Section VII

ENGINE

CONTENTS

SECTION VII

ENGINE

DATA AND SPECIFICATIONS

	C-71	C-72, C-73, C-70
ENGINE		
Type	V 90°	V 90°
Number of Cylinders	8	8
Bore	3.81	3.94
Stroke	3.63	3.63
Piston Displacement	331 cu. in.	354 cu. in.
Compression Ratio	8.5 to 1	9.0 to 1
Compression Pressure at 150 rpm (plugs removed) Wide Open Throttle	140 to 170 lbs.	150 to 180 lbs.
Maximum Variation Between Cylinders (any one engine)	15 lbs.	15 lbs.
Firing Order	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2
CYLINDER NUMBERING—		
From Front of Engine		
Left Bank	1-3-5-7	1-3-5-7
Right Bank	2-4-6-8	2-4-6-8
CRANKSHAFT		
Type	Fully Counter-Balanced	Fully Counter-Balanced
Bearings	Steel Backed Babbitt	Steel Backed Babbitt
Journal Diameter	2.4995 to 2.5005″	2.4995 to 2.5005″
Crank Pin Diameter	2.249 to 2.250″	2.249 to 2.250″
Maximum Out-of-Round Permissible	.001″	.001″
Number of Main Bearings	5	5
Diameter Clearance (Desired)	.0005 to .0015″	.0005 to .0015″
End Play	.002 to .007″	.002 to .007″
Thrust Taken By	No. 3 Main Bearing	No. 3 Main Bearing
Finish at Rear Seal Surface	Diagonal Knurling	Diagonal Knurling
Interchangeability of Bearings	Upper and Lower Nos. 1, 2, 4 Upper and Lower No. 3 Upper and Lower No. 5 Not interchangeable	Upper and Lower Nos. 1, 2, 4 Upper and Lower No. 3 Upper and Lower No. 5 Not interchangeable
MAIN BEARINGS (Service) All Available in Standard and the Following Undersizes	.001, .002, .003, .010, .012″	.001, .002, .003, .010, .012″
CONNECTING RODS AND BEARINGS		
Type	Drop Forged "I" Beam	Drop Forged "I" Beam
Length	6 5/8″	6 5/8″

ENGINE (Cont'd)

	C-71	C-72, C-73, C-70
Weight (less bearings)	25.2 oz.	25.2 oz.
Bearings	Steel-Backed Babbitt	Steel-Backed Babbitt
Diameter and Length	2.2507 to 2.2512″x29/32″	2.2507 to 2.2512″x29/32″
Diametral Clearance Desired	.0005 to .0015″	.0005 to .0015″
Maximum Allowable Before Reconditioning	.0025″	.0025″
Side Clearance	.006 to .014″	.006 to .014″
Bearings for Service	Standard .001, .002, .003, .010, .012″ US	Standard .001, .002, .003, .010, .012″ US
CONNECTING ROD BUSHING		
Type	Steel-Backed Bronze	Steel-Backed Bronze
Number of Bushings	8	8
Diameter and Length	.9843 to .9846x1¼″	.9843 to .9846x1¼″
Interchangeability	All	All
Clearance	.0001 to .0004″ Selective	.0001 to .0004″ Selective
CAMSHAFT		
Drive	Chain	Chain
Bearings	Steel-Backed Babbitt	Steel-Backed Babbitt
Number	5	5
Thrust Taken By	Thrust Plate	Thrust Plate
End Play	.002 to .006″	.002 to .006″
Maximum Allowable Before Reconditioning	.010″	.010″
Diametral Clearance	.001 to .003″	.001 to .003″
Maximum Allowable Before Reconditioning	.005″	.005″
Valve Lift—Intake	.375″	.375″
Valve Lift—Exhaust	.361″	.361″
CAMSHAFT BEARING JOURNALS		
Diameter and Length		
No. 1	1.998 to 1.999 x 15/16″	1.998 to 1.999 x 15/16″
Nos. 2, 3 and 4	1.998 to 1.999 x ¾″	1.998 to 1.999 x ¾″
No. 5	1.4355 to 1.4365 x 29/32″	1.4355 to 1.4365 x 29/32″
CAMSHAFT BEARINGS		
Diameter and Length (after reaming)		
No. 1	2.000 to 2.001 x 15/16″	2.000 to 2.001 x 15/16″
Nos. 2, 3 and 4	2.000 to 2.001 x 13/16″	2.000 to 2.001 x 13/16″
No. 5	1.4375 to 1.4385 x 29/32″	1.4375 to 1.4385 x ⅞″
TIMING CHAIN		
Adjustment	None	None
Number of Links	68	68

ENGINE (Cont'd)

	C-71	C-72, C-73, C-70
Pitch	.375″	.375″
Width	1⅛″	1⅛″
TAPPETS		
Type	Hydraulic	Hydraulic
Clearance in Block	.0005 to .0015″	.0005 to .0015″
Body Diameter	.9040 to .9045″	.9040 to .9045″
Clearance Between Valve Stem and Rocker Arm (Tappet Bled Down)	Dry Lash .060 to .210″	Dry Lash .060 to .210″
PISTONS		
Type	Horizontal Slot w/Steel Band	Horizontal Slot w/Steel Strut
Material	Aluminum Alloy Tin Coated	Aluminum Alloy Tin Coated
Land Clearance (diametral)	.027 to .032″	.028 to .033″
Clearance at Skirt	At Top of Skirt .0005 to .0015″	1½″ from Bottom of Skirt .0005″ to .0015″
Weight	595 gm.	646 gm.
Piston Length (overall)	3.55″	3.99″
Ring Groove Depth		
No. 1	.200″	.205″
No. 2	.200″	.205″
No. 3	.194″	.198″
Pistons for Service	Std., .005, .020, .040, .060″ OS	Std., .005, .020, .040, .060″ OS
PISTON PINS		
Type	Full Floating	Full Floating
Diameter and Length	.9841 to .9843 x 3.140 to 3.150″	.9841 to .9843 x 3.140 to 3.150″
Clearance in Piston (thumb press at 70° F.)	.0000 to .0005″	.0000 to .0005″
End Play	.004 to .026″	.004 to .026″
Clearance in Rod (Selective)	.0001 to .0004″	.0001 to .0004″
Piston Pins for Service	Std., .003, .008″ OS	Std., .003, .008″ OS
Direction Offset in Piston	Toward Right Side of Engine	Toward Right Side of Engine
PISTON RINGS		
Number of Rings Per Piston	3	3
Compression	2	2
Oil	1	1
Width of Rings—		
(Compression)	.0775 to .0780″	.0775 to .0780″
(Oil)	.1860 to .1865″	.1860 to .1865″
Piston Ring Gaps (All)	.010 to .020″	.010 to .020″
Ring Side Clearance (Compression)		
Upper	.0015 to .0030″	.002 to .0035″

ENGINE (Cont'd)

	C-71	C-72, C-73, C-70
Intermediate	.0010 to .0025″	.002 to .0035″
(Oil)	.0010 to .003″	.0010 to .0025″
VALVES—Intake		
Material	Silicon-Chromium Steel	Silicon-Chromium Steel
Head Diameter	$1\frac{13}{16}$ in.	$1\frac{15}{16}$ in.
Length (to top of valve face)	$4\frac{25}{32}$ in.	$5\frac{1}{32}$ in.
Stem Diameter	.372 to .373 in.	.372 to .373 in.
Stem to Guide Clearance	.001 to .003 in.	.001 to .003 in.
Maximum Allowable Before Reconditioning	.004 in.	.004 in.
Angle of Seat	45°	45°
Adjustment	None	None
VALVES—Exhaust		
Material	Nitrided Chrome-Nickel Steel	Nitrided Chrome-Nickel Steel
Head Diameter	$1\frac{1}{2}$ in.	$1\frac{3}{4}$ in.
Length (to top of valve face)	$4\frac{3}{4}$ in.	$5\frac{1}{32}$ in.
Stem Diameter	.371 to .372 in.	.371 to .372 in.
Stem to Guide Clearance	.002 to .004 in.	.002 to .004 in.
Maximum Allowable Before Reconditioning	.006 in.	.006 in.
Angle of Seat	45°	45°
Adjustment	None	None
VALVE SPRINGS—Outer		
Number	16	16
Free Length	2 in.	2 in.
Load When Compressed to (valve closed)	$1\frac{11}{16}$ in.—68 to 76 lbs.	$1\frac{11}{16}$ in.—68 to 76 lbs.
Load When Compressed to (valve open)	$1\frac{5}{16}$ in.—160 to 172 lbs.	$1\frac{5}{16}$ in.—160 to 172 lbs.
Valve Springs I. D.	.990 to 1.010 in.	.990 to 1.010 in.
VALVE SPRINGS—Inner	None	None
CYLINDER HEAD		
Number Used	2	2
Combustion Chamber	Polyspherical	Hemispherical
Valve Seat Runout (maximum)	.002 in.	.003 in.
Intake Valve Seat Angle	45°	45°
Seat Width (finished)	.040 to .060 in.	.040 to .060 in.
Cylinder Head Gasket Compressed (thickness)	.024 in.	.024 in.

ENGINE (Cont'd)

	C-71	C-72, C-73, C-70
ENGINE LUBRICATION		
Pump Type	Rotary, Full Pressure	Rotary, Full Pressure
Capacity (qts.)	5*	5*
Pump Drive	Camshaft	Camshaft
Operating Pressure at 40 to 50 mph	40 to 65 psi.	40 to 65 psi.
Pressure Drop Resulting from Clogged Filter	15 to 20 psi.	15 to 20 psi.
*When Filter Element is Replaced Add 1 Qt.		

SPECIAL TOOLS

Tool Number	Tool Name
C-119	Indicator—Cylinder Bore
C-385	Compressor—Piston Ring
C-425	Vacuum Gauge
C-455	Wrench—Starting Motor Flange Nut
C-647	Tester—Clutch and Valve Spring
C-690	Scale and Gauge—Piston Fitting
C-741	Reamer—Solid Valve Guide
C-756	Cleaner—Valve Guide
C-863	Timing Light—6 and 12 Volt
C-897	Driver—Welch Plug Installer
C-3005	Wrench—Torque 100 Foot-Pounds (Sensory Type)
C-3012	Reamer—Cylinder Bore Ridge
C-3024	Tool—Rocker Arm and Spring Compressor
C-3025	Sleeve—Guide Wear Measuring—Intake
C-3026	Sleeve—Guide Wear Measuring—Exhaust
C-3028	Reamer Set—Valve Tappet
C-3033	Puller Set—Damper, Sprocket, Crank Gear
C-3038	Fixtures—Cylinder Head Holding (FirePower)
C-3046	Tool—Piston Ring Installer (SpitFire)
C-3049	Reamer—Piston Pin Line (.980 to 1.030)
C-3052	Remover—Distributor Shaft Bushing
C-3053	Driver and Burnisher—Distributor Drive Shaft Bushing
C-3054	Wrench—Spark Plug
C-3059	Tool—Main Bearing Upper Shell
C-3061	Gauge—Valve Stem Length (FirePower)
C-3065	Gauge—Cylinder Compression
C-3066	Connector—Timing Light

SPECIAL TOOLS (Cont'd)

Tool Number	Tool Name
C-3068	Rack—Hydraulic Tappet
C-3075	Gauge—Top Dead Center (FirePower)
C-3132	Puller and Installer—Camshaft Bearing
C-3151	Driver—Welch Plug Installing
C-3160	Pliers—Hydraulic Tappet Leakdown Checking
C-3167	Stand—Engine Repair
C-3168	Adapter—Engine Repair Stand
C-3216	Puller—Hydraulic Tappet
C-3221	Tool—Piston and Connecting Rod Assembly
C-3339	Dial Indicator Set
C-3419	Wrench—Distributor Lock Plate
C-3422	Compressor—Valve Spring (FirePower)
C-3427	Reamer—Valve Guide (.404 to .405 inch)
C-3428	Compressor—Valve Spring (SpitFire)
C-3430	Reamer—Valve Guide (.389 to .390 inch) (SpitFire)
C-3433	Reamer—Valve Guide (.379 to .380 inch) (SpitFire)
C-3436	Gauge—Valve Stem Length (SpitFire)
C-3466	Plate—Engine Lifting
C-3491	Connecting Rod Aligner
C-3495	Tool—Piston Ring Installer (FirePower)
C-3501	Cylinder Bore Deglazing Hone
C-3506	Removing and Installing Tool—Chain Case Cover Oil Seal
C-3509	Tool—Camshaft Holding
C-3511	Tool—Rear Main Bearing Seal Installing
DD-883	Driver—Valve Guide

TIGHTENING REFERENCE

	(Foot-Pounds)
Camshaft Sprocket Bolt	35
Camshaft Sprocket Hub Thrust Plate Bolt	15
Carburetor to Manifold Stud Nut	15
Chain Case Cover Bolt	35
Connecting Rod Bearing Cap Bolt Nut	45
Cylinder Head Bolt	85
Distributor Clamp Bolt	15
Engine Front Support Foot Bolt Nut	45
Engine Front Support Insulator Bolt Nut	45
Exhaust Manifold Stud Nut	25
Exhaust Pipe Flange Bolt Nut	40

TIGHTENING REFERENCE (Cont'd)

Fan Blade Bolt	15
Flywheel Housing to Cylinder Block Bolt	50
Fuel Pump Bolt	30
Generator Adjusting Strap Bolt	15
Generator Adjusting Strap Mounting Bolt	30
Generator Bracket Bolt	50
Generator Mounting Bolt	20
Ignition Cable Cover Screw	7
Intake Manifold Bolt	30
Main Bearing Cap Bolt (With or Without Lockwasher*)	85
Oil Filter Bolt	25
Oil Level Indicator Tube Bracket Bolt Nut	10
Oil Pan Bolt	15
Oil Pan Drain Plug	35
Oil Pump Cover Bolt	10
Oil Pump Mounting Bolt	35
Spark Plugs	30
Vibration Damper Hub Bolt	135
Vibration Damper Inertia Member Flange Bolt	15
Water Outlet Elbow Bolt	35
Water Pump Housing Bolt	30

(Inch-Pounds)

Crankcase Ventilator Outlet Pipe Bolt	15
Manifold Heat Control Counterweight Bolt	50
Rocker Arm Cover Bolt Nut	30
Tappet Chamber Cover	50

*The use of main bearing cap screw lockwashers was discontinued during the 1956 model year. Be sure to use washers on reassembly of bearing caps which had washers to prevent bottoming of screws.

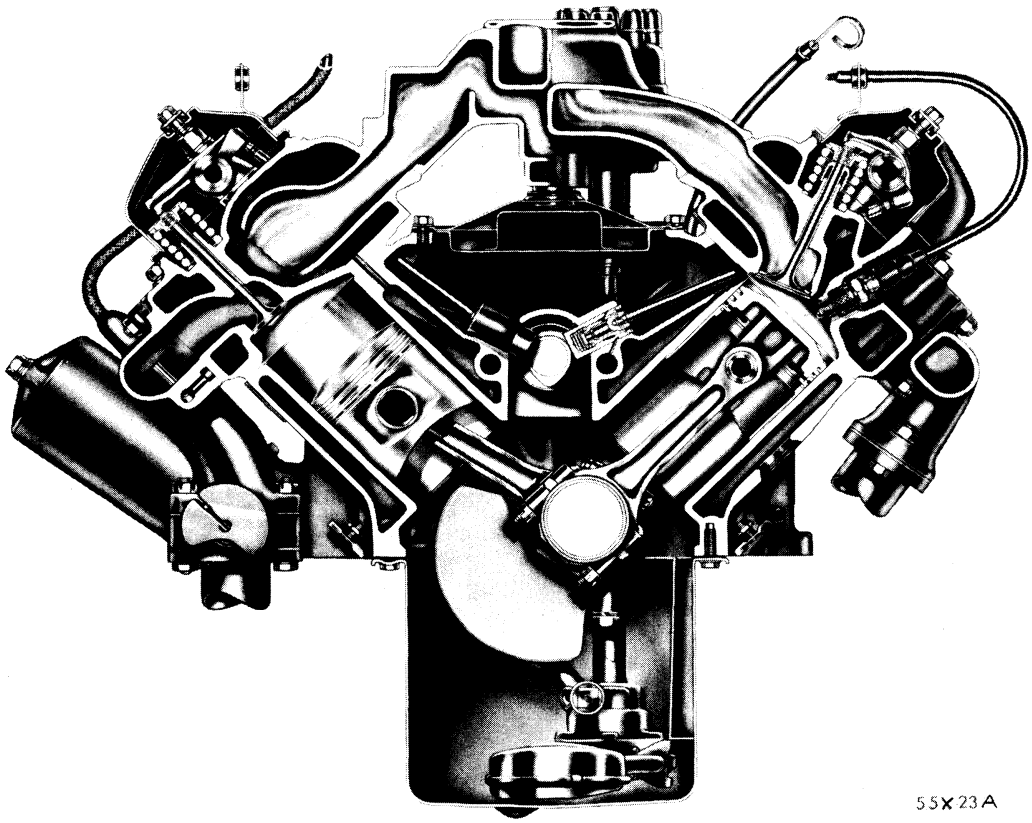

Fig. 1—SpitFire V-8 Engine (End Sectional View)

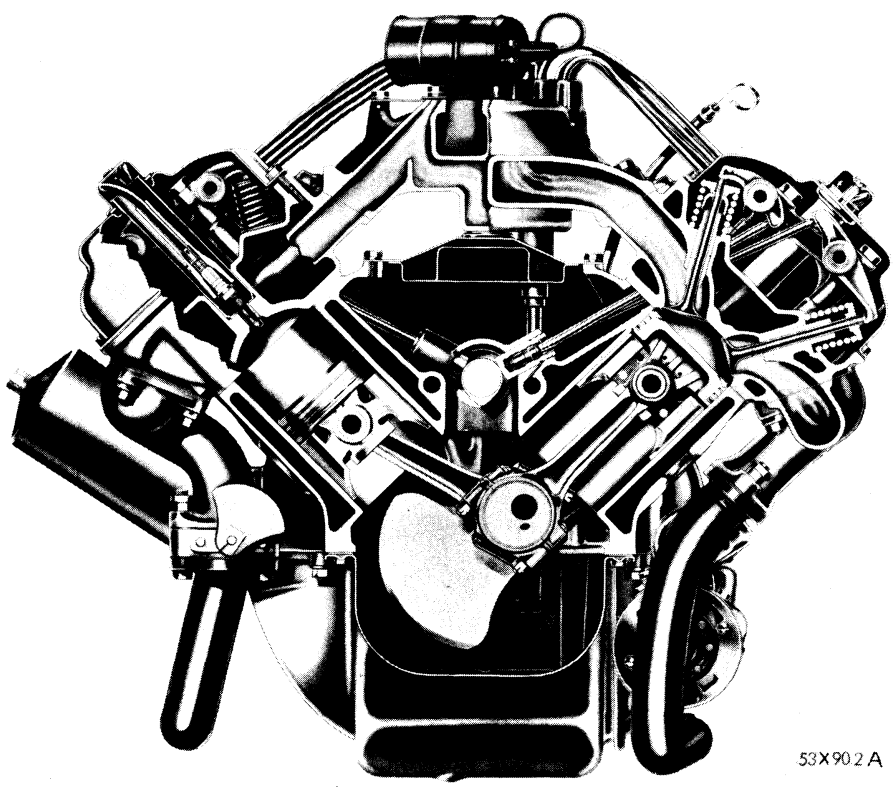

Fig. 2—FirePower V-8 Engine (End Sectional View)

Section VII
ENGINE

The Chrysler Engine, as shown in Figures 1 and 2 is a 90 degree, V-8 type, and the cylinder block and crankcase are cast integrally, along with transverse members, which support five main bearings. It is pressure lubricated by a

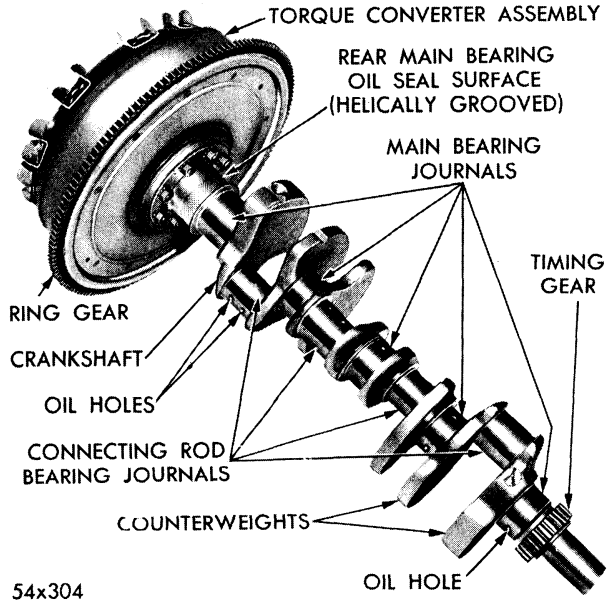

Fig. 3—Crankshaft and Torque Convertor Assembly

rotary type oil pump, driven by the lower distributor drive shaft. Drilled passages in cylinder block and cylinder heads, permit lubricating oil to circulate from the oil pump, to all moving parts of the engine. The crankshaft is a steel drop forging, and static and dynamic balance is achieved by the use of six counterweights, as shown in Figure 3. End thrust is taken by the Number 3 main bearing. Hydraulic tappets are used in the engine, and the camshaft is chain driven. The SpitFire engine cylinder heads have polyspherical combustion chambers, as shown in Figure 4, and the FirePower engine cylinder heads are equipped with hemispherical type combustion chambers, as shown in Figure 5.

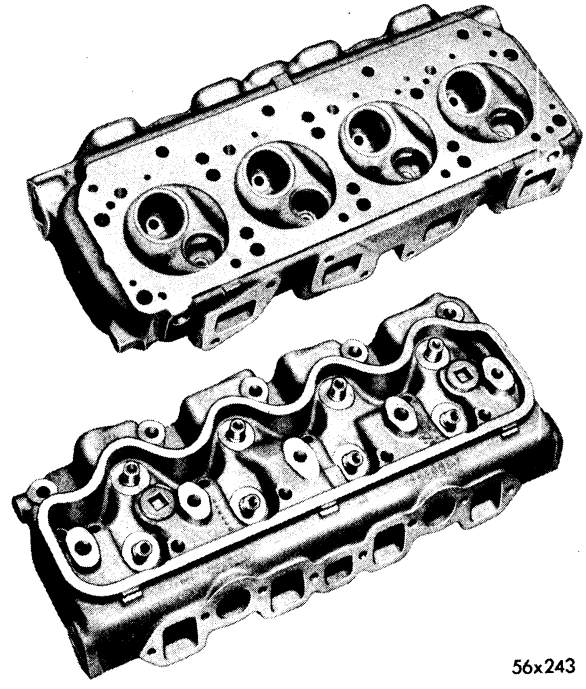

Fig. 4—Cylinder Head (SpitFire)

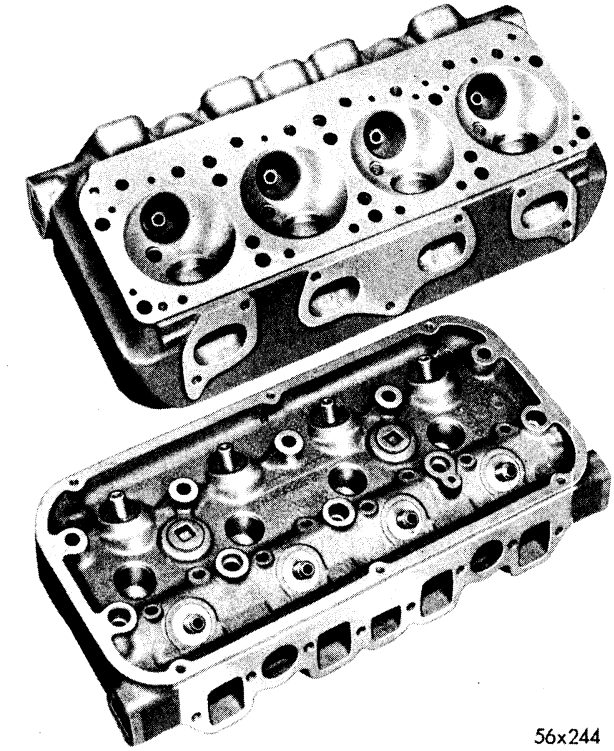

Fig. 5—Cylinder Head (FirePower)

ENGINE TUNE UP

1. MINOR TUNE-UP

Clean and adjust spark plugs (.035 inch gap). Adjust or replace distributor contact points (.015 to .018 inch gap). Check distributor cap for cracks and corrosion. Inspect rotor, rotor spring and plunger. Inspect distributor to spark plug wires for cracks. Inspect small lead wires for tightness, breakage, or damaged insulation. Check for excessive play in distributor vacuum advance plate bearing. Reset ignition timing. Check battery specific gravity and clean and tighten battery connections. Check starter amperage draw. Inspect fan belt, and check adjustment. Clean and oil the air cleaner. Tighten carburetor flange nuts. Set carburetor idle mixture adjustment. Adjust throttle stop screw so engine idles at 450 to 500 r.p.m. Check manifold heat control valve.

The following procedures are provided as a guide which should be followed when attempting minor engine repairs or a complete engine overhaul.

Service procedures for removal, inspection, repair and installation of engine components are provided in this section. In this way, information can be followed for specific operation, or for complete engine overhaul.

On cars equipped with air conditioning, power steering, power brakes, heater etc., refer to Section covering this equipment for removal, installation and adjustment procedures.

2. MAJOR TUNE-UP

A periodic engine tune-up will assure maximum engine performance and fuel economy. The following test should be made when a complete engine analysis is being made during a Major Tune-Up. In addition, perform all steps of a "Minor Tune-Up."

Tighten cylinder head bolts and manifold nuts. Cylinder head bolts should be tightened while engine is at normal operating temperature. Make a compression test. The compression should not vary more than 15 pounds between cylinders. Refer to "Specifications" for compression pressures. Check coil and condenser and inspect primary and secondary wires. Test fuel pump for pressure and vacuum, and adjust carburetor. Refer to Fuel and Exhaust System, Section VIII, "Carburetor Adjustments." Check combustion analysis. Clean and re-oil the air cleaner, and check manifold heat control valve. Road test car as a final check.

SERVICE PROCEDURES

3. REMOVAL OF ENGINE ASSEMBLY (From Car)

Drain cooling system and remove battery. Remove fan shroud, radiator and hood. **Before removing hood, scribe outline of hinge brackets on hood to assure proper adjustment when installing.** Disconnect fuel lines and wires attached to engine units. Remove air cleaner and carburetor. Attach engine lifting fixture, Tool C-3466, to carburetor flange studs on intake manifold and attach a chain hoist to fixture eyebolt.

Raise car and disconnect propeller shaft at transmission. Disconnect wires and linkage at transmission and clutch. Remove exhaust pipe. (Be sure exhaust system is sufficiently supported while engine is removed.)

Drain engine and transmission oil. Remove rear crossmember to transmission support attaching bolts.

NOTE:

Place a rollaway jack under transmission to relieve weight from crossmember. Place a wood block between head of jack and transmission to avoid damaging transmission oil pan. This jack must support weight of rear of power plant and must be able to roll with the engine as engine is being removed from chassis.

Remove crossmember to frame bracket attaching bolts, and remove crossmember and rear engine support.

Lower car to convenient working height and remove engine front support mounting bolts. With chain hoist, raise engine and, at same time, work engine out of chassis toward left front fender.

Remove transmission if engine and transmission were removed as an assembly. If engine is to be disassembled, place engine in engine repair stand, Tool C-3167, using transmission mounting bolts.

4. INSTALLING ENGINE IN CAR

Install engine lifting fixture, Tool C-3466 and attach chain hoist to fixture eyebolt. Lower engine carefully, entering rear of engine into vehicle until front and rear of engine are approximately positioned. Place a rollaway jack under transmission to support weight of the rear of engine. Install engine rear support crossmember. Position engine and install bolts at front mounts. Position and install rear engine support bolts and remove jack and hoist. Remove engine lifting fixture. Install manifold, carburetor, fuel lines, wiring and linkage. Install radiator, radiator hoses, wires and radiator shroud. Install battery. Install exhaust pipes, using new gaskets. Reinstall hood by checking scribe marks placed on inside of hood at removal.

Connect propeller shaft at transmission. Be sure all drain cocks are closed; refill cooling system, refill engine crankcase and transmission. Refer to Section XV, "Lubrication" for quantities and lubricants to use. Check entire system for leaks and correct as necessary.

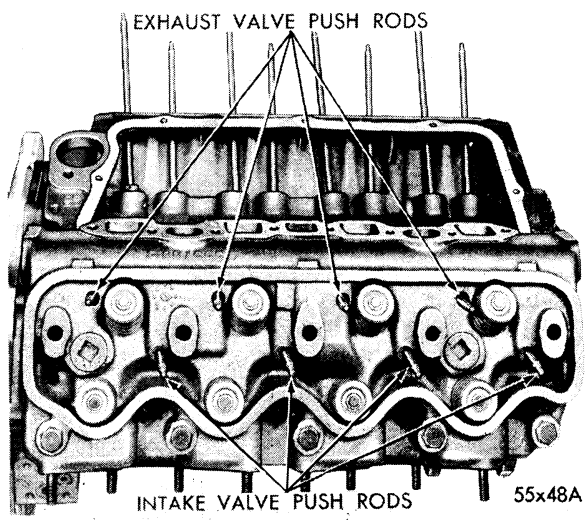

Fig. 6—Push Rods Installed (SpitFire)

NOTE:

Whenever an engine has been rebuilt and a new camshaft and/or new tappets have been installed, one quart of MOPAR Oil Additive should be added to engine oil to aid break-in. The oil mixture should be left in engine for a minimum of 500 miles. It is not necessary however, to drain the mixture before normal oil change is required, nor is it necessary to use the oil additive at subsequent oil changes.

Start engine, warm up to 160 degrees F., check timing and adjust carburetor as necessary.

5. REMOVAL OF CYLINDER HEADS

Drain cooling system. Remove generator adjusting strap and generator.

Remove carburetor air cleaner and fuel line between carburetor and fuel pump. Disconnect accelerator linkage at carburetor throttle lever. Remove vacuum control tube at carburetor and distributor. Disconnect coil wires and heater hose. Remove heat indicator sending unit wire. Remove oil level indicator (dip stick). Remove air tube between automatic choke and exhaust manifold. Remove bolts attaching water pump housing to cylinder heads and loosen remaining water pump housing bolts to allow sufficient forward movement to facilitate installation of cylinder head to water pump gaskets.

Remove ignition cable cover and disengage insulators from spark plugs. Use a thin wall socket, or Tool C-3054 to remove spark plugs and tubes. Remove cylinder head covers and gaskets. Remove intake manifold, ignition coil and carburetor as an assembly. Disconnect exhaust pipes at manifold flanges.

Remove bolts that attach rocker arm support brackets to cylinder head and block, and pull rocker assemblies and bolts directly away from heads.

CAUTION:

The rocker arm assembly attaching bolts (FirePower) also hold cylinder heads to block. When these bolts are removed, cylinder heads are loose and are held by two dowel pins only.

Remove push rods and place them in their respective slots in Holder Tool C-3068.

Lift off cylinder head and place into holding

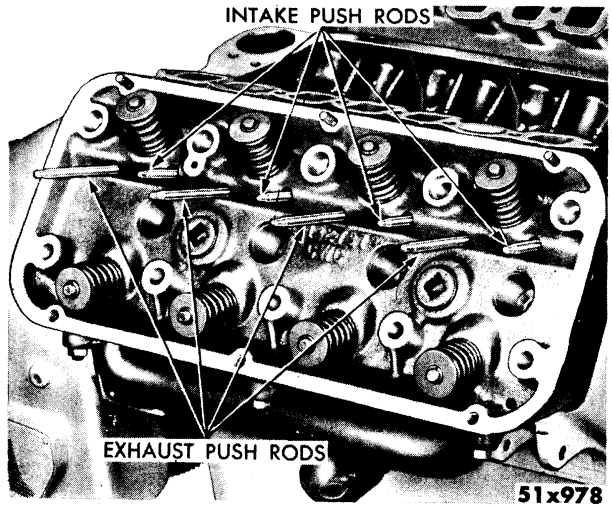

Fig. 7—Push Rods Installed (FirePower)

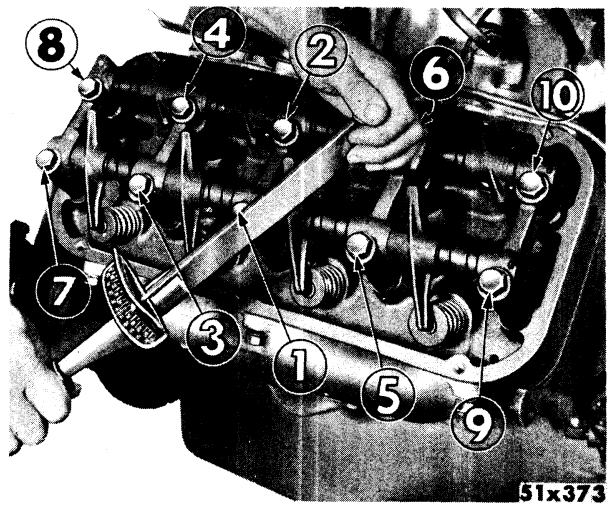

Fig. 9—Tightening Cylinder Head Bolts (FirePower)

fixture Tool C-3209 (SpitFire Engine), Tool C-3133 (FirePower Engine) to prevent damage to machined surfaces. Remove exhaust manifold and gasket, if cylinder head is to be replaced.

6. INSTALLATION OF CYLINDER HEADS

Clean gasket surfaces of cylinder block and cylinder head. Check all surfaces with a straightedge if there is any reason to suspect leakage.

Install exhaust manifold gasket and manifold on cylinder heads. Install cylinder heads and **new** cylinder head gaskets. Coat gaskets with a suitable sealer. Install push rods as shown in Figures 6 and 7. Insert cylinder head bolts into rocker arm support brackets, and place rocker arm assemblies in position on head, lining up all push rods to their respective rocker arms. Starting at top center, tighten all cylinder head bolts to 85 foot-pounds torque, in sequence shown in Figures 8 and 9.

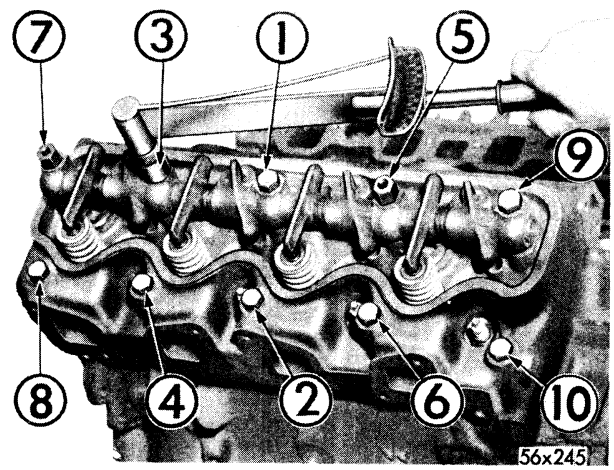

Fig. 8—Tightening Cylinder Head Bolts (SpitFire)

Place **new** valve tappet cover gaskets in position, and install tappet cover. Tighten bolts to 50 inch-pounds torque. Install crankcase breather tube on tappet cover and insert oil level indicator (dip stick) tube into position.

Install **new** cylinder head cover gasket and install cover. Tighten nuts and bolts to 30 inch-pounds torque. On FirePower engines slide spark plug tube seals over tubes, and install in position in heads. Check spark plugs for .035 inch gap and install plugs, being careful not to drop them on electrodes as this would cause

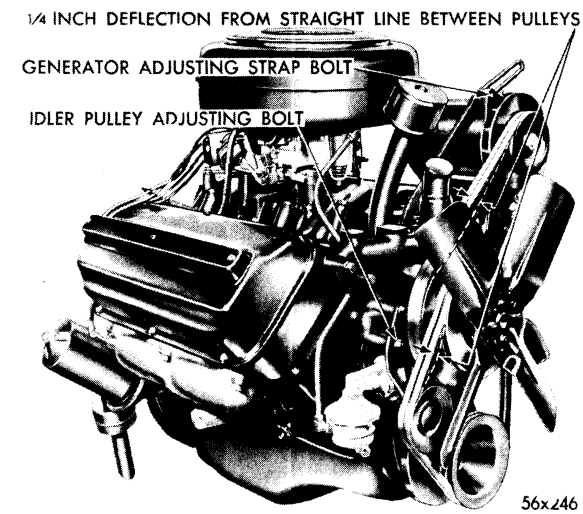

Fig 10—Adjustment of Fan Belts (FirePower) (Typical of SpitFire)

gap setting to be altered. Tighten spark plugs with Tool C-3054 to 30 foot-pounds torque. Install **new** intake manifold gaskets and manifold. Tighten bolts to 30 foot-pounds torque.

NOTE

When installing intake manifold, insert short bolts in holes on extreme ends of manifold.

Install distributor cap coil wire, spark plug cables and insulators. On FirePower Engines place spark plug tube seal retainers in position and install spark plug covers, after carefully arranging spark plug cables. Tighten screws securely.

Install generator and adjusting strap bolt. Tighten bolts to 15 foot-pounds torque.

NOTE

When adjusting fan and generator belts, obtain enough slack so that belts may be drepressed, as shown in Figure 10. When dual belts are used, both belts should have equal tension.

7. REMOVAL OF ROCKER ARMS AND SHAFT ASSEMBLY

a. Removal

Remove rocker arm cover and gasket. Remove bolts that attach rocker arm support brackets and cylinder head to cylinder block and remove rocker arms and brackets as an assembly.

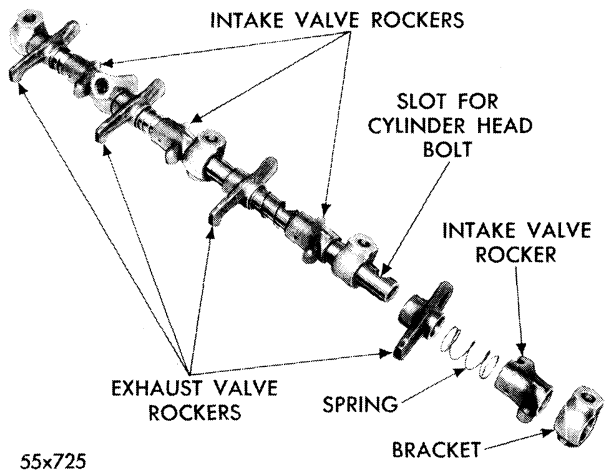

Fig. 11—Rocker Shaft Assembly-Disassembled View (Spitfire)

CAUTION

With bolts removed, the cylinder heads are only held in position by two locating dowel pins. (FirePower Engines)

If rocker arm assemblies have been disassembled for cleaning, inspection or replacement, refer to Figures 11 and 12 for proper reassembly.

NOTE

On FirePower engines rocker shafts are stamped "IN" for intake and "EX" for exhaust. The intake rocker arms are shorter than exhaust rocker arms.

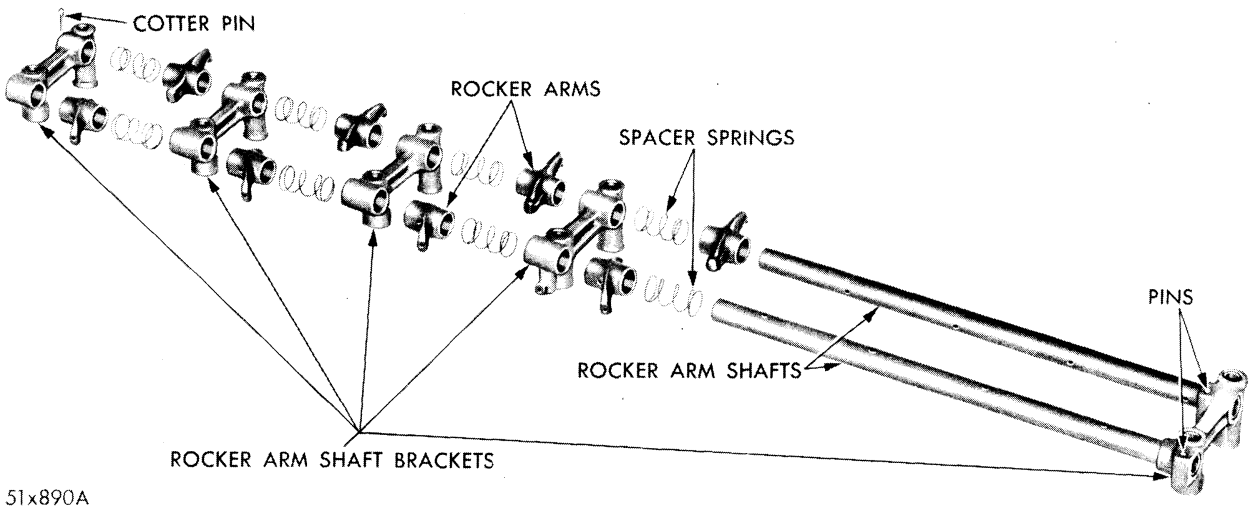

Fig. 12—Rocker Shaft Assembly-Disassembled View (FirePower)

8. INSTALLATION OF ROCKER ARM AND SHAFT ASSEMBLY

Install push rods as shown in Figures 6 and 7. The push rods should be properly positioned in rocker arm and tappets. Position rocker arm assemblies and install cylinder head bolts. Tighten bolts 85 foot-pounds torque in sequence shown in Figures 8 and 9.

9. REMOVAL OF VALVES AND VALVE SPRINGS

With cylinder head removed, compress valve springs with Tool C-3428 (SpitFire Engines). Tool C-3023 (FirePower Engines) and remove valve retaining locks, valve spring retainers, valve stem cup seals (intake valves only) and valve springs. **Remove burrs from valve stem lock grooves to prevent damage to valve guide when valves are removed.**

10. VALVE INSPECTION

Clean valves thoroughly, and discard burned, warped or cracked valves. Check valve stems for wear. Intake valve stems should measure .372 to .373 inch, and exhaust valve stems should measure .371 to .372 inch. If wear exceeds .002 inch, replace the valve. Remove carbon and varnish deposits from inside of valve guides with cleaner, Tool C-756.

NOTE

On SpitFire Engines, the valve guides are cast integrally with the cylinder head. Service valves with oversize stems are available for these engines.

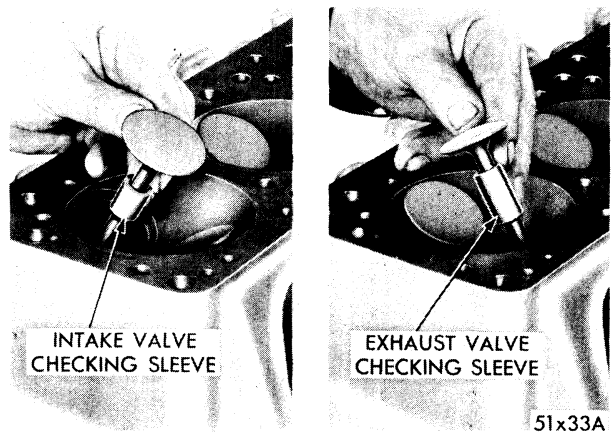

Fig. 13—Installing Sleeves To Check Guide Clearance (Firepower) (Typical of SpitFire)

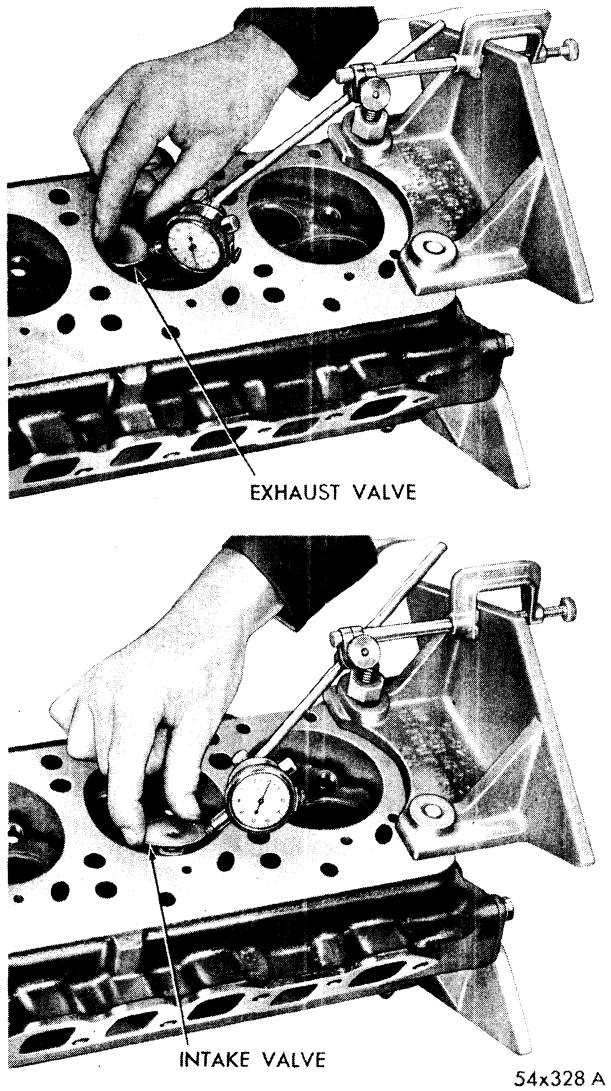

Fig. 14—Checking Valve Guide Clearance (SpitFire) (Typical of FirePower)

Check valve stem to guide clearance as follows:

Install sleeve, Tool C-3025, over intake valve stem, and sleeve Tool C-3026 on exhaust valve stem (Fig. 13) and install valves. These special sleeves place valve at working height for easy checking with a dial indicator. Attach dial indicator Tool C-3339 to cylinder head and set it at right angle to edge of valve being checked (Fig. 14). Move valve to and from indicator. The total dial indicator reading should not exceed .008 in. on intake valves, or .014 inch on exhaust valves. If readings exceed the above tolerances, install new valve guides (FirePower Engines), or ream guides for oversize valves (SpitFire Engines), to next oversize (if other than standard).

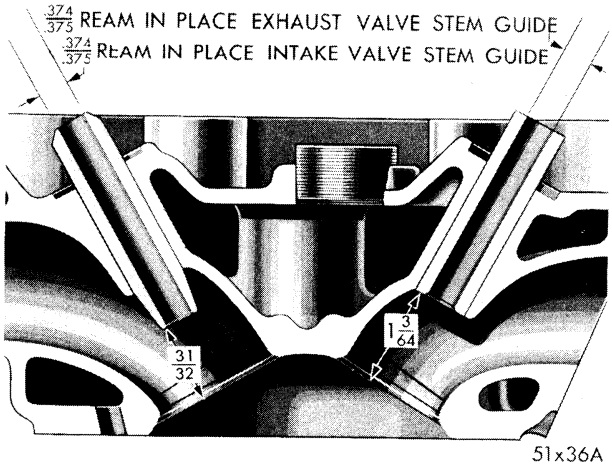

Fig. 15—Exhaust and Intake Valve Guides Installed in Head (FirePower)

11. REMOVAL AND INSTALLATION OF VALVE GUIDES (FIREPOWER ENGINE)

Drive out guides through top of cylinder heads with Tool C-3150. Install as follows: Turn cylinder head with combustion chamber facing up. Drive valve guides into position with a suitable driver to dimensions shown in Figure 15. After new valve guides have been installed, ream each guide from .374 to .375 inch with Tool C-741. Valves with oversize stems are available in .005, .015, and .030 inch. Reamers to accommodate the oversize valve stems are as follows. Reamer Tool C-3433 (.379 to .380 inch), Reamer Tool C-3430 (.389 to .390 inch) and Reamer Tool C-3427 (.404 to .405 inch). Slowly turn reamer by hand and clean guide thoroughly before installing new valve.

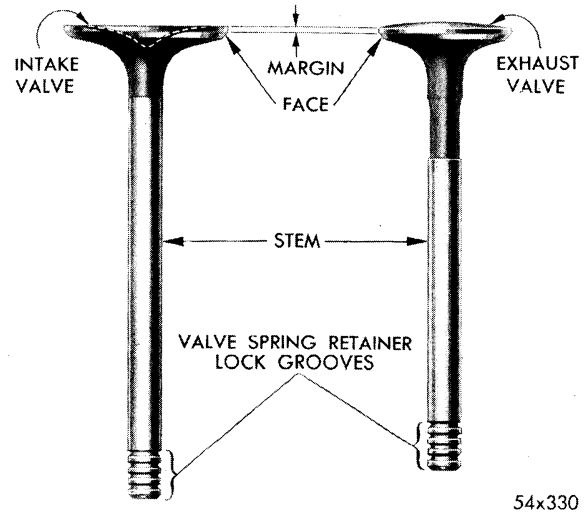

Fig. 16—Intake and Exhaust Valve Nomenclature

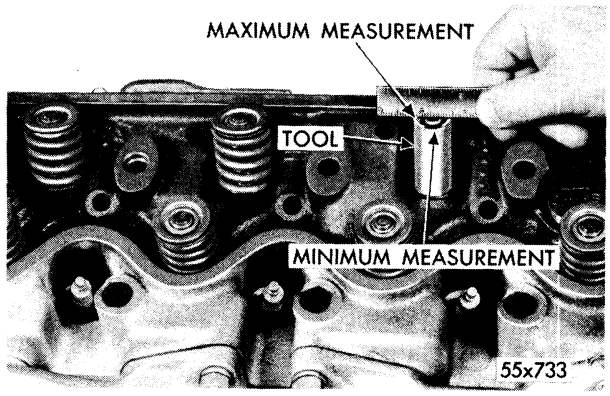

Fig. 17—Checking Valve Stem Position (SpitFire)

CAUTION

Do not attempt to ream valve guides from standard directly to .030 inch. Use step procedure of .005, .015, and .030 inch so the valve guides may be reamed true in relation to valve seat.

12. REFACING VALVES AND VALVE SEATS

The intake and exhaust valves are faced to a 45 degree angle. When refacing valve always check remaining margin (Fig. 16). Valves with less than $\frac{3}{64}$ inch margin should be discarded.

The angle of both valve and seat should be identical. When refacing valve seats with Tool MTH-80, it is important that correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained. Check concentricity of valve seat using a dial indicator; total runout should not exceed .002 inch (total indicator reading). When the seat is properly positioned, width of intake seats should be $\frac{1}{16}$ to $\frac{3}{32}$ inch. The width of exhaust seats should be $\frac{3}{64}$ to $\frac{1}{16}$.

When valves and seats are reground, the position of valve in head is changed, shortening operating length of hydraulic tappet. This means that plunger is operating closer to its bottomed position, and less clearance is available for thermal expansion of valve mechanism during high speed driving. Design of plunger travel includes a safety factor for normal wear and refacing of valves and seats. The dimension from valve spring seat in head to valve tip should be checked with Gauge Tool C-3436 for SpitFire Engines and Gauge Tool C-3061 for FirePower Engines, (Figs. 17 and 18).

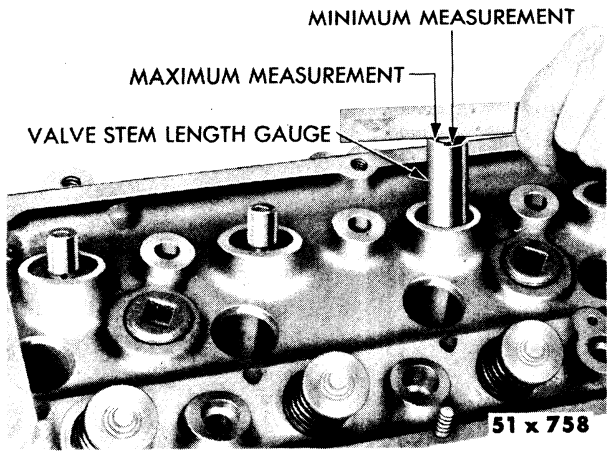

Fig. 18—Checking Valve Stem Position (FirePower)

The end of cylindrical gauge and bottom of slotted area represent maximum and minimum allowable extension of valve stem tip beyond spring seat. If tip exceeds maximum, grind to approach, but do not go below minimum allowable on gauge.

13. TESTING VALVE SPRINGS

Whenever valve springs are removed they should be tested with spring tester Tool C-647. Attach torque wrench, check tension and multiply reading by 2. The valve springs should test 160 to 172 pounds when compressed to $1\frac{5}{16}$ inch. Discard springs that do not meet these specifications.

Check each spring for squareness with a steel square and surface plate. (Fig. 19). If spring is more than $\frac{1}{16}$ inch out of square, install new spring.

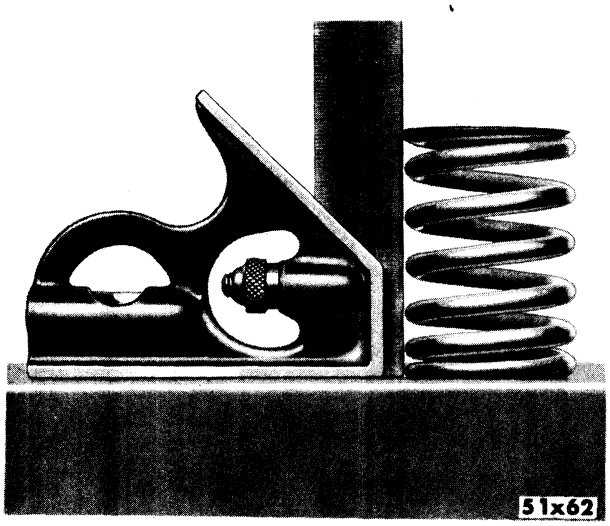

Fig. 19—Checking Valve Spring For Squareness

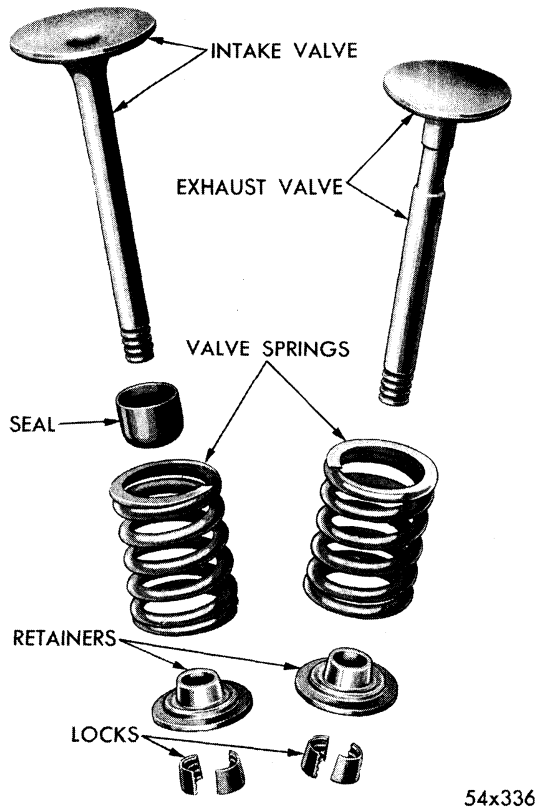

Fig. 20—Valves, Springs, Seals and Retainer (Disassembled View)

14. INSTALLING VALVES AND VALVE SPRINGS

Coat intake valve stems with lubricating oil and insert in position in cylinder head. Install

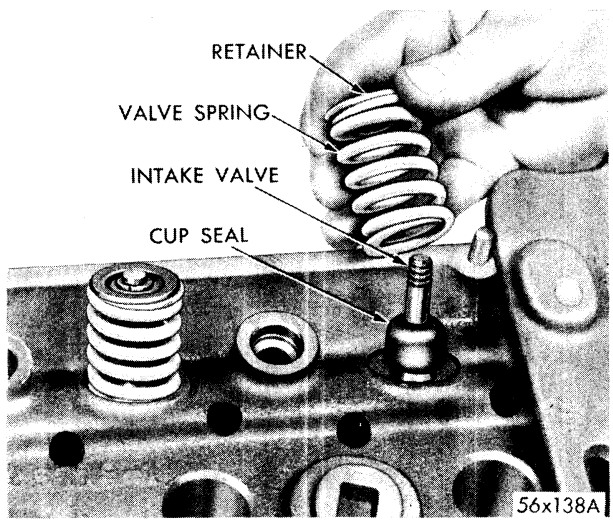

Fig. 21—Installing Intake Valves and Cup Seals

cup seals on intake valve stems and over valve guides (Figs. 20 and 21), and install valve springs and retainers. Compress valve springs with Tool C-3422. Install locks and release tool.

NOTE

If valves and/or seats are reground, check the installed height of springs. Make sure measurement is taken from full depth of counterbore in cylinder head to top surface of spring retainer. (If spacers are installed measure from top of spacer). If height is 1 23/32 inches or greater, install a 1/16 inch spacer (Part No. 1400482) in head counterbore to bring spring height back to normal 1 5/8 to 1 11/16 in.

15. HYDRAULIC TAPPETS

a. Preliminary to Checking Hydraulic Tappets

Before disassembling any part of engine to check for tappet noise, check oil pressure at gauge and oil level in oil pan. The pressure should be between 40 to 65 pounds at 2,000 r.p.m. The oil level in pan should never be above "full" mark on dip stick, nor below "add oil" mark. Either of two conditions could be responsible for noisy tappets.

Oil Level Too High—If oil level is above "full mark on dip stick, it is possible the connecting rods can dip into oil when engine is running and create foaming. This foam is fed to the hydraulic tappets by the oil pump, causing them to go flat and allowing valves to seat noisily.

Oil Level Too Low—Low oil level may allow pump to take in air which, when fed to tappets, causes them to lose length and allows valves to seat noisily. Any leaks on intake side of 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 run at fast idle for sufficient time to allow all of the air inside of tappets to be worked out.

b. Tappet Noises

To determine source of tappet noise run engine at idle with cylinder head covers removed. Feel each rocker arm to detect the noisy tappet.

NOTE

Worn valve guides or cocked springs are sometimes mistaken for noisy tappets. If such is the case, noise, in all probability, will be dampened by applying side thrust on valve spring. If noise is not appreciably reduced, it can then be assumed the noise is in the tappet.

Valve tappet noise can be separated into two types, light noise and heavy noise. A light noise is usually caused by excessive leakdown around the unit plunger, or by plunger partially sticking in cylinder. A heavy noise is caused either by a valve not seating, or by foreign particles becoming wedged between plunger and tappet body, causing plunger to stick in down position. This heavy noise will be further evidenced by clearance between valve stem and rocker arm as valve closes. A tappet causing light noise can be determined by pushing down on push rod end of rocker arm. The noise will become more audible and, if push rod end of rocker arm is held down long enough, the intensity of noise may increase. In either instance, the unit assembly should be removed for further inspection and cleaning.

c. Removal of Tappets (with Rocker Arms in Position)

NOTE

If all of tappets are to be removed, it will be

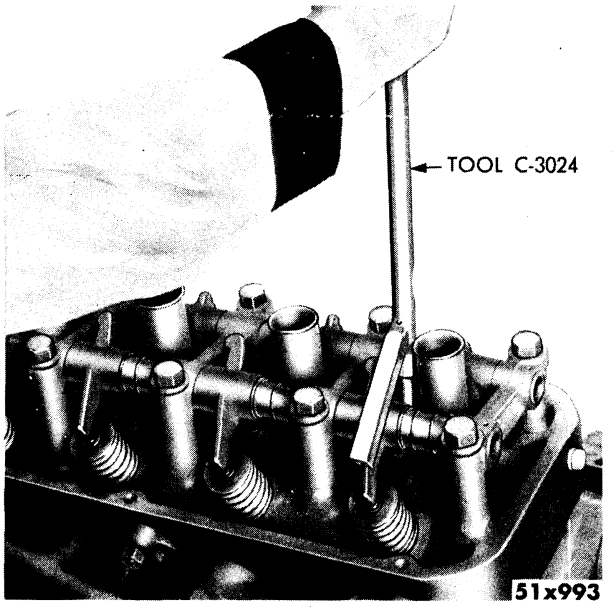

Fig. 22—Compressing Valve Spring (FirePower) (Typical of SpitFire)

advisable to remove rocker arms and shaft. If only one or two tappets are to be removed, proceed as follows:

Install valve spring compression Tool, C-3024, over rocker arm (Fig. 22) so heel of tool rests on valve stem side. Make certain valve is seated and tappet body is resting on low point of camshaft lobe. Refer to Paragraph 17 "Locating the Low Point of Camshaft Lobe In Conjunction With Valve Tappet Face." Using handle of tool for leverage, compress valve springs sufficiently to raise rocker arm above push rod. While holding rocker arm in this position, slide rocker arm to one side along the tube.

IMPORTANT

To avoid damage to valves, be sure that piston head is well below top of travel before compressing valve springs.

Drain cooling system below level of intake manifold. Remove carburetor air cleaner. Disconnect coil wires and wire from heat indicator sending unit. Disconnect heater hose and carburetor heat tube at the integral choke. Remove intake manifold, carburetor and coil as an assembly. Remove tappet chamber cover and gasket.

Insert hooked portion of Tool C-3216 into hole in tappet body (Fig. 23). (This portion of tool can be used to remove tappets without a varnish build-up). Lift tappet out of bore. If tappet sticks, slide puller portion of Tool C-3216 through cylinder head (push rod) holes (Fig. 24) and seat firmly in cap of tappet. Insert puller pin through tappet body and tool shaft in holes provided. Grasp tool handle and pull tappet out of bore with a twisting motion.

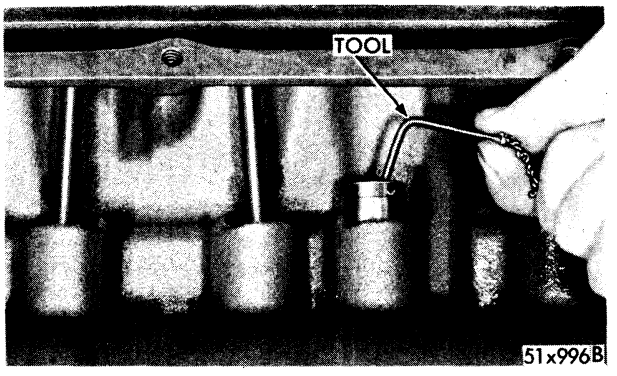

Fig. 23—Removing Tappet (without varnish build-up)

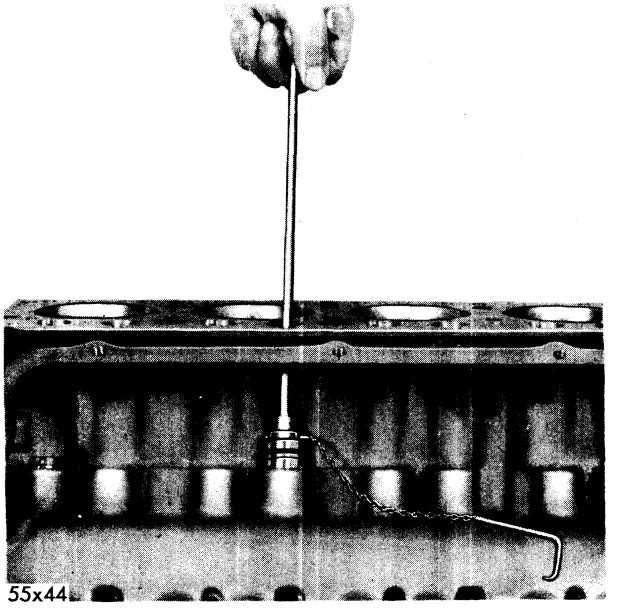

Fig. 24—Removing Tappet (With Varnish Build-Up)

If all tappets are to be removed, remove hydraulic tappets and place them in their respective holes in Tappet and Push Rod Holder, Tool C-3068. This will insure installation of tappets in their original locations.

NOTE

Do not disassemble a tappet in dirty surroundings or on a dirty work bench. 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 parts. Mixed parts are not usable.

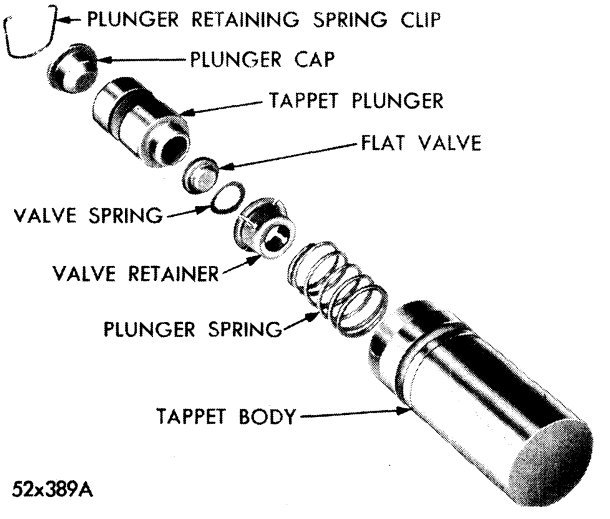

Fig. 25—Hydraulic Tappet (Disassembled View)

d. Disassembly

Refer to Figure 25 and proceed as follows. Pry out plunger retainer spring clip. Clean varnish deposits from inside of tappet body above plunger cap. Invert tappet body and remove plunger cap, plunger, flat check valve, check valve spring, check valve retainer, and plunger spring. Separate plunger, check valve retainer, and check valve spring. Place all parts in their respective place in tappet holder. Tool C-3068.

e. Cleaning and Assembly

Clean all tappet parts in a solvent that will remove all varnish and carbon. Replace tappets that are unfit for further service. Refer to Figure 25 and assemble tappets, as shown.

f. Inspection

If tappet or bore in cylinder block is scored, scuffed, or show signs of sticking, ream bore to next oversize, using Tool C-3028. If plunger shows signs of scoring or wear and valve is pitted, or if valve seat on end of plunger indicates any condition that would prevent valve from seating, install a new tappet assembly.

g. Testing

Use a clean container. Fill the container with clean kerosene. Remove cap from plunger and completely submerge tappet in an upright position.

Allow tappet to fill with kerosene, remove tappet, and replace cap. Hold tappet in an upright position and insert the lower jaw of pliers, Tool C-3160, in groove of tappet body (Fig. 26).

Engage jaw of pliers with top of tappet plunger. Check leakdown by compressing pliers. If plunger collapses almost instantly as pressure is applied, disassemble tappet, clean and test again. If tappet still does not operate satisfactorily after cleaning, install a new tappet.

h. Installation

After work has been completed on tappet, install tappet and push rod in their original bores. Position rocker arm so it is partially seated on valve stem. Install valve spring compressor tool and compress valve spring until rocker arm can be positioned over push rod. Remove tool and install tappet chamber cover.

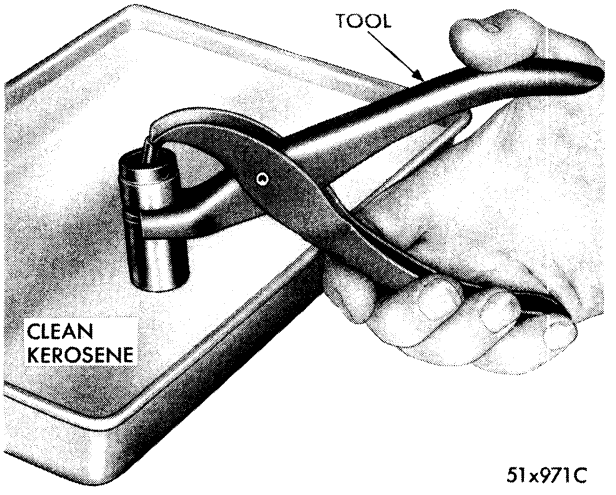

Fig. 26—Testing the Hydraulic Tappet (Typical)

Install intake manifold, carburetor and coil. Connect items which were disconnected during removal, refill cooling system, start engine, and warm up to normal operating temperature.

NOTE

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 become quiet.

16. CHECKING VALVE TIMING

Turn crankshaft until Number 1 intake valve is closed. Insert a .210 inch spacer between rocker arm and stem of Number 1 intake valve. (This can be done by prying between rocker and valve spring seat with a large screwdriver).

Install a dial indicator so that pointer contacts valve spring seat as nearly at a right angle as possible. Wait until seat stops moving. This indicates that oil has bled out of hydraulic tappet and plunger has bottomed, giving, in effect, a solid tappet.

Set dial indicator on zero and turn crankshaft clockwise (normal running direction) until dial indicator shows that valve has lifted .021 inch. The timing on the vibration damper should now read from 5 degrees Before Top Dead Center (BTDC) to 7 degrees After Top Dead Center (ATDC).

Before making this check, it is well to check the accuracy of the Top Dead Center (TDC) mark on the damper by bringing Number 1

piston to (TDC) by means of an indicator placed in spark plug opening. After valve timing has been checked, turn crankshaft **counterclockwise** until tappet is back down to valve-closed position. Remove the .210 inch spacer from between the rocker arm and valve stem.

CAUTION

Under no condition should crankshaft be turned further in clockwise direction, as spacer might cause valve spring to bottom and damage valve operating mechanism.

17. LOCATING LOW POINT OF CAMSHAFT IN CONJUNCTION WITH VALVE TAPPET FACE (CYLINDER HEAD INSTALLED)

Remove distributor cap, noting position of rotor for Number 1 and Number 6 cylinders. Set timing mark ("DC") on vibration damper to pointer. With rotor at Number 1 firing position, the following tappets will be on low side of cam lobe.

2—Intake	7—Intake
2—Exhaust	8—Intake
4—Exhaust	8—Exhaust

NOTE

To remove Number 1 intake and exhaust tappet, rotate the crankshaft ¼ turn clockwise from above position.

With rotor at Number 6 firing position, the following tappets will be on low side of cam lobe:

3—Intake	5—Intake
3—Exhaust	5—Exhaust
4—Intake	7—Exhaust

NOTE

To remove Number 6 intake and exhaust tappet, rotate crankshaft ¼ turn clockwise from above position.

18. REMOVAL OF TIMING GEARS AND CHAIN

Remove radiator and water pump. See Cooling System, Section V.

Remove bolt and flatwasher holding vibration damper on crankshaft. Remove two of the damper bolts, install Tool C-3033, and pull damper assembly off end of crankshaft.

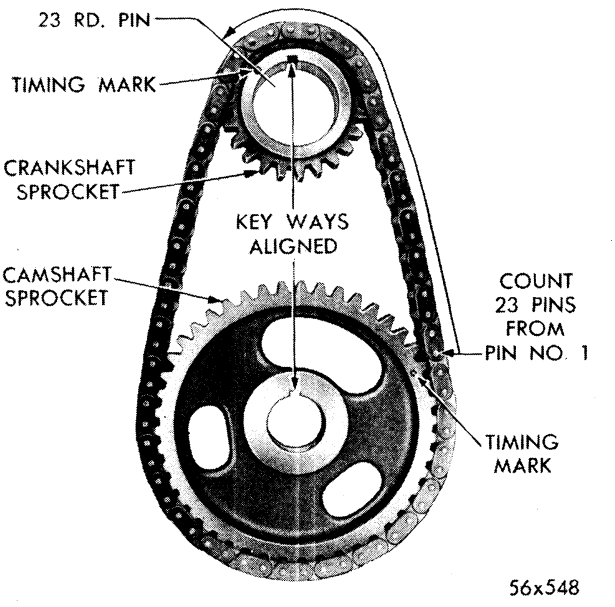

Fig. 27—Positioning Gears in Chain

Remove chain cover and gasket.

Slide crankshaft oil slinger off end of crankshaft. Remove fuel pump eccentric attaching bolt, cup washer and eccentric. Remove timing chain, with crankshaft and camshaft sprockets as an assembly.

19. INSTALLATION OF TIMING GEARS AND CHAIN

a. Installation

Insert camshaft and crankshaft Woodruff keys

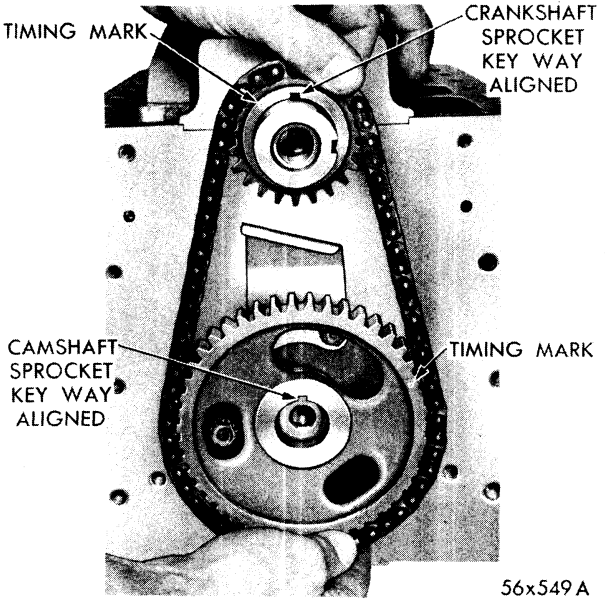

Fig. 28—Installing Timing Gears and Chain (Engine Shown in Repair Stand)

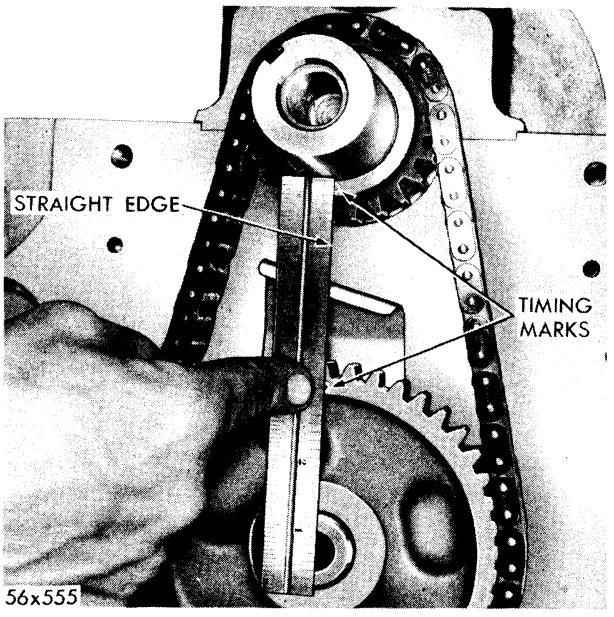

Fig. 29—Checking Alignment of Timing Marks

in their respective slots, and rotate shafts so that both keys are directly up and on an imaginary centerline through both shafts.

Place both camshaft gear and crankshaft gear on bench, with keyway slots up and aligned (Fig. 27). Place timing chain around camshaft gear so that camshaft gear timing mark tooth is between links of chain. Slide crankshaft gear into chain so that slot at timing mark (between teeth) is in direct line with **twenty-third** timing chain pin.

Lift gears and chain (keep gears tight in position as described), slide both gears evenly over their respective shafts (Fig. 28), and push gears over keyways. See "Paragraph 24, Camshaft Installation".

Rotate engine until timing marks on gears are on exact imaginary centerline through both camshaft and crankshaft. Use straightedge for this check. (Fig. 29.)

Slide fuel pump eccentric over camshaft against gear (Fig. 30). **Be sure slot in eccentric lines up with top of protruding camshaft gear key.** Install cup washer and bolt and tighten 35 foot-pounds torque.

b. Checking Timing Chain for Stretch

Place a scale next to timing chain so that any movement of chain may be measured. Place a torque wrench and socket over camshaft gear attaching bolt and apply torque in direction

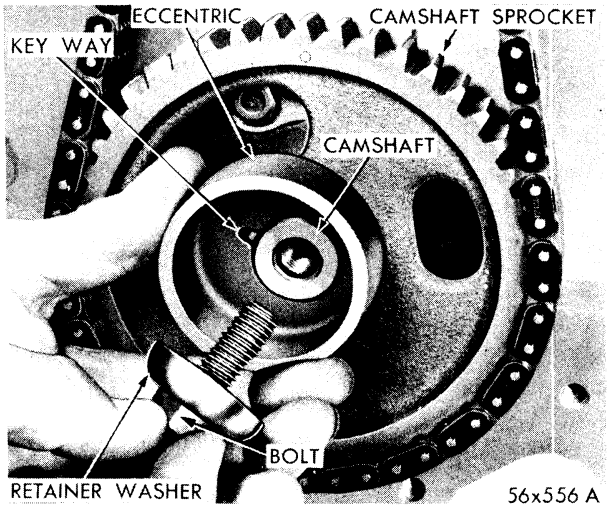

Fig. 30—Installing Fuel Pump Eccentric

of crankshaft rotation to take up slack; 30 foot-pounds torque (with cylinder heads installed) and 15 foot-pounds torque (heads removed). Holding scale with dimensional reading even with edge of a chain link, apply torque in reverse direction 25 foot-pounds (with cylinder heads installed) and 15 foot-pounds (heads removed), and note the amount of chain rotation (Fig. 31). Install new timing chain, if its movement is greater than $\frac{3}{16}$ inch.

NOTE

With a torque applied to camshaft gear bolt, the crankshaft should not move. If there is any movement, however, the crankshaft should be blocked to prevent rotation.

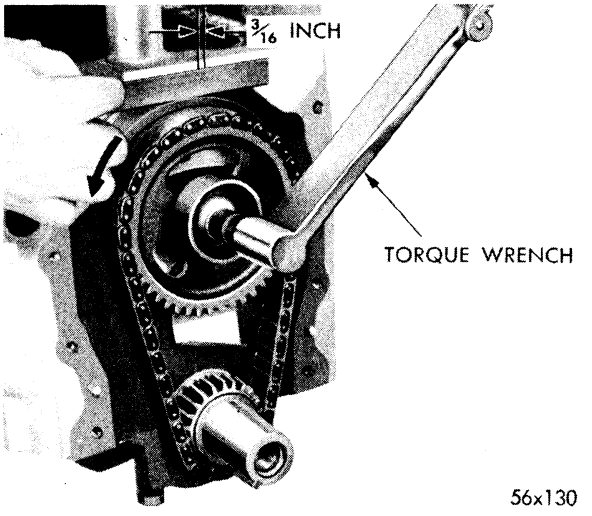

Fig. 31—Measuring Timing Chain Stretch (Typical)

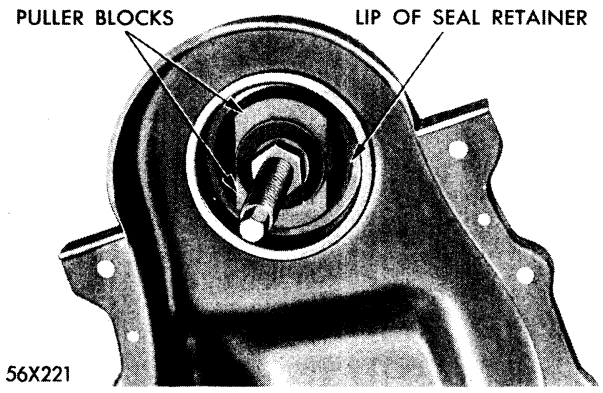

Fig. 32—Puller Blocks Expanded to Correct Pulling Position

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

20. TIMING CHAIN CASE COVER OIL SEAL REPLACEMENT

a. Removing Oil Seal

Position puller screw of Tool C-3506 through case cover, with inside of case cover up. Position puller blocks directly opposite each other, and force angular lip between neoprene and flange of seal retainer. Place washer and nut on puller screw. Tighten nut as tight as possible by hand, forcing blocks into gap to point of distorting seal retainer lip (Fig. 32). **THIS IS IMPORTANT!** (puller is only positioned at this point.) Place sleeve over seal retainer and place removing and installing plate into sleeve. Place flatwasher and nut on puller screw. Hold center screw and tighten lock nut to remove seal (Fig. 33).

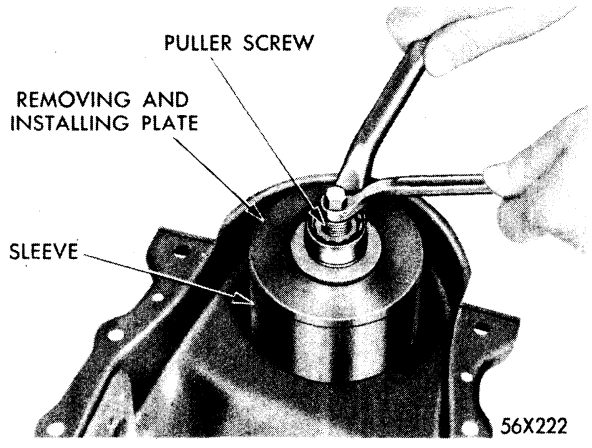

Fig. 33—Removing Oil Seal

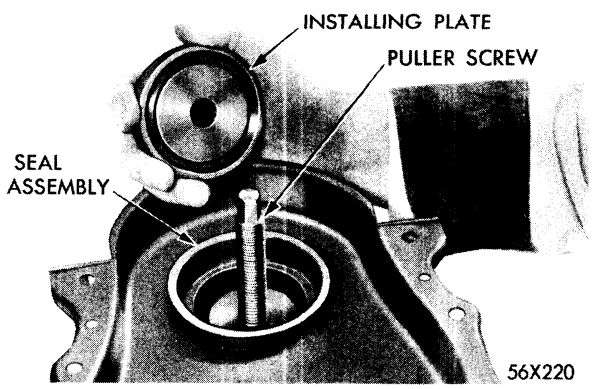

Fig. 34—Positioning the Installer Plate On New Seal

b. Installing Oil Seal

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

NOTE

Always have thin shoulder up with stamped case cover, and thick shoulder up with a cast iron case cover.

Insert puller screw with plate through seal opening (inside of chain case cover facing up). Place seal in cover opening, with neoprene down. Place seal installing plate into the new seal, with protective recess toward lip of seal retainer (Fig. 34). Install flatwasher and nut on puller screw, hold screw, and tighten nut (Fig. 35).

Seal is properly installed when neoprene is tight against face of cover. Try to insert a .0015 inch feeler gauge between neoprene and cover (Fig. 36). If seal is installed properly, the feeler gauge cannot be inserted.

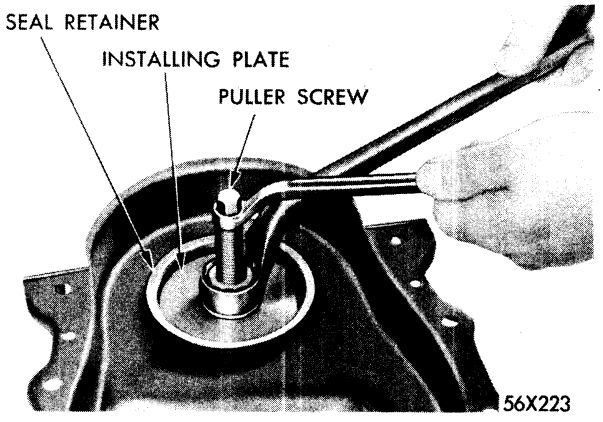

Fig. 35—Installing New Seal

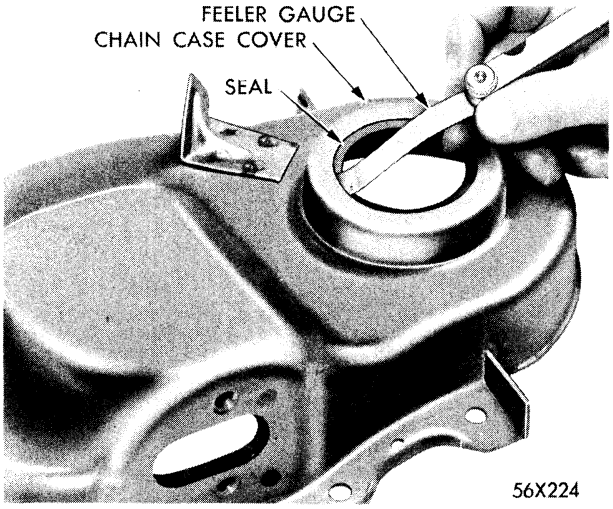

Fig. 36—Checking to Make Sure Seal is Properly Seated

NOTE

It is normal to find particles of neoprene collected between the seal retainer and crankshaft oil slinger.

c. Installing Chain Case Cover

Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs. Use a **new** gasket, slide chain case cover over locating dowels and tighten bolts 15 foot-pounds torque.

21. INSTALLING VIBRATION DAMPER

Refer to Figure 37 and proceed as follows. Place damper hub key in slot in crankshaft and position dust seal in hub. Slide hub and seal on crankshaft. Place installing tool (part of Puller set C-3033) in position and press damper hub on crankshaft. Slide damper and pulley over shaft and secure with bolts and lockwashers. Tighten bolts 15 foot-pounds torque. Install damper hub retainer washer and bolt. Tighten 135 foot-pounds torque.

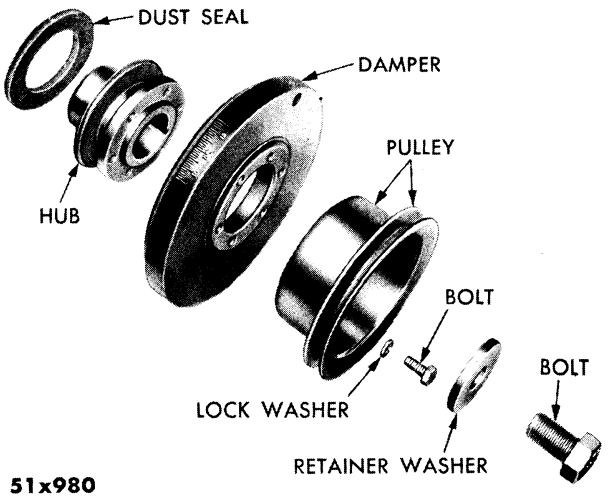

Fig. 37—Vibration Damper Assembly (Disassembled View)

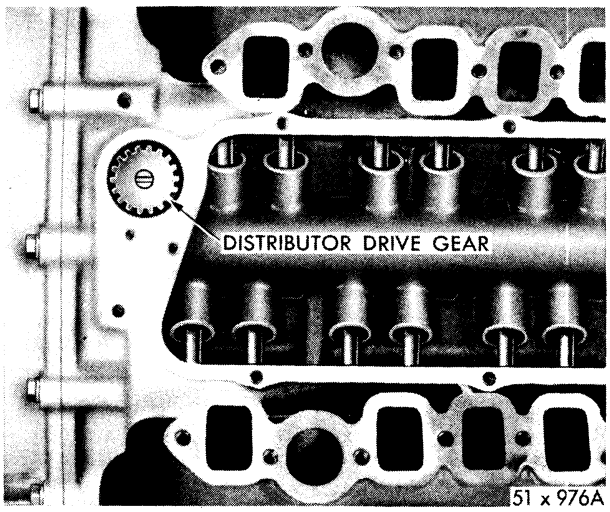

Fig. 38—Distributor Drive Gear Installation

22. CAMSHAFT REMOVAL

With intake manifold, tappet cover, push rods, tappets and timing gears removed, remove distributor. Lift out distributor drive gear and stub shaft, (Fig. 38). Remove camshaft thrust plate attaching bolts and oil trough, (Fig. 39). Withdraw camshaft and spacer, **being careful**

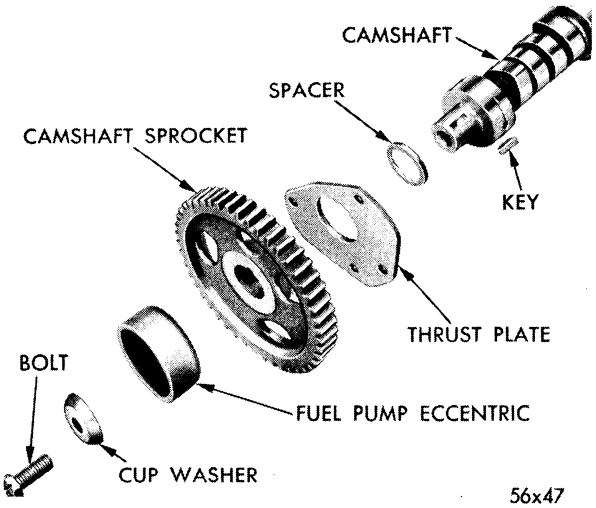

Fig. 39—Camshaft Drive Parts (Disassembled View)

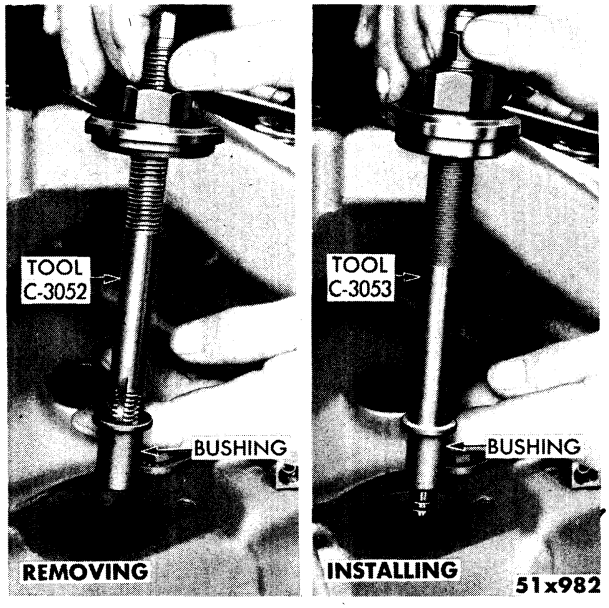

Fig. 40—Removing and Installing the Distributor Drive Shaft Bushing

not to damage the cam bearings with the cam lobes.

23. REMOVAL AND INSTALLATION OF DISTRIBUTOR DRIVE SHAFT BUSHING

a. Removal (Camshaft Removed)

Insert Tool C-3052 into old bushing and thread down until a tight fit is obtained, (Fig. 40). Hold puller screw and tighten puller nut until bushing is removed.

b. Installation

Slide new bushing over burnishing end of Tool C-3053 and insert tool and bushing into bore. Drive bushing and tool into position, using a soft hammer. As the burnisher is pulled through bushing by tightening puller nut, the bushing is wedged tight in block and burnished to correct size. **DO NOT REAM THIS BUSHING.**

24. CAMSHAFT INSTALLATION

Install Tool C-3509 in place of distributor drive gear, and stub shaft (Fig. 41). Hold 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, **and should remain installed until camshaft and crankshaft sprockets and timing chain have been installed.**

Lubricate camshaft bearing journals and install camshaft **being careful not to damage cam bearings with the cam lobes.**

Install thrust plate spacer (chamfered side toward camshaft fillet). Install thrust plate and oil trough; tighten screws 15 foot-pounds torque.

Check difference in thickness between spacer and thrust plate. The spacer should be thicker than thrust plate to extent that camshaft must have an end play of .002 to .006 inch.

NOTE

Whenever an engine has been rebuilt and a new camshaft and/or new tappets have been installed, one quart of MOPAR Oil Additive should be added to the engine oil to aid break-in. The oil mixture should be left in the engine for a minimum of 500 miles. However, it is not necessary to drain the mixture before normal oil change is required, nor is it necessary to use the oil additive at subsequent oil changes.

25. DISTRIBUTOR (BASIC) TIMING

Before installing the distributor drive shaft and gear, it will be necessary to time engine as follows: Rotate crankshaft until Number 1 cylinder is at top dead center (check with Tool C-3075). When in this position, the pointer on chain case cover should be over ("DC") on vibration damper. Position oil pump shaft so that it lines up with slot in drive gear. Coat shaft of drive gear with engine oil. Install so that, after gear spirals into place, it will index with oil pump shaft, and slot in top of drive

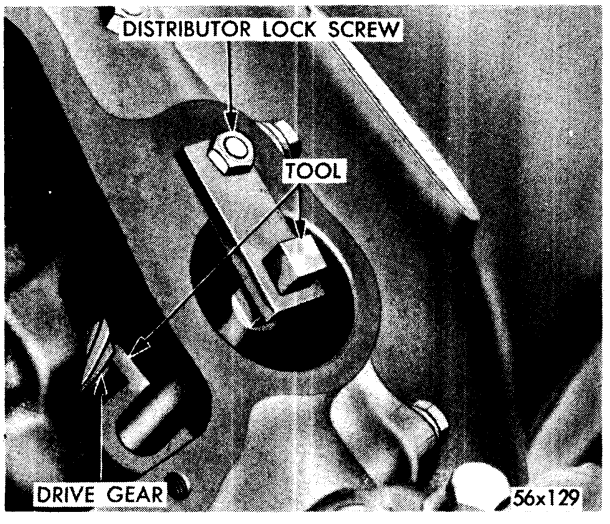

Fig. 41—Camshaft Holding Tool C-3509

gear will be parallel with centerline of crankcase (Fig. 38).

26. INSTALLATION OF DISTRIBUTOR

Hold distributor over mounting pad on cylinder block with vacuum chamber pointing toward right hand cylinder bank. Turn rotor until it points forward and to approximate location of Number 1 tower in distributor cap. Turn rotor counter-clockwise until breaker contacts are just separating. Place distributor oil seal ring in position. Lower distributor and engage shaft in slot of distributor drive shaft gear while holding rotor in position.

27. REMOVAL AND INSTALLATION OF CAMSHAFT BEARINGS (Engine Removed From Car)

a. Removal

With engine completely disassembled, drive out rear cam bearing Welch plug. Install proper size adapters and horse shoe washers (part of Tool C-3132) at back of each bearing shell to be demoved and drive out bearing shells.

b. Installation

Install new camshaft bearings with Tool C-3132 by sliding new rear camshaft bearing shell over proper size adapter. Position bearing in tool (Fig. 42). Install horseshoe lock and, by reversing removal procedure, carefully drive bearing shell into place. Install remaining shells in like manner.

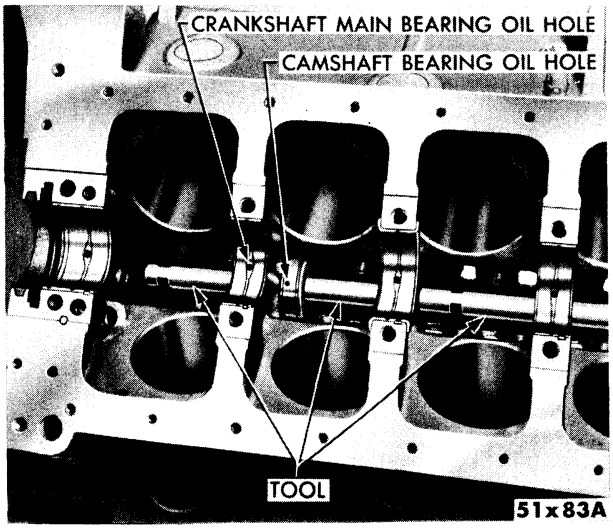

Fig. 42—Installing Camshaft Bearing Shells-Tool C-3034

The oil holes in camshaft bearings and cylinder block must be in exact alignment to insure proper lubrication. (Fig. 42). Camshaft bearing index can be checked after installation by inserting a pencil flashlight in bearing shell. The complete circumference of camshaft bearing hole should be visible by looking through main bearing drilled oil passage. If camshaft bearing shell oil hole is not in exact alignment, remove, and reinstall.

Use Tool C-897 to install a new Welch plug at rear of camshaft. Be sure this plug does not leak.

28. CYLINDER BLOCK

Clean cylinder block thoroughly, check all core hole plugs for evidence of leaking. If new core hole plugs are installed; coat edges of plug and core hole with a suitable sealer and drive plugs in place with driver, Tool C-897. Examine block for minute cracks or fractures. Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of piston 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 engine, rotate crankshaft so each connecting rod is centered in cylinder bore and proceed as follows:

Remove connecting rod cap and bearing shells. Install Tool C-3221 on one connecting rod bolt and protector over the other bolts and push each piston and rod assembly out of cylinder bore. After removal, install bearing cap to mating rod.

a. Checking Cylinder Bores

The cylinder bores should be checked for out-of round and taper with Tool CM-119. If cylinder bores show more than .005 inch out-of-round or a taper of more than .020 inch, the cylinder block should be rebored and new pistons and rings fitted.

b. Honing Cylinder Bores

To remove light scoring, scuffing, or scratches from cylinder walls, use Honing Tool C-823.

The crankshaft, bearings and internal parts should be protected during honing and boring operations. Usually one or two "passes" with a hone will clean up a bore and still maintain required limits.

If cylinder bores are found to be satisfactory in respect to taper and out-of-round and new rings are to be installed, use Cylinder Surfacing Hone Tool C-3501 with 280 grit stones for deglazing bores. This will facilitate in the break-in of new rings.

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. If this is impossible use SAE No. 10 oil and CLEAN rags. When the bore can be wiped with a clean white rag and be withdrawn clean, the bore is clean.

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 co-ordinated with the fitting of pistons and rings, in order that specifications may be maintained.

d. Fitting Pistons

The piston and cylinder wall must be clean and dry. Coat the bore very lightly with SAE 10W Engine Oil. The recommended clearance between the thrust face of piston and cylinder wall is .0005 to .0015 inch. Check clearance with a .002 inch feeler stock ½ inch wide on spring scale Tool C-690, by inserting piston in bore, upside down, with feeler stock between thrust face of piston and cylinder wall. Hold piston and draw the feeler stock straight out with spring scale (Fig. 43). The amount of pull required to withdraw the feeler stock should be from 8 to 12 pounds.

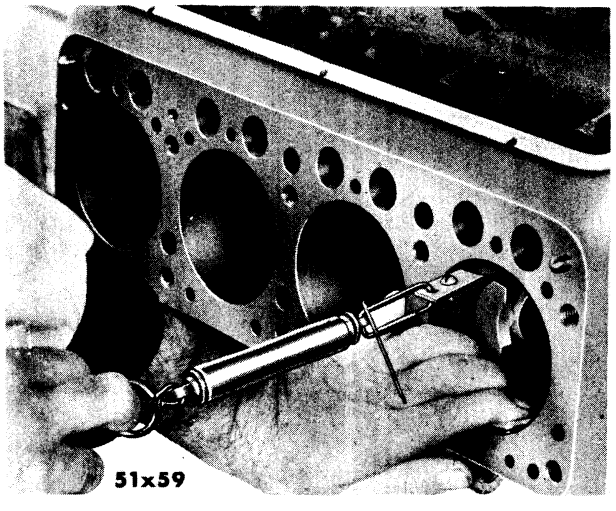

Fig. 43—Fitting Piston to Cylinder Bore (Typical)

NOTE

Piston fitting should be done at normal room temperature, 70° F.

All service pistons include piston pins and retaining rings and are available in standard and the following oversizes, .005, .020, .040 and .060 inch.

e. Fitting Rings

Measure 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 position.) This will insure positioning rings exactly square with cylinder wall before measuring.

Insert feeler stock in gap (Fig. 44). The ring gap should be between .010 to .020 inch. This measurement is the same for all rings.

Measure clearance between piston ring and ring groove (Fig. 45). The clearance should be .0015 to .0030 inch for top compression ring, .001 to .0025 inch for intermediate ring, and .001 to .003 for oil control ring.

Starting with oil ring expander, place expander ring in lower ring groove and install oil control ring. Install compression rings, in top and middle grooves. Use ring installer, Tool C-3418.

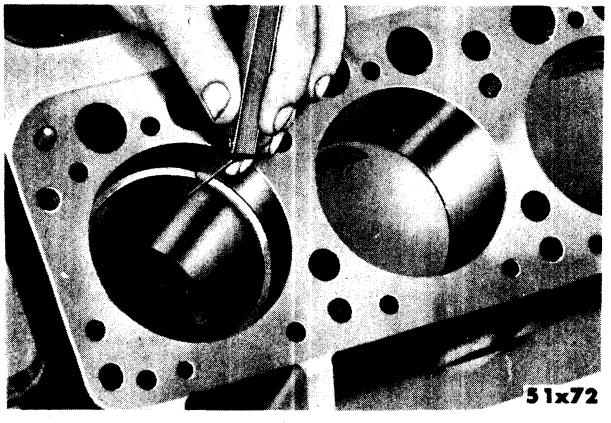

Fig. 44—Checking Ring Gap in Cylinder Bore (Typical)

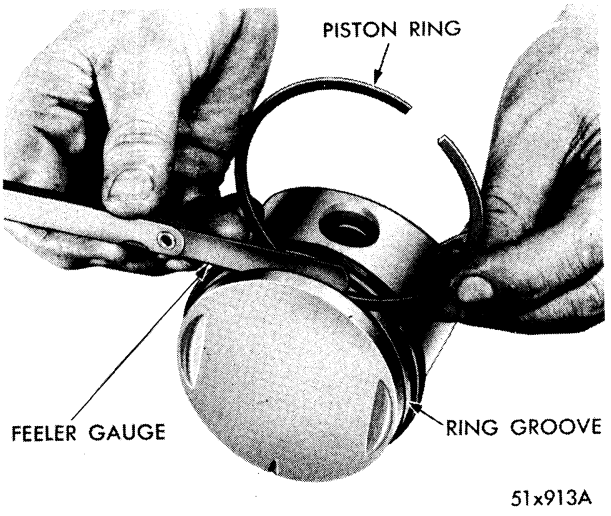

Fig. 45—Checking Piston Ring Side Clearance (Typical)

NOTE

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

f. Fitting Pins

The piston pin should be a tight thumb press fit in connecting rod (Fig. 46) and in piston (Fig. 47) at normal room temperature, 70° F.

If proper fit cannot be obtained with standard pins, ream piston and connecting rod, and install oversize piston pins. Piston pins are supplied in standard and the following oversizes: .003 and .008 inch.

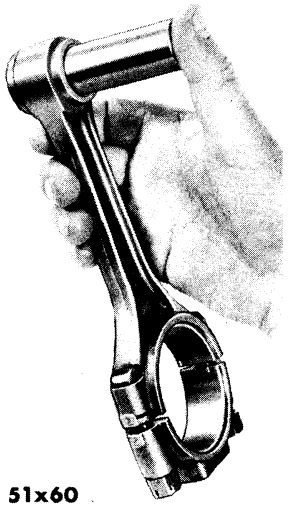

Fig. 46—Fitting Piston Pins in Connecting Rod

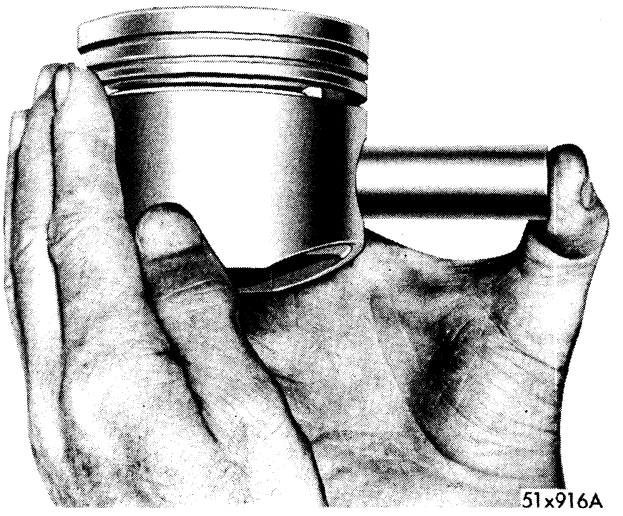

Fig. 47—Fitting Piston Pins in Piston (Typical)

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

29. CONNECTING RODS

IMPORTANT

A Maltese Cross stamped on the engine num-

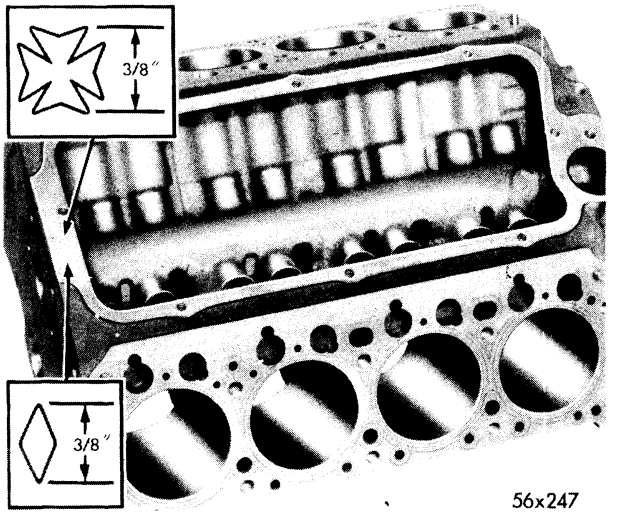

Fig. 48—External Identification (Parts Other Than Standard Size)

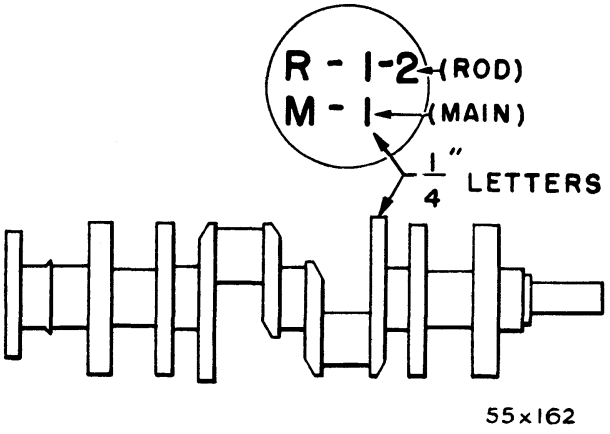

Fig. 49—Internal Identification (Parts Other Than Standard Size)

bering pad (Fig. 48) indicates that engine is equipped with a crankshaft which has one or more connecting rods and main bearing journals finished .001 inch undersize. The position of the undersize journal or journals will be stamped on machined surface of Number 3 counter-weight (Fig. 49). Connecting rod journals will be identified by letter "R" and main bearing journals by the letter "M". Thus, "M-1" indicates that number 1 main bearing journal is .001 inch undersize. Also, a diamond-shaped marking stamped on engine numbering pad indicates that all tappet bodies are .008 inch oversize. (See Figure 48).

30. CHECKING CONNECTING ROD ALIGNMENT

Check for Bend—Install connecting rod and piston in fixture (connecting rod bearing removed), as shown in Figure 50, A.

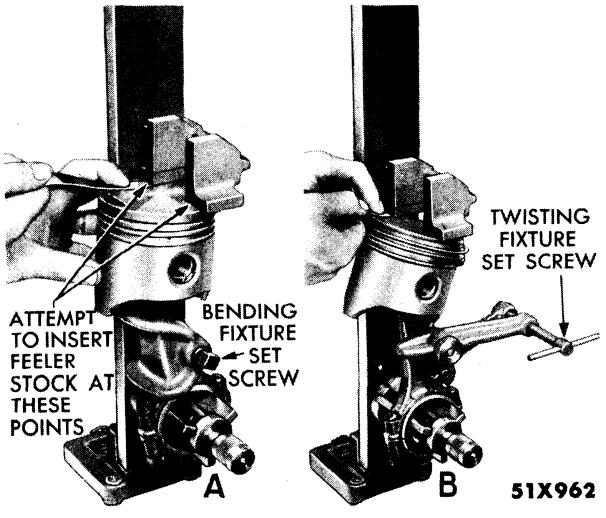

Fig. 50—Checking Connecting Rod and Piston for Alignment

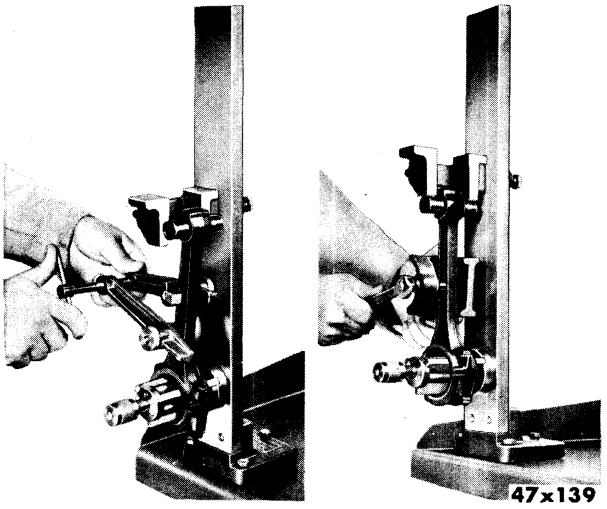

Fig. 51—Checking Connecting Rod for Bind or Twist

The top of piston should be flush with tool. If clearance is more than .002 inch, piston and connecting rod should be disassembled and rod checked, as shown in Figure 51. Straighten a bent rod or install a new one.

Check for Twist—With connecting rod and piston assembly, installed in fixture Tool C-841, tilt the piston (B, Fig. 50). If clearance is more than .002 inch, piston and connecting rod should be disassembled and rod checked as shown in Figure 51.

31. INSTALLING CONNECTING ROD BEARINGS

Fit connecting rods to crankshaft (Fig. 52)

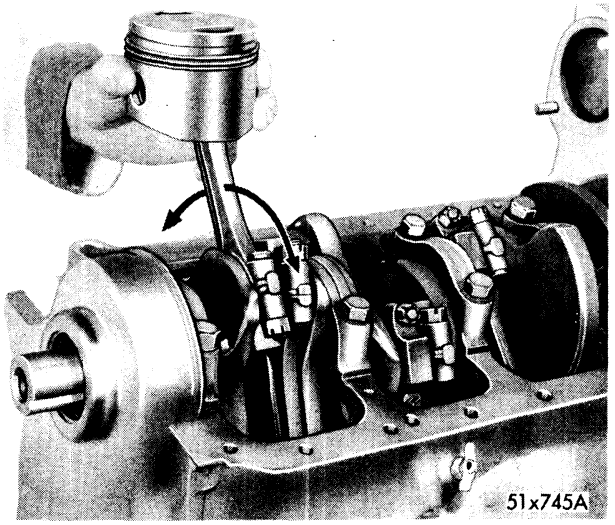

Fig. 52—Checking Connecting Rod Bearing Clearance (Typical)

without inserting piston and rod in cylinder bore, eliminating any possible drag that might be caused between piston and cylinder wall.

NOTE

Fit all rods of one bank until completed. Do not alternate from one bank to another, because, when 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 "V" groove in shell is in line with "V" groove in cap. This allows lubrication of the cylinder wall. The bearing shells should always be installed so that small formed tang fits into machined grooves of rods.

Limits of taper or out-of-round on any crankshaft journal should be held to .001 inch. Undersize bearings are serviced in .001, .002, .003, .010, and .012.

32. CHECKING CONNECTING ROD BEARING CLEARANCE

The correct connecting rod bearing shell clearance is from .0005 to .0015 inch. Place a piece of oiled .001 inch feeler stock (½ inch wide and ¾ inch long) between bearing shell and crankshaft journal. Make sure shim edges are smooth. Install bearing cap and tighten cap to 45 foot-pounds torque.

NOTE

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

Move connecting rod and piston from side to side (Fig. 52). A slight drag should be felt as rod is moved. This will indicate that clearance is .001 inch or less which is satisfactory. If connecting rod is difficult to move, the bearing shell is too small and should be replaced with the correct size. Make sure that tangs on bearing inserts fit grooves in connecting rods and caps. The side play should be from .006 to .014 inch (two rods).

33. INSTALLING PISTON AND CONNECTING ROD ASSEMBLY IN CYLINDER BLOCK

Before installing 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. The oil ring expander gap should be toward the outside of "V" of engine. The oil ring gap should be turned toward the inside of the "V" of engine.

Immerse piston head and rings in clean engine oil, slide ring compressor, Tool C-385, over piston, and tighten with special wrench (part of Tool C-385). Be sure position of rings does not change during this operation.

Screw connecting rod bolt protector (part of Tool C-3221) on one rod bolt, and insert rod and piston into cylinder bore. Attach puller part of Tool C-3221 on the other bolt, and guide the rod over crankshaft journal.

Tap piston down in cylinder bore, using handle of a hammer. At the same time, guide connecting rod into position on crankshaft journal. The **notch or groove** on top of piston **must** be pointing toward front of engine and the larger chamfer of connecting rod bore must be installed toward crankshaft journal fillet. Install rod caps, tighten nuts to 45 foot-pounds torque.

34. CRANKSHAFT

The crankshaft 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 thrust faces of No. 3 main bearing. After regrinding remove rough edges from crankshaft oil holes and clean out all oil passages.

35. CRANKSHAFT BEARINGS

The halves of Number 1, 2 and 4 bearings are interchangeable (the bearing caps are not interchangeable and should be marked at removal to insure correct reassembly. Number 3 bearing, which controls the crankshaft end thrust, is not interchangeable with the others. The upper and lower halves however, of Number 3 bearing are interchangeable. Number 5 bearing halves are not interchangeable.

IMPORTANT

A Maltese Cross stamped on the engine numbering pad (Fig. 48) indicates that engine is equipped with a crankshaft which has one or more connecting rod and main bearing jour-

nals finished, .001 inch undersize. The position of undersize journal or journals will be stamped on machined surface of Number 3 counterweight (Fig. 49). Connecting rod journals will be identified by letter "R" and main bearing journals by letter "M". Thus, "M-1" indicates that Number 1 main bearing journal is .001 inch undersize.

Bearing shells are available in standard and the following undersizes. .001, .002, .003, .010 and .012 inch. Never install an undersize bearing shell that will reduce the clearance below specifications.

36. REMOVAL AND INSTALLATION OF MAIN BEARINGS (CRANKSHAFT IN ENGINE)

a. Removal

Remove oil pan and mark bearing caps before removal. Remove bearing caps one at a time. Remove upper half of bearing by inserting Tool C-3059 (Fig. 53) in oil hole of crankshaft. Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

b. Checking Bearing Clearance

Remove spark plugs to relieve compression. Check each bearing separately, **do not** loosen the other bearing caps.

Install bearing shell in cap and place a piece of oiled, .001 inch feeler stock (½ inch wide and 1 inch long) between bearing and crankshaft journal (Fig. 54). Install and tighten bearing cap bolts to 85 foot-pounds torque.

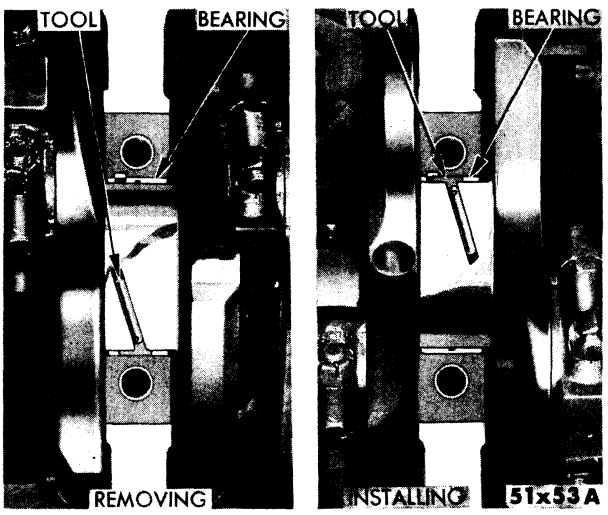

Fig. 53—Removing and Installing Main Bearing Upper Shell

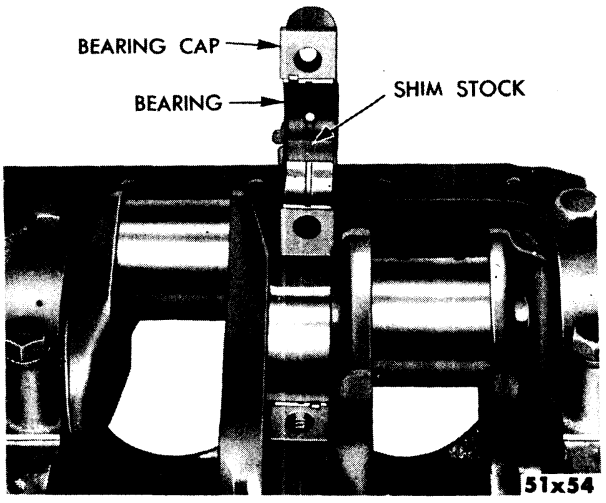

Fig. 54—Checking Main Bearing Clearance with Shim Stock

If a slight drag is felt as crankshaft is rotated, the clearance is .001 inch or less, and is considered satisfactory. If crankshaft cannot be rotated, the bearing is too small and should be replaced with the correct size.

If no drag is evident reduce clearance with undersize bearing inserts until a slight drag is felt with a .001 inch shim in place between bearing shell and crankshaft journal. **It is permissible to use a .001 inch undersize bearing with a standard bearing or a .002 inch bearing. Always use the smaller diameter bearing half as the upper housing half. Never use a new bearing with used bearing and never use an upper bearing half more than .001 inch smaller than the lower bearing half.**

c. Installation

NOTE

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

Start bearing in place, and insert Tool C-3059 in oil hole of crankshaft (Fig. 53.) Slowly rotate the crankshaft counter-clockwise, sliding bearing into position.

After all bearings have been fitted, tighten Number 3 (center) main bearing first, and work alternately to both ends. Tighten all caps to 85 foot-pounds torque.

Crankshaft end play should be .002 to .007 inch.

37. REMOVAL AND INSTALLATION OF OIL PAN

a. Removal

Drain oil and remove dip stock. Disconnect crossover and "Y" pipe at exhaust manifolds and at clamp to exhaust extension so that crossover and "Y" pipe may be moved out of way. **Be sure the rest of exhaust system is sufficiently supported.** Disconnect steering linkage at idler arm support bracket, and allow linkage to settle away from bottom of pan. Remove bolts that hold pan to cylinder block and remove pan.

b. Installation

Clean pan thoroughly and install new seals and gaskets. **End seals should be bottomed in their grooves and retained by crimping.** Ends of seals should extend approximately $\frac{1}{32}$ inch higher than the attaching face of oil pan to insure proper sealing. Tighten bolts evenly to 15 foot-pounds torque. Install exhaust pipes and connect steering linkage. Refill crankcase. See Lubrication, Section XV.

38. OIL PUMP

a. Removal

Remove oil pan, oil pump attaching bolts and remove pump by pulling straight down.

b. Disassembly

Refer to Figure 55 and proceed as follows: Remove the cotter pin, holding oil strainer to oil pump cover. Remove oil pump cover and oil seal ring. Remove pump rotor and shaft, and lift out pump rotor body. Remove oil pressure relief valve plug, and lift out spring and plunger.

c. Inspection and Repair

Wash all parts thoroughly. The mating face of oil pump cover should be smooth. Replace cover, if it is scratched or grooved.

Lay a straightedge across cover surface (Fig. 56). If a .0015 inch feeler gauge can be inserted between cover and straightedge, the cover should be replaced.

If rotor body measures less than .998 inch (Fig. 57) and diameter less than 2.244 inches, replace rotor body.

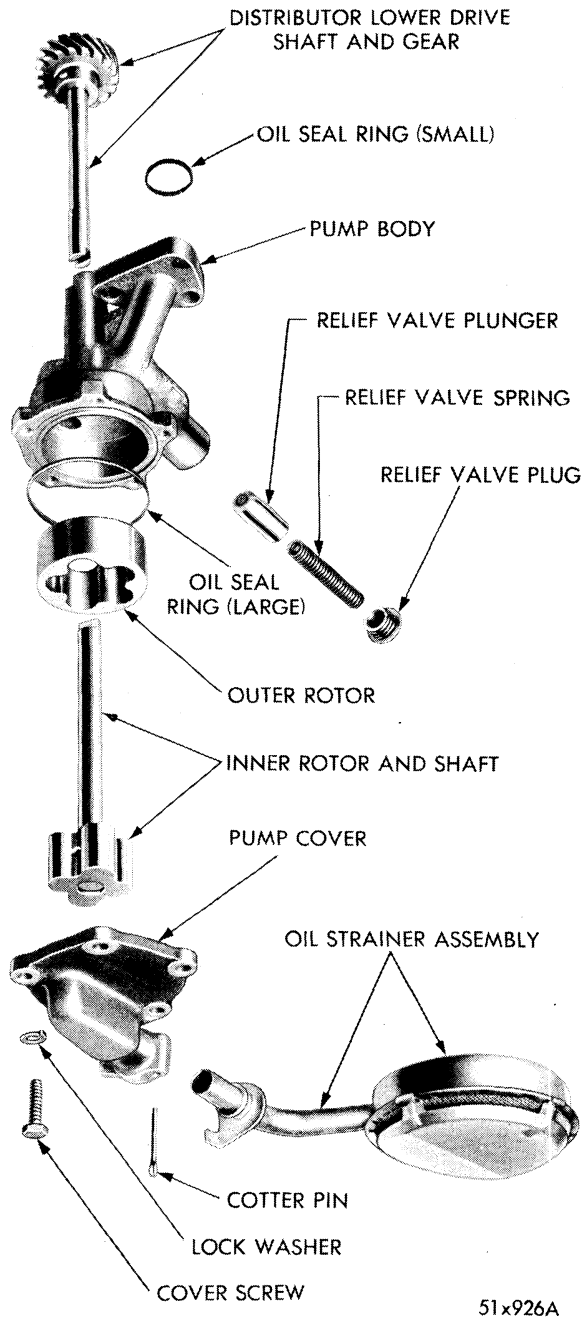

Fig. 55—Oil Pump (Disassembled View) (Typical)

If pump rotor measures less than .998 inch (Fig. 58) a new pump rotor should be installed. Slide rotor body and rotor into pump body and place a straightedge across face (between bolt holes), as shown in Figure 59. If a feeler gauge or more than .004 inch can be inserted between rotors and straightedge, replace pump body.

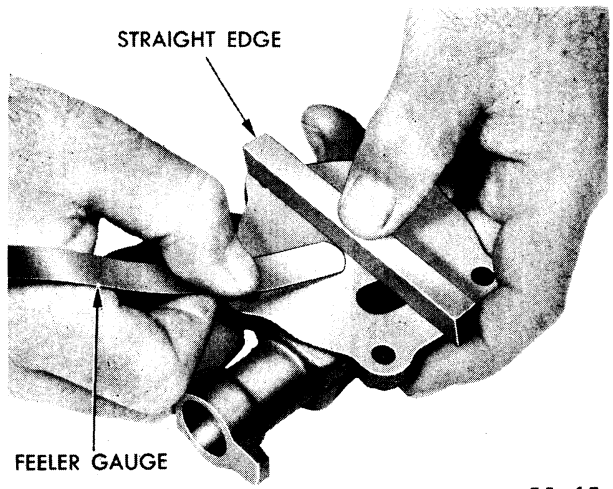

Fig. 56—Checking Oil Pump Cover

Remove pump rotor and shaft, leaving rotor body in pump cavity. Press rotor body to one side with fingers and measure clearance between rotor and pump bodies, (Fig. 60). If measurement is more than .012 inch, replace oil pump body.

If clearance between pump rotor and rotor body (Fig. 61) is more than .010 inch, replace pump rotor and rotor body.

Check oil pump relief valve plunger for scoring and for free operation in its bore. If plunger is scored, replace plunger.

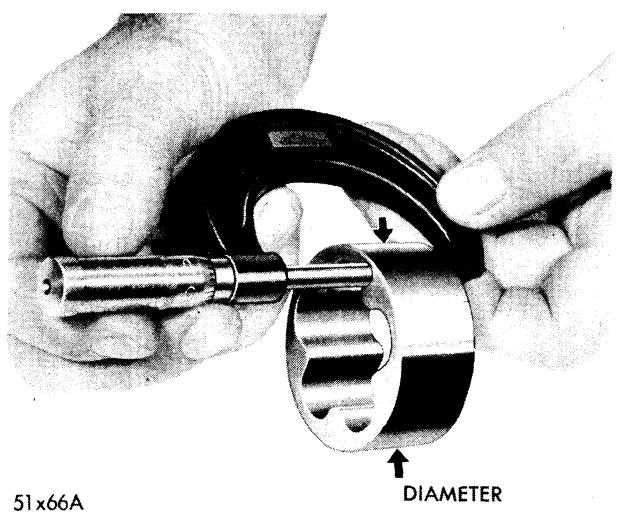

Fig. 57—Measuring Thickness of Rotor Body

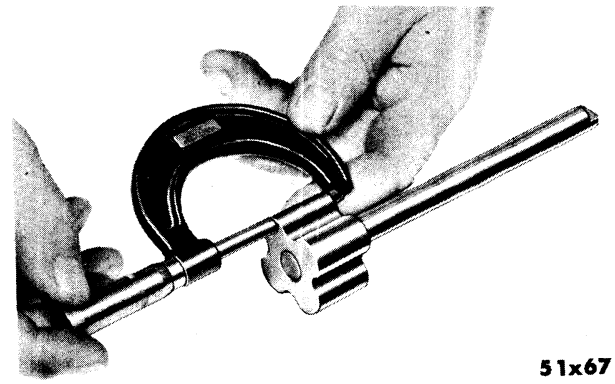

Fig. 58—Measuring Thickness of Pump Rotor

When assembling oil pump, be sure to use a new oil seal ring between cover and body. Tighten cover bolts to 10 foot-pounds torque.

Prime the oil pump.

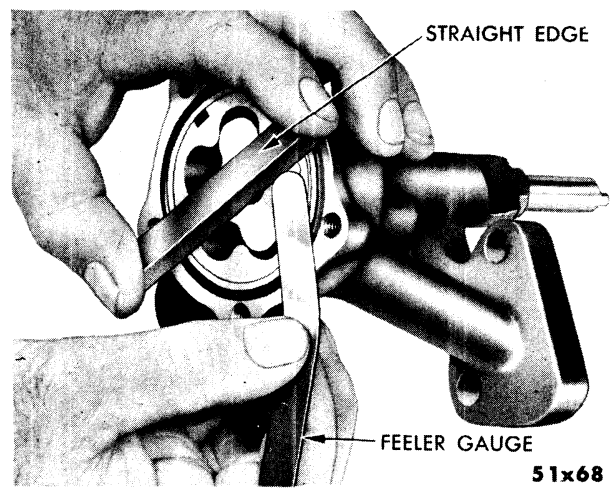

Fig. 59—Measuring Clearance Over Pump Rotors

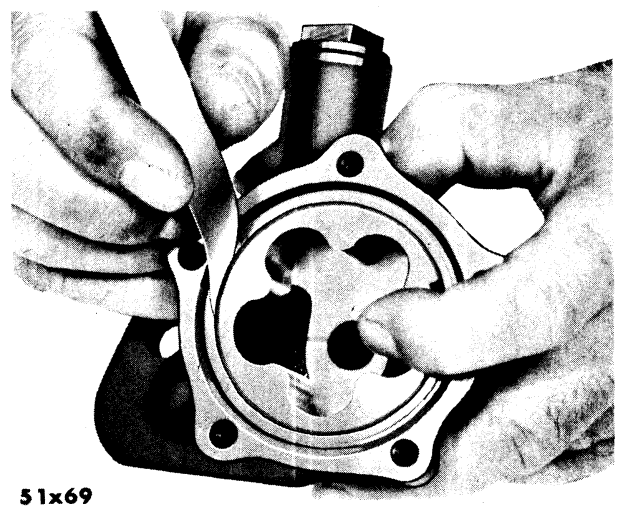

Fig. 60—Measuring Clearance Between Rotor Body and Pump Body

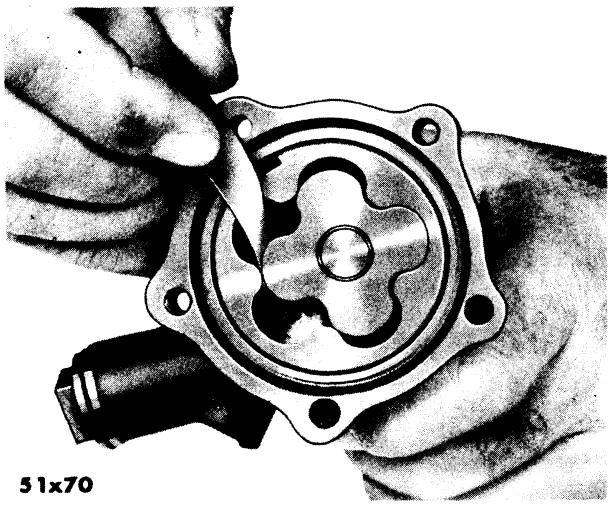
51x70

Fig. 61—Measuring Clearance Between Pump Rotors

RELIEF VALVE SPRING CHART

Color	Free Height	Under-Load Height	Tension Pounds
Gray (Lt.) ..	3 1/32 inch	2 1/16 inch	16.1 to 17.1
Red (Std.) ...	2 27/32 inch	2 1/16 inch	19.5 to 20.5
Brown (Hvy.)	2 31/32 inch	2 1/16 inch	22.0 to 23.9

Unscrew plug and remove relief valve spring and plunger. (Fig. 3) Clean all parts thoroughly.

If plunger shows signs of scoring or binds in bore, install a new plunger, and test spring. The spring should conform to Specifications on chart. If, for any reason, the spring has to be replaced, the same color spring should be used. An exception is where oil pressure is either above or below specifications.

e. Installation

Install strainer on end of suction tube and secure with a cotter pin. Install suction tube into pump body.

Make sure pump guide sleeve is in position in rear main bearing cap and install oil pump, suction tube, and strainer to rear main bearing cap. Align drive slot in pump shaft with distributor lower drive shaft. Tighten mounting bolts to 33 foot-pounds torque.

After oil pump has been installed, check alignment of strainer. The bottom of strainer must be on a horizontal plane with machined surface of cylinder block.

39. REMOVAL AND INSTALLATION OF OIL FILTER

Remove the shell retaining center bolt and lift off outer shell and gasket. (Fig. 62). Remove filter element. Remove filter base attaching bolts and filter base if necessary.

Use new gaskets, reinstall filter base and new filter element. Install outer shell and tighten center bolt securely.

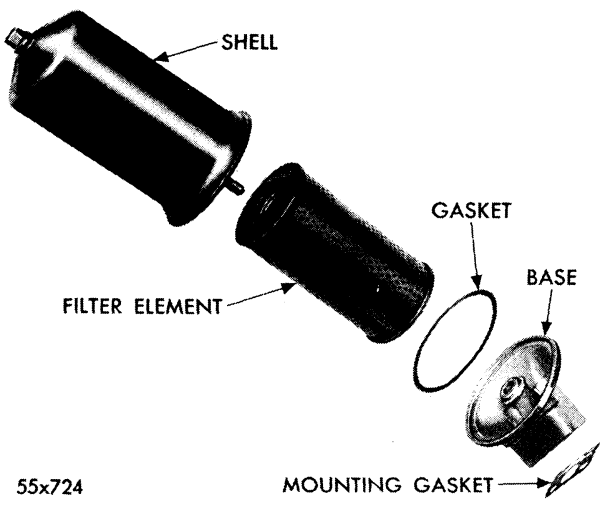

Fig. 62—Full Flow Type Oil Filter (Disassembled View)

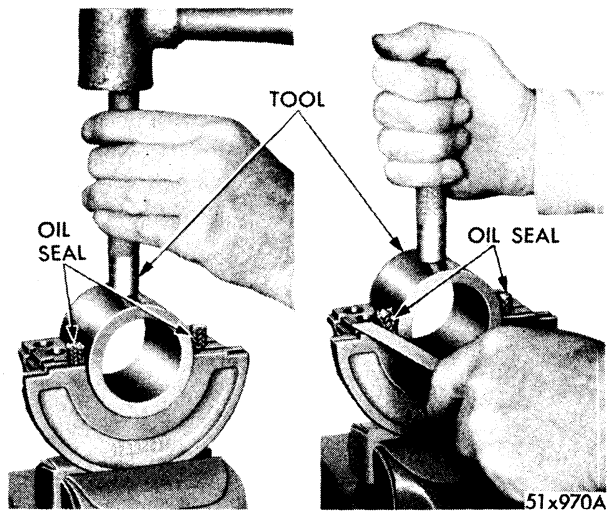

Fig. 63—Installing Rear Main Bearing Oil Seal

40. REPLACEMENT OF REAR MAIN BEARING OIL SEAL (CRANKSHAFT REMOVED)

Remove old oil seals from cylinder block and bearing cap. Install a new rear main bearing oil seal in block so that both ends protrude. Tap seal down into position with Tool C-3511, until tool is seated in bearing bore. Hold tool in this position, and cut off portion of seal that extends above block on both sides.

Install a new seal in bearing cap (bearing shell removed) so that the ends protrude. (Fig. 63). Tap seal down into position with Tool C-3511 (left-hand view, until tool is seated. Trim off portion of seal that protrudes above cap (right-hand view.) Install two cap side seals in grooves in cap. Care should be used when installing these seals as they are **NOT** interchangeable. The seal with the longer body should be installed on the oil filter side of the block. Seals incorrectly installed will cause an oil leak.

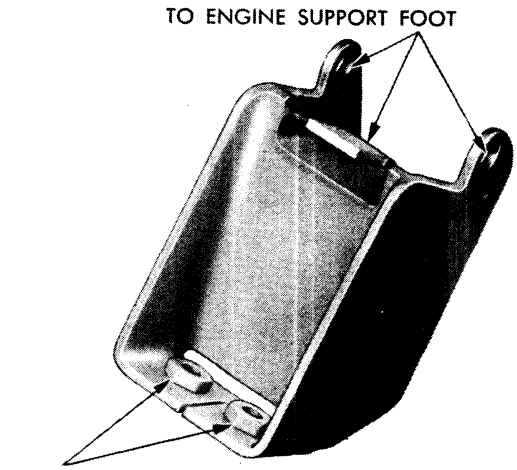

Fig. 64—Front Engine Mounting

41. REMOVAL OF FRONT ENGINE MOUNTINGS (Fig. 64)

Remove bolts on underside of each motor mount. Raise engine to relieve weight, and remove mounts by removing bolts from each engine support foot.