ENGINE

DATA AND SPECIFICATIONS

	C-67	C-68, C-69, C-70	C-300
ENGINE			
Type	V 90°	V 90°	V 90°
Number of Cylinders	8	8	8
Bore	$3\frac{5}{8}$ in.	$3\frac{13}{16}$ in.	$3\frac{13}{16}$ in.
Stroke	$3\frac{5}{8}$ in.	$3\frac{5}{8}$ in.	$3\frac{5}{8}$ in.
Piston Displacement	300 cu. in.	331.1 cu. in.	331.1 cu. in.
Taxable Horsepower (AMA)	42.05	46.51	46.51
Compression Ratio	8.0 to 1	8.5 to 1	8.5 to 1
Maximum Brake Horsepower	188 at 4400	250 at 4600	300 at 5200
Compression Pressure at 150 rpm (plugs removed) Wide Open Throttle	130 to 160	140 to 170	140 to 170
Maximum Variation Between Cylinders (any one engine)	15 lbs.	15 lbs.	15 lbs.
Firing Order	1-8-4-3-6-5-7-2	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	1-3-5-7
Right Bank	2-4-6-8	2-4-6-8	2-4-6-8
ENGINE WEIGHTS			
Weight of Engine (dry)	691 lbs.	729 lbs. (C-68) 744 lbs. (C-69, C-70)	735 lbs.
Weight of Power Plant Assembly (dry)	879 lbs. w/Std. Trans. 909 lbs. w/PowerFlite Trans.	962 lbs. (C-68) 980 lbs. (C-69, C-70)	968 lbs.
CRANKSHAFT			
Type	Fully Counter-Balanced	Fully Counter-Balanced	Fully Counter-Balanced
Bearings	Steel-Backed Babbitt	Steel-Backed Babbitt	Tri-metal No. 2 & 4 Steel-Backed Babbitt
	2.4995 to 2.5005 in.		Nos. 1, 3, & 5
Journal Diameter	2.249 to 2.250 in.	2.4995 to 2.5005 in.	2.4995 to 2.5005 in.
Crank Pin Diameter		2.249 to 2.250 in.	2.249 to 2.250 in.
Maximum Out-of-Round Permissible	.001 in.	.001 in.	.001 in.
Number Main Bearings	5	5	5
Diameter Clearance (Desired)	.0005 to .0015 in.	.0005 to .0015 in.	.0005 to .0015 in. (Babbitt) .001 to .0025 in. (Tri-metal)

ENGINE (Cont'd)

	C-67	C-68, C-69, C-70	C-300
Maximum Allowable	.0025 in.	.0025 in.	.0025 in.
End Play	.002 to .007 in.	.002 to .007 in.	.002 to .007 in.
Thrust Taken by	No. 3 Main Bearing	No. 3 Main Bearing	No. 3 Main Bearing
Finish at Rear Seal Surface	Diagonal Knurling	Diagonal Knurling	Diagonal Knurling
Interchangeability of Bearings	Upper and Lower Nos. 1, 2, 4 Upper and Lower No. 3 Upper and Lower not Interchangeable No. 5	Upper and Lower Nos. 1, 2, 4 Upper and Lower No. 3 Upper and Lower not Interchangeable No. 5	Upper and Lower Nos. 1, 2, 4 Upper and Lower No. 3 Upper and Lower not Interchangeable No. 5
BEARING SIZES			
Diameter and Length No. 1	2.5 x .875 in.	2.5 x .875 in.	2.5 x .875 in.
No. 2	2.5 x .875 in.	2.5 x .875 in.	2.5 x .875 in.
No. 3	2.5 x .870 in.	2.5 x .870 in.	2.5 x .870 in.
No. 4	2.5 x .875 in.	2.5 x .875 in.	2.5 x .875 in.
No. 5	2.5 x 1.595 in.	2.5 x 1.595 in.	2.5 x 1.595 in.
MAIN BEARINGS (service) All Available in Standard and the Following Undersizes	.001, .002, .003, .010, .012 in.	.001, .002, .003, .010, .012 in.	.001, .002, .003, .010, .012 in.
MAIN BEARING JOURNALS			
Diameter	2.4995 to 2.5005 in.	2.4995 to 2.5005 in.	2.4995 to 2.5005 in.
Maximum Allowable Out-of-Round	.001 in.	.001 in.	.001 in.
Maximum Allowable Taper	.001 in.	.001 in.	.001 in.
Center Bearing Run-Out (total indicator reading) When Supported at Front and Rear Main Bearing	.002 in.	.002 in.	.002 in.
CRANKPIN JOURNALS			
Diameter	2.249 to 2.250 in.	2.249 to 2.250 in.	2.249 to 2.250 in.
Length	1⅞ in.	1⅞ in.	1⅞ in.
Maximum Allowable Out-of-Round	.001 in.	.001 in.	.001 in.
Maximum Allowable Taper	.001 in.	.001 in.	.001 in.
CONNECTING RODS AND BEARINGS			
Type	Drop Forged "I" Beam	Drop Forged "I" Beam	Drop Forged "I" Beam
Length	6⅝ in.	6⅝ in.	6⅝ in.
Weight (less bearings)	25.2 oz.	25.2 oz.	25.2 oz.
Bearings	Steel-Backed Babbitt	Steel-Backed Babbitt	Tri-Metal

ENGINE (Cont'd)

	C-67	C-68, C-69, C-70	C-300
Diameter and Length	2.2507 to 2.2512 x 29/32 in.	2.2507 to 2.2512 x 29/32 in.	2.2507 to 2.2512 x 29/32 in.
Diameter Clearance Desired	.0005 to .0015 in.	.0005 to .0015 in.	.0005 to .0015 in.
Maximum Allowable Before Replacement	.0025 in.	.0025 in.	.0025 in.
Side Clearance	.006 to .014 in.	.006 to .014 in.	.006 to .014 in.
Bearings for Service	Standard, .001, .002, .003, .010, .012 in. US	Standard, .001, .002, .003, .010, .012 in. US	Standard, .001, .002, .003, .010, .012 in. US
CONNECTING ROD BUSHING			
Type	Steel-Backed Bronze	Steel-Backed Bronze	Steel-Backed Bronze
Number	8	8	8
Diameter and Length	.9843 to .9846 x 1¼ in.	.9843 to .9846 x 1¼ in.	.9843 to .9846 x 1¼ in.
Interchangeability	All	All	All
Clearance With Piston Pin	.0001 to .0004 in. Selective	.0001 to .0004 in. Selective	.0001 to .0004 in. Selective
CAMSHAFT			
Drive	Chain	Chain	Chain
Bearings	Steel-Backed Babbitt	Steel-Backed Babbitt	Steel-Backed Babbitt
Number	5	5	5
Thrust Taken By	Thrust Plate	Thrust Plate	Thrust Plate
End Play	.002 to .006 in.	.002 to .006 in.	.002 to .006 in.
Maximum Allowable Before Reconditioning	.010 in.	.010 in.	.010 in.
Diametral Bearing Clearance	.001 to .003 in.	.001 to .003 in.	.001 to .003 in.
Maximum Allowable Before Reconditioning	.005 in.	.005 in.	.005 in.
Valve Lift—Intake	.375 in.	.375 in.	.444 in.
Valve Lift—Exhaust	.361 in.	.361 in.	.435 in.
CAMSHAFT BEARING JOURNALS			
Diameter and Length.....No. 1	1.998 to 1.999 x 15/16 in.	1.998 to 1.999 x 15/16 in.	1.998 to 1.999 x 15/16 in.
Nos. 2, 3 and 4	1.998 to 1.999 x ¾ in.	1.998 to 1.999 x ¾ in.	1.998 to 1.999 x ¾ in.
No. 5	1.4355 to 1.4365 x 29/32 in.	1.4355 to 1.4365 x 29/32 in.	1.4355 to 1.4365 x 29/32 in.
CAMSHAFT BEARINGS			
Diameter and Length After Reaming.....No. 1	2.000 to 2.001 x 15/16 in.	2.000 to 2.001 x 15/16 in.	2.000 to 2.001 x 15/16 in.
Nos. 2, 3 and 4	2.000 to 2.001 x 13/16 in.	2.000 to 2.001 x 13/16 in.	2.000 to 2.001 x 13/16 in.
No. 5	1.4375 to 1.4385 x 29/32 in.	1.4375 to 1.4385 x 29/32 in.	1.4375 to 1.4385 x 29/32 in.

ENGINE (Cont'd)

	C-67	C-68, C-69, C-70	C-300
TIMING CHAIN			
Adjustment	None	None	None
Number of Links	68	68	68
Pitch	.375 in.	.375 in.	.375 in.
Width	1⅛ in.	1⅛ in.	1⅛ in.
TAPPETS			
Type	Hydraulic	Hydraulic	Mechanical
Clearance in Block	.0005 to .0015 in.	.0005 to .0015 in.	.0005 to .0015 in.
Body Diameter	.9040 to .9045 in.	.9040 to .9045 in.	.9040 to .9045 in.
Clearance Between Valve Stem and Rocker Arm	Dry Lash .060 to .210 in.	Dry Lash .060 to .210 in.	*Intake .015 in. *Exhaust .024 in.
*Engine hot and idling			
PISTONS			
Type	Comformatic with Steel Belt	Horizontal Slot with Steel Strut	Horizontal Slot with Steel Strut
Material	Aluminum Alloy Tin Coated	Aluminum Alloy Tin Coated	Aluminum Alloy Tin Coated
Clearance in Bore (pounds pull with .002x½ in. feeler stock)	5 to 12 lbs.	5 to 12 lbs.	5 to 12 lbs.
Land Clearance (diametral)	.028—.033 in.	.028—.033 in.	.028—.033 in.
Clearance at Skirt	Top of Piston .0005 to .0015 in.	1½ in. From Bottom .0005 to .0015 in.	1½ in. From Bottom .0005 to .0015 in.
Weight (Standard through .060 in. oversize)	570 grams	591 grams	591 grams
Piston Length (overall)	3$\frac{7}{16}$ in.	3$\frac{31}{32}$ in.	3$\frac{31}{32}$ in.
Ring Groove Depth No. 1	.188 in.	.200 in.	.200 in.
No. 2	.188 in.	.200 in.	200 in.
No. 3	.188 in.	.194 in.	.194 in.
Pistons for Service	Standard .005, .020, .030, .040, .060 in. OS	Standard .005, .020, .030, .040, .060 in. OS	Standard, .005, .020, .030, .040, .060 in OS
PISTON PINS			
Type	Full Floating	Full Floating	Full Floating
Diameter and Length	.9841 to .9843 x 3.040 to 3.050 in.	.9841 to .9843 x 3.140 to 3.150 in.	.9841 to .9843 x 3.140 to 3.150 in.
Clearance in Piston (Thumb press at 70° F.)	.0000 to .0005 in.	.0000 to .0005 in.	.0000 to .0005 in.
End Play	.004 to .026 in.	.004 to .026 in.	.004 to .026 in.
Clearance in Rod (Selective)	.0001 to .0005 in.	.0001 to .0004 in.	.0001 to .0004 in.
Piston Pins for Service	Standard .003, .008 in. OS	Standard .003, .008 in OS	Standard .003, .008 in. OS
Direction Offset in Piston	Toward Right Side of Engine	Toward Right Side of Engine	Toward Right Side of Engine

ENGINE (Cont'd)

	C-67	C-68, C-69, C-70	C-300
PISTON RINGS			
Number of Rings per Piston	3	3	3
Compression	2	2	2
Oil	1	1	1
Width of Rings—			
(Compresion)	.0775 to .0780 in.	.0775 to .0780 in.	.0775 to .0780 in.
(Oil)	.1860 to .1865 in.	.1860 to .1865 in.	.1860 to .1865 in.
Piston Ring Gaps (All)	.010 to .020 in.	.010 to .020 in.	.010 to .020 in.
Ring Side Clearance (Compression)			
Upper	.0015 to .0030 in.	.002 to .0035 in.	.002 to .0035 in.
Intermediate	.0010 to .0025 in.	.002 to .0035 in.	.002 to .0035 in.
(Oil)	.0010 to .003 in.	.0010 to .0025 in.	.0010 to .0025 in.
VALVES—Intake			
Material	Silicon-Chromium Steel	Silicon-Chromium Steel	Silicon-Chromium Steel
Head Diameter	$1\frac{13}{16}$ in.	$1\frac{15}{16}$ in.	$1\frac{15}{16}$ in.
Length (to top of valve face)	$4\frac{23}{32}$ in.	$5\frac{1}{32}$ in.	$5\frac{1}{32}$ in.
Stem Diameter	.372 to .373 in.	.372 to .373 in.	.372 to .373 in.
Stem to Guide Clearance	.001 to .003 in.	.001 to .003 in.	.001 to .003 in.
Maximum Allowable Before Reconditioning	.004 in.	.004 in.	.004 in.
Distance from Guide to Valve Seat Face	$\frac{31}{32}$ in.	$\frac{31}{32}$ in.	$\frac{31}{32}$ in.
Angle of Seat	45°	45°	45°
Adjustment	None	None	Adjusting Screw at Rocker Arm
VALVES—Exhaust			
Material	Silicon-Chromium Steel	Nitrided Chrome-Nickel Steel	Nitrided Chrome-Nickel Steel
Head Diameter	$1\frac{1}{2}$ in.	$1\frac{3}{4}$ in.	$1\frac{3}{4}$ in.
Length (to top of valve face)	$4\frac{5}{8}$ in.	$5\frac{1}{32}$ in.	$5\frac{1}{32}$ in.
Stem Diameter	.371 to .372 in.	.371 to .372 in.	.371 to .372 in.
Stem to Guide Clearance	.002 to .004 in.	.002 to .004 in.	.002 to .004 in.
Maximum Allowable Before Reconditioning	.006 in.	.006 in.	.006 in.
Distance from Guide to Valve Seat Face	$1\frac{3}{32}$ in.	$1\frac{3}{32}$ in.	$1\frac{3}{32}$ in.
Angle of Seat	45°	45°	45°
Adjustment	None	None	Adjusting Screw at Rocker Arm

ENGINE (Cont'd)

	C-67	C-68, C-69, C-70	C-300
VALVE SPRINGS—Outer			
Number	16	16	16
Free Length	2 in.	$2\frac{3}{64}$ in.	$2\frac{3}{64}$ in.
Load When Compressed to	$1\frac{11}{16}$ in.—	$1\frac{11}{16}$ in.—	$1\frac{11}{16}$ in.—
(Valve Closed)	68 to 76 lbs.	52 to 58 lbs.	52 to 58 lbs.
Load When Compressed to	$1\frac{5}{16}$ in.—	$1\frac{5}{16}$ in.—	$1\frac{5}{16}$ in.—
(Valve Open)	160 to 172 lbs.	122 to 130 lbs.	122 to 130 lbs.
Assemble with Closed Coils Toward	Head	Head	Head
Valve Springs I.D.	1.010 to 1.030 in.	.990 to 1.010 in.	.990 to 1.010 in.
VALVE SPRINGS—Inner			
Number	None	16	16
Free Length		$2\frac{1}{64}$ in.	$2\frac{1}{64}$ in.
Load When Compressed to		$1\frac{9}{16}$ in.—	$1\frac{9}{16}$ in.—
(Valve Closed)		20 to 23 lbs.	20 to 23 lbs.
Load When Compressed to		$1\frac{3}{16}$ in.—	$1\frac{3}{16}$ in.—
(Valve Open)		40 to 45 lbs.	40 to 45 lbs.
Assemble with Closed Coils Toward		Head	Head
Valve Spring I.D.		.690 to .710 in.	.690 to .710 in.
Valve Spring Installed Height (Cyl. Head Spring Seat to Retainer)		$1\frac{5}{8}$ to $1\frac{11}{16}$ in.	$1\frac{5}{8}$ to $1\frac{11}{16}$ in.
Recondition at (Use $\frac{1}{16}$ in. Spacer No. 1400482)		$1\frac{23}{32}$ in.	$1\frac{23}{32}$ in.
CYLINDER HEAD			
Number Used	2	2	2
Combustion Chamber	Polyspherical	Hemispherical	Hemispherical
Valve Seat Runout (maximum)	.002 in.	.003 in.	.003 in.
Intake Valve Seat Angle	45°	45°	45°
Exhaust Valve Seat Angle	45°	45°	45°
Seat Width (finished)	.040 to .060 in.	.040 to .060 in.	.040 to .060 in.
Cylinder Head Gasket Compressed (thickness)	.024 in.	.024 in.	.024 in.
ENGINE LUBRICATION			
Pump Type	Rotary, Full Pressure	Rotary, Full Pressure	Rotary, Full Pressure
Capacity (qts.)	5*	5*	5*
Pump Drive	Camshaft	Camshaft	Camshaft
Operating Pressure at 40 to 50 mph	40 to 65 lbs.	40 to 65 lbs.	40 to 65 lbs.
Pressure Drop Results from Clogged Filter	15 to 20 lbs.	15 to 20 lbs.	15 to 20 lbs.

*When Filter Element is Replaced Add 1 qt.

TIGHTENING REFERENCE
(ALL MODELS)

	Torque Foot-Pounds
Camshaft Sprocket Hub Nut	125
Camshaft Sprocket Hub Thrust Plate Bolt	15
Carburetor-To-Manifold Stud Nut	15
Chain Case Cover Bolt	35
Clutch Housing Bolt	30
Clutch Housing Pan Bolt	30
Clutch Housing Pan Drain Plug	35
Clutch Housing Vent Hole Screen Bolt	7
Connecting Rod Bearing Cap Bolt Nut (Plain)	45
(Chemical Surface Treatment)	40
Cylinder Head Bolt	85
Distributor Clamp Bolt	15
Engine Front Support Foot Bolt Nut	45
Engine Front Support Insulator Bolt Nut	25
Exhaust Manifold Stud Nut	25
Exhaust Pipe Flange Bolt Nut	40
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 Bolt	7
Intake Manifold Bolt	30
Main Bearing Cap Bolt	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

	Torque Inch-Pounds
Crankcase Ventilator Outlet Pipe Bolt	15
Manifold Heat Control Counterweight Bolt	50
Rocker Cover Bolt	30
Tappet Chamber Cover Bolt	50

SPECIAL TOOLS
(SPITFIRE ENGINE)

ESSENTIAL TOOLS

Tool Number	Tool Name
C- 455	Wrench—Starter Motor Flange Nut
C- 263	Remover and Installer—Piston Ring
C- 741	Reamer—Valve Guide (.374-.375 inch Std.)
C- 756	Cleaner—Valve Guide
C- 771	Tool—Flywheel Turning
C-3428	Compressor—Valve Spring
C-3025	Sleeve—Intake Guide Wear Measuring
C-3026	Sleeve—Exhaust Guide Wear Measuring
C-3033	Puller Set—Crankshaft Pulley and Timing Gear
C-3034	Puller and Installer—Camshaft Bearing Shells
C-3050	Driver—Chain Case Cover Oil Seal—Removing
C-3051	Driver—Chain Case Cover Oil Seal—Installing
C-3052	Remover—Distributor Drive Shaft Bushing
C-3053	Driver and Burnisher—Distributor Drive Shaft Bushing
C-3054	Wrench—Spark Plug
C-3059	Remover and Installer—Main Bearing Upper Shell
C-3436	Gauge—Valve Stem Length
C-3065	Gauge—Cylinder Compression
C-3066	Connector—Timing Light
C-3068	Rack—Hydraulic Tappet
C-3131	Installer—Rear Main Bearing Oil Seal
C-3158	Puller—Hydraulic Tappet
C-3160	Pliers—Hydraulic Tappet Testing
C-3466	Plate—Engine Lifting
C-3200	Reamer—Piston Pin
C-3209	Fixtures—Cylinder Head Holding
C-3231	Gauge—Timing Chain Aligning
C-3427	Reamer—Valve Guide (.404-.405 inch)
C-3430	Reamer—Valve Guide (.389-.390 inch)
C-3433	Reamer—Valve Guide (.379-.380 inch)

DESIRABLE TOOLS

C- 897	Driver—Welch Plug
C-3005	Wrench—100 Foot-Pounds Torque (Sensory Type)
C-3012	Reamer—Cylinder Bore Ridge
C-3028	Reamer Set—Hydraulic Tappet Bore
C-3221	Guide—Connecting Rod Bolt
C-3075	Gauge—Top Dead Center
C-3132	Removing and Installing—Cam Bearing Shell

SPECIAL TOOLS
(FIREPOWER ENGINE)

ESSENTIAL TOOLS

Tool Number	Tool Name
C- 263	Tool—Piston Ring Installer
C- 455	Wrench—Starting Motor Flange Nut
C- 693	Timing Light
C- 741	Reamer—Solid Valve Guide
C- 756	Cleaner—Valve Guide
C-3023	Compressor—Valve Spring
C-3024	Tool—Rocker Arm and Spring Compressor
C-3033	Puller Set—Damper, Sprocket, Crank Gear
C-3050	Driver—Chain Case Cover Oil Seal Removing
C-3051	Driver—Chain Case Cover Oil Seal Installing
C-3052	Remover—Distributor Shaft Bushing
C-3053	Driver and Burnisher—Distributor Drive Shaft Bushing
C-3054	Wrench—Spark Plug
C-3057	Tool—Intake Valve Oil Seal Ring Installer
C-3059	Tool—Main Bearing Upper Shell
C-3466	Plate—Engine Lifting
C-3065	Gauge—Cylinder Compression
C-3066	Connector—Timing Light
C-3068	Rack—Hydraulic Tappet
C-3133	Fixtures—Cylinder Head Holding
C-3131	Tool—Rear Main Bearing Seal Installing
C-3149	Reamer—Piston Pin Line
C-3150	Driver—Valve Guide
C-3025	Sleeve—Guide Wear Measuring—Intake
C-3026	Sleeve—Guide Wear Measuring—Exhaust
C-3160	Pliers—Hydraulic Tappet Leakdown Checking
C-3061	Gauge—Valve Stem Length
C-3158	Puller—Hydraulic Tappet

DESIRABLE TOOLS

C- 888	Stand—Engine Repair
C- 889	Adaptor—Engine Repair Stand
C- 897	Driver—Welch Plug Installer
C-3005	Wrench—Torque 100 Foot-Pounds (Sensory Type)
C-3012	Reamer—Cylinder Bore Ridge
C-3028	Reamer Set—Valve Tappet
C-3047	Tool—Piston and Connecting Rod Assembly
C-3075	Gauge—Top Dead Center
C-3132	Tool—Cam Bearing Removing and Installing
C-3134	Puller—Chain Case Cover
C-3140	Puller—Valve Seat Insert
C-3151	Driver—Welch Plug Installing

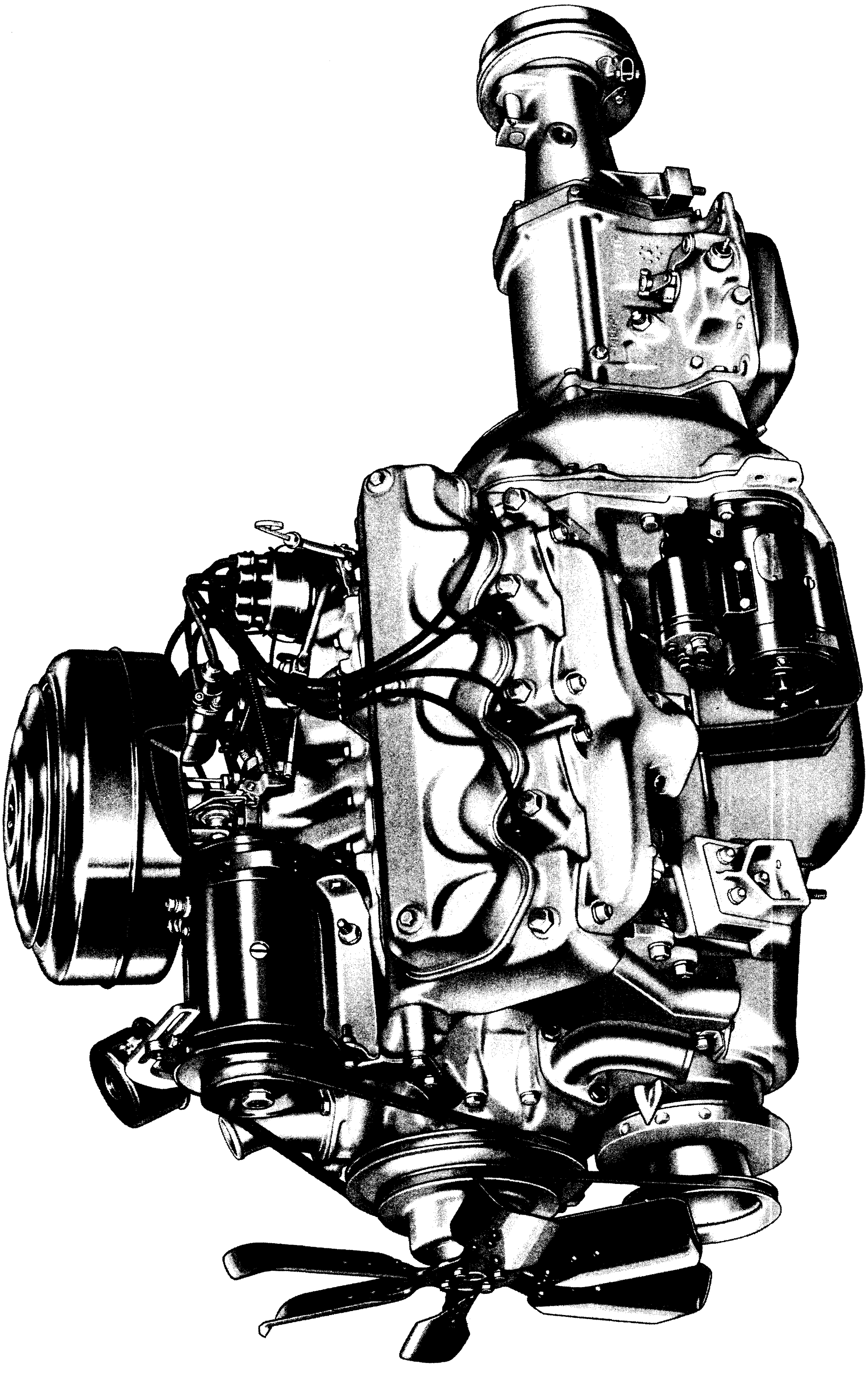

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Fig. 1—SpitFire V-8 Engine (Left View)

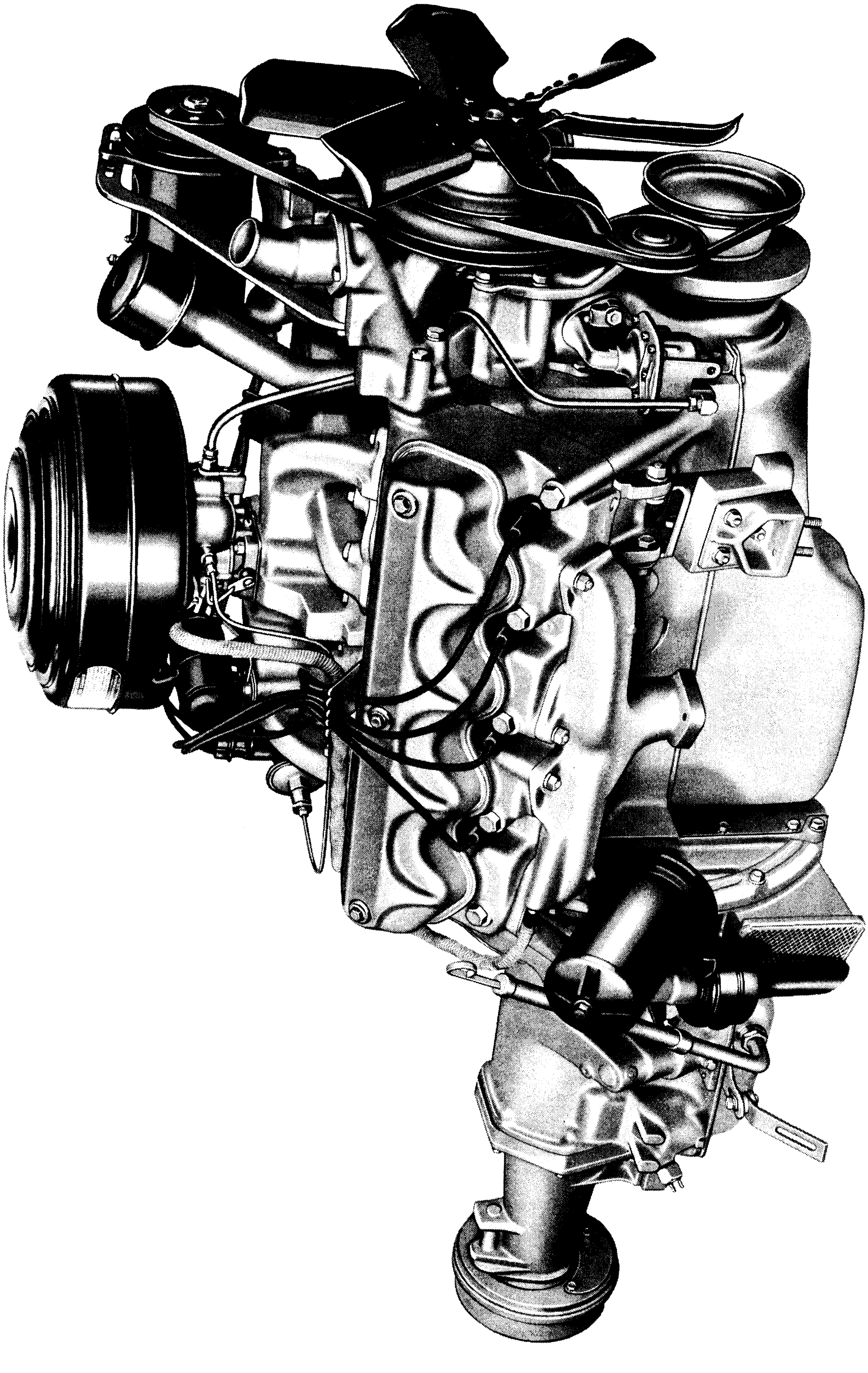

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Fig. 2—SpitFire V-8 Engine (Right View)

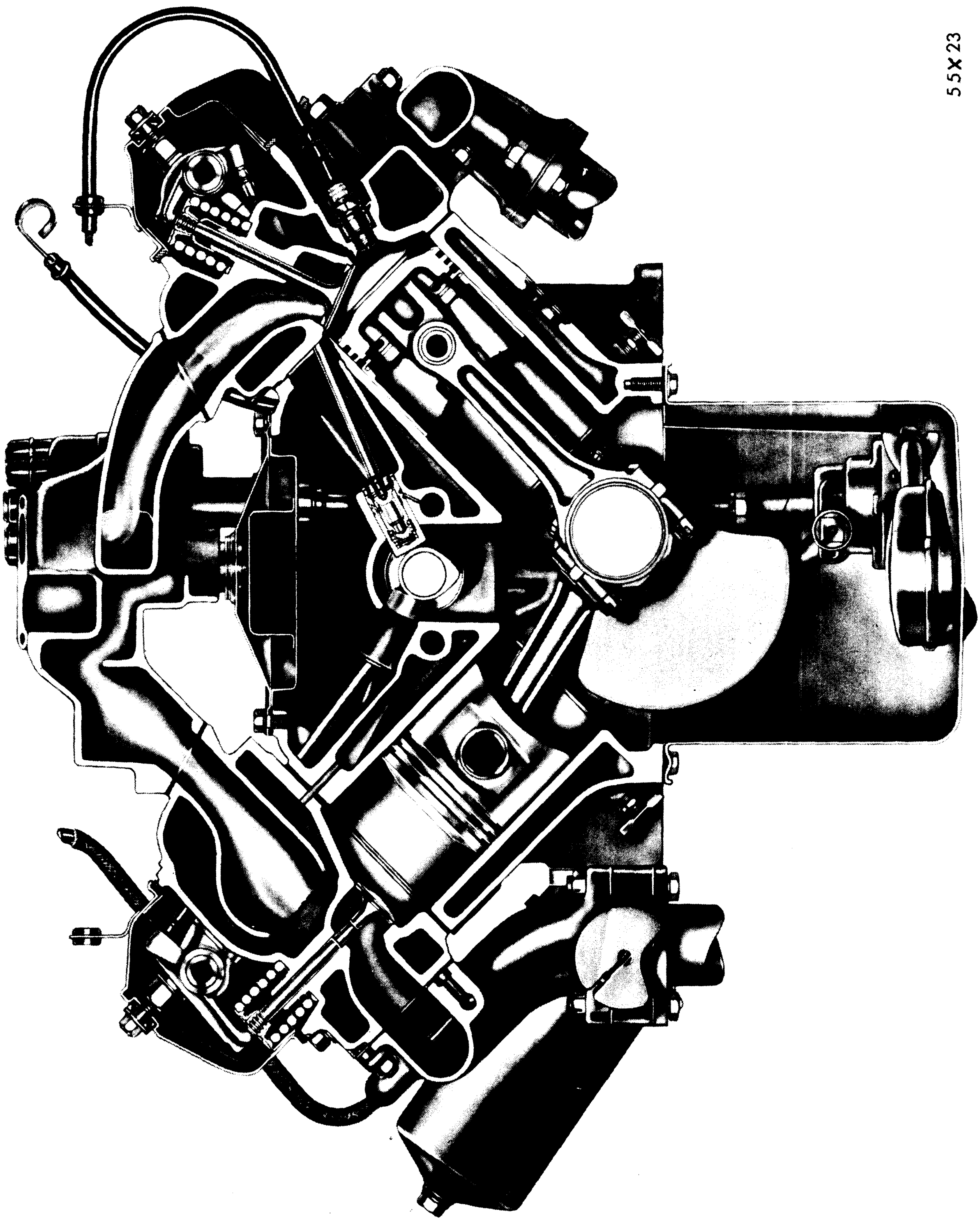

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Fig. 3—SpitFire V-8 Engine (End Sectional View)

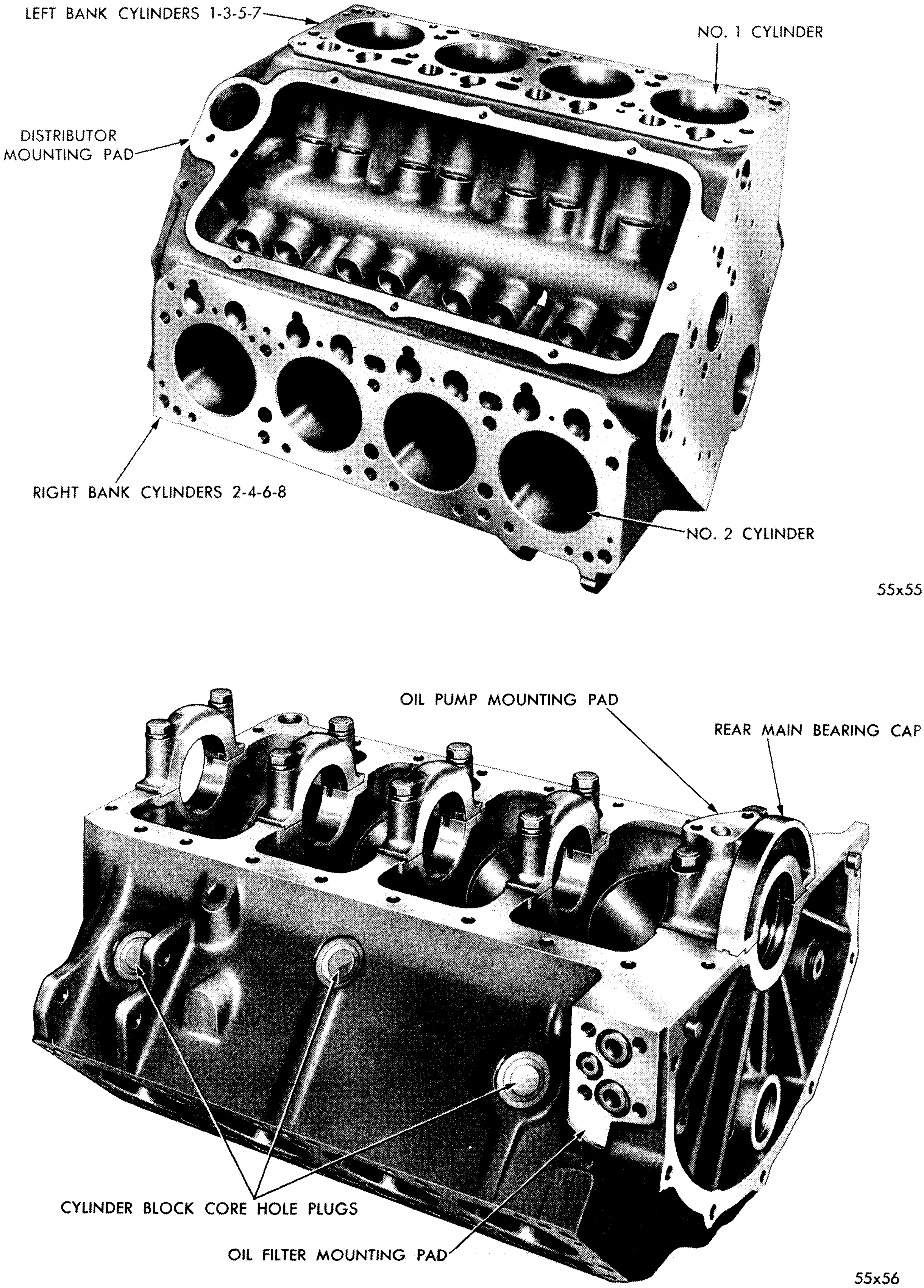

Fig. 4—Cylinder Block

Section VII
ENGINE

SPITFIRE V-8 ENGINE
(C-67 MODEL)

1. DESCRIPTION

The SpitFire V-8 Chrysler engine, as shown in Figures 1, 2, and 3, is a 90 degree V-8 type, with inclined lateral valves in the cylinder heads. The power plant is mounted in the chassis at three points in live rubber to prevent sound or other vibration from being transmitted to the body.

a. Cylinder Block

The cylinder block and crankcase, as shown in Figure 4, are cast integrally, along with the transverse members which support the five main bearings. This design provides the utmost rigidity and strength, insuring perfect alignment of bores and crankshaft under all engine operating conditions.

The cylinders are precision-bored and are completely encircled by full length water jackets for efficient cooling. Coolant from the water pump circulates through the block, around the cylinder bores, and up into the cylinder heads. The coolant then circulates through the cylinder heads, around the exhaust valve ports, and into the return passages of the pump housing, then to the thermostat for return to the radiator, or recirculation, until the thermostat opens. Drilled passages in the block and cylinder heads carry lubricating oil from the pump to all moving parts of the engine.

b. Crankshaft

The crankshaft in the SpitFire V-8 engine is a steel drop forging, carefully heat-treated to insure strength and durability.

The short stroke (3⅝ inches) incorporated in this engine, permits the connecting rod journals to overlap the main bearing journals, further increasing the rigidity of the crankshaft.

The static and dynamic balance of the crankshaft has been achieved by the use of six counterweights, and the end thrust is taken by the Number Three main bearing. The crankshaft is drilled for full pressure lubrication to the main and connecting rod bearings. A portion of the rear main bearing journal carries a knurled surface, extending completely around the journal. This knurled surface, shown in Figure 5, in conjunction with the rear main bearing oil seal, helps to eliminate the possibility of oil leakage at this point.

c. Camshaft and Valve Mechanism

The camshaft is supported by five replaceable steel-backed bearing shells and is driven by a short, sturdy, silent timing chain. A spiral gear cast integrally with the camshaft, meshes with a gear and stub shaft which drives the distributor and oil pump. The eccentric, which drives the fuel pump, is mounted on the camshaft timing gear. A special ramp, or quieting curve, on each cam, rapidly and quietly opens and closes the

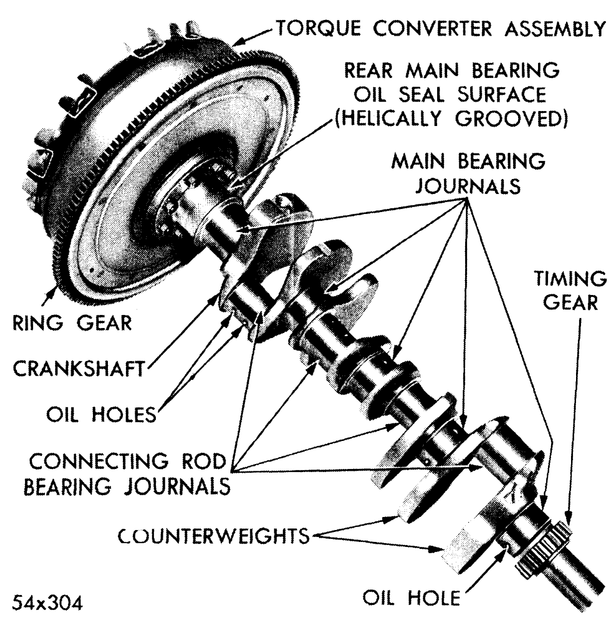

Fig. 5—Crankshaft and Torque Converter Assembly

valves, providing maximum duration of full opening and insures positive valve action at all speeds.

Hydraulic tappets are included in the valve mechanism to eliminate service adjustments and insure quiet valve operation. If necessary, the tappet assemblies may be removed from the engine to facilitate service. The hydraulic tappets automatically compensate for variations in the operating mechanism, resulting from temperature changes or wear. The hydraulic tappet provides zero (0) clearance in the operating mechanism from the cam lobe surface to the push rods, rocker arms, and valve stems.

The exhaust and intake rocker arms oscillate on two drilled steel shafts (one on each head),

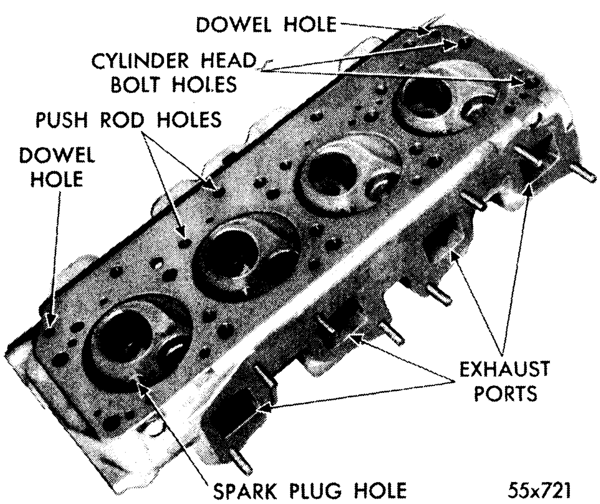

Fig. 6—Cylinder Head (Bottom View)

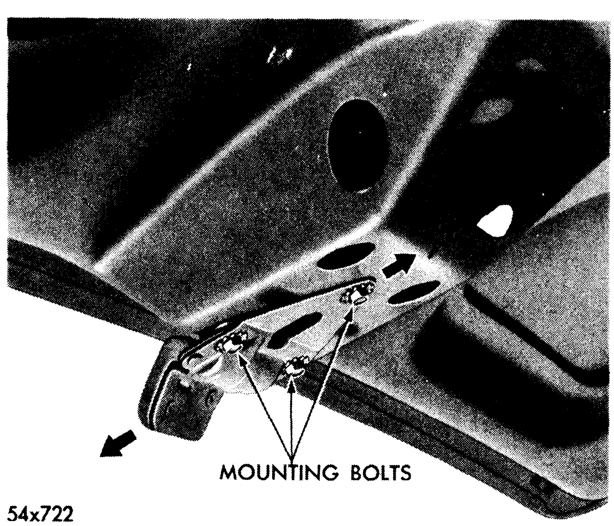

Fig. 6A—Cylinder Head (Top View)

supported by brackets on the cylinder heads. The rocker arms float in lubricating oil supplied under metered oil pressure through two special drilled passages from the Number Two and Number Four camshaft bearing bores. The rocker arms are prevented from excessive lateral movement along the shafts by a series of spacer springs.

d. Cylinder Heads

One of the outstanding features of the SpitFire V-8 engine is the polyspherical combustion chamber located in the cylinder heads (Fig. 6). This type of combustion chamber has surfaces so curved that the pressure cannot become centered at one point, but is equalized over the entire area. This type of combustion chamber also provides the maximum amount of space for extra large valves and permits direct and unrestricted exhaust and intake valve porting.

The water passages in the heads are large and well-designed to carry ample coolant over the combustion chamber wall and around the integral valve guide bosses and valve seats. The lower operating temperatures result in a marked increase in valve life.

Special oil drain holes in the heads return the liberated lubricating oil from the rocker arms and shafts back to the oil pan for redistribution.

e. Pistons, Rings and Connecting Rods

Aluminum alloy, steel belt, elliptical-turned pistons are used in the SpitFire V-8 engine. The piston skirts are relieved diagonally below the piston pin boss to allow clearance between piston and crankshaft counterweights, when the pistons are at the bottom of travel. The expansion and contraction is controlled by the steel belt in such manner that a more nearly constant clearance is maintained between the piston and cylinder wall. Consequently, the pistons can be correctly fitted to minimum clearance and this clearance is maintained whether the engine is idle or in operation. All piston and rod assemblies must be removed and installed through the top of each bank.

Two compression rings and one oil ring with an expander are fitted to seal the compression and control the oil. The oil ring is locked in position, with the gap up, by the expander spring to further control oil during idle or shut-down operation.

The piston pins are full-floating and retained by two snap rings, which fit in recessed grooves in the piston boss.

The connecting rods are made of drop-forged, heat-treated, carbon steel, and forged to an "I" section with a closed hub at the upper end and a separate cap on the lower. Each bearing shell and connecting rod cap has a small "V"-groove between the cap-to-rod mating surface (on one side only). This "V"-groove permits lubrication of the opposite cylinder wall. All main and connecting rod bearing shells are of the replaceable, steel-backed babbitt type and require no reaming for fitting.

f. Engine Lubrication

The SpitFire V-8 engines are pressure-lubricated by means of a rotary type oil pump. The pump is driven by the lower distributor drive shaft and draws oil from the deep sump at the rear of the oil pan.

Lubricating oil is drawn from the top of the crankcase oil supply, by means of a floating strainer, and is forced through drilled oil passages to the oil filter and then to the main oil gallery in the right-hand cylinder bank. The oil then travels to all main and connecting rod bearings, as well as to the camshaft bearings, hydraulic tappets, timing gears, and chain. The oil then circulates across Number One main bearing and into the left-hand cylinder bank oil gallery. Drilled passages from both oil galleries supply each hydraulic tappet with lubricating oil. (See Fig. 7 for oil flow through the engine.)

A drilled passage from the Number Two and Four camshaft bearings, allows a metered

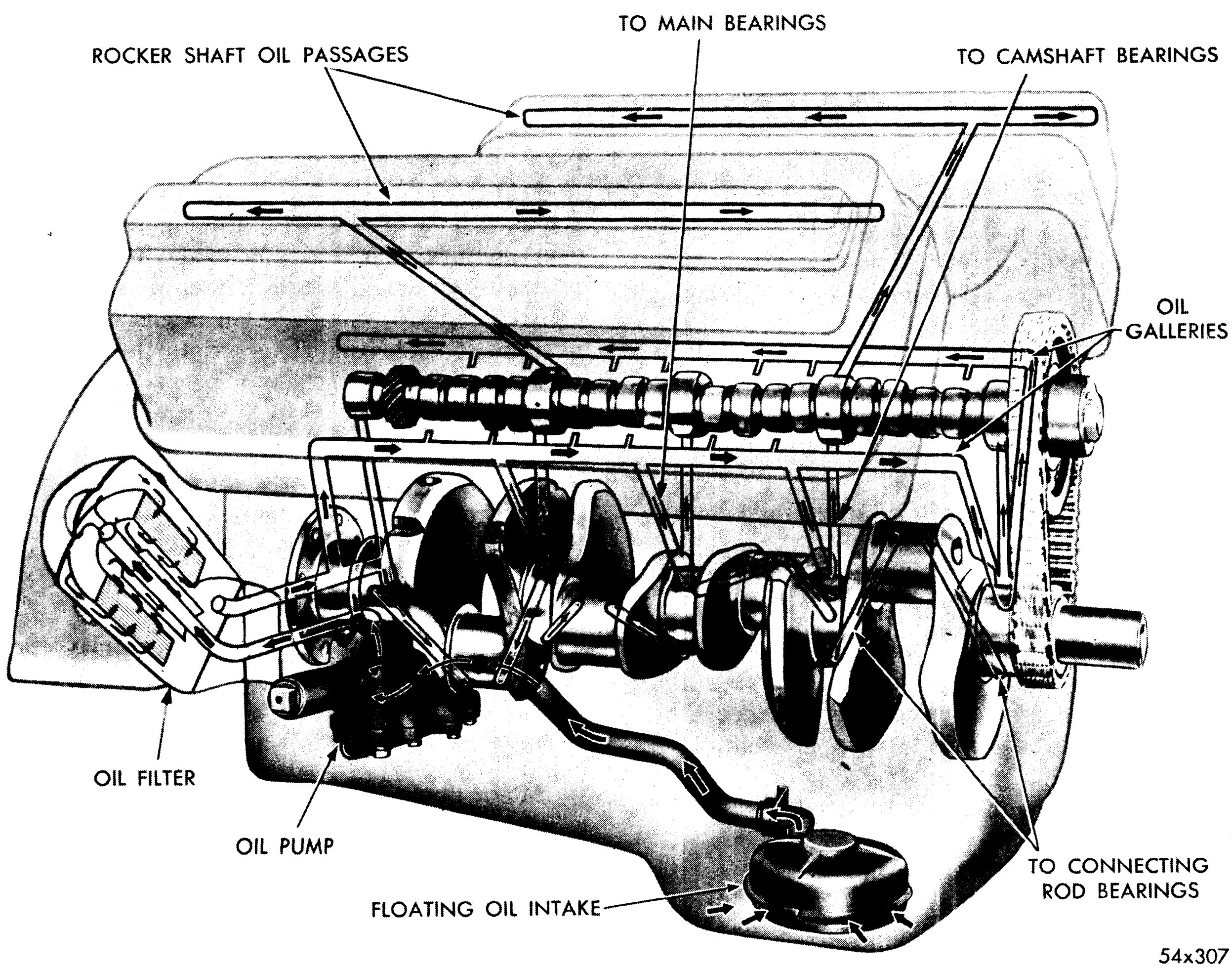

Fig. 7—Flow of Oil Through Engine (Typical)

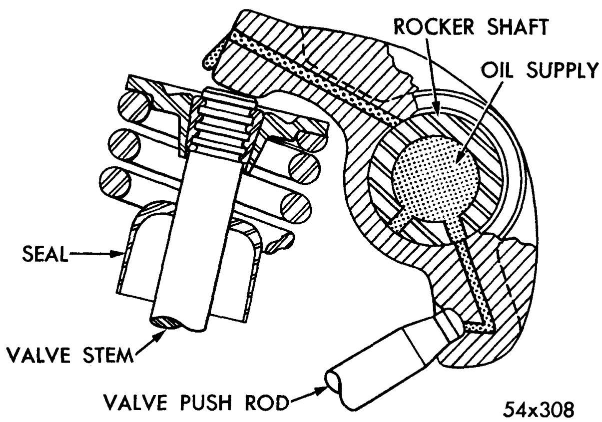

Fig. 8—Intake Rocker Arm Lubrication

amount of oil to be forced to the corresponding right and left bank around cylinder head bolts. The oil then flows into the steel rocker shafts and out through drilled holes and grooves in the shafts to the rocker arms. Special drilled passages in the rocker arms carry the oil to small orifices in the rocker arms. Oil is delivered directly to the push rod ends of both rocker arms, as shown in Figure 8, and to the valve tip end of the intake rocker arm only. The exhaust valve tip end is fed by gravity from a hole in rocker arm bushing.

Thus, oil is supplied to the valve operating mechanism only in spurts. When the lubricating oil hole in the camshaft journal is in alignment with the oil passage leading to the rocker shaft, the rocker arm bushing and socket is oiled.

A spring-loaded pressure relief valve, integral with the oil pump, controls the pump pressures.

2. ENGINE TUNE-UP (SpitFire and FirePower Models)

a. Performance Inspection

The following tests should be made when a complete engine analysis is being performed, to determine the cause of improper performance of an engine. These tests should also be completed during a Major Tune-Up. It is important that suitable testing equipment be used.

b. Battery and Line Voltage Check

Inspect the battery for cracked or damaged case. Test specific gravity (battery must be in a fully charged condition). Check voltage regulator with an accurate voltmeter.

c. Vacuum Test

The vacuum test will reveal many causes of unsatisfactory engine performance. The following conditions affect vacuum readings:

a. Improper carburetor adjustment.

b. Improper valve timing.

c. Burned or sticky valves.

d. Loose valve guides and weak springs.

e. Leaky intake manifold and carburetor gaskets.

f. Piston ring seal.

A steady reading of 18 to 20 inches of vacuum (when in altitude up to 1000 feet) indicates normal performance at idling speed. Most manufacturers of vacuum gauges furnish complete instructions for interpreting vacuum gauge readings.

d. Compression Test

Compression is checked with starter cranking the engine, all spark plugs removed, throttle wide open, and engine at normal operating temperature (180 degrees F.). Since compression pressures vary with compression ratios, check specifications of the engine being tested. However, compression should not vary more than 15 pounds between cylinders. An engine tune-up is of little value if compression is erratic or subnormal. If such conditions exists they must be corrected before engine can be properly tuned.

e. Condenser Test

A defective condenser will cause burning of the contact points. The condenser may be easily tested without removing it from the car.

f. Coil Test

The ignition coil transforms low battery voltage to high voltage required by spark plugs. Test the coil with an accurate coil tester. It does not have to be removed from the car.

g. Minor Engine Tune-Up

When performing a minor tune-up analysis, the following operations should be performed:

(1) Remove and clean spark plugs, adjust gap to .035 inch. Too wide a gap reduces speed and power; too narrow a gap causes uneven engine idling.

(2) Check distributor cap for cracks and corrosion. Check rotor spring and plunger. Inspect small lead wires for tightness, breakage, or damaged insulation. Check for excessive play in distributor vacuum advance plate bearing.

(3) Check and adjust distributor breaker points, as outlined in Electrical System.

(4) Check and adjust timing, as outlined in Ignition System.

(5) Clean and oil the air cleaner. Tighten carburetor flange nuts. Then set carburetor idle mixture adjustment, using a vacuum gauge. Adjust throttle stop screw so engine idles at not less than 450 to 500 rpm.

(6) Inspect primary and spark plug wires for breaks or poor insulation. Tighten connections, if necessary.

(7) Inspect fan belt and tighten, if necessary.

i. Major Engine Tune-Up

A Major Tune-Up consists of the "Performance Inspections" and the "Minor Tune-Up," plus the following operations.

(1) Clean and tighten battery connections and add water if necessary. Tighten all primary and high tension wire connections, particularly at ignition switch, ammeter, and fuel gauge behind instrument panel.

(2) Tighten cylinder head bolts and manifold nuts. Cylinder head bolts should be tightened with a torque wrench while engine is at normal operating temperature. See Tightening Reference.

(3) Check carburetor float level. If necessary, bend float arm to obtain correct position, see Fuel System Section. While carburetor cover is off, clean out dirt and foreign material from bowl.

(4) Check fuel pump operation and fuel lines for leaks.

(5) Road test car as a final check for other difficulties which might affect peak performance.

3. NEW CAR ENGINES IN STORAGE

Lack of proper storage preparation on vehicles which are not delivered immediately may result in the formation of rust on the operating parts of the engines. Such rust formation can cause excessive piston ring wear, sticking valves, excessive valve guide wear, and sticking rocker arms.

Since conditions produced by this rust can result in extreme customer dissatisfaction, needless service expense, and can also shorten engine life, it is recommended that cars, not being delivered immediately, have their engines prepared for storage in one of the following manners to protect against internal rusting:

a. Up to 30 Days

Add one quart of special rust preventive oil to each five gallons of gasoline in the fuel tank. Run the engine on this mixture for five minutes at approximately 1,000 rpm.

b. Over 30 Days

(Storage for over thirty days when the engine will not be started during the storage period.)

(1) Add one quart of special rust preventive oil to each five gallons of gasoline in the tank. Run the engine on this mixture for five minutes at approximately 1,000 rpm.

(2) Remove the rocker covers and spray the rocker arms, shafts, valve springs, push rods, and valve stems with the special rust preventive oil. Be sure to use a clean spray gun.

c. Over 90 Days

For vehicles to be stored more than 90 days, treat as described previously, but, in addition, remove the spark plugs and pour two ounces of special rust preventive oil into each cylinder. Turn the engine over several revolutions, with the starter, to distribute the rust preventive oil on the cylinder walls and pistons. Replace the spark plugs.

NOTE

The special rust preventive oil used should conform to U.S.A. specification 2-126. The oil may be obtained by this designation from reputable oil refiners.

SERVICE PROCEDURES

4. ENGINE REMOVAL (From Car) (SpitFire and FirePower)

NOTE

When removing the engine assembly it is not necessary to remove the transmission with the engine; however, time and labor can be saved if transmission is removed along with engine assembly.

(1) Drain the cooling system (both cylinder block draincocks and one at radiator).

(2) Disconnect heater hoses (if so equipped) and radiator hoses and remove radiator and shroud.

(3) Disconnect wires and linkage at transmission.

(4) Disconnect propeller shaft at transmission.

(5) Disconnect speedometer and hand brake cable at transmission.

(6) Disconnect the exhaust pipes and brackets.

(7) Remove the hood and battery.

(8) Disconnect the usual items under the hood such as fuel line, electrical wires, etc.

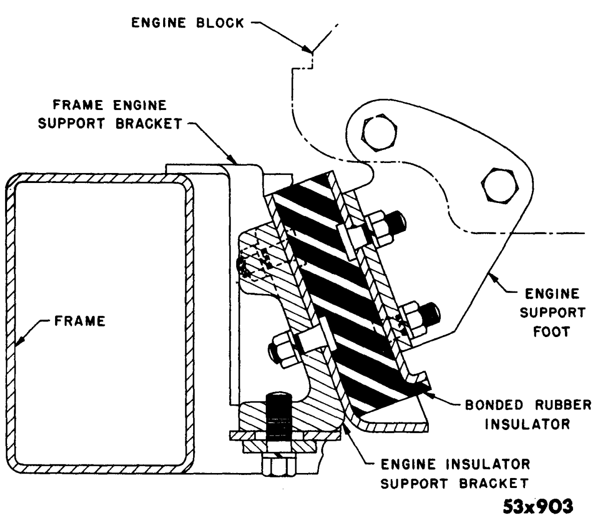

Fig. 9—Shear Type Front Engine Mounting

(9) If lifting fixture, Tool C-3466, is to be used, disconnect the automatic choke heat tube and vacuum and fuel lines from carburetor and remove carburetor. Attach Tool C-3466 to carburetor flange studs on intake manifold, and attach chain hoist to fixture eyebolt.

(10) Raise car off floor; install engine support fixture, Tool C-3082. Insert hooks of fixture firmly into holes in side of frame. Adjust fixture to support the weight of engine.

(11) Remove rear crossmember-to-transmission attaching bolts.

(12) Remove crossmember-to-frame bracket attaching bolts and remove crossmember and rear engine support.

(13) Remove the engine front support mounting bolts. (Refer to Fig. 9.)

(14) Raise engine and, at the same time, work engine out of chassis toward the left front fender.

(15) Lower engine to floor, brace engine with suitable blocks, and remove the transmission. Mount the engine in repair stand, Tool C-888 (Fig. 10). With the use of the repair stand the engine can be rotated 360 degrees to any convenient working position.

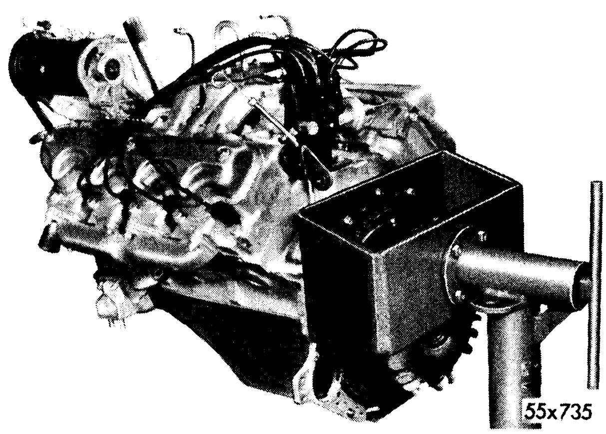

Fig. 10—Engine Mounted In Stand

5. ENGINE DISASSEMBLY

NOTE

In addition to the service procedure furnished for a complete engine overhaul, procedures will be included for servicing of components which can be performed without removal of engine. These procedures will be found immediately after procedure concerning a complete engine overhaul.

(1) Drain the lubricating oil from the crankcase (if not previously drained).

(2) Remove the generator adjusting strap bolt, and tilt the generator inward to disengage the generator belt. Loosen the idler pulley adjustment bolt and pivot the pulley inward to disengage the belt. Remove the bolt holding the generator to the intake manifold pad and the two bolts holding the generator bracket to the front of the water pump housing. Lift generator up and away from engine. Remove the bolt holding the adjusting strap to the engine. Remove strap.

(3) Disconnect and remove the fuel line between the carburetor and the fuel pump.

(4) Disconnect and remove the vacuum spark advance control tube between the carburetor and distributor.

(5) Disconnect and remove the heat tube between the automatic choke and exhaust manifold.

(6) Remove the water outlet connector and lift the thermostat out of the water pump housing. Discard the gasket.

(7) Remove the nuts attaching the carburetor to the intake manifold, then lift carburetor up and away from the engine. (This step is necessary only if any other tool except Tool C-3466 engine lifter is used.)

(8) Disconnect the primary lead wire from the ignition coil. Disengage the cables from the spark plugs and remove cables and distributor cap from the engine.

(9) Remove the crankcase ventilator outlet pipe attaching bolt and the clip bolt at the housing. Lift pipe and filter up and away from engine.

(10) Disconnect the secondary lead from the ignition coil then remove the distributor clamp bolt. Lift distributor straight up and away from engine. Remove the oil seal ring. Disconnect and remove the oil pressure gauge tube.

(11) Remove the bolts and lockwashers holding the intake manifold to the cylinder heads. Lift intake manifold and ignition coil up and away from engine. Discard the gaskets.

(12) Use a thinwall socket, or Tool C-3054, and remove the spark plugs and gaskets. Discard the gaskets.

(13) Remove the nuts that hold the exhaust manifolds to the cylinder heads. Pull manifolds out and away from the cylinder heads. Discard the gaskets.

(14) Remove the bolts and lockwashers that hold the fan blades and pulley to the water pump hub. Slide blades and pulley off hub and away from engine.

(15) Remove the bolts and lockwashers that attach the fuel pump to the chain case cover. Pull the fuel pump straight out and away from engine. Discard the gasket.

(16) Remove the bolts and lockwashers that hold the water pump housing to the block and cylinder heads. Pull housing away from the engine. Discard the gaskets.

(17) Remove the bolts, flatwashers, and insulating washers that hold the rocker covers to the cylinder heads. Lift covers up and away from the engine. Discard the gaskets.

(18) Remove bolts and flatwashers that hold the rocker shafts and heads to cylinder block. Lift rocker shaft and arms straight up and away from heads. Remove push rods and place in their respective slots in holder, Tool C-3068.

(19) Remove the remaining bolts on each bank that hold the cylinder heads to the block. Lift the cylinder heads up and away from the block. Immediately attach the cylinder head fixture, Tool C-3209, as shown in Figure 60. This will prevent damage to the machined head surface.

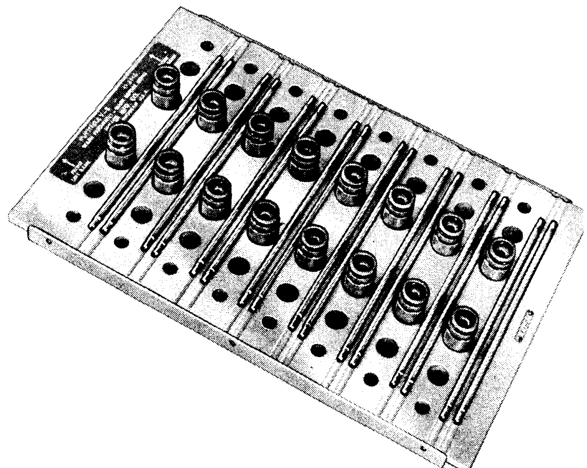
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Fig. 11—Tappets and Push Rods In Holder

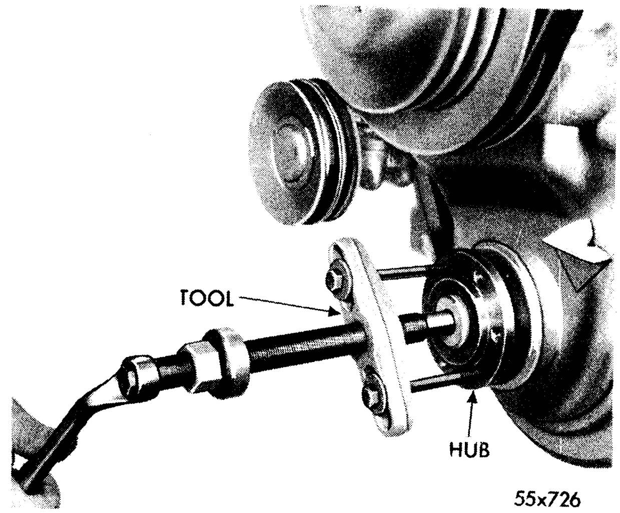

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Fig. 13—Removing Hub From Crankshaft

(20) Remove the bolts and lockwashers that hold the tappet chamber cover to the cylinder block. Lift cover up and away from the engine. Discard the gasket.

(21) Slide the hydraulic tappets out of the bores and place in their respective holes in the tappet and push rod holder, Tool C-3068, as shown in Figure 11. This will insure their being installed in their original locations. If tappets stick in bores due to a build-up of varnish and carbon around the tappet body (after high mileage), slowly withdraw tappet with a sharp twisting motion, using Tool C-3216, as shown in Figure 12. The sharp edge at the bottom of tappet bore will shave the varnish and carbon deposit off tappet as it is withdrawn.

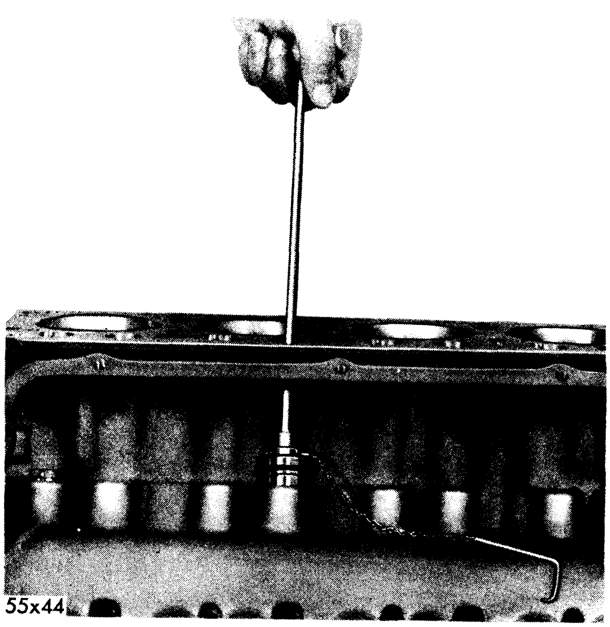
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Fig. 12—Removing Tappet Body From Bore

(22) Remove the distributor drive gear and stub shaft by inserting the nose of Tool C-484 into the gear slot. Compress the pliers and withdraw the gear and shaft, using a clockwise motion to unmesh the spiral gear.

(23) Remove the pulley and damper from hub. Install Tool C-3033, as shown in Figure 13, to remove the hub from end of crankshaft.

Before removing the piston and rod assemblies, remove the top ridge of bore (if present) with a reliable ridge reamer, or Tool C-3012. Be sure and keep the tops of the pistons covered during this operation.

(24) Remove the bolts and lockwashers that attach the oil pan to the crankcase. Lift oil pan straight up and away from engine. Discard the gaskets and seals.

(25) Remove the oil filter as follows: Loosen the filter center bolt and lift off the filter cover (shell). Remove the element. This will expose the filter base mounting bolts. Remove the bolts and lockwashers that hold the filter base to the cylinder block mounting pad. Lift the filter base out and away from block. Discard the gasket.

(26) Remove the bolts and lockwashers which hold the oil pump to the rear main bearing

cap. Pull pump and strainer up and away from cap with a slight twisting motion. Discard the oil seal ring.

NOTE

When removing piston and connecting rod assemblies from engine, rotate the crankshaft so that piston is at bottom dead center, then proceed as follows:

(27) Remove the nuts that hold the bearing cap to the connecting rod. Remove cap and bearing shell, then install Tool C-3221 on one connecting rod bolt and the protector over the other. Push piston and rod assembly out of the cylinder bore.

Repeat this operation for each piston and rod assembly. After removal, install bearing cap to mating rod.

(28) Remove the bolts and lockwashers that hold the chain case cover to the cylinder block. Work the cover off the locating dowels and away from engine. Discard the gasket.

(29) Slide the crankshaft oil slinger off end of crankshaft, then remove the camshaft sprocket hub nut and fuel eccentric. Pull camshaft sprocket off shaft and, at the same time, disengage and remove the timing chain.

(30) Loosen and remove the bolts holding the main bearing caps to block. Hit the caps lightly with a plastic hammer to loosen,

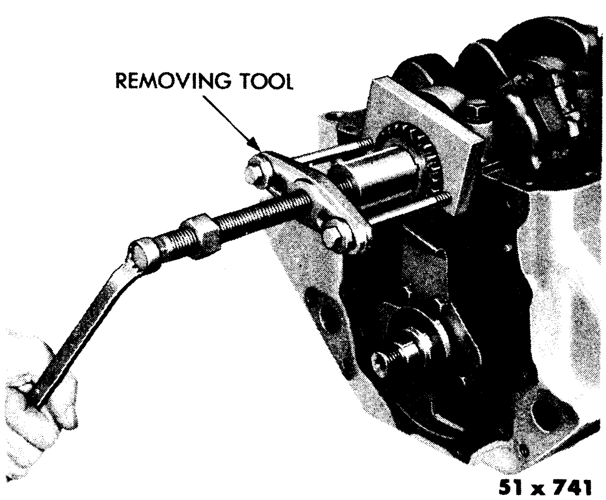


Fig. 14—Removing Crankshaft Timing Gear

and lift off the main bearing caps and lower bearing shells.

If necessary to remove the crankshaft timing gear, install Tool C-3033, as shown in Figure 14, and pull gear from end of crankshaft. Remove the key.

(31) Form a heavy rope sling and wrap around the Number Seven and Eight connecting rod bearing journals and hoist the crankshaft and torque converter, or clutch, straight up and away from the cylinder block. Remove the upper main bearing shells and the rear main bearing upper seal.

(32) Remove the bolts that hold the camshaft and thrust plate to the cylinder block. Lift off the timing chain oil trough..

(33) Ease the camshaft and thrust plate out of cylinder block, being careful not to damage the bearing shells.

(34) Remove the cylinder block from stand.

(35) Use a suitable tool to drive out the rear cam bearing welch plug, and remove the two main oil gallery plugs.

(36) Install the proper size adapters and horseshoes (part of Tool C-3034) at the back of each cam bearing shell to be removed, and remove camshaft bearings.

6. CYLINDER BLOCK

a. Cleaning

Whenever the engine is to be completely overhauled and the cylinder block is stripped, the block should be thoroughly cleaned and inspected for any condition that might render it unfit for further service.

Live steam or a suitable degreasing tank should be used. After cleaning a cylinder block, be sure and blow out all passages thoroughly with compressed air.

b. Inspection

Pay particular attention to the various core hole plugs and replace, if necessary. When installing new core hole plugs, coat the edges of plug and core hole with a suitable sealer; then drive in place, using Tool C-897, as shown in Figure 15.

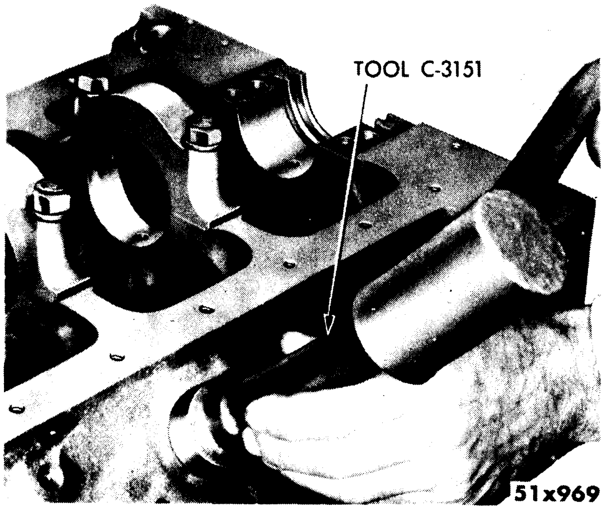


Fig. 15—Installing Cylinder Block Core Hole Plugs (Typical)

Examine the cleaned block for minute cracks or fractures and all machined surfaces for burrs or scoring.

Check the tappet bores for badly scored surfaces, if the tappet or bore is badly scored, scuffed, or shows signs of sticking, ream the bore to the next oversize, using Tool C-3028, as shown in Figure 16, and install a new tappet. Tappets are available in standard and the following oversizes: .001, .008, and .030 inch.

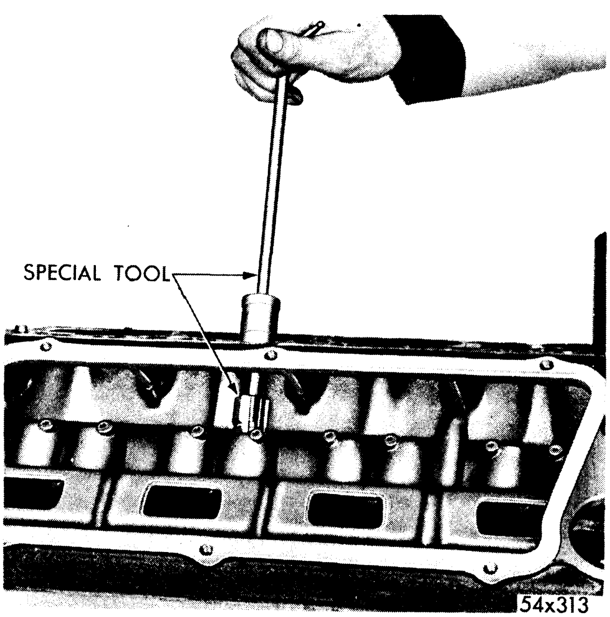


Fig. 16—Reaming Tappet Bores (Typical)

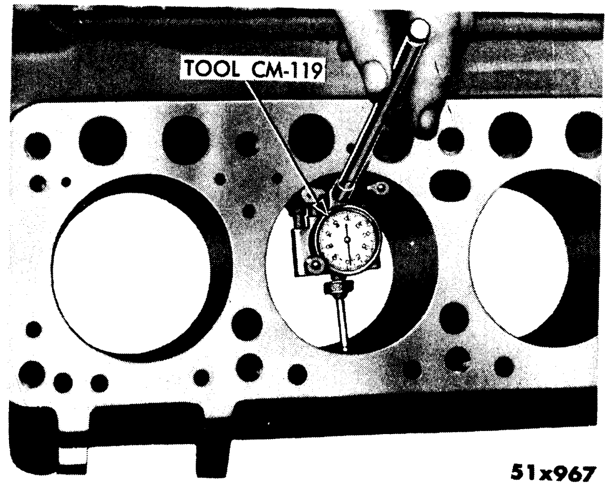


Fig. 17—Checking Cylinder Bores For Out-Of-Round or Taper

NOTE

A diamond mark on engine serial number pad indicates .008 inch oversize tappet bores.

c. Checking Cylinder Bores

The cylinder bores should be checked for out-of-round and taper, using Tool CM-119, as shown

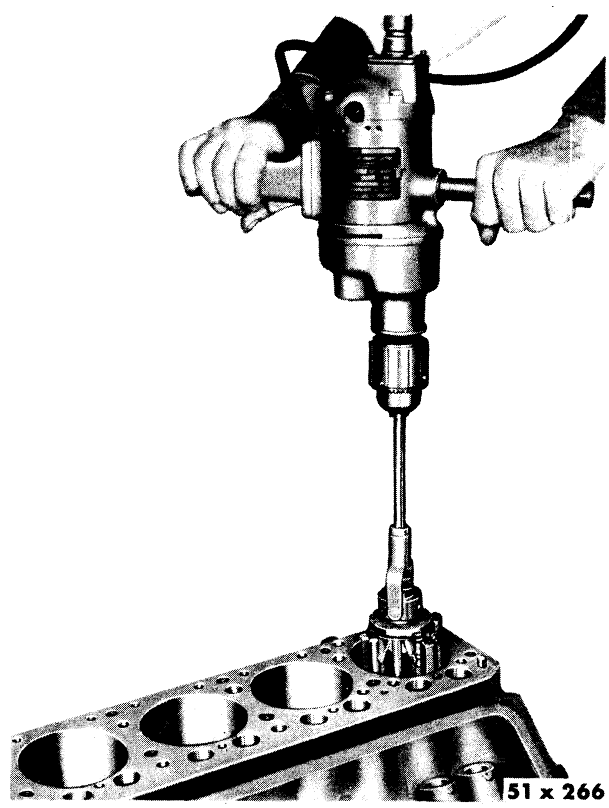


Fig. 18—Honing Cylinder Bores

in Figure 17. Check each bore at top, bottom, crosswise, and lengthwise to determine what variation exists.

If the 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.

d. Honing Cylinder Bores

To remove light scoring, scuffing, or scratches from the cylinder walls, use Tool C-823, as shown in Figure 18. Usually one or two "passes" will clean up a bore and still maintain required limits. After honing, remove all traces of abrasives. The hone may safely be used for removal of metal from .010 to .015 inch by an experienced operator.

e. Reboring Cylinder Bores

Cylinder walls which are badly scored, scuffed, scratched, or worn beyond the specified limits should be rebored. Boring Bar, Tool 377-S, as shown in Figure 19, contains a special feature for setting the cutter under positive control.

Whatever type of boring equipment is used, the boring operation should be closely co-ordinated with the fitting of pistons and rings, in order that specifications may be maintained.

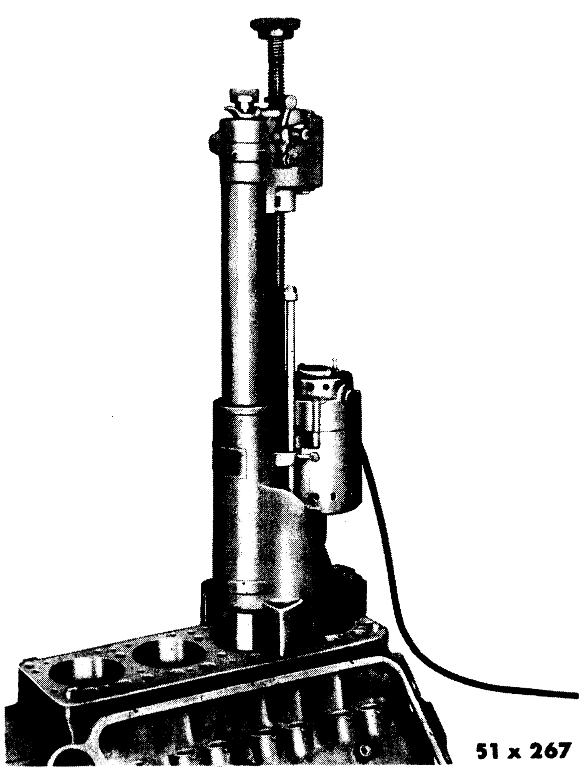


Fig. 19—Boring The Cylinders With Tool 377-S

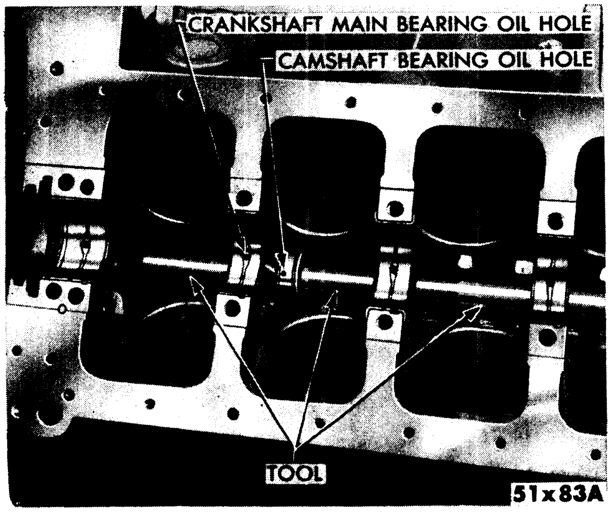


Fig. 20—Installing Camshaft Bearing Shells

7. CAMSHAFT AND CAMSHAFT BEARING SHELL INSTALLATION

(1) Coat a new welch plug with a suitable sealer and install in the cylinder block at the rear cam bearing, using Tool C-897. Coat the main oil gallery plugs with sealer, then install in the block. Tighten securely.

(2) Mount the cylinder block in the repair stand. Install the new camshaft bearing shells as follows: Slide new bearing shell over adaptor and insert in position, as shown in Figure 20. Install the horseshoe lock and drive in place. Install the remaining bearing shells in like manner.

NOTE

Be sure the oil holes in the cam bearing shell and cylinder block are in exact alignment. Check each bearing shell by inserting pencil flashlight in shell. The complete circumference of the camshaft bearing oil hole should be visible by looking through the main bearing drilled oil passage. If camshaft bearing oil hole is not in exact alignment, remove bearing shell and reinstall.

The above information is particularly important when installing the Number Two and Four camshaft bearing shells, as the lubrication of the valve operating mechanism depends on correct alignment of these two shells.

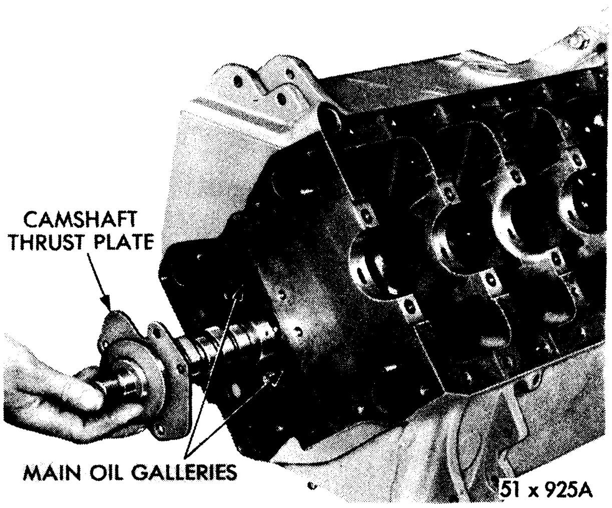


Fig. 21—Installing The Camshaft (Typical)

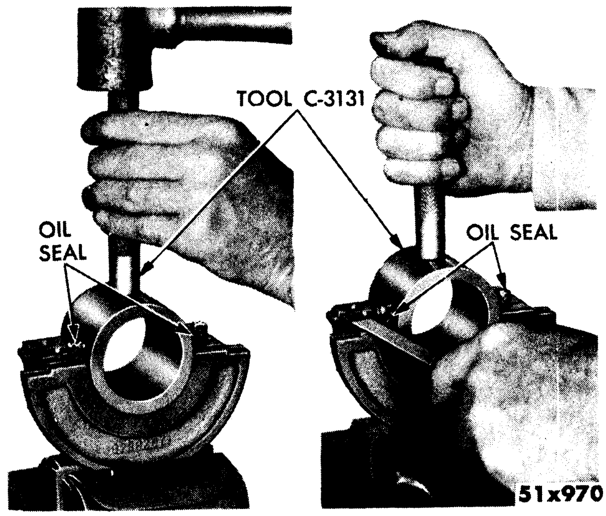


Fig. 23—Installing Rear Main Bearing Oil Seal

(3) Install the camshaft thrust plate on camshaft (if removed), insert key and press on the hub. Insert feeler gauge between hub and thrust plate to check for correct clearance. The clearance should be from .002 to .006 inch.

(4) Lubricate all camshaft bearings. Install camshaft and thrust plate, as shown in Figure 21. Place the oil trough in position and install bolts and lockwashers. Tighten bolts to 15 foot-pounds torque (See Fig. 22). Do not allow the camshaft lobes to ride on bearings when installing the camshaft, as damage to the bearings will result.

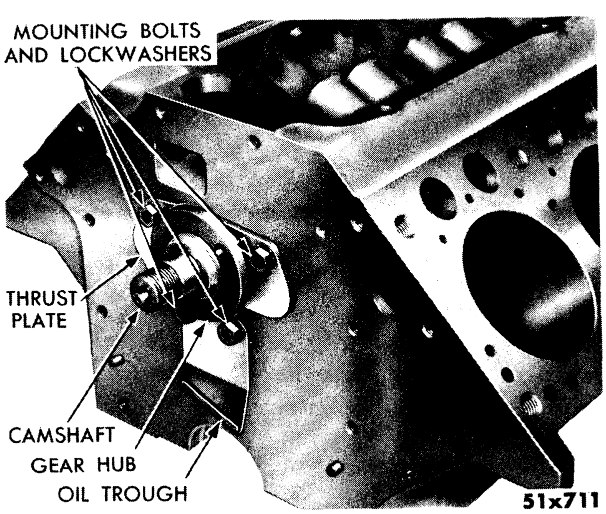


Fig. 22—Camshaft Thrust Plate and Gear Hub Installed

8. REAR MAIN BEARING OIL SEAL INSTALLATION

(1) Install a new rear main bearing oil seal in the block so that both ends protrude. Tap the seal down into position, with Tool C-3131, until tool is seated in the bearing bore. Hold the tool in this position, then cut off the portion of the seal that extends above the block on both sides.

(2) Install a new seal in bearing cap (bearing shell removed) so that the ends protrude. Tap seal down into position with Tool C-3131, as shown in Figure 23, until tool is seated. Trim off the portion of the seal that protrudes above cap, as shown in Figure 23. Install the two cap side seals in the grooves in the 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.

9. MAIN BEARINGS

The halves of Numbers One, Two, and Four bearings are interchangeable with one another. (The caps are not interchangeable and extreme care should be used in replacing them in their correct position.) Number Three bearing, which controls the crankshaft end thrust is not interchangeable with the others. However, the upper and lower halves of Number Three bearing are interchangeable with each other. Number Five bearing halves are not interchangeable.

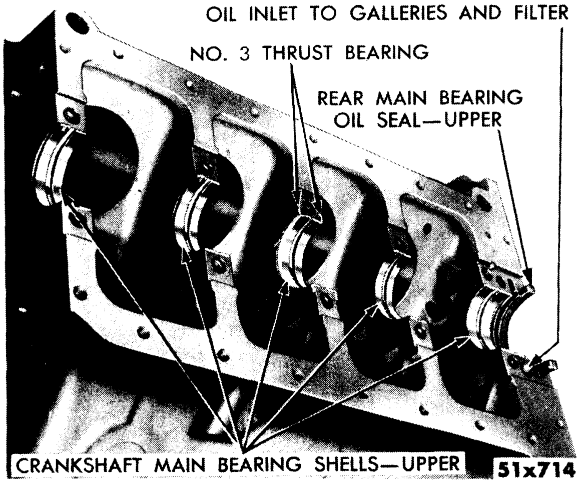


Fig. 24—Main Bearing Shells Installed—Upper

Bearing shells are available in .001, .002, .003, .010, and .012 inch undersizes.

The desired main bearing clearance is .0005 to .0015 inch. To determine if the clearance is within these limits, proceed as follows:

a. Installation

(1) Check each bearing shell carefully for a scored, chipped, or etched condition. Replace damaged bearing shells, as shown in Figure 24.

(2) Lubricate all bearing shells with engine oil, then carefully lower crankshaft and clutch, or torque converter (if so equipped), directly down on the bearing shells. The crankshaft should be lowered evenly and square with block to prevent damage to the bearings.

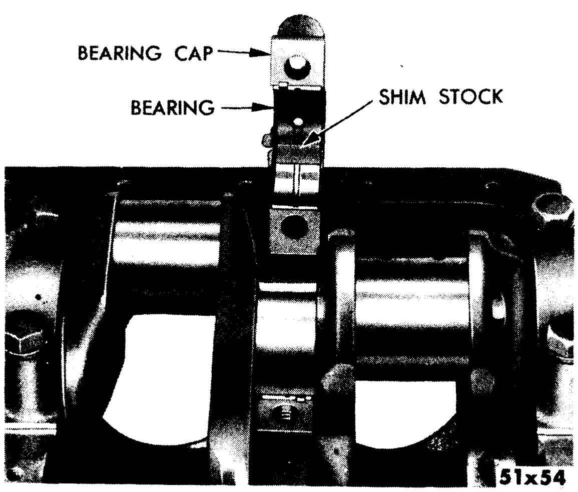


Fig. 25—Checking Main Bearing Clearance With Shim Stock

b. Checking Clearance

(1) Install the bearing shell in the cap. Start at the center main bearing; place a piece of oiled .001 inch feeler stock (1/2 inch wide and 1 inch long) between bearing and crankshaft journal, as shown in Figure 25. Install the bolts and lockwashers. Tighten bearing cap bolts to 85 foot-pounds torque.

If a slight drag is felt as the crankshaft is rotated, the clearance is .001 inch or less and is considered satisfactory. If no drag is felt, or the crankshaft cannot be rotated, the bearing should be replaced with the correct size. Fit the remaining bearings in like manner.

(2) At the final tightening of main bearings (after all bearings have been fitted), tighten the Number Three center main bearing thrust first, then work alternately to the ends.

(3) Check the crankshaft end play with a dial indicator. The end play should be .002 to .007 inch.

10. TIMING GEAR AND CHAIN

a. Installation

(1) Insert the crankshaft timing gear key in slot and install gear with the timing mark out. Press on shaft, using Tool C-3033, as shown in Figure 26.

(2) Rotate the crankshaft until the mark on the timing gear is exactly in line with the center

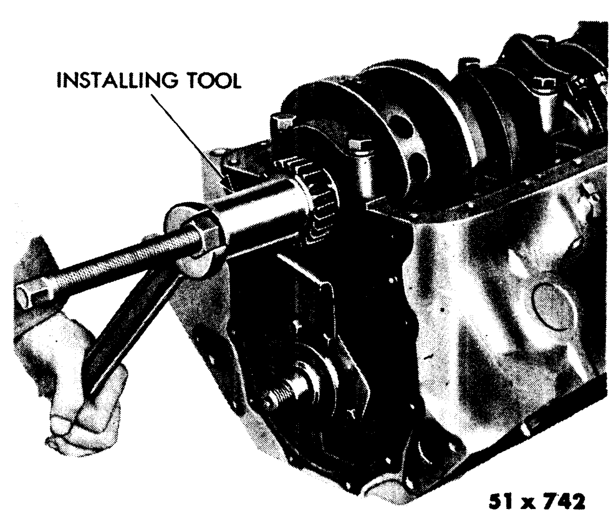


Fig. 26—Installing Crankshaft Timing Gear

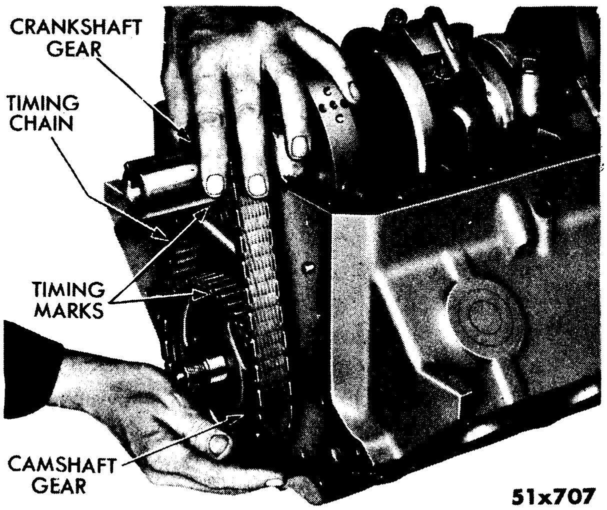


Fig. 28—Installing Timing Chain and Gear

of the camshaft. Temporarily install the camshaft gear (less chain) and line up the dowel pin holes in the hub and the gear, while at the same time, positioning the camshaft gear mark exactly in line with the center of the crankshaft (See Fig. 27). A straightedge should be used to check the accuracy of this alignment.

(3) Remove the camshaft gear and engage with timing chain. Place timing chain over crankshaft gear and, at the same time, slide the camshaft gear over the end of camshaft, keeping the timing mark in position, as shown in Figure 28.

b. Checking Chain For Stretch

Place a scale across the top of camshaft gear

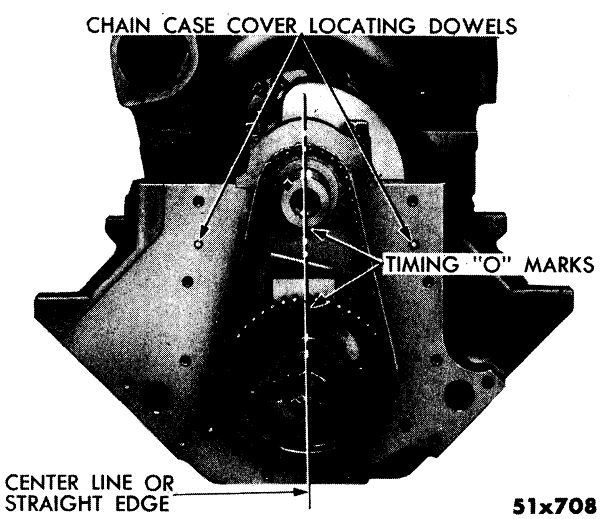


Fig. 27—Timing Marks on Camshaft and Crankshaft Gears

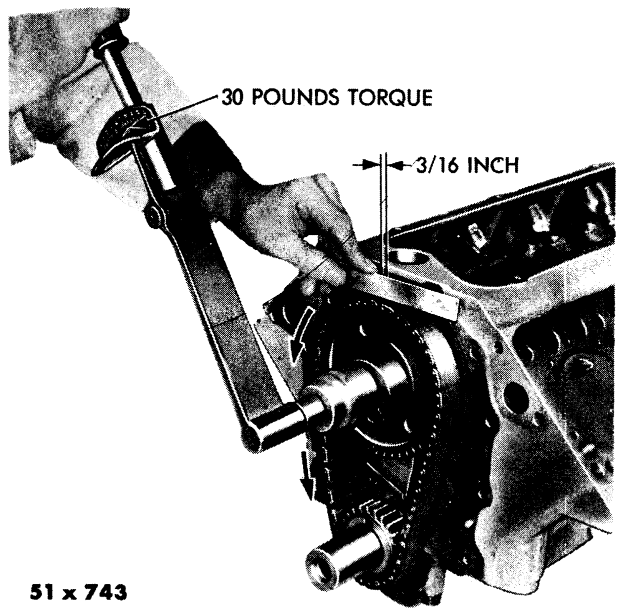


Fig. 29—Measuring Timing Chain Stretch

(chain installed), with the dimensional edge close to the chain; then proceed as follows:

(1) Place a 1¼ inch socket over the camshaft gear nut and attach a torque wrench to the socket.

(2) Apply 30 foot-pounds of torque in the direction of crankshaft rotation to take up slack. Holding the scale with the dimensional reading even with the edge, or a chain link, apply 30 foot-pounds of torque in the reverse direction and note the amount of chain rotation (See Fig. 29). If the movement of the chain is greater than 3/16 inch, as indicated by the stationary scale, install a new timing chain.

NOTE

With 30 foot-pounds of torque applied to the camshaft gear nut, the crankshaft should not move. However, if there is any movement the crankshaft should be blocked to prevent rotation.

(3) With the timing marks aligned, push gear on camshaft and install the fuel pump eccentric, as shown in Figure 30. Install nut and tighten to 125 foot-pounds torque.

(4) Slide the crankshaft oil slinger over shaft and up against gear (flange away from gear).

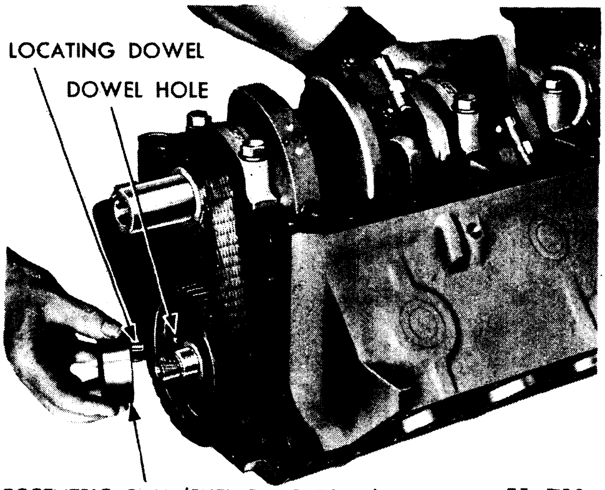


Fig. 30—Installing Fuel Pump Eccentric

11. TIMING CHAIN CASE COVER INSTALLATION

Use Tool C-3050 to drive out the oil seal from the front of the chain case cover, then lift out the gasket. Place a new gasket in position and position a new seal with the protecting flange of the seal facing the inside of cover. Drive the seal into position, using Tool C-3051, as shown in Figure 31.

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

(2) Slide chain case cover over locating dowels and, using a soft hammer, tap cover in place. Install bolts and washers after coating with a suitable sealer. (See Fig. 32). Tighten bolts to 15 foot-pounds torque.

12. PISTONS, PINS, AND RINGS

a. Fitting Pistons

New pistons (if required) should be fitted to the cylinder bore with the greatest accuracy and care. The recommended clearance between the thrust face of piston and cylinder wall is .0005 to .0015 inch, measured with a micrometer and dial indicator. The clearance can also be checked with a .0015 inch feeler stock (½ inch wide) on spring scale, Tool C-690, as follows:

(1) Starting with the Number One cylinder, coat the bore very lightly with SAE 10W engine oil. Insert the piston in the bore, upside down, with the feeler stock between the piston (thrust face) and the cylinder wall.

(2) Holding the piston, draw the feeler stock out straight with the spring scale, as shown in Figure 33. The amount of pull necessary to withdraw feeler stock should be from 5 to 10 pounds.

(3) Fit remaining pistons in like manner.

Due to the necessity of maintaining piston balance, all pistons are machined to the same weight in grams, regardless of oversizes. Only finished pistons are available for service and are supplied in standard and the following oversizes: .005, .020, .030, .040, and .060 inch.

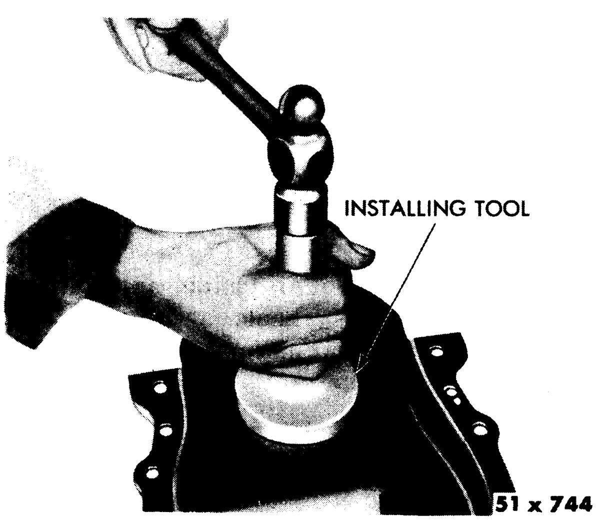
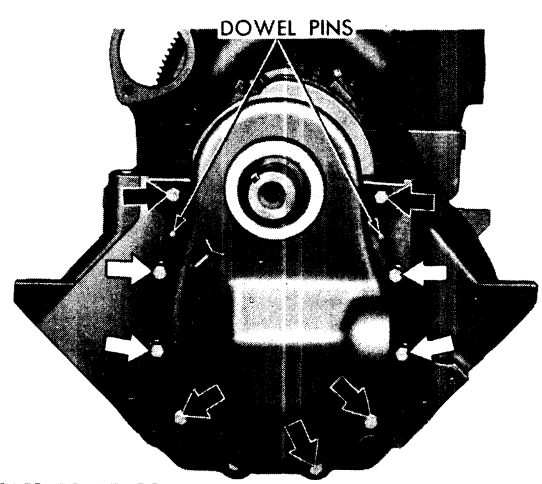


Fig. 31—Installing Chain Case Cover Oil Seal (Typical)



⇦BOLTS TO BE COATED WITH SUITABLE SEALER FOR WATER
⬅BOLTS TO BE COATED WITH SUITABLE SEALER FOR OIL
51x709

Fig. 32—Chain Case Cover Installed

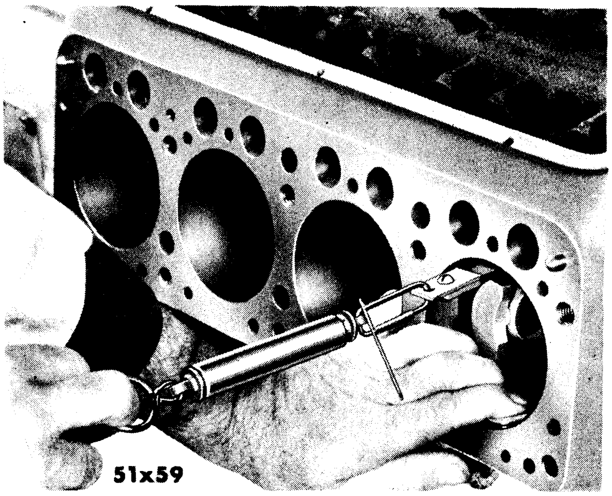


Fig. 33—Fitting Pistons to the Cylinder Bore

When selecting pistons for installation (new) be sure to secure pistons for the SpitFire V-8 engine. The FirePower V-8 engine pistons are not interchangeable with the SpitFire V-8 engine.

b. Fitting Rings

(1) Measure the piston ring gap about 2 inches from the top of the cylinder bore, to which it is to be fitted. (An inverted piston can be used to push the rings down into position.) This will insure the rings being exactly square with the cylinder wall before measuring.

(2) Insert feeler stock in gap and take measurement, as shown in Figure 34. The ring gap should be between .010 and .020 inch. This measurement is constant for all rings.

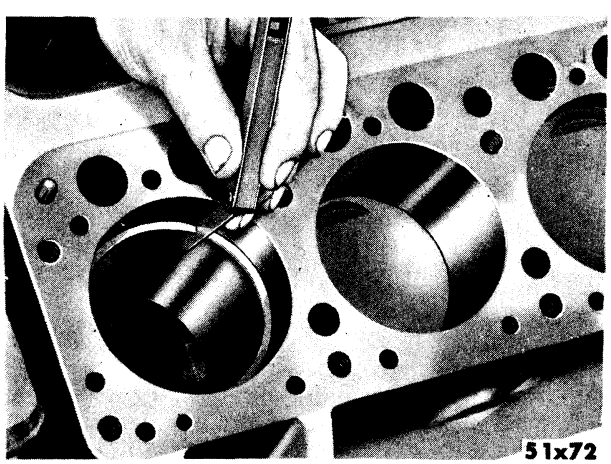


Fig. 34—Checking Ring Gaps In Bore

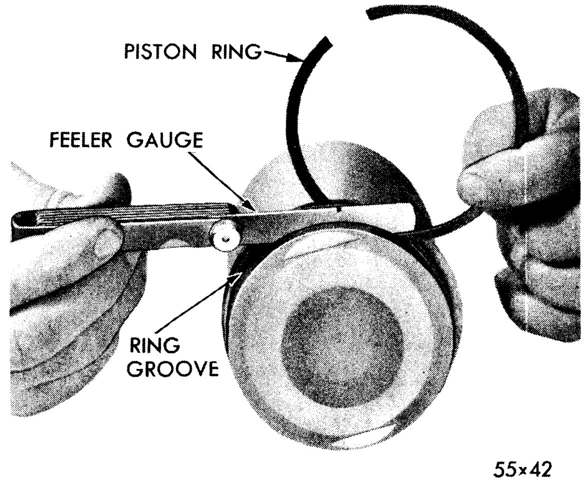


Fig. 35—Checking Piston Ring Groove Clearance

(3) Measure the clearance between piston ring and ring groove, as shown in Figure 35. This clearance should be .0015 to .003 inch for the top compression, .0010 to .0025 inch for the intermediate ring, and .001 to .003 inch for the oil control ring.

After the clearances have been checked on all rings, install rings on pistons.

(4) Start with the oil ring expander; place expander ring in lower ring groove. Install oil control ring and compression rings, using Tool C-469, as shown in Figure 36 and Figure 37.

NOTE

The oil ring must be installed with gap toward the "V" of the engine.

c. Fitting Pins

(1) Test piston pin fit in the connecting rod, as shown in Figure 38. This should be a tight thumb-press fit at normal room temperature.

(2) Test piston pin fit in piston, as shown in Figure 39. This should also be a tight thumb-press fit at normal room temperature.

Piston pins are supplied in standard and the following oversizes: .003 and .008 inch.

When using expansion reamer, Tool C-3200, to fit piston pins, shown in Figure 40, be careful and take a very light cut. Ream and try fit—

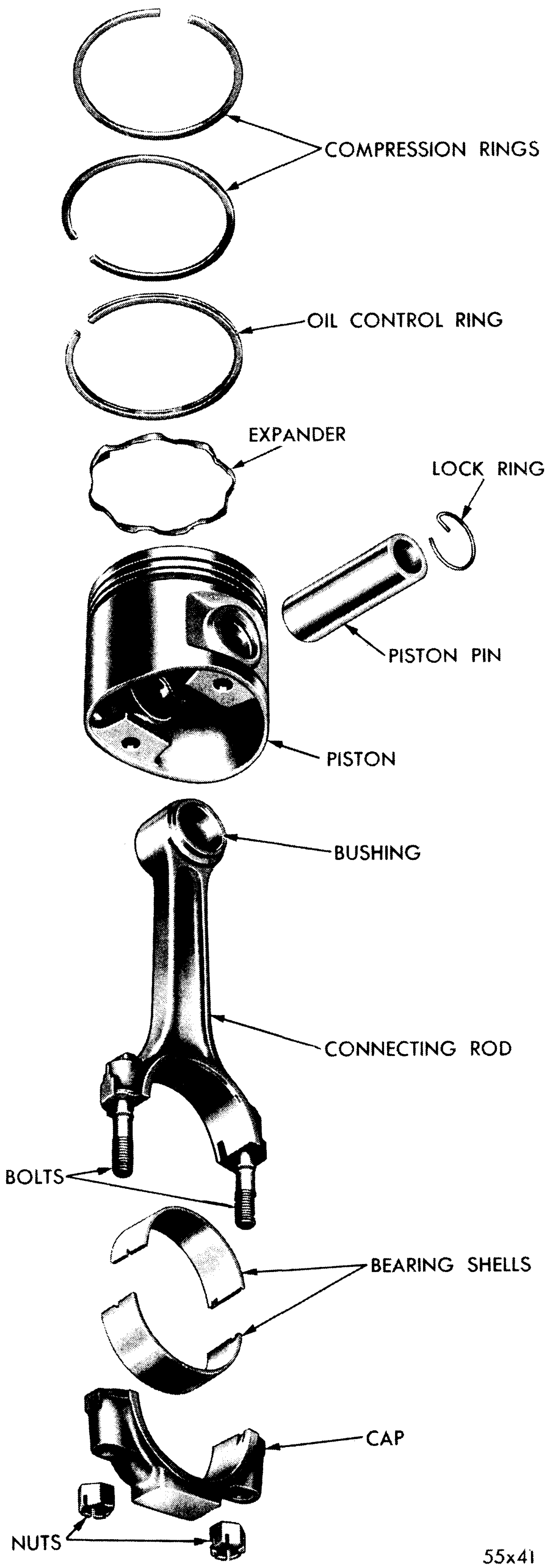


Fig. 36—Piston and Rod Assembly (Disassembled View)

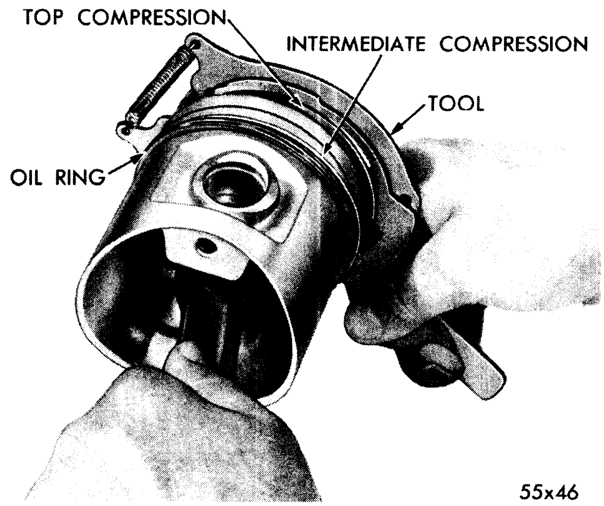


Fig. 37—Installing Rings on Piston

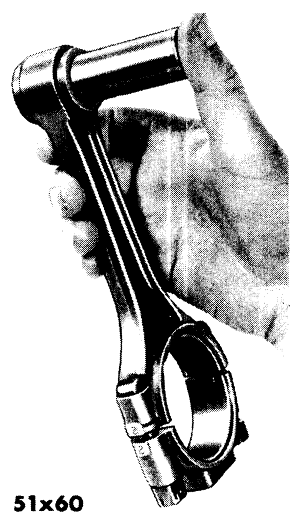


Fig. 38—Fitting Piston Pin In Connecting Rod

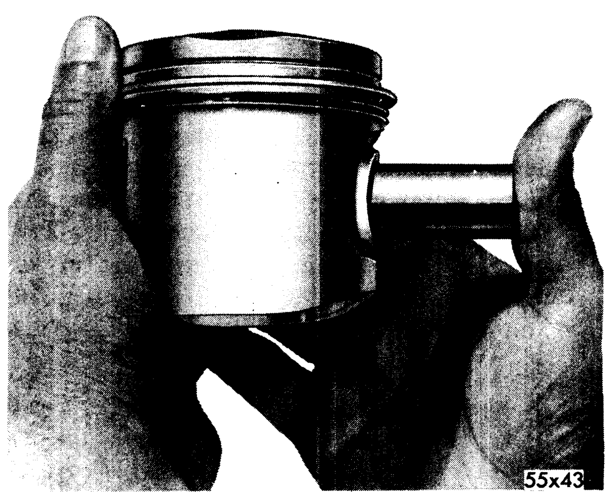


Fig. 39—Fitting Piston Pin In Piston

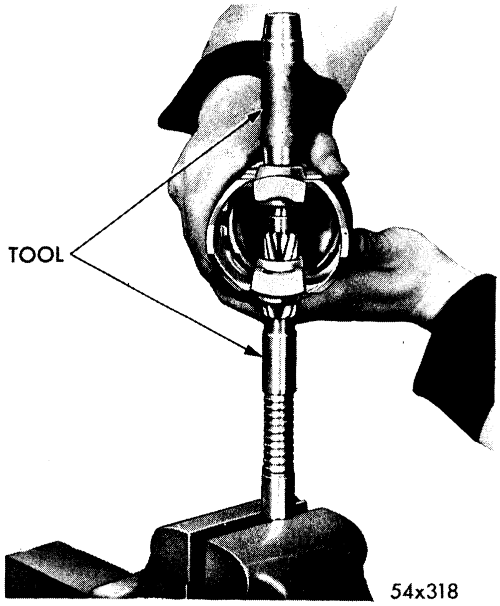


Fig. 40—Reaming Piston With Tool C-3200

ream and try again, until piston pin can be pushed into the piston or connecting rod as described above.

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

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

13. CONNECTING RODS

a. Checking Rod Alignment

(1) Check for Bend—Install the connecting rod and piston, as shown in Figure 41. The top of the piston should be flush with the tool. The clearance between the piston and tool, at the point shown in "A," should be zero (0); however, a .002 inch variation is allowable. If more than .002 inch, the piston and connecting rod should be disassembled and the rod straightened or replaced. (See Fig. 42).

(2) Check for Twist—With the connecting rod and piston assembly installed in fixture C-481, tilt the piston, as shown in Figure 41 "B." The clearance between the tool and the top of piston should be zero (0). However,

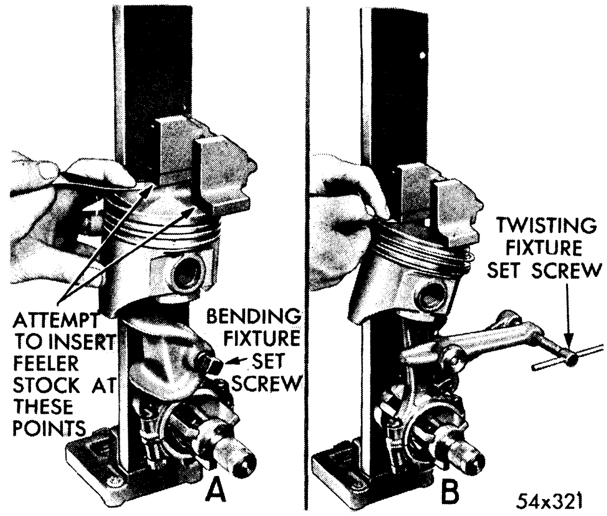


Fig. 41—Checking Connecting Rod and Piston For Alignment (Typical)

.002 inch variation is allowable. If more than .002 inch, the piston and connecting rod should be disassembled and the rod checked as outlined in the preceding paragraph.

b. Installing Bearings

The method of fitting connecting rods, as described, is accomplished without inserting the piston and rod in the cylinder bore, thereby eliminating any possible drag that might be caused between the piston and the cylinder wall.

NOTE

Fit all the rods of one bank until completed. Do not alternate from one bank to another, because

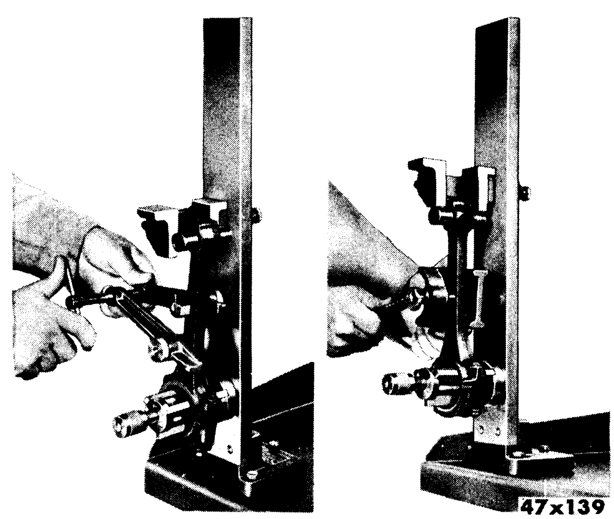


Fig. 42—Correcting Connecting Rod For Bend or Twist

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 the "v"-groove in the shell is in line with the "v"-groove in the cap. This allows lubrication of the cylinder wall. The bearing shells should always be installed so that the small formed tang fits into the machined grooves of the rods.

Limits on the taper or out-of-round on any crankshaft journal should be held to .001 inch. Undersize bearings should be installed if the crankshaft journals are worn enough to increase the bearing clearance above specifications.

c. Checking Clearance

The desired connecting rod bearing shell clearance is from .0005 to .0015 inch, with a side play of .006 to .014 inch, and may be checked as follows:

(1) Place a piece of oiled .001 inch feeler stock (1/2 inch wide and 3/4 inch long) between the bearing shell and crankshaft journal. Install the bearing cap and tighten the nuts to 45 foot-pounds torque.

(2) Move the connecting rod and piston from side to side, as shown in Figure 43. A slight drag should be felt as the rod is moved. This will indicate that the clearance is .001 inch or less, which is satisfactory. If the con-

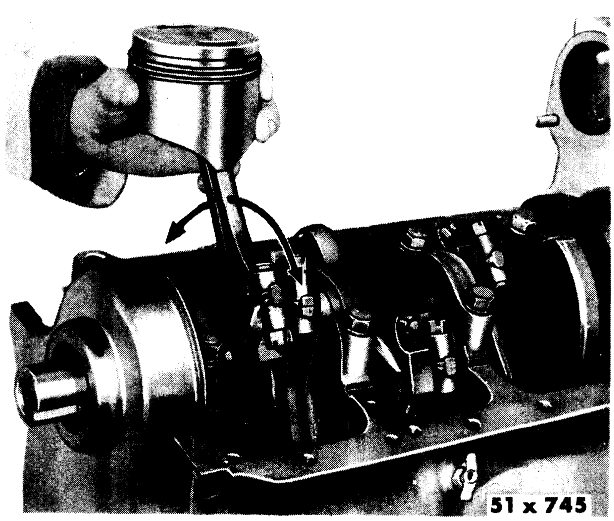


Fig. 43—Checking Connecting Rod Bearing Clearance (Typical)

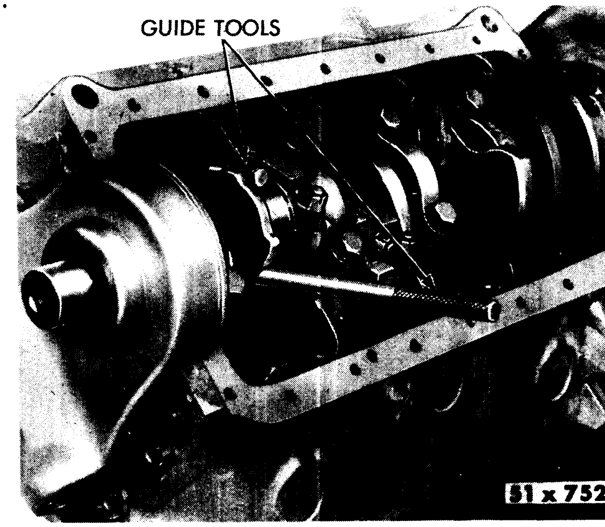


Fig. 44—Guiding Connecting Rod Over Crankshaft (Typical)

necting rod is difficult to move, the bearing shell is too small and should be replaced with the correct size. Fit remaining connecting rod bearing shells in like manner.

d. Installing Piston and Connecting Rod Assembly in Cylinder Block

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

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

(2) Screw the connecting rod bolt protector (part of Tool C-3221) on one rod bolt, then insert rod and piston into cylinder bore. Attach the puller part of Tool C-3221 on the other bolt, then guide the rod over the crankshaft journal, as shown in Figure 44.

(3) Tap the piston down in the cylinder bore, using the handle of a hammer, as shown in Figure 45, and at the same time, guide the connecting rod into position on the crankshaft journal. The marking on the top of the piston must be pointing toward the front of engine. As a double check; the

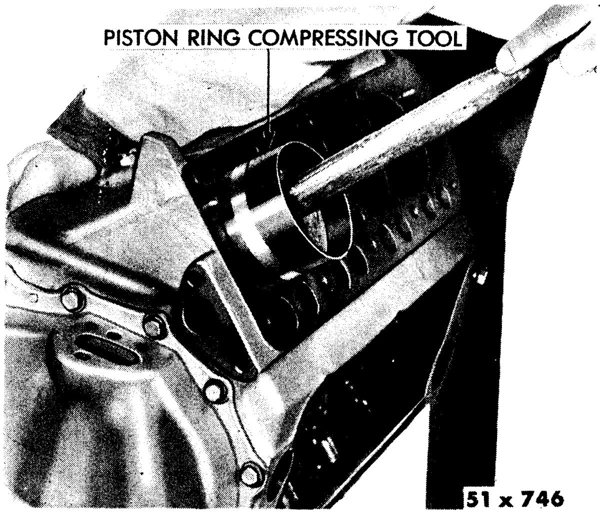


Fig. 45—Installing Connecting Rod Piston and Rings (Typical)

larger chamfer of the connecting rod bore must be installed toward the crankshaft journal fillet.

(4) Install the bearing caps and nuts. Tighten nuts to 45 foot-pounds torque.

14. OIL PUMP

a. Disassembly

Refer to Figure 46, and proceed as follows:

(1) Remove the cotter pin holding the oil strainer to the oil pump suction pipe and remove suction pipe from the oil pump body.

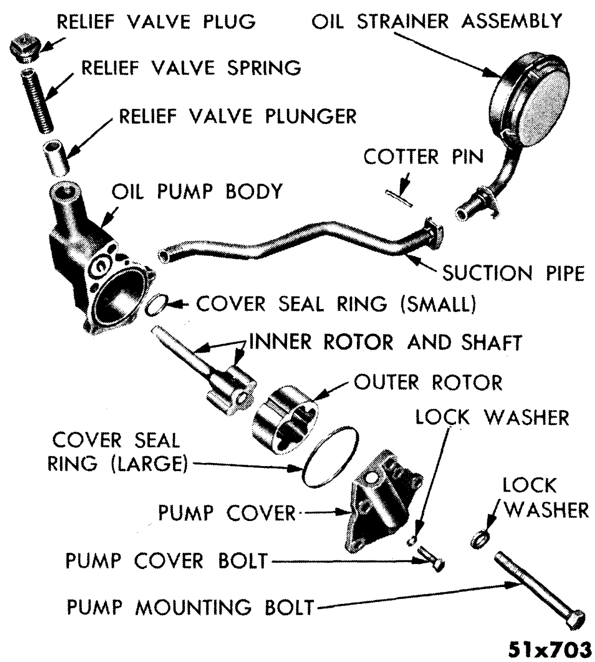


Fig. 46—Oil Pump (Disassembled View)

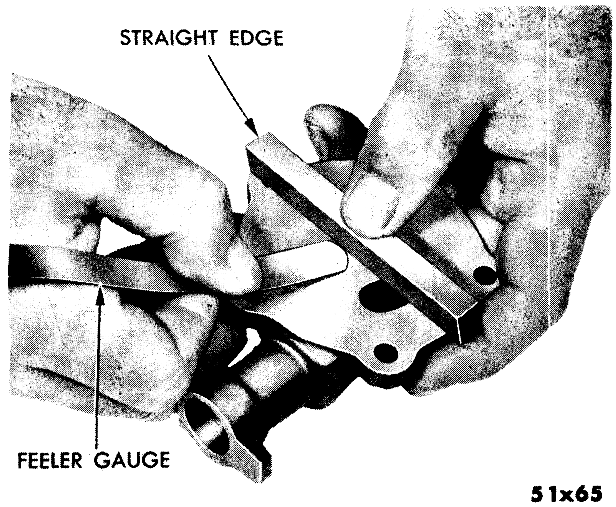


Fig. 47—Checking Oil Pump Cover

(2) Remove the oil pump cover bolts and lockwashers and lift off the cover. Discard the oil seal ring.

(3) Remove the pump rotor and shaft, then lift out the pump rotor body.

(4) Remove the oil pressure relief valve plug, and lift out the spring and plunger.

Wash all parts in a suitable solvent, then inspect for damage or wear.

b. Inspection and Repair

(1) The mating face of the oil pump cover should be smooth. If the cover is scratched or grooved, replace cover.

(2) Check for excessive cover to rotor wear, by laying a straightedge across the cover sur-

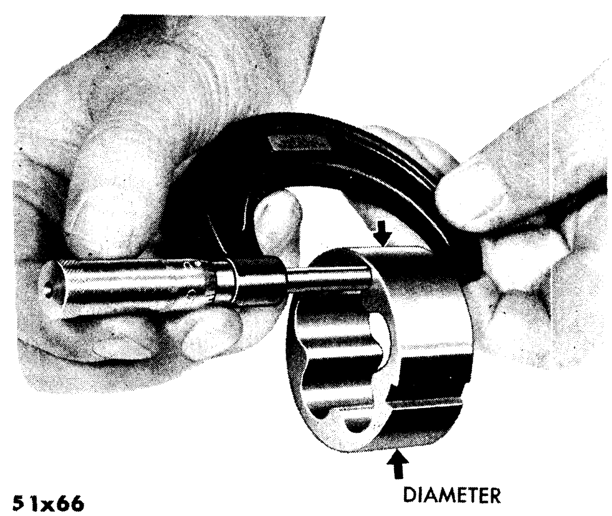


Fig. 48—Measuring the Thickness of Rotor Body

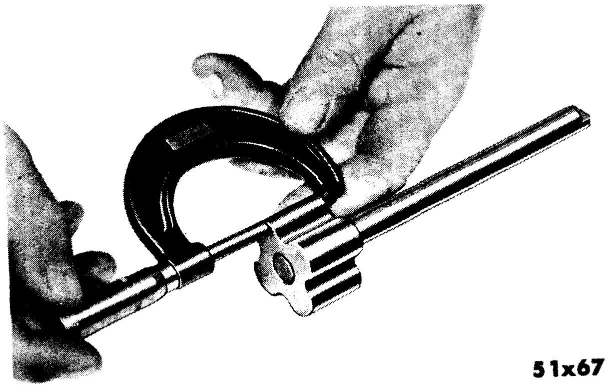


Fig. 49—Measuring the Thickness of Pump Rotor

face, as shown in Figure 47. If a .0015 inch feeler gauge can be inserted between cover and straightedge, the cover should be replaced.

(3) Measure the diameter and thickness of the rotor body, as shown in Figure 48. If the rotor body measures less than .998 inch and the diameter less than 2.244 inches, replace rotor body.

(4) Measure the thickness of the pump rotor, as shown in Figure 49. If the pump rotor measures less than .998 inch, a new pump rotor should be installed. Slide the rotor body and rotor into pump body and then place a straightedge across the face (between bolt holes), as shown in Figure 50. If a feeler gauge of more than .004 inch can be inserted between rotors and straightedge, replace pump body.

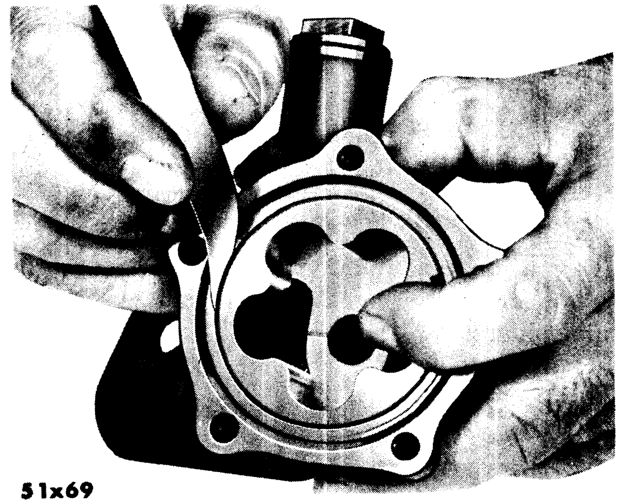


Fig. 51—Measuring Clearance Between Rotor Body and Pump Body

(5) Remove the pump rotor and shaft, leaving rotor body in pump cavity. Press the rotor body to one side with the fingers and measure the clearance between the rotor and pump bodies, as shown in Figure 51. If the measurement is more than .012 inch, replace oil pump body.

(6) Check the clearance between the pump rotor and rotor body, as shown in Figure 52. If measurement is more than .010 inch, replace pump rotor and rotor body.

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

(8) When assembling the oil pump, be sure to

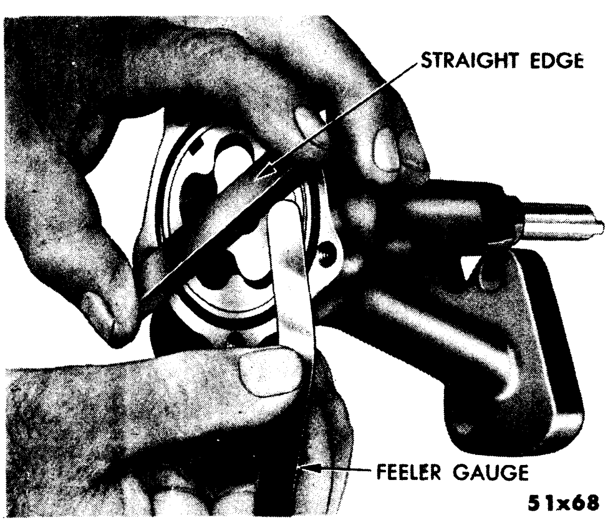


Fig. 50—Measuring Clearance Over Pump Rotors

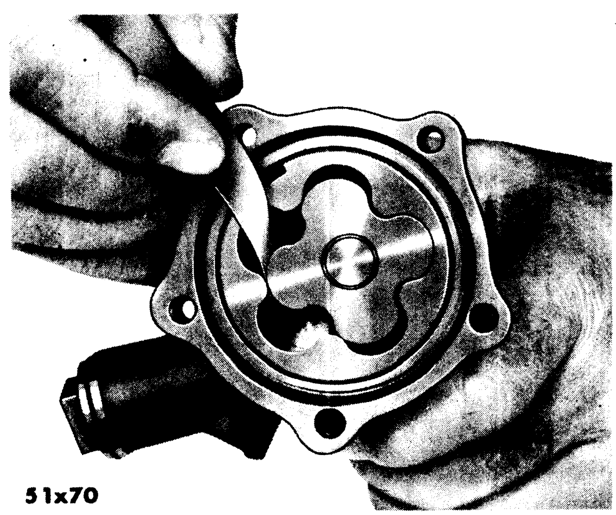


Fig. 52—Measuring Clearance Between Pump Rotors

use a new oil seal ring between the cover and body. Tighten cover bolts to 10 foot-pounds torque.

(9) Prime the oil pump, then place a new oil seal ring in the pump mounting face.

c. Inspecting Oil Pressure Relief Valve

The oil pressure relief valve is located in the oil pump body and consists of a plunger, spring and plug.

RELIEF VALVE SPRING CHART

Color	Free Height	Under-Load Height	Tension Pounds
Gray (Light)	$2\frac{1}{16}$ inch	$3\frac{1}{32}$ inch	16.1—17.1
Red (Standard)	$2\frac{1}{16}$ inch	$2\frac{27}{32}$ inch	19.5—20.5
Brown (Heavy)	$2\frac{1}{16}$ inch	$2\frac{31}{32}$ inch	22.9—23.9

To inspect the oil pressure relief valve, it will be necessary to unscrew the plug and remove the spring and plunger. Remove any dirt or foreign material, clean thoroughly.

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

The valve spring chart shows the springs available for installation, depending on the condition existing.

d. Installation

(1) Install the strainer on the end of the suction tube and secure with a cotter pin.

(2) Install suction tube into the pump body.

(3) Install the oil pump, suction tube, and strainer to the rear main bearing cap, as shown in Figure 53. Tighten the mounting bolts to 35 foot-pounds torque.

(4) After the oil pump has been installed, check the alignment of the strainer. The bottom of the strainer must be on a horizontal plane with the machined surface of the cylinder block, as shown in Figure 54.

(5) Using a new set of gaskets and seals, install the oil pan. Install the oil pan bolts and tighten evenly to 15 foot-pounds torque.

15. HYDRAULIC TAPPETS

a. Disassembly

The hydraulic tappets consist of a plunger, plunger cap, flat check valve, check valve spring, check valve retainer, plunger spring, tappet body, and plunger retainer spring clip, as shown in Figure 55.

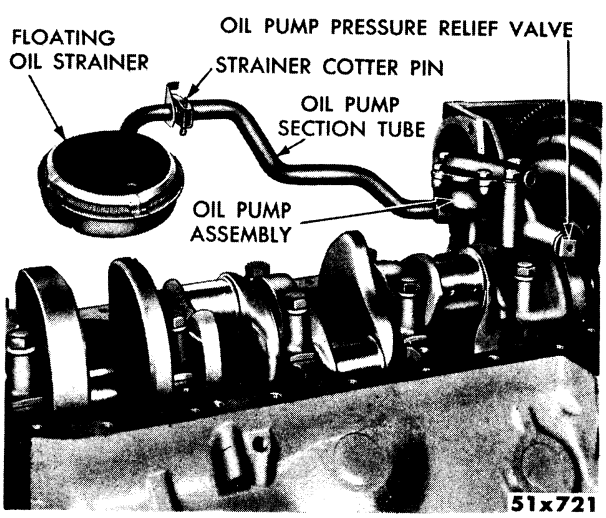


Fig. 53—Oil Pump, Suction Tube and Strainer Installed (Typical)

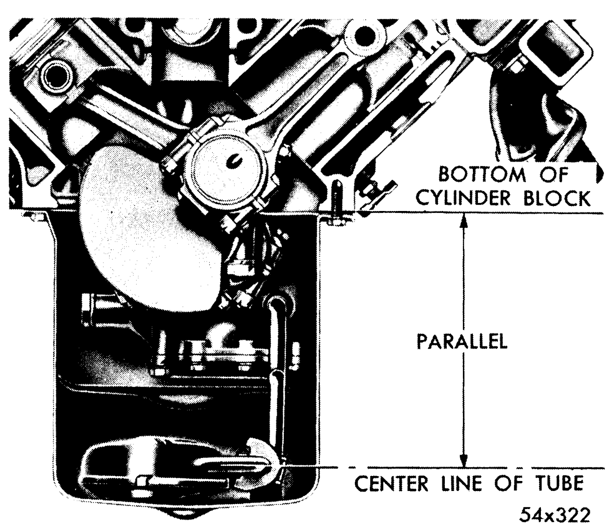


Fig. 54—Oil Strainer and Suction Tube Alignment (Typical)

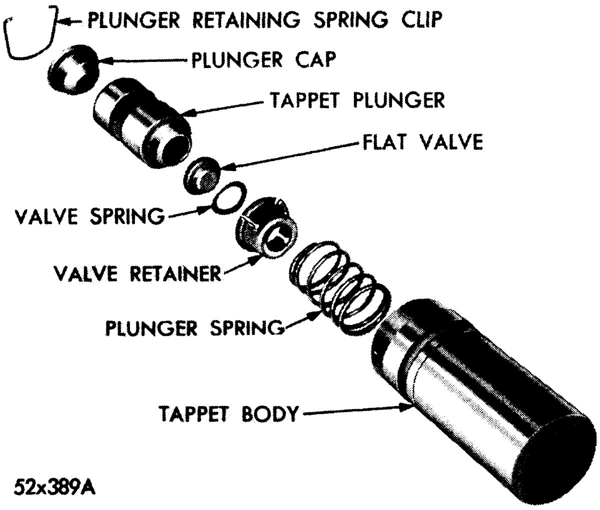


Fig. 55—Hydraulic Tappet (Disassembled View)

Because of the important part the hydraulic tappets play in the operation of the engine, the necessity for proper care and cleanliness of these units canot be over-emphasized.

Do not disassemble a tappet in dirty surroundings or on a dirty work bench. Use clean paper on the bench and, after the tappet has been disassembled, place the loose parts in the rack. Submerge in clean kerosene as a protection against dirt or corrosion.

Keep the parts of each tappet separate. The plunger and valve must always be fitted in the same body. To disassemble the hydraulic tappet for cleaning and inspecton, refer to Figure 55 and proceed as follows:

(1) Using a suitable tool, pry out the plunger retaining spring clip.

(2) Clean varnish deposits from inside of the tappet body above the plunger cap, then invert the body and remove the plunger cap, plunger, flat check valve, check valve spring, check valve retainer, and plunger spring.

(3) Separate the plunger, check valve retainer, and check valve spring.

(4) Place all parts in their respective locations in the tappet holder, Tool C-3068.

b. Cleaning and Assembly

Clean all the tappet parts in a suitable solvent that will remove all trace of varnish and carbon, then inspect the tappets for wear, scoring, or damage that would render them unfit for further service.

After having cleaned and inspected the tappets, assemble with care to make sure the parts are installed in the body exactly, as shown in Figure 55. Under no circumstances attempt to fit the check valve shoulder into the plunger. The finished seat of the check valve is on the side opposite the shoulder.

c. Testing

(1) Secure a container deep enough to completely immerse the tappet assembly (upright position).

(2) Fill the container with clean kerosene, then remove the cap from plunger and submerge tappet assembly, as shown in Figure 56.

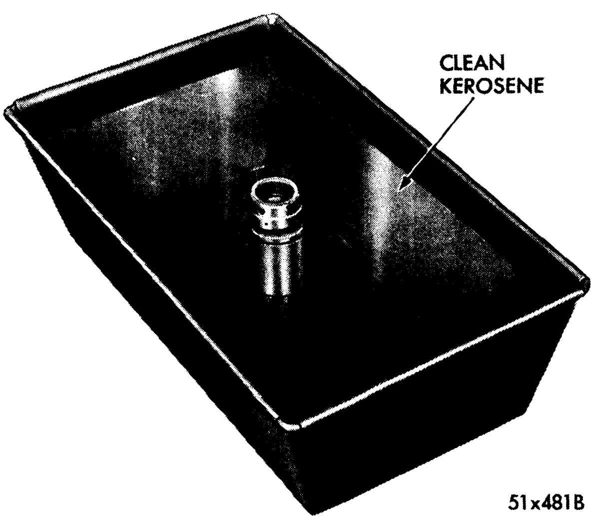


Fig. 56—Tappet Immersed In Clean Kerosene

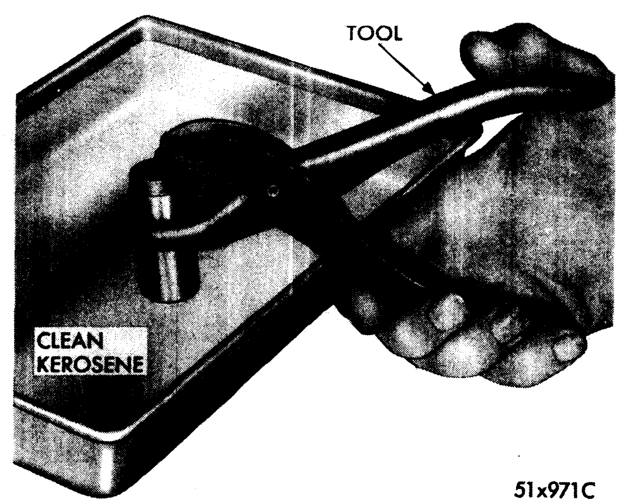


Fig. 57—Testing The Hydraulic Tappet

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

(4) Holding the tappet in an upright position, insert the lower jaw of pliers, Tool C-3160, in the groove in the tappet body, as shown in Figure 57. Engage the upper jaw of pliers with the top of tappet plunger (cap).

(5) Check the leakdown by compressing the pliers. If the plunger collapses almost instantly, as pressure is applied, disassemble tappet assembly and reclean. Test tappet again. If the tappet still does not operate satisfactorily after cleaning, install a new tappet assembly. If the tappet shows the least sign of not meeting the leakdown test, the tappet should be replaced.

d. Installation

After the hydraulic tappets have been cleaned, inspected, and tested, install in the engine as follows:

Place the engine in right-side up position, then install the hydraulic tappets, as shown in Figure 58. (When installing tappets, be sure each is installed in its original bore.)

16. ROCKER ARM ASSEMBLY

If the rocker arm assemblies have been disassembled for cleaning, inspection, or the installation of new parts, they should be assembled in the following manner:

(1) Hold the rocker arm shaft and the end bracket in a horizontal position with the oil grooves facing down. Slide an intake rocker arm over shaft and down against the bracket, with the diagonal slant of the arm close to the bracket, as shown in Figure 59.

(2) Now, slide a spacer spring over shaft and down against intake rocker arm. Next, slide an exhaust rocker arm over shaft and down against spacer spring, followed by a shaft bracket.

(3) Continue to slide first an intake rocker arm, then a spacer spring followed by an exhaust rocker arm and bracket, over shaft until the last bracket has been installed.

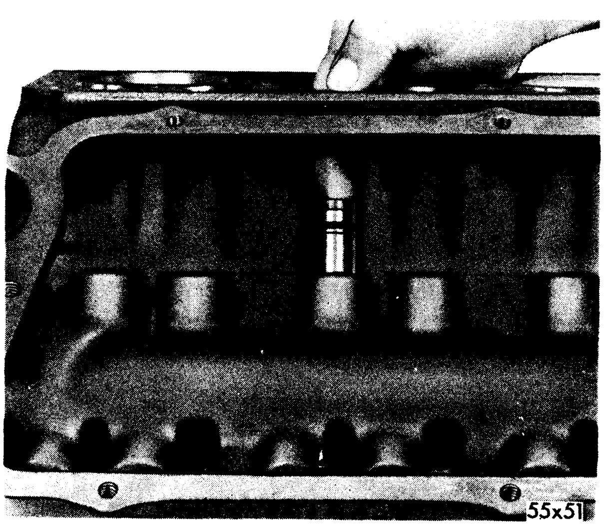


Fig. 58—Installing Tappet Assembly

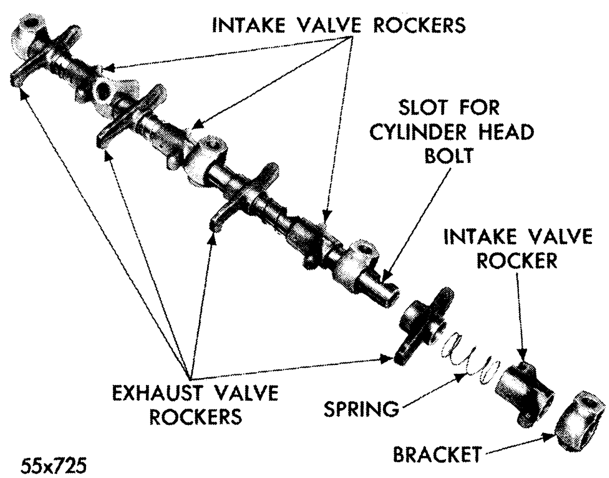


Fig. 59—Rocker Shaft Assembly (Disassembled View)

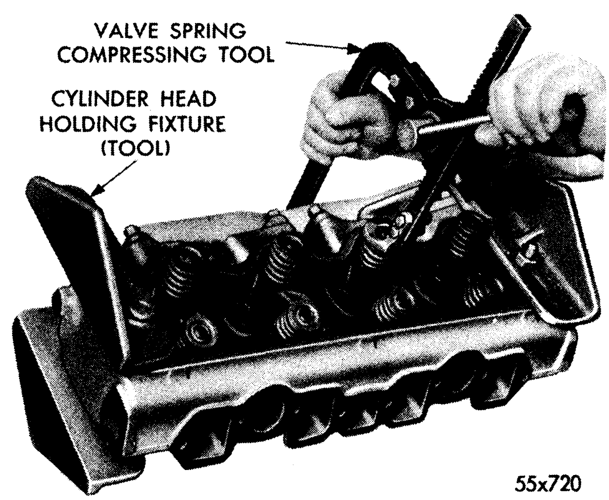


Fig. 60—Compressing Valve Springs With Compressing Tool

17. CYLINDER HEAD

a. Disassembly

With the cylinder heads mounted in holding fixtures, Tool C-3209, as shown in Figure 60, disassemble as follows:

(1) Compress the valve spring, using Tool C-3428, as shown in Figure 60. Remove the valve locks, then release and remove the spring compressing tool. Repeat procedure for all springs.

(2) Remove the valve spring retainer and valve stem seal rings (from intake valves only), then lift off the valve springs. The valve spring retainer and springs are interchangeable. Slide valves out of guides.

(3) Check the lock grooves in the valve stems for burrs. Remove burrs, if present, using a fine file or stone so as not to damage valve guides.

(4) Remove the valves from each head and place in a numbered rack. Clean all parts in a suitable solvent, then blow dry with compressed air.

b. Inspection

Check the cylinder heads for cracks, marred or scratched machined surface, or any other condition that might render the heads unfit for further service.

Be sure that the cylinder block and head mating surfaces are clean and that the water holes are fully open. Check the cylinder head water outlet covers at the rear of each head for leaks.

Remove all carbon and varnish from the valves and stems, using a fine, brass, wire brush. Inspect each valve carefully and discard any that are found to be burned, warped, or cracked.

Measure the stem of each valve. The intake valve stems should measure from .372 to .373 inch and exhaust valve stems should measure from .371 to .372 inch. This measurement should be taken at several places on the valve stem. If the wear exceeds .002 inch, ream the valve guide and install an oversize valve. It should be remembered, at this point, that the valve guides are cast integrally with the cylinder head and that valves with oversize stems are available for service.

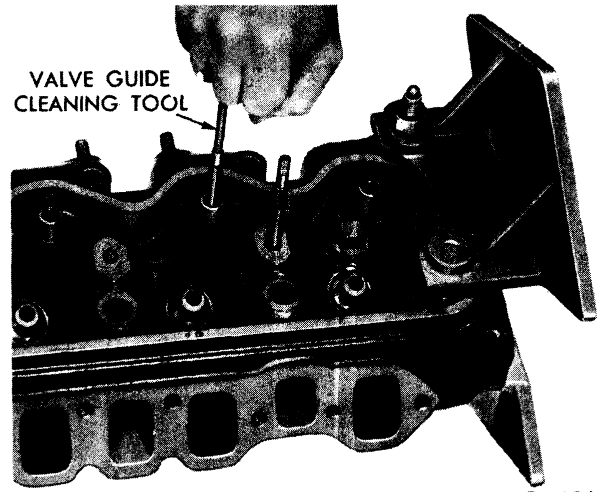


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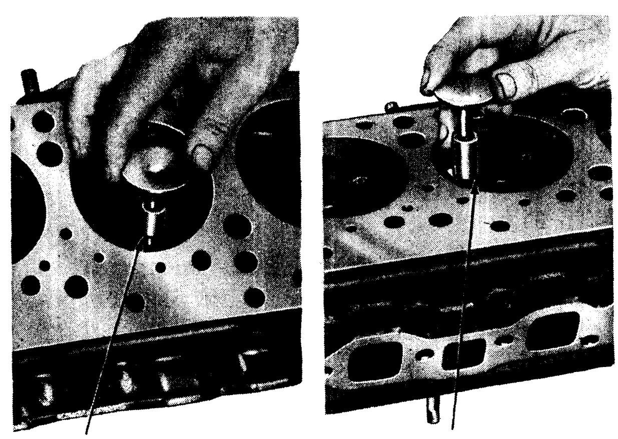
Fig. 61—Cleaning Valve Guides With Tool C-756 (Typical)

Remove the carbon and varnish deposits from the interior of the valve guides, using cleaner, Tool C-765, as shown in Figure 61. After all traces of carbon and varnish have been removed from the guides, check the valve stem-to-guide clearance with a dial indicator as follows:

NOTE

To insure an accurate reading, and also prevent unnecessary removal of parts, the valve stem-to-guide clearance should be checked with the valves that are to be installed in their respective guides.

(1) Slide sleeve, Tool C-3025, on the intake valve stem or Tool C-3026 on the exhaust valve stem, as shown in Figure 62. Insert the



INTAKE VALVE CHECKING SLEEVE

EXHAUST VALVE CHECKING SLEEVE

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Fig. 62—Installing Sleeves To Check Guide Clearance

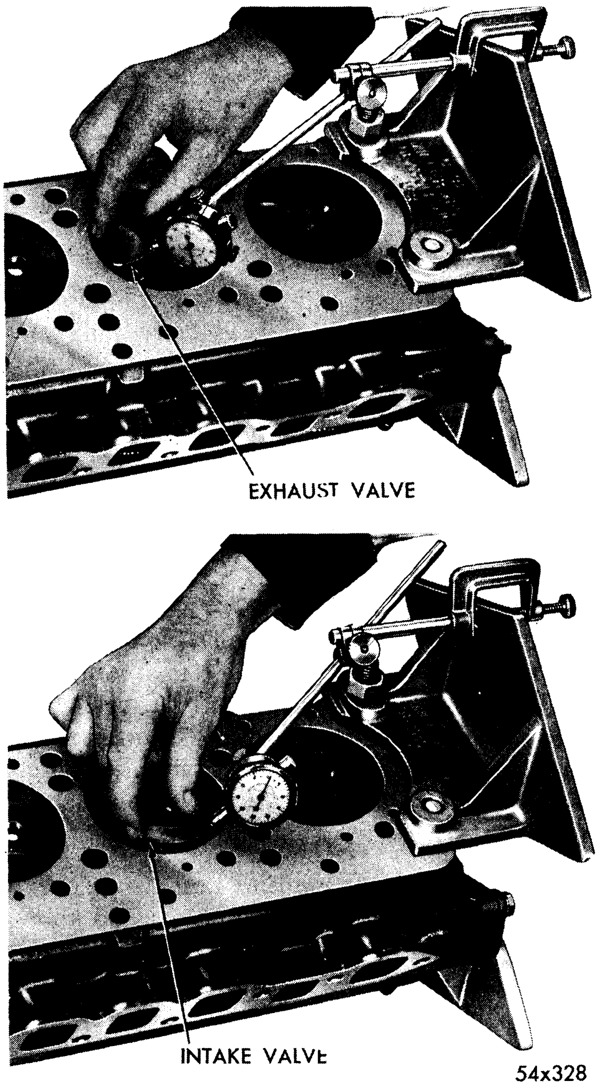

Fig. 63—Checking Valve Guide Clearance (Typical)

valve in position in the cylinder head.

(2) Attach dial indicator, Tool C-430, to the cylinder head and set the plunger so as to contact the edge of the valve being checked (at a right angle as near as possible), as shown in Figure 63.

(3) Move the valve to and from the indicator. The total dial indicator reading should not exceed .008 inch on the intake valves or .014 inch on the exhaust valves. If readings are more than the above specifications, install new valves and ream the guides as required.

c. Installing Valves with Oversize Stems

If after checking the valve to guide clearance, as described above, the total dial indicator reading is greater than .008 inch on the intake valves or .014 inch on the exhaust valves, ream the guides (cast in the head) to the next oversize (if other than standard) and install new valves. Valves with oversize stems are available in .005, .015, and .030 inch.

Before reaming the valve guides, check the rocker cover gasket boss at one end of the cylinder head for either a stamped "E" (exhaust) or "I" (intake). If a letter is found, all the guides in the head (either intake or exhaust depending on the letter) will be oversize.

The standard production reaming of both the intake and exhaust valve guides is .374 to .375 inch. Reamer Tool C-3433 is used to ream the intake and exhaust valve guides to obtain the correct clearance for a .005 inch oversize intake or exhaust valve stem (.379 to .380 inch).

Reamer Tool C-3430 is used to ream the intake and exhaust valve guides to obtain the correct clearance for a .015 inch oversize intake or exhaust valve stem (.389 to .390 inch).

Reamer Tool C-3427 is used to ream the intake and exhaust valve guides to obtain the correct clearance for a .030 inch oversize intake or exhaust valve stem (.404 to .405 inch).

Measure the valve stem to be sure of the diameter, then slide reamer of the desired size into the guide to be reamed.

Slowly turn reamer by hand, as shown in Figure 64, until guide is reamed. Clean inside of the guide thoroughly, then install the new valve, and check with a dial indicator as described.

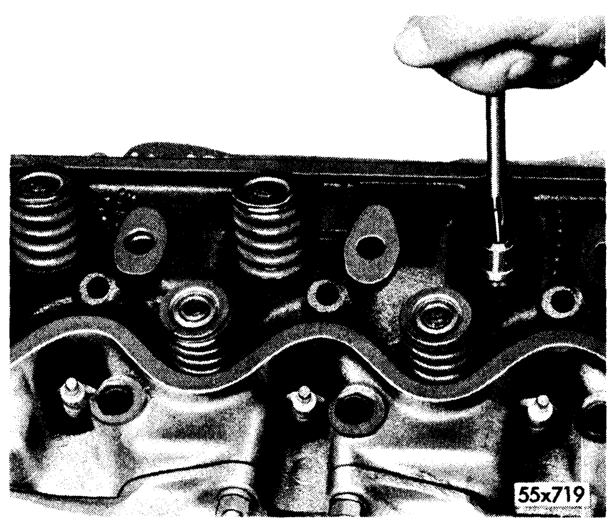

Fig. 64—Reaming Valve Guides

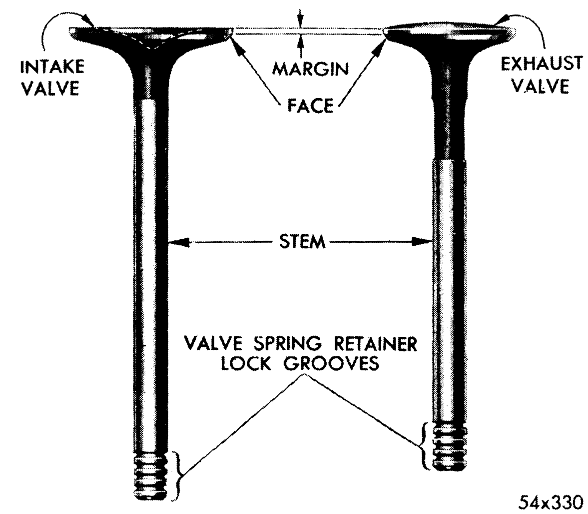

Fig. 65—Intake and Exhaust Valve Nomenclature

CAUTION

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

d. Refacing Valves and Seats

To insure a positive sealing of the valve to the seat, the grinding wheel of the valve refacer and the stones of the seat grinder should be carefully refaced. In each case the set up should be such that the finished angle of both the valve and the seat are identical.

When refacing the valves with Tool MTH-80, remove only a small amount of metal at a time

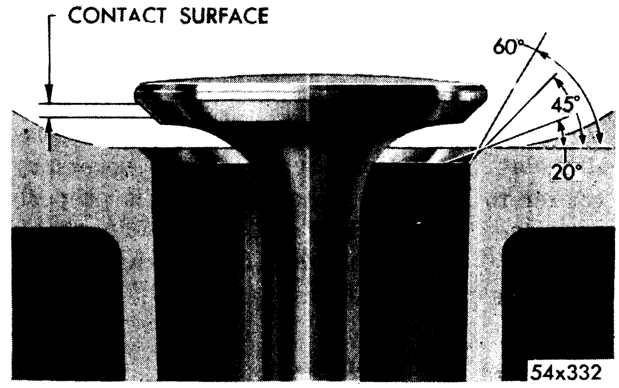

Fig. 67—Valve Seat Reconditioning Angles

to insure a smooth, accurate surface on the valve face. After the valves have been refaced, check the valve head margin of each valve. (See Fig. 65). The margin must be at least 3/64 inch, otherwise the valve should be discarded and a new valve installed.

When refacing the valve seats, it is important that the correct size valve guide pilot be used for the reseating stones.

Grind the seats with Tool MTH-JB-41, as shown in Figure 66. Remove only a small amount of metal at a time to insure a smooth accurate surface. Avoid overgrinding. A true and complete surface must be obtained. Check the concentricity of the seat, using dial indicator No. 9320. The total run-out should not exceed .002 inch (total indicator reading).

Check the valve seat with Prussian blue to determine where the valve contacts the seat. It

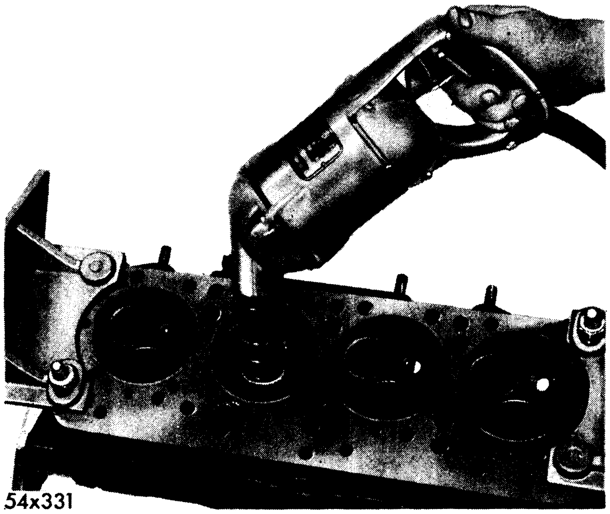

Fig. 66—Grinding Valve Seats

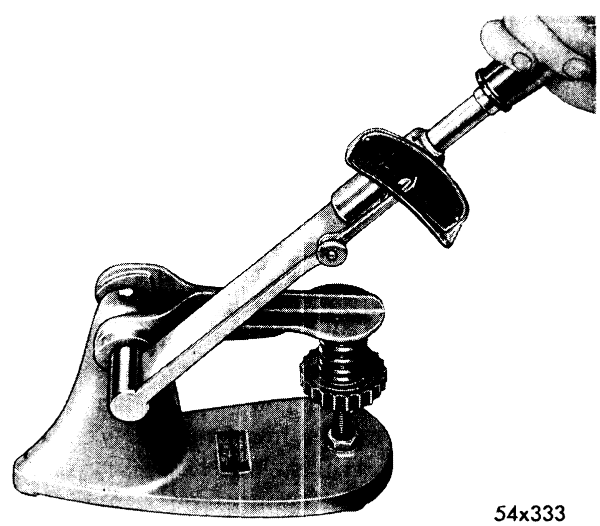

Fig. 68—Testing Valve Springs

is important that this contact be centralized on the valve face. If this contact surface is not properly centralized, the seat should be relocated by using a 20 degree stone at the top, or a 60 degree stone at the bottom, whichever is necessary. (Refer to Fig. 67.) When the seat is properly positioned, the width of the intake seats should be 1/16 to 3/32 inch. The width of the exhaust seats should be 3/64 to 1/16 inch.

e. Testing Valve Springs

Whenever the valves have been removed for inspection, reconditioning, or replacement, the valve springs should be tested. Place the valve spring on the seat of Tool C-647, as shown in Figure 68. Attach torque wrench and check the tension. (Multiply the reading on the torque wrench by two to obtain correct spring tension). Both the exhaust and intake valve springs should test 160 to 172 foot-pounds when compressed to 1 5/16 inch.

Each spring should be checked for trueness. This can be done with a steel square and a surface plate. Stand each spring and the square on end, on the surface plate and then slide the spring up the square. Then gradually revolve the spring while, at the same time, noticing the space between the top coil of spring and the square. The out-of-trueness of the spring should not exceed 1/16 inch. If the spring is more than 1/16 inch out-of-true, install a new valve spring.

If valves and/or seats are reground, check the installed height of the springs. A thin, metal scale may be used. Make sure that scale is inserted to the full depth of counterbore in cylinder head. Measure to spring seat surface of retainer. If the height is over 1 11/16 inch, install a 1/16 inch spacer (Part No. 14-00482) in the head counterbore to bring the spring height back to normal, 1 5/8 to 1 11/16 inches.

When valves and seats are reground, the position of the valve in the head is changed so as to shorten the operating length of the hydraulic tappet. This means that the plunger is operating closer to its bottom position, and less clearance is available for the thermal expansion of the valve mechanism during high speed driving. Design of plunger travel includes a safety factor for normal wear and refacing of valves and seats. However, if face and seat grinding is carried to the point where the valve position is changed

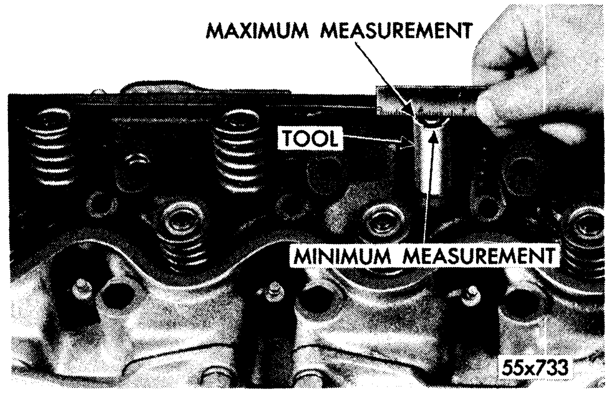

Fig. 69—Checking Valve Stem Position

1/32 inch or more from its factory installed position, the dimension from the valve spring seat in the head to the valve tip should be checked with gauge Tool C-3436, as shown in Figure 69. The end of the cylindrical gauge and the bottom of the slotted area represent the maximum and minimum allowable extension of the valve stem tip beyond the spring seat. If the tip exceeds the maximum, grind to approach (but do not go below) the minimum allowable on the gauge.

f. Assembly

After all parts of the cylinder heads have been checked and corrected, reassemble the cylinder heads as follows:

(1) Coat the exhaust valve stems with engine oil and insert in the head. Install the valve springs and retainer, as shown in Figure 70.

(2) Compress the valve springs, using Tool C-3428. Install the valve locks and remove tool.

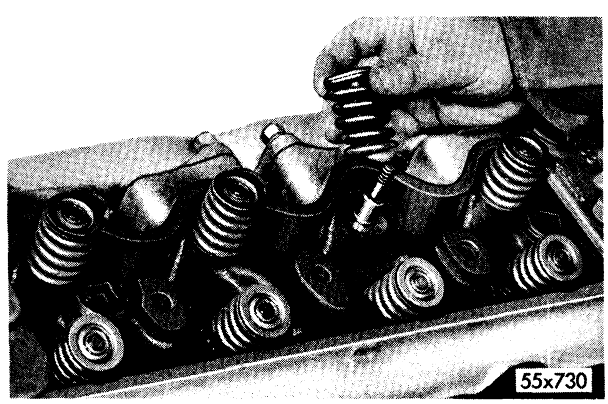

Fig. 70—Installing Exhaust Valve Spring and Retainer

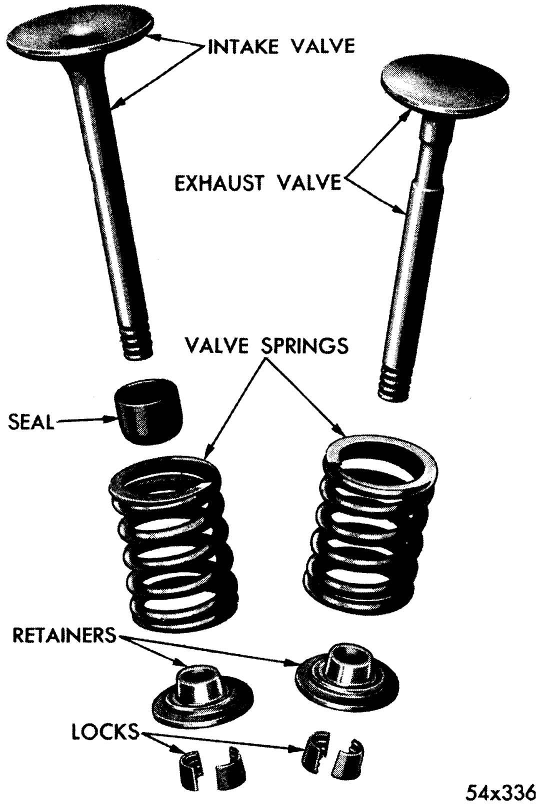

Fig. 71—Valves, Springs, Seal and Retainer (Disassembled View)

(3) Coat the intake stems with clean engine oil and slide into position in the head. Now, slide the valve stem seal over stem and down against valve guide. (The seals will automatically seat themselves in correct position when the engine is first run.) (See Fig. 71.)

(4) Install the valve springs and retainers, as shown in Figure 72. Using Tool C-3428, compress the valve spring and install the locks. Remove the tool.

g. Installing Cylinder Head and Rocker Arm Assembly

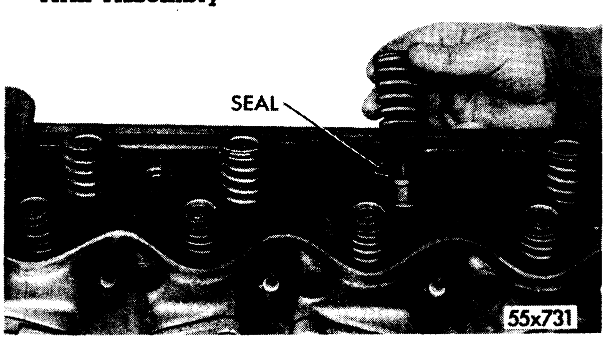

Fig. 72—Installing Intake Valve Spring, Stem Seal and Retainer

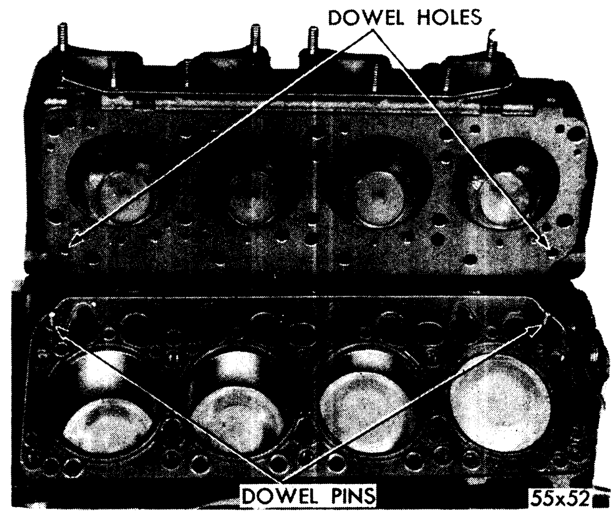

Fig. 73—Cylinder Head Locating Dowels

(1) Position the cylinder head on the block, using new gasket.

NOTE

Be sure the cylinder head is properly installed over the locating dowels and the cylinder head gasket is installed right side up. (Fig. 73.)

(2) Install lower cylinder head bolts (exhaust manifold side) and tighten only tight enough to keep cylinder head properly positioned.

(3) Install intake and exhaust push rods into their respective positions. (Fig. 74.)

(4) Position rocker arm assembly (along with cylinder head bolts) on cylinder head.

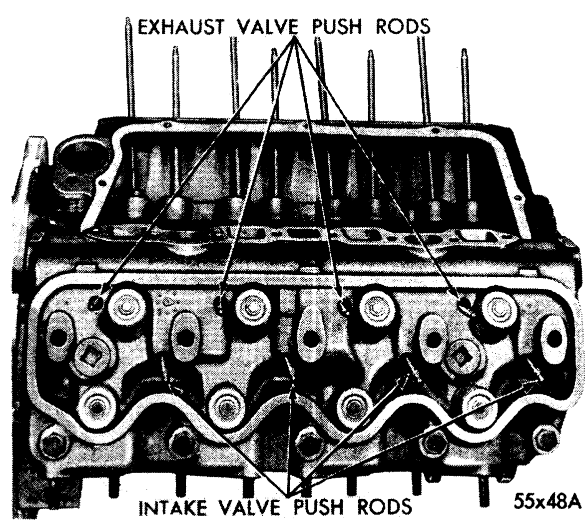

Fig. 74—Push Rods Installed In Head

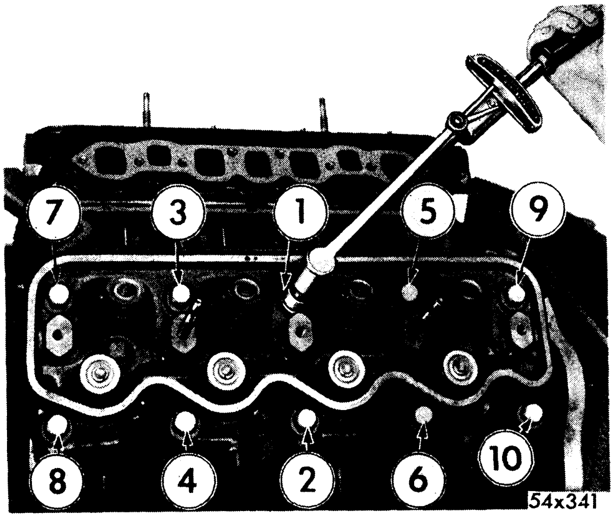

Fig. 75—Tightening Cylinder Head Bolts (Typical)

NOTE

Be sure that the special head bolts (drilled and tapped for rocker cover bolts) are installed in their proper positions.

(5) Tighten cylinder head bolts in sequence to 85 foot-pounds torque, as shown in Figure 75.

CAUTION

Extreme care must be taken in tightening the rocker shaft attaching bolts so that the tappets have time to bleed down to their operating length. Bulged tappet bodies, bent push rods, broken rocker arms, or permanent noisy operation will result if the tappets are forced down too rapidly.

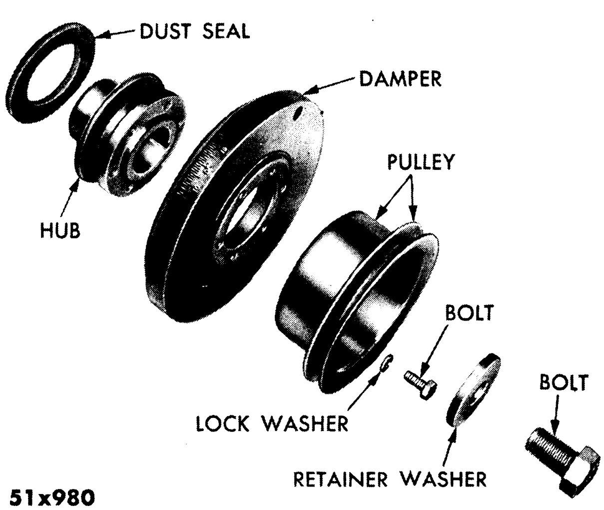

Fig. 76—Crankshaft Pulley, Hub, Seal and Damper (Disassembled View)

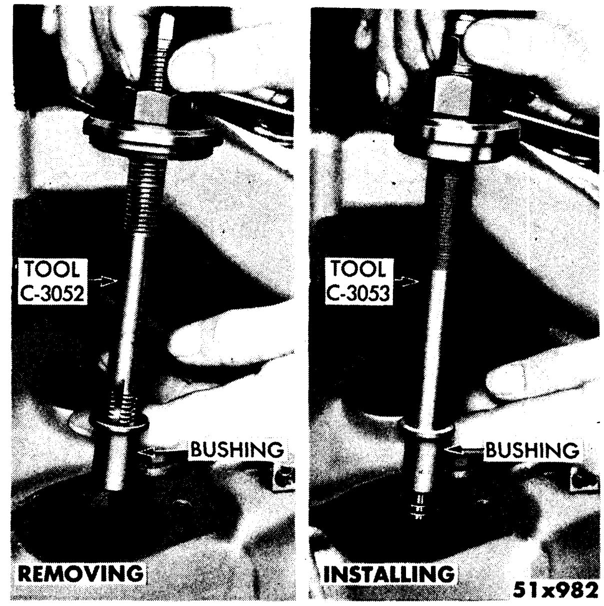

Fig. 77—Removing and Installing The Distributor Driveshaft Bushing

18. CRANKSHAFT PULLEY, HUB, AND DAMPER INSTALLATION

Refer to Figure 76, and proceed as follows:

(1) Insert the pulley hub key in the slot in the crankshaft, then position a new dust seal in the hub of the pulley and position the assembly on the crankshaft.

(2) Place installing tool, (part of puller set C-3033) in position, then insert the pulley flatwasher between the tool and hub. Press the pulley on shaft until seated.

(3) Remove the tool and install the damper and pulley to hub.

(4) Install washer and retaining nut. Tighten to 135 foot-pounds torque.

19. WATER PUMP

For servicing and installation of water pump refer to Cooling System Section.

20. FUEL PUMP

For servicing and installation of fuel pump, refer to Fuel System Section.

21. DISTRIBUTOR DRIVE SHAFT BUSHING

It is advisable to remove and install the distributor drive shaft lower bushing when the engine is completely overhauled. A worn bushing can cause erratic distributor operation, which will affect car performance.

To remove and install the distributor lower drive shaft bushing, proceed as follows:

(1) Insert Tool C-3052 into old bushing and thread down until a tight fit is obtained. Hold the puller head with a wrench, tighten puller bolt and pull out of bore in the block, as shown in Figure 77.

(2) Slide new bushing over burnishing end of Tool C-3053, as shown in Figure 77, then insert tool and bushing into bore of block.

(3) Drive the bushing and tool down into position using a soft hammer. As the burnisher is pulled through the bushing by pressure applied by tightening the puller nut, the tool swedges the bushing tight in its bore and burnishes to the correct size. DO NOT REAM THIS BUSHING!

22. DISTRIBUTOR BASIC TIMING

Before installing the distributor lower drive shaft gear, it will be necessary to time the engine as follows:

(1) Rotate the crankshaft until Number One cylinder is at top dead center (firing position. When in this position the pointer on the chain case cover should be over "DC" on the vibration damper.

(2) Using Tool C-3027, position the oil pump shaft so that it lines up with the slot in the drive gear, as shown in Figure 78.

(3) Coat the shaft of the drive gear with engine oil, then install so that as the gear spirals into position, it will index with the oil pump shaft and the slot in the top of the drive gear will be parallel with the centerline of the crankcase, as shown in Figure 78.

23. CHECKING THE VALVE TIMING

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

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

Set the dial indicator on zero and then turn the crankshaft clockwise (normal running direction) until the dial indicator shows that the valve has lifted .024 inch.

The timing on the crankshaft pulley should now read from 5 degrees before top dead center to 7 degrees after top dead center. If the reading

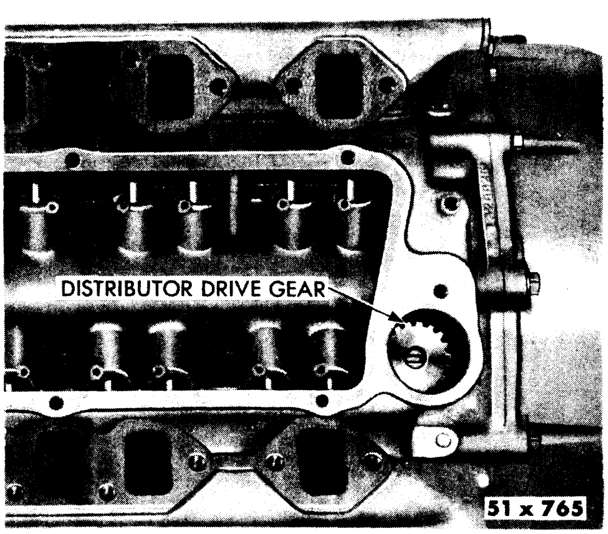

Fig. 78—Distributor (Basic) Timing (Typical)

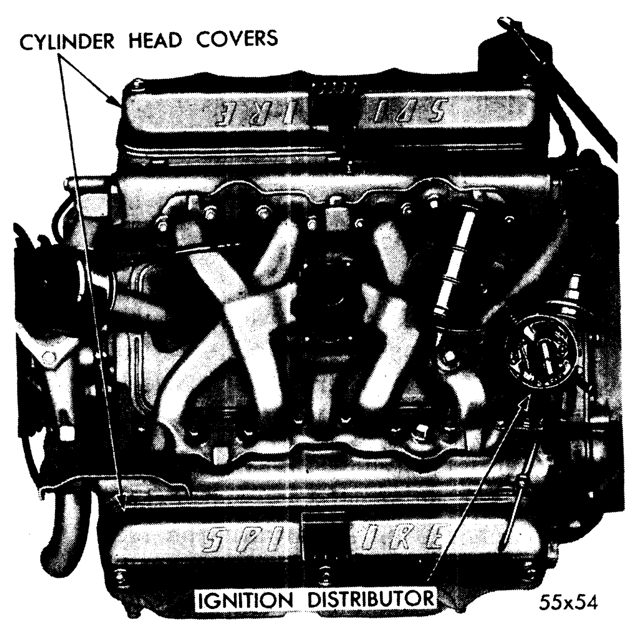

Fig. 79—Ignition Distributor Installed

is over the specified limits, check the gear indexing marks and the timing chain for wear.

Before making this check, it is well to check the accuracy of the TDC mark on the pulley by bringing the Number One piston to top dead center by means of an indicator placed in the spark plug opening.

After the valve timing has been checked, turn the crankshaft counter-clockwise until the tappet is back down to the valve closed position, then remove the .210 inch spacer from between the rocker arm and valve stem.

CAUTION

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

24. FINAL ASSEMBLY OF ENGINE

(1) Install the exhaust manifolds on the cylinder heads, using new gaskets. Tighten nuts to 25 foot-pounds torque.

(2) Place a new tappet chamber gasket in position, then install the tappet chamber cover. Tighten the attaching bolts to 50 inch-pounds torque.

(3) Install new rocker cover gaskets, then place rocker covers in position and secure with bolts. Be sure the rubber insulator is in correct position.

(4) Install new spark plug gaskets over plugs, after checking plug gap. The spark plug gap should be .035 inch. Insert the plugs and gaskets into the cylinder heads and tighten to 30 foot-pounds torque, using Tool C-3054.

(5) Place the distributor vacuum tube in position, then install the intake manifold, using new gaskets. Insert bolts and lockwashers and tighten to 30 foot-pounds torque.

(6) Hold the distributor over the mounting pad on the cylinder block, with the vacuum chamber pointing toward the right hand cylinder bank. Turn the rotor until it points forward and to the approximate location of the Number One insert in the cap. Now, turn the rotor counter-clockwise until the break contact points are just separating. Place the distributor oil seal ring in position, then lower the distributor and engage in the slot in the top of the drive gear. (Be sure to hold the rotor in position.) Secure with clamp and bolt. (See Figure 79).

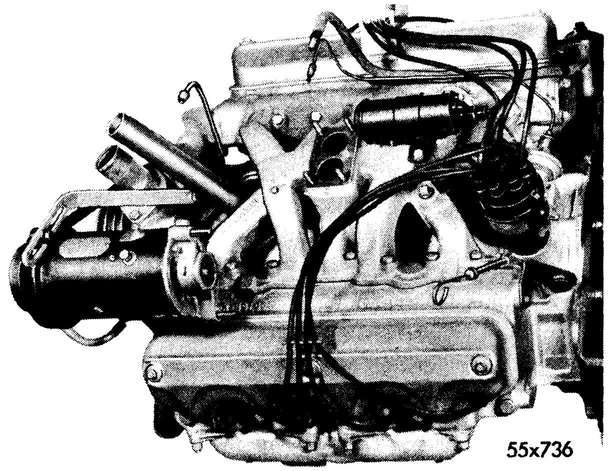

Fig. 80—Ignition System Installed

(7) Install the distributor cap and spark plug cables. Engage the ends of the cables to the plugs. (See Fig. 80).

(8) Install the fuel line at fuel pump, then insert the vacuum tube in position and tighten connections securely. Install the oil gauge tube.

(9) Install the automatic choke heat tube in the exhaust manifold.

(10) Install the generator, mounting bracket and the adjusting strap. Tighten bolts securely.

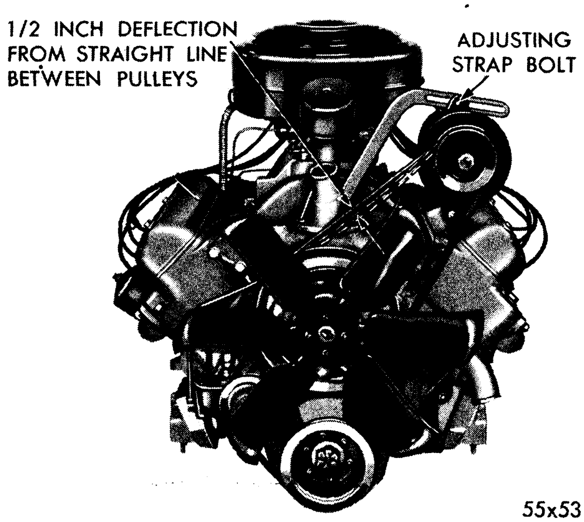

Fig. 81—Fan Belt Adjustment

(11) Install the fan pulley. Tighten bolts to 15 foot-pounds torque, then slide the fan belt over pulleys and adjust as follows:

When adjusting the fan belts, obtain enough slack so that the belt may be depressed ½ inch from a straight line midway between the pulleys, as shown in Figure 81.

When adjusting the fan belt on Power Steering or Air Conditioned equipped cars, refer to the Steering or Air Conditioning Section of this Shop Manual for correct procedures.

(12) Install the starting motor and tighten the attaching nuts to 55 foot-pounds torque.

(13) Install the oil filter base using a new gasket. Install a new filter element, shell, and new gasket. Tighten the center bolt securely.

(14) Install the crankcase breather pipe and new gasket, then secure with bolt and lockwasher. Install bolt and lockwasher through breather pipe clamp and tighten.

(15) Insert the oil level dip stick tube in position and down into block (if removed). Insert dip stick.

The engine now has been completely assembled with the exception of the transmission and converter housing. Remove engine from stand and install these items.

INSTALLATION OF ENGINE
(IN THE CAR)

25. ENGINE INSTALLATION

To install the engine assembly in the car, proceed as follows:

NOTE

If using the engine lifter plate, Tool C-3466, fasten the engine lifter plate securely to the carburetor mounting flange.

(1) Using a suitable overhead hoist, suspend the engine assembly over the engine compartment. (The engine must be tilted at an angle, slanting downward at the rear.)

(2) Lower the engine (being careful not to damage the accessories or the vehicle) on to the front mounts.

(3) Holding the engine with the overhead hoist, place a jack under the transmission to support the rear end of the engine, then install the rear engine support crossmember and secure with bolts. After the crossmember has been installed, remove the jack and relieve the hoist.

(4) Remove the engine lifter plate and install the carburetor.

(5) Install the radiator and connect the radiator hoses. Close all draincocks (one on each side of the block and the radiator).

(6) Connect the usual items under the hood, such as fuel lines, heat indicator thermocouple, heater tubes, electrical wiring, and the oil pressure gauge.

(7) Reinstall the hood and battery.

(8) Connect the exhaust pipes to the exhaust manifolds, using new gaskets.

(9) Connect the wires and linkage at the transmission and clutch (if so equipped).

(10) Connect the propeller shaft to the transmission.

(11) Refill the cooling system.

(12) Refill the engine crankcase. (Refer to Lubrication Section for break-in of new or rebuilt engine.)

(13) Install the carburetor air cleaner.

(14) Start the engine and warm up to 160 degrees F., then check the distributor timing, as described in the Electrical Section.

(15) Adjust the carburetor, as described in the Fuel System Section.

SERVICING OF COMPONENTS

26. PRELIMINARY TO CHECKING HYDRAULIC TAPPETS

Before disassembling any part of the engine to check for tappet noise, check the oil pressure at the gauge and the oil level in the oil pan. The pressure should be between 40 to 65 pounds at 1500 rpm. The oil level in the pan should never be above the "Full" mark on the dip stick, nor below the "Add Oil" mark. Either of these two conditions could be responsible for noisy tappets.

a. Oil Level Too High

If the oil level is above the "Full" mark on the dip stick, it is possible that the connecting rods can dip into the oil when the engine is running and thus create foaming. This foam is fed to the hydraulic tappet by the oil pump, and air gets into the hydraulic tappets causing them to go "flat," which allows the valves to seat noisily.

b. Oil Level Too Low

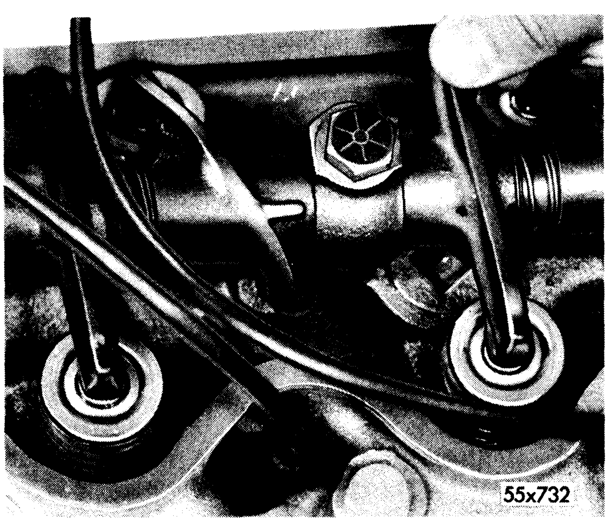

Fig. 82—Checking For Tappet Noise At Rocker Arm

Low oil level, on the other hand, may allow the oil pump to suck air which when fed to the tappets, again causing them to lose length and allowing the valves to seat noisily. Any leaks on the 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 it will often cause more than one tappet to be noisy, usually cylinders Number Two and Four. When the oil level and leaks have been corrected, the engine should be run at a fast idle for sufficient time to allow all of the air inside the tappets to be worked out.

27. TAPPET NOISES

a. Determining the Location of Noise

To determine the location of a tappet noise, remove the rocker covers and run the engine at idle or noisy speed. Feel each valve spring or rocker arm, as shown in Figure 82. The noisy position can be readily detected by the feel. In cases of light noise only, the use of a .015 inch feeler gauge between the rocker arm and valve tip will provide a noticeable change in noise level.

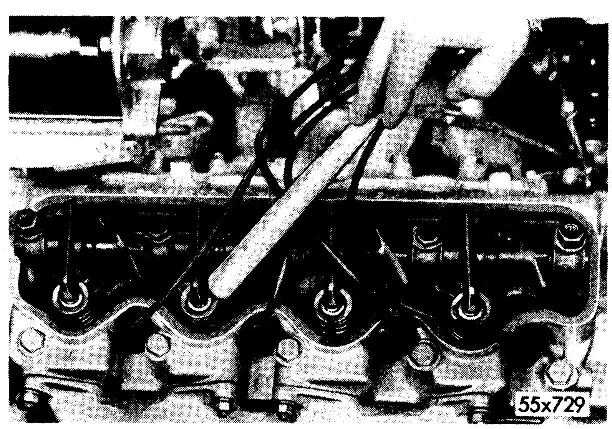

Fig. 83—Applying Side Pressure Against Valve Springs

b. Determining the Source of Noise

Tappet noise, or noisy valve seating, frequently is caused by other than hydraulic tappet malfunction. To most efficiently service a tappet noise the following possibilities should be quickly checked before installing a new tappet assembly:

(1) Aeration of oil feed.

(2) Excessively worn valve guides—Test by applying side thrust on valve spring, as in Figure 83.

(3) Cocked valve springs—Test same as for worn guide.

(4) Worn push rod or rocker arm—A close examination of these parts is simply performed. Pay close attention to rocker arm push rod socket.

(5) Broken valve spring.

(6) Tight rocker arm (sticky on shaft).

(7) Bent push rod.

(8) Tappet tight in bore.

(9) Blocked tappet oil feed hole.

(10) Worn tappet or cam lobe.

If other than a hydraulic tappet is determined to be the source of noise, replace worn or failed parts as necessary. When, on the other hand, it has been determined that the hydraulic tappet is at fault, remove the suspected unit or units only. Tappets functioning properly should be left in the engine. Replace the tappet or tappets found to be noisy with new units. Do not attempt to repair a noisy tappet by cleaning as dirt is seldom, if ever, the cause of its being noisy. This procedure is most advisable, as the task of removal and installation more than justifies the cost of a new tappet.

28. REMOVAL AND INSTALLATION OF THE HYDRAULIC TAPPET—(In the Car)

To remove the hydraulic tappets for cleaning or the installation of new units, it will be necessary to first remove the intake manifold, and the tappet chamber cover. (The rocker covers were removed during the tappet checking procedure.) Now, remove the hydraulic tappets as follows:

a. Removal

(1) Remove the bolts that hold the single rocker shafts and heads to the cylinder block. Lift rocker shafts and arms straight up and away from the heads. Remove the push rods and place in their respective slots in holder, Tool C-3068.

(2) Remove intake manifold, as described in Exhaust System Section.

(3) Remove the crankcase ventilator pipe and gasket.

(4) Remove the bolts that hold the tappet chamber cover to the cylinder block. Lift cover up and away from engine.

(5) Insert the hooked portion of Tool C-3158 into the hole in the tappet body, as shown in Figure 84. (This portion of the tool can be used to remove tappets without a varnish build-up (low mileage) around the lower part of the tappet body). Lift tappet out of bore; if the tappets stick in the bores, proceed as follows:

(6) Slide the puller portion of Tool C-3158 through the cylinder head (push rod) openings and seat firmly in cap of tappet.

(7) Insert the puller pin through the tappet body and tool shaft in the holes provided. Grasp the tool handle and slowly pull the tappet out of the bore with a sharp twisting motion, as shown in Figure 12. As the tappet clears the bore, withdraw the puller pin and then the puller tool; lift tappet out of tappet chamber.

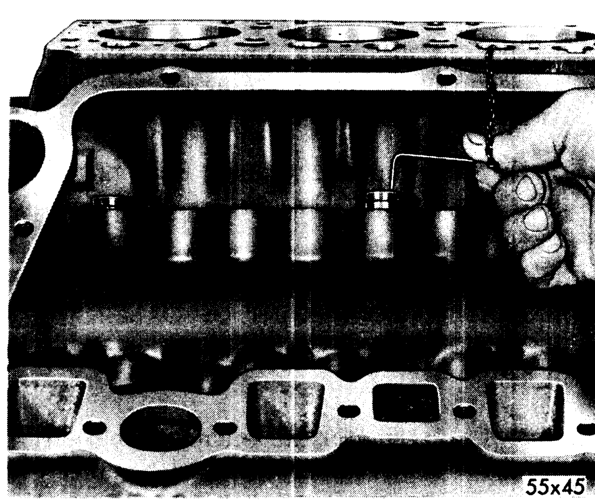

Fig. 84—Removing Tappet From Bore

(8) Replace tappets that were found to be noisy.

b. Installation

(1) Install the hydraulic tappets and the push rods.

(2) Be sure all the rocker arms are in a horizontal position, then position the rocker shaft assembly with cylinder head bolts on each head.

CAUTION

Extreme care must be taken in tightening the rocker shaft attaching bolts so that the tappets have time to bleed down to their operating length. Bulged tapped bodies, bent push rods, broken rocker arms, and permanent noisy operation will result if the tappets are forced down too rapidly.

(3) Tighten the rocker shaft assembly attaching bolts slowly, starting at the center bolt and working alternately to each end.

(4) Install the tappet chamber cover, using a new gasket. Tighten bolts to 50 inch-pounds torque.

(5) Install the crankcase ventilator pipe and gasket. Install bolt and tighten to 15 inch-pounds torque.

(6) Place new gaskets in position. Install the intake manifold, carburetor, and ignition coil as a unit. Install the attaching bolts and tighten to 30 foot-pounds torque.

(7) Make the necessary connections that were disconnected during removal of intake manifold.

Check operation of hydraulic tappets and, if satisfactory, install the rocker covers, using new gaskets.

29. LOCATING LOW POINT OF CAMSHAFT LOBE IN CONJUNCTION WITH TAPPET FACE

Remove the distributor cap and note the position of the rotor for Number One and Number Six cylinders. Set timing mark "DC" located on the crankshaft pulley to the pointer.

With the rotor pointing to Number One firing position and the crankshaft pulley with "DC" at the pointer, the following tappets will be on the low side of the cam lobe (heel):

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

To remove Number One intake and exhaust tappet, rotate the crankshaft ¼ turn clockwise from above position after removing the tappets listed.

With the rotor at Number Six firing position and the crankshaft pulley with "DC" at the pointer, the following tappets will be on the low side of the cam lobes (heel):

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

To remove Number Six intake and exhaust tappets, rotate the crankshaft ¼ turn clockwise from above position after removing the tappets listed.

30. REMOVAL OF CYLINDER HEADS

Before removing either of the cylinder heads, check the compression of each cylinder to determine the condition of the valves and piston rings. Before any compression checks are made, the engine should be run until it reaches normal operating temperature. The battery should be checked to see that it is in a fully charged condition. It is good practice to loosen all spark plugs slightly and run the engine briefly before starting the compression check. This procedure aids in cleaning out any carbon deposits broken off the spark plug ends.

If the compression varies more than 15 pounds between cylinders, or has dropped below 90 pounds per cylinder with a full open throttle, attention to the valves or piston rings can be considered necessary.

If the compression pressure is border line, it is well to run the engine a short time and then recheck the compression. Frequently, a small particle of foreign material, which may become lodged on the valve seat, causes a low reading.

The particles may then be blown off by the operation of the engine.

(1) Remove intake manifold, as outlined in the Exhaust System Section.

(2) Disconnect the exhaust pipes at the exhaust manifold flanges.

(3) Disconnect the spark plug ignition cables from the spark plugs. Disengage from clamp on rocker covers, remove distributor cap and cables.

(4) Remove the bolts, washers, and insulators that hold the rocker covers to the cylinder heads. Lift covers up and away from heads.

(5) Remove bolts that hold the single rocker shafts and heads to cylinder block. Lift rocker shafts and arms straight up and away from heads. Remove push rods and place in their respective slots in holder, Tool C-3068.

(6) Remove remaining bolts on each bank of cylinders that hold the cylinder heads to the block. Lift the cylinder heads up and away from block. Immediately attach the cylinder head holding fixture, Tool C-3209, to prevent damage to the machined head surface.

31. REMOVAL AND INSTALLATION OF THE CHAIN CASE COVER OIL SEAL

a. Removal

(1) Remove radiator, fan, fan shroud, and water pump housing, as described in Cooling System Section.

(2) Remove pulley and damper from hub, and remove hub with Tool C-3033.

(3) Loosen the bolts that hold the oil pan to the cylinder block. Drop the pan slightly to clear the chain case cover. Disconnect the inlet and outlet fuel lines at the fuel pump. Remove the fuel pump.

(4) Remove the bolts and washers that hold the chain case cover to the cylinder block. Disengage cover from locating dowels and remove from front of engine. Discard the gasket.

(5) Drive the oil seal out of the cover from the front, using Tool C-3050. Install new gasket, place a new seal in position with the projecting flange toward the inside of cover. Drive seal in place, using Tool C-3051.

b. Installation

(1) Clean both surfaces of the cylinder block and the chain case cover, install a new gasket.

Make certain that the crankshaft oil slinger is in the proper position (flange end pointing toward seal).

(2) Position the chain case cover on the two locating dowel pins and gently tap the cover in place.

(3) Coat the bolts with a suitable sealer. Install and tighten bolts to 15 foot-pounds torque. (Refer to Fig. 32).

(4) Insert the hub key in slot in the crankshaft. Position a new dust seal in the hub and position hub on the crankshaft.

(5) Place installing tool (part of puller set, Tool C-3033) in position and press on hub, as shown in Figure 85.

(6) Remove tool and install the damper and pulley to hub.

(7) Install washer and retaining nut. Tighten to 135 foot-pounds torque.

(8) Reinstall cooling fan, water pump housing, shroud, radiator, etc.

(9) Refill cooling system, start engine and warm up to 160 degrees F., and check for leaks.

32. REMOVAL AND INSTALLATION OF ENGINE OIL PAN

(1) Remove the oil level indicator (dip stick).

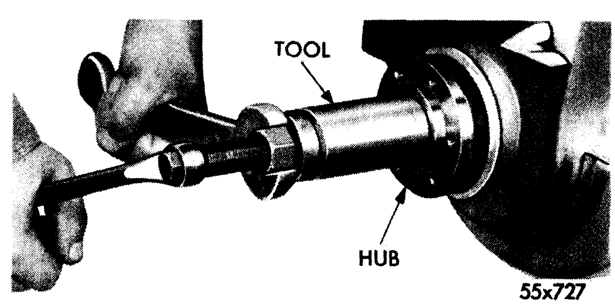

Fig. 85—Installing Hub

(2) Remove the crankcase plug and drain oil.

(3) Disconnect the steering linkage at the idler arm support bracket, and allow linkage to settle away from bottom of oil pan.

(4) Remove the bolts that hold the oil pan to the cylinder block. Slide pan out and down away from engine.

(5) When installing the oil pan, coat the gaskets with a suitable sealer, and proceed as follows:

(6) Place a new oil pan gasket in position. Install bolts and lockwashers and tighten evenly to 15 foot-pounds torque.

(7) Reconnect the steering linkage at the idler arm support bracket. Tighten bolts securely.

(8) Refill the crankcase with the correct viscosity motor oil, and install the dip stick.

33. REMOVAL AND INSTALLATION OF OIL PUMP

(1) Remove the oil pan.

(2) Remove the oil pump mounting bolts, and pull pump straight down and away from rear main bearing cap.

(3) Service the oil pump as described in this section.

After the oil pump has been reconditioned, install the pump assembly, being careful to align the drive slot in the pump shaft with the distributor lower drive shaft. Install new seal rings and slide pump up into position against rear main bearing cap. Insert bolts and tighten to 30 foot-pounds torque.

(4) Reinstall the oil pan.

34. REMOVAL AND INSTALLATION OF MAIN BEARING SHELLS

Remove the oil pan and pump and proceed as follows:

(1) Loosen and remove the main bearing caps, one at a time. Insert the pin end of Tool C-3059 into the oil hole of the crankshaft, as shown in Figure 86. Slowly rotate the crankshaft clockwise forcing the upper bearing shell out of position for easy removal.

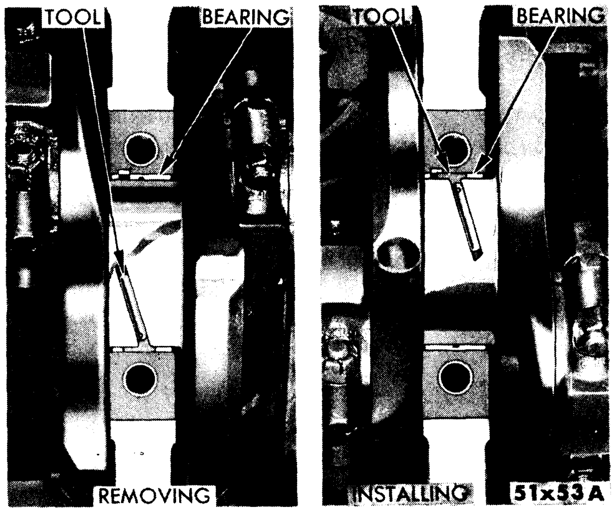

Fig. 86—Removing and Installing Main Bearing Seals

Fit new crankshaft bearing shells, as described in this section.

When tightening main bearings, start at Number Three center and work alternately toward each end. Reinstall the oil pump and oil pan.

NOTE

Though main bearing shells can be installed with engine in car, if much work is to be done on engine it is advisable to remove engine from car.

35. REPLACING THE REAR MAIN BEARING OIL SEAL

The rear main bearing oil seal, as shown in Figure 87, is of the braided asbestos type and is pressed into the upper and lower grooves behind the rear main bearing. This seal in conjunction with the helically grooved surface of the crankshaft seldom allows oil leakage at this point. However, should the lower half of this seal become damaged during servicing, replacement can be made as follows:

With the bearing cap removed, slide bearing shell out of cap, and remove the damaged seal. Pry out the cap side seals. Install new seal so that both ends of the seal protrude above the cap. Tap the seal down into position, using Tool C-3131 until the smaller end of tool is seated in the bearing cap bore. Holding the tool in this position, cut off the portion of the seal that protrudes above the bearing cap. Reinstall the bear-

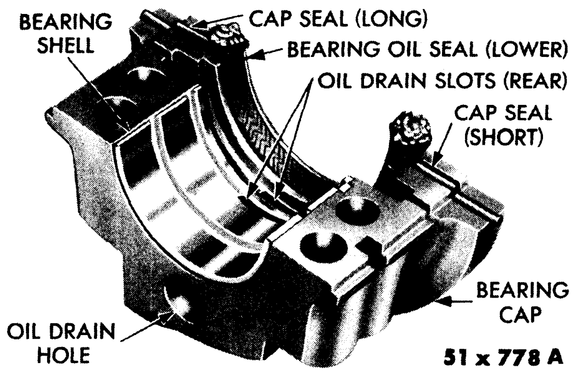

Fig. 87—Rear Main Bearing Oil Seal, Cap and Side Seals

ing shell, and install two new cap side seals. (The seal with the longer body should be installed so that when the cap is in position, the seal will be on the same side of the engine as the oil filter pad.)

Whenever the crankshaft is removed, it is, of course, advisable to replace both the upper and lower halves of the oil seal in like manner.

36. REMOVAL OF CAMSHAFT

(1) Drain cooling system and remove radiator and fan shroud.

(2) Remove the intake manifold.

(3) Remove the rocker covers and rocker shafts.

(4) Remove the push rods and hydraulic tappets.

(5) Remove the ignition distributor.

(6) Remove the chain case cover, timing chain, and camshaft gear.

(7) Remove the camshaft thrust plate bolts.

(8) Remove the distributor drive gear and stub shaft, by inserting the nose of Tool C-484 into gear slot. Compress pliers and withdraw gear and shaft, using a clockwise motion to unmesh the spiral gear.

(9) Remove camshaft.

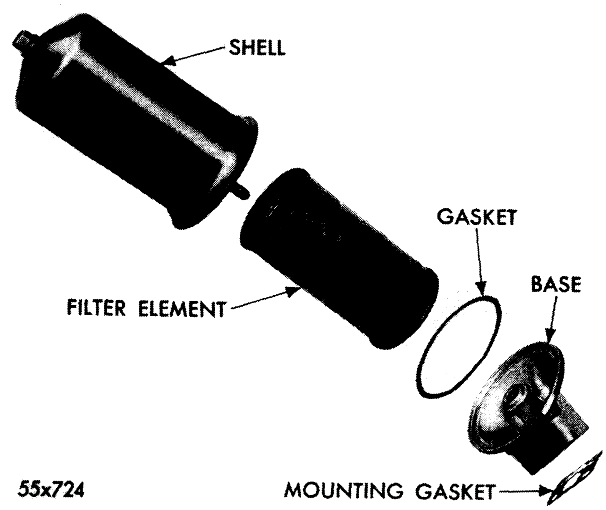

Fig. 88—Full Flow Type Oil Filter (Disassembled View)

37. REPLACING FULL FLOW TYPE OIL FILTER

To remove the oil filter from the engine, it will be necessary to remove the filter shell. (See Fig. 88).

(1) Loosen the shell retaining center stud and remove shell.

(2) Remove filter element. (This will expose the mounting bolts that hold the filter base to the cylinder block.)

(3) Remove bolts and lift filter base away from block.

When reinstalling the filter, use new gaskets.

CHRYSLER FIREPOWER V-8 ENGINE
(C-68, C-69 AND C-70 MODELS)

38. ENGINE DISASSEMBLY

The following disassembly procedures are presented as a guide and should be followed when completely overhauling the FirePower engine. (See Fig. 89). Time and labor can be saved by mounting the engine in repair stand, Tool C-888. Because of the stand's unusual design, the engine can be rotated 360 degrees to the most convenient working position.

NOTE

For servicing of components without removing engine refer to information given for servicing of components in the SpitFire engine, which is applicable to FirePower engine, except for servicing of cylinder heads.

(1) With the engine in upright position, drain

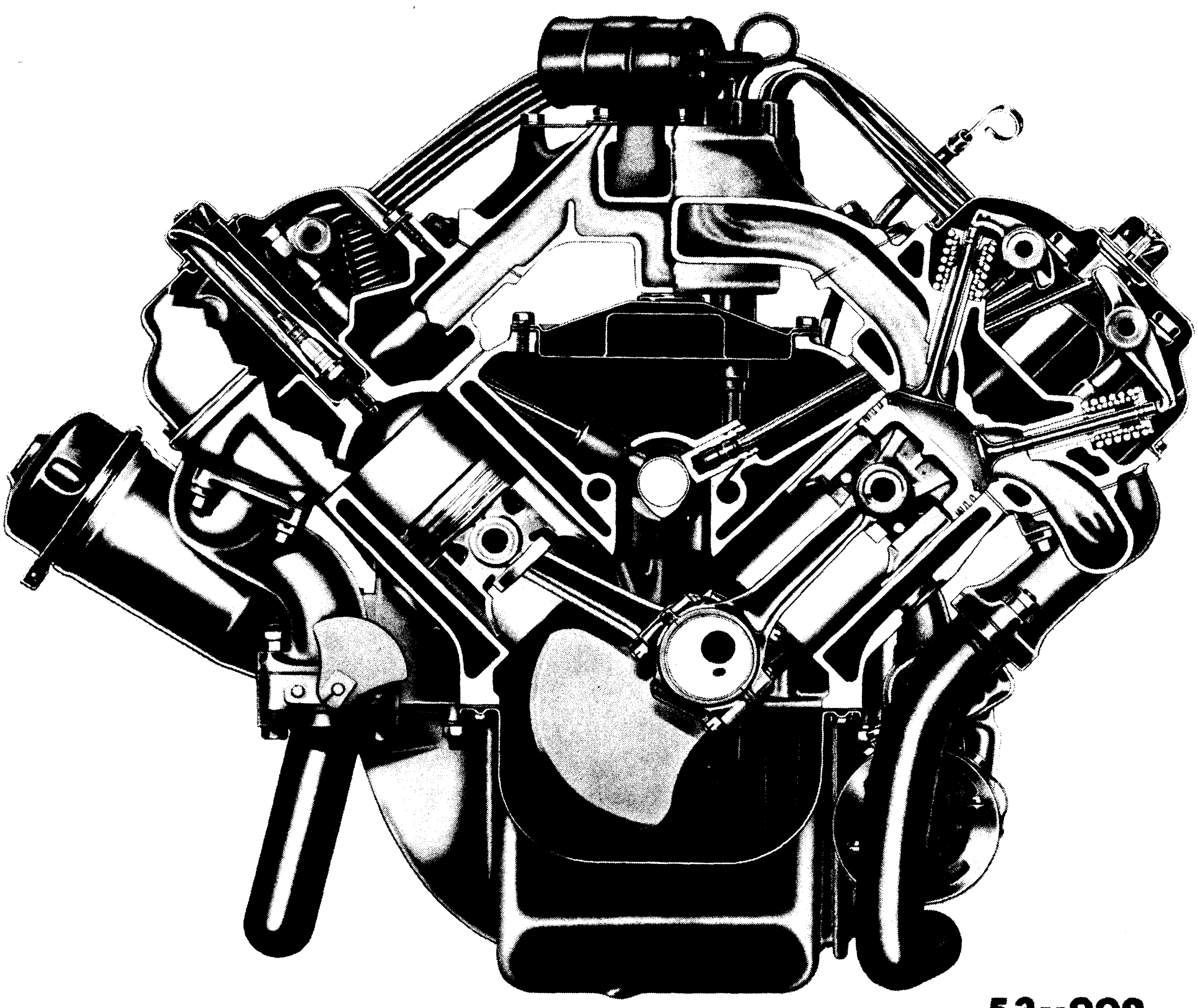

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Fig. 89—FirePower V-8 Engine (End Sectional View)

the lubricating oil from the crankcase (if not previously done).

(2) Remove the generator adjusting strap bolt, tilt generator inward, and disengage fan belt. Loosen and remove generator mounting bracket bolts and lift generator assembly up and away from engine.

(3) Remove the fuel line.

(4) Disconnect the vacuum spark advance control tube at the carburetor and distributor.

(5) Disconnect and remove the hot air tube between the integral choke and the exhaust manifold.

(6) Remove the right- and left-hand ignition cable covers, and disengage the porcelain insulators from spark plugs. Remove cables, insulators, clips, and the distributor cap from engine.

(7) Loosen and remove the distributor clamp bolt. Remove clamp and lift distributor straight up and away from engine. Remove the oil seal ring.

(8) Remove bolts and lockwashers holding the intake manifold to cylinder heads. Lift intake manifold and ignition coil up and away from heads. Discard gaskets.

(9) Remove the spark plug tube seal rings and seals. Remove the right- and left-hand rocker covers and gaskets. Discard the gaskets.

(10) Using a thin wall socket, or Tool C-3054, remove the spark plugs and tubes.

(11) Completely loosen the ten bolts on each cylinder bank that attach the rocker arm support brackets to the cylinder heads and block. Grasp the support brackets at each end of head and pull the rocker assemblies and bolts directly away from head. Remove the push rods and place them in their respective slots in holder, Tool C-3068.

WARNING

Care should be taken when removing the rocker assemblies to avoid jerking the cylinder heads off the locating dowels. This would allow them to drop and might cause personal injury.

(12) Lift off the cylinder heads and attach holding fixtures, Tool C-3038, to the heads to protect the machined surface from becoming damaged. Discard the cylinder head gaskets.

(13) After the heads have been mounted in holding fixture, remove the exhaust manifolds and discard the gaskets.

(14) Remove the crankcase ventilator outlet pipe, retaining bolt, and clip bolt at housing.

(15) Remove bolts holding valve tappet cover to cylinder block. Lift cover up and away from the block. Discard the gasket.

(16) Slide the hydraulic tappets out of the bores and place them in their respective holes in the tappet and push rod holder, Tool C-3068. This will insure installation in their original locations.

NOTE

If tappets stick in bores, due to a build up of varnish and carbon around the tappet body (after high mileage), withdraw tappet with a sharp twisting motion, using Tool C-3035. The sharp edge at the bottom of tappet bore will shave the carbon and varnish off tappet as it is withdrawn.

(17) Remove the distributor drive gear and stub shaft by inserting the nose of Tool C-484 into gear slot. Compress pliers and with-

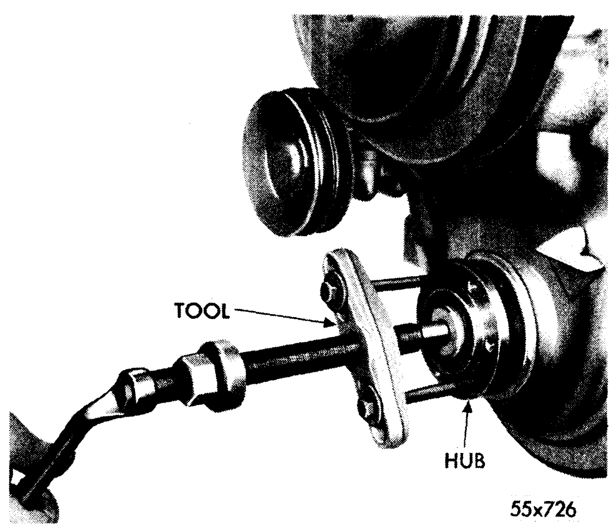

Fig. 90—Removing Hub From Crankshaft

draw gear and shaft, using a clockwise motion to unmesh spiral gear.

(18) Loosen the bolts holding the fan belt idler pulley. Push pulley toward block to release fan belt. Remove both belts.

(19) Remove bolts and lockwashers that hold fan blades and pulley to hub. Slide blades and pulley off hub and away from engine.

(20) Remove the bolt and flatwasher holding the vibration damper on crankshaft. Remove two of the damper bolts and install Tool C-3033, as shown in Figure 90. Pull damper assembly off end of crankshaft.

(21) Remove bolts holding fuel pump to chain case cover. Pull pump straight out and away from engine. Discard the gasket.

(22) Remove the water pump housing and discard the gasket.

NOTE

Before removing piston and rod assemblies, remove the top ridge of bore (if present) with a reliable ridge reamer, or Tool C-3012. Be sure to keep the tops of pistons covered during this operation.

(23) Remove bolts holding oil pan to crankcase. Lift oil pan straight up and away from engine. Discard the gaskets and seals.

(24) Using special box wrench, Tool C-455, remove the two starting motor mounting bolts. Ease starter out of housing.

(25) Remove the full-flow oil filter. Lift filter away from block and discard the gasket.

(26) Remove bolts holding the chain case cover to cylinder block and work cover off locating dowels.

(27) Remove the bolts which hold the oil pump to the rear main bearing cap. Pull pump and strainer up and away from cap with a slight twisting motion. Discard the oil seal ring.

NOTE

When removing piston and connecting rod assemblies from engine, rotate the crankshaft so that each connecting rod is centered in the cylinder bore, and proceed as follows:

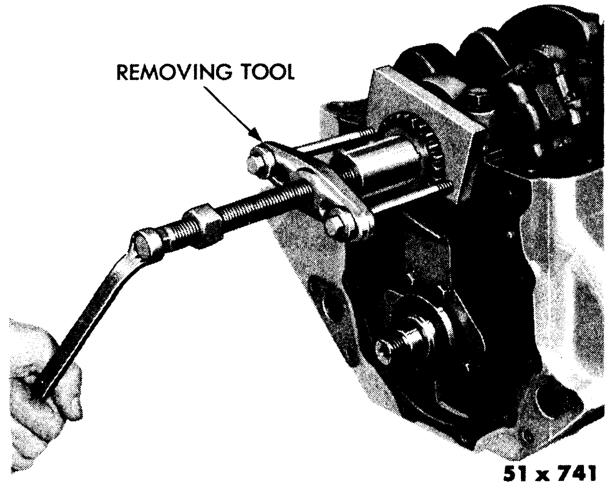

Fig. 91—Removing Crankshaft Timing Gear

(28) Remove the nuts that hold the cap to connecting rod. Remove cap and bearing shell and install Tool C-3047 on one connecting rod bolt and the protector over the other. Push piston and rod assembly out of cylinder bore.

Repeat this operation each time a piston and rod assembly is removed. After removal, install bearing cap to prevent the possibility of interchanging parts.

(29) Slide the oil slinger off end of shaft. Remove the camshaft sprocket hub nut and fuel pump eccentric. Pull camshaft sprocket off shaft and, at the same time, disengage the timing chain.

(30) Loosen and remove the bolts holding the main bearing caps to block. Hit the caps lightly on the side to loosen. Lift off main bearing caps and bearing shells.

NOTE

If it is necessary to remove the crankshaft timing gear, install Tool C-3033, as shown in Figure 91. Pull gear from end of crankshaft. Drive out the woodruff key.

(31) Form a heavy rope sling and wrap it around the Number Three and Four crankpin journals. Hoist the crankshaft and torque converter straight up and away from cylinder block. Remove the upper main bearing shells and rear main bearing upper seal.

(32) Remove the four camshaft thrust plate attaching bolts and lift off oil trough.

(33) Pull out the camshaft. Be careful not to damage the cam bearings with the cam lobes. Drive out the rear cam bearing welch plug.

(34) Install the proper size adapters and horseshoes (part of Tool C-3132) at the back of each bearing to be removed. Drive out the bearing shell.

(35) Remove the oil gallery plugs at the rear of block.

39. CYLINDER BLOCK

a. Cleaning

Whenever the engine is to be completely overhauled and the cylinder block is stripped, the block should be thoroughly cleaned and inspected for any condition that might render it unfit for further service.

Live steam or a suitable degreasing tank should be used. After cleaning a cylinder block, be sure to blow out all passages thoroughly with compressed air.

b. Inspection

Pay particular attention to the various core hole plugs and replace if necessary. When installing new core hole plugs, coat the edges of plug and core hole with a suitable sealer, then drive in place, using Tool C-897, as shown in Figure 92. Examine the cleaned block for minute cracks or fractures and all machined surfaces for burrs or scoring.

Fig. 93—Reaming Tappet Bores (Typical)

Check the tappet bores for badly scored surfaces, if the tappet or bore is badly scored, scuffed or shows signs of sticking, ream the bore to the next oversize using Tool C-3028, as shown in Figure 93, and install a new tappet. Tappets are available in standard and the following oversizes: .001, .008 and .030 inch.

NOTE

A diamond mark on engine serial number pad indicates .008 inch oversize tappet bores.

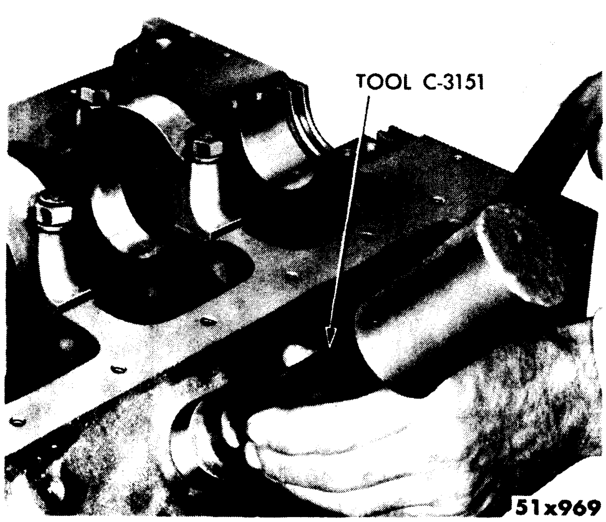

Fig. 92—Installing Cylinder Block Core Hole Plugs

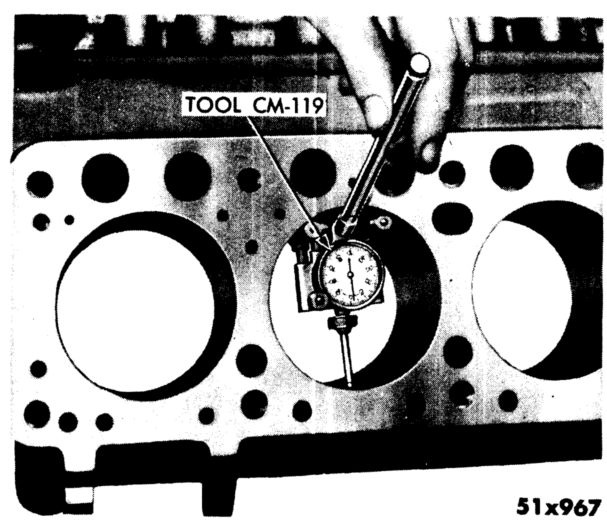

Fig. 94—Checking Cylinder Bores For Out-Of-Round or Taper

c. Checking Cylinder Bores

The cylinder bores should be checked for out-of-round and taper, using Tool CM-119, as shown in Figure 94. Check each bore at the top, bottom, crosswise and lengthwise to determine what variation exists.

If the 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.

d. Honing Cylinder Bores

To remove light scoring, scuffing, or scratches from the cylinder walls, use Tool C-823, as shown in Figure 95. Usually one or two "passes" will clean up a bore and still maintain required limits. After honing, remove all traces of abrasives. The hone may safely be used for removal of metal from .010 to .015 inch by an experienced operator.

e. Reboring Cylinder Bores

Cylinder walls which are badly scored, scuffed, scratched, or worn beyond the specified limits should be rebored. Boring Bar, Tool 377-S, as shown in Figure 96, contains a special feature for setting the cutter under positive control.

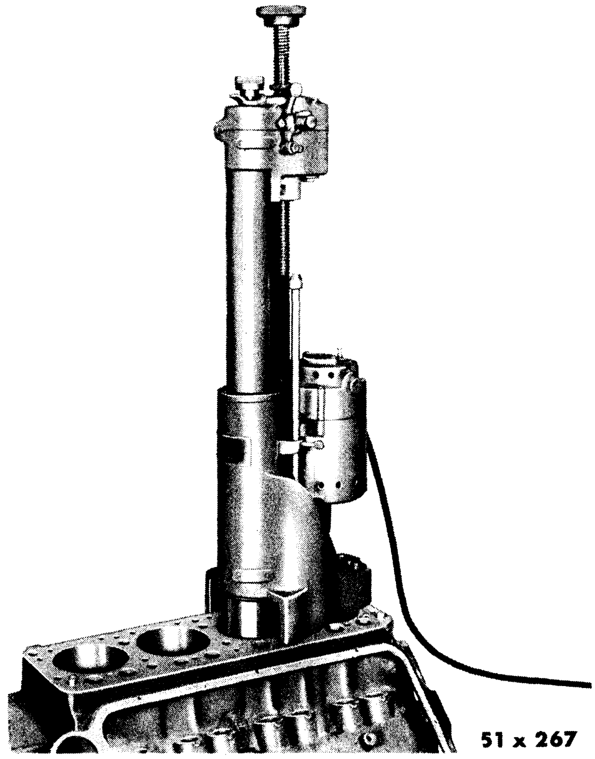

Fig. 96—Boring Cylinders (Tool 377-S)

Whatever type of boring equipment is used, the boring operation should be closely co-ordinated with the fitting of pistons and rings in order that specifications may be maintained.

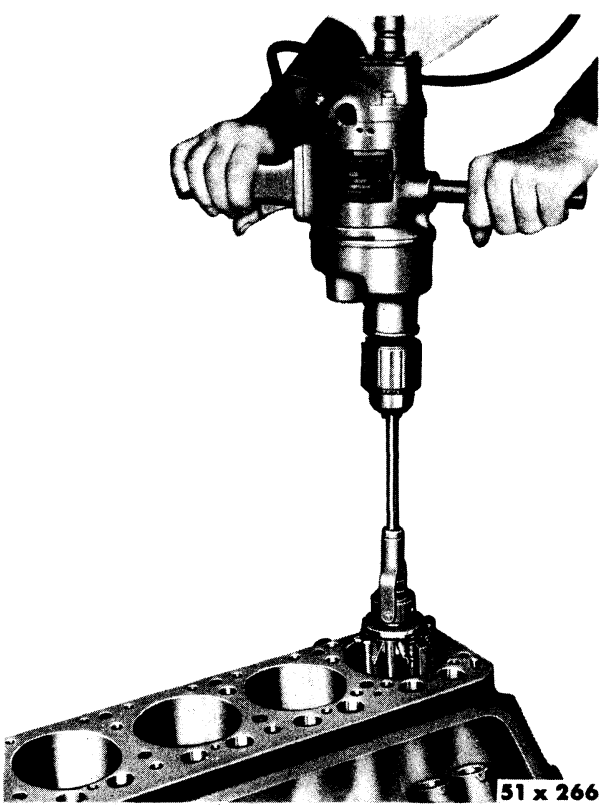

Fig. 95—Honing Cylinder Bores

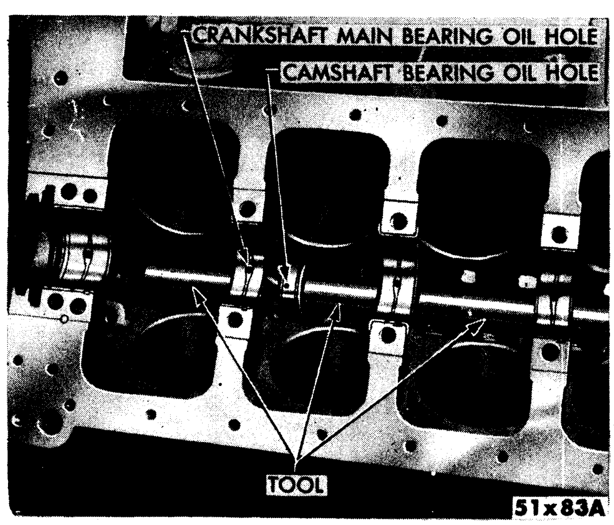

Fig. 97—Installing Camshaft Bearing Shells (Tool C-3034)

40. CAMSHAFT AND CAMSHAFT BEARINGS INSTALLATION

(1) Coat a new welch plug with a suitable sealer and install in the cylinder block at the rear cam bearing, using Tool C-897. Coat the main oil gallery plugs with sealer, then install in the block. Tighten securely.

(2) Mount the cylinder block in the repair stand. Install the new camshaft bearing shells as follows: Slide new bearing shell over adaptor and insert in position, as shown in Figure 97. Install the horseshoe lock and drive in place. Install the remaining bearing shells in like manner.

NOTE

Be sure the oil holes in the cam bearing shell and cylinder block are in exact alignment. Check each bearing shell by inserting pencil flashlight in shell. The complete circumference of the camshaft bearing oil hole should be visible by looking through the main bearing drilled oil passage. If camshaft bearing oil hole is not in exact alignment, remove bearing shell and reinstall.

The above information is particularly important when installing the Number Two and Four camshaft bearing shells, as the lubrication of the valve operating mechanism depends on correct alignment of these two shells.

(3) Install the camshaft thrust plate on camshaft (if removed), insert key and press on the hub. Insert feeler gauge between hub and thrust plate to check for correct clearance. The clearance should be from .002 to .006 inch.

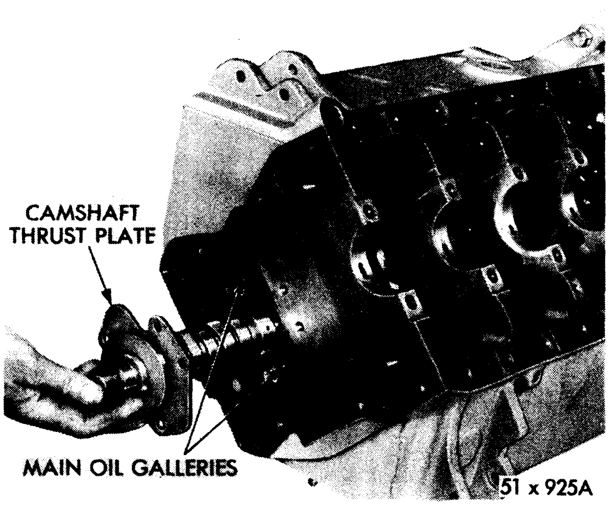

Fig. 98—Installing Camshaft

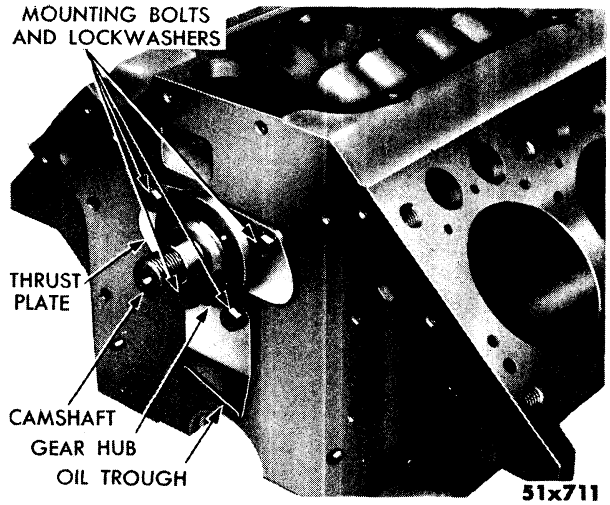

Fig. 99—Camshaft, Thrust Plate and Gear Hub Installed

(4) Lubricate all camshaft bearings. Install camshaft and thrust plate, as shown in Figure 98. Place the oil trough in position and install bolts and lockwashers. Tighten bolts to 15 foot-pounds torque. (See Fig. 99). Do not allow the camshaft lobes to ride on bearings when installing the camshaft, as damage to the bearings will result.

41. REAR MAIN BEARING OIL SEAL INSTALLATION

(1) Install a new rear main bearing oil seal in the block so that both ends protrude. Tap the seal down into position, with Tool C-3131, until tool is seated in the bearing bore. Hold the tool in this position, then cut off the portion of the seal that extends above the block on both sides.

(2) Install a new seal in bearing cap (bearing shell removed) so that the ends protrude. Tap seal down into position with Tool C-3131, as shown in Figure 100, until tool is seated. Trim off the portion of the seal that protrudes above cap. Install the two cap side seals in the grooves in the 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.

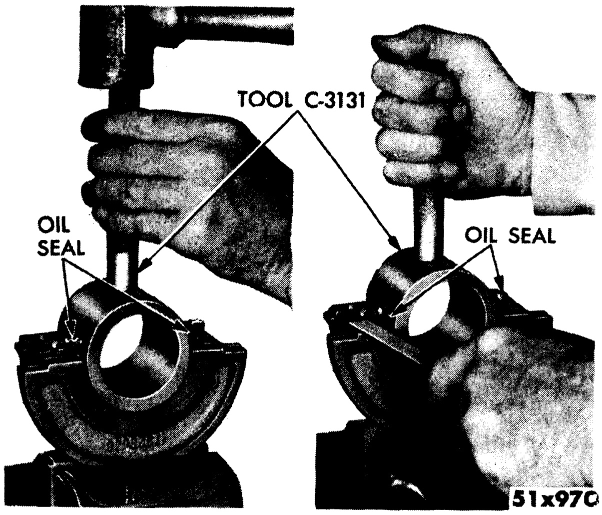

Fig. 100—Installing Rear Main Bearing Oil Seal

42. MAIN BEARINGS

The halves of Numbers One, Two and Four bearings are interchangeable with one another. (The caps are not interchangeable and extreme care should be used in replacing them in their correct position.) Number Three bearing, which controls the crankshaft end thrust, is not interchangeable with the others. The upper and lower halves of Number Three bearing, however, are interchangeable with each other. Number Five bearing halves are not interchangeable.

Bearing shells are available in .001, .002, .003, .010, and .012 inch undersizes.

The desired main bearing clearance is .0005 to .0015 inch. To determine if the clearance is within these limits, proceed as follows:

a. Installation

(1) Check each bearing shell carefully for a scored, chipped, or etched condition. Replace damaged bearing shells, as shown in Figure 101.

(2) Lubricate all bearing shells with engine oil, then carefully lower crankshaft, and clutch, or torque converter (if so equipped), directly down on the bearing shells. The crankshaft should be lowered evenly and square with block to prevent damage to the bearings.

b. Checking Clearance

(1) Install the bearing shell in the cap. Start at the center main bearing; place a piece of oiled .001 inch feeler stock (½ inch wide and 1 inch long) between bearing and crankshaft journal, as shown in Figure 102. Install the bolts and lockwashers. Tighten bearing cap bolts to 85 foot-pounds torque.

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

(2) At the final tightening of main bearings (after all bearings have been fitted), tighten

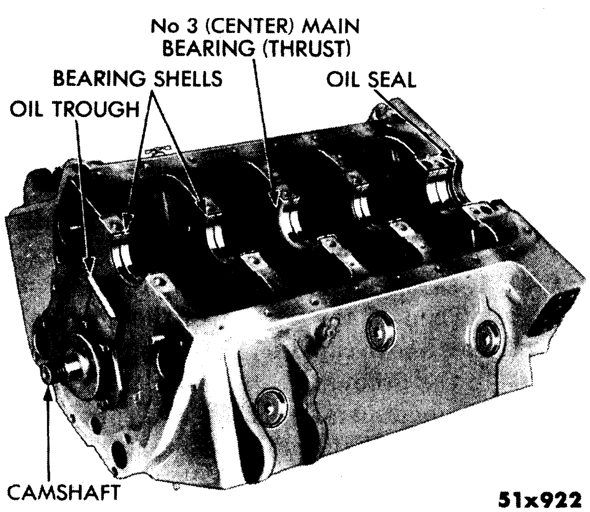

Fig. 101—Crankshaft Main Bearing Shells Installed

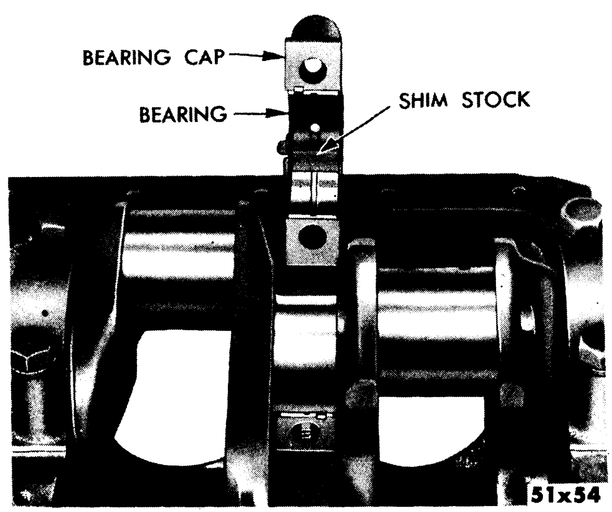

Fig. 102—Checking Main Bearing Clearance With Shim Stock

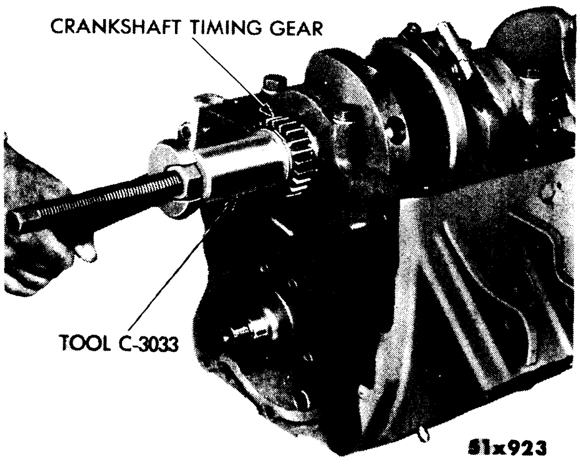

Fig. 103—Installing Crankshaft Timing Gear

the Number Three center main bearing thrust first, then work alternately to the ends.

(3) Check the crankshaft end play with a dial indicator. The end play should be .002 to .007 inch.

43. TIMING GEAR AND CHAIN

a. Installation

(1) Insert the crankshaft timing gear key in slot and install gear with the timing mark out. Press on shaft, using Tool C-3033, as shown in Figure 103.

(2) Rotate the crankshaft until the mark on the timing gear is exactly in line with the center of the camshaft. Temporarily install the camshaft gear (less chain) and line up the dowel pin holes in the hub and the gear, while at the same time, positioning the camshaft gear mark exactly in with the center of the crankshaft (See Fig. 104). A straightedge should be used to check the accuracy of this alignment.

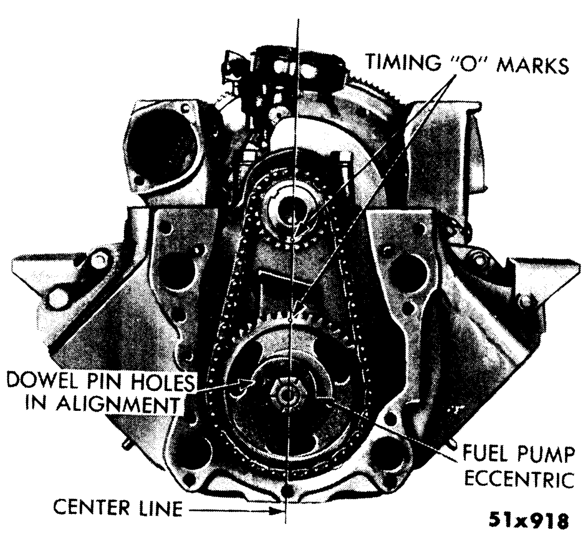

Fig. 104—Timing Marks On Camshaft and Crankshaft Gears

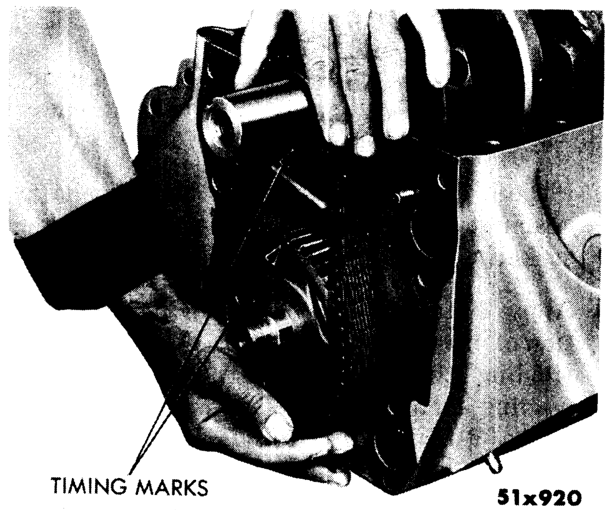

Fig. 105—Installing Timing Chain and Camshaft Gear

(3) Remove the camshaft gear and engage with timing chain. Place timing chain over crankshaft gear and, at the same time, slide the camshaft gear over the end of camshaft, keeping the timing mark in position, as shown in Figure 105.

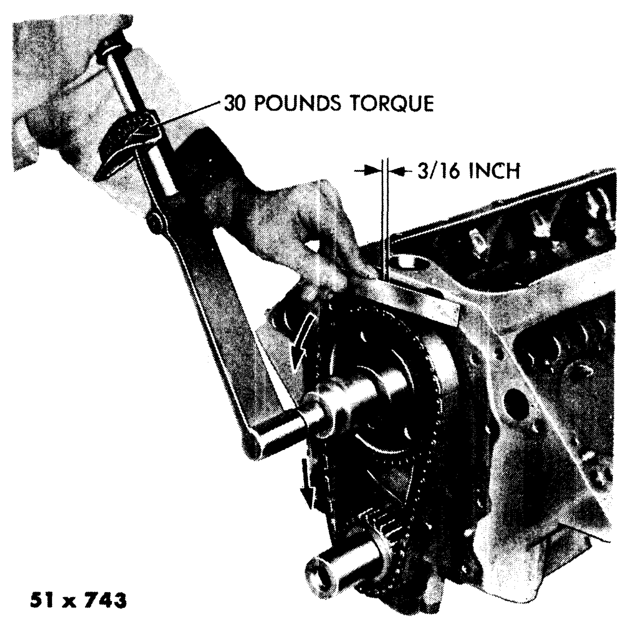

Fig. 106—Measuring Timing Chain Stretch

b. Checking Chain For Stretch

Place a scale across the top of camshaft gear (chain installed), with the dimensional edge close to the chain, then proceed as follows:

(1) Place a $1\frac{1}{4}$ inch socket over the camshaft gear nut and attach a torque wrench to the socket.

(2) Apply 30 foot-pounds of torque in the direction of crankshaft rotation to take up slack. Holding the scale with the dimensional reading even with the edge or a chain link, apply 30 foot-pounds torque in the reverse direction and note the amount of chain rotation. (See Fig. 106.) If the movement of the chain is greater than $\frac{3}{16}$ inch, as indicated by the stationary scale, install a new timing chain.

NOTE

With 30 foot-pounds of torque applied to the cam shaft gear nut, the crankshaft should not move. However, if there is any movement the crankshaft should be blocked to prevent rotation.

(3) With the timing marks aligned, push gear on camshaft and install the fuel pump eccentric, as shown in Figure 107. Install nut and tighten to 125 foot-pounds torque.

(4) Slide the crankshaft oil slinger over shaft and up against gear (flange away from gear).

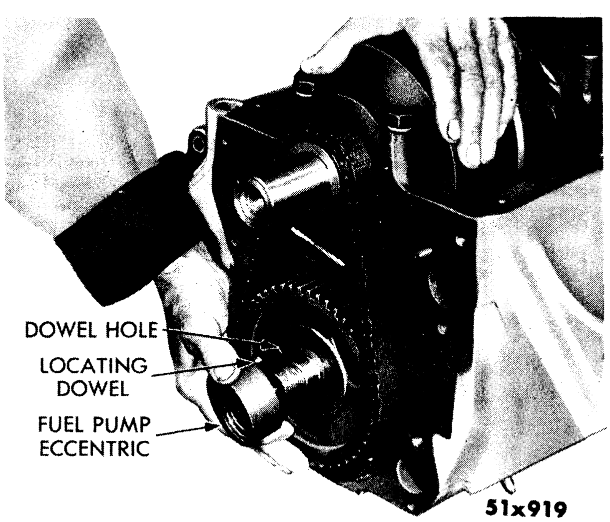

Fig. 107—Installing Fuel Pump Eccentric

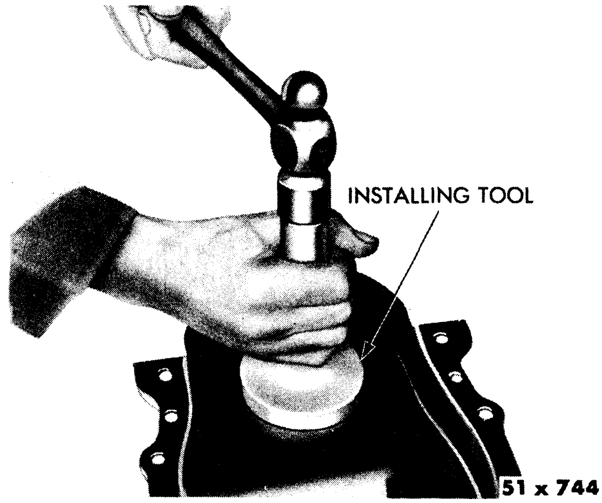

Fig. 108—Installing Chain Case Cover Oil Seal (Typical)

44. TIMING CHAIN CASE COVER INSTALLATION

Use Tool C-3050 to drive out the oil seal from the front of the chain case cover. Lift out the gasket. Place a new gasket in position, and position a new seal with the protecting flange of the seal facing the inside of cover. Drive the seal into position, using Tool C-3051, as shown in Figure 108.

(1) Be sure the mating surface of the chain case cover and the cylinder block are clean and free from burrs. Install a new gasket.

(2) Slide chain case cover over locating dowels and, using a soft hammer, tap cover in place. Install bolts and washers after coating with

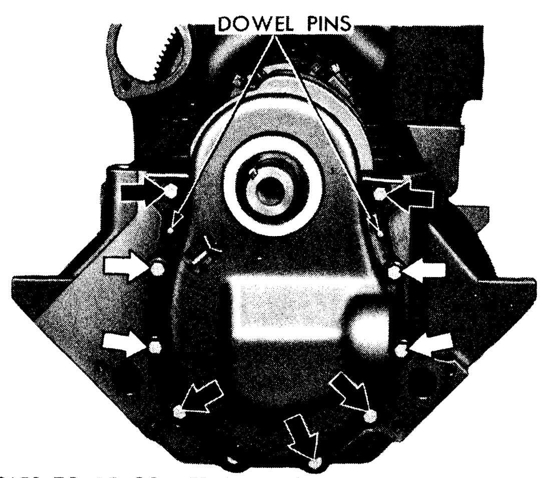

Fig. 109—Chain Case Cover Installed (Typical)

a suitable sealer. (See Fig. 109.) Tighten bolts to 15 foot-pounds torque.

45. PISTONS, PINS AND RINGS

a. Fitting Pistons

New pistons (if required) should be fitted to the cylinder bore with the greatest accuracy and care. The recommended clearance between the thrust face of piston and cylinder wall is .0005 to .0015 inch, measured with a micrometer and dial indicator. The clearance can also be checked with a .0015 inch feeler stock (½ inch wide) on spring scale, Tool C-690, as follows:

(1) Starting with the Number one cylinder, coat the bore very lightly with SAE 10W engine oil. Insert the piston in the bore, upside down, with the feeler stock between the piston (thrust face) and the cylinder wall.

(2) Holding the piston, draw the feeler stock out straight with the spring scale, as shown in Figure 110. The amount of pull necessary to withdraw feeler stock should be from 5 to 12 pounds.

(3) Fit remaining pistons in like manner.

Due to the necessity of maintaining piston balance, all pistons are machined to the same weight in grams, regardless of oversizes. Only finished pistons are available for service and are supplied in standard and the following oversizes: .005, .020, .030, .040, and .060 inch.

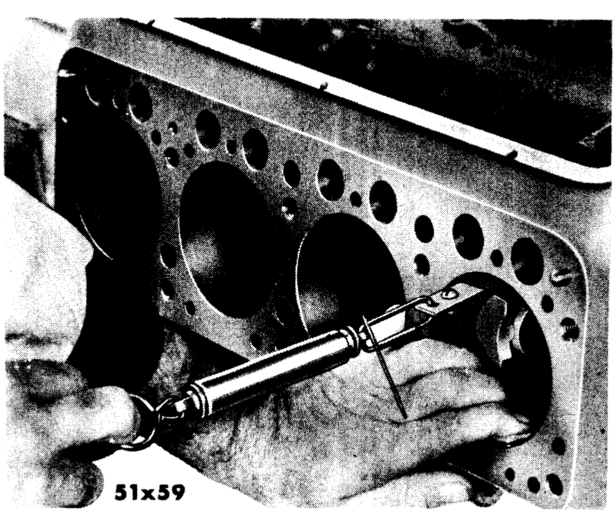

Fig. 110—Fitting Pistons To The Cylinder Bore

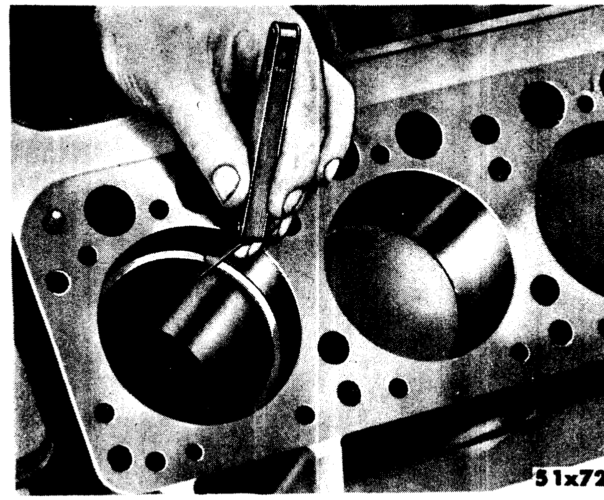

Fig. 111—Checking Ring Gaps In Bore

When selecting pistons for installation (new) be sure to secure pistons for the FirePower V-8 engine. The SpitFire V-8 engine pistons are not interchangeable with the FirePower V-8 engine.

b. Fitting Rings

(1) Measure the piston ring gap about 2 inches from the top of the cylinder bore, to which it is to be fitted. (An inverted piston can be used to push the rings down into position.) This will insure the rings being exactly square with the cylinder wall before measuring.

(2) Insert feeler stock in gap and take measurement, as shown in Figure 111. The ring gap

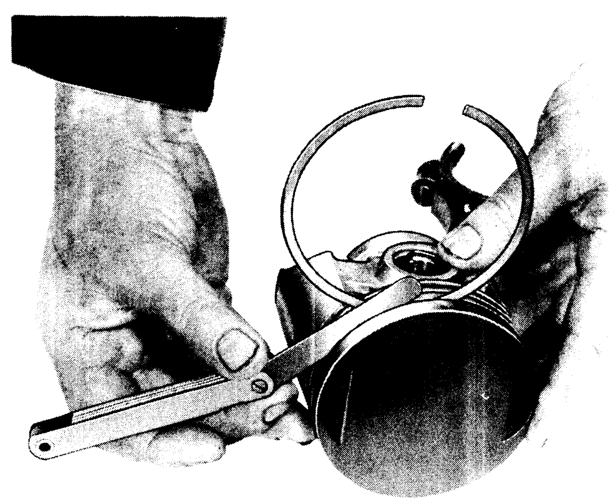

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Fig. 112—Checking Piston Ring Groove Clearance

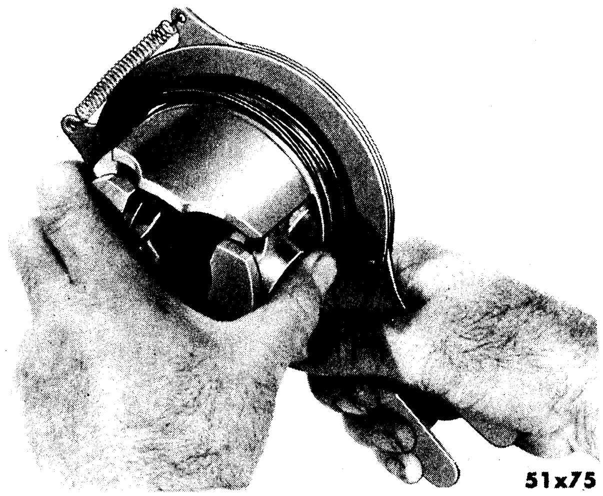

Fig. 113—Removing or Installing Piston Rings (Tool C-469)

should be between .010 and .020 inch. This measurement is constant for all rings.

(3) Measure the clearance between piston ring and ring groove, as shown in Figure 112. This clearance should be .002 to .0035 inch for the compression rings and .001 to .0025 inch for the oil control ring.

After the clearances have been checked on all rings, install rings on pistons.

(4) Start with the oil ring expander, place expander ring in lower ring groove. Then install oil control ring and compression rings, using Tool C-469, as shown in Figure 113.

NOTE

The oil control ring must be installed with the gap toward the "V" of the engine.

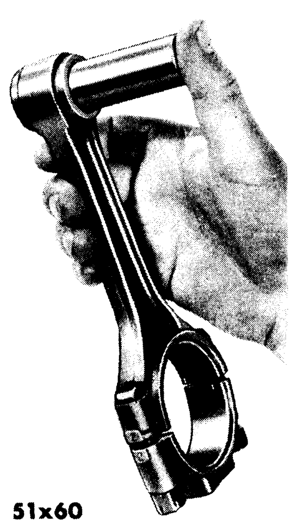

Fig. 114—Fitting Piston Pin In Connecting Rod

Fig. 115—Fitting Piston Pin In Piston

c. Fitting Pins

(1) Test piston pin fit in the connecting rod, as shown in Figure 114. This should be a tight thumb-press fit at normal room temperature.

(2) Test piston pin fit in piston, as shown in Figure 115. This should also be a tight thumb-press fit at normal room temperature.

Piston pins are supplied in standard and the following oversizes: .003 and .008 inch.

When using expansion reamer, Tool C-3200, to fit piston pins, shown in Figure 116, be careful and take a very light cut. Ream and try fit—ream and try again, until piston pin can be pushed into the piston or connecting rod, as described above.

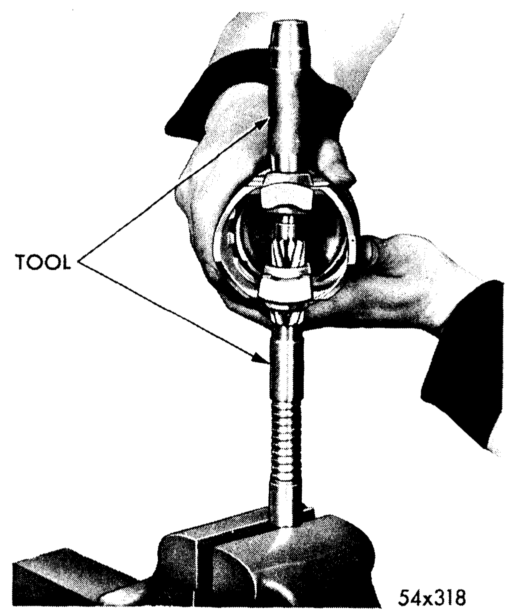

Fig. 116—Reaming Piston With Tool C-3200

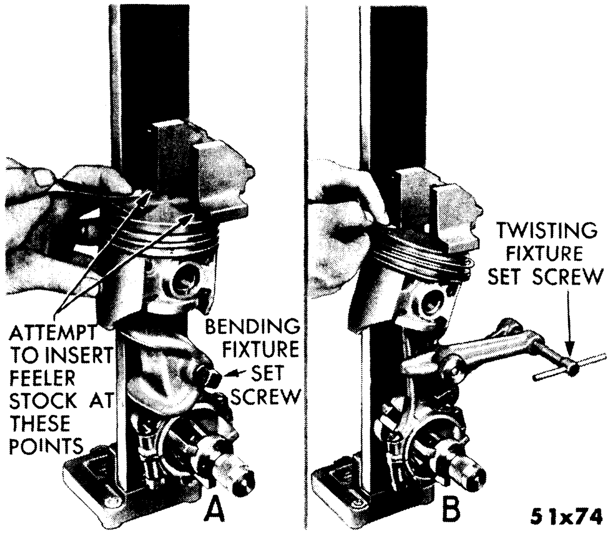

Fig. 117—Checking Connecting Rod and Piston For Alignment

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

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

46. CONNECTING RODS

a. Checking Rod Alignment

(1) **Check for Bend**—Install the connecting rod and piston in Figure 117. The top of the piston should be flush with the tool. The clearance between the piston and tool, at the point shown in "A", should be zero (0) ; however, a .002 inch variation is allowable. If more than .002 inch, the piston and connecting rod should be disassembled and the rod straightened or replaced. (See Figure 118).

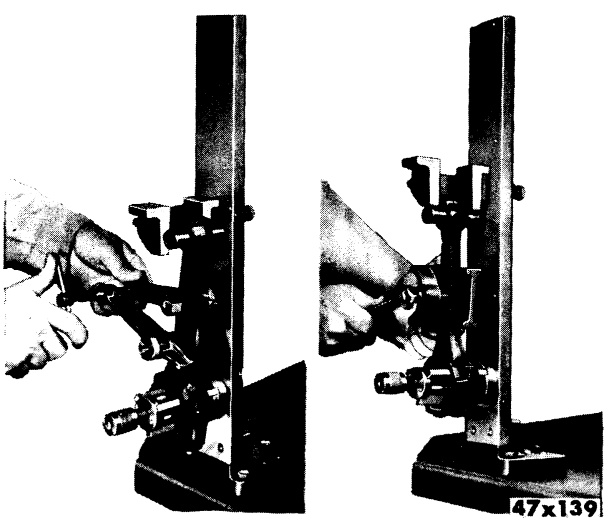

Fig. 118—Correcting Connecting Rod Bend or Twist

(2) **Check for Twist**—With the connecting rod and piston assembly installed in fixture, Tool C-481, tilt the piston, as shown in Figure 117 "B". The clearance between the tool and the top of piston should be zero (0). A .002 inch variation is allowable. However, if more than .002 inch, the piston and connecting rod should be disassembled and the rod checked, as outlined in the preceding paragraph.

b. Installing Bearings

The method of fitting connecting rods, as described, is accomplished without inserting the piston and rod in the cylinder bore, thereby eliminating any possible drag that might be caused between the piston and the cylinder wall.

NOTE

Fit all the 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 the "V"-groove in the shell is in line with the "V"-groove in the cap. (Fig. 119.) This is to allow lubrication of the cylinder wall. The bearing shells should always be installed so that the small formed tang fits into the machined grooves of the rods.

Limits on the taper or out-of-round on any crankshaft journal should be held to .001 inch. Undersize bearings should be installed if the crankshaft journals are worn enough to increase the bearing clearance above specifications.

c. Checking Clearance

The desired connecting rod bearing shell clearance is from .0005 to .0015 inch, with a side play of .006 to .014 inch, and may be checked as follows:

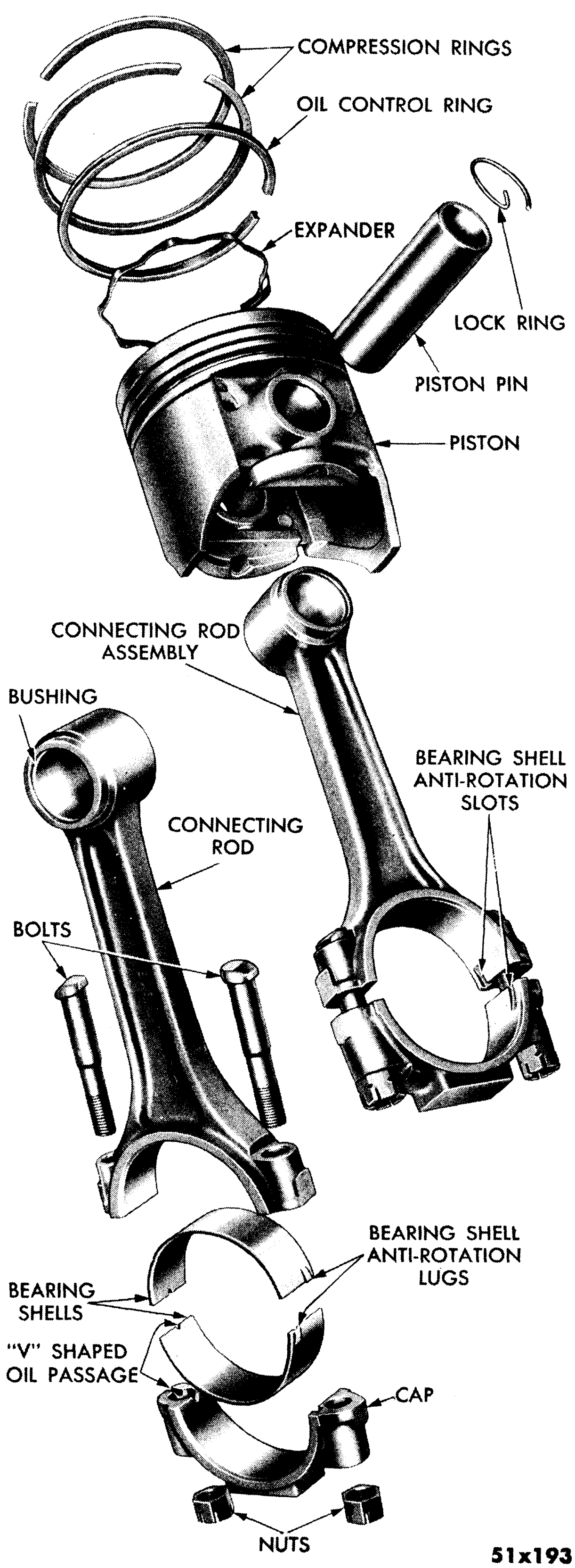

Fig. 119—Connecting Rod (Disassembled View)

(1) Place a piece of oiled .001 inch feeler stock (½ inch wide and ¾ inch long) between the bearing shell and crankshaft journal. Install the bearing cap and tighten the nuts to 45 foot-pounds torque.

(2) Move the connecting rod and piston from side to side, as shown in Figure 120. A slight drag should be felt as the rod is moved. This will indicate that the clearance is .001 inch or less, which is satisfactory. If the connecting rod is difficult to move, the bearing shell is too small and should be replaced with the correct size. Fit remaining connecting rod bearing shells in like manner.

d. Installing Piston and Connecting Rod Assembly in Cylinder Block

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

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

(2) Screw the connecting rod bolt protector (part of Tool C-3221) on one rod bolt, then insert rod and piston into cylinder bore. At-

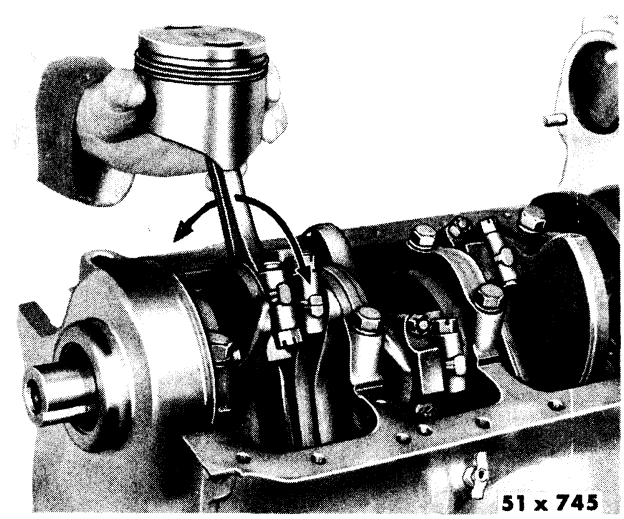

Fig. 120—Checking Connecting Rod Bearing Clearance (Typical)

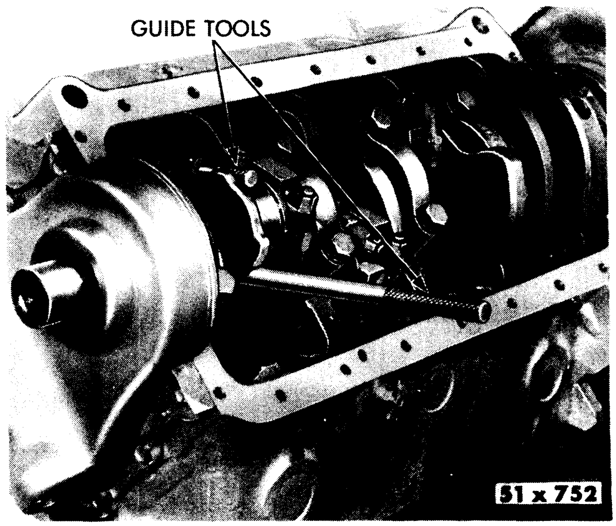

Fig. 121—Guiding Connecting Rod Over Crankshaft

tach the puller part of Tool C-3221 on the other bolt, and guide the rod over the crankshaft journal, as shown in Figure 121.

(3) Tap the piston down in the cylinder bore, using the handle of a hammer, as shown in Figure 122, and at the same time, guide the connecting rod into position on the crankshaft journal. The marking on the top of the piston must be pointing toward the front of engine. As a double check, the larger chamfer of the connecting rod bore must be installed toward the crankshaft journal fillet.

(4) Install the bearing caps and nuts. Tighten nuts to 45 foot-pounds torque.

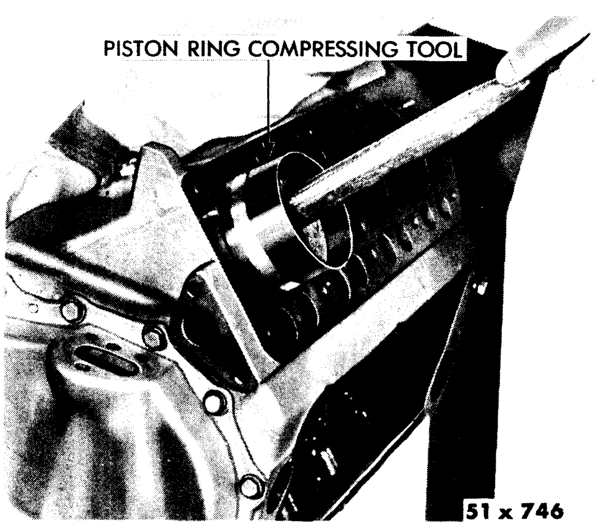

Fig. 122—Installing Connecting Rod, Piston and Rings (Typical)

47. OIL PUMP

a. Disassembly

Refer to Figure 123, and proceed as follows:

(1) Remove the cotter pin holding the oil strainer to the oil pump suction pipe and remove suction pipe from the oil pump body.

(2) Remove the oil pump cover bolts and lock-

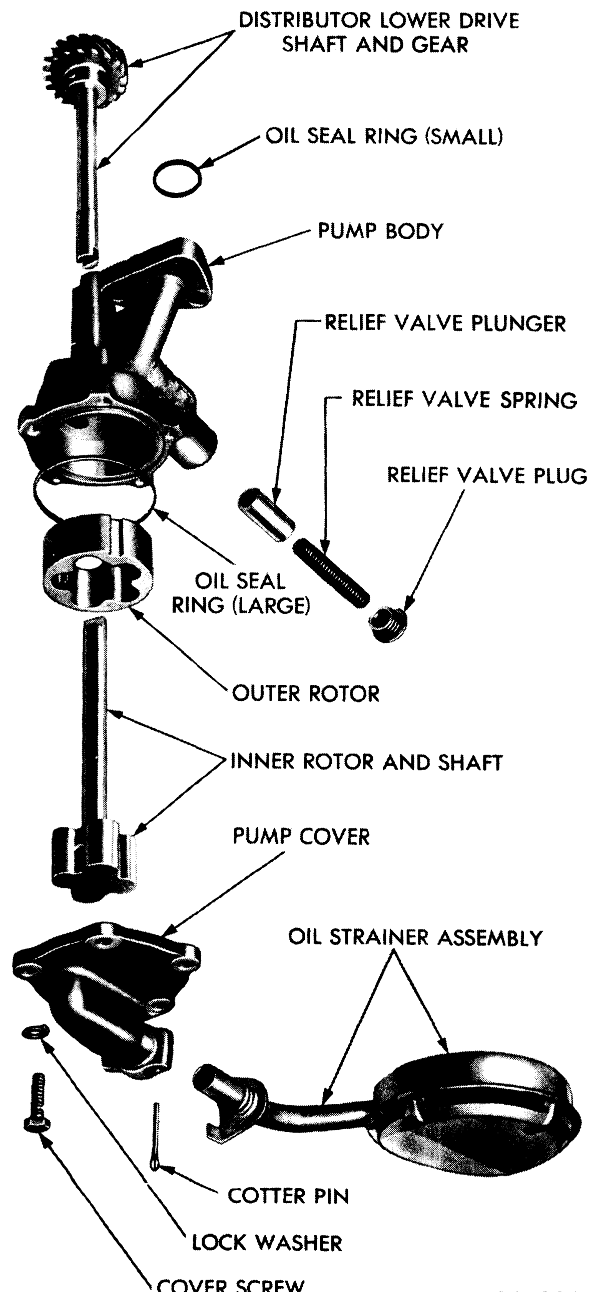

Fig. 123—Oil Pump (Disassembled View)

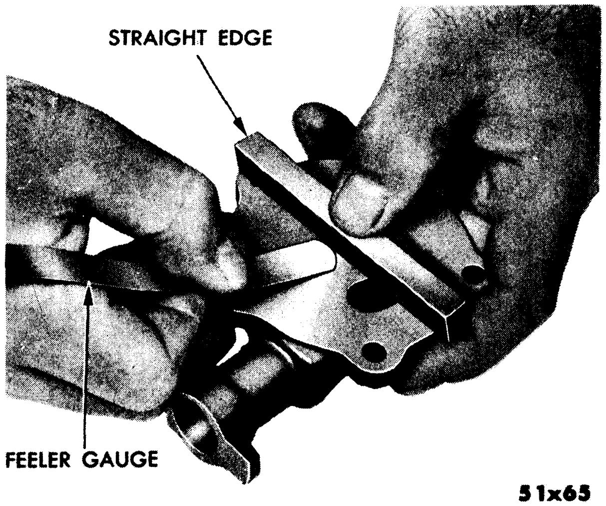

Fig. 124—Checking Oil Pump Cover

washers and lift off the cover. Discard the oil seal ring.

(3) Remove the pump rotor and shaft, then lift out the pump rotor body.

(4) Remove the oil pressure relief valve plug, and lift out the spring and plunger.

Wash all parts in a suitable solvent, and inspect carefully for damage or wear.

b. Inspection and Repair

(1) The mating face of the oil pump cover should be smooth. If the cover is scratched or grooved, replace cover.

(2) Check for excessive cover to rotor wear, by laying a straightedge across the cover surface, as shown in Figure 124. If a .0015 inch feeler gauge can be inserted between cover and straightedge, the cover should be replaced.

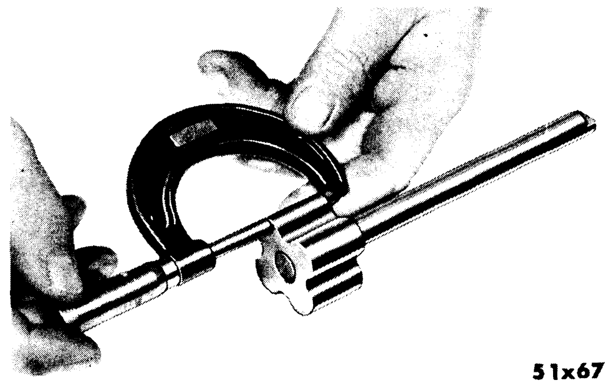

Fig. 126—Measuring Thickness of Pump Rotor

(3) Measure the diameter and thickness of the rotor body, as shown in Figure 125. If the rotor body measures less than .998 inch and the diameter less than 2.244 inches, replace rotor body.

(4) Measure the thickness of the pump rotor, as shown in Figure 126. If the pump rotor measures less than .998 inch, a new pump rotor should be installed. Slide the rotor body and rotor into pump body and then place a straightedge across the face (between bolt holes), as shown in Figure 127. If a feeler gauge of more than .004 inch can be inserted between rotors and straightedge, replace pump body.

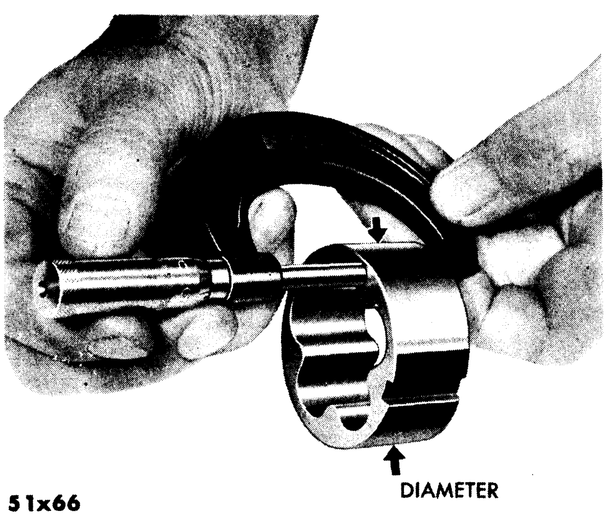

Fig. 125—Measuring Thickness of Rotor Body

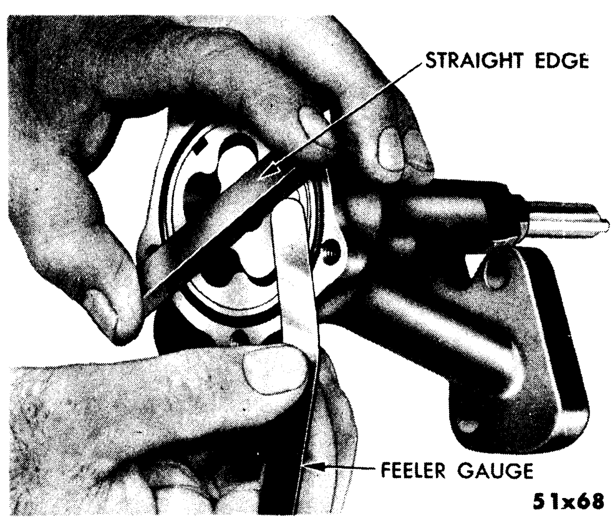

Fig. 127—Measuring Clearance Over Pump Rotors

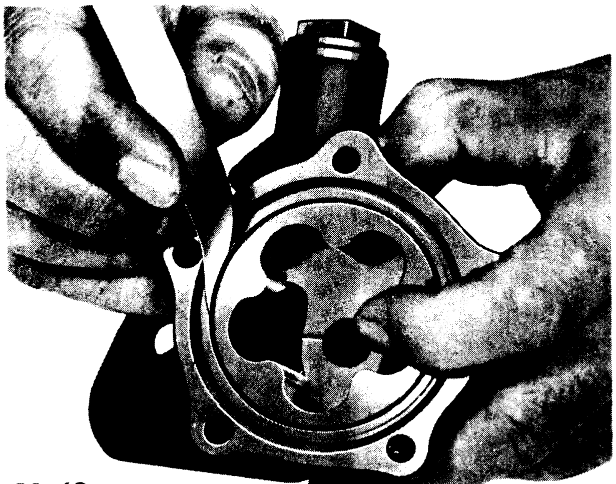

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Fig. 128—Measuring Clearance Between Rotor Body and Pump Body

(5) Remove the pump body and shaft, leaving rotor body in pump cavity. Press the rotor body to one side with the fingers and measure the clearance between the rotor and pump bodies, as shown in Figure 128. If the measurement is more than 0.12 inch, replace oil pump body.

(6) Check the clearance between the pump rotor and rotor body, as shown in Figure 129. If measurement is more than .010 inch, replace pump rotor and rotor body.

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

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

(9) Prime the oil pump, then place a new oil seal ring in the pump mounting face.

c. Inspecting Oil Pressure Relief Valve

The oil pressure relief valve is located in the oil pump body and consists of a plunger, spring and plug.

To inspect the oil pressure relief valve, it will be necessary to unscrew the plug and remove the spring and plunger. Remove any dirt or foreign material, clean thoroughly.

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

The valve chart spring shows the spring available for installation, depending on the condition existing.

RELIEF VALVE SPRING CHART

Color	Free Height	Under-Load Height	Tension Pounds
Gray (Light) . .	$2\frac{1}{16}$ inch	$3\frac{1}{32}$ inch	16.1—17.1
Red (Standard)	$2\frac{1}{16}$ inch	$2\frac{27}{32}$ inch	19.5—20.5
Brown (Heavy)	$2\frac{1}{16}$ inch	$2\frac{31}{32}$ inch	22.9—23.9

d. Installation

(1) Install the strainer on the end of the suction tube and secure with a cotter pin.

(2) Install the suction tube into the pump body.

(3) Install the oil pump, suction tube, and strainer to the rear main bearing cap. Tighten the mounting bolts to 35 foot-pounds torque.

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

(5) Using a new set of gaskets and seals, install

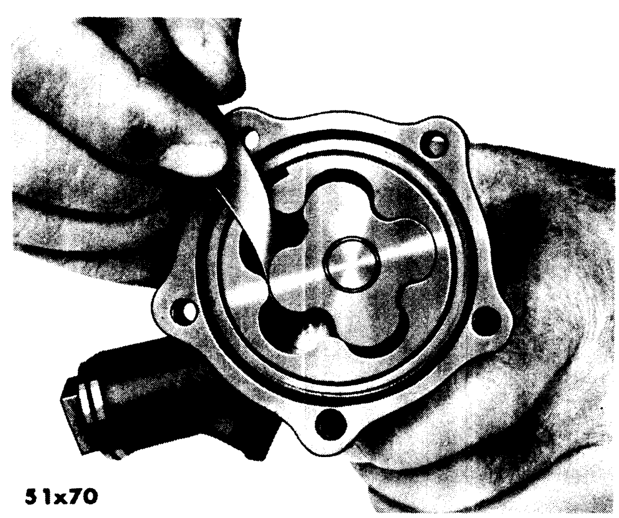

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Fig. 129—Measuring Clearance Between Pump Rotor and Rotor Body

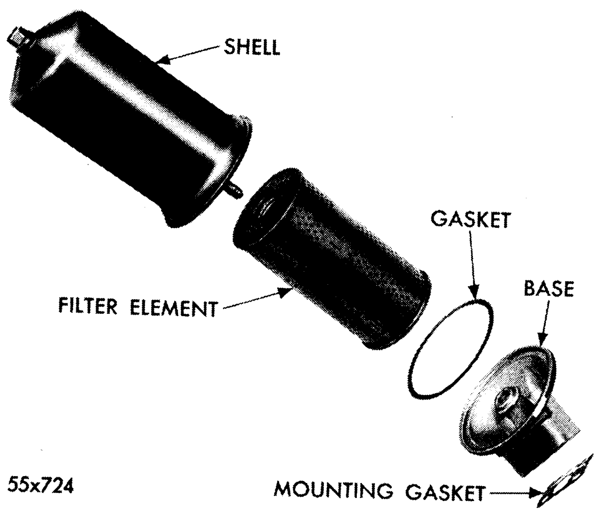

Fig. 130—Full Flow Type Oil Filter (Disassembled View)

the oil pan. Install the oil pan bolts and tighten evenly to 15 foot-pounds torque.

48. OIL FILTER

The Full-Flow Oil Filter, as shown in Figure 130, is standard equipment on Chrysler engines. The filter is designed, as the name implies, so that all the oil delivered to the various parts of the engine passes through the filter before entering the oil passages. (Fig. 131).

The filter is also designed in such a manner that it is impossible for the supply of oil to be cut off, even though the filter becomes clogged. The filter can be removed as follows:

(1) Loosen the shell retaining bolt, and lift off shell and center bolt.

(2) Remove the filter element.

(3) Remove bolts holding filter base to cylinder block and remove filter base.

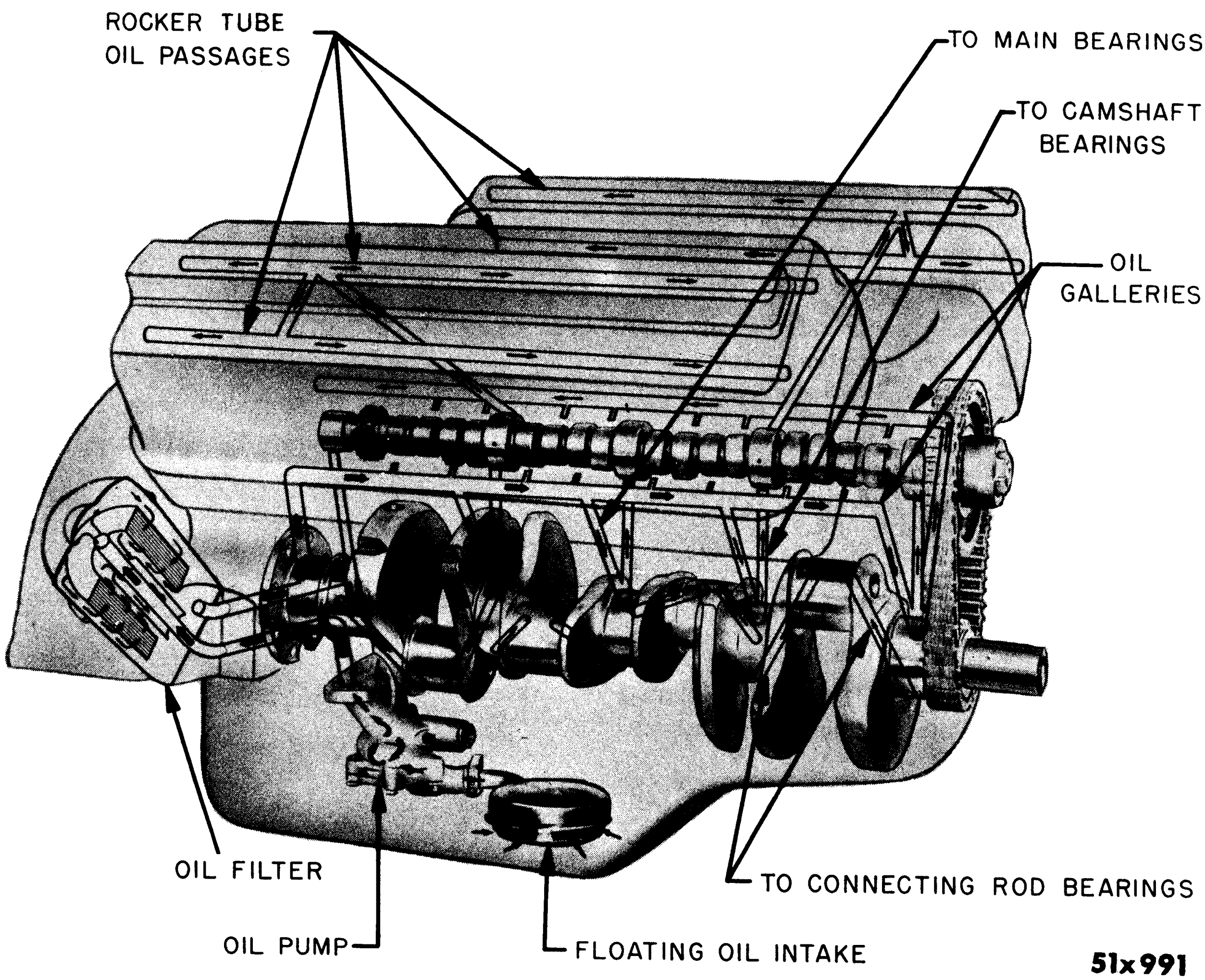

Fig. 131—Flow Of Oil Through Engine

NOTE

When reinstalling the filter, use new gaskets.

49. HYDRAULIC TAPPETS

a. Disassembly

The hydraulic tappets consist of a plunger, plunger cap, flat check valve, check valve spring, check valve retainer, plunger spring, tappet body, and plunger retainer spring clip, as shown in Figure 132.

Because of the important part the hydraulic tappets play in the operation of the engine the necessity for proper care and cleanliness of these units cannot be over-emphasized.

Do not disassemble a tappet in dirty surroundings or on a dirty work bench. Use clean paper on the bench and, after the tappet has been disassembled, place the loose parts in the rack. Submerge in clean kerosene as a protection against dirt or corrosion.

Keep the parts of each tappet separate. The plunger and valve must always be fitted in the same body. To disassemble the hydraulic tappet for cleaning and inspection, refer to Figure 132 and proceed as follows:

(1) Using a suitable tool, pry out the plunger retaining spring clip.

(2) Clean varnish deposits from inside of the tappet body above the plunger cap, then invert the body and remove the plunger cap, plunger, flat check valve, check valve spring, check valve retainer and plunger spring.

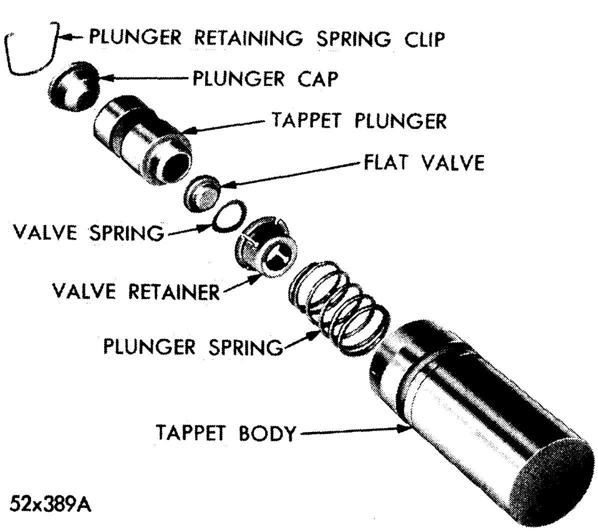

Fig. 132—Hydraulic Tappet (Disassembled View)

(3) Separate the plunger, check valve retainer and check valve spring.

(4) Place all parts in their respective locations in the tappet holder, Tool C-3068.

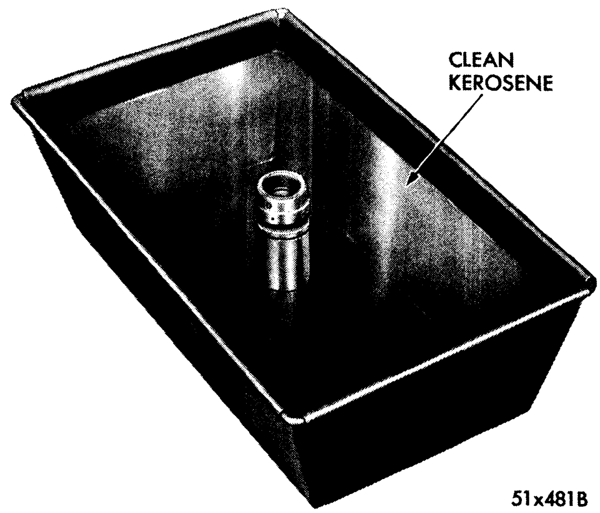

Fig. 133—Tappet Immersed In Clean Kerosene

b. Cleaning and Assembly

Clean all the tappet parts in a suitable solvent that will remove all trace of varnish and carbon, then inspect the tappets for wear, scoring, or damage that would render them unfit for further service.

After having cleaned and inspected the tappets, assemble with care to make sure the parts are installed in the body exactly, as shown in Figure 132. Under no circumstances attempt to fit the check valve shoulder into the plunger. The finished seat of the check valve is on the side opposite the shoulder.

c. Testing

(1) Secure a container deep enough to completely immerse the tappet assembly (upright position).

(2) Fill the container with clean kerosene. Remove the cap from plunger and submerge tappet assembly, as shown in Figure 133.

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

(4) Holding the tappet in an upright position,

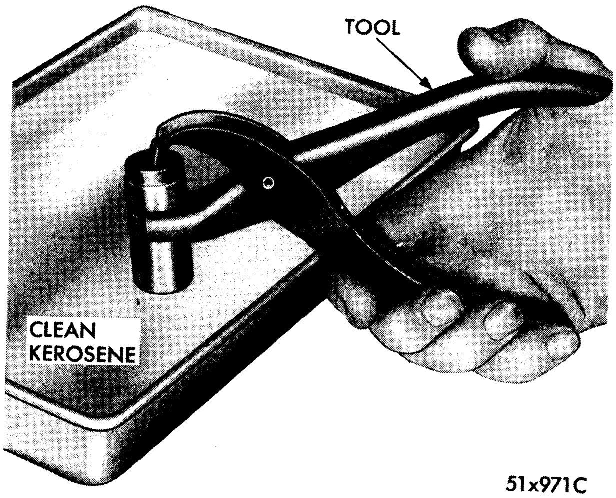

Fig. 134—Testing The Hydraulic Tappet

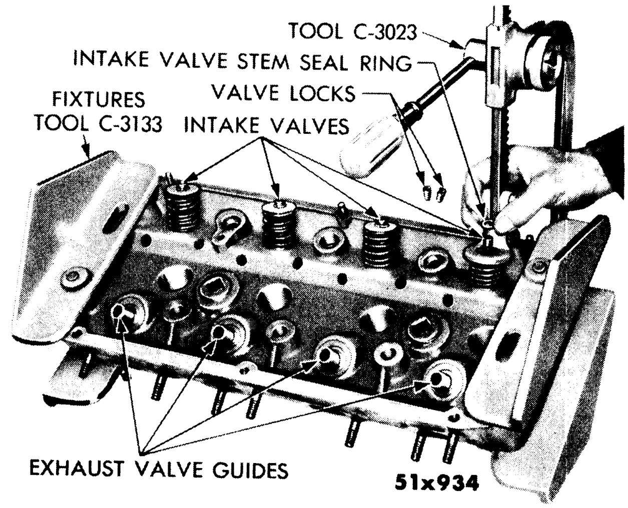

Fig. 136—Removing Valve Springs

insert the lower jaw of pliers, Tool C-3160, in the groove in the tappet body, as shown in Figure 134. Engage the upper jaw of pliers with the top of tappet plunger (cap).

(5) Check the leakdown by compressing the pliers. If the plunger collapses almost instantly, as pressure is applied, disassemble tappet assembly and reclean. Test tappet again. If the tappet still does not operate satisfactorily after cleaning, install a new tappet assembly. If the tappet shows the least sign of not meeting the leakdown test, the tappet should be replaced.

d. Installation

After the hydraulic tappets have been cleaned, inspected, and tested, install in the engine as follows:

(1) Place the engine in right-side up position, then install the hydraulic tappets, as shown in Figure 135. (When installing tappets, be sure each is installed in its original bore.)

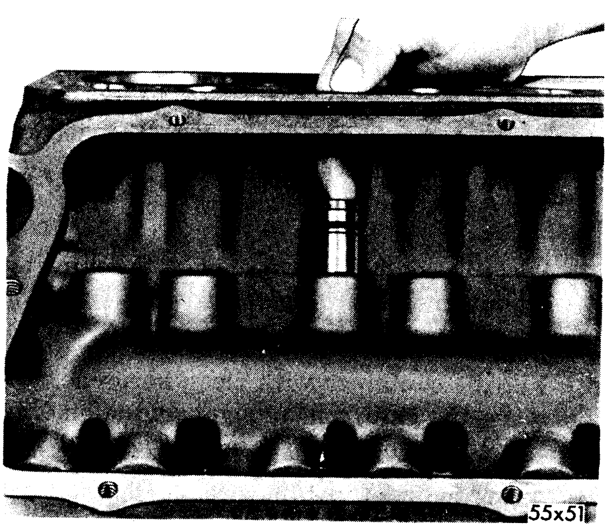

Fig. 135—Installing Tappet Assembly

50. CYLINDER HEAD

a. Disassembly

With the cylinder heads mounted in holding fixture, Tool C-3133, as shown in Figure 136, proceed to disassemble as follows:

(1) Compress the valve springs, using Tool C-3023. Remove each of the valve locks. Release and remove spring compressing tool.

(2) Remove the valve spring retainers and valve stem seal rings (intake valves only) and the outer and inner valve springs (Fig. 137).

NOTE

It should be noted for assembling purposes, that the intake valve spring retainers differ slightly from the exhaust valve spring retainers. Note also that thin valve stem seal rings are used in the intake valve spring retainers just under the valve locks.

(3) Check the lock grooves in the valve stems for burrs. Remove burrs, if present, with a file or stone to prevent damaging valve guides when the valves are removed.

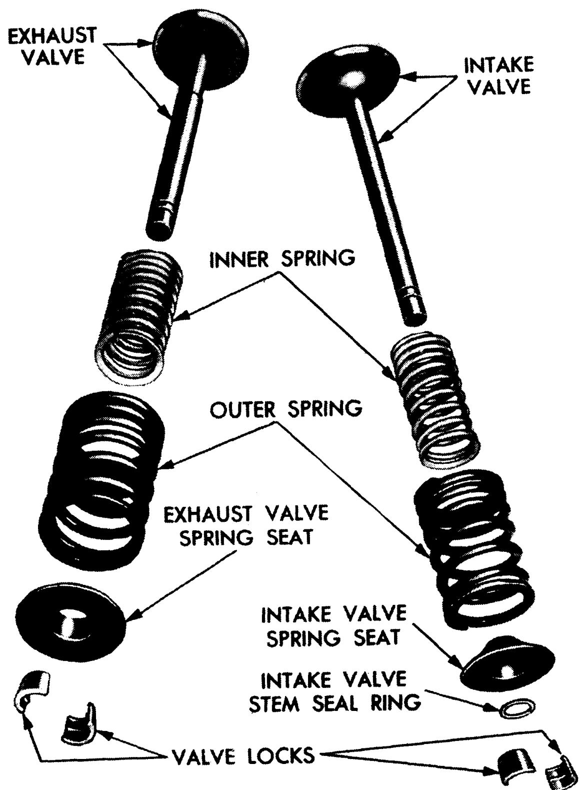

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Fig. 137—Valves and Valve Springs (Disassembled View)

(4) Remove valves from each head and place in a numbered rack.

Clean all parts in a suitable solvent and blow dry with compressed air.

b. Inspection

Remove all carbon and varnish from the valves, using a fine, brass wire brush. Inspect each valve and discard, if it is burned, warped, or cracked. Measure the stem of each valve. The intake valve stems should measure from .372 to .373 inch and exhaust from .371 to .372 inch. This measurement should be taken at several places on the valve stem with a micrometer. If wear exceeds .002 inch, replace the valve.

Remove the carbon and varnish deposits from the interior of the valve guides, using cleaner, Tool C-756, as shown in Figure 138. After all traces of carbon and varnish have been removed from both the valve stems and guides, check the valve stem-to-guide clearance with a dial indicator as follows:

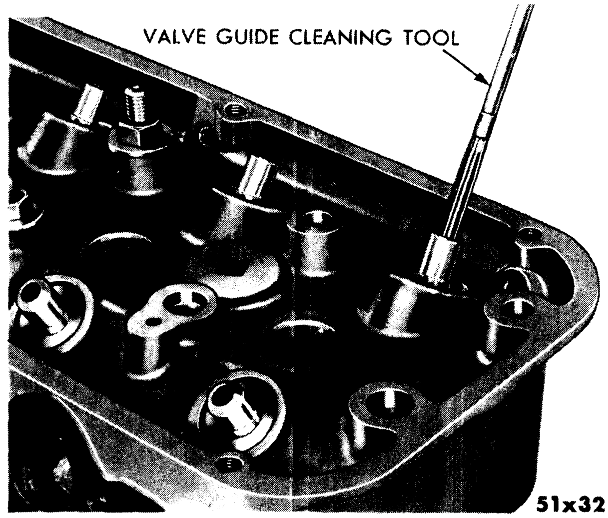

Fig. 138—Cleaning Valve Guides (Tool C-756)

To insure an accurate reading, and also to prevent unnecessary removal of parts, the valve stem-to-guide clearance should be checked with the valves that are to be installed in their respective guides. This means that if new valves are to be installed, they should be used for checking the old valve guides in the same manner.

(1) Slide sleeve, Tool C-3025, on intake valve, or Tool C-3026 on exhaust valve stem, as shown in Figure 139. Insert valve in position in the cylinder head.

(2) Attach dial indicator, Tool C-3339, to the cylinder head and set at right angle to the edge of valve being checked, as shown in Figure 140.

(3) Move the valve to and from the indicator. The total dial indicator reading should not

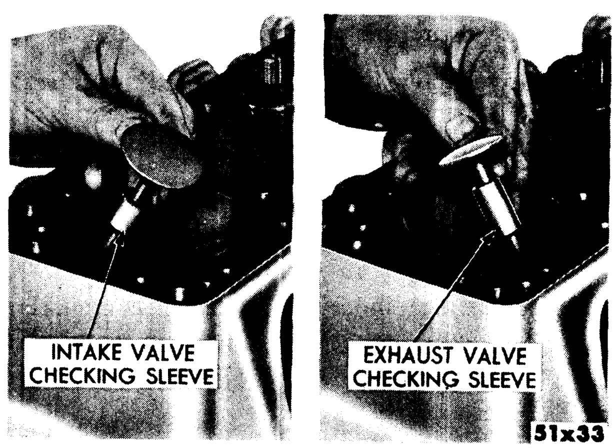

Fig. 139—Installing Sleeves To Check Guide Clearance

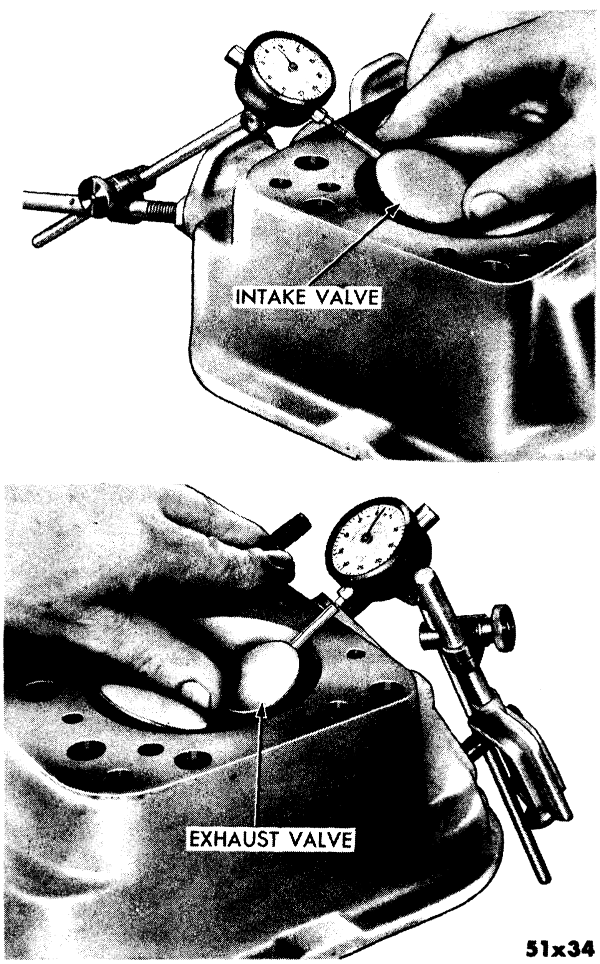

Fig. 140—Checking Valve Guide Clearance (Tool C-3339)

exceed .007 inch on intake valves, or .015 inch on exhaust valves. If readings are more than the above specifications, install new valve guides as required.

c. **Removal and Installation of Valve Guides**

Should the above dial indicator reading indicate the need for new valve guides, the old guides can be removed and new ones installed as follows:

(1) Using Tool C-3150, drive out the guides to be replaced through the top of the cylinder heads.

(2) Turn the cylinder head with the combustion chambers facing up. Place the new valve guide in position in valve port and drive into head.

NOTE

When installing new exhaust valve guides, make

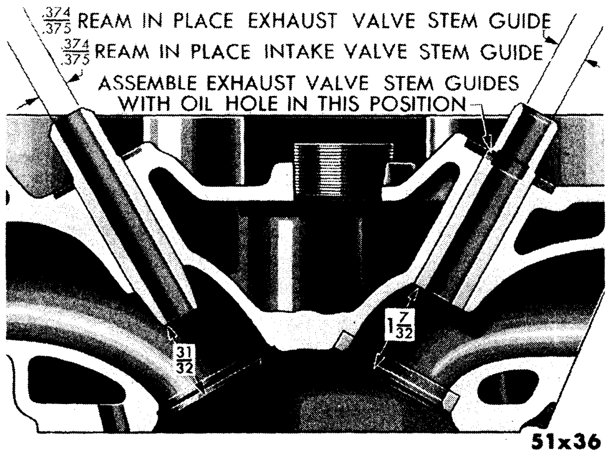

Fig. 141—Exhaust and Intake Valve Guides Installed In Head

certain that the oil hole near the top of the guide is facing up, as shown in Figure 141.

It is very important that the valve guides be driven down to the correct position. This can be determined as follows:

(3) Place a steel scale across the combustion chamber dome, as shown in Figure 142. Drive the intake valve guides down until the punch mark on the side of Driving Tool C-3150 is flush with the face of the cylinder head.

(4) Drive the exhaust valve guides down until the flat end of the valve guide is flush with the top of the valve guide boss.

(5) After new valve guides have been installed, using Tool C-741, ream each guide from .374 to

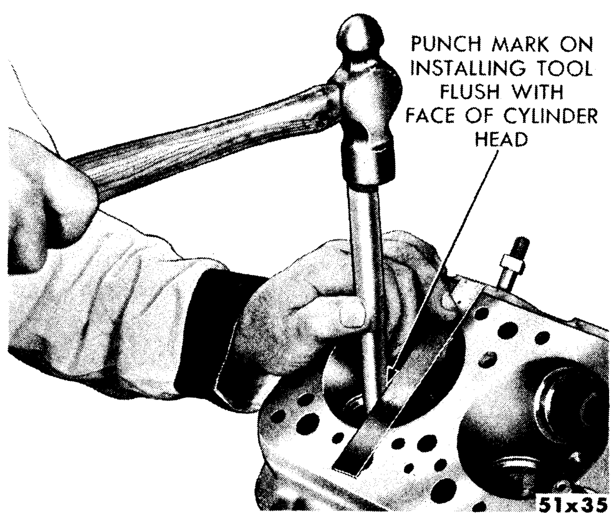

Fig. 142—Installing Intake Valve Guide (Tool C-3150)

.375 inch, as shown in Figure 143.

Should inspection of the cylinder heads indicate cracked, loose, or badly pitted valve seat inserts, they may be removed and new inserts installed.

d. Removal and Installation of Valve Seat Inserts

Valve seat inserts should be removed and installed with the use of proper tools. Inserts can be replaced several times, if necessary, without materially affecting the diametrical dimensions of the counterbore in the cylinder head, providing a certain amount of care is taken.

Replacement of valve seat inserts sometimes becomes necessary when reducing the valve seating surface with a 20 degree stone. NEVER, under any circumstances, should the grinding process be allowed to extend beyond the width of the insert.

(1) Position adaptor, Tool SP-1127 (part of Tool C-3140), over the insert to be removed.

(2) Insert the puller jaw head portion of the tool down in the valve port opening so that it rests in the depression of the adaptor.

(3) Tighten the puller bolt until the jaws of the tool are firmly embedded in position.

(4) Position the body of tool so that it also rests squarely on the adaptor, Tool SP-1127. Install the puller bolt nut and washer.

(5) Pull the insert from the cylinder head by turning the puller bolt nut in a clockwise direction and, at the same time, hold the puller bolt.

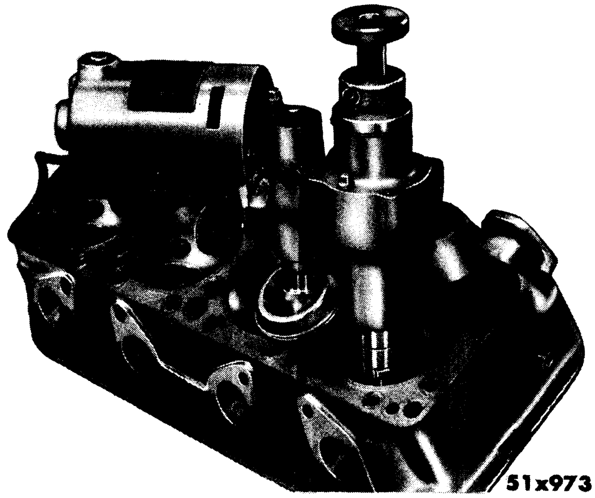

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Fig. 144—Enlarging Valve Seat Insert Counterbore (Tool MH-M-L)

After the inserts have been removed from the heads, smooth any irregularities at the bottom of the counterbore in the cylinder head with a blunt drift.

If a valve seat insert is loose, it will be necessary to remove the insert and to install an oversize insert. Exhaust valve seats are available in standard and .010 inch oversize.

The installation of an oversize insert will require enlarging the counterbore, as shown in Figure 144. Valve seat inserts should be from .002 to .004 inch larger than the counterbore to insure a correct and permanent fit. To prevent damaging the cylinder head surface during the

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Fig. 143—Reaming Valve Guides (Tool C-741)

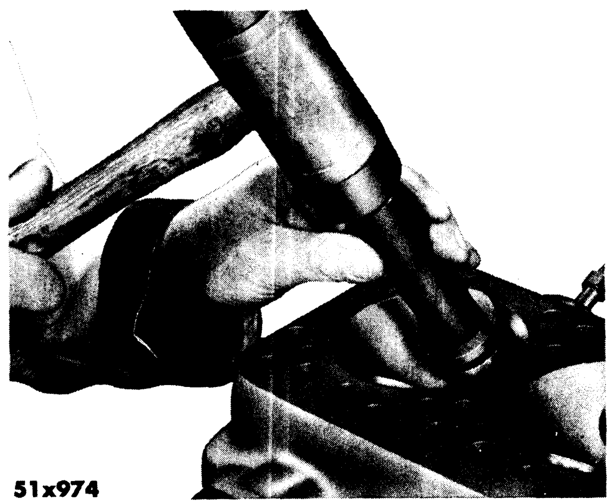

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Fig. 145—Installing New Valve Seat Insert (Tool C-767)

counterboring operation, place a used cylinder head gasket on the head, mount Tool MH-M-1, and proceed with the boring operation.

(6) Place the inserts to be installed in a container of dry ice (solidified carbon dioxide) for approximately 10 minutes.

(7) Thoroughly clean the counterbores in the cylinder heads, removing all metal chips and foreign material.

(8) Place a chilled insert in the counterbore—valve side up.

(9) Drive the insert in place, using installing Tool C-767, as shown in Figure 145.

NOTE

This operation must be done quickly while the insert is cold.

(10) Check the valve seat for concentricity with the valve guide, using a dial indicator. Runout should not exceed .002 inch total indicator reading after regrinding.

e. Refacing Valves and Seats

To insure a positive sealing of the valve to the seat, the grinding wheel of the valve refacer and the stones of the seat grinder should be carefully refaced. In each case, the setup should be such that the finished angle of both the valve and the seat are identical.

When refacing the valves with Tool MTH-80, remove only a small amount of metal at a time to insure a smooth, accurate surface on the valve

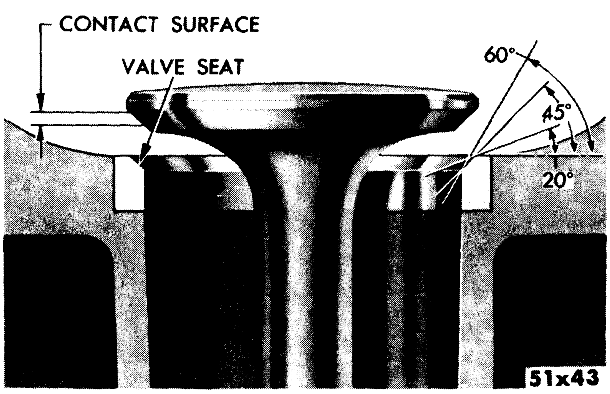

Fig. 146—Valve Seat Reconditioning Angles

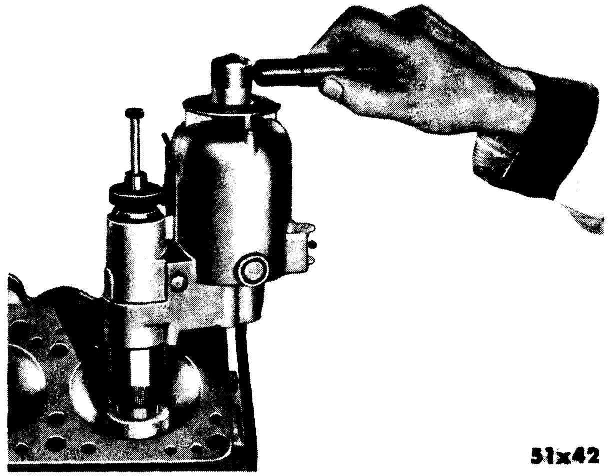

Fig. 147—Grinding Valve Seats (Tool MTH-JB-41)

face. After the valves have been refaced, check the valve head margin of each valve. (See Fig. 146). The margin must be at least $\frac{3}{64}$ inch. Otherwise, the valve should be discarded.

When refacing the valve seats, it is essential that the correct size valve guide pilot be used for the reseating stones.

Grind the seats with Tool MTH-JB-41, as shown in Figure 147. A true and complete surface must be obtained. Check the concentricity of the seat, using dial indicator No. 9320. The total runout should not exceed .002 inch (total indicator reading). Check the valve seat with Prussian blue to determine where the valve contacts the seat. It is important that this contact be centralized on the valve face. If this contact surface is not properly centralized, the seat should be relocated by using a 20 degree stone at the top, or a 60 degree stone at the bottom, whichever is necessary. When the seat is properly positioned, the width of intake seats should be $\frac{1}{16}$ to $\frac{3}{32}$ inch. The width of the exhaust seats should be $\frac{3}{64}$ to $\frac{1}{16}$ inch.

f. Testing Valve Springs

Whenever the valves have been removed for inspection, reconditioning or replacement, the valve springs should be tested. Place the outer valve spring on the seat of Tool C-647, as shown in Figure 148. Attach torque wrench and check the tension. The reading on torque wrench should be multiplied by two to obtain the correct spring tension reading. Discard springs that do not meet specifications.

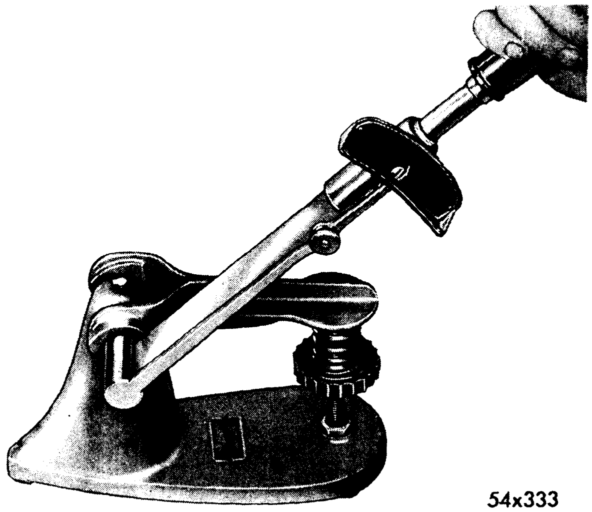

Fig. 148—Testing Valve Springs

Each spring should be checked for squareness. This can be done with a steel square and surface plate. Stand each spring and the square on end on the surface plate and slide the spring up to the square. Gradually revolve the spring and, at the same time, observe the space between the top coil of the spring and the square, as shown in Figure 149. The trueness of the spring should not exceed $1/16$ inch. If the spring is more than $1/16$ inch out of square, install new spring.

When assembling valve springs, make certain the closed coils are toward the cylinder head.

If valves and/or seats are reground, check the installed height of the springs. If the height is $1\frac{11}{16}$ inches or greater, install a $1/16$ inch spacer (Part No. 1400482) in the head counterbore to

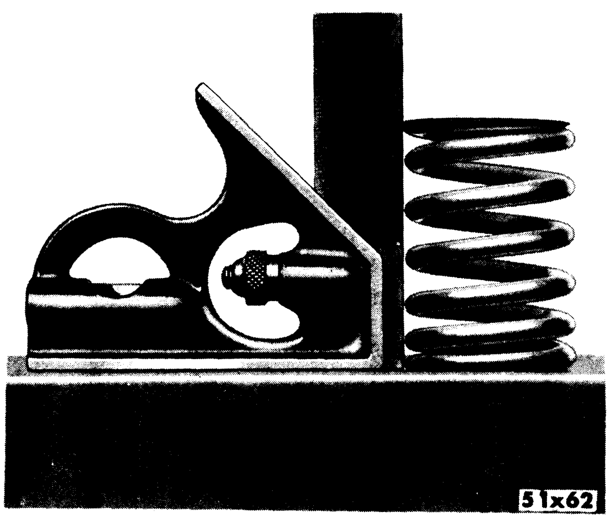

Fig. 149—Checking Valve Spring For Squareness

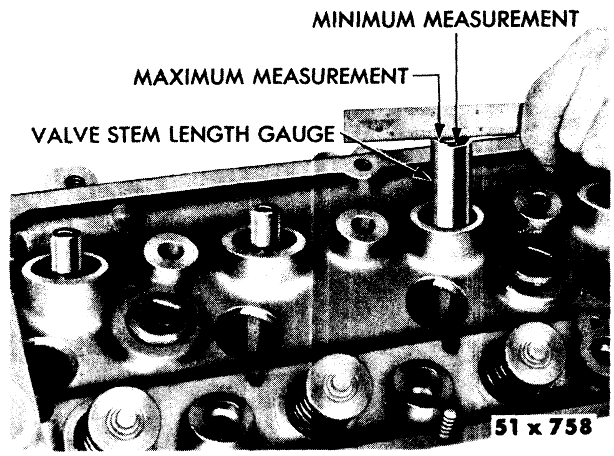

Fig. 150—Checking Valve Stem Position

bring the spring height back to a nominal $1\frac{5}{8}$ to $1\frac{11}{16}$ inches.

NOTE

Whenever valves and seats are reground, the position of the valve in the head will be changed, shortening the operating length of the hydraulic tappet. This means that the plunger is operating closer to its bottomed position and less clearance is available for the thermal expansion of the valve mechanism during high speed driving. Design of plunger travel includes a safety factor for normal wear and refacing of valves and seats. However, if face and seat grinding is carried to the point where the valve position is changed $1/32$ inch, or more, from its factory installed position, the dimension from the valve spring seat in the head to the valve tip should be checked with gauge C-3061, as shown in Figure 150.

NOTE

When new valves and inserts are installed, remove the hydraulic tappet and remove the varnish ring above the tappet plunger travel. Clean the tappet, as described in this section.

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

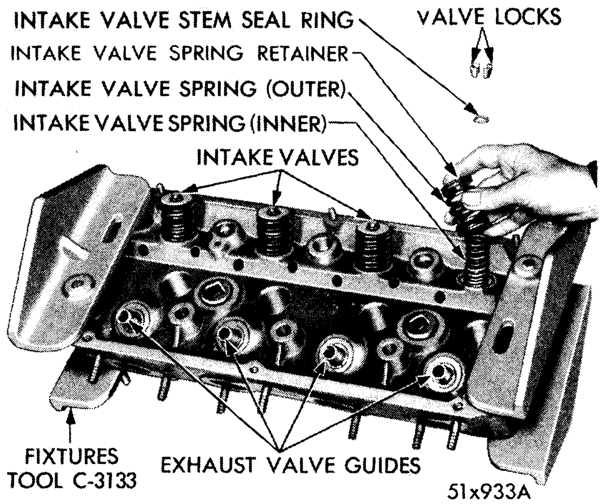

Fig. 151—Installing Inner and Outer Intake Valve Springs and Retainers

g. Assembly

After all parts of the cylinder heads have been checked and corrected, assemble the cylinder heads as follows:

(1) Coat the intake valve stems with lubricating oil, and insert in position in the head. Install the inner and outer valve springs and retainers, as shown in Figure 151.

(2) Compress the valve springs with Tool C-3023. Install the valve stem seal rings. Seat seal rings in bore of spring retainers, using Tool C-3057.

(3) Coat the exhaust valve stems with lubricating oil and insert in head. Install the inner and outer valve springs and retainers, as shown in Figure 152.

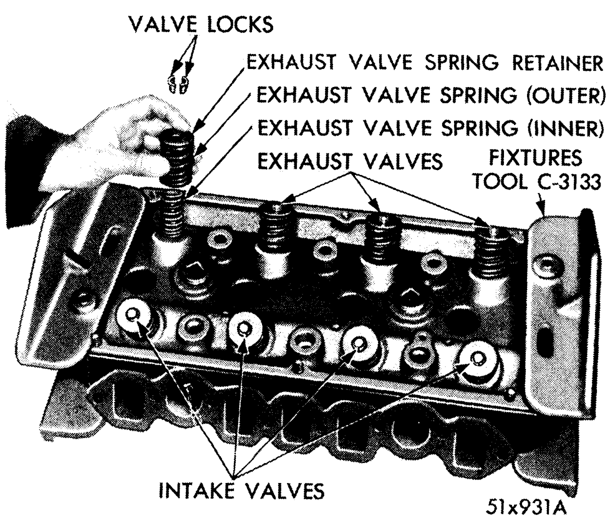

Fig. 152—Installing Inner and Outer Exhaust Valve Springs and Retainers

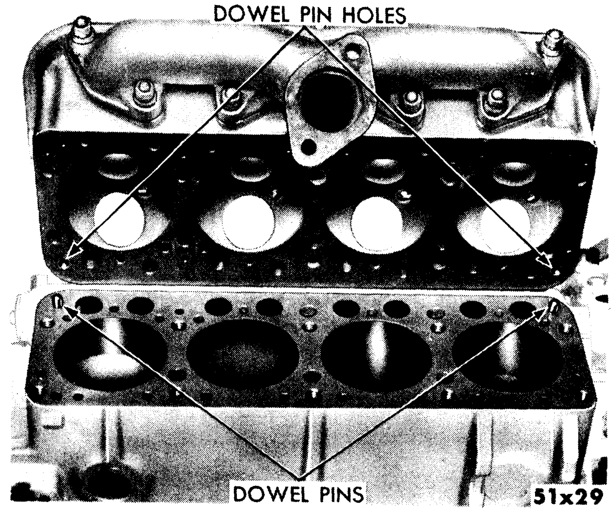

Fig. 153—Cylinder Head Locating Dowels

(4) Compress the valve springs with Tool C-3023, install valve locks, and release tool.

Install cylinder heads on block, using new head gaskets.

CAUTION

When installing cylinder heads, coat both sides of gaskets liberally with MOPAR Perfect Seal Sealing Compond to insure proper sealing. Be sure the cylinder heads and gasket faces are properly lined up over the locating dowels, as shown in Figure 153.

51. ROCKER ARM ASSEMBLIES

If the rocker arm assemblies have been disassembled for cleaning and inspection, or for the replacement of worn or damaged parts, assemble as follows:

(1) Refer to Figures 154 and 155 and set tubes and brackets on bench in a vertical position. (Both rocker arm tubes are stamped, "IN" for Intake and "EX" for Exhaust.)

(2) Slide a spacer spring over tube marked "IN". Install an intake rocker arm on tube with the push rod recess toward the exhaust tube.

NOTE

The intake rocker arms are smaller or shorter than the exhaust rocker arms.

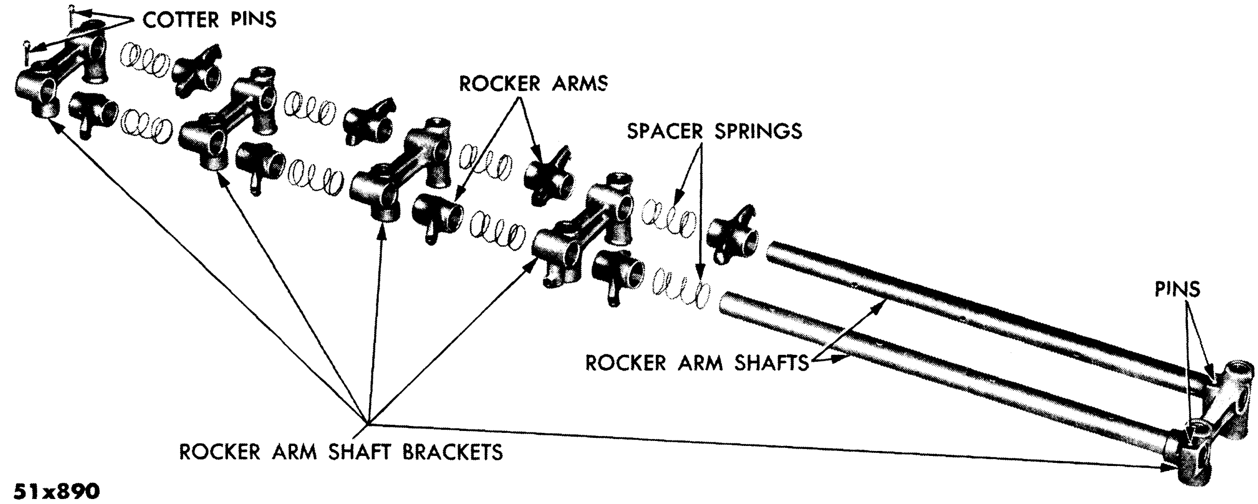

Fig. 154—Rocker Arm Assembly (Disassembled View)

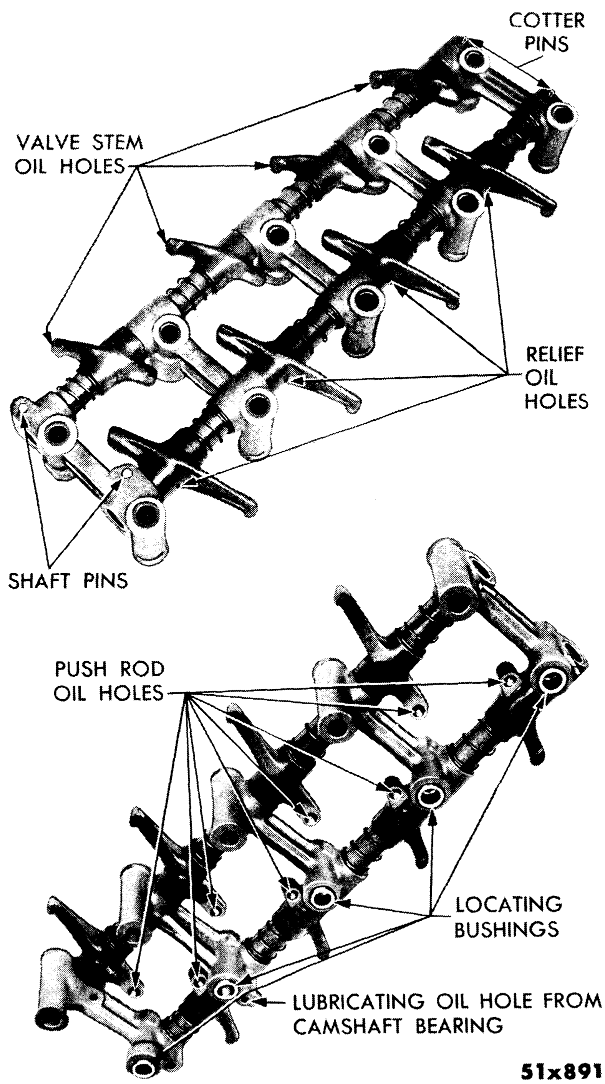

Fig. 155—Rocker Arm Assembly (Upper-Top View; Lower-Bottom View)

(3) Install an exhaust rocker arm on "EX" tube and a spacer spring.

(4) Install the rocker arm tube bracket with the oil inlet hole in the boss (hole should be on the outside of the "IN" tube).

(5) Slide a spacer spring on the "IN" tube and install the next intake rocker arm.

(6) Install the next exhaust rocker arm and spacer spring on the "EX" tube.

NOTE

Of the three remaining rocker tube brackets, the last bracket to install is the one with the cotter pin holes drilled through the tube bores.

(7) Install the next rocker arm bracket and slide a spacer spring on the "IN" tube.

(8) Install the next exhaust rocker arm on the "EX" tube and install a spacer spring.

(9) Install the next intake rocker arm on "IN" tube. Slide the next rocker arm tube bracket over tube and down into position.

Repeat steps (5) and (6) above. Install the last rocker arm tube bracket and secure the assembly with cotter pins. Assemble the remaining rocker arm assembly in like manner.

(10) Insert the cylinder head bolts into the brackets, with the short bolts toward the intake side.

(11) Insert the push rods through the push rod holes in the heads—the short rods in the upper holes (intake) and the long rods in the lower holes (exhaust) in the heads, as shown in Figure 156.

(12) Place rocker arm assemblies in position on the heads, lining up all push rods with their respective rocker arms. Starting at the top center, tighten all cylinder head bolts to 85 foot-pounds torque, as shown in Figure 157.

52. CRANKSHAFT PULLEY, HUB AND DAMPER INSTALLATION

Refer to Figure 158, then proceed as follows:

(1) Insert the pulley hub key in the slot in the crankshaft, then position a new dust seal in the hub of the pulley and position the assembly on the crankshaft.

(2) Place installing tool, (part of puller set C-3033) in position, then insert the pulley flatwasher between the tool and hub. Press the pulley on shaft until seated.

(3) Remove the tool and install the damper and pulley to hub.

(4) Install washer and retaining nut. Tighten to 135 foot-pounds torque.

53. WATER PUMP

For servicing and installation of water pump, refer to Cooling System Section.

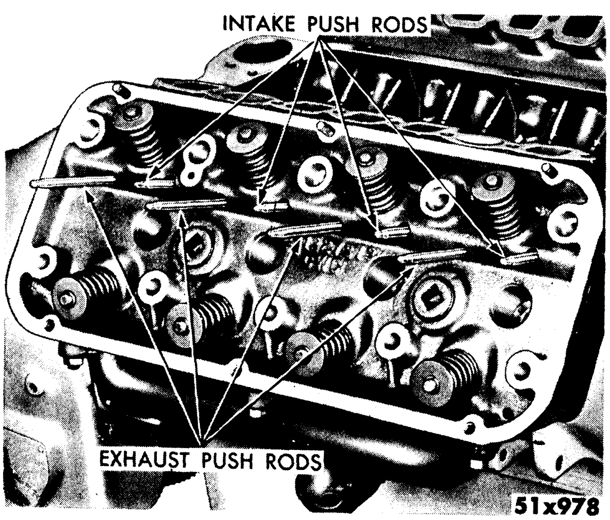

Fig. 156—Push Rods Installed In Head

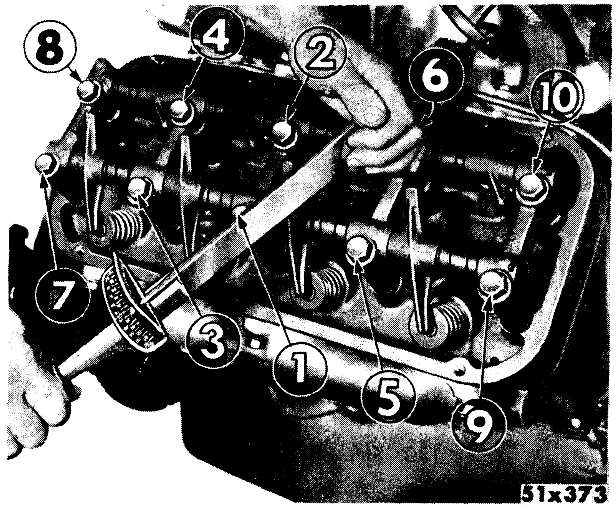

Fig. 157—Tightening Cylinder Head Bolts (Sequence)

54. FUEL PUMP

For servicing and installation of fuel pump, refer to Fuel System Section.

55. DISTRIBUTOR DRIVE SHAFT BUSHING (Removal and Installation)

It is advisable to remove and install the distributor drive shaft lower bushing when the engine is completely overhauled. A worn bushing can cause erratic distributor operation which will affect car performance.

To remove and install the distributor lower drive shaft bushing, proceed as follows:

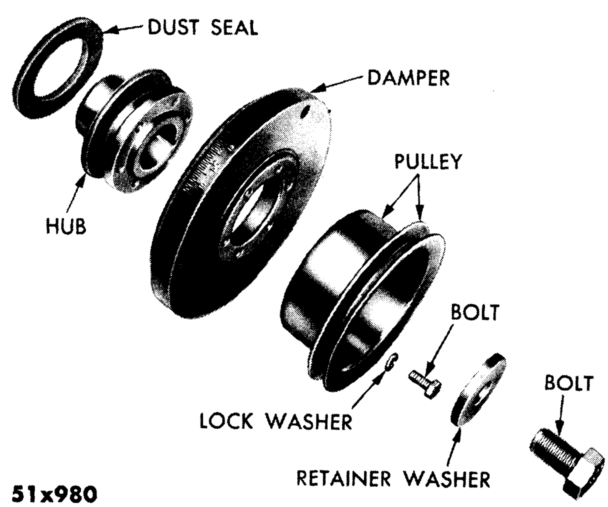

Fig. 158—Vibration Damper Assembly (Disassembled View)

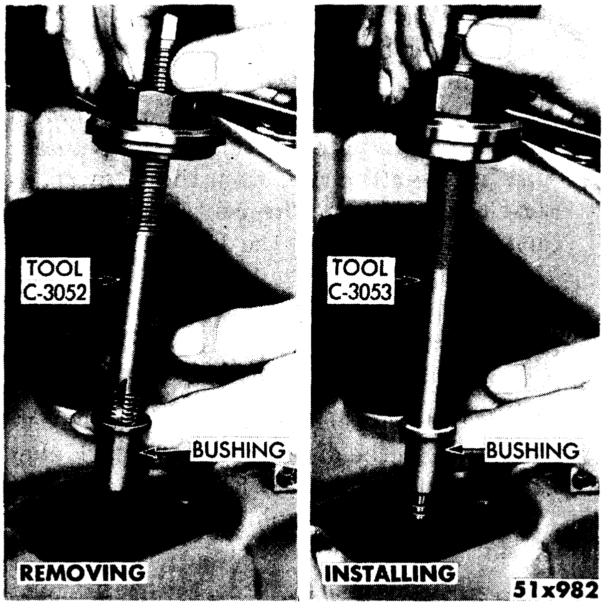

Fig. 159—Removing and Installing Distributor Drive Shaft Bushing

(1) Insert Tool C-3052 into old bushing and thread down until a tight fit is obtained. Hold the puller head with a wrench, tighten puller bolt and pull out of bore in the block, as shown in Figure 159.

(2) Slide new bushing over burnishing end of Tool C-3053, as shown in Figure 159. Insert tool and bushing into bore of block.

(3) Drive the bushing and tool down into position using a soft hammer. As the burnisher is pulled through the bushing by pressure applied by tightening the puller nut, the tool swedges the bushing tight in its bore and burnishes to the correct size. DO NOT REAM THIS BUSHING!

56. DISTRIBUTOR BASIC TIMING

Before installing the distributor lower drive shaft gear, it will be necessary to time the engine as follows:

(1) Rotate the crankshaft until Number One cylinder is at the top dead center (firing position). When in this position, the pointer on the chain case cover should be over "DC" on the vibration damper.

(2) Using Tool C-3027, position the oil pump shaft so that it lines up with the slot in the drive gear, as shown in Figure 160.

(3) Coat the shaft of the drive gear with engine oil, then install so that as the gear spirals into position it will index with the oil pump shaft and the slot in the top of the drive gear will be parallel with the centerline of the crankcase, as shown in Figure 160.

57. VALVE TIMING CHECKING

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

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

Set the dial indicator on zero and then turn the crankshaft clockwise (normal running direction) until the dial indicator shows that the valve has lifted .024 inch.

The timing on the crankshaft pulley should now read from 5 degrees before top dead center to 7 degrees after top dead center. If the reading is over the specified limits, check the gear indexing marks and the timing chain for wear.

Before making this check, it is well to check the accuracy of the TDC mark on the pulley by bringing the Number One piston to top dead cen-

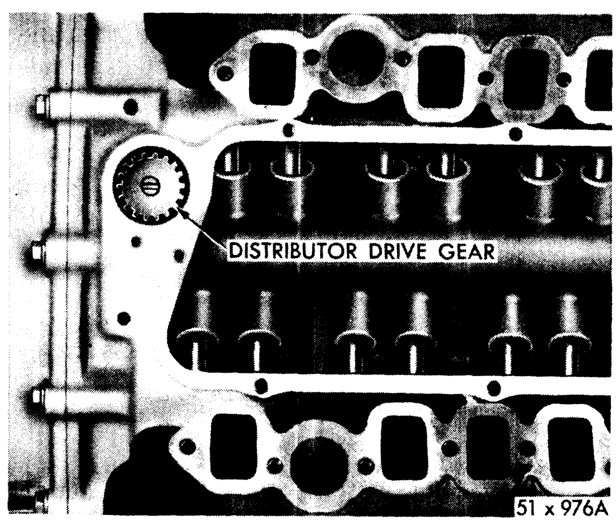

Fig. 160—Distributor (Basic) Timing

ter by means of an indicator placed in the spark plug opening.

After the valve timing has been checked, turn the crankshaft counter-clockwise until the tappet is back down to the valve closed position; then remove the .210 inch spacer from between the rocker arm and valve stem.

CAUTION

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

58. FINAL ASSEMBLY OF ENGINE

(1) Install the exhaust manifolds on the cylinder heads, using new gaskets. Tighten nuts to 25 foot-pounds torque.

(2) Place new valve chamber tappet cover gaskets in position and install tappet chamber cover. Tighten bolts to 35 foot-pounds torque.

(3) Install the crankcase ventilator pipe on the tappet chamber cover. Insert the oil level indicator (dip stick) tube in position and press into block.

(4) Install new rocker cover gaskets, place rocker covers in position, and secure with nuts and bolts. Tighten to 30 inch-pounds torque.

(5) Slide the spark plug tube seals over tubes and install in position in the heads.

(6) Secure a new set of spark plugs and check the gap for .035 inch. Install spark plugs and tighten with Tool C-3054 to 30 foot-pounds torque.

(7) Place the distributor vacuum tube in position and install the intake manifold, using new gaskets. Tighten bolts to 30 foot-pounds torque.

NOTE

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

(8) Place a new water outlet elbow gasket in position and install thermostat and outlet elbow.

(9) Hold the distributor over mounting pad on the cylinder block, with the vacuum chamber pointing toward the right hand cylinder bank. Turn the rotor until it points forward to the approximate location of the Number One insert in the cap. Turn the rotor counter-clockwise until the contact points are just separating. Place the distributor oil seal ring in position, lower the distributor, and engage with the drive shaft gear. At the same time, hold the rotor in position, secure with clamp and bolt, and tighten securely.

(10) Place the spark plug tube seal rings in position. Install the distributor cap, spark plug cables, and insulators. Engage the insulators with the spark plugs and connect the coil.

(11) Install the spark plug cable covers after arranging the spark plug cables. Tighten screws securely.

(12) Coat a new fuel pump gasket with MOPAR Perfect Seal Sealing Compound and place gasket in position on chain case cover. Insert fuel pump and tighten to 30 foot-pounds torque. Connect fuel pump outlet tube at fuel pump.

(13) Connect fuel and vacuum tubes and tighten securely.

(14) Insert the carburetor heat tube in the intake manifold and tighten securely.

(15) Install the generator assembly and secure with bolts and lockwashers. Install the fan pulley and generator drive belt.

(16) Install fan belt over fan pulley and around crankshaft pulley and idler pulley.

(17) Install the fan blades, lining up the bolt holes. Tighten bolts to 15 foot-pounds torque.

NOTE

When adjusting the fan and generator belts, obtain enough slack on the generator belt so that the belt may be depressed ½ inch from a straight line midway between the pulleys.

(18) Install the starting motor and tighten the bolts to 55 foot-pounds torque.

(19) Install oil filter.

INSTALLATION OF ENGINE
(IN THE CAR)

59. ENGINE INSTALLATION

To install the engine assembly in the car, remove engine from repair stand, mount the transmission, and proceed as follows:

(1) Using a suitable overhead hoist, suspend the engine assembly over the engine compartment. (The engine must be at an angle and slanting downward at the rear.)

(2) Being careful not to damage the accessories or the vehicle, lower the engine on the front engine insulators and install insulator bolts to hold engine in alignment.

(3) Holding the engine with the overhead hoist, place a jack under the transmission to support the rear end of engine. Install the rear engine support crossmember and secure with bolts. After the crossmember has been installed, remove the jack and relieve the hoist.

(4) Remove the engine lifter plate and install the carburetor.

(5) Install the radiator shroud.

(6) Connect the usual items under the hood, such as fuel lines, radiator hoses, wires, etc.

(7) Install the hood and battery.

(8) Install the exhaust pipes, using new gaskets as required.

(9) Connect the wires and linkage at the transmission and clutch.

(10) Connect the propeller shaft at the transmission.

(11) Be sure all drain cocks are closed and refill the cooling system. Check the entire system for leaks and correct as necessary.

(12) Refill the engine crankcase with engine oil. Refer to the Lubrication Section for break-in of new or rebuilt engine.

(13) Start engine and warm it up to 160 degrees F. Check the distributor timing, as described in the Electrical System Section.

(14) Adjust the carburetor, as described in the Fuel System Section.

C-300 CHRYSLER ENGINE

60. GENERAL INFORMATION

The C-300 Chrysler Engine is a modified Fire-Power V-8 engine. (Fig. 161).

The modifications include twin four-barrel carburetors, a full race camshaft, and mechanical tappets with adjustable valve tappet clearance made possible by adjusting screws at the push rod end of the rocker arms.

From the service standpoint the C-300 engine will be fundamentally the same as the FirePower engine. Though the intake manifold (Fig. 162) of the C-300 engine is different than that of the FirePower engine, the service procedure will remain the same.

To service the carburetors, refer to the Fuel System Section.

Adjust valve tappet clearance at rocker arm, as shown in Figure 163.

61. TUNE UP INFORMATION

NOTE

Because of the modifications described, the C-300 engine will exhibit characteristics which differ from other engines, but should be considered as standard performance for the C-300 engine.

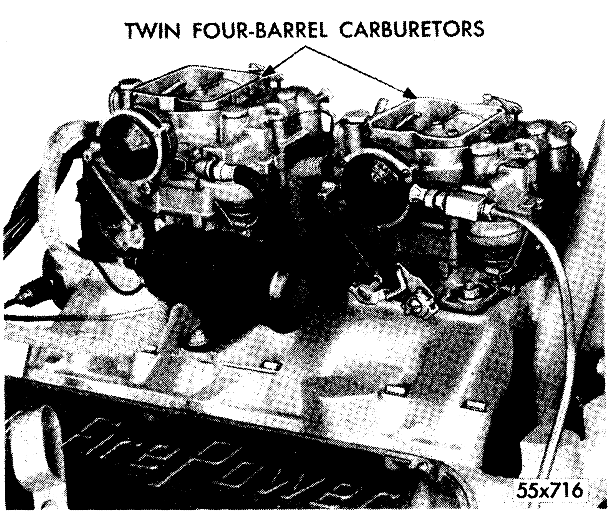

Fig. 161—C-300 Chrysler Engine

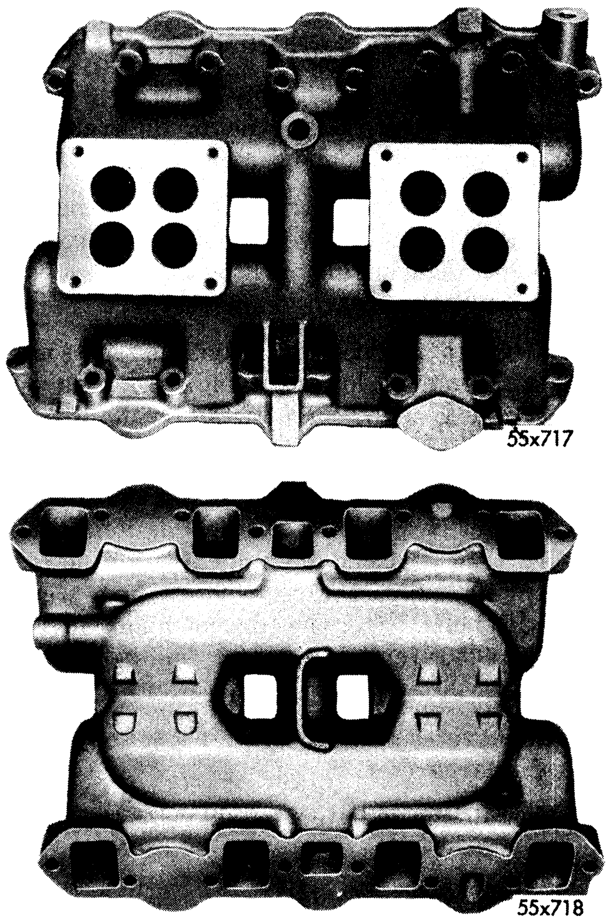

Fig. 162—Intake Manifold (Top View and Bottom View)

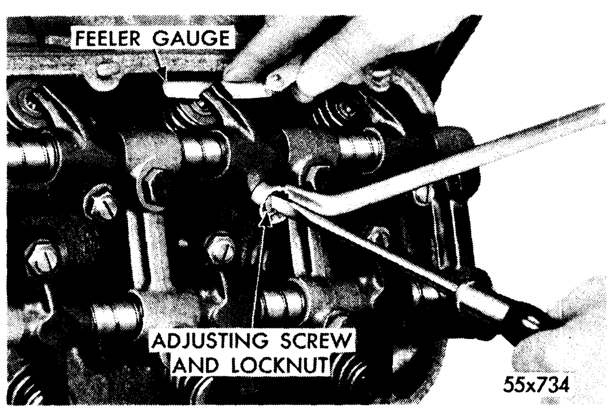

Fig. 163—Adjusting Valve Clearance

These characteristics are as follows:

(1) Somewhat uneven engine idle.

(2) Higher noise level, due to mechanical tappet valve clearance.

(3) Comparatively high engine idle rpm.

(4) Possible roughness on downshift with PowerFlite equipped units.

62. TUNE UP DATA

Valve Settings

	Hot	Cold
Intake	.015	.015
Exhaust	.024	.028

Engine Idle Setting .... 600 rpm

Ignition Timing .... 10 degrees B.T.D.C.

NOTE

Reduce engine idle to 500 rpm, set ignition at 10 degrees BTDC, and reset engine idle back to 600 rpm.

Automatic Advance Curve

Distributor RPM	Distributor Degrees
300-400	0
400	0 to 3½
500	3 to 5
800	7 to 9

Vacuum Advance Curve (In Inches of Mercury)

Distributor Vacuum	Distributor Degrees
5½ to 6½	1
10	5 to 6½
11	6 to 8

SERVICE DIAGNOSIS

63. ENGINE WILL NOT START

Possible Causes:

a. Weak battery.

b. Overheated engine.

c. Low compression.

d. Corroded or loose battery terminal connections.

e. Weak coil.

f. Broken or loose ignition wires.

g. Dirty or corroded distributor contact points.

h. Defective ignition switch.

i. Moisture on ignition wires, cap, or plugs.

j. Cracked distributor cap.

k. Fouled spark plugs.

l. Stuck valves.

m. Improper spark plug gap.

n. Improper timing (ignition).

o. Damaged distributor rotor.

p. Dirt or water in gas line or carburetor.

q. Ice in carburetor or fuel line.

r. Carburetor flooded.

s. Fuel level in carburetor bowl not correct.

t. Insufficient supply of fuel.

u. Defective fuel pump.

w. Vapor lock.

x. Sticking choke.

y. Defective starting motor or solenoid.

z. Defective neutral switch (PowerFlite) or kickdown switch (overdrive).

64. ENGINE STALLS

Possible Causes:

a. Idling speed too low.

b. Needle valve and seat in carburetor stuck.

c. Idle mixture too lean or too rich.

d. Carburetor flooding.

e. Dirt or water in gas line or carburetor.

f. Frozen gas line.

g. Incorrect carburetor float level.

h. Leak in intake manifold, distributor vacuum line, or carburetor mounting gaskets.

i. Worn accelerator pump. (Stall occurs on acceleration.)

j. Improper choke adjustment.

k. Choke sticking.

l. Carburetor icing (cold, wet weather).

m. Excessive pressures (air conditioning).

n. Loose or corroded battery terminals.

o. Loose ignition wires.

p. Weak battery.

q. Loose ignition switch connection.

r. Spark plugs dirty, damp, or gaps incorrectly set.

s. Distributor advance not operating.

t. Defective coil or condenser.

u. Distributor points dirty, burned, or incorrectly spaced.

w. Exhaust system restricted.

x. Trailing edge of rotor worn.

y. Leaks in ignition wiring.

z. Incorrect valve tappet clearance. (C-300)

aa. Burned valves.

bb. Low compression.

cc. Engine overheating.

dd. Use of winter fuels in hot weather.

65. ENGINE HAS NO POWER

Possible Causes:

a. Torque converter stator assembled in reverse.

b. Incorrect ignition timing.

c. Weak coil or condenser.

d. Stiff accelerator linkage.

e. Trailing edge of rotor worn.

f. Defective mechanical or vacuum advance (distributor).

g. Hydraulic tappet pump up (high speed).

h. Excessive play in distributor shaft.

i. Weak spring in contact points.

j. Distributor cam worn.

k. Spark plugs dirty or gap incorrectly set.

l. Insufficient point dwell.

m. Fouled spark plugs.

n. Low grade fuel.

o. Weak valve springs.

p. Carburetor in poor condition.

q. Valves sticking when hot.

r. Dirt or water in gas line or carburetor.

s. Ice in gas line or carburetor.

t. Improper carburetor float level.

u. Worn camshaft lobes.

v. Defective fuel pump.

w. Pistons or pins fit tight.

x. Valve timing incorrect.

y. Too rich or lean fuel mixture.

z. Incorrect valve tappet clearance (C-300).

aa. Blown cylinder head gasket.

bb. Low compression.

cc. Flow control valve not operating (Power Steering).

dd. Burned, warped, or pitted valves.

ee. Spark plug breakdown under load.

ff. Plugged, restricted, or damaged muffler or tail pipe.

gg. Overdrive locked. (If so equipped.)

hh. Brakes dragging.

ii. Tight wheel bearings.

jj. Clutch slipping. (If so equipped.)

kk. Engine overheating.

ll. Detonation.

mm. Stuck regulator valve (PowerFlite).

nn. Improper ignition or battery ground.

66. ENGINE "LOPES" OR MISSES (AT IDLE)

Possible Causes:

a. Air leak between intake manifold and block due to retaining bolts bottoming or damaged gasket.

b. Incorrect carburetor idle adjustment.

c. Dirt or water in gas line or carburetor.

d. Dirty jets or plugged passages in carburetor.

e. Incorrect valve tappet clearance. (C-300.)

f. Burned, warped, or pitted valves.

g. Incorrect ignition timing.

h. Leaks in ignition wiring.

i. Blown head gasket.

j. Air leak at carburetor mounting gasket.

k. Worn lobes on the camshaft.

l. Moisture on ignition wires, cap, or plugs.

m. Worn timing chain.

n. Defective spark advance mechanism.

o. Sticking valves.

p. Excessive play in distributor shaft.

q. Distributor cam worn.

r. Inoperative choke.

s. Spark plugs damp, dirty, or the gaps set too close.

t. Overheated engine.

u. Weak battery.

v. Uneven compression.

w. Low grade of fuel. (Winter fuel used in summer.)

x. Flooding carburetor.

y. Carburetor icing (cold, damp weather).

67. ENGINE MISSES WHILE IDLING

Possible Causes:

a. Spark plugs dirty, damp, or gap incorrectly set.

b. Broken or loose ignition wires.

c. Burned or pitted contact points, or set with insufficient gap.

d. Coil or condenser defective.

e. Weak battery.

f. Distributor cap cracked.

g. Trailing edge of rotor worn.

h. Moisture on ignition wires, cap, or plugs.

i. Excessive play in distributor shaft.

j. Distributor shaft cam worn.

k. Burned, warped, or pitted valves.

l. Incorrect valve tappet clearance. (C-300.)

m. Incorrect carburetor idle adjustment.

n. Improper carburetor float level.

o. Low compression.

68. ENGINE MISSES AT HIGH SPEED

Possible Causes:

a. Dirt or water in gas line or carburetor.

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

c. Weak coil or condenser.

d. Incorrect ignition timing.

e. Distributor points dirty or incorrectly spaced.

f. Trailing edge of rotor worn.

g. Loose ignition wiring.

h. Excessive play in distributor shaft.

i. Spark plugs fouled, damp, or dirty, or the gaps set too wide.

j. Insufficient point dwell.

k. Insufficient spring tension on points.

l. Normal hydraulic tappet pump up.

m. Worn camshaft lobes.

n. Weak valve springs.

o. Abnormal resistance in spark plugs.

p. Distributor cam lobe worn.

q. Engine overheating.

r. Low grade fuel.

s. Badly worn diaphragm in fuel pump.

t. Detonation or pre-ignition.

u. Frozen heat control valve.

69. EXTERNAL OIL LEAKAGE

Possible Causes:

a. Outside oil lines.

b. Timing gear case cover oil seal.

c. Rear main bearing oil seal.

d. Oil pan gaskets

e. Oil pan drain plug.

f. Oil filter gasket.

g. Clogged rear camshaft bearing drain hole.

h. Tappet cover gaskets.

i. Fuel pump or gasket.

j. Timing chain cover gasket.

70. OIL PUMPING PAST PISTON RINGS

Possible Causes:

a. Oil level too high. (a) Dip stick not entering oil pan far enough. (b) Dip stick incorrectly marked.

b. Loose main or connecting rod bearings.

NOTE

Excessive bearing clearance will cause the cylinder walls to be flooded with oil.

c. Too light oil for the type of service and conditions.

d. Excessively hot operating temperatures.

e. Piston ring gaps not staggered or incorrect size rings used.

f. Incorrect set of piston rings or rings out-of-round.

g. Cylinder head improperly torqued, causing a distortion of the cylinder bores for which the piston rings cannot compensate.

h. Rings fitted too tight in piston.

i. Oil rings carboned up or return grooves in piston clogged.

j. Insufficient piston ring tension.

NOTE

Common condition after engine has overheated.

k. Compression rings installed upside-down.

l. Excessive oil pressure or broken piston rings.

m. Burned piston.

NOTE

This condition can be brought about by excessive detonation and pre-ignition.

n. Scored cylinder walls or piston rings.

o. Excessively worn rings or cylinder walls.

NOTE

This condition can be traced to one or more of the following:

(1) Normal wear.

(2) Failure to keep air cleaners, carburetor, and crankcase filler cap installed and serviced.

(3) Failure to service the oil filter.

(4) Careless filling of the oil pan by allowing dirt or foreign material to fall in.

(5) Failure to clean cylinder walls properly after reboring or honing.

(6) Failure to prevent grindings and stone dust from getting on cylinder walls or improper cleaning of valve ports after grinding seats.

(7) Use of rings with heavier wall tension than necessary.

(8) Excessive speeding of a cold engine. In addition to the foregoing, many engines are overhauled for excessive use of oil or smoking without any degree of success, because the actual cause may be due to any one or more of the following:

(9) Excessive clearance between valve guide and valve stem.

(10) Diaphragm of fuel pump porous.

(11) External oil leaks.

(12) Internal oil leak into cooling system.

The above covers the most common causes of oil pumping past the rings.

71. OIL PUMPING AT VALVE GUIDES

Possible Causes:

a. Worn valve stems or guides.

b. Intake valve stem guide in inverted position. (FirePower engine.)

c. Intake valve seals damaged or missing.

72. HIGH OIL CONSUMPTION DUE TO LUBRICATING OIL

Possible Causes:

a. Oil level too high.

b. Contaminated oil.

c. Poor grade of oil.

d. Thin, diluted oil.

e. Oil pressure too high.

f. Sludge in engine.

73. HIGH OIL CONSUMPTION—MISCELLANEOUS

Possible Causes:

a. Overheated engine.

b. Sustained high speeds.

c. Misadjusted breather cap, causing excessive crankcase ventilation.

Certain mechanical conditions can affect engine oil pressure readings. In order to aid in determining the cause, the following conditions and possible causes are listed.

74. NO OIL PRESSURE WHEN ENGINE IS FIRST STARTED

Possible Causes:

a. Oil from the oil galleries and oil filter has drained back into the oil pan when the engine was shut off.

b. Frozen or partially clogged oil gauge line.

75. NO OIL PRESSURE AT IDLE

Possible Causes:

a. Oil gauge not registering properly, due to higher than normal pressure required to start gauge registering.

b. Excessive oil pump rotor end clearance.

c. Stuck oil relief valve.

d. Loose main and connecting rod bearings.

e. Loose camshaft bearings.

f. Plugs removed from end of rocker shafts, or are loose.

g. Internal oil passage leakage.

h. Oil pump body cover seal ring blown or missing.

i. Oil pump body cover seal ring replaced with common gasket.

76. NO OIL PRESSURE ON FAST STARTS OR RAPID ACCELERATION

Possible Causes:

a. Low oil level in oil pan.

b. Oil pump suction tube not aligned, or bent, causing the floating oil strainer to bind on side of oil pan.

c. Oil pump suction tube too long (allows the oil pump floater oil strainer to bind in recess in front of oil pan).

d. Floating oil strainer not adjusted properly.

The floating oil strainer should be horizontal with the bottom of the block when it is at the bottom of its travel.

e. Excessive main or connecting rod bearing clearances.

f. Oil pump rotor pin sheared.

g. Expansion plug missing in oil pump cover.

h. Oil filter and oil filter by-pass plugged.

i. Air leak in oil pump suction tube.

j. Oil pump floating strainer plugged.

k. Oil pump relief valve stuck open.

l. Internal oil passage leak.

77. BROKEN VALVES

Possible Causes:

a. Weak valve springs.

b. Worn valve guides.

c. Excessive tappet clearance. (C-300.)

d. Cocked springs or retainers.

e. Out-of-round block seats.

f. Defective valve forgings.

g. Excessive engine speeds.

h. Detonation.

78. BURNED OR STICKING VALVES

Possible Causes:

a. Close tappet clearance. (C-300.)

b. Weak valve springs.

c. Gum formations on stem or guide.

d. Eccentric valve face.

e. Deposits on valve seats.

f. Incorrect valve seat width.

g. Improper valve guide clearance.

h. Warped valves.

i. Improper block cooling.

j. Exhaust back pressure.

k. Improper spark timing.

l. Out-of-round valve seat.

79. NOISY VALVES

Possible Causes:

a. Incorrect tappet clearance. (C-300.)

b. Worn tappets or adjusting screws. (C-300.)

c. Wear in cam lobes.

d. Worn valve guides.

e. Excessive run-out of valve seat or valve face.

NOTE

When replacing valve guides, be sure the counterbore in guide is up for exhaust and down for intake.

80. BROKEN VALVE SPRINGS

Possible Causes:

a. Valve flutter at high speed.

b. Improper crankcase ventilation.

c. Worn timing chain.

d. Cold engine operation due to defective thermostat.

e. Rust, due to improper storage.

81. VALVE DEPOSITS

Possible Causes

a. Quality of fuel.

b. Quality of lubricating oil.

c. Valve stem wear.

d. Improper cooling of block.

e. Sludged engine.

f. Worn valve guides.

g. Improper lubrication of valve stem.

h. Excessive engine idling.

i. Rich carburetor setting.

When diagnosing the cause of valve failure, it must be remembered, that a valve can only transfer its heat to the cylinder block or head through the valve seats, guides, and tappets to the cooling system. There is only one basic cause for valve failure and that is the inability of a valve to dissipate its heat into the cooling system.

The following information is presented as an aid in diagnosing valve failure and also help in preventing a recurrence. Some of the common conditions which can cause both intake and exhaust valve failure are:

a. Deposit build-up under the head of the valves, as well as on the top. This deposit acts as a heat retainer and prevents cooling of the valve in the normal manner.

b. Deposits on the upper part of the valve stems which prevents full seating of the valves.

c. Sludge deposits on the end of the valve and springs will cause the valve to stick, and is caused by poor maintenance of engine oil or filter. Low engine operating temperatures due to inoperative thermostat, or short intermittent engine operation. This latter condition does not allow the engine to reach operating temperature to evaporate the condensation in the crankcase.

Another condition, is extreme slow driving of the vehicle which does not allow sufficient crankcase ventilation to remove condensation.

d. Insufficient tappet clearance or operating clearance between tappet plunger and bottom of tappet body (hydraulic tappets).

On hydraulic tappets, this condition is usually caused by excessive grinding and allows the valve stems to extend further out of the head.

Sufficient clearance is very important and will insure complete closing of the valves after maximum expansion has taken place under high speed operating conditions.

e. Valves or seats that are not ground concentric with the valve guide. This can be due to worn refacing equipment. Valve-to-seat contact should be checked with a film of Prussian blue.

f. Improper valve seat width. The maximum permissible width is 3/32 inch to 1/16 inch minimum. If the seats have been refaced and are wider than specified, they should be narrowed by using a 20 degree stone on top and a 60 degree stone at the bottom.

g. Valve and valve seat not refaced to a 45 degree angle, due to worn or inaccurate equipment.

h. Excessively refaced valves. The distance between the top edge of the valve face and the top of the valve must not be less than 3/64 inch. **Discard any valve that does not meet specifications.**

i. Weak valve springs. Springs that fail to pull the valve down and hold it firmly on its seat.

j. Incorrect valve timing.

k. Excessive valve guide wear. This condition will not allow proper cooling and permits oil to be sucked into the intake ports, causing a carbon formation which could lead to valve sticking.

l. Restrictions in the cooling passages around the valve seats caused by excessive scale and rust deposits. This is the result of not using a rust inhibitor in the cooling system.

m. Engine overheating to such a degree that there is insufficient coolant to help dissipate the valve heat.

82. CONDITIONS COMMON TO INTAKE VALVE FAILURE

a. Sticking valves. This condition can be brought about by heavy carbon and/or a varnish deposit on the valve stem and head. This gum, which has formed in the gasoline, is a result of its exposure to air for an extended period. In some cases, where gum and varnish has deposited on the valve stem, it has been known to cause valve sticking while the engine is hot and operating under power, yet still giving a good idle when the engine is relatively cool.

Cars which have been improperly prepared for extended storage or have been using fuel from bulk storage that is used very little—such as on a farm or ranch during the winter months—are susceptible to this type of valve sticking.

Heavy carbon deposit, as a result of short operation, such as driving the vehicle daily for a prolonged period in and out of the service department to an outside storage space.

Rust. This condition results from prolonged storage without proper preparation.

b. Valve pounding or face grooving. This condition is closely associated with valve sticking since it prevents free movement of the valve in the guides. This causes uncontrolled seating of the valves, which results in ridges being pounded into the face of the valve. This is more noticeable when the valves are running excessively hot due to deposits. When this condition exists, bright polished rings are usually found around the valve stem. This condition can be further aggravated should the fuel contain any corrosive additives.

c. Valve dishing and valve face grooving. This condition is usually the result of an overheating condition which can further be aggravated by, or attributed to, pre-ignition or detonation.

83. CONDITIONS COMMON TO EXHAUST VALVE FAILURE

a. Back-pressure due to restrictions in the exhaust system, which prevents rapid expulsion of the hot gases.

b. Excessively lean fuel-air mixture.

c. Carburetion (improper size jets).

d. Air leaking into the intake manifold.

e. Air leak at carburetor mounting or throttle body gaskets.

f. Air leaks in vacuum line for windshield wipers (if so equipped), booster brakes, or other vacuum-operated accessories.

When this type leak occurs, the same valves will fail and will usually be those at, or beyond, the point of leakage (further away from the carburetor).

Due to the rotating action of the valve, the actual point of burning on the face of the valve will not necessarily be an indication of actual point of air leakage into the intake manifold.

g. Early ignition timing.

h. Detonation or pre-ignition.

i. Overloaded engines, such as pulling heavy house trailers or luggage trailers.

j. Excessive compression due to improper or planned cylinder heads or improper pistons.

k. Low grade guel.

l. The use of fuels to which an engine may be converted, such as butane.

m. Heat control valves stuck in the closed position.

As a matter of interest, broken or cracked exhaust valve seats, as well as cylinder blocks or heads with cracks radiating out from an exhaust valve port, can be traced to prolonged operation with burned or leaking exhaust valves.

84. PISTON RING NOISE

Possible Causes:

a. Broken ring.

b. Top ring striking cylinder ridge.

c. Broken ring lands.

d. Excessive side clearance in groove.

85. PISTON NOISE

Possible Causes:

a. Piston pin fit too tight or too loose.

b. Excessive piston-to-bore clearance.

c. Carbon accumulations in head.

d. Collapsed piston skirt.

e. Insufficient clearance at top ring land.

f. Broken piston, skirt, or ring land.

g. Misaligned connecting rods.

86. CONNECTING ROD NOISE

Possible Causes:

a. Low oil pressure.

b. Insufficient oil supply.

c. Thin or diluted oil.

d. Misaligned rods.

e. Excessive bearing clearance.

f. Eccentric or out-of-round crank pin journal.

87. MAIN BEARING NOISE

Possible Causes:

a. Low oil pressure.

b. Insufficient oil supply.

c. Thin or diluted oil.

d. Loose flywheel or torque converter.

e. Excessive bearing clearance.

f. Excessive end play.

g. Eccentric or out-of-round journals.

h. Sprung crankshaft.

88. BROKEN PISTON RINGS

Possible Causes:

a. Wrong type or size.

b. Detonation.

c. Undersize pistons.

d. Pre-ignition.

e. Ring striking top ridge.

f. Worn ring grooves.

g. Rings assembled wrong.

h. Broken ring lands.

i. Insufficient gap clearance.

j. Excessive side clearance in groove.

k. Uneven cylinder walls (particularly due to a previous ring breakage in same cylinder).

89. BROKEN PISTONS

Possible Causes:

a. Undersize pistons.

b. Eccentric or tapered cylinders.

c. Misaligned connecting rod.

d. Engine overheating.

e. Water or fuel leakage into combustion chamber.

f. Detonation or pre-ignition.

90. DETONATION

Detonation, pre-ignition, and after-running are abnormal types of combustion. Normal combustion starts at the spark plug and the flame expands at the extremes of the combustion chamber. During the short period of combustion, a high pressure is produced which pushes down on the piston to develop engine power.

Detonation occurs after the spark plug fires, when some of the fuel-air mixture in the combustion chamber is ignited by spontaneous combustion before the flame reaches it. The mixture is burned much more rapidly than during normal combustion. This detonation creates an explosion which produces excessive temperatures and pressures. Detonation is most easily recognized by a pinging sound during acceleration or continuous wide open throttle operation, such as climbing a steep hill.

A detonation complaint is usually concerned with noise that is produced. Although a mild case of detonation will not damage an engine, excessive detonation may result in engine failure, caused by the excessive temperatures and pressures. The parts affected by detonation will be easily identified. Broken piston rings, broken and burned piston ring lands, and blown cylinder head gaskets.

Detonation is caused primarily by the following:

a. Advanced spark timing.

b. Combustion chamber deposits.

c. Low octane fuels.

d. Excessively high coolant or air temperatures.

When correcting a detonation complaint the first thing to check is the spark timing. If detonation persists at the proper timing, the distributor should be removed and checked to see if it conforms to the advance specifications and adjusted, if necessary. Further investigation depends on the type of operation. If the vehicle is used primarily for light duty, the detonation probably results from excessive combustion chamber deposits. These should be removed.

91. PRE-IGNITION

Pre-ignition is the burning of the air-fuel mixture before the spark plug fires. The mixture is ignited by a hot spot in the combustion chamber. Since this is equivalent to advancing the spark, it results in a reaction similar to severe detonation. The temperature and pressure in the combustion chamber are higher than those produced during normal combustion.

Generally, pre-ignition produces a pinging sound which is louder than detonation. However, if pre-ignition occurs early enough on the compression stroke, it is not audible. If it occurs before the intake valve closes, the engine will backfire through the air cleaner.

In many cases, it is difficult to distinguish between audible pre-ignition and detonation; in fact, they may occur simultaneously. Audible pre-ignition may be isolated from detonation by accelerating the vehicle at wide open throttle (not above 2000 rpm) until the loud pinging is heard and then turning off the ignition. If the engine continues to fire, it is pre-ignition; if it ceases to fire, the engine is detonating. Remove the foot from accelerator pedal before turning on the ignition again.

Inaudible pre-ignition is difficult to distinguish during operation, but it can be recognized by the failures it can produce, as noted below. If the engine back-fires through the air cleaner during wide open throttle operation, a colder set of spark plugs should be installed. If the back-firing ceases, it was probably caused by pre-ignition. If the engine continues to back-fire, it is caused by other factors, such as faulty ignition, incorrect carburetor mixture, incorrect valve timing, or a worn camshaft.

Inaudible pre-ignition cannot be recognized until a piston or valve failure occurs. It is generally caused by a hot spark plug. Check for hot plug as described previously.

92. AFTER-RUNNING

After-running is a compression ignition of the engine at very slow speeds after the ignition has been turned off.

This condition is a source of irritation to the owner but it does not cause engine failure. After-running is primarily caused by one or more of the following factors:

a. Fast idle speed.

b. High coolant temperatures.

c. Combustion chamber deposits.

After-running is generally caused by fast idle speed or cutting the ignition before the engine throttles down to idle. The idle speed should be properly adjusted and the owner questioned as to whether he has the habit of pumping the accelerator pedal before turning off the ignition. If this does not correct the complaint, the vehicle should be checked for overheating.

If the vehicle has been used primarily for light duty operation, some highway operation will remove combustion chamber deposits which may eliminate the complaint.

This complaint cannot be corrected with cold spark plugs.

93. IGNITION TIMING

Due to normal variations between engines in their fuel requirements, high altitude operation (which results in a richer fuel mixture that reduces the octane requirements of the engine), and the variations in octane ratings of the fuels being marketed, the established ignition timing setting of 4 degrees BTDC for the V-8 engines should be considered a basic or starting point when tuning an engine. As a result of the conditions mentioned, a variation of plus or minus 4 degrees from the starting setting is permissible.

CAUTION

The advancing of timing in excess of 4 degrees of the basic setting is not recommended, as inaudible pre-ignition could be encountered under some operating conditions at high speeds.

When tuning an engine to obtain maximum performance, economy, and smooth operation, and to take advantage of variations in octane requirements, it is desirable to make the final ignition timing during actual road test. Should the final timing be made during the road test, it is suggested the following procedure be followed:

a. Set the ignition timing at 4 degrees BTDC.

b. Drive the vehicle until normal operating temperature has been reached.

c. While in high gear, decelerate the car to 15 mph or just before the transmission downshifts (if automatic); then, with a wide open throttle, accelerate to about 30 mph.

d. During this wide open throttle operation, if a slight unobjectionable pinging or detonation is heard that disappears as the car approaches 30 mph, the timing can be considered to be the best setting; however, if the pinging or detonation is objectionable, the timing should be retarded 1 degree at a time until the proper setting has been reached.

94. STARTING NOISE

This is a condition where the tappets are noisy upon starting and remain so for approximately 5 or 10 minutes, or until the engine has reached normal operating temperature.

Possible Causes:

a. Engine oil drain-back.

If the check valve is plugged, the oil drains out of the oil galleries and drilled passages into the oil pan. This occurs when the engine is not operating. Upon starting, it is necessary that the oil pump refill the system and, at the same time, force the air that entered the system through the tappets out of the engine. Until the oil system has been refilled and all the air bled out, noisy tappets may be experienced.

b. Filter change.

This may cause the same condition as above, and for the same reasons. Air trapped in the lubricating system may require a minimum of 20 to 30 minutes to bleed out. When changing an oil filter element, there is always a possibility that air may be trapped in the cover of the filter and not work out through the tappets until some time later after the tappets have originally quieted.

c. Tappet varnish.

The problem of tappet varnish will not necessarily hinder the tappets since they are designed to allow the varnish to build up in areas that do not affect their operation. There is, however, a condition in which a varnish-coated tappet can possibly cause trouble; this is when a valve has been replaced. This repair can effectively change the length of the valve mechanism and thereby allow the tappet plunger to operate in a new position in the body which may have a varnish build-up and result in the plunger sticking.

d. Anti-freeze.

Starting noise can also be caused by a gummy deposit, which results from leakage of anti-freeze or glycol into the engine oil. When cold, this deposit will be hard, but when hot, it becomes soft and gummy. This, therefore, is another reason excessive tappet noise can be experienced when starting, gradually disappearing as the gummy substance softens and allows the plungers to assume their normal operating positions. If this deposit is permitted to remain, it can eventually cause scuffing of the hydraulic tappet plunger.

e. Normal tappet leakdown.

This condition occurs on all engines and is due to the normal leakdown of the tappets that remain under valve spring pressure when the engine is shut off. The expulsion of air and the duration for quieting these particular tappets is dependent on the clearance to which the tappet plunger body has been fitted. The closer the fit, the longer duration.

95. ALL TAPPETS NOISY

In cases where all 16 tappets are noisy, it is generally safe to assume that the noise is not the fault of the tappets, but of the oil supply, which is **inadequate, or into which air has been induced. No advantage can be gained by installing 16 new tappets unless they are found to be stuck due to an anti-freeze leak. In this case it is imperative that the leak be corrected to prevent reoccurrence.**

Possible Causes:

a. Drain plug out of oil pan.

The loss of the drain plug from the oil pan will result in the loss of oil and oil pump pressure.

b. Plug out of the oil pump cover.

A plug out of the oil pump cover will permit the majority of oil from the pump to escape back into the oil pan. This usually shows up as fluctuation or low oil pressure on the gauge.

c. Floating oil strainer stuck up.

The floating oil strainer momentarily hanging up and preventing oil from being drawn into the oil pump. When this condition occurs, tappet noise may occur shortly after a turn, stop, or fast acceleration. This condition may also be detected by close observation of the oil pressure gauge.

d. Low oil level.

Low oil level permits insufficient oil and air to be pumped into the lubrication system. This can be detected by close observation of the oil pressure gauge for fluctuation.

e. Plugged oil float screen.

A plugged oil float screen is generally due to inadequate oil and/or filter change periods for the type of operation.

f. Oil pump relief valve stuck.

When this condition occurs, it usually permits pressure to be normal at higher speeds while falling below normal at low engine speeds or at idle. **Normal oil pressure for a warm engine at idle is considered to be 12 psi or more at 500 rpm.**

g. A major oil pressure drop below normal.

A major oil pressure drop is generally caused by excessive bearing clearance, etc., which permits excessive leakage of hot engine oil and reduces the pressure of oil delivered to the tappets below the minimum required for quiet and proper operation of the tappet.

h. Oil foaming.

This is a condition where a large quantity of air bubbles are trapped in the oil, producing a condition of foaming or sudsing (aeration). Since air unlike oil, is compressible, tappet noise or loss of valve lift will result when the aerated oil enters the tappet.

i. Excessive oil supply.

When the oil level is too high in the oil pan, the crankshaft and connecting rods dip into the oil and churn it, causing an aerated condition.

j. Low oil supply.

This condition permits the reuse of a small quantity of oil which does not have sufficient time to cool and rid itself of the normal air induced into the oil.

k. Air entering the oil pump.

This condition can be caused by the oil screen in the float sticking above the oil level, or a leak in the suction tube, loose oil pump cover, etc. In all cases, air will be drawn into the oil pump and induced into the oil.

l. Plug out of oil pump cover.

A plug that is loose or missing out of the oil pump cover will cause excessive by-passing and aeration of the oil.

m. Prolonged use of engine oil.

Where operating conditions are such that the majority of driving is slow or short and intermittent, not permitting the engine to warm up to operating temperature, it is possible for normal condensation to build up in the crankcase to a point where it will cause the oil to foam.

n. Water from the cooling system leaking into the engine oil.

Water from the cooling system leaking into engine oil will cause excessive oil foaming.

o. Glycol in the engine oil.

When glycol leaks into the engine lubrication system, it has a tendency to form a gummy substance which deposits on the engine parts. This substance will normally affect the operation of the hydraulic tappets, first by causing sticking, and then gradually causing the tappets to scuff and become increasingly noisy until they reach a point where the plungers will stick completely. **This is the only condition which may require the replacement of all 16 tappets. However, unless the condition is corrected, it will repeat itself.**

96. ONE OR MORE TAPPETS NOISY

Possible Causes:

a. Excessive dry lash.

The term of dry lash refers to the clearance between the valve stem and rocker arm when the tappet is on the heel of the cam lobe and the plunger is bottomed in the tappet body. The normal clearance is .060 to .210 inch, and any lash exceeding .210 inch could cause a tappet to be noisy. **A condition of excessive dry lash usually indicates wear.**

To determine if proper dry lash is the problem, insert a 1/8 inch (.125) feeler between the rocker arm and the valve stem; then, start the engine. If the noise has disappeared it is quite possible it was caused by a worn rocker arm or push rod.

b. Broken valve spring.

This could be either the inner or outer valve spring. (FirePower engine.)

c. Sticking rocker arm.

This could be the result of any condition that prevents free movement of the rocker arm on the rocker shaft.

d. Worn rocker arm.

This condition is usually due to lack of hardness of the rocker arm or push rod end, and can be detected by the dry lash test as described above.

e. Face of rocker arm not true.

When this condition is present, it will be noted that the rocker arm is making contact on the edge of the valve stem. This can cause a valve cocking condition and result in the valve stem to ride heavy or bind in the guide.

f. Push rods worn, bent, or interfering (in head).

A worn push rod can be identified by a worn spot on one end. This can be caused by insufficient lubrication. Check holes in arm and rocker shaft.

When installing a new rocker arm, be sure the lubricating oil holes are open.

Worn, bent, or interfering push rods can be detected by the dry lash test, as described above.

A bent push rod is generally caused by mishandling and can result in interference in the cylinder head or increased dry lash.

The push rod interference in the cylinder head can be caused by inadequate clearance in the push rod passages through the cylinder heads. If this condition is found, it is only necessary to relieve the ends of the hole at the top and bottom.

g. Tight tappet.

While rare, this condition occurs where the tappet or the tappet bore is of incorrect size, bell-mouthed or out-of-round, causing the tappet to stick in its bore. A condition of this nature is indicated by heavy wear or scuff marks on portions of the side of the tappet body. Unless the tappet bores in the cylinder block are cleaned up, the same condition will occur with a replacement tappet. **To check bore, slide a new tappet in and out. If the tappet sticks, ream bore to next oversize and install new oversize tappet.**

h. Stuck hydraulic tappet plungers.

This condition is where a tappet plunger is stuck in the tappet body and is unable to compensate for changes in the valve train clearance. **Extended engine operation at high speed with this condition existing, could cause valve breakage.** Three basic causes for this condition are: **Dirt or metal chips; glycol in the lubricating oil; and, the mismatching of parts in assembly after cleaning.**

Varnish build-up around the top of the tappet above the operating range of the plunger is a normal condition, therefore, it should not be confused with a stuck tappet in which the plunger will normally be found stuck below the operating range.

i. Valve stem varnish.

Occasionally, this condition may occur where a heavy deposit of varnish has adhered to the valve stem and restricts the movement of the valve in the guide.

j. Faulty tappets.

This is caused by conditions that may be inherent in the individual tappets, such as bent valve washers, omitted valve washers, tight plunger caps, improperly fitted retainer, bad flat valve or valve seat, a plugged or missing oil hole in the tappet body or plunger, or a loose plunger to body fit that causes a fast leakdown under spring pressure. (The latter usually shows up at idle when the oil is hot.)

Since the hydraulic tappet is not reparable, only those determined to be faulty should be replaced. The replacement of any tappets other than the individual ones causing the condition, would serve no purpose.

k. Worn valve guide.

Tappet noise can also be caused by a guide that is worn .015 inch or more, or by a valve that is bent to a point where it will actually hang up in the guide. Valves can be bent in the field when attempting to compress a valve spring on an engine with the piston up or near TDC, or by failing to use the proper head holding fixtures, Tool C-3209, when the heads have been removed for repairs.

l. Tappet oil feed hole plugged or restricted.

In many cases where a tappet has been removed for being noisy, it has been found that the oil feed hole in the tappet or the cylinder block was restricted or plugged. This condition is due to varnish, sludge, dirt, or other foreign materials. **Again this condition can be attributed to infrequent filter element or oil change.** Before installing any tappet, it is a good policy to run a drill rod or drill into the feed hole to make sure it is open. **Be sure no burr is left in the tappet bore after opening with rod.**

m. Worn tappet or camshaft lobe.

There have been instances when some condition causes scoring to start between the cam lobe and the face of the tappet, in the same manner as any other bearing surface. When this condition occurs, it can result in damage not only to the face of the tappet, but to the camshaft lobe as well. It will produce tappet noise and a lack of engine performance.

This condition can be determined by measuring the lift of the valve. The lift can be measured by bottoming the tappet in the same way as checking for valve timing, by inserting a shim of sufficient size to take up the dry lash. The lift of the valve can then be measured with a dial indicator and compared with other valves shimmed in the same manner. The normal valve lift should be approximately .360 inch. Since wear of up to .030 inch is permissible, the mileage of the engine, as well as the comparison check with other cylinders, should be taken into consideration before a decision is reached to replace the camshaft. When tappets and/or camshaft replacement is necessary due to excessive wear, a very thorough cleaning of the lubricating system should be performed, or else the particles of worn metal that have deposited out of the oil will cause a reoccurrence of the same trouble.

97. INTERMITTENT TAPPET NOISE

Possible Causes:

a. Aerated or foaming oil.

This is a condition where a large quantity of air bubbles are trapped in the oil, producing a condition of foaming or sudsing (aeration). Since air, unlike oil, is compressible, tappet noise or loss of valve lift will result when the aerated oil enters the tappet.

b. Defective tappets.

Although these defects cannot be corrected in the field, and therefore require replacement of the individual tappet, the following is presented to point out possible defects:

c. Extremely wide seat on the lapped seat of the tappet plunger.

d. Insufficient check valve travel to compensate for various speeds.

e. Out-of-round tappet plunger.

Tappet Cleaning

When cleaning tappets (if needed) at the time of engine overhaul or valve grind, it should be done in accordance with the procedure described in this section. Extreme precautions must be taken to be sure that all work be done in clean surroundings and using clean materials. If the cleanliness precautions are not observed, it is more than likely the effort will be wasted and noisy or stuck tappets can be expected.