

INTRODUCTION

This maintenance manual has been prepared especially for the men who are responsible for the up-keep and availability of Cummins Diesel engines in construction, mining, and similar fields. It is recognized that these are the industries where maintenance is often difficult to practice, but they are also the ones which may profit most from maintenance work.

Objectives as well as procedures are described for every maintenance operation.

The program described herein is simple, realistic, easy to control, and a profitable one to practice.



CONSTRUCTION & INDUSTRIAL

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NEED FOR MAINTENANCE

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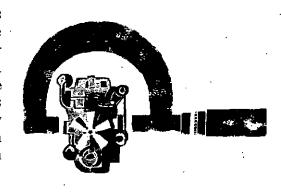
DIESEL MAINTENANCE



- 1 Keep dirt out of the engine
- 2 Maintain a lubricating film on all bearing surfaces
- Regulate the engine's fuel
- 4 Control operating temperatures
- 5 Guard against corrosion
- $oldsymbol{6}$ Let the engine breathe
- 7 Prevent overspeeding
- Know your engine's condition
- ${\mathfrak S}$ Correct troubles while they are simple
- 10 Schedule and control your maintenance

MINIMITAN BOT DEEM

If a person would watch a hundred new Cummins Diesels being built, he would expect each of them to have the same life expectancy. Further, this opinion would be confirmed after watching the engines come to life on the dynamometers and produce uniform horsepower. If the same person could see the same hundred engines a year later he would have to revise his opinion about uniform life expectancy. Two of the engines may have died an accidental death; a dozen of them may have been rebuilt, and the condition of all the others would range from very good to poor.





What makes uniform engines develop individual ailments? Why do some wear out after only a few hundred hours' operation while others last ten or twenty times as long — even those working just as hard and in the same type of equipment? How can an owner make sure his engine won't be one of the short-lived ones?

Engine owners and manufacturers' research departments have worked together and found positive ways of extending life. All their recommendations can be reduced to ten maintenance steps which will result in:

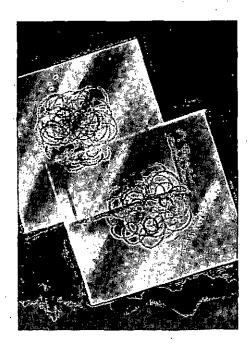
> Increased Equipment Availability Decreased Operating Expense Improved Working Conditions

These ten steps apply to any model or series of Cummins Diesel engines — as they do to other engines.

KEEP DIRT OUT OF THE ENGINE



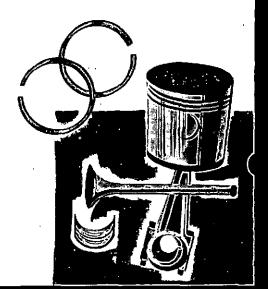
Dirt is the cause of most wear in an engine. Much of it is composed of gritty particles ranging in size from less than one ten-thousandth of an inch diameter to grains of coarse sand. The particles are hard enough to penetrate the toughest oil film and wear away metal.





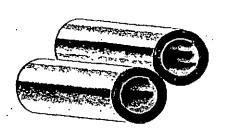
It is easy to illustrate the abrasive effects of dirt. Mix a pinch of sand with lubricating oil and put it between two pieces of glass. Exert a little pressure against one piece and rub it against the other. Wash off the dirt and look at the scratches. Or, look at the worn-out parts of an engine for signs of scratching, grinding and lapping by dirt. They are not difficult to find or recognize.

Valve stems, guides, faces, seats, cylinder and piston walls and piston rings suffer most from dirty intake air. These parts wear hundreds of times faster with dirty intake air than with air filtered by a good cleaner. A worn-out engine is one which has only an ounce or so worn away from critical bearing or sealing surfaces. Replacement of these worn parts and the time loss may cost hundreds of dollars — dollars which would have been saved by keeping out the dirt!





MAINTAIN A LUBRICATING FILM ON ALL BEARING SURFACES



Lubricating oil performs four functions in an engine: Reduces friction (heat and wear) by providing a film between bearing surfaces.

Scavenges by picking up carbon and other small particles, carrying them to the oil filter where they are taken out of circulation.

Cools pistons, liners and bearings.

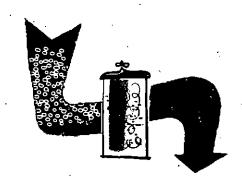
Completes the seal of rings to pistons and cylinder walls.

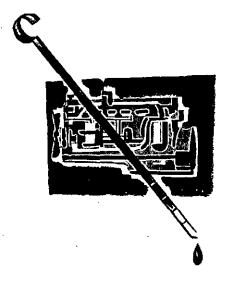
There are two broad classes of lubrication failures:

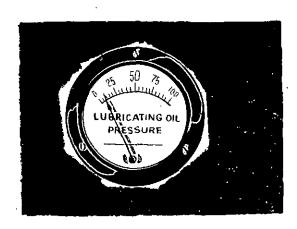
Those caused by running an engine without oil resulting in seizures of pistons or bearings within minutes.

Failures due to poor or marginal lubrication, from low oil pressure, dilution, partially clogged oil passages, or improper clearance.

Downtime and overhaul expense for one engine failure may cost as much as 1,000 oil changes.

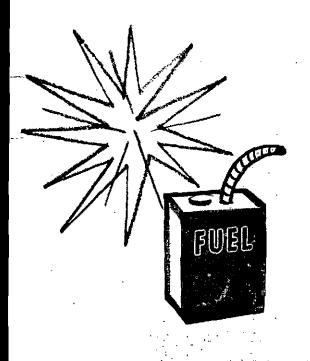






REGULATE THE ENGINE'S FUEL





Fuel must be delivered to the combustion chamber at the righttime and in condition to burn readily and completely.

Fuel injection must be complete and occur at precisely the right degree of crankshaft rotation.

Metered fuel charges must be uniform for all cylinders and injected as a fine spray to mix with the air and burn. The penalties for violations of these requirements are the same as for using poor grade fuel.

Fuel must be the type that will burn readily and completely within the engine.

Hard starting, decreased horsepower, smoky exhaust, dilution of lubrication oil, excessive wear of various engine parts, and fuel pump and injection troubles are some of the penalties of using fuel oil which does not meet recommended specifications.

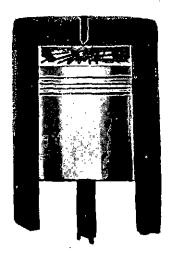


Fuel must be delivered to the combustion chamber in the right quantity.

The horsepower developed depends upon the amount of fuel being burned. Overfueling causes overspeeding and failure of turbochargers; and in a naturally-aspirated engine, it causes all the troubles associated with smoky exhaust and oil dilution. Underfueling decreases horsepower output.

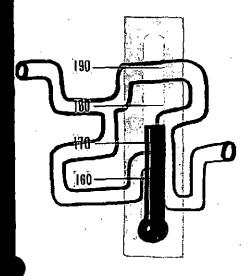
Loper fuel combustion depends upon air supply as well as fuel.

When intake air is restricted, the engine loses horsepower; the exhaust will be smoky, and some of the unburned fuel will get by the piston rings and dilute lubricating oil.





CONTROL OPERATING TEMPERATURES



Combustion temperature is high enough to melt the engine. Complete failure of the cooling system will ruin the engine within a few minutes. Nobody purposely operates an engine without water but many engines are being damaged slowly by cooling systems that are only 50% to 75% efficient.

Engine coolant temperatures should be maintained at 160°F. to 190°F.

This ideal temperature range for all operating conditions requires that every part of the cooling system be maintained in top condition. The cooling system must do its best job under the most adverse conditions. As ambient temperatures or engine loads increase, the coolant temperature rises. At the same time, it is expected to do more cooling of oil and iron masses.

When coolant temperature is below 160°F., fuel may not burn readily or produce its full power. When water temperature exceeds 190°F. and the engine is operating under full load, lubricating oil may get so hot and thin that it can not lubricate effectively.

Every part of the cooling system requires attention.

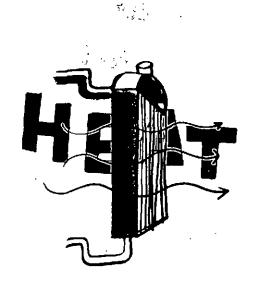
Water jackets lose ability to ABSORB heat when they become coated with scale, rust, or dirt.

Water pumps CIRCULATE less coolant as impellers wear, or as belts slip.

Thermostats fail to CONTROL water flow accurately after long periods of service.

When radiator and oil coolers get dirty they lose ability to absorb and RADIATE heat.

Water hose, gaskets and piping may develop leaks.

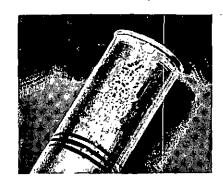


GUARD AGAINST CORROSION



Many engine owners have been shocked to find water in the crankcase and to learn that it got there through "pin holes" or "worm holes" that started on the water side of the cylinder liners.

This "eating away of metal" or corrosion, as it is commonly called, is likely to occur in any heating or cooling system where the coolant is not treated. Corrosion may or may not be associated with iron rust; as an example, severe corrosion may take place in a system that is protected against rust.





Research has shown there are many causes of corrosion and among the most serious are acid, salt or air in the coolant.

Corrosion can be controlled or prevented entirely — and at very little expense — by the measures described in Section 2.

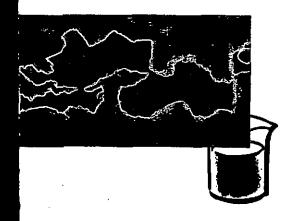
Rust and scale decrease the efficiency of the cooling system by retarding conduction and radiation of heat and flow of the coolant. Rust acts as an insulator against heat production, and pockets in the system get clogged with rust or scale deposits.

Cracked cylinder heads are a common result of poor cooling. The same maintenance that prevents corrosion will prevent rusting.





LET THE ENGINE BREATHE



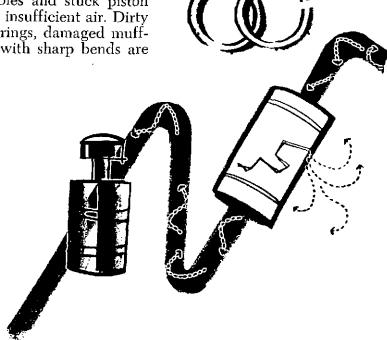
The diesel engine requires about 12,500 gallons of air for every gallon of fuel that it burns. For the engine to operate efficiently, the air system must meet these requirements:

The engine must breathe freely; the intake and exhaust must not be restricted.

Valves, pistons and rings must seal properly against compression and combustion pressures.

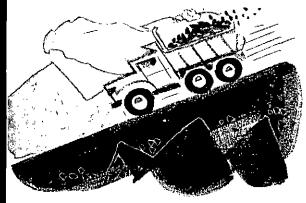
The amount of fuel which can be burned and the power developed is as dependent upon air as fuel. If there is too little air to burn all the fuel, the excess fuel causes a smoky exhaust—a sign of wasted dollars and lost horsepower.

Unfortunately, wasted fuel is not the only loss caused by incomplete combustion. The excess fuel washes lubricating oil off cylinder walls resulting in seized pistons and bearing failures. Carboned injector cup spray holes and stuck piston rings are other troubles which result from insufficient air. Dirty air cleaner elements, leaky valves, worn rings, damaged mufflers, and air piping that is too small or with sharp bends are common causes of air restriction.



PREVENT OVERSPEEDING

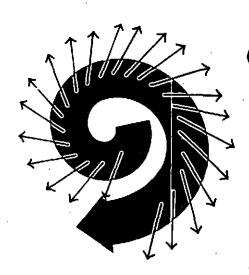


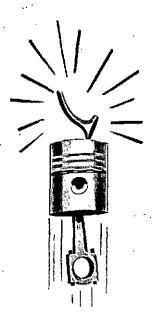


Engines must not be operated beyond the maximum rated rpm for which they were designed. Cummins diesels are protected against overspeeding during normal operation by governors which are correctly adjusted when they leave the factory. Increasing rpm by changing governors or by allowing a vehicle on a down grade to push the engine beyond its rated rpm leads to damage.

Turbocharger rpm depends upon exhaust temperature and air density. Overfueling will cause turbocharger overspeeding and failure.

In any rotating piece of machinery the mass tends to fly away from the center of rotation. Centrifugal force increases in proportion to the squares of the rotating speeds. A centrifugal force of 100 pounds at 1000 rpm increases to 400 pounds at 2000 rpm, or 900 pounds at 3000 rpm, etc. Any unbalanced load increases in the same proportion.



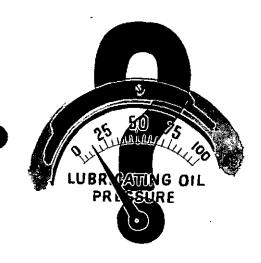


Overspeeding often causes pistons to strike and break valves. Prints of valves on piston heads is a certain indication that the engine has been overspeeded.

Cam lobes and valve seats and faces are also damaged by overspeeding which prevents tappets or cam followers from following cam lobes. Injectors may stick as a result of overspeeding when the governor shuts off the fuel and deprives the injector of lubrication.



KNOW YOUR ENGINE'S CONDITION



The engine constantly provides signs of its condition for the operator or the maintenance mechanic to interpret. In many cases, the operator is the first to detect signs of trouble. Unless he reports these conditions they may be missed until after real trouble develops. Interpretation of the signs is a very important part of maintenance. As an example, from low indicated oil pressure the mechanic knows to check the following conditions for correction:

A faulty gauge Low oil level Diluted lubricating oil Worn bearings A bearing failure

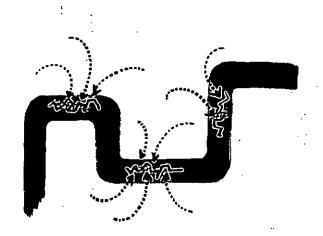
It never pays to run an engine until it fails because one part failure usually ruins other good parts. Some examples of approaching failure are:

Bearing metal found in the lube oil filter which if not corrected at the source may cause the loss of a crankshaft.

Excessive crankcase pressure, or blowby, which indicates conditions that may lead to a stuck piston, broken rod and ruined cylinder block.

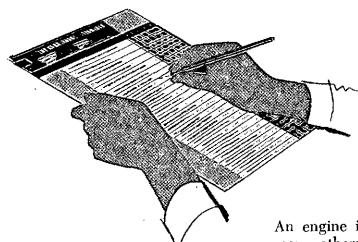
Leaks in the air intake system may permit entrance of enough dirt to wear out the engine within a few hours.





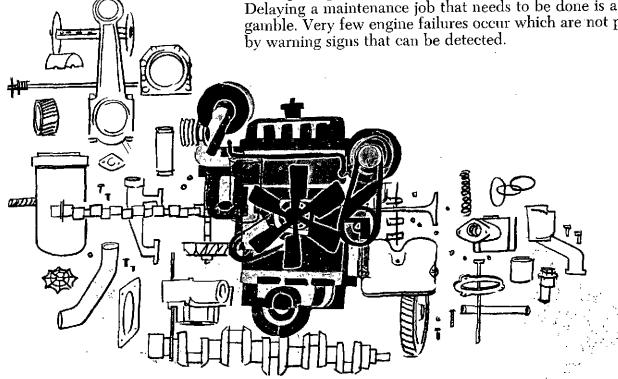
CORRECT TROUBLES WHILE THEY ARE SIMPLE





An engine is made of many parts — each closely related to many others. Each part has its own function and failure to perform that function places additional strain on other parts. As overloaded parts fail, they add to the overload on still others until the progressive failures put the engine out of commission.

Preventive maintenance is a series of simple checking, service and repair operations intended to forestall progressive damage. Delaying a maintenance job that needs to be done is a reckless gamble. Very few engine failures occur which are not preceded by warning signs that can be detected.





SCHEDULE & CONTROL YOUR MAINTENANCE

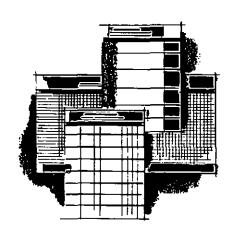


The objective of preventive maintenance is to correct unfavorable conditions that develop during engine usage before they get serious enough to cause damage. The value of the program is dependent upon having the equipment available for maintenance following a well-planned schedule.

Preventive maintenance performed on schedule is the easiest as well as the least expensive type of maintenance. It requires less work and material to prevent failures than to fix them. Maintenance must not be relegated to a position of secondary importance for the sake of a temporary increase in production.

A small amount of paper work is necessary to control the program. Check sheets are needed to detail the jobs to be done and as a record of what was done. A schedule board is necessary to make the best use of time. Summary sheets listing labor and materials are important to control costs.

It is important to remember that paper work is useful only as it reduces work load instead of contributing to it; it needs to be as simple as possible to maintain its effectiveness.



CUMMINS

Maintenance is the key to lower operating costs and a diesel engine — like any other engine — requires periodic maintenance to keep it running profitably. Engine failure or inefficient operation usually results in a double loss — reduced profits plus increased repair costs.

Preventive maintenance performed on schedule is the easiest as well as the least expensive type of maintenance. It permits the maintenance department to do the work on schedule rather than out on the job under poor working conditions and at unusual hours.

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ENGINE WEAR, ENGINE WORK AND THE MAINTENANCE SCHEDULE

Although it may vary in different applications, engine wear is, for the most part, proportional to engine work.

Engine work, measured in horsepower, is obtained from burning fuel. For that reason the maintenance schedule is based on fuel consumption. Engine application, difficult working conditions, adverse weather, and excessive engine loads, must also be considered when determining a practical maintenance schedule.

SCHEDULED MAINTENANCE OPERATIONS

This section is arranged so you can set up a maintenance program immediately. Instructions are complete for each operation and necessary forms are shown which you may have reproduced.

The schedule can be applied to all Cummins engines, allowing operators of equipment powered by various models to establish an integrate maintenance schedule by using one form.

MAINTENANCE OPERATIONS

Effective maintenance objectives can be accomplished by performing "system" maintenance as outlined on the chart on Page 2-2 and detailed in the following pages. Study this section carefully to familiarize yourself with the procedure. Later, the chart will be needed only as a check-off sheet.

Maintenance intervals given on the chart are based on average engine operation. To effectively adapt the chart to your specific application, calculate exact hourly fuel consumption for your engine and integrate these figures into the chart. For example, if the average fuel consumption on an NH engine is 5 to 6 gallons per hour the "B" check would be made every 1000 to 1200 gallons of fuel. The figure 1000 to 1200 would then be inserted above the "B" check, 2000 to 2400 above the "C" check, etc.

The summary sheet on Page 4-5 has space for complete maintenance data obtained from the maintenance schedule check sheets.

MAJOR INSPECTION

At the "F" check the engine must have a major inspection. This is not routine maintenance and therefore is described separately on Page 2-34.

	ANKATANAKAT EGHTEDAAR	interval						
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	Check Engine Oil Level Check Converter Oil Level							
	Lubricate Power Take-Off Clutch Throwout Bearing		L					
•	Check Leaks and Correct							
LUBRICATING	Change Engine and Aneroid Control Oil Change Engine and Turbocharger Filter (Full-Flow)							
SYSTEM	Change Hydraulic Governor Filters (Full-Flow)							
	Record Oil Pressure							
	Lubricate Electrical Equipment							
	Change By-pass Filter Element	**B		<u>}</u>				
. •	Change Converter Oil, Filter and Screen Lubricate Water Pump and Fan Hub					_		
	Fill Fuel Tanks. Check Leaks and Correct			_		_,	_	
•	Drain Sediment From Filter and Tanks	*A	` `					34
	Check Hydraulic Governor Oil Level							
FUEL	Clean Float Tank Breather Change Filter Element(s)	*B		·				
SYSTEM	Clean Fuel Pump Screen and Magnet						-	#
• · • · • · · · · · · · ·	Adjust Injectors and Valves							PAGE
	Clean Injectors and Screens							₹
	Check Fuel Manifold Pressure							1
	Change Hydraulic Governor Oil Fill Cooling System. Check Leaks and Correct		_					EE
	Check Heat Exchanger Zinc Plugs							S
COOLING	Check and Adjust Belt Tension			_				Ĭ
SYSTEM	Check Engine Coolant and Corrosion Resistor							1
\$	Check Thermal Controls Check Fan Hub and Drive Pulley							Z
·	Clean Heat Exchanger and Cooling System				SPRIN	G AND	FALL	Ō
	Check Air Cleaner Oil Level							Ě
	Clean Pre-Cleaner/Dust Cup							- 5
	Clean Composite/Dry-Type Cleaner Element Change Air Cleaner Oil	*A						Ď.
	Clean Crankcase Breather/Change Element	*A					 -	뜻
	Clean Tray Screen	*B						ヺ
	Check Air Piping and Vent Tube Connections	*B						
AIR	Check Inlet Air Restriction Replace Composite/Dry-Type Cleaner Element	*C			- '.			04
SYSTEM	Check Supercharger/Turbocharger For Oil Leaks							ᅙ
	Tighten Manifold and Turbocharger Mountings							MAJOR INSPECT
	Clean Air Compressor Breather	*CD						⋖ ।
	Clean Aneroid Air Filter Clean Oil-Bath Air Cleaner	*D						Σ
	Clean Turbocharger Compressor Wheel and Diffuser							_
	Check Turbocharger Bearing Clearances							
	Check Preheater							
	Check Operator's Report							
	Check Vibration Damper Alignment Check Power Take-Off Clutch Adjustment				 _		┝──┤	
<u>_</u>	Clean Electric Units and Tighten Connections							
OTHER	Check Alternator/Generator Brushes and Commutator							-
1	Clean Engine Tighten Mounting Bolts and Nuts							
	Check Engine Blow-By							
	Check Crankshaft End Clearance						 	

	SUGGES	TED IN	TERVAL	S FOR	CHECK	S	
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වෙන්වෙ	October	A	B	## C	D.	W.E	TF
	Callana Cual	DAILY	600	1200	2400	4800	19200
C .	Gallons Fuel	DAILY	750	1500	3000	6000	24000
	Hours Operation	DAILY	200	400	800 °	1600	6400
J.	Hours Operation	DAILY	200	400	800	1600	6400
	Gallons Fuel	DAILY	1000	2000	4000	8000	32000
H	daliblis ruel	DAILY	1200	2400	4800	9600	36400
NH	Hours Operation	DAILY	200	400	800	1600	6400
NHH	nours operation	DAILY	200	400	800	1600	6400
	Time	DAILY	6 WEEK	3 MONTH	6 MONTH	2 YEAR	5 YEAR
*V6-140	Gallons Fuel	DAILY	450	900	1800	3600	12000
	Hours Operation	DAILY	200	400	800	1600	6400
4350 305	Gallons Fuel	DAILY	850	1700	4100	8300	32000
*¥8-185	Hours Operation	DAILY	200	400	800	1600	6400
V6-200	Gallons Fuel	DAILY	1000	2000	4000	8000	32000
V8-365	Hours Operation	DAILY	200	400	800	1600	6400
	Gallons Fuel	DAILY	1200	2400	4800	9600	38400
V8-350		DAILY	1600	3200	6400	12800	51200
V70 400	Hours Operation	DAILY	200	400	800	1600	6400
VT8-430		DAILY	200	400	800	1600	6400
	Gallons Fuel	DAILY	3750	7500	15000	30000	90000
	Ganons ruei	DAILY	5000	10000	20000	40000	120000
V-12	Hours Operation	DAILY	250	500	1000	2000	6000
	nours Operation	DAILY	250	500	1000	2000	6000
L	Gallons Fuel	DAILY	2000	4000	8000	16000	64000
		DAILY	2500	5000	10000	20000	80000
	Hours Operation	_o DAILY	400	800°	1600	3200 %	12800
		DAILY	400	800	1600	3200	12800
NATURALLY ASPIRATED ENGINES							
SUPERCHARGED/TURBOCHARGED ENGINES							

The above Maintenance Schedule has been established on average fuel consumption per hour for series so specified. "Example, H/NH Series was established at a 5 to 6 gallon per hour rate." If the fuel consumption ratio to hours of operation for the engine being operated does not adhere to the above schedule, adjust Maintenance Schedule fuel-hour ratio accordingly.

The kind of oil used, the efficiency of the filtering system and condition of the engine must be considered in determining when oil needs changing. The above schedule is based upon use of both full-flow and by-pass filters for all except the V6-140 and V8-185 engines. IF A BY-PASS FILTER IS NOT USED THE OIL CHANGE PERIOD SHOULD BE REDUCED BY ONE-THIRD. The safest method for determining oil change is by lubricating oil analysis, see Page 4-7.

^aNote: V6-140 and V8-185 engines are usually supplied without a bypass filter, if used, the above suggested schedule for these engines may be extended by 50% i.e., 5000 miles oil change to 7500 miles, etc.

LUBRICATING SYSTEM MAINTENANCE

CHECK ENGINE OIL LEVEL

Check oil level with dipstick oil gauge located on the engine. For accurate readings, oil level should not be checked for approximately 30 minutes after engine shutdown. Keep dipstick with the oil pan with which it was originally shipped. Keep oil level as near "H" mark as possible. Fig. 2-1.

CAUTION: NEVER OPERATE THE ENGINE WITH OIL LEVEL BELOW THE "L" MARK OR ABOVE THE "H" MARK.

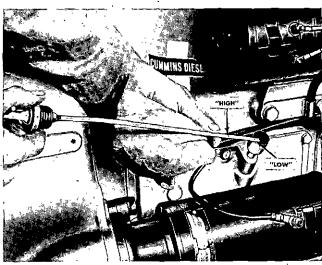


Fig. 2-1. Check oil level.

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CHECK CONVERTER OIL LEVEL

Different models of vehicles may vary in the manner in which oil level check is made — either with a dipstick, a level plug or a petcock. Oil level should be maintained at full. If needed, add oil according to oil specifications on nameplate.

1. Cold Check.

The cold check (engine not running) insures there is sufficient oil in system to start engine—especially if equipment has been standing idle for a long period of time. Be sure oil is at high level.

2. Hot Check.

The hot check should be made at operating temperature, with the engine running from 600 to 1000 rpm and with the transmission in neutral range.

3. If the converter is operating in combination with a Torqumatic transmission, the oil level check is made at the transmission.

LUBRICATE POWER TAKE-OFF AND CLUTCH THROW-OUT BEARING

Power Take-Off

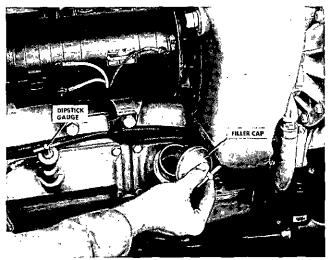
Apply a small amount of any high grade soda base, short fiber, heat resistant, gun lubricant grease once a day through fitting on tapered part of housing to throwout collar.

Manual Spring-Loaded Input Disconnect Clutch

Approximately once a week, lubricate the release bearings with two "shots" from a grease gun using above grease. Two grease fittings are usually provided atop the clutch housing.

CHECK LEAKS AND CORRECT

Check for evidence of external oil leakage. Tighten capserews, fittings, connections, or replace gaskets as necessary to correct. Check oil dipstick and filler tube caps. See that they are tightened securely. Fig. 2-2.



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Fig. 2-2. Lubricating oil filler tube NHRS

CHANGE ENGINE AND ANEROID CONTROL OIL

Engine Lubricating Oil

The kind of oil used, the efficiency of the filtering system and the condition of the engine must be considered in determining when oil needs changing.

The schedule for oil changes is based on average crankcase and filter capacity when both full-flow and by-pass filters are used. Note: If a by-pass filter is not used, the oil change period must be reduced by one-third, see Page 2-3.

The safest method for determining oil change period is by lubricating oil analysis. See "LUBRICATING OIL ANALYSIS," Page 4-7 and "LUBRICATING OIL SPECI-FICATIONS," Page 2-11.

CAUTION: ON ENGINES EQUIPPED WITH DOUBLE SUMP OIL PANS, BOTH SUMPS MUST BE DRAINED WHEN CHANGING OIL.

Aneroid Control Oil

- 1. At each "B" check, remove the plug from the bottom of aneroid control and drain oil.
- Replace drain plug and loosen vent line or remove pipe plug above "Lube Oil".
- Fill aneroid with clean engine lubricating oil through the vent line hole until oil fills to vent plug hole level.
 Fig. 2-3. Reinstall vent line, if used or pipe plug.
- On aneroid controls with an air filter mounted in the vent line tap, remove filter and fill with oil; replace filter.

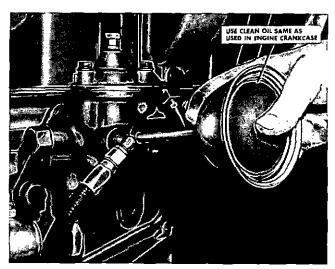


Fig. 2-3. Fill aneroid with lubricating oil

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CHANGE ENGINE AND TURBOCHARGER FILTER Engine (Bag Type) Full Flow Filter

- Drain full-flow lubricating oil filters on all models except V8-350 & VT8-430 Engines by removing drain plugs.
- 2. Drain V8-350 & VT8-430 Engines as follows:
 - a. Remove upper socket head pipe plug at flywheel side of filter case and attach drain hose. Fig. 2-4.

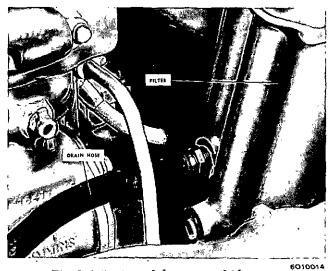


Fig. 2-4. Draining lubricating oil filter case V8-350/VT8-430

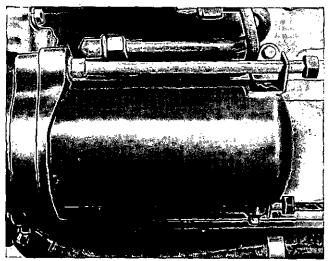


Fig. 2-5. Horizontal lubricating oil filter

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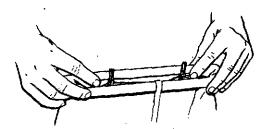
b. Loosen filter cover capscrews carefully.

Note: The element contains a spring which will force the cover up when capscrews are loosened.

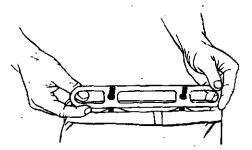
CAUTION: DO NOT REMOVE CASE.

- c. Completely drain oil from case and withdraw element.
- d. Use common suction gun to remove remaining oil in case. Wipe case interior with clean cloth and replace drain plug.
- 3. Turn used bag inside out and inspect for bearing metal, grit, etc. (Fig. 2-7). If metal is found in the bag, an inspection of all connecting rod and main

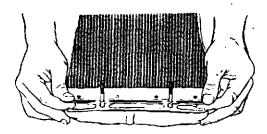
 Install ring in filter bag with studs protruding. Fold top of bag inward over ring about 1/2 inch; tuck bag snugly around ring stud bases to assure good seat.



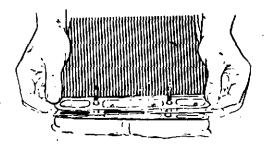
2. Install gasket over study and against bag.



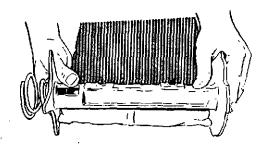
Install retainer attached to wire mesh spacer over studs.



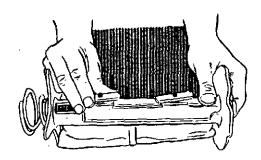
 Install second gasket over stude and down against spacer retainer.



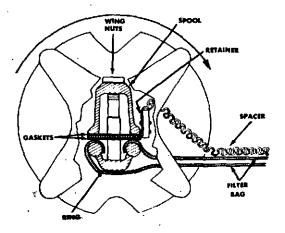
5. Insert ring studs in spool through oil channel.



Install wing nuts over studs and tighten until nuts are parallel with spool.



 Place filter assembly on clean flat surface with wire mesh spacer on top and filter bag on bottom. Roll bag and spacer around spool so that spacer is between bag and studs.



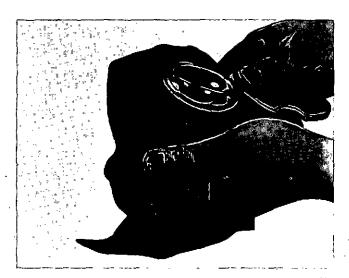


Fig. 2-7. Examining lubricating oil filter bag

bearings should be made at once. Inspect spool gasket, bag clamp, and spacer mat. If they are not in good condition, replace with new parts.

CAUTION: DO NOT ATTEMPT TO WASH AND RE-USE FILTER BAG.

- Clean all parts thoroughly except bag, gaskets and O-rings.
- 5. Install a new filter bag as shown in Fig. 2-6.
- 6. Insert element, spring end down, in filter case; position case to cover with new O-ring(s) and tighten capscrews to secure.

CAUTION: MAKE CERTAIN COVER CAP-SCREWS ARE DRAWN DOWN EVENLY TO ASSURE A GOOD SEAL BETWEEN COVER AND CASE.

- Add approximately one gallon of clean lubricating oil to fill filter case.
- Check engine oil level after operation; bring level to "H" mark to replace oil absorbed by new element.

Engine (Paper Element) Full Flow Filter

- Remove drain plug from filter case and allow oil to drain.
- Loosen center bolt and remove filter case from filter head. Some filters use the same case as the bag-type element and should be disassembled in a like manner.
- 3. Withdraw filter element, inspect, then discard.

Note: Inspect for metal particles. If metal is found, a check of connecting rods and main bearings should be made at once.

4. Remove seal ring from filter head and discard.

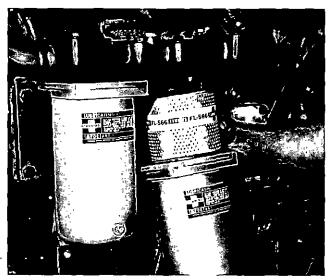


Fig. 2-8. Changing paper filter element V12

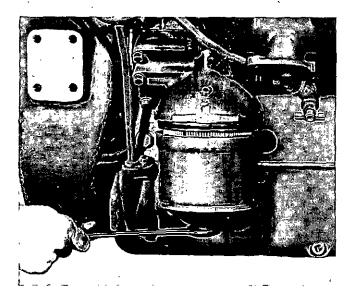


Fig. 2-9. Changing paper filter element V6 Val & V8 Vale

- 5. Clean filter case thoroughly.
- Check to make sure element seals are in place and install new element over pilot valve assembly.
- Position new seal ring in place; assemble filter case to head and tighten center bolt (if used) to 30/35 foot-pounds.
- 8. Check oil level. Run engine and check for leaks.
- 9. Recheck engine oil level; add oil as necessary to bring oil level to "H" mark on dipstick.

Note: Always allow oil to drain back to oil pan before checking level.

Change Turbocharger Oil Filter

The throw-away type turbocharger oil filter prevents clogging of the turbocharger oil supply orifice.

Change filter at each oil change or install a pressure gauge in the filter outlet line and change filter when gauge indicates a pressure drop of 15 psi or more across filter head at engine governed speed.

To change element:

1. Unscrew element and discard. Fig. 2-10.

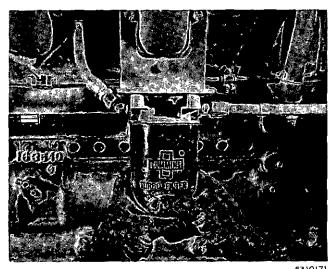


Fig. 2-10, Removing turbocharger oil filter

- 2. Clean filter head with solvent that is not harmful to aluminum.
- 3. Inspect head for cracks and distorted threads; discard if damaged.
- 4. Coat gasket atop new element with clean lubricating oil and fill element.
- 5. Install element to head; tighten until gasket contacts head.
- Rotate element in additional one-half turn to seal gasket. Do not overtighten.
 - CAUTION: DO NOT ATTEMPT TO USE SUB-STITUTE ELEMENTS, ELEMENT THREADS AND FILTER PAPER ARE OF A SPECIAL DESIGN,
- Reconnect oil supply and discharge lines, if previously removed.

CAUTION: MAKE SURE OIL SUPPLY LINE TO FILTER IS CONNECTED AT OPENING MARKED "IN". REVERSING CONNECTIONS WILL LEAD TO TURBOCHARGER FAILURE.

CHANGE HYDRAULIC GOVERNOR OIL FILTER

Change filter every 200 hours or install a pressure

gauge in the filter outlet line and change filter when gauge indicates a pressure drop of 7 psi or more across filter head at engine governed speed.

To change element:

- 1. Unscrew element and discard.
- Clean filter head in solvent that is not harmful to aluminum.
- 3. Inspect head for cracks and distorted threads; discard if damaged.
- 4. Coat gasket atop new element with clean lubricating oil and fill element.
- Install element to head; tighten until gasket contacts head.
- Rotate element an additional one-half turn to seal gasgasket. Do not overtighten.

CAUTION: DO NOT ATTEMPT TO USE SUB-STITUTE ELEMENTS, ELEMENT THREADS AND FILTER PAPER ARE OF A SPECIAL DESIGN.

RECORD OIL PRESSURE

Start the engine and increase speed until the oil temperature gauge, reads 140°F. Reduce engine speed to idle and record the oil pressure. A comparison of pressure at idling speed with previous readings will give an indication of progressive wear of lubricating oil pump, bearings, shafts, etc. These readings are more accurate and reliable when taken immediately after an oil change.

LUBRICATE ELECTRICAL EQUIPMENT Alternator or Generator

Lubricate alternator or generator by adding a few drops of SAE 20 lubricating oil to oil cup (Fig. 2-11) or by turning down grease cup a maximum of one turn.

CAUTION: AVOID OVER-LUBRICATION WHICH IS HARMFUL TO INSULATION.

If no cups are present, unit contains sealed bearings and requires no lubrication.

When a generator or alternator filter is used, clean filter screen at each lubrication period. Remove filter screen and wash in an approved cleaning solvent; blow dry with compressed air and reassemble.

Electric Cranking Motor

Add a few drops of clean SAE 30 weight lubricating oil to cranking motor bearings.

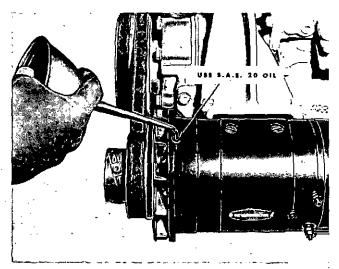


Fig. 2-11. Lubricating generator

Air Cranking Motor

Air cranking motor may be equipped with grease fittings, felt wicks with outer grease cups or air line lubricators. Follow manufacturer's recommendation for procedure, interval and lubricant specification.

CHANGE ENGINE BY-PASS FILTER ELEMENT

Change by-pass filter elements on engines so equipped as follows:

CAUTION: NEVER USE A BY-PASS FILTER IN PLACE OF A FULL-FLOW FILTER.

- 1. Remove drain plug from bottom of housing and drain oil.
- 2. Remove clamping ring capscrew and lift off cover.
- Unscrew pack hold-down assembly; lift out element and hold-down assembly (Fig. 2-12). Discard element
- 4. Clean housing and hold-down assembly in solvent.
- Inspect hold-down assembly spring and seal. Replace if damaged.
- 6. Inspect drain plug and connections. Replace plug.
- On the Cummins by-pass filter, check orifice plug inside oil outlet connection; blow out with air jet to make sure orifice is open and clean.
- Check filter cover "O" ring. Replace if damaged or deteriorated.
- 9. Install new element in housing.
- Replace hold-down assembly in filter and tighten down to stop.
- 11. Position cover "O" ring seal.

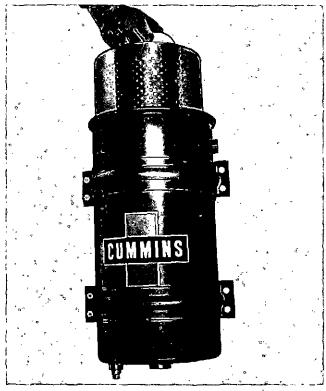


Fig. 2-12. By-pass filter and element

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- 12. Install cover and clamping ring; tighten capscrew until clamping lugs come together.
- Add enough extra oil to crankcase to fill case and element.
- 14. Loosen vent plug in cover and start engine. Close vent plug when oil reaches vent.

CHANGE CONVERTER OIL, FILTER AND SCREENS

Change Converter Oil

Oil should be changed every "D" check in the hydraulic system or oftener, depending on operating conditions. Also the oil must be changed whenever the oil shows traces of dirt or the effects of high operating temperature evidenced by discoloration or strong odor.

Change Converter Filter and Screen

The hydraulic system filter should be changed every oil change and the strainer thoroughly cleaned.

LUBRICATE WATER PUMP AND FAN HUB

- 1. If water pump and fan hub contains grease fittings or plugs through which grease may be applied, give one "shot" (approx. 1 tablespoon) each "E" check. Fig. 2-13.
- 2. Completely disassemble, clean and inspect at each third "E" check.
- 3. If water pump or fan hub has no provisions for greasing, disassemble, clean and inspect each second "E" check.
- 4. Pack bearings and fill water pump and fan hub bearing cavities 1/2 to 2/3 full of multi-purpose industrial grease meeting specifications shown below.

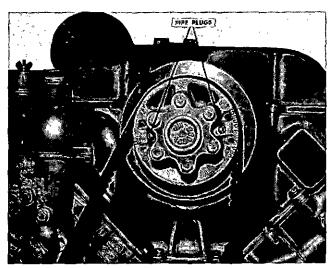
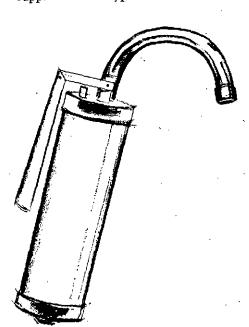


Fig. 2-13. Fan hub lubricating points

LUBRICANT SPECIFICATIONS

GREASE

Longer service, less maintenance and more effective lubrication is possible when a multi-purpose industrial lubricant is used. Cummins Engine Co. recommends use of lubricants meeting specifications given below. Contact your lubricant supplier for this type lubricant.



ASTM Penetration, Normal Worked

Water Resistance

Dropping Point

Oxidations

285 to 320.

10 lb. drop in 100 hrs.

20% maximum loss.

325°F.

Consistency Stability, Maximum ASTM

Penetration After 100,000 Strokes

Penetration shall not increase more than 50 points and in no case be

more than 350.

Water

Wheel Bearing Test

1%, Maximum.

a. 1% leakage (220°F., 6 hrs.)

b. No adherent deposits of varnish, gum or lacquer-like material acceptable after removal of the grease from the bearing.

One (1) rating - Pass.

Rust Preventive Properties

Mineral Oil Properties

Viscosity @ 100°F.

Viscosity @ 210°F.

Flash

Fire

750 Saybolt Universal Sec., maximum

70 Saybolt Universal Sec., minimum

340°F. minimum

380°F. minimum

CAUTION: DO NOT MIX GRADES OR BRANDS OF GREASE AS DAMAGE TO BEARINGS MAY RESULT. EXCESSIVE LUBRICATION IS AS HARMFUL AS INADEQUATE LUBRICATION.

LUBRICATING OIL

Cummins Engine Company, Inc., recommends that owners of Cummins Diesels give special consideration to use of heavy duty oils developed for use in diesel engines. Under normal conditions, the oil used should meet the requirements of U. S. Military Specifications Mil-L-2104-A. The responsibility for meeting these specifications, the quality of the product and its performance must necessarily rest with the oil supplier. Cummins Engine Company, Inc., does not recommend any specific brand of lubricating oil. Many brands which meet specifications following are listed in the "Lubricating Oils for Industrial Engines" booklet published by The Internal Combustion Engine Institute, (Chicago 6, Illinois).

Mil-L-2104-A and/or British Defense Spec. DEF-2101B Recommended for engines operating under normal conditions and where sulphur content of the diesel fuel is from 0.5% to 1% content by weight.

Supplement 1 (SI) Recommended where a fuel with a corrosive sulphur content in excess of 1% is used. These oils have a higher additive level than Mil-L-2104-A.

Mil-L-2104-B These oils meet or exceed the levels of Supplement 1 oils, and may be used in Cummins Engines, to provide additional sludge and rust protection.

Series 3 (Mil-L-45199) These are premium oils and are not required for Cummins Engines except under very unusual operating conditions. Do not use in applications where exhaust valve deposits are encountered.

Viscosity Recommendations Except in extreme climates most engine operation will be in the range of -10°F. to 90°F., oil viscosity should be as follows:

SAE 10W — temperatures consistently between —10°F. and 30°F.

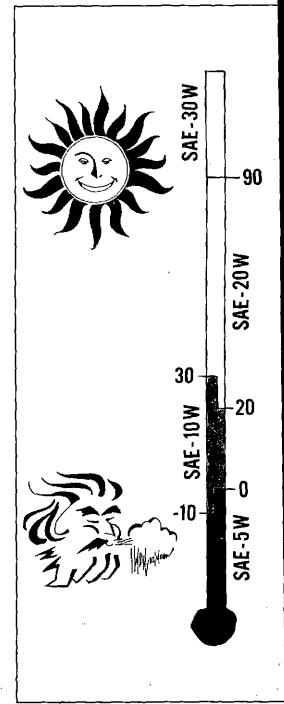
SAE 20 — temperatures consistently between 20°F. and 90°F.

SAE 30 — temperatures above 90°F.

Where temperatures are not above 0°F., SAE 5W oils meeting the requirements of Mil-L-10295 may be used. However, in heavily loaded applications it may be necessary to use one grade heavier oil to maintain minimum recommended oil pressures listed in Operators Manuals.

Oil which is best for general operation is also best for the "break-in" period. No change in oil viscosity or type is needed for new or newly rebuilt engines.

Do not mix brands or grades of oil in the engine. Choose carefully the best oil available and continue to use that brand consistent with above conditions and engine wear.



FUEL SYSTEM MAINTENANCE

FILL FUEL TANKS; CHECK LEAKS AND CORRECT

Always filter or strain the fuel before or while putting it in the tank. See "FUEL OIL SPECIFICATIONS", Page 2-20.

- 1. Check for evidence of fuel leakage.
 - a. Check fuel pump and filter.
 - b. Check fuel supply line and connections at fuel tank, fuel filter, and fuel pump.
 - c. Check fuel inlet tube and connections at fuel pump shut-down valve.
 - d. Check all fuel supply and drain lines, connections and fittings on cylinder heads.
 - e. Check fuel lines and tübing between engine and fuel tank(s)
- 2. Check for air leaks in fuel system by placing a sight gauge in the line between fuel filters and pump. Bubbles over 1/2 inch long or "milky" appearance indicates an air leak. Find and correct.

DRAIN SEDIMENT FROM FILTER AND TANKS

- Loosen the drain cock, if used, at the bottom of the fuel filter case and drain out any accumulated water
 and sediment. Tighten the drain cock and refill the filter case with clean fuel.
- 2. Unscrew throw-away units, dump water and sediment. Fill element with fuel and replace.
- 3. Loosen fuel tank drain cock or plug and drain approximately 1 pint of fuel. Close drain cock or plug. Check drained fuel for moisture.

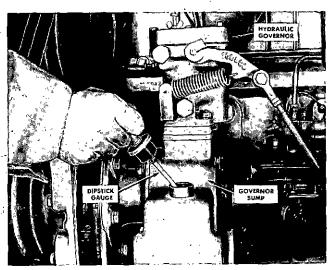


Fig. 2-14. Checking hydraulic governor oil level

CHECK HYDRAULIC GOVERNOR OIL LEVEL

All Series

If the fuel pump has a hydraulic governor, use clean lubricating oil of the same grade as used in the engine in the governor sump.

Keep level half-way up on the inspection glass or to high level mark on dipstick oil gauge.

CLEAN FLOAT TANK BREATHER

On applications equipped with a float tank, clean breather on same schedule as fuel filter.

- 1. Unscrew breather.
- Wash in an approved cleaning solvent. Dry with compressed air.
- 3. Install breather in float tank.

CHANGE FILTER ELEMENT

Change the single 5-3/4 inch long (throw-away) fuel filter after 2000 gallons of fuel consumption. Change the single 7-1/2 inch long (throw-away fuel filter after 3000 gallons of fuel consumption and the stack disc (replacement element) after 4000 gallons fuel consumption.

When double elements of the standard or extended life (throw-away) fuel filters are use, the capacity is approximately doubled.

Note: Capacities listed above are under normal working conditions and with proper storage of fuel.

The most accurate method of determining element change period is by measurement of fuel restriction as outlined below.

Check Filter Restriction

To check restriction, connect ST-434 Vacuum Gauge to the fuel pump as shown in Fig. 2-15 using the special adaptor furnished. If restriction reads 8 to 8.5 inches vacuum while the engine is running at full speed and load, change element or remedy other sources of restriction. When restriction becomes as great as 10 or 11 inches vacuum, the engine will lose power.

Change element as described below.

Throw-Away Type Filter

 Unscrew combination case and element; discard. Fig. 2-16.

Note: On elements that do not have an integral "O" ring seal, install new "O" ring before installing element.

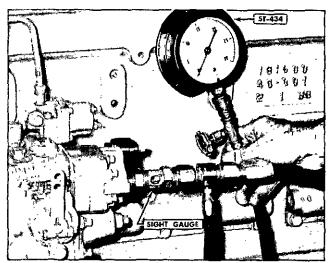


Fig. 2-15. Checking fuel filter restriction

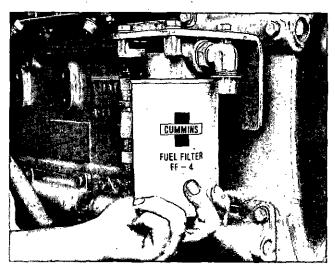


Fig. 2-16. Removing throw-away type fuel filter

- 2. Fill element with fuel.
- Install new case and element; tighten by hand until seal touches filter head. Tighten an additional onehalf turn.

CAUTION: MECHANICAL TIGHTENING WILL DISTORT OR CRACK FILTER HEAD.

Replaceable Element

- Remove drain plug from bottom of filter case and drain contents; install drain plug.
- Loosen nut at top of fuel filter. Take out dirty element, clean filter case, and install a new element. Fig. 2-17.

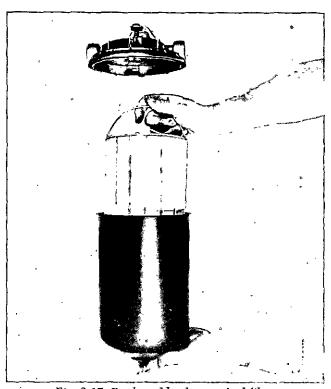


Fig. 2-17. Replaceable element fuel filter

- 3. Install a new gasket in filter head and assemble case and element. Fill filter case with clean fuel to aid in faster pick-up of fuel pump. Tighten center bolt to 20/25 foot-pounds with a torque wrench.
- 4. Check fittings in filter head for leaks. Fittings should be tightened to 30/40 foot-pounds.

CLEAN FUEL PUMP SCREEN AND MAGNET PT Fuel Pump

Remove and clean fuel pump filter screen at each "D" check. To clean filter screen;

- 1. Loosen and remove cap at top of fuel pump. Remove spring. Lift out filter screen assembly. Fig. 2-18.
- Remove top screen retainer from filter screen assembly.

Note: Some filter screens do not contain a magnet. If not, magnet can be obtained from any Cummins distributor. Magnetic action will remove any ferrous metal particles that may enter fuel system.

- Clean screen and magnet in cleaning solvent and dry with compressed air.
- Replace screen retainer and install filter screen assembly in fuel pump with hole down. Replace spring on top of filter screen assembly.

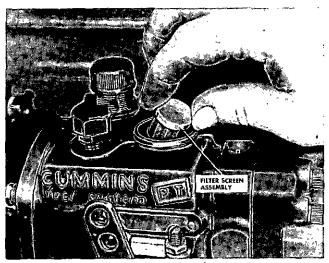


Fig. 2-18. Removing fuel pump filter screen

5. Replace cap, tighten to 20/25 foot-pounds.

PT Fuel Pump with MVS Governor

 Remove filter cap and dynaseal from governor housing. See Fig. 2-19.

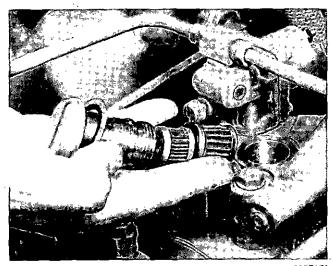


Fig. 2-19. Fuel pump screens — PT (Type G)

MVS governor

- 2. Remove "O" ring retainer, "O" ring, screen and spring from filter cap.
- 3. Using a screwdriver or wire hook, remove bottom screen and magnet assembly from fuel pump housing. Remove screen retainer.
- 4. Clean parts as described above.
- 5. Install screen retainer and place bottom screen assembly in fuel pump housing with removable end up.
- 6. Install spring, large coil first, in filter cap; install

- upper screen, closed end first, in cap and snug against spring.
- Install new "O" ring on "O" ring retainer; insert in filter cap, "O" ring first.
- Install filter cap and dynaseal in governor housing; tighten cap to 20/25 foot-pounds with torque wrench and screwdriver adapter.

CLEAN AND CALIBRATE INJECTORS

Clean and calibrate injectors regularly to prevent restriction of fuel delivery to combustion chambers. Because of the special tools required for calibration, most owners and fleets find it more economical to let a Cummins Distributor do the cleaning and calibration operations.

To clean and calibrate injectors, refer to Bulletin No. 983536.

ADJUST INJECTORS AND VALVES

It is essential that injectors and valves be in correct adjustment at all times for the engine to operate properly. One controls engine breathing; the other controls fuel delivery to the cylinders.

Adjust valves and injectors at "E" checks. Final adjustment must be made when the engine is at operating temperature. *Injectors must always be adjusted before* valves. The procedure is as follows:

Timing Mark Alignment

- If used, pull compression release lever back and block in open position to lift all intake valves. This allows the crankshaft to be rotated without working against compression.
- Bar engine in direction of rotation until No. 1 VS mark appears. See Figs. 2-20 through 2-30 for loca-

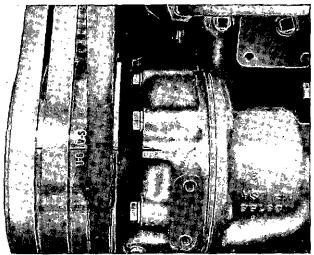


Fig. 2-20. C & J, valve set marks

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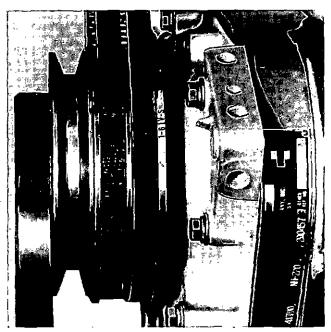


Fig. 2-21. H/NH, valve set marks

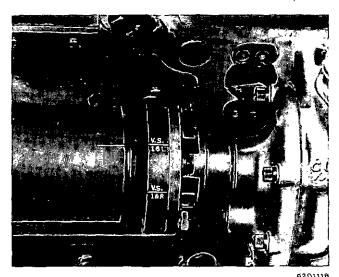


Fig. 2-22. V-12 (accessory drive), valve set marks

tion of valve set marks. (On horizontal engines, the valve set marks are on the vibration damper flange.) In this position, both intake and exhaust valves will be closed for cylinder No. 1.

3. Adjust injector plunger, then crossheads and valves of first cylinder as explained in succeeding paragraphs. Turn crankshaft in direction of rotation to the next VS mark corresponding to firing order of the engine and the corresponding cylinder will be ready for adjustment. 4. Firing order is as follows:

	TABLE I: EI	NGINE FIRING	ORDER
विद्युक्ति	ගුන්	Righthand	Condial
Series	Gylinders	Rotation	Rotation
B &]	4	1-2-4-3	1-3-4-2
	6	1 5362 4	1-4 -2-3-5
	4	1-24-3	1-3-4-2
	6	1-5-3-6-2-4	142635
$\mathbf{A}\mathbf{I}\mathbf{I}$ $\mathbf{V}\mathbf{G}$	6	1-4 -25-3-6	1-6-3-5-2-4
AII V8	6	1-5-4-8-6-3-7-2	1-27-3-63-4-5
<u>IL</u>	6	1-5-3-6-2-4	1-4 -2-6-3-5
V12	12		M-GR-2L-
•		ar-51-ir	5R-4L-3R
		OL-BR-AL-	OL-IR-FL
		5R-2L-6R	2R-3L-4R

Note: On L engines, Number 1 cylinder is at the flywheel end, on all other engines, No. 1 cylinder is at the opposite end. Facing the V6/V8 series at the flywheel end of the engine, the right bank is on the right hand side of the block and cylinders are numbered from the damper end. Facing the V12 series at the damper end of the engine, the left bank is on the left hand side of the block and No. 1L and No. 1K cylinders are at the damper end.

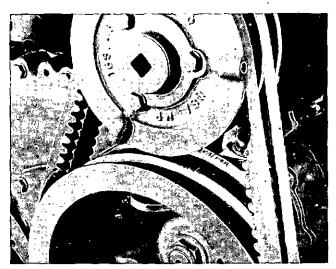


Fig. 2-23. V-12 (water pump drive pulley), value set marks

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- Continue turning crankshaft in direction of rotation and making adjustments until all injectors and valves have been correctly adjusted.
- 6. On engines without a compression release, turn each intake valve adjusting screw down one half turn from adjusted position before turning the engine. Then, adjust injectors and valves on each cylinder in manner described.

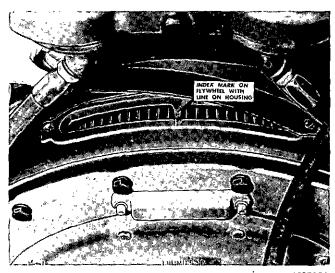


Fig. 2-24. V-12 (flywheel), valve set marks

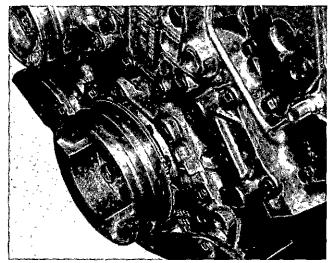


Fig. 2-26, V6-Val, valve set marks

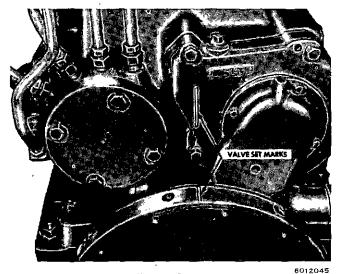


Fig. 2-25. L, valve set marks

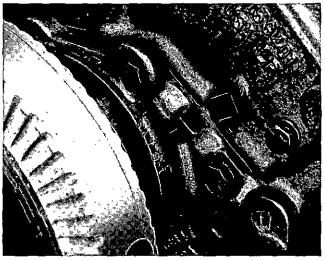


Fig. 2-27. V8-Vale, valve set marks

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TABLE II: INJECTOR	PLUNG	ER ADJU	STMENT
Gerles Gerles	(चन्द्री) स्वीति स्वी स्वीति स्वी	OII) Than	(UKIOALI) Darginio Sonido
G &] H//NH VE-140/VE-185 7//16 Thick Nuc 1/4 Thick Nuc VE-200/VE-255 VE-350 & VIS-480 VI2	70/30 70/30 70/30 50/35 50/60 40/45 70/30	49 49 49 49 49 49 49 49 49 49 49 49 49 4	80 48 48 50 50 188

Note: Two complete revolutions of the crankshaft are needed to set all injector plungers and valves. Injector and valves can be adjusted for only one cylinder at any one "VS" setting.

Injector Plunger Adjustment

The injector plungers of all engines must be adjusted with an *inch-pound* torque wrench to a definite torque setting. Snap-On Model TQ12B or equivalent torque wrench and a screwdriver adapter can be used for this adjustment. See Fig. 2-31.

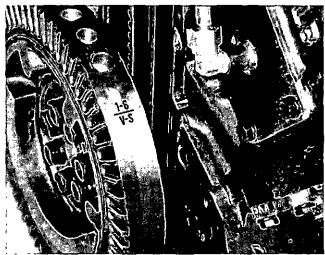


Fig. 2-28. V6-Vim, valve set marks

- 1. Turn adjusting screw down until plunger contacts cup and advance an additional 15 degrees to squeeze oil from cup.
- 2. Loosen adjusting screw one turn; then, using a torque

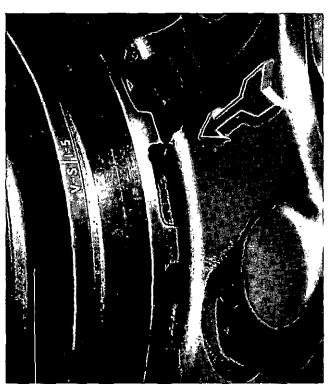


Fig. 2-29. V8-Vine, valve set marks

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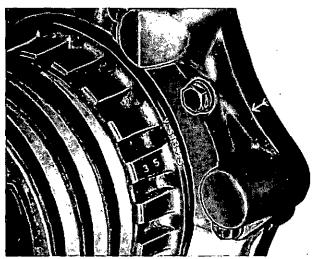


Fig. 2-30. V8-350/VT8-430, valve set marks

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wrench calibrated in inch-pounds and a screwdriver adapter, tighten the adjusting screw to values shown in Table II for cold setting and tighten the lock nut to torque listed in Table II. After all injectors and valves are adjusted and engine has been started and at 140°F. oil temperature; reset the injectors to the warm setting.

Crosshead Adjustments

On engines having four-valve heads, it is necessary to adjust the crossheads before making valve adjustments. Some crossheads pilot over a solid guide while others pilot within a tubular guide.

C, J, NH and V12 Engines

 Loosen valve crosshead adjusting screw locknut and back off screw one turn.

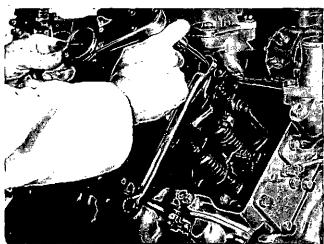


Fig. 2-31. Adjusting injector plungers

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- 2. Use light finger pressure at "A" to hold crosshead in contact with valve stem "B".
- Turn down crosshead adjusting screw until it touches valve stem "C".
- 4. With new crossheads and guides, advance screw an additional one-third of one hex (20°) to straighten stem in guide and compensate for slack in threads. With worn crossheads and guides, it may be necessary to advance screw as much as 30° to straighten stem in guide.
- 5. Hold adjusting screw in this position and tighten lock-nut to 25/30 foot-pounds torque.
- Check clearance between crosshead and valve spring retainer with wire gauge. There must be a minimum of .025 inch clearance at this point.

V6-Val, V8-Vale, V8-350 and VT8-430 Engines

- Loosen valve crosshead adjusting screw lock-nut and back off screw one turn.
- 2. Use light finger pressure at the rocker lever contact surface to hold crosshead in contact with valve stem nearest the push tube.
- 3. Turn adjusting screw down until it contacts its mating valve stem.
- Advance adjusting screw slightly, then loosen. Retighten adjusting screw until valve stem contact is made.
- Hold the adjusting screw in this position and tighten lock-nut to 25/30 foot-pounds torque.
- Check clearance between crosshead and valve spring retainer with a wire gauge on V8-350 & VT8-430 engines. There must be a minimum of .025 inch clearance at this point.

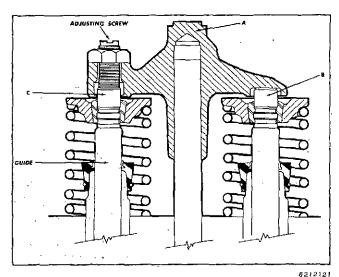


Fig. 2-32. Crosshead

V6-Vim and V8-Vine Engines

- Loosen valve crosshead adjusting screw lock-nut and back off screw one turn.
- Use light finger pressure at rocker lever contact surface to hold crosshead in contact with valve stem nearest push tube.
- 3. Turn adjusting screw down until it just contacts its mating valve stem.
- 4. Hold adjusting screw in this position and tighten locknut to 25/30 foot-pounds with a torque wrench.
- 5. Check clearance between crosshead and valve spring retainer with a wire feeler gauge. There must be a minimum of .025 inch clearance at this point.

Valve Adjustment

The same engine position used in adjusting injectors is used for setting intake and exhaust valves.

- While adjusting valves make sure that-the compression release, on those engines so equipped, is in running position.
- 2. Loosen lock-nut and back off the adjusting screw. Insert feeler gauge between rocker lever and top of the valve stem or crosshead. Turn the screw down until the lever just touches the gauge and lock the adjusting screw in this position with the lock-nut tightened to torque listed in Table II. Fig. 2-33.
- Always make final valve adjustment after injectors are adjusted and with the engine at operating temperature. Valve clearances are shown in Table III.

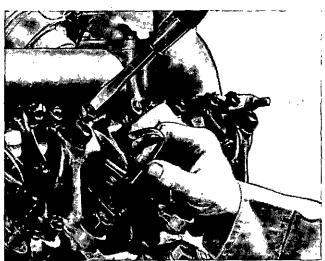


Fig. 2-33. Adjusting valves

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TABL	E III: VA	VLVE C	LEARA	NCE	
ගලාව ජොවෙ	ELD/AES COLUMN C	ghand		डि रीतगर	MOLF Anna
CAI CAI	70/30	016 ¹⁰	014p	.027 ¹²	.025 ¹⁰
V6-140/V8-135 V6-200/V8-265 V8-350/VT3-430	0 40/45	016 016 018	014P 014P 014P	.022 ¹² .029 ²² .029 ²²	.020 ^p .027 ^p
Vol. (10 = 10) Vol. (10 = 10) L	70/30	0187 0187	014p	.0297 .0197	,027 ¹² ,027 ¹² ,018 ²²

½ inch nuts tighten to 30/35 ft. lbs., 9/16 inch nuts to 70/80 ft. lbs.

CLEAN INJECTOR INLET SCREENS

On external fuel line engines, each fuel inlet connection has a fine mesh screen at the large end. This screen is the last protection against dirt entering the injector.

To clean: Remove the strainer screen; wash in solvent and dry with compressed air. Reassemble as removed. Fig. 2-34.



Fig. 2-34. Removing injector inlet screens

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CHECK FUEL MANIFOLD PRESSURE

Check maximum fuel manifold pressure with ST-435.
 Remove plug from shut-down valve and connect gauge line. Run engine up until governor "cuts in"

and check maximum pressure reached. Compare with previous readings to determine if fuel pressure output is satisfactory. Normally this check only required if loss of power is suspected.

CAUTION: ON TURBOCHARGED ENGINES ANEROIDS MUST BE DISCONNECTED TO REACH MAXIMUM FUEL PRESSURE DURING THE SHORT ACCELERATION PERIOD.

Always make the above checks on a hot engine and operate engine for a minimum of five minutes between checks to clear system of air.

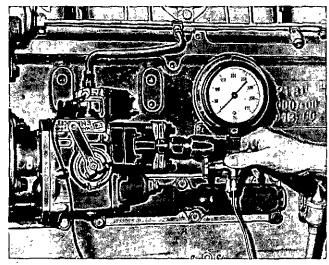


Fig. 2-35. Checking fuel manifold pressure

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CHANGE HYDRAULIC GOVERNOR OIL

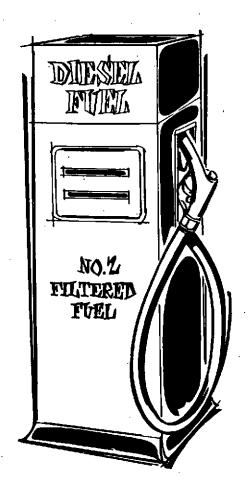
If the fuel pump has a hydraulic governor, maintain oil level between marks on dipstick gauge.

Change the oil in the governor at each "E" check.

Use the same grade oil as used in the engine. See "Lubricating Oil Specifications."

Note: When temperatures are extremely low, it may be necessary to dilute the lubricating oil with enough fuel oil or other special fluid to insure free flow for satisfactory governor action.

FUEL OIL SPECIFICATIONS



Fuel oil serves two purposes in a Cummins Diesel. It supplies the energy for the work done by the engine and it lubricates many of the fuel system parts.

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 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

FILL COOLING SYSTEM: CHECK LEAKS AND CORRECT

Keep cooling system completely filled. Check the coolant level daily or at each fuel fill point. Investigate for cause of coolant loss. Recheck the level after 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 for evidence of external coolant leakage. Tighten capscrews, hose clamps, fittings, and connections, or replace gaskets or hose as necessary to correct.

CHECK HEAT EXCHANGER ZINC PLUGS

Check zinc plugs in heat exchanger and change if badly erroded. Frequency of change depends upon chemical reaction of raw water circulated through heat exchanger.

CHECK AND ADJUST BELT TENSION

The service life of belts used to drive fans, water pumps, and generators/alternators can be greatly extended by proper installation, adjustment, and maintenance practices. Neglect or improper procedures often lead to problems of cooling or bearing failures, as well as short belt life. Following are the most important rules to be observed to extend belt life:

Installation

Note: In replacing worn belts, use Cummins belts; they are shaped to assure proper fit in the groove and are accurate and uniform in length to assure efficient operation. When two or more belts are used, they must be replaced as a set,

Always shorten distance between pulley centers so belt can be installed without force. Never roll or tighten a belt over the pulley and never pry it on with a tool such as a screwdriver. Both of these methods will damage belts and cause early failure.

Diagonal cuts on a failed belt indicate that the failure was caused by rolling a tight belt over the pulley. Cuts from prying a belt in place may be either diagonal or vertical. Always replace pairs of belts in complete sets to prevent early failure and to provide efficient operation.

Belt Tension

Tighten belts so that the pressure of the index finger will depress belt as shown in Table IV.

The index finger should be extended straight from the hand; in this manner, force will be approximately 13 pounds.

TABLE IN	: BELT TENSION
Can With	विवास्तीका दिय हिंद वर्ष दिव्या
Ja 1/3h 1/1gh 1/3h	9/167 18/827 18/827 18/827

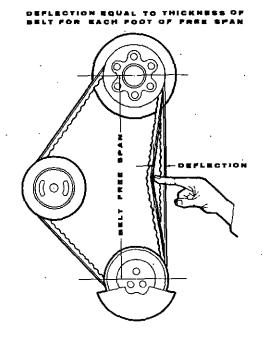


Fig. 2-36. Checking belt tension V6-V8

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Re-Tensioning New Belts

All new belts will loosen after running for an hour or more and must be retensioned. If the belt can be pushed down 1/8 inch more than recommended, retension as described under "Belt Tension."

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 approved belt lubricant or hydraulic brake fluid. Cleaning in this manner will eliminate most cases of squeaking. Do not tighten belt beyond figures given to eliminate belt squeak. Squeak does not necessarily mean belt slippage. Tightening to excess may damage bearings as well as belts.

CHECK ENGINE COOLANT AND CORROSION RESISTOR

Engine Coolant

Diligent maintenance of the engine cooling system is necessary to enable the system to cool the engine properly, 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 a pH value range of 8.5 to 10.5

Any water which is suitable for drinking can be treated as described below 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 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 is available from any Cummins Dealer and easily installed on any Cummins Engine.
 - a. When system does not contain anti-freeze, always use chromate-type element or elements, part number 132732. The 132732 element may be used with anti-freeze if desired.
 - b. Flush system before adding anti-freeze, then use "Permanent Anti-freeze" element or elements, part number 168481. Never use the 168481 element with plain water.
- 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 or three gallons of water. This is equivalent to 100 to 150 grains per gallon.

In Winter: Use ethylene-glycol base anti-freeze in the percentage required for winter protection. Anti-freeze can be used with a Cummins Corrosion Resistor.

Testing Engine Coolant

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

pH Value: Test Kit ABpH 1-11 (wide range paper and dispenser) 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.

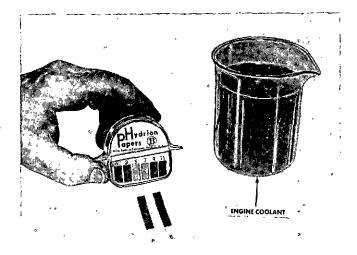


Fig. 2-37. pHydrion test paper

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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 unless antifreeze is used which destroys the possibility of color comparison. A good comparator, called "The Dearborn Cooling Water Treatment Comparator," is manufactured and sold by Dearborn Chemical Company, Merchandise Mart Plaza, Chicago 54, Illinois. When ordering, specify that the kit contain a 100 grains per gallon standard and a 150 grains per gallon standard.

Testing is accomplished by comparing the color of a sample with the standards supplied in the kit. Keep chromate concentration between 100 and 150 grains per gallon.

Adjusting Coolant to Specifications

If tests indicate that the coolant has a pH value below 8.5 or that chromate concentration is below 100 grains per gallon, make an adjustment immediately to prevent corrosion. The correction necessary depends upon which method of protection is being used in the cooling system.

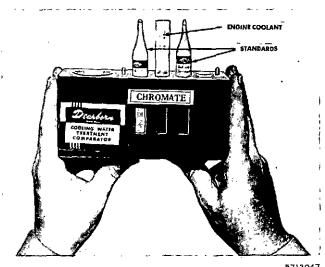


Fig. 2-38. Checking chromate concentration

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

If chromate compounds are used, add enough compound to bring the concentration to between 100 and 150 grains per gallon.

Corrosion Resistor

Change corrosion resistor element at each "C" check unless facilities are available for testing. See "Testing Engine Coolant." Change element when concentration drops below 100 grains per gallon.

Note: Change corrosion resistors on V12 Series and L Series at each "B" check.

CAUTION: NEVER USE SOLUBLE OIL IN COOLING SYSTEM WHEN A CORROSION RESISTOR IS INSTALLED.

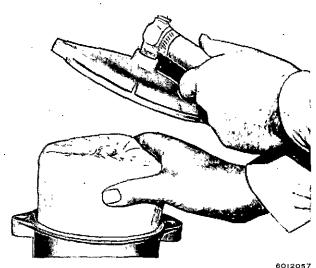


Fig. 2-39. Installing corrosion resistor element

To change element:

- Close shut-off valves on inlet and drain lines. Unscrew drain plug at bottom of housing.
- 2. Remove cover capscrews and cover.
- Remove plate securing element(s); lift element(s) from housing and discard. Remove plate below element.
- 4. Lift spring from housing.
- 5. Polish plates. If less than half of metal plates can be exposed by polishing, install new plates.
- 6. Replace spring and lower plate.
- 7. Remove transparent bag from new element(s); install element(s) in housing. Fig. 2-39.

Note: Check element, some are for use with antifreeze only and must not be used with plain water.

- 8. Replace upper plate, gasket and cover.
- Replace drain plug and open shut-off valves in inlet and drain lines.

CHECK THERMAL CONTROLS

Thermostat

Most Cummins Engines are equipped with either high (170/185°F.) or low (160/175°F.) and in a few cases higher range (180/195°F.) thermostats, depending on engine application.

The lower value indicates where thermostat starts to open and the higher value where it is fully open. 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. 2-40.

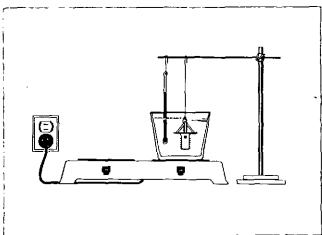


Fig. 2-40. Testing thermostat

Other Thermal Controls

Shutterstats and thermatic fans must be set to operate in same range as thermostat with which they are used. Table V gives settings for shutterstats and thermatic fans as normally used. The 180/195°F, thermostats are used with shutterstats only that are set to close at 187°F, and open at 195°F.

TABLE V: THERMAL CONTROLS					
CONTO	<u>U</u> 20/1	Seifings with 170/185°E Thermostats		APENIVOSV Entrometu	
	් දීම්මර ලාක	650D -(GD1)	(1000) (1000)	-@il	
Thermalic Fan Shullersial Shullersial With	195°F. 190°F.	18 2 °F.	185°F. 180°F.	170°F. 172°F.	
Thermatic Fan	180°F.	172°F.	170°F.	162°F.	

CHECK FAN HUB AND DRIVE PULLEY

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

Tighten 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 bracket capscrews.

CLEAN COOLING SYSTEM—SPRING AND FALL

The cooling system must be clean to do its work properly. 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 water passages in the block.

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

Chemical Cleaning

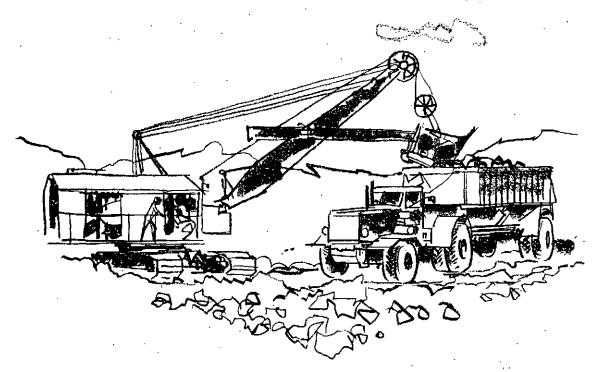
The best way to insure an efficient cooling system is to prevent formation of rust and scale by using a Cummins Corrosion Resistor, but if they have collected, the system must be chemically cleaned. Use a good cooling system cleaner such as sodium bisulphate or oxalic acid followed by neutralizer and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

Pressure Flushing

Flush the radiator and block when anti-freeze is added or removed, or before installing a Corrosion Resistor on a used engine.

When pressure flushing the radiator, open the upper and lower hose connections and screw the radiator cap on tight. Remove thermostats from housing and flush block with water. 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 water run until the radiator is full. When full, apply air pressure gradually to avoid damage to the core. Shut off air and allow radiator to refill, then apply air pressure. Repeat until water coming from radiator is clean.

Sediment and dirt settles into pockets in the block as well as the radiator core. Remove thermostats from housing and flush block with water. Partially restrict the lower opening until the block fills up. Apply air pressure and force water from the lower opening. Repeat the process until stream of water coming from block is clean.



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AIR SYSTEM MAINTENANCE

When engines operate under extremely dusty conditions, adjust the maintenance intervals indicated on Page 2-2 and 2-3 as necessary.

CHECK AIR CLEANER OIL LEVEL

Daily or at each trip, check oil level in oil bath air cleaner to be sure oil level is at indicated mark. During wet weather and in winter months, excessive moisture in air cleaner oil sometimes causes the cleaner to become flooded and results in oil pullover or plugging of the bottom air cleaner screen. Add or change oil as necessary. This is especially important if oil bath cleaner is the only cleaner on the engine.



Fig. 2-41. Checking oil level in air cleaner

CLEAN PRE-CLEANER AND DUST PAN

On engines working under extremely dirty conditions an air pre-cleaner may be used. Clean pre-cleaner jar and dry type air cleaner dust pans daily or oftener as necessary depending on operating conditions.

CLEAN COMPOSITE/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 the dirt. Do not hold air jet too close to paper element or damage to element will result.

When installing the element, make sure it seats on the gasket at the air cleaner outlet end. Fig. 2-42.

CAUTION: HOLES IN THE ELEMENT OF A DRY-TYPE AIR CLEANER RENDER CLEANER INOP-ERATIVE, DO NOT USE DAMAGED CLEANER ELEMENT. Composite cleaners combine a centrifugal cleaning stage with a paper filter element.

Air enters the cleaner through a hooded inlet on the side of the cleaner and passes into a tube. Vanes on the tube impart a cyclonic twist to the air which throw dust particles to the outside.

The separated dust collects in a cup at the bottom of the cleaner while the clean air passes up through the center of the tube to a paper filter. The paper filter then removes any small dust particles remaining in the air.

Before disassembly, wipe dirt from cover and upper portion of air cleaner. To clean composite-type:

- 1. Loosen clamps and remove cover.
- Unscrew wing bolt holding inner cover and element in position; remove element carefully so loose dirt will not fall into chamber.
- 3. Remove dust cup and clean.
- Tap side or bottom ring of element with palm of the hand or soft hammer.

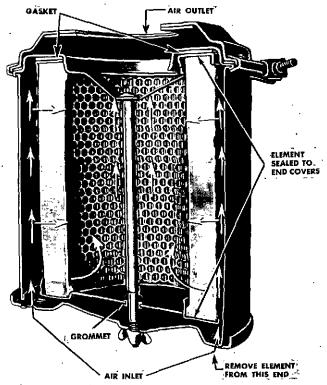


Fig. 2-42. Air cleaner — dry type

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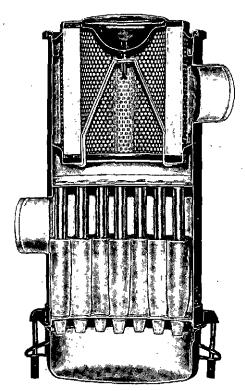


Fig. 2-43. Air cleaner - composite dry type

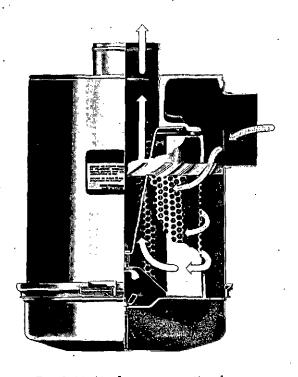


Fig. 2-44. Air cleaner — centrifugal type

- 5. Blow out element from clean air side with compressed
 - CAUTION: AIR PRESSURE SHOULD NOT BE MORE THAN 100 PSI TO AVOID RUPTURING ELEMENT, DO NOT CONCENTRATE AIR PRESSURE IN ONE SPOT.
- Wash element with non-sudsing household detergent and warm water. (120-140°F.) Dry with compressed air. (40 psi).
- Remove retainer clamp. Separate upper and lower bodies; remove "O" ring.
- 8. Hold element up to light and inspect tubes for dust deposits. Remove dust with stiff fiber brush.
- Inspect gaskets and "O" rings; discard if worn or mutilated.
- Inspect element after cleaning to be sure there are no holes in filter.
- Position upper body with gasket on lower body; secure with retainer clamp.
- 12. Install element and inner cover in position.
- Be sure gasket washer is in place under wingnut before tightening.
- 14. Install cover.
- 15. Install dust cup.

CHANGE AIR CLEANER OIL

Before dirt build-up reaches 1/2 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 on its side with clean, fresh oil and assemble to cleaner. An oil of the same grade as that in the crankcase should be used in the cleaner; however, in extremely cold weather a lighter grade may be necessary. A straight mineral, non-foaming detergent, or non-foaming additive oil may be used in air cleaners.

CAUTION: NEVER USE CRANKCASE DRAININGS.

CLEAN CRANKCASE BREATHER

Oil Bath

Immerse breather in kerosene or cleaning solvent. Wash thoroughly and dry with compressed air. Fill breather oil cup to level indicated with oil of the same grade used in the engine.

Screen Element

Clean element by washing in cleaning solvent and dry-

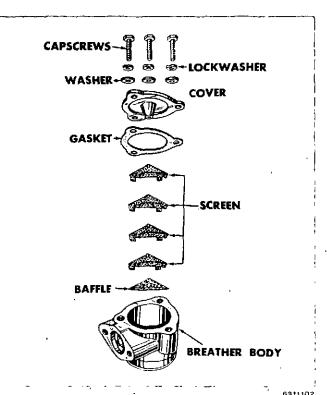


Fig. 2-45. Crankcase breather - screen element

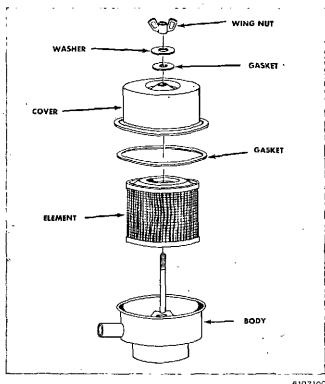


Fig. 2-46. Crankcase breather - paper element

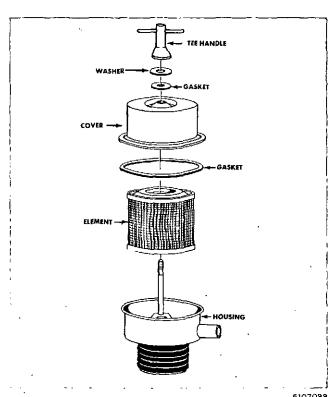


Fig. 2-47. Crankcase breather – paper element – bottle stopper type

ing with compressed air. Clean breather housing with a dry cloth.

Wire Mesh Element

Clean breather element in cleaning solvent and dry with compressed air. Wipe out breather housing. Soak element in oil; drain out excess. Fig. 2-45.

CHANGE CRANKCASE BREATHER ELEMENT

Paper Element

Dry-type crankcase breathers containing a chemically-treated paper element are used on naturally-aspirated engines. Install new element – DO NOT ATTEMPT TO CLEAN. DO NOT USE ON ENGINES WITH PRESSURIZED SYSTEMS.

CLEAN TRAY SCREEN

Immerse the tray screen in kerosene or cleaning solvent. Slosh the screen up and down several times. Dry thoroughly with compressed air, and reassemble to air cleaner.

Note: If the 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 tin plate on screens.

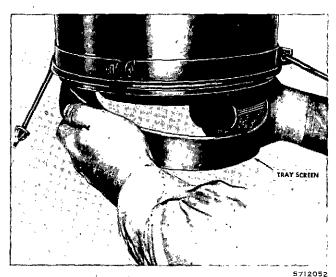


Fig. 2-48. Removing tray screen

CHECK AIR PIPING AND VENT TUBE

Check Air Piping

Check air intake piping from air cleaner to intake manifold. Check for loose clamps or connections, cracks, punctures, or tears in hose or tubing, collapsing hose, 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.

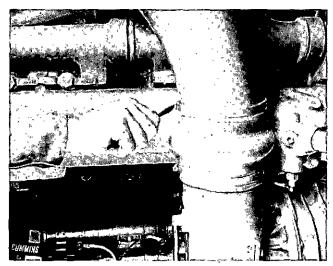


Fig. 2-49. Tightening air intake piping connections

Check Air and Vapor Line Connections

Check all air and vapor lines and connections from compressor, supercharger, rocker housing cover, and cylinder head for leaks, breaks, stripped threads, etc.; correct as needed. In cold weather, condensed moisture in air tanks and lines may freeze and make brakes useless.

Drain air tanks to keep all water out of the brake system.

CHECK INLET AIR RESTRICTION

The best method for determining dry-type air cleaner maintenance periods is through air restriction checks.

- 1. To Check Air Inlet Restriction at Engine:
 - a. On naturally aspirated engines attach vacuum gauge or water manometer in the middle of the intake manifold or on the air intake piping. When located in the air intake piping, the adaptor must be perpendicular to the air flow and not more than 6 inches from the air intake manifold connection.
 - b. On turbocharged or supercharged engines, attach the checking fixture one pipe diameter upstream from the supercharger or turbocharger in a straight section of tubing.
 - Idle the engine until normal operating temperature is reached.
 - d. Operate engine at rated speed, full-load and take reading from vacuum gauge or manometer. Air restriction must not exceed 25 inches of water or 1.8 inches of mercury.
 - e. If air restriction exceeds 25 inches of water or 1.8 inches of mercury:
 - (1) Clean or replace dry-type cleaner element.
 - (2) Replace damaged air piping, rain shield or housing.
 - (3) Remove excessive bends or other source of restriction in air piping.
- 2. To check air inlet restriction at cleaner:
 Air restriction readings may be taken at the air cleaner

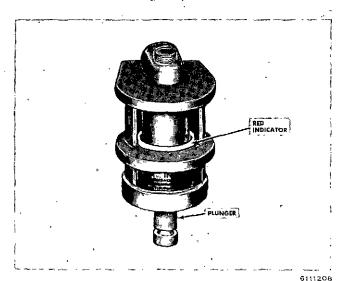


Fig. 2-50. Air inlet restriction gauge

outlet pipe. The adaptor must be mounted perpendicular to air flow, and the restriction must not exceed 20 inches of water or 1.5 inches of mercury when checked at this location.

A mechanical restriction gauge is available to indicate excessive air restriction. This gauge can be mounted in the air cleaner outlet or on the vehicle instrument panel. The gauge shows completely red in the indicator window when restriction reaches 20 inches of water.

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

Note: Air restriction checks should not be used to determine maintenance periods for oil-bath air cleaners.

Before dirt build-up reaches 1/2 inch maximum height, perform maintenance as described under "Change Air Cleaner Oil".

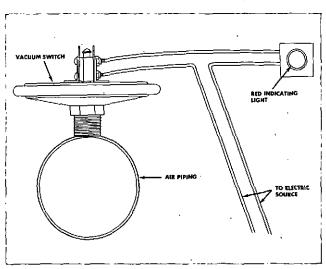


Fig. 2-51. Vacuum switch to check air inlet restriction

REPLACE COMPOSITE/DRY-TYPE CLEANER ELEMENT

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:

- 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.

Dry-Type Cleaner Element

Elements that have been cleaned several times will finally clog and air flow to the engine will be restricted. After cleaning, check restriction as previously described and replace the element if necessary.

Holes, loose end seals, dented sealing surfaces, and other forms of damage require immediate element replacement.

CHECK FOR OIL LEAKS AT SUPERCHARGER OR TURBOCHARGER

Supercharger

Remove supercharger outlet connection and visually check ends of the rotors and case for evidence of oil leakage from supercharger seals. Rotors will always show some oil from the vapor tube which is connected to a rocker housing cover. Only the appearance of "wet" oil at the ends of the rotors and excessive oil consumption should be cause for changing supercharger seals.

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

Turbocharger

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

TIGHTEN MANIFOLD AND TURBOCHARGER MOUNTINGS

Tighten all turbocharger mounting capscrews and nuts to be sure that they are holding securely. Tighten mounting bolts and supports so that vibration will be at a minimum.

Note: Oil passages are cast into the mounting "feet" of VT8-430 turbocharger casing. Mounting capscrews must be secure to prevent oil leaks.

Check exhaust, intake and water manifolds mounting hardware for tightness correct deficiencies as required.

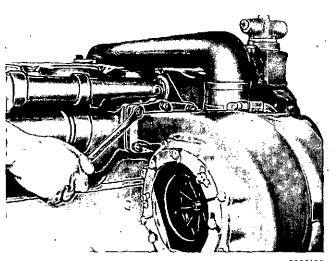


Fig. 2-52. Tightening turbocharger mounting nuts

CLEAN AIR COMPRESSOR BREATHER

Three types of breathers are available to provide filtered air for the air compressor when the intake line is not connected to the engine air intake system.

When used, service breathers regularly as follows.

Bendix-Westinghouse Compressor Mesh

Remove the breather and disassemble completely; wash all parts in solvent. Dry with compressed air, reassemble, and install on compressor. Oil the mesh element very lightly with SAE 20 oil to aid in capturing dirt particles.

Sponge

Remove the breather from the air compressor. Disassemble the breather, wash all metal parts in solvent and blow dry with compressed air. Wash the element in solvent using a squeezing action, remove all solvent from element; dip in clean engine oil and squeeze excess oil from element.

Oil Bath

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

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

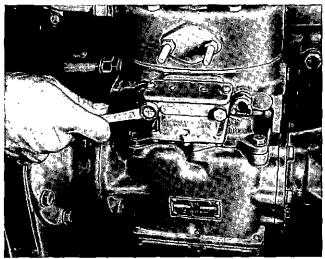


Fig. 2-53. Removing air compressor breather

Cummins Compressor

Paper

A lightweight self-contained air cleaner with "paper

element" is optional on Cummins air compressor. Clean the element at each "D" maintenance check. Remove wing nut securing front cover to body. Lift off front cover and element. Inspect paper element before cleaning by reverse flow of compressed air; discard if damaged or unsuitable for cleaning.

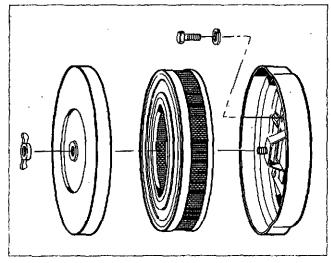


Fig. 2-54. Air compressor breather - paper element

CAUTION: DO NOT RUPTURE FILTER ELE-MENT.

Clean the body and front cover with a clean cloth. With rubber gasket on center bolt, place element in front cover and assemble over center bolt; secure with wing nut.

CLEAN ANEROID AIR FILTER

At each "E" check, remove filter and reverse flush with compressed air; it is not necessary to disassemble the filter.

CLEAN OIL BATH AIR CLEANER

Steam Cleaning

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

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.

- Introduce air into unit at 3/5 psi and leave in washer 10 to 20 minutes.
- Remove cleaner from solvent and steam clean thoroughly to remove all traces of solvent.
- Dry thoroughly with compressed air.
 CAUTION: FAILURE TO REMOVE SOLVENT MAY CAUSE ENGINE TO OVERSPEED UNTIL ALL SOLVENT IS SUCKED FROM CLEANER.
- 8. If air cleaner is to be stored, dip in lubricating oil to prevent rusting of screens.

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

CLEAN TURBOCHARGER COMPRESSOR WHEEL AND DIFFUSER

Keep the compressor wheel and diffuser clean for best turbocharger performance. Any buildup of dirt on the compressor wheel will choke off air flow and cause rotor imbalance.

At every "E" check, clean the compressor wheel and diffuser as follows:

- 1. Remove intake piping, air cleaner piping and support bracket from turbocharger.
- Loosen and remove capscrews, lockwashers and plain washers from the plate. Remove the front plate to expose compressor wheel and diffuser.
- Use a good carbon removing solvent and a brush with nylon or hog bristles to clean the compressor wheel and diffuser. Never use a solvent that may attack aluminum and result in an imbalanced compressor wheel.
- 4. If the unit is very dirty when the front plate is removed, remove the turbocharger from the engine.
- Remove front plate and immerse compressor wheel end of turbocharger in cleaning fluid to the diffuser plate face; allow to soak. Do not rest weight of turbocharger on compressor wheel or on end of shaft.
- Dry the unit thoroughly with compressed air. Reassemble front plate to turbocharger.

CHECK TURBOCHARGER BEARING CLEARANCES

Check bearing clearances every "E" check. This can be done, without removing the turbocharger from the engine, by using a dial indicator to indicate end-play of the rotor shaft and a feeler gauge to indicate radial clearance.

Checking Procedure

· 1. Remove exhaust and intake piping from the turbocharger to expose ends of rotor assembly.

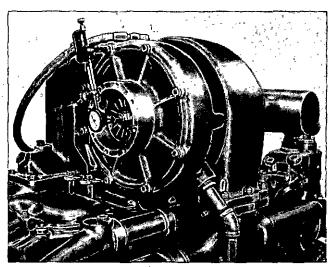


Fig. 2-55. Checking turbocharger bearing clearance

- 2. Remove one capscrew from the front plate (compressor wheel end) and install a long capscrew. Attach an indicator to the long capscrew and register indicator point on the flat of rotor shaft. Push the shaft from side to side, making note of total indicator reading. Move indicator point to the end of the shaft and check end-play of rotor assembly. See Table VI for
- Check radial clearance on compressor wheel only.
 Note that limits in Table VI are minimum figures.

TABLE VI:	TURBOC	HARG	R BEA	RING	CLEAR	ANCES
	340	5 0	Ţ÷€	10 3	Ω±€	900
	Min	War-	مثلاث	Max	Mb.	Moza
Radial Clearance	.01357°	===	.007w	-	.007w	€.
End Clearance	W	.008zz	.0037	.0107	.008v	M

 If end clearance exceeds limits shown above, remove turbocharger from engine and replace with a new or rebuilt unit.

CHECK PREHEATER

limits.

- Inspect wiring; remove 1/8" pipe plug from manifold near glow plug and check flame while a helper performs preheating operation.
- If no flame is observed, remove and replace with new or tested parts.

OTHER MAINTENANCE

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 power.
- 3. Abnormal water or oil temperature.
- 4. Unusual engine noises.
- 5. Excessive smoke.
- 6. Unusual air pressure.

CHECK VIBRATION DAMPER ALIGNMENT

Damper hub and inertia member are stamped with an index mark to permit detection of movement between the two components. Fig. 2-56.

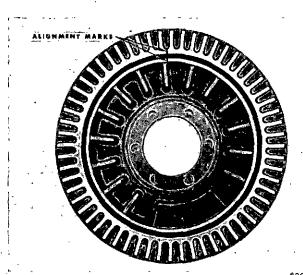


Fig. 2-56. Vibration damper alignment marks

Inspect damper every "C" check. There should be no relative rotation between hub and inertia member resulting from engine operation.

CHECK POWER TAKE-OFF CLUTCH ADJUSTMENT

If clutch does not pull, heats, or operating lever jumps out, clutch must be adjusted. To adjust clutch, remove hand hole plate in housing and turn clutch until adjusting lockpin can be reached. Disengage adjusting lockpin and turn adjusting yoke or ring to right, or clockwise, until operating lever requires a distinct pressure to engage. A new clutch generally requires several adjustments until friction surfaces are worn in.

CLEAN ELECTRIC UNITS AND TIGHTEN CONNECTIONS

Blow Dust From Generator/Alternator and Cranking Motor

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

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

Clean and Tighten Electric Connections

Hard starting is often traceable to loose or corroded battery connections. A loose connection will overwork the generator/alternator and regulator and shorten their life.

- Add water to battery cells to keep tops of plates covered.
- 2. Remove corrosion from and around terminals, then coat with petroleum jelly.
- 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 wires and their terminals.
- 5. Have battery tested periodically. Follow battery manufacturer's instructions for maintenance.

CHECK GENERATOR/ALTERNATOR BRUSHES AND COMMUTATOR

The failure of a generator/alternator may cause unit down-time and nearly always results in expensive replacement.

- 1. Clean dirty 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 the commutator. Check out-put and action of an ammeter indicator after brush replacement.
- Shorts and incorrect generator polarization can be detected at the ammeter. Incorrect polarization is indicated by minus reading when generator is in operation. Take unit to an electric service station for immediate correction.

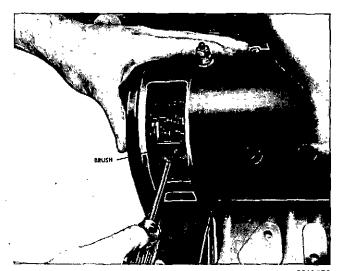


Fig. 2-57. Replacing generator brushes

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CLEAN ENGINE

There are many reasons why the exterior of the engine should be kept clean. Dirt from the outside will find its way into the fuel and lubricating oil filter cases and into the rocker housings when the covers are removed unless dirt is removed first.

Steam is the most satisfactory method of cleaning a dirty engine or piece of equipment. If steam is not available, use mineral spirits or some other solvent to wash down the engine.

All electrical components and wiring should be protected from the full force of the steam jet.

TIGHTEN MOUNTING BOLTS AND NUTS

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

CHECK ENGINE BLOW-BY

Engine blow-by, or escape of combustion gases past pistons and liners, is usually caused by worn or stuck piston rings, worn cylinder liners, or worn pistons.

Blow-by can be detected by running the engine and observing the gas escape from the lubricating oil filler hole with cap or breather open or removed. There is always some vapor or gas escape at this point due to heated oil and piston movement, but distinct puffs indicate blow-by. Experience and comparison with other units operating at the same speed are needed to make a conclusion as to the extent of blow-by. Normally, excessive blow-by is accompanied by oil consumption.

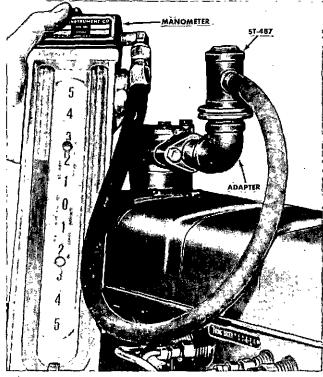


Fig. 2-58. Checking engine blow-by

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Cummins Distributors are equipped to check engines for blow-by under loaded conditions, with special tools, to determine if blow-by is excessive. Fig. 2-58.

CHECK CRANKSHAFT END CLEARANCE

The crankshaft of a new or newly rebuilt engine must

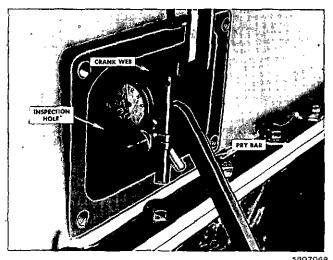


Fig. 2-59. Checking crankshaft end clearance

have end clearance as listed for that model in Table VII. A worn engine must not be operated with more than the worn limit end clearance shown in the same table.

H/NH, V12 and L Series

The check can be made by attaching an indicator to rest against the flywheel or end of the crankshaft while prying against a crankshaft throw through an inspection plate, (Fig. 2-59) if the oil pan is not removed. End clearance must be present with engine mounted in the unit and assembled to transmission or converter.

C, J, V6 and V8 Series

The check can be made by attaching a dial indicator gauge so the point will rest against the end of the vibration damper or crankshaft pulley as the crankshaft is pried back and forth. Pry against the crankshaft pulley or 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, riding the clutch, or other poor operating practices. End clearance in excess of maximum may result in bossing of connecting rods in pistons.

TABLE VII:	CRANKSHAFT	END CLEA	ARANCE
වැල්බ වැල්ව	New Mins	(New	Operating Mass Chair
C&] H/NH V&Val & V&Val V&VIII & VX VE-150 & VIX V12 L	7032 2013. 2013. 2013. 2014. 2014.	916 918 918 918 918 918 918 918	9805 9825 9825 9825 9825 98305

MAJOR INSPECTION

After the engine has had four "E" checks, it should have a major inspection to determine whether it may be

operated for another service period, or whether it should be overhauled. Oil consumption, oil pressure at idling, dilution and other signs of wear should be analyzed as part of the inspection.

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

Inspect the following items at this period:

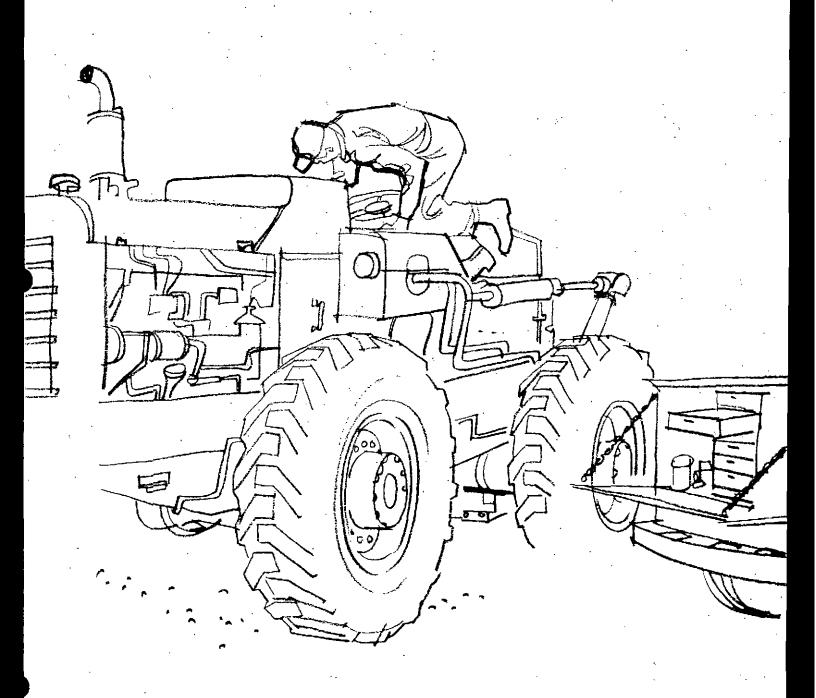
Main and Connecting Rod Bearing Shells
Crankshaft Journals
Camshaft Lobes
Cylinder Heads (Grind Valves)
Cylinder Liners
Pistons and Rings
Fuel Pump (Calibrate)
Injectors (Clean and Calibrate)
Supercharger Seals and Bearings
Oil Cooler (Clean)
Turbocharger Bearing Clearances
Air Compressor or Vacuum Pump
Alternator/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 any other engine parts are worn beyond worn replacement limits, the engine should be removed and completely rebuilt.

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 preventive maintenance schedule, the same dependable service can be expected from the engine that it gave during its first service period.



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

For all unit rebuilding or parts installation, see the nearest Cummins Distributor who is equipped to rebuild all Cummins engines or engine units. If you have the facilities to do your own rebuilding, he will supply you with the complete instructions contained in Shop Manuals. Through the use of the shop manual, factory approved service tools and trained mechanics, a rebuilt engine will perform as well as a new one.

Use only Cummins parts in Cummins engines. Years have been spent developing and testing these parts — each in relation to its mating parts. Cummins engines deserve only the finest replacement parts — genuine Cummins parts.

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

Protect all machined surfaces from contact with corners, edges, rough surfaces, dust, dirt, or any material that will mar, scratch or damage these surfaces in any way. Protect all parts which are to be stored with an oil or grease film.

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

THEO ANGERS THRU

CLEAN ENGINE EXTERIOR

After removal of electrical equipment, but before removal of remaining units, steam clean engine thoroughly. The time spent in cleaning will be made up quickly during disassembly. In addition to actual time saved by engine cleaning, the quality of work will be improved.

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

GENERATOR/ALTERNATOR

Removal

- 1. Disconnect wiring leads from the generator terminals.
- On belt-driven units, remove drive belt from the drive pulley.

Note: On some C and J Series applications, No. 1 cylinder injector inlet and drain manifolds may have to be disconnected to remove generator/alternator.

- Remove capscrews from mounting bracket; lift unit and bracket from engine.
- 4. Remove bracket from unit.

Installation

- Make sure the generator/alternator is the same type and rating as that removed.
- 2. Mount unit to bracket (install shims if used). If bracket does not have the word "Top" cast on it, be sure to mount the unit so the top unit-to-bracket mounting holes are closer to the horizontal center line of the bracket. Failure to do so will place lubricating oil cup and oil passages out of position.
- On gear driven generators, install the rubber buffer between the generator coupling and drive coupling; connect the two units. Mount generator and bracket assembly to the block.
- On belt driven units, install belt(s) over drive pulley. See Page 2-21.
- 5. Connect wiring leads to proper terminals.

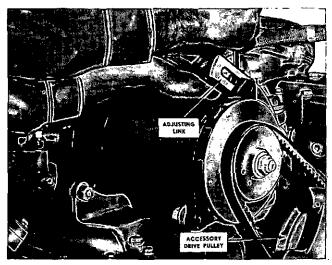


Fig. 3-1. Mounting generator

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CRANKING MOTOR

Electric

Removal

- Disconnect wiring leads from the cranking motor terminals.
- Remove capscrews holding cranking motor and mounting spacer to the flywheel housing.
- 3. Slide cranking motor forward and lift out.

Installation

- Check cranking motor; see that it is the same type as removed. Cranking motors are designed with different type drives and must be used with a matching flywheel ring gear. Thus, it is important to replace them with the same type.
- 2. If used, assemble spacer to cranking motor.
- Mount cranking motor to flywheel housing with capscrews. Fig. 3-2.
- Connect wiring leads to the cranking motor terminals.

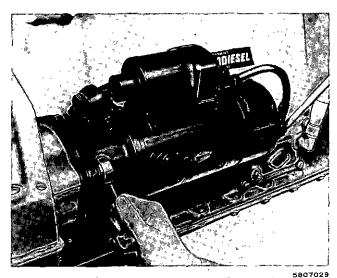


Fig. 3-2. Mounting electric cranking motor

Air

Removal

CAUTION: RELIEVE AIR SYSTEM BEFORE DIS-CONNECTING AIR LINES.

- 1. Disconnect air supply to cranking motor.
- 2. Depress starter handle to bleed off air in cranking
- 3. Uncouple union between starter handle and motor.
- 4. Remove capscrews and lockwashers holding motor to flywheel housing.
- 5. Support motor and slide out, to clear starter drive from flywheel ring gear.

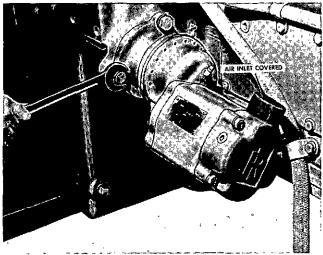


Fig. 3-3. Mounting air starter

601206

Installation

- 1. Put capscrews and lockwashers in place in cranking motor mounting flange to furnish support during installation. In some applications, a spacer is used between the mounting flange and the flywheel housing.
- 2. Slide motor into opening in flywheel housing, clearing flywheel ring gear.
- 3. Tighten capscrews securely.
- 4. Connect air supply line to starter.

CORROSION RESISTOR

Many engines are equipped with a corrosion resistor. A single element resistor is used on engines having cooling system capacities of 20/25 gallons; for larger systems, twin element resistors are used.

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.

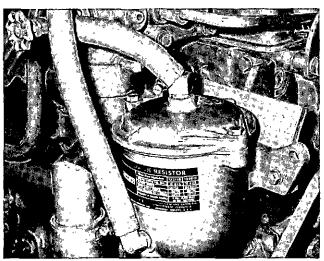


Fig. 3-4. Single element corrosion resistor

3. Remove capscrews securing corrosion resistor to engine block or mounting bracket.

Installation

- 1. Select location so that resistor will be grounded and inlet line will be less than 18 inches in length.
- 2. Secure resistor to engine or mounting bracket with capscrews.
- 3. Attach inlet and outlet lines. The inlet line connects the pressure side of the water pump to the bottom of the resistor. The outlet line connects the suction side of the water pump to the resistor cover.

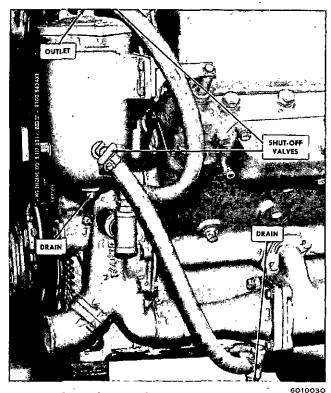


Fig. 3-5. Twin element corrosion resistor

Note: Corrosion resistor must never be used as a main coolant supply line.

- 4. If new hose are installed, cut to length from 5/8" I.D. heater hose.
- 5. Open shut-off valves; start engine and check for leaks.
- After a few minutes, check resistor cover temperature to see if coolant is circulating. If cold, disconnect outlet line to bleed off air. Recheck for circulation.

THERMOSTATS, THERMOSTAT HOUSINGS AND WATER CONNECTIONS

C, J and H/NH Series

C, J and H/NH Series engines use one thermostat located in the thermostat housing.

Removal

- 1. Drain cooling system.
- Loosen hose clamps; disconnect all water hose and lines.
- Remove capscrews and washers securing thermostat housing to water outlet connections; separate the units. Remove thermostat, seal and gasket; discard gasket.

Installation

 If thermostat housing seal was discarded, install new seal lip first and press in seal until flush with top surface of seal bore.

CAUTION: REVERSING LIP OF SEAL WILL PERMIT LEAKAGE.

- 2. Install new or tested thermostat (See Page 2-23).

 Note: Install thermostat with "V" notch at top to vent as much air as possible. Failure to do so may result in an air lock and incomplete coolant circulation.
- Install new gasket between housing and cover; secure with lockwashers and capscrews.
- On C and J Series engines, install new rubber "O" ring on water by-pass tube. Connect all water lines and hose; secure with clamps.
- Fill cooling system and open vent cock at top of housing to bleed air. Start unit and check for leaks.

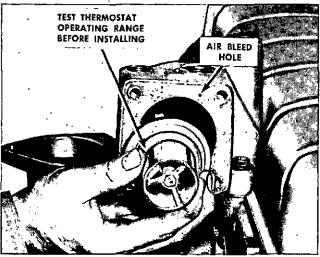


Fig. 3-6. Installing thermostat

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V8-350, VT8-430 Series

The twin thermostats on these engines are located in housings mounted on the front of each cylinder head.

Removal

- 1. Drain cooling system.
- Loosen clamps and disconnect hose from water outlet connections on each thermostat housing.
- Loosen nuts, washers and bolts securing thermostat housing covers to cross-over pipe; remove cross-over pipe and gaskets.

- Disconnect hose between water by-pass pipe and water pump. Remove capscrews, lockwashers and flatwashers securing thermostat housing cover to by-pass pipe; lift off by-pass pipe and gasket.
- Remove remaining capscrews, lockwashers and flatwashers securing thermostat housing covers to thermostat housings; lift off covers.
- Lift off thermostat housings, gaskets and thermostats from cylinder heads.
- 7. Remove thermostats from thermostat housings.

Installation

- If thermostat housing seals were discarded, install new seal, lip first, into each housing. Press seal in until it is flush with housing.
 - CAUTION: REVERSING LIP WILL ALLOW LEAKAGE BETWEEN BY-PASS AND MAIN COOLANT FLOW. DO NOT PRESS SEAL INTO BY-PASS PASSAGE.
- Insert new or tested thermostats in housing counterbore through seals.
- Position new gaskets; thermostat housings, and covers on cylinder head pads; secure with flatwashers, lockwashers, and capscrews.

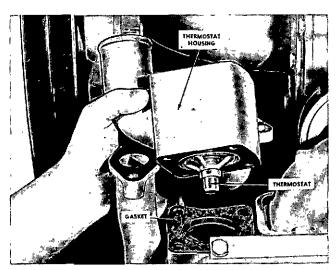


Fig. 3-7. Installing thermostat housing – VT8-430

- 4. Position water by-pass pipe between water pump and thermostat housing cover; secure to water pump with hose connection and to cover with flatwashers, lockwashers, and capscrews.
- Position cross-over pipe and new gaskets between thermostat housing covers; secure with lockwashers, bolts and nuts.

- Position hose on each thermostat water outlet connection and secure with hose clamps.
- Fill cooling system; open vent cock on top of right bank thermostat housing to remove any trapped air. Start unit and check for leaks.

V6-Val, V8-Vale, V6-Vim and V8-Vine Series

These engines have one thermostat, located in a housing mounted on the front of the right bank cylinder head.

Removal

- 1. Drain cooling system.
- Remove water outlet hose from the thermostat housing cover.
- 3. Remove capscrews and lockwashers securing cover to thermostat housing. Lift cover from housing.
- 4. Remove thermostat and gasket from housing; discard gasket.

Installation

 Install new or tested thermostat; spring end down. Fig. 3-8.

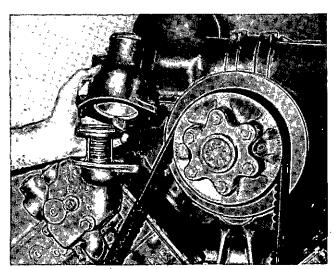


Fig. 3-8. Installing thermostat - V6-Vim & V8-Vine

- 2. With new gasket in place, position connection to housing and secure with lockwashers and capscrews.
- 3. Open vent cock and fill cooling system.
- 4. Close vent cock and start engine to check for leaks.

V-12 Series

V-12 Series engine thermostats may be mounted in either end — usually in the gear case end — of each water-cooled exhaust manifold.

Removal

- 1. Drain cooling system.
- Remove water outlet connections from the thermostat housings.
- Remove capscrews and lockwashers securing thermostat housings. Lift housings from water-cooled exhaust manifolds.
- Remove thermostat and gasket from each housing; discard gasket.

Installation

- 1. If thermostat housing seals were discarded, install new seal, lip first.
- 2. Install large half of thermostat housing on manifold with new gasket in position.
- Place a new gasket on the reamining half of the thermostat housing; install thermostat with 'V" notch at top to vent air.
- 4. Install thermostat housing; secure with lockwashers and capscrews.
- 5. Fill cooling system and open vent cocks in top of thermostat housing to bleed out any trapped air. Start unit and check for leaks.

L Series

Removal

- Remove capscrews and lockwashers securing the bypass connection to the thermostat housing. Remove connection, two by-pass thermostats, and discard bypass connection gasket.
- Remove capscrews and lockwashers securing water outlet connection to housing. Remove connection, three main thermostats, and discard gasket.

Note: L and LR engines have three main line and two by-pass thermostats. Main line thermostats open at 160/165°F, and by-pass thermostats close at 180/185°F.

CAUTION: MAIN LINE THERMOSTATS MUST ALWAYS OPEN AT A LOWER TEMPERATURE THAN THE CLOSING TEMPERATURE OF THE BY-PASS THERMOSTATS.

Installation

- Install the three main line thermostats in water outlet connection with thermostat spring out. Position new gasket and outlet connection to thermostat housing; secure with lockwashers and capscrews.
- Install the two by-pass thermostats in by-pass connection, with thermostat spring out. Position new gasket and by-pass connection to housing; secure with lockwashers and capscrews.

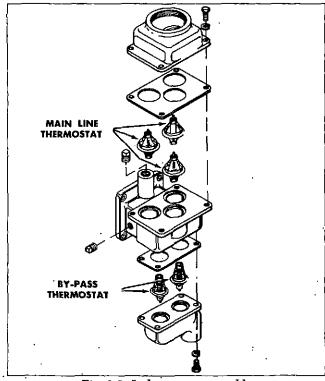


Fig. 3-9, L thermostat assembly

FAN, FAN HUB AND PULLEY

C and J Series (Standard)

Removal

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

Installation

- Assemble bracket and pulley to the block with lockwashers and capscrews.
- 2. Install fan pulley V-belts. Loosen large hex nut and adjust tension with pulley adjusting screw. See Page 2-21. Tighten hex nut.
- On engines with the water pump driven from fan hub, proceed as follows:
 - Before tightening fan drive belts, loosen water pump belt by separating water pump pulley sheaves.
 - Tighten water pump belt to proper tension by adjusting water pump pulley sheaves.

C and J Series (Eccentric Type)

Removal

- 1. Remove fan from pulley.
- Loosen locking nut and turn eccentric shaft to obtain closest point between fan pulley and drive pulley; loosen mounting capscrews and lower assembly. Lift off drive belts.
- 3. Remove capscrews and lockwashers securing fan mounting bracket to front of block; lift off assembly.

Installation

- Measure distance from block face to center of accessory drive pulley.
- Screw shaft of fan hub in mounting bracket to obtain distance found in Step 1 from rear of mounting bracket to center of fan drive pulley.
- Position hub assembly to face of block; install lockwashers and capscrews.
- Loosen locking nut and turn eccentric shaft to obtain closest point between fan pulley and drive pulley.
- 5. Install drive belts on fan drive pulley and accessory drive pulley.
- Lift mounting bracket as high as possible; secure in position with mounting capscrews.
- 7. Rotate eccentric to obtain proper belt tension. Hold in position and secure with locking nut.
- 8. Install fan on pulley.

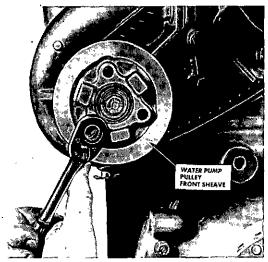


Fig. 3-10. Adjusting water pump pulley sheaves $-\overset{571206!}{C} \circlearrowleft J$

FAN, FAN HUB AND PULLEY H/NH, V6, V8, V12 and L Series

Removal

- 1. Remove fan from fan hub.
- 2. Loosen adjusting screw and remove fan drive belts.
- 3. Remove adjusting screw and fan hub locking nuts. Lift fan hub assembly from mounting bracket.
- Remove capscrews and lockwashers securing fan hub mounting bracket to front of engine block. Lift off bracket.

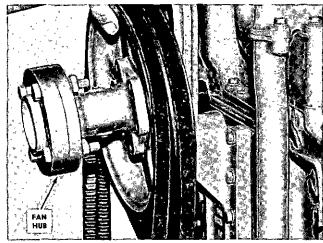


Fig. 3-11. Removing fan hub assembly

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Installation

- Position fan hub mounting bracket to front of engine block; secure with lockwashers and capscrews.
- 2. Position fan hub in mounting bracket; assemble locking nut and adjusting screw to fan hub.

CAUTION: AVOID STRETCHING BELTS. LOOSEN ADJUSTING SCREW UNTIL BELTS GO INTO POSITION EASILY.

- Place drive belts on fan hub pulley. Draw to proper tension. Refer to Page 2-21.
- 4. Install fan on fan hub.

WATER PUMP C and J Series Belt Driven

Remova

1. Drain cooling system.

- Loosen clamp and disconnect hose at water pump inlet connection.
- Loosen water pump belt enough to slip belt from pulley sheaves.
- 4. Remove capscrews holding pump to gear housing.
- 5. Remove pump from engine by separating from water by-pass coupling and oil cooler connection.

Installation

- Install new rubber "O" rings on oil cooler connection and water by-pass coupling.
- 2. Lift pump into position; install lockwashers and capscrews holding pump to gear housing.
- Adjust water pump belt tension as described on Page 2-21.
- 4. Fill cooling system and start engine to check for leaks.

Supercharger Driven

Removal

- 1. Drain cooling system.
- 2. Loosen clamp and disconnect hose at water pump inlet connection; remove and discard "O" ring.
- 3. Disconnect and remove oil cooler as described on Page 3-16.
- 4. Remove capscrews holding pump to supercharger.
- 5. Disconnect pump from water by-pass coupling; remove pump from engine.
- Remove capscrew holding oil cooler connection to water pump and remove connection; remove and discard "O" ring.



Fig. 3-12. Supercharger driven water pump - C $\overset{5712061}{6}$ J

Installation

- Assemble new rubber "O" ring on oil cooler connection; attach to water pump with lockwasher and capscrew.
- Install new rubber "O" ring on water by-pass coupling.
- Attach pump to coupling and supercharger using new gasket.
- 4. Install lockwashers and capscrews; tighten securely.
- 5. Install oil cooler as described on Page 3-16.
- 6. Fill cooling system and start engine to check for leaks.

WATER PUMP

H/NH Series

Removal, Fan and Pulley

- 1. Remove fan from fan pulley.
- 2. Loosen adjusting screw and remove fan hub, pulley, and belts from mounting bracket.
- 3. Drain cooling system.

Removal, Fan Bracket and Water Pump

- 1. When used, remove bell crank arrangement from rocker housing and compression release lever.
- 2. Loosen and remove capscrews that hold the fan bracket support to rocker housing.
- 3. The fan bracket on many engines is also a clamp ring to secure the water pump. Loosen capscrews in the clamp ring.
- Using a screwdriver in holes provided in water pump housing, turn water pump to the lowest point of its eccentric to loosen water pump belt.
- 5. Remove water pump belt, fan bracket and support.
- 6. Remove water pump from the block.

Installation, Fan Bracket and Water Pump

- 1. Place water pump clamp ring and gasket on water pump.
- Assemble drive belt on water pump pulley and water pump drive pulley.
- Turn water pump to the low point of its eccentric and install in the cylinder block. Secure loosely with capscrews and lockwashers. Fig. 3-13.
- Insert a large screwdriver in holes provided in water pump; turn water pump on its eccentric counterclockwise to tighten belt. Refer to Page 2-21.
- 5. Tighten capscrews in clamp ring.
- Secure fan bracket support to the rocker housing with capscrews and lockwashers.

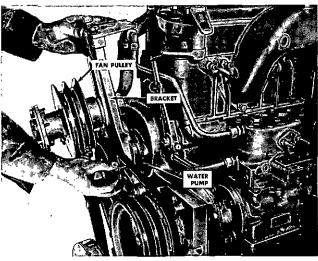


Fig. 3-13. Fan bracket and water pump - H & NH

Belt Adjustment

Refer to Page 2-21.

Installation, Fan and Fan Pulley

- 1. Assemble belts over fan pulley and fan drive pulley.
- Assemble fan pulley to water pump bracket.
 CAUTION: AVOID STRETCHING BELTS.
 LOOSEN ADJUSTING SCREW UNTIL BELTS
 GO INTO POSITION EASILY.
- Tighten adjusting screw to get proper tension on drive belts and tighten hub to bracket. See Page 2-21 for proper tension.
- 4. Assemble fan and dirt exclusion plate to fan hub.
- 5. Fill cooling system and start engine to check for leaks.

WATER PUMP

NHH Series

Removal

- 1. Drain cooling system.
- 2. Loosen hose clamps and remove water hose.
- Remove water pump pulley capscrews securing pulley sheaves.
- 4. Remove outer sheave and lift off drive belt.
- 5. Loosen water pump mounting capscrews to gear cover and pull out pump.

Installation

1. Position water pump with new gasket on gear case cover; secure with lockwashers and capscrews.

- 2. Install drive belt over drive pulley and water pump half pulley. Assemble the remaining half of the pulley.
- Using square drive flexible handle, hold water pump shaft securely and install pulley outer sheave. Fig. 3-14.

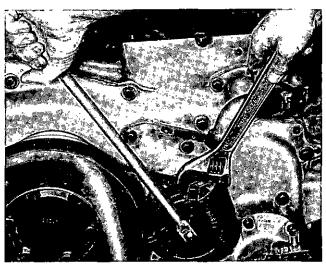


Fig. 3-14. Installing water pump pulley – NHH

- 4. Alternately rotate crankshaft and tighten outer sheave to adjust belt tension. Secure sheave halves together with capscrews when proper tension is achieved.
- Position hose on connections and secure with hose clamps.
- 6. Fill cooling system and start engine to check for leaks.

WATER PUMP

V8-350 and VT8-430 Series

Removal

- 1. Drain cooling system.
- Remove capscrews and lockwashers securing the pulley sheave to the drive pulley. Unscrew sheave from the pump shaft by turning counter-clockwise. Remove drive belt.
- Loosen hose clamps and disconnect all water hose connections.
- 4. Disconnect corrosion resistor hose from pump.
- Remove capscrews and lockwashers securing water pump to block; lift off water pump and gasket.

Installation

 Position water pump and new gasket to engine block; secure with lockwashers and capscrews.

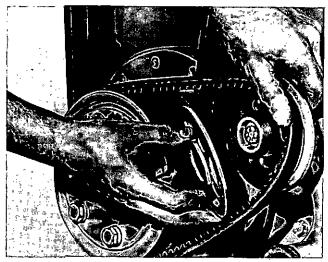


Fig. 3-15. Installing water pump belt - V8-350/VT8-430

- 2. Connect corrosion resistor hose to pump.
- 3. Position all hose connections; secure with hose clamps.
- 4. Place drive belt on water pump shaft and screw on pulley sheave. It may be necessary to bar engine to achieve proper belt tension. Secure sheave to drive half with lockwashers and capscrews.
- 5. Fill cooling system and start engine to check for leaks.

WATER PUMP

V6-Val, V8-Vale, V6-Vim and V8-Vine Series

Removal

- 1. Remove fan and spacer if used from fan pulley.
- Loosen generator or alternator adjusting link and remove drive belt.
- With high mount fan, loosen fan drive adjusting screw and remove fan and water pump drive belts.
- 4. Remove drain plugs and drain cooling system.
- 5. Remove lower hose from the water pump inlet connection and loosen clamps on upper hose.
- 6. Remove all accessory lines from water pump body.
- Remove capscrews and lockwashers securing pump to block. Rotate pump housing to clear upper hose connection; lift out pump assembly and remove gasket.

Installation

 Position new gasket on pump assembly. Insert pump in block; rotate pump to install upper hose and hose clamps. Secure pump in position with lockwashers and capscrews; secure upper hose clamps.

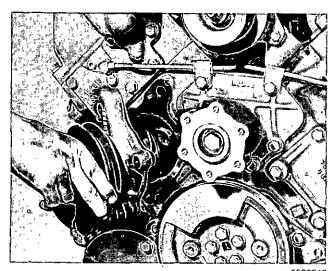


Fig. 3-16. Installing water pump - V6 & V8

- 2. Connect lower hose to water pump inlet connection and secure hose clamps.
- With high mount fan, place fan and water pump drive belts on pulleys and draw to proper tension with fan drive adjusting screw. See Page 2-21 for belt tension.
- Position generator or alternator drive belt on pulleys. Adjust belt to proper tension securing with adjusting link and capscrew.
- 5. Install fan and spacer if used on fan pulley; secure with lockwashers and capscrews.
- 6. Connect accessory water lines to water pump.
- Install drain plugs open vent cock and fill cooling system.
- 8. Close vent cock and start engine to check for leaks.

WATER PUMP

V12 Series

Gear Driven

Removal

- 1. Drain cooling system.
- Remove water by-pass from water pump.
- 3. Remove intake fitting from underside of water pump.
- Remove capscrews from outlet connection at cylinder block
- 5. Remove stud nuts holding water pump to gear case.
- 6. Slide water pump assembly from gear case.

Installation

CAUTION: BEFORE ASSEMBLING WATER PUMP TO GEAR CASE, SEE THAT SOCKET HEAD PLUG IS IN PLACE WHERE WATER INLET CONNECTION FITS BLOCK, THIS 1/8" PLUG SEALS A DRILLED HOLE TO THE OIL HEADER, SEE THAT HAND HOLE COVER BEHIND PUMP IS TIGHT.

- Place rubber packing ring in groove in water-pumpto-block inlet connection.
- 2. Assemble water pump and connection.
- 3. Shellac new gasket to gear case before mounting water pump.
- 4. Shellae new gasket to block connection.
- 5. Assemble water pump to gear case over studs.
- Secure water pump connection to block with lockwashers and capscrews.

Note: Bottom capscrews must be installed first and top of connection pushed to right so lower left capscrew will clear accessory drive mounting studs.

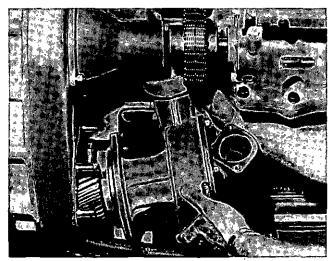


Fig. 3-17. Installing gear driven water pump - V12

Belt Driven, Rear Drive

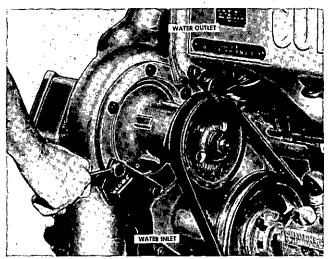
Removal

- Loosen hose clamp and remove connections from bottom of pump.
- Remove mounting capscrews and lockwashers securing belt shield to water pump, if shield is used; remove shield.
- 3. Slip belt from drive pulley.

- Remove capscrews securing bracket at front of pump. Remove spacer.
- 5. While supporting pump, remove capscrews and nuts from bracket at rear of pump. Remove pump.

Installation

- Install cover plate and gasket over gear case opening below accessory drive bore.
- 2. Assemble new "O" ring over water pump housing and slide block inlet connection in place.
- 3. Install belt over the accessory drive pulley.
- 4. Insert water pump assembly into drive belt and position on bracket, Tighten in place.
- 5. Adjust belt by turning pump housing on its eccentric; tighten clamp ring in place.
- Install water pump inlet connection and hose to water pump and gear case cover.



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Fig. 3-18. Installing belt driven, rear drive water pump - V12

Belt Driven, Front Drive

Removal

- 1. Remove water inlet connection.
- Loosen adjustable drive pulleys and lift drive belts from pump.
- 3. Remove air compressor water line, if used.
- Remove capscrews and washers securing water pump to gear case and gear case cover or to mounting bracket.
- Lift pump and separate from water connection, if used.

Installation

1. Position water pump assembly atop gear case cover

and secure in position with lockwashers and capscrews.

- 2. Install drive belts; install front pulley sheave.
- 3. Adjust belt tension by turning pulley sheaves; lock in place with lockwashers and capscrews. Fig. 3-19.
- 4. Fill cooling system and start engine to check for leaks.

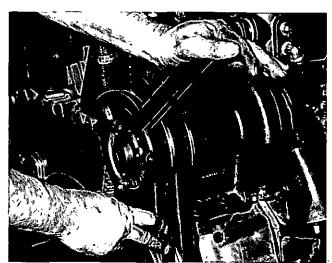


Fig. 3-19. Installing belt, front driven water pump - V12

WATER PUMP

L and LR Series

Removal

- 1. Drain cooling system.
- 2. Loosen hose clamps and slide hose back on pipe nipple.
- 3. Unscrew oil cup coupling and pipe nipple which extends through water pump inspection cover and into water pump body; remove cup, coupling, and nipple.
- 4. Remove four bolts that secure inspection cover to block; remove lockwashers and cover.
- 5. Partially unscrew the four bolts which secure water pump assembly to block. The two lower bolts must remain in block to support the weight of the pump during removal.
- 6. Take proper measures to support the weight of the pump. Remove four bolts and lockwashers; with a soft hammer tap pump body off dowels and out of coupling. Remove pump with driven coupling and gasket.
- Remove water pump drive sleeve from extension shaft or shaft of governor drive assembly.
- Remove four plugs securing couplings to extension shaft and water pump shaft. Pull couplings from both shafts; remove keys from shafts.

- 9. Pull shaft from block toward gear case end, without damaging extension shaft bushings.
- Unscrew four bolts securing bracket assembly to cylinder block; remove four bolts, lockwashers, assembly, and gasket.

Installation

- Insert water pump extension shaft from gear case cover end (splined end to the gear case) into cylinder block. Guide it carefully through extension shaft bushings.
- 2. Recheck shaft to be sure it turns freely.
- Place key in shaft and tap into position; install drive shaft coupling half on shaft and secure with two plugs.
- Position water pump over dowels with a new gasket; carefully fit coupling on water pump and coupling on extension shaft.

Note: If a new water pump or cylinder block is being installed, snug tighten water pump to cylinder block with bolts and turn water pump coupling and extension shaft to see that they are free turning. Shift pump until pump and extension shaft turn freely, then ream water pump and cylinder block dowel holes; install smallest permissible oversize dowels.

- 5. Secure pump to engine with bolts and lockwashers.
- 6. Recheck water pump and extension shaft for binding; shaft and pump must turn freely.
- Install water pump inspection cover on block and secure with four bolts and lockwashers.
- 8. Install oil cup pipe nipple, coupling, and cup through cover into water pump housing and tighten securely.
- Fill cooling system and start engine to check for leaks.

TURBOCHARGER

All production model Cummins turbochargers are oil cooled and can be mounted in several positions. Although disassembly and rebuild procedures may vary slightly with installation, the following precautions must be taken with all turbochargers.

- 1. Lubricating oil drain (large boss) must always be down or within 45° of that position. Fig. 3-20.
- 2. Never carry the weight of exhaust piping on the turbocharger.
- When turbocharger is removed, always cover inlet and outlet ports to prevent entry of foreign objects or dirt
- 4. Never stuff rags into ports.
- Never use a caustic solution to clean any part of turbocharger.

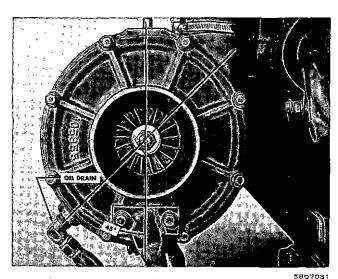


Fig. 3-20. Turbocharger oil drain position

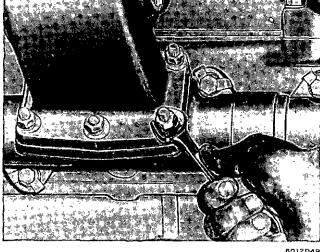


Fig. 3-21. Mounting turbocharger

- 6. Never use a wire brush to clean compressor wheel, turbine or diffuser plate.
- 7. Never attempt to disassemble or alter turbocharger rotor in any way. For complete information on turbocharger rebuild, contact the nearest Cummins Distributor equipped with the proper tools and knowledge to rebuild Cummins turbochargers.

TURBOCHARGER

C, J, NH and L Series

- 1. Disconnect oil supply and drain lines from turbo-
- 2. Disconnect hose connection from turbocharger to intake manifold.
- 3. Loosen and remove mounting capscrews; lift turbocharger from exhaust manifold mounting flange and bracket, if used.

Installation

- 1. Install gasket and position turbocharger against exhaust manifold. Secure with capscrews or stud nuts to exhaust manifold flange. Fig. 3-21.
- 2. If used, secure bracket between turbocharger and oil cooler. (Rear-mount fastens to clutch housing).
- 3. If used, install oil flow regulator valve in original location. With rear mount turbochargers, the regulator is installed in an elbow in the oil transfer connection.
- 4. Connect oil supply and drain lines to turbocharger.
- 5. Assemble and tighten air inlet and outlet piping to turbocharger.

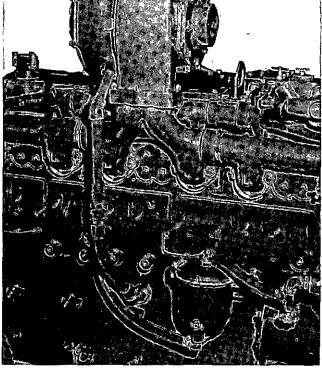


Fig. 3-22. Turbocharger oil drain line

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TURBOCHARGER

VT8-430 Series

Removal

1. Remove the glow plug electric leads and fuel lines to

- the preheater nozzles from both air intake connections between rocker cover and turbocharger.
- Remove aneroid control air line from left bank intake manifold connection.
- Remove capscrews and lockwashers securing connections to rocker covers; rotate and remove air connections from both banks, Discard "O" rings,

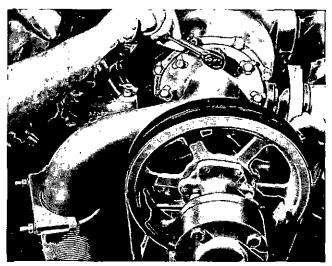


Fig. 3-23. Removing turbocharger exhaust connection VT8-430



Fig. 3-24. Removing turbocharger exhaust clamp ring

- 4. Disconnect connection between air cleaner and turbocharger at the turbocharger air intake.
- Remove connection from exhaust outlet of turbocharger. Fig. 3-23.
- Remove V-clamp rings attaching exhaust manifolds to turbocharger exhaust inlets. Fig. 3-24.
- Remove capscrews, lockwashers and flatwashers (Fig. 3-25) securing turbocharger to accessory support cover. Lift off turbocharger and gaskets; discard gaskets.

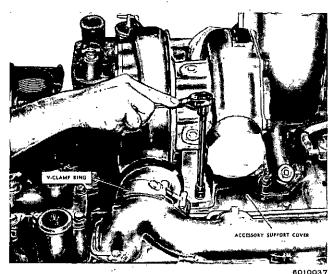


Fig. 3-25. Removing turbocharger – VT8-430 mounting capscrews

CAUTION: COVER ALL OPENINGS TO PRE-VENT FOREIGN MATERIALS FROM ENTER-ING THE ENGINE.

Installation

- Position new gasket and turbocharger on accessory support cover. Fig. 3-26. Secure finger tight with lockwashers and capscrews.
 - Note: Make sure the oil supply and drain holes to the turbocharger are open.
- 2. Connect exhaust manifolds to turbocharger exhaust inlets and secure with V-clamp rings.
- 3. Install connection on turbocharger exhaust outlet.
- Install connection from air cleaner to turbocharger air intake.
- Install new "O" rings on each air connection and insert connections in turbocharger; secure to each rocker cover with lockwashers and capscrews.
- Tighten exhaust manifold capscrews to 30 foot-pounds and lock. Tighten turbocharger capscrews to 30 footpounds torque.

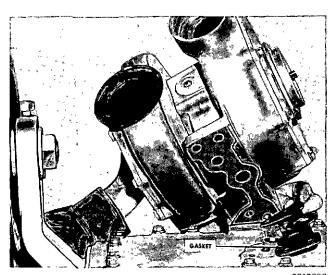


Fig. 3-26. Installing turbocharger — VT8-430

- 7. Connect fuel lines to the preheater nozzles in each air intake connection; connect electrical leads to each glow plug.
- 8. Reconnect aneroid control air line.

TURBOCHARGER

V12 Series

VT12 engines are equipped with dual turbochargers, one for each bank of cylinders. The turbochargers may be either top mounted or rear mounted, depending upon engine application. The following instructions treat each installation separately as well as noting variations between right and left-bank mounts.

Removal

- 1. Disconnect each turbocharger from exhaust and intake manifolds.
- 2. Disconnect oil lines from turbocharger.
- 3. Remove mounting capscrews or stud nuts. Lift turbocharger from engine.

Installation, Top Mounted

- Install gasket and lift turbocharger into position against exhaust manifold. Secure with capscrews or stud nuts to exhaust flange.
- 2. Secure turbocharger support bracket between turbocharger casing and rocker housing cover.
- Connect oil inlet line to top of turbocharger and oil drain line to large boss at bottom of turbocharger.
- 4. Install hose from blower outlet to intake manifold connection.

5. Install air cleaner and exhaust piping.

Installation, Rear Mounted

- 1, Same as Step 1, above.
- 2. Secure turbocharger support bracket between turbocharger casing and flywheel housing.
- 3. Same as Step 3 above.
- 4. Same as Step 4 above.
- 5. Same as Step 5 above.

SUPERCHARGER .

C, J and H/NH Series

Before removing supercharger on C and J Series engines, remove supercharger driven water pump. On H/NH Series, remove supercharger driven generator.

Removal

- Remove capscrews which secure air connection to intake manifold. Using a screwdriver, pry springs from supercharger connection at outlet. Cover connection opening in supercharger to prevent entry of foreign objects.
- 2. Remove heat shield and supercharger outlet.
- Remove oil filler tube and cover plate from cylinder block.
- Disconnect and remove lubricating oil supply and drain lines from supercharger and hand hole covers.
- 5. While supporting the supercharger, remove mounting capscrews from supercharger and cylinder block.
- Disengage supercharger coupling from drive unit and lift from engine.

Installation

 Keep ports covered at all times before final assembly of inlet and outlet ends of the manifold to the supercharger. Masking tape may be used.

Note: Do not stuff rags into inlet or outlet ports at any time as they might be left there on assembly to the engine.

- Assemble inlet and outlet connections to supercharger. Use hugnuts and flatwashers to secure connections.
- 3. Lift supercharger to engine and engage coupling to drive unit! Fig. 3-27.
- Start upper left and lower right bolts to support supercharger.
- Start and tighten upper right and lower left support bolts. The corresponding bolt holes in the supercharger are reamed to fit support bolts snugly.

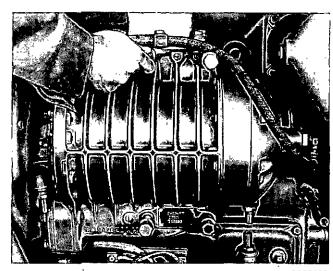


Fig. 3-27. Installing supercharger – H/NH

- Tighten remaining support bolts. Overtightening will distort housing and cause rotors to scrape. Do not overtighten.
- Install lubricating oil supply and drain lines to supercharger and hand hole covers. Fig. 3-28.

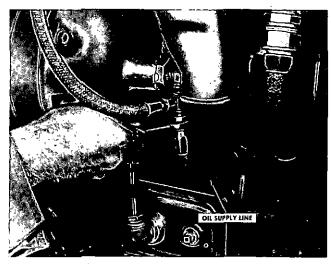


Fig. 3-28. Installing supercharger oil supply line - H/NH

8. Install supercharger driven water pump on C and J Series engines and supercharger driven generator on H/NH engines. See "WATER PUMP" this section.

SUPERCHARGER

NHH Series

Removal

1. Remove air inlet and discharge piping. Cover open-

- ings with tape.
- 2. Remove oil supply and drain lines.
- 3. Remove fuel manifold cover.
- 4. Remove fuel line clamp nut, washers and outer half.
- 5. Remove seven stud nuts on engine side of gear case.
- Pry on stud end to start supercharger from gear case. Use soft hammer to assist in withdrawing from studs. Fig. 3-29.

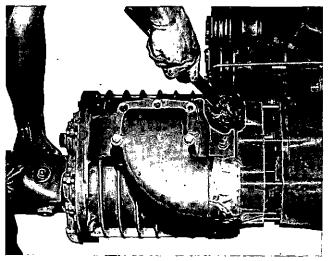


Fig. 3-29. Removing supercharger NHHS

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- 7. Lift off supercharger. Remove splined drive shaft from drive gear in gear case.
- 8. Remove lockwire from drive spring capscrews. Remove capscrews and drive spring assembly.

Installation

- 1. If not already assembled, install drive spring unit to adapter flange on supercharger gear.
- 2. Secure with capscrews. Install pin to keep spring unit from rotating. Fig. 3-30.
- 3. Lock capscrews in pairs with wire. Fig. 3-31.
- 4. Install splined shaft in supercharger drive.
- Apply new gasket over studs. Lift supercharger and start studs in gear case.
- 6. If drive splines do not match, insert pin in spring cover and rotate supercharger slightly.
- 7. Secure studs with nuts and lockwashers.
 - Note: Start all nuts before bringing supercharger against cover plate. Draw up evenly.
- 8. Assemble clamp over fuel lines and stud. Secure with flatwasher, lockwasher, and nut.
- 9. Install oil supply and drain lines.

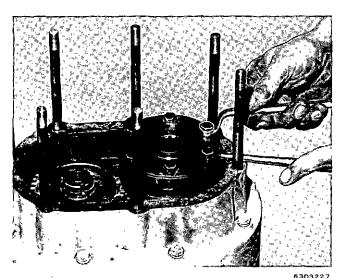


Fig. 3-30. Installing spring unit

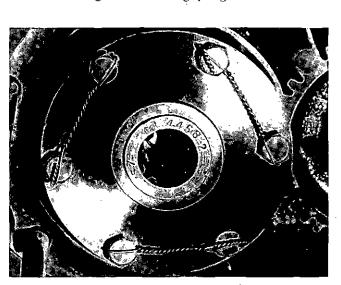


Fig. 3-31. Lockwiring capscrews

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- Remove tape from openings and install air inlet and discharge connections:
- 11. Install cover over fuel manifolds.

OIL COOLER

C and J Series

Removal

- 1. Disconnect all lines from oil cooler.
- Remove capscrews securing oil cooler to cylinder block. Lift cooler from engine. Fig. 3-32.
- 3. Remove front cover capscrews and front cover.
- 4. Discard all gaskets and "O" rings.

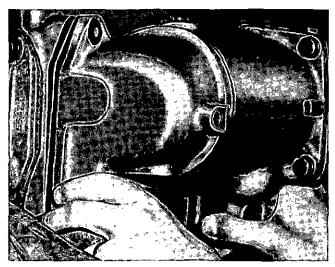


Fig. 3-32. Removing oil cooler − C & J

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Cleaning and Inspection

- Inspect element for corrosion or cracks where tubes are welded to end plates.
- 2. Discard "O" rings and gaskets. Inspect steel retainer ring for cuts, nicks, etc. Replace as necessary.
- 3. Clean element in any solvent that will dissolve oil film and sludge.

CAUTION: DO NOT USE ANY SOLVENT THAT IS HARMFUL TO COPPER OR TRY TO USE ANY MECHANICAL CLEANING METHOD SUCH AS SCRAPING.

- 4. Finish cleaning by blowing through bundle with compressed air.
- 5. Clean housing casting with solvent and compressed
- Inspect lubricating oil cooler assemblies for leakage between oil and water passages.
 - Clamp housing and cooler element assembly infixture and assemble air connection.
 - b. Place unit in water tank and apply 1 to 4 psi air pressure.
 - c. Inspect for air leaks at pipe plugs, porosity in casting, and air leaks past "O" ring seal.
 - d. Apply line air pressure, 70/100 psi.
 - e. Inspect for air leaks as per step c.

Note: Oil cooler cleaning operation will be more successful and faster if performed immediately after unit is removed from engine.

Installation

1. Lubricate "O" ring and insert at bottom of housing.

Install element aligning "O" marks on housing and element. Fig. 3-33.

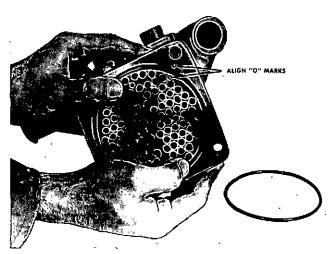


Fig. 3-33. Installing oil cooler element

- Place new front cover "O" ring on housing. Press into place with wood block to exert even pressure on entire circumference.
- 4. Place new retainer and gasket on housing and install front cover; tighten capscrews securely.
- Place new gaskets on block, position oil cooler on block and secure with lockwashers and capscrews.
 Use new gaskets and "O" rings on water pump connection.
- 6. Connect lines removed from cooler.

OIL COOLER

H/NH Series

All types of oil coolers used on the H/NH series engines are mounted on the exhaust side of the engine block. The standard cooler is mounted at a right angle directly to the block. A larger capacity cooler may be mounted along the block and secured by a mounting bracket. See Fig. 3-34. A third type of cooler also may be used. This is a combination oil cooler and oil filter. Fig. 3-35. All coolers have a removable tube bundle element.

Removal

- 1. Remove water and oil connections as used.
- 2. Remove capscrews securing cooler housing to cylinder block, adapter or bracket, as applicable.
- Loosen oil cooler head capscrews and remove oil cooler head. On some models, oil cooler head and housing are cast as one unit.
- 4. If puller holes are present, use two 10-32 capscrews

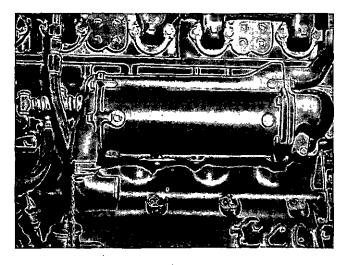


Fig. 3-34. Horizontal oil cooler - H/NH

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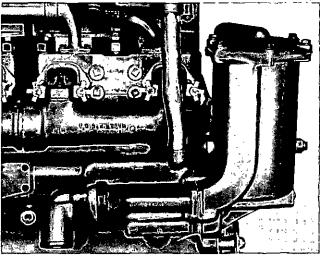


Fig. 3-35. Oil cooler and filter assembly — H/NH

to pull element from housing. Remove "O" rings and discard.

If puller holes are not provided, use wire book or equivalent to pull element from housing. Remove "O" rings and discard.

CAUTION: BE CAREFUL NOT TO DAMAGE COPPER TUBES.

Cleaning and Inspection

See "CLEANING AND INSPECTION" under C and J Series above.

Installation

1. Replace head to housing using retainer and new "O"

ring lubricated with ball bearing grease. If housing and head are one integral casting, install lubricated "O" ring at bottom of housing.

- 2. Push element into housing by hand, aligning index
- marks on housing and element. Fig. 3-33.

 3. Press a new "O" ring around top of element using a wooden block to exert uniform pressure on "O" ring circumference.
- 4. Install steel retainer ring (if used) over "O" ring.
- 5. Install new gasket and secure assembled cooler to cylinder block, adapter or bracket, as applicable.

Note: Some blocks with casting date before July 1, 1957, have a block water passage larger than element diameter. In such cases, use an oil cooler plate in addition to steel retainer ring.

OIL COOLER

V8-350 and VT8-430 Series

Removal

- 1. Drain cooling system.
- 2. Remove hose and clamps from water inlet and outlet connections.
- 3. Loosen four capscrews and remove the oil cooler and connections from the cylinder block. Discard gaskets.
- 4. Loosen capscrews securing connections to oil cooler; remove connections and gaskets. Discard gaskets.

Cleaning

See "CLEANING AND INSPECTION" under C and J Series above.

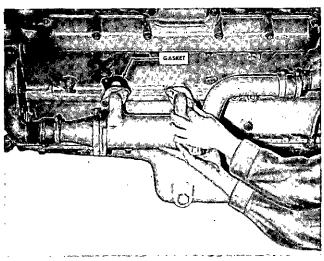


Fig. 3-36. Installing oil cooler - V8-350/VT8-430

Installation

- 1. Place new gaskets at each end of the bundle and install connections using lockwashers and capscrews.
- 2. Install cooler and connections to cylinder block with capscrews, lockwashers and flatwashers. Fig. 3-36.
- 3. Install inlet and outlet hose; secure with hose clamps.
- 4. Fill cooling system, start engine and check for leaks.

OIL COOLER

V12 Series

Three oil cooler units are mounted in the cylinder block between the engine banks and under the exhaust mani-

Removal

- 1. Remove all units and components mounted atop engine that would interfere with removal of exhaust manifolds and oil cooler units; remove exhaust manifolds.
- 2. Remove connectors between center cooler cover and two end covers. Lift out coolers.

Disassembly

- 1. Remove by-pass valve and oil connection or cover plate from two end covers.
- 2. Remove retainer plug, spring and plunger from bypass body.

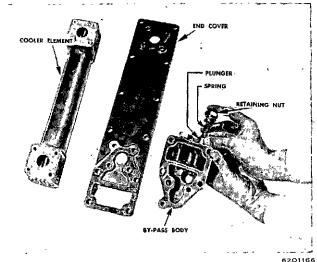


Fig. 3-37. Oil cooler and by-pass valve - V12

Cleaning

See "CLEANING AND INSPECTION" under C and J Series above.

DIESEMAINTENANCE MANUAL

Assembly

- Assemble each cooler element to its respective cover with gaskets and capscrews.
- 2. Assemble by-pass plunger, spring and retaining nut to by-pass body.
- 3. Install gasket, and tighten down oil cooler by-pass assembly to an end cover plate.

Note: The oil cooler by-pass connection can be assembled to either end cover plate according to installation. The other end is closed off with a gasket and cover plate or oil connection.

Installation

- Using new gaskets and lockwashers, install oil cooler elements between cylinder bank. Tighten securely with capscrews.
- Assemble two connections joining three cooler elements.
- Install exhaust manifolds with new gaskets and all other units and components originally mounted atop engine.

FUEL PUMP

J, C, H/NH, V6-Val, V8-Vale, V6-Vim, V8-Vine, V12 and L Series

Two basic pump models, PT (Type R) and PT (Type G), are used on all Cummins engines. When necessary, these designations will be used to point out differences in procedures.

CAUTION: ALWAYS MAKE SURE REPLACE-MENT PUMP HAS BEEN CALIBRATED TO SAME VALUES AS ONE BEING REPLACED.

Removal

- 1. Disconnect fuel tubing between fuel pump shut-down valve and engine.
- 2. Disconnect fuel pump supply line. Disconnect return line at top of PT (Type R) pump.
- 3. If engine is equipped with aneroid control, disconnect two lines from aneroid to fuel pump.
- 4. Disconnect throttle linkage.
- With flange mounted pump, remove capscrews or stud nut securing pump to drive. Disengage pump and remove rubber coupling or spline.
- 6. With bracket mounted pumps, remove bracket and pump as unit; disengage pump and remove coupling.

Installation

1. Install flange mounted pump to driving unit with rub-

- ber buffer or spline in position; secure with flatwashers, lockwashers and capscrews or stud nuts. Use new gasket when mounting pump.
- 2. Connect supply line to pump. On PT (Type R) pumps, connect return line.
- 3. Reconnect engine supply tubing to shut down valve.
- 4. Connect throttle linkage to pump.

Adjustments

Governor adjustments are described on Page 3-38.

FUEL PUMP

NHH Series

Removal

- I. Disconnect all fuel lines from fuel pump.
- Remove capscrews and lockwashers securing pump flange; slide pump away from gear case cover. Fig. 3-38.

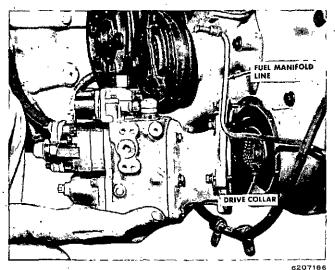


Fig. 3-38. Removing fuel pump - NHH

- 3. Slide coupling collar off drive gear.
- 4. Cover pump connections to prevent entrance of dirt.

Installation

- 1. Slide fuel pump drive collar over drive gear.
- 2. Engage fuel pump drive gear in drive collar.
- 3. Using a new gasket, mount fuel pump to gear case cover with capscrews and lockwashers.
- 4. Attach fuel line from fuel pump solenoid to fuel inlet manifold.

FUEL PUMP

V8-350 and VT8-430 Series

The fuel pump, mounted to the accessory support cover

by four capscrews, is driven through a spider coupling. The feet supporting the fuel pump are located by two dowels; drive coupling alignment is accomplished through shims under the fuel pump mounting feet.

Removal

- Remove generator adjusting link capscrew; lower generator and remove belt. Rotate generator outward to clear fuel pump.
- On turbocharged engines, disconnect fuel oil by-pass line to aneroid control. Disconnect fuel oil suction line at gear pump, and fuel supply tube at fuel shut-down valve.
- 3. Disconnect throttle linkage.
- 4. Remove capscrews, lockwashers and flatwashers securing fuel pump to mounting pads; lift off pump.
 - Note: Do not lose adjusting shims.

Installation

- 1. If a new or exchange pump is being installed, make certain the rubber coupling buffer works freely with a minimum of 1/16 inch end clearance to prevent binding during operation.
- Remove capscrews and lockwashers securing pulley spider to accessory drive pulley; lift off spider and shims.
- Mount fuel pump to mounting pads on accessory cover support.
- Attach dial indicator to accessory drive pulley; place dial arms on pump spider. Fig. 3-39.

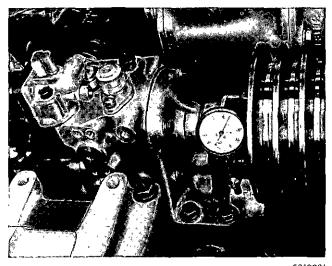


Fig. 3-39. Mounting fuel pump — V8-350/VT8-430

Bar engine and make indicator readings at 4 equidistant points on pump spider. Note reading and select shims to be installed between spider and accessory

- drive pulley as necessary to bring alignment within .010 inch.
- Remove pump and dial indicator; replace pulley spider, using shims selected through Step 5 above.
- Position fuel pump on engine. Insert shims under mounting feet as needed for alignment; secure with flatwashers, lockwashers and capscrews.
- Connect throttle linkage; connect all fuel lines and tubing.
- Rotate generator inward to position drive belt on pulley; secure to proper belt tension with adjusting link and capscrews.

ANEROID CONTROLS

All Turbocharged Engines

Removal

1. Disconnect line from aneroid to fuel pump on pressure side of gear pump. Fig. 3-40.

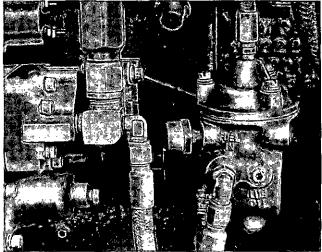


Fig. 3-40. Aneroid control installed

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- 2. Remove line from aneroid to fuel pump at inlet side of gear pump.
- 3. Remove air vent line, if used.
- 4. Remove air pressure hose.
- Remove bracket mounting capscrews.
- 6. Remove aneroid and bracket.

Installation

- 1. Assemble aneroid and mounting bracket with lock-washers and capscrews. Mount as an assembly as near fuel pump as possible.
- Install fuel pressure line from gear pump to "IN" connection on aneroid control.

- Install return line from "OUT" connection on aneroid control to "T" connection at suction side of gear pump.
- 4. Install line from top of aneroid to air intake manifold.

 Note: Use No. 5 size flexible bose between aneroid and fuel pump, and No. 4 size between aneroid and air intake manifold.
- 5. Install vent line, if used.

 Note: Current aneroids are equipped with air filters in place of air vent line.

AIR COMPRESSOR

C, J, H/NH and V12 Series

Cummins or Bendix-Westinghouse air compressors are usually used on C, J, H/NH and V12 series engines. Cummins offers a gear, belt, or coupling driven air compressor. Removal and installation instructions are as follows:

Cummins, Gear Driven

Removal

This Cummins air compressor is flange-mounted to the gear case and is gear-driven.

- Remove capscrew, lockwasher and washer securing accessory drive pulley to compressor crankshaft; using puller, remove pulley from crankshaft.
 - CAUTION: REPLACE CAPSCREW IN END OF CRANKSHAFT TO PREVENT DAMAGE TO THREADS.
- 2. Remove accessory drive pulley key.
- On H/NH Series internal oil line engines, remove oil slinger from compressor crankshaft before proceeding.

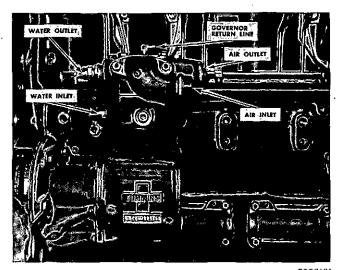


Fig. 3-41. Removing Cummins gear driven air compressor

- Remove fuel pump as described previously. Discard gasket.
- 5. Disconnect air, water and oil lines from compressor.
- 6. Remove capscrews and lockwashers mounting compressor support to gear case. Fig. 3-41.
- Lift compressor from engine; discard gasket.
 CAUTION: DO NOT LOSE COUPLING RETAINER PLATE AND RUBBER BUFFER FROM FUEL PUMP END OF CRANKSHAFT.

Installation

- Bar engine to No. 1 Top Center position. Remove inspection hole pipe plug in gear case cover.
- Rotate engine in operating direction to 90° ATC at which position marked valley on camshaft gear will be in line with inspection hole.
- Position new gasket and install compressor support to gear case with marked tooth on drive gear indexed with marked valley on cam gear. In this position, key slot on shaft will be straight up. Secure with capscrews and lockwashers.
- On H and NH series internal oil line engines, install oil slinger on crankshaft drive.
- Install drive pulley key in drive shaft by tapping into place with plastic mallet.
- Remove large capscrew from end of drive shaft. Install drive pulley. Secure with washer, lockwasher and capscrew.
- 7. Connect all air, water and oil lines.
- 8. Install fuel pump as described previously.

Cummins, Belt Driven

Removal

- Disconnect air, water and lubricating oil lines from air compressor. Fig. 3-42.
- Loosen belt adjustment jacking screw and bracket mounting capscrews, lower mounting bracket and air compressor; remove drive belts.
- Remove mounting bracket capscrews; lift air compressor and bracket from accessory drive housing. Discard gasket.

Installation

- Place new gasket on accessory drive housing and lift air compressor and bracket into position; install bracket mounting capscrews. DO NOT TIGHTEN.
- Install drive belts; using jack screw, raise compressor to obtain proper belt tension.
- 3. Secure air compressor to accessory drive housing by tightening bracket mounting capscrews.

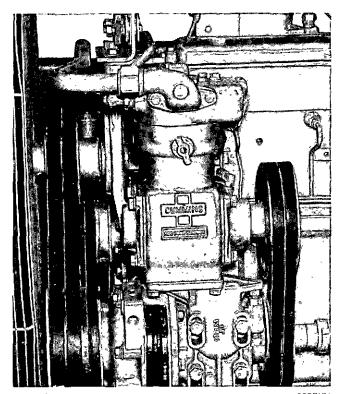


Fig. 3-42. Cummins belt driven air compressor

4. Connect air, water and oil lines between engine and air compressor.

Cummins, Coupling Driven

The Cummins coupling driven compressor is mounted in the same manner as the standard Bendix-Westinghouse unit. See instructions in next paragraph.

Bendix-Westinghouse

Removal

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

- 1. Remove fuel pump as described previously.
- Disconnect all air, water and oil lines from air compressor.
- 3. Remove capscrews holding compressor bracket to cylinder block and capscrews holding air compressor to accessory drive. Fig. 3-43.
- Remove compressor and splined coupling. Discard gasket.

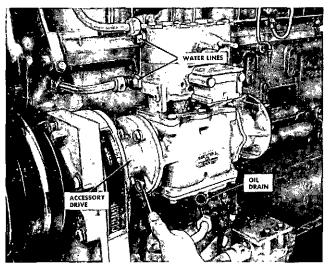


Fig. 3-43. Removing Bendix-Westinghouse Air compressor

Installation

 Assemble splined coupling to compressor drive. Fig. 3-44. Assemble air compressor to accessory drive using a new gasket. Install and tighten capscrews and lockwashers.

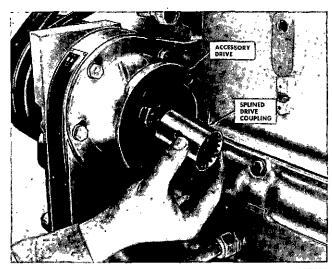


Fig. 3-44. Installing splined coupling

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- Attach compressor bracket to block with flatwashers, lockwashers, and capscrews.
- 3. Connect all water, air and oil lines, or tubing.
- 4. Install fuel pump as described previously.

AIR COMPRESSOR

C-4 and J-4 Series

Removal

1. Disconnect oil supply line,

- Remove bolts holding compressor to bracket; slide compressor to disengage belt.
- 3. Lift compressor from bracket. Fig. 3-45.

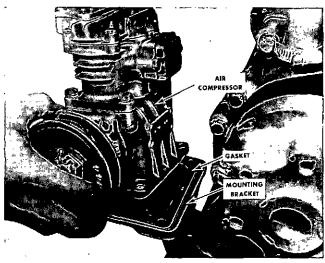


Fig. 3-45. Removing air compressor C-4

4. Remove and discard gasket if it is damaged.

Installation

- Assemble gasket on bracket.
- 2. Mount compressor on bracket.
- Assemble mounting bolts. (Tighten when adjusting belt.)
- 4. Connect oil supply line.
- 5. Adjust belt to proper tension. See Page 2-21.

AIR COMPRESSOR

V6-Val and V8-Vale

Description

The compact compressor head assembly is designed in three parts, each of which can be rotated 360° in 90° increments to allow ease of plumbing during installation.

CAUTION: THE GASKET BETWEEN THE HEAD AND HEAD COVER CAN ONLY BE ROTATED WHEN THE HEAD IS ROTATED. FOR INSTALLATION OF THE VALVE ASSEMBLY, REFER TO BULLETIN NO. 983422-A.

Removal

- 1. Open drain cocks and drain cooling system.
- Loosen hose clamps and remove compressor air intake hose from air intake crossover and air compressor.

- Remove water supply and drain lines from air compressor, cylinder head, and water crossover connection.
- 4. Disconnect compressor air pressure lines.
- Remove capscrews and lockwashers securing the air compressor. Lift out air compressor assembly and rubber buffer; discard gasket.

Installation

 Position air compressor to gear case with new gasket and rubber buffer in place. Fig. 3-46.

Note: Make sure the gears mesh properly.

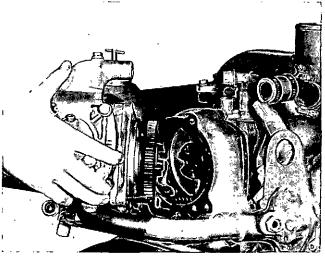


Fig. 3-46. Installing air compressor V6-Val/V8-Vale

- Secure air compressor with lockwashers and capscrews.
- Connect water supply and drain lines to air compressor, cylinder head and water crossover connection.
- Install compressor air intake hose to air intake crossover and air compressor; secure hose clamps.
- 5. Connect compressor air pressure lines.
- Close drain cocks; open vent cock and fill cooling system.
- 7. Close vent cock and start engine to check for leaks.

AIR COMPRESSOR

V6-Val, V8-Vale, V6-Vim and V8-Vine (Mounted in Vee)

Removal

- 1. Open drain cocks and drain cooling system.
- Remove compressor air intake hose from air intake crossover pipe or connection and air compressor.
- 3. Remove fuel pump as described previously.

- 4. Remove water intake and outlet lines from air compressor, cylinder block, and water crossover connection
- 5. Disconnect compressor air outlet line.
- Remove capscrews and lockwashers from accessory drive gear cover securing the air compressor to the gear housing; remove rear support plate. Lift out air compressor assembly; discard all gaskets.
- When a compressor rear drive is applicable, remove capscrew, lockwasher and flatwasher securing gear drive pulley to shaft.
- 8. Pull pulley from shaft with suitable puller; remove key.
- Remove capscrews and lockwashers securing air compressor and accessory drive bearing support to gear/ flywheel housing; remove accessory drive bearing support.
- Move air compressor toward front of engine to disengage drive gear; remove air compressor and discard all gaskets.

Installation

 Position new gasket on air compressor mounting flange. Align timing marks on air compressor drive gear with marks on the camshaft gear. Fig. 3-47.

Note: Make sure the gears mesh properly.

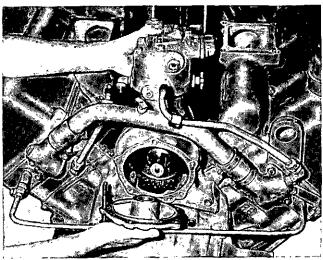


Fig. 3-47. Installing air compressor V6-Vim/V8-Vine

- 2. Position accessory drive rear support plate with new gasket to gear housing.
- 3. Secure support plate and air compressor with lock-washers and capscrews.
- 4. Connect water inlet and outlet tubes to air compressor.
- 5. Install fuel pump as described previously.
- 6. Connect compressor air intake line to air intake cross-

- over or connection and air compressor.
- 7. Connect compressor air pressure lines.
- On engines with rear accessory drive, slide bearing support over accessory drive shaft and position to gear/flywheel housing; secure with lockwashers and capscrews.
- 9. Position key in drive shaft and place pulley on shaft aligning key groove in pulley hub with key in shaft.
- 10. Using a suitable tool, press pulley on shaft with sleeve hub through oil seal. Remove tool and secure pulley to shaft with flatwasher, lockwasher and capscrew.
- Close drain cocks; open vent cock and fill cooling system.
- 12. Close vent cock and start engine to check for leaks.

AIR COMPRESSOR

V8-350 and VT8-430 Series

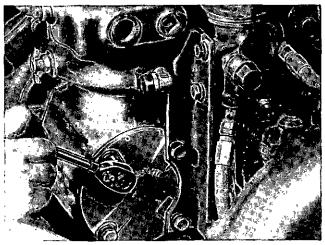
The complete air compressor, including the drive, cannot be removed while the engine is in the chassis. However, removal of the crankcase assembly — the air compressor unit most often exchanged—is easily accomplished.

Removal

- 1. Remove turbocharger intake connection.
- 2. Drain cooling system.
- 3. Remove lubricating oil filter.

CAUTION: COVER TURBOCHARGER INTAKE OPENING AND OIL FILTER CONNECTIONS IN ACCESSORY SUPPORT COVER WITH MASKING TAPE TO KEEP OUT DIRT.

4. Remove aperoid control.



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Fig. 3-48. Removing air compressor cover V8-350/VT8-430

- 5. Disconnect all air and water lines from compressor.
- Remove capscrews, lockwashers, and flatwashers securing air compressor cover and aneroid mounting bracket to compressor crankcase. Fig. 3-48. Lift off cover and bracket with aneroid attached.
- Bend down lockplate and remove capscrew, lockplate, and spacer securing counterweight to compressor crankshaft. Fig. 3-49.

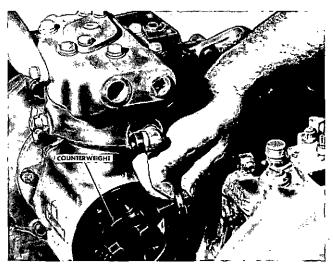


Fig. 3-49. Removing air compressor counterweight capscrew V8-350/VT8-430

- Separate lockplate and spacer from capscrew and reinstall capscrew a few threads. This will provide a support for the forcing screw on the ST-647 Puller.
- Position ST-647 against compressor crankcase and secure by installing two 5/16 NC capscrews at least three inches long through puller and into tapped holes in counterweight. Pull to remove weights and key from housing.
- Remove the capscrews and lockwashers securing the crankcase to the support. Slide off the crankcase and connecting rod assembly from the support and crankshaft.

Installation

- Bar the engine to a position which will allow the compressor rod to match the compressor crankshaft throw. This usually is bottom center.
- Slide compressor crankcase over crankshaft to support. Secure with lockwashers and capscrews.

CAUTION: CARE SHOULD BE TAKEN DURING ASSEMBLY NOT TO DAMAGE ROD BEARING.

- Install counterweight over key and crankshaft; counterweight is a snug fit. Secure in position with spacer, lockplate and capscrew. Bend lockplate over capscrew.
- 4. Position air compressor cover with new gasket and

- aneroid mounting bracket to compressor; secure with flatwashers, lockwashers and capscrews.
- 5. Connect all air lines and water tubes to compressor.
- 6. Install lubricating oil filter.
- 7. Install turbocharger intake connections.
- 8. Install aneroid control valve.
- 9. Fill cooling system and check for leaks.

INJECTORS

The C and J Series plus the 4-7/8 inch and 5-1/8 inch bore H/NH, V12 and L series have flanged injectors with external fuel manifolds.

All other engines covered in this manual have cylindrical injectors and internal fuel passages. On all NH and V12 engines, the injector is secured by a hold-down plate and 2 capscrews; on V6 & V8, a yoke and single capscrew secure the injector.

Flanged

Removal

- Remove capscrews and washers from rocker cover; remove cover.
- Disconnect fuel inlet and drain manifolds from fuel inlet and drain connections. Fig. 3-50.

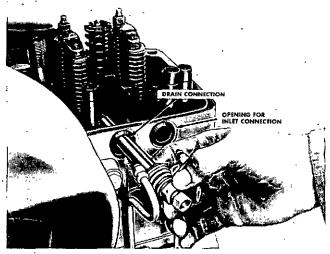


Fig. 3-50. Removing injector drain connections

- Remove fuel inlet and drain connections from injector body.
- Loosen injector adjusting screw, locknut and back-off screw until push tube can be disengaged.
- Disengage push tube and tip rocker lever back until injector can be removed.
- Remove hold-down capscrews and lift injector from the cylinder head.

CAUTION: DO NOT BRUISE INJECTOR TIP. DO NOT TURN INJECTOR UPSIDE DOWN. PLUNGER ASSEMBLY CAN FALL FROM INJECTOR BODY AND RUIN PLUNGER.

Installation

Clean injector seat with a clean cloth wrapped around a wooden stick. Never use screwdriver or metal tool for this operation; scratched seat may cause compression leak. Fig. 3-51. Make sure same type injectors are installed as removed.

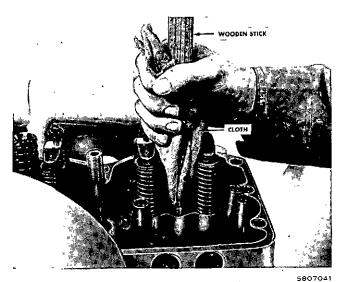


Fig. 3-51. Cleaning injector sleeve

1. Assemble injectors in position.

Note: When installing injectors in engine, position injector plunger so class mark is centered between inlet and drain connections.

CAUTION: BE CAREFUL NOT TO DAMAGE INJECTOR TIP.

- Start, but do not tighten, injector hold-down capscrews.
- In order to align injectors before tightening hold-down capscrews, screw in inlet and drain connections about three turns.

Note: Lubricate fuel connection threads before installing.

 Oil injector hold-down capscrews and tighten to value shown in Table VIII with a torque wrench. Start tightening on capscrew opposite inlet and drain connection.

Note: Hold-down capscrews containing a nylon insert that acts as a lock, may be reused 5 to 10 times before effectiveness of the insert is impaired.

	III: TORQUE: IN CAPSCREWS OR	
Engline Series	ගුණුලා වෙතු	धिन १ धिनी धिन्स
C & J H/NH & V12 V6-Vd & V8-Vde V6-Vim & V8-Vine V8-350 & VIS-430 L	56 FL Ula 56 FL Ula 1543 FL Ula 1543 FL Ula 643 FL Ula 1042 FL Ula	010-12 R. U.S. 00-12 R. U.S.

°12-14 Ft. Lbs. with Nylock capscrews.

- **4-7/8 inch and 5-1/8 inch bore H/NH with Nylock capscrews, 12-14 Ft. Lbs.; 5-1/2 inch bore NH and V12 with Nylock capscrews, 7-8 Ft. Lbs.
- ***15-20 Ft. Lbs. L with Nylock capserews, 24/26 Ft. Lbs.
- 5. Tighten inlet and drain connections to 20/25 footpounds with a torque wrench.
- 6. Position injector rocker lever on injector push tube.
- 7. Adjust injectors and valves as outlined in Section 2.
- 8. Install rocker lever cover.

Cylindrical

NH and V12 Series

Removal

- 1. Repeat Step 1 under "Injectors, Flanged, Removal".
- 2. Remove capscrews from injector hold-down plate.
- 3. Repeat Steps 4 and 5 under "Injectors, Flanged, Removal".
- 4. Insert one capscrew in tapped hole in hold-down plate and jack injector from head. Fig. 3-52.

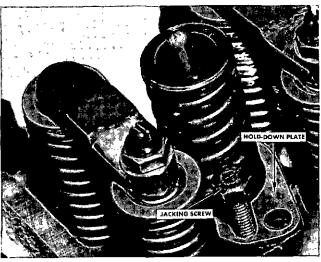


Fig. 3-52. Removing cylindrical injector

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Installation

- Clean injector sleeve with cloth wrapped around wooden stick.
- 2. Lubricate the injector body "O" rings with "Lubriplate". Lubricating oil or fuel oil is not adequate.

Note: The "O" rings should receive a fresh coat of Lubriplate each time the injectors are installed in the head.

 Start the injector into bore; guide by hand until injector is aligned in bore and not binding in any manner.

Note: Installation in the NH engines — standing on intake manifold side, injectors are to be placed with ball check retainer plug located at one o'clock. This provides a solid area for the hold-down clamp to rest on.

Installation in the V-12 engines — looking at the engine from the side, injectors are to be placed with ball check retainer plug at one o'clock. To further clarify the statement of which side, when installing the left bank, stand on that side and when installing the right bank, stand on that side. The ball check retainer plug would always be at one o'clock.

- 4. Place hammer handle butt on top of injector plunger guide, and "seat" injector by giving a quick hard push on the hammer. A "snap" should be heard and felt as the cup seats in the copper sleeve.
- Place hold-down plate over injector body with counterbore up; position half-collet locking clamps in injector body groove. Start hold-down capscrews. Do not tighten.
- With clamps centered, place injector spring on holddown plate with closed end down.

CAUTION: SPRING MUST SEAT ON HOLD-DOWN PLATE IF SPRING SITS ON LOCKING CLAMPS, INCORRECT IN JECTOR ADJUST-MENT WILL RESULT CAUSING PUSH TUBE AND CAMSHAFT DAMAGE.

 Holding injector spring in position, carefully insert injector plunger.

Note: Position plunger in injector bore with class mark on the plunger midway between inlet and drain ports of injector. This will provide the same operating position in which the injector was calibrated.

8. Torque Procedure—Nylock Capscrews—make sure injector is positioned correctly in head. Tighten one capscrew until clamp contacts head snug then back out one complete turn. Tighten other capscrew until it reaches a torque of 4-5 ft. lbs., then tighten first capscrew to 8 ft. lbs. The second capscrew should

- then be tightened to 8 ft. lbs. and the plunger checked to see if it is free. If the injector plunger is not free, the clamp should be loosened and retorqued.
- Repeat Steps 6 through 8 under "Injector Flanged, Installation".

Cylindrical V6 and V8 Series

Removal

- If the engine is equipped with air intake connections mounted directly on the cylinder head covers, the connections must be removed prior to removing the covers.
- Remove capscrews and washers from cylinder head covers; lift off covers and heat shields, if used.
- On V8-350 & VT8-430 Series Engines, remove spring clip securing spacer halves to rocker shaft; remove spacer halves.
- 4. Loosen locknut, back off injector adjusting screw and slide or tip injector rocker lever to the side.
- Remove injector hold-down clamp capscrew; remove clamp.
- Pry injector assembly from cylinder head using ST-836.

CAUTION: DO NOT BRUISE THE INJECTOR TIP.

Installation

1. Repeat Steps 1 and 2 under NH cylindrical injector installation procedures.

Note: Make sure class mark on injector plunger is located midway between inlet and drain ports of injector.

Start the injector into bore; guide by hand until in jector is aligned in bore and not binding in any manner.

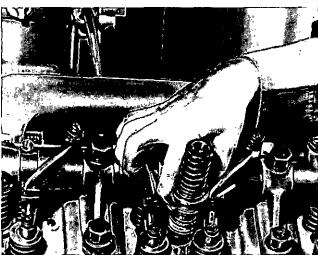


Fig. 3-53. Installing injector

Note: Position injector in head so ball retainer plug is toward inside of "V" and perpendicular to camshaft center line. Place plunger class marking midway between inlet and drain ports of injector.

- 3. Place hammer handle butt on injector bodies, and "seat" injectors by giving a quick, hard push on the hammer. A "snap" should be heard and felt as the cups seat in the copper sleeves.
- Install hold-down clamp and capscrew; torque capscrew to value shown in Table VIII.
- 5. Depress injector plunger with a screwdriver by pushing down on the plunger top. The injector rocker lever can then be slipped into location. The plunger link and the cup on the rocker lever must be engaged, and the rocker lever adjusting screw must seat into the push rod socket properly or the injector cannot be adjusted properly.
- On V8-350 & VT8-430 Series Engines, install spacer halves and secure with spring clip.
- Bar engine to appropriate valve set marking and adjust injectors.
- Position rocker housing covers with new gaskets and heat shields, if used; secure with lockwashers and capscrews.
- 9. Install air connections (if used), to rocker covers.

CYLINDER HEAD

C and J Series

Removal

- Remove rocker lever cover and gasket; discard gasket if damaged.
- Remove intake and exhaust manifolds; discard gaskets.
- If generator is high mounted, disconnect wiring and remove generator with bracket from the cylinder head.
- Disconnect rubber hose, remove capscrews, and remove thermostat housing from cylinder head. Remove and discard gasket.
- 5. Remove fuel manifolds.
- 6. Disconnect water tubing from cylinder head.
- 7. Remove injectors.
- Loosen all cylinder head capscrews. Remove center (long) capscrews and temporarily insert short capscrews in their place to act as guides in removing rocker lever assembly.
- Loosen injector plunger adjustment. Do not alter valve adjustments. Not loosening valve adjustments will allow easier barring over of engine at assembly.
- 10. Remove capscrews and stud nuts holding rocker lever shaft bearings to cylinder head. Using bar to keep

levers in position, remove rocker lever assembly. Fig. 3-54. Remove push tubes.

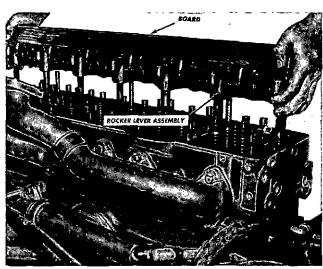


Fig. 3-54. Removing rocker lever assembly $-C \stackrel{\$712080}{\cup} J$

- 11. Attach lifting fixtures to cylinder head; remove head from block.
- Remove and discard cylinder head gasket, grommets, and grommet retainers.

Installation

- 1. Wipe surface of block clean, with lint-free rag.
- 2. Inspect new gasket on both sides. Be sure it is clean and grommets are not creased. Care must be taken to prevent contact of fuel and grommets. Fuels may cause swelling and render grommets unfit for service. Place gasket on block with "Top" stamp up. Fig. 3-55.

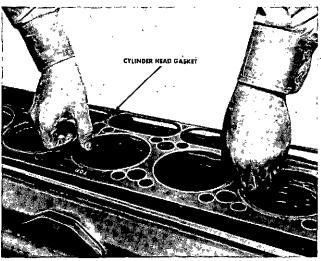


Fig. 3-55. Installing head gasket

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- 3. Install grommets and grommet retainers.
- While head is suspended in air, wipe under-surface with clean, lint-free rag to remove dirt and oil.
- Lower head into position. Lower slowly so that both ends touch gasket at the same time. Remove lifting fixture and hoist.

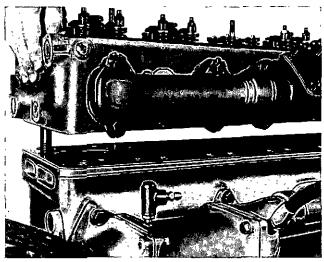


Fig. 3-56. Installing cylinder head - C & J

- 6. Install push tubes; largest push tube in diameter is center or injector push tube.
- 7. Using bar to keep levers in position and short capscrews as guides, lower rocker lever assembly into position. Be sure that two end studs and center oil supply dowel are in position in head.
- 8. Remove short head capscrews. Install in proper place. Install long capscrews through rocker lever bearings. CAUTION: THREE DIFFERENT SETS OF CYLINDER HEAD CAPSCREWS MAY BE USED ON J SERIES ENGINES. THE CAPSCREWS VARY IN LENGTH, DEPENDING UPON THE TYPE BLOCK BEING USED AND ARE NOT INTERCHANGEABLE. WHEN REPLACING CAPSCREWS, MAKE CERTAIN THEY ARE THE SAME LENGTH AS THOSE REMOVED AND THAT THEY ARE ALL FROM THE SAME SET.
- Lubricate capscrews or studs with Shell Rust Preventive-ENSIS-105 or equivalent.
- Tighten cylinder head capscrews or stud nuts to value shown in Table IX and in sequence shown in Fig. 3-57.
- 11. Install rocker lever capscrews; tighten securely.
- 12. Install injectors as previously described.
- Adjust injector plungers, then valves as described in Section 2.

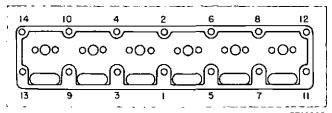


Fig. 3-57. Cylinder head tightening sequence $-C \stackrel{37/2085}{6} J$

		ABLE IX: C, HEAD TIGH	J SERIES	UENCE
Step	්ති ආර්ත	Capsarew	10716 Capacian 11716	8/4 Coperan Torgo GL Ub
1	Tighten	1, 2, 9,	Saug	Sing
2	Mghten	4, 7, 6 1	25	25
3 3	Lousen Mghten	4, 6 1	25	25
284567	Mighten Righten	ANI ANI	25 200	25 300
7	Torque	AII	250	400

Note: After first step in torquing head, check rocker levers to be sure they are free. End bearings and center bearings are dowelled in position while intermediate bearings are not. These bearings may shift to extent that rocker levers will bind on shaft when head is tightened.

- Connect water tubing, fuel supply and drain manifolds, thermostat housing and generator. Use new gaskets.
- 15. Install intake and exhaust manifolds with new gaskets. Tighten capscrews securely, beginning at center and working toward ends. Tighten exhaust manifold capscrews or stud nuts to value shown in Table X, alternating from top to bottom. If used, fasten lockplates on exhaust manifold.
- Install rocker lever cover.
- Install air piping, electric wiring, water piping and other units removed.

TABLE X: C & J MANIFOLD STUDS		
	Step (ගිලා වූ
7/16" O.D. Studs 1/2" O.D. Studs 1/3" O.D. Capetrous 3/3" O.D. Studs	20 ft. lbs. 20 ft. lbs. 10 ft. lbs. 10 ft. lbs.	°40 ft. Ibs. °°45 ft. Ibs. 22 ft. Ibs. 25 ft. Ibs.

- *Reduce to 25 ft. lbs. when washers or lockplates are used.
- *Reduce to 30 ft. lbs. when washers or lockplates are used.

CYLINDER HEADS

H/NH (4-7/8" & 5-1/8" Bore) Series

Removal

- 1. Remove pre-heater components from intake manifold or manifold connection, if used.
- Remove air piping and/or intake manifold connection, air crossover, supercharger/turbocharger outlet connections and turbocharger as applicable to facilitate removal of intake manifold.
- 3. Remove intake manifold capscrews and lockwashers, lift off manifold.
 - CAUTION: INLET AND OUTLET CONNECTIONS SHOULD BE KEPT COVERED WITH PLATES OR GUMMED PAPER TO KEEP OUT FOREIGN OBJECTS, DO NOT STUFF RAGS INTO PORTS.
- Remove capscrews and lockwashers at exhaust port; lift exhaust manifolds from engine.
- Remove capscrews from water by-pass connection; remove capscrews from each foot of water manifold and lift assembly from engine. Fig. 3-58.

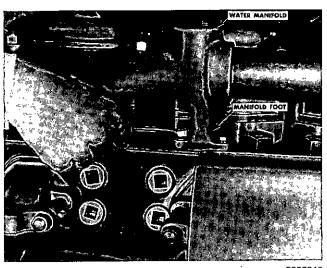


Fig. 3-58. Removing water manifold — II/NH

- Remove rocker housing cover capscrews, covers and lifting brackets, if used.
- 7. Remove lubricating oil pipe cap and gasket.
- Remove capscrews from each rocker housing and lift separately from engine by grasping end of each injector rocker housing.
- 9. Lift push tubes from sockets.
- 10. Remove injectors. See "Injectors".
- 11. Remove cylinder-head capscrews and lift heads from engine.

CAUTION: DO NOT LET MACHINED SURFACES BECOME SCRATCHED OR MARRED IN ANY WAY.

Installation

1. Make sure that cylinder heads on naturally-aspirated engines have top breather hole open. Supercharged or turbocharged engines breather hole are plugged with a 1/8 inch pipe plug. The breather hole is located at top of cylinder head between center stud holes. Fig. 3-59.

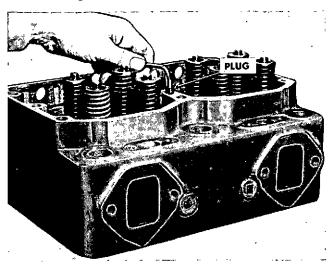


Fig. 3-59. Plugging cylinder head breather hole - H/NH

- Wipe cylinder block and cylinder head mating surfaces clean.
- 3. Place grommet retainers in water passages in block, small end up. Fig. 3-60.

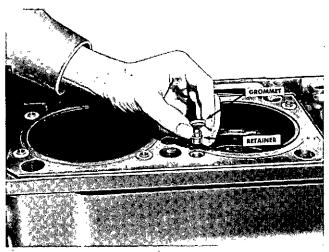


Fig. 3-60. Installing grommets and retainers – H/NH

- Lay gasket on flat surface; press grommets in place by hand.
 - CAUTION: AVOID ALL CONTACT BETWEEN GROMMETS AND FUEL OR LUBRICATING OIL TO PREVENT DAMAGE DUE TO SWELLING.
- Install head gasket, stamped word "TOP" to top, over oil pipes. Be careful not to dislodge grommets as gasket is lowered over grommet retainers.
- Lower head into place and install cork washer on oil pipe after cylinder heads have been placed on block.
- 7. Lubricate capscrews with Shell Rust Preventive ENSIS-105 or equivalent and tighten each slightly in sequence shown in Fig. 3-61. Complete tightening procedure, following steps outlined in Table XI.

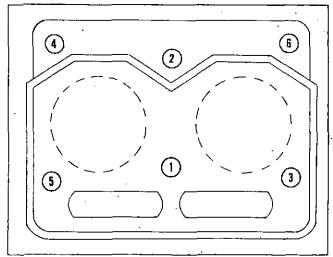


Fig. 3-61. Cylinder head tightening sequence — H/NH — 4-7/8" and 5-1/8" bore

CYL	TABLE XI: H (4-7/8" & INDER HEAD TI	5-1/8" BO	RE)
grop	Procedure	(dpscrew	<u>fordne</u>
1 2 3	Mehten Mehten Mehten	AII AII AII	225-275 ft. lbs. 350-400 ft. lbs. 460-430 ft. lbs.

- 8. Refer to "Injectors" above for installation procedure.
- 9. Insert push tubes in sockets of cam follower levers.

 Note: Injector push tube is largest and goes in middle socket. Intake push tubes have collars that match milled lift of compression release shaft on engine so equipped.
- On four-valve head engines, assemble cross heads with adjusting screw toward water manifold. Adjust as described in Section 2.
- 11. Install new rocker housing gaskets on cylinder heads.

- Loosen locknuts and rocker lever adjusting screws.
 Hold levers in place; position each housing in place
 with ball ends of levers in their respective push tube
 sockets.
- Place new gasket on each lubricating oil pipe; tighten caps. Fig. 3-62.

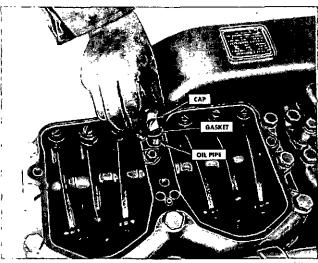


Fig. 3-62. Installing lubricating oil pipe cap — H/NH

14. Replace and tighten rocker housing capscrews to 55/75 ft. lbs. in sequence shown in Fig. 3-63.

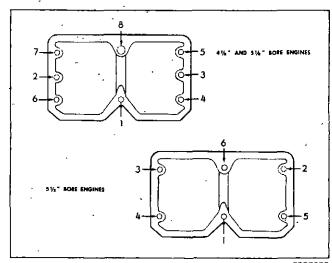


Fig. 3-63. Rocker housing tightening sequence — H/NH

- 15. Adjust injectors and valves; see Section 2.
- 16. Install covers to rocker housing and secure with washers and capscrews.
- Cement a new gasket to each manifold foot and secure manifold to cylinder heads with capscrews.
- 18. Install intake and exhaust manifolds, using new gaskets. Tighten capscrews or stud nuts securely, be-

ginning at center, work toward ends.

CAUTION: KEEP OUTLETS COVERED UNTIL CONNECTED TO MATING PART.

- Install a new rubber packing and gaskets, as necessary.
- 20. Assemble connection(s) and/or piping in place and secure with washers and capscrews.
- 21. Assemble pre-heater components.

CYLINDER HEADS

NH (5-1/2" Bore) Series

The 5-1/2 inch bore NH Series cylinder heads can be identified by internal fuel passages. See paragraphs below for removal and installation procedure.

Removal

- Remove turbocharger and connection as applicable to facilitate removal of intake manifold.
- 2. Remove rocker housing cover capscrews; remove covers and lifting brackets.
- Remove rocker housing capscrews; remove rocker housing.
- 4. Remove intake, exhaust, and water manifolds.
- Remove screws securing fuel connectors to head; remove fuel connectors. Discard "O" rings.
- Remove fuel and drain lines from No. 1 and No. 3 cylinder heads respectively.
- 7. Remove injectors; see "Injectors", this section.
- 8. Remove cylinder head capscrews and washers; lift heads from engine.

Installation

- Make certain top breather hole on naturally aspirated engine cylinder heads are open. Plug breather hole on turbocharged engine heads with 1/8 inch pipe plug.
- Clean mating surfaces of cylinder block and cylinder heads.
 - Note: Each cylinder head must have fuel passages plugged or fittings installed in proper locations. Check latest Parts Book for proper combination of parts.
- 3. Lay gasket on flat surface; press grommets in place by hand.
 - CAUTION: AVOID ALL CONTACT BETWEEN GROMMETS AND FUEL OIL TO PREVENT DAMAGE DUE TO SWELLING.
- 4. Check to make sure grommet retainers are in place in top of block. Install head gasket over dowels so that

word "top" on gasket is visible. Be careful not to dislodge grommet as gasket is lowered over grommet retainers.

Note: As an alternate method of assembly, first install grommet retainers in block water holes. Then install gasket and, finally, grommets, making sure grommets are pressed securely into gasket holes.

 Lubricate cylinder head capscrews with Shell Rust Preventive—ENSIS-105 or equivalent.

CAUTION: DO NOT DRIP LUBRICANT ON GROMMETS, PACKING RINGS, OR OTHER RUBBER MATERIALS.

 Install washers and cylinder head capscrews. Tighten each capscrew slightly in sequence as shown in Fig. 3-64 and to value shown in Table XII.

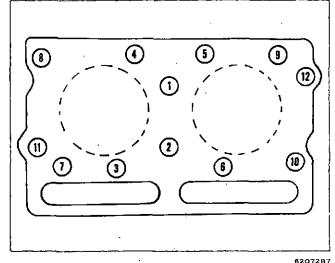


Fig. 3-64. Cylinder head tightening sequence – NH-5-1/2" bore

TABLE XII: NH	SERIES	(5-1/2"	BORE)
Step		Outpot	
1—Wighten in Sequence 2—Wighten in Sequence 3—Wighten in Sequence 4—Wighten in Sequence		25 (k.) 100 (k.) 200 (k.) 230/800	lbs.

- Install fuel connectors between cylinder heads; use new "O" rings for good seal. Install hold-down screws and tighten to 48/50 inch-pounds. Fig. 3-65.
- 8. Connect fuel supply and drain line to No. 1 and No. 3 cylinder heads respectively.
- Install intake, exhaust and water manifolds using new "O" ring seals and gaskets.
- Place new rocker housing gasket on head and install rocker housing assembly.

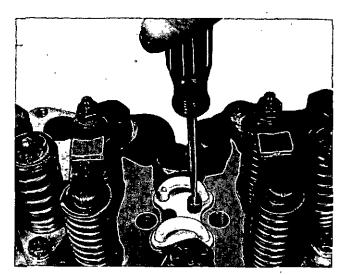


Fig. 3-65. Installing fuel connector – NH-5-1/2" bore

- 11. Place lifting brackets in position; install rocker housing capscrews and tighten to 55/75 foot-pounds in sequence shown in Fig. 3-63.
- 12. Bar engine to appropriate valve set marks; adjust injectors and valves. See Section 2.
- Install gaskets to rocker housing covers; install cover on housings and tighten capscrews securely.
- 14. Install turbocharger, if used.

CYLINDER HEADS

V6-Val, V8-Vale, V6-Vim and V8-Vine Series Removal

- 1. Disconnect air compressor intake line from crossover.
- 2. Open drain cock and drain cooling system.
- 3. Remove water connections from cylinder head.
- Remove capscrews, lockwashers and flatwashers securing air intake crossover connection to each air intake manifold; lift off crossover connections. Discard gaskets.
- 5. Remove generator or alternator, if applicable.
- Remove capscrews, lockwashers and flatwashers securing air intake manifold to push rod cavity cover on each bank; lift off manifold and discard gasket.
- Loosen hose clamps and remove capscrews and lockwashers securing thermostat housing to cylinder head; remove thermostat housing and discard gasket.
- 8. Remove fuel supply and drain line.
- 9. Remove exhaust manifold from cylinder heads.
- Remove capscrews, lockwashers and flatwashers securing cylinder head covers to cylinder heads; lift off cylinder head covers and discard gaskets.

- Remove capscrews and lockwashers securing push rod cavity cover to cylinder head and block. Lift off cover; discard gasket.
- Loosen locknuts and back out all valve and injector lever adjusting screws.
- 13. Secure rocker levers together with rubber bands.
- Remove capscrews and flatwashers securing rocker lever assemblies to cylinder head. Lift off rocker lever assemblies.
- 15. Remove all crossheads and push rods.
- Remove injector hold-down yoke capscrew and flatwasher; remove yokes.
- Pry injectors from cylinder heads, using ST-836 and lift out.
- 18. Remove remaining capscrews and flatwashers securing cylinder heads to block; lift off heads and discard gaskets, "O" rings, grommets and ferrules.

Installation

- 1. Clean cylinder head and block mating surfaces.
- 2. Install new head gasket with word "TOP" up.
- 3. Install grommets, ferrules, and "O" rings.

 CAUTION: DO NOT PERMIT FUEL OIL TO COME IN CONTACT WITH GROMMETS. USE .065-.075 GROMMETS ON V6-VAL AND V8-VALE ENGINES; OTHER SERIES ENGINES GROMMETS ARE .090-.105 THICK.
- Position heads on block over dowels; lubricate flatwashers and capscrews with lubricating oil. Install capscrews and snug tighten in sequence shown in Fig. 3-66.

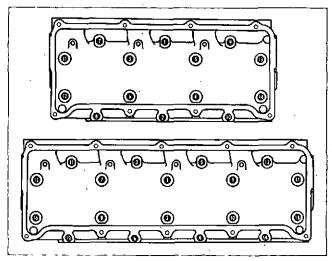


Fig. 3-66. Cylinder head tightening sequence — V6 & V8

- 5. Install injectors; see "Injectors" this section.
- 6. Install push rods and crossheads.
- Install rocker lever assemblies; secure with flatwashers and capscrews. Remove rubber band and tighten all cylinder head capscrews per sequence shown in Fig. 3-66 to values listed in Table XIII.

TABLE XIII. V6/V8 SERIES CYLINDER HEAD TIGHTENING SEQUENCE V3-V1 V3-V1m Step V3-V1m Step V3-V1m Step V3-V1m Step Smag Smag 2-Tighten in sequence S0 Ft. Libs. 50 Ft. Libs. 3-Tighten in sequence S0 Ft. Libs. 125 Ft. Libs. 4-Tighten in sequence 104 Ft. Libs. 185 Ft. Libs.

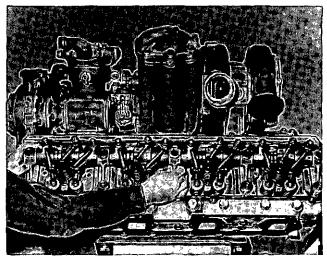
- 8. Adjust injectors, crossheads and valves.
- Position cylinder head covers with new gaskets to cylinder heads; secure with flatwashers, lockwashers and capscrews.
- Position push rod cavity covers with new gaskets to cylinder heads and block; secure with lockwashers and capscrews.
- 11. Position thermostat housing with new gasket to cylinder head; secure with lockwashers and capscrews. Tighten hose clamp.
- Position water crossover connections to cylinder heads with new gaskets; secure with lockwashers and capscrews.
- Position air intake manifolds to cylinder heads with new gaskets; secure with flatwashers, lockwashers and capscrews.
- Position air intake crossover to air intake manifolds with new gaskets; secure with flatwashers, lockwashers and capscrews.
- 15. Connect air compressor air intake hose to air intake crossover; secure with hose clamps.
- Install air compressor water intake and drain lines to air compressor, cylinder block and water crossover connection.
- 17. Connect fuel supply and drain lines.
- 18. Secure generator or alternator to mounting bracket; install drive belts and adjust to proper tension.
- 19. Install exhaust manifolds. Tighten to 25/30 ft. lbs.
- 20. Connect air compressor air pressure lines.
- Position air inlet hose to air intake crossover; secure with hose clamp.
- Close drain cocks; open vent cock and fill cooling system.
- 23. Close vent cock and start engine to check for leaks.

CYLINDER HEADS

V8-350 and VT8-430 Series

Removal

- 1. Drain cooling system.
- Remove intake manifolds, exhaust manifolds and cylinder head covers.
- Loosen all injector and valve adjusting screws. Tie all levers together or secure with rubber bands to prevent separation. Fig. 3-67.



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Fig. 3-67. Removing rocker lever assembly V8-350/VT8-430

- Remove the cylinder head capscrews securing rocker lever assemblies to heads; lift off rocker lever assemblies.
- 5. Remove injectors.
- 6. Lift push tubes from tappets.
- Remove remaining capscrews and washers securing head to block. Using a suitable hoist, lift off heads and discard gaskets.
- Clean all mating surfaces of gasket material and carbon.

Installation

- Four breather holes are drilled in the top of each cylinder head. On right bank side, two holes are located above No. 1 cylinder and two above No. 4 cylinder. On the lelt bank side two holes are located above No. 5 cylinder and two above No. 8 cylinder.
- 2. On naturally aspirated engines, the breather holes in line with the intake manifold ports must have vent tube installed. The hole in line with the exhaust manifold port must be plugged with an 1/8 inch pipe plug. See Fig. 3-68.

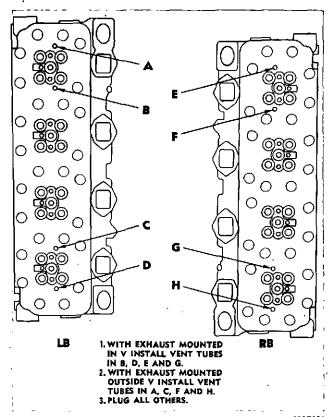


Fig. 3-68. Vent tube location - V8-350/VT8-430

- On turbocharged engines, all breather holes must be plugged with a 1/8 inch pipe plug.
- Clean mating surfaces of the cylinder block and cylinder head.
- 5. Place grommet retainers in water passages in block, small end up.
- Lay gasket on flat surface; press grommets into place by hand.

CAUTION: AVOID ALL CONTACT BETWEEN GROMMETS AND FUEL OR LUBRICATING OIL TO PREVENT DAMAGE DUE TO SWELLING.

- Install head gasket with stamped word "TOP" up. Be careful not to dislodge grommets as gasket is lowered over grommet retainers.
- Using a suitable hoist, carefully lower each head into position.
- Oil cylinder head capscrews with Shell Rust Preventive oil ENSIS-105 or equivalent, install and tighten each capscrew slightly in the correct sequence shown in Fig. 3-69 to value shown in Table XIV, Step 1.
- Insert push tubes and crossheads.

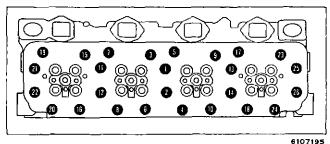


Fig. 3-69. Cylinder head tightening sequence — V8-350 and VT8-430

TABLE	XIV. V8 CYLINI	DER HEAD
TI	GHTENING SEQU	ENCE
31 2 2 3 4	Meyren Meyren Meyren Meyren Meccone	Torgus 25 ft. Ibs. 75/100 ft. Ibs. 125/150 ft. Ibs. 175/130 ft. Ibs.

- 11. Install injectors as outlined previously.
- 12. Position rocker lever assemblies on cylinder head. Align all push tubes to rocker lever adjusting screws. Snug tighten capscrews.
- 13. See Table XIV for Steps 2, 3 and 4; continue tightening cylinder head capscrews in rotation (see Fig. 3-69) to values shown.
- 14. Adjust injectors, crossheads and valves. See Section 2.
- Install intake and exhaust manifolds; install cylinder head covers.
- 16. Fill cooling system and check for leaks.

CYLINDER HEADS

V12 Series

Removal

- 1. Remove turbochargers, if used. See Page 3-14.
- 2. Remove capscrews and/or stud nuts at each intake port; lift intake manifolds from engine.
- 3. Disconnect fuel manifolds from connections; remove manifolds.
- 4. Remove fuel and drain connections from side of cylinder head and place in rack according to cylinder removed.
- Close shut-off valves in corrosion resistor inlet and outlet lines; remove drain plug and drain coolant. Disconnect inlet and outlet lines.
- Remove capscrews and lockwashers securing corrosion resistor to mounting bracket. Remove stud nuts securing bracket to exhaust manifold; remove mounting bracket
- 7. Loosen clamps and remove water connections from

- thermostat housings. Remove stud nuts securing thermostat housing to exhaust manifold; lift off housings.
- 8. Remove stud nuts securing lifting eyes to exhaust manifold; lift off lifting eyes.
- Remove stud nuts, capscrews and lockwashers securing exhaust manifolds to cylinder heads. Lift manifolds from heads. If manifold is stuck on gasket, use extreme caution in prying against cylinder head.
 Never use a screwdriver or wedge between machined surfaces.
- 10. Remove rocker housing cover.
- 11. Remove lubricating oil pipe cap and gasket.
- 12. Remove fuel supply crossover manifold bracket between front and rear rocker housings.
- 13. Remove stud nuts from each rocker housing and lift rocker housing from studs.
- 14. Remove push tubes.
- 15. Disconnect all fuel lines from fuel manifold; remove capscrew holding fuel crossover manifold to oil cooler; lift manifold from engine.
- 16. Remove injectors. See Pages 3-25 to 3-27.
- 17. Lift crossheads from guides.
- Remove cylinder head capscrews; using a chain hoist, lift cylinder head from engine.

Installation

- 1. Cylinder heads should have valve guides, valves and springs assembled in position.
- Clean mating surfaces of cylinder block and cylinder heads. See that cylinder walls are clean and lubricated with clean lubricating oil.
- Place cylinder head gaskets, with stamped word "TOP" up, over studs and oil pipes.

TABLE TIGH	XV: V12 SERIES TENING SEQUENCE	CYLINDE (5-1/8"	R HEAD BORE)
Step	Procedure	Capsaew .	යට යිට ගලාවෙ
1 2 3	Welten Welten Welten Melten	a aa	25 125/150 150/300 450

- Lubricate capscrews with Shell Rust Preventive EN-SIS-105 or equivalent and tighten to value shown in Table XV, and in sequence shown in Fig. 3-70.
- 6. Place two gaskets over each lubricating oil pipe into bores in cylinder head.
- 7. Position crossheads on guides.
- 8. Install injectors as outlined in "Injectors", Pages 3-25 to 3-27
- 9. Position fuel crossover to engine and secure with cap-

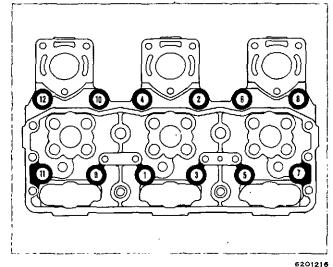


Fig. 3-70. Cylinder head tightening sequence — V12, 5-1/8" bore

screw; connect all fuel tubing and lines to fuel manifolds.

- 10. Install push tubes in proper positions.
- 11. Install new rocker housing gasket on cylinder head.
- 12. Loosen locknuts and rocker lever adjusting screw and install rocker housing assembly over studs. Hold rocker levers in place with ball ends of rocker levers fitting in their respective push tube sockets.
- Place new gasket on each lubricating oil pipe; tighten caps.
 - Note: Tighten oil pipe caps so that hex side is parallel with the sides of the engine to eliminate interference.
- 14. Install nuts to rocker housing studs; torque nuts to 70/80 foot-pounds.
- 15. Position new exhaust gaskets to cylinder heads; install exhaust manifold over studs to cylinder heads. Position lifting eyes on studs provided and secure manifolds and lifting eyes with lockwashers and stud nuts.
- Position thermostat housing with new gasket to exhaust manifold; secure with lockwashers and studenuts.
- 17. Install water hose and secure with hose clamps.
- 18. Position corrosion resistor mounting bracket to exhaust manifold and secure; position corrosion resistor to mounting bracket and secure with lockwashers and capscrews.
- 19. Connect inlet and drain lines to corrosion resistor connections; open shut-off valves.
- 20. Bar engine to appropriate valve set markings and adjust injectors and valves. See Pages 3-25 to 3-27.
- 21. Install rocker housing covers with new gaskets and secure.

CYLINDER HEADS

V12 Series

5-1/2 inch bore V12 cylinder heads contain internal fuel passages; see paragraphs below for removal and installation procedure.

Removal

Follow the same procedure as listed under V-12 Series with external fuel lines except the following:

- Remove fuel supply and drain lines from the side of each cylinder head.
- 2. Remove injectors. Pages 3-25 to 3-27,

Installation

 Lubricate capscrews with Shell Rust Preventive EN-SIS-105 or equivalent. Install cylinder head capscrews and tighten in sequence shown in Fig. 3-71 to values shown in Table XVI.

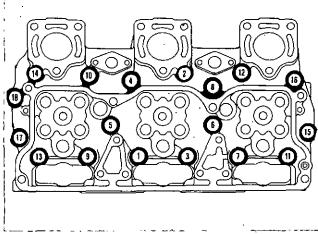


Fig. 3-71. Cylinder head tightening sequence – V12, 5-1/2" bore

- 2. Install injector. Pages 3-25 to 3-27.
- Connect fuel supply and drain lines to each cylinder head.

TABLE X	VI: CYLINDER HEAD	TIGHTENING
	(VI2, 5-1/2" BO	RE)
Step .	Surgaon.	विक्षा की प्रकार
1 2 8 4	Mighten Mighten Mighten	95/103 195/203 295/803 315/883

CYLINDER HEAD

L Series

Removal

- 1. Remove all air intake and exhaust connections.
- Remove air vent, fuel supply, drain tubing and connectors.
- Remove capscrews and lockwashers securing intake manifold to cylinder heads; lift off manifold and discard gaskets.
- Remove capscrews and lockwashers securing exhaust manifold to cylinder heads.
- 5. Disconnect air starting tubes from cylinder heads.
- 6. Remove rocker lever cover and housing.
 - a. Unscrew the two rocker lever housing cover capscrews from the rocker lever housing and cover assembly; remove cover and discard gasket. Remove the injector oil guard.
 - b. Loosen and remove the lubricating oil pipe cap and gasket.
 - c. Remove the three rocker housing stud nuts that secure the housing to the cylinder head.
 - d. Tap the housing lightly to loosen dowels and lift off the rocker lever housing and cover assembly; discard gasket.

Note: When removing the rocker housing, the injector plunger link should be held in place on the injector to prevent it falling into the crankcase. The link should be wired to the injector until reassembly.

- e. Mark housings for cylinder position. Reassemble gasket, cover, and nuts to housing.
- f. Tag and remove push tubes.
- 7. Remove fuel connections and injectors. Page 3-25 to 3-27.
- 8. Loosen four nuts securing cylinder head assembly to block; remove lubricating pipe packing collar and pipe packing.
- Mark cylinder head to identify position from which removed.
- Lift head from engine with suitable lifting device; remove and discard cylinder head gasket, stud gasket and push tube gasket.

CAUTION: DO NOT PLACE CYLINDER HEAD FACE DOWN ON HARD SURFACE, THIS WILL DAMAGE COPPER INJECTOR SLEEVE SEAT. AVOID NICKING OR MARRING GASKET SURFACES.

Installation

- Install head gasket, stud gasket and push tube gasket on cylinder block; lower cylinder head into position.
- 2. Lubricate studs with Shell Rust Preventive ENSIS-105 or equivalent; install stud nuts and tighten in sequence as shown in Fig. 3-72 to values shown in Table XVII.

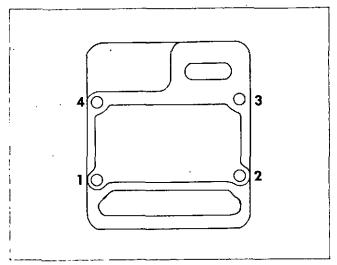


Fig. 3-72. Cylinder head tightening sequence $-\stackrel{ t b210120}{L}$

	XVII: L SERIES TIGHTENING		
5년 11 22 38 4	Merodina Melytan Melytan Greeche Greeche Greeche Melytan Melyt	Coesial All Nins L, 2 3, 4 All	Torque (A. U.s. 25 625-650 525-550 525-550

- After 8 hours operation.
- 3. Install oil pipe packing and collar over oil pipe.
- 4. Insert push tube assemblies in respective positions. Note: Intake push tube collars must fit into recesses in compression release shaft.
- Adjust intake push tube collars to hold intake valve open 1/16 inch when compression release lever is pulled all the way back.
- 6. Install injectors and connections. Page 3-25 to 3-27.
- 7. Position rocker housing assemblies with new gasket to cylinder heads; secure with nuts.
- 8. Connect air starting tubes to cylinder head.
- 9. Position exhaust manifold to cylinder head; secure with lockwashers and capscrews.
- 10. Install air intake manifold with new gasket to cylinder heads; secure with lockwashers and capscrews.
- Connect all air vent, fuel supply, drain manifold, and fuel connections.

- 12. Connect all air intake and exhaust connections.
- 13. Bar engine to appropriate valve set markings; adjust injectors and valves. See Page 2-14 to 2-19.
- Position rocker housing covers with new gasket to rocker housings; secure with lockwashers and capscrews.

GOVERNOR ADJUSTMENTS

All Series

Standard High-Speed Governor

High Speed Adjustment

Maximum engine speed for both PT (Type R) and PT (Type G) fuel systems 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 :

- Warm up engine to 140°F. oil temperature; then, shut-off or let it idle.
- 2. Remove pipe plug from spring pack cover.
- 3. The idle adjustment screw is held in position by a spring clip. Turn screw "in" to increase, or "out" to decrease the speed. Fig. 3-73. Idle speed should be set 40 to 50 rpm lower than desired if adjustment is made with engine running. With engine running, air collects in spring pack housing and speed change results when housing fills with fuel.

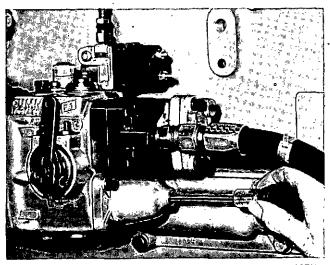


Fig. 3-73. Setting idle speed — PT (Type G) fuel pump with automotive governor

Replace pipe plug.

Variable-Speed Governor, PT (Type R) Fuel Pump

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

- 1. Loosen adjusting screw locknut.
- Screw adjusting screw "in" or "out" to get speeds required. Fig. 3-74.

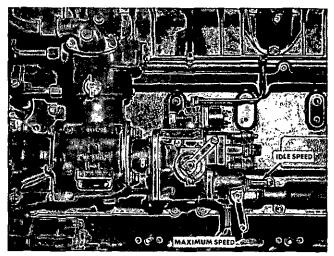


Fig. 3-74. Adjustment points — variable speed governor,
PT (Type R) fuel pump

3. Tighten adjusting screw locknut.

Variable-Speed Governor, PT (Type G) Fuel Pump

The maximum and idle screws are located on top and rear of the governor assembly atop the fuel pump body. To adjust, follow the same procedure as above. See Fig. 3-75.

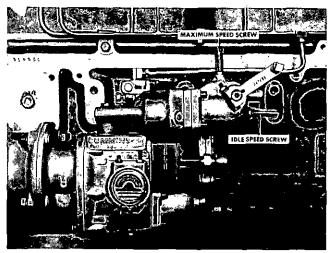


Fig. 3-75. Adjustment points — variable speed governor, PT (Type G) fuel pump

Torque Converter Governor, PT (Type R) Fuel Pump

Speed Adjustments

- Disconnect torque-converter governor flexible drive cable, or declutch converter from engine so engine governor will have complete control of engine. Disconnect drive cable at converter to prevent cable whipping.
- 2. Hold converter lever in clockwise position and turn in converter governor idle screw "C" (Fig. 3-76) until spring is compressed. Turn adjusting screw out; turn back in slowly to check this adjustment.
- Start engine and rotate engine governor lever in clockwise direction; set engine idle speed by adjusting idle screw "A" to get 515 to 700 rpm. Fig. 3-76.
- 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 counter-clockwise direction. See Fig. 3-76.

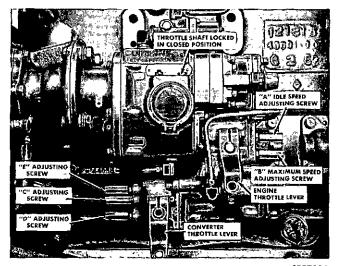


Fig. 3-76. Adjustment points -- torque converter governor, PT (Type R) fuel pump

- 5. Stop engine and engage torque-converter clutch or connect flexible drive cable to torque-converter governor. Make sure engagement is made so torque-converter drives governor. The flexible cable should have ten inch, or larger, radius bends for satisfactory service life.
- Start engine and bring speed up to 1000 rpm with engine governor lever.
- Increase engine speed until it 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 converter governor lever; turn lever in a counterclockwise direction.

- 9. Advance engine governor to maximum speed position.
- 10. If unit has a single speed setting:
 - a. Adjust screw "C" to get rated no-load tailshaft speed of converter. Fig. 3-76.
 - b. Adjust screw "D" until converter governor lever is locked in place. Fig. 3-76.
- 11. If unit has a two-speed setting:
 - a. Adjust screw "C" to get no-load tailshaft speed of converter. Fig. 3-76.
 - b. Adjust screw "D" until maximum converter speed desired is reached. Fig. 3-76.

Adjustments for Minimum Fuel

- 1. Operate engine at full-speed, no-load, with tailshaft governor in operation.
- 2. Loosen screw "C", Fig. 3-76, and back out approximately 3/4 inch.
- 3. Move converter governor-throttle-lever counterclockwise until engine speed is reduced to 400 rpm. Hold in this position.
- 4. Loosen screw "E" and turn clockwise approximately 1/16 inch, until engine speed begins to increase to approximately 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, stall converter and check engine speed:

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

Adjustments for Unstable Speeds

- 1. Start with minimum output-shaft speed setting; then, loosen pump throttle screws and adjust so throttle shaft turns in counterclockwise direction until engine speed increases 10 to 15 rpm. Continue throttle screw adjustment one-half turn 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, engine will tend to over-speed after load is released and engine rpm will stay up.

- b. If throttle leakage is too low, 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 above to get maximum speed of unit.

Changing Speed-Droop Converter Governor

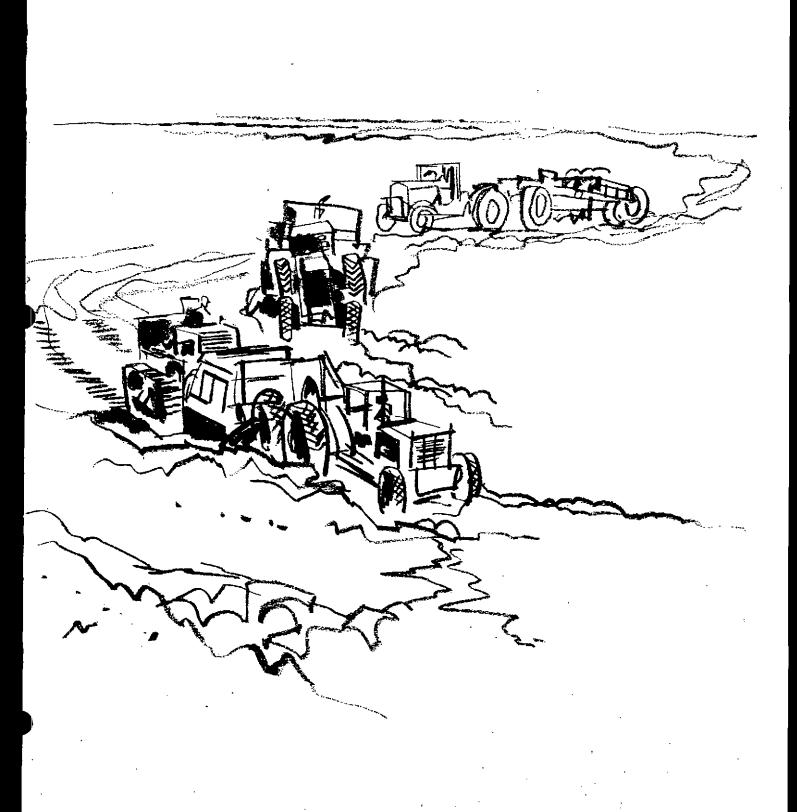
Due to the variety of applications, converter ratios, and operator preference for different operating characteristics, the converter governor spring furnished in fuel pump may not give desired speed droop. Speed droop is controlled by changing springs; springs listed in following table give full droop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

TABLE XVIII: CONVERTI	R GOVERNOR SPRINGS
िवारी विकासीहर	ල්බන ලේඛ
70321	Green and White
70822	@reen
101002	White
105422	Black
107787	Yellow and Blue
109686	Blue
109687	Yellow
109688	Brown
109689	Cray
109690	Birds
1110460	Orange
1110461	Ruple
1118935	Orange and White

Idle Speed

The fuel pump spring pack housing operates in fuel oil and is connected to the main pump housing by a drilling; therofore, whenever the pipe plug is removed to adjust idle speed some air will enter the system.

- 1. Check speed before opening pump or removing idle adjustment plug to determine amount of adjustment
- Remove idle adjustment plug from spring pack cover. Adjustment must be made quickly or the engine may
- 3. Screw idle screw in or out as required to change speed to rpm desired.
- 4. Replace plug and tighten securely. If air entered pump it will purge itself of air in approximately onehalf minute. Check speed for desired rpm, if not correct repeat steps 2 and 3 above.



"Trouble Shooting" is an organized study of a problem and the planned procedures for investigating and correcting the cause of that problem. Anyone familiar with the construction and operating principles of a given piece of equipment can "trouble shoot" a failure to that equipment simply by studying the functions of each part in relation to other parts, from beginning to end. The trouble shooting chart on Page 4-2 is designed to stimulate thought and to indicate a work procedure directed toward isolating the source of trouble.

"Maintenance Control" refers to the program of scheduling and performing periodic maintenance on the equipment before damage occurs. This program necessitates a certain amount of "paper work" for scheduling the work, recording repair details, summarizing costs involved, etc. However, it is important to remember that "paper work" is useful only as it reduces work load instead of contributing to it. The control procedures outlined on Page 4-3 are suggested as effective, yet simple, methods of achieving this result.

TROUBLE SECONDING

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; following this simple rule 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.

THEO WELL SHOOMING **CUMMINS ENGINES** CAUSES Restricted Air Intake • High Exhaust Back Pressure AIR Thin Air In Hot Weather or High Altitude • SYSTEM Air Leaks Between Cleaner & Engine Worn Turbocharger Seal & Bearing . Out of Fuel or Fuel Shut-Off Closed Poor Quality Fuel •• ٠ 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 ... • **FUEL** Scored Gear Pump or Worn Gears SYSTEM Loose Injector Inlet or Drain Connection Wrong Injector Cups 0 0 Cracked Injector Body or Cup Mutilated Injector Cup "O" Ring Throttle Linkage I Incorrect Assembled Idle Springs Governor Weights Assembled Incorrectly High-Speed Governor Set Too Low 9 9 Water In Fuel External and Internal Oil Leaks Dirty Lube Oil Strainer • . Faulty Cylinder Oil Control • . LUBRICATING 000 Clogged Oil Drillings SYSTEM Oil Suction Line Restriction 000 Faulty Oil Pressure Regulator • 000 Crankcase Low or Out of Oil • Wrong Grade Oil for Weather Conditions • • • Insufficient Coolant Worn Water Pump • Faulty Thermostats Damaged Water Hose Loose Fan Belts Radiator Shutters Stuck Open . COOLING . Clogged Water Passages • SYSTEM Internal Water Leaks Clogged Oil Cooler Radiator Core Openings Plugged with Dirt 9 0 9 0 • 0 Air in Cooling System Exterior Water Leaks Insufficient Radiator Capacity . . Dirty Filters and Screens **OPERATION** 000 . Long Idle Periods 0000 AND . Engine Overloaded • MAINTENANCE 000 Lube Oil Needs Changing **PRACTICES** Engine Exterior Caked with Dirt . 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 **MECHANICAL** Main Bearing Bore Out of Alignment **ADJUSTMENTS** Engine Due for Overhaul OR Damaged Main or Rod Bearings REPAIR Broken Tooth In Gear Train Excessive Gear Back Lash Misalignment of Engine with Driven Unit Loose Mounting Bolts Incorrect Valve and Injection Timing . ٠ 00 Worn or Scored Liners or Pistons Injectors Need Adjustment

MAINTENANCE CONTROL

MAINTENANCE SCHEDULE CONTROL SHEET

The maintenance superintendent schedules and records checks on units, using charts similar to those shown on Page 4-4. He makes the unit available and assigns a mechanic to the job.

MAINTENANCE CHECK SHEET

The mechanic checks off items as he performs them, using a check sheet like that shown on Page 2-2. He lists time spent and the parts requisition number, if parts are required. He then signs the form and returns it to the maintenance superintendent.

PARTS REQUISITION FORM

The mechanic lists parts, if required, on the company requisition form (similar to form on Page 4-6) and makes reference to it on the Maintenance Check Sheet. He gives the requisition to the maintenance superintendent.

NOTIFICATION TAG

The mechanic makes a new tag and attaches it to the vehicle when the maintenance job is completed. *He destroys the old tag*. The new tag, as shown on Page 4-6, lists daily maintenance requirements, the record of last maintenance and notice of the next maintenance.

MAINTENANCE OPERATIONS SUMMARY SHEET

The accounting department receives the maintenance check sheets and parts requisitions from the maintenance superintendent and transfers the data to a summary sheet, shown on Page 4-5. Each unit is recorded on a separate sheet. In this manner, a balance of total costs can be shown at any date.

MAINTENANCE SCHEDULE CONTROL

Each space under "B", "C", "B", "D", etc., represents check interval of 6,000 miles or equivalent. Insert date or hourmeter reading in proper space and due date in following column at each maintenance check. Perform next maintenance at due date or hourmeter reading indicated for the unit.

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ACCIDENTS - CAUSE OF FAILURE - MAJOR ITEMS REPLACED, ETC. REMARKS OPERATIONS IN NEXT 45P REPORTS TIME LOST HOURS EMERGENCY REPAIRS PERFORMED BEIMEEN! 4EPP PARTS LABOR HRS. OUT OF SERVICE LUBE OIL TIME LOST REFORMS QUARTS GALLONS FUÉL REQ. NO. COST PARTS Note: Weight Summary LABOR HOURS DATE MECHANIC PERFORMED GALLONS or MILES GALLONS or MILES DUE FUEL OPERATIONS F GOTTE CHECKS NO.

PARTS REGUISITION ENCINE **MAINTENANCE** B, C, D, E CHECK DAILY OF EACH SHIFTS MADE BY (MECHANIC) ON___ NEXT CHECK B, C, D, E 4 Add ad to all tall ar · DUE... (DATE)

LUBRICATING OIL ANALYSIS

The most satisfactory method for determining when to change lubricating oil is by oil analysis using laboratory tests. After several test periods a time (hours, weeks, etc.) interval for the oil change can be established; however, a new series of tests should be run if oil brands or grades are changed.

In the beginning, tests should be made each 100 gallons fuel consumed (after 400 gallons), or 20 hours (after 100 hours) until the analysis indicates the first oil change is necessary. Repeat analysis cycle until a definite pattern is established.

Wide variations in different brands of lubricating oil make it profitable to contact the oil supplier to assist in the development of the oil change period because he knows best the factors peculiar to his brand or brands of oil.

Analysis Test For Lubricating Oil

Following is a suggested list of lubricating oil properties which should be checked during laboratory analysis. The suggested methods are fully described in the American Society for Testing Materials Handbook.

OIL PROPERTY	TEST NUMBER
Viscosity at 100°F, and 200°F.	ASTM-D445
Sediment	ASTM-D893
Water	ASTM-D95
Acid and Base Number	ASTM-D664

Oil Change Limits

- A. Minimum Viscosity (dilution limit): Minus one SAE grade from oil being tested or point equal to a mixture containing five per cent by volume of fuel oil.
- B. Maximum Viscosity: Plus one SAE grade from oil being tested, or ten per cent increase at 210°F. or 25 per cent increase at 100°F.
- C. Sediment Content: Normal pentane insoluble 1.0 to 1.5 per cent. Benzine insoluble 0.75 to 1.0 per cent.
- D. Acid Number: Total number 3.5 maximum.
- E. Water Content: 0.2 per cent maximum.
- F. Additive Reduction: 25 per cent maximum.

If the above tests indicate presence of any metal particles, or if found in filters, the source should be determined before a failure results.

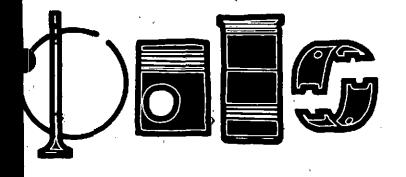
The efficiency of any maintenance program can only be judged on the basis of the failures prevented or intercepted before the engine or unit is damaged.

Adjust Injectors and Valves	2-14	Clean Composite-Type Cleaner Element	2-25
Adjustment		Clean Crankcase Breather	2-26
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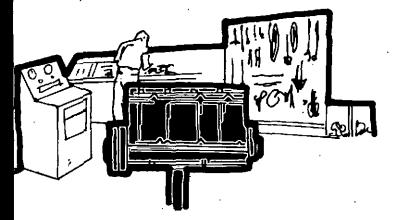
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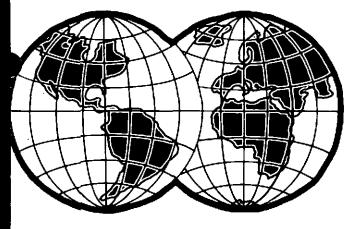
Genuine Cummins service parts are of the same high quality as those used on the original engine so your engine will continue to give good service after any repair or maintenance.

These parts are available only from authorized Cummins Distributors and Dealers, and we urge you to make full use of their parts stocking facilities.



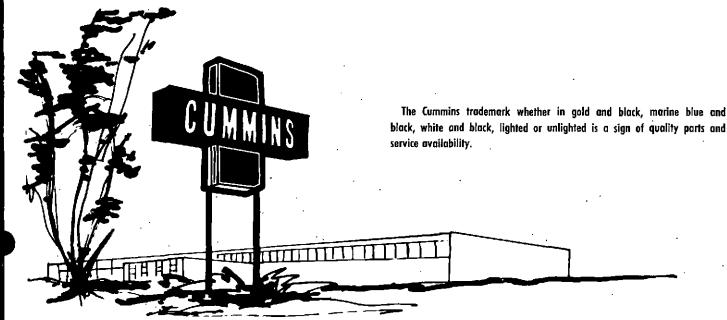
SERVICE

Trained servicemen, special tools and equipment (where required) and an active interest in each customer will make you immediately aware that service is the by-word of the Cummins Distributor and Dealer Organization.



LOCATION

The Cummins Distributor and Dealer Organization reaches to the "far corners" of the world and points in between. Each Distributor or Dealer is a respected businessman from the Locality which he serves; this is an important reason why Cummins Service has gained such an outstanding reputation. For assistance in selecting new engine power, parts and service; see your nearest Cummins Distributor or Dealer.



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