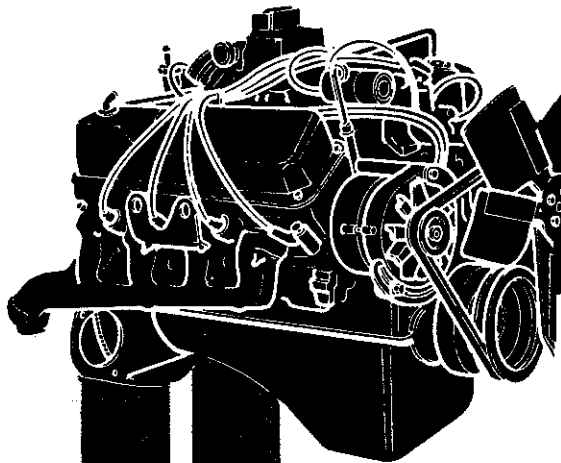




SERVICE MANUAL

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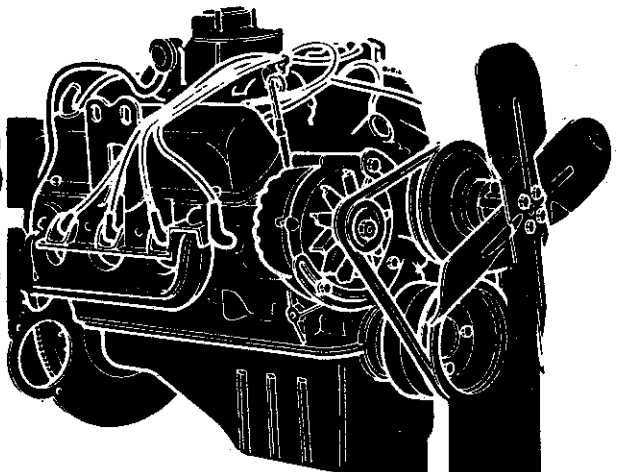
RS 94C-295



CSG-850
(302 CID)



WSG-858
(351 CID)



INDUSTRIAL AND MARINE ENGINES

Introduction

This Service Manual provides the Service technician with information for the proper servicing of the Ford CSG-850 and WSG-858 Industrial and Marine Engines.

In general, this manual covers the servicing of the engine and associated standard equipment. In many cases, engines are supplied with accessories and equipment that are unique to the application. If service information is ever required on such unique accessories or equipment it is suggested that the Industrial Engine Operations of Ford Motor Company be contacted. The proper information will either be forwarded or the Service Technician will be advised where it can be obtained.

The information in this manual is grouped in sections according to the type of work being performed. The various sections are indicated in the Index. In addition, each section is subdivided to include topics such as diagnosis and testing, cleaning and inspection, overhaul, removal and installation procedures, disassembly and assembly procedures, and service specifications.

Ford Motor Company
Power Products Division
19855 W. Outer Drive
Dearborn, MI 48124

The descriptions and specifications contained in this manual were in effect at the time the book was released for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design, without notice and without incurring obligation.

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all engines as well as the personal safety of the individual doing the work. This Service Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing engines, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the engine integrity by his choice of methods, tools or parts.

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal In.	Metric MM.	Fractions	Decimal In.	Metric MM.
1/64	.015625	.39688	33/64	.515625	13.09687
1/32	.03125	.79375	17/32	.53125	13.49375
3/64	.046875	1.19062	35/64	.546875	13.89062
1/16	.0625	1.58750	9/16	.5625	14.28750
5/64	.078125	1.98437	36/64	.578125	14.68437
3/32	.09375	2.38125	19/32	.59375	15.08125
7/64	.109375	2.77812	39/64	.609375	15.47812
1/8	.125	3.1750	5/8	.625	15.87500
9/64	.140625	3.57187	41/64	.640625	16.27187
5/32	.15625	3.96875	21/32	.65625	16.66875
11/64	.171875	4.36562	43/64	.671875	17.06562
3/16	.1875	4.76250	11/16	.6875	17.46250
13/64	.203125	5.15937	45/64	.703125	17.85937
7/32	.21875	5.55625	23/32	.71875	18.25625
15/64	.234375	5.95312	47/64	.734375	18.65312
1/4	.250	6.35000	3/4	.750	19.05000
17/64	.265625	6.74687	49/64	.765625	19.44687
9/32	.28125	7.14375	25/32	.78125	19.84375
19/64	.296875	7.54062	51/64	.796875	20.24062
5/16	.3125	7.93750	13/16	.8125	20.63750
21/64	.328125	8.33437	53/64	.828125	21.03437
11/32	.34375	8.73125	27/32	.84375	21.43125
23/64	.359375	9.12812	55/64	.859375	21.82812
3/8	.375	9.52500	7/8	.875	22.22500
25/64	.390625	9.92187	57/64	.890625	22.62187
13/32	.40625	10.31875	29/32	.90625	23.01875
27/64	.421875	10.71562	59/64	.921875	23.41562
7/16	.4375	11.11250	15/16	.9375	23.81250
29/64	.453125	11.50937	61/64	.953125	24.20937
15/32	.46875	11.90625	31/32	.96875	24.60625
31/64	.484375	12.30312	63/64	.984375	25.00312
1/2	.500	12.70000	1	1.00	25.40000

METRIC-ENGLISH CONVERSION TABLE

Multiply	by	to get equivalent number of:	Multiply	by	to get equivalent number of:
LENGTH					
Inch	25.4	millimetres (mm)	Foot/sec ²	0.304 8	metre/sec ² (m/s ²)
Foot	0.304 8	metres (m)	Inch/sec ²	0.025 4	metre/sec ²
Yard	0.914 4	metres	TORQUE		
Mile	1.609	kilometres (km)	Pound-inch	0.112 98	newton-metres (N-m)
			Pound-foot	1.355 8	newton-metres
AREA					
Inch ²	645.2	millimetres ² (mm ²)	POWER		
Foot ²	6.45	centimetres ² (cm ²)	Horsepower	0.746	kilowatts (kW)
Yard ²	0.092 9	metres ² (m ²)	PRESSURE OR STRESS		
	0.836 1	metres ²	Inches of water	0.249 1	kilopascals (kPa)
			Pounds/sq. in.	6.895	kilopascals
VOLUME					
Inch ³	16 387.	mm ³	ENERGY OR WORK		
	16.387	cm ³	BTU	1 055.	joules (J)
Quart	0.016 4	litres (l)	Foot-pound	1.355 8	joules
Gallon	0.946 4	litres	Kilowatt-hour	3 600 000.	joules (J = one W's)
Yard ³	3.785 4	litres		or 3.6 x 10 ⁶	
	0.764 6	metres ³ (m ³)	LIGHT		
			Foot candle	1.076 4	lumens/metre ² (lm/m ²)
MASS					
Pound	0.453 6	kilograms (kg)	FUEL PERFORMANCE		
Ton	907.18	kilograms (kg)	Miles/gal	0.425 1	kilometres/litre (km/l)
Ton	0.907	tonne (t)	Gal/mile	2.352 7	litres/kilometre (l/km)
			VELOCITY		
Kilogram	9.807	newtons (N)	Miles/hour	1.609 3	kilometres/hr. (km/h)
Ounce	0.278 0	newtons			
Pound	4.448	newtons			
TEMPERATURE					
Degree Fahrenheit	(°F-32) ÷ 1.8	degree Celsius			

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5.0L AND 5.8L INDUSTRIAL AND MARINE ENGINES

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Charging System	SECTION 4	Special Tools	SECTION 9
Starting System	SECTION 5		

Should your engine require service, parts, and technical information, contact the Ford Power Products Distributor in your state as listed.

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GASOLINE ENGINE SERVICE

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IDENTIFICATION INDUSTRIAL AND IRRIGATION

An Identification Decal (Figure 1) is affixed to each engine. The decal contains the engine serial number which identifies this unit from all others. Next is the engine displacement which determines the engine specifications, then the model number and S.O. or special options which determines the parts or components required on this unit. Use all the numbers when seeking information or ordering replacement parts for this engine.

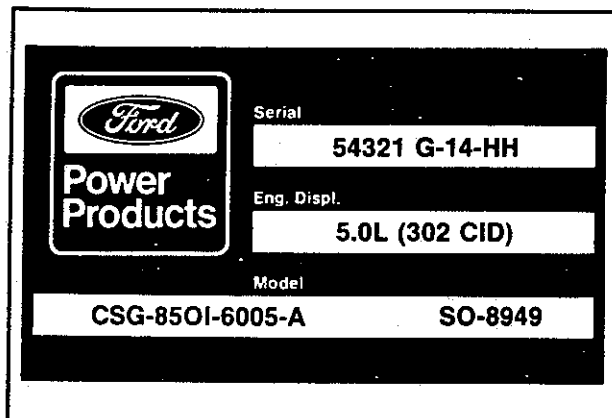


Figure 1 Identification Decal — Industrial — Typical

IDENTIFICATION MARINE

Marine engine identification is indicated by any Identifying Decal or stamped on the engine block by the marinizing engine company.

The marinizer's decal or stamping will identify the Marinizer's name, Ford engine model and size, engine rotation and horsepower. (Figure 2)

Marinizing identification information may be obtained from the yearly Parts and Service New Index by Model and Subject bulletin (example: bulletin #1-87, Parts and Service News Index, under the Marine title, indicates see bulletin #10-87 to identify marine applications).

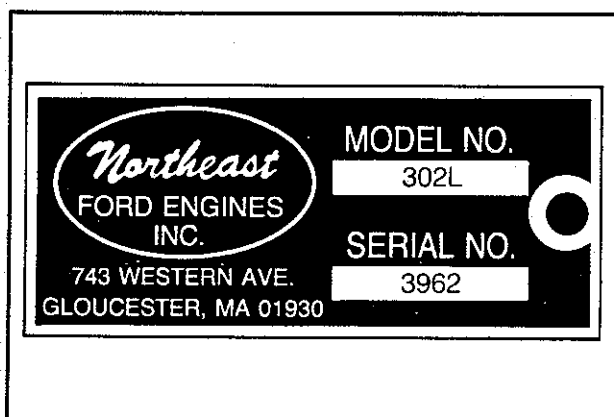


Figure 2 Marine Identification Decal — Typical

DESCRIPTION AND OPERATION

The Ford 5.0L and 5.8L 8-cylinder gasoline engines are available as engine assemblies and are available in industrial or marine versions. In addition, optional equipment is available to custom tailor each engine to individual requirements.

The Ford 5.0L 8-cylinder engine (Figure 3) and the Ford 5.8L 8-cylinder engine (Figure 4) are designed by Ford Motor Company to incorporate many features for smooth, powerful operation, long life and service. The cylinder block is cast iron for maximum strength and rigidity. They have five main bearings and full-length, full-circle water jackets. These full-length, full-circle water jackets help eliminate hot spots and provide more uniform cylinder wall expansion under heavy-duty operation. The cylinders are numbered from front to rear, on the right bank 1, 2, 3, 4 and on the left bank 5, 6, 7, 8. The firing order is indicated in figure 5. (All marine engines are available in either standard or reverse rotation of the camshaft and crankshaft depending upon the engine installation.)

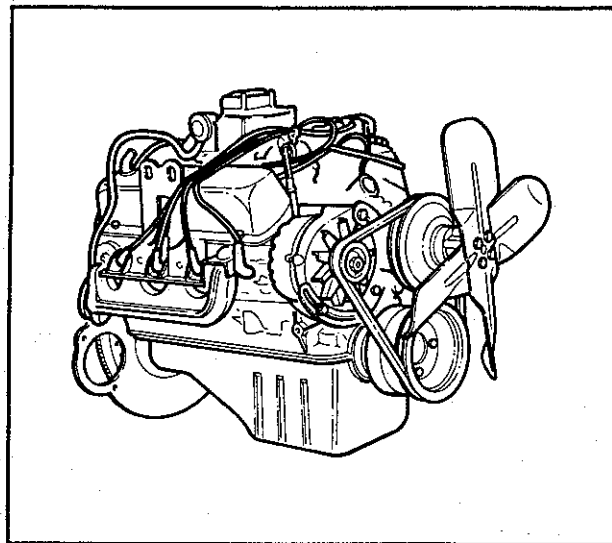


Figure 3 CSG-850 Engine — Typical
(Left 3/4 Front View)

The crankshaft is carried in five replaceable copper-lead alloy main bearings. Crankshaft end thrust is controlled by the center bearing. (Marine engines use four crankshaft assemblies, two for the 302 including the 302 low output engine and two for the 351 W. Standard or reverse rotation is the determining factor on which crankshaft is used. A different damper assembly is used for each crankshaft and can be identified by the part number stamped on the face of the damper and the direction of rotation as indicated by the timing marks on the damper.)

The camshaft is supported by five bearings pressed into the block. It is driven by a timing chain from the crankshaft. (There are six

different camshafts available for marine engines, two for the 302 low output engine, depending upon standard or reverse rotation and four for the other engines depending upon whether a two or four venturi carburetor is used and whether the engine is standard or reverse rotation. The camshafts are identified as per the chart in Figure 5.)

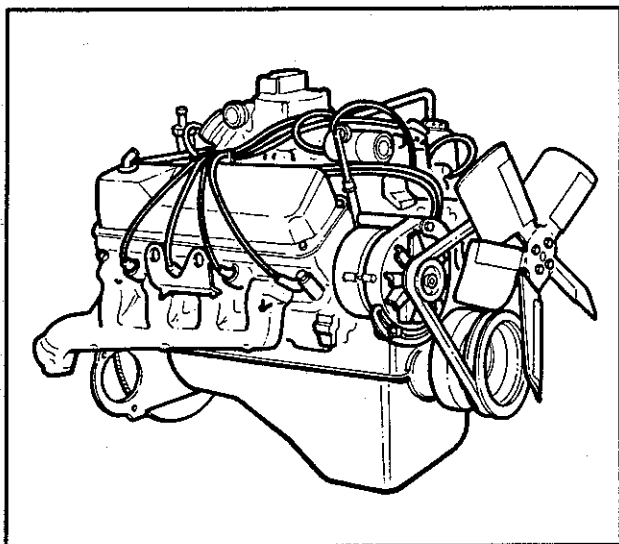


Figure 4 WSG-858 Engine — Typical
(Left 3/4 Front View)

Camshaft end play is controlled by a plate bolted to the front of the block. The distributor is driven by a gear at the front end of the camshaft. (Distributors used on marine engines may vary. The parts are not interchangeable between different makes of distributors, but complete distributors can be interchanged. The 302W marine engines use a Prestolite or Mallory distributor. The 351W marine engines use a Prestolite, GPD or Mallory distributor.)

The cylinder head assemblies contain the fuel intake and exhaust passages, the valves, and the valve rocker arm assemblies. Valve guides are an integral part of the head. The intake and exhaust valves are actuated through hydraulic-type valve lifters, tubular push rods

and individual rocker arms. The large intake and exhaust valves are the free-turning type which rotate slightly each time the valve opens and closes. Rotation promotes self-cleaning and long life.

The self-adjusting valve lifters are housed in bores located in the cylinder block valve lifter chamber. The valve lifters operate directly on the camshaft, thereby transmitting the thrust of the camshaft lobes, by means of hydraulic pressure, to the push rods which actuate the valve train.

All marine engines use positive rotating heavy duty valves and all have free rotating intake and exhaust valves. Free rotating valves rotate slightly each time the valve opens and closes.

The exhaust valves are the positive rotating type. A positive rotating spring retainer produces a definite amount of rotation each time the valve opens and closes.

The cylinder head gasket used on all marine engines is the composition type with a stainless steel core and should be installed dry, that is, without any sealer.

The intake manifold has two sets of fuel passages, each with its own separate inlet connection to the carburetor. A heat crossover passage permits exhaust gases to circulate through the intake manifold, thereby providing the initial heat necessary to assist in vaporizing the incoming fuel charge.

Oil from the oil pan sump, located in the front or rear of the oil pan, is forced through the pressure lubrication system by a rotor-type oil pump mounted in the front or rear of the crankcase. A spring-loaded relief valve in the pump maintains the maximum pressure in the system. A full-flow filter is used which filters the entire output of the pump before the oil enters the engine. A valve integral with the filter permits oil flow if the filter ever becomes clogged. From the filter, the oil flows to an oil gallery and through passages to the various bearings and engine components (Figure 6).

Engine & Application	Camshaft Service Part No. (6250) and Color Code	Camshaft	Cam Lobe Lift	
		Firing Order	Intake	Exhaust
CSG850 (302)				
I, M, Std., LO, 2V	D50Z-A Yellow	1-5-4-2-6-3-7-8	.2375	.2470
M, Std., 2V	D30Z-A Brown	1-3-7-2-6-5-4-8	.2600	.2780
M, Std., 4V	E7JE-AA Green	1-3-7-2-6-5-4-8	.2780	.2830
M, Rev., 4V	E7JE-BA Red	1-8-4-5-6-2-7-3	.2780	.2830
WSG858 (351)				
M, Std., 4V	E7JE-AA Green	1-3-7-2-6-5-4-8	.2780	.2830
M, Rev., 4V	E7JE-BA Red	1-8-4-5-6-2-7-3	.2780	.2830
I, Std., 2V	D60Z-C Blue	1-3-7-2-6-5-4-8	.2600	.2780

Application Codes: M = Marine, Std. = L.H. Rotation, Rev. = R.H. Rotation,
LO = Low Output, 2V Carburetor, 4V Carburetor, I = Industrial.

Figure 5 Camshaft Identification

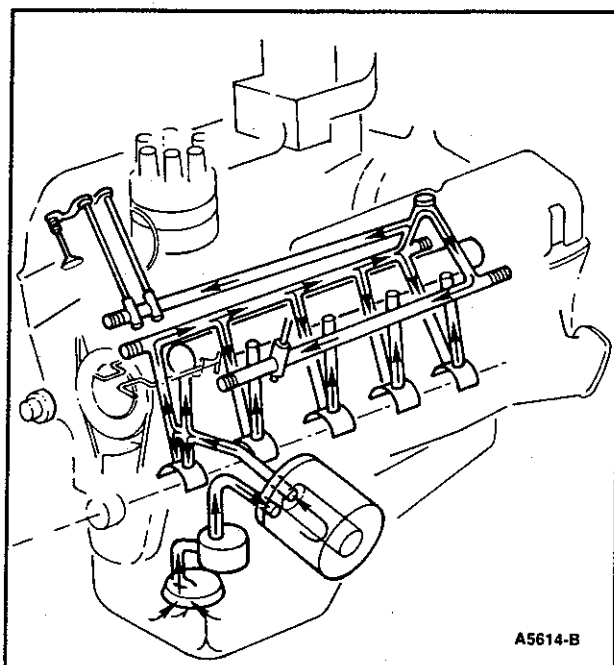


Figure 6 Lubrication System — Typical

The pistons have two compression rings and one oil control ring. The top compression ring is chrome-plated steel and the lower compression ring is phosphate-coated. The oil control ring consists of a serrated spring expander and two chrome-plated steel rails. The connecting rods are forged steel and use selective fit replaceable copper-lead alloy bearings.

A one-piece lip-type rear crankshaft seal is used for industrial and marine engines. The standard rotation (C.C.W.) industrial and marine engines identify the crankshaft rear seal by the engineering part number, moulded into the seal. The marine reverse rotation crankshaft seal is identified by the part number and one 3/4" wide white stripe (top and bottom).

NOTE: The most positive identification method is by reading the Ford part number, which is moulded into the seal in various locations. (The majority of part numbers on parts are engineering part numbers and will require to be crossed to service parts numbers to purchase replacement Ford parts.)

The engine is equipped with a positive crankcase system that directs the crankcase vapors through an emission valve to the intake manifold, where they are mixed with the incoming fuel charge and burned in the cylinders.

Industrial and irrigation engines use a standard water pump. Marine engines use a different water pump depending upon whether the engine is standard or reverse rotation.

The reverse rotation engines use a bi-rotational water pump assembly. The bi-rotational pump only is identified by a number, D3JE-AA, on the housing.

Marine engines use carburetors that have 2 or 4 venturies, flame arrestor air inlet assembly that meet the marine and Coast Guard codes.

DIAGNOSIS AND TESTING

Camshaft Lobe Lift

Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove the air cleaner. Remove the crankcase ventilation hoses. Remove valve rocker arm cover(s).
2. Remove the fulcrum bolts, fulcrum seat and rocker arm.
3. Ensure the push rod is in the valve tappet socket. Install Dial Indicator or equivalent, and Dial Indicator Bracketry or equivalent, so that the actuating point of the indicator is in the push rod socket or the Cup Shaped Adapter is on the end of the push rod and in the same plane as the push rod movement (Figure 7).
4. Disconnect the I terminal and S terminal leads at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the starter relay. Crank the engine with the ignition switch in OFF.

Turn the crankshaft over until the tappet is on the base circle of the camshaft lobe. At this point, the push rod will be in its lowest position.

5. Zero the dial indicator. Continue to rotate the crankshaft slowly until the push rod is in the fully raised position.
6. Compare the total lift recorded on the indicator with specification listed in Section 8.
7. To check the accuracy of the original indicator reading, continue to rotate the crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits listed in the specification Section, the camshaft and the valve tappets operating on the worn lobe(s) must be replaced.
8. Remove the dial indicator and auxiliary starter switch.

Install the rocker arm, fulcrum seat and fulcrum bolts. Check the valve clearance. Refer to specifications Section. Adjust if required, as outlined.

9. Install the valve rocker arm cover(s) and the air cleaner.

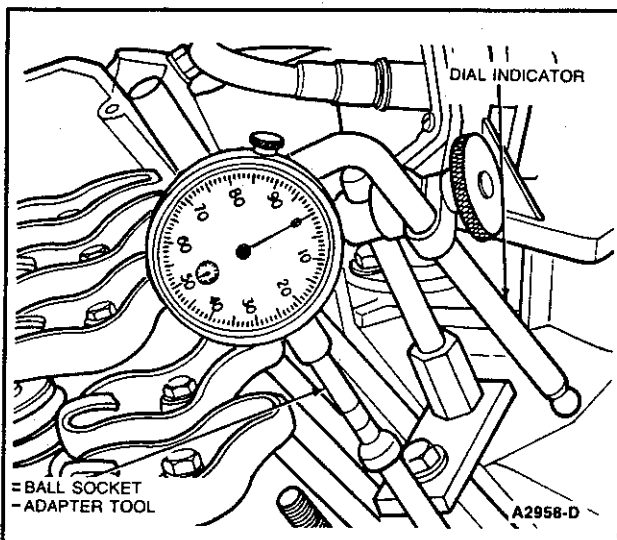


Figure 7 Typical Camshaft Lobe Lift Hydraulic Tappet — V-8 Engines with Pedestal Mounted Rocker Arms

Compression Test

The following procedure is to be used on all engines when checking compression:

1. Ensure the crankcase oil is of the correct viscosity and ensure that the battery is properly charged. Operate the engine for a minimum of 30 minutes at 1200 rpm, or until the engine is at normal operating temperature. Turn the ignition switch to OFF, then remove all the spark plugs.
2. Set the carburetor throttle or throttle body plates in the wide-open position.
3. Install a compression gauge in No. 1 cylinder.
4. Crank the engine (with the ignition switch in OFF) at least five pumping strokes and record the highest reading indicated. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat the check on each cylinder cranking the engine approximately the same number of compression strokes.

Test Conclusion

The indicated compression pressures are considered normal if the lowest reading cylinder is within 75 percent of the highest. Refer to the quick reference chart (Figure 8) for pressure limits between cylinders. Variations exceeding 75 percent imply an improperly seated valve or worn or broken piston rings. If one cylinder reads low, squirt approximately one tablespoon of engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

- a. If compression improves considerably, the piston rings are at fault.
- b. If compression does not improve, valves are sticking or seating poorly.

- c. If two adjacent cylinders indicate low compression pressures and squirting oil on the pistons does not increase the compression, the cause may be a cylinder head gasket leak between the cylinders. Engine oil and/or coolant in the cylinders could result from this problem.

Example

After checking the compression pressures in all cylinders, the highest reading obtained was 965 kPa (140 psi) and the lowest pressure reading was 689 kPa (100 psi). By locating 965 (140) in the Maximum column it is seen that the lowest allowable pressure listed in the Minimum column is 723 kPa (105 psi). Since the lowest cylinder reading was 689 kPa (100 psi), the engine is not within specifications and the compression is not considered satisfactory.

Hydraulic Valve Tappet

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap.
2. Sticking tappet plunger.
3. Tappet check valve not functioning properly.
4. Air in lubrication system.
5. Leakdown rate too rapid.
6. Excessive valve guide wear.

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts, incorrect initial adjustment, or wear of tappet face, push rod, rocker arm, rocker arm fulcrum or valve tip. With tappet collapsed, check gap between valve tip and rocker arm to determine if any other valve train parts are damaged, worn, or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. The sticking can be corrected by disassembling the tappet and removing the dirt, chips, or varnish causing the condition.

A tappet check valve that is not functional may be caused by an obstruction such as dirt or chips, preventing it from closing when the cam lobe is lifting the tappet, or it may be caused by a broken check valve spring.

Air bubbles in the lubrication system will prevent the tappet from supporting the valve spring load and may be caused by too high or too low an oil level in the oil pan, or by air being drawn into the system through a hole, crack, or leaking gasket on the oil pump pickup tube.

If the leakdown time is below the specified time for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, the leakdown rate should be checked and any outside the specification should be replaced.

Maximum kPa (PSI)	Minimum kPa (PSI)	Maximum kPa (PSI)	Minimum kPa (PSI)	Maximum kPa (PSI)	Minimum kPa (PSI)
923 (134)	697 (101)	1199 (174)	903 (131)	1475 (214)	1103 (160)
937 (136)	703 (102)	1213 (176)	910 (132)	1489 (216)	1116 (162)
951 (138)	717 (104)	1227 (178)	917 (133)	1503 (218)	1123 (163)
965 (140)	723 (105)	1241 (180)	930 (135)	1516 (220)	1137 (165)
979 (142)	737 (107)	1254 (182)	937 (136)	1530 (222)	1144 (166)
992 (144)	744 (108)	1268 (184)	951 (138)	1544 (224)	1158 (168)
1006 (146)	758 (110)	1282 (186)	965 (140)	1558 (226)	1165 (169)
1020 (148)	765 (111)	1296 (188)	972 (141)	1572 (228)	1179 (171)
1034 (150)	779 (113)	1310 (190)	979 (142)	1585 (230)	1185 (172)
1048 (152)	786 (114)	1323 (192)	992 (144)	1599 (232)	1199 (174)
1061 (154)	792 (115)	1337 (194)	999 (145)	1613 (234)	1206 (175)
1075 (156)	806 (117)	1351 (196)	1013 (147)	1627 (236)	1220 (177)
1089 (158)	813 (118)	1365 (198)	1020 (148)	1641 (238)	1227 (178)
1103 (160)	827 (120)	1379 (200)	1034 (150)	1654 (240)	1241 (180)
1116 (162)	834 (121)	1392 (202)	1041 (151)	1668 (242)	1247 (181)
1130 (164)	848 (123)	1406 (204)	1054 (153)	1682 (244)	1261 (183)
1144 (166)	854 (124)	1420 (206)	1061 (154)	1696 (246)	1268 (184)
1158 (168)	868 (126)	1434 (208)	1075 (156)	1709 (248)	1282 (186)
1172 (170)	875 (127)	1447 (210)	1082 (157)	1723 (250)	1289 (187)
1185 (172)	889 (129)	1461 (212)	1089 (158)		

CA1005-2B

Figure 8 Quick Reference Compression Pressure Limit Chart

Assembled tappets can be tested with Hydraulic Tappet Leakdown Tester Tool or equivalent to check the leakdown rate. The leakdown rate specification is the time in seconds for the plunger to move a specified distance of its travel while under a 22.68 kg (50-lb) load. Test the tappets as follows:

1. Disassemble and clean the tappet to remove all traces of engine oil.

NOTE: Do not mix parts from different tappets. Parts are select-fitted and are not interchangeable.

Tappets cannot be checked with engine oil in them. Only the testing fluid can be used.

2. Place the tappet in the tester, with the plunger facing upward. Pour hydraulic tappet tester fluid into the cup to a level that will cover the tappet assembly. The fluid can be purchased from the manufacturer of the tester. Using kerosene or any other fluid will not provide an accurate test.
3. Place the 7.938mm (5/16-inch) steel ball provided with the tester in the plunger cap (Figure 8).
4. Adjust the length of the ram (Figure 10) so that the pointer is 1.59mm (1/16 inch) below the starting mark when the ram contacts the tappet plunger, to facilitate timing as the pointer passes the Start Timing mark.

Use the center mark on the pointer scale as the Stop Timing point instead of the original Stop Timing mark at the top of the scale.

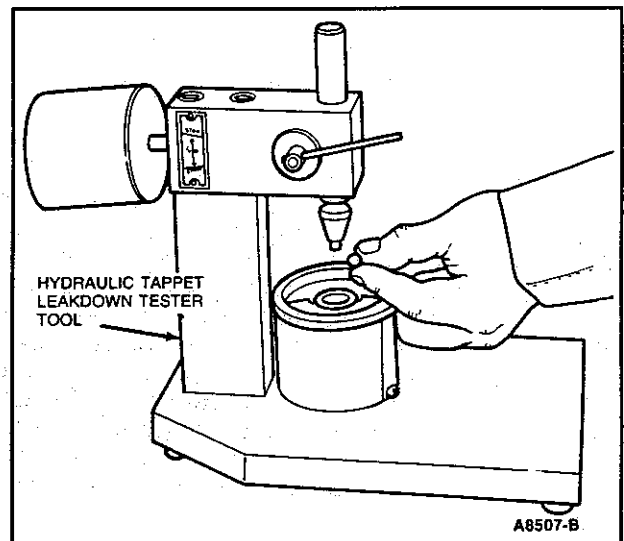


Figure 9 Placing Steel Ball in Valve Tappet Plunger

5. Work the tappet plunger up and down until the tappet fills with fluid and all traces of air bubbles have disappeared.
6. Allow the ram and weight to force the tappet plunger downward. Measure the exact time it takes for the pointer to travel from the Start Timing to the Stop Timing marks of the tester.
7. A tappet that is satisfactory must have a leakdown rate (time in seconds) within the minimum and maximum limits specified in the specific engine Section.

8. If the tappet is not within specifications, replace it with a new tappet. It is not necessary to disassemble and clean new tappets before testing, because the oil contained in new tappets is test fluid.
9. Remove the fluid from the cup and bleed the fluid from the tappet by working the plunger up and down. This step will aid in depressing the tappet plungers when checking the valve clearance.

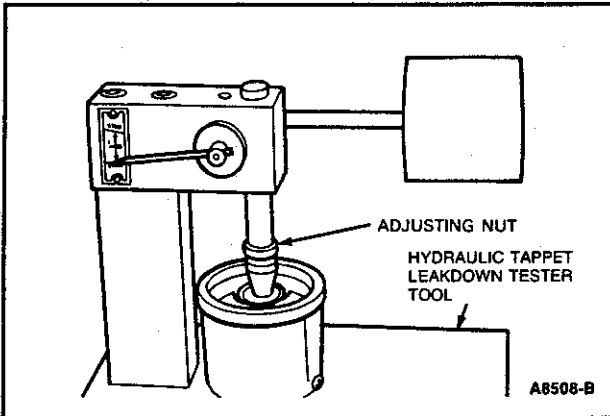


Figure 10 Adjusting the Ram Length

POSITIVE CLOSED-TYPE VENTILATION SYSTEM

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the crankcase ventilation system and making carburetor adjustments. The removal of the crankcase ventilation system from the engine will adversely affect the fuel economy and engine ventilation with resultant shortening of engine life. To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, perform either of the following tests.

Air Intake Test

This test is performed with the crankcase ventilation tester (Figure 11) which is operated by the engine vacuum through oil fill opening. Follow the procedures described below to install the tester and check the crankcase ventilation system for faulty operation.

1. With the engine at **normal operating temperature**, remove the oil filler cap.
2. Hold the tester over the opening in the valve cover. Make sure the surface is flat to form a seal between the cover and tester. If the cover is distorted, shape it as required to make an air tight seal. An air leak between the cover and tester will render the tester inoperative.
3. Start the engine and allow it to operate at the recommended idle speed.

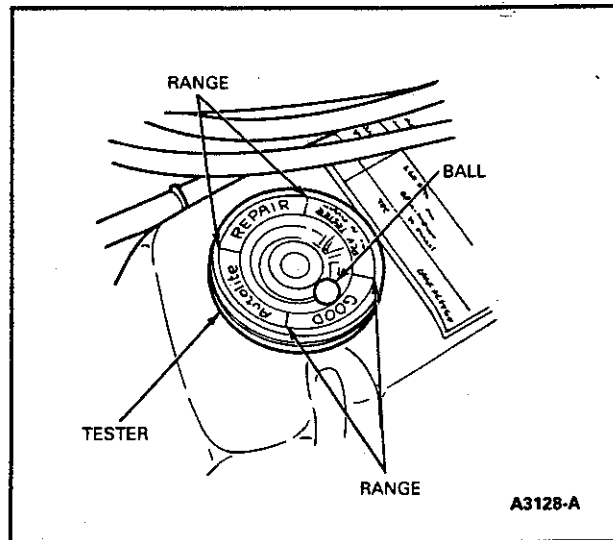


Figure 11 Crankcase Ventilation System Tester

4. Hold the tester over the oil filler cap opening making sure that there is a positive seal between the tester and cover.
5. If the ball settles in the **GOOD** (green) area, the system is functioning properly. If the ball settles in the **REPAIR** (red) area, clean or replace the malfunctioning components as required.
6. Repeat the test **AFTER** repairs are made to make sure that the crankcase ventilation system is operating satisfactorily.

Clean and replace the malfunctioning components as required. Repeat the test to ensure that the crankcase ventilation system is operating satisfactorily.

Crankcase Ventilation Regulator Valve Test

Install a known good regulator valve (PCV) in the crankcase ventilation system.

Start the engine and compare the engine idle condition to the prior idle condition.

If the idle condition is found to be satisfactory, use the new regulator valve and clean the hoses, fittings, etc.

If the loping or rough idle condition remains when the good regulator valve is installed, the crankcase ventilation regulator valve is not at fault. Check the crankcase ventilation system for restriction at the intake manifold or carburetor spacer. If the system is not restricted, further engine component diagnosis will have to be conducted to find the malfunction.

STATIC ENGINE OFF VALVE TRAIN ANALYSIS (ROCKER ARM COVER REMOVED)

Rocker Arm Cover Removal

1. Remove air cleaner.

2. Disconnect and remove any hoses, wires, spark plug leads and components that would interfere with the removal of the rocker arm cover.
3. Remove the rocker arm cover bolts.
4. Remove the rocker arm cover.

Valve Train Analysis

Check for damaged and /or severely worn parts and for correct assembly. Ensure use of correct parts by proceeding, as follows, with the static engine analysis.

1. Rocker Arm Assemblies — Individually Mounted:
 - a. Check for loose mounting stud and nut or bolt.
 - b. Check for plugged oil feed in the rocker arm.
2. Push Rods:

Check for bent push rods.
3. Valve Spring Assembly — With or Without Damper Spring:

Check for broken or damaged parts.
4. Retainer and Keys — Both two-piece and one-piece retainers:

Check for proper seating of keys on valve stem and in retainer.
5. Positive Rotator and Keys:

Check for proper seating of keys on valve stem in the positive rotator.
6. Valves and Cylinder Head
 - a. Check the cylinder head gasket for proper installation.
 - b. Check for plugged oil drain back holes.
 - c. Check for worn or damaged valve tips.
 - d. Check for missing or damaged valve stem oil seals.
 - e. Check collapsed tappet gap — hydraulic tappet applications.
 - f. Check installed spring height.
7. Overhead Cam Follower Arm and Lash Adjuster Assemblies:

Check for broken or severely worn parts.

Check for "soft" lash adjuster with hand pressure on rocker arm (arm on base circle of camshaft).
8. Camshaft — Overhead Camshaft Applications:
 - a. Check for plugged oil feed
 - b. Check for correct cam lift.

Static checks (engine off) are to be made on the engine prior to the following dynamic procedure.

DYNAMIC VALVE TRAIN ANALYSIS

Valve Train Analysis

CAUTION: Do not perform dynamic analysis on overhead camshaft engines because of oil splash.

Start the engine and while running at idle check for proper operation of all parts. Check the following items under firing engine operating conditions:

1. Rocker Arm Assemblies — Individually Mounted:

- a. Check for plugged oil feed in rocker arm.

If insufficient oiling is suspected, accelerate the engine to 1200 rpm \pm 100 rpm with the transmission in NEUTRAL and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arms are well oiled and/or, with the rocker arm cover off, oil splash may overshoot rocker arm. If oiling is insufficient for this condition to occur, check oil passages for blockage.

2. Push Rods:
 - a. Check for bent push rods.
 - b. Check for proper rotation of push rods.
3. Positive Rotator and Keys:

Check for proper operation of positive rotator.
4. Valves and Cylinder Head:
 - a. Check for plugged oil drain back holes.
 - b. Check for missing or damaged valve stem oil seals or for guide mounted oil seals.

Rocker Arm Cover Installation

1. Remove old gasket from cover. If necessary, scrape both the rocker arm cover rail on the cylinder head and the gasket flange on the cover to remove all traces of the old gasket.
2. Install a new gasket and replace the cover on the engine.
3. Install the rocker arm cover bolts and tighten in sequence to specification in the specific engine Section in this manual.
4. Connect all hoses, wires, spark plug leads, and components.

Crankshaft End Play

1. Force the crankshaft toward the rear of the engine.
2. Install a dial indicator so that the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (Figure 12).

3. Zero the dial indicator. Push the crankshaft forward and note the reading on the dial.
4. If the end play exceeds the wear limit, replace the thrust washers. If the end play is less than the minimum limit inspect the thrust bearing faces for scratches, burrs, nicks, or dirt.

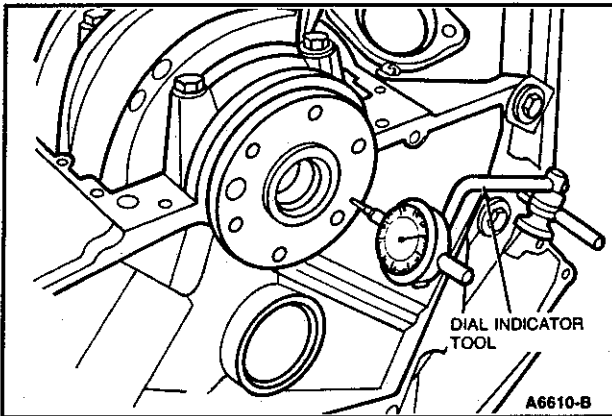


Figure 12 Checking Crankshaft End Play

FLYWHEEL FACE RUNOUT

Install a dial indicator so that the indicator point bears against the flywheel face. Turn the flywheel making sure that it is full forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If the clutch face runout exceeds specifications, remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange (Figure 13). If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft-flywheel mounting face sufficiently to true up the surface if the mounting flange runout exceeds specifications. Replace it or reinstall it on the flywheel.

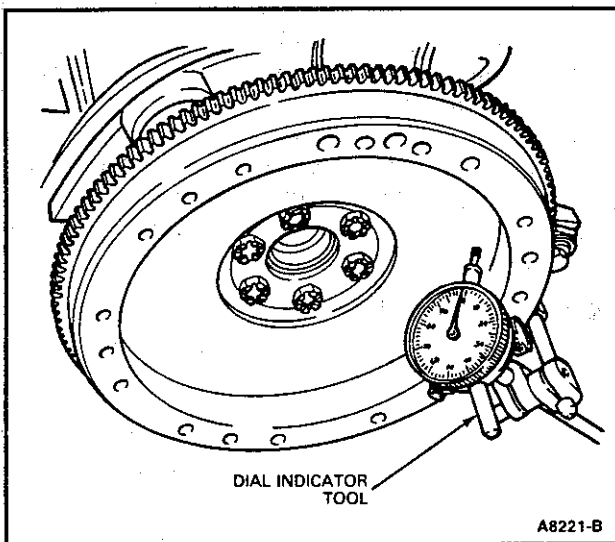


Figure 13 Flywheel Face Runout Check

CAMSHAFT END PLAY

Prying against the aluminum-nylon camshaft sprocket, with the valve train load on the camshaft, can break or damage the sprocket. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, adjust the valve clearance.

Push the camshaft toward the rear of the engine. Install a dial indicator so that the indicator point is on the camshaft sprocket attaching screw (Figure 14). Zero the dial indicator. Position a large screwdriver between the camshaft gear and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with the specifications.

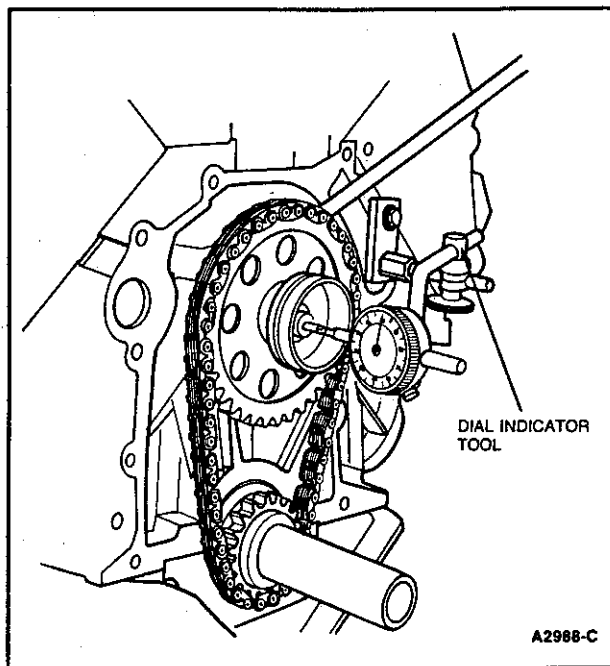


Figure 14 Checking Camshaft End Play

If the end play is excessive, check the spacer for correct installation before it is removed. If the spacer is correctly installed, replace the thrust plate.

Remove the dial indicator.

TIMING CHAIN DEFLECTION

1. Rotate the crankshaft in a counterclockwise position (as viewed from the front) to take up the slack on the left side of the chain.
2. Establish a reference point on the block and measure from this point to the chain.
3. Rotate the crankshaft in the opposite direction to take up the slack on the right of the chain. Force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements.

If the deflection exceeds specifications, replace the timing chain and sprockets.

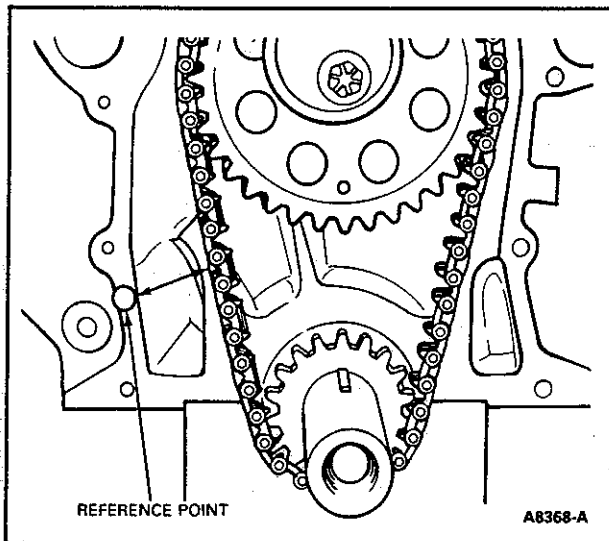


Figure 15 Checking Timing Chain Deflection

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. **Remove all filings and foreign matter that may have entered the manifold as a result of repairs.**

EXHAUST MANIFOLDS

Cleaning

Remove all gasket material from the manifolds.

Inspection

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

Inspect the manifolds for cracks, damaged gasket surfaces, or other defects that would make them unfit for further service.

VALVE ROCKER ARM ASSEMBLY

Cleaning

Clean all the parts thoroughly. Ensure that all oil passages are open.

On spherical and cylindrical fulcrum seat rocker arms, ensure the oil passage in the push rod end of the rocker arm is open.

If applicable, remove the plugs from both ends of the rocker arm shaft to thoroughly clean the shaft passages.

Inspection

Inspect the pad at the valve end of the rocker arms 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 spherical and cylindrical fulcrum seat rocker arms, check the fulcrum seat for excessive wear, cracks, nicks or burrs. Check rocker arm studs and nuts for stripped or broken threads, or looseness.

PUSH RODS

Cleaning

Clean all push rods in a suitable solvent. On push rods with an oil passage, blow out the passage with compressed air and ensure that the oil passage is fully open.

Inspection

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

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 with Bracketry Tool or equivalent (Figure 16).

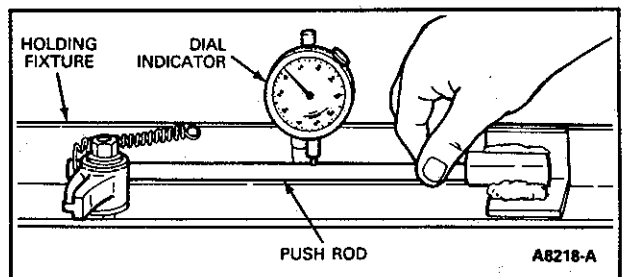


Figure 16 Checking Push Rod Runout

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 with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease and other deposits. Clean all bolt holes. Ensure the oil transfer passage is clean (V-8 engines).

Remove all deposits from the valves with a fine wire brush or buffing wheel.

Inspection

Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

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

On cylinder heads that incorporate valve seat inserts, check the inserts for excessive wear, cracks or looseness.

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.

Cylinder Head Flatness

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface (Figure 17) for conformance to specifications according to specific engine Sections. If necessary to refinish the cylinder head gasket surface, do not plane or grind off more than 0.254mm (0.010inch) from the original gasket surface.

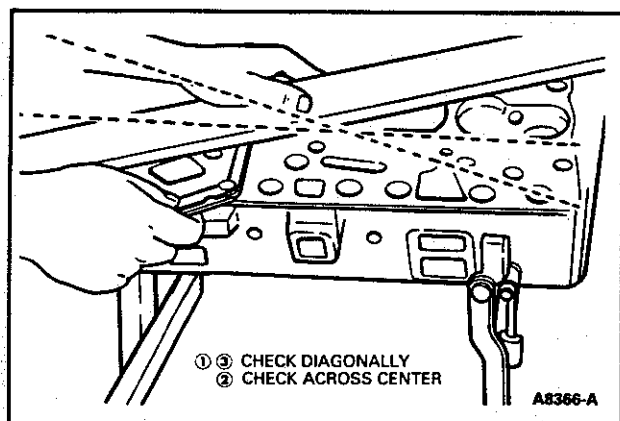


Figure 17 Checking Cylinder Head Flatness — Typical

Valve Seat Runout

Check the valve seat runout with an accurate Valve Seat Runout Gauge (Figure 18) or equivalent. Follow the instructions of the gauge manufacturer. If the runout exceeds the service limit, reface the valve and valve seat.

Valve Seat Width

Measure the valve seat width (Figure 32). Reface the valve seat(s) if the width is not within specifications. Refer to specific engine Section in this Manual.

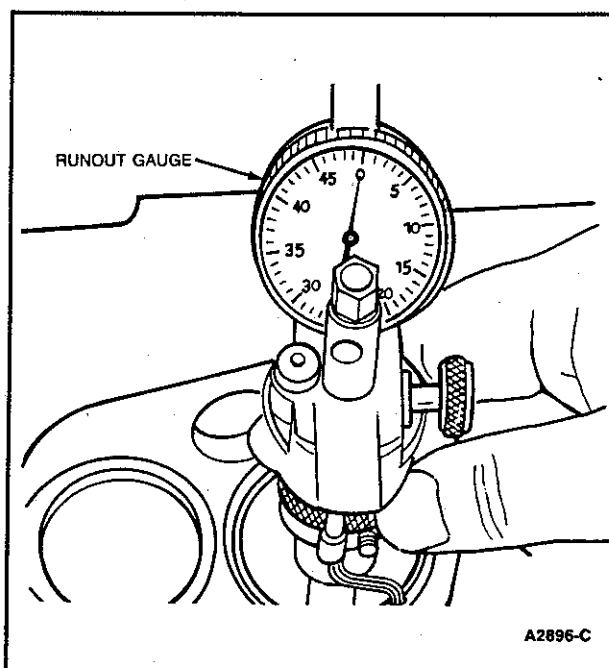


Figure 18 Checking Valve Seat Runout

Valves

The critical inspection points and tolerances of the valve are illustrated in Figure 33. Refer to specifications for service limits. Refer to specific engine Section.

Inspect the valve face and the edge of the valve head for pits, grooves or scores. Inspect the stem for a bent condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Inspect the valve springs, valve spring retainers, locks and sleeves and discard any visually damaged parts.

Valve Face Runout

Check the valve face runout. It should not exceed the specified service limit. If the runout exceeds the service limit, the valve should be replaced or refaced as outlined under Refacing Valves.

Valve Stem Clearance

Check the valve stem-to-valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance Tool (11/32-inch valves) or the equivalent shown in Figure 19. Use a flat end indicator point.

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. If valve stem-to-valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem as outlined under Valves.

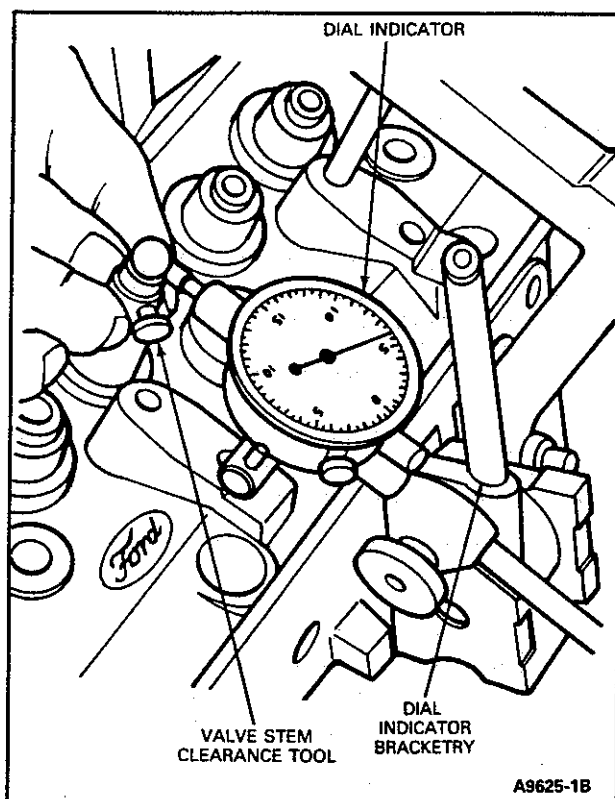


Figure 19 Checking Valve Stem Clearance — Typical

Valve Spring Pressure

Check the valve spring for proper pressure (Figure 20) at the specified spring lengths using Valve/Clutch Spring Tester or equivalent. Weak valve springs cause poor performance; therefore, if the pressure of any spring is lower than the service limit, replace the spring.

Valve Spring Squareness

Check each spring for squareness using a steel square and a surface plate (Figure 21). Stand the spring and square on end on the surface plate. Slide the spring up to the square. Rotate the spring slowly and observe the space between the top coil of the spring and square. If the spring is out of square more than 1.984mm (5/64 inch), replace it.

Follow the same procedure to check new valve springs before installation.

Ensure the proper spring (color coded) is installed.

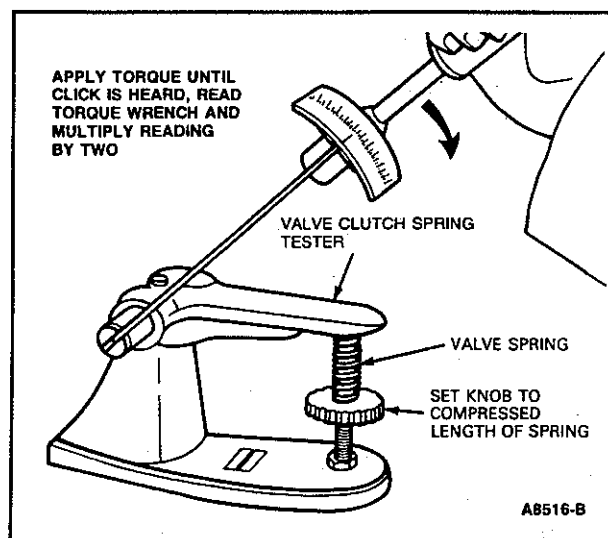


Figure 20 Checking Valve Spring Pressure

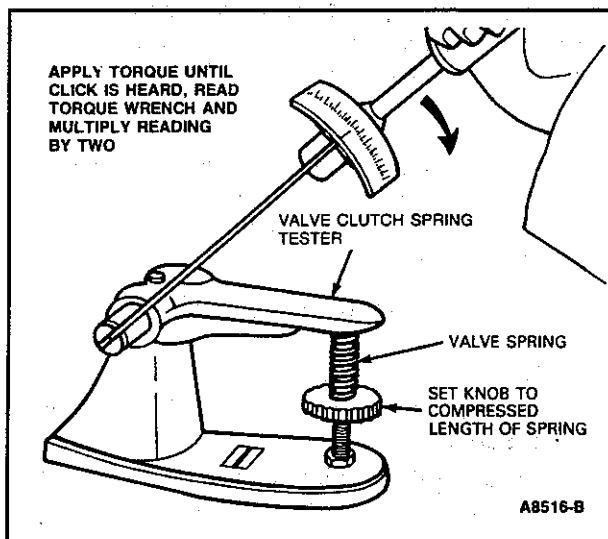


Figure 21 Checking Valve Spring Squareness

HYDRAULIC VALVE LIFTERS

The valve lifter assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each lifter separately so as not to intermix the internal parts. If any part of the lifter assembly needs replacing, replace the entire assembly.

Cleaning

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

Inspection

Inspect the parts and discard the entire lifter assembly if any part shows pitting, scoring, galling 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 lifter assembly and check for freeness of operation by pressing down on the push rod cup. The lifters can also be checked with a hydraulic tester to test the leak-down rate. Follow the instructions of the test unit manufacturer.

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, burrs or other imperfections 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 or sleeve oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

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 engine.

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.

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

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 wear characteristics may result in pitting in the general area of the lobe toe. This pitting 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 the distributor drive gear is broken or has chipped teeth.

Check the fuel pump eccentric, if so equipped, for excessive wear, replace if necessary.

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-of-round, taper or undersize condition (Figure 22).

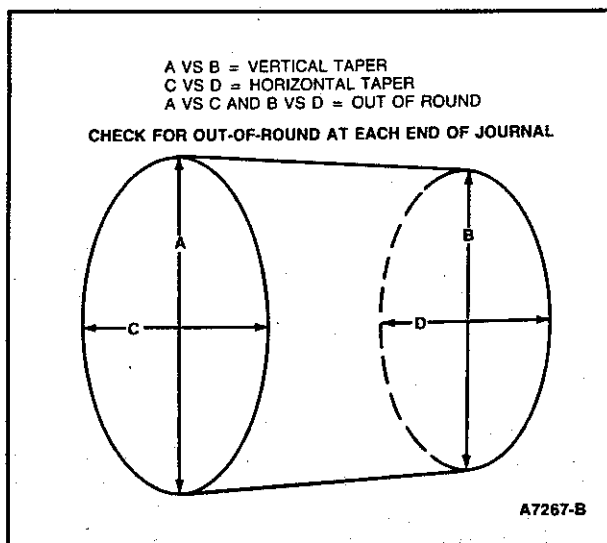


Figure 22 Crankshaft Journal Measurement

Check the fit of the clutch pilot bushing in the bore of the crankshaft. The bushing is pressed into the crankshaft and should not be loose. Inspect the inner surface of the bushing for wear or a bell-mouth condition. Check the ID of the bushing (Figure 23). Replace the bushing if it is worn or damaged or the ID is not within specifications.

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

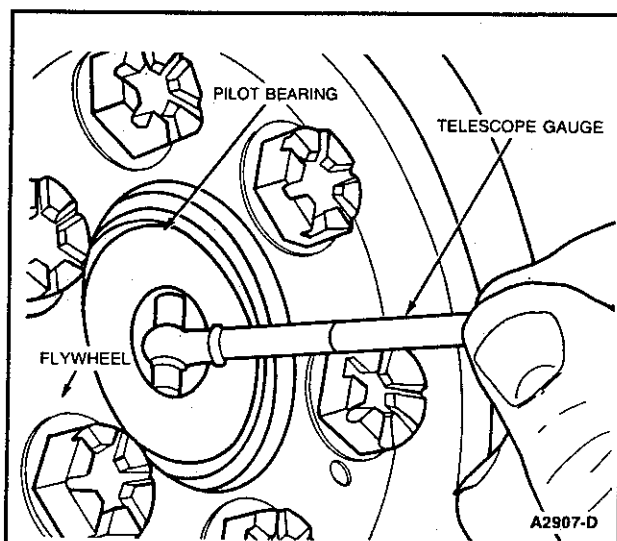


Figure 23 Checking Clutch Pilot Bushing Wear

FLYWHEEL

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.

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 easily 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 an oversize piston pin. First, prefit the oversize piston pin to the piston pin bore by reaming or honing the piston. Then, assemble the piston, piston pin and connecting rod following the procedures for assembly. **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 straightened or 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 (Figure 24). Ensure the oil ring slots (or holes) are clean.

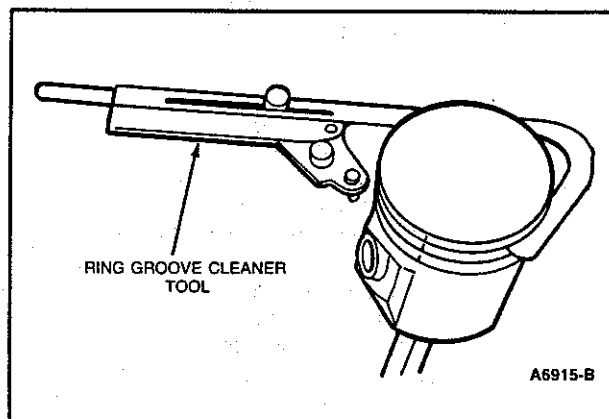


Figure 24 Cleaning Piston Ring Grooves

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.

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 approximately 2 1/4 inches below the dome and at 90 degrees to the piston pin bore.** 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.

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. Check the end gap and side clearance. **Rings should not be transferred from one piston to another regardless of mileage or hours.**

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 Figure 25. 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.

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.

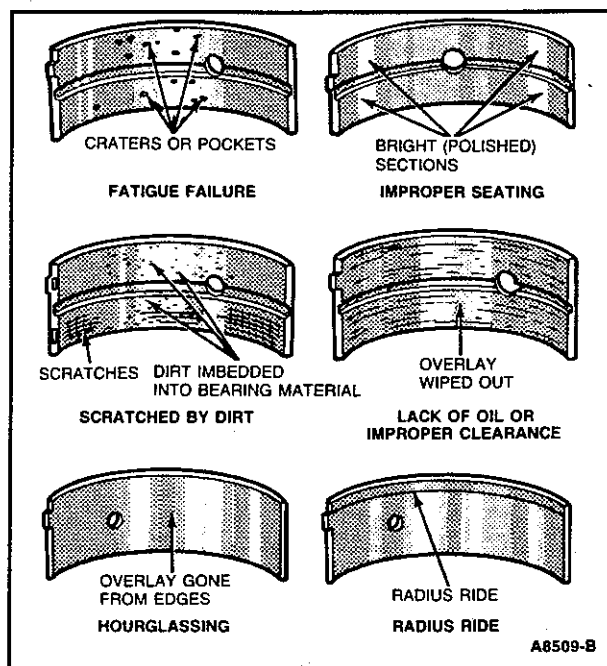


Figure 25 Typical Bearing Failures

If the engine is disassembled, thoroughly clean the block in 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.

Ensure 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 any deposits.

Inspection

After the block has been thoroughly cleaned, check it for cracks. Minute 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. Avoid use of methanol substitute rubbing alcohol. If cracks are present, the coating will become discolored at the cracked 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. Check the cylinder block for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications listed in the specific engine Section. **Do not exceed 0.254mm (0.010 inch) stock removal from the original gasket surface.**

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 (Figure 26). 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(s) the service limits.

If the cylinder walls have minor surface damage, but the out-of-round and taper are within limits, it may be possible to remove such damage by honing the cylinder walls and installing new service piston rings providing the piston clearance is within specified limits listed in the specific engine Section.

To remove the cylinder wall glaze or to re-finish a cylinder bore, follow the honing procedure described under Overhaul Cylinder Block-Refinishing Cylinder Walls.

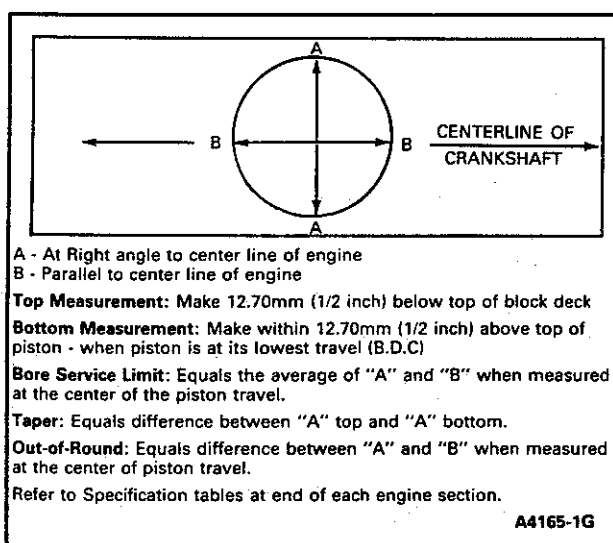


Figure 26 Cylinder Bore Measurement

OIL PAN

Cleaning

Scrape any foreign material 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. Ensure all foreign material and/or metal particles are removed.

Inspection

Refer to Specifications for clearances and service 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.

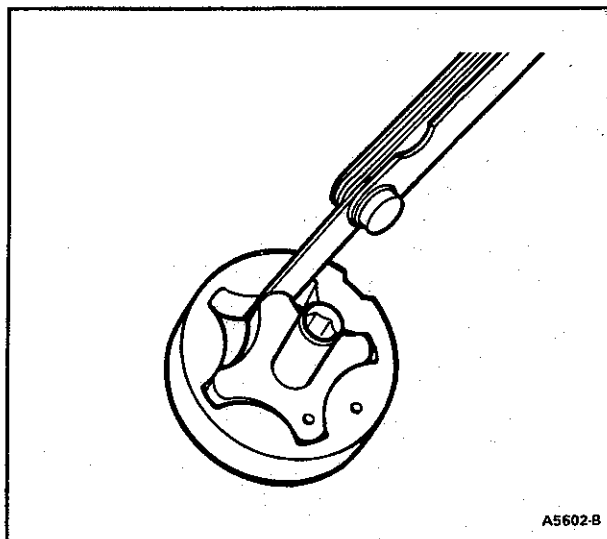


Figure 27 Inner Rotor Tip Clearance Check

Inspect the rotor for nicks, burrs or score marks. Remove all high points by stoning.

Measure the inner rotor tip clearance (Figure 27). Inner to outer rotor tip clearance must not exceed 0.254mm (0.010 inch) with the feeler gauge inserted 12.7mm (1/2 inch) minimum and rotors removed from pump housing.

With the rotor assembly installed in the housing, place a straightedge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straightedge and the rotor and outer race (Figure 28). 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 specification 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.

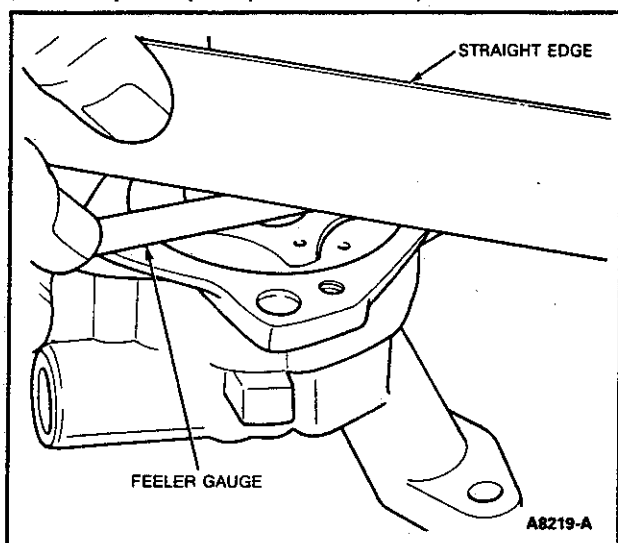


Figure 28 Rotor End Play Check

POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM (IF SO EQUIPPED)

Cleaning

Do not attempt to clean the crankcase ventilation regulator valve (Figure 29); it should be replaced at the specified maintenance interval. The oil filler cap and oil separator should be cleaned at the proper maintenance interval. Remove the cap and the oil separator and wash them in a low-volatility, petroleum-base solvent. Shake the cap dry and install them. Clean the crankcase ventilation system connection(s) on the intake manifold by probing with a flexible wire or bottle brush. Clean the hoses, fittings, tubes and associated hardware with a low-volatility, petroleum-base solvent and dry with compressed air.

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 as to 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 clear-

ance should be regarded as a practical working value, and used as a determinant for installing the next oversize valve to ensure extended service life.

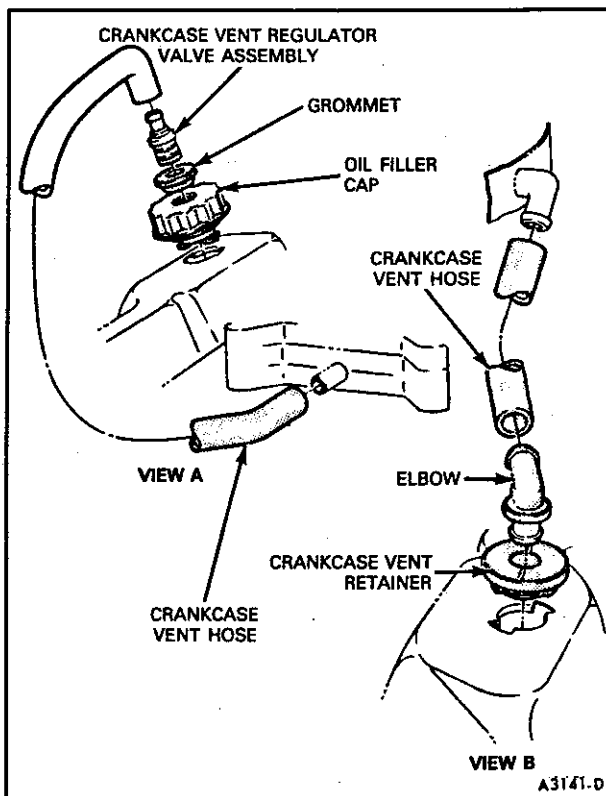


Figure 29 Crankcase Ventilation System Regulator Valve Installed

CYLINDER HEAD

Replace the head if it is cracked. Do not plane or grind more than 0.254mm (0.010 inch) from the cylinder head gasket original surface. Remove all burrs or scratches with an oil stone.

Reaming Valve Guides

If it becomes necessary to ream a valve guide (Figure 30) to install a valve with an oversize stem, Valve Guide Reamer Kit or equivalent is available which contains the following reamer and pilot combinations: 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, 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.

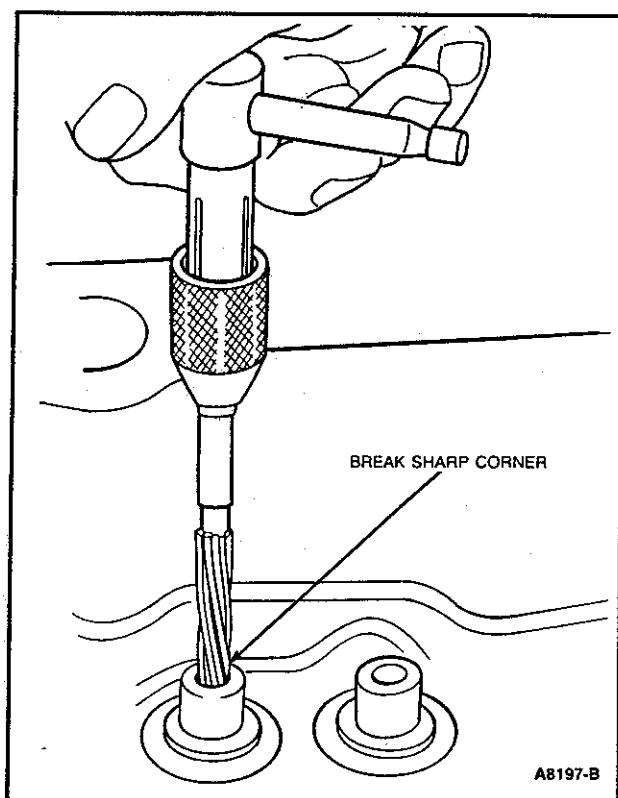


Figure 30 Reaming Valve Guides

Refacing Valve Seats

Refacing of the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference fit will be maintained. This is important so that the valve and seat will have a compression tight fit. Ensure the refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45-degree angle (Figure 31). 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 (Figure 32). Narrow the seat, if necessary to bring it within specifications. Refer to specifications Section.

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. Refer to specifications Section.

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) (Figure 31).

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 Prussian 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.

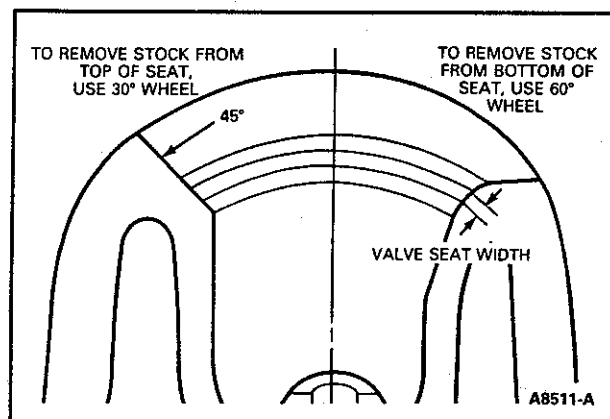


Figure 31 Refacing Valve Seat

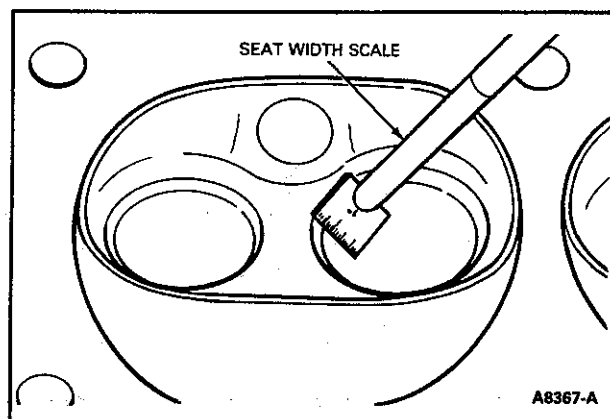


Figure 32 Checking Valve Seat Width

Valves

Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged, if the face runout cannot be corrected by refinishing, or if stem clearance exceeds specifications. Refer to specifications Section.

Discard any 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. Ensure 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 edge of the valve head is less than 0.794mm (1/32-inch) thick after grinding (Figure 33), replace the valve, as the valve will run too hot in the engine. **The interference fit 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 0.254mm (0.010 inch) from the end of the valve stem.**

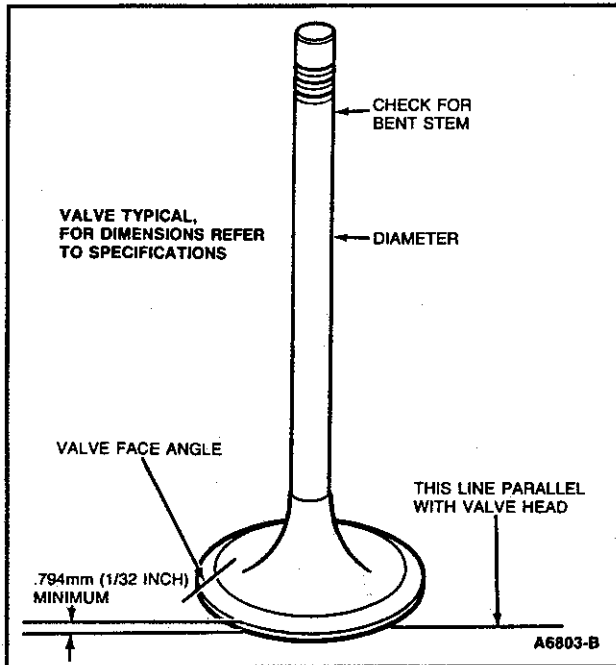


Figure 33 Critical Valve Dimensions

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

Select Fitting Valves

If the valve stem-to-valve guide clearance exceeds the service limit, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.003, 0.015, and 0.030 inch are available for service. **Always reface the valve seat after the valve guide has been reamed. Refer to Reaming Valve Guides.**

CAMSHAFT REPAIR

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone.

CRANKSHAFT

Dress minor scores with an oil stone. If the journals are severely marred or exceed the service limit, refinish them to size for the next undersize bearing.

Crankshaft Journals Refinishing

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 original journal shoulder radius. 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.

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, 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, position a jack under counterweight adjoining bearing which is being checked. **Do not place jack under front post of crankshaft.** Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.
3. Place a piece of Plastigage or equivalent on bearing surface across full width of bearing cap and about 6.35mm (1/4 inch) off center (Figure 34).
4. Install cap and tighten bolts to specifications. Refer to specific engine Section. 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 journal.
6. If clearance exceeds specified limits, try a 0.001 or 0.002 inch undersize bearing in combination with the standard bearing. Bearing clearance must be within specified limits. If 0.002 inch undersize main bearings are used on more than one journal, be sure they are all installed in cylinder block side of bearing. If standard and 0.002 inch undersize bearing does 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. Tighten cap bolts to specifications. Refer to Specifications Section.

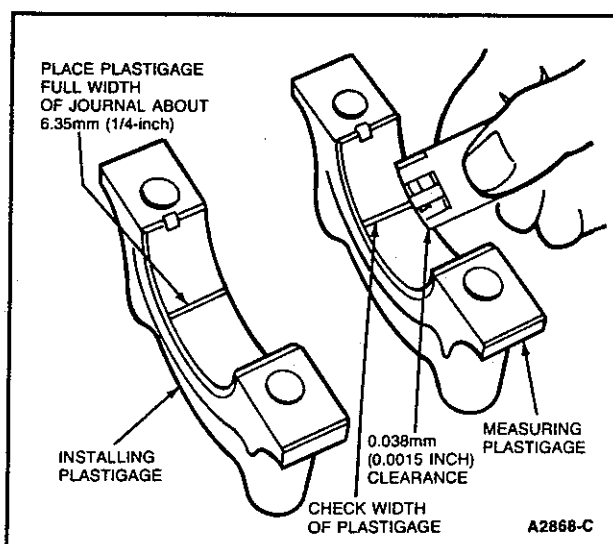


Figure 34 Installing and Measuring Plastigage — Engine Installed

8. Repeat procedures for remaining bearings that require replacement.

PISTONS, PINS AND RINGS

Fitting Pistons

Pistons are available in standard size or oversize for service. Refer to the Ford Parts Master Catalog for available oversize pistons.

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

NOTE: Cylinder bore must be clean and dry, and engine block must remain at room temperature for eight hours before taking cylinder measurements.

Measure the cylinder bore using an accurate cylinder micrometer gauge, such as Cylinder Bore Micrometer or equivalent. Refer to Figure 35.

Each cylinder must be checked for out-of-round conditions prior to fitting the piston. (Out-of-round is the difference between the two bore measurements of each cylinder — taken parallel and perpendicular to the centerline of the crankshaft.) Refer to Figure 36.

These measurements must be performed at the top, middle, and bottom of the ring travel area of the cylinder bore. Refer to Figure 37.

Each cylinder bore must be checked for excessive taper before fitting the piston. (Taper is defined as the difference between two bore diameters measured at the top and bottom of the cylinder bore ring travel area.) Both measurements must be made perpendicular to the crankshaft centerline.

Refer to the Specifications. This listing includes maximum allowable service limits for differences in the two measurements for out-of-round cylinder bore. This listing also provides maximum allowable service limits for differences in the two measurements for excessive cylinder bore taper. If beyond allowable service limits for taper and/or out-of-round dimensions, the cylinder must be rebored and/or honed to comply with piston clearance and fit requirements.

If the cylinder bore is within the acceptable limits for out-of-round and taper, the proper piston can be selected. The proper service piston is determined by measuring perpendicular to the crankshaft centerline at the middle of the ring travel area. Refer to Figure 36. Repeat the measurement three times and divide the sum of the three diameters by three to determine the average dimension.

Average Dimension = $\text{Dimension No. 1} + \text{Dimension No. 2} + \text{Dimension No. 3}$

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. Refer to Cylinder Block, Refinishing Cylinder Walls. Be sure to clean the cylinder bore thoroughly with soap and water.**

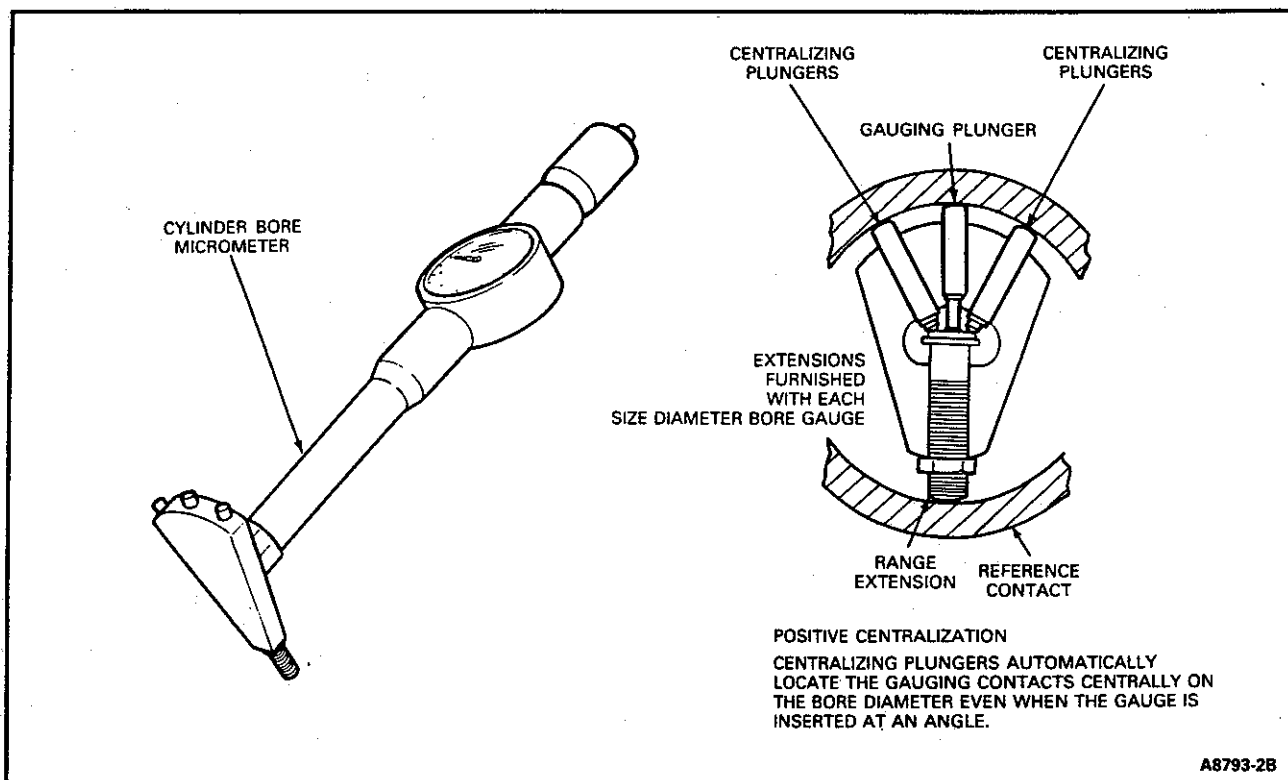


Figure 35 Cylinder Bore Micrometer

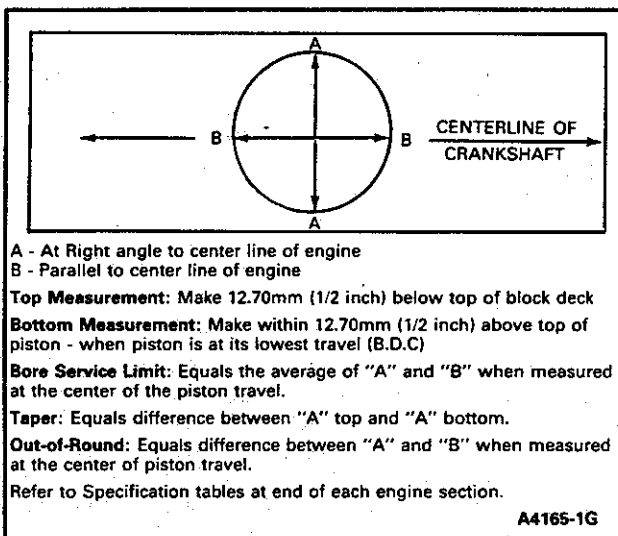


Figure 36 Cylinder Bore Measurement

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 Specifications section. Measure the piston diameter in line with the centerline of the piston pin and at 90 degrees to the piston pin axis.
3. Ensure the piston and cylinder block are at room temperature (21.1°C or 70°F). After any refinishing and washing operation allow the cylinder bore to cool. Ensure the piston and bore are clean and dry before the piston fit is checked.

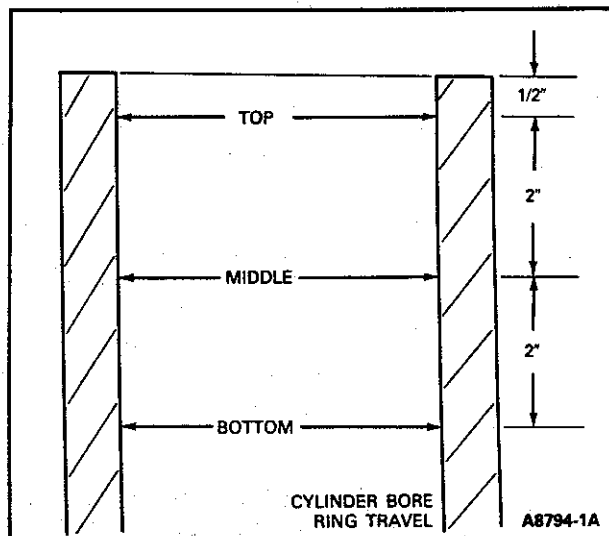


Figure 37 Cylinder Bore Travel Measurement

Fitting 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 (Figure 38). Ring gap in a worn cylinder is normally greater than specification. If the ring gap is 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 according to specification Section (Figure 39). 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 must be replaced.

Fitting Piston Pins

Install the piston pin following the procedure under Piston Assembly in the applicable Section.

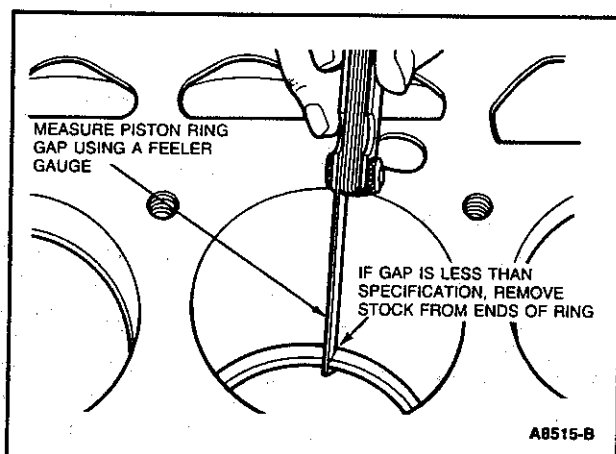


Figure 38 Piston Ring Gap Check

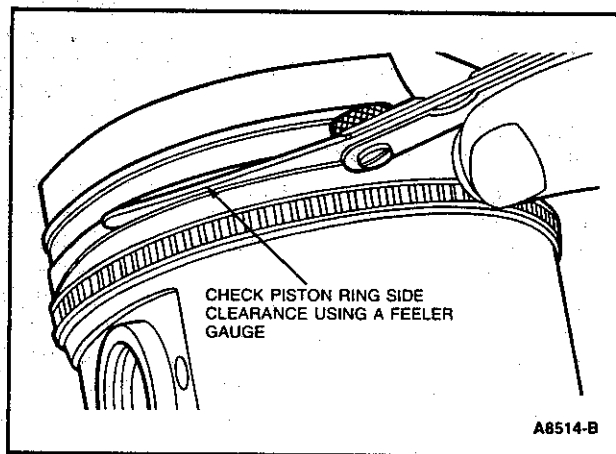


Figure 39 Piston Side Clearance Check

CYLINDER BLOCK

Refinishing Cylinder Walls

Honing is recommended for refinishing cylinder walls only when there is no visible sign of

cross hatching (hone pattern) remaining, when the walls have minor scuffs or scratches, 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. Thoroughly clean the cylinder bore walls with detergent and water solution after honing.

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 specification, so that the crankshaft bearing bores will not become distorted from the refinishing operation. Refer to the specifications Section.**

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 0.04mm (0.0015 inch) of the required oversized 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 technicians 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. 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 as 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 the cylinder walls with detergent and water solution, dry thoroughly 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 ENGINE CASTINGS WITH SAND HOLES OR POROSITY

Porosity or sand hole(s) causing oil seepage or leakage can occur with modern casting processes. A complete inspection of the engine 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 (Epoxy Resin) or an equivalent metallic plastic. **Do not repair cracks with this material. Repairs with this metallic plastic (Epoxy Resin) must be confined to those cast iron engine component surfaces (Figure 40) where the inner wall surface is not exposed to engine coolant pressure or oil pressure. For example:**

- 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.
- Lower rear face of the cylinder block.
- Intake manifold casting. Repairs are not recommended to the intake manifold exhaust crossover section since temperature can exceed the recommended temperature limit of metallic plastic (260°C or 500°F).

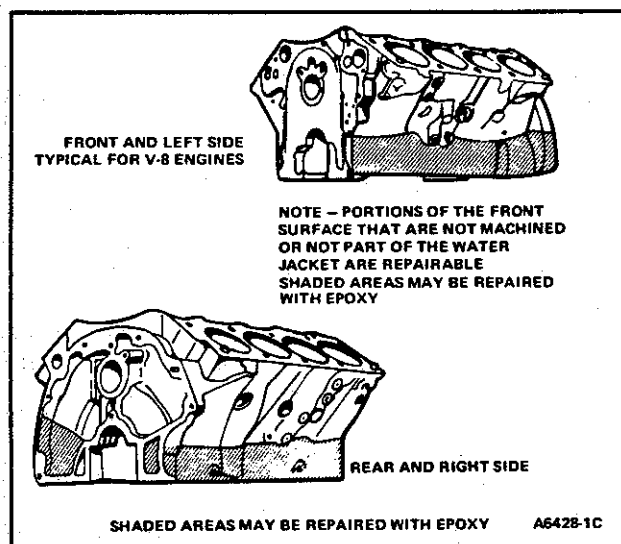


Figure 40 Typical Cast Iron Cylinder Block Areas Repairable with Metallic Plastic (Indicated by Shaded Areas)

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

The following procedures should be used to repair porous areas or sand holes in cast iron:

- 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 6.35mm (1/4 inch) should not be repaired using metallic plastic (Epoxy Resin). Openings in excess of 6.35mm (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.

- Mix the Epoxy Resin base and hardener as directed on the container. Stir thoroughly until uniform.
- Apply the repair mixture with a suitable clean tool (putty knife, wood spoon, etc.), forcing the metallic plastic into the hole or porosity.
- Allow the repair mixture to harden. This can be accomplished by two methods: heat cure with a 250-watt lamp placed 254mm (10 inches) from the repaired surface, as directed on the package label, or air dry for 10-12 hours at temperatures above 10°C (50°F).
- Sand or grind the repaired area to blend with the general contour of the surrounding surface.
- Paint the surface to match the rest of the block.

ADJUSTMENTS

VALVE CLEARANCE

The valve arrangement of the LH bank is E-I-E-I-E-I-E-I and on the RH bank is I-E-I-E-I-E-I-E.

A 1.52mm (0.060 inch) shorter push rod or a 1.52mm (0.060 inch) longer push rod is available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List.

Valve stem-to-valve rocker arm clearance should be within specifications with the hydraulic tappet completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if it is not compensated for, the hydraulic valve tappet will cease to function and the valve will be held open.

The use of positive stop rocker arm bolts eliminates the need to adjust the valve clearance. However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and tightened properly. On older model engines with positive stop studs, each stud nut should be removed and inspected for conditions shown in Figure 41 when adjusting valve clearance.

To determine whether a shorter or a longer push rod is necessary, make the following check.

- Install an auxiliary starter switch. Crank the engine with the ignition switch in OFF position until the No. 1 piston is on TDC after the compression stroke.
- Position the tappet compressor Tappet Bleed Down Wrench or equivalent on the rocker arm (Figure 41).

3. Slowly apply pressure to bleed down the tappet until the plunger is completely bottomed (Figure 41). Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip of #1 intake and exhaust valve with a feeler gauge.
4. Rotate the crankshaft 90° (in the direction of engine rotation) and measure the next two valves in the engine's firing order sequence. Repeat the procedure until all valves have been checked.
5. If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.

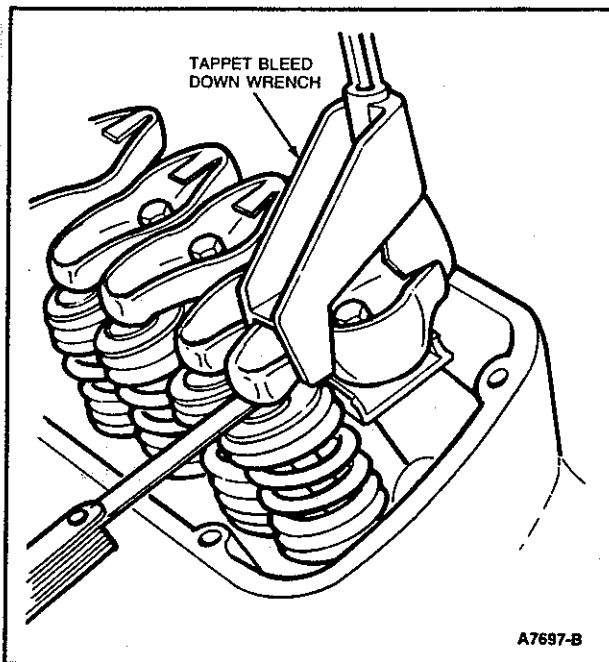


Figure 41 Checking Valve Clearance — Hydraulic Valve Tappets

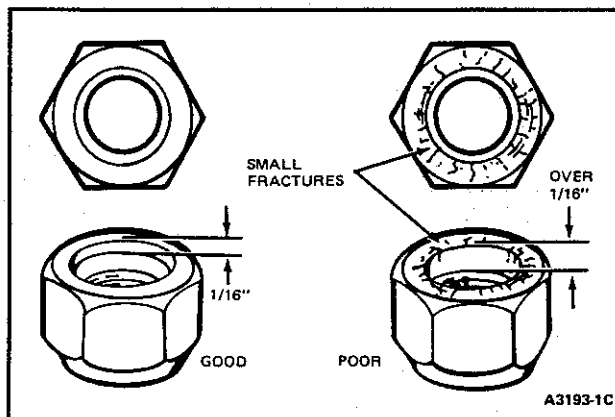


Figure 42 Inspection of Rocker Arm Stud Nut (If Applicable)

REMOVAL AND INSTALLATION CRANKCASE VENTILATION SYSTEM

The positive closed-type crankcase ventilation system components are shown in Figure 43.

Removal

1. Remove ventilation system air intake hose from air cleaner and the right valve cover.
2. Remove air cleaner.
3. Disconnect the crankcase vent hose from the carburetor spacer.
4. Pull the regulator valve out of the oil filler cap in the left valve cover.

Installation

1. Insert the regulator valve into the oil filler cap on the left valve cover.
2. Connect the vent hose to the regulator valve; install the hose on the carburetor spacer.
3. Install the air cleaner.
4. Install the ventilation system air intake hose to the air cleaner and right valve cover fitting.
5. Start the engine and check for leaks.

VALVE ROCKER ARM COVER AND ROCKER ARM

Two types of rocker arm assemblies may be found on the engine. Prior to 1978, the cast rocker was used (Figure 44). Present engines use a stamped rocker (Figure 45).

Removal

1. To remove a valve rocker arm from the right cylinder head, disconnect the automatic choke heat chamber air inlet hose from the inlet tube near the right valve rocker arm cover, if so equipped (302 only).

Remove the air cleaner.

Remove the automatic choke heat tube (302 only). Remove the crankcase ventilation fresh air tube from the valve rocker arm cover.

2. Disconnect the spark plug wires from the spark plugs using correct Tool. Do not pull on wire. Remove the wires from the bracket on the valve rocker arm cover(s) and position the wires out of the way.
3. On a left side rocker arm cover, remove the wire harness from the retaining clips. Remove the valve rocker arm cover attaching bolts and remove the cover.
4. Remove the valve rocker arm attaching bolt or nut, fulcrum or fulcrum seat and rocker arm.

If removal of the rocker arm stud is necessary, refer to the procedure under Cylinder Head Repairs.

Installation

All rocker arms and fulcrum are to be lubricated with heavy SF engine oil before installation.

1. Apply Lubriplate, or equivalent, to the top of the valve stem and underside of the fulcrum or fulcrum seat.

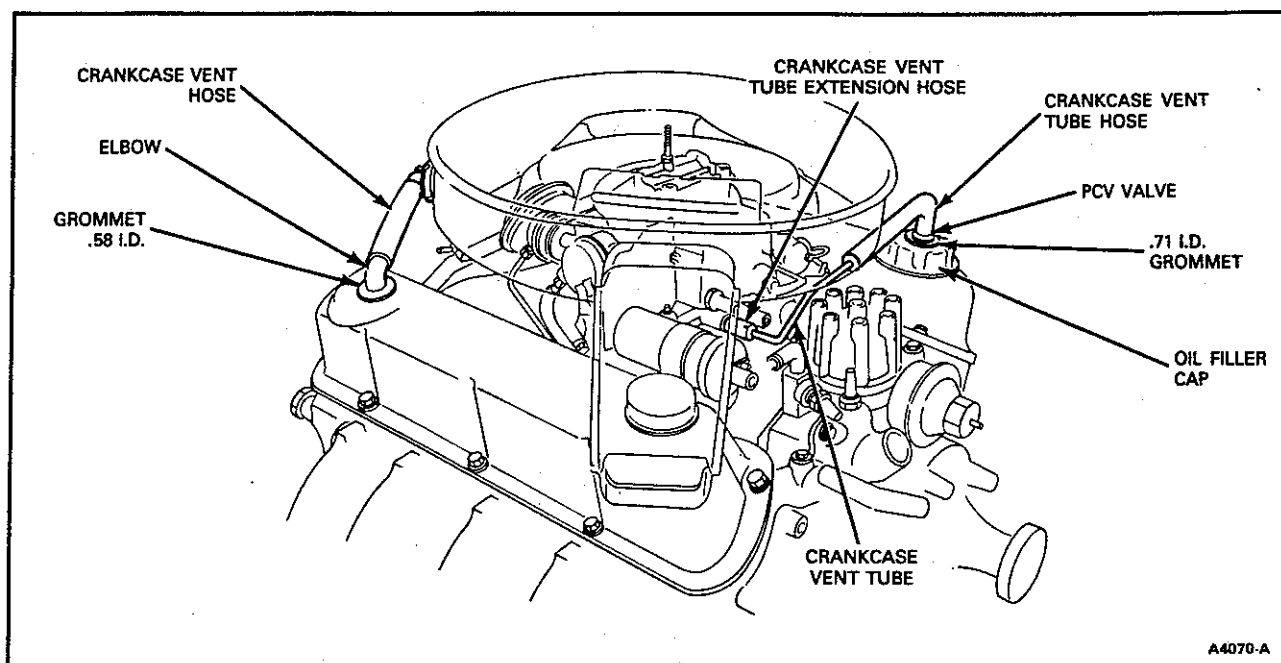


Figure 43 Typical Crankcase Ventilation System Components

2. Install the rocker arm, fulcrum or fulcrum seat and attaching bolt or nut.
3. Clean the valve rocker arm cover(s) and the cylinder head gasket surface(s). Position the valve rocker cover gasket in each cover, making sure that the tabs engage the notches in the cover.
4. Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts and wire loom clips on left hand cover. The cover is tightened in two steps. Torque the bolts to specifications.

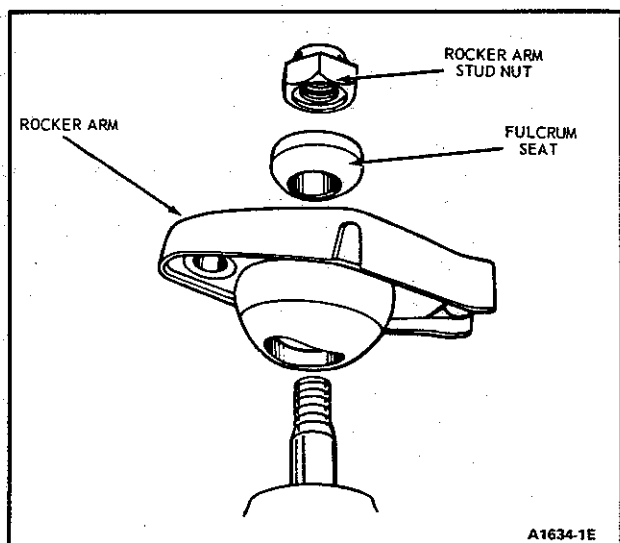


Figure 44 Valve Rocker Arm Assembly

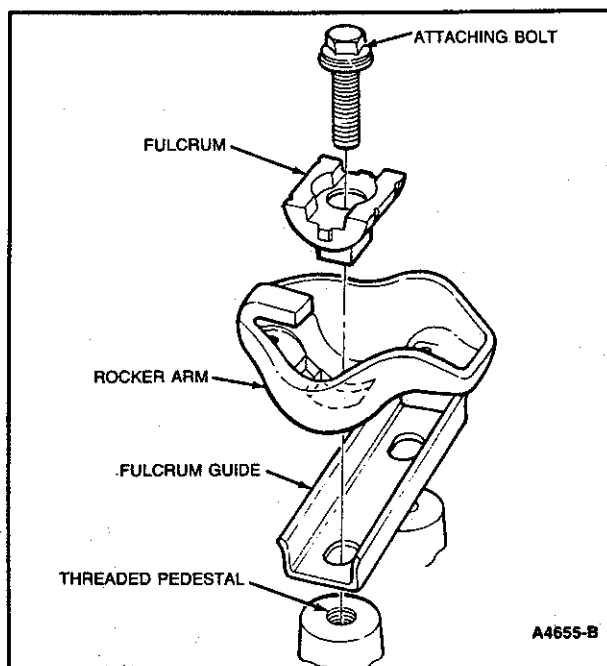


Figure 45 Valve Rocker Arm Assembly (Stamped)

Two minutes later, torque the bolts to the same specifications.

Install the crankcase ventilation hoses in the covers. Install the automatic choke heat tube and connect the automatic choke heat chamber air inlet hose at the air cleaner.

5. Install the spark plug wires in the bracket on the valve rocker arm cover(s). Connect the spark plug wires. Install the air cleaner.

VALVE SPRING, RETAINER AND STEM SEAL

Removal

Broken valve springs or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred.

1. Refer to Valve Rocker Arm Cover in this section for the cover removal and installation.
2. Remove the applicable spark plug and bring the piston to the top of the bore to prevent accidental loss of the valve into the cylinder.
3. Remove the valve rocker arms and push rods from the applicable cylinder. Remove the exhaust valve stem cap (if applicable).
4. Install an air line with an adapter in spark plug hole and apply air pressure to the cylinder. Failure of the air pressure to hold the valve(s) in the closed position is an indication of valve seat damage and required removal of the cylinder head.
5. Install the stud nut and position the compressor tool as shown in Figure 46. Compress the valve spring and remove the retainer locks, spring retainer, sleeve and valve spring.
6. Remove and discard the valve stem seal (Figure 47).
7. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.
8. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head for repairs.

Installation

1. If the condition of the valve proved satisfactory, lubricate the valve stem with heavy engine oil SF. Hold the valve in the closed position and apply air pressure within the cylinder.

2. Install a new valve stem seal (Figure 47). Place the spring in position over the valve and install the valve spring retainer and sleeve. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and stud nut.

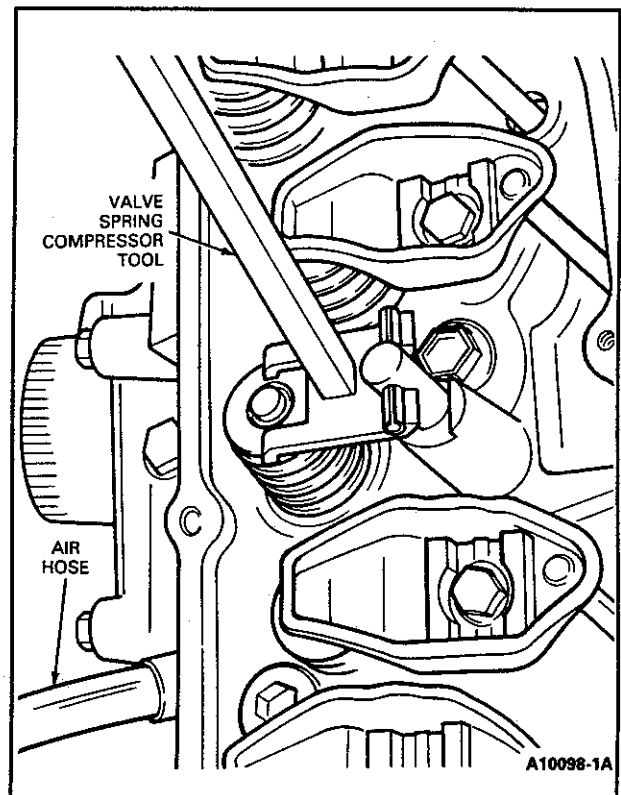


Figure 46 Compressing Valve Spring

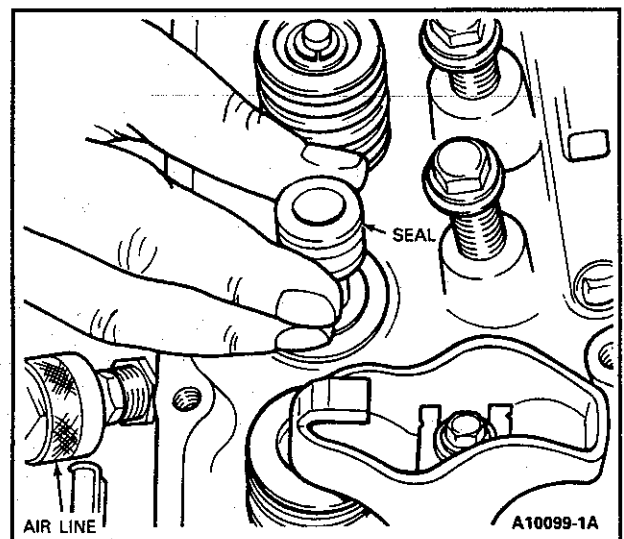


Figure 47 Removing or Installing Valve Stem Seal

3. Lubricate the push rod ends with Lubriplate or equivalent and install the push rod. Apply Lubriplate or equivalent to the tip of the valve stem. Install the exhaust valve stem cap.
4. Apply Lubriplate or equivalent to the rocker arms and fulcrum seats. Install the valve rocker arm assemblies.
5. Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
6. Clean and install the rocker arm cover.

INTAKE MANIFOLD

The intake manifold assembly is shown in Figure 48.

Removal

1. Drain cooling system. Remove air cleaner, including the crankcase ventilation hose.
2. Disconnect the throttle rod and choke cable from the carburetor. Remove the throttle retracting spring.
3. Disconnect the high-tension lead and wires from the coil.
4. Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the moulded cap using correct Tool. Remove the wires from the harness brackets on the valve rocker arm covers. Remove the distributor cap and spark plug wires as an assembly.
5. Remove the carburetor fuel inlet line.
6. Disconnect the distributor vacuum hose from the distributor. Remove the distributor hold down bolt and remove the distributor.
7. Disconnect the radiator upper hose from the coolant outlet housing.
8. Loosen the clamp on the water pump by-pass hose at the coolant outlet housing and slide the hose off the outlet housing.
9. Disconnect the crankcase vent hose at the valve rocker arm cover.
10. Remove the intake manifold and carburetor as an assembly. **It may be necessary to pry the intake manifold away from the cylinder heads. Remove the intake manifold gaskets and seals. Discard the intake manifold attaching bolt sealing washers.**
11. If the manifold assembly is to be disassembled, identify all vacuum hoses before disconnecting them. Remove the coolant outlet housing gasket and thermostat. Remove the carburetor, spacer, gasket, vacuum fitting, accelerator retracting spring bracket and choke cable bracket.

Installation

1. If intake manifold assembly was disassembled, install the temperature sending unit (threads coated with electrical

conductive sealer), ignition and coil, carburetor, spacer, gaskets, vacuum fittings, throttle retracting spring bracket and choke cable bracket. Install the coolant outlet housing.

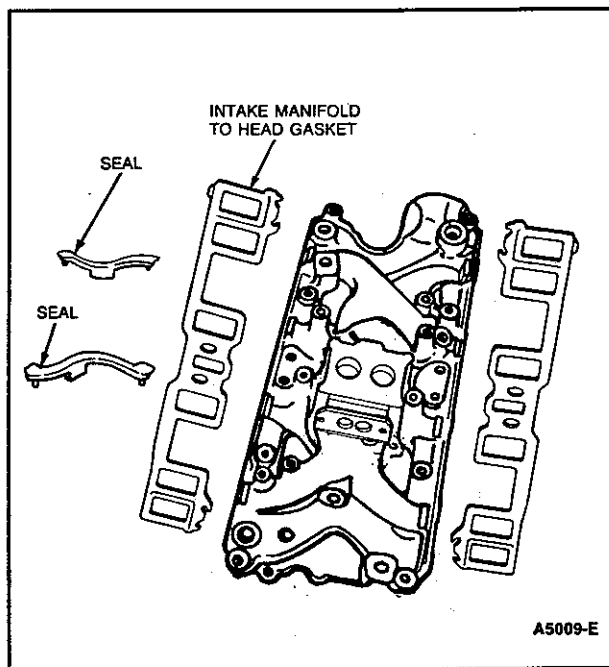


Figure 48 Intake Manifold Assembly

2. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block using a solvent such as Ford Spot Remover or equivalent. Apply a 1/8 inch bead of RTV sealer (or B) at the points shown in Figure 49.
3. Apply a 1/16 inch bead of RTV sealer to the outer end of each intake manifold seal for the full width of the seal (4 places). See Figure 49.

NOTE: This sealer sets-up in 15 minutes, so it is important that assembly be completed promptly. Do not drip any sealer into the engine valley. Position the seals on the cylinder block and new gaskets on the cylinder heads with the gaskets interlocked with the seal tabs. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.

4. Carefully lower intake manifold into position on the cylinder block and cylinder heads. **After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If the seals are not in place, remove the intake manifold and position the seals.**
5. Be sure the holes in the manifold gaskets and manifold are in alignment. Install the intake manifold attaching nuts and bolts. Tighten the nuts and bolts in two steps (Figure 50). Tighten all nuts and bolts in sequence to specifications.

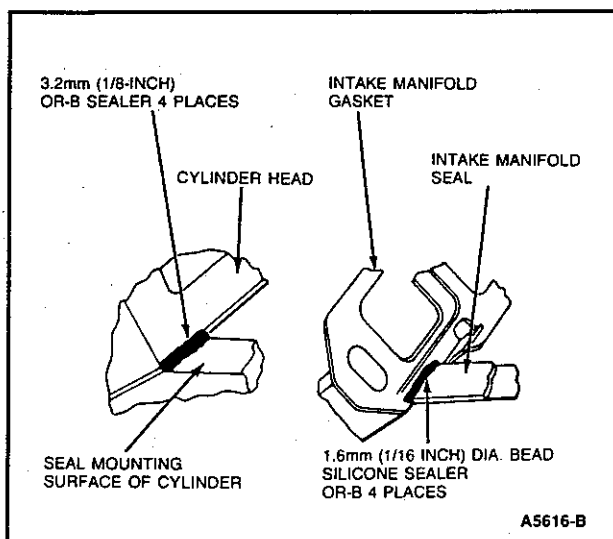


Figure 49 RTV Sealer Installation Intake Manifold

After completing the remaining assembly steps, operate the engine until it reaches normal operating temperature, then retighten the manifold nuts and bolts in sequence to specifications.

6. Install water pump by-pass hose on the coolant outlet housing. Slide the clamp into position and tighten the clamp.
7. Connect the radiator upper hose.
8. Install the carburetor fuel inlet line.
9. Rotate the crankshaft damper until the No. 1 piston is on TDC at the end of the compression stroke. Position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the holddown clamp.
10. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the plugs.
11. Connect crankcase vent hose. Connect the high-tension lead and coil wires.
12. Connect the accelerator rod and retracting spring. Connect the choke cable.
13. Fill and bleed the cooling system.
14. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses to the distributor.
15. Operate the engine at fast idle and check all hose connections and gaskets for leaks. Operate the engine until engine temperatures have stabilized and adjust the engine idle speed and idle fuel mixture. Retighten the intake manifold bolts to specifications.
16. Adjust the throttle linkage. Install the air cleaner and intake duct assembly, including the closed crankcase ventilation hose.

VALVE LIFTER

Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improperly adjusted valve to rocker arm clearance or by worn rocker arms or push rods.

Removal

1. Remove the intake manifold and related parts following procedures given in Intake Manifold Removal.
2. Remove the valve rocker arm cover, then loosen the valve rocker arm bolt or nut and rotate the rocker arms to the side.
3. Remove the valve push rods in sequence so that they can be installed in their original positions.
4. Using correct Tool shown in Figure 51, remove the valve lifters and place them in a rack so that they can be installed in their original bores.

If necessary to disassemble a lifter, refer to Valve Lifter Disassembly and Assembly in this Part.

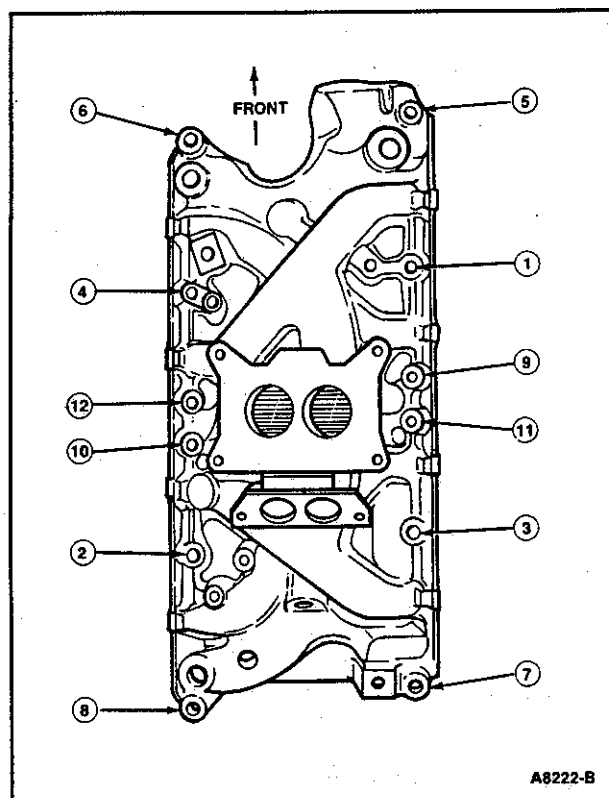


Figure 50 Intake Manifold Bolts Tightening Sequence — 302 CID and 351 W Engines

Installation

Valve lifters and bores are to be lubricated with heavy engine oil SF before installation.

1. Clean the external surfaces and install the valve lifters in the bores from which they were removed, using correct Tool. If a new lifter(s) is being installed, check the new lifter(s) for a free fit in the bore in which it is to be installed. Lubricate the lifter(s) and bore(s) with heavy engine oil before inserting the lifter.
2. Lubricate the ends of the push rods with Lubriplate or equivalent and install the push rods in their original positions. Apply Lubriplate or equivalent to the valve stem tip.
3. Lubricate the rocker arms and fulcrum seats with Lubriplate or equivalent and position the rocker arms over the push rods. Torque retaining bolts or nuts.
4. Install the valve rocker arm covers.
5. Install the intake manifold following instructions given under Intake Manifold Installation.

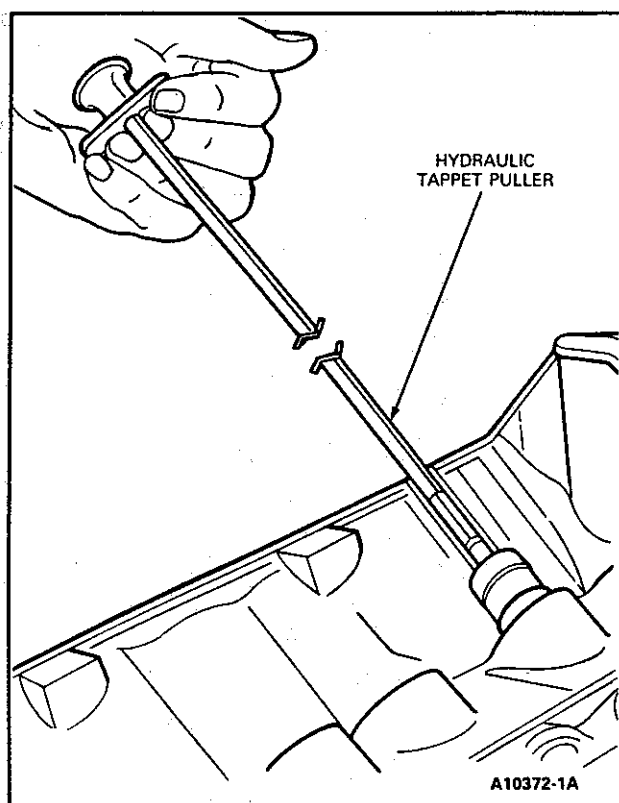


Figure 51 Removing Valve Lifter

CYLINDER HEADS

If a cylinder is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly in this Part, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, reface the valves and check all assembly clearances before assembling the new or used parts to the new cylinder head.

Removal

1. Remove the intake manifold and carburetor as an assembly, following the procedure under Intake Manifold Removal.
2. Remove the rocker arm cover(s).
3. If the right cylinder head is to be removed, loosen the alternator adjusting arm bolt and remove the alternator mounting bracket bolt and spacer. Swing the alternator down and out of the way.

Remove the air cleaner inlet duct from the right cylinder head assembly.

4. Loosen the rocker arm bolts or nuts so that the rocker arms can be rotated to the side. Remove the push rods in sequence (Figure 52) so that they may be installed in their original positions.
5. On 302 engines, remove the exhaust valve stem caps (if applicable).
6. Install the cylinder head holding fixtures. Remove the cylinder head attaching bolts and lift the cylinder head off the block. Remove and discard the cylinder head gasket.

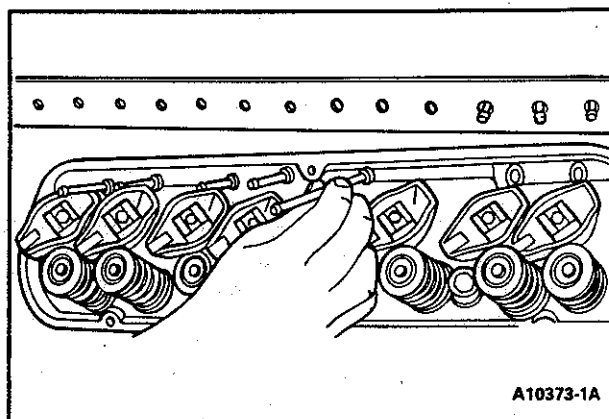


Figure 52 Removing Valve Push Rods

Installation

1. Clean the cylinder head, intake manifold, valve rocker arm cover and cylinder head gasket surfaces. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces.
2. On 302 and 351 V-8 engines, a specially treated composition gasket is used. **Do not apply sealer to a composition gasket. Position the new cylinder head gasket over the cylinder dowels on the block. Position the cylinder head on the block and install the attaching bolts. Remove the holding fixtures.**

3. The cylinder head bolts are tightened in two or three progressive steps. Tighten all the bolts in sequence (Figure 53) to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retighten the bolts after extended operation. However, the bolts may be checked and retightened if desired.
 4. Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air. Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Visually check the push rods for straightness or check push rod runout with a dial indicator. If runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**
 5. Lubricate the end of the push rods with Lubriplate or equivalent and install them in their original positions. Apply Lubriplate or equivalent to the valve stem tips. Install the exhaust valve stem cap on 302 engines (if used).
 6. Lubricate the rocker arms and fulcrum seats with Lubriplate or equivalent, then install the rocker arms.
 7. Position a new gasket(s) on the exhaust pipe(s). Tighten the nuts to specifications.
 8. If the right cylinder head was removed, swing the alternator into position and install the alternator attaching bolt, spacer, and air cleaner inlet duct on the right cylinder head. Adjust the drive belt tension to specifications.
- If the left cylinder head was removed, install the accelerator shaft assembly at the front of the cylinder head.
9. Clean the valve rocker arm cover and cylinder head gasket surfaces. Place the new gaskets in the covers making sure that the tabs of the gasket engage the notches provided in the cover. Install the valve rocker arm cover(s).
 10. Install the intake manifold and related parts, following the procedure under Intake Manifold Installation.

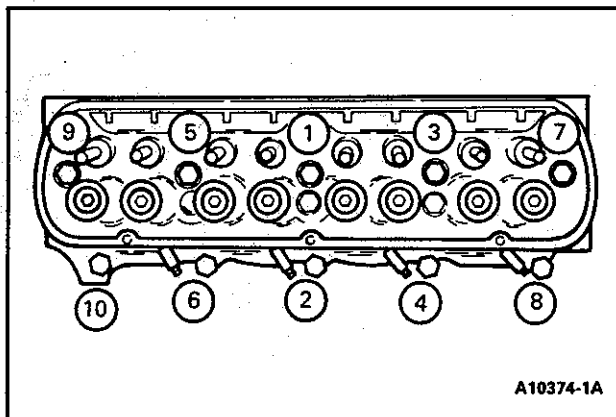


Figure 53 Cylinder Head Bolt Tightening Sequence

EXHAUST MANIFOLDS

Removal

1. Remove air cleaner and intake duct assembly, including the crankcase ventilation hose.
2. Remove the oil dipstick tube bracket on right exhaust manifold.
3. Disconnect exhaust manifold(s) from inlet pipe(s).
4. Remove the exhaust manifold.

Installation

1. Clean the mating surfaces of the exhaust manifold(s) and cylinder head(s). Clean the mounting flange of the exhaust manifold(s).
2. Position the exhaust manifold(s) on the cylinder head(s) and install the attaching bolts and flat washers. Working from the center to the ends, tighten the bolts to specifications.
3. Place a new gasket(s) on the exhaust pipe(s). Position the exhaust pipe(s) into the manifold(s). Install and tighten the attaching nuts to specifications.
4. Position the oil dipstick tube bracket on the right exhaust manifold. Install and tighten attaching bolts to specifications.
5. Install air cleaner and intake duct assembly, including the crankcase ventilation hose.

WATER PUMP

Removal

1. Drain the cooling system.
Remove the fan and spacer from the water pump shaft.
2. Remove the alternator drive belt.
Remove all accessory brackets which attach to the water pump.
Remove the water pump pulley.
3. Disconnect the radiator lower hose and water pump bypass hose at the water pump.
4. Remove the bolts that attach the pump to the cylinder front cover.
Remove the pump and gasket.
Discard the gasket.

Installation

1. Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.
2. Position a new gasket, coated on both sides with sealer, on the cylinder front cover; then install the pump.
3. Install the attaching bolts and torque them to specifications.
4. Connect the radiator hose, and water pump bypass hose at the water pump.

5. Install all the accessory brackets which attach to the water pump. Place the water pump pulley on the water pump shaft.
6. Install the alternator and drive belt.
7. Install the spacer or fan drive clutch and fan. Adjust the drive belts to the specified belt tension.
8. Fill and bleed the cooling system. Operate the engine until normal operating temperatures have been reached and check for leaks.

CYLINDER FRONT COVER AND TIMING CHAIN

Removal

1. Refer to Water Pump Removal. Perform all steps except removal of the pump. Leave it attached to the front cover.
2. Drain the crankcase.
3. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper (Figure 54) and remove the vibration damper.
4. Disconnect the fuel pump outlet line from the fuel pump. Remove the fuel pump attaching bolts and lay the pump to one side with the flexible fuel line still attached.
5. Remove the oil level dipstick.
6. Remove the oil pan to cylinder front cover attaching bolts. Use a thin blade knife to cut the oil pan gasket flush with cylinder block face prior to separating the cover from the cylinder block. Remove the cylinder front cover and water pump as an assembly.

If a new cylinder front cover is to be installed, remove the water pump and dipstick tube from the old cylinder front cover and install them on the new cover.

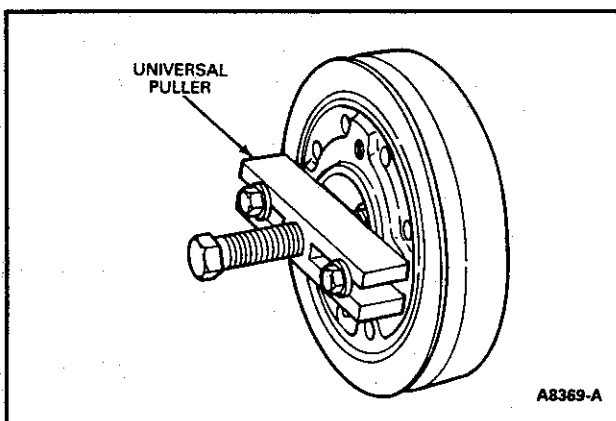


Figure 54 Removing Crankshaft Vibration Damper

7. Discard the cylinder front cover gasket. Remove the crankshaft front oil slinger.
8. Check the timing chain deflection.

9. Crank the engine until the timing marks on the sprockets are positioned as shown in Figure 55.
10. Remove the camshaft sprocket cap screw, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly (Figure 56).

Installation

1. Position the sprockets and timing chain on the camshaft and crankshaft simultaneously (Figure 56). Be sure the timing marks on the sprockets are positioned as shown in Figure 55.
2. Install the fuel pump eccentric, washers and camshaft sprocket cap screw. Torque the sprocket cap screw to specifications (Figure 57).
3. Clean the cylinder front cover, oil pan and the block gasket surfaces.
4. Install a new oil seal in the cylinder front cover following the procedures under Front Oil Seal Removal and Installation.
5. Lubricate the timing chain with engine oil.
6. Coat the gasket surface of the oil pan with sealer, cut and position the required sections of a new gasket on the oil pan, apply sealer at the corners. Install pan seal as required.

Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.

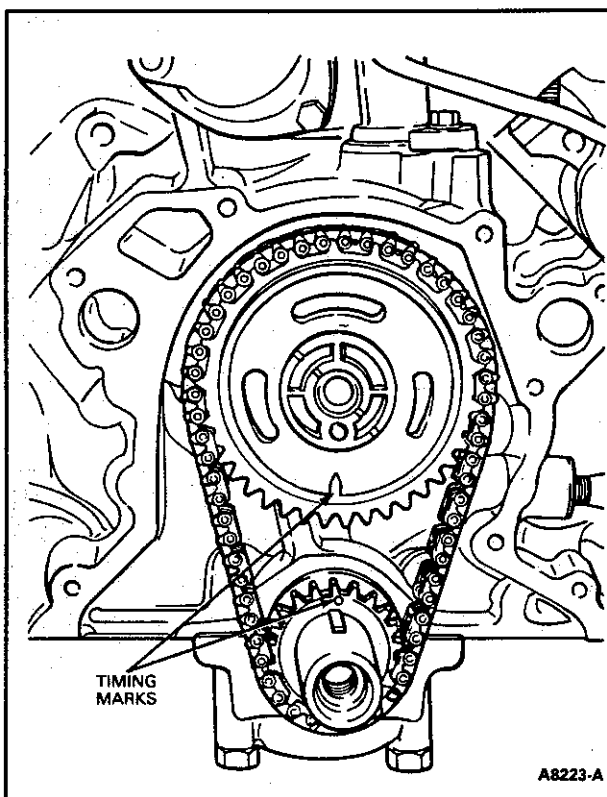


Figure 55 Aligning Timing Marks

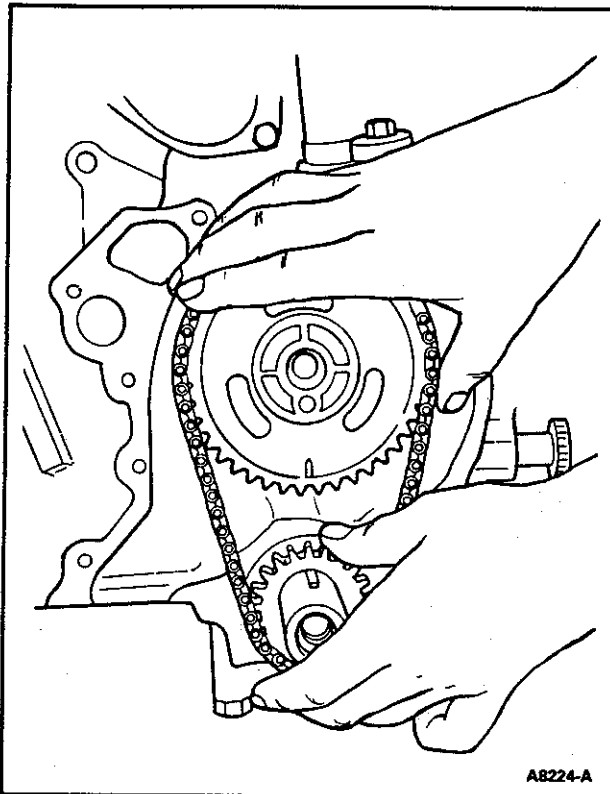


Figure 56 Timing Chain — Removal or Installation

7. Position the cylinder front cover on the cylinder block. Use care when installing the cover to avoid seal damage or possible gasket mislocation.
8. Install the cylinder front cover to seal alignment tool into proper position.
9. It may be necessary to force the cover downward to slightly compress the pan gasket. This operation can be facilitated by using a suitable tool at the front attaching hole locations.
10. Coat the threads of the attaching screws with oil resistant sealer and install the screws. While pushing in on the alignment tool, tighten the oil pan to cover attaching screws to specifications (Figure 58). Tighten the cover to block attaching screws to specifications. Remove the pilot.
11. Apply Lubriplate or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.
12. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft (Figure 59). Install the cap screw and washer. Tighten the screw to specifications. Install the crankshaft pulley.
13. Install the fuel pump using a new gasket. Connect the fuel pump outlet line.

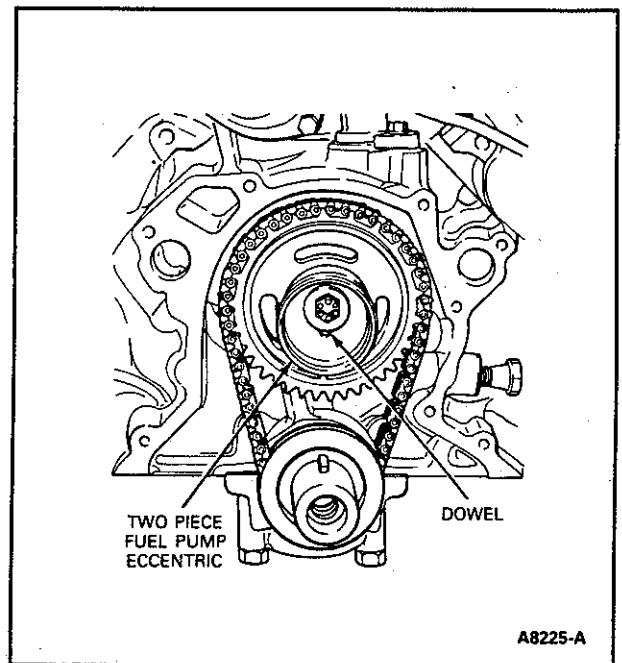


Figure 57 Fuel Pump Eccentric Installed

14. Install the oil level dipstick.
15. Refer to Water Pump Installation. Perform all the required steps except installation of the pump.
16. Fill the crankcase with the proper grade and quantity of engine oil.
17. Fill and bleed the cooling system.
18. Operate the engine at fast idle and check for coolant and oil leaks. Check and adjust the ignition timing.

FRONT OIL SEAL

1979 engines have the seal installed from the front. The front cover does not have to be removed to replace the seal.

Engines built prior to 1979 must use the following procedure.

Removal

1. Remove the cylinder front cover following the procedure under Cylinder Front Cover and Timing Chain Removal.
2. Drive out the old seal with the pin punch. Clean out the recess in the cover.

Installation

1. Coat a new seal with grease, then install the seal in the cover. Drive the seal in until it is fully seated in the recess (Figure 60). Check the seal after installation to be sure the spring is properly positioned in the seal.
2. Replace the cylinder front cover following the procedure under Cylinder Front Cover and Timing Chain Installation.

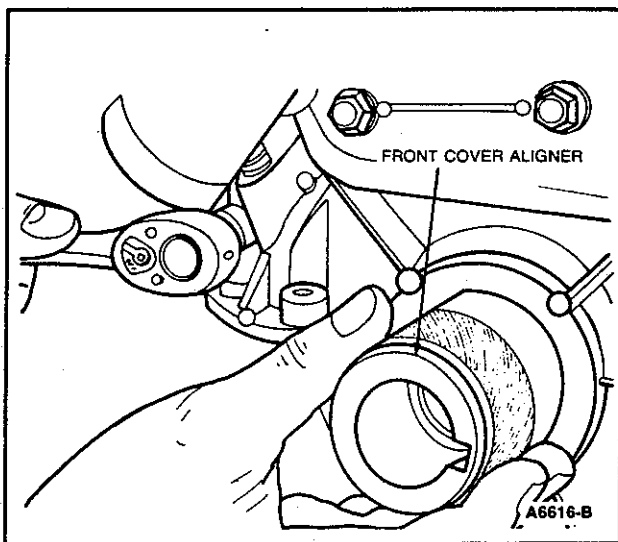


Figure 58 Cylinder Front Cover — Alignment

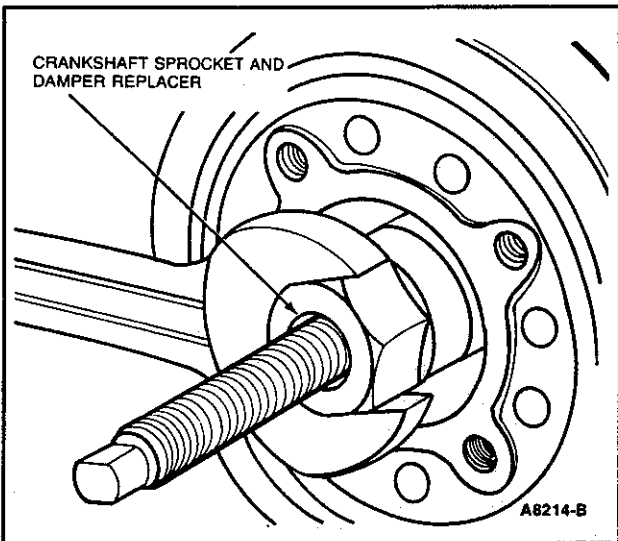


Figure 59 Crankshaft Vibration Damper Installation

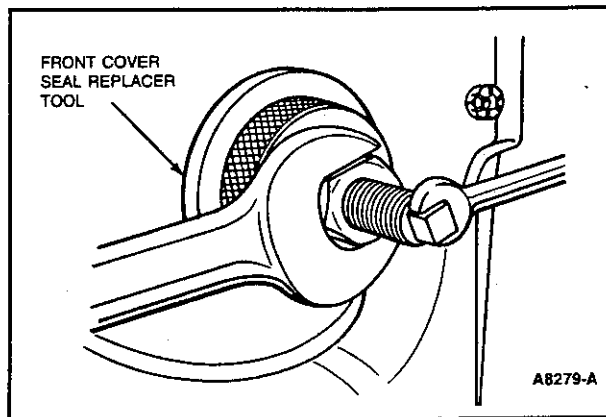


Figure 60 Crankshaft Seal — Front Installation

CORE PLUGS

Removal and Installation

To remove a large core plug, drill a 12.70mm (1/2-inch) hole in the center of the plug and remove with an Impact Slide Hammer or equivalent, or pry it out with a large drift punch. On a small core plug, drill a 6.35mm (1/4-inch) hole in the center of the plug and pry it out with a small pin punch. Clean and inspect the plug bore.

Prior to installing a core plug, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified over-size plug.

Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

Coat the plug and/or bore lightly with an oil-resistant (oil galley) sealer, Perfect Seal Sealing Compound or use equivalent sealer, and install it following the procedure for cup type or expansion type below.

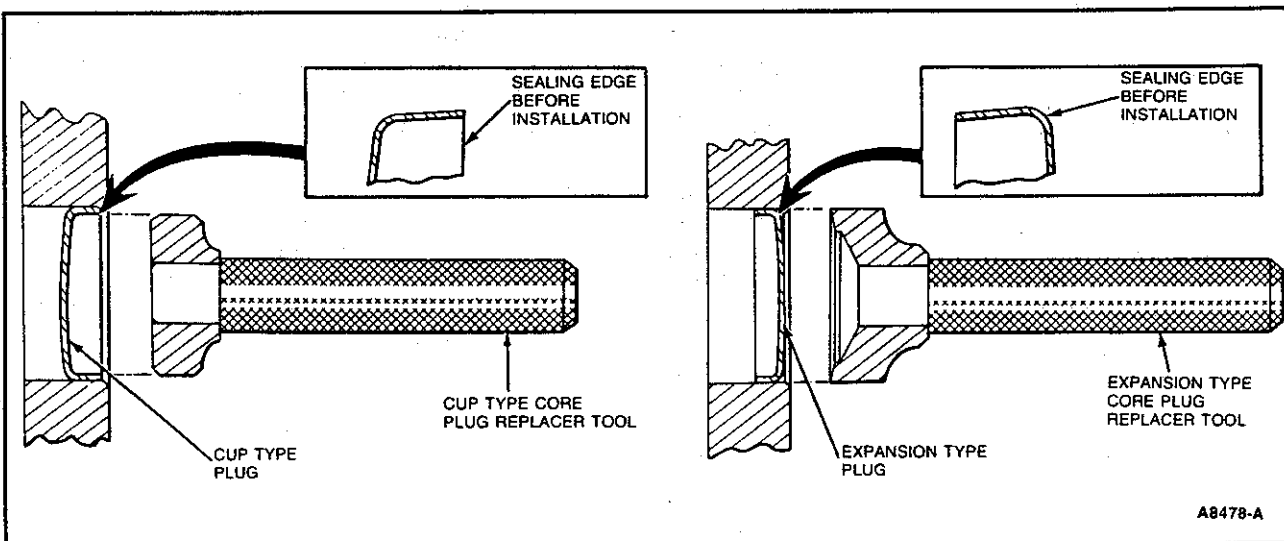


Figure 61 Typical Core Plugs and Installation Tools

CUP-TYPE

Cup-type core plugs (Figure 61) are installed with the flanged edge outward. The maximum diameter or sealing edge of this plug is located at the outer edge of the flange.

CAUTION: It is imperative to pull the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blowout.

The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

Expansion-Type

Expansion-type core plugs (Figure 61) are installed with the flanged edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

CAUTION: It is imperative to push or drive the plug into the machined bore using a properly designed tool. Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage the plug and/or plug bore.

When installed, the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

CAMSHAFT

The camshaft and related parts are shown in Figure 62.

Removal

1. Disconnect the upper and lower radiator hoses. Remove the radiator (if so equipped).
2. Remove the cylinder front cover and the timing chain following the procedure under Cylinder Front Cover and Timing Chain Removal.
3. Remove the intake manifold and related parts by following procedures under Intake Manifold Removal.
4. Remove the crankcase ventilation valve and tubes from the valve rocker arm covers. Remove the valve rocker arm covers. Loosen the valve rocker arm stud nuts and rotate the rocker arms to the side.

5. Remove the valve push rods and identify them so that they can be installed in their original positions.

6. Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Figure 50).

If necessary to disassemble a lifter, refer to Valve Lifter Disassembly and Assembly.

If the valve lifters are stuck in their bores by excessive varnish, etc., it may be necessary to use a plier-type tool or a claw type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

7. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling toward the front of the engine. **Use caution to avoid damaging the camshaft bearings.**

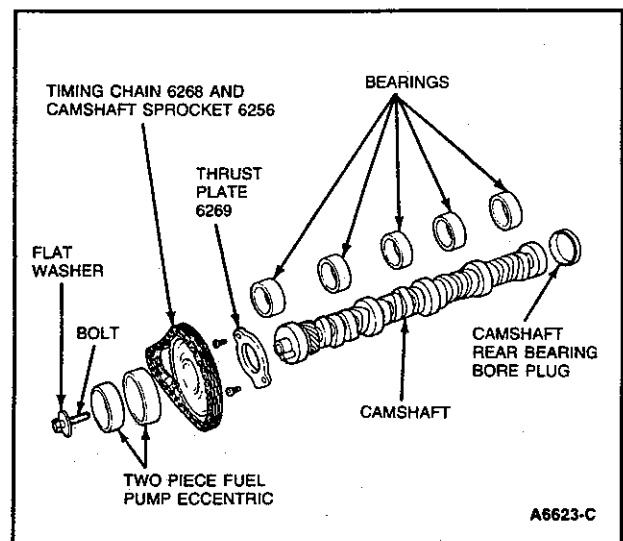


Figure 62 Camshaft and Related Parts

Installation

1. Oil the camshaft journals with heavy engine oil SF and apply Lubriplate or equivalent to the lobes. Carefully slide the camshaft through the bearings. Install camshaft thrust plate with groove towards the cylinder block. Check camshaft end play.
2. Lubricate the lifters and bores with heavy engine oil SF. Install the valve lifters in the bores from which they were removed.
3. Apply Lubriplate or equivalent to each end of the push rod and install the push rods in their original positions. Apply Lubriplate or equivalent to the valve stem tips. Lubricate the rocker arms and fulcrum seats with heavy engine oil SF. Position the rocker arms over the push rods.
4. Install the intake manifold and related parts by following procedures under Intake Manifold Installation.

5. Connect the throttle and retracting spring.
6. Position and connect the fuel line.
7. Replace the crankshaft front oil seal following procedures under Front Oil Seal Removal and Installation. Install the timing chain, cylinder front cover and related parts following procedures under Cylinder Front Cover and Timing Chain Installation.
8. Install the radiator and connect the upper and lower radiator hoses.
9. With No. 1 piston on TDC at the end of the compression stroke, position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the hold down clamp.
10. If any valve train components have been replaced, perform a Valve Clearance Adjustment as outlined under Hydraulic Valve Lifters.
11. Clean the valve rocker arm covers and the cylinder head gasket surface. Position the valve rocker cover gasket in each cover, making sure that the tabs engage the notches in the cover.
12. Position the covers on the cylinder heads. Make sure the gasket seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.
13. Clean and install the crankcase ventilation system.
14. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the plugs. Connect the high tension lead at the coil.
15. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.
16. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum line at the carburetor.
17. Operate the engine at fast idle and check all hoses, connections and gaskets for leaks. When the engine temperature has stabilized adjust the engine idle speed and idle fuel mixture. Retorque intake manifold bolts and nuts.
18. Adjust the throttle linkage. Install the air cleaner and intake duct assembly.
19. Connect the automatic choke heat chamber air inlet hose.

CAMSHAFT REAR BEARING BORE PLUG

Removal

1. Remove the transmission, clutch pressure plate and disc.

2. Remove the flywheel attaching bolts and remove the flywheel. Remove the engine rear cover plate.
3. Remove the bore plug.

Installation

1. Install the bore plug.
2. Coat the flywheel attaching bolts with oil-resistant sealer. Position the engine rear cover plate on the cylinder block dowels. Position the flywheel on the crankshaft flange. Install and torque the attaching bolts in sequence across from each other to specifications.

Install the clutch pressure plate, disc and the transmission.

CLUTCH PILOT BUSHING (IF SO EQUIPPED)

Removal

1. Remove the clutch pressure plate and disc.
2. Remove the pilot bushing.

Installation

1. A new clutch pilot bushing normally does not require lubrication. However, due to long storage periods, some of the lubricant pressed into the bushing in manufacture may be lost. It is therefore recommended that the new bushing be soaked in SAE-30 non-detergent engine oil for a minimum of one-half hour before installation. Wipe off all excess oil before installing. **Do not lubricate with grease of any kind.**
2. Install the pilot service bushing.
3. Install the clutch pressure plate, disc and the transmission.

OIL PUMP

Removal

1. Remove the oil pan and related parts as outlined under Oil Pan Removal.
2. Remove the oil pump inlet tube and screen assembly.
3. Remove the oil pump attaching bolts (Figure 63), and remove the oil pump gasket and intermediate drive shaft.

Installation

1. Prime the oil pump by the inlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.
2. Position the intermediate drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.

3. With the stop properly positioned, insert the intermediate drive shaft into the oil pump. Install the pump and shaft as an assembly. **Do not attempt to force the pump into position if it will not seat readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate drive shaft into a new position.** Tighten the oil pump attaching screws to specifications.
4. Clean and install the oil pump inlet tube and screen assembly.
5. Install the oil pan and related parts.

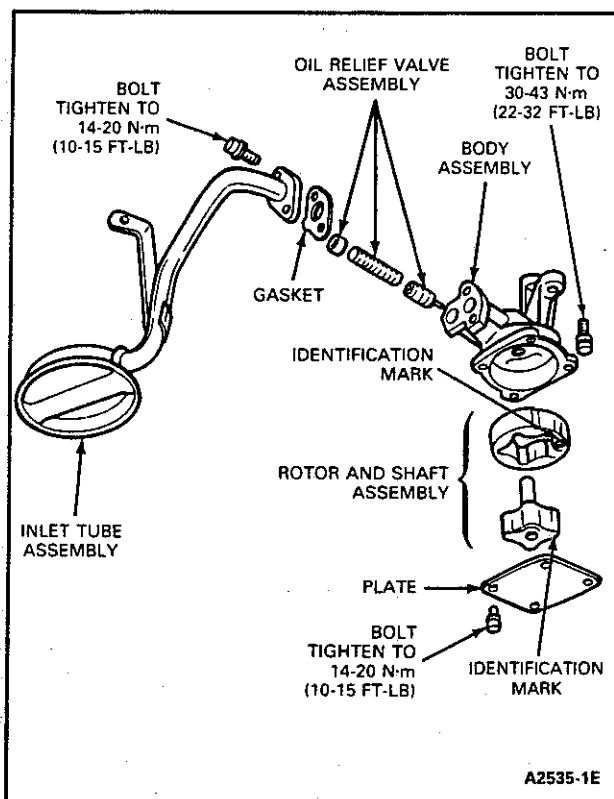


Figure 63 Oil Pump and Inlet Tube Installed

CRANKSHAFT REAR OIL SEAL — ONE-PIECE

The one-piece crankshaft rear oil seal is used on the 5.0L, 5.8L engines.

If the crankshaft rear oil seal replacement is the only operation being performed, it can be done in the vehicle as detailed in the following procedure. **If the oil seal is being replaced in conjunction with a rear main bearing replacement, the engine must be removed from the vehicle and installed on a work stand.**

Removal 5.0L and 5.8L

1. Remove the starter.
2. Remove the transmission.
3. On a manual-shift transmission, remove the pressure plate and cover assembly and the clutch disc.

4. Remove the flywheel attaching bolts and remove the flywheel and engine rear cover plate.

Using a sharp awl, punch one hole into the seal metal surface between the lip and block. Screw in the threaded end of Jet Plug Puller or equivalent. Use the plug puller to remove the seal. Use caution to avoid scratching or damaging the oil seal surface.

5. Clean the oil seal recess in the cylinder block and main bearing cap.

Installation 5.0L

1. Lubricate seal with engine oil.
2. Position oil seal on Rear Oil Seal Installer or equivalent. Position tool and seal on the rear of the engine. Alternate bolt tightening to properly seat the seal. (Two bolts are supplied with Rear Oil Seal Installer or equivalent. Engine flywheel bolts may also be used.) (Figure 64)

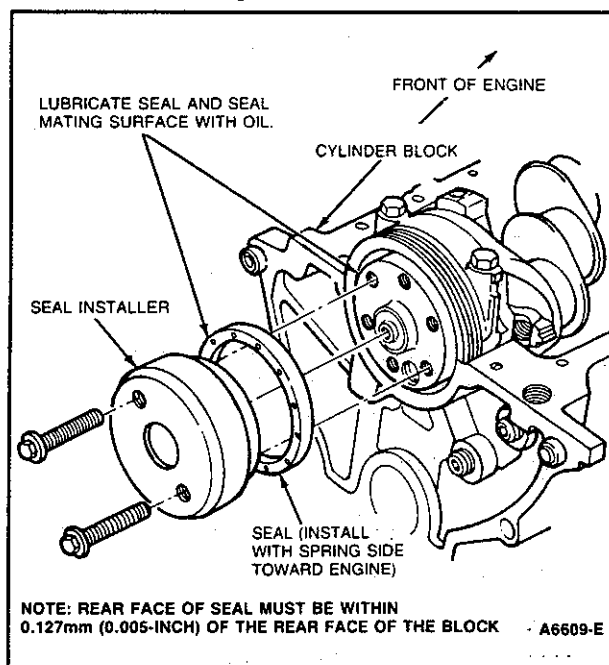


Figure 64 Oil Seal Installation, Rear — One Piece Seal — Typical

Installation 5.8L

1. Clean, inspect, and polish the rear oil seal rubbing surface on the crankshaft, if necessary.

Coat a new oil seal and the crankshaft with a light film of engine oil. Start the seal in the recess with the seal lip facing forward and install it with the Rear Oil Seal Replacer Tool or equivalent, as shown in Figure 65. Keep the tool straight with the centerline of the crankshaft and install the seal until the tool contacts the cylinder block surface.

Remove the tool and inspect the seal to ensure it was not damaged during installation.

2. Install the engine rear cover plate. Position the flywheel on the crankshaft flange. Coat the threads of the flywheel attaching bolts with Perfect Seal Sealing Compound or equivalent, and install the bolts. Tighten the bolts in sequence across from each other to 102-115 N·m (75-85 ft-lb).
3. On a manual-shift transmission, install the clutch disc and the pressure plate assembly.
4. Install the transmission.

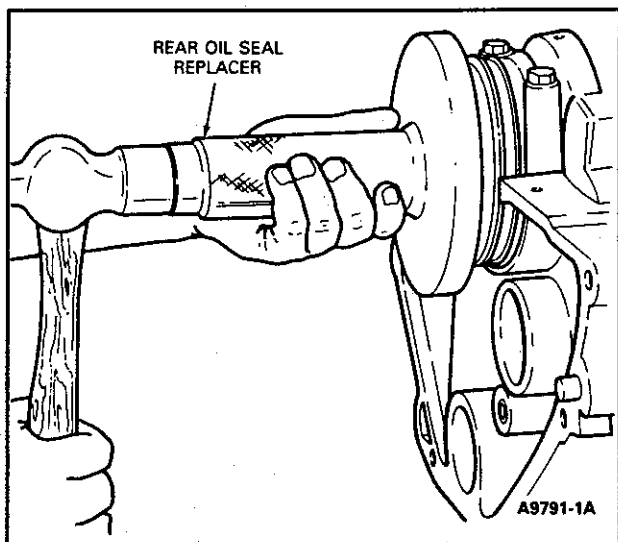


Figure 65 Installing One-Piece Crankshaft Rear Oil Seal 5. 8L

MAIN BEARING

The main bearing inserts are selective fit. Refer to the procedures under Fitting Main and Connecting Rod Bearings.

Removal

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal in this section.
2. Remove the oil pump inlet tube assembly and the oil pump.
3. Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.
4. Insert the upper bearing removal tool in the oil hole in the crankshaft.
5. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
6. Clean the crankshaft journal. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear.

7. If the rear main bearing is being replaced, remove and discard the rear oil seal following the procedures given under Crankshaft Rear Oil Seal Removal.

Installation

1. If the rear main bearing is being replaced, clean the rear oil seal groove with a brush and solvent.
2. Install the rear oil seal following the procedure given under Crankshaft Rear Oil Seal Installation.
3. To install an upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that correct Tool can be inserted in the oil hole in the crankshaft. With the Tool positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.
4. Install the bearing cap.
5. Select fit the bearing for proper clearance, following the procedures under Fitting Main and Connecting Rod Bearings.
6. If the bearing is being replaced on journal number 1, 2 or 4, apply a coat of heavy engine oil SF to the journal and bearings and install the bearing cap. Tighten the cap bolts to specifications.
7. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Lubricate the journal with heavy engine oil SF and install the thrust bearing cap with the bolts finger tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications (Figure 66).

8. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.
9. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts, following the procedure under Oil Pan Installation in this section. Install the oil level dipstick.
10. Fill the crankcase with the correct amount of oil. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

CONNECTING ROD BEARINGS

The connecting rod bearings are selective fit. Refer to the procedures under Fitting Main and Connecting Rod Bearings.

Removal

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal.
2. Remove the oil pump inlet tube assembly and the oil pump.
3. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.

Installation

1. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.
2. Clean the crankshaft journal.
3. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.
4. Pull the connecting rod assembly down firmly on the crankshaft journal.
5. Select fit the bearing, following procedures under Fitting Main and Connecting Rod Bearings.
6. After the bearing has been fitted, clean and apply a coat of heavy engine oil SF to the journal and bearings. Install the connecting rod cap. Tighten the nuts to specifications.
7. Repeat the procedure for the remaining connecting rods that require new bearings.
8. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.
9. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts, following the procedure under Oil Pan Installation in this section. Install the oil level dipstick.
10. Fill the crankcase with the correct amount of oil. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

PISTONS AND CONNECTING RODS

Removal

1. Drain the cooling system and crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump, following the procedures in this section.

2. Remove any ridges and/or deposits from the upper end of cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at the bottom of its travel, then place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer. **Never cut into ring travel area in excess of 1/32 inch when removing ridges.**

3. Make sure all connecting rod caps are marked so they can be installed in their original positions.
4. Turn the crankshaft until the connecting rod being removed is down.
5. Remove the connecting rod nuts and cap.
6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**
7. Remove the bearing inserts from the connecting rod and cap.
8. Install the cap on the connecting rod from which it was removed.

Installation

1. If new piston rings are to be installed, remove the cylinder wall glaze. Follow the instructions of the tool manufacturer.
2. Oil the piston rings, pistons and cylinder walls with heavy engine oil. **Be sure to install pistons in the same cylinders from which they were removed or to which they were fitted.** Connecting rod and bearing caps are numbered from 1 to 4 in the right bank and from 5 to 8 in the left bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

When installing the piston and connecting rod assembly, the largest chamfer at the bearing end of the rod should be positioned towards the crank pin thrust face of the crankshaft.

3. Make sure that ring gaps are properly spaced around circumference of piston (Figure 67).
4. Install piston ring compressor on the piston and push the piston in with hammer handle until it is slightly below top of the cylinder (Figure 68). Be sure to guide connecting rods to avoid damaging the crankshaft journals. Install the piston with indentation notch in piston head toward the front of the engine.
5. Check the clearance of each bearing, following the procedure under Fitting Main and Connecting Rod Bearings.

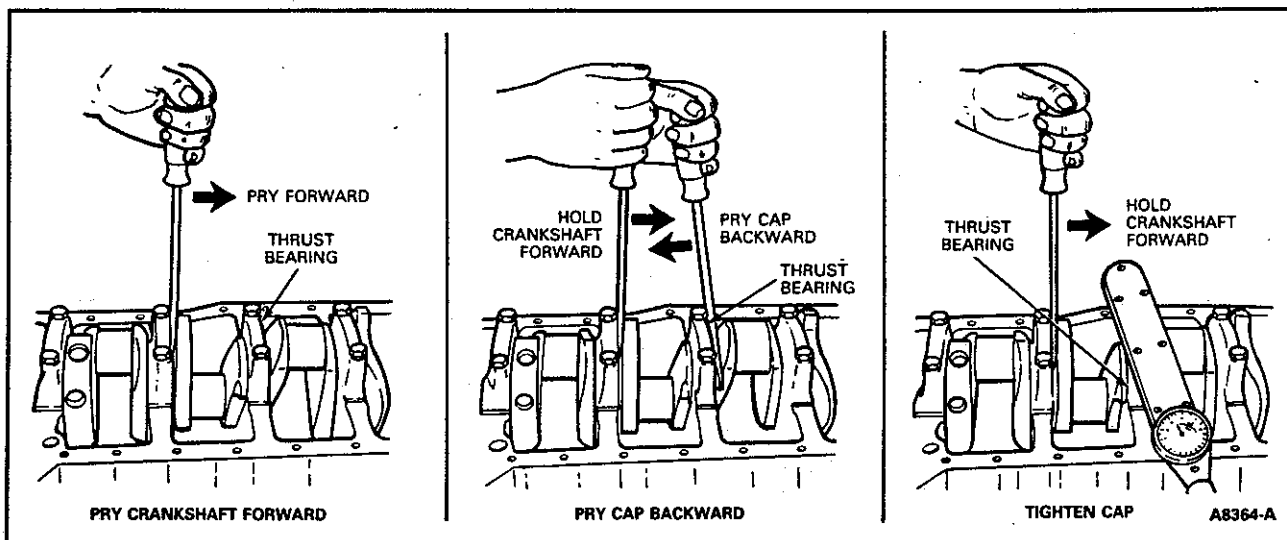


Figure 66 Aligning Thrust Bearing

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
7. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
8. Install the connecting rod cap. Tighten the nuts to specifications.
9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each shaft journal (Figure 69).
10. Disassemble, clean and assemble the oil pump. Clean the oil pump inlet tube screen, and oil pan and block gasket surfaces.
11. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and the oil pan, following the procedure under Oil Pan Installation in this section.
12. Install the cylinder heads, following the steps under Cylinder Head Installation.
13. Install the intake manifold, following the steps under Intake Manifold Installation.
14. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.
15. Start the engine, then check and adjust the ignition timing. Connect the distributor vacuum hoses to the distributor.
16. Operate the engine at fast idle and check for oil and coolant leaks. Operate the engine until engine temperatures have stabilized, then adjust the engine idle speed and idle fuel mixture.
17. Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

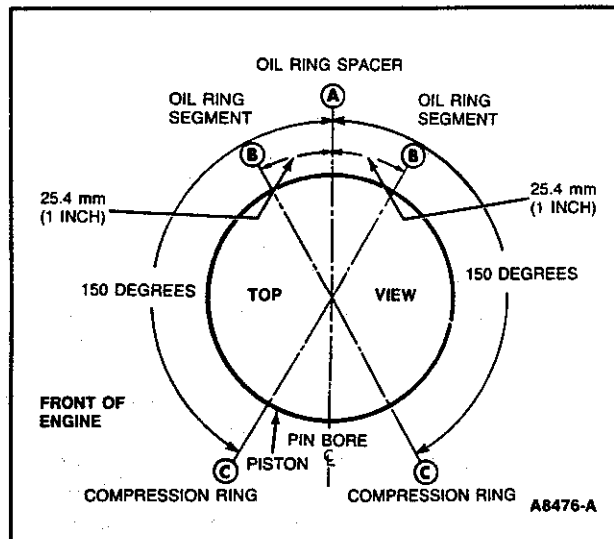


Figure 67 Piston Ring Spacing

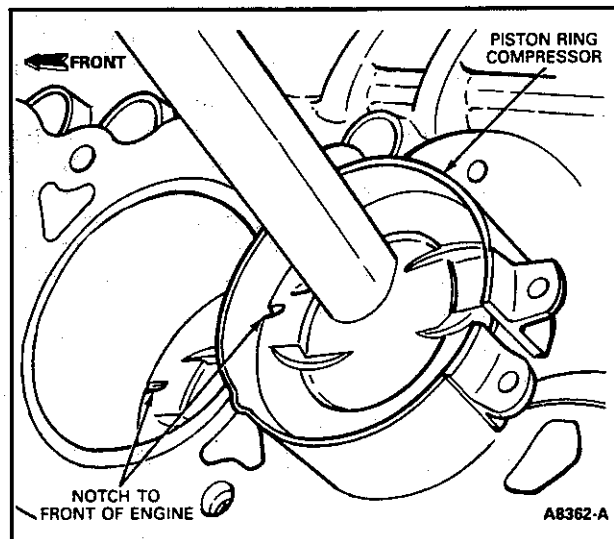


Figure 68 Installing Piston

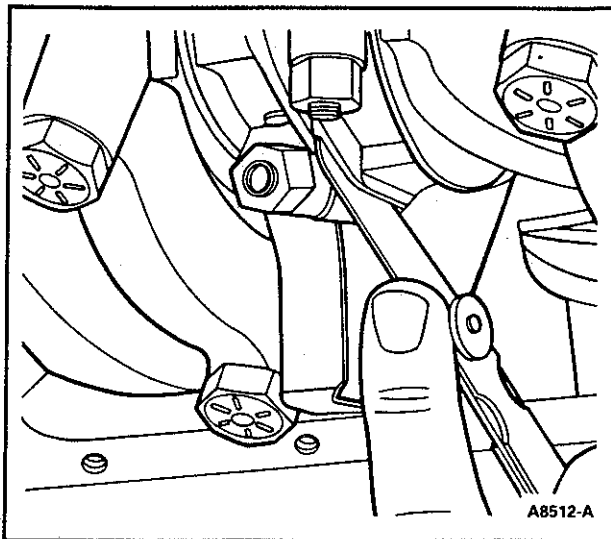


Figure 69 Checking Connecting Rod Side Clearance

CRANKSHAFT

The crankshaft and related parts are shown in Figure 70.

Removal

1. With the engine placed in a work stand, disconnect the spark plug wires at the spark plugs by hand only and remove the wires from the ignition harness brackets on the valve rocker arm covers. Disconnect the coil to distributor high-tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly. Remove the spark plugs to allow easy rotation of the crankshaft.
2. Remove the fuel pump and the oil filter. Slide the water pump by-pass hose clamp toward the water pump. Remove the alternator and mounting brackets.
3. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the capscrew and washer from the end of the crankshaft. Install the puller on the crankshaft vibration damper (Figure 54) and remove the damper.
4. Remove the cylinder front cover and water pump as an assembly.
5. Remove the crankshaft front oil slinger. Check the timing chain deflection, then remove the timing chain and sprockets by following steps under Cylinder Front Cover and Timing Chain Removal.
6. Invert the engine on a work stand. Remove the flywheel and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.
7. **Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations.** Turn the crankshaft until the connecting rod from which the cap is being removed is down, then remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all connecting rod bearing caps are removed.

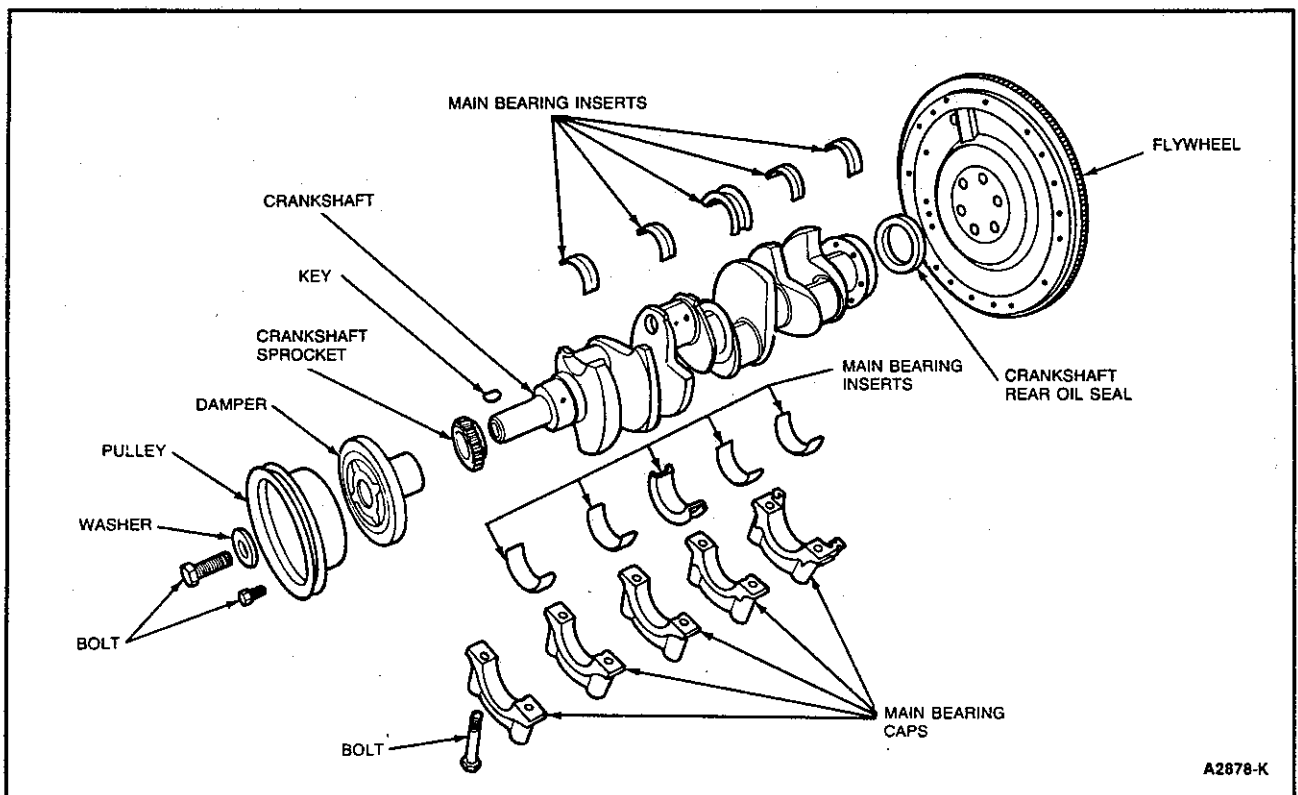


Figure 70 Crankshaft and Related Parts

8. Remove rear oil seal.
9. Remove the main bearing caps.
10. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to finished surfaces.**

Installation

1. Remove the main bearing inserts from the block and bearing caps.
 2. Remove the connecting rod bearing inserts from the connecting rods and caps.
 3. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under inserts will distort the bearing and cause failure.
 4. Place the upper main bearing inserts in position in bores with tang fitting in the slot provided.
 5. Install lower main bearing inserts in the bearing caps.
 6. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**
 7. Check the clearance of each main bearing by following the procedure under Fitting Main and Connecting Rod Bearings.
 8. After the bearings have been fitted, apply heavy engine oil SF to the journals and bearings.
 9. Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). **Be sure that the main bearing caps are installed in their original locations.** Tighten the bearing cap bolts to specifications.
 10. Install the rear oil seal following the procedures given under Crankshaft Rear Oil Seal Removal.
 11. Install the thrust bearing cap with the bolts finger-tight.
 12. Pry the crankshaft forward against the thrust surface of the upper half of the bearing.
 13. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.
 14. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specification.
 15. Force the crankshaft toward the rear of the engine.
 16. Check the crankshaft end play.
 17. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing, following the procedure under Fitting Main and Connecting Rod Bearings.
 18. After the connecting rod bearings have been fitted, apply a light coat of engine SF to the journals and bearings.
 19. Install the connecting rod cap. Tighten the nuts to specifications.
 20. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each connecting rod crankshaft journal (Figure 69).
 21. Install the timing chain and sprockets, cylinder front cover and crankshaft pulley and adapter, following steps under Cylinder Front Cover and Timing Chain Installation.
 22. Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the flywheel on the crankshaft flange. Install and tighten the bolts to specifications.
- Use correct Tool to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts.

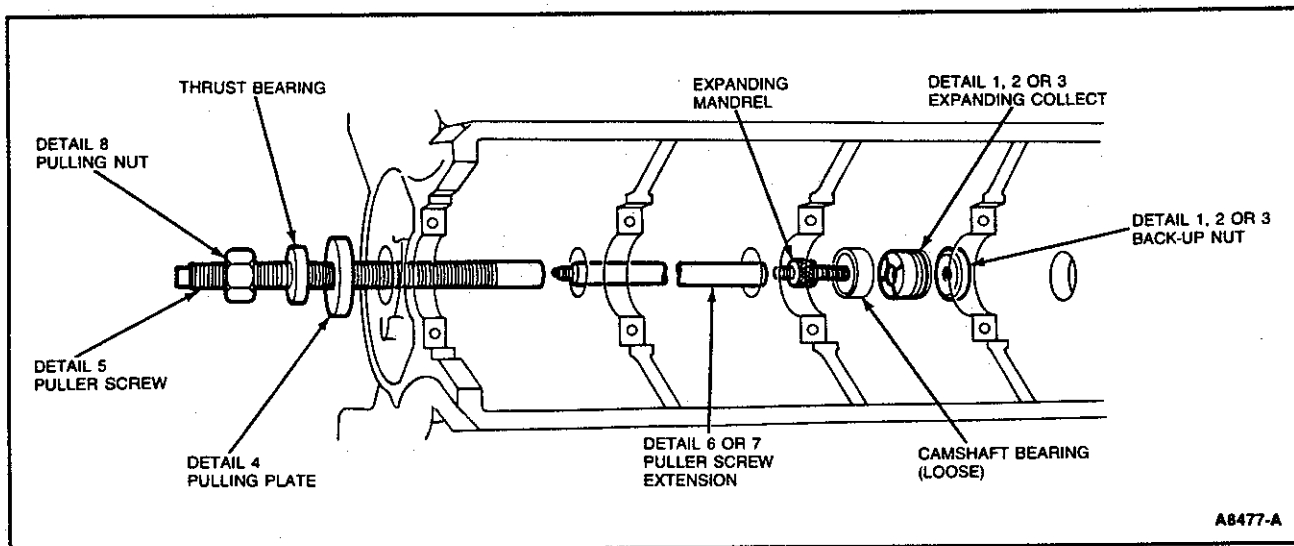


Figure 71 Camshaft Bearing Replacement

23. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and oil pan by following the procedures under Oil Pan and Oil Pump Installation.
24. Install the oil filter, fuel pump and connect the fuel lines. Install the alternator, shield and mounting bracket.
25. Install the spark plugs, distributor cap and spark plug wires. Connect the spark plug wires and high-tension lead.

CAMSHAFT BEARINGS

Camshaft bearings are available prefinished to size for standard and 0.015 inch undersize journal diameters. The bearings are not interchangeable from one bore to another.

Removal

1. Remove the camshaft, flywheel, and crankshaft, following the appropriate procedures in this Section. Push the pistons to the top of the cylinders.
2. Remove the camshaft rear bearing bore plug. Remove camshaft bearings (Figure 71).
3. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the back-up nut on the expanding mandrel until the collet fits the camshaft bearing.
4. Assemble the puller screw and extension (if necessary) as shown and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.
5. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

Installation

1. Position the new bearings at the bearing bores with the oil holes aligned and press them in place with the tool shown in Figure 71. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. **Failure to use the correct expanding collet can cause severe bearing damage. Be sure the front bearing is installed the specified distance below the front face of the cylinder block (Figure 72).**
2. Install a new rear bearing bore plug.

3. Install the camshaft, crankshaft, flywheel and related parts, following the appropriate procedures, except do not check connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement.

OIL FILTER

Spin-On Type

The spin-on type oil filter assembly is shown in Figure 73.

Removal

1. Place a drip pan under the filter.
2. Unscrew the filter from the adapter fitting. Clean the adapter filter recess.

Installation

1. Coat the gasket on a new filter with oil. Place the filter in position on the adapter. Hand tighten the filter until the gasket contacts the adapter face, then advance it 1/2 turn or further to prevent leakage.

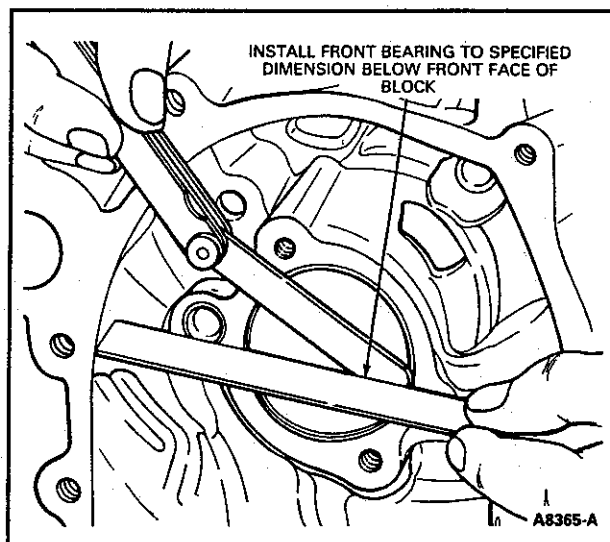


Figure 72 Camshaft Front Bearing Replacement

2. Operate the engine at fast idle and check for leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase if necessary.

DISASSEMBLY AND ASSEMBLY

When installing nuts or bolts that must be tightened (refer to torque specifications), oil the threads with light-weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

Refer to Page 1-13 for the cleaning and inspection procedures.

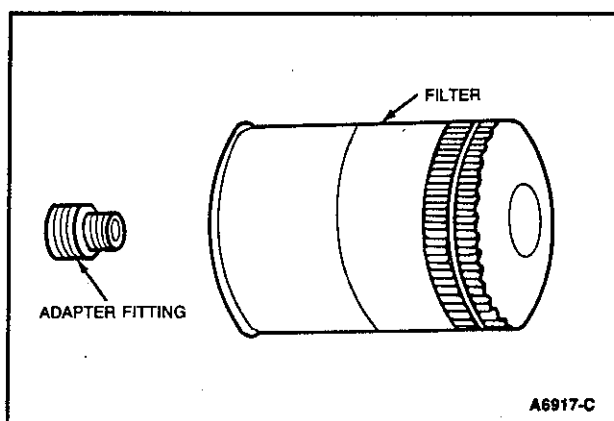


Figure 73 Typical Oil Filter Assy. — Spin-On Type

VALVE LIFTER

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

Valve lifters should always be tested after assembly; refer to the test procedures covered on page 1-09.

Disassembly

Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so that they can be installed in their original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.
2. Remove the push rod cup, metering valve (disc), plunger and spring.
3. Remove the plunger assembly, the check valve retainer and plunger spring. Carefully remove the plunger spring, the check valve retainer, and the check valve disc from the plunger.

Assembly

Hydraulic valve lifter assembly is shown in Figure 74.

1. Place the plunger upside down on a clean work bench.
2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
3. Position the check valve retainer over the check valve and spring then push the retainer down into place on the plunger.
4. Place the plunger spring, and then the plunger (open end up) into the lifter body.
5. Position the metering valve (disc) in the plunger, and then place the push rod cup in the plunger.

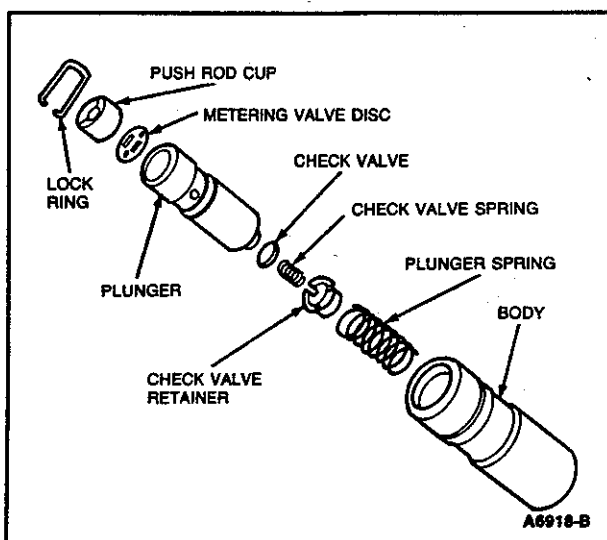


Figure 74 Hydraulic Valve Lifter Assy.

6. Depress the plunger, and position the closed end of the lock ring in the groove of the lifter body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.
7. Use a hydraulic valve lifter leakdown tester to fill the lifters with test fluid.

CYLINDER HEADS

Disassembly

1. Remove the exhaust manifolds and spark plugs.
2. Clean the carbon out of the cylinder head combustion chambers before removing the valves.
3. Compress the valve spring (Figure 75). Remove the spring retainer locks and release spring.

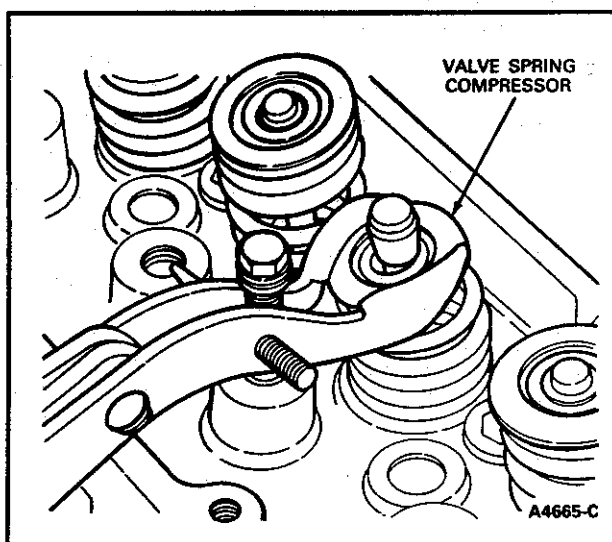


Figure 75 Compressing Valve Spring on Bench

4. Remove the spring retainer, sleeve, spring, stem seal and valve. Discard the valve stem seals. Identify all valve parts.
5. Clean, inspect and repair the cylinder head as required, or transfer all usable parts to a new cylinder head.

Assembly

1. Install each valve (Figure 76) in the port from which it was removed or to which it was fitted. Install a new stem seal on each valve.
2. Install the valve spring over the valve, and then install the spring retainer and sleeve. Compress the spring (Figure 75) and install the retainer locks (Figure 76).
3. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Figure 77). Check the dividers against a scale. If the assembled height is greater than specifications, install the necessary 0.030 inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended height.

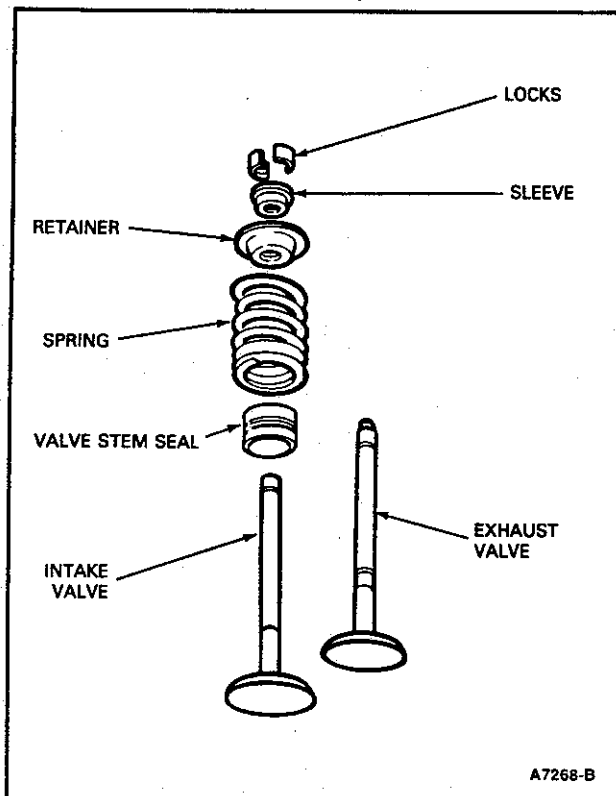


Figure 76 Valve Assembly — Typical

Do not install the spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.

4. Install the exhaust manifolds and the spark plugs.

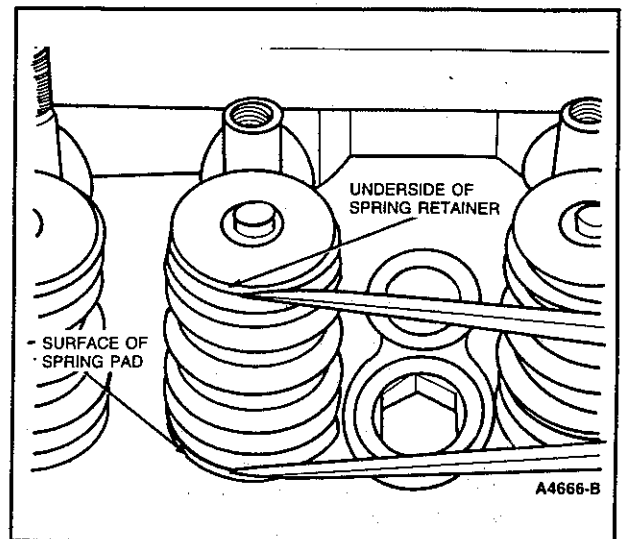


Figure 77 Checking Valve Spring Assembled Height

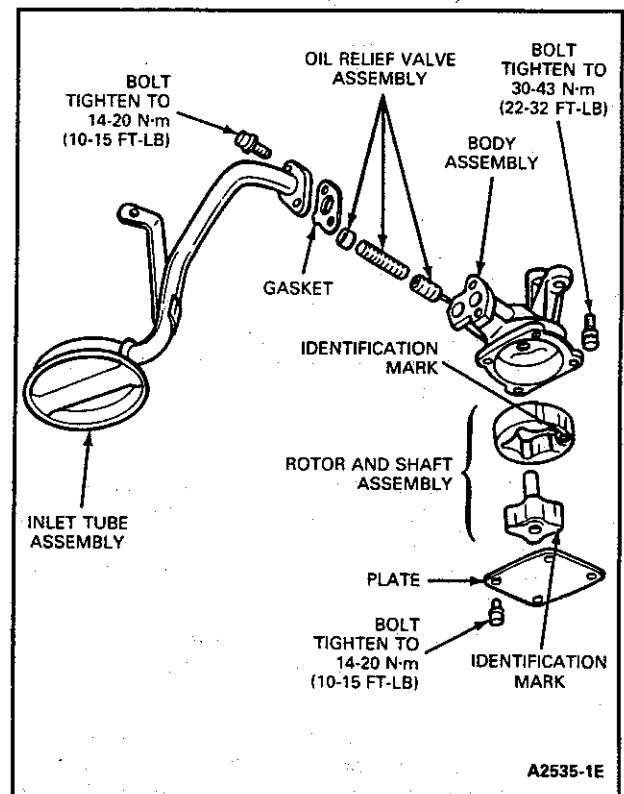


Figure 78 Oil Pump — Disassembled

OIL PUMP

Disassembly

1. Remove the oil inlet tube from the oil pump and remove the gaskets.
2. Remove the cover attaching bolts, then remove the cover. Remove the inner rotor and shaft assembly; then, remove the outer race.

3. Drill a small hole and insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

Assembly

The oil pump assembly is shown in Figure 78.

1. Clean, inspect and oil all parts thoroughly.
2. Install the oil pressure relief valve plunger, spring and a new cap.
3. Install the outer race and the inner rotor and shaft assembly. **Be sure the dimple (identification mark) on the outer race is facing outward and on the same side as the identification mark on the rotor. The inner rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other.** Install the cover and tighten the cover attaching bolts to specifications.
4. Install the attaching bolts.

PISTONS AND CONNECTING RODS

Disassembly

1. Remove the bearing inserts from the connecting rod and cap.
2. Mark the pistons to assure assembly with same rod and installation in the same cylinders from which they were removed.
3. Using an Arbor press and the tool shown in Figure 79, press the piston pin from the piston and connecting rod. Remove the piston rings.

Assembly

The piston, connecting rod and related parts are shown in Figure 80. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

1. Apply a light coat of engine oil SF to all parts. **Assemble the piston to the connecting rod with the indentation in the piston positioned as shown in Figure 81.**

On replacement connecting rods, install the large-chamfered side of the connecting rod bearing bore towards the crankshaft cheek; facing towards front of engine on the right bank rods, and facing towards rear of engine on left bank rods.

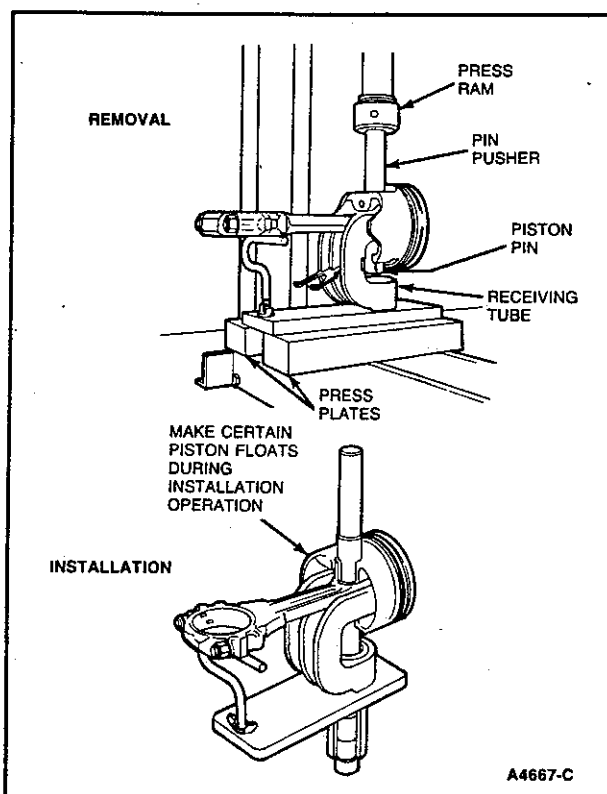


Figure 79 Removing or Installing Piston Pin

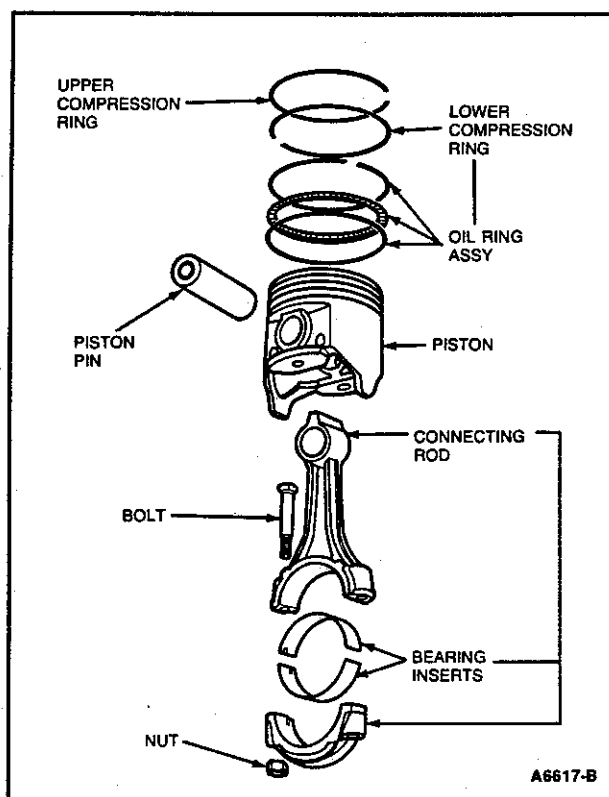


Figure 80 Piston, Connecting Rod and Related Parts

2. Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an Arbor Press, press the piston pin through the piston and connecting rod until the pin is centered in the piston (Figure 81).
3. Check the end gap of all piston rings. It must be within specifications. Follow the instructions contained on piston ring package and install the piston rings.
4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. 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.**
5. Be sure the bearing inserts and bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

CYLINDER ASSEMBLY

Disassembly

1. Mount the old engine in a work stand and remove all parts not furnished with the new cylinder assembly; following the procedures given in the Removal and Installation Section of this Part.
2. Remove the old cylinder assembly from the work stand.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly in a work stand.
3. Transfer all serviceable parts removed from the old cylinder assembly, following the procedures given in the Removal and Installation Section of this Part.
4. Check all assembly clearances and correct as necessary.

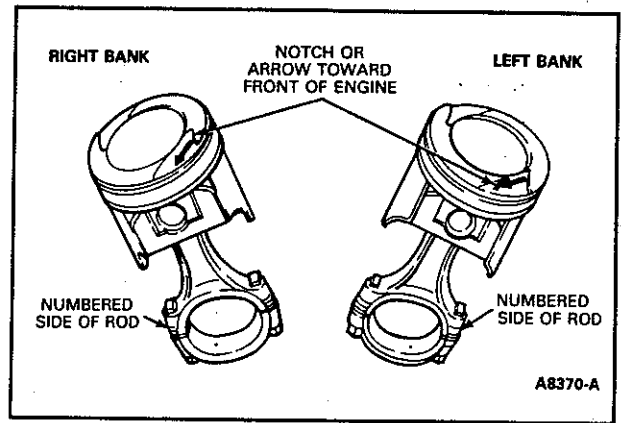


Figure 81 Correct Piston and Rod Positions

CYLINDER BLOCK

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs, following the procedures given earlier in this part.

Disassembly

1. Completely disassemble the old engine, following the procedures given in the Removal and Installation Section of this Part.
2. Remember to ridge-ream the cylinder bores before removing piston assemblies.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder block in a work stand.
3. Transfer all serviceable parts removed from the old cylinder block, following the procedures given in the Removal and Installation Section of this Part.
4. Check all assembly clearances and correct as necessary.

SECTION 8

SPECIFICATIONS

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GENERAL

Displacement	
850	8 cylinder 5.0 liter (302 cubic in.)
858	8 cylinder 5.8 liter (351 cubic in.)
Bore and Stroke	
850	4.00 x 3.00
858	4.00 x 3.50
Oil Pressure — Hot @ 2000 rpm	
850	40-60 psi
858	40-65 psi
Oil Capacity (Qts.) —	
(add 1 qt. with filter change)	Industrial 4, Marine 5

FIRING ORDER FOR CAMSHAFT IDENTIFICATION

Engine & Application	Camshaft Service Part No. (6250) and Color Code		Camshaft	Cam Lobe Lift	
			Firing Order	Intake	Exhaust
CSG 850 (302)					
IM, Std., LO, 2V	D50Z-A	Yellow	1-5-4-2-6-3-7-8	.2375	.2470
M, Std., 2V	D30Z-A	Brown	1-3-7-2-6-5-4-8	.2600	.2780
M, Std., 4V	E7JE-AA	Green	1-3-7-2-6-5-4-8	.2780	.2830
M, Rev., 4V	E7JE-BA	Red	1-8-4-5-6-2-7-3	.2780	.2830
WSG 858 (351)					
M, Std., 4V	E7JE-AA	Green	1-3-7-2-6-5-4-8	.2780	.2830
M, Rev., 4V	E7JE-BA	Red	1-8-4-5-6-2-7-3	.2780	.2830
I, Std., 2V	D60Z-C	Blue	1-3-7-2-6-5-4-8	.2600	.2780
Application Codes M = Marine, Std. = L.H. Rotation, Rev. = R. H. Rotation, LO = Low Output, 2V Carburetor, 4V Carburetor, I = Industrial.					

CYLINDER HEAD

Combustion Chamber Volume (cc)	
850 & 858	67.5-70.5
Valve Guide Bore Diameter	0.3433-0.3443
Valve Seat Width — Intake and Exhaust	0.060-0.080
Valve Seat Angle — Intake and Exhaust	45°
Valve Seat Runout — Maximum	0.0020
Surface Flatness	0.003 inch in any 6 inches or 0.007 inch overall
Valve Arrangement (Front to Rear)	Right I-E-I-E-I-E-I-E Left E-I-E-I-E-I-E-I
Rocker Arm Stud Bore Diameter — Standard	0.3680-0.3695
Gasket Surface Flatness	0.003 inch in any 6 inches or 0.006 inch overall
Gasket Surface Finish RMS	60-150

VALVE ROCKER ARMS, PUSH RODS AND LIFTERS

Rocker Arm Lift Ratio	1.61:1
Valve Push Rod Runout — Maximum	0.015
Rocker Arm Stud Diameter	
Standard	0.3714-0.3721
0.006 Oversize	0.3774-0.3781
0.010 Oversize	0.3814-0.3821
0.015 Oversize	0.3864-0.3871
Hydraulic Lifter Leakdown Rate5-50 seconds maximum measured at 1/16 inch plunger travel with 50 lbs. load and leak down fluid in tappet
Hydraulic Lifter Standard Diameter	0.8740-0.8745
Hydraulic Lifter Clearance to Bore	0.0007-0.0027 Service Limit — 0.005
Hydraulic Lifter Collapsed Gap	
850	
Allowable	0.071-0.193
Desirable	0.096-0.165
858	
Allowable	0.098-0.198
Desired	0.123-0.173

VALVES

Valve Stem Diameter	
Intake	
Standard	0.3416-0.3423
0.003 Oversize	0.3446-0.3453
0.015 Oversize	0.3566-0.3573
0.030 Oversize	0.3716-0.3723
Exhaust	
Standard	0.3411-0.3418
0.003 Oversize	0.3441-0.3448
0.015 Oversize	0.3561-0.3568
0.030 Oversize	0.3711-0.3718
Valve Face Angle	44°
Valve Stem to Valve Guide Clearance —	
Intake	0.0010-0.0027
Exhaust	0.0015-0.0032
Service Limit	0.0055
Valve Head Diameter	
Intake	1.770-1.794
Exhaust	1.453-1.468
Valve Face Runout (Maximum)	0.0020
Service Limit	10% Pressure Loss @ Spec. Length
Valve Spring Out-of-Square — Maximum	$\frac{5}{64}$ (0.078)

VALVE SPRING

Engine Model		Free Length (approx.)		Spring Pressure				Assembled Height (Pad to Retainer)	
Litre	Application	Exhaust (Inches)	Intake (Inches)	Exhaust		Intake		Exhaust	Intake
				(Lbs)	Length (Inches)	(Lbs)	Length (Inches)		
850	Industrial	1.87	2.04	80 ± 4	1.60	78 ± 4	1.78	1 ³⁷ / ₆₄ - 1 ³⁹ / ₆₄	1 ⁴³ / ₆₄ - 1 ⁴⁵ / ₆₄
858	Industrial	1.87	2.04	80 ± 4	1.60	78 ± 4	1.78	1 ³⁷ / ₆₄ - 1 ⁴¹ / ₆₄	1 ⁴⁸ / ₆₄ - 1 ⁵² / ₆₄
850	Industrial	—	—	200 ± 10	1.20	204 ± 10	1.36	—	—
858	Industrial	—	—	200 ± 10	1.20	204 ± 10	1.36	—	—
850	Marine	1.86	2.06	75 ± 4	1.60	78 ± 4	1.78	1 ³⁷ / ₆₄ - 1 ³⁹ / ₆₄	1 ⁴⁸ / ₆₄ - 1 ⁵¹ / ₆₄
858	Marine	1.86	2.06	75 ± 4	1.60	78 ± 4	1.78	1 ³⁷ / ₆₄ - 1 ³⁹ / ₆₄	1 ⁴⁸ / ₆₄ - 1 ⁵¹ / ₆₄
850	Marine	—	—	205 ± 10	1.15	204 ± 10	1.33	—	—
858	Marine	—	—	205 ± 10	1.15	204 ± 10	1.33	—	—

CAMSHAFT AND BEARINGS

Camshaft Journal to Bearing Clearance	0.001-0.003
Service Limit —	0.006
Camshaft End Play	0.001-0.007
Service Limit —	0.009
Camshaft Lobe Lift — Ref. Firing Order Chart (page 8-01)	
Maximum Allowable Lobe Lift Loss	0.005
Bearing Inside Diameter	
Bearing No. 1	2.0825-2.0835
Bearing No. 2	2.0675-2.0685
Bearing No. 3	2.0525-2.0535
Bearing No. 4	2.0375-2.0385
Bearing No. 5	2.0225-2.0235
Camshaft Journal Diameter — Standard	
Bearing No. 1	2.0805-2.0815
Bearing No. 2	2.0655-2.0665
Bearing No. 3	2.0505-2.0515
Bearing No. 4	2.0355-2.0365
Bearing No. 5	2.0205-2.0215
Camshaft Journal Maximum Runout T.I.R.	0.005
Camshaft Bearing Location — No. 1 Bearing	0.0050-0.0200*
Timing Chain Deflection — Maximum	0.500
*Distance in inches that the front edge of the bearing is installed toward the rear from the front face of the cylinder block.	

CRANKSHAFT AND FLYWHEEL**MAIN BEARING JOURNAL**

Diameter 850	2.2482-2.2490
Diameter 858	2.9994-3.0002
Diameter Maximum Out-of-Round (850 & 858)	0.0006
Runout TIR Maximum (850 & 858)	0.002
Service Limit	0.005
Taper Limit (850 & 858)	0.0004 per inch
Surface Finish Maximum	12 RMS

CONNECTING ROD JOURNAL

Diameter 850	2.1228-2.1236
Diameter 858	2.3103-2.3111
Diameter Maximum Out-of-Round (850 & 858)	0.0006 per inch
Taper Limit (850 & 858)	0.0006 per inch
Surface Finish Maximum	12 RMS

THRUST BEARING

Journal Length (850 & 858)	1.137-1.139
Face Runout Limit (850 & 858)	0.001
Face Finish (850 & 858)	25 Front 20 Rear RMS

CRANKSHAFT

To Rear Face of Block Runout Maximum (850 & 858)	0.005 TIR
End Play Clearance (850 & 858)	0.004-0.008
	Service Limit 0.012 Max.

FLYWHEEL

Clutch Face Runout Limit (850 & 858)	0.010 TIR
Assembled Ring Gear Lateral Runout (850 & 858)	
Standard	0.030 TIR
Automatic	0.060 TIR

MAIN BEARINGS

Journal Clearance	
850 No. 1 Bearing	
Desired	0.0001-0.0015
Allowable	0.0001-0.0020
All others	
Desired	0.0005-0.0015
Allowable	0.0005-0.0024
858	
Desired	0.0008-0.0015
Allowable	0.0008-0.0026
Wall Thickness	
850 No. 1 Bearing	0.0961-0.0966
All Others	0.0957-0.0962
858	0.0957-0.0960
All Others	0.0957-0.0962

CONNECTING ROD

Piston Pin Bore I.D. — Standard (850 & 858)	0.9096-0.9112
Rod Bearing Bore Diameter	
850	2.2390-2.2398
858	2.4265-2.4273
Bearing Bore Out-of-Round and Taper	0.0004
Connecting Rod Length — Center to Center	
850	5.0885-5.0915
858	5.9545-5.9575
Twist Total Difference — Maximum	0.024
Bend Total Difference — Maximum	0.012*
Connecting Rod Assembly — Assembled to Crankshaft —	
Side Clearance	0.010-0.020
	Service Limit — 0.023

*Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of an 8-inch long bar measured 4 inches on each side of rod.

CONNECTING ROD BEARINGS

Bearing to Crankshaft Clearance (850 & 858)	
Allowable	0.0008-0.0025
Desired	0.0008-0.0015
Wall Thickness — Standard (850 & 858)	0.0572-0.0577
0.002 Undersize	0.0582-0.0587

PISTONS

Piston Diameter — Coded Red

850	① 3.9984-3.9990
858	① 3.9978-3.9984
Coded Blue	
850	① 3.9996-4.0002
858	① 3.9990-3.9960
0.003 Oversize	
850	① 4.0020-4.0026
858	① 4.0014-4.0020
① Measured at the piston pin bore centerline at 90° to the pin.	
Piston to Cylinder Bore Clearance (850 ± 858)	0.0018-0.0026
Piston Pin Bore Diameter (850 ± 858)	0.9124-0.9127
Ring Groove Width, Compression —	
Top	<div style="display: flex; justify-content: space-around;"><div>302 0.060-0.061</div><div>351 0.080-0.081</div></div>
Bottom	<div style="display: flex; justify-content: space-around;"><div>0.060-0.061</div><div>0.080-0.081</div></div>
Oil Ring	<div style="display: flex; justify-content: space-around;"><div>0.1587-0.1597</div><div>0.1880-0.1890</div></div>

PISTON PIN

Piston Pin Diameter — Standard (850 & 858)	0.9120-0.9123
0.001 Oversize (850 & 858)	0.9130-0.9133
0.002 Oversize (850 & 858)	0.9140-0.9143
Piston Pin Length (850 & 858)	3.010-3.040
Piston Pin to Piston Clearance	
850	0.0002-0.0004
858	0.0003-0.0005
	Service Limit — 0.0008
Piston Pin to Connecting Rod	
Bushing Clearance (850 & 858)	Interference Fit

PISTON RINGS

	<div style="display: flex; justify-content: space-around;"><div>302</div><div>351</div></div>
Top Compression Ring Width	<div style="display: flex; justify-content: space-around;"><div>0.0577-0.0587</div><div>0.077-0.078</div></div>
Bottom Compression Ring Width	<div style="display: flex; justify-content: space-around;"><div>0.0577-0.0587</div><div>0.077-0.078</div></div>
Top Compression Ring Side Clearance (850 & 858)	0.002-0.004
Bottom Compression Ring Side Clearance (850 & 858)	0.002-0.004
	Service Limit - 0.002 max. increase in total clearance
Oil Ring Side Clearance (850 & 858)	Snug
Top Compression Ring — Ring Gap (850 & 858)	0.010-0.020
Bottom Compression Ring — Ring Gap (850 & 858)	0.010-0.020
Oil Ring (Steel Rail) — Ring Gap (850 & 858)	0.015-0.055

CYLINDER BLOCK

Bore Diameter	
850	4.0004-4.0052
858	4.0000-4.0048
Maximum Out-of-Round	0.0015
	Service Limit — 0.005
Maximum Taper	0.001
	Service Limit — 0.010
Crankshaft to Rear Face of Block Runout	
TIR Maximum (850 & 858)	0.005
Lifter Bore Diameter (850 & 858)	0.8752-0.8767
Main Bearing Bore Diameter	
850	2.4412-2.4420
858	3.1922-3.1930
Distributor Shaft Bearing Bore Diameter	
850	0.4525-0.4541
858	0.5155-0.5171
Head Gasket Surface Flatness (850 & 858)	0.003 inch in any 6 inches or 0.006 inch overall
Head Gasket Surface Finish RMS (850 & 858)	60-150
Cylinder Bore Surface Finish RMS (850 & 858)	18-38

OIL PUMP

Relief Valve Spring Tension (Lbs. @ Specified Length)	
850	10.6-12.2 @ 1.704
858	18.2-20.2 @ 2.49
Drive Shaft to Housing Bearing Clearance (850 & 858)	0.0015-0.0030
Relief Valve Clearance (850 & 858)	0.0015-0.0030
Rotor Assembly End Clearance (Assembled) (850 & 858)	0.001-0.004
Outer Race to Housing Clearance (Radial) (850 & 858)	0.001-0.013

CARBURETORS

CARBURETOR (Ford Part Number)	D2JL C 302	D2JL E 351	D3JL B 302&351	D4JL F 302	D4JL G 351	D9JL C 351	E0JL BA 302	E0JL CA 351	E6JL GA 302	E6JL HA 302	E6JL JB 351	E8JL AA 302	E8JL BA 302	E8JL CA 351
Carburetor Bore Diameter														
Primary (inches)	1.500	1.5625	1.500	1.5000	1.5610	1.5620	1.5000	1.5610	1.500	1.500	1.5610	1.500	1.500	1.5610
Secondary (inches)	1.500	1.5625	—	1.5000	1.5610	—	1.5000	1.5610	—	1.500	1.5610	—	1.500	1.5610
Primary Venturi (inches)	1.094	1.250	1.187	1.094	1.2500	N/A	1.094	N/A	1.187	1.094	1.250	1.187	1.094	1.250
Secondary Venturi (inches)	1.094	1.3125	—	1.094	1.2500	—	1.094	N/A	—	1.498	1.312	—	1.498	1.312
Fuel Bowl Level														
Fuel Level Wet (inches)	①	①	③	⑤⑥	③⑥	①	⑤⑥	③⑥	③	⑤⑥	③⑥	⑥	⑥	⑥
Float Level Dry (inches)	②	②	②	②	②	②	②	②	②	②	②	.50②	⑤	③
Main Metering System														
Primary Jet Number	58	64	60	ST.592	ST.662	ST.563	ST.592	ST.662	60	ST.592	ST.652	60	ST.592	652
Secondary Jet Number	.0635	—	—	.067	.067	—	.067	.067	—	.067	.067	—	.067	.067
Power Valve Open (man. vac)	8.5-11.5	4-6	4-6	8.5-11.5	2-4	5-7	8.5-11.5	2-4	4-6	8.5-11.5	2-4	4-6	8.5-11.5	2-4
Idle F/A Point Setting	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦
Accelerator System														
Capacity for 10 strokes (cc)	21-31	25-35	25-35	21-31	22-32	22-32	21-31	22-32	25-35	21-31	23-40	⑭ 25-35	⑮ 21-31	⑯ 23-40
Pump Level — Cam Location	2	1	1	2	1	2	2	1	1	2	2	1	2	2
Override Spring Adj (inches)	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧
Pump Cam Color	Red	Pink	Pink	Red	Pink	Red			Pink	41R240	41R427	41R330	41R240	41R427
RPM Settings														
Curb Idle (RPM)	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨
Fast Idle (RPM)	⑩	⑩	⑩	⑩	⑩	⑩	⑩	⑩	⑩	⑩	⑩	⑩	⑩	⑩
Maximum (RPM)														
Choke Set Points														
Dechoke range (inches)	⑪	⑪	⑪	⑪	⑪	Manual	⑪	⑪	⑪	⑪	⑪	⑪	⑪	⑪
Choke Qualifying	⑫	⑫	⑫	⑫	⑫	Manual	⑫	⑫	⑫	⑫	⑫	⑫	⑫	⑫
Cover Index Setting	3 Lean	3 Lean	3 Lean	Index	Index	None	Index	Index	3 Lean	Index	2 Rich	Index	Index	2 Rich
Vendor Information														
Vendor List Number	6407	6576A	7036	7159	7163	8970A	9393	9392	50417	50418	50419	50461	50462	50463
Vendor Model Number	4160C	4160C	2300C	4160C	4160C	2300MG	4160C	4160C	2300	4160C	4160C	2300	4160C	4160C
Vendor	⑬	⑬	⑬	⑬	⑬	⑬	⑬	⑬	⑬	⑬	⑬	⑬	⑬	⑬

① Lower edge of sight plug hole

② Parallel with float bowl flange (bowl inverted) or distance indicated in reference to the band flange (inverted)

③ ½ inch primary, ⅝ inch secondary

④ ½ inch primary, ¾ inch secondary

⑤ ⅝ inch primary, ¾ inch secondary

⑥ Use the Kent-Moore sight gauge, #10193

⑦ 1½ turns open (CCW) from the closed position (C.W.)

⑧ .015 clearance between the accelerator pump arm & pump lower arm spring bolt, with the primary throttle wide open and the accelerator pump arm bottomed out at the maximum travel position.

⑨ 550 to 575 RPM with parasitic load(s) (marine gear & prop turning, etc.) and engine coolant normal temperature

⑩ 1500 RPM

⑪ Dechoke clearance range .270 to .330 inches, measured with throttle at maximum open, ignition switch off and coil wire out of coil.

⑫ Choke piston pull down position .120 to .160 inch reference page 3-19 for measurement procedures

⑬ Holley

⑭ .028 Discharge orifice diameter

⑮ .021 Discharge orifice diameter

⑯ .025 Discharge orifice diameter

TORQUE LIMITS — 5.0L (302 CID) — 5.8L (351 CID)

NOTE: All values in N·m (ft-lbs), unless otherwise noted. Oil threads with engine oil unless the threads require oil or water-resistant sealer. The standard torque limits listed below are applicable for all functions not listed in the special torque chart.

1/4-20	5/16-18	5/16-24	3/8-16	3/8-24	7/16-14	7/16-20	1/2-13	9/16-18
8-12 (6-9)	17-24 (12-18)	19-27 (14-20)	30-43 (22-32)	37-51 (27-38)	61-77 (45-57)	55-81 (40-60)	75-81 (55-60)	116-162 (85-120)

PIPE THREADS

1/8-27	1/4-18	3/8-18	1/2-14
7-11 (5-8)	17-24 (12-18)	30-44 (22-33)	34-47 (25-35)

Item	Torque		Item	Torque	
	N·m	(ft-lbs)		N·m	(ft-lbs)
Camshaft Sprocket — Gear to Camshaft	55-61	(40-45)	Thermactor Pump Bracket Cylinder Block	44-67	(30-45)
Camshaft Thrust Plate to Cylinder Block	13-16	(9-12)	Carburetor Mounting Stud	7-13	(5-10)
Connecting Rod Nut — 5.0L (302 CID) V-8 — 5.8L (351 CID) W-V-8	26-32 55-61	(19-24) (40-45)	Distributor Clamp Down	24-32	(17-25)
Cylinder Front Cover	17-24	(12-18)	Oil Filter Insert to Cylinder Block/Adaptor	28-40	(20-30)
Cylinder Head Bolts	① ②		Oil Filter to Adaptor or Cylinder Block	1/2 turn after gasket contacts sealing surface — oiled gasket	
Damper to Crankshaft	95-122	(70-90)	Oil Inlet Tube to Pump	14-20	(10-15)
EFR Valve to Carburetor Spacer or Intake Manifold	17-24	(12-18)	Oil Pan Drain Plug	21-33	(15-25)
Fuel Line to Fuel Pump	20-24	(15-18)	Oil Pan to Cylinder Block	13-14	(9-11)
Fuel Pump to Cylinder Block of Front Cover	26-36	(19-27)	Oil Pump Cover Plate	8-13	(6-9)
Flywheel to Crankshaft	102-115	(75-85)	Oil Pump to Cylinder Block	30-43	(22-32)
Main Bearing Cap Bolts — 5.0L (302 CID) V-8 — 5.8L (351 CID) W-V-8	82-94 129-142	(60-70) (95-105)	Pulley to Damper Bolt	48-67	(35-50)
Manifold to Cylinder Head — Intake	32-33	(23-25)	Rocker Arm Stud/Bolt to Cylinder Head	25-33	(18-25)
Manifold to Cylinder Head — Exhaust	25-32	(18-24)	Spark Plug to Cylinder Head	14-20	(10-15)
Intake Manifold Vacuum Fittings — Aluminum — Cast Iron	8-13 32-37	(6-10) (23-28)	Valve Rocker Arm Cover	4-6	(3-5)
Intake Manifold Pipe Fittings — Aluminum — Cast Iron	17-24 32-37	(12-18) (23-28)	Water Outlet Housing	13-16	(9-12)
Oil Inlet Tube to Main Bearing Cap	30-43	(22-32)	Water Pump to Block/Front Cover	17-24	(12-18)
			Alternator Bracket to Cylinder Block — Bolt	17-24	(12-18)
			Alternator Adjusting Arm to Alternator Bolt	33-60	(24-40)
			Thermactor Pump Pivot Bolt	30-43	(22-32)
			Thermactor Pump Adjusting Arm to Pump	30-43	(22-32)
			Thermactor Pump Pulley to Pump Hub	17-24	(150-220 in-lbs)
			Fuel Filter to Carburetor	10-11	(80-100 in-lbs)
			Carburetor Attaching Nuts	17-20	(12-15)

① 5.0L (302 CID) V-8 — Tighten in steps: first to 75-88 N·m (55-65 ft-lbs.) then to 88-97 N·m (65-72 ft-lbs)

② 5.8L (351 CID) W-V-8 — Tighten in steps: first to 115 N·m (85 ft-lbs), then to 129 N·m (95 ft-lbs), final to 143-151 N·m (105-112 ft-lbs)

Metric/American Torque Conversion:

N·m x 0.738 = Ft-Lbs

Ft-Lbs x 1.3558 = N·m

CARBURETOR TORQUE SPECIFICATIONS

Description	N·m	In-Lb	Ft-Lbs	Description	N·m	In-Lb	Ft-Lbs
Carb Mounting Nuts	19-27	—	14-20	Choke Housing Screws	2.3-3.4	20-30	—
Choke Cap Retaining Screw	1.8-2.0	16-18	—	Throttle Body to Main Body Screws	4.4-5.9	39-52	—
Accelerator Pump Nozzle Screw	3.0-4.8	27-43	—	Accelerator Pump Cover Screws	1.1-1.6	10-14	—
Secondary Diaphragm Cover Screws	1.5-1.9	13-17	—	Fuel Inlet Fitting	30-35	—	22-26
Secondary Diaphragm Housing Screws	2.3-3.5	20-31	—	Fuel Level Sight Plug	2.2-2.7	19-24	—
Choke Plate Retaining Screws	0.7-0.9	6-8	—	Power Valve	12.2-16.3	—	9-12
Choke Thermostat Lever Nut	1.8-2.3	16-20	—	Main Jets	2.0-2.5	18-20	—
				Fuel Bowl Retaining Screws	5.7-6.8	50-60	—

IGNITION SYSTEM

CAUTION: The gasoline octane rating must be known when checking or resetting the initial spark advance. Some model year engines will require the initial spark advance to be lower than listed, if the gasoline octane is sub-standard. (Reference the chart below and fuel system specifications.)

INITIAL SPARK ADVANCE CHART

Distributor (Part Number)	Application (Type)	RPM	Gasoline Octane Number (minimum)	Initial Spark Advance (° BTDC)	Dwell at Idle RPM (Degree)	Breaker Point Gap (Inches)	Breaker Arm Tension
D3AZ-12127-A	Industrial	500-575	89	6	31	.014-.019	17-21
E2TZ-12127-U	Industrial	500-575	89	6	N/A	N/A	N/A
E3TZ-12127-AA	Industrial	500-575	89	15	N/A	N/A	N/A
D3JL-12100-B	Marine	600-800	89	6	31	.014-.019	17-21
D3JL-12100-C	Marine	600-800	89	6	31	.014-.019	17-21
D3JL-12100-D	Marine	600-800	89	6	31	.014-.019	17-21
D3JL-12100-E	Marine	600-800	89	6	31	.014-.019	17-21
D3JL-12100-B	Marine	600-800	87	2	21	.014-.019	17-21
D3JL-12100-C	Marine	600-800	87	2	31	.014-.019	17-21
D3JL-12100-D	Marine	600-800	87	2	31	.014-.019	17-21
D3JL-12100-E	Marine	600-800	87	2	31	.014-.019	17-21
E5JL-12100-AA	Marine	600-800	87	10	31	.014-.019	17-21
E5JL-12100-BA	Marine	600-800	87	10	31	.014-.019	17-21
E5JL-12100-CA	Marine	600-800	87	10	31	.014-.019	17-21
E5JL-12100-DA	Marine	600-800	87	10	31	.014-.019	17-21

Distributor Cap Screw Torque is 25-35 In/Lbs

Engine/Application	Spark Plug No.	Electrode Gap
850 Industrial	ASF 34C	0.042-0.046
858 Industrial	ASF 32	0.028-0.032
858 Industrial	ASF 42	0.042-0.046
850 & 858 Marine	ASF 32	0.028-0.032

Spark Plug Torque 15-20 Ft/Lbs

D3JL-12100-B,C,D & E DISTRIBUTOR MARINE 850 & 858

Centrifugal Advance		
Set the test stand to 0° at 250 RPM		
Distributor RPM	Centrifugal Advance	Vacuum (°Hg)
0-550	0	0
750	4¼-6¼	0
1000	8½-10½	0
1500	10½-12½	0
2000	12½-14½	0
2500	12½-14½	0

E5JL-12100-AA, BA, CA & DA DISTRIBUTOR MARINE 850 & 858

Centrifugal Advance		
Set the test stand to 0° at 250 RPM		
Distributor RPM	Centrifugal Advance	Vacuum (°Hg)
0-550	0	0
750	1½-3½	0
1000	3½-5¼	0
1500	5½-8	0
2000	7-9½	0
2500	8½-11¼	0

IGNITION SYSTEM (Cont'd)

E2TZ-12127-U DISTRIBUTOR (858 INDUSTRIAL)

Centrifugal Advance		
Set the test stand to 0° at 250 RPM, 0 Inches of Vacuum ("Hg)		
Distributor RPM	Centrifugal Advance	Vacuum ("Hg)
0-500	0	0
750	0-2	0
1000	¼-3	0
1500	4-6½	0
2000	7½-10	0
2500	11-14	0
Vacuum Advance		
Set the test stand to 0° at 1000 RPM and 0 ("Hg) Vacuum		
Distributor RPM	Vacuum Advance	Vacuum ("Hg)
1000	-½- +3	5
1000	2¾-5¼	10
1000	2¾-5¼	15
1000	2¾-5¼	20

E3TZ-12127-AA DISTRIBUTOR (850 INDUSTRIAL)

Centrifugal Advance		
Set the test stand to 0° at 250 RPM, 0 Inches of Vacuum ("Hg)		
Distributor RPM	Centrifugal Advance	Vacuum ("Hg)
0-500	0	0
750	1¼-3½	0
1000	3-5	0
1500	5-7½	0
2000	7½-9¾	0
2500	9½-12½	0
Vacuum Advance		
Set the test stand to 0° at 1000 RPM and 0 ("Hg) Vacuum		
Distributor RPM	Vacuum Advance	Vacuum ("Hg)
1000	2-5½	5
1000	8¾-11½	10
1000	8¾-11½	15
1000	8¾-11½	20

Gear Location Dimension — Distributor (Distance from bottom of mounting flange to bottom of gear)		4.031-4.038
Shaft End Play Clearance — Distributor		0.024-0.035
Condenser		
Capacity — Microfarads		0.21-0.25
Minimum Leakage — Megohms		10
Maximum Series Resistance Ohms		1
Coil		
Primary Resistance Wire — Ohms		1.40-1.54 (75°F)
Secondary Resistance — Ohms		7600-8800 (75°F)
Amperage Draw		
Engine Stopped		4.5
Engine Idling		2.5
Primary Circuit Resistance — Ohms		1.30-1.40 (75°F)

FUEL SYSTEM

Recommended Gasoline (Anti-Knock Index)*	87**
*Anti-Knock Index = $\frac{\text{Motor Octane} + \text{Research Octane Number}}{2}$	
**Reference Fuel Quality Information page 3-02 and the Spark Advance Chart on page 8-07 for timing modification if applicable	
Fuel Pump Static Pressure @ 500 rpm	5.0-7.0
Minimum Feed Pump Volume Flow @ 500 rpm	1 pint/20 sec
Eccentric Total Lift	0.690-0.710

COOLING SYSTEM

Thermostat	
Low Temperature	Opens 157°-164°F Fully Open — 184°F
High Temperature	Opens 188°-195°F Fully Open — 212°F
Drive Belt Tension	New — 140-160 Pounds Used — 90-110 lbs. (any belt operated over 10 minutes)

BELT TENSION

Belt Tension

New 140-160 pounds

Used 100-120 pounds

Reset Belt Tension if it checks below 75 pounds.

A used belt is one that has been in operation for 10 minutes or more.

POSITIVE ENGAGEMENT STARTER

POSITIVE ENGAGEMENT STARTER MOTOR

Dia. (Inches)	Current Draw Under Normal Load (Amps)	Normal Engine Cranking Speed (rpm)	Min. Stall Torque @ 5 Volts (Ft-Lbs)	Max. Load (Amps)	No. Load (Amps)
4	150-200	180-250	9.0	460	70
4½	150-180	150-290	15.5	670	80

STARTER BRUSHES

Mfg. Length (Inches)	Wear Limit (Inches)	Spring Tension (Ounces)	Through Bolt Torque (In-Lbs)	Mounting Bolt Torque (Ft-Lbs)
0.50	0.25	40	55.75	15-20
0.50	0.25	40	55-75	15-20

Maximum Commutator runout is 0.005 inch. Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.

ALTERNATOR

ALTERNATOR — REAR TERMINAL

Rating		Field Current* Amps @ 12V	Slip-Ring Turning mm (Inches)		Brush Length mm (Inches)		Pulley Nut Torque N-m (Ft-Lb)	Belt Tension ^①	
Amperes @ 15V	Watts @ 15V		Min. Dia.	Max. Runout	New	Wear Limit		N	(Lb)
40	600	4.25	31 (1.22)	.0127 (0.0005)	12.19 (.480)	6.35 (1/4)	82-135 (60-100)	311-489	(70-110)
60	900	4.25	31 (1.22)	.0127 (0.0005)	12.19 (.480)	6.35 (1/4)	82-135 (60-100)	311-489	(70-110)

① For belt tension specifications, refer to Section 27-06 Accessory Drive Belts in the Engine Shop Manual.

* A field current of 4 amps is used with solid-state regulator.

METRIC-ENGLISH CONVERSION TABLE

Multiply	by	to get equivalent number of:	Multiply	by	to get equivalent number of:
LENGTH			ACCELERATION		
Inch	25.4	millimetres (mm)	Foot/sec ²	0.304 8	metre/sec ² (m/s ²)
Foot	0.304 8	metres (m)	Inch/sec ²	0.025 4	metre/sec ²
Yard	0.914 4	metres	TORQUE		
Mile	1.609	kilometres (km)	Newton-metres	0.738	pound-feet
AREA			Pound-inch	0.112 98	Newton-metres (N-m)
Inch ²	645.2	millimetres ² (mm ²)	Pound-foot	1.355 8	Newton-metres
Foot ²	6.45	centimetres ² (cm ²)	POWER		
Foot ²	0.092 9	metres ² (m ²)	Horsepower	0.746	kilowatts (kW)
Yard ²	0.836 1	metres ²	PRESSURE OR STRESS		
VOLUME			Inches of water	0.249 1	kilopascals (kPa)
Inch ³	16 387.	mm ³	Pounds/sq. in.	6.895	kilopascals
	16.387	cm ³	ENERGY OR WORK		
	0.016 4	litres (L)	BTU	1 055.	joules (J)
Quart	0.946 4	litres	Foot-pound	1.355 8	joules
Gallon	3.785 4	litres	Kilowatt-hour	3 600 000.	joules (J = one W's)
Yard ³	0.764 6	metres ³ (m ³)		or 3.6 × 10 ⁶	
MASS			LIGHT		
Pound	0.453 6	kilograms (kg)	Foot candle	1.076 4	lumens/metre ² (lm/m ²)
Ton	907.18	kilograms (kg)	FUEL PERFORMANCE		
Ton	0.907	tonne (t)	Miles/gal	0.425 1	kilometres/litre (km/l)
FORCE			Gal/mile	2.352 7	litres/kilometre (l/km)
Kilogram	9.807	Newtons (N)	VELOCITY		
Ounce	0.278 0	Newtons	Miles/hour	1.609 3	kilometres/hr. (km/h)
pound	4.448	Newtons			
TEMPERATURE					
Degrees Fahrenheit	(°F - 32) ÷ 1.8	degrees Celsius			

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal In.	Metric MM.	Fractions	Decimal In.	Metric MM.
1/64	.015625	.39688	33/64	.515625	13.09687
1/32	.03125	.79375	17/32	.53125	13.49375
3/64	.046875	1.19062	35/64	.546875	13.89062
1/16	.0625	1.58750	9/16	.5625	14.28750
5/64	.078125	1.98437	36/64	.578125	14.68437
3/32	.09375	2.38125	19/32	.59375	15.08125
7/64	.109375	2.77812	39/64	.609375	15.47812
1/8	.125	3.1750	5/8	.625	15.87500
9/64	.140625	3.57187	41/64	.640625	16.27187
5/32	.15625	3.96875	21/32	.65625	16.66875
11/64	.171875	4.36562	43/64	.671875	17.06562
3/16	.1875	4.76250	11/16	.6875	17.46250
13/64	.203125	5.15937	45/64	.703125	17.85937
7/32	.21875	5.55625	23/32	.71875	18.25625
15/64	.234375	5.95312	47/64	.734375	18.65312
1/4	.250	6.35000	3/4	.750	19.05000
17/64	.265625	6.74687	49/64	.765625	19.44687
9/32	.28125	7.14375	25/32	.78125	19.84375
19/64	.296875	7.54062	51/64	.796875	20.24062
5/16	.3125	7.93750	13/16	.8125	20.63750
21/64	.328125	8.33437	53/64	.828125	21.03437
11/32	.34375	8.73125	27/32	.84375	21.43125
23/64	.359375	9.12812	55/64	.859375	21.82812
3/8	.375	9.52500	7/8	.875	22.22500
25/64	.390625	9.92187	57/64	.890625	22.62187
13/32	.40625	10.31875	29/32	.90625	23.01875
27/64	.421875	10.71562	59/64	.921875	23.41562
7/16	.4375	11.11250	15/16	.9375	23.81250
29/64	.453125	11.50937	61/64	.953125	24.20937
15/32	.46875	11.90625	31/32	.96875	24.60625
31/64	.484375	12.30312	63/64	.984375	25.00312
1/2	.500	12.70000	1	1.00	25.40000

SECTION 9

SPECIAL SERVICE TOOLS

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ACCESSORY DRIVE BELTS

Tool No.	Description
T63L-8620-A	Standard V-Belt Tension Gauge

CQ2126-1A

ALTERNATOR

Tool No.	Description
T63L-8620-A	Belt Tension Gauge

ROTUNDA EQUIPMENT

Model	Description
021-00019	Belt Tension Gauge
059-00010	Dwell-Tach-Volt-Ohmmeter

CJ3831-2A

BATTERY

ROTUNDA EQUIPMENT

Tool Number	Description
078-00005	Starting and Charging Tester
021-00046	Battery and Anti-Freeze Tester

CJ3682-1A

COOLING SYSTEM

ROTUNDA EQUIPMENT

Model	Description
021-00012	Cooling System Pressurization Kit
021-00046	Anti-Freeze Tester

CQ1443-1L

FUEL PUMP AND SYSTEM

ROTUNDA EQUIPMENT

Model	Description
059-00008	Vacuum and Pressure Tester
018-00003	Safety Can
113-00004	Gasoline Analyzer

IGNITION

Number	Description
D84L-1123-A	Bearing Puller Attachment
T74P-6666-A	Spark Plug Wire Remover
T75L-1165-A	Axle Bearing Seal Plate
T82L-12270-A	Distributor Hold Down Wrench

STARTER

Tool No.	Description
T00L-10044-A	Generator Pole Screw Wrench
T00L-4201-C	Dial Indicator

ROTUNDA EQUIPMENT

Number	Description
078-00005	Starting and Charging Tester

All Special Service Tools are Owatonna Tools except where identified. Tools may be ordered from the following:

O.T.C. TOOL & EQUIPMENT DIV.
SEALED POWER CORPORATION
2013 4TH Street N.W.
Owatonna, Minn. 55060
(507) 455-2626 or 800-533-5338
Ask for Ford Order desk.

Rotunda Equipment
1-800-762-6181

ENGINE

Tool Number	Description
D79P-100-A	Impact Slide Hammer (24 Inch, 5 Lbs)
T50T-100-A	Impact Slide Hammer (24 Inch, 2-1/2 Lbs)
T59L-100-B	Impact Slide Hammer
T58L-101-B	Puller (5/8" — 2-5/8" ID)
D80L-522-A	Damper Remover
TOOL-4201-C	Dial Indicator with Bracketry and Case
T70P-6000-	Engine Lifting Brackets
T75T-6000-A (351W)	Engine Lifting Plate
D81L-6002-D	Piston — Ring Groove Cleaner
D81P-6002-E	Gauge — Valve Seat Runout
T64L-6011-EA	Cylinder Ridge Reamer
T73L-6011-A	Cylinder Hone Set
T61P-6019-B	Front Cover Aligner
T70P-6049-A	Valve Spring Compressor
T68P-6135-A	Piston Pin Remover/Replacer
OTC-7366	Heavy Duty Reversible Ratchet
OTC-7369	Ratchet Handle
OTC-7367	Ratchet Adapter
OTC-7368	Ratchet Adapter
T65L-6250-A	Camshaft Bearing Set
T52L-6306-AEE	Crankshaft Damper and Sprocket Replacer
T58P-6316-D	Crankshaft Damper Remover
T79T-6316-A	Damper Remover/Replacer Tool Set
TOOL-6331-E (302) or TOOL-6331 (351 CID)	Upper Main Bearing Insert Remover and Replacer
T74P-6375-A	Flywheel Holding Tool
T75L-6392-A	Clutch Housing Alignment Tool*
TOOL-6500-E	Hydraulic Tappet Leakdown Tester
T71P-6513-B	Tappet Bleed Down Wrench
TOOL-6513-DD	Valve/Clutch Spring Tester (400 Lbs Capacity)
TOOL-6565-AB	Cup Shaped Adapter — Checking Cam Lobe Lift
T73L-6600-A	Pressure Gauge and 48" Hose
T74P-6666-A	Spark Plug Wire Remover
T82L-6701-A (302)	Crankshaft Rear Seal Installer
T65P-6701-A (351W)	Crankshaft Rear Seal Installer
D79L-6731-A	Oil Filter Wrench for 6" Diameter
D79L-6731-B	Oil Filter Wrench for 3-3/4" Diameter
T70P-6B070-A	Front Cover Seal Replacer
T77L-9533-B	One Piece Seal — Remover