## Engine Bearing Specifications

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† Rear bearing journal 1 1/2”; all others 2 1/2”.

‡ For Nos. 1, 4 and 7, 150-160 pounds; all others 210-230 pounds.

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### Diagram

- **Cylinder combustion chamber.**
- **Major air chamber.**
- **Minor air chamber.**
- **Fuel nozzle.**
- **Exhaust and intake valves.**
- **Glow plug.**
VALVE STEM GUIDES

1936-46 All: To remove valve guides, take off the cylinder head and take off the rocker shaft assembly, remove the valve springs and pull out the guides.

NOTE—On all engines, it is good practice to remove and install one guide at a time. When installing an intake guide, measure the depth of an intake guide not yet removed in order to determine the correct depth of the guide being installed. Similarly, when installing an exhaust guide, measure the depth of an exhaust guide not yet removed. When all guides are installed, they should be reamed to provide a clearance within the limits given in the VALVE SYSTEM table. It is recommended that the guides be drawn in place rather than driven.

VALVE TAPPETS & GUIDES

1936-46 All: Tappets must be a free fit in their guides without excessive side play.

VALVE TIMING, CHECK

1936-46 All: With the engine at normal room temperature and No. 1 intake valve tappet set to the clearance for timing as given in the VALVE SYSTEM table, crank the engine until there is a "I.O." (intake opens) mark on the flywheel in line with the center of the opening in the flywheel housing. In this position, No. 1 intake valve should just be starting to open.

TIMING GEARS

1936-46 All: Whenever these gears are removed for any reason, it is important that they be assembled so that the marked teeth on the crankshaft, camshaft and idler gears are meshed at the same time. If the gears are not marked, the correct assembly may be made in the manner described further along in this chapter under "Camshaft Timing".

Replacement Gears: These gears are marked with a number imprinted within a circle or a letter U. If marked with a number 2 within a circle, it signifies that the gear is .002" oversize. If marked with a number 3 within a U, it denotes a .003" undersize gear.

Fitting Gears: The crankshaft, camshaft and idler gears should be fitted with .002" backlash. When replacing one gear, use the same marking on the old gear, making allowance for wear on the others. The accessory drive gear may have considerably more lash than .002" and therefore, it need not be replaced as often as the others.

Idler Gear: On all engines, this gear rotates on a stud which is pressed into the crankcase. This stud is secured by means of a lock screw which is entered into the right side of the case. Since oil is fed to the base of the stud, an acorn lock nut is screwed over the protruding end of the screw and sealed against the crankcase by a gasket.

NOTE—When installing the stud, the setscrew hole in the stud must line up with the corresponding hole in the crankcase. With this arrangement, oil is fed to the base of the hollow stud which supplies a stream to the gear hub.

The idler gear bushing is of the thin wall type and broached in place after being installed and prior to the cutting of the gear teeth. Therefore, if worn excessively, the gear and bushing should be replaced as a unit.

Idler gear end play is controlled by a thrust washer on the end of the shaft and should not exceed .006".

NOTE—The idler gear thrust washer is pinned to the shaft to prevent its turning and secured by a capscrew. This capscrew has either a right or left-hand thread, depending upon the rotation of the gear, to prevent it from working loose.

Camshaft Gear: On all models, the camshaft end thrust is controlled by a thrust plate, attached to the front end of the crankcase, between the front face of the front camshaft bearing and the rear of the camshaft gear hub.

The gear is pressed on the shaft and retained by a spring wire lock, which snaps in a groove in the end of the shaft. When installing a gear of the pressed-on type, allow from .004" to .008" end play.

Crankshaft Gear: When installing, heat the gear in boiling water to expand the metal and coat the shaft with white lead in order to make assembly easier.

Camshaft Timing: If the gears are not marked, the correct valve timing may be obtained by proceeding as follows: Adjust
that all openings in the screen are open. If the screen has been crushed, it is better to replace it rather than attempt to make a repair.

If it is necessary to prime the pump, all engines except the 691 have a plug marked "Prime" in the side of the crankcase adjacent to the filter pad.

To prime the pump, take out the plug marked "Prime" from the side of the crankcase adjacent to the oil filter pad which opens into the suction passes. Using an oil gun, start the engine and pump the oil into the suction passes. The engine should not be allowed to run for more than about a half-minute without oil circulation. When the oil is injected into the priming hole, remove the gun and cover the hole with a finger until circulation starts. When started, shut off the engine and replace the priming hole plug.

OIL PRESSURE REGULATOR

1936-46 Four Cylinder: On these engines, the oil pressure relief valve is accessible from the bottom of the crankcase only. The hollow cap nut which holds the spring in position is located at the inner edge of the crankcase and oil pan flange near the fourth main bearing. If required, the spring may be compressed or lengthened to change oil pressure after removing the cap.

1936-46 Six Cylinder: The oil pressure relief valve spring and ball is accessible after removing the large hexagon cap nut located just back of the oil filter. On the 691 engines, the regulator is located midway on the oil filter side. The only adjustment is by lengthening or compressing the spring.

CRANKCASE VENTILATOR

1936-46 All: The interval at which the ventilator and air cleaner should be cleaned can only be determined by the type of service to which the vehicle is subjected. Vehicles operating in dusty or sandy areas require more frequent service than vehicles operating under more favorable conditions.

IMPORTANT—For vehicles operating in dust storm areas, the cleaner should be serviced immediately after such storms occur.

For normal service however, the breather should be inspected at least every 2,000 miles, and if a sludge formation is evident, the element should be removed and washed thoroughly in gasoline. Allow the breather to soak in the gasoline for at least 30 minutes, then blow it out with compressed air, while at the same time, tapping it lightly to dislodge any solid particles of sludge.

If the breather is fitted with an air cleaner, it should be removed and washed every 1,000 miles. After the element is washed, blow it dry with compressed air and, if the
cleaner is of the oil-wetted type, dip the element in fresh engine oil before assembling. If it is of the oil bath type, wipe out the oil reservoir thoroughly with a clean cloth and fill it to the proper level with fresh engine oil.

**OIL FILTER**

1936-46 All: On most engines, the pressure within the filter is controlled by a valve built into the base of cover handle. The cartridge is held in a rigid position by a perforated cap fitted to the cover.

To service the filter, remove the drain plug and unscrew the top cover by hand, exposing the filter cartridge to which a wire handle has been welded. Using the wire handle, lift the cartridge and remove it slowly. Do not use a tool to pry it out, as the edge of the filter shell has been accurately machined for a tight union with the cover gasket, and damage to the edge may cause a leak. Remove the drain plug and clean the bottom of the pump, removing all the accumulated sediment.

Insert the new cartridge and replace the cover, using a new gasket and tighten the cover by hand only. Start the engine, and when the oil pressure reaches normal, inspect for leaks around the cover and drain plug.

If another filter is used, other than the above type, see the "Oil Filters" chapter elsewhere in this book.

At frequent intervals, the filter should be drained to get rid of any solid matter which may have settled in the filter pump. Whenever this is done, be sure to add sufficient oil to the crankcase to compensate for the oil drained. If the dip stick shows that the oil is thick and very dirty, it indicates that the filter element requires service or replacement of the filter element.

**COOLING SYSTEM**

**WATER PUMP, OVERHAUL**

1936-46 Gear Driven Pump: The pump used on these engines is driven by a gear in the timing case cover and is of the conventional packing gland type. The pump shaft is supported in the body by two bronze bushings and packed with ring packing.

This type pump is easily disassembled by separating the pump housing, and when this is done, the internal parts are accessible and readily removed. If new bushings are to be installed, they should be reamed to provide a shaft clearance of from .002" to .003". When tightening the gland nuts, tighten only sufficiently to stop leakage and back off slightly to relieve the pressure.

Belt Driven Pump: This pump is of the spring gland or packingless type. Water sealing is accomplished by a non-adjustable packless seal, consisting of a carbon flexible seal, seal spring and brass shields.

**NOTE**—The water pump impeller is usually keyed and secured on the shaft by a spring wire retainer in a groove in the end of the shaft while in some cases, the impeller is merely pressed on the shaft over a Woodruff key. Before disassembling the pump, be sure to remove the burrs from the ends of the shaft to prevent damage to the pump bushings.

To disassemble the pump, disconnect the pump body from the drive housing. Use a suitable puller to remove the impeller from the shaft. Insert a screw driver through one of the slots in the impeller hub and press the snap ring out of the groove, after which, take out the seal parts.

When assembling, be sure the oil retainer is in the proper position in the pump housing. When installing the shaft, do not push it in any farther than necessary to assemble the impeller to avoid damaging the seal parts.

**ENGINE WATER THERMOSTAT**

If the thermostat fails to function properly, remove the assembly from the water outlet and see if the bellows and valve are in good condition. If they are, test its operation by completely submerging in water, heating the water gradually until it reaches the opening temperature of the thermostat, and then in water at the fully open temperature.
When taking temperature readings, agitate the water thoroughly, and if the thermostat fails to function properly, it should be replaced rather than attempt to make a repair. However, before installing a new unit, it is good practice to make a test as directed above.

Normally, the thermostat should start to open at from 145 to 150 degrees and be fully open at from 170 to 175 degrees F. However, thermostats are available which have lower, as well as high opening temperatures, depending upon the climatic conditions under which the vehicle is operating.

**FUEL SYSTEM**

**NOTE**—For detailed information on Diesel Fuel Injection Pumps, see the Table of Contents on page 1.
INJECTION PUMP, REMOVE

1936-46 All: If the pump timing has not been altered, the pump can be removed and replaced without the necessity of retiming. The two coupling flanges and center disc are each marked with the letter "O" to aid in replacing the pump without retiming.

Before removing the pump, note the relative position of these marks, which should be approximately in line. Then disconnect all fuel lines and governor control rod, unfasten the pump from its base and lift it off.

NOTE—Do not alter the coupling adjustment by loosening the two capscrews on the side of the drive flange.

INJECTION TIMING

1936-46 All: The fuel pump end plate and the coupling are marked for timing. The center mark on the end plate indicates the center line of the cam or the top plunger position. The center plate is located at an angle to the center line with a mating mark on the coupling flange on late model pumps, or on the flat side of the coupling hub on earlier model pumps.

To set the timing, crank the engine until No. 1 intake valve closes. Continue to turn the engine over slowly until the "FP1" (fuel pump injection) mark on the flywheel is exactly in line with the center of the timing hole in the flywheel housing. Then turn the fuel pump until the point of its rotation until the coupling mark is exactly in line with the mark on the end plate. Adjust the coupling jaws by means of the two capscrews on the side of the coupling flange and slip the coupling jaws in place.

NOTE—If the fuel pump drive gear or idler gear have been removed and replaced without regard to fuel pump timing, it will be necessary to remove one of the gears and remesh in the correct position to allow the coupling jaws to slip into place.

Align the fuel pump and drive coupling carefully, using shims if necessary, and fasten the hold down capscrews. Connect all fuel lines and governor control rod, making sure the control rod is absolutely free and not binding at any point.

NOTE—The coupling is adjustable for slight variations in timing which is indicated by graduation marks on the coupling flange. If necessary to check the timing for correct "point closed", see the "Diesel Fuel Injection Pump" chapter in the "American Bosch" section which explains this procedure of checking by the flow method.

Bear in mind that retarded injection will be indicated by excessive smoking while too much advance will be indicated by abnormal engine noise and tendency to knock. Provided the correct fuel is being used, a positive indication of too early injection will cause over-heating of the engine cells.

IMPORTANT—Whenever the engine is being rotated for the purpose of bringing the timing mark in line with the center of the flywheelers come up to the mark in the direction of engine rotation, so as not to bring the timing points together against the accumulated backlash between the flywheel and the injection pump. However, if the engine is rotated past the timing mark, it may be backfired up far enough so that it can be brought forward again with the lash taken up in the running position.

GOVERNOR

1936-46 All: The Pierce diesel engine governor is used on all these engines. Although the arrangement of the control levers and springs may be somewhat different to suit the various applications, the general construction and maintenance are the same.

The governor is of the centrifugal or flyball type, mounted on the fuel pump drive housing and driven through spiral gears. It is of the variable speed which permits closed regulation from idle to full load speeds. Lubrication is accomplished by means of a pressure lead from the main gallery line in the crankcase which supplies oil to all the working parts.

IMPORTANT—The control stop on the fuel injection pump is set at the factory for the maximum fuel the engine will burn efficiently under full load and speed. Therefore, it is very important that this setting never be changed for any governor adjustment.

Adjustments: If for any reason the governor setting has been disturbed, or if the governor is removed and requires adjustment, proceed as follows:

1. Remove the cover plate which exposes the springs and levers. Shift the control lever to the full load position until the stop screw strikes the housing. With the engine not running, the connecting link between the governor and the injection pump control rod should be of the proper length so that the control stop on the opposite end of the injection pump is as far as it will go against the housing.

2. Start the engine and place the speed control lever in the idling position and adjust the spring tension of the idling spring for the desired idling speed.

3. Then adjust the engine shut-off collar so that the idle travel of the speed control lever will shut off the engine.

4. With the engine running at low idle speed, adjust the main spring so that it floats freely and does not drag.

5. Shift the control lever to the full speed position and turn the stop screw until the desired high speed is obtained.

NOTE—If unsatisfactory engine performance is attributed to the governor, remove the cover and inspect the parts and linkage to see that no parts have worked loose or if lost motion has developed. Unsatisfactory performance can also be caused by rust or other accumulations due to atmospheric conditions; so, clean the parts and apply a thin coating of oil to the affected parts. An extreme change of engine speeds may require a different combination of governor weights and springs, but this should never be attempted without consulting the manufacturer to ascertain whether or not the engine will operate properly at such speeds.

ELECTRIC SYSTEM

NOTE—For service information concerning Generators, Generator Regulators, Starting Motors and Starter Switches, see the Table of Contents on page 1.

TROUBLE DIAGNOSIS

SUDDEN STOPPING

1. No fuel—see that there is fuel in supply tank and shut-off cock is open.

2. Insufficient flow and air traps in line. Check fuel supply by opening plug in fuel injection pump at opposite end from fuel inlet.

3. Too heavy a fuel—see that fuel is not too thick to flow properly under given temperature conditions.


5. Slug of water from excessive water in fuel.

6. Plugged fuel line—investigate fuel supply line for obstructions.

7. Turn engine over by hand to make sure that it is free and not stuck from lack of lubrication or other causes.

8. Start engine and check for loss of power.

LOSS OF POWER

It is assumed here that engine has lost power during a running period or that it has failed to give the proper power after being started according to instructions. Conduct investigation in order listed. Engine should be running unless otherwise noted. Each of the following items is a test or a remedy, or both, for possible trouble:

1. Note lubricating oil pressure and level. If pressure is low, check over lubricating system carefully.

2. The most common cause is lack of fuel or air in line. Vent system thoroughly. If fuel does not flow freely without any signs of air, check for obstruction in fuel supply system. Fuel may be too heavy to flow properly at atmospheric temperature in which engine is operating.

3. Determine the weak or missing cylinders by cutting out the cylinders, one at a time, while engine is under load. Cut out the cylinder by loosening fuel line at the nozzle. Cutting out good cylinders will cause a marked decrease in speed, while weak cylinders will show little or no change. The sound of the exhaust will also give an indication of which cylinders are weak.

4. Check for sticking fuel nozzle valve by pressing with the finger tips the feeling pin in nozzle holder if so equipped.

5. Check for sticking fuel injection pump plungers or broken plunger spring.

6. Look for broken engine valve spring or sticking valve. Replace with new spring, or free valve with fuel oil. A sticking valve should be removed and cleaned properly as soon as possible. To change valve spring with head in place, see Valve Springs.

7. Inspect engine valve tappet adjustment.