SECTION 1

CRANKCASE AND OIL PAN

ELECTRO-MOTIVE

ENGINE MAINTENANCE MANUAL

CRANKCASE AND OIL PAN

CRANKCASE

DESCRIPTION

The crankcase, Fig. 1-1, is the main structural part of the engine. It is a steel fabrication forming a rigid self-supporting assembly to accommodate the cylinder power assemblies, crankshaft, and engine mounted accessories.

Handholes in the side panels, provided with gasketed covers, allow inspection of liners and pistons, cleaning of air box, and access to water manifold and oil pan mounting bolts.

MAINTENANCE

CLEANING

The crankcase should be cleaned to remove foreign material, after any work has been done on the interior of the engine, or if damage has occurred in the engine. This can be done by using a spray gun and solvent. The equipment near the engine should be protected against the spray. After spraying the top deck, wipe with towels saturated with solvent. Wipe all solvent trapped in corners and pockets. Use only lintless, boundedge towels.

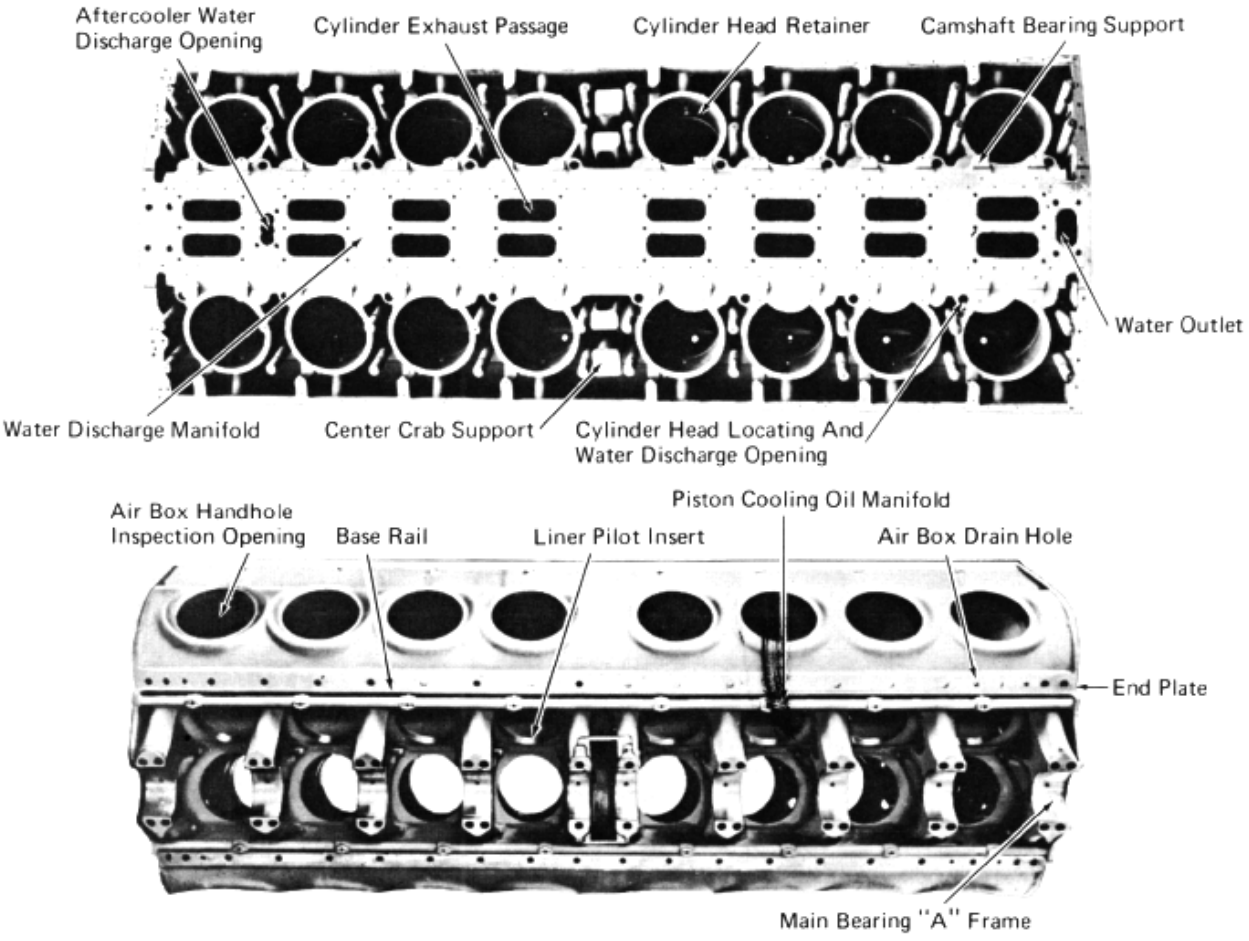


Fig. 1-1 -Crankcase, 16-Cylinder

Cleaning of the air box with a spray gun while liners are in place is not recommended practice, due to possibility of dirt entering liners at the ports.

At any time cleaning is done oil the crankcase, protection should be given to oil passages, bearing surfaces, and gears, to prevent gritty material from being trapped. Cleaning procedures should be in accord with accepted practice or as recommended by the supplier of cleaning material.

INSPECTION

Periodic inspection of the crankcase should be performed to detect minor discrepancies which, if not corrected, could result in major crankcase failure. Early detection and repair of the crankcase is essential since major repairs usually cannot be performed in the field. In instances where extensive welding is required, the crankcase must be stress relieved and remachined where necessary. Therefore, it is recommended that a crankcase requiring rebuild or reconditioning be returned to the manufacturer for repair.

LOWER LINER BORE INSERT

DESCRIPTION

A replaceable phosphate treated cast iron insert, Fig. 1-2, is used in each lower liner bore of the crankcase to provide a wear surface at the lower liner pilot. Seals held in grooves in the lower liner pilot, prevent air passage between the insert and the liner.

MAINTENANCE

When the inside diameter of the insert, installed in the crankcase, reaches the maximum limit. the insert should be removed and a new one installed. Replacement of the insert in the lower liner bore of the crankcase requires the use of a sturdily constructed tool to apply and remove the insert safely and efficiently. The lower liner insert application and removal tool, Fig. 1-3, is specifically designed to do this work. This tool consists of a press and puller assembly and a 10 ton hydraulic jack. The hydraulic jack consists of a 10 ton hydraulic ram, a high pressure hose. and a high pressure hydraulic pump.

INSERT APPLICATION

The arrangement of the tool for insert application is shown in Figs. 1-3a and 1-3c. The insert is installed as follows:

1. Coat the contact area of the outside diameter of the insert with mounting compound.

2. Manually place the insert (7) in place in the lower bore, and position it for the pressing operation by starting it uniformly in the bore.

3. Assemble the tool as shown in Fig. I-3a, with the ram screwed into the screw plug, and into the boss of the insert plate (6). The ram plunger should be in the retracted position. Disconnect the high pressure hose (12) if it is attached to the ram.

4. Lift the tool at the hoisting ring (2), and place the tool into the cylinder bore resting upon the cylinder retainer. The tool should be positioned so the hose connection is accessible from the stress plate inspection opening. Secure the tool using four crab nuts at the crab stud holding bosses.

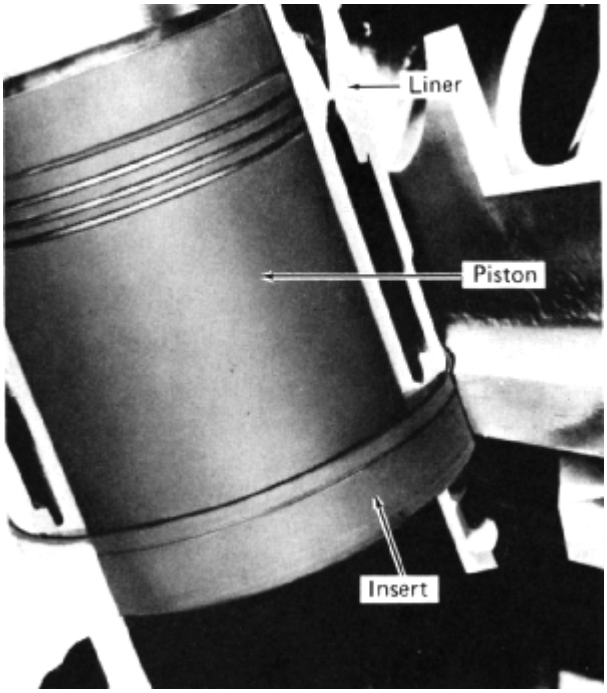
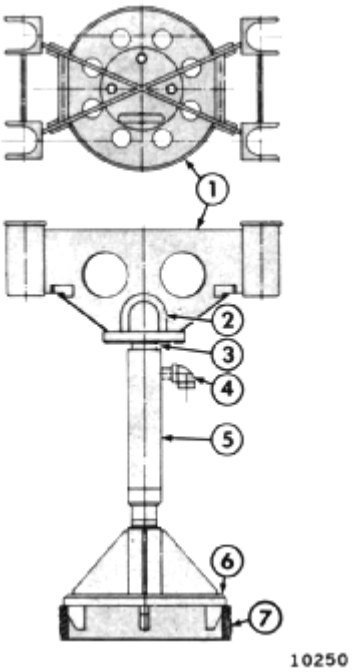
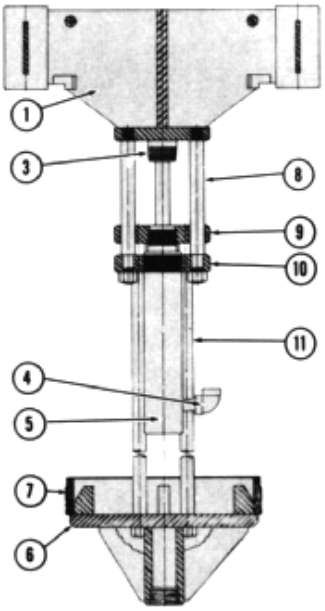


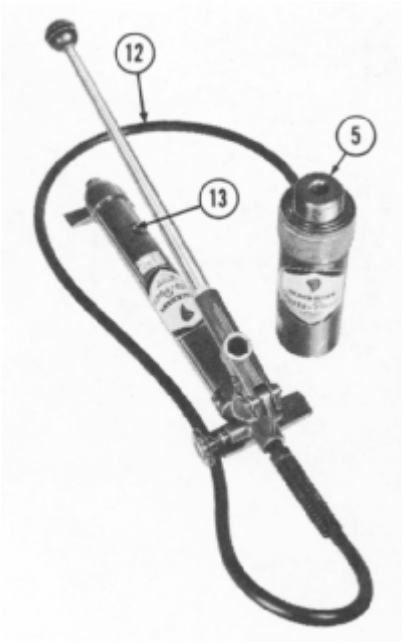
Fig. 1-2 - Lower Liner Bore Insert



a. Insert Application



b. Insert Removal



c. Hydraulic Jack

1. Crab Stud Holding Assembly
2. Hoisting Ring
3. Screw Plug
4. High Pressure Hose Connection
5. 10-Ton Ram
6. Insert Plate
7. Insert
8. Holding Studs
9. Upper Plate
10. Ram Plate
11. Pulling Studs
12. High Pressure Hose
13. Hydraulic Pump

Fig. 1-3 - Liner Bore Insert Application And Removal Tool

5. Attach the high pressure hose (12) to the ram (5) at the ram connection (4), and using the hydraulic pump, extend the plunger to contact and press the bore until the shoulder is seated.

INSERT REMOVAL

The arrangement of the tool for insert removal is shown in Fig. 1-3b. The insert is removed as follows:

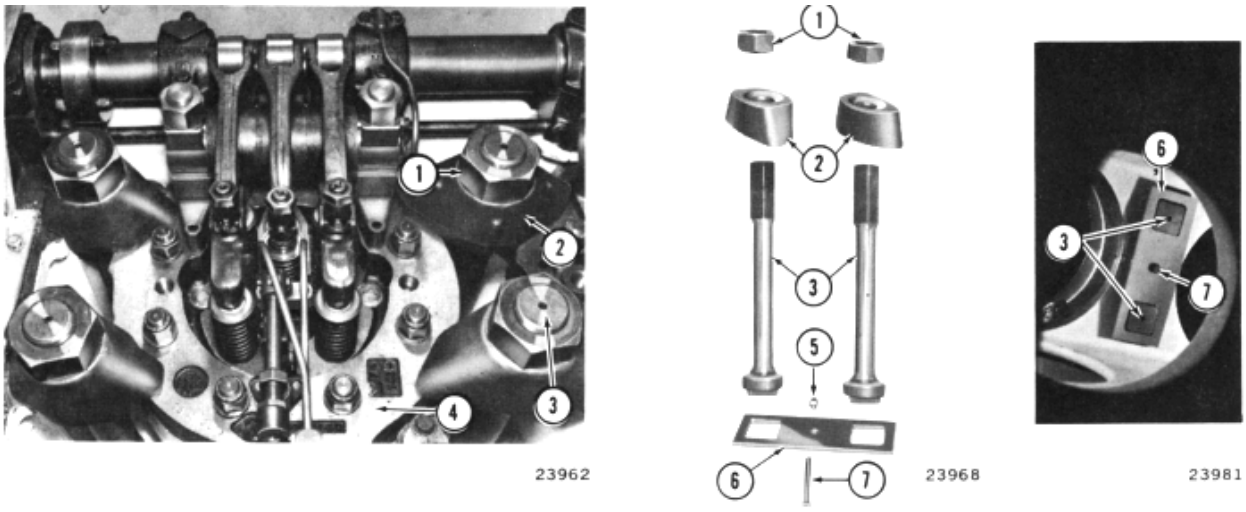
1. Assemble the tool for removal as shown and remove the four nuts holding the insert plate (6) and remove the plate. Also, remove the high pressure hose (12) from the ram (5) if it is connected.

2. Lift the tool using the hoisting ring and place in the cylinder, resting upon the retainer. Position the tool so that the hose fitting may be reached at the outboard side to permit hose application. Apply four crab nuts to secure the tool.

3. Place the ram plunger so that the insert plate bolts extend below the insert to permit insert plate application, as shown in Fig. 1-3b. Apply the insert plate and its holding bolts.

4. Connect the high pressure hose (12) to its fitting (4) on the ram (5) and using the pump (13) remove the insert (7) from the crankcase bore.

In the event that the insert application and removal tool is not available, the insert may be applied and removed using a mallet and a phenolic or wooden block.



1. Crab Nut
2. Crab
3. Crab Bolt
4. Cylinder Head
5. Retainer Bolt Nut
6. Retainer Plate
7. Retainer Bolt

Fig. 1-4 - Crab Bolt Installation

CRAB BOLTS

DESCRIPTION

The cylinder head and liner are bolted together and this assembly is held in the cylinder head retainer by crab bolts, head crabs, and nuts, Fig. 14. The crab bolts extend up through the cylinder bank upper deck plate adjacent to each cylinder retainer. The bolt heads have a spherical seating surface which seats in a like surface, the bolts being held in position by a separate plate and bolt for each pair of bolts. The square bolt heads fit corresponding holes in the plate which prevents their turning when being torqued.

MAINTENANCE

The crab bolts can be removed through the air box by removing the crab bolt retainer plate bolt and retainer plate. The retainer plate and bolt are easily accessible only after liner has been removed. Crab bolt threads may be cleaned up using a 1-3/4"-12-UNR thread die. Crab nut threads may be cleaned up using a 1-3/4"-12 tap. Whenever crab bolt threads are exposed, they should be covered with thread protectors.

CAUTION: To prevent damage to crab bolts having rolled threads, only the UNR type thread die should be used. This die may also be used on crab bolts having the former cut threads.

If one of the two crab bolts located at either end of either bank, or one of the center crab bolts (16 & 20-cyl.) was broken, the other three bolts holding the cylinder head should be changed. If a broken crab bolt was in any other location, the remaining five crab bolts holding the heads held by the broken crab bolt should be changed.

MAIN BEARING STUD BOLTS AND CAPS

DESCRIPTION

The main bearing stud bolts are shown in Fig. 1-5. Each "A" frame has four 1-1/4" coated main bearing studs except the center "A" frames (16 & 20-c:yl.), which have two each. They pass through the "A" frame and main bearing caps, Fig. 1-5. A transverse hole at the upper end of each stud accommodates a bolt which passes through the stud and slots in the upper nut. Semicircular or D-shaped nuts are used at the upper end of the stud.

The upper nuts have a spherical seating surface to match a similar surface in the "A" frame. Since the center "A" frames (16 & 20-cyl.) are separated from each other, a retainer assembly is used to prevent the upper nuts from turning. The retainer assembly is held in place over the nuts by bolts which pass through the nuts and studs.

MAINTENANCE

A thread die can be used to clean up the stud bolts while a tap can be used on the slotted stud nuts. To aid

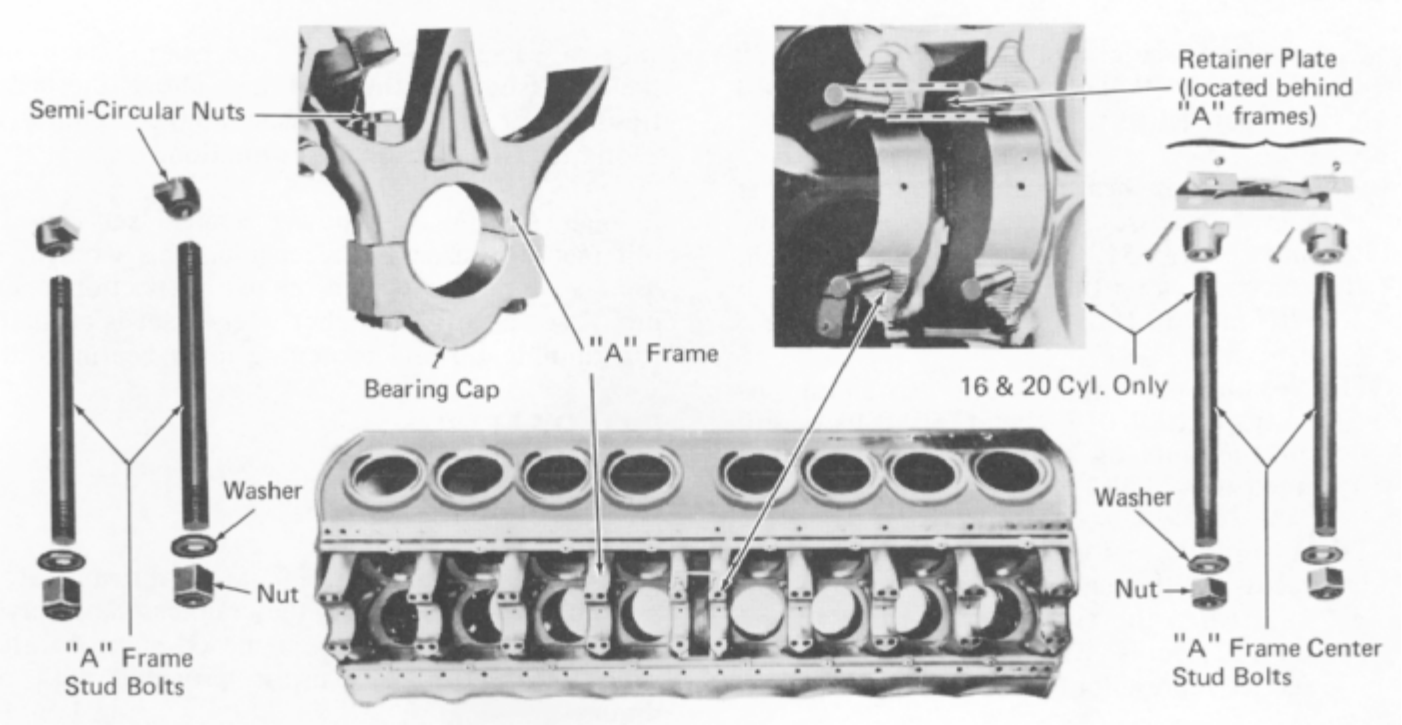


Fig. 1-5 - Main Bearing Stud Bolts

in obtaining correct torque values, the threads should be cleaned before parts application.

Upon application, each stud is inserted into its place in the "A" frame and run into its nut until the hole in the top of stud lines up with the bolt slot of the nut. The lower end of the stud should be 178 mm (7") from the serrations on the "A" frame when the stud is brought out with the spherical surface of the upper nut contacting the mating surface in the "A" frame. This is to ensure that the lower stud nuts can be properly tightened when the bearing cap is applied. The bolt and self-locking nut may then be applied except the center "A" frames (16 & 20-cyl.). The upper nut flats contact each other when in place on all "A" frames except the center "A" frames (16 & 20-cyl.), which are separated from each other. A retainer plate is used on the center "A" frame upper nuts to prevent them from turning. After the stud has been run into the nuts the proper amount, the retainer, which is like a channel, is placed over the nuts. The bolts are then applied through the retainer and stud and across the nut slots. The bolt slots in the retainer are of different widths, one slot being larger to secure the bolt head and prevent it from turning when being tightened. The retainers are cut away on one side to provide clearance for a stiffener plate between the center "A" frames (16 & 20-cyl.).

Main bearing caps are originally applied to the "A" frame and then are line bored; therefore, they are not interchangeable or available for replacement. They must be reapplied on the same "A" frame in the same position as removed. Each cap and "A" frame is stamped on the right side with their bearing number, and in addition, all caps and the end "A" frame are stamped with crankcase serial number. Before cap application, check serrations in cap and "A" frame and remove any burrs or foreign material that would prevent a good mating fit.

CHECKING MAIN BEARING STEEL BORE DIMENSIONS

At time of crankcase overhaul, or whenever a crankshaft is removed from an engine, it is necessary to determine whether main bearing steel bore dimensions arc within tolerance.

NOTE: Dimensional wear limits are contained in Service Data at the end of the section.

1. Place the crankcase on its side.

2. Be sure that the crankcase "A" frame bores and serrations are clean.

3. Lubricate the studs, nut seats, and hardened washers with Texaco Threadtex No. 2303.

CAUTION: Use of the hardened washer under the main bearing cap nut is mandatory to ensure proper bolt stretch and to retain nut torque. Damaged nut seat areas on the caps must be cleaned by spot-facing or by taking

a cut (1.59 min [1/16"1 maximum depth) parallel to the serration surface.

4. Apply the main bearing caps, and torque the nuts in two passes. On the first pass, torque the nuts to 475-542 N-m (350-400 ft-lbs). On the second pass, final torque the nuts to 1 017 N-m (750 ft-lbs).

NOTE: No one nut on any one cap should be torqued to 1 017 N-m (750 ft-lbs) until all the nuts on that cap have been torqued to 475-542 N-m (350-400 ft-lbs).

NOTE: A procedure using stud stretch measurements as the criteria for monitoring torques when the engine is disassembled and on its side is available from your EMD service representative.

5. Check that the main bearing bore dimensions are within the minimum and maximum limits. Take two sets of measurements at each bore, one set 12.70 mm (1/2") in from the accessory end of the bore and one set 12.70 mm (1/2") in from the generator end of the bore at points shown in Fig. 1-6.

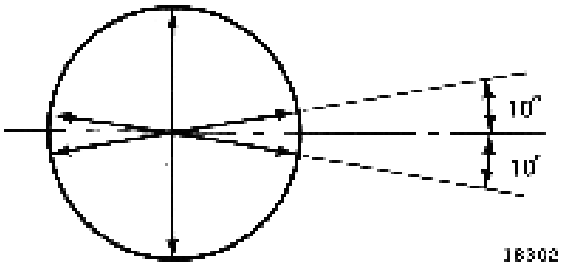


Fig. 1-6 - Main Bearing Bore Measurement

6. I any one diameter is out of tolerance -

   a. he crankcase may be shipped to EMD for remanufacture.

   b. f the engine owner has facilities for crankcase machining and wishes to do his own remanufacture, contact the EMD service representative for information concerning control of main bearing steel bores during remanufacture.

If an overheated bearing makes it necessary to check an "A" frame for "close-in" with the crankshaft in the engine, it may be checked using a new upper main bearing. The bearing must fit into the A" frame bore. Also, check the clear ance at each side between the bearing shell and the crankshaft at the split line above the serrations. Reference bearing inspection procedures in Section 6 for additional information.

A main bearing nut power wrench set may be obtained for use on the engine. This wrench, in use, is supported in the oil pan inspection opening. Also, an offset ratchet wrench set is available for running up and loosening main bearing nuts.

OIL PAN

DESCRIPTION

The engine oil pan, Fig. 1-7, is a fabricated steel assembly which supports the crankcase and serves as the engine base. The engine oil sump located centrally in the oil pan, is provided with oil drains.

A bayonet type oil level gauge extends from the side of the oil pan into the sump. A scavenging oil pump suction line is built into the oil pan extending from the sump to the front end plate. Openings in each end plate allow oil from the camshaft and accessory end housings to drain into the oil pan. Hand holes at each cylinder location, provided with gasketed covers, allow access to enclosed engine parts. Liquid accumulations from the air box are drained through pipes located at the front of the oil pan into a common flange for discharge.

MAINTENANCE

CLEANING

The oil pan should be thoroughly cleaned at the time of an oil change or any time the engine is damaged. Particular attention should be given the oil drain pipes to make certain there is no accumulation of foreign material. Wipe out accumulation from corners and pockets of pan and remove any loose or flaking paint from the pan interior.

INSPECTION

Inspect oil pan rails for nicks, burrs, or foreign material of any kind in seal grooves, and remove to provide a clean smooth surface. Any indentation in the seal grooves or base rails that would allow oil seepage must be filled with solder and finished flush with surrounding area. Also inspect air box drain pipes, end plates, and handhole cover gasket surfaces for any nicks or roughness.

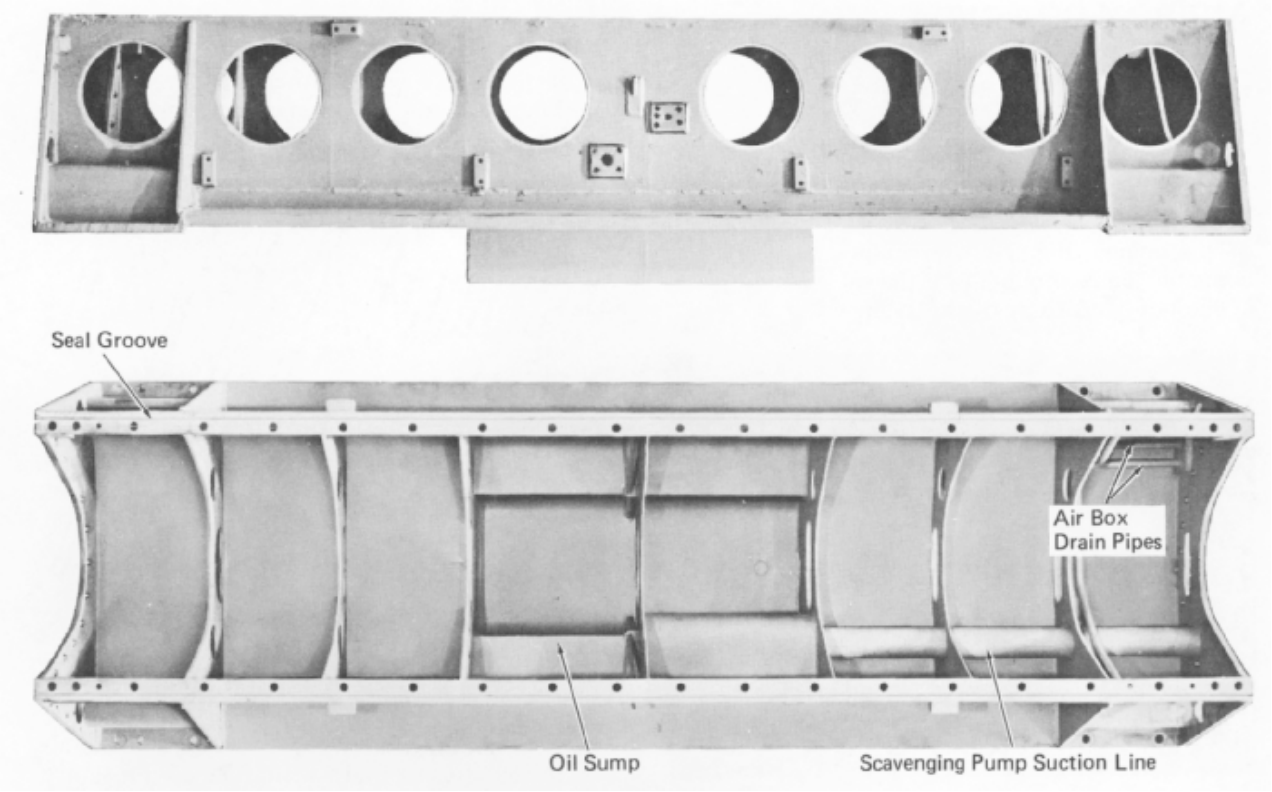


Fig. 1-7 - Typical Oil Pan (16-Cylinder)

CRANKCASE TO OIL PAN SEAL

DESCRIPTION

A round silicone seal cord placed in a groove, Fig. 1-8, in the oil pan mounting rail effectively prevents any leakage at the junction of the crankcase and oil pan.

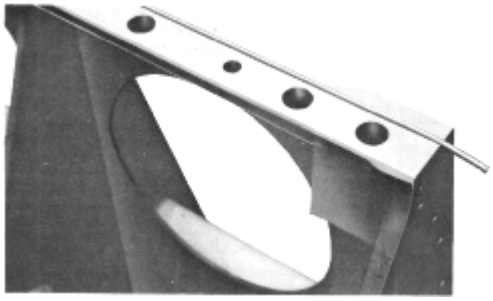


Fig. 1-8 - Crankcase To Oil Pan Seal

MAINTENANCE

Install seals in the grooves without twisting or stretching, and without lubricant. The individual seals for each model engine are longer than required, but do not cut off seal ends at this time.

Place crankcase over oil pan, and using lineup pin guides in the four corner holes, lower crankcase on oil pan. Apply taper dowel bolts and tighten. Check crankcase to oil pan alignment, using care not to damage seal cord.

CAUTION: Do not pull or stretch the ends of seal cord.

Assemble all crankcase to oil pan bolts with washers and snug four corner bolts to about 136 N-m (100 ft-lbs) torque. Starting with the center bolt and alternating between the bolts to the left and right of center, tighten bolts to a torque of 136 N-m (100 ft-lbs). After tightening bolts on both sides of engine to 136 N-m (100 ft-lbs) repeat tightening sequence bringing bolts to a final torque of 610 N-m (450 ft-lbs).

After all bolts have been tightened to 610 N-m (450 ft-lbs), cut seal cord ends to provide a seal protrusion from face of end plates of 2.38 mm ± 0.40 mm (3/32" ± 1/64"). This seal protrusion will seal the three way joint of oil pan, crankcase, and end housing.

AIR BOX DRAINS

DESCRIPTION

Accumulation of liquids from the engine air box is removed through drain holes in the base rails of the crankcase, which are aligned with pipes located on each side of the oil pan at the front of the engine, Fig. 1-9. Both pipes connect to a common flange mounted on the oil pan end plate at the left-hand front of the engine.

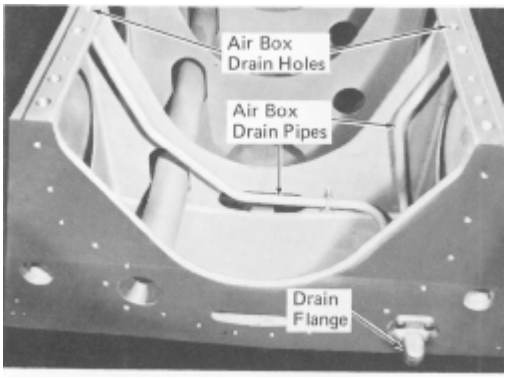


Fig. 1-9 - Typical Air Box Drain Installation

Off-engine piping connects to the flange and provides a constant draining feature for the air box.

MAINTENANCE

The air box drains should be cleaned at the intervals specified in the Scheduled Maintenance Program.

1. Disconnect external piping connected to the drain flange.

2. Remove the drain flange from the oil pan, and clean with brush and solvent.

3. Remove air box handhole covers nearest the drain holes.

4. Feed cleaning tool into the drain hole in the base rail, turning it and using a "rodding" motion to loosen carbon and sludge from inside of drain pipes.

   The cleaning tool can be fabricated from an ordinary plunber's 1/4" music wire snake as follows:

   Cut off the auger head. Fig. 1-10, and form new head by heating the first 25.4 mm (1 ") of the snake with a torch and stretching the tip area to form a loosely wound spiral.

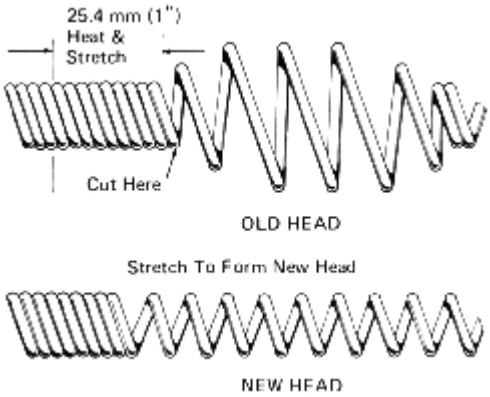


Fig. 1-10 - Snake Modification

5. Once both drains have been completely cleared, flush piping with fuel oil or similar solvent to remove loose material and dissolve additional residue.

6. Mount drain flange to oil pan, reconnect external piping, and reinstall air box handhole covers.

TOP DECK HEAD FRAME AND COVER

DESCRIPTION

Top deck cylinder head frames are mounted on the crankcase to protect and enclose the fuel lines and linkage, camshaft assemblies and rocker arm assemblies. The fabricated frames provide a flat seal surface for the top deck covers. The covers are held in place by easily released latches, making the top deck operating mechanism readily accessible. Support arms are provided to hold the cover open in any one of several positions. Special hinges provide easy removal of the cover for top deck maintenance.

A gasket between the bottom of the frame and crankcase and a rubber seal on the lower surface of the cover provide an air and oil tight seal.

When replacement of either the gasket or seal is necessary, see EMD parts catalog for the correct part numbers.

MAINTENANCE

Replace top deck cover seals at intervals stated in the applicable Scheduled Maintenance Program, or earlier if the seals are damaged or deteriorated.

When applying new seals to the cover, coat the seal lightly with a small amount of EMD High Temperature resistant grease No. 4. This will prevent the seal from sticking to the frame and being damaged when the cover is raised.

New gaskets should be installed between the frame and crankcase whenever the frames are removed from the crankcase or sooner if the gaskets show signs of leaking.

SERVICE DATA
CRANKCASE AND OIL PAN

SPECIFICATIONS

Clearance and dimensional limits listed below are defined as follows:

1. *New limits are those to which new parts are manufactured. (Drawing tolerances.)*
2. *Minimum, maximum, and tolerance measurements are provided as service limits. At time of rebuild or any time unscheduled maintenance is performed, the service limits should not be exceeded. Engine components within these limits may be reused with the assurance that they will perform satisfactorily until the next scheduled overhaul.*

Upper liner pilot bore -	
New	307.11-307.19 mm (12.091"-12.094")
Max.	307.44 mm (12.104")
Lower liner pilot insert bore (installed in crankcase) -	
New	263.58-263.75 mm (10.377"-10.384")
Max.	263.80 mm (10.386")
Lower liner pilot bore in crankcase -	
New	281.00-281.10 mm (11.063 "-11.067 ")
Max.	281.13 mm (11.068")

Main bearing bore with all caps applied and torqued to 1 017 N-m (750 ft-lbs). Take two sets of main bearing bore measurements at each bore, one set 12.70 mm (1/2") in from the accessory end of the bore and one set 12.70 mm (1/2") in from the generator end of the bore. Ref. Fig. 1-6.

Diameter of bore -	
Max.	209.652 mm (8.2540")
Min.	209.474 mm (8.2470")
Bearing shell to crankshaft clearance (Each side above serrations at split line)	
Min.	0.038 mm (.0015")

EQUIPMENT LIST

	Part No.
Crab stud thread protectors	8034600
Crab nut tap 1-3/4"-12	8050688
Towels (bound-edge wiping towels)	8052752
Main bearing bolt thread die 1-1/4"-12	8060349
Main bearing nut tap 1-1/4"-12	8060387
Crab stud thread die 1-3/4"-12-UNR	9511395
Hydraulic jack (10 ton)	8078281
Ratchet adapter	8140761
Main bearing nut offset ratchet wrench	8191591
Spray gun (for engine cleaning)	8193041
Crab nut power wrench set	8250855
Lower insert application and removal tool	8275379
Press and puller assembly	8275380
Thread Lubricant, Texaco Threadtex No. 2303	8307731
Main bearing stud nut power wrench	8335627
Torque indicator	8377322
High temperature resistant grease No. 4 (10 lbs)	8425725
Main bearing stud nut socket	8474773
Main bearing cap application and removal tool	8487487
Anchor plate assembly	9080987