CONTENTS

The instructions contained in this service manual are for the information and guidance of servicemen who are responsible for overhauling and repairing International 6, 6A, 264, 281-4, 9, 9A, 350 and 370 four cylinder diesel engines.

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

LUBRICATION

Instruction 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.

DIESEL FUEL SYSTEM

If detailed information on the diesel fuel system is desired, refer to the "Diesel Injection Pump" manual, ISS-1003.

SERVICE TOOLS

International crawler tractors are designed so that few service tools are required other than those in the mechanic's tool kit. However, whenever 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-1002. The IH Construction Equipment distributors already have most of this equipment and are in an excellent position to service these engines.

SERVICE PARTS

IH Engines deserve 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

Series	Machines used on
6	TD-6, UD-6
6A	TD-6, UD-6A
264	TD-6 (61) 38951 to 39973*
	UD-264
281	TD-6 (61) 39974 up*
	UD-281-4
9	TD-9, UD-9
9A	TD-9, UD-9A
350	TD-9 (91)
	UD-350
370	UD-370

*The serial numbers shown are chassis serial numbers.

PRINTED IN UNITED STATES OF AMERICA

1. DESCRIPTION

The diesel engines covered in this service manual are four cycle, valve-in-head type. A built in gasoline conversion starting system is a basic design feature of these engines. The engine is started on gasoline and, after a brief cylinder warm-up, is changed over manually to operate as a full diesel engine. For a complete description of the gasoline conversion starting system, refer to Section 8, "COMPRESSION RELEASE MECHANISM."

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

The camshaft is supported by babbitt-lined steel-backed bearings and is driven by the idler gear. The end thrust of the camshaft is controlled by a thrust flange located between the front camshaft journal and the camshaft journal and the camshaft gear.

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

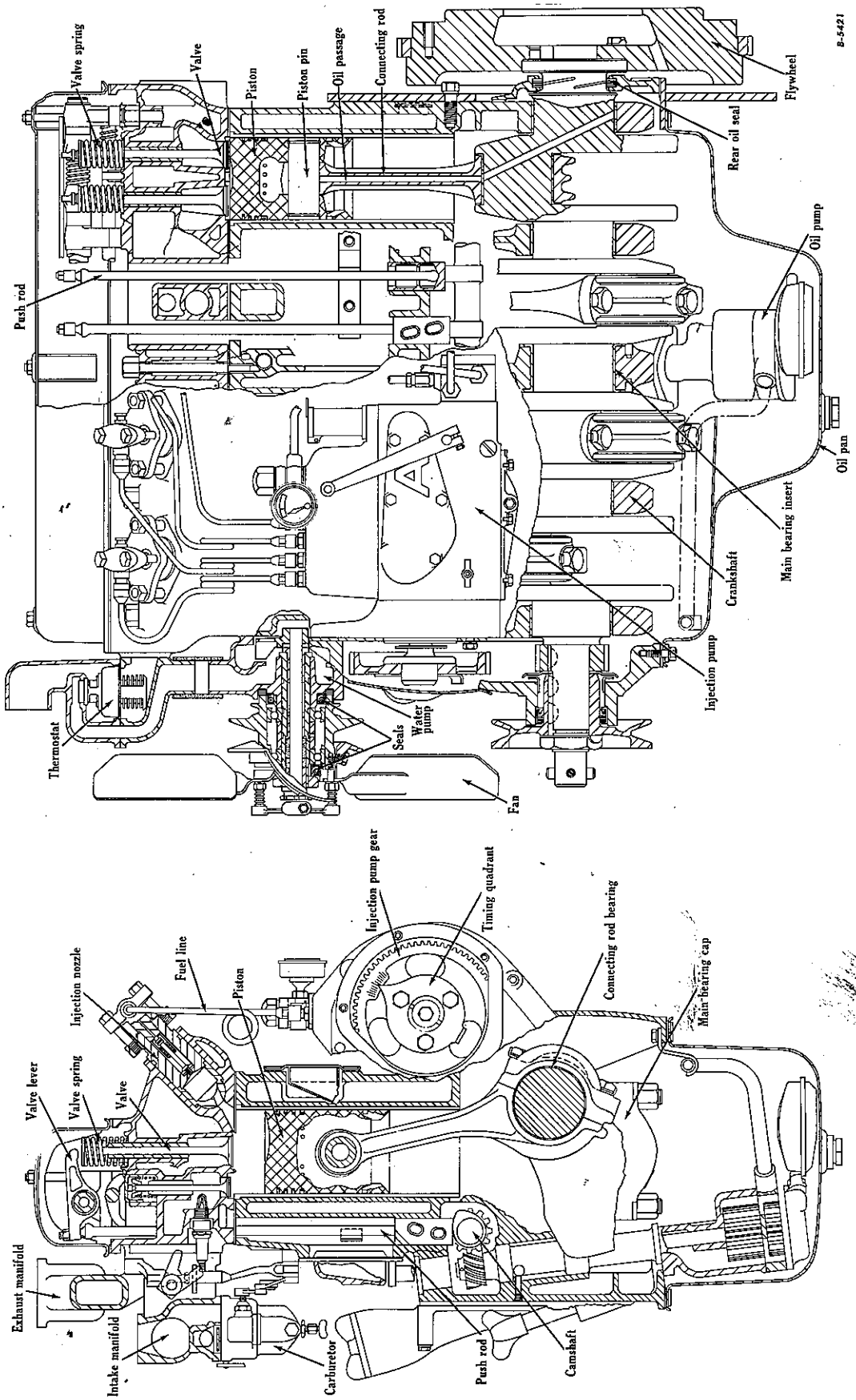
The cylinder sleeves are the replaceable dry type and are heat-treated to file hardness for maximum service.

The connecting rods are heat-treated forged steel and contain a bronze bushing at the upper end for installation on the piston pin, while the lower end and cap contain the locking type selective fit bearing inserts which require no fitting during assembly or replacement. The rods and caps are numbered for identification and reassembly.

The full pressure lubrication system assures positive lubrication to all working parts. A gear type oil pump is internally mounted to the bottom of the crankcase and is gear driven by the camshaft. Oil is drawn from the oil pan by the pump through a screen or float and is distributed under pressure, through rifle-drilled passages in the crankcase, crankshaft, connecting rods and cylinder heads. A by-pass or full-flow lubricating oil filter effectively cleans all of the lubricating oil. A crankcase breather and cylinder head breather assures positive crankcase ventilation.

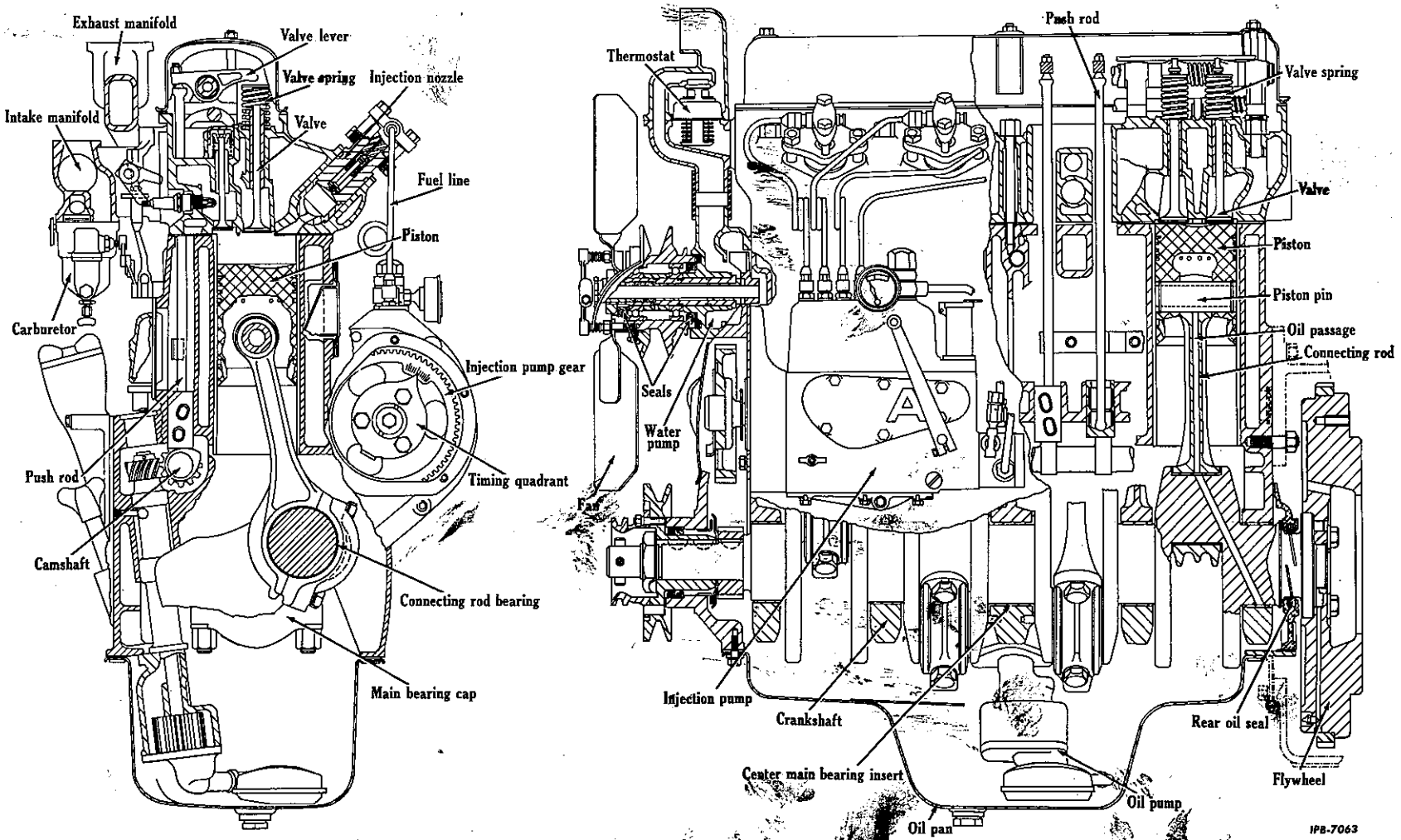
Coolant is circulated through the engine and radiator by a belt driven centrifugal water pump mounted at the front of the engine. A thermostat located in the water elbow controls the coolant temperature in the system.

The diesel fuel system consists of the fuel lines, fuel filters, a water trap, a fuel transfer pump (on power units), an injection pump, injection nozzles and lines. The engines are equipped with a single plunger injection pump and is flange mounted to the crankcase front plate. For complete detailed information on all diesel fuel system components refer to the "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.

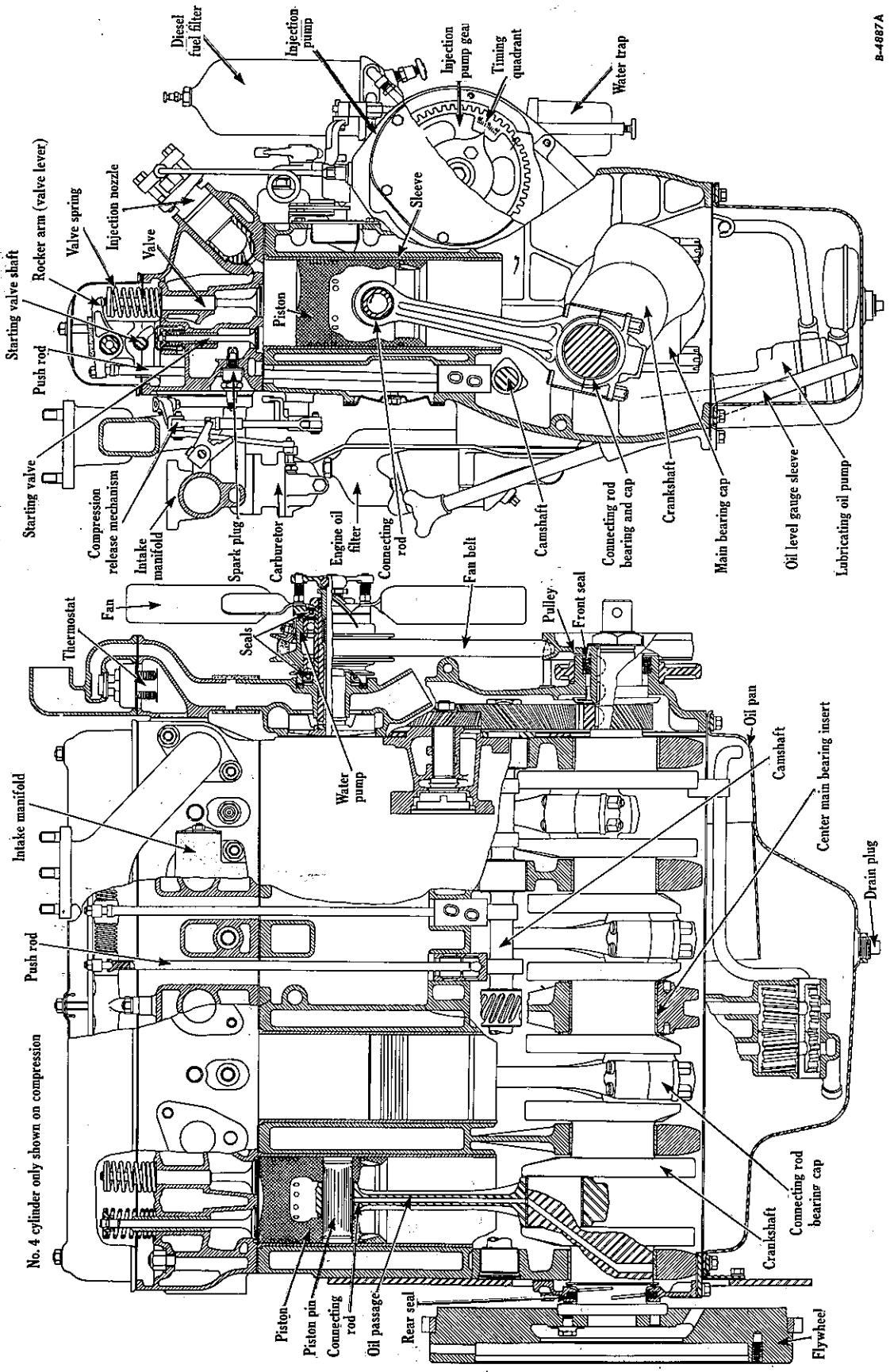


Illust. 1 - Cross Section of 6 Series Diesel Engine.

PRINTED IN UNITED STATES OF AMERICA



Illust. 2 - Cross Section of UD-264 Engine.



Illust. 3 - Cross Section of 9 Series Engine (UD-350 Similar).

PRINTED IN UNITED STATES OF AMERICA

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
GENERAL DATA							
Horsepower* - Maximum values corrected to sea level barometric pressure (29.92 inches of mercury) and 60° F.	39.0 (6) 45.0 (6A) 55.0 (264)	40.5	50.0	60.0	53.0 (9) 62.5 (9A) 75.0 (350) 85.0 (370)	51.5	66.0
Type of cylinders	Replaceable dry sleeve	Replaceable dry sleeve	Replaceable dry sleeve	Replaceable dry sleeve	Replaceable dry sleeve	Replaceable dry sleeve	Replaceable dry sleeve
Rated engine rpm	1500 (6) 1600 (6A) 1800 (264)	1450	1550	1800	1500 (9) 1600 (9A) 1800 (350, 370)	1400	1550
Engine rpm at maximum torque.	850 (6) 1000 (6A) 1050 (264)	900	1100	1350	800 (9,9A) 1200 (350) 1400 (370)	800	1100
Maximum torque, *foot-pounds.	155 (6) 164 (6A) 188 (264)	166	198-1/2	198-1/2	210 (9) 232 (9A) 247 (350, 370)	218	258
Number of cylinders.	4	4	4	4	4	4	4
Bore, inches (nominal).	3-7/8 (6,6A) 4 (264)	3-7/8	4-1/8 (281) 4 (264)	4-1/8	4-13/32 (9,9A) 4-1/2 (350) 4-5/8 (370)	4-13/32	4-1/2
Stroke, inches	5-1/4	5-1/4	5-1/4	5-1/4	5-1/2	5-1/2	5-1/2
Piston displacement, cubic inches	248 (6,6A) 264 (264)	248	281	281	335 (9,9A) 350 (350) 370 (370)	335	350
Piston speed, feet per minute at rated rpm	1313 (6) 1400 (6A) 1575 (264)	1269	1356	1575	1375 (9) 1467 (9A) 1650 (350, 370)	1283	1420
Compression ratio, diesel engine, diesel cycle	14.2 to 1 (6) 16.8 to 1 (6A) 16.4 to 1 (264)	16.8 to 1	16.4 to 1	16.4 to 1	14.4 to 1 (9) 15.7 to 1 (9A) 15.5 to 1 (350) 16.5 to 1 (370)	15.7 to 1	15.5 to 1
Compression ratio, diesel engine, gasoline cycle	6.40 to 1 (6,6A) 6.75 to 1 (264)	6.40 to 1	6.74 to 1	6.74 to 1	6.70 to 1 (9,9A) 7 to 1 (350, 370)	6.70 to 1	7 to 1
Engine weight (approx.), pounds	1215 (6,6A) 1250 (264)	1215	1250	1250	1500 (9,9A) 1600 (350, 370)	1500	1600
Shipping weight (approx., not including fuel, water or blocking), pounds	1740 (6,6A) 1765 (264)	1740	1765	1765	2060 (9,9A) 2221 (350, 370)	2060	2221
Engine rotation - flywheel end	CCW	CCW	CCW	CCW	CCW	CCW	CCW
ENGINE COMPRESSION PRESSURE							
Measured at 1000 rpm engine speed - psi	556-614	556-614	556-614	556-614	503-557	503-557	503-557

*Values are for intermittent loads - maximum, net.

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
Power Units:							
Engine length, overall, inches	38-1/2	- - - -	- - - -	38-1/2	41-1/2	- - - -	- - - -
Engine height, overall, inches	39-3/16	- - - -	- - - -	39-3/16	42-1/4 (9,9A) 42-1/2 (350, 370)	- - - -	- - - -
Engine width, overall, inches	23	- - - -	- - - -	23	24	- - - -	- - - -
Power unit length, overall, inches	62-9/16	- - - -	- - - -	62-9/16	67-3/4 (9,9A) 65-1/2 (350, 370)	- - - -	- - - -
Power unit height, overall, inches	50-1/4 (6,6A) 47 (264)	- - - -	- - - -	47	52	- - - -	- - - -
Power unit width, overall, inches	26-9/16	- - - -	- - - -	26-9/16	28-1/16 (9,9A) 27 (350, 370)	- - - -	- - - -
Power take-off shaft diameter, inches	1.749 to 1.750	- - - -	- - - -	1.749 to 1.750	2.249 to 2.250	- - - -	- - - -
Power take-off shaft length, inches	6	- - - -	- - - -	6	6-1/2	- - - -	- - - -
Power take-off shaft key, inches	1/2 x 1/2 x 5	- - - -	- - - -	1/2 x 1/2 x 5	5/8 x 5/8 x 5-3/8	- - - -	- - - -
CRANKSHAFT							
Crank pin diameter - inches	3.2475-3.2485	3.2475-3.2485	3.2475-3.2485	3.2475-3.2485	2.7475-2.7485 Counterbal. 3.6225-3.6235 Non-counterbal.	2.7475-2.7485	2.7475-2.7485
Main journal diameter - inches	3.7475-3.7485	3.7475-3.7485	3.7475-3.7485	3.7475-3.7485	4.1225-4.1235	4.1225-4.1235	4.1225-4.1235
Maximum permissible journal out-of-roundness, before reconditioning - inch	.004	.004	.004	.004	.004	.004	.004
Number of main bearings	5	5	5	5	5	5	5
Main bearing running clearance - inch	.0018-.0048	.0018-.0048	.0018-.0048	.0018-.0048	.0020-.0050	.0020-.0050	.0020-.0050
Maximum permissible main bearing clearance, before reconditioning - inch	.009	.009	.009	.009	.009	.009	.009
End clearance - inch	.003-.011 (6) .004-.008 (6A) .006-.010 (264)	.003-.011	.006-.010	.006-.010	.003-.011 (9) .004-.008 (9A) .006-.010 (350,370)	.003-.011	.006-.010
Maximum permissible end clearance, before reconditioning - inch	.024	.024	.024	.024	.024	.024	.024
End clearance, for flanged bearing - inch	006-.010 (264)	- - - - -	.006-.010	.006-.010	006-.010 (350)	- - - - -	.006-.010

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
CRANKSHAFT - Continued							
Counterbalanced	Old (No) 6 Redesigned (Yes) 6A, 264 (Yes)	No (6, old) Yes (6, redesigned)	Yes	Yes	Old (No) 9 Redesigned (Yes) 9A, 350, 370 (Yes)	No (9, old) Yes (9 redesigned)	Yes
Main bearing bore in crankcase (line reamed) inches.	3.9715-3.9725	3.9715-3.9725	3.9715-3.9725	3.9715-3.9725	- - - - - -	- - - - - -	- - - - -
CAMSHAFT							
Running clearance - inch	.0015-.0035	.0015-.0035	.0015-.0035	.0015-.0035	.0015-.0035	.0015-.0035	.0015-.0035
Maximum permissible running clearance - inch	.006	.006	.006	.006	.006	.006	.006
End clearance - inch	.005-.013	.005-.013	.005-.013	.005-.013	.005-.013	.005-.013	.005-.013
Maximum permissible end clearance - inch	.025	.025	.025	.025	.025	.025	.025
Service bushings furnished	Reamed to size	Reamed to size	Reamed to size	Reamed to size	Reamed to size	Reamed to size	Reamed to size
Number of teeth in drive gear	54	54	54	54	54	54	54
Number of bearings	4	4	4	4	4	4	4
Bearing journal diam., front - inches	2.4305-2.4315	2.4305-2.4315	2.4305-2.4315	2.4305-2.4315	2.4305-2.4315	2.4305-2.4315	2.4305-2.4315
Bearing journal diam., 2nd- inches	2.3055-2.3065	2.3055-2.3065	2.3055-2.3065	2.3055-2.3065	2.3055-2.3065	2.3055-2.3065	2.3055-2.3065
Bearing journal diam., 3rd - inches	2.1805-2.1815	2.1805-2.1815	2.1805-2.1815	2.1805-2.1815	2.1805-2.1815	2.1805-2.1815	2.1805-2.1815
Bearing journal diam., rear - inches	1.8680-1.8690	1.8680-1.8690	1.8680-1.8690	1.8680-1.8690	1.8680-1.8690	1.8680-1.8690	1.8680-1.8690
Cam lobe lift, inch	.2725	.2725	Int. .310 Exh. .272	.2725	.310	.310	.310
Maximum permissible camshaft lobe wear - inch	020	.020	.020	.020	.020	.020	020
CONNECTING RODS							
Side clearance - inch	.009-.015	.009- .015	.009- .015	.009- .015	.009- .015 .005- .015 (350, 370)	.009- .015	.005- .015
Bearing running clearance - inch	.0017-.0047	.0017-.0047	.0017-.0047	.0017- .0047	.0019-.0049	.0019-.0049	.0019-.0049
Maximum permissible bearing running clear - inch	.007	.007	.007	.007	.007	.007	.007

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
Bolt size and diameter - inches	2-5/16 x 9/16	2-5/16 x 9/16	2-5/16 x 9/16	2-5/16 x 9/16	2-9/16 x 1/2 (9) 3-13/16 x 7/16 (9A, 350, 370)	2-9/16 x 1/2 (9) 3-13/16 x 7/16 (with 9A series engine)	3-13/16 x 7/16
PISTONS							
Length overall - inches	5-45/64	5-45/64	5-45/64	5-45/64	6-7/16	6-7/16	6-7/16
Skirt clearance, bottom - inch (measured 90 degrees from pin hole)	.0046-.0054	.0046-.0054	.0046-.0054	.0046-.0054	.0066-.0074 (9, 9A) .0085 - .0093 (350) .0066-.0082 (370)	.0066-.0074	.0077-.0085
Skirt clearance, top - inch (measured 90 degrees from pin hole)	.0066-.0074	.0066-.0074	.0066-.0074	.0066-.0074	.0086-.0094 (9,9A) .0105 - .0113 (350) .0096-.0112 (370)	.0086-.0094	.0097-.0105
Number of rings per piston	5	5	5	5	5	5	5
Number of rings below pin	1	1	1	0	1 (9, 9A, 350) 0 (370)	1	1
Width of ring grooves							
Compression ring, top - inch	.0975-.0985	.0975-.0985	.0975-.0985	.0975-.0985	.1275-.1285	.1275-.1285	.1275-.1285
Compression ring, 2nd - inch	.1270-.1280	.1270-.1280	.1270-.1280	.1270-.1280	.1575-.1585	.1575-.1585	.1575-.1585
Compression ring, 3rd - inch	.1575-.1585	.1575-.1585	.1575-.1585	.1575-.1585	.1885-.1895	.1885-.1895	.1885-.1895
Oil control rings - inch	.2515-.2525	.2515-.2525	.2515-.2525	.2515-.2525	.2515-.2525	.2515-.2525	.2515-.2525
Ring gap							
Compression ring, top - inch	.010-.020 (6,6A) .012-.028 (264)	.010-.020	.012-.028	.012-.028	.010-.020 (9,9A) .013-.029 (350,370)	.010-.020	.013-.029
Compression ring, 2nd - inch	.010-.020 (6,6A) .012-.028 (264)	.010-.020	.012-.028	.012-.028	.010-.020 (9,9A) .013-.029 (350)	.010-.020	.013-.029
Compression ring, 3rd - inch	.010-.020 (6,6A) .012-.028 (264)	.010-.020	.012-.028	.012-.028	.013-.023 (370) .010-.020 (9,9A) .013-.029 (350) .013-.023 (370)	.010-.020	.013-.029
Piston rings - compression- Maximum permissible ring gap, before replacing; all rings - inch	.070	.070	.070	.070	.070	.070	.070
Oil control rings - inch	.010-.020 (6, 6A) .012-.028 (264)	.010-.020	.012-.028	.012-.028	.013-.023 (9, 9A) .013-.029 (350) .013-.023 (370)	.013-.023	.013-.029

2. SPECIFICATION - Continued

Engine

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
PISTONS - Continued							
Piston rings - oil control - Maximum permissible ring gap, before replacing - inch	.060	.060	.060	.060	.060	.060	.060
PISTON COMPRESSION RINGS							
Number of rings per piston	3	3	3	3	3	3	3
Type - top	Plain-Ferrox (6, 6A) Tapered chrome (264) face	Chrome plated Tapered face	Chrome plated Tapered face	Chrome plated Tapered Keystone	Chrome plated Tapered face	Chrome plated Tapered face	Chrome plated Tapered face
Type - 2nd	Standard	Standard	Standard	Standard	Standard	Standard	Standard
Type - 3rd	Tapered face	Tapered face	Tapered face	Tapered face	Tapered face	Tapered face	Tapered face
Width of ring, top - inch	.0930-.0935	.0930-.0935	.0930-.0935	.0930-.0935	.1235-.1240 .0930-.0935 (370)	.1235-.1240	.1235-.1240
Width of ring, 2nd - inch	.1235-.1240	.1235-.1240	.1235-.1240	.1235-.1240	.1545-.1550 .1235-.1240 (370)	.1545-.1550	.1545-.1550
Width of ring, 3rd - inch	.1540-.1550	.1540-.1550	.1540-.1550	.1540-.1550	.1860-.1865 .1235-.1240 (370)	.1860-.1865	.1860-.1865
PISTON OIL CONTROL RINGS							
Number of rings per piston	2	2	2	2	2	2	2
Type	One-piece, slotted	One-piece, slotted	One-piece, slotted	One-piece, slotted	One-piece, slotted	One-piece, slotted	One-piece, slotted
Width - inch	.2485-.2490	.2485-.2490	.2485-.2490	.2485-.2490	.2485-.2490	.2485-.2490	.2485-.2490
RING CLEARANCE IN GROOVE							
Compression ring, top - inch	.0040-.0045 (6,6A) .0040-.0055 (264)	.0040-.0045	.0040-.0055	.0040-.0055	.0035-.0050 .0025-.0030 (370)	.0035-.0050	.0035-.0050
Compression ring, 2nd - inch	.0030-.0045 (6,6A) .0030-.0050 (264)	.0030-.0045	.0030-.0050	.0030-.0050	.0025-.0040 .0030-.0035 (370)	.0025-.0040	.0025-.0040
Compression ring, 3rd - inch	.0025-.0045	.0025-.0045	.0025-.0045	.0025-.0045	.0020-.0035 .0030-.0035 (370)	.0020-.0035	.0020-.0035
Oil control rings - inch	.0025-.0040	.0025-.0040	.0025-.0040	.0025-.0040	.0025-.0040 .0030-.0035 (370)	.0025-.0040	.0025-.0040
Maximum ring side clearance before replacement	.008	.008	.008	.008	.008	.008	.008
PISTON PINS							
Diameter - inches	1.3125-1.3127	1.3125-1.3127	1.3125-1.3127	1.3125-1.3127	1.5000-1.5002	1.5000-1.5002	1.5000-1.5002
Length - inches	3.245-3.255	3.245-3.255	3.245-3.255	3.245-3.255	3.704-3.709	3.704-3.709	3.704-3.709
Clearance between pin and retainer ring - inch (For method of checking clearance, refer to Section 3.)	.016-.037 (6,6A) .016-.040 (264)	.016-.037	.016-.040	.016-.040	.016-.032 (9,9A) .016-.035 (350)	.016-.032	.016-.035

DESCRIPTION	Engine						
	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
Clearance - in rod - inch	.0004-.0008	.0004-.0008	.0004-.0008	.0004-.0008	.0004-.0008	.0004-.0008	.0004-.0008
Maximum permissible clearance in rod bushing before replacing - inch	.004	.004	.004	.004	.004	.004	.004
Clearance - in piston - inch *	.0001 (loose)* .0003 (tight)*	.0001 (loose)* .0003 (tight)*	.0001 (loose)* .0003 (tight)*	.0001 (loose)* .0003 (tight)*	.0003 (loose)* .0001 (tight)*	.0003 (loose)* .0001 (tight)*	.0003 (loose)* .0001 (tight)*
Maximum permissible clearance in piston, before replacing - inch	.0025	.0025	.0025	.0025	.0025	.0025	.0025
CYLINDER SLEEVES							
Diameter, inside - inches	3.8740-3.8760 (6, 6A), 3.9990-4.0010 (264)	3.8740-3.8760	3.9990-4.0010 (264), 4.1240-4.1256 (281)	4.1240-4.1256	4.3990-4.4010 (9, 9A), 4.4990-4.5010 (350) 4.6240-4.6256	4.3990-4.4010	4.4990-4.5010
Length - inches	10-1/2	10-1/2	10-1/2	10-1/2	11-7/8 11-3/4 (370)	11-7/8	11-7/8
Maximum permissible diametral sleeve wear (at top of ring travel) before replacement - inch	.010	.010	.010	.010	.010	.010	.010
Height of sleeve flange above crankcase deck	.000-.006	.000-.006	.000-.006	.000-.006	.000-.006	.000-.006	.000-.006
Top surface of sleeve extends above top surface of crankcase deck - inch	.039-.047	.039-.047	.039-.047	.039-.047	.037-.049 (350, 370) .039-.047 (9, 9A)	.039-.047	.037-.049
Thickness of sleeve flange - inch	.186-.188	.186-.188	.186-.188	.186-.188	.186-.188	.186-.188	.186-.188
INTAKE VALVES							
Stem diameter - inch	.371-.372	.371-.372	.371-.372	.371-.372	.4015-.4025	.4015-.4025	.4015-.4025
Port diameter - inches	1-1/2	1-1/2	1-1/2	1-1/2	1-21/32	1-21/32	1-21/32
Head diameter - inches	1-23/32	1-23/32	1-23/32	1-23/32	1-7/8	1-7/8	1-7/8
Tappet clearance, hot - inch	.017	.017	.017	.017	.017	.017	.017
Tappet clearance, cold - inch	.019	.019	.019	.019	.019	.019	.019
Stem clearance in guide - inch	.0015-.0040	.0015-.0040	.0015-.0040	.0015-.0040	.001-.004	.001-.004	.001.004

*"Loose" means clearance; "tight" means interference.

ISS-1035B 4-64

PRINTED IN UNITED STATES OF AMERICA

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
INTAKE VALVES - Continued							
Maximum permissible stem clearance in guide before reconditioning - inch	.008	.008	.008	.008	.008	.008	.008
Valve seat angle (in cylinder head) - degrees	45	45	45	45	45	45	45
Valve face angle (between seat and bottom of valve head) - degrees	45	45	45	45	45	45	45
EXHAUST VALVES							
Stem diameter - inch	.371-.372	.371-.372	.371-.372	.371-.372	.4015-.4025	.4015-.4025	.4015-.4025
Port diameter - inches	1-5/16	1-5/16	1-5/16	1-5/16	1-15/32	1-15/32	1-15/32
Head diameter - inches	1-17/32	1-17/32	1-17/32	1-17/32	1-11/16	1-11/16	1-11/16
Tappet clearance, hot - inch	.017	.017	.017	.017	.017	.017	.017
Tappet clearance, cold - inch	.019	.019	.019	.019	.019	.019	.019
Stem clearance in guide - inch	.0015-.004	.0015-.004	.0015-.004	.0015-.004	.001-.004	.001-.004	.001-.004
Maximum permissible stem clearance in guide before reconditioning - inch	.008	.008	.008	.008	.008	.008	.008
Valve seat angle (in cylinder head) - degrees	45	45	45	45	45	45	45
Valve face angle (between seat and bottom of valve head) - degrees	45	45	45	45	45	45	45
INTAKE AND EXHAUST VALVE GUIDES							
Length - inches	3-3/4	3-3/4	3-3/4	3-3/4	3-31/32	3-31/32	3-31/32
Inside diameter - inch	.374-.375	.374-.375	.374-.375	.374-.375	.4045-.4055	.4045-.4055	.4045-.4055
Set height of guide - inch (measured upward from valve spring counterbore in head to the stem end of the valve guide)	31/32	31/32	31/32	31/32	1-7/32	1-7/32	1-7/32

2. SPECIFICATIONS - Continued

Engine

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
INTAKE AND EXHAUST VALVE SPRINGS							
Outside diameter - inches	1-3/8	1-3/8	1-3/8	1-3/8	1-19/32	1-19/32	1-19/32
Free length - inches	2-11/32	2-11/32	2-11/32	2-11/32	2-7/8	2-7/8	2-7/8
Length, valve open - inches	1-9/16	1-9/16	1-9/16	1-9/16	2	2	2
Length, valve closed - inches	2-1/16	2-1/16	2-1/16	2-1/16	2-1/2	2-1/2	2-1/2
Test load, valve open - pounds	143-152	143-152	143-152	143-152	147-158	147-158	147-158
Test load, valve closed - pounds	47-51	47-51	47-51	47-51	50-56	50-56	50-56
STARTING VALVES							
Stem diameter - inches	.3085-.3095	.3085-.3095	.3085-.3095	.3085-.3095	.3085-.3095	.3085-.3095	.3085-.3095
Port diameter - inches	7/8	7/8	7/8	7/8	1	1	1
Head diameter - inches	31/32	31/32	31/32	31/32	1-3/32	1-3/32	1-3/32
Stem clearance in guide - inch	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004
Maximum permissible stem clearance in guide before reconditioning - inch	.008	.008	.008	.008	.008	.008	.008
Valve angle - degrees	45	45	45	45	45	45	45
Width of valve seat - inch	3/64	3/64	3/64	3/64	3/64	3/64	3/64
Approximate free movement of valve spring cover in cylinder head (gasoline position) - inch	1/64	1/64	1/64	1/64	1/64	1/64	1/64
STARTING VALVE GUIDES							
Length - inches	2-1/16	2-1/16	2-1/16	2-1/16	2-1/16	2-1/16	2-1/16
Inside diameter - inch	.312	.312	.312	.312	.312	.312	.312
Set height of guide - inches (distance from stem end of valve guide to valve lever mounting pads)	1-1/16	1-1/16	1-1/16	1-1/16	1-1/8	1-1/8	1-1/8
STARTING VALVE SPRINGS							
Outside diameter - inch	29/32	29/32	29/32	29/32	29/32	29/32	29/32

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
STARTING VALVE SPRINGS - Continued							
Free length - inches	1-31/32	1-31/32	1-31/32	1-31/32	1-31/32	1-31/32	1-31/32
Test length - inches	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32
Test load - pounds	21.5-26.3	21.5-26.3	21.5-26.3	21.5-26.3	21.5-26.3	21.5-26.3	21.5-26.3
VALVE LEVER AND SHAFT							
Valve lever shaft diam. - inch	.872-.873	.872.873	.872-.873	.872-.873	.872-.873	.872-.873	.872-.873
Running clearance, valve lever on shaft - inch	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004
Maximum permissible running clearance, valve lever on shaft - inch	.010	.010	.010	.010	.010	.010	.010
Valve lever bushing Inside diameter - inch	.875-.876	.875-.876	.875-.876	.875-.876	.875-.876	.875-.876	.875-.876
Length - inches	1-3/16	1-3/16	1-3/16	1-3/16	1-3/16	1-3/16	1-3/16
VALVE TAPPETS							
Diameter - inches	1.248-1.249 (6,6A), 1.2480-1.2485 (264)	1.248-1.249	1.248-1.249	1.248-1.249	1.373-1.374	1.373-1.374	1.373-1.374
Length - inches	2-21/32	2-21/32	2-21/32	2-21/32	2-21/32	2-21/32	2-21/32
Clearance in guide - inch	.0005-.0025 (6,6A) .001-.003 (264)	.0005-.0025	.0005-.0025	.0005-.0025	.0005-.0025	.0005-.0025	.0005-.0025
VALVE TIMING							
Intake opens - degrees before TDC	10°	10°	10°	10°	10°	10°	10°
Intake closes - degrees after BDC	30°	30°	30°	30°	30°	30°	30°
Exhaust opens - degrees before BDC	43°	43°	43°	43°	43°	43°	43°
Exhaust closes - degrees after TDC	10°	10°	10°	10°	10°	10°	10°
VALVE PUSH ROD							
Diameter - inch	7/16	7/16	7/16	7/16	7/16	7/16	7/16
Length - inches	16-27/32	16-27/32	16-27/32	16-27/32	18-15/32	18-15/32	18-15/32

2. SPECIFICATIONS - Continued

Engine

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
CYLINDER HEAD STUDS							
Diameter - inch	1/2	1/2	1/2	1/2	9/16	9/16	9/16
CYLINDER HEAD GASKET							
Thickness (compressed) - inch .	.062-.067	.062-.067	.062-.067	.062-.067	.062-.067	.062-.067	.062-.067
TIMING GEARS							
Backlash between any pair of gears -inch (except as indicated)	.003-.006	.003-.006	.003-.006	.003-.006	.003-.006	.003-.006	.003-.006
Maximum permissible backlash between any pair of gears, before reconditioning - inch (except as indicated)	.010	.010	.010	.010	.010	.010	.010
Backlash between idler gear and injection pump - inch . . .	.003-.009	.003-.009	.003-.009	.003-.009	.003-.009	.003-.009	.003-.009
Maximum permissible backlash between idler gear and injection pump gear before reconditioning - inch	.013	.013	.013	.013	.013	.013	.013
LUBRICATING SYSTEM							
Type	Forced feed	Forced feed	Forced feed	Forced feed	Forced feed	Forced feed	Forced feed
Oil filter (Purolator, radial fin) - type	By-pass (6,6A), By-pass and Full-flow (264)	By-pass and Full-flow	Full-flow	Full-flow	By-pass (9,9A) By-pass and Full-flow (350, 370)	By-pass and Full-flow	Full-flow
Number used	1	1	1	1	1	1	1
LUBRICATING OIL VALVE							
LOCATIONS							
Pressure regulating By-pass system . .	Filter base	Filter base	- - - - -	- - - - -	Filter base	Filter base	- - - - -
Pressure regulating Full-flow system .	Filter base	Filter base	Filter base	Filter base	Filter base	Filter base	Filter base
Safety (Full-flow system only) .	Oil pump (264)	Oil pump	Oil pump	Oil pump	Oil pump (350, 370)	Oil pump	Oil pump
By-pass (Full-flow system only)	Filter base (264)	Filter base	Filter base	Filter base	Filter base (350, 370)	Filter base	Filter base
PRESSURE REG. VALVE							
Opening pressure - psi	38-46	38-46	38-46	38-46	38-46	38-46	38-46

PRINTED IN UNITED STATES OF AMERICA

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
LUBRICATING OIL VALVE SPRINGS							
Pressure regulating (By-pass):							
Free length - inches . . .	3-49/64 * 4-15/64 ** 3.554 (264)	3.554	- - - - -	- - - - -	4-15/64 (9,9A) 3.554 (350, 370)	3.554	- - - - -
Test length - inches . . .	2-3/32	2-3/32	- - - - -	- - - - -	2-3/32	2-3/32	- - - - -
Test load - pounds	42.1 * 27 ** 19.5 (264)	19.5	- - - - -	- - - - -	27 (9, 9A) 19.5 (350, 370)	19.5	- - - - -
Pressure regulating (Full-flow):							
Free length - inches . . .	4.25 (264)	4.25	4.25	4.25	4.25 (350, 370)	4.25	4.25
Test length - inches . . .	2.188 (264)	2.188	2.188	2.188	2.188 (350, 370)	2.188	2.188
Test load - pounds	27.5 (264)	27.5	27.5	27.5	27.5 (350, 370)	27.5	27.5
Safety:							
Free length - inches . . .	3.84 (264)	3.84	3.84	3.84	2.51 (350, 370)	2.51	2.51
Test length - inches . . .	2-53/64 (264)	2-53/64	2-53/64	2-53/64	1-3/4 (350, 370)	1-3/4	1-3/4
Test load - pounds	51 (264)	51	51	51	59 (350, 370)	59	59
By-pass:							
Free length - inches . . .	5.28 (264)	5.28	5.28	5.28	5.28 (350, 370)	5.28	5.28
Test length - inches . . .	2-5/32 (264)	2-5/32	2-5/32	2-5/32	2-5/32 (350, 370)	2-5/32	2-5/32
Test load - pounds	10 (264)	10	10	10	10 (350, 370)	10	10
LUBRICATING OIL PUMP* **							
End play between gear and auxiliary gear housing - inch .	.0055-.0105	.0055-.0105	.0055-.0105	.0055-.0105	0055-.0105	.0055-.0105	- - - - -
Radial clearance between gear and housing - inch . . .	.0080-.0095	.0080-.0095	.0080-.0095	.0080-.0095	.0080-.0095	.0080-.0095	- - - - -
Backlash between idler and body gears - inch	.008-.012	.008-.012	.008-.012	.008-.012	.008-.012	.008-.012	- - - - -
Backlash between drive pinion and camshaft - inch	.005-.010	.005-.010	.005-.010	.005-.010	.005-.010	.005-.010	- - - - -
Drive shaft journals, diameter - inch	.6245-.6252	.6245-.6252	.6245-.6252	.6245-.6252	.6245-.6252	.6245-.6252	- - - - -

* 62 672 D (6, 6A) ** 255 684 R1 (6, 6A)

*** See Engine Balancer specifications for UD-350, UD-370 and TD-9 (91) engines so equipped.

2. SPECIFICATIONS - Continued

Engine

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
Drive shaft running clearance - inch	.0008-.0026	.0008-.0026	.0008-.0026	.0008-.0026	.0008-.0026	.0008-.0026	- - - - -
Idler gear to shaft running clearance - inch	.0015-.0030	.0015-.0030	.0015-.0030	.0015-.0030	.0015-.0030	.0015-.0030	- - - - -
Clearance between oil pump body and drive pinion - inch	.010-.020	.010-.020	.010-.020	.010-.020	.010-.020	010-.020	- - - - -
ENGINE BALANCER (INCLUDES OIL PUMP)*							
Backlash between balancer mating gears - inch	- - - - -	- - - - -	- - - - -	- - - - -	.004-.008	- - - -	.004-.008
Backlash between crankshaft ring gear and balancer driving weight gear - inch	- - - - -	- - - - -	- - - - -	- - - - -	003-.007	- - - -	.003-.007
Balancer weight shaft bore in housing - inch	- - - - -	- - - - -	- - - - -	- - - - -	1.1245-1.1255	- - - -	1.1245-1.1255
Balancer weight bushing: Inside diameter (line reamed in assembly) - inch	- - - - -	- - - - -	- - - - -	- - - - -	.985-.986	- - - -	.985-.986
Balancer weight shaft: Diameter - inch	- - - - -	- - - - -	- - - - -	- - - - -	.9825-.9830	- - - -	.9825-.9830
Running clearance - inch	- - - - -	- - - - -	- - - - -	- - - - -	.0020-.0035	- - - -	.0020-.0035
Backlash (driving weight gear and oil pump drive gear) - inch	- - - - -	- - - - -	- - - - -	- - - - -	.004-.008	- - - -	.004-.008
Oil pump drive shaft bushings (line reamed in assembly) I.D. - inch	- - - - -	- - - - -	- - - - -	- - - - -	.626-.627	- - - -	.626-.627
Oil pump idler shaft, diameter - inch	- - - - -	- - - - -	- - - - -	- - - - -	.6210-.6215	- - - -	.6210-.6215
Oil pump drive shaft, diameter - inch	- - - - -	- - - - -	- - - - -	- - - - -	.6244-.6252	- - - -	.6244-.6252
Oil pump drive shaft, running clearance	- - - - -	- - - - -	- - - - -	- - - - -	.0008-.0026	- - - -	.0008-.0026
Backlash (oil pump drive gear and idler gear) - inch	- - - - -	- - - - -	- - - - -	- - - - -	.008-.012	- - - -	.008-.012
Lubrication oil pump safety valve spring:							
Free length - inch	- - - - -	- - - - -	- - - - -	- - - - -	2.51	- - - - -	2.51
Test length - inch	- - - - -	- - - - -	- - - - -	- - - - -	1.750	- - - - -	1.750
Test load - pounds	- - - - -	- - - - -	- - - - -	- - - - -	59 ± 5%	- - - - -	59 ± 5%
COOLING SYSTEM							
THERMOSTATS							
Number used	1	1	1	1	1	1	1
Open at	165°F	165°F	165°F	165°F	165°F	165°F	165°F
Wide open at	190°F	190°F	190°F	190°F	190°F	190°F	190°F

* For TD-9 (91), UD-350 and UD-370 Engines so equipped.

DESCRIPTION	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
COOLING SYSTEM - Continued							
FAN							
Type	Suction	Suction	Suction	Suction	Suction	Suction	Suction
Diameter	19 in.	19 in.	19 in.	19 in.	20 in.	20 in.	20 in.
Number of blades	5 (264), 4 (6,6A)	4	6	5	6	4	6
Mean fan rpm	2164 (6, 6A) 2520 (264)	1960	2155	2430	2164 (9, 9A) 2520 (350, 370)	1890	2155
WATER PUMP							
Type of seal	Packing	Packing	Packing	Packing	Packing	Packing	Packing
Rotation, drive end	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise
Impeller shaft diameter	.6215-.6220	.6215-.6220	.6215-.6220	.6215-.6220	.6215-.6220	.6215-.6220	.6215-.6220
Shaft running clearance	.0025-.0035	.0025-.0035	.0025-.0035	.0025-.0035	.0025-.0035	.0025-.0035	.0025-.0035
Mean pump rpm	2164 (6, 6A) 2520 (264)	1960	2155	2430	2164 (9,9A) 2520 (350,370)	1890	2155
FAN AND WATER PUMP DRIVE							
Driven accessory	Fan and pump	Fan and pump	Fan and pump	Fan and pump	Fan and pump	Fan and pump	Fan and pump
Number and type of belts	Single V-belt	Single V-belt	Single V-belt	Single V-belt	Single V-belt	Single V-belt	Single V-belt
Belt adjustment, slack between pulleys	1/2 to 3/4	1/2 to 3/4	1/2 to 3/4	1/2 to 3/4	1/2 to 3/4	1/2 to 3/4	1/2 to 3/4
ELECTRICAL							
Spark Plug gap:							
Diesel Engines, gasoline starting, inch	.023-.028	.023-.028	.023-.028	023-.028	.023-.028	.023-.028	.023-.028
Spark Plug Thread diam. inch	18 M M	18 M M	18 M M	18 M M	18 M M	18 M M	18 M M
Spark Plug Hex Size, inch	7/8	7/8	7/8	7/8	7/8	7/8	7/8
FLYWHEEL HOUSING SAE No. 1 or 2 Flange	When assembled on the engine, the large bore of the housing is to be concentric with the crankshaft within .008 inch total indicator reading. The rear face of the housing is to be square with the crankshaft within .008 inch total indicator reading.						

2. SPECIFICATIONS - Continued

DESCRIPTION	Engine						
	UD-6, UD-6A and UD-264	TD-6	TD-6 (61)	UD-281-4	UD-9, UD-9A, UD-350 and UD-370	TD-9	TD-9 (91)
SPECIAL NUT AND BOLT TORQUE DATA - In foot-pounds*							
Cylinder head stud nuts	100-120	100-120	100-120	100-120	120-140	120-140	120-140
Connecting rod nuts or cap screws **	110-120	110-120	110-120	110-120	70-75 (9) 55-60 (9A, 350, 370)	55-60	55-60
Main bearing stud nuts 5/8 inch	135-155	135-155	135-155	135-155	135-155	135-155	135-155
3/4 inch	225-245	225-245	225-245	225-245	225-245	225-245	225-245
Flywheel bolts	65-68	65-68	65-68	65-68	65-68	65-68	65-68
Manifold stud nuts	50-55	50-55	50-55	50-55	75-80	75-80	75-80
Nozzle body stud nuts	20-25	20-25	20-25	20-25	45-50	45-50	45-50
Nozzle fitting cap screws	30-35	30-35	30-35	30-35	30-35	30-35	30-35
Idler gear shaft nut or cap screw ***	75 Min.	75 Min.	75 Min.	75 Min.	75 Min.	75 Min.	75 Min.
Water pump drive shaft nut to shaft	150-175	150-175	150-175	150-175	150-175	150-175	150-175
Front pulley nut to crankshaft	325-375	325-375	325-375	325-375	325-375	325-375	325-375
Camshaft gear nut	225-250	225-250	225-250	225-250	225-250	225-250	225-250
Injection pump drive hub nut	115-125	115-125	115-125	115-125	115-125	115-125	115-125
Timing pointer cap screw	21-24	21-24	21-24	21-24	21-24	21-24	21-24
Hydraulic pump or magneto drive gear nut	90-100	90-100	90-100	90-100	90-100	90-100	90-100
Water pump cap screws and nuts	35-40	35-40	35-40	35-40	35-40	35-40	35-40
Spark Plug, 18 M M, (Threads dry)	30-35	30-35	30-35	30-35	30-35	30-35	30-35

*All torques are given with bolts, studs and nuts lubricated with Grade-30 engine oil unless otherwise specified.
**Lubricated with white lead and lubricating oil.
***Additional as necessary to line up with hole in bolt.

ISS-1035B 4-64

PRINTED IN UNITED STATES OF AMERICA

STANDARD TORQUE DATA FOR NUTS AND BOLTS
(For applications not covered in preceding "Special Nut and Bolt Torque Data")

Recommended torques, in foot-pounds, for standard application nuts and bolts shown below are applicable, provided:

A. All threads are lubricated with engine oil or chassis grease. (Refer to NOTE.)

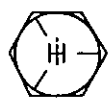
B. Joints are rigid; for example, no gaskets or compressible materials are used.

NOTE:

1. Multiply the standard torque by .85 when metallic plated bolts or nuts are used.
2. Multiply the standard torque by .75 when parkerized bolts or nuts are used.
3. Multiply the standard torque by .70 when Molykote, white lead or similar mixtures are used as lubricants.
4. Multiply the standard torque by .90 when hardened surfaces are used under the nut or bolt head.

Bolt Size	Type 2		Type 4	
	Min.	Max.	Min.	Max.
1/4	9	10	12	14
5/16	19	21	27	30
3/8	33	37	45	50
7/16	53	60	75	85
1/2	80	90	115	130
9/16	110	125	160	180
5/8	160	180	220	250
3/4	290	320	400	450
7/8	420	470	650	730
1	630	710	970	1090
1-1/8	850	950	1380	1550
1-1/4	1200	1350	1940	2180

BOLT TYPE IDENTIFICATION CHART

IH Type	SAE Grade	DESCRIPTION	BOLT HEAD * MARKING
2	5	WILL HAVE AN IH AND 3 RADIAL LINES Quenched and tempered medium carbon steel	
4	8	WILL HAVE AN IH AND 6 RADIAL LINES Quenched and tempered special carbon or alloy steel	

* The center marking identifies the bolt manufacturer. The IH monogram is currently used. Some bolts may still have a raised dot which previously identified IH bolts.

Magneto

NOTE: Specifications of magneto and distributor are the same for all series engines covered in this manual except as indicated.

Make	IH
Model	H4
No. of Cylinders	4
Magneto (Alnico Alloy)	Rotating
Grd. Switch	Automatic
Rotation	Counter Clockwise
Breaker Point Gap Inch	.013
Spark Advance	7°
Dist. Pinion Backlash Inch	.004 Max.
Inpulse Coupling Trips at	6-1/2° after TDC (13° after TDC for the TD-9 and TD-9 (91 series) Engines
Shaft End Clearance Inch	.003-.013
Magneto Gear Helical	27 Teeth
Magneto Dr. Shaft Diameter Inches	.9995-1.0005
Drive Gear	Camshaft
Bushing Diameter Inches	1.0015-1.0030

Distributor

Make	IH
Model	H
No. of Cylinders	4
Rotation	Clockwise
Breaker Point Gap Inch	.020
Spark Advance	8° at 1000 rpm
Volts	12

Cranking Motor

CHART A

Tractor or Power Unit Model Number	Cranking Motor Model Number
UD-6	1108904
UD-6A	1108904
TD-6	1108925 1108940
TD-6 (61)	1113038 1113052
UD-264	1108933
UD-281-4	1108933
UD-9	1108904
UD-9A	1108933
TD-9	1108925 1108940
TD-9 (91)	1113038 1113052
UD-350	1108933 or 1113038
UD-370	1113008

PRINTED IN UNITED STATES OF AMERICA

Cranking Motor

CHART B

Cranking Motor Model Number	Voltage	Type of Drive	Rotation (Viewing Drive End)	Brush Spring Tension (oz)	No Load Test	Lock Test
1108925	12	Bendix	Clockwise	36-40	80 amps at 11.2 volts at 4500 rpm	32 ft.lbs at 670 amps at 5.35 volts
1108940	12	Manual overrunning clutch	Clockwise	36-40	80 amps at 11.2 volts at 4500 rpm	32 ft.lbs at 670 amps at 5.35 volts
1113038 1113022	12	Solenoid overrunning clutch	Clockwise	28-36 48 (Minimum)	50 amps at 11.5 volts at 8000 rpm	22 ft.lbs at 500 amps at 3.25 volts
1108904	12	Bendix	Clockwise	36-40	80 amps at 11.2 volts at 4500 rpm	32 ft. lbs at 670 amps at 5.35 volts
1108933	12	Bendix	Clockwise	36-40	80 amps at 11.2 volts at 4500 rpm	32 ft.lbs at 670 amps at 5.35 volts
1113008	12	Bendix	Clockwise	28-36	50 amps at 11.5 volts at 8000 rpm	22 ft. lbs. at 500 amps at 3.25 volts

CHART A

Model	GENERATOR Model Number		VOLTAGE REGULATOR Model Number		GENERATOR RELAY Model Number	
	6 Volt	12 Volt	6 Volt	12 Volt	6 Volt	12 Volt
UD-6 and UD-6A	- - - -	1101726	- - - -	- - - -	- - - -	5884
TD-6	1101358	1101726 1100964	- - - - - - - -	1118381 1118779	1116807 - - - -	1116808 - - - -
TD-6 (61)	- - - -	1105109	- - - -	1119152	- - - -	- - - -
UD-264, UD-281-4, UD-350 and UD-370	- - - -	1100964	- - - -	1118779	- - - -	- - - -
UD-9	- - - -	1101726	- - - -	- - - -	- - - -	5884
UD-9A	- - - - - - - -	1101726 1100964	- - - - - - - -	- - - - 1118381	- - - - - - - -	5884 - - - -
TD-9	1101358 - - - -	1101726 1100964	- - - - - - - -	- - - - 1118381	1116807 - - - -	- - - - 1116808
TD-9 (91)	- - - -	1105109	- - - -	1119152	- - - -	- - - -

CHART B

Generator Model Number	Make	Voltage	Type	Field Current	Cold Output	Hot Output	Brush Spring Tension *	Rotation	Commutator End Bearing	Drive End Bearing
1100964	D.R.	12	Fixed third brush	2.0-2.14 amps at 12 volts **	11-13 amps. at 14.0 volts at 2300 rpm	9-11 amps. at 13.8-14.2 volts at 2400 rpm	24	Clockwise	Bronze bushing	Ball bearing
1101358	D.R.	6	Adj. third brush	3.5-4.5 amps at 6 volts	13-16 amps. at 7.7-8.11 volts at 1800 rpm	9-11 amps. at 7.3-7.6 volts at 1900 rpm	16	Clockwise	Bronze bushing	Ball bearing
1101726	D.R.	12	Adj. third brush	1.6-1.69 amps at 12 volts	8-10 amps. at 14.4-14.9 volts at 2200 rpm	6-8 amps. at 14.1-14.5 volts at 2400 rpm	16	Clockwise	Bronze bushing	Ball bearing
1105109	D.R.	12	Two brush shunt	1.54-1.67 amps at 12 volts	17 amps at 14 volts at 1450 rpm	- - - - -	28	Clockwise	Bronze bushing	Ball bearing
1105121	D.R.	12	Two brush shunt	1.54-1.67 amps at 12 volts	17 amps at 14 volts at 1450 rpm	- - - - -	28	Clockwise	Bronze bushing	Ball bearing

*Third brush spring tension - 19 ounces. ** Third brush lifted.

2. SPECIFICATIONS - Continued

Electrical

Current - Voltage Regulator. Delco-Remy No. 1118381, 12 Volt.

	Cutout Relay	Voltage Regulator
Air gap	.020 inch	.075 inch
Testing range	11.8 - 14.0 volts	13.6 - 14.5 volts
Adjusting specification	12.8 volts	14.0 volts
Point opening	.020 inch	- - - - - - - -

Current - Voltage Regulator. Delco-Remy No. 1118779, 12 Volt.

	Cutout Relay	Voltage Regulator
Air gap	.020 inch	.075 inch
Testing range	11.8 - 14.0 volts	13.6 - 14.5 volts
Adjusting specifications	12.8 volts	14.0 volts
Point opening	.020 inch	- - - - - - - -

Three-unit Regulator. Delco-Remy No. 1119152, 12 Volt.

	Cutout Relay	Voltage Regulator	Current Regulator
Air gap	.020 inch	.075 inch	.075 inch
Point opening	.020 inch	- - - - - - - -	- - - - - - - -
Closing voltage range	11.8 - 13.5 volts	- - - - - - - -	- - - - - - - -
Voltage setting range	- - - - - - - -	13.8 - 14.8 volts	- - - - - - - -
Current setting range	- - - - - - - -	- - - - - - - -	15.5 - 18.5 volts

Step Voltage Control. Delco-Remy No. 5884, 12 Volt.

	Cutout Relay	Step-voltage Control
Air gap	.015 inch	.030 inch
Point opening	.020 inch	.010 inch
Contact spring tension	- - - - - - - -	0.8 oz.
Armature travel	- - - - - - - -	.030 inch
Opening range	- - - - - - - -	14.0 - 15.5 volts
Adjusting specifications	13.3 volts	14.7 volts
Closing range	12.5 - 14.0 volts	12.5 - 14.0 volts

Relay. Delco-Remy No. 1116807, 6 Volt.

Air gap (points closed)	.024 inch
Point opening (armature down)	.016 inch
Closing voltage range	7.1 - 8.0 volts
Reverse current - maximum at 6.4 volts	1.5 amperes

Relay. Delco-Remy No. 1116808, 12 Volt.

Air gap (points closed)	.015 inch
Point opening	.020 inch
Closing voltage range	12.5 - 14.3 volts

3. CHECKING MECHANICAL PROBLEMS

Engine

PROBABLE CAUSE	REMEDY
Engine Fails to Turn	
1. Starting switch inoperative	Inspect for faulty cables and terminals.
2. Battery too low to turn engine fast enough	Charge the battery or install a new one.
3. Engine oil too heavy	Use correct grade of lubricating oil.
4. Internal seizure	Hand crank the engine with the spark plugs removed, engine clutch disengaged and compression release lever in starting position. If the engine does not turn easily, seizure due to internal damage is indicated.
5. Cranking motor inoperative	Inspect all cables and terminals. Check for tightness of mounting screws. Inspect the commutator for damage.
Engine Will Not Operate As Diesel	
1. Injection pump does not deliver fuel	Refer to "INJECTION PUMP SERVICE MANUAL," ISS-1003.
2. Compression release faulty (starting control)	Adjust linkage. (Refer to Section 8.)
Engine Does Not Develop Full Power	
1. Moisture in the fuel tank	Drain the fuel system including the water trap and filter. Refill with fuel oil, and vent air from system.
2. Fuel oil filter and strainer clogged	Disassembly and clean each unit.
3. Air cleaner clogged	Remove and clean oil cup.
4. Pre-cleaner clogged (when used)	Clean pre-cleaner.
5. Insufficient fuel	Check fuel tank.
6. Poor fuel	Use proper grade of diesel fuel.
7. Injection pump not properly timed to the engine	Remove the pump gear cover and make proper timing adjustments.
8. Injection pump not operating properly	Remove the injection pump and test it.
9. One or more cylinders misfiring	Locate and correct the cause.
Engine Turns But Will Not Start	
1. Fuel system inoperative	Inspect the gasoline tank and check the shut-off valve in the gasoline strainer.
2. Ignition system inoperative	Test the ignition system and make necessary repairs.
3. Intake or exhaust system clogged	Remove air flow restriction and clean the exhaust system.
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 cracked	Grind the valve seats. If cracked, install new valves.
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.

PRINTED IN UNITED STATES OF AMERICA

Engine

	PROBABLE CAUSE	REMEDY
	Engine Overheats	
1.	Insufficient water in the cooling system	Check the water level in the radiator and add water if necessary.
2.	Cooling system clogged	Flush out radiator and engine.
3.	Fan and water pump belt slipping, or broken	Check tension and make proper adjustments. Replace the belt.
4.	Insufficient oil	Maintain proper oil level.
5.	Engine oil diluted with fuel	Change oil and inspect fuel connections on injection nozzles.
6.	Defective thermostat	Remove and test the thermostat and replace if necessary.
7.	Water pump leaks	Service the packing gland.
8.	Water pump defective	Repair the pump.
	Engine Misses	
1.	Insufficient air to engine	Remove and clean the air cleaner and air cleaner pipe.
2.	Injection nozzle valve dirty or sticking	Remove and clean nozzle valve. If defective, replace with serviceable unit.
3.	Air lock in fuel pump	Bleed the air from the system and check all fuel lines and connections for leaks.
4.	Poor fuel	Use specified grade of diesel fuel.
5.	Air leaks around the intake manifold	Remove and install new intake manifold gasket.
	Excessive Oil Consumption	
1.	Piston rings worn or broken	Install new rings.
2.	Oil level in crankcase too high	Maintain proper oil level.
3.	Crankcase gasket leaking	Install new gasket.
4.	Worn valve guides	Install new valve guides.
5.	Cylinder sleeves worn	Install new sleeves.
6.	Front and rear crankshaft oil seals leaking	Install new oil seals.
7.	Piston rings not seating	Install new rings.
8.	Clogged oil rings	Remove and inspect and, if necessary, replace.
9.	Oil pan drain plug loose or worn	Tighten plug or replace.
10.	Overheating	Refer to problem "Engine Overheats."
	Engine Does Not Idle Properly	
1.	Gummy and sticky valves and plunger	Check the valves and check reverse check plunger. Replace them if necessary.
2.	Incorrect timing of injection pump	Time pump properly.
3.	Plunger spring broken	Install new spring.
4.	Cool engine temperature	Bring engine up to operating temperature.
5.	Governor springs loose or broken. (IH fuel injection pump.)	Repair or replace spring.
6.	Plunger scored, stuck, or worn. (IH pump.)	Install new plunger.
7.	Loose governor spring levers on control lever shaft. (IH pump.)	Tighten screw and nut.
8.	Restrictions to fuel delivery. (IH pump.)	Inspect fuel lines and valves. Inspect for proper level in fuel tank.

(Continued on next page.)

3. CHECKING MECHANICAL PROBLEMS - Continued

Engine

PROBABLE CAUSE	REMEDY
Engine Noises	
1. A sharp rap at idling speed indicates a loose piston pin. The pin at fault can be located by short-circuiting the spark plugs one at a time with the engine running on the gasoline cycle. The noise will disappear when the plug in the cylinder with the defective piston is short-circuited	Replace piston pin.
2. A flat slap, when advancing engine speed under load, indicates a loose piston	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 on the gasoline cycle. 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.
5. Combustion knock in one or more cylinders:	
(a) Leaky injection nozzle valve	Replace nozzle valve.
(b) Poor fuel and/or water in fuel	Drain entire diesel fuel system and refill with a good grade of clean diesel fuel. Remove and clean the water trap.
(c) Faulty injection pump timing	Retime pump to engine.
(d) Improper engine temperature	Keep temperature in working range of heat indicator.
Excessive Smoke	
1. Too much oil in air cleaner	Remove air cleaner cup and remove any excess oil.
2. Air cleaner pipe clogged	Remove the air cleaner and clean the pipe.
3. Improper fuel	Use proper grade of diesel fuel.
4. Defective injection nozzle	Repair or install a new injection nozzle.
5. Worn pistons, rings and sleeves	Install new parts.
6. Pre-cleaner clogged	Remove and clean. If defective, install new parts.
7. Injection pump not properly timed	Time injection pump.
8. Incorrect valve adjustment	Adjust the valves properly.
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 non-corrosive 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 engine are in good condition.
7. Oil lines clogged	Clean all oil passages.
8. Connecting rod bent	Align rod or install new.
9. Crankshaft out of alignment	Straighten, or install new shaft.

PRINTED IN UNITED STATES OF AMERICA
ISS-1035B 4-64

PROBABLE CAUSE	REMEDY
Valve 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. If necessary, install new valves.
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.
5. Piston rings not fitted properly	Install new rings. Refer to "SPECIFICATIONS," 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.
Loss Of Oil Pressure	
1. Low oil level	Add sufficient oil to bring up to specified mark on level gauge.
2. Engine oil pressure indicator or line defective.	Replace defective parts.
3. Main or connecting rod bearings worn . .	Replace defective parts.
4. Dirt in regulating valve, or regulating valve spring broken	Clean or replace spring.
5. Oil pump worn	Remove and repair, or replace.
6. Camshaft bearings worn excessively. . . .	Install new bearings.
7. Oil diluted or not as specified.	Change oil regularly, using correct grade.
8. Oil leaks	Check and service where necessary - at valve cover, side plates, dust seal at rear of oil pan, crankcase front cover, oil seals at front and rear of crankshaft, oil pan, oil filter and engine oil pressure indicator tube.
9. Clogged oil filter	Change filter element.
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 over-flow pressure valve (if equipped)..	Replace.
8. Defective water pump	Inspect water pump impeller and shaft. If necessary, replace.
9. Water pump leaks	Service packing gland. If packless type, repair or replace pump.
10. Dirty, scaled coolant passages.	Clean and flush passages.
11. Radiator clogged	Flush out radiator.
12. Fan belt slipping	Check the tension; replace if greasy or worn.

(Continued on next page.)

3. CHECKING MECHANICAL PROBLEMS - Continued

Electrical

(Refer to Sections 12 through 17.)

PROBABLE CAUSE	REMEDY
Discharging Battery	
1. Connections loose	Tighten connections.
2. Short circuits	Locate shorts and correct cause.
3. Connections dirty	Clean connections.
4. Voltage regulator unit out of order	Adjust or replace.
5. Generator not charging	Check voltage regulator unit and make necessary adjustments or replace defective unit.
Battery Overheating	
1. High charging rate	Inspect voltage regulator unit.
2. Voltage regulator unit out of order	Adjust voltage regulator unit. If necessary, replace.
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 spring.
Ammeter Shows Discharge With Engine Operating	
1. Generator inoperative	Service or replace generator.
2. Faulty voltage regulator unit	Adjust relay or replace if necessary.
3. Short circuits	Test cables for shorts.
4. Generator 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. Generator drive belt loose or broken	Adjust belt; if necessary, replace.
4. Low idling speed	Adjust idling speed; check voltage regulator unit.
Cranking Motor Will Not Operate	
1. Faulty batteries	Recharge, or install new batteries.
2. Cables and terminals defective	Check ground cable and battery-to-starter switch cable for secure mounting to terminals; replace cables if necessary. Inspect for dirty or loose connections.
3. Cranking motor inoperative	See below.
4. Cranking motor switch defective	Inspect for burned or corroded parts.

(Continued on next page.)

PRINTED IN UNITED STATES OF AMERICA

Electrical

PROBABLE CAUSE	REMEDY
Cranking Motor Inoperative	
1. Cranking motor burned out	Install new cranking motor.
2. Cranking motor worn or dirty	Service or replace cranking motor.
3. Batteries defective	Charge, or install new batteries.
4. Brushes not making proper contact	Inspect to see if brushes are seating properly.
5. Defective starting switch contact points	Inspect and clean; if necessary, replace.
Excessive Generator Output	
1. Generator field grounded	Check for external ground and correct.
2. Defective voltage regulator unit	Install new unit.
3. Shorted generator field	Service or replace generator.
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 or distributor parts	Test magneto or distributor and replace defective parts.
3. Defective breaker mechanism	Check and make proper adjustments; replace faulty parts.
Magneto Turns, Spark Is Generated, But Engine Does Not Develop Full Power	
1. Timing defective	Adjust timing to engine.
2. Spark plugs defective	Install new plugs.
3. Intermittent spark	Service spark plugs and inspect entire wiring system.
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 carbonized surfaces providing escape for current to ground	Replace rotor or cap if necessary.
5. Faulty condenser	Test condenser and replace if necessary.

(Continued on next page.)

3. CHECKING MECHANICAL PROBLEMS - Continued

(Refer to Sections 12 through 17.)

Electrical

PROBABLE CAUSE	REMEDY
Distributor Contact Points Burned or Pitted	
1. Points set too closely	Inspect to insure correct clearance. Refer to "SPECIFICATIONS," par. 2.
2. Excessive resistance in condenser due to broken strands in condenser lead	Replace as necessary.
3. High voltage in electrical system	Check for loose connections in charging circuit, faulty voltage regulator, and grounded generator field. Tighten connections, adjust voltage regulator, or replace defective parts.
4. Oil or foreign substances on contact points	Clean points.
5. Shaft or rubbing block in distributor worn	Replace as necessary.
Intermittent Spark	
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 Spark	
1. Dirty distributor contact points or poor rotor connections	Clean contacts and wipe off rotor with carbon tetrachloride on clean cloth.
2. Ignition timing incorrect	Check ignition timing.
3. Leakage of current to ground due to faulty wiring	Inspect wiring for fraying damaged or cracked insulation and broken strands. Replace.
4. Defective spark plugs	Service spark plugs, or replace.

4. BATTERY TESTING CHART

HYDROMETER TEST (80°F) (SEE NOTE)	CONDITION	REMEDY
1.250 to 1.280 SPECIFIC GRAVITY	Charged.	No remedy is required if variation among cells 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.
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 voltage regulator. On third brush generators, increase the charging rate. Make a thorough check of the electrical system for short circuits, loose connections, corroded terminals, etc.
LESS THAN 1.225 SPECIFIC GRAVITY	Poor.	Battery should be recharged. Adjust gravity of cells if not uniform. Proceed as outlined in B above.

PRINTED IN UNITED STATES OF AMERICA

4. BATTERY TESTING CHART - Continued

Electrical

HYDROMETER TEST (80° F) (SEE NOTE)	CONDITION	REMEDY
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 overcharge. 3. Improper addition of acid or "dopes." 4. Natural or premature failure.	Recharge battery at rate of 1 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: 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
IF THE VOLTAGE DROP IS MORE THAN .2 VOLT (2/10) BETWEEN THE CRANKING MOTOR CABLE AND THE FRAME WHILE CRANKING.	Poor contact between terminal and frame or between clamp terminal and battery post.	Locate the high resistance; repair or replace.
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 above.

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 a 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. ENGINE TUNE-UP

Engine

PROBABLE CAUSE	REMEDY
Improper Fuel Pressure	
1. Fluctuating injection pump fuel pressure	Inspect fuel injection pump.
2. Fuel injection pressure too low	Check for clogged fuel lines or defective fuel injection pump.
Low Engine RPM	
1. Linkage binding or damaged.	Repair and install new parts needed.
2. Fuel and air shut-off improperly adjusted	Make proper adjustments.
3. Governor control rod improperly adjusted	Adjust rod to proper length.
Low Fuel Pressure	
1. Broken fuel lines	Repair or install new line.
2. Clogged line	Clean or install new line.
3. Improper grade of fuel	Use correct fuel.
High Fuel Pressure	
1. Clogged fuel return elbow	Remove and clean.
Operates Unevenly and Vibrates	
1. Valve and spring assembly inoperative	Repair or install parts needed.
2. Incorrect injection pump timing	Time injection pump correctly. Refer to "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.

General

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.

Injection Pump

(Refer to "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.)

1. Test the injection pump either on or off the engine.

2. Check the timing of the injection pump.

Injection Nozzles

(Refer to "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.)

1. Test the injection nozzles on or off of the engine. Adjust and repair.

2. Remove the nozzle precombustion chambers and inspect for pitted or burned surfaces. Install new gaskets and replace precombustion chambers if necessary.

Diesel Throttle Control

(Refer to "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.)

1. Check the operation of the control.

2. Adjust friction on the disc if necessary.

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

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

Valves

(Refer to Section 2.)

1. Check the clearance on intake and exhaust valves, and make adjustments.

PRINTED IN UNITED STATES OF AMERICA

5. ENGINE TUNE-UP - Continued

Engine

Filters

1. Replace the lubricating oil filter elements, and clean the filter case assembly thoroughly.

2. Inspect the diesel fuel filter elements and replace them if necessary.

Spark Plugs
(Refer to Section 17.)

1. Clean, and adjust the spark gap.

2. Replace broken plugs.

Magneto
(Refer to Section 12.)

1. Check the breaker points.

2. Clean the breaker point chamber.

Generator
(Refer to Section 15.)

1. Inspect the commutator; clean thoroughly at frequent intervals.

Condenser and Ignition Coil
(When used) (Refer to Section 17.)

1. Check condenser; replace it if necessary.

2. Check ignition coil; replace it if necessary.

Distributor
(Refer to Section 13.)

1. Check the distributor contact points.

Cranking Motor
(Refer to Section 14.)

1. Inspect the commutator; clean thoroughly at frequent intervals.

Electrical Connections

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

2. Check all switches.

Starting System Control and Linkage
(Refer to Section 8.)

1. Check the entire linkage of the starting system.

2. Check approximate clearance travel of the starting valve cover in cylinder head (starting position).

Starting Carburetor
(Refer to Section 10.)

1. Remove the screen retainer and clean it.

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

3. Check float valve assembly for leakage.

Cooling System

1. Flush the radiator with clean water, then drain and refill with soft water if available, or anti-freeze solution in cold weather.
2. Check water pump packing, adjust packing nut or install new packing as needed.

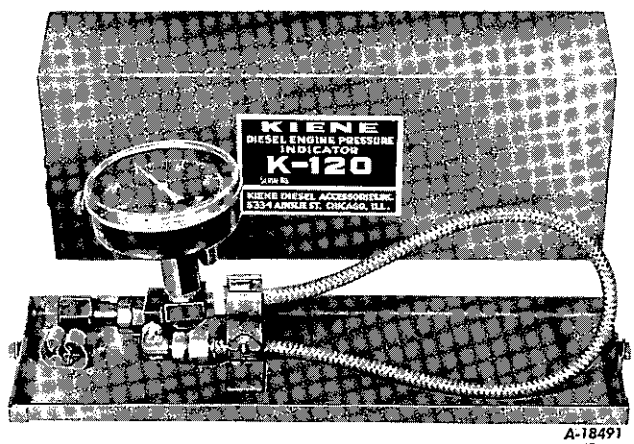
3. Check the fan belts for wear, and replace if necessary.

4. Check the fan belt tension.

Diesel Compression Pressure

Check the compression of each cylinder on the diesel cycle. Remove the No. 1 nozzle body from the cylinder head. Then insert either the special Kiene adapter or the Bacharach adapter into position in the cylinder head, and secure in place. Attach Kiene Model K-120 or Bacharach pressure indicator to the adapter. (Refer to the "SERVICE TOOLS MANUAL," ISS-1002.) Start the engine and switch to the diesel cycle. With the engine operating at 1,000 rpm, check the compression reading on the indicator. (Refer to par. 2 for compression pressure.) After the above procedure has been followed, remove the special adapter and check the other cylinders in the same manner. Install each nozzle assembly after checking.

NOTE: Be certain that the compression gauge used is in working order and is free of leaks.



A-18491

Illust. 4 - Kiene Pressure Indicator.

PRINTED IN UNITED STATES OF AMERICA

CYLINDER HEAD AND VALVES

1. DESCRIPTION

The IH diesel engine cylinder head differs from the conventional gasoline engine cylinder head in that it contains an auxiliary combustion chamber. When opened to the regular combustion chamber by a starting valve it increases the cylinder volume and decreases the compression ratio. It contains the conventional intake and exhaust valves of overhead design. The valve rocker arm housing mounts the starting valve operating shaft. The hood sheet and the valve mechanism must be removed to gain access to the cylinder head. The cylinder head must be removed when the valve seats need reconditioning or when the cylinder sleeves are to be removed.

The four-cylinder diesel engine has a single cylinder head assembly.

2. ENGINE VALVES

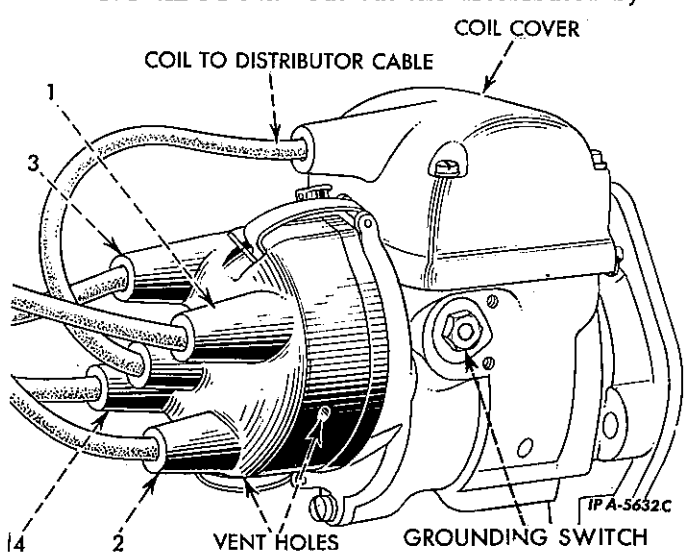
NOTE: For complete information on valve reconditioning refer to paragraph 7.

3. VALVE CLEARANCE ADJUSTMENT

1. Before starting adjustment, cut out the ignition as follows:

(a) DIESEL ENGINE EQUIPPED WITH H-4 MAGNETO: Cut out the magneto by placing a jumper from the grounding switch cable terminal (Illust. 1) to a cap screw on the coil cover.

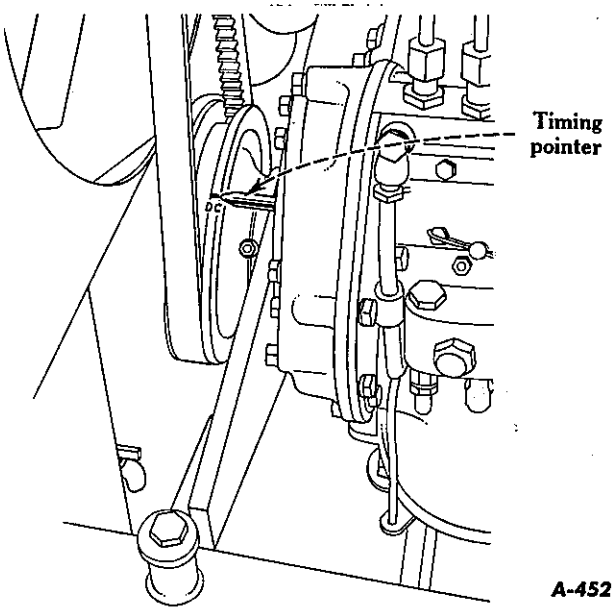
(b) DIESEL ENGINE EQUIPPED WITH DISTRIBUTOR: Cut out the distributor by removing the cable which connects the primary terminal (on the side of the distributor housing) to the ignition coil.



Illust. 1 - Showing Terminal on Magneto.

2. Pull the compression release lever all the way back to the gasoline position. Remove the valve housing cover and spark plugs.

3. Crank the engine until the exhaust valve for the No. 4 cylinder commences to close. The opening and closing can be seen plainly by observing the valve which is farthest to the rear. Continue cranking slowly until the "DC" timing mark on the fan drive pulley is in line with the timing pointer (Illust. 2).



Illust. 2 - Showing Timing Pointer and "DC" Mark on Fan Drive Pulley.

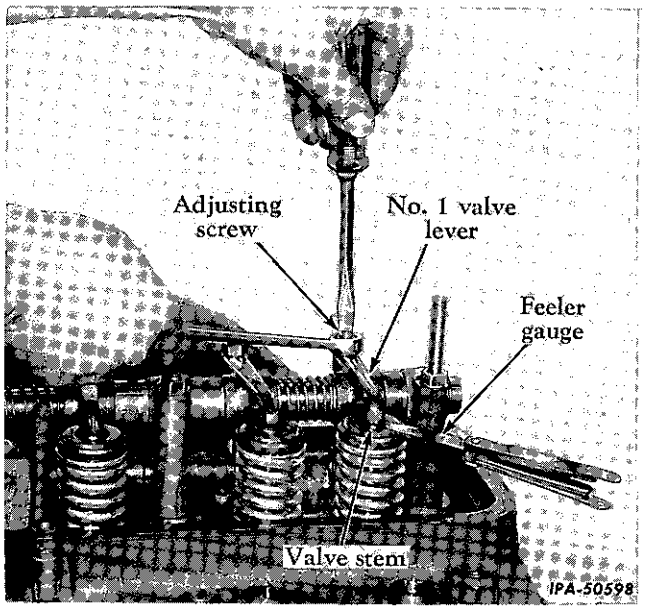
4. Insert a feeler gauge of the specified cold clearance (refer to "SPECIFICATIONS" in Section 1) between the valve lever and the valve stem of the No. 1 intake valve. Adjust the valve clearance by loosening the adjusting screw lock nut and turning the adjusting screw as shown in Illust. 3 until the feeler gauge is snug. Tighten the lock nut and recheck the clearance. Adjust the valve clearance of the No. 1 exhaust valve in similar manner.

5. Crank the engine one-half revolution at a time, measuring and adjusting the clearance of both the intake and exhaust valve for each cylinder in succession, according to the firing order of the engine which is 1-3-4-2.

(Continued on next page.)

CYLINDER HEAD AND VALVES

3. VALVE CLEARANCE ADJUSTMENT - Continued



Illust. 3 - Adjusting Valve Clearance.

6. Install the valve housing cover with gasket. Remove the short-circuiting jumpers as follows:

(a) DIESEL ENGINE EQUIPPED WITH H-4 MAGNETO: Remove the jumper wire from the grounding switch cable terminal (Illust. 1) and the cap screw on the coil cover.

(b) DIESEL ENGINE EQUIPPED WITH DISTRIBUTOR: Connect the cable to the primary terminal (on the side of the distributor housing) to the ignition coil.

4. REMOVAL

(Refer to Illust. 6.)

1. Drain any remaining coolant in the engine by opening the valve located on the left side of the cylinder wall.

2. Remove the lifting eye from the engine, if so equipped.

3. Remove the exhaust manifold.

4. Remove the valve cover and gasket. Remove the oiler felt on engine so fitted. Remove the cylinder head breather pipe.

5. Disconnect the linkage at the outer shaft lever (47). Remove the nuts from the shaft lever pins (42) and tap out the pins. Remove the levers, the oil seal (43) and the shaft (46) from the valve housing.

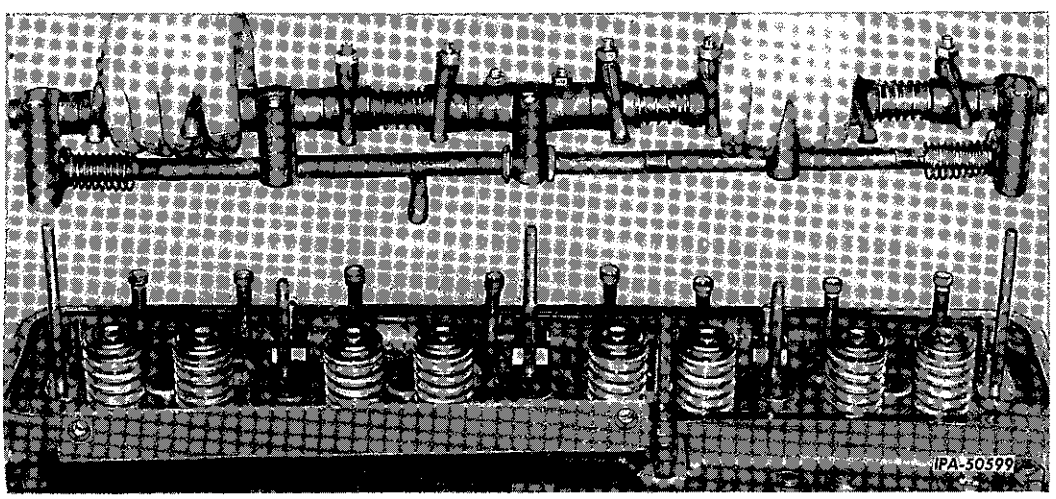
6. Remove the nuts from the studs which secure the valve assembly to the cylinder head. Remove the assembly and the bottom brackets (22). Lift the assembly evenly from the studs. Illust. 4.

7. Lift and remove the valve push rods.

8. Remove the injection pipes from the nozzles and from the injection pump. Install caps on the injection pump connections to prevent the entry of dirt. Remove the spark plugs.

9. Remove the water outlet elbow.

10. Remove the thermostat housing from its position above the water pump.



Illust. 4 - Removing Rocker Arm Assembly.

PRINTED IN UNITED STATES OF AMERICA

CYLINDER HEAD AND VALVES

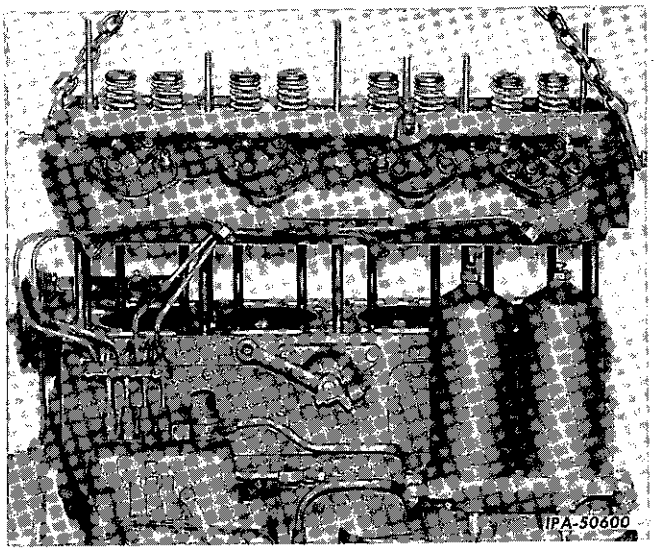
11. Disconnect the carburetor choke control, the fuel shut-off rod and the primer control. Disconnect the gasoline tube at the carburetor.

12. Remove the cover and gasket from the forward end of the intake manifold and disconnect the wires to the manifold switch. Pull the wires free of the manifold.

13. Remove the intake manifold assembly and gaskets.

14. Remove the exhaust manifold assembly.

15. Remove the cylinder head stud nuts and remove the cylinder head by lifting it evenly from position. See Illust. 5.



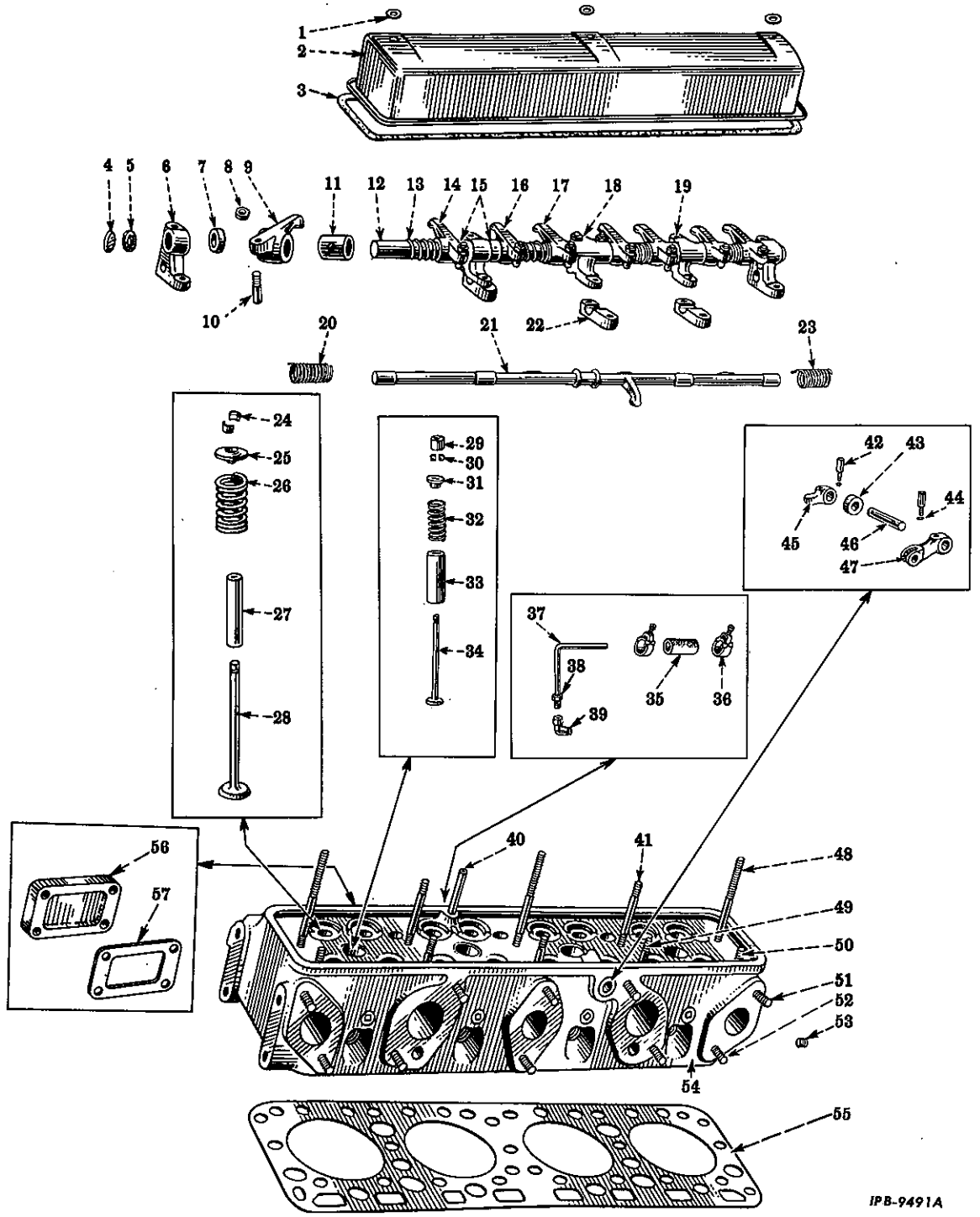
Illust. 5 - Removing Cylinder Head.

Legend for Illust. 6

1. Washer.
2. Valve cover.
3. Valve cover gasket.
4. Expansion plug.
5. Snap ring.
6. End bracket.
7. Lever spacer, short.
8. Adjusting screw nut.
9. Exhaust valve lever, R.H.
10. Lever adjusting screw.
11. Valve lever bushing.
12. Valve lever shaft.
13. Valve lever spring.
14. Intake valve lever, L.H.
15. Valve lever spacer, long.
16. Intake valve lever, R.H.
17. Exhaust valve lever, L.H.
18. Bracket, center, upper half.
19. Bracket, intermediate, upper half.
20. Starting valve shaft spring, rear.
21. Starting valve shaft.
22. Bracket, lower half.
23. Starting valve shaft spring, front.
24. Valve key.
25. Valve rotator.
26. Valve spring.
27. Valve guide.
28. Exhaust valve.
29. Starting valve cover.
30. Valve key.
31. Valve spring seat.
32. Valve spring.
33. Valve guide.
34. Starting valve.
35. Breather tube hose.
36. Breather tube hose clamp.
37. Breather tube.
38. Breather tube nut.
39. Breather tube elbow.
40. Breather pipe.
41. End bracket stud, short.
42. Operating shaft lever pin.
43. Operating shaft oil seal.
44. Lock washer.
45. Operating shaft lever, inner.
46. Operating shaft.
47. Operating shaft lever, outer.
48. Bracket stud, outer, long.
49. Bracket stud, center and intermediate, short.
50. End bracket stud, short.
51. Manifold stud, short.
52. Manifold stud, long.
53. Oil header plug.
54. Cylinder head.
55. Cylinder head gasket.
56. Cover plate.
57. Cover plate gasket.

CYLINDER HEAD AND VALVES

4. REMOVAL - Continued



Illust. 6 - Exploded View of Cylinder Head, Valves and Starting Mechanism (91 Series Shown - 61 Series Similar).

PRINTED IN UNITED STATES OF AMERICA

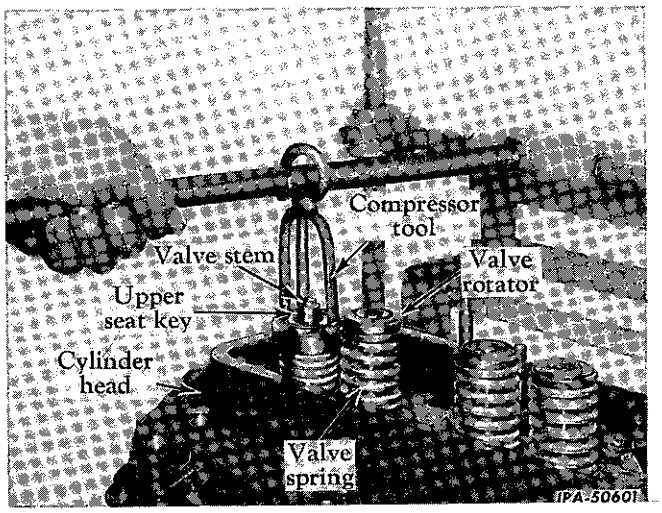
CYLINDER HEAD AND VALVES

5. DISASSEMBLY

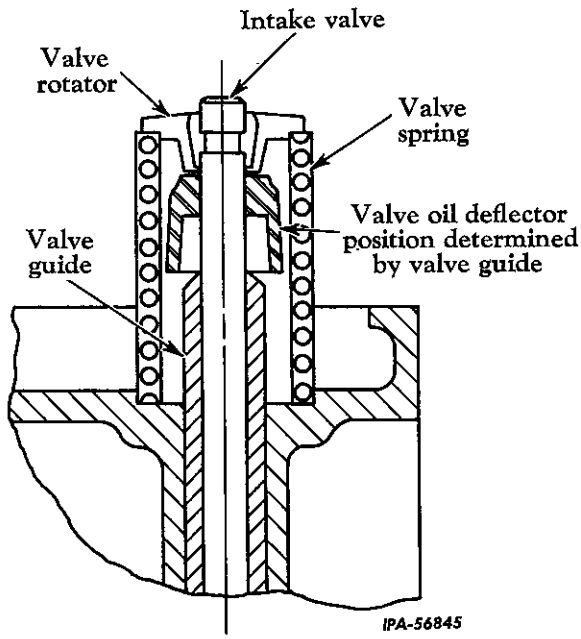
Intake and Exhaust Valves

Using a C-type compressor or valve lifter, compress the valve springs and remove each set of valve seat keys (24, Illust. 6). Remove the compressor and lift each valve spring seat (or positive valve rotator, whichever is used) and spring from position. Slide the valves from position. Keep each set in a numbered envelope or box so that they can be reassembled to their original positions.

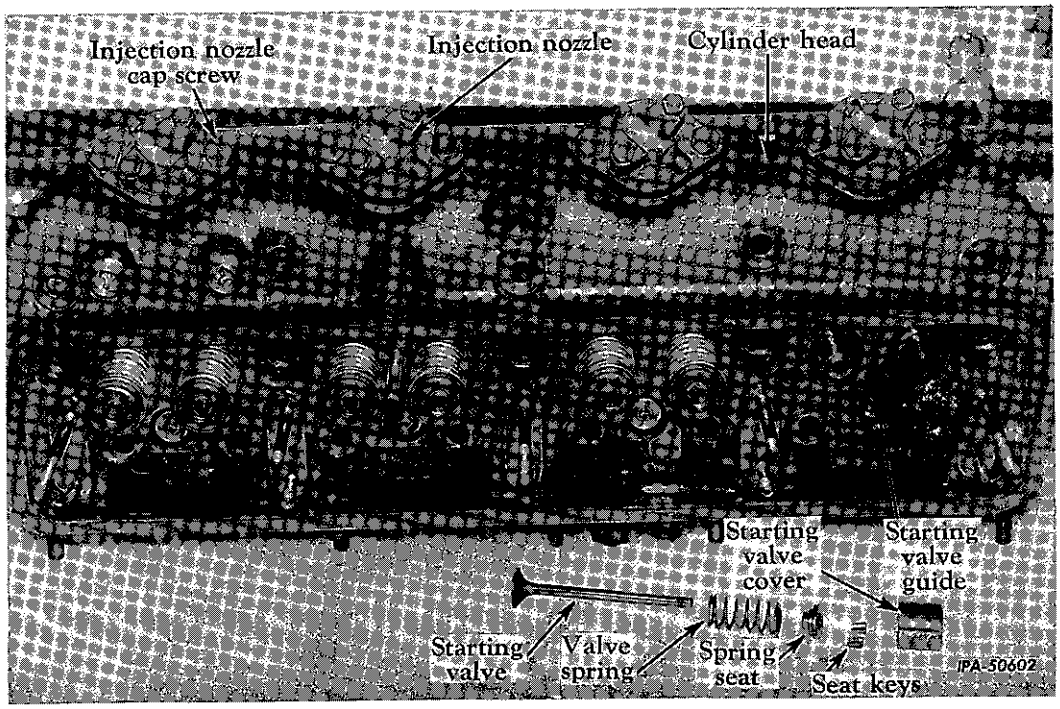
(Continued on next page.)



Illust. 7 - Compressing Valve Springs.



Illust. 8 - Valve Oil Deflector Location Diagram.



Illust. 9 - Starting Valves and Injection Nozzles.

CYLINDER HEAD AND VALVES

5. DISASSEMBLY - Continued

A valve oil deflector is installed on all valve assemblies in the TD-9 (91) engines after serial number 7796 and UD-370 power units after serial number 604. The oil deflector is installed on the valve stem (Illust. 8) and reduces the amount of lubricating oil flowing to the valve stems. Excessive amounts of oil at this point causes sticky valves and excessive build up of carbon deposits.

CAUTION: The oil deflector must be used on intake valves when valve levers 46 223 DBX and 46 224 DBX are used.

Starting Valves

Remove the starting valve covers (29, Illust. 6). Use the service tool 1 020 073 R1 to compress the springs and remove the keys (30). (Refer to the "SERVICE TOOLS MANUAL," ISS-1002.) Lift out the valve spring seats (31) and the springs and slide the valves from position. (Illust. 10.)

Injection Nozzles

Remove the nuts which secure the injection nozzles to the cylinder head studs (Illust. 9). Remove the nozzles by pulling them from position. A slide hammer type nozzle puller is available for this operation; various adapters permit its use with all engines. (Refer to the "SERVICE TOOLS MANUAL," ISS-1002.) For disassembly of nozzles, refer to "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.

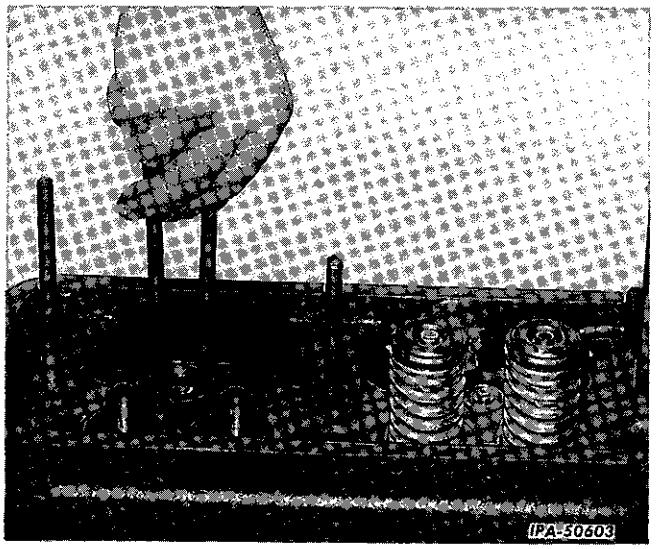
Valve Lever and Shaft

To disassemble the mechanism, remove the set screws in the shaft center bracket (18, Illust. 6), remove the nuts from the bracket studs and remove the retainer rings (5) from the ends of the shaft (12). Slide the parts from the shaft. Lift out the starting valve shaft.

NOTE: To remove the valve guides, use the service tool described in the "SERVICE TOOLS MANUAL," ISS-1002.

6. INSPECTION AND REPAIR

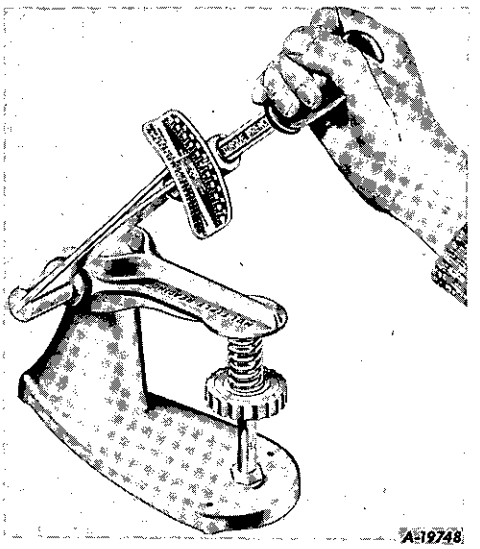
Clean all parts thoroughly. Carbon must be removed from the bottom face of the cylinder head, out of the valve ports and guide bores, and from the valve head and faces. Flush out the water passages.



Illust. 10 - Compressing Starting Valve Spring for Valve Removal.

Inspection

Inspect all parts for damage. Check the dimensions of the valves and the specifications for the valve springs against those listed in "SPECIFICATIONS" in Section 1. (Illust. 11.) If not too severe, any score marks or scratches on valves and related parts can be cleaned off with a fine abrasive.



Illust. 11 - Testing Valve Springs.

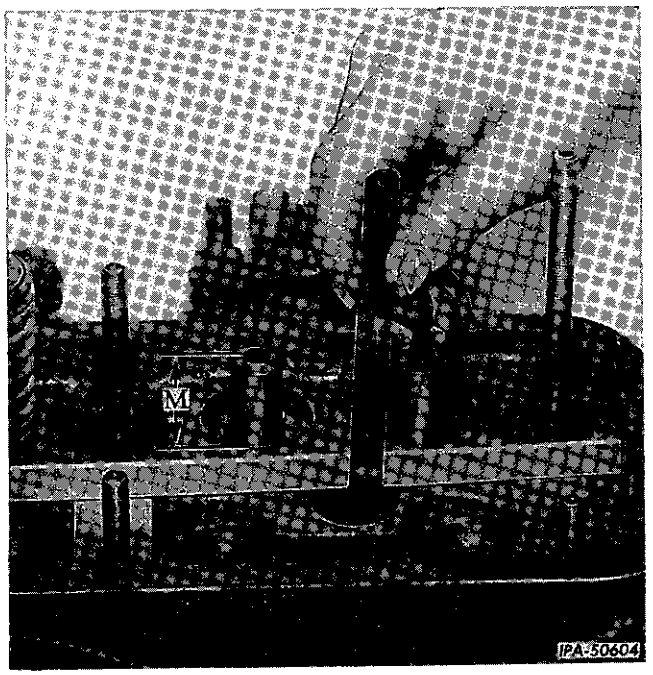
Repair

The cylinder head must have parts replaced if any doubt as to serviceability of the parts

PRINTED IN UNITED STATES OF AMERICA

CYLINDER HEAD AND VALVES

exists. Reface each valve seat and valve head with standard valve grinding equipment. Guides must be especially watched and replaced if worn. The sharp edged, chamfered end of the guide must be at the top of the cylinder head when installed. Intake and exhaust valve guides must extend the specified distance above the valve spring counterbore (M, Illust. 12). Refer to "SPECIFICATIONS" in Section 1 or chart in par. 7 for distance involved and additional information on engine valves and valve guides.



Illust. 12 - Measuring Position of Starting Valve Guide.

The valve guides are furnished for service reamed to size; but, installation may tend to diminish the bore slightly. Correct this after installation by reaming out the exhaust and intake valve guides and the starting valve guides, to give the dimension specified in "SPECIFICATIONS" in Section 1.

Valve Lever and Shaft Assembly

Replace the bushing if necessary. Be certain that the oil hole in the bushing corresponds in position with that of the valve lever and shaft when installed. Bushing running clearances are given in "SPECIFICATIONS" in Section 1.

7. VALVE RECONDITIONING

Carbon deposits on the valves and valve seats are normal effects of the fuel-burning engine and cannot be avoided completely (Illust. 13). However, as the amount of carbon in the engine increases, such deposits become detrimental to engine efficiency and valve assembly life.

Whenever the cylinder head of an engine is removed, the surfaces of the parts affected (valves and valve seats) should be examined for pitting, burning, warping and other defects.

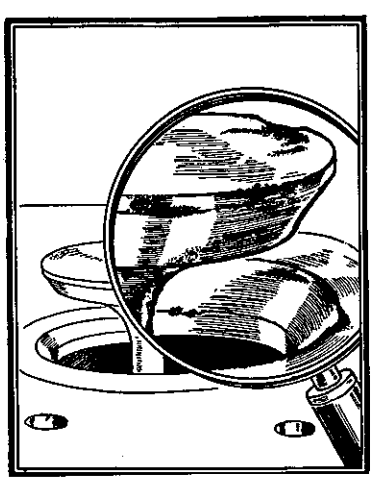
The formation of carbon cannot be avoided. However, it can be held to a minimum by the use of good grades of fuel and accurate engine timing.

Warpage, burning and pitting of valves is especially true of the exhaust valves, because these are exposed to the high temperature flow of exhaust gases. Such defects are generally caused by valves failing to seat tightly and evenly; this permits exhaust blowby. This 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 occurs chiefly 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 resulting misalignment.

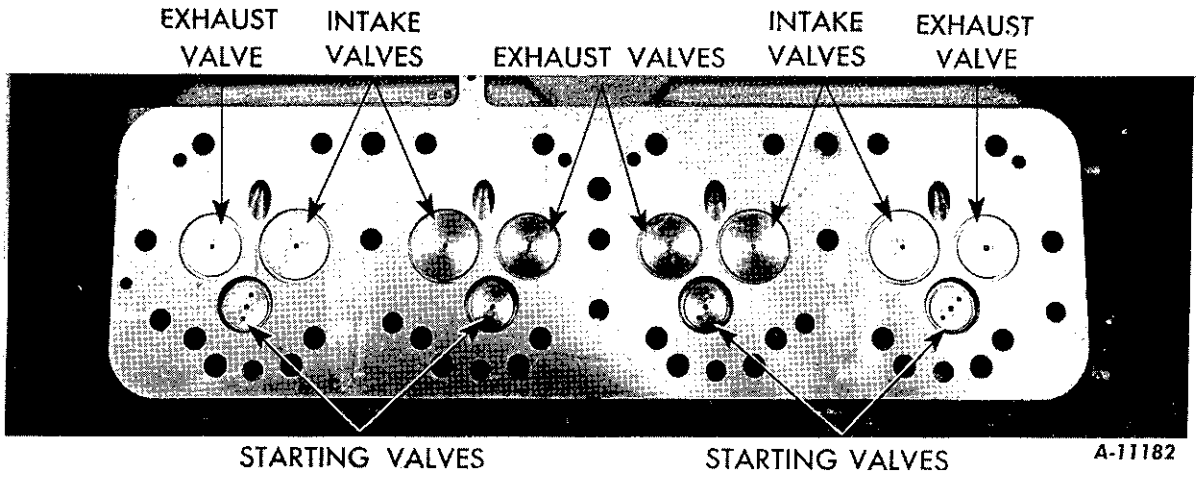
(Continued on next page.)



Illust. 13 - Carbon Corrosion and Wear are Inevitable Products of Normal Engine Operation.

CYLINDER HEAD AND VALVES

7. VALVE RECONDITIONING - Continued



Illust. 14 - Valve Locations on Diesel Engine.

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.

More 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 the 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 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. This will prevent leak-proof seating.

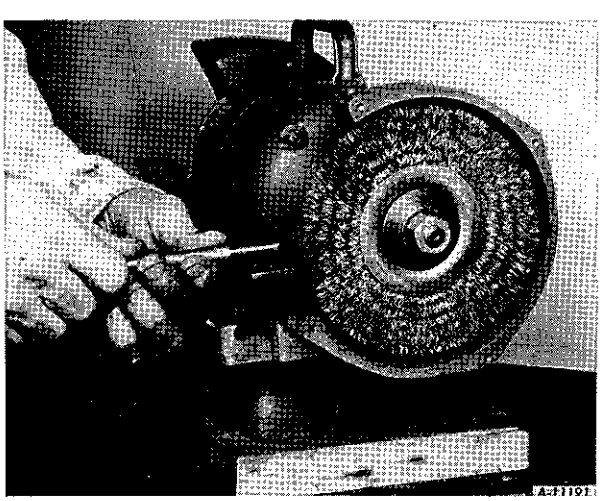
Oil and air are sucked past worn intake valves, stems and guides into the combustion chamber. This causes excessive oil consumption, which forms excessive carbon and dilutes fuel.

Inspection Prior to Disassembly

Before disassembly of the engine for removal of the cylinder head, 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. This will cause wear on the valves and guides and result in improper valve action. A defective gasket under the valve housing cover will permit the entrance of dirt; this will cause undue wear on valve stems and guides and damage to valve springs. Finding the cause of a valve failure will aid in reconditioning it.

Inspection After Disassembly

1. Inspect each valve to decide whether it is fit for further use. Remove all carbon from the valve face, head and stem. A wire brush or buffing wheel (Illust. 15) can be used to good purpose for this operation. Valve stems should be lightly polished, with an extremely fine abrasive cloth, enough to remove the carbon deposits only.



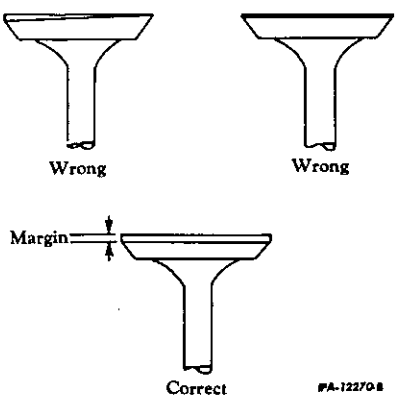
Illust. 15 - Cleaning Carbon from the Valve.

PRINTED IN UNITED STATES OF AMERICA

CYLINDER HEAD AND VALVES

2. Inspect each valve to 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. This would prevent valve spring retainer locks from fitting snugly.

3. All valves having bent, worn, warped or seriously pitted stems should be replaced with new valves. Scrap and replace any valve that cannot be satisfactorily refaced with a definite margin maintained (Illust. 16). 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 because of the amount of metal that must be removed to completely reface. Maximum heaviness in a valve head is required for strength and to provide for heat dissipation. Knife-edged valves lead to breakage and warpage.



Illust. 16 - A Definite Margin Must be Obtained and be Maintained during Reconditioning.

4. Clean all valve springs thoroughly and examine them for rust, pitting and broken or set coils. Test each spring against the spring specifications (refer to "SPECIFICATIONS" in Section 1) using a spring load tester (Illust. 17). (Refer to "SERVICE TOOLS MANUAL," ISS-1002.)

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

6. Check the valve rotators for proper operation. A load must be applied to the rotator to correctly check it. This can be done in a spring tester (or in an engine). When using a spring tester (Illust. 17), place the valve spring together with the rotator in the tester with a ball bearing between the rotator cap and the ram of the tester. Turning of the valve rotator may be observed by compressing the valve spring.

7. Clean parts thoroughly in solvent. Check the ribs in the inside of the locks to see that none are worn so much that they cause looseness.

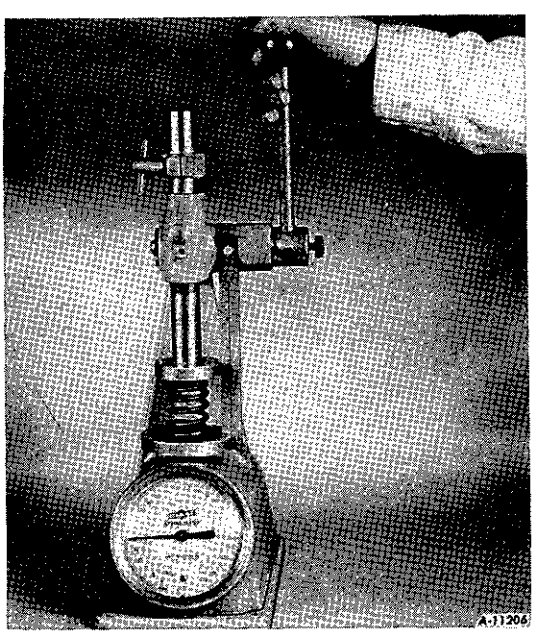
Replace parts as necessary. The locks must fit snugly into the valve stem groove. Check the locks for wear on the outside surface because this might cause the valve spring retainer to slide over the lock.

8. Clean the bores of the valve guides with solvent by using a wire rifle brush as shown in Illust. 18. To remove carbon, blow out with compressed air. Position a light at the bottom of the bore and examine the walls for burning blistering, cracking or 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 the following tables. Replace any guides considered unserviceable.

NOTE: Guides require very careful cleaning. Carbon left in the guide will deflect the pilot and result in inaccurate reconditioning of the valve seat.

9. Remove all carbon from the cylinder head. Inspect all valve seats for cracks. Be certain that all carbon is removed from the valve seat.

(Continued on next page.)



Illust. 17 - Checking the Valve Spring Free Length and Tension Insures a Uniform Set of Valve Springs.

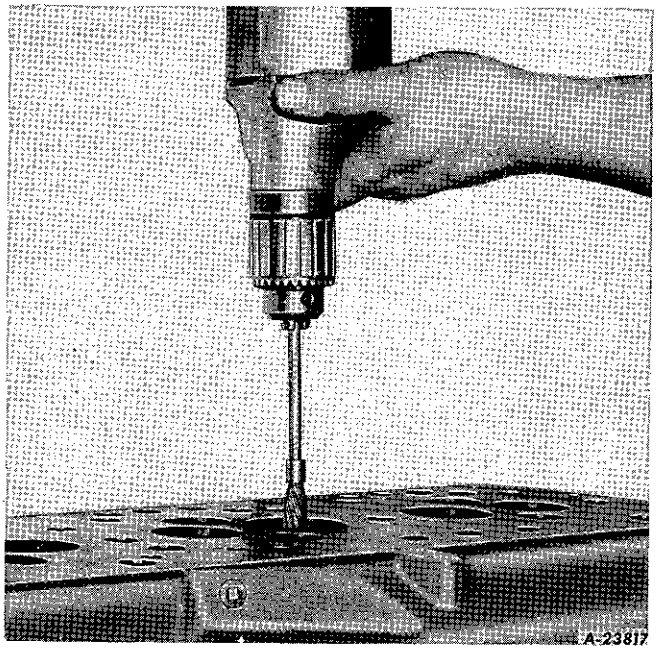
CYLINDER HEAD AND VALVES

7. VALVE RECONDITIONING - Continued

Inspection After Disassembly - Continued

10. With a micrometer, check the diameter of the valve lever shaft at the valve lever bushings. (See the following specification tables.) If the shaft is found to be worn excessively or out-of-round, replace the shaft with a new shaft.

11. Inspect the valve lever bushings and, if worn, replace with new bushings. If the valve levers show excessive hammering and wear at the ends which contact the valves, they should be reground with the valve lever grinding attachments furnished with the valve equipment (Illust. 19). Worn valve levers place side thrust on the valve stem, thereby causing wear on the guides. True valve levers will make possible a more accurate valve tappet setting. Remove only enough material to give a new even face on the end of the valve lever.



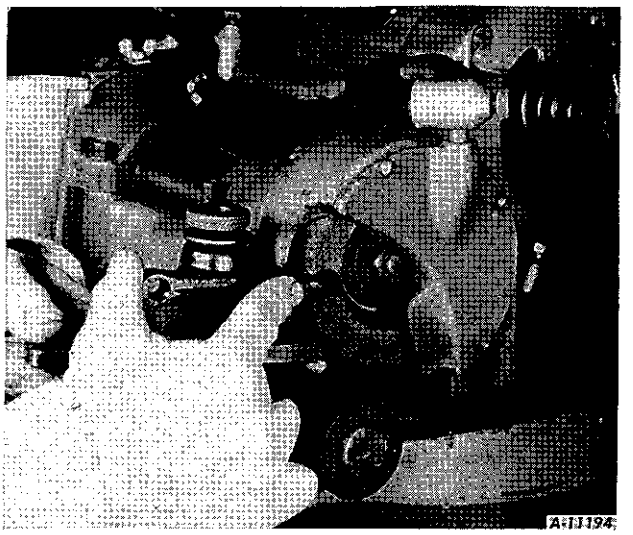
Illust. 18 - Cleaning Valve Guide by Using a Wire Rifle Brush.

12. After cleaning, inspect the cylinder head for cracks. Check the areas surrounding the exhaust valve ports for indications of blowby, such as burning away of the metal. Clean the water passages of the cylinder head thoroughly.

Reconditioning

VALVES

After being thoroughly cleaned and inspected, valves that are fit for continued use should be reconditioned as follows:

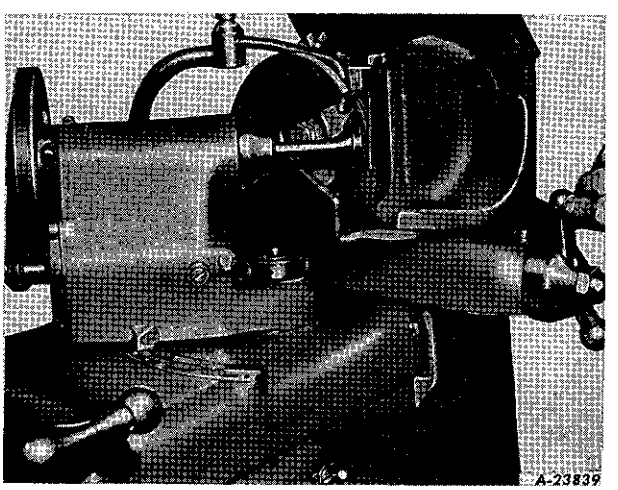


Illust. 19 - Grinding the Valve Lever Face Assures Proper Contour of Contact Faces.

In most engines, both intake and exhaust valves are ground to the same face angle. The angle for each is given in the following tables. Determine the correct face angle from the table.

1. Set the valve refacing machine to grind the desired angle (Illust. 20).

2. With the grinding stone dressed satisfactorily, insert a valve in the chuck. When it is precisely centered, take a light cut across its face. This is a check to determine whether or not 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 (Illust. 16).

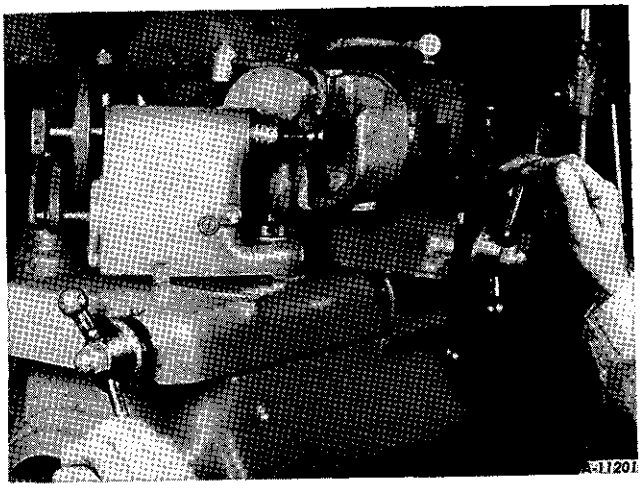


Illust. 20 - Locating the Valve and Grinding Stone to the Specified Angle.

PRINTED IN UNITED STATES OF AMERICA

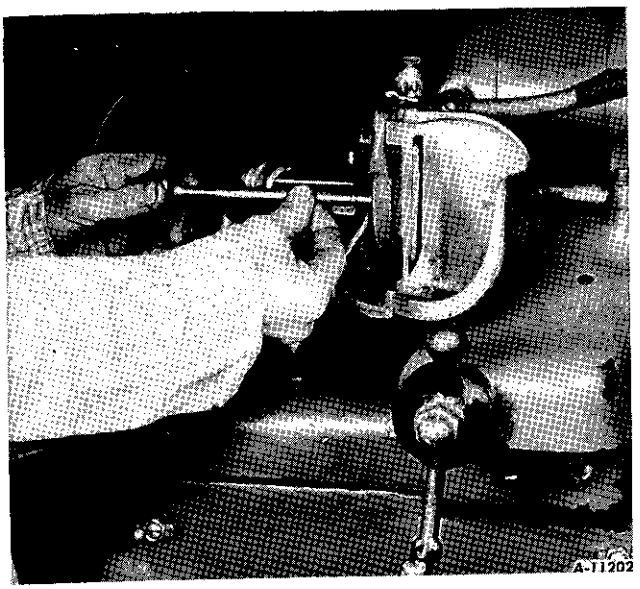
CYLINDER HEAD AND VALVES

Avoid taking heavy grinding cuts as this heats the valve head excessively, produces 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 (Illust. 16).



Illust. 21 - Grinding the Valve Face Angle. Take Light Cuts Only.

After refacing each valve, inspect the end of the stem. If wear is noticeable, reface the end of the stem with the attachment usually provided with the valve grinding equipment (Illust. 22). Grind sufficiently to true-up the end of the stem.



Illust. 22 - Refacing the Valve Stem End.

At times, unusually large amounts of heat scale may be found on exhaust valves. Therefore, frequent redressing of the stone will be necessary in order to maintain a smooth, even surface and a uniform set of valve face angles.

VALVE SEATS

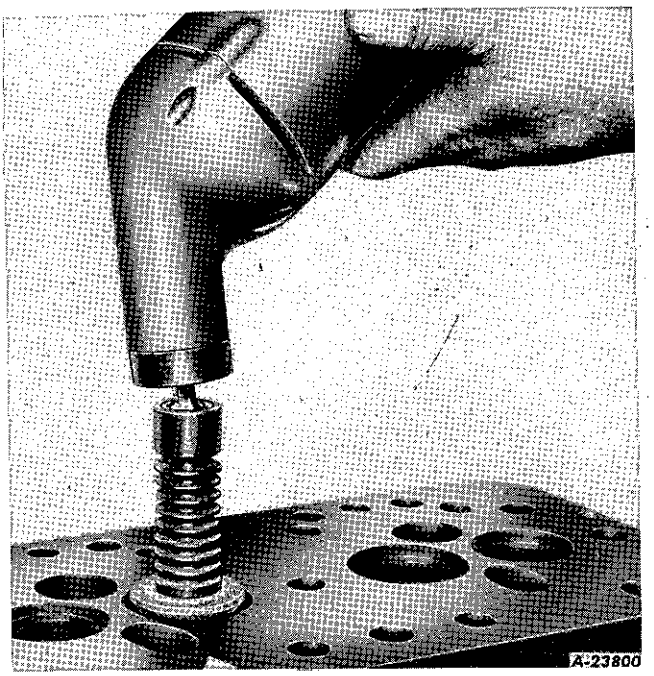
Remove all carbon, scale and oil before attempting to reface the valve seats. The grinding stone, when placed against an oil seat will become fouled and uneven grinding will occur.

1. Use a clean, oiled rag to lubricate the pilot shank lightly. Before installing the pilot, be certain that the valve guides are perfectly clean. This is important; otherwise, an eccentric seat will be cut.

2. Dress the stone to the correct angle and install the pilot of the correct size to the valve guide bore. (See the following tables.)

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

(Continued on next page.)



Illust. 23 - Grinding the Valve Seat by Using One of the Many Grinding Tools of Standard Manufacture.

CYLINDER HEAD AND VALVES

7. VALVE RECONDITIONING - Continued

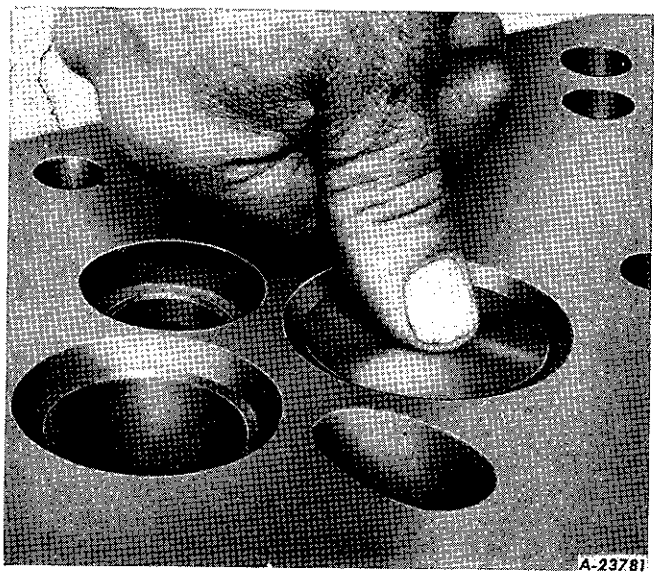
Reconditioning - Continued

VALVE SEATS - Continued

contact the valve seat (Illust. 23). Very little pressure other than the normal weight of the stone should be used. Sudden, hard pressures can cause cocking of the pilot on the guide and result in eccentric grinding. Frequently raise the stone from the valve seat in order to prevent overheating and to clear away grinding dust. Grind the seat sufficiently to provide an even, smooth surface.

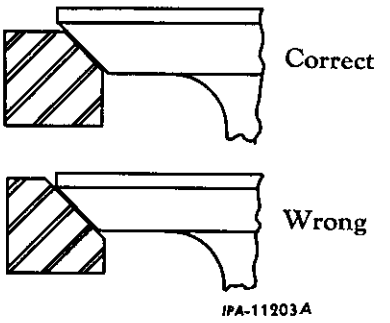
4. Check the seat concentricity with the valve guide by using a dial indicator mounted on the pilot. Run the indicator around the seat surfaces, thereby testing for concentricity. Run-out must not exceed a total of .002 inch.

5. The finish left by the regular type grinding stone is usually satisfactory for practical purposes. Lapping valves into their seats is unnecessary if precision equipment is used and extreme care taken. A simple and dependable method of testing refaced valves and seats for roundness and concentricity employs Prussian blue, a concentrated pigment sold in tubes. 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 (Illust. 24). 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 make sure that no error was made.

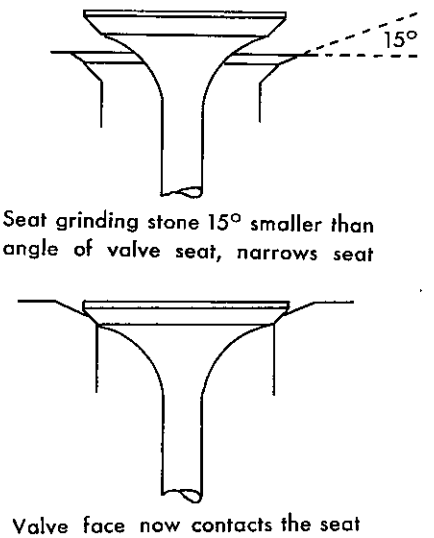


Illust. 24 - Testing Valve Seat and Face Contact by Using Prussian Blue.

6. After grinding the seats it may be found that the seats are considerably wider than the width recommended in the "SPECIFICATIONS" for that engine. Valve seats that are too wide (Illust. 25) may be narrowed by grinding down the top edge of the seat with a stone mounted on the grinder head. The stone must be a smaller angle than the valve seat (15 degrees preferably) (Illust. 26).



Illust. 25 - Valve Seat Width Should Conform to Specifications for that Engine on the Valve Face.



Illust. 26 - Narrowing Valve Seat Width.

PRINTED IN UNITED STATES OF AMERICA

CYLINDER HEAD AND VALVES

VALVE SPRINGS

Valve springs of uneven tension or unequal free length will cause faulty operation. Test all valve springs, whether new or used, as shown in Illust. 17 and select a set which is uniform. (Refer to "SPECIFICATIONS" in Section 1.)

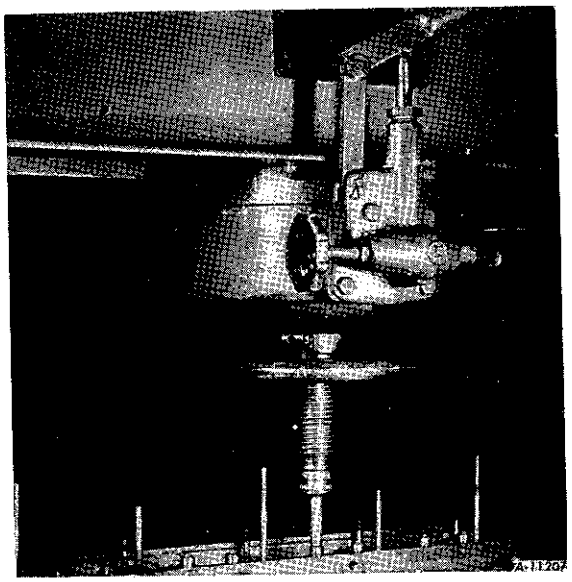
VALVE LEVERS

When replacing valve lever bushings, be sure that the oil hole in the bushing lines up with the oil hole in the valve lever. After installation, the bushing should be reamed. (See the following tables for bushing sizes.)

VALVE GUIDES

Worn valve guides in the cylinder head are pressed from the underside of the cylinder head; from the valve port up through the top. Use a pusher slightly smaller than the guide in order to prevent jamming it in the guideway (Illust. 27).

Press the replacement guides into the cylinder head from the top of the cylinder head. Valve guides that are improperly installed, even to within minute fractions of an inch, will cause faulty operation.

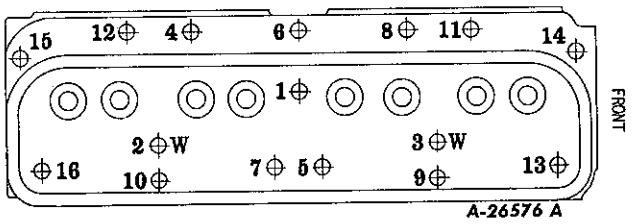


Illust. 27 - Pressing Valve Guides into Cylinder Head.

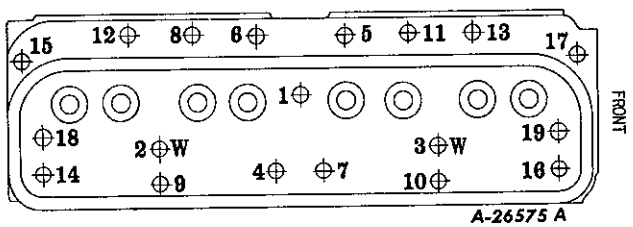
All guides furnished as service parts are reamed to size. However, as they are a press fit, it is necessary to ream them after installation to remove any possible burns or slight distortion caused by the pressing operation. (Refer to the following tables for specifications.)

TIGHTENING CYLINDER HEAD NUTS

With a torque wrench, retighten all nuts in the correct sequence as given in Illusts. 28, 29 and 32.



Illust. 28 - Sequence for Tightening Cylinder Head Nuts (6 Series).



Illust. 29 - Sequence for Tightening Cylinder Head Nuts (9 Series).

With the nuts all drawn down to final tension as specified, go back over them; use chalk marks to make sure none were missed. Never place one nut on a stud and draw it down to full tension until all other nuts have been pulled down to a tension near that of the specified amount. To pull nuts down unevenly will cause distortion of the cylinder head. Furthermore, it does not aid in securing a tight seal between the cylinder head and the crankcase. Refer to par. 9 for tightening the cylinder head nuts on diesel engines.

NOTE: The letters shown on Illust. 30 and 31 refer to either the degree of angle of the valve face or the dimensions found in the tables that follow.

KEY TO VALVE CHARTS

(Refer to Illust. 12, 30 and 31.)

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 outside diameter.
G. Valve seat width.

(Continued on next page.)

CYLINDER HEAD AND VALVES

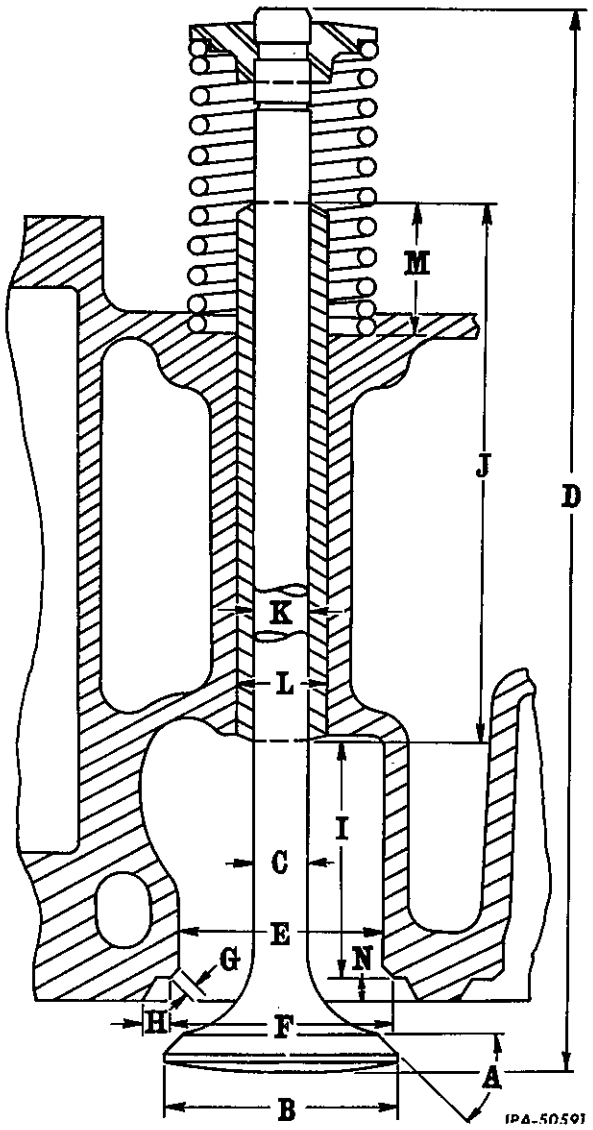
7. VALVE RECONDITIONING - Continued

Reconditioning - Continued

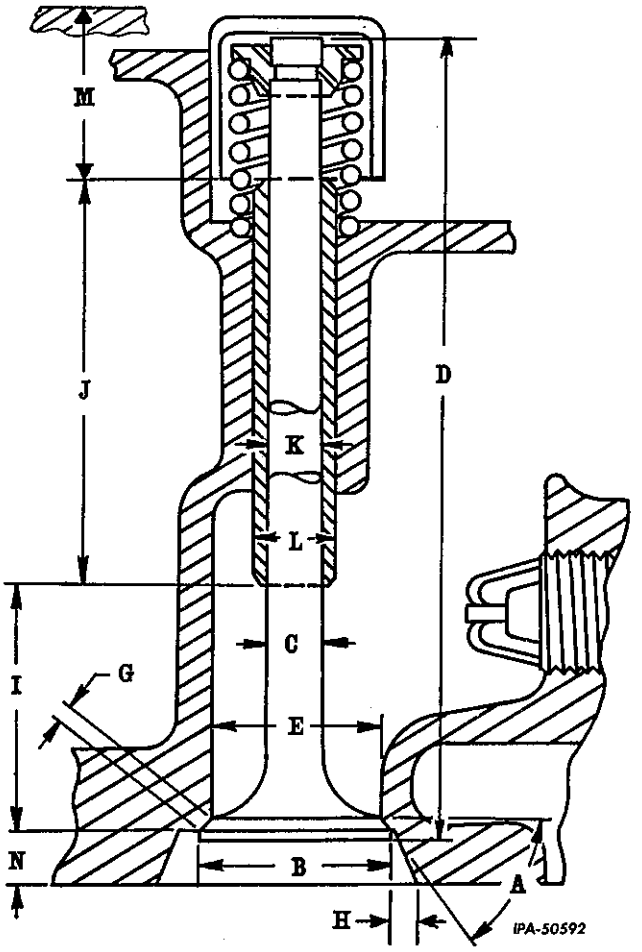
KEY TO VALVE CHARTS - Continued

(Refer to Illust. 12, 30 and 31.)

H. Distance from outside diameter of valve seat to the edge of the combustion chamber in the head.
I. Distance from the valve seat face to the head end of the valve guide.
J. Valve guide length.
K. Valve guide inside diameter.
L. Valve guide outside diameter.
M. Intake and Exhaust Valve: Distance from valve spring counterbore in head, to the stem end of the valve guide. Starting Valve: Distance from stem end of valve guide to valve lever mounting pads.
N. Distance from the face of the cylinder head to the face of the valve seat.



Illust. 30 - Intake and Exhaust Valve Data.



Illust. 31 - Starting Valve Data.

ANGLES AND DIMENSIONS OF DIESEL ENGINE VALVES

Symbol Illust. 30 and 31	TD-6, TD-6 (61 Series), UD-264 and UD-281-4	TD-9, TD-9 (91 Series), UD-350 and UD-370
A . . .	45° Int. 45° Exh. 45° Str.	45° Int. 45° Exh. 45° Str.
B . . .	1-23/32 Int. 1-17/32 Exh. 31/32 Str.	1-7/8 Int. 1-11/16 Exh. 1-3/32 Str.

PRINTED IN UNITED STATES OF AMERICA

CYLINDER HEAD AND VALVES

Symbol Illust. 30 and 31	TD-6, TD-6 (61 Series), UD-264 and UD-281-4	TD-9, TD-9 (91 Series), UD-350 and UD-370
C . . .	.372 Int. .372 Exh. .309 Str.	.402 Int. .402 Exh. .309 Str.
D . . .	7-7/32 Int. 7-7/32 Exh. 4-41/64 Str.	7-25/32 Int. 7-13/16 Exh. 5 Str.
E . . .	1-1/2 Int.* 1-5/16 Exh.* 7/8 Str.*	1-21/32 Int. 1-21/32 Exh. 1 Str.
F . . .	1-5/8 Int.* 1-7/16 Exh.* 15/16 Str.*	1-25/32 Int. 1-19/32 Exh. 1-1/16 Str.
G . . .	5/64 Int.* 5/64 Exh.* 3/64 Str.*	5/64 Int. 5/64 Exh. 3/64 Str.
H . . .	1/8 Int.* 1/8 Exh.* 1/8 Str.*	9/64 Int. 9/64 Exh. 1/8 Str.
I . . .	1-31/32 Int.* 1-31/32 Exh.* 1-9/16 Str.*	2-11/64 Int. 2-11/64 Exh. 1-27/32 Str.
J . . .	3-3/4 Int. 3-3/4 Exh. 2-1/16 Str.	3-31/32 Int. 3-31/32 Exh. 2-1/16 Str.
K . . .	.374 Int. .374 Exh. .312 Str.	.4055 Int. .4055 Exh. .312 Str.
L . . .	.689 Int. .689 Exh. .564 Str.	.7515 Int. .7515 Exh. .564 Str.
M . . .	31/32 Int.* 31/32 Exh.* 1-1/16 Str.*	1-7/32 Int. 1-7/32 Exh. 1-1/8 Str.
N . . .	1/8 Int.* 1/8 Exh.* 5/16 Str.*	11/64 Int. 11/64 Exh. 11/32 Str.

*UD-281-4
Abbreviations used: Int. = intake; Exh. = exhaust; Str. = starting.

8. REASSEMBLY

Intake and Exhaust Valves

1. Coat the valve stems with engine oil and insert them from the bottom of the head. Each valve should be returned to the position from which it came.

2. Install the valve oil deflector (if so equipped) on the valve stem (Illust. 8). Place the spring (26, Illust. 6), valve rotator (25) and valve spring seat key (24) in position on the valve stem. With a valve spring compressor or lifter tool, compress the springs sufficiently to install the key (24) in the groove at the top of each valve stem.

Starting Valves

3. Install the starting valves (Illust. 9) by inserting each valve, dipped in engine oil, into the valve guides located in the cylinder head. Install the springs and seats. Compress the springs, using the valve lifter. Insert the keys and remove the tool. Install the valve covers.

Valve Lever and Shaft Assembly

(Reference Numbers Refer to Illust. 6.)

NOTE: The valve lever shaft is a two piece shaft, which simplifies the assembly of the components.

4. Install the snap ring (5) on the lever shaft (12). Complete the assembly of this half of the shaft as follows:

Install end bracket (6), lever spacer, short (7), and exhaust lever, R.H. (9). The lever bushings (11) should be installed in the levers prior to being assembled on the shaft. Slide the following part in place in the given order: Lever spring (13), intake valve lever, L.H. (14), valve lever spacer, long (15) and one of the intermediate brackets, upper half (19). Next to the bracket install another lever spacer, long (15), intake lever, R.H. (16), lever spring (13) and exhaust lever, L.H. (17).

This completes the assembly of the half shaft. The other half should be then assembled, keeping in mind that when the two are finally joined together, the levers will all be heading in the same direction. Proceed as follows:

Install snap ring (5) on the lever shaft (12). Then install the end bracket (6), lever spacer, short (7), exhaust lever, L.H. (17), lever spring (13), intake lever, R.H. (16), lever spacer, long (15), intermediate bracket, upper half (19), valve lever spacer, long (15), intake valve lever, L.H. (14), lever spring (13) and exhaust lever R.H. (9).

Continued on next page.

CYLINDER HEAD AND VALVES

8. REASSEMBLY - Continued

Valve Lever and Shaft Assembly - Continued

(Reference Numbers Refer to Illust. 6.)

Placed end to end, the two assembled shafts will appear as in Illust. 6 except not joined together. To complete the final assembly, assemble the starting valve shaft (21) with rear spring (20) and front spring (23) in place. The next step is to assemble the lever shafts, valve lever center bracket, upper half (18) and the starting valve shaft. (This will be installed as a complete unit.)

Install the starting valve shaft, front end, into the end bracket shaft bore. Then slide the center bracket, upper half (18) on the end of the lever shaft with the detent lining up with the set screw tapped hole.

Insert set screw and tighten. Mount the other lever shaft in the same manner. Lock in the shaft springs to give torque on the starting shaft. Inspect the assembly to make sure all components are installed properly.

Injection Nozzles

5. Install the precombustion chamber gaskets into the cylinder head. Insert the precombustion chambers. The word "UP" stamped at the side must be at the top of the cylinder head. Install the second set of gaskets. Dip the dust seal into a thick soap solution and install it carefully into the groove of the nozzle retainer body.

6. Place the retainer in position on the studs. Install the nuts and tighten them to the specified torque. (Refer to "SPECIFICATIONS" in Section 1.) Nuts and studs must be clean and free of lubricant before torquing.

7. Place the nozzle body into position in the nozzle body retainer. Install the cap screws and tighten them as specified in "SPECIFICATIONS" in Section 1.

9. INSTALLATION

1. Clean all carbon from the tops of the pistons and the top surface of the crankcase.

2. Install a new cylinder head gasket. (All gaskets used in reassembly should be new.)

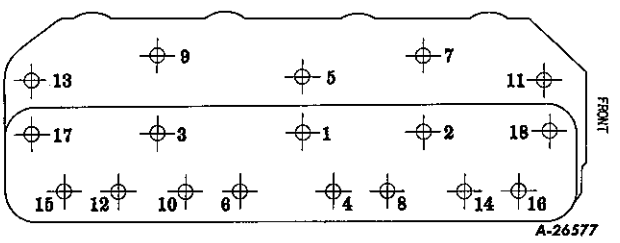
3. Install the cylinder head to the crankcase. Secure with the stud nuts. The nuts should be tightened as shown in Illust. 13, and must be torqued to the specified amounts. (Refer to "SPECIFICATIONS" in Section 1.) Nuts and studs must be clean and free of lubricant before torquing.

4. Install the push rods and the valve lever assembly.

5. Install the valve housing and gasket. Assemble the operating shaft (46, Illust. 6), the operating levers (45 and 47) and the lever pins and nuts to the valve housing bore.

6. Connect the starting valve linkage to the outside lever (47). Install the cylinder head breather.

7. Adjust the valves as described in par. 3. Set the valve clearances as specified for the cold setting in "SPECIFICATIONS" in Section 1. Install the valve cover, gasket and oiling felt on engine so equipped.



Illust. 32 - Sequence for Tightening Cylinder Head Nuts (350 and 370 Series).

8. Install the intake and exhaust manifolds, the water outlet elbow and thermostat housing.

9. Connect the carburetor fuel line and other linkage and controls which were removed to provide access to the cylinder head. Connect the wiring to the manifold switch.

10. Install the injection pipes and tighten the connections finger-tight. With a wrench, give the connection a further 1/8 turn, never more. If, however, new pipes and connections are being installed and have just been made up from new parts, tighten the connections finger-tight and give a further 1-1/2 turns with a wrench. Never tighten more than this amount as damage to the seal and subsequent leakage will result. In the future, the new lines and connections will be given only 1/8 turn past finger-tight when removed and installed.

11. Install the lifting eye on engines so equipped and torque to the specified amount. (Refer to "SPECIFICATIONS" in Section 1.) Install the spark plugs and spark plug cables in their correct positions.

PRINTED IN UNITED STATES OF AMERICA

CYLINDER HEAD AND VALVES

12. Fill the cooling system. Be certain that the drain valves below the radiator and on the left side of cylinder wall are closed. Check the oil level in the crankcase.

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

14. Install the engine hood and the exhaust mufflers.

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

MANIFOLDS

10. DESCRIPTION

Intake Manifold

The intake manifold is of a dual type. A small, high-velocity passageway is used only during starting and a large passageway on the diesel cycle. Two butterfly valves in the large passage open it to air when the engine is switched to diesel operation. An automatic switch that functions with the starting mechanism grounds the ignition circuit when the engine is on diesel. The grounding switch is located in the end of the intake manifold. Springs at the end of the valve shaft hold the butterfly valves securely open or closed.

Exhaust Manifold

The exhaust manifold is secured to the cylinder head exhaust ports with studs and nuts.

11. REMOVAL

Intake Manifold

1. A. MAGNETO IGNITION: Remove the manifold end cover and gasket from the forward end of the manifold. Remove the electrical leads from the manifold switch.

B. BATTERY IGNITION: Remove the electrical leads from the terminal screws of the manifold front cover and remove the front cover.

2. Turn off the gasoline at the tank and remove the gasoline supply tube at the carburetor.

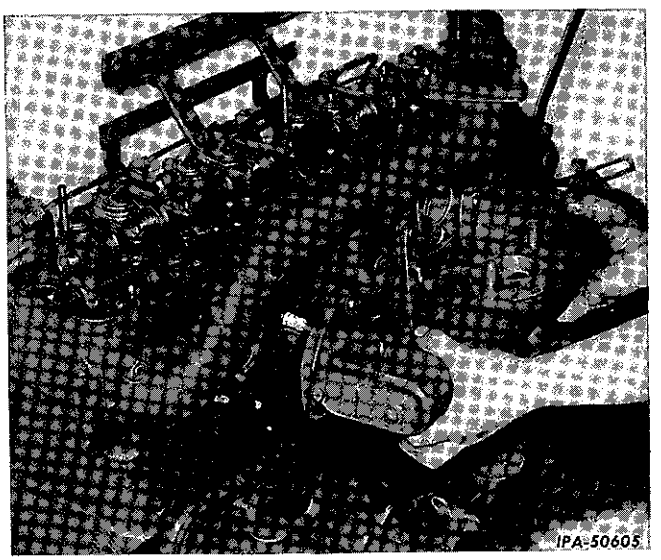
3. Remove the cotter and disconnect the choke control rod from the carburetor. Remove the primer control connections if used.

4. Remove the cap screws which secure the air intake flange.

5. Take out the pin and remove the carburetor control link at the carburetor.

6. Remove the carburetor.

7. Remove the nuts that secure the manifold to the engine and remove the manifold from the engine. (Illust. 33.)



Illust. 33 - Removing Intake Manifold.

Exhaust Manifold

Remove the nuts which secure the manifold to the engine and lift the manifold and gaskets from position.

MANIFOLDS

12. DISASSEMBLY

Intake Manifold

1. Remove the manifold end covers (4 and 26) and gaskets (5, Illust. 34).

2. Unhook the springs (14) and remove them.

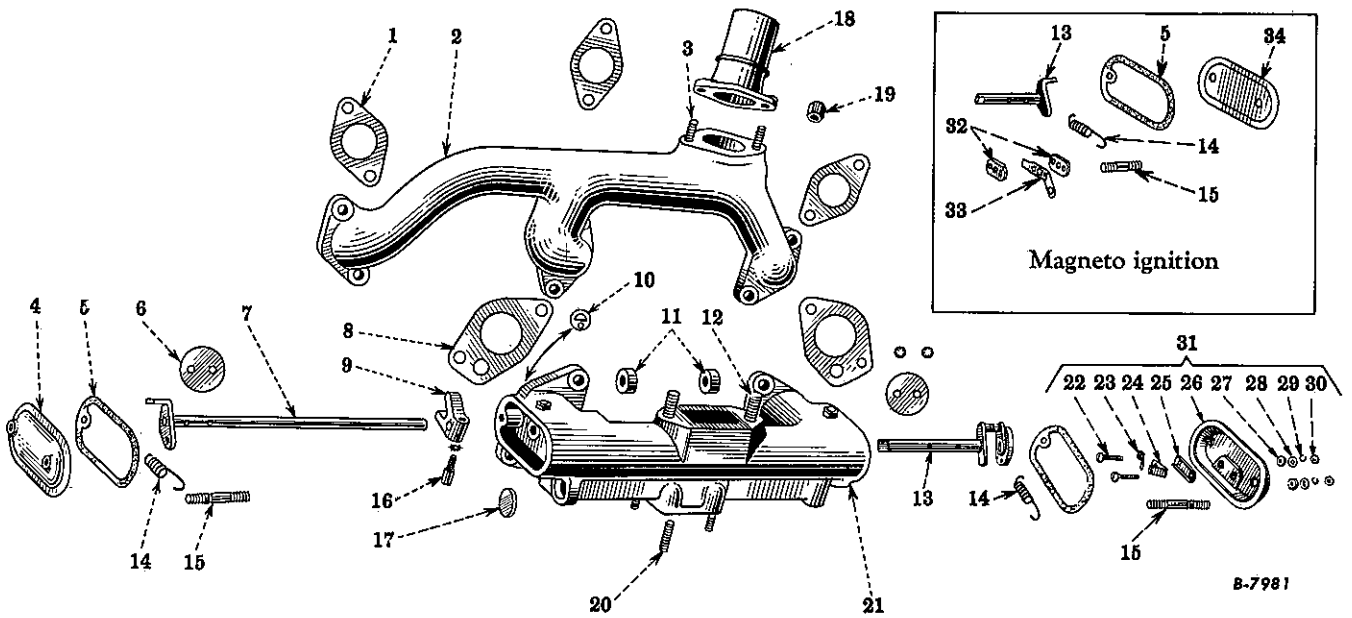
NOTE: On units equipped with the rotary switch, it is easier to unhook the spring from the front control shaft after the shaft has been removed.

3. Remove the nut from the control lever pin (16) and remove the pin from the lever (9).

4. Remove the screws which hold the butterfly valves (6) to the control shafts (7 and 13) and lift out the valves.

5. Pull the control shafts out of the intake manifold.

6. Remove the seals (11) if necessary. (The lips of the seals must face into the manifold to provide good sealing.)



Illust. 34 - Exploded View of the 6 (61) Series Engine Intake Manifold. 9 (91) Similar.

Legend

1. Exhaust manifold gasket.
2. Exhaust manifold.
3. Exhaust pipe stud.
4. Intake manifold end cover, rear.
5. Intake manifold end cover gasket.
6. Manifold butterfly valve.
7. Manifold control shaft, rear.
8. Intake manifold gasket.
9. Manifold control lever.
10. Manifold baffle.
11. Manifold control shaft seal.
12. Air cleaner pipe stud.
13. Intake manifold shaft, front.
14. Intake manifold control spring.
15. Intake manifold control spring stud.
16. Intake manifold control lever pin.
17. Intake manifold expansion plug.
18. Exhaust pipe.
19. Exhaust pipe stud nut.
20. Carburetor stud.
21. Intake manifold.
22. Pan head screw.
23. Switch contact blade.
24. Switch contact blade.
25. Switch blade mounting strip.
26. Intake manifold end cover, front.
27. Terminal insulator.
28. Flat round hole washer.
29. Lock washer.
30. Hex nut.
31. Intake manifold end cover, front, complete.
32. Ignition cut-out switch insulating plate.
33. Ignition switch contact plate.
34. Intake manifold end cover, front.

PRINTED IN UNITED STATES OF AMERICA

MANIFOLDS

13. INSPECTION AND REPAIR

Clean all parts thoroughly, using a cleaning solvent. Dry them with compressed air. Inspect all parts and replace (with new) any parts showing damage or wear sufficient to cause malfunctioning. Inspect the grounding switch terminals and insulation. Clean off any oxidation with a tungsten file.

14. REASSEMBLY

Intake Manifold

1. Install new seals (11, Illust. 34) if necessary. The lips must face into the manifold.

2. Install the two control shafts (7 and 13) and at the same time, install the control lever (9) on the shaft (7). Exercise care not to damage the seals.

3. Insert the butterfly valves (6) into the slots on the control shafts and secure with the screws.

4. Install the pin (16) into the control lever and hook the springs into position.

5. MAGNETO IGNITION: Install the end cover (4) and gasket (5). The cover for the switch end may be left off if installation to the engine will take place immediately. Secure the electrical wires to the switch and then install cover and gasket.

BATTERY IGNITION: Install the end covers and gaskets.

6. Adjust the butterfly valves by loosening the lock nuts on top of the manifold at each end. Adjust with the set screws until the butterfly valves are both perfectly horizontal inside the air passage when the levers on the shafts are against the ends of the set screws. Tighten the lock nuts, being careful not to disturb the obtained setting for the valves.

15. INSTALLATION

Intake Manifold

1. Fasten the carburetor to the manifold.

2. Place new gaskets on the mounting studs and then attach the manifold to the cylinder head. The surface of the cylinder head around the ports should be free from dirt. Be sure that the mounting faces of the manifold are clean. Torque down the stud nuts to the amount specified in "SPECIFICATIONS" in Section 1.

3. Connect the carburetor supply and overflow tubing.

4. MAGNETO IGNITION: Connect the switch cable and install the end cover and gasket.

BATTERY IGNITION: Connect the electrical cables to the terminals on the end cover.

5. Connect the choke control rod and the primer connections if used.

6. Install the linkage connecting the carburetor shut-off cam to the cross shaft.

Exhaust Manifold

1. Place the gaskets into position on the studs of the cylinder head and install the exhaust manifold. Be certain that the cylinder head port surfaces and the mounting surface of the manifold are free from dirt.

2. Torque down on the retaining stud nuts to the amount specified in "SPECIFICATIONS" in Section 1.

PRINTED IN UNITED STATES OF AMERICA

CONNECTING RODS, PISTONS AND 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 due to the high stresses under which these engine parts function. The rod has a bearing at each end; the one at the upper end being for the piston pin which anchors it to the piston. This is a bushing type bearing.

The bearing, at the crankshaft or lower end, is an inserted bearing in two halves which fits around the crankshaft and is secured by a bearing cap. The connecting rod bearing cap is furnished only with its connecting rod. The rods are drilled to provide an oil flow to lubricate the piston pin bushing.

The bearings are of the copper-lead, steel-backed type. Both halves of each bearing are identical and they are held in place by nibs, which engage in notches in the connecting rod and bearing cap. The bearings can be replaced easily without having to remove the rods.

Pistons

The piston is one of the simplest yet 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 in grooves between the piston and cylinder sleeve. The fit of the piston and rings in the sleeve must be close enough to prevent the escape of combustion gases, yet free enough to keep friction at a minimum.

Piston Rings

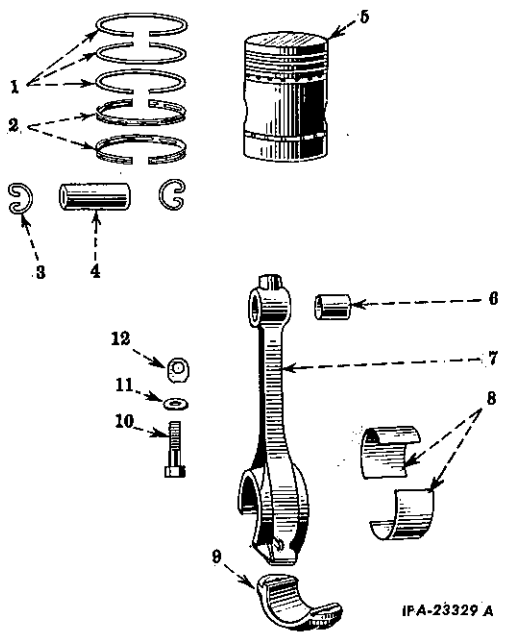
The pistons are fitted with five piston rings. Two oil regulating rings are fitted to each piston, one below and one immediately above the piston pin. The function of the oil regulating rings is to provide an even circulation of lubricating oil and, therefore, an all-over lubricating and cooling action for the piston and sleeve. Excess oil is wiped by the rings back down to the crankcase.

The remaining rings are termed compression rings and one of them is tapered. This tapered ring is located above and next to the upper oil regulating ring (third ring from the bottom). The tapered ring has the word "top" marked on it and it must be assembled in the manner indicated. The ring gaps and other dimensions are given in "SPECIFICATIONS" in Section 1. The 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 (Illust. 8). This is to prevent combustion pressure from escaping and causing abnormal heat which is inducive to ring seizure and loss of tension. The leakage from any one ring gap is not critical.

Piston Pins

The piston pin or wrist pin is cylindrical in shape and is made of steel. Its purpose is to anchor the piston to the connecting rod. The

(Continued on next page.)



Illust. 1 - Offset Connecting Rod and Piston with Component Parts. 6 Series (9 Series Similar).

1. Compression rings.
2. Oil regulating rings.
3. Piston pin retainer.
4. Piston pin.
5. Piston.
6. Connecting rod bushing.
7. Connecting rod (offset mounted).
8. Connecting rod bearings.
9. Bearing cap.
10. Rod bolt.
11. Washer.
12. Lock.

CONNECTING RODS, PISTONS AND RINGS

1. DESCRIPTION - Continued

Piston Pins - Continued

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. This is why it is sometimes necessary to heat the piston in order to remove the pin. The specified clearance for the piston pin is given in "SPECIFICATIONS" in Section 1.

2. REMOVAL

1. Drain the engine lubricating oil from the crankcase oil pan by removing the drain plug and removing the oil pan.

2. Remove the cylinder head. (Refer to Section 2.)

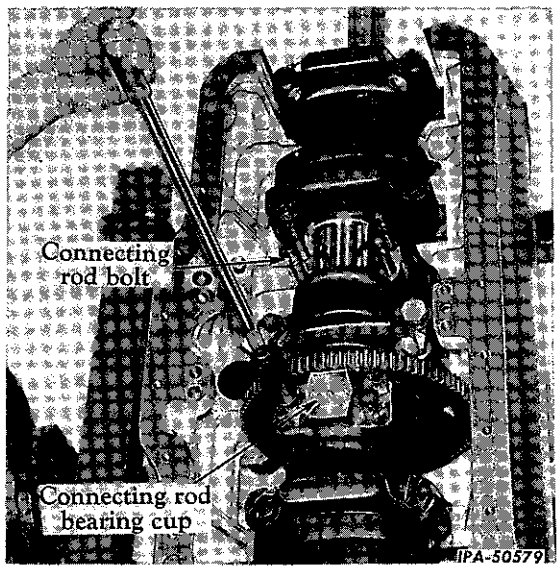
3. If the piston sleeve has been worn so that there is a ridge in the sleeve at the upper end of the ring travel, the ridge must be removed by using a good ridge grinder before the piston is removed. This prevents damage to the piston ring lands during removal of pistons and prevents damage to new top piston rings after the installation of new rings.

CAUTION: Pistons must be handled with care to avoid knocking them out-of-round, out of alignment, or other damage. 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 cylinders from which they were removed and in the same position.

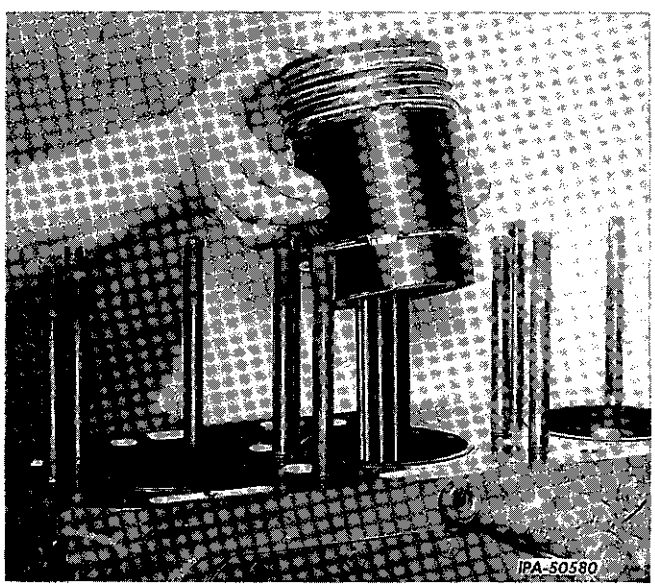
4. Remove the cotters from the nuts on the connecting rod studs. Remove the nuts and the bearing cap (Illust. 2). Tap the cap lightly with a mallet, if necessary, to aid removal. The lower bearing insert is removed with the cap where it is held by a nib in the notch.

CAUTION: On engines equipped with loose fitting sleeves (TD-6 (61) and 281-4), it will be necessary to block the sleeves in some manner to prevent them from being pushed out when the engine is cranked with the cylinder head removed.

5. Remove the connecting rod and piston through the top of the crankcase. Turn the crankshaft until the piston, which is to be removed, is on the compression stroke. Then push the piston up and through the crankcase (Illust. 3).



Illust. 2 - Removing Connecting Rod Bearing Cap.



Illust. 3 - Removing Piston and Connecting Rod through Top of Crankcase.

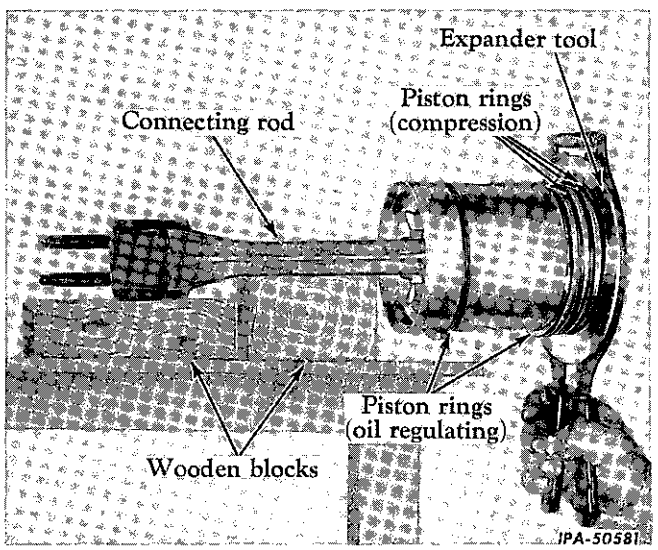
PRINTED IN UNITED STATES OF AMERICA

CONNECTING RODS, PISTONS AND RINGS

3. DISASSEMBLY

1. With the aid of a piston ring expander, remove the piston rings; remove the top ring first and the remaining rings in order (Illust. 4). (Refer to the "SERVICE TOOLS MANUAL," ISS-1002.)

2. Remove the piston pin retainer rings from each side of the piston and remove the piston pin. If the piston pin cannot be removed by hand, it is recommended to heat the piston in water at 160° to 180° F., at which temperature the pins are a light, hand-pressed fit. This heating of the piston makes it unnecessary to use force in removing the pins, thus preventing distortion of the pistons.



Illust. 4 - Removing Piston Rings.

4. INSPECTION AND REPAIR

Wash all parts in a dry-cleaning solvent and dry them with compressed air. Clean the passages in the oil control rings. Use a groove cleaning tool, or a broken piston ring which fits the ring grooves, to clean carbon from the ring grooves. Clean the holes in the oil control ring grooves in each piston. Clean the oil passage in each connecting rod. Wash all parts again and dry them with compressed air. Be sure to blow out the oil holes.

Pistons

Measure the inside of the cylinder sleeves with an inside micrometer at the top and bottom. Take the measurements at right angles to determine if the sleeves are out-of-round. Pistons can be checked with an outside micrometer. If any pistons are scored, new pistons and sleeves must be installed, together with new piston pins, connecting rod bushings and rings. New pistons are selected to give a certain clearance with the sleeves. For clearances, refer to "SPECIFICATIONS" in Section 1.

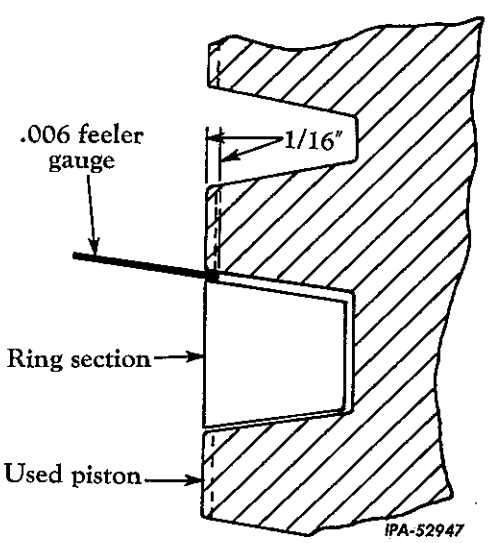
Inspect the piston ring grooves for wear (Illust. 5). For the clearance of new piston rings in the grooves of a piston, refer to "SPECIFICATIONS" in Section 1.

Rings must be checked also for the specified side clearance (Illust. 5). (Refer to par. 2, "SPECIFICATIONS" in Section 1 for ring clearance in groove.)

Insert a .006 inch feeler gauge in 1/16 inch against the top edge of the ring groove of the piston. Insert a small section of a new ring, for the groove being checked, in the groove.

If the ring section does not go in flush to the land of the piston, the side clearance is less than .006 inch.

If the ring section goes in flush or below the land of the piston, the side clearance is .006 inch or greater and the piston should be replaced.



Illust. 5 - Checking Piston Ring in Groove for Correct Fit.

CONNECTING RODS, PISTONS AND RINGS

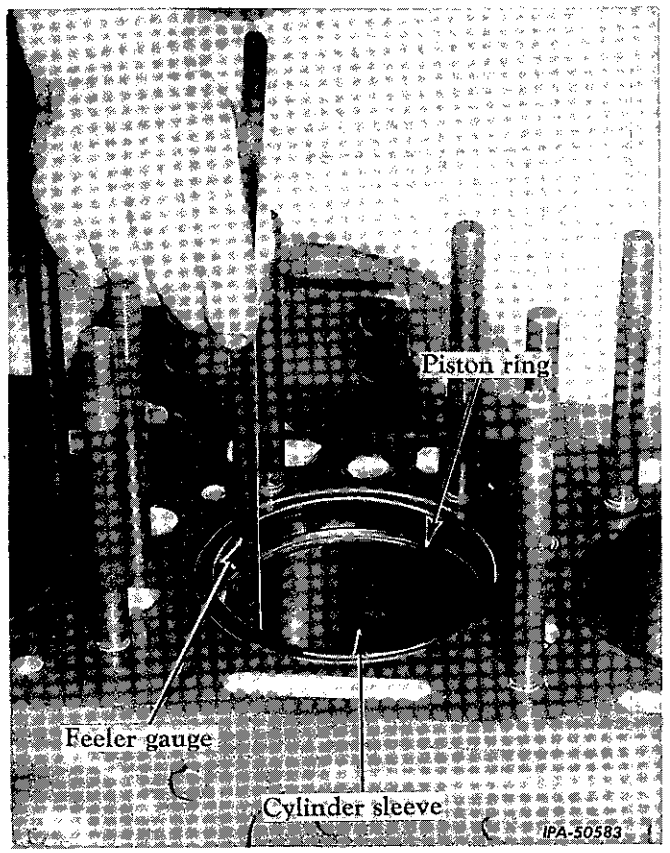
4. INSPECTION AND REPAIR - Continued

Connecting Rods

Inspect the connecting rods for straightness. The rods should be free of twist and be parallel to the pistons. Cylinder numbers are stamped on the sides of the rods and on the bearing caps; No. 1 cylinder is at the front of the engine. Inspect the piston pin bushings and connecting rod bearing bores for scratches and burrs. Dress off any such unevenness. Inspect the threads on the bearing cap studs.

Piston Rings

Inspect the piston rings for damage. Faulty rings cannot always be detected by the eye. Engine performance and irregularities such as excessive oil consumption must be taken into consideration. Wherever there is doubt as to the serviceability of the piston rings, it is advisable to replace them with new rings to eliminate duplication of labor in the immediate future should failure result.



Illust. 6 - Checking Piston Ring Gap in Cylinder Sleeve.

Coat the sleeve, piston and ring with clean engine oil. Insert each ring into the sleeve for that piston. Use the piston to force them squarely down inside the sleeve. Position a feeler gauge between the ends of the ring (Illust. 6) and compare the gap present against that specified for the ring in "SPECIFICATIONS" in Section 1. If it is necessary to remove material from the ring ends because the end gap is too close, clamp a mill file in a vise, hold the ring in proper alignment and dress off the ends squarely to obtain the desired gap.

NOTE: On a used piston, it will probably be found that the side clearances tend to increase toward the top of the piston due to the greater operating temperatures prevalent at this point.

Inspect the "windows" of the oil regulating rings for blocked oil ways. Failure to keep the oil ways clear will result in uneven lubrication of the piston and sleeve and hot spots on the cylinder sleeve and piston due to the absence of the heat absorbing oil flow.

The bearing surfaces of the rings should be of smooth and satin-like finish. Remove any burrs that may be present on new rings or old rings that will be used again.

CAUTION: When new rings are being installed to a used piston for operation in a used sleeve, wear on the sleeve may have left a ridge where the piston reaches the top of its stroke. This ridge will cause noisy engine operation and breakage of the top ring. Remedy this by using a ridge grinder to remove the ridge before installing the piston and ring.

Piston Pins and Bushings

Inspect the piston pins for score marks. If the score marks are not too severe, clean with a fine abrasive. Inspect the bushings for wear and replace with a new bushing if necessary. The bushings are furnished reamed to size for service; but, after installation in the connecting rods, a burnishing rod and reamer should be passed through them as a check on whether the inside diameter is as specified in "SPECIFICATIONS" in Section 1. (Refer to the "SERVICE TOOLS MANUAL," ISS-1002.) Piston pins are also furnished for oversize installation. (Refer to parts catalog.)

PRINTED IN UNITED STATES OF AMERICA

CONNECTING RODS, PISTONS AND RINGS

5. REASSEMBLY

1. With the piston pin as cool as possible and generously coated with a clean engine lubricating oil, heat the piston in hot water to approximately 160° to 180° F, at which point the piston pin can be entered into one boss of the piston by pushing with the hand. With the piston still hot, position the connecting rod inside the piston, aligning the bushing in the rod bore with the piston pin holes in the piston. Push the piston pin completely into position. Thoroughly dry the piston with compressed air.

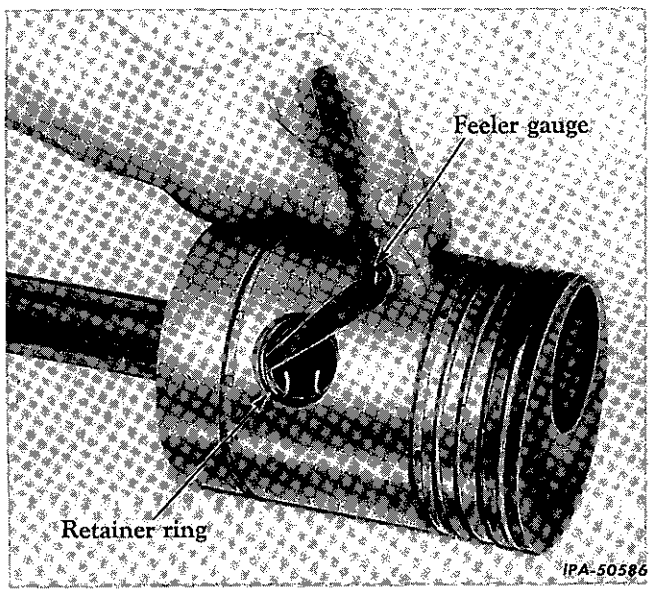
NOTE: The piston and connecting rod must be assembled so the off-center depression in the piston head and the position number stamped on the lower end of the connecting rod, are on opposite sides.

2. Squeeze the pronged ends of the piston pin retainer rings and install a ring in the groove at each side of the piston to secure the piston pin.

3. Check the fit of the piston pin in the piston for proper end clearance as follows:

(a) Push one end of the piston pin until it reaches a definite stop against the retainer ring on the opposite side of the piston.

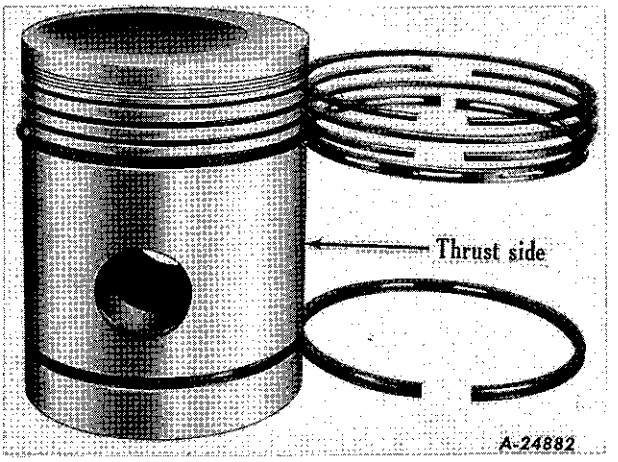
(b) Position a feeler gauge between the end of the pin that was pushed in and the retainer ring to check for end clearance as specified in "SPECIFICATIONS" in Section 1.



Illust. 7 - Checking Piston Pin End Clearance.

4. Using a piston ring expander, install the rings into the grooves of the pistons. The tapered ring must be installed as directed by the word "Top" stamped on its edge. Position oil regulating rings immediately below and above the piston pin.

Position the rings so that the gaps are 90 degrees from the thrust side of the piston (in line with the piston pin bore) and 180 degrees from one gap to another, as shown in Illust. 8.



Illust. 8 - Showing Position of Piston Ring Gaps.

6. INSTALLATION

When installing a piston and connecting rod assembly which was formerly used in the engine, install the assembly in the same cylinder sleeve from which it was removed. When a new piston or a new piston and connecting rod assembly is being installed, install a matched piston and sleeve set. (Refer to "Parts Catalog.")

NOTE: The piston and connecting rod assemblies must be installed from above and not past the crankshaft.

1. Place the ring compressor on the assembled piston and connecting rod. Wipe clean engine oil on the inside bore of the sleeve and the piston. Lower the connecting rod into the sleeve. Push down on the piston carefully until it is completely in the sleeve; remove the compressor (Illust. 10). Be sure the piston is installed in its correct sleeve and is facing in the correct direction with respect to the markings on its top face.

2. Wipe the crankshaft bearing end of the rod to remove any grit gathered during installation. Cleanliness of the bearings, journal and bearing supporting surfaces cannot be overstressed.

(Continued on next page.)

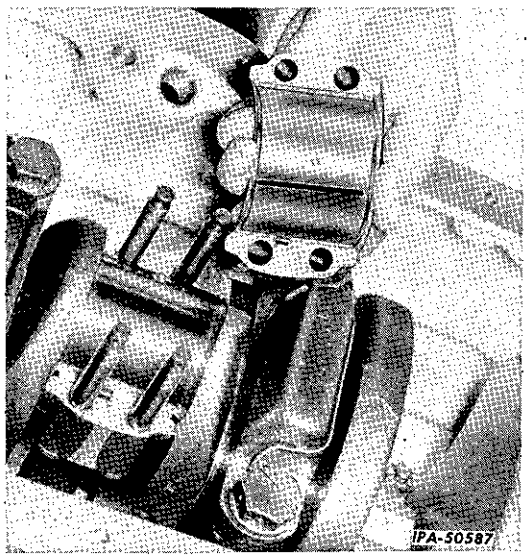
CONNECTING RODS, PISTONS AND RINGS

6. INSTALLATION - Continued

NOTE: If virgin lead wire is to be used, wipe clean and oil the crankshaft journal. If Plastigage is to be used, wipe the bearing surface and exposed half of the crankshaft journal free of oil because this plastic material is solvent in oil.

3. Torque the connecting rod bearings to the foot-pounds specified in "SPECIFICATIONS" in Section 1. Use virgin lead wire (or Plastigage) to check the clearance between the crankshaft and the lower bearing of the connecting rod. To make this check, remove the bearing cap and bearing, place a suitable length of .015 inch virgin lead wire (or Plastigage) across the bearing and install the bearing and bearing cap. Tighten the nuts to the specified torque; then, remove the nuts and bearing cap. If virgin lead wire was used, use a micrometer, measure the wire which will have been crushed down to the clearance between the crankshaft journal and the connecting rod bearing by the torque applied to the nuts. This measurement should fall between the figures specified in "SPECIFICATIONS" in Section 1. If Plastigage is used, the flattened plastic material will be found adhering to either the bearing shell or the crankshaft journal. DO NOT REMOVE THE PLASTIGAGE! To determine the bearing clearance, compare the width of the flattened plastic piece at its widest point, with the graduations on the envelope. The number within the graduation indicates the clearance in thousands of an inch. This measurement should fall within the figures found in "SPECIFICATIONS" in Section 1.

NOTE: DO NOT TURN THE CRANKSHAFT DURING THE ABOVE PROCEDURE.



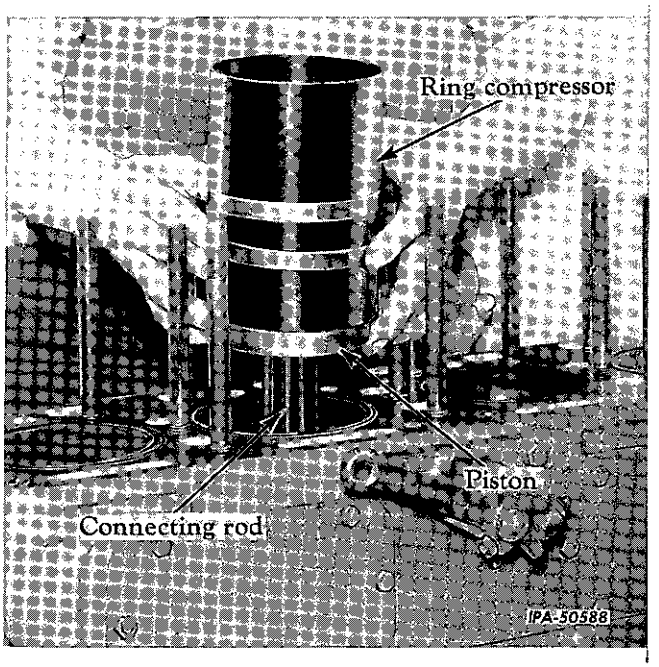
Illust. 9 - Checking Connecting Rod Bearing Clearance.

Reinstall the bearing and cap to the connecting rod and torque to the specified amount if the reading was as specified. Do this to all the connecting rod bearings.

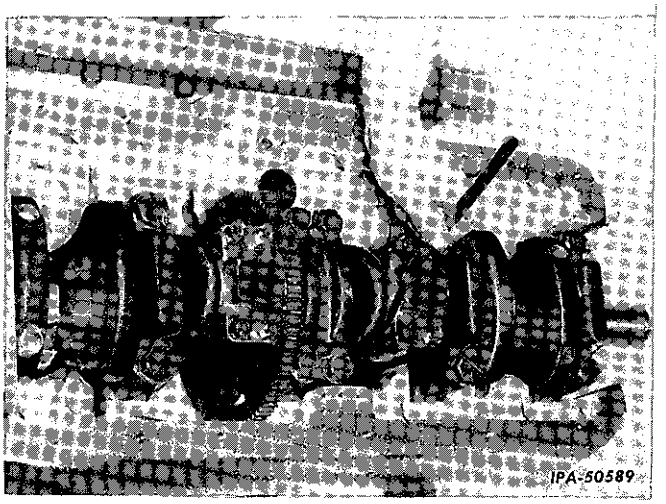
4. Install the crankcase oil pan and gasket, using shellac to seal the gasket in place.

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

6. After the installation of the new piston sets on the new piston rings, the engine must be "run-in," according to the conditioning schedules in Par. 11, before operating at normal load and speed.



Illust. 10 - Installing Piston with Ring Compressor.



Illust. 11 - Checking Connecting Rod Side Clearance.

PRINTED IN UNITED STATES OF AMERICA

CYLINDER SLEEVES

7. DESCRIPTION

The cylinder sleeves are of a dry type. Sleeves and their mated pistons should be marked and kept in sets when removed and installed back to their original positions. A flange at the top of each sleeve fits into a recess in the top of the crankcase and serves to position the sleeve correctly. The sleeves and pistons are furnished for service only in matched sets. (See "Parts Catalog.") The pistons are a select fit in the sleeves and must not be interchanged.

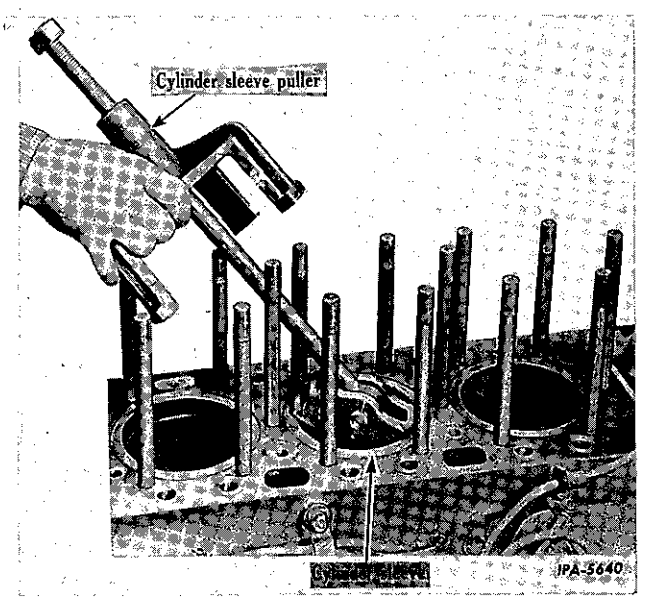
8. REMOVAL

1. Remove the cylinder head assembly. (Refer to "CYLINDER HEAD AND VALVES" in Section 2.)

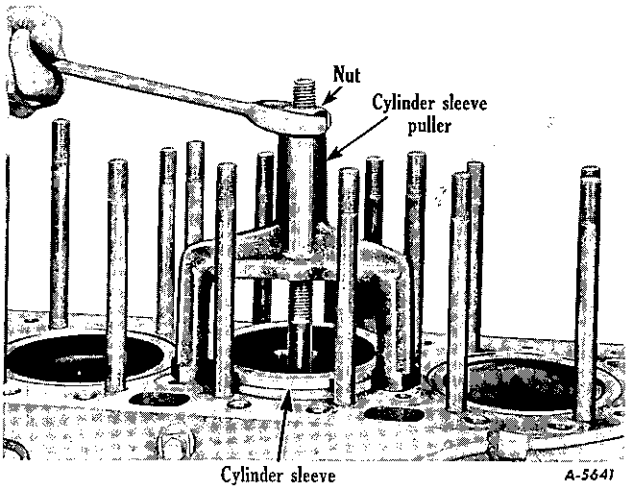
2. Remove the connecting rods and pistons. (Refer to par. 2.)

NOTE: It is advisable to wrap an oil-soaked cloth around the crankshaft connecting rod bearing journals to keep them as clean as possible. Wrap the piston and connecting rod assemblies in clean cloth also to protect them until installation.

3. Remove the cylinder sleeves by using a sleeve puller. These tools are listed in the "SERVICE TOOLS MANUAL," ISS-1002. (Illust. 12 and 13.)



Illust. 12 - Installing Cylinder Sleeve Puller Tool.



Illust. 13 - Removing Cylinder Sleeve.

NOTE: If more than one sleeve is to be removed, and they are to be used again, it is important that the sleeves be marked as to the location in the crankcase and the position in the sleeve bore.

9. INSPECTION AND REPAIR

1. Clean the sleeves in a dry-cleaning solvent and dry them with compressed air. Clean out the water jacket in the crankcase.

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

2. Measure the inside of the sleeve with an inside micrometer from the top to the bottom of the sleeve where it is subject to piston and ring travel. Take measurements at right angles to determine if the sleeve is out-of-round. If a sleeve is out-of-round or scored, a new piston and sleeve must be installed. For new piston and sleeve clearance, refer to "SPECIFICATIONS" in Section 1.

10. INSTALLATION

1. When inspection indicates that replacement of an individual or a set of cylinder sleeves is necessary, be sure to check the crankcase cylinder bores (sleeves removed) for out-of-round and taper. The allowable taper in the full length of the bore is .002 inch maximum, and the maximum allowable out-of-round is .002 inch. These checks are made with a three-point dial bore indicator as follows:

(Continued on next page.)

CYLINDER SLEEVES

10. INSTALLATION - Continued

(a) Take indicator readings in the bore at three locations: approximately one inch from the top, one inch from the bottom and at the middle.

(b) Take two readings at each location 90 degrees apart.

NOTE: Oversize cylinder sleeves are available and should be used only when the stancard service sleeve does not give the required "fit".

2. When the crankcase cylinder bore taper and/or out-of-round does not exceed .002 inch, but the standard sleeve does not give the necessary "fit" required, the bore can be enlarged with a "Lisle" CH-45-cylinder hone, to accommodate a .002 inch oversize sleeve.

350 and 370 Series ENGINES ONLY: When the crankcase cylinder bore taper and/or out-of-round exceeds the .002 inch limit, the crankcase cylinder bore must be enlarged to 4.760-4.761 inches with a maximum of .001 each taper in the full length of the bore and .0007 inch maximum out-of-round to accommodate the .010 inch oversize sleeve.

3. Clean the crankcase cylinder bars and counterbore carefully. Use a dry-cleaning solvent and wipe dry with a lint-free wiper. Clean the cylinder sleeve in the same manner.

NOTE: Install the sleeves dry. No lubricant is to be used on either the cylinder sleeve or crankcase bore.

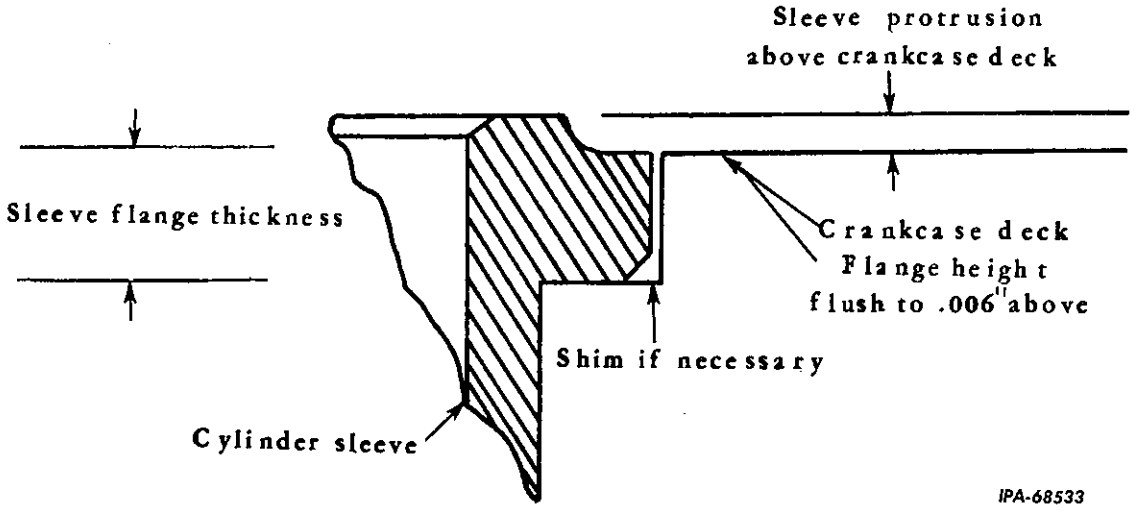
4. ENGINES EQUIPPED WITH "PRESS FIT" SLEEVES: Place the sleeve (s) in dry ice for a short time. This will shrink the sleeve and make for easier installation. Press the sleeve in place carefully.

ENGINES EQUIPPED WITH "PUSH FIT" SLEEVES: Place the sleeve in its bore and push down in position. This should require a force of from 50 to 100 lbs. only. If a greater force is required, remove the sleeve and hone the crankcase bore until the desired push fit is obtained. If a force of less than 50 lbs. is required, remove the sleeve and try another. In the event a substitution fails to provide a proper fit, an oversize sleeve should be fitted as previously described. Be sure the flange of the cylinder sleeve is firmly seated in the crankcase counterbore.

5. Check the sleeve inside diameter for taper and out-of-round. The taper must not exceed .0008 inch maximum; out-of-round must not exceed .0005 inch maximum. (Refer to "SPECIFICATIONS", Section 1).

6. Check the overall height of the cylinder sleeve protrusion above the crankcase deck. This dimension must be within the limits given in "SPECIFICATIONS" in Section 1. (Refer to Illust. 14.)

7. Check the sleeve flange with the crankcase deck. The flange must be from flush to .006 inch maximum above the crankcase deck to assure good cylinder head gasket contact to the cylinder sleeve flange for the proper sealing that is required to eliminate combustion leak-



Illust. 14 - Cross Section of Cylinder Sleeve.

PRINTED IN UNITED STATES OF AMERICA

age (Illust. 14.) If necessary, shims are available to be placed under the sleeve flange in the crankcase counterbore to obtain the desired flange height (Illust. 14.)

8. Install the pistons and connecting rods. (Refer to par. 6.)

9. Install the cylinder head. (Refer to "CYLINDER HEAD AND VALVES" in Section 2.)

11. ENGINE RUN-IN SCHEDULE

After the installation of new sleeve and piston sets or new piston rings, the engine must be "run in" according to the following conditioning schedule before operating at normal load and speed.

1. Before starting the engine, be sure that the cooling system is filled.

2. Fill the crankcase with the proper additive type lubricating oil as specified in the latest service bulletin on "Fuels and Crankcase Lubricating Oils for IH Diesel Engines."

3. Start the engine and run it for two minutes on the gasoline cycle.

4. Switch to the diesel cycle and run the engine at 1/4 throttle with no load until normal operating temperature is reached. Cover the radiator, if necessary, to bring the engine up to operating temperature.

5. CONDITIONING SCHEDULES

The following schedules are safe to follow after the engine has reached operating temperature:

Tractor

Period 1: 1 hour	Operate the tractor in 4th gear without load at 3/4 rated speed.
Period 2: 2 hours	Operate the tractor at 3/4 rated speed on light work.
Period 3: 1 hour	Operate the tractor at full rated speed on medium work.

Power Unit

Period 1: 1 hour	Operate the engine on work about 1/4 max. load at 3/4 rated speed.
Period 2: 2 hours	Operate the engine on work about 1/2 max. load at 3/4 rated speed.
Period 3: 1 hour	Operate the engine on 3/4 max. load at full rated speed.

CAUTION: Do not run the engine at idle speed for long periods after installing new rings or sleeves, as rings will not seat during idle operation.

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

7. After the engine has operated for 25 hours, the oil should be drained while the engine is hot. Refill the crankcase with an additive type oil compatible with fuels in use as defined in the latest service bulletin on "Fuels and Crankcase Lubricating Oils for IH Diesel Engines."

PRINTED IN UNITED STATES OF AMERICA

LUBRICATING OIL PUMP

1. DESCRIPTION

The engine lubricating oil pump used in the TD-6, TD-6 (61) and TD-9 tractors and the UD-264 and UD-281-4 power units is a gear type pump, internally mounted to the bottom of the crankcase and gear driven from the camshaft.

A plunger type safety valve in the pump, relieves the pressure build-up in the pump should a restriction occur between it and the filter base.

The TD-9 (91) tractor, UD-350 and UD-370 power units are equipped with an engine balancer and lubricating oil pump combined. The pump is gear driven by the balancer.

2. REMOVAL

(From engines not equipped with balancer.)

1. Drain the oil from the engine. Remove the cap screws which hold the oil pan to the crankcase and lift off the pan and gasket.

2. Remove the wired cap screws holding the pump and lift out the pump. Remove the oil return pipe (tractor engines only).

3. DISASSEMBLY

Double Gear Pump (tractor)

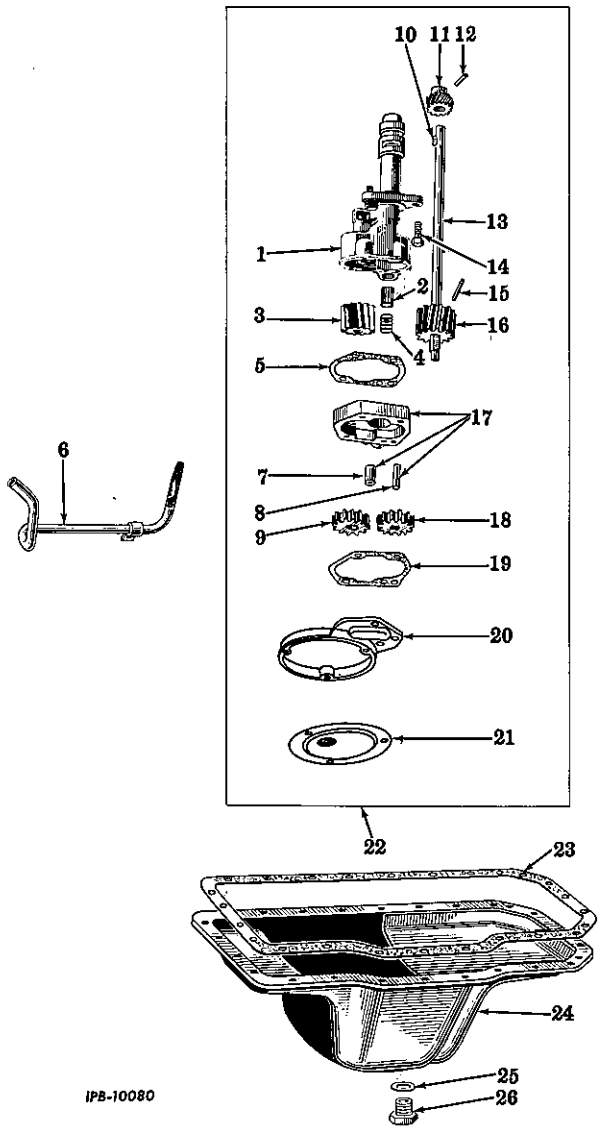
(Reference Numbers Refer to Illust. 1.)

1. Remove the bottom plate (21) from the cover (20). Remove the cover (20) which is held by four cap screws. The gasket (19) and auxiliary gears (9 and 18) may be removed along with the auxiliary gear housing (17) and body gasket (5).

2. Remove the pump drive pinion (11) by driving the pin (12) out in a manner similar to that shown in Illust. 2. Remove the pinion from the shaft (13) to which it is keyed and slide the drive shaft out of the pump body (1). Note the position of the pump idler gear (3) and reinstall it in its original position to maintain the same tooth wear pattern, unless the gears are to be replaced. The drive gear (16) is pinned to the drive shaft (13). This need not be removed unless it is being replaced.

3. Remove the safety valve spring (4) and valve (2) from the recess in the pump body (1).

(Continued on next page.)



Illust. 1 - Exploded View of Oil Pump (TD-6 (61 Series) Shown).

Legend

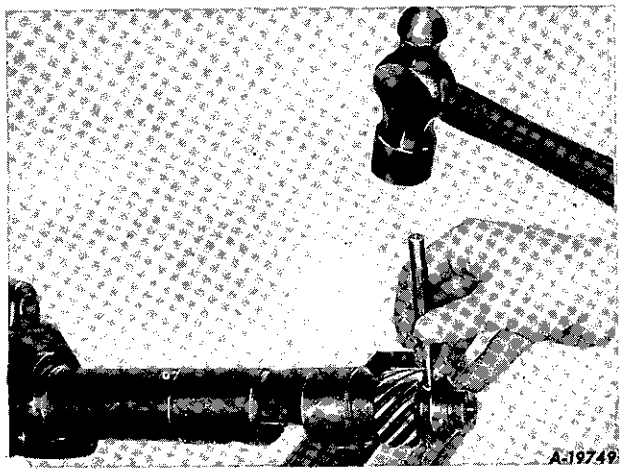
1. Pump body.
2. Safety valve.
3. Idler gear.
4. Safety valve spring.
5. Pump body gasket.
6. Oil return pipe.
7. Inlet tube.
8. Dowel pin.
9. Auxiliary idler gear.
10. Pump drive key.
11. Drive pinion.
12. Drive pinion pin.
13. Drive shaft.
14. Body cap screw.
15. Body gear pin.
16. Body gear.
17. Auxiliary gear housing.
18. Auxiliary body gear.
19. Cover gasket.
20. Pump cover.
21. Pump bottom plate.
22. Oil pump, assembly.
23. Oil pan gasket.
24. Oil pan.
25. Plug gasket.
26. Drain plug.

LUBRICATING OIL PUMP

3. DISASSEMBLY - Continued

Double Gear Pump (tractor) - Continued

NOTE: Do not remove the idler shaft from the pump body.



Illust. 2 - Removing Pinion from Drive Shaft.

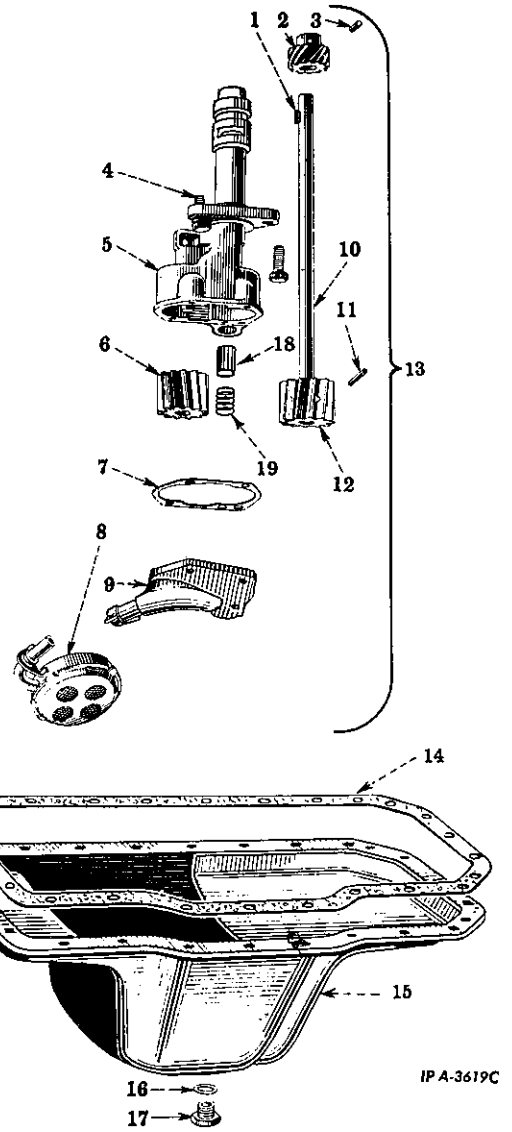
Single Gear Pump (Power Unit)

(Reference Numbers Refer to Illust. 3.)

4. Remove the pump screen float (8) from the pump cover (9) by removing a cotter pin.

5. Remove the four cap screws holding the cover (9) to the pump body (5). The cover can be tapped loose with a fibre hammer. The gasket (7) will come off with the cover.

6. The balance of disassembly is the same as for steps 2 and 3 on the preceding page except for reference numbers.



Illust. 3 - Exploded View of Lubricating Oil Pump (UD-264 and UD-281-4 Power Units).

Index to reference numbers in Illust. 3.

1. Drive key.
2. Drive pinion.
3. Drive pinion pin.
4. Cap screw.
5. Pump body.
6. Idler gear.
7. Cover gasket.
8. Pump screen.
9. Pump cover.
10. Drive shaft.
11. Body gear pin.
12. Body gear.
13. Oil pump, assembly.
14. Oil pan gasket.
15. Oil pan.
16. Drain plug gasket.
17. Drain plug.
18. Safety valve.
19. Safety valve spring.

4. INSPECTION AND REPAIR

Clean all parts thoroughly, being sure that the openings in the screen are free and clean. If the screen has been crushed, replace it rather than make a repair. The opening in the center of the float screen is a by-pass and should not be closed. Clean and flush out the return pipe. Clean all other parts thoroughly in a dry-cleaning solvent and dry them with compressed air.

Inspect all gears for wear, scoring and chipped teeth. If any gear is damaged, it must be replaced. Replace mating gear also. Inspect the

PRINTED IN UNITED STATES OF AMERICA

LUBRICATING OIL PUMP

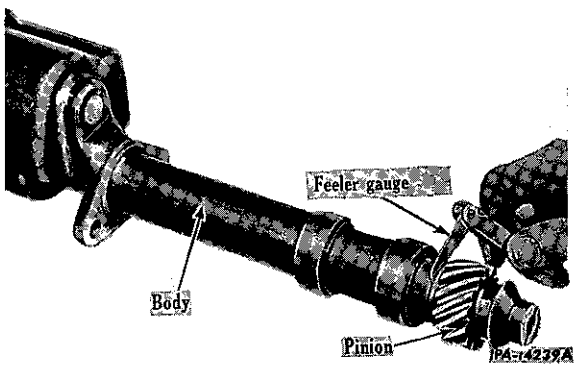
body and oil pump cover for any evidence of wear (gear contact) or damage. Replace any parts that are worn or damaged.

If the idler shaft in the body is loose, replace the body. The idler shaft is not furnished as a separate part.

Assemble the body gear to the drive shaft and then assemble to the pump body. Check the clearance between the gear and the bore of the body.

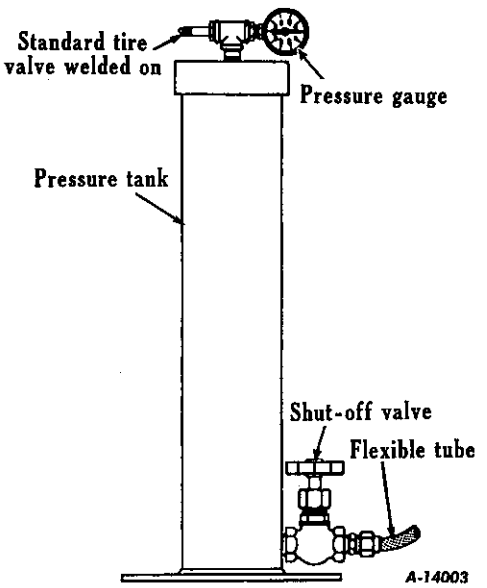
Place a feeler gauge between the gear and the body and turn the gear one complete revolution while holding the gauge in one position. Move the gauge around the body bore and again turn the gear one complete revolution to check the clearance. Repeat this operation until the entire distance around the body has been checked. Refer to "SPECIFICATIONS" in Section 1 for clearance between gear and body and between body and idler gear. Check the clearance between the idler gear and pump body in the same manner used to check the clearance between gear and body.

When idler and body gears are assembled check the backlash. The end clearance between the drive pinion and the pump body should also be checked. (See Illust. 4 and "SPECIFICATIONS" in Section 1.) When the assembly is made from all new parts, file or grind off the top of the pump body if necessary to obtain a minimum of .010 inch clearance between the pump body and the pinion.
The cover gasket is also used as a shim (.006 inch thick). This gasket should be replaced whenever the pump is disassembled but, if a replacement gasket is not available, do not attempt to cut a new gasket unless material of the correct thickness is used. If a new gasket or the proper material is not available, use the old gasket. The cover gasket provides a clearance of .003 to .006 inch between the gears and the cover. It is very important that this clearance be maintained to prevent wear on gears and cover.



Illust. 4 - Checking End Clearance Between Pinion and Body.

Drill and tap a hole near the bottom of the pipe for a shut-off valve. Attach a flexible hose to the valve to connect it to the oil pressure connections on the engine (Illust. 5).



Illust. 5 - Oil Leakage Test Unit.

The capacity of the tank will be in excess of 10 quarts. Fill the tank with SAE-10W oil, by removing the tank cap.

CAUTION: Before running any tests, remove the filter elements and clean out the filter base. This will remove all dirt accumulation that might otherwise be forced into the oil channels of the lubricating system.

Begin the test by applying air pressure through the air valve on top of the tank to 25-30 pounds gauge reading. With the flexible hose connected to the oil pressure line on the engine, open the valve at the bottom of the tank to allow the oil to flow into the lubrication system. Approximately half of the oil in the tank will be required to fill the oil lines. The pressure should be maintained at 25 pounds throughout the test.

A bearing condition is indicated by the drip or leakage from the ends. If this leakage appears as a steady stream, it is evident that a bearing is extremely worn or excessive clearance exists. Care must be exercised to differentiate between a stream coming from a faulty bearing and a stream existing because of engagement of oil holes (such as spurt holes in the connecting rods for cylinder lubrication) and grooves.

(Continued on next page.)

LUBRICATING OIL PUMP

4. INSPECTION AND REPAIR - Continued

It is advisable to reposition the shaft for each bearing, so that the leakage from the bearing under observation can be properly segregated and not confused with leakage from another source.

The frequency of the drops indicates the condition. A satisfactory bearing might pass 25 to 100 drops per minute.

If the time element between drops is excessive, the bearing is open to suspicion and should be investigated. It is either too tightly fitted or an obstruction in the oilway to the bearing exists.

On completing the tests, close the shut-off valve and relieve the tank pressure through the air valve.

Testing For Oil Leaks

In order to facilitate checking the main, the connecting rod and the camshaft bearings for excessive clearances and low oil pressure, the following method has been found to be effective:

Make a test tank from a piece of six inch pipe approximately 24 inches long (or use 1 020 183 R2 leakage tester shown in the "SERVICE TOOLS MANUAL," ISS-1002). Weld a plate or base on one end and thread the other end to take a cap. Drill and tap the cap to take a tee connection. In one side, weld a tire valve and, in the other end, install a pressure gauge registering at least 75 pounds.

5. REASSEMBLY

Double Gear Pump (Tractor)

(Reference Numbers Refer to Illust. 1.)

1. Install the pump drive shaft (13) with body gear (16) in place in the pump body (1). Install the shaft key (10), drive pinion (11) and pin (12). Check clearance between the pinion and top of pump body. (Refer to Par. 4, "INSPECTION AND REPAIR.")

2. Install the idler gear (3) on its shaft in mesh with the body gear. Be sure the idler gear is installed in its original position, if it is the original gear, to assure proper mating of teeth and tooth wear pattern.

3. Install the safety valve plunger (2) and valve spring (4) in the recess in the pump body (1).

4. Install a new gasket (5) and position the auxiliary gear housing with the inlet tube (7) and dowel (8) away from the pump body. Install the auxiliary gears (9 and 18) in their original position to maintain the same tooth wear pattern.

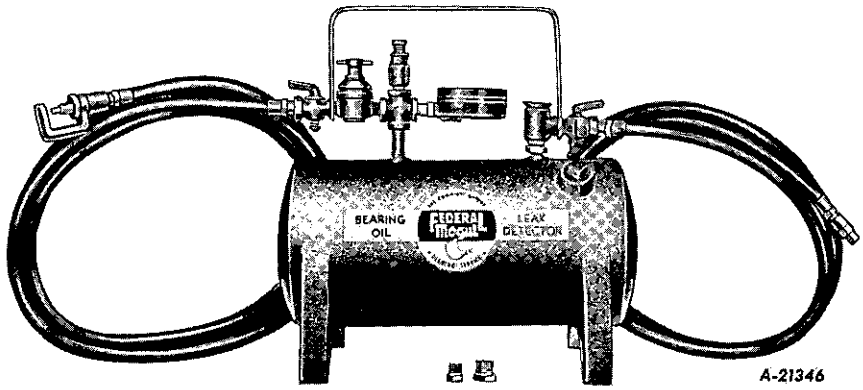
5. Install a new cover gasket (19) and secure the pump cover (20) with four cap screws. Install the bottom plate (21) to the cover (20).

Single Gear Pump (Power Unit)

(Reference Numbers Refer to Illust. 3.)

1. The procedure in steps 1, 2 and 3 above may be followed except for reference numbers.

2. Install a new cover gasket (7) and cover (9) to the pump body (5). Install the float screen (8) and secure with a cotter pin.



Illust. 6 - Oil Leak Detector.

PRINTED IN UNITED STATES OF AMERICA

Field Check

To make a fast field check of the lubricating oil pump to determine if it is working properly, proceed as follows:

1. Submerge the oil pump in a bucket of oil.

2. Place your hand over the outlet hole located at the top of the pump.

3. Turn the drive pinion until pressure is built up in the pump and the drive pinion "FREEZES" or cannot be turned. This indicates that the lubricating oil pump is in working condition.

6. INSTALLATION

1. Insert the oil pump into the crankcase and attach it with lock washers and cap screws. Lock the cap screws by placing a wire through the holes in the heads of the cap screws and twisting the ends of the wire together. Install the oil return pipe (tractor engine only).

2. Shellac new gaskets to the oil pan and attach the pan to the crankcase. Fill the crankcase with the correct amount and grade of lubricating oil.

LUBRICATING OIL FILTER

7. DESCRIPTION

The lubricating oil filter with a replaceable cartridge, removes the dirt and other foreign particles from the crankcase oil and prevents these injurious materials from being recirculated to the engine.

Two types of oil filter systems have been used. The by-pass system (not full-flow) used on earlier type engines, has a pressure regulating valve in the filter base. The oil pump pumps the oil to the oil gallery and to the filter. The filtered oil returns to the crankcase oil pan.

The full-flow system is in use on all current production engines covered in this manual.

The oil pressure in this type system is controlled by the regulating valve located in the filter base. A by-pass valve is also located in the filter base.

In addition to the two valves located in the filter base, which visually identifies the system as being a full-flow type, there is a safety valve in the oil pump. Its function is to relieve the pressure built-up in the pump should there be any restrictions between the pump and the filter base. The safety valve spring is the stronger of the three valve springs.

In the full-flow system, all of the lubricating oil is filtered before being distributed to the bearings. These filters have a no-drain-back feature which eliminates the necessity of pumping the oil up into the filters when starting the engine.

8. REMOVAL

Drain the filters by removing the drain plugs in the filter base. On full-flow filters also drain the filter cases by removing the case drain plugs. Remove the cap screws and lock washers from the filter base. Remove the filter assembly as a unit.

9. DISASSEMBLY

By-Pass Type Filter
(See Illust. 7.)

1. Loosen and remove the retaining bolt. The case element can then be removed from the base. Discard the case gasket.

2. Remove the pressure regulating nut, gasket and spring. Remove the regulating valve.

Full-Flow Type Filter
(See Illust. 8.)

3. Remove the retaining nut (1) along with the case cover. Unless replacement of "O" ring (2) is intended, do not disassemble the case cover.

4. Remove gasket (5), retaining spring (6) and sealing cup (7). Remove the filter cartridge (9) and dispose of both the cover gasket (5) and filter cartridge.

5. Remove the pipe plug (11) and drain the filter base.

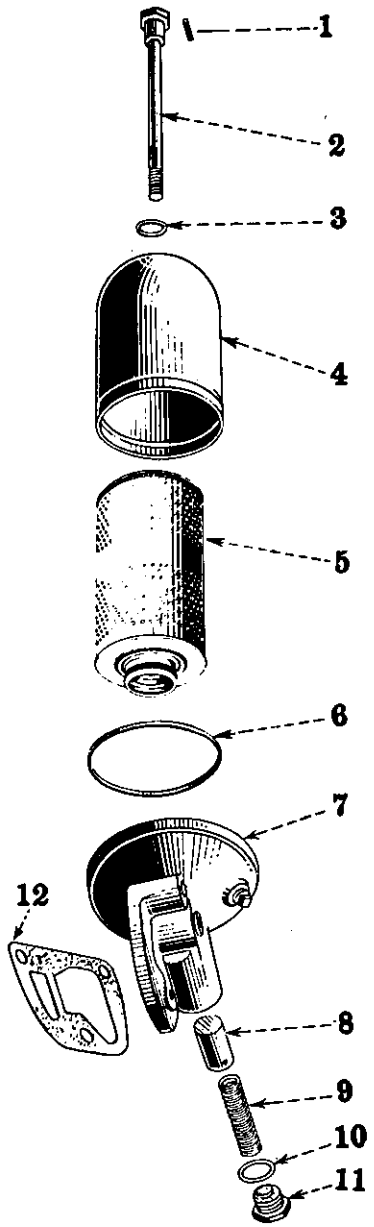
(Continued on next page.)

LUBRICATING OIL FILTER

9. DISASSEMBLY - Continued

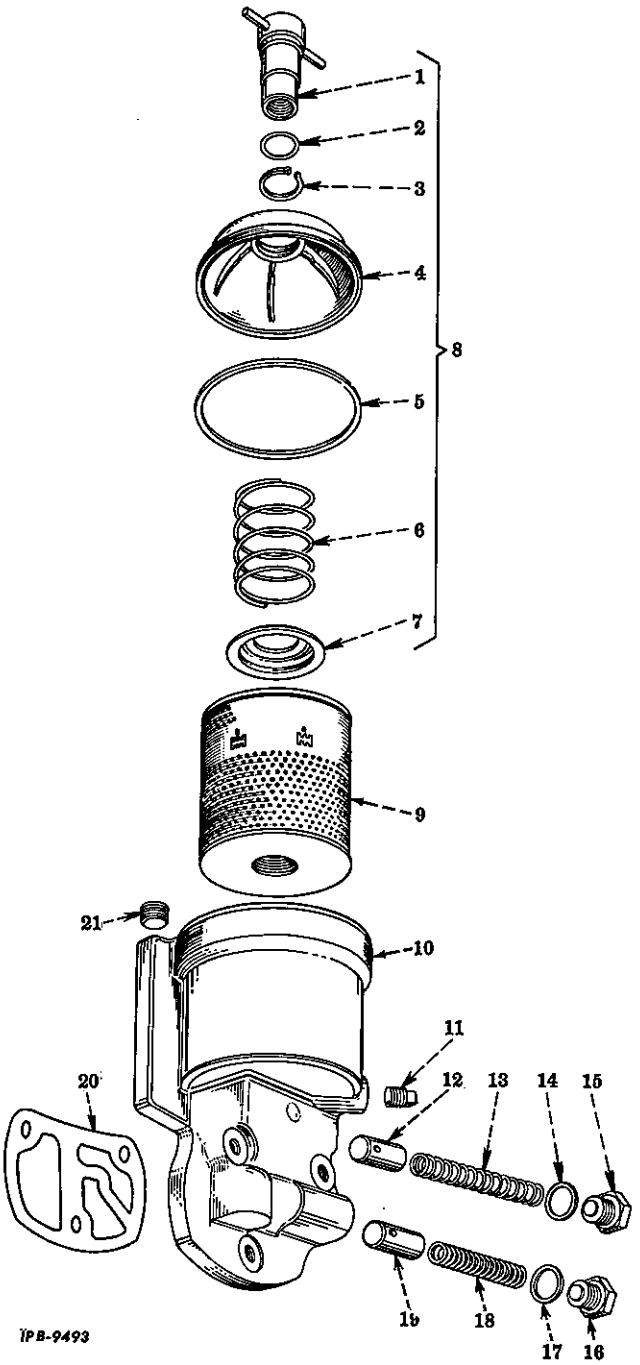
Full-Flow Type Filter - Continued

6. Remove the by-pass valve as well as the pressure regulating valve and hold for cleaning and inspection.



Illust. 7 - By-pass Lubricating Oil Filter.

1. Retaining bolt pin.
2. Retaining bolt.
3. Retaining bar gasket.
4. Case.
5. Element.
6. Case gasket.
7. Base.
8. Regulating valve.
9. Valve spring.
10. Valve nut gasket.
11. Valve nut.
12. Base gasket.



Illust. 8 - Lubricating Oil Filter (Full-flow).

1. Retaining nut.
2. "O" ring.
3. Snap ring.
4. Case cover.
5. Cover "O" ring.
6. Retaining spring.
7. Sealing cup.
8. Filter case cover, assembly.
9. Filter element.
10. Filter base.
11. Pipe plug.

PRINTED IN UNITED STATES OF AMERICA

LUBRICATING OIL FILTER

12. By-pass valve.
13. By-pass valve spring.
14. Retaining nut gasket.
15. By-pass valve retaining nut.
16. Regulating valve retaining nut.
17. Retaining nut gasket.
18. Regulating valve spring.
19. Regulating valve.
20. Filter base gasket.
21. Pipe plug.

10. INSPECTION AND REPAIR

Clean all parts thoroughly with a dry-cleaning solvent.

Check the pressure regulating valve spring and also the by-pass valve spring on the full-flow filters, for proper length, action and condition.

On the by-pass type filters the outside diameter of the pressure regulating valve is .900 to .901 inch; the valve bore is .905 to .906 inch; the diametral clearance is .004 to .006 inch.

On the full-flow filters the outside diameter of the pressure regulating valve is 1.040 to 1.041 inches; the valve bore is 1.043 to 1.045 inches; the diametral clearance is .002 to .005 inch.

The outside diameter of the by-pass valve is .918 to .919 inch; the valve bore is .921 to .923 inch; the diametral clearance is .002 to .005 inch.

11. REASSEMBLY

By-Pass Type Filter

(See Illust. 7.)

1. Install the pressure regulating valve and spring, closed end first, into place in the housing in the filter base. Be sure that the spring does not cock the valve in the housing, thus causing improper seating. Install a new valve retainer gasket and the retainer nut.

2. Install a new filter case gasket. Grease or otherwise lubricate the sealing rings located in each end of filter element to prevent possible damage. Place the element in position on the base. Install a new retaining bolt gasket on the bolt and insert the bolt through the case. Install the bolt pin. Using a slight twisting motion, install the case and bolt over the element and tighten the bolt.

Full-Flow Type Filter

(See Illust. 8.)

3. Install the pressure regulating valve and spring, closed end first, into place in the housing in the filter base. Be sure that the spring does not cock the valve in the housing, thus causing improper seating. Install a new valve retainer gasket and the retainer nut.

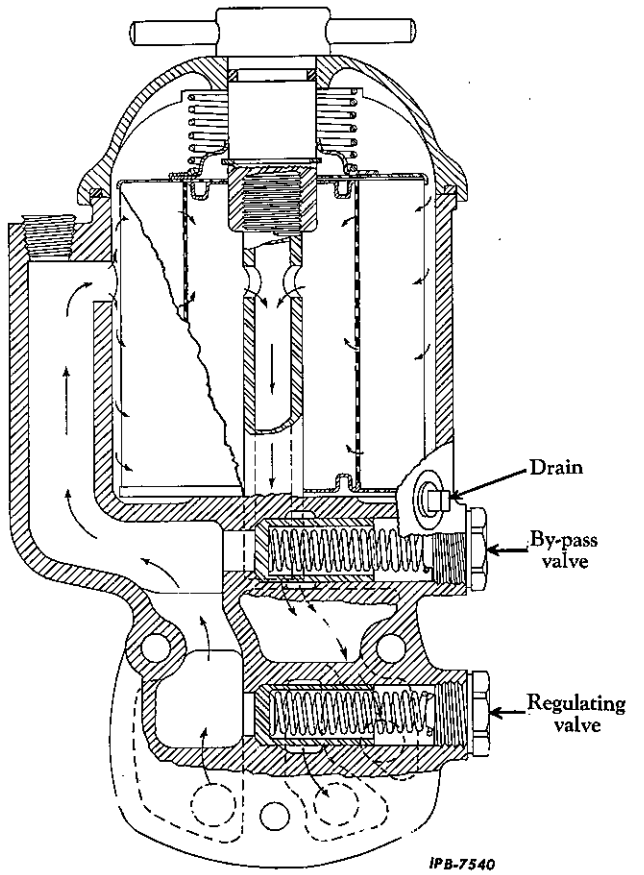
4. Install the by-pass valve and spring in the same manner as the pressure regulating valve.

5. Install a new filter element (9). Place the retaining spring (6) and sealing cup (7) on the element. Lubricate the cover "O" ring (5) to protect it and prevent possible damage when installing the case cover.

6. Install a new "O" ring (2) to the retaining nut (1) and slide it through the case cover (4) and secure it with snap ring (3).

7. Place the case cover (4) on the filter base (10) being careful to have the cover ring properly placed. Tighten the retaining nut (1).

8. Install the drain pipe plug (11) and plug (21).



Illust. 9 - Cross Section Of Full-flow Lubricating Oil Filter.

12. INSTALLATION

Position the filter assembly, with a new gasket, on the side of the engine and secure it with the cap screws. Install the drain plugs in the base. On the full-flow filters, also install the drain plugs in the filter cases.

Fill the crankcase with the required amount of oil (refer to "SPECIFICATIONS" in Section 1).

ENGINE BALANCER

13. DESCRIPTION

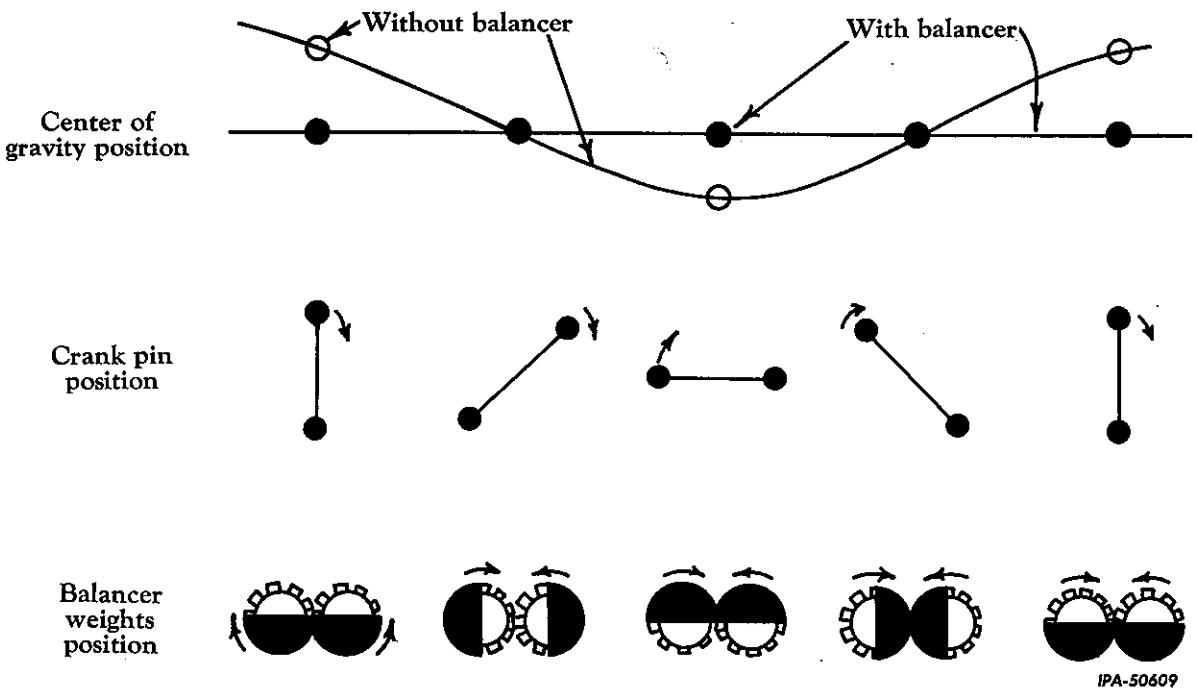
The TD-9 (91 Series) crawler tractor and UD-350 and 370 power units are equipped with an engine balancer mounted to the under side of the crankcase. The engine balancer consists of two eccentric weights located below the crankshaft in the exact middle of the engine. The weights are gear driven, in opposite directions, at twice the crankshaft speed and will reduce engine vibration at higher speeds; thereby, providing a smoother running engine. The oil pump is gear driven by the balancer and is integral with the balancer (Illust. 11).

The weighted gears are matched and timed to each other (Illust. 10) and they are also timed to the engine by means of timing marks on the gears. They counteract the change in center of gravity of the pistons by moving down when the total weight of the pistons is going up, and vice versa. Both weights, therefore, are all the way down when the pistons are at the end of their strokes. In one-fourth revolution of the engine crankshaft, they move to the top just as the pistons pass at the same level below mid-stroke. Unwanted sideways inertia forces of the balancer are cancelled by rotating the eccentric weights in opposite directions.

14. REMOVAL

1. Remove the oil pan.

2. Put piston No. 1 in the top-dead-center on the compression stroke. Check to see that the timing marks line up on the crankshaft ring gear and balancer drive gear. The chamfered tooth on the drive gear should be between the chamfered teeth on the crankshaft ring gear when the weights are in a horizontal position (Illust. 11 and 12), as viewed from the front of the engine.



Illust. 10 - Engine Balancer Operation.

PRINTED IN UNITED STATES OF AMERICA

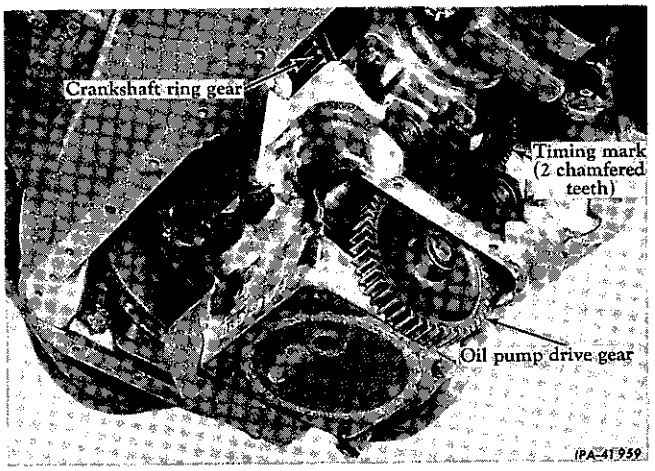
ENGINE BALANCER

3. Lock the engine balancer weights so they do not shift, by putting in set screw (No. 10-24, about 1" long) at the bottom of the weights housing.

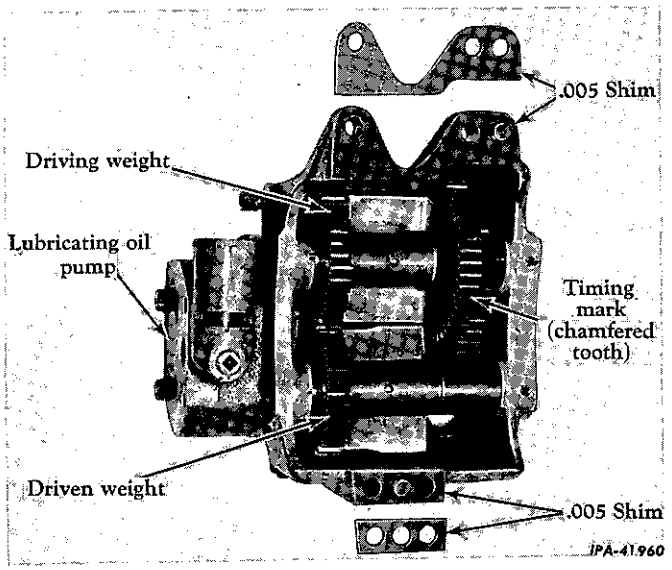
CAUTION: This is also a safety measure to prevent fingers getting in between the gear teeth of the weights. The balancer weights should be in a horizontal position when locked (Illust. 12).

4. Disconnect the oil line from the main oil gallery to the balancer.

5. Remove four cap screws holding the balancer in place. The balancer is now free to be removed from the crankcase. Remove the shims, if used, between the balancer weights housing and the crankcase.



Illust. 11 - Balancer Is Positioned in the Underneath Side of Crankcase.



Illust. 12 - Balancer Weights in Horizontal Position.

15. DISASSEMBLY

(Reference Numbers Refer to Illust. 13.)

LUBRICATING OIL PUMP

1. Remove the two cap screws from the transfer pipe (5) and remove the pipe. Unscrew the two lower cap screws that secures the oil pump body (33) to the balancer weight housing (16) and lift off the oil pump body.

2. The pump body idler gear (31) should be noted for position and reassembled in the same position to maintain tooth wear pattern. The pump body gear (29) is keyed to the shaft (28) and may be removed.

3. Remove the pump drive gear (22) by driving the pin (23) out of the gear hub. On later engines, the gear is also keyed to the shaft. Tap the shaft through the balancer weight housing (16). Unless necessary, due to wear, the bushings (19 and 15) need not be removed.

4. Remove the safety valve spring retainer (37) by driving out the roll pin (34).

5. Do not remove the idler gear shaft (20), except for replacement.

ENGINE BALANCER

NOTE: Check the backlash of all gears to determine their condition before disassembling the balancer. Refer to "SPECIFICATIONS" in Section 1.

6. Remove the shims (39 and 40) and save for reassembly.

7. Drive out the roll pins (21) and remove the balancer weight shafts (24). Support the balancer weights and avoid damaging the shaft or bushings when removing the shafts. The bushings (13A) should not be removed unless replacement is necessary. The dowel pins (14) in the weight housing need not be removed.

8. Remove the bottom plate (26), which is secured by four cap screws.

NOTE: For servicing the drive gear on the crankshaft refer to Section 7.

16. INSPECTION AND REPAIR

1. Wash all the parts thoroughly in solvent and blow dry with compressed air.

2. Check the bushings in the balancer weight housing for serviceability. (Refer to "SPECIFICATIONS" in Section 1.)

(Continued on next page.)

ENGINE BALANCER

16. INSPECTION AND REPAIR - Continued

3. Inspect all gears for chipped teeth, burrs and excessive wear. Use a hone to remove the burrs.

4. Check the weight shaft bearing surfaces for signs of excessive wear. Running clearances are given in "SPECIFICATIONS" in Section 1.

5. Check the oil pump body and ends of pump gears to see if end clearance has been excessive.

6. The safety valve spring may be checked, if there is any doubt as to its serviceability, by referring to "SPECIFICATIONS" in Section 1.

17. REASSEMBLY

(Reference Numbers Refer to Illust. 13.)

ENGINE BALANCER

1. Install the bottom plate (26) and secure with four cap screws.

2. Press in new bushings (13A) if the old bushings are found to be unserviceable. These will require line reaming to proper dimensions as given in "SPECIFICATIONS" in Section 1.

3. Install the balancer weights (12 and 13) in the housing (16) and secure the shafts (24) with roll pins. At this point, it would be advisable to lock the weights (in a horizontal position) with a set screw, No. 10-24. See "CAUTION" in paragraph 14.

LUBRICATING OIL PUMP

4. Assemble the safety valve (35) in the pump body (33) and insert the spring (36) and retainer (37). Secure the retainer with the roll pin (34).

5. Install the pump gear (29) with key (30A) (if it was removed) and slide the shaft (28) with gear into the housing. Be sure the gear is assembled in the same position it was originally to maintain the same tooth wear pattern with the idler gear (31) which should also be installed in its original position. Should it be necessary to replace one of the gears for reasons of wear or damage, the other gear should also be replaced. (Refer to "SPECIFICATIONS" in Section 1 for end play allowed.)

6. On later engines, install the pump drive key on the shaft. Install the pump drive gear (22) on the shaft and in mesh with the small gear on the weight (12). Secure with pin (23) through the gear hub.

7. Install the pump housing (33) to the balancer housing (16) with two cap screws. Attach the transfer pipe (5) to the pump housing with two cap screws and tighten.

18. INSTALLATION

1. Be sure engine is timed for top dead center of the No. 1 piston on the compression stroke.

2. Check to see that the weights are in a horizontal position (see Illust. 12) and locked with the set screw (No. 10-24).

NOTE: If general removal for inspection had been made and shims were present, these shims must be replaced and a backlash check should be made. If a replacement of the crankshaft, balancer weight housing complete, balance weight housing assembly or balancer drive weight is made, then shims are to be inserted between the housing and crankcase to maintain proper backlash between the crankshaft ring gear and the balancer driving weight gear. (Refer to "SPECIFICATIONS" in Section 1.)

3. Install the balancer to the crankcase, making sure that the timing marks on the crankshaft ring gear and balancer drive gear line up.

4. Tighten the balancer with the four cap screws. Install the lockwire to the cap screws.

5. Install the oil line.

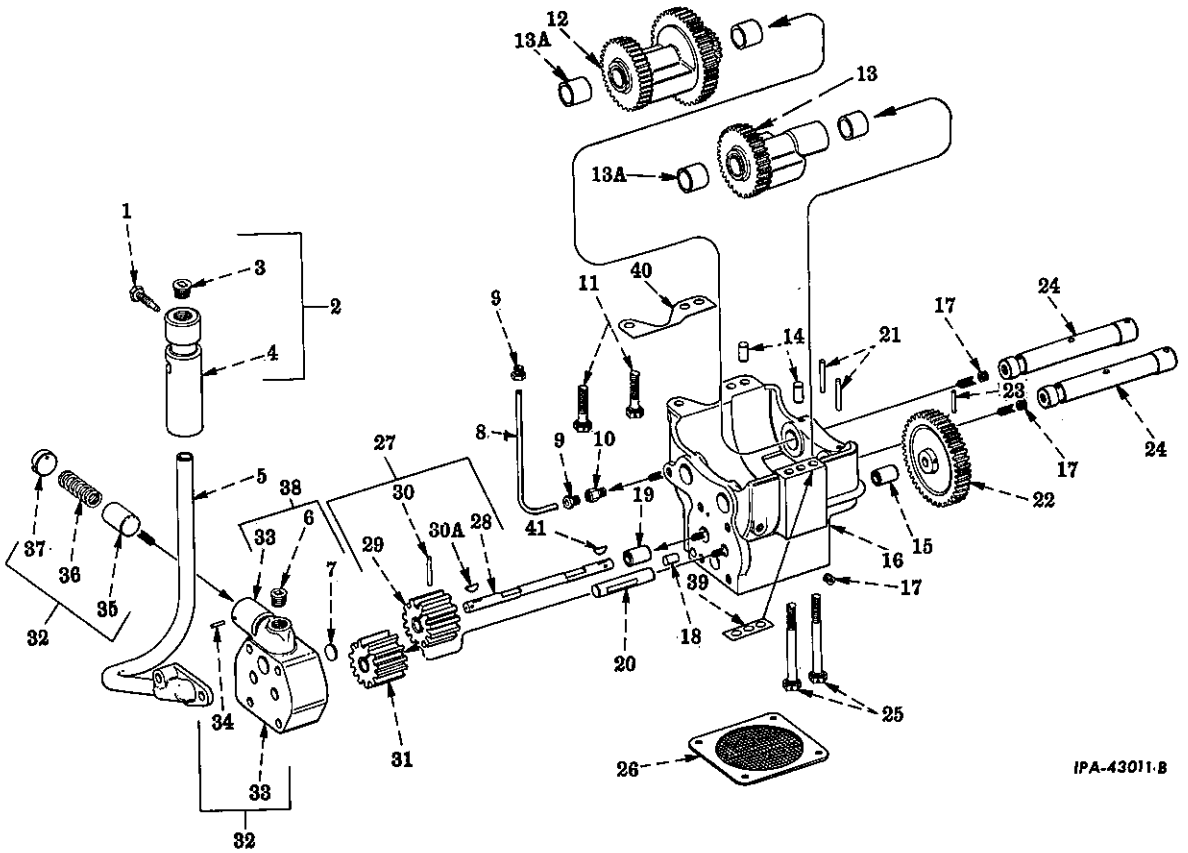
6. Remove the set screw (No. 10-24) used to lock the weights in place.

7. Reinstall the oil pan.

NOTE: Additional instructions will be found in Section 7, pertaining to the removal and installation of the crankshaft ring gear.

PRINTED IN UNITED STATES OF AMERICA

ENGINE BALANCER



Illust. 13 - Lubricating Oil Pump and Engine Balancer.

Legend

1. Transfer housing screw.
2. Transfer housing with plug.
3. Pipe plug.
4. Transfer housing.
5. Transfer pipe.
6. Pipe plug.
7. Expansion plug.
8. Pressure line with two nuts.
9. Pressure line connector nut.
10. Pressure line connector.
11. Cap screw, hex head, short.
12. Balancer driving weight.
13. Balancer driven weight.
13A. Bushings.
14. Dowel pin.
15. Oil pump drive shaft bushing, rear.
16. Balancer weight housing.
17. Pipe plug.
18. Dowel pin.
19. Oil pump drive shaft bushing, front.
20. Oil pump idler shaft.
21. Roll pin
22. Oil pump drive gear.
23. Roll pin.
24. Balancer weight shaft.
25. Cap screw, hex head, long.
26. Oil pump bottom plate.
27. Oil pump drive shaft with gear.
28. Oil pump drive shaft.
29. Oil pump body gear.
30. Roll pin.
30A. Key.
31. Oil pump body idler gear.
32. Oil pump body assembly.
33. Oil pump body.
34. Roll pin.
35. Oil pump safety valve.
36. Oil pump safety valve spring.
37. Oil pump safety valve spring retainer.
38. Oil pump body with plugs.
39. Balancer weight housing shim, left.
40. Balancer weight housing shim, right.
41. Key.

PRINTED IN UNITED STATES OF AMERICA

1. DESCRIPTION

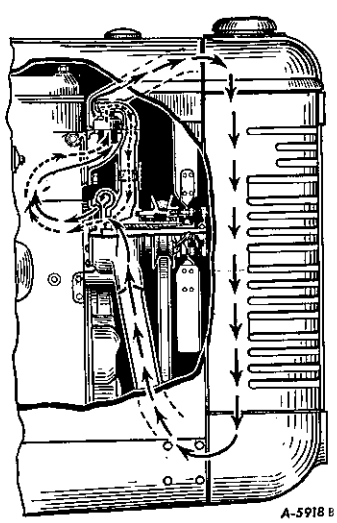
The cooling systems used on IH engines are conventional type and closed type systems. The closed type permits operation at extreme angles without loss of coolant through the overflow pipe and permits operation at higher engine temperatures without boiling. In the closed type, the overflow pipe is equipped with a pressure valve which opens at about 7 pounds pressure. For satisfactory operation of a closed cooling system, extra care must be taken that all connections are watertight. In all other respects, the closed cooling system functions the same as the conventional system.

The conventional system functions as follows: The water is stored in the radiator tanks. A positive displacement centrifugal water pump circulates the coolant from the lower radiator tank through the crankcase and cylinder head water jackets, past the thermostat into the radiator upper tank and down through the cooling area of the radiator core to the lower water tank, where the cycle is repeated. Hose connections provide the joints between the radiator, water pump and water outlet header.

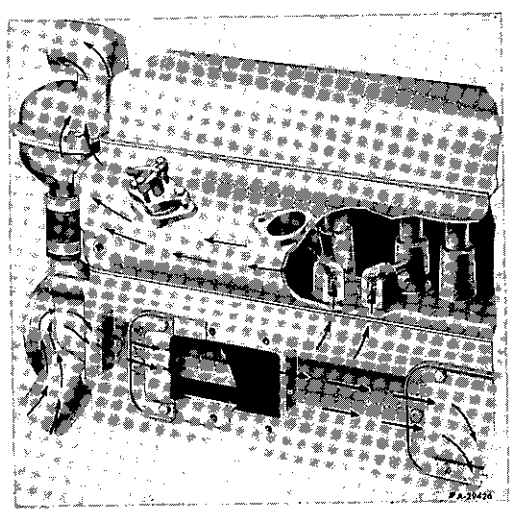
When the engine is started cold, the by-pass type thermostat is closed, preventing circulation of low temperature coolant through the radiator core. The coolant circulates only through the water pump and engine water passages as indicated by dotted arrows in illustration 1. This circulation during the warm-up period prevents formation of steam pockets. When the engine reaches operating temperature, which is set by thermostat specifications, the coil of the thermostat expands and opens the passage for the coolant to flow from the engine water passages through the radiator and back to the water pump as indicated by solid arrows in illustrations 1 and 2. The temperature of the coolant controls the extent of thermostat opening which, in turn, controls the amount of coolant circulation.

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 are mounted 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.

The engine uses just one thermostat of the by-pass type. It is located in the thermostat housing and controls the engine operating temperature. As the temperature reaches 165° F., the thermostat should start to open and be wide open upon reaching 190° F.



Illust. 1 - Circulation of Coolant.



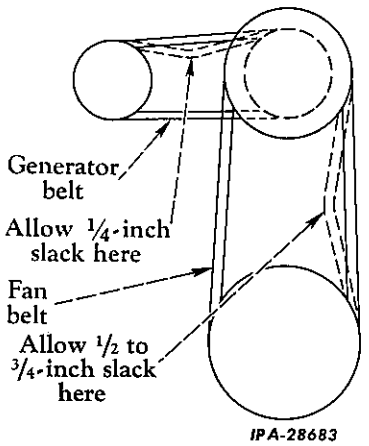
Illust. 2 - Cutaway Showing Coolant Circulation in Crankcase and Cylinder Head of Diesel Engine.

FAN AND FAN BELT

2. MAINTENANCE

Check and tighten the studs and cap screws which hold the fan to the pulley. Check the fan blades for looseness and for being bent. Check the blades for runout and bend into line if necessary.

The fan belt should be maintained at the correct tension and replaced if it is damaged, grease soaked or is bottoming in the drive pulley on the crankshaft. The belt tension is correct when it can be depressed 1/2 to 3/4 inch by thumb pressure midway between the pulleys.



Illust. 3 - Correct Belt Tension.

3. REMOVAL

(Refer to Illust. 4.)

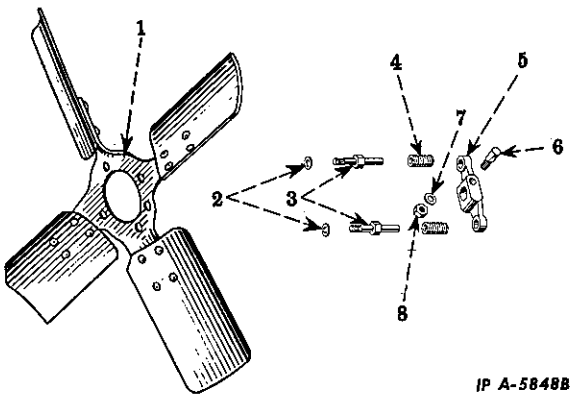
1. Remove the left housing sheet from around the fan.

2. Crank the engine to bring the driver pin (6) into position so that the lock nut (8) can be loosened.

3. Take off the nut (8) and washer (7). Tap out the drive pin (6).

4. Remove the driver (5) from the impeller shaft and studs (3) being careful to remove both springs (4) at the same time.

5. Remove the two studs (3) and the two cap screws (not shown) that attach the fan to the pulley hub.



Illust. 4 - Fan and Water Pump Driver (Not 9 (91 Series).

Legend

1. Fan assembly.
2. Lock washer
3. Driving stud.
4. Spring.
5. Water pump driver.
6. Driver pin
7. Lock washer.
8. Nut.

6. Remove the fan.

4. INSTALLATION

1. Line up the holes in the fan assembly with those in the pulley, placing the two cap screws with lock washer in opposite holes to hold the fan in position.

2. Add lock washers (2) to the threaded end of the studs (3) and screw in the studs until tight. Then tighten the cap screws to secure the fan to the pulley.

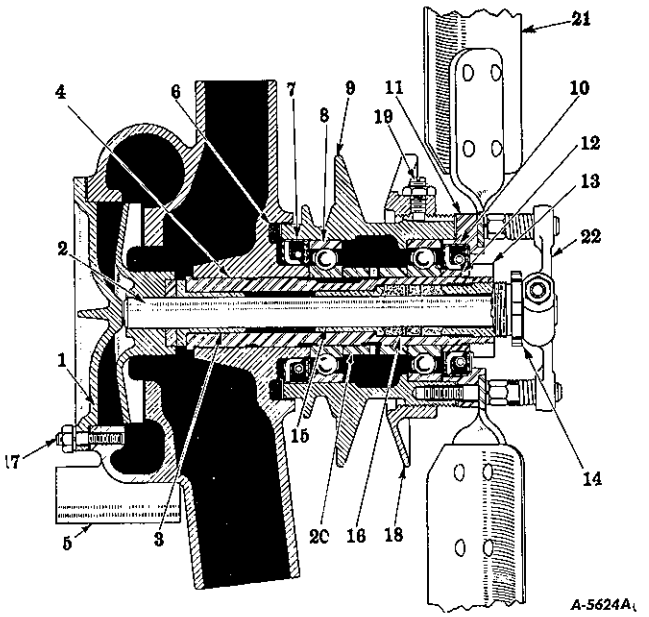
3. Slip the springs (4) over the stud nuts and place the driver (5), flat side toward the radiator, onto the studs after lining up the driver pin hole with the flat side of the impeller shaft.

4. Insert the driver pin (6) and tighten the nut (8).

5. Install the fan housing sheet.

PRINTED IN UNITED STATES OF AMERICA

WATER PUMP



Illust. 5 - Cross Section of Packing Type Water Pump and Fan Drive.

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 flange.
19. Set screw.
20. Bearing spacer.
21. Fan.
22. Pump shaft driver.

5. MAINTENANCE

Due to wear after considerable service, the pump packing may leak. If this does occur, 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.

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.

6. REMOVAL

1. Drain the cooling system.

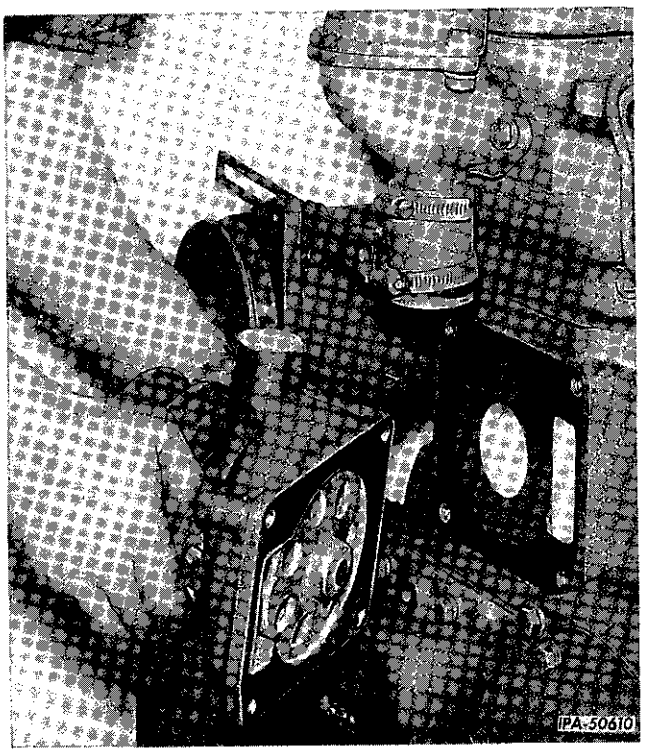
2. Remove the left fan housing sheet.

3. Remove the fan and water pump belt and generator belt.

4. Loosen the hose clamps and push or drive down the hose (Illust. 6).

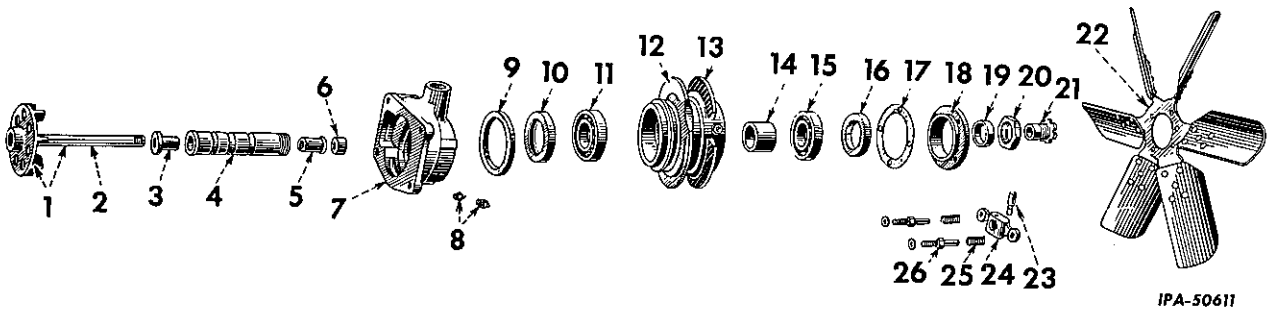
5. Loosen the upper hose clamp, remove the bolts which hold the water pump to the crankcase and remove the pump, pulley and fan assembly (Illust. 7).

Illust. 6 - Driving Hose down from Water Pump Body.



Illust. 7 - Removing the Water Pump.

WATER PUMP



Illust. 8 - Exploded View of Water Pump (91 Series). 61 Series Similar.

Legend for Illust. 8

1. Impeller with shaft.
2. Pump shaft.
3. Thrust bushing.
4. Sleeve.
5. Shaft bushing.
6. Pump packing.
7. Pump body.
8. Lubrication fitting.
9. Felt washer.
10. Oil seal.
11. Bearing.
12. Pulley hub.
13. Pulley flange.
14. Bearing spacer.
15. Bearing.
16. Oil seal.
17. Retainer gasket.
18. Bearing retainer.
19. Lock sleeve.
20. Clamp nut.
21. Packing gland.
22. Suction fan.
23. Driver pin.
24. Driver.
25. Driver spring.
26. Driving stud.

7. DISASSEMBLY

(Refer to Illust. 8.)

1. Screw out the packing gland (21) with a spanner wrench (Illust. 9) and remove the clamp nut (20). (See Illust. 10.)

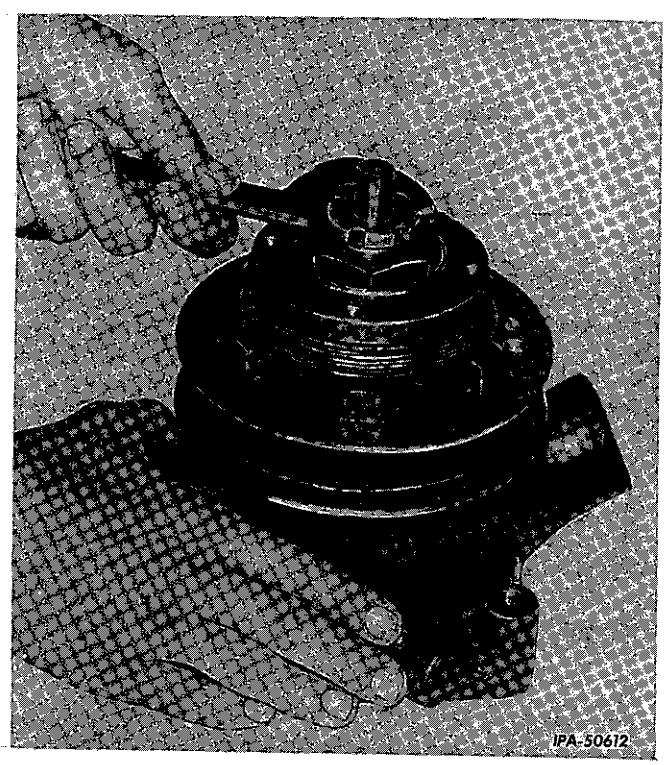
2. Slide the impeller and shaft (1) out of the pump body (see Illust. 11).

3. Remove the bearing retainer (18) with seal (16) (Illust. 12), lock sleeve (19) and retainer gasket (17).

4. Remove the pulley flange (13) and hub (12) as a unit from the shaft sleeve (4). (See Illust. 13.) The two ball bearings (11 and 15), spacer (14) and oil seals (10 and 16) will be in the hub (12). If it is necessary to replace either bearings or oil seals, they may be pressed or tapped out (see Illust. 14).

5. Remove the felt washer (9) from the pump body (7). Remove the packing (6) but do not try to salvage; always replace with new when reassembling the pump.

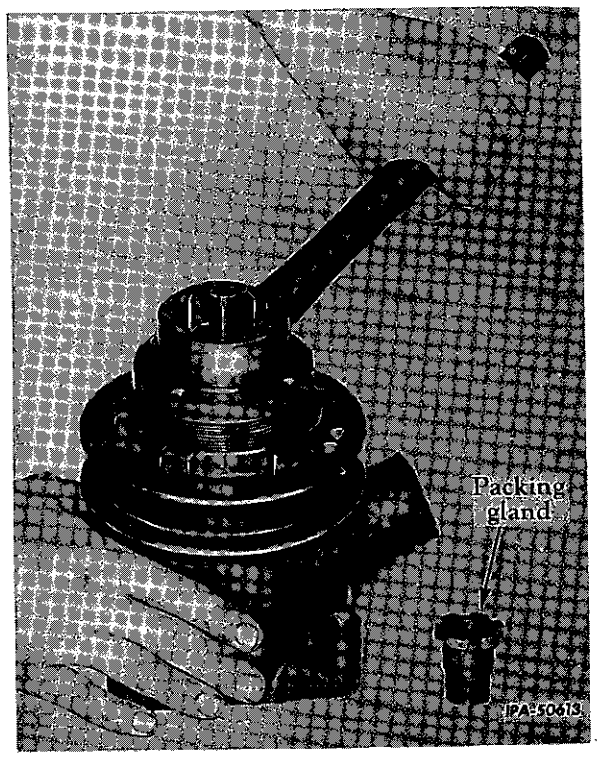
NOTE: Do not remove the bushings (3 or 5) or the shaft sleeve (4) without first determining the need for replacement by checking dimensions.



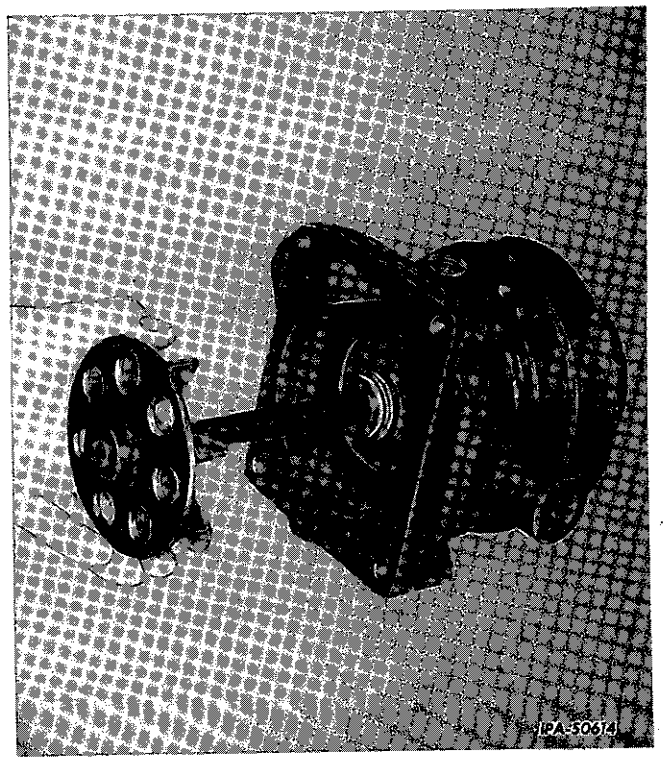
Illust. 9 - Removing the Water Pump Packing Gland.

PRINTED IN UNITED STATES OF AMERICA

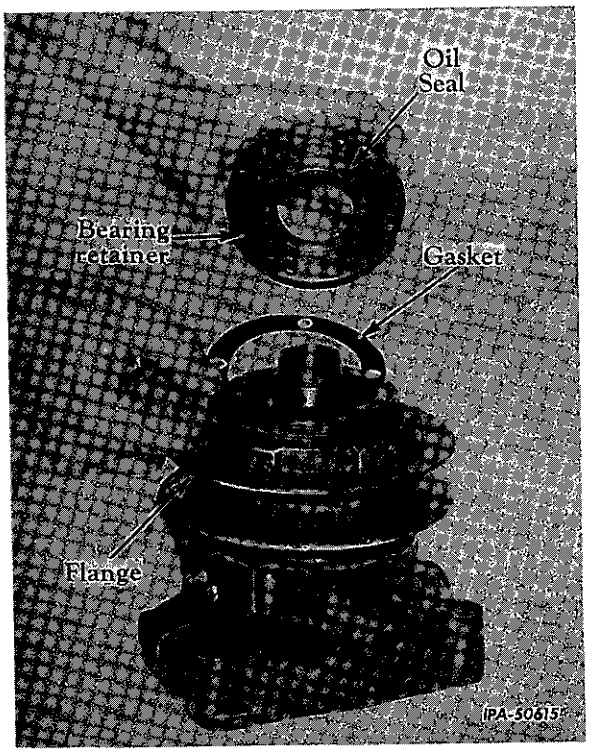
WATER PUMP



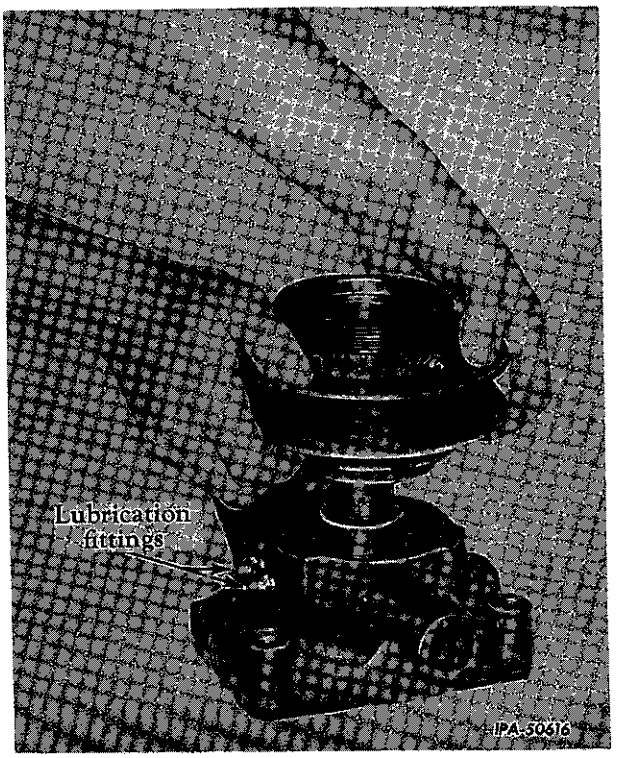
Illust. 10 - Removing the Water Pump Bearing Clamp Nut.



Illust. 11 - Removing the Water Pump Impeller and Shaft.



Illust. 12 - Removing the Water Pump Bearing Retainer, Seal and Gasket.



Illust. 13 - Removing the Water Pump Pulley from the Shaft Sleeve.

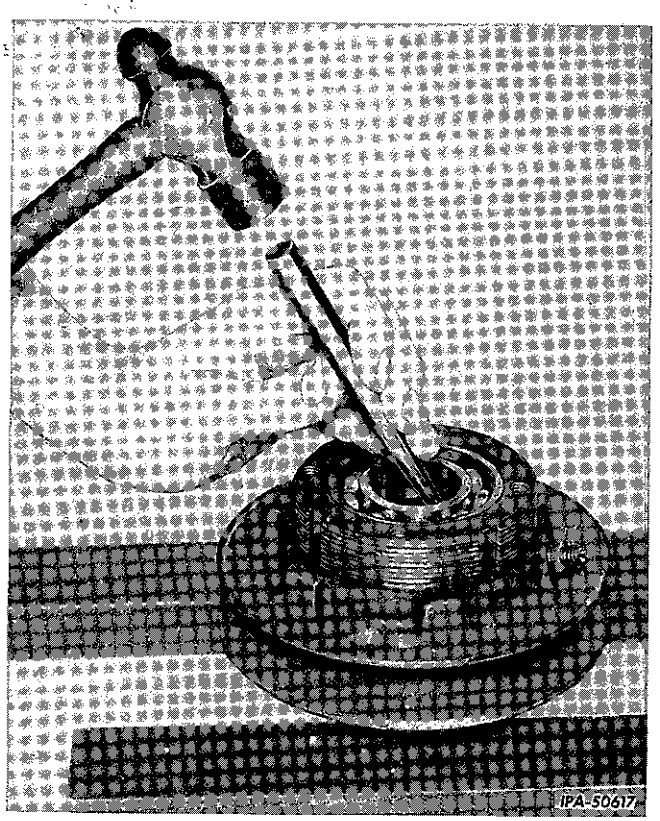
WATER PUMP

8. INSPECTION AND REPAIR

Examine carefully all parts for excessive wear, rust or scale and determine their serviceability. Do not remove the shaft bushing or thrust bushing unless it is necessary due to the running clearance between the impeller shaft and bushings exceeding .0025 - .0035 inches. Driving out a bushing with a drift will damage it for further use. They are sintered bronze bushings.

Inspect the impeller shaft for excessive wear or grooving. Replace if necessary. If the pump shaft sleeve needs replacing for any reason, press it out of the pump body and replace with a new one with bushings complete.

Remove the two lubricator fittings and clean out the drilled passages thoroughly. Inspect the front and rear bearings. If grooving is detected, replace the bearing. Bearings to be reinstalled should be packed and wrapped until needed for reassembly.



Illust. 14 - Tapping out the Rear Bearing and Seal.

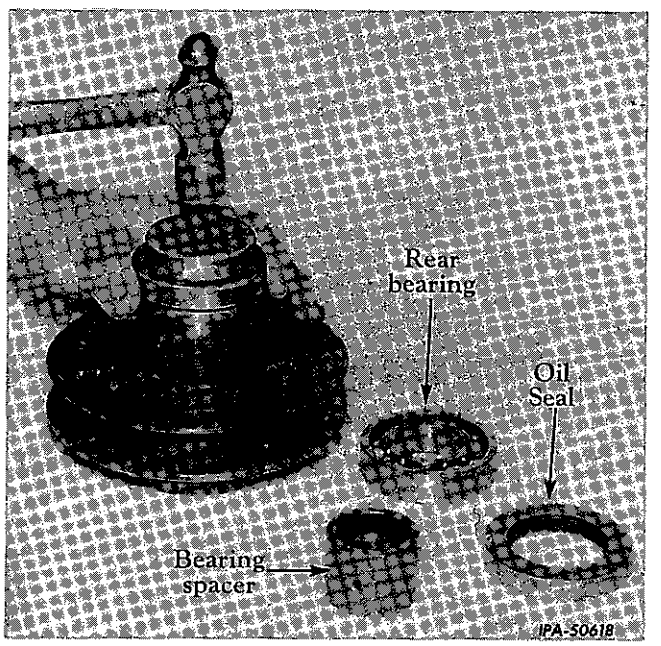
9. REASSEMBLY

(Reference Numbers Refer to Illust. 8.)

1. Install the thrust bushing (3) and shaft bushing (5) if they were removed but only if in proper condition.

CAUTION: The bushings are sintered bronze and should be pressed in with a suitable sleeve driver in a press. (Refer to step 9 also.) Driving them out generally renders them as unfit for further use. New bushings, when installed, should be checked for proper running clearance and reamed if necessary.

2. Install the front bearing (15) in the pulley hub (12) (see Illust. 15) until it bottoms in the bore.



Illust. 15 - Tapping the Front Bearing into the Pulley Hub.

3. Turn the pulley hub over and insert the bearing spacer (14). Install the rear bearing (11). Press or tap in as in step 2 until it bottoms in the bore.

4. Install the oil seal (10) in the pulley hub (12) using a suitable seal driver, making sure the lip of the seal faces toward the inside of the hub. Tap the seal in until it is seated. (See Illust. 16.)

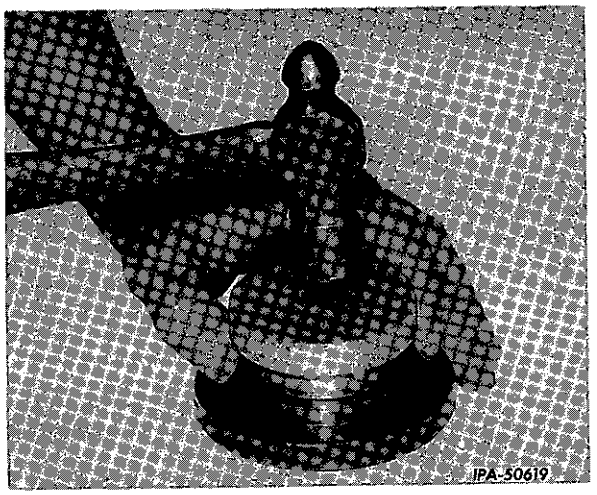
5. Place the felt washer (9) into the recess in the front of the pump body (7). If a new felt washer is being installed, soak it well in engine oil before installing.

6. Place the pulley hub (12) (with bearings installed) over the shaft sleeve (4). (See Illust. 13.)

NOTE: The shaft sleeve (4) should not be removed from the pump body unless replacement is necessary.

PRINTED IN UNITED STATES OF AMERICA

WATER PUMP



Illust. 16 - Tapping the Oil Seal into the Bearing Retainer.

7. Press or tap the front oil seal (16) into the bearing retainer (18) so that when the retainer is assembled on the pump the lip of the seal will be away from the bearing. Place the retainer gasket (17) on the inner flange of the bearing retainer (18).

8. Slide the bearing lock sleeve (19) into the oil seal in the retainer, inserting it from the inner side of the seal (16). Install the retainer over the shaft sleeve (4) and against the pulley hub (12).

9. Slide the impeller with shaft (1) into the pump. The shaft should turn freely. The running clearance on the impeller shaft in its bushings is .0025 - .0035 inch.

10. Place the bearing clamp nut (20) on the shaft sleeve (4) and tighten securely.

11. Insert new pump packing (6) into the shaft sleeve (4), making sure the beveled edges are out on the two end pieces. Screw the packing gland (21) in until it touches the packing. Fill the hub with the correct lubricant.

With the pump back on the tractor and the cooling system filled, tighten the packing gland (using a spanner wrench) only enough to stop any leaking. Start the engine and check for further leaking.

CAUTION: Do not over-tighten the packing gland or the impeller shaft will be damaged.

10. INSTALLATION

Install in the reverse order of removal as described in paragraph 6.

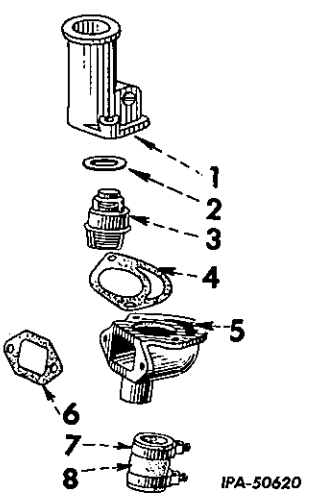
THERMOSTAT

11. MAINTENANCE

The thermostat can be checked by removing it and placing it in water. Place a thermometer in the water and then start heating the water. The thermostat should start to open at approximately 165° F. and be wide open at 190° F. (open approximately 3/8 inch). Replace the thermostat if it does not operate within the above range.

Legend

1. Thermostat housing.
2. Seal.
3. Thermostat.
4. Gasket.
5. Water outlet elbow.
6. Elbow gasket.
7. Hose clamp.
8. Hose.



Illust. 17 - Thermostat Housing and Components.

THERMOSTAT

12. REMOVAL

Illust. 18 - Removing the Thermostat.

1. Remove the hood and drain the coolant.

2. Remove the cap screws which hold the inlet pipe to the radiator and the cap screws which secure the thermostat housing to the water outlet elbow.

13. INSTALLATION

1. Insert the thermostat into the water outlet elbow with the bellows end down.

2. Apply sealer to the gasket surfaces of the thermostat housing and the water outlet elbow and install a new gasket.

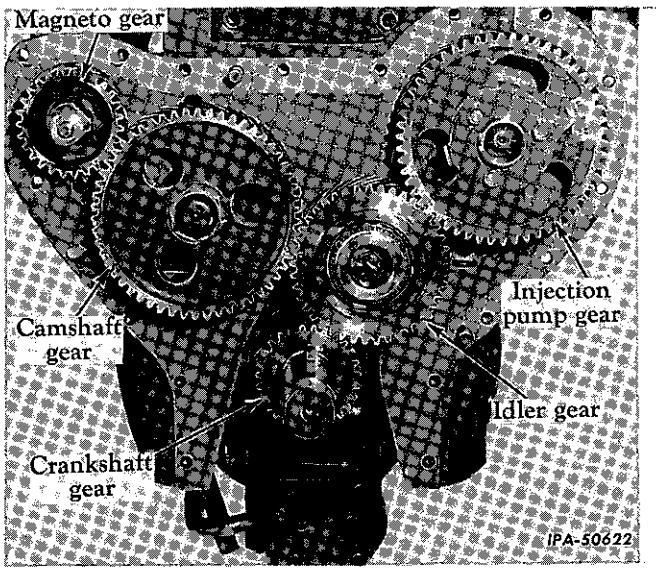
3. Secure the thermostat housing with two cap screws.

4. Using a new gasket, attach the inlet pipe to the radiator.

PRINTED IN UNITED STATES OF AMERICA

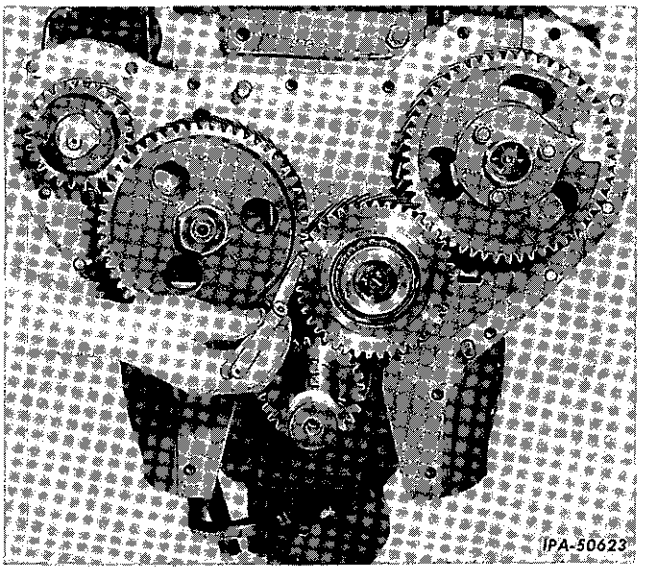
1. DESCRIPTION

A completely enclosed train of five helical gears is mounted on the front end of the engine. The gear on the crankshaft drives an idler gear which, in turn, drives the camshaft gear and the injection pump drive gear. The camshaft drives the magneto gear. The camshaft and injection pump drive gears turn at half the speed of the crankshaft. The magneto operates at the same speed as the crankshaft. The gears are all marked so the engine can be timed correctly whenever the injection pump, camshaft, magneto drive gear or idler gear have been removed. The idler gear teeth are punch marked and they must mesh with the teeth on the crankshaft gears, injection pump gears and camshaft gears so marked. The magneto drive gear and camshaft gear teeth are marked with a center punch. The back of the center punch marked camshaft gear tooth is beveled to make it possible to install the magneto drive gear correctly from the rear side of the front engine support without removing the gear cover.



Illust. 1 - Gear Train (In Time).

The camshaft is located in the crankcase on the right side of the engine and it is held to the crankcase by a thrust plate. The camshaft is supported at intervals along its length by four bushings. The bushings are removable and are furnished for service reamed to size. The bushings are a press fit in the crankcase.



Illust. 2 - Checking Backlash of Gears.

The camshaft drives the engine lubricating oil pump (all engines except the TD-9 (91), UD-350 and UD-370) by the gear located approximately in the center of the shaft. The camshaft has the main function of operating the intake and exhaust valve mechanism by action of its lobes upon the push rods during rotation. It is important to notice that the camshaft gear is twice the size of the crankshaft gear which primarily drives it. The camshaft, therefore, rotates at one-half the crankshaft speed due to the requirement to open and close the valves to each cylinder once for every two revolutions of the crankshaft.

The camshaft bearings are pressure lubricated and have oil holes drilled in them. When the bushings are installed, the oil holes must align with the ones drilled in the crankcase. Slots in the camshaft permit lubricating oil to travel to the valve lever mechanism.

TIMING GEAR TRAIN AND FRONT COVER

2. REMOVAL

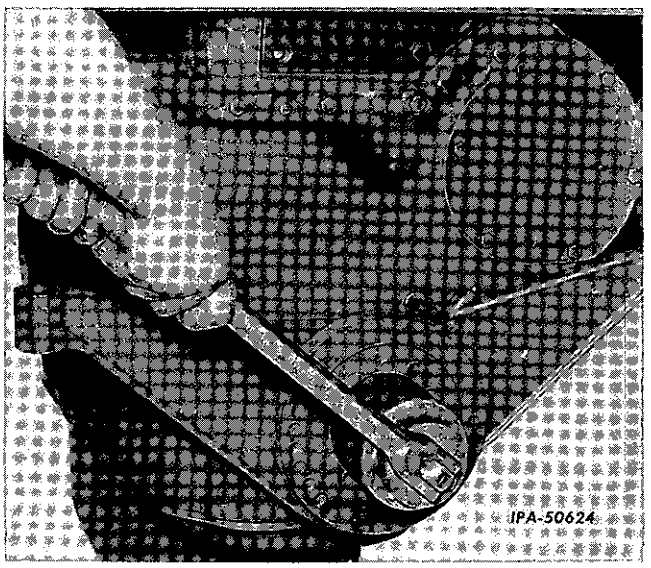
1. Remove the cotter from the front of the crankshaft; then remove crankshaft nut (Illust. 3).

2. Remove the fan drive pulley and vibration damper from the crankshaft. To do this, position service tool 1 020 077 R91 or a standard

(Continued on next page.)

TIMING GEAR TRAIN AND FRONT COVER

2. REMOVAL - Continued

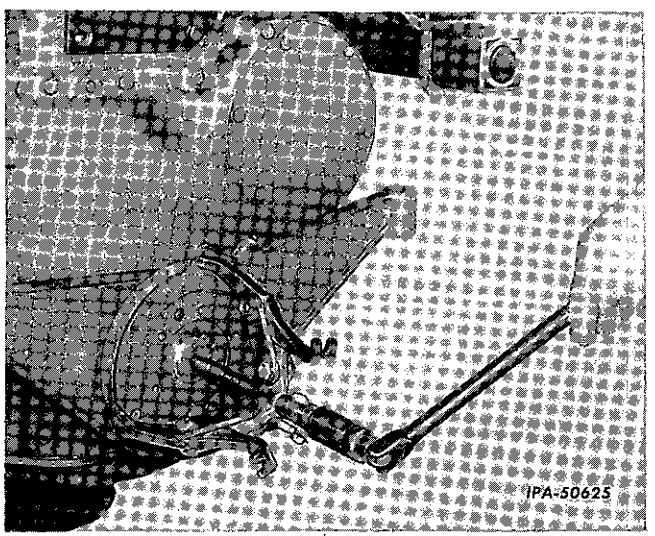


Illust. 3 - Removing Crankshaft Nut.

puller, in place on the pulley. (Refer to the "Service Tools Manual," ISS-1002.) Then, by turning the bolt inward which is a part of the puller, the damper and pulley will slide off the crankshaft. (See Illust. 4.)

3. Remove the front engine support.

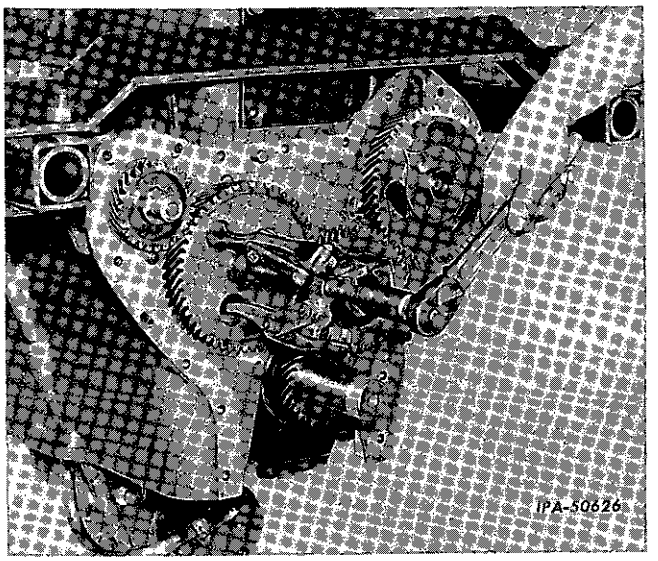
4. At the front end of the oil pan, remove the three cap screws which screw into the cover.



Illust. 4 - Removing Fan Drive Pulley.

On certain units, studs are used instead of cap screws. Therefore, it will be necessary to drop the front end of the oil pan far enough to clear the studs in the front cover.

5. Remove the cap screws which hold the front cover to the crankcase front plate and pry off the cover. (See Illust. 5.) The front cover gasket will adhere to the cover. Remove the fan drive pulley key from the crankshaft.



Illust. 5 - Removing Camshaft Gear with Puller.

6. Remove the cap screws which hold the thrust washer to the idler gear shaft and remove the idler gear.

7. Remove the nut and washer which hold the magneto drive gear to the shaft and pull the gear from the shaft.

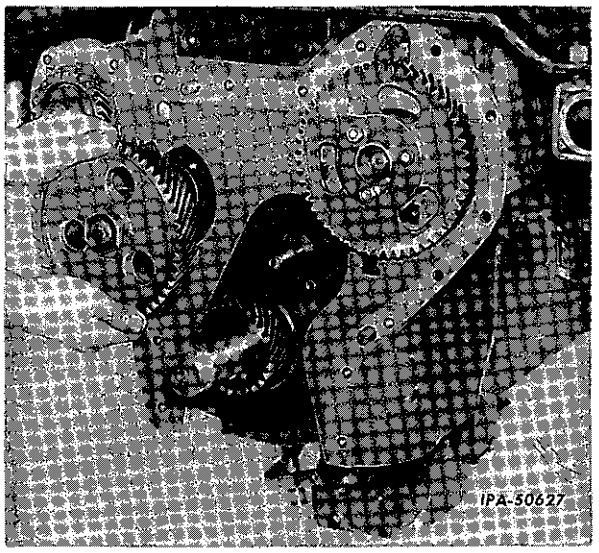
8. Remove the nut and washer from the camshaft and remove the camshaft gear. (See Illust. 6.)

9. Remove the cap screws which hold the injection pump gear timing indicator and gear to the hub and remove the gear and indicator.

10. Remove the Woodruff key from the crankshaft, slide off the spacer and oil flinger and pull off the crankshaft gear.

PRINTED IN UNITED STATES OF AMERICA

TIMING GEAR TRAIN AND FRONT COVER



Illust. 6 - Removing Camshaft with Gear.

3. INSPECTION AND REPAIR

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

2. Inspect all parts for wear and replace as necessary. Refer to "SPECIFICATIONS" in Section 1 for the correct diameter of new idler gear bushing. A new gear bushing, after being pressed into the gear, requires reaming.

3. Inspect the oil seal in the front cover for damage and replace if necessary. On engines equipped with oil seals, pry out the oil seal and drive in a new oil-soaked seal with the lips facing inward.

4. For the dimensions on the magneto drive shaft, refer to Section 12.

4. INSTALLATION

1. Install the camshaft gear and assemble the magneto and drive assembly to the front plate. Be sure that the punch marks match on the magneto gear and the camshaft gear.

2. Install the injection pump gear into place on the front plate. Assemble the injection pump gear on the gear hub so the groove in the hub and the groove in the hub surface of the gear match. Place the timing indicator on the gear with the pointer set at zero. Install the cap screws and cap screw locks.

3. Install the crankshaft gear on the crankshaft and slide the oil flinger and the spacer onto the crankshaft.

IMPORTANT NOTE: When installing the crankshaft gear (especially in the field), extensive damage can be caused if the gear is allowed to become cocked on the crankshaft. This applies to the straight bore crankshaft gears. It is suggested to heat the gear, not in excess of 250° F., to facilitate assembly and reduce the possibility of galling the inside bore of the gear.

4. Install the idler gear after all the other gears have been installed. Coat the idler gear shaft with engine oil; then slide the gear onto the shaft. Match the camshaft gear, injection pump gear and crankshaft gear so the punch marks match with corresponding teeth.

5. Install the oil flinger and spacer on the crankshaft.

6. Shellac a new gasket on the front cover; then install the front cover and secure with cap screws and dowels. If the oil pan was removed, install the oil pan and fill with oil. If the oil pan was not removed, install the front cap screws and tighten those that were loosened.

7. Install the front engine support.

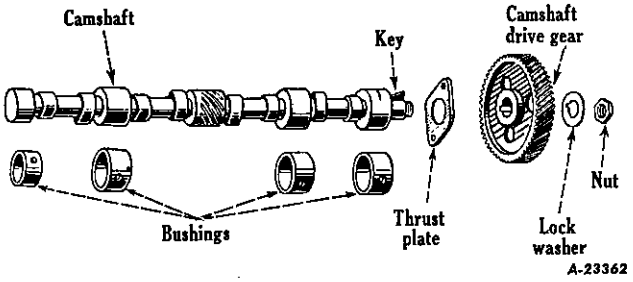
8. Install the Woodruff key into the crankshaft and drive on the pulley. The fan drive pulley should be seated firmly and fully upon the key. Install the nut lock and nut. Install the crank pin in the crankshaft and lock it with a set screw.

9. Install the fan and the water pump. (See Section 5.)

10. Install and tighten the fan belt.

11. Start the engine and check the timing of the magneto or distributor, the valves and the injection pump.

CAMSHAFT



Illust. 7 - Camshaft Components (6 Series). 9 Series Similar.

5. REMOVAL

1. Remove the valve mechanism and valve push rods. Identify the push rods so that they can be returned to their original positions. (Refer to Section 2.)

2. Remove the ignition distributor on engines so fitted.

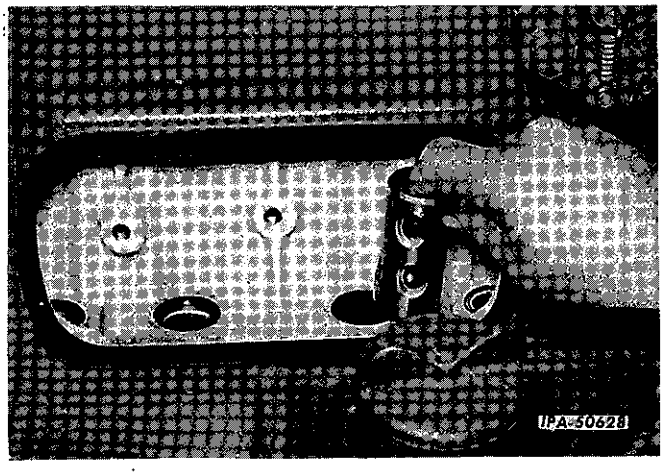
NOTE: If the engine is equipped with an engine balancer, disregard Step 3.

3. Remove the crankcase oil pan and lubricating oil pump. (Refer to Section 4.)

4. Remove the crankcase front cover and idler gear. (Refer to Par. 2.)

5. Rotate the camshaft gear until the cap screws which hold the thrust plate to the crankcase can be removed through the holes in the gear.

NOTE: Mark the tappets as to location in the engine block, so that they can be returned to their original position.



Illust. 8 - Removing Valve Tappets.

6. Remove the side cover and gasket from the right side of the engine. Remove the push rod bracket and the tappets. Lift the valve tappets from position. (Refer to Illust. 8.)

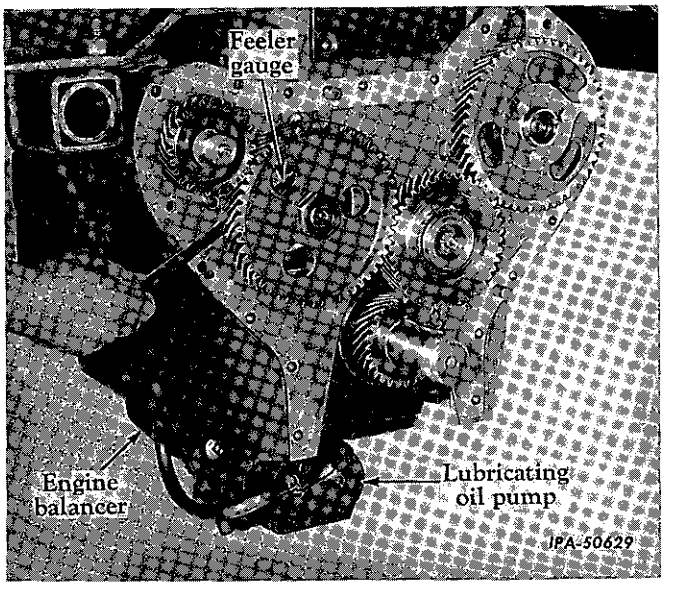
7. Pull the camshaft assembly from the crankcase. (Refer to Illust. 6.)

6. DISASSEMBLY

1. Remove the nut and lock which holds the gear on the camshaft. (Refer to Illust. 6.)

2. Use a gear puller to pull the gear from the shaft. The gear is keyed to the shaft.

3. Remove the key from the shaft and remove the thrust plate.



Illust. 9 - Checking Camshaft End Clearance.

7. INSPECTION AND REPAIR

1. Clean all parts in a cleaning solvent and dry them with compressed air. As inspection

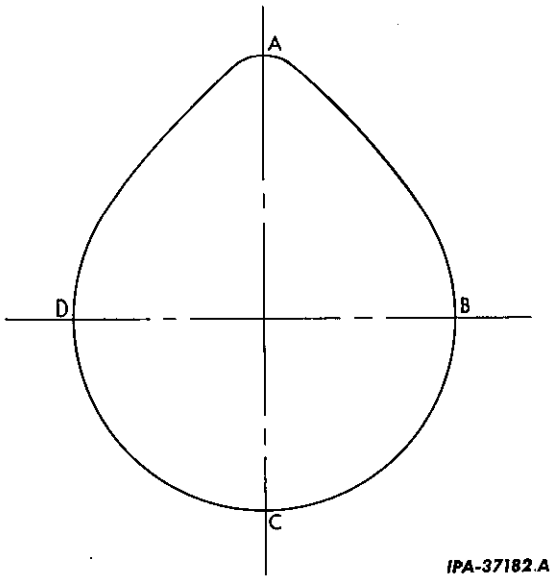
PRINTED IN UNITED STATES OF AMERICA

CAMSHAFT

of parts is completed, coat each part with clean engine oil and store safely until reassembly. Do not damage the journals and lobes of the camshaft or the teeth of the gear.

2. Inspect the lobes for wear. Refer to "SPECIFICATIONS AND TORQUE DATA" in Section 1 for cam lobe lift when new and for the maximum permissible 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 (Illust. 10):

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.



Illust. 10 - Points of Measurement to Determine Cam Lobe Wear.

3. Inspect the teeth of the oil pump drive gear integral with the camshaft. (Not TD-9 (91 series) UD-350, UD-370.) Replace the shaft if necessary.

4. Inspect the drive gear and thrust plate for wear due to lack of specified end clearance. Replace parts if necessary.

5. The bushings should be inspected for wear and, if replacement is necessary, remove the flywheel and engine rear support. Remove the expansion plug from the rear of the camshaft bore. Drive it from position with a long bar through the camshaft bore of the crankcase from the front end. Pull or press the bushings from position.

6. Inspect the bore in the crankcase for burrs and other roughness liable to damage the bushings when installation takes place.

7. Inspect the valve push rods for wear. Replace if necessary.

8. Inspect the valve tappets. Replace any that are scuffed, scored or cracked. If the tappet face is badly chipped, extreme wear can be expected in the cam lobe and a new camshaft must be installed.

8. REASSEMBLY

1. Assemble the camshaft by installing the thrust plate on the shaft. The countersunk side must be toward the threaded end. Install the camshaft gear key to the shaft.

2. Install the gear to the shaft with the timing marks facing away from the shaft.

3. Install the nut lock and nut. Torque the nut to the foot-pounds specified in "SPECIFICATIONS" in Section 1. Secure the nut with the lock.

NOTE: Torque can be applied to the nut after installation of the camshaft in the engine if this is easier; in which case, do not lock the nut until later. When tightening the nut, place a piece of clean cloth between the teeth of the cam gear and those meshing with it.

9. INSTALLATION

1. Install the camshaft rear bearing expansion plug if bushings were removed. Use a sealing compound on the plug and in the plug seat.

2. Install the flywheel and engine rear support. (Refer to Section 7.)

3. Install the camshaft assembly to its position in the crankcase after coating it with SCL (SULFO-CHLORO-lead) heavy duty axel lubricant.

4. Secure the thrust plate to the crankcase, using the cap screws, through the holes in the camshaft gear. Check the clearance between the thrust plate and the gear against that listed in "SPECIFICATIONS" in Section 1.

NOTE: The magneto and camshaft drive gears must be assembled in a specific manner. The magneto gear has a marked tooth and the camshaft gear has two marked teeth. The marked

(Continued on next page.)

CAMSHAFT

9. INSTALLATION - Continued

tooth on the former should mesh between the two marked teeth on the camshaft gear. (Refer to par. 1 and Illust. 1 for assembly details.)

5. Install the idler gear on the idler shaft so that the marks on the idler gear align with the markings of the crankshaft gear.

6. Install the crankcase front cover.

7. Install the distributor and check the distributor timing on engines so fitted. (Refer to Section 13.)

8. Install the valve tappets, push rod bracket, gasket and cover. (Refer to Section 2.)

9. Install the valve mechanism. (Refer to Section 2.)

10. Start the engine and check its operation.

NOTE: It is recommended that the engine be run at 1000 rpm from three to five minutes after assembly of the engine. At this rpm the tappets (or valve lifters) are under light load, thus initial lubrication at the tappets and tappet bores will be assured.

11. Engine valves should have clearances as specified in "SPECIFICATIONS" in Section 1. Adjust if necessary as described in Section 2.

PRINTED IN UNITED STATES OF AMERICA

1. DESCRIPTION

The crankshaft supports the connecting rods and pistons along its length. The crankshaft drive gear is located at the forward end. It supplies the drive for the camshaft, injection pump and magneto by means of the timing gear train. Two types of crankshafts are used: the straight throw type and the counterbalanced crankshaft. Two seals, one at the front and one at the rear, prevent leakage of engine lubricating oil around ends of the crankshaft.

Bearing caps are furnished with the crankcase and these support the crankshaft in true alignment. Webs integral with the crankcase provide the upper half of the main bearing supports and removable caps provide the lower support. The caps are held in place with studs and castellated nuts. The nuts are torqued as specified in "SPECIFICATIONS" in Section 1 and are locked in place with cotters after the correct tension is applied. The bearing caps are not interchangeable and each has a number stamped upon it which signifies its correct location in the crankcase. Number 1 is at the front of the engine. It is good practice to keep the nuts identified so that they may be returned to their original studs. This will make installation easier with reference to cotter hole alignment in nuts and studs when the specified torque and clearance is obtained.

The bearings are inserted between the crankshaft and the crankcase and between the crankshaft and the bearing caps. The center main bearing is the thrust bearing and it has thrust flanges. Some engines are equipped with the old type six piece center bearing. When a six piece bearing is to be replaced, it must be replaced with the two piece bearing, as the six piece bearing is not serviceable. When replacing the six piece bearing with the two piece bearing, the center main bearing cap and the crankcase must be modified to provide the specified fit. (Refer to par. 4.)

CAUTION: Be careful to assure perfect cleanliness of the crankcase, crankshaft and bearings after service has been completed. Whenever possible, the crankshaft should be removed when new bearings are being installed in order to clean the crankcase thoroughly. All bearing surfaces must be free of grit and burrs. Small particles of dust and dirt left between the crankshaft and bearings will cause rapid wear and scoring of the crankshaft journal and insert. Any foreign material left between the bearings and the crankcase and bearing caps will cause distortion of the bearing and a reduction in operating bearing clearance. The frictional heat thus produced will cause the bearing material to melt away from the steel back of the bearing at that point. Such melted material will create further hot spots until complete bearing failure takes place. Anything that interferes with the operating clearance of any bearing or the proper heat dissipation has its effect upon bearing life. Cleanliness cannot be overstressed.

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 centers on the pistons.

The flywheel is secured to the end of the crankshaft with bolts and locks. Dowels are provided as an aid to installation. One bolt is offset in order to prevent the flywheel installation in any other position with regard to its balanced point. The cranking motor drive ring gear is a shrink fit and is replaceable. (See "Parts Catalog.")

CRANKSHAFT AND MAIN BEARINGS

2. REMOVAL

Crankshaft Bearings

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

2. Remove the spark plugs and set the engine controls for gasoline operation to lower the compression ratio and to make it easier to crank the engine.

3. Remove the dust seal, gasket, oil seal retainer plate with gasket and oil seal retainer felt plugs, located at the rear underside of the crankcase.

4. Remove the crankshaft bearing caps by removing the cotters from the nuts which secure them. Tap the caps lightly with a soft metal hammer or mallet if they tend to bind on the

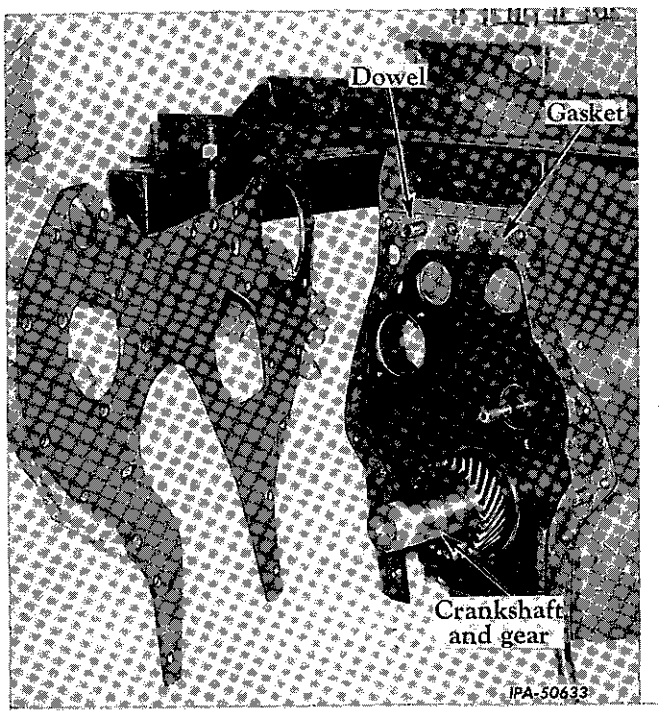
(Continued on next page.)

CRANKSHAFT AND MAIN BEARINGS

2. REMOVAL - Continued

Crankshaft Bearings - Continued

studs. Remove them squarely from the studs. If the bearings are to be reassembled, be certain that they are identified as to their original positions. Remove the lower bearing from the caps. If the center main bearing is of the 6-piece type, remove the thrust washers also. Wrap the pieces in a clean cloth and store until reassembly.



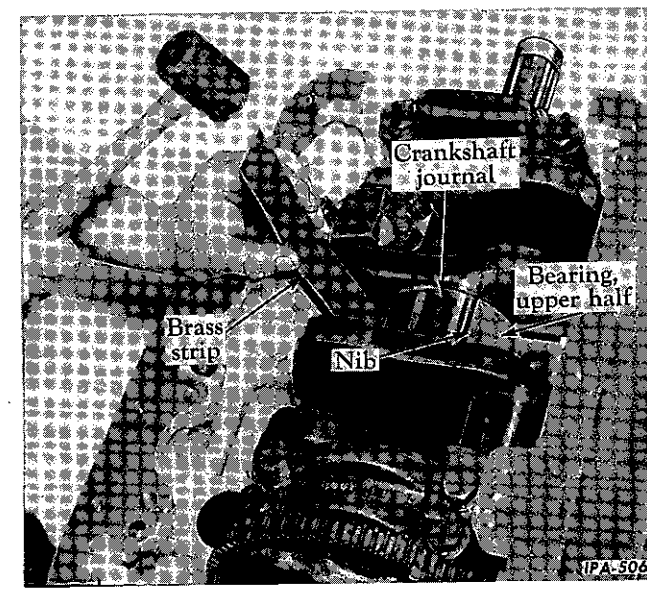
Illust. 1 - Removing Crankcase Front Plate.

NOTE: If the crankshaft is to be removed, disregard steps 5 and 6.

5. Remove the upper bearing halves from between the crankshaft and the crankcase by using a thin piece of flexible soft metal to push against the end of the bearing farthest from the nib holding the bearing in the crankcase support. At the same time turn the crankshaft in the direction of rotation. The bearing will slide easily from position (Illust. 2).

An alternate method of removing the upper halves of the bearings is to hammer the closed end of a small cotter to form a "T" and then insert the prongs of the cotter into the oil hole of the crankshaft journal with the flattened head just protruding. Rotate the crankshaft and the cotter head will push the bearing from position.

6. With the 6-piece bearing, push the separate thrust washer upper halves from the crankcase.



Illust. 2 - Removing Upper Half of Crankshaft Bearing.

Crankshaft

7. Remove the flywheel. (Refer to par. 6.)

8. Remove the engine rear support from the crankcase.

9. Remove the crankshaft rear upper and lower oil seal retainers (Illust. 3).

NOTE: Later model engines in the TD-6, TD-9, UD-350 and UD-370 diesel series, are equipped with split crankshaft rear oil seals of synthetic rubber and gray iron oil seal retainers. The oil return groove on the crankshaft has been eliminated. Whenever the service package is used for older type crankshafts, round the edges of the oil groove with a stone so that no sharp edges remain. This will insure proper life of the seal after installation. Fill the groove of the seal with grease before assembling on the crankshaft.

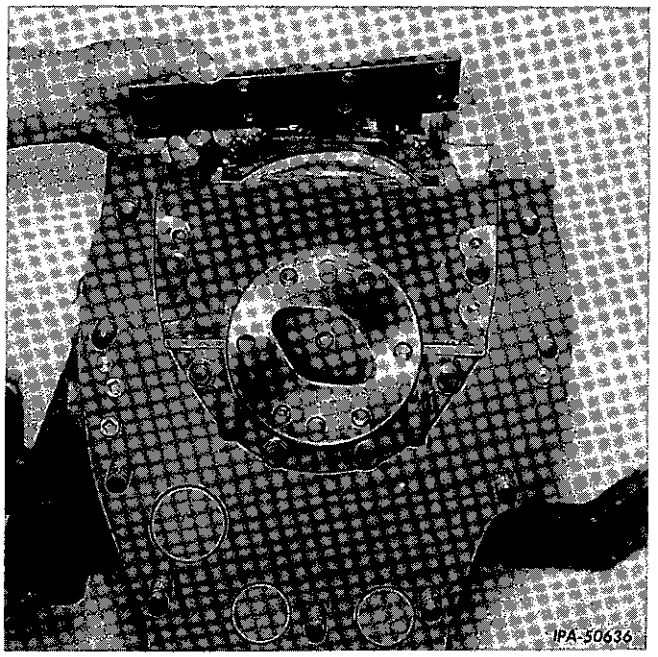
10. Remove the front cover assembly. (Refer to Section 6.)

11. Remove the connecting rod bearing caps and push the pistons and connecting rods to the top of their travel.

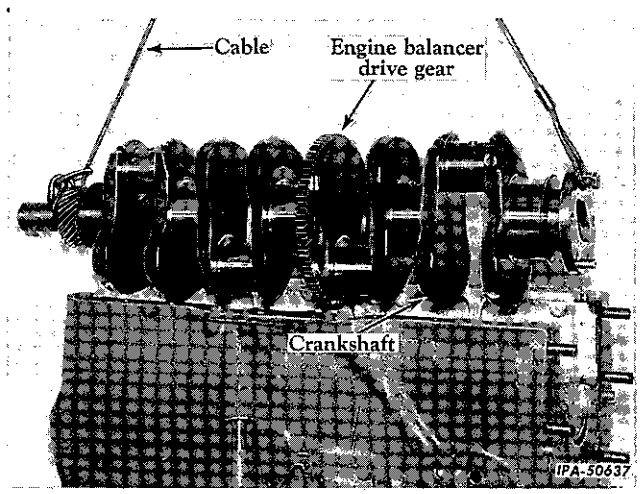
PRINTED IN UNITED STATES OF AMERICA

CRANKSHAFT AND MAIN BEARINGS

12. Lift the crankshaft out of the crankcase (Illust. 4).



Illust. 3 - Removing Crankshaft Rear Oil Seal Retainer.



Illust. 4 - Lifting Crankshaft from Crankcase.

3. INSPECTION AND REPAIR

1. Clean all parts with cleaning solvent, dry with compressed air and inspect the bearings for wear and evidence of uneven bearing support. If such evidence is present, examine the bearing caps and supporting surfaces of the crankcase for high spots and burrs.

2. Inspect the crankshaft journals for scoring and measure the diameter of each journal using a micrometer. Check the dimensions obtained against those specified in "SPECIFICATIONS" in Section 1. Measure each journal at two points, one at right angles to the other, in order to show any tendency of out-of-round. Move the micrometer over the entire width of the journal.

3. Inspect the crankshaft gear teeth for wear and chipping. If necessary to replace it, pull the gear from position.

CAUTION: When installing the crankshaft gear (especially in the field), extensive damage can be caused if the gear is allowed to become cocked on the crankshaft. This applies to the straight bore crankshaft gears. It is suggested to heat the gear, not in excess of 250° F, to facilitate assembly and reduce the possibility of galling the inside bore of the gear.

4. Inspect the crankcase for sludge deposits, especially in the corners. The crankcase should be thoroughly cleaned and inspected.

5. Replace the front and rear seals with new.

6. Inspect the crankshaft ring gear for broken teeth or other damage. If necessary to replace it, place the crankshaft in a lathe and remove the four welds by a turning operation or by using a small grinder and grinding off the four welds. Whichever way is used, remove only the weld area as shown in Illust. 5. (The depth is approximately 1/8 inch and 1/2 inch wide.)

NOTE: Removal of the gear can be facilitated by an application of torch heat on the outer circumference of gear only.

7. When ready to install the new ring gear on the crankshaft, heat the new ring gear to 200° F. before assembly, being sure to assemble with the chamfer teeth toward the front of the crankshaft.

8. Weld the ring gear to the crankshaft at the four places of the weld shown in the welding diagram 1/2 inch wide, and be sure the weld does not project above the finish surface of the crankshaft. Refer to Illust. 5 for detailed diagram.

CRANKSHAFT AND MAIN BEARINGS

4. INSTALLATION

Checking the Crankcase

Prior to crankshaft installation, check the crankcase for trueness, using the crankshaft as follows:

1. Wipe the bearing supports of the crankcase free of oil with a lint-free clean cloth. The crankcase should be bottom side up and levelly supported with blocks.

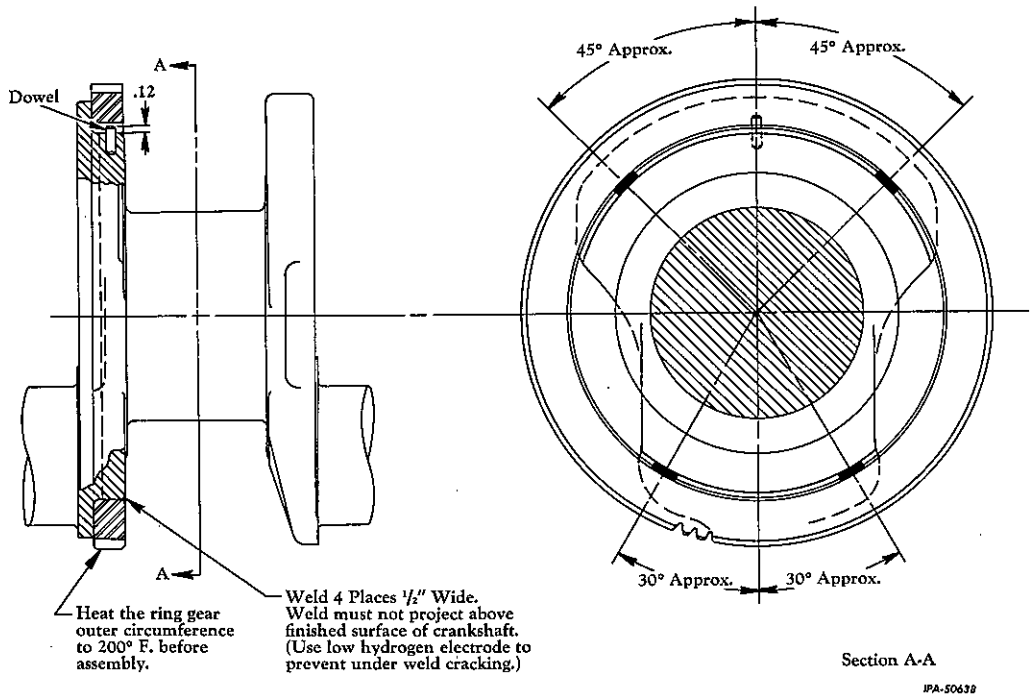
2. Install the upper halves of the bearings to the crankcase. If the original bearings are being reinstalled, be sure that they go to the positions from which they came. The nibs of the bearings must fit into the notches in the crankcase bearing supports.

3. Brush some blueing on the crankshaft main journals and lower it carefully and evenly onto the bearings. Do not install the bearing caps and lower bearings.

4. Rotate the crankshaft back and forth through approximately 1/2 revolution. Remove the crankshaft evenly and inspect the upper bearings for an even transfer of blueing from the journals to the bearings. The bearings that do not show an all-over even blueing should be replaced with new. It is advisable to replace all bearings with new if one of the originally used bearings has to be replaced. Bearings, crankshaft journals and the parts of the crankcase supporting the upper bearing must be free from oil when the test is carried out.

Installing the Crankshaft

1. When satisfied that the crankcase is in good order, free from any distortion and free of any burrs around the upper bearing seats, continue to install the crankshaft. Clean all blueing from the bearings and crankshaft journals. After coating the bearing surface only with a small amount of clean engine oil, install the upper bearing halves and thrust washers. Install the crankshaft in place carefully.



Illust. 5 - Crankshaft Ring Gear Welding Diagram.

PRINTED IN UNITED STATES OF AMERICA

CRANKSHAFT AND MAIN BEARINGS

CENTER MAIN BEARING

2. The 2-piece center main bearing consists of the upper and lower halves. Some engines are equipped with the old type 6-piece bearings. The 6-piece bearings are not serviceable. When the 6-piece bearing is to be replaced with the 2-piece flanged type bearing, it will be necessary to modify the crankcase and center main bearing cap as follows:

Chamfer the edges of the crankcase upper center main bearing seat as shown in Illust. 6. Also chamfer the front and rear edges of the center main bearing cap. The amount of chamfer is 3/32 inch x 45 degrees.

NOTE: Be certain that no burrs or metal particles remain on the parts if modified.

3. Install the lower main bearings and bearing caps and torque the stud nuts to the amount specified in "SPECIFICATIONS" in Section 1. It is important that the identification number stamped on the main bearing cap be installed toward the camshaft side of the crankcase.

Do not install the cotters, as it is necessary to check the clearance between the crankcase journals and the main bearings using .015 inch virgin lead wire or Plastigage, as described below.

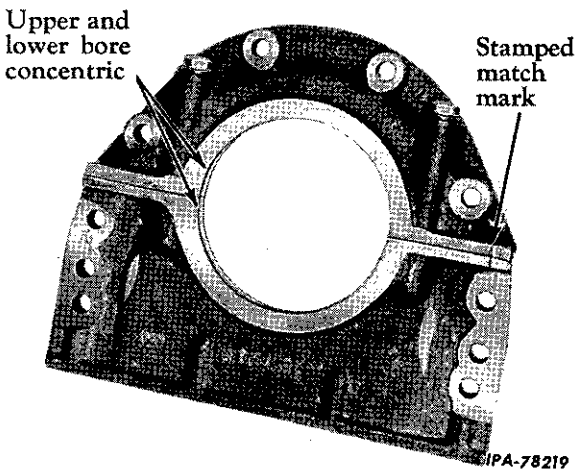
4. Pull the connecting rods down onto the crankshaft. Be sure that the bearings are in place. Install the connecting rod bearings and bearing caps, being sure that in each case the correct cap is located on its rod. Oil the bearings with clean engine oil. Torque the connecting rod stud nuts as specified in "SPECIFICATIONS" in Section 1.

COUNTERBALANCED CRANKSHAFTS

5. TD-9 (91 Series), UD-350 and UD-370 Power Units (See Illust. 6): Some oil seal retainers have match marks stamped on the outer edge for alignment purposes. When the retainers are installed on the engine, these marks must be aligned to assure concentricity of the oil seal. If the retainers do not have match marks, proceed as follows:

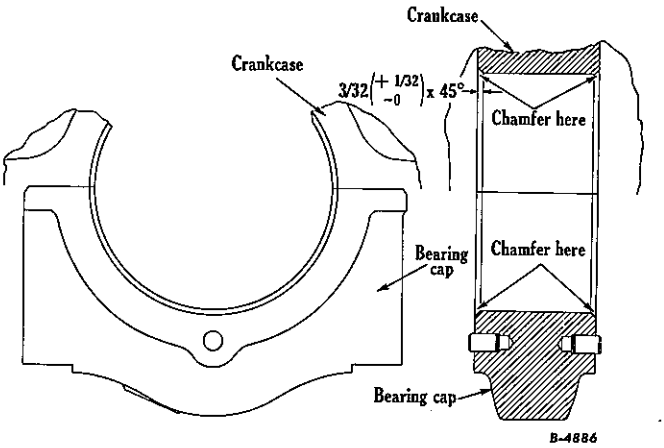
(a) Assemble the retainer halves off the engine making sure the bores are concentric. With the retainers aligned, stamp a match mark with a cold chisel (Illust. 6.) Separate the two retainers.

(b) Install the oil seals in the retainers, then proceed with step 7.



Illust. 6 - Oil Seal Retainers Aligned Concentrically.

6. NOT 350 OR 370 SERIES ENGINES: Install the crankshaft rear oil seal upper and lower retainers by placing new oil-soaked felts in the upper and lower retainers. The new felts should be assembled into the grooves of the crankshaft rear oil seal retainer so that the same amount of felt extends above the split line on each side. No pressing or trimming of felts is necessary. (Illust. 3.)



Illust. 7 - Crankcase and Center Main Bearing Cap Modifying Diagram. (To Fit Two Piece Flange Type Bearing in Place of Six Piece Bearing.)

The modifying diagram (Illust. 7) can be used in field replacement of a six piece center main bearing by a two piece flanged bearing. Modify the crankcase and center bearing cap as shown, except in case these parts are already properly chamfered.

(Continued on next page.)

CRANKSHAFT AND MAIN BEARINGS

4. INSTALLATION - Continued

Installing the Crankshaft - Continued

COUNTERBALANCED CRANKSHAFTS - Continued

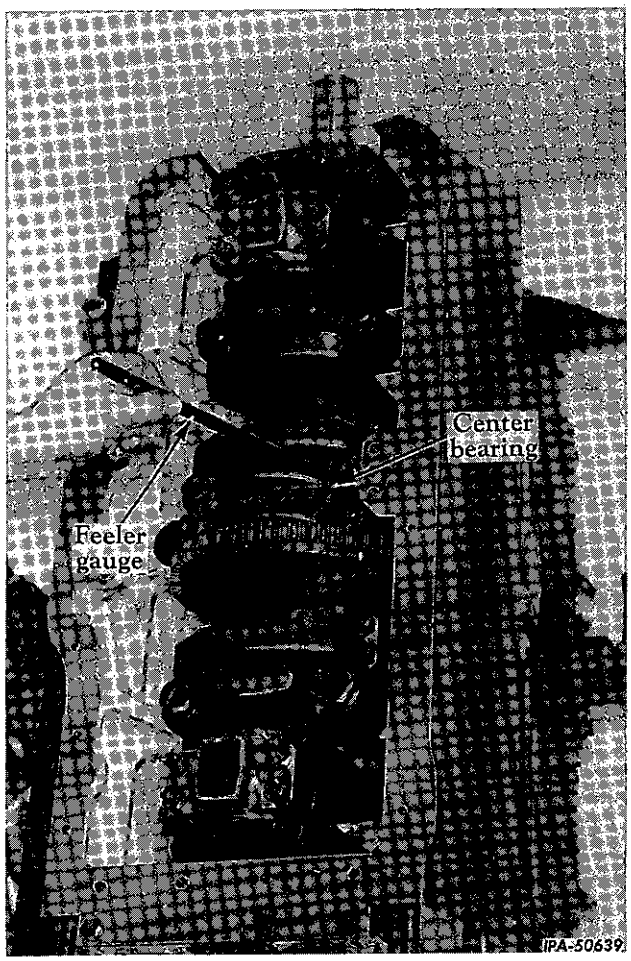
NOTE: Certain crankcases and center bearing caps were originally chamfered 3/32 inch x 45 degrees and do not require modification before installing a two piece flanged bearing.

7. Attach the upper and lower seal retainers to the crankcase but do not tighten the retainer cap screws until those which secure the two halves of the retainer have been tightened. Use new gaskets between retainers.

8. Install the rear engine support to the crankcase. Install the flywheel and bend the locks over the retaining cap screws. (Refer to par. 8.)

9. Check the end thrust present in the crankshaft by inserting a feeler gauge equal to the amount specified in "SPECIFICATIONS" in Section 1 and as shown in Illust. 8. Should the clearance present be less than the amount specified, remove the center main bearing and rub off material evenly from the thrust washer surface. Should the clearance be more than specified, replace the center main bearing with a new one.

10. Remove the center main bearing cap and the lower bearing. If virgin lead wire is to be used to check bearing clearance, wipe the bearing clean and oil the crankshaft journal. If "Plastigage" is to be used, wipe the bearing surface and exposed half of the crankshaft journal free of oil, as the plastic material is soluable in oil.



Illust. 8 - Checking End Clearance of Crankshaft.

Place a suitable length of .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 specified torque (See

Engine Model	A	B	C	D	E - All Main Bearings	F - All Crank Pin Bearings
TD-6, TD-6(61), UD-264 and UD-281-4	3.7175-3.7185	3.2175-3.2185	2.261-2.263	15.177-15.197	.150-.165	.110-.130
TD-9, TD-9(91), UD-350, UD-370						
Counterbalanced	4.0925-4.0935	2.7175-2.7185	2.763-2.765	16.927-16.949	.150-.165	.110-.130
Non-counterbal.	4.0925-4.0935	3.5925-3.5935	2.761-2.763	16.933-16.953	.150-.165	.110-.130

PRINTED IN UNITED STATES OF AMERICA

CRANKSHAFT AND MAIN BEARINGS

"SPECIFICATIONS" in Section 1). Then remove the nuts or cap screws and bearing cap. If virgin lead wire was used, carefully remove the lead wire which will have been crushed to the amount of clearance present. Measure the wire using a micrometer. If "Plastigage" was used, the flattened piece of plastic will be found adhering to either the bearing or crankshaft. 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 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. 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 parts catalog and Illust. 9.) Bearings are available in .002 inch, .010 inch, .020 inch, and .030 inch undersize. A chart following Illust. 8 shows the maximum dimensions to which the crankshaft journals may be ground. DO NOT GRIND BEYOND THESE LIMITS. If the results obtained were within the specified amount, add clean engine oil to the bearing and install the center main bearing cap. Torque the nuts to the amount specified and install the cotters.

NOTE: DO NOT TURN THE CRANKSHAFT DURING THE PREVIOUS PROCEDURE.

11. Continue checking the other main bearings in the same manner. Check the rear main next, followed by the front main and then the intermediates.

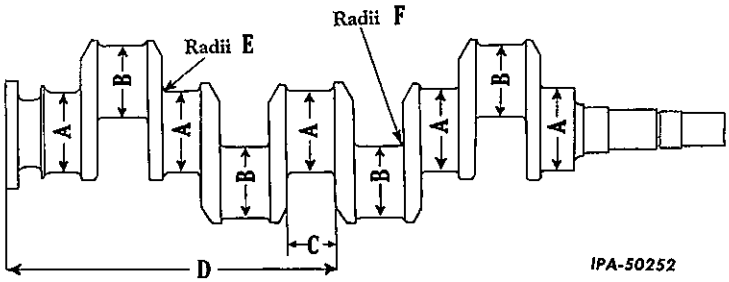
12. Install the rear oil seal retainer plate gasket, felt plugs and plate to the rear of the crankcase. Attach the dust seal and gasket to the retainer plate and rear engine support (Illust. 3).

13. Install the crankcase front cover. (Refer to Section 6.) Check to be sure that timing gears line up properly.

14. Install the oil pump and oil pan. (Refer to Section 4.)

15. Add clean engine oil of the specified grade to the crankcase. Check the water and start the engine. Observe the engine oil pressure and the engine operating temperature. During engine-run-in periods, after service has been completed for the replacement of main bearings and crankshaft, it is advisable to give the engine an initial run of five hours under light load. At the end of this short run-in period, drain the oil while the engine is hot. Inspect and, if necessary, replace the oil filter elements. Then refill with oil as specified in the operator's manual. This procedure will shorten the period for complete run-in of new parts.

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.



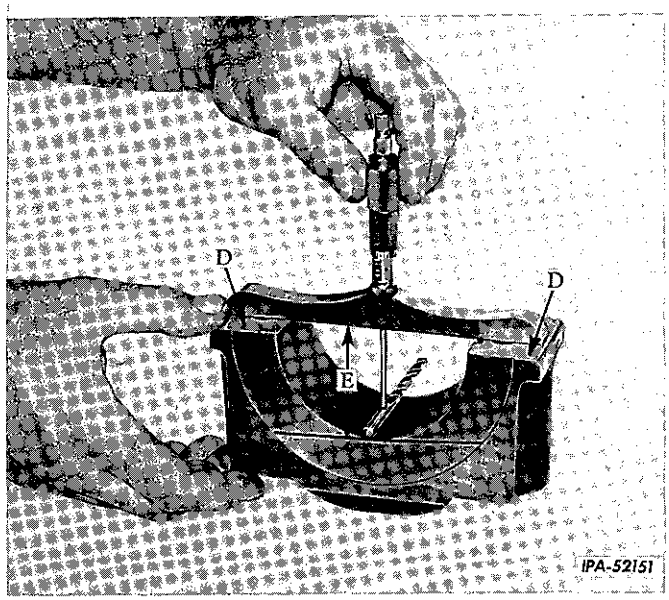
Illust. 9 - Limits for .030 Inch Undersize Crankshaft.

CRANKSHAFT AND MAIN BEARINGS

5. CRANKSHAFT BEARING CAPS (TD-6, 6 (61), UD-264 and UD-281-4 ONLY)

Crankshaft main bearing caps are rough machined and line reamed while fitted to the crankcase. This results in each cap being fitted only for its respective position. Therefore, a main bearing cap furnished as a regular service part needs line reaming to fit the particular bore where it is intended to mate.

Accidents do occur occasionally and in many cases it is undersirable to scrap a crankcase if only the bearing cap needs replacement. A main bearing cap, machined in the rough for such emergency cases, is available and can be obtained as specified in the parts catalog. However, it is necessary to have facilities available to line ream the bore for the finishing operation. Refer to "SPECIFICATIONS" Section 1 for dimensions of main bearing bore in crankcase.



Illust. 10 - Measuring Dimension "E."

6. FITTING CRANKSHAFT BEARING CAPS (Machine Method) (For TD-9, 9 (91), UD-350 and UD-370)

Replacement main bearing caps of nodular iron are available for service. The bore of these caps is finish machined, which eliminates the need of line boring after installation. However, the face and sides of the caps must be modified to the dimensions of the old cap to assure a perfect fit in the crankcase. Enough material has been left on the face and sides of the caps to allow for this modification. Following are detailed instructions for modifying the caps.

1. Place a drill rod or new drill of any size from 1/4 to 1/2 inch in the bore of the old caps. Measure the distance from the face of the cap to the drill rod or shank of the drill with a depth gauge (Illust.10), and record the reading.

Measure the diameter of the drill rod or drill shank with a micrometer and add this reading to the one taken with the depth gauge. This will be dimension "E."

2. Mill or grind surface "D" (Illust. 10)of the new cap to dimension "E" plus .002 inch.

NOTE: .002 inch is added to dimension "E" to allow enough stock for a finish cut on surface "D" after the cap and bearing have been fitted to the crankcase.

NOTE: The bearing cap must be located on its machined side when milling or grinding surface "D" to hold squareness.

3. Clamp the old bearing cap to a surface plate.

4. Place a drill rod or new drill of any size from 1/4 to 1/2 inch on the inside of the cap (against notched side). Measure dimension "A" with a micrometer as shown in Illust. 11 and record the reading.

5. Measure dimension "A" of the new cap in the same manner and record the reading.

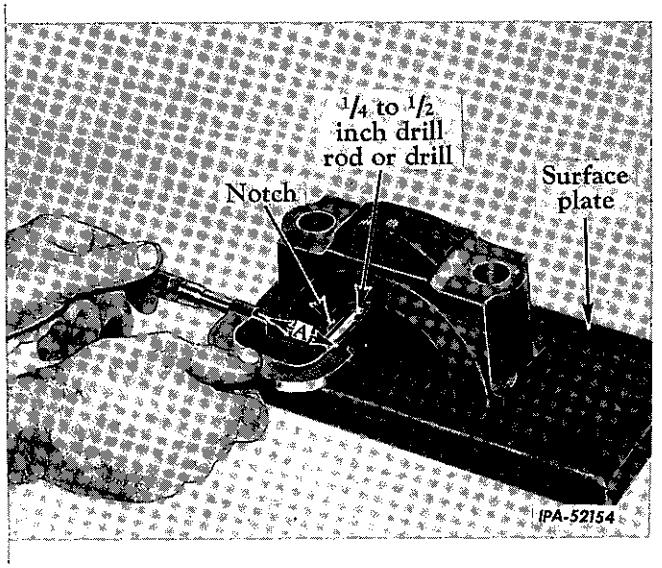
6. Subtract dimension "A" of the old cap from dimension "A" of the new cap and record the difference. Mill or grind this amount from surface "C" (Illust. 12) of the new cap. Dimension "A" of both caps will now be equal.

NOTE: Surface "C" must be held square with surface "D" (Illust. 10) and parallel to the bearing bore.

PRINTED IN UNITED STATES OF AMERICA

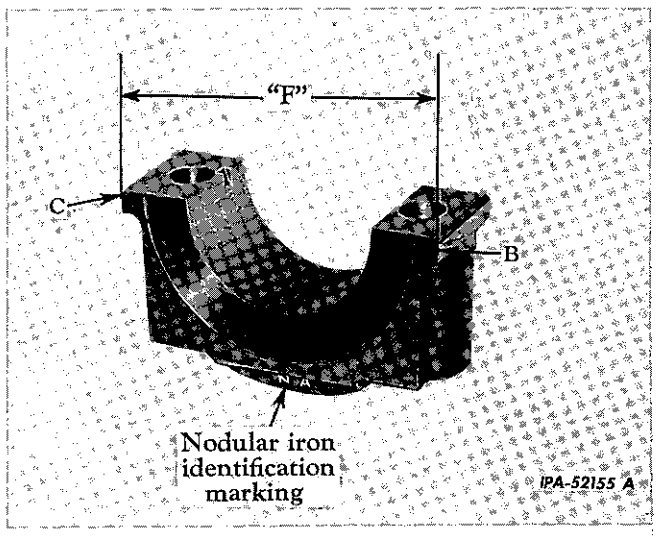
CRANKSHAFT AND MAIN BEARINGS

7. Mill or grind surface "B" (Illust. 12) of the new cap until the dimension "F" or 7.125-7.126 inch, shown from surface "C" to "B" in Illust. 12 is obtained.



Illust. 11 - Measuring Dimension "A."

NOTE: Surface "B" must be held square with surface "D" and parallel to the bearing bore.



Illust. 12 - Bearing Cap Finish Length.

Obtaining Finish Dimension "E" with Virgin Lead

8. Install a new bearing in the new bearing cap. Place a length of virgin lead or Plastigage across the bearing (Illust. 13).

9. Install the new bearing and bearing cap and tighten to the torque specified in "SPECIFICATIONS" in Section 1.

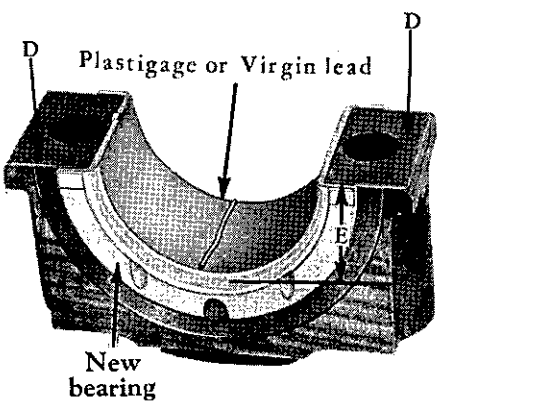
10. Remove the bearing cap and measure the virgin lead with a micrometer and record the reading. If Plastigage was used, follow instructions outlined in par. 4, "INSTALLATION" and record the reading.

11. Measure the diameter of the crankshaft journal and record this reading. If it is less than the main bearing journal size given in "SPECIFICATIONS" in Section 1 for new crankshafts, subtract the difference from the virgin lead or Plastigage reading.

12. Subtract the bearing running clearance as given in "SPECIFICATIONS" in Section 1, from the measurement obtained in step 11. Mill or grind this amount from surface "D" of the new bearing cap.

NOTE: Surface "D" must be held square with the bearing cap bore.

13. Recheck the bearing running clearance with virgin lead or Plastigage. The correct clearance is given in "SPECIFICATIONS", Section 1.



Illust. 13 - Position of Virgin Lead.

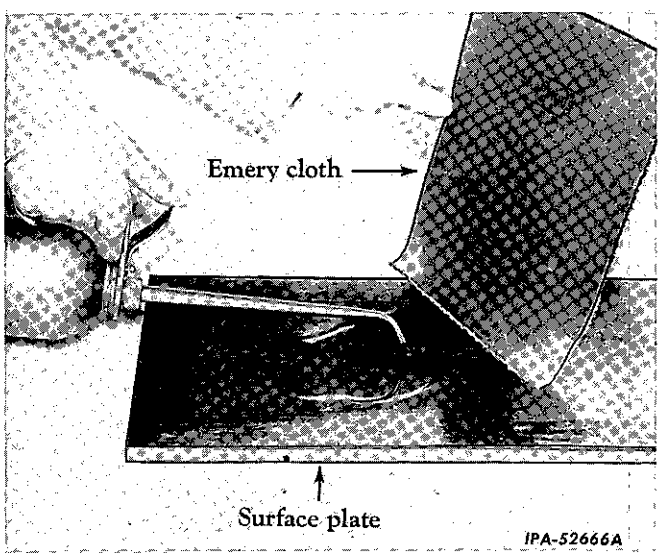
CRANKSHAFT AND MAIN BEARINGS

7. FITTING CRANKSHAFT BEARING CAPS (Hand Method)

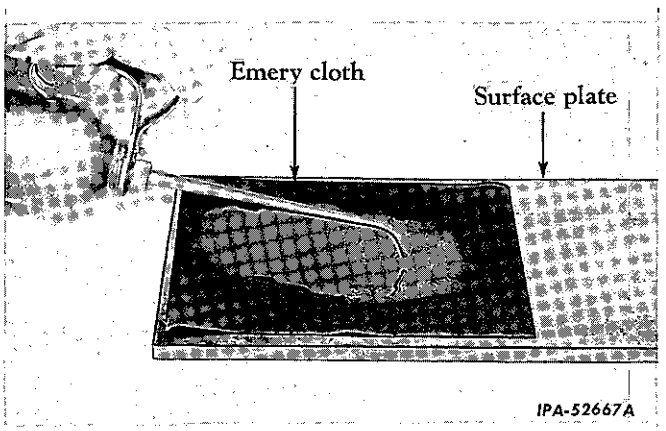
In the absence of machining or grinding facilities, nodular iron crankshaft bearing caps can be fitted satisfactorily using materials commonly available in the field as follows:

1. Place the new and old bearing cap in a vise. Surface "D" (Illust.10) must be level so the drill rod is in the center of the bearing cap.

2. Place a drill rod or new drill of any size from 1/4 to 1/2 inch in the bore of the new and old caps. Measure the distance from the face of the cap to the drill rod or shank of the drill with a depth gauge (Starrett 440-D is shown in Illust.10), or any similar depth gauge and record the reading.



Illust. 14 - Oiling Surface Plate.

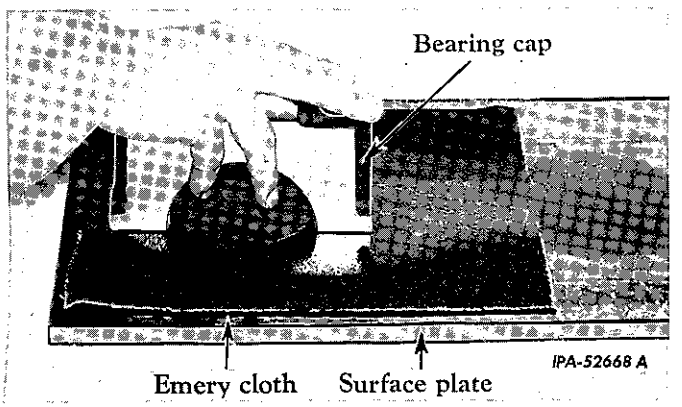


Illust. 15 - Oiling Emery Cloth.

Measure the diameter of the drill rod or drill shank with a micrometer and add this reading to the one taken with the depth gauge. This will be dimension "E" (Illust.10).

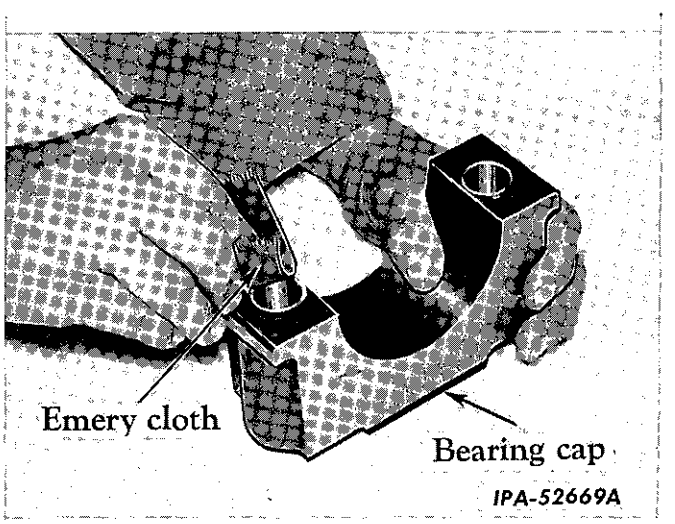
3. To remove stock from surface "D" quickly and accurately use a smooth metal or glass surface plate, extra coarse emery cloth (No. 430 grit) and heavy duty engine oil.

4. Oil the surface of the plate (Illust. 14) to keep the emery cloth from wrinkling and sliding.



Illust. 16 - Working Surface "D."

5. Oil the emery cloth (Illust. 15) to speed cutting and to carry cuttings away from the face of the bearing cap. ("Rule of thumb" for cutting speed is .001 inch per 100 strokes.)



Illust. 17 - Removing High Spots.

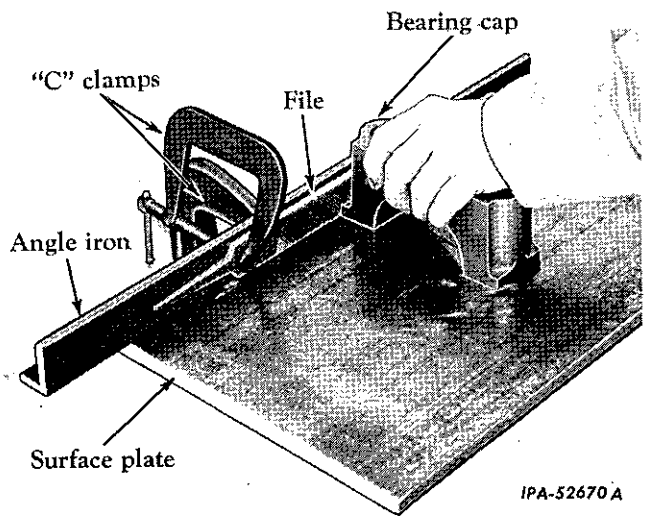
PRINTED IN UNITED STATES OF AMERICA

CRANKSHAFT AND MAIN BEARINGS

6. Place the bearing cap on the emery cloth and with hand pressure, move the cap back and forth (Illust. 16). Turn the cap after every 50 strokes to equalize the cutting width of surface "D."

7. With a fine file or fine emery cloth, remove the slight high spot immediately around the holes of the bearing cap (Illust. 17). (Usually about .0005 inch.)

8. Clamp the old bearing cap to a surface plate.



Illust. 18 - Working Surface "B" and "C."

9. Place a drill rod or new drill of any size from 1/4 to 1/2 inch on the inside of the old cap (against notched side). Measure dimension "A" with a micrometer as shown in Illust. 11 and record the reading.

10. Measure dimension "A" of the new cap in the same manner and record the reading.

11. Subtract dimension "A" of the old cap from dimension "A" of the new cap and record the difference.

12. Clamp an angle iron to the surface plate, then clamp a file to the angle iron (Illust. 18).

13. File from surface "C" (Illust. 12) of the new cap. Dimension "A" of the new and old caps will now be equal.

NOTE: Surface "C" must be held square with surface "D" and parallel to the bearing bore.

14. File surface "B" (Illust. 12) of the new cap until the dimension "F" (7.125-7.126)" shown from surface "C" to "B" in Illust. 12, is obtained. Refer to "SPECIFICATIONS" in Section 1 for dimension "F".

NOTE: Surface "B" must be held square with surface "D" and parallel to the bearing bore.

15. Install a new bearing in the new bearing cap. Place a length of virgin lead wire or Plastigage (Illust. 13) in the usual way in bottom of bearing.

16. Install the new bearing and bearing cap and tighten the nut to specified torque as given in "SPECIFICATIONS" in Section 1.

17. Remove the bearing cap and measure the virgin lead or Plastigage.

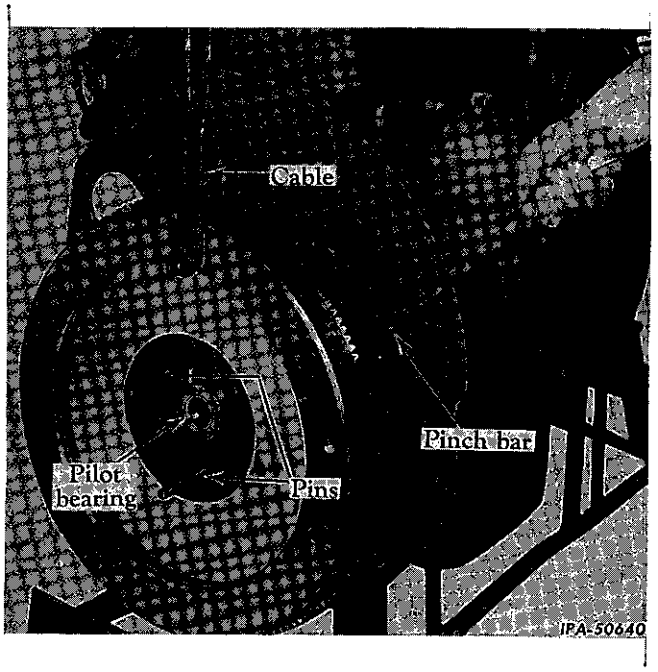
This measurement must be within limits as given in "SPECIFICATIONS," Section 1. If this measurement has not been obtained, repeat steps 6 and 7.

FLYWHEEL

8. REMOVAL

1. Bend back the locks from the bolt heads which hold the flywheel to the crankshaft and remove the bolts and locks.

2. Insert two cap screws into the tapped holes in the flywheel. Then tighten the cap screws evenly until the flywheel has been pulled from the crankshaft (Illust. 19.)



Illust. 19 - Removing Flywheel from Crankshaft.

9. INSPECTION AND REPAIR

1. Wash the flywheel and ring gear in dry-cleaning solvent.

2. Inspect the contact face on the flywheel for heat checks and scoring. If it is not in serviceable condition, replace the flywheel. Drive the dowel pins flush with the face of the flywheel.

3. Inspect the ring gear for broken teeth and replace the ring gear if necessary. To remove the ring gear from the flywheel, either heat the gear with a torch (to expand it) then driving it from the flywheel, or drive the ring gear off the flywheel by using a hammer and punch around the outer edges of the gear.

4. Install a new ring gear by first heating the gear to expand it and then placing it onto the flywheel while the ring gear is hot. The chamfered edge of the gear teeth must be toward the edge of the flywheel.

5. Remove the pilot bearing from the flywheel. Clean the bearing in dry-cleaning solvent and inspect it for wear and damage. If in serviceable condition, lubricate the bearing with engine lubricating oil and install it into the flywheel. If the bearing has had considerable service, it must be replaced.

Replacing the Flywheel Housing

When replacing the flywheel housing, it is suggested that the flywheel bore and face be checked relative to the crankshaft to establish proper alignment between the engine, clutch and/or converter. Misalignment between the flywheel housing and engine will cause corresponding misalignment of the clutch and transmission, resulting in damage to the clutch plates or pilot bearing and transmission main drive gear or main drive gear pilot bearing. The dowel pins between the crankcase and flywheel housing are for the purpose of maintaining this alignment, once the flywheel is mounted within tolerances.

NOTE: The mating surfaces of the crankcase and housing must be inspected and free from foreign material, burrs, ridges from nicks, thread pullout, etc. These surfaces must be flat and without assembly projections within the assembly area. Failure to clean mating surfaces will result in excessive face run-out.

6. Place the flywheel housing over the two flywheel housing-to-crankcase dowels and tap into place with a soft hammer.

7. Install the bolts and lock washers and secure the housing.

8. Check the concentricity of the housing bore and the squareness of the face with the crankshaft as described below. (See "SPECIFICATIONS", Section 1 for the proper tolerances.) If the concentricity is not within specifications, remove the housing and continue with the next step.

9. Remove the dowels from the crankcase.

10. Assemble the housing to the crankcase. Do not tighten the bolts to full torque. Just run the bolts down snug for housing adjustment.

11. Position the housing to meet the tolerances given in "SPECIFICATIONS" in Section 1.

12. Tighten all the bolts to full torque. Recheck the flange tolerances and reposition the housing if necessary.

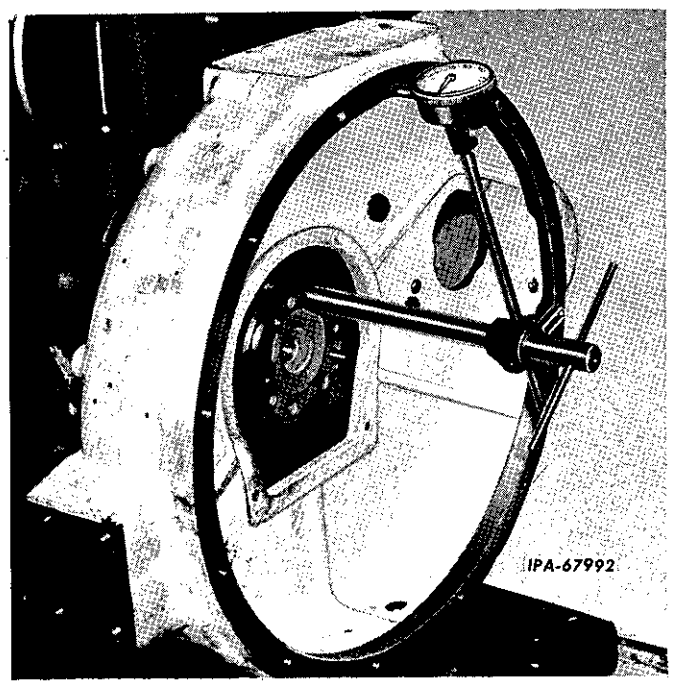
PRINTED IN UNITED STATES OF AMERICA

FLYWHEEL

13. Ream the dowel holes for oversize dowels and install oversize dowels.

Checking Flywheel Housing Face Run-out.

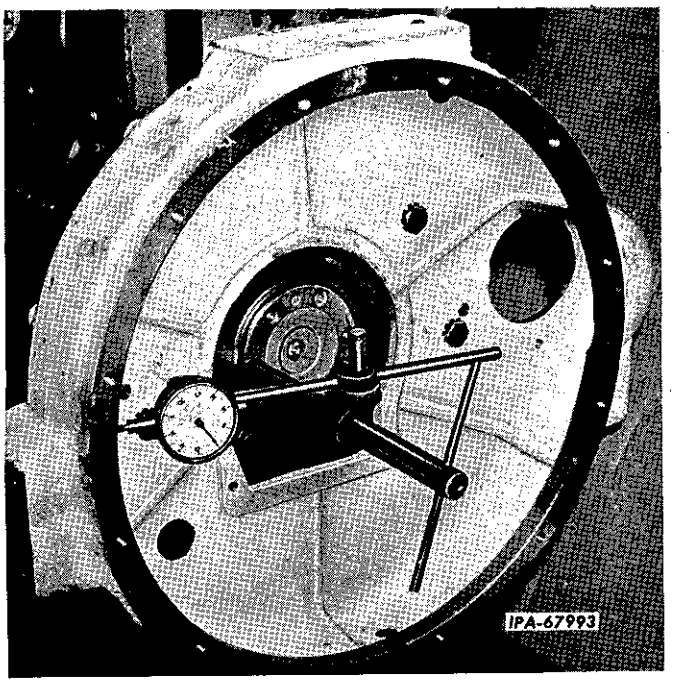
To check the run-out of the flywheel housing face, attach a dial indicator to the crankshaft flange placing the indicator pointer against the flywheel housing face. Remove crankshaft "end-play" and note reading. Check at four points 90 degrees apart for total face variation. Keep crankshaft "end-play" at zero in the same direction for all readings. (Refer to Illust. 20.) For allowable housing face run-out tolerance refer to "SPECIFICATIONS", Section 1.



Illust. 20 - Checking Run-out Of Flywheel Housing Face in Relation To The Axis Of The Crankshaft.

Checking Flywheel Housing Bore Concentricity

To check the concentricity of the flywheel bore relative to the crankshaft axis, attach a dial indicator to the crankshaft placing the indicator pointer against the flywheel housing bore as shown in Illust. 21. Rotate the crankshaft slowly and note total indicator reading variation. For allowable housing bore concentricity tolerance refer to "SPECIFICATIONS", Section 1.



Illust. 21 - Checking the Concentricity of The Flywheel Housing Bore in Relation To The Axis Of The Crankshaft.

10. INSTALLATION

1. Place the flywheel in position on the crankshaft flange so that the bolt and dowel pin holes line up.

2. Place the bolt locks on the bolts and install them in the flywheel and crankshaft flange. Do not tighten the bolts.

3. Drive the two dowel pins into place and torque the bolts to the specifications given in "SPECIFICATIONS," in Section 1. Lock the bolts.

4. Lubricate and install the pilot bearing.

PRINTED IN UNITED STATES OF AMERICA

1. DESCRIPTION

The starting mechanism consists of the parts which change the engine from gasoline to diesel or from diesel to gasoline operation. The starting mechanism cross shaft passes through the crankcase. This shaft is connected on the left side of the crankcase to the compression release lever and on the right side to the rods which operate the starting valve shaft, the carburetor fuel shut-off cam and the ignition system grounding switch.

The engine is temporarily converted into a gasoline engine during the starting process and, after operating for approximately 1 to 3 minutes, is switched to diesel operation. This method is positive regardless of weather conditions or temperature. When the starting lever is placed in the gasoline starting position, the following four operations are accomplished;

1. The starting valves in the cylinder head are opened, thus enlarging the combustion chambers and reducing the compression ratio to that of a gasoline engine.

2. The diesel air passage from the air cleaner to the intake ports is closed and the carburetor outlet passage above the carburetor is opened. This permits air to pass from the air cleaner into the carburetor and the flow of a mixture of air and gasoline into the cylinders.

3. The shut-off valve in the fuel bowl is released, permitting the needle valve to be actuated by the float.

4. The magneto or distributor is placed into operation by closing the primary circuit in the manifold, thus permitting a flow of current to the spark plugs.

2. REMOVAL

For removal of the starting valve shaft, the starting valve operating shaft and the starting valves, refer to Section 2.

Remove the cross shaft as follows:

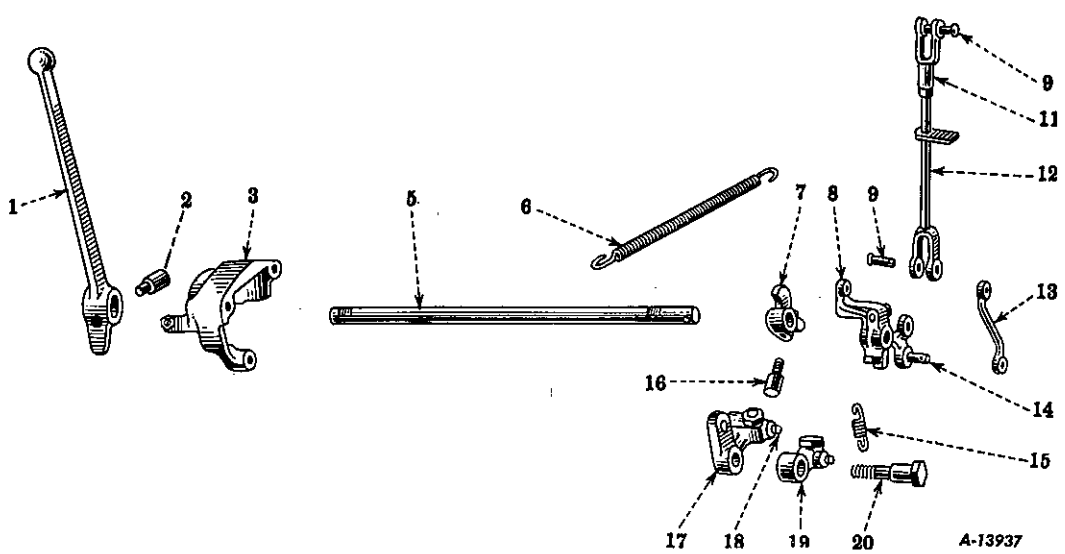
1. Remove the carburetor. (Refer to Section 10.)

2. Remove the compression release rod adjusting block from the operating lever (1, Illust. 1).

3. Remove the pin (2) from the operating lever and remove the lever from the shaft (5).

4. On the opposite side of the engine, remove spring (6) from the stud in the crankcase and the cross shaft jaw (8).

(Continued on next page.)



Illust. 1 - Exploded View of Starting Mechanism.

1. Lever.
2. Pin.
3. Bracket.
5. Shaft.
6. Spring.
7. Lever.
8. Jaw.
9. Pin.
11. Yoke.
12. Rod.
13. Link.
14. Pin.
15. Spring.
16. Pin.
17. Bracket.
18. Pin.
19. Latch.
20. Pin.

2. REMOVAL - Continued

5. Disconnect the yoke at the lower end of rod (12) from the jaw. Slide the shaft with jaw lever (7) out of the crankcase.

6. Take out latch pin (20), remove the spring (15) and remove the latch (19).

7. Remove the nut from the stud in the crankcase which holds latch bracket (17) to the crankcase and remove the bracket.

3. INSPECTION AND REPAIR

Clean all parts thoroughly with dry-cleaning solvent and dry them with compressed air. If any parts show wear to the extent that the latches and jaws will not hold, replace the worn parts. The cross shaft rotates in two bushings in the crankcase. Do not disturb the set screws unless the part in which they are located must be replaced.

4. INSTALLATION

1. Install the cross shaft (5, Illust. 1) through the crankcase. The cross shaft assembly must be packed with a good high melting point short-fibre or wheel bearing grease. Ordinary greases will run out at high operating temperatures, producing oil spots on the side of the crankcase which collect dirt.

2. Install the latch bracket (17) in the right side of the crankcase.

3. Install the latch (19) to the bracket with the latch bolt (20).

4. Install the spring (15) on the pins in the bracket and latch.

5. Install the jaw lever (7) and the jaw (8) on the shaft (5) through the crankcase and install the operating lever (1).

6. Connect the lever to the compression release rod adjusting block.

7. Connect the operating rod lower yoke (12) in the jaw (8) and spring (6) to the jaw and stud in the crankcase.

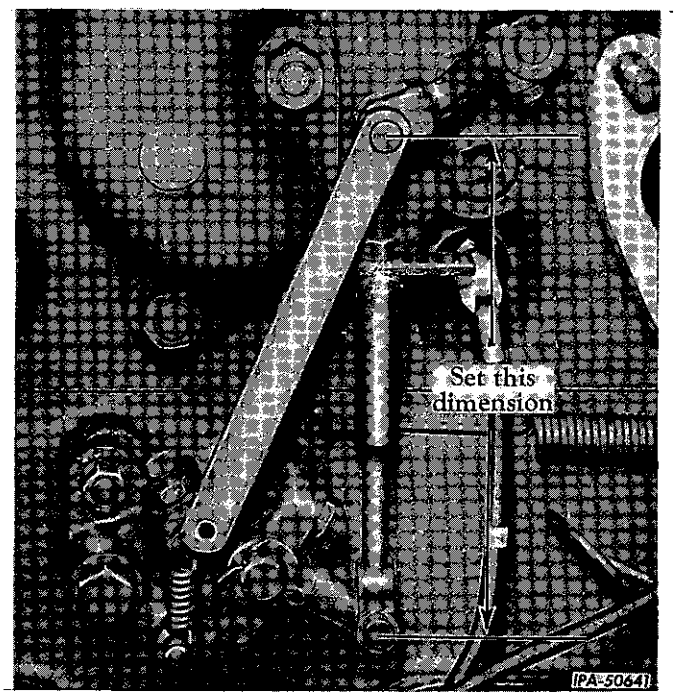
8. Install the carburetor. (Refer to Section 10.)

9. Adjust the compression release mechanism. (Refer to par. 5.)

5. ADJUSTMENT

NOTE: Before the following adjustments are made, the engine must be completely reassembled except for the intake and exhaust manifolds. All parts must be lubricated.

1. Adjust the compression release operating rod to give a distance of 6-7/16 inches between the pin hole centers on the TD-6, TD-6 (61), UD-264 and UD-281 series engines or 6-29/32 inches on the TD-9, TD-9 (91), UD-350 and UD-370 series engines (Illust. 2).



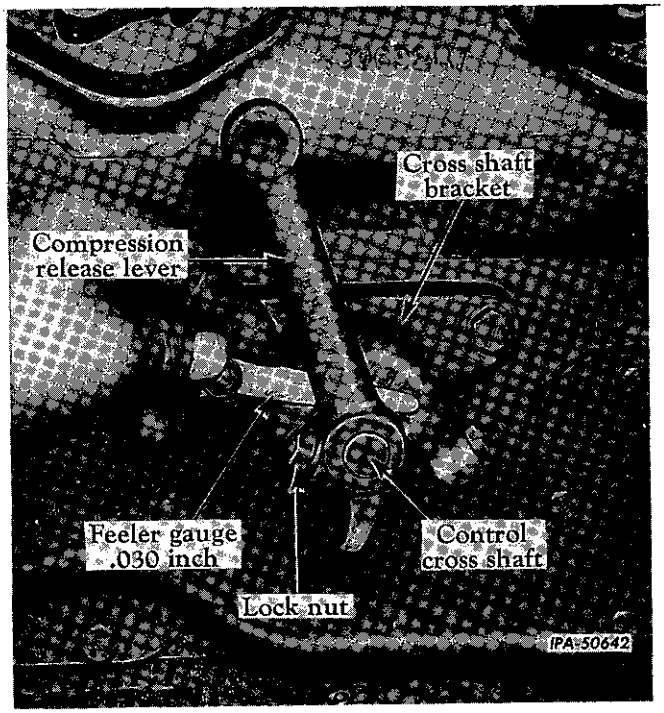
Illust. 2 - Adjusting Operating Rod.

2. Adjust the cross shaft and bracket to obtain .030 inch end play measured between the cross shaft compression release lever and the cross shaft bracket. Loosen the adjusting nuts of the operating lever, the cross shaft jaw lever and move the shaft to the correct position. Lock the nuts and recheck the clearance (Illust. 3).

3. Back off the adjusting screw on the cross shaft latch bracket, the adjusting screw on the cross shaft jaw and the adjusting screw on the cross shaft bracket (Illust. 4).

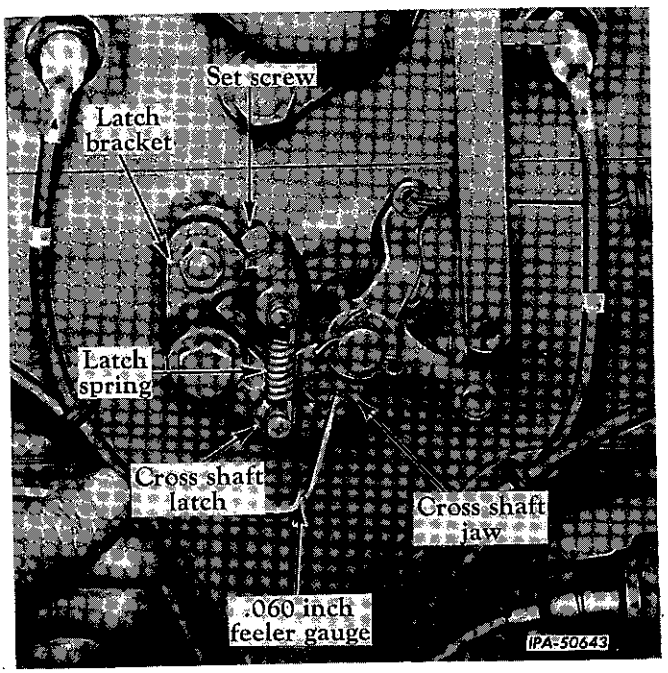
4. Adjust the screw in the cross shaft latch bracket to obtain .060 inch clearance between the cross shaft latch lever and the cross shaft jaw (Illust. 4). Lock the nut and recheck the clearance.

PRINTED IN UNITED STATES OF AMERICA

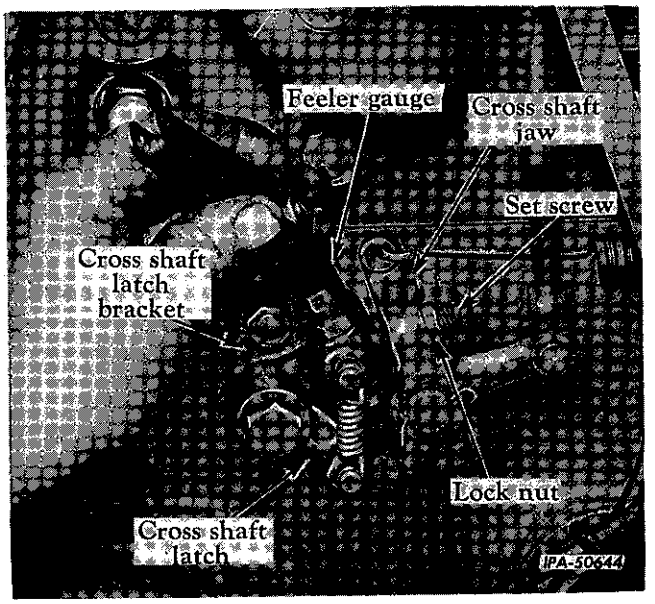


Illust. 3 - Checking and Adjusting Cross Shaft End Play.

5. Turn the cross shaft compression release lever clockwise until the pick-up faces on the cross shaft jaw and the cross shaft jaw lever are contacting. Adjust the screw in the cross shaft bracket to obtain .100 inch clearance between the screw and the cross shaft operating lever. (See Illust. 6.) Lock the nuts and recheck to be certain that clearances have been maintained.



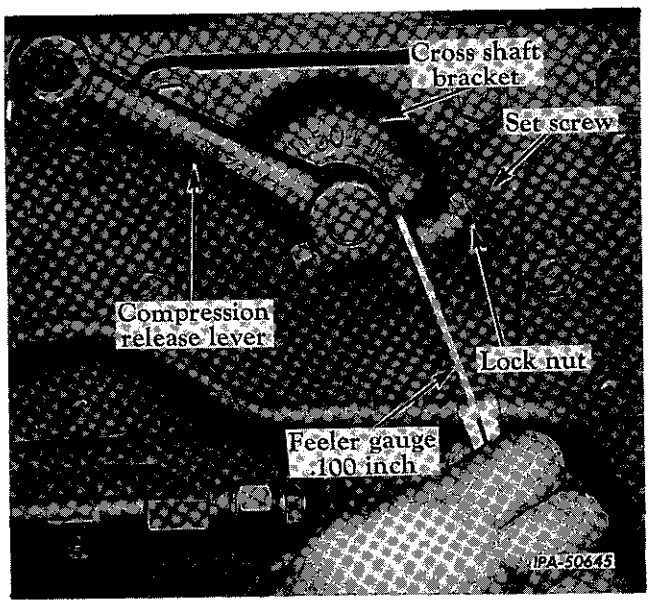
Illust. 4 - Checking and Adjusting Clearance between Cross Shaft Latch and Cross Shaft Jaw.



Illust. 5 - Checking and Adjusting Clearance between Set Screw in Cross Shaft Jaw and Latch Bracket.

6. Turn the cross shaft compression release lever clockwise until the cross shaft latch

(Continued on next page.)



Illust. 6 - Checking and Adjusting Clearance between Cross Shaft Release Lever and Cross Shaft Bracket Set Screw.

5. ADJUSTMENT - Continued

locks in place on the cross shaft jaw. The controls are now in the gasoline starting position.

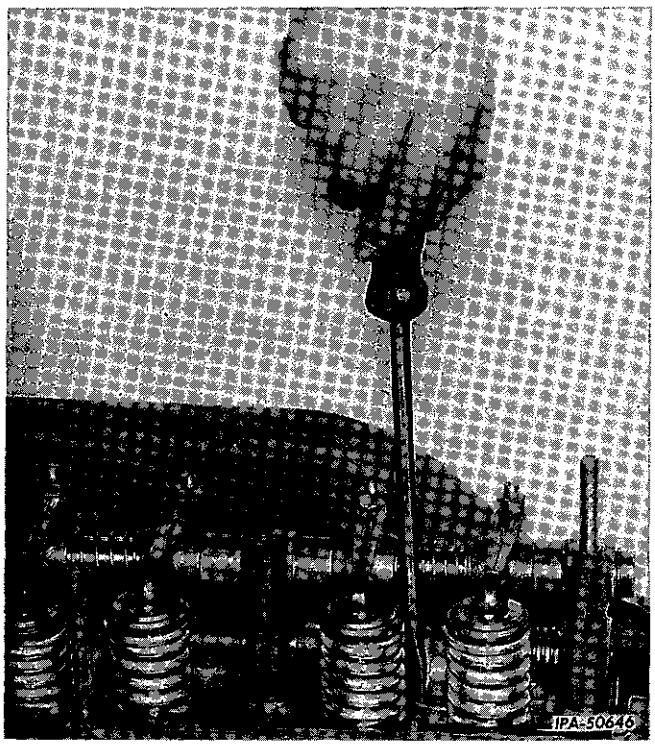
7. With controls in gasoline position, increase the length of the operating rod by turning the rod end to the left, one-half turn at a time, until the closest fitting of the starting valve covers has an additional travel of approximately 1/64 inch before bottoming in the cylinder head (Illust 2). After each half turn, check all the valve covers by applying pressure on the top with a screwdriver as shown in Illust. 7. In this way, determine which cover has the least amount of travel. Lock the yoke when adjustments have been made. Install the cotters to the rod.

8. Adjust the set screw in the jaw to obtain a clearance of .015 inch measured between the adjusting screw and the stop on the cross shaft latch bracket. Lock the nut and recheck the clearance (Illust. 5).

9. Trip the controls to the diesel position by turning the release lever to the left. In this position, check to determine that there is clearance between the starting valve shaft arms and the starting valve covers.

IMPORTANT: With the above adjustments made and with the controls in the gasoline position, each starting valve cover will have a slight additional travel before bottoming in the cylinder head. This check can be made with a screwdriver. If the check shows no travel, the controls must be rechecked to locate possible errors.

10. Install the link between the carburetor and the release lever (Illust. 4). Install the manifold assemblies. Trip and latch the mechanism a few times to check that adjustments are holding correctly.



Illust. 7 - Checking Starting Valve Cover Travel.

NOTE: The butterfly valves in the intake manifold must be set in a horizontal position by adjustment of the set screws before the manifold is assembled to the engine. This adjustment must not be altered later. The valves must fit the manifold with .0015 inch maximum clearance, using a feeler gauge 1/8 inch wide.

PRINTED IN UNITED STATES OF AMERICA

POWER UNITS

1. DESCRIPTION

Friction Disc Type

The governor speed control is a separate unit attached to the flywheel housing or, on some power units, to the rear hood sheet. This type consists of friction discs separated by a stationary plate that serves also as the mounting bracket. The discs are sandwiched between the control body to which is attached the control lever. The body has a projecting apron with an adjusting set screw at each end. These screws contact and limit movement of the control lever. (See Illust. 2.)

2. REMOVAL

Friction Disc Type (See Illust. 1.)

1. Disconnect the control rod (14) from the governor control body (4).

2. Remove the control lever bracket (9) from the flywheel housing and lift off the governor control lever (13).

3. Remove the governor control rod (14). Remove the cotter and yoke pin (18) securing the governor control rod to the governor control lever; then remove the governor control lever.

3. DISASSEMBLY

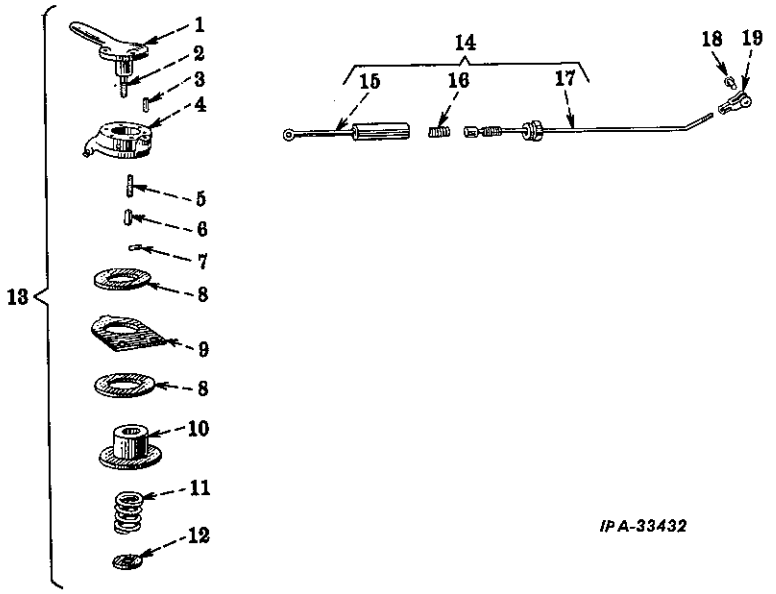
Friction Disc Type (See Illust. 1.)

1. Remove the spring tension nut from the governor control lever stud (2), thus releasing the spring retainer (12). Remove the spring (11), spring cup (10), lower friction disc (8), bracket (9) and upper friction disc (8) from the control body (4).

2. Scratch a mark on the edges of the control lever and the control body for a guide when reassembling.

3. Remove the cap screws, with lock washers, from the top of the control lever, thereby separating it from the body.

(Continued on next page.)



Illust. 1 - Exploded View of the Governor Control (Friction Disc Type).

1. Governor control lever.
2. Stud.
3. Pin.
4. Body.
5. Poppet spring.
6. Poppet.
7. Drive Pin.
8. Friction disc.
9. Bracket.
10. Cup.
11. Friction spring.
12. Retainer.
13. Control lever, complete.
14. Control rod, complete.
15. Rod, rear.
16. Rear spring.
17. Rod, front.
18. Yoke pin.
19. Rod yoke.

POWER UNITS

3. DISASSEMBLY - Continued

Friction Disc Type - Continued
(See Illust 1.)

4. The control rod pin (3) is a press fit in the control body.

4. INSPECTION AND REPAIR

Inspect the condition of all parts and replace all parts that are not serviceable.

5. REASSEMBLY

Friction Disc Type (See Illust. 1.)

1. Position the control lever (1) on the control body (4) and line up the scratch marks which were made before disassembly.

2. Insert three cap screws, with lock washers, through the top of the control lever and secure it in place.

3. With the flange side of spring cup (10) on a flat surface, place a friction disc (8) over the cup end; then add the control bracket (9) and add another friction disc (8) on top.

4. Place the spring cup, with discs and bracket, over the control lever stud and into the recess in the control body.

5. Place the friction spring (11) over the control lever stud (2); then add the spring retainer (12) and secure with a nut.

6. Tighten the nut to 10 foot-pounds torque for the proper friction tension of the control lever.

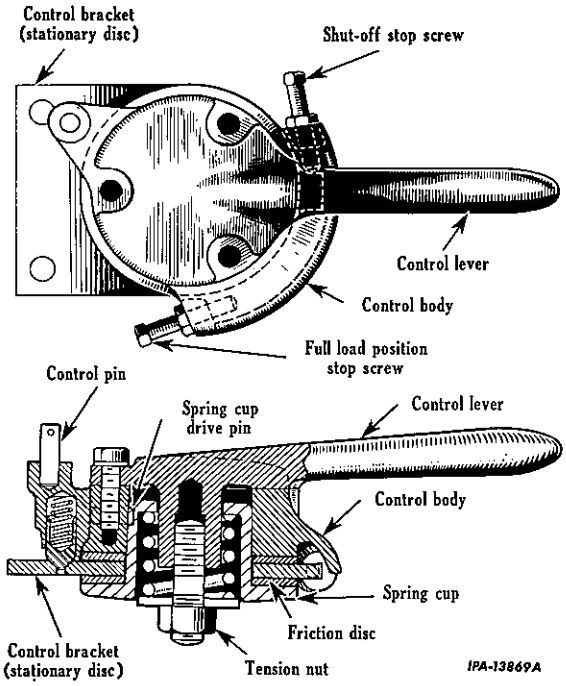
6. INSTALLATION

Friction Disc Type (See Illust. 1.)

1. Attach the complete governor control lever to the flywheel housing.

2. Attach the control rod (14) to the control body (4).

3. Attach the front rod (19) to the control lever on the pump with a pin (20) and cotter pin.



Illust. 2 - Governor Friction Control.

TRACTORS

7. DESCRIPTION

On 6 and 9 series diesel crawler tractors, two types of governor controls have been used. Early tractors were equipped with friction disc type and later models with ratchet lever type. The purpose of both types is to hold the governor control lever at any selected position.

Friction Disc Type

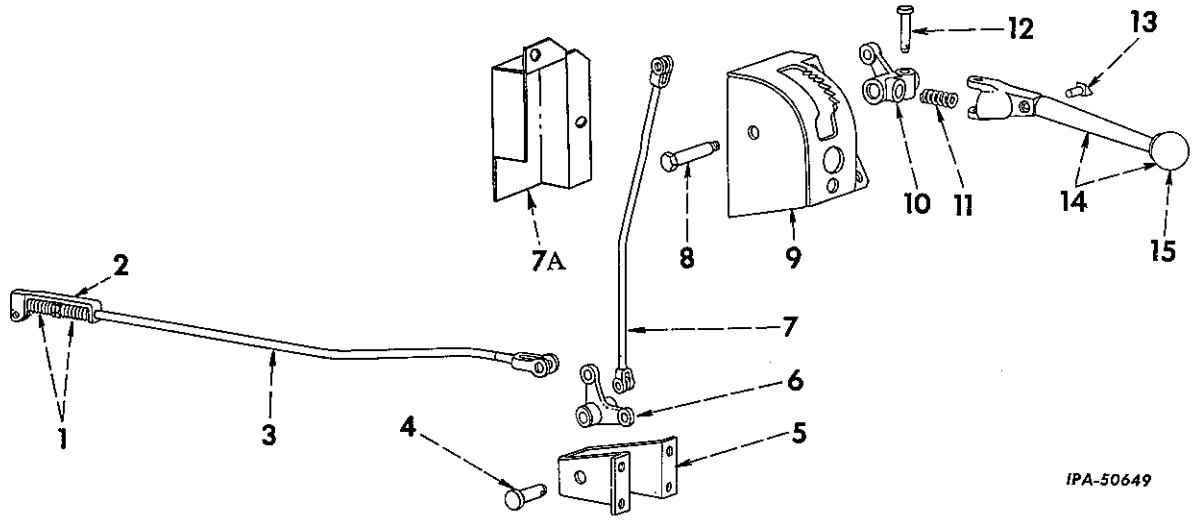
The friction unit is attached to the control lever "L" (Illust. 4), which turns freely on the cross shaft. Lever "L" has two arms; one arm is connected to the governor control lever "K" (Illust. 5) and the other arm is connected to the speed control. The shape of lever "L" is such that it will contact "D," which is connected to the compression release lever, if the throttle is opened while the engine is operating on gasoline. This is a reminder to trip the compression release lever to the diesel cycle before opening the throttle.

Ratchet Lever Type

This type is a vertically moving lever riding in a ratchet bracket mounted to the dash. (See Illust. 3.) It is connected to the speed control lever on the fuel injection pump by two rods and

PRINTED IN UNITED STATES OF AMERICA

TRACTORS



Illust. 3 - Exploded View of Governor Ratchet Type Control.

1. Rod spring.
2. Trunnion.
3. Rod, front.
4. Bellcrank pin.
5. Bellcrank support.
6. Bellcrank.
7. Rod, rear.
7A. Shield, heat.
8. Hand lever shaft.
9. Ratchet.
10. Hand lever hub.
11. Hand lever spring.
12. Hand lever pin.
13. Hand lever pawl.
14. Hand lever.
15. Hand lever ball.

a bellcrank. By raising or lowering the hand lever, the speed of the engine may be controlled under varying loads. Low and high idle adjustments are made at the pump.

8. REMOVAL

Friction Disc Type (See Illust. 4.)

Two independent friction discs sandwich a stationary disc that is anchored to the side of the engine crankcase. By removing the taper pin from lever "D," the cotter keys from lever "L" and the three cap screws from bracket "T," the entire assembly can be removed for adjustment to the tension desired to hold the throttle at the positions selected.

Ratchet Lever Type (See Illust. 3.)

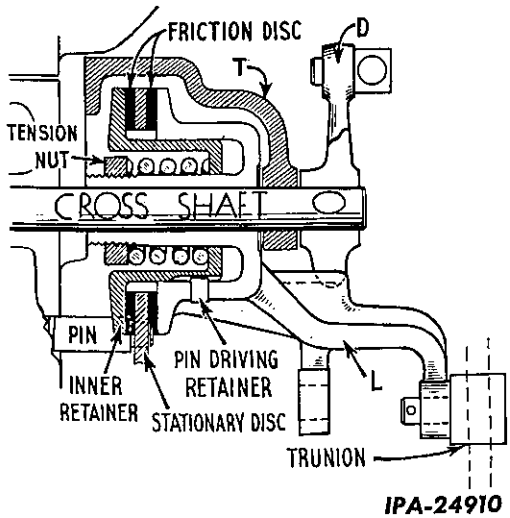
NOTE: Removing the ratchet control assembly, will result in complete disassembly. Proceed as follows:

1. Disconnect the rod trunnion (2) by removing the pin and cotter (not shown) from the injection pump speed control lever.

2. Remove the clevis pin from the bellcrank (6) and the front rod will come out. Remove the upper and lower clevis pins from the rear rod (7) and remove the rod.

3. To remove the control lever (14), it will be necessary to take out the four cap screws which secure the ratchet (9) to the dash.

NOTE: Late model 61 and 91 series tractors are equipped with a heat shield (7A), which will have to be removed to complete steps 2 and 3.



Illust. 4 - Cross Section of Governor Friction Control.

8. REMOVAL - Continued

Friction Disc Type - Continued
(See Illust. 4.)

4. Remove the hand lever shaft (8) by unscrewing the jam nut and washer (not shown). Take out the hand lever pin (12) and remove the hand lever (14) and spring (11) from the hand lever hub (10).

5. The bellcrank (6) can be removed by taking out the bellcrank pin (4). The support (5) is secured to the dash with four cap screws.

9. ADJUSTMENT

Friction Disc Type

With the unit off, reverse the friction assembly on the cross shaft to make the adjustment easy.

Turn the tension nut clockwise to increase the spring tension on the discs. Two holes are drilled in the tension nut for tightening purposes. A flat tool with two pegs can be used. Adjust the tension nut until 70 to 75 pounds load is obtained, as shown in Illust. 6.

Ratchet Lever Type

With the ratchet lever (14, Illust. 3) in low idle position, make sure the injection pump speed control lever adjustment is also in low idle position. Refer to "Injection Pump Manual," ISS-1003.

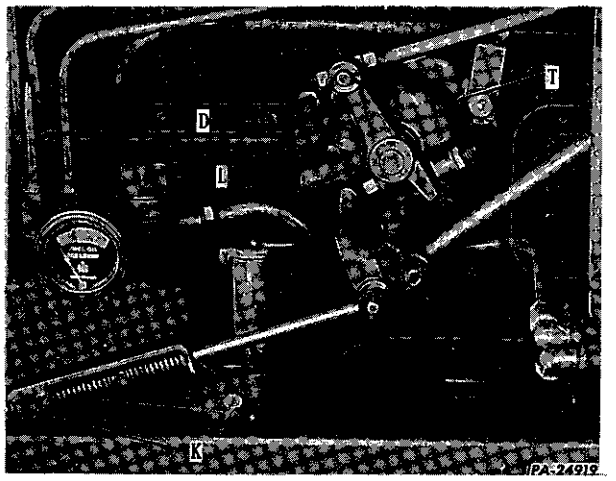
10. INSTALLATION

Friction Disc Type

Install the bracket and friction assembly on the shaft so the stationary disc engages the peg in the crankcase. Install the cap screws and connect the controls. Be sure that the cross shaft turns freely. The adjustment of the compression release mechanism has not been changed.

Ratchet Lever Type (See Illust. 3.)

1. Secure the support (5) to the engine side of the dash with four cap screws. Install the bellcrank (6) by inserting the bellcrank pin (4) and cotter pin.



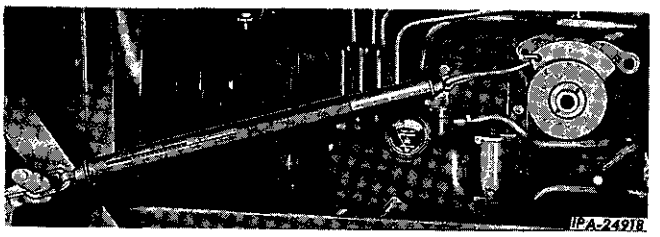
Illust. 5 - Governor Friction Control on Tractor Engine.

2. Install the hand lever (14) in the ratchet (9) and secure the lever in the lever hub (10), including the lever spring (11), with the lever pin (12). Insert the lever shaft (8) and tighten the jam nut to secure it.

3. Install the ratchet (9) to the dash with four cap screws. If the tractor is equipped with a heat shield (7A), install it after connecting the rod (7).

4. Install the rear rod (7) using a clevis pin at the top and bottom. Secure each with cotter pins.

5. Install the front rod (3) between the bellcrank (6) and the injection pump speed control lever. Secure the pins with cotter pins.



Illust. 6 - Adjusting Tension on Governor Friction Control.

PRINTED IN UNITED STATES OF AMERICA

F-8 STARTING CARBURETOR

1. DESCRIPTION

The F-8 model starting carburetor used on IH diesel engines is of the updraft type and is mounted directly on the underside of the intake manifold at the right side of the engine. The carburetor is used only on the gasoline starting cycle.

On later model TD-6 and TD-9 crawler tractors, UD-264, UD-281-4, UD-350 and UD-370 power units, the carburetore are of the adjustable jet type, to facilitate cold weather starting (for operating instructions refer to operator's manual).

All carburetors are equipped with starting shutters which are actuated by choke control levers. Some power units have the lever mounted directly on the carburetor; other power units and all tractors have the lever mounted on or near the instrument panel with connecting linkage to the carburetor.

2. MAINTENANCE

The carburetor must be removed, cleaned and inspected whenever the following conditions exist:

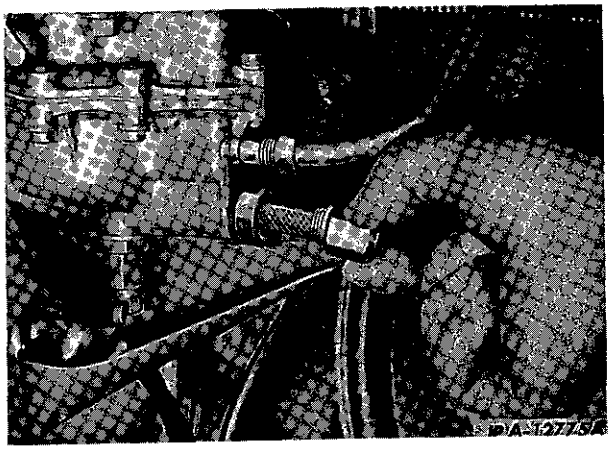
(a) Faulty carburetion.

(b) Engine speed exceeds maximum allowable value as given in "SPECIFICATIONS" in Section 1.

Cleaning Strainer Screen (Refer to Illust. 1.)

At regular intervals the strainer screen must be cleaned.

1. Turn the stem on the gasoline strainer to shut off the gasoline supply.



Illust. 1 - Removing the Strainer Screen.

2. Disconnect the gasoline strainer-to-carburetor tube at the carburetor.

3. Unscrew and remove the strainer screen retainer with screen.

4. Clean the retainer and screen thoroughly in cleaning solvent.

5. Install the retainer with screen in the carburetor.

6. Install the gasoline strainer-to-carburetor tube to the carburetor and secure the tube.

7. Turn the stem on the gasoline strainer to open the gasoline supply.

3. REMOVAL

1. Turn the valve stem on the gasoline strainer and shut off the gasoline supply.

2. Open the drain valve underneath the carburetor and allow all gasoline to drain from the bowl.

3. Disconnect the gasoline strainer-to-carburetor tube at the carburetor.

4. Move the compression release lever to the starting position. Disconnect the link attached to the locking shaft and lever assembly (25, Illust. 2).

5. Disconnect the choke control lever linkage from the carburetor at the starting shutter shaft lever (8, Illust. 2).

6. Remove the nuts and lock washers securing the carburetor to the intake manifold; remove the carburetor gasket.

4. DISASSEMBLY

(Reference Numbers Refer to Illust. 2.)

1. Remove the screws and lock washers securing the fuel bowl (37) to the body (26); remove the bowl and gasket (28).

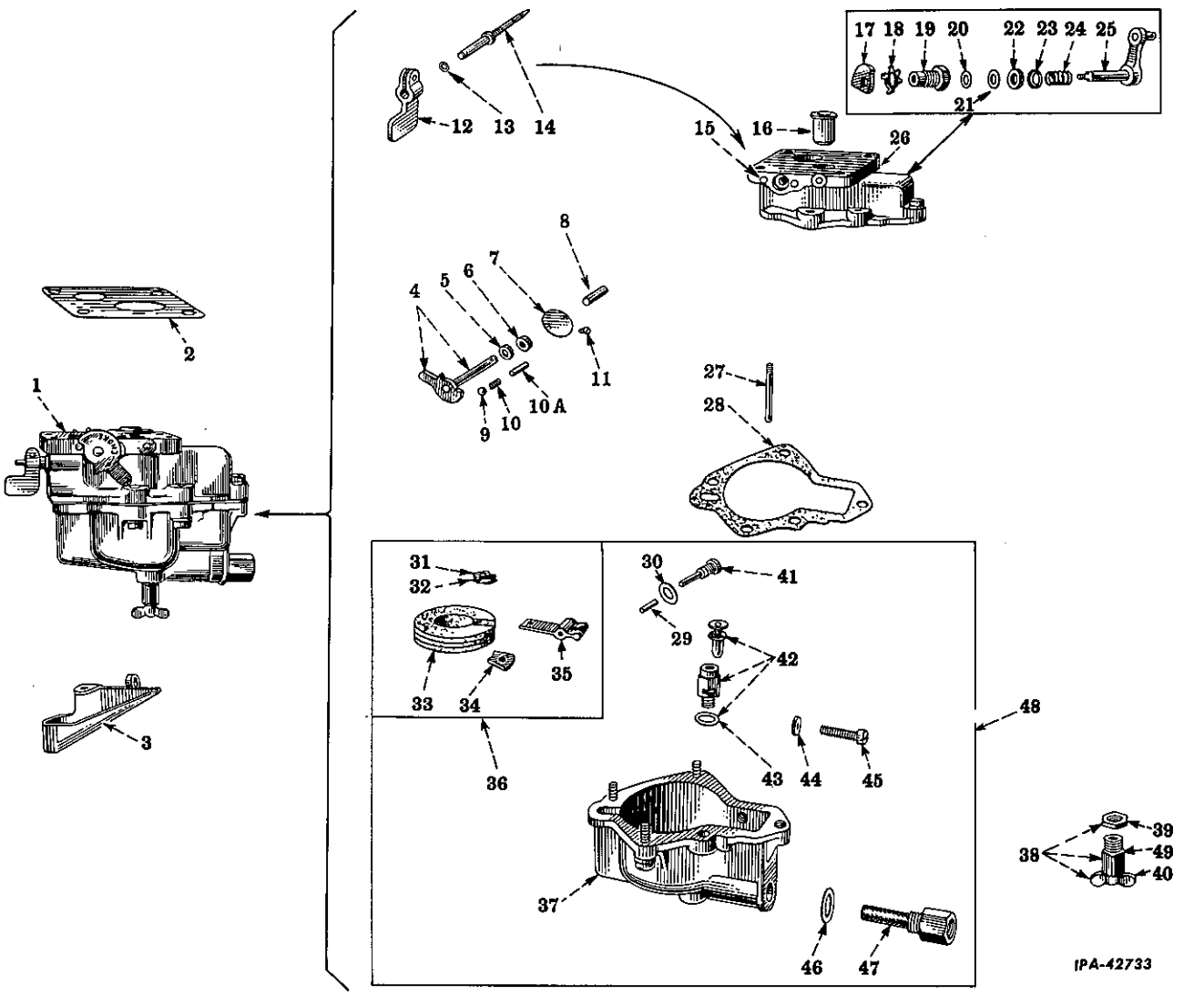
2. Use a thin screwdriver in the slot in the bottom of the fuel inlet tube (27) and unscrew the tube from the body.

3. Remove hand lever (12) and unscrew the needle valve (14). Do not remove the "O" ring from the needle valve unless replacement is necessary.

4. Remove the screws (11) securing starting shutter (7); remove the shutter. Remove the

(Continued on page 3.)

F-8 STARTING CARBURETOR



Illust. 2 - Exploded View of Starting Carburetor, Model F-8.

1. Carburetor, complete.
2. Carburetor gasket.
3. Drain trough.
4. Starting shutter shaft, long w/lever.
5. Dust seal retainer.
6. Dust seal.
7. Choke.
8. Starting shutter shaft, short.
9. Friction spring ball.
10. Starting lever friction spring.
10A. Roll pin.
11. Starting shutter screw.
12. Fuel adjustment lever.
13. "O" ring.
14. Needle valve
15. Starting lever stop pin.
16. Venturi.
17. Locking shaft cam.
18. Locking shaft bearing lock.
19. Locking shaft bearing.
20. Locking shaft "O" ring.
21. Locking shaft washer.
22. Locking shaft dust washer.
23. Locking shaft dust washer retainer.
24. Locking shaft dust washer spring.
25. Locking shaft and lever.
26. Carburetor body, complete.
27. Fuel inlet tube.
28. Fuel bowl gasket.
29. Float lever spacer.
30. Float lever pivot screw gasket.
31. Float lever spring leaf, upper.
32. Float lever spring leaf, lower.
33. Float with ferrule.
34. Float reinforcing nut.
35. Float lever.
36. Float and lever, complete.
37. Fuel bowl, with spacer.
38. Drain valve.
39. Drain valve locknut.
40. Drain valve stem.
41. Float pivot and screw.
42. Needle valve and cage.
43. Needle valve cage gasket.
44. Lock washer.
45. Screw.
46. Strainer screen gasket.
47. Strainer screw retainer, w/screen.
48. Fuel bowl, complete.
49. Drain valve body.

PRINTED IN UNITED STATES OF AMERICA

F-8 STARTING CARBURETOR

4. DISASSEMBLY - Continued

long shutter shaft (4) with retainer (5), seal (6), ball (9) and spring (10); remove shutter shaft (8) with retainer (5) and seal (6).

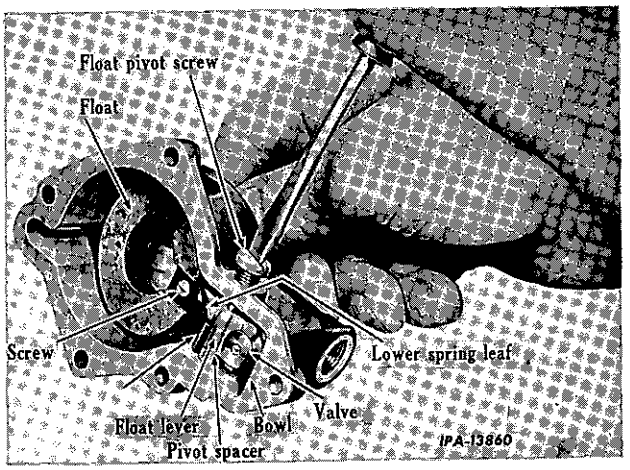
5. Remove the nut and lock washer securing the cam (17) to the shaft and lever assembly (25); slide the cam off the shaft. Pull out the shaft and lever assembly with spring (24), retainer (23) and washers (22). Unscrew and remove the bearing (19).

6. Remove the pivot screw (41) and spacer (29); remove the float assembly (36).

7. Remove the needle valve from its cage.

8. Remove the cage and gasket (43) from the bowl.

9. Remove the retainer with screen (47) and gasket (46) from the bowl.



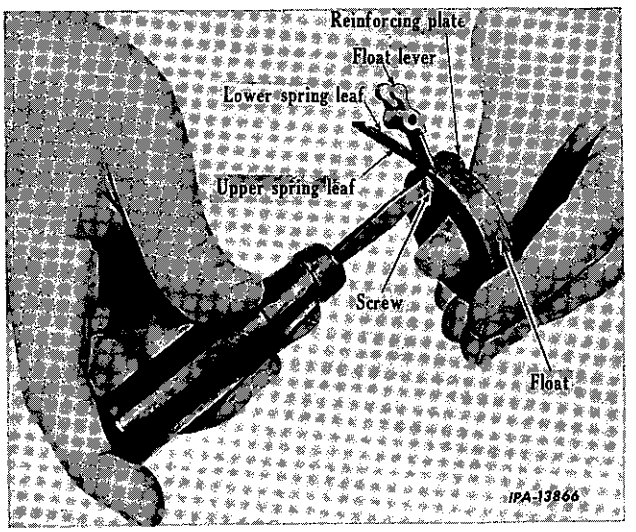
Illust. 3 - Removing the Float Assembly.

5. INSPECTION AND REPAIR

1. Clean all metal parts thoroughly with cleaning solvent; dry with compressed air. If gum deposits are present, clean the parts with acetone and blow out with compressed air.

2. Inspect the cork float for evidence of deterioration; replace if necessary by assembling a new float to the float lever and spring.

3. Inspect the needle valve and cage for wear. If either part is defective, both must be replaced.



Illust. 4 - Removing or Attaching the Float Lever and Spring.

6. REASSEMBLY

1. Install a new gasket (46, Illust. 2) and retainer with screen (47) in the bowl (37).

2. Install a new gasket (43) and cage in the bowl.

3. Place the needle valve in its cage; position the float assembly (36) and secure with the pivot screw (41), spacer (29) and gasket (30).

4. Perform leak test as follows: Connect the carburetor bowl to a source of gasoline (six foot head) as shown in Illust. 5. Be certain the bowl drain valve is closed. Slowly open the shut-off valve and allow the gasoline to flow into the bowl. The needle valve should close and stop the flow with the gasoline level between 13/32 and 7/16 inch below the top face of fuel bowl. If the needle valve does not shut off the flow of gasoline, replace the needle valve and cage assembly.

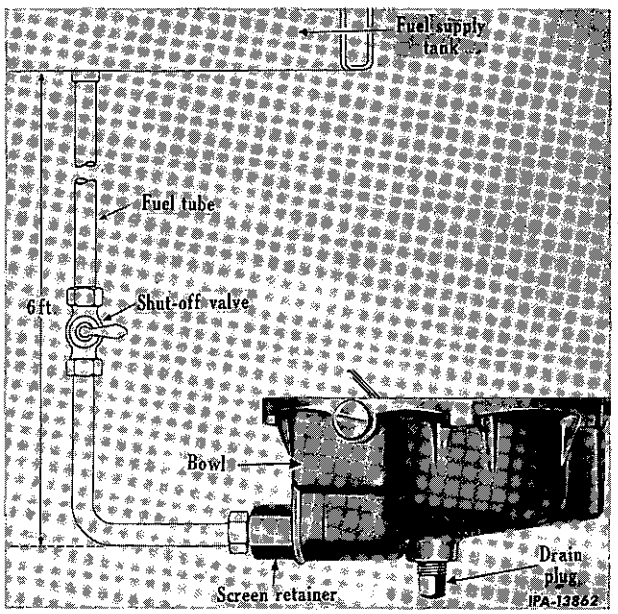
5. Hold the needle valve against its cage (Illust. 7) and check the float level. The float must be 9/32 inch below the surface of the bowl. If setting is incorrect, bend the float lever slightly to get the correct level.

6. With needle valve seated, check the height of the spring above the surface of the bowl (Illust. 6). This height must be 0.234 to 0.312 inch. Replace the spring leaves with new parts,

(Continued on next page.)

F-8 STARTING CARBURETOR

6. REASSEMBLY - Continued



Illust. 5 - Checking the Fuel Level of the Starting Carburetor.

if the measurement does not fall within these limits.

7. Screw the bearing (19) and bearing lock (18) into the body. Install the shaft and lever assembly (25) with spring (24), washer (22), dust washer retainer (23) and "O" ring (20). Install cam (17); secure with the lock washer and nut.

8. Install the shutter shaft (8) with retainer (5) and seal (6). Install the spring (10), ball (9), long shutter shaft (4) with retainer (5) and seal (6). Secure the shutter (7) to shafts with the screws (11).

9. Install the needle valve (14) and hand lever (12) in the body (26). With the needle valve on its seat, the hand lever must be installed down.

10. Install the fuel inlet tube (27) in the body (26).

11. Use the new gasket (28) and fasten the bowl (37) to the body (26) with the screws and lock washers.

7. INSTALLATION

1. Use a new carburetor gasket and secure the carburetor to the intake manifold studs with washers and nuts.

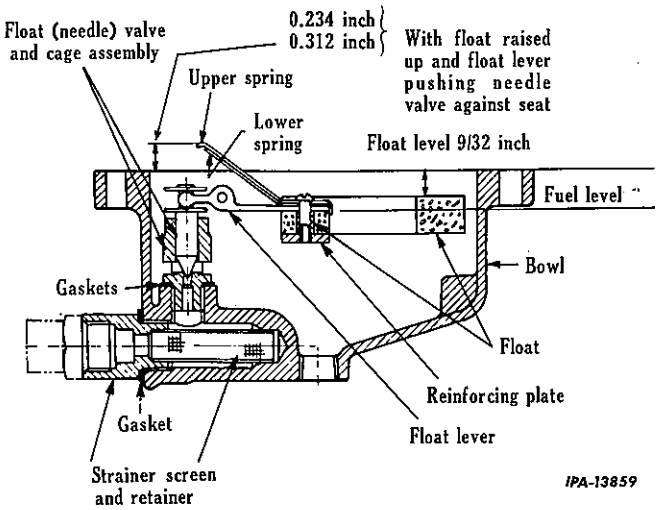
2. Connect the adjustable jet linkage. Connect the choke control lever linkage at the starting shutter shaft lever. Be sure full travel of the shutter can be obtained.

3. With the compression release lever in the starting position, connect the linkage to the locking shaft and lever assembly.

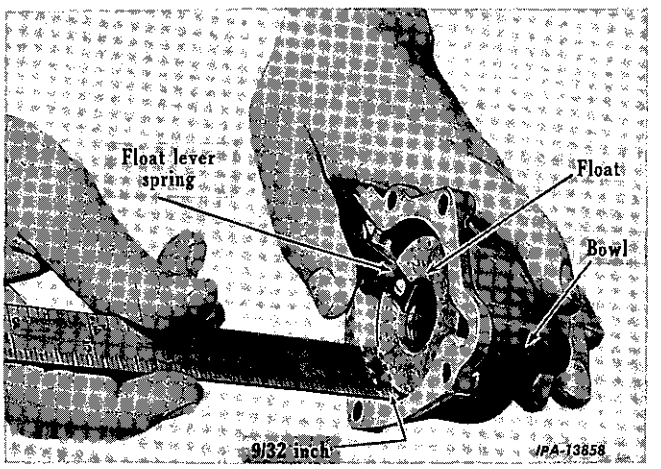
4. Connect the gasoline strainer-to-carburetor tube at the strainer screen retainer.

5. Turn the valve stem on the gasoline strainer and open the gasoline supply.

6. Operate the engine on gasoline cycle. Use an accurate tachometer and check the engine speed (refer to "SPECIFICATIONS" in Section 1).



Illust. 6 - Cross Section of Carburetor Bowl and Float Assembly.



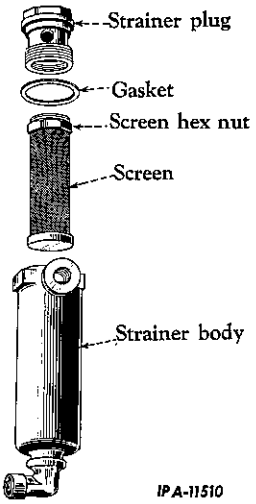
Illust. 7 - Checking the Float Level of the Carburetor.

PRINTED IN UNITED STATES OF AMERICA

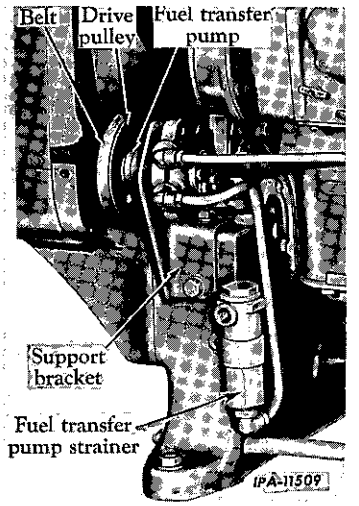
TRANSFER PUMP STRAINER

1. DESCRIPTION

The diesel fuel passes through a fine mesh wire screen in the transfer pump strainer before it enters the transfer pump. Location of the strainer varies with different power unit series. (Illust. 1 and 2.)



Illust. 1 - Fuel Transfer Pump Strainer Disassembled.



Illust. 2 - Transfer Pump and Strainer.

2. REMOVAL (Refer to Illust. 2.)

1. Shut off the flow of fuel at the filter.

2. Remove the fuel inlet pipe from the strainer and remove the cap screws securing the bracket to the engine support. Remove the strainer and bracket.

3. DISASSEMBLY (Refer to Illust. 1.)

1. Unscrew the strainer plug and gasket.

2. Disconnect the screen by unscrewing the integral nut from the plug. Lift the screen from the strainer.

4. INSPECTION AND REPAIR

The strainer screen in the transfer pump strainer must be removed and cleaned at regular intervals. Wash the screen in kerosene, fuel oil or solvent. Clean out the plug and strainer screen body also. If the strainer screen is cracked or broken, it must be replaced with a new strainer screen.

5. REASSEMBLY

Reassemble the strainer in the reverse order of disassembly.

6. INSTALLATION

Install the strainer in the reverse order of removal.

TRANSFER PUMP DRIVE

7. DESCRIPTION

The transfer pump is driven with a V-type belt by the pulley, attached to the front end of the crankshaft (Tuthill and Viking). (Illust. 2.)

8. REMOVAL

Tuthill And Viking Pumps

1. Loosen the cap screws holding the pump support bracket (3, Illust. 4).

2. Push the bracket (3) toward the engine to slacken the drive belt (1) and remove the belt from the pump pulley and the crankshaft drive pulley.

9. INSPECTION

Inspect the belt for grease, fraying and for other indication of slippage. Replace if necessary.

TRANSFER PUMP DRIVE

10. INSTALLATION

Tuthill And Viking Pumps

1. Install the belt over the pulley on the end of the crankshaft; then with the pump pushed as far toward the engine as possible, slip the belt over the pump pulley.

2. Pull back on the pump until the belt can be depressed by thumb pressure three-quarters to one inch midway between the pulleys. (Refer to Section 5.) To adjust tension, loosen the mounting screws holding the pump bracket to the engine support (Illust. 2). Push in to decrease tension; pull out to increase tension.

3. Tighten the cap screws which secure the pump support bracket to the front engine support.

TRANSFER PUMP

11. DESCRIPTION

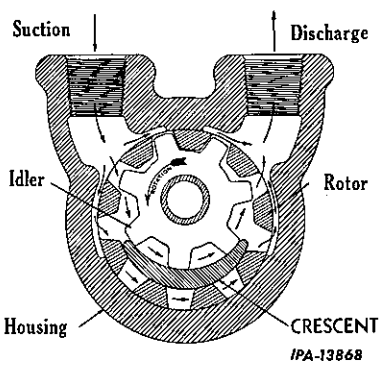
Tuthill And Viking Pumps

The transfer pump, which draws fuel from the main supply tank, is driven by a V-belt from a pulley attached to the front end of the crankshaft (Illust. 2). The following chart gives the approximate fuel pump rpm and fuel delivery.

MODEL	APPROXIMATE FUEL TRANSFER PUMP RPM	GAL. PER HR. AT NORMAL TEMP. WITH A 4 FT. VERTICAL SUCTION LIFT.
UD-6	1219	18
UD-6A	1300	19
UD-264	1300	19
UD-281-4	1450	22
UD-9	1219	18
UD-9A	1300	19
UD-350, UD-370	1460	21

NOTE: It should be remembered that fuel delivery for a given pump speed can vary according to the fuel suction lift and the piping length of the fuel tank installations.

The direction of rotation is stamped on the round portion of the pump housing. Rotation is clockwise as viewed from front of the engine. The pumping principle (Illust. 3) is known as the internal gear principle. Power is applied to the rotor and is transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler gear and the inside diameter of the rotor is sealed by a crescent-shaped projection which is an integral part of the front cover. As teeth come out of mesh, there is an increase in volume which creates a partial vacuum. Fuel rushes into the pump to fill the vacuum and stays in the spaces between both teeth of the idler gear and the rotor until the teeth mesh. Fuel is then forced from these spaces and out of the pump. In the drive end of the pump housing is located a spring-loaded, diaphragm type seal assembly which prevents fuel leakage past the revolving rotor shaft. The engine is supplied with either the Tuthill or the Viking pump.



Illust. 3 - Showing the Pumping Principle.

12. REMOVAL

Tuthill And Viking Pumps

1. Remove the pump drive belt (par. 8).

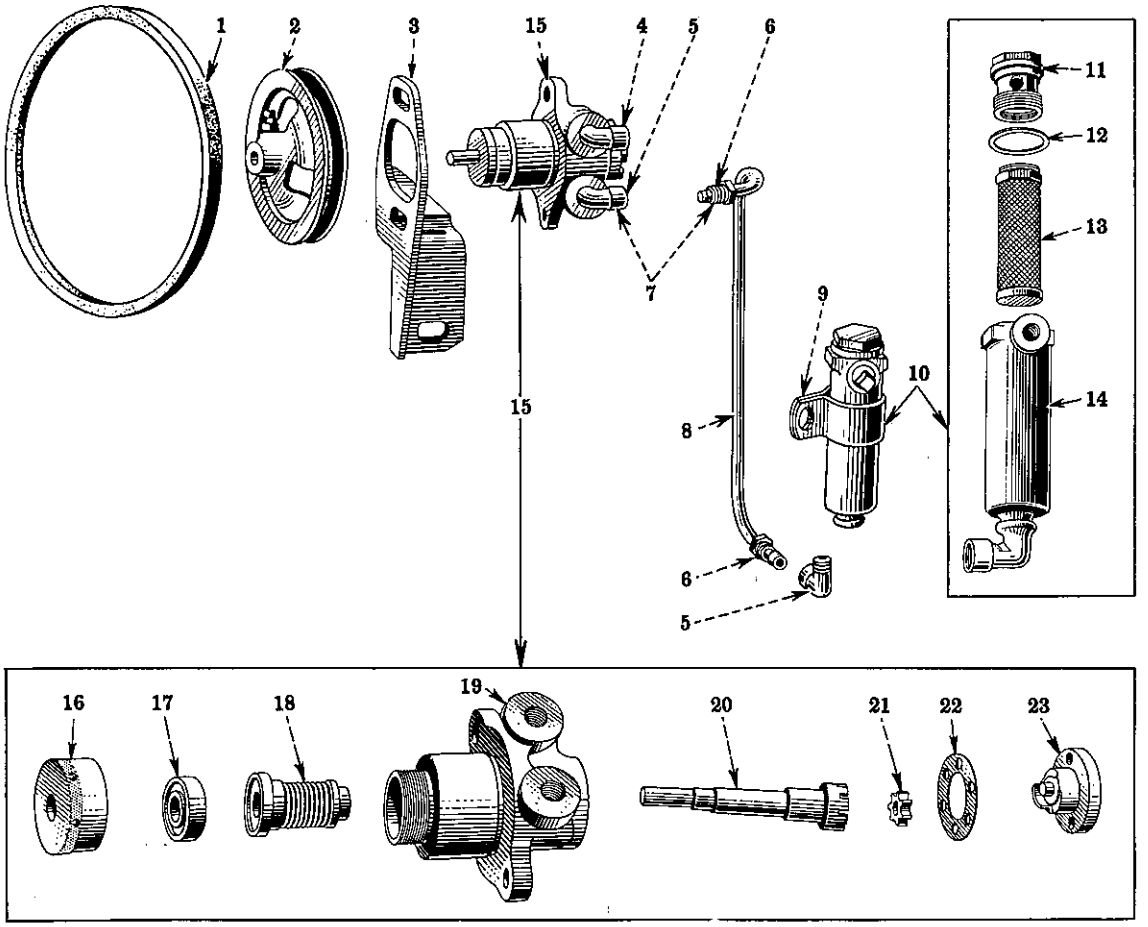
2. Disconnect the inlet and outlet fuel pipes from the pump housing.

3. Remove the cap screws, nuts and lock washers which secure the pump support bracket

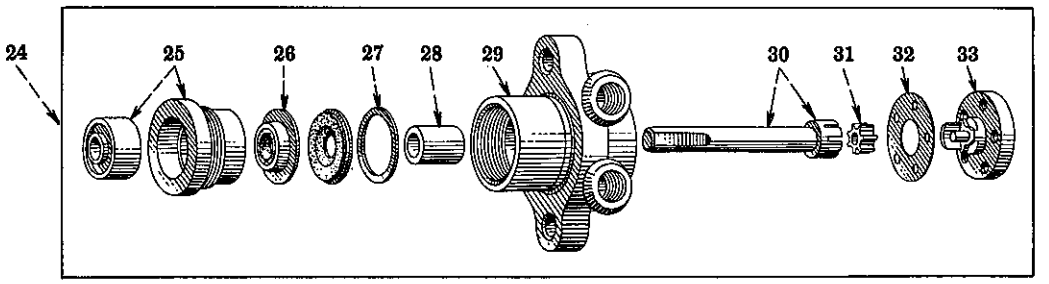
(Continued on page 4.)

PRINTED IN UNITED STATES OF AMERICA

TRANSFER PUMP



FUEL TRANSFER PUMP (Viking)



FUEL TRANSFER PUMP (Tuthill)

IPA-28749A

Illust. 4 - Exploded View of Transfer Pump and Strainer Assembly.

1. Belt.
2. Pulley.
3. Bracket.
4. Outlet tube elbow.
5. Inlet tube elbow.
6. Inlet tube nut.
7. Elbow with nut.
8. Inlet tube with nut.
9. Strainer bracket.
10. Strainer assembly.
11. Plug.
12. Gasket.
13. Screen.
14. Body.
15. Transfer pump.
16. Packing nut.
17. Bearing.
18. Seal.
19. Casing.
20. Rotor.
21. Idler.
22. Gasket.
23. Head.
24. Transfer pump.
25. Housing cap.
26. Seal.
27. Cap gasket.
28. Bushing.
29. Housing.
30. Rotor.
31. Idler gear.
32. Gasket.
33. Cover.

TRANSFER PUMP

12. REMOVAL - Continued

Tuthill And Viking Pumps - Continued

(3, Illust. 4) to the front engine support. (Illust. 2.)

4. Lift off the pump complete with support bracket and pulley.

5. Remove the pulley (2, Illust. 4) by loosening the jam nut at the pulley hub, and then back up the set screw and slide the pulley off the pump rotor shaft.

6. Remove the support bracket from the pump housing by removing two cap screws and lock washers.

13. DISASSEMBLY

Tuthill Transfer Pump

(Reference Numbers Refer to Illust. 4.)

1. Remove the cap screws holding the front cover (33) to the housing (29). The gasket (32) and idler gear (31) come off with the cover.

2. Place the pump in a vise with the jaws gripping across the two fuel ports and remove the housing cap (25) by using a spanner wrench. Do not remove the bearing from the cap. If the bearing is damaged, the housing cap with bearing must be replaced as a unit.

3. The bushing (28) need not be removed unless replacement is necessary. Tap out the rotor with shaft (30). Inspect the bushing. Any scratches on the shaft must be honed out with a stone.

4. Remove the two seals (26) and the cap gasket (27) will come out.

Viking Transfer Pump

(Reference Numbers Refer to (Illust. 4.)

1. Remove the cap screws holding the front cover (23) to the housing (19). The gasket (22) and idler gear (21) usually comes off with the cover (23).

2. Place the pump in a vise with the jaws gripping across the two fuel ports and remove the packing nut (16) with a spanner wrench.

3. Remove the ball bearing (17) and the seal assembly (18) from the rotor shaft.

4. Remove the rotor shaft (20) from the cover end of the housing (19).

14. INSPECTION AND REPAIR

Tuthill And Viking Pumps

1. Remove all rust, corrosion and dirt. Carefully inspect all parts for excessive wear. Use a cleaning solvent when necessary.

2. Inspect the surface of the cover around the bolt circle and the corresponding surface of the housing for smoothness and cleanliness.

3. Inspect the thrust surface of the cover against which the idler gear spins. Excessive wear at this point will cause end play of the rotor shaft and idler gear with a resultant loss of pump capacity.

4. Check for excessive clearance between the crescent on the cover and the idler gear. An excessive clearance will cause a loss of pressure in the pump. Replace the cover if the crescent is worn excessively.

5. Check the fit of the idler gear on the pin. There should be no perceptible play between the gear and the pin, but the gear must turn freely. If the pin is worn, replace the cover.

6. Remove any scale or dirt from the gear, especially any dirt or scale packed between the teeth.

7. The cover gasket acts not only as a gasket but also as a shim or spacer to control the clearance (end play) between the rotor shaft and the cover. This cover gasket is available in a variety of thicknesses ranging from 0.003 to 0.009 inch in steps of 0.001 inch.

8. Clean all parts of the pumping compartment using dry-cleaning solvent. Be sure to clean out the inlet and outlet ports.

9. Check the inside of the housing (29) or packing nut (16) for thread damage.

10. Check the fit of the inner race of the ball bearing on the rotor shaft. It should be fairly tight. If it is too loose, replace the bearing (17) or housing cap (25).

11. Check for excessive play in the bearing (17) itself and for pitted balls, worn races and corrosion.

12. Check the seal assembly (18). If the seal has been damaged, this complete assembly must be replaced.

PRINTED IN UNITED STATES OF AMERICA

TRANSFER PUMP

13. Check the rotor shaft for scratches and grooves. File or stone down any scratches or replace the shaft.

14. Check for undue wear and grooves in the bushing (28). If excessive wear has caused loose fit, it will be necessary to replace the housing (29).

15. REASSEMBLY

Tuthill Transfer Pump

(Reference Numbers Refer to Illust. 4.)

1. Reassemble the rotor and shaft (30) into the housing (29). Install the cover (33) together with the idler gear (31) and gasket (32). The shaft must not bind in the bushing.

2. Install the cap gasket (27) and the two seals (26) on the shaft.

3. Install the housing cap (25) with bearing and tighten with a spanner wrench.

Viking Transfer Pump

(Reference Numbers Refer to Illust. 4.)

1. Reassemble rotor shaft (20) to the housing (19). The cover (23), together with the idler gear (21) and gasket (22), can then be installed.

2. Insert the seal assembly (18), followed by the bearing (17) and packing nut (16). Turn down the packing nut with a spanner wrench until it is tight.

16. INSTALLATION

Tuthill And Viking Pumps

The installation procedure is the same for the Tuthill and the Viking pumps.

1. Attach the transfer pump support bracket (3, Illust. 4) to the pump body (4).

2. Slide the pump pulley (2) onto the rotor shaft; then turn in the set screw and tighten the jam nut.

3. Attach the pump support bracket, complete with the pump and pulley, to the top side of the front engine support (Illust. 2).

4. Connect the fuel pipe from the transfer pump strainer to the lower fitting of the transfer pump. Connect the remaining fuel pipe to the upper fitting of the transfer pump (Illust. 2).

5. Install and adjust the pump drive belt (par. 10).

NOTE: Also refer to step 7 in par. 14.

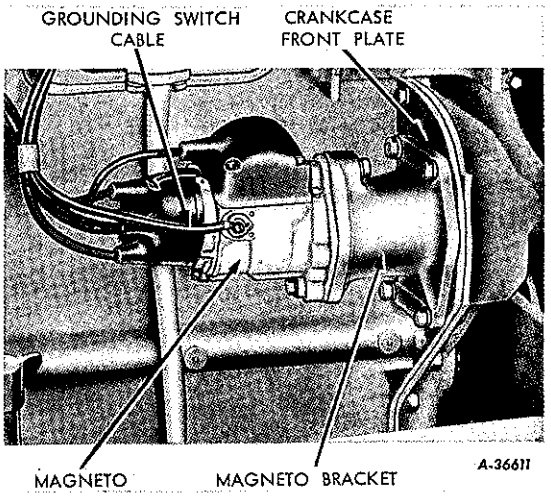
PRINTED IN UNITED STATES OF AMERICA

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. (See Illusts. 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.



Illust. 1 - Magneto Installed on Engine.

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. Illustration 3 shows the complete magneto assembly.

2. REMOVAL

Remove the grounding switch cable from the side of the magneto. (See Illust. 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.

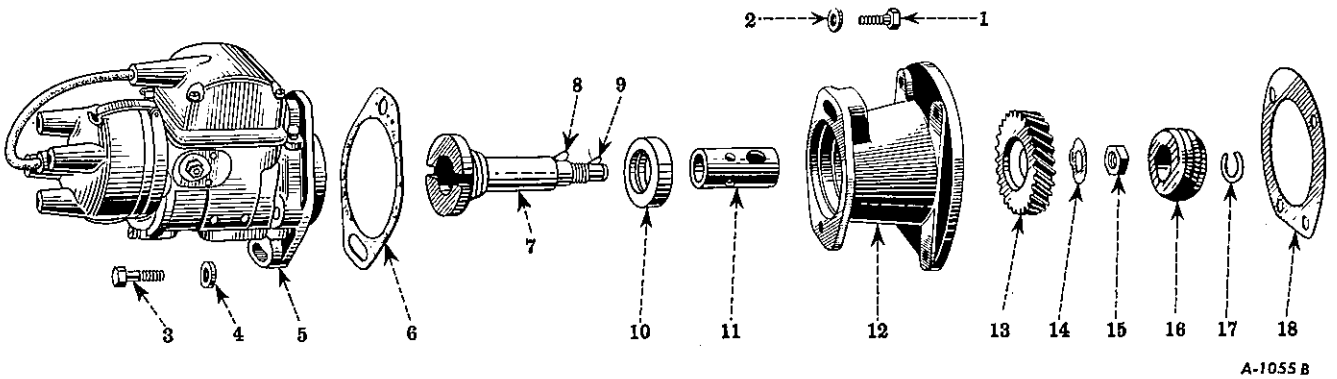
3. DISASSEMBLY

Remove the magneto (5, Illust. 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 (See Illust. 2.)

Wash all parts except the magneto in dry-cleaning solvent and dry with compressed air.

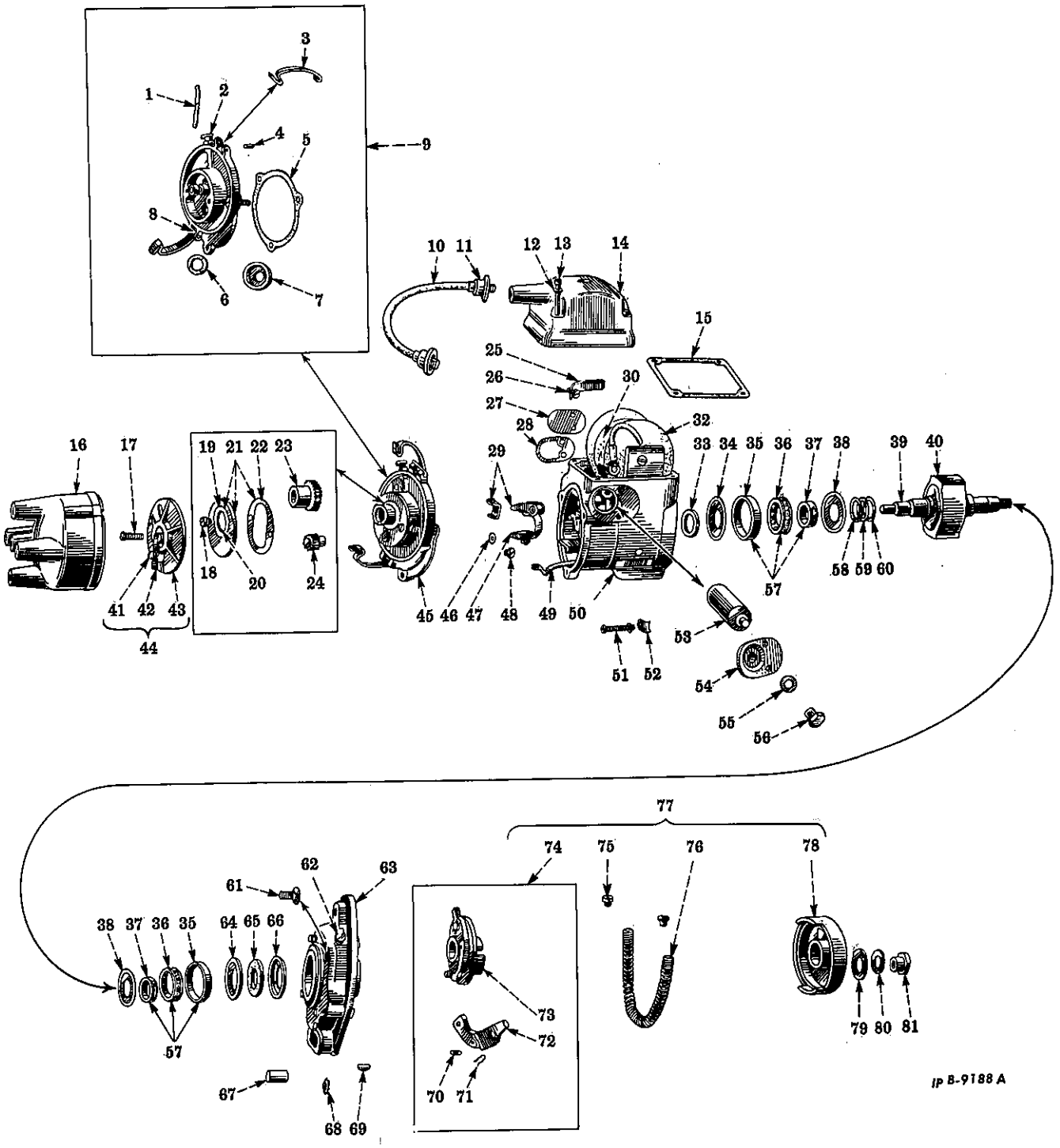
(Continued on page 3.)



Illust. 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



Illust. 3 - Exploded View of Magneto (H-4).

PRINTED IN UNITED STATES OF AMERICA

H-4 MAGNETO

Index to Reference Numbers in Illust. 3.

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.

4. INSPECTION AND REPAIR - Continued (Refer to Illust. 2.)

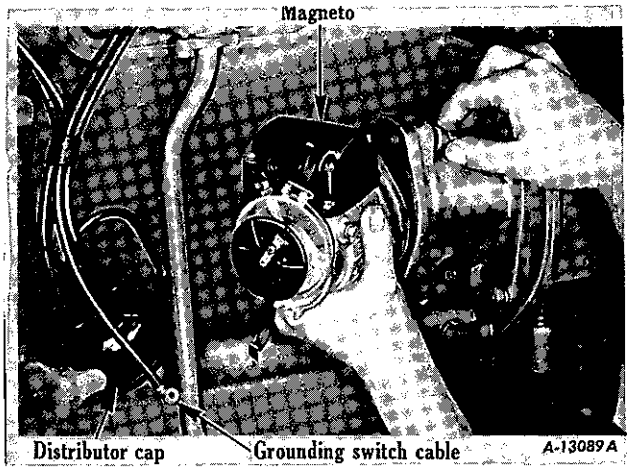
Inspect all parts for wear and damage; replace parts as necessary. The new shaft diameter is .9995 to 1.0005 inches; the bushing diameter is 1.0015 to 1.0030 inches. This gives a running clearance of .001 to .0035 inch. When pressing in a new bushing, the 9/16 inch holes must be toward the front end of bracket and arranged vertically to coincide with similar openings in the bracket. The four 3/16 inch holes are then toward the magneto end of bracket. The end of the bushing must be flush with the front face of the bracket. Be careful when reaming the bushing to have the bore square with the mounting face within .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, Illust. 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). Install the key (9), drive gear (16) and retainer (17) (if so equipped). The end clearance of the shaft must be .003 to .013 inch.

CAUTION: The gear must run true with the front face of the bracket.

H-4 MAGNETO



Illust. 4 - Removing the Magneto.

6. INSTALLING AND TIMING THE MAGNETO TO THE ENGINE

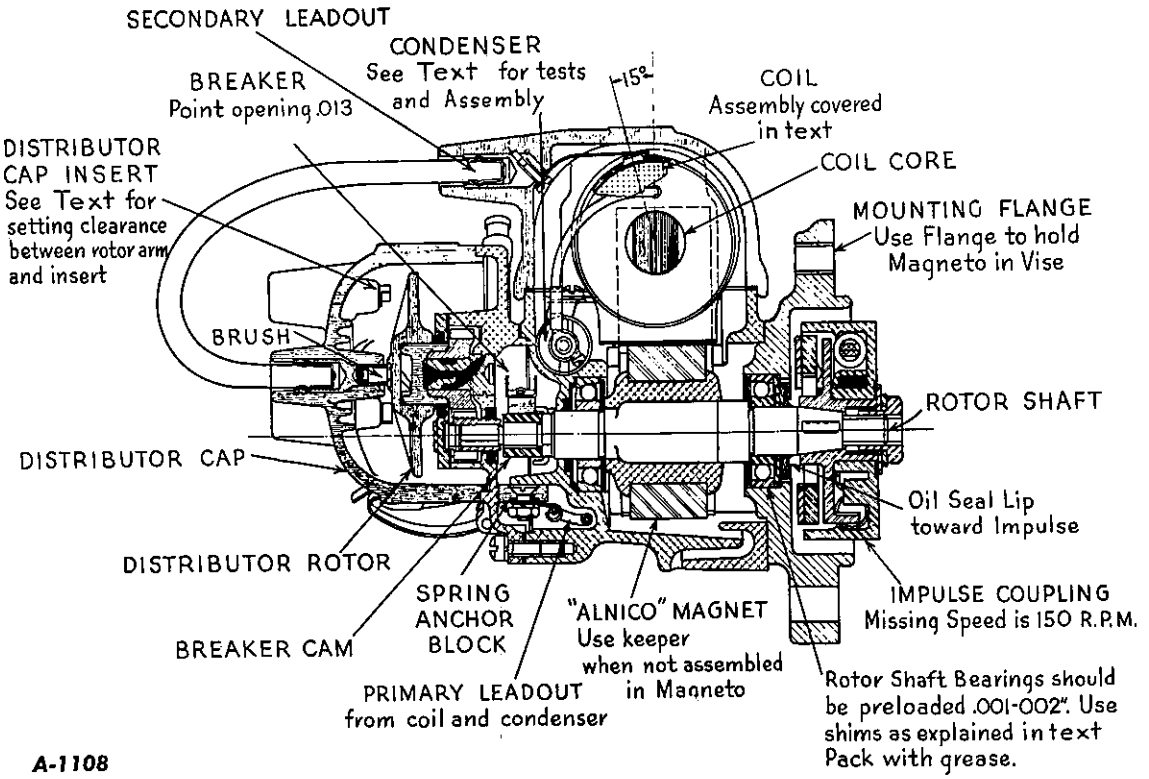
1. Shellac a new gasket to the bracket. Attach the bracket to the crankcase front plate, so the punch mark on the magneto gear tooth lines up with the chamfered tooth on the camshaft gear. Install the magneto.

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.



Illust. 5 - Cross Section of Magneto.

PRINTED IN UNITED STATES OF AMERICA

H-4 MAGNETO

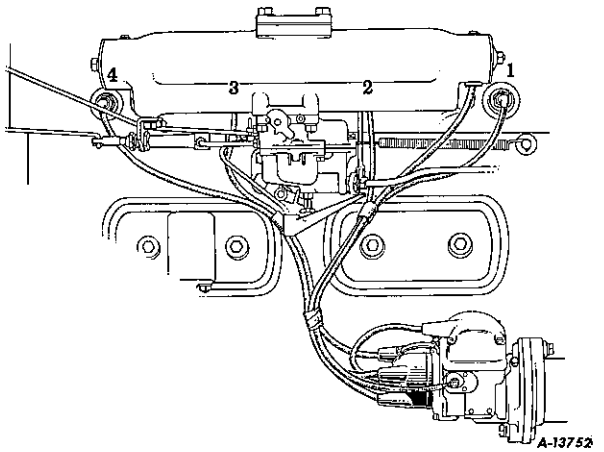
6. Insert the magneto mounting bolts loosely in the magneto flange, just enough to hold the magneto in place. Then crank the engine one complete revolution to the next top dead center. Now, pull the upper part of the magneto away from the engine until the impulse coupling just trips.

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.

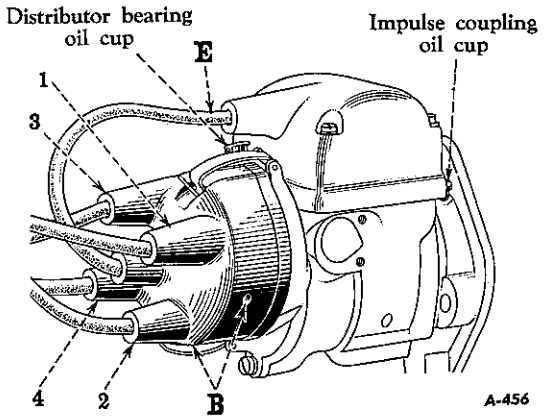
8. Remove the jumper wire from the magneto terminal, connect the grounding switch cable to the terminal and reconnect the jumper wire.

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.



Illust. 6 - Wiring Chart for Magneto. The Engine Firing Order Is 1, 3, 4, 2.



Illust. 7 - Counterclockwise Rotation (Viewed from the Distributor End.)

DISTRIBUTOR CAP

7. REMOVAL

Remove the secondary leadout wire (E, Illust. 7) from the coil cover. To remove the distributor cap, push the distributor cap springs (3, Illust. 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 (Illust. 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 must be removed from the monel metal strip on the distributor rotor to assure good contact. The distributor cap must be free of dust or dirt, inside and out, before assembling to the magneto. The two ventilating holes (B, Illust. 7) must 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 Illust. 9 and par. 10,11 and 12.

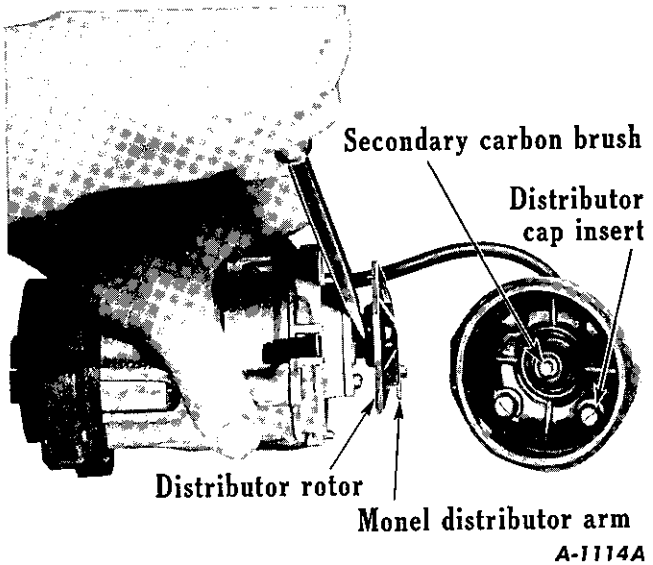
9. INSTALLATION

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

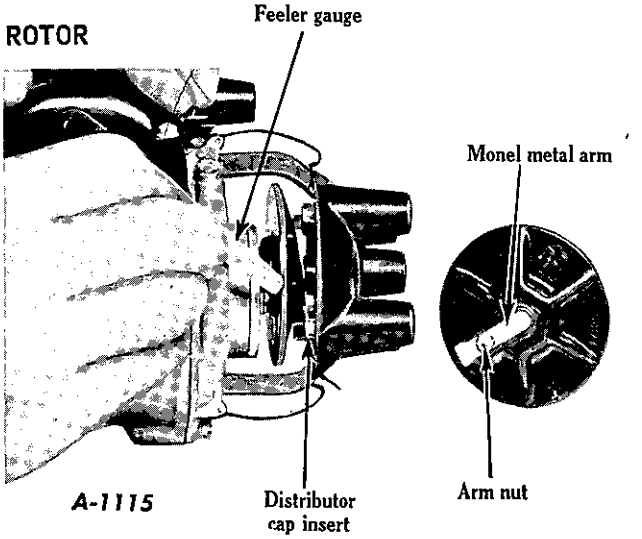
Remove the distributor cap. Apply the end of a screwdriver against the hub of the rotor and pry off the rotor as shown in Illust. 8. The bakelite rotor is fragile; handle it with care.



Illust. 8 - Method of Removing Distributor Rotor from its Spindle.

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 must operate as close to the insert in the distributor cap as possible without rubbing (Illust. 10). To adjust the distributor arm correctly, take a cap from stock and cut it away as shown in Illust. 10. Then, using a feeler gauge, check the distance between the distributor arm and the insert in the distributor cap.

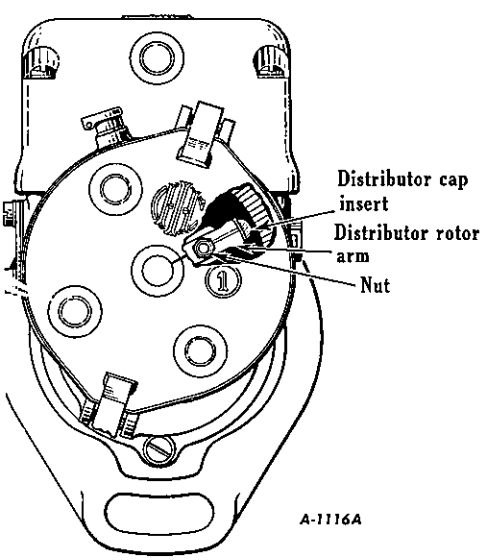


Illust. 10 - Inspecting Rotor Clearance.

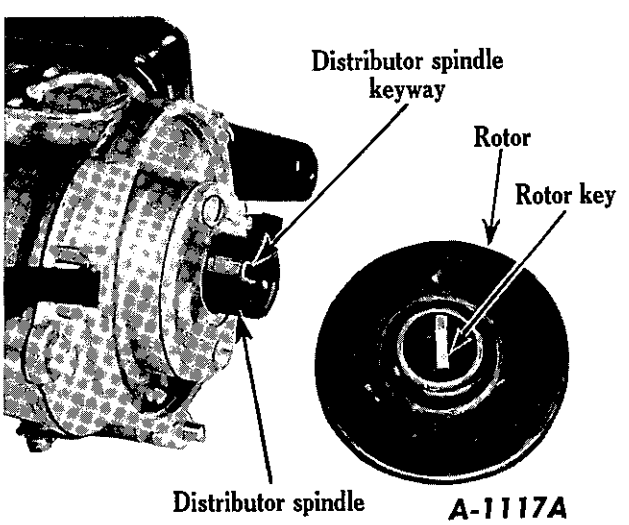
The arm can be adjusted slightly to gain the desired clearance. To adjust the rotor arm, loosen the nut (Illust. 9) and move the arm to the point where the outside end just clears the vertical portion of the distributor cap inserts.

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 (Illust. 11). To assist in lining up the key with the slot, use as a guide the rib which is



Illust. 9. Adjusting Rotor Arm.



Illust. 11 - Distributor Rotor Removed.

PRINTED IN UNITED STATES OF AMERICA

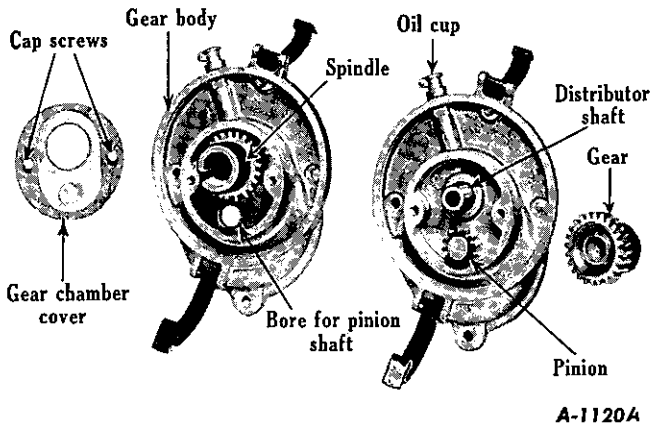
DISTRIBUTOR ROTOR

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 possibility of entrapped air preventing the rotor from being pushed all the way down on the hub of the distributor gear. The rotor must have a heavy hand-press fit on the distributor spindle. Install the distributor cap and the secondary cable.

DISTRIBUTOR GEARS

13. DESCRIPTION

The distributor gears are contained in a chamber which is a part of the distributor body (Illust. 2). This chamber is partially filled with magneto grease and sealed with felt washers around the hub of the gear.



Illust. 12 - Distributor Gear Assembly.

14. REMOVAL

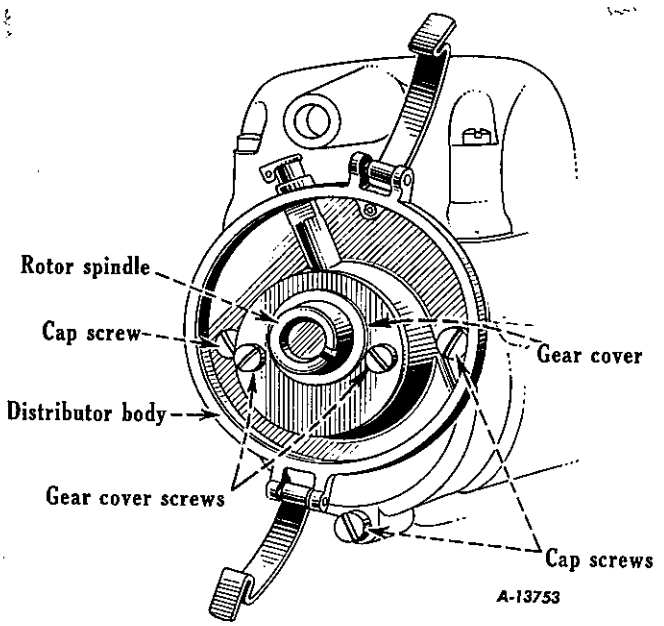
Remove the three cap screws (Illust. 13) from the body and remove the body with gasket.

15. DISASSEMBLY

By removing the two cap screws, the cover and gasket can be removed (Illust. 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.



Illust. 13 - Magneto with Distributor and Rotor Removed.

17. REASSEMBLY AND TIMING

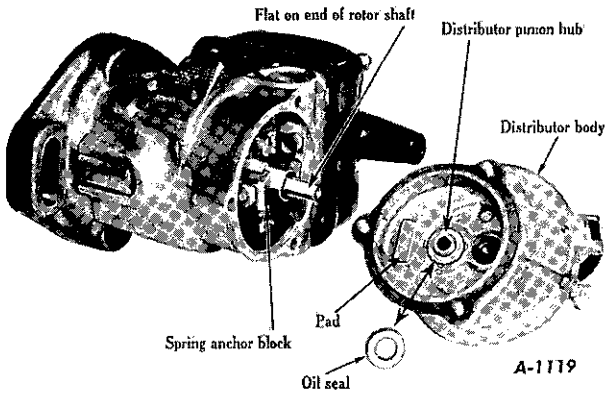
Secure the gear body, with the gasket, to the magneto frame. The body and gasket fit in one position only. Install the distributor gear spindle on the shaft. It must turn freely on the shaft. Install the distributor pinion and check the backlash with the gear. A slight movement should be felt (approx. .002 to .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 (Illust. 15). The "L" mark is for counter-clockwise magneto (this model), and the "R" mark is for a clockwise magneto.

(Continued on next page.)

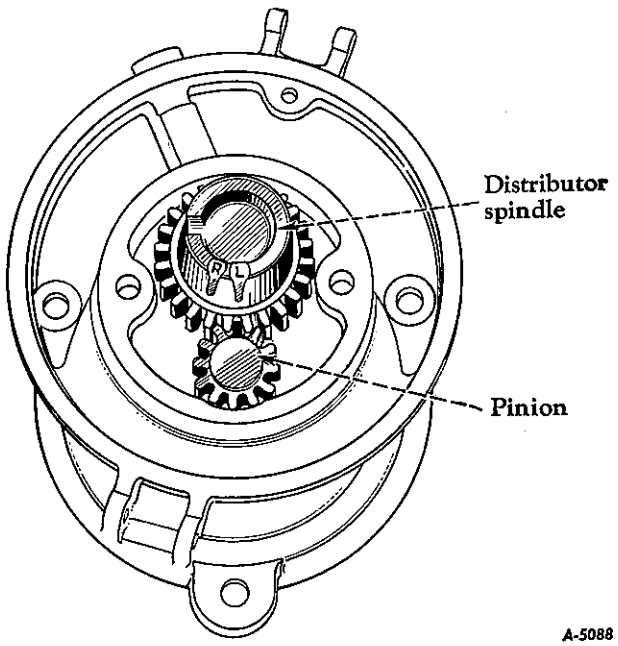
DISTRIBUTOR GEARS

17. REASSEMBLY AND TIMING - Continued

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 par. 13, and secure the distributor cap.



Illust. 14 - Magneto with Distributor Body Removed.



Illust. 15 - Timing Marks on Distributor.

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 Illust. 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 lead-out wire spring anchor terminal. The stationary point can be removed by removing one screw.

20. INSPECTION AND REPAIR (Refer to Illust. 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 Illust. 16 and 17.)

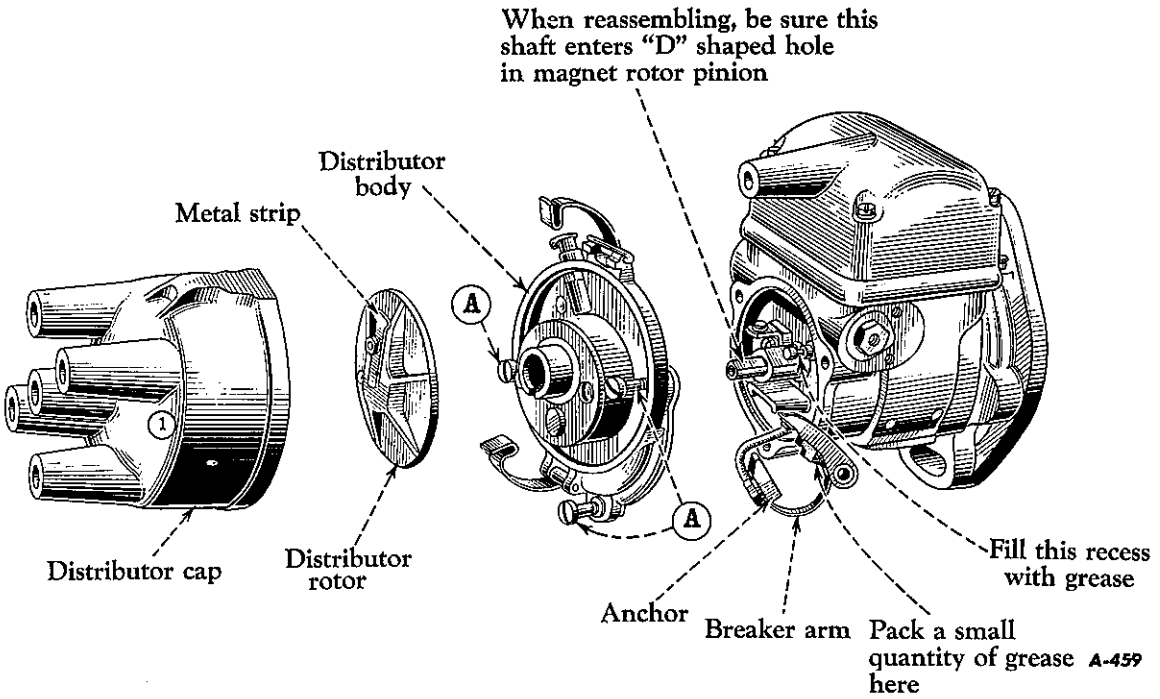
Before reassembling, thoroughly clean all parts to remove grease and oil. Apply a light coating of magneto grease to the breaker cam to prevent rusting. Reinstall the fixed breaker point, leaving the terminal screw slightly loose until the point opening has been adjusted. Secure the anchor block and 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 (Illust. 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 Illust. 18.)

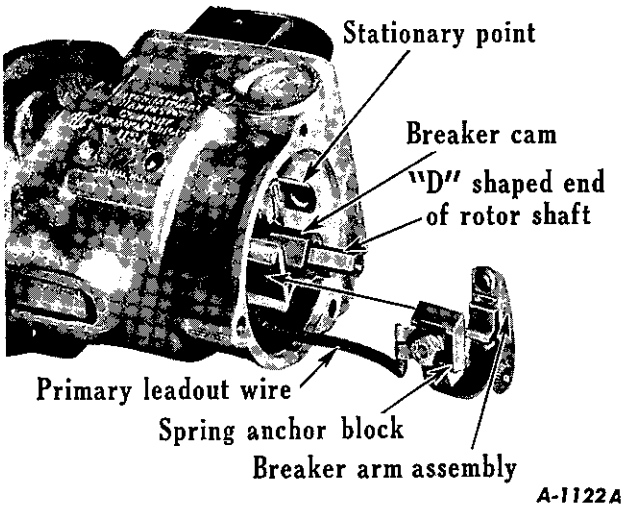
The breaker arm cam will last indefinitely if it is properly lubricated. If the cam becomes worn, it can be replaced. The cam is a press fit on the shaft and fits only one way.

PRINTED IN UNITED STATES OF AMERICA

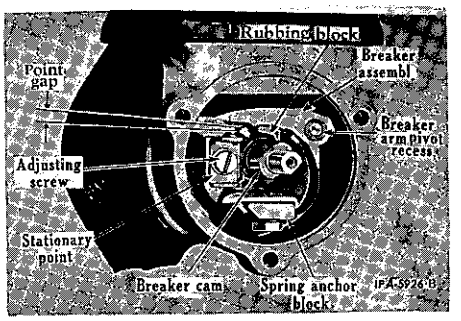
BREAKER MECHANISM



Illust. 16 - Magneto Parts Removed to Gain Access to Breaker Point Chamber.



Illust. 17 - Magneto Breaker Arm Removed.



Illust. 18 - End View of Breaker Mechanism.

CONDENSER

24. **REMOVAL** (See Illusts. 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.

(Continued on next page.)

CONDENSER

23. REMOVAL - Continued

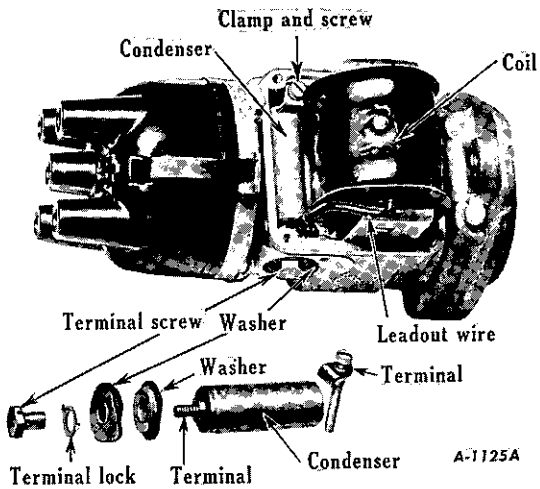
Remove the coil cover, the condenser hole cover plate and the clip and screw. Push the condenser back into the frame and remove the inner washer and two primary wires from the condenser terminal. Push the condenser out through the hole in the side of the magneto.

24. INSPECTION (TEST)

Test the condenser, if it does not show to be in good condition; it must be replaced.

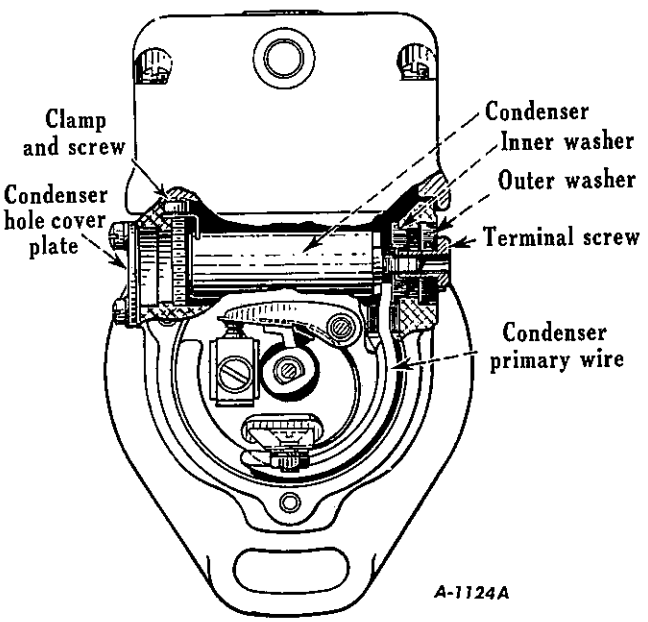
25. INSTALLATION (Refer to Illust. 19.)

Install the inner bakelite washer. Line up the terminals of the primary wires and insert the condenser.



Illust. 19 - Magneto with Coil Cover Removed.

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 possibility of breaking the bakelite washer or 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 with four cap screws.



Illust. 20 - Cross Section View of Condenser Assembly.

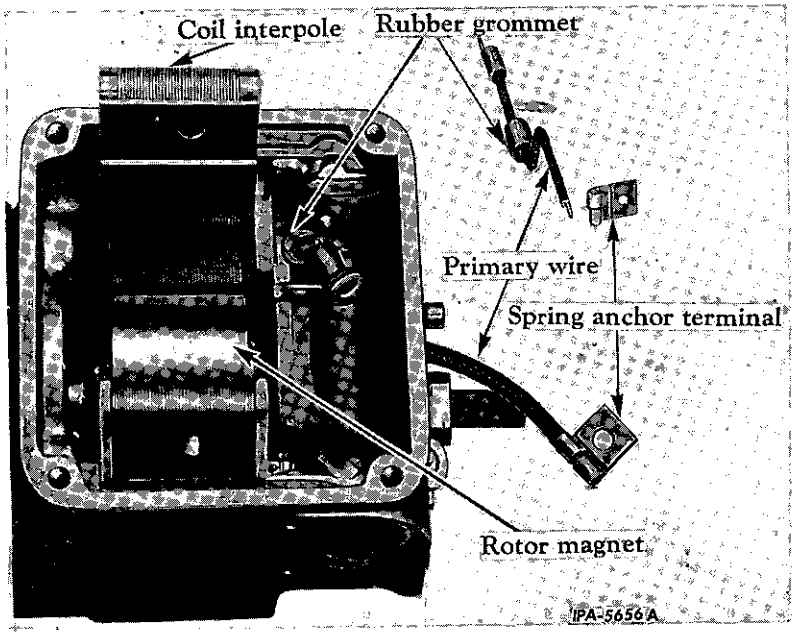
PRIMARY WIRE

26. GENERAL (Refer to Illust. 21.)

The primary wire connecting the breaker arm assembly to the condenser terminal must be a tight fit in the rubber grommet and the grommet must 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 must be pulled tight when the condenser is assembled.

PRINTED IN UNITED STATES OF AMERICA

PRIMARY WIRE



Illust. 21 - Location and Assembly of Primary Wire.

COIL AND COIL COVER

27. REMOVAL

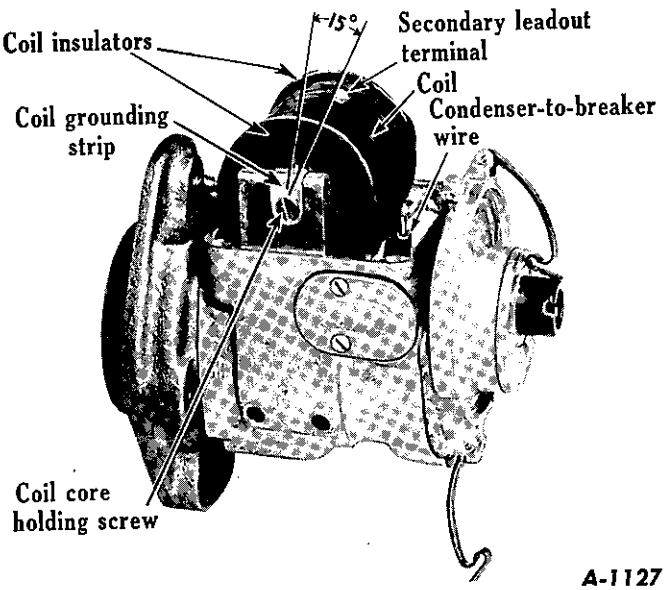
Remove the coil cover and gasket. The screws will be retained in the cover, if they are unscrewed only from the frame. Remove the primary wire from the condenser terminal. The magneto with the cover removed and the coil grounding strip attached under the coil core holding screw is shown in Illust. 19. Remove the two screws from each end of the core. Then remove the coil.

CAUTION: Before lifting the coil out, turn the magnet to the neutral position or so the pole of the magnet bridges the air gap between the end of the coil pole pieces.

28. INSPECTION AND REPAIR
(Refer to Illust. 22 and 23.)

Inspect the end insulators of the coil. If they are damaged, they must 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 Illust. 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

(Continued on next page.)



Illust. 22 - Coil Mounted on Magneto.

COIL AND COIL COVER

28. INSPECTION AND REPAIR - Continued

then tighten up in the countersunk hole of the pole piece before the screws bottom in the coil core.

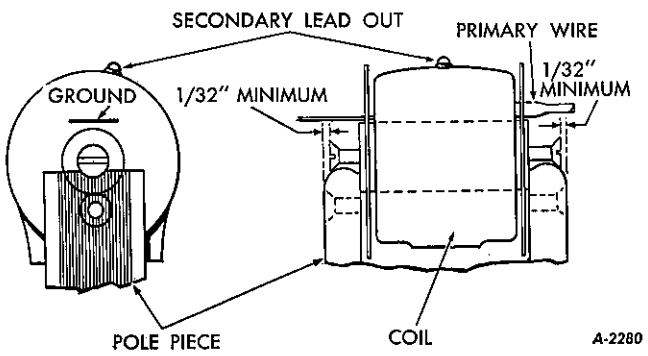
CAUTION: Do not file or otherwise deface the ends of the coil core or the face of the pole pieces, as this will impair the magnetic circuit and the efficiency of the magneto.

Test the coil, if it does not show to be in good condition, it must be replaced.

29. INSTALLATION
(Refer to Illust. 22.)

Press the coil in place; the secondary leadout terminal should be at an angle of 15 degrees 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.

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.



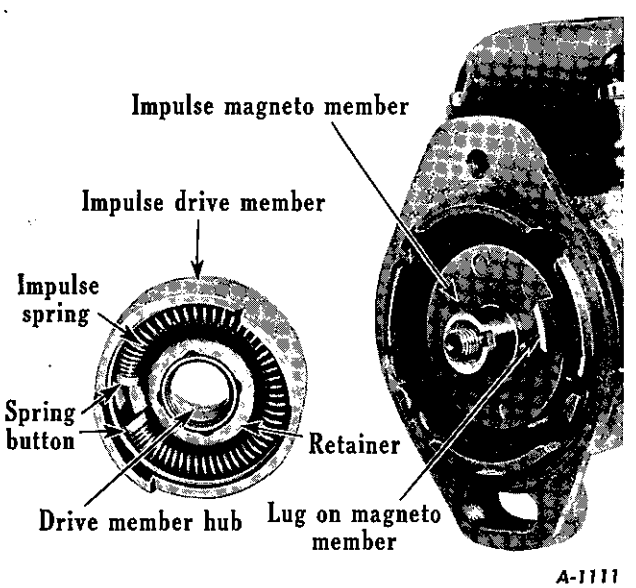
Illust. 23 - Assemble Coil Core Mounting Screws to Coil Core So They Do Not Bottom in Core when Assembled in the Magneto.

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 (Illust. 25) is retarded by the pawls at low speeds, these pawls are stopped by pawl stop pins (Illust. 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 from the pawl pin) and the magneto member (keyed to the magneto rotor) is forced to rotate by a 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.

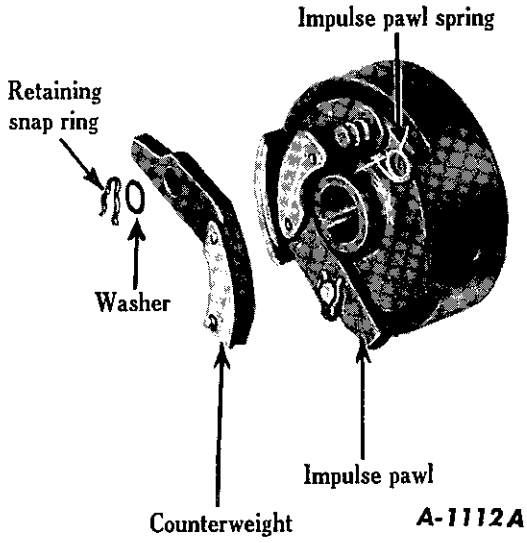
As the speed of the engine increases, the weighted ends of the pawls are thrown out by centrifugal force and their short ends no longer engage the pawl stop pins in the mounting flange. The spark is no longer retarded. The missing speed, approximately 150 rpm is the speed at which the impulse coupling no longer continually retards the spark. At this speed



Illust. 24 - Magneto Impulse Coupling Removed.

PRINTED IN UNITED STATES OF AMERICA

IMPULSE COUPLING

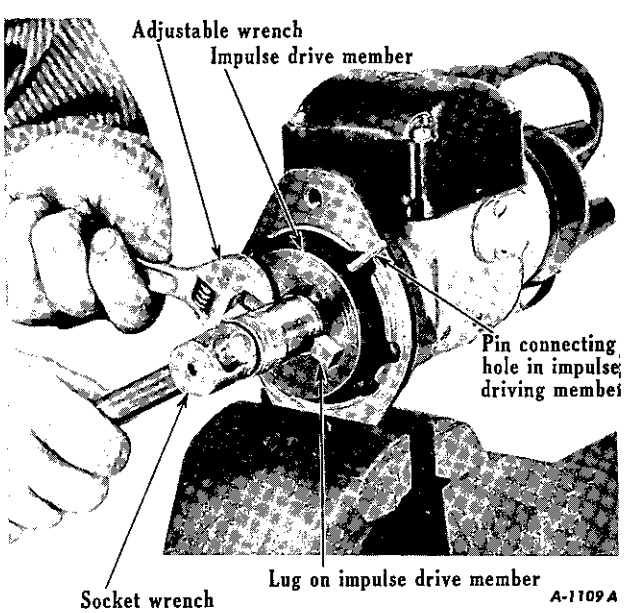


Illust. 25 - Complete Impulse Coupling Showing Rear Side of Magneto Member with Impulse Pawl Removed.

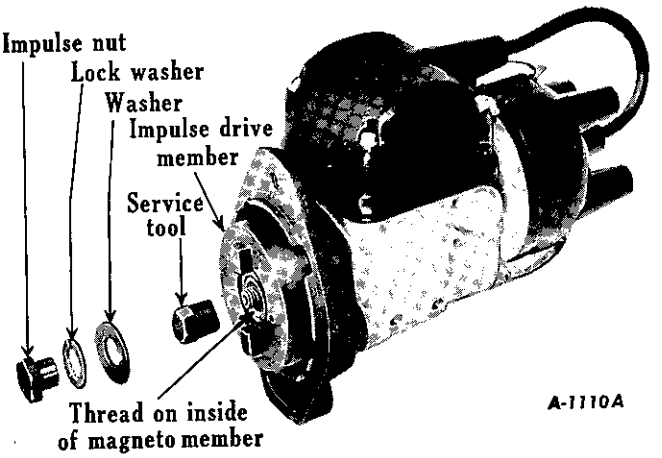
it retards the spark intermittently only. Over the range of the throw-out speed, 240 to 330 rpm, the impulse coupling must cease to function completely, giving the effect of a direct drive.

31. REMOVAL

To remove the impulse coupling, insert a nail or pin through a hole (Illust. 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) (Illust. 27). As the tool is turned in, the inside end contacts the rotor shaft and forces the member off the shaft.



Illust. 26 - Correct Method of Removing Impulse Coupling Nut.



Illust. 27 - Removing Impulse Coupling.

32. DISASSEMBLY AND REASSEMBLY
(Refer to Illust. 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, if it is 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 must 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.

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 must move freely on the pivots. When installing

(Continued on next page.)

IMPULSE COUPLING

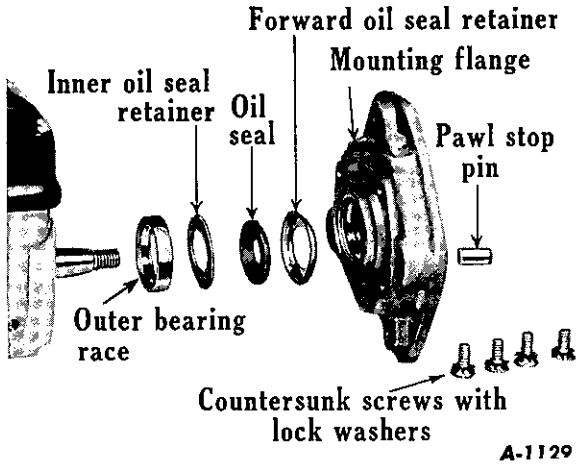
32. DISASSEMBLY AND REASSEMBLY - Continued

the drive member, be sure the lug of the magneto member fits between the spring buttons.

33. INSTALLATION

(Refer to Illust. 28.)

Place a small amount of magneto grease on the pawl pin. 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.



Illust. 28 - Magneto with Impulse Coupling.

MOUNTING FLANGE

34. REMOVAL

The mounting flange (Illust. 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 32). The flange is freed by taking out the four screws.

35. DISASSEMBLY AND REASSEMBLY

Remove the outer bearing race (Illust. 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 (Illust. 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. Be careful 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 puller and adapter shown in Illust. 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.

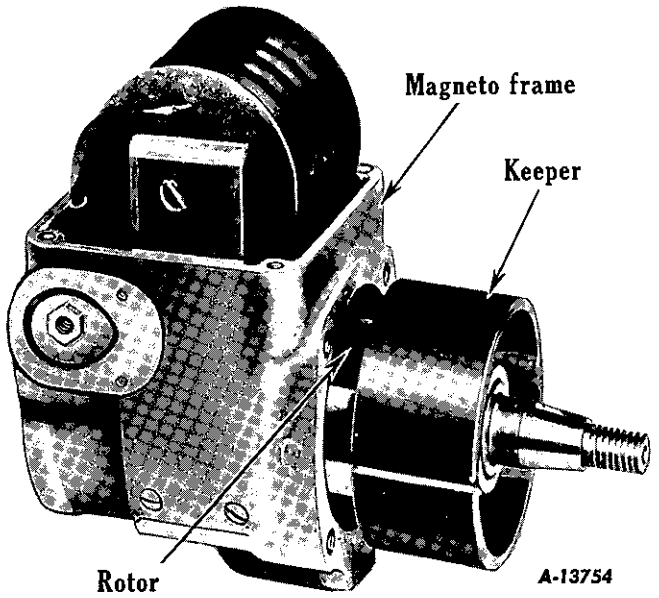
39. REASSEMBLY

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 (Illust. 32) with the upset portion toward the rotor magnet.

PRINTED IN UNITED STATES OF AMERICA

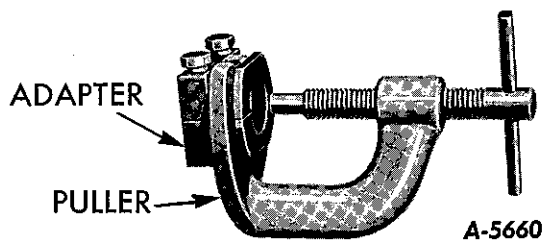
ROTOR



Illust. 29 - Removing Magneto Rotor.

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).

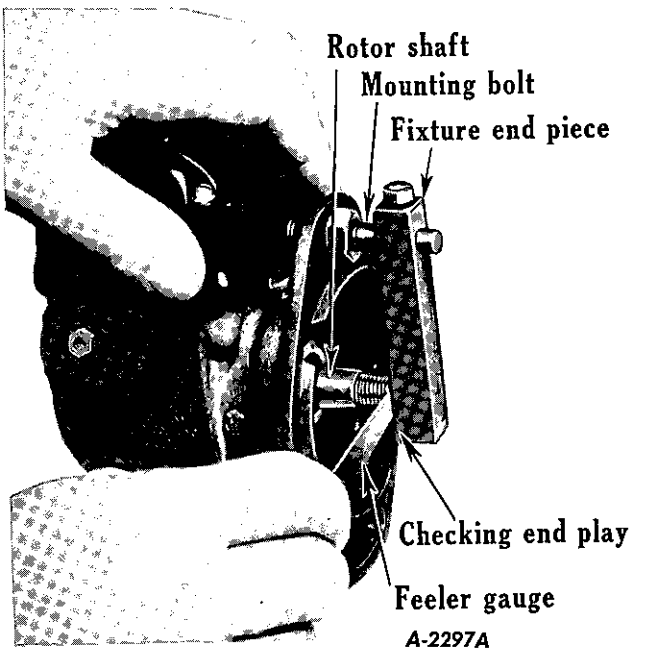


Illust. 30 - Inner Race Puller Tool SE-839.

40. ADJUSTMENT

Thoroughly clean the rotor assembly and bearing races of the old grease and any grit. Lubricating the bearings must not be done until they have been checked for end play.

The old bearings and races must be assembled without disturbing the shims. If an end play check reveals that end play is present, no attempt must be made to preload the old bearings, as this would cause rapid deterioration of the bearings. The recommended procedure, when



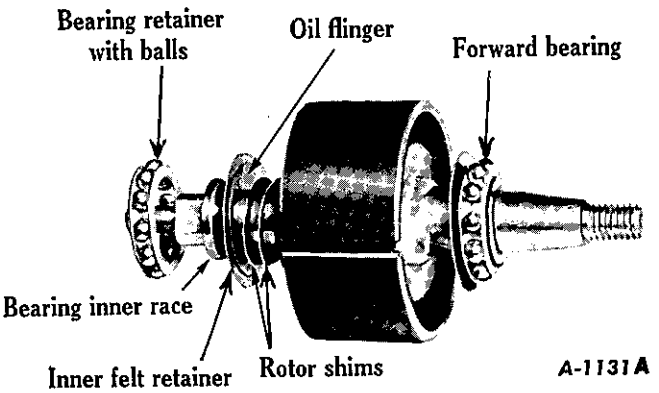
Illust. 31 - Checking Rotor End Play.

end play exists on old bearings, is to replace them.

The distributor body assembly (Illust. 14) must be removed to facilitate correct adjustment of the magneto rotor.

Place sufficient shims (Illust. 32) in back of the new bearing race to allow a small amount

(Continued on next page.)



Illust. 32 - Rotor Shaft with Keeper, Bearings and Shims.

ROTOR

40. ADJUSTMENT - Continued

of end play in the rotor shaft after it is completely assembled. The end play must be checked with no grease on the bearings. Secure the mounting flange in place with the mounting screws (Illust. 28). Then check the end play between the fixture and the end of the rotor shaft with a feeler gauge (Illust. 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 .001 inch to the difference between the two readings, which should be the thickness of the additional shims to be added.

Remove the mounting flange, slide the rotor into the keeper, pull the outer race from the shaft and add the required number of shims (Illust. 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 must not cause binding of the rotor.

41. INSTALLATION

Install the impulse coupling, distributor body, distributor and distributor cap.

BEARING OUTER RACES AND OIL SEALS

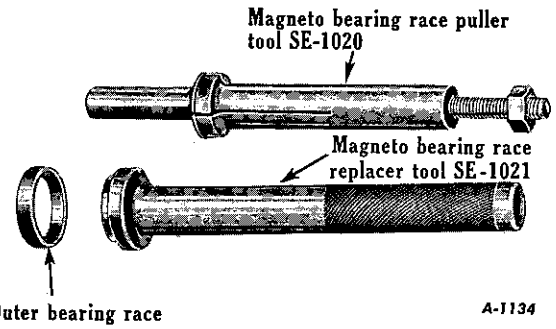
42. REMOVAL

The front bearing outer race and oil seal are assembled in the mounting flange (Illust. 38). They are accessible after removing the impulse coupling and the mounting flange as directed. (Refer to par. 31 and 34.) 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 (Illust. 28). The rotor bearing races can be removed with a puller (SE-1020) and installed with tool (SE-1021) shown in Illust. 33.



Illust. 33 - Tools Used for Removing and Installing Magneto Outer Bearing Races.

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 turn 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 assembling the outer bearing race and oil seal is shown in Illust. 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.

Set the bearing race on the end of the tool (Illust. 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.

PRINTED IN UNITED STATES OF AMERICA

1. DESCRIPTION

IH Models A, B and H

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) (Illust. 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) (Illust. 1).

The second function is to time these surges to the requirements of the engine. This is accomplished by the advance mechanism.

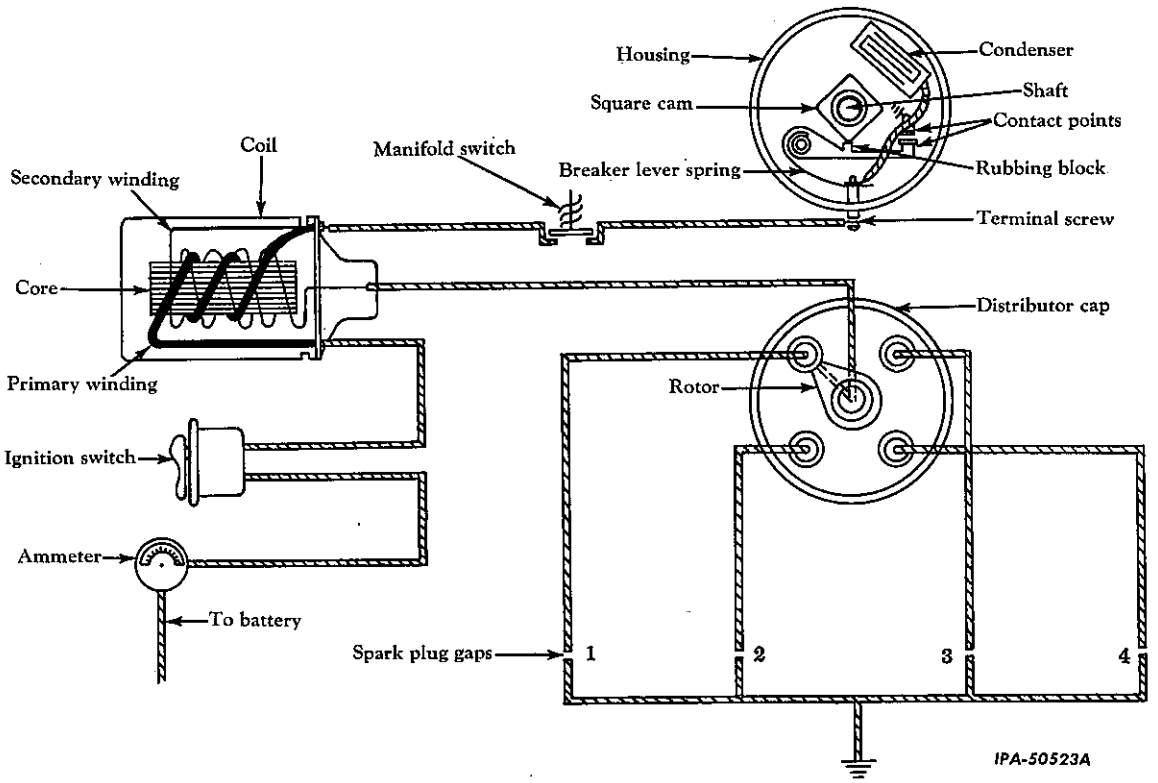
NOTE: Some distributors do not have an advance mechanism because engine performance does not require it.

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 (Illust. 2).

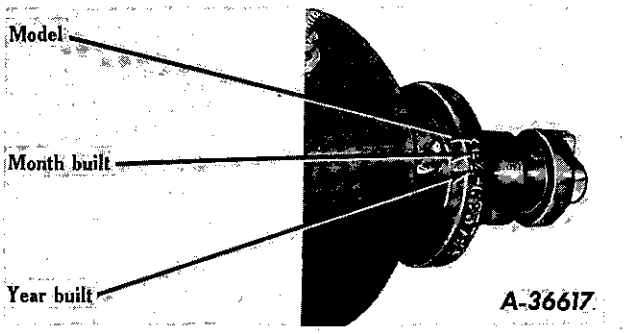
The distributor mounting bracket is located on the right rear side of the crankcase front plate and has a shaft which is geared to the gear train. The drive housing is mounted on the rear of the mounting bracket with a shaft that has lugs to engage with the slots in the shaft of the mounting bracket. 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. For removal of the mounting bracket, refer to par. 2 in Section 12.



Illust. 1 - Schematic View of the Ignition System Using a High Tension Distributor.

1. DESCRIPTION - Continued



Illust. 2 - Model Designation.

2. REMOVAL

IH Models A, B and H

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.

3. DISASSEMBLY

IH Models A, B and H

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.

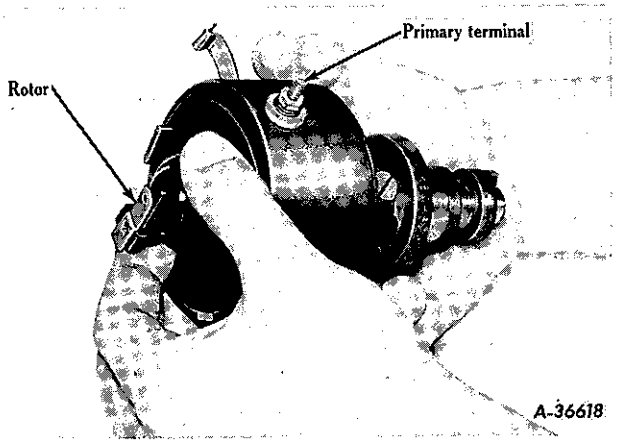
NOTE: Model H distributor coils have a mounting bracket attached to the drive housing by two cap screws. The coil and clamp are mounted to the bracket.

3. Remove the two distributor mounting clamps.

4. Remove the distributor from the drive housing.

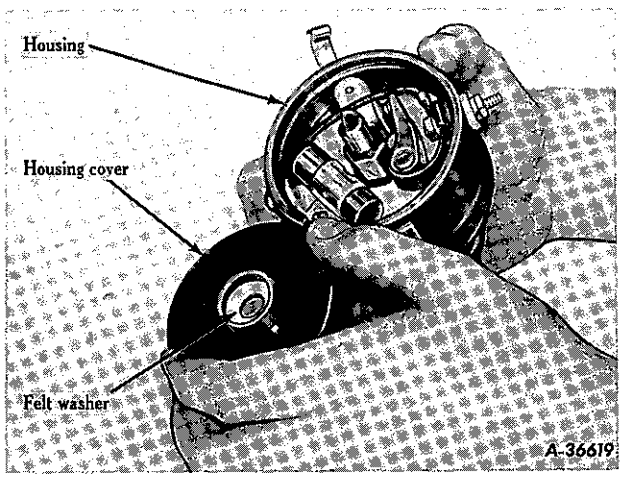
5. Remove the distributor rotor (Illust. 3).

CAUTION: The distributor rotor is made of bakelite and will crack or break easily.



Illust. 3 - Removing Distributor Rotor (IH Model K Shown, Others Similar).

6. Remove the housing cover and felt seal; rotating the cover will ease removal (Illust. 4).



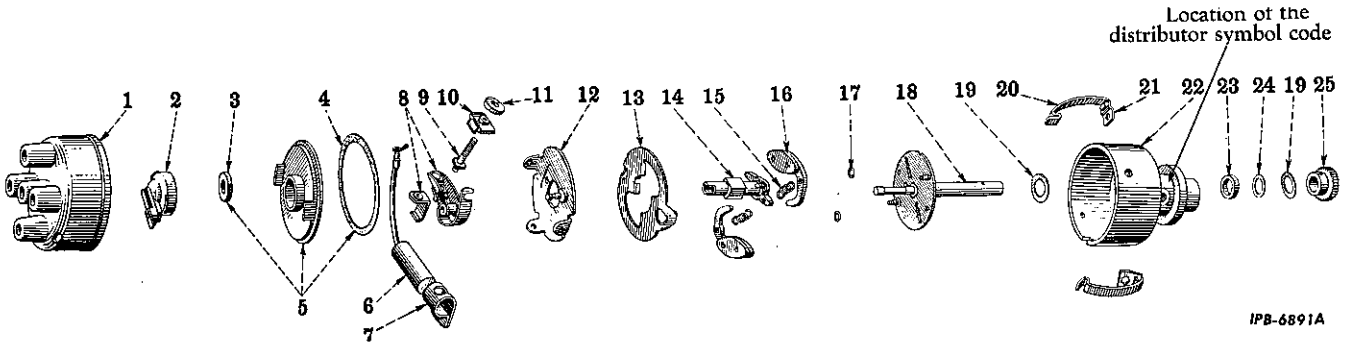
Illust. 4 - Removing Distributor Housing Cover and Felt Washer (IH Model K Shown, Others Similar).

7. Remove the slotted screw from the condenser clamp, remove the primary terminal screw nut (the nut inside the housing) and remove the condenser (Illust. 6).

8. Lift the breaker lever off the pivot (Illust. 7). Remove the stationary point.

9. Remove the terminal screw nuts, lock washers, brass washers, terminal insulators and terminal screw from the housing (Illust. 8).

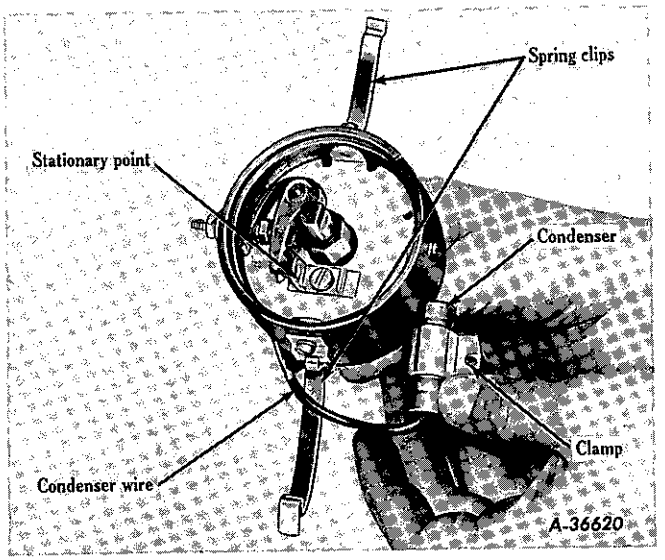
PRINTED IN UNITED STATES OF AMERICA



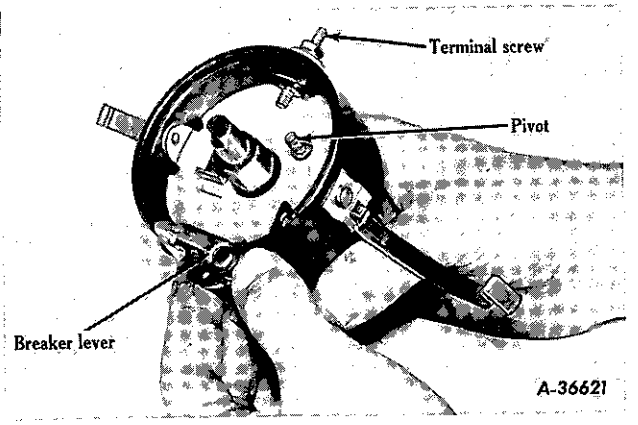
Illust. 5 - Battery Ignition Distributor (Type H).

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.



Illust. 6 - Removing Condenser (IH Model K Shown, Others Similar).



Illust. 7 - Removing Breaker Lever (IH Model K Shown, Others Similar).

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 (Illust. 8).

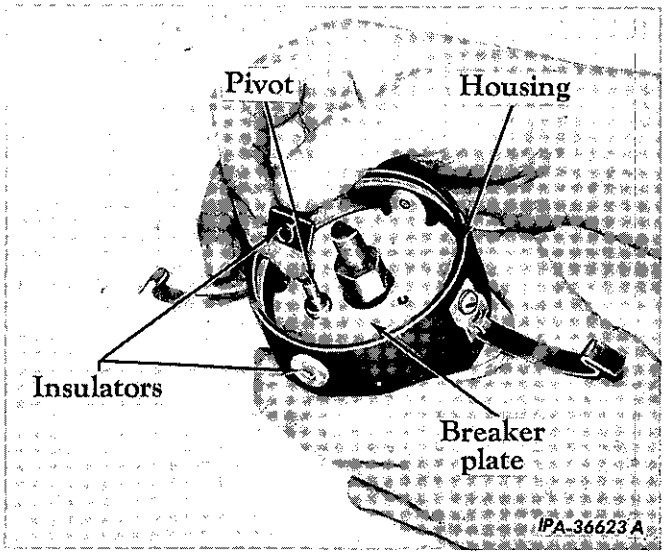
12. Remove the governor weight guard by removing the two slotted screws and lifting the guard out (Illust. 11).

13. Remove the governor weight arm springs.

14. Lift out the governor weight arms and spacers (Illust. 12).

15. Lift the cam off the shaft.

(Continued on next page.)



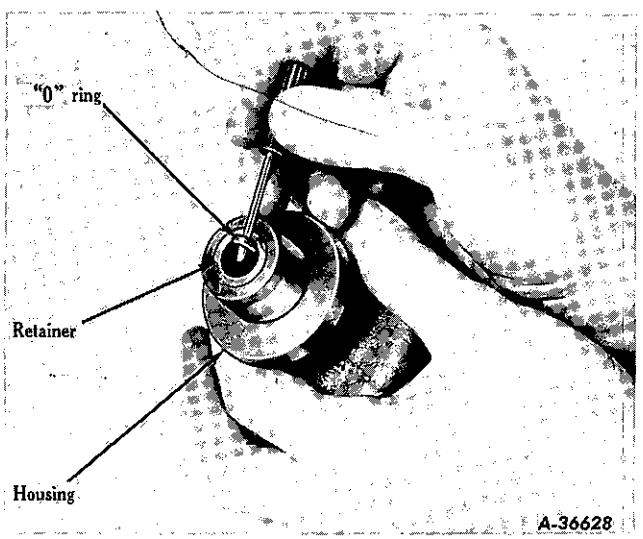
Illust. 8 - Removing Inside Terminal Insulator (IH Model K Shown, Others Similar).

16. Remove the pin from the drive gear and shaft. The gear can then be removed from the shaft (Illust. 13).

17. Remove the drive shaft through the top of the housing (Illust. 14).

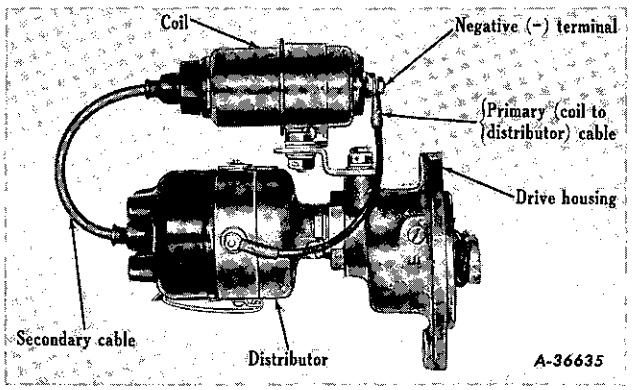
18. Remove the "O" ring from the retainer at the base of the housing (Illust. 9).

NOTE: The retainer does not have to be removed, unless it is badly worn or scored.

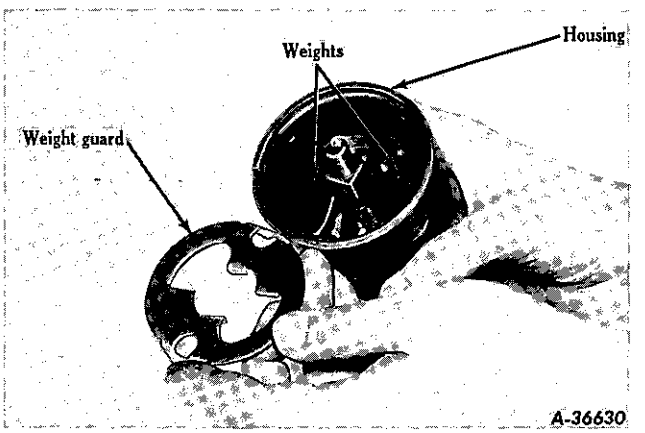


Illust. 9 - Removing Drive Shaft "O" Ring.

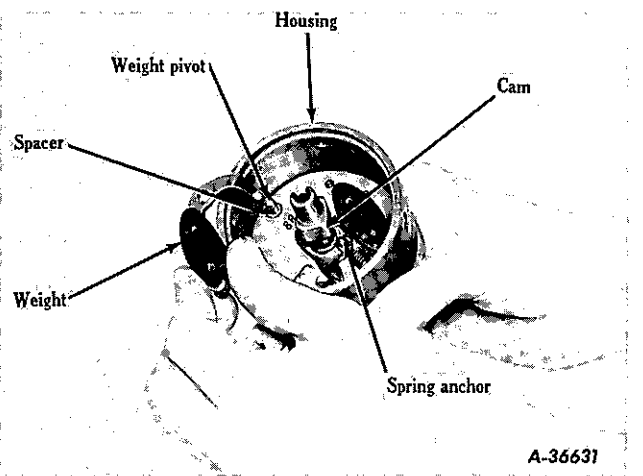
19. If the bushing is excessively worn or scored, install a new bushing. (Refer to par. 4, step 2 and Illust. 15.)



Illust. 10 - IH Model H Battery Ignition (Models A and B Similar).

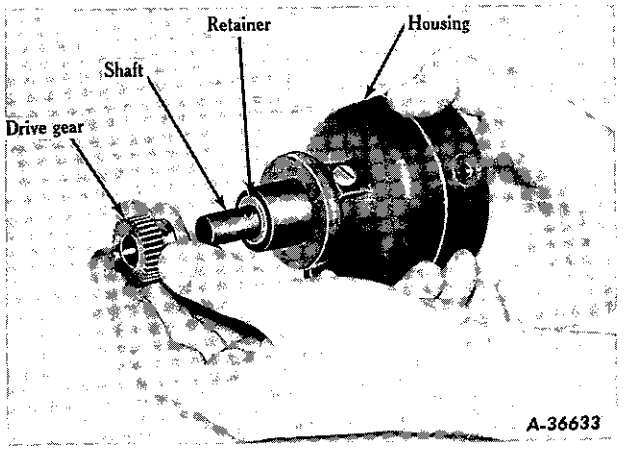


Illust. 11 - Removing Weight Guard (IH Model H Shown, Models A and B Similar).

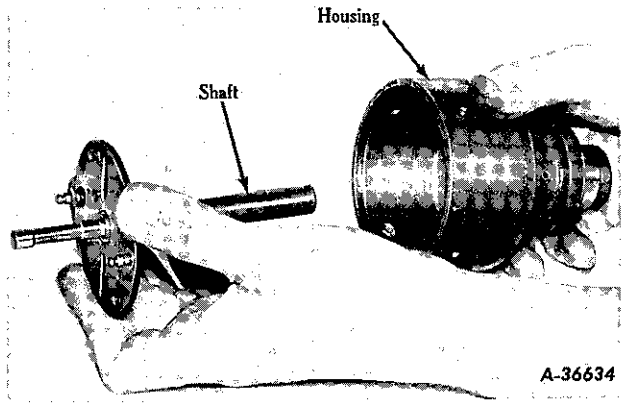


Illust. 12 - Removing Weights (IH Model H Shown, Models A and B Similar).

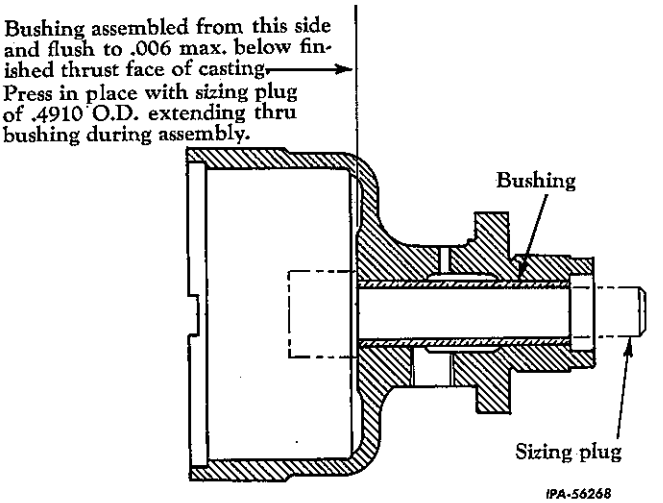
PRINTED IN UNITED STATES OF AMERICA



Illust. 13 - Removing Drive Gear (IH Model H Shown, Models A and B Similar).



Illust. 14 - Removing Drive Shaft (IH Model K Shown, Models A and B Similar).



Illust. 15 - Bushing Installation

4. INSPECTION AND REPAIR

The distributor cap, rotor, insulating washers and bushings must be wiped thoroughly with a soft, clean, dry cloth; other parts must be cleaned with a cloth dampened with carbon tetrachloride or similar dry-cleaning solvent.

CAUTION: Do not immerse the distributor in a degreasing tank; to do so will ruin electrical parts.

INSPECTION	REMEDY
1. Inspect the distributor cap, rotor and insulating washers for cracks, chips or burned surfaces.	1. Such damage can cause a leakage of high voltage to ground. Replace as necessary.
2. Inspect bushings for excessive wear, scoring, or looseness.	2. Replace with shaft bushing package, 373 577 R91 (Illust. 15).
3. Inspect contact points for pitting and burning, for oil and dirt, and for correct gap setting.	3. Clean points with a few strokes of a fine file or contact stone. Replace parts as necessary. Gap setting should be .020 inch. NOTE: It is not necessary to file contact points until all traces of pitting or burning have been removed. File only until the high spots have disappeared. Contact surfaces after usage may appear dull, but this does not indicate faulty contact. Never use emery cloth to clean contact points. Emery may embed in the point surface and cause rapid burning and pitting.

(Continued on next page.)

INSPECTION	REMEDY
4. Inspect for oxidized contact points.	4. 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.
5. Inspect condenser for secure connections.	5. 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.	6. 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 breakdown.	7. Replace as necessary. Such breakdown will cause a short circuit in the condenser.
8. Inspect rubbing block for excessive wear.	8. Replace as necessary.
9. Check breaker lever spring for correct tension.	9. Weak tension on the spring may permit contacts to bounce and chatter, causing heavy burning and arcing of the points.
10. Inspect ignition coil for secure terminals.	10. Tighten terminal connections.
11. Inspect ignition coil for cracks and burns, or dents and punctures in the coil insulation and containers.	11. Replace as necessary.

5. REASSEMBLY

IH Models A, B and H

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 (Illust. 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 (Illust. 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 must be .003 to .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 (Illust. 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 (Illust. 11).

PRINTED IN UNITED STATES OF AMERICA

15. Install the breaker plate so that the threaded holes are facing upward (Illust. 8).

16. Install the two spring clips and three slotted screws.

17. Install the two terminal screw insulators (Illust. 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 .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 (Illust. 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 (Illust. 4).

25. Install the rotor on the shaft (Illust. 3).

26. Install the distributor in the drive housing, so that the primary terminal is positioned as shown in Illust. 10.

27. Install the mounting clamps and cap screws, but do not tighten them.

28. On model A and B distributors, mount the coil and clamp on the drive housing. On model H distributors, the coil and clamp are mounted on a bracket and the bracket is then mounted on top of 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

IH Models A, B and H

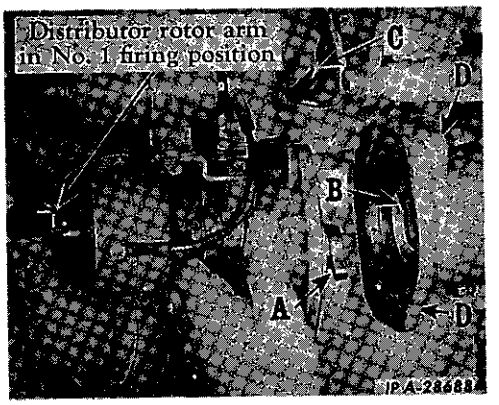
1. Before installing the distributor unit, crank the engine until the No. 1 piston (next to radiator) is on top dead center of the compression stroke. The compression stroke can be determined by removing the No. 1 spark plug, placing your thumb over the opening and cranking the engine until an outward 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.

3. Pull out the drive shaft to disengage the gears. Then turn the shaft clockwise, so that the drive shaft lugs (A, Illust. 16) are approximately 35 degrees 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, Illust. 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, Illust. 16) to the negative terminal of the coil.



Illust. 16 - Installing the Battery Ignition Unit.

7. TIMING THE DISTRIBUTOR TO THE ENGINE

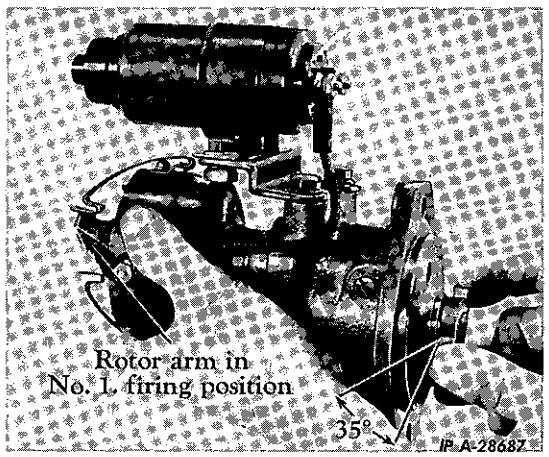
NOTE: The timing operation must be performed while the engine is on the gasoline cycle.

1. Loosen the distributor mounting bolts (B, Illust. 18). Set the engine with the No. 1 pis-

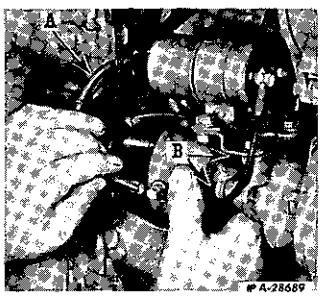
(Continued on next page.)

ton 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 degrees 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 (Illust. 18). Advance the distributor by turning the distributor body slowly in the direction opposite to the cam rotation until a spark occurs.



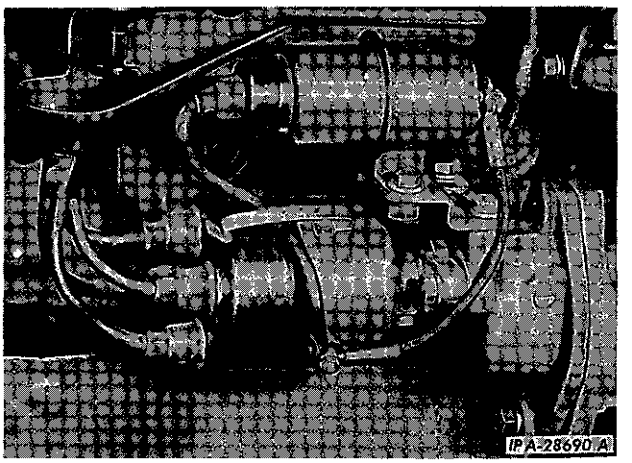
Illust. 17 - Adjusting Distributor Rotor and Drive Shaft Lugs for Timing Distributor.



Illust. 18 - Advancing the Distributor While Holding Secondary Cable 1/16 inch to 1/8 inch from Primary Terminal.

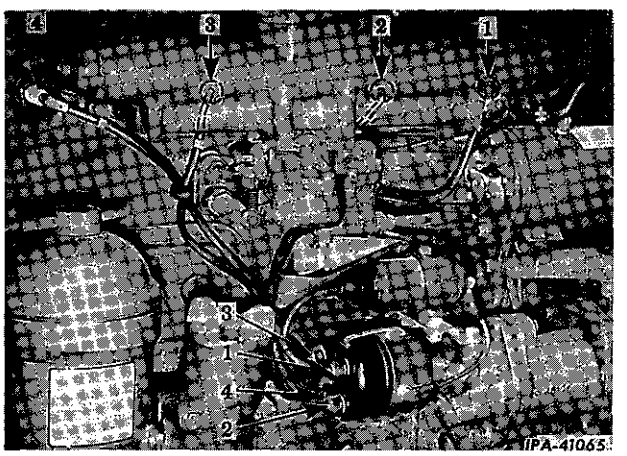
3. Place the secondary cable under the distributor cap spring and place the terminal within 1/16 to 1/8 inch of the distributor primary terminal (Illust. 19). A final check must be made by cranking the engine until the "DC" mark on the fan drive pulley again approaches the pointer on the crankcase front cover. Continue cranking until a spark just occurs at the gap between the secondary cable and the primary terminal.

4. The timing marks should just be in line or slightly past (never time before top dead center). 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.



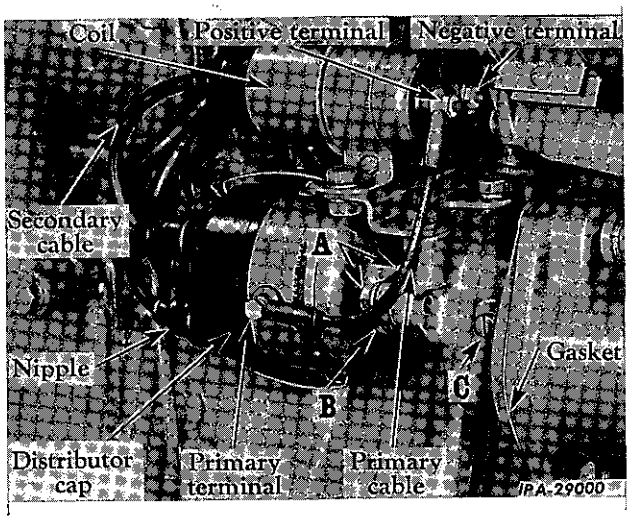
Illust. 19 - Secondary Cable Held Under Distributor Cap Spring for Timing Check.

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 (Illust. 20). Assemble the secondary cable in the distributor cap (Illust. 21).



Illust. 20 - Firing Order is 1,3,4,2 (Counterclockwise Rotation).

PRINTED IN UNITED STATES OF AMERICA



Illust. 21 - Distributor - Battery Ignition Unit.

PRINTED IN UNITED STATES OF AMERICA

1. DESCRIPTION

The type of cranking motors used on all 6 and 9 series tractor and power unit engines are listed in the "Chart A - Cranking Motors" in Section 1, par. 2. The cranking motors are all flange mounted to the flywheel housing. The two types of motor drives are - Bendix and Overrunning clutch types.

The starting switch used on all early 6 and 9 series tractors, is mounted directly to the cranking motor and actuated by a starting switch rod (extending through the dash) within reach of the operator. The switch is a simple contact type.

The 6 (61) and 9 (91) series tractors are equipped with the push button type starting switch which is mounted on the instrument panel and through which the circuit is closed between the battery and cranking motor.

When removing the starting switch, tag the cables as removed to facilitate installation. Replace defective switches with new ones instead of attempting a repair. (Refer to parts catalog.)

Bendix Drive

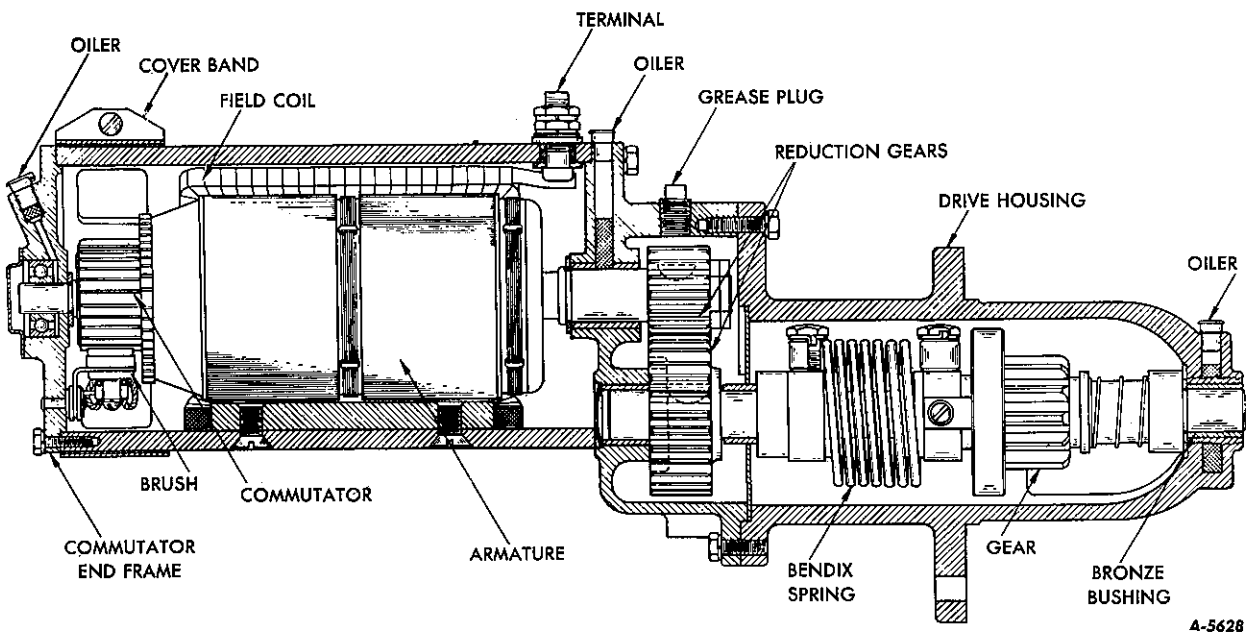
The Bendix drive is incorporated with the cranking motor. The pinion of the drive is mounted on a threaded sleeve in such a manner that when the armature of the cranking motor rotates, the threaded sleeve turns within a gear, moving it endwise. This causes the pinion to mesh with the flywheel ring gear and crank the engine. When the engine starts, the flywheel drives the gear at a higher speed than the armature; thus, causing the gear to be moved in the opposite direction on the threaded shaft. The gear then automatically unmeshes the pinion from the flywheel. The drive spring is arranged to take the sudden shock when the pinion meshes with the flywheel (Illust. 1).

Overrunning Clutch Drive

The overrunning clutch is designed to provide positive meshing and demeshing of the drive pinion and flywheel ring gear. The overrunning clutch cranking motor uses a shift lever, which slides the clutch and drive pinion assembly along the armature shaft, so that it can be meshed and demeshed as required. The clutch transmits cranking torque from the cranking motor armature to the flywheel but permits the drive pinion to overrun, or run faster than the armature after the engine is started. This protects the armature from excessive speed during the brief interval that the drive pinion remains in mesh.

The overrunning clutch consists of a shell-and-sleeve assembly which is splined internally to match the splines on the armature shaft; thus, both the shell-and-sleeve assembly and the armature must turn together. A pinion-and-collar assembly fits loosely into the shell, the

(Continued on next page.)



Illust. 1 - Cross Section of Cranking Motor with Bendix Drive.

1. DESCRIPTION - Continued

Overrunning Clutch Drive - Continued

collar is in contact with four hardened steel rollers which are assembled into notches cut in the inner face of the shell. These notches taper inward slightly so that there is less room in the end away from the rollers than in the end where the rollers are. The rollers are spring-loaded by small plungers.

When the shift lever is operated, the clutch assembly is moved endwise along the armature shaft allowing the pinion to mesh with the flywheel ring gear. If the teeth should butt instead of mesh, the clutch spring compresses. The pinion becomes spring-loaded against the ring-gear teeth, then, when the armature begins to rotate, meshing takes place at once.

Completion of the shift lever movement closes the cranking motor switch so that the armature begins to rotate. This rotates the shell-and-sleeve assembly, causing the rollers to jam tightly in the smaller sections of the shell notches. The rollers jam between the pinion collar and the shell, forcing the pinion to rotate with the armature and crank the engine.

When the engine begins to operate, it attempts, through the pinion, to drive the cranking motor armature faster than the armature is rotating. This causes the pinion to rotate with respect to the shell so that it overruns the shell and armature. The rollers are turned back toward the larger section of the shell notches where they are free; thus, permitting the pinion to overrun.

This protects the armature for the brief period in which the starting switch is engaged and disengaged. Opening the cranking circuit releases the shift lever, causing the lever spring to pull the overrunning clutch drive pinion out of mesh with the flywheel ring gear.

2. MINOR REPAIRS AND ADJUSTMENTS

The cranking motor must be inspected periodically, as outlined below, to determine its condition while it is still mounted on the engine. However, inspection must be made when the cranking motor is removed and disassembled for service or repair.

1. Inspect the terminals, external connections, wiring and mounting.

2. Remove the cover band so that the commutator, brushes and internal connections can be inspected.

3. If the commutator is glazed or dirty, it may be cleaned with a strip of No. 00 sandpaper. Do not use emery cloth to clean a commutator.

Hold the sandpaper strip against the commutator with a flat wood stick, moving it back and forth across the commutator, while the cranking motor is in operation. Glaze and dirt will be removed quickly. Blow all dust from the cranking motor after the commutator has been cleaned. A brush seating stone may also be used to clean commutators.

CAUTION: Never operate a cranking motor for periods longer than 30 seconds. Allow the cranking motor to cool for at least two (2) minutes.

4. If the brush length is less than 1/2 inch, or if the brush leads have broken strands or are otherwise damaged, the brushes must be replaced.

New brushes must be seated with a brush seating stone to be sure there is good contact with the commutator. Blow the dust out of the cranking motor after the brushes are properly seated.

5. Check the brush spring tension with a spring gauge. Hook the gauge to the brush arm or brush attaching screws. (Refer to par. 2, "SPECIFICATIONS" in Section 1.) It is important that the tension is correct, since escessive tension will cause rapid brush and commutator wear, while low tension causes arcing and burning of the brushes and commutator. Correct the tension by bending the brush spring as required. If the brush spring shows evidence of overheating (blued or burned), do not attempt to adjust it, but install a new spring. Overheating will cause a spring to lose temper.

If the cranking motor still fails to operate properly, remove it from the engine and test it with special testing equipment.

3. REMOVAL

1. Disconnect the electrical leads from the cranking motor and tag each to identify and to facilitate replacement.

2. Remove the cranking motor from the engine.

4. TESTING THE CRANKING MOTOR

To check the performance of the cranking motor or to determine the cause of abnormal operation, the cranking motor must be submitted to a no-load and a torque test. Detailed instructions for performing these tests can be

PRINTED IN UNITED STATES OF AMERICA

found in the service literature furnished with the testing equipment being used.

Interpreting Results of Test

Rated torque, current draw and no-load speed specifications are shown in par. 2, "SPECIFICATIONS " in Section 1.

1. Low free speed and high current draw with low developed torque may result from:

(a) Tight, dirty, or worn bushings, bent armature shaft or loose field pole screws which allow the armature to drag.

(b) Shorted armature. Check the armature further on a growler.

(c) A grounded armature or field. Raise the grounded brushes and insulate them from the commutator with cardboard and then check with a test lamp between the insulated terminal and the frame. If the test lamp lights, raise the other brushes from the commutator and check the fields and commutator separately to determine whether it is the field or armature that is grounded.

2. Failure to operate with high current draw:

(a) A direct ground in the switch, terminal or fields.

(b) Frozen shaft bushings which prevent the armature from turning.

3. Failure to operate with no current draw:

(a) Open field circuit. Inspect the internal connections and trace the circuit with a test lamp.

(b) Open armature coils. Inspect the commutator for badly burned bars. When running at free speed, an open armature will show excessive arcing at the commutator bar that is open.

(c) Broken or weakened brush springs, worn brushes, high mica on the commutator, or other causes which would prevent good contact between the brushes and commutator. Any of these conditions will cause burned commutator bars.

4. Low no-load speed with low torque and low current draw indicates:

(a) An open field winding. Raise and insulate the ungrounded brushes from the commutator and check the fields with a test lamp.

(b) High internal resistance due to poor connections, defective leads, dirty commutator and the causes listed under step 3.

5. High free speed with low developed torque and high current draw indicates shorted fields. There is no easy way to detect shorted fields since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

NOTE: To determine the presence of short circuits in the wiring, turn off all electrical equipment. Disconnect the battery-to-cranking motor solenoid switch cable at the battery. Tap the cable terminal against its battery post. Sparking will be produced, if there is a substantial short circuit in the wiring. Be sure that the fuses have not burned out before making this test. To detect a very slight short circuit, install a low reading ammeter (in a series) in the circuit.

5. DISASSEMBLY

Disassembly should proceed only as far as is necessary to make repairs or to replace defective parts.

For example, the field coils must be checked for opens or grounds and, if found to be in normal condition, must not be removed from the field frame.

The disassembly procedure to be followed for the cranking motor will vary according to the type and construction of the cranking motor.

Standard Bendix Drive

1. Remove the starting switch.

2. Take off the cover band and detach the brush leads from the field leads.

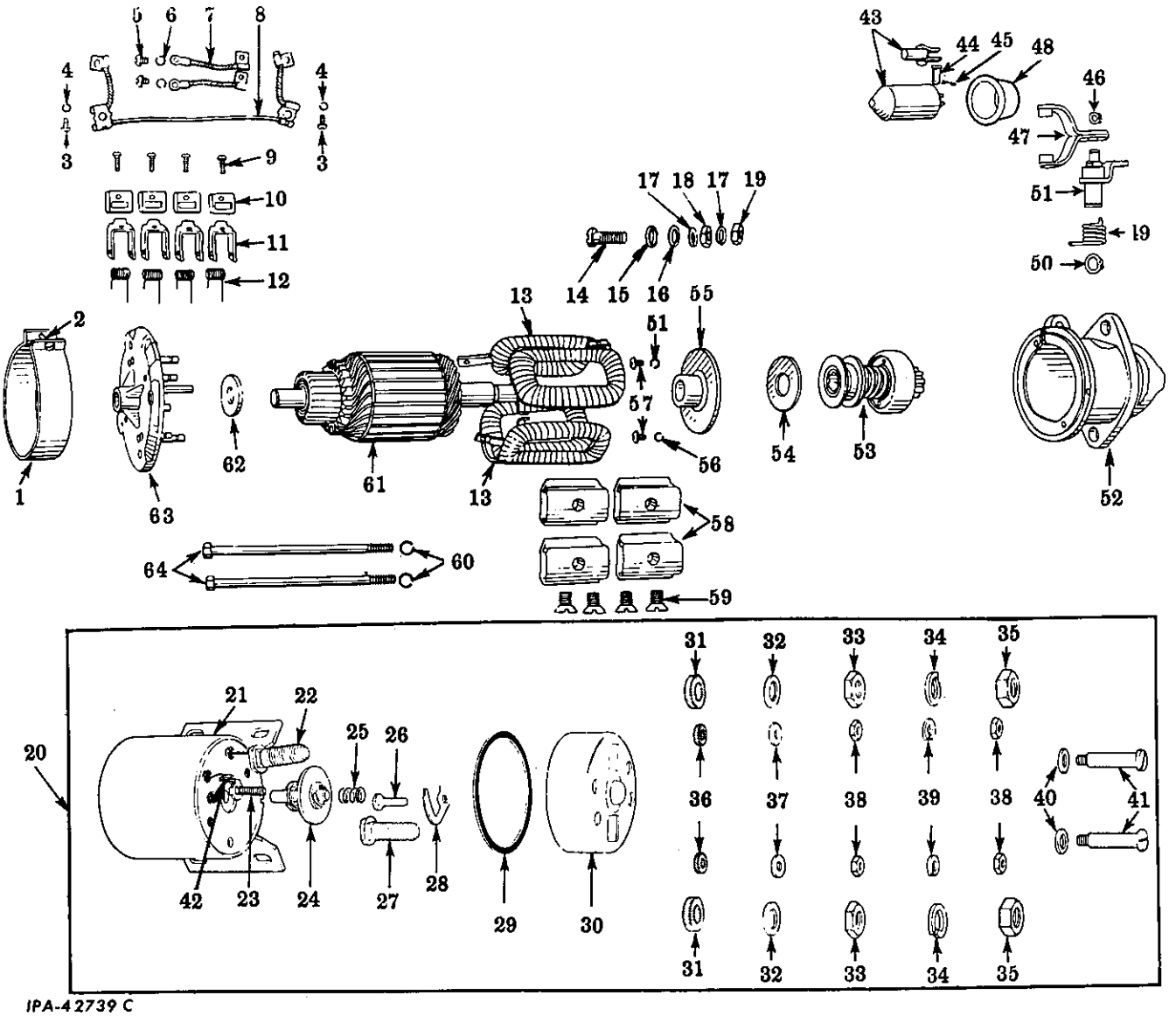
3. Unscrew the thru bolts and take off the commutator end frame and field frame assembly. Where there is a center bearing attached to the drive housing, detach it.

4. Remove the armature (with the Bendix drive) from the drive housing. The Bendix drive can be detached from the armature shaft by removing the head spring screw.

5. Unscrew the shaft spring screw to separate the drive spring from the drive pinion and shaft assembly. Discard the tang washers.

(Continued on page 5 .)

5. DISASSEMBLY - Continued



Illust. 2 - Exploded View of Solenoid-Overrunning Clutch Cranking Motor.

1. Cover band.
2. Screw.
3. Screw.
4. Washer.
5. Ground screw.
6. Lock washer.
7. Ground lead.
8. Jumper lead.
9. Brush screw.
10. Brush.
11. Brush holder.
12. Brush spring.
13. Field coil.
14. Terminal stud.
15. Washer.
16. Washer.
17. Lock washer.
18. Terminal nut.
19. Terminal nut.
20. Starting switch.
21. Case and coil.
22. Terminal stud.
23. Terminal stud.
24. Contact and rod.

PRINTED IN UNITED STATES OF AMERICA

25. Return spring.
26. Terminal stud.
27. Battery terminal stud.
28. Contact blade.
29. Cover gasket.
30. Cover.
31. Terminal (rubber) washer.
32. Terminal (plain) washer.
33. Terminal nut.
34. Terminal lock washer.
35. Terminal nut.
36. Terminal (rubber) washer.
37. Terminal (plain) washer.
38. Terminal nut.
39. Terminal stud washer.
40. Cover attaching screw washer.
41. Cover attaching screw.
42. Terminal clip.
43. Plunger and link.
44. Shift lever pin.
45. Shift lever cotter pin.
46. RH shaft retainer ring.
47. Shift lever.
48. Plunger boot.
49. Shift lever spring.
50. Shaft retainer ring.
51. Lever and shaft.
52. Drive housing w/ bushing.
53. Motor (clutch type) drive assembly.
54. Brake washer.
55. Plate w/bushing.
56. Lock washer.
57. Center bearing screw.
58. Pole shoe.
59. Pole shoe screw.
60. Thru bolt lock washer.
61. Armature.
62. Space washer.
63. End frame and pin assembly.
64. Thru bolt.

Gear Reduction Bendix Drive
(Refer to Illust. 1.)

1. Proceed as in steps 1 and 2 for standard Bendix drive type.

2. Remove the screws which attach the drive housing and separate the drive housing from the reduction gear housing.

3. Remove the drive shaft (with gear and Bendix drive) from the drive housing.

4. Separate the field-frame assembly from the reduction gear housing by removing the attaching screws.

5. Remove the armature from the gear housing. Where the gear is detachable from the armature, take off two nuts, gear and keys before separating the armature from the housing.

6. Remove the head spring screw and the Bendix drive can be detached from the drive shaft.

7. Remove the brush and springs from the commutator end frame if necessary to replace them.

Solenoid Overrunning Clutch
(Reference Numbers Refer to Illust. 2.)

1. Remove the starting solenoid assembly (20) from the field frame assembly. Remove the cover band.

2. Detach the brush leads from the field leads.

3. Remove the thru bolts and separate the commutator end frame (63), field frame assembly and the drive housing (52).

4. Remove the center bearing (55) by removing the two screws (57) and washers (56).

5. The shift lever (47) with attaching parts and the overrunning clutch or motor drive (53) may be taken from the drive housing (52).

6. INSPECTION AND REPAIR

1. Wash all metal parts except armature and fields in cleaning solvent. Degreasing solvents will damage the insulation in the fields and armature.

2. Inspect cranking motor bushings for roughness or scoring, replace if necessary.

3. Inspect the armature commutator. If it is worn, dirty, out-of-round or has high mica, the armature must be put in a lathe, the commutator turned down and the mica undercut. The mica must be undercut 1/32 of an inch and the slots cleaned out carefully to remove any trace of dirt or copper dust. As a final step in this procedure, sand the commutator lightly with No. 00 sandpaper to remove any slight burrs left from the undercutting.

4. An open circuited armature can be saved if the open is obvious and repairable. The most likely place that an open will occur is at the commutator riser bars. This usually results from excessively long cranking periods which causes overheating of the cranking motor and

(Continued on next page.)

6. INSPECTION AND REPAIR - Continued

melting of the solder which will be thrown on the cover band. Resolder the leads in the riser bars (using rosin flux). Turn down the commutator to remove the burned spot and undercut the mica as previously explained.

5. Short circuits in the armature are located by use of the growler. When the armature is revolved in the growler with a steel strip, such as a hacksaw blade, held above it, the blade will vibrate above the area of the armature core in which the short is located. Copper or brush dust in the slots between the commutator bars sometimes causes shorts between bars. These shorts can be eliminated by cleaning out the slots. Shorts at cross-overs of the coils at the core end can often be eliminated by bending wires slightly and reinsulating the exposed bare wire.

Grounds in the armature are detected by use of a a test lamp and test points. Place one lead of the test lamp on the armature core or shaft and the other lead on each commutator bar. If the lamp lights, the commutator is grounded. Repairs can sometimes be made if grounds are at core ends (where the coils come out of the slots) by placing insulating strips between the core and coil which has grounded.

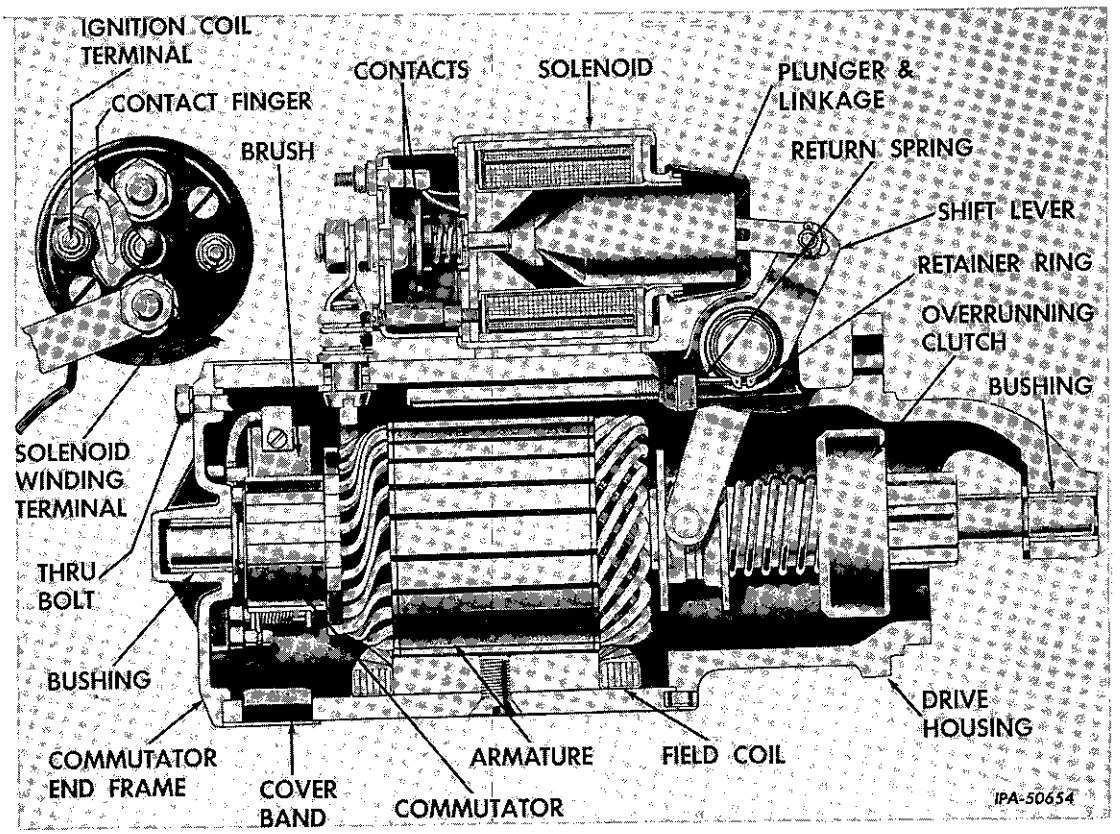
6. Grounded field coils can sometimes be repaired by removing them, so they can be reinsulated. Be careful to avoid excessive bulkiness when applying new insulation, since this might cause the pole shoe to cut through and cause another ground when the coils are reinstalled.

Usually, if a field coil is open or shorted internally, it will require replacement since it is difficult to repair such a defect.

7. FIELD COIL REMOVAL AND SERVICE

Field coils can easily be removed from the field frame assembly by the use of a pole shoe screwdriver, such as shown in Illust. 5, Section 15. A pole shoe spreader must also be used, since this prevents distortion of the field frame.

Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. Where the pole shoe has a long lip on one side and a short lip on the other, assemble



Illust. 3 - Sectional View of Overrunning Clutch Drive, Solenoid-Operated Cranking Motor.

PRINTED IN UNITED STATES OF AMERICA

the long lip in the direction of armature rotation. The long lip then becomes the trailing (not leading) edge of the pole shoe. If the varnish coating on the field coils becomes hard and interferes with assembly, they can be heated in an oven to sufficiently soften them for easy installation.

Grounded field coils can sometimes be repaired by removing and reinsulating them. Be careful in applying new insulation to avoid excessive bulkiness, since this might cause the pole shoe to cut through and produce another ground when the coils are installed.

8. LUBRICATION

Whenever the cranking motor is removed from the engine and disassembled, careful lubrication service must be performed, depending upon the type of lubrication fittings on the motor. Grease plugs must be repacked, oil wicks resaturated, and oilless bushings given a few drops of light engine oil. Drive mechanisms must be lubricated with a small amount of light engine oil or kerosene. Heavy oil or grease must not be used, as this may retard or prevent normal action of the drive mechanism. Avoid excessive lubrication. This will cause the lubricant to be forced onto the commutator and decrease its efficiency. Never lubricate the commutator or any part of the cranking motor while it is operating.

9. REASSEMBLY

Standard Bendix Drive

1. Assemble the drive spring to the drive pinion and shaft assembly and secure with the shaft spring screw. Use a new tang washer and bend the tang to lock it in place.

Use light engine oil sparingly to lubricate the Bendix drive when ready to install it.

2. Attach the Bendix drive to the armature shaft with the head spring screw. Slide the armature, with the Bendix drive assembled to it, into the drive housing.

3. Where there is a center bearing attached to the drive housing, attach it. Install the commutator end frame and thru bolts.

4. Connect the brush leads to the field leads and install the cover band.

5. Attach the starting switch to the frame.

Gear Reduction Bendix Drive

(Refer to Illust. 1.)

1. Install the brushes and springs to the commutator end frame if they are to be replaced.

2. Attach the Bendix drive to the drive shaft and secure with the head spring screw.

3. Install the armature in the gear housing. If the gear is the detachable type, install it with keys in place and secure it with two nuts. Then, install the armature in the housing.

4. Attach the reduction gear housing to the field frame with screws.

NOTE: The gear reduction housing must be repacked with medium grade graphite grease before assembly.

5. Install the drive shaft (with gear and Bendix drive) in the drive housing.

6. Assemble the drive housing to the reduction gear housing and attach the drive housing with screws.

7. Proceed as in steps 4 and 5 given for Standard Bendix drive.

Solenoid Overrunning Clutch

(Reference Numbers Refer to Illust. 2.)

1. Install the shift lever (47) with attaching parts and the overrunning clutch or motor drive (53) to the drive housing (52).

2. Install the center bearing (55) using two screws (57) and washers (56).

3. Assemble the drive housing (52), field frame assembly, commutator end frame (63) together and install the thru bolts.

4. Install the brush leads to the field leads.

5. Install the cover band. Install the starting solenoid assembly (20) to the field frame assembly. Refer to par. 11, "ADJUSTMENT - CRANKING MOTOR PINION."

10. INSTALLATION

1. Install the cranking motor to the flywheel housing.

2. Connect the tagged electrical leads to the cranking motor.

11. ADJUSTMENT - CRANKING MOTOR PINION

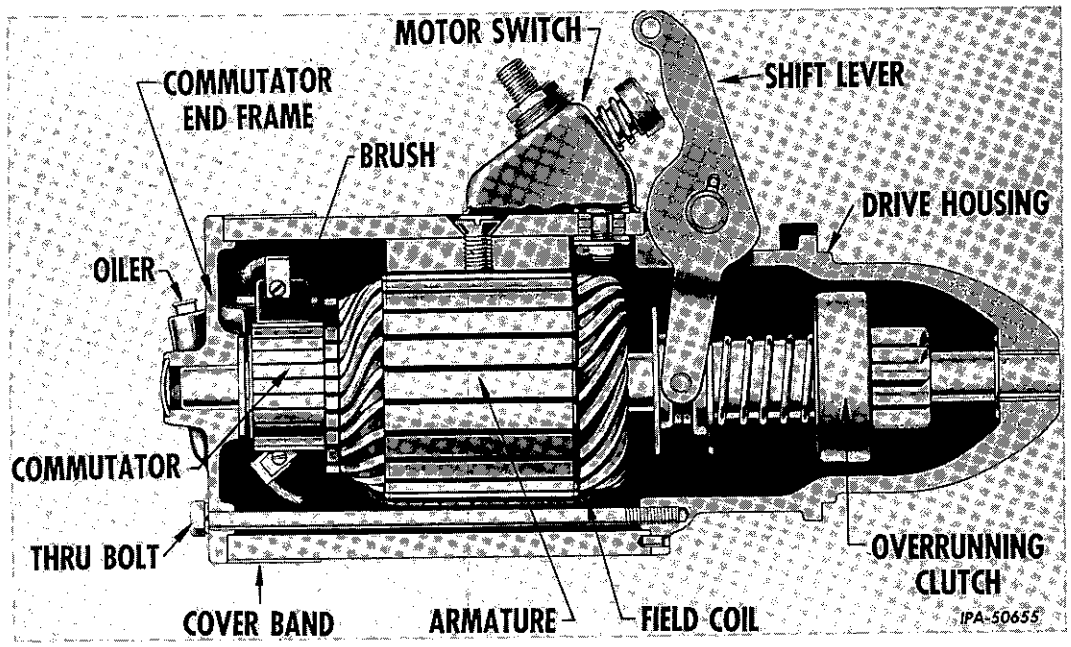
Manually Operated Overrunning Clutch
(Refer to Illust. 4.)

Clamp the cranking motor in a vise. Push the shift lever until the switch button is fully depressed and the pinion is forward. Push the pinion back until the play is taken out of the clutch mechanism. DO NOT COMPRESS THE CLUTCH SPRING.

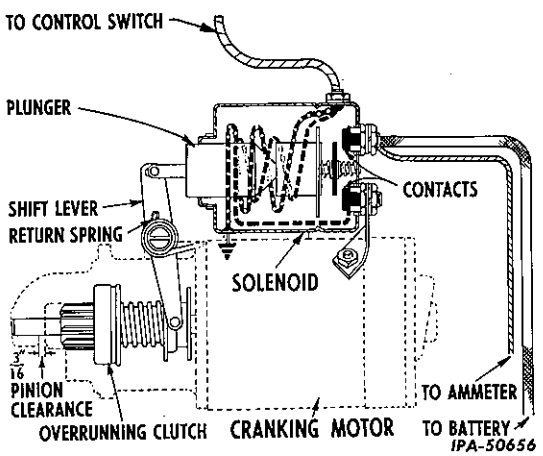
Measure the clearance between the face of the pinion and the inside nose of the drive housing. Clearance must be 23/64 inch ± 1/32 inch. Adjust by turning the lever adjusting screw in or out as necessary.

Solenoid Operated Overrunning Clutch

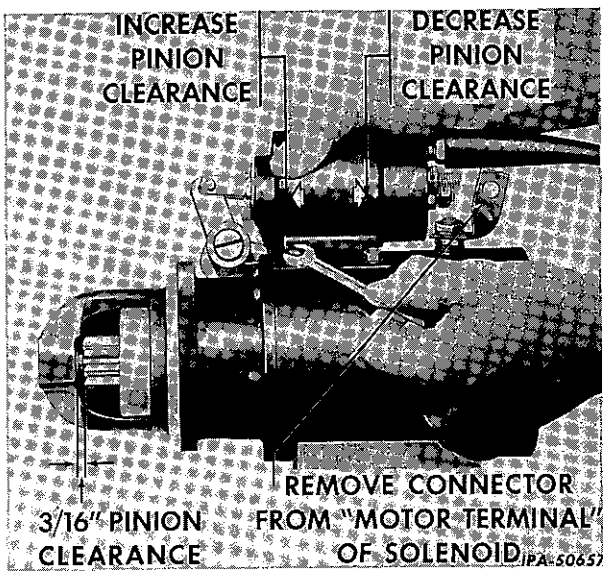
After the cranking motor is reassembled, the pinion clearance must be adjusted to give sufficient clearance between the end of the pinion



Illust. 4 - Sectional View - Overrunning Clutch, Manually Operated Shift Lever.



Illust. 5 - Schematic Diagram of Overrunning Clutch Type Cranking Motor - Showing Pinion Clearance.



Illust. 6 - Adjusting Pinion Clearance.

PRINTED IN UNITED STATES OF AMERICA

gear and the "nose" of the housing when the gear is in mesh with the ring gear of the engine (Illust. 5).

Clamp the cranking motor in a vise. Remove the cable from the "motor" terminal of the solenoid so that the cranking motor will not operate. Place a piece of 3/16 inch bar stock, or gauge, between the pinion and the housing.

Connect a battery of the proper voltage between the "switch" terminal of the solenoid and the solenoid base (ground). Push the solenoid plunger in by hand.

The battery current will hold the plunger in while the pinion clearance is being adjusted. Loosen the solenoid switch mounting screws. Pull the switch away from the shift lever until the play is taken out of the lever and clutch mechanism. DO NOT COMPRESS THE OVERRUNNING CLUTCH SPRING.

Moving the switch toward the lever increases the clearance and moving the switch away from the lever decreases the pinion clearance (Illust. 6).

Tighten the solenoid switch mounting screws and replace the connector at the "motor" terminal of the solenoid.

Solenoid Check

1. Connect a test lamp between the "switch" and "battery" terminals of the solenoid.

2. Place a 1-1/64 inch spacer block between the drive pinion and the inside nose of the drive housing.

3. Connect a battery of suitable voltage, in series, with an adjustable resistance between the solenoid "switch" terminal and "ground."

4. Adjust the voltage at the solenoid to specified * value. The test lamp should light, indicating the main contacts are closed.

* 6 - volt motor - 4.3 volts
*12 - volt motor - 9.0 volts

PRINTED IN UNITED STATES OF AMERICA

GENERATOR

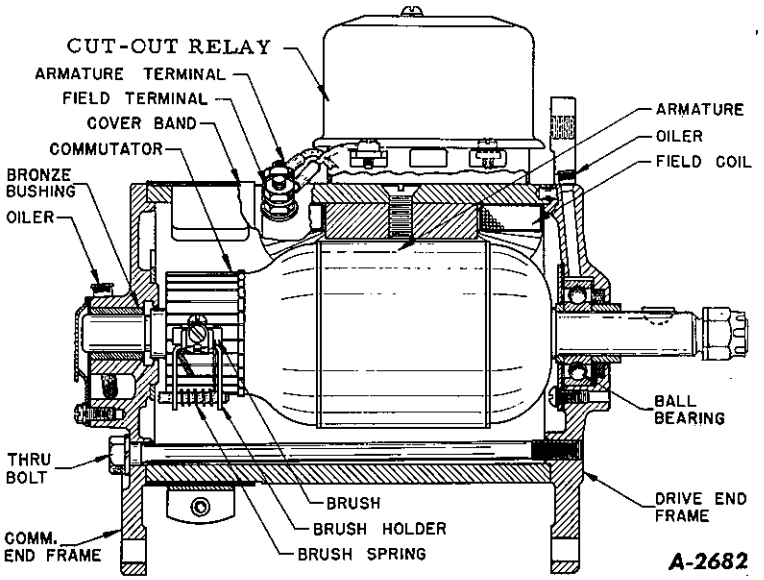
1. DESCRIPTION

The purpose of the generator is to supply current to keep the batteries in a charged condition by replacing electrical energy used by loads on the batteries. The generator is sealed against entrance of dirt and is mounted on the right side of the engine. It is driven by a V-belt from the fan and water pump pulley. The output of the generator is controlled by a current and voltage regulator.

On some engines, a 6-volt, third brush type generator is used. The third brush is set at the factory.

On some engines, a 12-volt, third brush type generator is used. The third brush is set at the factory. The TD-6 (61) and TD-9 (91) tractors are equipped with a two-brush, shunt type generator.

The direction of rotation for all generators used is clockwise, viewed from the drive end.



Illust. 1 - Cross Section of Generator.

2. REMOVAL

1. Remove the nuts, lock washers and leads from the terminals on the generator and the regulator unit. Tag each to facilitate replacement.

2. Remove the adjusting cap screw, lock washer and plain washer, which secures the generator brace to the generator housing. Push the brace upward and out of the way.

3. Loosen the mounting screws at the front and rear of the generator and push the generator toward the engine. Remove the drive belt from the generator.

4. Remove the mounting screws and lift the generator from the generator bracket.

3. INSPECTION AND REPAIR

1. Clean the generator externally by wiping it with a clean cloth dampened with a dry-cleaning solvent.

CAUTION: Do not immerse the generator in a degreasing tank; to do so will ruin electrical parts.

2. Inspect the generator wires for broken strands, corrosion and poor connections.

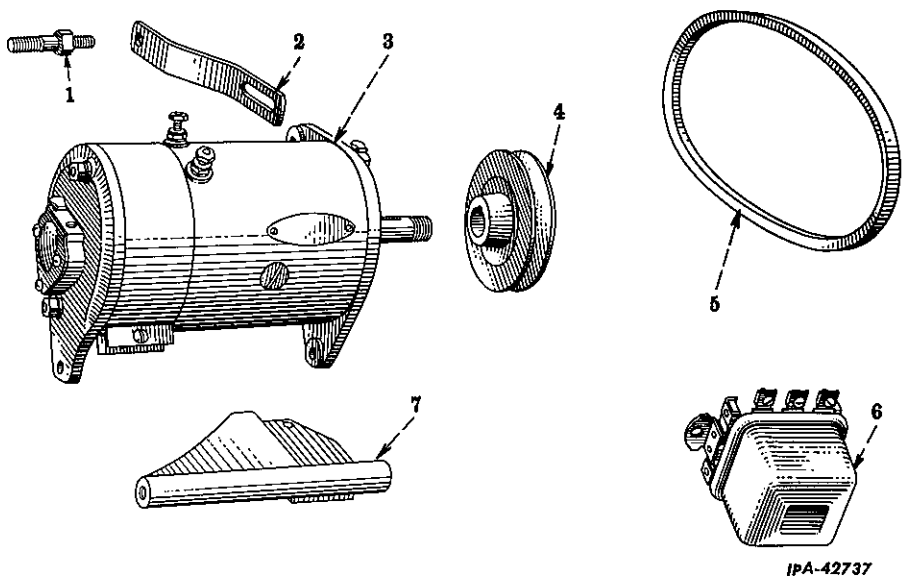
3. Check the pulley nut and generator mounting for security and damage.

4. Check for correct drive belt tension. If necessary, adjust the belt tension (par. 4).

5. Keep the commutator clean and free from grease and dirt. If the commutator is dirty or burned, polish it with No. 00 sandpaper.

CAUTION: Never use emery cloth or carborundum to clean the commutator or brushes. Particles of these abrasives will imbed in the surfaces of the commutator and brushes. There, they will burn and greatly reduce the life of the commutator or brush. Blow out dust after cleaning.

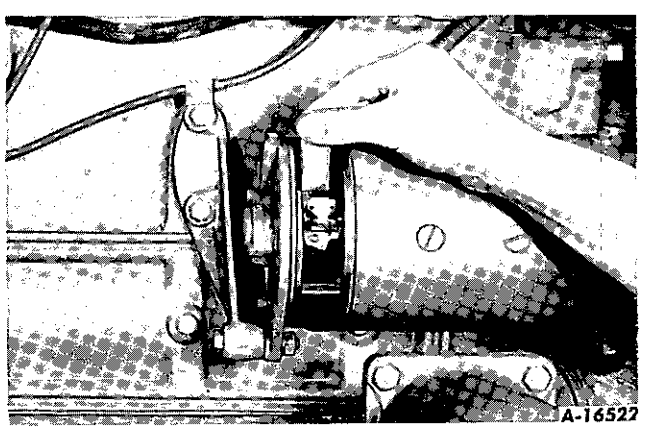
GENERATOR



Illust. 2 - Generator and Connections.

1. Generator brace stud.
2. Generator brace.
3. Generator.
4. Generator pulley.
5. Generator belt.
6. Voltage regulator.
7. Generator bracket.

3. INSPECTION AND REPAIR - Continued



Illust. 3 - Cleaning the Generator Commutator.

4. ADJUSTMENTS

Adjusting Generator Charging Rate - Third Brush Type

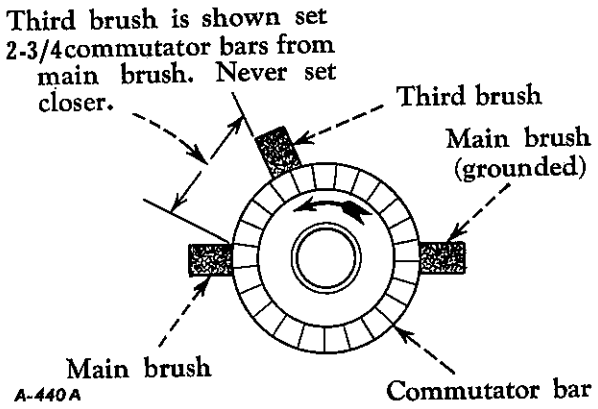
1. Check the maximum charging rate on the ammeter. Fully charged batteries must be used. With the engine operating and no electrical load imposed, remove the voltage regulator cover and slip a match between the regulator armature and the core in order to hold the contact points closed. Note the ammeter reading. With the generator cold, the reading must be in accordance with the chart given in "SPECIFICATIONS," Section 1.

2. If the charging rate is too low, check the commutator and brushes for oil and grease deposits, also, check the generator belt tension. If these checks reveal no discrepancy, loosen the third brush carrier lock screw, in the rear face of the generator, until the lock washer tension has been released. DO NOT REMOVE THE LOCK SCREW. To increase the charging rate, move the third brush in a clockwise direction as viewed from the drive end. To decrease the charging rate, move the third brush in the opposite direction.

NOTE: Never set the third brush closer than 2-3/4 commutator bars from the main brush (Illust. 4). When the required adjustment is made, secure the third brush and carrier by

PRINTED IN UNITED STATES OF AMERICA

GENERATOR



Illust. 4 - Third Brush Setting.

tightening the lock screw. Reassemble the cover band and recheck the charging rate.

Checking Brush Spring Tension

1. The generator brush tension must be as specified in "SPECIFICATIONS" in Section 1. Any brush with incorrect tension must be replaced. Excessive spring tension will cause the commutator and brushes to wear too rapidly. This will cause an unnecessary amount of dust from the brushes to be present in the generator. Low spring tension will reduce the generator output, cause sparking with consequent arcing and burning of brushes and commutator.

2. After checking the brush springs for the correct tension, inspect the brush pigtail leads for damage and bad connections. A poor connection in the charging circuit will cause the generator to build up an excessive voltage which can result in burned field or armature windings and a low current output.

Brush Length

Brushes must be replaced when their length becomes less than 1/2 inch.

Fixed Third Brush

There is no output adjustment on these generators. The output can be adjusted only by adjusting the regulator.

Two Brush - Shunt Type

There is no output adjustment on these generators. The output can be adjusted only by adjusting the current and voltage regulators, which prevent output and voltage from exceeding predetermined limits.

5. CHECKING INOPERATIVE GENERATOR

Several conditions may require removal of the generator from the engine and further checking of the generator.

No Output

Remove the cover band and check for sticking or worn brushes and burned commutator bars. Burned bars, with other bars fairly clean, indicates open circuited coils. If the brushes are making a good contact with the commutator and the commutator is in good condition, use test leads and lamp, and check as follows:

1. Raise the grounded brush; check with test points from "A" terminal to frame. The lamp should not light; if it does, the generator is grounded. Raise the other brushes from the commutator and check the field, commutator and brush holders to locate the ground.

2. If the generator is not grounded, check the field for an open circuit.

3. If the field is not open, check for a shorted field. Field draw at generator voltage should be as listed under "Field Current" in the chart in "SPECIFICATIONS," Section 1.

4. If the trouble has not been located as yet, remove the armature, and check on a growler for a short circuit.

Unsteady or Low Output

1. Check the brush spring tension and the brushes for sticking.

2. Inspect the commutator for roughness, grease, dirt, dirt in slots, high mica, out-of-round or burned bars. With any of these conditions present, the commutator must be turned down in a lathe, and the mica undercut. In addition, with burned bars, which indicate an open circuit, the open circuit must be eliminated or the armature replaced.

Excessive Output

Excessive output usually results either from wrong adjustment of the third brush, regulator or from a grounded generator field (grounded either internally or externally). To determine if the generator is at fault, open the field circuit (disconnect the lead from the "F" terminal of the regulator or the generator) with the generator running at a medium speed. If the output drops off, the field is grounded externally.

(Continued on next page.)

GENERATOR

5. CHECKING INOPERATIVE GENERATOR - Continued

Excessive Output - Continued

If the output remains high, the field is grounded in the generator, either at the pole shoes, leads, or at the "F" terminal.

Noisy Generator

A noisy generator can be caused by loose mountings, worn or loose coupling or pulley, worn, dry or dirty bearings, or improperly seated brushes. Brushes may be seated by using a brush seating stone.

6. DISASSEMBLY

Normally, disassembly should proceed only as far as is necessary to make repairs or to replace defective parts. For example, the field coils must be checked for opens, shorts or grounds before being removed from the field frame; then, they should be removed only if they require repair or replacement.

Third Brush Type

Remove the voltage control unit (if so equipped), and the cover band from the generator. Disconnect the brush leads from the brush holders and unscrew the thru bolts. Remove the commutator end frame and the drive end frame from the field frame. Place the armature in a vise (use soft jaws and avoid excessive tightening of the vise). Remove the nut, washer, pulley, key and drive end frame with the bearing.

Field Coil Removal

Field coils can be removed most easily from the field frame, by the use of a pole shoe screwdriver and spreader. The pole shoe spreader prevents distortion of the field frame while applying pressure to the pole shoe screw. The pole shoe screwdriver permits easy loosening and removal of the pole screws.

7. LUBRICATION

Follow the instructions given in the "Lubrication Charts" section of the Operator's Manual.

8. INSTALLATION

1. Place the generator in position on the bracket and install the generator mounting screws. Push the generator toward the engine and replace the generator drive belt.

2. Tighten the drive belt to the correct tension (par. 13) and secure the generator in position.

3. Install the generator regulator unit.

4. Connect all leads to the correct terminals.

5. Repolarize the generator (par. 4, in Section 16).

6. Check the generator output on the ammeter.

DRIVE BELT

9. DESCRIPTION

The generator drive belt is a single continuous V-belt around the generator drive pulley and the fan pulley.

10. REMOVAL

1. Loosen the generator mounting screws and the cap screw which secures the adjusting bracket. Push the generator towards the engine to relieve the belt tension. Remove the belt from the generator pulley.

2. Slip the generator belt over the fan drive pulley and fan blades.

11. INSPECTION AND REPAIR

Inspect the generator drive belts for grease, wear, fraying or slippage. If not in good condition, replace.

12. INSTALLATION

Reverse the procedure for removing the belts.

13. ADJUSTMENT

The slack of the drive belt must be checked frequently to assure maintenance of the correct tension. The tension is correct when the belts can be depressed without effort by thumb pressure approximately 1/4 inch midway between the pulleys. If tension is incorrect, adjust as follows:

1. Loosen the generator mounting screws and the cap screw which secures the adjusting bracket.

2. Move the generator away from the engine to increase the belt tension or push it toward the engine to decrease the tension.

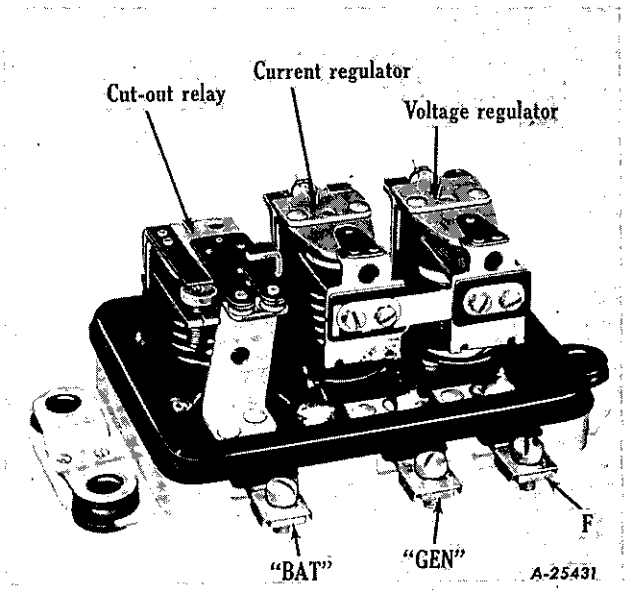
3. When the required tension is obtained, retighten the bracket and the generator mounting screws.

PRINTED IN UNITED STATES OF AMERICA

1. DESCRIPTION

The voltage regulator unit contains a cutout relay, voltage regulator and current regulator.

The CUTOUT RELAY closes the generator-to-battery circuit when the generator voltage is sufficient to charge the battery and it opens the circuit when the generator slows down or stops. This prevents the battery from discharging through the generator.



Illust. 1 - Three Unit Regulator Cover Removed.

The VOLTAGE REGULATOR is a voltage-limiting device which prevents the voltage from exceeding a specified maximum and reduces the generator output to a value required for any particular condition of battery charge and electrical load.

The CURRENT REGULATOR is a current-limiting device which prevents the generator from overloading itself when the voltage regulator is not operating.

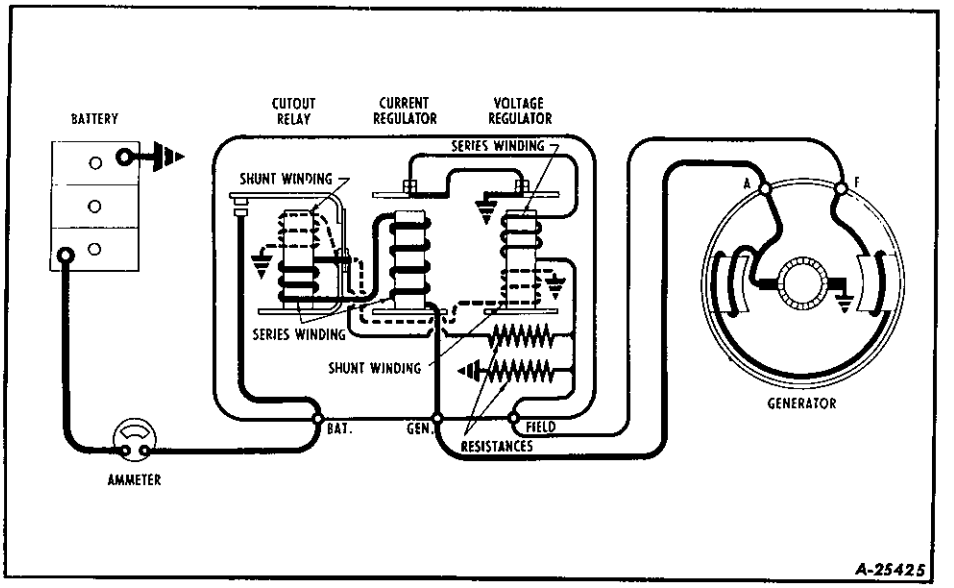
2. GENERAL

Before any repairs or adjustments are made, refer to "CHECKING MECHANICAL PROBLEMS," (par. 3 in Section 1) to see if possibly the regulator, and not the generator, might be at fault.

While some voltage regulators are designed for use with a positive (+) grounded battery, others are to be used with a negative (-) grounded battery.

CAUTION: Never use the wrong polarity regulator on an application.

Generators have a specific field draw, output, speed range and internal connections. Be sure that the proper regulator and generator are used Improper substitutions may not function correctly.



Illust. 2 - Circuit Wiring Diagram - Three-Unit Regulator.

3. ADJUSTMENTS (Three-Unit Regulator)

If the regulator is inoperative, or if tests show the unit is not adjusted according to specifications, proceed as follows:

Mechanical checks and adjustments (air gaps, point openings, etc.) should be made with the regulator off the tractor. Electrical checks and adjustments may be made with the regulator either on or off the tractor, mounted in operating position, and with the regulator at operating temperature.

To check the electrical settings outlined in the following paragraphs, special test equipment will be required. Instructions for use of this equipment will be found in the literature furnished with the test equipment. For "SPECIFICATIONS" refer to par. 2 in Section 1.

Contact Points

A majority of regulator problems can be eliminated by cleaning the contact points of the current and voltage regulator, plus some possible readjustments. Clean the flat points with a spoon or riffler file. On positive grounded regulators, the flat point is in the upper contact bracket; therefore, the bracket must be removed for cleaning the points (Illust. 21). A flat file cannot be used to clean flat contact points, because it will not touch the center where point wear generally occurs. Contact files must not be allowed to become greasy nor be used to file other metals. Never use sandpaper or emery cloth to clean contact points.

Cutout Relay Unit

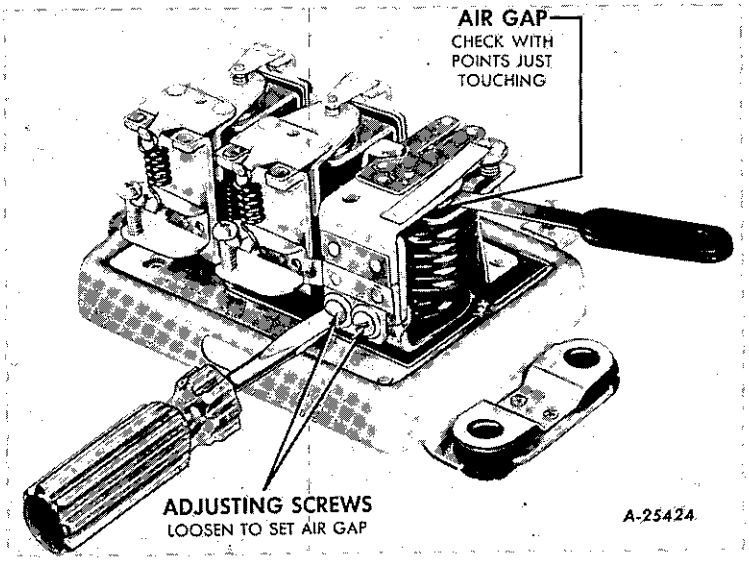
The cutout relay requires three checks and adjustments: air gap, point opening and closing voltage.

CAUTION: The cutout relay contact points must never be closed by hand when the battery is connected to the voltage regulator. This would cause damage to the relay contact points and other electrical equipment. Air gap and point opening checks must be made with the battery lead disconnected from the regulator.

1. AIR GAP: Hold the armature down, so the contact points are just closed. Measure the air gap (Illust. 3) between the armature and center of the core. Adjust the gap according to "SPECIFICATIONS," par. 2 in Section 1. Tighten the screws after adjustment.

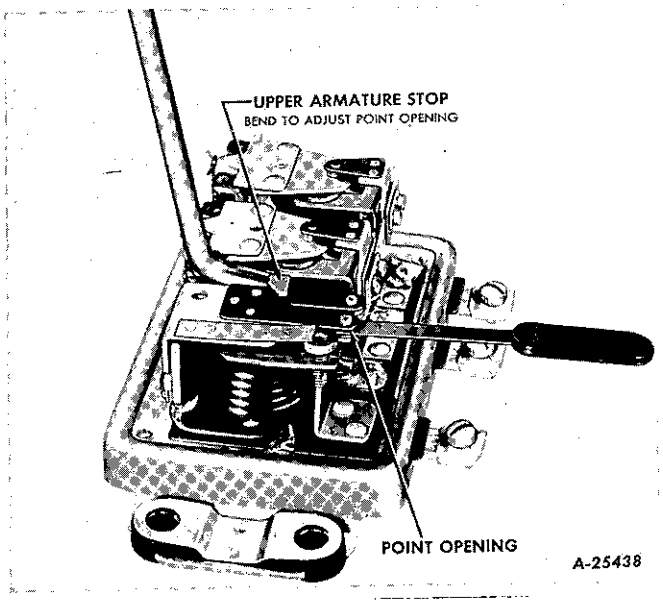
2. POINT OPENING: Check the point opening and adjust by bending the upper armature stop. Refer to "SPECIFICATIONS," par. 2 in Section 1 and Illust. 4 in this section.

3. CLOSING VOLTAGE: Follow the instructions for test equipment being used. Adjust the closing voltage by turning the adjusting screw clockwise to increase spring tension and closing voltage, or counterclockwise to decrease closing voltage (Illust. 5). For "SPECIFICATIONS," refer to par. 2 in Section 1.

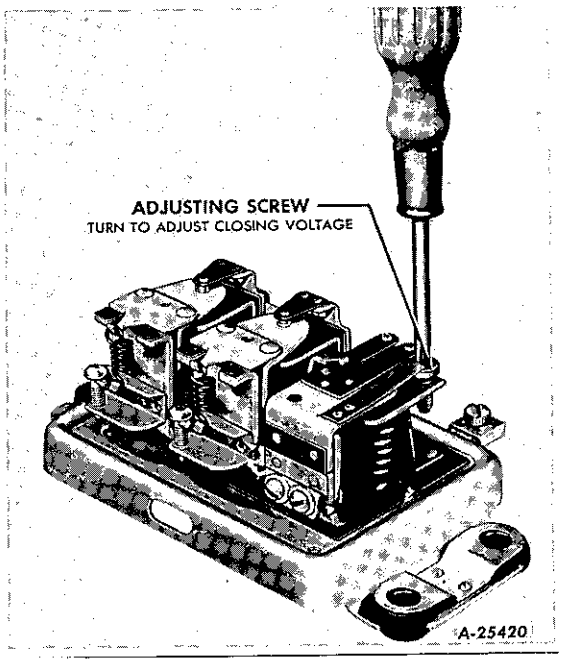


Illust. 3 - Cutout Relay Air Gap Adjustment (Three-Unit Regulator).

PRINTED IN UNITED STATES OF AMERICA



Illust. 4 - Cutout Relay Point Opening Adjustment (Three-Unit Regulator).



Illust. 5 - Adjustment of Cutout Relay Closing Voltage (Three-Unit Regulator).

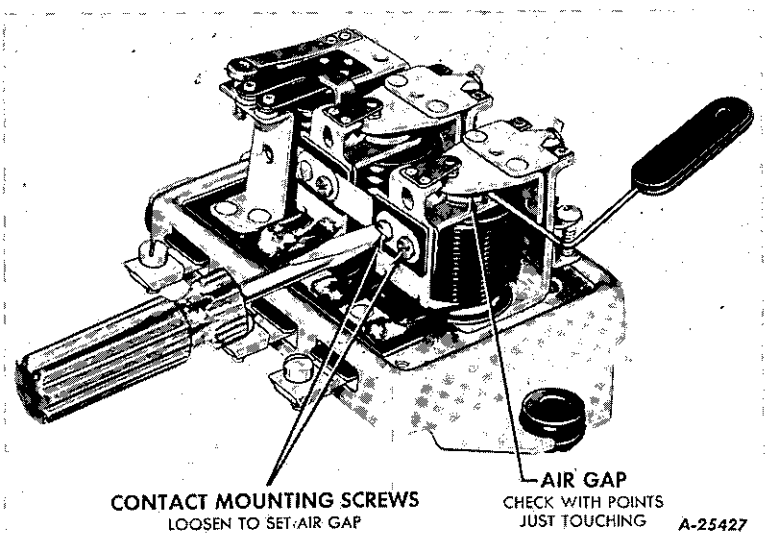
Voltage Regulator Unit

The following two checks and adjustments are required on the voltage regulator unit:

1. AIR GAP. To check air gap, push the armature down until the contact points are just touching and measure the air gap (Illust. 6). Adjust by loosening the contact mounting screws and raising or lowering the contact bracket as required. Be sure the points line up and tighten the screws after adjustment. Refer to "SPECIFICATIONS," paragraph 2 in Section 1.

2. VOLTAGE SETTING. Turn the adjusting screw clockwise to increase voltage setting or counterclockwise to decrease voltage setting. Refer to "SPECIFICATIONS," paragraph 2 in Section 1.

(Continued on next page.)



Illust. 6 - Air Gap Adjustment, Voltage Regulator Unit (Three-Unit Regulator).

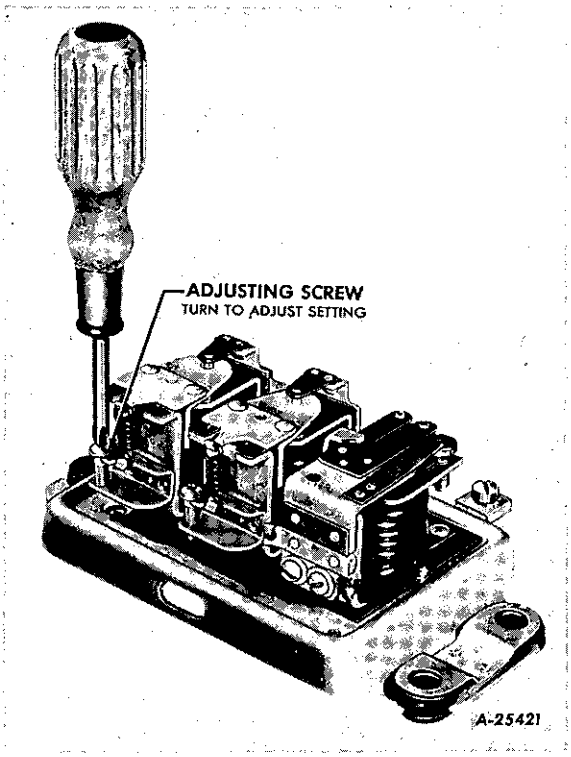
3. ADJUSTMENTS (Three-Unit Regulator) - Continued

Voltage Regulator Unit - Continued

CAUTION: If adjusting screw is turned down (clockwise) beyond normal adjustment range, the spring support may fail to return when pressure is relieved. If this occurs, turn the screw counterclockwise until there is sufficient clearance between the screw head and spring support. Then carefully bend the spring support upward with small pliers until contact is made with the screw head. Always approach the the final setting of the unit by increasing spring tension; never by reducing it. If setting is too high, adjust until below required value and then raise to exact setting by increasing spring tension.

NOTE: The voltage regulator unit must not be set outside of the specified limits, except in special cases.

Under conditions where constant high air temperatures prevail, battery overcharge may occur; this will be indicated by excessive use of water. Ordinarily the battery should require water about every 120 hours. If the voltage regulator is properly adjusted and water must be added more frequently than this, there is an indication of overcharge.



Illust. 7 - Voltage Setting, Voltage Regulator Unit (Three-Unit Regulator).

This condition can be corrected by reducing the voltage setting slightly. If the voltage setting is reduced, be sure to readjust the closing voltage of the cutout relay to approximately .5 of a volt below the voltage regulator setting. At the beginning of cold weather, increase the settings of the voltage regulator and cutout relay to the specified limits to avoid undercharging the battery.

Current Regulator Unit

1. AIR GAP: Check and adjust the air gap in the same manner as for the voltage regulator. Refer to "SPECIFICATIONS," par. 2 in Section 1 and Illust. 6 in this section.

2. CURRENT SETTING: Check and adjust the current setting (Illust. 7) in the same manner as for the voltage setting. Refer to par. 2, "SPECIFICATIONS" in Section 1.

4. REPOLARIZING THE GENERATOR

The generator must be repolarized after tests and adjustments have been completed. Connect all leads, BUT BEFORE the engine is started, proceed as follows: Using a jumper lead, touch one end on the "GEN" terminal (on regulator) and touch the other end to the "BAT" terminal on the regulator. The resulting flash allows a surge of current to flow through the generator which correctly polarizes it. Reverse polarity causes vibration, arcing and burning of the relay contact points. Establishing the proper polarity is important.

5. OPERATION OF STEP-VOLTAGE CONTROL

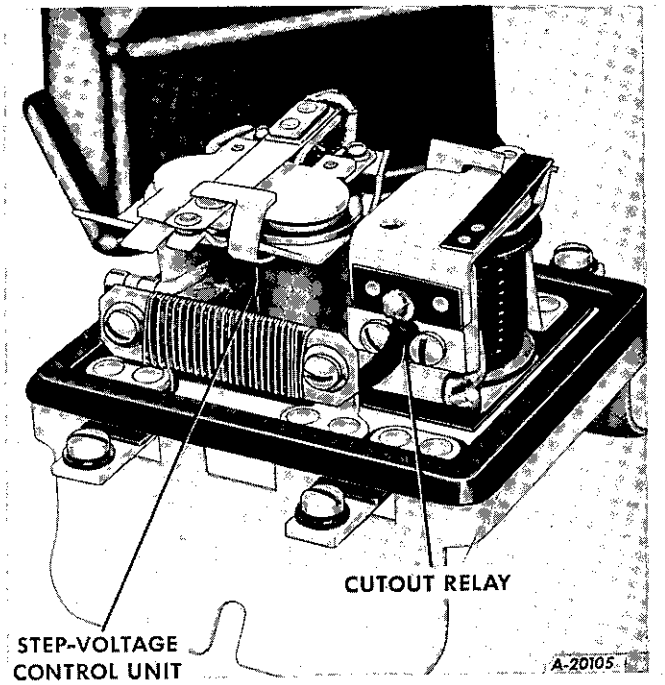
The step-voltage control includes a cutout relay and a step-voltage control located in a common housing (Illust. 8). The purpose and operation of the cutout relay is explained in par. 7, "OPERATION OF CURRENT-VOLTAGE REGULATOR."

Step-Voltage Control Unit

The step-voltage control (Illust. 9) provides, in effect, two generators; a normal output generator when the battery is low and a low output generator when the battery is fully charged. It utilizes an electro-magnet, which operates on generator voltage, to insert or remove the generator field resistance.

When the voltage reaches the value for which the step-voltage control is set, the points open. This inserts resistance into the generator field circuit and the generator output is reduced. The points remain open and the generator output remains at a low value, so long as the con-

PRINTED IN UNITED STATES OF AMERICA



Illust. 8 - Step-Voltage Control.

ditions of operation remain unchanged. As soon as the battery becomes partly discharged or an electrical load is added to the line and the line voltage is reduced, the points close, the generator field becomes directly grounded and the generator output increases. There is no vibrating action.

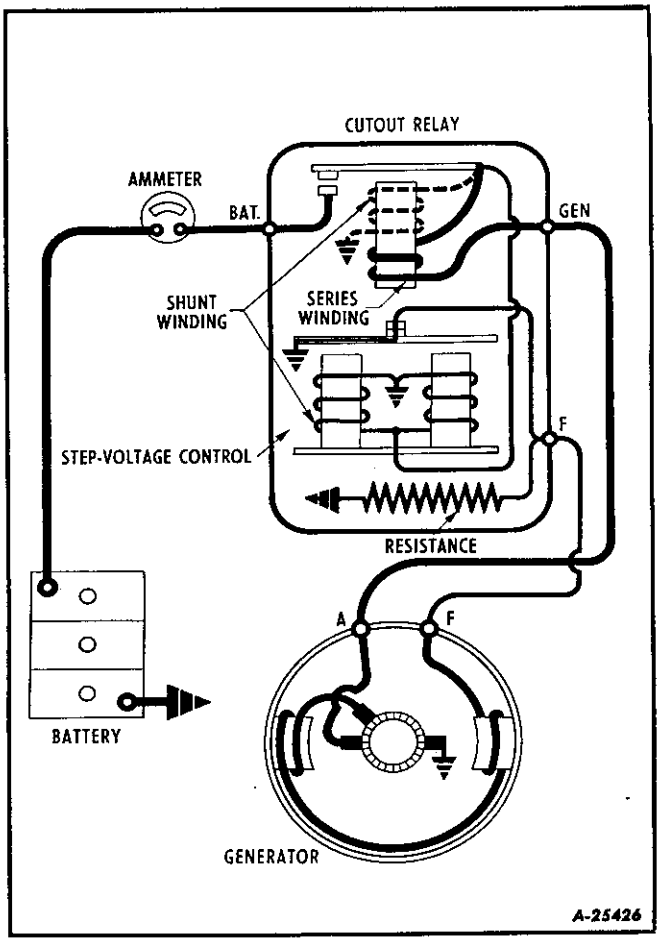
6. ADJUSTMENT AND REPAIR OF STEP-VOLTAGE REGULATOR

NOTE: Because of the similarities on the step voltage regulator to the two unit and three unit regulators, the procedures for "checking" and "adjusting," found in par. 3, may be followed except when otherwise specified.

If the regulator fails to operate or if the tests show that the units are outside specifications, check and adjust according to the procedures given for the three unit regulator in par. 3, "ADJUSTMENTS." Mechanical checks and adjustments (air gaps, point openings, etc.) must be made with the battery disconnected and the step-voltage control off the vehicle.

Cleaning Contact Points

Many cases of regulator trouble can be eliminated by a simple cleaning of the contact points and, possibly, some readjustment. The cutout relay and the step-voltage control contact points



Illust. 9 - Circuit Wiring Diagram of Step-Voltage Control System.

should be cleaned with a thin, fine-cut, contact file. The contact file must not be allowed to become greasy and should not be used to file other metals. Be very careful in cleaning the step-voltage contact points to avoid disturbing the step-voltage control settings. Never use sandpaper or emery cloth to clean contact points.

Cutout Relay Unit

The cutout relay requires three checks and adjustments; air gap, point opening and closing voltage.

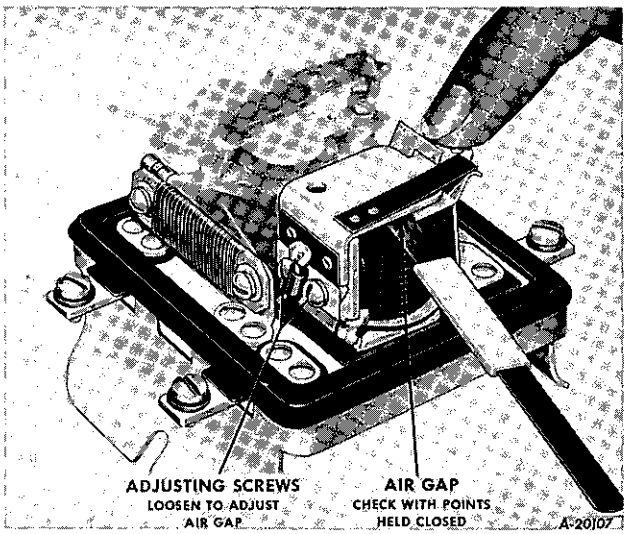
1. AIR GAP: Refer to par. 2, "SPECIFICATIONS" in Section 1 and also Illust. 10 in this section.

2. POINT OPENING: Refer to par. 2, "SPECIFICATIONS" in Section 1 and also Illust. 11 in this section.

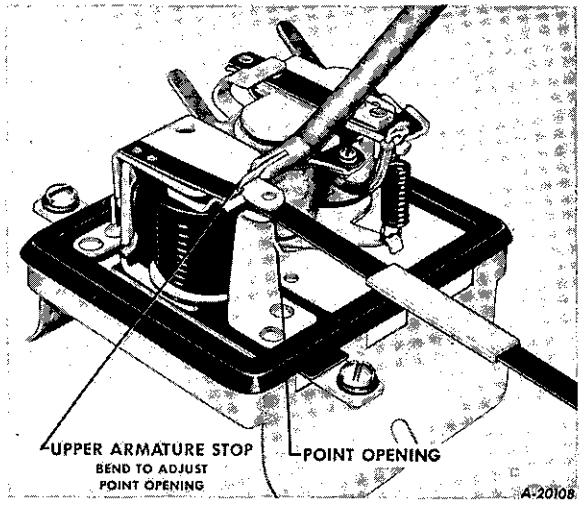
(Continued on next page.)

6. ADJUSTMENT AND REPAIR OF STEP-VOLTAGE REGULATOR - Continued

Cutout Relay Unit - Continued

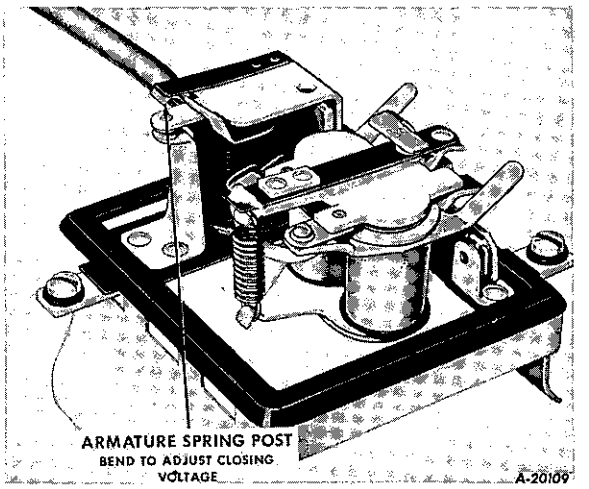


Illust. 10 - Checking and Adjusting Cutout Relay Air Gap.



Illust. 11 - Checking and Adjusting Cutout Relay Point Opening.

3. CLOSING VOLTAGE: Refer to par. 2, "SPECIFICATIONS" in Section 1 and also Illust. 12 in this section. Adjust the closing voltage by bending the armature spring post. Bend up to increase spring tension and closing voltage, and bend down to decrease the closing voltage.

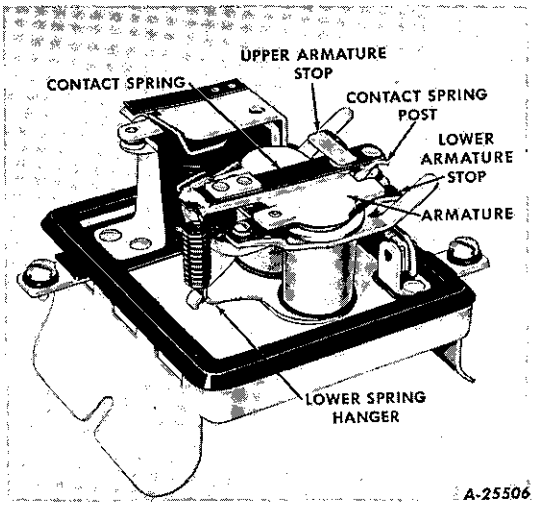


Illust. 12 - Adjusting Cutout Relay Closing Voltage.

Step-Voltage Control Unit

CHECKS AND ADJUSTMENTS

Five checks and adjustments are required on the step-voltage control unit: flat spring tension, air gap, armature travel, point opening and voltage setting. The various points of adjustment and the posts and stops which must be bent to make adjustments, are shown in Illust. 13.

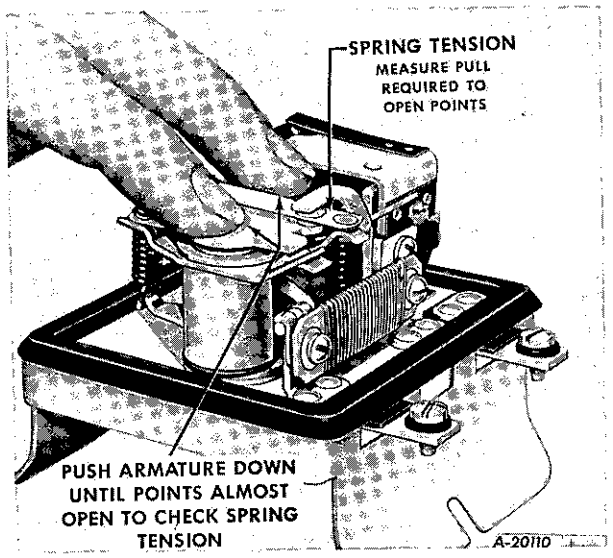


Illust. 13 - Places to Adjust on the Step-Voltage Control.

1. FLAT SPRING TENSION: The flat spring tension determines the amount of pressure between the step-voltage contact points. This spring tension must be 0.8 ounces at the instant the points separate. This can be measured by pushing the armature down until the points almost open and then using a spring

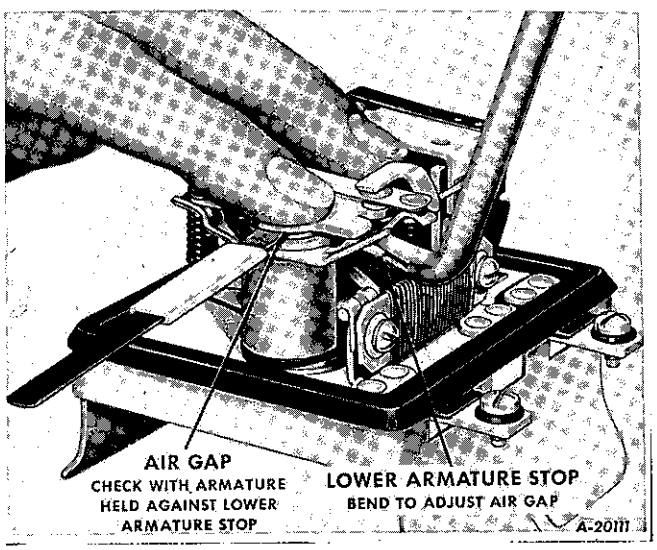
PRINTED IN UNITED STATES OF AMERICA

gauge to measure the upward pull required to open the points (Illust. 14). Adjustment can be made by bending the flat spring.



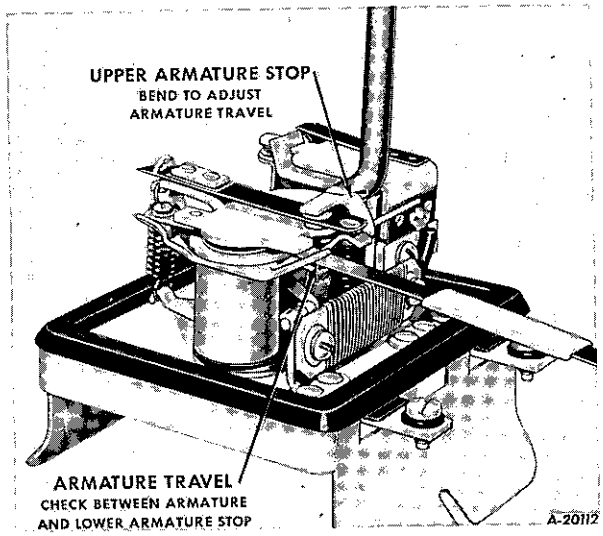
Illust. 14 - Checking Step-Voltage Control Contact Spring Tension.

2. AIR GAP. To check the air gap, hold the armature down against the lower armature stop by placing fingers on either side of the flat contact spring, as shown in Illust. 15. Adjust air gap by bending the lower armature stop. Adjust air gap as specified in par. 2, "SPECIFICATIONS" in Section 1.



Illust. 15 - Checking and Adjusting Step-Voltage Control Air Gap.

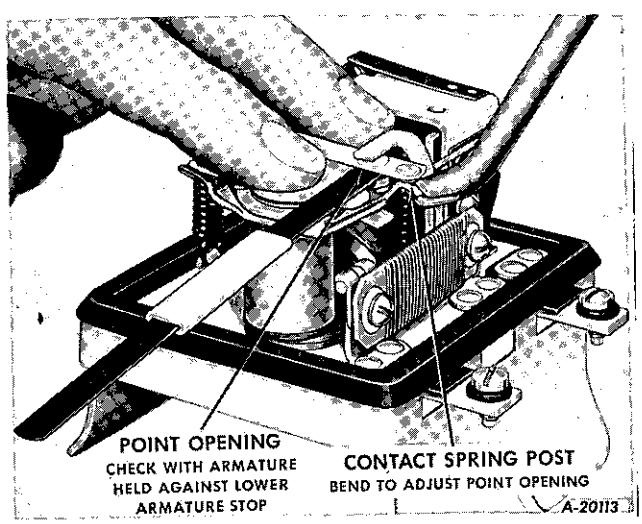
3. ARMATURE TRAVEL. To check the armature travel, release the armature so that it moves up against the upper armature stop and then measure the gap or armature travel between the armature and lower armature stop (Illust. 16). Adjust armature travel by bending the upper armature stop. Adjust armature travel as specified in par. 2, "SPECIFICATIONS" in Section 1.



Illust. 16 - Checking and Adjusting Step-Voltage Control Armature Travel.

4. POINT OPENING. Hold the armature down against the lower armature stop by placing your fingers on either side of the flat contact spring and measuring the contact point opening (Illust. 17). Adjust point opening by bending the con-

(Continued on next page.)



Illust. 17 - Checking and Adjusting Step-Voltage Control Contact Point Opening.

6. ADJUSTMENT AND REPAIR OF STEP-VOLTAGE REGULATOR - Continued

Step-Voltage Control Unit - Continued

tact spring post. Adjust point opening as specified in par. 2, "SPECIFICATIONS" in Section 1.

5. VOLTAGE SETTING. Check voltage setting as follows:

(a) Opening Voltage Adjustment. The voltage at which the step-voltage control contacts open is adjusted by bending the lower spring hanger (Illust. 18). Bend down to increase spring tension and opening voltage and bend up to decrease the opening voltage. Adjust opening voltage as specified in par. 2, "SPECIFICATIONS" in Section 1.

(b) Closing Voltage Adjustment. The voltage at which the step-voltage control contacts will close is adjusted by adjusting the air gap (Illust. 16). Increasing the air gap increases the closing voltage, while decreasing the air gap lowers the closing voltage. After this adjustment, it may be necessary to slightly readjust the contact point opening in order to keep it within specifications (par. 2, "SPECIFICATIONS" in Section 1).

NOTE: Check the polarity of the generator and, if necessary, repolarize as described in par. 4.

7. OPERATION OF CURRENT-VOLTAGE REGULATOR

The combined current-voltage type or two unit regulator protects the battery by providing better control during long periods of continuous duty. For example, when the equipment is frequently operated for days or weeks at a time with no electrical load other than the ignition coil and occasional cranking.

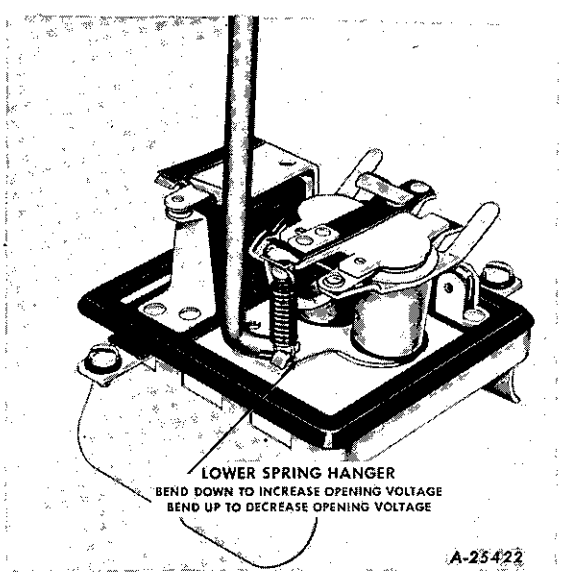
Although the combined current-voltage regulator is somewhat similar in appearance and construction to conventional voltage regulators, the two types are not interchangeable because of the difference in the wiring circuits. For the same reason, special testing procedures are also necessary. Follow the manufacturer's instructions furnished with the testing instruments to be used.

The charging circuit consists of the battery, generator and combined current-voltage regulator. (See Illust. 19.) The combined current-voltage regulator consists of two units, a cutout relay and a combination current-voltage regulator.

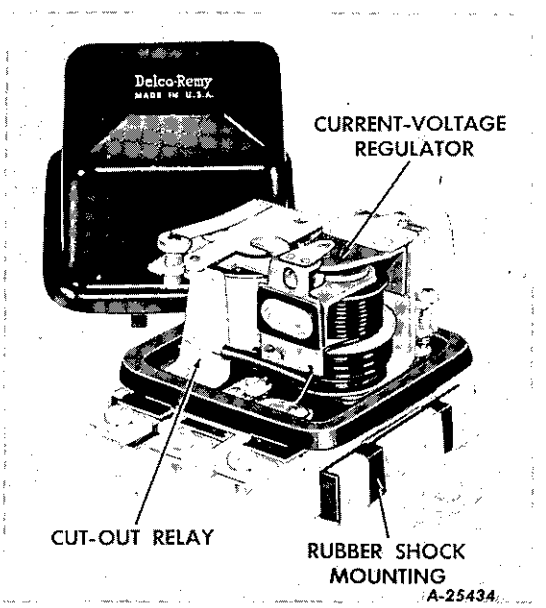
The combined current-voltage regulator is used in conjunction with a third brush generator to prevent excessive output when the battery is fully charged.

Cutout Relay Operation

The cutout relay points are open when the generator is not operating, thus preventing the bat-

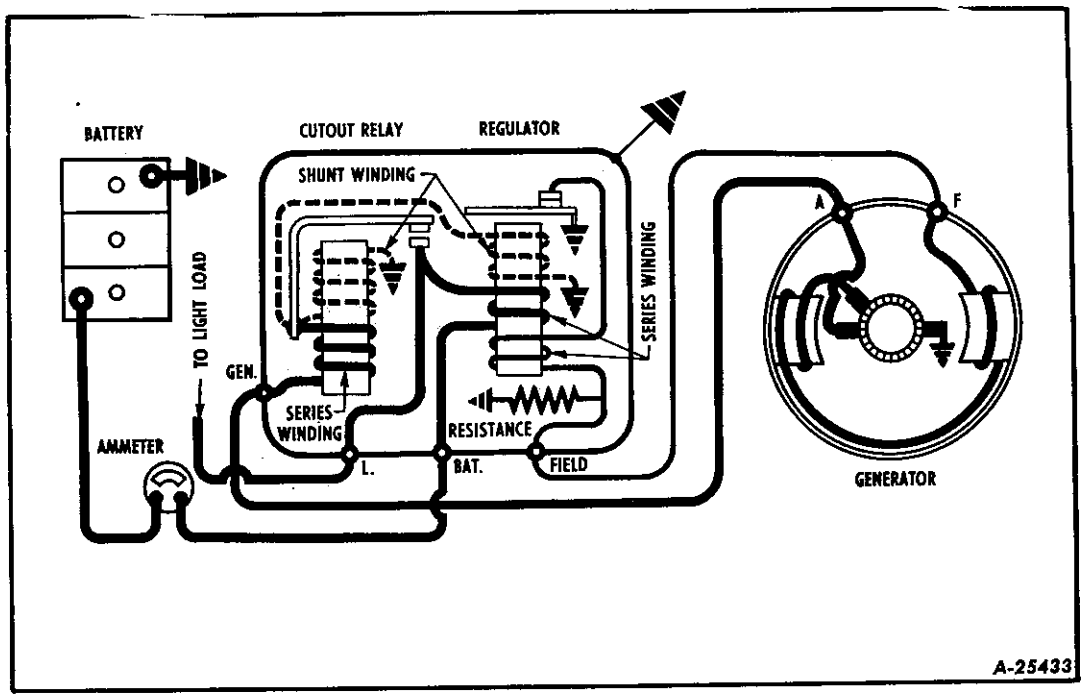


Illust. 18 - Opening Voltage Adjustment Step-Voltage Control.



Illust. 19 - Combined Current-Voltage Regulator.

PRINTED IN UNITED STATES OF AMERICA



Illust. 20 - Wiring Circuit of Combined Current-Voltage Regulator.

tery from discharging through the generator. When the generator begins to operate, the voltage builds up in the two relay windings, the series winding and the shunt winding, and this creates two magnetic fields which, working together, overcome the armature spring tension and close the points.

The shunt winding is the working coil and does most of the work in attracting the armature. With the point closed, the circuit between the generator and the battery is complete. Current flowing from the generator to the battery passes through the series winding of the relay in the proper direction to add to the magnetism which holds the points closed.

When the generator slows or stops and the battery voltage is higher than the generator voltage, current flows from the battery to the generator. It flows through the shunt winding in the same direction as before, but the direction of current flow through the series winding is reversed, and this causes the magnetic fields of the two windings to oppose each other. As a result, the total magnetic field is no longer strong enough to hold the armature down and the spring tension pulls the armature away from the winding core and the points open, breaking the circuit between the battery and the generator.

Current-Voltage Regulator Action

The combined current-voltage regulator consists of a voltage-sensitive shunt winding and a current-sensitive series winding wound on the same core. Both windings work together to insert a resistance in the field circuit. This regulator is of the vibrating type. Due to the added safety feature of preventing excessive overcharging, the charging rate will never exceed 50% of generator capacity regardless of battery condition.

A feature of the combined current-voltage regulator is that the generator output increases as the electrical load is added to the "L" terminal of the regulator. Since the load current bypasses the regulator current winding, it has no effect on the battery charging rate as long as the total load does not exceed the maximum output which is controlled by the third brush of the generator at operating speed.

8. ADJUSTMENT AND REPAIR OF CURRENT-VOLTAGE REGULATOR

NOTE: Because of similarities in the two unit and three unit regulators, the procedures for "checking" and "adjusting" are common for both

(Continued on next page.)

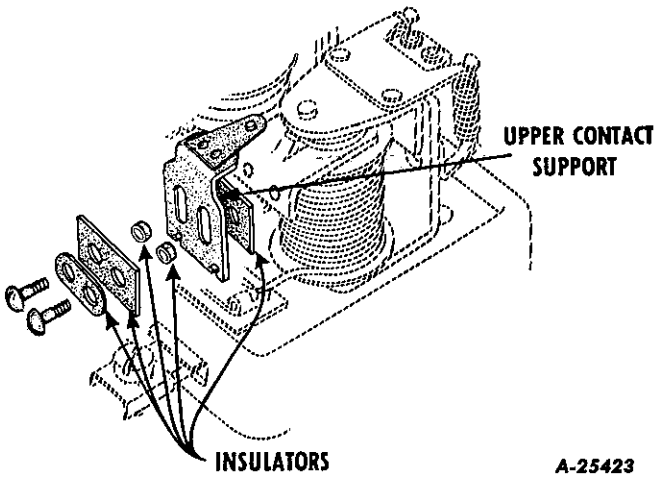
8. ADJUSTMENT AND REPAIR OF CURRENT-VOLTAGE REGULATOR - Continued

If the regulator fails to operate or if tests show that the units are outside specification, check and adjust according to the procedures given for the three unit regulator in par. 3, "ADJUSTMENTS."

To avoid damaging the wire-wound resistor beneath the base, be careful in removing and replacing the cover. In order that a good seal will be obtained, be sure the rubber gasket is compressed before the cover tangs are forced over.

Cleaning Contact Points

For cleaning the contact points, refer to the instructions given in par. 3 and to Illust. 21.



Illust. 21 - Disassembly of Upper Contact Support for Cleaning or Replacement.

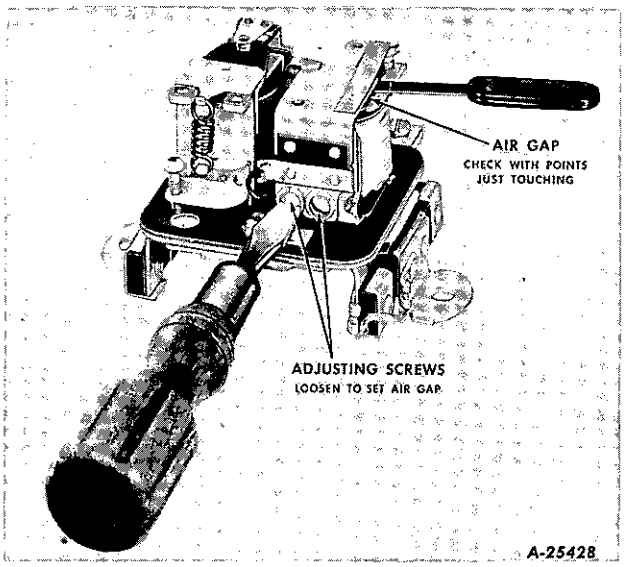
Cutout Relay Unit

The cutout relay requires three checks and adjustments; air gap, point opening and closing voltage. The air gap and point opening adjustments are made with the battery disconnected.

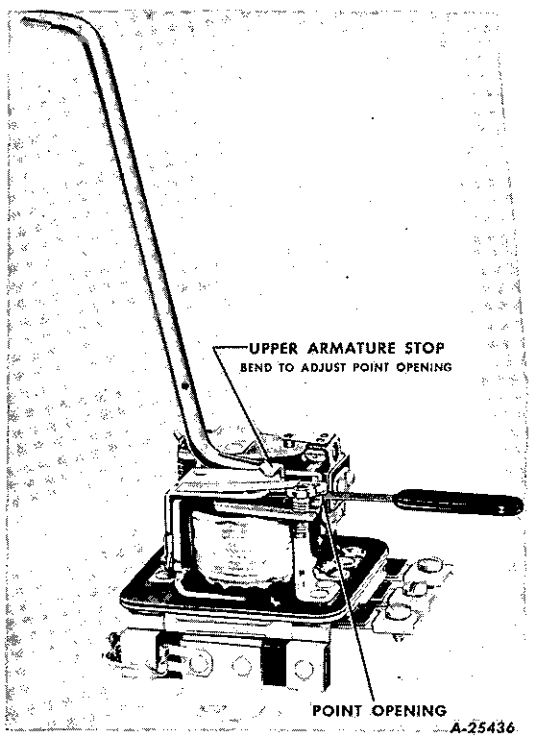
1. AIR GAP: Refer to par. 2, "SPECIFICATIONS" in Section 1 and to Illust. 22 in this section.

2. POINT OPENINGS: Refer to par. 2, "SPECIFICATIONS" in Section 1 and to Illust. 23 in this section.

3. CLOSING VOLTAGE: Refer to par. 2, "SPECIFICATIONS" in Section 1 and to Illust. 24 in this section.

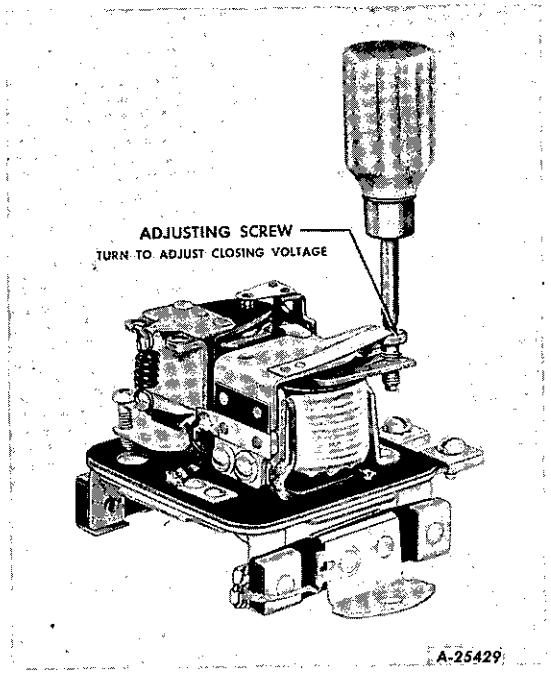


Illust. 22 - Cutout Relay Air Gap Check and Adjustment.



Illust. 23 - Cutout Relay Point Opening Check and Adjustment.

PRINTED IN UNITED STATES OF AMERICA



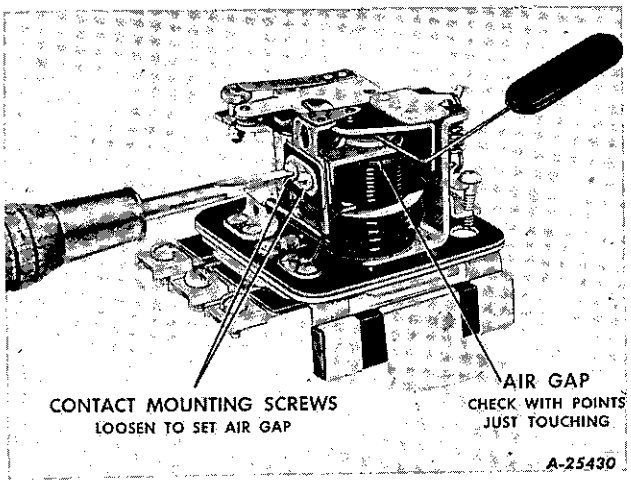
Illust. 24 - Adjustment of Cutout Relay Closing Voltage.

Current Voltage Unit

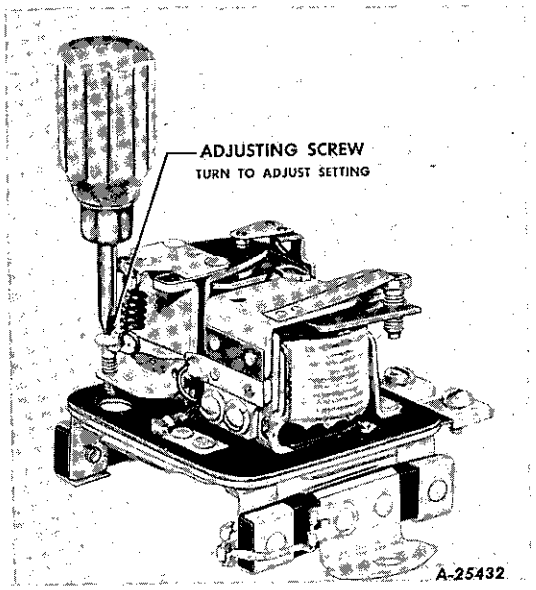
The current-voltage unit requires two checks and adjustments; air gap and voltage setting.

1. AIR GAP: Refer to par. 2, "SPECIFICATIONS" in Section 1 and to Illust. 25 in this section.

2. VOLTAGE SETTING: Refer to par. 2, "SPECIFICATIONS" in Section 1 and to Illust. 26 in this section.



Illust. 25 - Current-Voltage Unit Air Gap Check and Adjustment.



Illust. 26 - Adjusting Voltage Setting of Current-Voltage Regulator Unit.

CAUTION: If the adjusting screw is turned down (clockwise) beyond the normal range required for adjustment, the spring support may fail to return when pressure is relieved. If this occurs, turn screw counterclockwise until there is sufficient clearance between the screw head and spring support; then, carefully bend spring support upward, with small pliers, until contact is made with screw head. Final setting of the unit must always be made by increasing spring tension, never by reducing it. In other words, if setting is found to be too high, the unit must be adjusted below the required value and then raised to the exact setting by increasing the spring tension. Be sure that the screw is exerting force on the hanger.

Regulator Spring Replacement

When the current-voltage unit is out of adjustment or requires spring replacement, the following procedures must be followed:

When installing a new spring, be careful to avoid bending or distorting the spring supports or armature hinge. Preferably the spring should be hooked at the lower end first and then stretched upward (by means of a screwdriver blade inserted between the turns or by the use of any other suitable tool) until the upper end of the spring can be hooked. Do not try to pry the upper end of the spring over

(Continued on next page.)

8. ADJUSTMENT AND REPAIR OF CURRENT-VOLTAGE REGULATOR - Continued

Regulator Spring Replacement - Continued

the spring support. Adjust as described under "VOLTAGE SETTING OF CURRENT-VOLTAGE UNIT."

Replacing Contact Support Bracket

The current-voltage unit contact support bracket can be replaced by following the diagram shown in Illust. 21. New bushings must always be used when installing a contact support bracket, since the old bushing may be distorted or damaged.

PRINTED IN UNITED STATES OF AMERICA

IGNITION COIL

1. DESCRIPTION

The ignition coil transforms the low voltage of the batteries or generator into high voltage sufficient to jump the gap 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, rain, snow and road splash, and high pressure washing, particularly when the engine and the coil are hot after working, will 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.

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. Make sure 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.

A copper gasket is placed at the threaded end when the spark plug is screwed into position.

NOTE: 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.

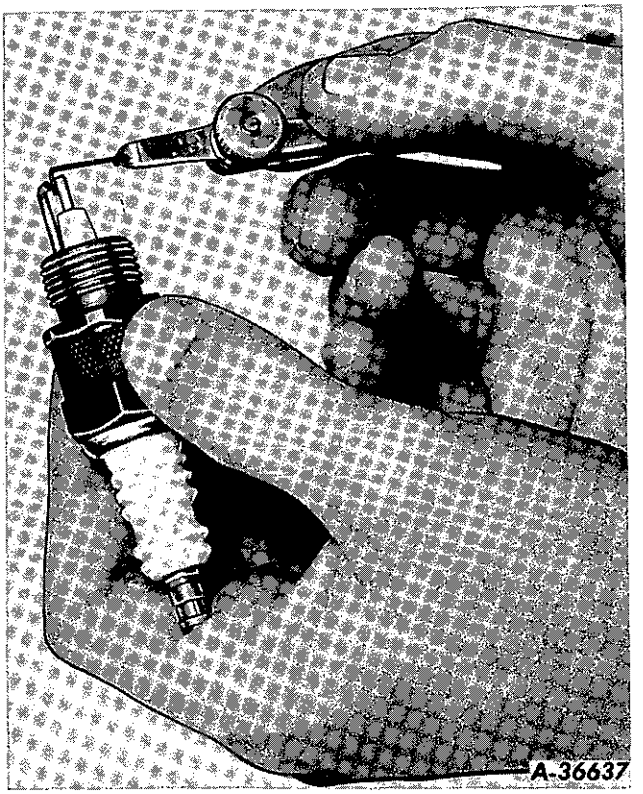
2. Unscrew the spark plugs with a spark plug wrench and remove the spark plugs and gaskets. These gaskets are compressible and are intended for use one time only.

7. INSPECTION AND REPAIR

1. Sand blasting is the recommended method of cleaning spark plugs, but do not expose the plug to the sand blast for more than three or four seconds or the insulator could be damaged. Plugs that are greasy or oily should be cleaned in a solvent and dried thoroughly.

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.

(Continued on next page.)



Illust. 1 - Checking Diesel Engine Spark Plug Gap.

SPARK PLUGS

7. INSPECTION AND REPAIR - Continued

3. Do not scrap or use a wire brush to clean the insulator or electrodes. Wire brushing spark plug electrodes will load the firing bore with electrically conductive metal particles from the brush and cause misfiring.

4. Never bend the center electrode as this will cause straining or cracking of the porcelain insulator. Before setting the gap on a used plug, file the center electrode flat across the end (of those that have the ground electrode located directly above it) and use a wire gauge to measure the gap. (Illust. 1.)

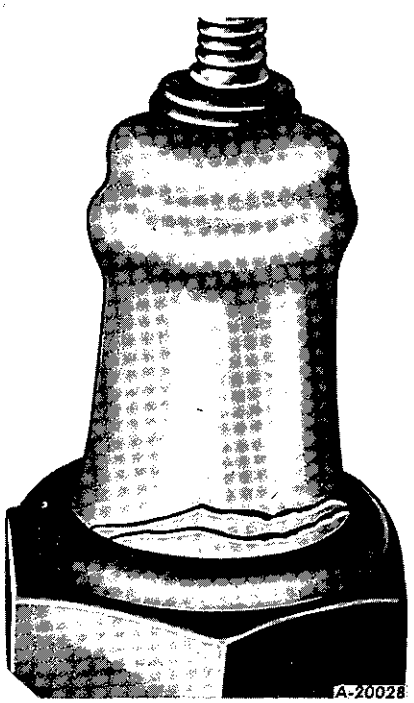
5. Do not use lubricants or graphite on threads of spark plugs.

6. When removing or installing spark plugs, use only a correctly fitting socket wrench. An end wrench can easily slip and break the porcelain.

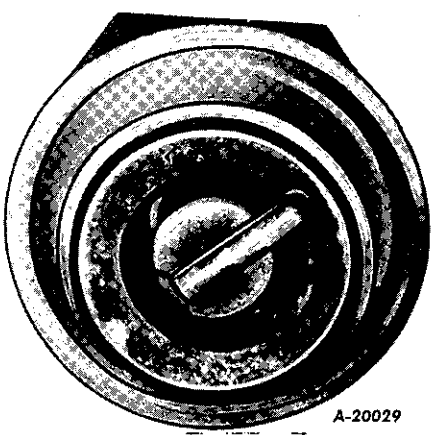
7. Do not screw a cold spark plug tightly into a hot cylinder head. Allow the cylinder head to cool first.

8. If a spark plug is thought to be faulty, it should be tested in spark plug tester.

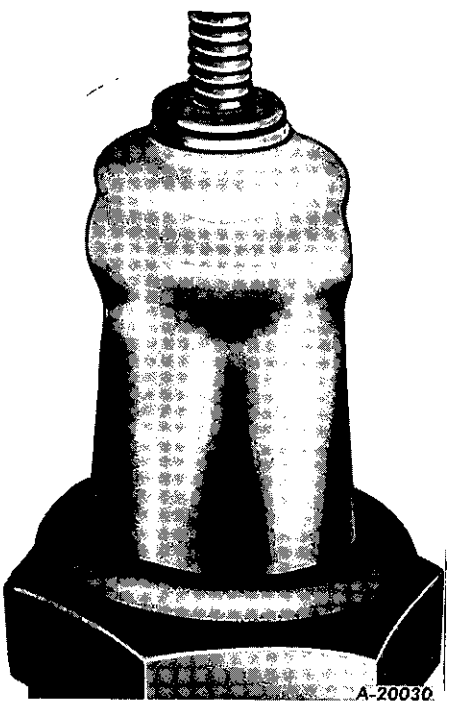
INSPECTION	REMEDY
. Inspect for cracked or blistered porcelain. . Inspect for dirty or worn electrodes. . Check gap between electrodes.	1. Replace spark plugs as necessary. 2. Clean dirty electrodes by scraping, brushing or sand blasting. Replace spark plugs having excessively burned electrodes. 3. Adjust (Refer to "SPECIFICATIONS," Section 1). Use a round wiregap gauge and pliers.



Illust. 2 - Broken Insulator (Careless Handling).



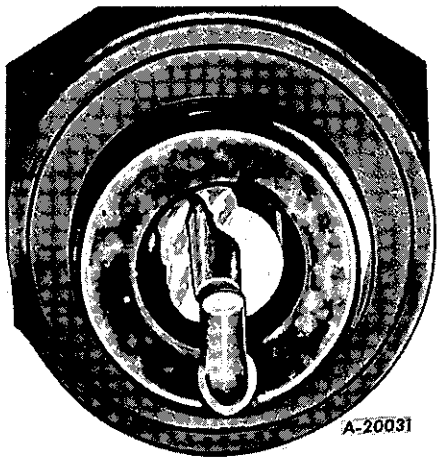
Illust. 3 - Carbon Coating (Rich Mixture, Oil Pumping or Cold Plug).



Illust. 4 - Streaked Insulator Tap (Blow-By).

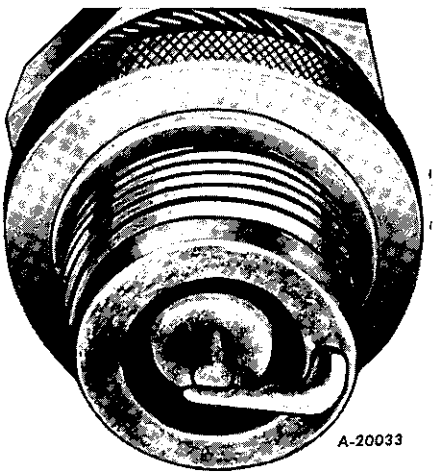
PRINTED IN UNITED STATES OF AMERICA

SPARK PLUGS



Illust. 5 - Split Insulator (Bending Center Electrode).

Illust. 6 - Badly Burned (Pre-Ignition or Poor Cooling).



Illust. 7 - Worn Side Electrode (Loose Plug or Too Hot).

8. INSTALLATION

1. Before installing the spark plugs, clean the seat around the spark plug holes in the cylinder head.

2. Check the spark plug gaps (Illust. 1).

3. Screw the spark plugs into the cylinder head using a new copper gasket with each one. Torque according to "SPECIFICATIONS", Section 1.

In the absence of a torque wrench, tighten a spark plug finger tight and 3/4 of a turn additional with a deep socket wrench.

NOTE: The plug gasket must be compressed to seal properly and when properly torqued, the transfer of heat from the plug to the cylinder head will keep the plug cool and avoid the possibility of pre-ignition. Excessive torque causes distrosion of the plug shell; often causes the porcelain to crack or change the plug gap.

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 must 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 must be corrected.

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.

(Continued on next page.)

STORAGE BATTERY

10. COMMON CAUSES OF BATTERY FAILURE - Continued

5. Dirt 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. That 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, sub-par. 7, are the defects that can occur in the battery itself. If shorted cells or loss of active material from the plates occurs when the battery has been in service for less than 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 must always be very carefully inspected before the actual testing is done. Many undesirable conditions can be seen and corrected before they result in battery failure. Other visible indications are very important when analyzing the hydrometer readings.

1. Inspect the battery case for cracks and leaks.

2. Inspect 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 battery for raised cell covers or warped case which may indicate that the battery has been overheated or overcharged at some time.

7. Inspect electrolyte level. If 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 battery visual and hydrometer tests, then refer to 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 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.

PRINTED IN UNITED STATES OF AMERICA

STORAGE BATTERY

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 must 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.

CAUTION: 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 manufacturer's specifications for proper information.

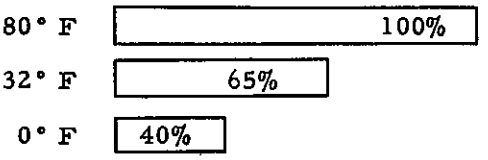
13. FREEZING POINTS OF ELECTROLYTE

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 80° 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 TEMPERATURES 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 the 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 RECOMMENDATION

POSSIBLE CAUSE	RECOMMENDATIONS
SPECIFIC GRAVITY ABOVE 1.290	The battery is overcharged. See NOTE 2 on next page.
SPECIFIC GRAVITY BELOW 1.225	The battery is undercharged. Recharge to full specific gravity. See NOTE 1 on next page.
LOW TEMPERATURE	Low temperature reduces capacity by retarding chemical reaction. Slow-charge battery until temperature is at least 60° F and recheck 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 lamp load, then recharging at a very slow rate. See NOTE 1 on next page.

(Continued on next page.)

STORAGE BATTERY

15. BATTERY TEST INDICATIONS AND RECOMMENDATIONS - Continued

POSSIBLE CAUSE	RECOMMENDATIONS
NEW BATTERY	Sometimes 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 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 battery 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. Overcharging is indicated by excessive use of water, extremely high specific gravity and eventually, raised cell covers and warped battery case.

PRINTED IN UNITED STATES OF AMERICA