

Fig. 11-8. 24 volt; 20 ampere Delco-Remy System with Bendix Drive starting motor and magnetic switch.

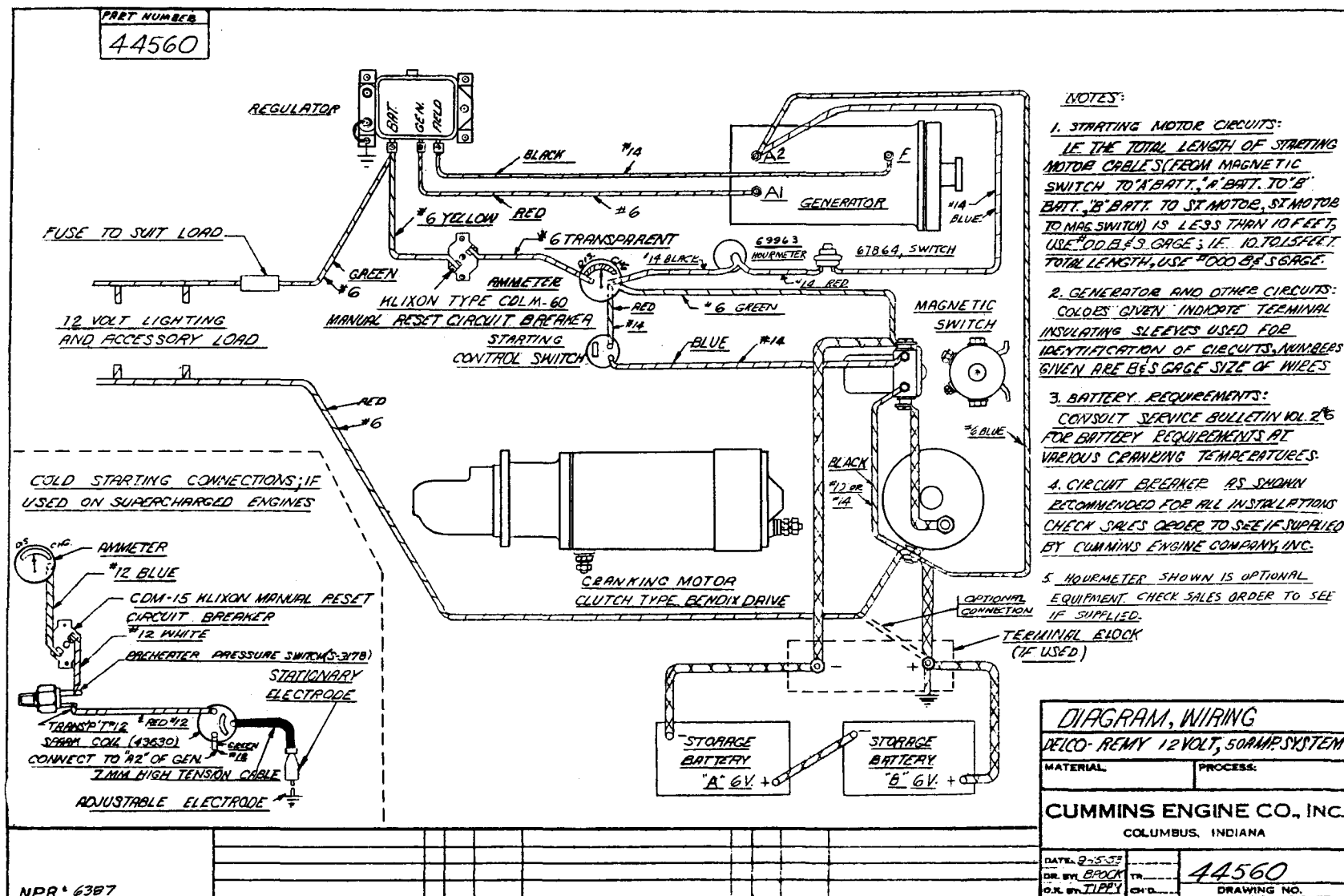


Fig. 11-9. 12 volt, 50 ampere Delco-Remy System with Small Regulator, Bendix Clutch, Starting Motor and Magnetic Switch

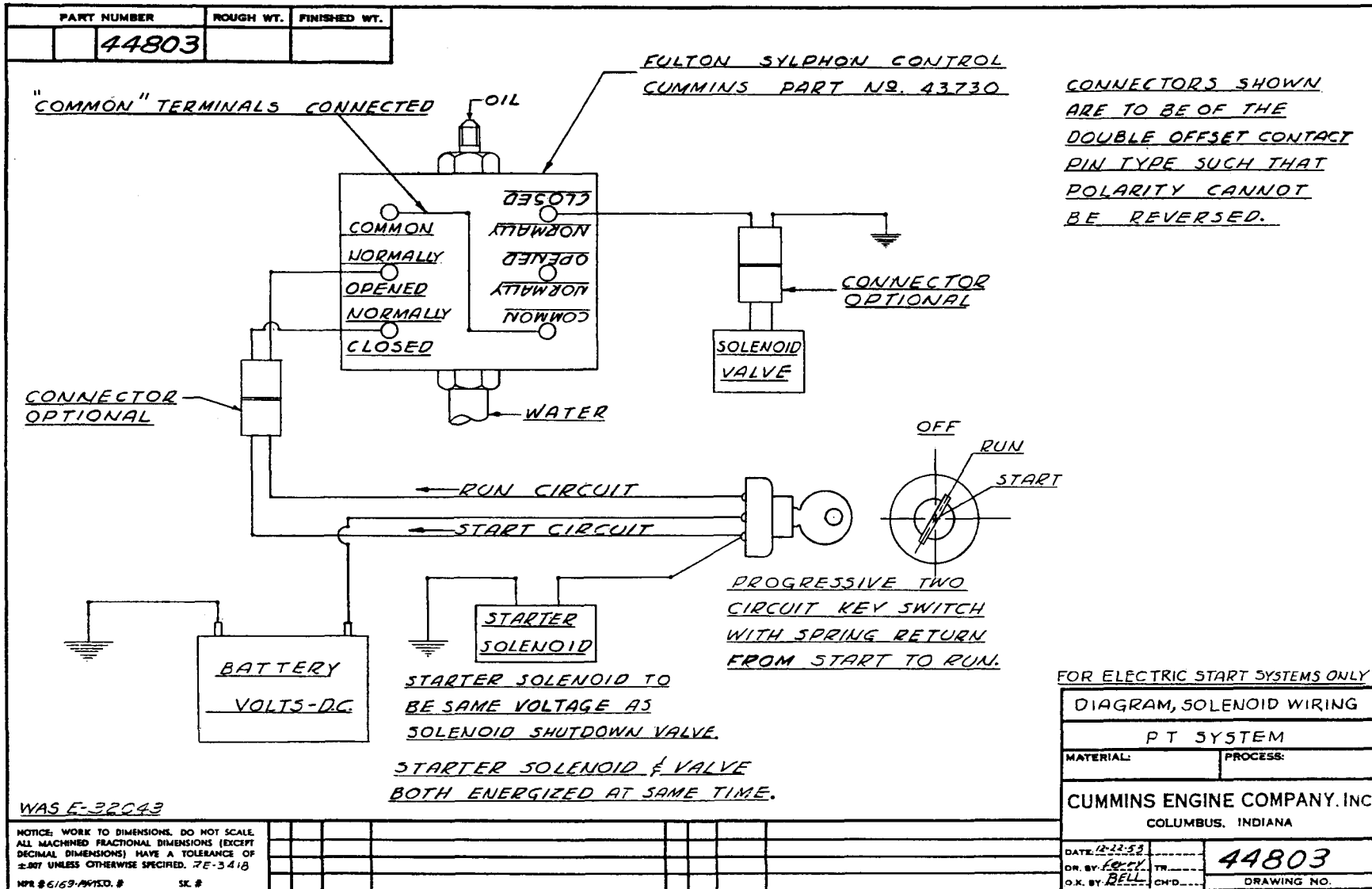


Fig. 11-10. Solenoid Valve and Safety Switch Wiring for PT Fuel System with Electric Starting Motor

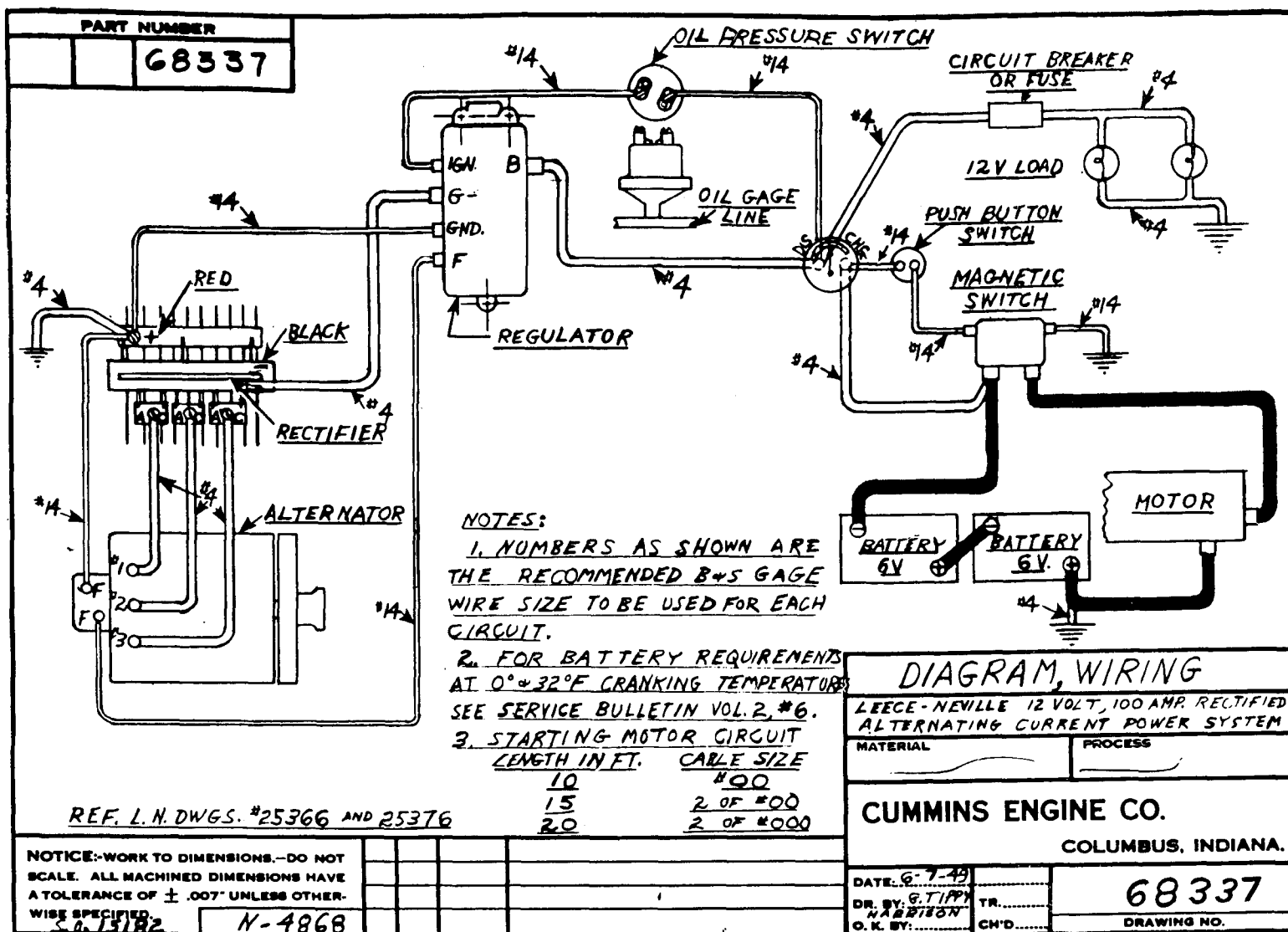


Fig. 11-11. 12 volt; 100 ampere; 1400 watt Leece-Neville Rectified Alternating Current Power System

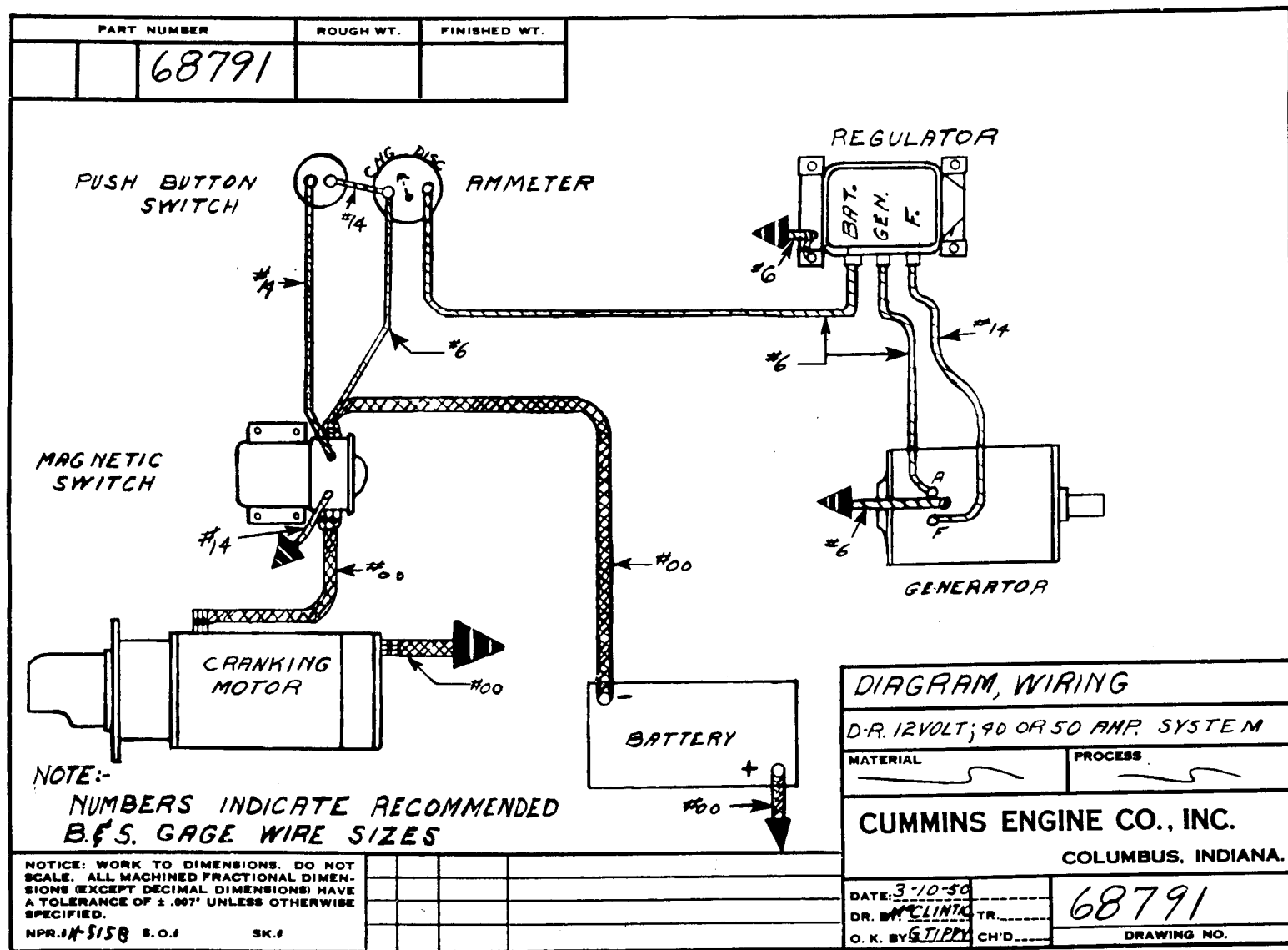


Fig. 11-12. 12 volt, 40 or 50 ampere; 560 or 700 watt Delco-Remy with Standard 3-element Regulator and P. B. Starting

SECTION XII

UNIT No. 14

Complete Engine Assembly

The material in this section deals with (1) Complete Engine Assembly and (2) Adjustments And Testing of The Engine.

Cylinder Block Group

ENGINE STAND: For convenience and safety the cylinder block should be secured to an engine stand like ST-255.

Crankshaft and Main Bearings

1. Check main bearing bores as detailed in "Unit Rebuilding Section."

2. Turn the block upside down in the engine stand. Make sure that all oil passages in the block and crankshaft are open and clean. Use a clean rag to wipe the main bearing bores and main bearing shells. Make sure there are no burrs in the main bearing bores.

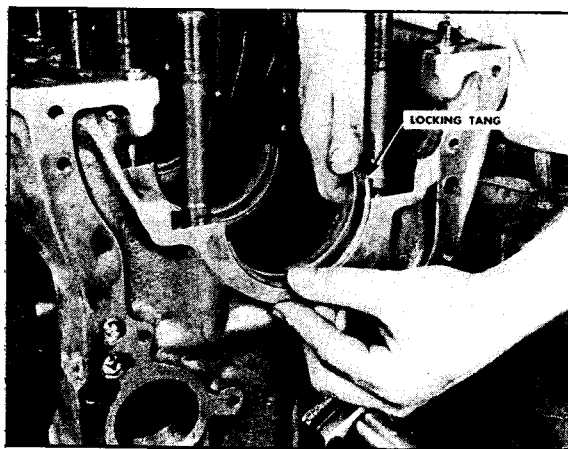


Fig. 12-1. Placing upper main bearing shells

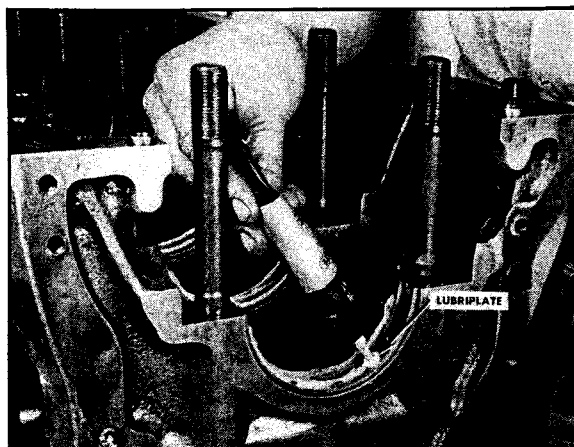


Fig. 12-2. Applying Lubriplate to upper main bearing shells

3. Lay an upper main bearing shell in each block bore so the locking tang is engaged with the recess in the block, and the drilled holes in the shell and block index. Fig. 12-1.

4. Coat the upper main bearing shells thoroughly with Lubriplate or similar high-pressure grease.

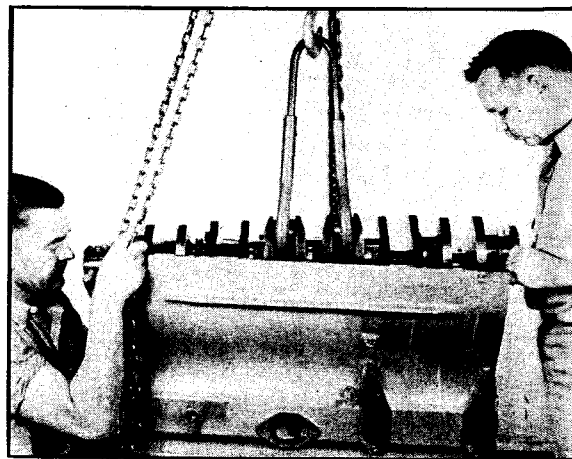


Fig. 12-3. Laying the crankshaft

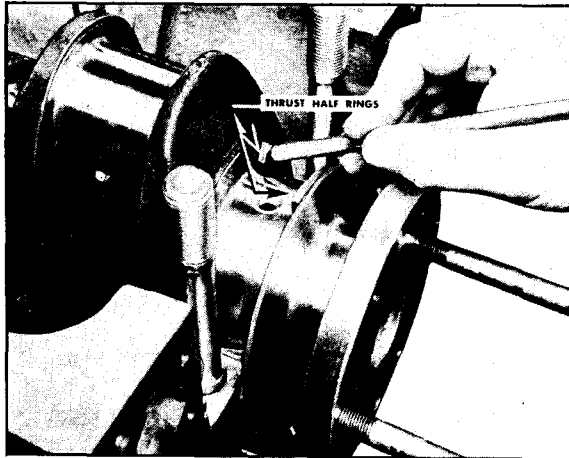


Fig. 12-4. Assembling upper thrust rings

5. Make sure all crankshaft journals are thoroughly clean. Lift the crankshaft with hooks protected with rubber hose, as shown in Fig. 12-3, and lower it in place carefully.

6. Roll upper thrust half-rings into position with babbitt sides next to crankshaft flanges. Fig. 12-4.

7. Snap the lower main bearing shells into position in their respective main bearing caps. The locking tangs for both upper and lower main bearing shells are opposite the camshaft side of the engine.

8. Coat the lower main bearing shells with Lubriplate.

9. Place thrust rings on each side of No. 7 cap with rings in counterbored recesses and secured by the dowels. No. 7 cap is also dowelled to the block. Fig. 12-5.

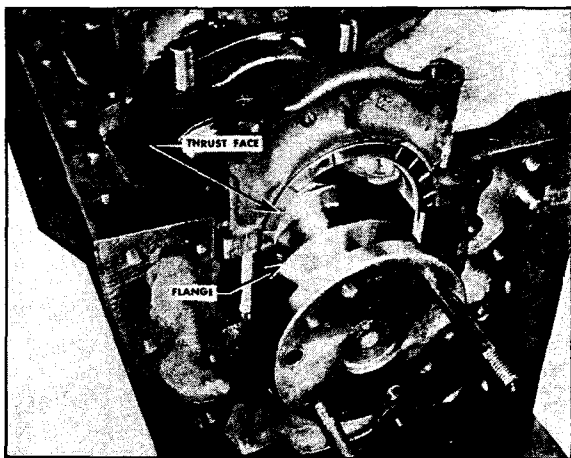


Fig. 12-5. No. 7 main bearing cap and lower thrust rings

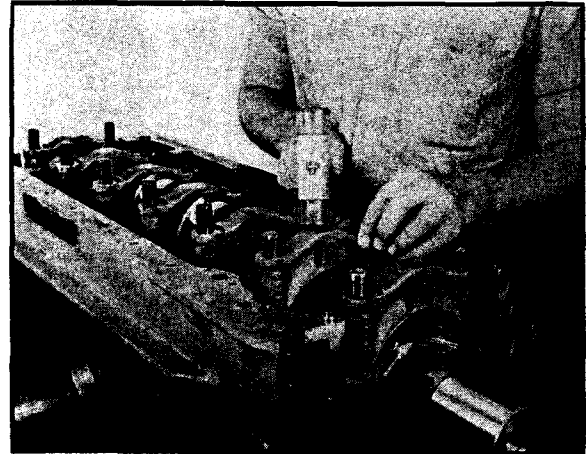


Fig. 12-6. Tapping main bearing caps in place

10. Drive caps in place over the lower shells with the numbered side of the cap to camshaft side of the engine. Caps are .002 to .004 interference fit in block. Recess in cap must match with locking tang of bearing shell.

11. Assemble lock plates and nuts over each main bearing stud. Lubricate threads and lock plates with clean lubricating oil. Do not use Lubriplate on stud threads.

12. Tighten main bearing stud nuts by the template method described in following paragraphs.

13. After tightening stud nuts, check for free turning of crankshaft. Shaft must be free enough so it can be turned easily by cranking flywheel dowel pins. If it is not free, remove crank and recheck for dirt or burrs in the shells or bore. *Never ream or scrape main bearing shells!*

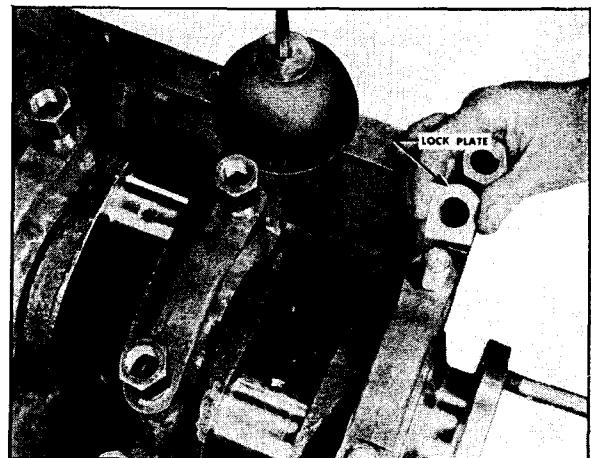


Fig. 12-7. Installing lock plates and stud nuts

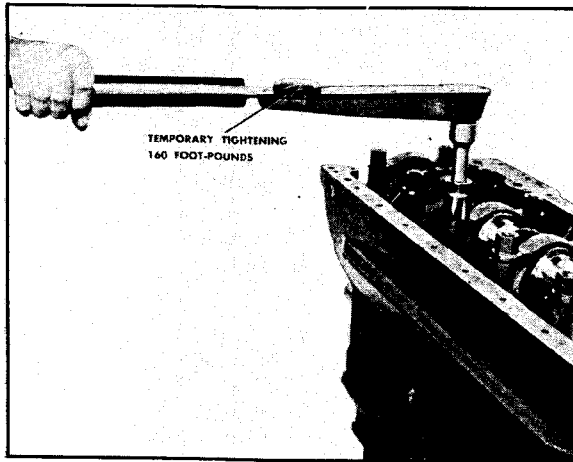


Fig. 12-8. Tightening stud nuts to 160 ft. lbs. to set caps and bearings

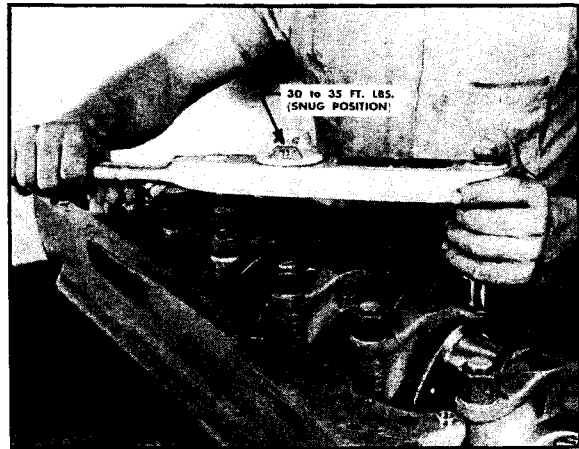


Fig. 12-9. Snug tighten to 30-35 ft. lbs.

Template Method of Tightening Main Bearings

The template method should be used to tighten main bearings stud nuts on the JS engine. It is important, in order to maintain a round hole, that the same method of tightening should be followed in service as that used when bores were originally machined.

Main bearing bores in the cylinder block are machined at the factory after the studs and bolts are tightened by the following described template method.

1. After bearing shells and caps are properly placed, oil the stud and nut threads. Install new lock plates.

2. Tighten main bearing stud nuts to 160 foot-pounds with a torque wrench. This is not operating tension: This step is used only to set the shells, caps and lock plates. Fig. 12-8.

3. *Loosen nuts completely.*

4. Retighten nuts to 30-35 foot pounds with a torque wrench. This is the "snug" position.

5. Scribe mark the nuts with a sharp pencil to coincide with the right permanent mark on the cap—or scribe mark each of the caps in line with one hex corner of a main bearing nut.

6. Advance the nut 60 degrees from snug position described in Step 4. See Fig. 2-10. This will align the scribed mark on the nut (or the next corner of the nut) with the mark on the main

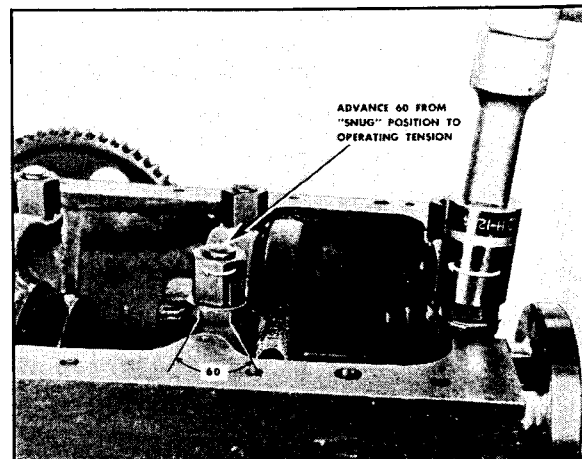


Fig. 12-10. Advancing nuts 60° from snug position to operation tension

bearing cap. Tighten each side of the bearing a little at a time bringing both sides up as evenly as possible. This is operating tension.

CRANKSHAFT END CLEARANCE: Attach a dial indicator securely to the cylinder block with the contact point of the gauge resting on the crankshaft flange end face. With a small bar, pry the crankshaft toward the front of the engine and set the gauge at "0," then pry the crankshaft toward the rear of the engine. The gauge should indicate .004 to .009 end clearance. Fig. 12-11. If the end clearance is less than .004, it will be necessary to loosen the nuts slightly and shift the crankshaft first toward the front end of the engine and then toward the rear of the engine. If the nuts have been loosened, retighten by the template method, and recheck.

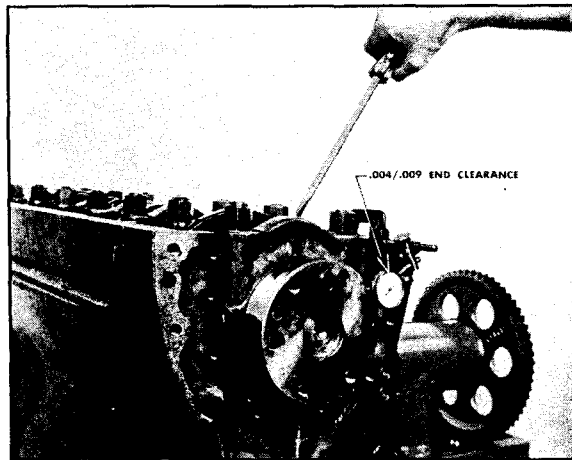


Fig. 12-11. Checking crankshaft end clearance

LOCK MAIN BEARING STUD NUTS: Lock the stud nuts in place by bending the lock plates against one side of each hex nut. Fig. 12-12.

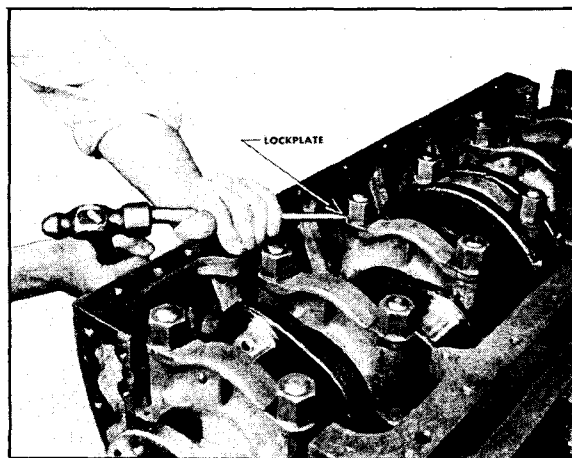


Fig. 12-12. Locking main bearing stud nuts

Main Bearing Replacement Without Pulling the Crankshaft

Provision is made so that main bearing shells can be removed and replaced in the JS engine without pulling the crankshaft. To change bearings in this manner:

1. Remove oil pan.
2. Remove one bearing cap and lower shell.
3. Turn the crankshaft until the drilled hole on the main bearing journal is visible. Insert a $7/32'' \times \frac{1}{2}''$ pin with a hex head $3/32''$ thick in the drilled hole of the shaft. Roll the pin against

the shell on the side opposite the locking tang. Shell will turn out as crank is rotated.

4. Should a bearing fail, the metal must be carefully removed from all oil passages in the crankshaft and in the cylinder block. Improper cleaning of these passages will result in another bearing failure. If the remaining bearings have had considerable service, it is recommended that all be replaced. Replacing one bearing when the others are badly worn means that the new bearing will take the load until it has attained the same diameter as the old ones. Another bearing failure usually results before this occurs. There must not be more than .002 variation in oil clearance between adjacent main bearings and journals.

5. Lay the new shell in proper position on the journal so that, when turned into position, the locking tang will fit into the recess in the block. Use the pin and rotate the shaft to turn the shell into position.

6. Replace lower shell and cap with locking tang in recess of cap. Install a new lockplate and tighten stud nuts by template method.

7. Check for free turning of crankshaft with compression released.

8. Install remaining shells, one pair at a time, in the same manner.

9. Check crankshaft end clearance as described under "Template Method of Tightening Main Bearings," Page 12-3.

Rear Cover

(All J, JS, JT engines built after Serial No. 117297)

The lip-type oil seal is intended to be self-aligning; therefore, it is very important that the rear cover plates be assembled properly.

1. Clean the crankshaft thoroughly with crocus cloth to smooth out any rough places in the seal area. Wipe with a clean rag.

2. Remove the spring from the oil seal, and with a pair of needle nose pliers, hook the spring around the crankshaft rear cover journal. Fig. 12-13. Be very careful not to over-stretch the spring as it is installed.

3. Apply Lubriplate to the seal area of the crankshaft and to all surfaces of the oil seal.

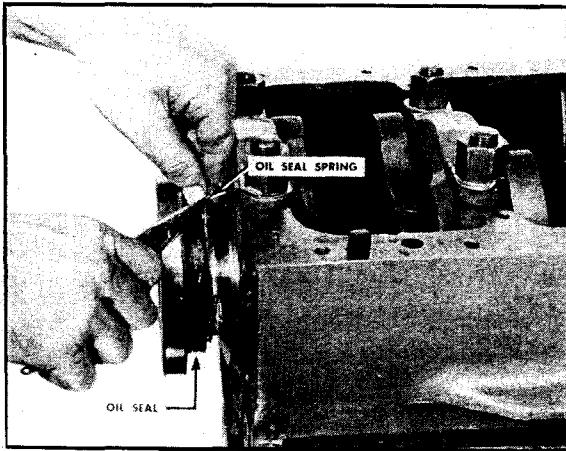


Fig. 12-13. Installing rear cover oil seal spring

4. Assemble the oil seal to the crankshaft with the lip-side (grooved or spring side) toward the block and with the "split" to the top.

5. Roll the spring into position inside the oil seal groove.

6. Make sure the seal lip has no cuts or creases which would prevent sealing.

7. Cement new gaskets to the joining surfaces of the upper cover plate-half. Fig. 12-14.

8. Cement a new gasket against the block and install the lower rear cover plate half. Tighten the cap screws only tight enough to prevent the plate from slipping.

9. Check the alignment of the milled surface of the bottom of the lower plate-half with the bottom surface of the block. Fig. 12-15.

10. Assemble and tighten the upper and lower

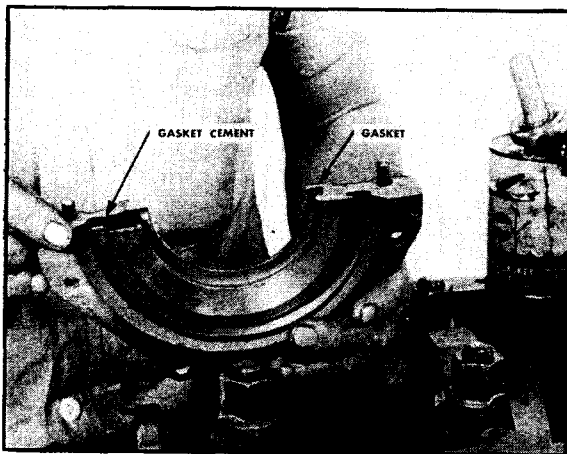


Fig. 12-14. Installing gaskets between rear cover plate-halves

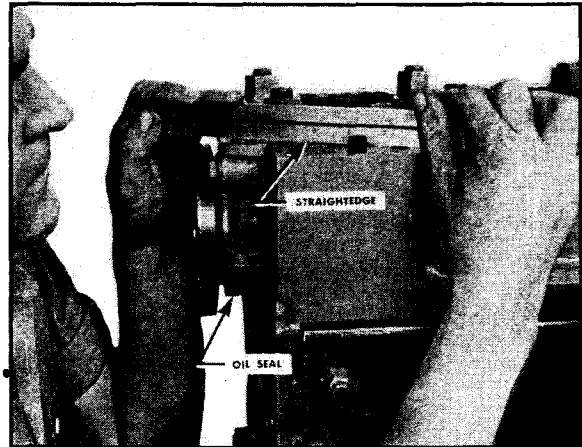


Fig. 12-15. Checking rear cover plate alignment

rear cover plate halves together with two dowel fit bolts, lockwashers and nuts.

11. Securely tighten all the rear cover plate cap screws.

12. Repeat the straight edge check to be sure the bottom surfaces of the cover plate and block are in alignment.

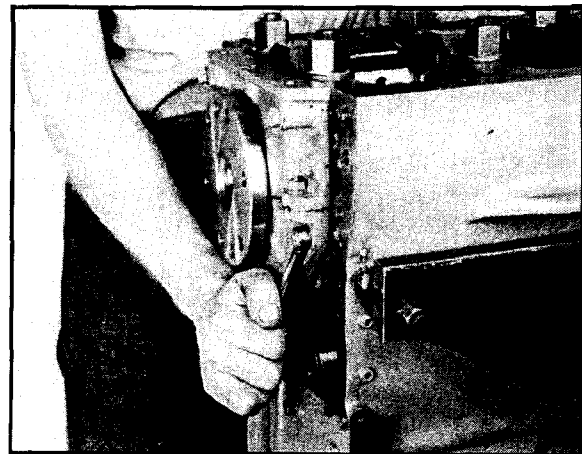


Fig. 12-16. Tightening rear cover plate cap screws

Rear Cover

(All JS engines built before
Serial No. 117297)

The rear cover has a braided-asbestos oil seal around the crankshaft.

LOCATE UPPER COVER: When the rear cover is assembled to the cylinder block, its bore must be in line with the main bearing bore.

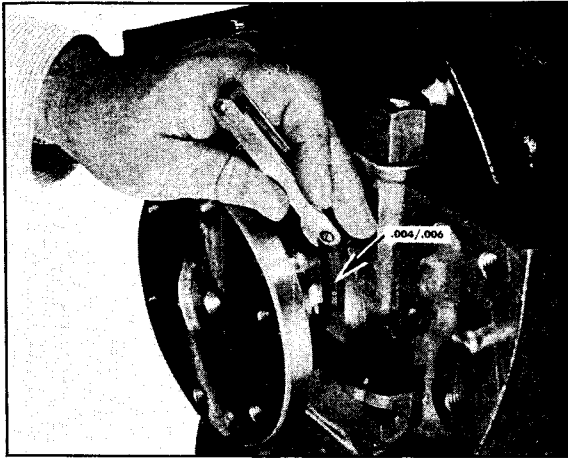


Fig. 12-17. Checking rear cover clearance

If the Original Rear Cover Plate is Undamaged and Will be Re-used: 1. Cement a new gasket over the dowel pins on the rear of the cylinder block. Assemble the upper cover plate over the dowel pins and tighten down the four capscrews and lockwashers. With the crankshaft pried toward the cover plate, check the clearance between the crankshaft flange and the opposing face of the cover plate. Clearance should be minimum of .004. See Fig. 12-17.

2. The .004 to .006 clearance between the crankshaft flange and the opposing face of the cover plate can be obtained by use of .005 and .010 gaskets to move the cover plates to or from the cylinder block.

3. The clearance between the crankshaft and the bore of the cover plate should be .009 to .011 around the entire circumference. This clearance is provided when the original rear cover is installed at the factory and maintained by locating dowels. This can be checked after the old asbestos seal has been removed by using .009 feeler stock between the shaft and upper cover.

4. Remove the cover plate and install new asbestos seals into the recess of both upper and lower cover plates. New asbestos seals must be beveled on three sides of each end, $1/32''$ by 45° , leaving the inside edge square. The ends of the seal should extend $1/32''$ above joining surfaces of cover plates. The seals must be thoroughly oiled, as an oil leak will develop if dry seals are run on a dry shaft. Seals should be soaked in lubricating oil for an hour or more before installing. Make sure that asbestos seals are well seated in grooves.

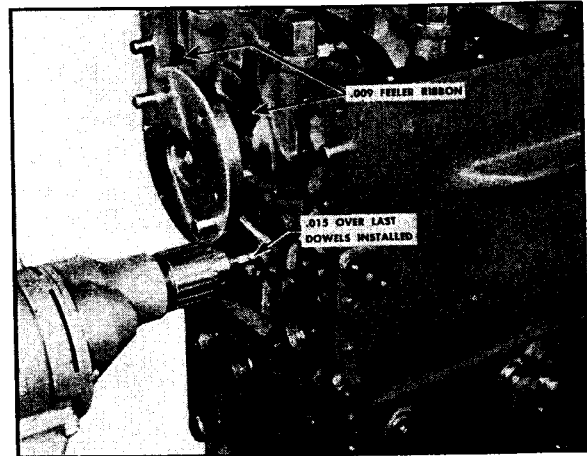


Fig. 12-18. Redowelling upper cover plate to block

5. Cement new connecting gaskets to the lower cover plate. Assemble the lower plate to the upper plate and bolt together tightly with dowel fit bolts, lockwashers and nuts. Install capscrews and lockwashers to the cover plates and pull up evenly to the cylinder block over the dowel pins.

If the Original Rear Cover Plate is Damaged and must be Replaced with New One:

1. Assemble the upper half of the rear cover with asbestos seals removed over the dowels, to the cylinder block.

2. Insert a ribbon of .009 feeler stock between the bore of the rear cover and the crankshaft. If the proper clearance is not present, it will be necessary to remove the old dowels from the block and redowel.

To Redowel: 1. After removing old dowels, reassemble upper plate to block, leaving feeler stock in position.

2. Drill and ream two dowel holes in the upper rear cover plate to the smallest permissible size. The upper plate is reamed to .187/.188 at the factory. New blocks are reamed .187/.186 - $1/4''$ deep as assembly. When redowelling, increase size by .015 over last dowels installed.

3. Procedure is now the same as previously outlined for reassembly of original cover plates.

Liners, Pistons and Rods

The use of the U-flex oil control ring on JS pistons makes it advisable to insert pistons from the bottom of the liner. This must be done before the liner is inserted in the block.

During a top overhaul or when minor repair work is necessary, a special auxiliary (U-flex) ring compressor ST-437, can be used with the standard ring compressor to allow assembly of the piston from the top of the liner.

Before assembling the liner, piston and rod assemblies check the liner-to-block clearances as described in following paragraphs.

Cylinder Liners

CYLINDER LINER TO BLOCK CLEARANCES:

1. Several types of failures can result when liners have been improperly installed, most serious of which would be scored liners and seized pistons. The following instructions should be carefully followed.

2. Make sure that all mating surfaces of liner and block have been thoroughly cleaned.

3. Place the liner, without packing rings, into the block. It should drop into position of its own weight. The liner must always seat freely in the block. Test liner-to-block clearance by shaking. If there is no detectable clearance, remove the liner and make sure both liner and block bore are perfectly clean. If necessary, scrape the block bores and counterbores until the liner does seat freely.

4. Check the clearance around the entire circumference of the block counterbore and the top liner flange with a .002 feeler gauge. Fig. 12-19.

5. Check liner flange and the counterbore depth in the block. Flange must be .0045 to

.00675 above surface of block when assembled.

6. Steel shims, No. 43782-A, B, C and D, are available to obtain this .004 to .006 protrusion. The shims are .002, .007, .008 and .009 thick respectively.

7. The protrusion must be gauged with liner held down by flanged tubes over studs and with head nuts tightened to approximately 30 foot-pounds. This is necessary to make sure shims are compressed when protrusion is measured.

8. Remove the liners from the block after all clearances have been checked.

CONNECTING ROD AND PISTON: 1. Before assembling the connecting rod, piston pin and piston, heat the piston in boiling water to increase the diameter of the piston pin hole.

2. Assemble the pin in place through the piston and rod before the piston has time to cool.

3. Lock each end of the piston pin with the snap rings provided.

4. Check piston ring gap as described on Page 2-9.

PISTON RINGS: 1. Clean and oil pistons, rings, and cylinder liners with clean lubricating oil.

2. To assure better performance, stagger the ring gaps so they are not in line with each other or with the piston pin.

3. Pistons, connecting rods, and caps are numbered to correspond with their respective cylinders.

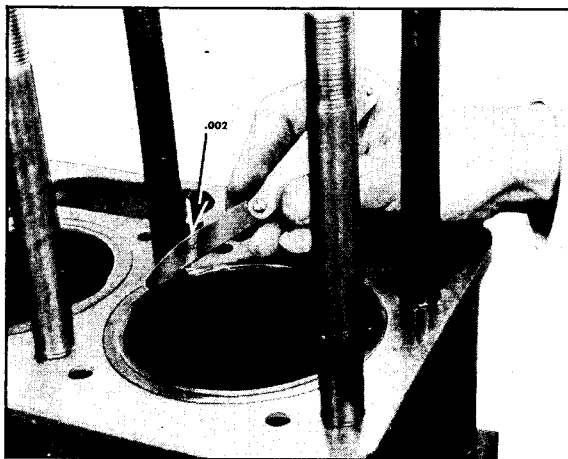


Fig. 12-19. Clearance at top of liner

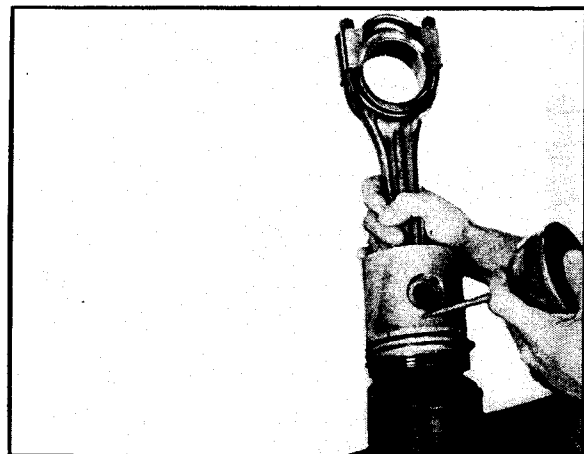


Fig. 12-20. Applying lubricating oil to piston and liner assemblies

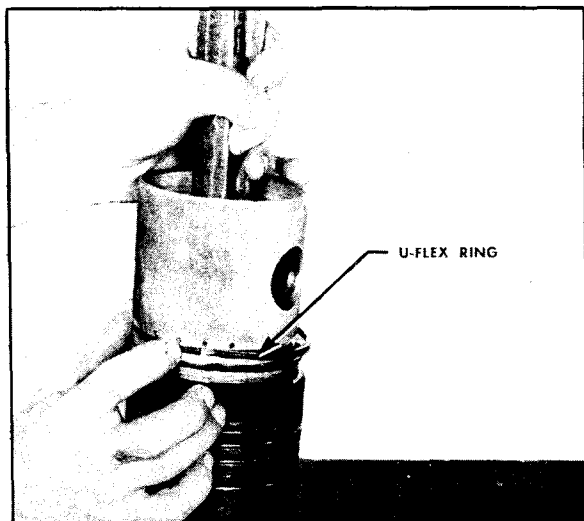


Fig. 12-21. Inserting piston into liner. Step 1

INSERT PISTONS INTO LINERS: 1. Place the piston and rod assembly into position for insertion from the bottom of the liner as shown in Fig. 12-21. See Page 2-9 for assembly of rings.

2. Use a standard ring compressor and insert the piston and rod assembly into the liner. Fig. 12-22. Butt the ends of the U-Flex rings together. *Do not overlap.* The ends of the ring must not be filed or ground under any circumstances.

3. Assemble the rubber packing rings being careful not to stretch them. Fig. 12-23.



Fig. 12-22. Inserting piston into liner. Step 2

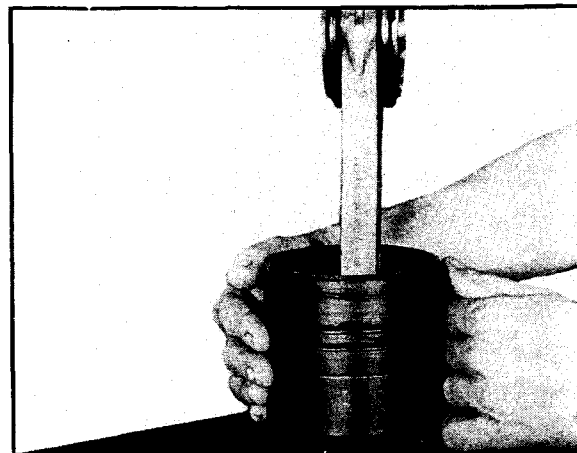


Fig. 12-23. Assembling rubber packing rings

4. Lubricate the packing rings and the machined portions of the block with Lubriplate or similar. Never use white lead as a lubricant for this operation.

5. Snap the upper and lower connecting rod bearing shells into position in the rod and cap bores. Be sure the bearing shell locking tangs make firm contact with the recesses in the rod and cap bores.

6. Coat the connecting rod bearing shells with Lubriplate. Fig. 12-24.

INSTALL LINER, PISTON AND ROD ASSEMBLIES: 1. Be sure the piston and rod is located in the liner so that the numbered side of the rod is on the camshaft side of the engine. Also the numbered side of the rod must be

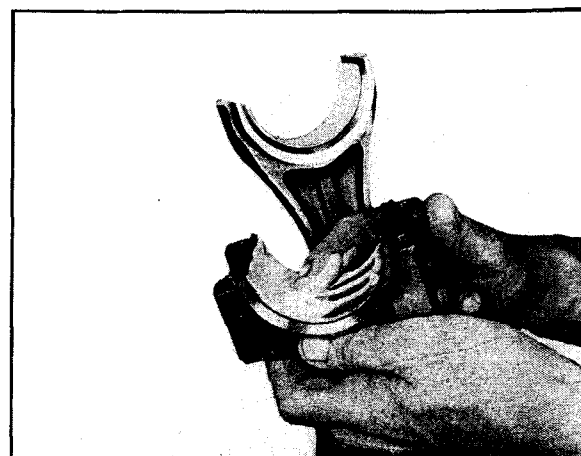


Fig. 12-24. Applying Lubriplate to rod shells

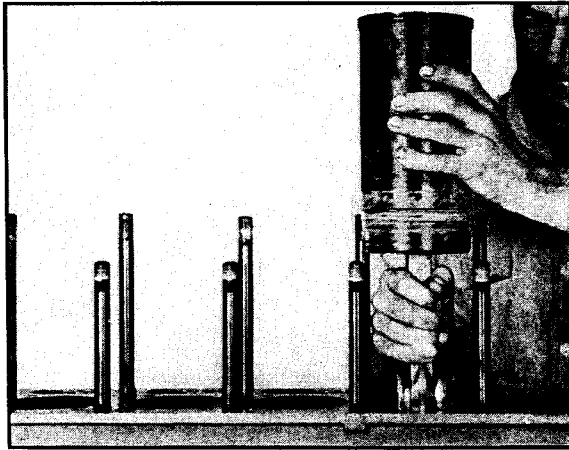


Fig. 12-25. Inserting liner, piston and rod

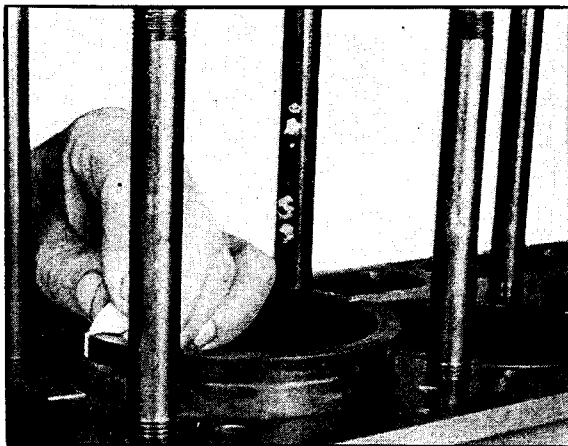


Fig. 12-26. Marking top of liner and block

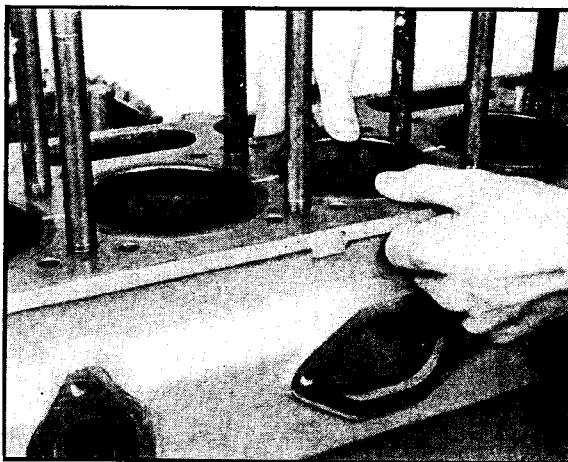


Fig. 12-27. Pushing liner into position

perpendicular to the centerline of the valve recesses at the top of the liner.

2. Carefully lower the liner, piston and rod assemblies into their respective liner bores. Fig. 12-25.

3. Chalk mark the top of the liner and block before pushing the liner into place. This must be done to assure alignment with valve recesses. Fig. 12-26. Four valve engines have plain liners.

4. Push the liner into position in the block bore. Fig. 12-27.

INSTALL CONNECTING ROD BEARING

CAPS: 1. Assemble the rod cap with bearing shell around the crankpin journal. Fig. 12-28. Numbers on rod and cap must match at shown in Fig. 12-29.

2. U-bolts should be assembled in original position as shown by matching "1" or "2" numbers on the end of the bolt and the side of the rod. Fig. 12-29.

Template Method of Tightening Connecting Rod Bolt Nuts

1. Oil threads and lockplates with clean lubricating oil.

2. Tighten the nut on each side of both U-bolts alternately, and in five foot-pound increments, to 25/30 foot-pounds.

NOTE: The low (25/30 foot-pounds) torque is used to avoid permanent stretching of the bolts during the initial tightening.

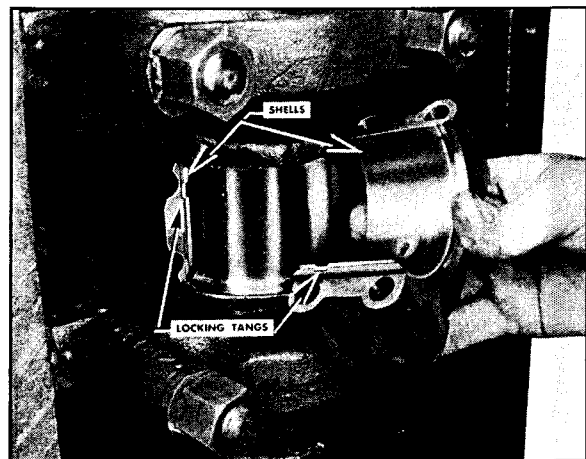


Fig. 12-28. Location of locking tangs and milled recess in rod and cap

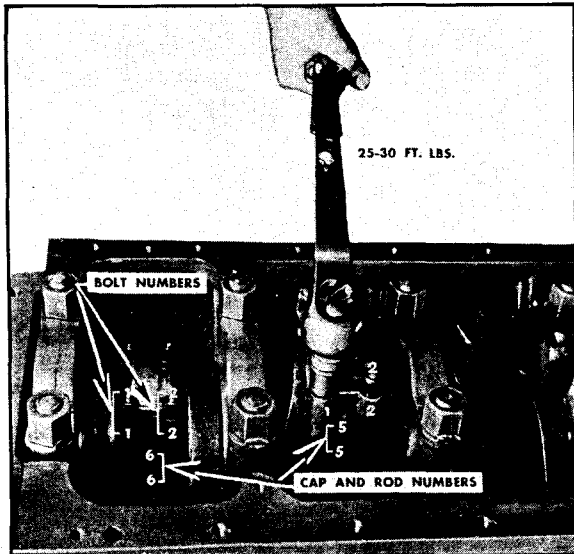


Fig. 12-29. Tightening U-bolt nuts

3. Loosen the nuts completely.
4. Retighten the nuts alternately, and in steps of five foot-pounds, to 25/30 foot-pounds.
5. Draw a thin pencil line on each nut to coincide with the permanent marks on the cap. If caps are not marked, extend a line from one hex of each nut to the cap.
6. Advance each nut one hex or 60 degrees. In order to prevent U-bolts from becoming misaligned, advance alternately in steps of 30 degrees until 60 degrees is reached.
7. Lock the nuts in place by bending the washer against the hex nuts.
8. The side clearance between the connecting rod and crankshaft should be .006 to .011. Check

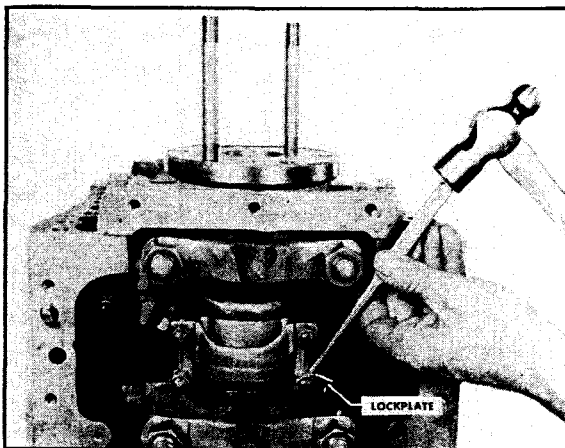


Fig. 12-30. Bend rod lock plates

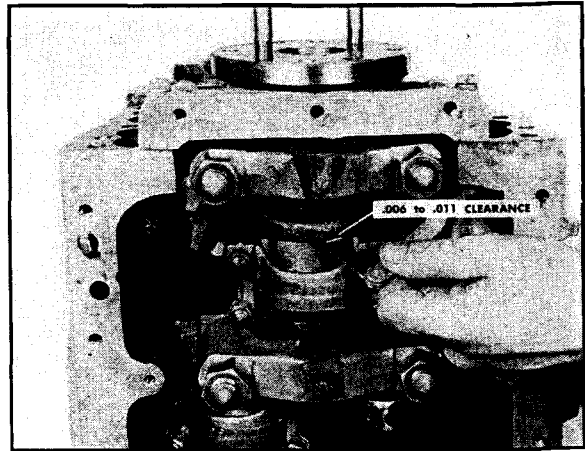


Fig. 12-31. Checking clearance between rod and crank

with feeler gauge and move rod on journal to detect clearance.

9. The clearance between the milled faces of the small end of the rod and the piston bosses must be at least .020 on the close side of the rod. This is extremely important because, if the rod should boss, it will almost certainly result in scoring or seizing of the piston and liner. It must be remembered that wear of the crankshaft thrust flange and thrust rings will increase the danger of bossing.

Gear Case

1. Assemble gasket and gear case over the dowel pins. Tighten the capscrews securely.



Fig. 12-32. Peening socket head cap screws

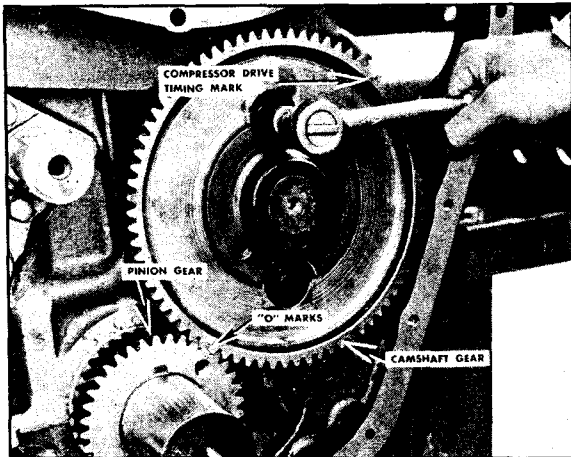


Fig. 12-33. Installing camshaft

2. Three socket head capscrews must be tightened and peened in place as shown in Fig. 12-32.

Camshaft

1. Before installing the camshaft, see that all cam bushings are properly lubricated. Rotate the camshaft while installing it in the block. This permits the lobes of the cam to pass through the camshaft bearings and allows the camshaft to enter freely.

2. Index the "O" on the camshaft gear with the "O" of the crankshaft gear for correct timing. This is Number 1 Top Center Firing position. Fig. 12-33.

3. The front bearing is fitted on the camshaft between a shoulder on the shaft and the drive gear. After partially inserting the camshaft in the block, slip this front bearing into the bore of the block and tighten into place with three capscrews through the openings in the cam gear. Fig. 12-33.

4. Camshaft end clearance of .007 to .011 is provided by the front camshaft bearing and the camshaft thrust flange.

Supercharger Idler Gears (JS Engine Only)

1. Install the inner thrust washer and place the supercharger idler and driven combination gear over the idler pin. Fig. 12-34.

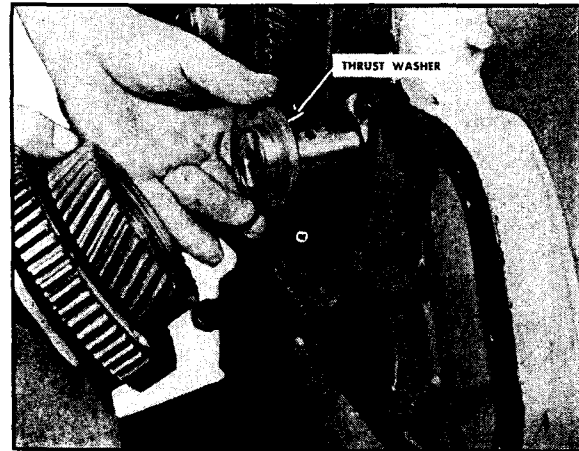


Fig. 12-34. Installing thrust washer and idler gear assembly

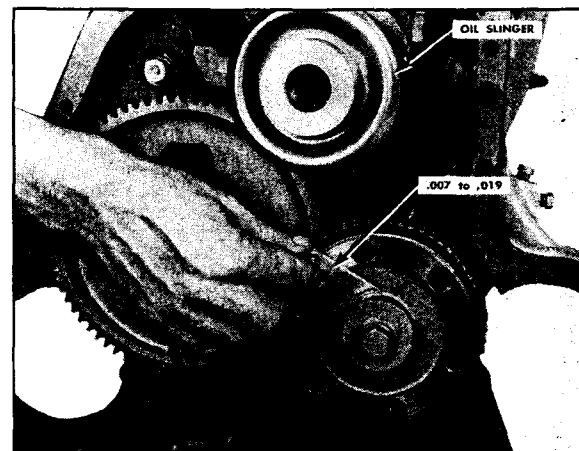


Fig. 12-35. Checking clearance between thrust washer and idler gear

2. Fit the outer thrust washer to the gear hub and bring the cover washer in place by tightening the capscrew over the washer.

3. The clearance between the thrust washer and gear should be .007 to .019. Fig. 12-35.

4. Remove the capscrew and cover washer. Leave the thrust washer in place against the idler gear.

Oil Slinger

Place the oil slinger in its position against the crankshaft gear as shown in Fig. 12-35.

Accessory Drive Gear

The accessory drive gear must be indexed with the camshaft gear by the following steps:

1. Remove the plug from the timing view hole in the gear case cover and with the aid of a pen light, assemble the accessory drive assembly in place with the center punch mark on the gear matched with the center punch mark on the camshaft gear. Fig. 12-37.

NOTE: Earlier model accessory drive gears have a "O" mark instead of a center punch mark.

2. Tighten the assembly securely to the gear case with four capscrews.

3. Replace the view hole plug.

ACCESSORY DRIVE PULLEY: 1. Insert key and, with a lead hammer and heavy wall tubing, drive the pulley to the shaft.

Gear Case Cover

1. Install new oil seals in the cover for the accessory drive and the crankshaft.

2. Cement a new gasket to the gear case cover and assemble the cover to the cylinder block over the dowel pins.

3. Secure the cover to the block with lock-washers and capscrews. Fig. 12-36.

4. Place the idler gear cover washer and rubber ring in the gear case cover opening, and

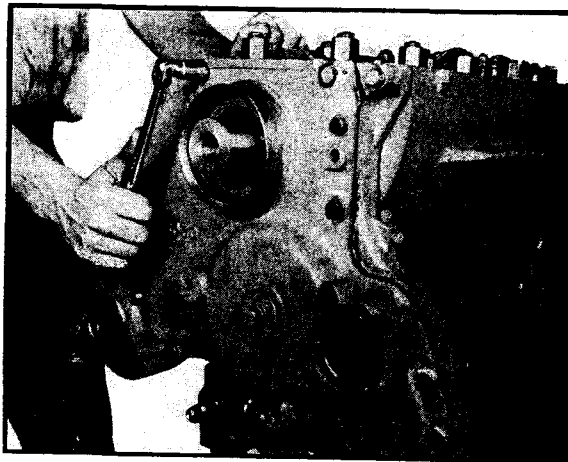


Fig. 12-36. Installing gear case cover

tighten securely to the idler gear shaft with the capscrew provided.

NOTE: If necessary to install a new gear case cover, it must be properly located and re-dowelled.

CAUTION: TO PREVENT BREAKAGE, AVOID EXCESSIVELY HEAVY HAMMER BLOWS WHEN DRIVING THE PULLEY TO THE SHAFT.

2. Secure the pulley with a washer, lock-washer and shaft nut.

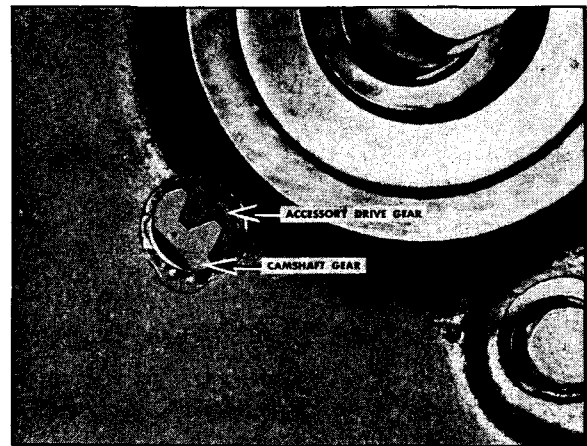


Fig. 12-37. Timing accessory drive gear to camshaft gear

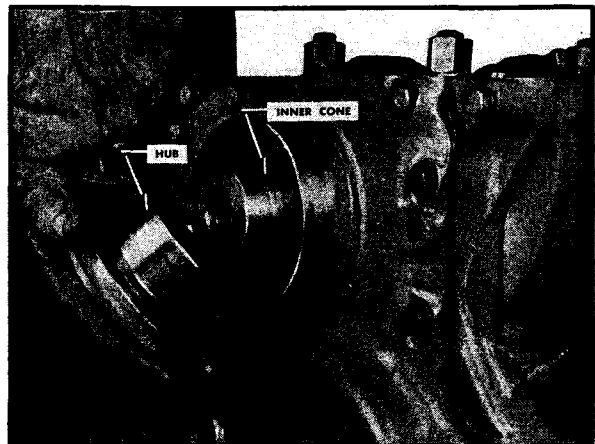


Fig. 12-38. Installing vibration damper hub

Vibration Damper and Hub

The vibration damper hub is mounted on the crankshaft with two opposing cones which, when tightened, wedge the hub in place. To assemble:

1. Assemble the first cone on the shaft with the large end against the oil slinger.
2. Place the vibration damper hub, flange-side away from the engine, over the crankshaft so that the taper in the hub coincides with the cone forming a wedge.
3. Place the second cone into the opposing hub taper.
4. Tighten the assembly securely with the crankshaft cone retainer, locknut and capscREW. Fig. 12-38.
5. Bolt the vibration damper, flange side toward the engine. Bend back the lock plates. Fig. 12-39.

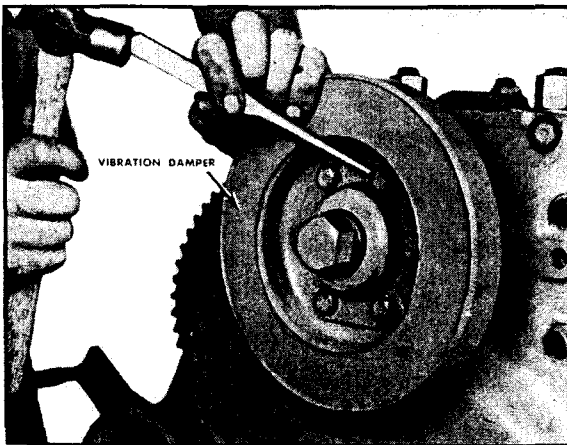


Fig. 12-39. Bending vibration damper lock plates

Valve and Injector Tappets

1. Assemble the roller tappets over the camshaft in the cylinder block bores. The injector tappets are largest and are placed in the center. Fig. 12-40. Intake and exhaust valve tappets are alike.
2. Tappets are kept from turning by inserting injector tappet guides.
3. Align the tappets with the holes in the side of the block and screw the tappet locking guides into position. Fig. 12-41.
4. Lock the tappet guides with safety wire. Fig. 12-42.

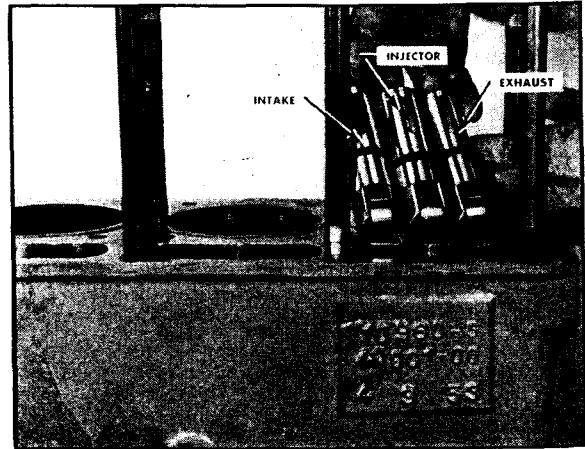


Fig. 12-40. Installing tappets

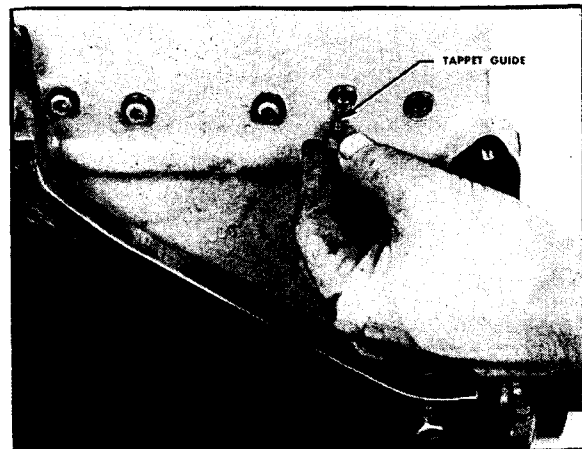


Fig. 12-41. Installing tappet guides

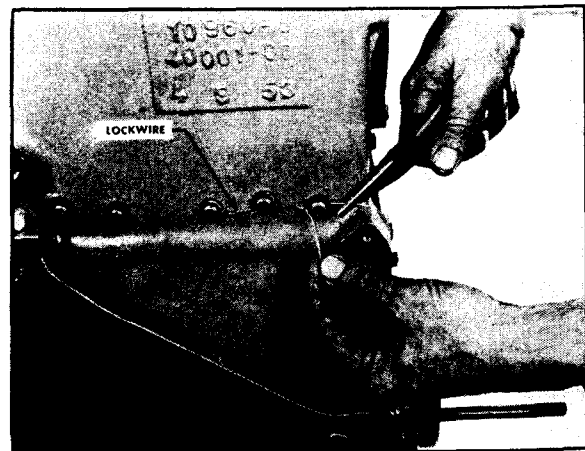


Fig. 12-42. Locking tappet guides

Cylinder Head

1. The cylinder head should have valve guides, valves and valve springs in position as described in "Unit Rebuilding" section.

2. Make certain cylinder walls are clean and well lubricated with clean lubricating oil. Check the oil hole in the head and the block to be sure it is open.

2. Make certain cylinder walls are clean and well lubricated with clean lubricating oil. Be sure all oil holes are open.

3. Wipe clean the mating surfaces of the cylinder block and cylinder head. Check to see that there are no burrs on the outside edges of water and oil holes.

4. Install the head gasket. Fig. 12-43.

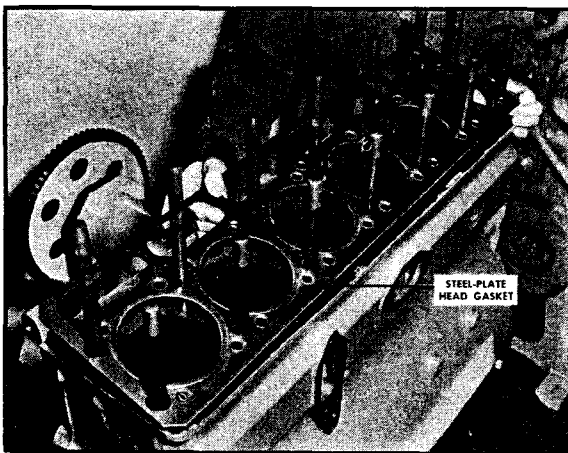


Fig. 12-43. Install head gasket

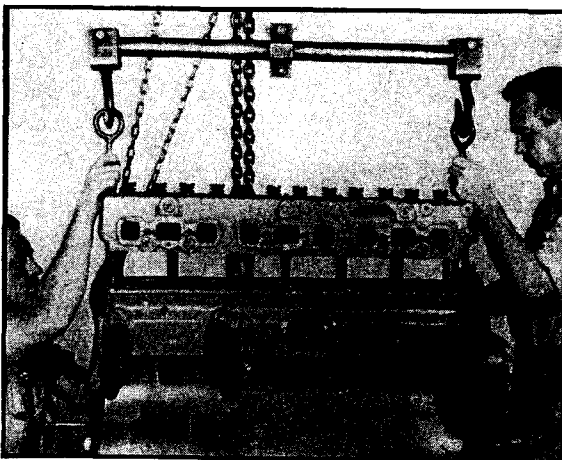


Fig. 12-44. Lowering cylinder head to block

5. With the lifting arrangement, carefully lower the cylinder head to the block.

6. Install oil transfer, dowel in head.

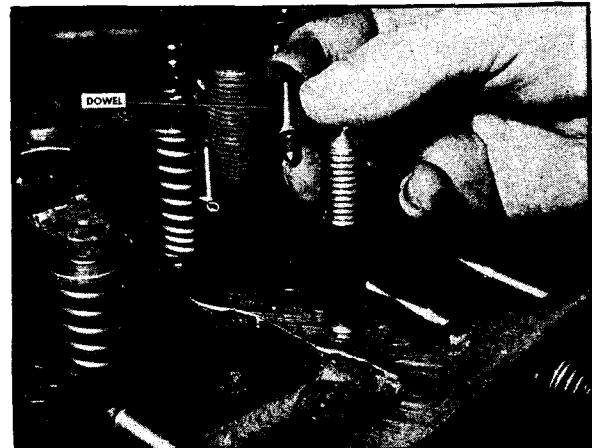


Fig. 12-45. Install oil transfer dowel in head

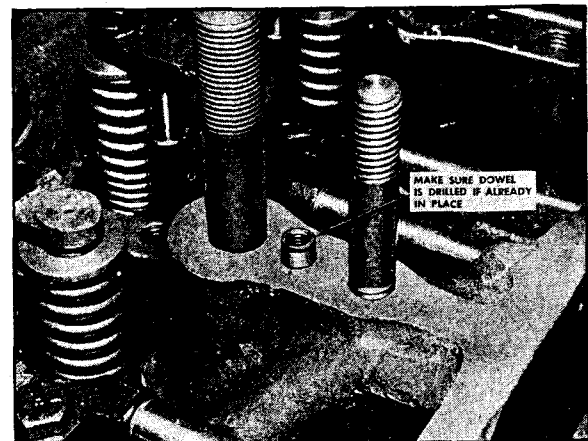


Fig. 12-46. Check dowel

NOTE: Cylinder head stud nuts will be installed and tightened after assembly of the rocker levers and shaft. Follow tightening procedure outlined under "Tighten Cylinder Head Stud Nuts," Page 12-16.

Push Rods

Assemble the push rods into the tappet sockets. The intake push rods have collars to match with the milled recesses of the compression relief shaft. Exhaust and injector push

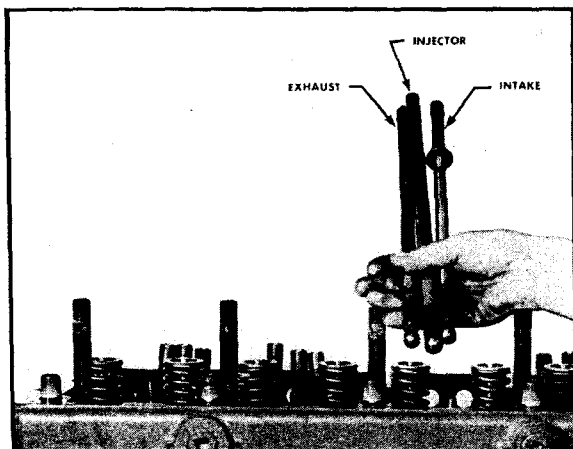


Fig. 12-47. Installing push rods

rods are plain. The injector push rod is the largest in diameter and it assembles between the two valve push rods.

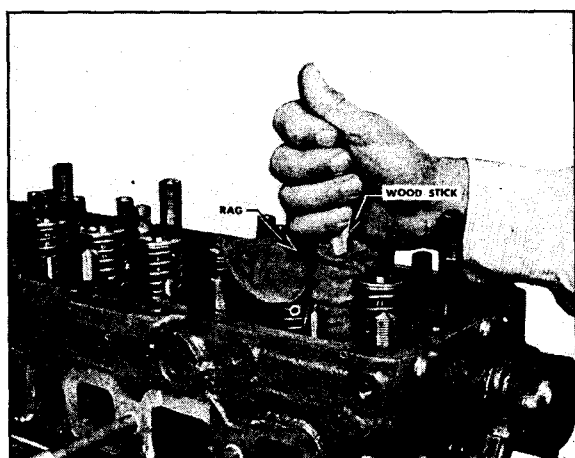


Fig. 12-48. Cleaning injector sleeves

Injectors and Connections

1. Before installing an injector, wrap a clean cloth around a wooden stick, clean out the injector sleeves in the cylinder head and carefully wipe the injector cup seat. Never use a metal rod or waste in this cleaning operation. Never attempt to scrape the injector seat. The sleeve and seat are copper, to allow faster heat dissipation, and are easily scratched or marred. Fig. 12-48.

2. Place the injector in its proper position in the cylinder head, being very careful not to hit or bruise the injector tip.

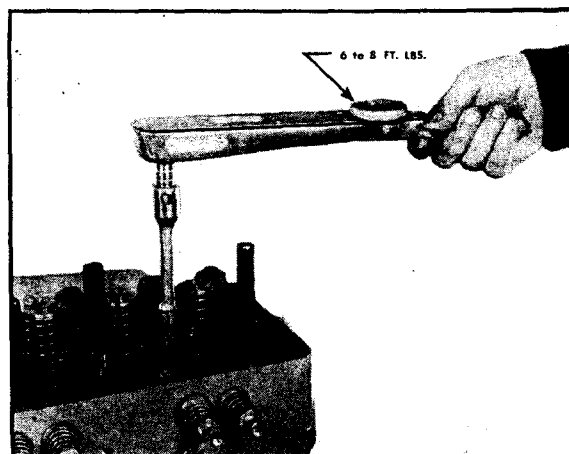


Fig. 12-49. Tightening injector hold down nuts

3. There are two fuel connection holes in the cylinder head for each cylinder. The right-hand hole is the inlet and the left-hand hole is the drain.

4. Place new gaskets on the fuel inlet and drain connections and screw the connections into the injector three turns. This is to align the injector body with the fuel connections so that the connection gaskets will seat squarely against the face of the injector.

5. Install the injector hold-down nuts. It is necessary that these nuts be tightened evenly. Hold a socket wrench with a knurled handle directly above the nut so that no leverage can be applied or tighten to 6 to 8 foot-pounds with a torque wrench. Tightening these nuts to excess will distort the valve seats and crack the cylinder heads. Fig. 12-49.

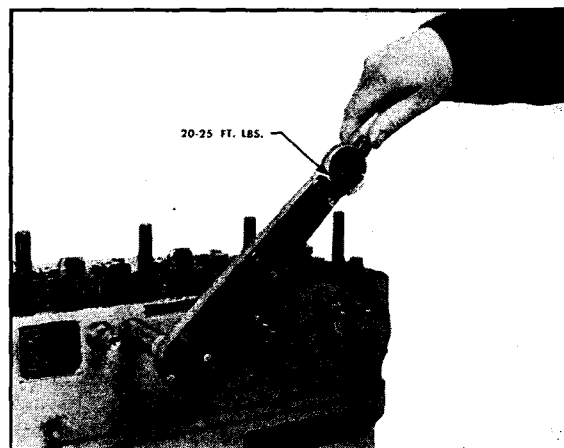


Fig. 12-50. Tightening inlet and drain connections

6. Tighten fuel inlet and drain connections to 20-25 foot-pounds. Loose connections will result in dilution of lubricating oil. If tightened too tight, threads in injector body may be stripped. Fig. 12-50.

Rocker Lever Assembly

1. Check center rocker bearing to see that it has a drilled dowel for oil transfer. Fig. 12-51.

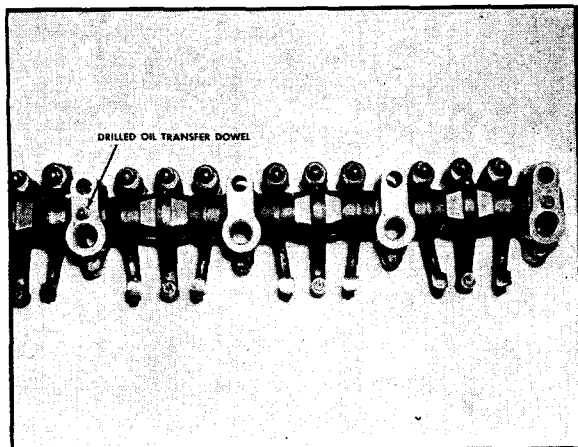


Fig. 12-51. Rocker shaft bearing oil transfer dowel

2. Lift the rocker lever assembly to the cylinder head using the bar arrangement to hold the rocker levers in place as shown in Fig. 12-52.

3. All seven rocker shaft bearings are doweled in place.

4. Loosen all valve and injector adjusting screws.

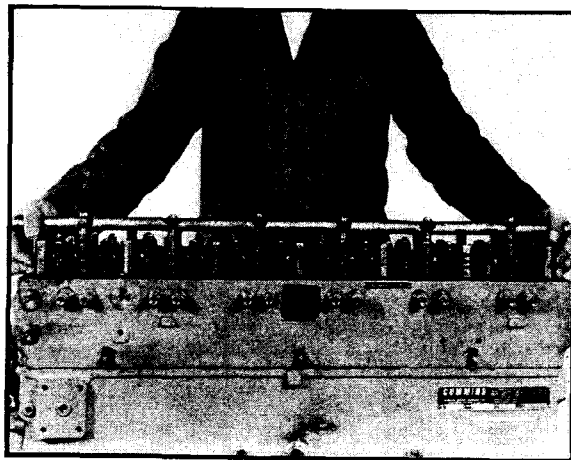


Fig. 12-52. Installing rocker lever assembly

5. With light blows from a soft hammer, drive the assembly over the dowel pins to the cylinder head.

6. Assemble rocker shaft bearing capscrews and tighten. Final tightening of these screws will be done as cylinder head stud nuts are being tightened.

Tighten Cylinder Head Stud Nuts

1. Apply lubricating oil to cylinder head stud threads.

2. Assemble the cylinder head stud nuts and flat washers. Tighten each nut to approximately 25 foot-pounds.

3. Tighten all cylinder head stud nuts to 240-250 foot-pounds. Tighten in steps of 50 foot-pounds and in the order shown in Fig. 12-54.

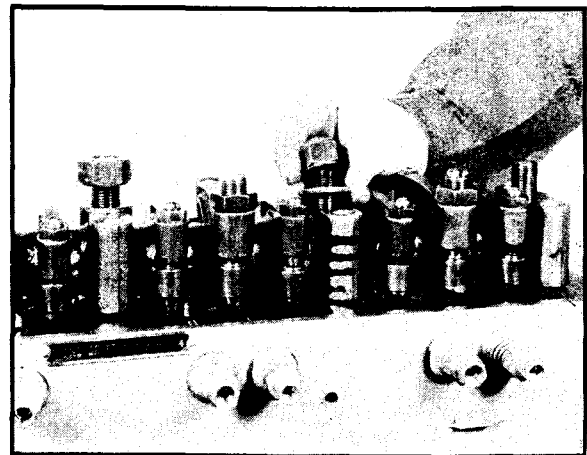


Fig. 12-53. Assembling cylinder head stud nuts and flat washers

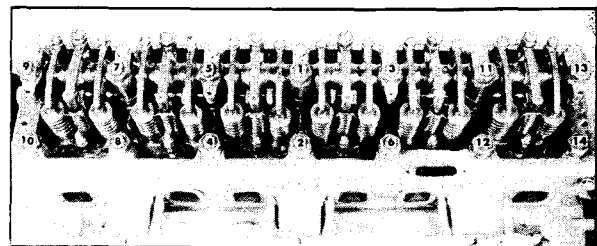


Fig. 12-54. Cylinder head stud nut tightening order

4. All nuts must be tightened in any one 50 foot-pound step before going to the next 50 foot-pound step.

5. Whenever a cylinder head is removed and installed, retighten the stud nuts three times:

- A. After one to four hours' operation, with water and oil temperatures at 140° F. to 165° F.
 - B. At the first oil change, with water and oil temperatures at 140° F. to 165° F.
 - C. At the first "D" maintenance check—2000 gallons fuel consumption, with water and oil temperatures at 140° F. to 165° F.
- Valves and injectors must be adjusted after each tightening of cylinder head stud nuts.

Supercharger (JS engine only)

CAUTION: AT ALL TIMES BEFORE FINAL ASSEMBLY OF THE OUTLET AND INLET CONNECTIONS TO THE SUPERCHARGER, THE PORTS SHOULD BE KEPT COVERED. MASKING TAPE MAY BE USED. DO NOT STUFF RAGS INTO THE INLET OR OUTLET PORTS AT ANY TIME AS THEY MIGHT BE LEFT THERE ON ASSEMBLY TO THE ENGINE.

1. Make sure the supercharger locating dowels are in the gear case. Close to the lower dowel is a lubricating oil ferrule or feed tube. The supercharger and water pump drive are lubricated under pressure through this connection. A counterbore is provided in the gear housing for a rubber "O" ring that fits over the oil supply ferrule. Fig. 12-55. Some of the older JBS engines may not have the proper size hole in the gear housing to take the $\frac{3}{8}$ inch tube; therefore, it will be necessary to drill and ream to $\frac{3}{8}$ diameter $\frac{1}{4}$ deep in housing so that the

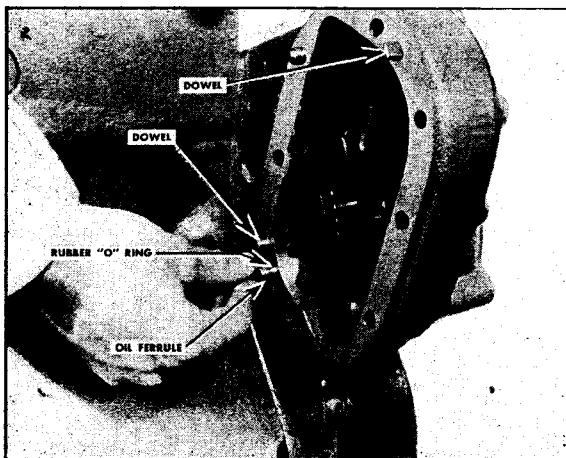


Fig. 12-55. Lubricating oil supply ferrule

tube will fit. The specifications for the counterbore for the small rubber "O" ring are 9/16 inch diameter by .040/.050 inch deep. If you do not have equipment to cut the counterbore to these dimensions, use a large drill with 120° point and cut a chamfer from $\frac{5}{8}$ to $\frac{41}{64}$ inch diameter. Allow the No. 43270 supercharger-to-gear-housing gasket to fit tight around the oil tube so it will compress the "O" ring.

2. Shellac a new gasket to the supercharger and lift the supercharger to the back of the gear case being careful to mesh the drive gear with the idler driven gear.

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

4. Using a new gasket, install the front bearing support to the gear housing cover and tighten the three capscrews.

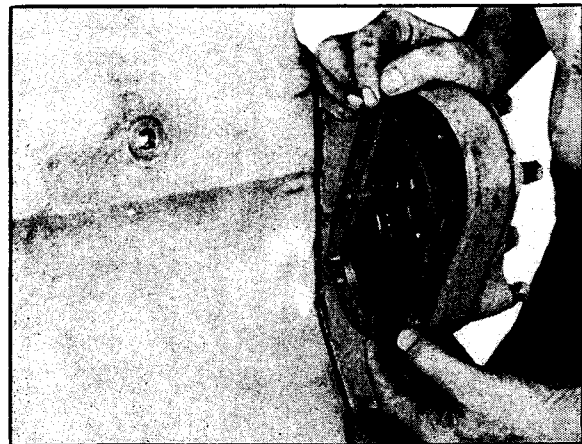


Fig. 12-56. Install supercharger gasket

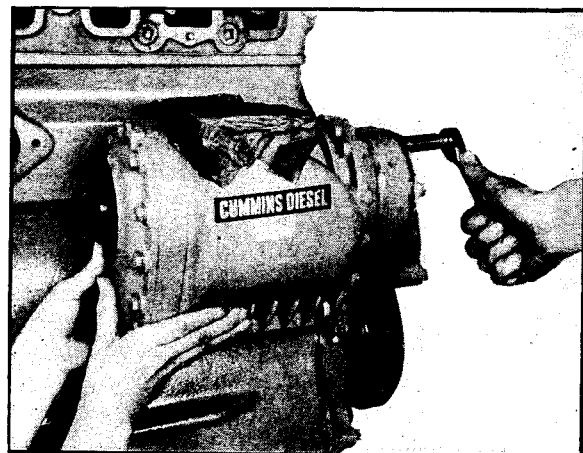


Fig. 12-57. Installing supercharger

Turbocharger

(JT engine only. See page 12-29)

Water Pump

1. Shellac a new gasket over the water pump connection to the block.
2. Install rubber seal ring to the water pump outlet and slide the mounting bracket over the ring.
3. Mount the water pump by engaging the drive coupling, with gasket, to the back of the supercharger and tighten securely to the supercharger with capscrews.
4. Tighten the flange to the block with two capscrews.

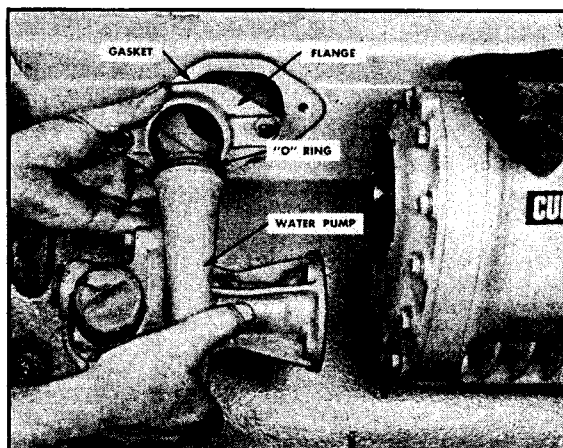


Fig. 12-58. Installing water pump "1"

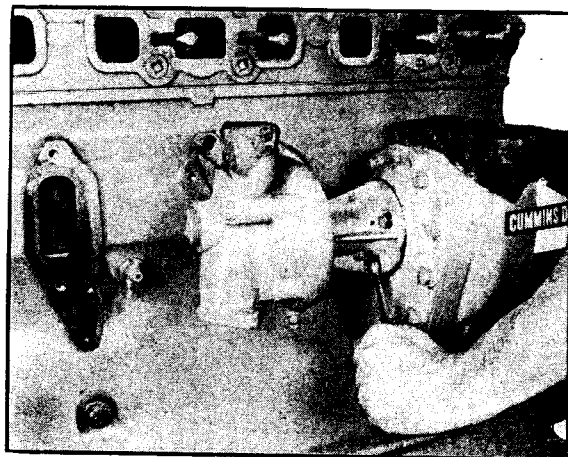


Fig. 12-59. Installing water pump "2"

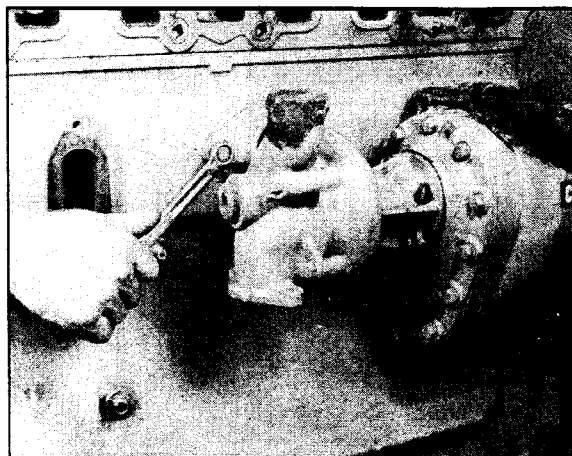


Fig. 12-60. Installing water pump "3"

NOTE: The mounting holes of the water pump flange are oversize to permit the flange to locate properly on the block without causing a binding condition between the supercharger, water pump and block.

Oil Cooler and By-Pass Connection

The oil cooler mounts over water and oil openings in the block directly behind the water pump.

1. Install new gaskets to all four openings and mount the oil cooler.
2. Install lockwashers and tighten the eight capscrews.

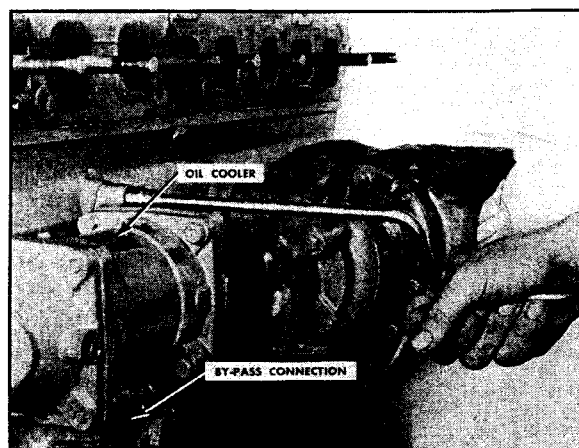


Fig. 12-61. Installing oil cooler

Intake and Exhaust Manifolds

1. Assemble the supercharger-to-intake-manifold connecting band loosely over the supercharger. Fig. 12-62.

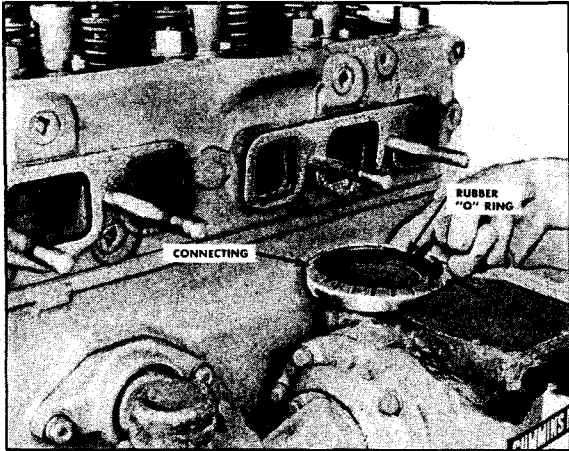


Fig. 12-62. Assembling connecting band

2. Install gaskets over the cylinder head port holes and place the intake manifold over the dowel pins against the head. Place the two manifold clamps on each side of the glow plug before installing the exhaust manifold.

3. Place the exhaust manifold in its position against the cylinder head.

4. Assemble the remaining manifold clamps and nuts on the studs between each exhaust and intake port. Tighten securely.

5. Be sure the supercharger-to-manifold connecting band is in its proper position to avoid

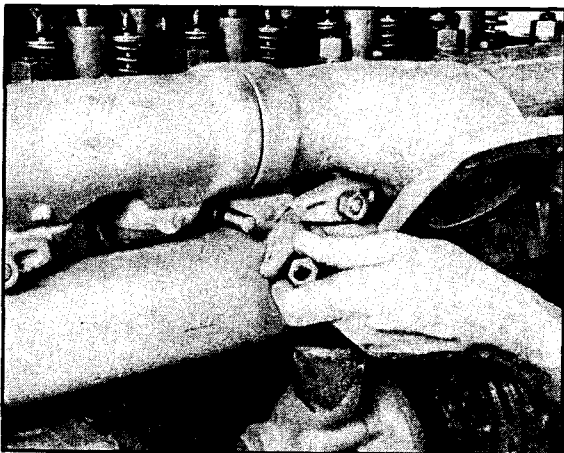


Fig. 12-63. Installing intake and exhaust manifolds

air leaks and distortion of the supercharger case. Tighten the band securely.

Thermostat Housing and Water By-Pass

The thermostat housing mounts with two capscrews on the cylinder head.

1. With a gasket between cylinder head and housing, assemble the thermostat housing and tighten the two capscrews.

2. Install the two main line-thermostats with the springs down. Fig. 12-64.

3. Place a gasket on the thermostat housing and assemble the thermostat housing cover in place with four capscrews.

4. Install rubber hose and clamps connecting the by-pass connection to the water pump. The

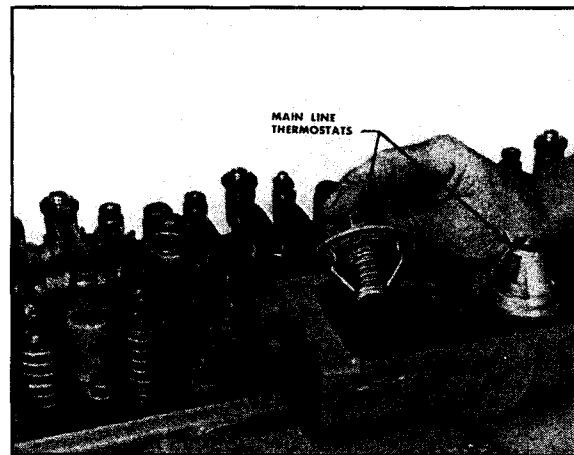


Fig. 12-64. Installing main line thermostats

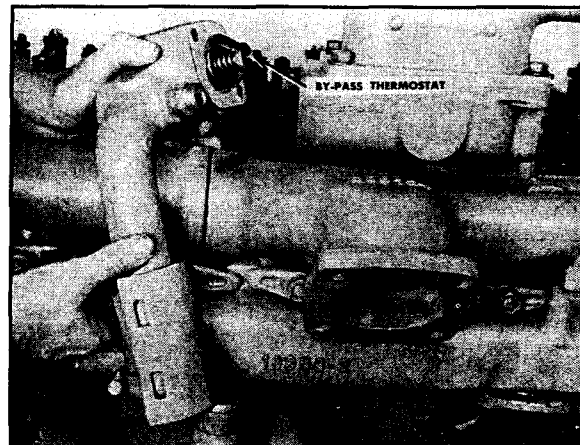


Fig. 12-65. Assembling water by-pass connection and thermostat

shield on the rubber hose is a protection against the hot exhaust manifold.

5. Install the by-pass thermostat with the spring toward the thermostat housing. Place gasket, and assemble the water by-pass connection to the housing with two capscrews and lockwashers. Fig. 12-65.

Supercharger Air Intake

1. Install gasket and tighten the air intake connection to the supercharger with four lockwashers and capscrews.

2. Assemble the vapor suction connection to the air intake. Complete assembly to the rocker housing cover after cover is installed.

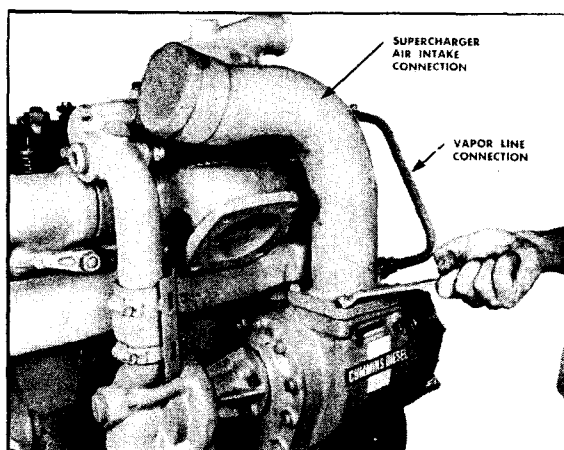


Fig. 12-66. Assembling supercharger air intake and vapor line connection

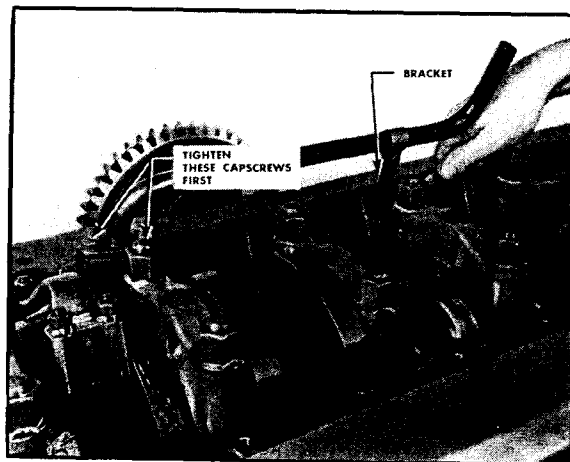


Fig. 12-67. Installing oil by-pass drain line

Oil By-Pass Drain Line

Turn engine upside down in stand. Assemble the oil by-pass drain line and bracket to the bottom of the block on the camshaft side of the engine. Tighten the drain line and bracket with lock plates or lock wire and three capscrews. Fig. 12-67.

NOTE: Tighten the drain line to the cylinder block first and then tighten the bracket clamp screw. This eliminates the possibility of the drain line binding between the bracket and the mounting flange.

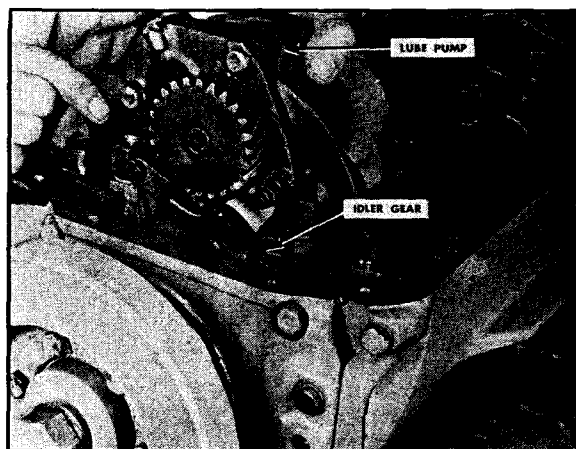


Fig. 12-68. Installing lubricating oil pump

Lubricating Oil Pump

The oil pump mounts directly to the underside of the cylinder block. The gears driving the oil pump mesh with the crankshaft pinion gear to furnish the drive.

1. Check to see that No. 1 main bearing cap has been ground off on one side to allow clearance for the lubricating oil pump. If the cap is not ground and the lubricating oil pump binds during assembly, the cap must be ground to allow at least 1/16" clearance.

2. The lubricating oil pump is dowelled on both sides of the block.

3. Mash the idler gear in place and tighten the lubricating oil pump securely to the block. Bend back the lock plates.

Suction Tube Assembly

1. Place the suction tube assembly in position on the cylinder block. Tighten the suction tube support, with gasket, to the lubricating oil pump. Fig. 12-69.

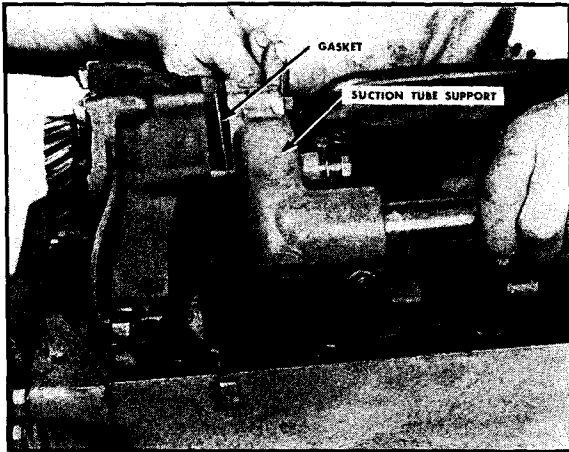


Fig. 12-69. Assembling suction tube to pump

2. Tighten the suction screen bracket to the cylinder block. Fig. 12-70.

Note: Turn the crankshaft slowly to be sure there is no binding between connecting rod caps and/or crankshaft counter-balances and the lubricating oil drain line or lubricating oil pump and suction tube assembly.

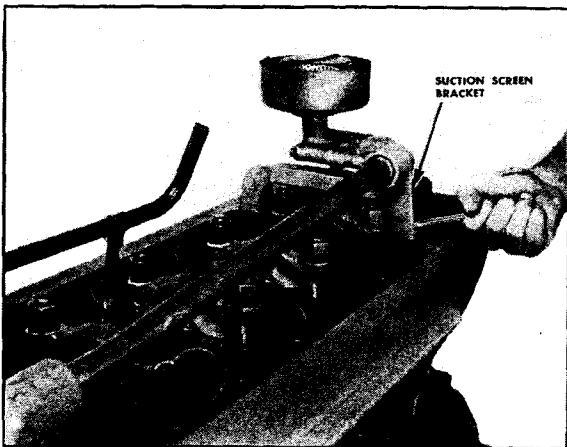


Fig. 12-70. Tightening suction screen bracket

Oil Pan

1. Shellac a new gasket and assemble the oil pan to the cylinder block with capscrews, flat washers and lockwashers.

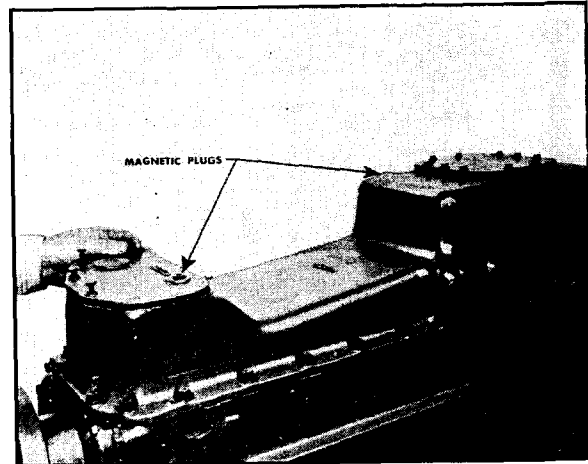


Fig. 12-71. Installing oil pump cover plate

NOTE: Always use flat washers next to aluminum.

2. The oil pan has two dowels; one at the flywheel end on the fuel pump side and the other at the gear case end on the supercharger side.

3. Shellac a gasket to the oil pump plate and secure in place. Fig. 12-71.

4. If a new oil pan is to be installed, the mounting capscrews should not be tightened securely until after the flywheel housing has been installed on the engine and until the pan has been redowelled to the block.

5. The oil pan has two magnetic plugs; the oil drain plug and the plug in the oil pump plate.

6. After the engine has been brought up to operating temperature, always retighten all oil pan nuts and capscrews to prevent leaks.

Flywheel Housing

1. Clean the mating surfaces of the flywheel housing and the cylinder block of all dirt and burrs. Cement gasket in camshaft counterbore of flywheel housing. Fig. 12-72.

2. Inspect the dowels and, if they show evidence of wear or shearing caused by previous operation, pull them. In all cases where a new flywheel housing is being installed, the old dowels must be pulled.

3. Secure the housing to the block and oil pan with 12 capscrews and lockwashers.

4. Tighten all oil pan capscrews, if not already tightened.

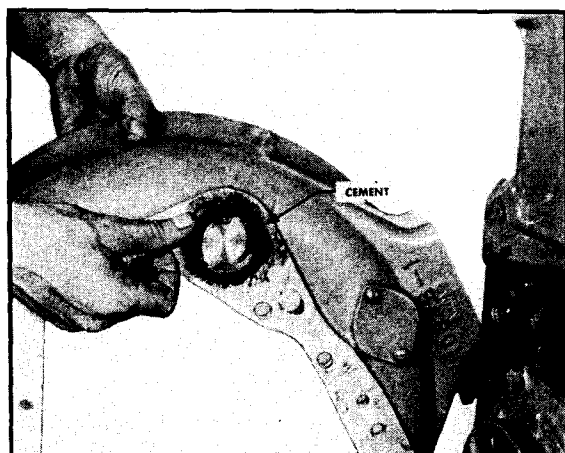


Fig. 12-72. Cementing gasket in camshaft counterbore

INDICATE BORE: 1. Fasten an indicator gauge to the crankshaft flange as shown in Fig. 12-74 to indicate the bore of the housing. Make four chalk marks at points A, A¹, B and B¹ as shown in Fig. 12-75. Take readings at the four points.

2. If the run-out exceeds .004, remove the flywheel housing and pull the dowels, unless they were previously removed. Loosen the capscrews just enough to allow the housing to be shifted. Use a pinch bar to shift the housing to obtain proper indicator reading. The readings at points A and A¹ should be the same and the readings at points B and B¹ should agree. Total run-out must not exceed .004.

3. After readings are within limits, tighten all the capscrews alternately, a little at a time, and recheck. If dowels were removed, redowel

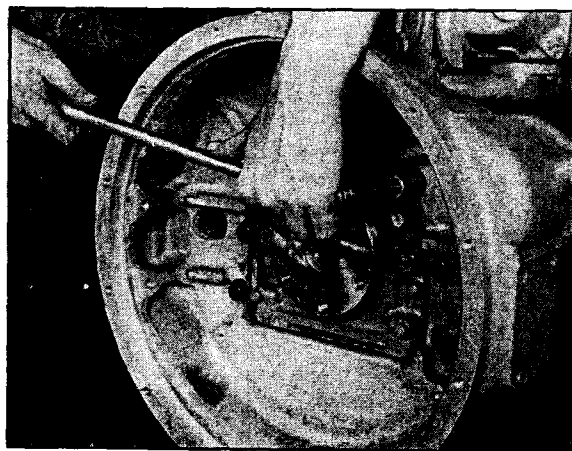


Fig. 12-73. Installing flywheel housing

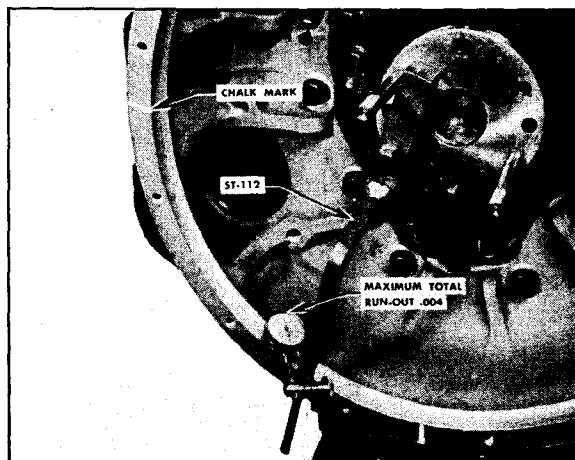


Fig. 12-74. Indicating bore of flywheel housing

to smallest permissible oversize after flywheel housing and face indicate within limits.

CAUTION: BE SURE ALL CAPSCREWS ARE TIGHT.

INDICATE FACE: 1. Shift the gauge to indicate the housing face. See Fig. 12-75. Turn the crankshaft to get readings at various points on the face of the housing. Each time before taking a reading, use a pinch bar between a main bearing cap and crankshaft throw to take up crankshaft end clearance. Take up end clearance the same direction each time. The readings taken at various points must not vary more than .008.

2. If the dowels were removed, ream the dowel holes in the housing and block to nearest oversize and drive in oversize dowels.

3. A drill and ream jig, ST-406, is available

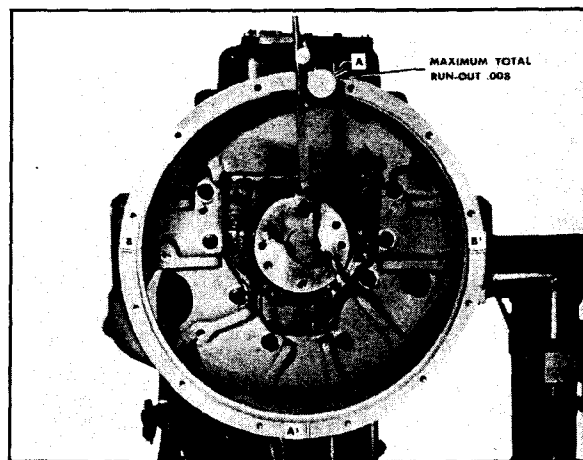


Fig. 12-75. Indicating face of flywheel housing

to locate the drill and reamer of flywheel housing oversize dowels. After the housing is properly located, the jig can be assembled in location and various bushings used for oversize drills and reamers. Unless dowel holes are pilot reamed, the new dowels may cause the housing to shift and, if dowels are not installed straight, trouble will be experienced during next engine tear-down.

Flywheel

1. Thoroughly clean the faces of the flywheel and crankshaft flange of all dirt and burrs. Inspect the dowels. If they are loose or show any signs of shearing or burrs, pull them. If a new flywheel is being installed, remove the old dowels, regardless of condition.

2. If a new flywheel is to be installed match the "O" on the flywheel with the "O" on the crankshaft flange before dowelling the flywheel to the flange.

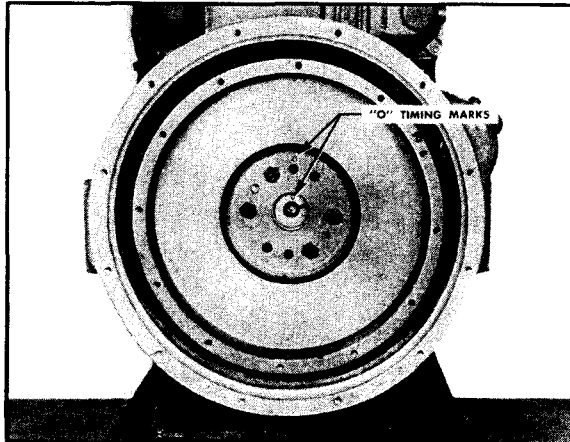


Fig. 12-76. "O" marks on flywheel and crankshaft flange

3. Screw two $\frac{1}{2}$ "-20 studs into the crankshaft flange as guides. Assemble the flywheel over the studs and dowels to the crankshaft flange. If dowels have been removed, match dowel holes in flywheel and crankshaft.

4. Insert the proper capscrews. Tighten them alternately, a little at a time, to pull the flywheel up evenly. Continue until all capscrews are tight. **INDICATE BORE:** Attach an indicator gauge to the side of the flywheel housing to indicate

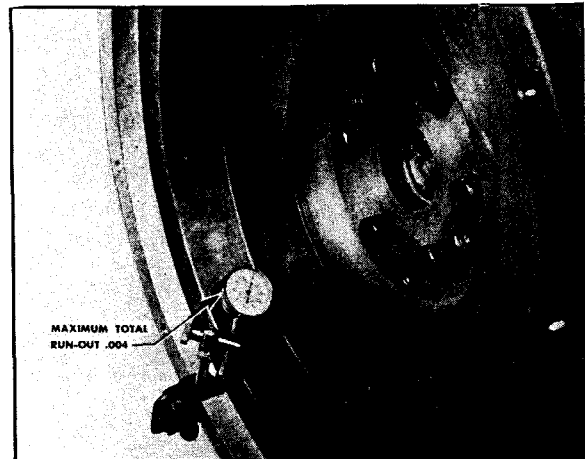


Fig. 12-77. Indicating flywheel bore

the bore of the flywheel. The total run-out must not be greater than .004. Fig. 12-77.

INDICATE FACE: 1. Shift the gauge to indicate the face of the flywheel. Mark with chalk four spots equidistant on the circumference of the flywheel. Fig. 12-78.

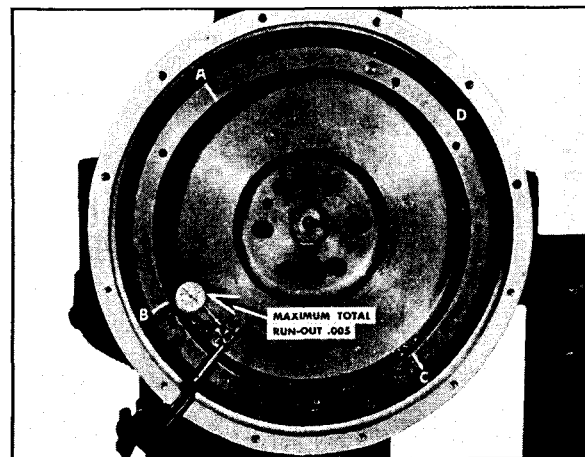


Fig. 12-78. Indicating flywheel face

2. As the crankshaft is turned to bring up each of these chalk marks even with the indicator, take up crankshaft end clearance. With the end clearance taken up, the total run-out at these four equidistant points must not exceed .005. If the run-out does exceed .005, remove the flywheel and again clean the faces of flywheel and crankshaft flange. Reinstall and recheck both bore and face.

3. If the old dowels have been removed, ream the dowel holes in the flywheel and flange to nearest oversize and drive in oversize dowels.

4. Lock the capscrews in pairs with lock wires.

Cranking Motor

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

Water Pump Extension Flange

1. Tighten the water pump extension flange with gasket to the pump inlet connection. Fig. 12-79.

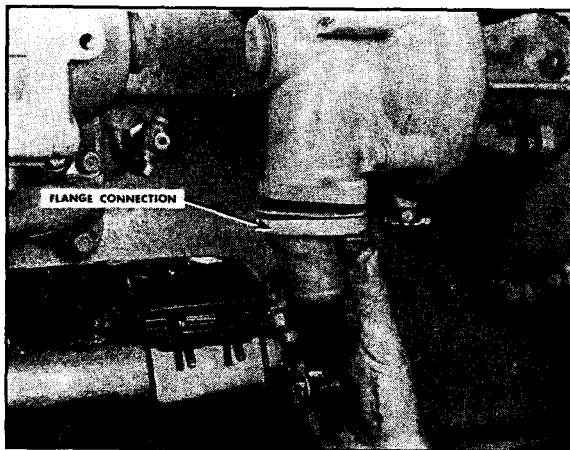


Fig. 12-79. Installing water pump extension flange

Remove Engine from Stand and Place in Skid or on Front and Rear Supports.

1-6 T.C. Mark on Flywheel Housing

1. As a double check to be sure that all units have been assembled for correct gear train and camshaft timing, turn the flywheel to index the 1-6 T.C. marks on the flywheel and flywheel housing. Fig. 12-80.

2. When the 1-6 TC (top center) marks on the flywheel are indexed with the mark on the flywheel housing, the 1-6 TC marks at the accessory drive pulley also must be indexed with

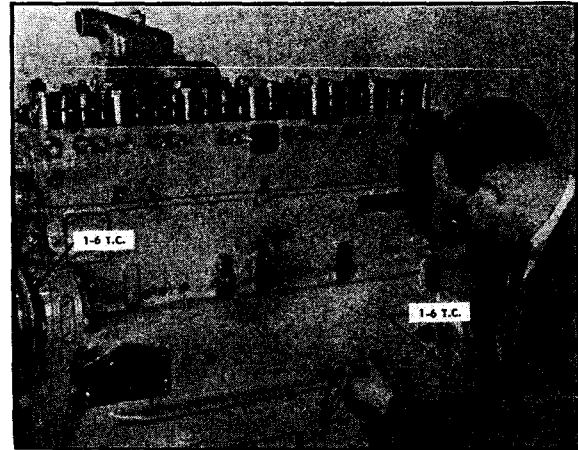


Fig. 12-80. 1-6 TC marks on flywheel and flywheel housing

the mark on the gear case cover. If the marks do not index, remove the gear case cover and re-check the gear train timing marks.

Oil Transfer Connection

With two gaskets, four lockwashers and capscrews, assemble the oil transfer connection to the block.

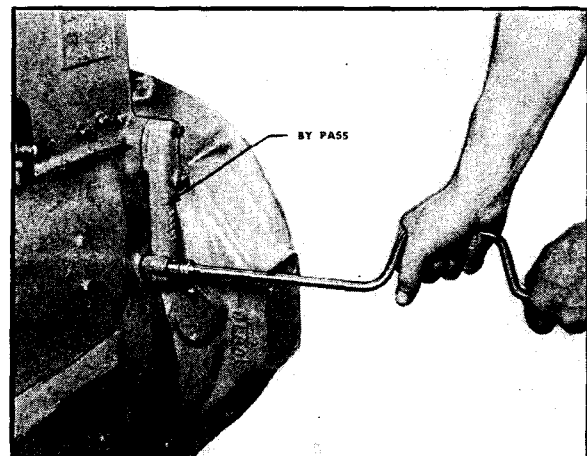


Fig. 12-81. Installing oil transfer connection

Dipstick and Bracket

1. Assemble the dipstick and bracket with gasket to the oil pan. Tighten the mounting capscrews.

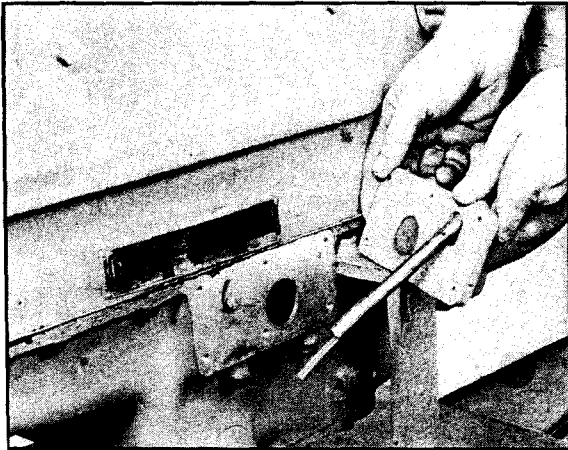


Fig. 12-82. Installing dipstick and bracket

Generator and Bracket

1. Assemble the generator and bracket to the cylinder head with three lockwashers and capscrews.
2. Tighten the generator V-belt so that belt will deflect $1 \frac{5}{32}$ " at 25-pound pull.

Fuel Inlet and Drain Lines

1. Clamp the injector fuel inlet and drain manifolds to the side of the cylinder head.
2. Start the inlet and drain line connections by hand to avoid cross threading.

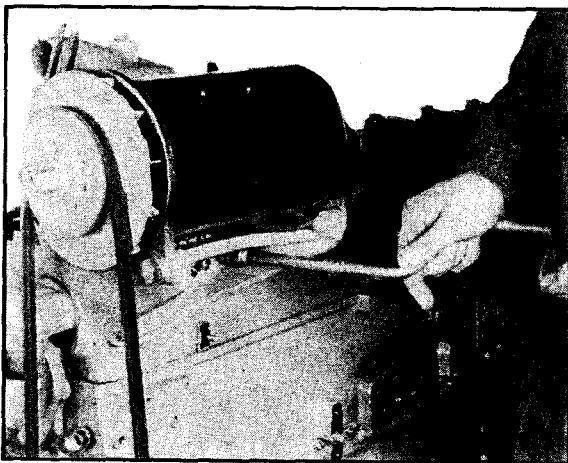


Fig. 12-83. Installing generator and bracket

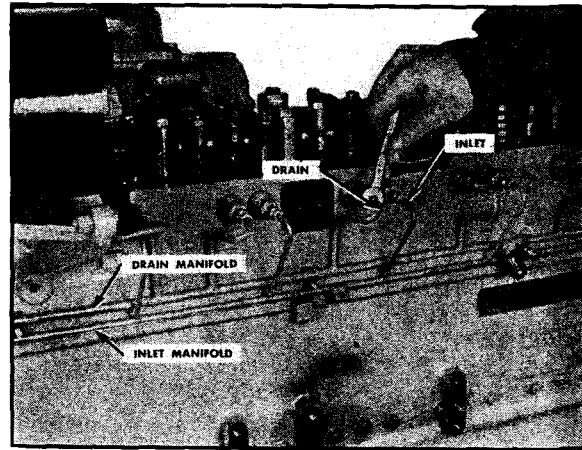


Fig. 12-84. Installing fuel inlet and drain lines

3. Fuel inlet connections are $\frac{3}{16}$ " diameter and drain connections are $\frac{1}{4}$ " diameter. Inlet connections are to the rear, or flywheel end, of each cylinder.

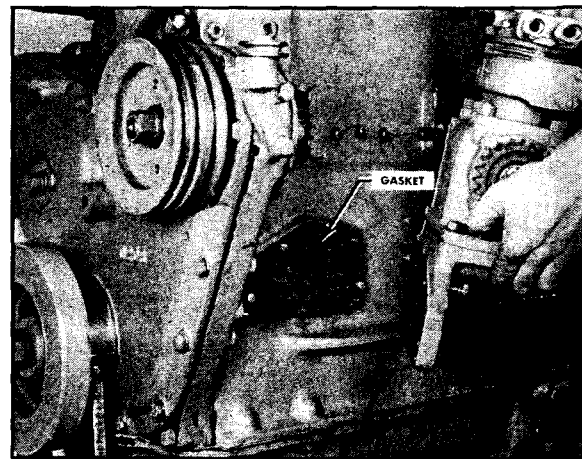


Fig. 12-85. Installing compressor

Air Compressor and Oil Strainer

1. Place the gasket and air compressor over the dowel pins, and fasten securely with two lockwashers and capscrews.
2. Assemble the oil strainer over the air compressor bracket with a gasket, four lockwashers and capscrews.

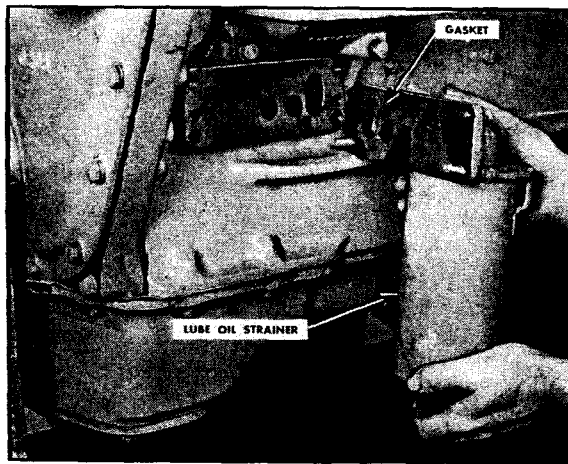


Fig. 12-86. Installing oil strainer

3. Assemble drive chain over accessory drive and compressor spider gears.
4. Install the water lines from the compressor to the cylinder head and block.

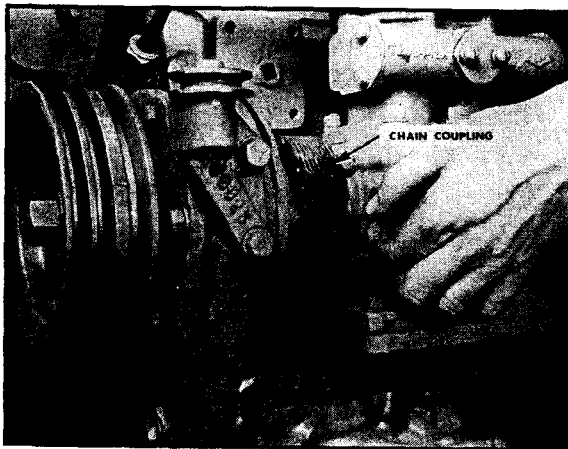


Fig. 12-87. Installing compressor drive chain

PT Fuel Pump (J, JS, JT Engines)

1. Place the fuel pump and bracket in position over the dowels and against the block.

NOTE: It may be necessary to bar the engine over slightly to turn the coupling in correct position to allow the fuel pump bracket to fit over the block dowels.

2. Be sure the rubber "spider" is correctly positioned between the fuel pump-to-compressor couplings.

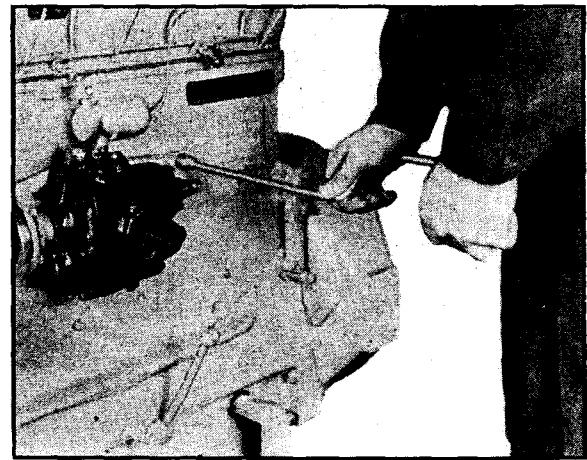


Fig. 12-88. Installing fuel pump

3. Tighten the four bracket mounting cap-screws.
4. Install the fuel line from the solenoid shut off valve to the fuel inlet manifold.
5. After engine is mounted, install the flexible fuel lines from the fuel pump to the fuel tank; from the fuel pump to the fuel filter, and from the drain manifold to the fuel tank.

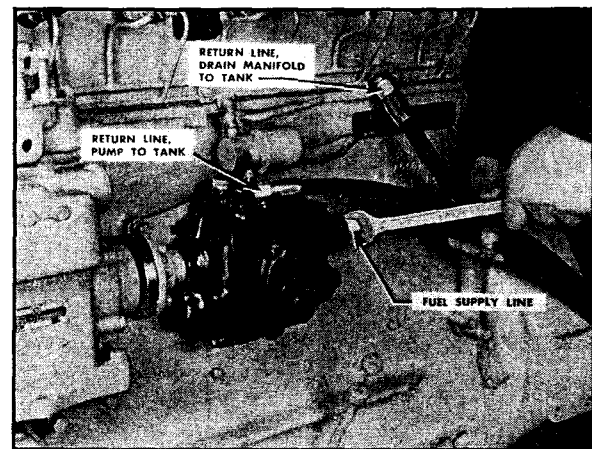


Fig. 12-89. Installing flexible fuel lines

DD Fuel Pump (JS engine only)

1. Assemble the fuel pump over the dowel pins to the block, and tighten mounting cap-screws. Two socket head cap screws are used to mount the fuel pump on the air compressor side.

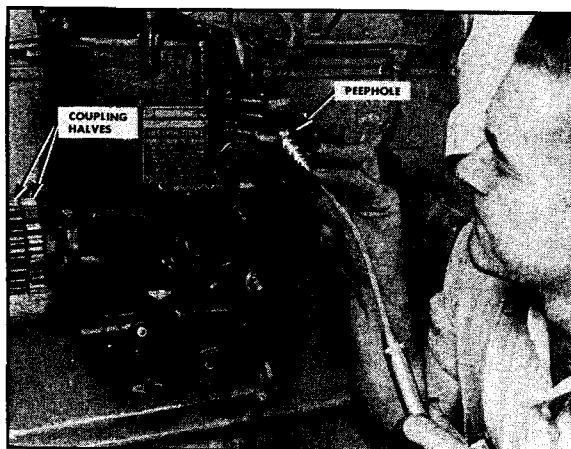


Fig. 12-90. Timing the fuel pump

2. Remove the $\frac{1}{8}$ " socket head plug from the peep hole and rotate the spider gear of the pump until the timing mark appears in the peep hole. Fig. 12-90.

3. Rotate the crankshaft until the engine is No. 1 Top Center position. At this point the "1-6 TC" mark on the accessory drive pulley will be indexed with the arrow on the boss of the gear case cover and both intake and exhaust valves for No. 1 cylinder will be closed. Fig. 12-91.

4. Install the Morse chain coupling to the fuel pump spider gear and the drive gear. Mate these gears to the nearest tooth.

5. Connect the fuel pump throttle control arm to the arm of the throttle linkage bracket.

6. The fuel pump is now timed to the engine.

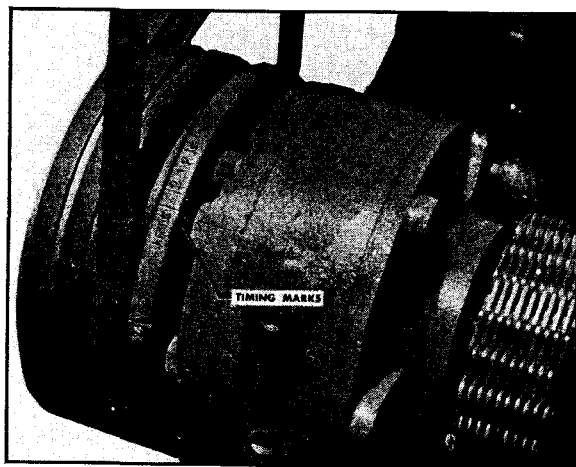


Fig. 12-91. "1-6 TC" mark on accessory drive pulley

Priming Pump

Install the priming pump bracket to the top of the fuel pump, if so located, with two lock-washers and capscrews.

Fuel Lines

1. Assemble fuel supply tubes from fuel pump distributor to each of the fuel inlet connections. Connections on the fuel pump distributor are numbered to correspond to the cylinders in firing order.

2. Start each connection by hand to avoid cross threading.

3. Assemble fuel drain tube from the injector drain manifold to the fuel pump.

4. Install and tighten fuel tubes from the fuel inlet connection of the fuel pump to the priming pump, then from the discharge side of the priming pump into a $\frac{1}{4}$ " tapped hole in the fuel pump housing.

Fuel Filter

1. The fuel filter may be mounted to the cylinder block or to the truck chassis or mounting frame, depending on the installation.

2. Connect and tighten the fuel filter fuel lines. The filter is marked for "inlet" and "outlet" connections.

Injector Plunger and Valve Adjustments (J, JS, JT Engines)

Injector plungers and valves should be adjusted before starting the engine the first time, after the first 50 hours service and every 2000 gallons fuel consumed thereafter.

Injector plungers and valves are adjusted 90° after top center firing position, and fan drive pulleys are so marked.

ENGINE FIRING ORDER: 1-5-3-6-2-4. Cylinders are numbered from front of engine.

POSITIONS FOR INJECTOR AND VALVE ADJUSTMENTS: 1. Pull the compression release lever back and block in the open position. This lifts all intake valves and makes it possible

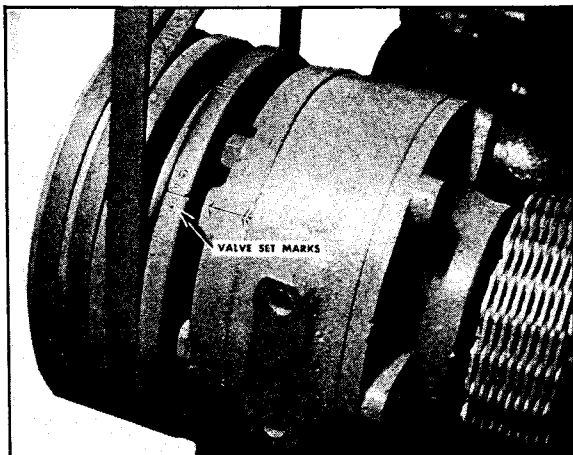


Fig. 12-92. Valve set marks

to turn the crankshaft without working against compression.

2. Bar the engine in its operating direction to No. 1 Top Center Firing position. In this position, both intake and exhaust valves will be closed for No. 1 cylinder.

3. Continue to rotate the crankshaft in its operating direction one-quarter turn and the "1-6VS" mark on the fan drive pulley will line up with the timing mark on the gear case cover. The engine is now in position to adjust the injector plunger and valves for No. 1 cylinder. Fig. 12-92.

4. Adjust injector plunger and valves of No. 1 cylinder as directed in succeeding paragraphs under ADJUSTING INJECTOR PLUNGERS and VALVE ADJUSTMENT.

5. Rotate the crankshaft in operating direction to the next "VS" mark corresponding to firing order of the engine. For right-hand six cylinder engines this will be "2-5VS" and the cylinder ready for adjustment will be No. 5.

6. Continue rotation of crankshaft in operating direction and continue adjustments until all injectors and valves have been correctly adjusted.

CAUTION: 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 SETTING.

ADJUSTING INJECTOR PLUNGERS: 1. Adjust injector plungers and valves in valve-set posi-

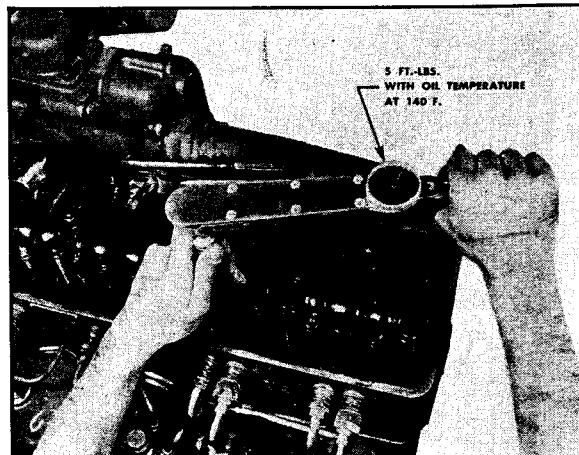


Fig. 12-93. Adjusting injector plunger

tion for the cylinder being adjusted as detailed in previous paragraphs under POSITIONS FOR INJECTOR AND VALVE ADJUSTMENTS: Always adjust injector plunger before valves.

2. Check threads of injector adjusting screw and nut to see that they are clean, well oiled, and free-turning.

3. With engine in valve-set position for injector being adjusted, turn the injector adjusting screw down until the plunger contacts the cup, and advance an additional 15 degrees to squeeze oil out of cup.

4. Loosen the adjusting screw one turn.

5. Use a torque screw driver or an accurately calibrated torque wrench to tighten the injector adjusting screw to the torque shown:

Temporary Adjustment: 4 foot-pounds with oil temperature at 70° F.

Final Adjustment: 5 foot-pounds with oil temperature at 140° F.

6. Do not use hold-down tools or injector adjusting clips when adjusting injectors by the torque method.

NOTE: Some of the first JS engines built have template marks 15° apart on the injector rocker levers. These marks are to be disregarded.

VALVE CROSSHEAD ADJUSTMENT: JT engine only: 1. Loosen the valve crosshead adjusting lock nut and back off the adjusting screw one turn.

2. Use light finger pressure at "A" to hold the crosshead in contact with the valve stem "B".

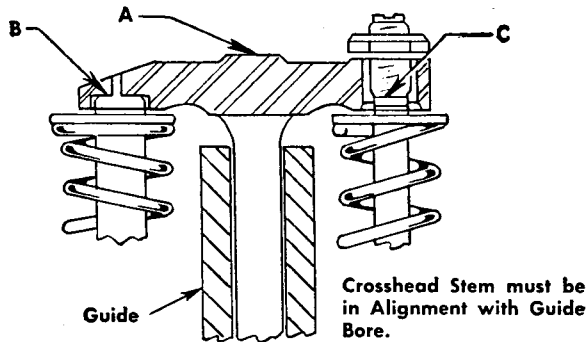


Fig. 12-94. Alignment of crosshead stem and guide

Turn down the crosshead adjusting screw until it touches the valve stem "C". Fig. 12-94.

3. For new crossheads and guides, advance the crosshead adjusting screw $\frac{1}{3}$ of one hex (or 20°) more to straighten the stem in its guide and to compensate for slack in threads. On old-style or worn crossheads and guides it may be necessary to advance the screw as much as 30 degrees in order to straighten the stem in its guide.

4. Lock the adjusting screw in this position. Adjust both intake and exhaust valve crossheads in this manner.

VALVE ADJUSTMENT: 1. The same engine position used in setting the injector is used for setting the intake and exhaust valves.

2. Make sure the compression release is in running position before setting the intake valves.

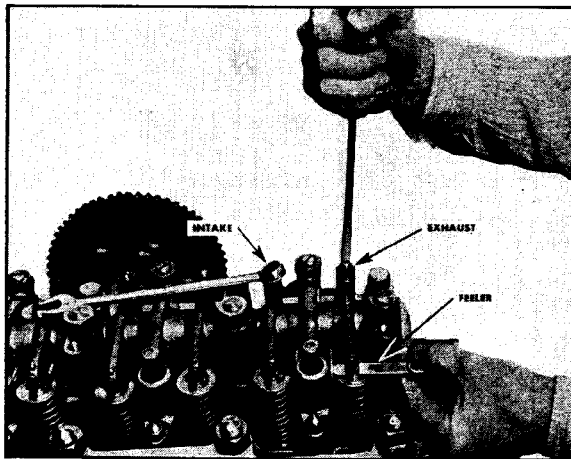


Fig. 12-95. Valve adjustment

3. Loosen the valve adjusting lock nut and back off the adjusting screw.

4. With a feeler gauge of proper thickness for the valve being adjusted inserted between the rocker lever and valve stem, turn the adjusting screw down until the lever just touches the feeler gauge. Lock adjusting screw in this position with the jam nut. Fig. 12-95.

5. Always make final valve adjustments after injectors are adjusted, and with the engine warm (oil temperature 140° F.). Set intake valves with .015 clearance, and exhaust valves with .025 clearance.

Turbocharger (JT engine only)

1. Lift the turbocharger, with gasket, into position over the exhaust manifold flange studs. Tighten securely with four hug-lock nuts.

2. Connect and tighten the water inlet line at the bottom of the turbocharger and at the water side of the oil cooler.

3. Connect and tighten the water outlet line at the top of the turbocharger and at the radiator connection on top of the thermostat housing.

4. Connect and tighten the oil inlet line at the oil cooler and at the side of the turbocharger.

5. Connect and tighten the oil drain line at the oil pan and at the bottom of the turbocharger directly over the exhaust manifold.

6. Install the rubber hose connection and tighten the hose clamps at the turbocharger fresh air outlet and at the intake manifold.

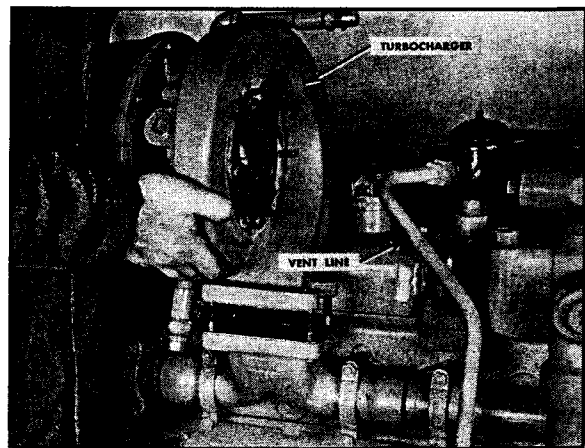


Fig. 12-96. Lifting turbocharger to engine

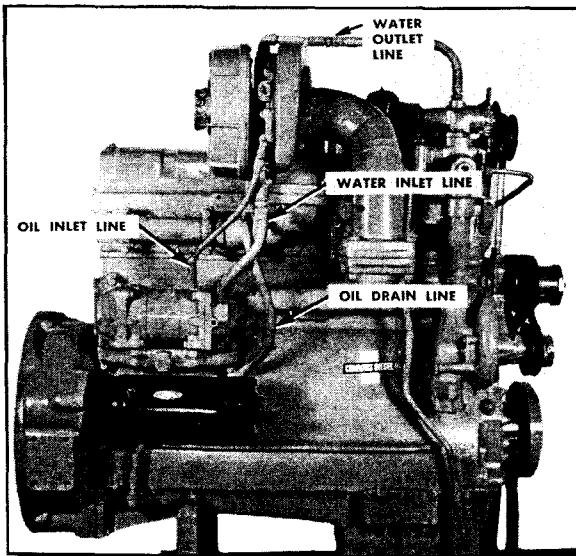


Fig. 12-97. Location of water and oil lines

Rocker Lever Cover

1. Shellac a new gasket to the rocker lever cover and assemble the cover to the cylinder head with four washers and capscrews.
2. Assemble the vapor suction line connecting the cover to the supercharger air intake.

Generator V-Belt

Install the generator V-belt and adjust to proper tension.

Vacuum Pump

The bracket for this unit is mounted with four capscrews to the main block so that the front of the vacuum pump hangs over the gear case cover. The vacuum pump is held to this bracket with four capscrews. It is important that its pulley be lined up with the drive pulley.

Fan and Pulley

1. Assemble the bracket and pulley to the block with three lockwashers and capscrews.
2. Install the two fan pulley V-belts, loosen the large hex nut and bring the belts to proper tension with the pulley adjusting screw as instructed in paragraph 4. Tighten the hex nut.

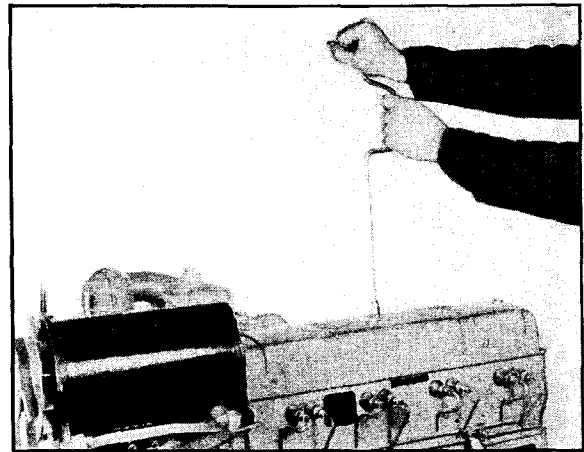


Fig. 12-98. Installing rocker lever cover

3. On JT engines with the water pump driven from the fan hub, proceed as follows:
 - A. Before tightening the fan drive belts, loosen the water pump belt by separating the water pump pulley sheaves.
 - B. Tighten the fan drive belts to proper tension as described in paragraphs 2 and 4.
 - C. Tighten the water pump belt by adjusting the water pump pulley sheaves with ST-491. After correct belt tension is obtained, tighten the two socket head screws on the pulley hub.
4. Adjust the tension of the fan and water pump belts so that a 25 pound pull midway between pulley centers will deflect the belts $\frac{1}{2}$ inch. Use a fish scale or any other small spring scale to check the belts for proper tension.

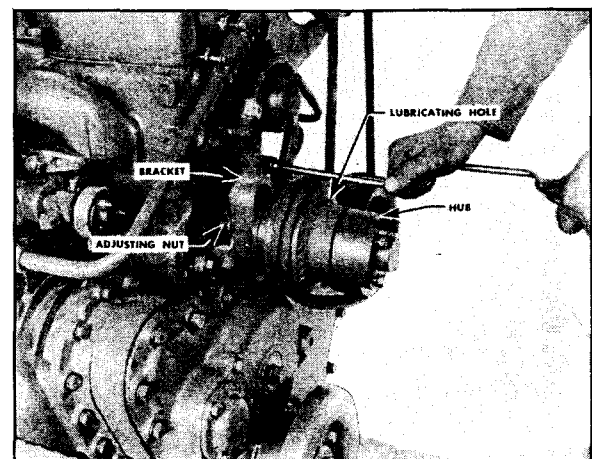


Fig. 12-99. Installing fan bracket and hub

5. Place the fan over the fan hub and tighten with four lock washers and capscrews.

Lubricating System

PRIME LUBRICATING OIL PASSAGES: 1. Remove one of the Allen set screws from the oil header at the side of the cylinder block and connect with a hand priming pump and source of good, clean SAE No. 20 lubricating oil.

2. Pump the oil into the oil gallery to make sure all bearings have an adequate supply of oil for starting.

3. Crank the engine over a few times by hand during this operation. Remove the pump connection and install the set screw.

FILL CRANKCASE: Finish filling the crankcase to the "H" (high) mark on the bayonet gauge with SAE No. 20 lubricating oil.

CAUTION: AFTER ENGINE IS RUN A FEW MINUTES IT WILL BE NECESSARY TO ADD LUBRICATING OIL TO COMPENSATE FOR THAT TAKEN UP BY THE FILTER AND OIL COOLER.

CRANKING MOTOR AND GENERATOR: Put several drops of SAE No. 10W or SAE No. 20 lubricating oil in bearing cups of cranking motor and generator.

Wiring

Install wire leads to terminals of generator, cranking motor, cold starting electrodes, and all other electric controls, as used.

Cooling System

1. Connect the engine cooling system to the radiator or other cooling unit.

2. Fill the cooling system with engine coolant consisting of 3% to 4% soluble oil and 96% to 97% water.

NOTE: If antifreeze is used, do not use soluble oil.

Priming the Pump and Fuel Lines (JS engines equipped with DD fuel pump)

All fuel passages in the entire fuel system must be full of fuel before starting the engine. "Empty" fuel lines are full of air, and the air must be displaced by priming. Priming will be

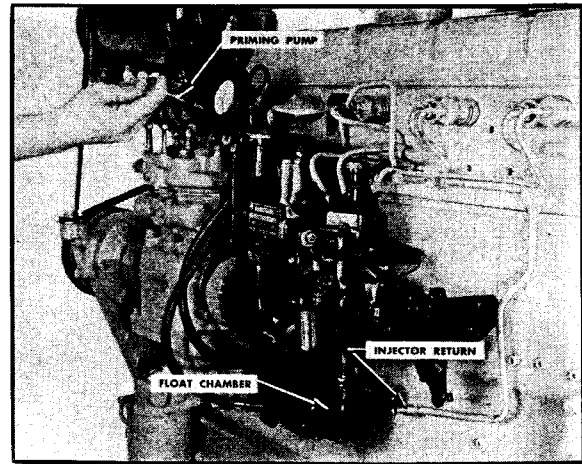


Fig. 12-100. Priming float chamber

necessary when the engine is started the first time, after it runs out of fuel or at any time air is allowed to enter the system. Priming also assures initial lubrication to the bearings and bushings.

1. Check all fuel lines to avoid possible fuel leaks.

2. Make sure that the emergency shut-off and reset button on the fuel pump is in the open or cocked position. Button should be in "pulled-out" position.

3. Disconnect injector return line at pump.

4. Open priming pump, and pump until solid fuel flows out this opening in the fuel pump. (Fig. 12-100).

5. Replace return line and tighten the connection.

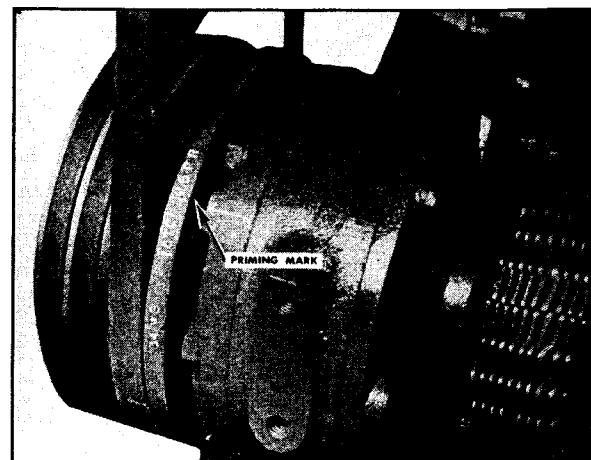


Fig. 12-101. Priming marks on gear case cover and fan drive pulley

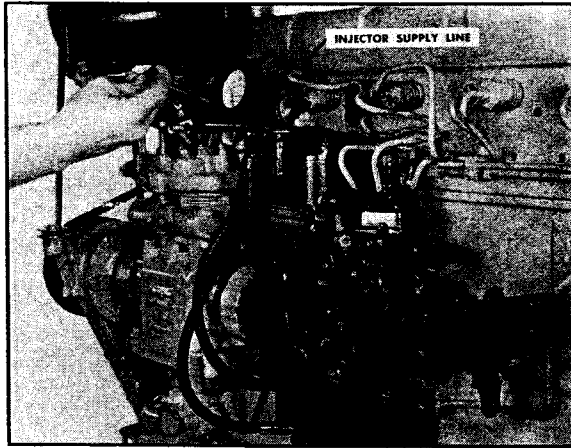


Fig. 12-102. Priming discharge disc

6. Loosen injector lines from injector inlet connections.

7. Crank or bar the engine in operating direction until a "PR" mark on the fan drive pulley is indexed with the timing mark on the gear case cover. See Fig. 12-99. Use the compression release for ease in turning. Work the priming pump until fuel comes out of the indexed line, then tighten this line to the injector and give two more strokes of the priming pump. Over priming is not necessary or desirable. Proceed in this manner until all six lines and injectors have been primed. Refer to Fig. 12-102.

NOTE: A small amount of air in the line may cause the engine to run unevenly for a short time; however, if the engine is allowed to continue running it will prime the air out of the lines and settle down to normal operation.

Priming Pt Fuel Systems (J, JS, JT engines)

The PT fuel system does not require priming, but if the pump is dry it will pick up fuel faster if the gear pump is primed. To do this, disconnect fuel suction line at pump and squirt a little clean lubricating oil into gear pump from an oil can.

Normal Starting Procedure

1. Set throttle for idle speed.
2. Release the clutch.
3. If you have a manual fuel shut-off valve, open it.

4. Pull the compression release.
5. Press the starter button or turn switch-key to "start" position.
6. After three or four seconds of cranking close the compression release and continue to crank until the engine starts.

NOTE: Do not crank for more than 30 seconds continuously or you may burn out the cranking motor. If engine does not fire within the first 30 seconds wait two to five minutes before re-cranking.

Cold Weather Starting

As an aid in starting the engine when the ambient temperature is 50° F. or below, an intake air preheater arrangement is supplied as standard equipment on all JS and JT engines. This equipment consists of a hand priming pump to pump fuel into the intake manifold, a glow plug electrically heated by the battery, and a switch to turn on the glow plug when fuel is pumped into the intake manifold. The fuel burns in the intake manifold and heats the intake air. The warm intake air is compressed and heated further by engine cranking so that with injection of fuel into the hot air, ignition is accompanied without delay.

To Use The Preheater For Cold Starting Follow This Starting Procedure:

1. Set throttle in idle position.
2. Give one or two strokes to preheater priming pump—just enough to prime it—then stop pumping immediately. Overpriming will wet glow plug and delay ignition in preheater.
3. Engage glow plug manual switch and keep it engaged for 20 seconds.
4. Crank engine while operating preheater priming pump to maintain approximately 60 psi fuel pressure. Red light must be on indicating that current is flowing to glow plug.
5. After engine starts, maintain only sufficient fuel pressure to keep the engine idling smoothly. Pressure may vary between 40 and 100 psi.
6. When engine has warmed up until it does not falter between preheater pump strokes, stop pumping and lock pump.

When the preheater is not in use, the dash indicator light should be off, indicating that no current is flowing to the glow plug.

DO NOT USE PREHEATER WHEN ENGINE IS PULLING LOAD. THE PREHEATER BURNS INCOMING AIR, AND MAY RESULT IN DAMAGE TO THE ENGINE.

TESTING THE ENGINE

The "break-in" or "run-in" period for an engine is that initial operating period when moving parts acquire their final finish and mating surfaces reach a full seat. Piston rings must seat or conform to the cylinder liner to control oil and exhaust gases.

An engine can not be broken-in without applying load. Generally speaking, the load should be a *maximum safe* figure. It is not safe to apply full load at the start nor is it safe or desirable to operate at top rpm during the first hour of running.

Engine testing and engine break-in are accomplished at the same time. Engine break-in is necessary for the reasons already given, while engine testing detects possible mistakes in assembly, the need for adjustments as the engine breaks in and the final adjustments for best performance.

Test Equipment

DYNAMOMETER: A dynamometer provides the easiest and most accurate method of applying load to a new or rebuilt engine. Running the engine without load for any extended period is worse than waiting until it is installed and then running it under controlled conditions.

The dynamometer must be equipped with an accurate scale and accurate instruments. A beam-type scale is most reliable.

AIR CLEANER: All engines should be tested with the standard air cleaner approved for the engine model, and it must be hooked up so that the depression does not exceed 12" of water in the intake manifold taken one inch from the intake opening for standard engines. For supercharged engines, a depression of 14" of water, taken on the intake side of the supercharger

housing at the tapped hole provided therefor, is permissible.

LUBRICATING OIL STRAINER: All engines must be tested with a full-flow lubricating oil strainer (Air-Maze or Nugent) installed to protect against entrapped grit and dirt.

LUBRICATING OIL: 1. Use a good grade SAE No. 20 lubricating oil for engine run-in and until the first oil change.

2. See Page 12-31 for method of priming oil passages before the engine is started.

Checks During Break-In Run

ENGINE BLOW-BY: 1. Remove all breathers or covers which would allow the blow-by gas to escape and close openings by using plain covers. On supercharged engines disconnect the supercharger vapor suction tube, and replace cover with plain one or plug the hole. It is not necessary to plug or remove the oil dipstick provided it is the sealed type.

2. Install a rocker housing cover with ST-487 tool mounted in it as shown on the attached sketch. The connection must be air-tight.

NOTE: ST-487 Blow-By Checking Tool consists of a T-connection with a .302 inch orifice and a manometer as shown in Fig. 12-103.

3. Attach a manometer to the hose coupling on ST-487, and fill the tube to the "0" mark at middle of the scale with water. To make reading easier add color to the water.

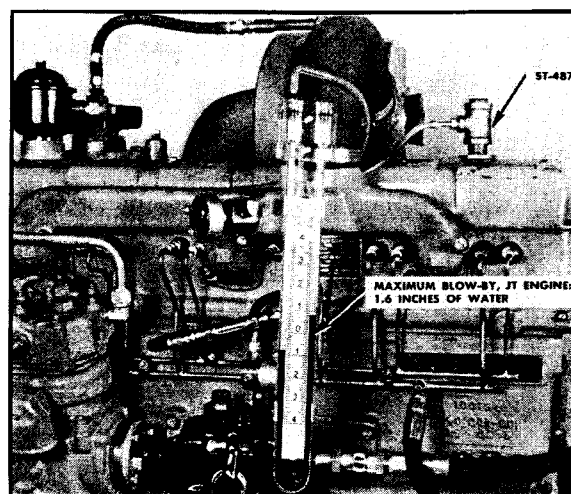


Fig. 12-103. Checking blow-by with ST-487

Table 1: Maximum and Test Horsepower Ratings

Standard Test Conditions:		Temperature Not Over 90° F.: Altitude Not Over 1000 Feet 1% for Each 10° Temperature Rise Above 90° F., 3% for Each 1000 Ft. Altitude Rise Above 1000 Feet			
Derate Horsepower:		HORSEPOWER			
ENGINE MODEL	100% Rated @ RPM	96% @ RPM	25% @ 1200	50% @ 1600	75% @ 1800
JS-600	150 @ 2500	144 @ 2500	20	55	91
JT-600	175 @ 2500	168 @ 2500	22	61	105

Table 2. Formula to Determine Brake Horsepower

$$\text{BRAKE HORSEPOWER} = \frac{\text{Torque (in Foot-Pounds)} \times \text{RPM}}{5252}$$

Table 3. Fuel Consumption

Standard Test Conditions:		Temperature Not Over 90° F.: Altitude Not Over 1000 Feet 1% for Each 10° Temperature Rise Above 90° F., 3% for Each 1000 Ft. Altitude Rise Above 1000 Feet	
Decrease Fuel Rate:		Fuel Rate for Maximum Horsepower	
ENGINE MODEL	Max. HP @ RPM	Lbs. Per Hour	Lbs. Per Five Minutes
JS-600	150 @ 2500	73-76	6.2
JT-600	175 @ 2500	72-74	6.1

4. If new elements or bags have been installed in the lubricating oil filters, the engine should be shut off after approximately 30 minutes operation and additional lubricating oil added to the crankcase to bring the oil level to the "H" mark on the bayonet oil gauge. Thereafter, the oil level should be checked every two hours during run-in test. Any appreciable loss of lubricating oil indicates that it is getting into fuel lines and being burned. Any increase in lubricating oil level indicates dilution by fuel oil.

Engine Coolant: 1. After the engine is started add coolant as needed to completely fill the cooling system and replace entrapped air.

2. 170° F. is the ideal water temperature for best engine performance.

3. Do not stop the engine suddenly after a load run. Heat stored in the iron masses will boil the cooling water in the jackets if air and water circulation is immediately stopped while the engine is hot. Allow the engine to idle for a few minutes before shutting down.

Fuel Lines: Check all fuel lines and fuel connections to see that they are tight and not leaking.

Lubricating Oil Lines: 1. Check all lubricating oil lines and connections to see that the lines on

the pressure side of the lubricating oil pump are not leaking oil.

2. Leaks in lubricating oil suction lines are harder to detect than those on the pressure side of the pump. These can generally be detected by testing with oil from an oil can. If the suction lines leak, it may cause foaming of oil in the crankcase and, eventually, bearing failure.

Overspeed Stop: 1. Overspeed stops, when used, are set to trip and shut off fuel supply when the engine exceeds maximum rated speed by approximately 15%. Under certain conditions the overspeed stop may permit enough fuel to pass to operate the engine at idling speed.

2. After determining and correcting the cause of the overspeed stop trip, reset the overspeed stop in running position.

Compression Release Lever: 1. All Cummins engines are equipped with a compression release lever. Pulling this lever lifts the intake valve push rod and opens the intake valves. This relieves compression inside the combustion chamber and the engine will not run.

CAUTION: IF THE COMPRESSION RELEASE LEVER IS INCORRECTLY ADJUSTED, PULLING THE HAND LEVER TO ITS EXTREME OPEN POSITION MAY CAUSE THE PISTONS TO STRIKE THE INTAKE VALVES AND RESULT IN EXTENSIVE DAMAGE.

SECTION XIII**UNITS NO. 15 AND NO. 16****Engine Mounting And Adaptations****UNIT No. 15 INSTRUMENT PANELS AND CONTROLS**

Because of special requirements and variations in instrument panels and control no attempt will be made in this manual to show panel wiring diagrams or instrument mounting.

Special wiring diagrams for power installations are available either from Cummins Engine Co., Inc., or from the contractor or company making the installation.

UNIT No. 16: ENGINE MOUNTING AND ADAPTATION

It is to the mutual advantage of the manufacturer, dealer organization and owners of Cummins engines that all engines be properly installed in their mountings and assembled to their driven units in a manner that will permit the engine to give its best service. This section is devoted to pointing out some of the more common errors in mounting and adaptation and in showing how to avoid those errors.

Front Engine Supports, Flywheels and Flywheel Housings

1. Cummins diesel engines are used in a wide variety of power applications. Literally hundreds of flywheel housings and flywheels are provided for adaptations. Special dealer manuals are provided dealers by Cummins' sales engineering department to help them select the right parts for the application. In case of doubt concerning any application, consult the factory.

2. No attempt should be made to remachine flywheels in a shop that is not equipped to maintain factory standards both as to dimensions and static balance. The static balance tolerance of JS flywheels is 2-inch ounces maximum.

Torsionals and Vibration Dampers

TORSIONAL VIBRATIONS: 1. All rotating crankshafts at certain speeds, called critical speeds, become unstable and torsional vibrations

are likely to develop. These vibrations, if allowed to continue, will cause excessive wear of gear train driven accessories and will, eventually, cause the crankshaft to break.

2. The diameter and length of the shaft and the load distribution determine, to a large degree, the critical speeds. Therefore, changing the length of crankshaft, by rigidly attaching another shaft of a driven unit to it, will change the critical speed of that crankshaft.

3. If the critical speed occurs in the engine operating range, a vibration damper must be used in that application to prevent crankshaft breakage.

4. Critical speeds are calculated for all standard applications and vibration dampers are specified where needed. Consult with Cummins engineers concerning the need for vibration dampers on any new or different power application.

5. Not all vibration dampers are alike. Most dampers used on JS engines are designed to combat, or damp, vibrations of 4½ and 6th orders. The damper must be applicable to the job.

VIBRATION DAMPERS: 1. Either one of two types of vibration dampers may be used on J, JS and JT engines.

2. The damper currently used is a viscous-type damper which consists of a doughnut-shaped ring inside a formed housing. Between the

ring and housing is a small amount of silicone fluid. Only 1/64" space is provided between the ring and the housing; therefore, careful periodic inspection is required to make sure that the housing is not dented. A dent may block the ring and render the damper useless. Also with this type damper, occasional inspection must be made to make sure the viscous fluid is not lost because of damage to the housing, broken welds, etc.

Marine Gears

ALIGNMENT WITH CRANKSHAFT: 1. The most important precaution to insure satisfactory operation of a marine reverse gear is to make sure that the closest possible alignment is provided between the engine crankshaft and the marine gear. Improper alignment will result in undue wear because of excessive stressing of parts in both the clutch and the reverse gear mechanism.

2. Check the flywheel housing and see that it is the one specified for use with the marine gear.

3. Make sure that flywheel housing and flywheel are assembled as directed in engine assembly section.

ASSEMBLY TO ENGINE: 1. The marine gear and clutch assembly are assembled to the engine as one unit and it is only necessary to remove the small cover plate on the top of the clutch housing for assembly purposes.

2. With the marine gear in place against the flywheel housing of the engine, the bolts which attach the clutch to the flywheel should be assembled first. Care should be taken to pull these bolts up uniformly and to make sure that the pilot on the clutch plate has definitely entered into the flywheel before any of these bolts are pulled up tight and securely locked by means of lockwashers.

3. It is advisable to insert two bolts in the flywheel housing and marine gear case which will serve to guide the pilot in the clutch housing to enter into the flywheel housing while the clutch bolts are being tightened.

MAINTAIN CRANKSHAFT END CLEARANCE: 1. Crankshaft end clearance must be maintained after assembly of gear to the engine.

Sometimes long pilot shafts, or tight fitting pilot bearings, tend to reduce crankshaft end clearance. This must be corrected to prevent engine failure.

2. Indicate end clearance with a dial gauge as directed in engine assembly instructions.

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

2. After the entire assembly has been set on the foundation provided for the same, it must be properly aligned with the propeller shaft. Care should be taken to make this alignment without pulling the support brackets on the marine gear out of their proper position, and for this reason it is recommended to provide clearance for shimming at this point. It is advisable to recheck the alignment after the engine foundation bolts have been tightened and then to carefully shim up under the marine gear support bracket.

3. Experience has shown that the hull often changes its shape after the boat has been launched, and it is advisable to recheck and correct the alignment, if necessary, with the boat in the water. This can be accomplished by removing the bolts in the propeller shaft coupling and checking the spacing of the two flanges on the circumference. For satisfactory alignment, the variation should not exceed .004.

Power Generators

1. The same rules given for assembly of marine gears to the engine apply to mounting of power generators.

2. Alignment of armature with crankshaft must be made within close limits.

3. Crankshaft end clearance must be maintained after assembly of generator, or of any driven unit, to the engine.

Intake Air Suctions

1. One essential to get maximum power from the Cummins Diesel is an ample supply of clean air. In addition, it is desirable to be able to control the temperature of that air in regard to outside air temperature. The most desirable tem-

perature for intake air is 60° F. to 90° F.

During hot weather it is recommended that air intake suctions be located outside the hood.

2. The air under the hood is generally extremely hot. In some instances, it runs up to 200° F., as it is heated not only when going through the radiator but also by the hot exhaust manifold. This heat expands the air and causes a reduction in the air weight or the actual amount of air which can be taken into the engine. Thus, when the engine lacks sufficient oxygen, the fuel can not be burned completely, causing loss of power and excess smoke.

3. Under cold weather conditions it may be necessary to provide some means of heating the air to keep it in the desirable temperature range.

Cold air will cause a delay in ignition, irregular combustion and a rough running engine. Also, air cleaner efficiency is lowered because of thickening of the oil in the cleaner cup.

However the air heating arrangement is made, two important points must be remembered: (1) Do not restrict air flow, and (2) Air must always go through the air cleaner.

4. If the engine operates in mountainous country, the oxygen content of air is reduced by altitude. Even though an engine has sufficient air at sea level, it would not have enough when it is most needed, pulling up a mountainside. Generally speaking, an engine loses about 3% of its power for each 1,000 ft. of elevation and 1% for each 5 degrees of temperature increase.

Radiator Shutters

1. The temperature of engine coolant should be kept as near 175° F. as possible for best engine performance. Thermostat controlled radiator shutters, when used in conjunction with main line and by-pass thermostats in the engine, should be set to open about 5° before by-pass thermostat closes. The shutters should close about 5° after the main line thermostat opens.

2. It is particularly important that the intake air suctions be outside the hood when radiator shutters are used. With the cool air supply cut off by the shutters, the air inside the hood gets heated from the exhaust manifold. Blowers of supercharged engines are not cooled by fan's slip stream and the fan is practically useless.

Fans

1. Sometimes a great deal of power is sacrificed by using oversize fans. In some cases, a fan that is oversize and overspeeded requires up to 16-18 horsepower. Naturally, the power taken for the fan is not available for the truck's propulsion. Large and oversize fans also cause fan belt failures because fan belts are designed for the standard fan only.

2. Generally speaking, the standard fan is quite adequate if you have the correct size radiator and, most important, if the fan is shrouded. Fans should always be shrouded. It is easy to see that there is no economy in wasting 10 hp. on a fan when it can be eliminated merely by using a shroud over the standard fan.

Exhaust Piping and Mufflers

EXHAUST BACK PRESSURE: Exhaust back pressure has become more and more important. If there is any question as to whether this condition is favorable or unfavorable, check it. If the back pressure is too high, you should bring it down to within the ranges given in succeeding paragraphs.

CHECKING BACK PRESSURE: 1. Tap into the side of the exhaust pipe 1½" aft of the outlet flange or manifold and insert a ⅛" Weather-head fitting. This connection should be flush with inside of pipe and perpendicular with it to avoid impact pressures which would give a false reading. Fasten about 3 feet of copper tubing to the fitting. From the end of the copper tube run a rubber tube to one end of a water or mercury manometer.

2. Back pressure readings must be taken when the engine is developing its maximum horsepower and rpm.

3. When you take a reading from the manometer, add the height reading of the liquid in both columns for the final figure. Example: If the liquid is 1.5 inches high in the left column and 1.5 inches low in the right column, you have 3 inches of pressure. If the mercury is 1.5 inches high in the right column and 1.5 inches low in the left column, you have 3 inches of vacuum.

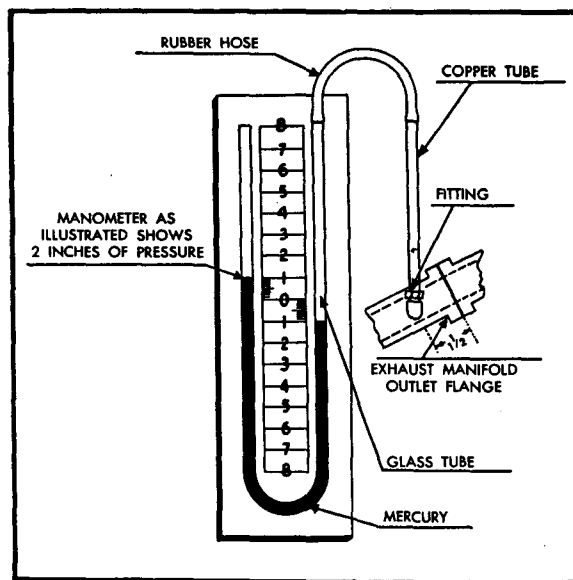


Fig. 13-1. Manometer scale and location on exhaust manifold outlet flange

4. A one-inch reading of mercury is equal to .4985 pounds of back pressure per square inch, or 13.6 inches of water.

5. The back pressure of a standard J and JN engine should not exceed 1 inch of mercury (.50 inches high and low in the two columns) or .49 pounds per square inch. Back pressure of JS and JT engines should not exceed 1.5 inches of mercury or .735 pounds per square inch.

6. If the back pressure reading on the manometer is too high, you must check the entire exhaust system from the exhaust manifold to the end of the tail pipe. Here are the things which will cause a high back pressure. If one or more of them are present in the engine's exhaust system, they should be eliminated.

- a. Right angles (90°) or sharp bends in the exhaust pipe. If it is necessary to bend the exhaust pipe at all, use gentle sweeping curves.
- b. Small exhaust pipe diameters. The diameter of pipe throughout the exhaust system must not be smaller than the diameter of the exhaust manifold's outlet flange.
- c. Restrictions or stoppages in the muffler device. If there is anything in the muffler which retards an easy passage of the exhaust gas, it should be removed.

d. Small diameter tail pipes aft of the muffler. Beware of this condition as it is a common one.

8. Too much back pressure in a supercharged or turbocharged engine definitely reduces the flushing action of the blower and is extremely detrimental to satisfactory operation.

Fuel Tanks and Piping

1. The fuel tank should have a sump that can be drained easily to eliminate water and other sediment.

2. Generous size fuel lines should be used because of the tendency of fuel to congeal during cold weather.

3. The inlet for the fuel line should be so located that foreign matter will not be picked up.

4. Fuel tank transfer valves located in the fuel line must be of a type which will prevent air being drawn into the fuel line at the stem. Valves must also seat, air tight when closed, otherwise air will be drawn into the fuel from an empty tank.

Gear Ratios and Tire Sizes

A full consideration and discussion of the problems involved in choosing gear ratios and tire sizes can not be undertaken in this manual. However, the following points should always be considered in fitting any engine to a job:

1. Peak horsepower is obtained *only* at maximum governed engine speed.

2. A special study should be made of every truck to determine what gear ratios will give the best over-all performance in the normal operating cycle. The unit would not be efficient if the gear ratios were chosen for only a small portion of the normal run.

3. The more gears there are, the better the over-all performance will be, if the gears are used skillfully. But since the number of gear ratios are of necessity limited, it is important that special attention be given to proper spacing. If some gear ratios are so poorly spaced that they can not be used, they are of no value.

SECTION XIV

Engine Rebuild Specifications

UNIT NUMBER	PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
		Minimum	Maximum	

01 Engine Block Group

0101	CYLINDER BLOCK			
	Liner Counterbore Depth	.30925	.31050	.31050
	Protrusion of Liner Above Block	.0045	.00675	.004
	Main Bearing Cap in Block	-.004	-.002	.001
	Main Bearing Bore	4.124	4.125	Same
	Main Bearing Bore—Alignment	Check with ST-409		
	Main Bearing Studs in Block:			
	Tighten to 5 $\frac{3}{4}$ "-5 21/32" height @ minimum	70 ft. lbs.		
	Camshaft Bushings I.D.	1.8745	1.8765	1.878
	Cylinder Liners—I.D.	4.125	4.126	4.130
	Liner to Block Clearance			
	Top Flange	.0015 (Around Entire Liner)		
	Packing Ring Bore	.003 (Around Entire Liner)		
	Bottom of Liner	.010 (Around Entire Liner)		
0102	CRANKSHAFT			
	Main Journals	3.874	3.875	3.872
	Rod Journals	2.624	2.625	2.622
	Fillet Radii	.141	.164	Same
	For Other Dimensions	See Crankshaft Dimensions' Chart, P.2-3		
	Main Bearings—Copper Lead			
	Shell Thickness	.1231	.1236	.1216
	Journal Clearance	.0018	.0048	.0068
	End Clearance	.004	.009	.022
	Tightening	Template Method		
	.010, .020, .030 and .040 undersize			
	main bearing shells are available.			
	Con. Rod Bearings—Copper Lead			
	Shell Thickness	.07225	.07275	.071
	Journal Clearance	.002	.0045	.008
	Tightening	Template Method		
	.005, .010, .020, .030 and .040 undersize			
	connecting rod shells are available.			
0103	CONNECTING ROD			
	Center to Center	9.498	9.500	Same
	Crankpin Bore	2.7725	2.7730	
	Maximum Out-of-round			.0015
	Weight Variation in Any one Engine		.03 lb.	

UNIT NUMBER	PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
		Minimum	Maximum	
	Piston Pin Bushing	1.500	1.5005	1.5015
	Bore Misalignment—Bend	.000	.004 in 12"	.004 on ST-227-A
	Bore Misalignment—Twist	.000	.010 in 12°	.010 on ST-227-A
	Bolt Fit in Rod	-.0005	.0005	.0008
	Clearance—Rod to Piston Boss	.050		.040 (Min.)
0104	PISTON			
	Ring Groove Clearance	Wedge Type Keystone Rings		
	Piston Skirt Diameter (at 70° F.)			
	21711, 100939	4.1196	4.120	4.116
	Piston Pin Bore (at 70° F.)	1.4988	1.4990	1.500
	Piston Pin	1.4988	1.4990	1.4978
	Ring Gap Clearances (with new liners)			
	68788, 68789	.013	.023	
	69656 (U-Flex)			
	.010, .020, .030 and .040 oversize pistons and rings are available for J, JS, and JT engines.			
0105	REAR COVER (Asbestos Type)			
	Cover Plate to Crankshaft Clearance	.004	.006	Use Gaskets
	Bore to Crankshaft Clearance	.009	.011	
0106	CAMSHAFT			
	Journal Diameter			
	Nos. 2, 3, 4, 5, 6, 7	1.872	1.873	1.871
	Front Journal Diameter	1.747	1.748	1.746
0107	SUPERCHARGER IDLER GEAR (JS Engine Only)			
	Bushing No. 68629-1	2.125	2.126	2.127
	Bushing No. 68578	1.500	1.501	1.502
	Idler Gear Hub	2.1225	2.1235	2.1215
	Thrust Bearing No. 68631	.096	.106	.091
	Thrust Bearing No. 68632	.061	.063	.059
	Thrust Bearing No. 68633-1	.192	.194	.190
	Idler Gear to Outer Thrust Washer Clearance	.007	.019	Same

02 Cylinder Heads

0201 CLYINDER HEAD

Valve Springs—Load Req'd to Compress

J, JS Intake and Exhaust—

Closed—2.406

81#

91#

76#

J, JS Intake and Exhaust—

Open—2.000

169#

187#

164#

JT Intake and Exhaust—

Closed—2.109

65#

74#

61#

UNIT NUMBER	PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
		Minimum	Maximum	
	JT Intake and Exhaust— Open—1.703	131#	141#	125#
	J, JS Intake and Exhaust Valve Seat Angle	30°	30°	30°
	Stem Diameter	.402	.403	.401
	J, JS Valve Guide Bore	.4045	.4052	.407
	JT Intake and Exhaust Valves Seat Angle	30°	30°	30°
	Stem Diameter	.340	.341	.339
	JT Valve Guide Bore	.3425	.3432	.345
	JT Valve Crosshead Stem Diameter	.3708	.3713	.370
	JT Valve Crosshead Guide	.3755	.376	.378
	J, JS Valve Seat Insert O.D. .005, .020, .030, .040 oversizes	1.690	1.6905	
	Valve Seat Counterbore	1.687	1.688	
	JT Valve Seat Insert O.D. .005, .020, .030, .040 oversizes	1.430	1.4305	
	JT Valve Seat Counterbore	1.427	1.428	
	Injector Seat in Sleeve	60°	60°	60°
	Injector Tip Protrusion Through Head	.040	.055	.065
	Injector Sleeve—Upper I.D.	1.375	1.380	

03 Rocker Levers

0301 ROCKER LEVER HOUSING AND LEVERS

Shaft	1.123	1.1235	1.122
Bushings	1.1245	1.1255	1.1265

04 Valve and Injector Tappets

0401 VALVE AND INJECTOR TAPPETS

Injector Tappet Roller O.D.	1.123	1.125	1.121
Injector Tappet Roller I.D.	.5655	.5665	.5675
Valve Tappet Roller O.D.	1.061	1.063	1.059
Valve Tappet Roller I.D.	.503	.504	.505
Injector Tappet Roller Pin O.D.	.562	.5625	.561
Valve Tappet Roller Pin O.D.	.4995	.5000	.4985
Injector Tappet O.D.	1.310	1.311	1.309
Valve Tappet O.D.	1.185	1.186	1.184

UNIT NUMBER	PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
		Minimum	Maximum	

06 Injectors and Connections (PT Fuel Pump)

0602 FUEL INLET CONNECTION
No Check Valves

0604 INJECTOR
Metering Orifice Use ST-453
Drain Orifice Use ST-452

06 Injectors and Connections (DD Fuel Pump)

0602 FUEL INLET CONNECTION
Check Valve Opening Pressure 45 psi 55 psi
Ball Check Valve must not leak at 2000 psi
Back Pressure

0604 INJECTOR
Check Valve Spring
Free Length 17/64
Load Req'd to Compress to .193 3.23 oz. 3.93 oz. 3.23 oz.
Load Req'd to Compress to .154 4.52 oz. 5.52 oz. 4.52 oz.
Fuel Flow With Dummy Cup @ 200 psi
Open pressure .4 gpm .4 gpm
Check Valve Travel .015 .025 Same
Body—Plunger Leakage @ 2000 psi 4 cc 6 cc

07 Lubricating System

0701 OIL PAN
Capacity 3 gal. 4 gal.

0705 OIL COOLER
Test Pressure See Name Plate

0706 LUBRICATING OIL PUMP

0707
Idler and Driver Shaft Bushings .6165 .6175 .6185
Idler Gear Bushings .9925 .9935 .9945
Idler and Drive Shaft O.D. .615 .6155 .614

UNIT NUMBER	PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
		Minimum	Maximum	
	Idler Gear Spindle	.990	.991	.989
	Gears, O.D.	1.832	1.833	1.831
	Bodies, Gear Pockets	1.840	1.842	1.843

08 Cooling System

0803 THERMOSTATS—LOW RANGE

69947 Main Line Thermostat Opens at	160° F.	165° F.	Same
69948 By-Pass Thermostat Closes at	180° F.	185° F.	Same

THERMOSTATS—HIGH RANGE

70086 Main Line Thermostat Opens at	170° F.	175° F.	Same
70087 By-Pass Thermostat Closes at	190° F.	195° F.	Same

THERMOSTAT—VERNATHERM

Minimum Vertical Plate Travel	.310" at 185° F.		
-------------------------------	------------------	--	--

10 and 11 Intake and Exhaust Systems

1002 SUPERCHARGER

Clearances

Radial Bearing Clearance			.003
Rotor Shaft End Play			.005
Rotor Timing Gear Backlash			.004
Gear Hub Protrusion over Bearing Cage	.001	.005	.006
Rotor to Gear End Plate	.003	.003	Add or Remove Shims

TURBOCHARGER

Turbine Shaft Bearing Journal Dia.	.6861	.6866	.6861
Turbine Wheel to Bearing Housing Clearance	.022	.037	Same
Thrust Bearing End Clearance	.005	.007	Add or Remove Shims
Compressor Wheel to Compressor Housing Clearance Including .005/.007 End Play	.019	.021	Same

14 Complete Engine Assembly

1402 CYLINDER HEADS

Tighten Head Stud Nuts—Manifold Side	220	230	
Push Tube Side	240	250	
Valve Clearance (Oil Temperature 140° F.)	Intake		Exhaust
J, JS, JT	.015		.025

UNIT NUMBER	PART OR LOCATION	NEW DIMENSIONS		WORN REPLACEMENT LIMIT
		Minimum	Maximum	
1406	INJECTORS			
	Mounting Stud Nuts	6 ft. lbs.	8 ft. lbs.	
	Adjustment	Refer to Page 12-27		
1406	INLET CONNECTIONS			
	Tighten to	20/25 ft. lbs.		
1407	LUBRICATING OIL PRESSURES			
	Idling to Governed Speed	15 psi	55 psi	
	Normal at Governed Speed	30 psi	50 psi	
1414	ENGINE HORSE POWER RATINGS			
	At Maximum Speed Ratings			
	J-6 Cylinder @ 2200 rpm		100 hp	
	JS-6 Cylinder @ 2500 rpm		150 hp	
	JT-6 Cylinder @ 2500 rpm		175 hp	
1416	EXHAUST BACK PRESSURES			
	Maximum Permissible—Inches of Mercury		1.0	
	J Engine		1.5	
	JS and JT Engines			
1416	FLYWHEEL HOUSING			
	Bore Run-out	.000	.004	.004
	Face Run-out	.000	.008	.008
	Clutch Pilot Bearing Bore Run-out	.000	.004	.004
	Clutch Drive Ring Pilot Bore	.000	.004	.004
	Clutch Face	.000	.005	.005
	Static Balance Tolerance—Flywheel		2 inch ounces	

SPRING DATA

PART NUMBER	SPRING	FREE LENGTH	LOAD	@ LENGTH
8521	Injector Connection Check Valve.....	5/8	11 ± 1 oz.	3 1/2
9315	Injector Fuel Connection.....	1 1/4	40 ± 4.5 #	7/8
9337	Injector Plunger Spring.....	1 7/8	64 ± 4 #	1 1/4
62411	Injector Check Valve.....	.289	3.58 ± .35 oz.	.193
66507-1	Lube Oil By-Pass Valve.....	2.185/2.371	6.44 ± .5 #	.968
69355	Lube Oil Press. Relief Valve.....	3.28	17.21 ± .8 #	2.055
70023	Intake and Exhaust Valve (J, JS).....	2.944	178 ± 9 #	2.000
70845	Intake and Exhaust Valve (JT).....	2.703	136 #	1.703
70856	Fuel Inlet and Drain Conn. (JT).....	1.063	20 ± 1.7 #	.688

