Group 9
ENGINE
CONTENTS

CONTENTS (Cont'd)

ENGINE

DATA AND SPECIFICATIONS

ENGINE	
Type	90° V
Number of Cylinders	8
Bore PS-1 363 cu. in.	4.125″
PS-1, PS-3 383 cu. in.	4.25″
PC-1, PC-2 383 cu. in.	4.031″
PC-3, PY-1 413 cu. in.	4.19″
Stroke—PS-1, PS-3	3.375″
PC-1, PC-2, PC-3, PY-1	3.750″
Piston Displacement—PS-1	361 cu. in.
PS-1, PS-3 (4.25″ bore)	383 cu. in.
PC-1, PC-2 (4.031″ bore)	383 cu. in.
PC-3, PY-1	413 cu. in.
Compression Ratio (All Engines)	10.1 to 1
Compression Pressure at 150 rpm (Plugs Removed)	
Wide Open Throttle	150 to 180 psi
Maximum Variation Between Cylinders—Any one engine	20 psi
Firing Order	1-8-4-3-6-5-7-2
CYLINDER NUMBERING (FRONT TO REAR)	
Left Bank	1-3-5-7
Right Bank	2-4-6-8
CRANKSHAFT	
Type	Fully Counter-Balanced
Bearings	Steel Backed Babbitt
Journal Diameter—(PS-1, PS-3)	2.6245 to 2.6255″
(PC-1, PC-2, PC-3, PY-1)	2.7495 to 2.7505″
Crank Pin Diameter	2.374 to 2.375″
Maximum Out-of-Round Permissible	.001″
Number of Main Bearings	5
Diametral Clearance Allowed	.0002 to .0025″
Diametral Clearance Minimum	.0005 to .0015″
End Play	.002 to .007″
Thrust Taken By	No. 3 Main Bearing
Finish at Rear Seal Surface	Diagonal Knurling
Interchangeability of Bearings	Upper Nos. 1, 2, 4, 5. Lower Nos. 1, 2, 4, 5.
MAIN BEARINGS (Service)	
All available in standard and the following undersizes	.001, .002, .003, .010, .012″
CONNECTING RODS AND BEARINGS	
Type	Drop Forged "I" Beam
Length (Center to Center) PS-1, PS-3	6.356 to 6.360″
PC-1, PC-2, PC-3, PY-1	6.766 to 6.770″
Weight (Less Bearing Shells)	29.4 oz.
Bearings	Steel Backed Babbitt
Diameter and Length	2.735 x .927″
Diametral Clearance Desired	.0005 to .0015″
Maximum Allowable Before Reconditioning	.0025″

ENGINE (Cont'd)

Side Clearance	.009 to .017"
Bearings for Service	Standard .001, .002, .003, .010" .012" Undersize
Piston Pin Bore Diameter	1.0925 to 1.0928"

CAMSHAFT

Drive	Chain
Bearings	Steel Backed Babbitt
Number	5
Thrust Taken By	Cylinder Block
Diametral Clearance	.001 to .003"
Maximum Allowable Before Reconditioning	.005"

CAMSHAFT BEARING JOURNALS

Diameter	
No. 1	1.998 to 1.999"
No. 2	1.982 to 1.983"
No. 3	1.967 to 1.968"
No. 4	1.951 to 1.952"
No. 5	1.748 to 1.749"

CAMSHAFT BEARINGS

Diameter (after reaming)	
No. 1	2.000 to 2.001"
No. 2	1.984 to 1.985"
No. 3	1.969 to 1.970"
No. 4	1.953 to 1.954"
No. 5	1.750 to 1.751"

TIMING CHAIN

Adjustment	None
Number of Links	50
Pitch	.50"
Width	.88"

TAPPETS

Type	Hydraulic
Clearance in Block	.0005 to .0018"
Body Diameter	.9040 to .9045"
Clearance Between Valve Stem and Rocker Arm Pad	Dry Lash .060 - .210"

PISTONS

Type	Horizontal Slot w/Steel Struts
Material	Aluminum Alloy Tin Coated
Land Clearance (Diametral)	.031 to 037"
Clearance at Top of Skirt	.0005 to .0010"
Weight (Standard Through .040" Oversize)	
PS-1 361 cu. in.	732 grms.
PS-1, PS-3, 383 cu. in. (bore 4.25")	770 grms.
PC-1, PC-2 383 cu. in. (bore 4.031")	725 grms.
PC-3, PY-1 413 cu. in.	780 grms.

ENGINE (Cont'd)

Piston Length (Overall) PS-1, PS-3	3.84 in.
PC-1, PC-2, PC-3, PY-1	3.96 in.
Ring Groove Depth	
No. 1. PS-1 361 cu. in.	.214 in.
PC-1, PC-2 383 cu. in. (bore 4.031")	.210 in.
PS-1, PS-3 383 cu. in. (bore 4.25")	.220 in.
PC-3, PY-1 413 cu. in.	.216 in.
No. 2. PS-1 361 cu. in.	.214 in.
PC-1, PC-2 383 cu. in. (bore 4.031")	.210 in.
PS-1, PS-3 383 cu. in. (bore 4.25")	.220 in.
PC-3, PY-1 413 cu. in.	.216 in.
No. 3. PS-1 361 cu. in.	.199 in.
PC-1, PC-2 383 cu. in. (bore 4.031")	.195 in.
PS-1, PS-3 383 cu. in. (bore 4.25")	.203 in.
PC-3, PY-1 413 cu. in.	.200 in.
Pistons for Service	Standard, .005", .020", .040" Oversize

PISTON PINS

Type	Press Fit in Rod
Diameter	1.0935 to 1.0937"
Length	3.555 to 3.575"
Clearance in Piston	.00045 to .00075"
Interference in Rod	.0007 to .0012"
Piston Pins for Service	Standard Only
Direction Offset in Piston	Toward Right Side of Engine

PISTON RINGS

Number of Rings per Piston	3
Compression	2
Oil	1
Width of Rings	
(Compression)	.0775 to .0780"
(Oil)	.1860 to .1865"
Piston Ring Gaps (all)	.013 to .025"

RING SIDE CLEARANCE

(Compression)	
Upper	.0015 to .0030"
Intermediate	.0015 to .0030"
(Oil)	.0010 to .0030"

VALVES—Intake

Material	Silicon—Chromium Steel
Head Diameter—PS-1, PC-1, PC-2	1.95"
PS-1, PS-3, PC-3, PY-1	2.08"
Length (to center of valve face)	4.79"
Stem Diameter	.372 to .373"
Stem to Guide Clearance	.001 to .003"
Maximum Allowable Before Reconditioning	.004"
Angle of Seat	45°
Adjustment	None
Lift	.389"

ENGINE (Cont'd)

VALVES—Exhaust	
Material	Nitrogen Treated Manganese Chromium—Nickel Steel
Head Diameter	1.60″
Length (to center of valve face)	4.79″
Stem Diameter	.371 to .372″
Stem to Guide Clearance	.002 to .004″
Maximum Allowable Before Reconditioning	.006″
Angle of Seat	45°
Adjustment	None
Lift	.389″
VALVE SPRINGS	
Number	16
Free Length	2.34″
Load When Compressed To (valve closed)	1.860″ @ 95-105 lbs.
Load When Compressed To (valve open)	1.470″ @ 187-203 lbs.
Valve Springs I.D.	1.010 to 1.030″
CYLINDER HEAD	
Number Used	2
Combustion Chamber	Wedge Type
Valve Seat Runout (maximum)	.002″
Intake Valve Seat Angle	45°
Seat Width (finished)	.060 to .085″
Exhaust Valve Seat Angle	45°
Seat Width (finished)	.040 to .060″
Cylinder Head Gasket	
Compressed (thickness)	.022″
ENGINE LUBRICATION	
Pump Type	Rotor Full Pressure
Capacity (qts.)	5 *
Pump Drive	Camshaft
Operating Pressure at 40 to 50 mph	45 to 65 lbs.
Pressure Drop Resulting from Clogged Filter	7 to 9 lbs.

*When Filter Is Replaced, Add 1 Quart

SPECIAL TOOLS

C-119	Cylinder Bore Indicator
C-385	Piston Ring Compressor
C-647	Valve Spring Testing Fixture
C-756	Valve Guide Cleaner
C-897	Core Hole Plug Driver
C-3026	Valve Guide Wear Checking Sleeves
C-3028	Tappet Bore Reamer

SPECIAL TOOLS (Cont'd)

C-3033	Engine Front End Puller Kit
C-3052	Distributor Drive Shaft Bushing Puller
C-3054	Spark Plug Socket
C-3059	Main Bearing Upper Shell Remover and Replacer
C-3068	Tappet and Push Rod Carrier
C-3132	Camshaft Bearing Remover and Replacer
C-3160	Tappet Checking Pliers
C-3167	Engine Repair Stand
C-3221	Piston and Connecting Rod Remover and Replacer
C-3339	Dial Indicator
C-3422	Valve Spring Compressor
C-3427	Reamer (.030″ O.S.)
C-3430	Reamer (.015″ O.S.)
C-3433	Reamer (.005″ O.S.)
C-3466	Engine Lifting Plate
C-3487	Engine Support Fixture
C-3501	Cylinder Bore Surfacing Hone
C-3506	Chain Case Cover Oil Seal Remover and Replacer
C-3509	Camshaft Gear Installer
C-3625	Rear Main Bearing Oil Seal Installer
C-3626	Cylinder Head Holding Fixture
C-3628	Piston Ring Remover and Replacer (361 cubic inch engine)
C-3648	Valve Stem Length Gauge
C-3654	Oil Filter Remover and Replacer
C-3661	Tappet Remover
C-3662	Engine Repair Stand Adapter
C-3671	Piston Ring Remover and Replacer (413 cubic inch engine)
C-3672	Piston Ring Remover and Replacer (383 raised cubic inch engine)
C-3673	Piston Ring Remover and Replacer (383 low-cubic inch engine)
C-3684	Piston Pin Remover and Replacer

TIGHTENING REFERENCE

	Torque Foot-Pounds	Thread Size
Connecting Rod Nut—Plain	45	3/8-24

TIGHTENING REFERENCE (Cont'd)

	Torque Foot-Pounds	Thread Size
Connecting Rod Nut—CST (Black)	40	3/8-24
Cylinder Head Bolt	70	7/16-14
Main Bearing Cap Bolt	85	1/2-13
Spark Plug	30	14mm
Camshaft Lockbolt	35	7/16-14
Carburetor to Manifold Nut	7	5/16-24
Chain Case Cover Bolt	15	5/16-18
Torque Converter Housing Bolt	30	3/8-16
Clutch Housing Bolt	30	3/8-16
Crankshaft Rear Bearing Seal Retainer	30	3/8-16
Crankshaft Bolt	135	3/4-16
Cylinder Head Cover Stud and Nut	40 in. lbs.	1/4-28
Distributor Vacuum Line Tube Nut	95 in. lbs.	3/8-24
Distributor Clamp Bolt	15	5/16-18
Engine Front Mounting to Frame Bolt	85	1/2-20
Engine Front Mounting to Block Nut	45	7/16-20
Exhaust Manifold Nut	30	3/8-16
Exhaust Pipe Flange Nut	40	7/16-20
Exhaust Pipe Clamp Bolt	20	3/8-24
Exhaust Pipe Support Clamp Bolt	20	3/8-24
Fan Attaching Bolt	15-18	5/16-18
Fan Belt Idler Pulley Nut	45	7/16-20
Fan Belt Idler Pulley Bracket Bolt	30	3/8-16
Flywheel Housing to Cylinder Block Bolt	50	7/16-14
Flywheel Housing Cover Bolt	7	1/4-20
Fuel Pump Attaching Bolt	30	3/8-16
Generator Bracket to Manifold Bolt	50	7/16-14
Generator Mounting Nut	20	5/16-24
Generator Adjusting Strap Bolt	15	5/16-18
Generator Adjusting Strap Mounting Bolt	30	3/8-16
Intake Manifold Bolt	50	3/8-16
Manifold Heat Control Counterweight Bolt	50 in. lbs.	No. 10-32
Oil Pan Drain Plug	35	5/8-18

TIGHTENING REFERENCE (Cont'd)

	Torque Foot-Pounds	Thread Size
Oil Pan Bolt	15	5/16-18
Oil Pump Cover Bolt	10	5/16-18
Oil Pump Attaching Bolt	35	3/8-16
Oil Filter Attaching Stud	30	3/4-16
Rocker Shaft Bracket Bolt	30	3/8-16
Starter Mounting Bolt	50	7/16-14
Vibration Damper Bolt	15	5/16-18
Valve Tappet Cover End Bolt	9	1/4-20
Water Pump to Housing Bolt	30	3/8-16
Water Pump Housing to Cylinder Block Bolt	30	3/8-16
A/C Compressor to Engine Bolt	30	3/8-16

SERVICE DIAGNOSIS

1. ENGINE WILL NOT START

Possible Causes

a. Weak battery.

b. Corroded or loose battery connections.

c. Faulty coil or condenser.

d. Dirty or corroded distributor contact points.

e. Moisture on ignition wires and distributor cap.

f. Improper spark plug gap.

g. Improper timing (ignition).

h. Faulty ignition cables.

i. Dirt or water in the fuel line or carburetor.

j. Carburetor flooded.

k. Incorrect carburetor float setting.

l. Faulty fuel pump.

m. Carburetor percolating. No fuel to carburetor.

n. Faulty starting motor.

2. ENGINE STALLS

Possible Causes

a. Idle speed set too low.

b. Idle mixture too lean or too rich.

c. Incorrect carburetor float setting.

d. Improper choke adjustment.

e. Leak in intake manifold. Check intake manifold gasket.

f. Distributor contact points dirty, burned or improperly gapped.

g. Worn distributor rotor.

h. Ignition wiring incorrect.

i. Faulty coil or condenser.

3. ENGINE HAS LOSS OF POWER

Possible Causes

a. Incorrect ignition timing.

b. Worn distributor rotor.

c. Wrong mechanical or vacuum advance (distributor).

d. Excessive play in distributor shaft.

e. Worn distributor cam.

f. Dirty or incorrectly gapped spark plugs.

g. Dirt or water in fuel line or carburetor.

h. Improper carburetor float level.

i. Faulty fuel pump.

j. Incorrect valve timing.

k. Blown cylinder head gasket.

l. Low compression.

m. Burned, warped, pitted valves.

n. Plugged or restricted muffler or tail pipe.

o. Faulty ignition cables.

p. Faulty coil or condenser.

4. ENGINE MISSES ON ACCELERATION

Possible Causes

a. Distributor contact points dirty or improperly gapped.

b. Spark plugs dirty or gap too great.

c. Incorrect ignition timing.

d. Dirt in carburetor.

e. Acceleration pump in carburetor.

f. Burned, warped, or pitted valves.

g. Coil or condenser faulty.

5. ENGINE MISSES AT HIGH SPEED

Possible Causes

a. Dirt or water in fuel line or carburetor.

b. Dirty jets in carburetor, especially the economizer jet.

c. Distributor contact points dirty or incorrectly gapped.

d. Spark plugs dirty or gap set too wide.

e. Distributor shaft cam worn.

f. Worn distributor rotor.

g. Excessive play in distributor shaft.

h. Coil or condenser faulty.

i. Incorrect ignition timing.

6. NOISY VALVES

Possible Causes

a. Oil level in crankcase too low or too high.

b. Low oil pressure.

c. Dirt in tappets.

d. Bent push rods.

e. Worn rocker levers.

f. Worn tappets.

g. Worn valve guides.

h. Excessive runout of valve seats or valve face.

7. CONNECTING ROD NOISE

Possible Causes

a. Insufficient oil supply. Inspect oil pump relief valve and spring. Check filter for restrictions and by-pass.

b. Low oil pressure.

c. Thin or diluted oil.

d. Excessive bearing clearance.

e. Crankpin journals out-of-round.

f. Misaligned connecting rods.

8. MAIN BEARING NOISE

Possible Causes

a. Insufficient oil supply.

b. Low oil pressure.

c. Thin or diluted oil.

d. Excessive bearing clearance.

e. Excessive end play.

f. Crankshaft journals out-of-round or worn.

g. Loose flywheel or torque converter.

9. OIL PUMPING AT RINGS

Possible Causes

a. Worn, scuffed or broken rings.

b. Carbon in oil ring slots.

c. Rings stuck.

d. Insufficient tension in rings.

e. Incorrect ring size.

f. Out-of-round rings.

g. Rings fitted too tight in grooves.

10. OIL PRESSURE DROP

Possible Causes

a. Low oil level.

b. Thin or diluted oil.

c. Oil pump relief valve stuck.

d. Oil pump suction tube bent or leaking.

e. Clogged oil filter.

f. Excessive bearing clearance.

g. Worn parts in oil pump.

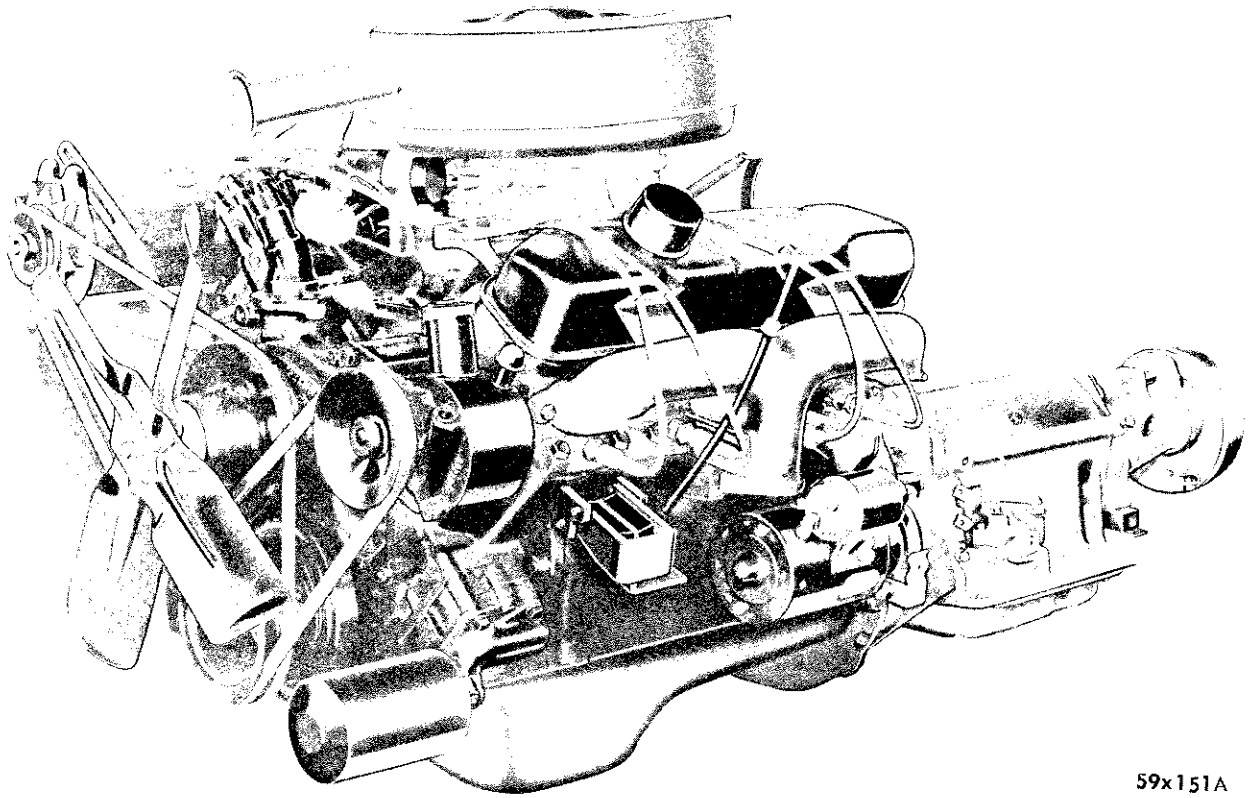

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Fig. 1—413 Cubic Inch Engine Assembly

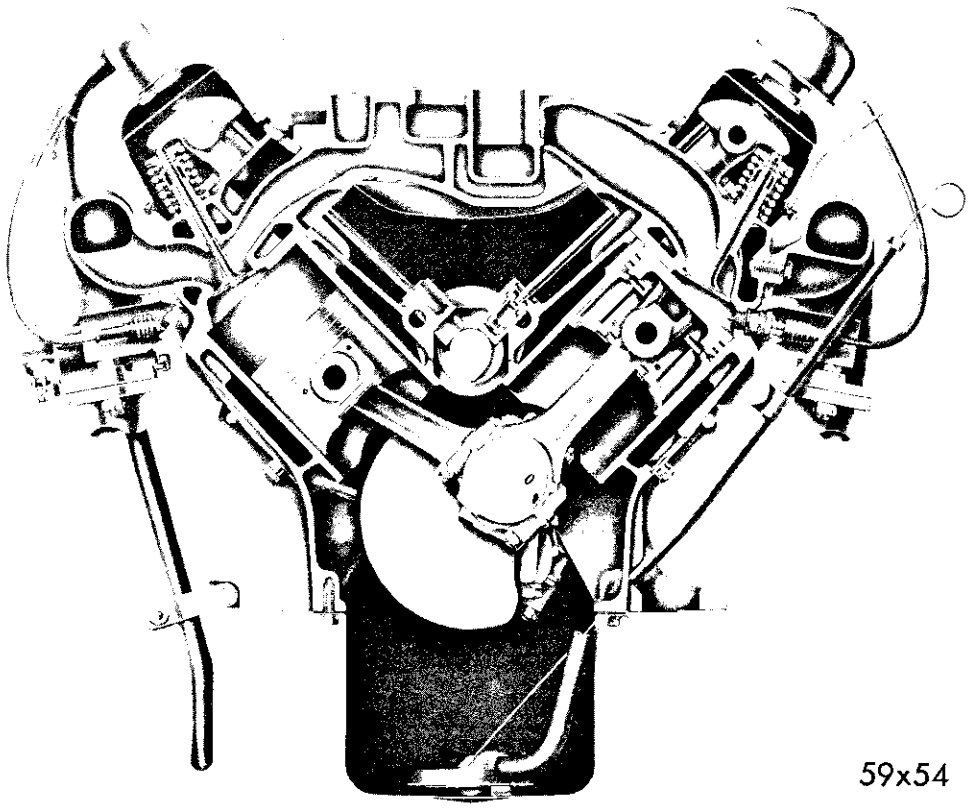

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Fig. 2—Front End Sectional View

Group 9
ENGINE

There are three V-8 engines (Figures 1, 2, 3, 4 and 5) used for the various car models and have the same basic design. The various engine model applications are as follows:

PS-1 361 cu. in.
PS-1, PS-3 383 cu. in.
(Bore 4.25″x3.375″ Stroke)
PC-1, PC-2 383 cu. in.
(Bore 4.031″x3.750″ Stroke)
PC-3, PY-1 413 cu. in.

The engines differ only in the piston displacement, bore diameter, power output and carburetor equipment. All engines are equipped with valves in head, having a wedge shaped combustion chamber of 10.1 to 1 compression ratio. A dual throat carburetor is standard equipment on Models PS-1 and PC-1. A four barrel carburetor is used on Models PS-3, PC-2, PC-3 and PY-1. All engines use premium fuel. A periodic engine tune-up will assure maximum engine performance and fuel economy.

ENGINE TUNE UP

11. MINOR TUNE-UP

(1) Check battery specific gravity, add water if necessary and clean and tighten battery connections.

(2) Clean and adjust the spark plugs (.035 inch gap). Tighten to 30 foot-pounds torque with Tool C-3054.

(3) Adjust the distributor contact points (.015 to .018 inch gap). Install new points if necessary.

(4) Remove the distributor and spark plug wires. Inspect the distributor cap for cracks and corrosion. Inspect the rotor, rotor spring and plunger. Inspect the distributor to spark plug cables for brittle,

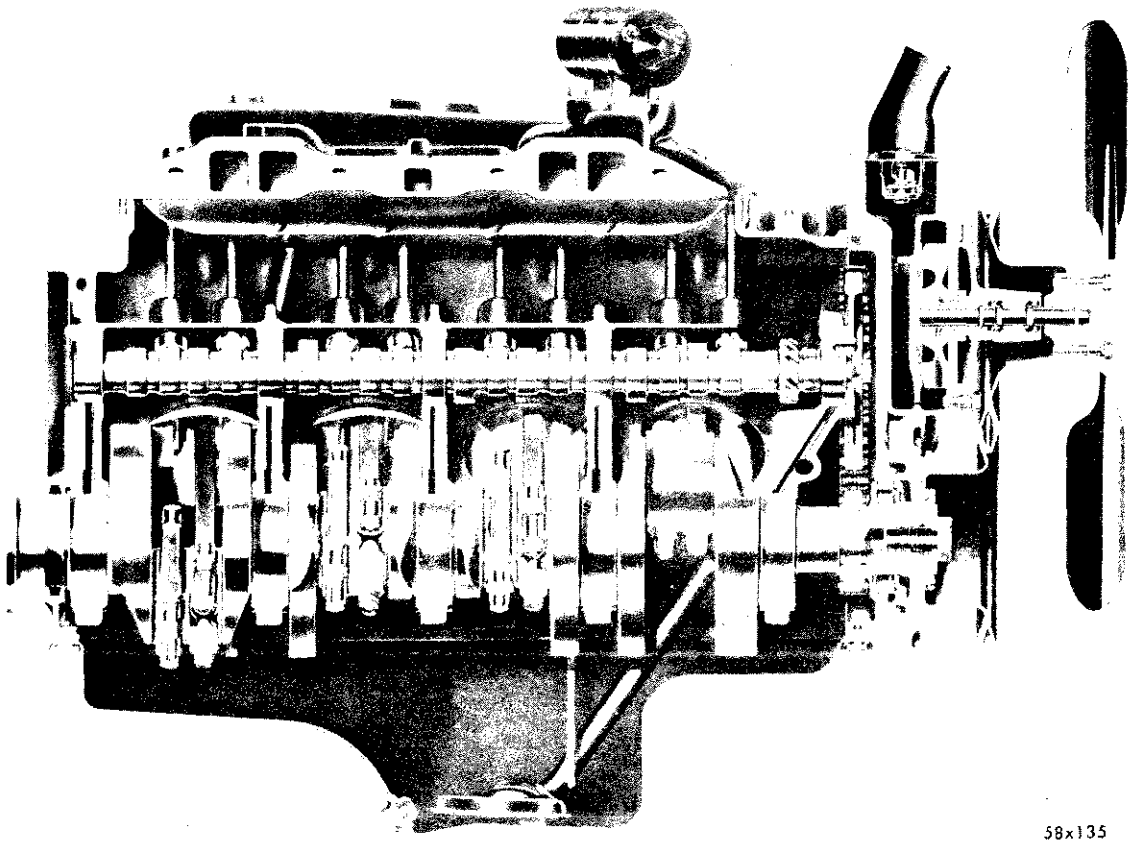


Fig. 3—Left Side Sectional View

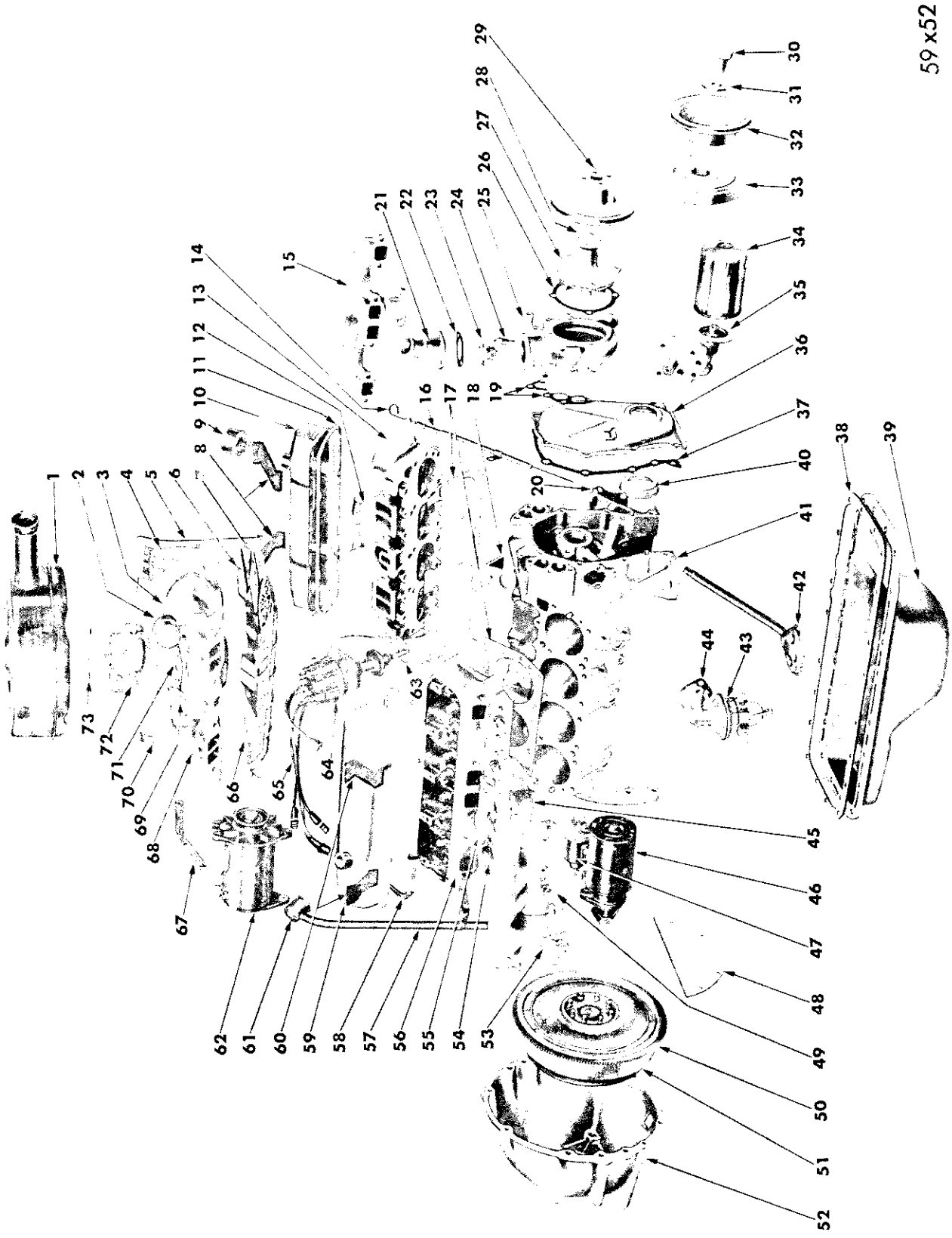


Fig 4—Complete Engine External Parts (Exploded View)

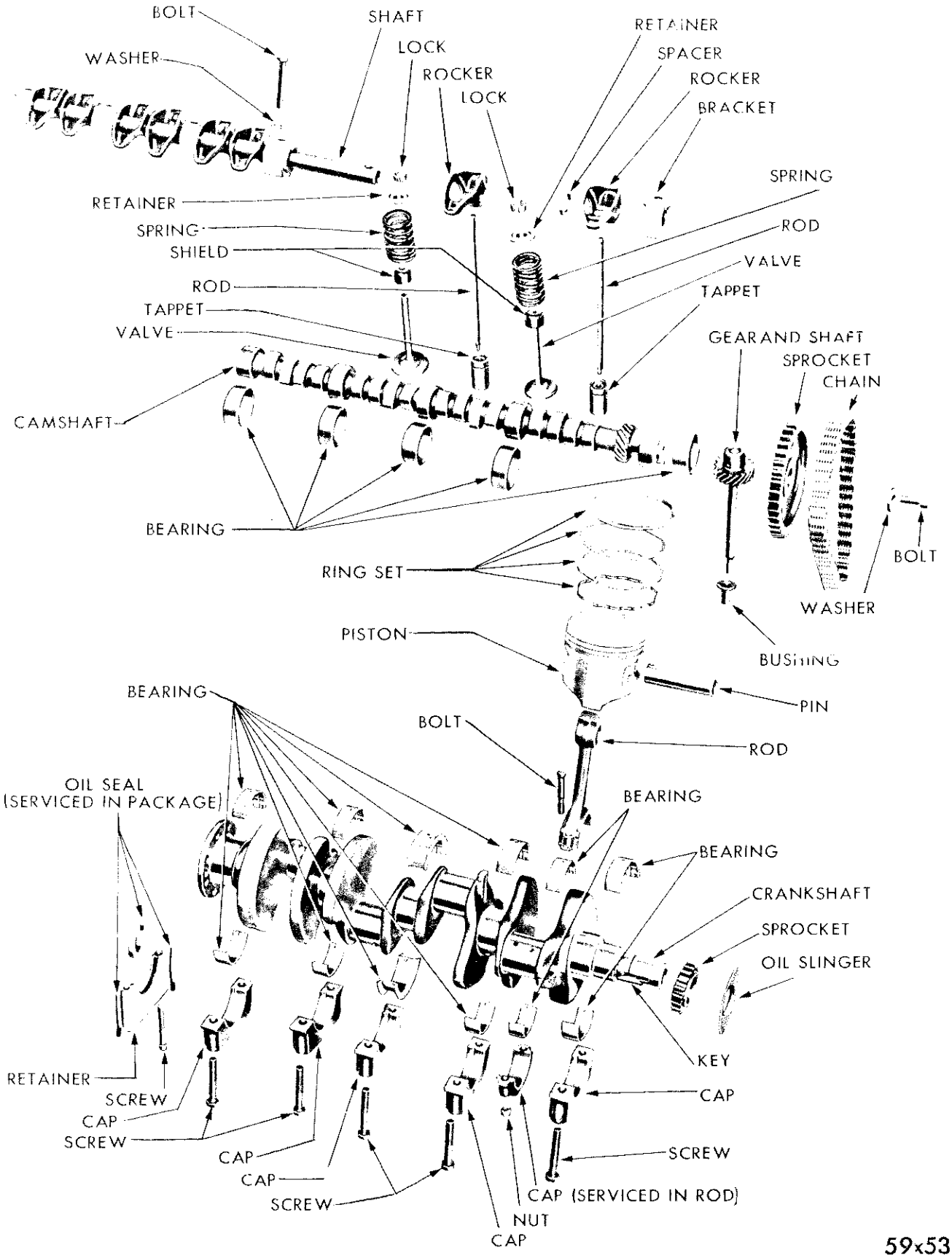


Fig. 5—Complete Engine Internal Parts (Exploded View)

cracked or frayed insulation. Inspect the spark plug cable terminals. Inspect small lead wires for tightness or damaged insulation. Tighten all electrical connections.

(5) Inspect the distributor vacuum advance for excessive looseness. Install a new plate if necessary.

(6) Reset the ignition timing with vacuum advance line disconnected.

(7) Inspect and adjust the accessory belt drives referring to "Accessory Belt Drives" Group 7A for proper adjustments.

(8) Tighten the carburetor flange nuts to 7 foot-pounds torque.

(9) Set carburetor idle mixture adjustment. Adjust the throttle stop screw so engine idles at 450 to 500 rpm (550 rpm with Air Conditioning).

(10) Check manifold heat control valve in the right exhaust manifold for proper operation and apply Manifold Heat Control Valve Solvent Number 1879318 to the bushing and shaft.

12. MAJOR TUNE-UP

Perform all the operations of a "Minor Tune-Up" and in addition, the following operations should be performed on an Engine Tune-Up.

(1) Tighten the manifold nuts.

(2) Perform the cylinder compression test. Compression pressures can be read from the top side of engine without interference using a 30 degree bend extension on the gauge. The compression should not vary more than 20 pounds between cylinders.

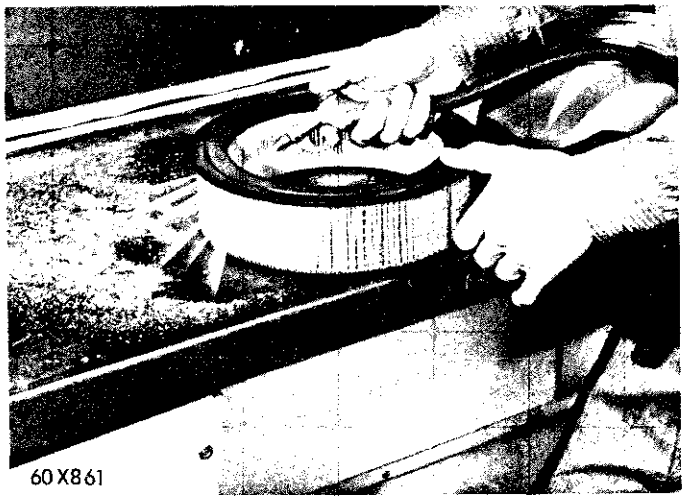


Fig. 6—Cleaning Filter Element Using Compressed Air

(3) Test the coil and condenser. Inspect the primary and secondary cables. Tighten terminal connections.

(4) Every 5,000 miles, remove filter element and blow out dirt gently with air hose. Direct air from inside out, and keep nozzle 1 inch away from element to avoid damaging. Clean the metal housing and replace the element. Every 15,000 miles, install a new factory recommended filter element. Service the unit more frequently when driving under severe conditions, such as in dusty areas.

(5) Test fuel pump for pressure and vacuum. Refer to Fuel Group 14, Data and Specifications.

(6) Perform a combustion analysis. Adjust the carburetor.

(7) Road test the vehicle as a final check.

SERVICE PROCEDURES

13. REMOVAL OF ENGINE ASSEMBLY (From Vehicle)

(1) Scribe the outline of hinge brackets on hood to assure proper adjustments when installing.

(2) Remove the hood.

(3) Drain the cooling system and remove the battery.

(4) Remove all hoses, the fan shroud, disconnect oil cooler lines and remove the radiator.

(5) Disconnect fuel lines and wires attached to engine units. Remove the air cleaner and carburetor.

(6) Attach the engine lifting fixture Tool C-3466 to carburetor flange studs on the intake manifold.

(7) Raise the car on hoist and install engine support fixture Tool C-3487 on the frame to support rear of engine.

(8) Drain the transmission and torque converter.

(9) Remove No. 6 spark plug.

(10) Disconnect exhaust pipes at manifolds, propeller shaft, wires, linkage, cable, oil cooler lines at transmission.

(11) Remove the engine rear support crossmember and remove the transmission from the car.

(12) Lower car and attach chain hoist to fixture eyebolt.

(13) Remove the engine front mounting bolts. Raise the engine with chain hoist and work engine out of the chassis.

(14) Place engine in repair stand Tool C-3167 and adapter C-3662 for disassembly using transmission mounting bolts.

14. INSTALLING THE ENGINE ASSEMBLY (In Vehicle)

(1) Attach the engine lifting fixture Tool C-3466, to carburetor flange studs on the intake manifold.

(2) Attach the chain hoist to fixture eyebolt.

(3) Remove the engine from repair stand and lower the engine carefully until engine is positioned in the vehicle.

(4) Install engine support fixture Tool C-3487 on the frame and adjust to support rear of engine.

(5) Remove chain hoist from fixture eyebolt.

(6) Raise the car on hoist and install and tighten engine front support mounting bolts.

(7) Install the transmission and install engine rear support crossmember.

(8) Lower the engine into position and install engine rear support crossmember bolts. Remove engine support fixture Tool C-3487 from the frame.

(9) Connect propeller shaft, wires, linkage, cable, oil cooler lines at the transmission, connect exhaust pipes to manifolds, using new gaskets, and install No. 6 spark plug. Install the transmission filler tube.

(10) Lower the car and install the radiator, fan shroud, hoses, oil cooler lines and connect all wires and linkage.

(11) Remove engine lifting fixture Tool C-3466 from intake manifold and install the carburetor and fuel lines. Connect throttle linkage.

(12) Install the hood, using scribe marks for proper alignment.

(13) Close all drain cocks and fill cooling system.

(14) Fill the engine crankcase and transmission. Refer to Lubrication Group for quantities and lubricants to use and check entire system for leaks and correct as necessary.

NOTE: Whenever an engine is rebuilt and a new camshaft and/or new tappets are installed, add one quart of factory recommended oil additive to engine oil to aid break-in (Engine Oil Additive No. 1643234). The oil mixture should be left in engine for a minimum of 500 miles, and drained at the next normal oil change.

(15) Start the engine and run until normal operating temperature is reached.

(16) Check the ignition timing and adjust carburetor as necessary.

(17) Adjust accelerator and transmission linkages. Road test the vehicle.

15. ROCKER ARMS AND SHAFT ASSEMBLY

The rocker arms are of stamped steel and are arranged on one rocker arm shaft, per cylinder head. The push rod angularity tends to force the pairs of rocker arms toward each other where oilite spacers carry the side thrust at each rocker arm. Five brackets attach each rocker shaft to the cylinder head.

a. Removal

(1) Remove cylinder head cover and gasket.

(2) Remove the bolts that attach rocker arm support brackets to cylinder head and remove the rocker arms, brackets and shaft as an assembly.

(3) If the rocker arm assemblies have been disassembled for cleaning, inspection, or replacement, refer to Figures 7 and 8 for proper reassembly.

b. Installation

(1) Install the rocker arms, brackets and shaft assembly.

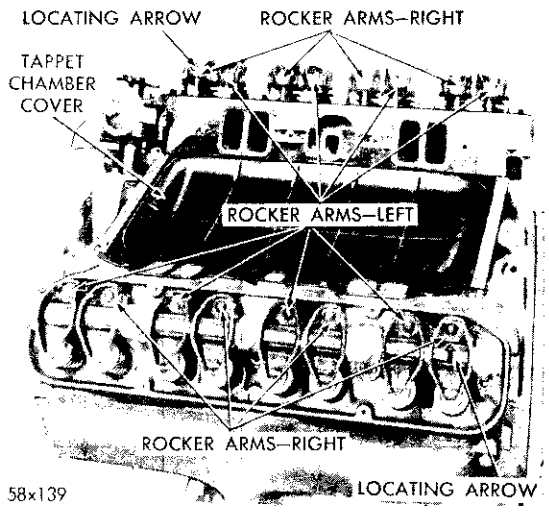


Fig. 7—Rocker Arm Installed

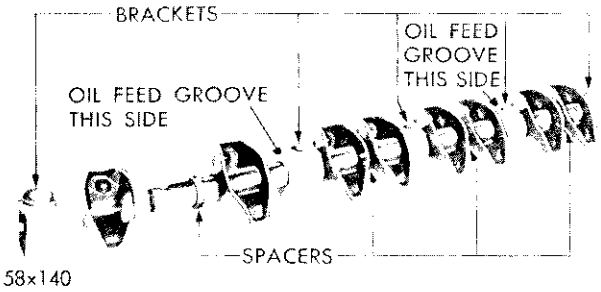


Fig. 8—Rocker Arm and Shaft Assembly

NOTE: The right and left rocker arms must be installed on rocker shaft, as shown in Figure 7. The stamped arrow on rocker shaft must be on top and the arrow must point toward the push rod side of the rocker arm. This is necessary to provide proper lubrication to the rocker assemblies. The two wide brackets must be installed with the oil feed grooves facing the push rod side of rocker arm, as shown in Figures 7 and 8.

NOTE: Use extreme care in tightening the bolts so that tappets have time to bleed down to their operating length. Bulged tappet bodies, bent push rods and permanent noisy operation may result if the tappets are forced down too rapidly.

(2) Tighten the rocker shaft bracket bolts to 30 foot-pounds.

16. CYLINDER HEADS

The chrome alloy cast iron cylinder heads, as shown in Figure 9, are held in place by 17 bolts. The spark plugs enter the cylinder head horizontally and are located at the wide edge of the combustion chambers.

a. Removal

(1) Drain the cooling system.

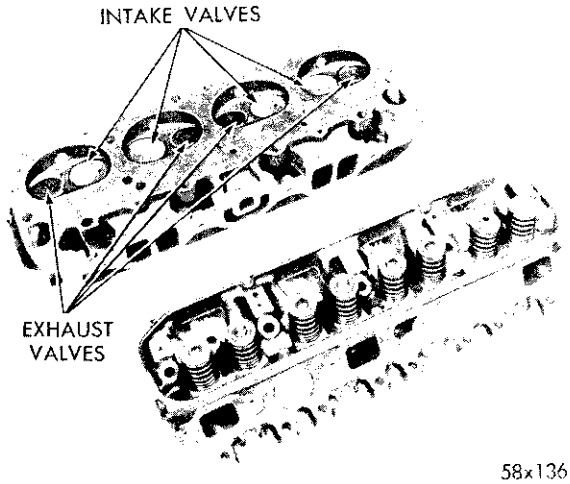


Fig. 9—Cylinder Heads

(2) Remove generator, carburetor air cleaner and fuel line.

(3) Disconnect the accelerator linkage.

(4) Remove the vacuum control tube at carburetor and distributor.

(5) Disconnect the distributor cap, coil wires and heater hose.

(6) Disconnect the heat indicator sending unit wire.

(7) Remove spark plugs.

(8) Remove the intake manifold, ignition coil and carburetor as an assembly.

(9) Remove the tappet chamber cover.

(10) Remove cylinder head covers and gaskets.

NOTE: On air conditioned cars, rotate the crankshaft until the number eight cylinder exhaust valve is open, to allow clearance to remove the right bank cylinder head cover and the heater housing.

(11) Remove exhaust manifolds.

(12) Remove the rocker arms and shaft assembly.

(13) Remove the push rods and place them in their respective slots in holder Tool C-3068.

(14) Remove the 17 head bolts from each cylinder head and remove cylinder heads.

(15) Place cylinder head in holding fixture Tool C-3626.

b. Installation

(1) Clean the gasket surfaces of cylinder block and cylinder head. Remove all burrs from edges of cylinder heads.

(2) Inspect all surfaces with a straightedge if

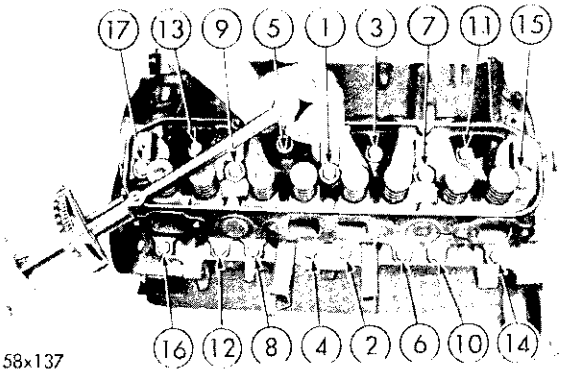


Fig. 10—Cylinder Head Tightening Sequence

there is any reason to suspect leakage.

(3) Coat the new gaskets with a suitable sealer, Number 1122893. Install the gaskets and cylinder heads.

(4) Install cylinder head bolts. Starting at top center, tighten all cylinder head bolts to 70 foot-pounds torque in sequence as shown in Figure 10.

Repeat the procedure, tightening all head bolts to 70 foot-pounds torque.

(5) Inspect push rods and replace worn or bent rods.

(6) Install push rods with the small ends in tappets maintaining alignment using rod, as shown in Figure 11.

(7) Install the rocker arm and shaft assembly starting each push rod into its respective rocker arm socket (Figure 7).

NOTE: Use extreme care in tightening bolts 30 foot-pounds torque so the tappets have time to bleed down to their operating length. Bulged tappet bodies, bent push rods, and permanently noisy operation may result if the tappets are forced down too rapidly.

(8) Place the new cylinder head gaskets in position and install cylinder head covers. Tighten the nuts to 40 inch-pounds.

(9) Install exhaust manifolds and tighten nuts to 30 foot-pounds.

(10) Adjust spark plugs to .035 inch gap and install the plugs, and tighten to 30 foot-pounds with Tool C-3054.

(11) Install a new tappet chamber cover and tighten end bolts to 9 foot-pounds.

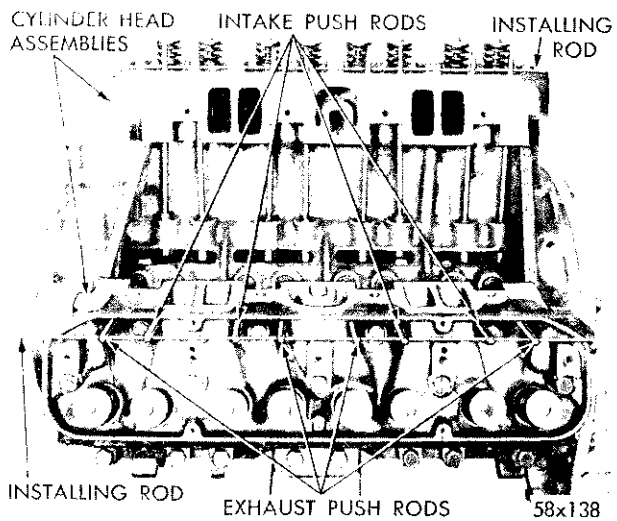


Fig. 11—Push Rods Installed

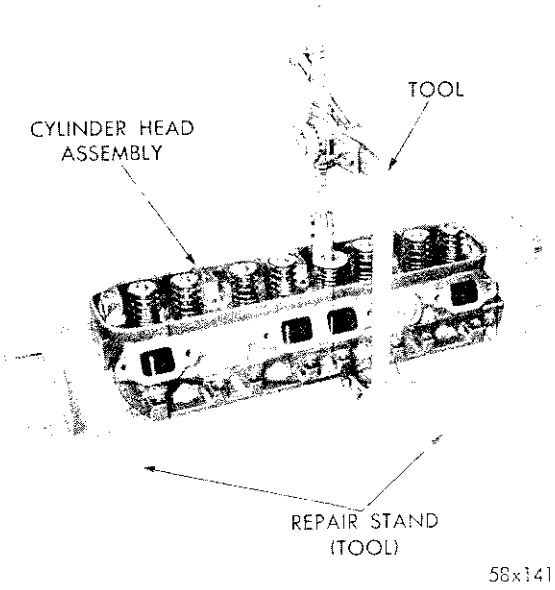


Fig. 12—Compressing Valve Spring Using Tool C-3422

(12) Install intake manifold, carburetor and ignition coil as an assembly and tighten manifold bolts to 50 foot-pounds.

(13) Install the distributor cap. Connect the coil wire, heat indicator sending unit wire, accelerator linkage, spark plug cables and insulators.

(14) Install the vacuum tube from carburetor to distributor.

(15) Install generator and drive belts. Tighten generator bracket bolts to 30 foot-pounds, and generator mounting nut to 20 foot-pounds.

(16) Install the fuel line and carburetor air cleaner.

(17) Fill the cooling system. Adjust belt tensions as outlined in "Accessory Belt Drives" in this manual.

17. VALVES AND VALVE SPRINGS

Valves are arranged in line in the cylinder heads and inclined 30 degrees outward from vertical. Intake and exhaust valves operate in guides that are cast integral with the heads.

a. Removal

(1) With the cylinder head removed, compress valve springs using Tool C-3422, as shown in Figure 12.

(2) Remove the valve retaining locks, valve spring retainers, valve stem cup seals and valve springs.

(3) Remove the burrs from the valve stem lock grooves to prevent damage to the valve guide when

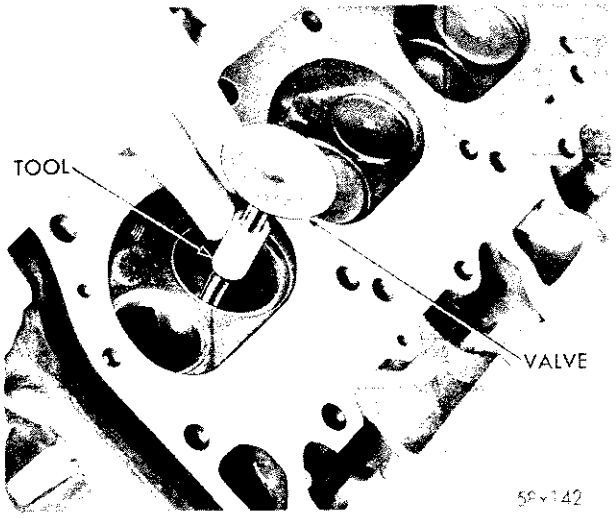


Fig. 13—Measuring Valve Stem Guide Clearance Using Tool C-3026

valves are removed.

b. Valve Inspection

(1) Clean the valves thoroughly, and discard burned, warped and cracked valves.

(2) Measure valve stems for wear. Intake valve stem diameter should measure .372 to .373 inch and exhaust valve stem diameter should measure .371 to .372 inch. If the wear exceeds .002 inch, replace the valve.

(3) Remove carbon and varnish deposits from the inside of valve guides with cleaner, Tool C-756.

(4) Measure the valve stem guide clearance as follows: Install sleeve Tool C-3026 over the valve stem, as shown in Figure 13, and install valve.

(5) The special sleeve places the valve at the correct height for checking with a dial indicator. Attach the dial indicator Tool C-3339 to cylinder head and set it at right angle of the valve stem being measured (Figure 14).

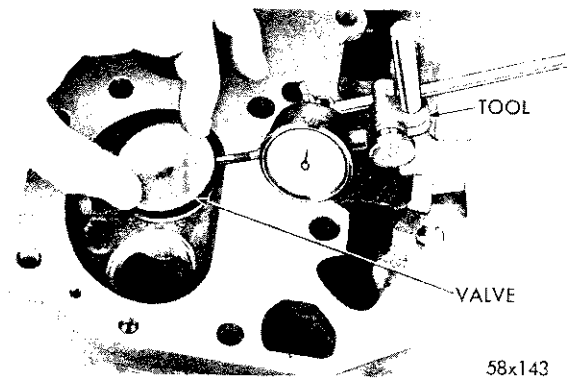


Fig. 14—Measuring Guide Wear Using Tool C-3339

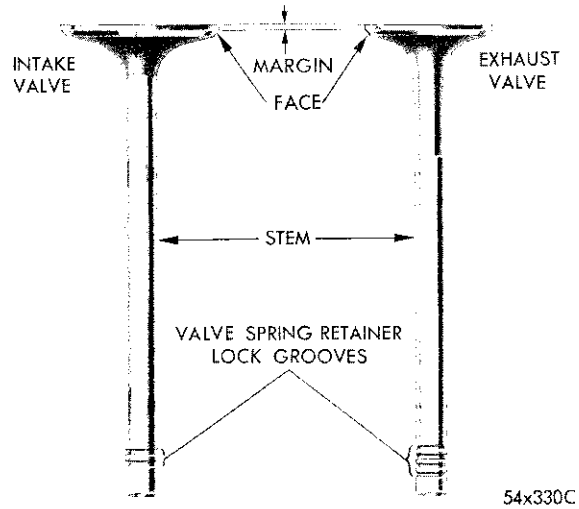


Fig. 15—Intake and Exhaust Valve Faces

(6) Move valve to and from the indicator. The total dial indicator reading should not exceed .010 inch on intake valves, and .014 inch on exhaust valves. Ream the guides for new valves with oversize stems if dial indicator reading is excessive or if the stems are scored or worn excessively.

(7) Service valves with oversize stems are available in .005, .015 and .030 inch oversizes. Reamers to accommodate the oversize valve stem are as follows: Reamer Tool C-3433 (.379 to .380 inch), Reamer Tool C-3427 (.404 to .405 inch).

(8) Slowly turn reamer by hand and clean guide thoroughly before installing new valve.

CAUTION

Do not attempt to ream the valve guides from standard directly to .030 inch. Use step procedure of .005, .015 and .030 inch so the original valve guide centers may be maintained.

c. Refacing Valves and Valve Seats

The intake and exhaust valve faces have a 45 degree angle. Always inspect the remaining valve margin after the valves are refaced (Figure 15). Valves with less than 3/64 inch margin should be discarded.

(1) The angle of both valve and seat should be identical. When refacing the valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete valve seat surface must be obtained.

(2) Measure the concentricity of valve seat using a dial indicator. The total runout should not exceed .002 inch (total indicator reading). When the seat is properly positioned, the width of intake seats should be 1/16 to 3/32 inch. The width of exhaust seats should be 3/64 to 1/16 inch.

(3) When the valves and seats are reground, the position of the valve in the cylinder head is changed, shortening the operating length of hydraulic tappet. This means that the plunger is operating closer to its bottomed position, and less clearance is available for thermal expansion of valve mechanism during high speed driving.

(4) The design of the valve mechanism includes a safety factor to allow for a limited amount of wear, and the refacing of valves and seats.

(5) To insure that the limits have not been exceeded, the dimension from valve spring seat in head to valve tip should be measured with Gauge, Tool C-3648, as shown in Figure 16.

(6) The end of the cylindrical gauge and the bottom of slotted area represent the maximum and minimum allowable extension of valve stem tip beyond the spring seat.

(7) If the tip exceeds maximum, grind the stem tip to within gauge limits. Clean tappets if tip grinding is required.

d. Testing Valve Springs

(1) Whenever the valves are removed for inspection, reconditioning or replacement, the valve springs should be tested. To test a spring, determine the length at which the spring is to be tested. As an example, the compressed length of the spring to be tested is 1-15/32 inches. Turn the table of Tool C-647 until surface is in line with the 1-15/32 inch mark on the threaded stud and the zero mark to the front. Place spring over stud on table and lift the compressing lever to set the tone device. Pull on torque wrench until a ping is heard. Take the reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at the test length. Fractional measurements are indicated on the table for finer adjustments. The valve springs should test 187 to 203 pounds when compressed to 1-15/32 inch. Discard springs that do not meet these specifications.

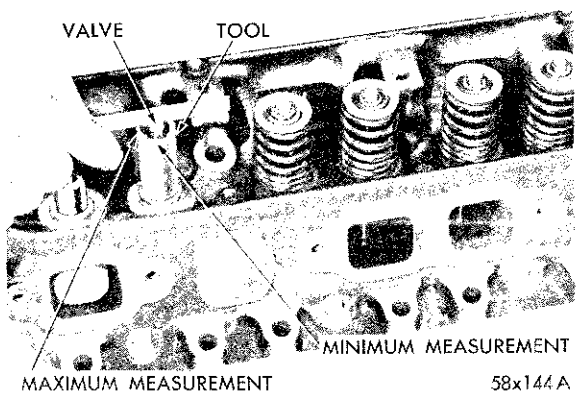


Fig. 16—Measuring Valve Stem Length Using Tool C-3648

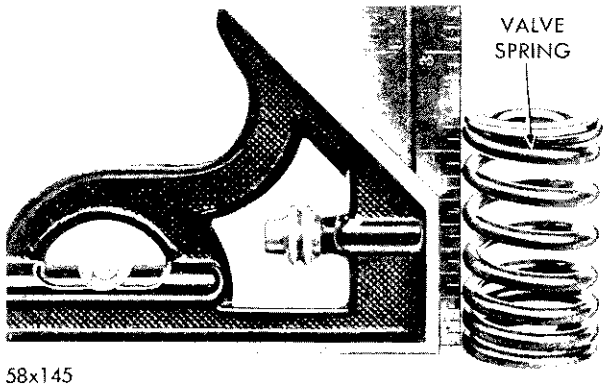


Fig. 17—Checking Valve Spring Squareness

(2) Inspect each valve spring for squareness with a steel square and surface plate, as shown in Figure 17.

(3) If the spring is more than 1/16 inch out of square, install a new spring.

e. Installation

(1) Coat the valve stems with lubricating oil and insert them in position in cylinder head.

(2) Install the cup seals on intake and exhaust valve stems and over valve guides, as shown in Figures 18 and 19 and install valve springs and retainers.

(3) Compress the valve springs with Tool C-3422. Install locks and release tool.

NOTE: If the valves and/or seats are reground, measure the installed height of springs. Make sure

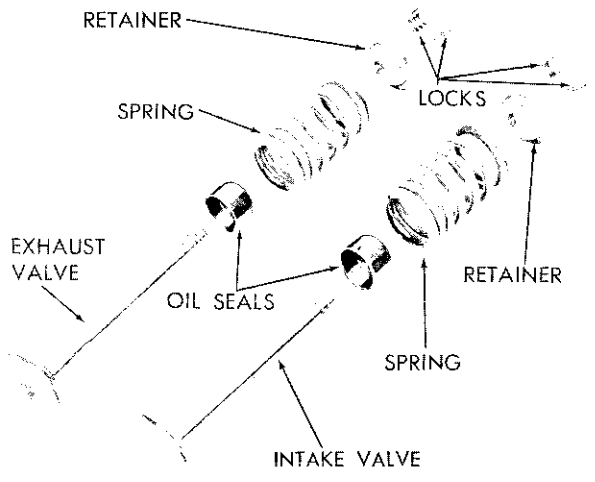


Fig. 18—Valve Assembly (Disassembled View)

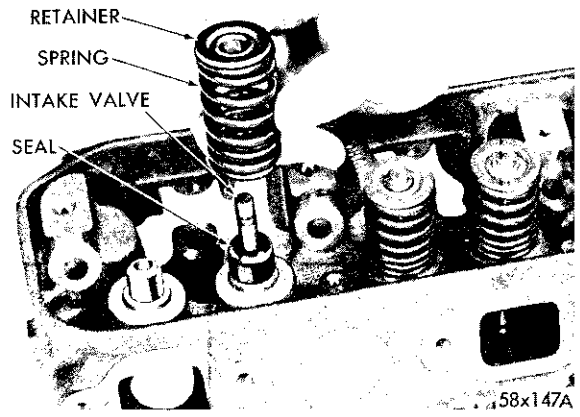


Fig. 19—Installing Valve and Cup Seals

measurement is taken from the bottom of the spring seat in cylinder head to the bottom surface of spring retainer. If height is greater than 1-57/64 inches, install a 1/16 inch spacer in head counterbore to bring spring height back to normal 1-53/64 to 1-57/64 inch. (If spacers are installed, measure from the top of spacer.)

18. HYDRAULIC TAPPETS

a. Preliminary to Checking Hydraulic Tappets

(1) Before disassembling any part of engine to correct tappet noise, read the oil pressure at gauge and check the oil level in the oil pan. The pressure should be between 45 and 65 pounds at 40 to 50 m.p.h.

(2) The oil level in the pan should never be above "full" mark on dipstick, or below "add oil" mark. Either of these two conditions could be responsible for noisy tappets.

Oil Level Too High

(3) If oil level is above "full" mark on dipstick, it is possible for the connecting rods to dip into oil while the engine is running and create foam. Foam in the oil pan would be fed to the hydraulic tappets by the oil pump causing them to lose length and allow the valves to seat noisily.

Oil Level Too Low

(4) Low oil level may allow the oil pump to take in air which, when fed to tappets, causes them to lose length and allows the valves to seat noisily. Any leaks on intake side of the pump through which air can be drawn will create the same tappet action. When tappet noise is due to aeration, it may be intermittent or constant, and usually more than one tappet will be noisy. When oil level and leaks have been corrected, the engine should be operated at fast idle for sufficient time to allow all of air inside of tappets to be bled out.

b. Tappet Noise Diagnosis

(1) To determine the source of tappet noise, operate the engine at idle with the cylinder head covers removed.

(2) Feel each valve spring or rocker arm to detect the noisy tappet. The noisy tappet will cause the affected spring and/or rocker arm to vibrate or feel rough in operation.

NOTE: Worn valve guides or cocked springs are sometimes mistaken for noisy tappets. If such is the case, noise may be dampened by applying side thrust on valve spring. Inspect rocker arm push rod sockets and push rod ends for wear. If noise is not appreciably reduced, it can be assumed the noise is in the tappet.

(3) Valve tappet noise ranges from a light noise to a heavy click. A light noise is usually caused by excessive leakdown around the unit plunger, or by the plunger partially sticking in the tappet body cylinder. A heavy click is caused either by a tappet check valve not seating, or by foreign particles becoming wedged between the plunger and tappet body, causing plunger to stick in the down position. This heavy click will be accompanied by excessive clearance between valve stem and rocker arm as valve closes. In either case, the tappet assembly should be removed for inspection and cleaning.

c. Tappet Removal

(1) Tappets can be removed without removing the intake manifold or cylinder heads by following this

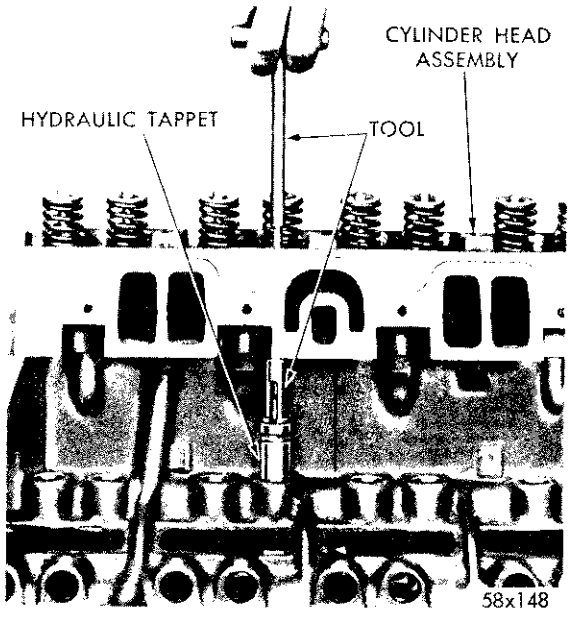


Fig. 20—Removing Tappet Using Tool C-3661

recommended procedure: Remove the cylinder head covers.

(2) Remove rocker arms and shaft assembly.

(3) Remove the push rods and place them in their respective holes in Tool C-3068.

(4) Slide puller Tool C-3661 through push rod opening in cylinder head and seat tool firmly in the head of tappet.

(5) Pull tappet out of bore with a twisting motion, as shown in Figure 20.

If all tappets are to be removed, remove the hydraulic tappets and place them in their respective holes in tappet and push rod holder, Tool C-3068. This will insure installation of the tappets in their original locations.

NOTE: A diamond shaped marking stamped on the engine numbering pad indicates that all tappet bodies are .008 inch oversize.

CAUTION

The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. Do not disassemble a tappet on a dirty work bench.

d. Disassembly (Figure 21)

(1) Pry out plunger retainer spring clip.

(2) Clean the varnish deposits from the inside of tappet body above the plunger cap.

(3) Invert the tappet body and remove plunger cap, plunger, flat check valve, check valve spring, check valve retainer and plunger spring.

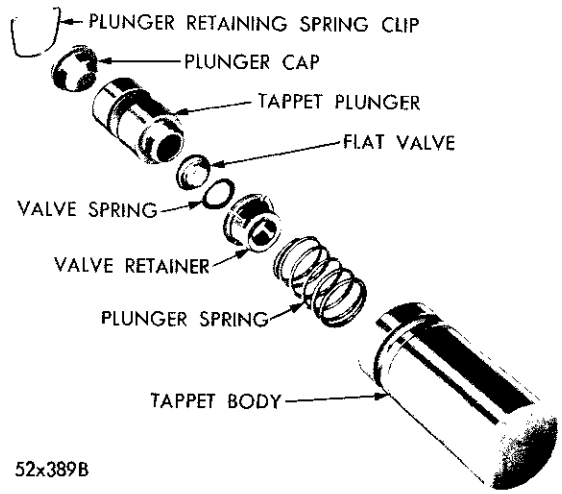


Fig. 21—Hydraulic Tappet Assembly (Exploded View)

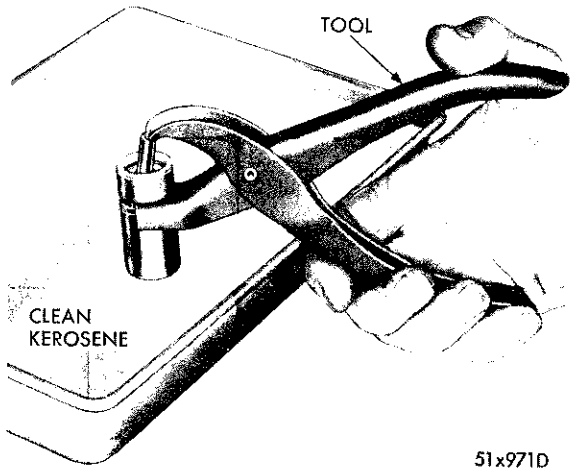


Fig. 22—Testing Tappet Using Tool C-3160

(4) Separate the plunger, check valve retainer and check valve spring. Place all parts in their respective place in the tappet holder, Tool C-3068.

e. Cleaning and Assembly

(1) Clean all tappet parts in a solvent that will remove all varnish and carbon.

(2) Replace the tappets that are unfit for further service with new assemblies.

(3) If plunger shows signs of scoring or wear and valve is pitted, or if the valve seat on end of plunger indicates any condition that would prevent valve from seating, install a new tappet assembly.

(4) Assemble the tappets, as shown in Figure 21.

f. Testing

(1) Fill a pan with clean kerosene.

(2) Remove cap from plunger and completely submerge the tappet in an upright position.

(3) Allow tappet to fill with kerosene, remove tappet, and replace the cap.

(4) Hold the tappet in an upright position and insert the lower jaw of pliers, Tool C-3160, in the groove of tappet body (Figure 22).

(5) Engage jaw of pliers with top of the tappet plunger. Check leakdown by compressing pliers. If plunger collapses almost instantly as pressure is applied, disassemble tappet, clean and test again.

(6) If the tappet still does not operate satisfactorily after cleaning, install a new tappet assembly.

g. Inspection

If the tappet or bore in cylinder block is scored,

scuffed, or shows signs of sticking, ream the bore to next oversize, using Tool C-3028.

h. Installation

(1) Lubricate the tappets.

(2) Install tappets and push rods in their original positions.

(3) Install the rocker arm and shaft assembly.

(4) Start and operate the engine. Warm up to normal operating temperature.

CAUTION

To prevent damage to valve mechanism, the engine must not be run above fast idle until all of hydraulic tappets have filled with oil and have become quiet.

19. CHECKING VALVE TIMING

(1) Turn crankshaft until the No. 6 exhaust valve is closing and the No. 6 intake valve is opening.

(2) Insert a ¼ inch spacer between the rocker arm pad and the stem tip of the No. 1 intake valve (second valve on the left bank).

(3) Install a dial indicator so that the plunger contacts the valve spring retainer as nearly perpendicular as possible.

(4) Allow the spring load to bleed the tappet down giving in effect a solid tappet. Zero the indicator.

(5) Turn the crankshaft clockwise (normal running direction) until intake valve has lifted .017 inch on standard engines and .025 inch on high performance engines. The timing on the timing indicator, located on the chain case cover, should read from 10 degrees BTDC to 2 degrees ATDC. If the reading is not within the specified limits: Inspect the timing sprocket index marks, inspect the timing chain for wear, and check the accuracy of the DC mark on the timing indicator. Turn crankshaft counter-clockwise

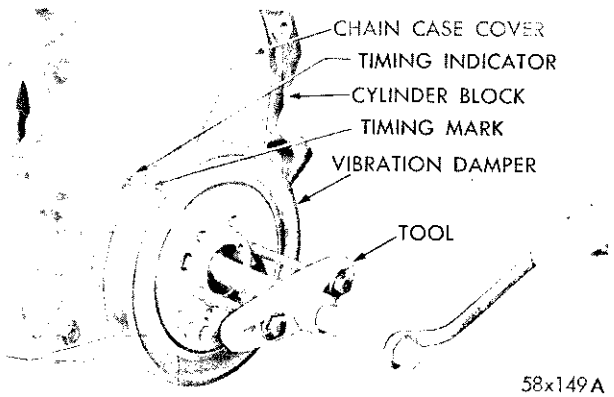


Fig. 23—Removing Vibration Damper Assembly Using Tool C-3033

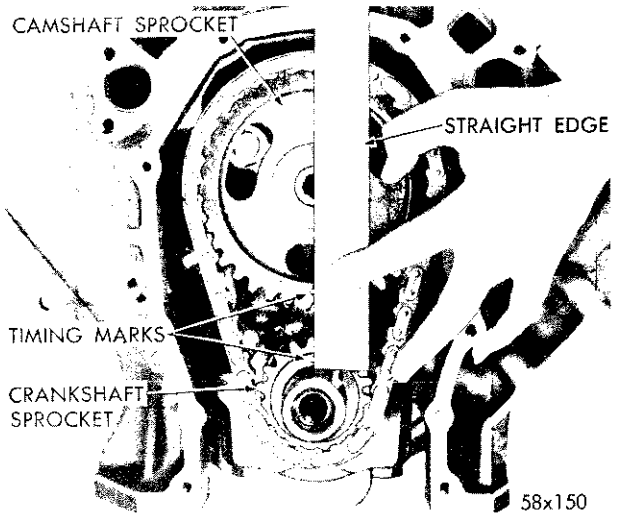


Fig. 24—Checking Alignment of Timing Marks Usin a Straightedge

until the valve is closed and remove the spacer.

CAUTION

Do not turn crankshaft any further clockwise as the valve spring might bottom and result in serious damage.

20. TIMING SPROCKETS AND CHAIN

a. Checking Timing Chain for Stretch

(1) Place a scale next to timing chain so that any movement of the chain may be measured.

(2) Place a torque wrench and socket over the camshaft sprocket attaching bolt and apply torque in the direction of crankshaft rotation to take up the slack; 30 foot-pounds torque (with cylinder heads installed) or 15 foot-pounds torque (cylinder heads removed).

(3) Holding a scale with dimensional reading even

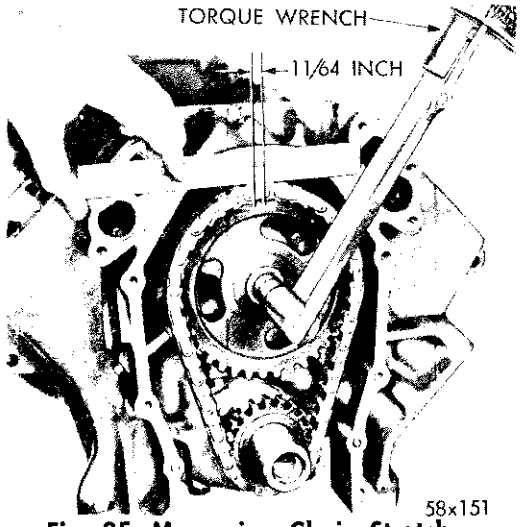


Fig. 25—Measuring Chain Stretch

with edge of a chain link, apply torque in the reverse direction 30 foot-pounds (with cylinder heads installed) or 15 foot-pounds (cylinder heads removed), and note the amount of chain movement, as shown in Figure 25.

(4) Install a new timing chain, if its movement exceeds 11/64 inch.

NOTE: With a torque applied to camshaft sprocket bolt, the crankshaft should not be permitted to move. It may be necessary to block the crankshaft to prevent rotation.

(5) If chain is satisfactory, slide the crankshaft oil slinger over shaft and up against the sprocket (flange away from sprocket).

b. Removal

(1) Drain the cooling system and remove the radiator and water pump assembly.

(2) Remove the crankshaft vibration damper attaching bolt.

(3) Remove two of the pulley bolts, install Tool C-3033, and pull the damper assembly off the end of crankshaft, as shown in Figure 23.

(4) Remove the chain cover and gasket.

(5) Slide the crankshaft oil slinger off end of crankshaft.

(6) Remove the camshaft sprocket attaching bolt.

(7) Remove timing chain with crankshaft and camshaft sprockets.

c. Installation

(1) Place both the camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(2) Place the timing chain around both sprockets.

(3) Turn the crankshaft and camshaft to line up with the keyway location on crankshaft sprocket and the dowel holes in the camshaft sprocket.

(4) Lift the sprockets and chain (keep sprockets tight against the chain in position as described).

(5) Slide both sprockets evenly over their respective shafts.

(6) Use a straight edge to check alignment of the timing marks (Figure 24).

(7) Install the washer and camshaft sprocket bolt and tighten to 35 foot-pounds torque.

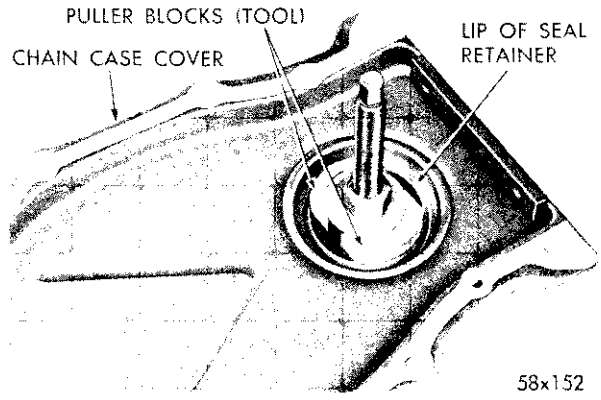


Fig. 26—Removing Timing Chain Case Cover Oil Seal Using Tool C-3506

21. TIMING CHAIN CASE COVER OIL SEAL REPLACEMENT (Cover Removed From Engine)

a. Removal

(1) Position puller screw of Tool C-3506 through case cover, the inside of case cover up. Position the puller blocks directly opposite each other, and force the angular lip between neoprene and flange of the seal retainer.

(2) Place washer and nut on puller screw. Tighten the nut as tight as possible by hand, forcing blocks into gap to a point of distorting the seal retainer lip (Figure 26). This is important (puller is only positioned at this point).

(3) Place sleeve over the retainer and place removing and installing plate into sleeve.

(4) Place the flat washer and nut on puller screw. Hold the center screw and tighten the puller nut to remove seal (Figure 27).

b. Installation of Oil Seal

(1) Insert puller screw through removing and installing plate so that the thin shoulder will be facing up.

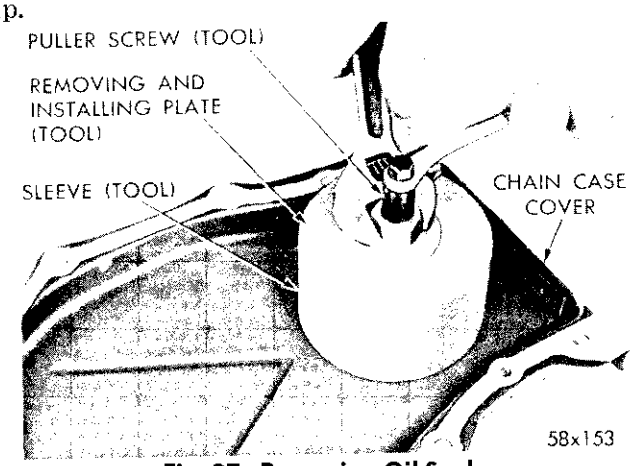


Fig. 27—Removing Oil Seal

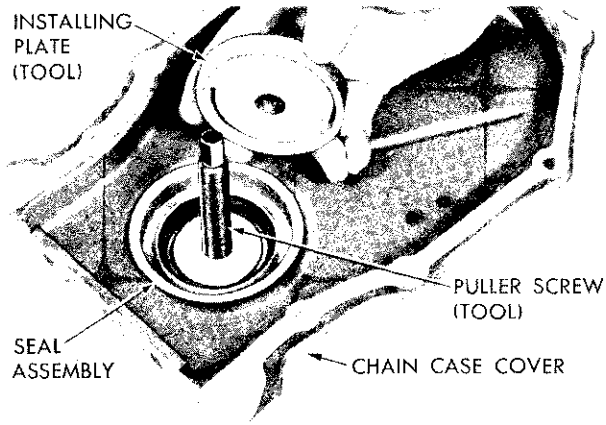


Fig. 28—Positioning Installer Plate on New Seal

(2) Insert puller screw with plate through the seal opening (inside of chain case cover facing up).

(3) Place the seal in cover opening, with neoprene down. Place the seal installing plate into the new seal, with protective recess toward lip of seal retainer (Figure 28).

NOTE: Lip of neoprene seal must be toward source of oil.

(4) Install the flat washer and nut on puller screw, hold screw and tighten the nut (Figure 29).

(5) The seal is properly installed when neoprene is tight against the face of cover. Try to insert a .0015 inch feeler gauge between neoprene and cover (Figure 30). If the seal is installed properly, the feeler gauge cannot be inserted.

NOTE: It is normal to find particles of neoprene collected between the seal retainer and crankshaft oil slinger after the seal has been in operation.

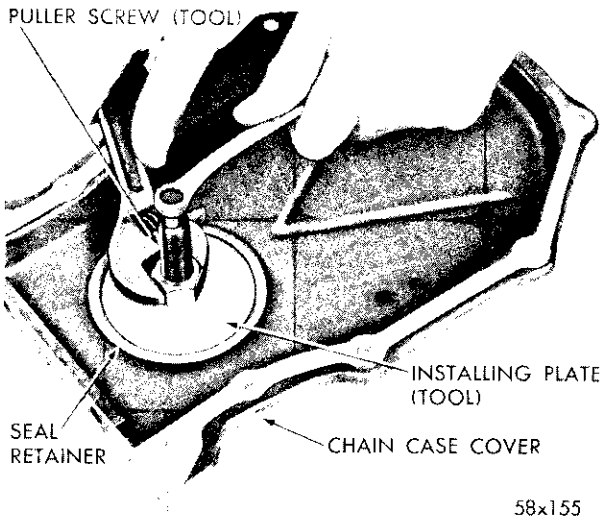


Fig. 29—Installing New Seal

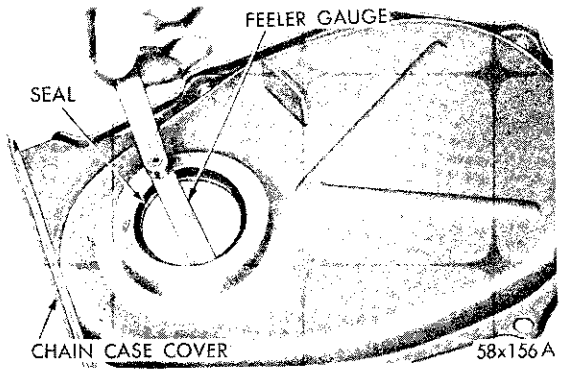


Fig. 30—Checking Seal for Proper Seating

c. Installing Chain Case Cover

(1) Be sure the mating surfaces of chain case cover and cylinder block are clean and free from burrs.

(2) Using a new gasket slide the chain case cover over the locating dowels. Install and tighten bolts to 15 foot-pounds torque.

d. Installing Vibration Damper

(1) Place the damper hub key in slot in crankshaft, and slide the vibration damper on crankshaft.

(2) Place the installing tool, part of Puller Set Tool C-3033 in position and press the damper on the crankshaft (Figure 31).

(3) Install damper retainer washer and bolt. Tighten to 135 foot-pounds torque.

(4) Slide the belt pulley over the shaft and attach with bolts and lockwashers.

(5) Tighten the bolts to 15 foot-pounds torque.

22. CAMSHAFT

The camshaft has an integral oil pump and distributor drive gear and fuel pump eccentric, as shown in Figure 32.

Rearward camshaft thrust is taken by the rear

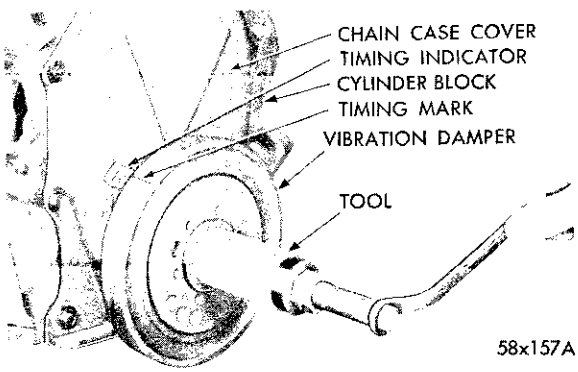


Fig. 31—Installing Vibration Damper Assembly

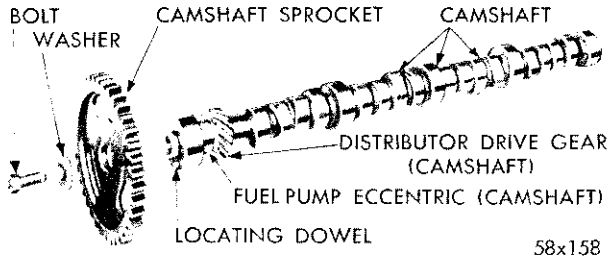


Fig. 32—Camshaft and Sprocket Assembly (Exploded View)

face of the cast iron camshaft sprocket hub, bearing directly on the front of the cylinder block, eliminating the need for a thrust plate. The load of the helical oil pump and distributor drive gear and the camshaft lobe taper both tend to provide a rearward thrust.

Removal

(1) With the tappets and timing chain and sprockets removed, remove distributor and lift out oil pump and distributor drive shaft.

(2) Remove the fuel pump to allow the fuel pump push rod to drop away from the cam eccentric.

(3) Remove the camshaft, being careful not to damage the camshaft bearings with the cam lobes.

23. DISTRIBUTOR DRIVE SHAFT BUSHINGS

a. Removal

(1) Insert Tool C-3052 into old bushings and thread down until a tight fit is obtained (Figure 33).

(2) Hold the puller screw and tighten puller nut until bushing is removed.

b. Installation

(1) Slide new bushing over burnishing end of Tool C-3053 and insert the tool and bushing into bore, as shown in Figure 34.

(2) Drive bushing and tool into position, using soft hammer.

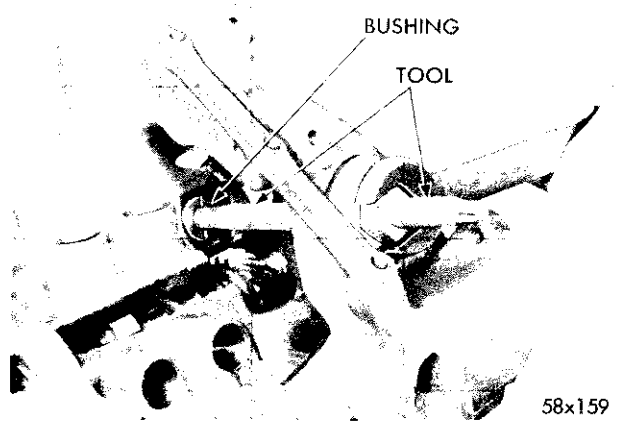


Fig. 33—Removing Distributor Drive Shaft Bushing

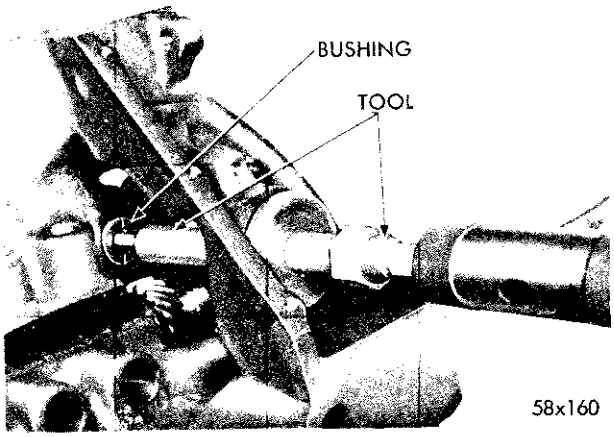


Fig. 34—Installing Distributor Drive Shaft Bushing Using Tool C-3053

(3) As the burnisher is pulled through bushing by tightening puller nut, the bushing is expanded tight in block and burnished to correct size, as shown in Figure 35. **DO NOT REAM THIS BUSHING.**

c. Camshaft Installation

(1) Lubricate the camshaft lobes and camshaft bearing journals and insert the camshaft to within

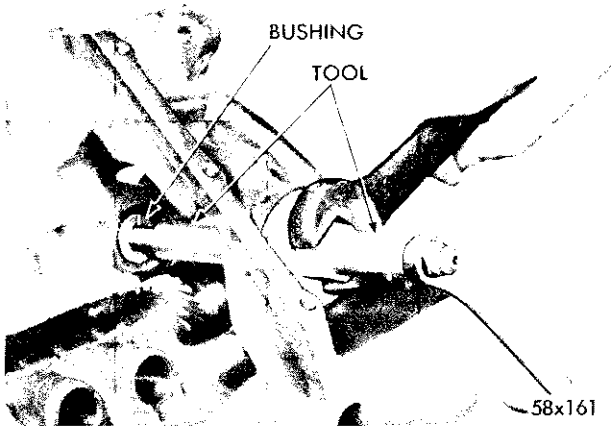


Fig. 35—Burnishing Distributor Drive Shaft Bushing

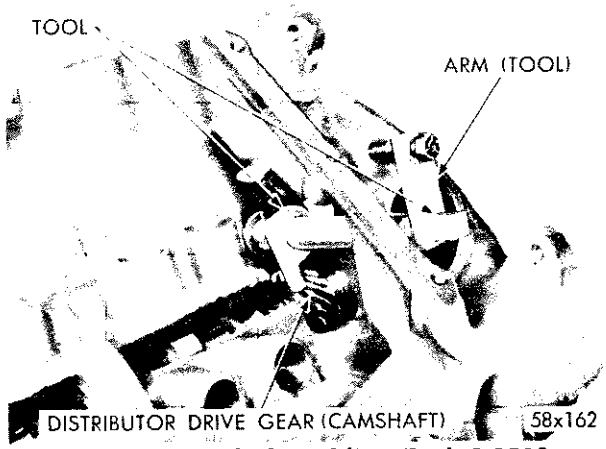


Fig. 36—Camshaft Holding Tool C-3509

2 inches of its final position in the cylinder block.

(2) Modify Tool C-3509 by grinding off the index lug holding upper arm on the tool and rotate arm 180 degrees.

(3) Install Tool C-3509 in place of distributor drive gear and shaft, as shown in Figure 36.

(4) Hold the tool in position with distributor lock plate screw. This tool will restrict the camshaft from being pushed in too far and prevent knocking out the welch plug in the rear of the cylinder block. **The tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

NOTE: Whenever an engine is rebuilt and a new camshaft and/or new tappets are installed, one quart of factory recommended oil additive should be added to the engine oil to aid in break-in. The oil mixture should be left in the engine for a minimum of 500 miles. Drain the oil mixture at the next normal oil change.

NOTE: Whenever the camshaft is replaced, all of the tappet faces must be inspected for crown with a straight edge. If any contact surface is dished or worn, the tappet must be replaced.

d. Distributor Timing

Before installing the distributor and oil pump drive shaft, time engine as follows:

(1) Rotate the crankshaft until No. 1 cylinder is at top dead center on firing stroke.

(2) When in this position, the straight line on the vibration damper should be under (DC) on the timing indicator.

(3) Coat shaft and drive gear with engine oil. Install the shaft so that after the gear spirals into place, it will index with oil pump shaft, so that the slot in top of drive gear will be parallel with center line of crankshaft, as shown in Figure 37.

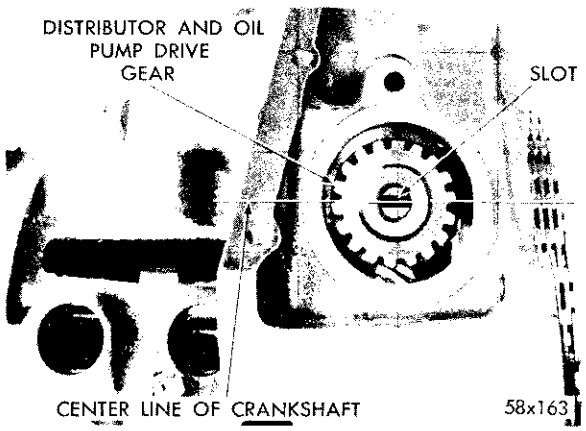


Fig. 37—Distributor Drive Gear Installed

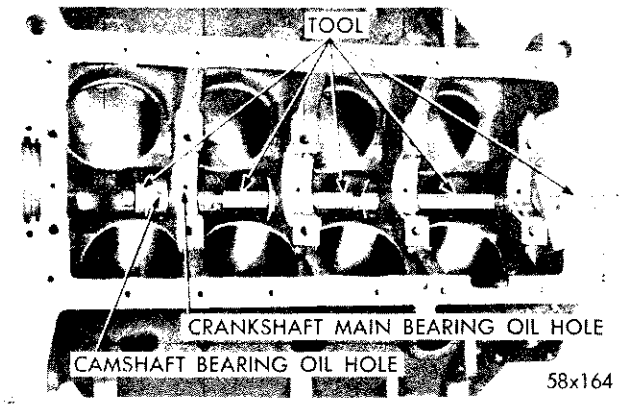


Fig. 38—Removing Camshaft Bearing Using Tool C-3132A

e. Installation of Distributor

(1) Hold distributor over the mounting pad on cylinder block with the vacuum chamber pointing toward the center of engine.

(2) Turn the rotor until it points forward and to the approximate location of the No. 1 tower terminal in the distributor cap.

(3) Place distributor gasket in position.

(4) Lower distributor and engage shaft in slot of distributor drive shaft gear.

(5) Turn distributor clockwise until the breaker contacts are just separating, install and tighten the hold down clamp.

24. REMOVAL AND INSTALLATION OF CAMSHAFT BEARINGS

(Engine Removed from Vehicle)

a. Removal

(1) With the engine completely disassembled, drive out the rear camshaft bearing welch plug.

(2) Install proper size adapters and horse shoe washers (part of Tool C-3132A) at back of each bearing to be removed and drive out the bearings.

b. Installation

(1) Install the new camshaft bearings with Tool C-3132A. Place the new camshaft bearing over the proper adapter.

(2) Position bearing in the tool. Install horse shoe lock and by reversing removal procedure, carefully drive bearing into place, as shown in Figure 38.

(3) Install remaining bearings in like manner.

NOTE: Install the No. 1 camshaft bearing 1/32" inward from front face of the cylinder block.

The oil holes in camshaft bearings and cylinder block must be in exact register to insure proper lubrication (Figure 38).

Camshaft bearing index can be checked after installation by inserting a pencil flashlight in the bearing. The camshaft bearing oil hole should be perfectly aligned with the drilled oil passage from the main bearing. Other oil holes in the camshaft bearings should be visible by looking down on the left bank oil hole above and between No. 6 and No. 8 cylinders to No. 4 camshaft bearing and on the right bank above and between No. 5 and 7 cylinders to No. 4 camshaft bearings. If the camshaft bearing oil holes are not in exact register, remove and reinstall them correctly. Use Tool C-897 to install a new welch plug at the rear of camshaft. **Be sure this plug does not leak.**

25. CYLINDER BLOCK

The cylinder block is of the deep block design which eliminates the need for a torque converter housing adapter plate. Its sides extend three inches below the crankshaft center line.

a. Piston Removal

(1) Remove the top ridge of cylinder bores with a reliable ridge reamer before removing the pistons from cylinder block. **Be sure to keep the tops of pistons covered during this operation.**

NOTE: Pistons and connecting rods must be removed from the top of cylinder block. When removing piston and connecting rod assemblies from the engine, rotate crankshaft so each connecting rod is centered in the cylinder bore.

(2) Remove connecting rod cap.

(3) Install Tool C-3221 on one connecting rod bolt and protector over the other bolt and push each piston and rod assembly out of the cylinder bore.

(4) After removal, install the corresponding bearing cap on the rod.

b. Cleaning and Inspection

(1) Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

(2) If new core hole plugs are installed, coat the edges of plug and core hole with a suitable sealer and drive plugs in place with driver, Tool C-897.

(3) Examine block for cracks or fractures.

c. Checking Cylinder Bores

The cylinder bores should be checked for out-of-round and taper with Tool C-119. If the cylinder bores show more than .005 inch out-of-round, or a taper of more than .010 inch, or if the cylinder walls are badly scored, scuffed or scored, the cylinder block should be rebored and honed, and new pistons and rings fitted.

d. Honing Cylinder Bores

(1) To remove light scoring, scuffing, or scratches from the cylinder walls, use Tool C-823. Usually a few strokes will clean up a bore and maintain the required limits.

(2) The cylinder walls should be deglazed, using a cylinder surfacing hone Tool C-3501 equipped with #280 grit stones, prior to installation of the new rings or to smooth down the cylinder walls after rough honing.

(3) A satisfactory finish can be obtained by giving each cylinder wall 20 strokes in approximately 20 seconds with the hone so that a cross hatch pattern will be obtained.

(4) The hone may be safely used for removal of metal up to .005 inch.

(5) After honing, it is necessary that the block be cleaned again to remove all traces of abrasives.

CAUTION

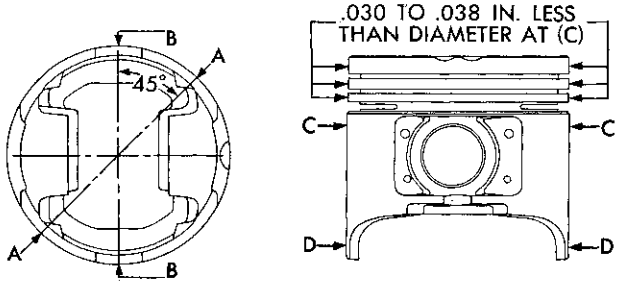
Be sure all abrasives are removed from engine parts after honing. It is recommended that a solution of soap and water be used with a brush and then thoroughly dried. The bore can be considered clean when it can be wiped with a clean white cloth and the cloth remains clean.

e. Cylinder Walls

Cylinder walls which are badly scored, scuffed, scratched, or worn beyond specified limits, should be rebored. Whatever type of boring equipment is used, boring operation should be closely coordinated with the fitting of pistons and rings in order that specified clearance may be maintained.

f. Pistons

The pistons are cam ground so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, thus, causing the piston to assume a more nearly round shape. It is important that old or new pistons be checked for taper and elliptical shape before they are fitted into the cylinder bore. See Figure 39.



THE ELLIPTICAL SHAPE OF THE PISTON SKIRT SHOULD BE .010 TO .012 IN. LESS AT DIAMETER (A) THAN ACROSS THE THRUST FACES AT DIAMETER (B). MEASUREMENT IS MADE 1/8 IN. BELOW LOWER RING GROOVE

DIAMETERS AT (C) AND (D) CAN BE EQUAL OR DIAMETER AT (D) CAN BE .0015 IN. GREATER THAN (C)

60x220

Fig. 39—Piston Measurements

g. Finished Pistons

All pistons are machined to the same weight in grams, regardless of oversize so piston balance can be maintained. For cylinder bores which have been honed or rebored, pistons are available in standard and the following oversizes: .005, .020, and .040 inch.

h. Fitting Pistons

The piston and cylinder wall must be clean and dry. The specified clearance between the piston and the cylinder wall is .0005 to .0010 inch.

The piston diameter should be measured at the top of skirt 90 degrees to the piston pin axis. The cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

NOTE: Pistons and cylinder bores should be measured at normal room temperature, 70 degrees F.

All service pistons include pins, and are available in standard and the following oversizes: .005, .020 and .040 inch.

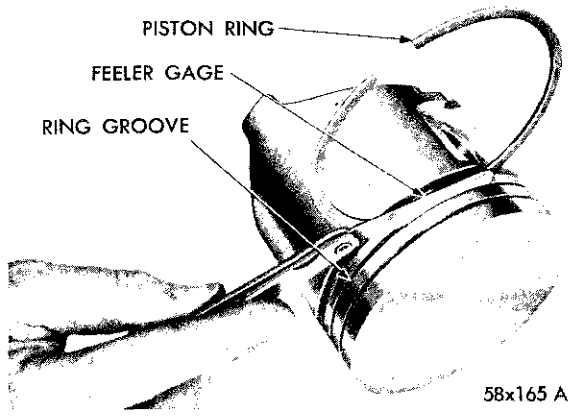


Fig. 40—Measuring Piston Ring Clearance

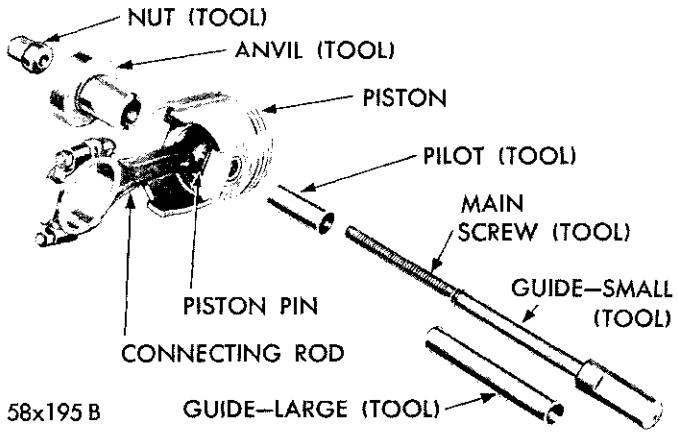


Fig. 41—Tool Arrangement for Removing Piston Pin

i. Fitting Rings

(1) Measure the piston ring gap about two (2) inches from bottom of cylinder bore in which it is to be fitted. (An inverted piston can be used to push the rings down to insure positioning rings squarely in the cylinder wall before measuring.)

(2) Insert the feeler stock in gap (Figure 40). The ring gap should be between .013 to .025 inch. This measurement is the same for all rings.

(3) Measure the side clearance between piston ring and ring land.

(4) The clearance should be .0015 to .003 inches for top compression ring and intermediate ring, and .001 to .003 inch for oil control ring.

(5) Starting with the oil ring expander, place expander ring in the lower ring groove and install oil control ring.

(6) Install the compression rings in the middle and top grooves.

(7) Use ring installer Tool C-3628 for the 361 cubic engine, and Tool C-3673 for the 383 cubic engine (Bore 4.25) and Tool C-3672 for the 383 cubic engine (Bore 4.031 inch) and Tool C-3671 for Models PC-3 and PY-1 413 cubic inch engines.

NOTE: Be sure the mark "Top" on each compression ring is to the top of piston when the ring is installed.

j. Removal of Piston Pin

(1) Arrange Tool C-3624 parts for the removal of piston pin, as shown in Figure 41.

(2) Install pilot on the main screw.

(3) Install the main screw through the piston pin.

(4) Install anvil over the threaded end of the main

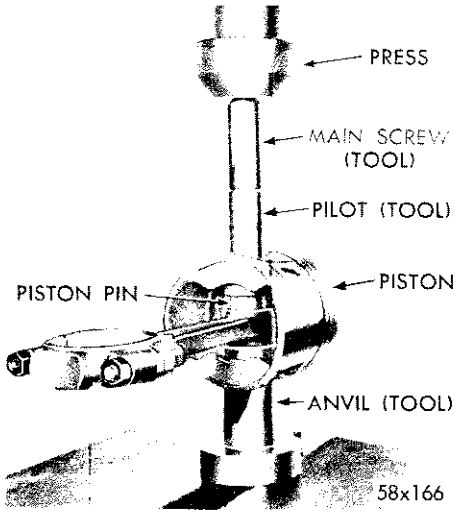


Fig. 42—Removing Piston Pin from Connecting Rod

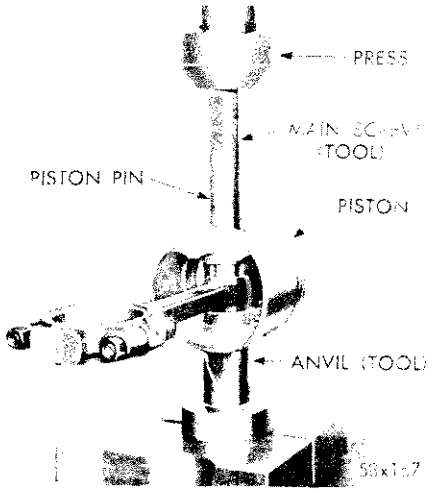


Fig. 44—Installing Piston Pin in Connecting Rod

screw with small end of anvil against the piston boss.

NOTE: Be sure spring is removed from the anvil.

(5) Install nut loosely on the main screw and place the assembly on a press, as shown in Figure 42.

(6) Press the piston pin out of connecting rod.

NOTE: When the pin falls free from connecting rod, stop the press to prevent damage to bottom of the anvil.

(7) Remove the tool from the piston.

k. Installation of Piston Pin

(1) Check the piston pin fit in the piston. It should be a sliding fit in the piston at 70 degrees F. Piston pins are supplied in standard sizes only.

(2) Lubricate piston pin holes in the piston and connecting rod.

(3) Arrange the Tool C-3624 parts for installation of piston pin, as shown in Figure 43.

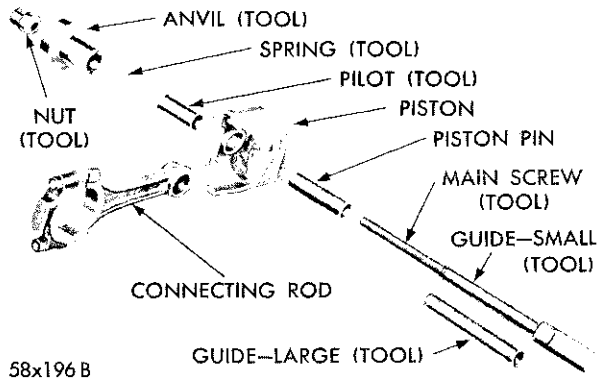


Fig. 43—Tool Arrangement for Installing Piston Pin

(4) Install the spring inside the pilot and install the spring and pilot in the anvil. Install the piston pin over main screw.

(5) Place piston, with "front" up, over pilot so that the pilot extends through the piston pin hole.

(6) Position connecting rod over the pilot which extends through the piston hole.

NOTE: Assemble rods to pistons of the right cylinder bank (2, 4, 6, and 8) with the indent on the piston head opposite to the larger chamfer on the large bore end of connecting rod. Assemble the rods to pistons of the left cylinder bank (1, 3, 5, and 7) with the indent on the piston head on the same side as the large chamfer on the large bore end of connecting rod.

(7) Install the main screw and piston pin in the piston, as shown in Figure 43.

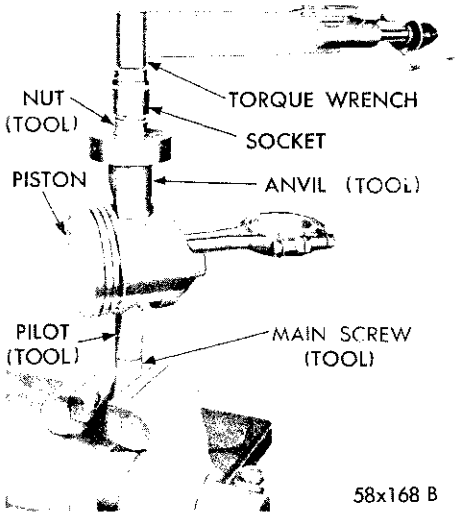


Fig. 45—Testing Fit with Pin in Connecting Rod

(8) Install the nut on puller screw to hold assembly together. Place assembly on a press, as shown in Figure 44.

(9) Press in the piston pin until piston pin bottoms on the pilot properly positioning the pin in the connecting rod.

(10) Remove the tool and arrange tool parts and piston assembly in the same manner, as shown in Figure 41.

(11) Place the assembly in a vise, as shown in Figure 45.

(12) Attach the torque wrench to nut and check torque up to 15 foot-pounds torque. If the connecting rod moves downward on piston pin, reject this connecting rod and piston pin combination. Obtain a connecting rod with proper small end bore diameter and repeat the installation and checking procedure.

(13) If connecting rod does not move under 15 foot-pounds torque, the piston pin and connecting rod interference is satisfactory, the tool may be removed.

26. CONNECTING RODS

IMPORTANT

A Maltese Cross stamped on the engine numbering pad (Fig. 46) indicates that engine is equipped with a crankshaft which has one or more connecting rods and/or main bearing journal finished .001 inch oversize. The position of the undersize journal or journals is stamped on machined surface of No. 3 counterweight (Figure 47).

Connecting rod journals are identified by the letter "R" and main bearing journals by the letter "M". Thus "M-1" indicates that No. 1 main bearing is .001 inch undersize.

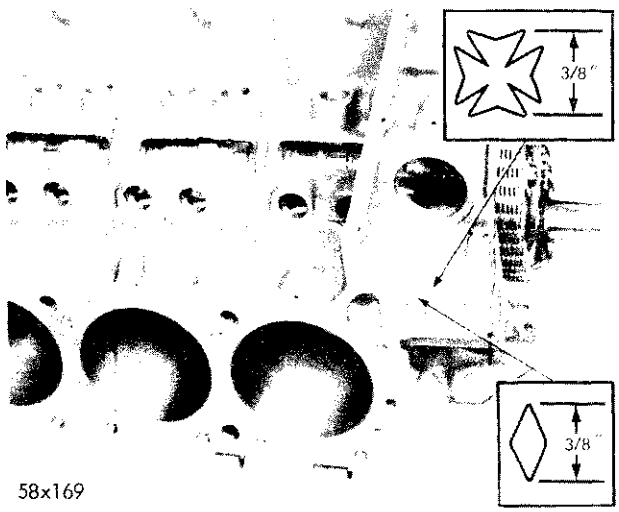


Fig. 46—Showing Location of External Engine Numbering Pad

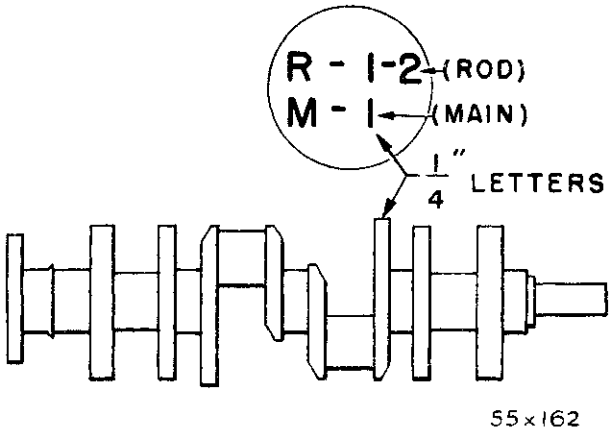


Fig. 47—Showing Location of Mark of No. 3 Counterweight

27. INSTALLATION OF CONNECTING ROD BEARINGS

NOTE: Fit all rods on one bank until completed. Do not alternate from one bank to another, because when the rods are assembled to pistons correctly, they are not interchangeable from one bank to another.

Each bearing cap has a small "V" groove across the parting face. When installing the lower bearing shell, make certain that the "V" groove in shell is in line with "V" groove in cap. This allows lubrication of the cylinder wall. The bearings should always be installed so that small formed tang fits into machined grooves of rods. The end clearance should be from .009 to .017 inch (two rods).

Limits of taper or out-of-round on any crankshaft journals should be held to a maximum of .001 inch. Bearings are available in .001, .002, .003, .010 and .012 inch undersize.

NOTE: Install the bearings in pairs. Do not use a new bearing half with an old bearing half. Do not file the rods or bearing caps.

28. CHECKING THE CONNECTING ROD BEARING CLEARANCE (PLASTIGAGE METHOD)

Connecting rod bearing clearance measurements can be made by the use of Plastigage with the engine in the chassis. After removing the connecting rod cap, wipe off the oil from the crankpin journal and bearing inserts. Place the Plastigage on bearing parallel with crankshaft. Reinstall the cap and tighten attaching nuts alternately to specified torque.

Remove cap and measure the width of the compressed material with the graduated scale to determine the bearing clearance. Desired clearance is from .0005 to .0015 inches. If taper of the compressed material is evident, measure with the graduated scale. If the taper appears to exceed .005 inch, the journal should be checked with micrometers.

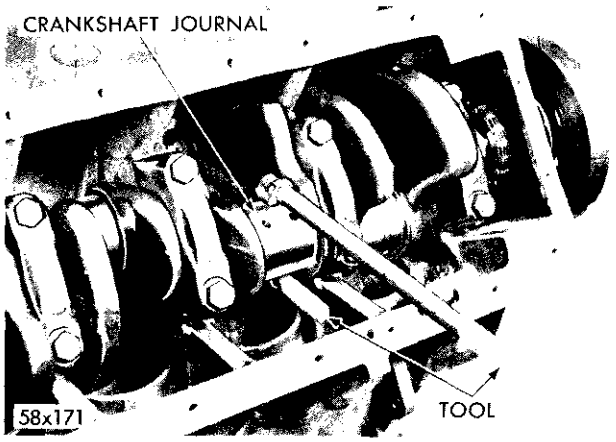


Fig. 48—Removing or Installing Connecting Rod Using Tool C-3221

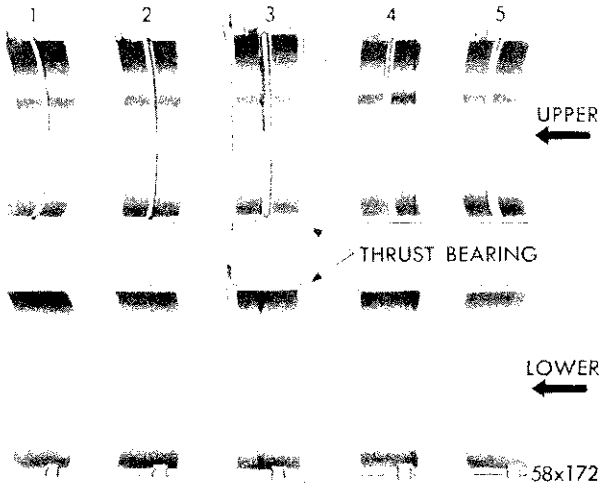


Fig. 49—Upper and Lower Main Bearings

29. INSTALLING PISTON AND CONNECTING ROD ASSEMBLY IN CYLINDER BLOCK

(1) Before installing the pistons, rods, and rod assemblies in bore, be sure that compression ring gaps are diametrically opposite one another and not in line with oil ring gap.

(2) The oil ring expander gap should be toward the outside of the "V" of the engine. The oil ring gap should be turned toward the inside of the "V" of engine.

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, Tool C-385, over the piston and tighten with the special wrench (part of Tool C-385).

(4) Be sure the position of rings does not change during this operation. Screw the connecting rod bolt protector (part of Tool C-3221) on one rod bolt, and insert the rod and piston into cylinder bore.

NOTE: Rotate the crankshaft so that connecting rod journal is on center of the cylinder bore.

(5) Attach the puller part of Tool C-3221 on the other bolt, and guide the rod over the crankshaft journal, as shown in Figure 48.

(6) Tap piston down in the cylinder bore, using the handle of a hammer. At the same time, guide connecting rod into position on crankpin journal.

(7) The notch or groove on the top of the piston must be pointing toward front of the engine and the larger chamfer of the connecting rod bore must be installed toward crankpin journal fillet.

(8) Install the rod caps, tighten nuts to 45 foot-pounds torque.

30. CRANKSHAFT MAIN JOURNALS

The crankshaft main bearing journals should be checked for excessive wear, taper and scoring. Journal grinding should not exceed .012 inch under the standard journal diameter. DO NOT grind the thrust faces of the No. 3 main bearing. DO NOT nick the crankpin or main bearing fillets. After regrinding, remove the rough edges from crankshaft oil holes and clean out all oil passages.

31. CRANKSHAFT MAIN BEARINGS

The lower main bearings of 1, 2, 4 and 5 numbers are interchangeable, as shown in Figure 49. The upper main bearings of 1, 2, 4 and 5 numbers are interchangeable. Upper and lower bearings are not interchangeable because the upper bearing is grooved and the lower is not.

The upper and lower No. 3 bearings are flanged to carry the crankshaft thrust loads and are **not interchangeable** with any other bearings in the engine.

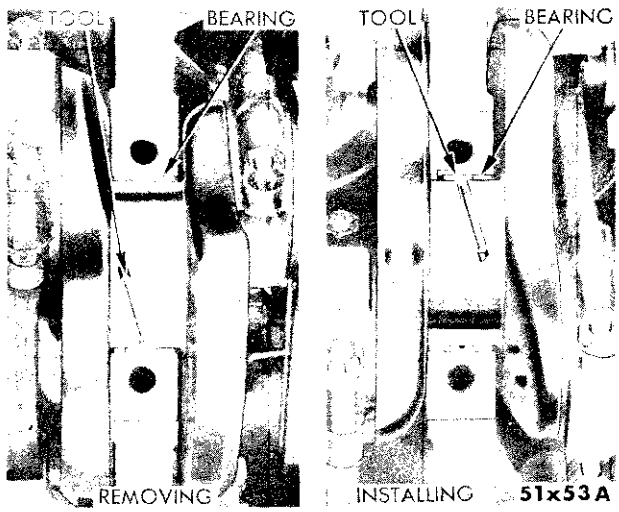


Fig. 50—Removing or Installing Main Bearing Upper Shell

NOTE: Bearings that are not badly worn or pitted must be reinstalled in the same position.

The bearing caps are not interchangeable and should be marked at removal to insure correct assembly. Bearings are available in standard and the following undersizes: .001, .002, .003, .010 and .012 inch. Do not install an undersize bearing that will reduce the clearance below specifications.

32. MAIN BEARINGS

a. Removal

(1) Remove the oil pan and mark bearing caps before removal

(2) Remove bearing caps one at a time. Remove upper half of bearing by inserting Tool C-3059 (Figure 50) into the oil hole of crankshaft.

(3) Slowly rotate crankshaft clockwise, forcing out upper half of bearing.

b. Checking Main Bearing Clearance

Plastigage Method. Use the same technique as described in "Checking the Connecting Rod Bearing Clearance."

CAUTION

If bearings are measured with the engine in the chassis, the crankshaft must be supported in order to take up clearance between the upper bearing insert and the crankshaft journal. This can be done by snugging bearing caps of the adjacent bearings with a strip of .005 to .015 inch cardboard between lower bearing and journal. Use extreme caution when this is done to avoid unnecessary strain on the crankshaft or bearings, or false reading may be obtained. Do not rotate crankshaft while plastigage is installed. Be sure to remove cardboard before reinstalling oil pan.

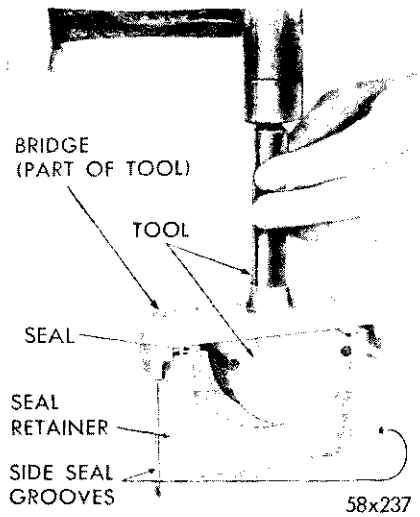


Fig. 51—Installing Rear Main Bearing Lower Oil Seal

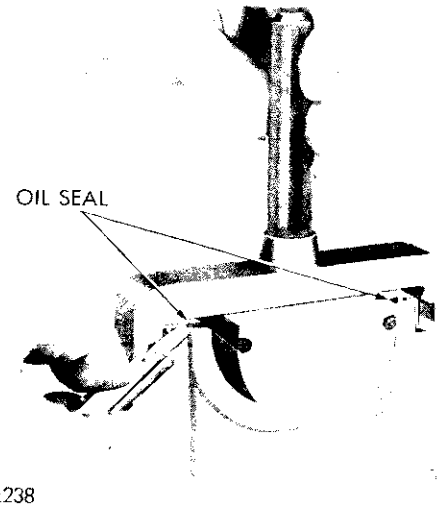


Fig. 52—Trimming Rear Main Bearing Lower Oil Seal

It is permissible to use one .001 inch undersize bearing shell with one standard bearing shell, or one .002 inch undersize bearing shell with one .001 inch undersize shell. Always use the smaller diameter bearing half as the upper. Do not use a new bearing with a used bearing and never use an upper bearing half more than .001 inch smaller than the lower bearing half.

c. Installation of Upper Main Bearing

NOTE: When installing a new upper bearing, slightly chamfer the sharp edge from the plain side.

(1) Lubricate the bearing. Start bearing in place, and insert Tool C-3059 into the oil hole of crankshaft (Figure 50).

(2) Slowly rotate the crankshaft counter-clockwise sliding the bearing into position.

(3) After all bearings have been fitted, tighten all caps to 85 foot-pounds torque. The crankshaft end clearance at #3 main bearing should be .002 to .007 inch.

33. REPLACEMENT OF THE REAR MAIN BEARING OIL SEAL (Crankshaft Removed)

a. Removal

(1) Install a new rear main bearing oil seal in the cylinder block so that both ends protrude.

(2) Tap seal down into position, using Tool C-3625 with bridge removed until the tool is seated in bearing bore.

(3) Hold tool in this position and cut off portion of seal that extends above the block on both sides.

b. Installation

(1) Install a new seal in the seal retainer so that the ends protrude. (Figure 51).

(2) Install bridge on tool and tap the seal down into position with Tool C-3625 until tool is seated.

(3) Trim off the portion of the seal that protrudes above the cap (Figure 52).

(4) Install the two side seals in grooves in seal retainer.

(5) When installing seal retainer tighten screws to 30 foot-pounds torque.

(6) Install the engine oil pan using a new gasket as described in the Engine Oiling Group 10 of this Manual.

34. FRONT ENGINE MOUNTS

a. Removal

(1) Disconnect throttle linkage at transmission and at carburetor.

(2) Remove bolts from front engine mounts.

(3) Raise the engine sufficiently enough to relieve weight from front engine mount assembly and remove engine mounts.

b. Installation

(1) Install front engine mount assembly as shown in Figure 53.

(2) Lower the engine and install bolts. Tighten to 85 foot-pounds torque.

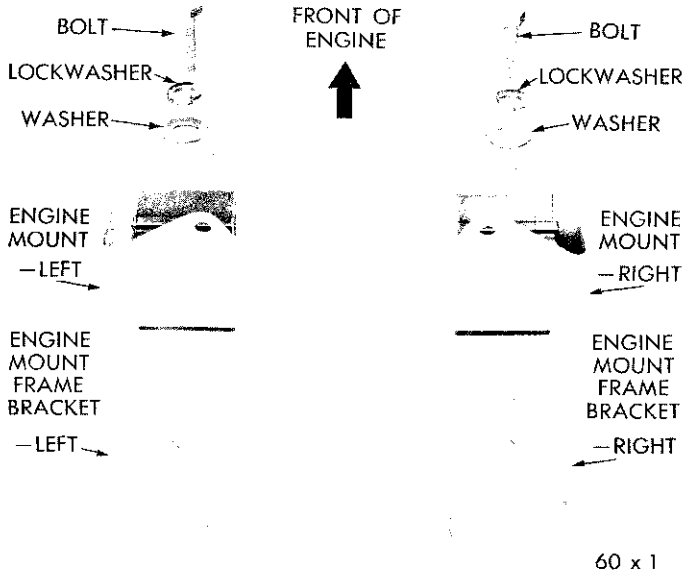


Fig. 53—Front Engine Mounts

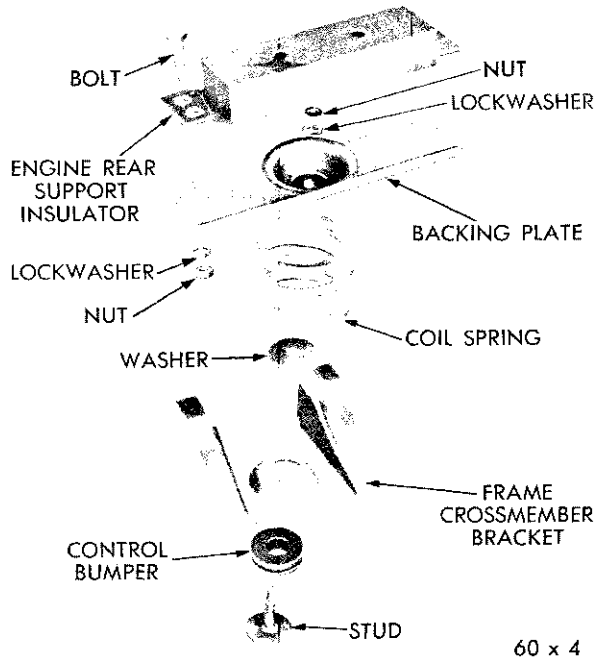


Fig. 54—Rear Engine Mounts

(3) Connect throttle linkage to transmission and to carburetor. Refer to Transmission Group of this Manual for adjustment.

35. REAR ENGINE MOUNT (Figure 54)

a. Removal

(1) Raise car on hoist.

(2) Install transmission jack.

(3) Remove rear engine crossmember from frame.

(4) Remove rear engine mount from crossmember.

b. Disassembly

When replacing the coil spring refer to Figure 54 for proper assembly.

c. Installation

(1) Install rear engine mount to the transmission and tighten bolts to 35 foot-pounds torque.

(2) Install rear engine crossmember to frame and tighten bolts to 75 foot-pounds torque.

(3) Remove transmission jack.

(4) Install rear engine mount to crossmember bolts and tighten to 35 foot-pounds torque.

(5) Lower the car.