SECTION 4

CYLINDER LINER

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CYLINDER LINER

DESCRIPTION

The cylinder liner, Fig. 4-1, consists of a casting having two separate water jackets applied and brazed to the casting. A row of air inlet ports completely encircles the liner. A flange on the outboard side of the liner below the ports, provides a connection for the liner water supply line. A water deflector, Fig. 4-2, prevents the inlet water from impinging directly on the inner liner wall.

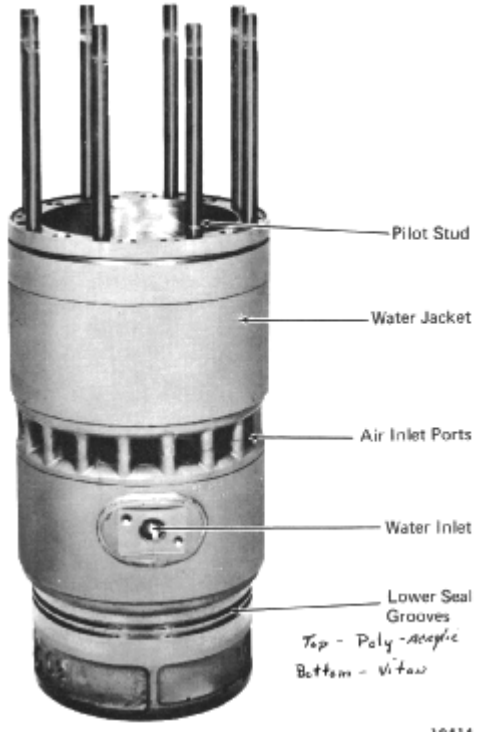

Fig. 4-1 - Cylinder Liner

The inlet water circulates around the bottom of the liner, progressing upward to discharge into the cylinder head through twelve drilled holes. A counterbore around each drilled hole accommodates a teflon heat dam and silicone water seal, Fig. 4-3, which seals the water passage when the cylinder head is installed. A copper clad steel gasket provides a combustion seal between the cylinder head and the liner.

MAINTENANCE

INSPECTION IN ENGINE

The air box handhole covers provide access to the cylinder liner upper bores while the oil pan handhole covers provide access to the lower bores.

1. Open the cylinder test valves and position the piston either below the ports for upper bore inspection or near top dead center for lower bore inspection.

2. Check the liner walls for scuffing or scoring above the ports.

3. Inspect externally for evidence of water leaks at liner to cylinder head gasket and water inlet line.

NOTE: Procedures for qualification of the liner are contained in this Section. Procedures for removal and installation of the liner, and of a complete cylinder power assembly are contained in Section 5.

CLEANING

General liner cleaning procedures should be in accord with accepted practice or as recommended by the supplier of cleaning material.

All water scale deposits and other foreign materials, which are detrimental to water seal life, should be removed from the seal counterbores. The details for construction of a cleaning tool are shown in Fig. 4-4.

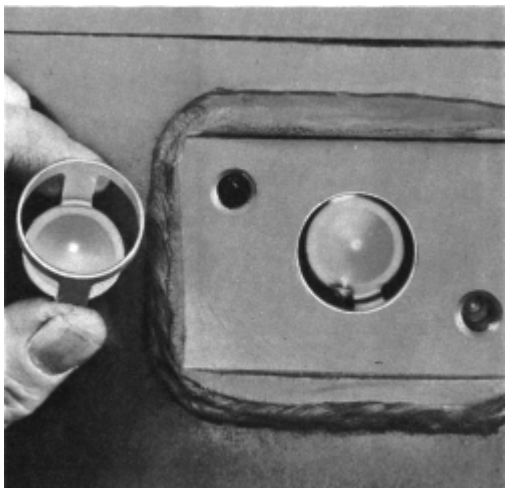

Fig. 42 -Water Inlet Deflector

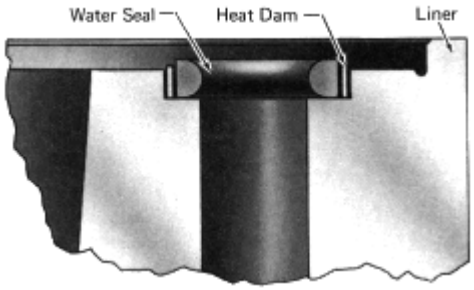

Fig 43 - Water Seal

With the liner removed from the engine, the tool should be used prior to washing the liner so that all the loosened deposits will be removed in the wash. Only the grade of abrasive as specified in Fig. 4-4 should be used to clean the counterbores without damaging the seating surfaces. Insert the tool in an electric or air powered drill which turns around 2000 RPM. Place a few drops of fuel or lubricating oil in the counterbore and, exerting a very light pressure on the tool, rock tool back and forth slightly for approximately five seconds per counterbore.

When the cylinder head is removed, but the liner remains installed in the engine, use the T-handle with the tool and manually clean counterbores so deposits will not enter cylinder.

MEASURING LINERS FOR WEAR

The cylinder liner should be measured in planes parallel and at right angles to the crankshaft. Wipe the interior of liner clean before measuring bore, and check for physical defects that would require rework on the liner. A liner bore gauge, Fig. 45, or standard inside micrometers may be used to measure liner bore diameter. The gauge is of a special design for liner bore measurement, and will provide accurate measurement when used carefully. 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 with visual measurement shown on the dial. A master gauge is used to calibrate the bore gauge.

A dial gauge locator should be used with the liner bore gauge. The gauge locator fits over the top of the liner and hangs down inside the liner bore. It has four 12.7 mm (1/2") drilled holes spaced at 50.8 mm (2"), 152.40 mm (6"), 304.8 mm (12"), and 406.40 mm (16") from the top to locate the measurement position.

A special box to protect the liner bore gauge also provides a place for the master gauge and the gauge locator.

NOTE: Dimensional wear limits are listed in Service Data at the end of the section. New cylinder liners have a bore diameter which falls between a low and a high limit. The bore diameter at the port relief zone has different dimensional limits.

Accumulated liner and piston wear will increase piston to liner clearance and this clearance is a limiting factor at time of reapplication. No liner should be matched with a new or used piston where the diameters result in a piston to liner clearance exceeding the maximum limit, at a point 152.4 mm (6") inches below the gasket face of the liner.

The liner bore should be checked for out-ofround at two points 50.8 mm (2") and 152.4

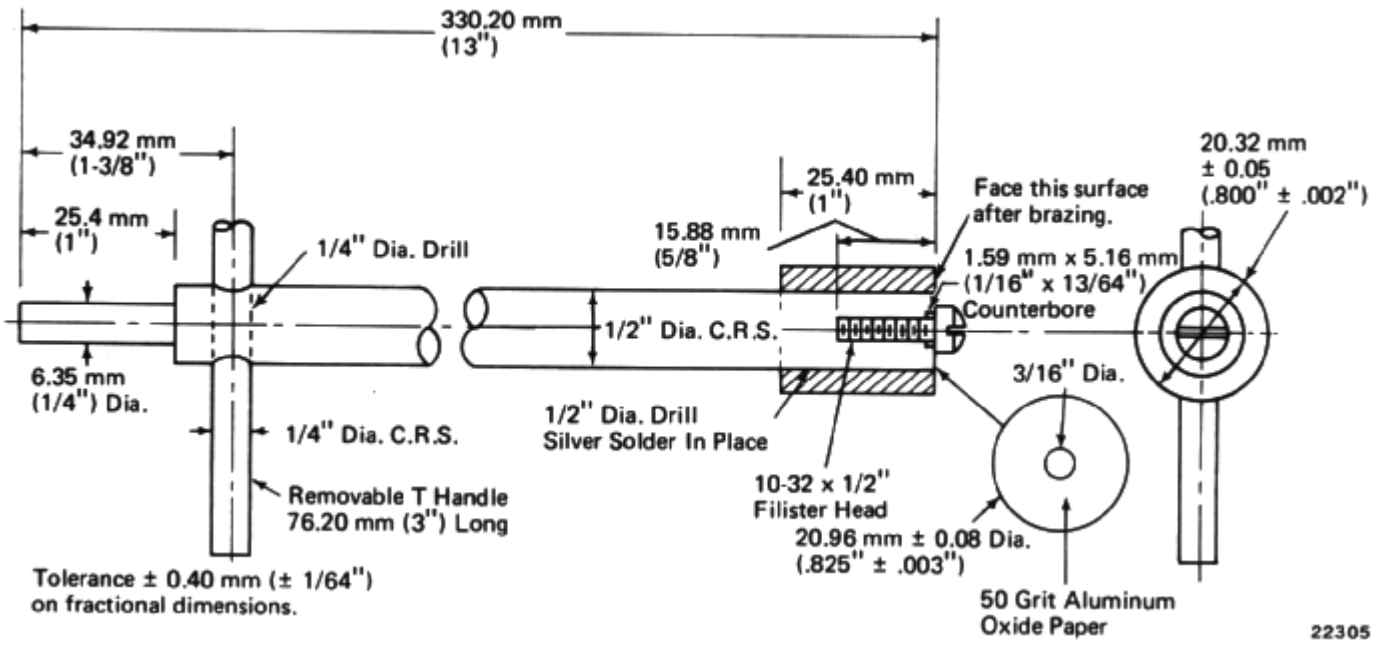

Fig. 4-4 - Counterbore Cleaning Tool

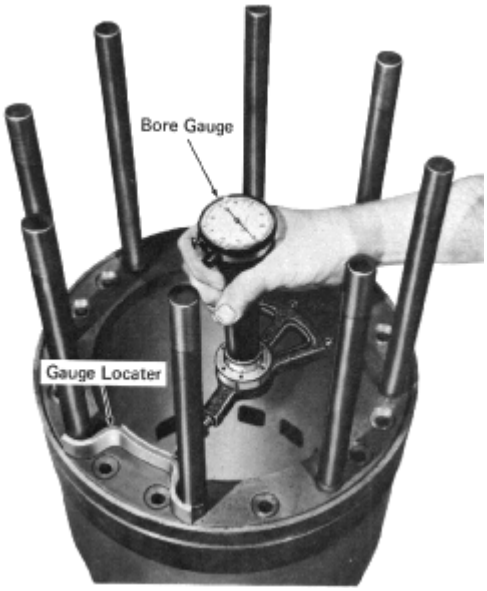

Fig. 4-5 - Liner Bore Gauge

mm (6") below top of liner, Fig. 4-6, using the dial gauge locator as a guide. Take two readings 90° apart to determine wear and out-of-round. Should the out-of-round exceed the limit, the liner must be rebored to the next oversize, regardless of other wear measurements which still may be within limits.

Using the maximum piston to liner clearance as a guide, worn liners may be used again, providing they are not over out-of-round limit, and are matched with pistons having a diameter which will not exceed the limit on piston to liner clearance. Maximum piston and liner

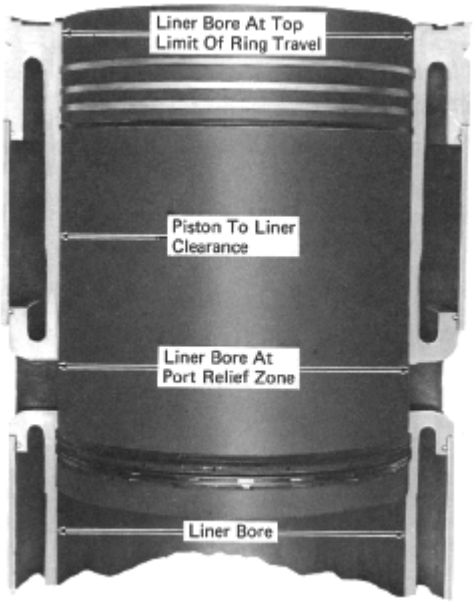

Fig. 4-6 - Liner Measurement Points

usage is obtained by selective assembly within the clearance limit.

Liners will wear tapered, with maximum wear normally occurring approximately 152.40 mm (6") below the top limit of piston ring travel. Check that wear, taking two readings 90° apart, is within specified limit. 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, losing a great amount of its wear life. Consequently, it is suggested that no liner be reinstalled if the bore diameter at point of maximum wear exceeds the allowable limit.

OVERSIZE LINERS

Liners can be rebored to 0.76 mm (.030") or 1.52 mm (.060") oversize. Oversize liner dimensions can be determined by increasing the standard liner figures in Service Data by 0.76 mm (.030") or 1.52 mm (.060") as the case may be. Standard or 0.76 mm (.030") oversize liners worn beyond their limits may be returned to ElectroMotive for refinishing to the next oversize. (Corresponding oversize piston assemblies must be used with oversize liners.)

REMOVING LINER RIDGE

After a long period of use, a wear ridge, caused by piston ring action, will appear near the top of the liner bore. After the liner is removed from the engine, the wear ridge must be entirely removed before honing the liner. 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. In addition, removal of the wear ridge precludes any possibility of interference with new piston rings.

The cylinder liner ridge reamer, Fig. 47, is used to remove the ridge at the top inside bore of the liner. The reamer can also be used for the oversize liners. Reamers may either be manually or motor operated. If the reamer is motor operated, a speed reducer must be used, which is mounted on the reamer. The operating motor used with the speed reducer can be an ordinary heavy-duty electric drill having a no load speed of approximately 500 RPM.

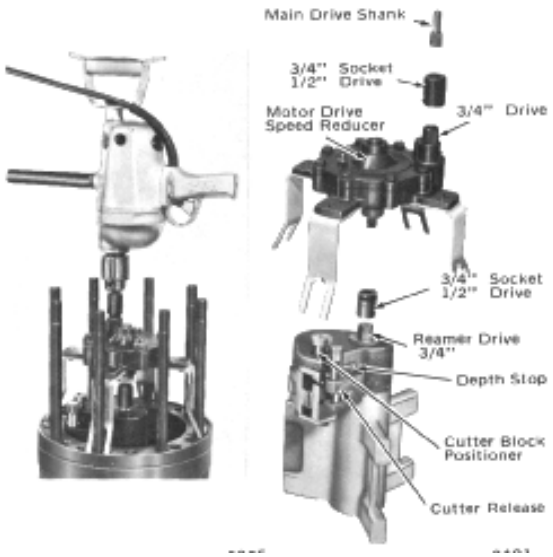

Fig. 4-7 - Application Of Liner Ridge Reamer And Speed Reducer

Extra cutting blades may be obtained for reamers. Refer to Service Data at the end of this section.

Reamer cutting blades also may be resharpened. To resharpen a dull cutter, it is necessary only to lightly grind the leading angle which does the cutting, using a grinding wheel suitable for grinding tungsten carbide tools. The clearance angle is 8° and must not be exceeded when grinding. It is better to provide "less" than more clearance, as these cutters will not stand up if given greater clearance.

In addition, a cutter should not be used if the guide portion has been reduced to a length of 16.67 mm (21/32") by resharpening, because the guide will not extend far enough past the pin hole to prevent undercutting. For resharpening service on the cutters, refer to the reamer manufacturer.

Liner ridge is removed as follows:

1. Oil liner wall just under the ridge, and see that felt pad in back of cutter is full of oil.

2. Retract cutting blade so it will be away from the liner wall when the reamer is installed, and position the depth stop on the blade retard cam. Position cutter blade at bottom of its travel.

3. Lower reamer into the liner until the depth stop rests on top of the liner.

4. Tighten reamer centering nut to hold reamer in correct position in the liner. Rotate the reamer to check centering, and adjust if required.

5. Operate the blade retarder cam to swing stop out of the way and release cutter so it can move out to contact the liner wall.

6. Operate reamer manually or by motor until ridge is entirely removed, carrying the cut into chamfer at liner top if necessary.

7. After completing ridge removal, remove reamer, and clean liner by wiping off oil and cuttings.

HONING LINERS

After removing the cylinder liner ridge, the liner must be honed for the final finish. The purpose of honing is to remove glaze and to provide a proper seating surface for new piston rings. Light scuffing on the liner wall may also be removed by honing. However, if this condition is too advanced, the liner should be scrapped or rebored oversize, depending upon its condition.

Equipment required to perform the honing operation includes the honing kit, electric drill, stone cleaning brush, and cylinder honing fixture. As the operation is "wet" honing, a suitable container is required for the honing liquid and the honing fixture. See the Service Data at the rear of this section for description and part numbers of the equipment required.

HONING PROCEDURE

1. Ensure that honing kit is assembled per manufacturer's instructions and contains a matched set of stones and guides (identified by W47-J43 stamped on stones and guides).

2. Inspect stone cutting surfaces for cleanliness and clean with wire brush, if required.

3. Install the liner properly in the honing fixture.

4. Chuck the hone shank in the drill motor, and insert the hone into the liner, Fig. 48. Stones should not protrude more than 12.70 mm (1/2") out of liner bore.

5. Raise the center pinion assembly about 6.35 mm (1/4") and turn it counterclockwise to set the stones roughly against the bore diameter. Lower the pinion assembly until it engages with the gear in the hone body.
6. Expand the stones firmly against the liner wall by turning the wing-wrench portion of the pinion assembly in a clockwise direction.

7. Always maintain firm stone pressure against the liner wall to ensure fast stock removal and accurate work. It may be necessary to increase the pressure after several strokes. If pressure is correct, the stones will emit a steady grinding noise.

8. A continuous flooding of the liner surface must be maintained with kerosene or honing oil, during the honing operation.

9. If the liner is not scuffed, merely break the glazed surface by stroking at a rate of approximately 30 complete cycles per minute to produce the cross-hatched pattern shown in Fig. 49.

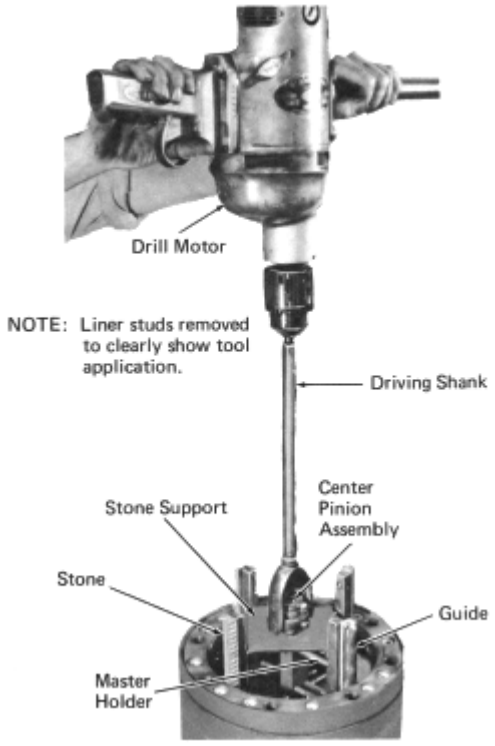

Fig. 4-8 - Honing Cylinder Liner

10. If the liner is scuffed, remove material buildup, or scuffing. Do not attempt to remove any isolated dirt scratches as they do not significantly affect operation. Honing out these scratches needlessly reduces liner life. After the surface has been "cleaned up," the hone should be removed and the stones wirebrushed to remove any loading of the stones. The liner should then be honed with the clean stones, using heavy pressure to obtain a good cross-hatched pattern, Fig. 49. Do not remove any more metal than is necessary to obtain desired finish.

CLEANING

The liners must be thoroughly cleaned of abrasive and iron dust after honing. If the liners are not properly cleaned after honing, tiny particles left by the honing operation will attack the liners, rings, and pistons causing excessive wear in a short period of time. The liner is cleaned as follows:

1. Wash liner with detergent and hot water using a stiff fiber brush.

2. Rinse liner thoroughly with clean water and wipe dry.

3. Swab liner with clean rag dipped in SAE No. 10 oil. It is important to use oil to pull the abrasive materials from the pores of the liner.

4. Wipe liner with a clean dry cloth.

5. Repeat Steps 3 and 4 until there is no evidence of contaminants on the liner surface.

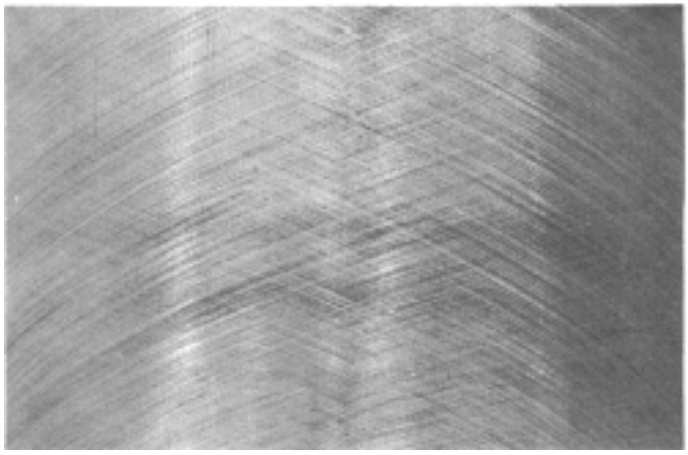

Fig. 49 - Honing Cross-Hatch Pattern

NOTE: If liner is to be stored, repeat Steps 3 through 5 prior to assembly.

MEASURING LINERS

After honing, the liners should be measured in planes parallel and at right angles to the crankshaft. Dimensional limits are listed in Service Data.

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. This will allow liner and piston combinations to be selected with a minimum of delay.

SERVICE DATA

CYLINDER LINER

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.*

Cylinder liner bore (except through port relief zone) -	
New	230.111-230.175 mm (9.0595"-9.0620")
Cylinder liner bore (port relief zone only) -	
New	230.454-230.543 mm (9.0730"-9.0765")
Cylinder liner bore (measured 152.40 mm [6"] below liner gasket face) -	
Max.	230.340 mm (9.0685")
Piston-to-liner clearance (152.40 mm [6"] below liner gasket face) -	
New	0.216-0.330 mm (.0085"-.0130")
Max.	0.56 mm (.022")

NOTE

Maximum piston to liner clearance of 0.56 mm (.022') determines the maximum wear limit of a liner at the 152.40 mm (6") dimension. If pistons are selectively fitted to liners, a liner at 230.45 mm (9.073' could be used with a 229.90 mm (9.051"1 piston. If pistons and liners are not selectively fitted, then the maximum wear limit of the liner at the 152.40 mm (6") dimension would be 230.33 mm (9.068") as the minimum wear limit of a used piston as 229.77 mm (9.046").

Cylinder liner bore out-of-round (measure at two points 50.8 mm [2"1 & 152.40 mm [6"1 below top of liner - 90° apart)	
Max.	0.13 mm (.005")
Cylinder liner bore (top limit of piston ring travel) -	
Max.	230.63 mm (9.080")
Length of studs above top of liner	241.30 mm (9-1/2)
Crankcase upper pilot bore -	
New	307.11-307.19 mm (12.091"-12.094")
Max.	307.44 mm (12.104")
Cylinder liner O.D. (at upper pilot)	
New	306.997-307.073 mm (12.0865"-12.0895")
Min.	306.93 mm (12.084")

Cylinder liner O. D. (bottom of liner) -

New	263.462-263.538 mm (10.3725"-10.3755")
Min.	263.42 mm (10.371")

Insert bore (installed in crankcase) -

New	263.58-263.75 mm (10.377"-10.384")
Max.	263.80 mm (10.386)

Crankcase lower insert bore -

New	281.00-281.10 mm (11.063"-11.067")
Max.	281.13 mm (11.068")

Cylinder liner stud torque -

Min.	67.79 N-m (50 ft-lbs)

EQUIPMENT LIST

	Part No.
Wire brush (honing stones)	8078883
Stone and guide block set (W47-J43)	8084163
Drill (1/ 2" - 345-500 RPM, 155 volt [AC or DC])	8104770
Drill (1/ 2" - 345-500 RPM, 230 volt [AC or DC])	8104771
Reamer speed reducer (used with 8374969)	8228304
Liner bore gauge	8275258
Gauge locator	8278541
Cylinder liner ridge reamer	8374969
Master gauge (used with 8275258)	8374970
Cutter blade (reamer)	8379037
Hone kit (less motor)	8431585
Honing fixture (facility drawing)	File 543
Cleaning tool (water seal counterbore)	File 686