ENGINE GROUP

SPECIFICATIONS

SECTION "A"-SILVER DIAMOND ENGINE

MODELS {L-110, L-120, LM-120, L-130, L-150, L-153, LM-150 (SD-220 Engine)
LB-140, L-160, L-163, L-164, L-165, LC-160 (SD-240 Engine)

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ENGINE GROUP—Continued

SECTION "B"-SUPER BLUE DIAMOND ENGINE

MODELS L-170, L-173, L-174, L-175, LF-170, L-180, L-183, L-184, LC-180 (BD-269 Engine)

ENGINE GROUP—Continued

SECTION "C"-SUPER RED DIAMOND ENGINE

MODELS { L-185, L-190, L-193, L-194, LC-190 (RD-372 Engine)
L-190, L-194, L-195, LC-190, LF-190, L-200, L-204 (RD-406 Engine)
L-200, L-204, L-205, LC-200, L-210, LF-210 (RD-450 Engine)

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SUPER BLACK DIAMOND 282 SLEEVELESS ENGINE SPECIFICATIONS

Engines used in R-Line chassis are the same as used in L-Line trucks except the new BD-282 Super Black Diamond Sleeveless Engine has been added for the RF-170, R-180, RC-180 as standard equipment. The following chart lists specifications of this new engine.

Engine	Super Black Diamond 282 Sleeveless Engine
Number of cylinders	6
Bore	3-13/16
Stroke	4-1/8
Displacement (cu. in.)	282.546
Rated H.P. (A.M.A.)	34.8
Brake H.P. (maximum)	130.2
At R.P.M.	3400
Brake H.P. (net)	117.5
At R.P.M.	3200
Torque maximum (lbs-ft)	246.3
At R.P.M.	1800
Torque net (lbs-ft)	238.2
At R.P.M.	1600
Maximum recommended speed R.P.M.	3400
Compression ratio	6.5
Firing order	1-5-3-6-2-4
Crankcase refill capacity (qts)	7
Weight (bare) (lbs.)	742
Weight with standard accessories (lbs.)	831

CRANKSHAFT

Main journal diameter	2.701
Crankpin diameter	2-1/8
Bearing clearance	.0013-.0043
Crankshaft end play	.0055-.0145
Trust taken by	Rear
Hardening method	Through

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CAMSHAFT

Camshaft journal diameter:

Front	1.8130-1.8145
Second	1.7248-1.7263
Third	1.7098-1.7113
Fourth	1.5010-1.5025
Camshaft bearing clearance	.0010-.0035
Camshaft end play	.0020-.0100
Thrust taken by	Thrust flange
Camshaft gear backlash	.0015 (desired)

CONNECTING RODS

Connecting rod bearing end clearance	.0070-.0130
Connecting rod bearing clearance	.0007-.0032

PISTONS

Material	Aluminum alloy
Recommended piston clearance	.003

PISTON PINS

Length	3.201
Diameter	.9193

Pin fit at room temperature (70°):

Recommended clearance in rod	.0003-.0005
Recommended clearance in piston	.0001 tight .0003 loose

FEELER GAUGE RIBBON CHECKING

Width	1/2"
Thickness	.003
Tension on scales (lbs.)	6-18
Desired tension (lbs.)	12

PISTON RINGS

Compression rings:

Number used on each piston 3

Size . . . . . (1) 3/32 (2) 1/8

OIL RINGS

Number used on each piston 1

Size 3/16

Ring diameter 3-13/16

RING GAP

Compression 010-.026

U-flex 0003-.027

FIT IN GROOVE

Compression top 0025-.0040

Second and third 0015-.0030

Oil control fourth 0015-.0035

VALVES	EXHAUST	INTAKE
Stem diameter	.372	.372
Angle of face	30°	15°
Tappet clearance (hot)	.023	.023
Stem clearance in guide	.003	.002
Width of valve seat	5/64-7/64	3/64-5/64
Slo Roto valve cap to stem clearance	.001-.005	. . . . .

VALVE TAPPET

Clearance in block 0015-.003

VALVE SPRINGS

Free length 2.187

Length valve open 1.468

Pounds pressure - valve open 186-196

Valve Rocker Arm Clearance in Shaft 0015-.004

VALVE TIMING

Intake opens (before T. D. C.)	12°
Intake closes (after T. D. C.)	38°
Exhaust opens (before T. D. C.)	55°
Exhaust closes (after T. D. C.)	15°
Intake valve timing checking clearance	.020

OIL PUMP

Body gear end clearance	.0025-.0055
Pump body to spiral gear clearance	.0048-.0088
Pump shaft diameter	.4885-.4890
Pump shaft clearance in bore	.005

OIL PRESSURE

Minimum lbs.	15-20
At R. P. M.	Idling
Maximum lbs.	40-45
At R. P. M.	1200 and up

ENGINE SPECIFICATIONS

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
Number of cylinders	6	6	6	6	6	6	6
Bore	3-9/16"	3-9/16"	3-9/16"	4-3/8"	4-3/8"	4-3/8"	4-7/8"
Stroke	3-11/16"	4-1/64"	4-1/2"	4-1/8"	4-1/2"	5"	5-/38"
Displacement (cu. in.)	220.50	240.30	269.10	372.06	405.89	450.99	602.00
Rated h.p. (A.M.A.)	30.4	30.4	30.4	45.9	45.9	45.9	
Brake h.p. (maximum)	100.0	108	100.5	143.8	154.2	162.2	
At r.p.m.	3600	3600	3000	3200	3200	3000	
Brake h.p. (net)	90	93	88.6	128	138	146	
At r.p.m.	3600	3400	2800	2850	2750	2600	
Torque maximum (lbs.ft.)	173.5	191.9	222.0	282.5	319.0	358.5	
At r.p.m.	2000	1400	1600	1600	1200	1200	
Torque net (lbs. ft.)	167	186	216.5	280.0	313.5	354.0	
At r.p.m.	1200	1100	1000	1000	1000	1000	
Maximum recommended speed r.p.m.	3600	3400	3000				
Governed speed r.p.m.				2850	2750	2600	
Compression ratio	6.5	6.5	6.3	6.3	6.3	6.2	
Firing order	153624	153624	153624	153624	153624	153624	153624
Crankcase refill capacity (qts.)	7	7	7	9	9	9	16
Weight, bare (lbs.)	607	607	781	937	942	948	1638
Weight, with standard accessories (lbs.)	673	673	874	1047	1076	1082	1863
CRANKSHAFT:							
Main journal diameter	2.748"-2.749"	2.748"-2.749"	2.7005"-2.7015"	3.2495"-3.2505"	3.2495"-3.2505"	3.2495"-3.2505"	3.249"-3.250"
Crankpin diameter	2.373"-2.374"	2.373"-2.374"	2.122"-2.123"	2.751"-2.752"	2.751"-2.752"	2.751"-2.752"	2.999"-3.000"
Bearing clearance	.0010"-.0040"	.0010"-.0040"	.0013"-.0043"	.0013"-.0043"	.0013"-.0043"	.0013"-.0043"	.0022"-.0046"
Crankshaft end play	.005"-.013"	.005"-.013"	.0055"-.0135"	.004"-.012"	.004"-.012"	.004"-.012"	.006"-.008"
Thrust taken by	rear interm.	rear interm.	rear	rear	rear	rear	front
Hardening method	through	through	through	tocco	tocco	tocco	tocco
Main bearing bolt tension (ft. lbs.)	75-85	75-85	100-110	100-110	100-110	100-110	105-115
CAMSHAFT:							
Camshaft journal diameter							
Front	2.109"-2.110"	2.109"-2.110"	1.811"-1.812"	2.109"-2.110"	2.109"-2.110"	2.109"-2.110"	2.1220"-2.1225"
Second	2.089"-2.090"	2.089"-2.090"	1.577"-1.578"	2.089"-2.090"	2.089"-2.090"	2.089"-2.090"	2.1220"-2.1225"

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ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
Third	2.069"-2.070"	2.069"-2.070"	1.562"-1.563"	2.069"-2.070"	2.069"-2.070"	2.069"-2.070"	2.1220"-2.1225"
Fourth	1.4995"-1.5005"	1.4995"-1.5005"	1.499"-1.500"	1.4995"-1.5005"	1.4995"-1.5005"	1.4995"-1.5005"	2.1220"-2.1225"
Fifth	.....	.....	.....	.....	.....	.....	2.1220"-2.1225"
Camshaft bearing clearance	.0010"-.0035"	.0010"-.0035"	.0010"-.0035"	.0010"-.0035"	.0010"-.0035"	.0010"-.0035"	.0015"-.0025"
Camshaft end play	.0020"-.0080"	.0020"-.0080"	.0020"-.0080"	.0020"-.0080"	.0020"-.0080"	.0020"-.0080"	.0050"-.0070"
Thrust taken by	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange	Thrust Flange
Camshaft gear backlash	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)	.0015" (desired)
CONNECTING RODS:							
Connecting rod bearing end clearance	.0070"-.013"	.0070"-.013"	.0070"-.0130"	.0070"-.0130"	.0070"-.0130"	.0070"-.0130"	.0060"-.0100"
Connecting rod bearing clearance	.0011"-.0011"-	.0011"-.0032"	.0007"-.0032"	.0012"-.0037"	.0012"-.0037"	.0012"-.0037"	.0012"-.0036"
Connecting rod bolt nut tension (ft. lbs.)	45-55	45-55	60-70	75-85	75-85	75-85	100-110
PISTONS:							
Material	aluminum-alloy	aluminum-alloy	aluminum-alloy	aluminum-alloy	aluminum-alloy	aluminum-alloy	aluminum-alloy
Recommended piston clearance:	.003	.003	.003	.003	.003	.003	
PISTON PINS:							
Length	2.950"	2.950"	2.950"	3.796"	3.796"	3.796"	
Diameter	.8748"-.8750"	.8748"-.8750"	.9192"-.9194"	1.1089"-1.1091"	1.1089"-1.1091"	1.1089"-1.1091"	1.4998"-1.5000"
Pin fit (room temperature 70° F.):-							
Recommended clearance in rod	.0002"-.0004"	.0002"-.0004"	.0003"-.0004"	.0005"-.0006"	.0005"-.0006"	.0005"-.0006"	.0003"-.0007"
Recommended clearance in piston	.0000"-.0002"	.0000"-.0002"	.0000"-.0002"	.0000"-.0002"	.0000"-.0002"	.0000"-.0002"	.0001"-tight .0001"-loose
FEELER GAUGE RIBBON CHECKING:							
Width	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
Thickness	.003"	.003"	.003"	.003"	.003"	.003"	.005"
Tension on scales (lbs.)	6-18	6-18	6-18	6-18	6-18	6-18	5-10
Desired tension (lbs.)	12	12	12	12	12	12	8

ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
PISTON RINGS:							
Compression Rings:-							
Number used on each piston	3	3	3	3	3	3	4
Size	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	1-3/32" 2-1/8"	
Oil Rings:							
Number used on each piston	1	1	1	1	1	1	1
Size	3/16"	3/16"	3/16"	3/16"	3/16"	3/16"	
Ring diameter	3-9/16"	3-9/16"	3-9/16"	4-3/8"	4-3/8"	4-3/8"	
Ring Gap:-							
Compression	.016"-.026"	.016"-.026"	.016"-.026"	.025"-.035"	.025"-.035"	.025"-.035"	.013"-.023"
U-Flex	.....	.....	.....	.....	.....	.....	.....
Fit in Groove:-							
Compression - top	.0025"-.0040"	.0025"-.0040"	.0025"-.0040"	.0040"-.0055"	.0040"-.0055"	.0040"-.0055"	.0055"-.0070"
- 2nd & 3rd	.0015"-.0030"	.0015"-.0030"	.0015"-.0030"	.0020"-.0035"	.0020"-.0035"	.0020"-.0035"	.0025"-.0035"
Oil Control - fourth	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"
Plain - fifth	.....	.....	.....	.....	.....	.....	.0015"-.0035"
INTAKE VALVES:-							
Stem diameter	.372"	.372"	.342"	.434"	.434"	.434"	.4973"
Angle of face	30°	30°	45°	15°	15°	15°	30°
Tappet clearance (hot)	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.020"
Stem clearance in guide	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0015"-.0035"	.0008"-.0021"
Width of valve seat	1/64"-3/64"	1/64"-3/64"	5/64"-7/64"	5/64"-7/64"	5/64"-7/64"	5/64"-7/64"	1/16"-3/32"
EXHAUST VALVES:							
Stem diameter	.370"	.370"	.341"	.434"	.434"	.434"	.494"
Angle of face	30°	30°	45°	45°	45°	45°	45°
Tappet clearance (hot)	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.018"-.020"	.020"
Stem clearance in guide	.002"-.004"	.002"-.004"	.002"-.004"	.002"-.004"	.002"-.004"	.002"-.004"	.0035"-.005"
Width of valve seat	3/64"-5/64"	3/64"-5/64"	5/64"-7/64"	3/32"-1/8"	3/32"-1/8"	3/32"-1/8"	5/64"-7/64"
Slo-roto valve cap to stem clearance	.....	.....	.....	.002"-.006"	.002"-.006"	.002"-.006"	.002"-.006"
VALVE TAPPET:-							
Clearance in block	.0015"-.003"	.0015"-.003"	.0015"-.003"	.001"-.003"	.001"-.003"	.001"-.003"	.0019"-.0002"
VALVE SPRINGS:-							
Free lenght:							
Inner	2-11-16"	2-11/16"	2-33/64"	2-11/32"	2-11/32"	2-11/32"	2-3/4"
Outer	.....	.....	.....	2-9/16"	2-9/16"	2-9/16"	2-13/16"

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ENGINE MODELS	SD-220	SD-240	BD-269	RD-372	RD-406	RD-450	CONT. R-6602
Length - valve open:							
Inner	1.683"	1.683"	1.668"	1.503"	1.503"	1.503"	1.750"
Outer	.....	.....	.....	1.706"	1.706"	1.706"	1.750"
Lbs. pressure - valve open:							
Inner	141-149	141-149	103-111	83-88	83-88	83-88	82-88
Outer	.....	.....	.....	133-141	133-141	133-141	160-170
VALVE ROCKER ARM CLEARANCE IN SHAFT	.0015"-.004"	.0015"-.004"	.0015"-.004"	.0015"-.004"	.0015"-.004"	.0015"-.004"	.0002"-.0014"
VALVE TIMING:							
Intake opens (before T.D.C.)	10°	10°	5°	8°	8°	8°	12°
Intake closes (after L.D.C.)	46°	46°	45°	52°	52°	52°	62°
Exhaust opens (before L.D.C.)	48°	48°	40°	55°	55°	55°	54°
Exhaust closes (after T.D.C.)	8°	8°	10°	15°	15°	15°	20°
Intake valve timing clecking clearance	.023"	.023"	.023"	.023"	.023"	.023"	.020"
OIL PUMP:							
Body gear end clearance	.0025"-.0055"	.0025"-.0055"	.0025"-.0055"	.0025"-.0055"	.0025"-.0055"	.0025"-.0055"	
Pump body to spiral gear clearance	.....	.....	.03125"	.03125"	.03125"	.03125"	
Pump shaft diameter	.4885"-.4890"	.4885"-.4890"	.4985"-.4992"	.4985"-.4990"	.4985"-.4990"	.4985"-.4990"	
Pump shaft clearance in bore	.005"	.005"	.005"	.005"	.005"	.005"	
OIL PRESSURES							
Minimum (lbs.)	15-20	15-20	15-20	15-20	15-20	15-20	
At r.p.m.	idling	idling	idling	idling	idling	idling	
Maximum (lbs.)	40-45	40-45	40-45	40-45	40-45	40-45	
At r.p.m.	1200 up	1200 up	1200 up	1500 up	1500 up	1500 up	
CYLINDER HEAD:							
Cylinder head bolt (ft. lbs.)	85-95	85-95	75-85	100-110	100-110	100-110	100-110

SILVER DIAMOND ENGINE

SIZE AND THREAD	NAME OF ASSEMBLY	RECOMMENDED WRENCH TORQUE LOAD, FT.-LB.
5/16 - 18	Generator strap to generator	14 - 16
5/16 - 18	Water outlet	8 - 10
5/16 - 18	Coil bracket to cylinder head	14 - 16
5/16 - 18	Fuel pump to crankcase	8 - 10
5/16 - 18	Oil pan to crankcase	14 - 16
5/16 - 18	Distributor adapter to crankcase	14 - 16
5/16 - 18	Oil pump cover to body	14 - 16
5/16 - 18	Vibration damper to pulley	16 - 18
5/16 - 18	Oil pump body to crankcase	14 - 16
5/16 - 24	Generator mounting	8 - 10
5/16 - 24	Coil mounting	16 - 18
3/8 - 16	Manifold to cylinder head	25 - 30
3/8 - 16	Engine support bracket to crankcase	25 - 30
3/8 - 16	Generator bracket to crankcase	25 - 30
3/8 - 16	Intake to exhaust manifold	25 - 30
3/8 - 16	Water pump to crankcase	25 - 30
3/8 - 16	Cylinder head cover	25 - 30
3/8 - 16	Gear case cover to crankcase	25 - 30
3/8 - 16	Camshaft thrust flange	25 - 30
3/8 - 24	Connecting rod bolt	45 - 55
3/8 - 24	Carburetor to manifold	23 - 28
3/8 - 24	Intake to exhaust manifold	23 - 28
5/16 - 24	Gear case cover to plate	9 - 11
7/16 - 14	Flywheel housing	50 - 60
7/16 - 14	Oil pressure relief valve	13 - 15
7/16 - 20	Flywheel to crankshaft	55 - 65
1/2 - 13	Starting motor	75 - 85
1/2 - 13	Cylinder head capscrew	85 - 95
1/2 - 13	Crankshaft bearing bolt	75 - 85
1 - 14	Starting crank nut	90 - 100
1 - 20	Camshaft lock nut	110 - 120
7/8 - 18	Spark plug (in cast iron)	32 - 35
14 MM	Spark plug (in cast iron)	25 - 28
14 MM	Spark plug (in aluminum)	21 - 25
18 MM	Spark plug (in cast iron)	28 - 31
18 MM	Spark plug (in aluminum)	25 - 28

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SUPER BLUE DIAMOND ENGINE

SIZE AND THREAD	NAME OF ASSEMBLY	RECOMMENDED WRENCH TORQUE LOAD, FT.-LB.
5/16 - 18	Air cleaner to cylinder head	18 - 22
5/16 - 18	Fuel pump to crankcase	8 - 10
5/16 - 18	Crankshaft rear oil seal, upper	14 - 16
5/16 - 18	Distributor bracket to cylinder head	14 - 16
5/16 - 18	Oil pump cover to body	14 - 16
5/16 - 24	Vibration damper to pulley	16 - 18
5/16 - 24	Gear case cover to plate	8 - 10
5/16 - 24	Generator mounting	8 - 10
3/8 - 16	Manifold to cylinder head	25 - 30
3/8 - 16	Oil pan to crankcase	25 - 30
3/8 - 16	Generator bracket to crankcase	25 - 30
3/8 - 16	Oil pump body to crankcase	25 - 30
3/8 - 16	Water pump to cylinder head	25 - 30
3/8 - 16	Crankshaft rear oil seal, lower	25 - 30
3/8 - 16	Gear case cover to crankcase	25 - 30
3/8 - 16	Cam shaft thrust flange	25 - 30
3/8 - 16	Starting motor	25 - 30
3/8 - 24	Carburetor to manifold	23 - 28
3/8 - 24	Gear case cover to plate	9 - 11
7/16 - 14	Oil pressure relief valve	13 - 15
7/16 - 20	Connecting rod bolt	60 - 70
7/16 - 20	Intake to exhaust manifold	55 - 65
7/16 - 20	Connecting rod bolt	60 - 70
1/2 - 13	Flywheel housing	75 - 85
1/2 - 13	Cylinder head cap screw	75 - 85
1/2 - 20	Flywheel to crankshaft	90 - 100
9/16 - 12	Crankshaft bearing capscrew	100 - 110
9/16 - 12	Crankshaft bearing capscrew	100 - 110
1 - 20	Camshaft lock nut	110 - 120
7/8 - 18	Spark plug (in cast iron)	32 - 35
14 MM	Spark plug (in cast iron)	25 - 28
14 MM	Spark plug (in aluminum)	21 - 25
18 MM	Spark plug (in cast iron)	28 - 31
18 MM	Spark plug (in aluminum)	25 - 28

SUPER RED DIAMOND ENGINE

SIZE AND THREAD	NAME OF ASSEMBLY	RECOMMENDED WRENCH TORQUE LOAD, FT.-LB.
5/16 - 18	Distributor bracket to cylinder head	18 - 22
5/16 - 18	Crankshaft rear oil seal, upper	18 - 22
5/16 - 18	Crankshaft rear oil seal, lower	18 - 22
5/16 - 24	Generator mounting	20 - 24
5/16 - 24	Carburetor to manifold (Holley)	20 - 24
3/8 - 16	Starting motor mounting	25 - 30
3/8 - 16	Oil pump body to crankcase	25 - 30
3/8 - 16	Camshaft thrust washer	25 - 30
3/8 - 16	Damper to pulley hub	30 - 35
3/8 - 16	Fuel pump to crankcase	25 - 30
3/8 - 16	Rocker arm bracket to head	25 - 30
3/8 - 16	Gear case to crankcase	25 - 30
3/8 - 16	Generator bracket to case	25 - 30
3/8 - 16	Water pump to cylinder head	25 - 30
3/8 - 16	Oil pan to crankcase	25 - 30
3/8 - 16	Oil filler	25 - 30
3/8 - 24	Gear case cover to crankcase plate	25 - 30
3/8 - 24	Carburetor to manifold (Zenith)	23 - 28
3/8 - 24	Gear case cover	23 - 28
3/8 - 24	Manifold to cylinder head	23 - 30
7/16 - 20	Intake to exhaust manifold	55 - 65
7/16 - 20	Intake to exhaust manifold	55 - 65
7/16 - 20	Connecting rod capscrew (place type)	75 - 85
7/16 - 20	Carburetor to manifold	40 - 45
1/2 - 13	Oil filter mounting	75 - 85
1/2 - 13	Cylinder head capscrew, oil	100 - 110
1/2 - 13	Cylinder head capscrew, long	100 - 110
1/2 - 13	Cylinder head capscrew, short	100 - 110
1/2 - 13	Flywheel housing to crankcase	75 - 85
9/16 - 18	Crankshaft to flywheel	150 - 160
9/16 - 18	Crankshaft to flywheel	150 - 160
9/16 - 18	Crankshaft bearing cap	100 - 110
9/16 - 18	Crankshaft bearing cap	100 - 110
1 - 20	Camshaft gear nut	110 - 120
7/8 - 18	Spark plug (in cast iron)	32 - 35
14 MM	Spark plug (in cast iron)	25 - 28
14 MM	Spark plug (in aluminum)	21 - 25
18 MM	Spark plug (in cast iron)	28 - 31
18 MM	Spark plug (in aluminum)	25 - 28

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SILVER DIAMOND ENGINE

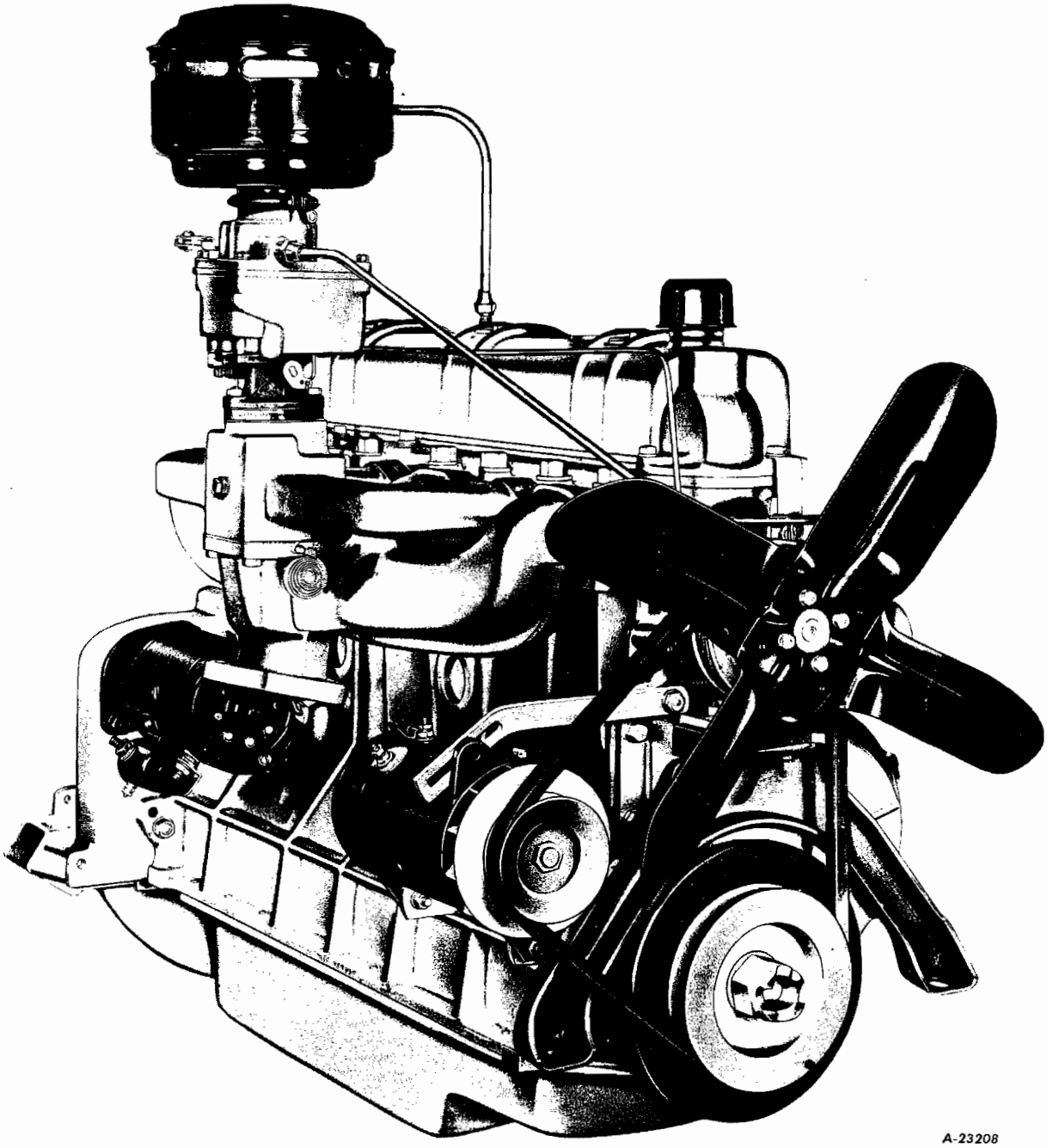

Fig. 1 - Silver Diamond Engine

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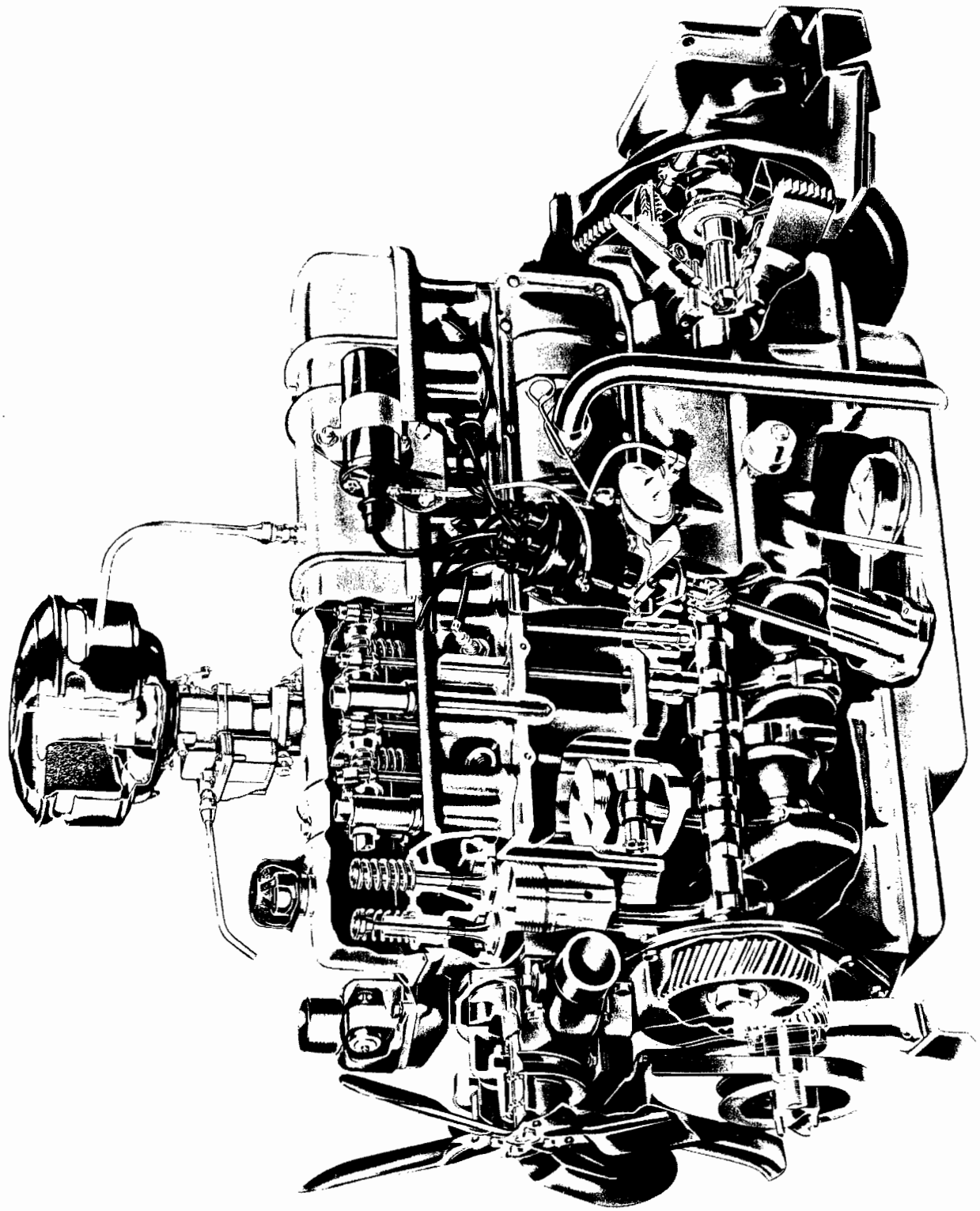

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Fig. 2 - Sectional view of Silver Diamond Engine

DESCRIPTION

General

The Model SD engine is a 4-cycle, 6-cylinder-in-line, overhead-valve-type engine (Fig. 1 and Fig. 2). The engine serial number is stamped on a pad at the front on the right side of crankcase just below the cylinder head. The block does not have replaceable liners for the cylinders. The detachable cylinder head contains all valves, valve guides, and springs. The cylinders are numbered from front (fan and timing gear end) to rear. Engine crankshaft rotation is clockwise as viewed from the front end of the vehicle. The intake and exhaust manifolds, carburetor, starter, and generator are located on the right side of engine. The ignition coil, distributor, fuel pump, oil pressure regulator, and breather are located on the left side of engine. The oil filler inlet is located in the valve cover on the top of engine. The bayonnet type oil level gauge is located on the left side of engine. The water pump is located at the front of engine.

Construction

1. The generator, fan, and water pump are driven by a V-type belt from a driven pulley mounted on the front end of crankshaft. The distributor, mounted at the left side of engine, is driven by the camshaft through the oil pump.

2. The exhaust and intake manifolds are bolted to each other and to the right side of the engine head. The intake manifold and the exhaust manifold are each cast in one piece.

3. A vibration damper is provided at the front end of the crankshaft on the model SD-240 engine only.

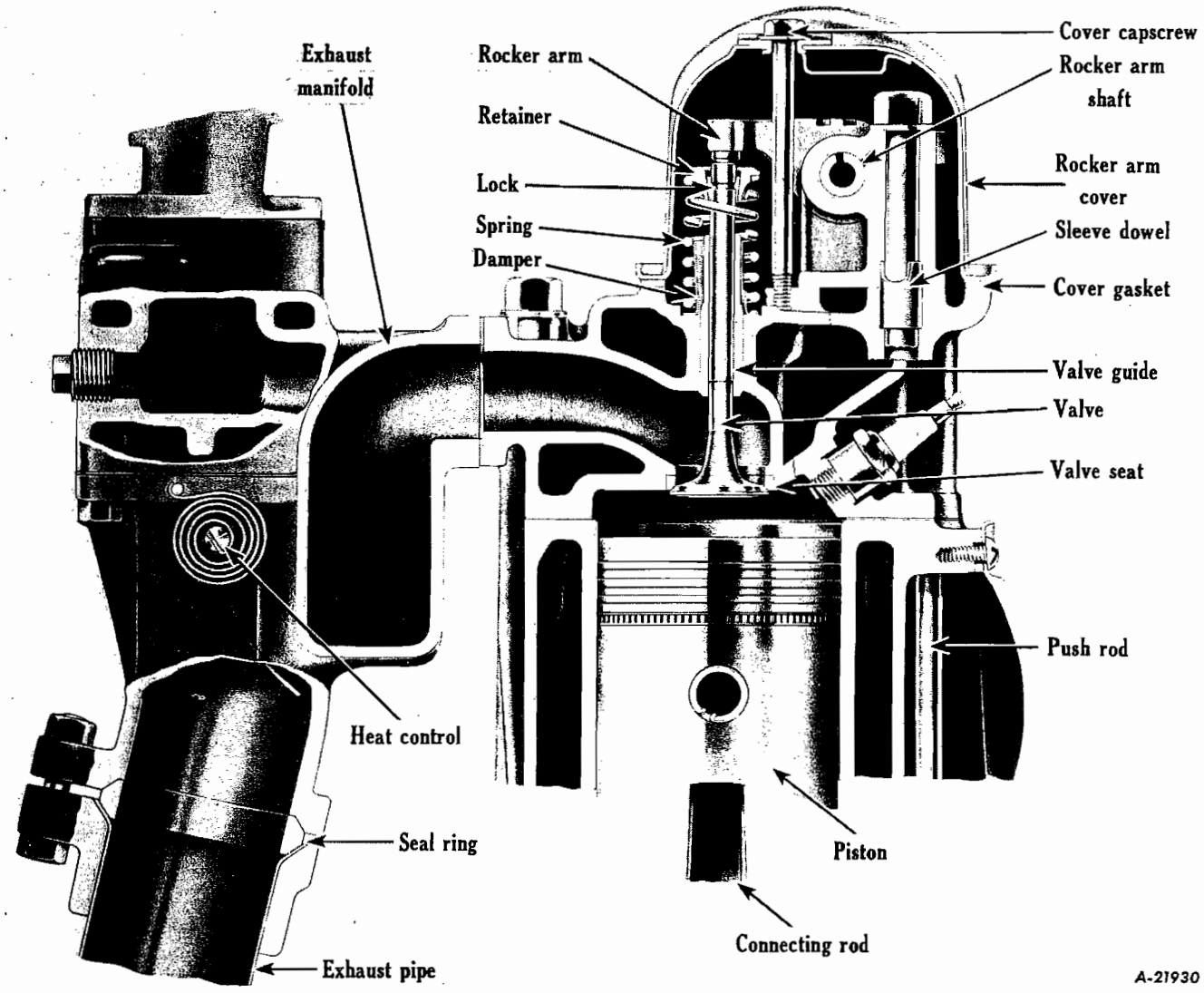

Fig. 3 - Sectional view through engine showing details of valve mechanism.

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4. The cylinder block and crankcase are cast in one piece, and carry the crankshaft main bearings. Water circulation passages completely surround the cylinders in the crankcase, and also provide coolant to the cylinder head.

5. Oil is supplied under pressure by the oil pump to the engine lubrication system. Oil spray from the revolving cranksahft is distributed to the cylinder walls, pistons, and other moving parts inside the engine.

6. Exhaust valve seats are of alloy, and are pressed into place (Fig. 3). These valve seats lengthen the period between valve reconditioning operations. Valves and valve seats are cooled by continuous circulation of water through the cylinder head.

7. The detachable cylinder head is bolted to the crankcase, and a gastight and watertight seal is maintained by means of a gasket.

8. The crankshaft is a drop forging of heat-treated steel. It is counterweighted, balanced both statically and dynamically, and ground to close limits. The shaft is mounted in four precision-type replaceable shell bearings, the number three bearing taking up the thrust.

9. The pistons are made of an aluminum alloy, are cam ground, and are fitted with three compression rings and one oil control ring. The full-floating type piston pins are held in place in the pistons, at the ends of the pins, by snap rings.

10. The camshaft is machined from a solid drop forging and mounted in four special replaceable bearings.

11. The flywheel is bolted and doweled to the crankshaft flange. The timing mark is located on the flywheel.

ENGINE REMOVAL

The engine, with transmission removed, can be lifted from chassis, without disturbing the fender and grille assembly by using a suitable chain sling and a floor crane (Fig. 4). Disconnect the following electrical circuits, hose connections, and various units as outlined:

1. Drain engine oil pan. Drain all coolant from engine cooling system by opening the drain cock on side of engine as well as the radiator drain cock.

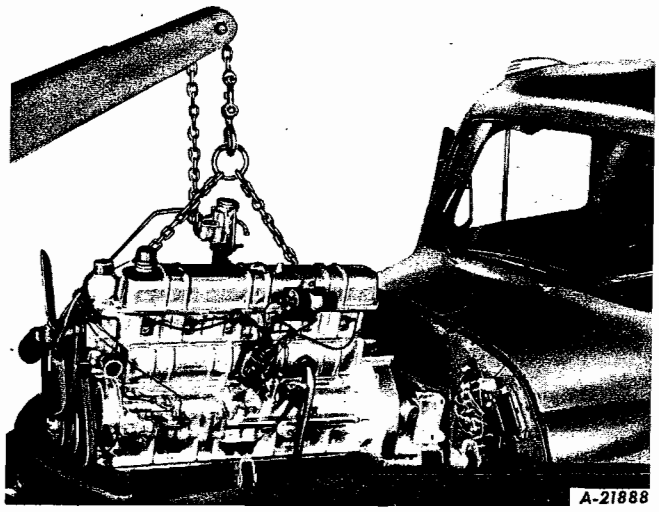

Fig. 4 - Removing Silver Diamond Engine.

2. Disconnect upper and lower radiator hose connections.

3. Disconnect engine circuit wiring. This includes coil wire, starter cable, engine ground strap, and instrument sender unit wires.

4. Disconnect fuel line at fuel pump. Disconnect throttle control linkage at left side of engine and remove choke at carburetor.

5. Disconnect clutch linkage at bell housing.

6. Remove engine rear mounting bolts from both sides of engine support pads.

7. Remove engine front mounting bolts from support bracket; these are the bolts at the front crossmember. NOTE: The engine front support bracket is removed with the engine.

8. Remove radiator mounting bolts, and lift out radiator support and core assembly.

9. Disconnect engine exhaust pipe at manifold.

ENGINE DISASSEMBLY

Install the engine in a suitable rotating engine overhaul stand. NOTE: Many of the disassembly operations can be performed with the engine in the chassis. However, the following disassembly outline is performed with the engine removed from the chassis to clearly illustrate each of the units. Except where indicated, no attempt has been made to prescribe a particular sequence for removing the various units, since some can be readily removed with the engine in the chassis. The extent of the service required on a particular unit will govern the necessity for its removal.

Removing Rocker Arms

The following steps are to be followed when removing the rocker-arm cover and rocker-arm assembly. (Carburetor and air cleaner previously removed):

1. Remove three capscrews from rocker-arm cover. Remove air cleaner line and remove cover (Fig. 5).

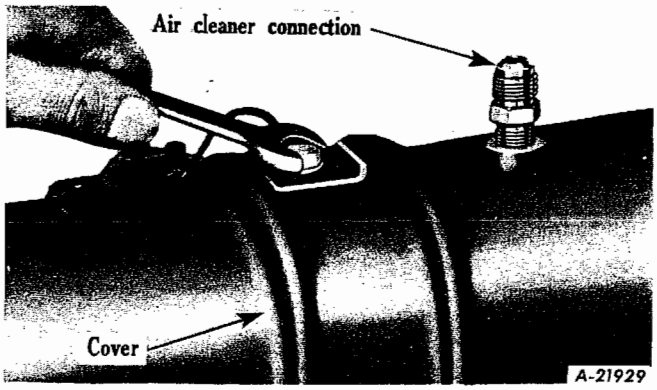

Fig. 5

2. Remove capscrews from shaft brackets (Fig. 6).

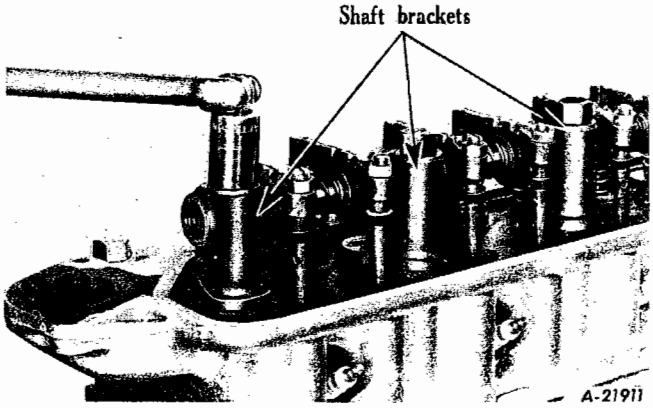

Fig. 6

3. Remove rocker-arm assembly as a unit (Fig. 7).

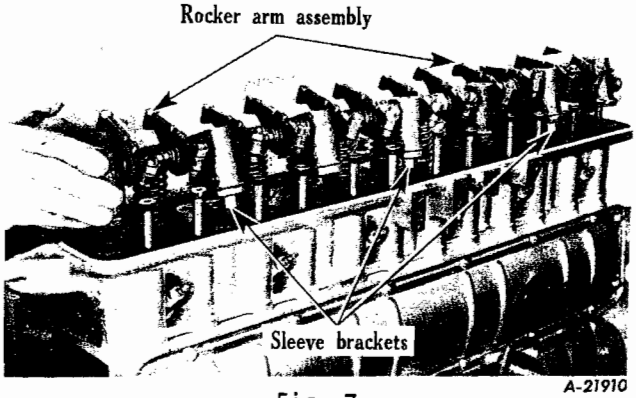

Fig. 7

Rocker-Arm and Valve Mechanism Disassembly

1. The rocker-arm assembly is composed of front and rear shafts joined at the center, on which are mounted twelve rocker arms and six tension springs (Fig. 8). The shafts are mounted in seven brackets, and are prevented from turning at the two end brackets by slots in the shaft into which the cylinder-head bolts fit.

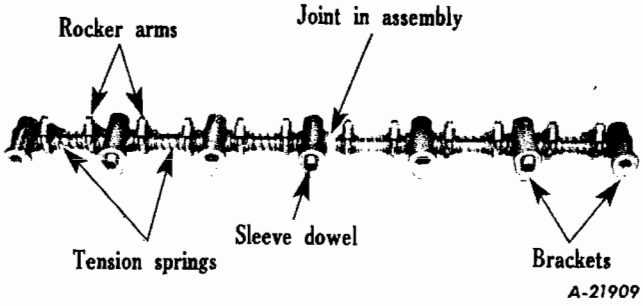

Fig. 8

2. Number two, four and six rocker-arm brackets have sleeve dowels which keep the rocker-arm assembly aligned.

3. These sleeve dowels measure approximately 5/8" in diameter, 1" long, and 1/32" wall.

4. The three hold-down brackets are reamed, from the bottom side (Fig. 9) so that the sleeve dowels will fit .0005"-.0035" tight in brackets. About one-half inch of dowel is in the bracket. The remaining half of dowel is fitted .0025"-.0055" loose in the head. When removing rocker-arm assembly the dowels will remain in hold-down brackets.

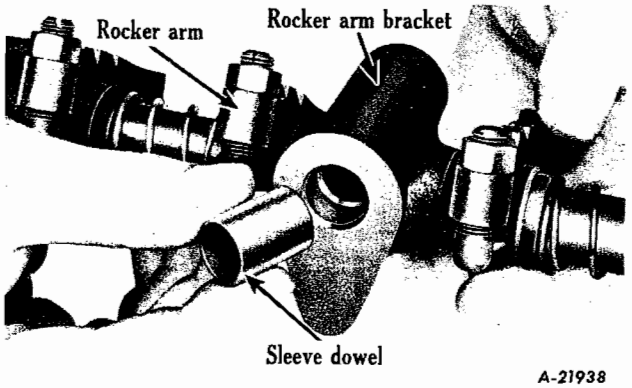

Fig. 9 - Details of sleeve dowel located in bracket.

5. Separate the shafts and slide rocker arms, springs, and brackets from shafts.

6. Clean all parts in a solvent cleaning fluid, being careful to clean all accumulated sludge and carbon deposits from oil holes and slots.

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Rocker Arm Inspection

Carefully inspect all parts for defects and wear:

1. Inspect rocker-arm shaft expansion plugs. Check on a surface plate for signs of bending, check for wear from rocker arms. If a shaft is bent or shows perceptible wear, it must be replaced.

2. Inspect rocker-arm adjusting screws for wear at contact surface and for thread wear. Replace worn screws. Check rocker-arm bushings for wear. If clearance on shaft exceeds .004", replace bushings. Inspect valve stem contact pad surface of rocker arms, and resurface if wear is perceptible.

3. Inspect tension springs for breakage or loss of tension. Replace defective springs. Remove valve lifter rods.

Re-bushing Rocker Arms

With properly fitting adapter, press old rocker-arm bushing from rocker arm (Fig. 10). Place new rocker-arm bushing in position. Align oil hole in bushing with oil hole in rocker arm, which is located 23° from top of rocker arm toward rocker-arm adjusting nut. Use an installing tool and press new bushing into rocker arm (Fig. 11). Burnish bushing into place in the rocker arm (Fig. 12), then ream rocker-arm bushing to provide .0015"-.004" clearance.

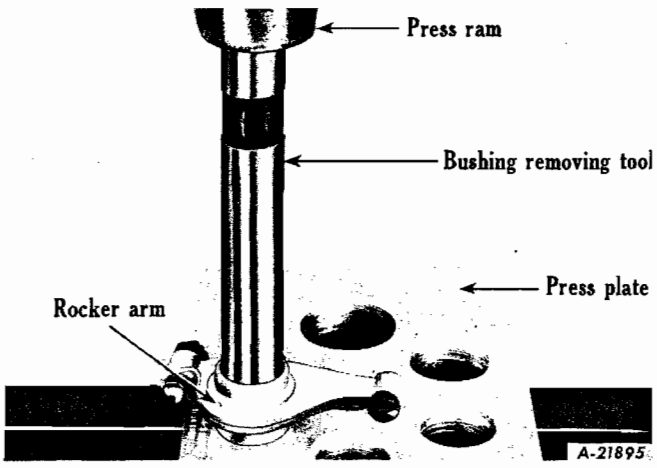

Fig. 10 - Use SE-1036-1 Bushing Removing Tool when removing the rocker arm bushing. Support the rocker arm on the SE-1033 support block. Select a hole in the support block to properly support the rocker arm at the same time permit the bushing to clear the support block when being removed. Use the support block when installing and burnishing the new bushing.

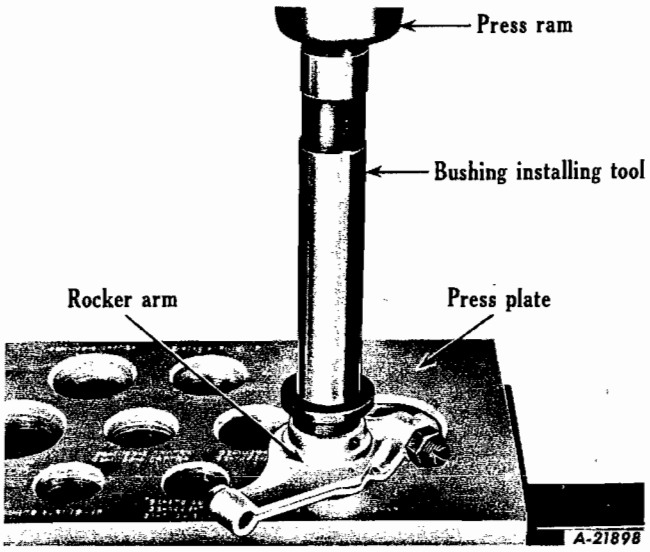

Fig. 11 - Installing new rocker arm bushing.

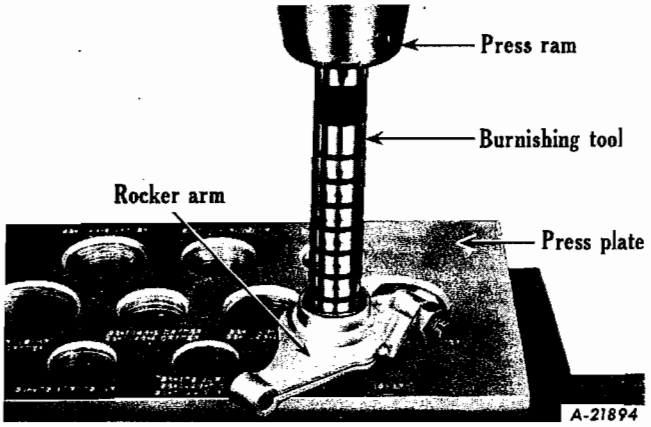

Fig. 12 - Use SE-931 Burnishing bar.

Cylinder Head and Valves

The following instructions are to be followed when reconditioning cylinder head and gasket. Remove push rods, remove cylinder-head bolts and lift off cylinder head and gasket (Fig. 13). Place cylinder head on bench.

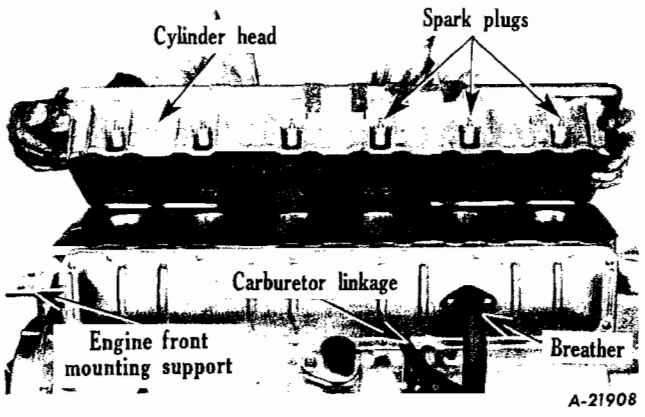

Fig. 13

1. Compress valve spring with a valve compressor and remove valve spring retainer locks (Fig. 14). Remove retainer. Remove valve spring and damper and separate valve spring damper from valve spring. Note that valve springs can be installed with either end toward the cylinder head. Remove all valve springs as outlined, and remove valve spring damper from each spring (Fig. 15).

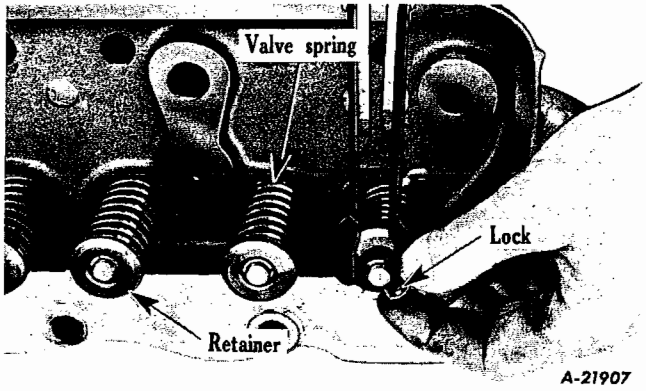

Fig. 14

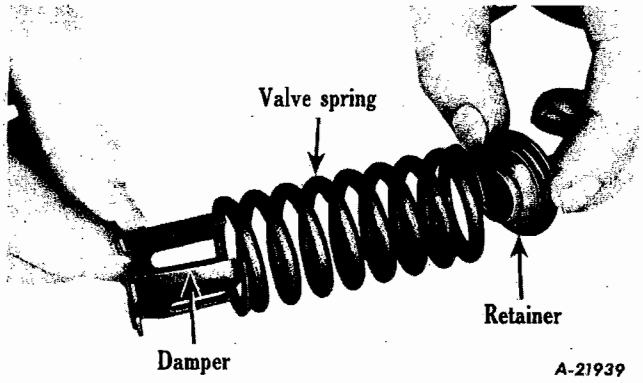

Fig. 15 - Dampers are used at all the valves. Assemble damper, spring and retainer as shown.

2. Invert cylinder head. Remove all valves from their valve guides and from the head.

3. Scrape all carbon from cylinder-head combustion chamber, and clean any gasket material from surface of head. Clean the head using steam cleaning or other suitable cleaning equipment

4. Clean all carbon deposits from valve heads and valve stems with a wire brush. Wash all valve springs and retainers in cleaning solvent.

Inspection of Cylinder Head

1. Inspect cylinder head visually for signs of cracks or sand holes. If found defective, weld or replace head.

2. Inspect exhaust valve seat rings for looseness and inspect for excessive width of valve seat surface. If rings are loose, replace. If a seat has been previously ground to such extent that it cannot be narrowed from top to bring to proper position near center of valve face, the ring must be replaces.

Inspection of Valve Guides, Valve Springs, and Valves

1. Clean valve guides with a suitable cleaning tool. Check each valve guide with a "Go and No-Go" gauge, if available; otherwise, use a new valve to check fit. If "No-Go" portion of gauge enters, the guide must be replaced. Recommended valve stem to valve guide clearance is from .0015" to .0035" for intake valves, and from .002" to .004" for exhaust valves. Clearance in excess of .006" for intake valves or .008" for exhaust valves, require guide replacement. Valve guides are reamed to .3743"-.3758" after assembly in cylinder head.

2. Test valve springs with damper in position. Test tension of each valve spring at valve open length with a valve-spring tester (Fig. 16). Check valve springs at 1-11/16" length, and replace if pressure is less than 149 lbs.

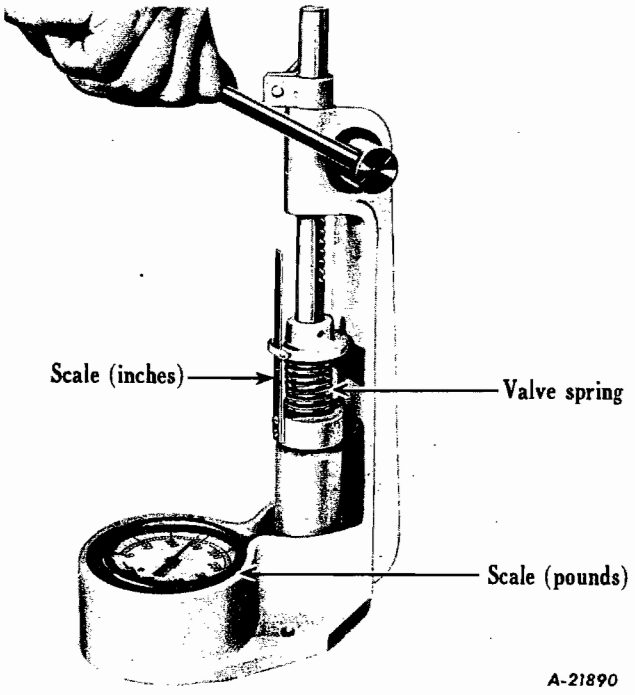

Fig. 16 - Use SE-1565 Valve spring testing tool or similar tool to check spring tension.

3. Inspect each valve for warpage, for severely burned condition, and for excessive grinding on the valve head. Inspect valve stem for scuff marks or perceptible wear.

Inspect valve stem end for wear at contact surface with valve rocker arm. If valve is warped, excessively burned, or has been previously ground to extent that valve head is thin at edge, replace valve; otherwise, valve can be reconditioned and reinstalled.

Repair of Cylinder Head

1. If cylinder head has to be resurfaced, remove only enough material to true-up surface.

2. If any valve guide shows excess clearance or out-of-round condition, press guide from cylinder head with a special removing tool (Fig. 17). Install new guide, and press into cylinder head until approximately 1-1/4" remains above the top surface of cylinder head (Fig. 18). Check valve guides after installation to .3758" to .3743" with "Go and No-Go" gauge. Ream valve guides to .3743"-.3758" after assembly in cylinder head.

3. If an inspection has indicated the necessity, replace the valve seat.

4. Grind the valve seats in cylinder head to 30° on exhaust and 30° on intake.

Reconditioning Valves and Seats

One of the principal difficulties experienced in reconditioning valves is obtaining nearly identical angles on the valve seat and valve face. The importance of these angles in the grinding operation cannot be overemphasized, because it is impossible to produce a flat or square seat by lapping.

The grinding stones on both the valve-refacing machine and valve-seat grinder should be dressed before starting a reconditioning job. You will be unable to determine how closely the angle of the seat will match the valve face until the valve and seat have been ground and a check made with a very light tint of Prussian blue. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to redress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve. No more material should be removed from the valve face than is necessary to true it up and remove the burned or pitted portion. New valves should not be refaced, but should be checked for trueness. When a satisfactory match of valve seat and valve face angles has been obtained, the adjustment of both the valve refacer and the seat grinder should be locked in position, in order to eliminate this trial-by-error method on additional valves having the same angle.

Valve Seats

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to prevent burning of the seat and warping of the valve head.

The location of the valve seat on the valve face and its width controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperatures and poor heat dissipation also produce excessive valve stem temperatures and hasten the accumulation of carbon on the stem, causing them to stick in the guides.

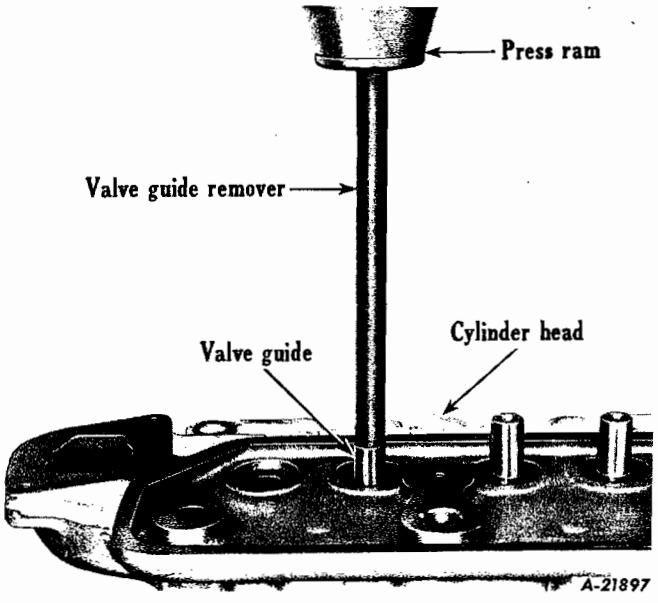

Fig. 17 - Use SE-1722 Valve stem guide tool.

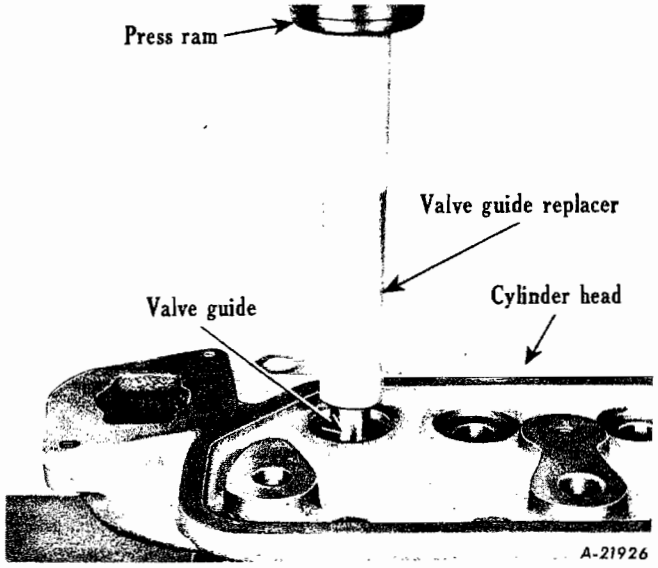

Fig. 18 - Using SE-1723 Guide replacer. Push guide down until tool bottoms on head.

Valve Seat Widths

In general, the width of exhaust seat should range between the average and maximum specifications and the intake seats between the minimum and average specifications. The intake seats may be narrower than the exhaust because they are usually larger in diameter, thus providing a total seat area approximately equal to smaller exhaust valve with the wider seat. Also the less severe heat conditions do not require as large a seat area for heat dissipation purposes.

There are also objections to an excessively wide seat, a few of which are as follows:

1. In city or light delivery service a wide seat collects carbon and particles of dirt that will produce variations or loss of compression, resulting in poor idle and possibly a loss of general performance and economy.
2. A wide seat in severe service operating in the presence of dirt or an excess of carbon will produce a badly pitted seat which may be just as detrimental to valve life as a too narrow seat. Under these conditions a seat width to the minimum limit would possible be better; however, the source of trouble (which is the dirt and excessive carbon) should be eliminated, making it possible to retain the wider seat.

Valve Seat Inserts

Necessity for replacing valve seat inserts should be very rare; however, if a replacement is made it is important that new inserts be peened securely in place, using either insert peening tool or a dull-pointed chisel, 1/4" wide, to peen cylinder head metal over outer edge of valve seat insert.

Valve seat insert installing tools are available.

Valve seat inserts supplied for service are standard size and .030" oversize which permits a tight fit in cylinder head.

Repair of Valves

1. True-up the ends of valve stem against face of grinder. Remove only enough material to true the surface.
2. Reface exhaust valves to 30°. The valve face and valve seat angle must be identical.
3. Reface intake valves to 30° with valve seat being the same.
4. Place valves in cylinder head. Place a thin coat of Prussian blue on each valve face, and tap valve lightly to its seat. NOTE: This is merely for test and proof of results of refacing and reseating operations. A poor grinding job cannot be corrected by valve lapping.
5. Inspect each valve coated with blue for seat position. The seat should be at the approximate center of valve face, 3/64"-5/64" wide for exhaust, and 1/64"-3/64" wide for intake (Fig. 19).

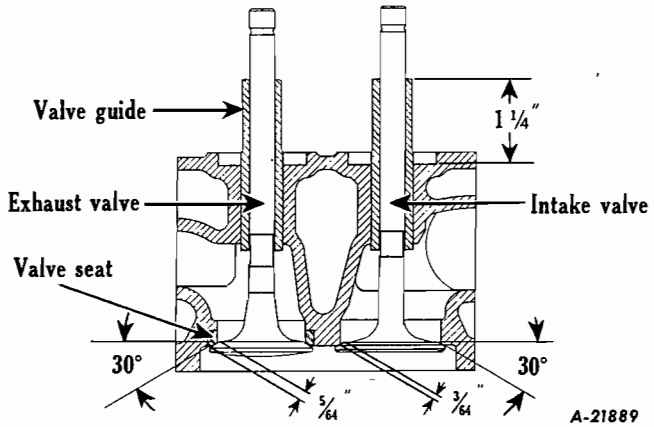

Fig. 19 - Diagram showing valve installation.

Valve Assembly

1. Wipe valve faces and valve seats with a cleaning solvent to remove all dirt or foreign material. Coat valve stems and valve faces with oil, and install valves in same seats to which they were checked.
2. Install valve springs with dampers. Compress valve springs with a valve spring compressor, and install valve spring retainers and retainer locks. Be sure that retainers and locks are correctly seated.

When overhauling engine with head and pan removed, the following procedures are recommended:

1. Remove front motor to frame bracket by removing two nuts on top side (Fig. 20). Remove fan drive pulley nut and washer from end of crankshaft. Install puller and remove crankshaft fan drive pulley from crankshaft (Fig. 21). Remove 4 capscrews holding motor mounting bracket to block (Fig. 22).
2. Remove nuts and capscrews from engine gear case cover, remove gear case cover and gasket. Remove crankshaft oil slinger from end of shaft (Fig. 23).
3. Remove two self-locking capscrews from camshaft retainer thrust flange plate, working through two holes in camshaft gear (Fig. 24). Pull camshaft and gear assembly from cylinder block. Remove

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two capscrews holding the gear case cover plate to block; remove plate and gasket (Fig. 25). Remove crankshaft timing gear, using a special gear puller (Fig. 26). (NOTE: Lubricate puller screw to prevent damage to screw threads).

Turn engine in the overhaul stand and proceed with disassembly as follows:

4. Each connecting rod is numbered as to its position in the engine and these numbers are located on the camshaft side of the engine. Remove self-locking capscrews from connecting-rod cap and remove cap. Push connecting-rod and piston assembly toward top of block, but first remove ridge from top of cylinder wall, if any. Lift piston and connecting-rod assembly from top of cylinder block (Fig. 27). Replace cap on connecting rod. Remove the remaining pistons, following the same procedure.

Note that the connecting-rod caps are aligned with the rods by means of tongue and groove construction (Fig. 28).

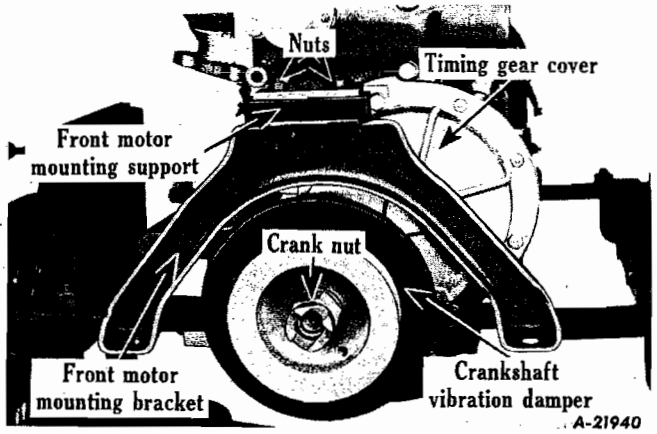

Fig. 20

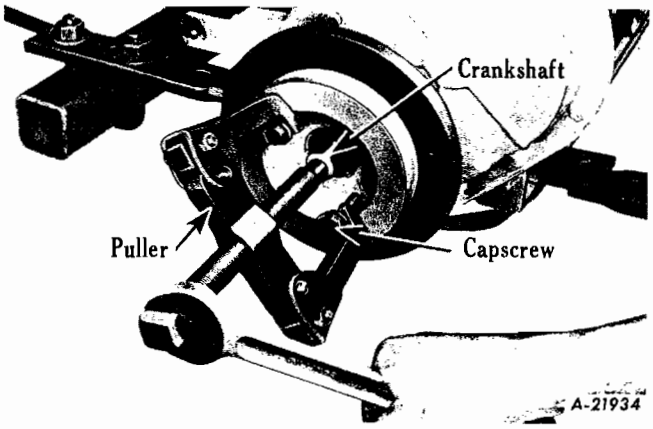

Fig. 21

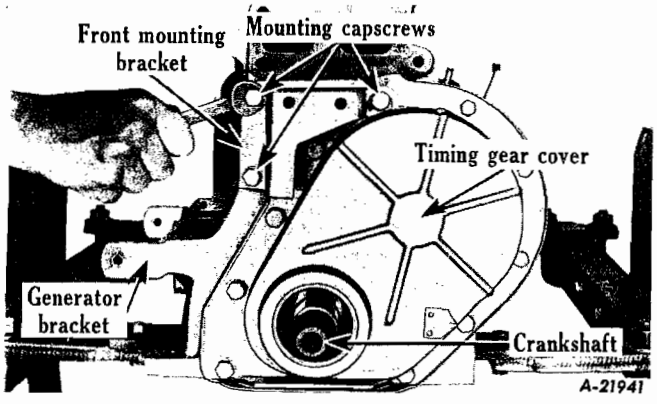

Fig. 22

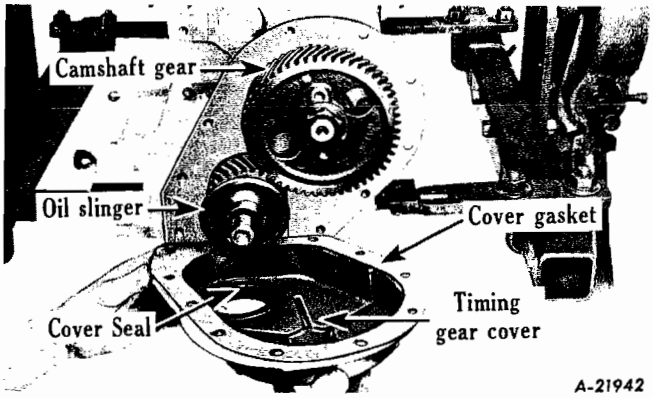

Fig. 23 - Gear case cover removed showing timing gear details.

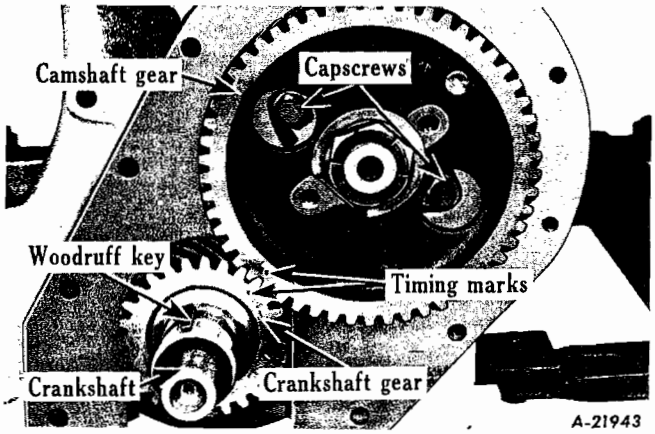

Fig. 24 - Timing gear timing marks and camshaft thrust plate details.

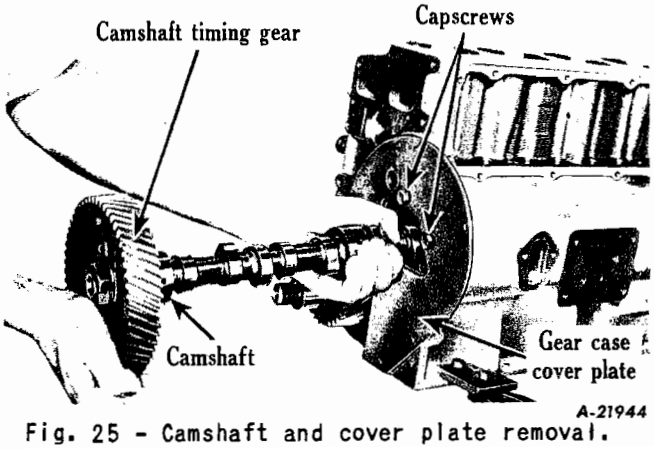

Fig. 25 - Camshaft and cover plate removal.

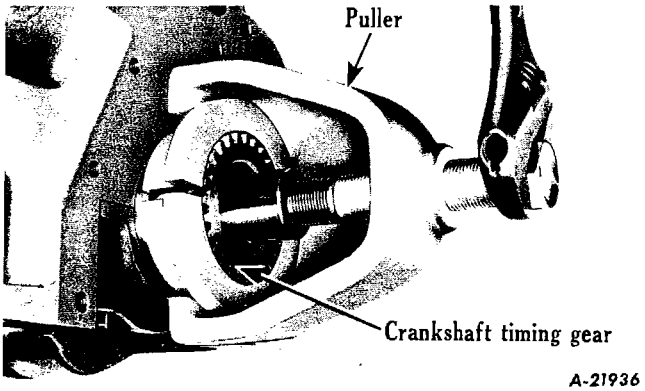

Fig. 26 - Crankshaft gear puller SE-1715 is installed with puller plates in position shown. Lubricate puller screw thoroughly.

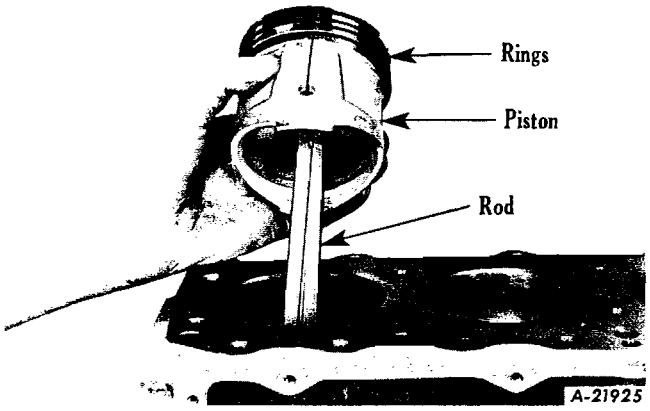

Fig. 27 - Remove piston and rod from top of cylinder block.

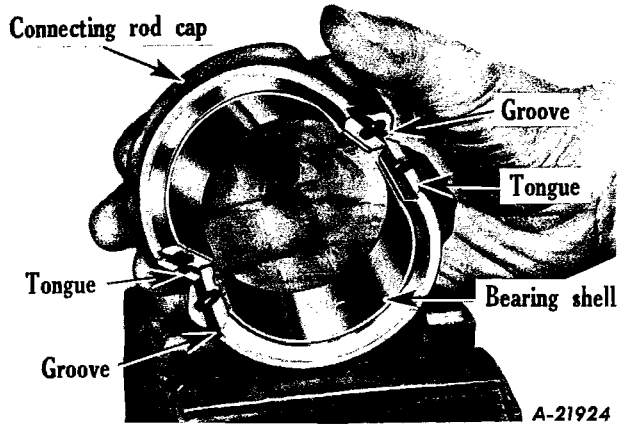

Fig. 28 - Connecting rod caps are aligned by means of tongue and groove construction.

5. The crankshaft bearing caps are numbered to identify their position and they must be reinstalled in their respective positions. Remove self-locking capscrews from each bearing cap. Remove all crankshaft main bearing caps. NOTE: To remove the rear, or No. 4, main bearing cap, a puller is required (Fig. 29). After all caps have been removed, lift crankshaft straight up and out of cylinder block, and place in a vise equipped with soft jaws.

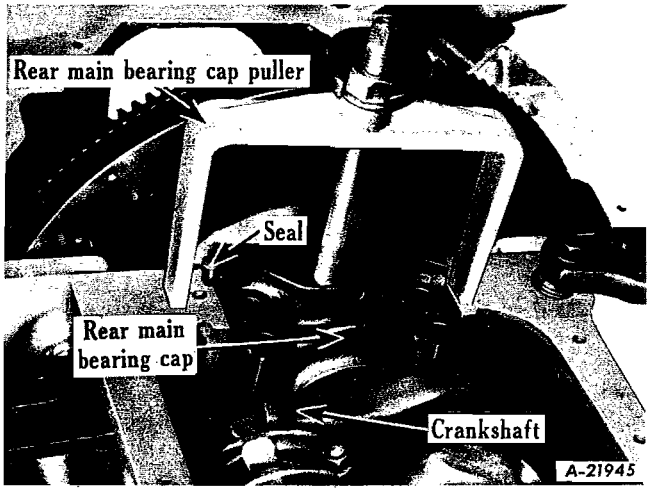

Fig. 29 - Use SE-1719 Bearing cap puller to remove rear main bearing cap.

6. With crankshaft securely clamped in vise, remove the six self-locking capscrews holding flywheel to crankshaft (Fig. 30). Tap flywheel with a soft hammer to loosen it from crankshaft; remove flywheel with ring gear assembly.

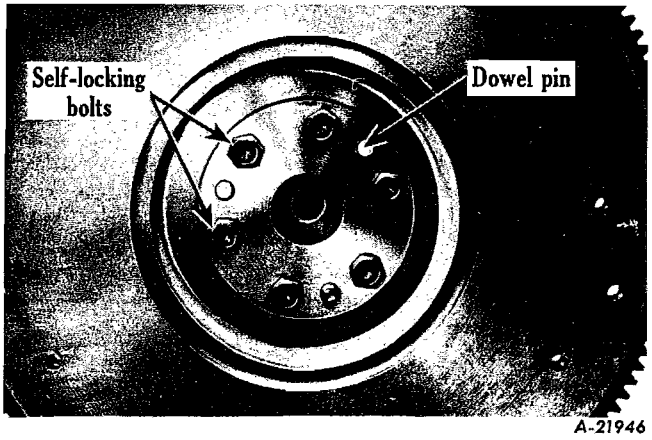

Fig. 30 - Remove self locking capscrews to remove flywheel.

7. Remove six capscrews and lockwashers from engine flywheel housing. Drive out the two engine block dowels, remove flywheel housing.

8. Remove fuel pump, starter, oil pressure regulator valve assembly, distributor, generator, oil gauge, coil, and all "freeze plugs" in block. (NOTE: Removal of the "freeze plugs" or core hole plugs is only necessary when it is determined that the condition of the water passages in the block warrant a thorough cleaning, or the plugs appear to be leaking.) Clean inside and outside of block with a solvent cleaner or steam. Install core plugs using SE-1725 Adapter and SE-1581-1B Handle.

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Water Pump Removal and Overhaul

The water pump is of the centrifugal packless type (Fig. 31). It is bolted to the front end of the engine and is driven by the fan pulley. It requires no external adjustment. The bearing is of the sealed lubricated type and does not require added lubrication at any time. The water pump is driven by a V-belt on the fan pulley. The pump, by means of centrifugal force developed by the impeller rotation, draws water up from the lower part of the radiator into the water passages in the cylinder block and cylinder head. The water circulates through the cylinder block and then out through the thermostat housing into the radiator upper tank.

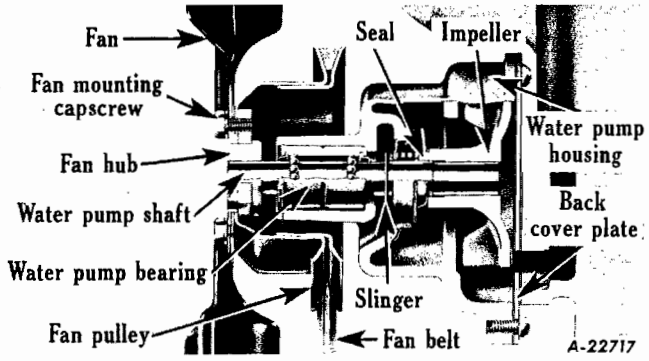

Fig. 31 - Sectional view of water pump.

Water Pump Disassembly

1. Remove four capscrews and lockwashers holding fan to hub. Remove fan blade assembly from hub.

2. Remove four mounting capscrews from water pump (Fig. 32). Remove water pump from front end of cylinder head.

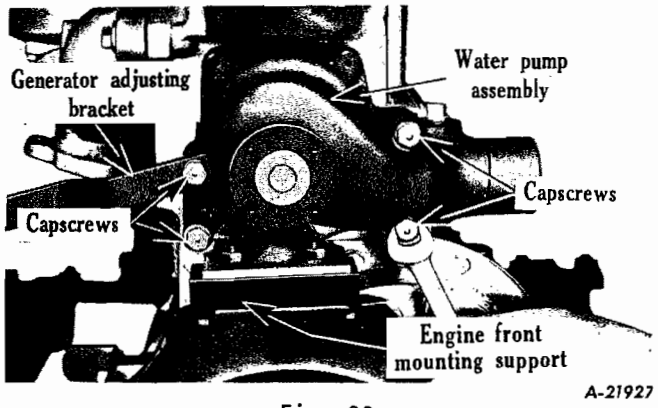

Fig. 32

3. Remove three screws from back cover plate. Remove plate and gasket from pump body (Fig. 33).

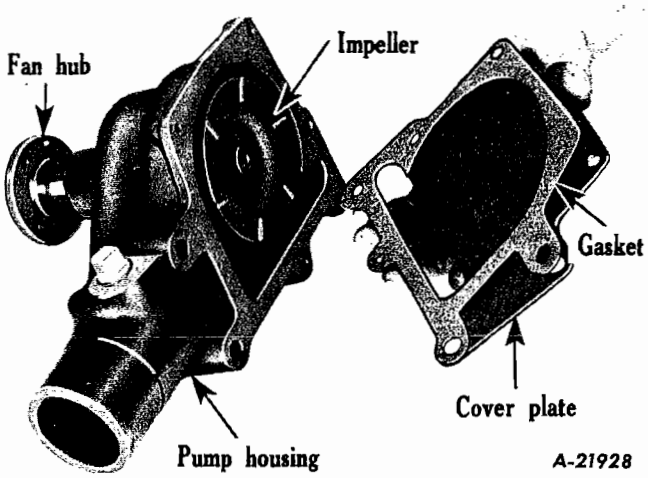

Fig. 33

4. Remove snap ring from front of water pump shaft bearing (Fig. 34). Support the water pump on an arbor press and push shaft and bearing out, as one assembly (Fig. 35).

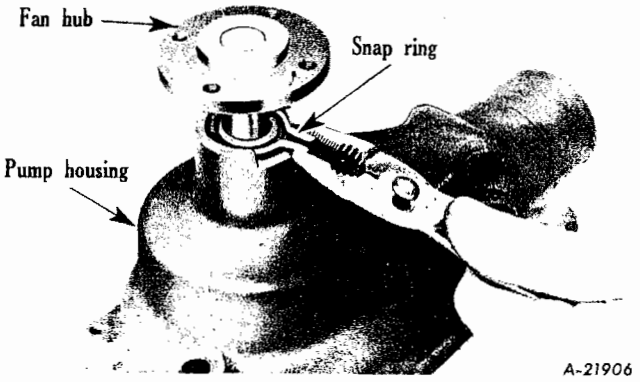

Fig. 34

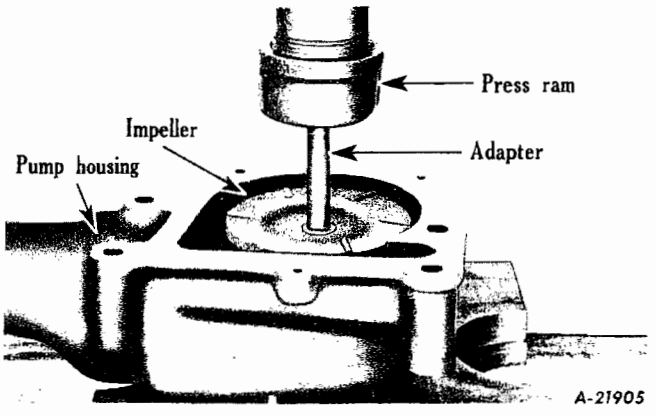

Fig. 35

5. Place shaft assembly in press and press fan hub from shaft (Fig. 36). Do not attempt to remove bearing or slinger, as they are factory installed on the shaft in the proper location.

6. Remove seal from housing through back side of pump. Use a drift, and carefully drive seal from the pump body.

Water Pump Cleaning and Inspection

Before reassembling water pump, the following should be checked:

1. Clean all parts by steam or cleaning solvent.

2. Examine seal for wear or damage and replace parts as necessary. Use special tool when installing seal. Use a new seal when rebuilding the pump since the old seal may have been damaged upon removal.

3. Examine pump impeller seat seal surface, if face of surface is scored, it must be resurfaced or replaced to prevent leakage.

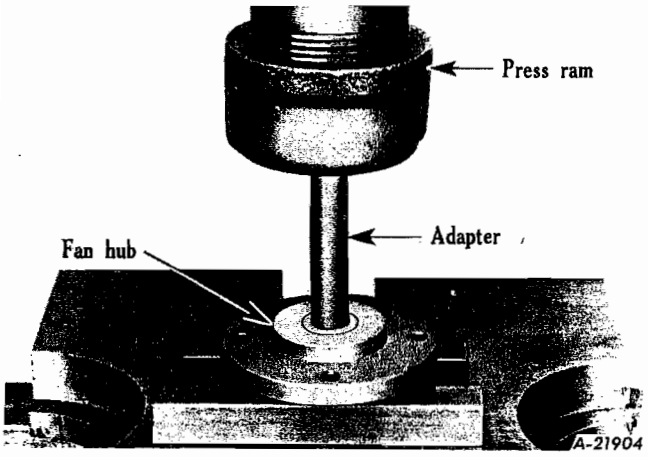

Fig. 36

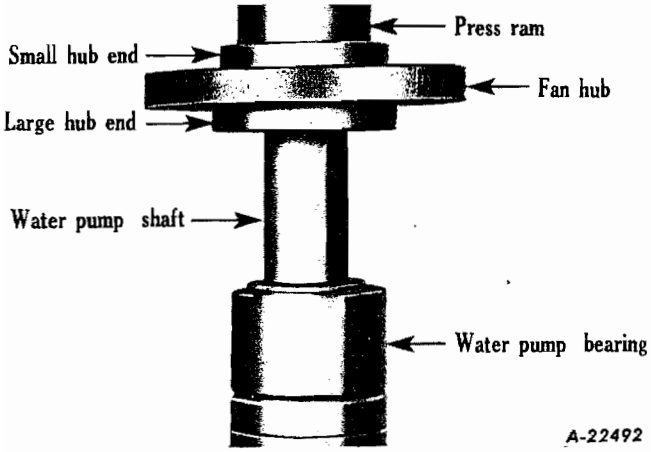

Fig. 37

4. Inspect pump shaft bearing for wear. If worn, replace bearing.

5. Examine shaft for wear and replace if needed.

Water Pump Assembly

1. Press fan hub on shaft with the smaller diameter of the hub to the front (Fig. 37).

2. Install shaft in housing from front end by pressing shaft, bearing, slinger, and fan hub in as one unit (Fig. 38).

3. Install snap ring in place behind fan hub (Fig. 39).

4. Mount assembly in press. Press impeller on rear end of shaft. Place a straight edge across the back of the water pump housing and check the clearance between the straight edge and impeller. There should be about .025" clearance (Fig. 40).

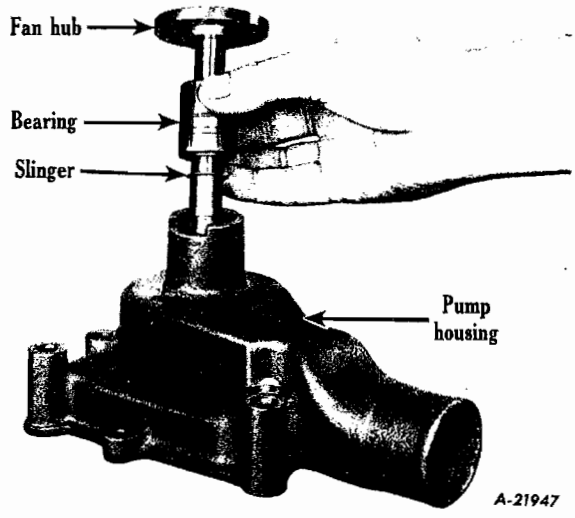

Fig. 38

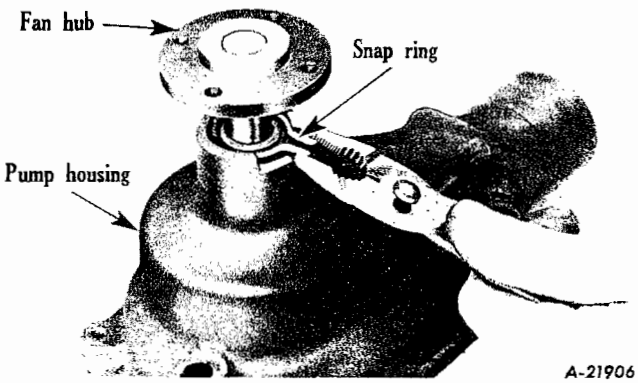

Fig. 39

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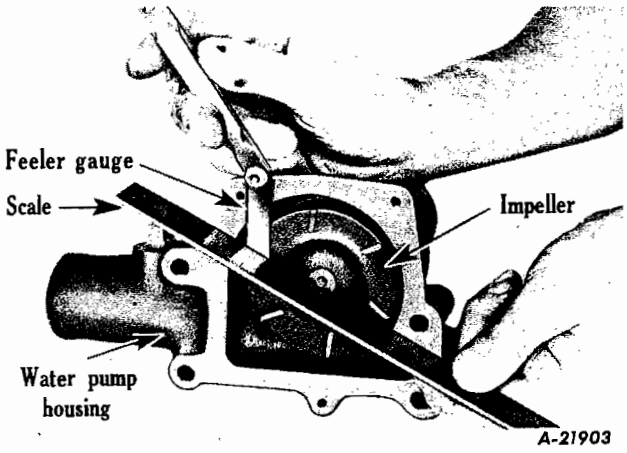

Fig. 40

5. Install cover plate with new gasket, and mount fan blades.

Intake and Exhaust Manifolds

When disassembling and assembling the manifolds, the following procedures are used:

1. After removing the eight capscrews from head and three bolts from exhaust flange, remove both intake and exhaust manifolds as a unit (Fig. 41). NOTE: Let manifolds cool before starting above operations.

2. To separate the two manifolds, remove the two outside capscrews and two inside nuts from the center of manifolds (Fig. 42).

3. The intake and exhaust manifolds are each of one piece construction, requiring no disassembly after separation.

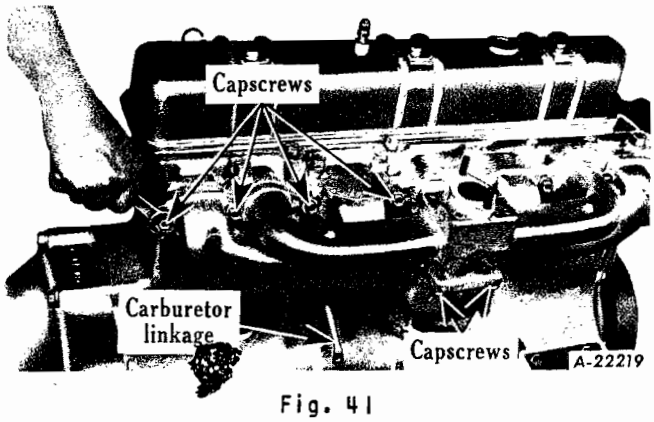

Fig. 41

Intake Manifold

1. The intake manifold consists of three outlets, each supplying fuel to two cylinders. Two studs are located on the top for carburetor mounting.

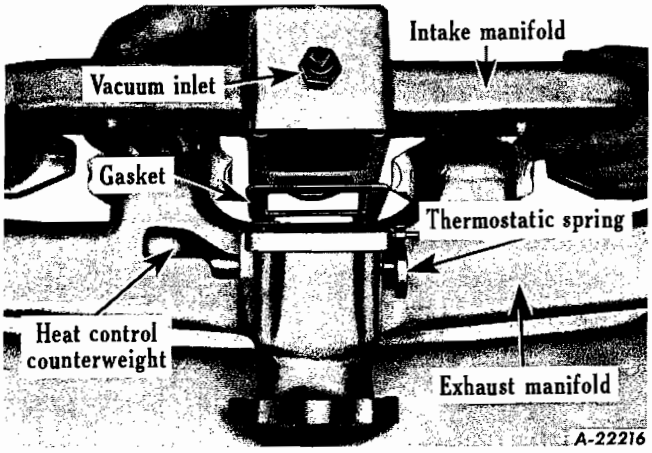

Fig. 42

2. If vacuum is needed to operate any unit within the truck, a threaded inlet is provided in the manifold for such purposes.

Exhaust Manifold

1. The exhaust manifold consists of four outlets. The two end outlets remove burned gases from the No. 1 and No. 6 cylinders, while the two center outlets remove burned gases from Nos. 2, 3, 4 and 5 cylinders.

2. Located in the exhaust manifold, in the center, is the manifold heat control unit (Fig. 43).

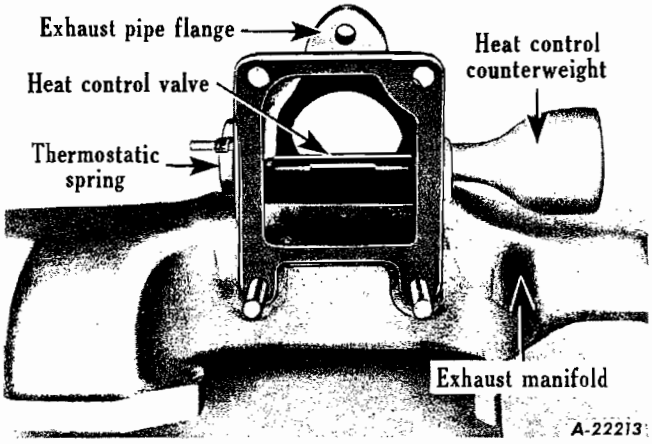

Fig. 43

3. The purpose of the heat control unit is to keep the intake manifold warm enough to vaporize the fuel mixture as completely as possible. The heat control is automatic in operation, being controlled by a coiled thermostatic spring. A counterweight, under spring tension, is mounted on the heat control valve shaft and this counterweight operates with the spring to close and operate the heat control valve.

4. Should the valve hold too much heat, the engine is likely to detonate or "ping" when engine is accelerated. If valve opens too early, not enough heat is retained in the manifold, resulting in a slow warm-up. If the thermostatic spring becomes disconnected, the whole heat control system will be upset.

5. Should the shaft of the heat control become stuck, tapping it with a hammer and working the valve back and forth by hand usually frees it. An application of penetrating oil will help the process of freeing a sticking heat valve.

Manifold Inspection

Inspect intake and exhaust manifolds visually for cracks or breakage. Place manifolds on surface plate and check for warpage. If cracked or broken, replace or weld. If slightly warped, true-up on surface grinder but replace if warpage is extreme.

Manifold Assembly

Place new gasket between the intake and exhaust manifolds and install two capscrews and two nuts. Mount manifolds together loosely before installing on engine. This will assure proper alignment of the units with each other and with the engine cylinder head.

Oil Pump Removal and Overhaul

After oil pump has been removed, the following steps are to be used for disassembly:

1. Remove cotter pin holding float to oil pump (Fig. 44). Remove float from pump. Remove two capscrews holding pump in block. Remove oil pump.

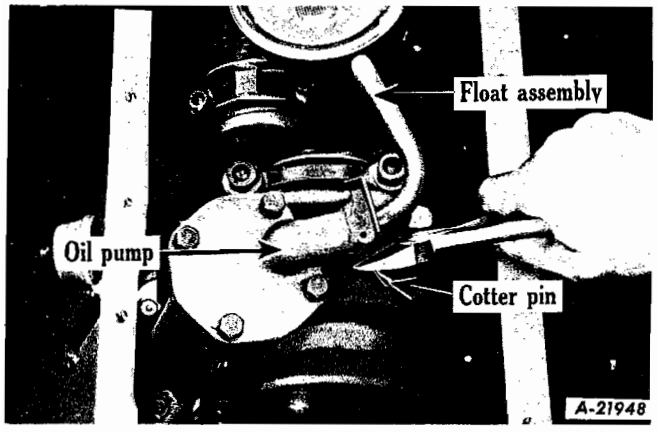

Fig. 44

2. Remove four capscrews and lockwashers from oil pump cover plate. Then lift cover and gasket from oil pump body (Fig. 45).

3. Lift out oil pump idler gear from idler gear shaft (Fig. 46).

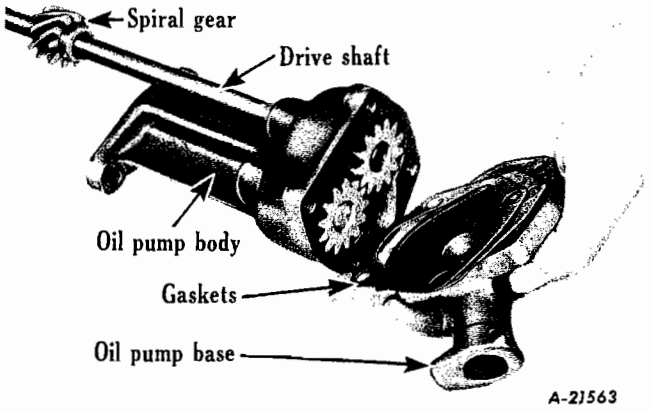

Fig. 45

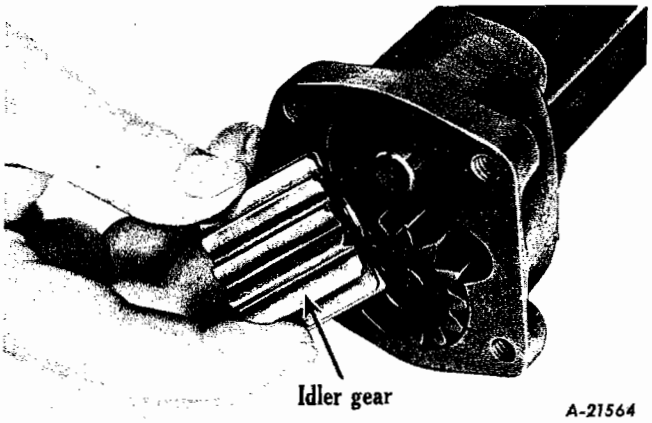

Fig. 46

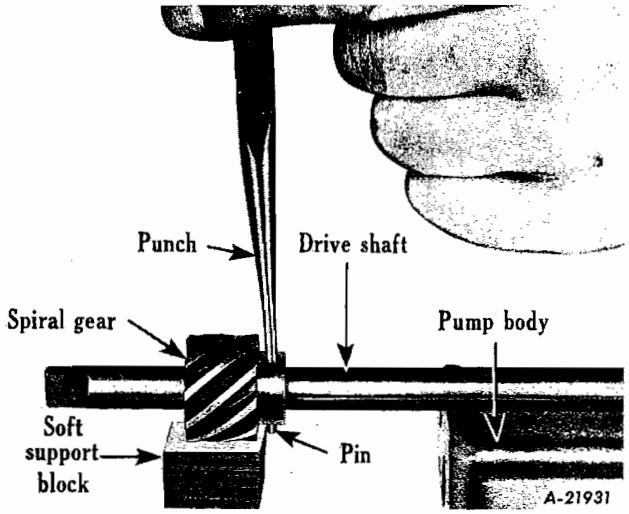

Fig. 47

4. Support oil pump shaft to prevent bending shaft, and using a small punch, drive out spiral gear pin from oil pump spiral gear (Fig. 47).

5. Place two support plates under spiral gear in press, and press oil pump drive shaft out of pump spiral gear (Fig. 48). Remove Woodruff key.

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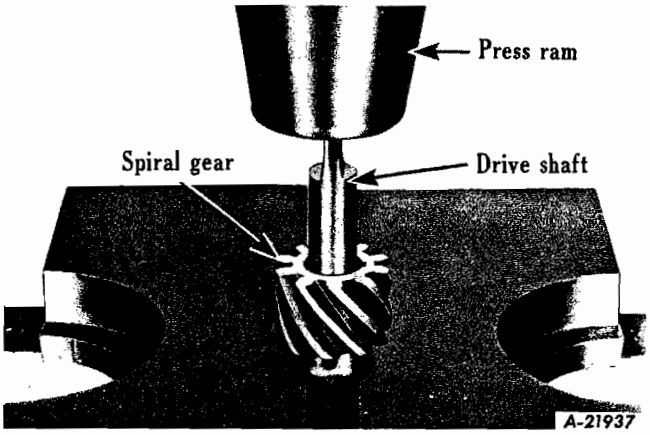

Fig. 48 - Use SE-1499 Oil pump support plate or other suitable support when pressing shaft from gear.

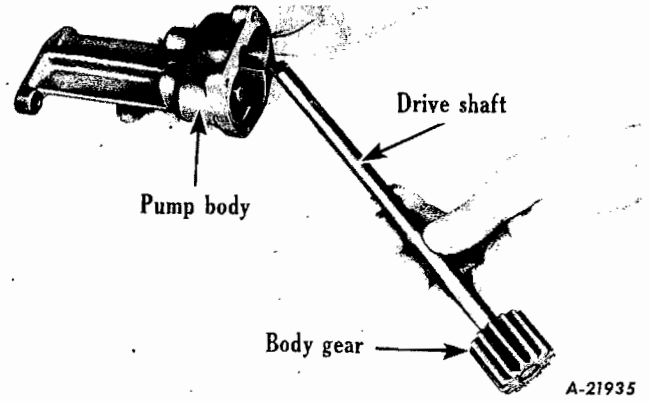

Fig. 49

6. Remove body gear and drive shaft from oil pump body (Fig. 49).

7. Press pump body gear from shaft and remove Woodruff key.

8. Wash all parts in a cleaning solvent.

Oil Pump Inspection

Check the following parts carefully:

1. Check oil pump drive shaft for wear at points of contact with body. If shaft is worn or bent, it should be replaced.

2. The standard measurement of oil pump shaft is .4885"-.4890". The shaft should be concentric and straight through its entire length within .004" indicator reading.

3. Check oil pump body for warpage, damage, and wear. Replace if body is warped or cracked, or if shaft bore is worn so that clearance between shaft and bore is in excess of .005". The oil pump body shaft bore measures .490".

4. Inspect oil pump gears, and replace if wear is perceptible.

Oil Pump Assembly

The following instructions are to be followed for reassembly:

1. Install new Woodruff key on body end of drive shaft.
2. Place in press and press body gear on drive shaft. The end of the shaft can be from flush to .030" below the level of gear face.
3. Insert oil pump drive shaft and body gear into oil pump body.
4. Install new Woodruff key in spiral gear end of drive shaft and press on spiral drive gear. Make sure that spiral gear hub is down. Install new spiral gear pin in place.
5. Install idler gear on idler gear shaft. Install gaskets, oil pump body cover, four capscrews, and lockwashers.
6. Check oil pump body gear end clearance by using a dial indicator (Fig. 50). If end clearance is less than .0025" add one gasket that measures not more than .003" in thickness. If end clearance is in excess of .0055" remove one gasket of not more than .003" in thickness. Body gear end clearance should measure between .0025" and .0055".
7. Insert oil pump float in oil pump, line up cotter pin holes, install new cotter pin, and fasten securely.

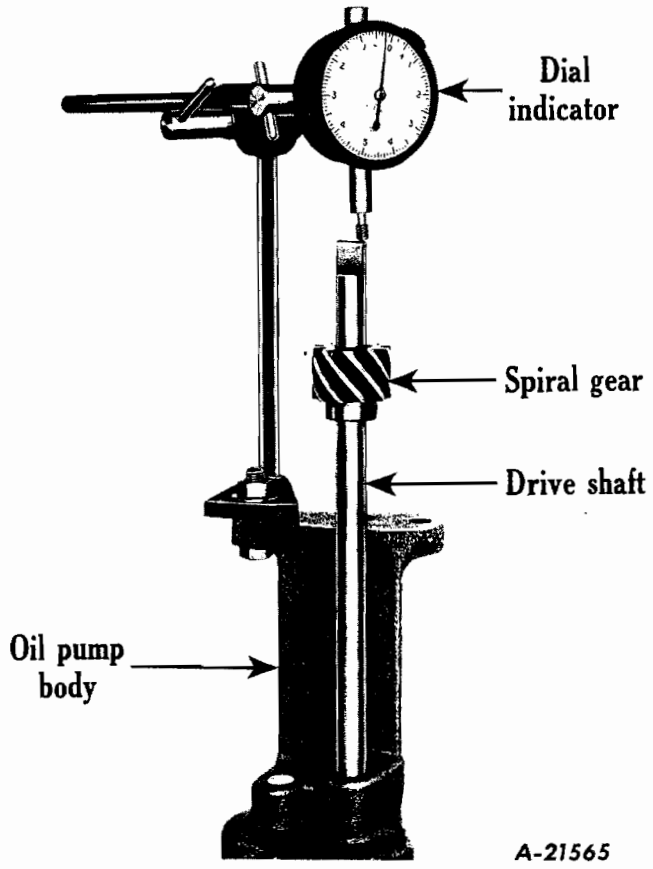

Fig. 50 - Checking end clearance of pump shaft and body gear.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

Cleaning the Cylinder Block

1. Remove all old gasket material from block. Clean both inside and outside of block with steam or cleaning solvent. Remove all dirty oil, sludge, scale, and carbon from cylinder block. Check core plugs for indication of leakage. Remove and replace plugs that show signs of leaking, or rusting through. Use installing tool for core plug replacement (Fig. 51).

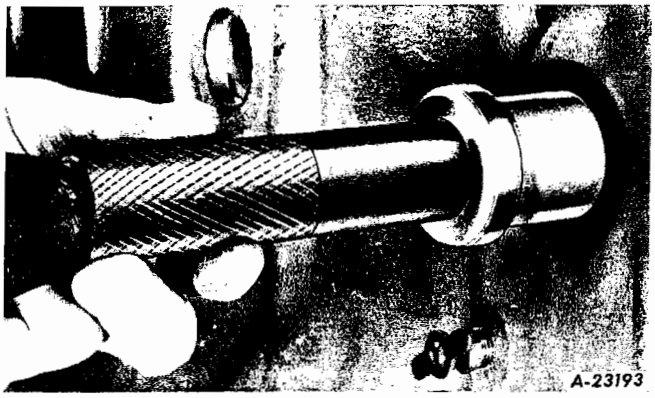

Fig. 51 - Installing core plug using SE-1725 Installing tool with SE-1581-B handle.

Cylinder Block Inspection

1. Inspect cylinder walls for cracks. Weld the cracks or replace block if necessary.

2. Check top surface for trueness with a straight-edge. Test by attempting to insert a .012" feeler gauge ribbon between the straight-edge and the cylinder block. If this is possible, either surface or replace the cylinder block.

3. Inspect camshaft bearings for damaged or scored condition, and inspect for wear. Replace if damaged or if worn beyond clearance limit of .006".

4. Measure cylinder walls with an inside reading micrometer to determine taper, out-of-round, or worn condition. The measurements must be made not only at top of the cylinder bore, just below ring groove, but at several places around the inside circumference of the bore. Bore should be checked at the bottom, below ring wear surface, to determine the amount of taper. Rebore if worn beyond .008" clearance.

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Replacing Camshaft Bushings

1. If camshaft bearing replacement is necessary, remove and install new bushings with special camshaft bearing installation tool (Fig. 52). No reaming is required.

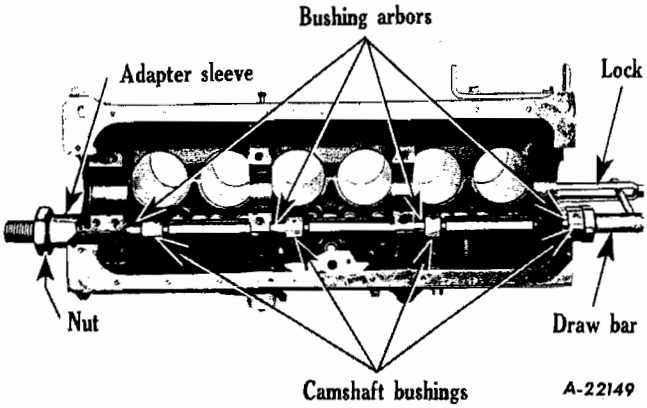

Fig. 52 - SE-1724 Camshaft bushing installation. Showing tool in position.

Connecting-Rod and Piston

1. Remove piston-pin retainers from each piston, and remove piston rings from piston ring grooves.

2. Heat piston in boiling water or piston heater. Place piston in piston vise, and using pin-driving tool, drive piston pin from piston and connecting rod (Fig. 53). After piston pin is removed, lift piston from connecting rod.

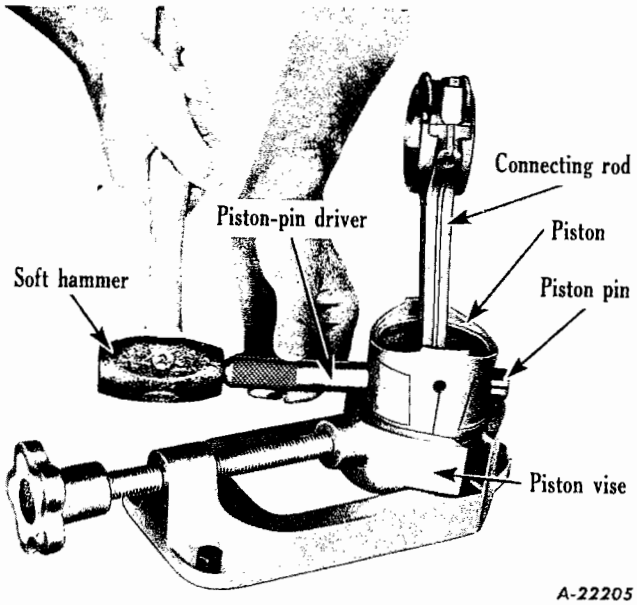

Fig. 53 - Use suitable piston vise to hold piston and drive piston pin out using SE-1263. Use soft (bronze or brass) hammer when driving to prevent damage to tools.

3. Wash all parts in a cleaning solvent. CAUTION: Do not use a caustic solution for aluminum pistons. Clean the carbon from piston ring grooves with a broken ring or ring groove cleaner.

4. Inspect connecting rods, caps, and bearing shells. All connecting-rod bearings and piston-pin bushings should be replaced at every major overhaul. Test rods for alignment. Rods only slightly mis-aligned can be straightened with proper equipment. Badly twisted or bent connecting rods must be replaced.

5. Inspect pistons for cracks, breakage, or scores. Check piston ring grooves and ring lands for wear, using a new piston ring and feeler gauge. If clearance between ring and ring land exceeds .005", (total clearance) replace piston (see specifications for data covering piston fit in cylinder block).

6. Inspect piston pins for wear, and if wear is perceptible, replace pins. Replace piston pins which show signs of corrosion or etching.

7. With properly fitting adapter, press old piston-pin bushing from connecting rod (Fig. 54). Place new piston-pin bushing in position, align oil hole in bushing with oil hole in connecting rod, install bushing with a .0055" to .0035" press fit (Fig. 55). Burnish bushing into place in the connecting rod (Fig. 56).

8. With reamer, ream piston-pin bosses in piston to provide a tight fit of from .0000" to .0002" with piston pin. NOTE: When fitting piston pins, the pins should be at room temperature (70° F.) and the pistons should be heated to approximately 200° F. in boiling water or piston heater. The pin should be a "palm-push" fit under these conditions.

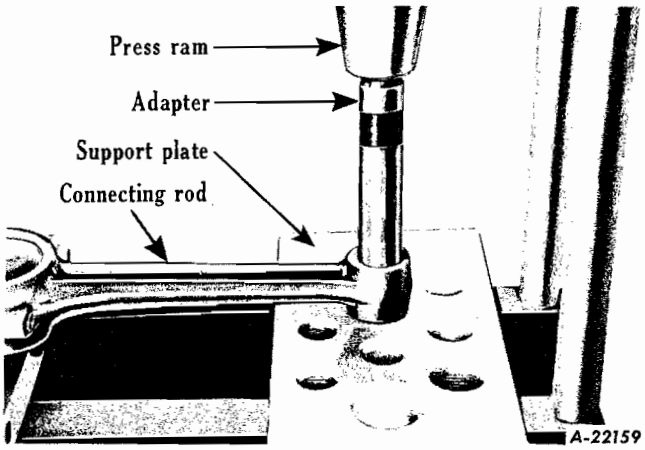

Fig. 54 - Press bushing from rod using SE-1036-4 Bushing adapter and SE-1033 support plate.

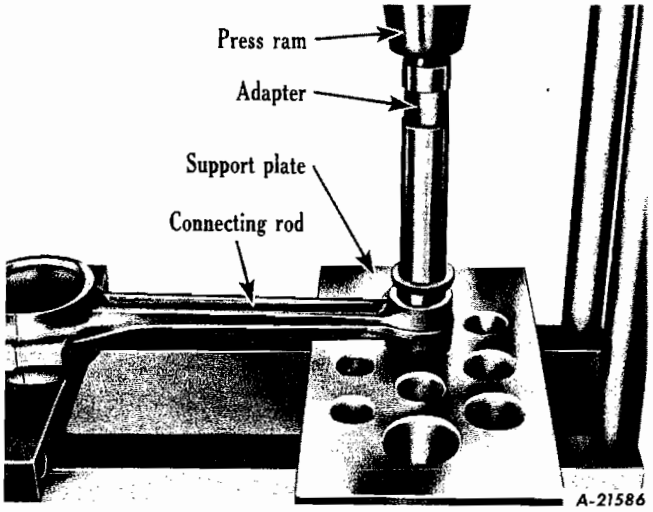

Fig. 55 - Installing new bushing in rod.

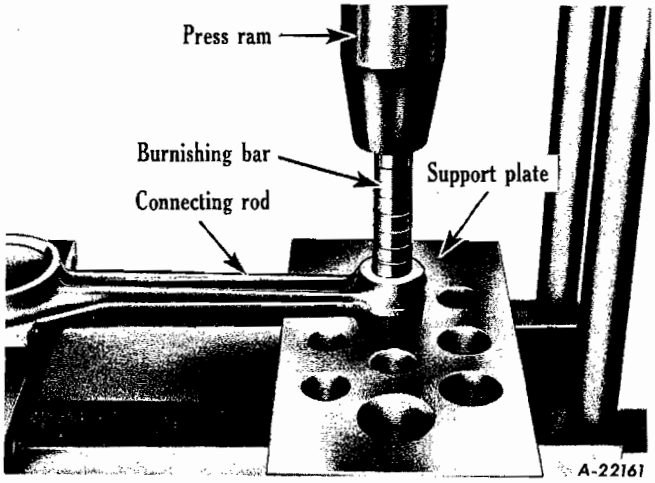

Fig. 56 - Use SE-879 Burnishing tool.

Connecting-Rod and Piston Assembly

1. With piston heated to approximately 200° F., support connecting rod in vise, push piston pin into piston bosses while piston is hot (Fig. 57). When assembling piston on rod, the slot in the piston skirt must be toward the camshaft side of the engine, which is the numbered side of the connecting rod. Install piston-pin retainer in piston at each end of pin, making sure that

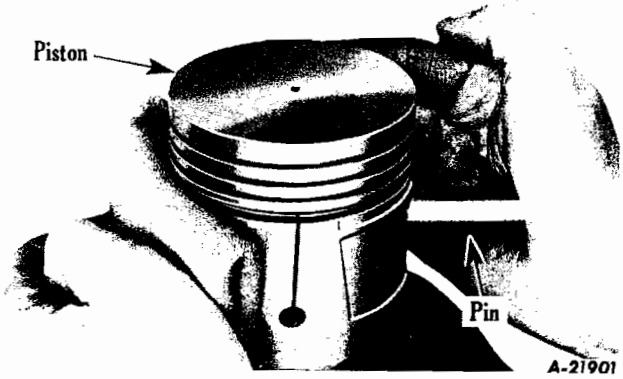

Fig. 57

retainers seat fully and with tension in grooves. Test connecting-rod and piston assembly on a connecting-rod aliner, and correct any misalignment.

2. Place piston and connecting rod in vise. Test each piston ring for proper gap by placing in cylinder and measuring gap with feeler gauge. Gap should be .016" to .026" (Fig. 58).

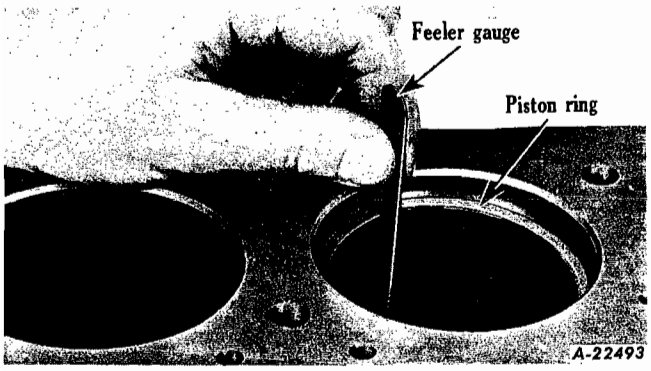

Fig. 58 - Checking ring gap.

3. When installing piston rings in piston grooves, be careful not to distort rings. If possible use a suitable piston-ring expander tool (Fig. 59). Also check new piston rings in piston ring grooves for clearance between ring and ring lands. The correct ring clearance is shown in specifications.

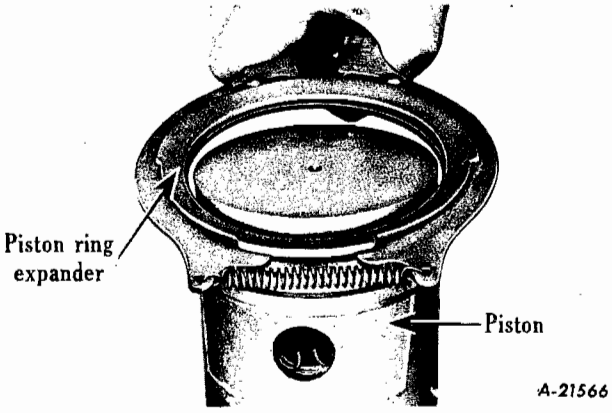

Fig. 59 - Installing piston ring using SE-1149-8 piston ring installing tool.

Crankshaft Cleaning and Inspection

1. Wash and clean crankshaft with cleaning solvent or steam.

2. Inspect main bearing and connecting-rod journals for wear. If journals show wear, or out-of-round in excess of .003", the shaft should be either reground and undersize bearings installed, or replaced. Use micrometers for checking.

3. Check crankshaft and flywheel dowels for damage and fit, and replace if worn or damaged.

4. Examine crankshaft timing gear teeth, and replace gear if teeth are worn or damaged.

5. Install Woodruff key in groove in crankshaft. Heat crankshaft gear in boiling water or piston heater. This will expand the gear enough to let it be tapped on the crankshaft without the danger of damaging the gear. Use gear driver to insure alignment when starting gear (Fig. 60).

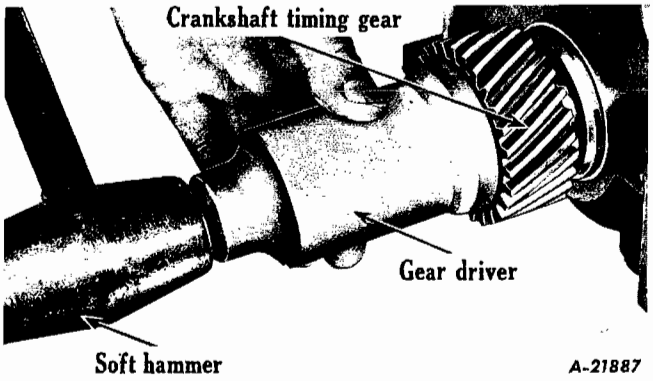

Fig. 60 - Installing crankshaft timing gear using SE-1716 Installing tool.

Flywheel and Ring Gear Inspection

1. Clean flywheel and ring gear with a cleaning solvent, remove all traces of oil and grease.

2. Inspect the flywheel ring gear. If any teeth are damaged, or if ring gear is loose on flywheel, the ring gear must be replaced.

3. Check the flywheel dowel holes and mounting bolt holes for wear, also check for flywheel having been loose.

4. To replace flywheel ring gear, heat gear with torch, and remove from flywheel with a hammer and drift. Heat new ring gear with torch, heating evenly all the way around. While the ring gear is hot, install gear on flywheel and allow it to cool.

5. Check pilot bearing in flywheel for wear or damage and replace if needed.

6. Install flywheel on crankshaft. Install six self-locking capscrews, drive dowel pins through flywheel to crankshaft.

Camshaft Cleaning and Inspection

1. Remove nut from front of camshaft gear. Attach gear puller, and remove camshaft gear from camshaft, and remove camshaft thrust flange. Remove Woodruff key.

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2. Wash parts in cleaning solvent, brushing to facilitate removal of all sludge or carbon deposits.

3. Inspect camshaft journals for signs of wear or out-of-round.

4. Inspect oil pump drive gear in center of shaft. If teeth are worn or damaged, the camshaft must be replaced, as the gear is integral with shaft.

5. Inspect camshaft lobes. If worn, chipped, or scored, replace the camshaft.

6. Inspect camshaft gear, and replace if wear is evident or gear teeth are nicked or otherwise damaged.

7. To reassemble, install thrust flange over end of camshaft. Install Woodruff key in slot in shaft. Place camshaft gear in boiling water or piston heater, and install over Woodruff key. Install camshaft nut and tighten to approximately 120 foot-pounds tension.

Cleaning and Inspecting Miscellaneous Parts

1. Cleaning miscellaneous engine parts includes brackets, oil pan, engine case cover, flywheel housing, and other parts that were removed during disassembly of engine and were not covered by procedure. Wash in cleaning solvent or steam clean preliminary to inspection.

2. Check all twelve valve lifter or push rods for straightness by rolling on flat surface. Replace any that are bent or have loose ends (Fig. 61).

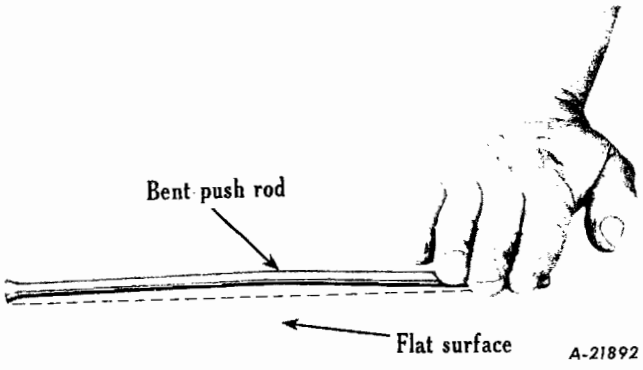

Fig. 61

3. Inspect oil pan for cracks or deep bends, and straighten or weld.

4. Inspect oil pan drain plug and drain plug boss for fit and thread wear. If plug is loose or threads are damaged, replace plug. If threads in oil pan boss are worn or damaged, repair threads or replace oil pan.

5. Inspect crankshaft vibration damper for evidence of rubber coming loose from steel plates (SD-240 engines only) and inspect for wear. Replace damper if either condition is encountered. Do not submerge vibration damper assembly in hot cleaning solvents.

6. Inspect crankshaft fan drive pulley for wear in hub bore. If inner diameter of bore is worn, scored, or Woodruff keyway damaged, replace pulley.

7. Inspect engine gear case cover, and replace if cracked or broken. Remove old cover seal (Fig. 62) and with special driver install new seal (Fig. 63).

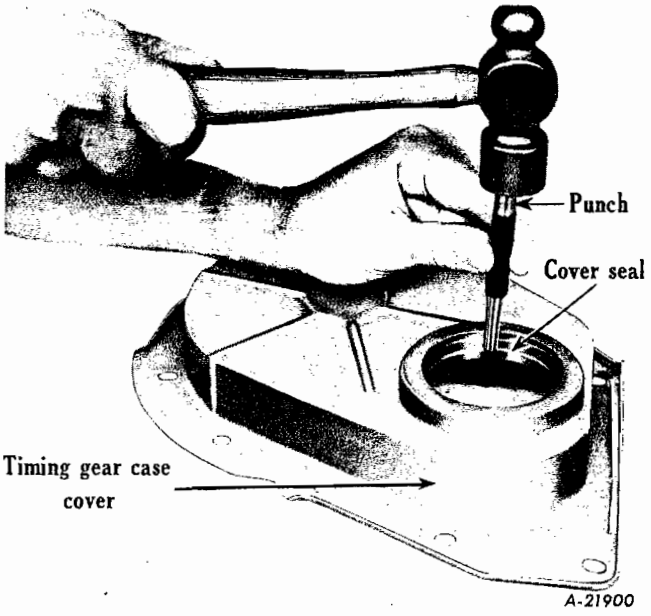

Fig. 62

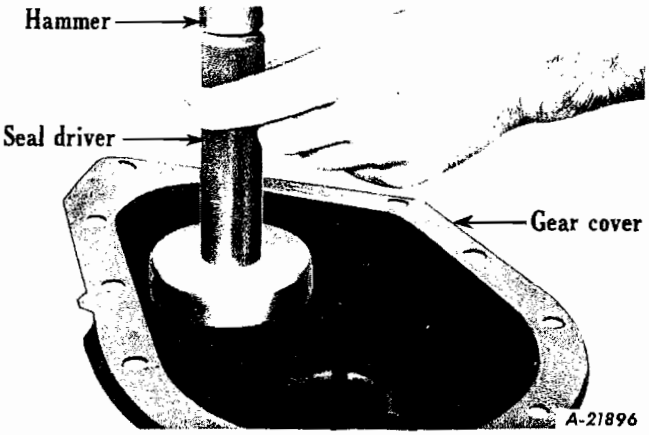

Fig. 63 - Use SE-1718 Seal Installing tool with the SE-1581-B Handle.

8. Check each of 12 engine valve tappets for irregular wear, chipping, cracking, or scores. Replace defective tappets.

9. Inspect engine flywheel housing for cracks or breakage and replace if damaged. Inspect flywheel housing to crankcase pilot dowel holes for wear. If wear is evident, drill or ream the holes and install oversize dowels. Also inspect dowels for wear and replace if wear is evident.

10. Inspect all capscrews and nuts for thread wear or breakage, and replace as necessary. Use new lockwashers when reassembling engine.

11. All gaskets and oil seals must be replaced at each overhaul or major repair.

ASSEMBLY OF ENGINE

When all parts have been cleaned. inspected, and repaired, and necessary replacement parts have been procured, install engine cylinder block in engine overhaul stand for reassembly.

Main Bearing and Connecting-Rod Bearing Installation

BEARING CRUSH. Undersize precision-type bearing shells should be installed when, because of wear, bearing-to-crankshaft running clearances are to be reduced. Bearing caps must not be filed, lapped, or in any other manner reworked.

Premature bearing failure will result from attempts to reduce journal-to-bearing running clearance by reworking of either bearing caps, bearings, or both, because such reworking will alter the engineered fit of the bearing shells in their bores and destroy the specifically desired "crush".

When installing precision-type connecting-rod or main bearings, it is important that the bearing shells fit tightly in the rod or case bore. To accomplish this, the bearing manufacturer makes the diameter at right angles to the parting line slightly larger than the actual diameter of the bore into which they are assembled. When the assembly is drawn up tight, the bearing is compressed, assuring a good contact between the bearing back and the bore. This increased diameter is referred to as bearing "crush" (Fig. 64).

To obtain proper bearing assembly with the correct "crush", care must be taken when tightening the clamping bolts to make sure they are drawn down alternately and evenly, using a tension wrench and tightening as specified.

As a result of excessive bearing crush due to reworking the caps, the rod or main bearing bore will possibly become distorted, because more force is required to draw the cap and housing together.

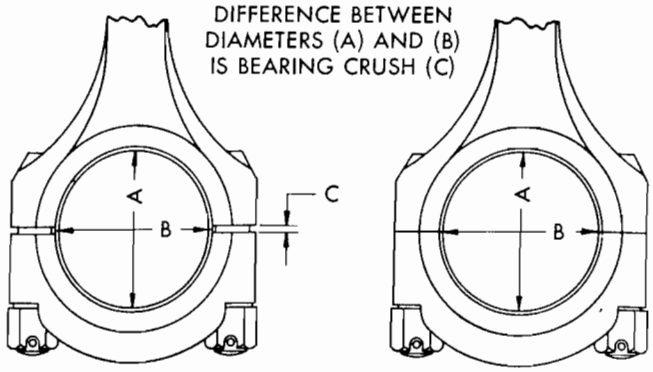

Fig. 64

Rods, caps, or blocks must not be filed, lapped, or in any other manner reworked in order to reduce clearance. While such practice will make a tighter fit at top and bottom, it will result in an out-of-round bore and bearing shell distortion. New bearing shells will have to be installed eventually and that is when additional trouble starts.

In general, a visual inspection of the parting faces of the rod or caps under a magnifying glass will provide sufficient proof of any attempt at reworking. Under the glass, the parting line surface of standard parts will show the manufacturing cutter tool marks and will not have a polished or extremely smooth appearance. On the other hand, reworked parts will have a polished surface and, if a file was used, will show the even pattern of the file teeth. Seriousness of this condition is in direct proportion to the amount of reworking.

BEARING SPREAD. Main and connecting-rod bearings are designed with the "spread" (width across the open ends) slightly greater than the diameter of the crankcase bore or connecting-rod bore into which they are assembled, (Fig. 65). For example, the width across the open ends of the Silver Diamond engine connecting-rod bearing, not in place, is approximately .025" more than when the bearing is in position in the rod. This condition causes the bearing to fit snugly in the rod bore and the bearing must be "snapped" or lightly forced into its seat.

Rough handling in shipment, storage, or normal results of use in an engine, may cause the bearing spread to be increased or decreased from the specified width. Bearing spread

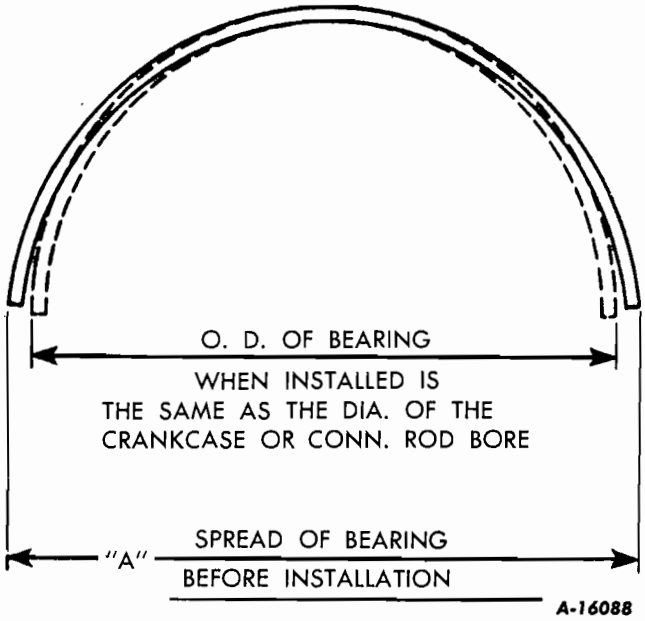

Fig. 65

should, therefore, be carefully measured and corrected as necessary before installation in an engine.

Bearing spread can be safely adjusted as follows, although care and judgment should be exercised in the process:

1. Excessive spread. If measurement of spread (Fig. 65) indicates that distance "A" is excessive (see chart for specifications), place bearing on a wood block (Fig. 66) and strike the side lightly and squarely with a soft mallet. Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

2. Insufficient spread. If measurement of spread indicates insufficient spread, place bearing on wood block (Fig. 66) and strike the back of the bearing lightly and squarely with a soft mallet. Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

Chart of Bearing Spread Dimensions. Silver Diamond Engine (Minimum)		
"A"	Connecting-Rod Bearing	2.500" + .025"
	Main Bearing	2.942" + .025"

1. INSTALL CRANKSHAFT AND BEARINGS. Clean all surfaces of crankshaft bearing journals and wipe clean the bearing bores in the cylinder block. Remove bearing cap self-locking capscrews and bearing cap. Wipe backs of cylinder block half of bearings, making sure that dirt and oil are removed. Place bearing shell halves in position in bore in cylinder block, making sure that bearing shells are fully seated, that oil holes in bearing shells line up with oil holes in cylinder block, and that locking tongs on bearings fit into recesses. Follow same procedure, place bearing shell cap halves in bearing caps. Place a film of engine oil on shell surfaces and lift crankshaft to align itself in the bearings, and also provide lubrication. Place bearing caps and bearing lower halves over crankshaft journals. Be sure bearing caps are properly installed with numbers to camshaft.

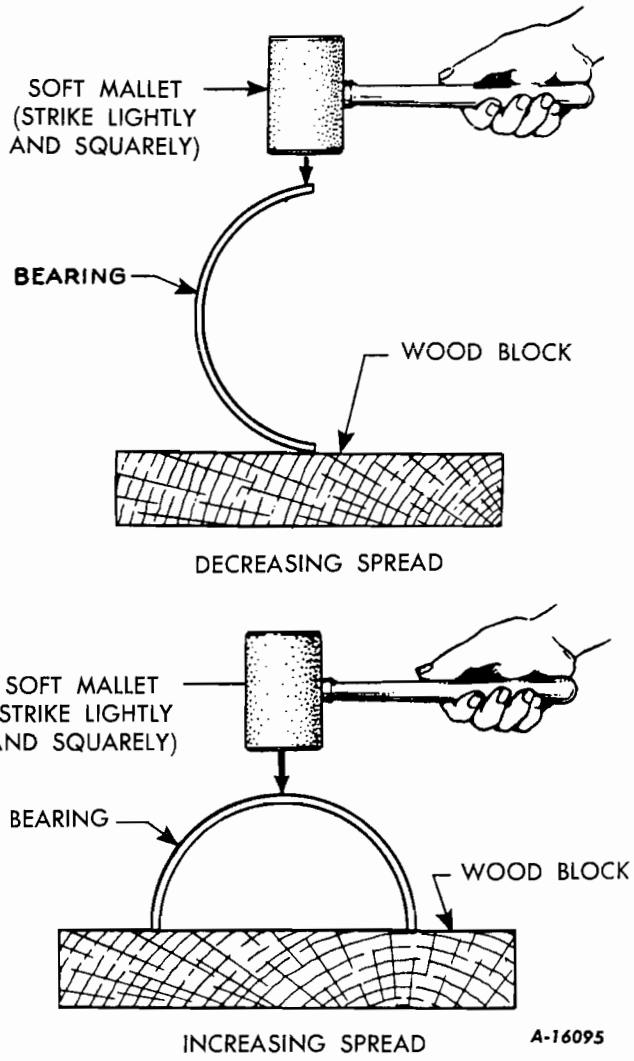

Fig. 66

2. In order that an accurate measurement can be made to check all bearing clearances, "plastigage" can be used.
3. Use the following instructions when using "plastigage":-
   (a) Remove oil from bearing cap insert and exposed half of crankshaft journal.
   (b) Place a piece of "plastigage" the full width of the bearing insert.

(c) Reinstall the bearing cap. Tighten the self-locking capscrews to approximately 80 foot-pounds.

(d) Remove the bearing cap. The flattened plastic material will be found adhering to either the bearing shell or the crankshaft.

(e) To determine the bearing clearance, compare the width of the flattened plastigage at its widest point with the graduations on the envelope (Fig. 67). The number within the graduation on the envelope indicates the clearance in thousandths of an inch. NOTE: Do not turn crankshaft during the above procedure.

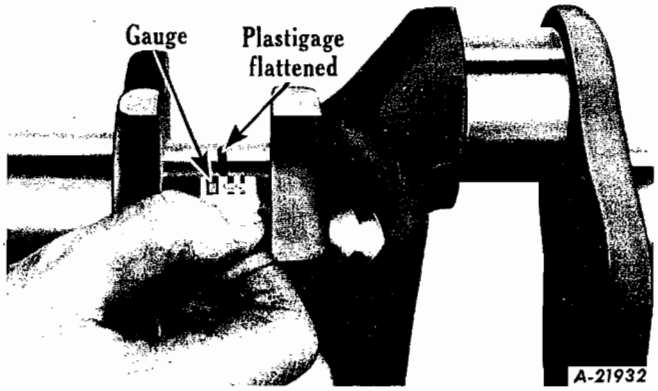

Fig. 67

4. If clearance is not within .001" to .004", either use undersize bearing, regrind shaft or replace shaft. Check crankshaft for end-play which is taken up by number three main bearing. End clearance should be from .0055" to .0135".

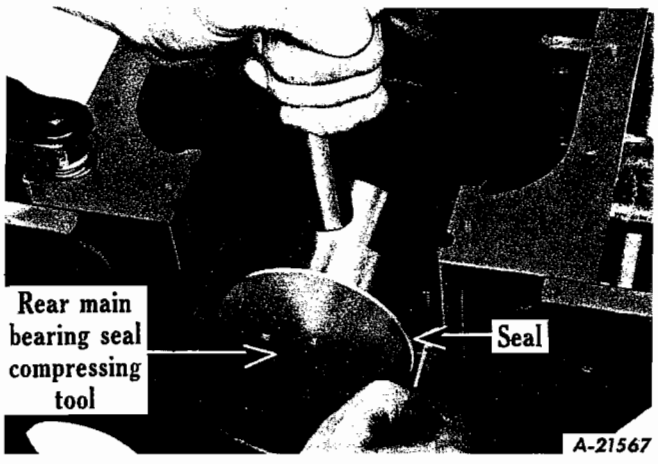

Fig. 68 - Installing upper oil seal in crankcase using SE-1720 Rear Main Bearing Oil seal compressor.

5. Before installing rear main bearing cap (after all bearing clearances have been checked) install upper seal in block. Use special tool to press or roll seal in place (Fig. 68). After seal has been seated in block, trim ends of seal that project above cap surface level. Repeat the same operation with main bearing cap. Install wicking on each side of rear main bearing cap (Fig. 69). Tighten all main bearing cap bolts to 80 foot-pounds.

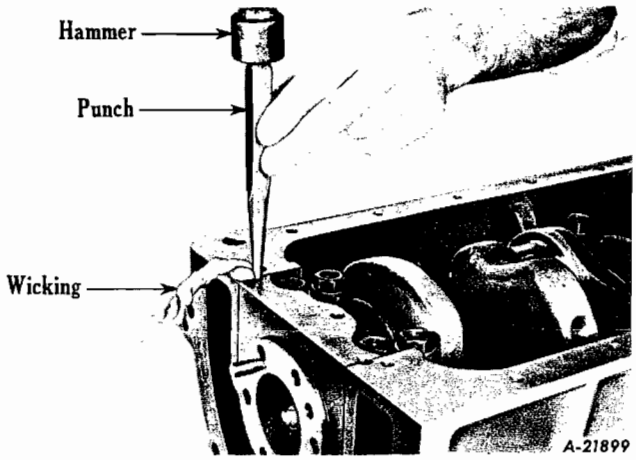

Fig. 69 - Pack wicking securely using punch to work wicking into holes provided.

6. INSTALL FLYWHEEL HOUSING. Place flywheel housing in position over two flywheel-housing-to-cylinder-block dowels, and tap into place with soft hammer. Install six capscrews and lockwashers in flywheel housing. If either block or flywheel housing is replaced, the flywheel housing will have to be aligned with a dial indicator. When correctly aligned, run-out of bore should not exceed .005".

7. INSTALL ENGINE FLYWHEEL. Place engine flywheel and ring gear into position on dowels in crankshaft flange. Install six self-locking capscrews in flywheel and crankshaft flange, and tighten to a tension of approximately 60 foot-pounds, using a tension wrench.

8. INSTALL GEAR CASE COVER PLATE. Place plate and gasket at front end of engine cylinder block. Install two capscrews and lockwashers.

9. INSTALL CAMSHAFT AND GEAR. Coat camshaft with engine oil. Insert camshaft into front end of engine block, being careful not to damage camshaft bearings. Before completely entering camshaft rotate shaft until marked teeth on crankshaft gear and camshaft gear index (Fig. 70). Install two capscrews and lockwashers in camshaft thrust flange, working through large holes in camshaft gear. Rotate crankshaft and camshaft to establish that gears do not bind or interfere. Backlash must be from .000" to .007" (.0015" preferred).

10. INSTALL GEAR COVER CASE. Place gasket in position on case cover. Place

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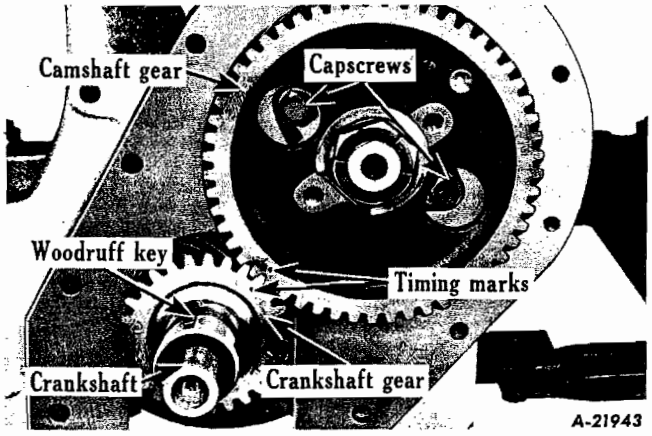

Fig. 70

crankshaft oil slinger over end of crankshaft and install Woodruff key for fan drive pulley in crankshaft. Place gear case cover in position and install gear case cover aligning tool (Fig. 71). Install capscrews, new lockwashers, and nuts. Remove aligning tool.

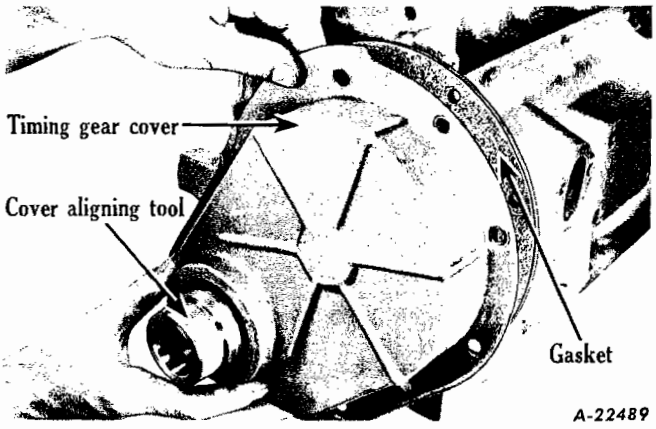

Fig. 71 - Aligning timing gear cover using SE-1717 Aligning tool.

11. INSTALL FAN DRIVE PULLEY AND VIBRATION DAMPER. Heat crankshaft fan drive pulley and vibration damper assembly in boiling water. When heated, quickly install assembly on crankshaft and install washer and fan drive pulley nut. Tighten nut with wrench of about 36" leverage. Vibration damper is used on the model SD-240 engine only.

Installing Connecting Rods and Pistons

1. Install one connecting-rod and piston assembly down through top of cylinder block having slot in piston towards camshaft side of engine. Pistons are also marked with an arrow indicating front of engine. Use a piston ring compressor sleeve to compress piston rings and thus avoid possible ring damage (Fig. 72).
2. Wipe base of connecting rod free of oil and dirt. Place bearing shell upper half in connecting rod base, being sure that oil hole aligns with oil hole in connecting rod and that locking tangs of bearing shell fit into recess. Clean connecting-rod cap bearing bore and clean back of bearing. Place bearing shell lower half in connecting rod cap, making sure that tang of bearing fits into recess in cap. (NOTE: See instructions under "Main Bearing and Connecting-Rod Bearing Installation".)

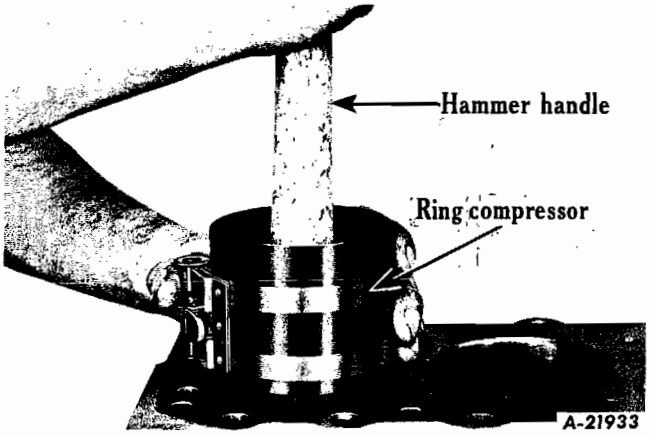

Fig. 72

3. Coat bearing surfaces with oil. Pull connecting rod into position on crankshaft journal and install connecting-rod cap and bearing. NOTE: Bearing cap can only be installed on connecting rod one way, because of the construction of rod and cap. Install two self-locking capscrews and tighten to 50 foot-pounds, using tension wrench.
4. To check connecting-rod bearing to crankshaft clearance, follow procedure given for "plastigage" test. Specified connecting-rod bearing to crankshaft clearance is from .001" to .0035". Do not attempt to file connecting rod or bearing caps.
5. Follow the foregoing procedure for installing remaining connecting rods and pistons.
6. INSTALL OIL PUMP. Place crankshaft and piston in position for firing on No. 1 piston. Insert oil pump assembly into opening in cylinder block, rotate pump drive shaft so that tang in top of shaft is parallel to engine block. This position will assure the oil pump drive shaft being in proper position for distributor installation. Install and tighten two capscrews. Place one-piece oil pan gasket in place and install 25 capscrews around oil pan flange.
7. INSTALL CLUTCH. Install clutch driven disc against flywheel so that the long portion of the hub is toward the rear. Place clutch in position on flywheel over clutch driven disc. Locate clutch so that arrow

on flange of clutch backing plate or cone is as near as possible to the letter "L" on the flywheel, and install two or three mounting capscrews and lockwashers loosely. Insert a clutch aligning arbor, if available, or a transmission main drive gear shaft, through clutch driven disc hub spline and into clutch pilot bearings. Hold clutch driven disc in position while completing installation of six mounting capscrews and lockwashers in flange of clutch backing plate or cover. Tighten all six capscrews securely. Remove three retaining capscrews and flat washers which were installed to hold clutch compressed. NOTE: Clutch will not operate properly unless these retaining capscrews are removed.

8. INSTALL VALVE TAPPETS. Coat each of 12 valve tappets with heavy engine oil and drop each, flat side down, through recess in side of cylinder block into sockets in block (Fig. 73).

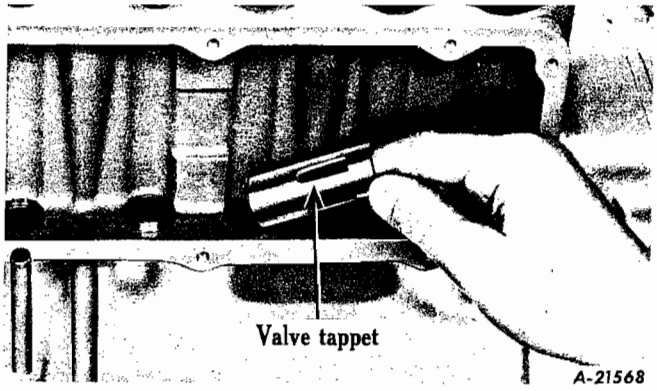

Fig. 73

9. INSTALL VALVE LIFTER ROD COVER. Install new gasket over opening at left-hand side of engine block. Install valve lifter rod covers and slotted screws.

Install Cylinder Head

1. INSTALL HEAD. Place gasket on cylinder block and align bolt holes. Place cylinder head on crankcase, being careful not to damage of shift gasket position. Loosely install all cylinder-head bolts and flat washers, omitting bolts in holes for rocker-arm assembly.

2. INSTALL VALVE ROCKER-ARM ASSEMBLY. Insert 12 valve lifter rods in cylinder head, make sure they enter the valve tappet. Lift the valve rocker-arm assembly into position on cylinder head with the drilled oil bracket placed third from front. Make sure number 2, 4, and 6 bracket sleeve dowels are in place (Fig. 74). Install the remainder of cylinder-head bolts and tighten alternately and evenly in sequence to 90 foot-pounds.

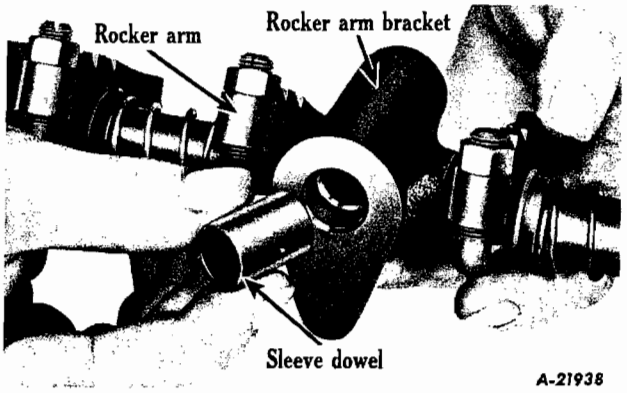

Fig. 74

3. ADJUSTING VALVES. To adjust valve stem to valve rocker arm clearance correctly, each cylinder must be on top-dead-center on its compression stroke at the time of adjustment of valves for that cylinder. To determine the correct position, turn the engine crankshaft until No. 1 piston is at top-dead-center on compression stroke and the ignition timing dot on the flywheel is in line with the pointer on the flywheel housing (Fig. 75). Adjust clearance on each valve of No. 1 cylinder to .018" to .020" by using a feeler gauge between valve stem and valve rocker arm and turn rocker-arm adjusting screw out of rocker arm until clearance is obtained. Tighten adjusting screw lock nut and recheck clearance. (NOTE: Valve clearance should be rechecked with engine at normal operating temperature.)

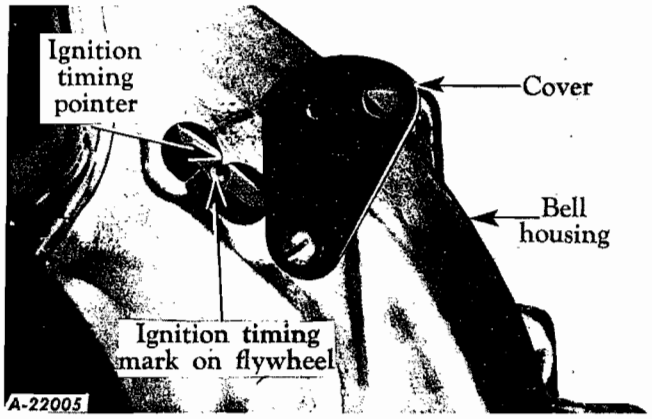

Fig. 75

4. Turn crankshaft one-third revolution and adjust clearance on No. 5 valves. Working in firing order sequence, continue to set valves of each of the remaining cylinders, turning crankshaft one-third turn after each valve adjustment.

5. INSTALL INTAKE AND EXHAUST MANIFOLDS. To facilitate installing the manifolds, after manifold gaskets and pilot rings are installed, start capscrews at each end of intake manifold. This will permit the

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manifold to slide straight up between the engine head and capscrews and flat washers. When manifold is lined up with pilot rings and gasket, tilt bottom of manifold toward engine block. This will force manifold out at top enough to bind against the two capscrews and hold manifold in position until the front and rear capscrews can be installed (Fig. 76).

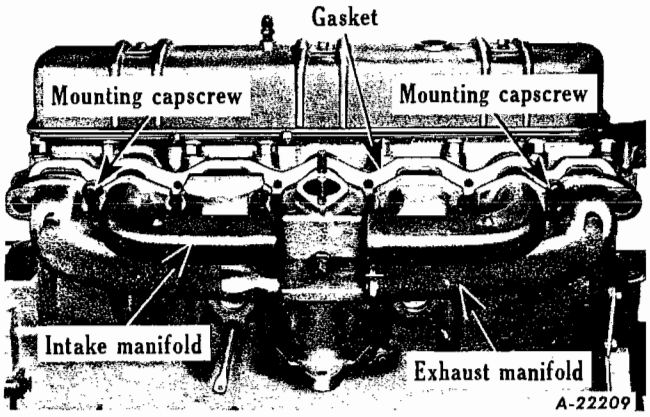

Fig. 76

6. INSTALL WATER PUMP. Place water pump gasket in position, at water pump opening in front of cylinder head. Install water pump and fan and install four capscrews and lockwashers in pump and cylinder block.

7. INSTALL OIL FILTER. Place oil filter and new gasket in place on cylinder block. Install four capscrews and lockwashers in oil filter base. (NOTE: Be sure filter assembly is thoroughly cleaned and a new cartridge is installed before replacement on engine.) Tighten center tube nut using wrench SE-1728.

8. INSTALL ACCESSORIES. Install carburetor, generator, distributor and connecting wires, starter, fuel pump, ignition coil, oil gauge, and thermostat.

9. FILL ENGINE WITH OIL. After making certain that oil drain plug is securely installed, fill crankcase with oil. After engine has been installed and placed in operation, again recheck oil level and if necessary add sufficient oil to bring level up to full mark on gauge.

10. INSTALL CYLINDER-HEAD COVER. If engine is not to be installed at this time, install new cylinder-head cover gasket and install cylinder-head cover. Install three flat copper washers and three capscrews on cover.

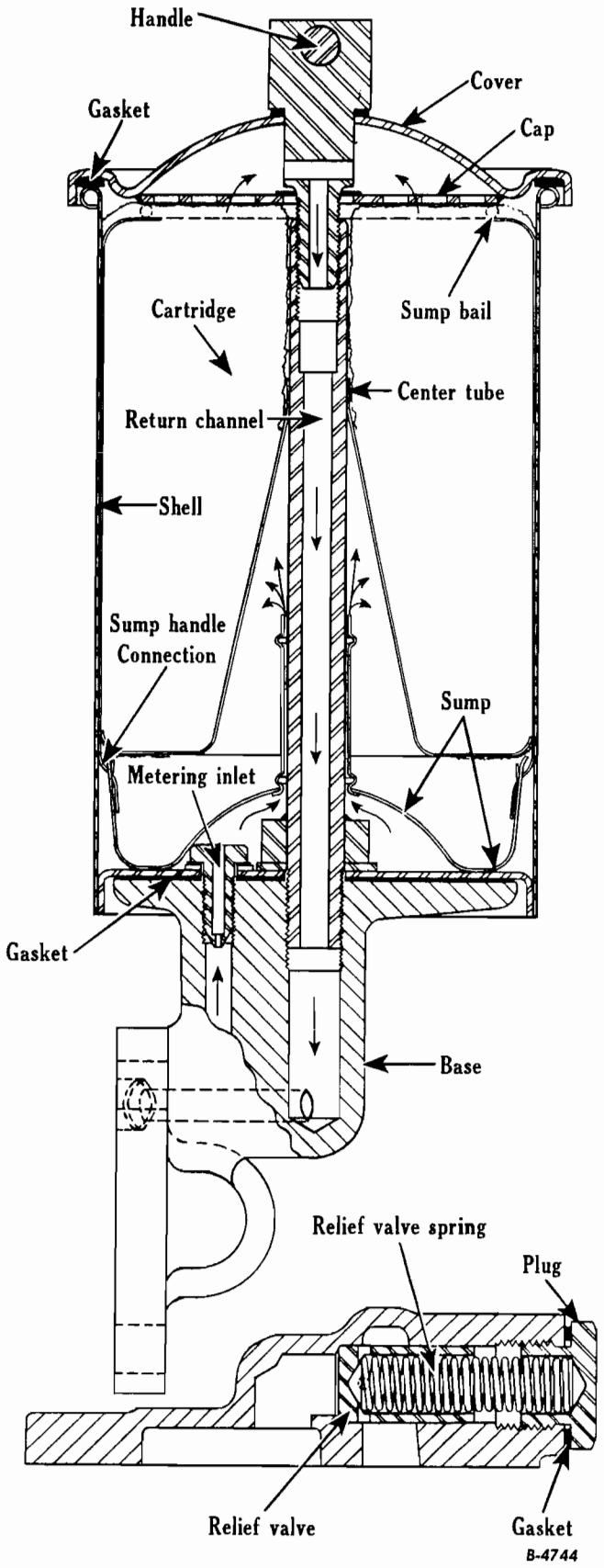

Fig. 77 - Details of Deluxe Oil Filter.

SUPER BLUE DIAMOND ENGINE

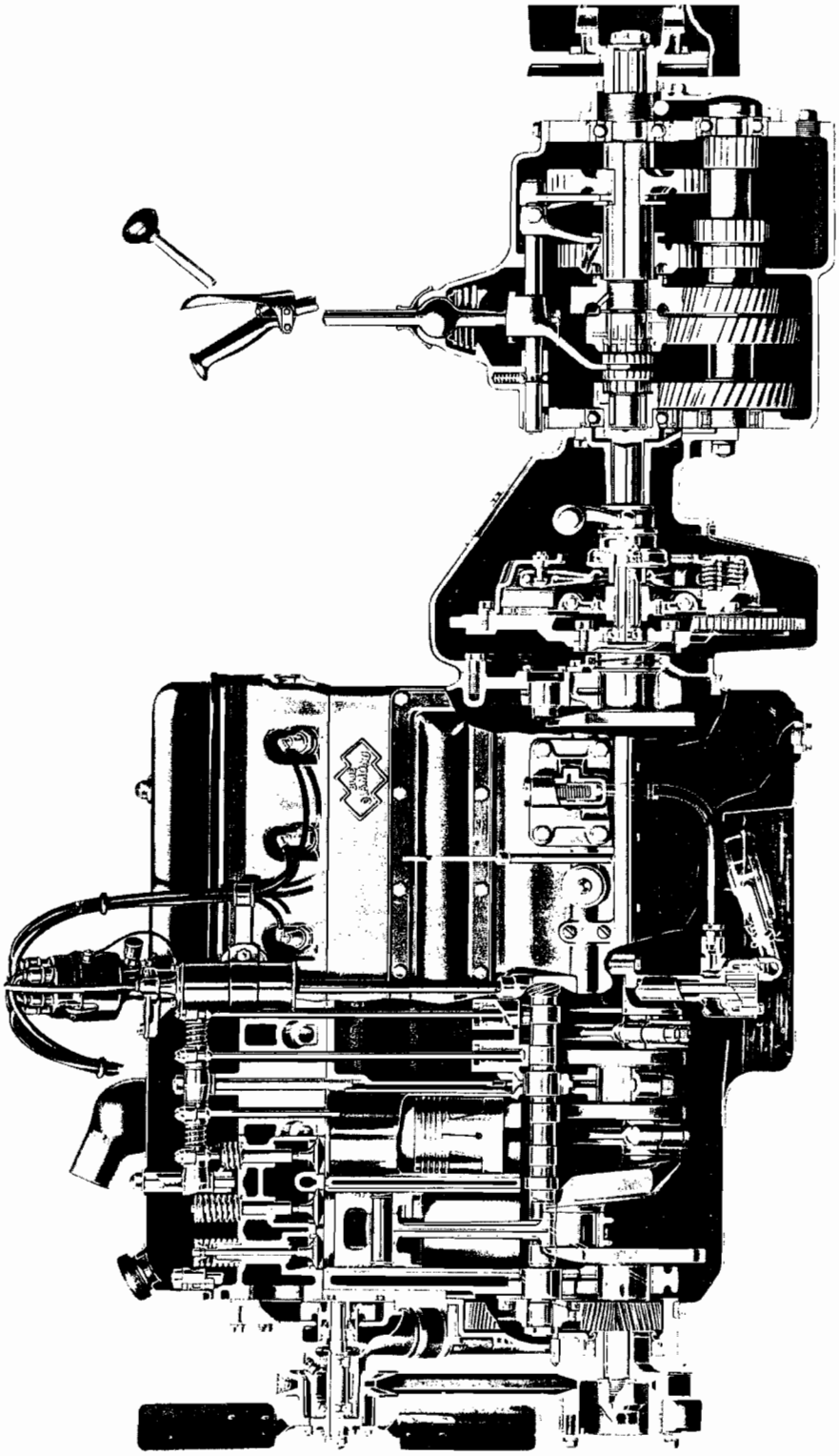

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Fig. 1 - Sectional view of Super Blue Diamond Engine.

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DESCRIPTION

General

The Model BD, Super Blue Diamond engine is a 4-cycle, 6-cylinder-in-line, overhead-valve-type engine (Fig. 1). The engine serial number is stamped on a pad at the front on the left side of the crankcase just below the cylinder head. The block has dry-type replaceable liners for the cylinders. The detachable cylinder head contains all valves, valve guides, and springs. The cylinders are numbered from front (fan and timing gear end) to rear. Engine crankshaft rotation is clockwise as viewed from the front end of the vehicle. The intake and exhaust manifolds, carburetor, starter, and generator are located on the right side of the engine. The distributor, fuel pump, and oil filter are located on the left side. The oil filler inlet is located in the valve cover on the top of engine. The bayonet type oil level gauge is located on the left side. The water pump is located at the front of engine.

Construction

1. The generator, fan, and water pump are driven by a V-type belt from a driven pulley mounted on the front end of the crankshaft. The distributor, mounted at the left side of the engine, is driven by the camshaft through the oil pump.

2. The exhaust and intake manifolds are bolted to each other and to the right side of the engine head. The intake manifold and the exhaust manifold are each cast in one piece.

3. A vibration damper is provided at the front end of the crankshaft.

4. The cylinder block and crankcase are cast in one piece, and carry the crankshaft main bearings. Water circulation passages completely surround the cylinders in the crankcase and also provide coolant to the cylinder head.

5. Oil is supplied under pressure by the oil pump to the engine lubrication system. Oil spray from the revolving crankshaft is distributed to the cylinder walls, pistons, and other moving parts inside the engine.

6. Exhaust valve seats are of alloy and are pressed into place. These valve seats lengthen the period between valve reconditioning operations. Valves and valve seats are cooled by continuous circulation of water through the cylinder head.

7. The detachable cylinder head is bolted to the crankcase, and a gastight and watertight seal is maintained by means of a gasket.

8. The crankshaft is a drop forging of heat-treated steel. It is counterweighted, balanced both statically and dynamically, and ground to close limits. The shaft is mounted in four precision-type replaceable shell bearings, the number four (rear) bearing taking up the thrust.

9. The pistons are made of an aluminum alloy, are cam ground, and are fitted with three compression rings and one oil control ring. The full-floating type piston pins are held in place in the pistons, at the ends of the pins, by snap rings.

10. The camshaft is machined from a solid drop forging and mounted in four special replaceable bearings.

11. The flywheel is bolted and doweled to the crankshaft flange. The timing mark is located on the front crankshaft pulley.

ENGINE REMOVAL

The engine, with transmission removed, can be lifted from chassis without disturbing the fender and grille assembly, by using a suitable chain sling and a floor crane.

Disconnect the following electrical circuits, hose connections, and various units as outlined (Fig. 2 and Fig. 3):

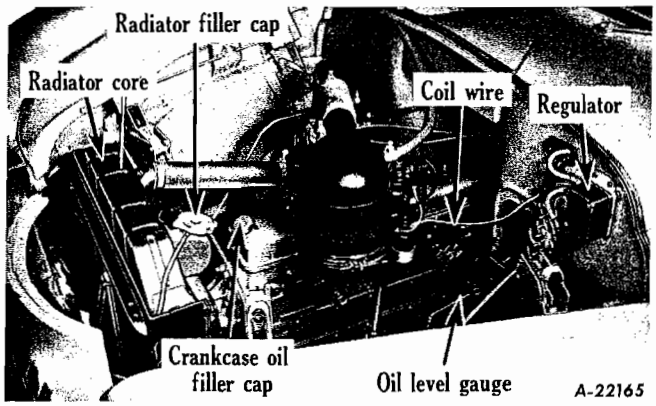

Fig. 2

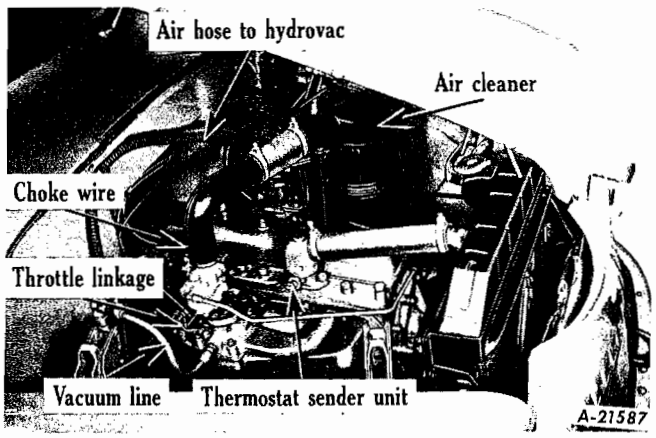

Fig. 3

1. Drain engine oil pan. Drain all coolant from engine cooling system by opening the drain cock on side of engine as well as the radiator drain cock. Remove radiator filler cap when draining cooling system.

2. Disconnect upper and lower radiator hose connections. Disconnect engine air cleaner and remove air cleaner. Disconnect vacuum line at manifold.

3. Disconnect engine circuit wiring. This includes coil wire, starter cable, engine ground strap and instrument sender unit wires.

4. Disconnect fuel line at fuel pump. Disconnect throttle control linkage and remove choke at carburetor.

5. Disconnect clutch linkage at bell housing.

6. Remove engine rear mounting bolts from both sides of engine support pads.

7. Remove engine front mounting bolts from support bracket; these are the bolts at the front crossmember.

8. Remove radiator mounting bolts and lift out radiator support and core assembly.

9. Disconnect engine exhaust pipe at manifold.

10. Attach engine sling to front and rear right side cylinder head bolts and remove engine (Fig. 4).

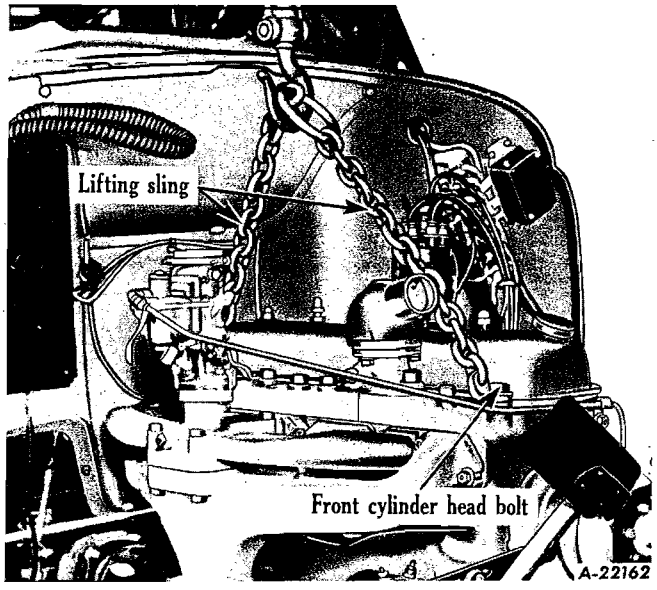

Fig. 4 - Removing engine from chassis. Chain sling attached to front and rear right side cylinder head bolts.

ENGINE DISASSEMBLY

Install the engine in a suitable rotating engine overhaul stand. NOTE: Many of the disassembly operations can be performed with the engine in the chassis. However, the following disassembly outline is performed with the engine removed from the chassis to clearly illustrate each of the units. Except where indicated, no attempt has been made to prescribe a particular sequence for removing the various units, since some can be readily removed with the engine in the chassis. The extent of the service required on a particular unit will govern the necessity for its removal.

Removing Rocker Arms

The following steps are to be followed when removing the rocker-arm cover and rocker-arm assembly. (Carburetor and air cleaner previously removed.):

1. Remove three nuts from rocker-arm cover. Remove air cleaner line and remove cover.
2. Remove bolts from shaft brackets (Fig. 5.) NOTE: Left front head bolt supplies oil to rocker arms.

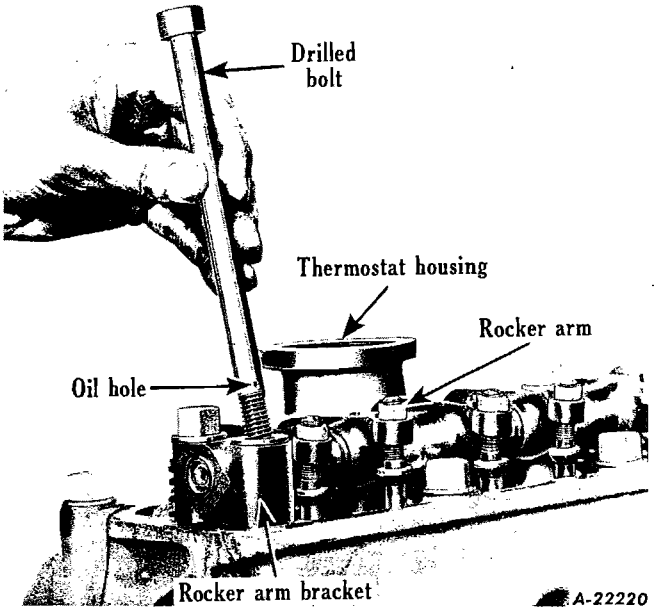

Fig. 5

3. Remove rocker-arm assembly as a unit.

Rocker-Arm and Valve Mechanism Disassambly

1. The rocker-arm assembly is composed of front and rear shafts joined at the center, on which are mounted twelve rocker arms and six tension springs. The shafts are mounted in seven brackets, and are prevented from turning at the two end brackets, by slots in the shaft into which the cylinder-head bolts fit (Fig. 6).

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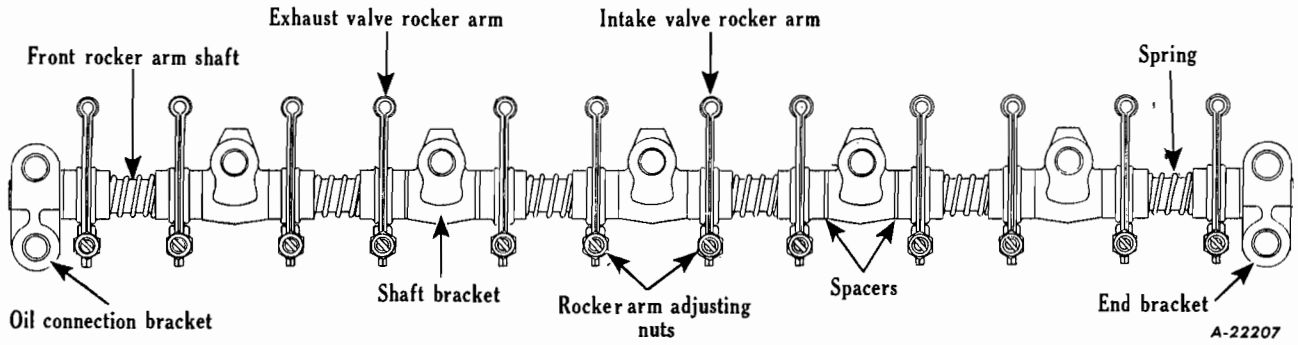

Fig. 6 - Details of rocker-arm assembly.

2. Separate the shafts and slide rocker arms, springs, and brackets from shafts.

3. Clean all parts in a solvent cleaning fluid, being careful to clean all accumulated sludge and carbon deposits from oil holes and slots.

Rocker Arm Inspection

Carefully inspect all parts for defects and wear.

1. Inspect rocker-arm shaft expansion plugs. Check on a surface plate for signs of bending, check for wear from rocker arms. If a shaft is bent or shows perceptible wear, it must be replaced.

2. Inspect rocker-arm adjusting screws for wear at contact surface and for thread wear. Replace worn screws. Check rocker-arm bushings. Inspect valve stem contact pad surface of rocker arm, and resurface if wear is perceptible. Do not remove more than .010" of material when resurfacing rocker-arm pads.

3. Inspect tension springs for breakage or loss of tension. Replace defective springs. Remove valve lifter rods from engine.

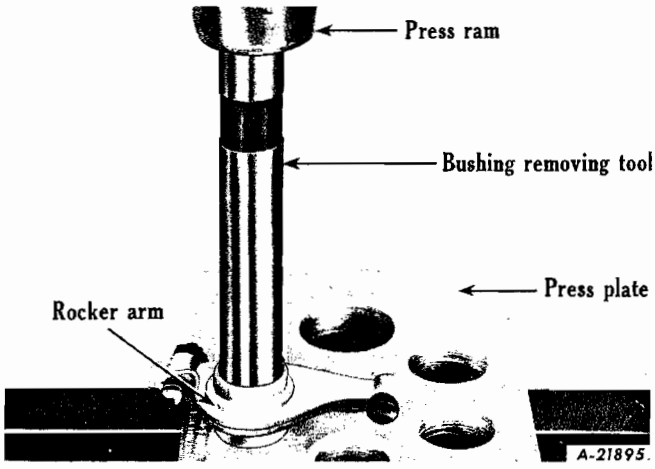

Fig. 7 - Use SE-1036-1 Bushing Removing Tool when removing the rocker arm bushing. Support the rocker arm on the SE-1033 support block. Select a hole in the support block to properly support the rocker arm at the same time permit the bushing to clear the support block when being removed. Use the support block when installing and burnishing the new bushing.

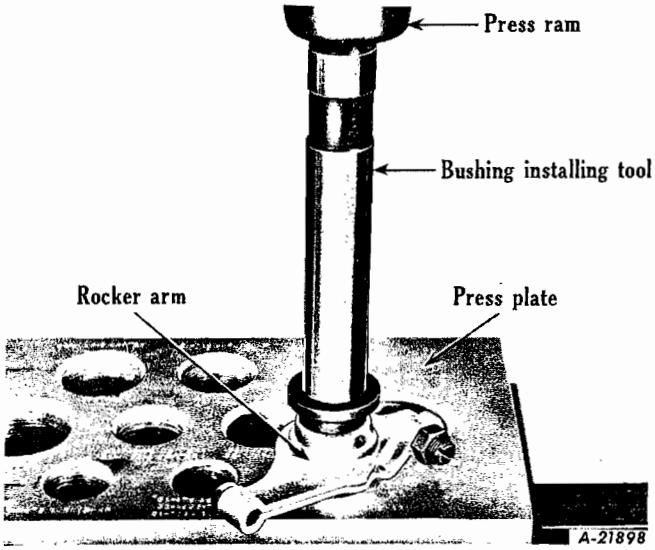

Fig. 8 - Showing method of installing new rocker arm bushing.

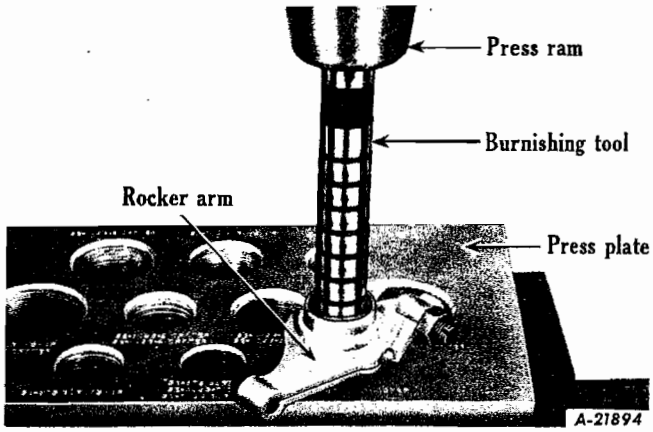

Fig. 9 - Burnishing rocker arm bushing. Use SE-931 Burnishing Tool.

Re-bushing Rocker Arms

With properly fitting adapter or special tool equipment provided (Figs. 7, 8 and 9), press old rocker-arm bushing from rocker arm. Place new rocker-arm bushing in position. Align oil hole in bushing with oil hole in rocker arm, which is located 30° from top of rocker arm toward rocker-arm adjusting nut. Using installing tool, press new bushing into rocker arm. Burnish bushing into place in the rocker arm, then ream rocker-arm bushing to provide .0015" to .004" clearance. Ream dimension is .7505" - .7520".

Cylinder Head and Valves

The following instructions are to be followed when reconditioning cylinder head and valves. Remove push rods, remove cylinder-head bolts and lift off cylinder head and gasket. Place cylinder head on bench.

1. Compress valve spring with a valve compressor and remove valve spring retainer locks. Remove retainer. Remove valve spring and damper and separate valve spring damper from valve spring. Remove all valve springs as outlined, and remove valve spring damper from each spring.

2. Invert cylinder head. Remove all valves from their valve guides and from the head, keeping each valve in a suitable rack which will assure replacement of the valves in their original location.

3. Scrape all carbon from cylinder-head combustion chamber, and clean any gasket material from surface of head. Clean the head using steam cleaning or other suitable cleaning equipment.

4. Clean all carbon deposits from valve heads and valve stems with wire brush. Wash all valve springs and retainers in cleaning solvent.

Inspection of Cylinder Head

1. Inspect cylinder head visually for signs of cracks or sand holes and if found defective, weld or replace head.

2. Inspect exhaust valve seat rings for looseness and inspect for excessive width of valve seat surface. If insert rings are loose, replace. If a seat has been previously ground to such extent that it cannot be narrowed from top to bring to proper position near center of valve face, the ring must be replaced.

Inspection of Valve Guides, Valve Springs and Valves

1. Clean valve guides with a suitable cleaning tool. Check each valve guide with a "Go and No-Go" gauge, if available; otherwise, use a new valve to check fit. If "No-Go" portion of gauge enters, the guide must be replaced. Recommended valve stem to valve guide clearance is from .002" to .004" for exhaust valves, and from .0015" to .0035" for intake valves. Clearance in excess of .006" for intake valves or .008" for exhaust valves, require guide replacement. Ream guides to .3435"-.3455" after assembly in cylinder head.

2. Test valve springs with damper in position. Test tension of each valve spring at valve open length with a valve-spring tester (Fig. 10). Check valve springs at 1-43/64" length, and replace if pressure is less than 111 lbs.

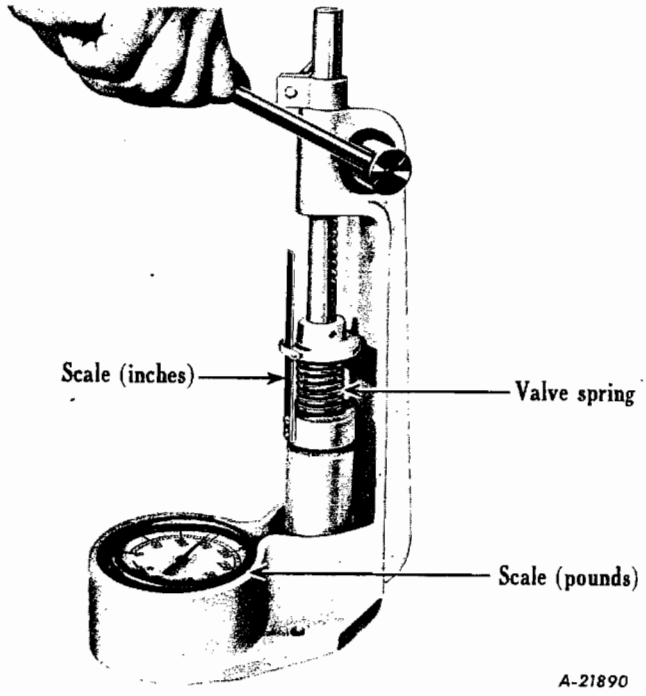

Fig. 10 - Test valve springs in SE-1565 Valve spring testing tool.

3. Inspect each valve for warpage, for severely burned condition, and for excessive grinding on the valve head. Inspect valve stem for scuff marks or perceptible wear. Inspect valve stem end for wear at contact surface with valve rocker arm. If valve is warped, excessively burned, or has been previously ground to extent that valve head is thin at edge, replace valve; otherwise, valve can be reconditioned and reinstalled.

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Repair of Cylinder Head

1. If cylinder head has to be resurfaced, remove only enough material to true-up surface.

2. If any valve guide shows excessive clearance or out-of-round condition, press guide from head with special removing tool. Install new guide, and press into head until approximately 1-1/16" remains above the top surface of the head. Check valve guides after installation to .002" to .004" for exhaust and .0015" to .0035" on intake with "Go and No-Go" gauge. Ream valve guides to .3435"-.3455" after assembly in cylinder head.

3. If inspection indicates necessity, replace valve seat.

4. Grind valve seats in cylinder head to 45° on both exhaust and intake.

Reconditioning Valves and Seats

One of the principal difficulties experienced in reconditioning valves is obtaining nearly identical angles on the valve seat and valve face. The importance of these angles in the grinding operation cannot be overemphasized, because it is impossible to produce a flat or square seat by lapping.

The grinding stones on both the valve-refacing machine and valve seat grinder should be dressed before starting a reconditioning job. You will be unable to determine how closely the angle of the seat will match the valve face until the valve and seat have been ground and a check made with a very light tint of Prussian blue. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to redress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve. No more material should be removed from the valve face than is necessary to true it up and remove the burned or pitted portion. New valves should not be refaced, but should be checked for trueness. When a satisfactory match of valve seat and valve face angles has been obtained, the adjustment of both the valve refacer and the seat grinder should be locked in position, in order to eliminate this trial-by-error method on additional valves having the same angle.

Valve Seats

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to prevent burning of the seat and warping of the valve head.

The location of the valve seat on the valve face and its width controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperature and poor heat dissipation also produce excessive valve stem temperatures and hasten the accumulation of carbon on the stem, causing them to stick in the guides.

Valve Seat Widths

In general, the width of exhaust seat should range between the average and maximum specifications and the intake seats between the

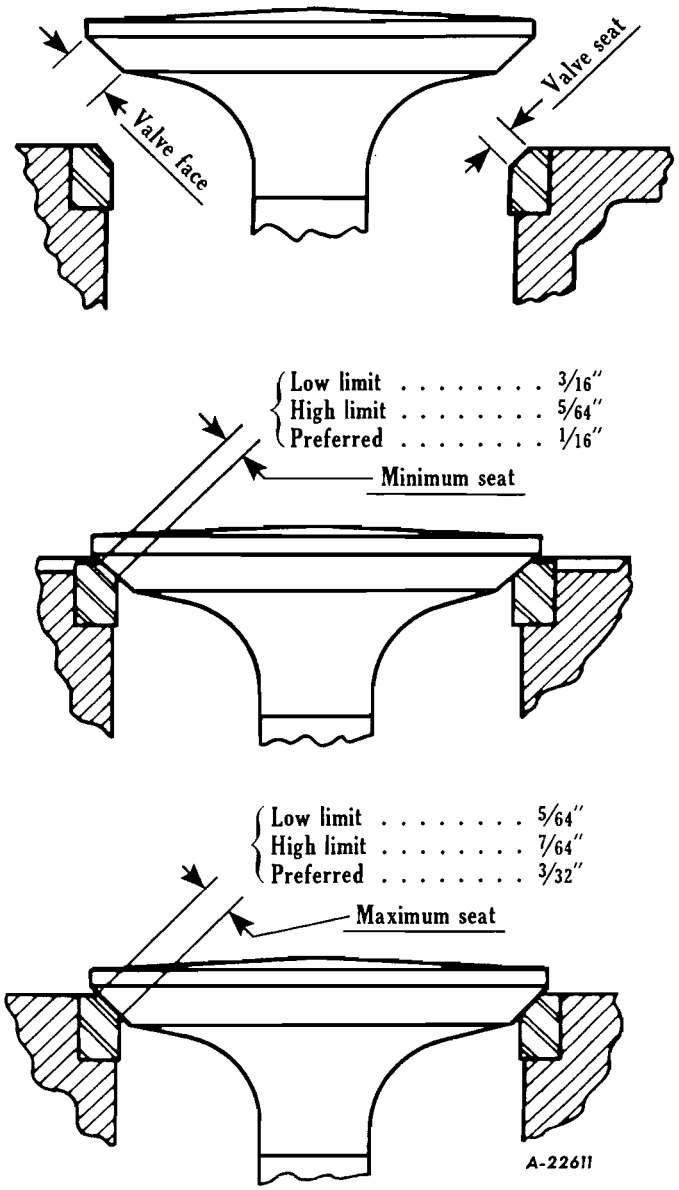

Fig. 11 - Valve seat widths.

minimum and average specifications. The intake seats may be narrower than the exhaust because they are usually larger in diameter, thus providing a total seat area approximately equal to smaller exhaust valve with the wider seat. Also the less severe heat conditions do not require as large a seat area for heat dissipation purposes. Fig. 11 illustrates recommended valve seats to be obtained.

There are also objections to an excessively wide seat, a few of which are as follows:

1. In city or light delivery service, a wide seat collects carbon and particles of dirt that will produce variations or loss of compression, resulting in poor idle and possible a loss of general performance and economy.

2. A wide seat in severe service operating in the presence of dirt or an excess of carbon will produce a badly pitted seat which may be just as detrimental to valve life as a too narrow seat. Under these conditions, a seat width to the minimum limit would possibly be better; however, the source of trouble (which is the dirt and excessive carbon) should be eliminated, making it possible to retain the wider seat.

Valve Seat Inserts

Necessity for replacing valve seat inserts should be very rare; however, if a replacement is made it is important that new inserts be peened securely in place, using either insert peening tool or a dull-pointed chisel, 1/4" wide, to peen cylinder head metal over outer edge of valve seat insert.

Valve seat insert installing tools are available.

Valve seat inserts supplied for service are standard size and .030" oversize which permits a tight fit in cylinder head.

Repair of Valves

1. True-up the ends of valve stem against face of grinder. Remove only enough material to true the surface.

2. Reface exhaust valves to 45°. The valve face and valve seat angle must be identical.

3. Reface intake valves to 45° with valve seat being the same.

4. Place valves in cylinder head. Place a thin coat of Prussian blue on each valve face, and tap valve lightly to its seat. NOTE: This is merely for test and proof of results of refacing and reseating operations. A poor grinding job cannot be corrected by valve lapping.

5. Inspect each valve coated with blue for seat position. The seat should be at the approximate center of valve face, 7/64"-5/64" wide for exhaust, and 5/64"-7/64" wide for intake.

Valve Assembly

1. Wipe valve faces and valve seats with a cleaning solvent to remove all dirt or foreign material. Coat valve stems and valve faces with oil, and install valves in same seats to which they were checked.

2. Install valve springs with dampers. Compress valve springs with a valve spring compressor, and install valve spring retainers and retainer locks. Be sure that retainers and locks are correctly seated.

Engine Disassembly - Continued

When overhauling engine with head and pan removed, the following procedures are recommended:

1. Remove fan drive pulley nut and washer from end of crankshaft. Install puller and remove crankshaft fan drive pulley and damper assembly from crankshaft.

2. Remove nuts and capscrews from engine gear case cover (Fig. 12), remove gear case cover (Fig. 13). Remove crankshaft oil slinger from end of shaft (Fig. 14). Remove side cover plate and remove valve tappets (Fig. 15). Remove nut from end of camshaft and remove camshaft gear with puller (Fig. 16). NOTE: Camshaft may be removed without removing timing gear, by removing thrust plate retainer screws.

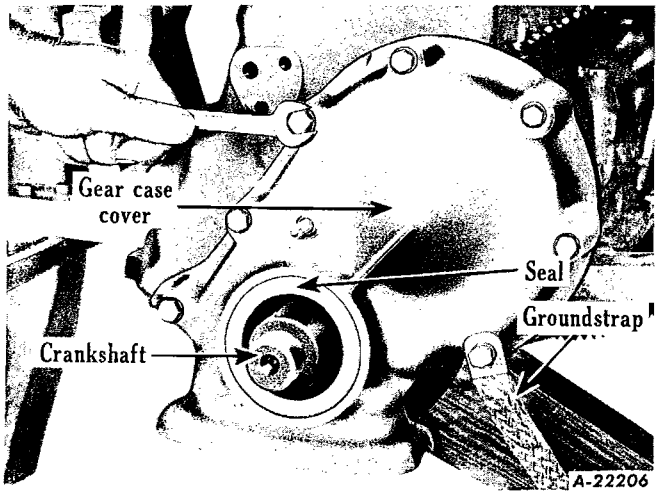

Fig. 12 - Removing timing gear case cover.

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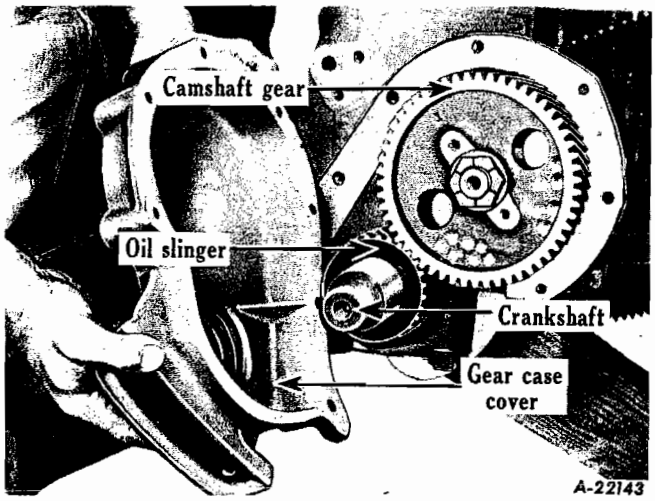

Fig. 13 - Showing details of timing gears. Cover removed.

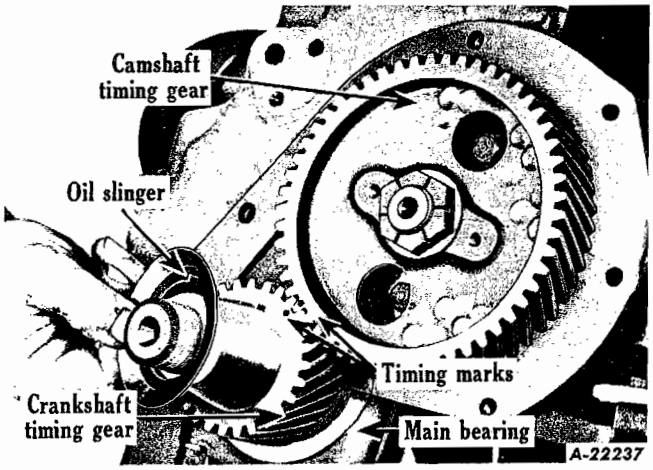

Fig. 14 - Removal of oil slinger. Note that flange of slinger is bent outward.

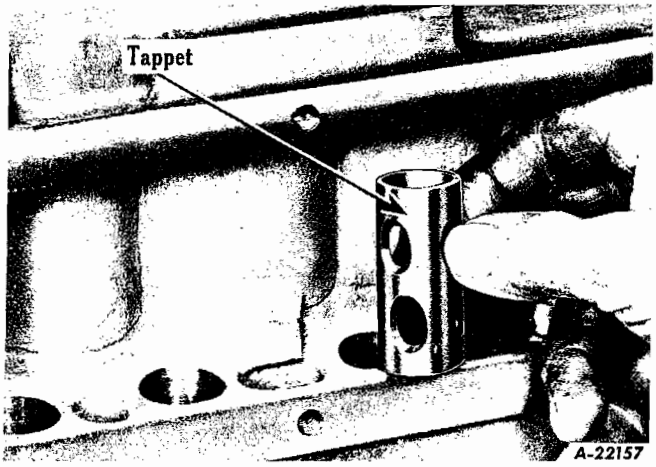

Fig. 15 - Tappets are removed to permit removal of camshaft.

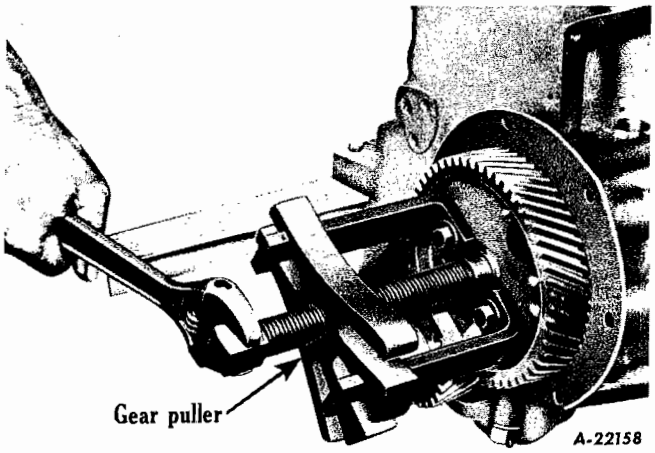

Fig. 16 - Pulling camshaft gear.

3. Remove capscrews from camshaft retainer thrustflange plate (Fig. 17). Remove camshaft (Fig. 18). Remove capscrew holding the gear case cover plate to block; remove plate and gasket. Remove crankshaft timing gear, using a gear puller (Fig. 19). (NOTE: Lubricate puller screw to prevent damage to screw threads.)

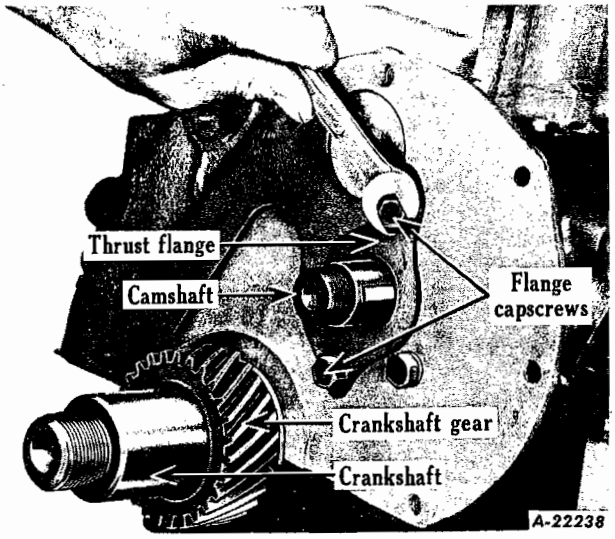

Fig. 17 - Removing camshaft with gear removed. Camshaft may be removed with gear attached.

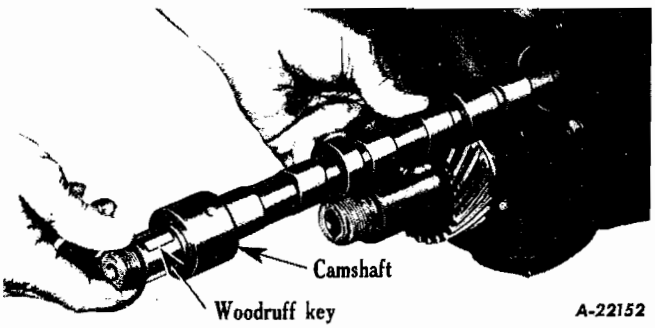

Fig. 18 - Removing camshaft.

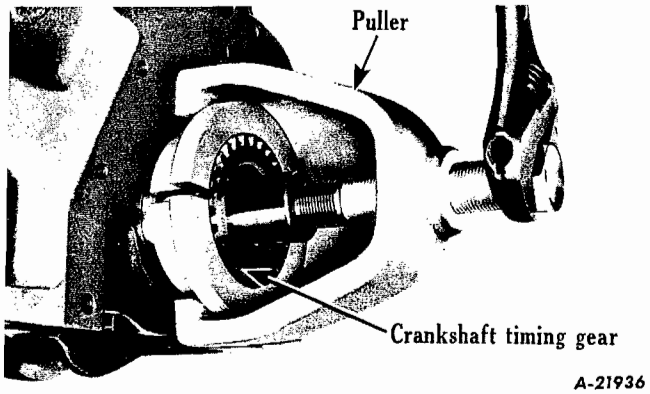

Fig. 19 - Pull crankshaft gear, using SE-1715 Gear puller. Lubricate threads of puller to prevent damage to puller threads.

Turn engine in overhaul stand and proceed with disassembly as follows:

4. Each connecting rod is numbered as to its position in the engine and these numbers are located on the camshaft side of the engine (Fig. 20). Remove self-locking capscrews from connecting-rod cap and remove cap. Push connecting-rod and piston assembly toward top of block, but first remove ridge from top of cylinder wall, if any. Lift piston and connecting-rod assembly from top of cylinder block. Replace cap on connecting rod. Remove the remaining pistons, following the same procedure.

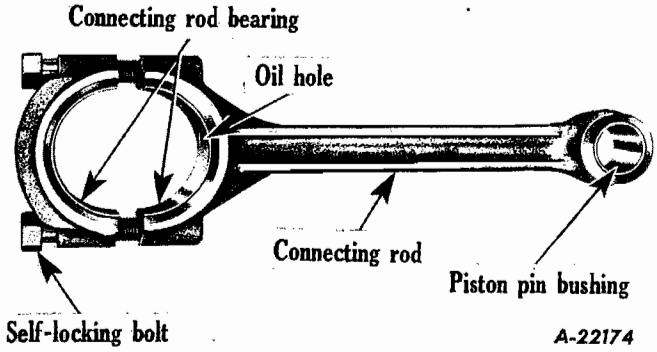

Fig. 20

5. The crankshaft bearing caps are numbered to identify their position and they must be reinstalled in their respective positions. Remove self-locking capscrews from each bearing cap. Remove all crankshaft main bearing caps (Fig. 21). After all caps have been removed, lift crankshaft straight up and out of cylinder block, and place in a vise equipped with soft jaws.

6. With crankshaft securely clamped in vise, remove the six self-locking capscrews holding flywheel to crankshaft. Tap flywheel with a soft hammer to loosen it from crankshaft; remove flywheel with ring gear assembly.

7. Remove capscrews and lockwashers from engine flywheel housing. Drive out the two engine block dowels, remove flywheel housing (Fig. 22).

8. Remove fuel pump, starter, oil pressure regulator valve assembly, distributor, generator, oil gauge and coil.

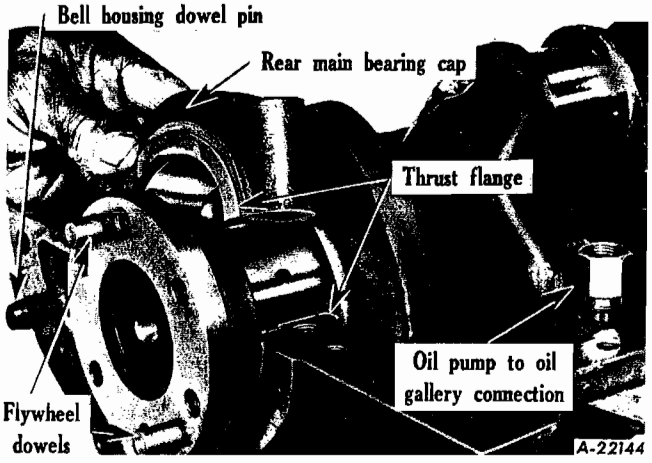

Fig. 21

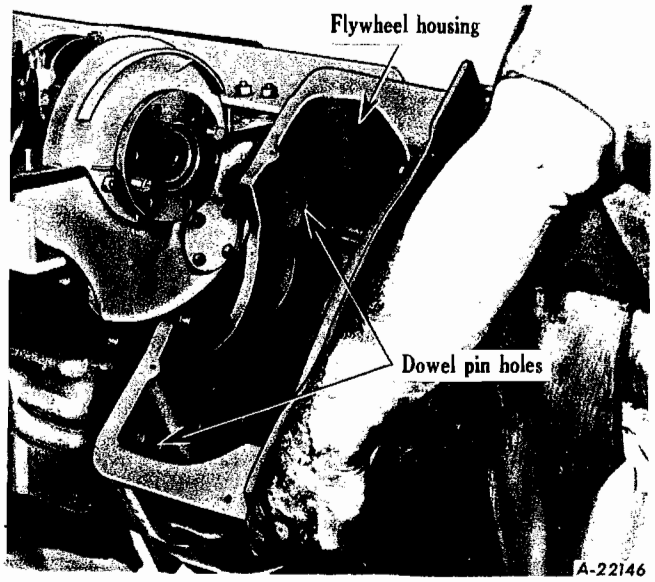

Fig. 22

Water Pump Removal and Overhaul

See sectional view of BD Engine water pump (Fig. 23). The water pump assembly is composed of a body and cover plate which house a ball-bearing mounted pump shaft and impeller. The rear and front bearings are pressed onto the shaft and are separated by a spacer. A slinger is held in place by two half-lock rings. The shaft assembly with its two bearings is held in place in the housing by a retaining snap ring. The fan pulley is pressed onto the shaft (press fit .0007" to .0018") and held in place by a nut and plain washer.

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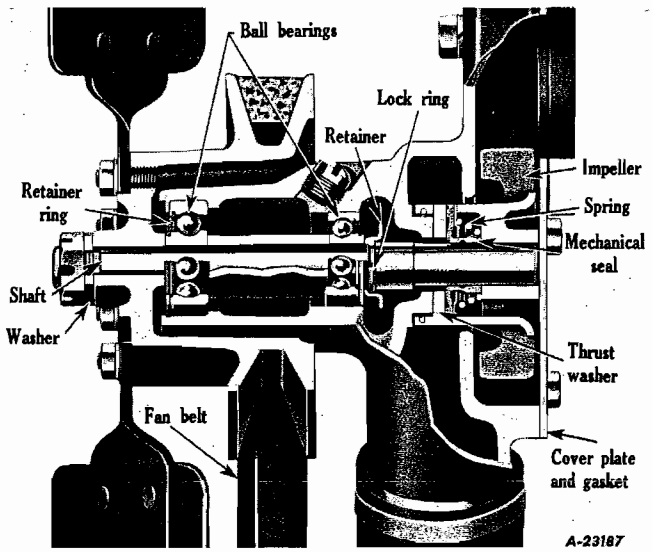


Fig. 23

The impeller seal assembly consists of a seal spring, seal clamp ring, flexible seal, seal spring guide, and a seal carbon washer. The parts are held in place in the impeller by a snap ring. The impeller and seal assembly is pressed onto the pump shaft (press fit of .002" to .0035").

Water Pump Disassembly

(Complete illustrated procedure for water pump servicing is given in Shop Talk No. 14)

1. Remove six capscrews and lockwashers holding fan to pulley. Remove fan blade assembly from pulley. Remove water pump from front end of cylinder head.
2. Remove nut and flat washer holding pulley to water pump shaft. Remove pulley from water pump shaft with puller.
3. Remove four capscrews from cover plate. Remove plate and gasket from pump body.
4. Remove snap ring from front of the water pump shaft front bearing. Supporting water pump on arbor press, push shaft and bearing as an assembly out of impeller from the rear.
5. Support the shaft and bearing assembly on an arbor press, force shaft out of bearing, spacer, and slinger, pressing shaft toward rear bearing. Be careful not to lose the two halfmoon lock rings from under the slinger.
6. Remove snap ring from groove in the front of impeller, and lift out the seal parts from the impeller.

Water Pump Cleaning and Inspection

1. Following disassembly, wash all except rubber parts in cleaning solvent.
2. Examine seal parts for wear, corrosion, or damage, and replace with new parts as necessary. Examine the pump body seal seat surface. If face of surface is scored, it must be resurfaced to prevent leakage. Inspect pump shaft bearing for wear or corrosion. If worn or corroded, replace bearings. Examine shaft for wear at ends, or for damaged threads at front end.

Water Pump Repair

If water pump body seal seat is scored, pitted, or rough, it must be resurfaced. Use special water pump housing seat finishing tool and adapter.

Water Pump Assembly

1. Install rear bearing, spacer, and front bearing onto water pump shaft. Place slinger in position behind rear bearing. Place two half-moon lock rings in groove in shaft, and press shaft into bearing and spacer from rear until rear bearing rests firmly against slinger and ring locks.
2. Place seal clamp ring, seal spring, seal spring guide, flexible seal and retainer, and carbon seal thrust washer into position in impeller. Hold them in position while installing snap ring in impeller groove.
3. Install water pump shaft and bearing assembly into body and hold in place by inserting snap ring in groove in front of front bearing.
4. Support water pump shaft at front end, press impeller and seal assembly onto rear end of water pump shaft. Press impeller only flush with end of shaft.
5. Place new gasket in position on water pump body and install cover plate and four capscrews.
6. Place fan assembly in position on front of pulley, and install six capscrews and lockwashers. Fill pump housing with wheel bearing grease. Use low pressure gun.

Intake and Exhaust Manifolds

When disassembling and assembling the manifolds, the following procedures are used:

1. After removing the eight capscrews from head and three bolts from exhaust flange, remove both intake and exhaust manifolds as a unit (Fig. 24). Remove three manifold pilot rings (Fig. 25). NOTE: Let manifolds cool before starting above operations; this will help to prevent manifold warpage.

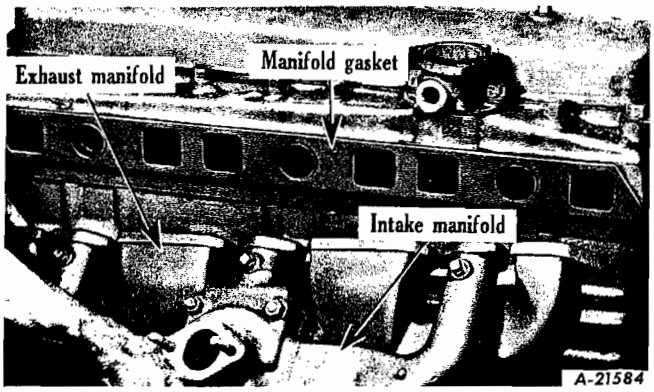


Fig. 24 - Removing intake and exhaust manifold.

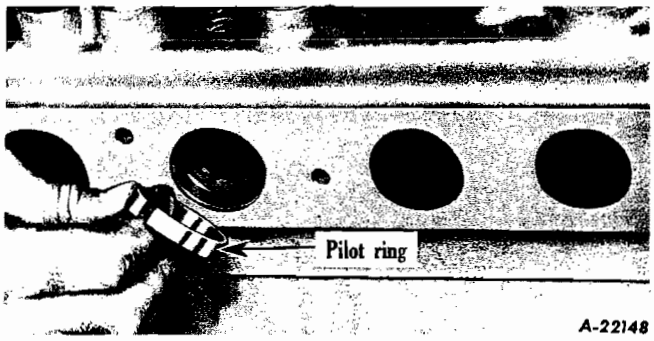


Fig. 25 - Pilot rings are used to hold the intake manifold in alignment and should always be reinstalled.

2. To separate the two manifolds, remove the two outside bolts and nuts and two inside bolts and nuts from the center of manifolds.

3. The intake and exhaust manifolds are each of one piece construction, requiring no disassembly after separation.

Intake Manifold

1. The intake manifold consists of three outlets, each supplying fuel to two cylinders. Two studs are located on the top for carburetor mounting.

2. If vacuum is needed to operate any unit within the truck, a threaded inlet is provided in the manifold for such purposes.

Exhaust Manifold

The exhaust manifold consists of four outlets. The two end outlets remove burned gases from the No. 1 and No. 6 cylinders, while the two center outlets remove burned gases from Nos. 2, 3, 4 and 5 cylinders.

Manifold Inspection

Inspect intake and exhaust manifolds visually for cracks or breakage. Place manifolds on surface plate and check for warpage. If cracked or broken, replace or weld. If slightly warped, true-up on surface grinder but replace if warpage is extreme.

Manifold Assembly

Place new gasket between the intake and exhaust manifolds and install two capscrews and two nuts. Mount manifolds together loosely before installing on engine. This will assure proper alignment of the units with each other and with the engine cylinder head. NOTE: Do not eliminate the intake manifold aligning pilot rings.

Oil Pump Overhaul

(Complete illustrated procedure for oil pump overhaul is given in Shop Talk No. 28)

Special tool equipment is available for oil pump overhaul under SE-1499. Use of these tools will speed up the job and assure accurate work.

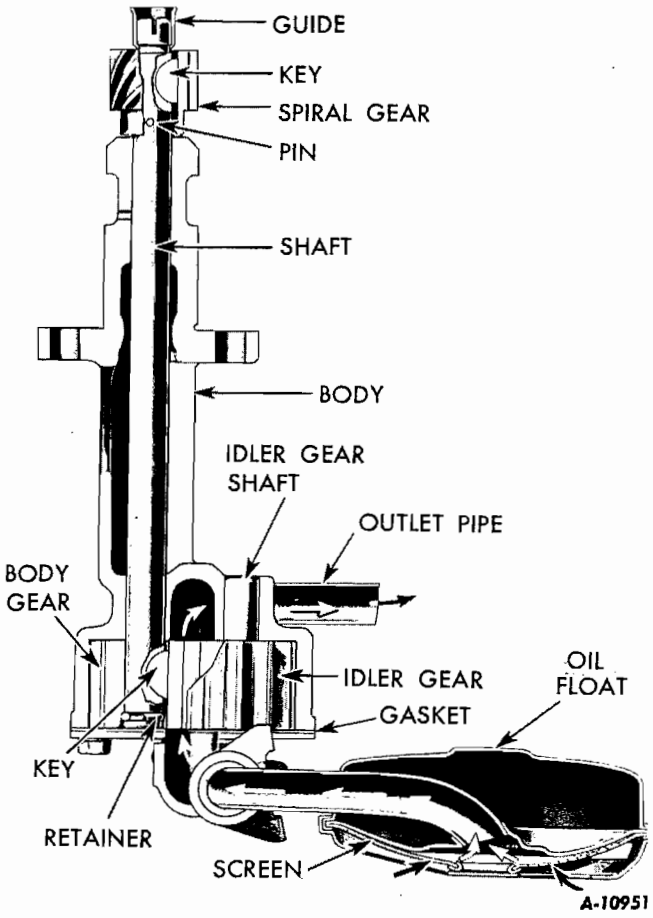


Fig. 26

Oil Pump Disassembly

See sectional view of the model BD engine oil pump (Fig. 26).

1. Remove cotter pin holding float to oil pump.

Remove float from pump. Loosen oil outlet coupling and remove oil line from pump.

2. Remove four capscrews and lockwashers from oil pump body cover and lift cover and gaskets from oil pump body.

3. Lift out oil pump idler gear from idler gear shaft. After removing oil pump drive gear shaft guide from top of shaft, use small punch to drive out spiral gear pin from oil pump spiral gear. Using an adapter collar which fits underneath the spiral gear, and an adapter with a tang which will fit down into the slot of the oil pump drive shaft so as to apply pressure of press at bottom of slot, press oil pump drive shaft out of oil pump spiral gear. Remove Woodruff key from shaft. Remove oil pump body gear and oil pump drive shaft from oil pump body.

4. Press oil pump gear onto oil pump drive shaft far enough to reveal retainer ring. Remove ring from oil pump shaft. Press oil pump body gear from shaft and remove Woodruff key from shaft. Wash all parts in cleaning solvent.

Oil Pump Inspection

Check the following parts carefully:

1. Check the oil pump drive shaft for wear at points of contact with body. If wear is perceptible, the shaft must be replaced. Diameter of shaft is from .4985 to .4992 inches.

2. Check the oil pump body for warpage, damage and wear. Replace if body is warped or cracked, or if shaft bore is worn so that clearance between shaft and bore is in excess of .005". Inspect all oil pump gears, and replace if wear is perceptible.

Oil Pump Assembly

1. Press body gear onto oil pump drive shaft after placing new Woodruff key in slot of shaft. Press gear onto shaft far enough to permit installation of retainer ring in groove in oil pump. Press oil pump body gear down against ring.

2. Insert oil pump drive shaft and body gear into oil pump body. Install new Woodruff key in slot at top end of shaft. Install oil pump spiral gear, with gear hub down, onto drive shaft. Press spiral gear down onto shaft until 1/32" clearance remains between gear hub and pump body when oil pump body gear is up against pump body. Using hole in spiral gear as guide, drill .1255" hole in shaft. Drive new spiral gear pin into place. Install a new guide on the end of the pump shaft, use guide installing tool.

3. Install idler gear on idler gear shaft. Install gasket and oil pump body cover, and install four capscrews and lockwashers. Test oil pump body gear end play to cover by using a feeler gauge between oil pump spiral gear hub and oil pump body. End play must be from .0025" - .0055". If clearance is in excess of .0055", remove one gasket from cover. If clearance is less than .0025", add one gasket between cover and body. Recheck end play after making any alterations. Insert oil pump into cylinder block so that slot in top of shaft is at right angles to the side of the engine with the number one piston in firing order.

4. Connect oil pump outlet to pump and tighten coupling. Insert oil pump float in oil pump body, line up cotter pin holes, install new cotter pin, and fasten securely.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR AND ASSEMBLY OF SUB-ASSEMBLIES

Cleaning the Cylinder Block

Remove all old gasket material from block, clean both inside and outside of block with steam or cleaning solvent. Remove all dirty oil, sludge, scale, and carbon from cylinder block.

Cylinder Block Inspection

1. Inspect cylinder walls for cracks. Weld cracks or replace block, if necessary.

2. Check top surface for trueness with a straight-edge. Test by attempting to insert a .012" feeler gauge ribbon between the straight-edge and the cylinder block. If this is possible, either surface grind or replace the cylinder block.

3. Inspect camshaft bearings for damaged or scored condition, and inspect for wear. Replace if damaged or if worn beyond clearance limit of .0035".

4. Measure cylinder walls with an inside reading micrometer to determine taper, out-of-round or worn condition. The measurements must be made not only at top of the cylinder bore, just below ring groove, but at several places around the inside circumference of the bore. Bore should be checked at the bottom, below ring wear surface, to determine the amount of taper. Re-sleeve if worn beyond .008" clearance.

Cylinder Sleeve Fits

The fit of the cylinder sleeve in the crankcase should be 100 to 200 lbs. hand push fit or approximately .0005" to .001" loose fit. This fit can be obtained by honing the cylinder bore sufficiently in the crankcase until the cylinder sleeve can be pushed all the way in by hand.

Before installation of cylinder sleeve, the crankcase bores should be cleaned of all carbon and foreign matter.

Installation of cylinder sleeves in the foregoing manner will preclude to a large extent the necessity of excessive honing when fitting pistons to the cylinder sleeves.

NOTE: If cylinder water jacket shows an excessive amount of lime deposits, the cooling system cannot provide effective heat dissipation.

Whenever the top of the sleeve flange goes below the top of the crankcase, a thin tag wire should be placed under the sleeve flange to raise it flush with the crankcase, or not to exceed .006" above the crankcase face.

Cylinder wall surface finish is of utmost importance in piston and piston ring life and in oil consumption control. The best type surface is one having characteristics midway between "smooth" and "highly polished". The resulting surface of a boring or honing operation consists of numerous microscopic scratches or grooves which act as oil reservoirs or retainers of oil while the surface between the grooves provides a load-bearing surface. If the scratches are too deep and too close together, the surface is referred to as "rough" and will not provide adequate ring and piston contact area which results in fast wear. Should the finish be highly polished or too "smooth", the scratches or grooves are shallow and will have insufficient oil-retaining capacity to provide adequate lubrication for the adjacent contact or load-bearing area and will result in scuffing or scoring. It is therefore advantageous to strike a "happy medium" by removing only the sharp peaks of these microscopic ridges and in this way still reap the benefits of the oil-retaining grooves. This type of cylinder wall surface is obtained through exercise of care in finishing operation and through proper use of equipment.

The following procedure will produce the best results when fitting pistons to sleeves:

1. Using 150-grit hone stones and having both sleeve and stones coated with one of the vegetable shortenings (Crisco, Spry, Dexo, or equivalent), work hone up and down in cylinder approximately 20 strokes. This should bring the bore diameter to within .0003" of the desired size. (Hone should be moved up and down at a speed rate of approximately one stroke per second.)

2. Using 280-grit hone stones and having both sleeve and stones coated with vegetable shortening, work hone up and down in the cylinder bore approximately 20 strokes. This operation should bring the bore to the desired size.

3. Still using 280-grit hone stones, but having lubricant only on the stones, pass the hone up and down in the bore about 5 times. This operation will not increase the bore diameter but will merely serve to remove the sharp ridges and leave the desired type of surface finish.

   NOTE: In steps 1 and 2, the hone should be quite snug in the bore. In step 3, the tension should be a little less.

   CAUTION: Extreme care must be taken to assure that no abrasive remains in the engine.

4. After engine has been reassembled, it should be allowed to run-in for two or three hours at a fast idle (approximately 1200 r.p.m.).

Replacing Camshaft Bushings

If camshaft bearing replacement is necessary, remove and install new bushings with special camshaft bearing installation tool. No reaming is required. Fig. 27 illustrates the use of camshaft bearing installing tool.

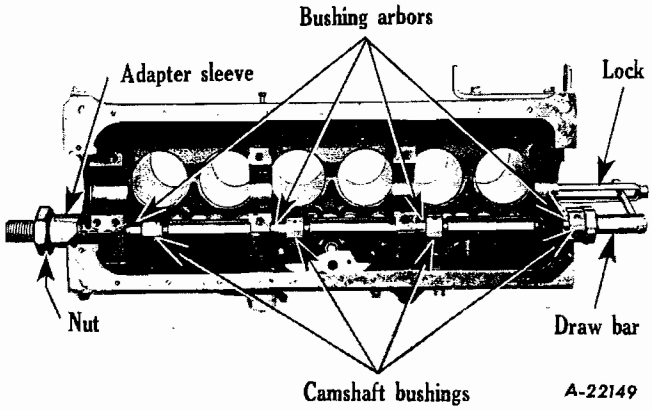


Fig. 27 - Using the SE-1724 Camshaft Bushing installing tool.

Connecting Rod and Piston Disassembly

1. Remove piston-pin retainers from each piston, and remove piston rings from piston ring grooves.

2. Heat piston in boiling water or piston heater. Place piston in piston vise, and using pin-driving tool, drive piston pin from

piston and connecting rod (Fig. 28). After piston pin is removed, lift piston from connecting rod.

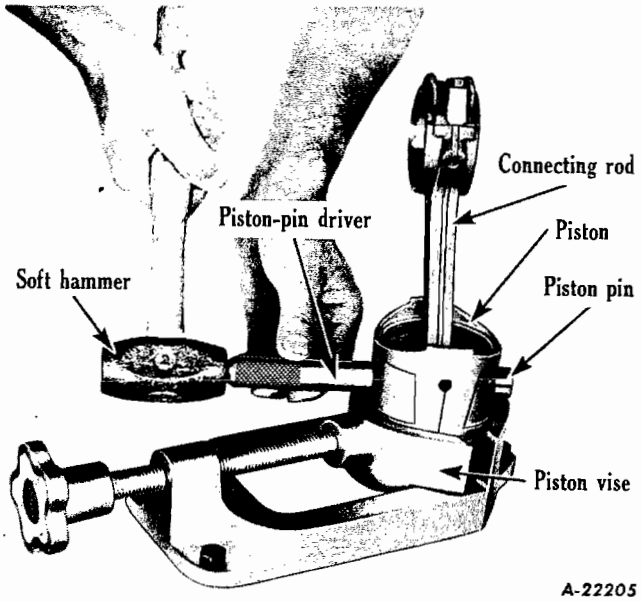


Fig. 28 - Use suitable piston vise to hold piston and drive pin out with SE-1263 Piston Pin Driver. Use soft hammer.

3. Wash all parts in a cleaning solvent. CAUTION: Do not use a caustic solution for aluminum pistons. Clean the carbon from piston ring grooves with a broken ring or ring groove cleaner.
4. Inspect connecting rods, caps, and bearing shells. All connecting-rod bearings and piston-pin bushings should be replaced at every major overhaul. Test rods for alignment. Rods only slightly misaligned can be straightened with proper equipment. Badly twisted or bent connecting rods must be replaced.
5. Inspect pistons for cracks, breakage, or scores. Check piston ring grooves and ring lands for wear, using a new piston ring and feeler gauge. If clearance between ring and ring land exceeds .005", (total clearance) replace piston (see specifications). Pistons which are scored or damaged, must be replaced.
6. Inspect piston pins for wear, and if wear is perceptible, replace pins. Replace piston pins which show signs of corrosion or etching.
7. With properly fitting adapter, press old piston-pin bushing from connecting rod (Fig. 29). Place new piston-pin bushing in position, align oil hole in bushing with oil hole in connecting rod, (Fig. 30), install bushing with a .0035" to .0055" press fit. Burnish bushing into place in the connecting rod (Fig. 31), then ream pin bushing to provide a hand-push fit.
8. With reamer, ream piston pin bosses in piston to provide a tight fit of from .0000" to .0002" with piston pin. NOTE: When fitting piston pins, the pins should be at room temperature (70° F) and the pistons should be heated to approximately 200° F

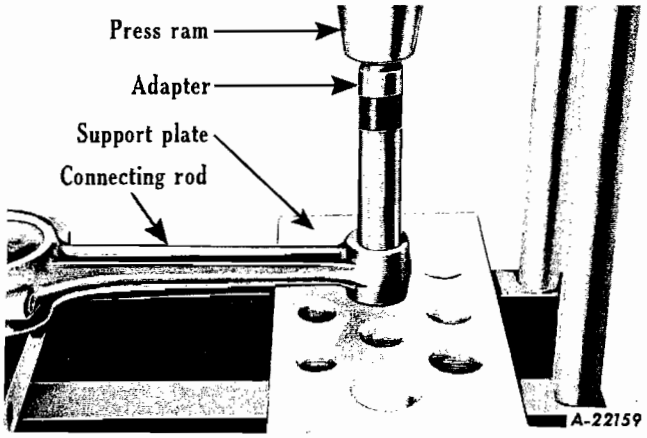


Fig. 29 - Use SE-1036-4 to remove bushing. Select proper hole in SE-1033 Support plate to permit clearance for bushing.

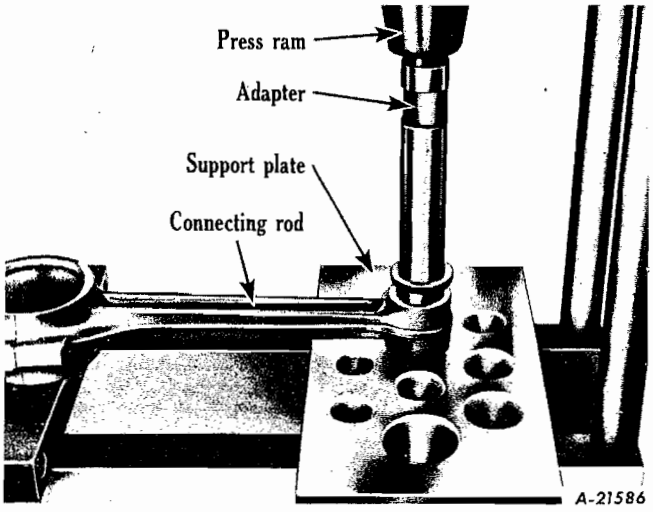


Fig. 30 - Installing new bushing in rod.

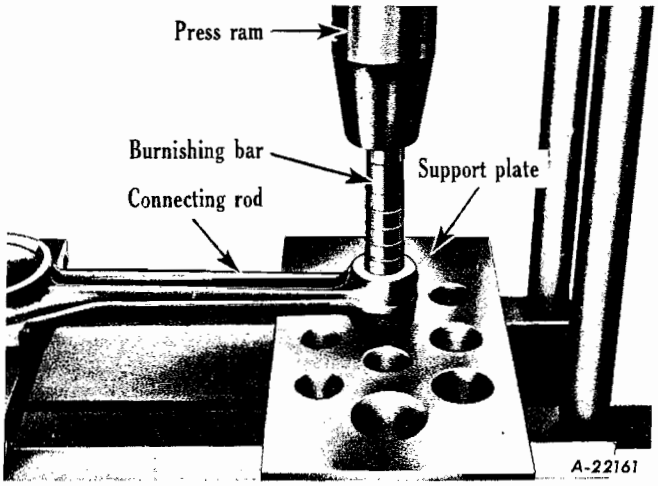


Fig. 31 - Burnish bushing using SE-879.

in boiling water or piston heater. The pin should be a "palm-push" fit under these conditions.

Piston Fitting

When fitting pistons in the cylinder sleeves, use a .003" feeler ribbon 1/2" wide between the piston and cylinder 90° from the piston pin hole and in line with the thrust face of the piston (Fig. 32). Apply a tension pull on scale to the feeler ribbon, and check clearance to specifications as outlined in the chart.

Feeler Gauge Ribbon Checking	
Width	1/2"
Thickness	.003"
Tension on Scale (Lb.)	6-18
Desired Tension (Lb.)	12

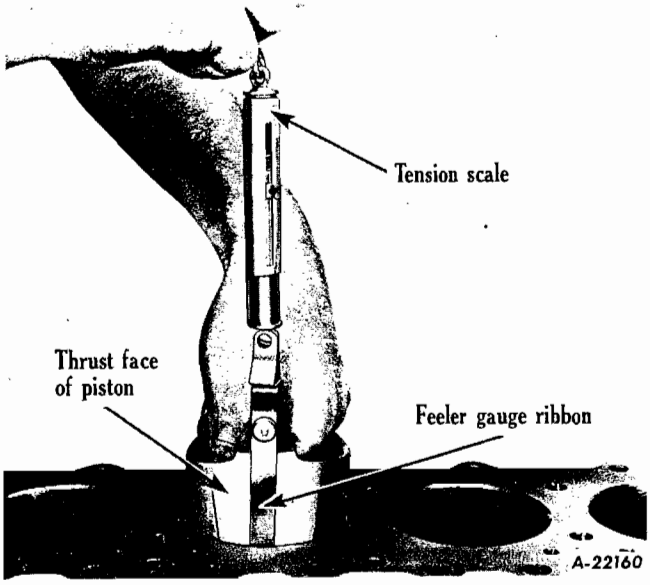


Fig. 32 - Checking piston fit using feeler gauge ribbon. SE-1007 Gauge Set is available for this operation.

Connecting-Rod and Piston Assembly

1. With piston heated to approximately 200° F., support connecting rod in vise, push piston pin into piston bosses while piston is hot. When assembling piston on rod, the slot in the piston skirt must be toward the camshaft side of the engine, which is the numbered side of the connecting rod. Install piston-pin retainer in piston at each end of pin, making sure that retainers seat fully and with tension in grooves. Test connecting-rod and piston assembly on a connecting-rod aligner, and correct any misalignment.

2. Place piston and connecting rod in vise. Test each piston ring for proper gap by placing in cylinder and measuring gap with feeler gauge. Gap should be .016" to .026" (Fig. 33).

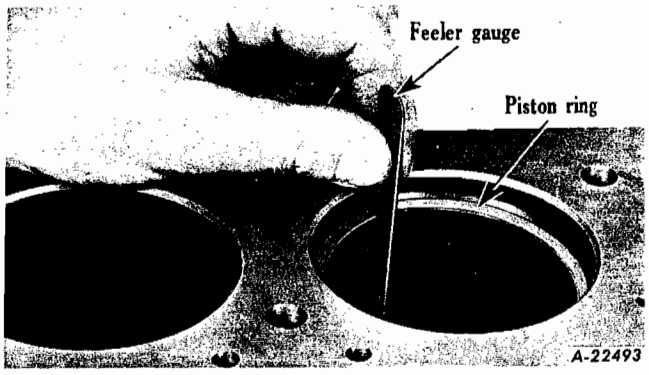


Fig. 33 - Checking ring gap.

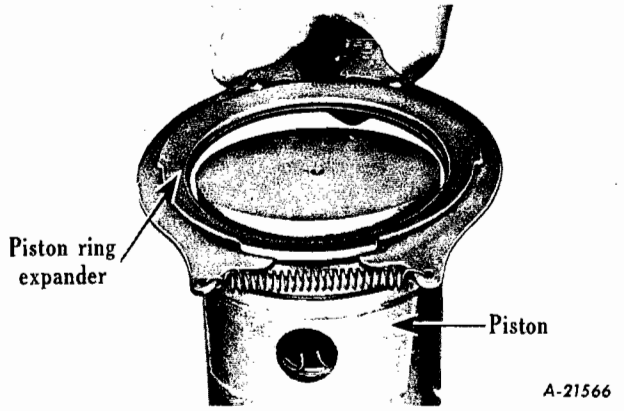


Fig. 34 - Installing piston ring using SE-1149-8 Ring installing tool.

3. When installing piston rings in piston grooves, be careful not to distort rings. If possible, use a suitable piston ring expander tool (Fig. 34). Also check new piston rings in piston ring grooves for clearance between ring and ring lands. The correct ring clearance is shown in specifications.

Crankshaft Cleaning and Inspection

1. Wash and clean crankshaft with cleaning solvent or steam.

2. Inspect main-bearing and connecting-rod journals for wear. If journals show wear or out-of-round in excess of .003", the shaft should be either reground and undersize bearings installed, or replaced. Use micrometers for checking.

3. Check crankshaft and flywheel dowels for damage and fit, and replace if worn or damaged.

4. Examine crankshaft timing gear teeth, and replace gear if teeth are worn or damaged.

5. Install Woodruff key in groove in crankshaft. Heat crankshaft gear in boiling water

or piston heater. This will expand the gear enough to allow it to be tapped onto the crankshaft without the danger of damaging the gear. A special crankshaft gear installing tool is available under SE-1088.

Flywheel and Ring Gear Inspection

1. Clean flywheel and ring gear with a cleaning solvent, remove all traces of oil and grease.

2. Inspect the flywheel ring gear. If any teeth are damaged, or if ring gear is loose on flywheel, the ring gear must be replaced.

3. Check the flywheel dowel holes and mounting bolt holes for wear, also check for flywheel having been loose.

4. To replace flywheel ring gear, heat gear with torch, and remove from flywheel with a hammer and drift. Heat new ring gear with torch, heating evenly all the way around. While the ring gear is hot, install gear on flywheel and allow it to cool.

5. Check pilot bearing in flywheel for wear or damage and replace if needed.

6. Install flywheel on crankshaft. Install six self-locking capscrews, drive dowel pins through flywheel to crankshaft.

Camshaft Cleaning and Inspection

1. Wash camshaft in cleaning solvent, brushing to facilitate removal of all sludge or carbon deposits.

2. Inspect camshaft journals for signs of wear or out-of-round.

3. Inspect oil pump drive gear in center of shaft. If teeth are worn or damaged, the camshaft must be replaced, as the gear is integral with shaft.

4. Inspect camshaft lobes. If worn, chipped, or scored, replace the camshaft.

5. Inspect camshaft gear, and replace if wear is evident or gear teeth are nicked or otherwise damaged.

6. To reassemble, install thrust flange over end of camshaft. Install Woodruff key in slot in shaft. Place camshaft gear in boiling water or piston heater, and install over Woodruff key. Install camshaft nut and tighten to approximately 120 foot-pounds tension.

Cleaning and Inspecting Miscellaneous Parts

1. Cleaning miscellaneous engine parts. This includes brackets, oil pan, engine case cover, flywheel housing, and other parts that were removed during disassembly of engine and were not covered by procedure. Wash in cleaning solvent or steam clean preliminary to inspection.

2. Check all twelve valve lifter or push rods for straightness by rolling on flat surface. Replace any that are bent or have loose ends.

3. Inspect oil pan for cracks or deep bends, and straighten or weld.

4. Inspect oil pan drain plug and drain plug boss for fit and thread wear. If plug is loose or threads are damaged, repair threads or replace oil pan.

5. Inspect crankshaft pulley and vibration damper assembly for evidence of rubber coming loose from pulley, and inspect for wear. Replace damper assembly if either condition is encountered. Do not submerge vibration damper assembly in hot cleaning solvents. Inspect crankshaft fan drive pulley for wear in hub bore. If inner diameter of bore is worn, scored, or Woodruff key way damaged, replace pulley.

6. Inspect engine gear case cover, and replace if cracked or broken. Remove old cover seal and install new seal.

7. Check each of twelve engine valve tappets for irregular wear, chipping, cracking or scores. Replace defective tappets.

8. Inspect engine flywheel housing for cracks or breakage and replace if damaged. Inspect flywheel housing to crankcase pilot dowel holes for wear. If wear is evident, drill or ream the holes and install oversize dowels. Also inspect dowels for wear and replace if wear is evident.

9. Inspect all capscrews and nuts for thread wear or breakage, and replace as necessary. Use new lockwashers when reassembling engine.

10. All gaskets and oil sales must be replaced at each overhaul or major repair.

ASSEMBLY OF ENGINE

When all parts have been cleaned, inspected and repaired, and necessary replacement parts have been procured, install engine cylinder block in engine overhaul stand for reassembly.

Main-Bearing and Connecting-Rod Bearing Installation

It is essential that main bearings be in alignment with the crankshaft journals. The

model BD engines do not have the bearing caps piloted in the crankcase. When no means of piloting the bearing caps has been provided, misalignment is possible due to a slight shifting of the bearing caps when the bearing cap bolts are tightened. If a bearing cap bolt is not straight or if the threads are not concentric with the body of the bolt, this condition will be aggravated; therefore, all bolts should be carefully examined before installation, to avoid such a condition.

The following method has proved successful in holding the caps and bearings in alignment with the crankshaft. After bearings have been fitted to specified clearances, remove the caps and apply a coating of petrolatum or white vaseline, or heavy engine oil to the bearing surfaces, then reassemble the caps and tighten the bolts.

It will be noted that a small quantity of the petrolatum or vaseline may be squeezed out when the bearing caps are tightened; however a sufficient quantity will remain which will serve as a cushion or filler between the bearings and crankshaft journals, thereby reducing the tendency of the cap and bearing to shift.

The petrolatum or vaseline will also serve as a lubricant when the engine is first started and will dissolve and mix with the regular engine lubricating oil after a few revolutions.

Under no circumstances should anything other than petrolatum or vaseline or heavy engine oil be used due to the possibility of chemical reactions which would cause damage to the bearing material.

BEARING CRUSH. Undersize precision-type bearing shells should be installed when, because of wear, bearing-to-crankshaft running clearances are to be reduced. Bearing caps must not be filed, lapped, or in any other manner reworked.

Premature bearing failure will result from attempts to reduce journal-to-bearing running clearance by reworking of either bearing caps, bearings, or both, because such reworking will alter the engineered fit of the bearing shells in their bores and destroy the specifically desired "crush".

When installing precision type connecting rod or main bearings, it is important that the bearing shells fit tightly in the rod or case bore. To accomplish this, the bearing manufacturer makes the diameter at right angles to the parting line slightly larger than the actual diameter of the bore into which they are assembled. When the assembly is drawn up tight, the bearing is compressed, assuring a good contact between the bearing back and the bore. This increased diameter is referred to as bearing "crush" (Fig. 35).

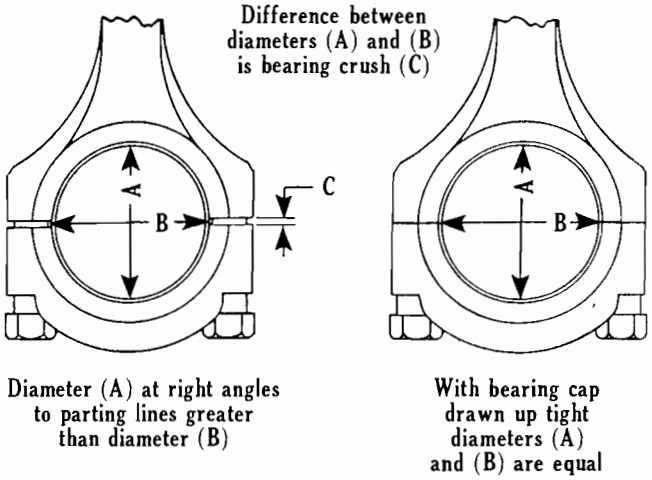


Fig. 35

To obtain proper bearing assembly with the correct "crush", care must be taken when tightening the clamping bolts to make sure they are drawn down alternately and evenly, using a tension wrench and tightening as specified.

As a result of excessive bearing crush, due to reworking the caps, the rod or main bearing bore will possible become distorted because more force is required to draw the cap and housing together.

Rods, caps, or blocks must not be filed, lapped, or in any other manner reworked in order to reduce clearance. While such practice will make a tighter fit at top and bottom, it will result in an out-of-round bore and bearing shell distortion. New bearing shells will have to be installed eventually and that is when additional trouble starts.

In general, a visual inspection of the parting faces of the rod or caps under a magnifying glass will provide sufficient proof of any attempt at reworking. Under the glass, the parting line surface of standard parts will show the manufacturing cutter tool marks and will not have a polished or extremely smooth appearance. On the other hand, reworked parts will have a polished surface and, if a file was used, will show the even pattern of the file teeth. Seriousness of this condition is in direct proportion to the amount of reworking.

BEARING SPREAD. Main and connecting-rod bearings are designed with the "spread" (width across the open ends) slightly greater than the diameter of the crankcase bore or connecting-rod bore into which they are assemblied. For example, the width across the open ends of the BD engine connecting-rod bearing not in

place is approximately .025" more than when the bearing is in position in the rod. This condition causes the bearing to fit snugly in the rod bore and the bearing must be "snapped" or lightly forced into its seat (Fig. 36).

Rough handling in shipment, storage, or normal results of use in an engine, may cause the bearing spread to be increased or decreased from the specified width. Bearing spread should, therefore, be carefully measured and corrected as necessary before installation in an engine.

Bearing spread can be safely adjusted as follows, although care and judgment should be exercised in the process:

1. Excessive spread. If measurement of spread indicates that distance "A" is excessive (see chart for specifications), place bearing on a wood block and strike the side lightly and squarely with a soft mallet (Fig. 37). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

2. Insufficient spread. If measurement of spread indicates insufficient spread, place bearing on wood block and strike the back of the bearing lightly and squarely with a soft mallet (Fig. 37). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

Chart of Bearing Spread Dimentions.
BD Engine (Minimum)

"A"	Connecting-Rod Bearing	2.237" + .025"
	Main Bearing	2.875" + .025"

1. INSTALL CRANKSHAFT AND MAIN BEARINGS. Clean all surfaces of crankshaft bearing journals and wipe clean the bearing bores in the cylinder block. Remove bearing cap self-locking capscrews and bearing cap. Wipe backs of cylinder block half of bearings, making sure that dirt and oil is removed. Place bearing shell halves in position in bore in cylinder block, making sure that bearing shells are fully seated, that oil holes in bearing shells line up with oil holes in cylinder block, and that locking tongs on bearings fit into recesses. Follow same procedure, place bearing shell cap halves in bearing caps. Place a film of engine oil on bearing shell surfaces and lift crankshaft to align itself in the bearings, and also provide lubrication. Place bearing caps and bearing lower halves over crankshaft journals. Be sure bearing caps are properly installed with numbers to camshaft.

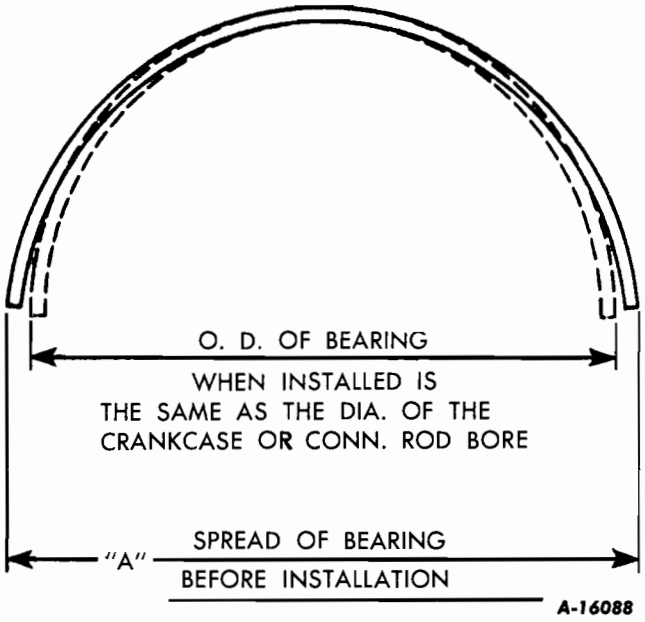
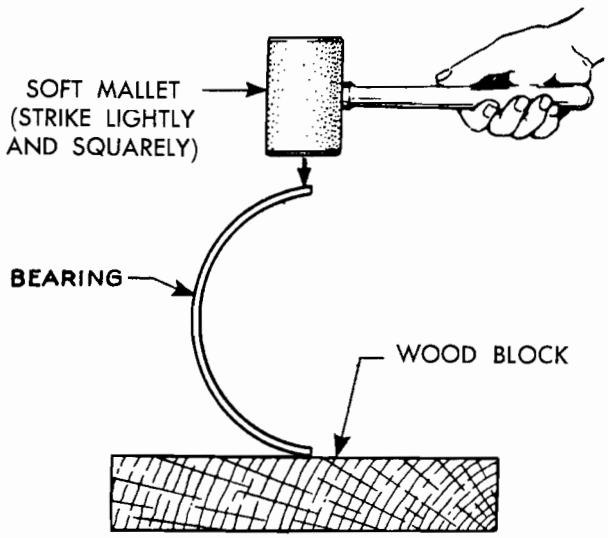
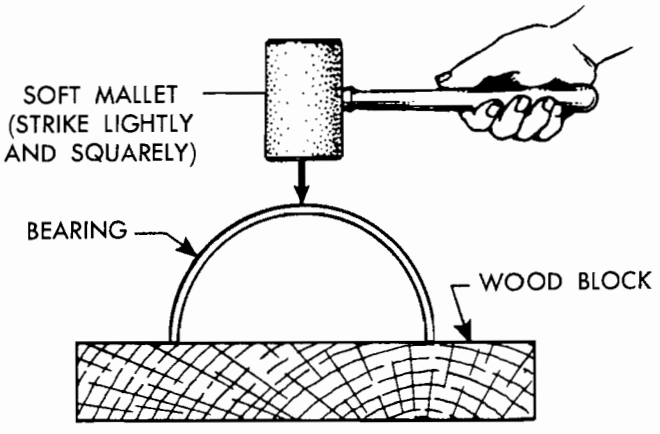


Fig. 36



DECREASING SPREAD



INCREASING SPREAD

Fig. 37

2. In order that an accurate measurement can be made to check all bearing clearances, a material similar to "plastigage" or "virgin lead" can be used.

3. Use the following instructions when using "plastigage".

   (A) Remove oil from bearing cap insert and exposed half of crankshaft journal.

   (B) Place a piece of "plastigage" the full width of the bearing insert.

   (C) Reinstall the bearing cap. Tighten the self-locking capscrews to approximately 105 foot-pounds.

   (D) Remove the bearing cap. The flattened plastic material will be found adhering to either the bearing shell of the crankshaft.

   (E) To determine the bearing clearance, compare the width of the flattened plastigage at its widest point with the graduations on the envelope (Fig. 38). The number within the graduation on the envelope indicates the clearance in thousandths of an inch. NOTE: Do not turn crankshaft during the above procedure.

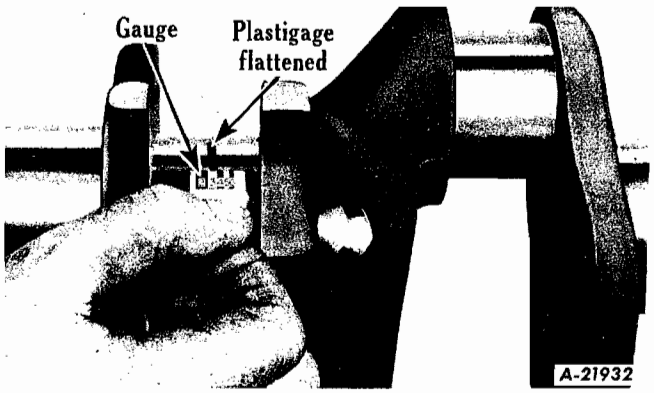


Fig. 38 - Checking bearing clearance.

4. When using the "virgin lead method" use the following procedure:

   (a) Virgin lead wire of approximately .010" thickness should be used. If wire of .010" thickness is not available and thicker wire must be used, it must be rolled to approximately .010" thickness.

   (b) Remove one bearing cap. Place 1/2" piece of virgin lead length wise on top of crankshaft bearing journal.

   (c) Install cap and bearing shell half. Install bearing cap bolts and tighten to 30 to 40 foots-pounds tension.

   (d) Rock the crankshaft back and forth two or three times. Further tighten bolts to 60 to 70 foot-pounds and again rock the crankshaft two or three times. Tighten bolts to 105 foot-pounds and remove bearing cap.

   (e) The virgin lead will now be compressed exactly in accordance with the amount of bearing to crankshaft clearance. Peel off flattened piece of virgin lead wire and measure with micrometer. Thickness of flattened piece of wire is exact amount of bearing clearance present. Repeat above operations on all bearings.

5. If clearance is not within .0013" - .0043", either use undersize bearing, regrind shaft, or replace shaft. Check crankshaft for endplay which is taken up by number four main bearing. End clearance should be from .013" to .005".

6. INSTALL FLYWHEEL HOUSING. Place flywheel housing in position over two flywheel housing to cylinder block dowels and tap into place with soft hammer. Install six capscrews and lockwashers in flywheel housing. If either block or flywheel housing is replaced, the flywheel housing will have to be aligned with a dial indicator. When correctly aligned, run-out of bore should not exceed .005" (Fig. 39). NOTE: If possible align flywheel housing while engine is in overhaul stand and with engine in vertical position (flywheel housing up).

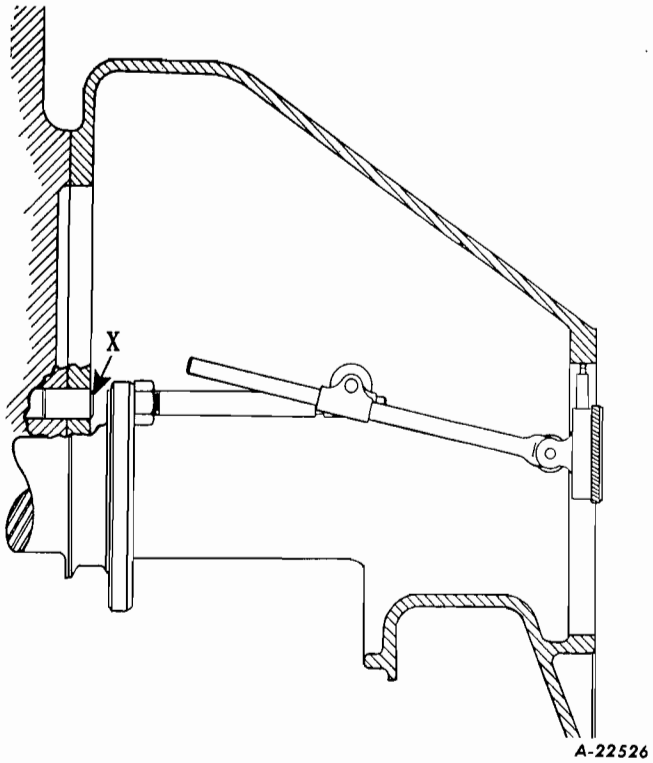


Fig. 39

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7. INSTALL ENGINE FLYWHEEL. Place engine flywheel and ring gear into position on dowels in crankshaft flange. Install six self-locking capscrews in flywheel and crankshaft flange, and tighten to a tension of approximately 100 foot-pounds, using a tension wrench.

8. INSTALL GEAR CASE COVER PLATE. Place plate and gasket at front end of engine cylinder block. Install one capscrew and lockwasher.

9. INSTALL CAMSHAFT AND GEAR. Coat camshaft with engine oil. Insert camshaft into front end of engine block, being careful not to damage camshaft bearings. Before completely entering camshaft rotate shaft until marked teeth on crankshaft gear and camshaft gear index (Fig. 14). Install two capscrews and lockwashers in camshaft thrust flange, working through large holes in camshaft gear. Rotate crankshaft and camshaft to determine that gears do not bind or interfere. Back-lash must be from .000" to .002" (.0015" preferred).

10. INSTALL GEAR COVER CASE. Place gasket in position on case cover. Place crankshaft oil slinger over end of crankshaft and install Woodruff key for fan drive pulley in crankshaft. Place gear case cover in position. Install capscrews, new lockwashers and nuts.

11. INSTALL FAN DRIVE PULLEY AND VIBRATION DAMPER. Heat crankshaft fan drive pulley and vibration damper assembly in boiling water. When heated, quickly install assembly on crankshaft and install washer and fan drive pulley nut. Tighten nut with wrench of about 36" leverage.

Installing Connecting Rods and Pistons

1. Install one connecting-rod and piston assembly down through top of cylinder block having slot in piston towards camshaft side of engine. Pistons are also marked with an arrow indicating front of engine. Use a piston ring compressor sleeve to compress piston rings and thus avoid possible ring damage.

2. Wipe bore of connecting rod free of oil and dirt. Place bearing shell upper half in connecting rod bore, being sure that oil hole aligns with oil hole in connecting rod and that locking tangs of bearing shall fit into recess. Clean connecting-rod cap bearing bore and clean back of bearing. Place bearing shell lower half in connecting rod cap, making sure that tang of bearing fits into recess in cap. (NOTE: See instructions under "Main Bearing and Connecting-Rod Bearing Installation".)

3. Coat bearing surfaces with oil. Pull connecting rod into position on crankshaft journal and install connecting-rod cap and bearing. NOTE: Bearing cap must only be installed on connecting rod one way, with both connecting rod number and bearing cap number to camshaft side. Install two self-locking capscrews and tighten to 65 foot-pounds, use tension wrench.

4. To check connecting-rod bearing to crankshaft clearance, follow procedure given for "plastigage" on "virgin lead" test. Specified connecting-rod bearing to crankshaft clearance is from .0007"-.0032". Do not attempt to file connecting rods or bearing caps.

5. Follow procedure outlined in steps above for remaining connecting rods and pistons.

6. INSTALL CLUTCH Install clutch driven disc against flywheel so that the long portion of the hub is toward the rear. Place clutch in position on flywheel over clutch driven disc. Locate clutch so that arrow or inspection mark (usually a dab of white paint) on flange of clutch backing plate or cover is as near as possible to the letter "L" on the flywheel, and install two or three mounting capscrews and lockwashers loosely. Insert a clutch aligning arbor, if available, or a transmission main drive gear shaft, through clutch driven disc hub spline and into clutch pilot bearings. Hold clutch driven disc in position while completing installation of six mounting capscrews and lockwashers in flange of clutch backing plate or cover. Tighten all six capscrews securely. Remove three retaining capscrews and flat washers which were installed to hold clutch compressed. NOTE: clutch will not operate properly unless these retaining capscrews are removed.

7. INSTALL VALVE TAPPETS. Coat each of twelve valve tappets with heavy engine oil and drop each, flat side down, through recess in side of cylinder block into sockets in block.

8. INSTALL VALVE LIFTER ROD COVER. Install new gasket over opening at left-hand side of engine block. Install valve lifter rod covers and slotted screws.

Install Cylinder Head

1. INSTALL HEAD. Place gasket on cylinder block and align bolt holes Place cylinder head on crankcase, being careful not to damage or shift gasket position. Loosely

install all cylinder-head bolts and flat washers, omitting bolts in holes for rocker arm assembly.

2. INSTALL VALVE ROCKER ARM ASSEMBLY. Insert twelve valve lifter rods in cylinder head, make sure they enter the valve tappet. Lift the valve rocker-arm assembly into position on cylinder head with the drilled oil bracket on the front end. Install the remainder of cylinder-head bolts and tighten alternately and evenly in sequence to 80 foot-pounds (Fig. 40). Be sure to place stud with oil hole in the left front cylinder-head bolt hole. Retighten cylinder head after engine has been operated for a short period.

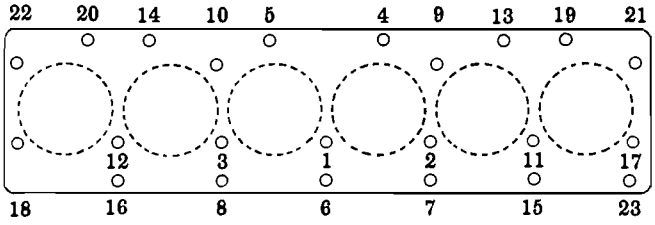

Fig. 40

3. ADJUSTING VALVES. To adjust valve stem to valve rocker arm clearance correctly, each cylinder must be on top dead center on its compression stroke at the time of adjustment of valves for that cylinder. To determine the correct position, turn the engine crankshaft until No. 1 piston is at top dead center on compression stroke and the ignition timing mark on the crankshaft pulley in line with the pointer on the timing gear case. Adjust clearance on each valve of No. 1 cylinder to .018" to .020" by using a feeler gauge between valve stem and valve rocker arm and turn rocker arm adjusting screw out of rocker arm until clearance is obtained. Tighten adjusting screw lock nut and recheck clearance. (NOTE: Valve clearance should be rechecked with engine at normal operating temperature.)

4. Turn crankshaft one-third revolution and adjust clearance on No. 5 valves. Working in firing order sequence, continue to set valves of each of the remaining cylinders, turning crankshaft one-third turn after each valve adjustment.

5. INSTALL INTAKE AND EXHAUST MANIFOLDS. To facilitate installing the manifolds. after manifold gaskets and pilot rings are installed, start capscrews at end of intake manifold. This will permit the manifold to slide straight up between the engine head and capscrews and flat washers. When manifold is lined up with pilot rings and gasket, tilt bottom of manifold toward engine block. This will force manifold out at top enough to bind against the two capscrews and hold manifold in position until the front and rear capscrews can be installed.

6. INSTALL WATER PUMP Place water pump gasket in position, at water pump opening in front of cylinder head. Install water pump and fan and install three capscrews and lockwashers in pump and cylinder block.

7. INSTALL OIL FILTER. Place oil filter and new gasket in place on cylinder block. Install four capscrews and lockwashers in oil filter base. (NOTE: Be sure filter assembly is thoroughly cleaned and a new cartridge is installed before replacement on engine.)

8. INSTALL ACCESSORIES. Install carburetor, generator, distributor and connecting wires, starter, fuel pump, ignition coil, gauge, and thermostat. Tighten fan belt sufficiently to secure 1/2" depression on belt midway between generator pulley and fan pulley.

9. FILL ENGINE WITH OIL. After making certain that oil drain plug is securely installed, fill crankcase with oil. After engine has been installed and placed in operation, again recheck oil level and add as necessary to bring oil level to full mark.

10. INSTALL CYLINDER HEAD COVER If engine is not to be installed at this time, install new cylinder-head cover gasket and install cylinder-head cover. Install three flat washers and three nuts on cover.

ENGINE MOUNTINGS

Fig. 41 and 42 illustrate engine front and rear mountings.

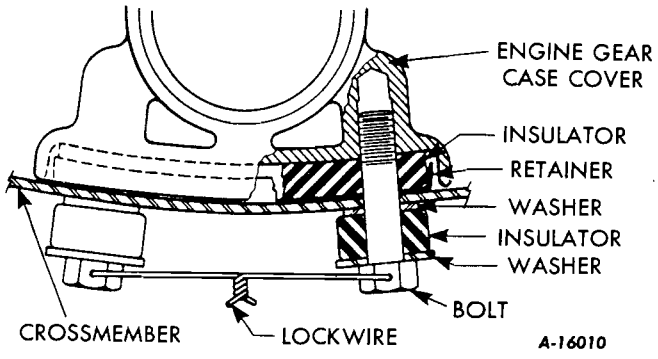

Fig. 41 - Front mounting.

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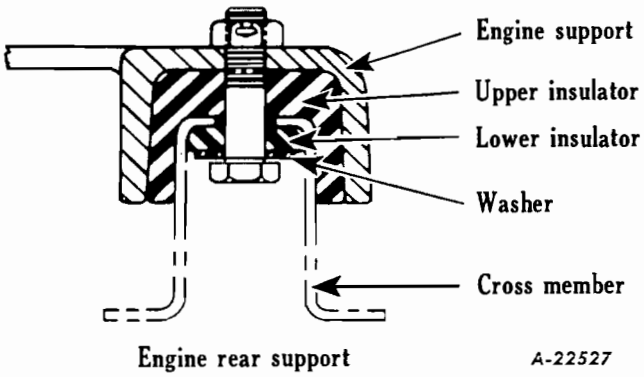

Fig. 42

OIL FILTER

1. The DeLuxe oil filter is used on the BD engines and incorporates a removable sump (Fig. 43).

2. Water, grit, metal particles, sludge and other contaminants that settle out of the oil are held in the sump away from the cartridge. When the cartridge is changed the cartridge and sump quickly and easily lift out as a single unit. Change filter cartridge and clean sump at regularly established periods; according to operating conditions.

3. When reassembling filter unit after complete disassembly: tighten center tube nut securely using wrench SE-1728.

CRANKCASE VENTILATION

The BD engine has a crankcase ventilator metering valve installed at the rear left side of engine on the tappet cover. To remove valve, disconnect the vacuum line and unscrew unit from tappet cover plate. To service, separate the two halves of the unit and remove weight. Clean all parts thoroughly. When reinstalling the valve, make sure the arrow on the housing is pointed up. (Fig. 44).

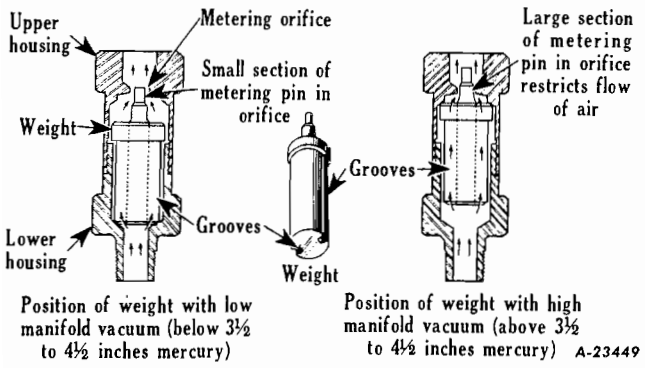

Fig. 44

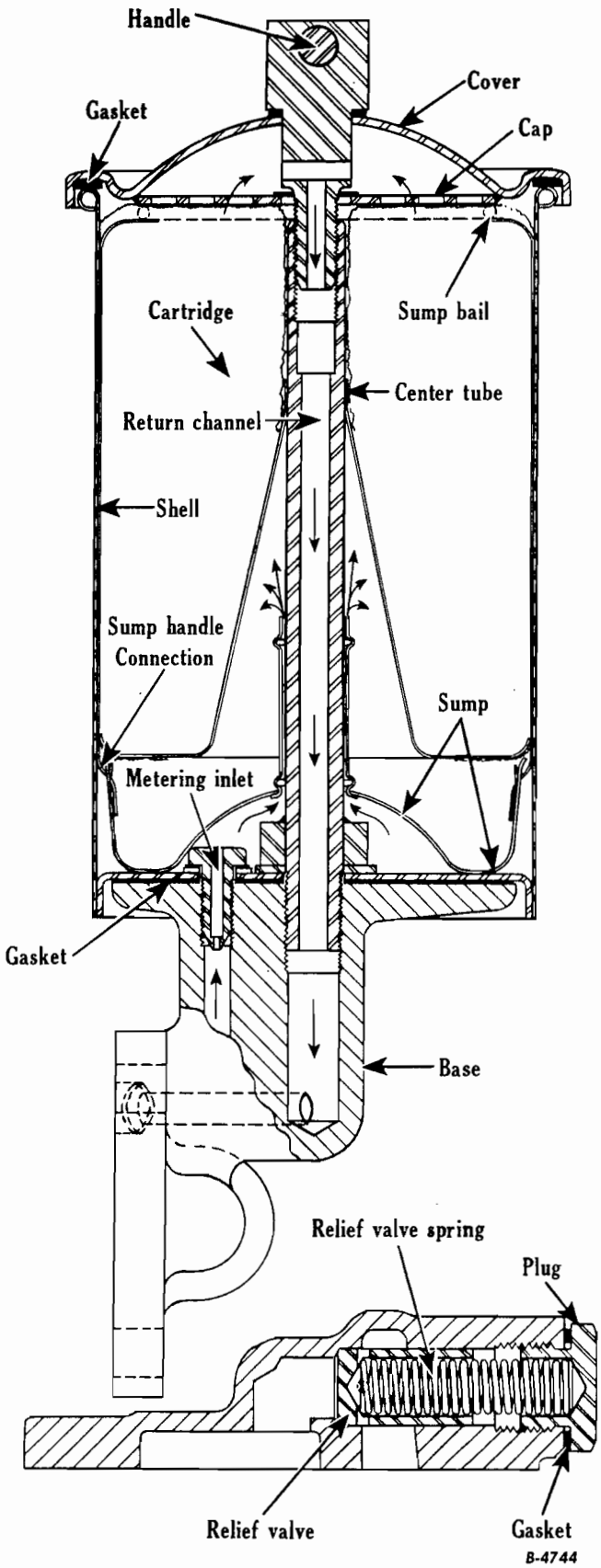

Fig. 43

SUPER RED DIAMOND ENGINE

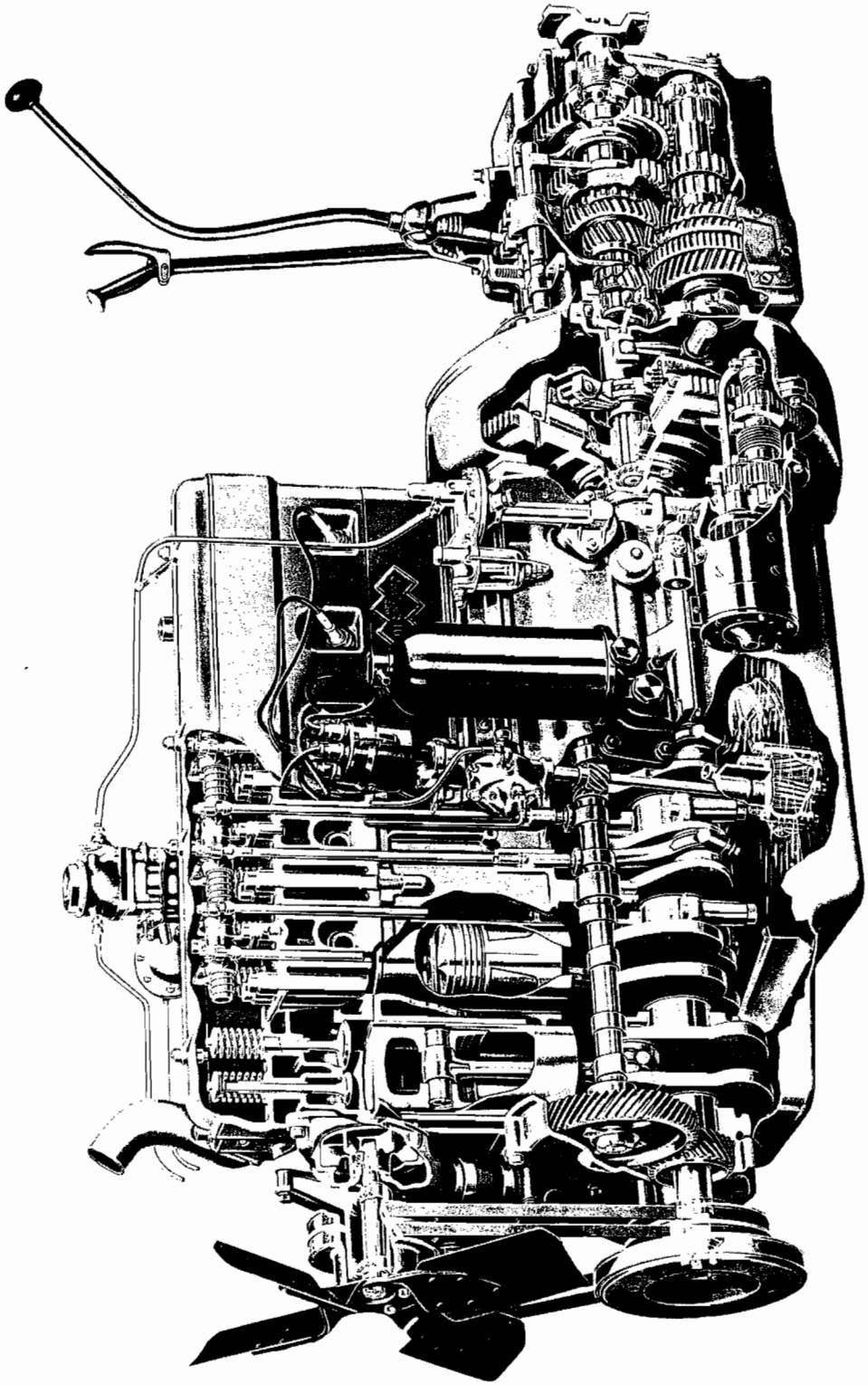

Fig. 1 - Sectional view of Super Red Diamond Engine

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DESCRIPTION

General

The Model RD, Super Red Diamond engine is a 4-cycle, 6-cylinder-in-line, overhead valve type engine (Fig. 1). The engine serial number is stamped on a pad at the front on the left side of the crankcase just below the cylinder head. The block has dry-type replaceable liners for the cylinder. The detachable cylinder head contains all valves, valve guides, and springs. The cylinders are numbered from front (fan and timing gear end) to rear. Engine crankshaft rotation is clockwise, as viewed from the front end of the vehicle. The intake and exhaust manifold, carburetor, and generator are located on the right side of the engine. The distributor, starter, fuel pump, and oil filter are located on the left side. The oil filler inlet is located on the left side of engine at the front. The bayonnet type oil level gauge is located on the left side. The water pump is located at the front of engine.

Construction

1. The generator, fan, and water pump are driven by V-type belts from a driven pulley mounted on the front end of the crankshaft. The distributor, mounted at the left side of the engine, is driven by the camshaft through the oil pump.

2. The exhaust and intake manifolds are bolted to each other and to the right side of the engine head. The intake manifold is cast in one piece. The exhaust manifold is made of three parts which are held together by expansion clamps and seal.

3. A vibration damper is provided at the front end of the crankshaft.

4. The cylinder block and crankcase are cast in one piece, and carry the crankshaft main bearings. Water circulation passages completely surround the cylinders in the crankcase and also provide coolant to the cylinder head.

5. Oil is supplied under pressure by the oil pump to the engine lubrication system. Oil spray from the revolving crankshaft is distributed to the cylinder walls, pistons, and other moving parts inside the engine.

6. Exhaust valve seats are of alloy and are pressed into place. These valve seats lengthen the period between valve reconditioning operations. Valves and valve seats are cooled by continuous circulation of water through the cylinder head.

7. The detachable cylinder head is bolted to the crankcase, and a gas-tight and water-tight seal is maintained by means of a gasket.

8. The crankshaft is a drop forging of heat-treated steel. It is counterweighted, balanced both statically and dynamically, and ground to close limits. The shaft is mounted in seven precision-type replaceable shell bearings, the number seven (rear) bearing taking up the thrust. The rear main bearing is made up of two shell halves together with four thrust flanges. The two lower thrust flanges are held in position by dowels in the main bearing cap.

9. The pistons are made of an aluminum alloy, are cam ground, and are fitted with three compression rings and one oil control ring. The full-floating type piston pins are held in place in the pistons, at the ends of the pins, by snap rings.

10. The camshaft is machined from a solid drop forging and mounted in four special replaceable bearings.

11. The flywheel is bolted and doweled to the crankshaft flange. The timing mark is located on the front crankshaft pulley.

ENGINE REMOVAL

Disconnect the following electrical circuits, hose connections, and various units as outlined:

1. Drain engine oil pan. Drain all coolant from engine cooling system by opening the drain cock on side of engine as well as the radiator drain cock. Remove radiator filler cap when draining cooling system.

2. Disconnect upper and lower radiator hose connections. Disconnect engine air cleaner and remove air cleaner. Disconnect vacuum line at manifold. (Air line at compressor when vehicle is equipped with air brakes.)

3. Disconnect engine circuit wiring. This includes coil wire, starter cable, engine ground strap and instrument sender unit wires.

4. Disconnect fuel line at fuel pump. Disconnect throttle control linkage and remove choke wire at carburetor.

5. Remove hood and floor boards. Remove fenders and radiator grille as a unit.

6. Remove radiator mounting bolts and lift out radiator support and core assembly.

7. Remove ending front mounting bolts from support bracket. These are the bolts at the front crossmember.

8. Support transmission using floor jack or suitable blocking. Remove capscrews from around bell housing.

9. Disconnect engine exhaust pipe at manifold.

10. Attach engine sling to front and rear right side cylinder head bolts and remove engine.

ENGINE DISASSEMBLY

Install the engine in a suitable rotating engine overhaul stand. NOTE: Many of the disassembly operations can be performed with the engine in the chassis. However, the following disassembly outline is performed with the engine removed from the chassis to clearly illustrate each of the units. Except where indicated, no attempt has been made to prescribe a particular sequence for removing the various units, since some can be readily removed with the engine in the chassis. The extent of the service required on a particular unit will govern the necessity for its removal.

Removing Rocker Arms

The following steps are to be followed when removing the rocker-arm cover and rocker-arm assembly. (Carburetor and air cleaner previously removed):

1. Remove four nuts from rocker-arm cover. Remove air cleaner line and remove cover.

2. Remove nuts, capscrews and oil bolts from shaft brackets. NOTE: Third bolt from the rear on the left side of the cylinder head supplies oil to rocker arms (Fig. 2).

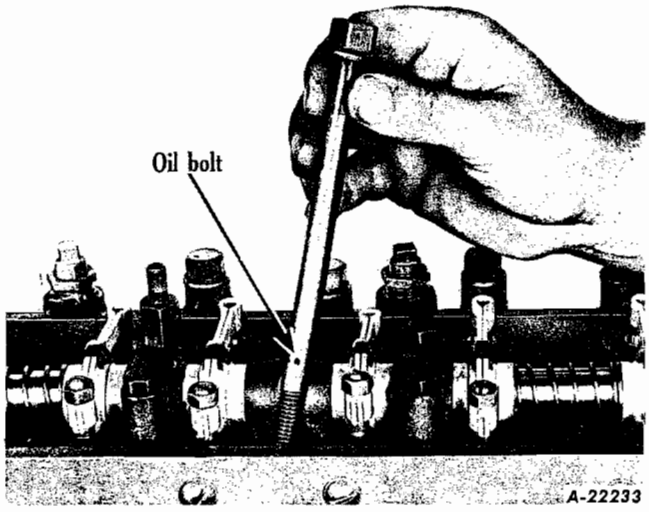

Fig. 2

3. Remove rocker-arm assembly as a unit (Fig. 3).

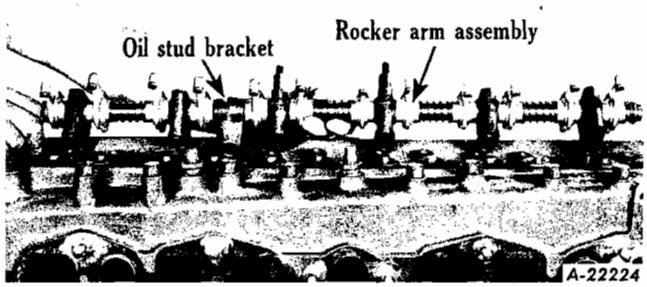

Fig. 3 - Removing Rocker Arm Assembly

Rocker-Arm and Valve Mechanism Disassembly

1. The rocker-arm assembly is composed of front and rear shafts joined at the center, on which are mounted twelve rocker arms and four tension springs. The shafts are mounted in seven brackets, and are prevented from turning at the two center brackets which contain locking washers fitting into slots in the shaft. Remove locking washers from two center brackets (Fig. 4).

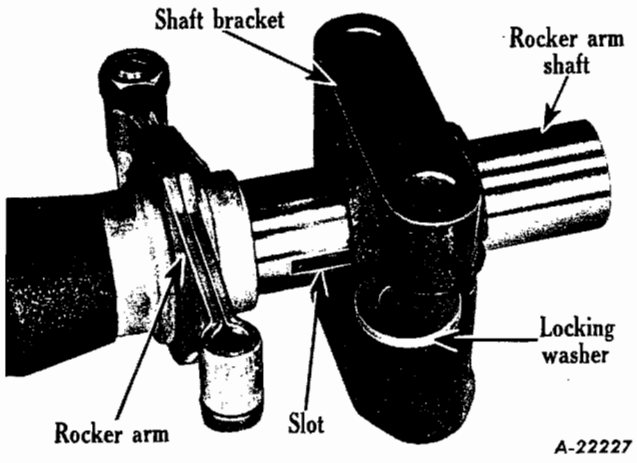

Fig. 4

2. Separate the shafts, and slide rocker arms, springs, and brackets from shafts.

3. Clean all parts in a solvent cleaning fluid, being careful to clean all accumulated sludge and carbon deposits from oil holes and slots.

Rocker Arm Inspection

Carefully inspect all parts for defects and wear.

1. Inspect rocker-arm shaft and expansion plugs. Check on a surface plate for signs of bending, check for wear from rocker arms. If a shaft is bent or shows perceptible wear, it must be replaced.

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2. Inspect rocker-arm adjusting screws for wear at contact surface and for thread wear. Replace worn screws. Check rocker-arm bushings. Inspect valve stem contact pad surface of rocker arm, and resurface if wear is perceptible. Do not remove more than .010" of material when resurfacing rocker-arm pads.

3. Inspect tension springs for breakage or loss of tension. Replace defective springs.

Re-Bushing Rocker Arms

With properly fitting adapter of special tool equipment provided (Figs. 5, 6 and 7), press old rocker-arm bushing from rocker arm. Place new rocker-arm bushing in position. Align oil hole in bushing with oil hole in rocker arm, which is located approximately 30° from top of rocker arm toward rocker-arm adjusting nut. Using installing tool, press new bushing into rocker arm. Burnish bushing into place in the rocker arm, then ream rocker-arm bushing to provide .0015" to .004" clearance. Ream dimension is .8745" - .8760".

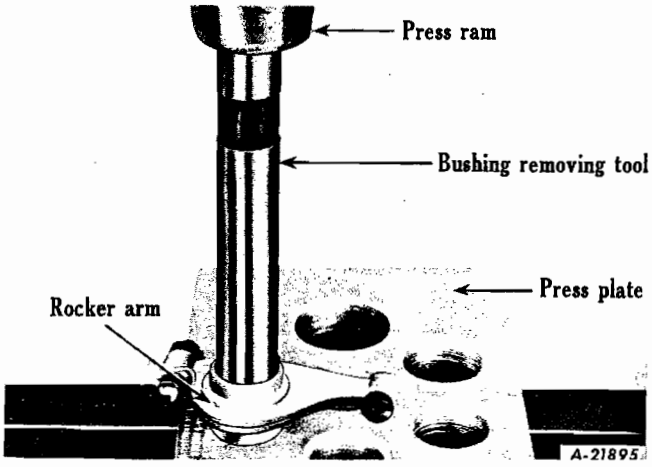

Fig. 5 - Use SE-1036-2 Bushing Removing Tool when removing the rocker arm bushing. Support the rocker arm on the SE-1033 support block. Select a hole in the support block to properly support the rocker arm at the same time permit the bushing to clear the support block when being removed. Use the support block when installing and burnishing the new bushing.

Cylinder Head and Valves

The following instructions are to be observed when reconditioning cylinder head and valves: Remove push rods (Fig. 8). Remove caps from end of exhaust valve stems, remove cylinder-head bolts and lift off cylinder head and gasket. Place cylinder head on bench.

1. Compress valve spring with a valve compressor and remove valve spring retainer locks. Remove retainer. Remove outer spring and inner spring. Remove valve spring spacer. NOTE: Valve springs are installed with close-coiled ends toward the cylinder head. Remove all valve springs as outlined.

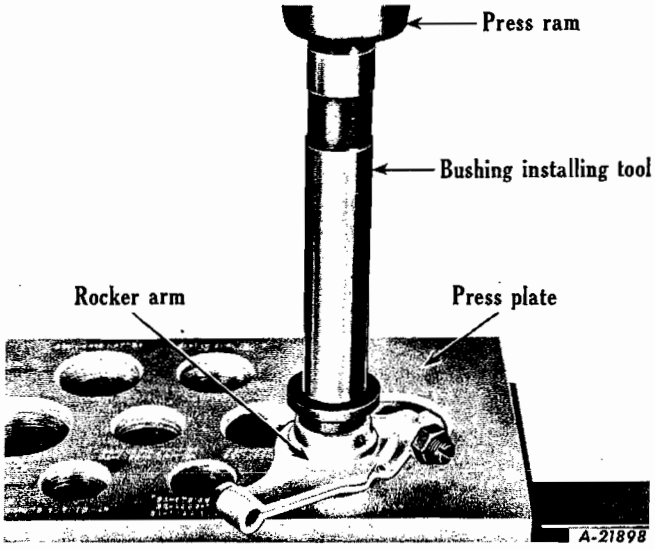

Fig. 6 - Showing method of installing new Rocker Arm Bushing.

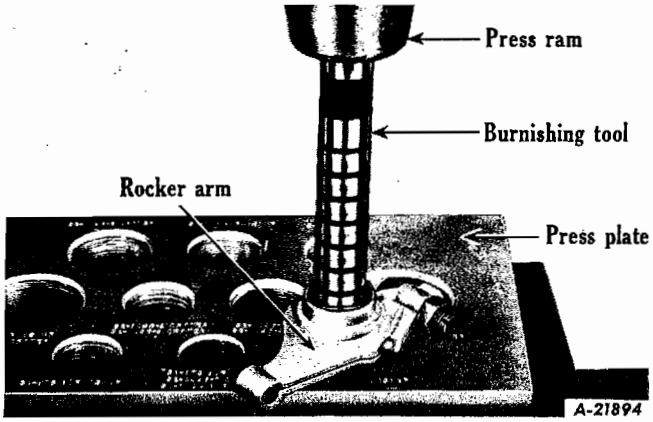

Fig. 7 - Burnishing Rocker Arm Bushing. Use SE-879 Burnishing Tool.

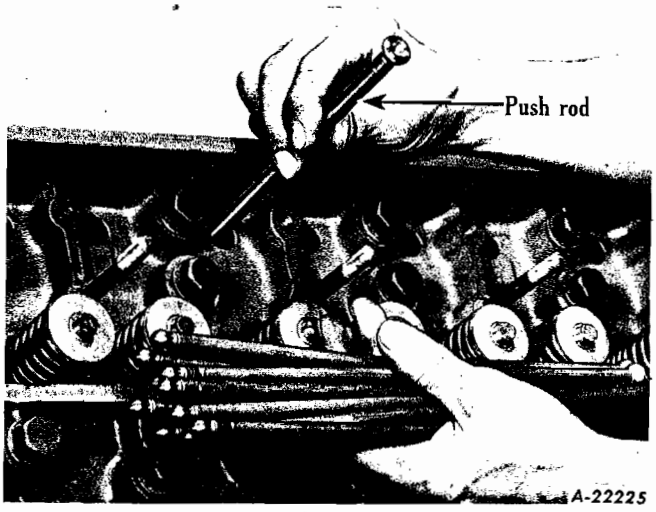

Fig. 8

2. Invert cylinder head. Remove all valves from their valve guides and from the head, keeping each valve in a suitable rack which will assure replacement of the valves in their original location.

3. Scrape all carbon from cylinder head combustion chamber, and clean any gasket material from surface of head. Clean the head using steam cleaning or other suitable cleaning equipment.

4. Clean all carbon deposits from valve heads and valve stems with wire brush. Wash all valve springs and retainers in cleaning solvent.

Inspection of Cylinder Head

1. Inspect cylinder head visually for signs of cracks or sand holes and if found defective, weld or replace head.

2. Inspect exhaust valve seat rings for looseness and inspect for excessive width of valve seat surface (Fig. 9). If insert rings are loose, replace. If a seat has been previously ground to such extent that it cannot be narrowed from top to bring to proper position near center of valve face, the ring must be replaced.

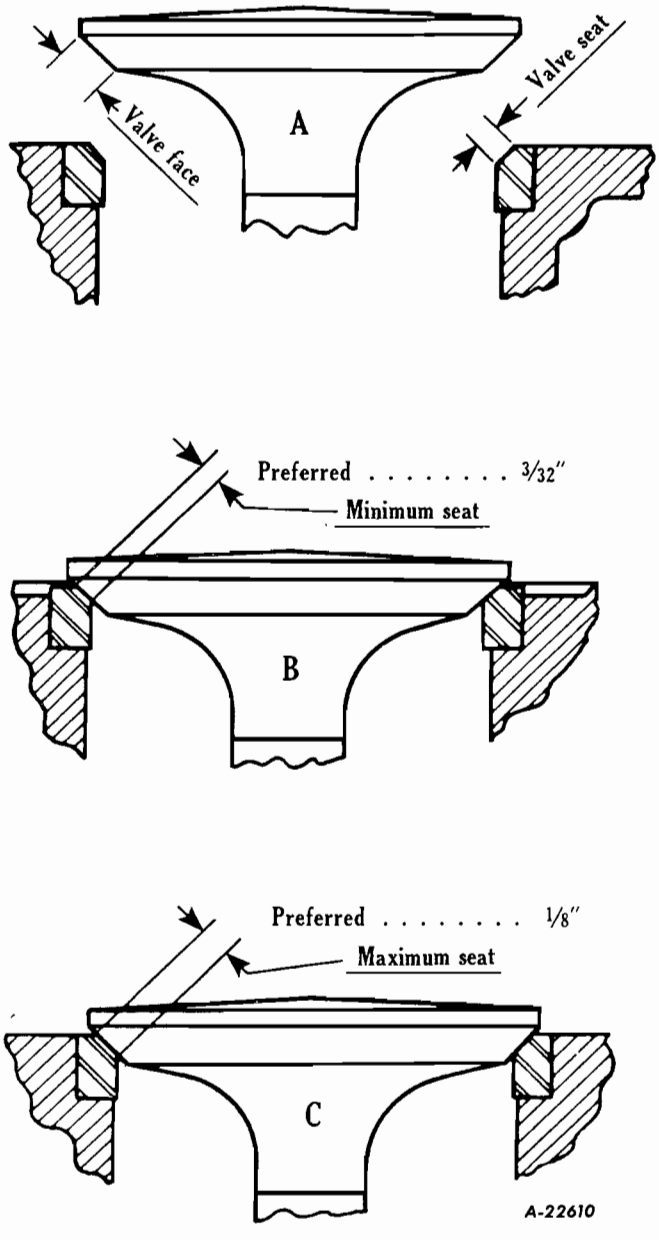

Fig. 9 - Valve Seat Widths, Exhaust.

Inspection of Valve Guides, Valve Springs, and Valves

1. Clean valve guides with a suitable cleaning tool (Fig. 10). Check each valve guide with a "Go and No Go" gauge (Fig. 11), if available; otherwise, use a new valve to check fit. If "No-Go" portion of gauge enters, the guide must be replaced. Recommended valve stem to valve guide clearance is

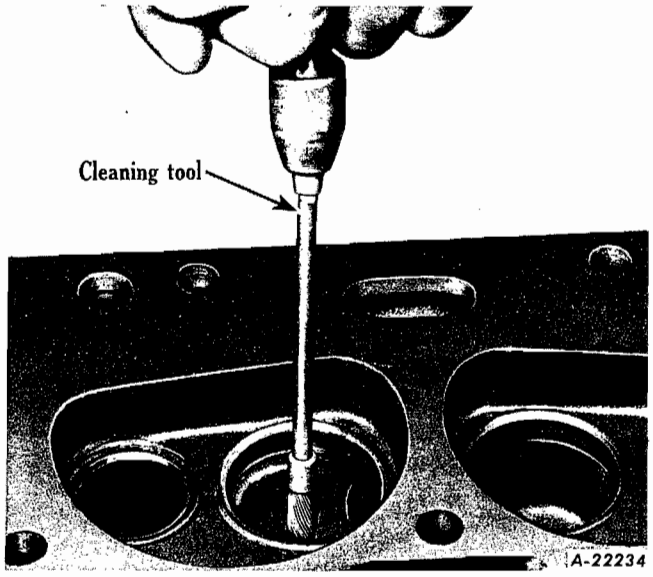

Fig. 10

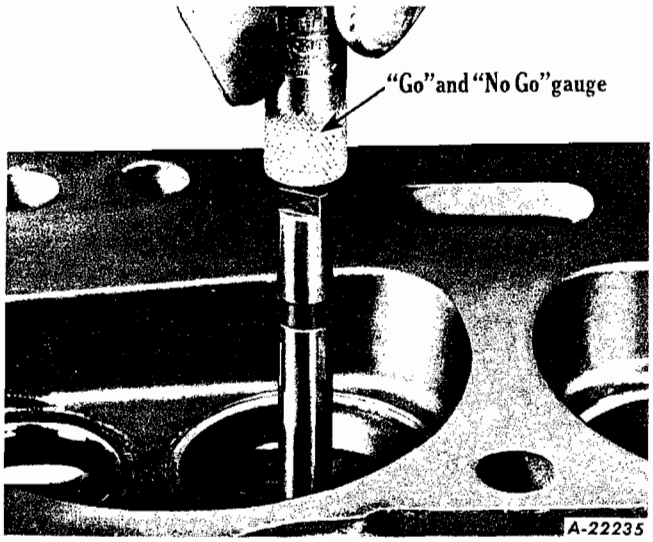

Fig. 11 - Use SE-1145 "Go and No-Go" set.

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from .002" to .004" for exhaust valves, and from .0015" to .0035" for intake valves. Clearance in excess of .006" for intake valves or .008" for exhaust valves, requires guide replacement. Valve guides are reamed to .437" after assembly (Fig. 12).

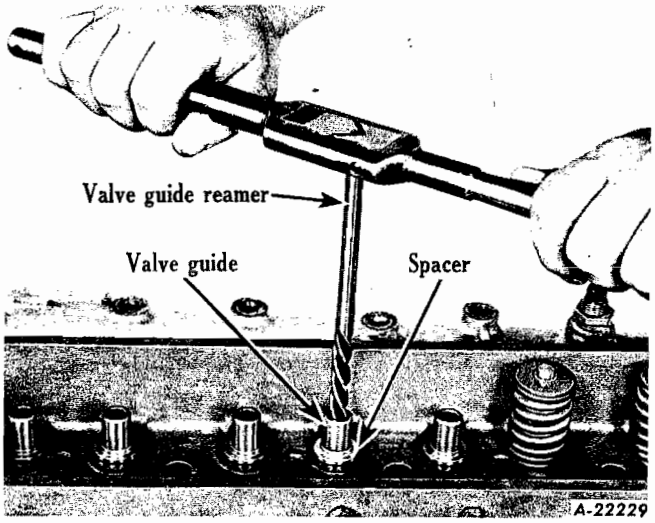

Fig. 12

2. Test valve springs (Fig. 13). Test tension of each valve spring at valve open length with a valve spring tester. Check inner valve springs at 1-1/2" length, replace if pressure is less than 86 pounds. Test outer spring at 1-45/64" length, and replace if pressure is less than 136 pounds.

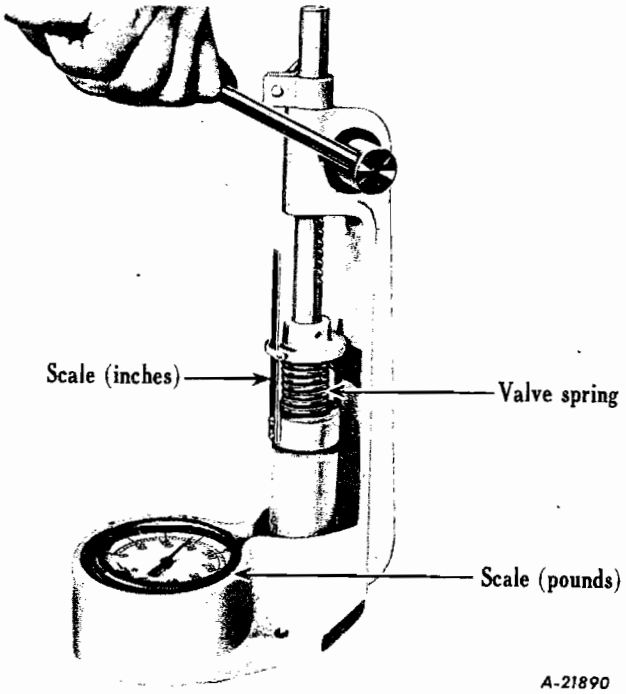

Fig. 13 - Testing valve springs in SE-1565 Valve Spring Testing Tool.

3. Inspect each valve for warpage, for severely burned condition, and for excessive grinding on the valve head. Inspect valve stem for scuff marks or perceptible wear. Inspect valve stem end for wear at contact surface with valve rocker arm. If valve is warped, excessively burned, or has been previously ground to extent that valve head is thin at edge, replace valve; otherwise, valve can be reconditioned and reinstalled.

Rotating Exhaust Valve Mechanism ("Slo-Roto Valves")

Valve burning is commonly caused by deposits accumulating on valve seat, thus holding valves open to be burned to escaping exhaust gases. Carbon deposits collecting under valve head hold valves open, further causing blow-by. With the valve slowly rotating, these accumulations are kept from forming to a great degree, thus improving valve life. All rotator parts are interchangeable, but should be checked after assembly to insure proper clearance required for rotation. Care should be taken not to damage or nick valve stem ends or tips as this will alter the clearance.

The parts involved in the rotating valve mechanism are: special spring seat retainer, a pair of flat half-moon keys, a close fitting cap located on the valve stem, and a specially constructed valve stem.

In order to accommodate valve expansion, the tappet lash (valve tappet clearance) must be maintained. When camshaft rotation causes this lash or tappet clearance to be taken up, the cap on the valve stem causes the valve keys to lower the spring retainer, removing the load of the valve springs from the valve before the valve is raised from its seat. A clearance of .002" to .006" should be maintained between the end face of the valve stem and cap (Fig. 14).

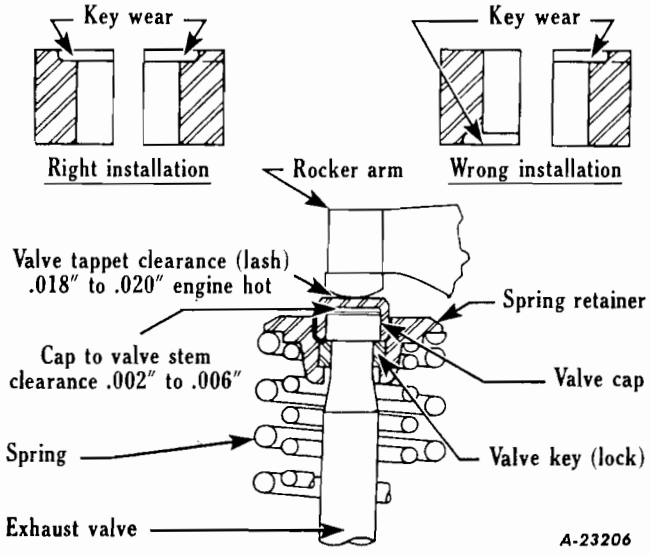

Fig. 14

This is the distance the spring retainer is lowered before the valve is moved. The slow valve rotating motion is caused by vibration of the valve, the flowing of exhaust gases around the valve head, and a slight rotating motion imparted to the valve by the valve spring.

Checking Clearance Between Valve Stem and Cap

Operation of the rotating valve feature required that clearance between the valve stem face and valve cap be maintained at all times.

If no clearance exists after assembly, remove cap, wash and wipe clean, then recheck clearance. Examine the keys to see if they are resting against the shoulder of the valve stem properly. If they are in proper position, replace the cap and check again. If clearance still does not exist, remove all parts and adjust clearance by grinding valve stem tip. If clearance is too great, remove enough stock from lower face or skirt of the cap to reduce clearance to the proper limits. NOTE: Because of manufacturing tolerances, in both valve stem ends and the valve cap, it is possible to select a new cap and valve combination with the required clearance.

Maximum service lift and efficiency is largely dependent upon cap-clearance which should be set at the time of installation at, or very near, the low limit of .002" to provide for the wear factor. Cap-clearance normally increases in service due to wear caused by impact of the half-moon keys against the shoulder on the valve stem. As the cap-clearance increases, the rate of wear increases due to longer key travel, which increases the impact.

When rotating mechanism parts have been fitted, the same combination or group of parts should be maintained once the engine is placed in service. After the valves have been in operation over an extended period, the keys may show signs of wear at the point of contact with the valve stem. As long as the .002" to .006" clearance is maintained, this wear is not harmful; however, when reinstalling keys make sure that both parts of the key set are in the same position, with the wear facing in the same direction (Fig. 14). This will eliminate cocking of the spring retainer. The valve keys can be reversed (turned worn side down) to utilize the unworn face of the keys, thus reestablishing the specified cap-clearance. However, when this practice is resorted to, it is important that an accurate check be made to assure that desired cap-clearance is present.

Check the rotating valve cap-clearance using the special clearance gauge as follows:

Remove cap from exhaust valve. (The rotating feature is used on the exhaust valves only) (Fig. 15). Make sure end of valve stem

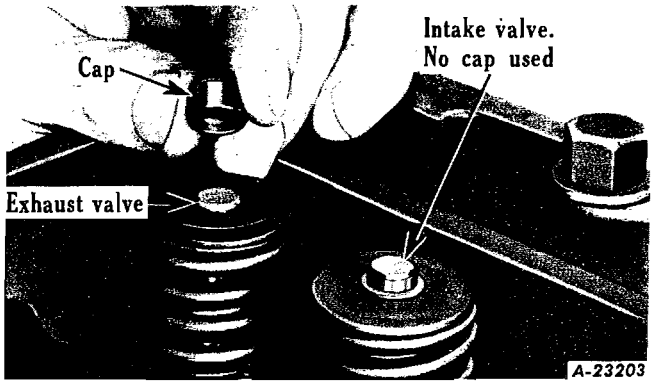

Fig. 15

and gauge plunger pin are clean. Place Clearance Gauge on end of exhaust valve with gauge set at "0" marking. Press the plunger pin of the gauge firmly against the valve stem and tighten clamp screw (Fig. 16). Remove gauge

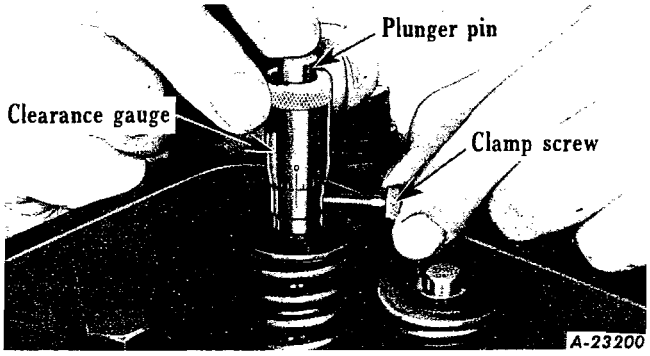

Fig. 16 - Showing use of SE-1726 Gauge.

from stem and place valve cap on plunger pin of gauge. The clearance (or lack of clearance) that existed between the valve stem and cap are now transfered to the end of the gauge plunger pin and valve cap and shows in thousandths of an inch on the spindle barrel (Fig. 17). Press

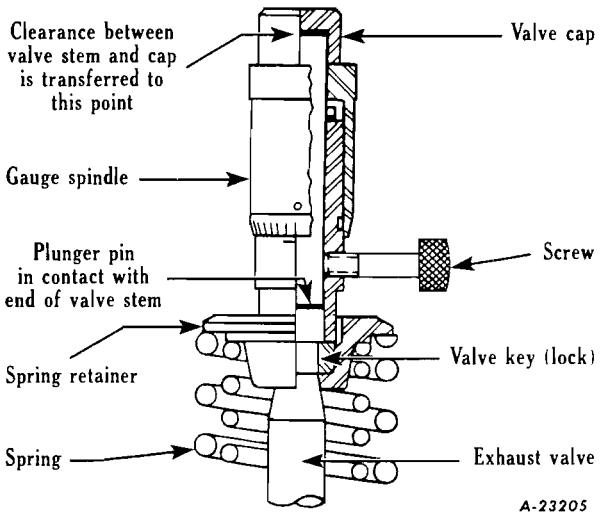

Fig. 17

the cap firmly against the gauge. Turn spindle of gauge to right or left until cap bottoms on gauge pin, and rim of cap just contacts top of gauge. Read gauge. Readings to right of Zero indicate positive clearance (see "B" in Fig. 18) and readings to left indicate negative clearance

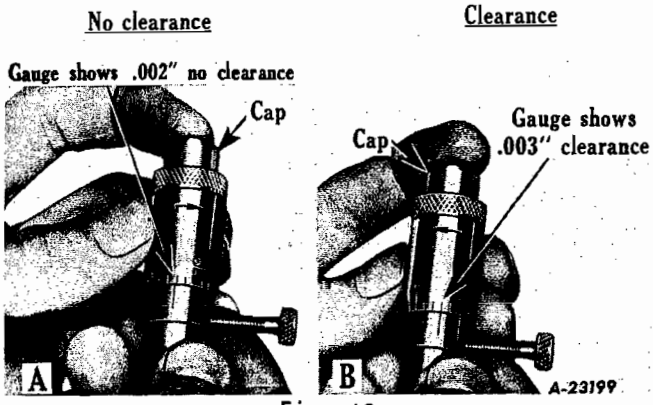

Fig. 18

(see "A" in Fig. 18). To check cap clearance with valve removed from engine, install keys and valve spring retainer under shoulder of valve stem. Position clearance gauge on valve stem. Place cap on plunger pin pressing down firmly. Turn spindle of gauge and check reading as outlined in foregoing (Fig. 19).

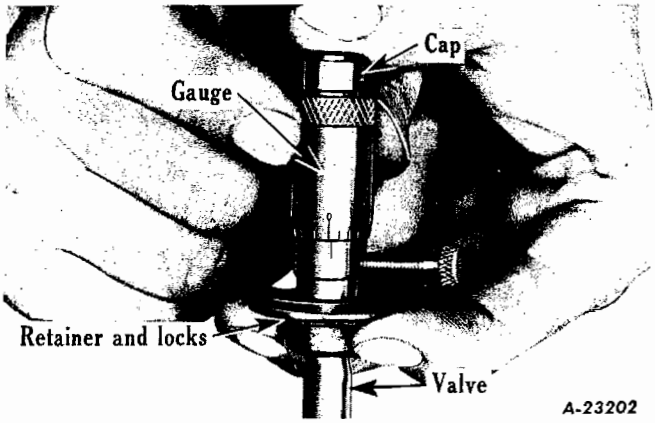

Fig. 19 - Checking cap clearance with valve removed.

Repair of Cylinder Head

1. If cylinder head has to be resurfaced, remove only enough material to true-up surface.
2. If any valve guide shows excessive clearance or out-of-round-condition, press guide from head. Install new guide, and press into head until approximately 1-1/16" remains above the top surface of the head. Check valve guides after installation to .002" to .004" for exhaust and .0015" to .0035" on intake with "Go and No-Go" gauge. Ream valve guides to .437" after assembly in cylinder head (Fig. 12).
3. If inspection indicates necessity, replace valve seat.
4. Grind valve seats in cylinder head to 45° for exhaust and 15° for intakes.

Reconditioning Valves and Seats

One of the principal difficulties experienced in reconditioning valves is obtaining nearly identical angles on the valve seat and valve face. The importance of these angles in the grinding operation cannot be overemphasized, because it is impossible to produce a flat or square seat by lapping.

The grinding stones on both the valve refacing machine and valve seat grinder should be dressed before starting a reconditioning job. You will be unable to determine how closely the angle of the seat will match the valve face until the valve and seat have been ground and a check made with a very light tint of Prussian blue. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to redress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve. No more material should be removed from the valve face than is necessary to true it up and remove the burned or pitted portion. New valves should not be refaced, but should be checked for trueness. When a satisfactory match of valve seat and valve face angles has been obtained, the adjustment of both the valve refacer and the seat grinder should be locked in position, in order to eliminate this trial-by-error method on additional valves having the same angle.

Valve Seats

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to prevent burning of the seat and warping of the head.

The location of the valve seat on the valve face and its width controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperatures and poor heat dissipation also produce excessive valve stem temperatures and hasten the accumulation of carbon on the stem, causing them to stick in the guides.

Valve Seat Widths

In general, the width of exhaust seat should range between the average and maximum specifications and the intake seats between the minimum and average specifications. The intake seats may be narrower than the exhaust

because they are usually larger in diameter, thus providing a total seat area approximately equal to smaller exhaust valve with the wider seat. Also the less severe heat conditions do not require as large a seat area for heat dissipation purposes. Figure 9 illustrates recommended valve seats to be obtained.

There are also objections to an excessively wide seat, a few of which are as follows:

1. In city or light delivery service, a wide seat collects carbon and particles of dirt that will produce variations or loss of compression, resulting in poor idle and possible loss of general performance and economy.

2. A wide seat in severe service operating in the presence of dirt or an excess of carbon will produce a badly pitted seat which may be just as detrimental to valve life as a too narrow seat Under these conditions, a seat width to the minimum limit would possibly be better; however, the source of trouble which is the dirt and excessive carbon should be eliminated, making it possible to retain the wider seat.

Valve Seat Inserts

Necessity for replacing valve seat inserts should be very rare; however, if a replacement is made it is important that new inserts be peened securely in place, using either insert peening tool or a dull-pointed chisel, 1/4" wide, to peen cylinder head metal over outer edge of valve seat insert.

Valve seat insert installing tools are available.

Valve seat inserts supplied for service are standard size and .030" oversize which permits a tight fit in cylinder head.

Repair of Valves

1. True-up the ends of valve stem against face of grinder. NOTE: This refacing operation applies to the intake valves, however, in the case of the exhaust valves, where slow rotating valve mechanism is used, refacing of valve stems is not necessary except when clearance adjustment is made. See under "ROTATING EXHAUST VALVE MECHANISM". Remove only enough material to true the surface.

2. Reface exhaust valves to 45°. The valve face and valve seat angle must be identical.

3. Reface intake valves to 15° with valve seat being the same.

4. Place valves in cylinder head. Place a thin coat of Prussian blue on each valve face, and tap valve lightly to its seat.

   NOTE: This is merely for test and proof of results of refacing and reseating operations. A poor grinding job cannot be corrected by valve lapping.

5. Inspect each valve coated with blue for seat position. The seat should be at the approximate center of the valve face. 3/32"-1/8" (exhaust) with the widest seat preferable. Intake seat should be 5/64"-7/64".

Valve Assembly

1. Wipe valve faces and valve seats with a cleaning solvent to remove all dirt or foreign material. Coat valve stems and valve faces with oil, and install valves in same seats to which they were checked. NOTE: Check exhaust valve rotating mechanism to assure proper clearance between valve stem and cap before installing valves.

2. Install inner and outer valve springs. Install retainers. Compress valve springs with a valve spring compressor, and install valve spring retainer locks. Be sure that retainers and locks are correctly seated. Recheck exhaust valve cap clearance.

Engine Disassembly - Continued

When overhauling engine with head and pan removed, the following procedures are recommended:

1. Remove fan drive pulley nut and washer from end of crankshaft. Install puller and remove crankshaft fan drive pulley and damper assembly from crankshaft.

2. Remove nuts and capscrews from engine gear case cover, remove gear case cover. Remove crankshaft oil slinger from end of shaft. Push twelve tappets up into retaining clips to permit camshaft removal. Remove nut from end of camshaft and remove camshaft gear with puller. NOTE: Camshaft may be removed without removing timing gear, by removing thrust plate retainer screws.

3. Remove capscrews from camshaft retainer thrust flange plate. Remove camshaft. Remove two capscrews holding the gear case cover plate to block; remove plate and gasket. Remove crankshaft timing gear, using a gear puller. (NOTE: Lubricate puller screw to prevent damage to screw threads.)

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Turn engine in the overhaul stand and proceed with disassembly as follows: (Fig. 20).

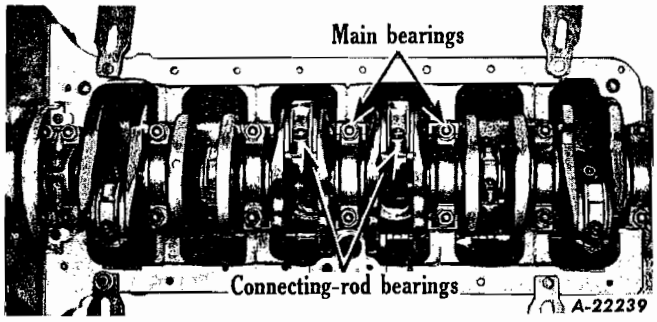

Fig. 20

4. Each connecting rod is numbered as to its position in the engine and these numbers are located on the camshaft side of the engine. Remove self-locking capscrews from connecting-rod cap and remove cap (Fig. 21). Push connecting-rod and piston assembly toward top of block. Lift piston and connecting-rod assembly from top of cylinder block. Replace cap on connecting rod. Remove the remaining pistons, following the same procedure.

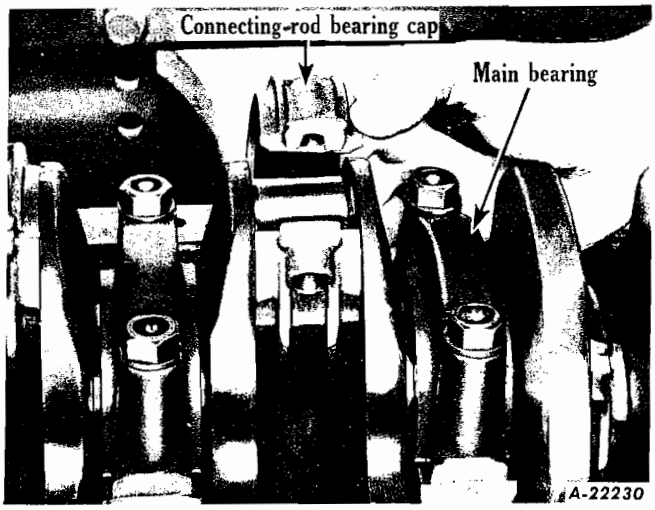

Fig. 21

5. The crankshaft bearing caps are numbered to identify their position and they must be reinstalled in their respective positions. Remove rear oil seal retainer (Fig. 22). Remove all crankshaft main bearing caps (Fig. 23). Remove twelve capscrews from clutch and remove clutch. Remove six self-locking bolts from flywheel. Install two 1/2" N.C. bolts, 2" long, in threaded holes in flywheel and force flywheel from crankshaft flange dowels (Fig 24). Remove flywheel from housing. Remove six bolts from engine flywheel housing (Fig. 25). Tap housing with a soft hammer to knock it from dowels. Remove housing from crankcase. Lift crankshaft straight up and out of cylinder block and place in vise with

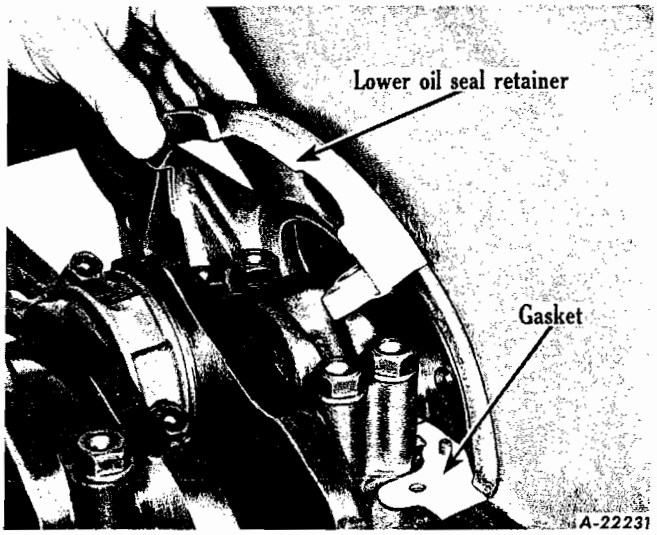

Fig. 22

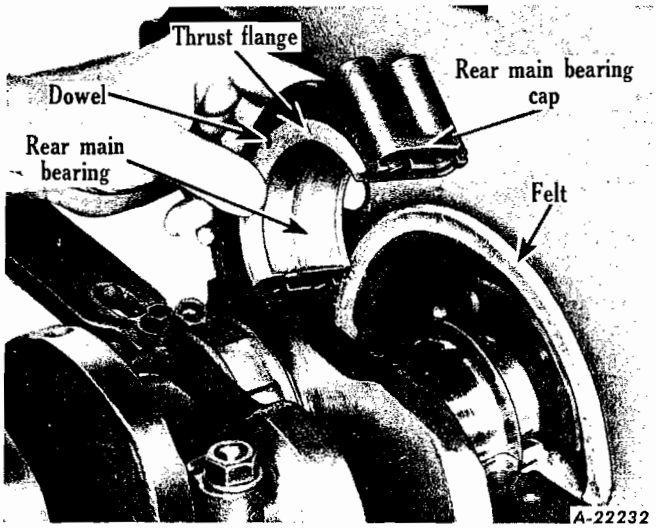

Fig. 23

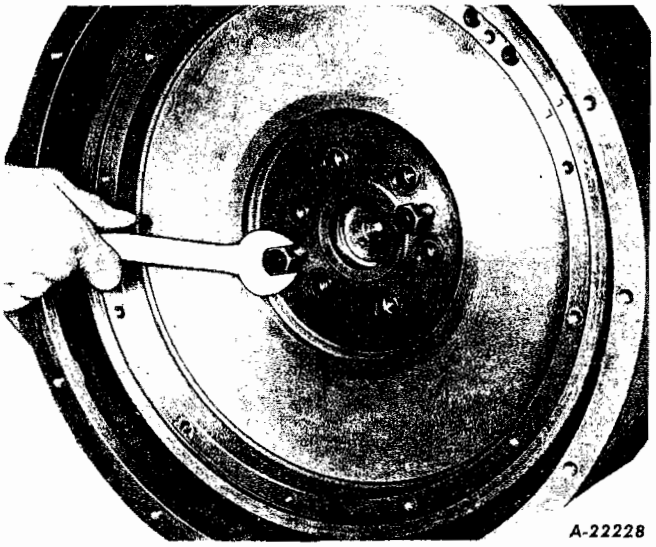

Fig. 24

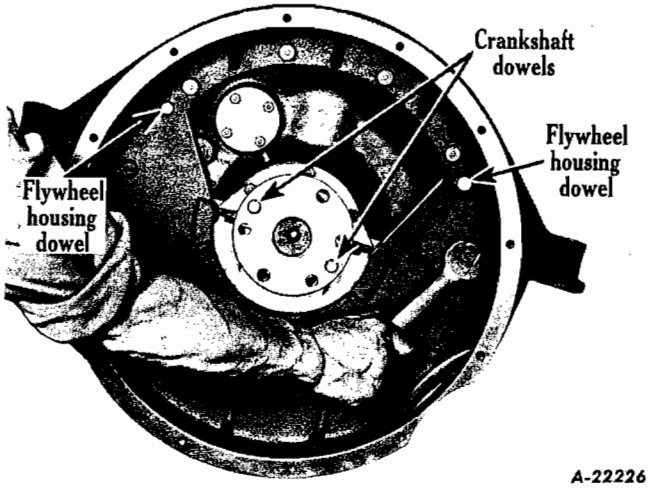

Fig. 25

soft jaws. NOTE: Self-locking bolts may be used instead of bolts requiring locking wires. The self-locking bolts, identifiable by the depression in their heads, require no locking wires.

6. Remove fuel pump, starter, oil pressure regulator valve assembly, distributor, generator, oil gauge, and ignition coil.

Water Pump Removal and Overhaul

See sectional view of RD Engine water pump (Fig. 26). The water pump assembly is composed of a body and cover plate which house a ball-bearing mounted pump shaft and impeller. The rear and front bearings are pressed onto the shaft and are separated by a spacer. A slinger is held in place by two half lock rings. The shaft assembly with its two bearings is held in place in the housing by a retaining snap ring. The fan pulley is pressed onto the shaft (press fit .0007" to .0018") and held in place by a nut and plain washer.

The impeller seal assembly consists of a seal spring, seal clamp ring, flexible seal, seal spring guide, and a seal carbon washer. The parts are held in place in the impeller by a snap ring. The impeller and seal assembly is pressed onto the pump shaft (press fit of .002" to .0035").

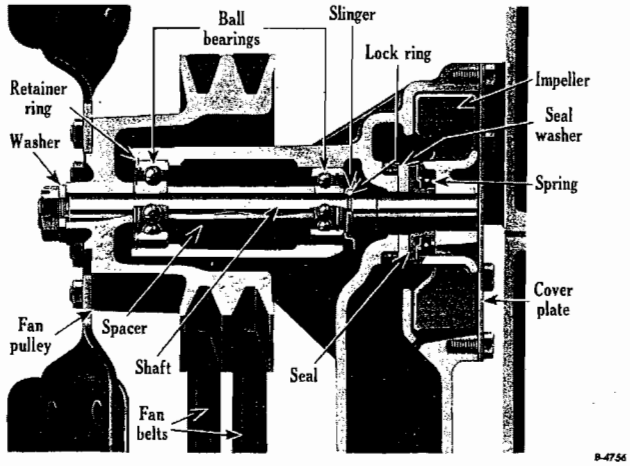

Fig. 26.

Water Pump Disassembly

(Complete illustrated procedure for Water Pump Servicing is given in Shop Talk No. 14)

1. Remove four capscrews and lockwashers holding fan to pulley. Remove fan blade assembly from pulley. Remove water pump from front end of cylinder head.

2. Remove nut and flat washer holding pulley to water pump shaft. Remove pulley from water pump shaft with puller.

3. Remove five capscrews from cover plate. Remove plate and gasket from pump body.

4. Remove snap ring from in front of the water pump shaft front bearing. Supporting water pump on arbor press, push shaft and bearing as an assembly out of impeller from the rear.

5. Support the shaft and bearing, assembly on an arbor press, force shaft out of bearing, spacer, and slinger, pressing shaft toward rear bearing. Be careful not to lose the two half-moon lock rings from under the slinger.

6. Remove snap ring from groove in the front of impeller, and lift out the seal parts from the impeller.

Water Pump Cleaning and Inspection

1. Following disassembly, wash all except rubber parts in cleaning solvent.

2. Examine seal parts for wear, corrosion, or damage, and replace with new parts as necessary. Examine the pump body seal seat surface. If face of surface is scored, it must be resurfaced to prevent leakage. Inspect pump shaft bearing for wear or corrosion. If worn or corroded, replace bearings. Examine shaft for wear at ends, or for damaged threads at front end.

Water Pump Repair

If water pump body seal seat is scored, pitted, or rough, it must be resurfaced. Use special water pump housing seat finishing tool and adapter.

Water Pump Assembly

1. Install rear bearing, spacer, and front bearing onto water pump shaft. Place

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slinger in position behind rear bearing. Place two half-moon lock rings in groove in shaft, and press shaft into bearing and spacer from rear until rear bearing rests firmly against slinger and ring locks.

2. Place seal clamp ring, seal spring, seal spring guide, flexible seal and retainer, and carbon seal thrust washer into position in impeller. Hold them in position while installing snap ring in impeller groove.

3. Install water pump shaft and bearing assembly into body and hold in place by inserting snap ring in groove in front of front bearing.

4. Support water pump shaft at front end, press impeller and seal assembly onto rear end of water pump shaft. Press impeller only flush with end of shaft.

5. Place new gasket in position on water pump body and install cover plate and four capscrews.

6. Place fan assembly in position on front of pulley, and install six capscrews and lockwashers.

Intake and Exhaust Manifolds

When disassembling and assembling the manifolds the following procedures are used:

1. After removing eight nuts, eight flat washers, four capscrews and three bolts from exhaust flange, remove both intake and exhaust manifolds as a unit (Fig. 27). Remove two manifold pilot rings (Fig. 28). NOTE: Let manifolds cool before starting above operations; this will help to prevent manifold warpage.

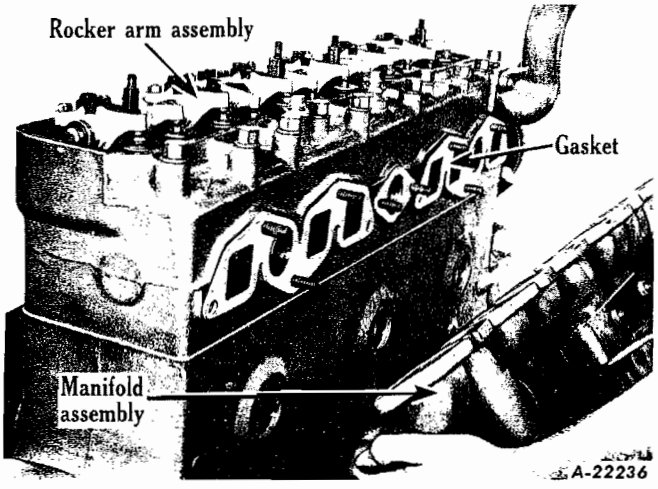

Fig. 27

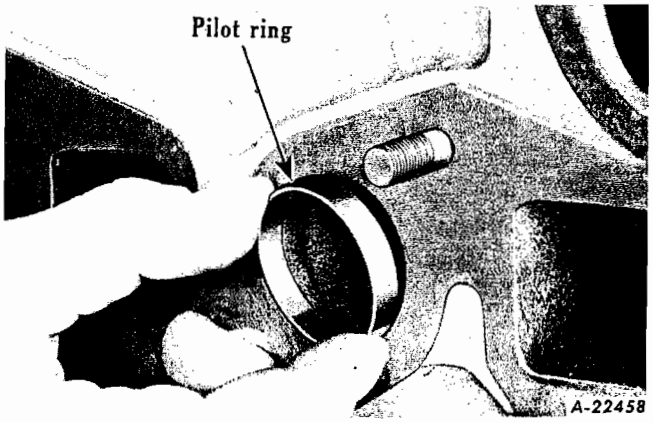

Fig. 28

2. To separate the two manifolds, remove the two outside bolts and nuts and two inside bolts and nuts from the center of manifolds.

3. The intake manifold is of one piece construction. The exhaust manifold is of three piece construction (Fig 29).

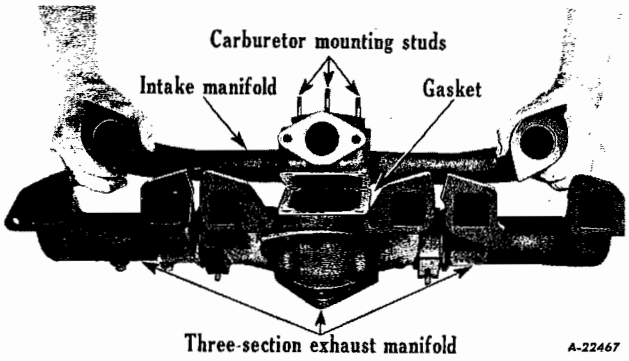

Fig. 29

Intake Manifold

1. The intake manifold consists of three outlets, each supplying fuel to two cylinders. Two studs are located on the top for carburetor mounting.

2. If vacuum is needed to operate any unit within the truck, a threaded inlet is provided in the manifold for such purposes.

Exhaust Manifold

The exhaust manifold consists of three parts and four outlets. The two end outlets remove burned gases from the No. 1 and No. 6 cylinders, while the two center outlets remove burned gases from Nos. 2, 3, 4, and 5 cylinders.

Manifold Inspection

Inspect intake and exhaust manifolds visually for cracks or breakage. Place manifolds

on surface plate and check for warpage. If cracked or broken, replace or weld. If slightly warped, true-up on surface grinder but replace if warpage is extreme.

Manifold Assembly

Place new gasket between the intake and exhaust manifolds and install four bolts and four nuts. Mount manifolds together loosely before installing on engine. This will assure proper alignment of the units with each other and with the engine cylinder head. NOTE: Do not eliminate the intake manifold aligning pilot rings. Tighten both manifolds to head. Tighten exhaust manifold expansion clamp bolts (Fig. 30), and replace with new seals if needed, and tighten intake to exhaust manifold bolts.

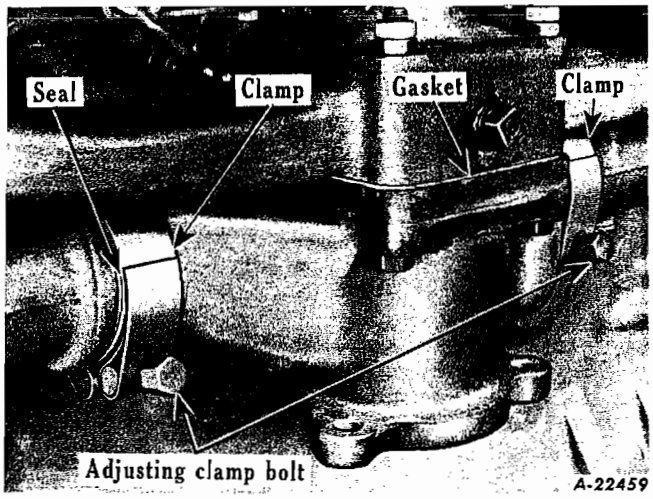

Fig. 30

Oil Pump Overhaul

(Complete illustrated procedure for Oil Pump Overhaul is given in Shop Talk No. 28)

Special tool equipment is available for oil pump overhaul under SE-1499. Use of these tools will speed up the job and assure accurate work.

Oil Pump Disassembly

See Sectional view of model RD engine oil pump (Fig. 31).

1. Remove cotter pin holding float to oil pump. Remove float from pump.
2. Remove six capscrews and lockwashers from oil pump body cover and lift cover and gaskets from oil pump body.
3. Lift out oil pump idler gear from idler gear shaft. After removing oil pump drive gear shaft guide from top of shaft, use small punch to drive out spiral gear pin from oil pump spiral gear. Using an adapter collar which fits underneath the spiral gear, and an adapter with a tang which will fit down into the slot of the oil pump drive shaft so as to apply pressure of press at bottom of slot, press oil pump drive shaft out of oil pump spiral gear. Remove Woodruff key from shaft. Remove oil pump body gear and oil pump drive shaft from oil pump body.
4. Press oil pump gear onto oil pump drive shaft far enough to reveal retainer ring. Remove ring from oil pump shaft. Press oil pump body gear from shaft and remove Woodruff key from shaft. Wash all parts in cleaning solvent.

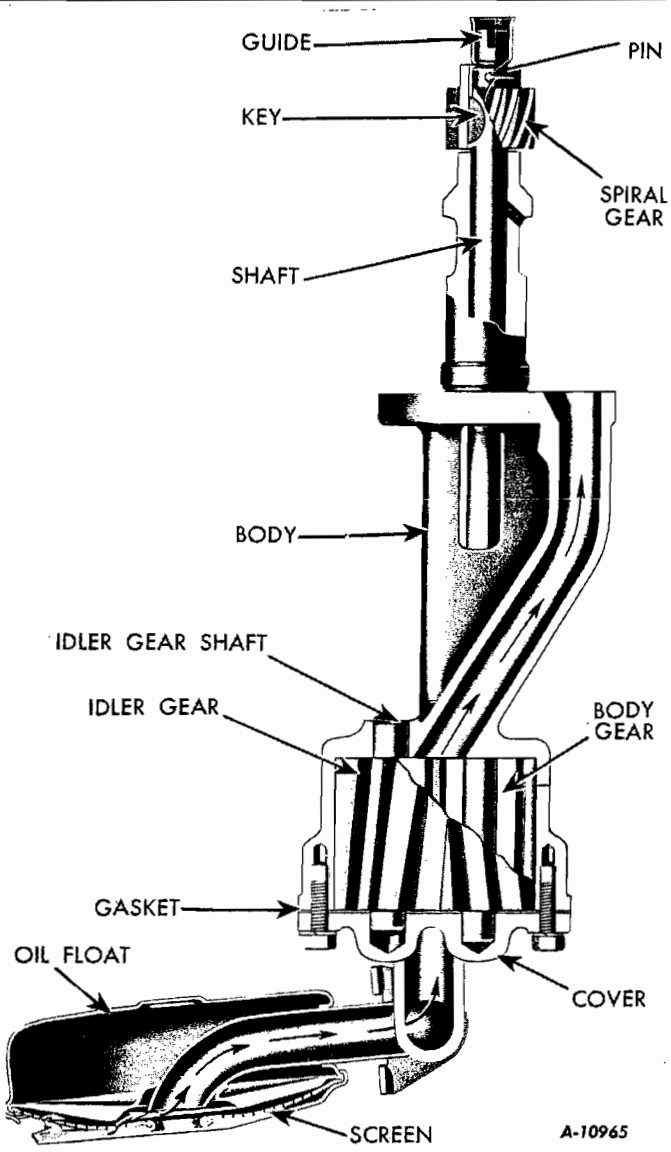

Fig. 31

Oil Pump Inspection

Check the following parts carefully:

1. Check the oil pump drive shaft for wear at points of contact with body. If wear is perceptible, the shaft must be replaced. Diameter of shaft is from .4985 to .4990 inches.

2. Check the oil pump body for warpage, damage and wear. Replace if body is warped or cracked, or if shaft bore is worn so that clearance between shaft and bore is in excess of .005". Inspect all oil pump gears, and replace if wear is perceptible.

Oil Pump Assembly

1. Press body gear onto oil pump drive shaft after placing new Woodruff key in slot of shaft. Press gear onto shaft far enough to permit installation of retainer ring in groove in oil pump. Press oil pump body gear down against ring.

2. Insert oil pump drive shaft and body gear into oil pump body. Install new Woodruff key in slot at top end of shaft. Install oil pump spiral gear, with gear hub down, onto drive shaft. Press spiral gear down onto shaft until 1/32" clearance remains between gear hub and pump body when oil pump body gear is up against pump body. Using hole in spiral gear as guide, drill .1255" hole in shaft. Drive new spiral gear pin into place. Install a new guide on the end of the pump shaft, use guide installing tool.

3. Install idler gear on idler gear shaft. Install gasket and oil pump body cover, and install four capscrews and lockwashers. Test oil pump body gear and play to cover by using a feeler gauge between oil pump spiral gear hub and oil pump body. End play must be from .0025"-.0055". If clearance is in excess of .0055", remove one gasket from cover. If clearance is less than .002", add one gasket between cover and body. Recheck end play after making any alterations. Insert oil pump into cylinder block so that slot in top of shaft is 30° angle to the side of the engine with the No. 1 piston in firing order (Fig. 32).

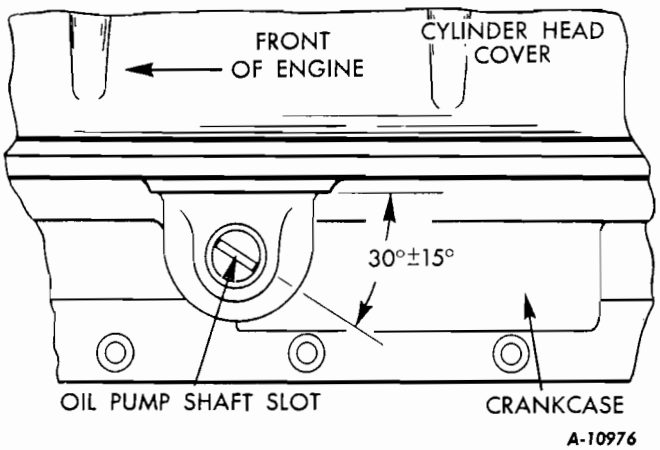

Fig. 32

4. Insert oil pump float in oil pump body, line up cotter pin holes, install new cotter pin, and fasten securely.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR AND ASSEMBLY OF SUB-ASSEMBLIES

Cleaning the Cylinder Block

Remove all old gasket material from block, clean both inside and outside of block with steam or cleaning solvent. Remove all dirty oil, sludge, scale, and carbon from cylinder block.

Cylinder Block Inspection

1. Inspect cylinder walls for cracks. Weld cracks or replace block, if necessary.

2. Check top surface for trueness with a straight-edge. Test by attempting to insert a .012" feeler gauge ribbon between the straight-edge and the cylinder block. If this is possible, either surface grind or replace the cylinder block.

3. Inspect camshaft bearings for damaged or scored condition, and inspect for wear. Replace if damaged or if worn beyond clearance limit of .0035". End play should be from .001" to .0035". Special tool equipment is available for installation of the prereamed camshaft bearings (Fig. 33).

4. Measure cylinder walls with an inside reading micrometer to determine taper, out-of-round or worn condition. The measurements must be made not only at top of the cylinder bore, just below ring groove, but at several places around the inside circumference of the bore. Bore should be checked at the bottom, below ring wear surface, to determine the amount of taper. Re-sleeve if worn beyond .008" clearance.

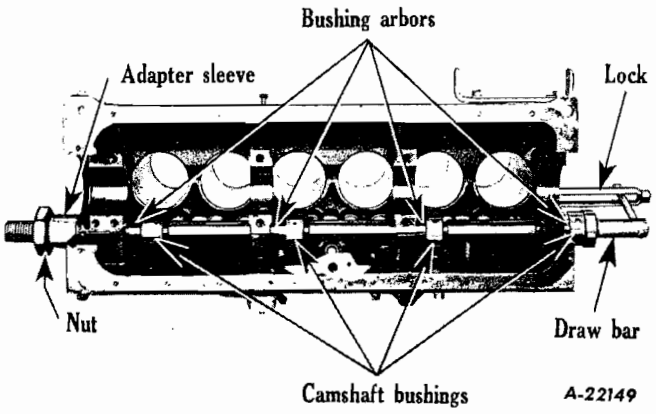

Fig. 33

Cylinder Sleeve Fits

The fit of the cylinder sleeve in the crankcase should be 100 to 200 lbs. hand push fit or approximately .0005" to .001" loose fit. This fit can be obtained by honing the cylinder bore sufficiently in the crankcase until the cylinder sleeve can be pushed all the way in by hand.

Before installation of cylinder sleeve, the crankcase bores should be cleaned of all carbon and foreign matter.

Installation of cylinder sleeves in the foregoing manner will preclude to a large extent the necessity of excessive honing when fitting pistons to the cylinder sleeves. NOTE: New cylinder sleeves are rough honed and must be finish honed to size in the crankcase.

NOTE: If cylinder water jacket shows an excessive amount of lime deposits, the cooling system cannot provide effective heat dissipation.

Whenever the top of the sleeve flange goes below the top of the crankcase, a thin tag wire should be placed under the sleeve flange to raise it flush with the crankcase, or not to exceed .006" above the crankcase face.

Cylinder wall surface finish is of utmost importance in piston and piston ring life and in oil consumption control. The best type surface is one having characteristics midway between "smooth" and "highly polished". The resulting surface of a boring or honing operation consists of numerous microscopic scratches or grooves which act as oil reservoirs or retainers of oil while the surface between the grooves provides a load-bearing surface. If the scratches are too deep and too close together, the surface is referred to as "rough" and will not provide adequate ring and piston contact area which results in fast wear. Should the finish be highly polished or too "smooth", the scratches or grooves are shallow and will have insufficient oil-retaining capacity to provide adequate lubrication for the adjacent contact or load-bearing area and will result in scuffing or scoring. It is therefore advantageous to strike a "happy medium" by removing only the sharp peaks of these microscopic ridges and in this way still reap the benefits of the oil-retaining grooves. This type of cylinder wall surface is obtained through exercise of care in finishing operation and through proper use of equipment.

CAUTION: Extreme care must be taken to assure that no abrasive remains in the engine after the finish honing operation.

After engine has been reassembled, it should be allowed to run-in for two or three hours at a fast idle (approximately 1200 r.p.m.).

Replacing Camshaft Bushings

If camshaft bearing replacement is necessary, remove and install new bushings with special camshaft bearing installation tool. No reaming is required. Fig. 33 illustrates the use of camshaft bearing installing tool.

Connecting Rod and Piston Disassembly

1. Remove piston-pin retainers from each piston, and remove piston rings from piston ring grooves.

2. Heat piston in boiling water or piston heater. Place piston in piston vise, and using pin-driving tool, drive piston pin from piston and connecting rod (Fig. 34). After piston pin is removed, lift piston from connecting rod.

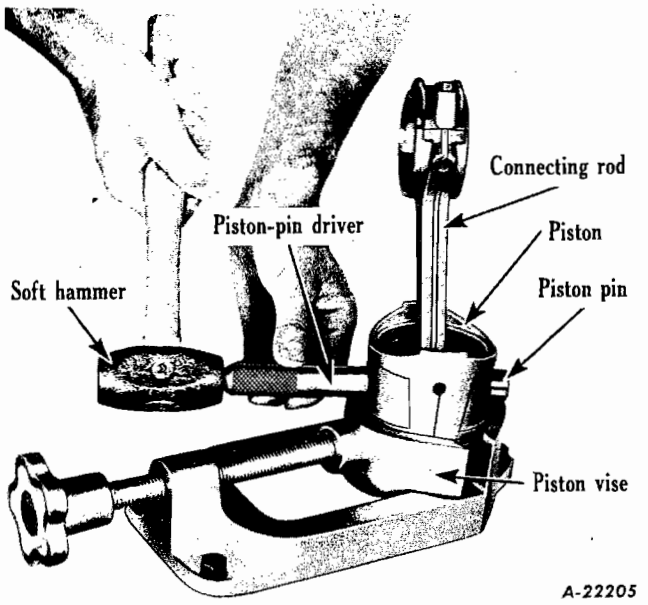

Fig. 34 - Use suitable piston vise to hold piston and drive pin out with SE-1264 Piston Pin Driver. Use soft hammer.

3. Wash all parts in a cleaning solvent. CAUTION: Do not use a caustic solution for aluminum pistons. Clean the carbon from piston ring grooves with a broken ring or ring groove cleaner.

4. Inspect connecting rods, caps, and bearing shells. All connecting-rod bearings and piston-pin bushings should be replaced at every major overhaul. Test rods for alignment. Rods only slightly misaligned can be straightened with proper equipment. Badly twisted or bent connecting rods must be replaced.

5. Inspect pistons for cracks, breakage, or scores. Check piston ring grooves and ring lands for wear, using a new piston ring and feeler gauge. If clearance between ring and ring land exceeds .005",

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(total clearance) replace piston (see specifications). Pistons which are scored or damaged, must be replaced.

6. Inspect piston pins for wear, and if wear is perceptible, replace pins. Replace piston pins which show signs of corrosion or etching.

7. With properly fitting adapter (Fig. 35), press old piston-pin bushing from connecting rod. Place new piston-pin bushing in position, align oil hole in bushing with oil hole in connecting rod, (Fig. 36), install bushing with a .0035" to .0055" press fit. Burnish bushing into place in the connecting rod (Fig. 37), then ream pin bushing to provide a hand-push fit.

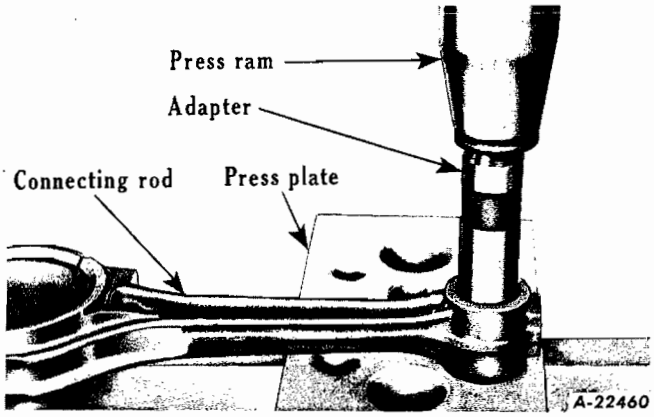

Fig. 35 - Use SE-1036-6 to remove bushing. Select proper hole in SE-1033 Support Plate.

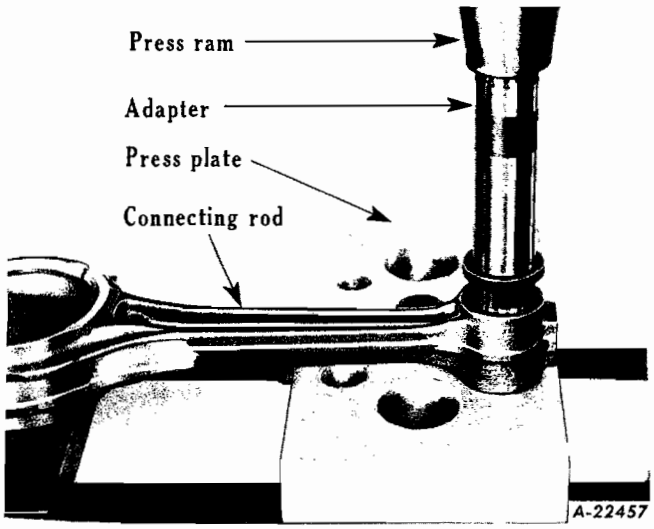

Fig. 36 - Installing new bushing in rod.

8. With reamer, ream piston pin bosses in piston to provide a tight fit of from .0000" to .0002" with piston pin.

Piston Fitting

When fitting pistons in the cylinder sleeves, use a .003" feeler ribbon 1/2" wide between the piston and cylinder, 90° from the piston pin hole and in line with the thrust face of the piston

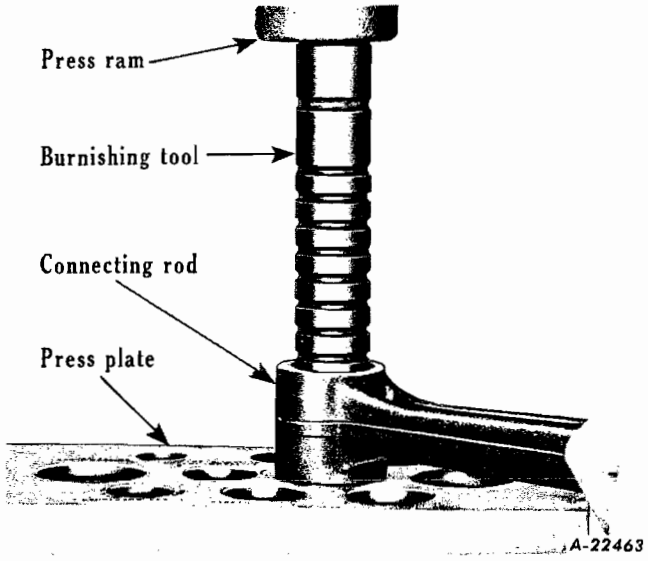

Fig. 37 - Burnish Bushing using SE-789.

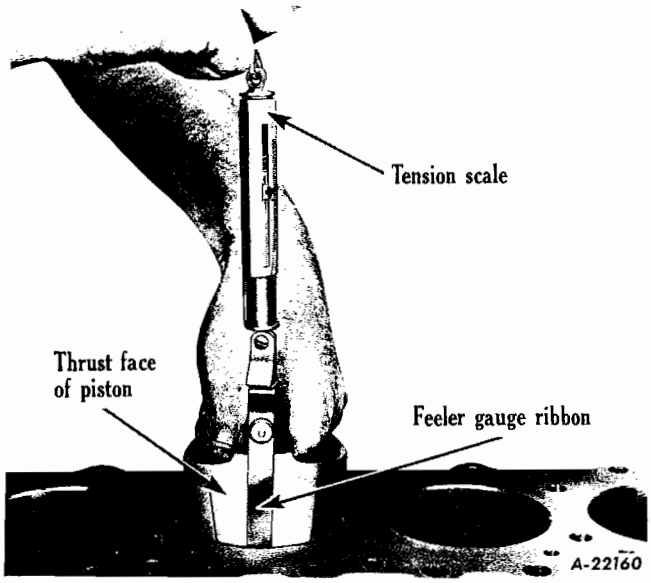

Fig. 38 - Checking piston fit using feeler gauge ribbon. SE-1007 gauge set is available.

(Fig. 35). Apply a tension pull on scale to the feeler ribbon and check clearance to specifications as outlined in the chart below.

Feeler Gauge Ribbon Checking	
Width	1/2"
Thickness	.003"
Tension on Scale (lb.)	6-18
Desired Tension (lb.)	12

Connecting-Rod and Piston Assembly

1. With piston heated to approximately 200° F., support connecting rod in vise, push piston pin into piston bosses while piston is hot (Fig. 36). When assembling piston on rod, the slot in the piston skirt must be toward the camshaft side of the engine, which is the numbered side of the connecting rod. Install piston pin retainer in piston at each

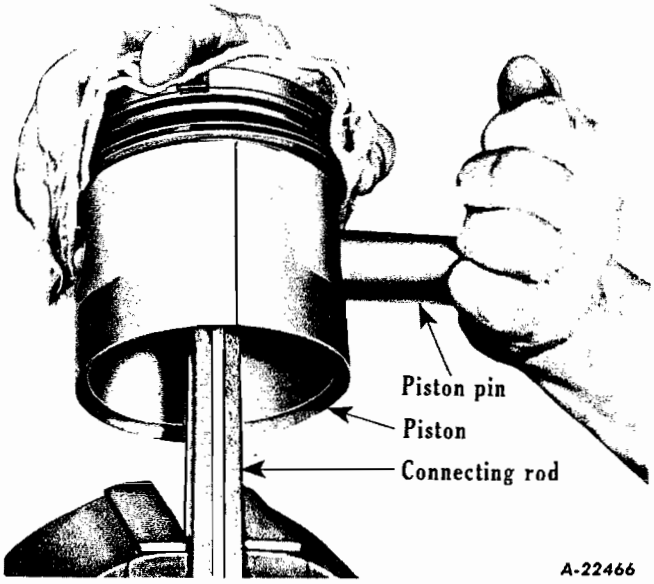

Fig. 39

end of pin, making sure that retainers seat fully and with tension in grooves. Test connecting-rod and piston assembly on a connecting-rod aligner, and correct any mis-alignment.

2. Place piston and connecting rod in vise. Test each piston ring for proper gap by placing in cylinder and measuring gap with feeler gauge. Gap should be .016" to .026" (Fig. 40).

Piston Ring Installation

1. Before installing rings in glazed cylinder bores, a surface-hone should be passed through the bores to remove the glaze and minor irregularities. This should only be done provided a thorough job of cleaning the grit and abrasives from the engine is performed after the honing operation. IMPORTANT -- if the engine is not thoroughly cleaned after surface-honing, the benefits are more than offset by damage caused by the remaining grit and abrasives.
2. When installing piston rings in piston grooves, be careful not to distort rings. If possible, use a suitable piston ring expander tool (Fig. 41). Also check new piston rings in piston ring grooves for clearance between ring and ring lands. The correct ring clearance is shown in specifications.

Crankshaft Cleaning and Inspection

1. Wash and clean crankshaft with cleaning solvent or steam.
2. Inspect main-bearing and connecting-rod journals for wear. If journals show wear or out-of-round in excess of .003", the shaft should be either reground and undersize bearings installed, or replaced. Use micrometers for checking.

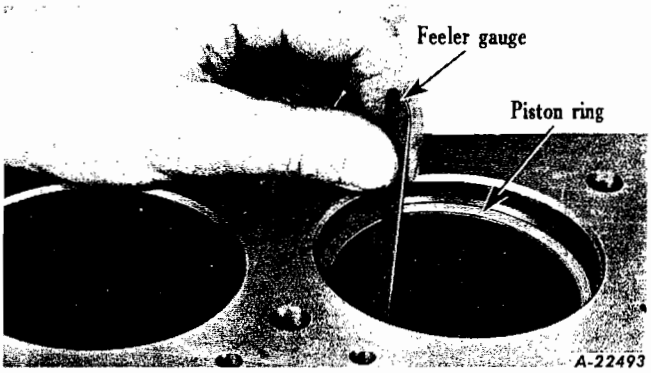

Fig. 40 - Checking ring gap.

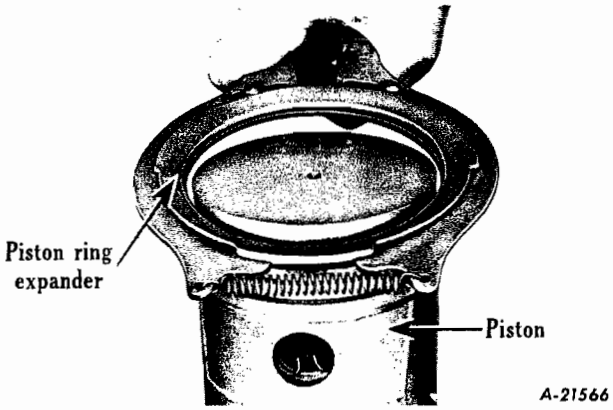

Fig. 41 - Installing piston ring using SE-1149-6 Ring Installing Tool.

3. Check crankshaft and flywheel dowels for damage and fit, and replace if worn or damaged.

4. Examine crankshaft timing gear teeth, and replace gear if teeth are worn or damaged. NOTE: Replace timing gear on camshaft when replacing crankshaft gear. These gears are provided in matched sets.

5. Install Woodruff key in groove in crankshaft. Heat crankshaft gear in boiling water or piston heater. This will expand the gear enough to allow it to be tapped onto the crankshaft without the danger of damaging the gear. A special crankshaft gear installing tool is available.

Flywheel and Ring Gear Inspection

1. Clean flywheel and ring gear with a cleaning solvent, remove all traces of oil and grease.

2. Inspect the flywheel ring gear. If any teeth are damaged, or if ring gear is loose on flywheel, the ring gear must be replaced.

3. Check the flywheel dowel holes and mounting bolt holes for wear, also check for flywheel having been loose.

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4. To replace flywheel ring gear, heat gear with torch, and remove from flywheel with a hammer and drift. Heat new ring gear with torch, heating evenly all the way around. While the ring gear is hot, install gear on flywheel and allow it to cool.

5. Check pilot bearing in flywheel for wear or damage and replace if needed.

6. Install flywheel on crankshaft. Install six self-locking capscrews, drive dowel pins through flywheel to crankshaft. Tighten to 155 foot-pounds.

Camshaft Cleaning and Inspection

1. Wash camshaft in cleaning solvent, brushing to facilitate removal of all sludge or carbon deposits.

2. Inspect camshaft journals for signs of wear or out-of-round.

3. Inspect oil pump drive gear in center of shaft. If teeth are worn or damaged, the camshaft must be replaced, as the gear is integral with shaft.

4. Inspect camshaft lobes. If worn, chipped, or scored, replace the camshaft.

5. Inspect camshaft gear, and replace if wear is evident or gear teeth are nicked or otherwise damaged. NOTE: Timing gears are factory matched and are furnished in sets. The gears should be replaced in sets.

6. To reassemble, install thrust flange over end of camshaft. Install Woodruff key in slot in shaft. Place camshaft gear in boiling water or piston heater, and install over Woodruff key. Install camshaft nut and tighten to approximately 120 foot-pounds tension.

Cleaning and Inspecting Miscellaneous Parts

1. Cleaning miscellaneous engine parts. This includes brackets, oil pan, engine case cover, flywheel housing, and other parts that were removed during disassembly of engine and were not covered by procedure. Wash in cleaning solvent or steam clean preliminary to inspection.

2. Check all twelve valve lifter or push rods for straightness by rolling on flat surface. Replace any that are bent or have loose ends.

3. Inspect oil pan for cracks or deep bends, and straighten or weld.

4. Inspect oil pan drain plug and drain plug boss for fit and thread wear. If plug is loose or threads are damaged, repair threads or replace oil pan.

5. Inspect crankshaft pulley and vibration damper assembly for evidence of rubber coming loose from pulley flange plate, and inspect for wear. Replace damper assembly if either condition is encountered. Do not submerge vibration damper assembly in hot cleaning solvents. Inspect crankshaft fan drive pulley for wear in hub bore. If inner diameter of bore is worn, scored, or Woodruff key way damaged, replace pulley.

6. Inspect engine gear case cover, and replace if cracked or broken. Remove old cover seal and install new seal.

7. Check each of twelve engine valve tappets for irregular wear, chipping, cracking or scores. Replace defective tappets.

8. Inspect engine flywheel housing for cracks or breakage and replace if damaged. Inspect flywheel housing to crankcase pilot dowel holes for wear. If wear is evident, drill or ream the holes and install oversize dowels. Also inspect dowels for wear and replace if wear is evident.

9. Inspect all capscrews and nuts for thread wear or breakage, and replace as necessary. Use new lockwashers when reassembling engine.

10. All gaskets and oil seals must be replaced at each overhaul or major repair.

ASSEMBLY OF ENGINE

When all parts have been cleaned, inspected, and repaired, and necessary replacement parts have been procured, install engine cylinder block in engine overhaul stand for reassembly.

Main-Bearing and Connecting-Rod Bearing Installation

It is essential that main bearings be in alignment with the crankshaft journals. The model RD engines have the main bearing caps piloted in the crankcase (Fig. 42). All bolts should be carefully examined before installation.

BEARING CRUSH. Undersize precision type bearing shells should be installed when, because of wear, bearing-to-crankshaft running clearances are to be reduced. Bearing caps must not be filed, lapped, or in any other manner reworked.

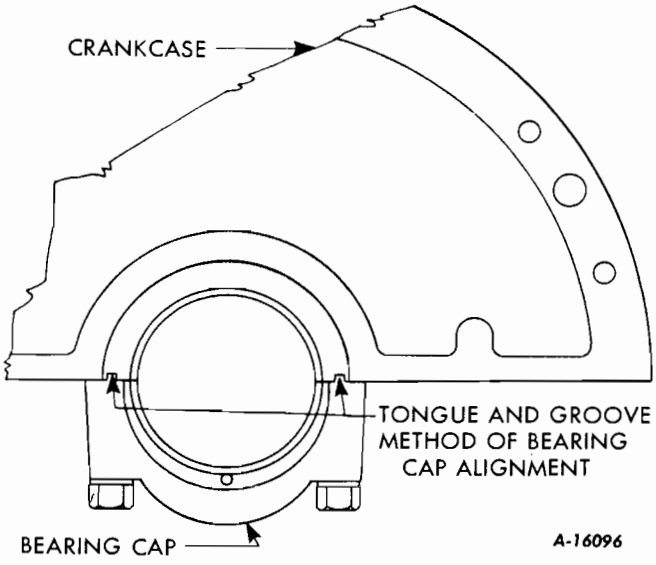

Fig. 42 Illustrates tongue and groove method of Behring Cap Alignment with crankcase.

Premature bearing failure will result from attempts to reduce journal-to-bearing running clearance by reworking of either bearing caps, bearings, or both, because such reworking will alter the engineered fit of the bearing shells in their bores and destroy the specifically desired "crush".

When installing precision type connecting rod or main bearings, it is important that the bearing shells fit tightly in the rod or case bore. To accomplish this, the bearing manufacturer makes the diameter at right angles to the parting line slightly larger than the actual diameter of the bore into which they are assembled. When the assembly is drawn up tight, the bearing is compressed, assuring a good contact between the bearing back and the bore. This increased diameter is referred to as bearing "crush" (Fig. 43).

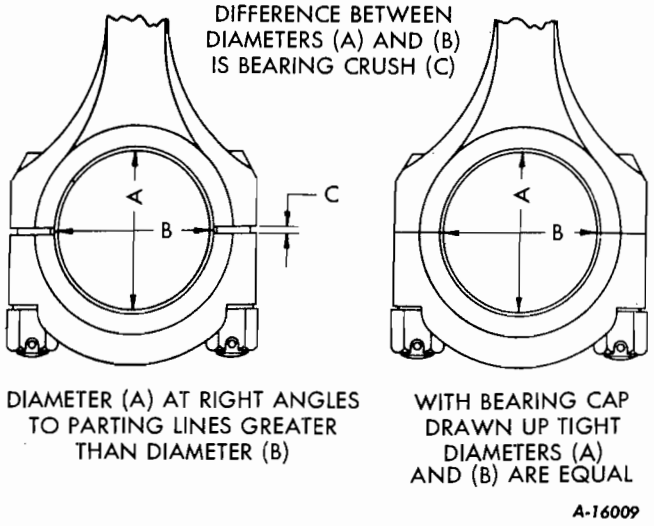

Fig. 43

To obtain proper bearing assembly with the correct "crush", care must be taken when tightening the clamping bolts to make sure they are drawn down alternately and evenly, using a tension wrench and tightening as specified.

As a result of excessive bearing crush, due to reworking the caps, the rod or main bearing bore will possibly become distorted because more force is required to draw the cap and housing together.

Rods, caps, or blocks must not be filed, lapped, or in any other manner reworked in order to reduce clearance. While such practice will make a tighter fit at top and bottom, it will result in an out-of-round bore and bearing shell distortion. New bearing shells will have to be installed eventually and that is when additional trouble starts.

In general, a visual inspection of the parting faces of the rod or caps under a magnifying glass will provide sufficient proof of any attempt at reworking. Under the glass, the parting line surface of standard parts will show the manufacturing cutter tool marks and will not have a polished or extremely smooth appearance. On the other hand, reworked parts will have a polished surface and, if a file was used, will show the even pattern of the file teeth. Seriousness of this condition is in direct proportion to the amount of reworking.

BEARING SPREAD. Main and connecting-rod bearings are designed with the "spread" (width across the open ends) slightly greater than the diameter of the crankcase bore or connecting rod bore into which they are assembled. For example, the width across the open ends of the engine connecting rod bearing not in place is approximately .025" more than when the

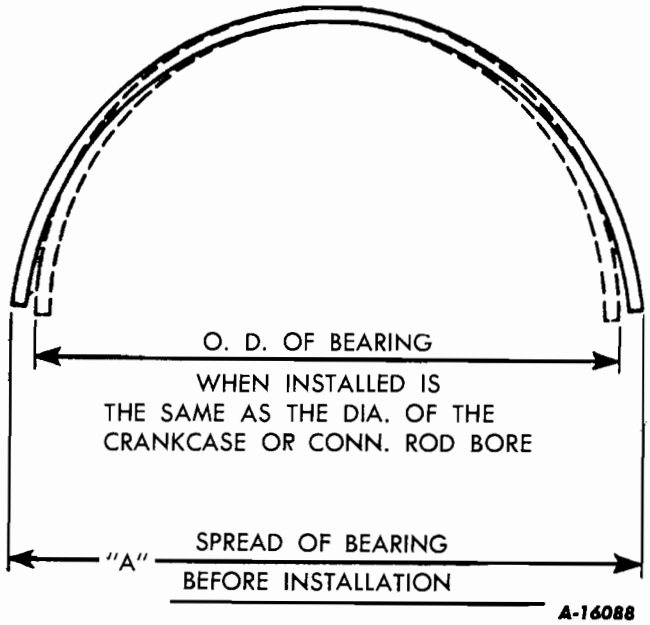

Fig. 44

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bearing is in position in the rod. This condition causes the bearing to fit snugly in the rod bore and the bearing must be "snapped" or lightly forced into its seat (Fig. 44).

Rough handling in shipment, storage, or normal results of use in an engine, may cause the bearing spread to be increased or decreased from the specified width. Bearing spread should, therefore, be carefully measured and corrected as necessary before installation in an engine.

Bearing spread can be safely adjusted as follows, although care and judgment should be exercised in the process:

1. Excessive spread. If measurement of spread indicates that distance "A" is excessive (see chart for specifications), place bearing on a wood block and strike the side lightly and squarely with a soft mallet (Fig. 45). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

2. Insufficient spread. If measurement of spread indicates insufficient spread, place bearing on wood block and strike the back of the bearing lightly and squarely with a soft mallet (Fig. 45). Recheck measurement and, if necessary, continue until correct width (measurement "A" in chart) is obtained.

Chart of Bearing Spread Dimensions. RD Engine (Minimum)		
"A"	Connecting-Rod Bearing	2.8985" + .025"
	Main Bearing	3.424" + .025"

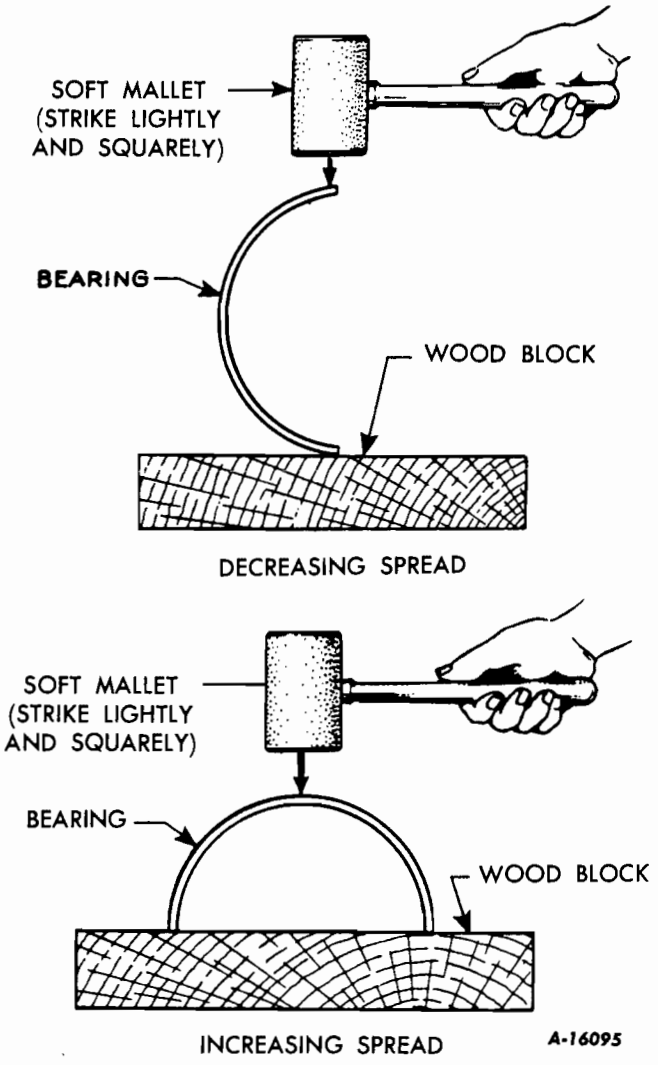

Fig. 45

1. INSTALL CRANKSHAFT AND MAIN BEARINGS. Clean all surfaces of crankshaft bearing journals and wipe clean the bearing bores in the cylinder block. Remove main bearing cap self-locking capscrews and main bearing cap. Wipe backs of cylinder block half of bearings, making sure that dirt and oil is removed. Place bearing shell halves in position in bore in cylinder block, making sure that bearing shells are fully seated, that oil holes in bearing shells line up with oil holes in cylinder block, and that locking tangs on bearings fit into recesses. Follow same procedure, place bearing shell cap halves in bearing caps. Place a film of engine oil on bearing shell surfaces and lift crankshaft to align itself in the bearings, and also provide lubrication. Place bearing caps and bearing lower halves over crankshaft journals. Be sure bearing caps are properly installed with numbers to camshaft.

2. In order that an accurate measurement can be made to check all bearing clearances, a material similar to "plastigage" or "virgin lead" can be used.

3. Use the following instructions when using "plastigage":

   (a) Remove oil from bearing cap insert and exposed half of crankshaft journal.

   (b) Place a piece of "plastigage" the full width of the bearing insert.

   (c) Reinstall the bearing cap. Tighten the self-locking capscrews to approximately 105 foot-pounds.

   (d) Remove the bearing cap. The flattened plastic material will be found adhering to either the bearing shell or the crankshaft.

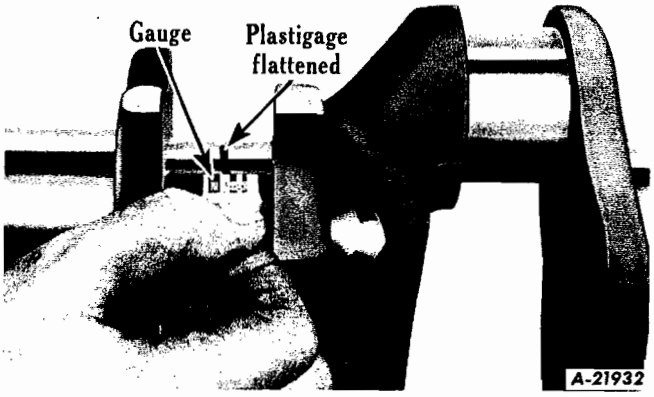

Fig. 46 - Checking Behring Clearance

(e) To determine the bearing clearance, compare the width of the flattened plastigage at its widest point with the graduations on the envelope (Fig. 46). The number within the graduation on the envelope indicates the clearance in thousandths of an inch. NOTE: Do not turn crankshaft during the above procedure.

4. When using the "virgin lead method" use the following procedure:

(a) Virgin lead wire of approximately .010" thickness should be used. If wire of .010" thickness is not available and thicker wire must be used, it must be rolled to approximately .010" thickness.

(b) Remove one bearing cap. Place 1/2" piece of virgin lead lengthwise on top of crankshaft bearing journal.

(c) Install cap and bearing shell half. Install bearing cap bolts and tighten to 30 to 40 foot-pounds tension.

(d) Rock the crankshaft back and forth two or three times. Further tighten bolts to 60 to 70 foot-pounds and again rock the crankshaft two or three times. Tighten bolts to 105 foot-pounds and remove bearing cap.

(e) The virgin lead will now be compressed exactly in accordance with the amount of bearing to crankshaft clearance. Peel off flattened piece of virgin lead wire and measure with micrometer. Thickness of flattened piece of wire is exact amount of bearing clearance present. Repeat above operations on all bearings.

5. If clearance is not within .0013" to .0043", either use undersize bearing, regrind shaft or replace shaft. Check crankshaft for end-play which is taken up by No. 4 main bearing. End clearance should be from .004" to .012".

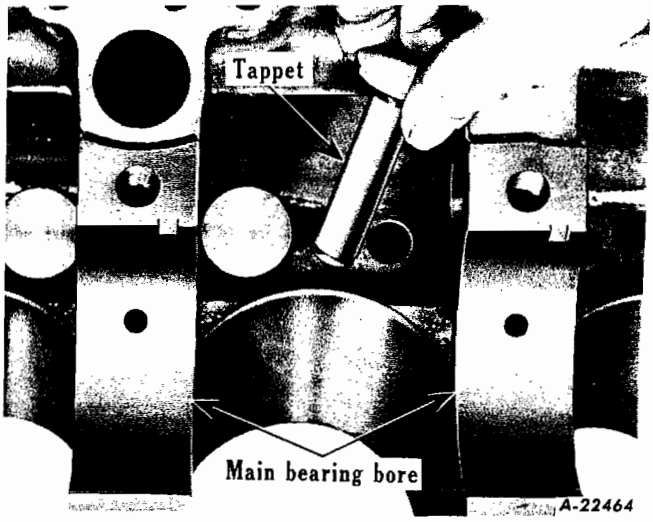

Fig. 47

6. INSTALL FLYWHEEL HOUSING. Place flywheel housing in position over two flywheel housing to cylinder block dowels and tap into place with soft hammer. Install six capscrews and lockwashers in flywheel housing. If either block or flywheel housing is replaced, the flywheel housing will have to be aligned with a dial indicator. When correctly aligned, run-out of bore should not exceed .005". NOTE: If possible, align flywheel housing while engine is in overhaul stand and with engine in vertical position (flywheel housing up).

7. INSTALL ENGINE FLYWHEEL. Place engine flywheel and ring gear into position on dowels in crankshaft flange. Install six self-locking capscrews in flywheel and crankshaft flange, and tighten to a tension of approximately 155 foot-pounds, using a tension wrench.

8. INSTALL VALVE TAPPETS. Coat each of twelve valve tappets with heavy engine oil and install from crankcase side of engine (Fig. 47).

9. INSTALL GEAR CASE COVER PLATE. Place plate and gasket at front end of engine cylinder block. Install two capscrews and lockwashers. NOTE: To be sure that cover plate is in line with the gear case mounting bolts, which go through the cover plate, install or start three or four gear case bolts before tightening the two cover plate capscrews. Remove gear case bolts after tightening operation.

10. INSTALL CAMSHAFT AND GEAR. Coat camshaft with engine oil. Insert camshaft into front end of engine block, being careful not to damage camshaft bearings. Before completely entering camshaft, rotate

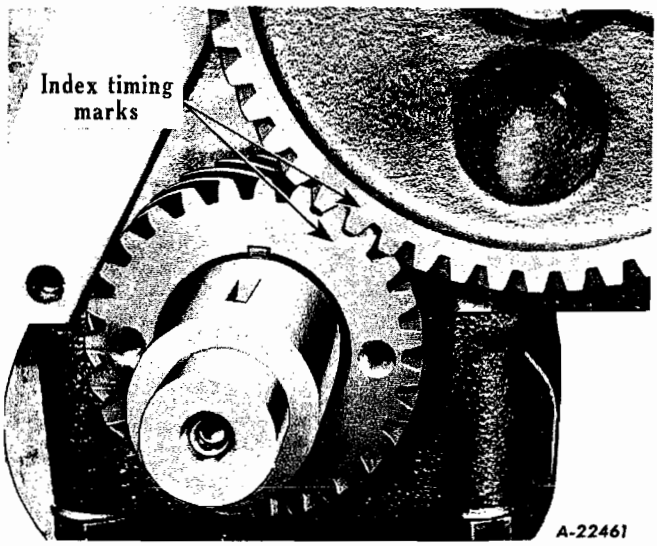

Fig. 48

shaft until marked teeth on crankshaft gear and camshaft gear index (Fig. 48). Install two capscrews and lockwashers in camshaft thrust flange, working through large holes in camshaft gear. Rotate crankshaft and camshaft to determine that gears do not bind or interfere. Back-lash must be from .000" to .002" (.0015" preferred).

11. INSTALL GEAR COVER CASE. Place gasket in position on case cover. Place crankshaft oil slinger over end of crankshaft and install Woodruff key for fan drive pulley in crankshaft. Place gear case cover in position. Install capscrews, new lockwashers, and nuts. NOTE: Do not tighten gear case capscrews and bolts at this point.

12. INSTALL FAN DRIVE PULLEY AND VIBRATION DAMPER. Heat crankshaft fan drive pulley and vibration damper assembly in boiling water. When heated, quickly install assembly on crankshaft and install washer and fan drive pulley nut. Tighten nut with wrench of about 36" leverage. Tighten gear case capscrews and bolts. By tightening the gear case cover to the engine block after the drive pulley had been installed, the pulley has served to align the gear case cover.

Installing Connecting Rods and Pistons

1. Install one connecting-rod and piston assembly down through top of cylinder block having slot in piston towards camshaft side of engine. Pistons are also marked with an arrow indicating front of engine. Use a piston ring compressor sleeve to compress piston rings and thus avoid possible ring damage (Fig. 49).

2. Wipe bore of connecting rod free of oil and dirt. Place bearing shell upper half in connecting rod bore, being sure that oil hole aligns with oil hole in connecting rod and that locking tangs of bearing shell fit into recess. Clean connecting rod cap bearing bore and clean back of bearing (Fig. 50). Place bearing shell lower half in connecting rod cap (Fig. 51), making sure that tang of bearing fits into recess in cap. (NOTE: See instructions under "Main Bearing and Connecting-Rod Bearing Installation.")

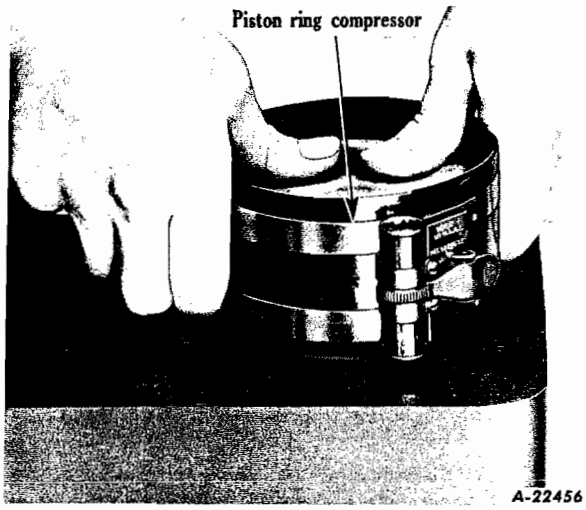

Fig. 49

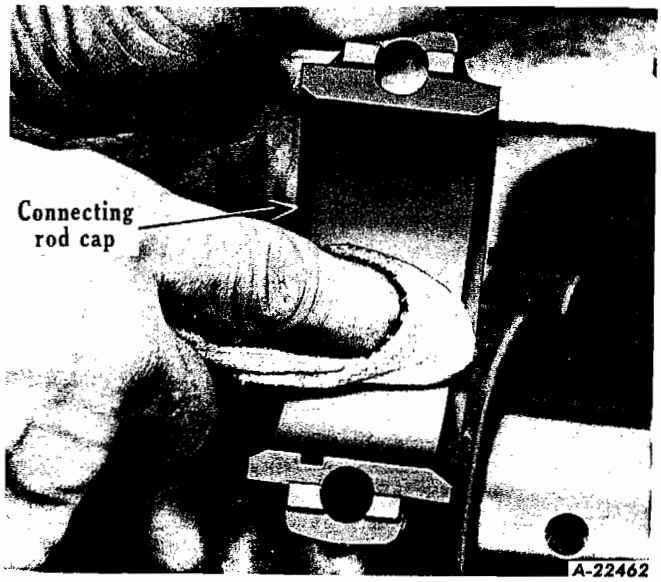

Fig. 50

3. Coat bearing surfaces with oil. Pull connecting rod into position on crankshaft journal and install connecting-rod cap and bearing.

NOTE: Bearing cap must only be installed on connecting rod one way, with both connecting rod number and bearing cap number to camshaft side. Install two self-locking capscrews and tighten to 80 foot-pounds, use tension wrench.

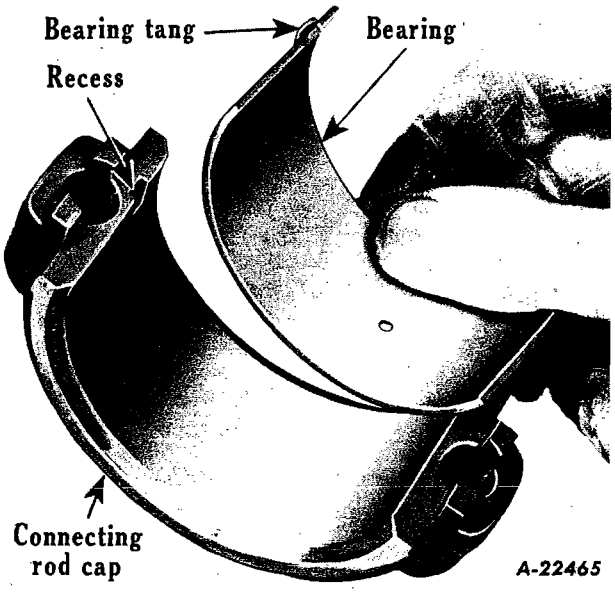

Fig. 51

4. To check connecting-rod bearing to crankshaft clearance, follow procedure given for "plastigage" or "virgin lead" test. Specified connecting rod bearing to crankshaft clearance is from .0012" to .0037". Do not attempt to file connecting rods or bearing caps.

5. Follow procedure outlined in steps above for remaining connecting rods and pistons.

6. INSTALL CLUTCH. Install clutch driven disc against flywheel so that the long portion of the hub is toward the rear. Place clutch in position on flywheel over clutch driven disc. Locate clutch so that arrow or inspection mark (usually a dab of white paint) on flange of clutch backing plate or cover is as near as possible to the letter "L" on the flywheel, and install two or three mounting capscrews and lockwashers loosely. Insert a clutch aligning arbor, if available, or a transmission main drive gear shaft, through clutch driven disc hub spline and into clutch pilot bearings. Hold clutch driven disc in position while completing installation of twelve mounting capscrews and lockwashers in flange of clutch backing plate or cover. Tighten all twelve capscrews alternately, evenly and securely. Remove three retaining capscrews and flat washers which were installed to hold clutch compressed (Fig. 52). NOTE: Clutch will not operate properly unless these retaining capscrews are removed.

7. INSTALL VALVE LIFTER ROD COVER. Install new gasket over opening at left-hand side of engine block. Install valve lifter rod cover and six capscrews and copper washers.

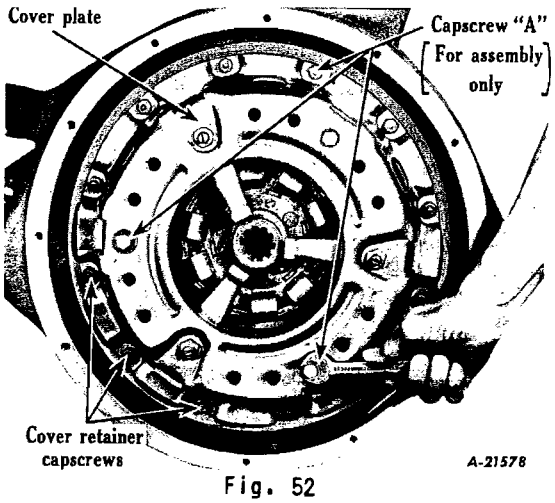

Fig. 52

Install Cylinder Head

1. INSTALL HEAD. Place gasket on cylinder block and align bolt holes. Place cylinder head on crankcase, being careful not to damage or shift gasket position. Loosely install all cylinder-head bolts and flat washers, omitting rocker arm oil feeding bolt. Tighten alternately and evenly in sequence to 105 foot-pounds.

2. INSTALL VALVE ROCKER ARM ASSEMBLY. Insert twelve valve lifter rods in cylinder head, make sure they enter the valve tappet. Lift the valve rocker-arm assembly into position on cylinder head. Install rocker-arm oil feeding bolt six 3/8" SAE nuts on hole-down bracket studs, and six hold-down bracket capscrews. Be sure to place stud with the oil hole, in the left third from rear, cylinder-head bolt hole and tighten to 105 foot-pounds. Retighten cylinder head after engine has been operated for a short period. Install oil pan making sure all gasket joints are leak-proof. See Fig. 53).

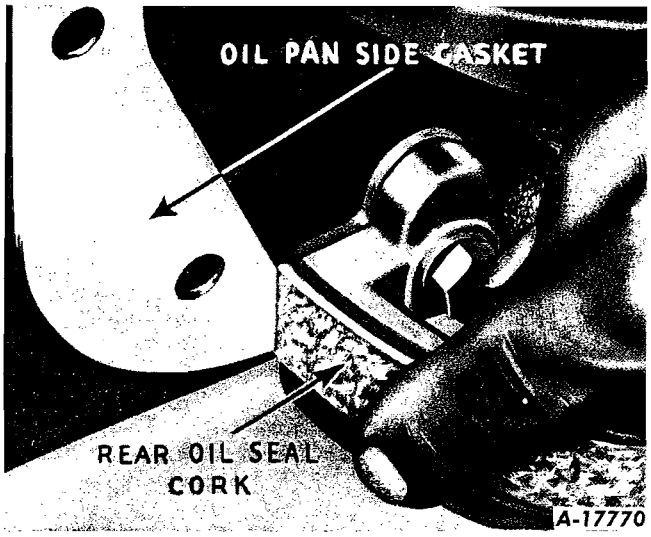

Fig. 53

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3. ADJUSTING VALVES. To adjust valve stem to valve rocker arm clearance correctly, each cylinder must be on top dead center on its compression stroke at the time of adjustment of valves for that cylinder. To determine the correct position, turn the engine crankshaft until No. 1 piston is at top dead center on compression stroke and the ignition timing mark on the crankshaft pulley in line with the pointer on the timing gear case. Adjust clearance on each valve of No. 1 cylinder to .018" to .020" by using a feeler gauge between valve stem and valve rocker arm and turn rocker arm adjusting screw out of rocker arm until clearance is obtained. Tighten adjusting screw lock nut and recheck clearance. (NOTE: Valve clearance should be rechecked with engine at normal operating temperature.)

4. Turn crankshaft one-third revolution and adjust clearance on No. 5 valves. Working in firing order sequence, continue to set valves of each of the remaining cylinders, turning crankshaft one-third turn after each valve adjustment.

5. INSTALL WATER PUMP. Place water pump gasket in position, at water pump opening in front of cylinder head (Fig. 54). Install water pump and fan and install three capscrews and lockwashers in pump and cylinder block.

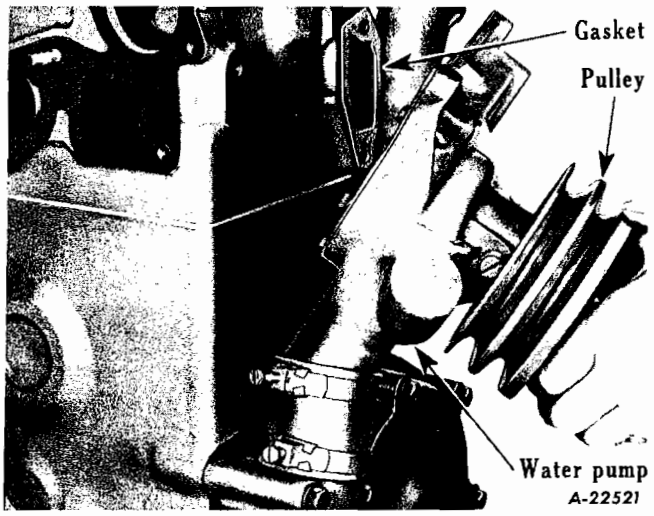

Fig. 54 - Installing Water Pump

6. INSTALL OIL FILTER. Place oil filter and new gasket in place on cylinder block. Install four capscrews and lockwashers in oil filter base. (NOTE: Be sure filter assembly is thoroughly cleaned and a new cartridge is installed before replacement on engine.)

7. INSTALL ACCESSORIES. Install carburetor, generator, distributor and connecting wires, starter, fuel pump, ignition coil, oil gauge, and thermostat. Tighten fan belt sufficiently to secure 1/2" depression on belt midway between generator pulley and fan pulley. Install oil pan making sure that gaskets are in place when tightening the pan.

8. FILL ENGINE WITH OIL. After making certain that oil drain plug is securely installed, fill crankcase with oil. After engine has been installed and placed in operation, again recheck oil level and add as necessary to bring oil level to full mark.

9. INSTALL CYLINDER HEAD COVER. If engine is not to be installed at this time, install new cylinder-head cover gasket and install cylinder-head cover. Install four flat washers and four nuts on cover.

ENGINE MOUNTINGS

Figs. 55 and 56 illustrate engine front and rear mountings.

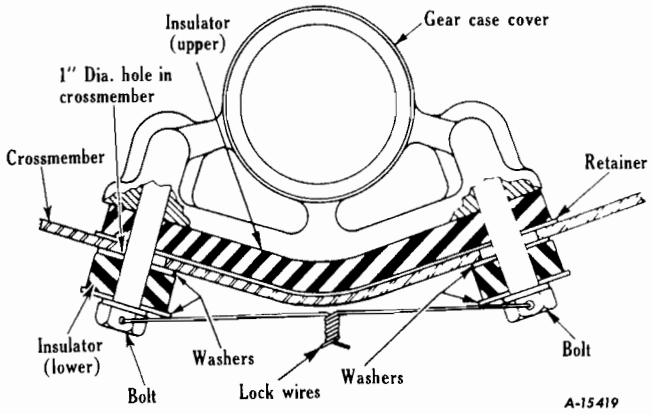

Fig. 55

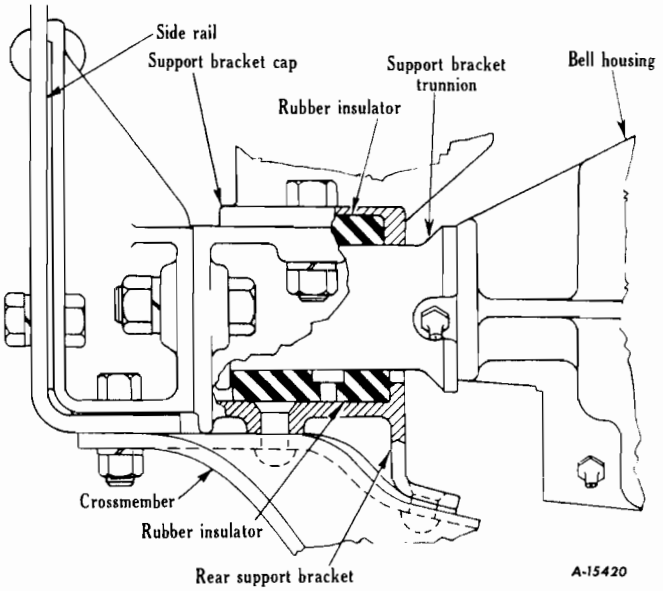

Fig. 56

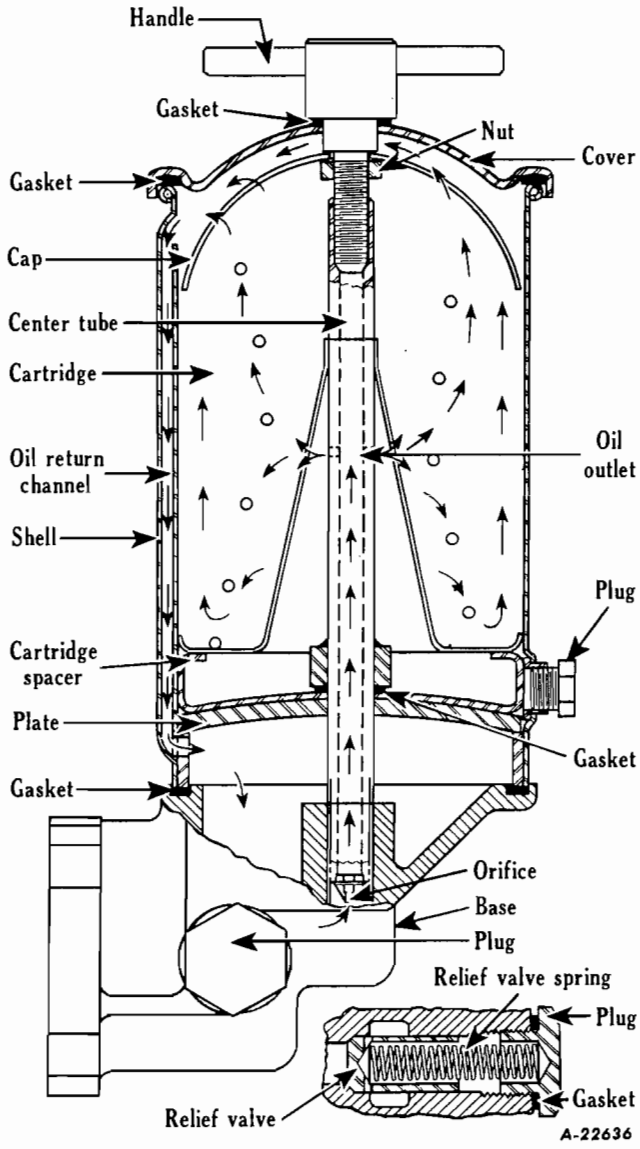

Fig. 57 - DeLuxe Oil Filter

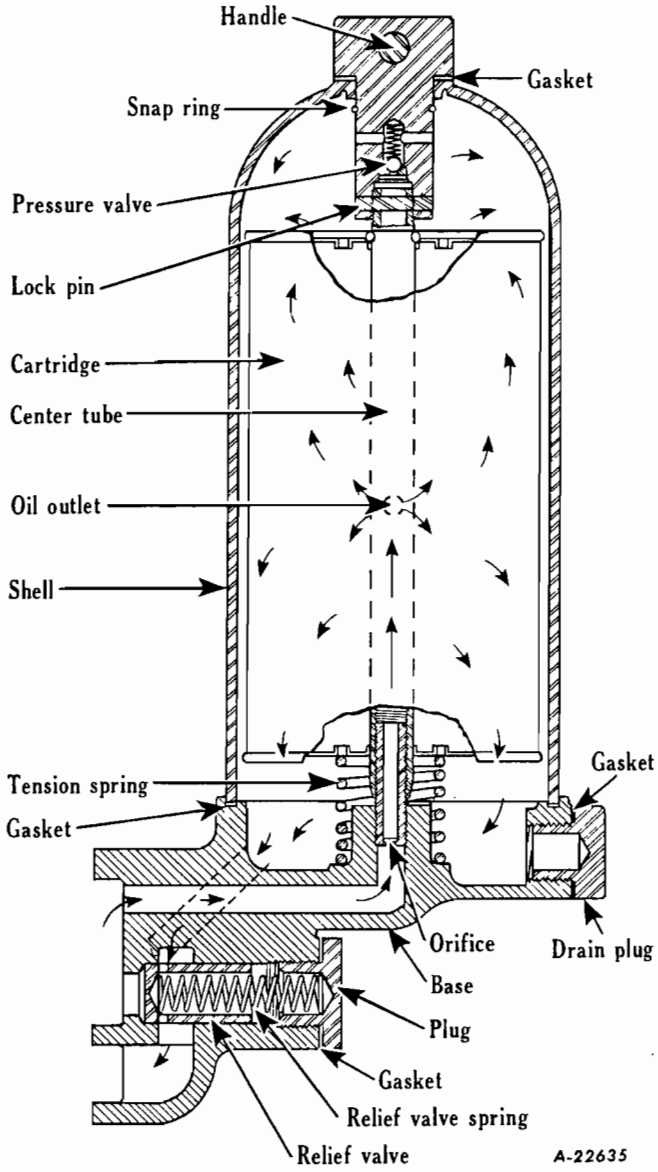

Fig. 58 - Michiana Oil Filter

OIL FILTER (DELUXE)

1. The DeLuxe oil filter is used on the RD engines and incorporates a removable sump (Fig. 57).

2. Water, grit, metal particles, sludge and other contaminants that settle out of the oil are held in the sump away from the cartridge. When the cartridge is changed the cartridge and sump quickly and easily lift out as a single unit. Change filter cartridge and clean sump at regularly established periods; according to operating conditions.

OIL FILTER (MICHIANA)

1. The Michiana oil filter is used on the RD engines (Fig. 58). Oil from the engine is delivered by the oil pump into the filter center tube through the oil filter base. Pressure at which the oil is discharged into the filter element is controlled by the pressure valve at the top of the center tube. The orifice at the bottom of the center tube contains a 7/64" hole.

2. Oil leaves the tube at the center of the filter element and flows through the element toward the ends. The filtered oil returns to the engine oil pan through the oil filter base.

3. The filter element or cartridge should be replaced when the oil appears smoky or black. The element is replaced by unscrewing handle at the top of filter and lifting off cover. The old filter element can then be removed and a new one installed.

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4. Do not attempt to wash out the old filter element. Replace with a new one.

5. Remove drain plug in filter sump whenever a new element is installed and drain sump.

6. If new engine oil discolors too rapidly after the filter element has been replaced it may indicate that the pressure valve in the center tube is not functioning and the oil is not going through the element. Remove the complete filter unit from the engine and wash the parts with cleaning solvent.

7. Avoid using a wrench on the filter cover handle. If the cover cannot be drawn down by hand tight enough to prevent oil leakage it is necessary to replace the gasket.

CRANKCASE VENTILATION

1. The RD engine has a crankcase ventilator metering valve installed at the oil filler pipe. The purpose of the crankcase ventilator metering valve, which is connected to the intake manifold by a vacuum line, is to control the amount of fumes and vapors drawn from the crankcase by the intake manifold vacuum. The operation of the crankcase ventilation system consists of drawing cleaned air into the engine and withdrawing the fumes from the crankcase.

2. CRANKCASE VENTILATOR METERING VALVE. To remove the ventilator metering valve disconnect the vacuum line leading to the intake manifold. Unscrew the ventilator metering valve unit from the oil filler pipe. To service, separate the two halves of the valve unit, and remove the weight. Clean all parts. When installing the ventilator metering valve on filler pipe, point arrow up. Screw unit into filler pipe. Connect vacuum line leading to the intake manifold (Fig. 59).

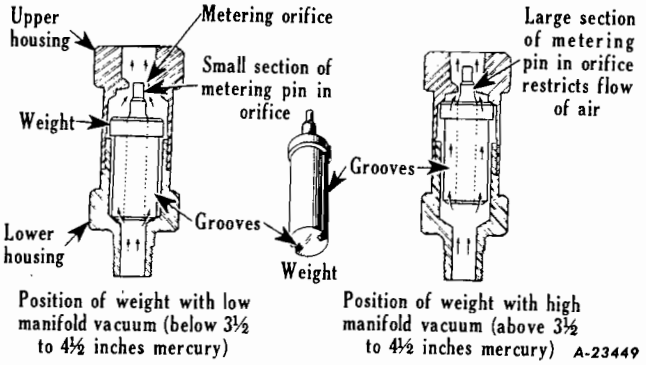

Fig. 59

CRANKSHAFT PULLEY TIMING MARKS

The ignition timing mark and the timing pointer is located on the front of the engine at the crankshaft pulley. To assure efficient operation of the engine, the timing should be checked with a timing light, and the timing mark and pointer should be in register as indicated for the best engine performance. Two marks are located on the crankshaft pulley. One marked with an "O" indicates top dead center (T.D.C.) and the other mark shows 5° before top dead center (T.D.C.)