJECTORS

#### REMOVAL:

1. Remove the rocker lever cover.
2. Disconnect and remove the fuel supply and drain manifolds.
3. Remove the fuel inlet and drain connections from the injector and cylinder head.
4. Loosen injector adjusting nut and disengage rocker lever from injector and push tube. Turn rocker lever backward to allow removal of injector.

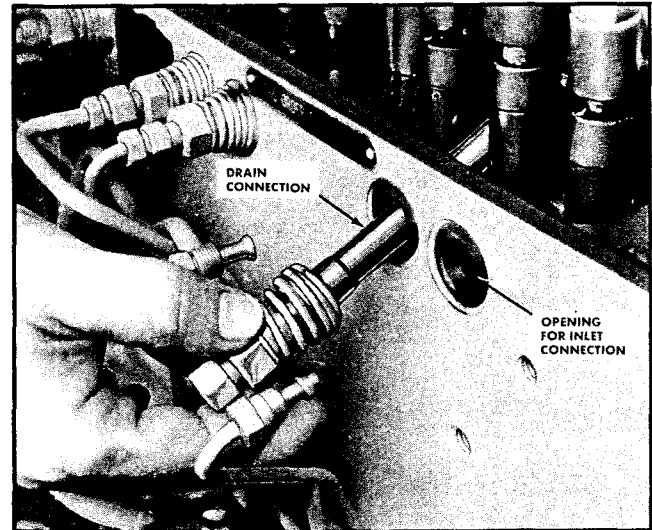


Fig. 4-21. Removing fuel drain connection

5. Remove the capscrews and lift the injector from the cylinder head. Be careful not to damage the tip of the injector cup or to drop the injector plunger.

#### INSTALLATION:

1. Before installing an injector, wrap a clean cloth around a wooden stick and clean out the injector sleeve in the cylinder head. Never use a metal rod or waste material in this cleaning operation. Do not scrape the injector seat as the sleeve is made of copper, and it can be easily scratched or marred.
2. Place injector in position with hold-down capscrews, but do not tighten. Use new copper gaskets

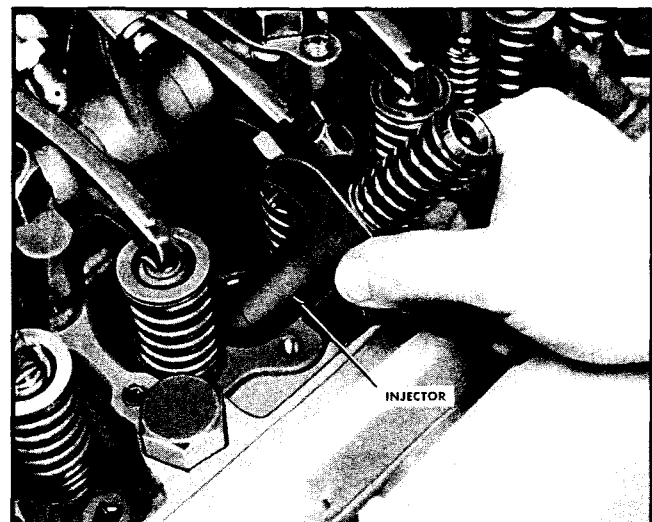


Fig. 4-22. Installing injector

and start fuel inlet and drain connections into the injector by hand to avoid cross threading. Inlet connections are on the right as you face the cylinder head.

3. Tighten injector hold-down capscrews with torque wrench to 10/12 foot-pounds. Tightening these capscrews to excess will distort the valve seats and crack the cylinder head.

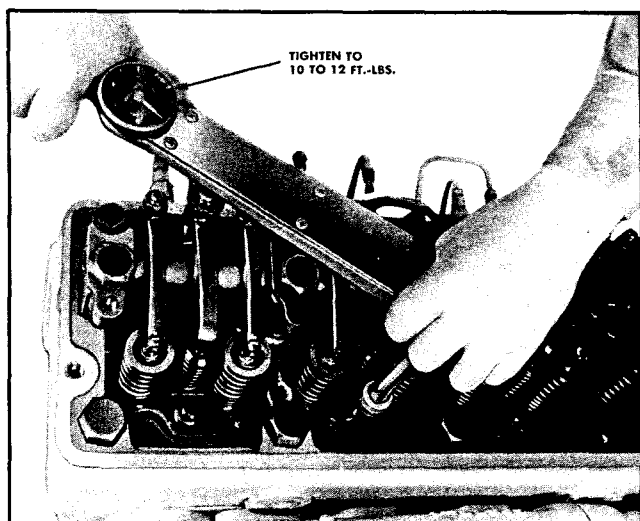


Fig. 4-23. Tightening hold-down capscrews

4. Tighten the connection to 20/25 foot-pounds with torque wrench.
5. Adjust injector plunger as described on Page 3-11.
6. Install the fuel supply and drain manifolds.
7. Install rocker lever cover.

## CYLINDER HEAD

### Removal:

1. If generator is high-mounted, remove generator and bracket.
2. Remove rocker lever cover. Discard gasket.
3. Remove intake and exhaust manifolds. Discard gaskets.
4. Disconnect thermostat hoses; remove thermostat housing from cylinder head. Discard gasket.
5. Disconnect and remove fuel inlet and drain manifolds from cylinder head.
6. Disconnect water lines.
7. Loosen injector plunger adjustment. To facilitate baring engine over at assembly, do not alter valve adjustment.

8. Loosen and remove cylinder head and rocker lever bearing capscrews.

9. Using a board to keep levers in position, lift rocker lever assembly from engine. Fig. 4-24.

10. Lift push tubes from push tube cavities.

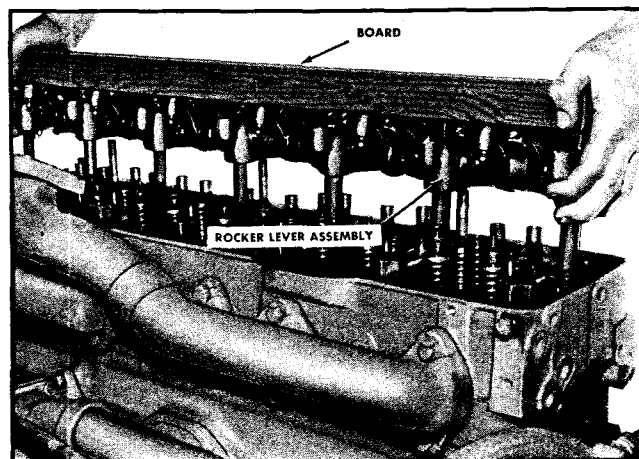


Fig. 4-24. Rocker lever assembly

11. Remove injectors. Page 4-9.
12. Attach lifting fixture to cylinder head; remove head from block.
13. Remove cylinder head gasket, grommets and grommet retainers; discard all these parts.



Fig. 4-25. Installing head gasket

### Installation:

1. Wipe cylinder head and block mating surfaces with lint-free rag.
2. Place grommet retainer in block water passages,

small end up. Fig. 4-26. If water hole in block is eroded, install retainer then rubber grommet. If water hole in head is eroded, install rubber grommet then retainer with small end down.

**NOTE:** All engines prior to serial number 248989 have  $\frac{1}{4}$  inch water holes in the block and head. At first rebuild, drill out water holes to  $\frac{7}{16}$  inch and install grommet retainer sleeves for use thereafter.

**CAUTION:** DO NOT ALLOW GROMMETS TO CONTACT FUEL OR LUBE OIL TO PREVENT DAMAGE DUE TO SWELLING.

3. Install new gasket with word "TOP" up.



Fig. 4-26. Installing grommets and retainers

4. Lower cylinder head onto block.

**NOTE:** Cylinder head must be parallel with block when under-surface of head touches block.

5. Remove lifting fixture.

6. Install push tubes; largest in diameter is center or injector push tube.

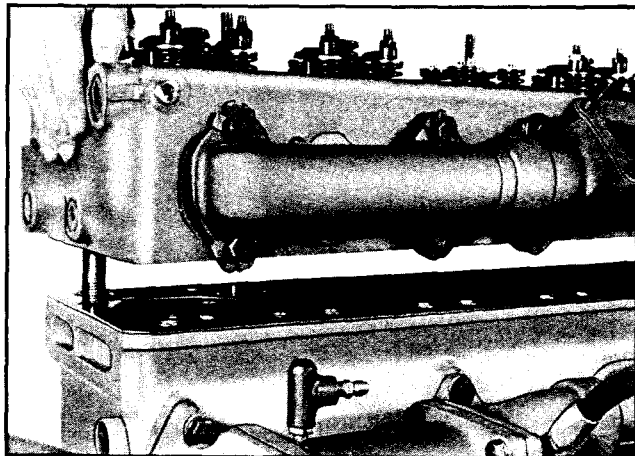


Fig. 4-27. Lowering head on gasket

7. Check to see that center oil supply dowel and ventilator plug are in position on cylinder head. Ventilator plug holes must be open. Fig. 4-28. If engine is turbocharged or supercharged, plug breather hole with  $\frac{1}{8}$  N. P. T. plug.

8. Install long cylinder head capscrews through rocker lever bearings to use as guides when installing rocker levers.

9. Using a board to keep rocker levers in position, lower rocker lever assembly into position on cylinder head. Fig. 4-24.

10. Dip all cylinder head capscrews or stud nuts in clean lubricating oil. DO NOT USE GREASE OR LUBRIPLATE. Install head capscrews or stud nuts finger tight.

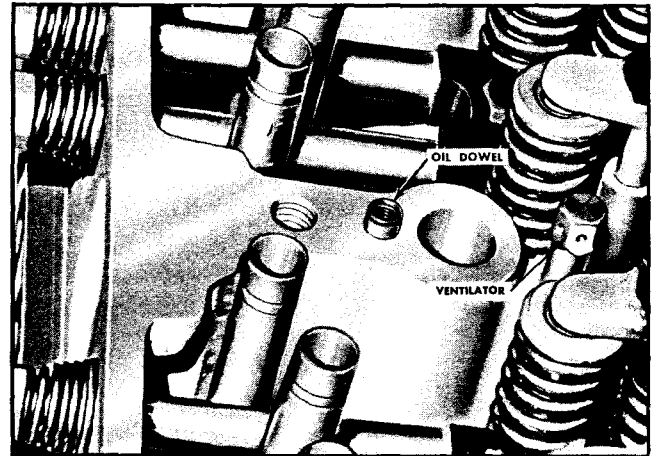


Fig. 4-28. Oil transfer dowel

11. Tighten all cylinder head capscrews, in sequence, to 25 ft. lbs. Fig. 4-29.

12. Check rocker levers to see they are free. End bearings and center bearing are dowelled into position, intermediate bearings are not. These bearings may shift to extent that rocker levers will bind on shaft when head is tightened.

13. Install rocker lever bearing capscrews and tighten securely.

14. Tighten all cylinder head capscrews, in sequence (Fig. 4-29) to foot-pound torque values shown in table below.

TABLE — CYLINDER HEAD CAPSCREW TORQUE

3/4" capscREW	
Step 1	25
Step 2	100
Step 3	390

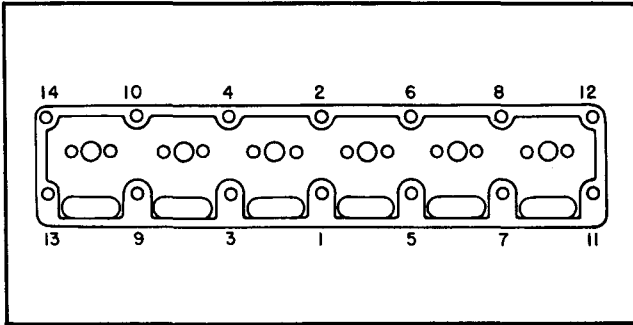


Fig. 4-29. Tightening sequence

15. Install injectors. Page 4-9.
16. Adjust injector plungers and valves. Page 3-11.
17. Using new gaskets, connect water tubing, fuel supply and drain manifolds, thermostat housing and generator.
18. Using new gaskets, install intake and exhaust manifolds. Tighten exhaust manifold capscrews to 22 foot-pounds. Tighten from center toward ends, alternating from top to bottom capscrew. Fasten lock plates on exhaust manifold.
19. Install rocker lever cover gasket and rocker lever cover.

**NOTE:** Current rocker lever covers have a gasket retaining channel. Use only gasket Part No. 128428 with this style rocker lever cover.

20. Install electric wiring, air and water tubing and other units removed.

## GOVERNOR ADJUSTMENTS

### STANDARD HIGH-SPEED GOVERNOR:

#### High Speed Adjustment:

Maximum engine speed is adjusted by adding or removing shims under the high-speed governor spring. Normally this adjustment is made on the fuel pump test stand as the fuel pump is calibrated.

#### Idle Speed:

1. Warm engine up to 140° F. oil temperature, then shut off or let it idle.
2. Remove pipe plug from spring pack cover. Fig. 4-30.
3. The idle adjustment screw is held in position by a spring clip. Turn screw in to increase, or out to decrease the speed. Idle speed should be set 40 to 50 rpm lower than desired if the adjustment is made with

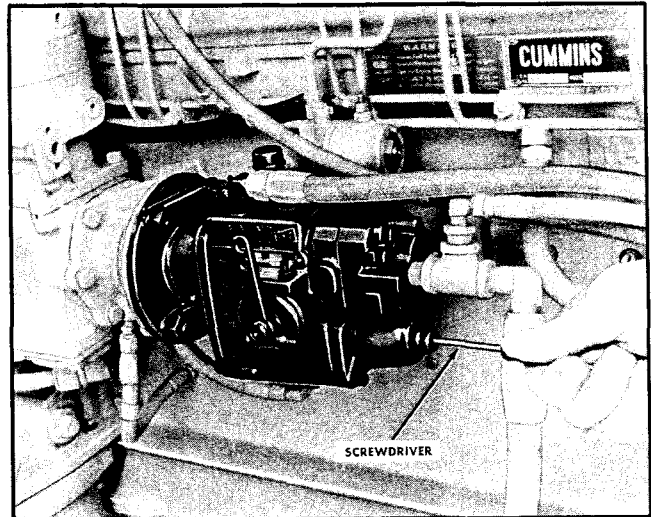


Fig. 4-30. Idle speed adjustment

the engine running. With the engine running, air collects in the spring pack housing, and speed change results when the housing fills with fuel.

4. Replace pipe plug.

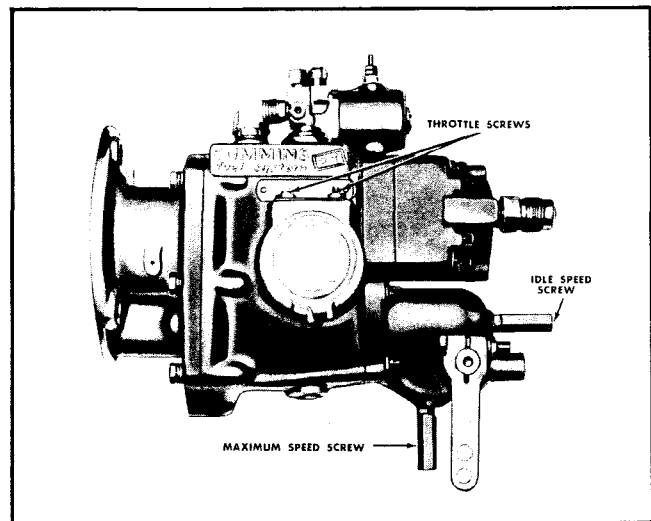


Fig. 4-31. Adjusting screws, variable-speed governor

### VARIABLE-SPEED GOVERNOR:

Both the maximum and idle adjusting screws are located on the governor cover. To adjust:

1. Loosen the adjusting screw lock nut.
2. Screw adjusting screw in or out to get speeds required. Fig. 4-31.
3. Tighten adjusting screw lock nut.

### PT TORQUE CONVERTER GOVERNOR:

1. Disconnect the torque-converter governor flexible drive cable, or declutch the converter from the engine so the engine governor will have complete control of the engine. Disconnect the drive cable at the converter to prevent the cable from whipping.

2. Hold the converter lever in clockwise position and turn in converter governor idle screw "C" (Fig. 4-32) until you are sure the spring is compressed. Turn adjusting screw out; then, back in slowly to check this adjustment.

3. Start the engine and rotate the engine governor lever in a clockwise direction; then, set engine idle speed by adjusting the idle screw "A" to get 515 to 700 rpm. See Fig. 4-32.

4. Set approximate engine maximum no-load speed by adjusting maximum speed screw "B" while holding engine governor lever against its stop; turn lever in counterclockwise direction. See Fig. 4-32.

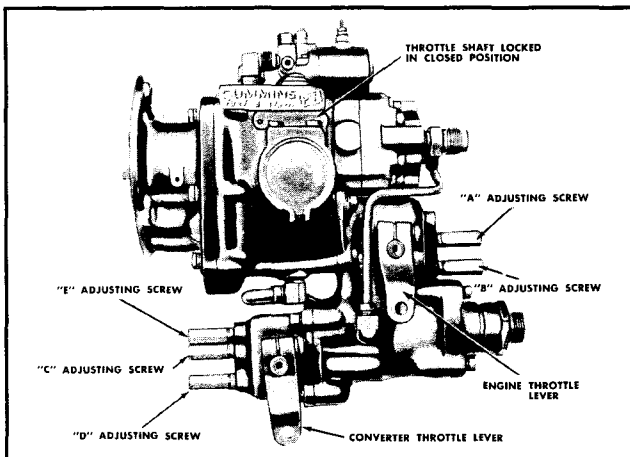


Fig. 4-32. PT Pump with torque converter governor

5. Stop the engine and engage the torque-converter clutch or connect the flexible drive cable to the torque-converter governor. Make sure that engagement is made so that the torque converter drives the governor. The flexible cable should have 10" radius bends, or larger, for satisfactory service life.

6. Start the engine and bring speed up to 1000 rpm with engine governor lever.

7. Advance speed of engine until engine speed reaches rated speed of converter tailshaft.

8. Decrease speed at torque-converter governor by adjusting screw "C" (out) until converter speed can be controlled by the converter governor lever; turn lever in a counterclockwise direction.

9. Advance engine governor to maximum speed position.

10. If the unit has a single speed setting:

a. Adjust screw "C" to get rated no-load tailshaft speed of converter. Fig. 4-32.

b. Adjust screw "D" until converter governor lever is locked in place. Fig. 4-32.

11. If the unit has a two-speed setting:

a. Adjust screw "C" to get no-load tailshaft speed of converter. Fig. 4-32.

b. Adjust screw "D" until you reach maximum converter speed desired. Fig. 4-32.

### Adjustments For Minimum Fuel:

1. Operate the engine at full speed, no-load, with tailshaft governor in operation.

2. Loosen screw "C", Fig. 4-32, and back out approximately  $\frac{3}{4}$  inch.

3. Move the converter governor throttle lever counterclockwise until engine is reduced to 400 rpm. Hold in this position.

4. Loosen screw "E" and turn clockwise approximately  $\frac{1}{16}$  inch, until engine speed begins to increase 450 rpm.

5. Lock screw "E" in position and readjust screw "C" as described previously.

### Stall Speed Settings:

Where a given speed is important with converter output shaft stalled, check as follows:

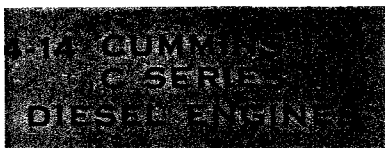
1. Stall the converter and check the engine speed.

2. If engine rated speed is excessive, adjust the engine governor maximum-speed adjusting screw "B", or if governor adjustment does not affect the unit, decrease fuel delivery.

3. If engine speed is low, adjust the engine-governor maximum-speed adjusting screw "B" or if the governor adjustment does not affect the unit, the fuel delivery must be increased. Check fuel delivery on a pump test stand.

### Changing Speed-Droop Converter Governor:

Due to the variety of applications, converter ratios and operator preference for different operating characteristics, the converter governor spring furnished in the fuel pump may not give the desired speed droop. Speed droop is controlled by changing springs; the springs listed below give a full droop range, the top spring gives the most droop and those below correspondently less.



**TABLE: CONVERTER GOVERNOR SPRINGS**

<i>Part Number</i>	<i>Color Code</i>
109690	Pink
109689	Gray
109688	Brown
70822	Green
109687	Yellow
109686	Blue
70821	Green and White
107787	Yellow and Blue
101002	White
110461	Purple
110460	Orange
105422	Black
118935	Orange and White

**Adjustments For Unstable Speeds:**

1. Start with minimum output shaft speed setting; then, loosen pump throttle screws and adjust so the throttle shaft turns in counterclockwise direction until engine speed increases 10 to 15 rpm. Continue throttle screw adjustment one-half turn of screws or approximately 10 to 20 rpm more and lock in place. *Make this check with a hot engine only.*

a. If throttle leakage is too high, the engine speed will tend to over-speed after the load is released and engine rpm will stay up.

b. If throttle leakage is too low, the engine speed will surge or be unstable at half or no-load.

2. If necessary readjust converter-governor speed-adjusting screws as described in steps 10 or 11 (Page 4-13.) to get maximum speed of the unit.

**CUMMINS**

## **C SERIES DIESEL ENGINES**

### **Section V**

#### **TROUBLE SHOOTING**

The term "trouble shooting" means locating the basic cause of the difficulty so that when repairs are made there will be no repetition of the failure. Trouble shooting, in most cases, is very simple. In the majority of problems the only requirement is a knowledge of the construction of the units and the principles of its operation. Knowing these two factors, anyone who is qualified to make repairs on the unit can start at the beginning and follow through each step in the functioning of each part until the cause of the trouble is found.

Trouble shooting is nothing more nor less than an organized study of the problem and a planned method of procedure for the investigation and correction of the difficulty. The following chart includes some of the most common complaints that may be encountered during the service life of your diesel engine.

The chart does not give all the answers for correction of the complaints listed, but it is meant to stimulate a train of thought and indicate a work procedure directed to the source of the trouble.

#### **THINK BEFORE YOU ACT:**

Study the problem thoroughly. Ask these questions:

What were the warning signs preceding the trouble?

What previous repair and maintenance work has been done?

Has similar trouble occurred before?

If the engine still runs, is it safe to continue running it to make further checks?

#### **DO EASIEST THINGS FIRST:**

Most troubles are simple and easily corrected; examples are "low-power" complaints caused by loose throttle linkage or dirty fuel filters, "excessive lube oil consumption" caused by leaking gaskets or connections, etc.

Always check the easiest and most obvious things first; you will save time and trouble.

#### **DOUBLE-CHECK BEFORE YOU BEGIN DISASSEMBLY OPERATIONS:**

The source of most engine troubles can be traced not to one part alone but to the relationship of one part with another. Too often, engines are completely disassembled in search of the cause of a certain complaint and all evidence is destroyed during disassembly operations. Check again to be sure you have not missed an easy solution to the problem.

#### **FIND AND CORRECT THE BASIC CAUSE OF THE TROUBLE:**

After a mechanical failure has been corrected, be sure to locate and correct the cause of the trouble so that the same failure will not repeat itself. A complaint of "sticking injector plungers" is corrected by repairing or replacing the faulty injectors, but something *caused* the plungers to stick. The cause may be improper injector adjustments, or more often, water in the fuel.

# TROUBLE SHOOTING

CUMMINS DIESELS

## Complaints

Hard Starting or Failure to Start  
 Engine Misses  
 Excessive Smoking at Idling  
 Excessive Smoke Under Load  
 Low Power or Loss of Power  
 Cannot Reach Governor RPM  
 Throttle Has Flat Spot  
 Excessive Fuel Consumption  
 Poor Operation  
 Erratic Idle Speeds  
 Engine Dies  
 Surging at Governor RPM  
 Excessive Lube Oil Consumption  
 Crankcase Sump  
 Oiling  
 Low Lubricating Oil Pressure  
 Coolant Temperature Too Low  
 Coolant Temperature Too High  
 Lube Oil Too Hot  
 Piston Liner and Ring Wear  
 Wear of Bearings and Journals  
 Worn Valves and Guides  
 Pin Knock  
 Mechanical Knock  
 Gear Train Noise  
 Excessive Engine Vibration

## Causes

### Air System

Restricted Air Intake  
 High Exhaust Back Pressure  
 Thin Air in Hot Weather or High Altitude  
 Air Leaks Between Cleaner & Engine  
 Worn Turbocharger Seal & Bearing  
 Dirty Crankcase Breather

### Fuel System

Out of Fuel or Fuel Shut-Off Closed  
 Poor Quality Fuel  
 Air Leaks in Suction Lines  
 Restricted Fuel Lines  
 Pressure Regulator Faulty or Set Wrong  
 External or Internal Fuel Leaks  
 Plugged Injector Spray Holes  
 Broken Fuel Pump Drive Shaft  
 Scored Gear Pump or Worn Gears  
 Loose Injector Inlet or Drain Connection  
 Wrong Injector Cups  
 Cracked Injector Body or Cup  
 Multilobed Injector Cup "O" Ring  
 Throttle Linkage  
 Incorrect Assembled Idle Springs  
 Governor Weights Assembled Incorrectly  
 High-Speed Governor Set Too Low

### Lubricating System

External and Internal Oil Leaks  
 Dirty Lube Oil Strainer  
 Faulty Cylinder Oil Control  
 Clogged Oil Drillings  
 Oil Suction Line Restriction  
 Faulty Oil Pressure Regulator  
 Crankcase Out of Oil  
 Wrong Grade Oil for Weather Conditions

### Cooling System

Insufficient Coolant  
 Worn Water Pump  
 Faulty Thermostats  
 Damaged Water Hose  
 Loose Fan Belts  
 Radiator Shutters Stuck Open  
 Clogged Water Passages  
 Internal Water Leaks  
 Clogged Oil Cooler  
 Radiator Core Openings Plugged with Dirt  
 Air in Cooling System  
 Exterior Water Leaks  
 Insufficient Radiator Capacity

### Operation and Maintenance Practices

Dirty Filters and Screens  
 Long Idle Periods  
 Engine Overloaded  
 Lube Oil Needs Changing  
 Engine Exterior Caked with Dirt

### Mechanical Adjustments or Repair

Gasket Blow-by or Leakage  
 Faulty Vibration Damper  
 Unbalanced or Loose Flywheel  
 Valve Leakage  
 Broken or Worn Piston Rings  
 Incorrect Bearing Clearances  
 Excessive Crankshaft End Clearance  
 Main Bearing Bore Out of Alignment  
 Engine Due for Overhaul  
 Damaged Main or Conn. Rod Bearings  
 Broken Tooth in Gear Train  
 Excessive Gear Back Lash  
 Misalignment of Engine with Driven Unit  
 Loose Mounting Bolts  
 Incorrect Valve and Injection Timing  
 Worn or Scored Liners or Pistons  
 Injectors Need Adjustment

Think!  
before you act

Investigate  
all possible causes

Correct  
the trouble

Re-Check  
the finished job



## C SERIES DIESEL ENGINES

### Section VI

#### ENGINE SPECIFICATIONS

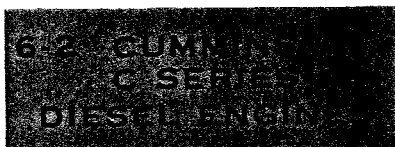
Cummins C Series engines are full-diesel, 4-stroke-cycle type. Valves are located in the head. Fuel oil specifications are detailed on Page 3-14 and lubricating oil specifications on Page 3-8. Horsepower ratings for each model engine are listed on Page 1-10.

Firing order for 4-cylinder right-hand engines is 1-2-4-3, and for 6-cylinder engines it is 1-5-3-6-2-4.

Detailed engine specifications and dimensional specifications are given in the chart and tables which follow.

#### UNIT SPECIFICATIONS

PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
	Minimum	Maximum	
CAMSHAFT			
Journal Diameter			
Nos. 2, 3, 4, 5, 6, 7	1.872	1.873	1.871
Front Journal Diameter	1.747	1.748	1.746
CONNECTING ROD			
Center to Center	9.498	9.500	Same
Crankpin Bore	2.7725	2.7730	
Piston Pin Bushing	1.500	1.5005	1.5015
Bore Misalignment—Bend	.000	.004 in 12"	.004 with ST-561 & 562
Bore Misalignment—Twist	.000	.010 in 12"	.010 with ST-561 & 562



PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT
	Minimum	Maximum	LIMIT
CRANKSHAFT			
Main Journals	3.874	3.875	3.872
Rod Journals	2.624	2.625	2.622
Fillet Radii	.141	.164	Same
Main Bearings—Copper Lead			
Shell Thickness	.1231	.1236	.1216
Journal Clearance	.0018	.0048	.0068
End Clearance	.004	.011	.022
Tightening	Template Method		
.010, .020, .030 and .040 undersize main bearing shells are available.			
Con. Rod Bearings—Copper Lead			
Shell Thickness	.07225	.07275	.071
Journal Clearance	.002	.0045	.008
Tightening	Template Method		
.005, .010, .020, .030 and .040 undersize connecting rod shells are available.			
CYLINDER BLOCK			
Protrusion of Liner Above Block	.0045	.00675	.004
Main Bearing Bore	4.124	4.125	Same
Camshaft Bushings I.D.	1.8745	1.8765	1.878
Cylinder Liners—I.D.	4.437	4.438	4.442
CYLINDER HEAD			
Tighten Capscrews:			
Foot-pounds 3/4"	380	400	
Intake and Exhaust Valve			
Seat Angle	30°	30°	30°
Valve Guide Bore	.3425	.3432	.345
Valve Crosshead Stem Diameter	.3708	.3713	.370
Valve Crosshead Guide	.3755	.376	.378
Injector Tip Protrusion Through Head	.040	.055	.065
Valve Clearance	Intake .015	Exhaust .025	
EXHAUST BACK PRESSURES			
Maximum Permissible—Inches of Mercury			
Naturally Aspirated and Supercharged Engines		1.0	
Turbocharged Engines		1.5	
FLYWHEEL HOUSING			
Bore Run-out	.000	.004	.004
Face Run-out	.000	.008	.008

PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
	Minimum	Maximum	
Clutch Pilot Bearing Bore Run-out	.000	.004	.004
Clutch Drive Ring Pilot Bore	.000	.004	.004
Clutch Face	.000	.005	.005
INJECTORS			
Mounting Stud Nuts Adjustment	10 ft. lbs.	12 ft. lbs.	
Refer to Page 3-11.			
INLET CONNECTIONS			
Tighten to	20 ft. lbs.	25 ft. lbs.	
LUBRICATING OIL PRESSURES			
Idling to Governed Speed	15 psi	55 psi	
Normal at Governed Speed	30 psi	50 psi	
OIL PAN			
Capacity	3 gal.	4 gal.	
PISTON			
Ring Groove Clearance	Wedge Type Keystone Rings		
Piston Pin Bore (at 70° F.)	1.4988	1.4992	1.500
Piston Pin	1.4990	1.4988	1.4978
Ring Gap Clearances (with new liners)			
112870, 112880	.013	.023	
118630	.015	.055	
.010, .020, .030 and .040 oversize pistons and rings are available for C series engines.			
ROCKER LEVER HOUSING AND LEVERS			
Shaft	1.123	1.1235	1.122
Bushings (Steel Precision)	1.1245	1.1265	1.1275
THERMOSTAT			
Low-range, opens at	160° F.	175° F.	
High-range, opens at	170° F.	185° F.	

