Component Servicing

Complete information on removal and installation of marine components is covered in the Shop Manual applicable to that series of Cummins Engines.

Marine Gear

Removal Of Marine Gear

Capitol Marine Gear

1. Remove capscrews and lockwashers securing engine mounting brackets to marine gear and flywheel housing; drive mounting brackets from dowels with a soft hammer. Fig. 5-1.

2. Remove shims on each side of marine gear; tag for future assembly.

3. Attach a suitable lifting device to marine gear; lift only enough to assume weight of marine gear.

4. Remove capscrew, lockwashers and flatwashers securing marine gear to oil dam; slide gear assembly to rear to clear clutch assembly, Fig. 5-2. Discard gaskets.

5. Lift off clutch assembly, Fig. 5-3.

6. Remove snap ring securing driving drum in oil dam, Fig. 5-4, lift out driving drum.

7. Remove capscrews, lockwashers and flatwashers securing oil dam assembly to flywheel housing, Fig. 5-5, lift off oil dam and discard gasket.

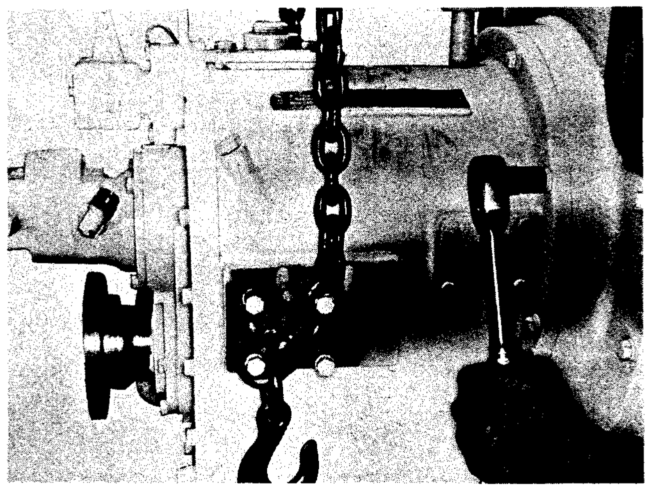


Fig. 5-2, (V22000). Removing marine gear

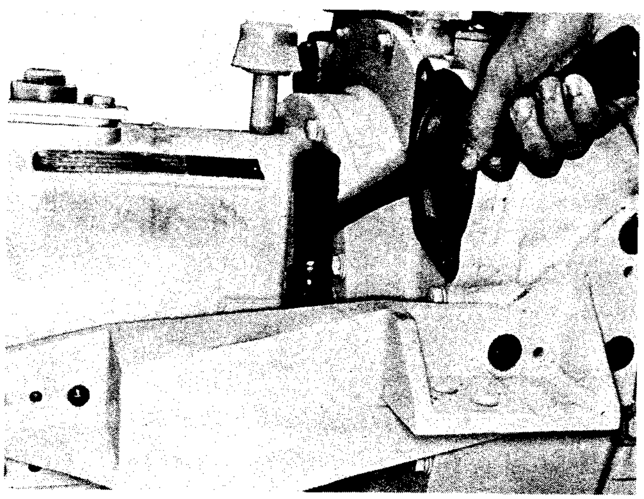


Fig. 5-1, (V21999). Removing marine gear mounting brackets

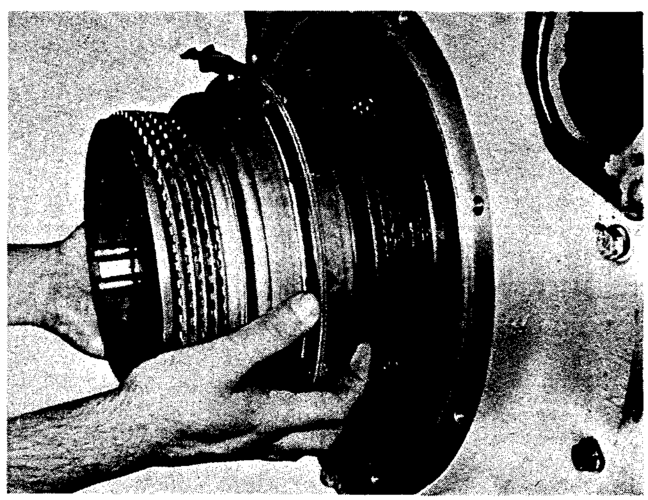


Fig. 5-3, (V22001). Removing clutch assembly

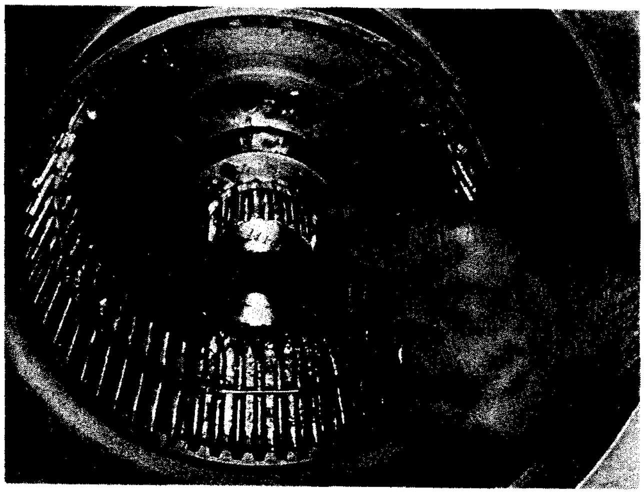


Fig. 5-4, (V22002). Removing snap ring from drive shaft

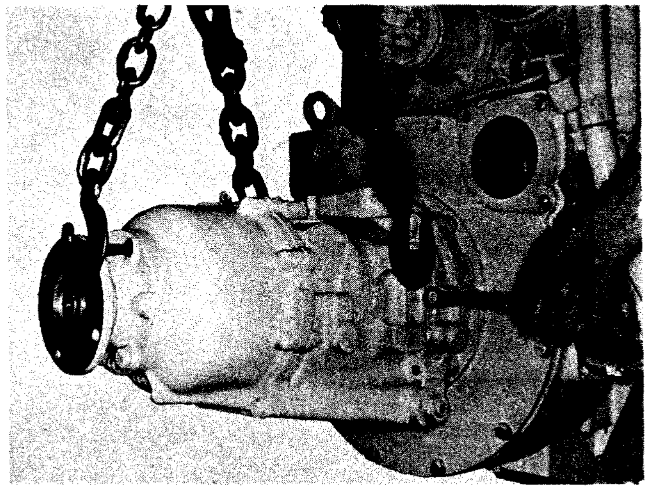


Fig. 5-6, (V10058). Removing marine gear

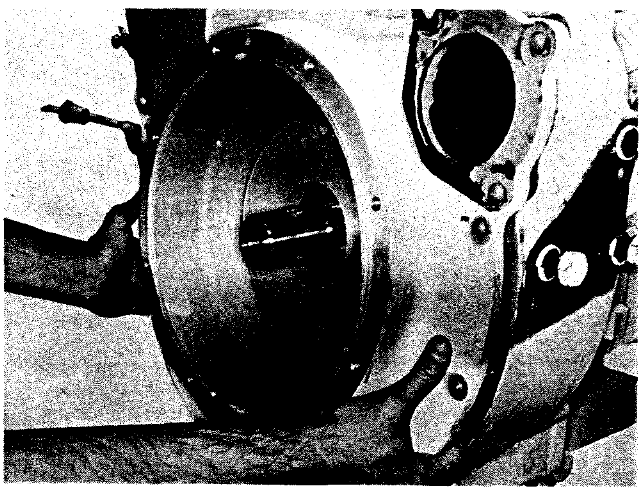


Fig. 5-5, (V22003). Removing oil dam assembly

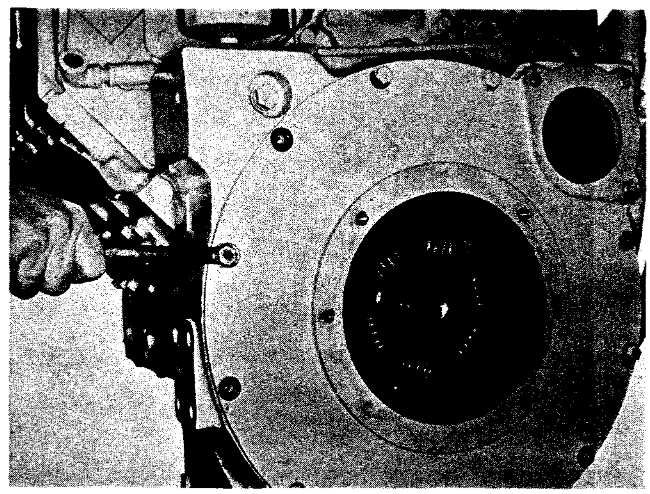


Fig. 5-7, (V10059). Removing adapter plate

8. Remove capscrews and lockwashers securing driving flange to flywheel. Lift out driving flange.

Borg Warner Or Paragon Marine Gear Removal

1. Disconnect and remove fuel drain tubing from fuel check valve.

2. Remove check valve.

3. Remove capscrews and lockwashers securing rear mounting brackets to marine gear. Lift off mounting brackets.

4. Using a suitable hoist attached to marine gear, snug tighten chain on hoist. Remove capscrews and lockwashers securing marine gear to adapter plate. Fig. 5-6. Lift marine gear slightly and slide to rear to disengage drive.

5. Remove capscrews and lockwashers securing adapter plate to flywheel housing. Fig. 5-7. Lift off adapter plate.

6. Remove capscrews and lockwashers securing drive plate to engine flywheel. Fig. 5-8. Lift off drive plate.

Twin Disc Marine Gear Removal

1. Using a suitable hoist attached to marine gear, snug tighten chain on hoist.

2. Remove capscrews and lockwashers securing marine gear to flywheel housing. Lift marine gear slightly and slide to rear to disengage ring drive.

3. Remove driving ring from flywheel.

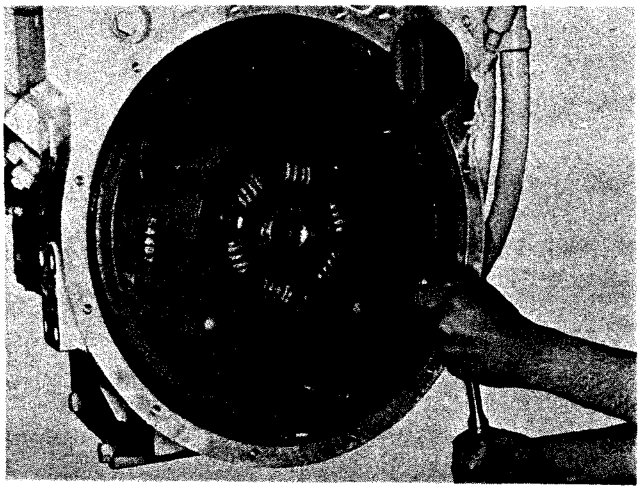


Fig. 5-8, (V10060). Removing drive plate

Installation

Capitol Marine Gear

1. Remove all inspection covers from marine gear housing to facilitate assembly of marine gear to engine.

2. Insert splined driving stub shaft into driving flange, if removed.

3. Position driving flange in counterbore of engine flywheel; secure with lockwashers and capscrews. Check flywheel to driving flange and stub shaft for alignment. Total misalignment, both radially and axially, must not exceed 0.005 inch [0.13 mm].

4. Lubricate oil seal in oil dam and position oil dam over driving stub shaft and against engine flywheel housing; align bolt holes.

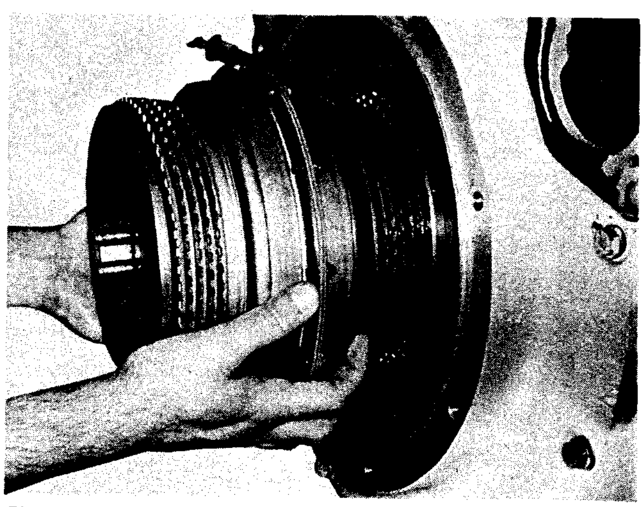


Fig. 5-9, (V22001). Installing Capitol gear clutch assembly

5. Position driving drum over stub shaft and snug against driving flange; secure driving drum in position with snap ring in groove of driving stub shaft.

6. Place clutch assembly over splined stub shaft and align clutch plates to enter spline of driving drum. Slide into driving drum until clutch assembly seats. Fig. 5-9.

Caution: Be sure "7" plate section of clutch assembly is installed toward flywheel.

7. Using suitable lifting device, position marine gear with new gasket, over clutch assembly and to oil dam. This must be done while aligning clutch plates with splines in reverse drum and oil pump drive shaft enters internal splines of stub shaft. Secure in position with flatwashers, lockwashers, nuts and capscrews. Remove lifting device.

Caution: Care must be used to align clutch discs with splines in reverse clutch drum to prevent damage to clutch disc teeth. It may be necessary to bar engine or to turn clutch disc with a bar through inspection holes to obtain alignment.

8. Remove tags from oil supply and drain lines; connect to respective connection on marine gear and marine gear oil cooler.

9. Position all inspection plates with new gaskets to marine gear housing; secure with lockwashers and capscrews.

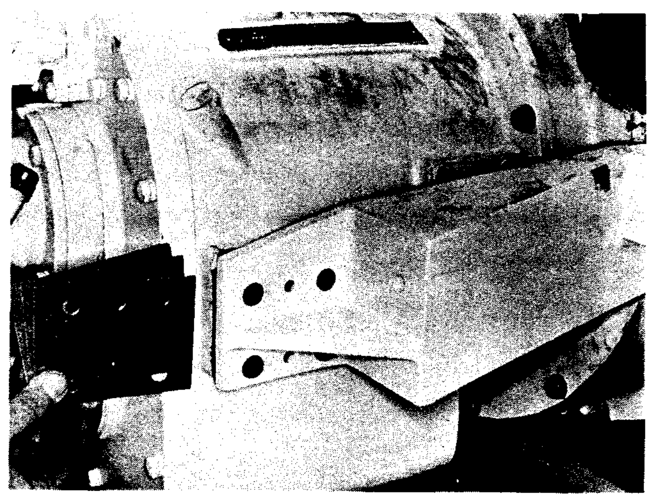


Fig. 5-10, (V22034). Installing shims for marine gear alignment

10. Install shims removed during disassembly over dowels; position mounting brackets on dowels, secure and position to marine gear and flywheel housing with lockwashers and capscrews. Fig. 5-10.

Borg Warner Or Paragon Marine Gear Installation

1. Position drive plate to flywheel; snug-tighten lockwashers and capscrews.

2. Attach ST-112 and a dial indicator to flywheel housing; bar engine over in direction of rotation and check drive plate run-out. Fig. 5-11. It should be within TIR of 0.005 inch [0.13 mm].

3. Torque drive plate capscrew to 30 to 32 ft-lbs [4.15 to 4.43 kg m]. Fig. 5-12. Wipe housing mounting clean and check mounting face for nicks or burrs. Remove any irregularities on flywheel housing mounting face.

4. Position adapter plate to flywheel housing; snug-tighten lockwashers and capscrews.

5. Use a magnetic base with a dial indicator to check adapter plate bore run-out. Fig. 5-13. It should be within TIR of 0.010 inch [0.25 mm].

6. Torque adapter plate capscrew to 30 to 32 ft-lbs [4.15 to 4.43 kg m]. Fig. 5-14.

7. Using a suitable hoist, position marine gear to adapter plate; insert spline drive of marine gear in spline of drive plate. Secure with lockwashers and capscrews; torque to 48 to 50 ft-lbs [6.64 to 6.91 kg m]. Fig. 5-15.

8. Position mounting brackets to marine gear; secure with lockwashers and capscrews.

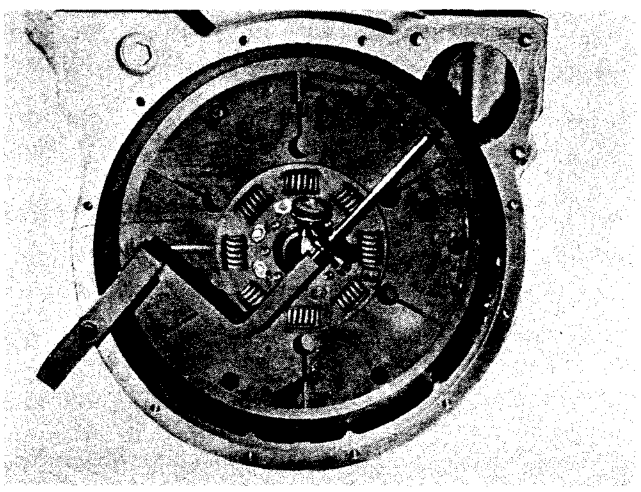


Fig. 5-11, (V11475). Checking drive plate run-out

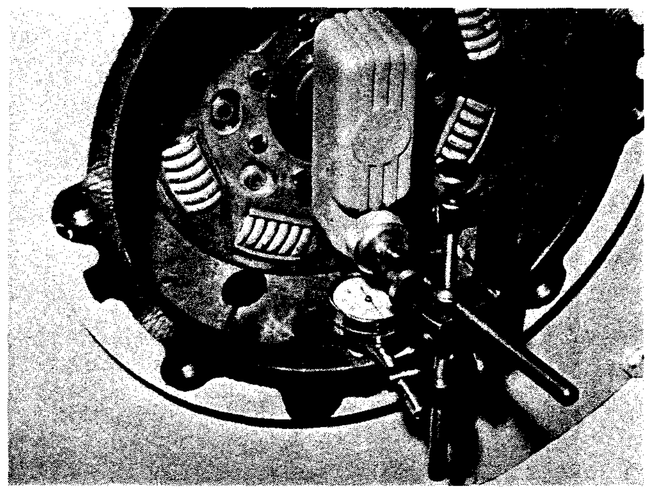


Fig. 5-13, (V11477). Checking adapter plate bore

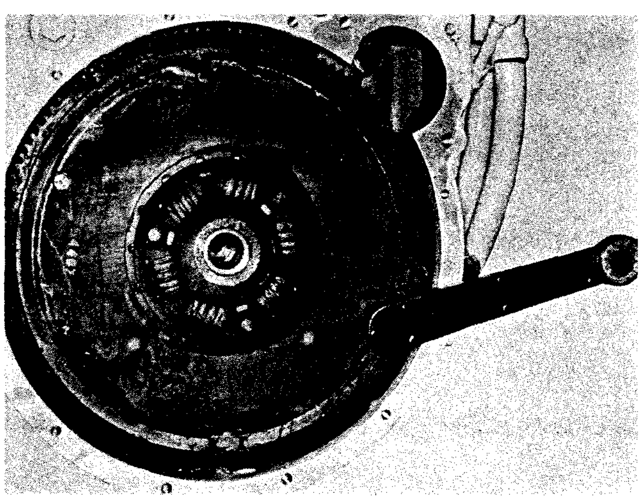


Fig. 5-12, (V11476). Torquing drive plate capscrews

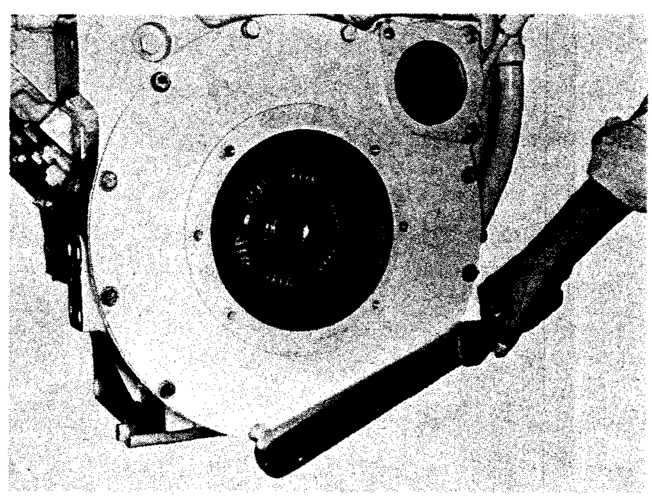


Fig. 5-14, (V11478). Torquing adapter plate capscrews

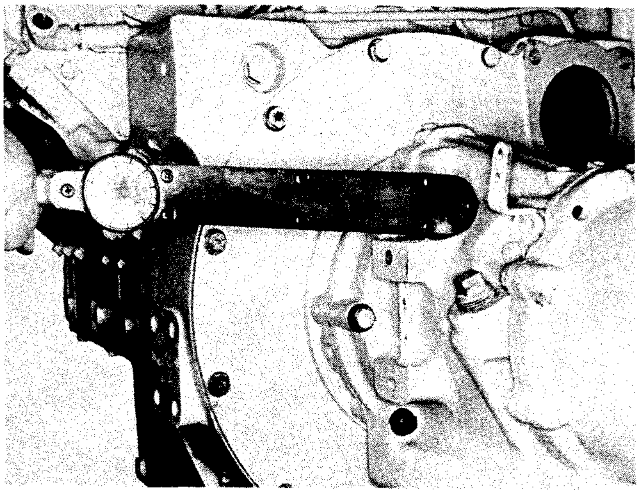


Fig. 5-15, (V11479). Torquing marine gear mounting capscrews

Twin Disc Marine Gear Installation

1. Position driving ring to flywheel, Fig. 5-16, with lockwashers and capscrews. Torque to 30 to 32 ft-lbs [4.15 to 4.43 kg m].

2. Attach dial indicator to flywheel housing and measure run-out of driving ring face and bore. The face run-out should not exceed 0.008 inch [0.20 mm]. Bore run-out should not exceed 0.010 inch [0.25 mm].

3. Install rubber blocks on drive spider teeth (if removed).

4. Install 2 guide studs approximately 6 inches long in flywheel mounting face.

5. Use suitable hoist to lift marine gear; install marine gear on guide studs and push toward flywheel mounting, at the same time engaging drive spider into driving ring.

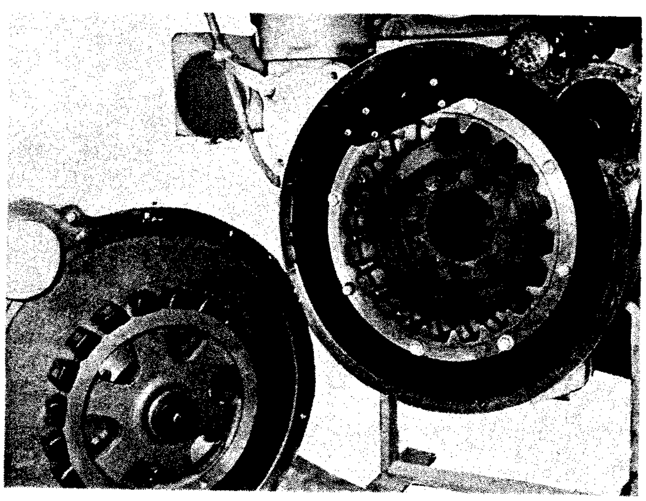


Fig. 5-16, (V22033). Torquing Twin Disc driving ring

6. Install lockwashers and capscrews. Torque to 30 to 32 ft-lbs [4.15 to 4.43 kg m].

Assembly Of Marine Gear And Engine To Boat

1. Whenever possible, it is recommended that the new marine gear be assembled to engine before it is installed in boat.

2. After entire assembly has been set on its foundation, it must be properly aligned with propeller shaft. Make this alignment without pulling support brackets on marine gear out of position. It is recommended that clearance for shimming be provided at this point. Recheck alignment after engine foundation bolts have been tightened and then carefully shim up under marine gear support bracket.

3. Experience has shown that hulls often change shape after boat is launched; recheck and correct alignment, if necessary, with boat in water. This can be accomplished by removing the bolts in propeller shaft coupling and checking spacing of the two flanges on the circumference. For satisfactory alignment, variation should not exceed 0.004 inch [0.10 mm]. Fig. 5-17.

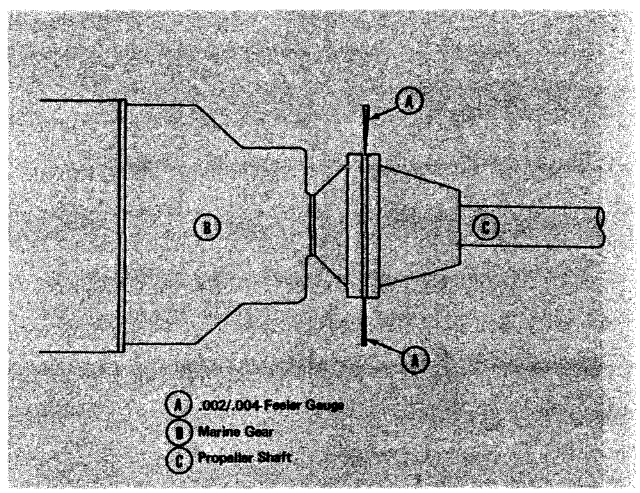


Fig. 5-17, (V11967). Checking alignment between marine gear and propeller shaft

Marine Gear Information

Capitol

See Cummins Bulletin No. 983695 for Capitol Gear rebuild instructions or contact:

Service Department
Capitol Gear Co.
343 N. Hamline
St. Paul, Minnesota 55104

Twin Disc

Rebuild information may be obtained from the nearest Twin-Disc Distributor or contact:

Service Department
Twin-Disc Clutch Company
1320 Racine Street
Racine, Wisconsin 53403

Borg Warner

Rebuild information may be obtained from the nearest Borg Warner Distributor or contact:

Service Department
Warner Gear
1106 E. Seymour
Muncie, Indiana 47302

Paragon

Rebuild information may be obtained from the nearest Paragon Gear Distributor or contact:

Service Department
Paragon Gear Works
Taunton, Massachusetts 02780

Operating Principles

Dependable service can be expected from a Cummins Diesel Engine when the operating procedures are based upon a clear understanding of the engine working principles. Each part of the engine affects the operation of every other working part and of the engine as a whole. Cummins Diesel Engines treated in this manual are four-stroke-cycle, high-speed, full-diesel engines. Horsepower ratings and other engine specifications for each model are tabulated on preceding pages.

Cummins Diesel Engine

Cummins Diesel Cycle

Cummins Diesel Engines differ from spark-ignited engines in a number of ways. Compression ratios are higher, the charge taken into combustion chamber during the intake stroke consists of air only -- with no fuel mixture. Cummins Injectors receive low-pressure fuel from the fuel pump and deliver it into individual combustion chambers at the proper time, in equal quantity and atomized condition for burning. Ignition of fuel is caused by heat of compressed air in the combustion chamber.

It is easier to understand the function of engine parts if it is known what happens in the combustion chamber during each of the four piston strokes of the cycle. The four strokes and order in which they occur are: Intake Stroke, Compression Stroke, Power Stroke and Exhaust Stroke.

In order for the four strokes to function properly, valves and injectors must act in direct relation to each of the four strokes of the piston. The intake valves, exhaust valves and injectors are camshaft actuated, linked by tappets or cam followers, push rods, rocker levers and valve crossheads. The camshaft is gear driven by the crankshaft gear, thus rotation of the crankshaft directs the action of the camshaft which in turn controls the opening and closing sequence of the valves and the injection timing (fuel delivery).

Intake Stroke

During intake stroke, the piston travels downward; intake valves are open, and exhaust valves are closed. The downward travel of the piston allows air from the atmosphere to enter the cylinder. On turbocharged engines the intake manifold is pressurized as the turbocharger forces more air into the cylinder through the intake manifold. The intake charge consists of air only with no fuel mixture.

Compression Stroke

At the end of the intake stroke, intake valves close and piston starts upward on compression stroke. The exhaust valves remain closed.

At end of compression stroke, air in combustion chamber has been forced by piston to occupy a smaller space (depending upon engine model about one-fourteenth to one-sixteenth as great in volume) than it occupied at beginning of stroke. Thus, compression ratio is the direct proportion in the amount of air in the combustion chamber before and after being compressed.

Compressing air into a small space causes temperature of that air to rise to a point high enough for ignition of fuel.

During last part of compression stroke and early part of power stroke, a small metered charge of fuel is injected into combustion chamber.

Almost immediately after fuel charge is injected into combustion chamber, fuel is ignited by the existing hot compressed air.

Power Stroke

During the beginning of the power stroke, the piston is pushed downward by the burning and expanding gases; both intake and exhaust valves are closed. As more fuel is added and burns, gases get hotter and expand more to further force piston downward and thus adds driving force to crankshaft rotation.

Exhaust Stroke

During exhaust stroke, intake valves are closed, exhaust valves are open, and piston is on upstroke.

Upward travel of piston forces burned gases out of combustion chamber through open exhaust valve ports and into the exhaust manifold.

Proper engine operation depends upon two things – first, compression for ignition; and second, that fuel be measured and injected into cylinders in proper quantity at proper time.

Fuel System

The PT fuel system is used exclusively on Cummins Diesels. The identifying letters, "PT," are an abbreviation for "pressure-time."

The operation of the Cummins PT Fuel System is based on the principle that the volume of liquid flow is proportionate to the fluid pressure, the time allowed to flow and the passage size through which the liquid flows. To apply this simple principle to the Cummins PT Fuel System, it is necessary to provide:

1. A fuel pump to draw fuel from the supply tank and deliver it to individual injectors for each cylinder.

2. A means of controlling pressure of the fuel being delivered by the fuel pump to the injectors so individual cylinders will receive the right amount of fuel for the power required of the engine.

3. Fuel passages of the proper size and type so fuel will be distributed to all injectors and cylinders with equal pressure under all speed and load conditions.

4. Injectors to receive low-pressure from the fuel pump and deliver it into the individual combustion chambers at the right time, in equal quantities and proper condition to burn.

The PT fuel system consists of the fuel pump, supply lines, drain lines, fuel passages and injectors. Fig's. 6-1 and 6-2. There are two types of PT fuel pumps. The first type, commonly called PT (type G), is shown in Fig. 6-3. The second type, called PT (type R), is shown in Fig. 6-4.

The designations PT (type G) and PT (type R) stand for "Governor-Controlled" and the "Pressure-Regulated" respectively. Hereafter, these designations will be used to describe both the fuel system and the fuel pump.

Fuel Pump

The fuel pump is coupled to the compressor, vacuum pump or fuel pump drive which is driven from the engine gear

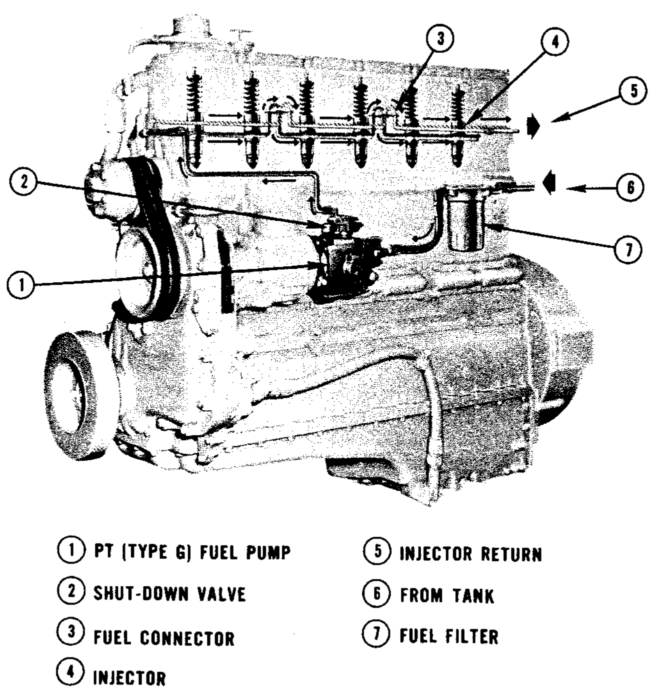


Fig. 6-1, (FWC-13). Fuel flow diagram – PT (type G) pump and cylindrical injectors – Inline Engine

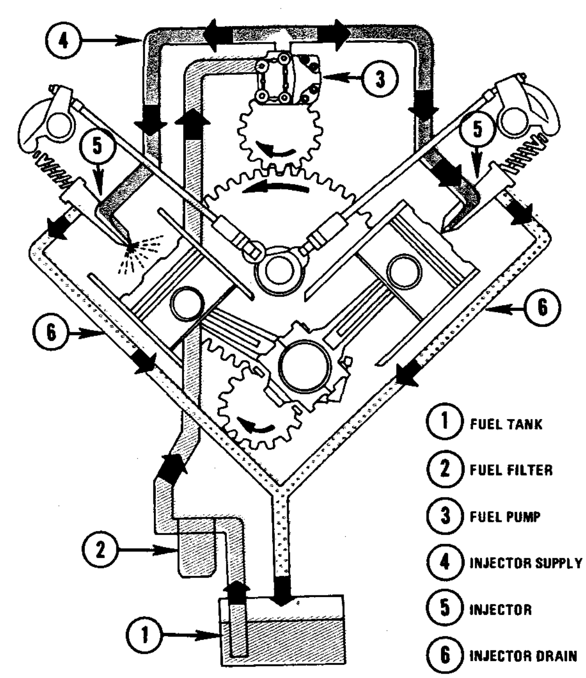
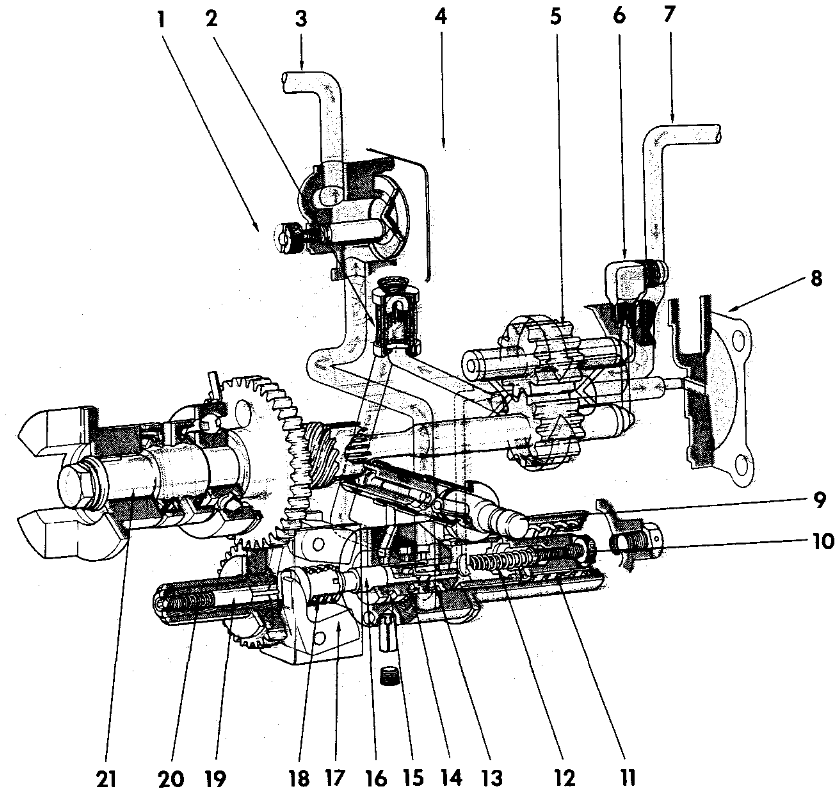


Fig. 6-2, (FWC-30). PT fuel system flow schematic – V Engine



1 TACHOMETER SHAFT
2 FILTER SCREEN
3 FUEL TO INJECTORS
4 SHUT-DOWN VALVE
5 GEAR PUMP
6 CHECK VALVE ELBOW
7 FUEL FROM TANK
8 PULSATION DAMPER
9 THROTTLE SHAFT
10 IDLE ADJUSTING SCREW
11 HIGH SPEED SPRING
12 IDLE SPRING
13 GEAR PUMP PRESSURE
14 FUEL MANIFOLD PRESSURE
15 IDLE PRESSURE
16 GOVERNOR PLUNGER
17 GOVERNOR WEIGHTS
18 TORQUE SPRING
19 GOVERNOR ASSIST PLUNGER
20 GOVERNOR ASSIST SPRING
21 MAIN SHAFT

Fig. 6-3, (FWC-31). PT (type G) fuel pump and fuel flow

governor and tachometer shaft assemblies.

The location of fuel pump components is indicated in Fig's. 6-3 and 6-4.

PT (type G) Fuel Pump

The PT (type G) fuel pump can be identified by the absence of the return line at the top of the fuel pump. The pump assembly is made up of three main units:

1. The gear pump, which draws fuel from the supply tank and forces it through the pump filter screen to the governor.

2. The governor, which controls the flow of fuel from the gear pump, as well as maximum and idle engine speeds.

3. The throttle, which provides a manual control of fuel flow to the injectors under all conditions in the operating range.

PT (type R) Fuel Pump

The PT (type R) fuel pump can be identified easily by the presence of a fuel return line from the top of the fuel pump housing to the supply tank. The pump assembly is made up of four main units:

1. The gear pump, which draws fuel from the supply tank, forcing it through the pump filter screen into the pressure regulator valve.

2. A pressure regulator, which limits the pressure of the fuel to the injectors.

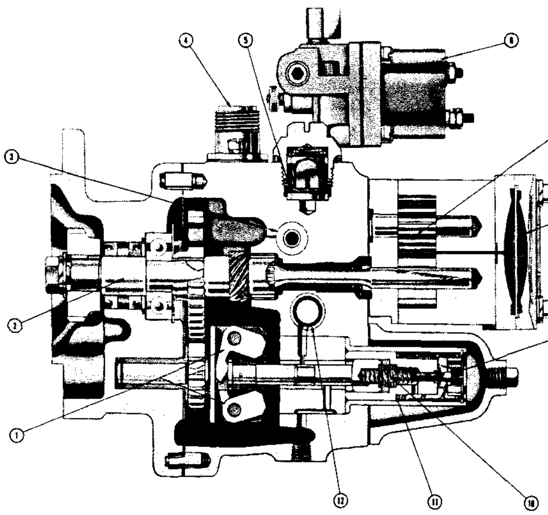
3. The throttle, which provides a manual control of fuel flow to the injectors under all conditions in the operating range.

4. The governor assembly, which controls the flow of fuel at idle and to maximum governed speed.

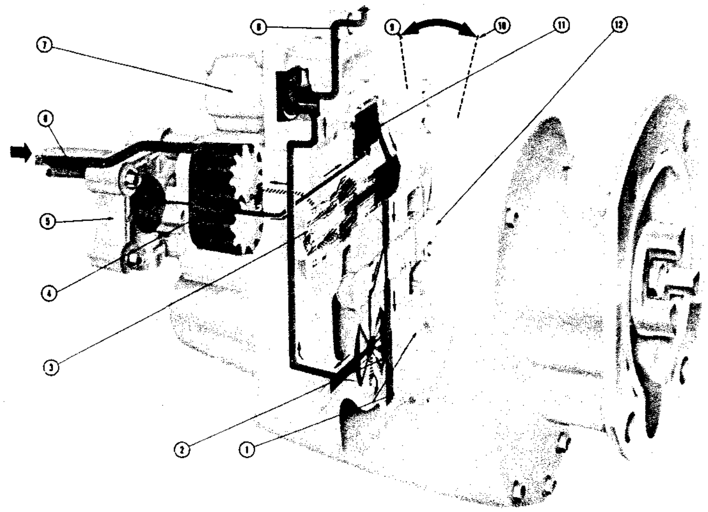
Gear Pump And Pulsation Damper

The gear pump and pulsation damper located at the rear of the fuel pump perform the same function on both PT (type G) and PT (type R) fuel pumps.

The gear pump is driven by the pump main shaft and contains a single set of gears to pick up and deliver fuel throughout the fuel system. Inlet to the gear pump on small V-type engines may be through the fuel pump main housing. On other engines it's at the rear of the gear pump.



1 GOVERNOR WEIGHTS
2 MAIN SHAFT
3 PRESSURE REGULATOR
4 TACHOMETER CONNECTION
5 FILTER SCREEN
6 SHUT-DOWN VALVE
7 GEAR PUMP
8 PULSATION DAMPER
9 IDLE SPEED SCREW
10 IDLE SPRINGS
11 MAXIMUM SPEED SPRING
12 THROTTLE SHAFT



1 GOVERNOR WEIGHTS
2 GOVERNOR PLUNGER
3 PRESSURE REGULATOR
4 GEAR PUMP
5 PULSATION DAMPER
6 FROM TANK
7 SHUT-DOWN VALVE
8 TO INJECTORS
9 IDLE
10 FULL
11 FILTER SCREEN
12 THROTTLE SHAFT

Fig. 6-4, (FWC-4). PT (type R) fuel pump and fuel flow

A pulsation damper mounted to the gear pump contains a steel diaphragm which absorbs pulsations and smoothes fuel flow through the fuel system. From the gear pump, fuel flows through the filter screen and:

1. In the PT (type G) fuel pump to the governor assembly as shown in Fig. 6-3.

2. In the PT (type R) fuel pump to the pressure regulator assembly as shown in Fig. 6-4.

Pressure Regulator

Used in the PT (type R), Fig. 6-5, functions as a by-pass valve to regulate fuel pressure to the injectors. By-passed fuel flows back to the suction side of the gear pump. See Fig. 6-4.

Throttle

In both fuel pumps, the throttle provides a means for the operator to manually control engine speed above idle as required by varying operating conditions of speed and load.

In the PT (type G) fuel pump, fuel flows through the governor to the throttle shaft. At idle speed, fuel flows through the idle port in the governor barrel, past the throttle shaft. To operate above idle speed, fuel flows through the main governor barrel port to the throttling hole in the shaft.

In the PT (type R) fuel pump, fuel flows past the pressure regulator to the throttle shaft. Under idling conditions, fuel

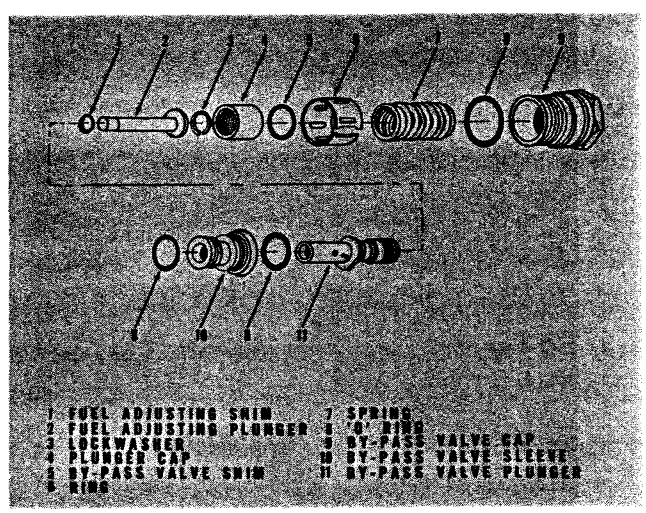


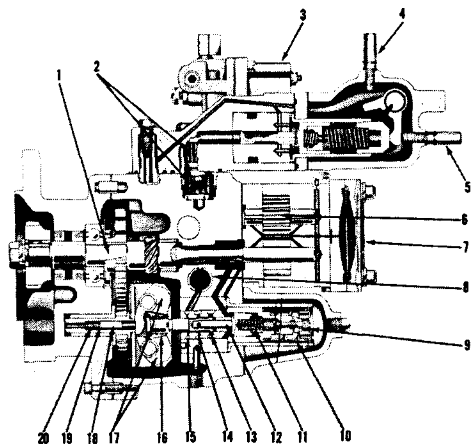
Fig. 6-5, (F5134). Pressure regulator — exploded view

passes around the shaft to the idle port in the governor barrel. For operation above idle speed, fuel passes through the throttling hole in the shaft and enters the governor barrel through the main fuel port.

Governors

Idling and High-Speed Mechanical Governor: The mechanical governor, sometimes called "standard governor," on both PT (type G) and PT (type R) fuel pumps, is actuated by a system of springs and weights, and has two functions. First, the governor maintains sufficient fuel for idling with the throttle control in idle position; second, it cuts off fuel to the injectors above maximum rated rpm. The idle springs in the governor spring pack position the governor plunger so the idle fuel port is opened enough to permit passage of fuel to maintain engine idle speed.

During operation between idle and maximum speeds, fuel flows through the governor to the injectors. This fuel is controlled by the throttle and limited by the size of the idle spring plunger counterbore on PT (type G) fuel pumps and pressure regulator of PT (type R) fuel pumps. When the engine reaches governed speed, the governor weights move the governor plunger, and fuel passages to the injectors are shut off. At the same time another passage opens and dumps the fuel back into the main pump body. In this manner, engine speed is controlled and limited by the governor regardless of throttle position. Fuel leaving the governor flows through the shut-down valve, inlet supply lines and on into the injectors.



1 MAIN SHAFT	11 IDLE SPRING
2 FILTER SCREENS	12 GOVERNOR PLUNGER
3 SHUT-DOWN VALVE	13 GEAR PUMP PRESSURE
4 MAXIMUM SPEED SCREW	14 FUEL MANIFOLD PRESSURE
5 IDLE SPEED SCREW	15 IDLE PRESSURE
6 GEAR PUMP	16 TORQUE SPRING
7 PULSATION DAMPER	17 GOVERNOR WEIGHTS
8 THROTTLE SHAFT	18 GOVERNOR ASSIST PLUNGER
9 IDLE ADJUSTING SCREW	19 SHIMS
10 MAXIMUM SPEED SPRING	20 GOVERNOR ASSIST SPRING

Fig. 6-6, (FWC-9). PT (type G) fuel pump with MVS governor

PT (type G) Variable-Speed Governors

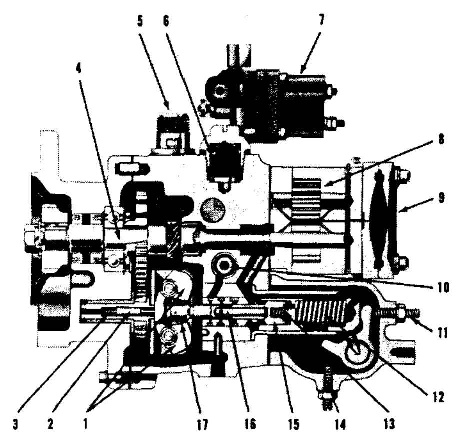
There are two mechanical variable-speed governors used with the PT (type G) fuel pumps. The "Mechanical Variable-Speed (MVS)" governor which is mounted directly on top of the fuel pump or remotely near the fuel pump; and the "Special Variable-Speed (SVS)" governor which is a special spring pack assembly at the lower rear of the fuel pump. See Fig's. 6-6 and 6-7.

Mechanical Variable-Speed (MVS) Governor

This governor supplements the standard governor to meet the requirements of applications when the engine must operate at a constant speed, but where extremely close regulation is not necessary.

Adjustment for different rpm can be made by means of a lever control or adjusting screw. At full-rated speed, this governor has a speed droop between full-load and no-load of approximately eight percent. A cross section of this governor is shown in Fig. 6-6.

As a variable-speed governor, this unit is suited to the varying speed requirements of power take-off, etc., in which the same engine is used for propelling the unit and driving a pump or other fixed-speed machine.



1 GOVERNOR WEIGHTS	10 THROTTLE SHAFT
2 WEIGHT ASSIST PLUNGER	11 IDLE SPEED SCREW
3 WEIGHT ASSIST SPRING	12 MAXIMUM SPEED SPRING
4 MAIN SHAFT	13 IDLE SPEED SPRING
5 TACHOMETER CONNECTION	14 MAXIMUM SPEED SCREW
6 FILTER SCREEN	15 IDLE PLUNGER BUTTON
7 SHUT-DOWN VALVE	16 GOVERNOR PLUNGER
8 GEAR PUMP	17 TORQUE SPRING
9 PULSATION DAMPER	

Fig. 6-7, (FWC-10). PT (type G) fuel pump with SVS governor

The MVS governor assembly mounts atop the fuel pump, and the fuel solenoid is mounted to the governor housing. The governor may also be remote mounted.

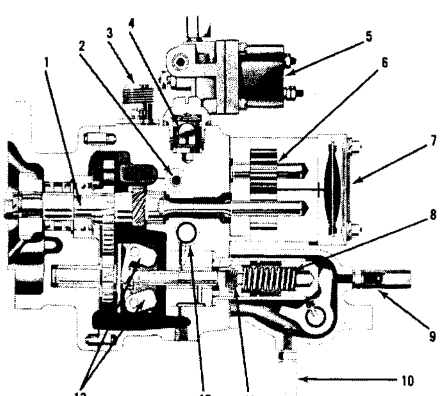
Fuel from the fuel pump body enters the variable-speed governor housing and flows to the governor barrel and plunger. Fuel flows past plunger to the shut-down valve and on into the injector according to governor lever position, as determined by the operator.

The variable-speed governor cannot produce engine speeds in excess of the standard governor setting. The governor can produce idle speeds below the standard pump idle speed setting, but should not be adjusted below the standard fuel pump speed setting when operating as a combination standard and variable-speed governor.

Special Variable-Speed (SVS) Governor

The SVS governor provides much of the same operational features of the MVS governor but is limited in application. An overspeed stop should be used with SVS governors in unattended applications and in attended installations, a positive shut-down throttle arrangement should be used if no other overspeed stop is used. Fig. 6-7.

Power take-off applications use the SVS governor lever to change governed speed of the engine from full rated speed to an intermediate power take-off speed. During operation as a marine unit, the SVS governor is in high-speed position. See operation instructions for further information.



1 MAIN SHAFT
2 PRESSURE REGULATOR
3 TACHOMETER SHAFT
4 FILTER SCREEN
5 SHUT-DOWN VALVE
6 GEAR PUMP
7 PULSATION DAMPER
8 GOVERNOR SPRING
9 IDLE SPEED SCREW
10 MAXIMUM SPEED SCREW
11 IDLE SPRING
12 THROTTLE SHAFT
13 GOVERNOR WEIGHTS

Fig. 6-8, (FWC-7). PT (type R) fuel pump with MVS governor

PT (type R) Mechanical Variable-Speed Governor

On some applications this governor replaces the standard "automotive" governor to meet the requirements of applications on which the engine must operate at a constant speed, but where extremely close regulation is not necessary.

Adjustment for different rpm can be made by means of a lever control or adjusting screw. At full-rated speed this governor has a speed droop between full-load and no-load of approximately eight percent. A cross section of this governor is shown in Fig. 6-8.

As a variable-speed governor, this unit is suited to the varying speed requirements of power take-off, etc., in which the same engine is used for propelling the unit and driving a pump or other fixed-speed machine.

PT (type D) Injectors

The injector provides a means of introducing fuel into each combustion chamber. It combines the acts of metering, timing and injection. Principles of operation are the same for Inline and V-engines but injector size and internal design differs slightly. Fig's. 6-9 and 6-10.

Fuel supply and drain flow are accomplished through internal drillings in the cylinder heads. Fig's. 6-1 and 6-2. A radial groove around each injector mates with the drilled passages in the cylinder head and admits fuel through an adjustable (adjustable by burnishing to size at test stand) orifice plug in the injector body. A fine mesh screen at each inlet groove provides final fuel filtration.

The fuel grooves around the injectors are separated by "O" rings which seal against the cylinder head injector bore. This forms a leak-proof passage between the injectors and the cylinder head injector bore surface.

Fuel flows from a connection atop the fuel pump shut-down valve through a supply line into the lower drilled passage in the cylinder head. A second drilling in the head is aligned with the upper injector radial groove to drain away excess fuel. A fuel drain allows return of the unused fuel to the fuel tank.

The injector contains a ball check valve. As the injector plunger moves downward to cover the feed opening, an impulse pressure wave seats the ball and at the same time traps a positive amount of fuel in the injector cup for injection. As the continuing downward plunger movement injects fuel into the combustion chamber, it also uncovers the drain opening and the ball rises from its seat. This allows free flow through the injector and out the drain for cooling purposes and purging gases from the cup.

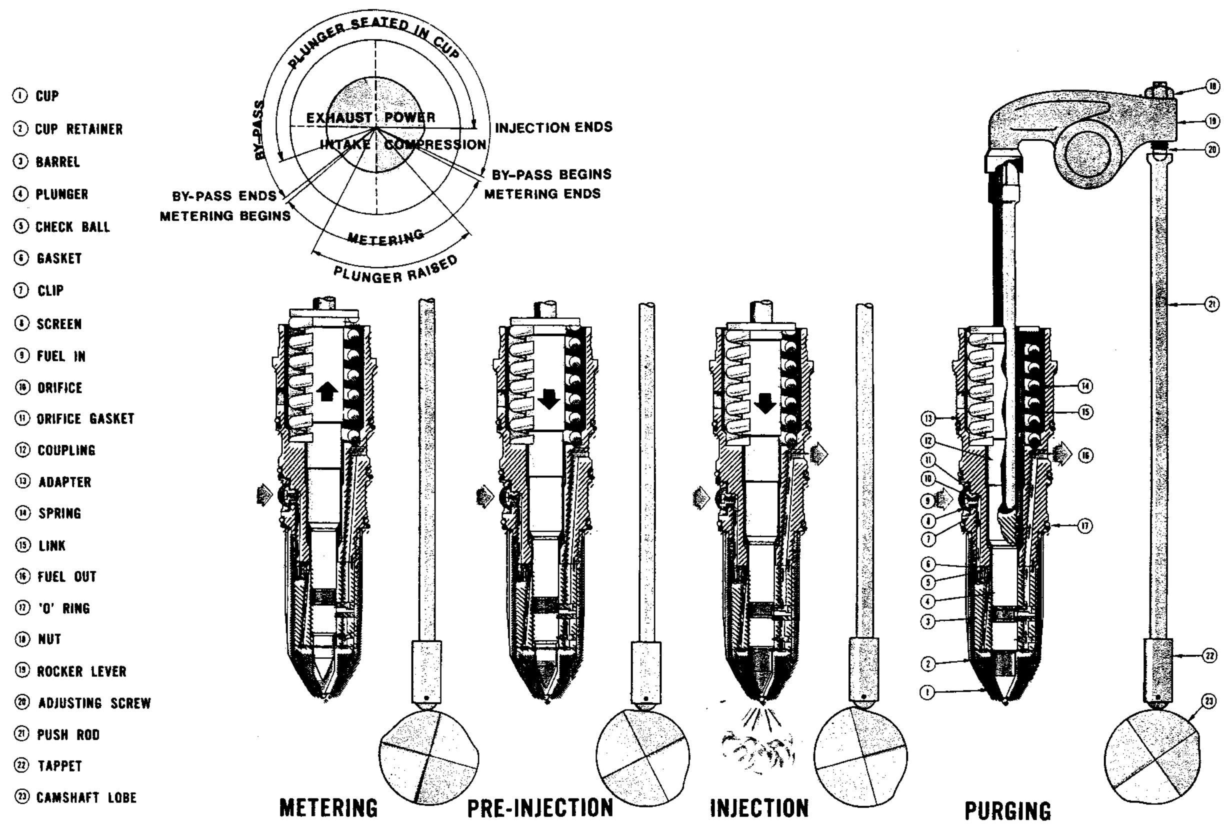


Fig. 6-9, (FWC-28). Fuel injection cycle. PT (type D) injector 3/8 inch diameter plunger

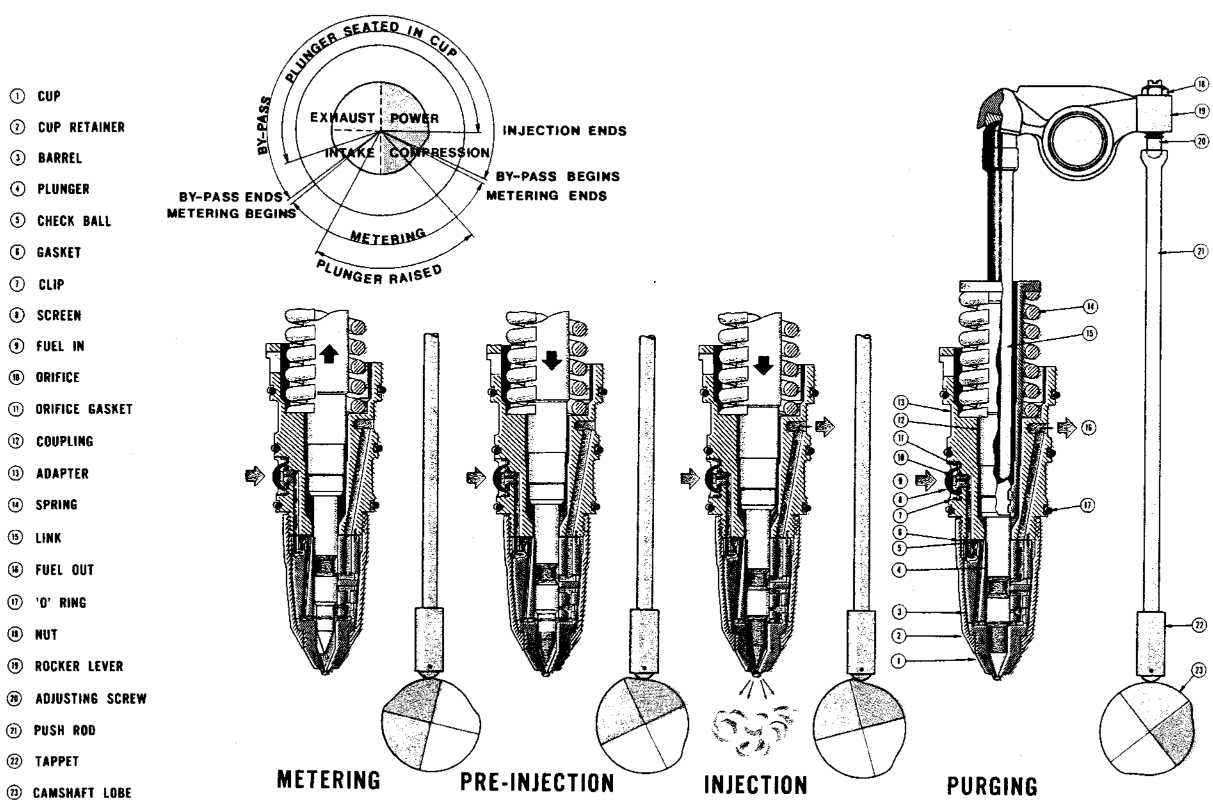


Fig. 6-10, (FWC-29). Fuel injection cycle, PT (type D) injector 5/16 inch diameter plunger

Fuel Lines, Connections And Valves

Supply And Drain Lines

Fuel is supplied through lines to cylinder heads. A common drain line returns fuel not injected, to supply tank.

The PT (type R) fuel pump has a drain line returning from the top of the pump to the supply tank. This line is not necessary with the PT (type G) pump. Fig's. 6-1 and 6-2.

Connections

Fuel connectors are used between the Inline engine cylinder heads to bridge the gap between each supply and drain passage (3, Fig. 6-1).

Shut-Down Valve

Either a manual or an electric shut-down valve is used on Cummins Fuel pumps.

With a manual valve, the control lever must be fully clockwise or open to permit fuel flow through the valve.

With the electric valve, the manual control knob must be fully counterclockwise to permit the solenoid to open the valve when the "switch key" is turned on. For emergency operation in case of electrical failure, turn manual knob clockwise to permit fuel to flow through the valve.

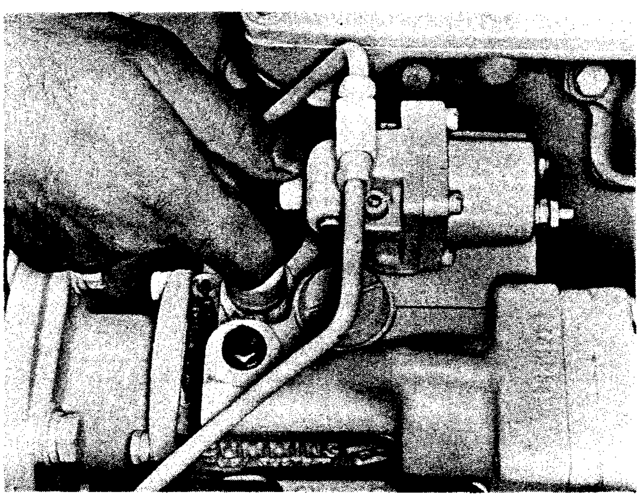


Fig. 6-11, (V21970). Fuel pump manual override knob

Lubricating System

Cummins engines are pressure lubricated, pressure is supplied by a gear-type lubricating oil pump located in oil pan or on side of the engine.

A pressure regulator is mounted in the lubricating oil pump to control lubricating oil pressure.

Filters and screens are provided in lubricating oil system to remove foreign material from circulation and prevent damage to bearings or mating surfaces. A by-pass valve is provided in full-flow oil filter head as insurance against interruption of oil flow by a dirty or clogged element.

Maximum cleansing and filtration is achieved through use of both by-pass and full-flow lubricating oil filters. Full-flow filters are standard on all engines; by-pass filters are used on all turbocharged models and optionally on all other engines.

Some engines are equipped with special oil pans and filters for some applications, and others with auxiliary oil coolers to maintain closer oil temperature regulation.

Turbochargers are lubricated and cooled by same lubricating oil used for engine lubrication.

Fuel pumps and injectors are lubricated by fuel oil.

NH And NT Engine Series

Oil is drawn into the pump through an external oil line connected to the oil pan sump. A screen in the sump filters the oil. Oil is drawn from the pan by the pump, out through a full-flow filter and circulates back into the block. The filter may be mounted directly to the rear of pump, vertically mounted on exhaust side of engine or remote mounted. External lines are used for remote mounting arrangements. Fig. 6-12.

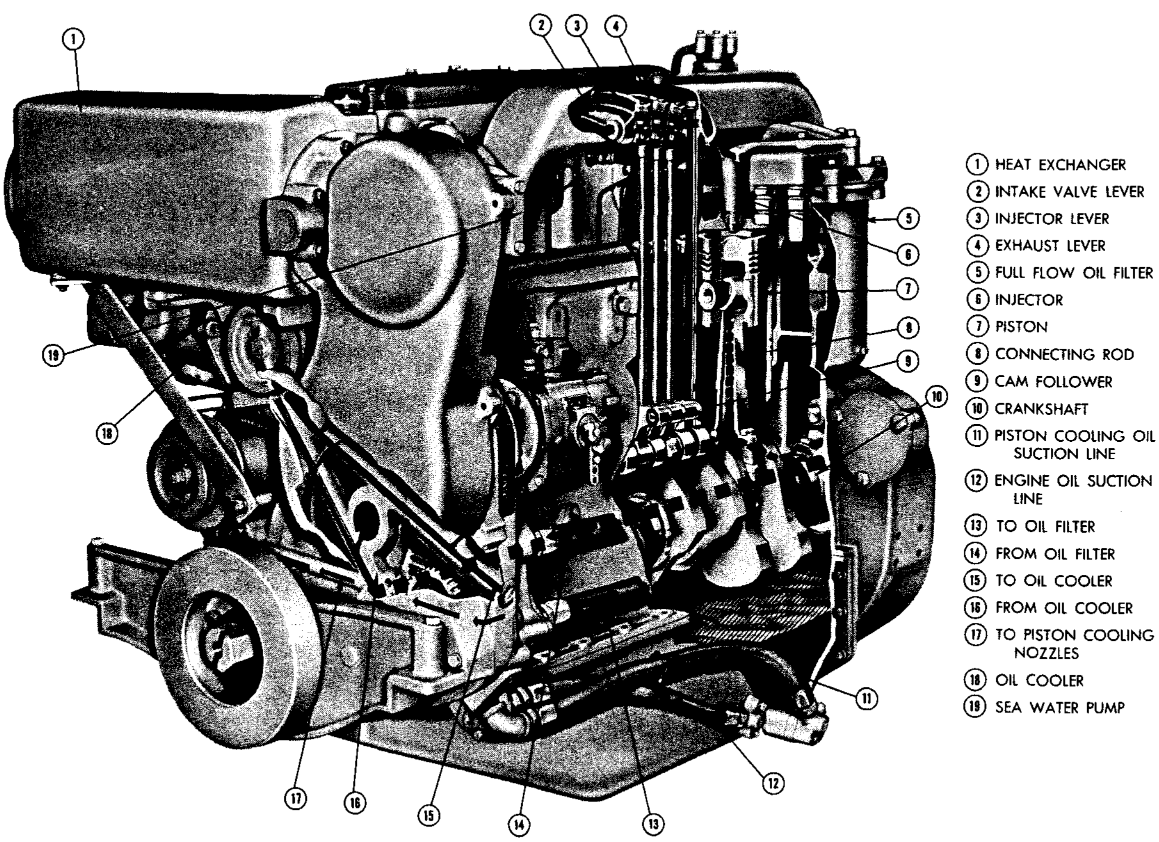


Fig. 6-12, (LWC-9). Lubricating oil flow — NH, NT Engines

On remote and pump mounted filters, oil flows from the pump to the oil cooler, then flows to oil header through internal drillings in the gear case.

An oil header drilled full length of block, fuel pump side, delivers oil to moving parts within the engine. Oil pipes carry oil from the camshaft to upper rocker housings and drillings through the block, crankshaft, connecting rods, and rocker levers complete the oil circulating passages.

On engines equipped with oil cooled pistons, an oil header drilled the length of the block on exhaust manifold side, supplies oil to six spray nozzles used for piston cooling.

A piston cooling oil pump, as a second section of engine lubricating oil pump or a larger capacity oil pump, pumps this oil to the oil header.

V6 And V8 Engines

Small Vee engines are pressure lubricated, pressure is supplied by a gear-type lubricating oil pump driven from the crankshaft gear and mounted to the cylinder block inside oil pan of engine.

A pressure regulator in the lubricating oil pump controls lubricating oil pressure.

A by-pass valve is provided in full-flow oil filter head as insurance against interruption of oil flow by a dirty or clogged element. By-pass type filters are also used on most engines as optional equipment and are standard on turbocharged engines.

1. Oil is drawn into lubricating oil pump through a slotted suction tube.

2. Oil flows to the lubricating pump pressure regulator, where pressure is controlled, through a full-flow filter and lubricating oil cooler and into engine drilled passages.

3. Various drillings throughout the cylinder block, cylinder heads, camshaft, crankshaft, accessory drive, rocker levers and tappets route oil to moving parts of engine. Fig. 6-13 and 6-14.

4. Connecting rod bearings are oiled through passages in crankshaft. The rod piston pin end bushing on V-903 Series Engines, receives oil via a drilling through length of the rod from crankshaft bearing.

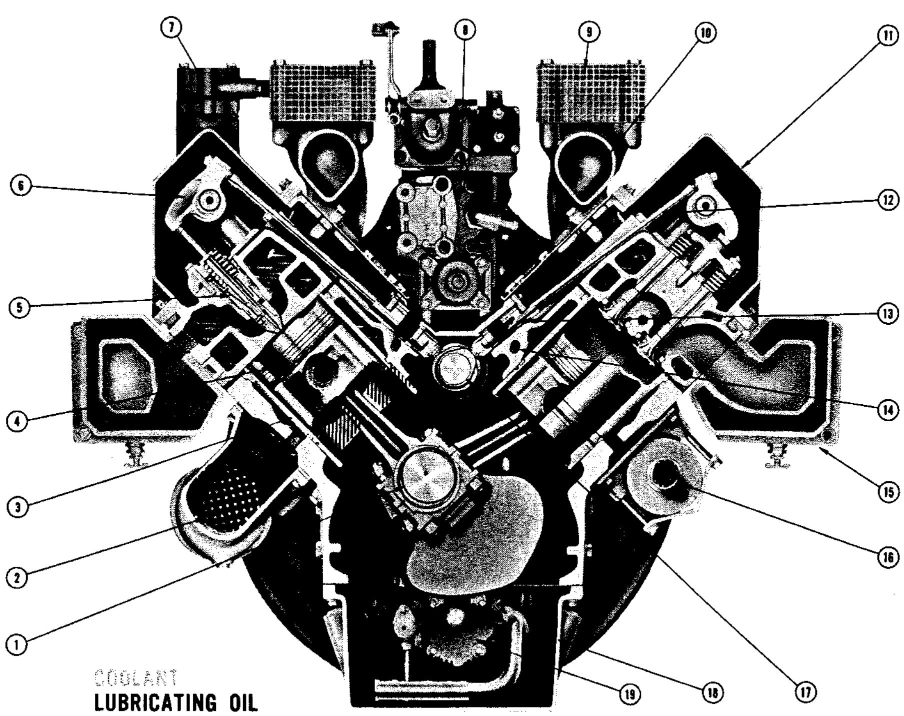


Fig. 6-13, (V11805). Lubricating oil and coolant flow — V-504 engine

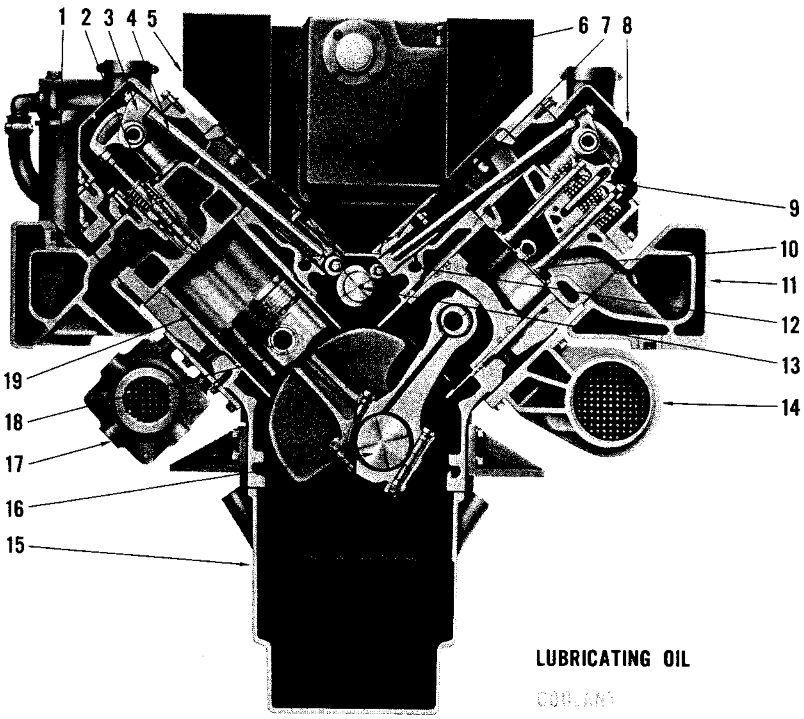


Fig. 6-14, (LWC-26). Lubricating oil and coolant flow – V-903 Engine

V12 Engines

Cummins V12 Series engines are pressure lubricated, pressure being supplied by a gear-type lubricating oil pump.

A by-pass valve is provided in full-flow oil filter(s) as insurance against interruption of oil flow by a dirty or clogged element.

1. Oil is drawn into pump through an oil line to oil pan sump. A screen in sump strains the oil. Fig. 6-15.

2. Oil flow from pump is:

a. External lubricating oil pump and cooler in Vee: from pump to full-flow filters to cooler then to oil headers in block.

b. External lubricating oil pump and external cooler (cooler not in Vee) mounted transversely at front at top of engine or along side of engine: from pump to cooler to full-flow filters, then to oil headers in block.

c. Internal lubricating oil pump and cooler mounted on side of engine in combination with filter head and filters: from pump to cooler to full-flow filters, then to oil headers in block.

3. Oil headers, drilled full length of block on each side, deliver oil to moving parts within engine.

4. Oil pipes – or a combination of pipes and passages – carry oil from camshaft to upper rocker housings; various drillings through block, crankshaft, connecting rods and rocker levers complete oil circulating system.

5. On engines equipped with oil-cooled pistons, oil headers are drilled the length of block on each side; headers supply oil to spray nozzles, which direct oil to piston skirts.

6. Lubricating oil pressure is controlled by a regulator located in the lubricating oil pump.

Cooling System

Water is circulated by a centrifugal water pump mounted on front of engine. The water pump is either belt driven or gear driven from accessory drive or crankshaft.

Water circulates around wet-type cylinder liners, through the cylinder heads and around injector sleeves. Fig. 6-13, 6-14 and 6-15. Injector sleeves, in which injectors are mounted, are designed for fast dissipation of heat. The engine has a thermostat or thermostats to control engine operating temperature.

The engine coolant is cooled in a heat exchanger. Sea water is circulated through heat exchanger by a belt-driven sea water pump, mounted on front of engine, and discharged through connections on the heat exchanger.

The Cummins Corrosion Resistor is standard on Cummins Engines. The resistor by-passes a small amount of coolant from the system through a filtering and treating element which must be replaced periodically.

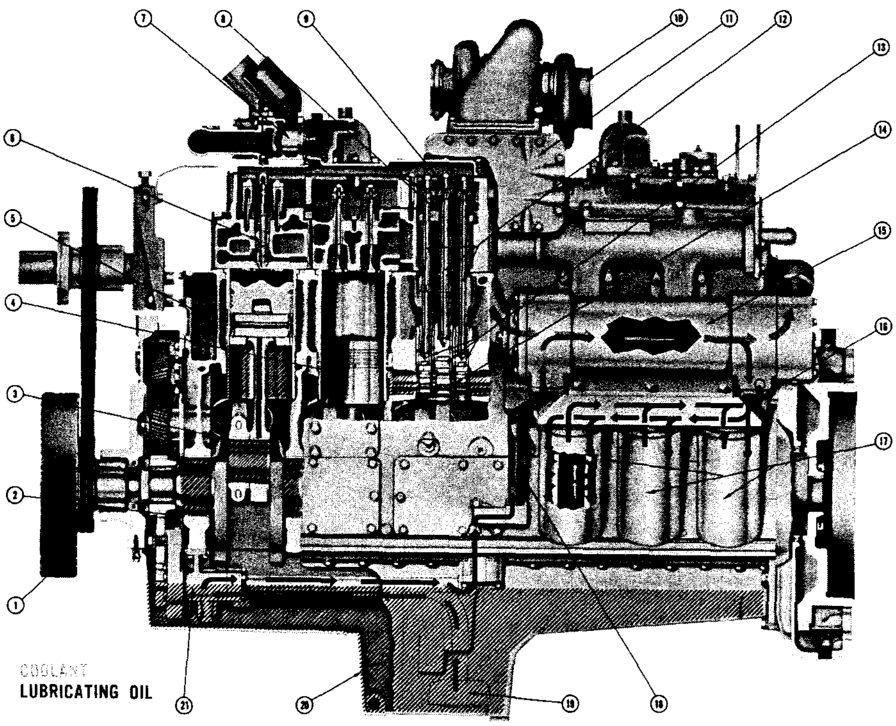


Fig. 6-15, (LWC-14). Lubricating oil and coolant flow – V12 engine

1. VIBRATION DAMPER
2. MAIN BEARING
3. CONNECTING ROD BEARING
4. PISTON
5. COOLANT PASSAGE
6. INJECTOR
7. THERMOSTAT
8. VALVE ROCKER LEVERS
9. INJECTOR ROCKER LEVER
10. T-50 TURBOCHARGER
11. INTER-COOLER/AIR INTAKE MANIFOLD
12. PUSH TUBES
13. TAPPETS
14. CAMSHAFT
15. OIL COOLER
16. OIL TO ENGINE
17. FULL-FLOW OIL FILTERS
18. OIL TO COOLER
19. OIL SUCTION
20. LUBRICATING OIL PAN
21. LUBRICATING OIL PUMP

Air System

The diesel engine requires hundreds of gallons of air for every gallon of fuel that burns. For the engine to operate efficiently, it must breathe freely, intake and exhaust systems must not be restricted.

The intake air should always be routed through an air cleaner or air silencers. The cleaner may be mounted on engine or remotely mounted, depending upon engine location. Air is routed from air cleaner directly to intake air manifold or turbocharger.

VT12-700, 800 Aftercooler

An aftercooler (or intercooler as it is sometimes called) is a device in the engine intake system designed to reduce intake air temperature and/or preheat intake air temperature.

The aftercooler consists of a housing, used as a portion of the engine intake air manifold, with an internal core. The core is made of tubes through which engine coolant circulates. Air is cooled or heated by passing over the core prior to going into the engine combustion chambers. Therefore, improved combustion results from better control of intake air temperature cooling or warming as applied by the aftercooler.

Turbocharger

The turbocharger forces additional air into combustion chambers so engine can burn more fuel and develop more horsepower than if it were naturally aspirated. In some cases the turbocharger is used for the engine to retain efficiency (balanced fuel to air ratio) at altitudes above sea level.

The turbocharger consists of a turbine wheel and a centrifugal blower, or compressor wheel separately encased but mounted on and rotating with a common shaft.

The power to drive turbine wheel — which in turn drives the compressor — is obtained from energy of engine exhaust gases. Rotating speed of the turbine changes as the energy level of gas changes; therefore, the engine is supplied with enough air to burn fuel for its load requirements. The turbocharger is lubricated and cooled by engine lubricating oil. Fig. 6-16 and 6-17.

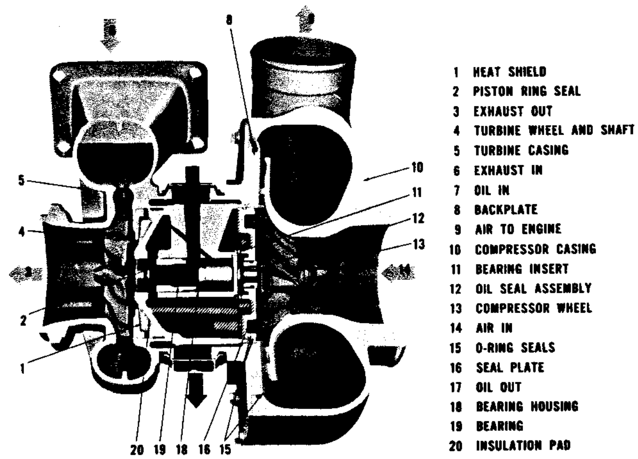


Fig. 6-16, (AWC-9). VT-50 Turbocharger cross section

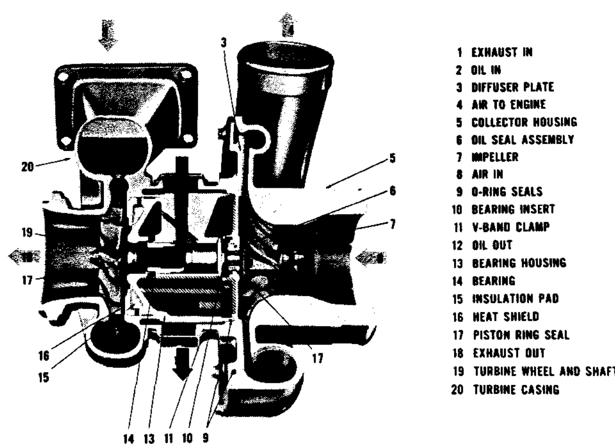


Fig. 6-17, (AWC-12). ST-50 Turbocharger cross section

Air Compressor

Optional units are covered by publications available from the manufacturer.

Index

Index

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