PAY LINE DIVISION OF INTERNATIONAL HARVESTER

SERVICE MANUAL

Due to a continuous program of research and development, some procedures, specifications and parts may be altered in a constant effort to improve machines.

Periodic revisions may be made to this publication and mailed automatically to distributors. It is recommended that customers contact their distributor for information on the latest revision.

4 CYLINDER CARBURETED ENGINES

FORM ISS-1039-1

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NOTE: Industrial Product Applications were formerly covered in Engine Service Manual GSS-1295-J.

SECTION INDEX

This manual is divided into major sections covering various components for INTERNATIONAL 4 – Cylinder Carbureted Engines (refer to "Introduction" for engine models).

These sections are also indexed by title with thumb index tabs as shown below and to the right.

To use this manual, grasp the right-hand side of book between thumb and fingers. Bend book back and find the pages containing the corresponding section index tab.

Section identification is also contained in the upper corner of each page.

INTRODUCTION

The instructions contained in this service manual, are for the information and guidance of servicemen who are responsible for overhauling and repairing International 60, 135, 146, 153, 175 and 281 series four-cylinder carbureted engines specifically.

However, the instructions apply generally to the 1, 2A, 123, 4, 164, 169, 6, 264 and 9 series as well. Detailed specifications and data for all engines will be found in Section 1, Par. 2.

This manual provides the serviceman with a fast, convenient reference to information on maintenance and repairs, as well as descriptions of the major units and their functions in relation to other components of the engine.

LUBRICATION

Instructions on the lubrication of each assembly is given in the Lubrication Chart in the operator's manual for the particular engine. When assembling any parts, always coat all wearing surfaces with the lubricant specified in the chart. Except for such installations as taper pins, etc., whose surfaces should be clean and dry, use sufficient quantities of lubricant to prevent any danger of seizing, scoring, or excessive wear when the assembly is first operated. Failure to provide "starting lubrication may result in serious damage.

GASKETS AND SEALS

Always use new gaskets and seals. When installing a seal, be sure to install it as specified in the instructions. Be extremely careful not to damage the seal in any way during installation.

SERVICE TOOLS

International engines are designed so that few service tools are required other than those in the mechanic's tool kit. However, when the use of inexpensive special service equipment will facilitate work, such equipment is mentioned in this manual. Other than this, it is assumed that servicemen will select such tools as are required. Information regarding special tool equipment is given in the "SERVICE TOOLS MANUAL," ISS-1531, CTS-1147 or GSS-1251. Your distributor has most of this equipment and is in an excellent position to service these engines.

SERVICE PARTS

Always use genuine IH service parts. The best material obtainable and experience gained through many years of engine manufacturing, enable International Harvester to produce quality that will not be found in imitation or "just as good" repair parts. No serviceman can afford to guarantee a repair job that is not serviced with genuine IH parts. No owner should be satisfied with other than genuine IH parts.

For the correct service parts to be used, always refer to the parts catalog for that particular engine. The loose-leaf parts catalogs are accurate and are brought up-to-date continually by issuing new pages covering any changes in part numbers.

SERIAL NUMBERS

The engine serial number is stamped on the crankcase where it is plainly visible.

ENGINE APPLICATION CHART

Refer to Engine Service Charts Manual Form ISS-1516 for Engine Service Charts.

Series	Machines used on
1	U-1 Power Unit
2	U-2A Power Unit
4	U-4 Power Unit
6	U-6 Power Unit
6	T-6 PAYdozer
9	U-9 Power Unit
9	T-9 PAYdozer
60	UC-60 Power Unit
123	U-123 Power Unit
123	I-100 and 100HC PAYtractor
123	I-130 PAYtractor
123	I-140 and 140HC PAYtractor
123	T-4 and T-4B PAYdozer
135	UC-135 and UC-135B Power Unit
135	T-340 and T-340A PAYdozer
135	T-5 and TC-5B PAYdozer
135	2404 PAYtractor
146	2424 PAYtractor
146	TD-500 and TD-500C PAYdozer
153	UC-153 Power Unit
153	4000 PAYlift
153	2444 PAYtractor
153	2500 Constructall
153	2504 PAYtractor
153	3514 PAYtractor
153	H-25B PAYloader
164	U-164 Power Unit
169	U-169 Power Unit

(Continued on next page)

ENGINE APPLICATION CHART (Cont.)

Series	Machines used on
175	U-175 Power Unit
264	U-264 Power Unit
264	T-6 (61) PAYdozer (38951 to 39765*)
281	U-281 Power Unit
281	T-6 (61) PAYdozer (39766 and up *)

* – Chassis Serial Number

1. DESCRIPTION

The IH 4-cylinder carbureted engines are all equipped with updraft type carburetors.

The 135, 135B, 175 and 281 series valve-inhead engines are all equipped with replaceable type cylinder sleeves. The 135 and 135B series sleeves are the wet type; the 175 and 281 series are dry type. The 153 series is a sleeveless version of the 135B engine.

The aluminum alloy, tin-plated, solid-skirt pistons are cam ground, and are fitted with two or three (according to series of engine) compression and one oil control rings. The full-floating type piston pins are held in place by snap rings at the ends of each pin.

The 60 series valves are in the block and the cast iron pistons are fitted in the cylinder bore in the crankcase, using two compression rings and one oil control ring.

The crankshaft main and connecting rod bearing journals are fully hardened. Steel-backed tri-metal main bearings support the crankshaft with the center bearing absorbing the crankshaft end thrust. These bearings are the precision insert type and require no machining during assembly or replacement.

The camshaft is driven by the idler gear and supported by three bearings. The end thrust is controlled by a thrust plate.

The connecting rods are heat-treated pressed steel and contain a bronze bushing at the upper end for installation of the piston pin. The lower end and cap contain the locking type selective fit bearing inserts that require no machining during assembly or replacement. The rods and caps are marked for identification and reassembly.

The lubrication system of the engine is forced fed. The cylinder walls are lubricated by oil forced out the sides of connecting rod bearings and thrown up to the pistons and the cylinder walls.

The crankcase, valve housing, and governor housing are ventilated through a pipe connected to the intake air filter to hold condensation to a minimum. The engine is protected against dust by a replaceable-element oil filter system. Seals are used at all shaft openings to prevent unnecessary wear of engine parts by the entry of dust, and to effectively prevent oil leakage.

A sensitive variable-speed governor makes it possible for the operator to select the most economical speed for the job to be done.

The magneto equipped engines are equipped with IH waterproof, high tension magnetos having automatic impulse coupling, or with distributors, thus insuring a hot spark for all engine speeds and for easy starting.

Refer to "SPECIFICATIONS" in Section 1, Par. 2.

GENERAL

2. SPECIFICATIONS

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
Number of cylinders	4	4	4	4	4	4
Bore and stroke-inches	2-5/8 x 2-3/4	3 x 4	3-1/8 x 4	3-1/4 x 4-1/16 3-3/8 x 4-1/4(153)	3-3/8 x 4-1/16	3-3/8 x 4-1/4
Displacement-cubic inches	60	113	123	135, 152 (153)	146	152
RPM-governed	2500	1800	*	*	*	1650
RPM-governed high idle	2750	1980	*	*	*	1815
RPM-governed low idle	450-500	500-550	400-450	*	*	400-450
Compression ratio-gasoline	7.0:1	6.0:1	7.3:1(gasoline) 4.8:1 (distillate)	7.8:1 (135, 135B) 8:1 (153)	7.6:1	5.9:1
Compression pressure at cranking speed (150 rpm)psi.**	– – –	– – –	175(gasoline) 95(distillate)	177 (135) 180(135B,153)	180	– – –
Compression pressure at hand cranking speed (50 rpm) psi.	89-93	119-125	– – –	– – –	– – –	115-120
CRANKSHAFT						
Crank pin diameter-inches	1.498-1.499	1.749-1.750	1.749-1.750	1.809-1.810(135) 2.059-2.060 (135B, 153)	2.059-2.060	2.2475-2.2485
Main journal diameter-inches	1.623-1.624	2.124-2.125	2.124-2.125	2.244-2.245 (135) 2.6235-2.6245 (135B, 153)	2.6235-2.6245	2.4975-2.4985
Maximum permissible journal out-of-roundness-inch	0.003	0.003	0.003	0.003	0.003	0.003
Number main bearings	3	3	3	3	3	3
Main bearing running clearance-inch	0.0004-0.0034	0.0009-0.0039	0.0009-0.0039	0.0009-0.0039	0.0009-0.0039	0.0010-0.0035
Maximum permissible main bearing clearance-inch	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
End Clearance-inch	0.006-0.010 (1) 0.004-0.008(60)	0.006-0.010	0.004-0.010	0.004-0.010(135) 0.004-0.010(135B, 153)	0.004-0.010	0.004-0.008
Maximum permissible end clearance-inch	0.012	0.012	0.012	0.012	0.012	0.012
Thrust taken by	Center main bearing	Rear main bearing	Rear main bearing	Rear main bearing	Rear main bearing	Center main bearing

* – Refer to Operators Manual

** – Compression pressures are based on the following conditions: Engine warmed up, battery fully charged, throttle wide open and all spark plugs removed.

Compression gauge readings given will apply at sea level barometric pressure. For each 1000 feet above sea level deduct 3-1/2 percent. For engines with high altitude pistons, the readings given will apply at 5000 feet. Deposits in combustion chambers will increase readings to some extent.

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
4	4	4	4	4	4	4
3-1/2 x 4-1/4	3-9/16 x 4-1/4	3-5/8 x 4-1/4	3-7/8 x 5-1/4	4 x 5-1/4	4-1/8 x 5-1/4	4.4 x 5.5
164	169	175	248	264	281	335
1800	2000	2000	1450	1600	1800	1500
1980	2200	2200	1595	1780	1980	1650
400-450	400-450	400-450	400-450	400-450	400-450	400-450
6.151:1	6.6:1	6.9:1	5.65:1	5.9:1	6.6:1	5.4:1
– – –	145	154	– – –	– – –	– – –	– – –
– – –	– – –	– – –	114-116	110-121	– – –	103-106
2.2975-2.2985	2.2975-2.2985	2.2975-2.2985	2.5475-2.5485	2.5475-2.5485	2.5475-2.5485	2.9965-2.9975
2.5575-2.5585	2.5575-2.5585	2.5575-2.5585	2.8075-2.8085	2.8075-2.8085	2.8075-2.8085	3.2475-3.2485
0.003	0.003	0.003	0.003	0.003	0.003	0.003
3	3	3	3	3	3	3
0.0011-0.0037	0.0011-0.0041	0.0011-0.0041	0.0011-9.0037	0.0011-0.0041	0.0011-0.0041	0.0020-0.0045
0.0055	0.0055	0.0055	0.0055	0.0065	0.0065	0.0065
0.004-0.008	0.004-0.008	0.004-0.008	0.004-0.008	0.004-9.008	0.003-0.011	0.003-0.011
0.012	0.012	0.012	0.012	0.012	0.012	0.016
Center main bearing	Center main bearing	Center main bearing	Center main bearing	Center main bearing	Center main bearing	Center main bearing

GENERAL

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
CAMSHAFT						
Running clearance-inch	Front & Center 0.0020-0.0045 rear 0.0010-0.0035	0.0015-0.0040	0.0009-0.0054	0.0009-0.0054	0.0009-0.0054	0.0015-0.0035
Maximum permissible running clearance-inch	0.006	0.006	0.006	0.006	0.006	0.006
End clearance-inch	0.003-0.012	0.003-0.012	0.003-0.012	0.003-0.012	0.003-0.012	0.003-0.011
Maximum permissible end clearance-inch	0.015	0.015	0.015	0.015	0.015	0.015
Number of teeth in drive gear	36	66	66	66	66	48
Number of bearings	3	3	3	3	3	3
Bearing journal diameter, front-inches	1.8710-1.8720	1.8110-1.8120	1.8110-1.8120	1.8110-1.8120	1.8710-1.8720	1.9305-1.9315
Bearing journal diameter, center-inches	1.7460-1.7470	1.5770-1.5780	1.5770-1.5780	1.5770-1.5780	1.5770-1.5780	1.8055-1.8065
Bearing journal diameter, rear-inches	.8720 - .8730	1.4990-1.5000	1.4990-1.5000	1.4990-1.5000	1.4990-1.5000	1.3680-1.3690
CONNECTING RODS						
Bearing end clearance-inch	0.005-0.012	0.003-0.013	0.005.0.014	0.005-0.014	0.005-0.014	0.008-0.012
Bearing clearance-inch	0.001-0.003	0.0010-0.0035	0.0009-0.0034	0.0009-0.0034 (135) 0.0009-0.0039 (135B, 153)	0.0009-0.0039	0.0010-0.0035
Maximum permissible bearing clearance-inch	0.0055	0.006	0.006	0.006	0.006	0.006
Service bushing bore -inches (ream after assembly)	0.6879-0.6882	0.9196-0.9199	0.9196-0.9199	0.9196-0.9199	0.9196-0.9199	1.1093-1.1096
PISTONS						
Overall length-inches	2-7/8	3-1/2	3-47/64	3-45/64 (135B) 3-31/64 (135,153)	3-31/64	4-7/16
Diameter -inches	2.6230-2.6250	2.9976-2.9996	3.1232-3.1257	3.2482-3.2507 (135, 135B) 3.3735-3.3760(153)	3.3735-3.3760	3.3701-3.3733
Skirt clearance, bottom-inch	0.0016-0.0024	0.0022-0.0030	0.0011-0.0019	0.0011-0.0019 (135,135B) 0.0010-0.0020(153)	0.0010-0.0020	0.0039-0.0047
Skirt clearance, top-inch (measured 90° from pin hole)	0.0016-0.0024	0.0022-0.0030	0.0011-0.0019	0.0011-0.0019 (135, 135B) 0.0010-0.0020(153)	0.0010-0.0020	0.0039-0.0047
Piston check with 1/2 inch shim stock - lbs.	4-14	6-14	6-14	6-14	6-14	7-15
Shim stock thickness used - inch	0.001-0.002	0.002-0.003	0.002-0.003	0.002-0.003	0.002-0.003	0.0035-0.0045
Number or rings per piston	3	4	4* 3**	3	3	4

* — Serial No. 501 - 35830 ** — 35831 and up

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
0.0015-0.0035	0.0015-0.0035	-.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035
0.006	0.006	0.006	0.006	0.006	0.006	0.006
0.003-0.011	0.003-0.011	0.003-0.011	0.003-0.011	0.003-0.011	0.003-0.011	0.002-0.010
0.015	0.015	0.015	0.015	0.015	0.015	0.015
48	48	48	58	58	58	54
3	3	3	3	3	3	3
1.9305-1.9315	1.9305-1.9315	1.9305-1.9315	2.2430-2.2440	2.2430-2.2440	2.2430-2.2440	2.3055-2.3065
1.8055-1.8065	1.8055-1.8065	1.8055-1.8065	2.1180-2.1190	2.1180-2.1190	2.1180-2.1190	2.1805-2.1815
1.3680-1.3690	1.3680-1.3690	1.3680-1.3690	1.8680-1.8690	1.8680-1.8690	1.8680-1.8690	1.8680-1.8690
0.007-0.014	0.007-0.014	0.007-0.014	0.005-0.012	0.007-0.014	0.007-0.014	0.008-0.015
0.0011-0.0037	0.0011-0.0041	0.0011-0.0041	0.0011-0.0037	0.0011-0.0041	0.0011-0.0041	0.0020-0.0045
0.006	0.006	0.006	0.006	0.006	0.006	0.007
1.1093-1.1096	0.8751-0.8753	0.8751-0.8753	1.3131-1.3134	1.0001-1.0003	1.0001-1.0003	1.5007-1.5009
4-7/16	4-1/4	4-1/4	5-5/16	5-5/16	5-1/8	6
3.4961-3.4977	3.5600-3.5620	3.6220-3.6230	3-7/8	4	4.1220-4.1240	4.4
0.0039-0.0047	0.0039-0.0047	0.0039-0.0047	0.005-0.006	0.007-0.009	0.0025-0.0035	0.006-0.007
0.0039-0.0047	0.0039-0.0047	0.0039-0.0047	0.005-0.006	0.014-0.015	0.0025-0.0035	0.006-0.007
7-15	7-15	7-15	2-7	7-15	7-15	3-6
0.0035-0.0045	0.0035-0.0045	0.0035-0.0045	0.0045	0.0015-0.0025	0.0015-0.0025	0.0045
4	4	4	4	4	4	5

GENERAL

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
PISTONS (Continued)						
Width of ring groove - compression ring, top-inch	0.0955-.0965	0.127-0.128	0.0965-0.0975	0.0965-0.0975	0.0965-0.0975	0.127-0.128
Width of ring groove - compression ring, second-inch	0.0955-0.0965	0.126-0.127	0.095-0.096	0.095-0.096	0.095-0.096	0.157-0.158
Width of ring groove - compression ring, third-inch	– – –	0.126-0.127	0.095-0.096	– – –	– – –	0.157-0.158
Width of ring groove - oil ring-inch	0.1880-0.1890	0.2505-0.2515	0.2605-0.2615	0.1880-0.1890 (135) 0.1885-0.1895 (135B, 153)	0.1885-0.1895	0.2505-0.2515
Ring gap - compression ring, top-inch	0.007-0.017	0.010-0.020	0.010-0.020	0.010-0.020	0.010-0.020	0.010-0.020
Ring gap - compression ring, second-inch	0.007-0.017	0.010-0.020	0.010-0.020	0.010-0.020	0.010-0.020	0.010-0.020
Ring gap - compression ring, third-inch	– – –	0.010 - 0.018	0.010-0.018	– – –	– – –	0.010-0.018
Maximum permissible compression ring gap - inch	0.030	0.030	0.030	0.030	0.030	0.030
Ring gap - oil ring - inch	0.007-0.015	0.010-0.020	0.018-0.028	0.018-0.028		0.010-0.020
Maximum permissible oil ring gap - inch	0.030	0.030	0.030	0.030	0.030	0.030
PISTON COMPRESSION RINGS						
Number or rings per piston	2	3	3* or 2**	2	2	3
Type	Top, counter-bored; lower, scraper	Upper two, plain; lower, taper face	Top, thick wall lower two, plain	Top, thick wall lower, plain 153	Top, thick wall lower plain	Upper two plain; lower, taper face
Width of ring, first-inch	0.0930-0.0935	0.1235-0.1240	0.0930-0.0935	0.0930-0.0935	0.0930-0.0935	0.1235-0.1240
Width of ring, second-inch	0.0930-0.0935	0.1235-0.1240	0.0930-0.0935	0.0930-0.0935	0.0930-0.0935	0.1545-0.1550
Width of ring, third-inch	– – –	0.1235-0.1240	0.0930-0.0935	– – –	– – –	0.1545-0.1550
PISTON OIL RING						
Number of rings per piston	1	1	1	1	1	1
Type	Ventilated - WS 85-1	Ventilated	Ventilated	Ventilated - with expander	Chrome- wide slot	Ventilated - with expander
Width, inch	0.1860-0.1865	0.2485-0.2490	0.2485-0.2490	0.1860-0.1865	0.1860-0.1865	0.2485-0.2490
RING CLEARANCE IN GROOVE						
Compression ring, top-inch	0.0020-0.0035	0.0035-0.0040	0.0030-0.0045	0.0030-0.0045	0.0030-0.0045	0.0030-0.0045
Compression ring, second-inch	0.0020-0.0035	0.0035-0.0040	0.0020-0.0035	0.0015-0.0030 (135B, 153) 0.0020-0.0035 (135)	0.0020-0.0035	0.0020-0.0035
Compression ring, third-inch	– – –	0.0035-0.0040	0.0020-0.0035	– – –	– – –	0.0020-0.0035
Oil rings - inch	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030

* – Serial No. 501 - 35830 ** – 35831 and up.

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
0.097-0.098	0.097-0.098	0.097-0.098	0.127-0.128	0.097-0.098	0.097-0.098	0.158-0.159
0.0955-0.0965	0.0955-0.0965	0.0955-0.0965	0.157-0.158	0.0955-0.0965	0.0955-0.0965	0.157-0.158
0.0955-0.0965	0.0955-0.0965	0.0955-0.0965	0.157-0.158	0.0955-0.0965	0.0955-0.0965	0.157-0.158
0.2505-0.2515	0.2505-0.2515	0.2505-0.2515	0.2505-0.2515	0.2505-0.2515	0.2505-0.2515	0.251-0.252
0.007-0.017	0.010-0.020	0.010-0.020	0.010-0.020	0.013-0.023	0.013-0.023	0.010-0.020
0.007-0.017	0.010-0.020	0.010-0.020	0.010-0.020	0.013-0.023	0.013-0.023	0.010-0.020
0.007--.017	0.010-0.020	0.010-0.020	0.010-0.018	0.013-0.023	0.013-0.023	0.010-0.018
0.030	0.030	0.030	0.030	0.030	0.030	0.030
0.007-0.017	0.010-0.018	0.018-0.028	0.010-0.020	0.013-0.023	0.021-0.033	0.013-0.023
0.030	0.030	0.030	0.030	0.035	0.035	0.035
3	3	3	3	3	3	3
Top, taper face; lower two, Type No. 70	Top, taper face; lower two, Type No. 70	Top, taper face; lower two, Type No. 200	Upper two, plain; lower, taper face	Top, taper face; lower two, scraper	Top, thick wall; lower two, Type No. 200	Upper two, plain; lower, taper face
0.0930-0.0935	0.0930-0.0935	0.0930-0.0935	0.1235-0.1240	0.0930-0.0935	0.0930-0.0935	0.1545-0.1550
0.0930-0.0935	0.0930-0.0935	0.0930-0.0935	0.1540-0.1550	0.0930-0.0935	0.0930-0.0935	0.1545-0.1550
0.0930-0.0935	0.0930-0.0935	0.0930-0.0935	0.1540-0.1550	0.0930-0.0935	0.0930-0.0935	0.1540-0.1550
1	1	1	1	1	1	2
Ventilated	Ventilated - WS-85-3	Ventilated with expander	Ventilated with expander	Ventilated	Ventilated with expander	Ventilated
0.2485-0.2490	0.2485-0.2490	0.2441-0.2474	0.2485-0.2490	0.2485-0.2490	0.2441-0.2474	0.2485-0.2490
0.0035-0.0050	0.0035-0.0050	0.0035-0.0050	0.0030-0.0045	0.0035-0.0050	0.0035-0.0050	0.0030-0.0045
0.0020-0.0035	0.0020-0.0035	0.0020-0.0035	0.0020-0.0040	0.0020-0.0035	0.0020-0.0035	0.0020-0.0035
0.0020-0.0035	0.0020-0.0035	0.0020-0.0035	0.0020-0.0040	0.0020-0.0035	0.0020-0.0035	0.0020-0.0035
0.0015-0.0020	0.0015-0.0030	0.0031-0.0074	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0020-0.0035

GENERAL

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
PISTON PINS						
Retained by	Snap rings	Snap rings	Snap rings	Snap rings	Snap rings	Snap rings
Diameter - inches	0.6875-0.6878	0.9192-0.9195	0.9192-0.9195	0.8591-0.8593	0.8591-0.8593	1.1089-1.1092
Length - inches	2.185-2.195	2.483-2.493	2.483-2.493	2.738-2.753	2.738-2.753	2.770-2.775
*Clearance - between end of pin and retainer ring - inch	0.010-0.030	0.005-0.039	0.005-0.039	0.005-0.039(135) 0.005-0.055 (135B, 153)	0.005-0.055	0.005-0.034
Maximum permissible clearance in rod - inch	0.004	0.004	0.004	0.004 (135) 0.003 (135B,153)	0.003	0.004
Maximum permissible clearance in piston - inch	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
CYLINDER SLEEVES						
Type	– – –	Wet, replaceable	Wet, replaceable	Wet (135, 135B only)replaceable	– – –	Dry, replaceable
Diameter, inside - inches	2-5/8 (Cylinder bore)	3	3-1/8	3-1/4	– – –	3-3/8
Length - inches	– – –	6-13/16	7	7	– – –	8-5/16
Maximum permissible diametrical sleeve wear (at top of ring travel) - inch	– – –	0.006	0.006	0.006	– – –	0.007
Top surface of cylinder sleeve flange, extends above top surface of crankcase, - inch	– – –	0.000-0.006	0.000-0.006	0.003-0.007	– – –	0.000-0.006
INTAKE VALVES						
Stem diameter - inch	0.3095-0.3105	0.3405-0.3415	0.3405-0.3415	0.3405-0.3415	0.3405-0.3415	0.3405-0.3415
Port diameter - inches	63/64	1-3/16	1-3/16	1-3/16	1-3/16	1-11/32
Tappet clearance, hot - inch	0.013	0.014	0.014	0.014 (135)	0.014	0.017
Tappet clearance, cold - inch	0.010 (1) 0.015 (60)	0.016	0.016	0.016	0.016	0.019
Head diameter - inches	1-3/32	1-11/32	1-1/2(gasoline) 1-11/32(distillate)	1-1/2	1-1/2	1-1/2
Stem clearance in guide - inch	0.001-0.003 (1) 0.0015-0.0035(60)	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.002-0.004
Maximum permissible stem clearance in guide - inch	0.006	0.006	0.006	0.006	0.006	0.006
Valve seat angle - degrees	45	45	45	45	45	45-1/2-46
Valve face angle - degrees	45	45	45	45	45	45
Width of valve seat (face of valve) - inch	3/64	5/64	5/64	5/64	5/64	5/64
Stem guides, length - inches	1-1/2	2-11/16	2-11/16	2-11/16	2-11/16	2-15/16

* – For method for checking clearance, refer to Par. 5, "REASSEMBLY," Section 3.

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
Snap rings	Snap rings	Snap rings	Snap rings	Snap rings	Snap rings	Snap rings
1.1089-1.1092	0.8747-0.8750	0,8747-0.8750	1.3125-1.3128	1.3125-1.3128	1.3125-1.3128	1.500-1.5003
2.770-2.775	2.945-2.956	2.945-2.956	3.225-3.235	3.324-3.334	3.324-3.334	3.698-3.703
0.010-0.015	0.009-0.030	0.009-0.030	0.005-0.031	0.005-0.031	0.005-0.031	0.005-0.022
0.004	0.004	0.004	0.004	0.004	0.004	0.004
0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
Dry, replaceable	Dry, replaceable	Dry, replaceable	Dry, replaceable	Dry, replaceable	Dry, replaceable	Dry, replaceable
3-1/2	3-9/16	3-5/8	3-7/8	4	4-1/8	4.4
8-5/16	8-5/16	8-5/16	10-1/8	10-1/8	10-1/8	11-3/8
0.007	0.007	0.007	0.008	0.008	0.008	0.010
0.000-0.006	0.000-0.006	0.000-0.006	0.000-0.006	0.000-0.006	0.000-0.006	0.000-0.006
0.3405-0.3415	0.3405-0.3415	0.3405-0.3415	0.371-0.372	0.371-0.372	0.371-0.372	0.4015-0.4025
1-23/64	1-23/64	1-23/64	1-19/32	1-19/32	– – –	1-7/8
0.017	0.017	0.017	0.017	0.017	0.017	0.017
0.019	0.019	0.019	0.019	0.019	0.019	0.019
1-1/2	1-1/2	1-1/2	1-13/16	1-13/16	1-13/16	2-3/32
0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004
0.006	0.006	0.006	0.006	0.006	0.006	0.006
45	45	45	45	45-1/2-46	45	45
45	45	45	45	45	45	45
5/64	5/64	5/64	5/64	5/64	5/64	5/64
2-29/32	2-29/32	2-29/32	3-7/32	3-7/32	3-7/32	3-3/4

GENERAL

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
INTAKE VALVES – Continued						
Valve guides, I.D., inch	0.312-0.313	0.343-0.344	0.343-0.344	0.343-0.344	0.343-0.344	0.3435-0.3445
Clearance, valve to guide - inch (See "Stem clearance in guide" on page 8)						
EXHAUST VALVES						
Stem diameter - inch	0.3095-0.3105	0.3405-0.3415	0.3405-0.3415	0.3405-0.3415	0.3405-0.3415	0.3405-0.3415
Port diameter - inches	51/64	1	1	1-5/32	1-5/32	1-7/32
Tappet clearance, hot-inch	0.013	0.014	0.014	0.014 (135)	– – –	0.017
Tappet clearance, cold-inch . . .	0.015	0.016	0.016	0.016 (135) 0.020 (135B,153)	0.020	0.019
Head diameter - inches	29/32	1-5/32	1-5/16(gasoline) 1-5/32(distillate)	1-5/16	1-5/16	1-3/8
Valve seat angle - degrees	45	45	45	45	45	45
Valve face angle - degrees	45	45	45	45	45	45
Width of valve seat (face of valve) - inch	3/64	5/64	5/64	5/64	5/64	5/64
Stem guides, length - inches.	1-1/2	2-11/16	2-11/16	2-11/16	2-11/16	2-15/16
Clearance of valve to guide-inch	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.002-0.004
Maximum permissible clearance of valve to guide-inch	0.006	0.006	0.006	0.006	0.006	0.006
VALVE TIMING						
Intake opens-degrees	10 before TDC(1) 5 after TDC (60)	15 before TDC	15 before TDC	15 before TDC	15 before TDC	5 after TDC
Intake closes - degrees	45 after BDC	45 after BDC	45 after BDC	45 after BDC	45 after BDC	41 after BDC
Exhaust opens - degrees	45 before BDC(1) 42 before BDC(60)	45 before BDC	45 before BDC	45 before BDC	45 before BDC	42 before BDC
Exhaust closes - degrees	10 after TDC(60) 5 after TDC (1)	10 after TDC	10 after TDC	10 after TDC	10 after TDC	10 after TDC
VALVE LEVER AND SHAFT						
Valve lever shaft diameter-inch. .	– – –	3/4	3/4	3/4	3/4	3/4
Valve lever clearance on shaft-inch	– – –	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004
Maximum permissible valve lever clearance on shaft-inch	0.006	0.006	0.006	0.006	0.006	0.006
Valve lever service bushing (reamed to size):						
Diameter, outside - inch	– – –	7/8	7/8	7/8	7/8	7/8
Length - inches	– – –	1	1	1	1	1

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
0.3435-0.3445	0.3435-0.3445	0.3435-0.3445	0.374-0.375	0.374-0.375	0.374-0.375	0.4045-0.4055
0.3405-0.3415	0.3405-0.3415	0.3405-0.3415	0.371-0.372	0.371-0.372	0.371-0.372	0.4015-0.4025
1-15/64	1-15/64	1-15/64	1-7/16	1-7/16	1-7/16	1-11/16
0.017	0.017	0.017	0.017	0.017	0.017	0.017
0.019	0.019	0.019	0.019	0.019	0.019	0.019
1-3/8	1-3/8	1-3/8	1-21/32	1-21/32	1-21/32	1-29/32
45	45	45	45	45	45	45
45	45	45	45	45	45	45
5/64	5/64	5/64	3/32	3/32	5/64	3/32
2-29/32	2-29/32	2-29/32	3-7/32	3-7/32	3-7/32	3-3/4
0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004
0.006	0.006	0.006	0.006	0.006	0.006	0.006
10 before TDC	10 before TDC	10 before TDC	5 after TDC	5 before TDC	5 before TDC	5 after TDC
40 after BDC	40 after BDC	40 after BDC	41 after BDC	41 after BDC	41 after BDC	41 after BDC
40 before BDC	40 before BDC	40 before BDC	42 before BDC	42 before BDC	42 before BDC	42 before BDC
10 after TDC	10 after TDC	10 after TDC	10 after TDC	10 after TDC	10 after TDC	10 after TDC
3/4	3/4	3/4	3/4	3/4	3/4	7/8
0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004	0.002-0.004
0.006	0.006	0.006	0.006	0.006	0.006	0.006
7/8	7/8	7/8	7/8	7/8	7/8	1
1	1	1	1	1	1	1-3/16

GENERAL

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
VALVES TAPPETS						
Diameter - inches	19/32	9/16	9/16	9/16	9/16	1
Length - inches	2-3/8	2-5/16	2-5/16	2-5/16	2-5/16	2-1/4
Tappet clearance in guide-inch	0.0007-0.0032	0.0005-0.0030	0.0005-0.0030	0.0005-0.0030	0.0005-0.0030	0.001-0.003
Push rod diameter - inch	– – –	1/4	9/32	9/32	9/32	9/32
Push rod (bottom of cup to ball tip) - inches	– – –	10-5/8	10-5/8	10-5/8	10-5/8	14-9/16
VALVE SPRINGS (NOTE 1)						
Free length - inches	1-31/32 ± 1/32	2-17/32 ± 3/64	2-13/32(gasoline) 2-47/64 (distillate)	2-13/32(Intake) 2-15/64 (135B and 153 Exhaust)	2-13/32	2-17/32 ± 3/64
Test length - inches	1-1/4	1-43/64	1-11/16(gasoline) 1-43/64 (distillate)	1-11/16(Intake) 1-29/64 (135B and 153 Exhaust)	1-11/16	1-43/64
Test load - pounds	22-24	40-45	73-81 (gasoline) 40-44 (distillate)	73-81.6 (Intake) 80.1-87.1 (135B and 153 Exhaust)	73-81	40-45
CYLINDER HEAD						
Maximum allowable removal of material, inch	0.005	0.005	0.005	0.005	0.005	0.005
TIMING GEARS						
Backlash - inch	0.003-0.006	0.003-0.006	0.003-0.006	0.003-0.006	0.003-0.006	0.003-0.006
Maximum permissible backlash - inches	0.009	0.009	0.009	0.009	0.009	0.009
Idler gear end clearance	0.007-0.011	– – –	– – –	– – –	– – –	0.007-0.011
Maximum permissible idler gear end clearance	0.017	– – –	– – –	– – –	– – –	0.017
LUBRICATION SYSTEM (Oil Pressure)						
Oil pressure at rated rpm - psi	30-35	50-60	45-55	45-55	45-55	60-70
LUBRICATING OIL PUMP						
End play - between gear and end plate - inch	0.0015-0.0025	0.0035-0.0065	0.0035-0.0060	0.0035-0.0060	0.0035-0.0060	0.0035-0.0065
Clearance, gear to housing - inch total	0.004-0.012	0.005-0.009	0.007-0.013	0.007-0.013 (135) 0.0068-0.0108 (135B and 153)	0.0068-0.0108	0.007-0.013
Backlash	0.007-0.012	0.003-0.006	0.004-0.006	0.004-0.006	0.004-0.006	0.004-0.006
Drive shaft journals, diameter - inch	– – –	1/2	1/2	1/2	1/2	5/8

NOTE 1: C-123 w/Serial Number 120979 and below, C-135 w/Serial Number 120229 and below, C-146 w/Serial Number 015949 and below and C-153 w/Serial Number 042264 and below use springs with a free length of 2-47/64 inches, test length of 1-11/16 inches and test load of 49 to 54.6 pounds.

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
1	1	1	1-1/4	1-1/4	1-1/4	1-1/4
2-1/4	2-1/4	2-1/4	2-21/32	2-21/32	2-21/32	2-21/32
0.0005-0.0030	0.0005-0.0030	0.0005-0.0030	0.0005-0.0030	0.0005-0.0030	0.0005-0.0030	0.0005-0.0030
9/32	5/16	5/16	7/16	7/16	7/16	7/16
14-13/32	14-27/32	14-27/64	17-13/32	17-11/64	17-11/64	19-3/16
2-9/32 ± 3/64	2-9/32 ± 3/64	2-9/32 ± 3/64	2-37/64 ± 1/16	2-37/64 ± 1/16	2-37/64 ± 1/16	2-7/8 ± 1/16
1-9/16	1-9/16	1-9/16	1-21/32	1-21/32	1-21/32	2-1/2
66-73	66-73	66-73	90-97	90-97	90-97	50-56
0.005	0.005	0.005	0.005	0.005	0.005	0.005
0.003-0.006	0.003-0.006	0.003-0.006	0.003-0.006	0.003-0.006	0.003-0.006	0.003-0.006
0.009	0.009	0.009	0.009	0.009	0.009	0.009
0.007-0.011	0.007-0.011	0.007-0.011	0.004-0.009	0.004-0.009	0.004-0.009	0.009-0.013
0.017	0.017	0.017	0.014	0.014	0.014	0.020
60-70	60-70	60-70	60-70	60-70	60-70	60-70
0.0035-0.0065	0.0035-0.0065	0.0035-0.0065	0.0035-0.0065	0.0035-0.0065	0.0035-0.0065	0.0035-0.0065
0.007-0.013	0.007-0.013	0.007-0.013	0.007-0.013	0.007-0.013	0.007-0.013	0.012-0.015
0.004-0.006	0.004-0.006	0.004-0.006	0.004-0.006	0.004-0.006	0.004-0.006	0.004-0.006
5/8	5/8	5/8	5/8	5/8	5/8	5/8

GENERAL

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
LUBRICATING OIL PUMP - Cont.						
Drive shaft running clearance - inch	– – –	0.0010-0.0025	0.0010-0.0025	0.0010-0.0025 (135) 0.0010 - 0.0035 (135B and 153)	0.0010-0.0035	0.0010-0.0025
Idler gear running clearance, in on shaft	0.001-0.004	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030
Clearance between body and drive pinion - inch	– – –	1/32	1/32	1/32 (135) 0.002-0.004 (135B and 153)	0.002-0.004	1/32
OIL FILTER (Purolator-radial fin) or (Umbrella type)						
Number used	1	1	1	1	1	1
Oil pressure valve location	Crankcase	Oil pump body	Oil pump body	Oil pump body	Oil pump body	Oil pump body
OIL PRESSURE VALVE REGULATING SPRING						
Free length - inches	2-31/32	2-31/32	2-13/32	2-13/32	2-13/32	3-49/64
Test length - inches	2-15/32	2-15/32	1-43/64	1-43/64	1-43/64	2-3/32
Test load - pounds	0.63	26.02	24.2	24.2	24.2	42.2
WATER PUMP						
Type of seal	– – –	– – –	– – –	Packless	Packless	Packing
Rotation, drive end	– – –	– – –	– – –	Clockwise	Clockwise	Clockwise
Impeller shaft dia. inch	– – –	– – –	– – –	– – –	– – –	0.4355-0.4360
Shaft running clearance, inch	– – –	– – –	– – –	– – –	– – –	0.0010-0.0025
THERMOSTAT						
Number used	– – –	– – –	– – –	1	1	1
Open at, degrees F	– – –	– – –	– – –	180	180	165
Wide open at, degrees F	– – –	– – –	– –	192	192	195

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
0.0010-0.0025	0.0010-0.0025	0.0010-0.0025	0.0010-0.0025	0.0010-0.0025	0.0010-0.0025	0.0010-0.0025
0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030	0.0015-0.0030
1/32	1/32	1/32	1/32	1/32	1/32	0.005-0.010
1 Oil pump body	1 Oil pump body	1 Oil pump body	1 Oil pump body	1 Oil pump body	1 Oil pump body	1 Oil filter base
3-49/64 2-3/32 42.1	3-49/64 2-3/32 42.1	3-49/64 2-3/32 42.1	3-49/64 2-3/32 42.2	3-49/64 2-3/32 42.2	3-49/64 2-3/32 42.2	3-39/64 2-3/32 38.2
Pacing Clockwise 0.4355-0.4360 0.0010-0.0025	Packing Clockwise 0.4355-0.4360 0.0010-0.0025	Packing Clockwise 0.4355-0.4360 0.0010-0.0025	Packing Clockwise 0.6215-0.6220 0.0025-0.0040	Packing Clockwise 0.6215-0.6220 0.0025-0.0040	Packing Clockwise 0.6215-0.6220 0.0025-0.0040	Packing Clockwise 0.6215-0.6220 0.0025-0.0040
1 165 195	1 165 195	1 180 192	1 165 195	1 165 195	1 165 195	1 165 195

GENERAL

DESCRIPTION	1 and 60 Series	2A Series	123 Series	135, 135B and 153 Series	146 Series	4 Series
*NUT AND BOLT TORQUE DATA (Foot-pounds torque)						
Cylinder head, nut to stud	47	85	85	85	85	73
Connecting rod, nut to stud	18	45	46	46	46	43
Crankshaft pulley nut	– – –	– – –	140	140	140	– – –
Main bearing, nut or bolt	58	78	78	78	78	78
Flywheel bolt	47	41	41	49	49	67
Manifold, nut to stud	23	23	35	35	34	53
Idler gear shaft nut or cap screw	95	80	– – –	– – –	– – –	80
Spark plugs	33	33	33	33	33	33
Crankcase oil pan			15	15	15	

* – All torques are given with bolts, studs and nuts lubricated with SAE-30 engine oil.

164 Series	169 Series	175 Series	6 Series	264 Series	281 Series	9 Series
73	73	73	113	113	113	155
43	43	43	57	57	57	88
– – –	– – –	– – –	– – –	– – –	– – –	– – –
78	78	78	103	103	103	128
67	67	67	67	67	67	67
53	53	53	53	53	53	43
80	80	80	80	80	80	80
33	33	33	33	33	33	33

LOCTITE RETAINING AND SEALING COMPOUNDS

(Special Loctite data, if any, is shown in the specific section of this manual that is affected.)

GENERAL

Compound Description

These products are single component, self-curing, polyester compounds which remain liquid while exposed to air, and hardened by chemical action into tough structural solids when confined between closely mated metal parts. These compounds will resist solvents, heat, shock and vibration and are intended to provide a positive seal against leakage, and shear strength resistance to loosening when used in the assembly of threaded, slip fit, or press fitted parts.

Loctite Grades (General Usage)

1. GRADE 262 or GRADE B (Yellow) – Straight threaded fasteners.

2. GRADE "AVV" or GRADE 277 - Straight threaded fasteners, higher strength for studs, etc.

3. PLASTIC GASKET – Use as seal between mating surfaces.

4. UNFILLED PIPE SEALANT (HVV) - Use on tapered pipe threads. DO NOT substitute grades or usage unless specified.

5. HYDRAULIC SEALANT – Fuel fittings, straight pipe threads.

Temperature Range

Once cured, these compounds have an operating temperature range of -65 to 300°F, and will resist attack by oils, chemicals, hydraulic fluids and solvents.

Exceptions – DO NOT use Loctite:

1. Where other means of retaining the assembly are provided such as, prevailing torque fasteners (fasteners with distorted threads or plastic inserts), lock washers, lock plates and lock wires.

2. On items requiring frequent servicing.

3. When the operating temperature exceeds 300°F. (Example: Engine exhaust system.)

4. On brass fittings and plugs.

SURFACE PREPARATION

Plain and Phosphate Coated Parts

Clean the surfaces where compounds are to be applied to remove heavy coatings of oil, grease and dirt (rust or light oil film are not detrimental). Normal shop practice of cleaning or degreasing is adequate. Phosphage and oiled hardware is used in the "as received" condition.

Zinc or Cadmium Plated Parts or for Rapid Hardening

At least one of the mating surfaces should be degreased with a cleaning solution to which concentrated primer has been added. (1 part primer concentrated to 30 parts trichlorethylene or 1-1-1 trichlorethylene.) Allow surfaces to dry for 3 to 5 minutes before applying compound.

Drawbar Studs or Special Stud Applications

Degrease parts with a cleaning solution to which concentrated primer has been added. (1 part primer concentrated to 30 parts trichlorethylene or 1-1-1 trichlorethylene). Allow surfaces to dry for 3 to 5 minutes before applying compound. In blind holes be sure to remove all chips and oil.

Face Sealant (Plastic Gasket)

Mating parts must be cleaned as for plain and phosphate coated parts.

APPLICATION

Cap Screws and Pipe Threads

Fill the first 2 to 3 leading threads in area of engagement with compound. For large quantities of cap screws, may also be applied by tumbling method (refer to manufacturer's instructions).

Studs

Apply by hand to individual studs. Fill full length of thread with one strip on diameters up to 1 inch, two strips 180° apart on diameters up to 2 inches, and three strips 120° apart on diameters over 2 inches. In all cases apply one strip into tapped holes.

Blind hole applications - apply enough compound to fill the bottom 2 to 3 threads of engagement, then insert stud. If engagement length exceeds one diameter use proportionally more compound.

For non-seated studs (studs that can go deeper in hole than required) turn stud one turn deeper than required. After bubbling stops, apply a ring of compound around stud at top of hole, then turn back to required height.

Primers

Apply primer to surface where sealant is to be applied. Allow primer solvent to evaporate 3 to 5 minutes before applying adhesive. When adhesive is applied to a primed surface, parts should be assembled within 3 minutes.

APPLICATION - Continued

Face Sealant (Plastic Gasket)

Spread an even coat (1 cc per 40 sq. inches) on one of the mating surfaces. Assemble and tighten bolts.

NOTE: *On crawler tractor applications only, when compound is used as a gasket, bolts which attach the parts should be coated with MPL (gear lubricant) to prevent compound from sticking to bolts.*

SETTING TIME (BEFORE PLACING IN OPERATION)

A. Normal time for compound grades without use of any primer - 6 to 24 hours at room temperature with machined carbon steel parts. Higher temperatures will accelerate cure and lower temperatures will retard cure. Other base metals will provide more or less catalytic effect on cure.

B. Primed surfaces - 2 to 6 hours. This may be speeded by pretreating mating surfaces with special primers. Some metals (such as zinc and cadmium plate, anodized aluminum, and passivated stainless steel) are inactive and require heat or primer to cure the compound.

C. A fast curing type primer will fix parts for normal handling in 10 to 15 minutes and will achieve 75 percent of ultimate strength in 1 hour and full cure in 2 to 4 hours.

REMOVAL

Parts difficult to remove can be preheated to 400° to 500°F prior to removal.

APPLICATION AT LOW TEMPERATURES

A. Without special precautions, these compounds can be applied and will cure at temperatures down to 50°F, and at that temperature full strength will be obtained within 72 hours.

B. At temperatures from 50° to 0°F, only a job identified compound with the use of a primer can be recommended.

C. If necessary, the compounds can be applied at temperatures below 0°F, only if heat is used to accelerate the cure as follows:

150° F for 60 minutes
200° F for 45 minutes
250° F for 30 minutes

GENERAL

TORQUE – VALUES FOR STANDARD FASTENERS

This chart provides tightening torque for general purpose applications using original equipment standard hardware as listed in the Parts Catalog for the machine involved. DO NOT SUBSTITUTE. Original equipment standard hardware is defined as IH Type 8, coarse thread bolts and nuts and thru hardened flat washers (Rockwell "C" 38-45), all phosphate coated and assembled without supplemental lubrication (as received condition).

The torques shown below also apply to the following:

1. Phosphate coated bolts used in tapped holes in steel or gray iron.
2. Phosphate coated bolts used with phosphate coated prevailing torque nuts (nuts with distorted threads or plastic inserts).
3. Phosphate coated bolts used with copper plated weld nuts.

Marking on bolt heads or nuts indicate material grade ONLY and are NOT to be used to determine required torque.

NOMINAL THREAD DIAMETER	STANDARD TORQUE ± 10%	
	FOOT LBS.	NEWTON METERS
1/4	7	10
5/16	14	19
3/8	24	32
7/16	38	51
1/2	60	80
9/16	80	110
5/8	115	155
3/4	200	270
7/8	320	440
1	480	650
1-1/8	590	800
1-1/4	830	1100
1-3/8	1100	1500
1-1/2	1400	1900
1-3/4	2300	3100
2	3400	4600

SPECIAL TORQUES

Each machine has some non-standard torques which are necessary for proper component function. These are listed under "SPECIAL TORQUES" shown elsewhere in this manual. Typical examples are hose clamps, non-rigid joints (gaskets), non-ferrous fasteners or tapped holes, spanner nuts, fine thread fasteners, jam nuts, and cases where loading or distortion are critical factors.

TORQUE VALUES FOR HOSE CLAMPS

The following chart provides the tightening torques for hose clamps used in all rubber applications (radiator, air cleaner, operating lever boots, hydraulic system, etc.).

Clamp Type & Size	Torque Plus or Minus 5 in. lbs. (0.6 NM)			
	Radiator, Air Cleaner, Boots, etc.		Hydraulic System	
	Inch Lbs.	Newton Meters	Inch Lbs.	Newton Meters
"T" Bolt (any diameter)	60	7	45	5
Worm Drive - 1-3/4" Open Diameter & Under	25	3	45	5
Worm Drive - Over 1-3/4" Open Diameter	45	5	45	5

ELECTRICAL

NOTE: *For electrical components, except distributor, on applications other than Power Units, refer to Chassis Service Manuals.*

CRANKING MOTOR

Model Number (Delco-Remy)	1109613	1107430	1107926	1108921	1107343
Tractor or Power Unit Model Number	U-1, UC-60	U-2A, U-123, UC-135, T-340, U-4, U-164, U-169 & U-175	U-6, U-264 and U-281	U-9	UC-135B, UC-153 and H-25B
Volt	6	6	6	6	12
Type of Drive	Bendix	Bendix	Bendix	Bendix	Over-running clutch
Rotation (Viewing drive end)	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise
Brush spring tension (ounces)	24-28	24-28	24-28	36-40	35
No Load Test	60 amps at 5.7 volts at 5000 rpm	65 amps at 5 volts at 6000 rpm	60 amps at 5 volts at 6000 rpm	70 amps at 5.65 volts at 3000 rpm	49 amps (min) at 10.6 volts at 6200 rpm (min)
Lock Test	8.5 lbs. ft. at 450 amps at 3.75 volts	15 lbs. ft. at 570 amps at 3.15 volts	15 lbs. ft. at 600 amps at 3 volts	19 lbs. ft. at 500 amps at 3 volts	———

GENERATOR CHART A

ENGINE MODEL	GENERATOR MODEL NUMBER	VOLTAGE REGULATOR MODEL NUMBER	GENERATOR RELAY MODEL NUMBER
U-2A (new), U-164, U-6 (new), U-264	1100501	1118308	———
U-123, U-4 (new), U-169, U-175, U-281	1100501	1118780	———
U-1 (new), UC-60	1100535	1118790	———
UC-135, T-340	1100042	1118780	———
U-1 (old), U-2A (old), U-4 (old), U-6 (old), and U-9	1101369	———	5839
UC-135 (Series B) and UC-153	1100374	1118999	———

GENERATOR

CHART B

Generator Model Number	Make	Type	Field Current (Third Brush Lifted)	Cold Output	Hot Output	Brush Spring Tension*	Rotation	Type of Drive	Commutator End Bearing	Drive End Bearing	Frame Diameter	Frame Length	Voltage
1100501	D.R.	Fixed third brush	2.5 - 2.72 amps at 6 volts	20-25 amps at 7.0 volts at 2400 rpm	16-19 amps, at 6.9 - 7.1 volts at 2500 rpm	24	Clockwise	V-belt	Bronze bushing	Ball bearing	4-7/16"	7-1/8"	6
1100042	D.R.	Shunt	1.85 - 2.03 amps at 6 volts	35 amps at 8 volts at 2650 rpm	**	28	Clockwise	V-belt	Bronze bushing	Ball bearing	4-5/8"	9-19/32"	6
1100535	D.R.	Adj. third brush	2.5 - 2.72 amps at 6 volts	20-25 amps at 7 volts at 2400 rpm	16-19 amps at 6.9 - 7.1 volts at 2500 rpm	16	Clockwise	V-belt	Bronze bushing	Ball bearing	4-7/16"	9-1/2"	6
1101369	D.R.	Adj. third brush	3.5-4.5 amps at 6 volts	13-16 amps at 7.7-8.1 volts at 1800 rpm	9-11 amps at 7.3-7.6 volts at 1900 rpm	16	Clockwise	V-belt	Bronze bushing	Ball bearing	4-7/16"	10"	6
1100374	D.R.	Shunt	1.5 - 1.62 amps at 12 volts	25 amps. at 14 volts at 2710 rpm	**	28	Clockwise	V-belt	Ball bearing	Ball bearing	4-5/8"	6-1/8"	12

* — Third brush spring tension - 19 ounces.

** — Maximum output controlled by current regulator

MAGNETO (IH-6 VOLT)

Series	Magneto Model	Rotation*	Breaker Point Gap, Inch	Spark Advance, Degrees	Pinion Backlash, Inch, Max.	Impulse Coupling Trips at	Shaft End Clearance Inch	Drive Gear	Maximum Backlash of Gears
1, 60	J-4	CW	0.013	13	0.005	TDC #	0.003 - 0.013	Governor drive gear	0.004
2A, 123	H-4	CW	0.013	35	0.004	TDC #	0.003 - 0.013	Governor drive gear	0.004
135	H-4	CW	0.013	24-28	0.004	TDC #	0.003 - 0.013	Governor drive gear	0.004
4, 164	H-4	CW	0.013	35	0.004	TDC #	0.003 - 0.013	Idler	0.004
169, 175	H-4	CW	0.013	20	0.004	TDC #	0.003 - 0.013	Camshaft	0.004
6, 264, 281	H-4	CW	0.013	35	0.004	TDC #	0.003 - 0.013	Camshaft Idler Camshaft	0.004
9	H-4	CCW	0.013	35	0.004	TDC #	0.003 - 0.013	Camshaft	0.004

* – Viewed from drive end. # – For gasoline only.

DISTRIBUTOR (IH)

Series	Model Letter	Rotation*	Breaker Point Gap (inch)	Degrees of Spark Advance at Given RPM						
				400	800	1200	1600	1800	2000	2200
2A	A	CC	0.020	0-1	17-21	33-37	39-41①	---	---	---
123,164 and 264	J	CC	0.020	0	8-12	23-27	29-31①	---	---	---
281	N	CC	0.020	0-2	9-13	20-24	24-26①	---	---	---
169 & 175	S	CC	0.020	0-2	6-10	12-16	17-21	---	21-23	---
123	T	CC	0.020	0-2	7-11	14-17	15-17②	---	---	---
123 & 135	X	CC	0.020	0-2	9-13	18-22	26-30	29-31	---	---
123	A B	CC	0.020	0-2	9-13	18-22	21-22③	---	---	---
135	A E	CC	0.020	0-2	7-11	14-18	20-24	---	24-26	---
135B	A H	CC	0.020	0	---	---	---	---	---	20④
153	A F	CC	0.020	0-1	4-8	10-14	16-20	---	20-23	21-23
153	A G	CC	0.020	0-1	2-6	7-11	13-17	---	17-20	18-20
146 & 153	A K	CC	0.020	0	0-3	5-9	11-15	---	16-18	---
146	B C	CC	0.020	0-2	---	---	---	---	---	20⑤

1 – at 1450 RPM
2 – at 1350 RPM
3 – at 1400 RPM
4 – at 2400 RPM
5 – at 2500 RPM

(*) – Viewed from drive end.

CURRENT - VOLTAGE REGULATOR

Regulator Model Number	Make	Battery Ground	Type	Cutout Relay				Current Voltage Regulator		
				Air Gap	Point Opening	Closing Voltage	Adjust to	Air Gap	Opening Range	Adjust to
1118780 1118308	DR	P	Current - voltage regulator-12 volt	0.020	0.020	5.9 to 7.0	6.4	0.075	6.6 to 7.2	6.9
1118790	DR	P	Current-voltage regulator-12 volt	0.020	0.020	5.9 to 7.0	6.4	0.075	6.8 to 7.4	7.1
1118999	DR	N	Current-voltage regulator-12 volt	0.020	0.020	11.8 to 14.0	12.8	0.075	13.6 to 14.5	14.0

STEP - VOLTAGE CONTROL Delco-Remy (6 Volt) No. 5839

Cutout Relay Unit:		Step-Voltage Control Unit:	
Air gap	0.020 inch	Air gap	0.035 inch
Point opening	0.022 inch	Point opening	0.010 inch
Closing voltage	6 to 7.1 volts	Contact spring tension	0.8 ounce
Adjust to	6.6 volts	Armature travel	0.035 inch
		Opening range	7.5 to 8.3 volts
		Adjust to	7.9 volts
		Closing voltage	6.4 to 7.2 volts
		Minimum difference between opening and closing	0.9 volt

GENERAL

FUEL PUMP (A.C.)

	U-1 UC-60	U-2A	U-123 U-135 UC-135B	U-4	U-164, U-169 U-175	U-6, T-6, U-264 U-9, T-9, U-281	Older 4, 6 and 9 Serie
Model No.	——	1537313	5590657	1539555	5594081	1539555	1521676
Pressure, lbs.	——	3 - 4-1/4	3 - 4-1/4	1-1/2 - 3	1-1/2 - 3	1-1/2 - 3	1-1/2 - 3
Regular or Attachment	——	Attach.	Attach.	Attach.	Attach.	Regular	Regular

CARBURETORS (UP-DRAFT-GASOLINE)

Model Number	Engine Model	Model Number	Engine Model
IH 3/4"	U-1, UC-60	IH D-10, 1"	U-4
Zenith 67 x 7	U-2A, U-123		U-6, T-6, U-164
Zenith 68 x 7 Zenith 161 x 7 Zenith 267 x 9	UC-135 U-2A UC-153	IH 1-1/4"	U-169, U-175, U-264, U-281
Marvel Shebler TSX	U-2A*		
Carter UT	U-2A, U-123	IH 1-3/8"	U-9, T-9

* — Distillate or Kerosene.

SPARK PLUGS

Models	Spark Gap When Used With		Thread Diameter	Hex. Size Inches
	Combination Gas and/or Gasoline	LPG or Natural Gas		
All	0.023 - 0.028	0.015 - 0.020	18 mm	7/8

135B and 153 SERIES

ALTERNATOR WITH INTEGRAL VOLTAGE REGULATOR								
Delco-Remy Alternator w /Integral Regulator Model No.	Ground	Rotation Viewing Drive End	Amps	Volts	Cold Output At Specified Voltage			Rated Hot (Amps) Output +
					Spec. Volts	Amps	Approx. RPM	
1102364	N	EITHER	4.0 - 4.5	12	#	30	6500	30

— Voltmeter not needed for cold output check. Load battery with carbon pile to obtain maximum output. Refer to Delco-Remy service manual from No. 1. 2. for test procedure.

COIL *

Part Number	Primary Resistance (OHMS)	Secondary Resistance (OHMS)	Secondary Output Minimum	Test Voltage
395 330 R92	1.17 - 1.31	5300 - 6300	20 K.V.	6.1 - 6.2
395 331 R92	4.25 - 4.6	6600 - 7700	18 K.V.	12.2 - 12.4

(*) – Ambient temperature of 75° F.

NOTE: For detailed information on the repair, test and adjustment of alternator, cranking motor, voltage regulator and distributor, refer to Delco-Remy Service Manual Form No. 1. 2. Delco-Remy Service Manual may be purchased from United Motors Service, Division of General Motors Corp., Detroit, Michigan.

3. CHECKING MECHANICAL PROBLEMS

This manual cannot cover all possible problems that may occur under the many conditions of operation. If a specific problem and remedy is not covered here, proceed to isolate the system in which the problem occurs and then locate the defective component. The greater the number of symptoms of problems that can be evaluated, the easier will be the isolation of the defect.

Much can be learned about the condition of an engine if a good visual inspection is performed before the actual cleaning operations are begun. Many engine parts give external evidence of some failure or defect which can be looked for when the engine is later disassembled. For example, a heavy accumulation of oil or grease at some spot might indicate a leaking seal or gasket; or, excessive rust and other corrosion at another place might well mean leaks in the cooling system. If an engine can be operated, unusual noises also help determine what defects to look for. However, before engine disassembly is started, the outer surfaces should always be given a thorough cleaning. Methods used will depend on the facilities available or other local conditions. The dry steam vapor method is recommended since this is both fast and effective. After steam cleaning, the engine should be wiped dry with a clean cloth to minimize possible rusting.

After cleaning, the exterior of the engine should once more be inspected carefully and a note made of any parts such as brackets, covers, bolts, etc., that are bent, broken, rusted or missing completely. The crankcase or cylinder block should be checked for evidence of freezing around core plugs or for actual breaks in the water jacket.

PROBABLE CAUSE	REMEDY
ENGINE	
Engine Fails to Turn Over	
1. Cranking motor inoperative or defective	Refer to "Cranking Motor Will Not Operate or Operates Slowly."
2. Battery faulty	Refer to "Battery Testing Chart," Par. 4.
3. Cables and terminals faulty	Inspect ground cable and battery-to-starting switch cable for any faults which may cause shorting; also inspect for incorrect connections. Replace cables if necessary.
4. Starting switch button defective	Replace starting switch button.
5. Internal seizure	Hand crank engine with spark plugs removed and clutch disengaged. If engine does not turn easily, internal damage is indicated.
6. Engine oil too heavy	Use correct grade of lubricating oil. Refer to "Operator's Manual."
Engine Turns But Will Not Start	
1. Fuel system faulty	
a. No fuel in tank	Fill tank with fuel.
b. Fuel pump bowl screen clogged	Clean bowl and screen.
c. Water in gasoline	Drain gasoline tank, strainer and carburetor. Refill with clean fuel.
d. No gasoline at carburetor	Clean fuel line from tank to carburetor; clean fuel inlet screen in carburetor. Check fuel pump as outlined in Section 8.
e. Carburetor choke does not close completely	Check linkage and check choke valve plates for bends.
f. Dirt in carburetor fuel passages or jets	Clean carburetor.
g. Low fuel level in bowl	Adjust float level as specified in reassembly instructions.
2. Battery charge low and does not turn engine fast enough	Refer to "Battery Testing Chart," Par. 4.
3. Ignition system faulty	
a. Broken distributor rotor	Replace rotor.
b. Moisture in the distributor	Remove cap and rotor and dry thoroughly.
c. Condenser shorted or open	Replace condenser.
d. Broken distributor cap	Replace cap.
e. Excessively pitted distributor cap contact terminals	Clean contact terminals with fine sandpaper.
f. Points not properly adjusted	Readjust points. Refer to "SERVICE CHARTS."
g. Short or open circuit in distributor	Correct or replace.
h. Ignition circuit broken	Check cable from distributor cap-to-ignition coil and check spark plugs for correct wiring or loose connections.
i. Wet or fouled spark plugs	Remove spark plugs, wipe off moisture and dry plugs. Remove carbon. Reset plug gap, refer to "SERVICE CHARTS."
j. Cracked or broken spark plug insulators	Replace spark plugs.
k. Ignition switch inoperative	Place a jumper wire across the two ignition switch terminals on the back of switch. Attempt to start the engine. If engine starts, the switch is inoperative and must be replaced.
4. Carburetor choked too much	Open the choke. Wait a few minutes before attempting again to start engine.
5. Air intake restricted or exhaust clogged	Service the air cleaner and clean exhaust.
Missing and Backfiring But Fails to Start	
1. Water in gasoline	Drain fuel tank, fuel pump bowl and carburetor. Refill with clean gasoline.
2. Air leaks around intake manifold	Tighten manifold stud nuts. Replace gasket if necessary.
3. Improper firing order	Check spark plug cables for correct installation at spark plugs and distributor cap.
4. Distributor or magneto not correctly timed to engine	Check and adjust timing. Refer to Section 11, 12 or 12A.
5. Moisture in the distributor	Remove cap and rotor and dry thoroughly.
6. Distributor cap shorting out	Check for loose contact terminals or dirt in cracked cap.

PROBABLE CAUSE	REMEDY
ENGINE	
Excessive Pinging - Detonation	
1. Distributor	
a. Point gap incorrect	Readust point gap. Refer to "SERVICE CHARTS."
b. Spark advanced too far	Check and adjust timing. Refer to Section 11.
c. Fouled spark plugs	Clean and reset plugs. Refer to "SERVICE CHARTS."
2. Carburetor	
a. Main metering system too lean	Refer to Section 10.
b. Float level set too low	Check float level and reset. Refer to Section 10.
3. Improper or broken thermostat causing overheating	Replace.
4. Cylinder head not bolted down tight	Torque cylinder head bolts. Refer to Section 2 for tightening chart. Refer to Section 1, "SPECIFICATIONS" for correct cylinder head torque.
Missing or Cutting Out at High Speed	
1. Distributor breaker plate not grounded properly	Check ground lead wire and screws.
2. Primary lead not tightened or partially broken	Check primary lead wire and screws.
3. Weak point spring tension	Adjust point spring tension or replace points and spring.
4. Spark plugs faulty	Check plug gap. Refer to "SERVICE CHARTS," for correct plug gap. Replace plugs if necessary.
5. Point gap incorrect	Readjust point gap.
6. Low voltage to spark plugs caused by defective coil	Replace coil.
7. Carburetor	
a. Float level set too low	Check float level and reset if necessary. Refer to Section 10.
b. Inoperative accelerator pump	Repair or replace. Refer to Section 10.
c. Dirt in main jet	Clean out main jet. Replace if necessary.
d. Partially closed choke plates	Reposition choke control linkage.
e. Restriction in filter	Clean out fuel inlet filter in carburetor.
8. Defective fuel pump	Check the fuel pump as outlined in Section 8.
9. Poor compression	
a. Head gasket leaks	Replace head gasket.
b. Burned valves	Grind valves.
c. Worn piston rings	Replace piston rings.
Engine Does Not Develop Full Power	
1. Moisture in fuel tank	Drain fuel system and refill with clean, good grade fuel.
2. Air cleaner	
a. Air cleaner clogged	Remove and clean. Refer to operator's manual.
b. Oil level too high	Remove oil cup and pour off excess oil.
3. Pre-cleaner clogged (when used)	Remove and clean.
4. Insufficient fuel	Check fuel tank.
5. Poor fuel	Use proper grade fuel.
6. Distributor or magneto	
a. Point gap incorrect	Readjust point gap. Refer to Section 11, "REASSEMBLY."
b. Ignition timing incorrect	Check and adjust timing. Refer to Section 11, 12 or 12A.
7. Low voltage to spark plugs caused by defective coil	Replace coil.
8. Fouled spark plugs	Clean plugs and reset the gaps. Refer to "SERVICE CHARTS."

PROBABLE CAUSE	REMEDY
ENGINE	
Engine Does Not Develop Full Power - Continued	
9. Carburetor	
a. Float level set too high or low	Check float level and reset. Refer to Section 10.
b. Accelerating pump not operating	Repair or replace. Refer to Section 10.
c. Power or economizer valve inoperative	Repair or replace. Refer to Section 10.
d. Choke plate partially restricted	Reposition choke control linkage.
e. Restricted throttle linkage	Repair or replace.
f. Leaky carburetor fuel valve	Clean valve. Replace valve and seat if wear is evident.
10. Defective fuel pump	Check fuel pump as outlined in Section 8.
11. Insufficient air to engine	Service the air cleaner. Refer to the operator's manual.
12. Late valve timing	Check and adjust timing. Refer to Par. 5.
13. Air leaks around intake manifold	Tighten manifold or install new gasket if necessary.
14. Exhaust restricted	Remove restriction.
15. Lack of compression	See "Lack of Compression" in this chart.
16. Governor worn out or out of adjustment	Refer to Section 9.
Loss of Oil Pressure	
1. Low lubricating oil level	Add sufficient oil to bring level up to specified mark on level gauge.
2. Clogged oil filter	Change filter element.
3. Oil leaks	See "Excessive lubricating oil consumption" in this chart.
4. Engine oil pressure indicator or line defective	Replace.
5. Worn main, connecting rod or camshaft bearings	Replace. Refer to Sections 3, 6 or 7.
6. Dirt in oil filter relief valve or relief valve spring broken	Clean valve or replace spring.
7. Oil pump worn	Repair or replace.
8. Oil diluted or not as specified	Change oil regularly using correct grade.
9. Defective cylinder head gasket	Replace.
10. Broken valve spring	Replace.
Lack of Compression	
1. Valves sticking	Clean valve guides and stems. Grind valves if needed.
2. Worn pistons, rings and cylinder walls	Replace pistons, rings and rebore cylinder block or replace sleeve. Refer to Section 3.
Smoky Exhaust	
1. Engine overload	Reduce load.
2. Incorrect grade lubricating oil	Use grade of oil specified in operator's manual.
3. Worn valve guides, valve stems, pistons and sticky or worn oil control rings	Repair or replace.
4. Distributor or magneto not properly timed	Check and adjust timing. Refer to Section 11, 12 or 12A.
5. Defective fuel pump	Check fuel pump. Refer to Section 8.
6. Too much oil in air cleaner	Remove air cleaner and remove any excess oil.
7. Air cleaner pipe clogged	Remove air cleaner and clean pipe.
8. Pre-cleaner clogged	Remove and clean.
9. Incorrect valve adjustment	Adjust valves properly.
Engine Overheats	
1. Insufficient coolant in cooling system	Check level of coolant in radiator and add necessary coolant. Check for leaks.
2. Radiator cap loose	Tighten cap.
3. Loose hose connections	Tighten hose connections.
4. Fan belt slipping	Check and adjust fan belt tension.
5. Cooling system clogged	Drain and flush cooling system.
6. Dirt and trash on outside of radiator	Clean between the tube fins with air or water pressure.
7. Lack of sufficient lubricating oil	Add sufficient oil to bring up to the specified mark on the level gauge.

PROBABLE CAUSE	REMEDY
ENGINE	
Engine Overheats - Continued	
8. Engine overloaded	Reduce load.
9. Clogged oil filter	Replace filter element.
10. Thermostat inoperative	Replace thermostat.
11. Water pump defective	Repair pump.
12. Engine oil diluted with fuel	Drain oil and refill using correct grade.
Excessive Lubricating Oil Consumption	
1. Oil leaks	Check and service where necessary, valve covers, tappet cover plate, crankcase front cover, oil seals at front and rear of crankshaft, oil pan plug and gasket, oil filter and oil pressure indicator tube.
2. Worn valve guides, piston rings, pistons and clogged oil control rings	Replace worn parts.
3. Incorrect grade of lubricating oil	Use grade of oil specified in operator's manual.
4. Overheated engine	Refer to "Engine Overheats" in this chart.
5. Excessive oil poured into crankcase	Drain oil and add amount specified in operator's manual.
Excessive Fuel Consumption	
1. Distributor or magneto	
a. Point gap incorrect	Readjust point gap. Refer to Section 11, 12, or 12A.
b. Ignition timing incorrect	Check and adjust timing. Refer to Section 11, 12 or 12A.
2. Low voltage to spark plugs caused by defective coil	Replace coil.
3. Worn or fouled spark plugs	Clean and reset plugs. Refer to "Service Charts."
4. Carburetor	
a. Float level set too high	Check float level and reset. Refer to Section 10.
b. Power or economizer valve stuck open	Repair. Refer to Section 10.
c. Leaking needle or seat	Repair or replace. Refer to Section 10.
d. Choke plate not fully open	Reposition choke control linkage.
e. Carburetor adjusted too rich	Adjust carburetor. Refer to Section 10.
f. Fuel strainer leaking	Tighten bail nut or replace gasket if necessary.
g. Leaky carburetor fuel valve	Clean valve. Replace valve and seat if wear is noticed.
5. Fuel pump pressure too high	Perform pressure test (Section 8, Par. 2). If pressure is above maximum in "SPECIFICATIONS," Section 1, repair or replace fuel pump.
6. Restriction in air cleaner or cleaner oil level too high	Service air cleaner. Refer to the operator's manual.
Engine Noises	
1. Loose piston pin - a sharp rap at idling speed. The pin at fault can be found by short circuiting the spark plugs, one at a time, until the noise stops	Repair or replace.
2. Loose piston - flat slap when advancing engine speed under load	Replace piston and sleeve.
3. A metallic knock when idling and retarding engine speed, but disappears under load indicates worn or loose connecting rod bearings. The bearings at fault can be found by short-circuiting the spark plugs one at a time with the engine running. The noise will disappear when the plug in the cylinder with loose connecting rod bearings is short-circuited	Replace worn bearings.
4. Constant rapid clicking indicates incorrect valve clearance	Adjust valve clearance.

PROBABLE CAUSE	REMEDY
ENGINE	
Bearing Failure	
1. Low oil pressure	Refer to problem "Loss of Oil Pressure."
2. Lack of oil	Maintain proper oil level. Check for leaks.
3. Engine runs too hot	Keep engine at normal operating temperature.
4. Loose bearings	Install new bearings.
5. Improper lubricating oil	Use a suitable oil of noncorrosive type, correct grade and viscosity.
6. Foreign materials entering engine	Use clean oil containers when filling engine with oil and see that all gaskets on the engine are in good condition.
7. Oil lines clogged	Clean all oil passages.
8. Connecting rod bent	Align or install new connecting rod.
9. Crankshaft out of alignment	Straighten or install new shaft.
Valves Sticking	
1. Valve springs weak or broken	Install new springs.
2. Gummy deposits from inferior fuel or oil	Clean and use proper fuel or oil.
3. Valve stems scored or carboned	Clean. Install new valves if necessary.
4. Insufficient clearance between valve stem and guide	Ream guides for proper clearance.
Piston and Cylinder Sleeve Wear	
1. Oil of unsuitable grade or viscosity	Change to oil of suitable specifications.
2. Piston rings stuck or broken	Install new rings.
3. Lack of oil	Keep oil at proper level.
4. Foreign materials entering engine	Inspect and service air cleaner and pre-cleaner regularly.
5. Piston rings not fitted properly to cylinder	Install new rings and fit properly. (Refer to "SPECIFICATIONS" in Par. 2.)
6. Dirty containers used for lubricating oil	Lubricating oil should be kept in a clean place and clean containers used when filling crankcase.
Engine Operates Unevenly and Vibrates	
1. Valve and spring assembly inoperative	Repair or install parts needed.
2. Governor inoperative or not correctly adjusted	Repair or adjust governor. Refer to Section 9.
Poor Compression	
1. Piston rings worn, broken or cracked	Install new rings.
2. Cylinder sleeves excessively worn	Install new sleeves.
3. Valves damaged	Install new valves.
4. Broken valve springs	Install new valve springs.
5. Worn cylinder head gasket	Install new gasket.
6. Valve seats worn or damaged	Grind the valve seats.
7. Worn pistons	Install new pistons.
8. Excessive valve guide wear	Install new valve guides.
9. Sticking valves	Free the valve stem and correct the cause.
10. Faulty valve action	Adjust the valve clearance.
Defective Cooling System	
1. Insufficient water	Add water, inspect for leaks.
2. Faulty thermostat	Test. If necessary, replace.
3. Dirty water	Drain and clean system.
4. Defective connections	Replace swelled or worn hose and defective hose clamps.
5. Radiator defective	Repair radiator. If necessary, replace.
6. Fan defective	Inspect fan. If damaged, replace.
7. Defective overflow pressure valve (if equipped)	Replace.
8. Defective water pump	Inspect water pump impeller and shaft. If necessary, replace.
9. Water pump leaks	Repair or replace pump.

PROBABLE CAUSE	REMEDY
ENGINE	
Defective Cooling System - Continued	
10. Dirty, scaled coolant passages	Clean and flush passages.
11. Radiator clogged	Flush out radiator.
12. Fan belt slippage	Check the tension; replace if greasy or worn.
ELECTRICAL	
Discharging Battery	
1. Connections loose	Tighten connections.
2. Short circuits	Locate shorts and correct cause.
3. Connections dirty or corroded	Clean connections.
4. Voltage control unit out of order	Adjust or replace control unit.
5. Generator not charging	Check voltage control unit and make necessary adjustments.
6. Battery case cracked	Install new battery.
Battery Overheating	
1. High charging rate	Inspect voltage control unit.
2. Voltage control unit out of order	Adjust voltage control unit. If necessary, replace.
Batteries Fully Charged and Generator Charging Rate High	
1. Poor ground connection at voltage regulator	Check ground wire and connections.
2. Improper voltage regulator setting	With engine operating at 1000 rpm, disconnect the lead from the "F" terminal on the voltage regulator. If the output remains high the generator field is grounded in the generator or in the wiring harness. (Refer to Delco-Remy Service Manual). If the output drops off, the voltage regulator is at fault and should be checked for high voltage setting or grounds. (Refer to Delco-Remy Service Manual.)
3. Defective voltage regulator	(See "Improper voltage regulator setting.")
4. Grounded generator field circuit (in either generator, regulator or wiring)	(See "Improper voltage regulator setting.")
Batteries Low in Charge and Low or No Generator Charging Rate	
1. Loose connections, frayed or damaged wiring	Check wiring.
2. Defective batteries	Check batteries (Refer to "Batteries" in Section 13.)
3. Low voltage regulator setting	Momentarily touch a jumper from the "F" terminal on the regulator to the ground terminal on the regulator and increase the generator speed. If output does not increase, check generator for no output. (Refer to Delco-Remy Service Manual.) If output does increase the regulator is at fault. (Refer to Delco-Remy Service Manual.)
4. Oxidized regulator contact points	Refer to Delco-Remy Service Manual.
5. Defective generator	Refer to Delco-Remy Service Manual.
No Generator Output	
1. Worn brushes	Replace brushes.
2. Burned commutator bars	Recut commutator.
3. Sticking brushes	Clean brushes.
4. Rough, dirty or greasy commutator bars	Clean commutator bars.
5. Commutator out-of-round	Recut commutator.
6. Low brush tension	Adjust or replace brush springs.

PROBABLE CAUSE	REMEDY

ELECTRICAL

Ammeter Shows Discharge with Engine Operating

1. Generator inoperative	Service or replace generator.
2. Faulty generator relay	Adjust relay or replace, if necessary.
3. Short circuits	Test cables for shorts.
4. Fan drive belt loose or broken	Tighten or replace belt.

Noisy Generator

1. Loose mountings	Tighten mounting bolts.
2. Loose pulley	Tighten pulley.
3. Worn bearings	Install new bearings.

Ammeter Pointer Fluctuates Rapidly

1. Shorted or loose connections	Test for short circuits and tighten connections.
2. Generator defective	Service or replace generator.
3. Fan drive belt loose or broken	Adjust belt; if necessary, replace.
4. Low idling speed	Adjust idling speed; check voltage control unit.

Cranking Motor Will Not Operate or Operates Slowly

1. Faulty battery	Recharge, or install new battery.
2. Cables or terminals loose or defective	Check all cables for secure mounting to terminals. Replace all corroded or broken cables.
3. Starting switch defective	Inspect for burned or corroded switch parts. Clean up the points.
4. Cranking motor burned out	Install a new cranking motor.
5. Commutator worn or dirty	Remove cover band and clean commutator. Inspect brushes.
6. Brushes not making proper contact	Inspect to see that brushes are seating properly.

Distributor Inoperative

1. Contact lever spring broken due to corrosion attacking metallic materials	Replace spring and clean distributor carefully to avoid repetition.
2. Wiring to or from distributor broken, frayed or damaged by moisture, oil or corrosion	Inspect all wiring and replace if faulty.
3. Poor electrical connections at distributor or plugs	Inspect connections and be sure they are free from dirt and oil.
4. Rotor or cap cracked or having carbonized surfaces providing escape for current to ground	Replace rotor or cap if necessary.
5. Condenser short-circuited due to insulation breakdown caused by cracks in condenser sealing materials allowing moisture to enter	Inspect condenser and sealing for cracks. Replace condenser if necessary.

Distributor Contact Points Burned or Pitted

1. Points set too closely	Inspect to ensure correct clearance.
2. Excessive resistance in condenser due to broken strands in condenser lead	Replace as necessary.
3. High voltages due to overcharged battery (high voltage in starting system may be caused by loose connections at batteries, etc.)	Check voltage in battery. Check connections for secure fitting on terminals. Clean points.
4. Oil or foreign substances on contact points	Clean points.
5. Hexagon shaft or rubbing block in distributor worn	Replace as necessary.

PROBABLE CAUSE	REMEDY

ELECTRICAL

Intermittent Sparking

1. Weak tension on distributor contact points. Vibration causing chatter	Correct tension.
2. Dirty points or incorrect setting on contact point gap	Clean points and check contact gap.

Weak Sparking

1. Dirty distributor contact points or poor rotor connections	Clean contacts and wipe off rotor with carbon tetrachloride on clean cloth.
2. Leakage of current to ground due to faulty wiring	Inspect wiring for fraying and broken strands. Replace.

MAGNETO

Magneto Does Not Turn

1. Defective magneto or magneto drive	Test magneto and make necessary adjustments.

Magneto Turns But No Spark is Generated

1. Defective impulse coupling action	Test for impulse action.
2. Shorted coil	Replace coil.
3. Bad points or condenser	Dress points or replace as necessary.
4. Faulty grounding switch	Repair or replace switch.

No Spark at Distributor Cap

1. Defective cables	Check cables; replace if necessary.
2. Defective magneto parts	Test magneto, and replace defective parts.
3. Defective magneto breaker mechanism	Check and make proper adjustments.

Magneto Turns, Spark is Generated, But Engine Does Not Develop Full Power

1. Timing defective	Adjust timing, magneto to engine.
2. Spark plugs defective	Install new plugs.
3. Intermittent spark	Service spark plugs and inspect entire wiring system.

4. BATTERY TESTING CHART

HYDROMETER TEST 80°F) (SEE NOTE "A" BELOW)	CONDITION	REMEDY
A. 1.250 to 1.280 Specific Gravity	Charged.	No remedy is required if variation among the cells is not over .015 Sp. Gr. If variation is much more than .015 Sp. Gr., give high rate discharge test. If cells test O.K., recharge and adjust gravity of all cells uniformly.
B. 1.225 to 1.250 Specific Gravity	Fair.	Advisable to recharge, especially in cold weather. Adjust gravity of cells if not uniform. Check operation and setting of generator regulator. On adjustable third brush generators, increase the charging rate. Make a thorough check of the electrical system for short circuits, loose connections, and corroded terminals.
C. Less than 1.225 Specific Gravity	Poor.	Battery should be recharged. Adjust gravity of cells if not uniform. Proceed as outlined in "B."
D. Cells show more than 25 points (.025 Sp. Gr.)variation in gravity. Look for:	1. Short circuit in low cell. 2. Loss of electrolyte by leakage or excessive over-charge. 3. Improper addition of acid or "dopes." 4. Natural or premature failure.	Recharge battery at rate of one ampere for each positive plate in one cell until gravity readings show no rise in three consecutive readings when taken one hour apart. Cell voltages on charge should also be fairly uniform. Adjust gravity of cells to 1.280 - 1.290 at 80°F by addition of water to lower, or 1.400 Sp. Gr. acid to raise the gravity of the acid. Make high rate discharge test after not less than 12 hours and not more than 96 hours standing on open circuit; and check discharge voltages of each cell; if more than .15 volt between cells is shown on discharge, the battery may be considered to be no longer serviceable.

NOTE "A": *Electrolyte level should be 1/4 to 1/2 inch above the separators. Do not take the reading soon after adding water. Hydrometer readings should be corrected for temperature if temperature is extremely low or high.*

VOLTMETER TEST	CONDITION	REMEDY
E. If the voltage drop is more than .2 volt (2/10) between the cranking motor cable and the frame while cranking, look for:	Poor contact between terminal and frame or between clamp terminal and battery post.	Locate the high resistance; repair or replace.
F. While operating the cranking motor, without ignition turned on, check the voltages of all cells. (This test can also be done on the high rate tester) If the voltage varies more than .15 volt between cells, look for:	Defective Cell or cells.	Compare voltage readings with hydrometer readings -low voltage is usually accompanied by low gravity. Apply remedy given for "D."

The presence of short circuits in the wiring can be determined by switching off all electrical equipment and, with the ground strap connected, tapping the other cable terminal against its battery post. Sparking will be produced if there is substantial short circuit in the wiring. Be sure that fuses have not been burned out before making the test. To detect a very slight short circuit, place a low reading ammeter in the circuit.

5. TUNE - UP

The following steps outline the operations which should be followed in an engine tune-up. These steps point out the various parts of the engine to be checked, cleaned, timed or repaired, as needed.

1. Check the throttle control.

   a. Check the operation of the control.

   b. Check the operation of the springs on the governor control rod.

   c. Check the rpm of the engine, using a tachometer.

2. Check the clearance on intake and exhaust valves and make adjustments if necessary. (Refer to "Valve Clearance Adjustments" in Section 2.)

3. Check the air cleaner and connections for possible leaks. Clean the oil cup and screen. Refer to the operator's manual.

4. Replace the lubricating oil filter element and clean the filter case assembly thoroughly.

5. Remove the water trap (if so equipped) and clean thoroughly.

6. Flush the radiator with clean water, then drain and refill with soft water if available, or anti-freeze solution in cold weather.

7. Check the fan belt for wear and correct tension. Replace if necessary.

8. Check the distributor points, cap and condenser. Replace necessary parts and reset point gap.

9. Check the spark plugs. Replace broken plugs and clean and reset all plugs to be reinstalled.

10. Check the ignition coil and the primary wires and be sure the connections are clean and tight. A few broken wire strands on an otherwise sound connection will still result in difficult starting and improper engine performance.

11. Check all electrical connections in both the high and low tension circuits of the ignition system.

12. Check all switches.

13. Remove and clean the carburetor inlet screen.

14. Remove the fuel bowl and check the float level. Adjust if necessary.

15. Check the float valve assembly for leakage.

16. Inspect the generator and cranking motor commutators and clean as instructed in the operator's manual. Also refer to Delco-Remy Service Manual for additional information.

17. Check the ignition timing and correct if necessary.

18. Check the ignition compression pressures. Refer to "SPECIFICATIONS" in this section.

19. Be certain the manifold heat control valve functions correctly.

GENERAL

BASIC TUNE-UP DATA CHART

Engine	Distributor Description Part No. and/or Vendor	Distributor Point Gap +.001"	Dwell	High Idle RPM	Gasoline Timing		LPG Timing		Natural Gas Timing		Valve Lash		Spark Plug Gap	
					Static	Advance @ Rated RPM	Static	Advance @ Rated RPM	Static	Advance @ Rated RPM	Intake	Exhaust	Gasoline	LPG/NG
C-60	353 893 R91 (IH)	.020"	62°-68°	2750	TDC	20° @2500					.015"	.015"	.023"-.028"	
C-123	364 696 R92 (IH)	.020"	62°-68°		TDC	16° @1350					.016"	.022"	.023"-.028"	
C-135B	380 622 R91 (IH)	.020"	62°-68°	2580	TDC	20° @2400	5°BTDC	25° @2400	8°BTDC	28° @2400	.016"	.022"	.023"-.028"	.015"-.020"
C-146	405 814 R91 (IH)	.020"	62°-68°		2°BTDC	20° @2500					.016"	.022"	.023"-.028"	
	381 687 R91 (IH)	.020"	62°-68°		TDC	17° @2000								
C-153	376 555 R92 (IH)	.020"	62°-68°	2580	TDC	20° @2400	5°BTDC	25° @2400	8°BTDC	28° @2400	.016"	.022"	.023"-.028"	.015"-.020"

6. MOUNTING ENGINE TO STAND

1. Remove the starter, generator and generator bracket from the engine.

2. C-123 engine only: Install attaching plate PLT: 540-2 (FES 52-11).

3. C-135, C-146 and C-153: Install attaching plate PLT: 540-2 (FES 52-11) with attaching ears FES 52-12.

4. Mount the engine to engine stand PLT-540 (FES 52).

7. SPECIAL TOOLS REQUIRED

SECTION USED IN	DESCRIPTION	TOOL NUMBER*
2	Spring Tester Intake Valve Guide tool Exhaust Valve Guide tool	PLT - 100 FES 6-4 FES 6-5
5	Water Pump Oil Seal Installer	SE - 1721
6	Puller Puller ** Camshaft Bearing Puller	FES 33-1 1 020 323 R91 PLT - 543 or FES 101
7	Oil Seal Driver	FES 6-15
12	Impulse Coupling Removing Tool Inner Race Puller Tool Magneto Bearing Race Puller Magneto Bearing Race Replacer Tool	SE - 912 SE - 839 SE - 1020 SE - 1021

(*) – For Pay Line Tool numbers, (PLT) order from Tool Manual ISS-1531. For Farm Equipment Tool numbers, (FES) order from Tool Manual GSS-1251. For truck Tool numbers (SE), order from Tool Manual CTS-1147.

(**) – Tool no longer available.

MANIFOLDS

1. DESCRIPTION

(See Fig. 1 and 2)

On 4-cylinder engines, both the intake and exhaust manifolds are combined in one casting which is stud-mounted to the left side of the engine cylinder head. Two gaskets are used for the front and rear sections of the manifold.

Manifolds on the high compression gasoline engines do not have a manifold heat control such as is fitted on medium and low compression distillate or kerosene engines. The adjustable heat control on the latter allows the operators to control the intake manifold jacket temperature to meet conditions of load, air temperature, and fuel used (Fig. 3).

The high compression gasoline engine manifold is not equipped with a heat shield.

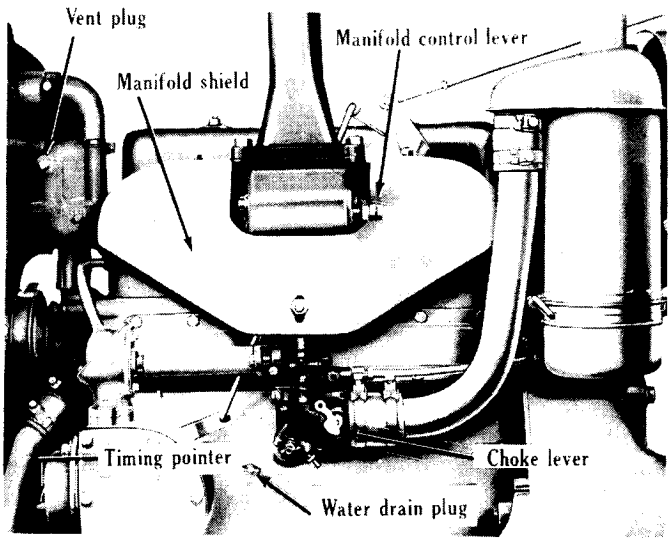

Fig. 1 - The Gasoline-Distillate Engine Showing "Hot" Type Manifold, Heat Shield and Heat Control Assembly.

2. REMOVAL

1. Loosen the hose clamps that secure the air pipe hose to the carburetor and to the air cleaner. Remove the air cleaner-to-carburetor pipe with hoses.

2. Disconnect the choke control rod from the carburetor starting shutter by removing the cotter. Push the rod to the rear.

3. Turn off the fuel and disconnect the fuel line from the carburetor.

4. 175 AND 281 SERIES: Remove the cap screws and lock washers that secure the governor throttle shaft housing to the carburetor (Fig. 5).

60, 135, 135B, 146 AND 153 SERIES: Disconnect the governor connecting rod from the carburetor.

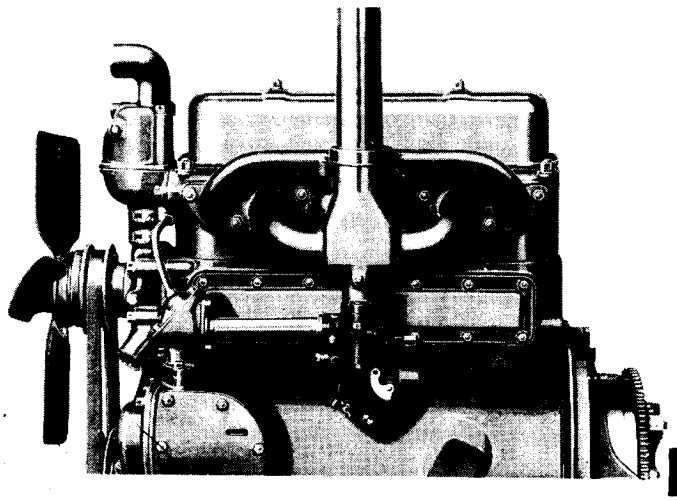

Fig. 2 - The High Compression Engine Showing "Cold" Manifold

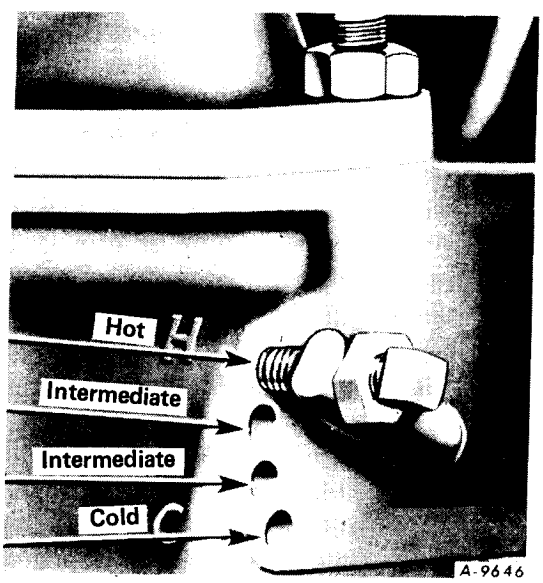

Fig. 3 - Intake Manifold Heat Control (281 Series).

5. NOT 60, 135, 135B, 146 OR 153 SERIES: Remove the cap screws and lock washers which secure the throttle shaft retainer plate to the governor control rod housing.

6. NOT 60, 135, 135B, 146, OR 153 SERIES: Remove the cap screws and lock washers securing the control rod housing and the governor housing together. Push the throttle shaft housing to the front to disengage the throttle shaft from the carburetor.

MANIFOLDS, CYLINDER HEAD AND VALVES

7. Remove the nuts and washers securing the manifold to the cylinder head (Fig. 5).

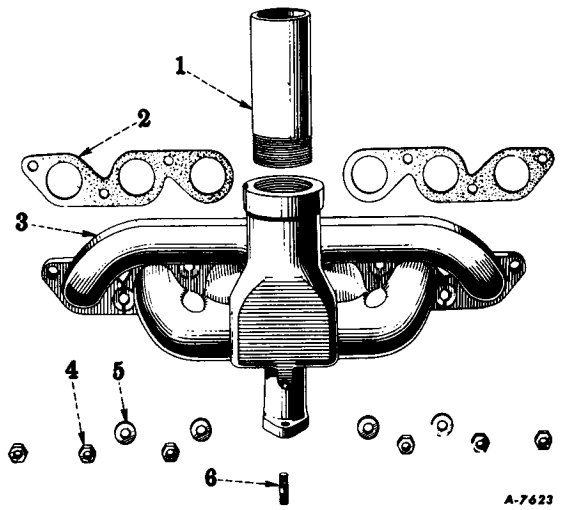

Fig. 4 - Exploded View of Manifold Assembly.

1. Exhaust pipe.
2. Gasket.
3. Exhaust and intake manifold assembly.
4. Stud nut.
5. Washer.
6. Carburetor or stud.

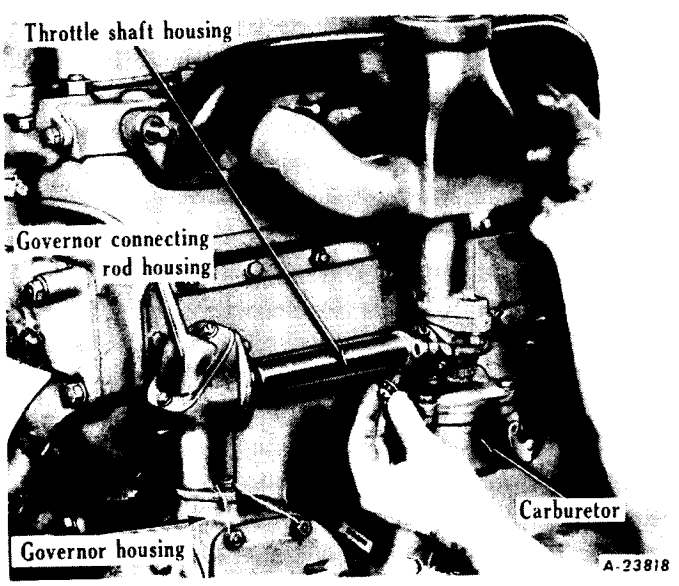

Fig. 5 - Removing Throttle Shaft Housing from Carburetor.

8. Lift the manifold, together with the carburetor, from the engine and remove the gaskets. (Fig. 6 and 7)

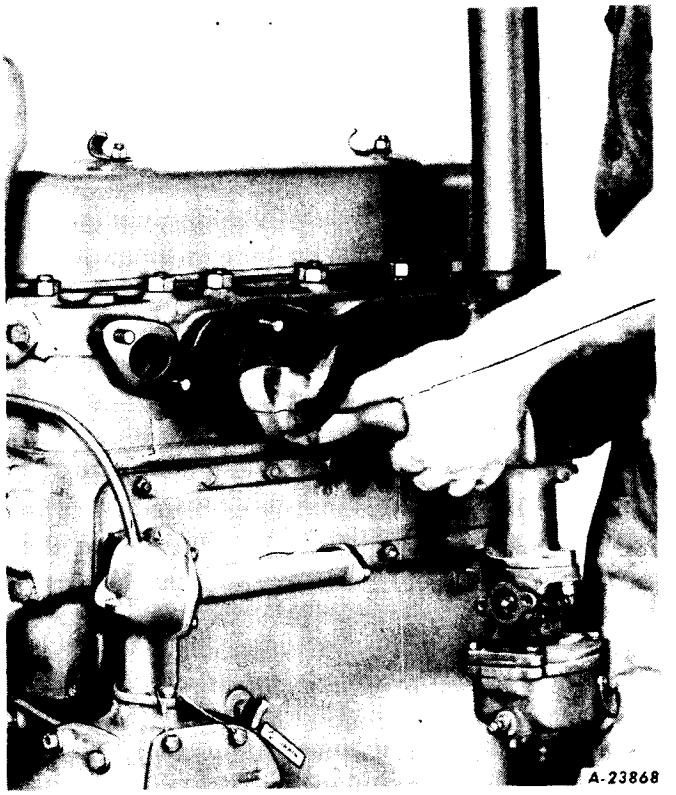

Fig. 6 - Removing the Manifold Assembly and Carburetor (175 and 281 Series).

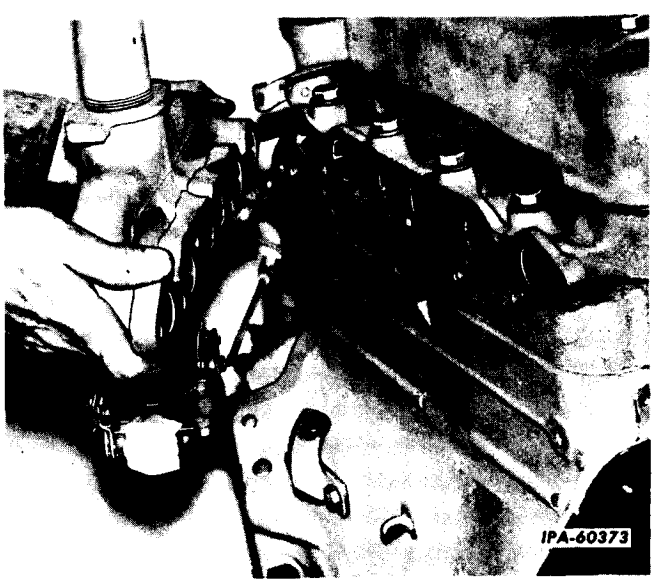

Fig. 7 - Removing the Manifold and Carburetor (135 Series Shown).

3. DISASSEMBLY

1. Remove the cap screws and lock washers securing the carburetor to the intake manifold (Fig. 8). Wrap the carburetor in a clean cloth until reassembly.

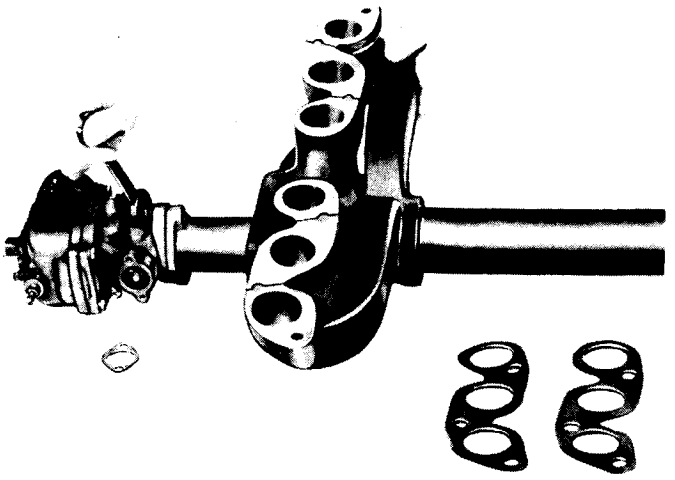

Fig. 8 - Removing the Carburetor from the Manifold

2. Remove the exhaust pipe from the assembly by unscrewing it (Fig. 9).

4. INSPECTION AND REPAIR

1. Examine the inside surface of the exhaust pipe for coke deposits. Such deposits act as insulation and lessen the amount of heat reaching the intake manifold.

2. Manifold gaskets must be in good condition to prevent entry of dirt and to maintain the fuel/air ratio of the intake mixture.

5. REASSEMBLY

1. Install the exhaust pipe in the manifold (Fig. 9).

2. Assemble the carburetor to the intake manifold (Fig. 8).

6. INSTALLATION

1. Install new gaskets on the studs. Position the manifold on the studs. Install washers and nuts. Tighten the nuts to torque as given in "SPECIFICATIONS" in Section 1.

2. 175 AND 281 SERIES: Pull the governor throttle shaft housing (Fig. 5) with throttle shaft and gasket up to the carburetor and engage the throttle shaft with the butterfly. Secure the throttle shaft housing to the carburetor.

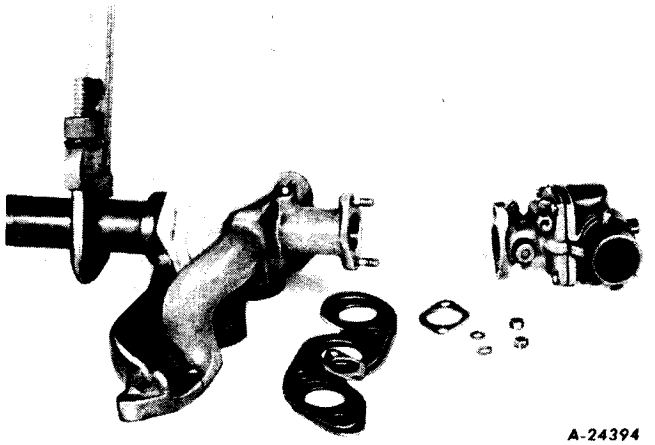

Fig. 9 - Removing the Exhaust Pipe.

3. 175 AND 281 SERIES: Secure the felt retainer and plate to the governor control rod housing with cap screws and lock washers. Secure the control rod housing to the governor housing.

60, 135, 135B AND 153 SERIES: Connect the governor control rod to the carburetor.

4. Connect the fuel line to the carburetor.

5. Connect the choke control rod to the starting shutter of the carburetor and secure with a cotter.

6. Install the air cleaner to the carburetor pipe and hoses on the air cleaner and carburetor. Tighten the hose clamps.

CYLINDER HEAD AND VALVES

7. DESCRIPTION

The 60 series engine is a valve-in-block, type engine. The valve tappets have self-locking tappet screws. Valve springs are interchangeable and can be assembled either end up.

The 135, 135 B, 146, 153, 175 and 281 Series engine employ the overhead type valve mechanism (Fig. 10 shows a typical overhead valve carbureted four cylinder assembly).

The valve lever shaft assembly is securely stud-mounted to the top of the cylinder head and it is lubricated by pressure oil from a rifle-drilled passage running through the crankcase and the cylinder head.

A perforated breather tube, connected to the top of the cylinder head and in series to the air cleaner, aerates the valve chamber enclosed by the valve cover. The cylinder head is a one-piece casting.

MANIFOLDS, CYLINDER HEAD AND VALVES

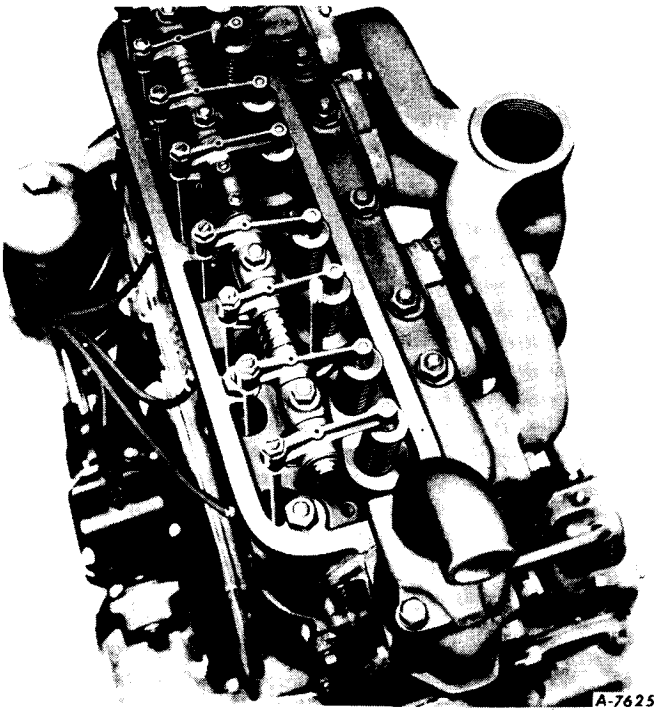

Fig. 10 - Overhead View of Carbureted Engine Showing Valve Mechanism.

8. MAINTENANCE

1. 60 SERIES ONLY: Valves may be adjusted by removing the tappet side cover from the crankcase. Check for rust due to lack of proper lubrication and for broken springs.

135, 135B, 146, 153, 175 AND 281 SERIES: With the valve cover removed, inspect the entire valve mechanism for rust and dirt caused by lack of lubrication or by leaky valve cover gasket. Clean the mechanism with cleaning solvent. Clean the holes in the breather pipe. Inspect for looseness in the valve mechanism and for worn or broken valve springs.

2. Check the valve adjustments. Use a feeler gauge and set the valves if necessary. (Refer to Par. 9).

9. VALVE CLEARANCE ADJUSTMENT

Check the valve clearance after ever 500 hours of operation and adjust if necessary. Refer to "SPECIFICATIONS" in Section 1 for proper clearances.

1. 60 SERIES: Attach a jumper wire between the magneto terminal "F" and the coil cover mounting bolt "G," Fig. 11. This will ground the magneto and prevent accidental starting.

135, 135B, 146, 153, 175 AND 281 SERIES: Before checking the valve clearance, disconnect the ignition switch cable from the ignition coil to prevent accidental starting.

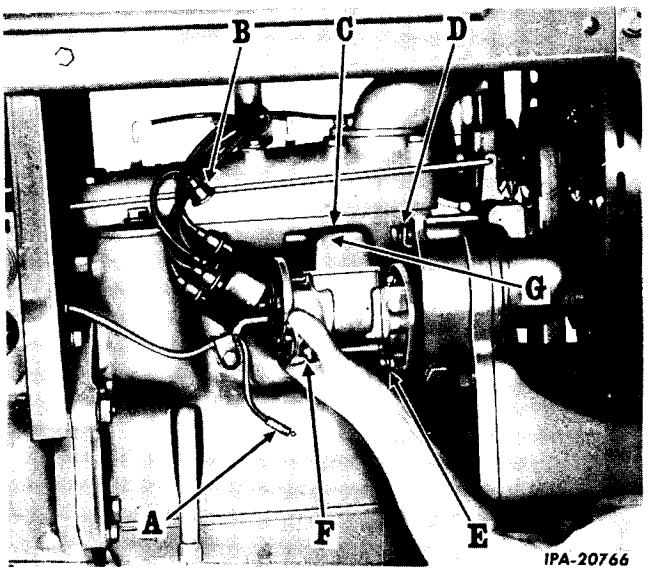

Fig. 11 - Magneto and Connections (60 Series).

2. Remove the valve cover, or tappet side cover.

3. Remove the spark plug from No. 1 cylinder (the cylinder nearest the radiator).

4. Place a thumb over the spark plug opening and slowly crank the engine until an outward pressure can be felt. Pressure indicates the No. 1 piston is moving toward top-dead-center of the compression stroke.

5. Continue cranking slowly until the "DC" mark or notch on the fan drive pulley is in line with the timing pointer on the crankcase front cover.

6. By referring to the chart as follows and using the simplified procedure (steps 7 thru 10), all valves can be adjusted by cranking the engine only twice. The valve lash is adjusted with the engine warm which means any temperature above freezing. Valve lash can be adjusted while the engine is hot - however the quality of workmanship usually suffers due to the heat.

Four valves are adjusted when the No. 1 piston is at T.D.C. (Compression) and the remaining four are adjusted when the No. 4 piston is at T.D.C. (Compression) as shown in the following chart. The number 1 valve is at the front of the engine and the number 8 valve is at the rear.

WITH	ADJUST VALVES(Engine Warm)							
No. 1 Piston at T.D.C. (Compression)	1	2	3		5			
No. 4 Piston at T.D.C. (Compression)				4		6	7	8

7. 60 SERIES ONLY: Use two thin wrenches when adjusting the valve clearance (Fig. 12).

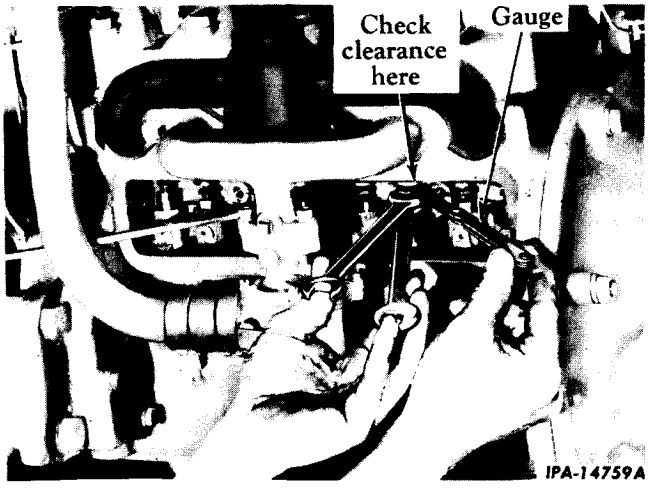

Fig. 12 - Adjusting and Checking Valve Clearance (60 Series)

Use the lower wrench to hold the tappet and the upper wrench to raise or lower the tappet adjusting screw. The gauge should slip snugly between the valve stem and the tappet adjusting screw.

135, 135B, 146, 153, 175 AND 281 SERIES ONLY: Loosen the adjusting screw lock nuts (Fig. 13) and insert the feeler gauge between the valve lever and the valve stem. Turn the adjusting screw in or out as necessary to hold the feeler gauge snugly. When the correct clearance is secured, hold the adjusting screw in place with a screwdriver and tighten the lock nut.

8. Crank the engine one revolution and check the clearance of the remaining valves and adjust if necessary.

9. Install the valve cover or tappet side cover. Check that the cover gasket makes an oiltight seal. Use a new gasket if necessary.

10. 135, 135B, 146, 153, 175 AND 281 SERIES ONLY: Connect the ignition switch cable to the ignition coil.

60 SERIES ONLY: Remove the jumper wire from the coil cover mounting bolt "G" to the magneto terminal "F" (Fig. 11).

10. REMOVAL

1. Remove the intake and exhaust manifold assembly. (Refer to Par. 2 and see Fig. 6)

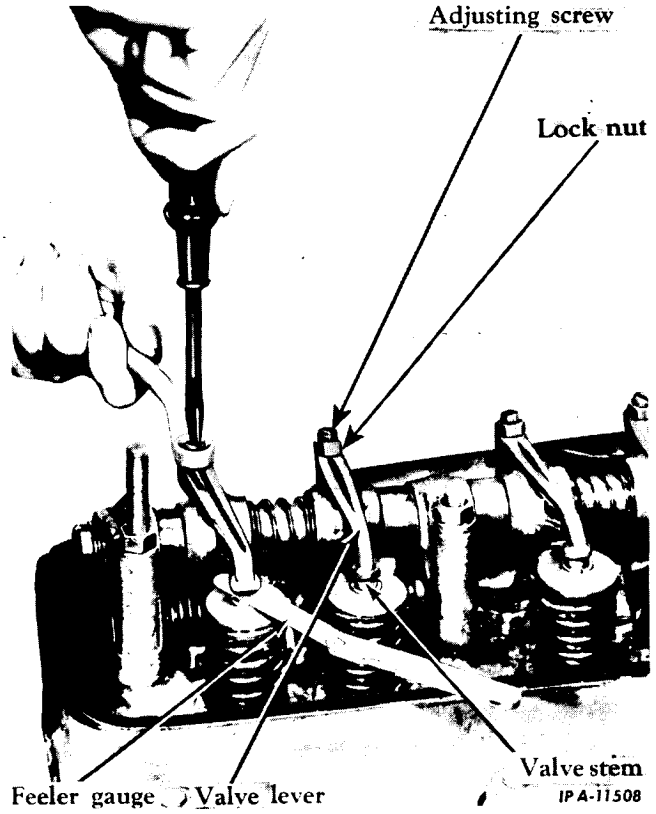

Fig. 13 - Adjusting Valve Clearance with Feeler Gauge.

2. Remove the instrument panel.

3. Remove the rods from the radiator tie plate and the fuel tank and air cleaner support.

4. 135, 135B, 146, 153, 175 AND 281 SERIES ONLY: Remove the nuts securing the valve cover, and remove the cover and gasket.

5. Disconnect the battery ground cable. Disconnect the cable from the junction block at the radiator grille cross bar, and tag the cable end as to location to facilitate replacement. Disconnect the cable from the "BAT" terminal on the relay and tag it "BAT." Disconnect the cable from the field terminal on the generator "F." Tag this cable end "F." Pull the cable harness away from the generator.

6. Pull the coil-to-distributor cable from the coil socket. Crank the engine slowly until the set screw in the generator pulley flange is accessible. Loosen the jam nut and back out the set screw until it clears the slot in the pulley hub. Turn the flange counterclockwise, viewed from the front end, until the generator belt rests in the bottom of the pulley groove. Remove the cap screws securing the generator to the bracket and remove the generator assembly and the pulley. (Refer to Sec. 15.)

7. With the water drained from the cooling system and the block, remove the cap screws securing the water outlet elbow to the front of the cylinder head. Remove the gasket. (Refer to Section 5.)

MANIFOLDS, CYLINDER HEAD AND VALVES

8. Remove the spark plug cables from the plugs. Tag the cables as removed to facilitate reassembly to their correct positions.

9. 175 AND 281 SERIES ONLY: Remove the cylinder head breather pipes and tube by unscrewing the breather pipes and tube by unscrewing the breather pipe (37, Fig. 16) from the rear of the cylinder head. Loosen the coupling nut on the upper end of the breather pipe and push the pipe to the rear, away from the cylinder head. Remove the elbow (34). Disconnect the governor breather pipe from the front of the cylinder head. Remove the connector. Remove the cap screws from the governor breather tube cover; remove the breather pipe, cover and gasket. Disconnect both ends of the cylinder head breather tube from the cylinder head and remove the tube.

10. Remove the stud nuts securing the valve lever brackets to the cylinder head. Lift off the complete valve lever and shaft assembly (Fig. 14). Remove the valve push rods.

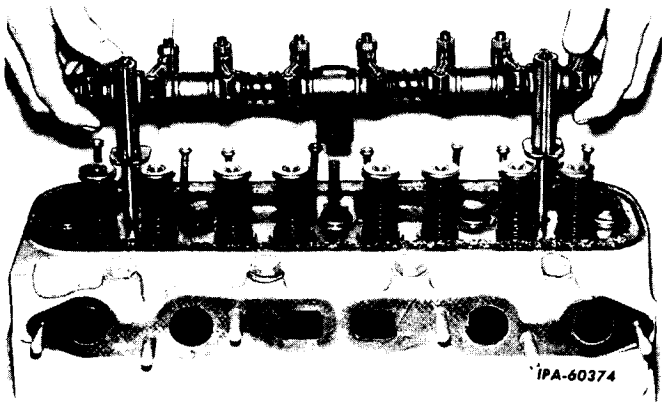

Fig. 14 - Removing the Valve Lever and Shaft Assembly.

11. Remove the nuts or bolts securing the cylinder head to the crankcase. Pry the cable clips apart and free the cable harness from the front and rear clips. Lift the cylinder head from position and remove the gasket (Fig. 15).

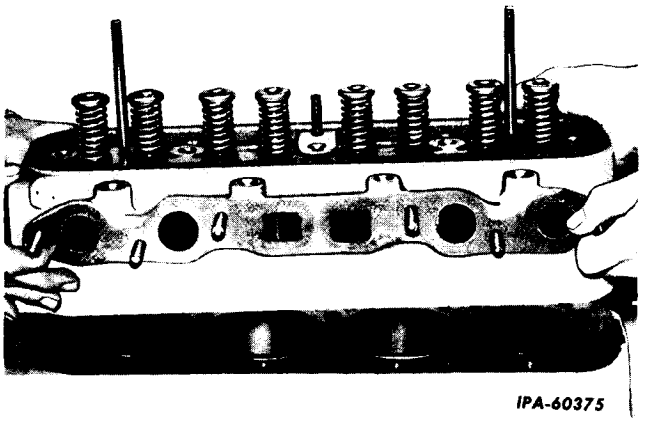

Fig. 15 - Removing the Cylinder Head Assembly.

Legend for Fig. 16

1. Washer.
2. Valve cover.
3. Gasket.
4. Plug.
5. Exhaust valve lever, LH.
6. Intake valve lever, RH.
7. Valve lever spring.
8. Intake valve lever, LH.
9. Lever bracket.
10. Exhaust valve lever, RH.
11. Shaft oil sleeve.
12. Valve lever shaft.
13. Adjusting screw nut.
14. Lever bushing.
15. Shaft spring washer.
16. Snap ring.
17. Adjusting screw.
18. Spring seat key.
19. Spring seat, upper.
20. Valve stem retainer.
22. Valve spring.
23. Valve guide.
24. Intake valve.
25. Head gasket.
26. Cylinder head.
27. Breather pipe.
28. Valve cover stud.
29. Head stud sleeve.
30. Stud.
31. Rotocap.
32. Exhaust valve seat insert.
33. Exhaust valve.
34. Elbow.
35. Elbow, w/nut.
36. Nut.
37. Breather pipe.

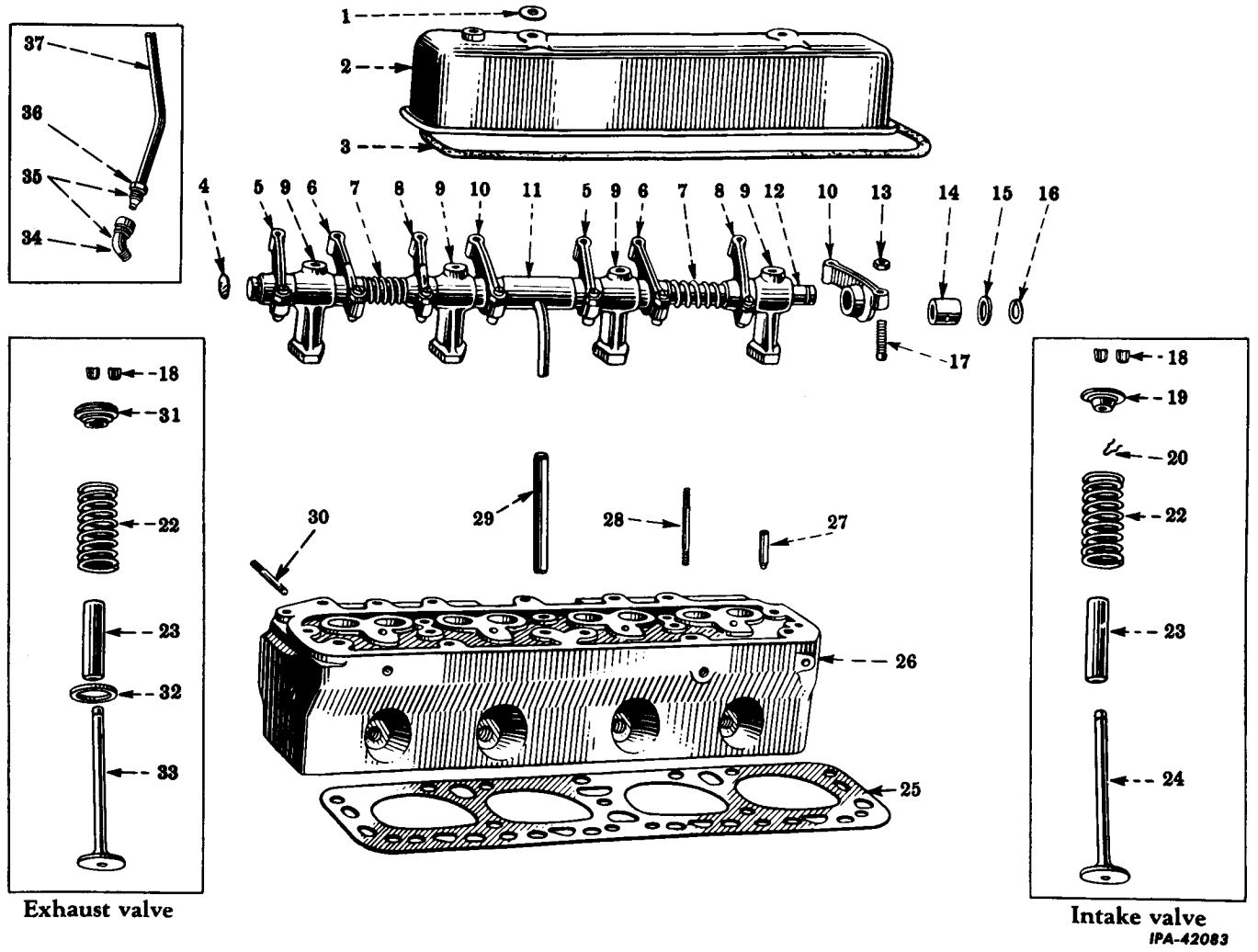

Fig. 16 - Cylinder Head, Valve Cover, Valves and Valve Levers (U-175 Shown - 281 Similar).

11. DISASSEMBLY

60 Series

NOTE: *Be very careful in using a compressor that a burr is not raised on the valve stem. If the valve fails to drop out easily, check it and remove any burrs with a hone. Damage to the valve guide would result if the valve was removed with a burr on valve stem.*

1. Remove the valve tappet side cover from the crankcase and turn down the tappet adjusting screws several turns so that the valve springs may be removed easily. Also, to prevent interference with valve stems after the seats and faces are re-ground.

2. Compress the valve springs with a suitable compressor and remove the valve spring seat retaining keys (Fig. 17).

Be careful not to compress the valve springs more than necessary, as they can be distorted.

NOTE: *When only grinding the valves, cover the holes in the valve compartment with clean wiping rags to prevent dropping the valve spring seat retainers into the crankcase.*

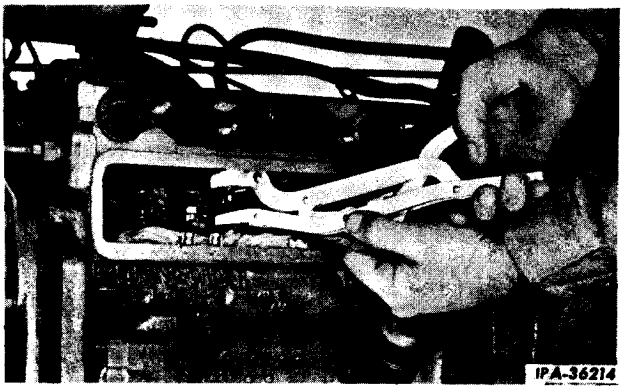

Fig. 17 - Removing Valve Spring Seat Retaining Keys.

MANIFOLDS, CYLINDER HEAD AND VALVES

3. Remove the valve spring seats, valve springs and valves. Keep the valves in order so they may be reinstalled in the same valve port from which they were removed.

135, 135B, 146, 153, 175 and 281 Series

(Reference Numbers Refer to Fig. 16)

1. Remove the snap ring (16), valve levers (5, 6, 8, and 10), lever brackets (9) and valve lever spring (7) from the valve lever shaft (12). The snap ring (16) can be removed if necessary.

NOTE: *The 175 and 281 series have a two-piece valve lever shaft, where as, the 135, 135B, 146, and 153 series have a one-piece shaft.*

2. Remove the spark plugs and gaskets. Using a valve compressor, compress the valve springs (22) sufficiently to permit removal of the valve spring seat keys (18). Remove the valve lifter. Lift off the valve spring seats (19) and the valve springs (22) (Fig. 18).

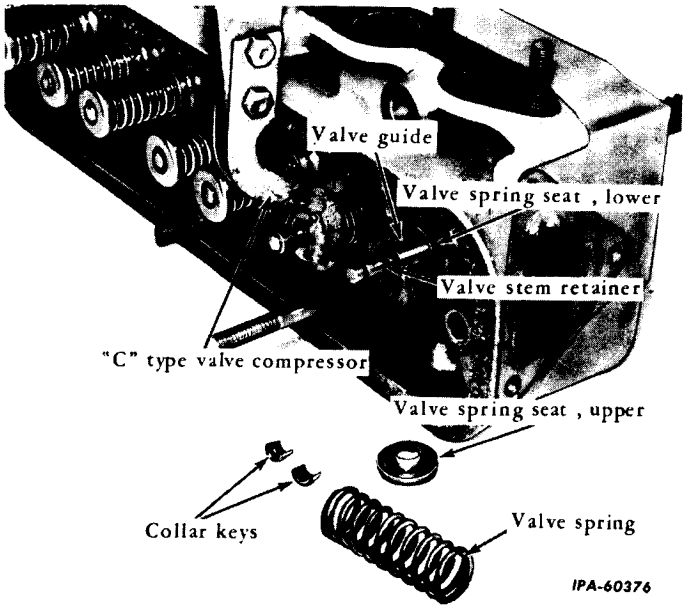

Fig. 18 - Removing Valves with a Compressor.

NOTE: *135, 135B, 146 and 153 SERIES ONLY: The valve springs must be kept with the valves as they are removed, because the exhaust and intake springs are not alike.*

With pliers, remove the valve stem retainers (20). Slide the valves out of the cylinder head. The 135, 135B, 146 and 153 series have both upper and lower valve spring seats.

12. INSPECTION AND REPAIR

General

Carbon deposits on the valves and valve seats are normal and cannot be avoided completely (Fig. 19). However, such deposits are detrimental to engine efficiency and valve assembly life as the amount of carbon in the engine increases.

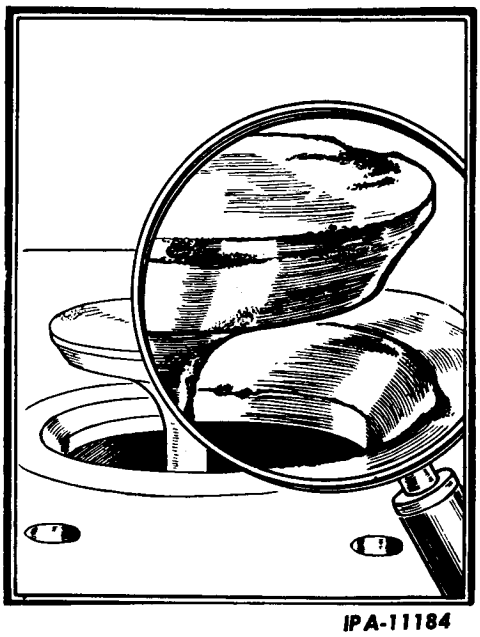

Fig. 19 - Carbon, Corrosion and Wear are Inevitable Products of Normal Engine Operation.

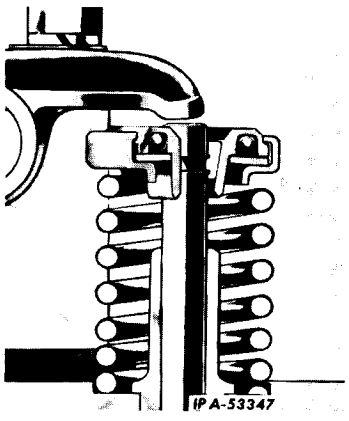

Fig. 20 - Cutaway View Showing Exhaust Valve Stem with Rotator.

Valves and valve seats should be examined for pitting, burning, warping and other defects.

The formation of carbon cannot be avoided. However, it can be held to a minimum by the use of good grade fuels and accurate engine timing.

Warpage, burning and pitting of valves is mainly directed against the exhaust valves which are exposed to the high temperature flow of exhaust gases. Such defects are generally caused by valves failing to seat tightly and evenly, permitting exhaust blow-by. This, in turn, can generally be traced to hard particles of carbon being present on the slopes of the valve seats. It may, however, be due to weak springs, insufficient valve clearance, or warpage and misalignment of the valve stem or guide.

WARPAGE chiefly occurs on the valve stem due to its exposure to heat. Out-of-round wear occurs when the seat has been pounded by a valve head which is not in line with its stem or guide.

MISALIGNMENT is a result of wear, warpage and distortion. Wear, when accentuated by insufficient lubrication will eventually create sloppy clearances with resultant misalignment.

Warpage of the valves, and in known extreme instances, that of the crankcase, can result from the engine overheating due to a blocked, dirty or insufficiently filled cooling system.

Most frequently, however, warpage of a valve stem or a guide is due to uneven temperatures being applied along its length. The lower part of the guide and stem is near the combustion heat, and the upper portions are closer to cylinder head water passages. Valve materials are carefully chosen to withstand such varying temperatures. However, an engine that is allowed to operate continually in an overheated condition is definitely open to valve stem and guide distortion and warpage. Distortion can also be caused by failure to tighten cylinder head bolts to the specified foot-pounds torque and in the sequence recommended. Valve clearances are also affected in this manner. Thus any abnormal wear, warpage or distortion affecting a valve guide will destroy its function as an accurate bearing to maintain the valve head concentric with its seat, and will prevent leak-proof seating.

Oil and air are sucked past worn intake valve stems and guides into the combustion chamber, causing excessive oil consumption, forming excessive carbon, and diluting the fuel.

When excessive oil consumption is evident, note if the intake valves or parts appear to have an excess quantity of oil on their surface, indicating that oil is being pulled through valve intake guides that are within the specified dimensions. Replacement of intake valve stem seals will be found helpful in correcting this condition.

Examine the engine for signs which may indicate the reason for the need of valve reconditioning. Dry and rusted valve springs are an indication that the oil passages to the valve levers may be blocked, causing wear on the valves and guides, and resulting in improper valve action. A defective gasket under the valve cover will permit the entrance of dirt which will cause undue wear on the valve stems and guides and damage to the valve springs. Observing the cause of a valve failure will aid the serviceman in the reconditioning.

Valves

1. Remove all carbon from the valve head and stem. Valve stems should be lightly polished with an extremely fine abrasive cloth sufficiently to remove the carbon deposits only. Because of the nature of the valve deposits, solvent cleaning ordinarily will not remove all the deposits from the valves. Wire brushes will do this job satisfactorily, but only brass wire brushes should be used since steel brushes may scratch the surface. Such scratches are likely to cause localized stresses in an operating valve and may eventually result in fatigue fractures of the valve. For similar reasons the use of coarse emery cloth or sandpaper should be avoided.

2. Inspect each valve. See that the stem is not worn excessively and that the head is not burned or warped. Check the grooves in the stem to see that they have not lost the shoulders through wear, which prevents the valve spring retainer locks from fitting snugly.

3. All valves having bent, worn, warped or seriously pitted stems must be replaced. Replace any valve that cannot be satisfactorily refaced with a definite margin maintained (Fig. 21). The amount of grinding necessary to true the valve face is a definite indication of the valve head warpage from the axis or centerline of its stem. With excessive warpage, a knife edge will be ground on part or all of the valve head due to the considerable amount of metal that must be removed to completely reface. Maximum heaviness in a valve head is required for strength and to provide as large an area possible for heat dissipation. Knife-edge valves lead to breakage and warpage.

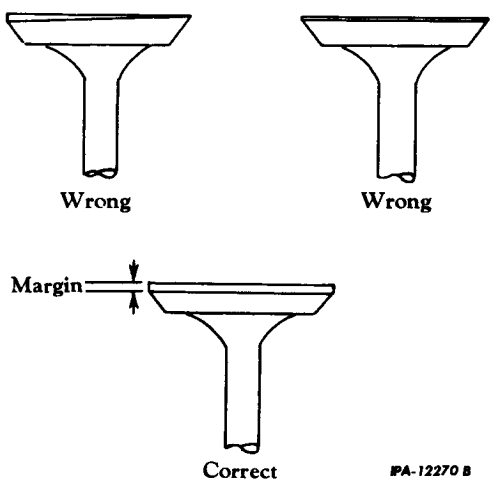

Fig. 21 - Example of Right and Wrong Valve Refacing.

Valve Springs

4. Clean and examine all valve springs for rust, pitting, broken or set coils. Test each spring against the spring specifications (refer to "SPECIFICATIONS," Section 1) using a spring load tester PLT-100 (Fig. 22).

MANIFOLDS, CYLINDER HEAD AND VALVES

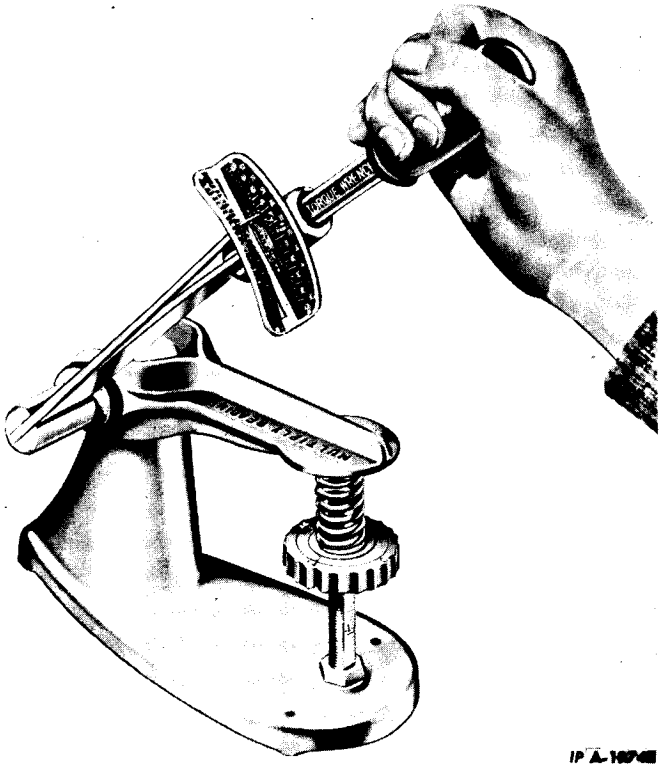

Fig. 22 - Testing Valve Springs.

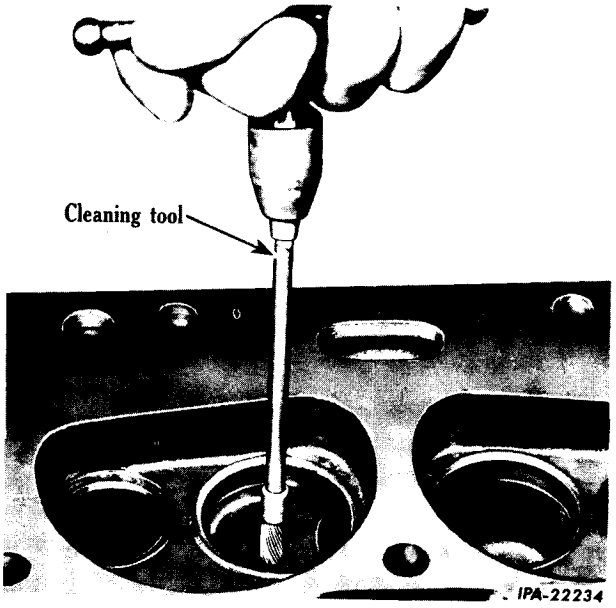

Fig. 23 - Valve Guide Cleaning Tool.

Valve Spring Retainers

5. Clean all valve spring retainers with solvent, and examine them for rust, cracks and bending characteristics. Replace parts as necessary.

6. Check the valve rotators for proper operation. A valve rotator in the free state (not assembled in the engine) may rotate in either direction, rotate in one direction or not rotate in any direction and still be satisfactory for use.

To properly test a valve rotator for rotation, the valve spring load must be applied to the rotator. This can be done in a spring tester or assembled in an engine.

When using a spring tester, place the valve spring together with the rotator in the tester. Place a ball bearing between the rotator cap and the ram of the spring tester. Turning of the valve rotator can then be observed by compressing the valve spring.

Valve Spring Retainer Locks

7. Clean parts thoroughly in solvent. Check the ribs in the inside of the locks to see that none are worn sufficiently to cause looseness. The locks must fit snugly into the valve stem groove. Check the locks for wear on the outside surface which might allow the valve spring retainer to slide over the lock.

Valve Guides

8. Clean the bores of the valve guides, using a wire rifle brush and solvent as shown in Fig. 23. Blow out all carbon with compressed air.

Position a light at the bottom of the guide bore, and examine the walls for burning, cracking and signs of excessive wear. Check the inside diameter of the guide bore at several points around its circumference and along its length. Specifications for the guides are given in "SPECIFICATIONS," Section 1. Replace any guides considered unserviceable or that appear close to a serviceable borderline. (Refer to "Valve Guides" in Par. 13.)

> NOTE: *All valve reconditioning equipment requires the installation of a pilot in the valve guide to produce a seat concentric with the guide bore. For this reason the guides must be clean and meet the engine specifications before the valve seats can be reconditioned.*

Valve Seats

9. Remove all carbon and any remaining gasket material from the cylinder head. Inspect all valve seats for cracks or loose valve seat inserts. Replace loose or burned inserts. Remove all carbon from the valve seat recesses or counterbores. (Refer to "Valve Seats and Valve Seat Inserts," in Par. 13.)

Valve Lever Assembly

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

11. Inspect the valve lever shaft expansion plugs. Check the shafts on a surface plate for signs bending, also check for wear from valve levers. If either shaft is bent or shows valve lever wear, it must be replaced.

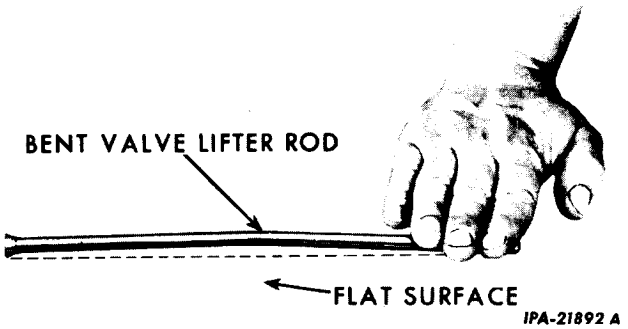

Fig. 24 - Checking Valve Lifter Rods for Straightness.

12. Inspect the valve lever adjusting screws for wear at contact surface and for thread wear. Replace worn screws.

13. Check the valve lever bushings for wear. If clearance on shaft exceeds 0.004 inch, replace the valve lever.

14. Inspect valve stem contact pad surface of the valve levers and resurface if wear is indicated.

15. Inspect tension springs for breakage or loss of tension. (Refer to "SPECIFICATIONS," Section 1.) Replace defective springs.

16. Check all of the valve lifter rods for straightness by rolling on a flat surface (Fig. 24). Replace any rods that are bent, have loose ends or are damaged in any way.

17. Inspect each of the engine valve tappets for irregular wear, chipping, cracking or scoring. Replace any that may be defective.

Cylinder Head

18. Remove any remaining carbon or grease accumulation from the cylinder head. Clean the water passages of the cylinder head. Inspect the cylinder head for signs of cracks or sand holes. Check the areas surrounding the exhaust valve ports for indications of blow-by such as burning away of the metal. If the head is found defective, repair or replace it, as necessary. Do not remove the six cylinder head stud sleeves (if so equipped) unless leakage is apparent.

19. Check the gasket surface of the cylinder head for trueness with a straightedge. Test by attempting to insert a 0.003" feeler gauge ribbon between the straightedge and cylinder head. If this is possible, either resurface (See NOTE) or replace the cylinder head.

NOTE: *When resurfacing the cylinder head do not remove more than 0.005" material, otherwise, contact between top of piston and head of valve may result.*

13. RECONDITIONING

Valve Guides

1. Press the guide from the cylinder head.

NOTE: *Valve guide tools FES 6-4 (Intake) and FES 6-5 (Exhaust) may be used for removing and installing valve guides.*

2. Install a new guide from the top of the head, and press it into the head (or crankcase, 1 and 6 series only), until the specified length remains above the top surface of the head. (Refer to "Valve Dimensional Chart" in this section (Fig. 34 or 35.)

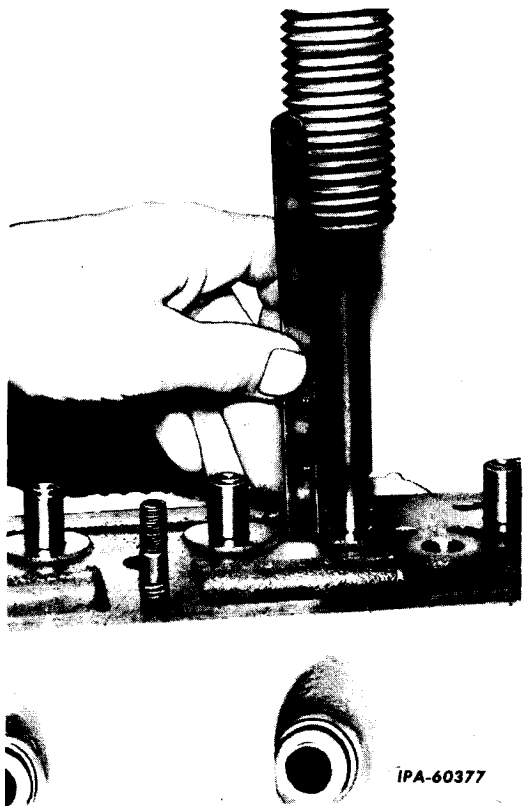

Fig. 25 - Pressing Valve Guide in Head to Proper Height (135 Series Shown)

3. All guides furnished as service parts are reamed to size; however, as they are a press fit, it is necessary to ream them after installation to remove any possible burrs or slight distortion caused by the pressing operation. (Refer to "SPECIFICATIONS," Section 1.)

MANIFOLDS, CYLINDER HEAD AND VALVES

Valves

After being thoroughly cleaned and inspected, valves that are fit for continued use should be reconditioned as follows: Determine the correct face angle as given in the "SPECIFICATIONS," Section 1.

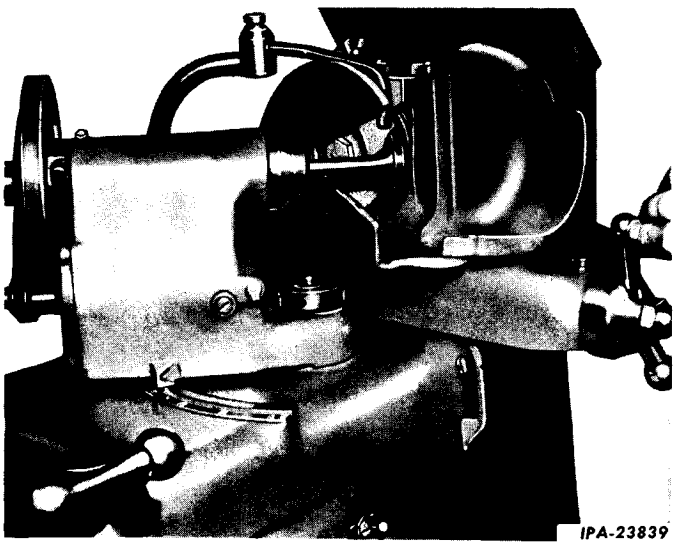

Fig. 26 - Grinding the Valve Face Angle Taking Light Cuts Only.

1. Set the valve refacing machine to grind the desired angle (Fig. 26), and dress the grinding stone. Both intake and exhaust valves are to be ground to the same face angle.

2. Insert a valve in the chuck and take a light cut across its face (Fig. 26). This is a check to determine whether the valve can be reconditioned to service standards with a correct amount of margin maintained. Warpage that may not be apparent in the visual inspection will be clearly definable (Fig. 21).

Avoid taking heavy grinding cuts as this heats the valve head excessively, producing an unsatisfactory valve face, and necessitates dressing the grinding wheel frequently. Repeated light grinding cuts are preferred until a true face of even width is obtained around the valve.

Avoid passing the stone beyond the face of the valve as this will cause ridging and grooving of the stone surface and make dressing of the stone necessary. Reject all valves with distorted heads which produce an uneven face and valves which grind down to a thin edge (Fig. 21).

One of the principal difficulties in reconditioning valves is to obtain 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.

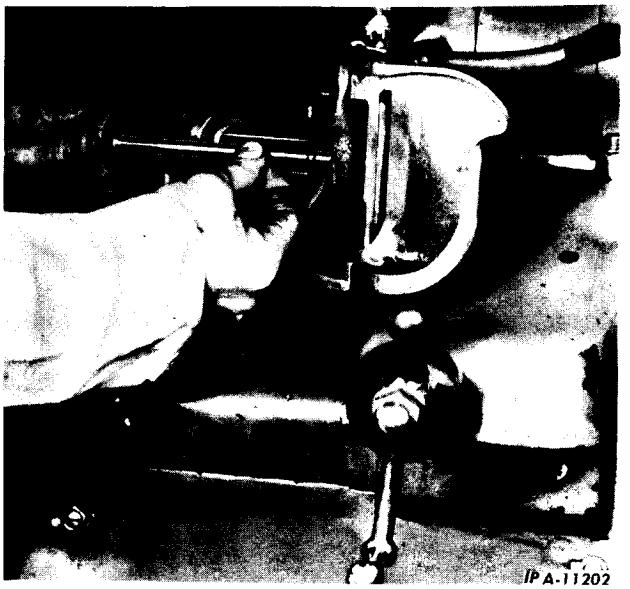

Fig. 27 - Refacing the Valve Stem End.

It will be difficult 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 have 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.

At times unusually large amounts of heat scale may be found on exhaust valves, which is hard on the grinding stone. Frequent redressing of the stone will be necessary to maintain a smooth even surface and a uniform set of valve face angles.

After refacing each valve, inspect the end of the stem. If wear is noticeable, reface the end of the stem (Fig. 27). Grind sufficiently to true-up the end of the stem.

Valve Seats and Valve Seat Inserts

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 produces excessive valve stem temperatures. This will hasten the accumulation of carbon on the stems, which causes them to stick in the guides.

To assure maximum valve and valve insert life, it is essential that the valve insert ring be installed to obtain maximum contact with the bottom and sides of the ring counterbore. Proper exhaust heat dissipation through the valve insert ring can only be accomplished by the valve insert ring being a tight fit in the cylinder head with the bottom of the insert ring squarely seated on the bottom of the counterbore as shown ing Fig. 28. It is recommended that a skin cut be taken from the bottom of the ring counterbore (in head) to assure a square seat for the insert ring.

Valve insert rings which are not fitted sufficiently tight, work loose, permitting carbon formations to collect on the outer surface of the insert ring, thus insulating the exhaust heat within the insert ring, preventing proper heat dissipation through the cylinder head.

The following procedure applies for refacing seats or seat inserts or facing new inserts. Install valve seat insert rings as follows:

a. Chill the insert rings and driver thoroughly in dry ice for at least one-half hour before installing.

b. Properly align insert to avoid cocking.

c. Using an arbor press and driver, press the insert ring into the cylinder head. An evenly applied 500 pound load is required for proper installation and is to be sustained for a five second period to guaranteee proper seating.

NOTE: *DO NOT install inserts by hammering or striking insert driver.*

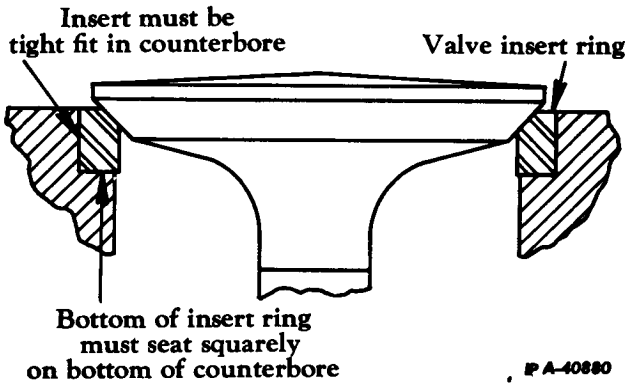

Fig. 28 - Insert Ring Properly Installed.

1. Remove all carbon, scale and oil before attempting to reface valve seats. The grinding stone, when placed against an oily seat, will become fouled, and uneven grinding will occur.

NOTE: *Before installing the pilot, be certain that the valve guides are perfectly clean and meet the engine specifications. This is important; otherwise, an eccentric seat will be cut.*

2. Dress the stone to the correct angle. Lightly lubricate and install the pilot of the correct size into the valve guide bore.

3. Lower the grinder head over the pilot shank until the stone just clears the valve seat. Turn on the power and very gently allow the stone to contact the valve seat. Very little pressure other than the normal weight of the stone should be used. Sudden hard pressure can cause cocking of the pilot in the guide and result in eccentric grinding. Raise the stone frequently from the valve seat to prevent overheating and to clear away grinding dust. Grind the seat sufficiently to provide an even, smooth surface.

4. Check the seat concentricity, roundness and valve face contact using Prussian blue. Spread an extremely thin film of this blue on the valve face and insert the valve into its guide. With pressure on the exact center of the valve head, make a quarter turn rotation in the seat. Remove the valve and inspect the impression made upon the seat by the transfer of blueing, and upon the valve face by the removal of blueing. Check several times to guarantee that no error was made. 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. Refer to Valve Dimensional Chart and Fig. 29 and 30.

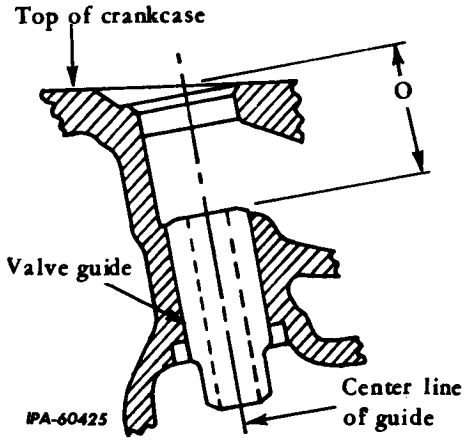

Fig. 29 - Proper Location of Valve Guide in the Crankcase (1 and 60 Series).

MANIFOLDS, CYLINDER HEAD AND VALVES

KEY TO VALVE ILLUSTRATION AND VALVE CHART

A. Valve face angle (between valve seat and bottom of valve head).
B. Valve head diameter.
C. Valve stem diameter.
D. Valve length.
E. Valve port inside diameter.
F. Valve seat insert bore depth.
G. Valve seat outside diameter.
H. Valve seat width.
I. Distance from outside diameter of valve seat to edge of combustion chamber in the head (or crankcase in 1 and 60 Series).
J. Valve seat insert bore inside diameter.
K. Distance from valve seat insert face or valve seat face to head end of valve guide.
L. Valve guide length.
M. Valve guide inside diameter.
N. Valve guide outside diameter.
O. Distance from valve spring counterbore in head to stem end of valve guide.

60 SERIES ONLY: Distance from top surface of crankcase to head end of valve guide measured on centerline (Refer to Fig. 29).

P. Distance from face of cylinder head (or crankcase in 1 and 60 Series) to face of valve seat.

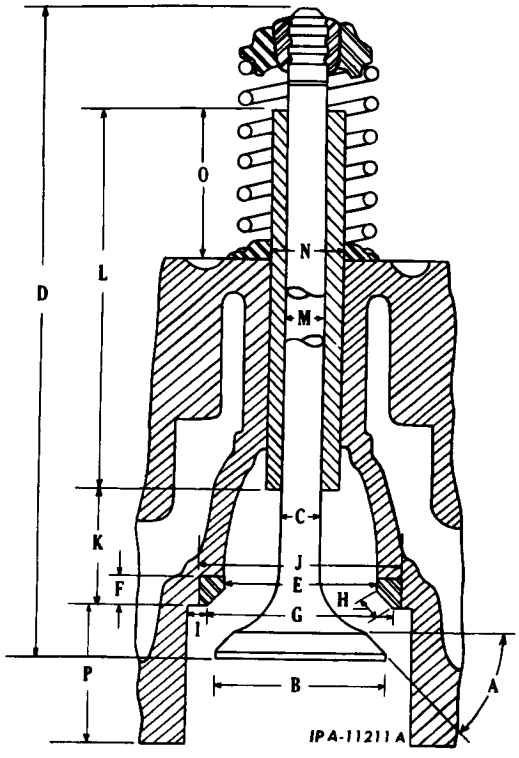

Fig. 30 - Intake and Exhaust Valve Data.

VALVE DIMENSIONAL CHART, 4 – CYLINDER CARBURETED ENGINES

Symbol (See Fig. 29 and 30)	4 Series	U-164	U-169 U-175	6 and 264 Series	U-281	9 Series
A	45° Int. 45° Exh.	45° Int. 45° Exh.	45° Int. 45° Exh.	45° Int. 45° Exh.	45° Int. 45° Exh.	45° Int. 45° Exh.
B	1-1/2 Int. 1-3/8 Exh.	1-1/2 Int. 1-3/8 Exh.	1-1/2 Int. 1-3/8 Exh.	1-13/16 Int. 1-21/32 Exh.	1-13/16 Int. 1-21/32 Exh.	2-3/32 Int. 1-29/32 Exh.
C	.341 Int. .341 Exh.	.341 Int. .341 Exh.	.341 Int. .341 Exh.	.372 Int. .372 Exh.	.372 Int. .372 Exh.	.402 Int. .402 Exh.
D	5-23/64 Int. 5-25/64 Exh.	5-29/64 Int. 5-29/64 Exh.	5-29/64 Int. 5-29/64 Exh.	5-27/32 Int. 5-7/8 Exh.	6-1/64 Int. 6-3/64 Exh.	6-29/32 Int. 6-15/16 Exh.
E	1-11/32 Int. 1-7/32 Exh.	1-23/64 Int. 1-15/64 Exh.	1-23/64 Int. 1-15/64 Exh.	1-19/32 Int. 1-7/16 Exh.	1-19/32 Int. 1-7/16 Exh.	1-7/8 Int. 1-11/16 Exh.
F	1/4 Exh.	17/64 Exh.	9/32 Exh.	17/64 Exh.	17/64 Exh.	17/64 Exh.
G	1-29/64 Int. 1-21/64 Exh.	1-15/32 Int. 1-21/64 Exh.	1-15/32 Int. 1-11/32 Exh.	1-45/64 Int. 1-9/16 Exh.	1-45/64 Int. 1-9/16 Exh.	1-63/64 Int. 1-13/16 Exh.
H	5/64 Int. 5/64 Exh.	5/64 Int. 5/64 Exh.	5/64 Int. 5/64 Exh.	5/64 Int. 3/32 Exh.	5/64 Int. 5/64 Exh.	5/64 Int. 3/32 Exh.
I	5/32 Int. 3/16 Exh.			5/32 Int. 3/16 Exh.		11/64 Int. 3/16 Exh.
J	1-1/2 Exh.	1-1/2 Exh.	1-1/2 Exh.	1-13/16 Exh.	1-13/16 Exh.	2-1/16 Exh.
K	1-3/16 Int. 1-3/16 Exh.	1-15/64 Int. 1-15/64 Exh.	1-15/64 Int. 1-7/32 Exh.	1-13/64 Int. 1-3/16 Exh.	1-23/64 Int. 1-23/64 Exh	1-15/32 Int. 1-29/64 Exh.
L	2-15/64 Int. 2-15/16 Exh.	2-29/32 Int. 2-29/32 Exh.	2-29/32 Int. 2-29/32 Exh.	3-7/32 Int. 3-7/32 Exh.	3-7/32 Int. 3-7/32 Exh.	3-3/4 Int. 3-3/4 Exh.
M	.344 Int. .344 Exh.	.344 Int. .344 Exh.	.344 Int. .344 Exh.	.374 Int. .374 Exh.	.374 Int. .374 Exh.	.405 Int. .405 Exh.
N	.596 Int. .596 Exh.	.596 Int. .596 Exh.	.596 Int. .596 Exh.	.689 Int. .689 Exh.	.689 Int. .689 Exh.	.751 Int. .751 Exh.
O	31/32 Int. 31/32 Exh.	15/16 Int. 15/16 Exh.	15/16 Int. 15/16 Exh.	31/32 Int. 31/32 Exh.	29/32 Int. 29/32 Exh.	1-3/16 Int. 1-3/16 Exh.
P	63/64 Int. 63/64 Exh.	15/16 Int. 59/64 Exh.	15/16 Int. 59/64 Exh.	1-13/32 Int. 1-13/32 Exh.	1-3/16* Int. 1-3/16* Exh.	1-15/32 Int. 1-31/64 Exh.

Abbreviations used: Int. = intake; Exh. = exhaust

* Vertical Dimensions to valve center line at diameter "G" Valves are at 7 degree angle from vertical.

VALVE DIMENSIONAL CHART, 4 - CYLINDER CARBURETED ENGINES

Symbol (See Fig. 29 and 30)	U-1 UC-60	U-2A	U-123	135 Series	135B, 146 and 153 Series
A	45° Int. 45° Exh.	45° Int. 45° Exh.	45° Int. 45° Exh.	45° Int. 45° Exh.	45° Int. 45° Exh.
B	1-3/32 Int. 29/32 Exh.	1-11/32 Int. 1-5/32 Exh.	1-11/32 Int. 1-5/32 Exh.	1-1/2 Int. 1-5/16 Exh.	1-1/2 Int. 1-5/16 Exh.
C	0.310 Int. 0.310 Exh.	0.341 Int. 0.341 Exh.	0.341 Int. 0.341 Exh.	0.341 Int. 0.341 Exh.	0.341 Int. 0.341 Exh.
D	3-25/64 Int. 3-25/64 Exh.	4-59/64 Int. 4-59/64 Exh.	5 Int. 5 Exh.	5-9/32 Int. 5-9/32 Exh.	5-9/32 Int. 5-9/32 Exh.
E	63/64 Int. 51/64 Exh.	1-3/16 Int. 1.0 Exh.	1-3/16 Int. 1.0 Exh.	1-11/32 Int. 1-5/32 Exh.	1-1/4 Int. 1-5/32 Exh.
F					
G	1-1/32 Int. 55/64 Exh.	1-9/32 Int. 1-3/32 Exh.	1-9/32 Int. 1-3/32 Exh.	1-29/64 Int. 1-17/64 Exh.	1.428 Int. 1-241 Exh.
H	3/64 Int. 3/64 Exh.	5/64 Int. 5/64 Exh.	5/64 Int. 5/64 Exh.	5/64 Int. 5/64 Exh.	5/64 Int. 5/64 Exh.
I		7/64 Int. 13/64 Exh.			
J					
K	59/64 Int. 59/64 Exh.	1-1/8 Int. 1-1/8 Exh.	1-1/8 Int. 1-1/8 Exh.	1-5/32 Int. 1-5/32 Exh.	1-5/32 Int. 1-5/32 Exh.
L	1-1/2 Int. 1-1/2 Exh.	2-11/16 Int. 2-11/16 Exh.	2-11/16 Int. 2-11/16 Exh.	2-11/16 Int. 2-11/16 Exh.	2-11/16 Int. 2-11/16 Exh.
M	0.3120 Int. 0.3130 Exh.	0.343 Int. 0.343 Exh.	0.3435 Int. 0.3435 Exh.	0.3435 Int. 0.3435 Exh.	0.3435 Int. 0.3435 Exh.
N	0.626 Int. 0.626 Exh.	0.564 Int. 0.564 Exh.	0.564 Int. 0.564 Exh.	0.564 Int. 0.564 Exh.	0.564 Int. 0.564 Exh.
O	1.0 Int. 1.0 Exh.	1.0 Int. 1.0 Exh.	1.0 Int. 1.0 Exh.	3/4 Int. 3/4 Exh.	13/16 Int. 13/16 Exh.
P	5/64 Int. 5/64 Exh.	59/64 Int. 59/64 Exh.	59/64 Int. 59/64 Exh.	45/64 Int. 45/64 Exh.	49/64 Int. 49/64 Exh.

Abbreviations used: Int. = Intake; Exh. = Exhaust

14. REASSEMBLY

(U-1 and 60 Series)

1. Insert the valve tappets in the crankcase.

2. Coat valve stems with clean engine oil and install the valves, valve springs and valve spring seats. Secure the valves with the valve spring seat keys, using a valve lifter tool and key inserter. Each valve and its ports must be returned to the position from which it came.

3. Adjust the intake and exhaust valve tappet clearances to that shown in "SPECIFICATIONS," Section 1. (Also refer to Fig. 31.)

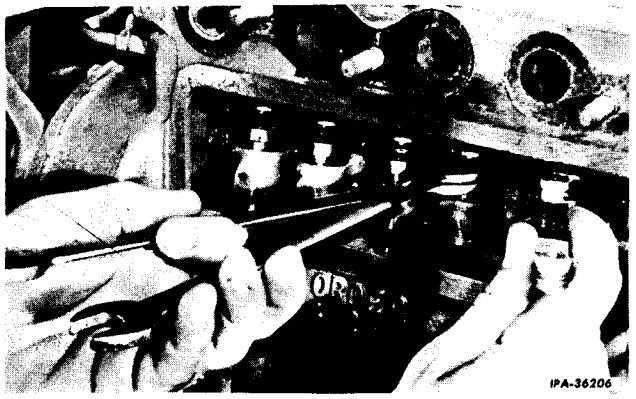

Fig. 31 - Adjusting Valve Tappets.

4. Install the valve tappet side cover and a new gasket.

5. Install a new cylinder head gasket. Position the cylinder head on the gasket; install the head bolts and tighten according to sequence as shown in Fig. 37. Finally, torque as given in "SPECIFICATIONS," Section 1.

6. Install the spark plugs after properly gapping them according to that shown in "SERVICE CHARTS" in Section 1. Attach the spark plug cables to the proper plugs.

135, 135B, 146, 153, 175 and 281 Series
(Reference Numbers Refer to Fig. 16)

1. Coat valve stems with clean engine oil and install the valves in the cylinder head. Be sure to install the intake and exhaust valves in their original positions.

Install the valve stem retainers into the valve stem grooves closest to the valve heads.

> **NOTE:** *The 135, 135B, 146 and 153 Series engine is also equipped with lower valve spring seats. Install the seats before installing the valve stem retainers.*

Position the valve springs with the coils speced closer together (damper coils) contacting the cylinder head. Assemble the valve spring seats over the tops of the valve springs; compress the springs with seats, using a valve lifter, until the valve spring seat keys can be inserted into place.

Valve Lever Mechanism

2. Refer to Fig. 16 and assemble the valve lever mechanism to each section of the valve lever shaft (12) as indicated. Join the two sections with the oil sleeve (11) and secure with set screws and jam nuts.

15. INSTALLATION

> **NOTE:** *Never use a sealer or lubricant on the cylinder head or crankcase mating surfaces. Check the cylinder head bolt holes in the crankcase and be sure there is NO OIL IN THE HOLES. This would cause a hydrostatic lock and with high torques, the result could be a cracked crankcase.*

1. Clean the carbon from the pistons and be sure the gasket surfaces of the crankcase and cylinder head are clean and dry. Be sure there is no oil in the bottom cylinder head bolt holes to prevent hydraulic lock when the bolts are torqued. Remove any metal pull-up around the bolt holes. Install gasket and head. Install and tighten the cylinder head nuts or bolts. Torque must be applied to the nuts or bolts with a torque wrench to the amount specified in Par. 2, Section 1. Tighten the nuts or bolts in correct rotation as shown in Fig. 32, 33, 34, 35 and 36, which ever applies.

> **NOTE:** *Be certain that stud washers have been assembled to the studs having symbol (W) after the numbers in the tightening down illustrations. With all nuts or bolts torqued as specified, recheck them, using chalk marks on studs to avoid missing one.*

2. Install the valve mechanism as follows: Install the push rods after examining them for wear and misalignment. Loosen the adjusting screws and nuts in each valve lever (Refer to Fig. 16) and back up on the adjusting screws. Lift the complete valve lever mechanism onto the studs provided for the brackets. Be sure that the tube in the oil sleeve (11, Fig. 17) enters the drilled hole in the top of the cylinder head.

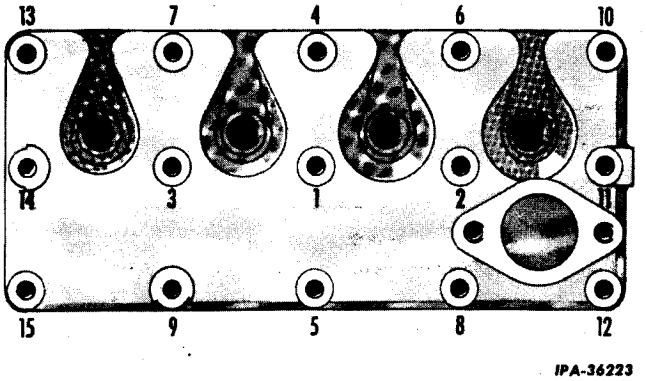

Fig. 32 - Sequence for Tightening Cylinder Head Bolts (U-1 and 60 Series)

MANIFOLDS, CYLINDER HEAD AND VALVES

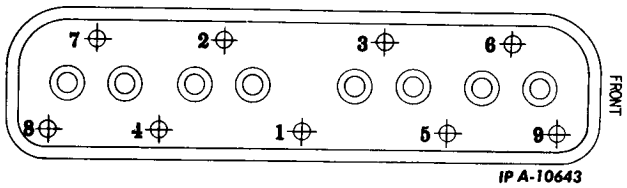

Fig. 33 - Nut Tightening Sequence for U-2A, U-123 and 135 Series Engine

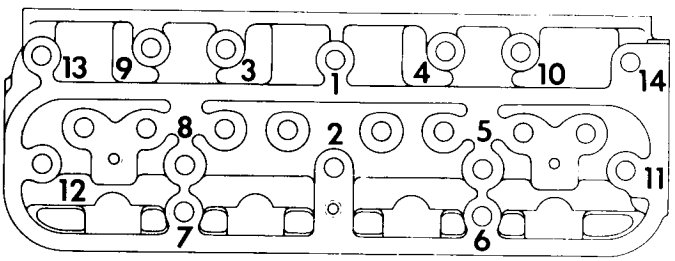

Fig. 34 - Nut Tightening Sequence for 135B, 146 and 153 Series.

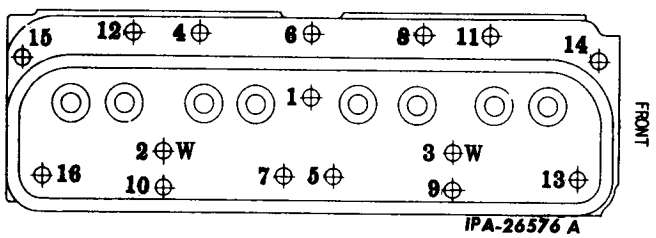

Fig. 35 - Nut Tightening Sequence for 4, 164, 169, 175, 6, 264 and 281 Carbureted Engines.

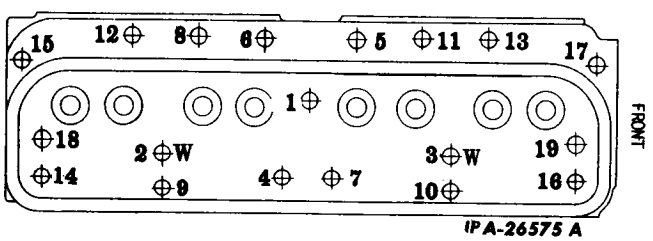

Fig. 36 - Nut Tightening Sequence for 9 Series Carbureted Engines.

3. Tighten the bracket retaining stud nuts. Adjust the valves to the specified cold clearance. (Refer to Par. 2, Section 1.)

4. Attach the breather tube to its connections. Install the valve cover and gasket.

5. Turn the breather pipe connector (34, Fig. 17) into the cylinder head. Attach the lower end of the breather pipe (37) to the connector (34) at the rear of the cylinder head, through the hole in the air cleaner support. Attach the other end with gasket to the governor control rod housing with the cap screws and lock washers.

6. Install the spark plugs.

7. Using a new gasket, install water outlet elbow.

8. Reconnect all cables.

9. Install the manifold assembly.

10. Fill the complete cooling system. Be certain that the drain valves below the radiator are closed and that the vent valve on the water manifold is also closed after venting (if so equipped). Check the oil level in the crankcase.

11. With all fuel lines and controls connected, start the engine and allow it to operate for one hour after reaching normal operating temperature. Stop the engine and remove the valve cover and gasket. Remove the valve lever assemblies and recheck the torque of the cylinder heat nuts. Tighten to the specified torque where necessary. Install the valve rocker arm assemblies and back off on rocker arm adjusting screws to insure adequate clearance. Adjust the valves for clearance. Install the cover and gasket.

12. On new engines, or whenever new cylinder head gaskets have been installed, the valve lever assemblies must be removed and the cylinder head stud nuts retorqued and the valve clearances adjusted after the first 50 to 100 hours of operation.

NOTE: *When retorquing cylinder head stud nuts, only those nuts below torque are to be retorqued to proper specifications. Those above torque are to remain as they are.*

CONNECTING RODS, PISTONS, PISTON RINGS AND SLEEVES

CONNECTING RODS, PISTONS AND PISTON RINGS

1. DESCRIPTION

Connecting Rods

The connecting rods serve as the links between the pistons and the crankshaft. The surfaces of the rods must be kept free of scoring and dents because of the high stresses under which they function. The rod has a bushing at each end, the one at the upper end is a bushing for the piston pin which anchors it to the piston. The bearing at the crankshaft or lower end is inserted in two halves which fit around the crankshaft and are secured by a bearing cap. The bearing cap is furnished only with its respective connecting rod.

The lower bearings used in these engines are the replaceable insert type and insure correct running clearances when they are properly installed. This is possible without boring, reaming, scraping or using shims. The three important fundamentals on bearings and bearing fitting are "bearing crush," "bearing spread," and "bearing clearance." An explanation of these will be covered later.

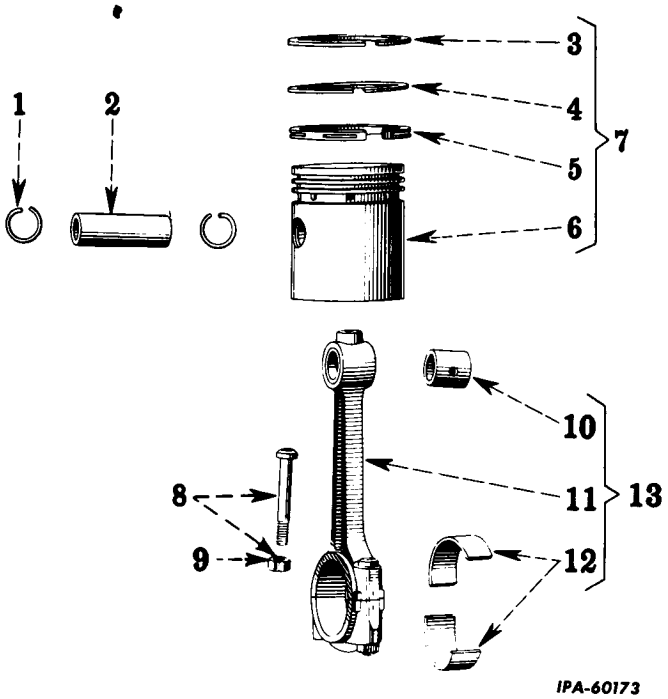

Fig. 1 - Connecting Rod, Bearings, Piston and Rings (60 and 146 Series)

1. Retainer.
2. Pin.
3. Compression ring.
4. Compression ring.
5. Oil ring.
6. Piston.
7. Piston, assembly.
8. Rod bolt.
9. Nut.
10. Bushing.
11. Connecting rod.
12. Bearings.
13. Rod assembly.

Pistons

The piston is one of the most important units in the engine, and its condition has much to do with the performance of the engine. Its function is to receive the force of the combustion pressure and transmit it to the connecting rod and crankshaft. The escape of combustion pressure past the piston is prevented by the piston rings. The fit of the piston and rings in the sleeve must be close enough to prevent the escape of combustion gases but must be free enough to keep friction to its working minimum.

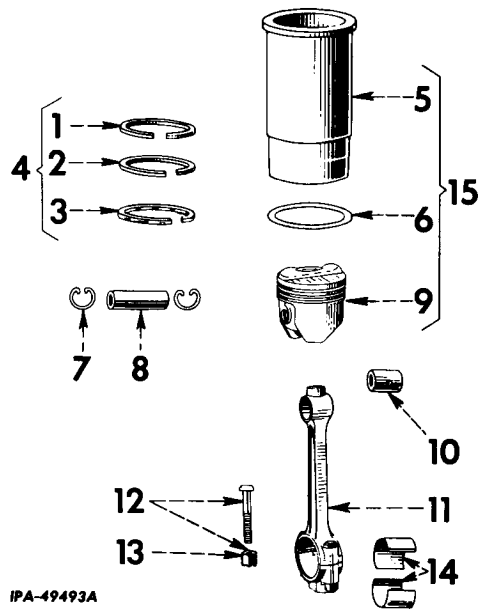

Fig. 2 - Connecting Rod, Piston and Cylinder Sleeve (135 and 135B Series).

1. Compression ring
2. Compression ring.
3. Oil ring.
4. Ring set.
5. Sleeve (wet).
6. Sleeve ring.
7. Retainer
8. Pin.
9. Piston.
10. Bushing.
11. Rod.
12. Rod bolt.
13. Nut.
14. Bearings.
15. Piston and sleeve assembly.

Piston Rings

The pistons are fitted with three, four or five piston rings (depending on the series engine). One oil regulating ring is fitted to each piston. The oil regulating ring provides an even circulation of lubricating oil and, therefore, an all-over lubricating and cooling action for the piston and crankcase sleeve. Excess oil is wiped by the rings, back down to the crankcase. The remaining rings are compression rings. Ring gaps and other dimensions are given in "SPECIFICATIONS," Section 1. Rings should be installed on a piston so that the gaps are 90 degrees from the thrust side of the piston and 180 degrees from one gap to another.

CONNECTING RODS, PISTONS, PISTON RINGS AND SLEEVES

Piston Pins

The piston pin is made of steel and is cylindrical in shape. Its purpose is to anchor the piston to the connecting rod. The pin is retained in the piston by retainer rings that lock into grooves of the piston pin bore. The pin is allowed to float in its bushing in the upper end of the rod. The aluminum of the piston is an excellent bearing material and, therefore, no bushing is provided between the pin and the piston. The bearing of the steel pin in the aluminum piston is the reason for the tight fit of the pin when the piston is cold. It is usually necessary to heat the piston in order to remove the pin. The specified clearance for the piston pin is given in "SPECIFICATIONS," Section 1.

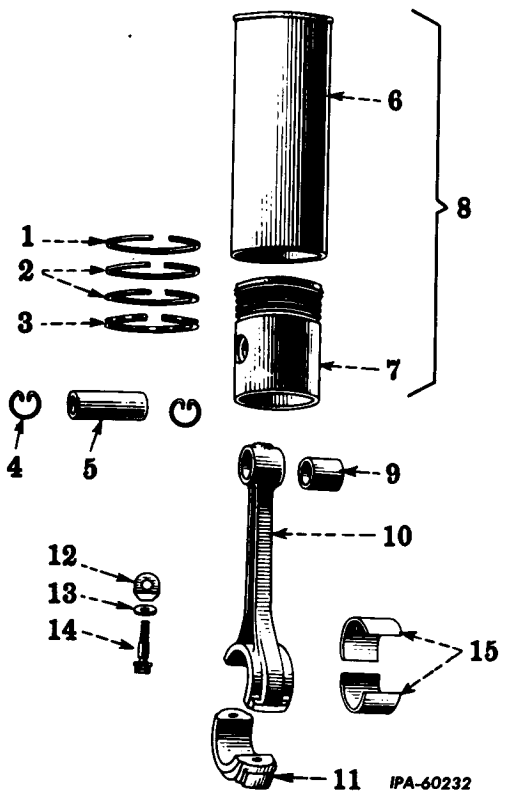

Fig. 3 - Connecting Rod, Bearings, Piston and Rings (175 and 281 Series).

1. Compression ring.
2. Compression ring.
3. Oil ring.
4. Retainer ring.
5. Pin.
6. Sleeve (dry).
7. Piston.
8. Piston and sleeve assembly.
9. Bushing.
10. Connecting rod.
11. Bearing cap.
12. Bolt lock.
13. Washer.
14. Bolt.
15. Bearing.

2. REMOVAL

1. Remove the intake and exhaust manifolds and the cylinder head. (Refer to "CYLINDER HEAD AND VALVES," Section 2.)

2. Remove the drain plug and drain the engine lubricating oil from the crankcase oil pan. Replace the drain plug.

3. Remove the cap screws securing the oil pan, and remove the oil pan and gasket.

> NOTE: *Before proceeding with piston and connecting rod removal, the ridge, existing on the cylinder wall at the upper end of the ring travel, must be removed by using a grinder. This prevents damage to the piston ring lands during removal of pistons, and prevents damage to new top piston rings after the installation of new rings.*

4. Remove the oil pump. (Refer to "OIL PUMP AND FILTER," Section 4.)

5. Remove the connecting rod bearing cap nut and bolt or bolt and lock, as the case may be. Remove the bearing cap (Fig. 4). Be sure that each bearing and cap can be identified with the connecting rod from which it was removed. Each connecting rod should be found numbered on the camshaft side of the rod, indicating its position in the engine.

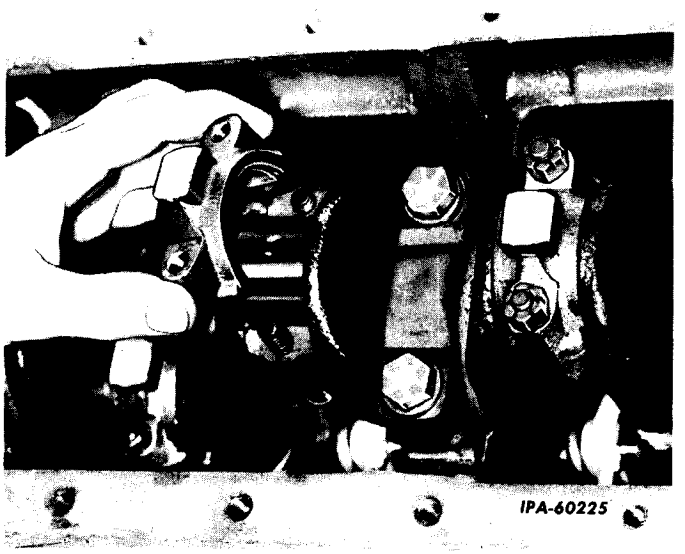

Fig. 4 - Removing Connecting Rod Bearing Cap (135 Series Shown).

6. Push the connecting rod and piston assembly to the top and lift out from the crankcase (Fig. 5). Replace the cap on the connecting rod to avoid damage.

7. Crank the engine by hand to make each rod and cap accessible and remove all pistons and connecting rods in the same manner.

CONNECTING RODS, PISTONS, PISTON RINGS AND SLEEVES

NOTE: *Pistons must be handled with care to avoid damage and knocking out-of-round or alignment. When removing a piston from the crankcase, do not allow the skirt of the piston to strike the crankcase or connecting rod. Mark the pistons so they can be installed in the same position and cylinder from which they were removed. It will be noted in Fig. 5, the dome of the piston is stamped with an arrow, indicating its position when properly installed.*

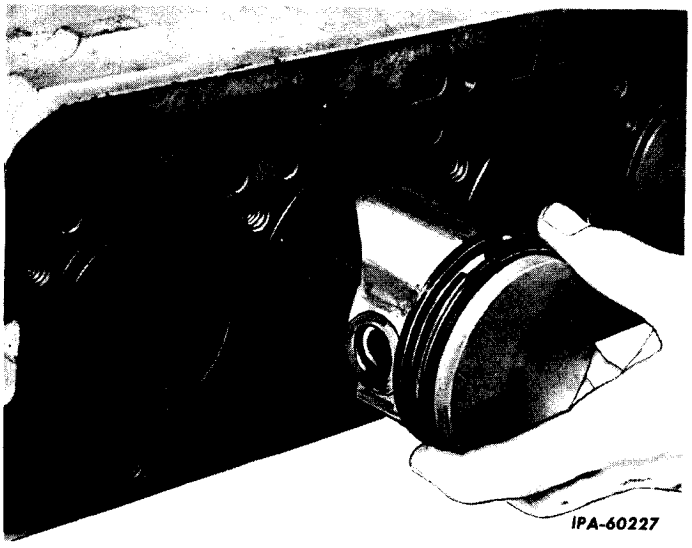

Fig. 5 - Removing Piston Assembly Out of Top of Cylinder (135 Series Shown).

Fig. 6 - Removing Piston Rings with (135 Series Shown).

3. DISASSEMBLY

1. Remove the piston rings with a piston ring expander such as is shown in Fig. 6. Remove the top ring first and the remaining rings in order.

2. Remove the piston pin retainer rings.

3. Remove the piston pins from the pistons. As an aid in removing the pin, heat the piston in a piston heater or dip the piston in hot-to-boiling water and then clamp the piston in a piston vise and drive the pin out with a suitable pin driver and soft hammer.

4. INSPECTION AND REPAIR

1. Wash all parts in a cleaning solvent.

NOTE: *DO NOT USE A CAUSTIC SOLUTION FOR ALUMINUM PISTONS. Clean the carbon from the piston ring grooves with ring groove cleaner.*

2. Inspect the connecting rods, caps, bearing shells and pin bushings as follows:

a. All connecting rod bearings and piston pin bushings should be replaced in a major overhaul. Refer to "SPECIFICATIONS," for piston pin bushing finished diamension.

b. Test rods for alignment. Rods only slightly misaligned can be straightened using the proper equipment. Badly twisted or bent rods must be replaced.

3. Inspect the pistons for cracks, breaks or scores.

4. Measure the piston skirt at right angles to the pin to determine if it is worn excessively; replace if necessary.

NOTE: *On a used piston, it will probably be found that the piston ring side clearances tend to increase toward the top of the piston due to the higher operating temperature prevalent at this point. When this side clearance becomes excessive, the piston will have to be replaced.*

5. Inspect the pistons pins for wear; if wear is perceptible, replace pins. Replace piston pins showing signs of corrosion or etching.

6. Inspect the connecting rod bushins for scratches and burrs; dress off any such unevenness. Replace if necessary.

7. Connecting rod bolts must be cleaned of all foreign matter including the anti-rust materials that may be caked in the threads. This is also true of the connecting rod thread holes.

A good method of checking to determine thread condition is to turn the connecting rod bolt (threads lubricated with a light engine oil) all the way into the connecting rod with the fingers. If the bolt runs in relatively free without sticking or without the need for applying more than a very light (2-4 foot-pounds) wrench effort, the bolt is satisfactory for use.

CONNECTING RODS, PISTONS, PISTON RINGS AND SLEEVES

Connecting Rods

Connecting rod cap bolt thread condition is most important. Threads that are dry, excessively rough, battered or that are filled with dirt, require considerable effort just to rotate the bolt. Then, when the clamping load is first developed, or the bolt tension is applied, the torque reading mounts rapidly (due to thread friction) to the specified figure without approaching the desired bolt tension and maximum clamping effect. Under these conditions the desired torque reading is obtained but the clamping effect might be far below requirements, leading to bearing failure or to connecting rod bolt breakage. The proper bolt tension and clamping effect can never be attained if the bolt is dry. The bolt must have a film of lubricant in the thread section and under the head (Fig. 7).

Due to the close fit of connecting rod bolts, the slightest thread imperfection increases thread friction to the extent that incorrect bolt tension is likely. The threads in the rod should also be examined. Be sure that they are free of chips or hard foreign material.

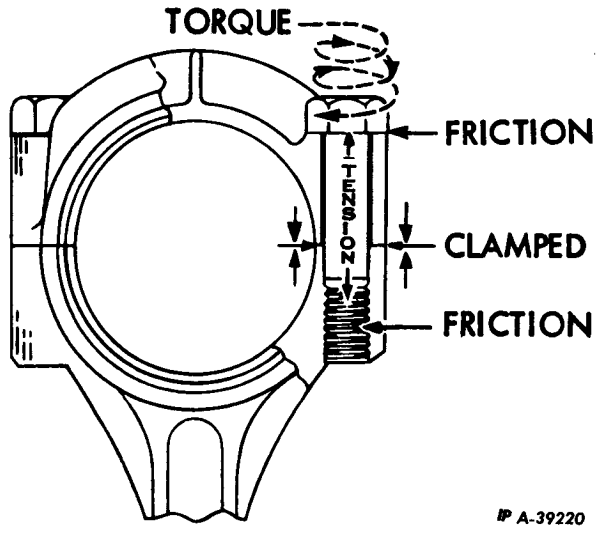

Fig. 7 - Connecting Rod, Cap and Bolt.

8. Rings should be checked also for the specified side clearance by placing each ring in its groove on the piston and inserting a feeler gauge around its edge.

Piston Rings

NOTE: *Faulty rings cannot always be detected by the eye. Engine performance and irregularities such as excessive oil consumption must be taken into consideration. Therefore, whenever a piston is removed from a cylinder, it is recommended that the piston rings be replaced.*

9. Inspect the new rings for any signs of damage before installing them.

10. Insert each ring into the sleeve or cylinder bore for that piston. Force them squarely down inside the sleeve or cylinder bore. Position a feeler gauge between the ends of the ring (Fig. 8), and compare the existing gap against the specified gap for a new ring. (Refer to "SPECIFICATIONS," Section 1.) Replace if not as specified.

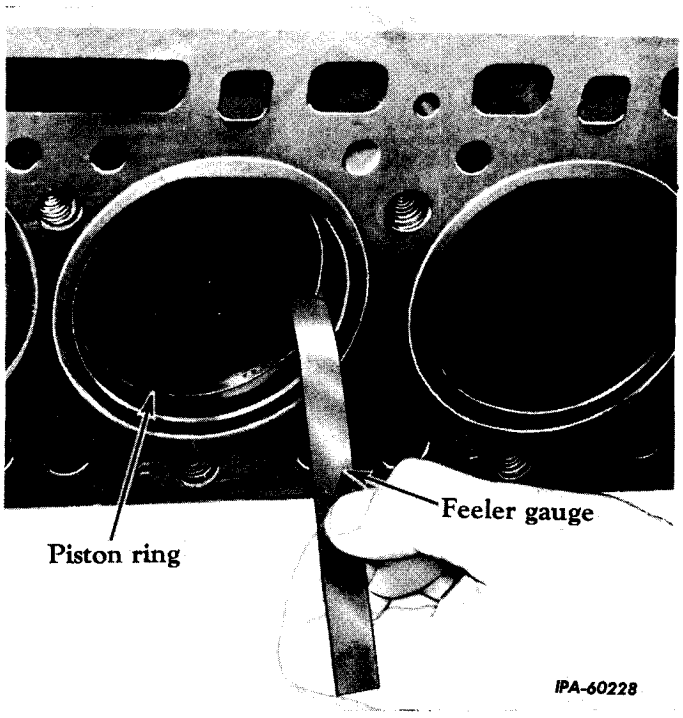

Fig. 8 - Checking Ring Gap (135 Series Shown).

11. Inspect the "windows" of the oil regulating ring and piston for blocked oilways. Failure to keep the oilways clear will result in uneven lubrication and "hot-spots" of the piston and cylinder sleeve. All rings should fit loosely in the piston grooves without binding.

Piston Pin Bushing Replacement

12. Place connecting rod in arbor press and press old piston pin bushing from the connecting rod (Fig. 9).

13. Align the new piston pin bushing on the connecting rod so that the oil hole in the bushing will match with the oil hole in the connecting rod. Press the bushing into the rod.

14. Burnish bushing into place in the connecting rod (Fig. 10) and then ream bushing to provide the dimensions shown in "SPECIFICATIONS," Section 1.

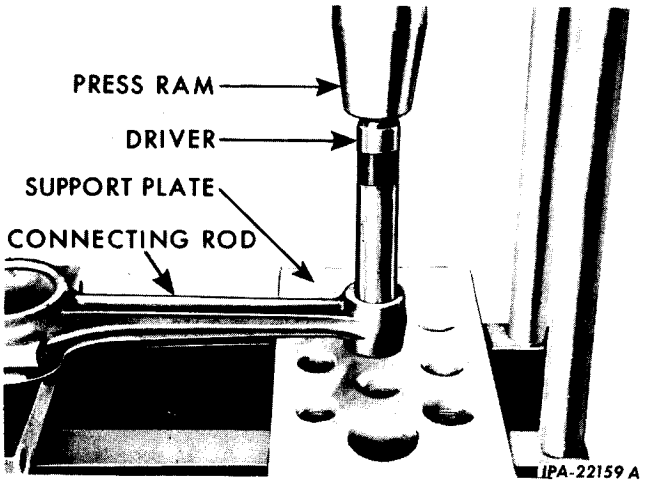

Fig. 9 - Removing Piston Pin Bushing.

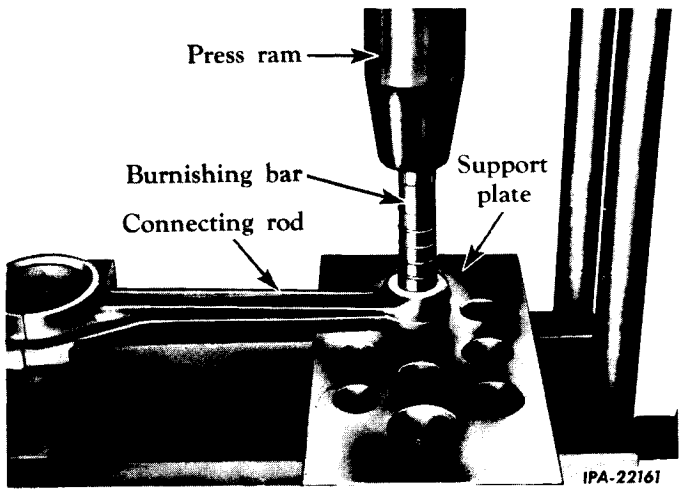

Fig. 10 - Burnishing Connecting Rod Bushings.

5. REASSEMBLY

1. Before assembling the piston and connecting rod, check the fit of the piston pin in the piston for proper end clearance as follows:

a. Prepare the piston and the pin for assembly as outlined in Step 2.

b. Push the pin into the piston and install a retainer ring at each side of the piston.

c. Push one end of the piston pin until it stops against the retainer ring on the opposite side of the piston.

d. Using a feeler gauge, in the gap between the piston pin and the retainer ring, check for end clearance. Refer to "SPECIFICATIONS," Section 1.

e. Remove the retainer rings and proceed with the reassembly as follows:

NOTE: *When assembling the pistons to the rods, the front of the piston will be indicated by an arrow.*

2. With the piston pin at room temperature (70°) and generously coated with clean engine lubricating oil, and the piston heated in hot water to approximately 150°F, the piston pin can be entered into one boss of the piston by pushing with the hand. While the piston is hot, quickly and correctly position the connecting rod inside the piston, align the bushing in the rod bore with the piston pin holes in the piston and push the piston pin completely into position. Thoroughly dry the piston with compressed air.

3. Install a retainer ring in the groove at each side of the piston to secure the piston pin.

4. Using a piston ring expander, install the rings, oil control ring first, into the grooves of the pistons (Fig. 11).

Position the ring gaps 90 degrees from the thrust side of the piston (in line with the piston pin bore) and 180 degrees from one gap to another.

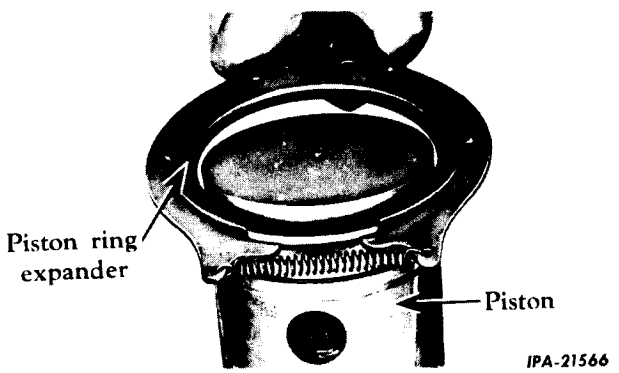

Fig. 11 - Installing the Piston Rings.

6. INSTALLATION

NOTE: *When reinstalling a piston and connecting rod assembly, install the assembly in the same cylinder sleeve and in the same position from which it was removed.*

1. Generously coat the piston ring compressor and sleeve with lubricating oil. Install the ring compressor on the piston and insert the piston and connecting rod assembly through the top of the crankcase.

2. Push down on the piston carefully until it is in the crankcase sleeve (Fig. 12)

3. Wipe clean and oil the crankshaft journals and fit the connecting rod bearings as outlined in "BEARING FITTING PROCEDURE," Par. 7.

4. Install all the pistons, connecting rods and bearings in the same manner.

CONNECTING RODS, PISTONS, PISTON RINGS AND SLEEVES

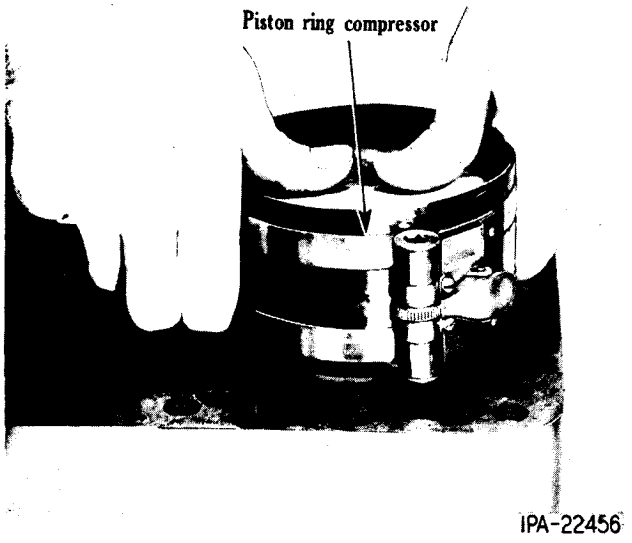

Fig. 12 - Installing the Piston and Connecting Rod Assembly.

5. Check the connecting rod side clearance (Refer to "SPECIFICATIONS," Section 1) by inserting a feeler gauge between the bearing cap and lobe of the crankshaft.

6. Install the oil pump. (Refer to "OIL PUMP AND FILTER," Section 4.)

7. Using a new gasket, install the crankcase oil pan. Fill the crankcase to the level on the gauge with the specified grade of engine oil.

8. Install the cylinder head and gasket. (Refer to "CYLINDER HEAD AND VALVES," Section 2.)

9. After the installation of new piston sets or new piston rings, the engine must be "run-in" according to the conditioning schedule given in the "ENGINE RUN-IN SCHEDULE," Par. 12, before operating at normal load and speed.

7. BEARING FITTING PROCEDURE

NOTE: *Bearings or bearing caps MUST NOT be filed, lapped or modified in any manner to reduce journal-to-bearing clearance. Premature bearing failure will result from attempts to reduce journal-to-bearing running clearances. While such methods will make a tighter fit at the top and bottom of the bearing, it will result in an out-of-round bore and distortion of the bearing shell. New bearing shells will have to be installed eventually and additional problems will be encountered. Such modification alters the engineered fit of the bearing shells in their bores and destroys the desired "crush."*

1. When installing precision type bearings, it is important that the bearing shells fit tightly in the rod or crankcase bore. To accomplish this, the diameter of the bearing at right angles to the parting line is slightly larger than the actual diameter of the bore onto which the bearing will be assembled. When the bearing cap is drawn up tight the bearing is compressed, assuring a positive contact between the bearing back and bore. The increased bearing diameter is called "bearing crush" (Fig. 13).

2. To assemble the bearings with the correct "bearing crush," tighten the clamping bolts alternately and evenly to the specified torque with a torque wrench.

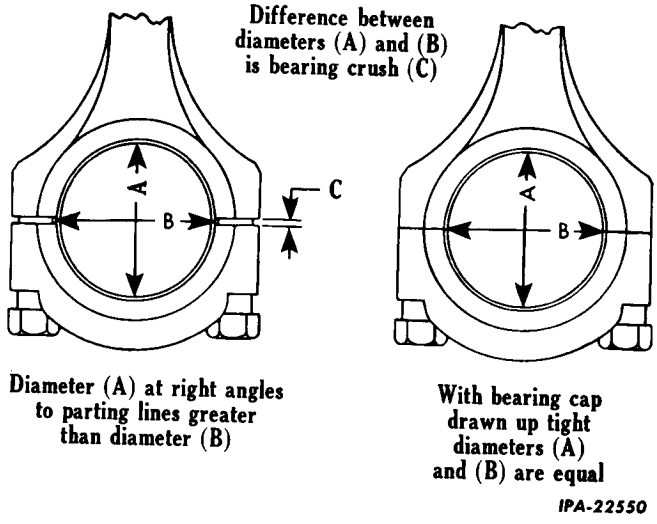

Fig. 13 - Graphical Illustration of Bearing Crush.

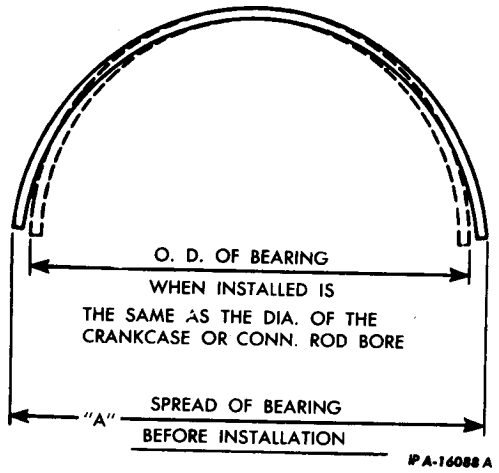

Fig. 14 - Diagram Showing Bearing Spread.

3. 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 to be assembled (Fig. 14). For example, the width across the open ends of the connecting rod bearing not in place is approximately 0.025 inch 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 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 before installation in an engine.

4. BEARING CLEARANCE: When installing bearings in an engine, the proper clearance between bearing surface should be checked closely. Refer to "SPECIFICATIONS," Section 1, for allowable limits. To get an accurate measurement of this clearance, the "Plastigage" method, or virgin lead, can be used. The following instructions can be used when measuring with "Plastigage."

a. Remove bearing cap and wipe bearing surface and exposed half of crankshaft journal free of oil.

b. Place a piece of "Plastigage" the full width of bearing insert.

c. Reinstall the bearing cap and tighten the self-locking cap screws to recommended torque (Refer to "TORQUE CHART" in Section 1).

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 plastic material at its widest point with the graduations on the envelope (Fig. 15). The number within the graduation on the envelope indicates the clearance in thousandths of an inch.

f. If using virgin lead, carefully remove the flattened lead and measure its thickness with a micrometer.

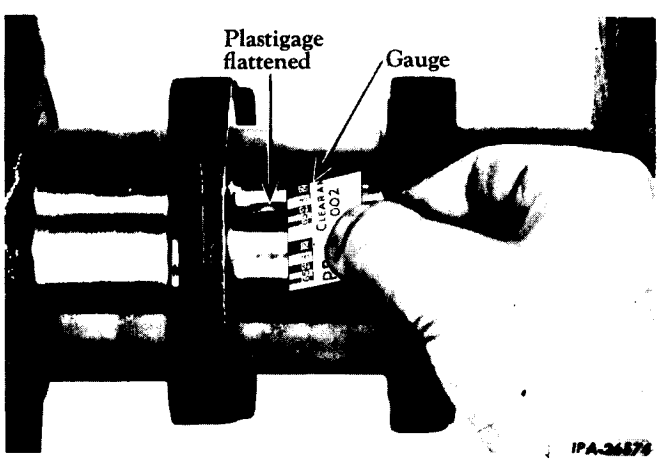

Fig. 15 - Using "Plastigage" Method for Checking Bearing Clearance.

NOTE: *Do not turn crankshaft during the above procedure.*

Should the readings not fall within the specified limits, and the torque wrench is known to be accurate in its measurement, remove the bearing from the connecting rod and replace it with a new one. However, with the precision bearings used, no difficulty should be encountered providing the crankshaft and/or connecting rod are in proper condition.

CYLINDER SLEEVES

8. DESCRIPTION

The cylinder sleeves are of the replaceable, wet or dry liner type depending upon the engine series; however, the U-1, UC-60 and UC-153 power unit engines and the 146 Series engine do not have sleeves. When furnished as service parts, the cylinder sleeves cannot be obtained separately but only in combination with matched pistons. When installing a new set of sleeves and pistons, do not interchange the pistons and sleeves, or the piston pins, between the pistons.

9. REMOVAL

Use a suitable sleeve puller (Refer to "Service Tools Manual, "ISS-1531) to remove the cylinder sleeves from the crankcase (Fig. 16).

If difficulty is encountered, use dry ice packed in the sleeve around the puller to cold-shrink the sleeve.

10. INSPECTION AND REPAIR

1. Clean the sleeves in a cleaning solvent, and dry them with compressed air. Clean out the water jacket in the crankcase, and clean out the cylinder sleeve sealing ring grooves on the wet type cylinder sleeves.

NOTE: *Abrasive material is not to be used to clean the cylinder sleeves.*

2. Each cylinder sleeve should be checked with an inside reading micrometer to determine taper, out-of-round of worn condition. Measure the diameter of the cylinder sleeve, at the top of the piston ring travel, at a right angle to the centerline of the crankshaft. Record the readings. Next, measure each bore so the gauge reading coincides with the centerline of the crankshaft. The difference between the readings is the out-of-round condition at the top of the bore. Repeat this same procedure at the bottom of the ring travel. The difference between the diameters measured at the top and bottom of the bore is the taper of the bore. Replace sleeves if worn beyond a serviceable clearance or taper. Refer to "SPECIFICATIONS," Section 1.

A dry sleeve application is shown in Fig. 17.

CONNECTING RODS, PISTONS, PISTON RINGS AND SLEEVES

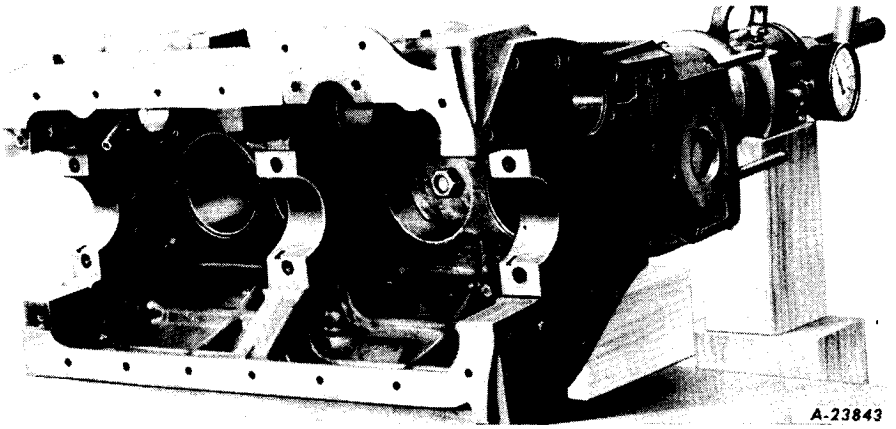

Fig. 16 - Removing Cylinder Sleeve, Using Sleeve Puller Tool and Jack.

11. INSTALLATION

NOTE: *Be sure that the sleeves fit freely in the crankcase before installing the sealing rings used with wet type sleeves. The rings are to be placed in the crankcase groove dry; the tapered outer surface of the sleeve should be coated with a soap solution. The solution acts as a lubricant and permits the sleeve to enter the ring without damage to it. Dry sleeves should be coated with clean 30 W engine oil before installing.*

1. Install the sealing rings on engines having wet type sleeves.

2. Insert the cylinder sleeves into the crankcase and hand-push them into position. If the rubber sealing ring is accurately installed and not pinched, the sleeve should enter easily into its position.

3. Install the connecting rods and pistons. Install the bearing caps. (Refer to "INSTALLATION," Par. 6.)

12. ENGINE RUN-IN SCHEDULE

After reboring cylinders or installing new sleeves, pistons, or piston rings, the engine must be run-in according to the conditioning schedule given below, before operating at normal load and speed.

1. Before starting the engine, fill the cooling system with the specified amount of coolant.

2. Fill the crankcase with lubricating oil as specified in the latest service bulletin on "Crankcase Lubricating Oils."

3. Warm up the engine at approximately 3/4 throttle and no load until normal operating temperature is reached. Depending on the application, it may be necessary to cover the radiator to bring engine up to operating temperature. During the warm-up, the cooling system should be vented of air and the oil pressure noted. The pressure should be within the specified range.

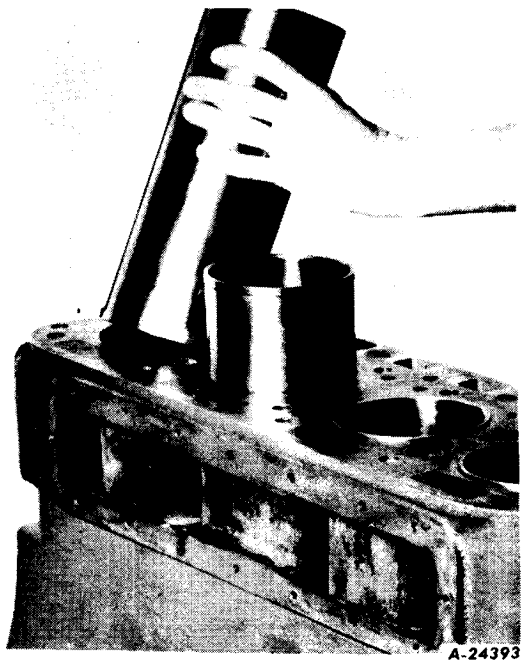

Fig. 17 - Dry Type Replaceable Cylinder Sleeves.

Conditioning Schedules

NOTE: *All rubbing surfaces in a rebuilt engine require mating during the break-in process, and good piston ring seating is the major objective. Until ring seating and good seating of the combustion space occurs, the following conditions will be noted:*

a. Compression will be low, combustion poor and smoking can be expected.

b. Lubricating oil consumption will be high since all rings play a part in oil control.

c. Blow-by will be high and will be reflected in high crankcase pressure.

The first phase of break-in must be accomplished gently enough to reduce welding process dangers. Rubbing surfaces should not be subjected to excessive pressures and temperatures. However, breaking the engine in too gently may result in cylinder walls glazing before the rings can seat properly. This glazing caused by low combustion temperatures and incomplete combustion, results in short engine life, loss of power and high oil consumption.

The following run-in schedules are recommended, after the engine has reached operating temperature:

TRACTOR

Period 1: Operate tractor in fourth gear without load 15 minutes at 75 per cent rated speed.

Period 2: Operate tractor at 75 per cent rated speed, 45 minutes on light work.

Period 3: Operate tractor at full rated speed, two hours on medium heavy work.

(Three hours total)

POWER UNIT

Period 1: Operate power unit without load, 15 minutes at 75 per cent rated speed.

Period 2: Operate power unit at 25-50 per cent of rated load, 30 minutes at 75 per cent rated speed.

Period 3: Operate power unit at 60-75 per cent of rated load, 45 minutes at 75-90 per cent rated speed.

Period 4: Operate power unit at 80-100 per cent of rated load, one hour 30 minutes at 90-100 per cent rated speed.

(Three hours total)

IRRIGATION ENGINES

Period 1: Operate engine without load 15 minutes at 75 per cent rated speed.

Period 2: Operate engine at 80-90 per cent of rated load, two hours 45 minutes at 90-100 per cent rated speed.

(Three hours total)

4. Recheck for oil, air and water leaks and adjust tappets. Inspect and replace the oil filter elements if necessary.

5. For engines equipped with full-flow lubricating oil filter systems, the oil can be used for the duration of the recommended oil change period.

For engines equipped with by-pass oil filter systems, the oil should be drained while the engine is hot after 20 to 25 hours of operation, and the crankcase refilled with lubricating oil as specified in Column 1 of the latest service bulletin on "Fuels and Crankcase Lubricating Oils for IH Diesel Engines" and viscosity grade recommended for the existing ambient temperature.

6. Retighten the cylinder head bolts after the engine has been brought up to operating temperature and shut down. (See NOTE.) Valve adjustments should be rechecked after cylinder head bolts are tightened.

7. After the first 100 hours of operation, the cylinder heads must be retorqued again and the valve tappets adjusted.

NOTE: *When retorquing cylinder head bolts, only those below proper torque are to be retorqued to specifications. The remaining bolts complying with or above torque specifications are to remain untouched.*

OIL PUMP AND FILTER

OIL PUMP

1. DESCRIPTION

The engine lubricating oil is taken from the oil sump through a screened intake to the oil pump.

60 SERIES: The screened inlet is attached to the lower part of the crankcase and is positioned near the bottom of the oil pan. The oil pump drive gear is keyed to the rear end of the camshaft.

135, 135B, 146, 153, 175 AND 281 SERIES: The floating screened inlet is pivoted from the oil pump cover and must be free to move up and down. A gear type pump is secured to the bottom of the crankcase and driven by a spiral gear on the camshaft.

From the oil pump, the oil is directed under pressure through rifle-drilled passages in the crankcase to the main bearings, camshaft bearings, timing gears, governor, valve lever assemblies and to the oil filter.

A plunger type, spring-loaded relief valve, located in the pump body, maintains the required circulating pressure.

Should the oil pressure become excessive, the relief valve will by-pass the oil to the crankcase oil pan in sufficient amounts to reduce the pressure. Refer to Fig. 1 for a typical lubricating system and Fig. 2 for an actual engine application.

2. REMOVAL

60 Series

1. Drain the crankcase oil pan and remove the oil pan.

2. Remove the two cap screws and washers that attach the pump screen to the crankcase.

3. Remove the oil screen tube and fittings that connect to the oil pump body.

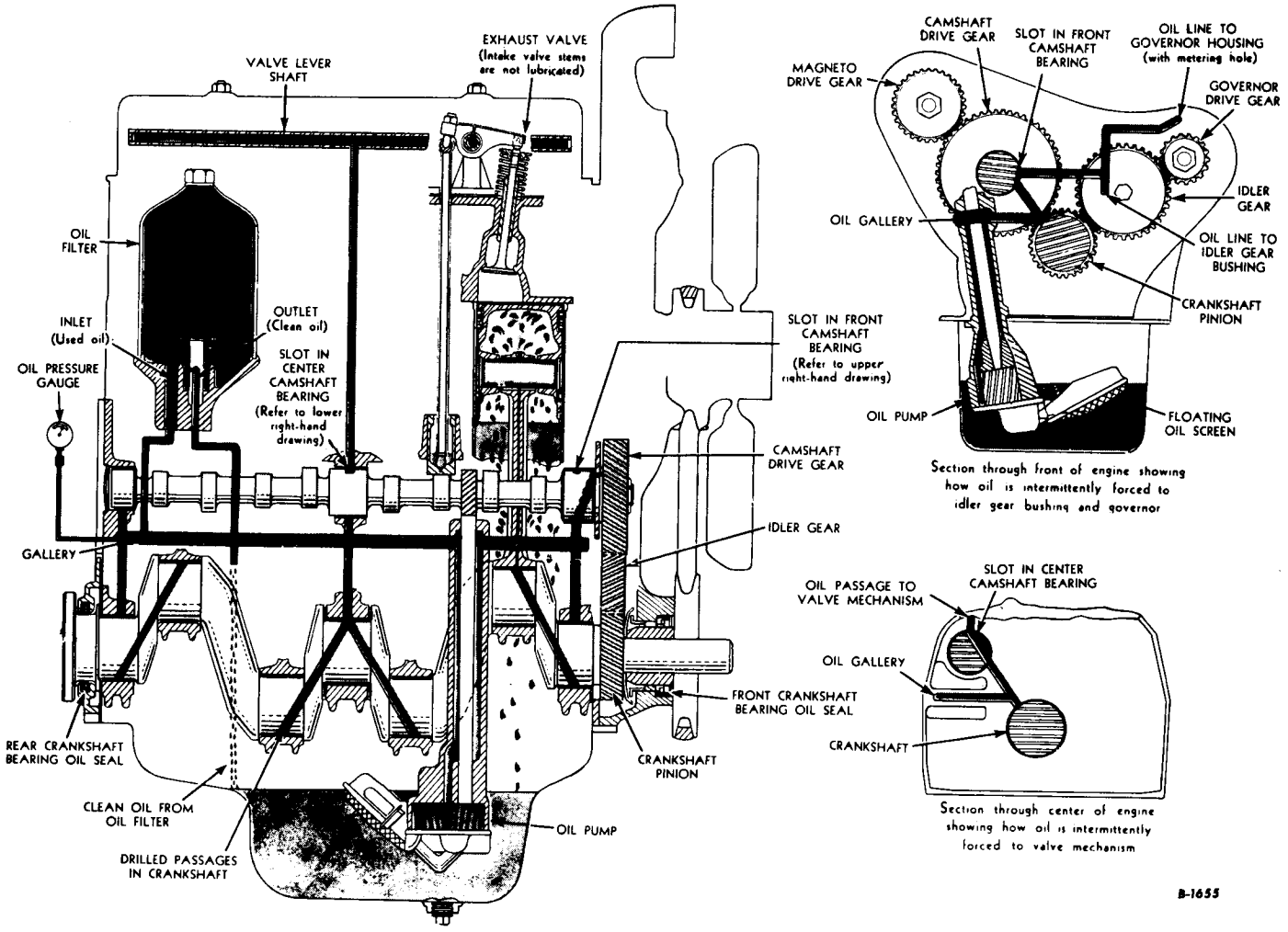

Fig. 1 - Typical Lubrication System.

OIL PUMP AND FILTER

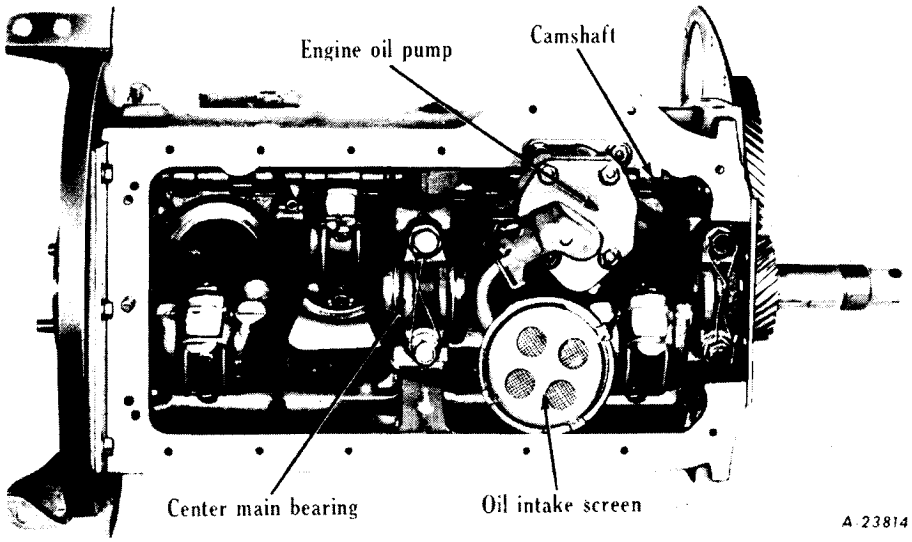

Fig. 2 - Engine Lubricating Oil Pump Assembly (6 Series Shown).

4. Remove the three cap screws that attach the oil pump body to the crankcase and remove the pump body (1, Fig. 3) together with the driven or idler gear (3). Remove the gasket (2).

5. The pump drive gear (4) is keyed to the camshaft (6). Use a suitable type puller and remove the gear and key (5) from the camshaft.

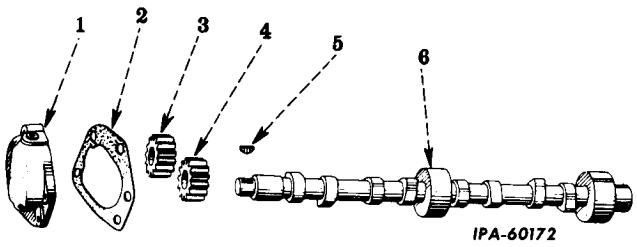

Fig. 3 - Lubrication Oil Pump Components (60 Series).

1. Oil pump body.
2. Body gasket.
3. Idler gear.
4. Drive gear.
5. Key.
6. Camshaft.

135, 135B, 146, 153, 175 and 281 Series

6. Drain the crankcase oil and remove the oil pan.

7. Remove the two cap screws that secure the oil pump to the crankcase. Remove the pump, complete with screen, from the crankcase (Fig. 4).

3. DISASSEMBLY
(Reference Numbers Refer to Fig. 6).

135, 135B, 146, 153, 175 and 281 Series

1. Remove the four cap screws securing the cover (2) to the oil pump body (7) and remove the cover and screen (1) as a unit (Fig. 5).

To separate the cover from the screen, remove the cotter pin.

2. Remove the pressure spring (4) and valve (5), and idler gear (6).

3. To remove the pump drive shaft (11), drive the pin (10) out of the shaft spiral gear (9) and press the gear off. Remove the key (8). Pull the shaft out of the body (7).

4. INSPECTION AND REPAIR

1. Clean the pump parts thoroughly in cleaning solvent and dry with compressed air.

2. Inspect the gears for wear, scoring and chipped teeth. If either the body or idler gear is damaged, replace both.

3. Inspect the body and cover for traces of gear contact or other damage. Replace all worn or damaged parts.

U-1, UC-60, UC-135B, 146, and 153: If the oil pump idler gear shaft is worn excessively or loose in the crankcase, it should be removed and a new one pressed into the crankcase (front).

ALL OTHER UNITS covered in this manual, replace the body assembly, as the idler shaft is not serviced separately.

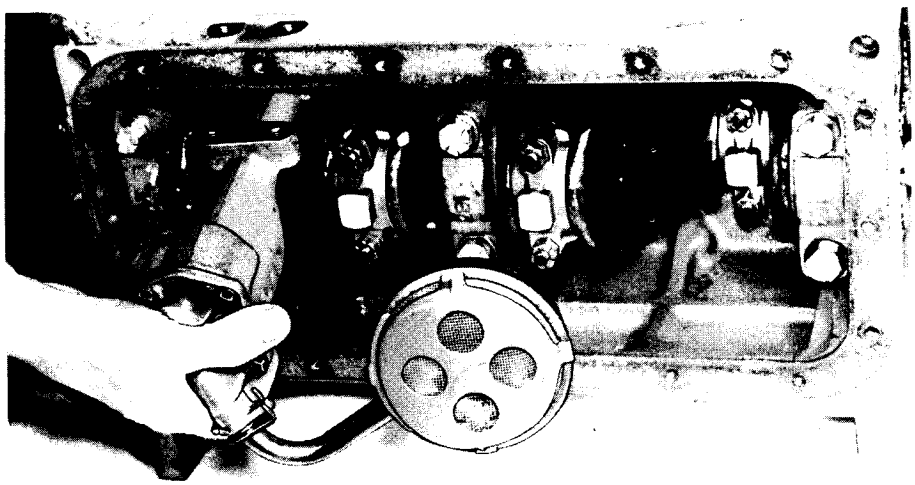

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Fig. 4 - Removing the Oil Pump Assembly (135 Series - Others Similar).

4. Both the idler shaft and the drive shaft, when assembled, should be square with the inside face of the body within 0.001 inch. Insert the drive shaft (11, Fig. 6) into the body. Place the idler gear (6) on the idler shaft. Use a feeler gauge of the proper thickness (Refer to "SPECIFICATIONS," Section 1) to check the running clearance between the gears and the body bore (Fig. 7).

Place the gauge between the gear and body and turn the gear through a complete revolution while holding the gauge in one position. Repeat this operation at various points around the body bore.

5. Check the backlash of the gears and refer to "SPECIFICATIONS," Section 1.

6. The gasket (3) is also a shim and should be replaced whenever a pump is serviced. If a replacement gasket is not available, do not use a makeshift gasket, use the old one. When necessary, two gaskets are used to maintain the proper end clearance between the gears and the cover. Refer to "SPECIFICATIONS," Section 1. It is important to maintain this clearance to prevent wear on the gears and cover.

5. REASSEMBLY
(Reference Numbers Refer to Fig. 6.)

135, 135B, 146, 153, 175 and 281 Series

1. Insert the key (8) and press the spiral pinion gear (9) on the shaft (11). Drive the pin (10) through the gear and shaft. Peen over to retain the pin.

2. Check the pinion end clearance as indicated in Fig. 8. Refer to "SPECIFICATIONS," Section 1. When clearances are excessive replace worn gears and pump body. When the assembly is made from all new parts, file or grind off the top of the pump body if necessary, to obtain the clearance specified between the pump body and the pinion.

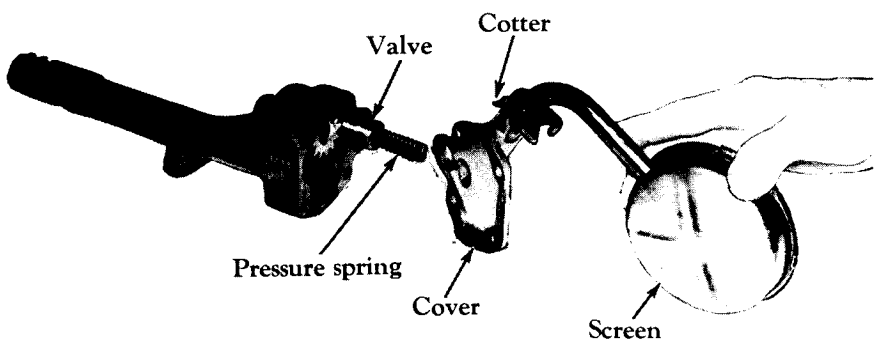

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Fig. 5 - Oil Pump with Cover Removed (135 Series Shown).

OIL PUMP AND FILTER

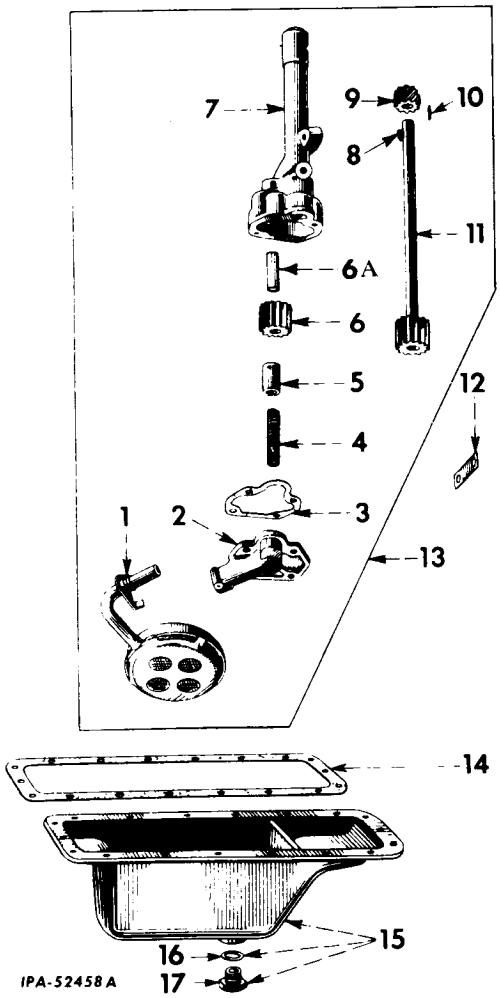

Fig. 6 - Exploded View of Oil Pump.

1. Screen.
2. Cover.
3. Gasket.
4. Pressure spring.
5. Pressure valve.
6. Idler gear.
6A. Idler shaft.
7. Body.
8. Key.
9. Gear.
10. Pin.
11. Gear and shaft.
12. Lock.
13. Pump assembly.
14. Gasket.
15. Pan.
16. Gasket.
17. Plug.

3. With the idler gear in place, put a thin coating of grease on the gasket surfaces of the body (7) and cover (2). Install the gasket or gaskets (3) and cover to the body with cap screws and lock washers.

Be sure that there is no binding in the pump assembly.

4. Install the screen, if it was removed, and secure with a cotter pin.

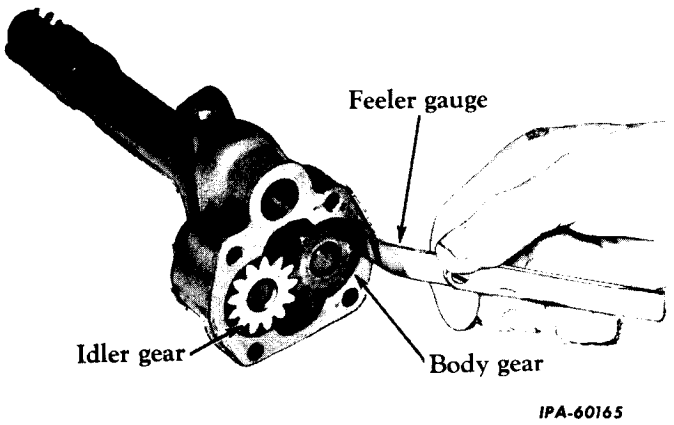

Fig. 7 - Checking the Gear to Housing Running Clearance.

Fig. 8 - Checking Oil Pump Pinion End Clearance.

OIL PUMP AND FILTER

6. INSTALLATION

60 Series
(Reference Numbers Refer to Fig. 3)

1. Place the shaft key (5) in the camshaft and install the pump drive gear (4). Install a new gasket (2) on the oil pump body (1).

2. Install the pump idler gear (3) in the pump body. Attach the oil pump body to the crankcase and secure.

3. Connect the oil pump screen and tube with the connector to the oil pump body. Attach the oil screen bracket to the crankcase and secure with two cap screws.

4. Install the oil pan and new gasket.

135, 135B, 146, 153, 175 and 281 Series

1. Lift the oil pump assembly into position and secure it to the crankcase with the cap screws and lock washers.

2. Install a new oil pan gasket and attach the oil pan to the crankcase. Tighten the cap screws to standard torque for size and class.

LUBRICATING OIL FILTER

7. DESCRIPTION

The purpose of the lubricating oil filter is to separate and remove foreign substances from the engine oil and to prevent these injurious materials from being circulated to the engine (Fig. 9) or (Fig. 10).

8. REMOVAL

ELEMENT TYPE

1. Open the filter base drain and drain the oil from the filter and base completely.

2. Clean off the filter and base to prevent dirt from getting into the base when the filter is lifted off.

3. 60, 135, 135B, 146 AND 153 SERIES: The filter base is cast into the crankcase.

175 AND 281 SERIES: Remove the four cap screws that hold the filter base to the crankcase and remove.

NOTE: *For disassembly and maintenance, refer to the operator's manual of the model involved.*

SPIN-ON TYPE (Reference Numbers Refer to Fig. 10)

NOTE: *This filter cannot be cleaned and should not be disturbed except when it becomes necessary to replace it.*

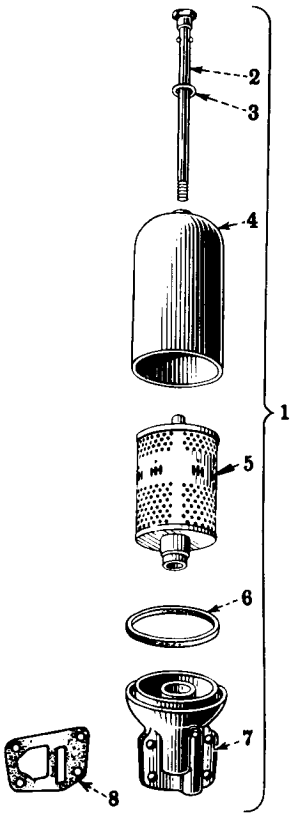

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Fig. 9 - Lubricating Oil Filter. (Element Type)

1. Oil filter.
2. Case bolt.
3. Gasket.
4. Case.
5. Element.
6. Gasket.
7. Base.
8. Gasket.

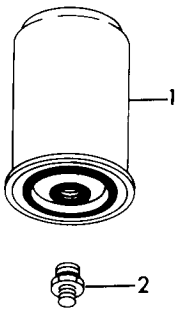

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Fig. 10 - Lubricating Oil Filter (SPIN-ON TYPE)

1. Filter.
2. Connector.

OIL PUMP AND FILTER

1. Clean the outside of the filter to prevent dirt from entering the system while servicing.

2. Remove the spin-on filter (1) by turning it counter clockwise. Discard the filter.

9. INSTALLATION

ELEMENT TYPE

1. Clean the area covered by the gasket and install a new filter base gasket.

2. Place the filter and base in position on the crankcase and secure with four cap screws. Tighten to standard torque.

3. Be sure the filter base drain is closed before filling the crankcase with oil. Check for leaks at the base of the case.

SPIN-ON TYPE (Reference Numbers Refer to Fig. 10)

1. Install a new filter (1) by applying a little engine oil to the seal, and thread the filter on by hand turning it clockwise until hand tight. Do not use tools to tighten the filter.

1. DESCRIPTION

The 135, 135B, 146, 153, 175 and 281 series engines all use the conventional closed type cooling systems, and the water stored in the radiator is circulated by a positive displacement centrifugal pump. (The 60 series engine has no water pump.) The fan is mounted on the pump shaft and driven by a belt from the fan drive pulley on the crankshaft.

A thermostat, located in the water outlet elbow, controls the temperature of the coolant. When the engine is started cold, the by-pass type thermostat is closed, preventing circulation of the low temperature coolant through the radiator core. This circulation during the warm-up period prevents formation of steam pockets. When operating temperature is approached, the thermostat begins to open and allows the coolant to flow from the engine water passages through the radiator and back to the water pump.

The thermal specifications of the thermostat determines the extent of the thermostat opening that controls the amount of coolant circulation.

WATER PUMP (PACKLESS TYPE)

2. REMOVAL

1. Loosen and remove the fan belt.

2. Remove the four cap screws securing the fan and water pump pulley to the pulley hub.

3. Loosen the upper hose clamp (7, Fig. 1). Remove the three mounting bolts securing the pump housing to the crankcase and lift the pump, complete with the radiator outlet elbow, off the engine (Fig. 2).

3. DISASSEMBLY
(Reference Numbers Refer to Fig. 1.)

1. Remove the screws from the water pump plate. Remove the plate (10) and gasket (11, Fig. 3).

2. Remove the front snap ring (18) that retains the pump shaft bearing (Fig. 4).

Support the water pump in an arbor press and push the shaft and bearing out as one assembly (Fig. 5).

3. Place the shaft assembly in a press and press the shaft from the hub (Fig. 6).

NOTE: *Do not remove the bearing or slinger; they are factory installed in the proper location. The shaft, bearing and slinger are serviced as an assembly.*

4. INSPECTION AND REPAIR

1. Clean all parts (except the pump shaft and bearing) in cleaning solvent.

2. Examine the pump shaft and bearing for wear or damage. If necessary, replace the shaft, bearing and slinger as an assembly.

3. Examine the pump plate for evidence of excessive end play. Scoring of the plate will indicate this.

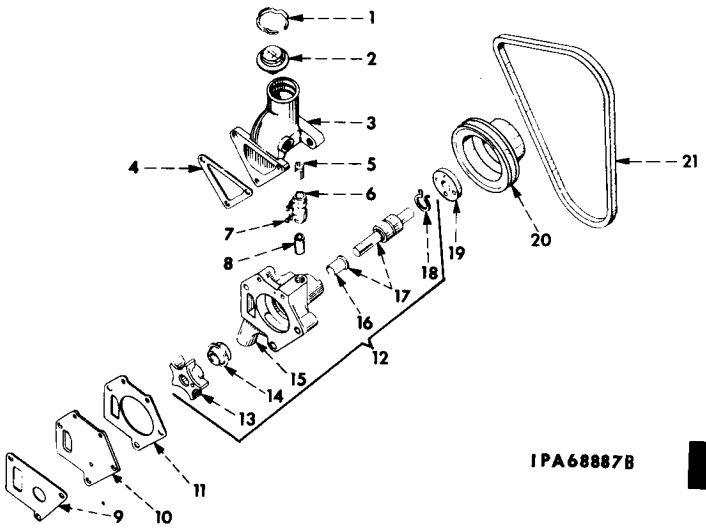

Fig. 1 - Exploded View of Water Pump (135B Series Shown).

1. Retainer ring.
2. Thermostat.
3. Outlet elbow.
4. Gasket.
5. Upper by-pass pipe.
6. By-pass hose.
7. Hose clamp.
8. Lower by-pass pipe.
9. Plate gasket.
10. Pump plate.
11. Body gasket.
12. Pump assembly.
13. Impeller.
14. Pump seal.
15. Body w/seal.
16. Slinger.
17. Shaft and bearing.
18. Front snap ring.
19. Pulley hub.
20. Pump pulley.
21. Belt.

4. Replace the impeller if it is badly eroded.

5. Discard all old gaskets and install new gaskets in reassembly.

6. 175 AND 281 SERIES: If there is any evidence of leaking, install new packing.

7. If the seal leaks or is damaged, replace the complete seal assembly. Carefully drive the seal from the pump body with a small soft drift. Place the new seal assembly on the installing tool (Fig. 7). Place the pump body in a press and, after aligning the seal and installing the tool (SE-1721), press the seal into the body (Fig. 8).

FAN, FAN BELT, WATER PUMP AND THERMOSTAT

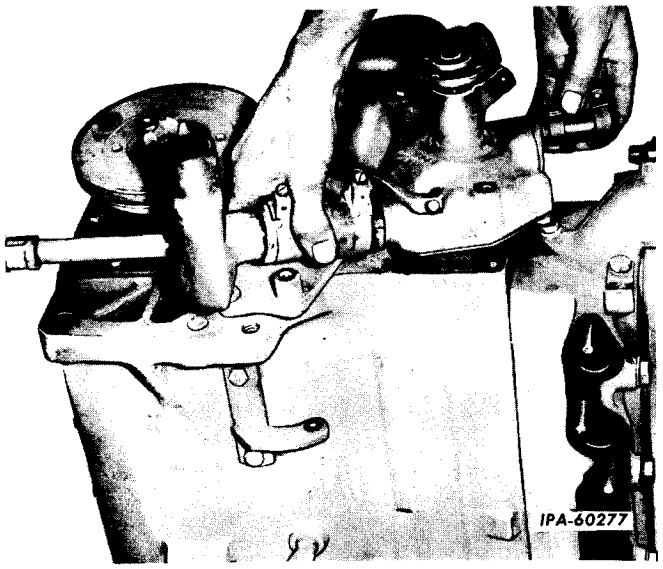

Fig. 2 - Removing the Water Pump (135 Series - Others Similar).

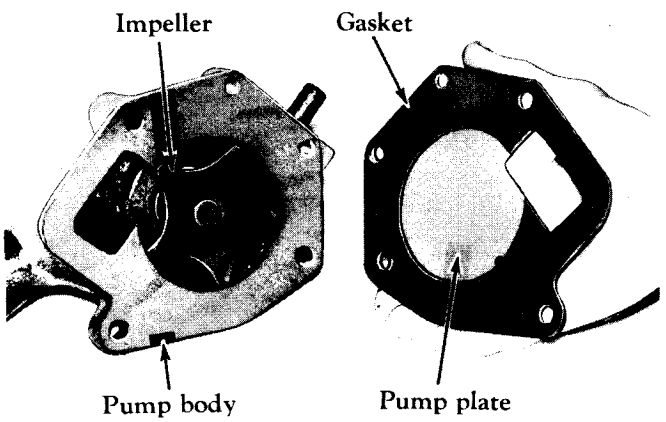

Fig. 3 - Removing the Water Pump Plate.

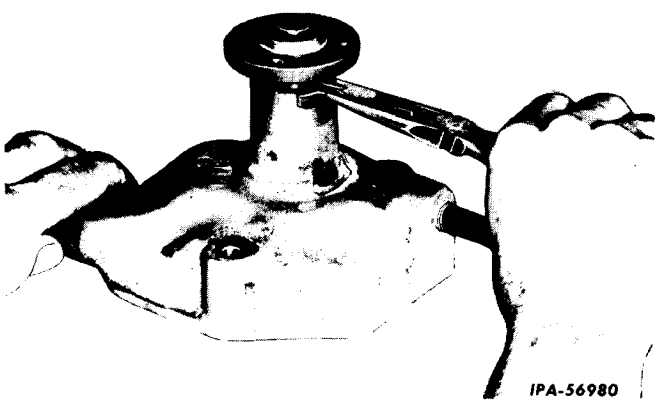

Fig. 4 - Removing the Front Snap Ring.

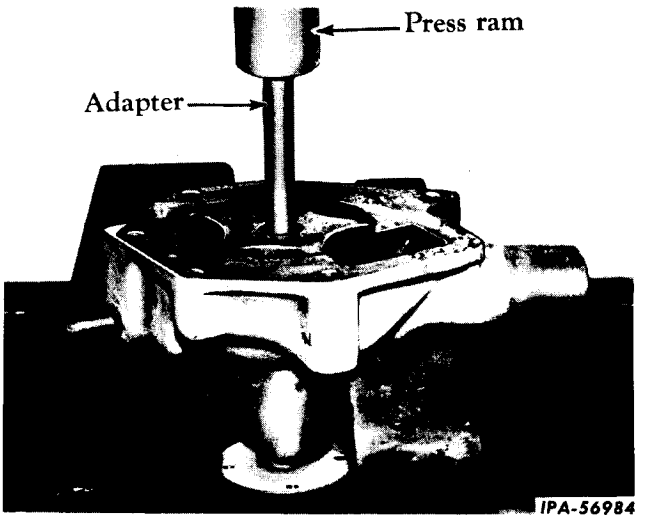

Fig. 5 - Pressing Out the Shaft and Bearing.

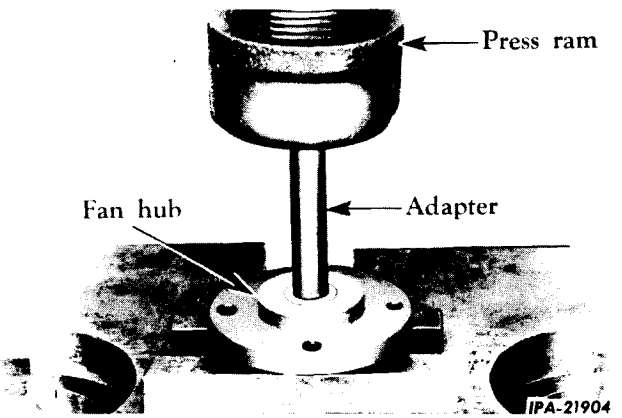

Fig. 6 - Separating the Shaft and Hub.

8. Check the fan belt. If found to be cracked or oil soaked, discard it and install a new one.

9. Inspect the hoses and hose clamps. Unless the hoses are pliable and minus cracks, replace them.

5. REASSEMBLY

NOTE: *When assembling hub, bearing and impeller, press load must not be transferred through the bearing.*

1. Press the hub on the shaft, with the small diameter of the hub facing out (Fig. 9).

2. Install the pump shaft, bearing and slinger assembly in the front end of the pump body (Fig. 10). Tap the shaft into place so that the bearing is firmly seated and clears the front snap ring groove.

3. Install the snap ring in its groove at the front end of the pump body (Fig. 4).

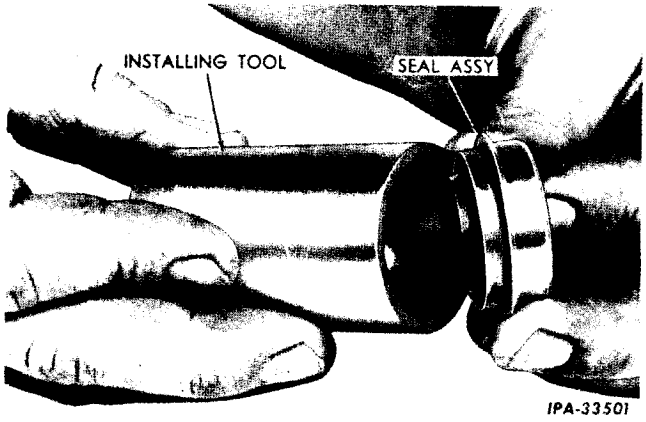

Fig 7 - Installing Tool for Water Pump Seal Assembly

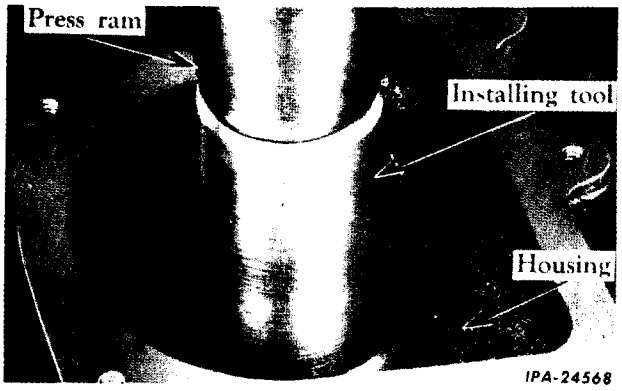

Fig. 8 - Water pump Seal Installation

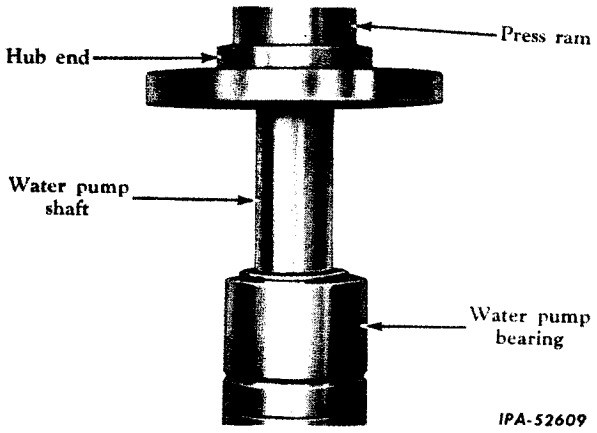

Fig. 9 - Installing the Hub.

4. Press the impeller on the rear of the shaft so that there is proper clearance between the machined face of the pump body and the face of the impeller (Refer to "SPECIFICATIONS," Section 1). Check the clearance with a straight edge and a feeler gauge (Fig. 11).

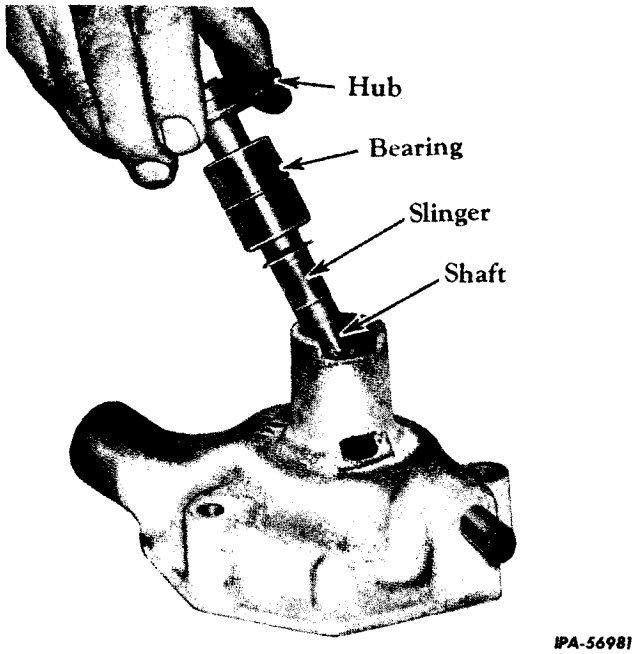

Fig. 10 - Installing the Shaft Assembly.

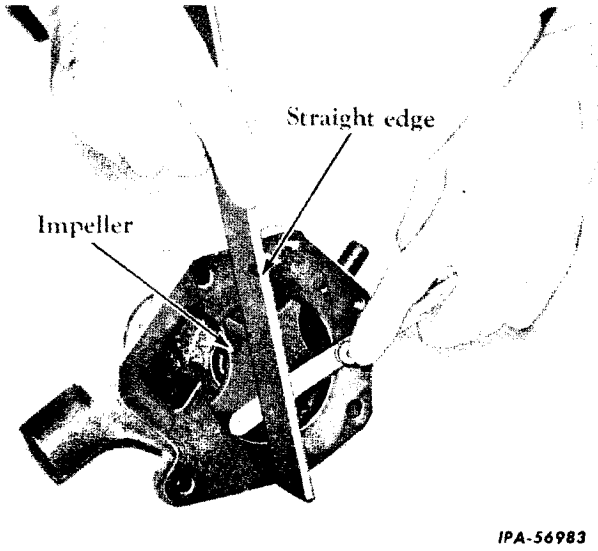

Fig. 11 - Checking the Impeller Clearance.

5. Install a new gasket and then the water pump plate.

6. INSTALLATION

1. Install a new gasket and secure the water pump to the crankcase with three cap screws.

2. Connect the water by-pass hose to the water outlet elbow (Fig. 2).

FAN, FAN BELT, WATER PUMP AND THERMOSTAT

3. Connect the water pump inlet hose to the water pump.

4. Install the water pump pulley, fan and fan belt. For fan belt tension adjustment, refer to the operator's manual.

WATER PUMP (PACKING TYPE)

7. DESCRIPTION

The centrifugal water pump is fastened to the front end of the crankcase. The drive pulley, which also drives the fan, runs on two ball bearings. The bearings mount on a sleeve which is a press fit in the pump body. The full-floating impeller with shaft is driven by a cross-arm type driver, which is secured at the front end of the pump to the impeller shaft and to the fan and water pump pulley. Packing, compressed by an adjustable packing gland nut, seals the impeller shaft against leakage.

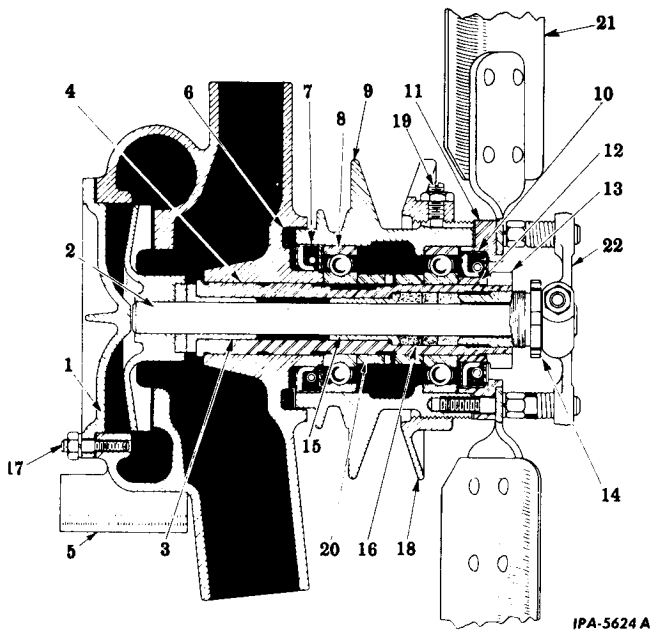

Fig. 12 - Water Pump and Fan Drive Cross Section (Packing Type)(Not "4" Series).

1. Cover.
2. Impeller with shaft.
3. Thrust bushing.
4. Sleeve.
5. Body.
6. Felt washer.
7. Oil seal, rear.
8. Ball bearing.
9. Fan and generator drive pulley.
10. Oil seal, front.
11. Bearing retainer.
12. Bearing clamp nut spacer.
13. Bearing clamp nut.
14. Packing gland.
15. Bushing.
16. Packing.
17. Stud.
18. Adjustable pulley flange.
19. Set screw.
20. Bearing spacer.
21. Fan.
22. Pump shaft driver.

8. MAINTENANCE

Due to wear after considerable service, the pump packing may leak. If this does occur, use a water pump wrench and tighten the packing gland just enough to stop the leaking. After all adjustment of the packing gland has been taken up, it is necessary to add new packing or to replace the packing. (Refer to Fig. 12.)

To install new packing, remove the driver pin and driver. Remove the packing gland and old packing. Place the water pump packing around the shaft, and reassemble the packing gland, driver, and driver pin.

9. REMOVAL

1. With the cooling system drained, remove the fan belt. On units so equipped, remove the fuel transfer pump belt.

On units with electric starting, remove the generator belt.

2. Loosen the hose clamps and push the hose down (Fig. 13).

Fig. 13 - Driving Hose Down From Water Pump Body.

3. Loosen the upper hose clamp, remove the bolts holding the water pump to the crankcase and remove the pump, pulley and fan assembly (Fig. 14).

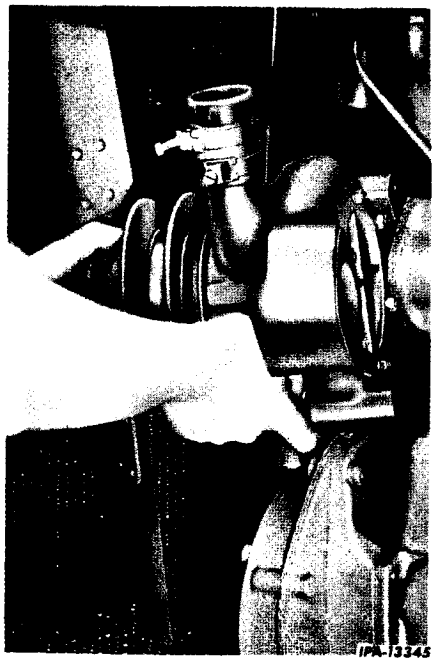

Fig. 14 - Removing the Water Pump, Pulley, and Fan From the Crankcase.

10. DISASSEMBLY

(Not "4" Series).
(Reference Numbers Refer to Fig. 17.)

1. Remove the fan and driver assembly (Fig. 15).

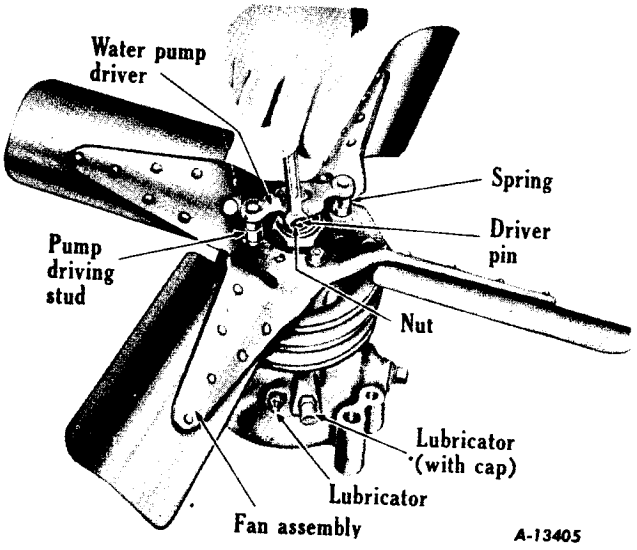

Fig. 15 - Water Pump Driver Removal.

2. Remove the packing gland (Fig. 16).

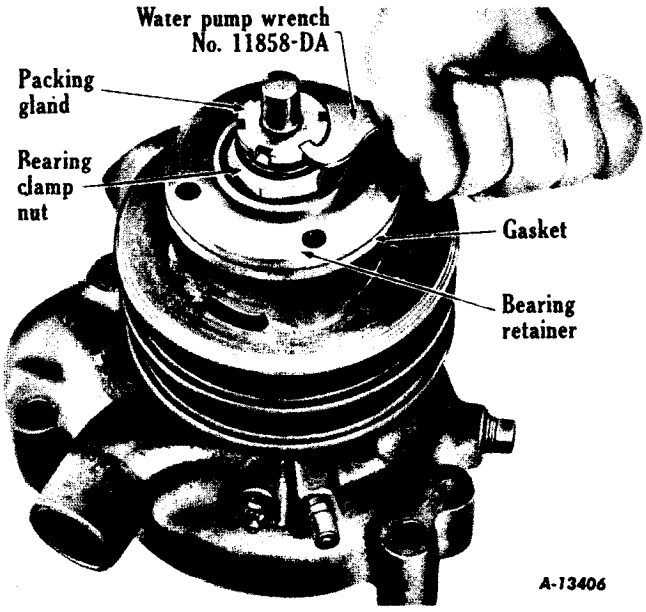

Fig. 16 - Pump Packing Gland Removal.

3. Remove the bearing clamp nut (17) and top bearing retainer (15), with the front oil seal (13) and gasket (14) free of the pulley hub. Tap the oil seal out of the bearing retainer.

4. Remove the water pump body cover (1) and gasket (2). (Fig. 18) Push out the shaft with impeller (3) from the shaft end.

5. Remove the pump pulley (11) with flange. Remove the pump oil seal, front (13), ball bearing (26) and spacer (25) from the pulley. Drive the rear bearing (10) and the oil seal (9) out of the opposite end of the pulley hub.

6. Remove the water pump packing and shaft bushings from the shaft sleeve (Fig. 19). Do not press or drive the sleeve (5) out unless inspection reveals that the sleeve or pump body must be replaced.

7. When it is necessary to replace the sleeve or pump body, the sleeve may be pressed from the body with an arbor press as shown in Fig. 20.

"4" Series
(Reference Numbers Refer to Fig. 22.)

1. Remove the fan assembly and the packing gland.

2. Remove the bearing retainer nut (7) and take out the oil seal (8).

3. Push out the shaft with impeller (15) from the shaft end.

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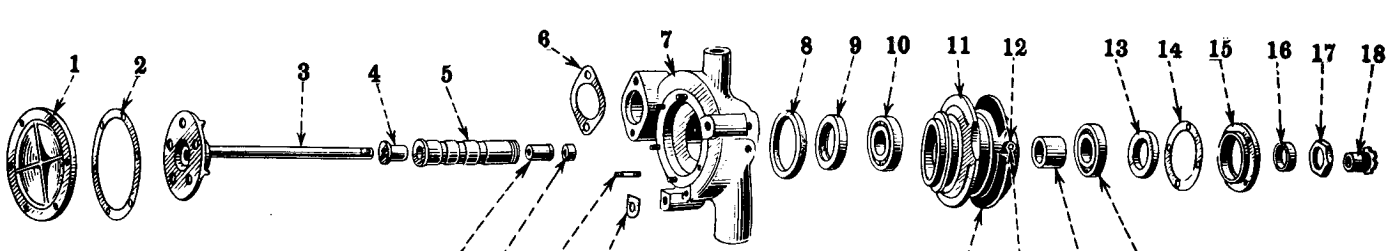

Fig. 17 - Water Pump Components (Packing Type) (Not "4" Series).

1. Cover.
2. Gasket.
3. Impeller with shaft.
4. Thrust bushing.
5. Sleeve.
6. Gasket.
7. Body.
8. Felt washer
9. Oil seal, rear.
10. Ball bearing.
11. Fan and generator drive pulley.
12. Jam nut.
13. Oil seal, front.
14. Gasket.
15. Bearing retainer.
16. Bearing clamp nut spacer.
17. Bearing clamp nut.
18. Packing gland.
19. Bushing.
20. Packing.
21. Stud.
22. Body spacer.
23. Pulley adjustable flange.
24. Set screw.
25. Bearing spacer.
26. Ball bearing.

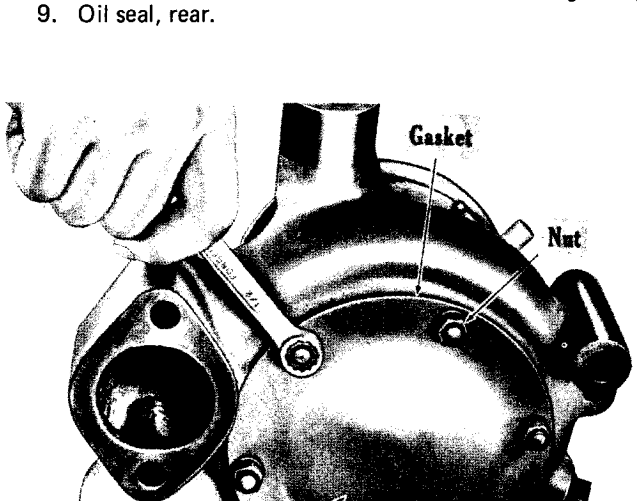

Fig. 18 - Water Pump Cover Removal.

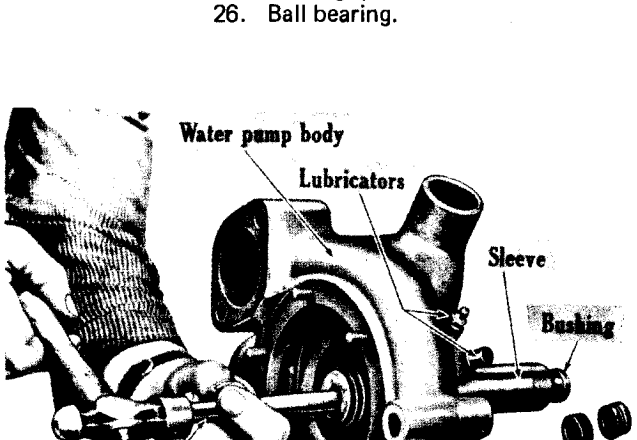

Fig. 19 - Water Pump Packing and Shaft Bushing Removal.

4. Remove the fan hub assembly (1, 9, 10) from the sleeve and body. Remove the rear bearing (12) from the sleeve and body, and tap the front bearing out from the opposite end of the pulley hub.

5. Remove the water pump packing from inside the sleeve (Fig. 19). Do not press or drive out the sleeve from the body unless necessary to replace either one.

6. If necessary to replace the adjustable pulley flange, it will be necessary to remove the fixed flange first by driving out the pin (11, Fig. 22).

NOTE: *Refer to Fig. 21 for exploded view.*

11. INSPECTION AND REPAIR

1. Examine all parts for wear and for excessive rust or scale. Replace parts as necessary. Check the fit of the bushing on the impeller shaft. Inspect the finished rear thrust surface of the sleeve and thrust face of the thrust washer in the impeller for evidence of excessive wear or grooving. Polish these surfaces or replace parts according to condition.

2. Check the fit of the impeller shaft in the bushing. The normal running clearance of the shaft in the bushing, and the shaft diameter, are given in "SPECIFICATIONS," Section 1. If the bushings are worn and the running clearance is excessive, replace the sleeve with bushing.

3. Remove the lubricator fittings and thoroughly clean the drilled lubricant passages. Replace the lubricator fittings. Wash all parts thoroughly in solvent and dry with compressed air.

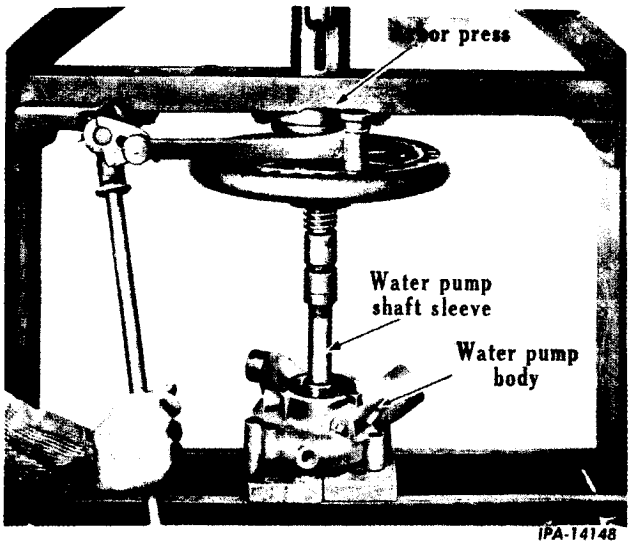

Fig. 20 - Removing Water Pump Shaft Sleeve From the Pump Body.

12. REASSEMBLY

Not "4" Series

1. If the sleeve has been removed, press it into the body as shown in Fig. 20, except that the sleeve should be entered into the body from the cover side.

2. Install the pump shaft bushing using an arbor press.

3. Press a new pump shaft thrust bearing into the shaft sleeve if the old one is not serviceable (Fig. 23).

4. Place a new felt washer, slightly oil-soaked, over the sleeve and into the groove in the front side of the pump body, and insert the bearing retainer ring into the pump pulley by hand.

5. Place the ball bearing in position on the retainer end of the pulley, and tap it into place against the retainer ring (Fig. 24). Fill the hub with the specified lubricant. Install the bearing spacer, and press the rear ball bearing into the rear of the pulley hub (with the adjustable flange of the hub already assembled).

6. Install the oil seal with the lip toward the bearing end of the pulley opposite the retainer end, and place the pulley over the pump shaft sleeve with the bearing retainer side away from the body.

7. Install the bearing lock sleeve over the end of the water pump shaft sleeve.

8. Press the oil seal into the retainer, using a steel bar slightly smaller than the seal. The leather lip of the seal should face away from the pump body when installed.

9. Install a new bearing retainer gasket and the bearing retainer, lining up the holes in the retainer with the holes in the pulley.

10. Tighten the fan pulley bearing clamp nut and install a new water pump cover gasket. Then attach the cover.

11. Install the impeller shaft and packing.

NOTE: *The beveled edges of the first and last pieces of packing should face toward the outside.*

12. Run in the packing gland until it contacts the packing. Do not tighten until after installation of the pump.

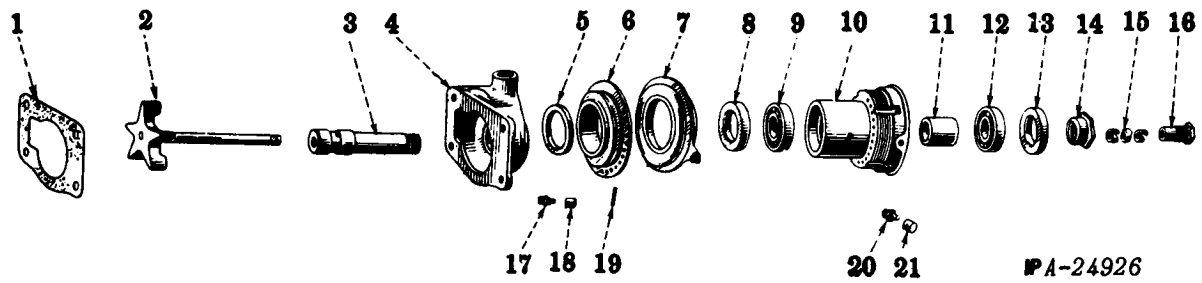

Fig. 21 - Water Pump Components (Packing Type) ("4" Series).

1. Gasket.
2. Impeller with shaft.
3. Sleeve with bushings.
4. Body.
5. Felt washer.
6. Pulley flange (fixed).
7. Pulley flange (adjustable).
8. Oil seal.
9. Bearing.
10. Hub.
11. Bearing spacer.
12. Bearing.
13. Oil seal.
14. Bearing clamp nut.
15. Packing.
16. Packing gland.
17. Lubricator.
18. Cap.
19. Pulley flange pin.
20. Lubricator.
21. Cap.

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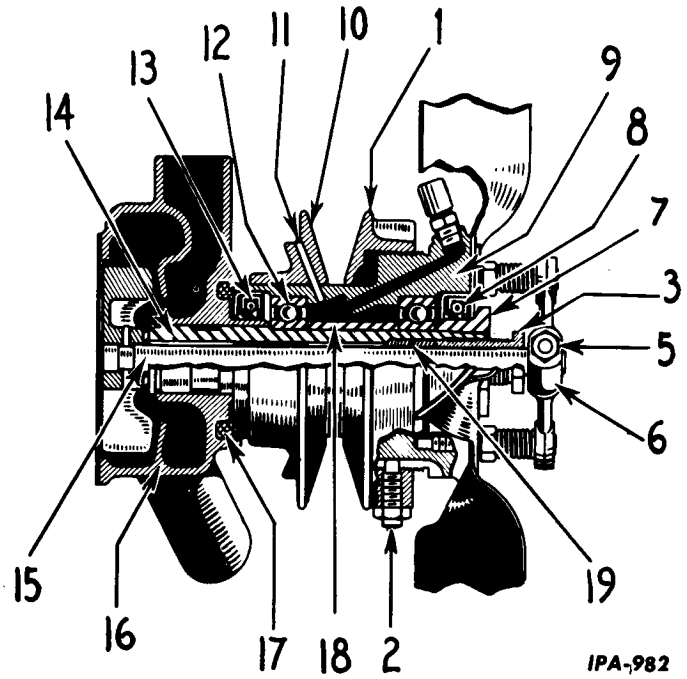


Fig. 22 - Water Pump and Fan Drive Cross Section (Packing Type) ("4" Series).

1. Adjustable flange.
2. Set screw.
3. Packing gland.
5. Driver pin.
6. Driver.
7. Bearing retaining nut.
8. Oil seal.
9. Fan hub.
10. Fixed flange.
11. Flange retaining pin.
12. Rear ball bearing.
13. Rear oil seal.
14. Sleeve with bushing.
15. Shaft with impeller.
16. Pump body.
17. Felt washer.
18. Bearing spacer.
19. Pump packing.

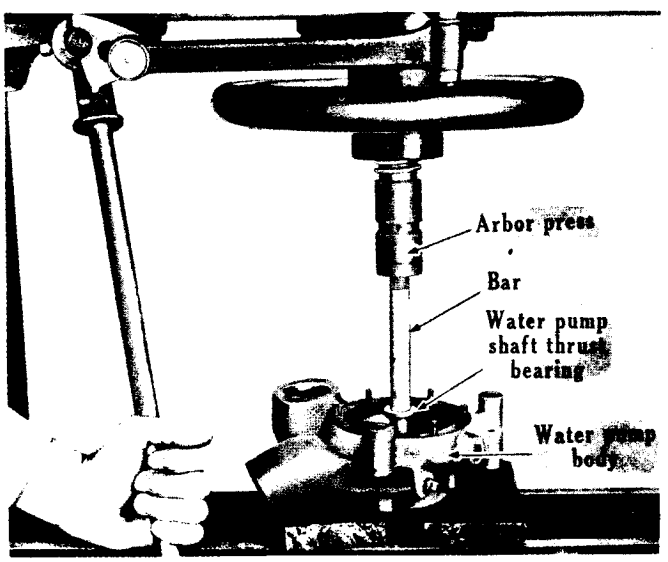


Fig. 23 - Pressing Water Pump Shaft Thrust Bearing Into Water Pump Shaft Sleeve.

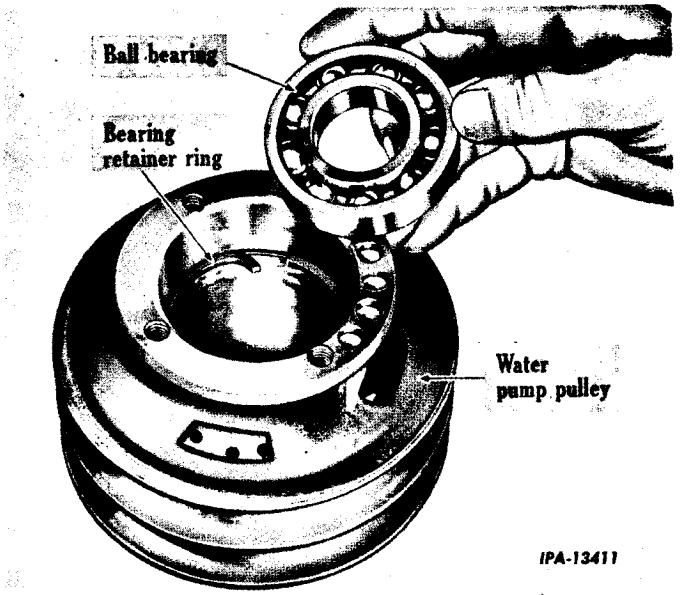


Fig. 24 - Installing Water Pump Ball Bearing Into The Pump Pulley.

"4" Series

1. If the sleeve has been removed, press it into the body from the rear opening, being sure that the 1/8 inch drilled hole in the sleeve lines up with a similar drilled hole in the pump body.

2. Place a new felt washer, lubricated with oil, over the sleeve and into the groove in the front side of the pump body.

3. Assemble the rear bearing to the hub with the fixed flange and adjustable flange already assembled to the hub. Place the rear oil seal in the hub with the lip toward the bearing and the outside edge flush with the end of the hub.

4. Press the hub assembly onto the sleeve and body until the rear bearing is against the pump body.

5. With the bearing spacer in place, assemble the outer bearing to the hub and sleeve, being sure that the bearing inner race is tight against the spacer. Assemble the outer oil seal to the hub with the lip toward the fan and the outside edge of the seal flush with the end of the hub. Assemble the bearing clamp nut.

6. Place the impeller and shaft in the assembly and add new packing. The beveled edges of the first and last pieces of packing should face away from the center piece.

7. Turn in the packing gland until it contacts the packing. Do not tighten the packing gland until after installation of the pump.

13. INSTALLATION

Follow the instructions as given in Par. 6.

THERMOSTAT

14. REMOVAL

1. Loosen the hose clamps and remove the radiator inlet hose.

2. Remove the thermostat retainer ring (Fig. 25), rubber washer (if equipped) and remove the thermostat from the water outlet elbow.

15. INSPECTION

The thermostat should be checked for operation by heating it in a pan of hot water, with a thermometer to check the temperatures. Observe the temperature reading at the time the thermostat starts to open and again when it is wide open. It should start to open at temperature marked on thermostat (Refer to "SPECIFICATIONS" in Section 1) and be wide open at 195° F (for 165 thermostat) or 192° F (for 180 thermostat).

Replace the thermostat if it does not operate within this range.

16. INSTALLATION

1. Place the thermostat (bellows down) in the water outlet elbow. Install the rubber washer (if equipped) and retainer ring (Fig. 25).

2. Install the radiator inlet hose and tighten the hose clamps securely.

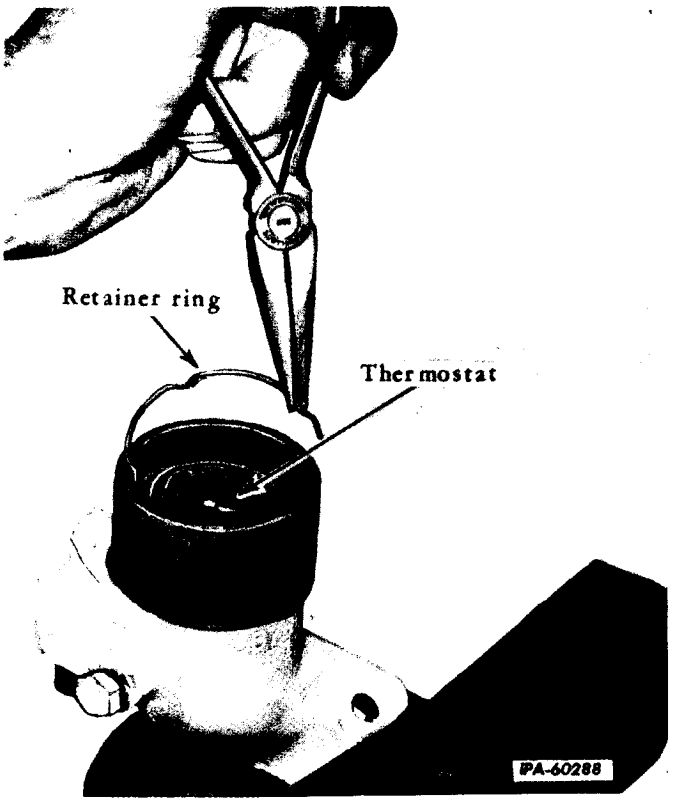


Fig. 25 - Removing the Retaining Ring.

TIMING GEAR TRAIN AND FRONT COVER

1. DESCRIPTION

The crankcase front cover encloses the timing gear train. It is a single casting and, in the 175 and 281 series, it is doweled to the crankcase. It also provides mounting for the governor and ignition drive. The gear train comprises the crankshaft gear, camshaft gear and, in some series, an idler gear.

2. REMOVAL

1. Remove the fan, fan belt and water pump. (Refer to "WATER PUMP," Section 5.)

2. Disconnect the mechanical governor control linkage from the connecting points on the front cover.

3. Remove the starting crank nut from the crankshaft.

4. Using a puller, remove the fan drive pulley (Fig. 1).

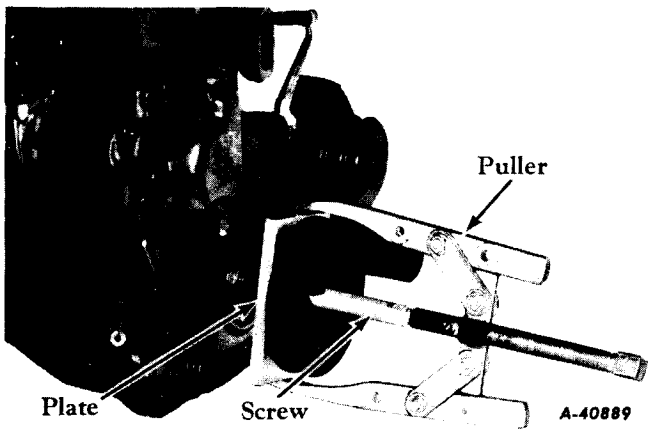


Fig. 1 - Pulling fan drive pulley (U-123 Shown).

On the 1, 60, 2A, 123, 135, 135B, 146 and 153 series, use a puller and special tool FES 33-1 as shown in Fig. 1. Install the tool screw in the end of the crankshaft and the puller plate behind the pulley.

On the 6 and 9 series, special tool 1 020 323 R91 is used (Fig. 2).

5. Remove the magneto and magneto drive or the distributor and distributor drive. (Refer to Section 11, 12 or 12A.)

6. Remove the governor assembly. (Refer to "GOVERNOR" Section 9.)

7. Remove the cap screws and lock washers from the front cover and remove (Fig. 3).

It will be necessary to remove the cap screws and lock washers from the front end of the crankcase oil pan to remove the front cover on some series engines.

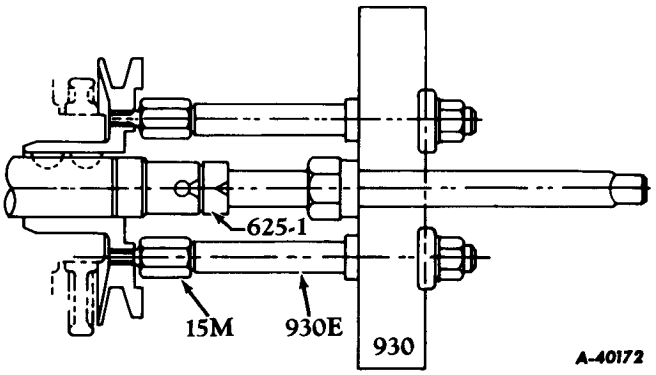


Fig. 2 - Removing fan drive pulley (6 and 9 Series).

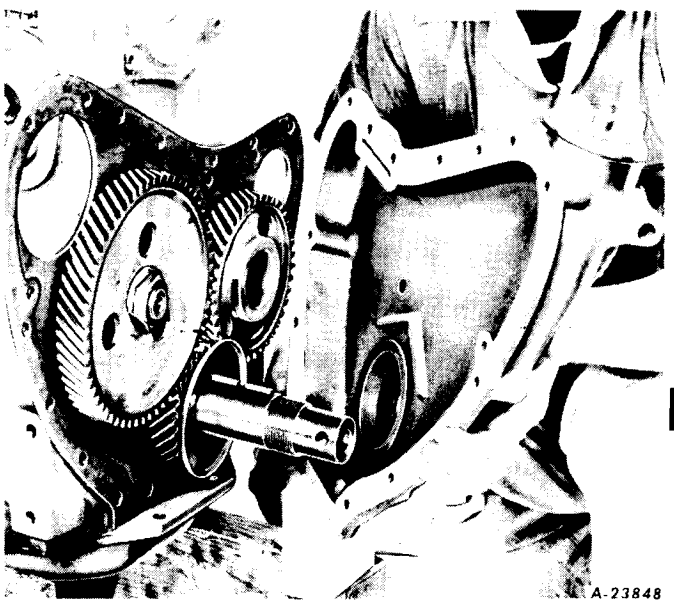


Fig. 3 - Removing the front cover (175 and 281 Series).

8. NOT 135, 135B, 146 AND 153 SERIES: Remove the cap screw and washer securing the idler gear shaft to the crankcase. Remove the shaft with the idler gear (Fig. 4).

9. Remove the camshaft gear nut and nut lock (if so equipped).

NOTE: *Some camshaft gear nuts have a left hand thread. Determine the thread before attempting to remove the nut.*

10. Remove the camshaft gear with a puller. The gear is keyed to the shaft. Remove the keys and thrust plate.

11. NOT 135, 135B, 146 AND 153 SERIES: Remove the cap screws securing the front plate to the crankcase. Remove the front plate (Fig. 5).

TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT

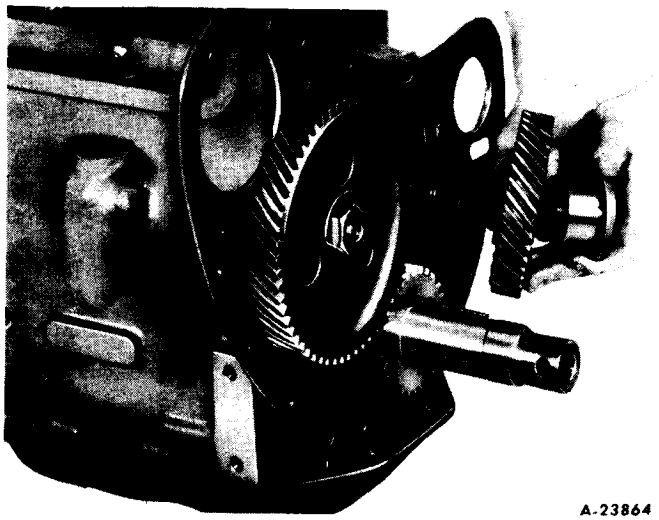


Fig. 4 - Removing the Idler Gear and Shaft.

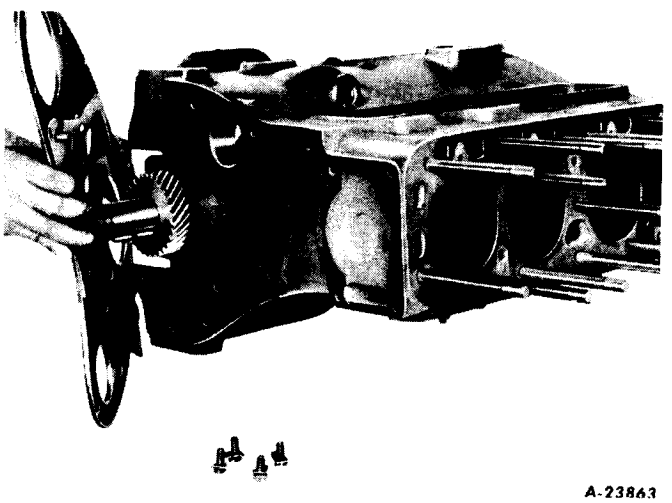


Fig. 5 - Removing the Front Plate.

12. Using a puller, pull the crankshaft gear and remove the shaft key.

3. INSPECTION AND REPAIR

1. Clean all parts thoroughly in a cleaning solvent and dry with compressed air.

2. Remove all gasket material from the crankcase, front plate, cover and retainers with a putty knife so that a clean surface can be had when the new gaskets are installed.

3. Inspect all gears for excessive wear, chipping or cracks.

4. Check the clearance of the idler gear bushing and idler shaft (if so equipped). The proper clearance is given in "Specifications," Section 1.

5. Remove the oil seal from the front cover.

4. INSTALLATION

1. NOT 135, 135B AND 153 SERIES: Install a new crankcase front plate gasket. A light coat of grease should be applied to each side of the gasket. Install the front plate and secure with cap screws.

2. Place the thrust plate on the camshaft with the word "OUT" (stamped on the face) to the front. Place the key in the camshaft. Heat the camshaft gear in boiling water, or a piston heater, then install the camshaft gear. The side of the gear with the longer hub must be installed facing the thrust plate.

NOT 135, 135B, 146 AND 153 SERIES: Secure the gear to the shaft and tighten the nut to proper torque as given in "SPECIFICATIONS," Section 1.

3. NOT 135, 135B, 146 AND 153 SERIES: Install the idler gear and shaft to the crankcase and secure with the screw torqued properly (Fig. 4).

4. Place a key in the crankshaft. Heat the crankshaft gear and install the gear, being sure the timing marks of the camshaft gear, idler gear or ignition drive gear and crankshaft gear are in time. Check the back lash and end play. (Refer to "SPECIFICATIONS," Section 1.)

5. Place the crankshaft oil slinger over the end of the crankshaft. Install the Woodruff key in the keyway for the fan drive pulley.

6. Install a new crankshaft oil seal in the front cover.

7. Place a new gasket in position on the front cover. Install the cover on the front of the crankcase. Install the lock washers, bolts and nuts, but do not torque them until the fan drive pulley has been installed.

8. Install the fan drive pulley. Heating the pulley will facilitate installation.

9. Tighten all front cover bolts to proper torque. (Refer to "SPECIFICATIONS," Section 1.)

10. Install the starting crank nut on the crankshaft.

11. Install the governor assembly. (Refer to "GOVERNOR," Section 9.)

12. Install the magneto and magneto drive (Refer to Section 12 or 12A), or distributor and distributor drive (Refer to Section 11).

13. Connect the mechanical governor control linkage to the connecting points on the front cover.

14. Install the fan, fan belt and water pump. (Refer to Section 5.)

CAMSHAFT

5. DESCRIPTION

The camshaft is a single piece, drop forged shaft, supported in the crankcase by bushings that are replaceable. A helical gear, keyed to the shaft at the forward end of the camshaft, is driven through the idler gear by the crankshaft gear. (In some series engines the camshaft is driven direct from the crankshaft gear.)

The camshaft operates at one-half the engine speed. Specifications for the camshaft are given in Section 1.

The camshaft has an integral gear located half way along its length and this provides drive for the engine lubricating oil pump.

The camshaft bushings located in the crankcase are pressure lubricated.

The camshaft has the main function of operating the intake and exhaust valve mechanism, by action of the lobes upon the push rods during camshaft rotation.

6. REMOVAL

1. Perform steps 1 through 8 of Par. 2.

2. Remove the valve mechanism and valve push rods. Identify the push rods in some way so they can be installed in their original position. (Refer to "CYLINDER HEAD AND VALVES," Section 2.)

3. NOT 135, 135B, 146 AND 153 SERIES: Remove the engine side plate (or plates) and breather tube assembly (Fig. 6).

4. NOT 135, 135B, 146 AND 153 SERIES: Remove the valve tappet stop plate (Fig. 6).

5. Remove the crankcase oil pan and lubricating oil pump. (Refer to "OIL PUMP," Section 4.)

6. Lift out the valve tappets or push away from the camshaft (Fig. 7).

135, 135B, 146 AND 153 ONLY: With the engine on its side, the tappets may be pushed up enough to clear the camshaft when it is being withdrawn from the crankcase.

7. Rotate the camshaft gear until the cap screws, holding the thrust plate to the crankcase, can be removed through the holes in the camshaft gear.

8. Pull the camshaft and gear carefully from tne crankcase to avoid striking the cam lobes against the camshaft bearings or case.

9. If necessary to remove the camshaft gear, remove the nut, and lock (not 135, 135B, 146 and 153 series) and press or pull the gear off. The gear is keyed to the shaft.

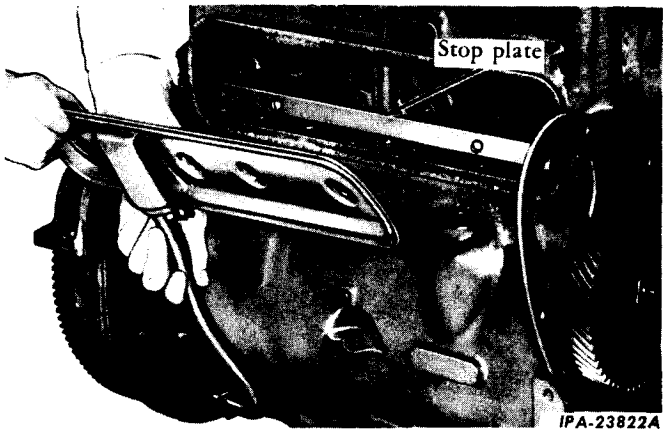


Fig. 6 - Removing The Engine Side Plate (6 Series Engine Shown).

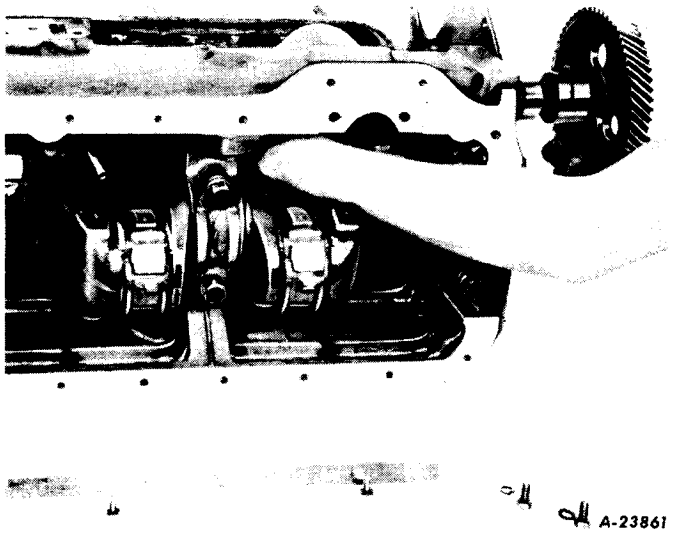


Fig. 7 - Pushing the Valve Tappets From Position (6 and 9 Series).

NOTE: *Some camshaft gear nuts are left hand thread. Determine the type thread before trying to remove the nut. The thrust plate and key can now be removed from the camshaft.*

7. INSPECTION AND REPAIR

1. Clean the camshaft in cleaning solvent and dry with compressed air.

2. Inspect the camshaft journals for excessive wear. Dimensions of camshaft journals are given in "SPECIFICATIONS," Section 1. If excessively worn or out-of-round the camshaft must be replaced.

TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT

Check any run-out in the camshaft, using a dial indicator at the center bearing journal. Place the shaft in a lathe or between centering blocks. The total run-out must not exceed 0.002 inch.

3. Inspect the cam lobes for scuffing, scoring or cracking and replace the shaft if this is found.

4. Inspect the lobes for wear. Refer to "SPECIFICATIONS" in Section 1, for cam lobe lift when new and for the maximum lobe wear. If the lifting areas of the cam lobes, when compared with a new camshaft, show excessive wear, the camshaft must be replaced. If a new camshaft is not available for comparison, the cam lobe wear can be measured with a micrometer in the following manner (Fig. 8):

Take a reading across A-C and deduct the reading B-D; this will give the lobe lift. When the cam lobe wear limit has been reached, the camshaft must then be replaced with a new one.

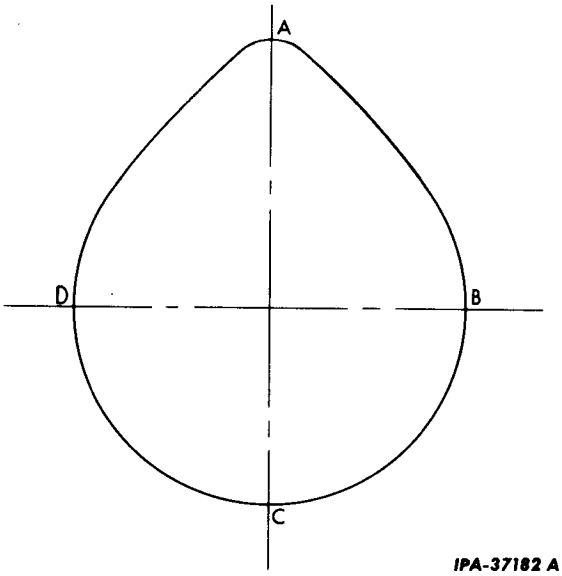


Fig. 8 - Points Of Measurement To Determine Cam Lobe Wear.

5. Replace the camshaft gear if the teeth are excessively worn, chipped or scored. Small nicks or burrs can be removed with a hone or fine mill file.

6. Check the condition of the thrust flange and replace if excessively worn.

7. Inspect the oil pump drive gear on the shaft. If found to be damaged or excessively worn, replace the camshaft.

8. The camshaft bearings located in the crankcase are replaceable (See NOTE). Bearings furnished as service parts are reamed to size. Refer to "SPECIFICATIONS," in Section 1 for clearance specified between shaft and bearings. When installing camshaft bearings, be certain that the oilways in the bearings, line up with the oil passages in the crankcase. When installing the rear bearing, press the bearing flush to the front of bearing bore in the crankcase. Press in the front bearing with the 20 degree chambered edge to the rear until flush with face of crankcase.

NOTE: *Camshaft bearing puller and installer set PLT-543 (FES 101) (Collect assembly 817-9) is used to remove the old bearing and install the new one.*

9. Inspect the tappets. Replace any scratched or worn tappets.

8. INSTALLATION

1. Install a plug at the rear of the camshaft bore in the crankcase, if it was removed to service the camshaft bushings.

2. Place the thrust plate on the camshaft with the word "OUT" (stamped on the face) to the front. Install the key in the keyway. Heat the camshaft gear in boiling water or piston heater, and install the gear with the timing mark facing out, on the camshaft.

3. NOT 135, 135B, 146 AND 153 SERIES: Install the nut and nut retainer and tighten the nut to proper torque as given in "SPECIFICATIONS," Section 1.

4. 135, 135B, 146 AND 153 SERIES ONLY: Be sure to install the tappets (if they were removed) before installing the camshaft. Coat tappet faces with Molycote "G-n" paste and O.D. generously with engine oil and install each one in the same bore from which it was removed. (Fig. 11)

5. Coat the camshaft bearings, cams and journals with clean engine oil. This will provide initial lubrication and prevent possible cam lobe scuffing when the engine is first started. Install it into the crankcase being sure that the timing mark on the camshaft gear is correctly indexed with the timing mark on the crankshaft gear. (Refer to Fig. 8, 9 and 10).

When the gear train includes an idler gear, this also must be indexed.

6. Secure the thrust plate to the crankcase and torque the cap screws. Access to each of the two screws is through the holes in the camshaft gear.

Check the camshaft end play and gear backlash and compare with that shown in "SPECIFICATIONS," Section 1.

7. Install the front cover and fan drive pulley as outlined in Par. 4 of this section (Fig. 3).

8. Install the oil pump and oil pan with gasket. (Refer to "OIL PUMP," in Section 4.)

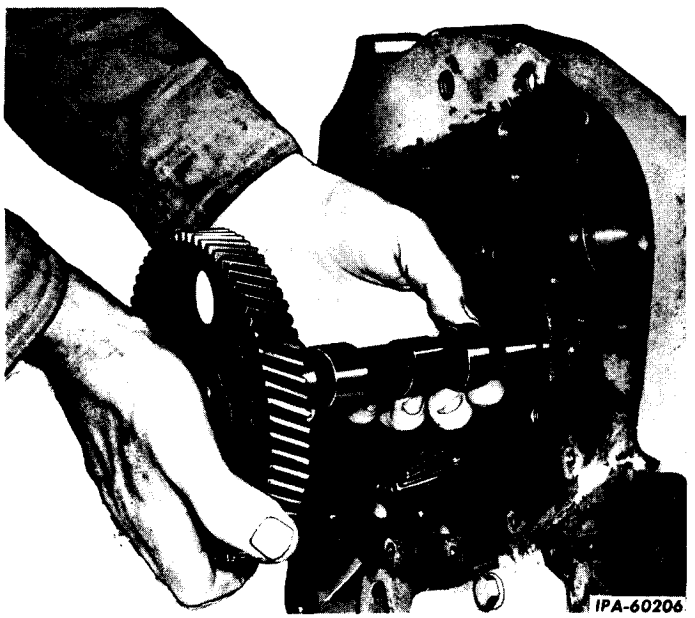


Fig. 9 - Installing Camshaft (135 Series Shown).

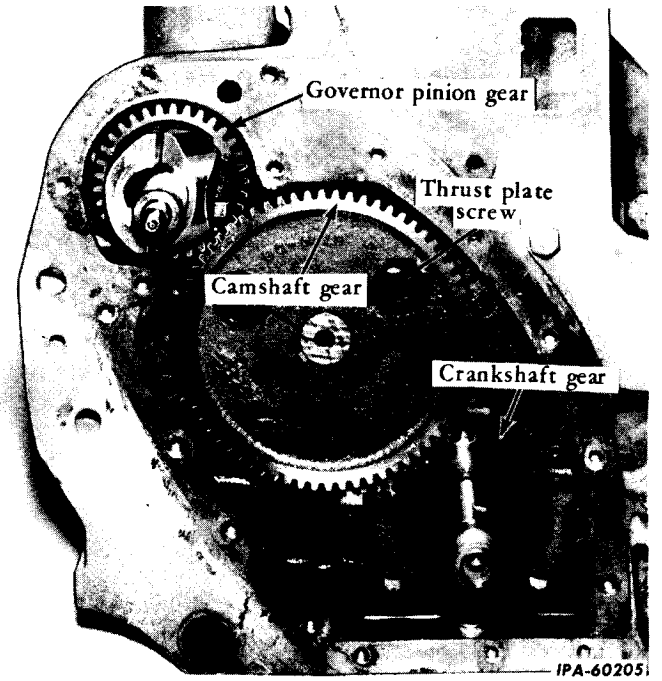


Fig. 10 - Gear Train (135 Series Shown, "in time").

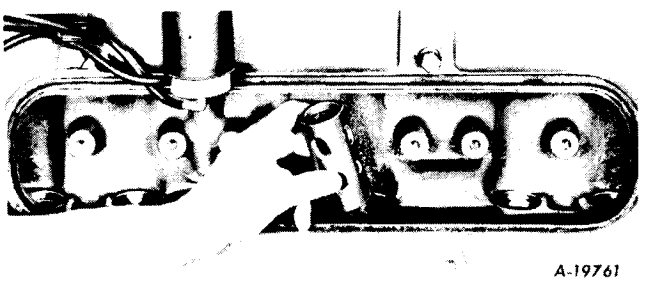


Fig. 11 - Installing the Valve Tappets (175 Series Shown).

9. Coat the tappets generously with engine oil and install each one in the same bore from which it was removed. Install a new side cover gasket (not UC-135, 135B, 146 and 153), and then secure the side cover. (Refer to Step 4.)

Install the tappet stop plate (if so equipped). (Refer to Fig. 6.) Install a new gasket to the side plate and attach the side plate and breather tube to the crankcase.

10. Install the valve mechanism and valve push rods, being sure to install the push rods to their original positions. (Refer to "CYLINDER HEAD AND VALVES," in Section 2.)

11. Install the governor assembly and controls. (Refer to Section 9.)

12. Install the water pump, fan and fan belt. (Refer to "WATER PUMP," in Section 5.)

13. Install the magneto and magneto drive (Refer to "MAGNETO," Section 12 or 12A), or distributor and distributor drive. (Refer to "DISTRIBUTOR," Section 11.)

14. With the engine conditioned for running, start the engine and bring up to operating temperature.

a. Inspect for oil leaks and check for correct engine oil pressure.

b. Shut the engine off and recheck the cylinder head stud nut torques. Refer to Section 2, Par. 15.

c. Check and adjust the ignition timing. (Refer to Sections 11, 12 or 12A.)

d. Check and adjust the valve clearance if necessary. (Refer to "CYLINDER HEAD AND VALVES," in Section 2.)

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL

CRANKSHAFT AND MAIN BEARINGS

1. DESCRIPTION

The crankshaft has Tocco hardened journals and is supported in the crankcase by replaceable insert type bearings. The center main bearing (rear main for 135B, 146 and 153) is the thrust bearing and the bearing insert has flanges that form the thrust washer. The flanges are integral with the bearing.

The connecting rods and all crankshaft journals are rifle-drilled to provide passage-way for pressure lubricant. Each main bearing cap, which supports the lower half of the inserted bearings, is numbered consecutively to correspond with a number stamped on the camshaft side of the crankcase. The bearing caps are not interchangeable in position.

The main bearings can be replaced without removing the crankshaft, but extreme care must be taken to insure cleanliness of the bearing backs and the crankcase bearing bore. These surfaces must be absolutely clean and DRY when bearings are installed. Small particles of dirt between the bearing and the crankcase bore will distort the bearing insert, reducing the clearance at that localized point; frictional heat produced thus will result in bearing material being melted loose from the steel backing at that point. Such melted material lodging between the bearings and crankshaft will create further hot spots until complete bearing failure often results. Anything that interferes with the normal heat dissipation of a bearing has its effect on bearing life. When carrying out service work on an engine, attention to cleanliness cannot be overstressed.

2. REMOVAL

Crankshaft Bearings

1. Remove the oil pan and oil pump. Refer to Section 4.

2. Remove the crankshaft bearing caps by removing the bolts. Tap the caps lightly with a lead hammer if necessary, to dislodge them and remove squarely from position.

Remove the lower bearing from each cap. If they are to be reassembled, be certain that they are identified as to their original positions. Wrap them in clean cloths and store until reassembly.

3. Remove the upper bearing halves from between the crankshaft and the crankcase. With a thin piece of flexible soft sheet metal, push against the end of the bearing without the positioning nib, while turning the crankshaft in the direction of rotation. The bearing will slide easily from position.

4. Remove the flywheel. (Refer to "FLYWHEEL" in this section.)

Crankshaft

5. Remove the engine front support from the crankcase (if so equipped.)

6. Remove the crankshaft rear oil seal and seal retainer (See NOTE).

NOTE: *Rear oil seal retainer may be one piece or two pieces depending on application.*

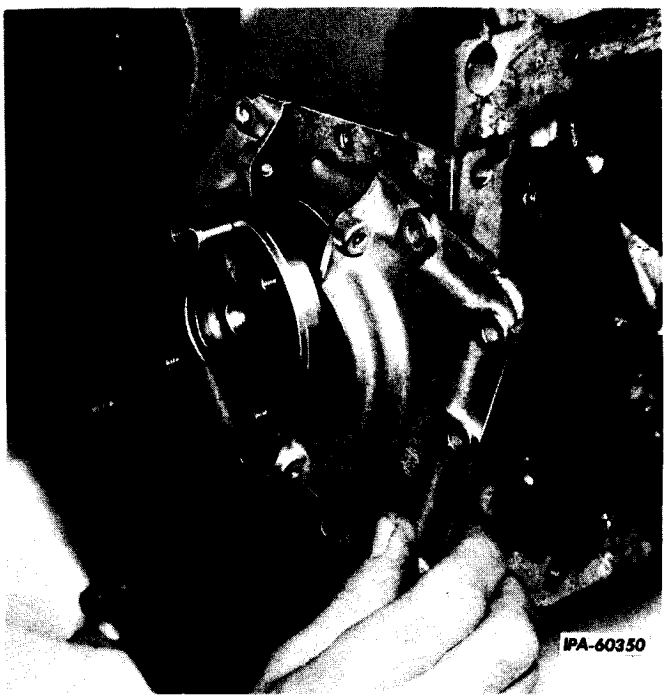


Fig. 1 - Removing the Rear Main Oil Seal and Retainers (135 Series Shown.)

7. Remove the front cover if it has not previously been removed. (Refer to "TIMING GEAR AND FRONT COVER," in Section 6.)

8. Remove the retainer plates by tapping them lightly with a soft hammer.

9. Remove the connecting rod bearing cap bolt nuts and bearing caps. Push the piston and rod assemblies to the top of their travel. (Refer to "CONNECTING RODS, PISTONS AND RINGS," Section 3.)

10. Lift the crankshaft out of the crankcase (Fig. 2).

3. INSPECTION AND REPAIR

1. Clean all parts with cleaning solvent and dry with compressed air.

2. Inspect the bearings for wear and evidence of uneven bearing support. Examine the bearing caps and supporting surfaces of the crankcase for high spots and burrs.

3. Inspect the crankshaft journals for scoring and measure the diameter of each journal with a micrometer. Check the dimensions obtained, with those listed in "SPECIFICATIONS," Section 1.

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL

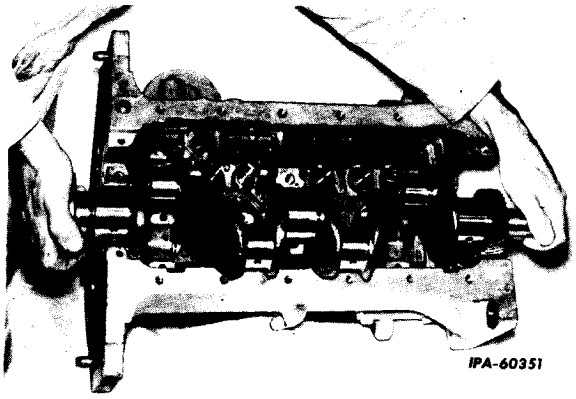


Fig. 2 - Removing the Crankshaft (135 Series).

Measure each journal at two points, one at right angles to the other, in order to detect any out-of-roundness. Move the micrometer over the entire width of the journal (Fig. 3).

Fig. 3 - Checking Connecting Rod Journal with Micrometer (60 Series Shown).

4. Inspect the crankshaft gear teeth for excessive wear and chipping. If necessary to replace it, pull the gear with a puller.

5. Inspect the crankcase for sludge and deposits and thoroughly flush and clean it.

6. Replace all seals and gaskets with new ones.

4. INSTALLATION

1. Wipe all surfaces of the crankshaft bearing bores of crankcase and bearing caps free of oil, and place bearing shell halves in the bore of the crankcase and bearing caps. Be certain the shells are fully seated, oil holes are in alignment, and locking tangs on the bearings fit into the recesses

2. Apply a film of engine oil on the bearing shell surfaces and place the crankshaft into position.

NOTE: *When installing the crankshaft, be certain to correctly index the timing marks on the crankshaft gear, idler gear (or ignition drive gear) and cam shaft gear. (Refer to Section 6.)*

3. Install the bearing caps over the crankshaft journals, being certain to install the caps in their correct positions and with the numbered side of the caps to the camshaft side of the engine.

4. Check the main bearing clearances and compare with the bearing clearances given in "SPECIFICATIONS," Section 1. Remove the center main bearing cap and the lower bearing. If virgin lead wire is to be used to check the bearing clearance, wipe the bearing clean and oil the crankshaft journal. If "PLASTIGAGE" is to be used, be sure to wipe the bearing surface and exposed half of the crankshaft journal free of oil, as the plastic material is soluable in oil.

Place a suitable length of 0.015 virgin lead wire, or a piece of "Plastigage, across the bearing surface and install the bearing and cap. Torque the nuts or cap screws to the specified torque (Refer to "SPECIFICATIONS" in Section 1). Then, remove the nuts, or cap screws, and bearing cap. If virgin lead wire was used, carefully remove the wire which will have been crushed to the amount of clearance present. Measure the wire with a micrometer. (Refer to Fig. 4.)

If "Plastigage" was used, the flattened piece of plastic will be found adhering to either the bearing or crankshaft journal. DO NOT REMOVE THE PLASTIGAGE! To determine the bearing clearance, compare the width of the flattened plastic at its widest point, with the graduations on the Plastigage envelope. The numbers within these graduations indicate the clearance in thousands of an inch. If the crankshaft, bearings, and crankcase are in good condition, the measurement taken should fall within the specified clearance given in "SPECIFICATIONS" in Section 1. NOTE: DO NOT TURN THE CRANKSHAFT DURING THE ABOVE PROCEDURE. Should the clearance obtained be more or less than the specified amount, replace the bearing with a new one. Should the clearance remain excessive, it may be necessary to grind the crankshaft and install undersize bearings for the ground crankshaft. Refer to Fig. 7 and the chart that follows it. DO NOT GRIND BEYOND THESE LIMITS.

However, if the results obtained were within the specified amount, add clean engine oil to the bearing and install the main bearing cap. Torque the bearing cap screws.

Continue checking the other main bearings in the same manner.

5. Install the bearing caps to their original position and tighten the cap screws to proper torque as given in "SPECIFICATIONS," Section 1. (Refer to Fig. 5).

6. Check the crankshaft end clearance and compare with "SPECIFICATIONS," Section 1. (Refer to Fig. 6.)

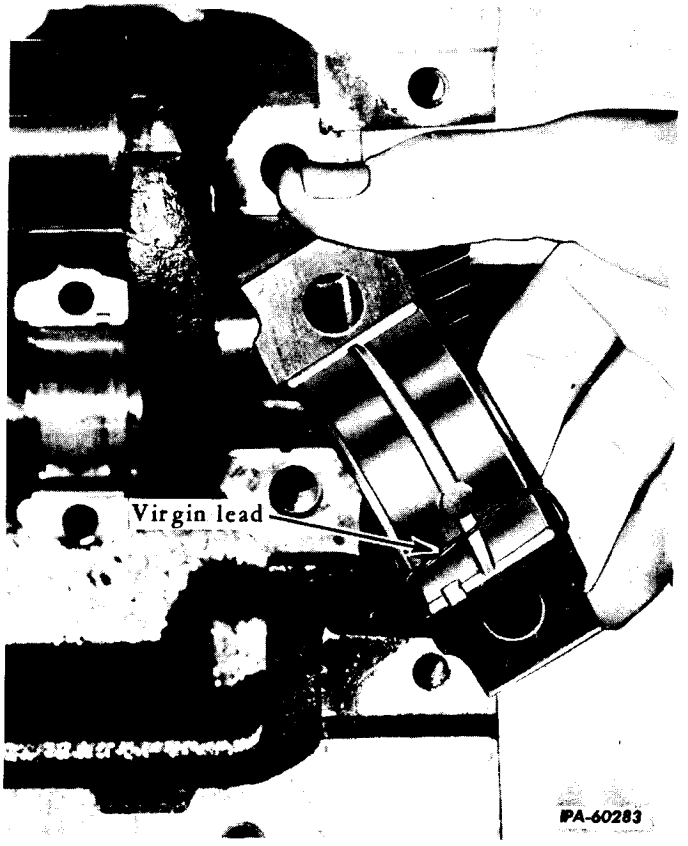


Fig. 4 - Checking Bearing to Journal Clearance and Virgin Lead (135 Series).

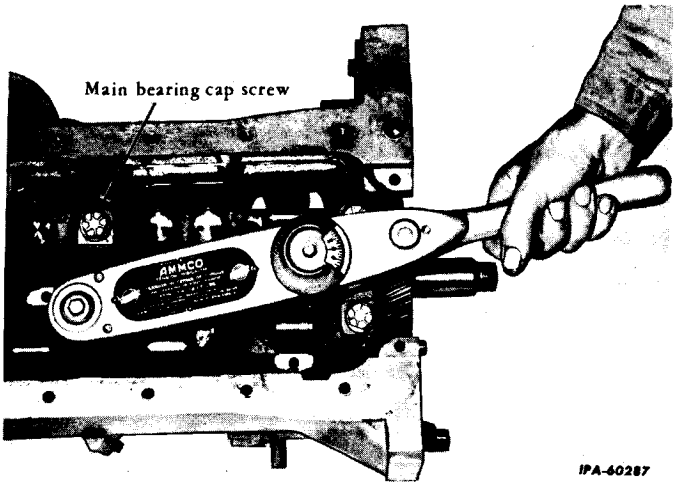


Fig. 5 - Torquing Main Bearing Cap Screws (135 Series Shown).

7. Install the connecting rod bearings and caps. (Refer to Section 3.)

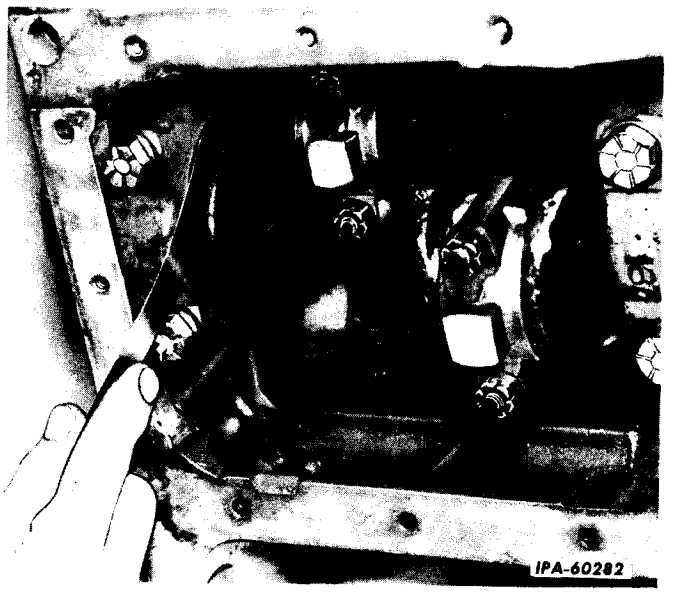


Fig. 6 - Checking Crankshaft End Clearance (135 Series Shown).

8. Install the retainer plates by tapping them lightly with a soft hammer. Use new gaskets.

9. Install the front cover. (Refer to "TIMING GEAR TRAIN AND FRONT COVER," Section 6.)

Installing Rear Oil Seal

SPLIT TYPE RETAINER

10. Install new rear oil seal felts in the oil seal retainer.

11. Install the retainer halves and tighten the cap screws.

ONE PIECE RETAINER

12. Thoroughly clean the gasket surfaces of the crankcase and the oil seal retainer.

13. Apply sealer to a new gasket and position the gasket on the retainer. Place three cap screws (one at the top and one opposite the other) through the retainer and gasket to keep the gasket in position on the retainer.

14. Using oil seal driver tool FES 6-15 to line up the retainer with the crankshaft oil seal surface, install the retainer over the crankshaft flange and to the crankcase. DO NOT REMOVE the driver from the retainer until step 15 is completed.

15. With the driver remaining in position on the crankshaft and in the retainer, install the cap screws. Tighten the cap screws in sequence (one across from the other) rotating the driver in the retainer at the same time. Remove the driver after all the cap screws have been tightened.

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL

NOTE: *If binding of the driver occurs during the tightening of the cap screws the cap screws must be loosened and the tightening procedure repeated.*

A freely rotating driver after screws have been tightened means the crankshaft oil seal surface is aligned with the retainer.

16. Apply a film of lubricating oil to the oil seal, crankshaft flange and the seal bore in the retainer. Install the seal on the crankshaft flange, and push forward so that the seal is in contact with the retainer.

17. Push the seal forward by hand to insure that the sealing lip on the O.D. of the seal has entered the chamber on the retainer around the entire circumference of the seal.

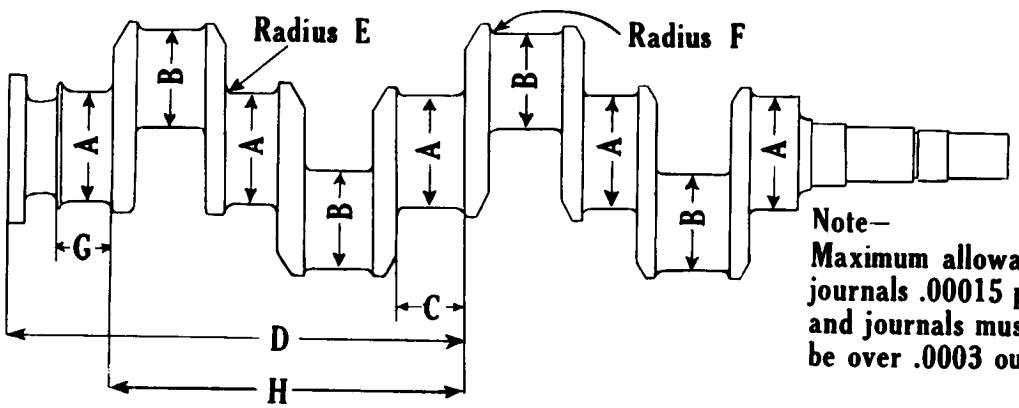
18. Position oil seal driver FES 6-15 on the crankshaft flange. With a hammer, tap the oil seal in place until the shoulder of the driver contacts the rear surface of the crankshaft flange.

19. Install the engine front support, if so equipped.

20. Install the flywheel housing and secure with cap screws. Tighten to standard torque.

21. Install the oil pump and oil pan. (Refer to "OIL PUMP" in Section 4.)

22. Install the flywheel. (Refer to "FLYWHEEL" in this section.)



Note–
Maximum allowable taper on crankpins and journals .00015 per inch of length. Crankpins and journals must be polished, and must not be over .0003 out of round.

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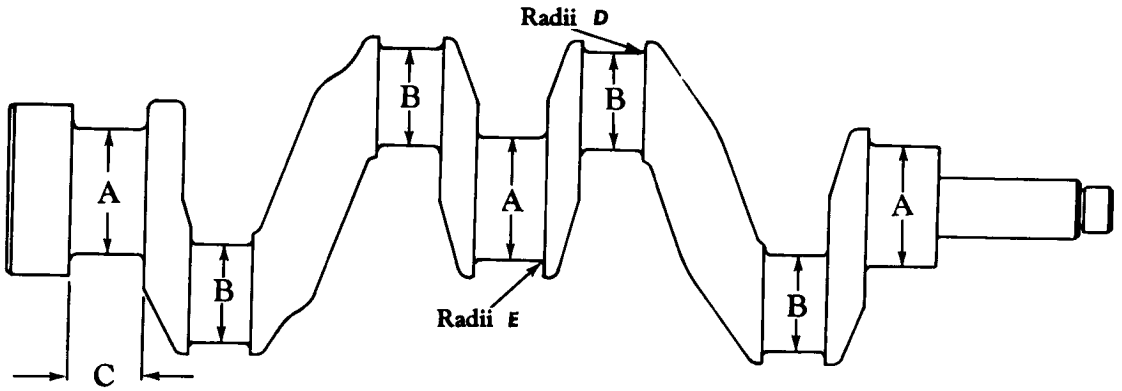
Fig. 7 - Limits for .030 - inch Undersize Crankshafts.

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL

CARBURETED ENGINE	SERIES	A	B	C	D	E - MAIN BEARING JOURNALS	F - CRANK PIN BEAR'G. JOURNALS	G	H
2-5/8 x 2-3/4 x 4	1, 60	1.593 1.594	1.468 1.469	1.1985 1.2005		0.075 0.095	0.045 0.065		6.527 6.547
3 x 4 x 4 3-1/8 x 4 x 4	2A, 123	2.094 2.095	1.719 1.720			0.045 - 0.065 (except rear) 0.124 - 0.145	0.045 0.065	1.8555 1.8575	
3-1/4 x 4-1/16 x 4	135	2.214 2.215	1.779 1.780	1.313 1.317	11.608 11.628	0.064 - 0.094 (except rear) 0.118 - 0.149	0.135 0.155	1.642 1.644	
3-3/8 x 4-1/4 x 4	4	2.4675 2.4685	2.2175 2.2185	2.011 2.013	12.746 12.766	0.110 0.125	0.110 0.125		
3-1/2 x 4-1/4 x 4	164								
3-9/16 x 4-1/4 x 4	169	2.5275 2.5285	2.2675 2.2685	1.989 1.991	12.729 12.749	0.110 0.125	0.110 0.125	1.918 1.928	9.421 9.431
3-5/8 x 4-1/4 x 4	175								
3-7/8 x 5-1/4 x 4	6	2.7175 2.7185	2.4675 2.4685	2.261 2.263	14.433 14.453	0.150 0.165	0.110 0.130		
4 x 5-1/4 x 4	264	2.7775 2.7785	2.5175 2.5185	2.239 2.241	14.416 14.436	0.150 0.165	0.130 0.130	2.012 2.022	10.859 10.879
4-1/8 x 5-1/4 x 4	281								
4.4 x 5.5 x 4	9	3.2175 3.2185	2.9665 2.9675	2.761 2.763	16.308 16.328	0.150 0.165	0.110 0.130		

CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL



Grinding Limits:
Maximum allowable taper on crankpins and journals .00015 per inch of length. Crankpins and journals must be polished, and must not be over .0005 out of round.

Fig. 8 - Limits for Undersize Crankshaft Grinding.

LIMITS FOR UNDERSIZE CRANKSHAFT GRINDING - INCHES

ENGINE	UNDERSIZE, INCH	A	B	C *	D	E
135B, 146 and 153	0.010	2.6135 2.6145	2.049 2.050	1.636 1.638	0.135 0.155	0.110 0.130
	0.020	2.6035 2.6045	2.039 2.040	1.640 1.642	0.135 0.155	0.110 0.130
	0.030	2.5935 2.5945	2.029 2.030	1.644 1.646	0.135 0.155	0.110 0.130

*Grind an equal amount of material from each thrust face to maintain the proper end play.

FLYWHEEL

5. DESCRIPTION

The flywheel is attached to the rear of the crankshaft. Its purpose is to oppose and moderate, by its inertia, any fluctuations in the speed of the engine. It counteracts variable torques during the stroke of the engine, and provides a rotating balance weight that carries the engine crankshaft over dead center on the pistons.

The ring gear can be removed from the flywheel when replacement is necessary.

6. REMOVAL

1. Rotate the flywheel to place the locating dowel at the top. Loosen and remove the bolts and bolt lock.

2. Using a soft hammer, tap on the flywheel to loosen it from the crankshaft.

NOTE: *Consider the weight and avoid the possibility of the flywheel dropping. Use a sling if necessary (Fig. 9).*

7. INSPECTION AND REPAIR

1. Clean the flywheel in solvent and inspect carefully for cracks, excessively worn dowel hole or mounting holes. Replace if necessary.

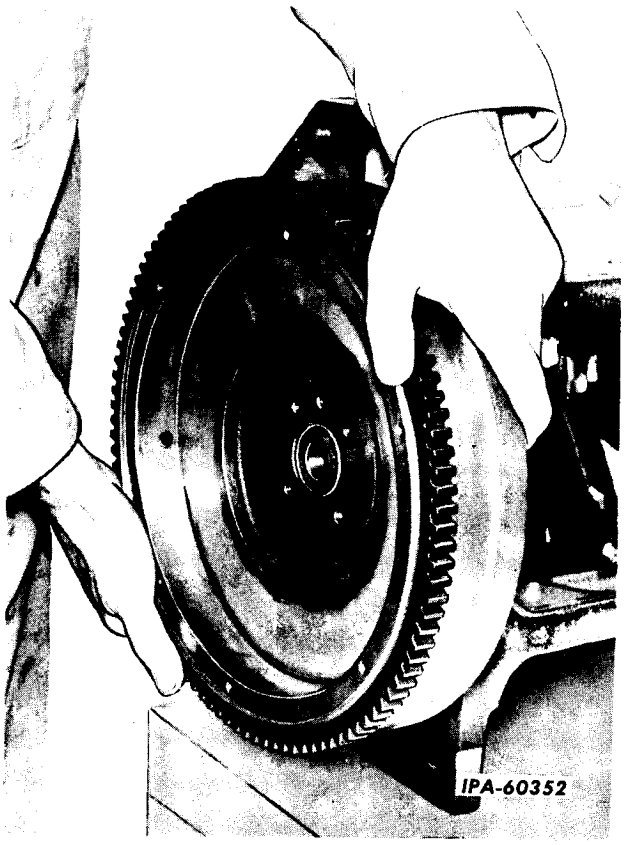


Fig. 9 - Removing the Flywheel

2. Inspect the ring gear for chipped or excessively worn teeth. Replace if necessary. (Refer to Steps 4 and 5.)

3. Inspect the pilot bearing. Discoloration of the bearing would indicate the lack of sufficient lubrication and overheating. If there is any question as to serviceability, install a new bearing. Be sure it is well lubricated with grease.

Replacing the Ring Gear

4. Heat the entire circumference of the ring gear with a torch, and drive it from position with a hammer and drift.

5. Heat a new ring gear to expand it and, while it is still hot, install it on the flywheel. The chamfered edge of the ring gear (ID) is placed on the flywheel first.

8. INSTALLATION

1. Pack the pilot bearing well with grease and install it in the flywheel.

2. Install the flywheel. A locating dowel in the crankshaft flange makes it possible to install the flywheel only one way. With the dowel at the top, lift the flywheel into position and install the four bolts and bolt lock. Tighten the bolts and torque to the amount shown in "SPECIFICATIONS," Section 1. Be sure the bolt lock is bent over to securely lock the bolt heads.

FUEL PUMP (POWER UNITS)

1. DESCRIPTION

The fuel pump is a diaphragm type pump and serves to keep the carburetor float bowl supplied with fuel, in accordance with the demands of the engine, by drawing the fuel from a supply tank.

The pump is mounted on the engine and the linkage to the pump is actuated by the engine camshaft.

2. PRESSURE TEST

This test can be used to determine if it is necessary to replace or repair the fuel pump. It is performed with the fuel pump installed on the engine. Fuel pump faults are of two kinds. Either the pump is supplying too little fuel or, in rare cases, too much. If the pump is supplying too little fuel, the engine will not run at all, or will falter or misfire. If the pump is supplying too much fuel, fuel will drip from the carburetor, or the engine will not run smoothly when idling. Engines are hard to start when getting too much fuel. As a rule, an oversupply of fuel is due to causes other than faulty pump.

1. Be sure that there is fuel in the tank.

2. Disconnect the fuel line from the inlet side of the fuel pump. If fuel flows freely from the end of the disconnected line, the fuel supply line and fuel tank are not at fault; proceed with the pressure test. If little or no fuel flows freely from the line, check for loose connections or clogged lines from the fuel pump all the way to the tank. Blow out the lines with compressed air, and tighten all connections.

3. Connect the fuel line to the fuel pump inlet.

4. Connect a pressure gage with a tee fitting in the fuel line between the fuel pump and the carburetor, making all connections secure and leakproof.

5. Start the engine and run at rated high idle speed. Stop the engine when maximum pressure reading is indicated. If the pressure indicated is below the minimum or above the maximum listed in Section 1, "SPECIFICATIONS," repair or replace the fuel pump.

3. REMOVAL

1. Disconnect the fuel pump-to-carburetor fuel line.

2. Disconnect the fuel line leading from the fuel tank to the fuel pump.

3. Remove the cap screws securing the fuel pump and gasket to the engine.

4. INSTALLATION

1. Before installing the fuel pump, a simple check of the suction and pressure should be made. This can be done by holding the fingers over the inlet and outlet openings of the pump and then manipulating the rocker arm by hand.

2. Install the fuel pump, using a new fuel pump gasket.

3. Connect the fuel tank-to-fuel pump line and the fuel pump-to-carburetor line. Be sure that there is no dirt on the fittings which might be drawn into the system.

4. If the carburetor has not been removed, there will usually be sufficient fuel in it to run the engine long enough to fill the strainer bowl. If there is an air leak between the strainer bowl and gasket, the pump cannot draw fuel into the bowl. To remedy this, install a new gasket and be sure that the bowl seats squarely. Tighten bail nut securely with finger pressure only.

5. If the strainer bowl still does not fill, the trouble may be due to an air-bound condition. In this case, the bowl should be loosened slightly so that air can escape and, by blowing in the gasoline tank filler neck, fuel will be forced into the pump. Then tighten bowl securely and start engine.

6. Perform pressure test (Par. 2).

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GOVERNOR

1. DESCRIPTION

(Refer to Fig. 1 and 2)

The engine governor used on the carbureted engines is the fly-ball, variable speed type, designed to maintain a selected engine speed (rpm) within reasonably constant limits, under varying load conditions, by proportioning the fuel with respect to the load imposed. The governor depends upon centrifugal force for its action. The force is developed by a pair of weights rotating about a shaft driven by the engine. A spring is used which tends to counteract the outward movement of the weights. The movement of the weights is passed to the carburetor throttle valve by linkage.

As the engine starts and its speed increases, the governor weights move outward by centrifugal action until the spring tension force equals that of the centrifugal force, tending to throw the weights against the springs. Thus, at a certain point both spring and governor forces are balanced and the engine speed will remain constant at the speed at which the forces, spring and governor weight, became equal.

When changes in engine speed occur through variations in load while operating, the change in speed causes a small movement in or out of the governor weights due to centrifugal force. This weight movement causes a change in throttle valve position and allows more (or less) fuel to enter the cylinders, thus maintaining an engine speed capable of supplying the power needed for the load imposed.

The engine speed settings are controlled by the speed change hand lever increasing or decreasing the governor spring tension and not by direct connection with the carburetor throttle valve.

Increasing the governor spring tension allows the throttle to be pulled farther open, increasing the engine speed until the added centrifugal force of the governor weights balance the increased spring tension. Decreasing the spring tension will result in the opposite action.

When the engine is stopped and the governor weights are at rest, with a slight tension on the springs, the throttle plate in the carburetor should be in wide open position (parallel to the throttle barrel and against its stop)

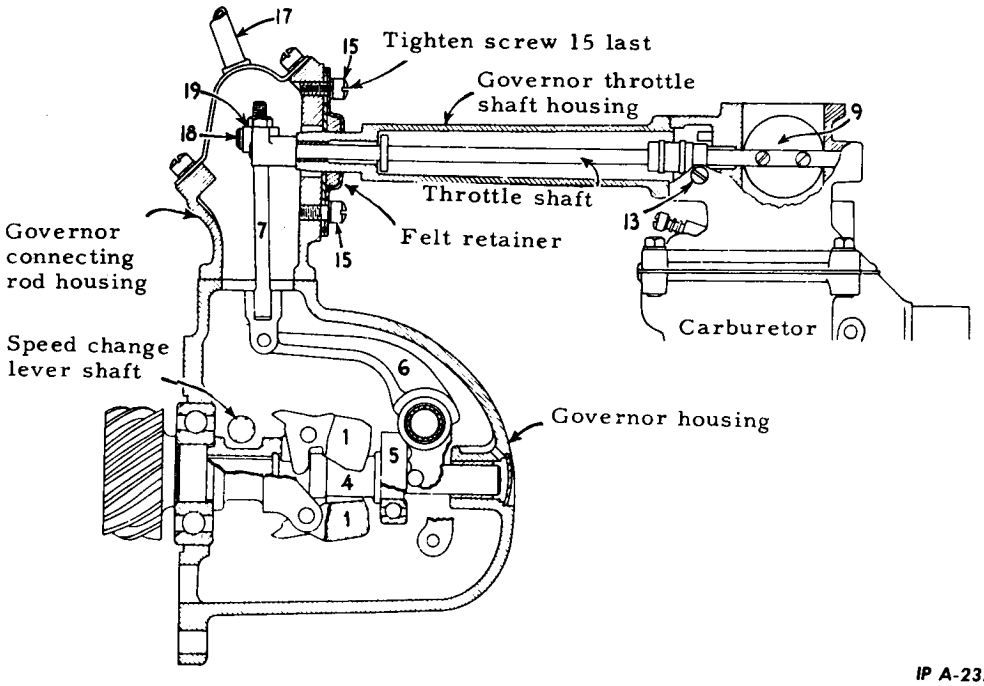


Fig. 1 - Section through Governor Showing Weight and Control Linkage to Carburetor Butterfly Governor shown in Medium Speed Position.

1. Governor weights.
4. Governor sleeve.
5. Sleeve bearing.
6. Governor lever.
7. Connecting rod.
8. Throttle shaft lever.
9. Throttle.
13. Throttle stop screw.
15. Felt retainer screws.
16. Ventilating tube.
18. Pin.
19. Adjusting block.

GOVERNOR

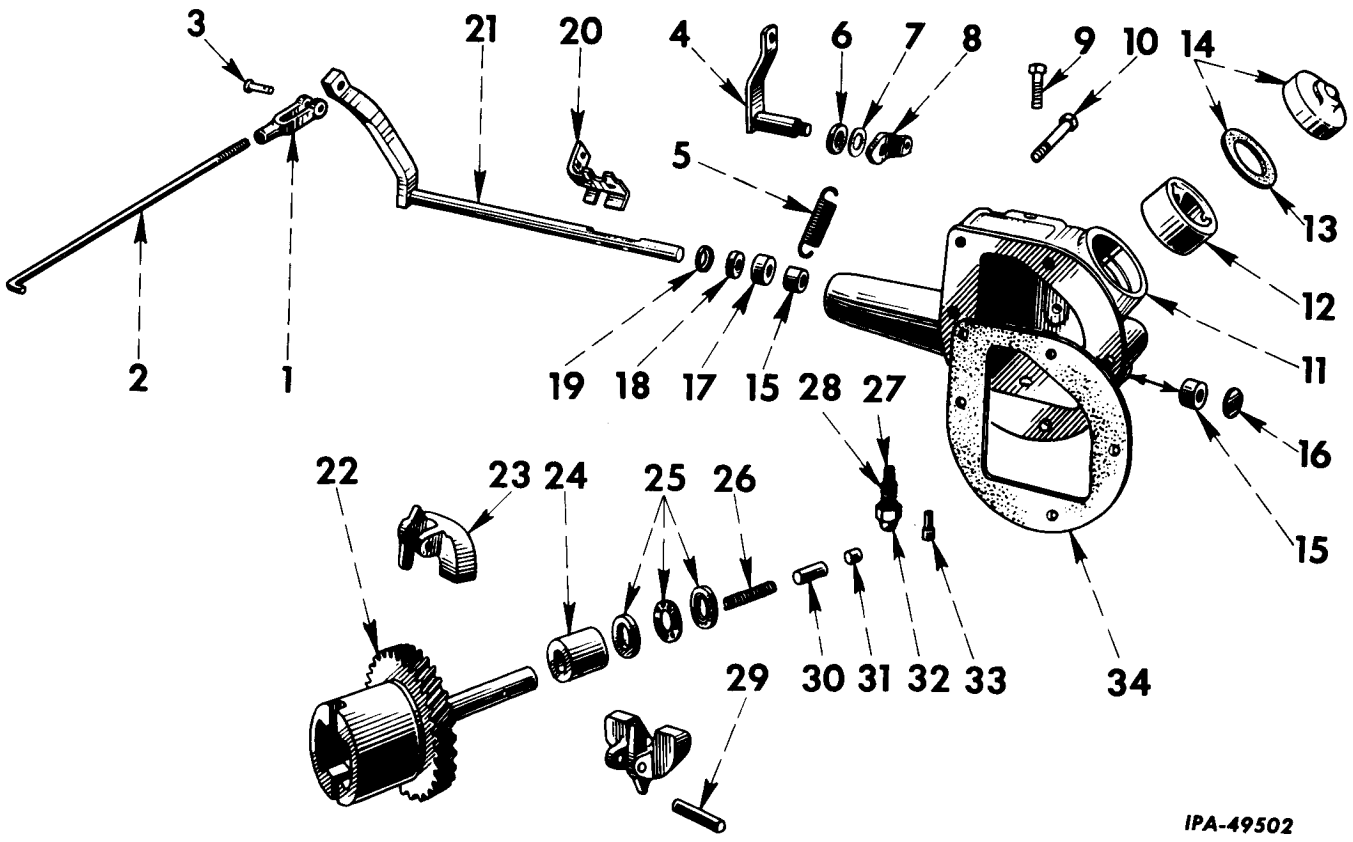


Fig. 2 - Exploded View of Governor (135 Series Shown) (60 Series Similiar).

1. Clevis.
2. Connecting rod.
3. Rod end pin.
4. Lever and shaft.
5. Governor spring.
6. Shaft oil seal.
7. Washer.
8. Spring lever.
9. Change lever stop.
10. Housing bolt.
11. Governor housing
12. Filler neck.
13. Gap gasket.
14. Cap w/gasket.
15. Needle bearing.
16. Expansion plug
17. Rockshaft bushing.
18. Rockshaft seal.
19. Seal retainer.
20. Rockshaft fork.
21. Rockshaft.
22. Rockshaft.
23. Governor weight.
24. Thrust sleeve.
25. Thrust ball bearing.
26. Shaft bumper spring.
27. Governor bumper spring.
28. Governor bumper spring body.
29. Weight pin.
30. Shaft bumper pin.
31. Shaft stop pin.
32. Nut.
33. Retainer pin.
34. Housing gasket.

2. REMOVAL

60, 135, 135B, 146 and 153 Series

(Reference Numbers Refer to Fig. 2).

1. Disconnect the connecting rod (2) to the carburetor at the clevis (1) by removing the cotter from the pin (3). Disconnect the rod at the speed change lever and shaft (4).

2. Remove the five housing bolts (10) and lift the governor housing away from the engine (Fig. 3).

3. Remove the governor weight and pinion assembly (Fig. 4).

175 and 281 Series

1. Disconnect the accelerator rod from the governor by removing the pin. Remove the breather tube assembly (17, Fig. 1) from the connecting rod housing.

2. Remove the cap screws securing the throttle shaft housing to the carburetor. Remove the cap screws securing the connecting rod housing to the governor housing (Fig. 1). Remove the cap screws from the felt retainer.

3. Work the throttle shaft housing forward to the connecting rod housing until the throttle shaft is free of the carburetor. Remove the cap screws securing the governor housing to the front cover, and remove the assembly from the engine (Fig. 5).

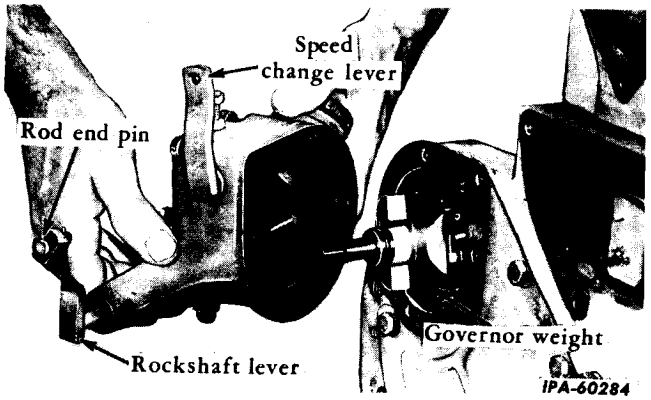


Fig. 3 - Removing the Governor Housing (135 Series).

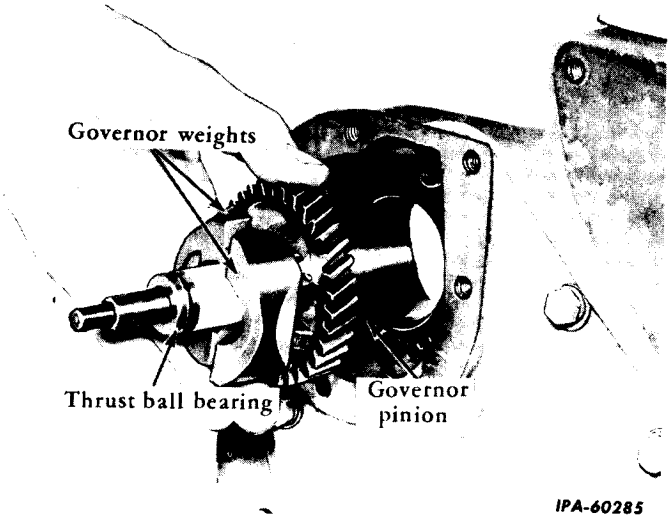


Fig. 4 - Removing the Governor Weight and Pinion Assembly.

3. DISASSEMBLY

60, 135, 135B, 146 and 153 Series
(Reference Numbers Refer to Fig. 2).

1. Remove the governor shaft stop pin (31), bumper pin (30) and shaft bumper spring (26). Slide the governor thrust ball bearings (25) and the thrust sleeve (24) off the pinion shaft (22). The governor weights (23) are held to the pinion with weight pins (29) secured with cotter pins.

2. The governor rockshaft (21) may be removed from the governor housing (11) by first removing the two small machine screws from the fork (20). Then withdraw the rockshaft carefully. Unless the seal (18) is damaged, it need not be removed. If there is any doubt, replace the seal.

3. Remove the jam nut that secures the speed change lever and shaft (4) and release the spring (5) from the spring lever (8). Pull the speed change lever out. The shaft oil seal (6) and washer (7) will drop off the shaft.

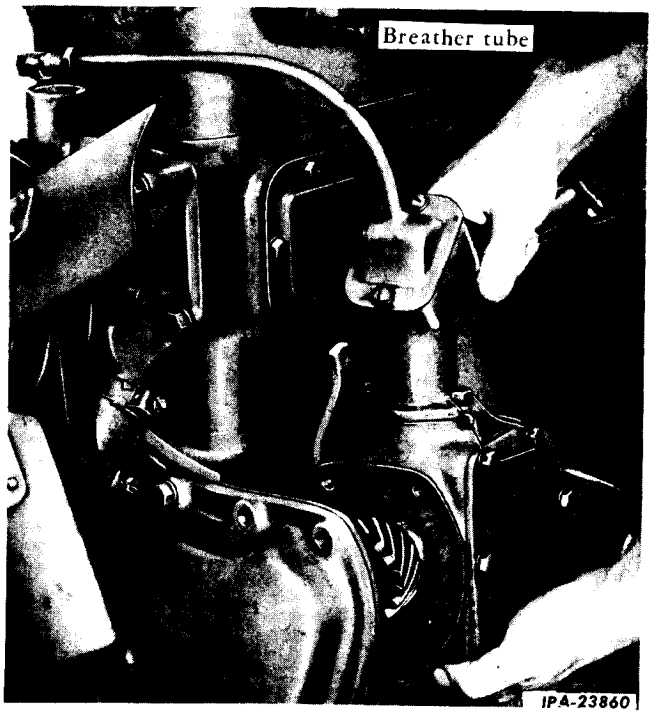


Fig. 5 - Removing Engine Governor (6 Series Shown).

175 and 281 Series

1. Separate the throttle shaft housing and the governor connecting rod housing from the governor housing (Fig. 7).

2. Separate the throttle shaft and housing, felt retainer and felt from the connecting rod housing (Fig. 8).

3. Remove the cover from the governor housing.

4. Remove the cotter and pin securing the end of the governor spring (2, Fig. 12). Run out the lock bolt in the governor spring lever (14, Fig. 12) and pull the lever from the speed change lever.

5. Remove the key from the shaft (30, Fig. 6) and remove the speed change lever and the seal (47) from the governor housing (Fig. 9).

6. Drill a hole in the plug (34) and remove it. Drive the entire governor shaft assembly out of the front end of the governor housing. Remove the nut (23) and pull the gear (24), bearing (54) and governor weight carrier (53) from the shaft.

7. Press the bearing from the weight carrier. Remove the sleeve (49), with bearing (48) and washers, from the rear end of the governor shaft (51). Press the bearing off the sleeve.

8. Remove the expansion plug and press the rockshaft (39) out of the snap ring side of the governor housing. This will free the rockshaft lever (41). Drive the bearing (40) out of the lever (41).

GOVERNOR

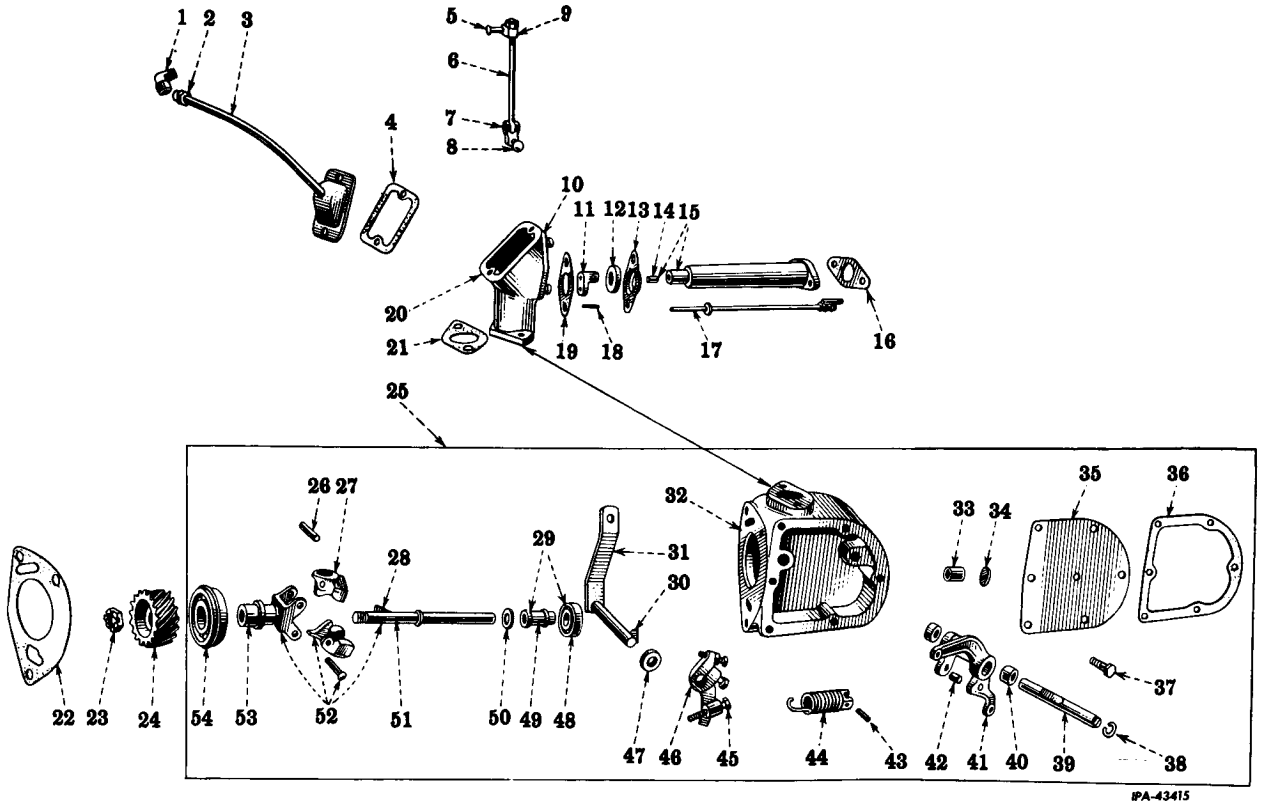


Fig. 6 - Governor and Connections (281 Series Shown) (175 Series Similiar).

1. Pipe elbow.
2. Coupling nut.
3. Breather tube.
4. Gasket.
5. Connecting pin.
6. Connecting rod.
7. Rod pin.
8. Lever pin.
9. Adjusting block.
10. Retainer plate.
11. Throttle shaft lever.
12. Washer (felt).
13. Felt retainer.
14. Throttle shaft bushing.
15. Throttle shaft housing.
16. Gasket.
17. Throttle shaft.
18. Lever pin.
19. Gasket.
20. Connecting rod housing.
21. Gasket.
22. Gasket.
23. Jam nut.
24. Governor gear.
25. Governor assembly.
26. Weight pin.
27. Governor weight.
28. Key.
29. Governor sleeve.
30. Key.
31. Speed change lever.
32. Governor housing.
33. Housing bushing.
34. Expansion plug.
35. Housing cover.
36. Gasket.
37. Cover screw.
38. Snap ring.
39. Rockshaft.
40. Bearing.
41. Rockshaft lever.
42. Thrust pin.
43. Spring pin.
44. Governor spring.
45. Lever bolt, long.
46. Governor spring lever.
47. Shaft seal.
48. Thrust ball bearing.
49. Governor sleeve.
50. Thrust washer.
51. Governor shaft.
52. Weight w/carrier assembly.
53. Governor weight carrier.
54. Shaft ball bearing.

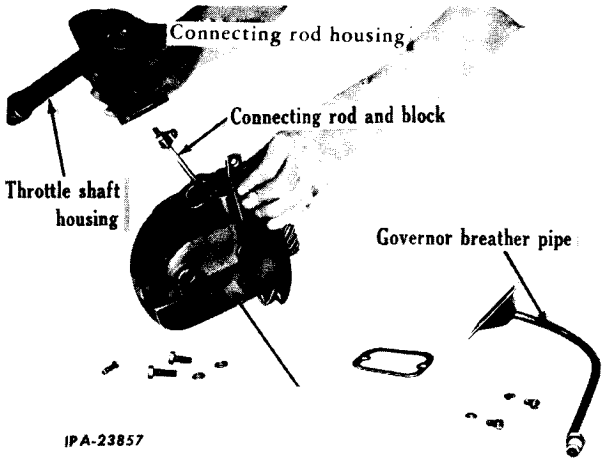


Fig. 7 - Disassembly of Governor Mechanism.

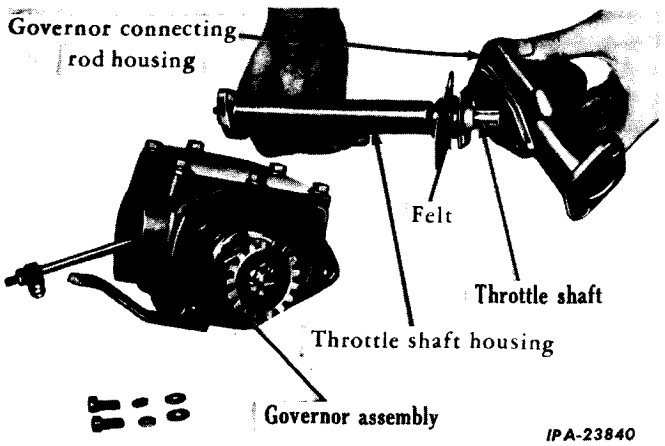


Fig. 8 - Removing the Throttle Shaft Housing Assembly from the Connecting Rod Housing.

4. INSPECTION AND REPAIR

1. Clean all parts in a clean container using clean solvent. Wash the ball bearings first. Rotate the bearings slowly while dipping up and down to dislodge any dirt. Dry them with compressed air but AVOID spinning them.

Examine the bearing for roughness and wear. Lubricate the bearings with a few drops of oil and spin by hand to test for roughness or evidence of wear.

2. Clean the rest of the parts in solvent, examining the weights, carrier and pins for damage or wear. The normal clearance between new weights and pins is 0.001 - 0.004 inch. Replace the parts when the clearance reaches 0.007 inch or more.

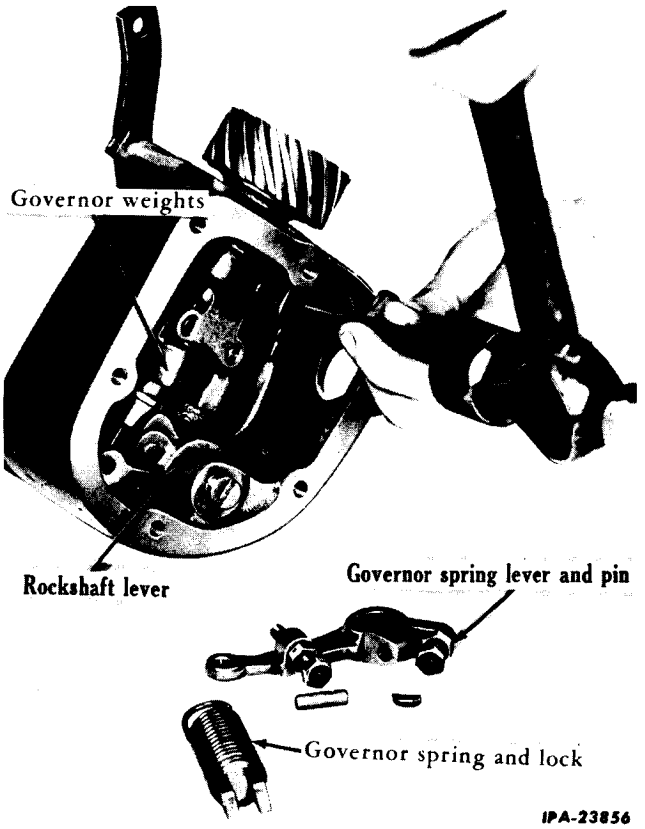


Fig. 9 - Removing Speed Lever (6-Series Engine Governor Shown.

3. Clean the housing and remaining parts and inspect all bearing surfaces for excessive wear or damage.

4. Old seals and gaskets should be replaced with new when a general overhaul is undertaken, to assure oil-tight and dust proof operation.

5. Be sure that all oil holes in the governor housing are open and clean.

5. REASSEMBLY

60, 135, 135B and 153 Series
(Reference Numbers Refer to Fig. 2)

1. Install the speed change lever (4). Coat the shaft with engine oil and insert it in the governor housing. Slide a new, well oiled, oil seal (6) onto the shaft. Install the washer (7) and spring lever (8). Refer to step 6 before installing the jam nut.

2. Install a new seal (18) if the old one is not serviceable or has been removed.

3. Lubricate the surface of the rockshaft (21) and insert it into place carefully. Secure the rockshaft fork (20) with the two machine screws.

4. Dip the weight pins (29) in engine oil and assemble the weights (23) to the pinion (22). Secure the pins with cotters.

5. Assemble the governor pinion assembly. Using clean engine oil to lubricate the parts, slide the thrust sleeve (24) on the pinion, then the three part bearing (25). Insert the spring (26), shaft bumper spring (30) and the shaft stop pin (31). This assembly is now ready for installation so keep it covered for protection until needed.

NOTE: *The rockshaft must turn freely. Be sure the oil seal on its outer end is not causing a drag, as this has the tendency to make the governor surge or "hunt."*

6. With the upper spring lever (8) removed from the shaft, and the upper hook of the spring pointing toward the outside of the governor housing, hook the spring in the rockshaft fork (20) and then in the outer or end hole of the upper spring lever (8). Install the lever of the shaft and secure with the jam nut.

175 and 281 Series

(Reference Numbers Refer to Fig. 6)

1. Press the bearings (40) into the rockshaft lever (41). Position the lever in the housing, and press the rockshaft (39) into the governor housing (32) with cut-out half of the shaft on the bottom side and parallel to the governor shaft (51). The arc is cut out of the shaft to allow bearings (48) to clear it. The arc should center directly over the governor shaft. Be sure that the rockshaft bearings rotate freely.

2. Secure the connecting rod (6) to the rockshaft lever with pin (8) and install the cotter.

3. Press the bushing (33) into the governor housing flush with the front end of the bore. Burnish the bore to a dimension of 0.5035 to 0.5045 inch. The governor shaft (51) has a diameter of 0.501 to 0.502 inch. giving a clearance of 0.0015 to 0.0035 inch.

4. Press the bearing (48) onto the sleeve (49). The wide thrust face of the bearing should be on the side away from the sleeve flange. Slide the washer (50) onto the shaft, and reinstall the sleeve with the bearing end last onto the governor shaft. The sleeve diameter is 0.5045 to 0.5060 inch, which gives a clearance of 0.002 to 0.005 inch with the shaft.

5. Press the bearing (54) onto the weight carrier (53). Install the key (28). Push the carrier assembly (52) over the shaft (51).

6. Position the assembly in the governor housing, and press the bearing (54) into the housing until it seats against the snap ring of the bearing. Install the gear (24) and secure it with nut (23). Install the cotter through the governor shaft (51).

7. Install the oil seal (47) in the governor housing, with the leather lips facing the governor shaft. Install the speed change lever (31) and insert the key (30). Drive the governor spring lever (46) onto the shaft of the speed change lever (31) and secure it firmly with the lock bolt (Fig. 12).

8. Hook the governor spring (44) in the spring lever; secure it to rockshaft with pin (43).

9. The bushing (14) in the throttle shaft housing (15) is replaceable and is furnished for service reamed from 0.2545 to 0.2555 inch. The throttle shaft has a diameter of 0.248 to 0.250 inch. Place the throttle shaft (17) in the throttle housing..

10. Slide a new felt washer (12) and the retainer (13) over the end of the shaft housing. Secure the lever (11) to the shaft with pin. Place a new expansion plug (34) in the housing bore.

6. INSTALLATION AND ADJUSTMENT

60, 135, 135B and 153 Series

When installing the governor assembly in the engine, time the ignition gear as follows:

1. Turn the engine over to top-dead-center on No. 1 cylinder on compression stroke. Chalk mark the top surfaces of the two teeth on each side of the single punch mark on the idler gear (60 series) or camshaft (135 series).

2. Mark the top surface of the tooth having single punch mark on the ignition gear (Fig. 10).

3. Mesh the marked tooth of the ignition drive gear with the two teeth previously marked on the idler gear (Fig. 10), or camshaft gear (135 series).

4. Check to be sure the governor rockshaft is free to oscillate.

5. Connect the governor and carburetor connecting rod and adjust its length so that the carburetor butterfly is in wide open position when the governor rockshaft arm (on carburetor side of the engine) is at the rear end of its travel. Move the rockshaft arm to this position by moving the governor speed change lever.

6. With the engine running, pull the governor speed change lever back against the stop and adjust the speed adjusting screw (vertical screw on top of the governor housing) to obtain specified fast idle speed. (Refer to "GOVERNOR SPEED CHART" at the end of this section.

7. Check the governor action by moving the governor speed change lever by hand and then releasing suddenly. If the governor surges more than twice, screw in the bumper spring (27, Fig. 2) just enough to stop excessive surging. After proper adjustment has been obtained, lock in place with jam nut. (Refer to "GOVERNOR SPEED CHART" at the end of this section.)

175 and 281 Series
(Reference Numbers Refer to Fig. 6)

1. Before installing the governor on the engine, remove the cover on the side of the governor housing. Then install a new gasket and assemble the governor to the engine and check the governor gear, after the housing is tight in place, to be sure the gear has a small amount of backlash and is not tight.

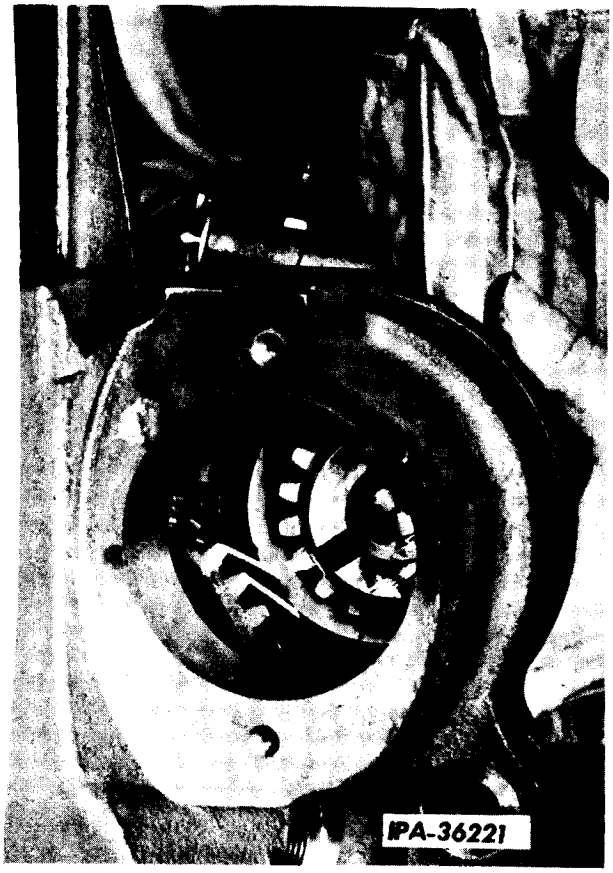


Fig. 10 - Installing Governor and Ignition Drive Gear. Note Chalk Marked Gear Teeth in Proper Position (60 Series Shown).

. With the throttle shaft (17) installed in the throttle shaft ousing (15), secure the flanged end to the carburetor, and ıe other end, together with the felt washer (12), felt retain- · (13), retainer plate gasket (19) into the connecting rod ousing. Leave these screws loose temporarily. Be sure that l parts are aligned properly without any binding.

is important that the linkage connecting the governor eight movement to the carburetor throttle is not worn and correctly adjusted. The adjustment consists of synchroniz- ıg the wide open position of the throttle (9, Fig. 1) with the osition of the governor weights at rest.

. Tighten the screws in the carburetor end, and secure the ɔnnecting rod housing to the governor housing. The two otted screws that secure the shaft housing felt retainer (13) ıould also be tightened.

. Hold the throttle shaft lever (11) up as far as it will go nd set the governor connecting rod adjusting block (9) in osition so the lever connecting pin (5) can be installed. ighten the lock nut on the end of the connecting rod (6) ıith the throttle in wide open position. (Refer to Fig. 11).

. Remove the governor housing side plate for access to the djusting screws.

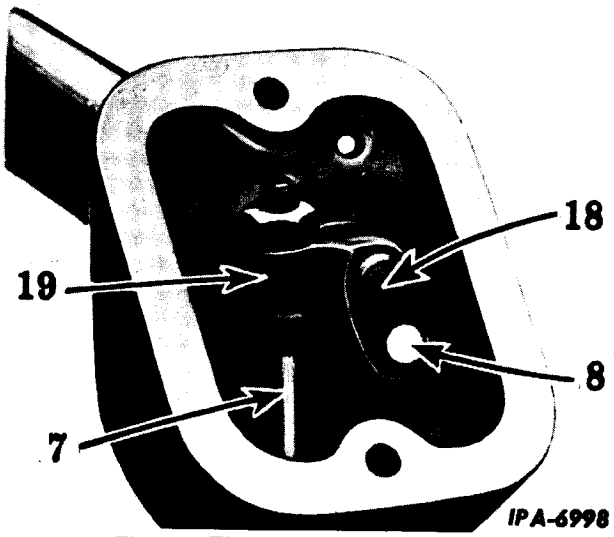


Fig. 11 - Throttle Shaft Connection.

7. Connecting rod.
8. Throttle shaft lever.
18. Pin.
19. Adjusting block.

NOTE: *The governor speed chart will be found at the end of this section.*

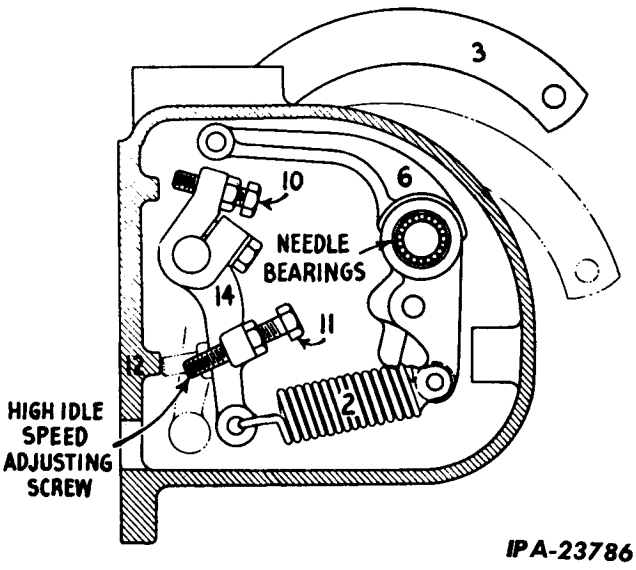


Fig. 12 - Governor Spring Adjusting Screws and Spring.

2. Governor spring.
3. Speed change lever.
6. Governor lever.
10. Stop screw.
11. Adjusting screw.
12. Housing.
14. Governor spring lever.

GOVERNOR

6. The screw (11, Fig. 12) controls the maximum no-load speed. Screw (10) limits the travel of the governor spring lever (14) at the low speed of its range. The "maximum no-load speed" is the speed at which the engine operates with the speed change hand lever in full speed position and the engine operating without load. This predetermined speed assures the carburetor throttle plate being in the wide open position when the engine is operating under its maximum normal rated load speed.

To adjust for maximum no-load speed, the engine should first be brought up to normal operating temperature. When this is done, set the speed change hand lever to the limit of its travel in high speed; then turn the adjusting screw (11, Fig. 12) out to increase or in to decrease the speed. After completing the adjustment, lock the screw by setting the lock nut. The engine rpm may be checked for this adjustment by using a tachometer.

7. When the throttle stop screw (13, Fig. 1) on the carburetor is adjusted for correct low idle speed, the upper stop screw (10, Fig. 12) on the governor spring lever (14) should be adjusted to just touch its stop. At this setting, the governor spring (2) should be free. It will not be possible to set the low idle speed of the engine when the screw (10) is adjusted so there is a tension in the spring (12).

8. The linkage between the hand lever and the governor speed change lever (3) should be adjusted so that both stop screws (10 and 11) will touch their stops at the extreme movement of the hand lever.

9. Install the gasket and breather tube assembly. Secure the breather tube to the housing.

10. Attach the accelerator rod to the lever on the governor with a cotter.

GOVERNOR SPEED CHART

MODEL	FUEL	NORMAL GOVERNED ENGINE RPM AT TEST LOAD AND WIDE OPEN THROTTLE	GOVERNED FAST IDLE	SPEED VARIATION PERCENT	GOVERNOR SPRING NUMBER	GOVERNOR SPRING FORK	GOVERNOR WEIGHT NUMBER	SPEED CHANGE LEVER ASSEMBLY NO.
U-1	Gasoline	2500 ± 10	2750 ± 25	10	251 464 R1	– – – – –	351 891 R1	– – – – –
UC-60	Gasoline	1800 ± 10	2000 ± 25	11	251 464 R1	– – – – –	351 778 R1	– – – – –
U-2A	Gasoline	1200 ± 10	1260 ± 25	5	57 287 D	– – – – –	351 778 R1	– – – – –
U-2A	Gasoline	1570 ± 10	1727 ± 25	10	69 235 D	– – – – –	351 778 R1	– – – – –
U-2A	Gasoline	1800 ± 10	1890 ± 25	5	57-02-2	– – – – –	351 778 R1	– – – – –
U-2A	Gasoline	1800 ± 10	1980 ± 25	10	46 944 DA	– – – – –	351 891 R1	– – – – –
U-123	Gasoline	1200 ± 10	1260 ± 25	5	1017-1-U-1	– – – – –	45 655 DA	– – – – –
U-123	Gasoline	1500 ± 10	1650 ± 25	10	– – – – –	– – – – –	– – – – –	– – – – –
U-123	Gasoline	1500 ± 10	1575 ± 25	5	– – – – –	– – – – –	45 655 DA	– – – – –
U-123	Gasoline	1800 ± 10	1980 ± 25	10	357 012 R1	– – – – –	45 655 DA	– – – – –
U-123	Gasoline	1800 ± 10	1890 ± 25	5	250 971 R1	– – – – –	45 655 DA	– – – – –
U-123	Gasoline	2000 ± 10	2200 ± 25	10	362 142 R1	– – – – –	364 018 R1	– – – – –
UC-135, T-340 UC-135B	Gasoline	2000 ± 10	2200 ± 25	10	369 686 R2	– – – – –	351 778 R1	– – – – –
UC-153	Gasoline	2400 ± 10	2580 ± 25	7.5	381 242 R1	– – – – –	351 778 R1	– – – – –
U-4	70-72 gaso.	1200 ± 10	1260 ± 15	5	57 593 D	57 594 DA	45 655 DA	48 245 DX
U-4	70-72 gaso.	1400 ± 10	1540 ± 15	10	55 871 D	49 406 D	45 655 DA	48 245 DX
U-4	70-72 gaso.	1600 ± 10	1760 ± 25	10	49 407 DA	49 406 D	45 655 DA	48 245 DX
U-4	70-72 gaso.	1650 ± 10	1815 ± 25	10	49 407 DA	49 406 D	45 655 DA	48 245 DX
U-4	70-72 gaso.	1800 ± 10	1980 ± 25	10	53 064 D	55 214 D	45 655 DA	48 245 DX
U-4	70-72 gaso.	1800 ± 10	1890 max.	5 max.	250 971 R91	49 406 D	250 966 R1	48 245 DX
U-164	Gasoline	1800 ± 10	1980 ± 25	10	357 013 R1	– – – – –	45 655 DA	48 245 DX
U-169	Gasoline	2000 ± 10	2200 ± 25	10	362 142 R1	– – – – –	364 018 R1	48 245 DX
U-175	Gasoline	2000 ± 10	2200 ± 25	10	362 142 R1	– – – – –	364 018 R1	48 245 DX
U-6	70-72 gaso.	1200 ± 10	1260 ± 15	5	57 595 D	57 594 D	45 655 DA	48 245 DX
U-6	70-72 gaso.	1500 ± 10	1650 ± 25	10	49 407 DA	49 406 D	45 655 DA	48 245 DX
U-6	70-72 gaso.	1800 ± 10	1980 ± 25	10	57 596 D	57 597 D	45 655 DA	48 245 DX
U-264	70-72 gaso.	1200 ± 10	1260 ± 25	5	57 595 D	– – – – –	45 655 DA	48 245 DX
U-264	70-72 gaso.	1600 ± 10	1780 ± 25	11	357 673 R1	– – – – –	45 655 DA	48 245 DX
U-264	70-72 gaso.	1800 ± 10	1980 ± 25	10	57 596 D	– – – – –	45 655 DA	48 245 DX
U-281	Gasoline	1800 ± 10	1980 ± 25	10	57 596 DX	– – – – –	45 655 DA	48 245 DX
T-6(61)*	Gasoline	1550 ± 10	1705 ± 25	10	357 012 R1	– – – – –	45 655 DA	363 931 R11
U-9	Gasoline	1250 ± 10	1375 ± 25	10	55 871 D	49 406 D	45 655 DA	48 245 DX
U-9	Gasoline	1300 ± 10	1430 ± 25	10	26-09-1	49 406 D	45 655 DA	48 245 DX
U-9	Gasoline	1400 ± 10	1540 ± 25	10	49 407 DA	49 406 D	45 655 DA	48 245 DX
U-9	Gasoline	1500 ± 10	1650 ± 25	10	49 407 DA	49 406 D	45 655 DA	48 245 DX

*Serial 39 766 and up.

CARBURETOR

1. DESCRIPTION

A carburetor is designed to mix fuel and air in proper proportions and to furnish the proportionate mixture to the engine under varying operating conditions. The air-fuel ratio is not constant for all loads and speeds. The carburetor must be able to supply a rich fuel for idle and low speeds; slightly leaner fuel mixtures for full load operations at full speed; and the leanest fuel mixture for part load operations at medium speeds.

Carburetors used on International four-cylinder carbureted engines are the updraft type, having the air-bleed-well method of compensation.

The principal components include the float assembly, valve and seat, fuel bowl and bowl air vent.

FLOAT SYSTEM: The function of the float system is to maintain the correct level of fuel in the fuel bowl under all operating conditions. The correct fuel level, together with proper ventilation of the fuel bowl, will supply the different systems with the correct amount of fuel necessary for good operation.

If the fuel level is too high, flooding or too rich a mixture will occur. If the fuel level is too low, the mixture will be too lean.

FUEL VALVE AND SEAT: The fuel supply line is connected to the fuel inlet. Fuel passes through the fuel valve seat into the fuel chamber. When the amount of fuel reaches a predetermined level, it causes the float to rise and push the fuel valve needle against its seat and thus stop the inflow of fuel.

OPERATION OF THE FLOAT AND VALVE: When the engine is operating, fuel flows from the bowl to the jets of the metering systems, and the fuel valve assumes a position with just enough valve opening to supply the required amount of fuel in the bowl. The valve opening at load speeds is greater than for the idling speeds because of the engine demand for a larger volume of fuel.

FUEL BOWL VENT: The bowl air vent passage is a drilling in the throttle body, connecting the bowl float chamber with a channel which surrounds the venturi. Air for the well vent, bowl vent, and idling system is taken from the channel which connects with a drilling to the carburetor main air intake. In this manner, all air taken into the carburetor passes through the air cleaner. This method not only insures clean air, but creates what is known as a "balanced" vent.

IDLE SYSTEM: The idle system controls the mixture at closed throttle positions to idle the engine and at slow speeds until the throttle is opened wide enough to allow the main metering system to function. It is independent of the other systems. This system consists of an idle discharge port located in the side of the throttle body, an idle jet to meter fuel, a vacuum passage connecting with the idle port, and an idle air adjusting needle.

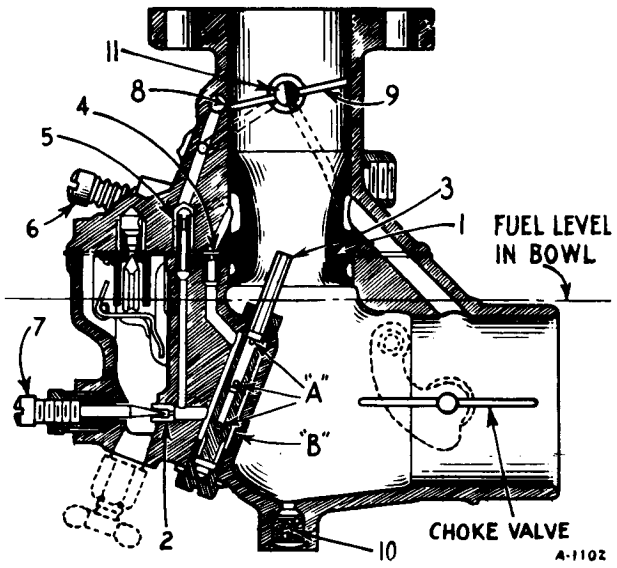


Fig. 1 - Cross Section of Carburetor.

1. Venturi.
2. Main metering needle valve seat.
3. Main discharge jet.
4. Main air bleed.
5. Idle metering jet.
6. Idle adjusting needle valve.
7. Main metering needle valve.
8. Idling slot.
9. Throttle valve plate.
10. Drip hole filler.
11. Economizer slot.

"A" Holes in the main discharge jet.
"B" Metering well.

THROTTLE OPENING FOR IDLING: At idling speeds of the engine, the throttle valve plate is slightly advanced from a completely closed position, leaving about one-half of the area of the idle discharge port in the side of the throttle body bore revealed to the suction in the engine manifold. This suction is transmitted to the idle metering jet through a passage running through the throttle body.

OPERATION OF THE IDLE SYSTEM: Fuel from the fuel bowl chamber flows through the main discharge jet into the metering well. Fuel for idling flows from this well through the idle fuel restrictions at the lower end of the well, and through the idle jet calibration.

The idle well is restricted at the bottom to control the amount of fuel delivered to the idle system and to prevent this system from being effective at higher engine speeds. As the fuel leaves the idle metering jet and enters the vacuum passage leading to the idle discharge port, it is mixed with a variable amount of air admitted from behind the venturi through the idle air passage.

RELATION OF IDLE SYSTEM TO LOAD SYSTEM: As the throttle valve plate opening is increased, more of the idle discharge port is revealed to the engine suction and more air passes the throttle valve plate. This arrangement permits the correct mixture of fuel to air to be maintained at the various throttle openings.

CARBURETOR

When the throttle valve plate is a short distance beyond the idle port, sufficient air passes the plate to start the load system functioning. As the throttle valve plate is opened wider, the idle system gradually ceases to function and less fuel is delivered to the engine by this system. The delivery of fuel through the load system increases as the throttle valve plate is advanced to wide open position.

Further movement of throttle valve plate, due to increased load, requires less fuel from the idle system to maintain an economical fuel ratio. This is accomplished on most of the carburetors by an economizer slot in the throttle shaft (11, Fig. 1) opening up an air passage from the carburetor air intake to the vacuum passage below the idle discharge port. The additional quantity of air thus added to the idle system reduces the delivery of fuel from the idle metering jet (5). With the throttle shaft and plate in the idling position as shown in Fig. 1, the economizer air passage is closed.

LOAD SYSTEM: The load system controls the air-fuel mixture from the partially opened throttle position to the full throttle, full load range of the carburetion. It consists of the venturi (1, Fig. 1), main discharge jet (3), main air bleed (4), metering well (B), main metering needle valve seat (2), and main metering needle valve (7).

As the throttle valve plate is opened past the idle position, an increasing amount of air is drawn through the venturi. The velocity of the air is speeded up at the point of smallest diameter in the venturi where the outlet of the main discharge jet is located. The effect of the venturi is to create a partial vacuum at the discharge jet, causing fuel to be discharged. The float chamber and metering well (B, Fig. 1), being vented, places normal pressure on the fuel, causing it to flow through the main metering needle valve seat (2) into the metering well (B) and out through the main discharge jet where it is delivered into the air stream.

The main metering needle valve seat is adjusted to meter the the maximum amount of fuel necessary for full load operation. When the engine is stopped or idling, the level of the fuel in the metering well (B) and main discharge jet (3) is similar to the level in the fuel bowl. As the load system goes into operation with increased load and throttle valve plate opening, the fuel is drawn from the discharge jet at a higher rate than supplied to the well by the main jet, thereby lowering the level of fuel in the metering well. As the load and throttle opening are increased further, the fuel level in the metering well drops below a series of air bleed holes (A) in the jet, admitting an increasing amount of air from the main air bleed (4). This metered addition of air to the discharge jet is necessary to compensate for the fact that the partial vacuum produced at the jet increases out of proportion with the increased velocity of air through the venturi. Were it not for the metered introduction of air into the jet to lean the mixture, the proportion of fuel to air would steadily increase with the throttle opening, producing an extremely rich mixture at full throttle opening.

A small additional amount of fuel is necessary to insure rapid response from the engine upon acceleration. When the throttle is suddenly opened, the resulting rush of air through the venturi picks up this extra fuel which remains above the jet in the metering well at part throttle operation.

The carburetor fuel bowl, as used on the high compression gasoline engine, has an additional air bleed opening, the well-reload bleed (12, Fig. 2). With this arrangement, the metering well (B, Fig. 1) will be reloaded with fuel more rapidly for acceleration purposes to care for rapid fluctuation of engine load.

CHOKE SYSTEM: The choke system consists of a manually operated choke valve plate mounted in the carburetor main air intake. The choke valve plate is used to restrict the air entering the carburetor and to increase the suction on the fuel discharge openings when starting the engine.

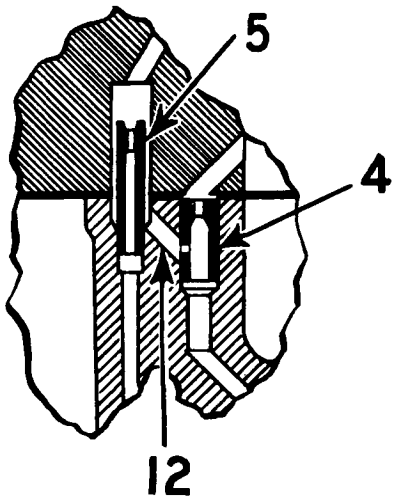


Fig. 2 - Gasoline Carburetor Well-Reload Bleed Construction.

Under cold conditions of air, manifold, and cylinder combustion chambers, it is necessary to supply a very rich starting mixture. Only the "light ends" or more volatile portions of the fuel can be vaporized because of the temperature and slow movement of air past the discharge nozzle (caused by low cranking speeds). The necessary large quantity of fuel is supplied by closing the choke valve during the cranking period. As the engine fires and cranking speed increases the rich mixture must be reduced rapidly by opening the choke valve plate sufficiently to keep the engine running.

An opening is provided in the bottom of the main air intake to drain off any excess fuel which may return from the manifold. This opening is protected against the entry of dust by a drip hole filler (10, Fig. 1).

2. REMOVAL

Before removing the carburetor from the engine for inspection or repair, clean the area and various connecting points to prevent entry of dirt into those parts which remain with the engine. Failure to perform this simple operation may result in an ultimate condition much worse than that which made the carburetor removal necessary.

1. Shut off the fuel supply.
2. Drain the carburetor.
3. Disconnect the choke and governor linkage.
4. Disconnect the fuel line.

5. Remove the air cleaner connections to the carburetor.

6. Remove the nuts and lock washers which secure the carburetor to the manifold, and lift off the complete carburetor (Fig. 3).

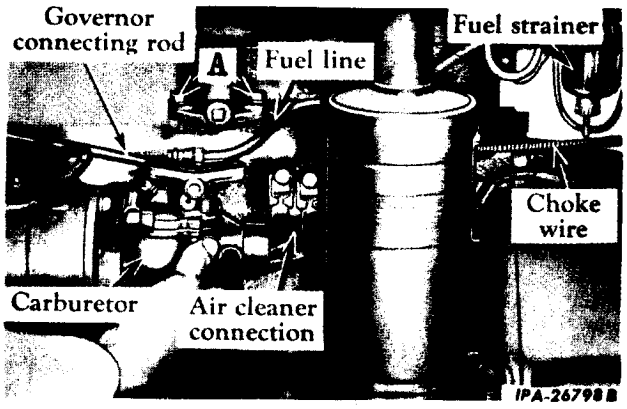


Fig. 3 - Removing the Carburetor (Zenith - 68 x 7-7/8").

3. DISASSEMBLY

IH 3/4" for C - 60 Series

(Reference Numbers Refer to Fig. 4.)

Before disassembling, the outside surfaces of the carburetor should be cleaned of dirt and grease so the solvent used to clean the dismantled parts will not become contaminated.

1. Remove the idle adjusting needle valve (22) and spring (23) from the throttle body.

2. Remove the main metering jet (28) and gasket (27) from the fuel bowl (26).

3. Remove the square head drain plug.

4. Remove the four slotted screws and washers, and separate the fuel bowl (26) from the throttle body (6). The gasket (7) should be replaced when reassembling the carburetor.

5. Remove the float lever pivot (11) from the float (24) and remove the float.

6. Remove the needle valve, cage and gasket (9).

7. Remove the discharge nozzle (12) using a hollow socket wrench. Remove the gasket (25).

8. Hold the throttle in the closed position and remove the valve plate (4) screws and lock washers. Remove the throttle shaft and lever (2). Carefully pry out the dust seal retainer (19) and seal (20).

9. Remove the idle tube (10).

10. Before removing the choke valve parts, the fuel bowl casting and the choke valve lever should be match-marked with a file or scribe to indicate the side on which the lever is located; also, to avoid confusion at reassembly, the position of the relief valve in the choke valve plate in relation to the air intake should be noted.

11. Hold the choke valve plate in the closed position, and remove the choke valve plate screws and washers.

12. Remove the choke valve plate (18).

NOTE: *Do not remove the relief valve from the choke valve plate; the two are serviced as a unit.*

13. Remove the choke valve shaft (29) with lever. The seal retainer (13) and dust seal (14) can now be removed as in Step 8.

Zenith Model 68 x 7, 67 x 7, 161 x 7 and 267 x 9 Up draft Carburetor (Reference Numbers Refer to Fig. 5)

Before disassembling, the outside surfaces of the carburetor should be cleaned of dirt and grease so the solvent used to clean the dismantled parts will not become contaminated.

1. Remove the idling adjusting needle valve (3) and spring (4) from the throttle body.

2. Remove the main jet passage lower plug (18), or main jet adjustment needle valve as the case may be, and fiber washer (19) from the fuel bowl.

3. Remove the main jet (20) and fiber washer (21), using a pronged carburetor socket or a wide-blade screwdriver so the jet will not be damaged.

4. Remove the bowl drain cock or drain plug (22).

5. Remove the fuel screen and elbow fitting (2).

6. Remove the four bowl-to-body screws (17) and lock washers.

7. Lift the throttle body (5) and gasket (36) clear of the bowl (16), being careful to avoid damaging the float (35).

8. Remove the float axle (14), using a screwdriver to push the axle from the slotted end of the float hinge bracket.

9. Remove the float (35) and the fuel valve (part of item 13).

10. Remove the venturi (39).

11. With a pronged carburetor socket or wideblade screwdriver, remove the fuel valve seat (13) and fiber washer (12).

12. Using a small screwdriver, remove the idling jet (40).

13. Hold the throttle in the closed position, and remove throttle valve plate screws (37), lock washers and the throttle valve plate (38).

CARBURETOR

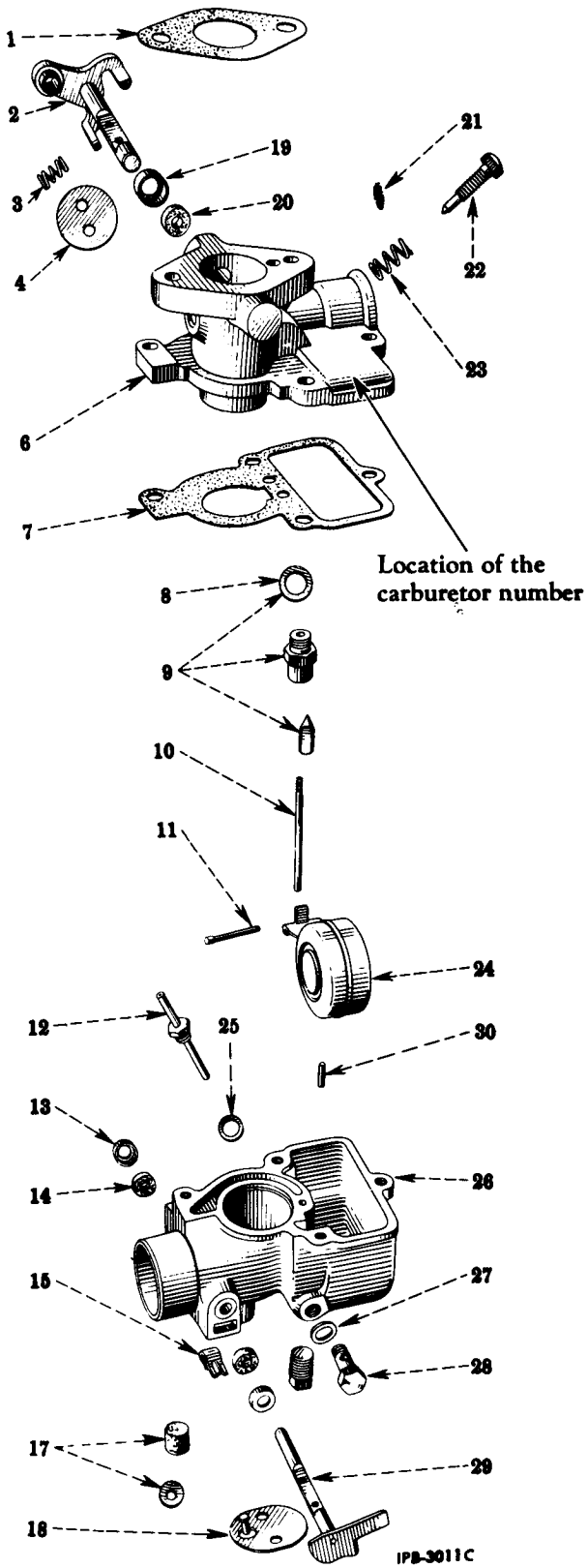


Fig. 4 - Exploded View of International 3/4 in. Carburetor.

Legend for Fig. 4

1. Gasket.
2. Throttle shaft w/lever.
3. Retainer spring.
4. Throttle valve plate.
6. Throttle body assembly.
7. Bowl gasket.
8. Needle valve cage gasket.
9. Needle valve.
10. Idle tube.
11. Float lever pivot.
12. Discharge nozzle.
13. Seal retainer.
14. Dust seal.
15. Lever friction spring.
17. Filler and plug.
18. Choke valve plate.
19. Dust seal retainer.
20. Dust seal.
21. Strainer screen.
22. Idle adjusting needle valve.
23. Retainer spring.
24. Float w/lever.
25. Discharge nozzle gasket.
26. Fuel bowl assembly.
27. Metering jet gasket.
28. Metering jet.
29. Choke valve shaft.
30. Main air bleed.

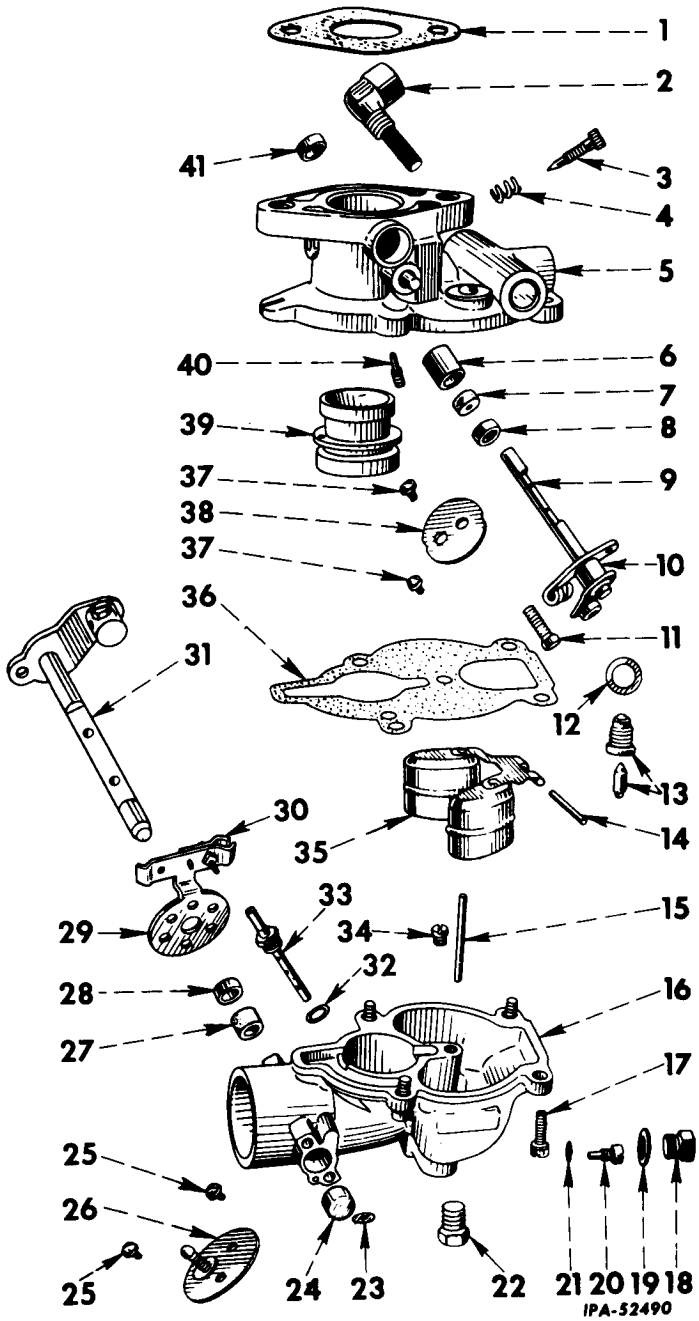


Fig. 5 - Exploded View of Zenith 68 x 7 - 7/8" Updraft Carburetor (67 x 7, 161 x 7 and 267 x 9 similar).

Legend for Fig. 5

1. Gasket.
2. Elbow and strainer assembly.
3. Idle adjusting needle valve.
4. Needle valve spring.
5. Throttle body assembly.
6. Throttle shaft bushing.
7. Shaft seal.
8. Shaft seal retainer.
9. Throttle shaft and lever.
10. Taper pin.
11. Throttle stop screw.
12. Fuel valve washer.
13. Fuel valve and seat.
14. Float axle.
15. Idle filter tube.
16. Bowl assembly.
17. Screw.
18. Plug.
19. Washer.
20. Main jet.
21. Washer.
22. Drain plug.
23. Drip plug.
24. Choke shaft hole plug.
25. Screw.
26. Choke valve plate assembly.
27. Packing washer.
28. Washer retainer.
29. Choke valve bracket.
30. Bracket clamp.
31. Lever and shaft.
32. Discharge jet fiber washer.
33. Main discharge jet.
34. Well vent jet.
35. Float assembly.
36. Gasket (bowl to body).
37. Throttle valve plate screws.
38. Throttle valve plate.
39. Venturi.
40. Idling jet.
41. Throttle shaft hole plug.

14. Remove the throttle shaft with lever (9) and the lever spacer.

15. Use a screwdriver to pry and remove the throttle shaft packing retainer (8) and washer (7). The throttle shaft bushing (6) need not be removed unless damaged or excessively worn.

16. Do not remove the shaft hole plug (41), priming hole plug or channel plug. (These items are part of throttle body (5).)

17. Remove the well vent (34) from the upper surface of the fuel bowl.

18. Remove the main discharge jet (33) and fiber washer (32).

19. Before removing the choke valve parts, the fuel bowl casting and the choke valve lever should be match-marked with a file or scribe to indicate the side on which the lever is located; also, to avoid confusion at reassembly, the position of the relief valve in the choke valve plate in relation to the air intake should be noted.

CARBURETOR

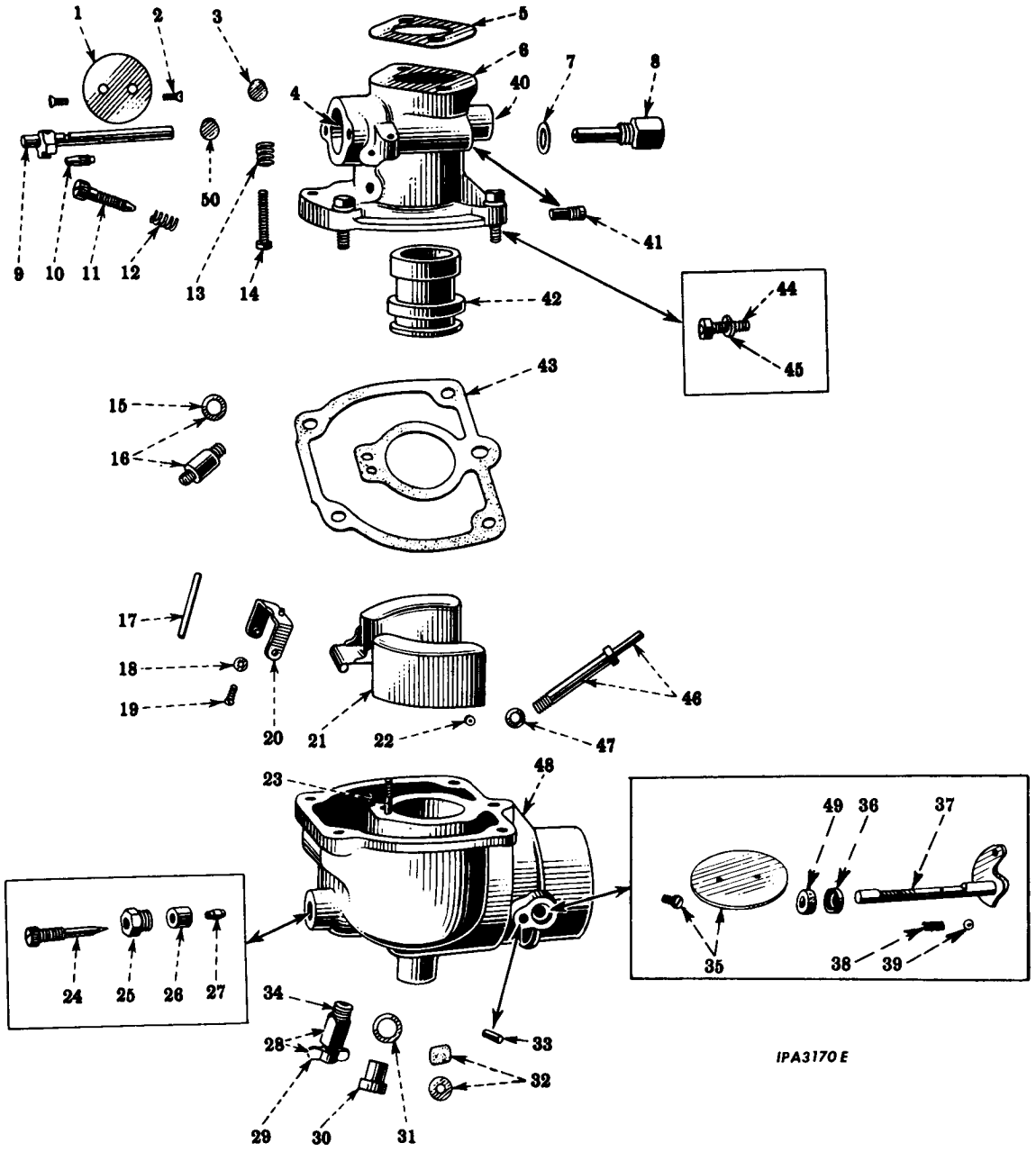


Fig. 6 - Exploded View of International Model E-12, 1-1/4" Updraft and E-13, 1-3/8" Updraft Carburetors.

1. Throttle valve plate.
2. Valve plate screws.
3. Expansion plug.
4. Throttle shaft bushing.
5. Gasket.
6. Throttle body assembly.
7. Gasket.
8. Retainer w/screen.
9. Throttle shaft.
10. Throttle stop pin.
11. Idle adjusting needle valve.
12. Needle valve spring.
13. Stop screw spring.
14. Screw.
15. Seat gasket.
16. Fuel valve and seat.
17. Float lever axle.
18. Screw.
19. Washer.
20. Float lever axle support.
21. Float w/lever.
22. Main air bleed.
23. Idle metering jet.
24. Needle valve.
25. Packing nut.
26. Needle valve packing.
27. Needle valve seat.
28. Drain cock.
29. Drain cock body.
30. Metering nozzle clamp nut.
31. Clamp nut gasket.
32. Drip hole filler.
33. Groove pin.
34. Drain cock stem.
35. Starting shutter.
36. Dust seal retainer.
37. Shaft and lever.
38. Friction spring.
39. Friction spring ball.
40. Throttle shaft bushing.
41. Idle outlet plug.
42. Venturi.
43. Bowl gasket.
44. Screw.
45. Washer.
46. Metering nozzle.
47. Metering nozzle gasket
48. Fuel bowl assembly.
49. Dust seal.
50. Expansion plug.

20. Hold the choke valve plate in the closed position, and remove the choke valve plate screws (25) and lock washers.

21. Remove the choke valve plate (26).

NOTE: *Do not remove the relief valve from the choke valve plate; they should be serviced as a unit.*

22. Remove the choke valve shaft with lever (31) and choke valve bracket (29) and clamp (30).

23. Remove the shaft packing washers (27) and retainers (28) from both sides of the air intake. Use a screwdriver to pry out the retainers.

24. Do not remove the drip plug (23) or choke shaft hole plug (24).

IH Models E-12, 1-1/4"; E-13, 1-3/8" and D-10, 1" Updraft Carburetors. (Reference Numbers Refer to Fig. 6)

NOTE: *The carburetor used on the 175 series is very similar and procedures for disassembly and reassembly can be used as for the Model E-12 carburetor.*

Before disassembling, the outside surfaces of the carburetor should be cleaned of dirt and grease so the solvent used to clean the dismantled parts will not be contaminated.

1. Separate the throttle body (6) from the fuel bowl (48) by removing screws (44) and lock washers (45).

2. Slide the float axle (17) from the float axle support (20). Remove the float (21).

3. Remove the fuel valve (part of 16) (Fig. 7). Remove the fuel valve seat (16) and gasket (43).

4. Remove the float axle support by removing screws (19).

5. Remove the venturi (42) and gasket (43).

6. Remove the fuel valve (16) and gasket (15) from the throttle body.

7. Remove the idle adjusting needle valve (11) and spring (12).

8. Remove the retainer with screen (8) and gasket (7).

9. Remove the screws (2) from the throttle valve plate (1), and remove the plate from the slot in the throttle shaft (9). Remove the throttle shaft (9).

10. Remove the idle metering jet (23) from the fuel bowl (48).

11. Hold the hexagonal head on the main discharge jet (46), and turn off the clamp nut (30) and gasket (31). Remove the discharge jet (46) and gasket (47).

12. Run out the packing nut (25), and remove the packing (26). The seat (27) is pressed in the fuel bowl (48). The main metering needle valve (24) comes out with the packing nut (25).

13. Remove the screws securing the choke valve plate (35) to the choke valve shaft (37). The spring (38) and ball (39) will be freed. Remove the dust seal (49) and retainer (36).

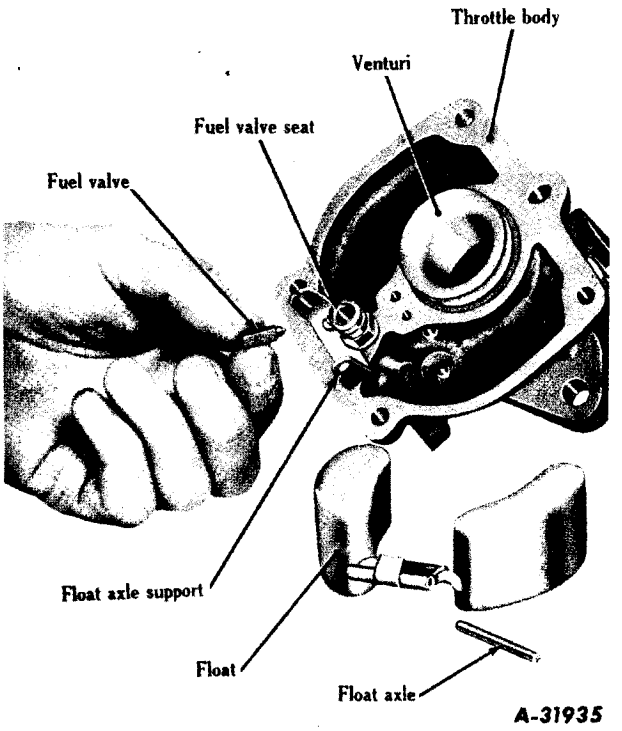


Fig. 7 - Float Assembly and Fuel Valve Removed (IH Model E-12 and E-13 Carburetor)

NOTE: *The IH D-10, one inch updraft carburetor for the U-4 carbureted engine is shown in Fig. 8. Disassembly is similar to the E-12 but the reference numbers are different. Use for reference only.*

Marvel Schebler Model TSX

(Reference Numbers Refer to Fig. 9)

Before disassembling, the outside surfaces of the carburetor should be cleaned of dirt and grease so the solvent used to clean the dismantled parts will not be contaminated.

1. ON DISTILLATE OR KEROSENE CARBURETOR ONLY: Remove the main jet adjusting needle valve (1), spring (2), washer and gasket (3 and 4).

2. Separate the bowl and throttle body castings by removing the four body-to-bowl screws (28).

3. Remove the float axle (10).

4. Remove the float (11) and fuel valve needle (part of item 9).

5. Remove the fuel valve (9) and washer (8).

CARBURETOR

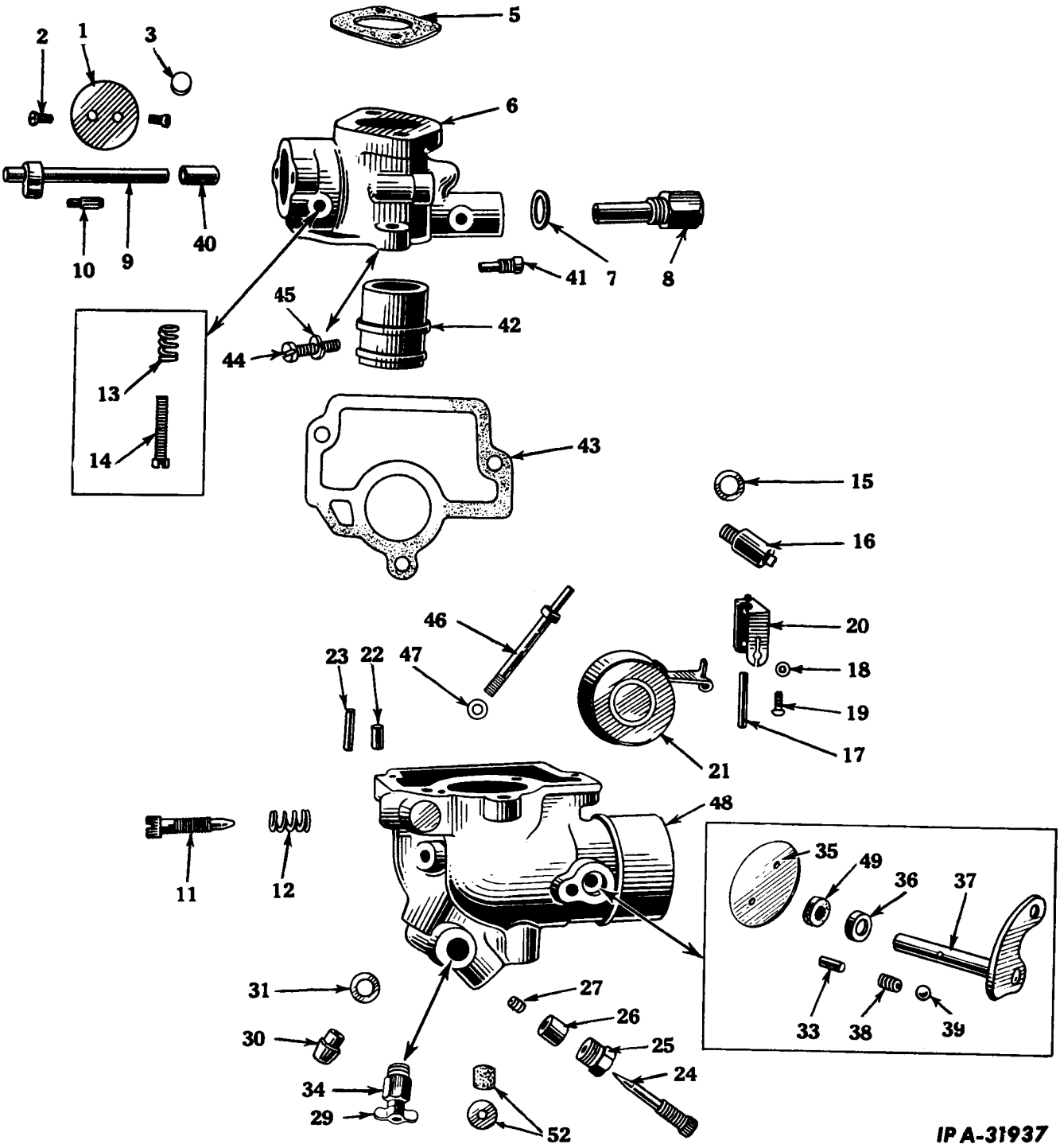


Fig. 8 - Exploded View of IH Model D-10 (1-Inch Updraft) Carburetor.

Legend for Fig. 8

1. Throttle valve plate.
2. Screw.
3. Expansion plug.
5. Gasket.
6. Throttle body.
7. Gasket.
8. Retainer with screen.
9. Throttle shaft.
10. Throttle stop pin.
11. Idle adjusting needle valve.
12. Spring.
13. Throttle stop screw spring.
14. Throttle stop screw.
15. Fuel valve seat gasket.
16. Fuel valve and seat.
17. Float axle.
18. Lock washer.
19. Screw.
20. Float axle support.
21. Float.
22. Main air bleed.
23. Idle metering jet.
24. Main metering needle valve.
25. Packing nut.
26. Packing.
27. Seat.
29. Drain cock body.
30. Main discharge jet clamp nut.
31. Gasket.
33. Groove pin.
34. Drain cock stem.
35. Choke valve plate.
36. Retainer.
37. Choke valve shaft and lever.
38. Choke valve lever friction spring.
39. Friction spring ball.
40. Throttle shaft bushing.
41. Idle outlet plug.
42. Venturi.
43. Fuel bowl gasket.
44. Body-to-bowl screw.
45. Lock washer.
46. Main discharge jet.
47. Gasket.
48. Fuel bowl.
49. Choke valve dust seal.
52. Drip hole filler and plug.

CARBURETOR

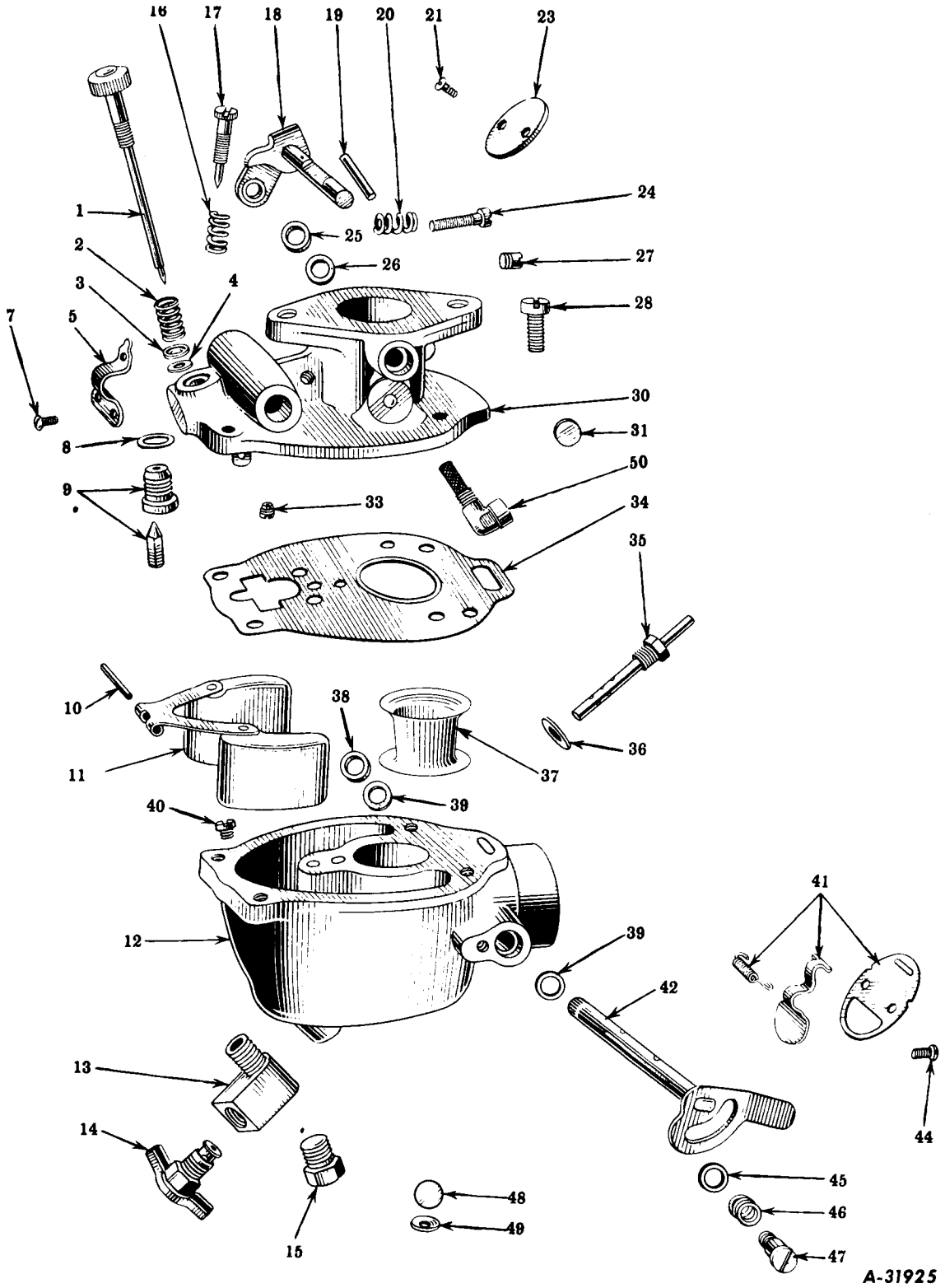


Fig. 9 - Exploded View of Marvel Schebler Carburetor.

Legend for Fig. 9

1. Main jet adjustment needle valve (distillate or kerosene).
2. Main jet adjustment spring (distillate or kerosene).
3. Washer (distillate or kerosene).
4. Gasket (distillate or kerosene).
5. Main jet adjustment ratchet (distillate or kerosene).
7. Main jet adjustment ratchet screw (distillate or kerosene).
8. Fuel valve washer.
9. Fuel valve.
10. Float axle.
11. Float.
12. Fuel bowl.
13. Drain cock elbow (distillate or kerosene).
14. Drain cock (distillate or kerosene).
15. Drain plug (gasoline).
16. Idle adjusting needle valve spring.
17. Idle adjusting needle valve.
18. Throttle shaft.
19. Throttle stop pin.
20. Throttle stop screw spring.
21. Throttle valve plate screw.
23. Throttle valve plate.
24. Throttle stop screw.
25. Throttle shaft packing retainer.
26. Throttle shaft packing washer.
27. Idle drilling screw.
28. Body-to-bowl screw.
30. Throttle body.
31. Throttle shaft hole plug.
33. Idling jet.
34. Body-to-bowl gasket.
35. Main discharge jet.
36. Washer.
37. Venturi.
38. Choke valve shaft packing retainer.
39. Choke valve shaft packing washer.
40. Main jet (gasoline).
41. Choke valve plate.
42. Choke valve shaft with lever.
44. Choke valve plate screw.
45. Washer.
46. Choke valve shaft stop screw spring.
47. Choke valve shaft stop screw.
48. Drip plug felt.
49. Drip plug.
50. Elbow with strainer.

6. Lift out the venturi (37) and body-to-bowl gasket (34).

7. Remove the idle jet (33).

8. Remove the idle adjusting needle valve (17) and spring (16).

9. Remove the fuel inlet elbow with strainer (50).

10. Hold the throttle in the closed position. Remove the throttle valve plate screws (21), and throttle valve plate (23).

11. Remove the throttle shaft (18).

12. Remove the throttle shaft packing washer (26) and retainer (25).

13. Remove idle drilling screw (27).

14. Remove the discharge jet (35).

15. ON THE GASOLINE CARBURETOR ONLY: Remove the main jet (40). On the kerosene or distillate carburetor, the main jet is pressed in place and is not a serviceable part. Do not remove.

16. Remove the bowl drain cock (14) and elbow (13) on the distillate or kerosene carburetor, or plug (15) on the gasoline carburetor.

17. Do not remove the drip plug felt (48) and drip plug (49) unless the filter is too badly clogged to clean with compressed air.

18. Remove choke valve (41) and screws (44).

19. Remove the choke valve shaft stop screw (47), spring (46), and washer (45). Remove choke shaft and lever (42).

20. Remove the choke valve shaft packing retainer (38) and packing washers (39).

Carter Model UT

(Reference Numbers Refer to Fig. 10)

1. Separate the throttle body (35) and fuel bowl (24) by removing the four screws (23, Fig. 11).

2. Remove the venturi (6) and the main metering jet (26) with gasket (25) on gasoline carburetors, or the main jet adjustment needle valve (21) and gasket (20) on distillate or kerosene carburetors.

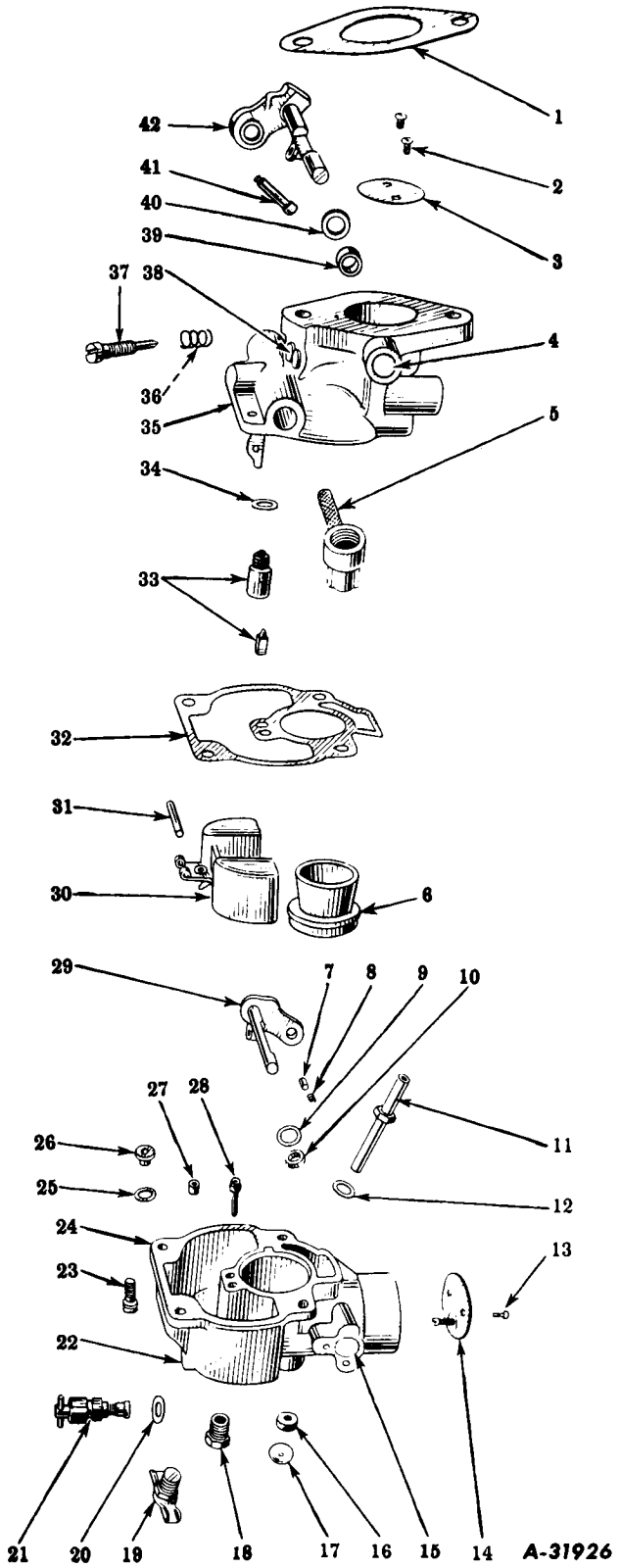
3. Remove nozzle bleed screw plug (27) and low speed jet (28) (Fig. 12).

4. Remove the nozzle (11) and gasket (12) (Fig. 13).

5. Remove the choke valve plate screws (13) and pull out the choke shaft (29). Remove the valve plate from the bore (Fig. 14).

6. Remove the choke lever lock pin (7) and spring (8). Pry out the washer (9) and dust seal (10). (Fig. 15).

CARBURETOR



1. Carburetor gasket.
2. Throttle valve plate screw.
3. Throttle valve plate.
4. Expansion plug.
5. Elbow with strainer.
6. Venturi.
7. Choke lever lock pin.
8. Spring.
9. Dust seal retainer washer.
10. Choke lever shaft dust seal.
11. Nozzle.
12. Gasket.
13. Choke valve plate screw.
14. Choke valve plate.
15. Expansion plug.
16. Air horn felt seal.
17. Retainer washer.
18. Drain plug (gasoline).
19. Drain cock (distillate or kerosene).
20. Gasket (distillate or kerosene).
21. Main jet adjustment needle valve (distillate or kerosene).
22. Main gas passage plug rivet (gasoline).
23. Attaching screw and washer.
24. Fuel bowl.
25. Gasket (gasoline).
26. Main metering jet (gasoline).
27. Nozzle bleed screw plug.
28. Low speed jet.
29. Choke shaft and lever.
30. Float.
31. Float lever pin.
32. Body gasket.
33. Needle valve with seat.
34. Gasket.
35. Throttle body.
36. Spring.
37. Idle adjusting needle valve.
38. Idle passage plug rivet.
39. Dust seal.
40. Washer.
41. Throttle adjusting screw.
42. Throttle shaft with lever.

Fig. 10 - Exploded View of Carter Carburetor Model UT.

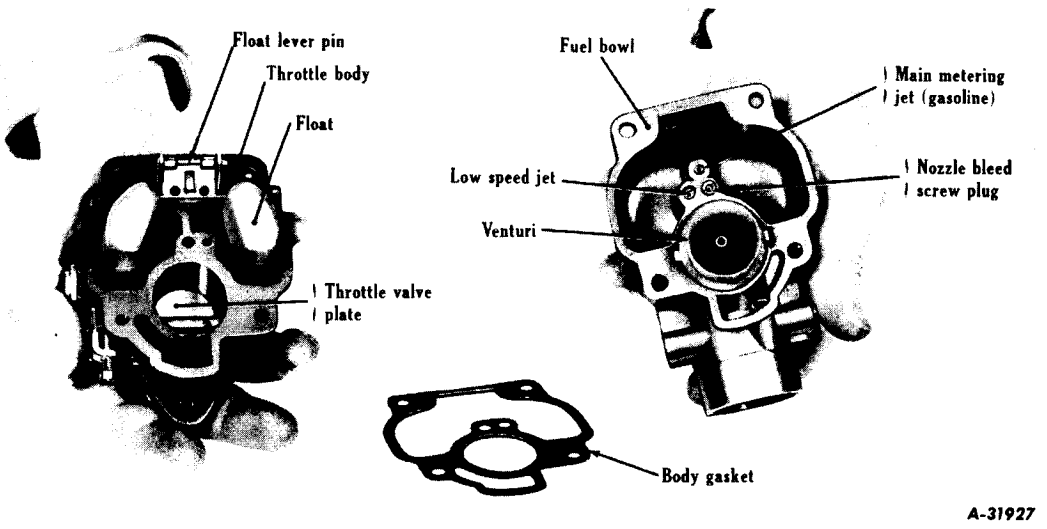


Fig. 11 - Throttle Body and Fuel Bowl (Carter Model UT).

7. Push out the float lever pin (31) and remove the floats (30) and needle valve (part of 33). Remove the valve seat (33) and gasket (34). (Fig. 16).

8. Remove the throttle valve plate screws (2), and pull out the throttle shaft (42). Remove the valve plate from the bore.

9. Pry out the washer (40) and dust seal (39).

10. Remove the idle adjusting needle valve (37) and spring (36) (Fig. 17).

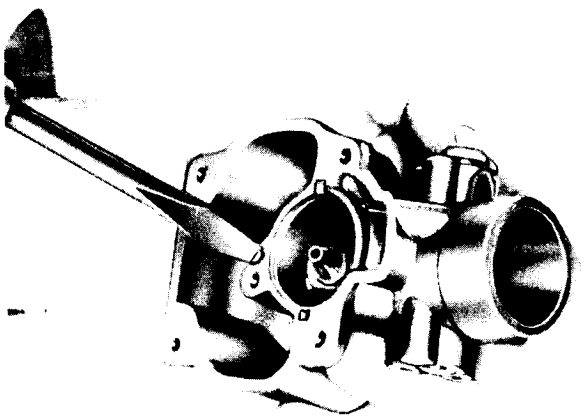


Fig. 12 - Removing Nozzle Bleed Screw Plug (Carter Model UT).

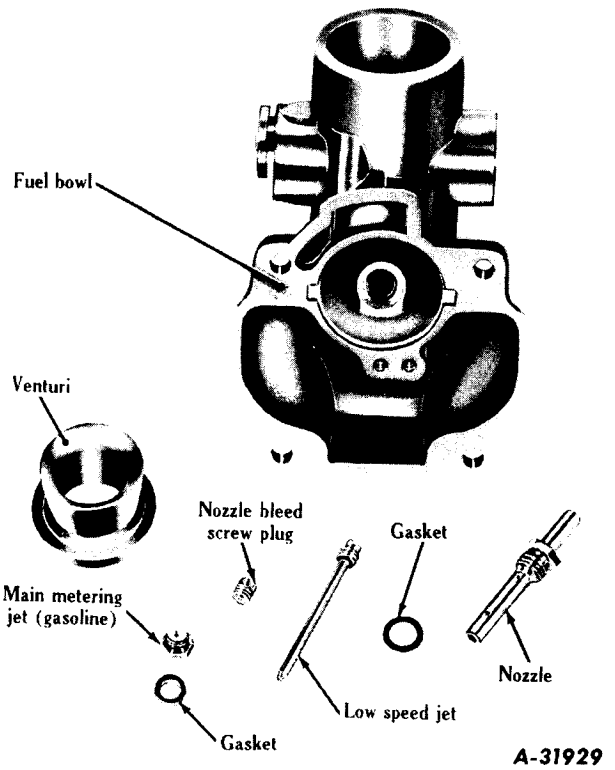


Fig. 13 - Nozzle, Jets, Venture and Plug Removal from Fuel Bowl (Carter Model UT).

CARBURETOR

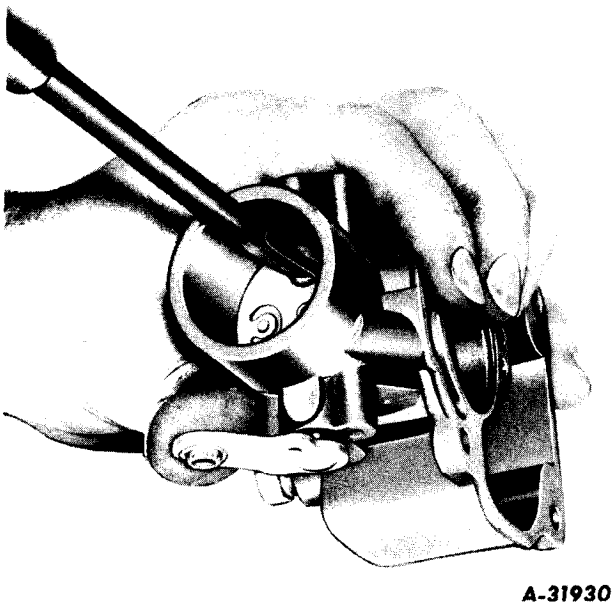


Fig. 14 - Removing Choke Valve Plate (Carter Model UT).

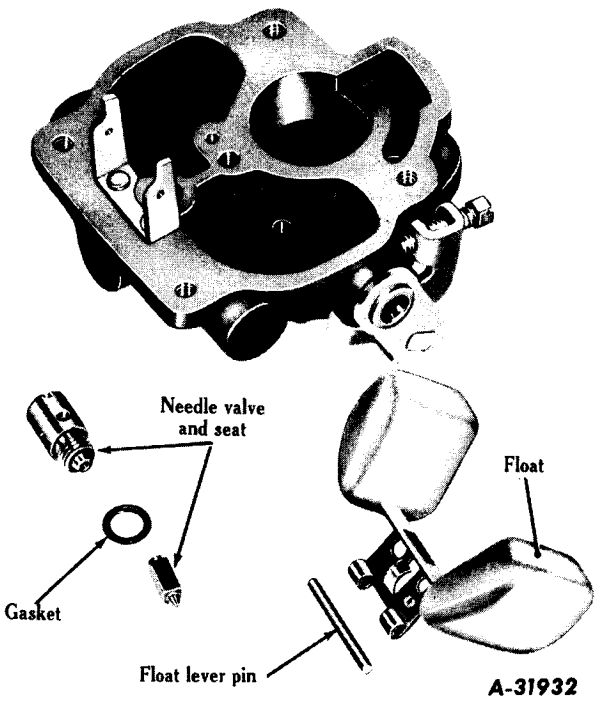


Fig. 16 - Float, Needle Valve and Seat Removed (Carter Model UT).

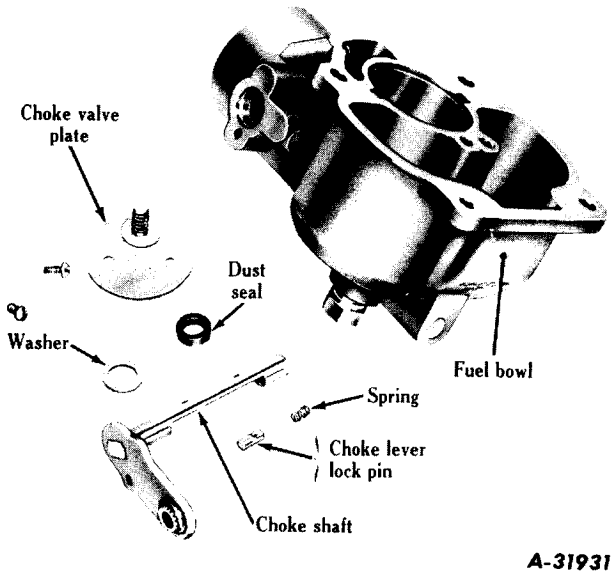


Fig. 15 - Choke Assembly Removed (Carter Model UT).

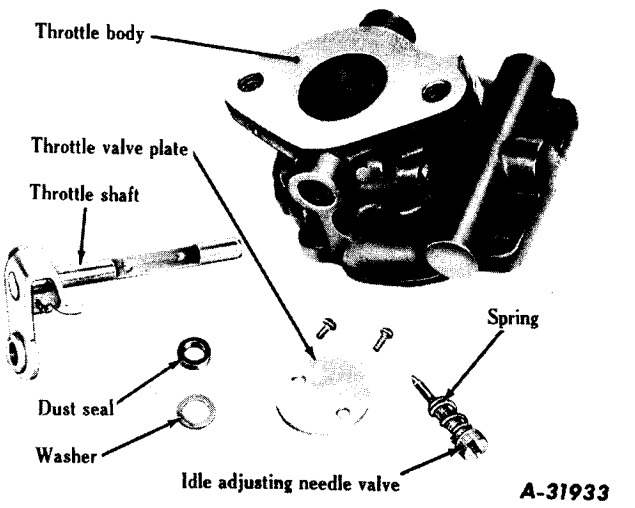


Fig. 17 - Throttle Assembly and Idle Adjusting Needle Valve Removed (Carter Model UT).

4. INSPECTION AND REPAIR

Clean all metal parts in a good commercial gum solvent, a half-and-half alcohol and benzol solution or pure acetone.

Gum or varnish-like coating from evaporated fuel is often found inside the carburetor. Such coatings restrict the flow of fuel through the jets and passages and must be removed to restore satisfactory operation.

After the gum has been dissolved, rinse the parts in cleaning fluid and blow through each channel and jet opening (both directions) with compressed air to be sure that the channels are clear.

NOTE: *Never use a wire or drill to clean out the calibrated openings in jets.*

Inspect parts of the carburetor as follows:

1. MAIN CASTINGS: Examine for damaged or broken flange or badly worn shaft openings. Replace if necessary.

2. FLOAT: Replace the float if leaking or damaged.

3. FLOAT AXLE: Replace if wear can be detected on the bearing surfaces.

4. FUEL VALVE AND SEAT: Replace the fuel valve and seat if one or both show wear and cause improper fuel level.

5. IDLE ADJUSTING NEEDLE VALVE: The point of the valve must be smooth and free from ridges.

6. MAIN JET ADJUSTING NEEDLE VALVE: The point of the valve must be smooth and free from ridges.

7. THROTTLE VALVE PLATE: Inspect the plate for burrs, bends, or damaged edges. Never clean the throttle plate with a buffing wheel or a sharp instrument.

8. CHOKE VALVE PLATE: Inspect the plate for bends, burrs, or damaged relief valve.

9. SHAFT: Inspect both throttle and choke shafts for wear on bearing surfaces. Check shafts for straightness.

10. GASKETS: Replace all gaskets and fiber washers each time a carburetor is dismantled. Be sure that all gasket surfaces are square and smooth to insure a good seal.

11. SHAFT PACKINGS: Replace packing washers and retainers to insure against entrance of dust into the engine at these points.

12. VENTURI AND JETS: Replace if damaged, particularly if the calibrated openings appear to have been damaged by probing in previous cleaning operations.

5. REASSEMBLY

IH 3/4 - inch Updraft
(Reference Numbers Refer to Fig. 4)

1. Install the idle adjusting needle valve (22) and retainer spring (23).

2. Install the dust seal (20) and retainer (19). The retainer may be pressed in on a press or tapped in place with a light hammer.

3. Install the throttle valve shaft (2) and throttle valve plate (4). Be sure that the idle adjusting needle valve is backed out to permit the throttle valve plate to close in the bore. The valve plate must fit the bore closely with a minimum of light showing between the bore and the valve plate. After the valve plate is located and the screws tightened, clinch over the exposed ends of throttle valve plate screws.

4. Install the needle valve and cage (9) and gasket (8). NEVER USE AN OLD VALVE IN A NEW CAGE OR A NEW VALVE IN AN OLD CAGE.

5. Install float (24) and float lever pivot (11). Turn the throttle body upside down and measure the distance from the bottom of the float (now the top of the float) to the gasket surface of the throttle body. If the measurement is not between the limits as shown in Fig. 18, the location of the float may be changed by bending the lever, while holding it with a pair of pliers, at the point marked "A." When bending the lever, be sure to apply pressure on the lever itself and not on the thin wall of the float.

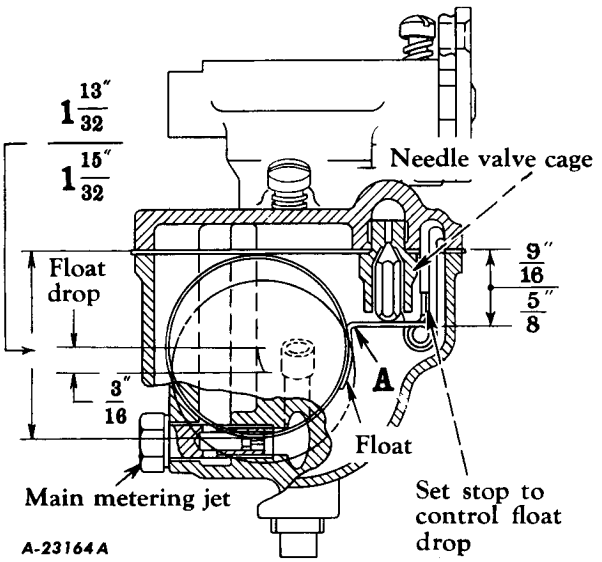


Fig. 18 - Float Height and Fuel Level Measurement of IH 3/4 - inch Updraft Carburetor.

6. Install idle tube (10). Care should be used in installing the idle tube to be sure that it is screwed in tightly but is not turned in so far that it interferes with the idle adjusting needle valve.

7. Install strainer screen (21) by pressing it in place with a piece of 5/16-inch OD tube.

8. Install choke valve shaft dust seal retainers (13), seals (14) and friction spring (15).

9. Install choke valve shaft (29) and choke valve plate (18). Locate the plate in the bore with the same care used in locating the throttle valvle plate. After assembly, clinch over the choke valve plate screws to prevent them from loosening.

10. Install the drip hole filler and plug (17) if they were removed during disassembly. Stake the fuel bowl metal over the plug with a center punch. Do not try to expand the plug.

11. Install the main metering jet (28), gasket (27), discharge nozzle (12) and gasket (25).

12. Position the fuel bowl gasket (7) on the fuel bowl. Assemble the two carburetor halves with screws and lock washers.

13. Set the idle adjusting needle valve about one and one half turns off the seat. Set the throttle stop screw to open the throttle about one turn of the screw.

14. Check the body-to-bowl screws after the engine has been in operation a few hours.

Zenith Model 68 x 7, 67 x 7, 161 x 7 and 267 x 9 Updraft Carburetor

(Reference Numbers Refer to Fig. 5.)

1. Install the choke valve shaft packing washers (27) and retainers (28).

2. Refer to match-marks on the lever and the body (Step 19 of "DISASSEMBLY") and install the choke valve shaft and lever assembly (31).

3. Hold the lever in the closed position. Place the choke valve plate (26) in position with valve down and the valve stem and spring toward the open end of the air intake.

4. Install the choke valve plate screws (25) and lock washers into the shaft. Be sure that the choke valve plate is properly centered and the screws securely tightened. Check the operation of the choke valve plate. It should open and close freely.

5. Install the main discharge jet (33) and new fiber washer (32).

6. Install the well vent jet (34) in the upper surface of the fuel bowl.

7. Install the throttle shaft packing washer (7) and retainer (8).

8. Place the lever spacer on the throttle shaft.

9. Install the throttle shaft and lever assembly (9).

NOTE: *Be sure that the throttle stop screw (11) is unscrewed until it is flush with the lever so it cannot prevent complete closing of the throttle valve plate.*

10. Hold the throttle lever in the closed position and install the throttle vavle plate (38).

NOTE: *The beveled edges of the plate will fit snugly against the body when the plate is properly centered.*

11. When the throttle valve plate has been properly centered and the screws (37) and lock washers tightened, hold the throttle closed and screw in (clockwise) on the stop screw (11) until it just touches the stop pin. Then turn the stop screw 1-1/2 turns more to hold the throttle slightly open as preliminary adjustment.

12. Install the idling jet (4).

13. Install a new fuel valve seat (13) with valve and new fiber washer (12).

14. Place a new bowl-to-body gasket (36) in position on the throttle body. Be sure that the holes in the gasket coincide with the channels in the casting.

15. Install the venturi (39), inserting the end with the thin edge through the gasket into the throttle barrel. Be sure that the venturi is far enough down for its flange to rest on the gasket.

16. Place the fuel valve (13) in the seat.

NOTE: *NEVER USE AN OLD VALVE IN THE NEW SEAT, OR A NEW VALVE IN AN OLD SEAT.*

17. Hold the float (35) in position. Insert the tapered end of the float axle (14) into the float bracket (on side opposite the slot) and push it through to the slot. Use a screwdriver handle to push or tap the axle into the slotted side of the bracket.

NOTE: *The axle should be centered so it extends on both sides. The float should move freely on the axle with a minimum of sideplay.*

18. With the throttle body in an inverted position and viewed from the free end of the float, the float body should be centered and at right angles to the throttle body.

With the throttle body in the inverted position, set the float level (Fig. 19). The float setting is measured from the bowl-to-body gasket surface to the highest point on the float bodies (Fig. 19).

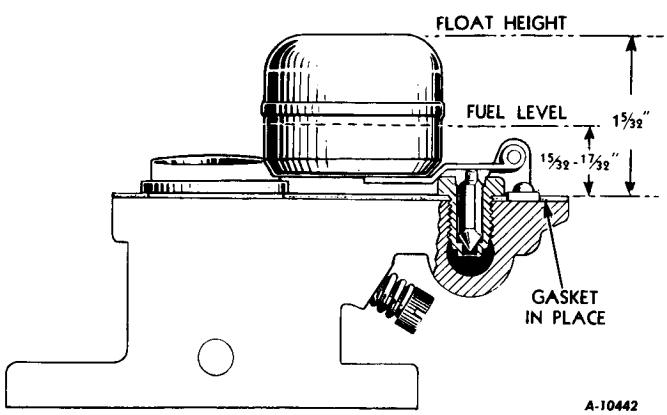


Fig. 19 - Dimensions for Measuring Fuel Level and Position of Float of Zenith Carburetor.

To increase or decrease the distance between the float body and the gasket surface, use longnosed pliers to bend the float hinge close to the float body.

Do not bend, twist or apply pressure to the float bodies.

19. Place the fuel bowl (16) in position on the throttle body (5), being careful to avoid damaging the float.

20. Install the four bowl-to-body cap screws (17) and lock washers. These should be rechecked after the engine has been in operation a few hours.

21. Install the fuel screen and elbow fitting (2).

22. Install the drain cock or plug (22).

23. Install the main jet (20) and new fiber washer (21).

24. Install the main jet passage plug (18), or main jet adjustment needle valve as the case may be, and a new fiber washer (19).

NOTE: *If a main jet adjustment needle valve is used, turn the needle valve in (clockwise) until it seats, then unscrew it 1-1/2 full turns as a preliminary adjustment.*

25. Install the idling adjusting needle valve (3) and spring (4).

NOTE: *As a preliminary adjustment, set the idling adjusting needle valve at one full turn off the seat.*

IH Models E-12, 1-1/4"; E-13, 1-3/8" and D-10, 1" Updraft Carburetors.

(Reference Numbers Refer to Fig. 6)

1. Install the throttle shaft (9). Attach the throttle valve plate (1) to the shaft.

2. Install the needle valve spring (12) and idle adjusting needle valve (11).

3. Install the retainer with screen (8) and gasket (7).

4. Install the fuel valve (16) and gasket (15).

5. Secure the float axle support (20) with screws (19) and lock washers (18). Insert the float axle (17) through the float (21) and support (20).

6. The float (21) should now be checked for level. Invert the throttle body (6). The bottom of the float should be set as shown in Fig. 20.

7. Place the venturi (42) in the throttle body (6).

8. Insert the packing (26), packing nut (25), and the main metering needle valve (24). Unscrew the needle valve (24) several turns before tightening the packing nut (25). This will prevent possible damage to the seat (27). The main metering needle valve (24) should be hard to turn in the packing.

9. Install the idle metering jet (23).

10. Screw the choke valve shaft (37) in position with the choke valve plate (35). In doing so, be sure that the friction ball (39) and spring (38) are in position over the grooved pin (33). The choke valve plate (35) will fit only one way. In the closed position, it must entirely shut off the flow of air into the carburetor. Upset the threaded ends of the choke valve plate screws to prevent the plate from loosening.

11. Install gasket (43), and secure the throttle body (6) to the fuel bowl (48).

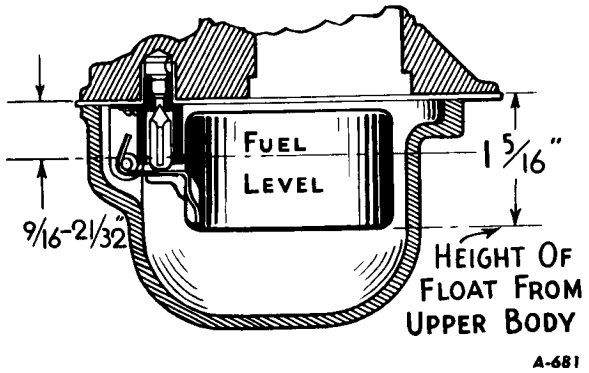


Fig. 20 - Float Height and Fuel Level Measurements for the IH Model E-12 Carburetors.

Marvel Schebler Model TSX

(Reference Numbers Refer to Fig. 9)

1. Insert the choke valve shaft packing washer (39) and retainer (38).

2. Install the choke valve shaft and lever (42), screw (47), spring (46), and washer (45).

3. Install the choke valve plate (41), valve opening side of plate first, valve and spring up, into the shaft. Center the valve in the air inlet bore by moving the choke lever to closed position. While held firmly in this position, install screws (44). There should be no binding in the movement of the choke valve plate.

4. On gasoline carburetors, install the main jet (40).

5. Install the main discharge jet (35) and washer (36).

6. Install the bowl drain plug (15), or drain cock (14) and elbow (13).

7. Install the idle drilling screw (27) and idling jet (33).

8. Install the throttle shaft packing washer (26), retainer (25), and throttle shaft (18).

9. Assemble the throttle valve plate (23) on shaft (18) with screws (21). Before tightening the screws, center the valve plate by tightly closing the throttle. Be sure that the throttle stop screw (24) is backed out to allow the valve plate to seat firmly in the bore. Tighten screws (21) and check throttle for free movement. Hold the throttle closed, and screw in stop screw (24) until it just touches stop pin (19). Turn the stop screw 1-1/2 turns more to hold the throttle open as a preliminary adjustment.

10. Install the idle adjusting needle valve (17) and spring (16).

NOTE: *Do not force the adjusting needle valve too firmly against the seat, as it will groove the needle point and prevent proper adjustment.*

CARBURETOR

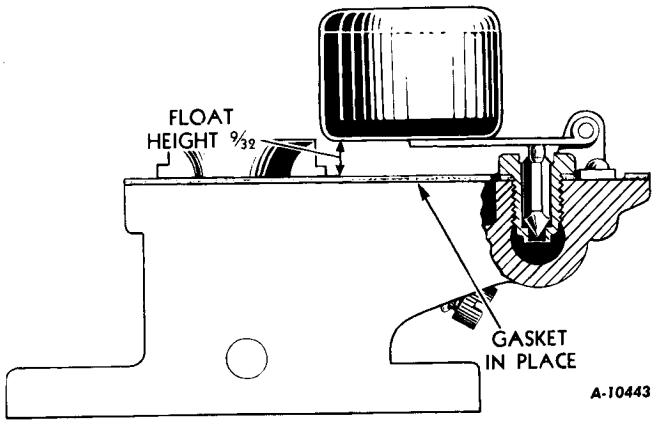


Fig. 21 - Dimensions for Measuring Fuel Level and Position of Float of Marvel Schebler Carburetor

11. Install the fuel valve (9) and washer (8). Insert the fuel valve into the seat.

12. Place the venturi (37) in the throttle body (30) with the large opening toward the throttle. Put the body-to-bowl gasket (34) in place.

13. Position the float (11) and install the float axle (10). Check float for free movement.

14. With the throttle body inverted, set the float height (Fig. 21).

The float distance is measured from the bowl gasket surface to the nearest edge of the float.

To increase or decrease the distance between the gasket surface and the float body, use long-nosed pliers to bend the float hinge close to the float body. DO NOT BEND, TWIST, OR APPLY PRESSURE TO THE FLOAT BODY.

The float should be centered and at right angles to the machined surface of the throttle body.

15. With the throttle body and fuel bowl in the inverted positions, lower the fuel bowl over the throttle body, taking precautions that the venturi (37) guides the bowl into position. With the two bodies held firmly together, turn the carburetor to the upright position and install the four body-to-bowl screws (28). Recheck body-to-bowl screws after the engine has been in operation a few hours.

16. On distillate or kerosene carburetors, install the main jet adjustment needle valve (1), spring (2), washer (3), and gasket (4). Seat the valve lightly, and back out approximately one full turn for preliminary setting.

17. Install the fuel inlet elbow with strainer (50), if so equipped.

Carter Model UT

(Reference Numbers Refer to Fig. 10).

1. Install the idle adjusting needle valve (37) and spring (36).

2. Insert the dust seal (39) into the shaft bore with the lipped side out. Install washer (40) over the dust seal.

3. Install the throttle shaft (42). Assemble the throttle valve plate (3) on the shaft with screws (2). Before tightening the screws, center the valve plate by tightly closing the throttle. Be sure that the throttle stop screw is backed out to allow the valve plate to seat firmly in the bore. Tighten screws (2) and check the throttle for free movement. Clinch over the ends of the screws to prevent them from loosening.

4. Install the needle valve and seat (33) and gasket (34).

5. Hold the float (30) in position and insert the pin (31) in place.

6. Invert the throttle body. Set the float level to the dimensions shown in Fig. 22.

7. Install the main metering jet (26) and gasket (25) on gasoline carburetors, or the main jet adjustment needle valve (21) and gasket (20) on distillate or kerosene carburetors.

8. Install the low speed jet (28) and the nozzle bleed screw plug (27).

9. Insert the dust seal (10) into the choke shaft bore with the lipped side out. Install washer (9) over the dust seal.

10. Install the spring (8) and lock ping (7).

11. Install the choke shaft (29) and hold it in the closed position. Locate the choke valve plate (14) in the bore and install the screws (13). Be sure that the choke valve plate is properly centered and the screws tightened securely. Clinch over the ends of the screws to prevent them from loosening.

12. Install the nozzle (11) and gasket (12).

13. Install the venturi (6).

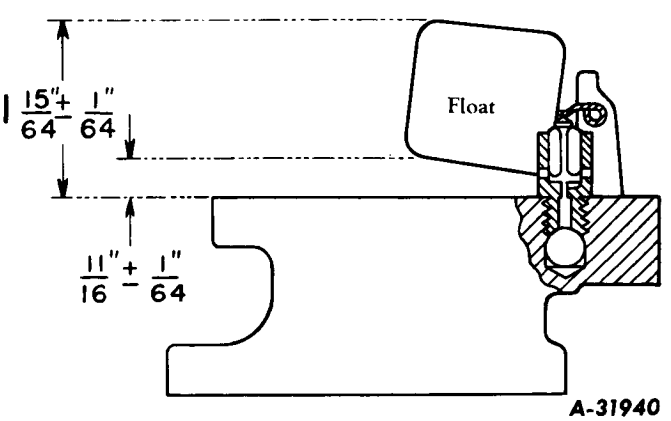


Fig. 22 - Float Setting for Carter Model UT Carburetor.

14. Place the gasket (32) in position and lower the throttle body over the fuel bowl. Install the screws (23). These should be rechecked after a few hours of engine operation.

6. INSTALLATION

1. Attach a carburetor to the manifold, using a new gasket.
2. Connect the air cleaner line to the carburetor.
3. Connect the fuel line to the carburetor.
4. Connect the choke and governor linkage.
5. Turn on the fuel supply.

7. ADJUSTMENTS

For Carburetors used on the 1, 60, 2A, 123, 135, 135B, 146 and 153 Series Engines.

Adjusting the Idle Adjusting Needle Valve

1. Close the idle adjusting needle valve to its seat by turning it all the way to the right.

2. Start the engine and operate it at high idle speed until it is thoroughly warmed up. (Cover the radiator if necessary, or close the radiator shutter if the engine is so equipped.)

3. Close the throttle by pulling the governor control lever all the way back. If the engine misses or rolls, turn the idle adjusting needle valve in or out until the engine operates smoothly.

4. Speed up the engine for a few seconds, then recheck the operation of the engine at low idle speed. The idle speed is set by the throttle stop screw.

Adjusting the Main Metering Needle Valve

(For Distillate or Kerosene Carburetors Only)

1. Set the manifold heat control lever in "HOT" position and operate the engine on gasoline until it is thoroughly warmed. If the engine is equipped with a heat indicator, the pointer should be on the high side of the "RUN" range.

2. Change over to operate on distillate or kerosene, and operate the engine for a short time before making any adjustments.

3. Advance the governor control lever to the high idle position.

4. Turn the main metering needle valve clockwise until the fuel flow is shut off and the speed of the engine drops because of the lean mixture, then open the main metering needle valve until the engine operates smoothly.

5. After the engine has been under load, readjust the main metering needle valve if necessary. Always adjust so that the engine operates smoothly with as lean mixture as possible.

6. Recheck the idling speed as described above under "Adjusting the Idle Adjusting Needle Valve."

For Zenith Carburetors Only.

If the engine is not getting the correct mixture of fuel, it may be that the main metering needle valve has loosened. If necessary, tighten the main metering needle valve packing nut securely.

For Carburetors used on the 4, C-164, C-169, C-175, 6, C-264, C-281 and 9 Series Engines.

Before making any adjustments, close the idle adjusting needle valve and the main metering needle valve. Open the main metering needle valve 2-1/2 to 3 turns and the idle adjusting needle valve 1 to 1-1/2 turns. Start the engine, fully advance the governor control lever, and allow the engine to run until it is hot (about 20 minutes).

If the engine is equipped to run on distillate or kerosene, set the manifold heat control valve in the "HOT" position. When the heat indicator pointer is on the high side of the "RUN" portion of the dial, change over to operate on distillate or kerosene. Run the engine on distillate or kerosene for a short time before making any adjustments.

Adjusting the Main Metering Needle Valve

1. Turn the main metering needle valve in until the engine starts to miss or operate unsteady, then unscrew it to a point where the engine runs steady. Check this adjustment with the engine under load to be certain that you have secured the most satisfactory operation and maximum amount of power. Be sure that the main metering needle valve packing nut is properly tightened.

2. For the best operation and minimum dilution, keep the fuel mixture as lean as possible. (The main metering needle valve turns in for lean mixtures and out for rich mixtures.)

Adjusting the Idle Adjusting Needle Valve

1. Fully retard the governor control lever. Adjust the idle adjusting needle valve to give a slight increase in idle speed.

2. Turn the idle adjusting needle valve in or out to give the smoothest idle with the highest speed. (The idle adjustment needle valve turns in for rich and out for lean mixtures.)

3. Adjust the idle throttle stop screw to give the desired speed. On engines with magnetos, the engine should not be set to idle so slowly that the magneto impulse coupling will trip continually.

BATTERY IGNITION DISTRIBUTOR

1. DESCRIPTION

The distributor has three functions: First, it opens and closes the low voltage circuit, between the source of current and the ignition coil, so that the primary winding (of the ignition coil) (Fig. 1), is supplied with intermittent surges of current. Each surge of current builds up a magnetic field in the coil. The magnetic field is collapsed by opening the low voltage circuit. This in turn induces a high voltage surge in the secondary winding (of the ignition coil).

The second function is to time these surges to the requirements of the engine. This is accomplished by the advance mechanism.

NOTE: *Some distributors do not have an advance mechanism because engine performance does not require it.*

The third function is to direct the high voltage surge through the rotor, cap and high tension wiring to the proper spark plug at the proper time.

On distributors of IH manufacture, there are two letters and a number stamped on the housing. The first letter designates the model distributor, the second letter designates the month of manufacture and the number designates the year the housing was built (Fig. 2).

The distributor mounting bracket is located on the right rear side of the crankcase front plate and has a shaft which is geared to the gear train. The drive housing is mounted on the rear of the mounting bracket with a shaft that has lugs to engage with the slots in the shaft of the mounting bracket. The other end of the drive housing shaft is geared to the distributor in the drive housing.

For removal of the drive housing, refer to the removal and disassembly paragraphs for these models.

2. REMOVAL

1. Remove the secondary "coil-to-distributor-cap" cable from the ignition coil.

2. Remove the distributor cap by loosening the spring clips from the cap.

3. Remove the distributor drive housing mounting bolts.

4. Lift off the distributor and drive housing.

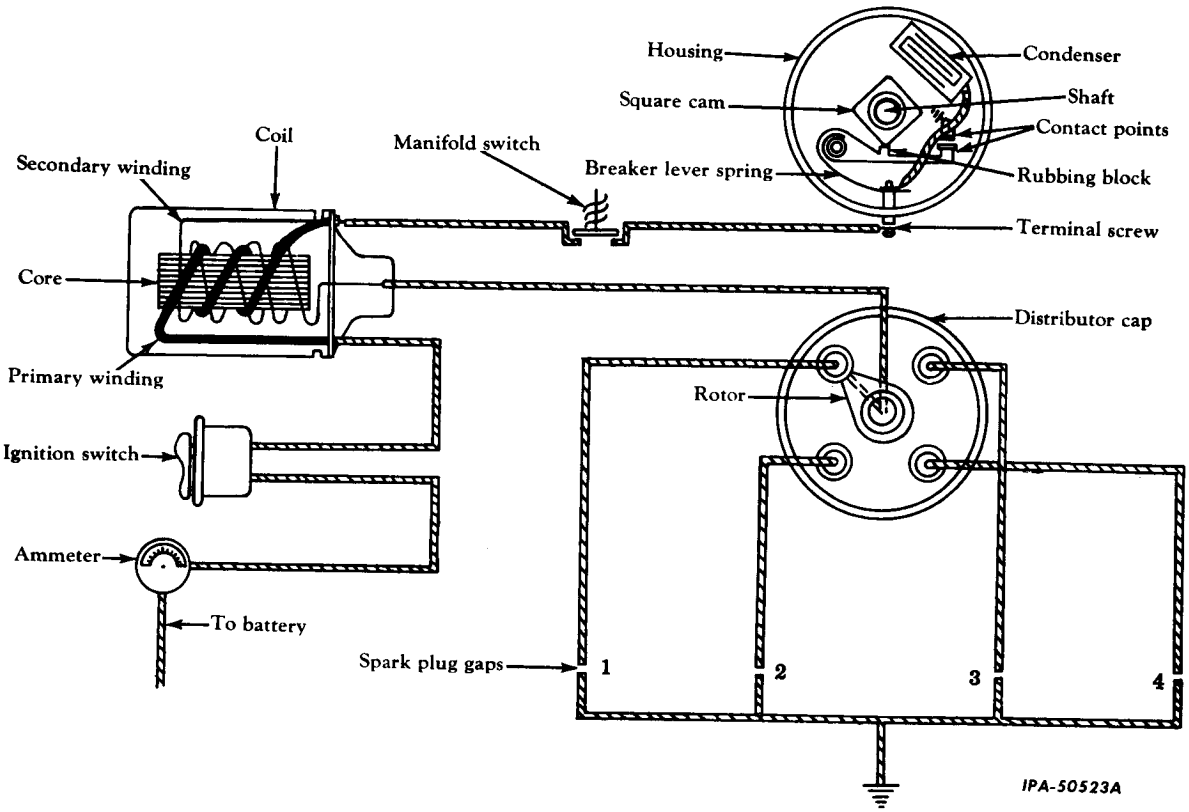


Fig. 1 - Schematic View of the Ignition System Using a High Tension Distributor.

BATTERY IGNITION DISTRIBUTOR

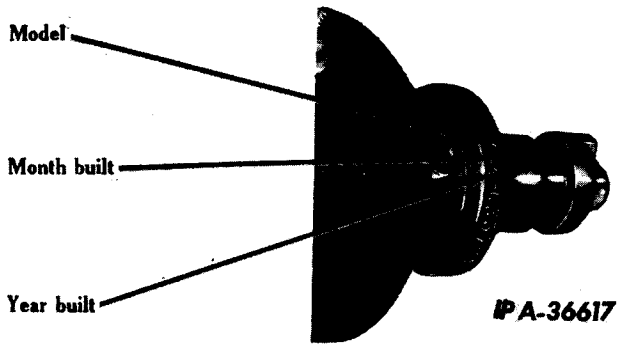


Fig. 2 - Model Designation.

3. DISASSEMBLY

NOTE: *Owing to difference in direction or rotation, and/or amount of automatic advance, the design of parts varies from one distributor to another.*

1. Remove the primary "coil-to-distributor" cable from the coil and distributor.

2. Remove the coil from the drive housing by removing two cap screws from the coil clamp and then lift off the coil.

NOTE: *Model H distributor coils have a mounting bracket attached to the drive housing by two cap screws. The coil and clamp are mounted to the bracket.*

3. Remove the two distributor mounting clamps.

4. Remove the distributor from the drive housing (Fig. 13).

5. Remove the distributor rotor (Fig. 3).

NOTE: *The distributor rotor is made of bakelite and will crack or break easily.*

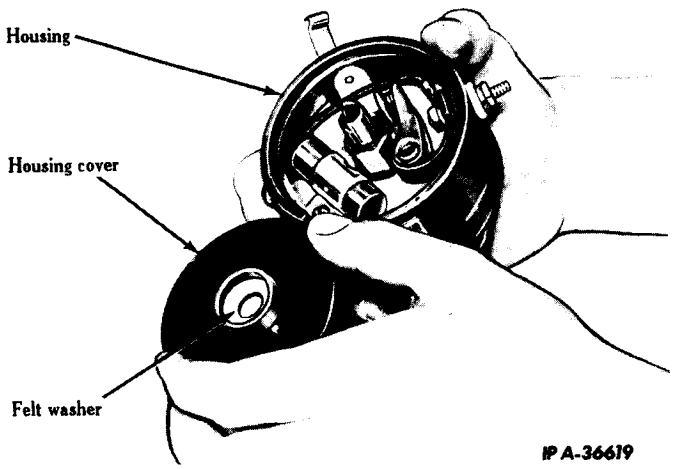


Fig. 3 - Removing Distributor Rotor (IH Model K Shown, Others Similar).

6. Remove the housing cover and felt seal rotating the cover will ease removal (Fig. 4).

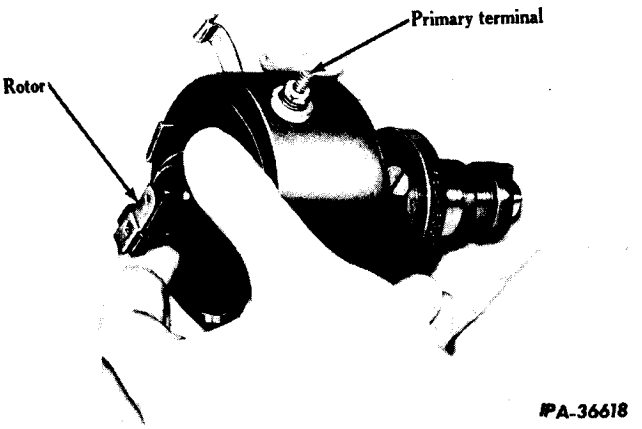


Fig. 4 - Removing Distributor Housing Cover and Felt Washer (IH Model K Shown, Others Similar)

7. Remove the slotted screw from the condenser clamp, remove the primary terminal screw nut (the nut inside the housing) and remove the condenser (Fig. 6).

8. Lift the breaker lever off the pivot (Fig. 7). Remove the stationary point.

9. Remove the terminal screw nuts, lock washers, brass washers, terminal insulators and terminal screw from the housing (Fig. 8).

10. Remove the two slotted screws which secure the spring clips to the housing; remove the clips.

11. Remove the remaining slotted screw (opposite the terminal screw opening) which secures the breaker plate to the housing; lift the breaker plate from the housing (Fig. 8).

12. Remove the governor weight guard by removing the two slotted screws and lifting the guard out (Fig. 11).

13. Remove the governor weight arm springs.

14. Lift out the governor weight arms and spacers (Fig. 12).

15. Lift the cam off the shaft.

16. Remove the pin from the drive gear and shaft. The gear can then be removed from the shaft (Fig. 13).

17. Remove the drive shaft through the top of the housing (Fig. 14).

18. Remove the "O" ring from the retainer at the base of the housing (Fig. 9).

NOTE: *The retainer does not have to be removed, unless it is badly worn or scored.*

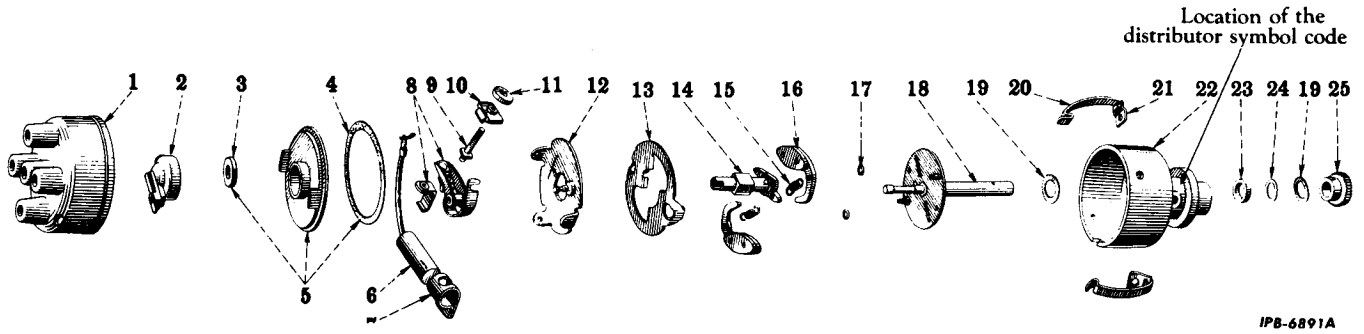


Fig. 5 - Battery Ignition Distributor.

1. Cap.
2. Rotor.
3. Felt seal.
4. Cover gasket.
5. Cover.
6. Condenser.
7. Clamp.
8. Breaker points.
9. Screw.
10. Insulator.
11. Washer.
12. Breaker plate.
13. Weight guard. *
14. Cam. *
15. Spring. *
16. Weight arm. *
17. Spacer.
18. Shaft. *
19. Washer.
20. Spring.
21. Support.
22. Housing.
23. Retainer.
24. Oil seal.
25. Gear.

* Owing to the difference in direction of rotation and/or amount of automatic advance, the design of parts varies from one distributor to another.

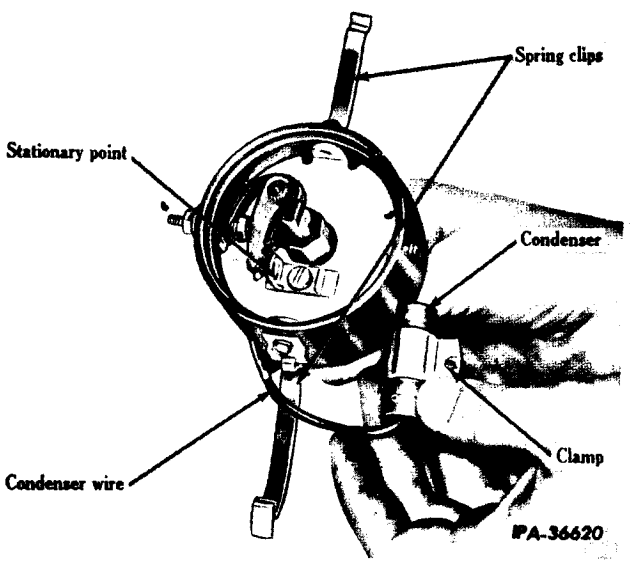


Fig. 6 - Removing Condenser.

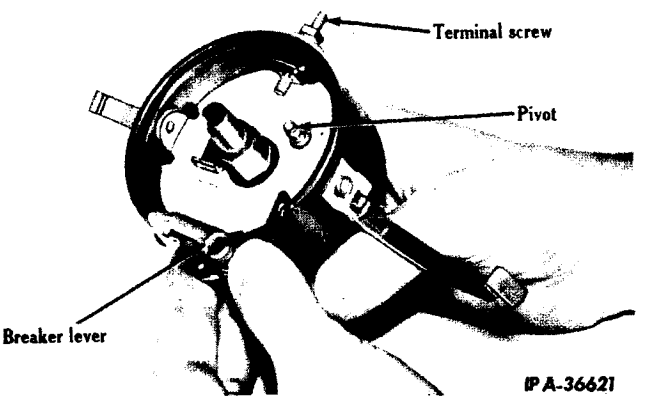


Fig. 7 - Removing Breaker Lever.

19. If the bushing is excessively worn or scored, a new bushing must be installed. Refer to Par. 4, Step 2 and Fig. 15.

BATTERY IGNITION DISTRIBUTOR

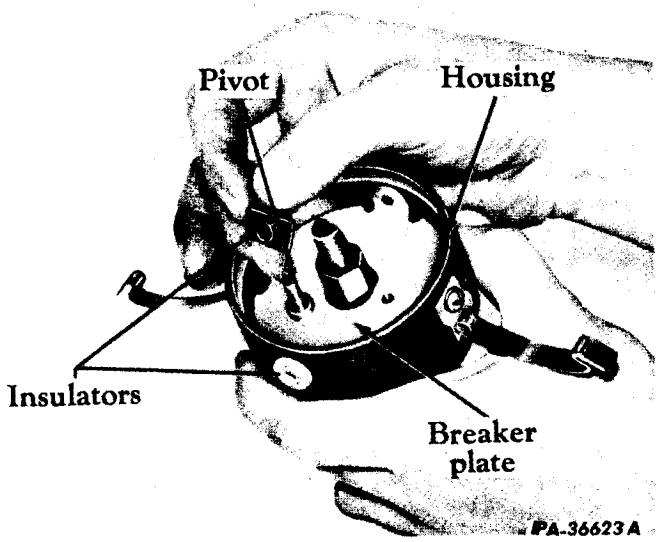


Fig. 8 - Removing Inside Terminal Insulator.

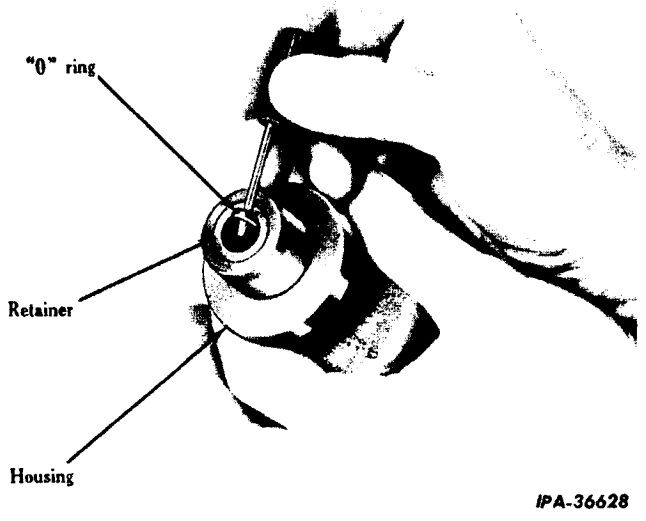


Fig. 9 - Removing Drive Shaft "O" Ring.

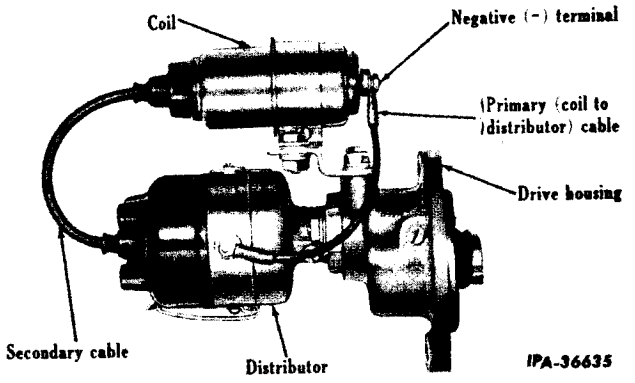


Fig. 10 - Battery Ignition Unit.

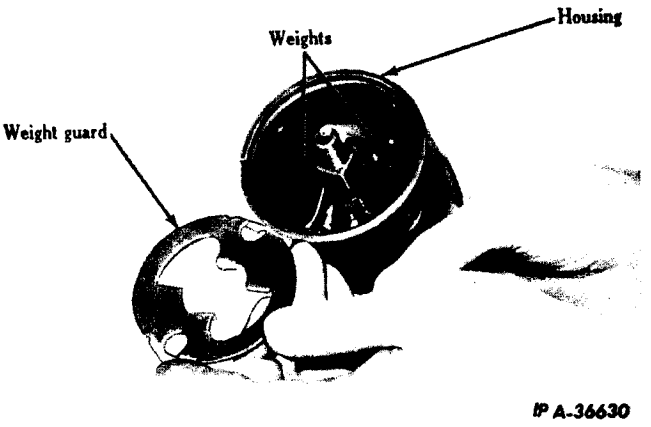


Fig. 11 - Remove Weight Guard.

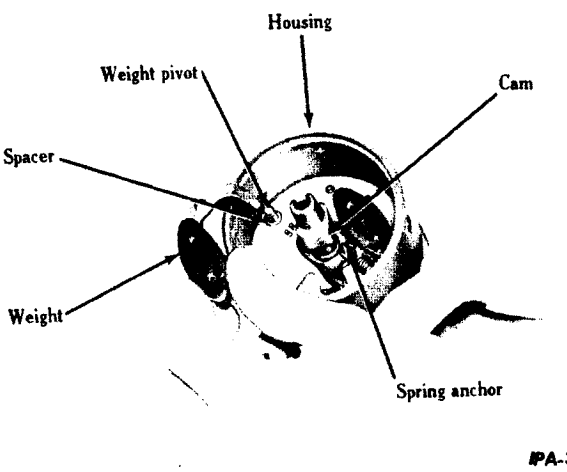


Fig. 12 - Removing Weights.

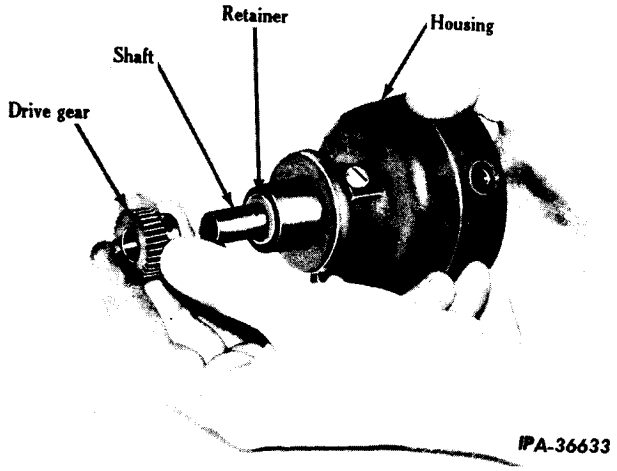


Fig. 13 - Removing Drive Gear.

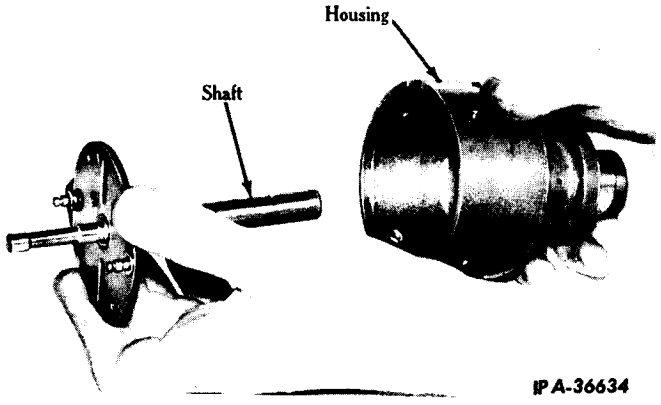


Fig. 14 - Removing Drive Shaft.

4. INSPECTION AND REPAIR

The distributor cap, rotor, insulating washers and bushings should be wiped thoroughly with a soft, clean, dry cloth; other parts should be cleaned with a cloth dampened with carbon tetrachloride or similar dry-cleaning solvent.

NOTE: *Do not immerse the distributor in a degreasing tank; to do so will ruin electrical parts.*

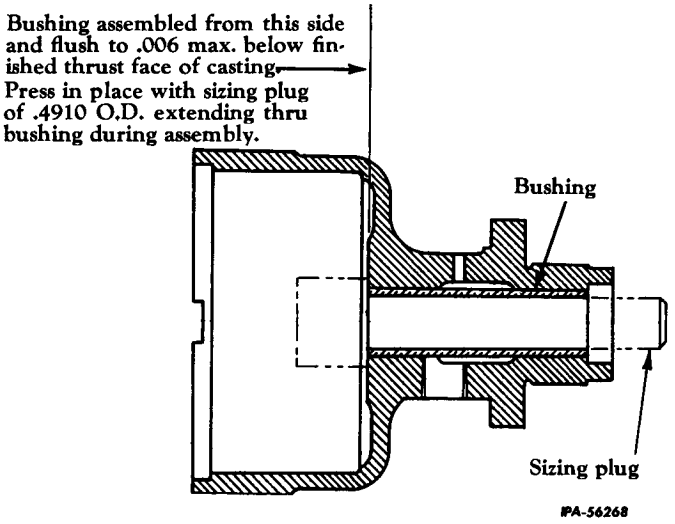


Fig. 15 - Bushing Installation.

INSPECTION	REMEDY
1. Inspect the distributor cap, rotor and insulating washers for cracks, chips or burned surfaces	Such damage can cause a leakage of high voltage to ground. Replace as necessary.
2. Inspect bushings for excessive wear, scoring or looseness	Replace with new shaft bushing (Fig. 15).
3. Inspect contact points for pitting and burning, for oil and dirt and for correct gap setting	Replace as necessary. **NOTE:** *Never use emery cloth to clean contact points. Emery may embed in the point surface and cause rapid burning and pitting.*
4. Inspect for oxidized contact points	Replace as necessary. This condition is usually caused by high resistance due to loose connections in the condenser circuit, oil or foreign matter on the contact surfaces or excessive high voltage caused by bad connections or broken strands.

BATTERY IGNITION DISTRIBUTOR

INSPECTION	REMEDY
5. Inspect condenser for secure connections	Be sure the condenser cable is not frayed or corroded with broken strands or defective connections. Broken strands will cause high resistance in the condenser circuit, burning the distributor points.
6. Inspect condenser sealing for cracks	Replace as necessary. Openings in condenser sealing may admit water or oil and cause a short circuit in the condenser.
7. Inspect condenser insulation for break-down	Replace as necessary. Such breakdown will cause a short circuit in the condenser.
8. Inspect rubbing block for excessive wear	Install new rubbing block if necessary.
9. Check breaker lever spring for correct tension	Weak tension on the spring may permit contacts to bounce and chatter, causing heavy burning and arcing of the points. Replace weak spring.
10. Inspect ignition coil for secure terminals	Tighten terminal connections.
11. Inspect ignition coil for cracks and burns, or dents and punctures, in the coil insulation and containers	Replace as necessary.
12. Check primary and secondary resistance (Refer to "SPECIFICATIONS" in Section 1)	Replace as necessary.
13. Check secondary out put. (Refer to "SPECIFICATIONS" in Section 1)	Replace as necessary.

5. REASSEMBLY

1. If the sealing ring retainer was removed, press in a new one so that it is snug against the shoulder in the base of the housing.

2. Install a sealing ring in the retainer and coat the exposed surface with IH magneto grease.

3. Place a thrust washer (in good condition) in the housing over the bushing.

4. Install the drive shaft through the thrust washer and bushing (Fig. 14) using a twisting motion.

5. Install a second thrust washer on the coupling end of the shaft.

6. Install the drive gear on the shaft (Fig. 13) and place a new pin through the gear and shaft.

NOTE: *Do not peen the pin.*

7. Check the end play of the shaft between the coupling and the lower thrust washer. This end play should be 0.003 to 0.009 inch.

8. Upset the ends of the pin so that it fills the entire hole after the correct end play has been obtained.

9. Place the cam over the shaft.

10. Place a governor weight spacer over each of the pivots.

11. Install the governor weights on the pivot so that the spring anchor is closest to the weight (Fig. 12).

12. Install a second spacer on each pivot.

13. Install the governor weight spring to the pivots and spring anchors.

14. Install the weight guard and secure it with two slotted screws (Fig. 11).

15. Install the breaker plate so that the threaded holes are facing upward (Fig. 8).

16. Install the two spring clips and three slotted screws.

17. Install the two terminal screw insulator (Fig. 8).

18. Install the terminal screw and secure with a brass washer, lock washer and a hex nut on the outside of the housing.

19. Install the breaker lever on the pivot so that the rubbing block is against the cam and the spring is on the terminal screw.

20. Install the stationary point and adjust the point gap so that when the rubbing block is on the high point of the cam, there is a gap of 0.020 inch.

21. Place the brass washer and lock washer on the terminal screw. Start the hex nut, but do not tighten it.

22. Place the condenser on the breaker plate (Fig. 6) and secure it with a slotted screw.

23. Connect the condenser wire to the terminal screw so that it is under the brass washer. Tighten the terminal screw hex nut.

24. Install the housing cover and felt washer in the housing (Fig. 4).

25. Install the rotor on the shaft (Fig. 3).

26. Install the distributor in the drive housing so that the primary terminal is positioned as shown in Fig. 10.

27. Install the mounting clamps and cap screws, but do not tighten them.

28. On model A distributors, mount the coil and clamp on the drive housing.

29. Connect the primary "coil-to-distributor" cable to the primary terminal on the housing and the negative (-) terminal of the coil. Be sure these connections are tight.

6. INSTALLATION

1. Before installing the distributor unit, crank the engine until the No. 1 piston (next to radiator) is on top-dead-center of the compression stroke. The compression stroke can be determined by removing the No. 1 spark plug, placing your thumb over the opening and cranking the engine until an outward pressure is felt. Continue cranking slowly until the "DC" mark on the fan drive pulley is in line with the pointer on the crankcase cover.

2. Turn the drive lugs slowly and lightly in a clockwise direction until a slight resistance is felt and the rotor arm is in the No. 1 firing position. The rotor arm is in position when the metal strip on the rotor arm is pointing toward the No. 1 spark plug cable in the distributor cap.

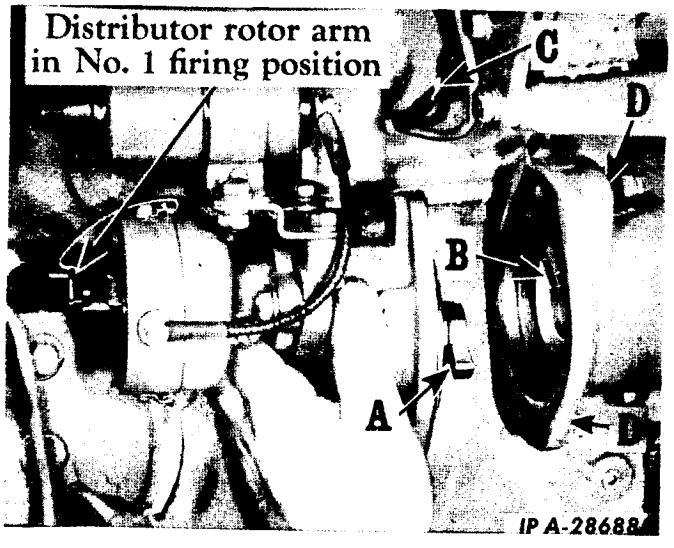


Fig. 16 - Installing the Battery Ignition Unit.

3. Pull out the drive shaft to disengage the gears. Then turn the shaft clockwise so that the drive shaft lugs (A, Fig. 16) are approximately 35° past horizontal or approximately in the same position as the drive shaft slots (B). Engage the gears and press the drive shaft in with the palm of the hand.

4. Assemble the distributor unit and gasket to the mounting bracket, being sure the drive lugs (A, Fig. 16) are meshed with drive slots (B). Secure with two mounting bolts and washers. Assemble the distributor cap.

5. Connect the ignition switch cable (C, Fig. 16) to the negative terminal of the coil.

7. TIMING THE DISTRIBUTOR TO THE ENGINE

1. Loosen the distributor mounting bolts (B, Fig. 18). Set the engine with the No. 1 piston on top-dead-center of the compression stroke. The timing pointer on the crankcase front cover will line up with notch "DC" on the fan drive pulley. The secondary cable should be assembled properly in the coil terminal.

2. Turn on the ignition switch and note if the ammeter shows discharge. If it shows discharge, the points are closed and retarding the distributor is not necessary. If the ammeter does not show discharge, retard the distributor by turning the body about 30° in the same direction as that of the cam rotation. Hold the free end of the secondary cable (A) within 1/16 to 1/8 inch from the distributor primary terminal. (See Fig. 18) Advance the distributor by turning the distributor body slowly in the direction opposite to the cam rotation until a spark occurs.

3. Place the secondary cable under the distributor cap spring and place the terminal within 1/16 to 1/8 inch of the distributor primary terminal (Fig. 19). A final check should be made by cranking the engine until the "DC" mark on the fan drive pulley again approaches the pointer on the crankcase front cover. Continue cranking until a spark just occurs at the gap between the secondary cable and the primary terminal.

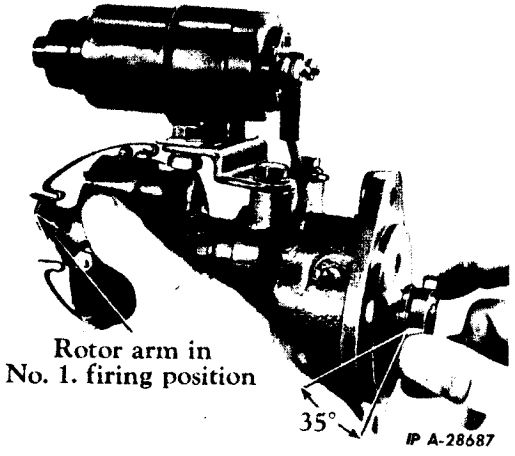


Fig. 17 - Adjusting Distributor Rotor and Drive Shaft Lugs for Timing Distributor.

BATTERY IGNITION DISTRIBUTOR

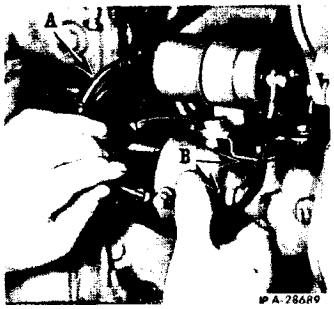


Fig. 18 - Advancing the Distributor While Holding Secondary Cable 1/16" to 1/8" from Primary Terminal.

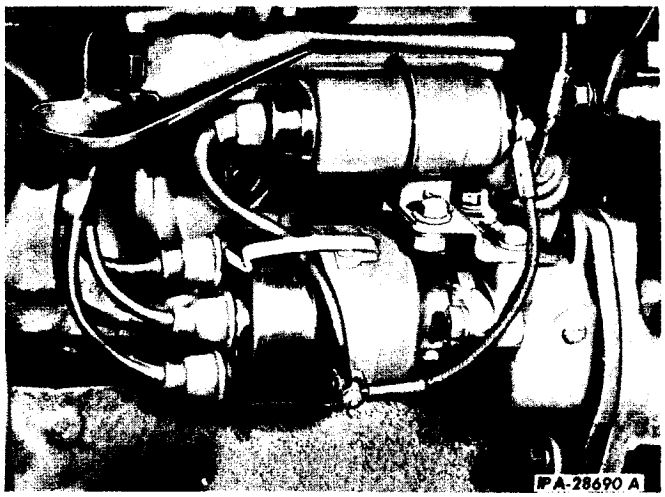


Fig. 19 - Secondary Cable Held Under Distributor Cap Spring for Timing Check.

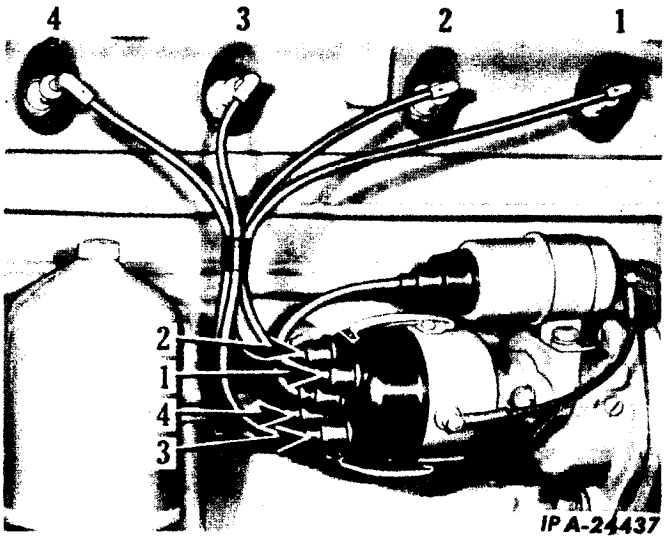


Fig. 20 - Firing Order is 1, 3, 4, 2 (Counterclockwise Rotation).

4. The timing marks should be approximately at specified static timing (Refer to "SPECIFICATIONS" in Section 1). If necessary, make the required adjustment to have the spark occur as specified. When correct timing is obtained, be sure to tighten the distributor unit mounting bolts.

To check the timing, use a timing light connected from the terminal on the distributor to ground. Loosen the two clamping bolts and turn the distributor about 30 degrees in a direction to move the top of the distributor away from the engine. The timing light should be lighted during most of this movement. Then, turn the body in the reverse direction until the light just goes out. This will set the distributor to fire No. 1 spark plug at static timing at cranking speeds.

5. If the spark plug cables have been removed from the distributor cap, reassemble them in the proper sequence using the rubber nipples provided. The No. 1 plug is connected to the No. 1 distributor terminal, etc., in the same direction as that of the cam rotation (Fig. 20). Assemble the secondary cable in the distributor cap (Fig. 21).

Instructions for the proper hook-up and operation of the power timing light are furnished with the tool by the manufacturer.

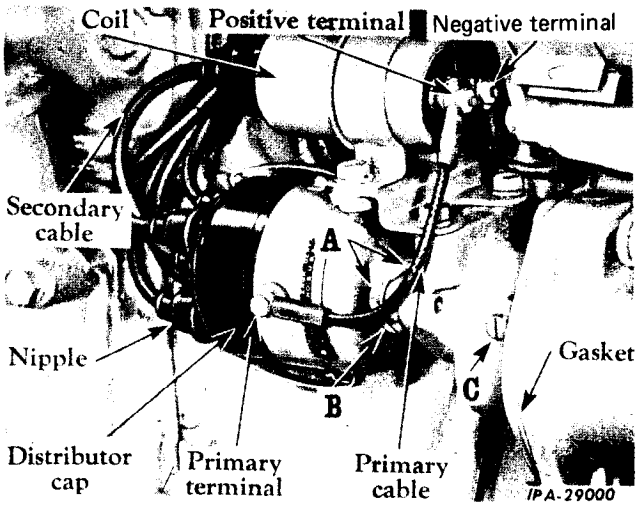


Fig. 21 - Distributor - Battery Ignition Unit.

H-4 MAGNETO

1. DESCRIPTION

The International model H-4 magneto is flange mounted to a bracket on the right side of the engine.

The magneto is driven from a shaft and gear supported in a bracket which attaches to the right rear side of the crankcase front plate (Fig. 1 and 2). The magneto is driven by two lugs which engage in slots of the magneto drive shaft. The magneto is grounded out during diesel operation by an automatic grounding switch in the intake manifold that shorts the primary circuit. The magneto features a completely enclosed breaker chamber, a starting impulse coupling and an Alnico rotor magnet that should never require remagnetizing.

The magneto requires care in handling. The following instructions must be adhered to closely. The magneto is driven through the impulse coupling which has a 150 rpm missing speed. Throw-out speed is 240 to 330 rpm. Fig. 3 shows the complete magneto assembly.

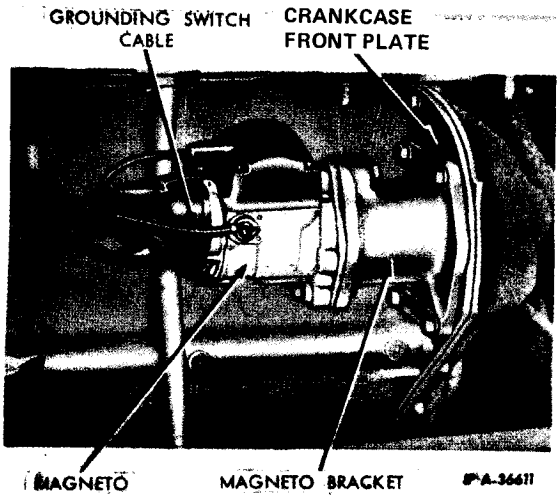


Fig. 1 - Magneto Installed on Engine.

2. REMOVAL

Remove the grounding switch cable from the side of the magneto (Fig. 1). Pull four spark plug cables from the distributor cap. Remove the screws holding the magneto bracket to the crankcase front plate and remove the magneto and bracket as a unit.

3. DISASSEMBLY OF MOUNTING BRACKET

Remove the magneto (5, Fig. 2) and gasket (6) from the bracket (12). Some engines are equipped with a service meter drive gear. On these units the drive gear (16) and retainer (17) will have to be removed. Bend the nut lock (14) back and remove the nut (15) and lock. Press the shaft (7) out of the gear (13) or pull the gear from the shaft. Remove the keys (8 and 9) from the shaft. The shaft can now be removed. The bushing (11) and seal (10) (if so equipped) should not be removed unless it is necessary to replace them, in which case they can be pressed out.

4. INSPECTION AND REPAIR

(Refer to Fig. 2)

Wash all parts except the magneto in dry-cleaning solvent and dry with compressed air.

Inspect all parts for wear and damage; replace parts as necessary. The new shaft diameter is 0.9995 to 1.0005 inches; the bushing diameter is 1.0015 to 1.0030 inches. This gives a running clearance of 0.001 to 0.0035 inch. When pressing in a new bushing, the 9/16 inch holes should be toward the front end of bracket and arranged vertically to coincide with similar openings in the bracket. The four 3/16 inch holes are then

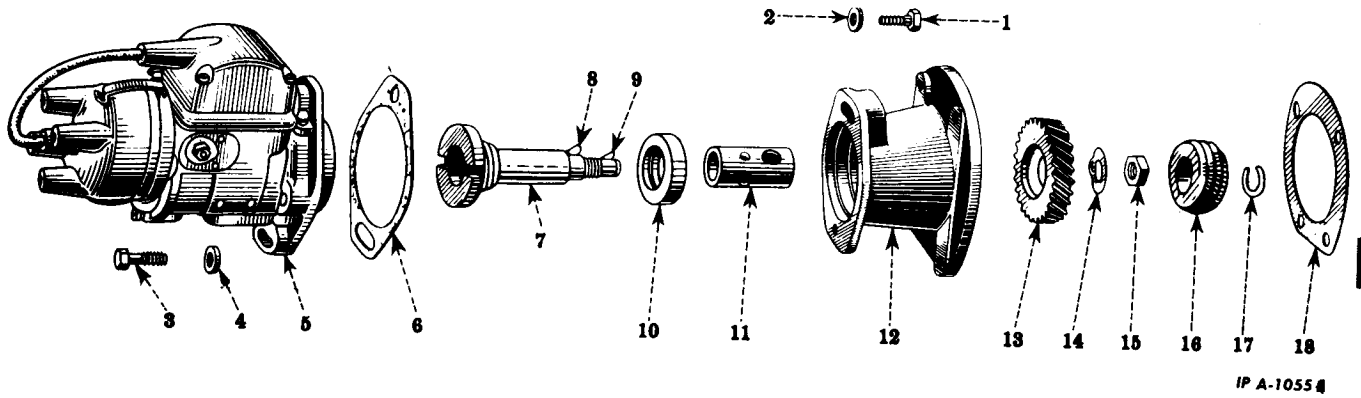


Fig. 2 - Magneto Mounting Bracket Components.

1. Cap screw.
2. Washer.
3. Cap screw.
4. Washer.
5. Magneto.
6. Gasket.
7. Shaft.
8. Key.
9. Key.
10. Seal.
11. Bushing.
12. Bracket.
13. Gear.
14. Lock nut.
15. Hex jam nut.
16. Gear.
17. Gear retainer.
18. Gasket.

H-4 MAGNETO

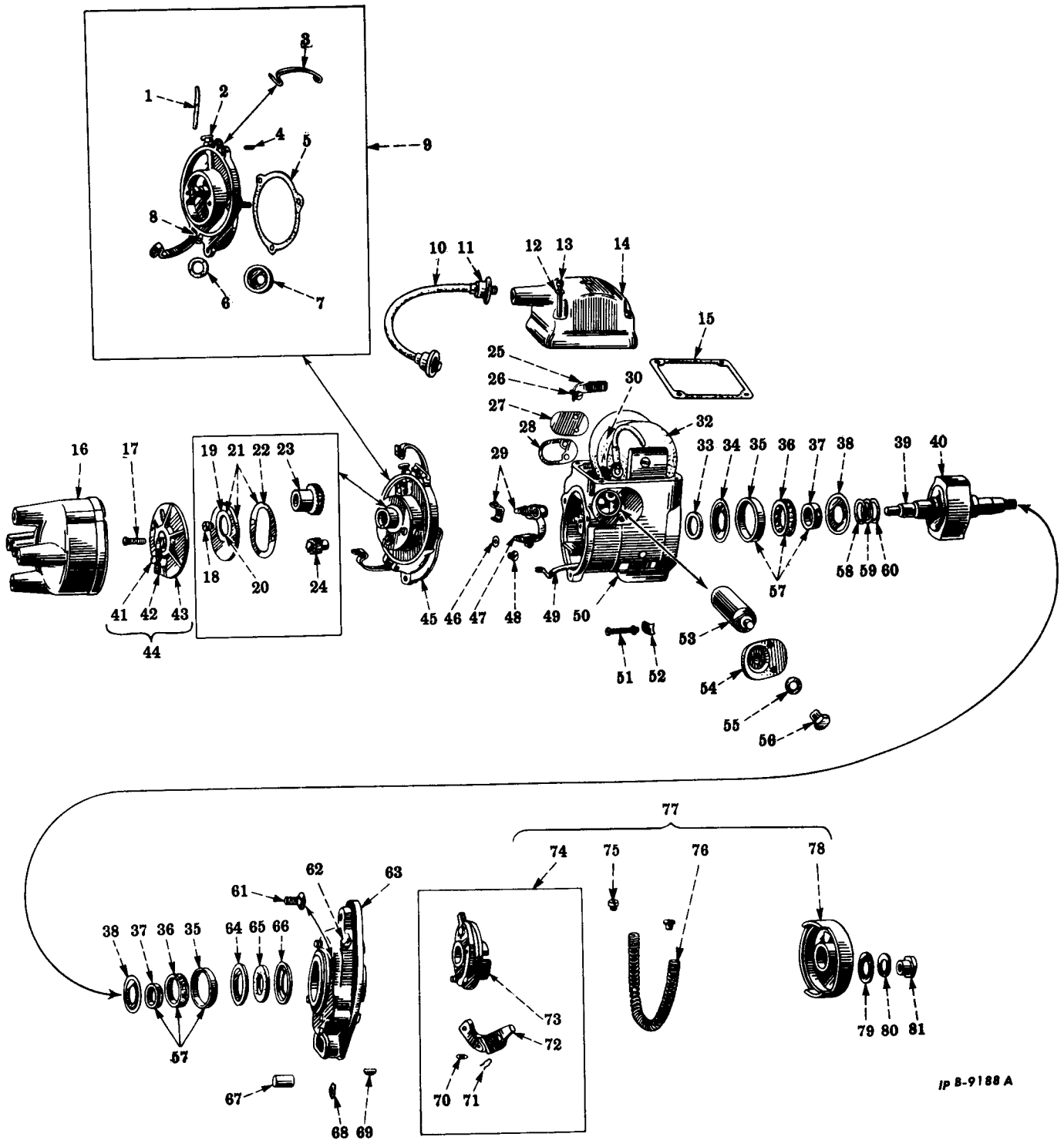


Fig. 3 - Exploded View of Magneto.

1. Oil well felt.
2. Oiler.
3. Distributor cap spring.
4. Locating pin.
5. Body gasket.
6. Felt seal retainer.
7. Felt seal.
8. Cap spring pin.
9. Distributor body.
10. "Coil to Distributor" cable.
11. Cable nipple.
12. Coil cover mounting washer.
13. Screw.
14. Coil cover.
15. Coil cover gasket.
16. Distributor cap.
17. Distributor brush.
18. Screw.
19. Gear cover felt seal retainer.
20. Gear cover felt seal.
21. Distributor gear cover.
22. Distributor gear cover gasket.
23. Distributor gear.
24. Rotor pinion.
25. Secondary leadout strap.
26. Screw.
27. Condenser hole cover.
28. Hole cover gasket.
29. Breaker arm and stationary point.
30. Coil core.
32. Coil end insulator.
33. Bearing felt.
34. Inner bearing felt retainer.
35. Bearing outer race.
36. Bearing retainer.
37. Bearing inner race.
38. Oil flinger.
39. Breaker cam.
40. Rotor, assembly.
41. Distributor rotor nut.
42. Distributor arm.
43. Distributor rotor.
44. Distributor rotor, assembly.
45. Distributor.
46. Terminal washer.
47. Spring anchor.
48. Screw.
49. Primary leadout cable.
50. Frame, assembly.
51. Screw.
52. Condenser clip.
53. Condenser.
54. Terminal insulator.
55. Lock washer.
56. Short circuiting terminal.
57. Rotor shaft ball bearing.
58. Rotor shim, light.
59. Rotor shim, medium.
60. Rotor shim, heavy.
61. Screw.
62. Impulse coupling oiler.
63. Mounting flange.
64. Oil retainer washer.
65. Oil seal.
66. Oil retainer washer.
67. Impulse coupling stop pin.
68. Lock washer.
69. Woodruff key.
70. Pawl pin washer.
71. Pawl pin snap ring.
72. Pawl.
73. Magneto member.
74. Magneto member w/pawls.
75. Spring end button.
76. Coupling spring.
77. Rotating unit.
78. Drive member.
79. Lock washer.
80. Lock washer.
81. Impulse coupling nut.

toward the magneto end of bracket. The end of the bushing must be flush with the front face of the bracket. Particular care must be taken when reaming the bushing to have the bore square with the mounting face within 0.002 inch or the gear will run out, causing a noisy timing gear train.

5. REASSEMBLY OF MOUNTING BRACKET

Press in a new oil seal (10, Fig. 2)(if so equipped) with the lip facing the front of the bracket. Lubricate the magneto shaft with engine oil and place it in the bracket (12). Install the key (8) in the shaft. Press the gear (13) on the shaft with the flat side facing the bracket. Secure the gear with nut lock (14) and nut (15).

NOTE: *The gear must run true with the front face of the bracket. Install the key (9), drive gear (16) and retainer (17) (if so equipped). The end clearance of the shaft should be 0.003 to 0.013 inch.*

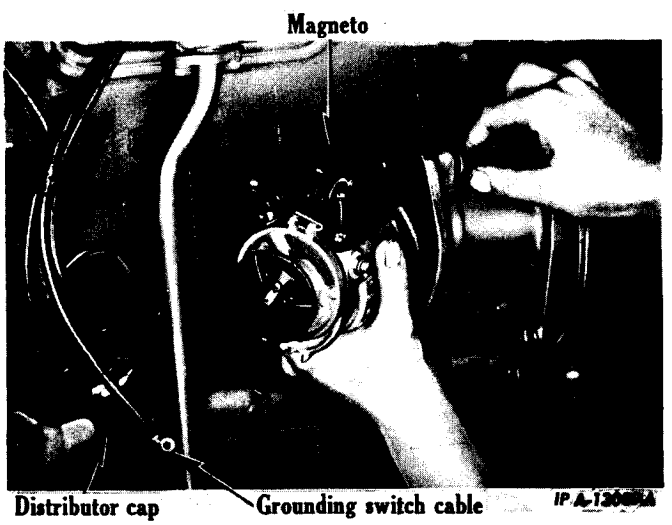


Fig. 4 - Removing the Magneto.

H-4 MAGNETO

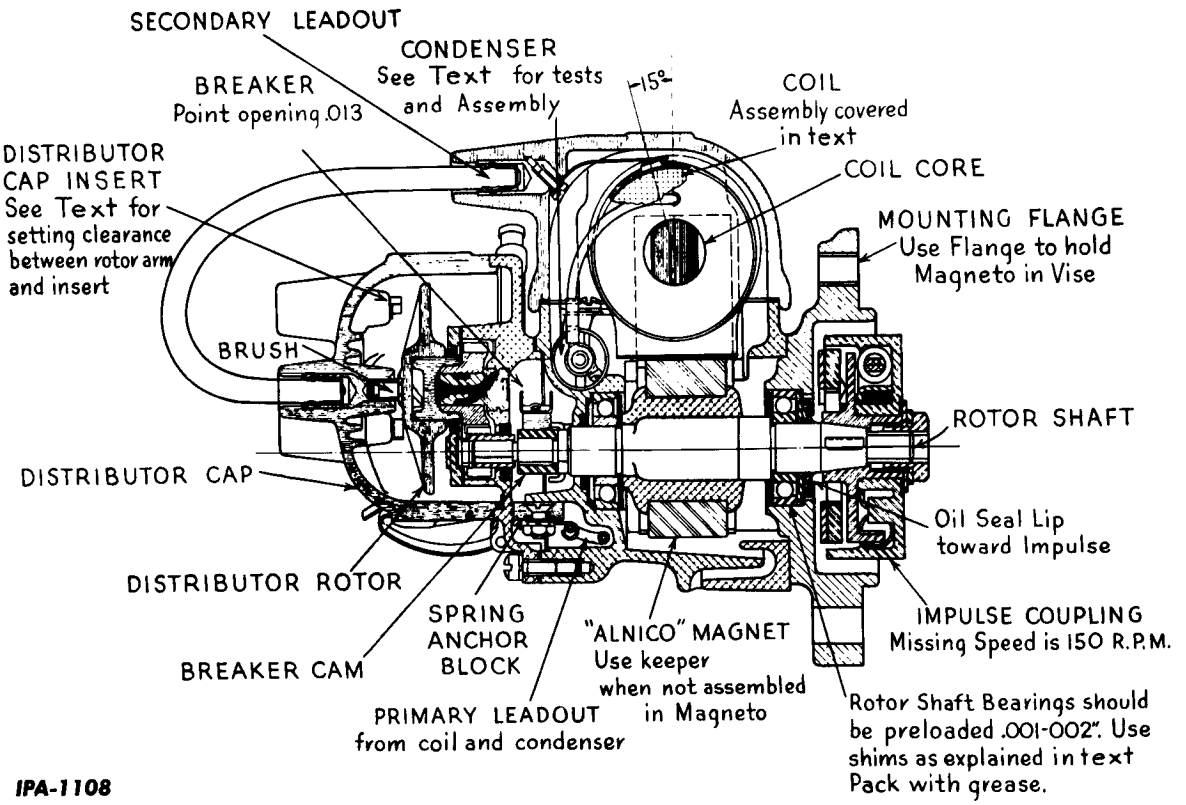


Fig. 5 - Cross Section of Magneto.

6. INSTALLING AND TIMING THE MAGNETO TO THE ENGINE

1. Shellac a new gasket to the bracket. Attach the bracket to the crankcase front plate so the punch mark on the magneto gear tooth lines up with the chamfered tooth on the camshaft gear. Install the magneto.

2. Attach a jumper wire between the magneto terminal and the coil cover mounting bolt. This will ground the magneto and prevent accidental starting.

3. Crank the engine until the No. 1 piston (next to the radiator) is on top-dead-center of the compression stroke. The compression stroke can be determined by removing the No. 1 spark plug, placing your thumb over the opening and cranking the engine until an outward pressure is felt. Continue cranking slowly until the timing mark is in line with the pointer. The intake and exhaust valves are now both closed.

4. Remove the distributor cap and turn the magneto coupling in a counterclockwise direction (as viewed from the coupling end) until the metal strip on the distributor rotor points to the No. 1 terminal on the distributor cap. Install the distributor cap.

5. Assemble the magneto on the engine, being sure that the lugs on the impulse coupling engage in the slots on the magneto drive gear coupling. Assemble the magneto so the top is as close to the crankcase as possible.

6. Insert the magneto mounting bolts loosely in the magneto flange, just enough to hold the magneto in place. Then crank the engine one complete revolution to the next top-dead-center. Now, pull the upper part of the magneto away from the engine until the impulse coupling just trips.

7. Tighten the mounting bolts firmly. Attach the spark plug cables to the engine and to the magneto. Start by connecting the No. 1 cylinder spark plug to the socket marked "1" on the distributor cap; connect the next socket with the No. 3 cylinder, the next socket with the No. 4 cylinder and the last with No. 2 cylinder.

8. Remove the jumper wire from the magneto terminal, connect the grounding switch cable to the terminal and reconnect the jumper wire.

9. To check the timing, crank the engine slowly until the top-dead-center of the No. 1 cylinder is reached, at which time the impulse coupling should just trip. The magneto is now correctly wired and timed.

10. Remove the jumper wire from the coil cover mounting bolt to the magneto terminal.

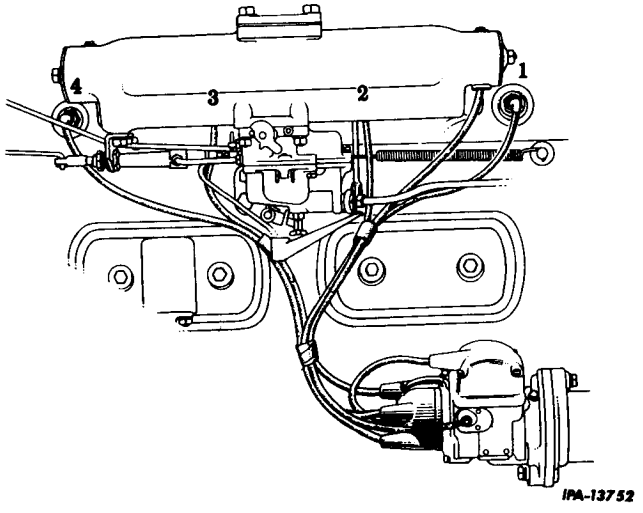


Fig. 6 - Wiring Chart for Magneto. The Engine Firing Order is 1, 3, 4, 2.

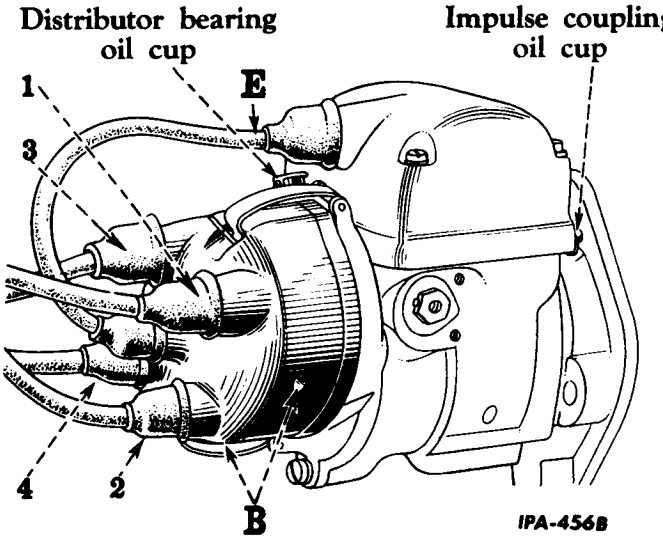


Fig. 7 - Counterclockwise Rotation (Viewed from the Distributor End).

DISTRIBUTOR CAP

7. REMOVAL

Remove the secondary leadout wire (E, Fig. 7) from the coil cover. To remove the distributor cap, push the distributor cap springs (3, Fig. 3) out of the cap recesses and pull off the cap.

8. INSPECTION AND REPAIR

The carbon brush in the central socket contacts the monel metal strip of the distributor rotor (Fig. 5). The brush and spring can be pulled out of the socket if replacement is necessary. If the four inserts are badly worn, replace the cap. All the grease should be removed from the monel metal strip on the distributor rotor to assure good contact. The distributor cap should be free of dust or dirt, inside and out, before assembling to the magneto. The two ventilating holes (B, Fig. 7) should be open at all times.

Check thoroughly for cracks in the bakelite distributor cap around the spark plug cables and "coil to distributor" cable sockets. Very small cracks will allow a spark to go through the cap and partially short out the engine. For adjustment of the rotor arm with respect to the inserts, refer to Fig. 9 and Par. 10, 11 and 12.

9. INSTALLATION

The cap fits only one way; the ventilating holes are always on the bottom side. Snap the body springs into the distributor cap recesses and install the secondary wire.

DISTRIBUTOR ROTOR

10. REMOVAL

Remove the distributor cap. Apply the end of a screwdriver against the hub of the rotor and pry off the rotor as shown in Fig. 8. The bakelite rotor is fragile; handle it with care.

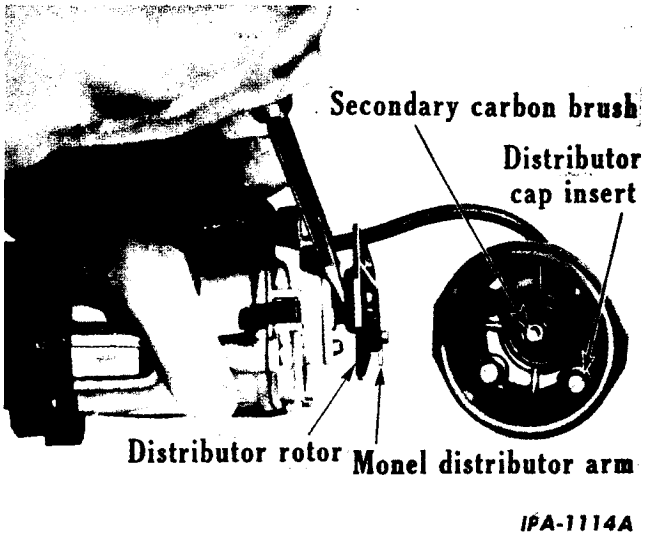


Fig. 8 - Method of Removing Distributor Rotor from its Spindle.

H-4 MAGNETO

11. ADJUSTMENT

The monel metal arm on the distributor rotor is adjustable and renewable. It is removed by running out the arm nut. The arm should operate as close to the insert in the distributor cap as possible without rubbing (Fig. 10). To adjust the distributor arm correctly, take a cap from stock and cut it away as shown in Fig. 10. Then, using a feeler gauge, check the distance between the distributor arm and the insert in the distributor cap.

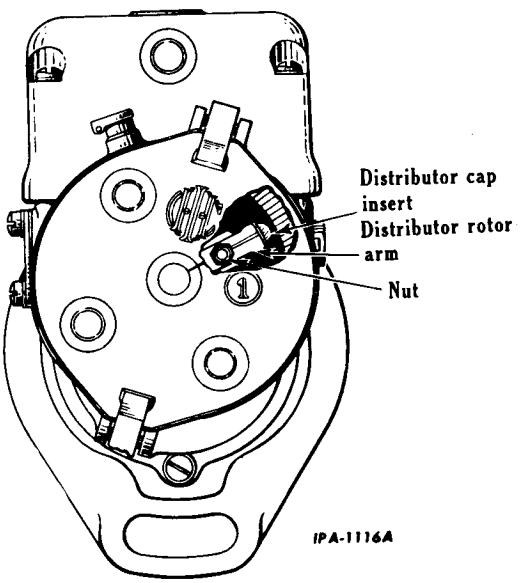


Fig. 9 - Adjusting Rotor Arm.

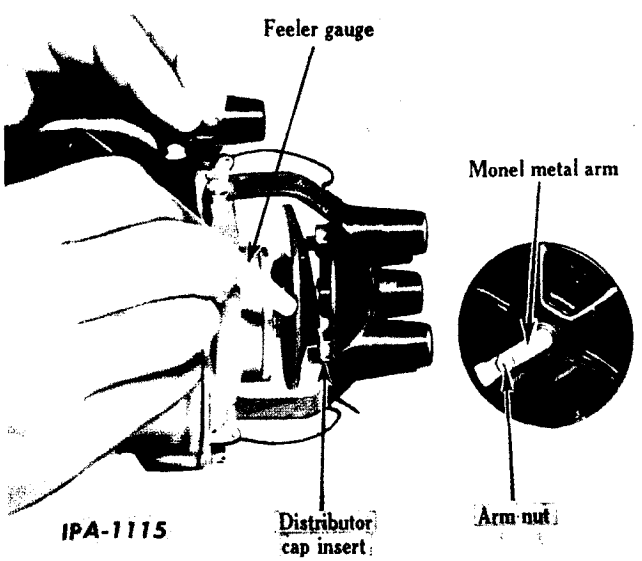


Fig. 10 - Inspecting Rotor Clearance.

The arm can be adjusted slightly to gain the desired clearance. To adjust the rotor arm, loosen the nut (Fig. 9) and move the arm to the point where the outside end just clears the vertical portion of the distributor cap inserts.

12. INSTALLATION

When installing the rotor, be sure that the rotor key on the inside of the rotor coincides with the slot on the end of the distributor spindle (Fig. 11). To assist in lining up the key with the slot , use as a guide the rib which is opposite the monel metal arm on the opposite side of the rotor, the rib being in line with the key. Be sure that the rotor is pressed on as far as it will go, as there is a possiblity of entrapped air preventing the rotor from being pushed all the way down on the hub of the distributor gear. The rotor should have a heavy hand-press fit on the distributor spindle. Install the distributor cap and the secondary cable.

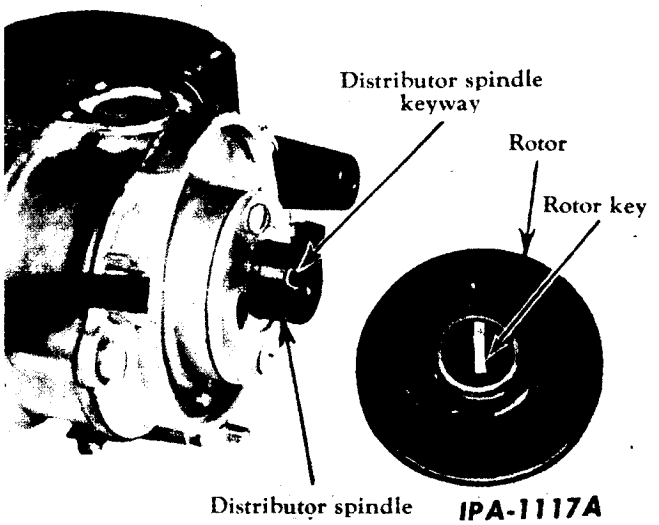


Fig. 11 - Distributor Rotor Removed.

DISTRIBUTOR GEARS

13. DESCRIPTION

The distributor gears are contained in a chamber which is a part of the distributor body (Fig. 2). This chamber is partially filled with magneto grease and sealed with felt washers around the hub of the gear.

14. REMOVAL

Remove the three cap screws (Fig. 13) from the body and remove the body with gasket.

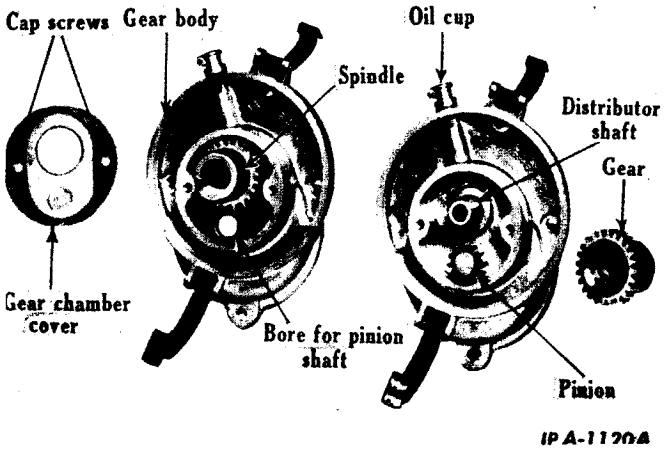


Fig. 12 - Distributor Gear Assembly.

15. DISASSEMBLY

By removing the two cap screws, the cover and gasket can be removed (Fig. 12). Then the distributor and distributor spindles can be lifted out. The felt oil seal may be replaced by driving out the old retainer.

16. INSPECTION AND REPAIR

Before replacing the retainer and felt, clean out the hole with a metal cutting tool such as a bearing scraping tool. Replace the felt and retainer and lock the new retainer in place by very lightly crimping over the edge of the body with a center punch. The thrust surface of the retainer should be flat. Do not soak the new seal in oil. After assembly, coat it lightly with magneto grease.

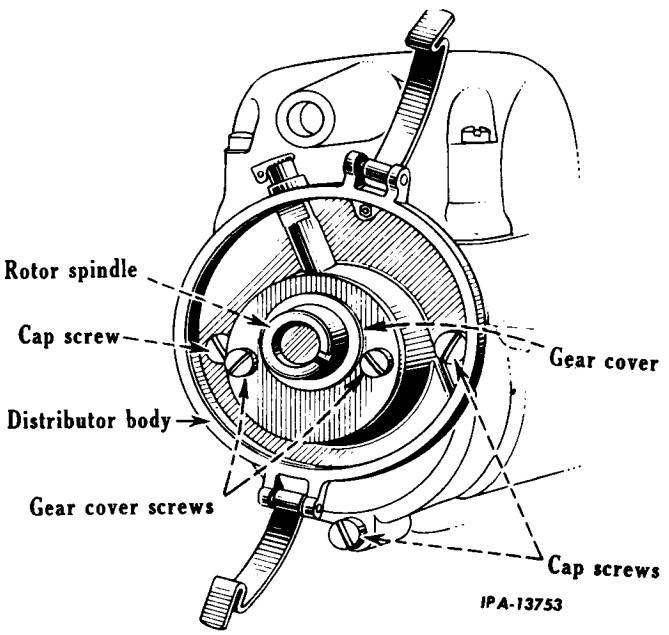


Fig. 13 - Magneto with Distributor and Rotor Removed.

17. REASSEMBLY AND TIMING

Secure the gear body, with the gasket, to the magneto frame. The body and gasket fit in one position only. Install the distributor gear spindle on the shaft. It should turn freely on the shaft. Install the distributor pinion and check the backlash with the gear. A slight movement should be felt (approx. 0.002 to 0.004 inch). Turn the rotor shaft to make the flat spot on the pinion hub line up with the flat spot on the rotor. Take off the distributor spindle and fill the bore with magneto grease. Press the distributor gear spindle onto the shaft. As the teeth of the spindle gear come into contact with the teeth of the pinion, line up the distributor spindle gear with the pinion so the marked tooth on the pinion is in line with the "L" mark on the spindle gear (Fig. 15). The "L" mark is for counterclockwise magneto (this model), and the "R" mark is for a clockwise magneto.

Partially fill the remaining chamber space with magneto grease. Install the cover, with the gasket, and secure with two screws. Install the distributor rotor as directed in paragraph 13, and secure the distributor cap.

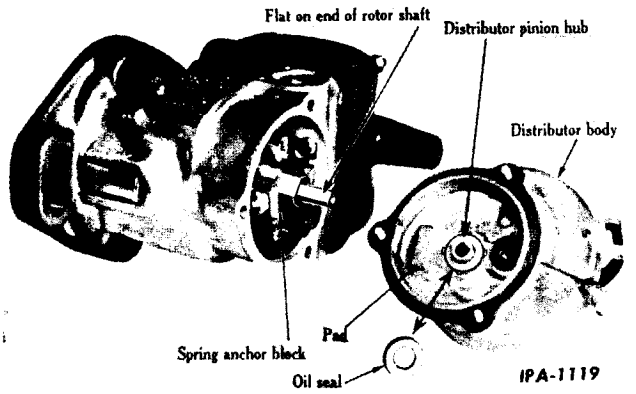


Fig. 14 - Magneto with Distributor Body Removed.

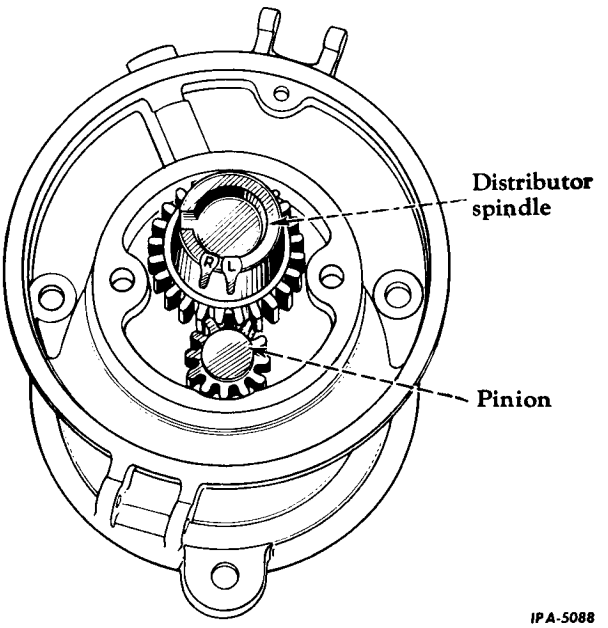


Fig. 15 - Timing Marks on Distributor.

H-4 MAGNETO

BREAKER MECHANISM

18. DESCRIPTION

The entire breaker mechanism of the magneto is in its own separate compartment, thoroughly sealed against dirt and moisture. This makes it possible to thoroughly grease the mechanism without the possibility of grit working into the lubricant and causing an abrasive action on working parts.

19. REMOVAL

(Refer to Fig. 16)

Remove the distributor cap, distributor rotor and the distributor body. Now the breaker arm assembly and spring anchor block can readily be inspected and removed for any modification that may be required. The spring anchor block can be removed by unscrewing the nut that secures it to the breaker arm and primary leadout wire spring anchor terminal. The stationary point can be removed by removing one screw.

20. INSPECTION AND REPAIR
(Refer to Fig. 17 and 18)

If the rubbing block is worn, install a new breaker arm. Examine the inside of the breaker housing for oil or grease. If oil has been leaking into the breaker housing, the grease being used in the distributor gear case is too thin. Another possible cause is that excessive lubricant is being injected into the distributor gear oil cup or that the felt oil seal is not functioning properly.

21. REASSEMBLY
(Refer to Fig. 16 and 17)

Before reassembling, thoroughly clean all parts to remove grease and oil. Apply a light coating of magneto grease to the breaker cam to prevent rusting. Reinstall the fixed breaker point, leaving the terminal screw slightly loose until the point opening has been adjusted. Secure the anchor block and primary spring terminal to the breaker arm and to the magneto. Do not flatten the spring terminal and be careful that it does not touch any part of the magneto frame. When reinstalling the anchor block, do not push it tight against the magneto body frame, but allow it to stick out far enough so it is pushed into place by the distributor pad on the distributor body (Fig. 19). Install the gear body, with gasket, and secure it with screws (Par. 18). Install the distributor rotor and distributor cap.

22. BREAKER ARM CAM —
(Refer to Fig. 18)

The breaker arm cam will last indefinitely if it is properly lubricated. If the cam becomes worn, it can be replaced. The cam is a press fit on the shaft and fits only one way

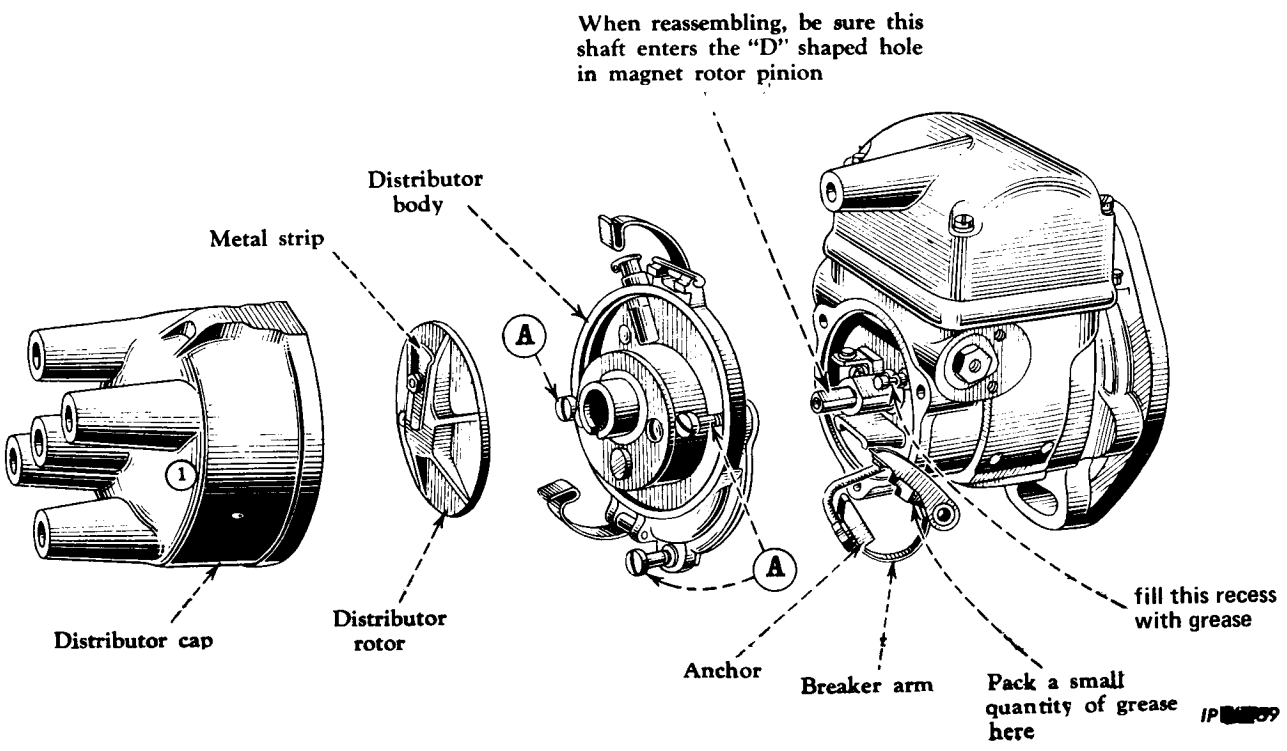


Fig. 16 - Magneto Parts Removed to Gain Access to Breaker Point Chamber.

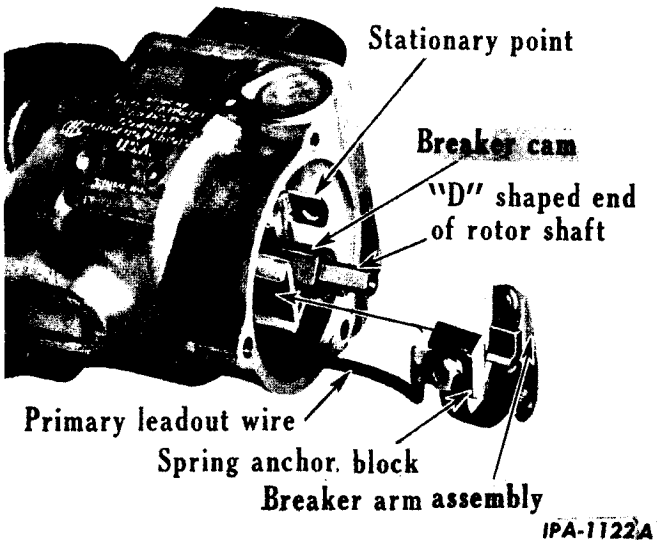


Fig. 17 - Magneto Breaker Arm Removed.

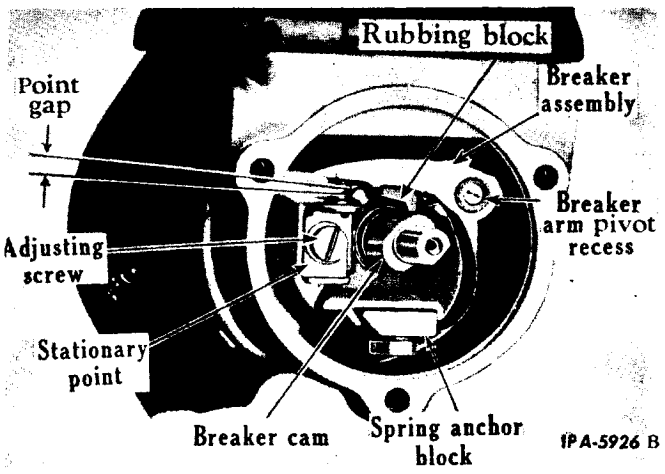


Fig. 18 - End View of Breaker Mechanism.

23. REMOVAL
(Refer to Fig. 19 and 20)

To remove the condenser with the coil in place, bend the condenser terminal lock from the flat on the condenser terminal screw. The screw can then be removed with the lock and outer bakelite washer.

Remove the coil cover, the condenser hole cover plate and the clip and screw. Push the condenser back into the frame and remove the inner washer and two primary wires from the condenser terminal. Push the condenser out through the hole in the side of the magneto.

24. INSPECTION (TEST)

Test the condenser and if it does not show to be in good condition, it should be replaced.

25. INSTALLATION

Install the inner bakelite washer. Line up the terminals of the primary wires and insert the condenser (Fig. 19).

Install the outer washer and secure the condenser in position with a nut lock and terminal screw. When tightening the condenser terminal screw, there is a possiblity of breaking the bakelite washer or of breaking the condenser terminal. Do not apply too much pressure to the wrench when tightening the screw. Secure the condenser clamp and screw. Attach the condenser hole cover plate and gasket with cap screws and washers. Install the coil cover and gasket and secure them with four cap screws.

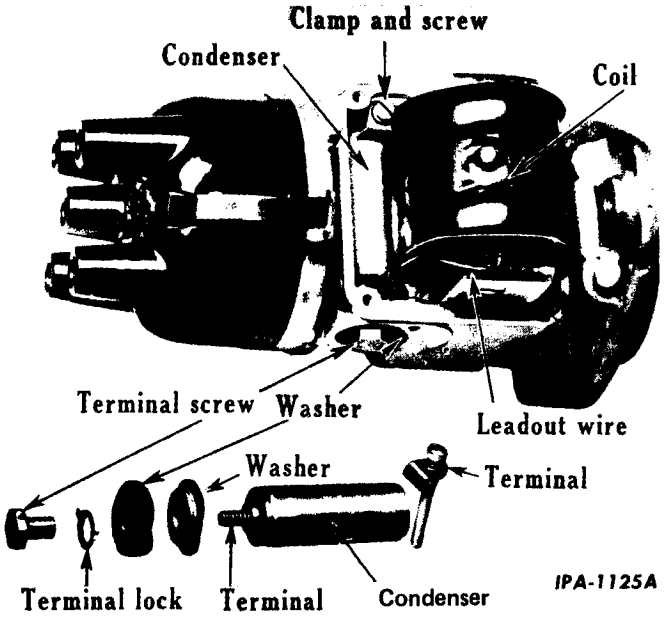


Fig. 19 - Magneto with Coil Cover Removed.

H-4 MAGNETO

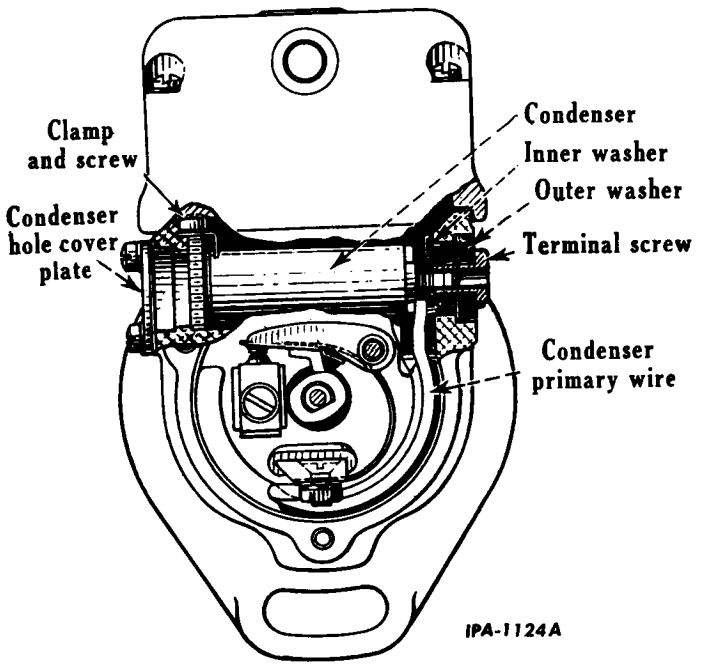


Fig. 20 - Cross Section View of Condenser Assembly.

PRIMARY WIRE

26. GENERAL

(Refer to Fig. 21)

The primary wire connecting the breaker arm assembly to the condenser terminal should be a tight fit in the rubber grommet and the grommet should be a tight fit in the magneto frame. To remove the primary wire, the spring anchor terminal must first be unsoldered (assuming the coil cover, distributor cap, rotor and body are removed). Then pull the terminal wire out from the top of the magneto. In reassembling the primary wires, reverse the above procedure. The primary wires to both the coil and condenser should be pulled tight when the condenser is assembled.

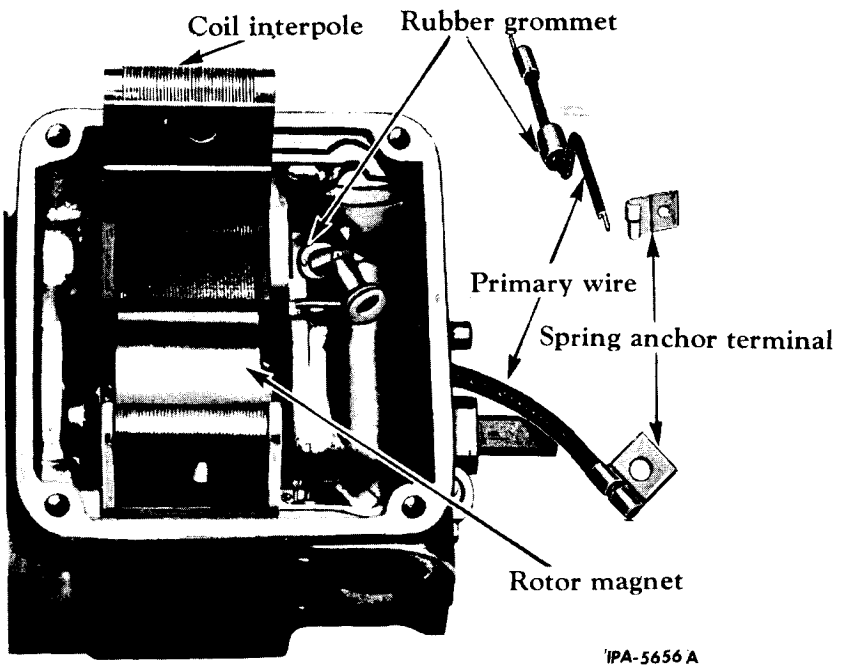


Fig. 21 - Location and Assembly of Primary Wire.

COIL AND COIL COVER

27. REMOVAL

Remove the coil cover and gasket. The screws will be retained in the cover if they are unscrewed only from the frame. Remove the primary wire from the condenser terminal. The magneto with the cover removed and the coil grounding strip attached under the coil core holding screw are shown in Fig. 19. Remove the two screws from each end of the core. Then remove the coil.

NOTE: *Before lifting the coil out, turn the magnet to the neutral position or so that the pole of the magnet bridges the air gap between the end of the coil pole pieces.*

28. INSPECTION AND REPAIR

(Refer to Figs. 22 and 23)

Inspect the end insulators of the coil. If they are damaged, they should be replaced. Test the length of the coil core mounting screws by bottoming the screws lightly in the coil core and pressing the assembly into position as shown in Fig. 23. The mounting screws are 5/8 inch long. If either screw head does not fall back of the face of the pole piece by 1/32 inch as shown, it must be removed and enough cut off the threaded end to make it fit properly.

When the coil core is in place, the screws will then tighten up in the countersunk hole of the pole piece before the screws bottom in the coil core.

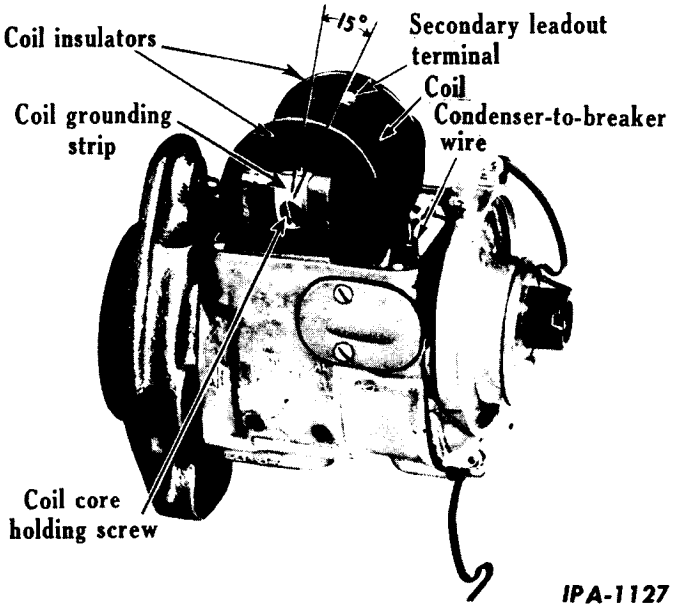


Fig. 22 - Coil Mounted on Magneto.

NOTE: *Do not file or otherwise deface the ends of the coil core of the face of the pole pieces, as this will impair the magnetic circuit and the efficiency of the magneto.*

Test the coil. If it does not show to be in good condition, it should be replaced.

29. INSTALLATION

(Refer to Fig. 22)

Press the coil in place; the secondary leadout terminal should be at an angle of 15° with the center line of the coil. The reason for so positioning the coil terminal is to secure a good contact with the secondary terminal outlet in the coil cover. Position the grounding strip and secure the coil core holding screws tightly in position.

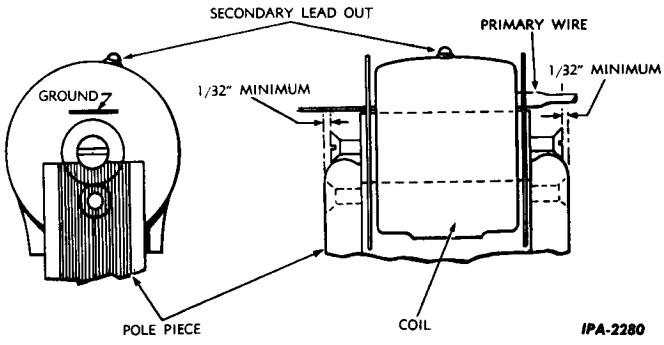


Fig. 23 - Assemble Coil Core Mounting Screws to Coil Core So They Do Not Bottom in Core when Assembled in the Magneto.

Install the condenser (Par. 26). Before installing the coil cover, be sure that the contact points are clean and that the secondary leadout in the coil cover bears firmly against the secondary leadout terminal. Install the coil cover, with gasket, and secure it to the magneto frame with four screws.

IMPULSE COUPLING

30. DESCRIPTION

The impulse coupling, inserted between the magneto and the magneto drive, provides easy and positive starting of the engine at low starting speeds. The first purpose of the impulse coupling is to retard the spark at low engine speeds to approximately top-dead-center of the piston stroke, thereby preventing the engine from backfiring. As the magneto member (Fig. 25) is retarded by the pawls at low speeds, these pawls are stopped by pawl stop pins (Fig. 28). The lug on the magneto member compresses the impulse spring. The lugs on the impulse drive member, which continues to rotate at constant speed, trips the pawls (forces them away

H-4 MAGNETO

from the pawl pin) and the magneto member (keyed to the magneto rotor) is forced to rotate by compressed spring at a greater speed than that of the drive member. The increased speed of the rotor provides a much hotter spark to the engine than would be provided by a direct drive to the magneto.

As the speed of the engine increases, the weighted ends of the pawls are thrown out by centrifugal force and their short ends no longer engage the pawl stop pins in the mounting flange. The spark is no longer retarded. The missing speed, approximately 150 rpm is the speed at which the impulse coupling no longer continually retards the spark. At this speed it retards the spark intermittently only. Over the range of the throw-out speed, 240 to 330 rpm, the impulse coupling should cease to function completely, giving the effect of a direct drive.

31. REMOVAL

To remove the impulse coupling, insert a nail or pin through a hole (Fig. 26) in the coupling drive member, locking the two elements together. Apply a socket wrench to the nut and an adjustable wrench to one of the driving lugs to prevent shearing the nail or pin while removing the nut. The impulse coupling can now be removed with a tool (SE-912) (Fig. 27). As the tool is turned in, the inside end contacts the rotor shaft and forces the member off the shaft.

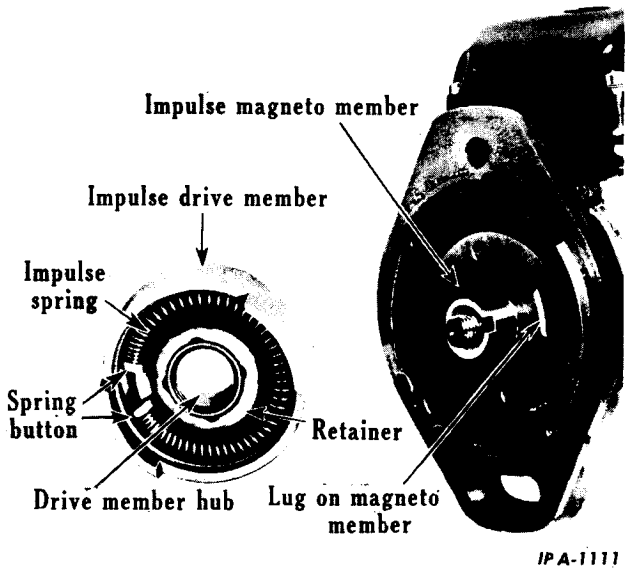


Fig. 24 - Magneto Impulse Coupling Removed.

32. DISASSEMBLY AND REASSEMBLY

(Refer to Fig. 24)

The impulse coupling drive member, with impulse coupling spring, can readily be removed. The impulse coupling spring should seldom be removed from the driving member but, should it be necessary, it can be pried out of place. To install this spring, just compress it sufficiently to fit into the drive member as shown. Before assembling the impulse drive member with the magneto member, soak the wick inside the impulse coupling spring with light oil. Coat the inside drive member hub of the driving member with magneto grease. The lug of the magneto member should be a tight fit between the hardened buttons on each end of the impulse coupling spring. If the buttons become worn or grooved, install new ones.

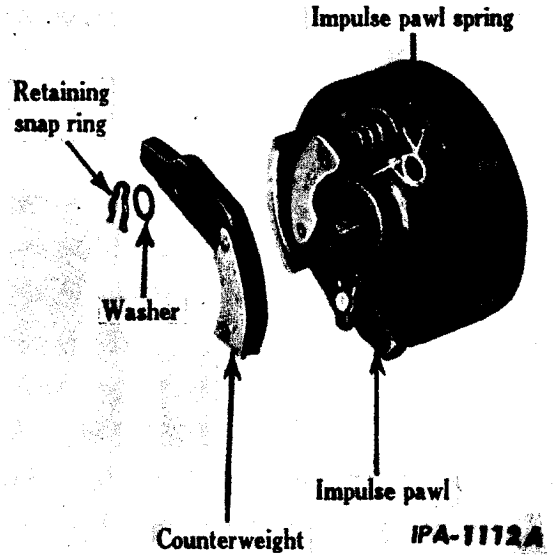


Fig. 25 - Complete Impulse Coupling Showing Rear Side of Magneto Member with Impulse Pawl Removed.

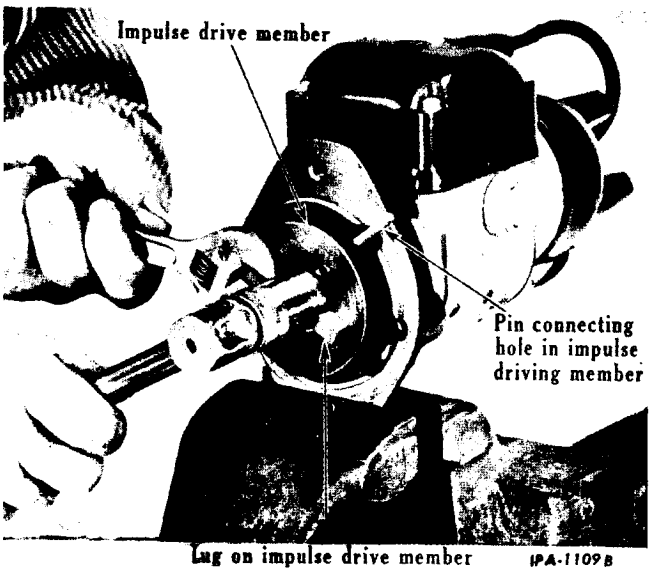


Fig. 26 - Correct Method of Removing Impulse Coupling Nut.

The impulse pawl can be taken off after removing the retaining snap ring and washer. The impulse pawl spring can then be reinstalled. Use a small amount of grease on the pawl pivot and install the springs, pawls, washers and snap rings. The pawls should move freely on the pivots. When installing the drive member, be sure the lug of the magneto member fits between the spring buttons.

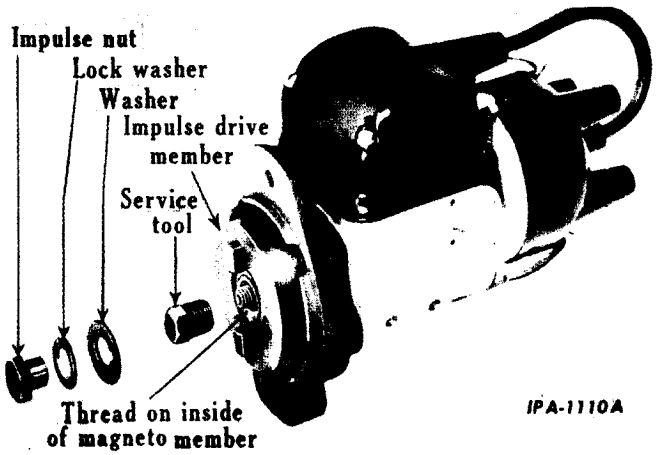


Fig. 27 - Removing Impulse Coupling.

33. INSTALLATION

(Refer to Fig. 28)

Place a small amount of magneto grease on the pawl pin (Fig. 28). Press the assembled impulse coupling on the rotor shaft. Be sure that the keyway in the magneto member engages the key in the magneto rotor shaft. Install the washer and lock washer, which will fit in one position only. Tighten the impulse coupling nut.

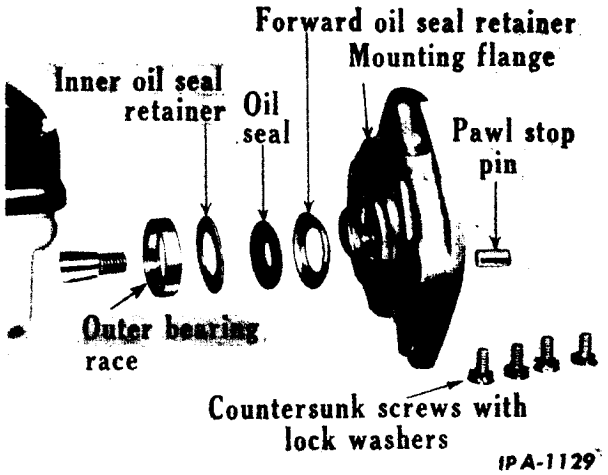


Fig. 28 - Magneto with Impulse Coupling.

MOUNTING FLANGE

34. REMOVAL

The mounting flange (Fig. 28) is attached to the magneto bracket and is held to the magneto with four countersunk screws and lock washers.

Remove the impulse coupling (Par. 33). The flange is freed by taking out the four screws.

35. DISASSEMBLY AND REASSEMBLY

Remove the outer bearing race (Fig. 28). Place the inner retainer in position with the internal taper side of the oil seal facing the bearing race (the bulged side of the oil seal faces the retainer.) Then install the inner retainer and press the bearing race in position. Assemble the mounting flange to the magneto body and check the rotor shaft for end play (Par. 40).

36. INSTALLATION

After the proper reassembly of the mounting flange has been made as directed in Par. 35, install the flange and secure it with screws and lock washers.

ROTOR

37. REMOVAL

To remove the rotor and bearing, it is necessary to remove the impulse coupling (Par. 31) and mounting flange (Par. 34). Then slide the rotor magnet into a keeper (Fig. 29) as it is being removed from the magneto frame. Always have the rotor in the keeper while it is out of the magneto frame. Use extreme care to be sure that the rotor magnet does not pick up dirt and metal particles.

38. DISASSEMBLY

1. The inner bearing race can be removed readily from the rotor by using a puller and adapter as shown in Fig. 30. It is necessary to remove the inner bearing race when removing or inserting rotor shims for preloading the rotor bearings.

2. When the bearing inner race has been removed, the inner oil flinger and the rotor shims are free.

39. REASSEMBLY

1. Thoroughly clean the rotor and bearing parts and reassemble to the rotor approximately the same thickness of shims as taken out.

2. Replace the inner oil flinger (Fig. 32) with the upset portion toward the rotor magnet.

3. Press the bearing inner race firmly into place and install the bearing retainer with balls.

4. The oil seal in the magneto frame and mounting flange can now be installed (Par. 35).

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40. ADJUSTMENT

Thoroughly clean the rotor assembly and bearing races of the old grease and any grit. Lubricating the bearings should not be done until they have been checked for end play.

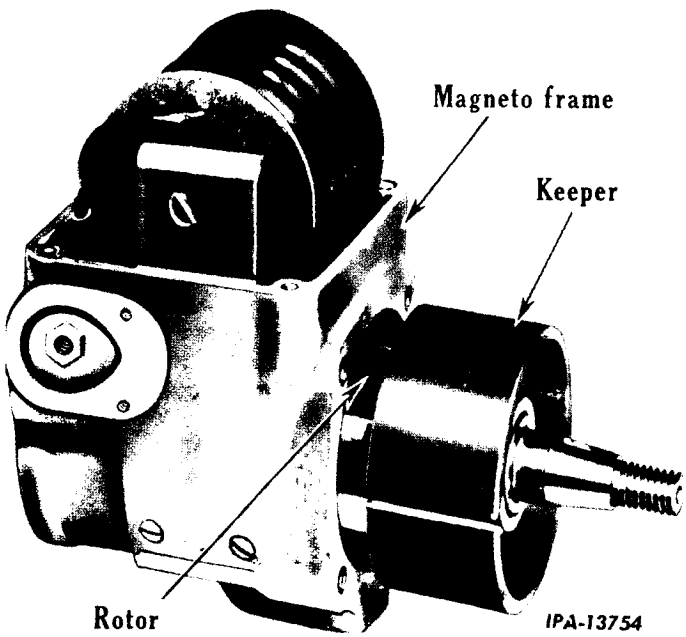


Fig. 29 - Removing Magneto Rotor.

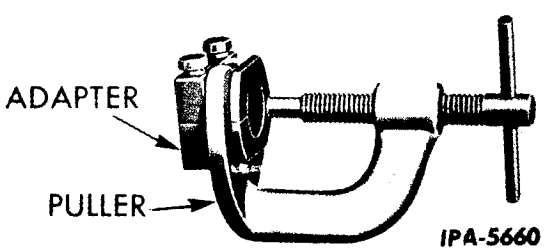


Fig. 30 - Inner Race Puller Tool SE-839.

The old bearings and races should be assembled without disturbing the shims. Should an end play check reveal that end play is present, no attempt should be made to preload the old bearings, as this would cause rapid deterioration of the bearings. The recommended procedure, when end play exists on old bearings, is to replace them.

The distributor body assembly (Fig. 14) should be removed to facilitate correct adjustment of the magneto rotor.

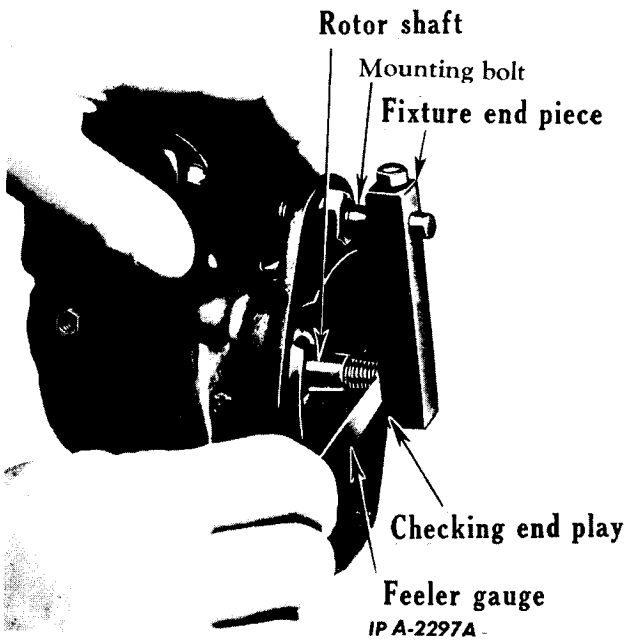


Fig. 31 - Checking Rotor End Play.

Place sufficient shims (Fig. 32) in back of the new bearing race to allow a small amount of end play in the rotor shaft after it is completely assembled. The end play should be checked with no grease on the bearings. Secure the mounting flange in place with the mounting screws (Fig. 28). Then check the end play between the fixture and the end of the rotor shaft with a feeler gauge (Fig. 31).

Take two readings with the feeler gauge; one with the rotor as far one way as it will go and the other with the rotor moved as far in the opposite direction as it will go. The difference in these two readings will be the actual end play. Add 0.001 inch to the difference between the two readings, which should be the thickness of the additional shims to be added.

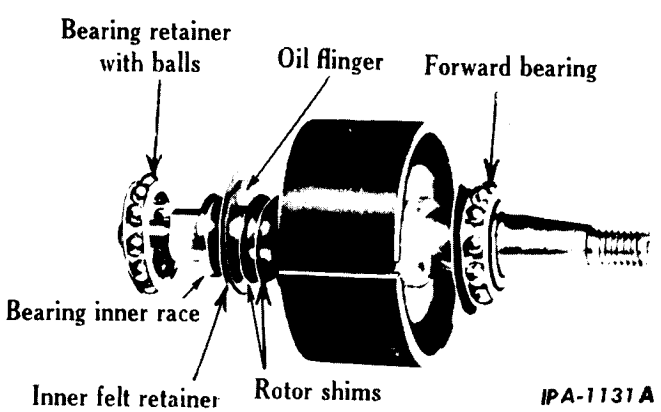


Fig. 32 - Rotor Shaft with Keeper, Bearings and Shims.

Remove the mounting flange, slide the rotor into the keeper, pull the outer race from the shaft and add the required number of shims (Fig. 32) in the proper location. Grease the ball bearings, reassemble the rotor and the mounting flange and check the rotor for free turning. Be careful not to overfill the bearing retainer with grease; just fill the spaces between the balls in the retainer with magneto grease. The preloading of the bearing should not cause binding of the rotor.

41. INSTALLATION

Install the impulse coupling, distributor body, distributor and distributor cap.

BEARING OUTER RACES AND OIL SEALS

42. REMOVAL

The front bearing outer race and oil seal are assembled in the mounting flange (Fig. 28). They are accessible after removing the impulse coupling and the mounting flange as directed. (Refer to Par. 32 and 35). The purpose of the oil seal is to keep lubricating oil out of the magneto body.

The rear bearing outer race and oil seal are assembled in the main frame. The magneto rotor distributor cap, distributor rotor, and distributor body assembly must be removed in order to remove the rear bearing outer race and oil seal.

43. DISASSEMBLY

The rotor shaft oil seal and the retaining members are held in place by the press fit of the rotor ball bearing outer race (Fig. 28). The rotor bearing races can be removed with a puller (SE-1020) and installed with a tool (SE-1021) shown in Fig. 33.

The magneto outer bearing races in both the main frame and the magneto flange can be removed readily. Loosen the expander and insert the tool into the bearing race. Manipulate the split sleeve flange through the bearing race and hold it against the felt retainer. Draw up on the expander by applying a wrench to the flats on the threaded end of the expander and turning in a counterclockwise direction until a definite pressure is felt. Then tighten the nut and carefully drive the bearing race from place on the shaft.

44. REASSEMBLY AND INSTALLATION

The sequence of assembly of the outer bearing race and oil seal is shown in Fig. 28. The internal taper side of the oil seal faces the bearing race and the bulged side of the oil seal faces the oil seal retainer. Careful centering and proper arrangement of the oil seal produces maximum compression and efficiency.

Before installing the outer bearing, be sure the felts and retainers are correctly assembled in place.

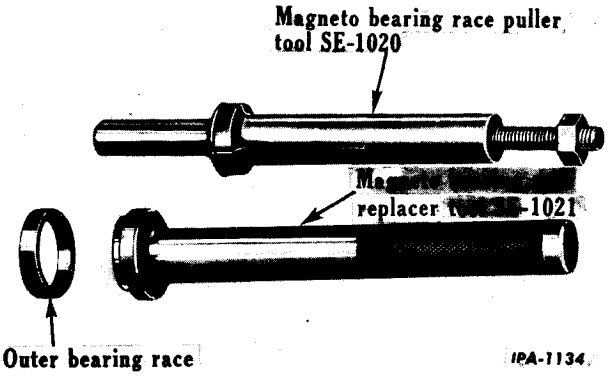


Fig. 33 - Tools Used for Removing and Installing Magneto Outer Bearing Races.

Set the bearing race on the end of the tool (Fig. 33). A small amount of clean grease will hold the race on the tool. Carefully line up the tool over the hole and drive the race in place.

J-4 MAGNETO

1. DESCRIPTION

The I.H. J-4 magneto is a waterproofed, fixed-spark, high tension ignition unit. The automatic impulse coupling insures a hot spark for easy starting and retards the ignition timing at cranking speed for the protection of the operator or cranking motor. It is flange mounted to the crankcase and the drive operates at the same speed as the crankshaft. The direction of rotation is clockwise as viewed from the drive end.

As the magneto is rotated, electrical current is generated and discharged across the point gaps of the spark plugs to ignite the fuel in the cylinders. The impulse coupling retards the spark timing approximately 13 degrees for starting purposes. The magneto is timed to the engine to trip the impulse coupling at top-dead-center of piston travel at cranking speeds.

At all engine speeds above 230 to 340 rpm, the impulse coupling does not operate and the ignition spark occurs between 12 and 16 degrees before the piston reaches top-dead-center.

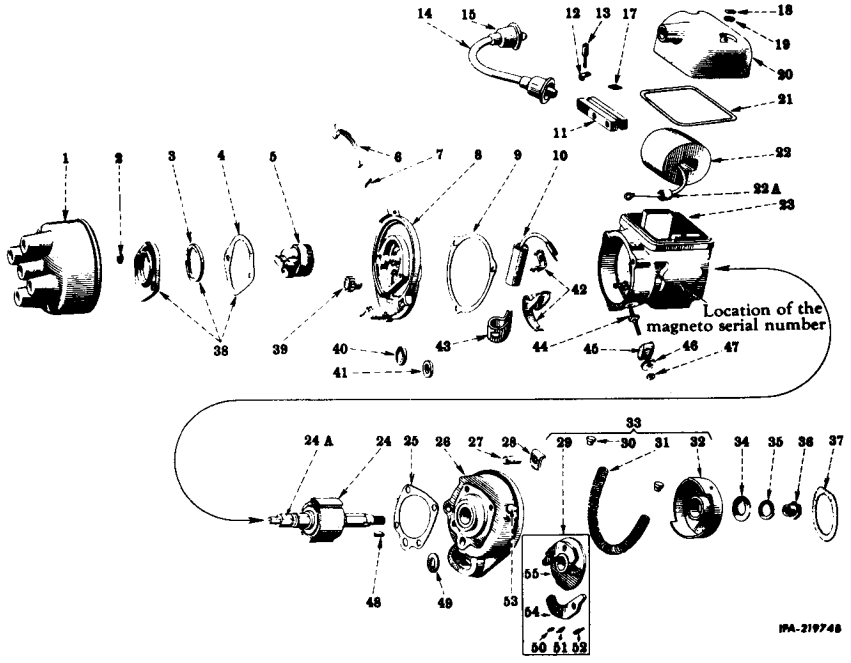


Fig. 1 - Exposed View of I.H. J-4 Magneto.

1. Distributor cap.
2. Washer.
3. Gear cover felt.
4. Gear cover gasket.
5. Rotor.
6. Cap spring.
7. Cap spring pin.
8. Distributor body.
9. Body gasket.
10. Condenser.
11. Coil core.
12. Coil core clip.
13. Hold down screw.
14. Coil-to-distributor cable.
15. Nipple.
17. Coil wedge.
18. Washer.
19. Washer.
20. Coil cover.
21. Coil cover gasket.
22. Coil.
22A. Tube.
23. Frame.
24. Rotor assembly.
24A. Breaker cam.
25. Gasket.
26. Mounting flange assembly.
27. Coupling stop pin.
28. Magneto mounting clip.
29. Magneto member assembly.
30. Spring end button.
31. Coupling spring.
32. Drive member.
33. Impulse coupling rotating unit assembly.
34. Lock washer.
35. Lock washer.
36. Coupling nut.
37. Gasket.
38. Gear cover.
39. Rotor pinion.
40. Felt retainer.
41. Distributor body felt.
42. Point set.
43. Condenser clamp.
44. Terminal screw.
45. Insulator.
46. Insulator washer.
47. Washer.
48. Key.
49. Washer.
50. Washer.
51. Snap ring.
52. Pawl spring.
53. Bearing oiler.
54. Pawl.
55. Magneto member.

J-4 MAGNETO

2. REMOVAL

1. Disconnect the switch wire from its terminal on the side of the magneto case. Removal all of the spark plug cables.

2. Remove the cap screws and washers that secure the magneto to the engine crankcase (Fig. 2).

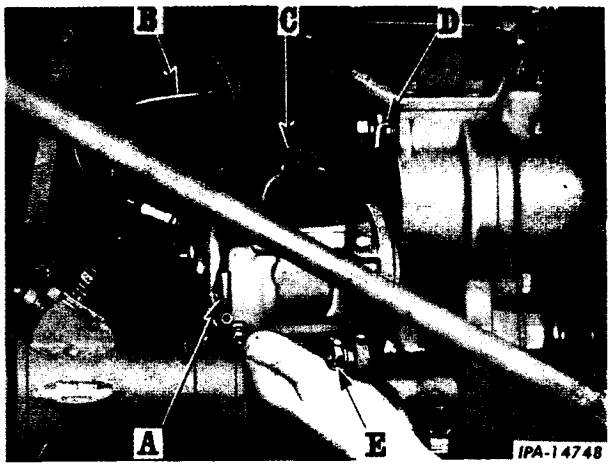


Fig. 2 - Removing the Magneto: A, Switch wire; B, Center cable; C, Coil cover; D and E, Retaining Capscrews and Washers.

Because of similarities in the two magnetos, follow the procedures for "Disassembly" and "Reassembly" as given for the International H-4 magnetos (Sec. 12). The major difference is that the H-4 is equipped with ball bearings instead of bushing type bearings (Fig. 1).

3. INSPECTION AND REPAIR

1. Inspect the breaker mechanism. Remove the distributor cap (Fig. 3) and then turn the engine over slowly with the crank. Stop when the metal strip on the distributor rotor points toward the No. 1 terminal on the distributor cap and the impulse coupling just trips. Then, remove the distributor body by removing the three flat head 10-32 screws. This exposes the breaker arm with the points and the condenser.

2. If the breaker chamber is dirty or the parts are oily, remove the breaker arm and clean all of the parts thoroughly. If oil or grease reaches the surface of the breaker points, it will cause sparking or arcing that will accelerate wear and pitting.

3. Inspect the points and, if necessary, dress them carefully with a sharp fine ignition file. If the points are excessively worn or pitted, replace both points.

4. Fill the recess in the breaker arm post with IH magneto grease.

Pack a small quantity at the back of the breaker arm rubbing block; then, reassemble the breaker arm.

5. Reset the adjustable point until a 0.013-inch feeler gauge will just slip between the points when the rubbing block of the arm rests on the high point of the cam and the adjustable point retaining screw is tight (Fig. 4).

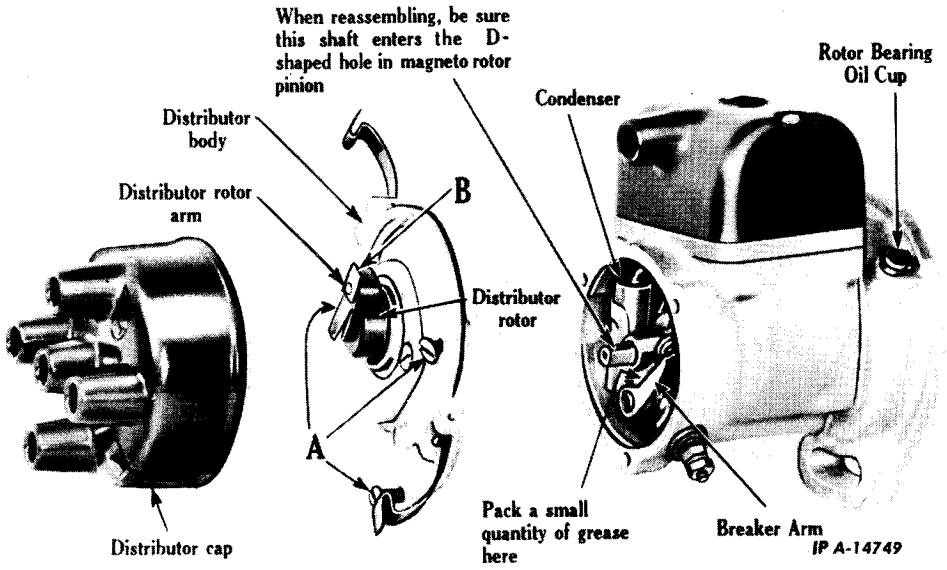


Fig. 3 - Magneto Disassembled. Note A, Flat - head Retaining screws; B, Rotor.

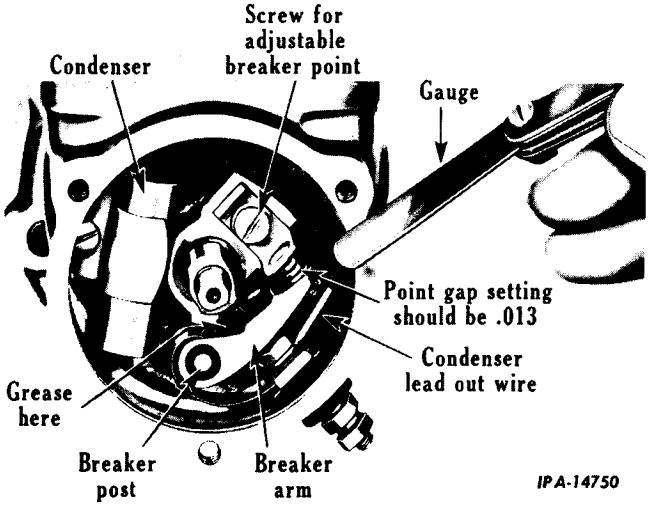


Fig. 4 - Adjusting the Breaker Points.

6. With No. 1 piston at top-dead-center of the compression stroke, position the distributor rotor so that it points toward the No. 1 terminal of the distributor cap. Now, place the distributor body back onto the magneto. The rotor shaft should enter the distributor pinion freely in this position. Tighten the three flat-head screws and replace the distributor cap.

NOTE: *The distributor cap and rotor should be kept as free of dust and oil as possible at all times, as such accumulations tend to absorb moisture and cause misfiring. The small ventilating holes in the distributor cap should be kept open at all times. Ventilation aids in evaporation and reduces the condensation of moisture in the distributor.*

4. INSTALLATION AND TIMING

1. Remove the center cable from the distributor cap to the magneto coil cover to prevent accidental starting of the engine during the following step-by-step procedure. See B in Fig. 2.

2. Turn the engine with the crank until the No. 1 piston (at the timing gear end of the engine) is on top-dead-center of its compression stroke. This can be determined by removing the No. 1 spark plug, placing your thumb firmly over the opening, and cranking slowly until outward pressure is felt. Continue cranking very slowly until the notch on the fan drive pulley is in line with the timing pointer on the crankcase cover. This notch indicates top-dead-center.

NOTE: *Later engines have two notches; the first indicates 16 degrees and the second indicates top-dead-center.*

3. Remove the magneto distributor cap and turn the magneto coupling in a counterclockwise direction (as viewed from the coupling end) until the distributor rotor points toward the No. 1 terminal on the cap.

4. Replace the distributor cap.

5. Assemble the magneto on the engine, being certain that the lugs on the impulse coupling engage the slots in the timing gear. Assemble the magneto so that the top is as close to the crankcase as possible.

6. Insert cap screws with washers in the magneto flange, and tighten only sufficiently to hold magneto in place. Then crank the engine one complete revolution bringing the "TDC" notch on the fan drive pulley again in line with the pointer (Fig. 5). Now, slowly move the upper part of the magneto away from the engine until the impulse just trips.

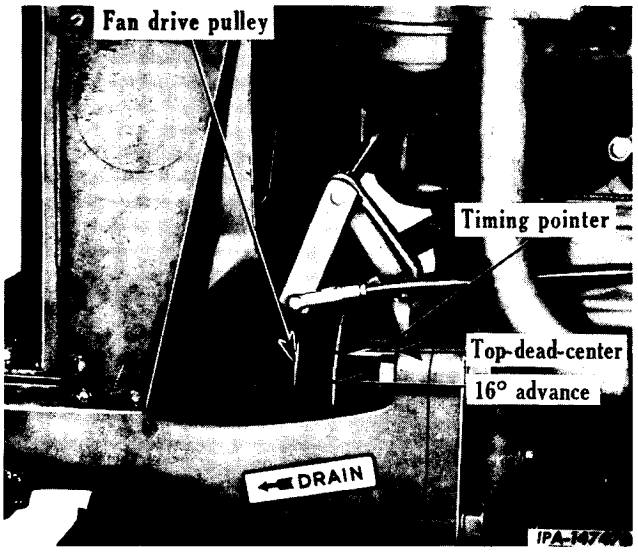


Fig. 5 - Top - dead - center notch on the Fan Drive Pulley in Line with Timing Pointer.

7. Without moving this position of the magneto, tighten the mounting cap screws securely. Attach the spark plug cables, connecting the No. 1 cylinder spark plug cable to the socket marked "1" on the distributor cap. As the distributor turns clockwise facing the cap, place the No. 3 plug wire in the next clockwise cap socket. Then place the No. 4 plug wire in the next clockwise cap socket, and the No. 2 plug wire in the remaining cap socket (Fig. 6).

8. Connect the switch wire to the terminal on the side of the magneto.

9. Recheck the timing by cranking the engine slowly. The impulse coupling should trip each time the "TDC" notch on the fan drive pulley lines up with the pointer in the crankcase front cover.

10. If timing is correct, replace the cable between the magneto coil cover and the center socket of the distributor cap.

J-4 MAGNETO

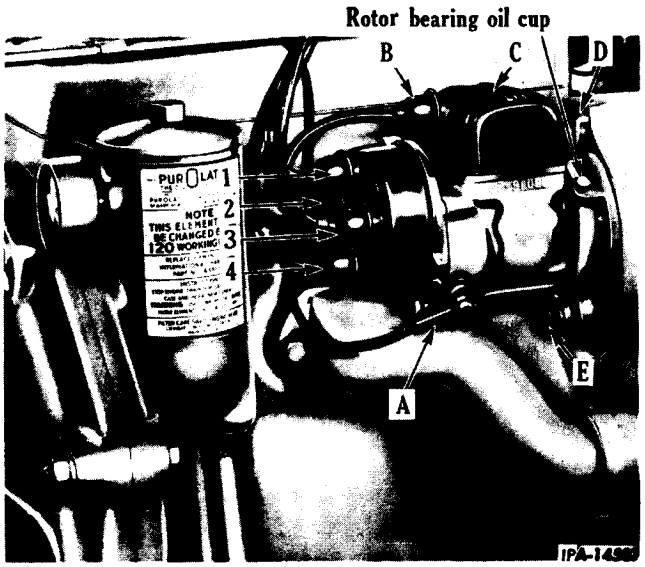


Fig. 6 - Magneto Wiring: A, Switch wire, B, Center cable; C, Coil cover; D and E, Retaining capscrews and washers.

IGNITION COIL, SPARK PLUGS AND BATTERIES

IGNITION COIL

1. DESCRIPTION

The ignition coil transforms the low voltage of the batteries or generator into high voltage sufficient to jump the gaps at the spark plugs.

There are two windings in the coil. The primary winding is composed of a comparatively few turns of heavy wire wound on the outside of the secondary winding. The secondary winding is composed of many thousands of turns of fine wire.

Unless the coil is hermetically sealed, moisture in the form of rain, snow and road splash, and high pressure washing, particularly when the engine and the coil are hot after working, tends to decrease the service that could otherwise have been expected.

2. REMOVAL

Remove the electrical leads from the coil, tagging each to facilitate correct replacement. Remove cap screws which secure the coil to the engine.

3. INSPECTION AND REPAIR

Clean the terminals and lead ends. No repairs should be attempted if the coil is inoperative; replace with new.

4. INSTALLATION

Install the coil in the reverse order of removal. Be sure that the connections are secure.

SPARK PLUGS

5. DESCRIPTION

Spark plugs are made with a central electrode imbedded in porcelain or mica insulation which is securely clamped in the metal spark plug body. Attached to the lower end of the spark plug is the grounded electrode. The two electrodes are separated by the spark gap.

The function of the spark plug is to furnish a spark which jumps the gap and ignites the mixture of fuel and air in the cylinder.

A copper gasket is placed at the threaded end when the spark plug is screwed into position.

CAUTION: Never touch the spark plugs or the spark plug high tension cables while the engine is operating.

6. REMOVAL

1. Disconnect the spark plug cables.

2. Unscrew the spark plugs with a spark plug wrench, and remove the spark plugs and gaskets.

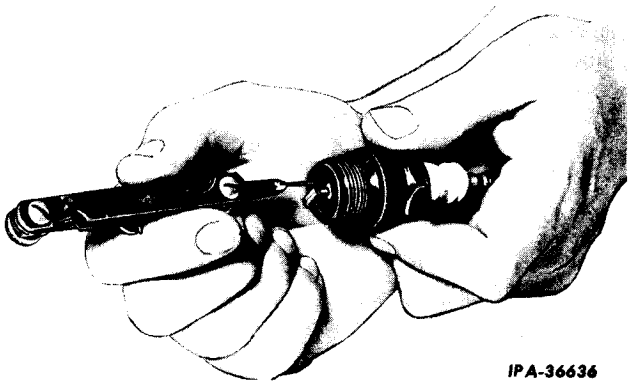


Fig. 1 - Checking Spark Plug Gap.

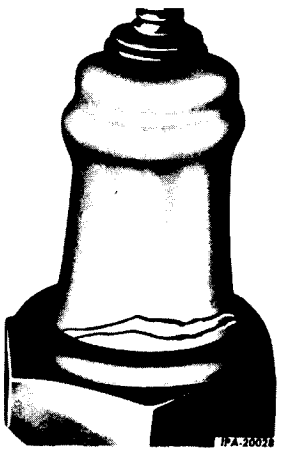


Fig. 2 - Broken Insulator (Careless Handling).

Fig. 3 - Carbon Coating (Rich Mixture, Oil Pumping or Cold Plug).

IGNITION COIL, SPARK PLUGS AND BATTERIES

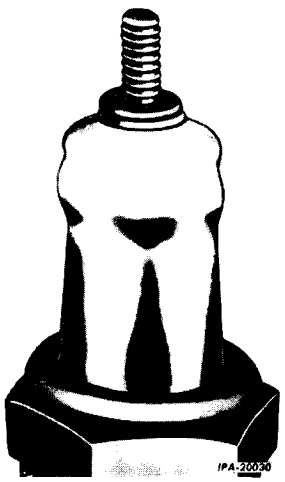


Fig. 4 - Streaked Insulator Top (Blow-By).

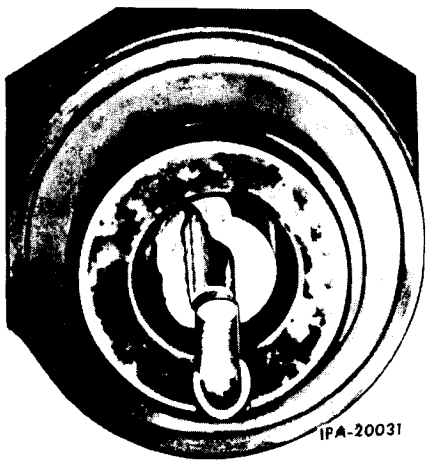


Fig. 5 - Split Insulator (Bending Center Electrode).

Fig. 6 - Badly Burned (Pre-Ignition or Poor Coupling).

Fig. 7 - Worn Side Electrode (Loose Plug or Too Hot).

7. INSPECTION AND REPAIR

1. Sand blasting is the recommended method of cleaning spark plugs. Do not expose the plug to sand blasting for more than three or four seconds.

2. Never use any cleaning material on the insulation that may crack or chip it. Such cracks or chips will provide a recess for carbon deposits and provide a path for leakage of high tension current to ground.

3. Never scrape the insulator. Wash the plugs in a petroleum solvent and blow dry with clean compressed air.

4. Never bend the center electrode. To do so will cause straining or cracking of the porcelain insulator.

5. Never use graphite or other lubricants on the threads of spark plugs.

6. When removing or installing spark plugs, use only a correctly fitting deep socket wrench. An end wrench can easily slip and break the porcelain. Spark plugs should be torqued to be able to perform efficiently.

7. Do not screw a cold spark plug tightly into a hot cylinder head. Allow the cylinder head to cool first. Use a new copper gasket for each plug.

8. If a spark plug is thought to be faulty, it should be tested in a spark plug tester to be sure of its condition.

INSPECTION	REMEDY
1. Inspect for cracked or blistered insulation	Replace spark plugs as necessary.
2. Inspect for dirty or worn electrodes	Clean dirty electrodes by soaking in a petroleum solvent, or sand blasting. Replace spark plugs having worn electrodes.
3. Check gap between electrodes	Adjust as specified in Par. 2, Section 1, "SPECIFICATIONS." Use a gap gauge and pliers.

8. INSTALLATION

1. Before installing spark plugs, clean the seats around the spark plug holes in the cylinder head.

2. Check the spark plug gaps and be sure the recommended gap is used.

3. Screw the spark plugs into the cylinder head, using a new copper gasket with each one. Torque as given in service chart.

4. Connect the spark plug cables in the proper firing order.

STORAGE BATTERY

9. GENERAL

The purpose of the storage battery is to provide energy for starting the engine and to supply, for a limited period of time, electrical loads exceeding the output of the generator.

The amount of energy that a fully charged battery can produce depends primarily upon the size and number of the plates.

The total energy that a good battery can produce when at full charge is indicated by its ampere hour rating. A 120 ampere hour battery has greater capacity for storing energy and doing work than a 100 ampere hour battery because the 120 ampere hour battery has larger plates or a greater number of plates.

The ampere hour rating of a battery is usually stamped or printed on the battery case.

A battery should be maintained at not less than 3/4 full charge in normal operation in the tractor or power unit. If it is found that the battery is less than 3/4 charged, it is almost certain that some condition exists which should be corrected without delay.

10. COMMON CAUSES OF BATTERY FAILURE

1. Resistance in the charging circuit.

2. Defective generator or slipping generator drive belt.

3. Improper regulator adjustment, or faulty regulator.

4. Overload due to defective starting system, or excessive use of accessories.

5. Dirt, corrosion and electrolyte on top of battery causing a constant drain.

6. Hardened battery plates, commonly called "sulphation" due to the battery being in a low state of charge over a long period of time.

7. Physical defects such as shorted cells, loss of active material from the plates, broken terminals, etc.

It is important to note that, of the seven common causes of battery failure listed above, the first five causes are outside the battery. Any one of these conditions will result in a battery being at less than normal state of charge.

The sixth cause listed can result from any one of the first five causes. This is, sulphation occurs when any condition causes the battery to be undercharged for long periods of time. When a battery becomes sulphated, it will not accept a normal rate of charge and also, its capacity decreases. Sulphation can usually be overcome by prolonged slow charging or by discharging the battery completely, letting it stand discharged for 6 to 12 hours, and then recharging it slowly.

The causes of battery failure listed in Par. 10, Step 7 are the defects that can occur in the battery itself. If shorted cells or loss of active material from the plates occur when the battery has been in service for less that its guaranteed life, it is usually a result of overworking or overcharging of the battery. Cracked cases, broken terminals and, also, shorted cells can be caused by improper handling of the battery or a faulty battery carrier in the tractor or power unit.

NOTE: *When a battery fails, do not be satisfied to merely recharge or replace it. Find the cause of failure to prevent recurrence.*

11. BATTERY VISUAL INSPECTION

The battery should always be very carefully inspected before the actual testing is done. Many undesirable conditions can be seen and corrected before they result in battery damage. Other visible indications are very important when analyzing the hydrometer readings.

1. Inspect the battery case for cracks and leaks.

IGNITION COIL, SPARK PLUGS AND BATTERIES

2. Inspect the battery posts, clamps and cables for breakage, loose connections, corrosion and other faults.

3. Note whether the top of the battery is clean and dry. Dirt and electrolyte on top of the battery causes excessive self-discharge.

4. Be sure that the cell vents are open.

5. Be sure that the battery carrier is solidly mounted and in good condition, and that the battery hold-down is properly tightened. A loose battery carrier or battery hold-down will allow the battery to be damaged by vibration and jarring. An excessively tightened battery hold-down may buckle or crack the battery case.

6. Inspect the battery for raised cells covers or warped case which may indicate that the battery has been overheated or overcharged at some time.

7. Inspect the electrolyte level. If the electrolyte is below the top of the plates, add water. If not below the plates, make hydrometer test before adjusting electrolyte level.

8. Note the ampere hour rating of the battery (usually stamped on the case). If not indicated, refer to the manufacturer's specifications for battery capacity.

> **NOTE:** *Make the battery visual and hydrometer test, then see the battery test indications and recommendations (Par. 15).*

12. SPECIFIC GRAVITY TEST

A hydrometer is used to test the specific gravity (weight) of the battery electrolyte. The weight of the electrolyte indicates the approximate state of charge of the battery. A temperature corrected hydrometer must be used when testing specific gravity of battery fluid, so that the hydrometer readings can be corrected for the effects of temperature and the true specific gravity determined.

> **NOTE:** *If water has been recently added to the cells or the battery fast-charged, the hydrometer reading will be false.*

1. Remove the cell caps, being careful to keep dirt out of cells.

2. Draw enough fluid into the hydrometer from one cell to raise the float off the bottom of the tube, but not enough for the float to touch the top of the tube.

3. Hold the hydrometer straight so that the neck of the float does not touch the sides of the tube, and take the reading at eye-level.

4. Return all the fluid from the hydrometer to the cell being tested and record the reading for that cell.

5. Test the remaining cells in the same manner. Then note the reading on the thermometer on the side of the hydrometer and correct to standard reading at 80° F by referring to the following table.

At the top of the table find the column headed by the temperature nearest to the electrolyte temperature; find in that column the figure nearest the observed specific gravity reading and trace horizontally across to the 80° F column. The figure in the 80° F column is the true electrolyte specific gravity and should form the basis for any adjustment.

0° F	20° F	40° F	80° F	100° F	110° F	120°F
1.251	1.243	1.236	1.220	1.213	1.209	1.205
1.261	1.253	1.246	1.230	1.223	1.219	1.215
1.271	1.263	1.256	1.240	1.233	1.229	1.225
1.281	1.273	1.266	1.250	1.243	1.239	1.235
1.291	1.283	1.276	1.260	1.252	1.248	1.245
1.301	1.294	1.286	1.270	1.262	1.258	1.255
1.312	1.304	1.296	1.280	1.272	1.268	1.265

Test Indications

1.250 to 1.290 specific gravity - normal state of charge.

1.290 specific gravity or above - possible overcharging; voltage regulator setting and regulator ground must be tested.

Less than 1.250 specific gravity - undercharged; entire charging system must be tested.

Specific gravity readings vary .025 or more between cells - Loss of acid or defective cell.

> **NOTE:** *Some tractor batteries and "stay-full" type batteries have approximately 20 points lower specific gravity at any given state of charge than standard batteries. Refer to the manufacturer's specifications for proper information in this regard.*

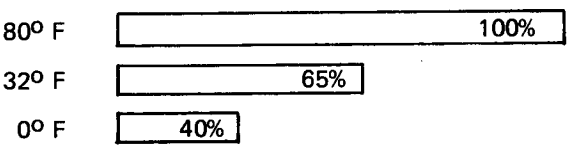
13. FREEZING POINTS OF ELECTROLYTE

The electrolyte of a battery will start to freeze (first ice crystals begin to appear in the electrolyte although it does not freeze solid until a lower temperature is reached) approximately as indicated below (specific gravity readings corrected to 80o F):

1.280 sp. gr.	Freezes at -90°F
1.250 sp. gr.	Freezes at -62°F
1.200 sp. gr.	Freezes at -16°F
1.150 sp. gr.	Freezes at + 5°F
1.100 sp. gr.	Freezes at +19°F

14. EFFECT OF LOW TEMPERATURE ON BATTERY PERFORMANCE

Battery capacity is greatly reduced by cold, as cold has a decided numbing effect on the electro-chemical action in the battery. The following comparison indicates the reduction in cranking power of a fully charged battery when the temperature of the electrolyte drops from 80°F to 32°F and to 0°F.



15. BATTERY TEST INDICATIONS AND RECOMMENDATIONS

PROBABLE CAUSE	REMEDY
SPECIFIC GRAVITY ABOVE 1.290	The battery is overcharged. Refer to NOTE 2 on bottom of page.
SPECIFIC GRAVITY BELOW 1.225	The battery is undercharged. Recharge to full specific gravity. Refer to NOTE 1 on bottom of page.
LOW TEMPERATURE	Low temperature reduces capacity by retarding chemical reaction. Slow-charge battery until temperature is at least 60°F and re-check specific gravity.
HARD PLATES	Battery plates become hard (sulphated) if the battery is not maintained above approximately 1.240 specific gravity. Cycle the battery by discharging completely with a light load, then recharging at a very slow rate. Refer to NOTE 1 on this page.
NEW BATTERY	Some times a new battery does not reach full capacity until in normal use for 60 to 90 days. If necessary, as in cold weather, the battery can usually be brought quickly to full capacity by cycling.
WORN OUT	A battery gradually loses active material from the plates in normal use, and more rapidly if overworked. When too much active material has been lost, the battery cannot be depended upon for cold weather starting or other severe operation even when fully charged and can be considered to be worn out.
DEFECTIVE CELLS	A defective cell or cells will result in a low capacity and is indicated by wide variation in specific gravity readings between cells.

NOTE 1: A battery must be maintained at a specific gravity of at least 1.250 to prevent sulphation (hardening) of the battery plates, to assure cold weather starting and normal life. Undercharging can be caused by low voltage regulator setting, high charging circuit resistance, high cranking motor amperage draw, faulty generator or generator drive belt, excessive use of accessories, etc.

NOTE 2: Overcharging of a battery can be caused by high voltage regulator setting or the battery being exposed to abnormally high external temperatures. Over-charging is indicated by excessive use of water, extremely high specific gravity and eventually, raised cell covers and warped battery case.

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