196", 231" V6 & 350" VIN CODE X V8 ENGINES

IDENTIFICATION CODING

ENGINE IDENTIFICATION

Engines are identified by a letter code within a production number stamped on front of engine block below right cylinder head. Number is also found on code letter tape on front of left valve cover on Oldsmobile and Pontiac models.

Application	VIN Code
196" 2-Bbl. V6	C
231" 2-Bbl. V6	A
231" Turbocharged 2-Bbl. V6	G
231" Turbocharged 4-Bbl. V6	3
350" 4-Bbl. V8	X

ENGINE REMOVAL

See Engine Removal at end of ENGINE Section.

CYLINDER HEAD & MANIFOLDS

INTAKE MANIFOLD

Removal – 1) Disconnect battery, remove air cleaner and drain cooling system. Disconnect upper radiator hose and accelerator linkage and bracket. Disconnect downshift linkage if equipped with automatic transmission. Disconnect booster vacuum line and fuel line at carburetor. Remove choke pipe at choke housing and disconnect vacuum modulator line if equipped with automatic transmission.

2) Disconnect idle stop solenoid lead (if equipped). Disconnect distributor wires and temperature sending unit lead. Disconnect vacuum hoses from distributor TVS and EFE valve pipe and vacuum tank hose. Disconnect coolant by-pass hose at manifold. Remove distributor cap and rotor to gain access to intake manifold Torx head bolt. Remove Torx head bolt using a suitable tool (J-24394). Remove spark plug wires and accelerator linkage springs. Remove intake manifold and carburetor as an assembly.

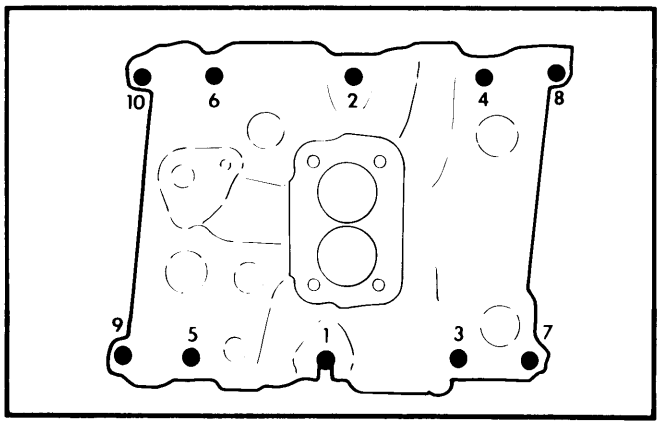

Fig. 1 Intake Manifold Tightening Sequence V6

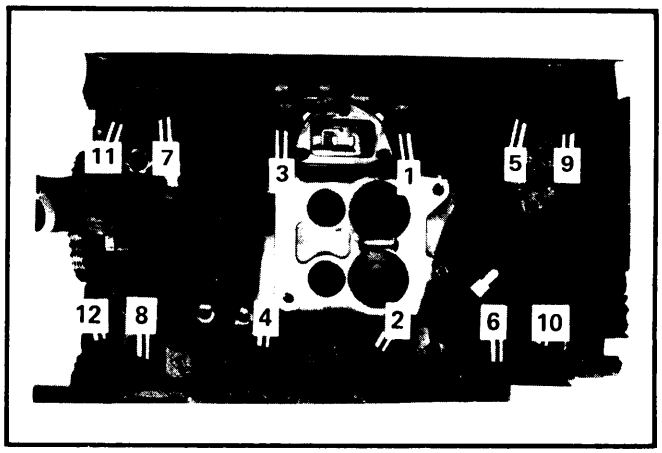

Fig. 2 Intake Manifold Tightening Sequence V8

Installation – Install new intake manifold gaskets and position new rubber seals on front and rear rails on cylinder block. Make sure pointed end of rail seals tight against block and head. Apply RTV sealer or equivalent to end of seals. Install intake manifold and tighten bolts in sequence shown in illustration. To complete installation, reverse removal procedure.

CYLINDER HEAD

Removal – Remove intake manifold as previously outlined. Remove dip stick. Remove power steering pump and mount without disconnecting lines and position pump out of way. Disconnect spark plug wires from spark plugs. Remove exhaust manifold retaining bolts. Remove valve cover, rocker arm assembly and push rods. Mark push rods to ensure that they are installed in original position. Remove cylinder head.

NOTE – *On 350" engine remove left front engine mount through bolt. Raise engine for exhaust manifold to clear steering gear.*

Installation – Make sure mating surfaces and bolt holes are clean. Check bolt threads for burrs. Position new gasket on block and install head. Lubricate bolts and tighten in sequence. See *Fig. 3 or 4*. To complete installation, reverse removal procedures.

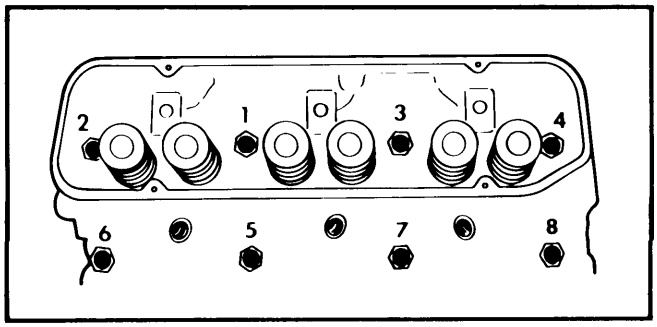

Fig. 3 Cylinder Head Tightening Sequence V6

196", 231" V6 & 350" VIN CODE X V8 ENGINES (Cont.)

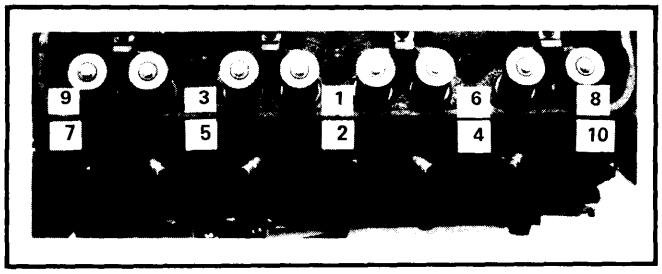

Fig. 4 Cylinder Head Tightening Sequence V8

VALVES

VALVE ARRANGEMENT

E-I-E-I-I-E (Left side, front to rear.)
E-I-I-E-I-E (Right side, front to rear.)

VALVE GUIDE SERVICING

If valve stem-to-guide clearance exceed specifications, ream guides with .003" oversize reamer, then use .006" oversize reamer. Oversize valves are .006" on V6 engines. Use .006" oversize reamer then use .010" oversize reamer on V8 engines. Oversize valves are .010" on V8 engines. Oversize valves are identified by size stamped on head.

VALVE STEM OIL SEALS

Valve stem oil seals are installed on intake valves only. Seal is mounted on valve guide. A new seal should be installed whenever valve spring is removed. To install new seals, carefully slide seal over valve stem and push down until it contacts valve guide. Using a suitable tool (J-22509) push seal onto guide until seal bottoms against guide.

VALVE SPRINGS

Removal – With cylinder head removed, compress valve spring with a suitable spring compressor and remove valve keepers. Release spring compressor and remove spring retainer and spring. Remove valve stem oil seal from intake valves.

Installation – Check valve springs in a suitable valve spring tester and replace as necessary. Install valve stem oil seals on intake valves. Install intake valve springs on 350" engine with closely wound coils toward cylinder head. Exhaust valve springs on 350" and V6 engines may be installed with either end up.

ROCKER ARM ASSEMBLY

With rocker arm assembly removed, remove nylon rocker arm retainers and remove rocker arms from shaft. Inspect shaft and rocker arms for wear, scoring or damage. Replace components as necessary. If rocker arms are being replaced, note that rocker arms are marked left and right. Reverse disassembly procedure to assemble rocker arms. Rocker arms must be installed in correct order on shafts (see illustration) and new nylon retainers installed.

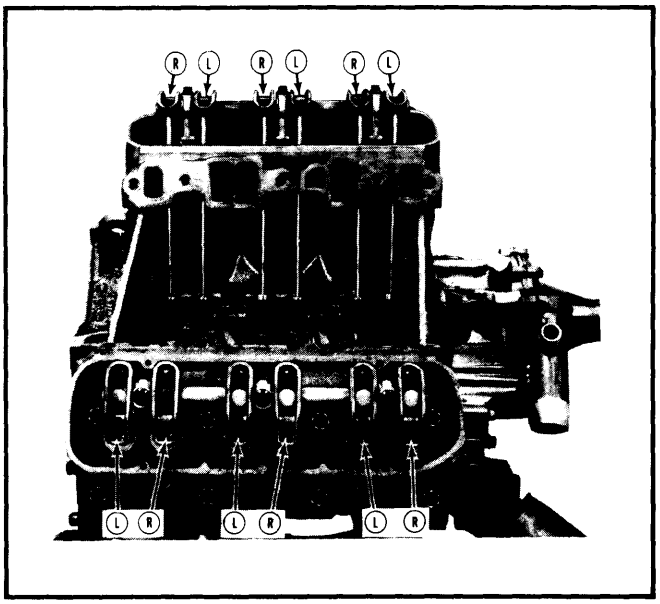

Fig. 5 Rocker Arm Positioning

HYDRAULIC VALVE LIFTER ASSEMBLY

If hydraulic valve lifters are being removed, mark or identify lifters to ensure that they are installed in original position. Lifters are serviced as complete assemblies only. If lifter is damaged or worn, complete lifter must be replaced. If lifters are disassembled for cleaning and inspection, after reassembly they should be tested using a suitable leak-down rate tester.

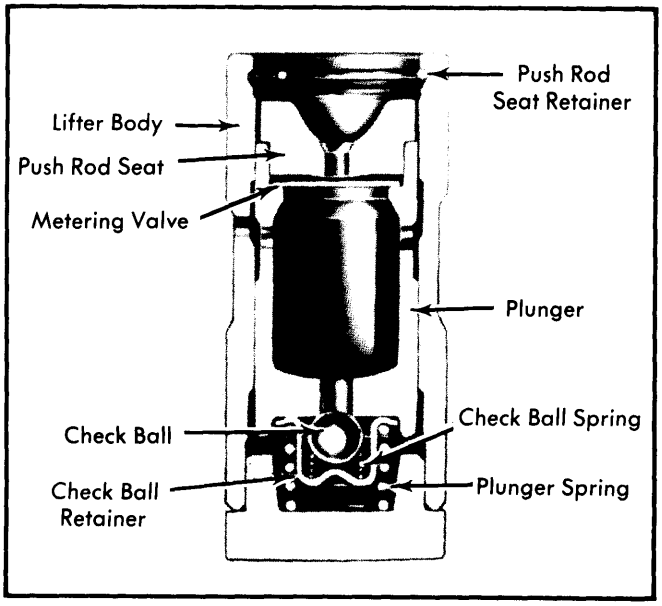

Fig. 6 Hydraulic Valve Lifter

196", 231" V6 & 350" VIN CODE X V8 ENGINES (Cont.)

PISTONS, PINS & RINGS

OIL PAN

See Oil Pan Removal at end of ENGINE Section.

PISTON & ROD ASSEMBLY

Removal – With cylinder heads removed, check top of cylinder bore for a ridge. Remove ridge using a suitable ridge reamer. Mark or identify pistons to cylinders to ensure that they are installed in original position. With oil pan removed, rotate engine until number one rod is straight down. Remove rod nuts and caps. Install suitable guide on rod bolts and push piston and rod assembly out of cylinder bore. Follow same procedure to remove remaining piston and rod assemblies.

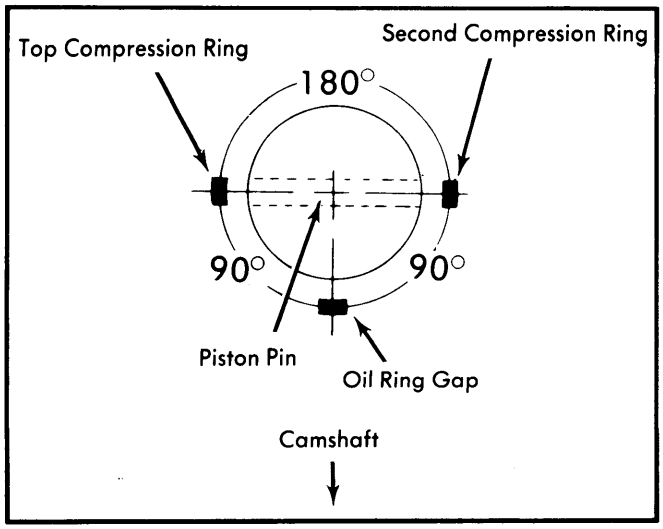

Fig. 7 Piston Ring Gap Position

Installation – Position rings in piston as shown in illustration. Make sure cylinder bore, pistons and bearing journals are clean. Coat bearing surfaces and cylinder bore with oil. Rotate crankshaft until rod journal of piston and rod assembly being installed is straight down. Place bearing insert in rod and install guides on rod bolts. Compress piston rings using a suitable ring compressor. Position piston in bore so that notch in top of piston is facing toward front of engine. Push piston into bore, carefully guiding rod over crankshaft until bearing is seated against journal. Remove guides and install rod cap and bearing. Tighten rod nuts.

FITTING PISTONS

With piston and rod assembly removed, thoroughly clean cylinder bore. Inspect bore for scoring or grooves. Measure cylinder bore for taper or out-of-round. If cylinder tapers more than .005" or is out-of-round more than .003", cylinder must be bored and oversize pistons and rings installed. Measure piston diameter at right angle to piston pin and ¼" below oil ring groove. If clearance between piston and cylinder is excessive, cylinder must be bored and oversize pistons and rings installed.

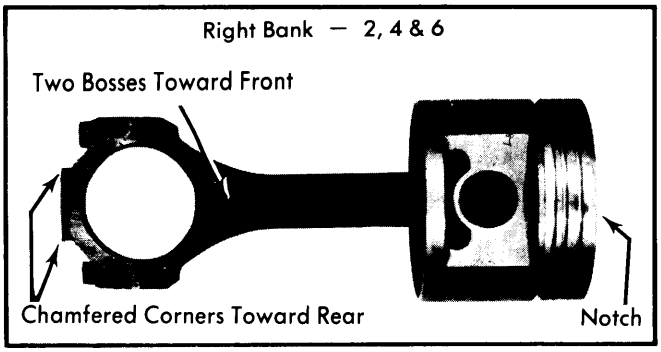

Fig. 8 Right Bank Piston & Rod Assembly for V6

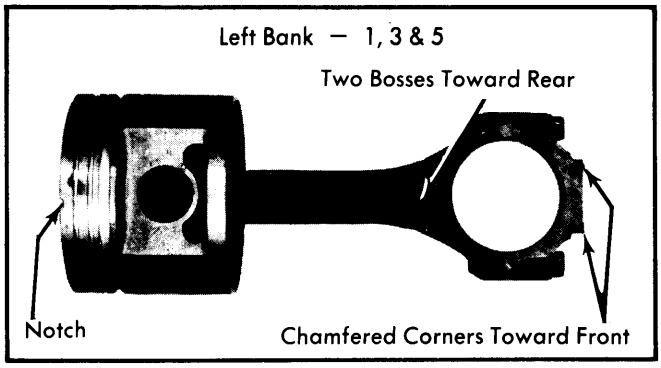

Fig. 9 Left Bank Piston & Rod Assembly for V6

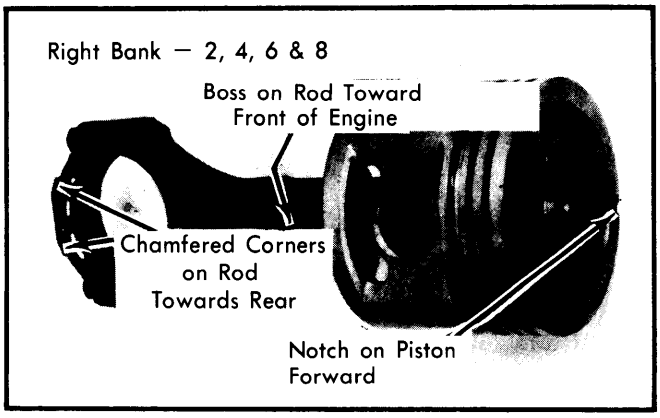

Fig. 10 Right Bank Piston & Rod Assembly for V8

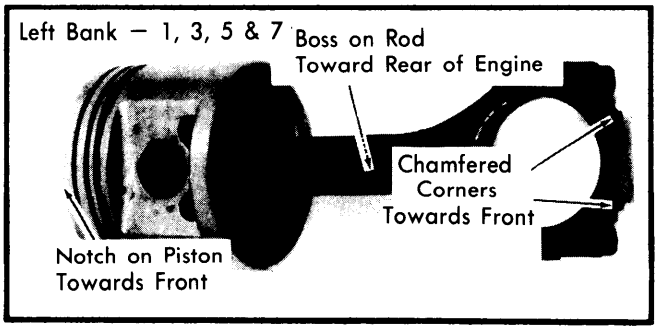

Fig. 11 Left Bank Piston & Rod Assembly for V8

196", 231" V6 & 350" VIN CODE X V8 ENGINES (Cont.)

PISTON PINS

Piston pin is selective press fit in connecting rod. Using a suitable tool set and a press, remove piston pin and separate piston and connecting rod. Inspect pin for wear or scoring. Check clearance of pin in piston. If clearance is excessive, piston and pin assembly must be replaced. Place piston on rod in correct position depending on which bank piston and rod are being installed in (see illustration). Lubricate piston pin and press into piston and rod using a suitable tool and press.

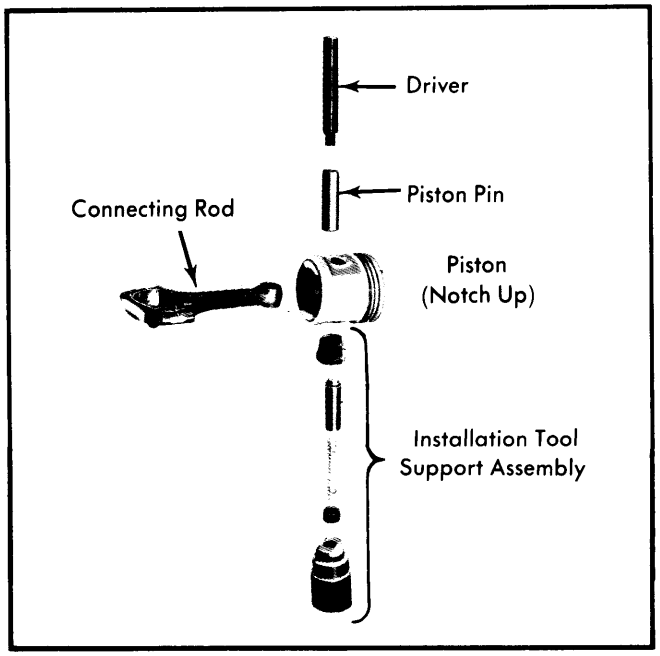

Fig. 12 Piston Pin Installation

CRANKSHAFT & ROD BEARINGS

MAIN & CONNECTING ROD BEARINGS

Connecting Rod Bearings – With rod cap removed, inspect bearings for flaking or wear. Check connecting rod journal for scoring or grooves. Measure rod journal with a micrometer and check journal for out-of-round conditions. Journal should not exceed .0015" out-of-round. Check bearing to journal clearance using the Plastigage method. If clearance exceeds .003", a selective fit undersize bearing may be installed to obtain correct clearance. If clearance is still excessive, crankshaft must be replaced.

Main Bearings – With main bearing cap removed, inspect bearing for flaking or scoring. Inspect main bearing journal for wear or grooves. Check journal for out-of-round conditions with a micrometer. If journal is out-of-round more than .0015", crankshaft must be replaced. Check bearing to journal clearance using the Plastigage method. If clearance exceeds specifications, a selective fit undersize bearing may be installed to obtain correct clearance. If clearance is still excessive, crankshaft must be replaced.

NOTE – *If main journals on turbocharged engine are scored or ridged, crankshaft must be replaced.*

REAR MAIN BEARING OIL SEAL

Upper half of seal can only be replaced if crankshaft is removed. A seal that leaks can be repaired without being replaced.

Oil Seal Repair – **1)** With rear main bearing cap removed, insert a suitable packing tool (J-21526-2) against one end of seal in block. Pack seal in until tight, by driving in against seal with tool. Seal should be approximately ¼" to ¾" below edge of cylinder block. Repeat this procedure on both ends of seal. Measure amount that is packed into groove and add 1/16". Measure this total on seal removed from main bearing cap and cut off amount. Cut off amount for opposite side also.

2) Install a suitable guide tool (J-21526-1) on cylinder block. Using packing tool, drive cut off piece into groove until packing tool reaches stop on guide tool. Follow same procedure to pack cut off piece into opposite side. Install new seal into rear main bearing cap. Install rear main bearing cap.

Oil Seal Replacement – With crankshaft removed, pry old seals out of cylinder block and main bearing cap. Position new seal halves in grooves. Roll seals into grooves with a hammer handle. Continue rolling seal until ends protrude 1/16" above edge and cut off flush with a razor blade. Lubricate seal contact surface on crankshaft. Install crankshaft and main bearing cap.

Main Bearing Cap Side Seals – Neoprene seals are placed on sides of bearing cap. Seals are slightly undersize when newly installed (and may leak) since neoprene composition swells in presence of heat and oil. Seals are slightly longer than grooves in cap, but should not be cut off. Soak seals in light oil or kerosene for one or two minutes before installation. After seals are installed, force up into cap with end of hammer handle. Apply RTV sealer to mating surface of main bearing cap before installation.

THRUST BEARING ALIGNMENT

With thrust bearing cap bolts finger tight, move crankshaft forward and backward with last movement being forward. Tighten thrust bearing cap bolts.

CAMSHAFT

FRONT ENGINE COVER

Removal – Drain cooling system and disconnect upper and lower radiator hoses and heater hose at water pump. Remove drive belts, fan and pulleys. Disconnect fuel lines and remove fuel pump. Remove alternator and mount, and distributor. If timing chain and sprockets are not being removed, note position of rotor on distributor for installation. Loosen front clamp on thermostat by-pass hose. Remove harmonic balancer. Remove front engine cover retaining bolts and remove cover.

Installation – Oil pump cover should be removed and petroleum jelly packed around oil pump gears whenever front engine cover is removed. Oil pump may loose its prime when front engine cover is removed. Make sure gasket surfaces are

196", 231" V6 & 350" VIN CODE X V8 ENGINES (Cont.)

clean and use new gasket. Use sealer on bolt threads. Reverse removal procedure to install front engine cover.

FRONT COVER OIL SEAL

Removal – With front engine cover removed, drive seal out from front to rear of cover, using a drift punch.

Installation – Coil new packing around opening so that ends are at top. Using a suitable punch, drive in shedder and stake in place at three points. Size packing by rotating a hammer handle around packing until balancer hub can be inserted through opening.

TIMING CHAIN

Removal – 1) With front cover removed, temporarily install harmonic balancer washer and bolt. Rotate engine until timing marks on sprockets are aligned. See *Fig. 13*. Remove harmonic balancer bolt without disturbing position of sprockets. Remove front oil slinger. On 231" engine remove oil pan.

2) Take out bolt and special washer securing distributor drive gear and fuel pump eccentric to camshaft. Slide gear and eccentric off camshaft, alternately pry sprockets on camshaft and on crankshaft to enable removal of timing chain and sprockets. Clean all parts thoroughly and replace any piece showing wear or fatigue.

Installation – 1) Make sure No. 1 piston is at TDC and align camshaft and crankshaft timing marks. Carefully install timing chain and sprockets without disturbing alignment of marks. Place oil slinger (with concave side to front of engine) on crankshaft.

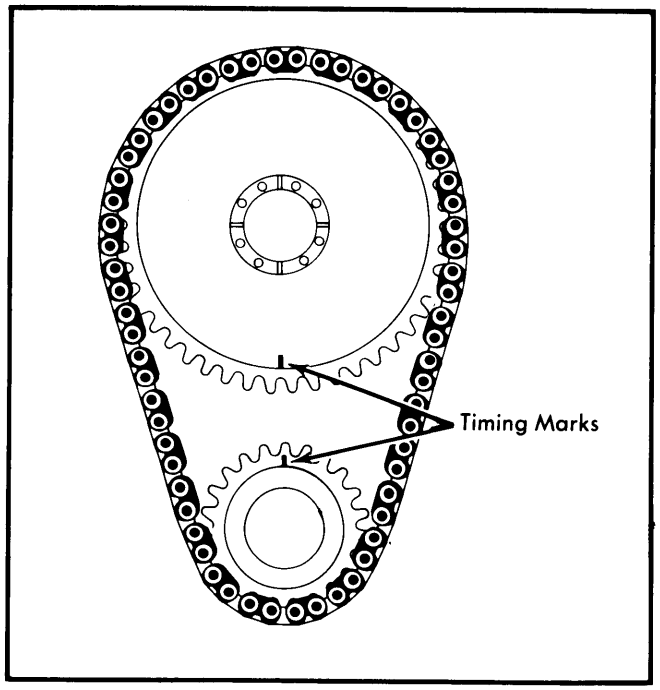

Fig. 13 Timing Chain Sprocket Alignment

2) Position fuel pump eccentric on camshaft so that oil groove is outboard of keyway and to front of engine. Install distributor drive gear, retaining washer, and eccentric bolt. Tighten to specification. Position camshaft thrust button and spring, and timing chain dampener. Install front cover and tighten bolts.

CAMSHAFT

Removal – Remove intake manifold, rocker arm assemblies, push rods and lifters. Mark or identify push rods and lifters to ensure that they are installed in original position. Remove front engine cover and timing chain and sprockets, as previously outlined. Remove radiator and shroud. Carefully slide camshaft out to avoid damaging camshaft bearings or lobes.

Installation – Thoroughly clean and inspect camshaft. Lubricate journals and camshaft lobes. Carefully insert camshaft taking care not to damage bearings or camshaft lobes. Reverse removal procedures to complete installation.

CAMSHAFT BEARINGS

Remove camshaft and crankshaft. Using suitable camshaft bearing removal tool, remove inner bearings first. In order to remove rear bearing, welch plug must be removed. Front bearings may be removed by using a spacer between engine block and puller plate and remove from rear. Bearings are installed by reversing removal procedures and carefully pulling into place with same tool. Be sure oil holes in bearing and journal are aligned. Use non-hardening sealer on welch plug before installation.

ENGINE OILING

Crankcase Capacity – Capacity is four quarts, add one quart with filter change.

Oil Filter – Replace at first oil change and then every other oil change. Filter is spin-on disposable type.

Normal Oil Pressure – Oil pressure should be 37 psi at 2600 RPM.

Pressure Regulator Valve – Located in oil pump, nonadjustable.

ENGINE OILING SYSTEM

Lubrication is force-feed type. Oil is supplied under full pressure to crankshaft, connecting rods, camshaft bearings and valve lifters. Controlled volume of oil is supplied to rocker arms and push rods. All other moving parts are lubricated by splash or gravity flow.

196", 231" V6 & 350" VIN CODE X V8 ENGINES (Cont.)

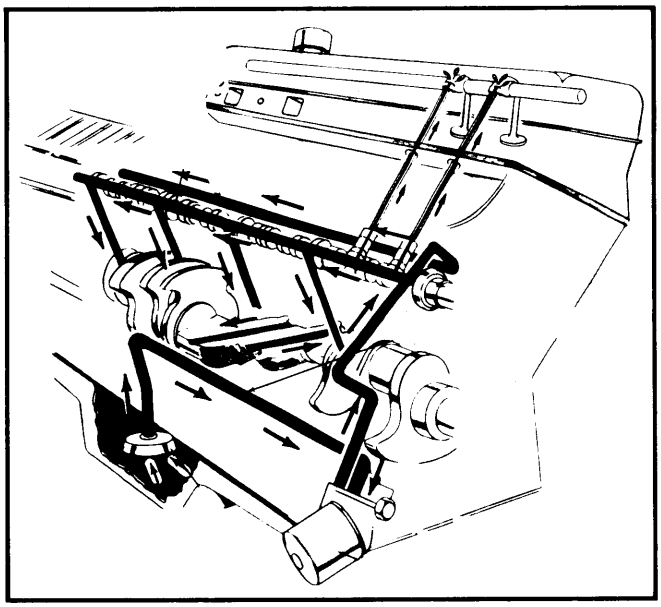

Fig. 13 Engine Oiling System

OIL PUMP

Removal – Remove oil filter. Remove bolts securing oil pump cover assembly to front engine cover. Remove cover assembly and slide pump gears out of pocket. Remove pressure regulator plug, spring and valve from cover assembly.

Inspection – Thoroughly clean all components and inspect for wear or damage. Check fit of valve in bore. If clearance is excessive, replace valve and/or cover. Position gears in pocket in cover. Place a straight edge across gears and measure clearance between straight edge and gasket surface with a feeler gauge. Specified clearance is .002-.006". If clearance is less than .002", check gear pocket for wear.

Assembly – Pack gear pocket with petroleum jelly and insert gears into pocket, making sure that jelly is packed into all pockets. Lubricate and install regulator valve in cover. Install spring, gasket and plug. Install new gasket and position cover on oil pump. Tighten cover retaining bolts.

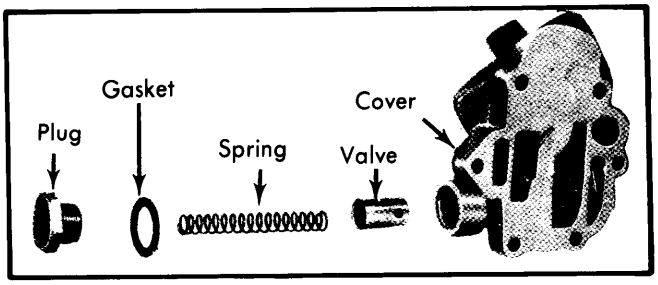

Fig. 14 Oil Pump and Components

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs.
Cylinder Head	80
Connecting Rod	40
Main Bearing Caps	①
Harmonic Balancer	②
Flywheel or Torque Plate	60
Intake Manifold	45
Exhaust Manifold	25
Front Engine Cover	30
Camshaft Sprocket Bolt	③
Rocker Arm Assembly	30
Pulley-to-Harmonic Balancer	20
Motor Mount-to-Block	55
Oil Pan	14
Oil Pump Cover	10

① – Oldsmobile – 115 ft. lbs. All others 100 ft. lbs.
② – Oldsmobile & Chevrolet – 175 ft. lbs. All others 225 ft. lbs.
③ – Oldsmobile – 50 ft. lbs. All others 22 ft. lbs.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Engine	Net HP At RPM	Torque (Ft. Lbs. at RPM)	Compr. Ratio	Bore	Stroke	Displ. Cu. Ins.
196" 2-Bbl.	90@3600	165@2000	8.0-1	3.50"	3.40"	196
231" 2-Bbl.	105@3400	185@2000	8.0-1	3.80"	3.40"	231
231" 2-Bbl.①	150@3800	245@2400	8.0-1	3.80"	3.40"	231
231" 4-Bbl.①	165@4000	265@2800	8.0-1	3.80"	3.40"	231
350" 4-Bbl.	170@3800	270@2400	8.0-1	3.80"	3.85"	350

① – Turbocharged engines.

196", 231" V6 & 350" VIN CODE X V8 ENGINES (Cont.)

ENGINE SPECIFICATIONS (Cont.)

VALVES

Engine & Valve	Head Diam.	Face Angle	Seat Angle	Seat Width	Stem Diameter	Stem Clearance	Valve Lift
196" & 231"							
Int.	1.620-1.630"	45°	45°	.063"	.3405-.3412"	.0015-.0032"	.....
Exh.	1.420-1.430"	45°	45°	.094"	.3405-.3412"	.0015-.0032"	.....
350"							
Int.	1.870-1.880"	45°	45°	.....	.3405-.3412"	.0015-.0032"	.....
Exh.	1.545-1.555"	45°	45°	.....	.3405-.3412"	.0015-.0032"	.....

VALVE SPRINGS

Engine	Free Length	PRESSURE (LBS.)	
		Valve Closed	Valve Open
196" & 231"	.....	56-69@1.73"	162-174@1.33"
350"	.....	72-77@1.73"	177-184@1.45"

CAMSHAFT

Engine	Journal Diam.	Clearance	Lobe Lift
196" & 231"	1.785-1.786"	①.0005-.0025"	.....
		②.0005-.0035"	.....
350"	1.785-1.786"	①.0005-.0025"	.....
		②.0005-.0035"	.....

① — Journal No. 1.
② — Remaining journals.

PISTONS, PINS, RINGS

Engine	PISTONS	PINS		RINGS		
	①Clearance	Piston Fit	Rod Fit	Rings	End Gap	Side Clearance
196" 231" & 350"	.0013-.0035"	.0004-.0007"	②.0007-.0017"	1	.010-.020"	.003-.005"
				2	.010-.020"	.003-.005"
				3	.015-.035"	.0001-.0035"

① — Measured at bottom of piston skirt
② — Press fit.

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

Engine	MAIN BEARINGS				CONNECTING ROD BEARINGS		
	Journal Diam.	Clearance	Thrust Bearing	Crankshaft End Play	Journal Diam.	Clearance	Side Play
196" & 231"	2.4995"	.0003-.0017"	2	.004-.008"	2.2491"	.0005-.0025"	.006-.027"
350"	3.0000"	.0004-.0015"	3	.003-.009"	1.996"	.0004-.0015"	.006-.027"

260", 350" VIN CODE R & 403" V8 ENGINES

IDENTIFICATION CODING

ENGINE IDENTIFICATION

Engines may be identified by code tape located on left front valve cover on Oldsmobile and Pontiac. Code on Buick is located on front left side of cylinder block. Codes are as follows:

Application	Code
Buick	
350" 4-Bbl.	R
403" 4-Bbl.	K
Oldsmobile	
260" 2-Bbl.	F
350" 4-Bbl.	R
403" 4-Bbl.	K
Pontiac	
350" 4-Bbl.	R
403" 4-Bbl.	K

ENGINE REMOVAL

See Engine Removal at end of ENGINE Section.

CYLINDER HEAD & MANIFOLDS

INTAKE MANIFOLD

Removal – Drain radiator and remove air cleaner assembly. Disconnect all coolant hoses to manifold, throttle cable, fuel and vacuum lines. Remove coil and disconnect or remove alternator and A/C compressor brackets as necessary. Remove bolts and remove intake manifold assembly from engine with carburetor attached.

Installation – Clean all gasket surfaces. Coat both sides of new intake manifold gasket with sealer and install gasket on head. Install end seals, being sure that end of seals are positioned under edges of heads. Install manifold and bolts. Tighten bolts in two steps in sequence shown in *Fig. 1*.

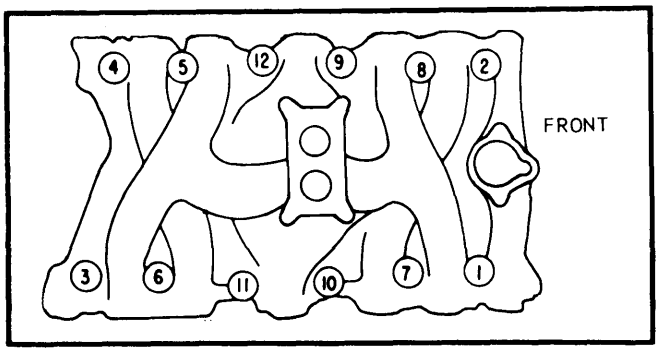

Fig. 1 Intake Manifold Tightening Sequence

CYLINDER HEAD

Removal – 1) Drain cooling system and remove intake manifold. Remove exhaust manifold. Remove valve cover, rocker arm bolts, pivots, rocker arms and push rods.

NOTE – *Keep components separate for reinstallation in original location.*

2) Loosen or remove any accessory brackets which interfere. Disconnect ground strap. Remove bolts and cylinder head.

Installation – Clean all gasket surfaces and coat both sides of head gasket with sealer. Install gasket on block and install cylinder heads. Dip cylinder head bolts in engine oil. Install and tighten in sequence in two steps. *See Fig. 2.*

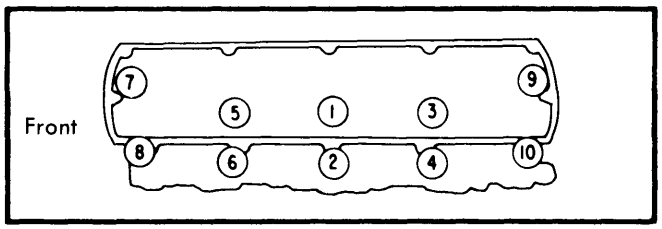

Fig. 2 Cylinder Head Tightening Sequence

VALVES

VALVE ARRANGEMENT

I-E-I-E-E-I-E-I (both banks, front to rear).

VALVE GUIDE SERVICING

Guides are integral with cylinder head. If stem-to-guide clearance is excessive, replace valve. Some valves with oversize stems are used in production, and can be identified by marks on inboard side of cylinder head on machined surface just above intake manifold. Valve guide reamers are available in .003", .005" and .013" oversize. When reconditioning, always use next oversize reamer and replacement valve. Service valves are available in standard, .003", .005", .010", and .013" oversizes.

VALVE STEM OIL SEALS

Cup type seals are used on all valves. Install with cupped side down, toward cylinder head. Position seals down as far as possible on valve stem. Seals will correctly position themselves when engine is started.

VALVE SPRINGS

Removal – Remove rocker arm cover, spark plug and rocker arm assemblies on cylinder(s) to be serviced. Install air line adapter (BT-72-1B) to spark plug port and apply air to hold valves in place. Using suitable tool (BT-6413), compress valve spring and remove valve keys, rotators and springs.

Installation – Reverse removal procedure and ensure that valve keys are securely locked in groove of valve stem.