

1965-72 152", 196" 4 CYL. ENGINES

GENERAL SPECIFICATIONS							
Year	Displ. Cu. Ins.	Carburetor	HP at RPM	Torque (Ft. Lbs. at RPM)	Compr. Ratio	Bore	Stroke
1965	152"	1-Bbl.	87@4400	135@2400	8.2:1	3.875"	3.219"
1966	152"	1-Bbl.	87@4400	135@2400	8.2:1	3.875"	3.219"
1967	152"	1-Bbl.	87@4400	135@2400	8.2:1	3.875"	3.219"
1968	152"	1-Bbl.	87@4400	135@2400	8.2:1	3.875"	3.219"
	196"	1-Bbl.	111@4000	181@2000	8.02:1	4.125"	3.656"
1969	196"	1-Bbl.	111@4000	181@4000	8.02:1	4.125"	3.656"
1970	196"	1-Bbl.	111@4000	181@4000	8.02:1	4.125"	3.656"
1971	196"	1-Bbl.	111@4000	181@4000	8.02:1	4.125"	3.656"
1972	196"	1-Bbl.	103@4000	176@2000	8.02:1	4.125"	3.656"

► **NET HORSEPOWER & TORQUE NOTE** — Horsepower and Torque figures given for 1972 and later are NET. NET Horsepower and Torque represent power at the flywheel when the engine is installed in the vehicle, with wide open throttle and all systems operating such as; air cleaner, exhaust system, water pump, generator, oil pump and air conditioning.

ENGINE IDENTIFICATION

The Engine Identification Number is located on left side, upper front corner of cylinder block. The first four digits indicate cubic inch displacement.

Application	Digits
152"	4-152
196"	4-196

ENGINE REMOVAL

See Engine Removal at end of ENGINE Section.

INTAKE MANIFOLD

Removal — Remove air cleaner. Disconnect throttle linkage, choke control, fuel line and vacuum line from carburetor and remove carburetor. Remove intake manifold retaining bolts and pull off intake manifold.

Installation — Position intake manifold gasket on cylinder head. Gasket is marked manifold side and must be installed correctly. Install manifold and bolts, and tighten bolts evenly from center. To install remaining components, reverse removal procedure.

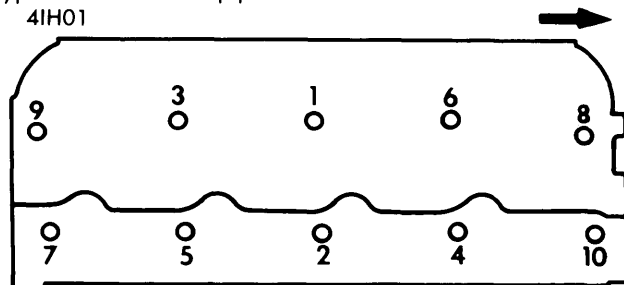
CYLINDER HEAD

Removal — 1) Drain cooling system and remove air cleaner. Disconnect spark plug wires from spark plugs and remove valve cover. Loosen drive belt and remove alternator or

generator and bracket. Disconnect exhaust pipe from manifold. Loosen all exhaust manifold bolts and remove three bolts that secure manifold gasket and remove gasket and air cleaner heat shield. Remove remaining manifold bolts and manifold.

2) Remove water pipe retaining bolt on cylinder head and remove water pipe. Remove rocker arm assembly and push rods. Remove cylinder head bolts and cylinder head.

Installation — Make sure cylinder head and block gasket surfaces are clean and position gasket on cylinder block side marked "UP" in up position. Install cylinder head and tighten bolts in sequence shown in illustration. To install remaining components, reverse removal procedure. Install new "O" ring type seals on water pipe.



CYLINDER HEAD BOLT TIGHTENING SEQUENCE

VALVES							
Engine & Valve	Head Diam.	Face Angle	Seat Angle	Seat Width	Stem Diameter	Stem Clearance	Valve Lift
1965-66 152"	Int.	.....	45°	45°	.063-.094"	.372-.373"	.001-.0035"
	Exh.	.....	45°	45°	.078-.109"	.3715-.3725"	.0015-.004"
1967-68 152"	Int.	.....	45°	45°	.063-.094"	.372-.373"	.0015-.004"
	Exh.	.....	45°	45°	.078-.109"	.372-.373"	.0015-.004"
196" 196"	Int.	.....	45°	45°	.063-.094"	.372-.373"	.001-.0035"
	Exh.	.....	45°	45°	.078-.109"	.372-.373"	.0015-.004"
1969-70 196"	Int.	.....	45°	45°	.063-.094"	.372-.373"	.001-.0035"
	Exh.	.....	45°	45°	.078-.109"	.414-.415"	.0015-.004"
1971-72 196"	Int.	30°	30°	.063-.094"	.372-.373"	.001-.0035"
	Exh.	45°	45°	.078-.109"	.414-.415"	.0015-.004"

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VALVE ARRANGEMENT

E-I-E-I-E-I-E-I (Front to rear.)

VALVE GUIDE SERVICING

Check valve stem to guide clearance, if clearance exceeds .004", valve guides must be replaced. Guides are driven out from combustion chamber side using a suitable driver (SE-1722). Drive new guides in from top using a suitable guide installer (SE-1943). Guide installer can be adjusted to drive in guides until correct amount of guide is protruding from top of cylinder head. See *Valve Guide Installed Height Specifications*.

Valve Guide Installed Height Specifications

Application	Intake	Exhaust
152"		
1965-68	$3\frac{1}{32}"$	$1\frac{3}{32}"$
196"		
1968-72	$3\frac{1}{32}"$	$1\frac{1}{64}"$

VALVE STEM OIL SEALS

An "O" ring type seal is installed in second groove of valve stem before valve keepers are installed. See *Valve Spring*.

VALVE SPRINGS			
Engine	Free Length	PRESSURE (LBS.)	
		Valve Closed	Valve Open
152" & 196"	2.065"	.....	.....

VALVE SPRINGS

Removal – With cylinder head removed, compress valve spring with a suitable spring compressor. Remove valve keepers

and release spring compressor. Remove spring retainer, valve stem shield, spring, valve stem seat or rotator.

Installation – Before installation of valve spring, test spring in a suitable spring tester. With spring compressed to 1.429", tester should read 188.1 ± 8 pounds. Replace springs as necessary. To install valve springs, reverse removal procedure. Install new valve stem seals in second groove of valve stem before installing keepers.

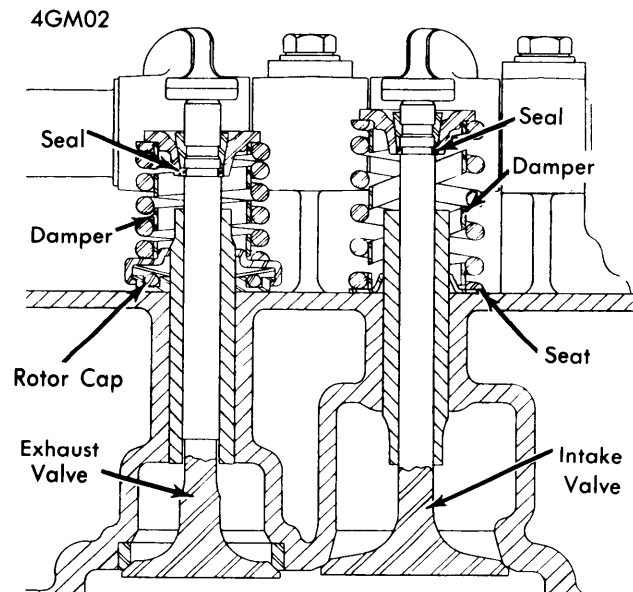
ROCKER ARM ASSEMBLY

1) With rocker arm assembly removed, remove retaining bolts from rocker supports. Remove supports, rocker arms and spacers from rocker shaft. Keep parts in order to ensure that they are installed in original position. Clean all components thoroughly, to ensure that all oil passages are open.

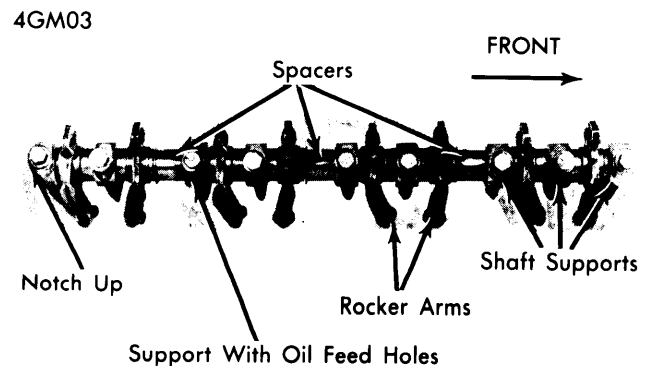
2) If rocker arm shaft is plugged, drill a hole in plug in one end, insert a rod and knock out opposite plug. Reverse shaft and knock out remaining plug. Thoroughly clean inside of shaft and install new plugs making sure that they are properly seated.

3) Inspect rocker arm shaft for wear or damage. Roll shaft on a flat surface to check if shaft is bent or distorted. Check rocker arm bushings for wear or damage and replace as necessary. Check clearance of rocker arms on shaft. If clearance exceeds .007", replace rocker arms or shaft.

4) Check valve contact surface on rocker arm for wear or scoring. If contact surface is damaged, it can be remachined. If more than .010" of material must be removed to resurface valve contact surface, rocker arm must be replaced. Lubricate all components and reverse disassembly procedure to assemble. Make sure components are installed in original position. Rocker arm shaft must be installed with notches up. Rocker support with oil feed hole must be positioned at third support from rear of engine.



VALVES & COMPONENTS

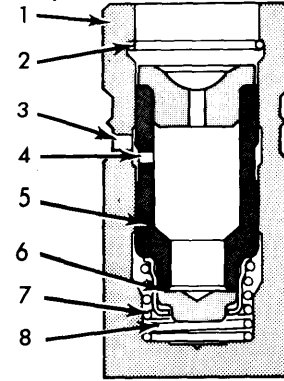
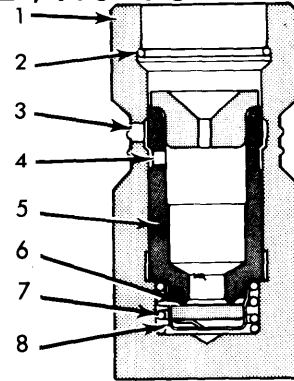
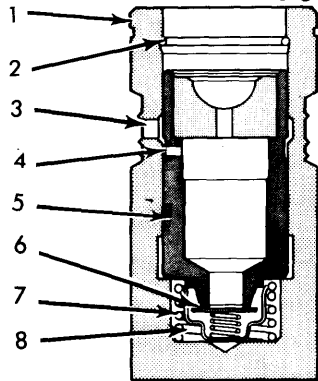


ROCKER ARM ASSEMBLY

HYDRAULIC VALVE LIFTERS

Three types of valve lifters may be used. Type of lifter is determined by number of ribs in recessed area of lifter body. Push rods are common to all three lifters and operating principles are basically the same.

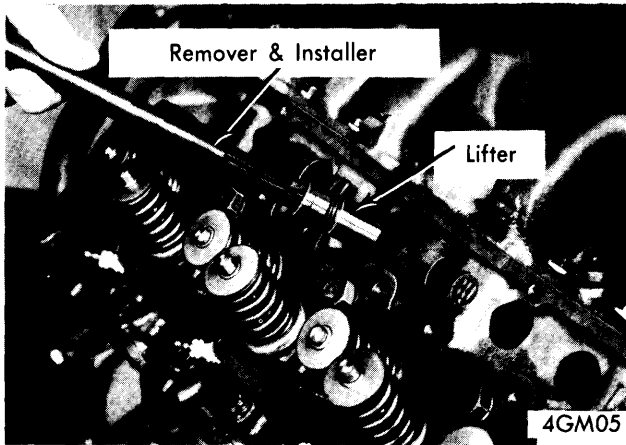
1965-72 152", 196" 4 CYL. ENGINES (Cont.)



- 1 - Lifter Body
- 2 - Snap Ring
- 3 - Body Oil Passage
- 4 - Plunger Oil Passage
- 5 - Plunger
- 6 - Check Valve
- 7 - Spring
- 8 - Oil Chamber

HYDRAULIC LIFTER ASSEMBLIES

Removal - Remove valve cover, rocker arm assembly and push rods. Use a suitable lifter removal tool (SE-1877 or SE-1947) to withdraw lifters (see illustration). Identify or mark lifters to ensure that they are installed in original position.



HYDRAULIC LIFTER REMOVAL

Disassembly - Position lifter upside down for approximately five minutes to drain excess oil from lifter. Compress plunger with a push rod and remove snap ring from inside top of assembly. Shake assembly to remove plunger. If plunger is lodged, tap top of lifter on a soft surface to remove plunger. Check valve assembly on bottom of plunger may be loose. Care should be taken not to lose any components of check valve.

Reassembly - Clean all components in a suitable cleaning solution to remove varnish or oil. Inspect all components for wear or scoring. If any components are damaged, complete lifter must be replaced. Make sure all oil holes are clean. Fill lifter body $\frac{1}{3}$ full with kerosene and lubricate all components with kerosene. Reverse disassembly procedure to assemble lifter. Use a suitable tester (Leakdown Rate Tester SE-1893). Correct leakdown rate is $\frac{1}{8}$ " travel at 50 pounds in 8 to 50 seconds.

Installation - To install hydraulic valve lifters, lubricate with oil and reverse removal procedure. Make sure lifters are installed in original position.

HYDRAULIC VALVE LIFTER ADJUSTMENT

Hydraulic valve lifters do not require periodic adjustment.

PISTONS, PINS, RINGS						
Engine	PISTONS	PINS		RINGS		
	① Clearance	Piston Fit	Rod Fit	Rings	End Gap	Side Clearance
1965-66 152"	.0035"	.0005-.0009"	.0006-.0012"	1	.010-.020"	.0015-.003"
				2	.010-.020"	.0015-.003"
				3	.015-.055"	.0006-.0084"
1967-68 152"	.0025"	.0005-.0012"	.0003-.0007"	1	.010-.020"	.0015-.003"
				2	.010-.020"	.0015-.003"
				3	⊙	.0006-.0084"
1968-70 196"	.0025"	.0005-.0012"	.0005-.0009"	1	.013-.023"	.0015-.003"
				2	.013-.023"	.0015-.003"
				3	.013-.028"	.002-.0035"
1971-72 196"	.0035"	.0005-.0009"	.0005-.0012"	1	.013-.023"	.0015-.003"
				2	.013-.023"	.0015-.003"
				3	.013-.028"	.002-.0035"

① - Interference fit.

⊙ - Ring ends butt together.

1965-72 152", 196" 4 CYL. ENGINES (Cont.)

OIL PAN

No information available from manufacturer at time of publication for removal of oil pan with engine still installed in vehicle.

PISTON & ROD ASSEMBLY

Removal — With oil pan and cylinder head removed, check top of cylinder bore for a ridge and remove ridge with a suitable ridge reamer before removing piston and rod assemblies. Mark or identify rod caps to rods to make sure that they are installed in original position. Remove rod bolts and caps and push piston and rod assemblies out toward top of cylinder block.

Installation — 1) Make sure piston, rings and cylinder bore are thoroughly cleaned and lubricated. Make sure piston ring gaps are staggered with one compression ring gap aligned with one end of piston pin and other compression ring gap aligned with opposite end of piston pin. Place oil ring gap centered between compression ring gaps. Center oil ring spacer gaps between compression ring and oil ring gaps.

2) Compress piston rings and position piston and rod in bore with word "UP" on top of piston on camshaft side of engine. Push piston and rod assembly into engine carefully aligning rod and bearing on crankshaft journal. Install correct rod cap and tighten rod bolts.

FITTING PISTONS

1) Measure each cylinder bore with a micrometer to determine if cylinder is worn, tapered or out-of-round. If cylinder is not tapered more than .001" or is not out-of-round more than .001", cylinder bore will not need servicing, providing piston to cylinder bore clearance is within specifications.

2) To check piston to bore clearance, check pistons for scuffed or scored skirts and replace as necessary. With rings and piston pin removed, insert piston in bore upside down with a

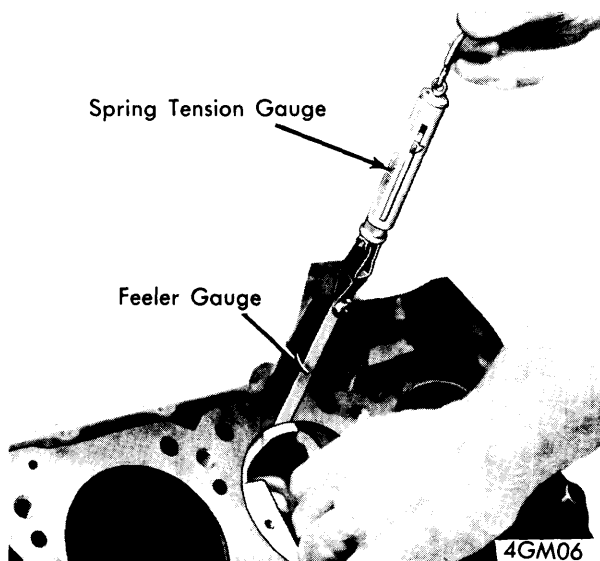
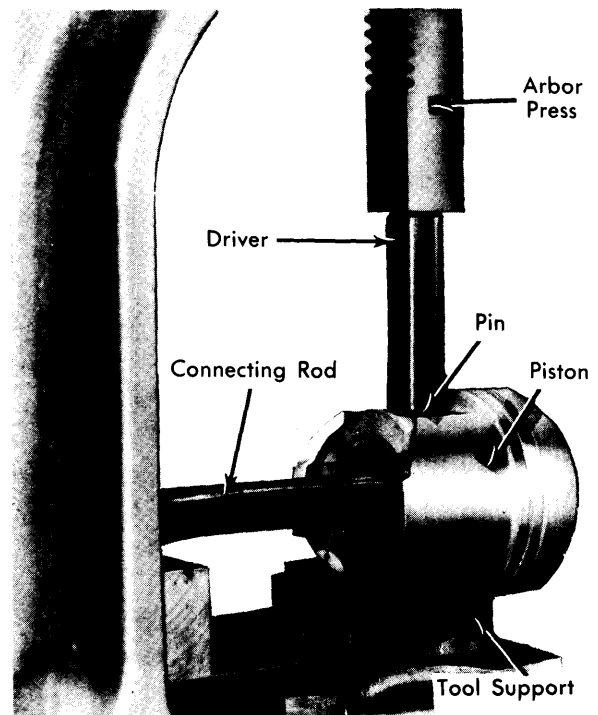
.0025" feeler gauge between piston and bore. Position feeler gauge equally between piston pin holes. One to three pounds, measured on a spring tension gauge, will be required to withdraw feeler gauge if clearance is correct.

3) If clearance is excessive or cylinder is tapered or out-of-round more than .001", cylinder must be rebored and oversize pistons and rings installed. Pistons and rings are available .010", .020", .030" and .040" oversize.

PISTON PINS

Removal — With piston and rod assembly removed, press out piston pin using a suitable piston removal and installation tool (Tool Set No. SE-1946) and an arbor press. Place piston and rod assembly in tool support mounted in arbor press. Position piston in tool support with camshaft side of piston to the left. Press out piston pin with tool set driver. Separate piston from connecting rod.

Installation — Check fit of pin in piston. If clearance exceeds specifications, replace piston and pin. Check interference fit of pin in connecting rod. If fit not to specifications, replace piston pin or rod. To assemble piston and rod assembly, position connecting rod in piston with bearing tang notches aligned with side of piston marked "UP". Lubricate pin holes and piston pin and press in using same tools as previously outlined.

**CHECKING PISTON-TO-BORE CLEARANCE****PISTON PIN REMOVAL**

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CRANKSHAFT MAIN & CONNECTING ROD BEARINGS							
Engine	MAIN BEARINGS				CONNECTING ROD BEARINGS		
	Journal Diam.	Clearance	Thrust Bearing	Crankshaft Endplay	Journal Diam.	Clearance	Sideplay
1965-66 152"	2.7484-2.7494"	.001-.004"	No. 3	.001-.005"	2.373-2.374"	.0011-.0032"	.004-.011"
1967-68 152" & 196"	2.7484-2.7494"	.001-.004"	No. 3	.003-.008"	2.373-2.374"	.0011-.0036"	.004-.011"
1969-72 196"	2.7484-2.7494"	.001-.004"	No. 3	.003-.008"	2.373-2.374"	.0011-.0036"	.004-.011"

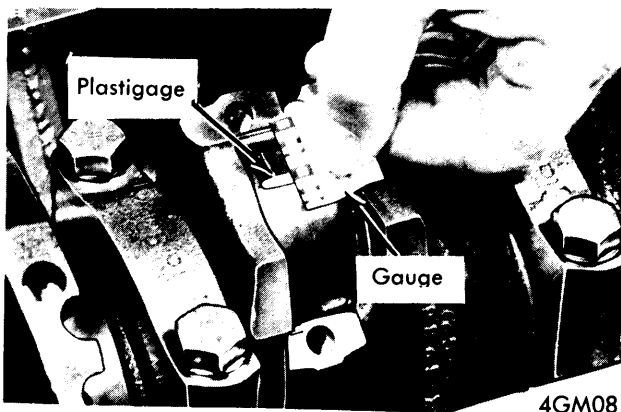
MAIN & CONNECTING ROD BEARINGS

Main Bearings – 1) With oil pan removed, remove oil pump. Remove main bearing bolts and caps. Remove rear main bearing cap using a suitable puller (SE-1719). Caps are numbered as to position and must be installed in original position.

2) Main bearing clearance is checked using the Plastigage method. Check crankshaft main journals for taper or out-of-round using calipers or a micrometer. If clearance exceeds specifications, or if journal is tapered more than .0005" or if journal is worn or out-of-round more than .002", crankshaft must be removed and ground for undersize bearings.

Connecting Rod Bearings – 1) With oil pan removed, remove oil pump. Remove connecting rod bearing cap bolts and remove bearing caps. Push up on connecting rod and piston and remove upper bearing insert. Check bearings for wear or scoring and replace as necessary.

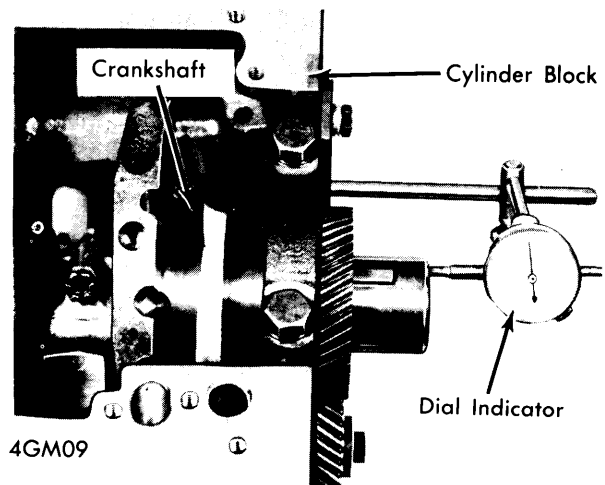
2) Check bearing clearance using the Plastigage method. Check crankshaft connecting rod journals for taper or out-of-round with calipers or a micrometer. If clearance exceeds specifications, or if journal is tapered more than .0005" or if journal is worn or out-of-round more than .002", crankshaft must be removed and ground for undersize bearings.



CHECKING CLEARANCE USING PLASTIGAGE METHOD

THRUST BEARING ALIGNMENT

Check crankshaft end play with a dial indicator (see illustration). If end play exceeds specifications, thrust bearing at number three main bearing must be replaced.



CHECKING CRANKSHAFT END PLAY

REAR MAIN BEARING OIL SEAL

Removal – Remove transmission, clutch and flywheel. Pry out seal using a suitable seal removal tool (SE-1941). Position protector plate on crankshaft flange. Insert prying tool in long notch on protector plate and pry on seal in various positions around seal. Finally insert prying tool in short notch and pry out seal.

Installation – Position rear main seal on a suitable pilot tool (SE-1942-2). Position pilot on a suitable installer tool (SE-1942-1). Place installer and pilot over end of crankshaft and drive seal into position. Seal should be flush with rear face of cylinder block.

FRONT ENGINE COVER

Removal – Drain cooling system and remove radiator. Remove oil pan and drive belts. Remove crankshaft pulley from hub and hub retaining bolt. Loosen front engine mounts and jack up front of engine until a suitable puller (SE-1368) can be installed on pulley hub, and remove hub. Disconnect water pipe from cylinder head. Remove front cover retaining bolts and remove front cover.

Installation – Position cover and new gasket on cylinder block. Install cover retaining bolts but do not tighten. Align front cover to crankshaft with a suitable aligning tool (SE-1949) and tighten bolts. To install remaining components, reverse removal procedure.

FRONT COVER OIL SEAL

Removal – Drain cooling system and remove radiator. Remove drive belts and crankshaft pulley. Remove crankshaft

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hub retaining bolt. Loosen front engine mounts and raise engine until a suitable puller (SE-1368) can be installed on pulley hub, and remove hub. Using a suitable puller (SE-1961) and a slide hammer, remove front cover oil seal.

Installation — Coat outside diameter of seal with motor oil and drive seal into place with a suitable driver (SE-1949). To install remaining components, reverse removal procedure.

CAMSHAFT			
Engine	Journal Diam.	① Clearance	Lobe Lift
152" & 196"			
No. 1	2.099-2.100"	.0015-.0035"	.....
No. 2	2.089-2.090"		
No. 3	2.079-2.080"		
No. 4	2.069-2.070"		
No. 5	2.059-2.060"		

① — Clearance for 1965-66 152" is .001-.005".

TIMING GEARS

Removal — Remove front engine cover as previously outlined. Rotate engine until timing marks on timing gears are aligned. Pull off crankshaft gear with a suitable puller (SE-1368). To remove camshaft gear, remove gear retaining bolt and pull off gear with a suitable puller (SE-1368).

Installation — To install crankshaft gear, lubricate inside of gear and position on crankshaft aligning gear keyway with key. Press gear into position using a suitable installation tool (SE-1900 and SE-1900-16). To install camshaft gear, lubricate inside of gear and position on camshaft, aligning gear keyway with key. Press gear into position using a suitable installation tool (SE-1900 and SE-1900-17). Install and tighten retaining bolt. Make sure gear timing marks are aligned (see illustration).

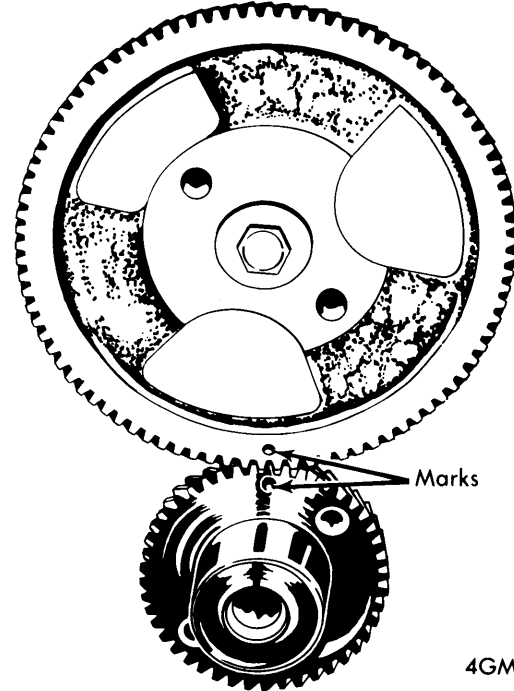
CAMSHAFT

Removal — Remove rocker arm assembly, valve lifters and front engine cover as previously outlined. Remove two screws securing camshaft thrust plate to cylinder block. Carefully pull camshaft toward front to remove. Care must be taken not to damage camshaft lobes or camshaft bearings.

Inspection — Thoroughly clean camshaft and inspect all camshaft lobes and journals for wear or scoring. Check camshaft journals for wear or out-of-round. If wear or out-of-round exceeds .001", camshaft should be replaced. Check

camshaft for runout with a dial indicator and camshaft mounted in two "V" blocks. If camshaft runout exceeds .002", camshaft should be replaced.

Installation — To install camshaft, reverse removal procedure. Make sure timing marks on gears are correctly aligned (see illustration).



VALVE TIMING MARKS

CAMSHAFT BEARINGS

With camshaft removed, check clearance of camshaft and bearings, if clearance is excessive and camshaft journals are within specifications, bearings must be replaced. Bearings are removed and replaced using a suitable camshaft bearing removal and installation tool set (Set No. SE-1897) and a slide hammer. Make sure all holes in camshaft bearings align with oil holes in cylinder blocks. Make sure that none of the bearings interfere with lifter travel.

CAMSHAFT END THRUST

Camshaft end play is controlled by camshaft thrust plate. If camshaft end play exceeds .014", replace camshaft thrust plate.

ENGINE OILING

Crankcase Capacity — All engines 4 quarts, add 1 quart with filter change.

Oil Filter — Full-flow, disposable element type. Replace every oil change.

Normal Oil Pressure — Minimum at normal idle, 10 to 20 psi. Minimum at 1800 RPM, 40 to 50 psi.

Pressure Regulator Valve — Mounted in oil pump cover. See Oil Pump.

ENGINE OILING SYSTEM

Oil pump driven by distributor, provides full pressure lubrication to all camshaft, crankshaft and connecting rod bearings. Full pressure lubrication is also provided to valve lifters, push rods and rocker arm assemblies. Cylinder walls and piston pins are lubricated by splash oil from connecting rod journals. A spring loaded pressure regulator valve, limits maximum pressure in system.

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ENGINE OILING (Cont.)

OIL PUMP

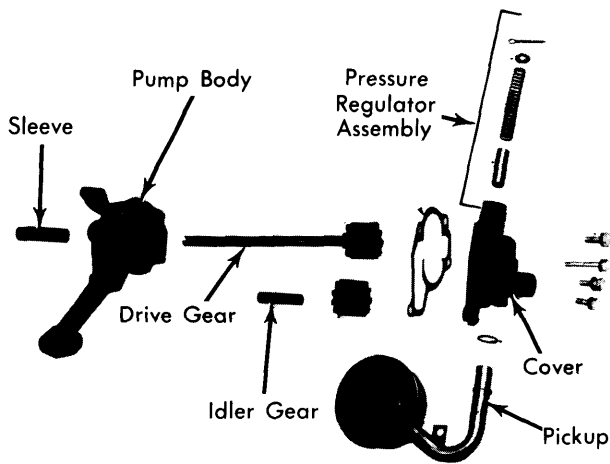
Disassembly – With oil pump removed, thoroughly clean outside of pump before disassembling. Remove cover retaining bolts, remove cover and pull pickup tube out of cover. Place pump in a press and press drive gear shaft out of sleeve. Remove drive gear and idler gear. Remove cotter pin from cover and withdraw washer, spring and pressure regulator valve.

Inspection – Place gears in pump body and push gears toward outlet side of pump with thumb. Measure side clearance of gear in bore. If clearance not to specifications, replace gears or pump assembly. Check gear backlash and clearance of shaft in bore. If not to specifications, replace pump assembly. Make sure pressure regulator valve is not nicked or burred.

Assembly – Coat gears and shaft with oil and install in pump. Check gear end play in pump body. Clearance is determined by gasket between cover and pump body. Add or remove gaskets to obtain correct gear end play. Install cover and tighten bolts. Install oil pickup tube and tighten bolt. Lubricate pressure regulator valve and install in cover with chamfered end first. Install spring, washer and cotter pin. Install sleeve on shaft so that sleeve protrudes .200" from end of shaft. Crimp sleeve on shaft to prevent from moving.

Oil Pump Specifications

Application	Specification
Gear End Play.....	.0015-.006"
Gear Side Clearance.....	.0007-.0027"
Shaft Clearance.....	.001-.0025"
Gear Backlash.....	.0107"
Pressure Regulator Spring.....	1.812" @ 13.33 Lbs.



4GM11

OIL PUMP

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs.
Main Bearing Bolts.....	75-80
Connecting Rod Bolts.....	45-55
Cylinder Head Bolts.....	90-100
Manifold-to-Cylinder Head.....	40-45
Camshaft Gear Nut.....	55-65
Camshaft Thrust Flange.....	15-20
Flywheel Bolts.....	45-55
Crankshaft Pulley Hub Bolt.....	100-110