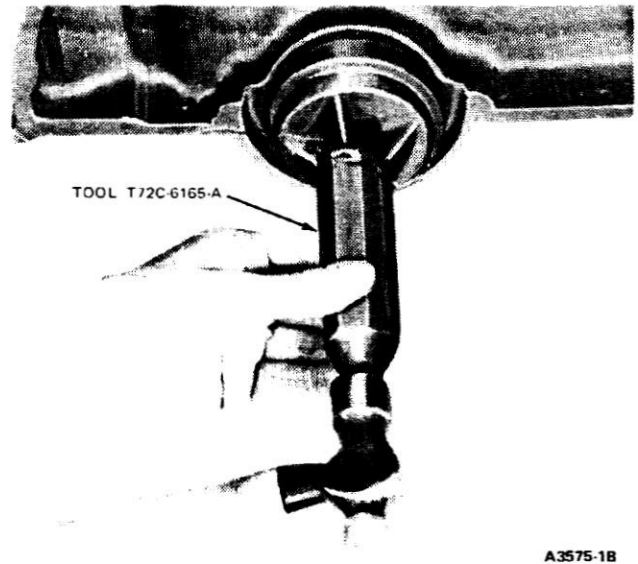


Installation

1. Coat the oil seal to cylinder block surface of the oil seal with oil. Coat the seal contact surface of the oil seal and crankshaft with Lubriplate or equivalent. Start the seal in the recess and install it with the tool as shown in Fig. 30. Drive the seal into position until it is firmly seated.
2. Install the rear plate and the flywheel. Tighten flywheel bolts to specification.
3. Install the clutch disc and clutch pressure plate, if so equipped. Align clutch disc before tightening pressure plate attaching screws.
4. Install the flywheel housing.
5. Install the transmission.



A3575-1B

**FIG. 30 Installing Crankshaft Rear Oil Seal—
2.8L V-6 Engine**

OVERHAUL

INTERPRETATION OF "SERVICE LIMIT" SPECIFICATIONS

"Service Limit" specifications are intended to be a guide only, to be used when overhauling or reconditioning an engine or engine component. A determination can be made whether a component is suitable for continued service or should be replaced for extended service while the engine is disassembled.

In the case of "Valve Stem To Valve Guide Clearance," the "Service Clearance" is intended as an aid in diagnosing engine noise only, and does not constitute a failure or indicate need for repair. However, when overhauling or reconditioning a cylinder head, the service clearance should be regarded as a practical working value, and used as a determinant for installing the next oversize valve to assure extended service life.

CYLINDER HEAD

Replace the head if it is cracked. **Do not plane or grind more than 0.010 inch from the original cylinder head gasket surface.** Remove all burrs or scratches with an oil stone.

Reaming Valve Guides

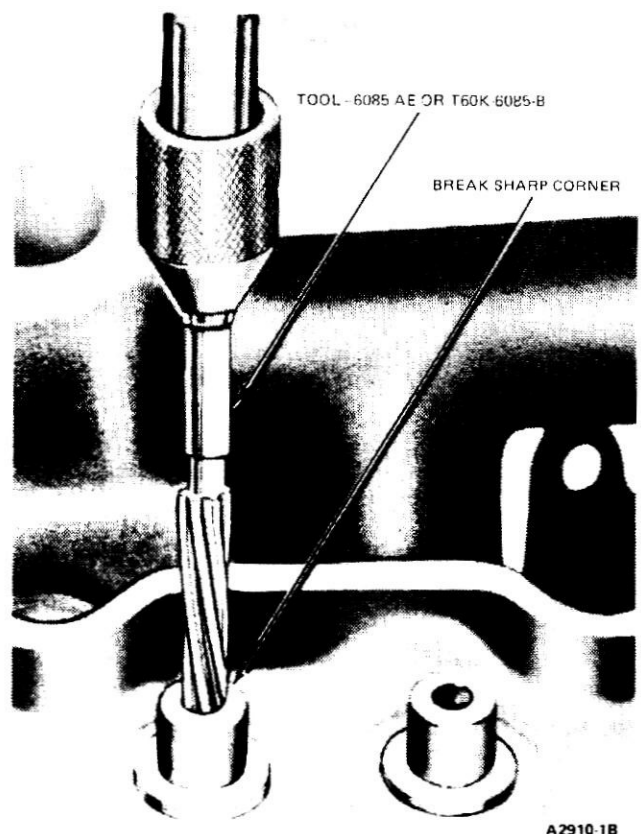
If it becomes necessary to ream a valve guide (Fig. 31) to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: a 0.003-inch OS reamer with a standard diameter pilot, a 0.015-inch OS reamer with a 0.003-inch OS pilot, and a 0.030-inch reamer with a 0.015-inch OS pilot.

When replacing a standard size valve with an oversize valve always use the reamer in sequence (smallest oversize first, and then next smallest, etc.) so as not to overload the reamers. **Always reface the**

valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

Refacing Valve Seats

Refacing of the valve seat should be closely coordinated with the refacing of the valve face so that



A2910-1B

**FIG. 31 Reaming Valve Guides—Typical I-6
Engine Shown**

the finished seat and valve face will be concentric and the specified interference angle will be maintained. This is important so that the valve and seat will have a compression-tight fit. Be sure that the refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45 degree angle (Fig. 32). Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width (Fig. 33). Narrow the seat, if necessary, to bring it within specifications.

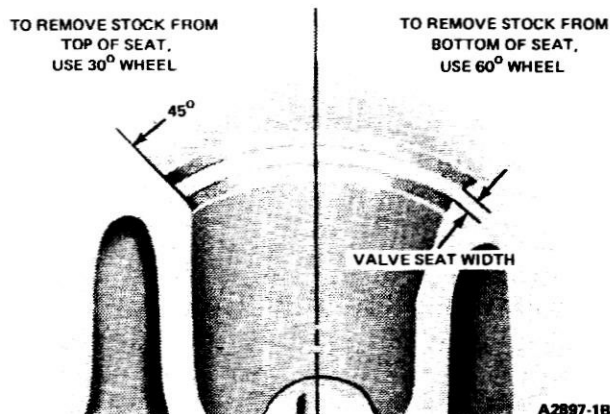


FIG. 32 Refacing Valve Seat

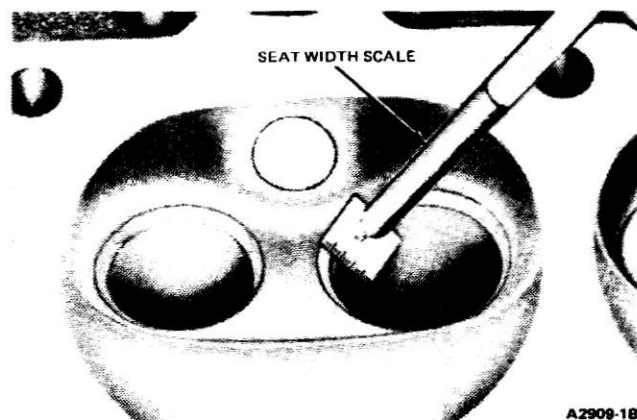


FIG. 33 Checking Valve Seat Width

If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specifications.

On the valve seats of all engines, use a 60 degree angle grinding wheel to remove stock from the bottom of the seats (raise the seats) and use a 30 degree angle wheel to remove stock from the top of the seats (lower the seats).

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face. To do this, coat the seat with Prussion blue and set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat.

If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

VALVES

Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged, if the face runout cannot be corrected by refinishing or stem clearance exceeds specifications. **Discard any excessively worn or damaged valve train parts.**

Refacing Valves

The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and of the valve seat will be to specifications and provide a compression-tight fit. Be sure that the refacer grinding wheels are properly dressed.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the dge of the valve head is less than 1/32 inch thick after grinding (Fig. 34), replace the valve as the valve will run too hot in the engine. **The interference angle of the valve and seat should not be lapped out. Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.010 inch from the end of the valve stem.**

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

Select Fitting Valves

If the valve stem to valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem

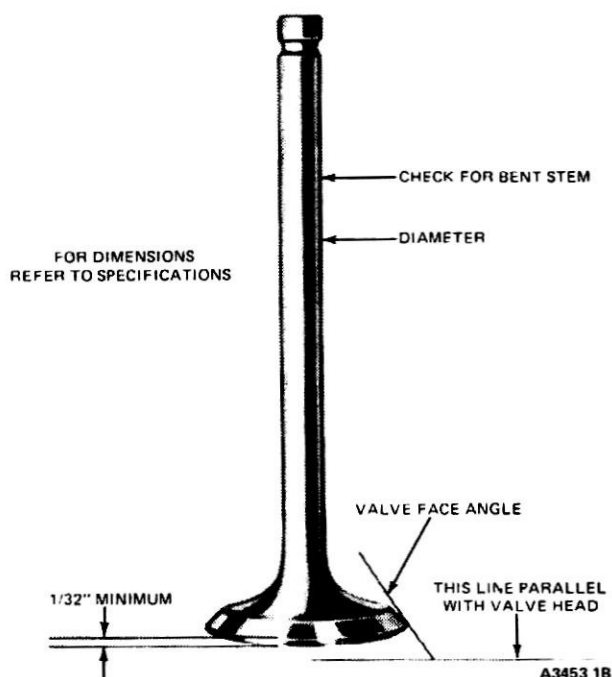


FIG. 34 Critical Valve Dimensions

diameters of 0.003, 0.015 and 0.030 inch are available for service for all engines except 2.3L I-4 and 2.8L V-6. For these engines, oversize valve stems are available in diameters of 0.008, 0.016, and 0.032 inch oversize. **Always reface the valve seat after the valve guide has been reamed. Refer to Reaming Valve Guides.**

CAMSHAFT REPAIR

Clean and inspect camshaft as outlined under Cleaning And Inspection.

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone. Camshaft journals can be refinished to accommodate 0.015" undersize service bearings. If the journals will not clean up to 0.015" undersize, the camshaft must be replaced.

PISTONS, PINS AND RINGS

Fitting Pistons

Pistons are available for service in standard size and the oversizes shown in Specification section at the end of each engine Part.

The standard size pistons are color coded red or blue, or have 0.003 OS stamped on the dome. Refer to the Specifications for standard size piston dimensions.

Measure the cylinder bore and select the piston to assure the proper clearance. When the bore diameter is in the lower one third of the specified range, a red piston should be used. When the bore diameter is in the middle one third a blue piston should be used. When the bore diameter is in the upper one third the 0.003 OS piston should be used.

Measure the piston diameter to ensure that the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger, or smaller to achieve the specified clearance. **If none can be fitted, refinish the cylinder to provide the proper clearance for the piston.** When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted. If the taper, out-of-round and piston to cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service. **If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze using only a spring-loaded cylinder hone set (T73L-6011-A or equivalent) and only if there is no visible sign of cross-hatch markings on the cylinder walls. (Refer to Cylinder Block, Refinishing Cylinder Walls).** Be sure to clean the cylinder bore thoroughly.

1. Calculate the size piston to be used by taking a cylinder bore check. Follow the procedures outlined under Cleaning and Inspection.
2. Select the proper size piston to provide the desired clearance (refer to the specifications). Measure the piston diameter in line with the centerline of the piston pin and at 90 degrees to the piston pin axis.
3. Make sure the piston and cylinder block are at room temperature (70 degrees F.). **After any**

refinishing operation allow the cylinder bore to cool, and make sure the piston and bore are clean and dry before the piston fit is checked.

Fitting Piston Rings

1. Select the proper ring set for the size cylinder bore.
2. Position the ring in the cylinder bore in which it is going to be used.
3. Push the ring down into the bore area where normal ring wear is not encountered.
4. Use the head of a piston to position the ring in the bore so that the ring is square with the cylinder wall. **Use caution to avoid damage to the ring or cylinder bore.**
5. Measure the gap between the ends of the ring with a feeler gauge (Fig. 35). If the ring gap is less or greater than the specified limits, try another ring set.
6. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (Fig. 36). The gauge should slide *freely around the entire ring circumference without binding*. Any wear that occurs will form a step at the inner portion of the lower land. **If the lower lands have high steps, the piston should be replaced.**

Fitting Piston Pins

Install the piston pin, following the procedure under Piston Assembly in the applicable engine part.

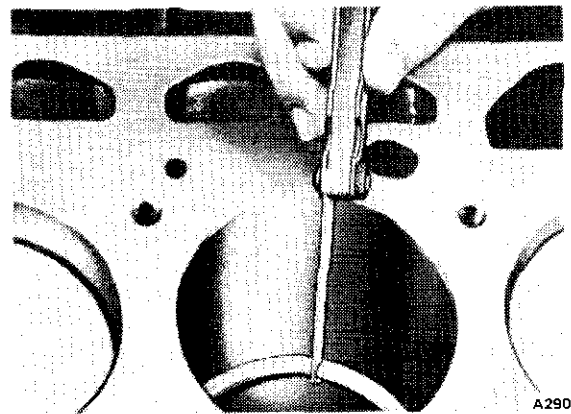


FIG. 35 Checking Piston Ring Gap

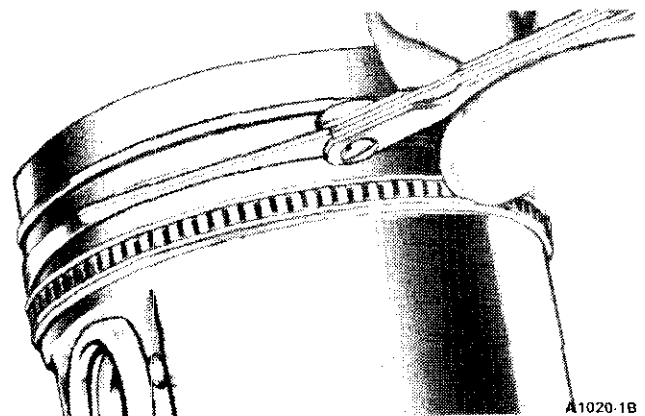


FIG. 36 Checking Piston Ring Side Clearance

CRANKSHAFT

Dress minor scores with an oil stone. If the journals are severely marred or exceed the wear limit, they should be refinished to size for the next undersize bearing.

Refinishing Journals

Refinish the journals to give the proper clearance with the next undersize bearing. If the journal will not clean up to maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

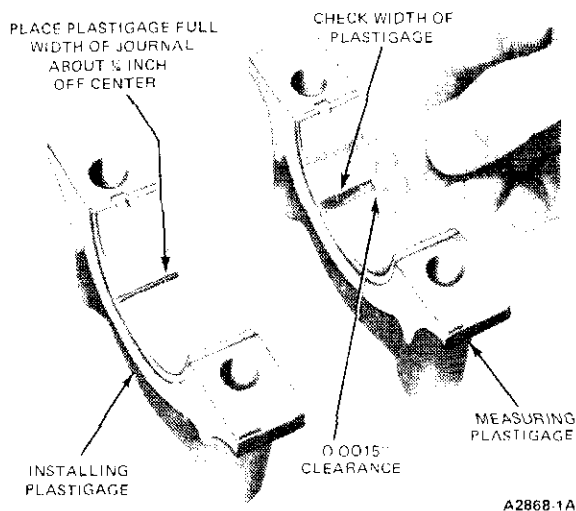
After refinishing the journals, chamfer the oil holes; then polish the journal with a No. 320 grit polishing cloth and engine oil. Crocus cloth may also be used as a polishing agent.

All oil passages must be cleaned thoroughly after chamfering and polishing, using a suitable bristle brush and solvent.

FITTING MAIN OR CONNECTING ROD BEARINGS WITH PLASTIGAGE

1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear. **When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance.** If the desired clearance cannot be obtained with a standard bearing, try one half of a 0.001 or 0.002 inch undersize in combination with a standard bearing to obtain the proper clearance.
2. If fitting a main bearing in the vehicle, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.
3. Place a piece of Plastigage on bearing surface across full width of bearing cap and about 1/4 inch off center (Fig. 37).
4. Install cap and torque bolts to specifications. Do not turn crankshaft while Plastigage is in place.
5. Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals.
6. If clearance exceeds specified limits, try 0.001 or 0.002 inch undersize bearings in combination with the standard bearings. Bearing clearance must be within specified limits. If 0.002 undersize main bearings are used on more than one journal, be sure they are all installed in cylinder block side of bearing. If 0.002 inch undersize bearings do not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.
7. After bearing has been fitted, apply light coat of engine oil to journal and bearings. Install bearing cap. Torque cap bolts to specifications.

8. Repeat procedure for remaining bearings that require replacement.



A2868-1A

FIG. 37 Installing and Measuring Plastigage CYLINDER BLOCK

Refinishing Cylinder Walls

Honing is recommended for refinishing cylinder walls only when no cross hatch pattern is visible on cylinder walls, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance. After honing, thoroughly clean cylinder bores with a detergent and water solution.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. **Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.** Refinish only the cylinder or cylinders that require it. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance. Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

Refinish the cylinder to within approximately 0.0015 inch of the required oversize diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained. For the proper use of the refinishing equipment follow the instructions of the manufacturer. Only experienced personnel should be allowed to perform this work. Use a motor-driven, spring pressure-type hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 18-38 RMS.

When honing the cylinder bores use a lubricant mixture of equal parts of kerosene and SAE No. 20

motor oil. Operate the hone in such a way to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore. **After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly clean with a detergent and water solution and oil the cylinder walls.** Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls.

Repairing Sand Holes or Porous Engine Castings

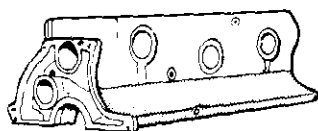
Porosity or sand hole(s) which will cause oil seepage or leakage can occur with modern casting processes. A complete inspection of engine and transmission should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), repairs can be made with metallic plastic (part No. C6AZ-19544-A or equivalent). **Do not repair cracks with this material.** Repairs with this metallic plastic must be confined to those cast iron engine component surfaces (Fig. 38) where the inner wall surface is not exposed to engine coolant pressure or oil pressure, for example:

1. Cylinder block surfaces extending along the length of the block, upward from the oil pan rail to the cylinder water jacket but not including machined areas.
2. Lower rear face of the cylinder block.
3. Intake manifold casting. **Repairs are not recommended to the intake manifold exhaust crossover section, since temperatures can exceed the recommended temperature limit of 500 degrees F.**

SHADED AREAS MAY BE REPAIRED WITH EPOXY



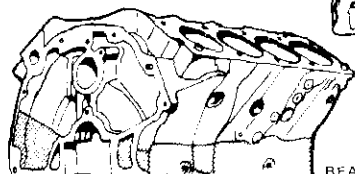
FRONT AND LEFT SIDE
TYPICAL FOR 1.4 AND 1.6 ENGINES



REAR AND RIGHT SIDE



FRONT AND LEFT SIDE
TYPICAL FOR V-6 AND V-8 ENGINES



REAR AND RIGHT SIDE

A2386-1D

FIG. 38 Typical Cast Iron Cylinder Block Areas Repairable with Metallic Plastic

4. Cylinder front cover on engines using cast iron material.
5. Cylinder head, along the rocker arm cover gasket surface.

The following procedure should be used to repair porous areas or sand holes in cast iron.

1. Clean the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porosity to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole. Openings larger than 1/4 inch should not be repaired using metallic plastic. Openings in excess of 1/4 inch can be drilled, tapped and plugged using common tools. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.
2. Mix the metallic plastic base and hardener as directed on the container. Stir thoroughly until uniform.
3. Apply the repair mixture with a suitable clean tool, (putty knife, wood spoon, etc.) forcing the epoxy into the hole or porosity.
4. Allow the repair mixture to harden. This can be accomplished by two methods, heat cure with a 250 watt lamp placed 10 inches from the repaired surface, or air dry for 10-12 hours at temperatures above 50 degrees F.
5. Sand or grind the repaired area to blend with the general contour of the surrounding surface.
6. Paint the surface to match the rest of the block.

CLEANING AND INSPECTION

The cleaning and inspection procedures are for a complete engine overhaul; therefore, for partial engine overhaul or parts replacement, follow the pertinent cleaning or inspection procedure.

INTAKE MANIFOLD

Cleaning

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

Inspection

Inspect the manifold for cracks, damaged gasket surfaces, or other defects that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. Clean the EGR exhaust passages.

Remove all filings and foreign matter that may have entered the manifold as a result of repairs. Check the baffle plate on the underside of the manifold if so equipped. The baffle should be securely fastened.

EXHAUST MANIFOLDS

Cleaning

Remove all gasket material from the manifolds.

On the right exhaust manifold of V-8 engines, make sure the automatic choke air inlet and outlet holes are completely open and the cover does not leak (if so equipped).

Inspection

Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

Inspect the manifolds for cracks, damaged gasket surfaces, or other damage that would make them unfit for further service. Warped or cracked exhaust manifolds must be replaced.

VALVE ROCKER ARM AND/OR SHAFT ASSEMBLY

Cleaning

Clean all the parts thoroughly. Make sure all oil passages are open.

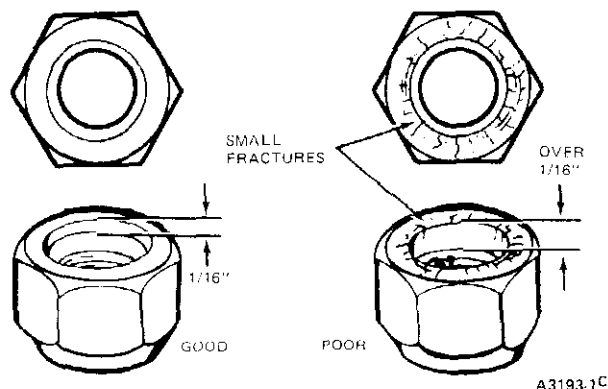
Make sure the oil passage in the push rod end of the rocker arm is open.

Inspection

Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs. Replace any damaged parts.

Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm. **Do not attempt to true this surface by grinding. On stud-mounted rocker arms, check the rocker arm pad, side rails and fulcrum seat for excessive wear, cracks, nicks or burrs. Check the rocker arm stud and nut for stripped or broken threads. On rocker arm stud nuts, check the shoulder for damage as shown in Fig. 39. Replace all damaged nuts.**

On pedestal mounted rocker arms, check the rocker arm pad and fulcrum seat for excessive wear, cracks, nicks or burrs. Replace all damaged rocker arms.



A3193-1C

FIG. 39 Rocker Arm Stud Nut Inspection

PUSH RODS

Cleaning

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air.

Inspection

Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Replace damaged push rods.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator (Fig. 40).

If the push rod is bent beyond specifications, it should be replaced. **Do not attempt to straighten pushrods.**

CYLINDER HEADS

Cleaning

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores. Use cleaning solvent to remove dirt, grease and other deposits. Clean all bolt holes. Remove all deposits from the valves with a fine wire brush or buffing wheel.

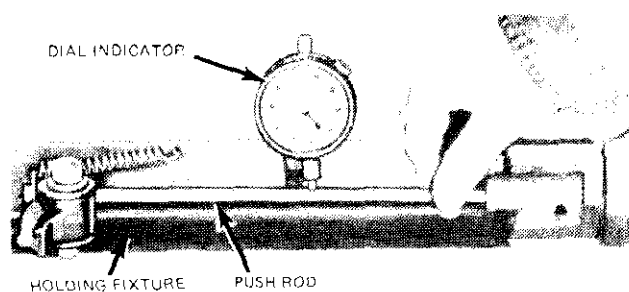
Inspection

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Replace the head if it is cracked.

The following inspection procedures are for a cylinder head that is to be completely overhauled. For individual repair operations, use only the pertinent inspection procedure.

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface (Fig. 41) for conformance to specifications. If necessary to refinish the cylinder head gasket surface, **do not plane or grind off more than 0.010 inch.**

Check the valve seat runout with an accurate gauge (Fig. 42). Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. Measure the valve seat width (Fig. 32). **Reface any valve seat whose width is not within specifications.**



A1003 1B

FIG. 40 Checking Push Rod Runout

The critical inspection points of the valves are illustrated in Fig. 34. Refer to the specifications for service limits.

Inspect the stem for bends and the end of the stem for grooves or scores. Check the valve head for burning, erosion, warpage and cracking. Minor pits, grooves etc., may be removed. Discard valves that are severely damaged.

Inspect the valve spring, valve spring retainers, locks and sleeves for wear or damage. Discard any damaged parts.

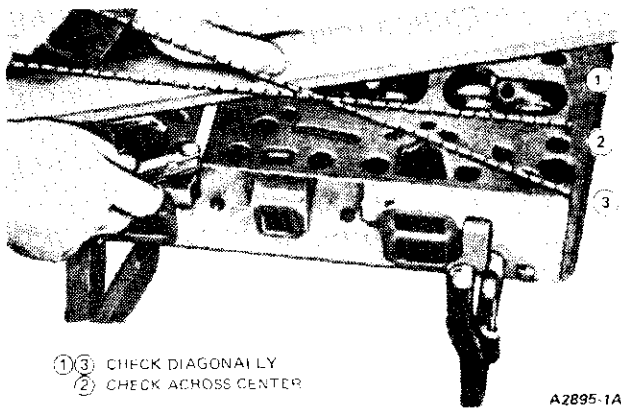


FIG. 41 Typical Cylinder Head Flatness Check

Install the tool on the valve stem until it is fully seated, and tighten the knurled set screw firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.

Position the dial indicator with its flat tip against the center portion of the tool's spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool. The resulting measurement is the valve stem clearance.

Check the springs for proper pressure (Fig. 44) at the specified spring lengths (Tool-6513-DD). Weak valve springs cause poor engine performance. Replace any spring not within specifications. Manually rotating the valve spring assemblies while installed in the engine will not determine condition of valve springs.

Check each spring for squareness, using a steel square and a flat surface (Fig. 45). Stand the spring on end on the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square.

See Specifications for out-of-square limits. Follow the same procedure to check new valve springs before installation.

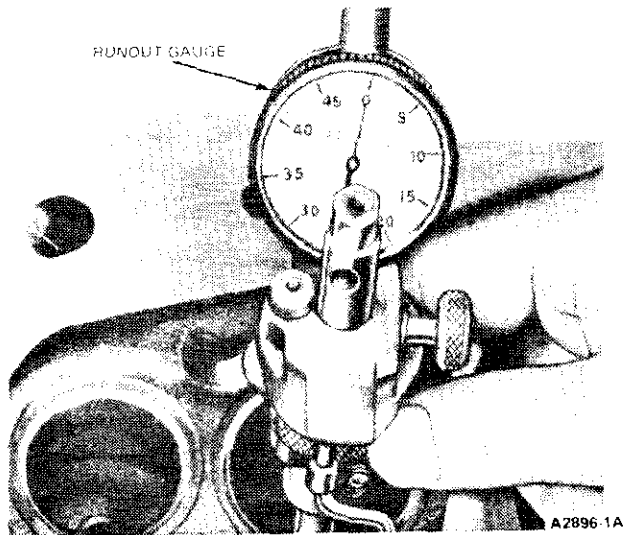


FIG. 42 Checking Valve Seat Runout

Check the valve stem to valve guide clearance of each valve in its respective valve guide with the tool shown in Fig. 43 or its equivalent. Use a flat end indicator point.

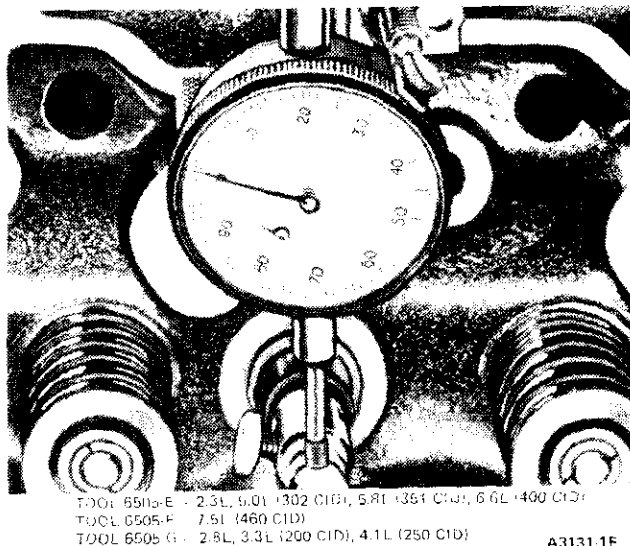
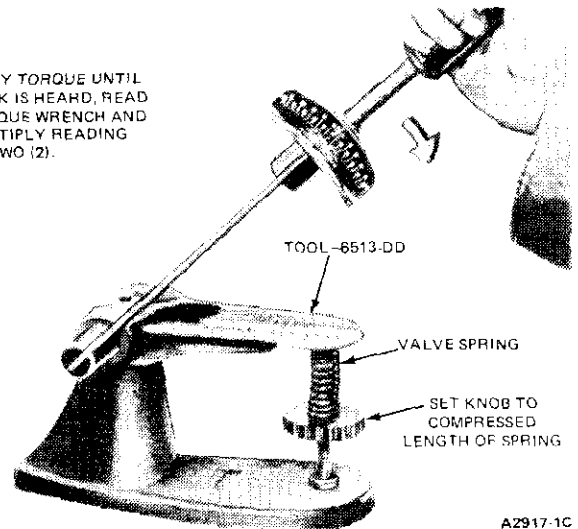


FIG. 43 Checking Valve Stem Clearance

APPLY TORQUE UNTIL
CLICK IS HEARD, READ
TORQUE WRENCH AND
MULTIPLY READING
BY TWO (2).

FIG. 44 Checking Valve Spring Pressure
HYDRAULIC TAPPETS AND HYDRAULIC LASH
ADJUSTERS

The tappet (or lash adjuster) assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each tappet separately so as not to intermix the internal parts (see Fig. 46). **If any part of the tappet assembly needs replacing, replace the entire assembly.**

Cleaning

Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint-free cloth.

Inspection

Inspect the parts and discard the entire tappet assembly if any part shows pitting, scoring, galling,

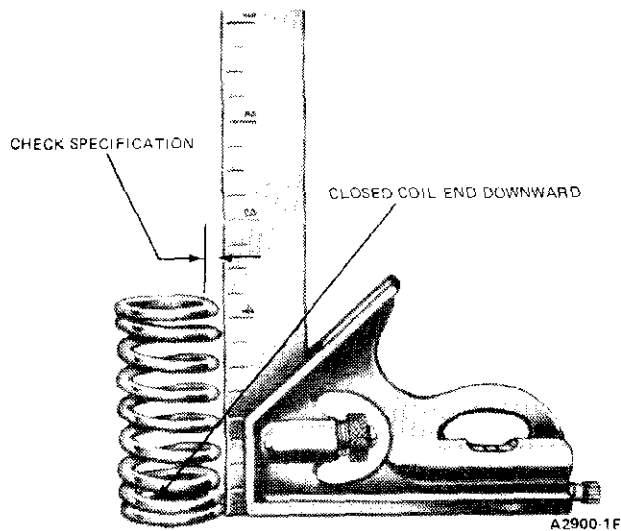


FIG. 45 Checking Valve Spring Squareness

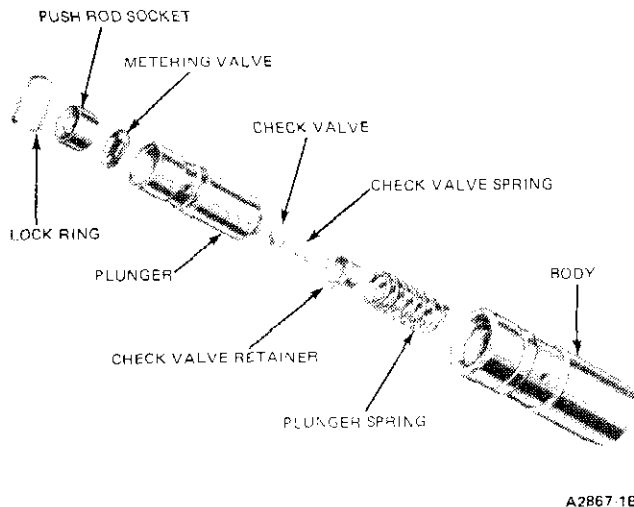


FIG. 46 Hydraulic Tappet

excessive wear or evidence of non-rotation. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the tappet assembly and check for freeness of operation by pressing down on the push rod cup. The tappets can also be checked with a hydraulic tester to test the leakdown rate. Follow the instructions of the test unit manufacturer or the procedure under Diagnosis and Testing.

TIMING CHAIN AND SPROCKETS

Cleaning

Clean all parts in solvent and dry them with compressed air.

Lubricate the timing chain with engine oil before installing it on the sprockets.

Inspection

Inspect the chain for broken links. Inspect the sprockets for cracks and worn or damaged teeth.

Replace all the components of the timing chain and sprocket assembly, if any one item needs replacement.

FUEL PUMP ECCENTRIC

Cleaning

Clean the fuel pump eccentric in solvent and dry with compressed air.

Inspection

Inspect the fuel pump drive eccentric for scores, nicks and excessive wear. If the eccentric surface is scored, nicked or worn, replace it.

On two-piece designs, inspect inner and outer rings for scoring, nicks, and excessive wear. Replace any part indicating scoring or excessive wear.

CAMSHAFT

Cleaning and Inspection

Clean the camshaft in solvent and wipe it dry. Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe pitting in the general area of the lobe toe is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced unless the lobe lift loss has exceeded specifications.

The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers. Refer to Camshaft Lobe Lift.

Replace the camshaft if distributor drive gear has chipped or broken teeth.

OIL PAN

Cleaning

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly. Be sure all foreign particles are removed from below the baffle plate.

Inspection

Check the pan for cracks, holes, damaged drain plug threads, and a loose baffle or a damaged gasket surface.

Inspect for damage (uneven surface) at the bolt holes caused by over-torquing the bolts. Straighten surfaces as required. Repair any damage, or replace the pan if repairs cannot be made satisfactorily.

OIL PUMP

Cleaning

Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and metal particles are removed.

Inspection

Refer to Specifications for clearances and wear limits.

Check the inside of the pump housing and the outer race and rotor for damage or excessive wear.

Check the mating surface of the pump cover for wear. Minor scuff marks are normal, but if the cover

mating surface is worn, scored or grooved, replace the pump. Inspect the rotor for nicks, burrs or score marks. Remove all high points by stoning.

Measure the outer race to housing clearance (Fig. 47).

With the rotor assembly installed in the housing, place a straight edge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straight edge and the rotor and outer race (Fig. 48). Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not within specifications and/or the spring is worn or damaged replace the pump. Check the relief valve piston for free operation in the bore.

NOTE: Internal components are not serviced; if any component is out of specification, the complete pump must be replaced.

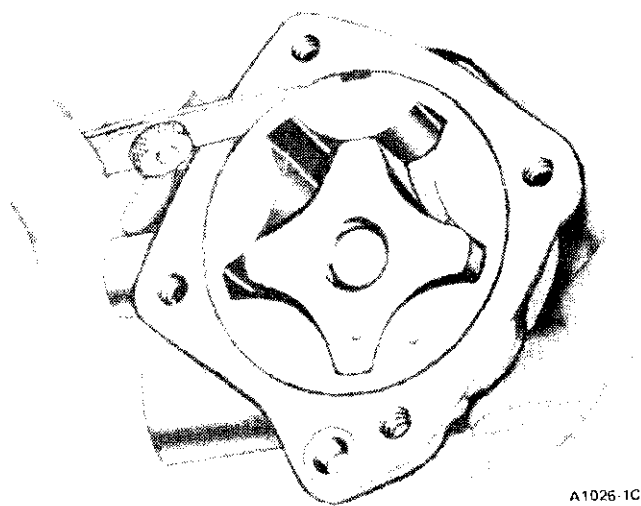


FIG. 47 Checking Outer Race to Housing Clearance

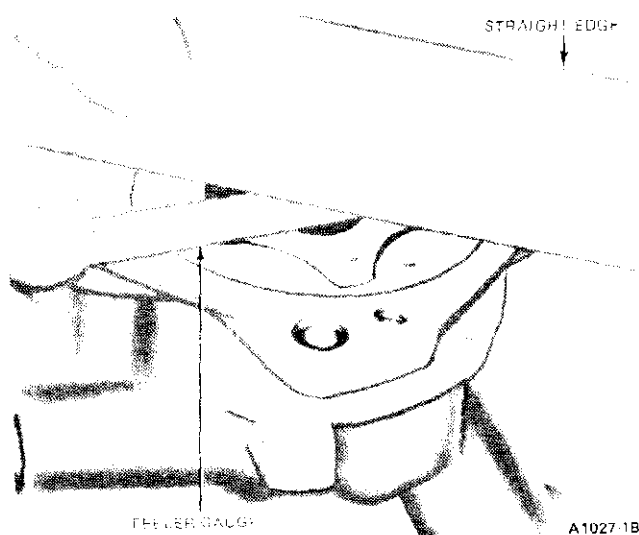


FIG. 48 Checking Rotor End Play

CONNECTING RODS

Cleaning

Remove the bearings from the rod and cap. Identify the bearings if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic cleaning solution.** Blow out all passages with compressed air.

Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss side of the piston usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged crankpin, or a tapered connecting rod bore.

Twisted connecting rods will not create an identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston, rings and connecting rod assembly and may be the cause of excessive oil consumption.

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and/or if the connecting rod is fractured, it should be replaced. Check the ID of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specifications, install a 0.001 inch oversize piston pin. First, pre-fit the oversize piston pin to the piston pin bore by reaming or honing the piston to provide 0.0002-0.0004 inch clearance (light slip fit). Then, assemble the piston, piston pin and connecting rod following the procedures for the specific engine being worked on. **It is not necessary to ream or hone the pin bore in the connecting rod. Replace damaged connecting rod nuts and bolts. Check the connecting rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist exceeds specifications, the connecting rod must be replaced.**

PISTONS, PINS AND RINGS

Cleaning

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.**

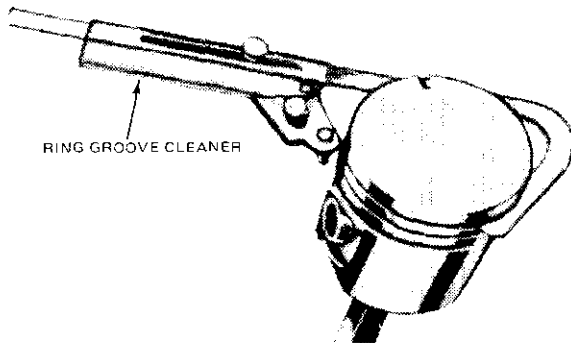
Clean the ring grooves with a ring groove cleaner (Fig. 49). Make sure the oil ring slots (or holes) are clean.

Inspection

Carefully inspect the pistons for fractures at the ring lands, skirts and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves has a high step, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation or pre-ignition. A shiny surface on the thrust surface of the

piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures or damage from detonation or pre-ignition.



A2918-1B

FIG. 49 Cleaning Piston Ring Grooves

Check the piston to cylinder bore clearance by measuring the piston and bore diameters. Refer to the specifications for the proper clearance. Refer to Cylinder Block Inspection for the bore measurement procedure. **Measure the OD of the piston with micrometers at the centerline of the piston pin bore and at 90 degrees to the pin bore axis.** Check the ring side clearance following the procedure under Fitting Piston Rings in this section.

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod. Refer to Piston and Connecting Rod Assembly, in the pertinent engine section.

Check the OD of the piston pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specifications.

Replace all rings that are scored, broken, chipped or cracked. Check the end gap and side clearance. **Rings should not be transferred from one piston to another regardless of mileage.**

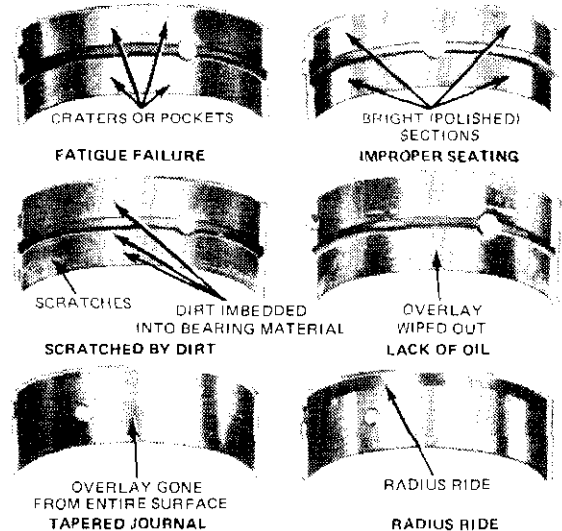
MAIN AND CONNECTING ROD BEARINGS

Cleaning

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air. **Do not scrape gum or varnish deposits from the bearing shells.**

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in Fig. 50. The copper lead bearing base may be visible through the bearing overlay. This does not mean that the bearing is worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage as detailed under Main and Connecting Rod Bearings.



A2903-1A

FIG. 50 Typical Bearing Failures

CRANKSHAFT

Cleaning

Handle the crankshaft with care to avoid possible fractures or damage to the finished surfaces. Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

Inspection

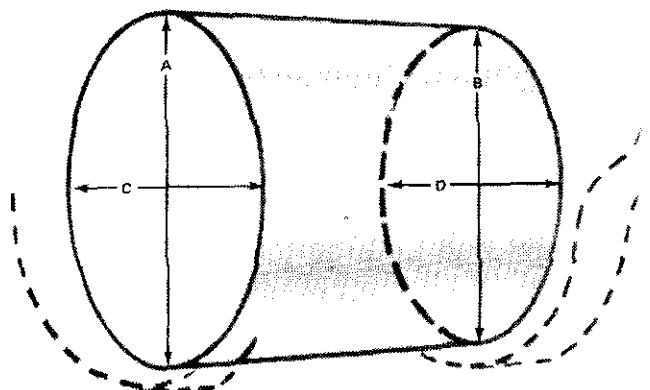
Inspect the main and connecting rod journals for cracks, scratches, grooves or scores. Inspect the crankshaft oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

Measure the diameter of each journal in at least four places to determine an out-to-round, taper or undersize condition (Fig. 51).

Inspect the pilot bearing (roller bearing) when so equipped, for roughness, evidence of overheating or loss of lubricant. Replace it if any of these conditions are found.

A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A2901-1B

FIG. 51 Crankshaft Journal Measurement

CRANKSHAFT VIBRATION DAMPER AND SLEEVE

Cleaning

Clean the oil seal contact surface on the crankshaft damper or sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits that are not readily removed with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges or burrs which might damage the oil seal during installation or cause premature seal wear. **Do not use crocus cloth to the extent that the seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.**

Inspection

Inspect the crankshaft damper seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

FLYWHEEL—MANUAL-SHIFT TRANSMISSION

Inspection

Inspect the flywheel for cracks, heat check, or other damage that would make it unfit for further service. Machine the friction surface of the flywheel if it is scored or worn. If it is necessary to remove more than 0.045 inch of stock from the original thickness, replace the flywheel.

Inspect the ring gear for worn, chipped, or cracked teeth. If the teeth are damaged, replace the ring gear.

With the flywheel installed on the crankshaft, check the flywheel face runout, following the procedure under Diagnosis and Testing.

FLYWHEEL—AUTOMATIC TRANSMISSION

Inspection

Inspect the flywheel for cracks or other defects that would make it unfit for further service. Inspect the flywheel ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear and flywheel assembly.

With the flywheel installed on the crankshaft, check the gear face runout.

CYLINDER BLOCK

Cleaning

After any cylinder bore repair operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean, lint-free cloth. Finally wipe the bore(s) with a clean cloth dipped in engine oil. **If these procedures are not followed, rusting of the cylinder bore(s) may occur.**

If the engine is disassembled, thoroughly clean the block with solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages; then clean out all the passages. Blow out all passages, bolt holes, etc., with compressed air. Make sure the threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true up threads and to remove all deposits. Thoroughly clean the

grooves in the crankshaft bearings and bearing retainers.

Inspection

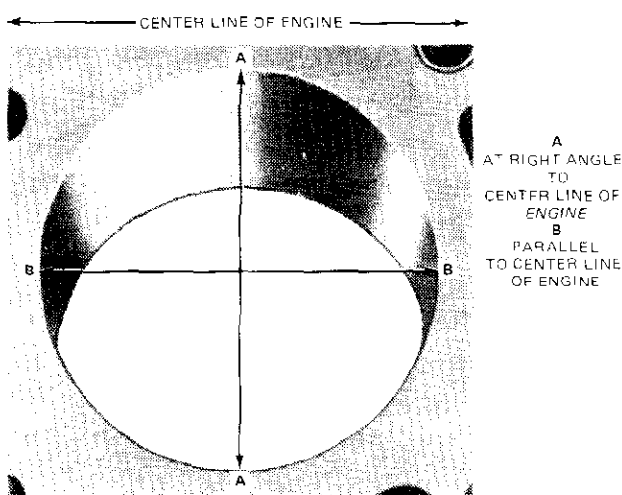
After the block has been thoroughly cleaned, check it for cracks. Tiny cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the defective area. Replace the block if it is cracked.

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.

Replace all expansion-type plugs that show evidence of leakage.

Inspect the cylinder walls for scoring, roughness, or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine (Fig. 52). **Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston to cylinder bore clearance.**

Refinish cylinders that are deeply scored and/or when out-of-round and/or taper exceed the service limits. If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings providing the piston clearance is within specified limits.



1. OUT-OF-ROUND - DIFFERENCE BETWEEN A AND B
2. TAPER - DIFFERENCE BETWEEN THE A MEASUREMENT AT TOP OF CYLINDER BORE AND THE A MEASUREMENT AT BOTTOM OF CYLINDER BORE

A2905-1A

FIG. 52 Cylinder Bore Out-of-Round and Taper

SPECIAL SERVICE TOOLS

Description	Ford Tool No.	Former No.	Application Engine Size					
			2.3L	2.8L V-6	3.3L/4.1L (200/250 CID) Six	5.0L/5.8L (302/351 CID) "W" V-8	5.8L "M"/6.6L (351M/400 CID) V-8	7.5L (460 CID) V-8
Hydraulic Tappet Remover	T70P-14151			X	X	X	X	X
Crankshaft Front Seal Installing Tool	T70P-6B070-A						X	
Crankshaft Front Seal Removing Tool	T70P-6B070-B						X	
Impact Hammer	T50T-100-A				X	X	X	X
Puller Attachment Use with T50T-100-A or T59L-100-B	T58L-101-A				X	X	X	X
Handle Adapter	T53L-200-A				X	X	X	X
Differential Backlash and Runout Gauge, with Universal Bracket and Dial Indicator (1-1/4 inch range). Includes Indicator TOOL-6565	TOOL-4201-C		X	X	X	X	X	X
Engine Lifting Hook	T60K-6000-A				200			
Engine Lifting Hook	T65L-6000-A							X
Engine Lifting Brackets	T58P-6000-A					X	X	X
Cam Bearing Bore Plug Installing Tool	T70P-6001-A						X	
Core Plug Replacer	T54L-6015-A				200			
Cylinder Front Cover Pilot	T61P-6019-B	6059-F			200			
Front Cover Alignment Tool	T61K-6019-A				X			
Cylinder Front Cover Pilot	T68P-6019-A							X
Valve Spring Compressor, on Engine	T70P-6049-A						X	X
Valve Guide Reamer Kit	T52L-6085-AEE					X	X	X
Engine Lifting and Head Holding Brackets **	T62F-6085-A	6005-BDA			X	X		
Piston Pin Remover and Replacer Kit	T68P-6135-A		X	X [†]	X	X		X
Camshaft Bearings Remover and Replacer Adapters	T65L-6250-A	T52L-6261-CEE		X	X	X	X	
Camshaft Rear Bearing Bore Plug Replacer-Adapter-- Use with T53L-200-A	T62F-6266-A					X		X
Cylinder Block Core Plug Replacer	T68P-6266-A							X
Core Plug Replacer	T52L-6266-BGD				X			
Crankshaft Damper Replacer	T64T-6306-A				X	X	X	X
Camshaft Timing Gear Replacer Screw Adapter	T65L-6306-A							
Crankshaft Damper Installer	T52L-6306-AEE				X	X	X	
Camshaft Gear Installer	T65L-6306-A							
Crankshaft Damper Remover	T58P-6316-B				200			
Cylinder Block Core Plug Replacer	T72C-6015		X	X				
Valve Guide Reamer Kit	T72C-6085		X	X				
Crankshaft Rear Oil Seal Replacer	T72C-6165		X	X				
Cam Bearing Remover and Replacer Adapter Tube	T72C-6250		X	X				
Cam Bearing Bore Plug Replacer	T72C-6266		X	X				
Cover Plate Retaining Studs	T72C-7007		X	X				
Front Cover Aligner, Seal Replacer and Timing Gear Replacer	T74P-6019-A		X	X				
Piston Pin Remover and Replacer/Adapter	T74P-6135-A		X	X				
Crankshaft Timing Gear Remover Adapter	T74P-6136-A		X	X				
Crankshaft Damper Pulley Remover and Replacer	T74P-6316-A		X	X				
Crankshaft Damper Pulley Replacer	T74P-6316-B		X	X				
Valve Spring Compressor Lever	T74P-6565-A		X	X				
Valve Spring Compressor Bar	T74P-6565-B			X				
Front Cover Seal Remover	T74P-6700-A		X	X				
Pilot Bearing Replacer Adapter*	T74P-7137-A			X				
Pilot Bearing Replacer Adapter*	T74P-7137-B		X					

*Use with TOOL T74P-7137-H or T74P-7137-H

[†]Use with TOOL T68P-6135-A

**When Removing Engine with Exhaust Manifolds Attached

CA1327-2F

SPECIAL SERVICE TOOLS (Continued)

Description	Ford Tool No.	Former No.	Application Engine Size					
			2.3L	2.8L V-6	3.3L/4.1L (200/250 CID) Six	5.0L/5.8L (302/351 CID) "W" V-8	5.8L "M"/6.6L 351M/400 CID) V-8	7.5L (460 CID) V-8
Camshaft Damper Remover Adapter Screw	T64T-6316-A							X
Crankshaft Damper Remover	T52L-6316-FEE	6316-FF			X			
Upper Main Bearing Insert Remover and Replacer	T00L-6331				X	X	X	
Upper Main Bearing Remover and Replacer	T00L-6331-E							X
Hydraulic Tappet Leakdown Tester	T00L-6500-E				X	X	X	X
Hydraulic Tappet Plunger Remover and Replacer	T00L-6500-F				X	X	X	X
Valve Stem Deburring Tool	T70P-6505-A						X	
Valve Stem Clearance Checking Tool	T00L-6505-E					X	X	X
Valve Stem Clearance Checking Tool	T00L-6505-F				200			X
Valve Gauge	T64L-6507-A				X	X	X	X
Valve Spring Compressor	T65P-6513-A				200			
Valve Spring Compressor	T71P-6513-A						X	X
Air Adapter and Hose-Valve Holdup	T00L-6513-ABA	6513-AB			X	X		X
Compressor-Tappet Bleed-Down	T00L-6513-AC					X		X
Valve and Clutch Spring Tester	T00L-6513-DD				X	X	X	X
Valve Spring Compressor	T00L-6513-H				X			
Rocker Arm Stud Kit	T62F-6A527-B				X	X		
Rocker Arm Stud Installer (Supplements T62F-6A527-B)	T65P-6A527-A				X	X		
Hydraulic Tappet Bleed-Down Tool	T79P-6564-A						X	
Cup Shaped Adapter to T00L-6565	T00L-6565-AB				X	X	X	X
Crankcase Ventilation System Tester (Kit)	CHAZ-6B627-A				X	X	X	X
Cylinder Block Front Cover Oil Seal Replacer Adapter	T60K-6700-A	6700-C			200			
Cylinder Block Front Cover Oil Seal Replacer Adapter Use with T53L-200-A	T58P-6700-B				250	X	X	X
Front Cover Oil Seal Replacer	T68P-6700-A							X
Crankshaft Rear Oil Seal Forming Tool	T60K-6701-A				200			
Crankshaft Rear Seal Replacer	T62F-6701-A					X		
Crankshaft Rear Seal Replacer	T65P-6701-A							
Crankshaft Rear Seal Replacer	T68P-6701-A							X
Fibre Block for 6701 Tools	T58P-6701-AC				200	X		X
Clutch Disc Pilot	T58P-7563-A					X		
Clutch Pilot Bearing Replacer	T00L-7600-H	7600-H			X	X		
Clutch Pilot Bearing Replacer	T65L-7600-A				X			
Rocker Arm Stud Driver	T69P-6049-D					351W		
Clutch Disc Aligner	T71P-7137-H		X					
Clutch Disc Aligner	T74P-7137-H		X*					
Clutch Disc Aligner	T74P-7137-K			X				

*Mustang Only

CA1327-2E1

2.3L I-4 Engine

PART 21-05

Pinto/Bobcat/Mustang II/Fairmont/Zephyr

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION		Main Bearings	05-17
Crankcase Ventilation System	05-3	Oil Filter	05-17
Exhaust Emission Control System	05-1	Oil Pan	05-13
ADJUSTMENTS		Oil Pump	05-17
Camshaft Timing	05-4	Pistons and Connecting Rods	05-17
Valve Clearance	05-3	Seals — Cylinder Front Cover, Camshaft and Auxiliary Shaft	05-10
REMOVAL AND INSTALLATION		Timing Belt Tensioner	05-12
Auxiliary Shaft and Bearings	05-13	Valve Rocker Arm (Cam Follower) and Hydraulic Lash Adjuster	05-8
Camshaft Timing Belt	05-12	Valve Rocker Arm Cover	05-8
Clutch Pilot Bearing	05-13	Valve Spring, Retainer and Stem Seal	05-9
Connecting Rod Bearings	05-17	Water Pump	05-10
Crankcase Ventilation System	05-8	DISASSEMBLY AND ASSEMBLY	
Crankshaft Rear Oil Seal	05-17	Cylinder Head	05-23
Cylinder Front Cover	05-13	Hydraulic Lash Adjuster	05-24
Cylinder Head	05-10	Oil Pump	05-23
Engine Assembly	05-5	Piston and Connecting Rod	05-23
Engine Front Support	05-6	SPECIAL TOOLS	05-28
Engine Rear Supports	05-7	SPECIFICATIONS	05-29
Exhaust Manifold	05-9		
Flywheel	05-13		
Intake Manifold	05-9		

CA4183-2B

DESCRIPTION

The 2.3L I-4 overhead cam engine is of lightweight iron construction. The crankshaft is supported on five main bearings and the camshaft by four. Main, connecting rod, camshaft and auxiliary shaft bearings are all replaceable.

The camshaft is driven from the crankshaft by a cogged belt, which also operates the auxiliary shaft, and through this shaft, the oil pump, fuel pump and the distributor. Tension on the cam drive belt is maintained by a locked idler pulley bearing on the outside of the belt.

Water pump and fan are separately driven from the crankshaft by a conventional V-belt, which also drives the alternator. **CAUTION: Do not operate the engine with the hood open until the fan has been first examined for possible cracks and separation.**

Hydraulic valve lash adjusters are used in the valve train. These units are placed at the fulcrum point of the cam followers (or rocker arms). Their action is similar to the hydraulic tappets used in push-rod engines and they are constructed and serviced in the same manner. The cylinder head has drilled oil passages to provide engine oil pressure to the lash adjusters (Fig. 2).

A set of metric wrenches is required to service the 2.3L I-4 engine.

EXHAUST EMISSION CONTROL SYSTEM

Operation, removal, installation and required maintenance of the exhaust emission control devices used on this engine are covered in Group 29 of this Volume, and Part 50-29 of Volume 5.