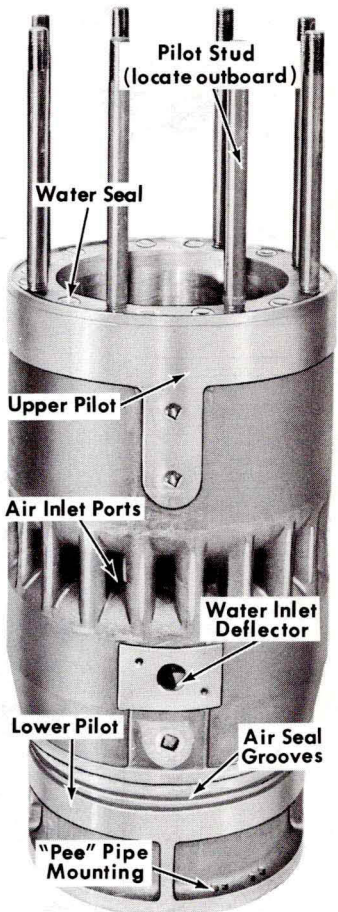
SECTION IV

CYLINDER LINERS

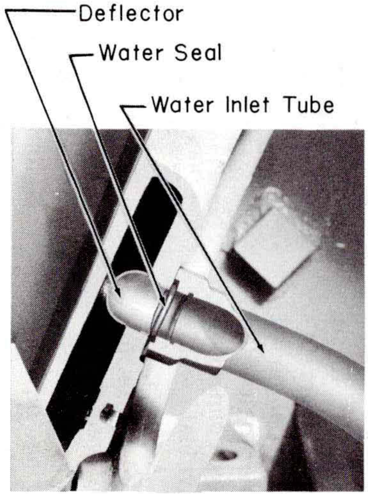
A. DESCRIPTION

The cylinder liner, Fig. 4-1, is made of cast iron having a water jacket formed by a cored annular space between the outer and inner walls. The liner is secured to the cylinder head by eight studs and nuts and the entire assembly held in place in the crankcase by the cylinder head crabs. A "pilot stud" locates the liner in proper angular relation to the cylinder head and assures alignment with the piston cooling pipe mounted at the bottom of the liner.

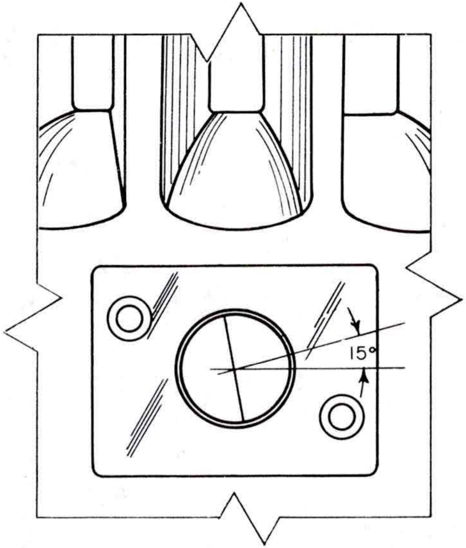
Scavenging air inlet ports are completely around the liner just above the piston when it is at bottom center. A water inlet flange on the outboard side of the liner below the ports provides connection for the individual water supply line. A water deflector, Fig. 4-2, is inserted at the water inlet opening, to prevent inlet water impinging on the liner wall. The water



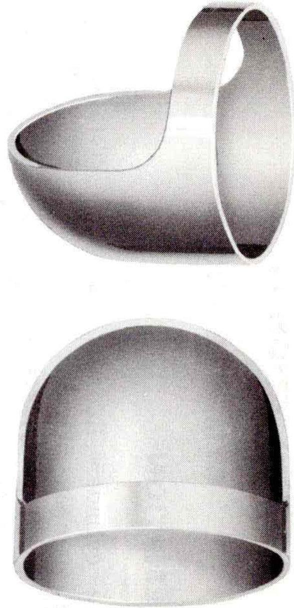
Basic 567C
Cylinder Liner
Fig. 4-1



Cross-Section View
Deflector In Liner



Deflector Installation
Looking At Liner

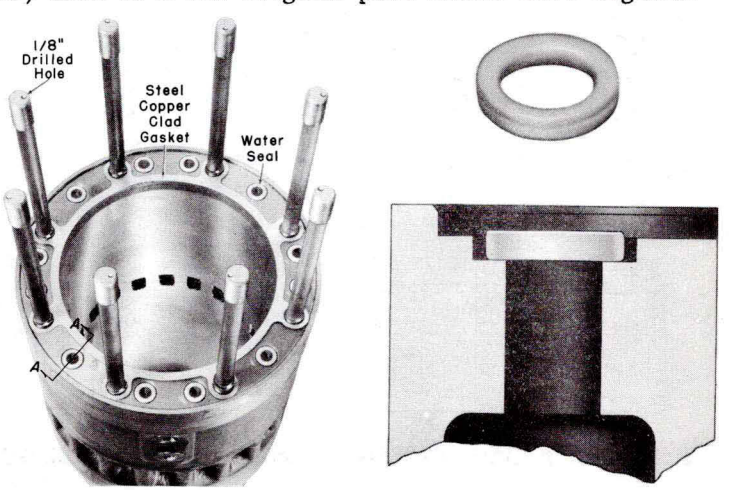


Views Of Deflector

567C Liner Water Inlet Deflector
Fig. 4-2

jacket is closed at the bottom and water discharges to the head at the gasket surface through twelve drilled holes. A counterbore around each drilled hole accommodates a synthetic rubber seal ring which seals the water passage when the cylinder head is installed. (Water tubes originally used in the drilled holes are no longer applied.) A thin copper clad steel gasket is used between the cylinder head and liner, Fig. 4-3. The liner has an extended lower pilot fitting into an insert ring in the crankcase. Seal rings are used at this pilot to prevent air pressure transfer between air box and oil pan.

Liner 8262891, Fig. 4-4, is now used in all 567C engines. This liner is the same as prior used liner 8206208, except that it is provided with two air seal grooves at the lower pilot instead of the single groove as shown on liner 8206208. It should be noted that neither of these liners, later 8206208 or current liner 8262891, are provided with any identifying groove at the top pilot. A groove was originally used on liner 8206208, which has the 12.089" upper pilot diameter, to distinguish it from liner 8163841 (having a 12.060" upper pilot diameter) used in a few original pilot model 567C engines.



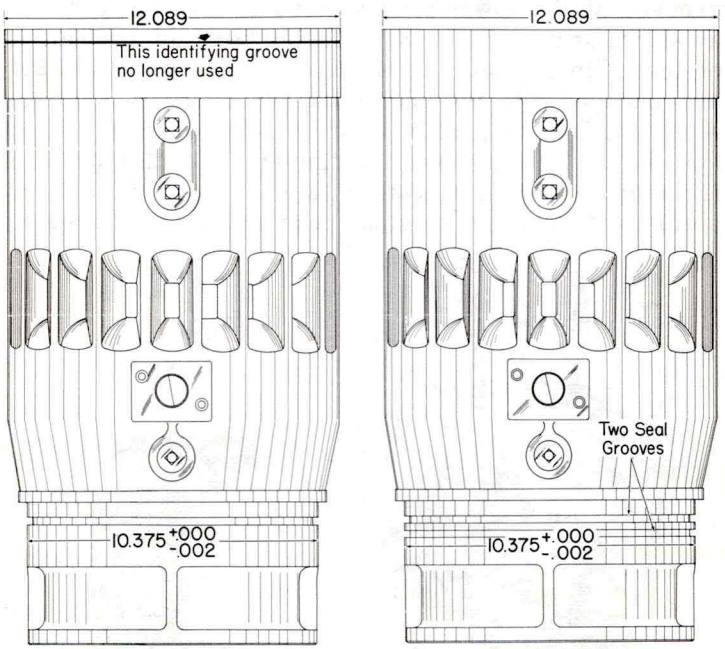
Cylinder Liner Seals
Fig. 4-3

Current production 567C engine liner 8262891 can be used in any 567C type engine, such as early 567 series engines modified for "C" type liners, providing they have a 12.091" upper pilot bore in the crankcase. For crankcase and liner dimension limits, see Fig. 4-7.

B. MAINTENANCE

1. Inspection

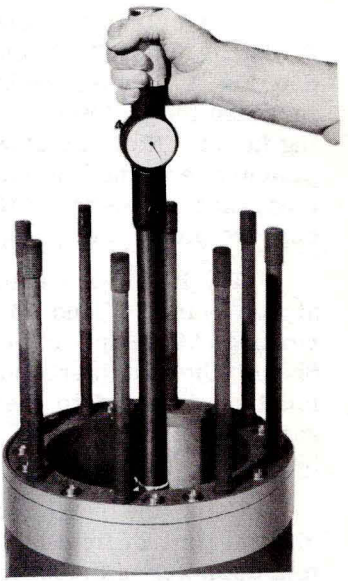
Cylinder liners are inspected while in the engine (engine shut-down) by removing the air box and oil pan hand-hole covers. Open cylinder test valves and position



Prior Used Liner 8206208 Production Liner 8262891

567C Engine Cylinder Liners
Fig. 4-4

piston so inspection may be made above it through the liner ports and also from the oil pan. Check liner walls for scuffing or scoring above and below ports. Inspect externally for evidence of water leaks at liner to head gasket, and water inlet line.



Liner Bore Gauge Application
Fig. 4-5

2. Removing Cylinder Liner

Remove cylinder head and piston and rod assemblies as outlined in Section 2 and 3. Remove piston cooling oil pipe and liner water inlet line. Apply liner lifting tool 8116358 to liner studs and remove liner. Use care when handling to avoid damage to studs.

3. Cleaning Cylinder Liners

Liner cleaning instructions are contained in parts cleaning bulletin, Maintenance Instruction 1706. After cleaning, service liners as follows:

4. Measuring Cylinder Liners for Wear

Wipe interior of liner clean before measuring bore and check for physical defects that would require rework on the liner. Liner bore gauge 8187645 or standard inside micrometers may be used to measure liner bore diameter. Gauge 8187645 is designed for liner bore measurement. It has a three-pronged centering and measuring end that fits the liner bore. A dial indicator mounted on an upright that extends down to the measuring prongs, gives instant reading of bore diameter. The upright allows the gauge to be raised and lowered in the bore, Fig. 4-5, with visual

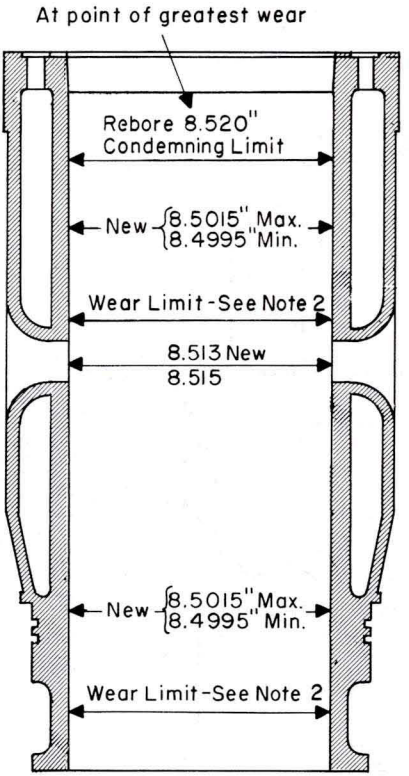
measurement shown on the dial. A master ring 8187647 is used with the gauge to provide gauge calibration.

New cylinder liners are finished to a diameter of 8.4995" - 8.5015", except through the port relief zone. See Fig. 4-6. Accumulated liner and piston wear will increase the piston to liner clearance, which is the limiting factor. No liner should be used with a new or worn piston where the diameters result in a piston to liner clearance exceeding .018", at any point in the liner except the port relief zone, at time of service application.

The liner bore should be checked for out-of-round at two points 6" and 16" below top of liner. Take two readings 90° apart, to determine wear and out-of-round. Should the out-of-round be .005" or more, the liner must be rebored to the next oversize allowable, regardless of other wear measurements which still may be within limits.

Using the maximum piston to liner clearance of .018" at time of field installation as a guide, liners worn to a diameter of 8.508" may be used again, providing they are not .005" out-of-round, and are matched with a NEW piston of top limit diameter of 8.490". This would assure the .018" maximum piston to liner clearance would not be exceeded. If a piston worn to a diameter of 8.485" were to be used, the diameter of the liner must not exceed 8.503", and so forth, not to exceed the .018" limit. By observing these limiting dimensions provided for the piston and cylinder liner, they may be used in selective assembly.

Liners will wear tapered, with maximum wear normally occurring at the top limit of piston ring travel. Maximum wear should be checked at "point of greatest wear," taking two readings 90° apart. The wear limit at this point is 8.520". A liner worn to this dimension will leave some stock to allow for cleaning up the bore to the first oversize. If this limit is exceeded, it may not be possible to rebore liner to the first oversize. It would then have to be rebored to the next oversize, .060",

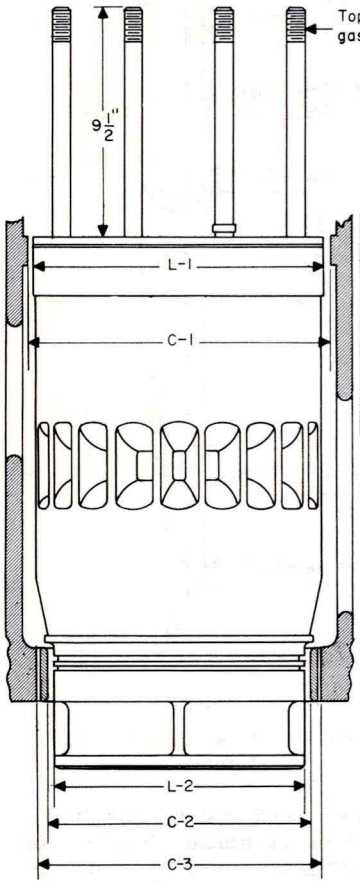


NOTES:

1. Piston to liner clearance — New .0095" - .0135"; Limit .018"

2. For service applications, used pistons and liners should be matched within maximum clearance of .018" (from bottom to 6" from top of liner, except at ports). For example, with a liner worn to 8.508" diameter a high limit piston of 8.490" diameter must be used. With a piston worn to 8.485" diameter, the liner diameter must not exceed 8.503".

Wear Limits Of Cylinder Liner
Fig. 4-6



CRANKCASE & LINER DIMENSIONS - 567C		
	NEW	LIMITS
* L-1	12.087"-12.089"	12.085"
L-2	10.373"-10.375"	10.371"
** C-1	12.091"-12.094"	12.104"
C-2	10.377"-10.382"	10.386"
C-3	11.062"-11.065"	11.066"

Original Pilot Model 567C Engine Only

* 12.060" diameter-min. 12.056"

** 12.061" bore-max. 12.079"

Crankcase To Liner Dimensions And Condemning Limits
Fig. 4-7

losing a great amount of its wear life. Consequently, it is suggested, no liner be re-installed if the maximum bore diameter at point of greatest wear at top of ring travel exceeds 8.520".

5. Oversize Liners

Liners can be rebored to .030" or .060" oversize. The dimensions of oversize liners are the same as shown on Fig. 4-6, except that the diameters are increased by .030" or .060" as the case may be. Standard or .030" oversize liners worn beyond their limits can be returned to Electro-Motive for refinishing to the next oversize.

6. Liner Studs

The 567 series engine liner studs can be classified according to their relative tensil strength as high strength and low strength studs. This applies to pilot studs as well as regular studs.

Low strength liner studs are not available from our parts department for service replacement. They are applied at EMD only to liners which use the steel copper clad shim type gasket. These gaskets require a cylinder head to liner nut torque of 200 foot pounds. Low strength studs can be identified by a small off center hole at the top of the stud and black lubrized color. They are straight shank studs. If low strength studs are removed from their original liners, care should be taken only to re-apply them in liners which use the shim type gasket. (All 567C, 567BC engine liners use the shim type gasket as does the #3 liner design used in other 567 series engines.)

High strength studs can be divided into two categories, current design straight shank, and prior used

"necked down" studs. High strength straight shanked studs can be identified by a groove around the shank, just below the head end threads. These studs can further be divided as lubrized and non-lubrized studs having zinc plated liner end threads. Only the plated thread studs are supplied by our parts department, since they can be used in any liner, being particularly suited for use in #1 liners made before 1946 which do not have blind tapped liner stud holes. Lubrized high strength studs are applied to #2 design liners in our rebuild department only.

The zinc plated thread high strength studs are also available in the following oversizes; .002", .004", .015", .017" and .019", at the liner thread end. The oversize is stamped on both ends of the stud. The .002" and .004" oversize studs may be used without tapping the stud hole. However, a tap .015" oversize on the pitch diameter and .015" oversize on the outside diameter must be used before driving the .015", .017" and .019" oversize studs. Minimum driving torque for all liner studs is 50 foot pounds.

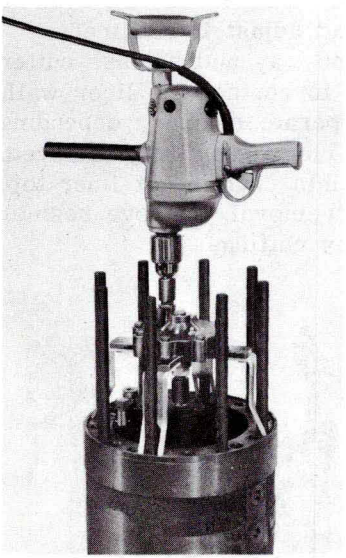
Cylinder head to liner nut torque values must correspond to the liner gasket used; 200 foot pounds for the shim type gasket and 290-300 foot pounds for the sandwich type gasket used on all liners except 567C engine type and #3 design liners.

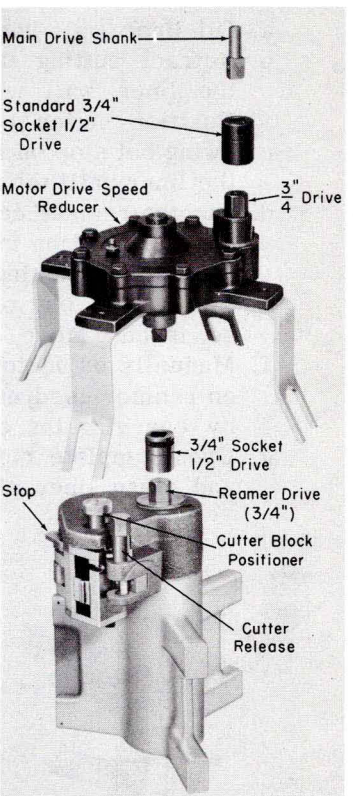
7. Removing Cylinder Liner Ridge

A ridge will appear at the top of the piston ring travel on the liner wall after use, caused by piston ring wear. After the liner is removed from the engine the wear ridge must be entirely removed before honing the liner. The wear ridge is removed by extending the cutting until the liner reamer cutting blade cuts into the 13/16" deep chamfer at the top of the liner bore. Unless complete removal of the wear ridge

is accomplished, it is not possible to properly hone the critical area of the liner at the top of the ring travel. Removal of the wear ridge precludes any possibility of interference with new piston rings.

Ridge reamers 8228303, Fig. 4-8, or 8157279, Fig. 4-9, may be used to remove the wear ridge in the liner. Reamer 8228303 is of new design superseding 8157279 reamer and may be manually operated or motor operated. If reamer 8228303 is motor operated, speed reducer 8228304 must be used. A 345-500 RPM electric motor should also be used to drive the speed reducer, which is mounted on the





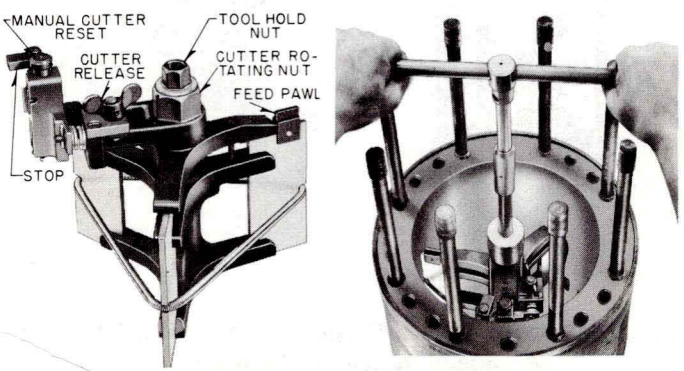
Application Of Liner Ridge Reamer 8228303 And Speed Reducer 8228304
Fig. 4-8

basic 8228303 reamer. Reamer 8157279 is a manually operated reamer.

The cutting blades used with these reamers are: 8228305 for reamer 8228303 and blade 8157327 is used on reamer 8157279. Consult Tool Catalog for additional reamer replacement parts.

Liner ridge is removed as follows:

a. Oil liner wall just under the ridge.
b. Retract cutting blade so it will be away from the liner wall when the reamer is installed. Position cutter blade at bottom of its travel.
c. Swing out stop on reamer and lower reamer into the liner until the stop rests on top of the liner.
d. Tighten reamer centering nut to hold reamer in correct position in the liner. Rotate the reamer to check centering and adjust if required.
e. Swing stop out of the way and release cutter so it can move out to contact the liner wall.
f. Manually or motor operate reamer, depending on reamer used, until ridge is entirely removed, by carrying the cut into chamfer at liner top.
g. Upon complete ridge removal, remove reamer and clean liner of any cuttings.



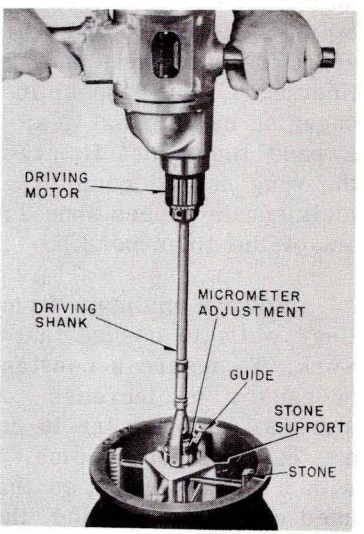
Cylinder Ridge Reamer 8157279
Fig. 4-9

8. Honing Cylinder Liners

After removing the cylinder liner ridge, the cylinder liner must be honed before re-use. The purpose of honing the liner is to remove any glaze and provide a wall finish that will allow lubrication and quick, proper seating of new piston rings. Light scuffing and scoring on the liner wall may also be removed by honing. However, if this condition is too advanced, the liner should be returned for reboring oversize or scrapped, depending upon its condition.

The following equipment is required to hone the liners:

Hone kit (less motor) #8039177
1/2" Heavy duty electric drill with 345-500 RPM motor - 110 volt - #8104770, or 220 volt - #8104771
Stone cleaning brush #8078883



Honing Cylinder Liner
Fig. 4-10

It is also necessary to provide a fixture to hold the liner during honing. Construction details of a liner honing fixture is given in Maintenance Facility Drawing, File #543, which is available upon request. This fixture provides for the support of the liner, a counter-balance arrangement to facilitate motor and hone handling and other details that should be provided when honing liners.

To hone the liner proceed as follows:

Install the liner properly in the honing fixture. Chuck the driving shank of the hone in the drill motor

as shown in Fig. 4-10. Place stone support on the hone body. Note that one end is marked top. Check that stones and guides are firmly secured in their master holders. Remove the center pinion and adjustment assembly from the hone body by pulling it straight out. Wire brush stones to insure they are clean. Insert stones and guides as far as they will go in their proper holes, marked "X" on the hone body. The two stones are applied on opposite sides of the body. Apply splined shaft and lower hone into the liner bore. Raise spline shaft assembly about 1/4" to prevent adjustment gears from meshing and turn to expand hone to fit the liner bore. Push the spline shaft assembly back down, engaging its internal gear with gear on the hone body. Expand the stones firmly against the walls by turning the wing nut micrometer adjustment. (During the adjustment the stones should not protrude more than 1/2" out of the liner bore.)

Always maintain firm stone pressure against the liner walls to assure fast stock removal and accurate work. To insure a constant heavy pressure it may be necessary to increase the pressure after several strokes. If pressure is correct, the stones will emit a steady grinding noise. The driving shank is made with a weak section, so that if the hone is improperly used causing it to bind, the shank will break.

The liner may be honed "wet" or "dry." Both methods produce identical results. However, if stones and guides are once used with "wet" honing they should not again be used for dry honing. Also, stones and guides must be kept together in sets. Keep same guide blocks with the same stones, do not mix sets. When honing "dry" the liner and hone must be absolutely dry. Fuel oil can be used for "wet" honing. During wet honing the liner must be continuously flooded. There cannot be any "in-between" in the method used.

If the liner does not have a scuffed or scored condition, merely break the glazed surface by stroking

rapidly a maximum of fifteen (15) strokes, being sure that a heavy pressure is retained on the stones.

If the liner is scuffed or scored, remove any material build up (and consequent scuffing) and any heavy scoring. Do not attempt to remove any isolated dirt scratches as they do not significantly affect operation. Honing out these scratches needlessly reduce liner life. After the surface has been "cleaned up" the hone should be removed and the stones brushed, using brush #8078883, to remove any loading of the stones. The liner should then be honed with the clean stones using a heavy pressure and six (6) to ten (10) rapid strokes.

A correct honing operation should result in a characteristic "cross-hatch" pattern on the liner wall surface. In no case should an attempt be made to produce a polished or mirror finish. It is important to remember that when using the correct stones #8084163, (identified by W47J43 stamped on stones and guides) too rough a finish will not be produced. Do not remove any more metal than is necessary to obtain the desired finish.

After honing, the liner should be thoroughly cleaned of abrasive or iron dust and given storage protection until ready for use.

9. Marking Used Liners and Pistons In Stock

It is suggested that used pistons and liners, which are not going back into an engine immediately, but are to be placed in stock, be thoroughly cleaned, inspected and checked for size. The dimensions as checked can be chalk marked on the outside of the liners and on the crown of pistons which will allow liner and piston combinations to be selected with a minimum of delay.

10. Installing Cylinder Liners

Check the liner pilot surfaces in the crankcase to see that they are clean and smooth. All current 567C engines use liners having 12.089" upper pilot diameters, as shown in Fig. 4-4. (Very few early pilot models may use 12.060" upper pilot liners.)

Before installing the liner, inspect it for cleanliness and general condition. Check seal counterbores around the drilled water discharge holes. Make sure they are free from nicks which may cut the seals, and be sure they are clean. Brush 8190175, Fig. 4-11, is specially made for cleaning these counterbores. Apply the water seals at the gasket surface, as shown in Fig. 4-3. Check water inlet tube deflector for fit and position. The deflector has a press fit in the liner and its cup edge should be positioned 15 degrees from vertical, counterclockwise, Fig. 4-2. Wipe the inside of the liner with a clean oily cloth. Apply the synthetic rubber seals in the grooves around the lower liner pilot.

Using liner lifting tool 8116358, install liner into position in the crankcase bore. The water inlet connection should be centered in relation to the hole in the stress plate, for line up.

After liner is in position, complete assembly by installing connecting rod assembly as outlined in Section 3 and cylinder head as outlined in Section 2. Then apply piston cooling oil "pee" pipe and water inlet tube assembly, using new seals.

Note water inlet tube assembly differences as given in Section 9.

Cleaning Tool
Fig. 4-11

C. SPECIFICATIONS

Cylinder liner wear limits	See Fig. 4-6
Crankcase to liner limits	See Fig. 4-7
Liner stud torque	Min. 50 ft. lbs.
Bore	8-1/2"
Length of studs above liner top	9-1/2"

D. EQUIPMENT LIST

Name	Part No.
Cylinder liner lifter	8116358
Cylinder liner ridge reamer	8228303
(Blade for reamer 8228303)	8228305
Hone kit less motor	8039177
Drill (1/2") 345 - 500 RPM, 110 volt	8104770
Drill (1/2") 345 - 500 RPM, 220 volt	8104771
Honing fixture (facility drawing)	File 543
Cleaning tool (counterbore)	8190175