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MAINTENANCE MANUAL

IN-LINE DIESEL ENGINE SERIES 71

GMC TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN

10M—Mar. 1959
Printed in U.S.A.
Reprinted 8M—Feb. 1960
Reprinted 1M—Feb. 1963
Reprinted 2M—Aug. 1963
Reprinted 3M—Feb. 1964
Reprinted 3M—Feb. 1965
Reprinted 3M—Mar. 1966

Introduction

This maintenance manual includes complete maintenance and repair information on the basic current GM Diesel engines used in GM coaches and GMC Trucks.

Information on accessories allied with the diesel engine such as starters, generators, air cleaners, etc., are covered in applicable truck or coach Maintenance Manuals. Operation information from the standpoint of the driver will be found in applicable Truck or Coach Operating Manuals.

The manual is divided into ten general sections as shown on opposite page. The page numbers in the book are consecutive; *however, the illustration numbers are consecutive within each section.*

The index on opposite page shows page numbers of each major item in each general section. The alphabetical index at end of book lists important subjects together with page numbers.

SECTION INDEX

Replacement Engines

The models 4-71 and 6-71 Diesel engines are supplied as complete automotive replacement units for trucks. Available in four and six cylinder models, with a wide power range to choose from, these engines provide operators and the truck replacement field in general with a complete automotive power plant.

Everyday GMC engineered Diesel replacement power units are making new records of savings in fuel and maintenance costs in many different makes of trucks and tractors.

The GMC Diesel reputation for performance and "up to the minute" improvements is upheld by the experience of our Transportation Engineers who have been modernizing commercial equipment with the GMC Diesel power unit for many years.

When replacing present equipment with GMC Diesel power, you may be sure of these four points:

1. Correct Application for your requirements.
2. Engineered installation.
3. Nation-wide parts and service.
4. Latest Diesel design and engineering.

See your GMC dealer for information on the availability of GM Diesel engines for installation in practically any make of truck.

General Information

THE GM 2-CYCLE DIESEL ENGINE

THE DIESEL PRINCIPLE

The Diesel engine is an internal combustion power unit, in which the heat of fuel is converted into work in the cylinder of the engine.

Diesel engines differ from gasoline engines principally in the method used to introduce and ignite the fuel. Gasoline engines draw a mixture of fuel and air through the carburetor into the combustion chamber, where it is compressed, then ignited by an electric spark. In the Diesel engines, air alone is compressed in the cylinder; then, a charge of fuel is sprayed into the cylinder, after the air has been compressed, and ignition is accomplished by the heat of compression.

THE GM 2-CYCLE ENGINE

Four strokes are required to complete a cycle in the four-cycle engine, which functions half the time as an air pump.

In the two-cycle engine, intake and exhaust take place during part of the compression and power strokes. A two-cycle engine, therefore, does not function as an air pump, so an external means of supplying the air is provided. A specially designed blower, on the side of the engine, forces cleaned air into the cylinders to expel the exhaust gases and fill the cylinders with fresh air for combustion, as shown in figure 1.

A series of ports cuts into the circumference of the cylinder wall (liner), above the piston, in its lowest position, admits air from the blower into the cylinder when top face of piston uncovers the ports, as shown in figure 1. The swirling flow of air toward the exhaust valve produces a scavenging effect, leaving the cylinders full of clean air when the piston rises and covers the inlet ports.

As piston continues on upward stroke, exhaust valves close and the charge of fresh air is subjected to the final compression, as shown in figure 1. Air in cylinder is heated to approximately 1000°F. while being compressed.

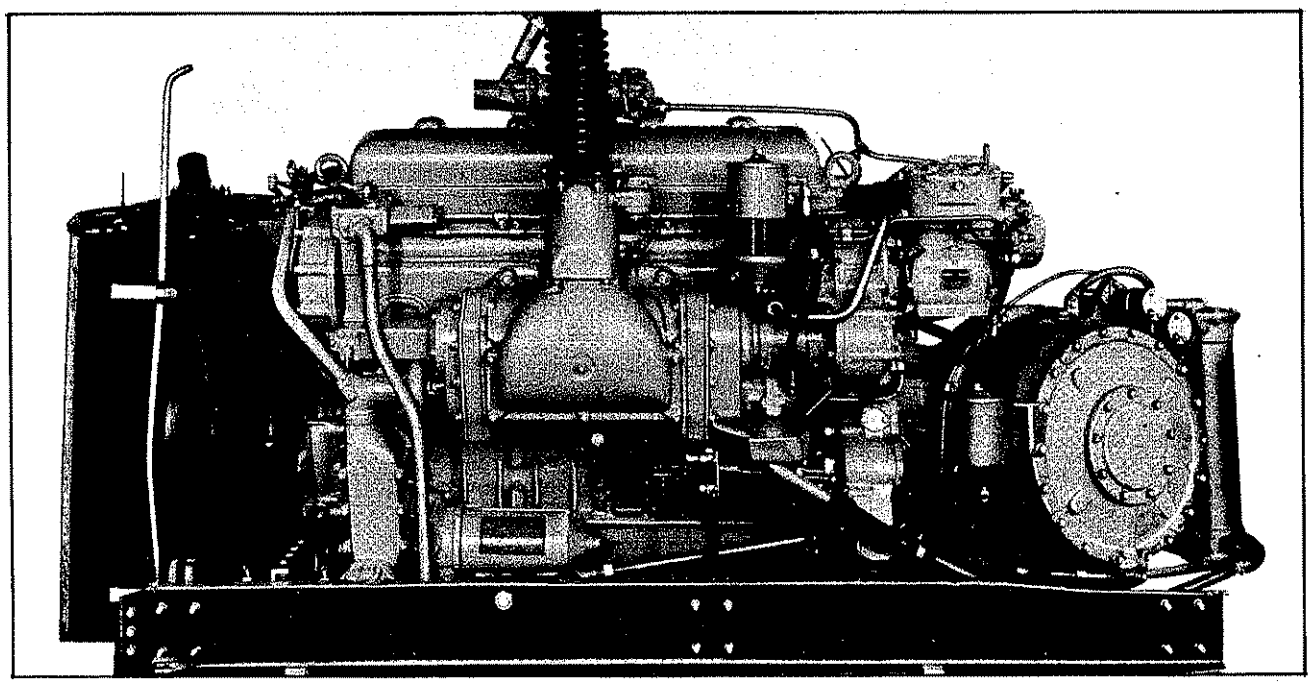


Figure 1—Transit Coach Power Plant

GENERAL INFORMATION

Shortly before the piston reaches its highest position, the required amount of fuel is sprayed into the combustion space by the unit fuel injector. The intense heat generated during the high compression of the air ignites the fine fuel spray immediately, and the combustion continues as long as the fuel spray lasts. The resulting pressure forces the piston downward to provide a power stroke. Figure 3 illustrates fuel injection and beginning of power stroke.

As piston nears the bottom of the downward stroke exhaust valves are opened (fig. 1) and spent gases are released. Still further downward movements of piston uncovers liner ports and cycle is repeated.

This entire combustion cycle is completed in each cylinder for each revolution of the crankshaft, or, in other words, two strokes; hence, the "two stroke cycle."

GM DIESEL ENGINE DATA

GENERAL

An engine model and serial number are stamped on the blower side of the cylinder block at the upper right hand corner. Refer to figure 4.

When ordering engine parts, order by part number and description, and refer to engine model and serial numbers.

The two-cycle Diesel engines discussed in this text include the four- and six-cylinder models having the same bore and stroke and using the same parts wherever possible. Thus, different power capacities are available in the same type of engine, in which the major working parts, such as injectors, pistons, connecting rods, and all bearings and other numerous parts are interchangeable. Engines with either direction of rotation can be supplied to suit specific requirements.

Furthermore, the blower, water pump, oil cooler,

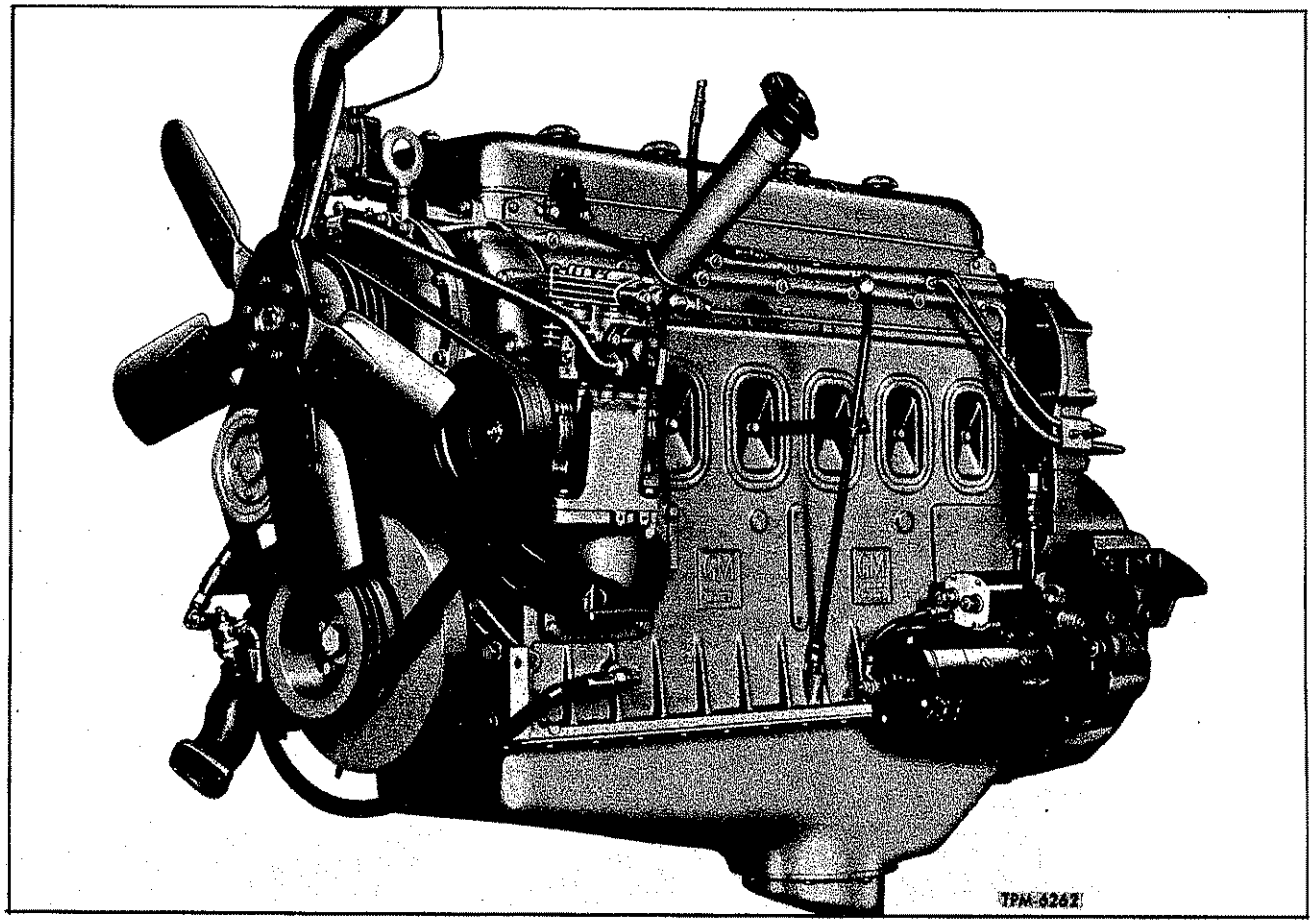


Figure 2—Truck Diesel Engine—4 Cyl. Shown

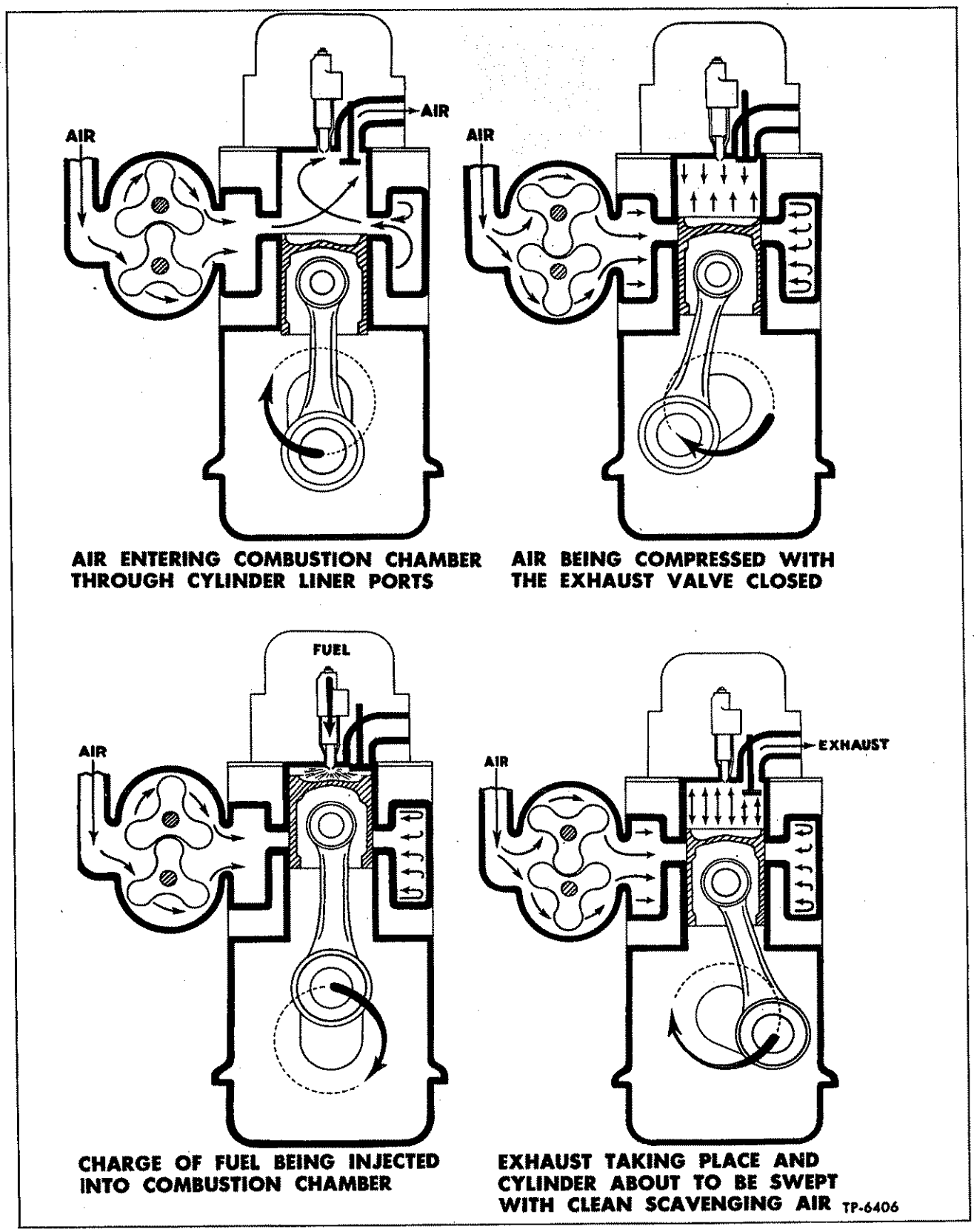


Figure 3—GM Diesel Engine 2-Cycle Operation

GENERAL INFORMATION

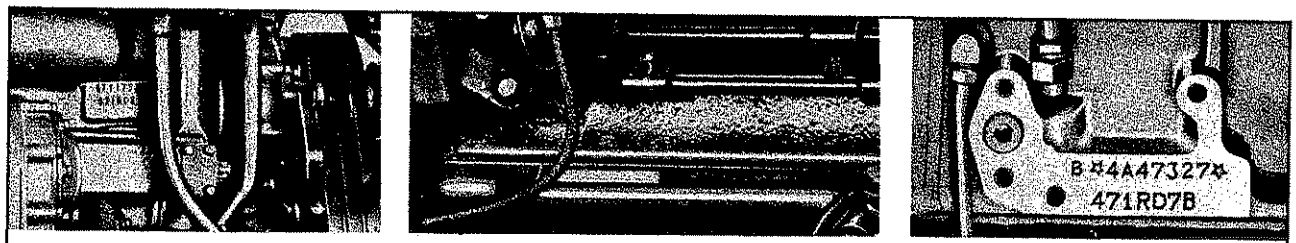


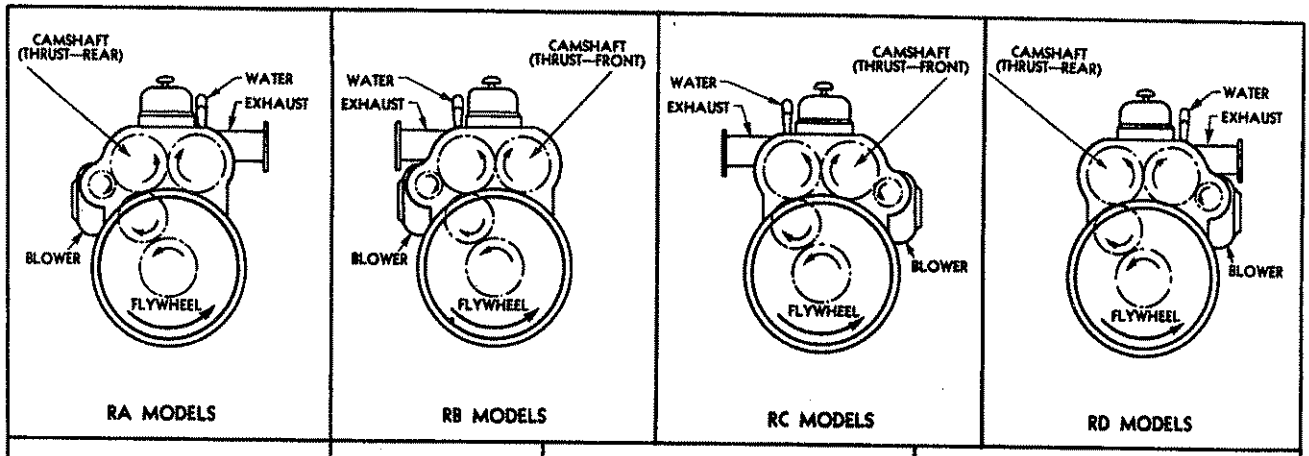
Figure 4—Engine Model and Serial Number Locations

oil filter, governor, and fuel pump form a group of standard accessories which can be located on either the right or left side of the engine, regardless of the direction of rotation. Further flexibility in meeting installation requirements can be had by placing the exhaust manifold and water outlet manifold on either side of the engine. This flexibility in the arrangement of parts is obtained by having both the cylinder block and cylinder head symmetrical at both ends and with respect to each other.

Figure 4 shows these various arrangements, which are designated by the letter R or L in the model number, denoting right-hand or left-hand rotation, and the letters A, B, C, or D designating the accessory arrangements. The table in figure 5 shows the particular arrangement of standard accessories and exhaust and water outlet manifolds designated by letter A, B, C, or D, used as part of the model number.

Right and left side of engine is determined by standing at rear (transmission end) and looking toward front. Transmission end of engine is referred to in manual as rear end, while opposite end is front.

Rotation is determined by standing at front and



ENGINE TYPE	ON LEFT SIDE	ON RIGHT SIDE
A	All standard accessories	Exhaust outlet. Water outlet
B	All standard accessories Exhaust outlet Water outlet	
C	Exhaust outlet Water outlet	All standard accessories
D		All standard accessories Exhaust outlet Water outlet

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Figure 5—Rotation and Accessory Arrangement

looking toward rear (transmission end). If crankshaft rotates clockwise engine is right-hand or "R" model, or if rotation is anti-clockwise engine is left-hand or "L" model.

Selection of the proper flywheel housing permits placing the starting motor on either the right or left side of the engine. Other accessories may be driven from either the camshaft or balancer shaft timing gear at the rear end of the engine or from the front end of the crankshaft.

GENERAL SPECIFICATIONS

Engine Model	4-71	6-71
Number of Cylinders	4	6
Bore	4-¼"	4-¼"
Stroke	5"	5"
Total Displacement—Cu. In.	283.7	425.6
Taxable H.P. (S.A.E.-A.M.A.)	28.9	43.35
Firing Order		
R.H. Rotation	1-3-4-2	1-5-3-6-2-4
L.H. Rotation	1-2-4-3	1-4-2-6-3-5

MAXIMUM ENGINE RPM

The following information is the approved maximum no-load setting of governor for current engines used in various truck and coach models. Do not permit engine operation with governor settings higher than indicated.

Model	*No-Load RPM Gov. Setting*
4-71—Truck	2450 + 0 — 25
6-71—Truck	2450 + 0 — 25
6-71—("E" or "SE" Series) Truck	2150 + 0 — 25
Transit Coach (4-71)	2100 + 0 — 25
Transit Coach (6-71)	2100 + 0 — 25
Parlor Coach (PD-4104)	2150 + 0 — 25

USE OF ORIGINAL PARTS

At the present time several types and capacities of units, such as: injectors, pistons, cylinder liners, and blowers are being used. In no instance should operators install any parts other than those originally used in the engine, unless permission is obtained from an authorized source. The use of such parts may result in premature failure of engine parts, and will be considered sufficient cause to void the warranty.

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this Manual. The information contained in these bulletins should be noted in the text and bulletin filed for future reference.

Basic Engine Overhaul

CONTENTS OF THIS SECTION

This section includes maintenance and repair information on the components and subassemblies of the basic engine assembly under major sub-titles. Reference is made to other sections for information on related units. It is recommended that the information in special tools and equipment also specifications sections be studied before using this section, particularly bolt sizes, torque specifications, and fits and tolerances.

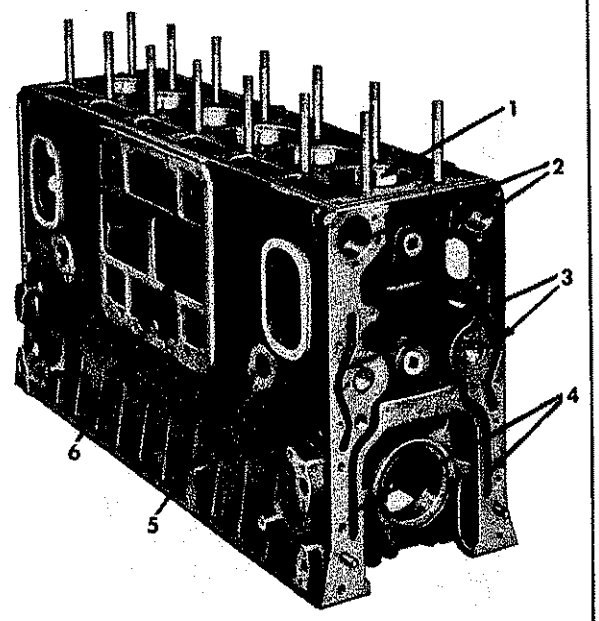
CYLINDER BLOCK

Cylinder block and crankcase (fig. 1) which is main structural part of the engine, is a box-like, one-piece casting made of alloy cast iron. The blocks for the four- and six-cylinder engines are identical in design and dimensions, except the necessary length for the additional bores and the correspondingly larger blower mounting flanges. The two ends of block are similar, so that same flywheel housing and gear train can be installed on either end of any one of the models.

Rugged transverse members, cast integral, provide rigidity and strength, and assure perfect alignment of bores and bearings under all loads. Cylinder bores are counterbored and fitted with an insert to support cylinder liners, into which a number of air inlet ports are drilled. Water jackets extend full length of bores and are divided into upper and lower sections, which are connected by hollow struts. Cooling water enters at bottom of water jacket from the water pump and leaves jacket at top through holes which register with corresponding openings in cylinder head. Surrounding the water space is an air chamber which conducts air from blower to all of the inlet ports in cylinder liners (fig. 2).

The upper halves of main bearing seats are cast integral with block. Drilled passages in block carry lubricating oil to all moving parts thereby eliminating tubing.

Hand-hole plates (fig. 3) on the side opposite to



1 Cylinder Liner Bore
2 Camshaft and Balance Shaft Opening
3 Balance Weight Cover Drain
4 Air Box Drain
5 Water Pump Opening
6 Air Box

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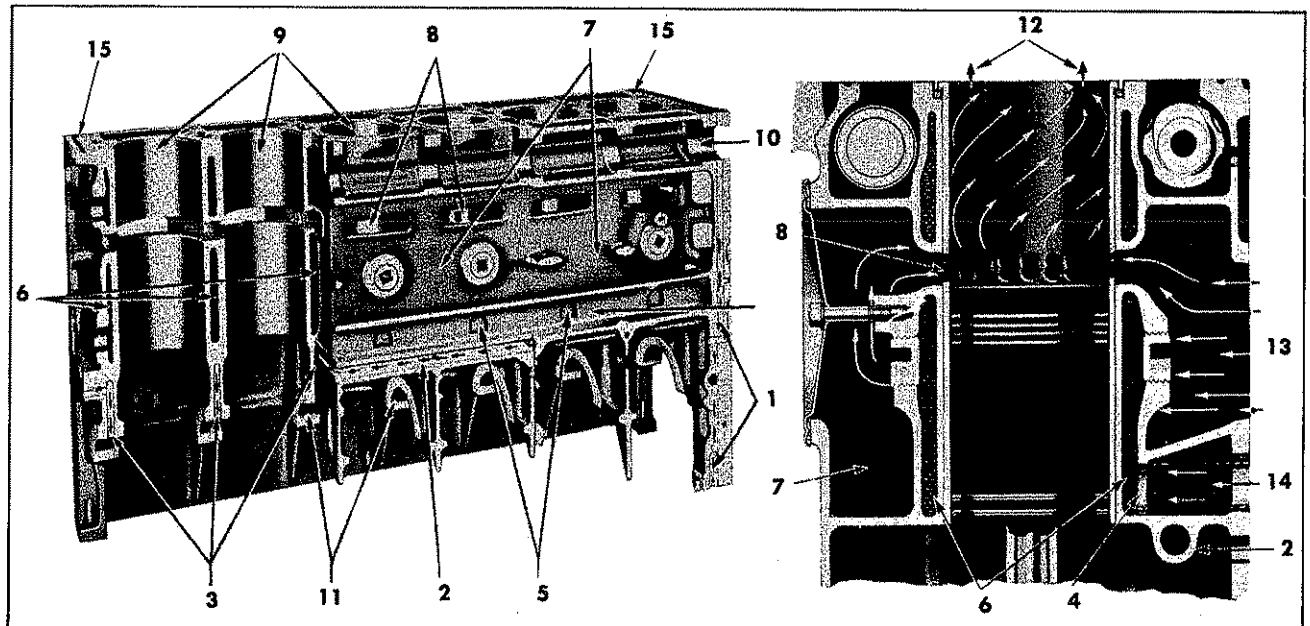
Figure 1—Typical Cylinder Block and Crankcase

CYLINDER BLOCK



1 Vertical Oil Passage
2 Oil Gallery
3 Oil Passage to Crankshaft
4 Coolant Passage
5 Coolant Inlet to Liner Jacket
6 Liner Cooling Jacket
7 Air Box
8 Air Passages to Cylinder
9 Bore for Cylinder Liner
10 Bore for Cam or Balance Shaft
11 Upper Half of Main Bearing Seat
12 Water to Cylinder Head
13 Air from Blower
14 Water from Pump
15 Plugged Holes Each Corner

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Figure 2—Cylinder Block and Crankcase Sections

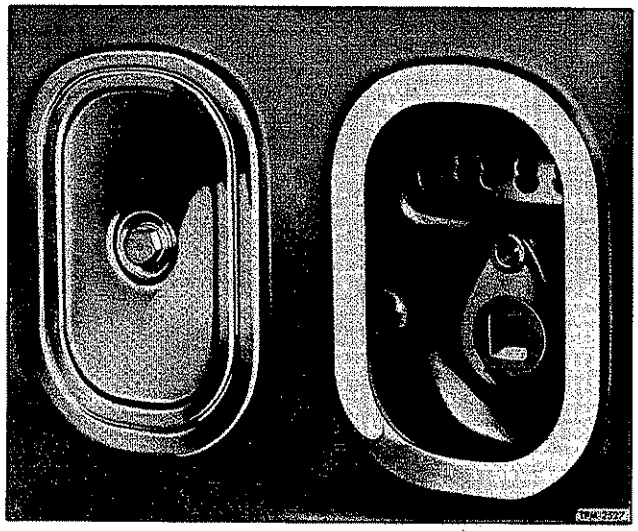

Figure 3—Hand-hole Plates and Air Intake Ports

blower permit access to air chamber, and inspection of liner wall, pistons, and rings through the air intake ports in cylinder walls. The six-cylinder engine also has two hand-hole plates on the blower side.

Camshaft and balancer shafts, located on opposite sides near the top of the block, are supported by bearings located in machined supports near top of block.

DISASSEMBLY

Procedure for removing each assembly and subassembly from the cylinder block together with disassembly, inspection, repair, and reassembly of each, will be found in the various sections of this manual. Reference to the subject and alphabetical indexes will show the location of any desired information on particlar accessories or engine parts.

After stripping and before any parts are reassembled to the cylinder block, the block should be cleaned and thoroughly inspected for any conditions that would render the part unfit for further use.

CLEANING

Since the cylinder block is main structural part of engine, whenever engine is being overhauled, block should be thoroughly cleaned and inspected for any conditions that would render the block unfit for further use. Such inspections should take place after

block has been thoroughly cleaned in either live steam or suitable solvent and blown dry with compressed air.

If shop facilities are available, it is recommended that block be completely disassembled; then cleaned of grease and scale in the following manner:

1. Remove grease by agitating the block in a commercial heavy duty alkaline bath as sold by trade chemical suppliers.
2. Wash in hot water or steam clean to remove alkaline.
3. Remove scale by agitating the block in a bath of inhibited commercial pickling acid, as sold by trade Chemical suppliers. A 50-50 solution of Oakite 32 and water has been found satisfactory. After block is cleaned of grease and scale it must be rinsed and the cleaner acid neutralized. Carefully follow directions of chemical manufacturer as to cleaning, rinsing, and neutralizing.
4. Wash block in a bath of clean water or steam clean.
5. Make certain that all oil galleries, water passages, and air box drain holes are thoroughly cleaned.
6. After block is inspected, dip in rust preventive, such as Rust Ban No. 392 or equivalent as castings free of grease and oil will rust immediately when exposed to atmosphere.

NOTE: Completely clean all traces of rust preventive from block before reassembling.

INSPECTION

Air box drains should be opened and blown out with dry compressed air after air box has been cleaned. NOTE: When servicing air box drains on an assembled engine, remove or at least loosen an air box hand hole cover, or blower or end plate gaskets may be damaged by excessive air pressure. Refer to "Air Box Drains" in **AIR INTAKE SYSTEM** section of this manual.

After cleaning inspect all surfaces to be sure that all traces of gaskets and sealing compound are removed.

PRESSURE TEST

1. Block off water inlets and outlets so that they are air tight (fig. 4).
2. Immerse cylinder block for twenty minutes in water heated to 180° to 200°F.
3. Using a suitable fitting at one of the water inlets or outlets, apply 80 to 100 lbs. per sq. inch of air pressure and observe water in tank for air bubbles. Presence of air bubbles in water indicates cracks or leaks in block.

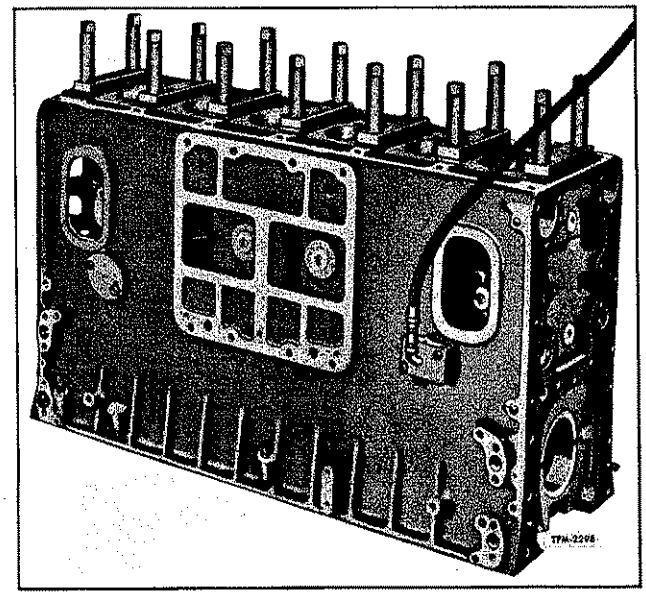

Figure 4—Checking Cylinder Block for Cracks and Leaks

FLATNESS

1. Remove cylinder head studs from cylinder block and smooth down any nicks or raised areas around studs.
2. Check flatness of block using straight edge and feeler in manner illustrated in figure 5. Top of block should not vary more than .003" transversely or longitudinally more than .007" for the 4-71 and .009" for the 6-71 engines.
3. Whenever necessary to machine top of cylinder block do not remove more than .008". The amount removed should be stamped on the face of the block. Counterbores for oil and water seal rings must be

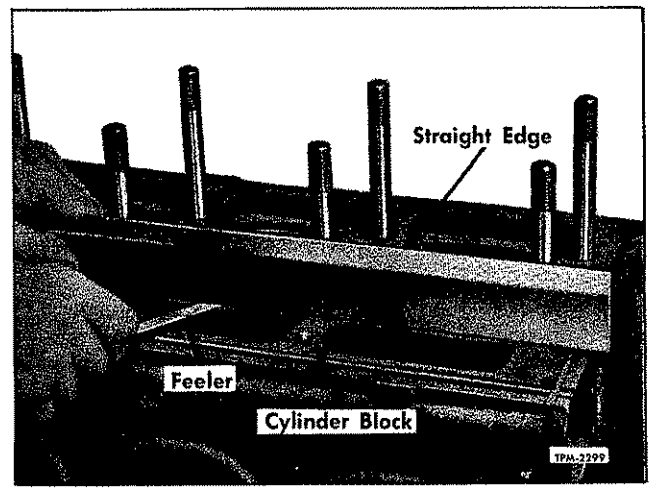

Figure 5—Checking Top of Cylinder Block

CYLINDER BLOCK

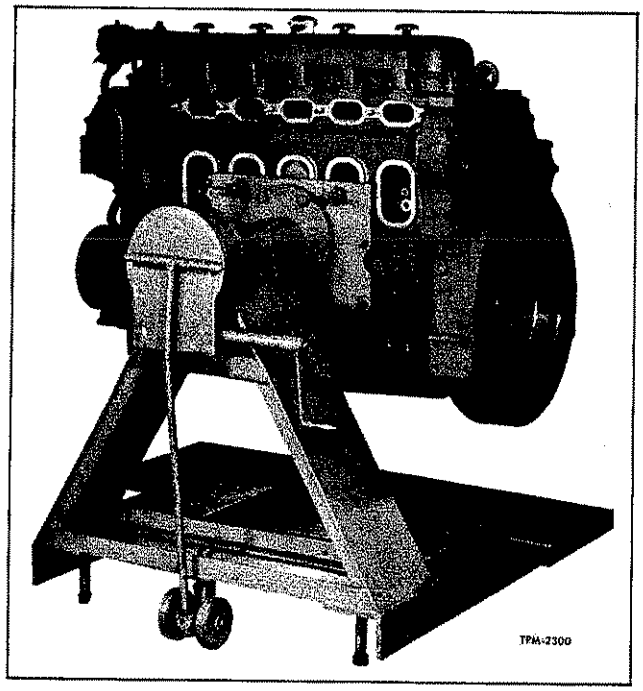

Figure 6—Engine Mounted in Overhaul Stand

machined deeper by the same amount as was removed from top of block. Counterbores for cylinder liners should not be deepened, since .004" and .008" undersize inserts are available.

STUDS

Cylinder block studs should be inspected for damaged or stretched threads, also for straightness and tightness. Studs should extend $4\frac{7}{16}" \pm \frac{3}{32}"$ above the block. Studs should be tightened to 50 ft. lbs. when being installed.

MAIN BEARING BORE ALIGNMENT

1. Install main bearing caps and tighten cap bolts to recommended torque.
2. Check for longitudinal alignment using an aligning bar which has a diameter of .00075" less than bearing bore. Aligning bar must extend through all the bores.
3. If bores are in proper alignment the alignment bar can be turned with a 15" wrench.
4. Main bearing bores that are out of alignment can be line bored. However, not more than 0.001" of stock should be removed from any bore.

COUNTERBORES

Check cylinder liner counterbores for squareness, depth and diameter. Refer to **SPECIFICATIONS** section of this manual for dimension and limits. Whenever top of cylinder block has been machined, it is not necessary to deepen the liner counterbore as undersize inserts are available.

Check oil and water seal ring counterbores for depth and diameter. Counterbores for oil and water seals must be deepened whenever top of cylinder block is machined to provide flatness within limits.

CYLINDER BLOCK LINER BORE

Refer to CYLINDER LINERS section later in this manual for information on inspection, boring, and fitting of cylinder liner in cylinder block.

MOUNT ENGINE ON OVERHAUL STAND

1. Locate center lug of overhaul stand support-plate in proper air-box opening on exhaust manifold side of block. The center lug is located in the number two air-box opening on four cylinder engines, and in the number four air-box opening of six cylinder engines (see fig. 6).
2. Loosen lock nuts on the two holding lugs of overhaul stand and lower engine while entering these lugs into air-box openings opposite adjacent cylinders.
3. Turn holding lugs crossways of air-box openings. Tighten lock nuts, drawing engine tight against overhaul stand support-plate.
4. To insure engine does not shift on or break away from the overhaul stand support-plate, insert a $\frac{7}{16}"$-14 x 2" bolt through hole in overhaul stand support-plate and into pad on cylinder block, using a plain washer under head of bolt.

CAUTION: **Be absolutely positive that engine is securely mounted to stand before releasing lifting sling. Severe injury to personnel and destruction of engine parts will result if engine breaks away from overhaul stand. Check fastenings carefully.**

SERVICE CYLINDER BLOCK

NOTE: **Cylinder block must have an opening at port area that will fully expose liner ports. Whenever new block is being installed inspect carefully to be sure that all liner ports are fully exposed.**

Service cylinder blocks are furnished with cylinder head studs, also main bearing caps, studs and nuts. Included with each service block is a bag containing miscellaneous plugs, studs, dowel pins, and other small parts. Whenever a service block is being built-

up, extreme caution should be exercised to be sure that the new block is fitted the same as the old block. In some instances, it may be necessary to remove some of the plugs already installed in block in order that new block will be the same as old block. Bag attached to block, contains an assortment of parts that would be necessary to build any type of block, therefore all of these parts are not always necessary.

CYLINDER BLOCK END PLATES

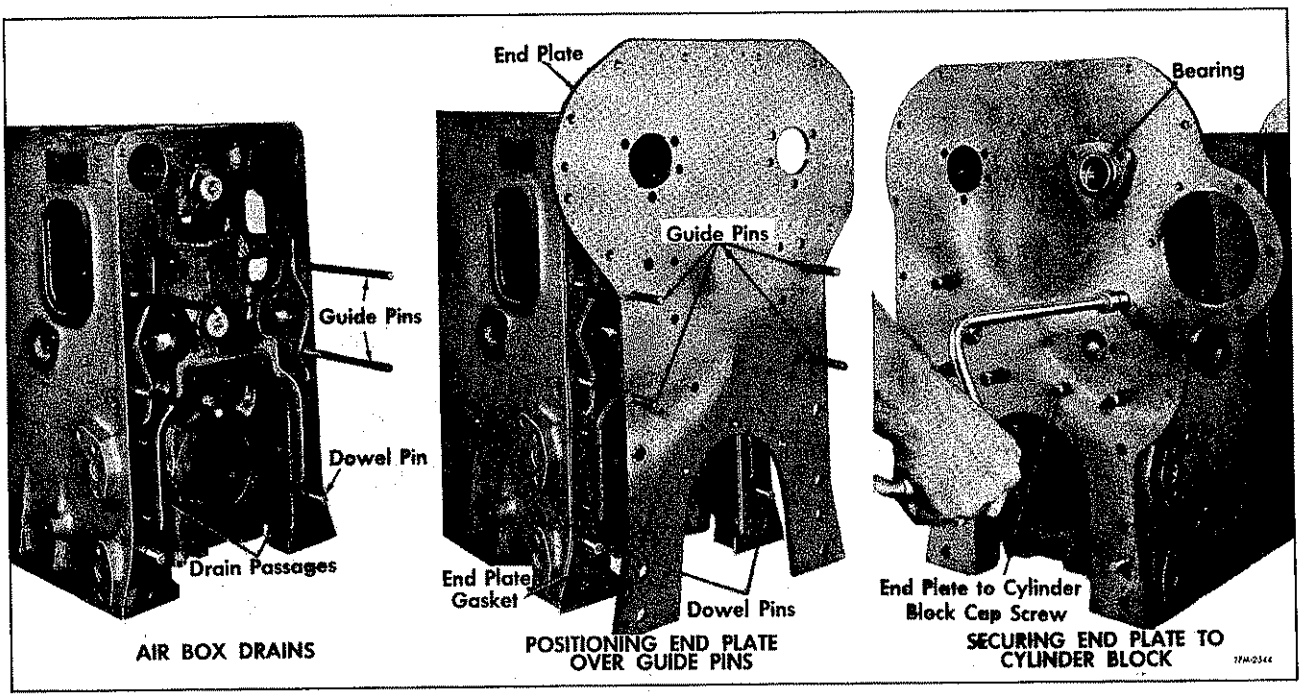

Figure 7—Cylinder Block End Plate Installation

GENERAL

A flat steel end plate, bolted to each end of cylinder block, affords a rigid construction and a means of attaching flywheel housing at the rear, and the balance weight and crankshaft cover at the front. Since the blower drive gear assembly is supported on the rear end plate, this plate has a different contour than one used at front. As both ends of cylinder block are alike, the same gasket is used between block and each end plate.

INSPECTION

Cylinder block end plates should require very little service under ordinary conditions. At the time of complete engine overhaul or of cylinder block change, end plates will be removed and reinstalled. When such replacement is necessary, inspect as follows:

1. Remove all of the old gaskets from inner and outer plate surfaces. Clean both surfaces of plates to remove all dirt, grease or other foreign matter.
2. Plates must be flat and smooth.
3. Remove nicks or damaging marks which would prevent a tight seal between the surfaces of block and plates, also flywheel housing, and plate.

INSTALLATION

The holes in the end plates for cam and balancer shaft bearing cages are not the same size. The smaller hole is accurately machined to 2.1885″ diameter while larger hole measures 2¼″ diameter. When installing end plates, the smaller hole must be accurately aligned with the bearing bore in cylinder block before end plate attaching bolts are tightened. The smaller hole in front end plate should be on same side of cylinder block as the smaller hole in the rear end plate. Installation may be properly accomplished by referring to figure 7 and proceeding as follows:

1. Inspect to be sure that all necessary plugs are properly installed in block and end plate to cylinder

CYLINDER LINERS

block dowels are in place (fig. 7). Four guide studs made locally (½"-13 x 6") with screwdriver slot in end, such as shown in figure 7 will be found essential when locating the plates on the cylinder block.

2. Apply a light even coating of non-hardening cement to each side of gasket. Position new gasket at end of cylinder block, being careful that gasket is aligned with mating holes.

3. Carefully position end plate over temporary guide studs and with blower drive gear opening in rear plate on blower side of the block.

4. Temporarily install bearing (fig. 7) through the smaller of the two cam and balancer shaft holes in end plate to align plate with block. Start six attaching bolts into place and draw up only finger tight. **BE SURE REAR PLATE** is installed with blower drive support bore on blower side of block, also that **SMALL CAM OR BALANCE BEARING HOLE** in front and rear plates are both on same side.

5. The six cap screws may now be tightened and bearing removed. Temporary guide studs can be left in place until flywheel housing has been installed.

CYLINDER LINERS

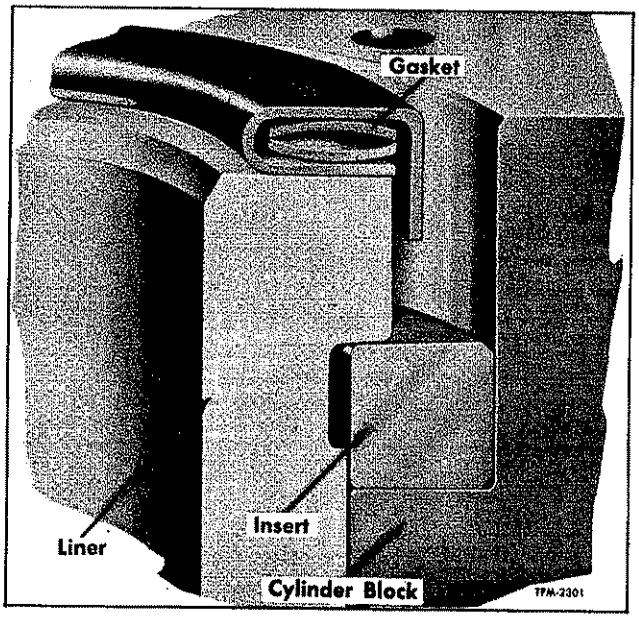

Figure 8—Cylinder Liner, Insert, and Gasket Mounting in Block

GENERAL

Construction of cylinder block, cylinder head, and liner provides that top of cylinder liner flange be below the top of cylinder block and compression seal is accomplished by use of individual gaskets at each cylinder (fig. 8), thus cylinder head rests directly on cylinder block and is called metal-to-metal contact. Water and oil passages between cylinder block and cylinder head are individually sealed with special grommet type rubber gaskets which are installed in cylinder block counterbores.

The replaceable liner, made of hardened alloy cast iron, in each cylinder is accurately honed to a very smooth finish. Even temperature and minimum

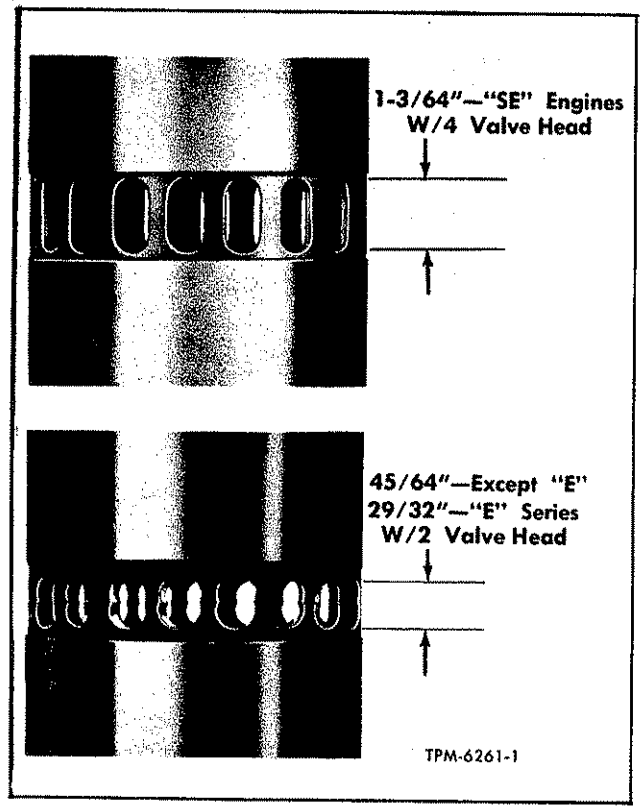

Figure 9—Cylinder Liner

distortion are insured by cooling each liner over its entire length, except at the ports, which are cooled by the scavenging air. To permit introduction of fresh air into the cylinder, twenty ports, with a figure 8 appearance, are drilled into the circumference of each cylinder liner. Refer to figure 9.

NOTE: Cylinder liners with three sizes of ports are used. Liner used in "E" series engines with two valve heads measure .900" (approx. $^{29}/_{32}$") high, or

1 7/64" with four-valve heads, others measure .703" (approx. 45/64"). Refer to figure 9.

LINER MAINTENANCE

Cylinder liners will render satisfactory service for extended periods if the engine has proper care. Wear on a cylinder liner and piston is directly related to the amount of abrasive dust and dirt introduced into the engine combustion chambers via air intake. Dust so introduced and combined with lubricating oil on the cylinder walls forms an ideal lapping compound. To avoid such a condition, the vehicle air cleaners should be serviced regularly as instructed in the maintenance manual covering the specific vehicle.

When the clearance between the piston and cylinder liner becomes excessive the performance of the engine will be unsatisfactory. Replacement or reconditioning of liners and associated parts will be necessary.

When a cylinder liner change is necessary, due to either wear or scoring, the old liner may be removed from the cylinder block and a new liner installed, or the old liner may be honed oversize and reinstalled. New cylinder liners are available only in the standard size inside diameter; however, .005", .010", .020", and .030" oversize outside diameter liners are available for use in cylinder block bores which have been oversized to correct distortion or out-of-roundness.

CLEANING LINER PORTS

Whenever 1000 hour inspection indicates that air ports in liners require cleaning, the operation can be performed as follows:

1. Remove hand hole covers at side of cylinder block, also remove blower assembly.

2. Use suitable tool to remove deposits from liner ports, being careful that liner is not damaged.

3. Use vacuum to lift all carbon deposits from air box, then use compressed air to remove all remaining particles.

4. Inspect air box drains to be sure they are clean.

5. Install blower assembly and hand hole covers as directed in respective sections of this manual.

6. Whenever cylinder liners have been removed, the air ports can be cleaned by soaking in a hot caustic soda or lye solution to loosen carbon deposits. Final cleaning can then be accomplished by brushing loose deposits.

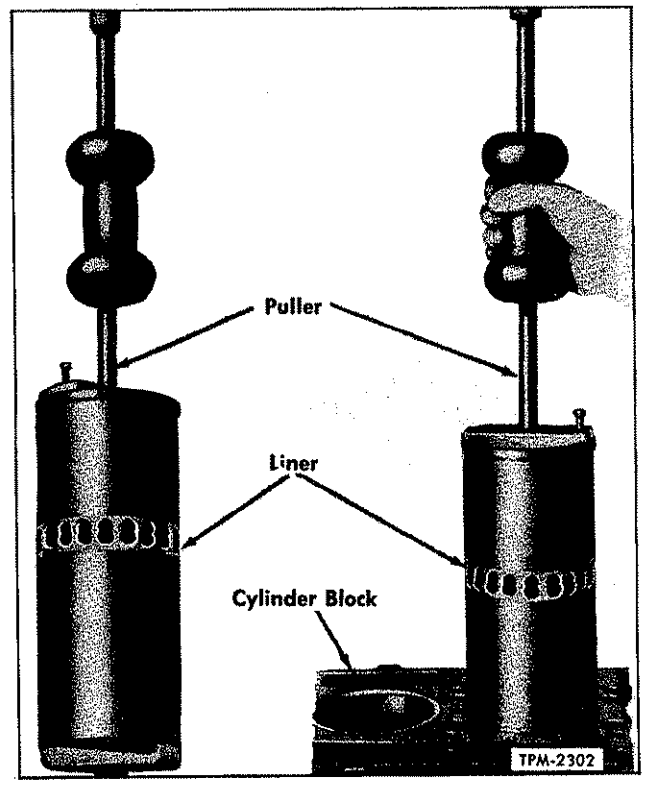

Figure 10—Removing Cylinder Liner

LINER REMOVAL

To remove a cylinder liner, the following preliminary operations will be necessary.

1. Remove the cylinder head assembly as instructed in CYLINDER HEAD section of this manual.

2. Remove the oil pan.

3. If necessary, remove the lubricating oil pump and discharge line assembly together with the pump drive shaft. Refer to LUBRICATING OIL PUMP in LUBRICATION section of this manual.

4. Remove cylinder liner compression gasket from each liner.

5. Scrape carbon from the upper inner surface of cylinder liner, before attempting to remove piston assembly.

6. Remove piston and connecting rod assembly. Refer to PISTON AND CONNECTING ROD section later in this manual.

7. Since the cylinder liners are a loose fit, they may be removed easily from the top of the cylinder block by hand, after loosening with the tool illustrated in figure 10. Use tool in following manner:

(a) Slip lower puller clamp upward on puller rod and off tapered cone. Cock lower clamp on

CYLINDER LINERS

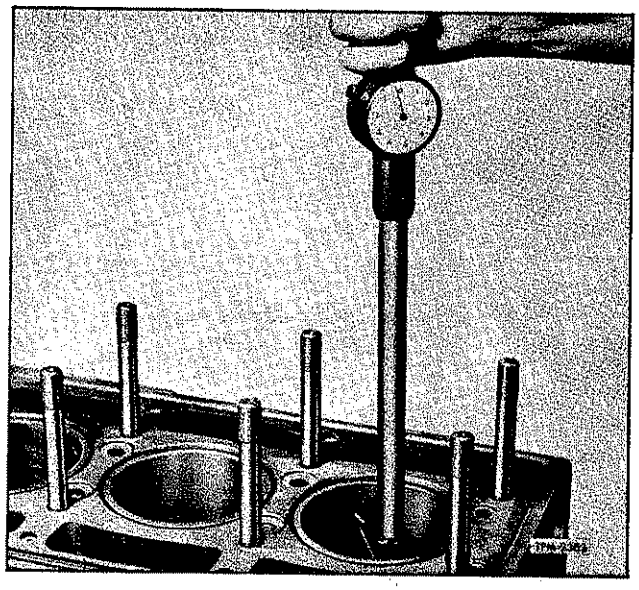

Figure 11—Checking Bore of Cylinder Liner

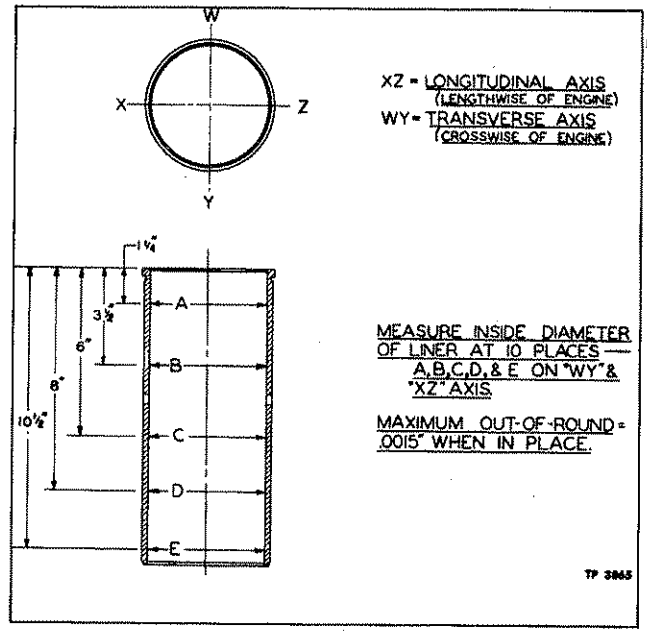

Figure 12—Cylinder Liner Measurements

rod so it will slide down through liner. When rod is lowered down through liner, clamp will drop back onto the tapered cone in a horizontal position.

(b) Slide upper clamp down against top edges of liner.

(c) With tool so mounted, strike the upset head on upper end of puller rod a sharp blow with the puller weight, thus releasing liner from cylinder block.

CLEANING AND INSPECTION

CLEANING

With cylinder liners removed from block, air port cleaning may be carried out as follows:

1. Use a brass rod or sharpen a stick of 1" square x 12" long hard wood to a tapering point with square edges. Clean each of the ports by inserting pointed end of the stick or similar tool in the port and twisting. Resharpen stick as often as necessary.

2. After cleaning ports, examine the inside of the liner around the port area for burrs. If burrs are found, remove with 250 grit emery paper. Burrs must be removed by hand whether liner is to be honed or not. Failure to remove these burrs may result in premature failure of piston and rings.

3. An alternate method of cleaning air inlet ports is to soak the liner in a hot caustic soda or lye solution long enough to loosen the carbon deposits. Final cleaning can be accomplished with a bristle brush.

INSPECTION

The liners must not taper more than 0.001" in full length or be out-of-round more than 0.002". When measuring cylinder liner with dial indicator as shown in figure 11, measurements must be taken on inside diameter of liner at ten places. Refer to figure 12 for diagram of cylinder liner measurement.

When liners have been in service for any length of time, the inside diameter becomes very smooth or glazed. This glaze, if not removed, lengthens the time required to seat new rings. Therefore, even though inspection reveals a liner to be within specifications and honing unnecessary, the glaze must be removed by working the hone up and down lightly once or twice.

HONING LINER

Cylinder liners are furnished in standard size inside diameter only, therefore installation of oversize pistons becomes necessary when liners are honed oversize. Also, liners are furnished in oversize outside dimensions which must be used whenever cylinder block bores are honed.

A cylinder liner may be honed on inside diameter and used again, if honing operation is carried out in proper manner. To be sure that none of the abrasive gets into the air box or ports, it will be necessary to remove liners from cylinder block, place in a honing fixture (a scrapped cylinder block will make an

excellent honing fixture), and then hone to proper size. After honing, the liners may then be replaced in the cylinder block.

Whenever liners must be honed to cylinder block, completely dismantle engine, and then after honing, wash block in a solution of hot caustic soda, to be sure that all abrasive is removed from openings in block and liners.

The ordinary honing stones used on cylinder blocks are rather ineffective on hard cylinder liners. For rough honing, use a No. 80 grit and for smooth mirror finish required for inside of liners use No. 120 grit.

Necessary steps for honing liners are as follows:

1. Remove liner from cylinder block as previously described under "Liner Removal" in this section.
2. Place liner into liner honing fixture.
3. Hone liner in fixture with honing stones described above.
4. After cylinder liner has been honed and removed from honing fixture, it must be thoroughly washed and blown off with air before installation into cylinder block. If this precaution is not taken some of the honing abrasive might be drawn into engine and cause serious damage.
5. Remove liner from fixture and install in cylinder block in manner described under "Liner Installation" in this section.

HONING CYLINDER BLOCK

The fit of a liner depends to a great extent upon the condition of the bore before honing. Distortion may cause low spots that will not clean up. A low spot is not objectionable above the ports if it does not exceed 1¼" or the size of a half dollar. Below the ports, larger spots are permissible.

The hone, selection of hone stones, and method of honing are important, especially when truing distorted bores. An adjustment for setting the cutting radius of the stones is preferable to spring loaded stones. Spring loaded stones will follow instead of remove irregularities in the bore. Keep the stones dressed and brush them frequently to prevent loading. Follow the hone manufacturer's instructions regarding the use of oil or kerosene on the stone. With a dry type hone, such cutting agents should not be used. Roughing and finishing stones should be fairly coarse. A No. 80 grit stone may be used for roughing, and a No. 120 grit stone is satisfactory for finishing.

The following inspection should be made before honing cylinder block:

1. Remove oil, dirt, and grease from the bore and inlet port opening.
2. Measure the bore for high spots and the most narrow section.
3. Liners are fitted from .0005" to .0025" loose. A clearance of .0005" produces a slip fit and .0025" clearance allows the liner to slide freely into place. Refer to chart for standard and oversize cylinder liner bore in cylinder block.

CYLINDER LINER AND CYLINDER BORE DIMENSION CHART

Size	Liner Diameter	Block Diameter	Use Next Oversize Liner when Bore Measures
Std.	4.6250"	4.6265"	4.6280"
	4.6260"	4.6275"	
0.005"	4.6300"	4.6315"	4.633"
	4.6310"	4.6325"	
0.010"	4.6350"	4.6365"	4.638"
	4.6360"	4.6375"	
0.020"	4.6450"	4.6465"	4.648"
	4.6460"	4.6475"	
0.030"	4.6550"	4.6565"	4.658"
	4.6560"	4.6575"	

Rough Honing

Insert hone in bore and adjust stones snugly to the most narrow section. When correctly adjusted, hone will not shake in bore, but will still drag freely up and down the bore while the hone is stopped.

Start hone and "feel out" bore for high spots. These will cause an increased drag on the stone. Move hone up and down bore with short overlapping strokes about 1" long. Concentrate on the high spots in the first cut. As these are removed, the drag of the hone will become lighter and smoother. Do not hone as long at the ports as in the rest of the bore—this area, as a rule, cuts away more rapidly. When drag of hone becomes light and smooth, increase the feed on the stones. Feed lightly to avoid excessive oversize of bore; roughing stones cut rapidly even under low tension.

When bore is fairly clean, remove hone to inspect the stones and measure bore. Decide carefully which spots must be honed most. To move the hone from top to bottom of bore will not correct an out-of-round condition. To remain in one spot too long may cause bore to become tapered. Where and how much to hone can be judged by feel. A heavy cut in distorted bore produces a more steady drag on the hone than a light cut and so makes it difficult to feel the high spots. Therefore, use a light cut with frequent stone adjustment.

CYLINDER LINERS

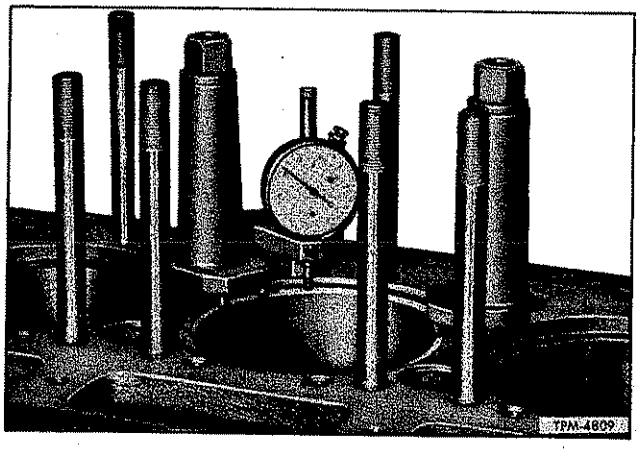

Figure 13—Checking Depth of Liner Below Top of Block

FINISH HONING AND FITTING LINER

Rough hone cylinder bore until the liner can be pushed from 3″ to 4″ into the bore, or until bore is within approximately .0005″ of the diameter of the liner. Do not expect finishing stones to remove more than .001″ of stock, or to true up the bore to any extent.

Work the finish hone with short, rapid strokes up and down the bore. Use light tension on the stones and hone only enough to allow the liner to enter the bore either with a light push fit or a free slip fit.

If new liners are to be used after honing the block, follow instructions for replacing loose liners. If old liners requiring rehoning on the inside diameter are to be used, follow instructions under "Honing Liner" previously in this section.

LINER INSTALLATION

Check bore in cylinder block. Bore must be round and smooth within .0015″ from top to bottom. When checking for these conditions, use a dial indicator, or if a new, undamaged (round) liner will slip fit into the bore, the fit is satisfactory. Hone bore as outlined under "Honing Cylinder Block" previously in this section to remove roughness or distortion.

Before installing the liner or insert in cylinder block wipe the liner, insert and block counterbore until absolutely clean. Use a fine flat honing stone to remove any burrs that may be present on the liner or insert or in cylinder block counterbore. Liner must be installed dry—do not use oil.

Since cylinder head and cylinder block are metal-to-metal contact, each cylinder liner is sealed individually by compression seals. This construction requires that top of liner flange be .0465″ to .050″ below top of cylinder block.

When insert and cylinder liner are installed, height of liner must be checked to determine that liner is proper distance below top of cylinder block. Install hold-down tool over top of liner to hold liner tightly in place, while measuring liner depth below top of block (fig. 13). Use a dial indicator and a surface plate on a flat surface gauge to measure depth of cylinder liner below top of cylinder block.

LINER HEIGHT

When cylinder liner and insert are installed and liner depth is checked in manner previously outlined the depth should be .0465″ to .050″ as indicated. If liner depth is not within these limits, and inspection indicates they are properly installed, the insert or liners or both should be removed for careful inspection of mounting surfaces and condition of cylinder block counterbore. Undersize cylinder liner inserts are available for use when top of cylinder block has been "trued up" by removing a small amount of stock. **DO NOT USE SHIMS TO OBTAIN CORRECT LINER HEIGHT.**

Having replaced the cylinder liners, the pistons may be fitted and the engine rebuilt. In this process, see "Fitting Pistons," in PISTON AND CONNECTING ROD section later in this manual, also refer to the various other sections of this text for detailed instructions relative to correct location of parts, bearing clearances, etc.

Operate engine as instructed in ENGINE RUN-IN PROCEDURE section later in this manual.