INTERNATIONAL DIESEL ENGINES 14, 18, AND 20 SERIES TRACTORS AND 14, 18 AND 691 SERIES POWER UNITS

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The instructions contained in this service manual are for the information and guidance of servicemen who are responsible for overhauling and repairing any part of International 14, 14A, 18, 18A and 691 Series 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.

GASKETS AND SEALS

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

DIESEL FUEL SYSTEM

If detailed information on the diesel fuel system is desired, refer to the "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.

SERVICE TOOLS

International diesel engines are designed so that few service tools are required other than those in the mechanic's tool kit. However, when the use of inexpensive special service equipment will facilitate work, such equipment is mentioned in this manual. Other than this, it is assumed that servicemen will select such

tools as are required. Information regarding special tool equipment is given in the "SERVICE TOOLS MANUAL," ISS-1002. The IH Construction Equipment distributors and dealers 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 manufacutring, 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
14	TD-14, UD-14
14A	TD-14A, UD-14A, TD-14A (141), TD-14 (142
18	TD-18, UD-18
18A	TD-18A, UD-18A, TD-18A (181), TD-18 (182)
*691	TD-20 (200) and UD-691

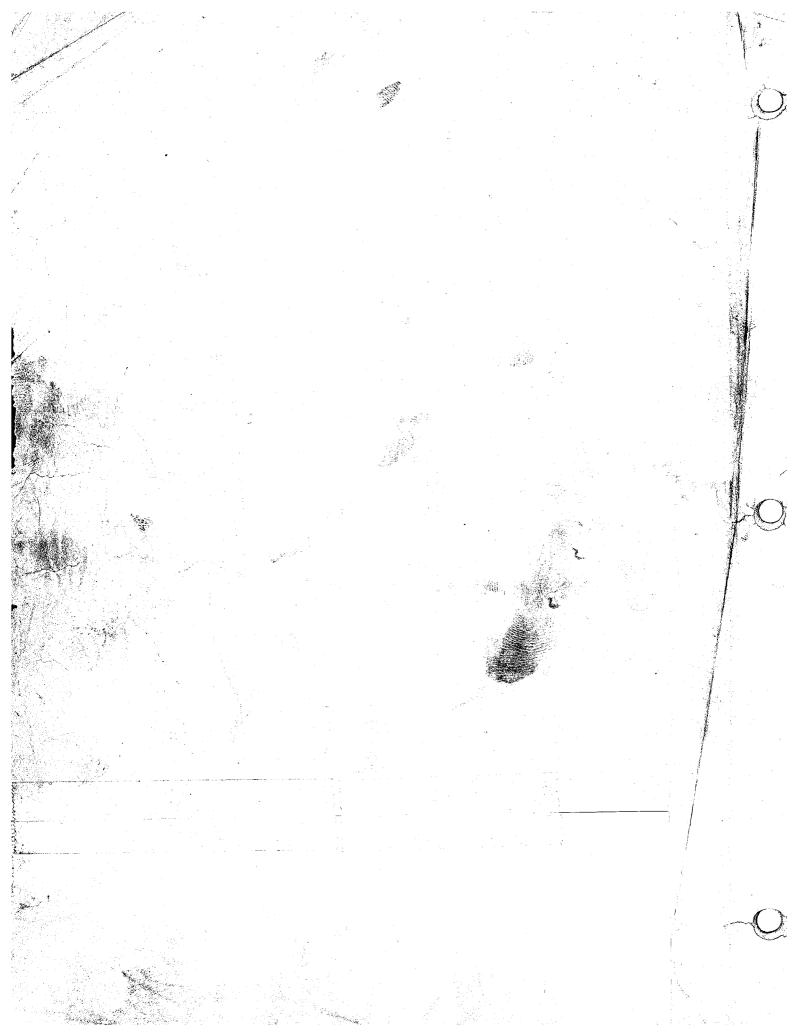
*Throughout this manual, all references to 18A series also include the 691 series engines.

ISS-1038 With Revision No. 1 and 2



This manual contains Revision No. 1, Form No. ISS-1038W dated (8-60) and Revision No. 2, Form No. ISS-1038A dated (7-63).

SERVICE PUBLICATIONS SECTION
CONSTRUCTION EQUIPMENT DIVISION
INTERNATIONAL HARVESTER COMPANY
MELROSE PARK, ILLINOIS







1. DESCRIPTION

The 14 and 18 series diesel engines are 4 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 four 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 wet type and are heat treated to file hardness for maximum service. An "O" ring, seated in the lower end of crankcase sleeve bore, provides an effective seal between the cylinder sleeve and the water jacket surrounding it.

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 double element 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.

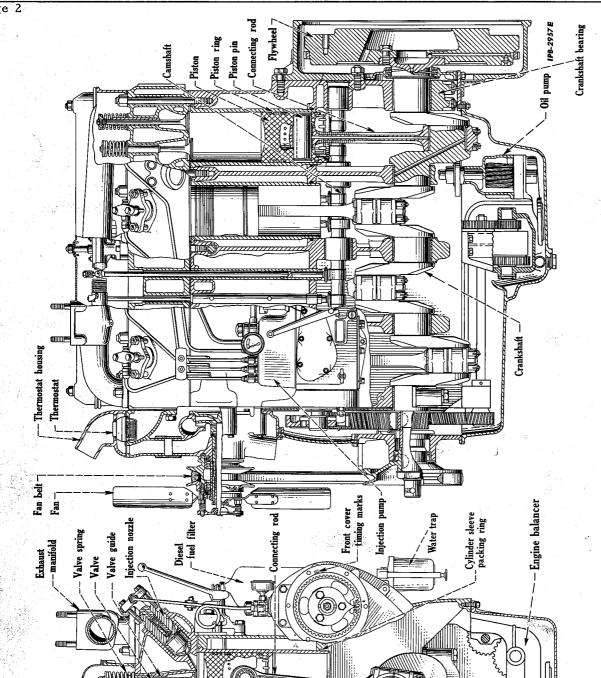
Coolant is circulated through the engine and radiator by a belt driven centrifugal water pump mounted at the front of the engine. Two thermostats located in the water outlet header (18 series) and one located in the water elbow (14 series) control the coolant temperature in the system.

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 18 series engines are equipped with a twin plunger injection pump and is base mounted to the side of the crankcase. The 14 series 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.









Cylinder sleeve

Piston ---Oil filter

Illust. 1 - Cross Section of UD-14A Engine.



Rocker arm-

Starting valve cover

Starting valve --Intake manifold

Butterfly valve

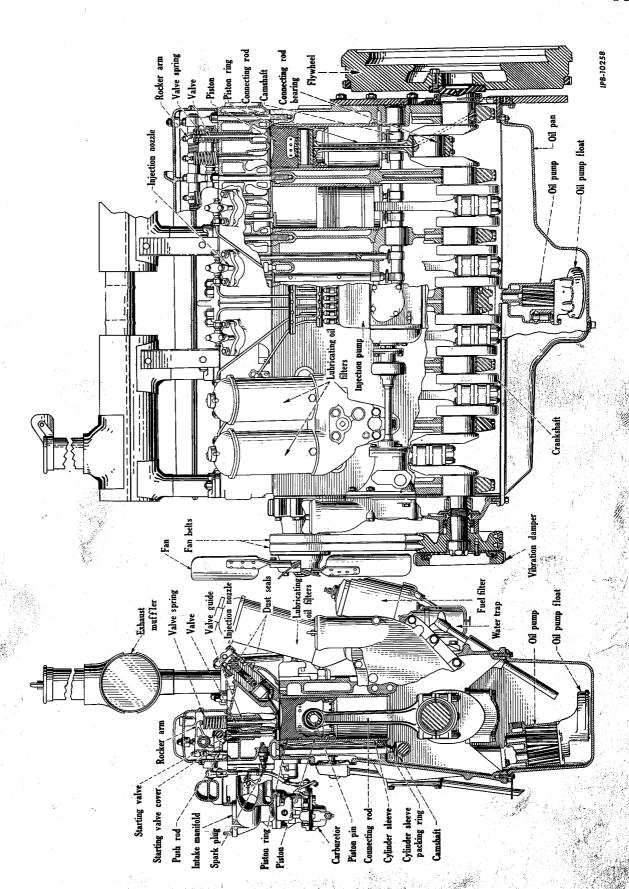
Passage from carburetor

Spark plug -Carburetor - Oil pump

regulating valve

Oil pressure

EM



Illust 2 - Cross Section of TD - 18A Engine.



2. SPECIFICATIONS

Engine

14 Series includes TD-14 and UD-14 14A Series includes TD-14A, TD-14A (141), TD-14 (142) and UD-14A 18 Series includes TD-18 and UD-18
18A Series includes TD-18A, TD-18A(181), TD-18(182), TD-20(200 & 201), UD-18A

DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
GENERAL DATA		
Number of cylinders	4	6
Type of cylinder sleeves	Replaceable, wet	Replaceable, wet
Bore and stroke - inches	$4-3/4 \times 6-1/2$	$4-3/4 \times 6-1/2$
Displacement - cubic inches	460.7	691.1
Engine speed - rpm		
Full load, governed	1350 UD-14	1400 UD-18
	1500 ± 10 UD-14A &	1600 UD-18A
	1650 ± 10 UD-14A ⊕⊕	1300 TD-18
병기 가장 아무님들이 가장 하는 것이다.	1400 TD-14	1350 TD-18A
	1400 TD-14A	1450 TD-18A (181)
나를하다. 그런 시간속 시작으로	1500 TD-14A (141)	$1450 \pm 10 \text{ TD-} 18 (182)*$
	$1650 \pm 10 \text{ TD-}14 (142)$	1550 ± 10 TD-18 (182)**
		$1550 \pm 10 \text{ TD-20 (200)}$
	Land	1600 ± 10 UD-691
High idle	1500 UD-14	1555 UD-18
eign tare	1635 ± 30 UD-14A Q	$1775 \pm 30 \text{ UD-} 18A$
	1800 ± 30 UD-14A GG	1445 TD-18
	1555 TD-14	1500 TD-18A
	1555 TD-14A	1580 ± 30 TD-18A (181)
	$1635 \pm 30 \text{ TD-14A}$ (141)	
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1		1580 ± 30 TD-18 (182)* 1690 ± 30 TD-18 (182)**
	1800 ± 30 TD-14 (142)	
		1690 ± 30 TD-20 (200) 1745 ± 30 UD-691
•	450-550	■ 보고 있는 가입니다. 그 사람들은 사람들은 사람들은 사람들은 사람들은 사람들은 사람들은 사람들은
Low idle	900-1200	450-550
Gasoline cycle, starting	900-1200	900-1200
Compression ratio	6 AE-1	
	6.45:1	6.45:1
Running	15.0:1	15.0:1
Sompression pressure psi	433 467 (14)	422 447 (10)
(measured at 1000 rpm)	423-467 (14)	423-467 (18)
	513-567 (14A)	513-567 (18A)
Tractor chassis serial num!		
**Tractor chassis serial numl		
Tractor chassis serial num		
💮 \varTheta 🏵 Tractor chassis serial numl	qer UDF-40041 up.	
CRANKSHAFT		
SWAINCOHAF I		
Crank pin, diameter-inches	2 2475 2 2405	2 2475 2 2405
Main journal diameter-inches	3.2475-3.2485	3.2475-3.2485
	3.2475-3.2485	3.4975-3.4985
Maximum permissible journal		
out-of-roundness, before		
reconditioning - inch	.004	.004
Number of main bearings	5	7
Main bearing running	0024	
clearance - inch	.00240050 (14)	.00240045 (18)
	.00240054 (14A)	.00360066 (18A)
1. No. M. Market (1986) (1986) (1986) (1987) (1987) (1987) (1987) (1987) (1987) (1987) (1987) (1987) (1987) (1	* 그는 그는 사람이 가장하는 사람들이 되었다. 그 가장 그는 사람들이 되었다.	■ 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

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DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
Maximum permissible main bearing clearance, before reconditioning - inch	.009	.009
End clearance - inch	.008012	.008012
conditioning - inch	.024 3.5515 - 3.5525	.024 3.8015 - 3.8025
CAMSHAFT		
Running clearance - inch Maximum permissible running	.00150035	.00150035
clearancé - inch	.006	.006
clearance - inch	.025 Reamed to size .3115	.025 Reamed to size .3115
Maximum permissible cam- shaft lobe wear - inch	.020 54 3	.020 54 4
Bearing journal diameter Front - inches Second - inches Third - inches Rear - inches	2.6180-2.6190 2.3680-2.3690 	2.6180-2.6190 2.4305-2.4315 2.3680-2.3690 1.9305-1.9315
CONNECTING RODS		
Side clearance - inch	.005015	.005015
Maximum permissible bearing running clearance - inch	.00250055 (14A) .007	.00250055 (18A) .007
Number per rod	4 4-11/32 1/2 - 20 NF	4 4-11/32 1/2 - 20 NF
PISTONS		
Length over-all - inches	6-3/16	6-3/16
Bottom - inch	.006010 .008012	.006010: .008 -/.012



2. SPECIFICATIONS - Continued

Engine - Continued

DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
PISTONS - continued		
Number of rings per piston Number of rings below pin Width of ring groove	6	6 1
Top compression - inch Second compression - inch Third compression - inch Fourth compression - inch	.12801290 .12701280 .12651275 .12651275	.12801290 .12701280 .12651275 .12651275
Oil control - inch Ring clearance in groove	25152525	. 2515 2525
Top compression - inch Second compression - inch Third compression - inch Fourth compression - inch Oil control - inch	.00400055 .00300050 .00250045 .00250045 .00250040	.00400055 .00300050 .00250045 .00250045 .00250040
PISTON RINGS - Compression Number of rings per piston	4	4
Type (face and finish) Top Second, Third and Fourth	Tapered chrome Tapered	Tapered chrome Tapered
Width Top - inch	.12351240	.12351240
inch	.12351240	.12351240
Ring gap (all compression rings) - inch	.014030	.014030
gap, before replacing; all rings - inch	.070	.070
PISTON RINGS - Oil Control		
Number of rings per piston Type	2 l piece slotted 24852490 .020036	2 1 - piece slotted .24852490 .020036
Maximum permissible ring gap, before replacing - inch	.060	.060
PISTON PINS		
Diameter - inches	1.6250-1.6252 4.100-4.110	1.6250-1.6252 4.100-4.110
Clearance between end of pin and retainer ring - inch .	.012044	.012044



DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
Clearance in rod bushing - inch . Maximum permissible clearance	.00050009	.00050009
in rod bushing, before reconditioning - inch	.004 .0001 (tight)0003 (loose)	.004 .0001 (tight)0003 (loose)
ance in piston, before reconditioning - inch	.0025	.0025
CYLINDER SLEEVES Diameter, inside - inches Length - inches	4.7490-4.7510 11-3/4	4.7490-4.7510 11-3/4
Maximum permissible diameter sleeve wear (at top of ring travel) - inch Vertical distance, top surface	.010	.010
of cylinder head gasket ring (installed) extends above top surface of crankcase - inch	.06550715	.06550715
INTAKE VALVES Stem diameter - inch	.432433	.432433
Port diameter - inches	1-25/32 2 .0015004	1-25/32 2 .0015004
Maximum permissible stem clearance in guide before re- conditioning - inch	.008	.008
and bottom of valve head - degrees	45	4 5
head - degrees	45 .018	.018
Hot - inch	.020	.020
Stem diameter = inch	.431432 1-17/32 1-3/4	.431432 1-17/32 -1-3/4
Stem clearance in guide - inch	.0025005	.0025005
reconditioning - inch Valve face angle, between seat	.008	.008
and bottom of cylinder head - degrees	45 45	45 45
head - degrees	.018 .020	.018 .020
Cold - inch	1 .320	



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2. SPECIFICATIONS - Continued

Engine - Continued

DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
INTAKE AND EXHAUST VALVE GUIDES		
Length - inches	5 •4345 - •436 1-3/8 Top face of cylinder head	5 .4345436 1-3/8 Top face of cylinder head
		97.
INTAKE AND EXHAUST VALVE SPRINGS		
Outside diameter - inches	1-37/64 (14) 1-17/32 (14A) 2-7/8 (14) 3-5/32 (14A)	1-37/64 (18) 1-17/32 (18A) 2-7/8 (18) 3-5/32 (18A)
Length, valve open - inches Length, valve closed - inches Test load, valve open - pounds	2	2 2-1/2 147-158 (18) 115-125 (18A)
Test load, valve closed - pounds	50-56 (14) 55-60 (14A)	50-56 (18) 55-60 (18A)
STARTING VALVES		
Stem diameter = inch	.37103720 (14) .30853095 (14A) 1-3/16 (14)	.37103720 (18) .30853095 (18A) 1-3/16 (18)
Head diameter - inches	1 (14A) 1-9/32 (14) 1-3/32 (14A) .002004	1 (18A) 1-9/32 (18) 1-3/32 (18A) .002004
Stem elearance in guide - inch	.002004	.002004
reconditioning - inch	.008 45	.008 45
head - degrees	45 3/64	45 3/64
inder head (gasoline position) - inch.	1/64	1/64





GENERAL Linaust Neam Section 1
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DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
STARTING VALVE GUIDES		An and a second
Length - inches	2-11/16 .374375 (14) .31153125 (14A)	2-11/16 .374375 (18) .31153125 (18A)
Set height of guide - inch measured downward from	15/16 Top face of cylinder head	15/16 Top face of cylinder head
STARTING VALVE SPRINGS		
Outside diameter - inch Free length - inches	29/32 1-31/32 ± 1/16 1-5/32 22.7 -25.1	29/32 1-31/32 ± 1/16 1-5/32 22.7 - 25.1
VALVE LEVER AND SHAFT		
Valve lever shaft diameter - inch Running clearance, valve	.96559665	.96559665
lever on shaft - inch	.00050025	.00050025
shaft - inch Valve lever bushing Inside diameter - inch Length - inches	.010 .967968 1-1/4	.010 .967968 1-1/4
VALVE TAPPETS		
Head diameter - inches	1.458-1.478 .623624 .00050030	71: 458-1.478 .623624 .00050030
VALVE TIMING		
Intake opens - degrees before TDC	10° (14) 20° (14)* 20° (14A)	10° (18) -20° (18)* -20° (18A)
Intake closes - degrees after BDC	25° (14) 40° (14)* 40° (14A)	25° (18) 40° (18)* 40° (18A)

^{*} Engine equipped with 14A or 18A camshafts and valve springs.





2. SPECIFICATIONS - Continued

Engine - Continued

14 Series includes TD-14 and UD-14 14A Series includes TD-14A, TD-14A (141), TD-14 (142) and UD-14A
18 Series includes TD-18 and UD-18
18A Series includes TD-18A, TD-18A (181), TD-18 (182), TD-20 (200 & 201), UD-18A and UD-691

DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
VALVE TIMING - Continued		
Exhaust opens - degrees before BDC Exhaust closes - degrees after TDC	43° (14) 40° (14)* 40° (14A) 10°	43° (18) 40° (18) * 40° (18A) 10°
* Engines equipped with 14A or 18A c	amshafts and valve springs.	
VALVE PUSH ROD		
Diameter - inch	7/16 17-3/32	7/16 17-3/32
CYLINDER HEAD STUDS		
Diameter - inch	5/8	5/8
CÝLINDER HEAD GASKET		
Thickness compressed - inch	.062067	.062067
TIMING GEARS Backlash between any pair of gears - inch (except idler		
and injection pump gear) Maximum permissible backlash between any pair of gears, be- fore reconditioning - inch (except idler and injection	.003006	.003006
pump gear)	.010	.010
and injection pump gear - inch Maximum permissible backlash between idler gear and injection pump gear before reconditioning -	.003009	.003009
inch	.013 .009013	.013
conditioning - inch	.020 .0010025	.020 .0010025
Maximum permissible idler gear bushing to shaft clearance before reconditioning - inch	.0055	.0055
ID - inch	1.500-1.501	1.500-1.501

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DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
LUBRICATING SYSTEM		
Type Oil filter (Purolator, radial	Forced feed	Forced feed
fin) - type	By-pass (14) Full-flow (14A)	By-pass (18) Full-flow (18A)
Number used	2	2
LUBRICATING OIL VALVE LOCATIONS		
Pressure regulating	Oil filter base	Oil pump (by-pass system Oil filter base (full-flow
Safety		system) Oil pump (full-flow system only)
By-pass	Oil filter base (14A) (full-flow system only)	Oil filter base (18A) (full-flow system only)
LUBRICATING OIL VALVE SPRINGS		
Pressure regulating Free length - inches	3-39/64 (14 with by-pass system)	2-25/32 - 2-27/32 (18 and 18A with by-pass system)
	4-13/64 - 4-17/64 (14A with by-pass system) 3-41/64 (14A with full-flow system)	4-15/64 (18A with full- flow system)
Test length - inches	2-3/32 (14 and 14A with by-pass system)	2-3/32 (18 and 18A with by-pass or full-flow system)
	1-7/8 (14A with full-flow system)	
Test load - pounds	36.3-40.1 (14 with by- pass system)	35.15-38.85 (18 and 18A with by-pass system)
	25.65-28.35 (14A with by- pass or full-flow system)	38.95-43.05 (18A w/full- flow system)
By-pass (Full-flow only) Free length - inches Test length - inches Test load - pounds	5.28 2-5/32 9-11	5.28 2-5/32 9-11
Safety (Full-flow only) Free length - inches Test length - inches		3-39/64 2-3/32
Test load - pounds		36.3-40.1
PRESSURE REGULATING VALVE Opening pressure - psi	38-46	38-46





2. SPECIFICATIONS - Continued

Engine - Continued

14 Series includes TD-14 and UD-14

14A Series includes TD-14A, TD-14A (141), TD-14 (142) and UD-14A

18 Series includes TD-18 and UD-18

18A Series includes TD-18A, TD-18A (181), TD-18 (182), TD-20 (200 & 201), UD-18A and UD-691

DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
LUBRICATING OIL PUMP		
End play-between gear and end plate - inch	.00550105	.00550105
Clearance, gear to housing -	.0055=.0105	.00550105
inch	.00800095	.00800095
body gears - inch	.008012	.008012
Backlash-between drive pinion and camshaft - inch	.005010	.005010
Drive shaft journals, diameter - inch	.85948602	.85948602
Drive shaft running	.63748002	.83748002
clearance - inch	.00130031	.00130031
clearance - inch	.00150030	.00150030
Clearance between oil pump		and the second second
body and drive pinion - inch	.010020	.010020
ENGINE BALANCER*		
Backlash-between driving		
weight and driven weight	000 000	·
gears - inch	.003009	
Backlash-between drive		
gear and driving weight gear - inch	002 007	
Backlash-between crankshaft	.003007	
gear and balancer idler	·	
gear - inch	.003009	
Backlash-between idler and	.005=.007	
pinion gear - inch	.003009	
Balancer weight shaft bore		·
in housing - inches	1.1245-1.1255	
Balancer weight shaft bushing		
ID (Reamed in assembly) -		
inch	.985986	
Balancer weight shaft		
Diameter - inch	.98259830	
Running clearance - inch	.00200035	
Balancer drive shaft		
Diameter - inch	.74807485	
Running clearance - inch	.00150030	
Balancer drive shaft bushing		
ID (Reamed in assembly) -	7500 7510	
inch	.75007510	
Balancer drive shaft end	010 015	
play - inch	.010015	
Pinion thrust washer	1 1 3	1
thickness - inch	.178198	4

^{*} For 14A Series engines so equipped.





DESCRIPTION	14 and 14A SERIES	18 and 18A SERIES
FUEL TRANSFER PUMP (Power units only)		
Approximate fuel pump rpm	1090 (14) 1129 (14A)	1138 (18) 1600 (18A)
Gallons per hour at normal temperature with a 4 foot		
vertical suction lift	16 (14) 17 (14A)	16 (18) 52 (18A)
WATER PUMP		
Type	Centrifugal Packing	Centrifugal Packless
Type of seal	Clockwise	Clockwise
Impeller shaft diameter - inch Impeller shaft running	.62156220	
clearance - inch	.00250035	(Ball bearing)
Clearance from face of body to face of impeller hub - inch		.182192 (late 18 series
		without jet type cooling .055065 (late 18 series with jet type cooling)
		.088098 (early 18 series)
THERMOSTATS		
Number used Begin to open at - degrees Wide open at - degrees	1 165° F. 190° F.	2 165° F. 190° F.
FAN AND WATER PUMP DRIVE		
Units driven	Fan and pump Single V-belt	Fan and pump Double V-belt
Belt adjustment - slack between pulleys - inch	1/2 - 3/4	3/4-1
SPARK PLUG		
Gap, inch	.023 18 mm 7/8	.023 18 mm 7/8
	and the second s	

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2. SPECIFICATIONS - Continued

Engine - Continued

14 Series includes TD-14 and UD-14 14A Series includes TD-14A, TD-14A (141), TD-14 (142) and UD-14A 18 Series includes TD-18 and UD-18

18A Series includes TD-18A, TD-18A (181), TD-18 (182), TD-20 (200 & 201), UD-18A and UD-691

SPECIAL NUT AND BOLT	DESCRIPTION		14 and 14A SERIES	18 and 18A SERIES
Cylinder head stud nuts				
Case	Cylinder head stud nuts • • •	• • •	180-200 -	- 180-200
Connecting rod muts **.	•		50-120	50-120
Stud nuts 150-155 (14) 225-245 (14A) (141) (142) 225-245 (18A) 170-190 170	Connecting rod nuts **		70-75	
Nozzle body stud nuts 45-50 Nozzle body stud to cylinder head 25-70 Nozzle fitting cap screws 30-35 Idler gear shaft nut 225-250 Water pump drive shaft nut 150-175 to shaft or sleeve 150-175 Front pulley nut to crankshaft 325-375 Camshaft gear nut 225-250 Rear oil seal and retainer 30 plate cap screws 30 Injection pump drive hub nut 115-125 Injection pump gear nut 115-125 Injection pump drive coupling 45-50 Timing pointer cap screws to injection pump coupling 21-24 Hydraulic pump or magneto gear nut 90-100 Water pump cap screws and nuts 35-40 3/8 inch 1/2 inch 60-70 Oil pan draining plug 30-35	Stud nuts		225-245 (14A) (141) (142) 170-190	225-245 (18A) 170-190 75-80 (Intake)
Nozzle fitting cap screws 30-35 225-250 30-35 225-250 225-250	Nozzle body stud to			45-50
to shaft or sleeve	Nozzle fitting cap screws Idler gear shaft nut		30-35	30-35
Rear oil seal and retainer plate cap screws	to shaft or sleeve Front pulley nut to crankshaft		325-375	325-375
### ##################################	Rear oil seal and retainer			225-250
nut	Injection pump drive hub nut. Injection pump gear nut.			115-125
Hydraulic pump or magneto 90-100 90-100 gear nut 90-100 90-100 Water pump cap screws 3/8 inch. 35-40 1/2 inch. 60-70 60-70 Oil pan draining plug 30-35 30-35	nut			45-50
Water pump cap screws and nuts	Hydraulic pump or magneto gear nut			 9 0 -100
1/2 inch	Vater pump cap screws			
Oil pan draining plug 30-35	1/2 inch		60-70	
Spark plug	Oil pan draining plug • • • •		I	30-35

^{*}All torques are given with bolts, studs, and nuts lubricated with SAE-30 engine oil, unless otherwise specified.

NOTE: All bolts and nuts not shown in this chart must be torqued according to the "STANDARD TORQUE DATA CHARTINShown on the following page.



^{**}Connecting rod bolts are to be lubricated with a mixture of white lead and L-5 lubricating oil.



Engine - Continued

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 is 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.

	1x.
5/16 19 21 27 3 3/8 33 37 45 5	1 12
3/8 33 37 45 5	n
	U 🤙
7/16 53 60 75 8	0
1/10	5
1/2 80 90 115 13	0
9/16 110 125 160 18	0 🛴
5/8 160 180 220 25	0
3/4 290 320 400 45	0
7/8 420 470 650 73	0
1 630 710 970 109	0
1-1/8 850 950 1380 155	0
1-1/4 1200 1350 1940 218	Ò

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	(H)

^{*} 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.



2. SPECIFICATIONS - Continued

Engine - Continued

14 Series includes TD-14 and UD-14

14A Series includes TD-14A, TD-14A (141), TD-14 (142) and UD-14A

18 Series includes TD-18 and UD-18

18A Series includes TD-18A, TD-18A(181), TD-18(182), TD-20(200 & 201), UD-18A and UD-691

DESCRIPTION	MAGNETO 14 and 14A SERIES	18 and 18A SERIES
Make. Magneto model No. of cylinders. Magneto (Alnico Alloy) Ground switch. Rotation Breaker point gap - inch Spark advance - degrees Distributor pinion backlash - inch Impulse coupling trips at Shaft end clearance - inch Magneto gear (No. of teeth) Magneto drive shaft diameter - inch Drive gear	IH H-4 4 Rotating Automatic Counterclockwise .013 7 .004 Max. TDC .003013 27 .9995-1.0005 Camshaft	IH F-6 6 Fixed Automatic Clockwise .020 5 .004 Max. 4° after TDC .004014 36 .87208725 Magneto drive bracket idler
Bushing diameter - inch	1.0015-1.0030 DISTRIBUTOR 14 and 14A SERIES	.874875 18 and 18A SERIES
Make Distributor model Number of cylinders Rotation (viewed from drive end) Breaker point gap - inch Breaker lever spring tension - ounces Spark advance Volts	IH H 4 Clockwise .020 23 ± 2 8° at 1000 rpm 12	IH K 6 Clockwise .020 23 ± 2 Fixed 12

CRANKING MOTOR CHART A

\$7.2	CHA	NI A	<u> </u>
Tractor or Power unit Model	Cranking Motor Model Number (Delco-Remy)	Tractor or Power Unit Model	Cranking Motor Model Number (Delco-Remy)
TD-14A	710 1109014	TD-18A (181) TD-18 (182)	756 1113302 or 1113368
TD-14A (141)	1109014	TD-20 (200 and 201)	1113339, 1113346 or 1113368
TD-14 (142)	1113303	UD-18A	1109106
UD-14A	1109108	UD-691	1109106
ΓD-18A VSS-1038A (7-63)∕	756	PRINT	ED IN UNITED STATES OF AMERICA





CRANKING MOTOR CHART B

		china.		AL 1 75'4		
Cranking Motor Model Number Delco-Remy	Voltage	Type of Drive	Rotation (Viewing drive end)	Brush Spring Tension (Ounces)	No-Load Test	Lock Test
710	12	Bendix	Clockwise	36-40	100 amps. at 11.3 volts at 2250 rpm.	55 ft. lbs. at 700 amps. at 5.0 volts
756	12	Bendix	Clockwise	36-40	75 amps. at 11.3 volts at 2250 rpm.	55 ft.lbs. at 700 amps. at 5.0 volts
1109014	12	Bendix	Clockwise	36-40	75 amps. at 11.3 volts at 2250 rpm.	55 ft. lbs. at 700 amps. at 5.0 volts
1109106	12	Bendix	Clockwise	36-40	65 amps. at 12.0 volts at 4500 rpm.	44 ft. lbs. at 725 amps. at 4.8 volts
1109108	12	Bendix	Clockwise	36-40	65 amps. at 12.0 volts at 4500 rpm.	44 ft. lbs. at 725 amps. at 4.8 volts
1113302	12	Overrunning Clutch	Clockwise	28-36	65 amps. at 11.4 volts at 6000 rpm.	44 ft. lbs. at 725 amps. at 5.0 volts
111330%	12	Overrunning Clutch	Clockwise	28-36	65 amps. at 11.4 volts at 6000 rpm.	44 ft. lbs. at 725 amps. at 5.0 volts
1113339	12	Overrunning Clutch	Clockwise	28-36	65 amps. at 11.4 volts at 6000 rpm.	44 ft. lbs.at 725 amps. at 5.0 volts
1113346	12	Overrunning Clutch	Clockwise	48	65 amps. at 11.4 volts at 6000 rpm	28 ft. lbs. at 500 amps. at 3.2 volts
1113368	12	Overrunning Clutch	Clockwise	80	65 amps. at 11.4 volts at 6000 rpm	28 ft. 155, at at 500 amps. a 3.2 volts

GENERATOR CHART A

Tractor or Power Unit Model	Generator Model Number 6 Volt 12 Volt	Voltage Regulator Model Number 12 Volt	Generator Relay Model Number 6 Volt 12 Volt
TD-14A	1101355		1116777
	1101725		<i>=</i> 1116766
	1100964	1118779 or 1118381	
TD-14A (141)	1100964	1118779	
TD-14 (142)	1105102	1119152	
UD-14A	1101738	5838	
	1100964	1118779 or 1118381	
TD-18A	1101724	 -	1116810
<u>, 7</u> 7 7 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1100986		1116810
	1100988	1118306	
TD-18A(181)	1100988	1118306	
TD-18 (182)	1105102	1119152	
UD-18A	1101737	5838	
	1100987	5838	
	1100988	1118306	
TD-20 (200 & 201)	1105102	1119152	
UD-691	1100988	1118306	



2. SPECIFICATIONS - Continued

Generator Model							Brush Spring		Commutator	Drive
Number	Make	Voltage	Туре	Field Current	Cold Output	Hot Output	lension Oz. *	Rotation	End Bearing.	End Bearing
1100964	DR	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
1100986	DR	12	djustab hird Bı	2.0-2.14 amps. at 12 volts	8-10 amps. at 14.5-14.9 volts at 2100 rpm.	6-8 amps. at 14.1-14.5 volts at 2300 rpm.	16	Clockwise	Bronze Bushing	Ball Bearing
1100987	DR	12	Fixed Third Brush	2.0-2.14 amps. at 12 volts	8-10 amps. at 14.5-14.9 volts at 2100 rpm.	6-8 amps. at 14.1-14.5 volts at 2300 rpm.	16	Clockwise	Bronze Bushing	Ball Bearing,
1100988	DR	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 14 volts at 2400 rpm.	16	Clockwise	Bronze Bushing	Ball Bearing
1101355	DR	9	Adjustable Third Brush	3.5-4:5 amps. at 6 volts	13-16 amps. at 7.7-8.1 volts at 1800 rpm.	9-11 amps, at 7,3-7,6 volts at 1900 rpm.	16	Clockwise	Bronze Bushing	Ball Bearing
1101724	DR	12	Adjustable Third Brush	1.48-1.56 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
1101725	DR	12	Adjustable Third Brush	1.48-1.56 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
1101737	DR	12	Fixed 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
1101738	DR	12	Fixed 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
1105102	DR	12	Two Brush Shunt	1,54-1,67 amps. at 12 volts	17 amps.at 14.0 volts at 1400 rpm.	Controlled by current regulator	16	Clockwise	Bronze Bushing	Ball Bearing
* Third	Brush Spring	Third Brush Spring Tension - 19 ounces	9 ounces. ** Thir	ird Brush Lifted.			j .			

ENERATO

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ELECTRICAL

ULATOR	Adjust To	17.0	
CURRENT REGULATOR	Setting Range	15.5-18.5	
CU	t Air Gap	• 075	
LATOR	Adjust Air To Gap	14.3	
VOLTAGE REGULATOR	Sett ing Range	.020 .020 11.8 - 13.5 12.8 .075 13.8 - 14.8 14.3 .075 15.5 - 18.5 17.0	
TOA	Air Gap	.075	
	Adjust Air To Gap	12.8	
CUTOUT RELAY	Closing Voltage	11.8 - 13.5	All the second
CUTO	Air Point Gap Opening	.020	
	Air Gap	.020	
	Ground	д	
	Type	D.R. Three unit regulator	
	Make	D.R.	
D 2011240	Model Number	1119152	

		EL	-EC	IXI	CAI
		Adjust Closing	Range	12.5-14.0	
	;	Adjust	То	14.7	
NTROL		Opening	Range	8 oz030 14.0-15.5 14.7 12.5-14.0	
AGE CO	Arma-	ture	Travel	.030	
STEP-VOLTAGE CONTROL	Contact Arma-	Spring	Tension	8 oz.	
STI	20,	Point	Opening	ŀ	
		Air ,	Gap	.030	
		Adjust	To	13.3	
CUTOUT RELAY		Closing	Opening Voltage To Gap Opening Tension Travel	.020 12.5-14.0 13.3 .030 .010	
CUTOU		Point	Opening	.020	
		Air		.015	
			Ground	Ъ	
			Number Make Type Ground Gap	5838 D.R. Two unit	regulator
			Make	D.R.	
	Regulator	Model	Number	5838	

D 0401					CUTOL	CUTOUT RELAY		CURRE	T-VOLTAGE	CURRENT-VOLTAGE REGULATOR
Model			0.000	Air	Air Point	Closing Adjust Air	Adjust	Air	Opening Adjust	Adjust
Number	Make	Type	Ground		-	Voltage	To	Gap	Range	To
1118306	D.R.	Two unit regulator	ď	. 020	.020	11.8-14.0 12.8	12.8	. 075	.075 13.6-14.5 14.0	14.0
1118779 or 1118381	D.R.	Two unit regulator	Д	.020	.020	020 .020 11.8-14.0 12.8	12.8	.075	075 13.6 - 14.5 14.0	14.0
		, , , , , , , , , , , , , , , , , , , ,	10 4 Ox							







3. CHECKING MECHANICAL PROBLEMS

Engine

PROBABLE CAUSE

REMEDY

Engine Will Not Turn

	Engine Will N	ot Turn
1 2. 3. 4.	Starting switch inoperative	Inspect for faulty cables and terminals. Charge the battery or install a new one. Use correct grade of lubricating oil. 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
5.	Cranking motor inoperative	to internal damage is indicated. Inspect all cables and terminals. Check for tightness of mounting screws. Inspect the commutator for damage.
	Engine Will Not Op	erate As Diesel
	Injection pump does not deliver fuel	Refer to "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003. Adjust linkage. Refer to Section 8, "COM-PRESSION RELEASE MECHANISM."
	Engine Does Not De	velop Full Power
1.	Moisture in the fuel tank	Drain the fuel system including water trap and filter. Refill with fuel oil and vent air from system.
3. 4. 5. 6.	Fuel oil filter and strainer clogged Air cleaner clogged	Disassemble and clean each unit. Remove and clean oil cup. Clean pre-cleaner. Check fuel tank. Use proper grade of diesel fuel.
	the engine	Remove the pump gear cover and make proper timing adjustments.
8. 9.	Injection pump not operating properly One or more cylinders misfiring	Remove the injection pump and test it. Determine cause and correct.
	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 Comp	ression Page 1
1. 2. 3. 4. 5. 6. 7. 8.	Piston rings worn, broken or cracked Cylinder sleeves excessively worn	Install new rings. Install new sleeves. Install new valves. Install new valve springs. Install new gasket. Grind the valve seats. Install new pistons. Install new valve guides. Free the valve stem and correct the cause.
10.	Faulty valve action	Adjust the valve clearance.



3. CHECKING MECHANICAL PROBLEMS - Continued

Engine - Continued

PROBABLE CAUSE

REMEDY

Engine Overheats

1.	Insufficient water in the cooling system	Check the water level in the radiator and add
	G 11 1	water if necessary.
	Cooling system clogged	Flush out radiator and engine.
3.	Fan and water pump belt slipping or broken .	Check tension and make proper adjustments.
	T 001 1 4 11	Replace the belt if necessary.
4.		Maintain proper oil level.
5.	Engine oil diluted with fuel	Change oil and inspect fuel connections on
,	D. C. Al. Allerman and A.	injection nozzles.
6.	Defective thermostat	Remove and test the thermostat. Replace if
77	Water and looks	necessary. Service the packing gland.
8.	Water pump leaks	Repair the pump.
٥.	Water pump defective	Repair the pump.
ės.	Engine N	lisses
1.	Insufficient air to engine	Remove and clean the air cleaner and air
٠.	msufficient all to engine	cleaner pipe.
2	Injection nozzle valve dirty or sticking	Remove and clean the nozzle valve. If defec-
٠.	injection nozzie valve drity or sticking	tive, replace with a serviceable unit.
3	Air lock in fuel lines of injection pump	Vent the air from the system and check all
	ziii tock in tuci iiics of injection pump	fuel lines and connections for leaks.
4	Poor fuel	Use a good grade of diesel fuel.
	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.
	Oil pan drain plug loose or worn	Tighten plug or replace with a new one.
10.	Overheating	Refer to problem "Engine Overheats."
5.0	Engine Does Not	Idle Properly
,	Commission and addalous colored and already	
1.	Gummy and sticky valves and plunger	There et the sheet and neverse sheet walves
er.	(Injection pump)	Inspect the check and reverse check valves
2	Income at timing of injection	and plunger. Replace them if necessary.
	Incorrect timing of injection pump	Time pump properly.
	Plunger spring borken	Install new spring.
	Engine temperature too low	Bring engine up to operating temperature.
٥.	Governor springs loose or broken	Panair or realises anning
Z	(Injection pump)	Repair or replace spring.
	Plunger scored, stuck, or worn	Install new plunger.
1.	Loose governor spring levers on control	Tighten or your and nut
	lever shaft	Tighten screw and nut.



8. Restriction to fuel delivery.

Inspect fuel lines and valves. Inspect for

proper level in fuel tank.



Engine - Continued

PROBABLE CAUSE

7. Oil lines clogged .

8. Connecting rod bent

9. Crankshaft out of alignment

REMEDY

are in good condition. Clean all oil passages.

Align or install new connecting rod.

Straighten or install new shaft.

Engine Noises

	Lingthe Moi	3 63
	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. Replace piston and sleeve.
	rod bearings is short-circuited	Replace worn bearings.
	Constant rapid clicking indicates incorrect valve clearance	Adjust valve clearance.
	(a) Leaky injection nozzle valve (b) Poor fuel and/or water in fuel (c) Faulty injection pump timing (d) Improper engine temperature	Replace nozzle valve. Drain entire diesel fuel system and refill with a good grade of clean diesel fuel. Remove and clean the water trap. Retime pump to engine. Keep temperature in working range of heat indicator.
	Excessive	Smoke
1. 2. 3. 4. 5. 6.	Air cleaner pipe clogged	Remove the air cleaner cup and remove any excess oil. Remove the air cleaner and clean the pipe. Use recommended grade of diesel fuel. Repair or install a new injection nozzle. Install new parts. Remove and clean. If defective, install new parts. Time injection pump. Adjust the valves.
	Bearing F	ailure
1. 2. 3. 4. 5.	Low oil pressure	Refer to problem "Loss of Oil Pressure." Maintain proper oil level. Check for leaks. Keep engine at normal operating temperature. Install new bearings. Use a suitable oil of noncorrosive type, correct grade and viscosity. Use clean oil containers when filling engine with oil and see that all gaskets on the engin



3. CHECKING MECHANICAL PROBLEMS - Continued

Engine - Continued

Valves Sticking

PROBABLE CAUSE

REMEDY

1.	Valve springs weak or broken	Install new springs.
2		Class and was well as

- Gummy deposits from inferior fuel or oil . . Clean and use proper fuel or oil.
- 3. Valve stems scored or carboned Clean. Install new valves if necessary.
- 4. Insufficient clearance between valve stem

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.
- Keep oil at proper level.
- 4. Foreign materials entering engine Inspect and service air cleaner and pre-
- cleaner regularly. 5. Piston rings not fitted properly to cylinder . Install new rings and fit properly. (Refer to
- "SPECIFICATIONS" in par. 2.) 6. Dirty containers used for lubricating oil . . Lubricating oil should be kept in a clean place and clean containers used when filling crank-

case.

Loss of Oil Pressure

- 1: Low oil le Add sufficient oil to bring up to specified mark on level gauge.
- 2. 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. Remove, and repair or replace.
- 5. Oil pump worn. Camshaft bearings worn excessively . . .
- Install new bearings.
- 7. Oil diluted or not as specified Change oil regularly using correct grade.
- Check and service where necessary - at valve lever housing, 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 filters, and oil pressure indicator
- tube. 9. Clogged oil filters Change filter elements.

Improper Fuel Pressure

- 1. Fluctuating injection pump fuel pressure Inspect fuel injection pump.
- 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.



Engine - Continued

PROBABLE CAUSE

REMEDY

	Engine Operates Uneve	nly And Vibrates
1. 2.	Valve and spring assembly inoperative Incorrect injection pump timing	Repair or install parts needed. Time injection pump correctly. Refer to "DIESEL INJECTION PUMP SERVICE MANUAL," ISS-1003.
	Defective Cooli	ng System
	3 010011170 3 00111	
1. 2. 3.	Insufficient water	Add water, inspect for leaks. Test. If necessary, replace. Drain and clean system.
4.	Defective connections	Replace swelled or worn hose and defective hose clamps.
	Radiator defective	Repair radiator. If necessary, replace. Inspect fan. If damaged, replace.
	equipped)	Replace. Inspect water pump impeller and shaft. If necessary, replace.
	Water pump leaks	Service packing gland. If packless type, repair or replace pump.
10. 11. 12.	Dirty, scaled coolant passages	Clean and flush passages. Flush out radiator. Check the tension; replace if greasy or worn
	ELECTRIC	CAL
	Discharging I	Battery
1. 2.	Connections loose	Tighten connections. Locate shorts and correct cause.
3. 4.	Connections dirty	Clean connections. Adjust or replace.
5.	Generator not charging	Check voltage regulator and make necessary adjustments.
	Battery Over	heating
2.	High charging rate	Inspect voltage regulator unit. Adjust voltage regulator unit. If necessary, replace.
	No Generator	Output
1. 2. 3. 4. 5.	Worn brushes	Replace brushes. Recut commutator. Clean brushes. Clean commutator bars. Recut commutator. Adjust or replace the brush spring.
	Ammeter Shows Discharge W	ith Engine Operating
1.	Generator inoperative	Service or replace generator. Adjust relay or replace if necessary.

l.	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 helt loose or broken	Tighten or replace helt



3. CHECKING MECHANICAL PROBLEMS -Continued

Electrical - Continued

PROBABLE CAUSE

REMEDY

Noisy Generator

1.	Loose mountings	Tighten mounting bolts.
	Loose pulley	Tighten pulley.
2	Worn haarings	Install new hearings

Ammeter Pointer Fluctuates Rapidly

1.	Shorted or loose connections	Test for short circuits, and tighten connections.
		Check battery terminals.
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 securing mounting to termin-
	,	als; replace cables if necessary. Inspect for
**		dirty or loose connections.
3.	Cranking motor inoperative	See below.
4.	Cranking motor switch defective	
		switch.

Cranking Motor Inoperative

1.	Cranking motor burned out		Install new cranking motor.
2.	Cranking motor worn or dirty		Service or replace cranking motor.
	Batteries defective		Charge, or install new batteries.
4.	Brushes not making proper contact		Inspect to see if brushes are seating properly.
	Defective starting switch contact points.		Inspect and clean; if necessary, replace the
			switch.

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
		or replacements.

Magneto Turns But No Spark Is Generated

ordere .		
	Defective impulse coupling action Shorted coil	Test for impulse action. Replace coil.
3.	Bad points or condenser shorted	Dress points or replace condenser if necessary.
	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 de-
	fective parts.
3. Defective magneto breaker mechanism	Check and make proper adjustments; replace
	faulty parts.



Electrical - Continued

PROBABLE CAUSE

4. Defective spark plugs.

REMEDY

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	Inonerativo
		moperative :
1	Contact lever spring broken due to corrosion	* 电影 1980年
1.	attacking metallic materiels	Ponlago garring and alegar distant
	attacking inclaine materiers	Replace spring and clean distributor carefully to avoid repetition.
2.	Wiring to or from distributor broken, frayed	to avoid repetition.
	or damaged by moisture, oil or corrosion.	Inspect all wiring and replace if faulty.
3.	Poor electrical connections at distributor	The state of the s
	or plugs	Inspect connections and be sure they are free
		from dirt and oil.
4.	Rotor or cap cracked or carbonized surface	
_	providing escape for current to ground	Replace rotor or cap if necessary.
5.	Faulty condenser	Test condenser and replace if necessary.
		<u> </u>
	Distributor Contact Po	ints Burned or Pitted
1.	Points set too closely	Inspect to insure correct clearance. Refer to
2.	Excessive resistance in condenser due to	"SPECIFICATIONS" in par. 2.
-•	broken strands in condenser lead	Replace as necessary.
3.	High voltage in electrical system	Check for loose connections in charging circuit
		faulty generator regulator, and grounded generator field. Tighten connections, adjust gen
		erator 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.
	Intermitter	nt Spark
1	Work tongion on distributor contact which	
1.	Weak tension on distributor contact points.	Common to the second
2	Vibration causing chatter	Correct tension.
۵.	point gap	Clean points and check contact gap.
	point gap	Orean points and check contact gap.
	Weak S	park
_		
1.	Dirty distributor contact points or poor	
	rotor connections	Clean contacts and wipe off rotor with carbon
2	Tomition timeing in comment	tetrachloride on clean cloth.
	Ignition timing incorrect	Check ignition timing.
٠.		Inquest wining for function days and
	wiring	Inspect wiring for fraying damaged or cracked
4.	Defective spark plugs	insulation and broken strands. Replace.

Service spark plugs or replace.



4. BATTERY TESTING CHART

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

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

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

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

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5. ENGINE TUNE-UP

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 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 "DIE-SEL INJECTION PUMP SERVICE MANUAL," ISS-1003.

- 1. Check the operation of the control.
- 2. Adjust friction on the disc if equipped.
- 3. Check the operation of the springs on the governor control rod.
- 4. Check the rpm of the engine, using a Sun tachometer. (Illust. 3.)

VALVES refer to Section 2, "MANIFOLDS, CYLINDER HEADS AND VALVES."

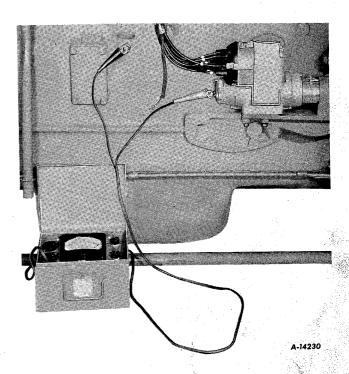
1. Check the clearance on intake and exhaust valves, and make adjustments.

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 18, "IGNITION COIL, SPARK PLUGS AND BATTERIES."

- 1. Clean, and adjust the spark gap.
- 2. Replace broken plugs.



Illust. 3 - Checking Engine rpm using Sun Tachometer.

MAGNETO refer to Section 13, "MAGNETO."

- 1. Check the breaker points.
- 2. Clean the breaker point chamber.

GENERATOR refer to Section 16, "GENERATOR."

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

CONDENSER AND IGNITION COIL (When Used.) (Refer to Section 18, "IGNITION COIL, SPARK PLUGS AND BATTERIES."

- 1. Check condenser; replace it if necessary.
- 2. Check ignition coil; replace it if necessary.

DISTRIBUTOR refer to Section 14, "BATTERY IGNITION DISTRIBUTOR."

1. Check the distributor contact points.

CRANKING MOTOR refer to Section 15, "CRANKING MOTOR."

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



MANIFOLDS

5. ENGINE TUNE-UP - Continued

General - Continued

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, "COMPRESSION RELEASE MECHANISM."

- 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, "CARBURETOR (DIESEL STARTING)."

- 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 antifreeze solution in cold weather.
- 2. (Packing type water pump.) Check water pump packing, adjust packing nut or install nev packing as needed.
- 3. Check the fan belts for wear and replace if necessary.

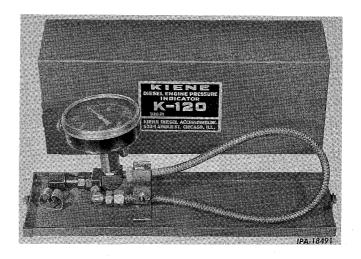
4. Check the fan belt tension. Refer to Section 5, "FAN BELT, WATER PUMP AND THER-MOSTAT."

DIESEL COMPRESSION PRESSURE

1. 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 "SERVICE TOOL 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, "SPECIFICATIONS" 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.



Illust. 4 - Kiene Pressure Indicator.



MANIFOLDS

1. DESCRIPTION

Intake Manifold

The intake manifold is of the dual type. A small, high-velocity passageway is used only during starting, and a large passageway on the diesel cycle. Two butterfly valves (4 on 18 series engines) 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.

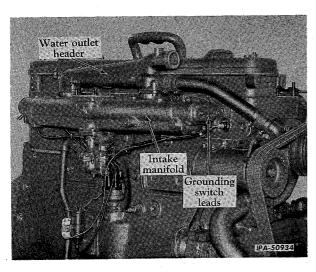
Exhaust Manifold

The exhaust manifold (two are used on early model 18 series engines, while later models have either two exhaust mufflers or a one-piece exhause muffler in place of the manifolds), is secured to the cylinder head exhaust ports with studs and nuts.

2. REMOVAL

Intake Manifold

1. MAGNETO IGNITION: Remove the manifold end cover and gasket from the forward end of the manifold. Remove the electrical leads from the blade type ignition cut-out switch. On later models using the rotary type ignition cut-out switch, it is not necessary to remove the manifold end cover because the switch leads can be disconnected from the outside of the cover.

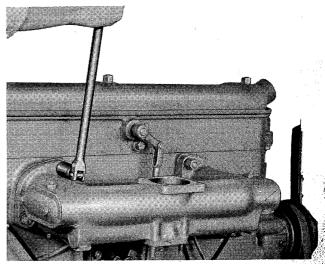


Illust. 1 - Intake Manifold on 18 Series Engines.

BATTERY IGNITION: Remove the electrical leads from the terminal screws of the manifold front cover (Illust. 1).

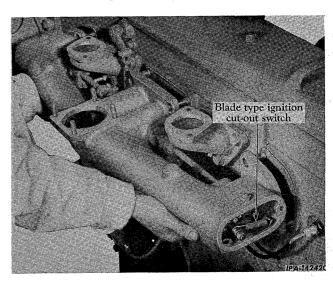
- 2. Turn off the gasoline at the tank and remove the gasoline supply tube at the carburetor.
- 3. Remove the cotter pin and disconnect the choke control rod from the carburetor. Remove the primer control connections if used.
- 4. Remove the cap screws which secure the air intake flange.
- 5. Take out the cotter pin and remove the carburetor control link at the carburetor.

(Continued on next page)



A-14243

Illust. 2 - Removing Intake Manifold From 14 Series Engines.



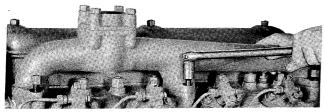
Illust. 3 - Removing Intake Manifold From 18 Series Engines.

MANIFOLDS

2. REMOVAL - Continued

Intake Manifold - Continued

- 6. Remove the carburetor.
- 7. Remove the nuts that secure the manifold to the engine (Illust. 2) and remove the manifold from the engine (Illust. 3).



A-14244

Illust. 4 - Removing Exhaust Manifold From 14 Series Engines.

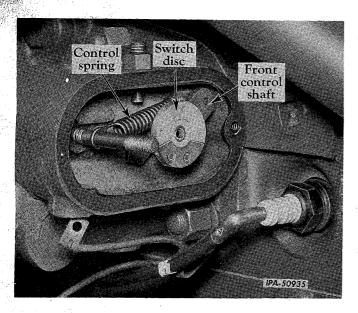
Exhaust Manifold

Remove the nuts which secure the manifold to the engine and lift the manifold and gaskets from position. (Illust. 4.)

3. DISASSEMBLY

Intake Manifold - 14 Series Engines

- 1. Remove the manifold end covers (9 and 24) and gaskets (10, Illust. 6).
- 2. Unhook the springs (11) and remove them.



Illust. 5 - Rotary Type Ignition Cut-out Switch.

- NOTE: On units equipped with the rotary switch (Illust. 5), 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 (20).
- 4. Remove the screws which hold the butterfly valves (5) to the control shafts (7 and 22) and lift out the valves.
- 5. Pull the control shafts out of the intake manifold.
- 6. Remove the seals (8) if necessary. (The lips of the seals must face into the manifold to provide good sealing.)

Intake Manifold - 18 Series Engines

- 1. Remove the end covers (14 and 28, Illust. 7) and gaskets (15).
- 2. Unhook the springs (1) and remove them.

NOTE: On units equipped with the rotary switch (Illust. 5), it is easier to unhook the spring from the front control shaft lever after the shaft has been removed. Also, the contact blades are mounted inside the end cover, and are freed by removing the two through screws. The contact disc is secured to the front manifold control shaft with an eyelet.

3. Remove the butterfly valves (11) from the shafts (2, 6, 8, 9).

NOTE: Do not use force to remove the valves or damage will result.

- 4. Remove the control shaft flange pins from the control shaft flanges and end couplines. Remove the shafts by tapping them lightly.
- 5. Remove the seals (21) if necessary to replace them.

4. 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 ignition cut-out switch terminals and insulation. Clean off any oxidization with a tungsten file.



MANIFOLDS 29 **^18 19 21 23 24 25 26 27 28**

15 Illust. 6 - Exploded view of Intake Manifold and Exhaust Manifold (14 Series Engine).

- 1. Muffler stud.
- 2. Exhaust manifold gasket.
- 3. Exhaust manifold.
- 4. Intake manifold gasket.
- 5. Butterfly valve.

- Butterfly valve.
 Butterfly valve screw.
 Manifold control shaft, rear.
 Manifold control shaft seal.
 Intake manifold end cover.
 Intake manifold end cover gasket.
 Manifold control spring.

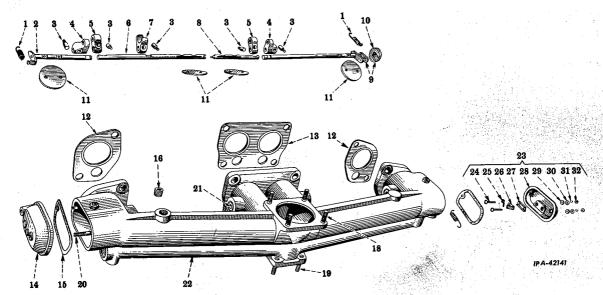
11 12

10

- 12. Manifold control spring stud.
- 13. Intake manifold expansion plug.14. Intake manifold.
- 15. Carburetor stud.

- 16. Manifold control lever pin.
- 17. Washer.
- 18. Screw.
- 19. Switch contact blade.
- 20. Manifold control lever.
- 21. Switch contact blade.
- 22. Manifold control shaft, front.
- 23. Switch blade mounting strip.
- 24. Intake manifold end cover, front.
- 25. Terminal insulator.
- 26. Washer.
- 27. Lock washer.
- 28. Hex nut.
- 29. Intake manifold end cover, assembly.

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Illust. 7 - Exploded View of Intake Manifold (18 Series Engine).



MANIFOLDS

Index to reference numbers shown in Illust. 7.

- 1. Manifold control spring.
- 2. Manifold control shaft, rear.
- Control shaft flange pin.
 Control shaft coupling.

- 5. Control shaft flange.6. Control shaft, intermediate, rear.
- 7. Control lever.
- Control shaft, intermediate, front.
 Control shaft, front.
- 10. Disc.
- 11. Butterfly valve.
- 12. End gasket.
- 13. Center gasket.
- 14. End cover, rear.
- 15. End cover gasket.
- 16. Pipe plug.

5. REASSEMBLY



Intake Manifold - 14 Series Engines

- 1. Install new seals (8, Illust. 6) if necessary. The lips must face into the manifold.
- 2. Install the two control shafts (7 and 22) and at the same time, install the control lever (20) on the shaft (7). Be careful not to damage the seals.
- Insert the butterfly valves (5) 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 (9) and gasket (10). 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. and adjust with the set screws until the butterfly valves are both perfectly horizontal inside of 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.

Intake Manifold - 18 Series Engines

1. Install new seals (21, Illust.7) if necessary. The lips of the seals must face the inside of the manifold to seal effectively.

- 18. Air intake flange stud.
- 19. Carburetor stud.20. End cover rear stud.

- 21. Control shaft seal.
 22. Manifold assembly.
 23. Manifold end cover, front, assembly.
 24. Screw.
 25. Switch contact blade, left.
 26. Switch contact blade, right.

- 27. Switch blade mounting strip.
- 28. Manifold end cover, front.
- 29. Terminal insulator.
- 30. Flat washer.
- 31. Lock washer.
- 32. Hex nut.
- 2. Install the control shafts, couplings and levers into the manifold, being careful not to damage the seals (21).
- 3. Insert the butterfly valves into the slots in the control shafts, and secure each with two screws.
- 4. Hook the springs (1) onto the stud (20) and to the end of the shafts (2 and 9).
- 5. Adjust the butterfly valves by loosening the lock nuts of the set screws on top of the manifold. Adjust the set screws until the butterfly valves are horizontal within the manifold air passage when the levers contact the set screws. The butterfly valve screws have a "V" cut at the bottom and will cause expansion when installed. This is to prevent any possibility of the screws coming loose during operation.

NOTE: Butterfly valves should fit the bore of the manifold without cocking or binding. They should not have more than .0015 inch clearance measured with a feeler gauge 1/8 inch wide between the circumference of the valve and the bore of the manifold.

6. 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 surfaces of the cylinder head around the ports should be free from dirt. Also 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.

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MANIFOLDS

- 3. Connect the carburetor supply and over-flow 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 or mufflers. 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.

CYLINDER HEAD AND VALVES

7. DESCRIPTIÓN

The IH diesel engine cylinder head differs from the conventional gasoline engine cylinder head in that it contains an auxiliary combustion chamber. When the auxiliary combustion chamber is opened to the regular combustion chamber by a starting valve, the cylinder volume increases the compression ratio decreases. The cylinder head 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 valve seats need reconditioning, or when cylinder sleeves are to be removed.

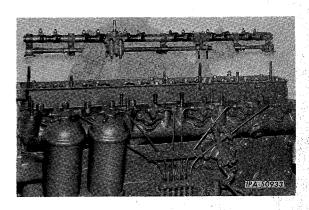
The 18 series engines have front and rear cylinder heads, connected by a water manifold. Either the front or rear head can be removed independently of the other. While basically of uniform construction, slight modifications in design prevent the front and rear cylinder heads from being interchangeable. A separate cylinder head gasket is provided for each head.

The 14 series engine has a single cylinder head assembly but its general design features are identical with the 18 series engine.

8. REMOVAL (Refer to Illusts. 10 and 11.)

- 1. Drain any remaining coolant in the engine by opening the water drain valve in the engine block.
- 2. Remove the engine lifting eye, if so equipped.
- 3. Remove the gasoline tank. Also remove the steering booster hydraulic oil reservoir on tractor engines so equipped.

- 4. Remove the intake manifold. (Refer to par. 2 in this section.)
- 5. Remove the water outlet header on 18 series engines and remove the thermostat housing on 14 series engines.
- 6. Remove the exhaust manifold on 14 series engines, also 18 series engines if so equipped.
- 7. Remove the valve cover and gasket. Remove the cylinder head breather pipe.
- 8. Disconnect the cross shaft operating rod from the starting valve operating shaft lever (37, Illust. 10).
- 9. Remove the nuts and cap screws which secure the valve lever assembly to the cylinder head. Lift the assembly evenly from the studs (Illust. 8).
- 10. Remove the valve push rods and bracket (20, Illust. 10).

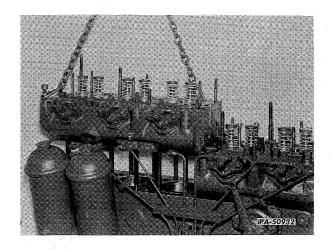


Illust. 8 - Removing Valve Lever Assembly.



8. REMOVAL (Refer to Illusts 10 and 11.) - Continued

- 11. Remove the valve housing (24) and gasket (25, Illust. 10).
- 12. Remove the injection pipes from the nozzles and from the injection pump. Install caps on the injection pumps connections to prevent the entry of dirt. Remove the spark plugs.
- 13. Remove the cylinder head stud nuts, and remove the cylinder head by lifting it evenly from position (Illust. 9).
- 14. Remove the cylinder head gasket and gasket rings.



Illust. 9 - Removing Cylinder Head.

Index to reference numbers shown in Illust. 10.

- . Washer.
- Cover nut.
- 3. Valve housing cover.
- 4. Cover gasket.
- 5. Expansion plug.
- Retainer ring.
- 7. Lever bracket, outer.
- 8. Adjusting screw nut.
 9. Adjusting screw.
- 10. Exhaust valve lever, R.H.
- 11. Lever bushing.
 12. Lever spacer, outer.
 13. Lever spring.
 14. Valve lever shaft.

- 14. Valve lever shaft.
 15. Valve lever, straight.
 16. Lever spacer, intermediate.
 17. Lever bracket, intermediate.
 18. Exhaust valve lever, L. H.
 19. Lever center bracket, upper.
 20. Lever center bracket, lower.
 21. Starting valve shaft
- 22. Starting valve shaft.
- 23. Starting valve shaft.
 23. Starting valve shaft spring, rear.
 24. Valve housing.
 25. Valve housing gasket
 26. Expansion plug.
 27. Collar key.
 28. Positive valve rotator

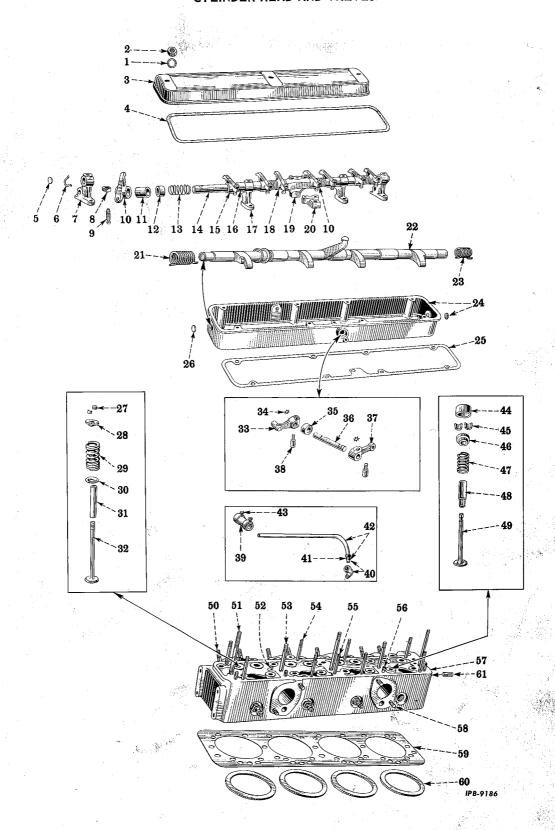
- 29. Valve spring.
- 30. Valve spring seat, lower.
- 31. Valve guide.

- 32. Valve, intake and exhaust.
- 33. Starting valve operating shaft lever.
- 34. Lock washer.
- 35. Starting valve shaft oil seal.
- 36. Starting valve operating shaft.
- 37. Starting valve operating shaft lever, outer.
- 38. Starting valve operating shaft lever pin.
- 39. Breather tube hose.
- 40. Breather tube elbow.
- 41. Breather tube coupling nut.42. Breather tube.43. Breather tube hose clamp.

- 44. Starting valve cover.
- 45. Spring collar key.
- 46. Starting valve spring seat.
- 47. Starting valve spring.
- 48. Starting valve guide.
- 49. Starting valve.
- 50. Nozzle body stud.
- 51. Lever bracket stud, long.
- 52. Shaft locating pin.
- 53. Intermediate bracket stud.
- 54. Valve housing stud.
- 55. Valve housing stud, short.
- 56. Valve lever bracket stud, short.57. Cylinder head.58. Manifold stud.

- 59. Cylinder head gasket.60. Cylinder head gasket ring.
- 61. Oil header plug.



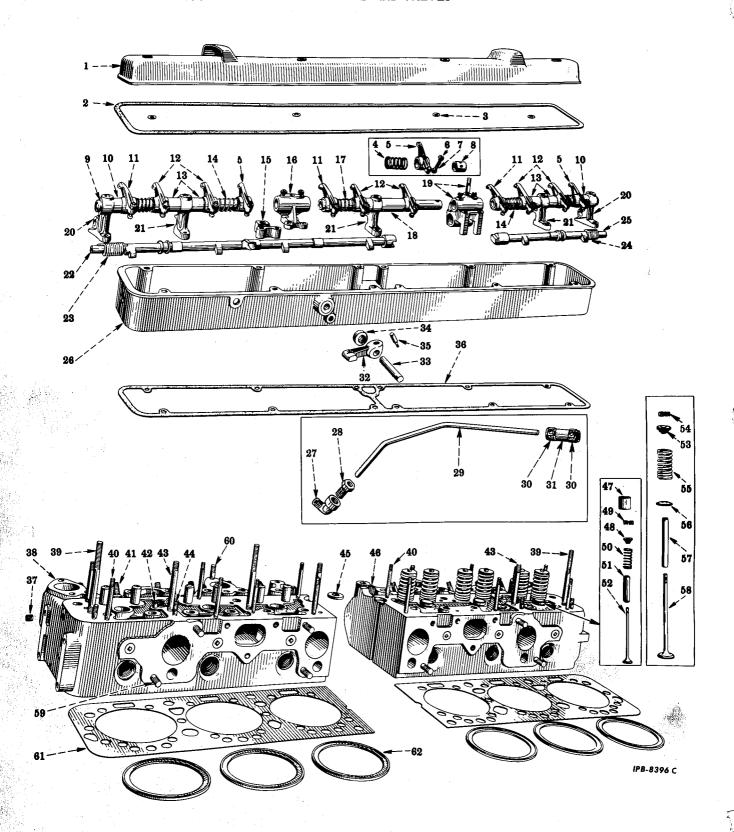


Illust. 10 - Cylinder Head, Valve Housing, Valves and Starting Valve Mechanism (14 Series Engine).



Page 8

CYLINDER HEAD AND VALVES



Illust. 11 - Cylinder Head, Valve Housing, Valves and Starting Valve Mechanism (18 Series Engine).



Index to reference numbers shown in Illust. 11.

- 1. Valve housing cover.
- 2. Cover gasket.
- 3. Cover nut gasket.
- 4. Valve lever spring.
- 5. Exhaust valve lever, R.H.
- 6. Adjusting screw nut.
- 7. Adjusting screw.
- 8. Valve lever bushing.
- 9. Shaft snap ring.
- 10. Spacer, outer and rear center.
- 11. Exhaust valve lever, L. H.
- 12. Intake valve lever.
- 13. Lever spacer, intermediate.14. Lever shaft, front and rear.
- 15. Lever bracket, rear center, lower.
 16. Lever bracket, rear center, upper.
 17. Lever shaft, center.
 18. Lever spacer, front center.
 19. Lever bracket, front center.

- 19. Lever bracket, front center.
 20. Lever bracket, end.
 21. Lever bracket, intermediate.
 22. Starting valve shaft, rear.
 23. Starting valve shaft spring, rear.

- 24. Starting valve shaft spring, front.

- 25. Starting valve shart spring,
 25. Starting valve shaft, front.
 26. Valve housing.
 27. Breather pipe elbow, front.
 28. Pipe elbow nut.
 29. Breather tube.
 30. Breather tube hose clamp.
 31. Breather tube hose.

9. DISASSEMBLY

Intake and Exhaust Valves

Compress the valve springs and remove the valve seat keys (Illust. 12). Remove the compressor and lift each valve spring seat (28) (or positive valve rotator, whichever is used), and spring from position. Remove the valve stem oil deflectors from the intake valves (if so equipped). With pliers, remove the valve retainers (if so equipped) and slide the valves from position. Keep each set in a numbered envelope or box so that they can be reassembled to their original positions.

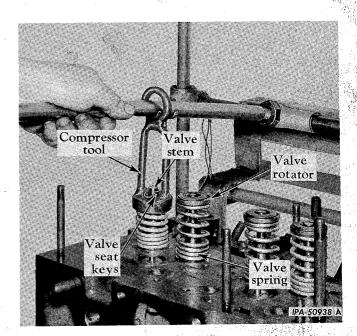
Starting Valves

Remove the starting valve covers (44, Illust. 10). Use the service tool 1 020 073 R1 to compress the springs and remove the keys (45). (Refer to the "SERVICE TOOL MANUAL," ISS-1002.) Lift out the valve spring seats (46), the springs, and slide the valves from position.

- 32. Starting valve operating shaft lever.
- 33. Starting valve operating shaft.
- 34. Starting valve shaft oil seal.
- 35. Starting valve shaft pin.
- 36. Valve housing gasket.
- 37. Oil header plug.
- 38. Cylinder head, rear.
- 39. Lever bracket stud, long.
- 40. Valve housing stud. 41. Injection nozzle stud.
- 42. Valve housing stud, short.
 43. Lever bracket stud, intermediate.
 44. Lever bracket stud, short.
- 45. Cylinder head center stud washer.46. Cylinder head, rear.47. Starting valve spring cover.

- 48. Starting valve spring seat.
- 49. Spring collar key.
- 50. Starting valve spring.
- 51. Starting valve guide.
- 52. Starting valve.
- 53. Positive valve rotator.
- 54. Spring collar key.
- 55. Valve spring, intake and exhaust.
- 56. Valve spring lower seat.
- 57. Valve guide, intake and exhaust.
 58. Valve, intake and exhaust.
 59. Manifold stud.

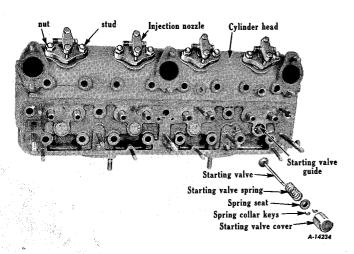
- 60. Manifold stud, long.
- 61. Cylinder head gasket.62. Cylinder head gasket ring.



Illust. 12 - Compressing Valve Springs



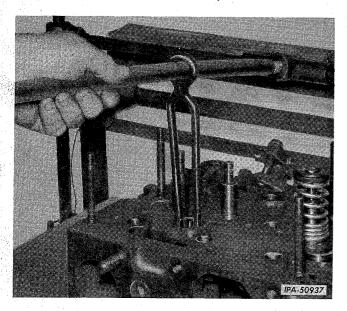
DISASSEMBLY - Continued



Illust. 13 - Starting Valves and Injection Nozzles.

Injection Nozzles

Remove the nuts which secure the injection nozzles to the cylinder head studs. (Illust. 13.) 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 TOOL MANUAL," ISS-1002.) For disassembly of nozzles, refer to "DIESEL INJECTION PUMP MANUAL," ISS-1003.



Illust. 14 - Compressing Starting Valve Spring For Valve Removal.

Valve Lever and Shaft

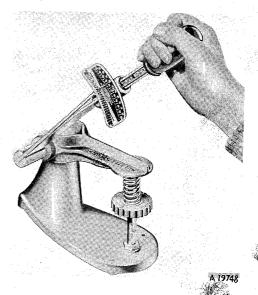
To disassemble the mechanism, remove the

set screws in the shaft center bracket (19. Illust. 10), remove the nuts from the bracket studs, and remove the retainer rings (6) from the ends of the shaft (14). Slide the parts from the shaft. Lift out the starting valve shaft.

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

10. INSPECTION AND REPAIR

- 1. 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.
- 2. Inspect all parts for damage. Check dimensions of valves and specifications for valve springs against those listed in "SPECIFICA-TIONS" in section 1. (Illust. 15.) Any score marks or scratches on valves and related parts can be cleaned off with a fine abrasive if not too severe.
- 3. The cylinder head must have parts replaced if any doubt as to serviceability of the parts 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 valves must extend the specified distance above the top surface of the cylinder head. (Refer to "SPECIFICATIONS" in section 1 for distance involved.) (Illust. 16.)



Illust. 15 - Testing Valve Springs

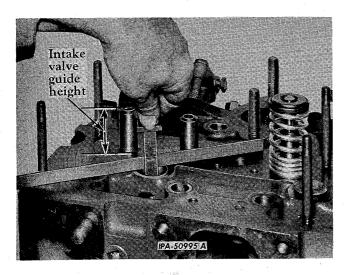


NOTE: Refer to par. 11, "VALVE RECONDITIONING" for more information on engine

4. The valve guides are furnished for service reamed to size but installation may tend to diminish the bore slightly. Correct 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

5. Replace the bushings if necessary. Be certain that the oil hole in the bushing corresponds in position with that of the valve lever and shaft when installed. The bushing running clearance is given in "SPECIFICATIONS," in Section 1.



Illust. 16 - Measuring Position of Starting Valve Guide.

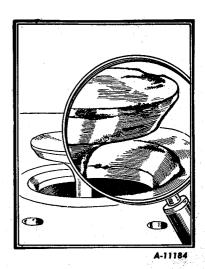
11. VALVE RECONDITIONING

General

Carbon deposits on the valves and valve seats are normal effects of the fuel-burning engine and cannot be avoided completely. (Illust. 17.) However, such deposits are detrimental to engine efficiency and valve assembly life as the amount of carbon in the engine increases.

Whenever the cylinder head is removed for service, remove all carbon from the surfaces of the parts affected. Examine valves and

valve seats for pitting, burning, warping and other defects.



Illust. 17 - Carbon Corrision and Wear are Inevitable Products Of Normal Engine Operation.

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

Warpage burning and pitting of valves is mainly directed against the exhaust valves 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 blow-by. This, in turn, can generally be traced to hard particles of carbon being present on the slopes of the valve seats. It may, however, be due to weak springs, insufficient valve clearance, or warpage and misalignment of the valve stem or guide.

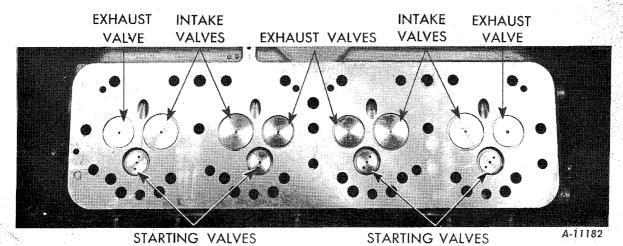
Warpage chiefly occurs on the valve stem due to its exposure to heat. Out-of-round wear occurs when the seat has been pounded by a valve head which is not in line with its stem or guide.

Misalignment is a result of wear, warpage, and distortion. Wear, when accentuated by insufficient subrication, will eventually create sloppy clearances with resulting misalignment.

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

11. VALVE RECONDITIONING - Continued

General - Continued



Illust. 18 - Valve Locations on 14 Series Engine.

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 cylinder head water passages. Valve materials are carefully chosen to withstand such varying temperatures. However, an engine that is Nowed to operate continually in an overheated dition 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 clearance 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 in the valve head concentric with its seat. This will prevent leak-proof seating.

Oil and air are drawn 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 Valve Reconditioning

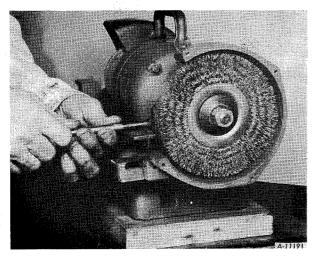
Before disassembly of the engine for removal of the cylinder head, examine the engine for signs which may indicate the reason for the need of valve reconditioning. Dry and rusted valve springs are an indication that the oil passages to the valve levers may be blocked. This will cause wear on the valves 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 the reconditioning.

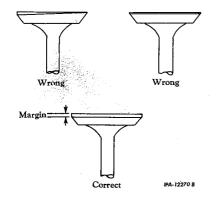
Valves

- 1. Remove all carbon from the valve face. head, and stem. A wire brush or buffing wheel (Illust. 19) can be used to a good purpose for this operation. Valve stems should be lightly polished, with an extremely fine abrasive cloth. enough to remove the carbon deposits only.
- 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, which prevents the valve spring retainer locks from fitting snugly.
- 3. All valves having bent, worn, warped, or seriously pitted stems should be replaced. Replace any valve that cannot be satisfactorily refaced with a definite margin maintained (Illust. 20.) 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, as large an area as possible. Knife-edged valves lead to breakage and warpage.





Illust. 19 - Cleaning Carbon From The Valve.



Illust. 20-A Definite Margin Must Be Obtained And Be Maintained During Reconditioning.

Valve Springs

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. 21.) (Refer to "SERVICE TOOL MANUAL," ISS-1002.)

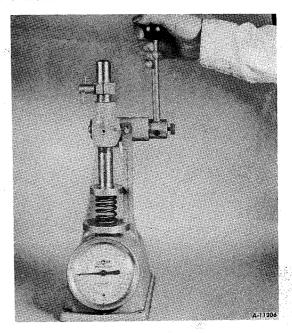
Valve Spring Retainers

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

Valve Spring Retainer Locks

6. Clean parts thoroughly in solvent. Check the ribs in the inside of the locks to see that none are worn sufficiently to cause looseness.

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



Illust. 21 Checking the Valve Spring Free Length And Tension Insures A Uniform Set of Valve Springs.

Valve Rotators

7. Inspect the valve rotators for proper operation. A valve rotator in the free state (not assembled in the engine) may rotate in either direction, rotate in one direction or may not rotate in any direction and still be satisfactory for use. To properly test a valve rotator for rotation, the valve spring load must be applied to the rotator. This can be done in a spring tester, or assembled in an engine. When using a spring tester, place the valve spring together with the rotator in the tester. Place a ball bearing between the rotator cap and the ram of the spring tester. Turning of the valve rotator can then be observed by compressing the valve spring.

Valve Guides

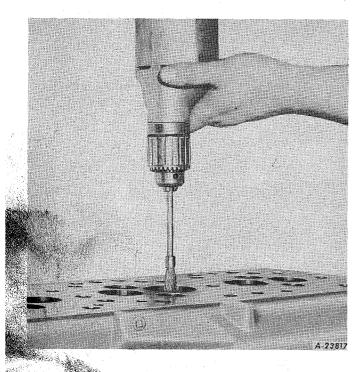
8. Clean the valve guide bores using a wire rifle brush and solvent (Illust. 22). Blow out all carbon with compressed air. Examine the walls for burning, blistering, cracking or excessive wear. Check the inside diameter of the guide bore at several points around its circumference and along its length. Specifications for the guides are given in the table following. Replace guides as necessary.

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

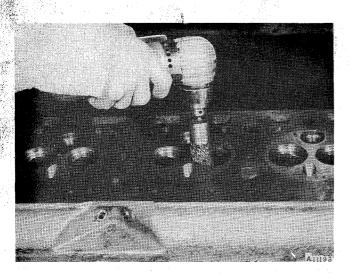


11. VALVE RECONDITIONING - Continued

Valve Guides - Continued



Illust. 22 - Cleaning Valve Guide By Using A Wire Rifle Brush.



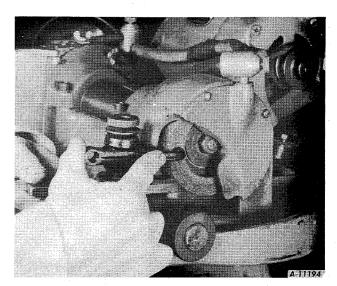
Illust. 23 - Cleaning Carbon From The Cylinder Head and Valve Ports.

Valve Seats

9. Remove all carbon from the cylinder head. (Illust. 23.) Inspect all valve seats for cracks. Be sure all carbon is removed from the valve seat.

Valve Lever Assembly

- 10. With a micrometer, check the diameter of the valve lever shaft at the valve lever bushings. (Refer to "SPECIFICATIONS," in Section 1.) If the shaft is found to be worn excessively or out-of-round, replace the shaft.
- 11. Inspect and replace worn valve lever 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. 24.) Worn valve levers place side thrust on the valve stem, thereby causing wear on the guides. True valve levers 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. 24 - Grinding The Valve Lever Face Assures Proper Contour Of Contact Faces.

Cylinder Head

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

Reconditioning

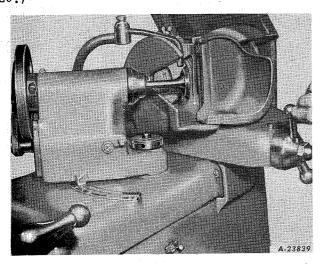
VALVES: After being thoroughly cleaned and inspected, recondition valves that are fit for continued use as follows:

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



- 1. Set the valve refacing machine to grind the desired angle, (Illust. 25.) and dress the grinding stone.
- 2. 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. 20.)

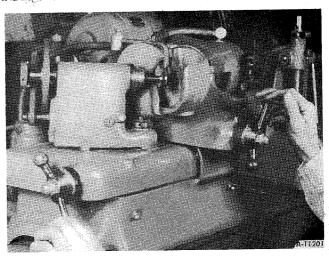
Avoid taking heavy grinding cuts as this heats the valve head excessively, produces an unsatisfactory valve face, and necessitates dressing the grinding wheel frequently. Repeated light grinding cuts are preferred until a true face of even width is obtained around the valve. Avoid passing the stone beyond 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. 20)



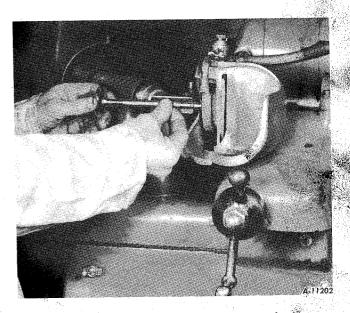
Illust. 25 - Locating The Valve And Grinding Stone To The Specified Angle.

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

After refacing each valve, inspect the end of the stem. If wear is noticeable, reface the end of the stem with the attachment usually provided with the valve grinding equipment. (Illust. 27.) Grind sufficiently to true-up the end of the stem.



Illust. 26 - Grinding The Valve Face Angle. Take Light Cuts



Illust. 27 - Refacing The Valve Stem End.

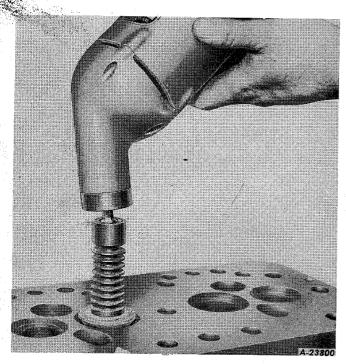
VALVE SEATS: Remove all carbon, scale, and oil before attempting to reface the valve seats. The grinding stone, when placed against an oily seat, will become fouled and uneven grinding will occur.

- 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.

11. VALVE RECONDITIONING - Continued

Reconditioning - Continued

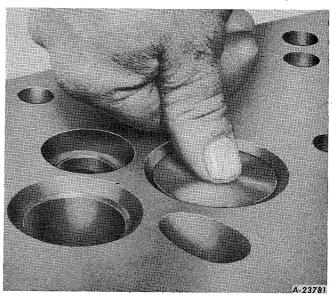
- 3. Lower the grinder head over the pilot shank until the stone just clears the valve seat. Turn on the power and very gently allow the stone to contact the valve seat. (Illust. 28.) Very little pressure other than the normal weight of the stone should be used. Sudden, hard pressures can cause cocking of the pilot in 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. Runout must not exceed a total of .002 inch.



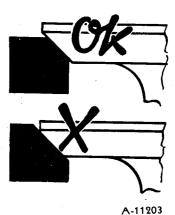
Illust. 28 - Grinding The Valve Seat By Using One Of The Many Grinding Tools Of Standard Manufacture.

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. 29.) 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 be sure that no error was made.

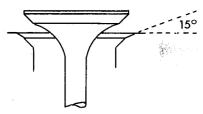


Illust. 29 - Testing Valve Seat And Face Contact By Using Prussion Blue.



Illust. 30 - Valve Seat Width Should Conform To Specifications For That Engine And Center On The Valve Face.

6. After grinding the seats it may be found that the seats are considerably wider than the width recommended in the following table for that engine. Valve seats that are too wide (Illust. 30) 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° preferably). (Illust. 31.)



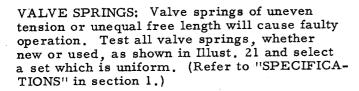
Seat grinding stone 15° smaller than angle of valve seat, narrows seat



Valve face now contacts the seat

A-11205

Illust. 31 - Narrowing Valve Seat Widths.



Valve Levers

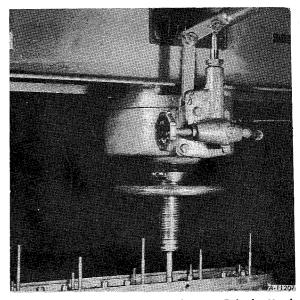
When replacing valve lever bushings, be sure that the oil hole in the bushing lines up with the oil hole in the valve lever. After installation, the bushing should be reamed. (Refer to "SPECIFICATIONS" in section 1.)

Valve Guides

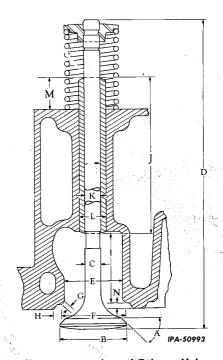
Worn valve guides in the cylinder head are pressed from the underside of the cylinder head, from the valve port up through the top. Use a driver slightly smaller than the guide in order to prevent jamming it in the guideway (Illust. 32).

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.

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 table for specifications.)



Illust. 32 - Pressing Valve Guides Into Cylinder Head.



Illust. 33 - Intake and Exhaust Valve.

KEY TO VALVE CHARTS (See Illusts. 32, 33 and 34.)

- A. Valve face angle.
- 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.



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CYLINDER HEAD AND VALVES

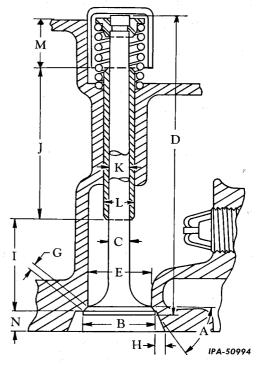
11. VALVE RECONDITIONING - Continued

Valve Guides - Continued

- H. Distance from outside diameter of valve seat to the edge of the combustion chamber in the head.
- 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. Starting valve guide; distance from top of valve guide to top edge of cylinder head.

Intake and Exhaust: Distance from top face of cylinder head to the stem end of the valve guide.

N. Distance from the bottom face of the cylinder head to the face of the valve seat.



Illust. 34 - Starting Valve.

SPECIFICATIONS OF VALVE ANGLES AND DIMENSIONS (Symbols refer to Illusts. 33 and 34.)

14 Series includes TD-14 and UD-14.

14A Series includes TD-14A, TD-14A (141), TD-14 (142) and UD-14A.

18 Series includes TD-18 and UD-18.

18A Series includes TD-18A, TD-18A (181), TD-18 (182), TD-20 (200 & 201), UD-18A and UD-691

NOTE: Abbreviations used: Int. - intake; Exh. - exhaust; Str. - starting.

SYMBOL	14 and 14A Series	18 and 18A Series
A - (degrees)	45 Int.	45 Int.
	45 Exh.	45 Exh.
	45 Str.	45 Str.
B - (inches)	2 Int.	2 Int.
	1-3/4 Exh.	1-3/4 Exh.
	1-9/32 Str. (14)	1-9/32 Str. (18)
	1-3/32 Str. (14A)	1-3/32 Str. (18A)
C = (inch)	.432433 Int.	.432433 Int.
	.431432 Exh.	.431432 Exh.
	.37103720 Str. (14)	.37103720 Str. (18)
	.30853095 Str. (14A)	30853095 Str. (18A)
D - (inches)	8-29/64 Int. and 8-15/32 Exh.	8-29/64 Int. and 8-15/32 Exh.
	5-23/64 Str. (14)	5-23/64 Str. (18)
	5-29/64 Str. (14A)	5-29/64 Str. (18A)



	SYMBOL 14 AND 14A SERIES 18 AND 18A SERIES		18 AND 18A SERIES
	E - (inches)	1-37/64 Int. 1-11/32 Exh. 1-3/16 Str. (14) 1 Str. (14A)	1-37/64 Int. 1-11/32 Exh. 1-3/16 Str. (18) 1 Str. (18A)
	F - (inches)	1-29/32 Int. 1-21/32 Exh. 1-1/4 Str. (14) 1-1/16 Str. (14A)	1-29/32 Int. 1-21/32 Exh. 1-1/4 Str. (18) 1-1/16 Str. (18A)
	G - (inch)	5/64 Int. and Exh. (14) 3/32 Int. and Exh. (14A) 3/64 Str.	5/64 Int. and Exh. (18) 3/32 Int. and Exh. (18A) 3/64 Str.
	H - (inch)	11/64 Int. and Exh. (14) 13/64 Int. and Exh. (14A) 3/32 Str. (14) 13/64 Str. (14A)	11/64 Int. and Exh. (18) 13/64 Int. and Exh. (18A) 3/32 Str. (18) 13/64 Str. (18A)
	I - (inches)	2-21/64 Int. and Exh. (14) 1-51/64 Int. and Exh. (14A) 1-19/32 Str. (14) 1-5/8 Str. (14A)	2-21/64 Int. and Exh. (18) 1-51/64 Int. and Exh. (18A) 1-19/32 Str. (18) 1-5/8 Str. (18A)
	J -(inches)	5- Int. and Exh. 2-11/16 Str.	5 Int. and Exh. 2-11/16 Str.
d	K - (inch)	.4345436 Int. and Exh. .374375 Str. (14) .31153125 Str. (14A)	.4345436 Int. and Exh. .374375 Str. (18) .31153125 Str. (18A)
	L -(inch)	7517515 Int. and Exh752 Str. (14) .6266265 Str. (14A)	.7517515 Int. and Exh752 Str. (18) .6266265 Str. (18A)
•	M -(inches)	. 1-3/8 Int. and Exh. 15/16 Str.	1-3/8 Int. and Exh. 15/16 Str.
	N - (inch)	13/64 Int. and Exh. 13/32 Str. (14) 3/8 Str. (14A)	13/64 Int. and Exh. 13/32 Str. (18) 3/8 Str. (18A)

12. REASSEMBLY (Refer to Illust. 10)

Intake and Exhaust Valves

- 1. Coat the valve stems with engine oil and insert them from the bottom of the head. Return each valve and its parts to the position from which it came.
- 2. Place the spring seat, lower (30); oil deflector on intake valves (if so equipped); spring (29); and positive valve rotator (28) on the valve stem (32). With a valve spring compressor or lifter tool, compress the spring far enough to install the keys (27) in the groove at the top of each valve stem.

Starting Valves

3. Install the starting valves (Illust. 13) 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 starting valve covers.

Starting Valve Shaft Assembly

4. Install the starting valve shaft (22) with springs (21 and 23).

12. REASSEMBLY (Refer to Illust. 10) - Continued

Injection Nozzles

NOTE: Before installing the precombustion chambers, brush Dixon's No. 635 lubricating flake graphite or equivalent on their external surfaces.

- 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 of gaskets. Dip the dust seal into a thick soap solution and carefully install it 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.

Valve Lever and Shaft

8. Install the valve levers on the shaft, being streethat the spacers are in the correct location and that the right, left and straight levers are positioned correctly. Install the ser screws and retainer rings (6, Illust. 9).

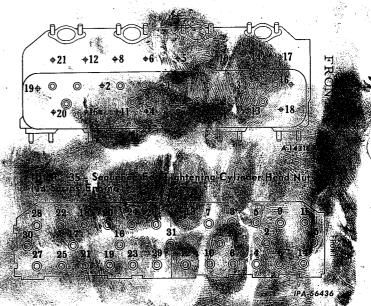
13. INSTALLATION

- Clean all carbon from the tops of the pistons and the top surface of the crankcase.
- 2. Install a new cylinder head gasket and gaset rings. (Use all new gaskets in reassembly.) The flange (recessed) side of the cylinder head gasket rings should be up.
- 3. Install the cylinder head to the crankcase. Secure with the stud nuts. Tighten the nuts as shown in Illust. 35 or 36 and torque them to the specified amounts after lubricating the threads with SAE-30 oil. Do not tighten to full torque immediately; it is advisable to tighten to full torque in three steps. (Refer to "SPECIFICATIONS," in Section 1. Install the valve cover and gasket.

NOTE: On 18 series engines, it is important to line up both cylinder heads in order to provide a good seal at the intake manifold. A suggested method for obtaining proper alignment is as follows:

(a) Install the cylinder heads on the crankcase but do not secure with the stud nuts.

- (b) Install the intake manifold without kets to the cylinder heads, and secure wis stud nuts.
- (c) Secure the cylinder heads with stud nuts as in step 3 above.
- (d) Remove the intake manifold.
- 4. Install the valve housing and gasket. Assemble the operating shaft (36, Illust. 10), the operating levers (33 and 37) and the lever pins and nuts to the valve housing bore if they were removed.
- 5. Install the push rods and the valve lever assembly.



Illust: 36 - Sequence For Tightening Gyffinder Hegd Nurs (18 Series Engine).

- 6. Connect the starting valve linkage to the outside lever (37). Install the cylinder head breather.
- 7. Adjust the valves as described in par. 14. Set the valve clearances as specified for the cold setting in "SPECIFICATIONS" in section 1. Install the valve cover and gasket.
- 8. Install the intake and exhaust manifolds, the water outlet header and thermostats on 18 series engines, and the water outlet elbow and thermostat housing on 14 series engines.
- 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 prantfold 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.

- 1. Install the lifting eye on engine 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.
- 12. Fill the radiator and the cooling system. Be certain that the drain valves below the radiator and on the left side of cylinder block are closed. Check the oil level in the crankcase.
- With all fuel lines and controls connected, start the engine and allow it to operate until its temperature is that of normal operation. 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 rocker arm 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. On new engines, or whenever new cylinder head gaskets have been installed, the valve rocker arm assemblies must be removed and the cylinder head stud nuts retorqued; adjust the valve clearance after the first 50 to 100 hours of operation.

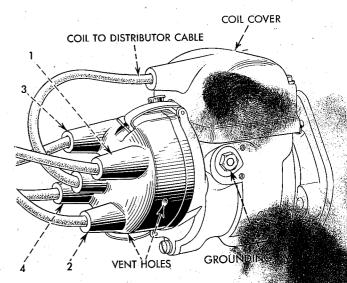
CAUTION: Only those nuts below torque are to be re-torqued to proper specifications. Those above torque are to remain as they are.

14. VALVE CLEARANCE ADJUSTMENT

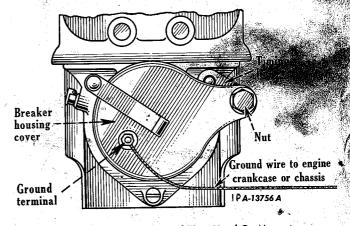
- 1. Before starting the adjustment, cut out the ignition as follows:
 - (a) 14 SERIES ENGINES EQUIPPED WITH H-4 MAGNETO: Cut out the magneto by placing a jumper from the grounding switch cable terminal (Illust. 37) to a cap screw on the coil cover.
 - (b) 18 SERIES ENGINES EQUIPPED WITH F-6 MAGNETO: Ground the magnete by

fastening a wire to the ground terminal (Illust. 38).

(c) 14 AND 18 SERIES ENGINES 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. 37 - Showing Grounding Switch Terminal On Ma (14 Series Engine).

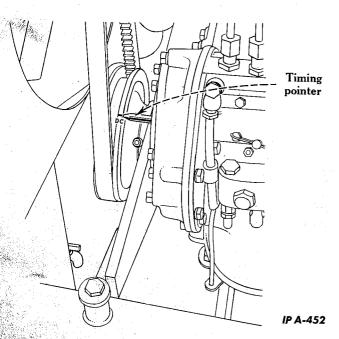


Illust. 38 - Showing Ground Wire Used On Magneto (18 Series Engine).

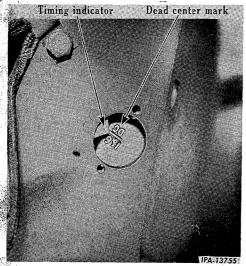
- 2. Pull the compression release lever all the way back to the gasoline position. Remove the valve housing cover and spark plugs.
- 3. On 14 series engines, crank the engine until the exhaust valve for the No. 4 cylinder commences to close. The opening and closing can be seen plainly by observing the valve which is farthest to the rear. Continue crank-



14. VALVE CLEARANCE ADJUSTMENT - Continued



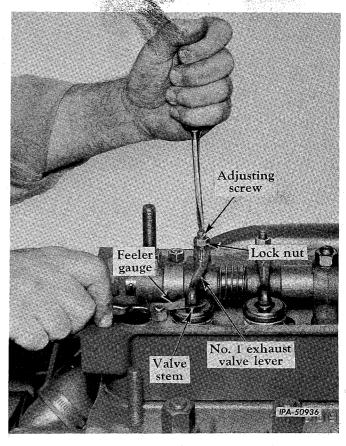
Illust. 39 - Showing Timing Pointer And "DC" Marks On Ean Drive Pulley (14 Series Engine).



Illust: 40 - Showing Flywheel Timing Marks (18 Series Engine).

ing slowly until the "DC" timing mark on the fan drive pulley is in line with the timing pointer (Illust. 39). On an 18 series engine, crank the engine until No. 6 cylinder exhaust valve commences to close. Continue cranking slowly until the "DC" mark on the flywheel is in line with the timing pointer (Illust. 40).

4. Insert a feeler gauge of the specified thickness (refer to "SPECIFICATIONS" in section 1)



Illust. 41 - Adjusting Valve Clearance.

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. 41 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. On a 14 series engine, 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. On an 18 series engine crank the engine one-third 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 which is 1-5-3-6-2-4.
- 6. Install the valve housing cover and gasket, and remove the magneto or distributor short-circuiting jumpers.





1. DESCRIPTION

Connecting Rods

The connecting rods serve as the links between the pistons and the crankshaft. The surfaces of the rods must be kept free of scoring and dents because of the high stresses under which these engine parts function. The rod has a bearing at each end, the one at the upper end being for the piston pin that 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 fit 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 bushings.

The bearings are of the precision, 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

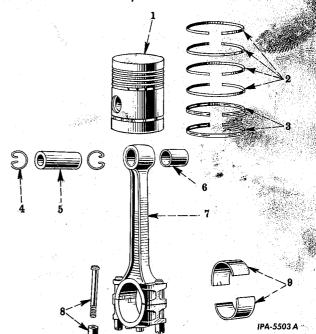
The pistons are fitted with six piston rings. Two oil regulating rings are fitted to each piston, one below and one immediately above the piston pin. The function of the oil regulating rings is to provide an even circulation of lubricating oil and, therefore, an all-over lubricating and cooling action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

The remaining rings are termed compression rings. The top ring is chrome plated and the other three are tapered face. The ring gaps and other dimensions are given in "SPECIFICATIONS." in Section 1. Install rings on a

piston with the gaps 90 degrees from the thrust side of the piston and 180 degrees from one gap to another. (Illust. 11.) 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 pin is retained in the piston by retainer rings that lock into the grooves of the piston pin bore. The pin is allowed to float in its bushing in the upper end of the rod. The aluminum of the piston is an excellent bearing material and therefore, no bushing is provided between the pin and the piston. The bearing of the steel pin in the aluminum piston is the reason for the tight fit of the pin when the piston is cold. It is 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.



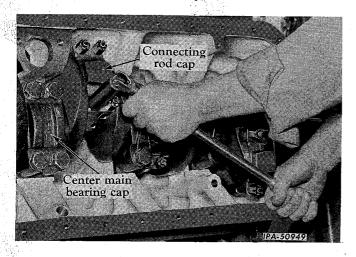
Illust. 1 - Connecting Rod and Piston with Component Parts

- l. Piston.
- Compression rings.
- 3. Oil regulating rings.
- 4. Piston pin retainer.
- 5. Piston pin.
- 6. Connecting rod bushing.
- 7. Connecting rod.
- 8. Connecting rod bolt and nut.
- Connecting rod bearing.

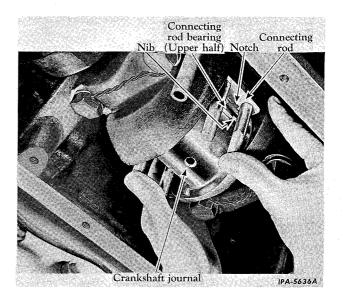
2. REMOVAL

- 1. Drain the engine lubricating oil from the crankcase oil pan by removing the drain plug.
- 2. Remove the oil pan. Before all cap screws are removed, it will help to place a shop jack under the oil pan to support its weight.
- 3. Remove the oil pump. Remove the engine balancer on 14 series so equipped. (Refer to section 4, "OIL PUMP, LUBRICATING OIL FILTERS AND ENGINE BALANCER.")
- 4. Remove the spark plugs from the engine. (Check the spark plug electrode gaps against the gaps specified in section 18, "SPARK PLUGS, IGNITION COIL AND BATTERIES" before reinstalling them.) Place the engine on the gasoline cycle and crank it until the connecting rod to be removed is at its lower position.
- 5. Remove the cotter pin (if equipped) from the nuts on the connecting bolts. 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.
- 6. Push up on the connecting rod until the bolts are clear of the crankshaft. Remove the upper bearing insert by rotating it free of the connecting rod.

CAUTION: Pistons must be handled carefully to avoid damage. When removing a piston from the crankcase, do not allow the skirt of the piston to strike the crankcase. Mark the pistons so they can be installed in the same cylinders from which they are removed, and in the same position.



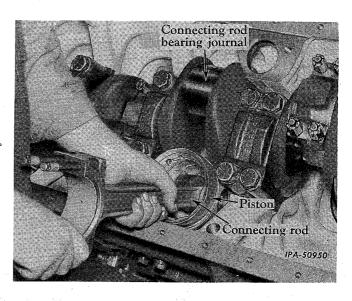
Illust. 2 - Removing Connecting Rod Bearing Cap.
ISS-1038A (7-63)



Illust. 3 - Removing Upper Connecting Rod Bearing.

7. Turn the connecting rod journal toward the camshaft side of the crankcase. Pull the connecting rod and piston down and out from the injection pump side of the crankcase (Illust. 4).

NOTE: On 18 series engines, the flywheel is marked, indicating the exact location for removal of connecting rods and pistons. (Refer to Section 7, "CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL.")



Illust. 4 — Removing Connecting Rod and Piston.
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3. DISASSEMBLY

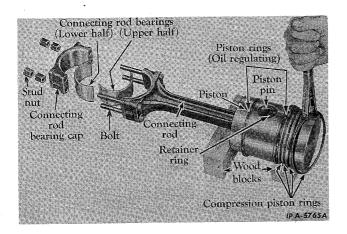
- 1. With the aid of a piston ring expander, remove the piston rings; remove the top ring first and the remaining rings in order. (Illust. 5.) (Refer to the "SERVICE TOOLS MANUAL," ISS-1002.)
- 2. Remove the piston pin retainer rings from each side of the piston, and remove the piston pin. If the piston pin cannot be removed by hand, it is recommended to heat the piston in water at 160° to 180° F. This heating of the piston makes it unnecessary to use force in removing the pins, thus preventing distortion of the pistons.

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 (II-lust. 6). 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.

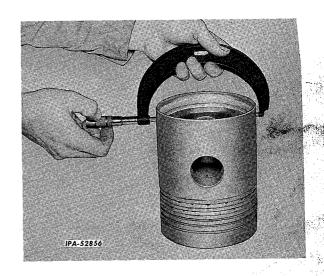


Illust. 5 - Removing Piston Rings.

Inspect the piston ring grooves for wear. (Illust. 7.) For the clearance of new piston rings in the grooves of a piston, refer to "SPECIFICATIONS" in Section 1.

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.



Illust. 6 - Checking Piston O. D.

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 such parts with new rings to eliminate duplication of labor in the immediate future should failure result.



4. INSPECTION AND REPAIR - Continued

Piston Rings - Continued

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 (II-lust. 8) 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.

Check rings also for the specified side clearance by placing each ring in its groove on the piston and inserting a feeler gauge around its edge (Illust. 7).

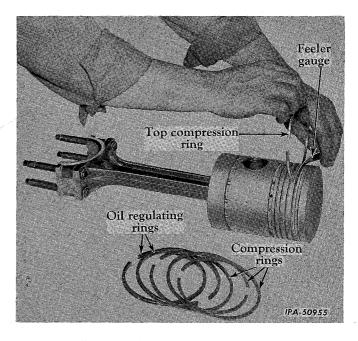
NOTE: On a used piston, it will probably be found that the side clearances tend to increase toward the top of the piston due to the greater operating temperatures prevalent at this point.

If it is necessary to increase the side clearance of the rings, it can be done in one of the following ways:

- (a) True the ring grooves of the piston on a lathe.
- (b) Lap the sides of the rings with lapping compound on a surface plate. Mount the ring in a block or other jig to provide uniform pressure. Work the ring around the surface plate using a circular motion.
- (c) Grind the sides of the rings on a surface grinder. Special care must be taken to obtain a square and even removal of material.

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 burns that may be present on new rings or old rings that will be used again.

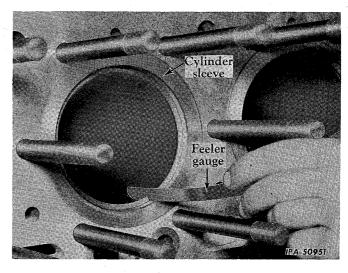


Illust. 7 - Checking Piston Ring in Piston Groove for Correct Fit.

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 and 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



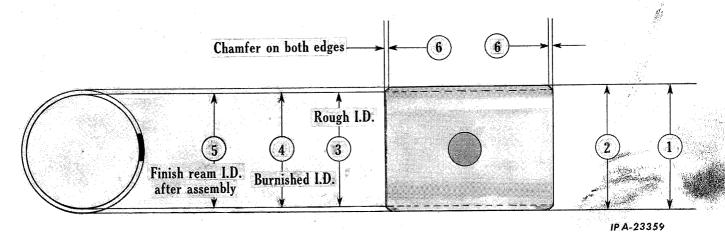
Illust. 8 — Checking Piston Ring Clearance in Cylinder Sleeve.





fine abrasive. When installing new piston pins, be sure that they have the same inside diameter as the piston pins being re-used in the engine. Piston pins are available with a .807.817 inch inside diameter or with a .959 - .969 inside diameter with tapered ends. Never intermix piston pins of different inside diameters in the same engine. Piston pins are also available for oversize installation (refer to parts catalog). Inspect the connecting rod bushings for wear and replace with a new bushing if nec-

essary. The inside diameters of the bushings furnished for service are shown as Ref. No. 3 in the following table. After installation in the connecting rods, they must be burnished and reamed to the diameters (Ref. no. 4 and Ref. no. 5) shown in the following table. Refer to "Service Tool Manual," ISS-1002. When new connecting rods are installed, the bushings in the rods are already finished reamed to the proper size.



Illust. 9 - Checking Piston Pin Bushing Dimensions.

Dimension to be Checked		All Engines
BUSHING OUTSIDE DIAMETER	(Ref. No. 1) Press fit - inches	1.7235 - 1.7255 1.7305
BUSHING INSIDE DIAMETER	(Ref. No. 3) As furnished - inches	1.612 - 1.614 1.6165 - 1.6175
	(Ref. No. 5) Finish reamed - inches	1.6257 - 1.6259
BUSHING CHAMFER	(Ref. No. 6) On both edges	1/32 x 20 - 25°

5. REASSEMBLY

1. With the piston pin as cool as possible and generously coated with 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 of 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.

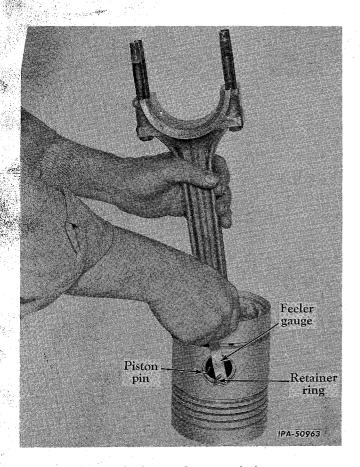
NOTE: The piston and connecting rod must be assembled so the off-center depression in the piston head and the position number stamped on the lower end of the connecting rod, are on opposite sides.

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.

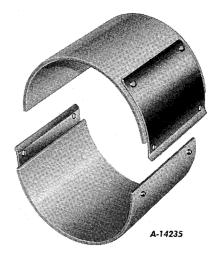
5. REASSEMBLY - Continued

- 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 (Illust. 10) as specified in "SPECIFICATIONS," in Section 1.
- 4. Using a piston ring expander, install the rings into the grooves of the pistons. The tapered compression rings must be installed as directed by the word "TOP" stamped on their 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. 12.



Illust. 10 - Checking Piston Pin End Clearance.

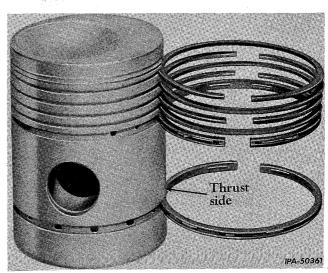


Illust. 11 - Piston Ring Compressor.

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.

1. Place the ring compressor on the assembled piston and connecting rod. (Illust. 13). (Refer to "SERVICE TOOL MANUAL," ISS-1002.) Smear the inside bore of the sleeve and the piston with clean engine oil. Align the piston with its sleeve in the bottom of the crankcase and push the piston into the sleeve. (Illust. 14.) The ring compressor will fall free when the piston is completely in the sleeve. Be sure that the piston is installed to its correct direction with respect to the markings on its top face.



Illust. 12 - Showing Positions of Piston Ring Gaps.

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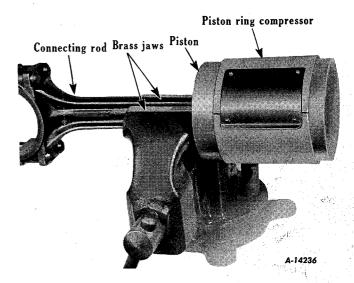


- 2. Remove the ring compressor. Wipe the crankshaft bearing end of the rod to remove any grit gathered during installation. Install the crankshaft bearing upper half to the rod after wiping it clean and swabbing it with clean engine oil. Position it into the end of the connecting rod. Cleanliness of the bearings, journal, and bearing supporting surfaces cannot be overstressed.
- 3. Wipe clean and oil the crankshaft journal and temporarily install the lower bearing and bearing cap. Do not tighten the bearing cap nuts. The nib of the bearing must fit in the notch in the bearing cap. The number stamped on the bearing cap must correspond in number and position with that on the connecting rod.
- 4. Install the other pistons, connecting rods and bearings in the same manner.
- 5. Torque the connecting rod bearings to the foot-pounds specified in "SPECIFICATIONS" in Section 1. Use virgin lead wire to check the clearance present between the crankshaft and the lower bearing of the connecting rod. Remove the bearing cap and bearing, place a suitable length of .015 inch virgin lead wire across the bearing (Illust. 15), and install the bearing and bearing cap. Tighten the nuts to the specified torque; then remove the nuts and bearing cap and, with a micrometer, measure the wire which will have been crushed down to the dimension of the clearance between the crankshaft journal and the connecting rod bearing by the torque applied to the nuts. The micrometer measurement should fall between the figures specified for the engine in "SPECI-FICATIONS" in Section 1. 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. On engines not equipped with lock nuts, secure the nuts with cotter pins.

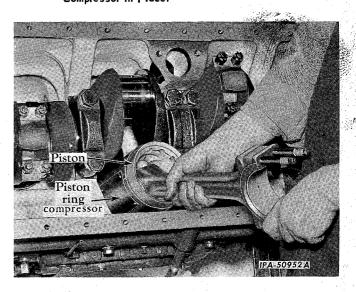
NOTE: If the readings do not fall within the specified limits, and the torque wrench is known to be accurate in its measurement, remove the bearing from the connecting rod and replace it with a new one. However, with the precision bearings used, no difficulty should be encountered providing the crankshaft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

6. Check the connecting rod side clearance by inserting a feeler gauge between the bearing cap and lobe of the crankshaft (Illust. 16). (Refer to "SPECIFICATIONS" in Section 1 for specified clearance.)

- 7. Install the crankcase lubricating oil pump, oil pan and gasket, using shellac to seal the gasket in place. (Refer to Section 4, "OIL PUMP, LUBRICATING OIL FILTERS AND ENGINE BALANCER.")
- 8. Install the cylinder head or heads. Use new cylinder head gaskets. (Refer to Section 2, "MANIFOLDS, CYLINDER HEAD AND VALVES.")

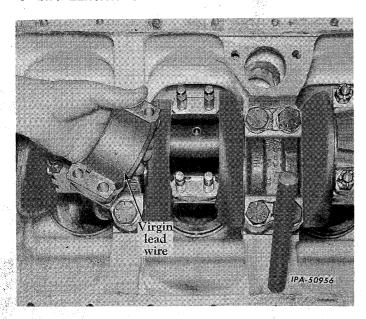


Illust. 13 — Connecting Rod and Piston with Ring Compressor in Place.



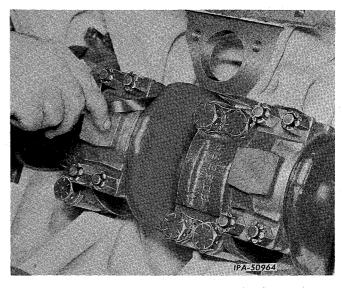
Illust. 14 - Installing Connecting Rod and Piston with Piston Ring Compressor in Place.

6. INSTALLATION - Continued



Illust. 15 - Checking Connecting Rod Bearing Running Clearance.

9. After the installation of new piston sets or new piston rings, the engine must be "run-in" according to the conditioning schedules in paragraph 11.



Illust. 16 - Checking Connecting Rod Side Clearance.

SLEEVES

7. DESCRIPTION

The 14 and 18 series engines are equipped with Wet type sleeves. The bottoms of the sleeves are sealed in the crankcase by rubber "O" rings (Illust, 19). 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 wet type sleeve is water-cooled over its entire length.

8. REMOVAL

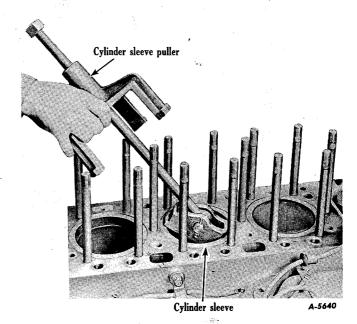
- 1. Remove the cylinder head assembly. (Refer to Section 2, "MANIFOLDS, CYLINDER HEAD AND VALVES.")
- 2. Remove the connecting rods and pistons. (Refer to par. 2.)

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. (Illusts. 17 and 18.)

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 their location in the crankcase and position in the sleeve bore.

4. Remove the sealing ring located in a groove in the crankcase at the bottom of each sleeve bore. (Illust. 19.)



Illust. 17 - Installing Cylinder Sleeve Puller Tool.

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SLEEVES

9. INSPECTION AND REPAIR

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

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 the 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 "SPECI-FICATIONS," in Section 1.

10. INSTALLATION

1. Install the cylinder sleeves into their previously identified positions in the crankcase. Make a solution of one pint of water, half an ounce of glycerine, and one tablespoonful of soap flakes. Dip the new cylinder sleeve rings into the soap solution and install them in the grooves in the crankcase. (Illust. 19.) Apply a liberal coat of Permatex No. 3 (liquid) sealer to the underside of the cylinder sleeve flange, being sure that the entire surface is coated with the sealer. Coat the finished surface at the bottom of each sleeve with the soap solutions. The cylinder sleeves are a loose fit in the crankcase and can be pressed into place past the sleeve ring by hand.

NOTE: After installing a cylinder sleeve in the crankcase, check the amount of clearance between the deck of the crankcase and the top surface of the sleeve flange. This amount must never exceed that of the top limit given in "SPECIFICATIONS" in Section 1.

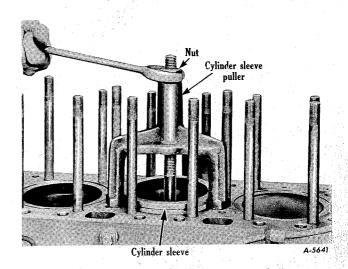
CAUTION: Be sure the cylinder sleeve ring has not been forced out of its groove when installing the sleeve.

- 2. Install the pistons and connecting rods. (Refer to par. 6.)
- 3, Install the cylinder head. (Refer to Section 2, "MANIFOLDS, CYLINDER HEAD AND VALVES."

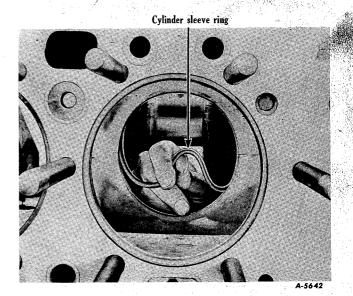
11. ENGINE RUN-IN SCHEDULE

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.



Illust. 18 - Removing Cylinder Sleeve.



Illust. 19 - Installing Cylinder Sleeve Ring.

- 1. Before starting the engine, be sure that the cooling system is filled.
- 2. Fill the crankcase with a MIL lubricating oil as specified in the latest service bulletin on "Fuels and Crankcase Lubricating Oils for IH Diesel Engines."
- 3. Install an oil inlet filter into the turbocharger (on units so equipped). (Refer to Section 10A.)

Page 10



SLEEVES

11. ENGINE RUN-IN SCHEDULE - Continued

Be sure to remove this filter after run-in to coincide with the first oil change.

- 4. Start the engine on the gasoline cycle and run it for two minutes.
- 5. 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.
- 6. The following schedules are safe to follow after the engine has reached operating temperature:

CONDITIONING SCHEDULES

Tractor

Period 1: Operate the tractor in 4th gear 1 hour without load at 3/4 rated speed.

Period 2: Operate the tractor at 3/4 rated speed on light work.

Period 3: Operate the tractor at full rated speed on medium work.

Power Unit

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

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

Period 3: Operate the engine on 3/4 max. load at full rated speed.

- 7. Do not run the engine at idle speed for long periods after installing new rings or sleeves, as the rings will not seat during the idle operation.
- 8. Recheck for oil, air, and water leaks, and adjust tappets. Inspect and replace the oil filter elements if necessary.
- 9. After the engine has operated for 25 hours, drain the oil while the engine is hot. Refill the crankcase with lubricating oil as specified in the operator's manual.
- 10. After the first 100 hours of operation, the cylinder head stud nuts must be retorqued and the valve tappets adjusted.

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



Page 1

1. DESCRIPTION

The engine lubricating oil pump is a gear type pump internally mounted to the bottom of the crankcase and gear driven from the camshaft.

14 SERIES: The oil pressure regulating valve is located in the oil filter base.

18 SERIES: (Engines equipped with by-pass (not full-flow) filter systems.) The oil pressure regulating valve is located in the oil pump.

(Engines equipped with full-flow filter systems.) The oil pressure regulating valve is located in the filter base.

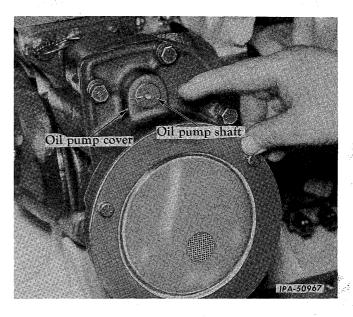
INSPECTION PRIOR TO REMOVAL (18 AND 18A SERIES ONLY): To check the wear of the oil pump drive gears on diesel engines with distributor ignition:

Remove the distributor cap, rotor and dust shield; reinstall the rotor, turn the rotor as far as it will go in one direction, noting the travel of the outer end of the rotor by using a dial indicator or a scale graduated in 1/32's. The maximum travel should not be greater than 1/8 inch. When the 1/8 inch maximum travel is reached, the oil pump drive gears and camshaft should be inspected for wear.

2. REMOVAL

- 1. Drain the oil from the engine. Remove the cap screws which hold the oil pan to the crank-case, and then remove the pan and gasket.
- 2. The lubricating oil pump can be pulled out after removing the lock wire and the cap screws. (Also remove the cap screws which hold the two oil return pipe clips on engines so equipped.)

NOTE: On 18 series engines which are equipped with battery ignition starting systems (instead of magneto ignition), it is necessary to have the oil pump correctly timed with the camshaft. Correct timing is necessary because the pump drive gear also drives the distributor through a slotted connection. Before removing the oil pump from an engine which is equipped with battery ignition starting system, it is advisable first to mark the position of the pump shaft so that the pump can be readily replaced in correct time. Crank the engine over until the No. 1 piston is on top dead center of the compression stroke. Then, with a punch, mark the lower end of the pump shaft and the pump cover so that the shaft can be again set in the same position. (Illust. 1.)



Illust. 1 - Oil Pump Marked for Removal (18 Series with Battery Ignition).

3. DISASSEMBLY (Illust. 2)

- 1. Remove the float from the cover (15) on engines so equipped.
- 2. Remove the cap screws which secure the cover (15) to the pump body (5). Tap the cover lightly with a rawhide hammer until the cover and dowel break free. Remove the gasket (14).

NOTE: Prior to the TD-20 and certain TD-14 and TD-18 crawler tractors, auxiliary gears in the pump kept the pump supplied with oil when the tractor was operating on steep grades, by drawing oil from the front or rear section of the oil pan, through the oil return pipes.

- 3. On units so equipped, remove the lower auxiliary gear housing by tapping downward until it is free of the drive shaft (11) and the idler gear shaft (6). The auxiliary drive gears will come out with the cover. Remove the upper auxiliary housing in the same manner.
- 4. BY-PASS SYSTEMS: Remove the oil pump pressure regulating valve spring (9) and valve (8) from the recess in the oil pump body (5).

FULL-FLOW SYSTEMS: Remove the safety valve spring (9) and safety valve (8).

NOTE: This spring is a heavier spring than the one used in the by-pass system as a pressure

(Continued on next page.)

3. DISASSEMBLY - Continued

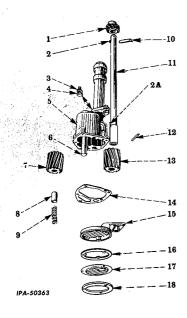
regulating valve and the function has been changed. Refer to the "Lubricating Oil Filters" in this section.

5. Remove the pump idler gear (7) from the idler gear shaft (6).

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

Press off the pinion gear (1) after driving out the pin (10).

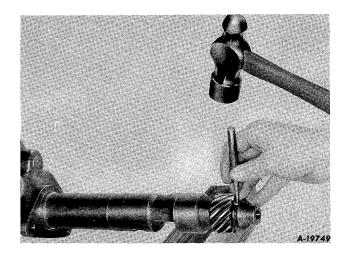
- 6. Remove the gear (13) from the shaft (11) by driving out the pin (12). (Illust. 3.) Press the gear off the shaft and remove the key.
- 7. On later model pumps, the body gear (13) is pinned and then the gear is peened over the end of the pin to hold it from working loose. (Illust. 5.)



Illust. 2 - Exploded View of Oil Pump. TD-20 (200) Shown. (Others Similar.)

- l. Drive pinion.
- 2. Key.
- 2A. Key.
- Lock washer
- Cap screw.
- Pump body.
- Idler shaft.
- Idler gear. 7.
- 8. Safety valve.
- Safety valve spring.

- 10. Drive pinion pin.
- ll. Drive shaft.
- 12. Body gear pin.13. Body gear.
- 14. Cover gasket.
- 15. Cover.
- 16. Bottom plate gasket.
- 17. Bottom plate.
- 18. Bottom plate stiffener ring.



Illust. 3 - Removing Pinion from Drive Shaft.

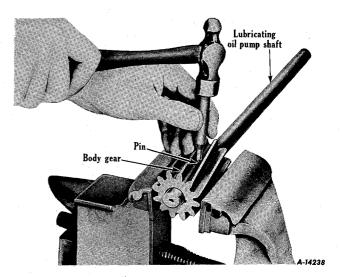
4. INSPECTION AND REPAIR

Clean all parts thoroughly in a dry-cleaning solvent and dry with compressed air. Inspect all tubes and screen for possible damage and replace rather than repair the defective parts.

Inspect all gears for wear, scoring and chipped teeth. When a gear is found to be damaged, it should be replaced, including the mating gear.

Assemble the body gear (13) to the drive shaft (11) and assemble to the pump body (5). Check the clearance between the gear (13) in the base of the body (5).

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



Illust. 4 - Removing Body Gear From Shaft.



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 the body gear and body.

When the idler and body gears are assembled, check the backlash. Check the end clearance between the drive pinion and the pump body. (Illust. 6.) When the assembly is made from all new parts, file or grind off the top of the pump body (if necessary) to obtain a maximum 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 the gears and cover.

On the TD-18, TD-18A Tractors and early UD-18A power unit, check the oil pressure regulating valve spring for proper length, action and condition.

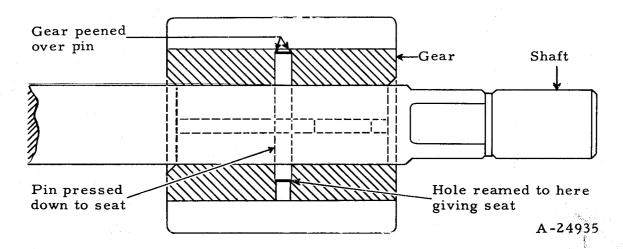
For the specified free length, test load and the test length, refer to "SPECIFICATIONS" in Section 1. A valve spring which falls below these standards should be replaced.

The outside diameter of the oil regulating valve is .900 to .901 inch, and the valve bore is .905 to .906 inch; the running clearance between the valve and body is .004 to .006 inch. Be sure that the valve is in good condition, that it slides freely, and that the valve seat in the body is not damaged. The 14 series engines have the oil regulating valve spring and valve in the lubricating oil filter base. The spring should be tested for load pressure, free length and test length as specified in "SPECI-FICATIONS" in Section 1.

FIELD CHECK

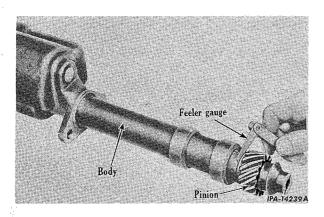
To make a fast field check of the lubricating oil pump to determine if it is working properly, proceed as follows:

- Submerge the oil pump in a bucket of oil.
- Place your hand over the outlet. located at the top of the pump.
- 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.



Illust. 5 - New Method of Pinning Oil Pump Body Gear to Shaft.





Illust. 6 - Checking End Clearance Between Pinion and Body.

5. OIL PRESSURE TEST FOR DETECTING WORN BEARINGS

To pre-determine the location of excessive clearances or bearing failures without having to tear down an engine, an oil leak detector No. 1 020 183 R2 is shown in "SERVICE TOOL MANUAL," ISS-1002. It is especially designed for full pressure lubrication. Complete instructions for its use are included. (Illust. 7.)

The general purpose of this device is to supply oil at a pre-determined pressure to an engine lubrication system, so that with the oil pan removed, the oil leakage at the main, connecting rod and cam shaft bearings can be observed, and the worn or improper clearance of bearings picked out by the amount of leakage, which appears in the form of drops or spurts of oil.

A similar tester can be made up from available parts, and has been found to be effective; secure a section of 6-inch pipe approximately 24 inches long. (Illust. 8.) Weld a plate for a base on one end, and thread the other end to take a cap. Drill and tap the cap to take a tee connection and, in one side, weld a standard

tire valve and the other side, a pressure gauge registering at least 75 pounds.

Drill and tap a hole near the bottom of the pipe to take a shut-off valve. To the valve attach a flexible hose to connect up with the oil pressure connections on the engine.

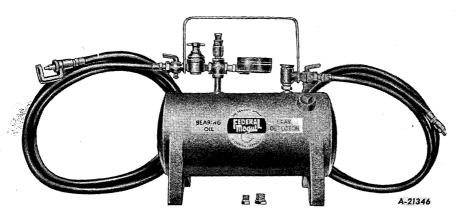
The capacity of the tank will be in excess of 10 quarts. Fill the tank with SAE-10W oil, by removing the tank cap.

CAUTION: Before running any tests, remove the filter elements and clean out the filter base to 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 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 connecting rods for cylinder lubrication) and grooves.

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



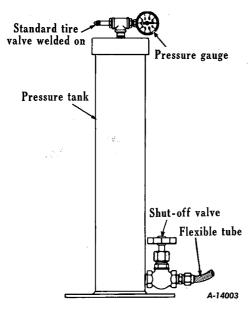
Illust. 7 - Leak Detector.



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.



Illust. 8 - Oil Leakage Test Unit.

6. REASSEMBLY (Illust. 2)

- 1. Insert the Woodruff key (2A) in the shaft (11) and assemble the body gear on the shaft. Drive the pin (12) in place and on later model pumps, peen the gear over the pin end to secure it against working loose. Install the drive shaft with gear into the pump body (5).
- 2. Insert the key (2) into the upper end of the drive shaft (11) and install the drive pinion (1) and drive the pin (10) in place. With the shaft forced as far toward the top of the pump body as possible, check the clearance with that given in "SPECIFICATIONS" in Section 1, and measured between the top of the pump body (5) and the bottom face of the drive pinion (1). (Illust. 6.)

Excessive clearance at this point indicates worn gears and pump body. Replace the parts or noisy operation, increased wear and decreased

pump efficiency will result. 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. After checking the end clearance of drive shaft (11, Illust. 2), lock both ends of the pin (10) into the drive pinion (1) by using a small punch and peening each end of the pin. Be careful not to damage the gear when using a punch to lock the end of the pin, and be sure that the end of the pin does not project out into the bottom of the gear teeth.

3. Insert the valve (8) and valve spring (9) into the pump body (5). Be sure the spring does not cock the valve in the base, causing improper seating.

NOTE: This step does not apply to the 14 series engines as there is no valve in the pump.

- 4. Assemble the idler gear (7) to the idler shaft (6).
- 5. On pumps so equipped, install the auxiliary gears and housings in reverse order of disassembly, using new gaskets.
- 6. Install new gasket (14) using light grease to hold it in place. Place the cover (15) in position and tap on with a rawhide or fibre hammer. Secure the cover with cap screws. Hand turn the pinion to be sure that no binding exists in the oil pump assembly.
- 7. Install the float if the unit is so equipped and secure with a cotter pin.

7. INSTALLATION

NOTE: Before installing the lubricating oil pump on an 18 series engine equipped with battery ignition for starting, it is first necessary to remove the distributor assembly. Then set the No. I piston on the top dead center position of the compression stroke. Install the pump so that the timing marks on the bottom of the pump shaft and pump cover line up when the pump is tightened into place. (Timing marks should have been made before removing the pump, as outlined in Par. 3.) If no timing marks were made, install the pump in the engine with the drive slot in the pump gear approximately parallel to the crankshaft, and the offset toward the center of the engine. The distributor shaft will engage the pump gear only one way.

Page 6

LUBRICATING OIL PUMP

7. INSTALLATION - Continued

1. Install the oil pump into the crankcase and attach it with lock washers and cap screws. Lockwire the cap screws. Install the oil return pipes and attach the brackets.

- 2. Shellac new gaskets to the oil pan and attach the pan to the crankcase. Fill the engine with the correct quantity and grade of lubricating oil as specified in the operator's manual.
- 3. Install the distributor.

LUBRICATING OIL FILTERS

8. 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 located in the oil pump on 18 series engines and in the oil filter base on 14 series engines. 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.

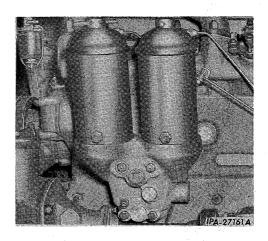
The two valves located in the filter base, visually identify the system as being a full-flow type. On 18 series engines there is a safety valve located in the oil pump. Its function is to relieve the pressure buildup in the pump should there be any restrictions between the pump and the filter base. The 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.

The filter assembly on the 14 series is located on right side of the engine. On the 18 series the filter assembly is located on the left side of the engine.

9. 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.



Illust. 9 - Full-Flow Lubricating Oil Filters (18 Series).

10. DISASSEMBLY

By-Pass Type Filters (Illust. 10).

- 1. Loosen and remove the retaining bolt (2). The case (4) and element (5) can then be removed from the base (7). Discard the case gasket (6).
- 2. 14 SERIES ONLY: Remove the pressure regulating nut, gasket and spring. Remove the regulating valve.

Full-Flow Type Filters (Illust. 11).

3. Loosen the cover retaining nut and remove the case cover; discard the cover gasket. The retaining nut can be separated from the cover by removing the snap ring. Lift out the filter element. Remove the three cap screws which secure the standpipe and case in the base. Lift out the standpipe and discard the gasket. Remove the filter case and unscrew the filter case stud. Discard the filter case gasket. Remove all filters in a similar manner.



LUBRICATING OIL FILTERS

10. DISASSEMBLY - Continued

4. Remove the pressure regulating valve retainer nut and gasket and remove the spring and valve. Remove the by-pass valve retainer nut and gasket from the filter base, Remove the spring and by-pass valve.

11. 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 for proper length, action and condition (Refer to "SPECIFICATIONS" in Section 1.)

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.

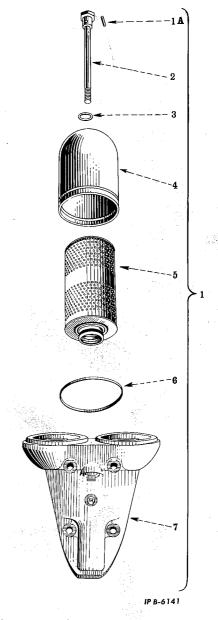
The outside diameter of the by-pass valve is .918 to .919 inch; the valve bore is .921 to .923 inch; the diametral clearance is .002 to .005 inch.

12. REASSEMBLY

By-Pass Type Filters (Illust. 10).

- 1. 14 SERIES ONLY: 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, which would cause 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.

(Continued on next page.)



Illust. 10 - Lubricating Oil Filter (Not Full-Flow).

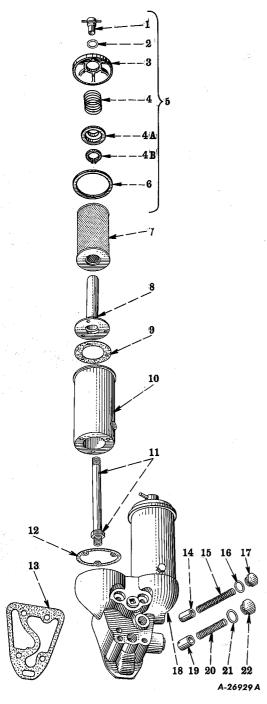
Legend

- Lubricating oil filter, complete.
- 1A. Retaining bolt pin.
- 2. Retaining bolt.
- 3. Retaining bolt gasket.
- 4. Oil filter case.
- 5. Oil filter element.
- 6. Oil filter case gasket.
- 7. Oil filter base with plug

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LUBRICATING OIL FILTERS

12. REASSEMBLY - Continued



Illust. 11 - Full-Flow Lubricating Oil Filter. 18 Series Shown. (14 Series Similar).

Full-Flow Type Filters (Illust. 11).

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, which would cause 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 case gasket. Install the filter case stud.

CAUTION: Do not over tighten the stud and nut in the filter case, as this will only impair the filtering system.

Position the filter case, standpipe gasket, and filter standpipe over the stud and secure them to the filter base with three cap screws. Grease or otherwise lubricate the sealing rings located in each end of the filter element to prevent possible damage. Install the element over the stud, using a slight twisting motion.

NOTE: The new element, 268 462 R91, can be used ONLY with the new aluminum die cast oil filter case cover, 267 808 Rll. However, the new aluminum die cast oil filter case cover can be used with the old element, 261 627 R91. There are packages available to change to the latest type elements and case covers.

Legend for Illust. 11.

- 1. Retaining nut.
- 2. Nut gasket.
- 3. Cover.
- 4. Retaining spring.
- 4A. Sealing cup.
- 4B. Sealing cup snap ring.
- 5. Cover complete.
- 6. Cover gasket.
- 7. Filter element.
- 8. Stand pipe.
- 9. Stand pipe gasket.
- 10. Case.
- 11. Stud.
- 12. Case gasket.
- 13. Base gasket.
- 14. By-pass valve.
- 15. By-pass valve spring.
- 16. Nut gasket.
- 17. Valve retaining nut.
- 18. Filter base.
- 19. Pressure regulating valve.20. Pressure regulating valve spring.
- 21. Nut gasket.
- 22. Valve retaining nut.



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LUBRICATING OIL FILTERS

12. REASSEMBLY - Continued

Install a new greased or lubricated cover gasket. Secure the cover retaining nut and gasket to the cover with the snap ring. Position the cover on the case and tighten the retaining nut. Install all filters in a similar manner.

13. 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. When refilling an engine with oil, the filter cases are to be filled (one quart of oil per case) after the drain plugs have been installed and new filter elements have been inserted.

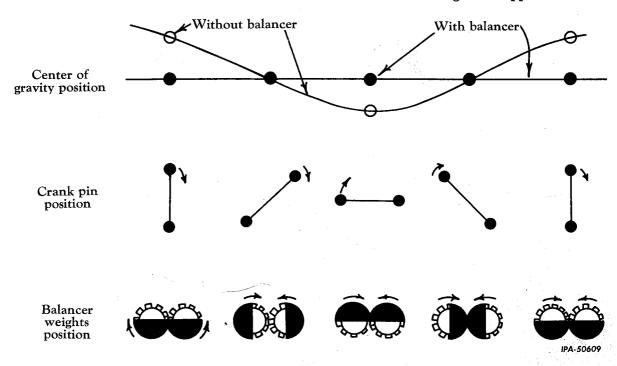
The lubricating oil used in the filter cases (two quarts) should be deducted from the amount added to the crankcase oil pan, so that the sum of these two quantities equal the amount of oil specified for the engine. Adding oil to each filter case speeds up lubrication to the bearings, oil pump drive gears, and other vital parts of the engine, eliminating the time required by the oil pump to fill the filter cases. Refer to the operator's manual for the correct amount and type of lubricant to use.

ENGINE BALANCER

14. DESCRIPTION

The TD-14A (141), TD-14 (142) crawler tractors and UD-14A power unit is 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 center 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, (Illust. 12). The balancer is driven by the crankshaft gear.

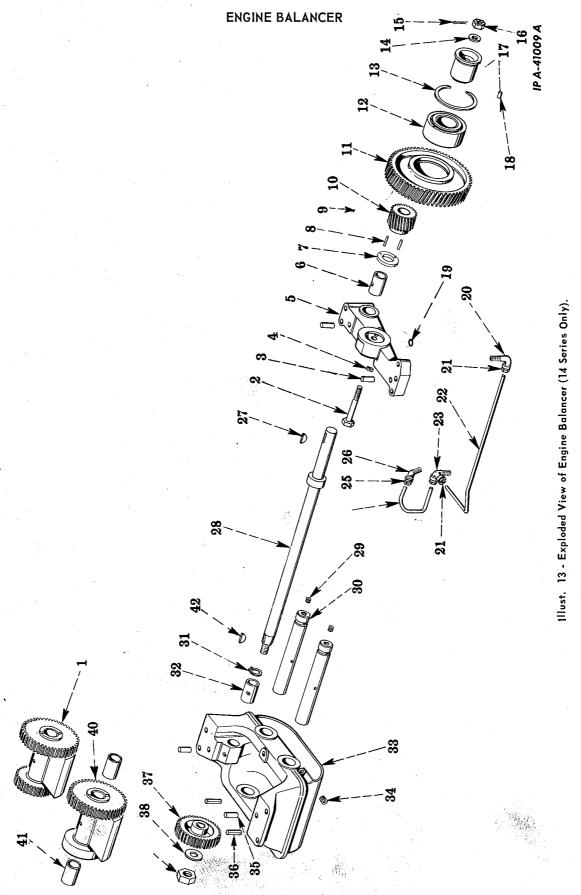
The weighted gears are matched and timed to each other (Illust. 12) and they are also timed to the engine by means of timing marks on the gears. They counteract the change in center of gravity of the pistons by moving down when the total weight of the pistons is going up, and vice versa. Both weights, 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.



Illust. 12 Engine Balancer Operation.



Page 10







ENGINE BALANCER

	40.00			egi .						t di												
Description		Oil pressure line.	Side outlet male pipe elbow.	Drive shaft pressure line.	Drive shaft pressure line nut.	Male pipe elbow.	Woodruff key.	Drive shaft and collar.	Weight shaft pipe plug.	Weight shaft with plug.	Drive gear retaining ring.	Drive shaft bushing.	Weight housing.	Pipe plug.	Weight housing dowel pin.	Roll pin.	Drive gear.	Drive gear nut lock.	Hex nut.	Driven weight.	Weight bushing.	Woodruff kev.
Ref. No.		22.	23,	24.	25.	26.	27.	28.	29.	30.	31,	32.	33*	34.	35.	36.	37.	38.	39.	40.	41.	42.
				in.			front.	asher.	pin.					ap ring.	vasher.		nut.	pin.		("O" ring).		
Description		Driving weight.	Idler gear shaft bolt.	Front support dowel p	Pipe plug.	Front support.	Drive shaft bushing - front.	Drive pinion thrust washer	Thrust washer dowel	Roll pin.	Drive pinion.	Idler gear.	Idler gear bearing.	Idler gear bearing snap ring.	Idler gear shaft bolt w	Cotter pin.	Idler gear shaft bolt nut.	Idler gear shaft with pin.	Roll pin.	Front support gasket ("O" ring)	Male pipe elbow.	Oil pressure line nut.
																35.						

Legend for Engine Balancer-Illust. 13.

Ref.

Page 12



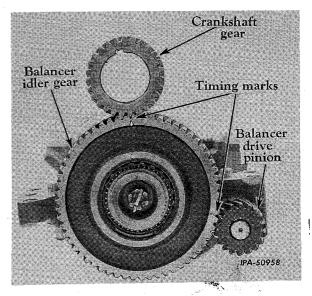
ENGINE BALANCER

15. REMOVAL

- 1. Remove the oil pan.
- 2. Locate No. 1 piston on top dead center. Check to see that the chamfered tooth on the crankshaft gear and arrows on the balancer idler gear rim are aligned. Also check to see that the timing marks on the balancer idler gear and balancer drive pinion line up. (Illust. 14.)
- 3. Disconnect the oil line between the drive housing and balancer. Remove two cap screws holding the oil pump in place and remove the oil pump and oil return lines on crawler tractors so equipped.
- 4. Lock the balancer weights so they cannot shift around by putting in No. 10-24, one inch long set screw at the bottom of the weights housing (Illust. 15).

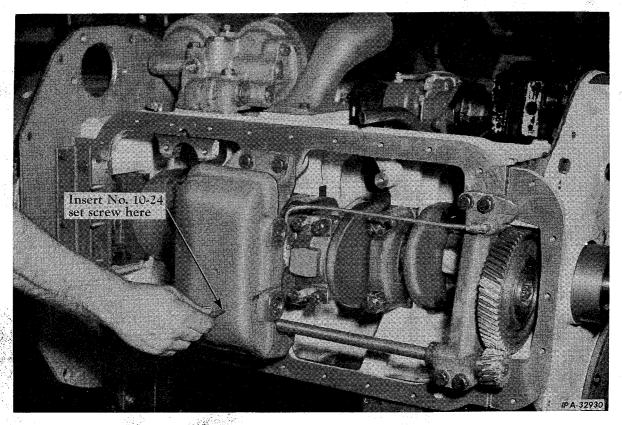
NOTE: This is also a safety measure to prevent fingers getting in between the gear teeth of the balancer weights. The timing marks on the weights should be aligned with the marks on the housing when locked (Illust. 16).

5. Remove eight cap screws holding the balancer in place and remove the balancer from the crankcase.



Illust. 14- Balancer Idler Gear, Drive Pinion and Crankshaft Gear Timing Marks.

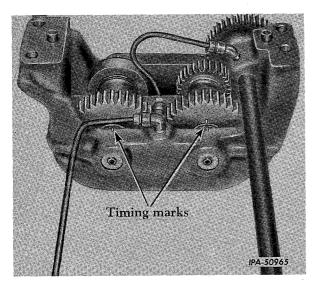
NOTE: Check the backlash of all gears to determine their condition before disassembling the balancer. Refer to "SPECIFICATIONS" in Section 1.



Illust. 15 - Locking Engine Balancer Weights.



ENGINE BALANCER



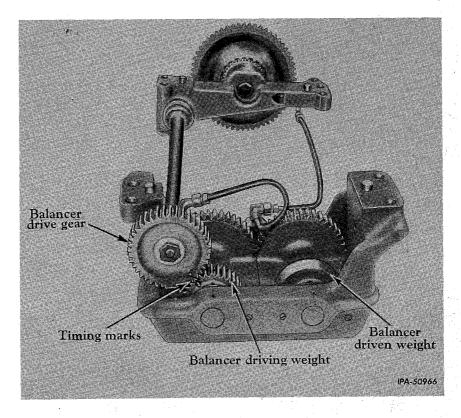
Illust. 16 - Balancer Weight Timing Marks.

16. DISASSEMBLY (Illust. 13)

NOTE: The results obtained from checking the tolerances given in "SPECIFICATIONS" in Section 1 with those found on checking the balancer, will determine the extent of disassembly necessary. The following steps, however,

- covers complete disassembly for overhauling the unit. The balancer when removed will appear as shown in Illust. 17.
- 1. Remove the idler gear (11). Draw the cotter pin (15) and unscrew the nut (16) and washer (14). The gear (11) with bearing (12) and shaft (17), will come off as a unit. If it is necessary to service the bearing (12), remove the snap ring (13).
- 2. Disconnect the oil line (24).
- 3. Remove the balancer drive gear (37), by unlocking and removing the nut (39). Tap the gear off the shaft, and pull the Woodruff key (42) out. Use a fine flat file to smooth off the edges of the keyway. This will avoid causing damage to the bushing when removing the shaft. Slide the shaft (28) with the front support (5) out of the weight housing (33). From shafts so equipped, remove the Tru-arc snap ring (31) from the shaft groove. (Later models do not have a snap ring.)
- 4. Drive the roll pin (9) out of the drive pinion (10) and press the shaft out of the pinion using an arbor press. Remove the key (27) and smooth off the edges of the keyway with a fine flat file. Remove the thrust washer (7).

(Continued on next page.)



Illust. 17 - Balancer Drive Gear and Driving Weight Timing Marks.



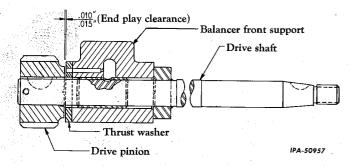
ENGINE BALANCER

16. DISASSEMBLY - Continued

5. Remove the weights from the housing. Drive the roll pins (36) out of the housing and weight shaft (30). Use a brass drift and drive the weight shafts out. Loosen the locking screw and remove the weights.

17. INSPECTION AND REPAIR

- 1. Clean all parts thoroughly in solvent and dry with compressed air.
- 2. Check the bushings in the weight housing and front support for serviceability. (Refer to "SPECIFICATIONS" in Section 1.)
- 3. Inspect all gears for chipped teeth, burrs and excessive wear. Use a hone to remove any burrs. Replace any defective gears.
- 4. Check the weight shafts bearing surfaces for signs of excessive wear. Clearances are given in "SPECIFICATIONS" in Section 1.
- 5. Check the oil pipes to be sure there are no restrictions and that they are clean. Balancer bearings depend on a constant flow of lubricating oil to give efficient service.
- 6. Check the thickness of the thrust washer which determines the end play between the drive pinion and the balancer front support. (Refer to "SPECIFICATIONS" in Section 1.



Illust. 18 - Balancer Drive Shaft End Play.

18. REASSEMBLY (Illust. 13)

1. Assemble the weights in the weight housing by driving the weight shafts (30) into place with a brass hammer. Use lubricating oil when assembling parts. Line up the holes in the shaft with the holes in the housing so the roll pins can be driven into place. Match the timing marks on the weights with those on the housing (Illust, 16) and tighten the locking screw to hold them from rotating.

CAUTION: Do not remove the No. 10-24 screw until the balancer has been installed in the engine.

- 2. Assemble the shaft (28) in the front support (5) and install the thrust washer (7). Use an arbor press and after inserting the key (27), press the pinion gear (10) on the shaft. Then, drive the roll pin (9) through the gear into the shaft to secure it.
- 3. If the balancer drive shaft (28) has a ring groove near the balancer housing end, install the Tru-arc snap ring (31). (Later models do not have a snap ring.) Slide the shaft (28), with the front support assembled to it, into the weight housing (33). Insert key (42) into the key slot and tap the gear (37) onto the shaft. Place the nut lock (38) on the shaft and tighten the hex nut (39). Lock the nut by binding up the edge of the nut lock to the flat of the nut.
- 4. Install the oil pipe fittings (20) and (23) and install the pressure line (24). (Illust. 16.)
- 5. Install the balancer idler gear (11). Insert the idler gear shaft bolt (2) into the front support (5). The bearing (12) assembly and idler gear (11) can be placed on the shaft bolt, turning the gear to match the timing marks of the drive pinion. Assemble the washer (14) and tighten the hex nut (16). Lock the nut with cotter pin (15).
- 6. Check all timing marks for correct position. Check the backlash of all gears before installing balancer to the engine. Refer to "SPECI-FICATIONS" in Section 1. Check the end play between the thrust washer (7) and gear (10).

19. INSTALLATION

- 1. Be sure the engine is timed for top dead center on No. 1 piston on compression stroke.
- 2. Install the balancer to the crankcase. Be sure that the arrow on the balancer idler gear rim and the chamfered tooth on the crankshaft gear are aligned. (Illust. 14.) Be sure to assemble the "O" ring (19) at the oil hole in the front support or loss of oil pressure will result.

NOTE: If the crankcase front cover has been removed it must be installed before the engine balancer is installed to avoid shearing the "O" ring.

- 3. Be sure the 1/8 inch hole in the oil gallery pipe plug is open. Install a new timing gear case cover gasket. Be sure the oil hole in the gasket has been properly located.
- 4. Tighten the balancer to the crankcase with the eight cap screws. Lockwire the cap screws.
- 5. Install the oil pump and oil line. On older crawler tractors install the oil return line. Remove the No. 10-24 set screw used to lock the weights in place.
- 6. Install the crankcase oil pan.



1. DESCRIPTION

The cooling system used on early model 14 and 18 series engines is the conventional type. The closed or pressure type is used on all current 14 and 18 series engines.

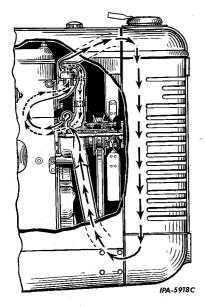
The conventional system functions as follows: The water is stored in the radiator tanks. A positive displacement centrifugal water pump circulates the coolant from the lower radiator tank through the crankcase and cylinder head water jackets, past the thermostats into the radiator upper tank and down 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.

The closed type cooling system automatically maintains the most desirable engine temperature under all normal conditions of operation. A regulating pressure valve built into the radiator cap (on early models the overflow pipe is equipped with a pressure valve), is designed to open at approximately four pounds per square inch pressure. A positive centrifugal pump circulates the coolant through the engine block, cylinder head and radiator. A thermostat of the by-pass type prevents circulation to the radiator until the engine has reached an efficient operating temperature, at which time the heat indicator pointer should be in the "RUN" range.

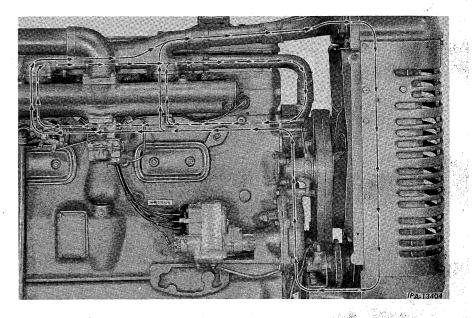
When the engine is started cold, the by-pass type thermostat is closed, preventing circulation of low temperature coolant through the radiator core. The coolant circulates only through the water pump and engine water passages as indicated by dotted arrows in illustrations 1 and 2. This circulation during the warmup 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 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.

Packing Type Pump (14 Series).

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



Illust. 1 — Circulation of Coolant in 14 Series Engines.



Illust. 2 - Circulation of Coolant in 18 Series Engines.



1. DESCRIPTION - Continued

Packless Type Pump (18 Series).

The packless type pump is also of the centrifugal design, but differs from the packing type in that the shaft is supported by two ball bearings. Water sealing is accomplished by a special seal assembly. The mechanical seal and impeller form one assembly which is pressed onto the pump shaft.

The 14 series engine has one thermostat; the 18 series engine has two thermostats. The thermostats are the by-pass type and are located in a thermostat housing or water outlet header. The thermostats control the engine operating temperature. They are set to start opening at 165° F. and be wide open at 190° F.

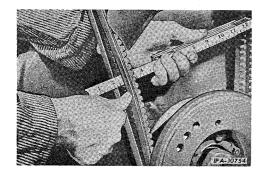
FAN AND FAN BELTS

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 life of a fan belt depends to a great extent on proper tension adjustment when it is first installed, and readjustments made at proper intervals. If damaged, grease soaked or is bottoming in the drive pulley and can no longer be adjusted, the belt should be replaced. By depressing the belt with the thumb midway between the pulleys (Illust. 3), check the allowable slack. For the 18 series engine the allowable slack is 3/4 to 1 inch. However, the 14 series should not exceed 1/2 to 3/4 inch slack, or excessive slippage may result.

NOTE: Before checking fan belt tension, rotate top of fan pulley toward the side of belt to be checked for tension, thereby removing slack from the opposite side of belt.



Illust. 3 - Checking Fan Belt Tension.

3. REMOVAL (Refer to Illust. 4.)

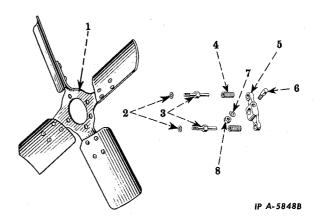
(14 Series)

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

- 2. Take off nut (8) and washer (7). Tap out the drive pin (6).
- 3. Remove driver (5) from the impeller shaft and studs (3) being careful to remove both springs (4) at the same time.
- 4. Remove the two studs (3) and the two cap screws (not shown) that attach the fan to the pulley hub.
- 5. Remove the fan.

(18 Series)

1. Remove the cap screws which hold the fan to the pulley.



Illust. 4 - Fan and Water Pump Driver (14 Series).

- 1. Fan assembly
- 2. Lock washer
- Driving stud
 Spring
- 5. Water pump driver
- 6. Driver pin
- 7. Lock washer
- 8. Nut
- 4. INSTALLATION (Refer to Illust. 4.)

(14 Series)

500 W

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



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FAN AND FAN BELTS

- 2. Add lock washers (2) to the threaded end of studs (3) and screw in studs until tight, then tighten the cap screws to secure fan to the pulley.
- 3. Slip springs (4) over stud ends and place drive (5), flat side toward 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 nut (8).

(18 Series)

 Install the cap screws which hold the fan to the pulley.

NOTE: Instructions for replacing and adjusting the fan belts are given in the operator's manual.

WATER PUMP

5. MAINTENANCE

Packing Type Pump

Due to wear after considerable service, the pump packing may leak. If this does occur, tighten the packing gland, using a water pump wrench, 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.

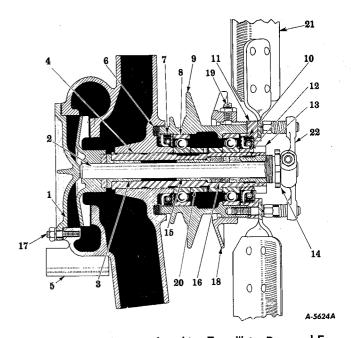
To install new packing, remove the driver pin and driver. Remove the packing gland and old packing. Place the water pump packing around the shaft, and reassemble the packing gland, driver, and driver pin.

Packless Type Pump

If a water leak develops, it indicates that the sealing parts are worn. Disassembly of the pump is necessary to replace these parts. After installing new pump sealing parts, check the level of the lubricant in the pump by removing the level plug on the side of the housing. If no lubricant is visible through the plug hole, remove the filler plug and fill with lubricant as specified in the operator's manual. Install the plugs. Later engines are equipped with lubrication fittings for supplying pump lubrication. Apply lubricant to the fitting until it backflows around the nozzle.

Packless Type Pump

- 2. Loosen the upper and lower hose clamps.
- 3. Remove the bolts which hold the water pump to the crankcase, and remove the pump (Illust.



Illust. 5 - Cross Section of Packing Type Water Pump and Fan Drive (14 Series).

6. REMOVAL

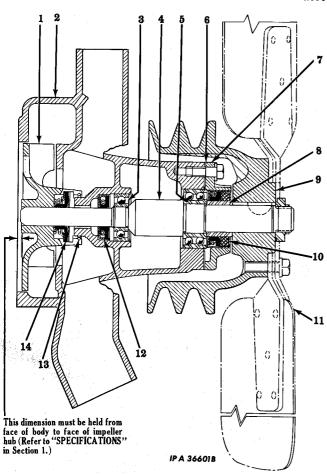
Packing Type Pump

- 1. Remove the fan and water pump belt, and generator belt.
- 2. Loosen the hose clamps and push or drive down the lower hose.
- 3. 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).

- 1. Cover.
- Impeller with shaft. 2.
- Thrust bushing.
- 4. Sleeve.
- 5. Body. 6. Felt washer.
- 7. Oil seal, rear.
- 8. Ball bearing.
- 9. Fan and generator 19. Set screw. 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.
- 20. Bearing spacer.
- 21. Fan.
- 22. Pump shaft driver.





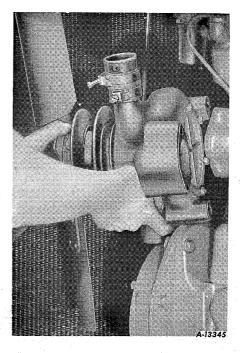
Illust. 6 — Cross Section of Packless Type Water Pump and Fan Drive (Early 18 Series Shown).

- 1. Impeller.
- Body.
 Bearing, inner.
- 4. Pump shaft.
- 5. Bearing, outer.
- 6. Housing gasket.7. Oil seal housing.
- 8. Spacer.
- 9. Pulley.
- 10. Oil seal, outer.
- ll. Fan.
- 12. Oil seal, inner.
- 13. Impeller snap ring.
- 14. Water pump seal.

7. DISASSEMBLY

Packing Type Pump (Refer to Illust. 9.)

- 1. Remove the fan assembly and the packing gland (18).
- 2. Remove the bearing clamp nut (17) and top bearing retainer (15), with the oil seal (13) and gasket, free of the pulley hub. Tap the oil seal out of the bearing retainer.



Illust. 7 - Removing Water Pump, Pulley and Fan (14 Series).

- 3. Remove the water pump body cover and the gasket (Illust. 10). Push out the shaft (3), with impeller, from the shaft end.
- 4. Remove the water pump pulley (11). Remove the water pump oil seal (13), ball bearing (26), and spacer (25) from the pulley. Drive the rear bearing (10) and the oil seal (9) out of the opposite end of the pulley hub.

If difficulty is encountered when adjusting or removing the pump pulley flange (23), loosen the jam nut (12) and turn the set screw (24) all the way out and use a spanner wrench on the reinforcing ribs on the flange. If a spanner wrench is not available, place a block of wood on the ribs and tap loose.

CAUTION: Never use a hammer and punch as this will cause damage.

5. Remove the water pump packing and shaft bushings from the shaft sleeve (Illust. 11).

NOTE: Do not press or drive the sleeve out unless inspection reveals that the sleeve or pump body must be replaced.

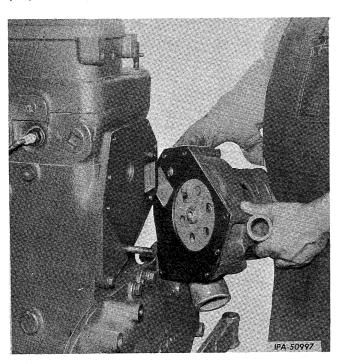
6. If necessary, remove the water pump shaft sleeve from the body (Illust. 12).



Packless Type Pump (Early 18 Series) (Refer to Illust. 13)

1. Remove the water pump shaft nut (21). Then remove the fan pulley (20), from the pump, either by pressing or by using a puller.

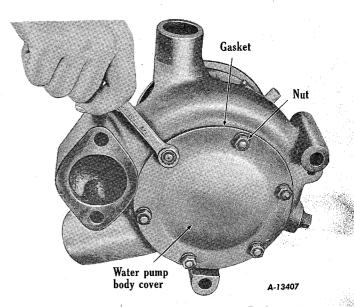
NOTE: Be careful not to damage the flanges of the pulley. Remove the key (14) from the shaft (13).



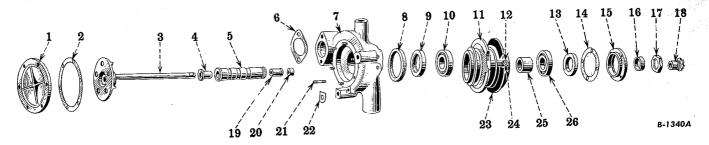
Illust. 8 - Removing Water Pump (18 Series).

- 2. Remove the oil seal housing (19), oil seal (18) and bearing spacer (16). Remove the gasket (17).
- 3. Press the impeller shaft out of the impeller and body from the rear. The impeller shaft and bearing assembly will be removed as an assembly.
- 4. Remove the snap ring (8) from the groove in the impeller. Remove the seal washer (7), seal (6) and spring (3).

(Continued on next page)



Illust. 10 - Removing Water Pump Cover (14 Series).



Illust. 9 - Packing Type Water Pump Components (14 Series).

- 1. Cover.
- 2. Gasket.
- 3. Impeller with shaft.
- 4. Thrust bushing.
- 5. Sleeve.
- 6. Gasket.
- Body.
- 8. Felt washer.
- 9. Oil seal, rear.

- 10. Ball bearing.
- 11. Fan and generator drive pulley.
- 12. Jam nut.
- 13. Oil seal, front.
- 14. Gasket.
- 15. Bearing retainer.
- 16. Bearing clamp nut spacer.17. Bearing clamp nut.

- 18. Packing gland.
- 19. Bushing.
- 20. Packing.
- 21. Stud.
- 22. Body spacer.23. Pulley adjusts Pulley adjustable flange.
- 24. Set screw.25. Bearing spacer.26. Ball bearing.

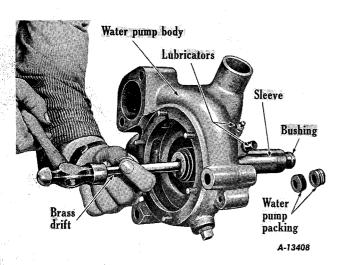
7. DISASSEMBLY - Continued

Packless Type Pump (Early 18 Series) — Continued (Refer to Illust, 13)

- 5. Remove the inner bearing snap ring (11) from the water pump shaft. Support the inner bearing in a press and push the shaft from the bearing. Reverse the shaft and press it from the outer bearing.
- 6. Remove the seal (10) from the pump body and the seal (18) from the seal housing.

Packless Type Pump (Late 18 Series) (Refer to Illust. 14.)

1. Remove pulley nut from the pump shaft (11). Then remove the fan pulley from the pump either

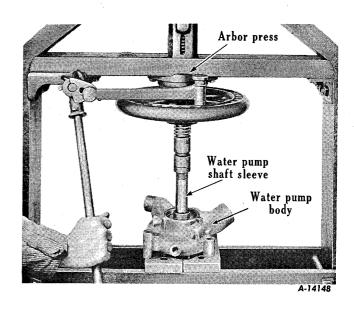


Illust. 11 - Removing Water Pump Packing and Shaft Bushing (Series 14).

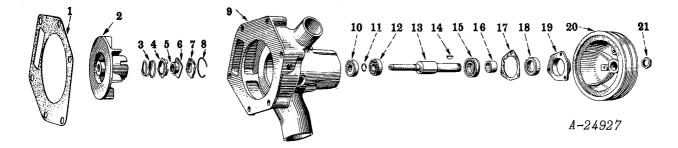
by pressing or using a puller. Be careful not to damage the pulley flanges. Remove the key (12) from the slot in pump shaft.

2. Chisel away enough of the outer oil seal (16) to relieve the pressure against the bore and pull spacer (15) with the damaged seal out of the body and off the shaft to make snap ring (14) accessible for removal. Then remove the snap ring (14) with the aid of two screw drivers to work the ring out of the groove in the body.

NOTE: Be careful so as not to nick or damage the surface of bore when using chisel and screw drivers to remove oil seal and snap ring.



Illust. 12 — Removing Water Pump Shaft Sleeve From Body (Series 14).



Illust. 13 - Packless Type Water Pump Components (Early 18 Series).

- 1. Gasket.
- 2. Impeller.
- 3. Seal spring.
- 4. Spring guide.
- 5. Seal clamp ring.
- 6. Seal.
- 7. Carbon washer.
- ISS-1038A (7-63)

- 8. Snap ring.
- 9. Pump body.
- 10. Oil seal, inner.
- 11. Inner bearing snap ring.
- 12. Inner bearing.
- 13. Shaft.
- 14. Pulley key.

- 15. Outer bearing.
- 16. Bearing spacer.
- 17. Seal housing gasket.
- 18. Oil seal, outer.
- 19. Oil seal housing.
- 20. Pulley.
- 21. Pulley nut.

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- 3. Place the pump in a press and apply pressure at the impeller end to press the pump shaft (11) out of the impeller (4). The inner and outer ball bearings come out with the shaft, therefore, continue to apply pressure until the outer bearing (13) is free of the pump body. Hold the end of shaft to prevent the assembly from dropping out of the pump body.
- 4. Release the press and lift the impeller out of the pump body. Use precaution to protect the impeller vanes or blade edges and the hub water seal contact surface. On engines equipped with jet type cooling systems, the seal seat (21) will come off with the impeller and can easily be removed from the impeller hub.
- 5. Remove the water seal assembly (5) or seal (20) from the pump body.
- 6. ENGINES WITH JET TYPE COOLING SYSTEM ONLY: Pull the seal seat and retainer assembly (19) from the pump body.
- 7. Drive the inner oil seal (7) from its seat in pump body.

8. INSPECTION AND REPAIR

Packing Type Pump

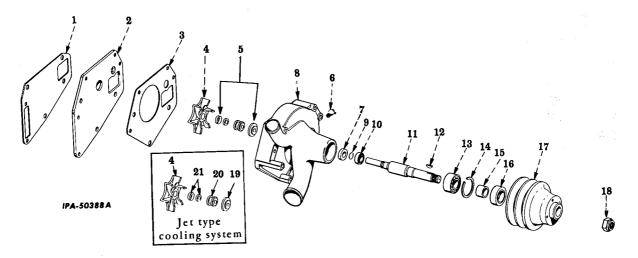
1. Wash all parts in an oil solvent and dry with compressed air.

- 2. Check the fit of the impeller shaft in the bushing. Refer to "SPECIFICATIONS" in Section 1 for shaft diameter and running clearance.
- 3. If the bushings are worn and the running clearance is excessive, replace the sleeve with bushing.
- 4. Remove the lubricator fittings and clean the drilled lubricant passages thoroughly. Install the fittings.
- 5. Inspect the bearings and replace if found to be excessively worn or damaged.

Packless Type Pump

- 1. Clean and inspect all of the disassembled parts. Examine the parts for wear and for rust or scale. Replace parts as necessary if they cannot be polished to give satisfactory service, especially shaft to seal contact surfaces.
- 2. Use new seals to replace the water seal assembly, also the inner and outer oil seals but do not install until reassembly.
- 3. Thoroughly clean the inner and outer bearings with dry cleaning solvent and blow dry

(Continued on next page)



Illust. 14 - Packless Type Water Pump Components (Late 18 Series).

- 1. Mounting plate gasket.
- Mounting plate.
- 3. Pump body gasket.
- 4. Pump impeller.
- 5. Water seal assembly.
- 6. Lubrication fitting.

- 7. Inner oil seal.
- 8. Pump body.
- 9. Bearing snap ring.
- 10. Inner bearing.
- 11. Pump shaft.
- 12. Pulley key.
- 13. Outer bearing
- 14. Bearing snap ring.

- 15. Pulley spacer.
- 16. Outer oil seal.
- 17. Fan pulley.
- 18. Pulley nut.
- 19. Seal seat and retainer assembly.
- 20. Seal.
- 21. Seal seat.

8. INSPECTION AND REPAIR - Continued

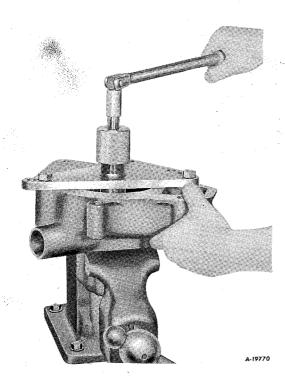
Packless Type Pump - Continued

with compressed air. Make absolutely sure that no chip particles remain in the bearing races to impair bearing service. If in doubt or, if bearings appear worn or damaged replace with new.

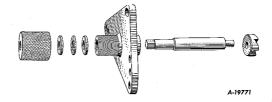
To remove the bearings, first remove the snap ring at the inner bearing, support the bearing in a press and push the shaft from the bearing. Then reverse the shaft and press the shaft from the outer bearing.

When installing the new bearings, be sure that both the inner and outer races of each bearing are supported when the shaft is pressed into the bearings to avoid distortion and bearing damage. Install the snap ring for the inner bearing.

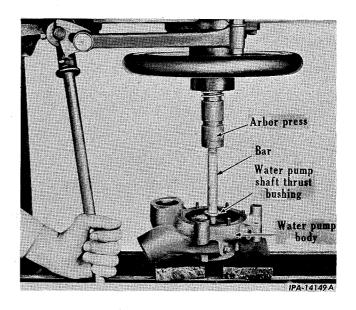
4. Examine the finished impeller hub contact surface for evidence of wear or grooving. Polish this surface or replace the impeller according to condition. Also inspect the impeller vanes, remove any nicks, burrs or roughness, particularly along the edges.



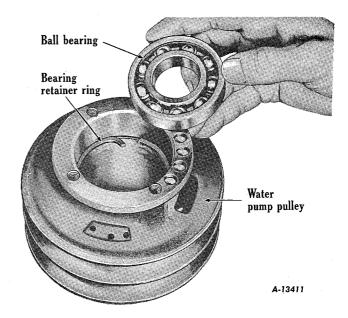
Illust. 15 - Resurfacing the Carbon Seal Seat.



Illust. 16 — Exploded View of the Water Pump Carbon Seal Seat Resurfacing Tool.



Illust. 17 — Pressing Thrust Bushing Into Water Pump Shaft Sleeve (Series 14).



Illust. 18 - Installing Ball Bearing Into Pump Pulley (14 Series).



- 5. Remove the lubricator fitting and clean the drilled lubricant passage in pump body. Also clean the fitting and check the pressure release action. This fitting is designed to release when 3-1/2 to 5 pounds grease pressure in pump chamber is reached. Replace with a new fitting if outward appearances indicate damage.
- 6. EARLY 18 SERIES ENGINES ONLY: A resurfacing tool should be used to remove rust and pitting from the carbon seal seat. Blue-prints are available for making this tool, shown in Illusts. 15 and 16. Order blueprint number 1 020 102 R91. Send request to International Harvester Company, Post Office Box 270, Service Publication Section, Melrose Park, Illinois.

9. REASSEMBLY

Packing Type Pump (Refer to Illust. 9.)

- 1. If the sleeve was removed, press it into the body from the cover side.
- 2. Install the pump shaft thrust bushing (Illust. 17).
- 3. Place a new felt washer, slightly oil-soaked, over the sleeve and into the groove in the front side of the pump body. Insert the bearing retainer ring into the pump pulley by hand.
- 4. Place the ball bearing in position on the retainer end of the pulley (Illust. 18) and tap it into place against the retainer ring. Fill the hub with the correct lubricant. Install the bearing spacer and press the rear ball bearing into the rear of the pulley hub (with the adjustable flange of the hub already assembled).
- 5. Install the oil seal with the lip toward the bearing end of the pulley opposite the retainer end, and place the pulley over the pump shaft sleeve with the bearing retainer side away from the body.
- 6. Install the bearing lock sleeve over the end of the water pump shaft sleeve.
- 7. Press the oil seal into the retainer, using a steel bar slightly smaller than the seal. The leather lip of the seal should face away from the pump body when installed.
- 8. Install a new bearing retainer gasket and the bearing retainer, lining up the holes in the retainer with the holes in the pulley.
- 9. Tighten the fan pulley bearing clamp nut and install a new water pump cover gasket. Then attach the cover.

10. Install the impeller shaft and packing.

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

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

Packless Type Pump (Early 18 Series) (Refer to Illust. 13)

- 1. Insert a new oil seal (10) into the pump body from the pulley end so that the number stamped on the seal is toward the impeller end of the body. Using a suitable driver, seat the seal against the shoulder in the bore.
- 2. Install the bearings (12 and 15). Be sure that both the inner and outer races of the bearings are supported when pressing the shaft with the bearings. The double-row ball bearing must be installed so that its retaining ring is toward the threaded end of the shaft. Install the inner bearing snap ring (11).
- 3. Pack lubricant into the bearings and apply a film on the smaller end of the shaft.
- 4. Insert the shaft into the pump body, and into the oil seal (10). Use a rotary motion when passing the shaft through the seal to avoid damage to the sealing surface. Work the shaft in as far as it will go.
- 5. Place the pump body in a press (impeller end down) and using a driver that will contact both races of the bearing (15), apply pressure until the outer bearing retaining ring bottoms in its seat in the pump body. This operation also seats the inner bearing and positions the shaft.
- 6. Place the seal housing in a press with the hub of the housing up. Install a new seal (end with seal number down) into the housing until it is flush with the top edge. Secure the seal housing to the pump body. Use a new housing gasket. Install the spacer (16) on the shaft and up against the bearing (15).
- 7. Install a new water seal assembly in the impeller engaging the tangs of the seal washer (7) with the slots in the impeller. Secure the seal in the impeller with the snap ring (8).
- 8. With the impeller end up, place the pump in a press to rest the pulley end of the shaft on a support. Position the impeller on the shaft and press the impeller onto the shaft until the im-

(Continued on next page)



9. REASSEMBLY - Continued

Packless Type Pump (Early 18 Series) (Refer to Illust. 13)

peller hub is flush with the end of the shaft. The distance from the face of the body to the face of the impeller hub must be held to the dimensions given in "SPECIFICATIONS" in Section 1, to prevent impeller vanes from scraping the pump chamber. Measure this distance (refer to Illust. 6) and continue to apply pressure until the correct measurement is obtained.

- 9. Remove the pump from the press, insert the pulley key into the shaft slot and drive or press on the pulley.
- 10. Install the nut (21) and torque to the amount shown in "SPECIFICATIONS" in Section 1. Stake the nut to the shaft.
- 11. Lubricate the water pump assembly as described in the operator's manual.

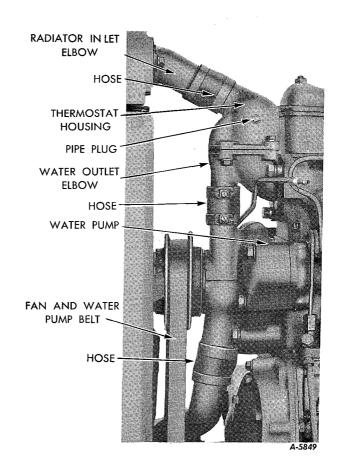
Packless Type Pump (Late 18 Series) (Refer to Illust. 14)

- 1. Insert a new inner oil seal (7) into the pump body from the pulley end so that the number stamped on the seal is toward the impeller end of the body. Turn the pump body impeller end down and, using a 1-1/2 inch diameter driver, drive the oil seal to seat in the body bore.
- 2. Pack lubricant into the bearings and apply a film on the smaller end of shaft.
- 3. Insert the shaft, with both bearings installed, into the pump body and into the inner oil seal. Use a rotary motion when passing the shaft through the seal to avoid damage to sealing surface. Work the shaft in as far as it will go.
- 4. Place the pump body in a press, impeller end down and supported so that the shaft can emerge beyond the body. Select a cylindrical fixture having a wall thickness that will contact both races of the outer bearing to avoid bearing distortion and damage when pressure is applied. Place this fixture over the pulley end of the shaft and onto both races of the outer bearing. Apply pressure until bearing bottoms in its seat and the snap ring can be installed in the groove of the body. This operation also seats the inner bearing and positions the shaft in the body.
- 5. Insert a new pulley spacer (15) into the new outer oil seal (16) and slip the spacer over the pulley end of the shaft so that the number stamped on the oil seal is toward the bearing.

Using a 2-1/2 inch O.D. driver, drive the outer seal to bottom in its seat, then tap the spacer to rest against the outer bearing.

6. ENGINES NOT EQUIPPED WITH JET TYPE COOLING: Turn the pump impeller end up, work new water seal cartridge over the shaft and tap the cartridge case to seat in the pump body.

ENGINES EQUIPPED WITH JET TYPE COOL-ING: Install a new seal seat (21) in the bore of the impeller. Install a new seal seat and retainer assembly (19) into the pump body until it bottoms in the body bore. Position the seal (20) on the pump shaft and up against the seat and retainer assembly (19).



Illust. 19 - Water Pump Installed (14 Series)

7. With the impeller end up, place the pump in a press to rest the pulley end of the shaft on a support. Position the impeller on the shaft and press the impeller onto the shaft until the impeller hub is flush with the end of the shaft. The distance from the face of the body to the face of the impeller hub must be held to the dimensions



given in "SPECIFICATIONS" in Section 1, to prevent impeller vanes from scraping the pump chamber. Measure this distance (refer to Illust. 6) and continue to apply pressure until the correct measurement is obtained.

- 8. Remove the pump from the press, insert the pulley key into the shaft slot and drive or press on the pulley.
- 9. Install the elastic stop nut to the end of the shaft and tighten the nut to the torque given in "SPECIFICATIONS" in Section 1.
- 10. Install the lubricator fitting and lubricate the pump chamber until 3-1/2 to 5 pounds pres-

sure is reached, at which point the lubricant will backflow around the nozzle.

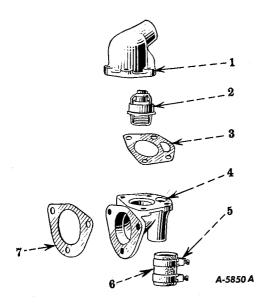
10. INSTALLATION

- 1. Install the pump to the crankcase with the gaskets and mounting plate using a suitable sealer, and tighten the mounting cap screws evenly.
- 2. Install the fan belt, reconnect the water hoses, install the fan, and refill the cooling system.

THERMOSTATS

11. MAINT ENANCE

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.



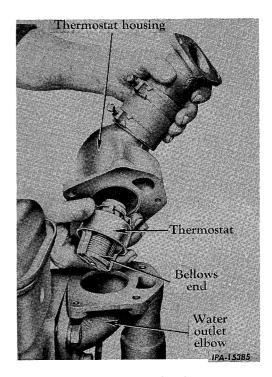
Illust: 20 - Thermostat Components (14 Series)

5. Hose clamp.

6. Hose.

7. Gasket.

- 1. Thermostat housing.
- 2. Thermostat.
- 3. Gasket.
- 4. Water outlet elbow.



Illust. 21 - Removing the Thermostat.

12. REMOVAL

Single Thermostat (14 Series)

- 1. Remove the cap screws which secure the inlet pipe to the radiator, and the cap screws which secure the thermostat housing to the water outlet elbow.
- 2. Lift the complete assembly away from the engine. Lift the thermostat from the water outlet elbow (Illust. 21).

(Continued on next page)



THERMOSTATS

12. REMOVAL - Continued

Multiple Thermostats (18 Series).

- 1. Loosen the hose clamps and push back the hoses which connect the water outlet header to the by-pass and radiator inlet pipe.
- 2. Remove the cap screws which secure the water outlet header to the water outlet elbows. Lift off the water header and remove the thermostats (Illust. 22).

13. INSTALLATION

Single Thermostat (14 Series)

- 1. Insert the thermostat into the water outlet elbow with the bellows end down. Have the mark "FRONT" (stamped on the lip of the thermostat) face toward the radiator.
- 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 the two cap screws.

Multiple Thermostats (18 Series).

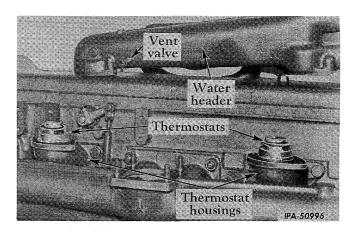
1. Insert the thermostats into the water outlet header, each with the bellows end down and the

mark "FRONT" (stamped on the lip of the thermostat) toward the radiator.

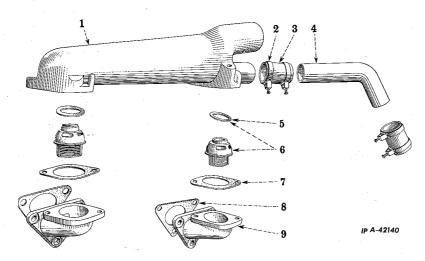
2. Apply sealer to the gasket surfaces of the header and the elbows, and install new gaskets.

NOTE: Be sure to insert the thermostats before installing the gaskets.

3. Assemble the water outlet header, with thermostats, to the elbows, and install the hoses and clamps.



Illust. 22 - Removing Thermostats.



Illust. 23 - Engine Water Outlet Header and Thermostats (18 Series).

- 1. Water outlet header.
- 2. Hose clamp.
- 3. By-pass pipe hose.
- 4. By-pass pipe.
- 5. Thermostat gasket.
- 6. Thermostat.

- 7. Header gasket.
- 8. Elbow gasket.
- 9. Elbow.







14. REMOVAL

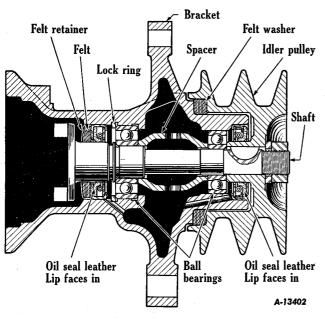
Remove the bolts which secure the idler bracket to the pulley brace and crankcase front cover.

15. DISASSEMBLY (OLD STYLE).

- 1. Make a scratch mark from the bracket to the generator. Remove the generator from the idler bracket.
- 2. Remove the nut and lock washer from the end of the idler shaft.
- 3. Using a puller, remove the idler pulley from the idler shaft.
- 4. Remove the key from the idler shaft, and tap the idler shaft from the bracket.
- 5. Tap out the front oil seal by placing a drift against the front bearing and tapping evenly all around. The bearing drives out the seal. The idler bearing and the spacer will then drop out.
- 6. Drive out the felt retainer, remove the felt, and drive out the oil seal.
- 7. Remove the bearing lock ring. Tap the bearing evenly around the outer race to remove it.

(New Style) (Refer to Illust. 27.)

1. Remove the generator and coupling spacer from the idler bracket.

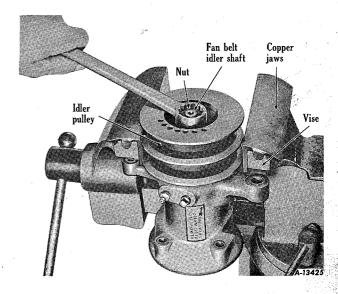


Illust. 24 - Fan Idler Bracket and Pulley (Old Style).

- 2. Remove the cotter pin and nut from the end of the idler shaft.
- 3. Use a puller and remove the idler pulley from the idler shaft.
- 4. Remove the key and "O" ring from the idler shaft and tap the shaft from the bracket.
- 5. Remove the front oil seal from the idler bracket with a puller.
- 6. Remove the front bearing lock ring. Using a 15/16 inch diameter brass rod, press the sleeve and front bearing out the front of the fan belt idler housing bracket.
- 7. Press the rear oil seal out the front of the idler bracket. The oil seal will drive the rear bearing out ahead of it.

16. INSPECTION AND REPAIR

- 1. Clean all parts thoroughly in clean solvent.
- 2. Check the bearings and make sure each bearing fits tightly on the shaft and in the bracket. If the outer race of a bearing should be loose in the bracket, try a new bearing. If this does not fit snugly, the bracket may be worn and need to be replaced. If the inner race does not fit snugly on the shaft, and the new bearing does not correct this condition, replace the shaft.
- 3. Be sure that there is no stoppage in the lubricator on the idler bracket.



Illust. 25 - Removing Nut From Fan Belt Idler Shaft.



FAN IDEER PULLEY AND BRACKET

16. INSPECTION AND REPAIR - Continued

4. After every 240 hours of operation, set the idler bracket so the plug hole is horizontal. Remove the plug to see if the lubricant shows at the plug hole. If not, fill with universal gear lubricant (UGL) as shown below:

Above +50°F. . . . SAE-140 +50° to +20°F. . . SAE-90 +20° to -10°F. . . SAE-80

17. REASSEMBLY (OLD STYLE)

- 1. Tap the rear bearing into place against the shoulder in the housing. Be sure to use a drift in the outer race, and to tap it evenly all around.
- 2. Install the lock ring and a new oil seal. Place the new oil seal in the housing with the lip toward the bearing.
- 3. Install a new felt washer on the oil seal, and install a new shaft felt retainer, placing the flared edge toward the bearing.
- 4. Tap the idler shaft into place, and install the bearing spacer so the end with the largest opening goes on first (Illust. 28).
- 5. Position the front bearing snugly against the spacer. Set a wooden block under the idler shaft to keep the shaft from pushing out of the

bracket while the bearing is being tapped into place.

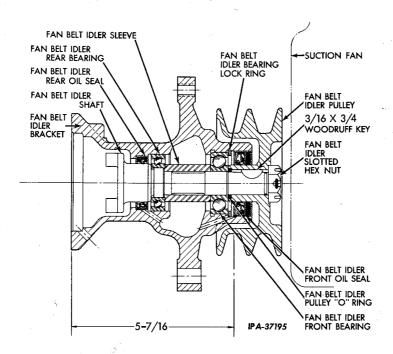
6. Install a Woodruff key to the shaft, and insert an oil seal over the shaft (Illust. 29), with the lip of the oil seal toward the inside of the bracket. Tap the seal down into the bracket until it is flush with the end of the bracket.

NOTE: Be sure to install the key before installing the oil seal.

- 7. Install a new felt on the idler bracket (Illust. 30). Tap the pulley down into position so the slot in the pulley lines up with the key in the idler shaft. Secure the pulley to the shaft with a lock washer and nut.
- 8. Line up the scratch marks on the generator and the bracket. Turn the pulley until the male part of the coupling on the idler shaft engages with the coupling on the generator shaft. Then fasten the idler to the generator with a cap screw.

18. REASSEMBLY (NEW STYLE) (Refer to Illust. 27.)

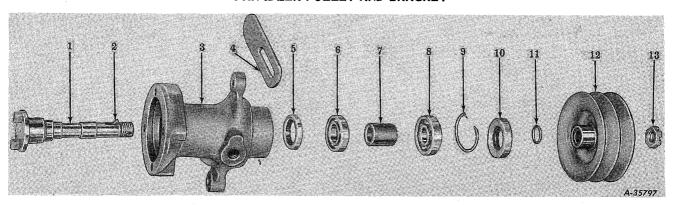
- 1. Install a new rear bearing oil seal in the bracket, with the lip toward the bearing. Be sure the seal is seated firmly against the shoulder in the bracket.
- 2. Using the outer race, press the rear bearing into place evenly, approximately 2-15/16 inches below the machined front face of the idler bracket.



Illust. 26 - Cross Section of Fan Belt Idler (New Style).



FAN IDLER PULLEY AND BRACKET

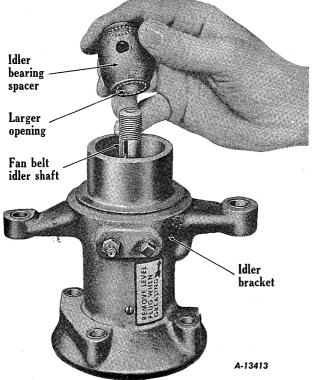


Illust. 27 - Exploded View of New Style Fan Idler.

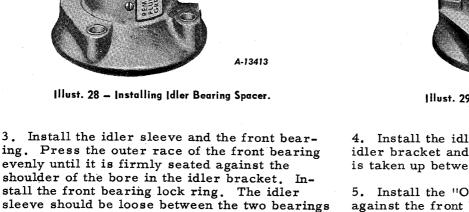
- 1. Idler shaft.
- 2. Pulley key.
- 3. Idler bracket.
- 4. Pulley brace.
- 5. Rear oil seal.

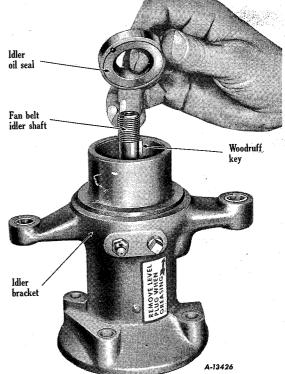
- 6. Rear bearing.
- Bearing spacer.
 Front bearing.
- 9. Snap ring.

- 10. Front oil seal.
- 11. Idler shaft "O" ring.
- 12. Pulley.
- 13. Shaft nut.



at this stage of assembly.





Illust. 29 - Installing Idler Oil Seal.

- 4. Install the idler shaft from the rear of the idler bracket and tap into place so that all play is taken up between the bearings and sleeve.
- 5. Install the "O" ring on the idler shaft against the front bearing. Insert the key in the idler shaft.



FAN IDLER PULLEY AND BRACKET

18. REASSEMBLY (NEW STYLE) - Continued

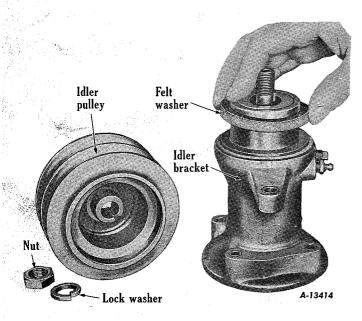
6. Install a new front bearing oil seal in the idler bracket, with the lip toward the bearing. Tap the seal in until it is flush with the end of the bracket.

NOTE: Be sure to install the shaft key before installing the oil seal.

- 7. Tap the pulley into position on the shaft so the key and the keyway are aligned. Secure the pulley to the shaft with the castellated nut and cotter pin.
- 8. Install the generator coupling spacer on the drive lugs of the idler shaft. Line up the marks on the generator and the bracket. Turn the pulley until the generator coupling engages with the spacer. Secure the idler to the generator with cap screws and lock washers.

19. INSTALLATION

Fasten the fan idler assembly to the pulley brace and the crankcase front cover.



Illust 30 - Installing Felt Washer.

20. FIELD TEST OF JET TYPE COOLING SYSTEMS

In order to realize the full potential of the jet type cooling system's ability to prevent deposit formation and thereby increase the service life of the cylinder head, it is essential to maintain coolant flow rates above a specified minimum. Whether a particular installation meets these requirements can be determined by pressure testing the cooling system and analyzing the data obtained as described below.

Test Set-up

Drain the cooling system and install gauges as indicated; then refill the system.

Pressure Gauge Location	Pressure Gauge Range						
Jet type cooling system	14A Series, 18A Series and 691 diesel engines						
Pump inlet *	0-15 psi and 0-30 "Hg" (Mercury)						
Pump outlet	0-30 psi						
Crankcase drain	0-30 psi						
Cylinder head	0-15 psi						

^{*}Combination pressure and vacuum gauge.

Test Procedure

Check fan belt tension and adjust, if required. With coolant cold, check level in radiator or auxiliary tank and add if below the baffle. With the pressure cap installed, start the engine and allow it to warm up. When the hand of the heat indicator begins to move, bring the engine up to high idle. Partially block the radiator with strong paper or cardboard and adjust until the temperature stabilizes in the middle of the green or RUN band. Record coolant pressures at the locations indicated, remove the pressure cap and again take pressure readings. Remove paper or cardboard and allow engine to cool at low idle for five minutes before reinstalling pressure cap.

Analysis Data

The prevention of deposit formation is dependent upon the scrubbing action of high velocity jet streams directed at the critical areas of the cylinder head lower deck. It has been established that flow through the jet tubes is proportional to the difference between coolant pressures in the crankcase and cylinder head, referred to as pressure differential. As indicated by the chart, the maximum benefit of jet cooling will be obtained when at high idle, pressure differential of 8 psi is maintained in the respective jet type cooling systems. Pressure differential of 4 psi on 14A Series diesel engines. When these figures are not obtained, it will be necessary to investigate various cooling system components as follows:



- FAN IDLER PULLEY AND BRACKET
- 1. If the pump inlet vacuum WITH THE THER-MOSTAT (S) OPEN and the pressure cap removed exceeds the limits specified, restriction in the radiator core is indicated. (This may be due to partially plugged tubes.) Rod out radiator core or replace if necessary, and repeat test. (Pressurization of the cooling system decreases the vacuum reading, thereby introducing an error relative to determining radiator restriction; the maximum vacuum figure refers to data obtained with the pressure cap removed.)
- 2. Coolant pressures should decrease by 2 to 4 psi when the pressure cap is removed, providing that the cooling system is full and that the cap was installed with the coolant cold. If this drop does not occur, allow engine to cool, install a new cap and repeat test. A defective pressure cap will affect coolant pressures and flow rates under extreme weather conditions where cooling is marginal, and will also contribute to coolant loss.
- 3. When all coolant pressures with the pressure cap removed are insufficient, investigate the operation of the water pump. If the fan belt(s) or pulleys are worn, replace with new parts as required and repeat test. If pressures are still too low, inspect the impeller and replace where justified. Rebuild water pump and repeat test.
- 4. If the pump inlet vacuum, pump outlet and crankcase pressure appear to be normal while pressure in the cylinder head is high, thereby resulting in a low differential, the cylinder head gauge should be checked. This may be done by removing the pump outlet gauge, plugging the hole at this location and installing the gauge at the cylinder head pressure tap. Then by taking a set of readings at high idle, shutting down and reversing the crankcase drain and cylinder head gauges and repeating the test, the accuracy of all three gauges can be checked.

Pressure Gauge Location	Pressure Data Range **								
Jet Type Cooling System	14A Series Diesel Engines	18A Series and 691 Diesel Engines							
Pump Inlet (1)	2 "Hg" (Mercury) Vacuum to 3 psi	4 "Hg" (Mercury) Vacuum to 2 psi							
Pump Outlet (2)	12 - 16 psi	18 - 22 psi							
Crankcase Drain (3)	10 - 14 psi	17 - 21 psi							
Cylinder Head (4)	6 - 10 psi	9 - 13 psi							
Maximum Pump Inlet Vacuum ***	0 to 2 "Hg" (Mercury) Vacuum	0 to 4 "Hg" (Mercury) Vacuum							
Minimum Pressure Differential (3 minus 4)	4 psi	8 psi							

**At high idle speeds, with pressure cap installed pressures should be at high limit range.

*** With pressure cap remove.

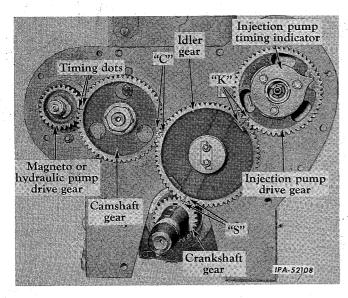




TIMING GEAR TRAIN AND FRONT COVER

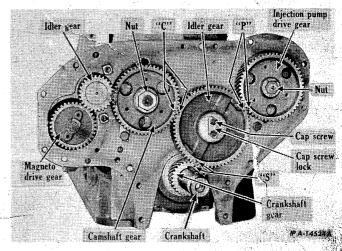
1. DESCRIPTION (Refer to Illusts. 1, 2 and 3)

The timing gears are located at the front of the engine and are accessible when the crankcase front cover is removed. All gears are the

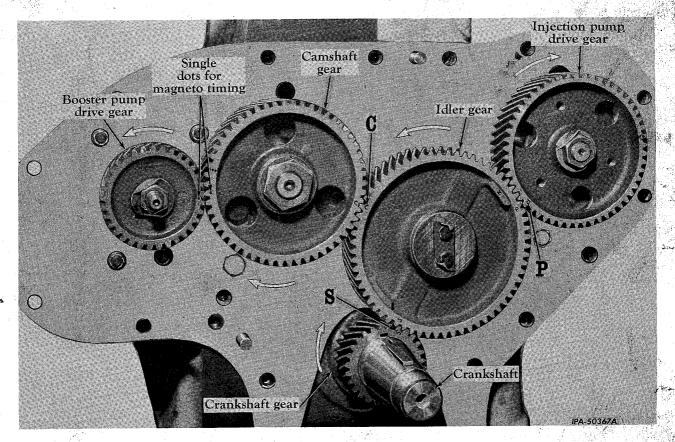


Illust. 1 - Gear Train (14 Series).

helical type and are stamped or punch marked for timing purposes. The camshaft and injection pump gears turn at one-half crankshaft speed. On the 14 series engines, the distributor or magneto is driven at crankshaft speed. The magneto on 18 series engines, so equipped, is driven at three-fourths of crankshaft speed.



Illust. 2 - Gear Train (Early18 Series Tractors and All Power Units.)



Illust. 3 - Gear Train (Late 18 Series Crawler Tractors).

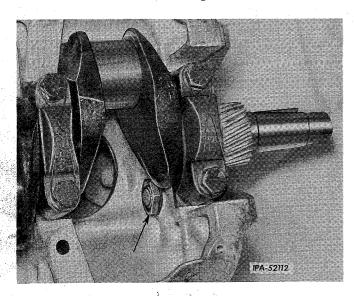
TIMING GEAR TRAIN AND FRONT COVER

3. INSPECTION AND REPAIR - Continued

the crankcase bore. If any movement is present the shaft must be replaced.

NOTE: An idler gear shaft with a .015 inch oversize shank is available. Before installing the oversize shaft, ream the shaft bore in the crankcase to 1.0765-1.0775 inch. When reaming, be extremely careful not to get dirt or chips in the oil line in the bore.

If it is necessary to replace the idler gear shaft, remove the crankcase oil pan. Remove the staked nut from inside the crankcase (Illust. 8). Remove the idler gear shaft from the front end of the crankcase with a puller.



Illust. 8 - Idler Gear Shaft Nut.

When reinstalling the shaft, line up the dowel pin in the shaft with the groove in the crankcase bore. This will assure correct alignment of the oil holes in the shaft and the bore. Drive the shaft into the bore with a babbitt hammer. The fit between the shaft and the bore is .000-.015 inch tight. Install a new nut and torque as specified in "SPECIFICATIONS," in Section 1. Stake the nut to the shaft.

5. Inspect the oil seal in the front cover and replace if necessary.

4. INSTALLATION

- 1. If the crankcase front plate was removed, reinstall as follows:
 - (a) Cement a new gasket to the front of the crankcase and install the front plate, securing it with cap screws and locks.

- (b) 14 SERIES: Install the injection pump. Refer to the "DIESEL INJECTION PUMP MANUAL," ISS-1003. Install the magneto drive housing or hydraulic booster pump, depending upon the application.
- (c) 18 SERIES: Install the injection pump drive housing. Install the hydraulic booster pump, magneto drive housing or transfer. pump drive housing, depending upon the application.
- 2. Install the crankshaft gear key. Heat the crankshaft gear to 250°F. Position the gear on the crankshaft with the timing mark (letter "S") facing out. Be sure that the gear is not cocked on the crankshaft. Drive the gear into position.
- 3. 14 SERIES: Install the injection pump gear on the gear hub so the groove in the hub and the groove in the front face of the gear line up. Place the timing indicator on the gear with the pointer set at zero. Install the three cap screws in the pointer and torque as specified in "SPECIFICATIONS," in Section 1.
- 18 SERIES: Tap the injection pump gear onto the injection pump drive shaft, lining up the key in the shaft with the keyway in the gear. Drive the gear onto the shaft. Install the nut and nut lock. Torque the nut to the torque specified in "SPECIFICATIONS," in Section 1 and secure with the nut lock.
- 4. Tap the camshaft gear onto the camshaft, lining up the key in the camshaft with the keyway in the gear. Drive the gear onto the shaft. Install the nut and nut lock. Block the gear to prevent it from turning. Torque the nut to the torque specified in "SPECIFICATIONS," in Section 1 and secure with the nut lock.
- 5. 14 SERIES: Install the distributor or magneto drive gear, lining up the double punch mark on the distributor or magneto gear tooth with the double punch mark between the two teeth on the camshaft gear.

NOTE: Disregard the single punch mark on the camshaft gear.

Drive the gear onto the shaft until the gear bottoms against the shoulder of the shaft. Install the nut and nut lock. Torque the nut as specified in "SPECIFICATIONS," in Section 1 and secure with the nut lock.

EARLY 18 SERIES TRACTOR ENGINES AND ALL POWER UNITS: Install the magneto or transfer pump housing drive gear. Secure with nut and lock. Torque the nut as specified in "SPECIFICATIONS," in Section 1. Install the



TIMING GEAR TRAIN AND FRONT COVER

idler gear and shaft into the magneto or transfer pump housing, aligning the dowel pin in the shaft with the groove in the housing bore. This will assure correct alignment of the oil holes in the shaft and the bore. Mesh the teeth of the idler gear with the camshaft gear and magneto or transfer pump housing drive gear. There are no timing marks to align. Drive the idler gear shaft into the bore with a babbitt hammer. Install the idler gear shaft nut and lock. Tighten the nut securely and bend the lock over the flat of the nut.

LATE 18 SERIES TRACTOR ENGINES: Install the hydraulic booster pump drive gear, lining up the single punch between two teeth with the single punch mark on the camshaft gear tooth.

NOTE: Disregard the double punch mark on the camshaft gear. Drive the gear onto the shaft until the gear bottoms against the shoulder of the shaft. Install the nut and nut lock. Torque the nut as specified in "SPECIFICATIONS," in Section 1 and secure with the nut lock.

6. Back-off all the valve lever adjusting screws to release the valve levers. Rotate the crankshaft until the piston in the number 1 cylinder is at top of its compression stroke. This will place the crankshaft gear and cap keyway at 12 o'clock position, and the letter "S" stamped on the gear facing toward the idler gear shaft.

Install the idler gear so that the timing marks align with the corresponding marks on the camshaft, crankshaft and injection pump gears (Illusts. 1, 2 and 3). Install the thrust washer, locking strip and cap screws. Tighten the cap screws securely and bend the locking strip over the flat of the cap screws.

7. Check the backlash between all gears and check the idler gear and camshaft end play

(Illusts. 5, 6 and 7). Refer to "SPECIFICA-TIONS," in Section 1 for specified clearances. Apply a film of engine oil to the teeth of all gears in the gear train.

- 8. Install the fan drive pulley key and oil flinger. On later 18 series engines, install the crankshaft gear nut which holds the oil flinger in place. Use a new gasket and install the crankcase front cover. Secure with cap screws, nuts and washers. 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. Install the engine front support (if so equipped).
- 9. On engines equipped with straight bore fan drive pulleys (not tapered) it is suggested that the pulley be heated to 300°F to make installation easier. The fit between these pulleys and the crankshaft is .0005 loose to .0015 tight.

Drive the pulley on until it bottoms against the shoulder on the crankshaft. Install the pulley nut and nut lock and torque as specified in "SPECIFICATIONS," in Section 1.

NOTE: On 18A series engines do not install the nut lock washer as the raised edges of the hard lock washer will cut into the nut resulting in loss of torque.

- 10. Adjust the valve clearance. Refer to Section 2, "MANIFOLDS, CYLINDER HEAD AND VALVES." Check the magneto or distributor timing. Refer to Section 13, "H-4 MAGNETO;" Section 13A, "F-6 MAGNETO;" Section 13B, "BOSCH MAGNETO;" or Section 14. "BATTERY IGNITION DISTRIBUTOR."
- 11. Start the engine and check the injection pump timing. Refer to "DIESEL INJECTION PUMP MANUAL," ISS-1003.

CAMSHAFT

5. DESCRIPTION

The camshaft is located in the crankcase on the right-hand 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 three or four bushings, depending upon the engine series. The bushings are removable and are furnished for service reamed to size. Illusts. 9 and 10 show camshaft components. The bushings are a press fit in the crankcase.

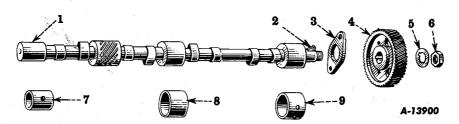
The camshaft drives the engine lubricating oil pump by the gear located approximately in the center of the shaft. The camshaft has the main function of operating the intake and exhaust

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 of 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 subricated 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 subricating oil to travel to the valve lever mechanism.



CAMSHAFT

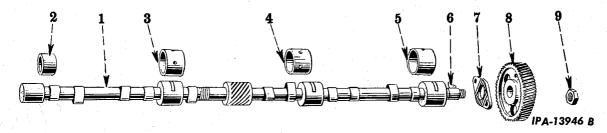


Illust. 9 - Camshaft Components (14 Series).

- 1. Camshaft.
- 2. Key.
- 3. Plate.

- 4. Gear.
- 5. Nut lock.
- 6. Nut.

- 7. Bearing, rear.
- 8. Bearing, center.
- 9. Bearing, front.



Illust. 10 - Camshaft Components (18 Series).

- 1. Camshaft.
- 2. Bearing, rear.
- 3. Bearing, No. 3.

- 4. Bearing, No. 2.
- 5. Bearing, front.
- 6. Key.

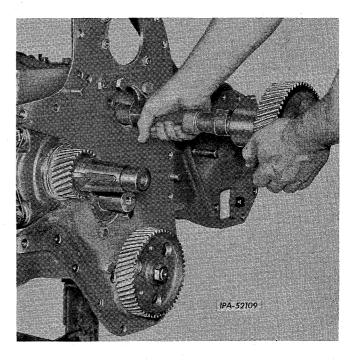
- 7. Plate.
- 8. Gear.
- 9. Nut.

6. REMOVAL

NOTE: For a method of detecting too much camshaft bearing clearances prior to removal and disassembly procedures, refer to "OIL PRESSURE TEST FOR DETECTING WORN BEARINGS," in Section 4.

- 1. Remove the rocker arm assembly and push rods. Refer to Section 2, "MANIFOLDS, CYL-INDER HEAD AND VALVES."
- 2. Remove the ignition distributor on 18 series engines so equipped. Refer to Section 14, "BATTERY IGNITION DISTRIBUTOR."
 - 3. Remove the crankcase oil pan and lubricating oil pump. Refer to Section 4, "OIL PUMP, LUBRICATING OIL FILTERS AND ENGINE BALANCER."
 - 4. Remove the crankcase front cover and idler gear. Refer to par. 2 in this section.
 - 5. Rotate the camshaft gear until the two cap screws which hold the thrust plate to the crank-case can be removed through the holes in the gear.
 - 6. Push the tappets up into the tappet guides from inside the crankcase, so the lobes on the

camshaft will clear the heads of the tappets when removing the camshaft. Pull the camshaft with gear from the crankcase (Illust. 11).

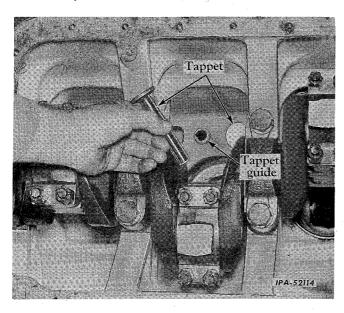


Illust. 11 - Removing Camshaft.



CAMSHAFT

7. Remove the tappets from the tappet guides (Illust. 12). If the tappet guides are to be removed, remove the cylinder head and lift the guides out of the crankcase. Refer to Section 2, "MANIFOLDS, CYLINDER HEAD AND VALVES," for cylinder head removal procedure.



Illust. 12 - Removing Tappets.

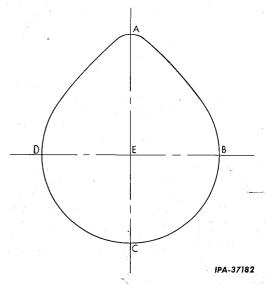
7. DISASSEMBLY (Refer to Illusts. 9 and 10)

- 1. Remove the nut and lock which secure the gear to the camshaft.
- 2. Pull the gear off the camshaft with a gear puller.
- 3. Remove the gear key from the camshaft and remove the thrust plate.

8. INSPECTION AND REPAIR

- 1. Clean all parts in a cleaning solvent and dry with compressed air. As inspection of parts is completed, coat each 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 journals for wear. Dimensions for the camshaft journals are given in "SPECI-FICATIONS," in Section 1. Compare those of the camshaft being serviced with the ones listed. If the journals are worn beyond the limits specified, replace the camshaft.
- 3. Inspect the lobes for wear. Refer to "SPEC-IFICATIONS" in Section 1 for cam lobe lift when new and for the maximum permissible lobe wear. face is badly If the lifting areas of the cam lobes, when compared with a new camshaft, show excessive wear, be installed.

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. 13): Take a reading across A-C and deduct the reading B-D; this will give the cam lobe lift. When the cam lobe wear limit has been reached, this valve lift will be .2915 inch and the camshaft must then be replaced with a new one.



Illust. 13 - Points of Measurement to Determine Cam Lobe Wear.

- 4. Inspect the teeth of the oil pump drive gear integral with the camshaft. Replace the shaft if necessary.
- 5. Inspect the drive gear and thrust plate for wear due to lack of specified end clearance. Replace parts if necessary.
- 6. Inspect the bushings for wear and, if replacement is necessary, remove the flywheel and engine rear support. Refer to Section 7, "CRANKSHAFT MAIN BEARINGS AND FLY-WHEEL." 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.
- 7. Inspect the bushing bore in the crankcase for burrs and other roughness liable to damage the bushings when installation takes place.
- 8. When installing new bushings, be sure that the oil holes in the bushings line up with the oil holes in the crankcase.
- 9. 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.

Page 8



CAMSHAFT

9. REASSEMBLY

- 1. Install 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. Tighten the nut to the foot-pounds specified in "SPECIFI-CATIONS," in Section 1, using a torque wrench. 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.

10. INSTALLATION

- 1. Install the tappet guides, if they were removed. Install the cylinder head, but do not install the push rods or rocker arm assembly. Refer to Section 2, "MANIFOLDS, CYLINDER HEAD AND VALVES," for cylinder head installation procedure.
- 2. Install the camshaft rear bushing expansion plug if bushings were replaced. Use a sealing compound on the plug and in the plug seat.
- Install the flywheel and engine rear support. Refer to Section 7, "CRANKSHAFT, MAIN BEARINGS AND FLYWHEEL."
- 4. Install the tappets into the tappet guides. Coat the cam lobes with SCL (sulfo-chloro-lead) heavy duty axle lubricant and install the camshaft. (Support the camshaft along its length when installing it to prevent the cam lobes from damaging the bushings.)

- NOTE: On 14 series engines engage the double punch mark between the two teeth on the camshaft gear with the double punch marked tooth on the hydraulic booster pump or magneto drive gear (Illust. 1). On 18 series engines equipped with a hydraulic booster pump, engage the single punch marked tooth on the camshaft gear with the single punch mark between the two teeth on the hydraulic booster pump drive gear (Illust. 3).
- 5. Install the two cap screws which secure the thrust plate to the crankcase. Check the camshaft end plug as shown in Illust. 5. Refer to "SPECIFICATIONS," in Section 1.
- 6. Install the idler gear on the idler shaft so that the timing marks on the idler gear align with the corresponding marks on the camshaft gear, crankshaft gear and injection pump drive gear (Illusts. 1, 2 and 3). Install the idler gear thrust plate, locking strip and cap screws.
- 7. Check the idler gear end play (Illust. 6) and check the backlash between all mating gears (Illust. 7). Refer to "SPECIFICATIONS," in Section 1 for specified clearances.
- 8. Install the crankcase front cover and fan drive pulley. Refer to par. 4 in this section.
- Install the lubricating oil pump and crankcase oil pan. Refer to Section 4, "OIL PUMP, LUBRICATING OIL FILTERS AND ENGINE BALANCER."
- 10. Install the ignition distributor on 18 series engines, so equipped. Refer to Section 14, "BATTÉRY IGNITION DISTRIBUTOR."
- 11. Install the push rods and rocker arm assembly. Adjust the valve clearance. Refer to Section 2, "MANIFOLDS, CYLINDER HEAD AND VALVES."

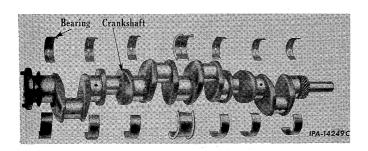






1. DESCRIPTION

The crankshaft is the straight throw type. The flywheel is mounted on the rear of the crankshaft. The front end of the crankshaft is equipped with a gear which drives the timing gear train. An oil seal at both ends, prevents leakage of lubricating oil. The crankshaft is supported by five or seven main bearings depending on the engine series.



Illust. 1 - Crankshaft and Main Bearings.

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 or cap screws. The bearing caps are not interchangeable, and each has a number stamped on it which signifies its correct location in the crankcase. Number one is at the front or fan end of the engine.

The bearing inserts are the two-piece type. The crankshaft end thrust is taken by the flanges of the center main bearing (Illust. 2).

CAUTION: Be extremely careful to guarantee cleanliness of the crankcase, crankshaft and bearings after service has been completed. Whenever possible, remove the crankshaft 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 at that point. The frictional heat thus produced will in turn cause the bearing material to melt away

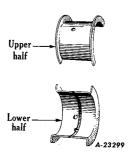
from the steel back of the bearing at that point. Such melted material will create further hot spots until complete bearing failure takes place. Anything that interferes with the operating clearance of any bearing or proper heat dissipation has its effect upon bearing life. Cleanliness cannot be overstressed.

2. REMOVAL

Crankshaft Bearings

NOTE: For a method of detecting excessive bearing running clearance prior to removal and disassembly, refer to "OIL PRESSURE TEST FOR DETECTING WORN BEARINGS" in Section 4.

- 1. Remove the crankcase oil pan and oil pump. On 14 series engines, remove the engine balancer, if equipped. Refer to Section 4, "OIL PUMP, LUBRICATING OIL FILTERS AND ENGINE BALANCER."
- 2. Remove the spark plugs, and set the engine for gasoline operation to lower the compression ratio make it easier to crank the engine.



Illust. 2 - Two-Piece Center Main Bearing.

- 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 (Illust. 3).
- 4. Remove the cotter pins and nuts or lock-wire and cap screws securing the crankshaft bearing caps. Tap the caps lightly with a soft metal hammer or mallet to loosen them. If the bearings are to be reassembled, be sure that they are identified as to their original positions. Remove the lower bearing from the

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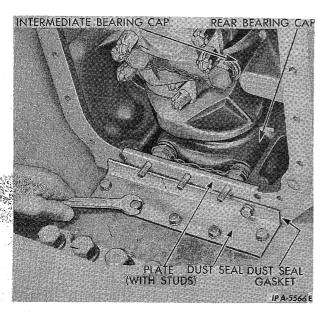


2. REMOVAL - Continued

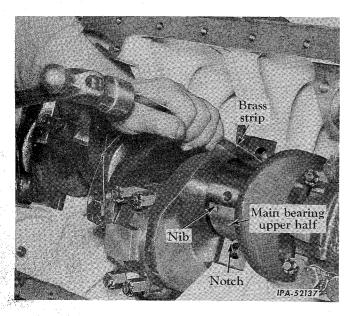
Crankshaft Bearings - Continued

caps. Wrap the pieces in a clean cloth and store until reassembly.

5. Remove the upper bearing halves from between the crankshaft and the crankcase with a thin piece of flexible soft metal. This will push against the end of the bearing farthest from the nib holding the bearing in the crankcase sup-



Illust. 3 - Removing Dust Seal and Plate.



Illust. 4 - Removing the Upper Half of the Crankshaft Bearing. ISS-1038A (7-63)

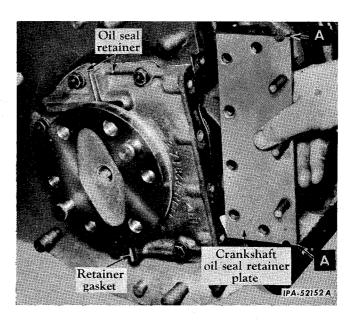
port and at the same time turning the crankshaft in the direction of rotation. The bearing will slide easily from position (Illust. 4).

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

6. If equipped with the six-piece bearing, push the separate thrust washer upper halves from the crankcase.

Crankshaft

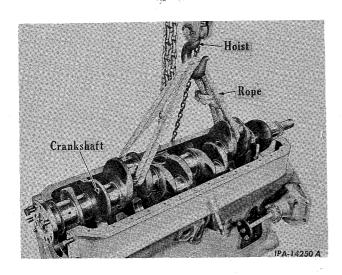
- 7. Remove the flywheel. (Refer to "FLY-WHEEL" in this Section.)
- 8. Remove the engine rear support from the crankcase.
- 9. Remove the crankshaft rear upper and lower oil seal retainer (Illust. 5).
- 10. Remove the front cover assembly. (Refer to Section 6, "TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT.")
- 11. Remove the connecting rod bearing caps and push the assemblies to the top of their travel.



Illust. 5 - Removing the Crankshaft Rear Oil Seal Retainer Plate.



12. Lift the crankshaft out of the crankcase (Illust. 6).



Illust. 6 - Lifting the Crankshaft from the 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 it is necessary to replace it, pull the gear from position.
- 4. On 18 series engines, inspect the vibration damper for breaks or for signs of poor bonding between the rubber and the metal portion of the damper. If either condition is found, the vibration damper should be replaced.
- 5. Inspect the crankcase for sludge deposits, especially in the corners. The crankcase should be thoroughly cleaned and inspected.
- 6. Replace the front and rear seals with new.

4. INSTALLATION

NOTE: 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. Smear 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 one-half revolution. Remove the crankshaft evenly, and inspect the upper bearings for an even transfer of blueing from journals to bearings. Any 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.
- 5. When satisfied that the crankcase is in good order and 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. Install the upper bearing halves (bearings with oil hole in center) after coating the bearing surface only with a small amount of clean engine oil. Install the crankshaft in place carefully.

NOTE: When new bearings are to be installed in engines having brass dowels in the center bearing caps, the dowels must be removed or the protruding ends of the dowels must be cut off flush with the side face of the cap.

6. Install the lower main bearings and bearing caps, and torque the cap screws or stud nuts to the amount specified in "SPECIFICATIONS" in Section 1. Do not lock the bearing caps, because it is necessary to check the clearance between the crankshaft journals and the main

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4. INSTALLATION - Continued

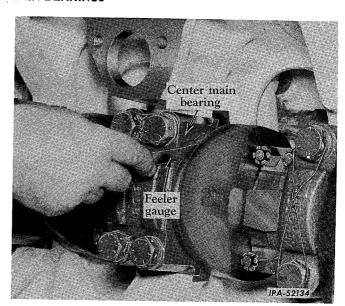
bearings, using virgin lead wire as described below.

NOTE: The number that is stamped on each main bearing cap (to identify its location) must be toward the camshaft side of the crankcase when installed.

- 7. 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 the correct cap is located on its rod and that the identifying numbers are on the same side. Oil the bearings with clean engine oil. Torque the connecting rod stud nuts as specified in "SPECIFICA-TIONS" in Section 1.
- 8. Install new oil-soaked felts in the upper and lower rear oil seal retainers. The new felts must 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. Shellac a new oil retainer seal gasket to the crankcase.

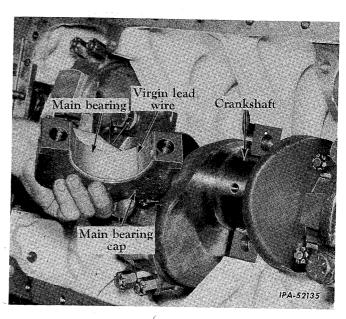
NOTE: Late model engines are equipped with split crankshaft rear oil seals of synthetic rubber and gray iron oil seal retainers. When the seal is bottomed in the retainer, the total height variation between the seal ends must not exceed .030 inch. The oil return groove on the crankshaft has been eliminated. 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 seal after installation. Fill groove of seal with grease before assembling on crankshaft.

- 9. Attach the upper and lower seal retainer and seal assemblies as follows:
- (a) Apply Permatex No. 3 liquid sealer to the bottom, top and mounting face surfaces of the lower seal retainer. Also th the rear of the crankcase at the "horseshoe" gasket mounting surface.
- (b) Install the "horseshoe" shaped gasket to the crankcase, aligning the retainer mounting holes. Place the lower seal retainer in position on the case, inserting bolts by hand just to hold the retainer in position. Trim the "horseshoe" gasket off flush with the bottom of the crankcase.
- (c) Place the two center gaskets in position on the lower seal retainer.



Illust. 7 - Checking the End Clearance of the Crankshaft.

- (d) Apply Permatex No. 3 to the gasket surface of the seal retainer plate and sparingly brush (national) dual purpose sealer at each end of the seal retainer plate to the rear of the neoprene plug opening only (A, Illust. 5).
- (e) Install the retainer plate gasket and retainer plate to the lower seal retainer and crankcase, tightening the mounting bolts by hand only. Pull the plate up tight to the crankcase with the bolt at each end of the plate only.



Illust. 8 - Checking Main Bearing Clearance.





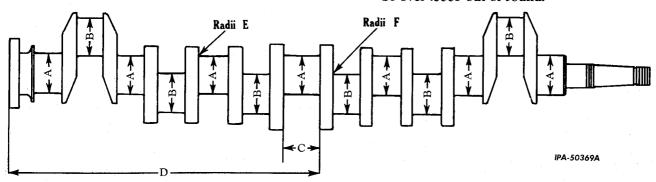
- (f) Apply Permatex No. 3 to the lower and crankcase mounting surfaces of the upper seal retainer and install the two bolts to hold it to the lower seal retainer by hand only. Tighten the bolts securing the lower seal retainer to the crankcase just enough to put slight compression on the lock washers.
- (g) Now adjust the two center gaskets to be against the "horseshoe" gasket.
- (h) Hold the upper seal retainer flat against the case and tighten the two bolts holding the retainer halves together just enough to put slight compression on the lock washers.
- (i) Insert the upper seal retainer-to-case bolts, just enough to put slight compression on the lock washers. Tighten the seal retainer plateto-lower seal retainer bolts just enough to put slight compression on the lock washers.
- (j) Tighten bolts to approximately 30 ft-lbs in the following order: (1) upper seal retainer to lower seal retainer, (2) upper and lower seal retainer halves-to-crankcase and (3) seal retainer plate-to-lower seal retainer.
- (k) The neoprene plug must be assembled with the rounded corner in the hole and flush with, or slightly above, seal retainer plate and crankcase surface. Plug must not be assembled by a method which squashes the plug cover hole thus preventing the oil pan to pull up flat against gasket and case.
- (1) Remove the two bolts securing the seal retainer plate to the bottom of the crankcase.
- 10. Install the rear engine support to the crankcase. Install the flywheel, and bend the locks over the retaining cap screws. (Refer to "FLYWHEEL" in this Section.
- 11. 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. 7. Should the clearance present be less than the amount specified, remove the center main bearing and rub off material evenly from the flange surface. Should the clearance be more than specified, replace the center main bearing with a new one.
- 12. Remove the center main bearing cap and the lower bearing, and insert a suitable length of .015 inch virgin lead wire across the bearing surface of the lower bearing and the crankshaft journal (Illust. 8). Install the bearing cap and torque to the amount specified in "SPECI-FICATIONS" in Section 1. Remove the bearing cap, and carefully remove the wire which will have been crushed to the amount of clearance

- present. Measure the wire, using a micrometer. The clearance desired is given in "SPECIFICATIONS" in Section 1. If the crankshaft, bearings and crankcase are in good condition, these tolerances should permit the reading obtained with the micrometer to fall within the specified clearance. Should the clearance obtained be more or less than the specified amount, replace the bearing with new. Should the clearance remain excessive, it may be necessary to grind the crankshaft and install a bearing service package for the ground crankshaft. Bearings are available in .002", .010", .020" and .030" undersize. Illustration 9 and 10 show 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 or cap screws to the amount specified, and lock with cotter pins or lock wire.
- 13. Continue checking the other main bearings in the same manner. Check the rear main next, followed by the front main and then the intermediates.
- 14. Attach the dust seal and gasket to the retainer plate and rear engine support.
- 15. Install the crankcase front cover. (Refer to Section 6, "TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT.") Be sure that timing gears line up properly.
- 16. Install the engine balancer (if equipped), oil pump and crankcase oil pan. Refer to Section 4, "OIL PUMP, LUBRICATING OIL FIL-TERS AND ENGINE BALANCER."
- 17. Fill the crankcase with lubricating oil as specified in the latest Service Bulletin on "Crankcase Lubricating Oils."
- 18. Install an oil inlet filter into the turbocharger (on units so equipped) for the first 25 hours of operation. (Refer to Section 10A.) Be sure to remove this filter after the 25 hours have elapsed.
- 19. Check the water level in the cooling system and start the engine. Observe the engine oil pressure and the engine operating temperature. Run the engine under light load for a period of five hours. At the end of this short run-in period, drain the oil while the engine is hot. Inspect and replace the oil filter elements if necessary. Then refill with oil as specified in the operator's manual. This procedure will shorten the period required for complete runin of the new parts.



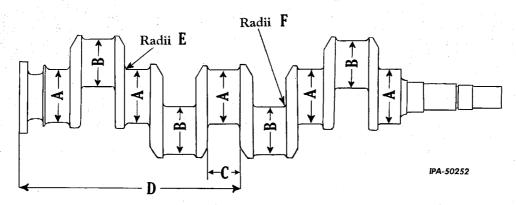
4. INSTALLATION - Continued

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 (18 Series).

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. 10 - Limits for .030 Inch Undersize Crankshaft (14 Series).

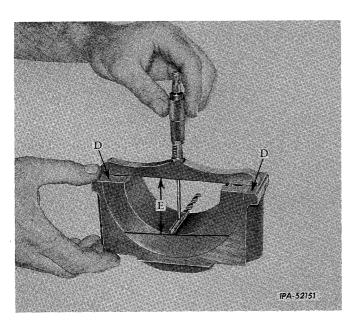
Engine Model	Α	В	С	D	E-All Main Bearings	F-All Crank Pin Bearings
14 & 14A	3.2175-3.2185	3.2175-3.2185	2.382-2.384	19.177-19.197	.150165	.110130
18 & 18A	3.4675-3.4685	3.2175-3.2185	3.140-3.142	26.177-26.197	. 240 255	.240255



5. FITTING CRANKSHAFT BEARING CAPS (MACHINE METHOD)

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.

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. 11).



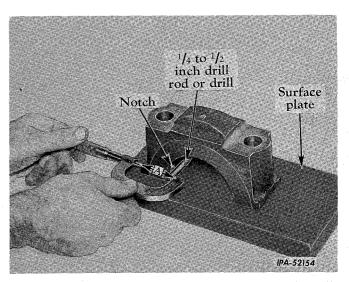
Illust. 11 - Measuring Dimension "E".

- 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. 11), and record the reading.
- 2. Mill or grind surface "D" (Illust, 11) of the new cap to dimension "E" plus .002 inch.

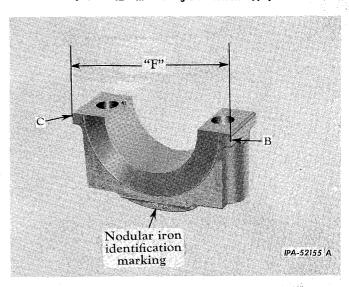
NOTE: .002 inch is added to dimension "E" to allow enough stock for a finish cut on surface "D" after the cap and bearing have been fitted to the crankcase.

IMPORTANT: 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. 12 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. 13) of the new cap. Dimension "A" of both caps will now be equal.



Illust. 12 - Measuring Dimension "A".



Illust. 13 - Bearing Cap Finish Length.

5. FITTING CRANKSHAFT BEARING CAPS (MACHINE METHOD) - Continued

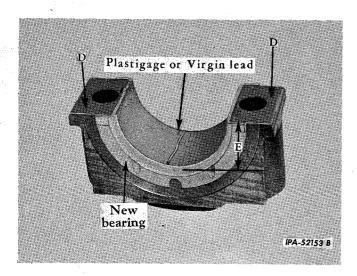
IMPORTANT: Surface "C" must be held square with surface "D" and parallel to the bearing bore.

7. Mill or grind surface "B" (Illust. 13) of the new cap until the dimension "F" shown from surface "C" to "B" in Illust. 13 is obtained. Dimension "F" should be 6.125 to 6.126 for the 14 series and 6.312 to 6.313 for the 18 series.

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

Obtaining Finish Dimension "E" with Virgin Lead

- 8. Install a new bearing in the new bearing cap. Place a length of virgin lead at each end of the bearing (Illust. 14).
- 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.
- 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 reading.



Illust. 14 - Position of Virgin Lead for Obtaining Finish Dimension "E".

12. Subtract the bearing running clearance, which is .0024 to .0054 inch for 14 series en-

gines or .0036 to .0066 for 18 series engines, from the measurement obtained in step 11. Mill or grind this amount from surface "D" of the new bearing cap.

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

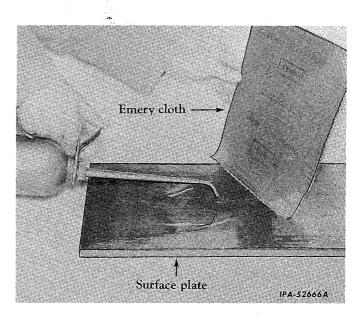
13. Recheck the bearing running clearance with virgin lead. The correct clearance is .0024 to .0054 inch for 14 series engines, and .0036 to .0066 for 18 series engines.

6. 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. 11) 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. 11), or any similar depth gauge 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" (Illust. 11).

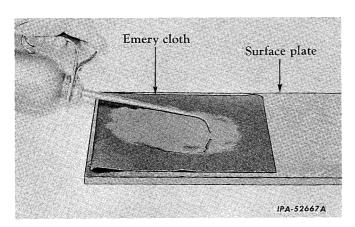


Illust, 15- Oiling Surface Plate.

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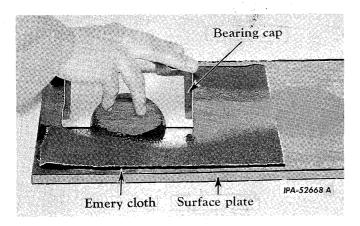


- 3. To remove stock from surface "D" quickly and accurately use a smooth metal or glass surface plate, extra coarse emery cloth (No. 430 grit) and heavy duty engine oil.
- 4. Oil the surface of the plate (Illust. 15) to keep the emery cloth from wrinkling and sliding.
- 5. Oil the emery cloth (Illust. 16) 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.)



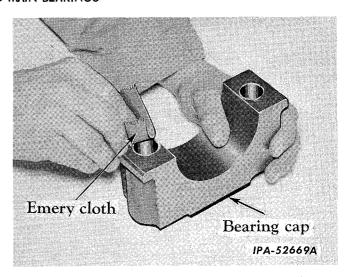
Illust. 16- Oiling Emery Cloth.

6. Place the bearing cap on the emery cloth and with hand pressure, move the cap back and forth (Illust. 17). Turn the cap after every 50 strokes to equalize the cutting width of surface "D."



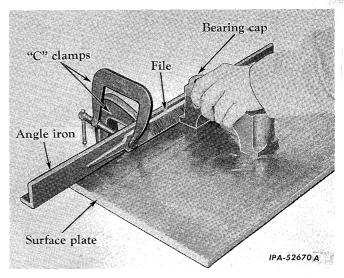
Illust. 17- Working Surface "D"

7. With a fine file or fine emery cloth, remove the slight high spot immediately around the holes of the bearing cap (Illust. 18). (Usually about .0005 inch.)



Illust. 18 - Removing High Spots.

- 8. Clamp the old bearing cap to a surface plate.
- 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, 12 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.



Illust. 19- Working Surface "B" and "C."

6. FITTING CRANKSHAFT BEARING CAPS (Hand Method)-Continued

- 12. Clamp an angle iron to the surface plate, then clamp a file to the angle iron (Illust. 19).
- 13. File from surface "C" (Illust. 13) of the new cap. Dimension "A" of the new and old caps will now be equal.

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

14. File surface "B" (Illust. 13) of the new cap until the dimension "F," (6.125 to 6.126 for the 14 series, and 6.312 to 6.313 for the 18 series) shown from surface "C" to "B" in Illust. 13, is obtained.

- IMPORTANT: 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 (Illust. 14) 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 with a micrometer.

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

7. DESCRIPTION

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

It 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 flywheel installation in any order position with regard to its balanced point. The cranking motor drive ring gear is a shrink fit and is replaceable.

On 18 series engines, the flywheel has a "1-6 DC" mark on its forward face near the rim. A pointer is provided on the rear engine support (flywheel housing on power units) and enables the mark to be set so, when in line with the pointer, the number one or six cylinder piston is at top-dead-center. On power unit applications a small aperture on the forward side of the flywheel housing, having a removable coverplate, permits the serviceman to observe the rim of the flywheel and the flywheel markings.

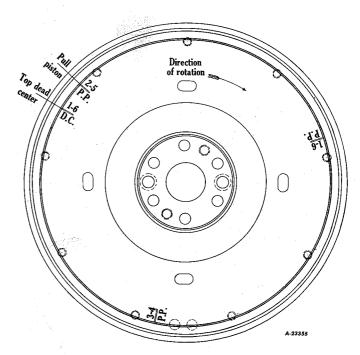
The 18 series engine, in addition to the "1-6 DC" mark, carries "PP" (pull piston) marks on its flywheel rim. (Illust. 20).

These markings are numbered "1-6", "2-5"

PP

and "3-4" and are used when the pistons are PP

to be removed. When one of these marks is in line with the pointer on the rear engine support or flywheel housing, the crankshaft is in the correct position for the removal of both the pistons.



Illust. 20 - Showing "PP" (Pull Piston) Marks on Flywheel (18 Series).

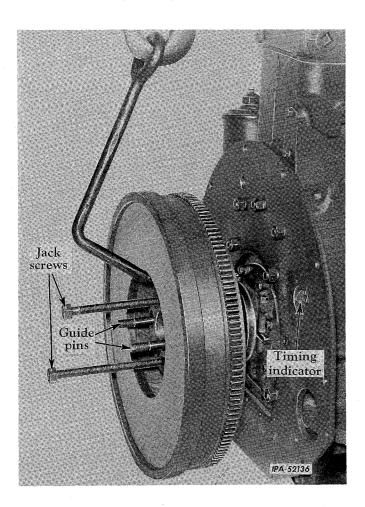


FLYWHEEL

8. REMOVAL

Crawler Tractors Only - If the engine is in a tractor, remove the engine clutch. (Refer to Chassis Manual, Form No. ISS-1033.) Measure the diameter of the flywheel and the diameter of the opening in the main frame. If the flywheel is larger than the opening in the main frame it will be necessary to remove the engine from the tractor chassis before the flywheel can be removed. (Refer to Chassis Manual, Form No. ISS-1033.)

- 1. Bend back the locks from the flywheel bolt heads and remove the bolts and locks.
- 2. Attach a hoist to the flywheel. Insert two jack screws into the tapped puller holes in the flywheel. Also install two guide pins. These can be made from old cylinder head studs. (Refer to Illust. 21).

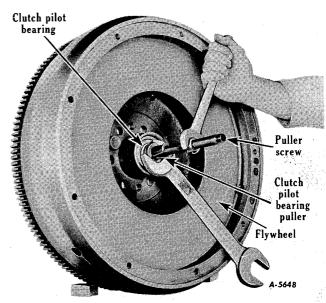


Illust. 21 - Removing Flywheel (18 Series).

3. Tighten the jack screws evenly until the flywheel has been pulled from the crankshaft. Lift the flywheel with the hoist and slide it off the guide pins.

9. INSPECTION AND REPAIR

- 1. Wash the flywheel and ring gear in drycleaning solvent.
- 2. Inspect the contact face of 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. Inspect the ring gear for broken teeth and replace the ring gear if necessary.



Illust. 22 - Removing Clutch Pilot Bearing.

- 3. Remove the ring gear from the flywheel either by heating the gear with a torch to expand it, following that operation by driving it from the flywheel, or the ring gear may be driven 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 front of the engine.
- 5. Remove the pilot bearing from the flywheel. (Illust, 22.) 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.

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FLYWHEEL

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. Tighten the bolts evenly, so the flywheel is drawn onto the crankshaft flange evenly.
- 3. Drive the two dowel pins into place and tighten the flywheel bolts to the torque specified in "SPECIFICATIONS" in Section 1. Bend the locks over the bolt heads.
- 4. Install and lubricate the clutch pilot bearing.
- 5. Install the engine clutch. (Refer to Chassis Manual, Form No. ISS-1033.)

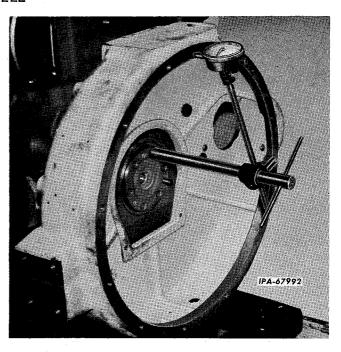
NOTE: If the engine was removed from the tractor, install the engine before installing the engine clutch. (Refer to Chassis Manual, Form No. ISS-1033.)

11. INSTALLING A NEW FLYWHEEL HOUSING (POWER UNITS ONLY)

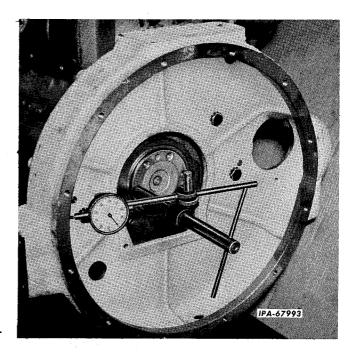
When installing a new flywheel housing, the flywheel housing bore and face must be checked for concentricity and run-out in relation to the axis of the crankshaft. Misalignment between the flywheel housing and engine will cause corresponding misalignment of the clutch, power take-off and transmission (if equipped) resulting in serious damage. The dowel pins between the crankcase and flywheel housing are for the purpose of maintaining this alignment (within tolerances) once the flywheel is mounted.

CAUTION: The mating surfaces of the crankcase and flywheel 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.

Install the housing to the engine using the existing dowels. Check the flange concentricity and run-out tolerances as described under "Checking Flywheel Housing Face Run-Out" and "Checking Flywheel Housing Bore Concentricity." If not within these tolerances, remove the housing and continue as follows:



Illust. 23 - Checking Flywheel Housing Face Run-out.



Illust. 24 - Checking Flywheel Housing Bore Concentricity.



FLYWHEEL

Page 13

- (a) Remove the dowels from the crankcase.
- (b) Assemble housing to crankcase. Do not tighten bolts to full torque; only enough to snug position for housing adjustment.
- (c) Position the housing until it meets the tolerances described under "Checking Flywheel Housing Face Run-out" and "Checking Flywheel Housing Bore Concentricity."
- (d) Tighten all bolts to full torque.
- (e) Recheck tolerances and reposition housing, if necessary.
- (f) Ream dowel holes for oversize dowels and install the dowels.

Checking Flywheel Housing Face Run-out

Attach a dial indicator to the crankshaft flange placing the indicator pointer against the fly-

wheel housing face as shown in Illust. 23. Remove crankshaft "end-play" and take a minimum of four checks approximately 90 degrees apart for total face variation. Care must be taken to keep crankshaft "end-play" at zero in the same direction for all readings. For flywheel housings on 14A Series engines, the face run-out should not deviate more than .008 inch total indicator reading. On 18A Series engines the face run-out should not deviate more than .010 inch total indicator reading.

Checking Flywheel Housing Bore Concentricity

Attach a dial indicator to the crankshaft placing the indicator pointer against the flywheel housing bore as shown in Illust. 24. Rotate the crankshaft slowly and note any variations on the gauge. The reading should not vary more than .008 inch total indicator reading in 14A Series engines (.010 inch on 18A series engines).





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 one to three 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 (Refer to Illust. 1)

For removal of the starting valve shaft, the starting valve operating shaft, and the starting valves, refer to Section 2, "MANIFOLDS, CYL-INDER HEAD AND VALVES."

Remove the cross shaft as follows:

- 1. Remove the carburetor. (Refer to Section 10, "CARBURETOR.")
- 2. Remove the compression release rod adjusting block from the operating lever (1).
- 3. Remove the pin (2) from the operating lever, and remove the lever from the shaft (10).

- 4. Remove the governor control rod (7) after removing the cotter pin and flat washers.
- 5. Disconnect the throttle control lever at the governor control lever (6) by removing a cotter pin, washer and clevis pin.
- 6. Remove two cap screws in the cross shaft bracket (3), together with the governor control lever (6).
- 7. Moving over to the right side of the engine, remove the spring (11) from the stud on the crankcase and the cross shaft jaw (23).
- 8. Disconnect the yoke at the lower end of the rod (14) from the jaw. Slide the shaft with jaw lever (22) out of the crankcase.
- 9. Remove the cross shaft latch pin (19), spring (18) and cross shaft latch (17).
- 10. Remove the nut from the stud in the crankcase which holds latch bracket (16) to the crankcase, and remove the bracket. Disconnect the carburetor control rod (24).

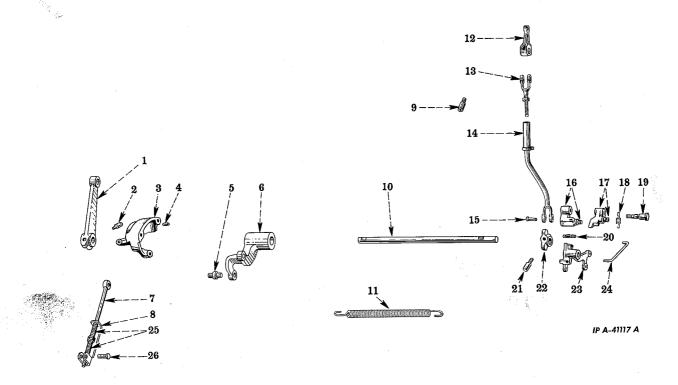
3. INSPECTION AND REPAIR

- 1. Clean all parts thoroughly with solvent, and dry them with compressed air.
- 2. If any parts show wear to the extent that the latches or jaws will not hold, replace them with new parts.
- 3. Do not remove the set screws unless the part in which they are located must be replaced.
- 4. The cross shaft rotates in two bushings in the crankcase. It will not be necessary to remove them unless replacement is necessary.

4. INSTALLATION (Refer to Illust. 1)

- 1. Install the cross shaft (10) through the crankcase. The cross shaft assembly should be packed with a good high-melting-point (HT) grease (MIL-L-3545). Ordinary greases will run out at high operating temperatures.
- 2. Install the latch bracket (16) to the crank-case using the nut to secure it to the stud. Connect the carburetor control rod (24).
- 3. Install the cross shaft latch (17), spring (18), and cross shaft latch pin (19).





Illust. 1 - Exploded View of Compression Release Mechanism.

- 1. Cross shaft operating lever.
- 2. Lever pin.
- 3. Cross shaft bracket.
- 4. Locating pin.
- 5. Lever pin.
- 6. Governor control lever.
- 7. Governor control rod.
- 8. Governor control rod trunnion.
- 9. Lever pin, outer.
- 10. Control cross shaft.
- 11. Return spring.
- 12. Operating lever, outer.
- 13. Operating rod, upper.
 - 4. INSTALLATION (Refer to Illust. 1) Continued
 - 4. Install the jaw lever (22). Connect the yoke at the lower end of the rod (14) to the jaw.
 - 5. Install the return spring (11) on the stud in the crankcase and cross shaft jaw (23).
 - 6. Install the governor control lever (6) and the cross shaft lever bracket (3) to its position on the left side of the engine.
 - 7. Connect the throttle control lever at the governor control lever (6) and secure with the clevis pin, washer and cotter pin.

- 14. Starting valve operating rod.
- 15. Operating rod pin.
- 16. Latch bracket.
- 17. Cross shaft.
- 18. Cross shaft latch spring.
- 19. Cross shaft latch pin.
- 20. Set screw.
- 21. Jaw lever pin.
- 22. Jaw lever.
- 23. Cross shaft jaw.
- 24. Carburetor control rod.
- 25. Control rod spring.
- 26. Control rod pin.
- 8. Install the governor control rod (7) and secure with flat washer and cotter pin.
- 9. Install the cross shaft operating lever (1) to the control cross shaft (10). Secure with the lever pin (2).
- 10. Install the compression release rod to the cross shaft operating lever (1).
- 11. Adjust the compression release mechanism. (Refer to par. 5.)

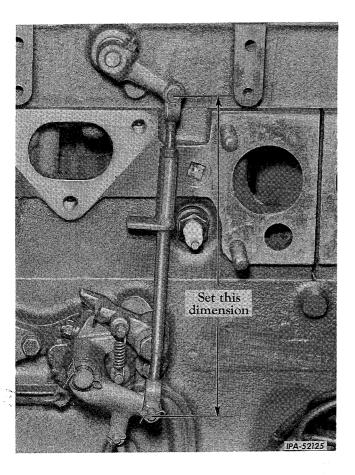


5. ADJUSTMENT

14 and 18 Series Engines

NOTE: Before the following adjustments are made, the engine should be completely assembled with the exception of the intake and exhaust manifolds and the valve housing cover. Set the controls in diesel position.

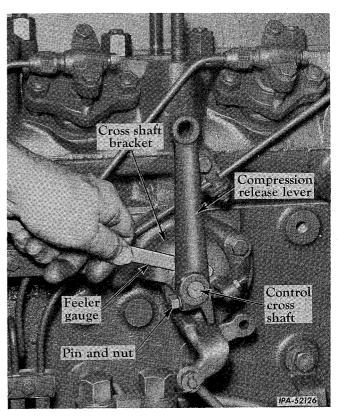
1. Disconnect the operating rod, and adjust its length to 9-7/16 inches, measured between the centers of the pin holes. (Illust. 2.)



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. 18 SERIES ONLY: Remove the valve housing, rocker arm assembly, and starting valve shaft assembly. Measure the height of the starting valve spring retainer to determine

if height is .240 to .250 inch from milled surface of the cylinder head to the top of the spring retainer. To obtain this height, remove the cotter pin and adjust the spring retainer. All six retainers should be checked. When settings have been obtained, lock the nut with a cotter pin, and install the valve housing, rocker arm and starting valve assemblies. Intake and exhaust valves should be checked for the specified cold clearance. (Refer to "SPECIFICATIONS," in Section 1.)



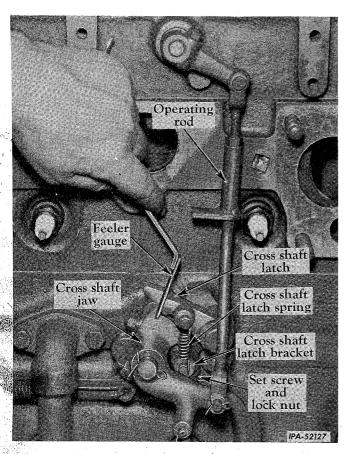
Illust. 3 - Checking and Adjusting Cross Shaft End Play.

- 4. Back off on the adjusting screws of the cross shaft latch bracket, the cross shaft jaw, and the cross shaft bracket. Set the adjusting screw in the cross shaft latch bracket to obtain .060 inch feeler gauge clearance between the cross shaft latch lever and the jaw. (Illust. 4.)
- 5. 14 SERIES ONLY: Adjust the yoke of the release operating rod until the minimum clearance between the starting valve shaft roller and the starting valve cover (spring retainer) is .060 inch over the closest valve and .080 inch maximum on other valves. All valves must be checked. The operating rod must be connected and adjusted as previously described. Lock the clevis when adjustment has been made.



5. ADJUSTMENT - Continued

14 and 18 Series Engines - Continued

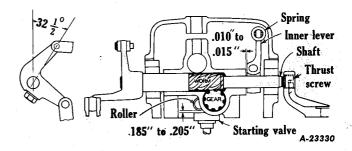


Illust. 4 - Checking and Adjusting Clearance Between Cross Shaft Latch and Cross Shaft Jaw.

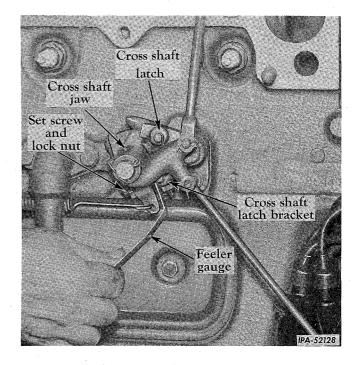
6. 14 SERIES ONLY: Turn the cross shaft counterclockwise with the release lever until the pick-up faces on the cross shaft jaw and on the cross shaft jaw lever are contacting. Then adjust the set screw on the cross shaft bracket to give a clearance of .100 inch between the screw and the cross shaft operating lever. Lock the nuts and recheck the clearances.

7. 18 SERIES ONLY: (Illust. 5.) Loosen the cross shaft inner lever on the starting valve cross shaft. Adjust the clearance to .185 inch between the starting valve shaft cam roller and the valve cover (starting valve spring retainer). This must be measured at the closest of the valves. Adjust by moving the starting valve cross shaft end-wise with the adjusting cross shaft thrust screw. All play must be removed from the assembly. This includes the backlash between the starting valve cross shaft gear and the gear on the starting valve cam; also the end play on the starting cross shaft. The play can be taken out by holding back the starting

valve cam roller when checking clearance. Clearance at all of the spring retainers must be checked to be sure that none is less than .185 inch. Lock the retainers with a cotter pin and nut.



Illust. 5 - Cross Section of Starting Mechanism Cross Shaft (Early 18 Series).



Illust. 6 - Checking and Adjusting Clearance Between Set Screw in Cross Shaft Jaw and Latch Bracket.

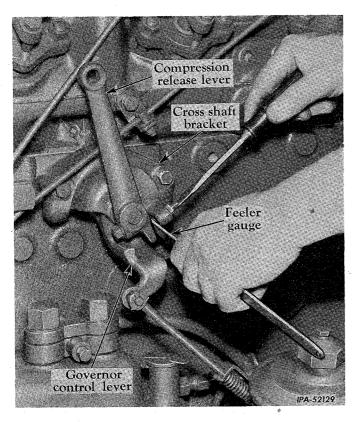
8. A SERIES ONLY: Turn the cross shaft clockwise, viewed from injection pump side, until the release lever can be locked in place in the gasoline position behind the front catch on the cross shaft jaw. Adjust the set screw in the lever to give .015 inch clearance measured between the end of the screw and the stop on the cross shaft latch bracket. Lock the nut and recheck for clearance. (Illust. 6.)

9. 18 SERIES ONLY: With the starting valve cross shaft held against the shaft end thrust



screw, locate the inner lever to obtain .015 inch end play. Lock the lever in this position and recheck the clearance. (Illust. 6.)

10. 18 SERIES ONLY: Turn the cross shaft operating lever clockwise until the pick-up faces of the cross shaft jaw and cross shaft jaw lever are contacting. Set the adjusting screw on the cross shaft bracket to obtain .100 inch clearance between the adjusting screw and the operating lever at the adjusting screw. Lock the screw with nut and recheck for exact clearance. (Illust. 7.)

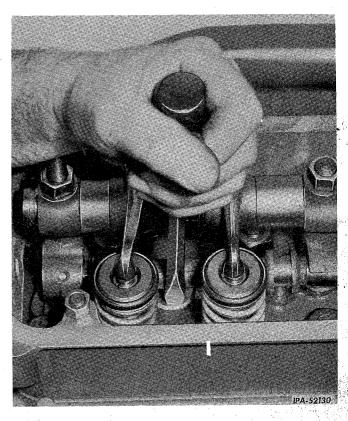


Illust. 7 - Checking and Adjusting Clearance Between Cross Shaft Release Lever and Cross Shaft Bracket Set Screw.

11. 18 SERIES ONLY: Turn the cross shaft release lever clockwise until the cross shaft latch lever locks with the cross shaft jaw. The control is now latched in the gasoline position. Set the adjusting screw in the cross shaft jaw to obtain .015 inch clearance between the adjusting screw and the cross shaft latch bracket. Lock the adjusting screw and recheck the clearance. (Illust. 6.)

IMPORTANT: After all adjustment have been made and with the controls in the gasoline position, each starting valve must be checked for an additional travel before it bottoms in the cylinder head. Check by pressing down on each

starting valve cover (spring retainer) with a screwdriver. If this check shows no travel, the controls should be rechecked for error in adjustments. (Illust. 8.)



Illust. 8 - Checking Starting Valve Cover Travel.

12. With all adjustments made, place the controls in the diesel position and install the intake and exhaust manifolds. Connect the link between the release lever and the carburetor.

NOTE: The butterfly valves in the intake manifold must be in a horizontal position. This can be adjusted by the set screws provided and should not be altered afterward. The butterfly valves should fit with a maximum clearance of .0015 inch measured with a feeler gauge not more than 1/8 inch wide.

14A and 18A Series Engines

NOTE: Before the following adjustments are made, the engine should be completely assembled with the exception of the intake and exhaust manifolds. The mechanism should be clean and lubricated.

5. ADJUSTMENT - Continued

14A and 18A Series Engines - Continued

- 13. Adjust the cross shaft operating rod to a distance of 9-7/16 inches, measured from the centers of the pin holes. (Illust. 2.)
- 14. Adjust the cross shaft to have an end clearance of .030 inch, measured between the release lever and the cross shaft bracket. (Illust. 3.) Obtain this play by loosening the nuts on the levers at each end of the cross shaft. Tighten the nuts when the end play has been obtained, and recheck the clearance.
- 15. Back off the adjusting screw located in the cross shaft latch bracket, the cross shaft jaw and the cross shaft bracket. (Illust. 4.)
- 16. Adjust the set screw in the cross shaft latch bracket to obtain a clearance of .060 inch, measured between the latch lever and the jaw. (Illust. 4.) Lock the nut and recheck the clearance.
- 17. Turn the cross shaft release lever clockwise until the pick-up faces on the cross shaft jaw and on the cross shaft jaw lever are contacting. Adjust the screw in the cross shaft bracket to obtain .100 inch clearance between the set screw and the cross shaft operating lever. (Illust. 7.) Lock the nut and recheck the clearance.
- 18. Turn the release lever until the cross shaft latch locks in place on the cross shaft jaw. The controls are now set in the gasoline position.
- 19. With controls in gasoline position, increase the length of the operating rod (Illust. 2) 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. After each half-turn, check all starting valve covers by applying pressure with a screwdriver to the top of the covers, as shown in Illust. 8, to determine which one has the least amount of additional travel. When this adjustment has been made, lock the yoke of the operating rod with the nut and insert cotter pins in the pin ends.
- 20. Adjust the set screw in the cross shaft jaw to obtain .015 inch clearance between the set screw and the stop on the bracket. (Illust. 6.) Lock the set screw nut and recheck the clearance.
- 21. Trip the controls to the diesel position by moving the lever to the left. In this position, check to determine that there is clearance between the starting valve shaft and the starting valve cover. Check all covers.
- IMPORTANT: After all adjustments have been made, move the controls to the gasoline position and check to determine that the starting valve covers have a slight additional travel before bottoming in the cylinder head. Press down on the covers, using a screwdriver. If the check shows no travel, recheck the control settings for errors.
- 22. Check the butterfly valves in the intake manifold to be certain that they are in an exactly horizontal position. Adjust with the set screws if necessary. Under no conditions should this adjustment be altered after once being set. Valves must operate freely and should have a maximum clearance of not more than .0015 inch when seated fully in the manifold bore, measured with a feeler gauge 1/8 inch wide.
- 23. Install the intake and exhaust manifolds, the valve cover, and the link between the carburetor and the lever. Latch and unlatch the release mechanism to check its function and that all adjustments made are holding satisfactorily.



POWER UNITS

1. DESCRIPTION

The governor speed control is a separate unit attached to the flywheel housing or, on some power units, to the rear hood sheet. Two types are used: one 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 (Illust, 2,)

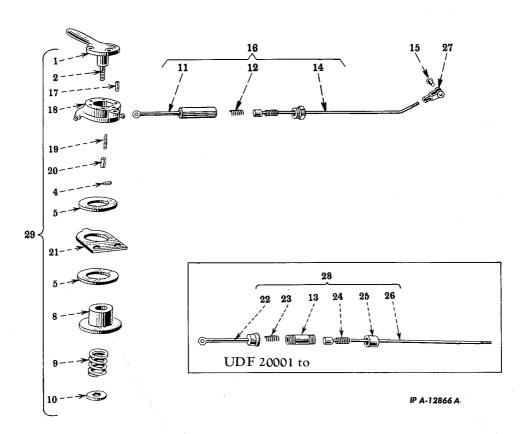
2. REMOVAL (Refer to Illust. 1)

1. Disconnect the control rod (16) from the governor control body (18).

- 2. Remove the control lever bracket (21) from the flywheel housing, and lift off the governor control lever (29).
- 3. Remove the governor control rod (16). Remove the cotter and yoke pin (15) securing the governor control rod to the governor control lever; then remove the governor control lever.

3. DISASSEMBLY (Refer to Illust. 1)

1. Remove the spring tension nut from the governor control lever stud (2), thus releasing the spring retainer (10). Remove the spring (9), spring cup (8), lower friction disc (5), bracket (21) and upper friction disc (5) from the control body (18).



Illust. 1 - Exploded View of the Governor Control Assembly (For UD-14 A Engines) (UD-18 A Similar).

- l. Lever.
- 2. Spring retainer stud.
- 4. Spring cup drive pin.
- 5. Friction disc.
- 8. Spring cup.
- 9. Friction spring.
- 10. Spring retainer.11. Rod, rear.12. Rod spring.

- 13. Rod spring housing.14. Rod, front.15. Rod yoke pin.

- 16. Control rod with rod and pin17. Rod pin.
- 18. Control body with drive pin.
- 19. Low idle poppet spring.20. Low idle poppet.
- 21. Control bracket.

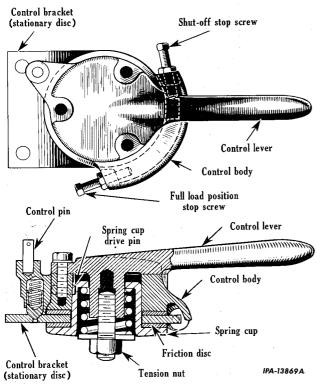
- 22. Control rod, rear.
- 23. Rod spring, rear. 24. Rod spring, front.
- 25. Rod spring housing cap, front. 26. Rod, front with collar. 27. Rod yoke.

- 28. Control rod, complete,
- 29. Control lever, complete.

POWER UNITS

3. DISASSEMBLY (Refer to Illust. 1) - Continued

- 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.
- 4. The control rod pin (17) is a press fit in the control body.



Illust. 2 - Governor Friction Control.

4. INSPECTION AND REPAIR

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

5. REASSEMBLY (Refer to Illust. 1)

- 1. Position the control lever (1) on control body (18) 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 (8) on a flat surface, place a friction disc (5), over the cup end; then add control bracket (21) and add another friction disc (5) 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 (9) over the control lever stud (2); then add the spring retainer (10), 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 (Refer to Illust. 1)

- 1. Attach the complete governor control lever to the flywheel housing.
- 2. Attach the control rod (16) to the control body (18).
- 3. Attach the front rod (14) to the control lever on the pump with pin (15) and a cotter pin.

TRACTORS

7. DESCRIPTION

Two types of governor controls have been used on the 14 and 18 series engines. Early engines were equipped with the friction disc type. Later engines used the 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 and the other arm is connected to the speed

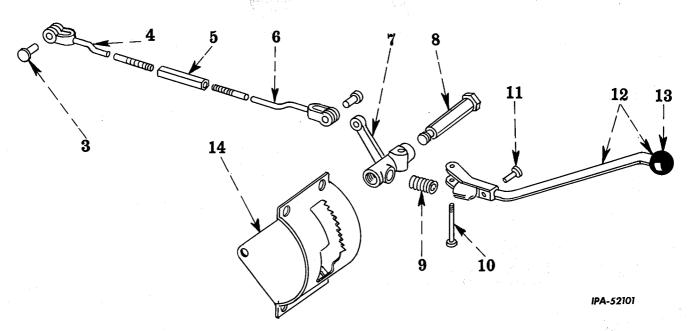
control. The shape of lever "L" is such that it will contact "D," which is connected to the compression release lever, if the throttle is opened while the engine is operating on gasoline. This is a reminder to trip the compression release lever to the diesel cycle before opening the throttle.

Ratchet Lever Type

This type is a vertically moving lever riding in a ratchet bracket mounted to the dash. (Illust. 3.) It is connected to the speed control lever on the fuel injection pump by two rods and a bellcrank. By raising or lowering the hand lever, the speed of the engine may be controlled



TRACTORS



Illust. 3 - Exploded View of Governor Controls (Ratchet Type).

- 3. Yoke pin.
- Rod, front.
- Turnbuckle.
- Rod, rear.

- Hand lever hub.
- 8. Hand lever shaft.
- 9. Hand lever spring.
- 10. Hand lever pin.

- 11. Hand lever pawl
- 12. Hand lever.
- 13. Hand lever ball.14. Ratchet.

under varying loads. Low and high idle adjustments are made at the pump.

8. REMOVAL

Friction Disc Type

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 (Illust. 3)

NOTE: To remove the ratchet control assembly will result in complete disassembly.

Proceed as follows:

1. Disconnect the rod, front (4) by pulling the yoke pin (3). The rod, rear (6) is disconnected in the same manner.

- 2. To remove the hand lever (12), it will be necessary to remove the four cap screws which secures the ratchet (14) to the dash.
- 3. Remove the hand lever shaft (8) by removing the jam nut (not shown) and washer. Remove the hand lever pin (10) and take out the hand lever with pawl (11). The hand lever spring (9) and hub (7) will be free to remove.

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.

Ratchet Lever Type

With the ratchet lever (12) in low idle position, be sure the injection pump speed control lever

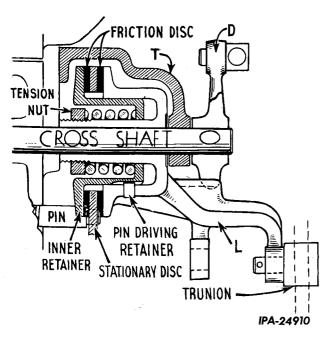


TRACTORS

9. ADJUSTMENT - Continued

Ratchet Lever Type - Continued

adjustment is also in low idle position. Refer to "DIESEL INJECTION PUMP MANUAL," ISS-1003.



Illust. 4 - Cross Section of Governor Control (Friction Disc Type).

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 (Illust. 3)

- 1. Insert the hand lever (12) through the front of the ratchet (14), and install the hub (7) and spring (9) to the lever and secure with the hand lever pin (10).
- 2. Install the hand lever (12) with hub (7) by screwing the nut on the hand lever shaft (8).
- 3. Install the ratchet (14) to the dash and secure it with four screws, washers and nuts.
- 4. Install the front and rear rods (4 and 6) by using the yoke pins (3) to secure them.



1. DESCRIPTION

The starting carburetor 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 models of the 14 series engines, the carburetors are of the adjustable jet type, to facilitate cold weather starting (for operating instructions see "Operator's Manual").

Two models of carburetors are used; the F-8 model is used on 14 series engines, and the C-12 are used on 18 series engines.

All carburetors are equipped with starting shutters which are actuated by choke control levers. Some power units and tractors have the lever mounted directly on the carburetor; others have the lever mounted on or near the instrument panel with connecting linkage to the carburetor.

2. MAINTENANCE

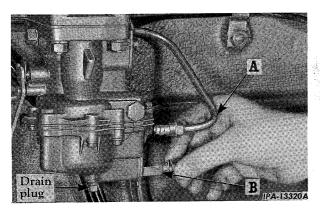
The carburetor must be removed, cleaned, and inspected whenever the following conditions exist:

- (a) Faulty carburetion.
- (b) Engine speed exceeds maximum allowable value as given in "SPECIFICATIONS," in Section 1.

Cleaning Strainer Screen (All Models) (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 "A" at the carburetor.
- 3. Unscrew and remove the strainer screen retainer with screen "B."
- 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.

Drip Hole Filler (Early F-8 Model)

The drip hole filler must be tight in the drip hole. A loose filler may allow foreign material to enter the fuel system.

- 1. Disconnect the drain pipe at the carburetor. Pull the tube out of the adapter; remove the adapter.
- 2. Inspect the filler for tightness in the hole; replace a loose filler.
- 3. Install adapter.
- 4. Secure drain pipe to the carburetor.

Drip Hole Filler (C-12 Model) (Illust. 5)

The drip hole filler must be inspected for tightness in the drip hole and for cleanliness. A loose filler may allow foreign material to enter the fuel system.

- 1. Check the opening in the drip hole filler plug (44, Illust. 3). Clean a clogged hole with a small wire.
- 2. Check the filler plug for tightness in the drip hole; replace a loose filler. To be properly secured, the bottom plate must be staked in four places over the plug (Illust. 5).

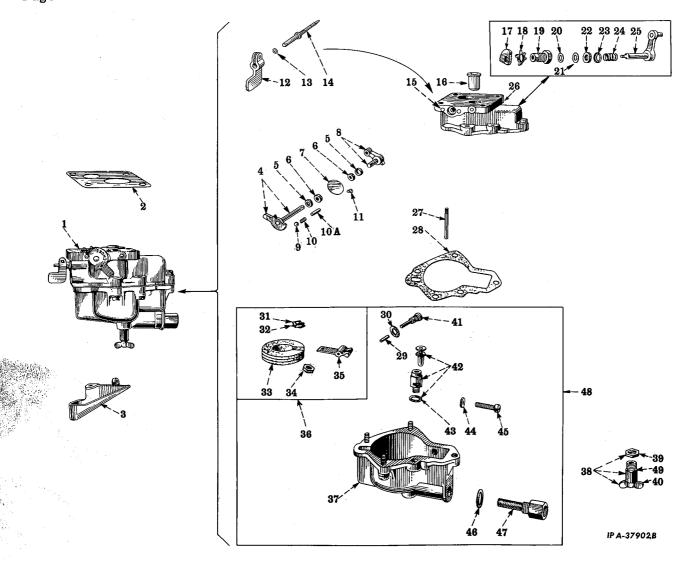
3. REMOVAL (ALL MODELS)

- 1. Turn the valve stem on the gasoline strainer to shut off the gasoline supply.
- 2. Open the drain valve (F-8 model) or remove the plug (C-12 model) underneath the carburetor, and allow all gasoline to drain from the bowl.
- 3. Disconnect the gasoline strainer-to-carburetor tube at the carburetor.

(Continued on page 4)







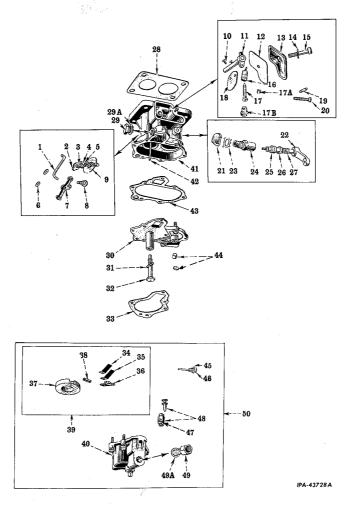
Illust. 2 - Exploded View of Starting Carburetor, Model F-8 (14 Series Engine).

- Carburetor, complete.
 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 w/lever.
- 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.





Illust. 3 - Disassembled View of Model C-12 Carburetor. (18 Series Engine).

1.	Bellcrank connecting rod	18.	Throttle butterfly.	36.	Float lever.
2.	Starting shutter shaft.	19.	Throttle stop pin.	37.	Float assembly.
3.	Packing spring.	20.	Throttle stop screw.	38.	Float lever spacer.
4.	Packing retainer.	21.	Locking shaft cam.	39.	Float and lever assembly.
5.	Dust packing.	22.		40.	Fuel bowl.
6.	Washer.	23.	Bearing lock.	41.	Carburetor body.
7.	Starting lever bellcrank.	24.	Locking shaft bearing.	42.	Idling tube.
8.	Screw.	25.		43.	Bottom plate gasket.
9.	Starting shutter.	26.	Washer retainer.	44.	Drip hole filler.
10.	Butterfly screw.	27.	Dust washer spring.	45.	Pivot screw gasket.
11.	Throttle shaft.	28.	Carburetor gasket.	46.	Float pivot screw.
12.	Cover gasket.	29.	Body plug.	47.	Needle valve cage gasket.
13.	Throttle lever cover.	29A.	Plug gasket.	48.	Needle valve and
14.	Clamp screw gasket.	30.	Carburetor bottom plate.	-	cage assembly.
15.	Clamp screw.	31.	Metering well screw.	49.	Screen and retainer.
16.	Throttle lever spring.	32.	Metering well.	49A.	Screen gasket.
17.	Throttle spring screw.	33.	Fuel bowl gasket.	50.	Fuel bowl assembly.
17A.	Screw lock.	34.	Upper leaf.		
17B.	Screw plug.	35.	Lower leaf.		
	<u> </u>				

3. REMOVAL (ALL MODELS) - Continued

- 4. Move the compression release lever to the starting position. Disconnect the link attached to the locking shaft and lever assembly (25, Illust. 2; or 22, Illust. 3).
- 5. Disconnect the choke control lever linkage from the carburetor at the starting shutter shaft lever (8, Illust. 2; or 2, Illust. 3).
- 6. Remove the nuts and lock washers securing the carburetor to the intake manifold; remove the carburetor and mounting gasket.

4. DISASSEMBLY

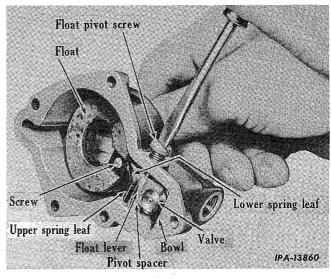
IH Model F-8 Carburetor (Illust. 2)

- 1. Remove the screws and lock washers securing fuel bowl (37) to 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 long shutter shaft (4) with retainer (5) and seal (6), ball (9), and spring (10); remove shutter shaft (8) with retainer (5) and seal (6).
- 5. Remove nut and lock washer securing cam (17) to shaft and lever assembly (25); slide the cam off the shaft. Pull out shaft and lever assembly with spring (24), retainer (23), and washers (22). Unscrew and remove bearing (19).
- 6. Remove pivot screw (41) and spacer (29); remove float assembly (36).
- 7. Remove the needle valve from its cage.
- 8. Remove cage and gasket (43) from the bowl.
- 9. Remove retainer with screen (47) and gasket (46) from the bowl.

IH Model C-12 Carburetor (Illust. 3)

Remove screws securing bowl (40, Illust.
 to body (41); remove the bowl and gasket (33).

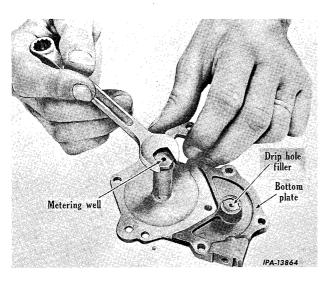
- 2. Remove the cap screws securing the bottom plate (3) to the body (41). Pry off the bottom plate and gasket (43).
- 3. Remove strainer screen and retainer (49) and strainer screen gasket (49A) from the fuel bowl (40).
- 4. Remove float lever pivot screw (46), pivot gasket (45) and spacer (38) from the fuel bowl; remove float assembly (39). Refer to Illust. 4.
- 5. Lift needle valve out of the cage and valve assembly (48); remove needle valve cage and needle valve cage gasket (47) from fuel bowl.
- 6. Remove metering well (32). (Illust. 5.) Be careful not to bend bottom plate (30). Remove metering well gasket (31).
- 7. Remove locking shaft body plug (29) with gasket from carburetor body. Remove the nut and lock washer from locking shaft and lever (22) with a thin open end wrench. Withdraw shaft, together with "O" ring, dust washer (25) washer, dust washer retainer (26), and spring (27). Lift out cam (21). Remove locking shaft bearing (24) and lock (23) from the carburetor body. Refer to Illust. 6.
- 8. File off the ends of the two screws holding starting shutter (9) in place; remove screws, and lift out starting shutter. Withdraw starting shutter shaft (2) together with packing spring (3), and packing retainer (4). Withdraw and discard starting shutter dust packing (5). Remove the short starting shutter shaft from the side of the carburetor body opposite the choke.



Illust. 4 - Removing the Float Assembly.



- 9. Remove stop screw (20). Remove screws (10) holding butterfly (18) to throttle shaft (11); remove the butterfly. Remove spring (16) and spring screw (17); remove throttle shaft.
- 10. Unscrew throttle lever cover clamp screw (15); remove throttle lever cover (13) and gasket (12). Remove idle stop lock screw and throttle stop screw (20). Remove throttle stop pin (19) and throttle spring screw (17); lift out throttle lever spring (16) and throttle spring screw lock (17A). File off ends of two butterfly screws (10) securing throttle butterfly (18) to throttle shaft (11); remove screws, lift out butterfly, and withdraw throttle shaft from carburetor body. (Refer to Illust. 8.)



Illust. 5 - Removing the Metering Well (IH Model C-12 Carburetor).

5. INSPECTION AND REPAIR (ALL MODELS)

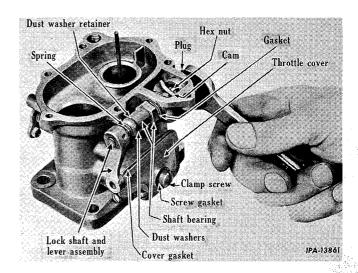
- 1. Clean all metal parts thoroughly with cleaning solvent; dry with compressed air. If gum deposit is present, clean the parts with acetone and blow out with compressed air.
- 2. Inspect the cork float for evidence of deterioration; replace if necessary by assembling a new float to the float lever and spring.
- 3. Inspect the needle valve and cage for wear. If either part is defective, both must be replaced.
- 4. MODEL (C-12) CARBURETOR: Check to see if the drip hole filler is clean and properly secured as described in Par. 2, "MAINTEN-ANCE." The filler plug should not be removed from the bottom plate unless replacement of the filler is necessary.

EARLY F-8 MODEL CARBURETOR: The drip hole filler should be removed and a new one installed. Refer to Par. 2, "MAINTENANCE."

6. REASSEMBLY

IH Model F-8 Carburetor - (Illust. 2)

- 1. Install new gasket (46) and retainer with screen (47) in bowl (37).
- 2. Install new gasket (43) and cage in bowl.



Illust. 6 - Removing the Locking Shaft (IH Model C-12 Carburetor).

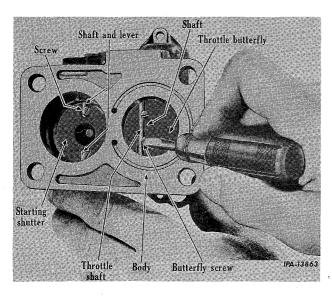
- 3. Place needle valve in its cage; position float assembly (36) and secure with pivot screw (41), spacer (29), and gasket (30).
- 4. Perform leak test as follows: Connect carburetor bowl to a source of gasoline (6-ft. head) as shown in Illust. 10. Be certain bowl drain valve is closed. Slowly open shut-off valve and allow gasoline to flow into the bowl. The needle valve should close and stop flow with the gasoline level between 13/32 and 7/16 inch below top face of fuel bowl. If needle valve does not shut off the flow of gasoline, replace needle valve and cage assembly.
- 5. Hold needle valve against its cage (Illust. 12) 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 correct level.
- 6. With needle valve seated, check height of spring above surface of bowl (Illust. 11). This

6. REASSEMBLY - Continued

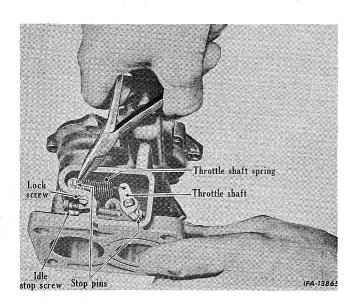
IH Model F-8 Carburetor (Illust. 2) - Continued

height should be 0.234 to 0.312 inch. Replace spring leaves with new parts if measurement does not fall within these limits.

7. Screw bearing (19) and bearing lock (18) into body. Install shaft and lever assembly (25) with spring (24), washer (22), retainer (23) dust washer and "O" ring (20). Install cam (17); secure with lock washer and nut.

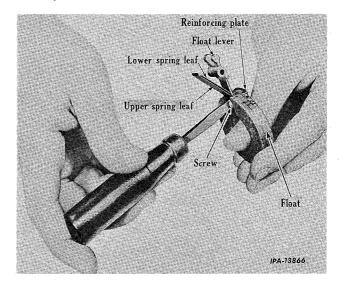


Illust. 7 - Removing the Throttle Butterfly (IH Model C-12 Carburetor).

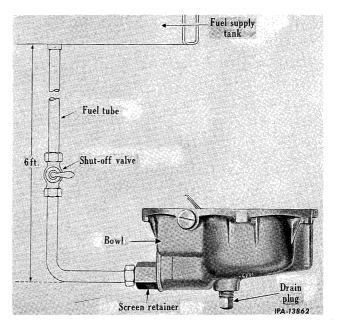


Illust. 8 - Removing the Throttle Shaft Assembly (IH Model C-12 Carburetor).

- 8. Install shutter shaft (8) with retainer (5) and seal (6). Install spring (10), ball (9), and long shutter shaft (4) with retainer (5) and seal (6). Secure shutter (7) to shafts with screws (11).
- 9. Install needle valve (14) and hand lever (12) in body (26). With needle valve on seat, the hand lever should be installed down.
- 10. Install fuel inlet tube (27) in body (26).
- 11. Use new gasket (28) and fasten bowl (37) to body (26) with screws and lock washers.



Illust. 9 - Removing or Attaching the Float Lever and Spring.

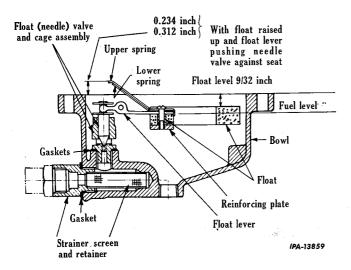


Illust. 10 - Checking the Fuel Level of the Starting Carburetor.



IH Model C-12 Carburetor (Illust. 3)

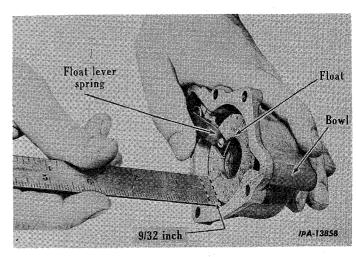
- 1. Install new gasket (49A) and retainer with screen (49) in bowl (40).
- 2. Use new gasket (47) and install cage. Place needle valve in its cage, position float assembly, and secure with float lever pivot screw (46), gasket (45), and spacer (38).
- 3. Perform leak test as described previously for F-8 model carburetor.
- 4. Hold needle valve against its cage, and check the float level. The float must be 1/4 inch below surface of the bowl. If setting is incorrect, bend the float lever slightly to get correct level.
- 5. With needle valve seated, check height of spring above surface of bowl. This height should be 0.234 to 0.312 inch. Replace spring leaves with new parts if measurement does not fall within these limits.



Illust. 11 - Cross Section of Carburetor Bowl and Float Assembly.

6. Insert throttle shaft (11) through carburetor body (41). Place the throttle butterfly (18) on shaft so that the beveled edges completely shut off the air passage when the throttle is closed. Secure the butterfly to shaft with new screws (10). Upset the ends of the screws after installation to lock the butterfly in place. Hook the throttle lever spring (16) into throttle shaft (11) and secure to carburetor body (41) with throttle spring screws (17). Replace throttle stop pin (19), throttle stop screw (20), and throttle stop lock screw. Install throttle lever cover gasket (12) and cover (13); secure with throttle cover clamp screw gasket (14) and clamp screw (15).

7. Insert short starting shutter shaft into carburetor body. Slip packing retainer (4), packing spring (3), and starting shutter dust packing (5) onto the starting shutter shaft (2). Insert shaft part way through the side of the carburetor body. Slide starting shutter (9) through slots in shaft and attach with new starting shutter screws. Upset ends of screws after installation.



Illust. 12 - Checking the Float Level of the Carburetor.

- 8. Install the locking shaft bearing (24) and lock (23) into carburetor body. Slip the dust washer spring (27), retainer (26), and new dust washer (25) over locking shaft and lever (22). Insert shaft into carburetor body. Place cam (21) on the shaft; secure with lock washer and nut. Install the locking shaft body plug (29) and gasket (29A).
- 9. Check to see that the drip hole filler plug is tight in the drip hole. To be properly secured, the bottom plate casting must be staked in four places over the plug.
- 10. Place a new metering well gasket (31) over metering well (32), and install metering well securely into bottom plate.
- 11. Use a new gasket (43) and install bottom plate (30) with screws and lock washers; use a new gasket (33) and secure bowl (40) with screws and lock washers.

7. INSTALLATION (ALL MODELS)

1. Use a new carburetor gasket, and secure the carburetor to the intake manifold studs with washers and nuts. Be sure the drain plug (C-12



Page 8

7. INSTALLATION (ALL MODELS) - Continued

model) or drain valve (F-8 model) is installed and tight.

- 2. Connect adjustable jet linkage. Connect the choke control lever linkage at the starting shutter shaft lever. Be sure full travel of shutter can be obtained.
- 3. With compression release lever in starting position, connect linkage to 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 to open the gasoline supply.
- 6. Operate the engine on gasoline cycle. Use an accurate tachometer and check engine speed (see "SPECIFICATIONS," in Section 1). If the engine is equipped with the C-12 model carburetor, the throttle spring tension or idle stop screw may require adjustment.



1. DESCRIPTION

The T-7 Airesearch turbocharger is designed to increase diesel engine power output by supplying compressed inlet air to the engine. The unit consists essentially of a single stage centrifugal compressor mounted on a common shaft with a single stage radial inflow turbine, a one piece main housing, a turbine housing and a compressor housing.

The turbine wheel which drives the compressor impeller during operations, is driven by engine exhaust gases.

2. GENERAL HANDLING AND MAINTENANCE

General Handling

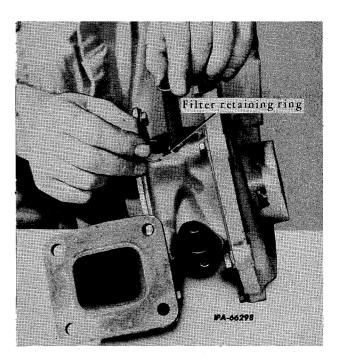
- 1. Cover or plug all openings in the turbocharger when handling to prevent entrance of foreign material.
- 2. After servicing and before installation, prime the lubrication system of the turbocharger by adding clean filtered oil into the oil inlet connection. Rotate the shaft and check for interference of compressor or turbine wheel in the housing.
- 3. All connections to the turbocharger (manifolds and piping) must be clean and free of foreign material since serious damage to the turbocharger or engine could result. All connections must be air tight.
- 4. Install turbocharger support brackets as provided to relieve excess stress on the turbocharger inlet flange and exhaust manifold. Exhaust stacks of extra long length and other fixtures should not be rigidly attached to the turbocharger. If extended stacks are used, they should be supported by the hood. Exhaust stack must be higher than the intake stack.

Maintenance

5. For initial running when installing a new or rebuilt turbocharger or after the engine has been overhauled or put in storage for thirty days or more, or when the filters have been changed, it is recommended that four or five ounces of oil (same type and grade as used in the crankcase) be put into the oil inlet opening in the turbocharger with a squirt can. This will provide sufficient lubrication for the turbocharger bearings until normal engine lubrication is established. Connect the oil inlet line.

6. If the engine oil becomes contaminated by water, the turbocharger must be drained to prevent sludge formation. It is recommended that after an engine overhaul, an oil inlet filter (Illust. 1) be installed and used for the first 5 to 25 hours of operation and then removed.

NOTE: Do not leave this filter in the turbocharger more than 25 hours as this filter can clog with carbon that is normally suspended in the oil of a diesel engine. This clogging will "starve" the turbocharger bearings of oil resulting in premature failure of the turbocharger.



Illust. 1 - Installing Filters

7. It is imperative that the air cleaner be serviced as outlined in the operator's manual because of the oil carryover and power loses that can be incurred with a restricted air cleaner.

NOTE: Air flow requirements for diesel turbocharged engines are considerably greater than for a non-turbocharged engine of the same size running at the same speed. Air inlet accessories such as pre-cleaners must be selected to minimize the restriction at this higher air flow and to maintain performance of the turbocharger unit.

Page 2



2. GENERAL HANDLING AND MAINTENANCE - Continued

Maintenance - Continued

- 8. Engine crankcase breather should be cleaned periodically to assure that there is no restriction.
- 9. During normal operation the turbocharger should be free from vibration or unusual noises.
- 10. It is important to operate the engine at 1/2 throttle (no load) for 3 to 5 minutes before final shut-down after operating under load to allow the turbocharger to cool down. This will aid in heat dissipation of both engine and turbocharger thus minimizing possibility of damage.
- 11. When starting turbocharged diesel engines, do not fully advance the engine speed control lever immediately. Run the engine at part throttle for a few minutes to allow thorough distribution of the lubricating oil. The machine must not be placed under load until normal oil pressure is reached.
- 12. Cap screws, hold down nuts, air connections, and oil connections to and from the turbocharger should be checked for tightness at periodic intervals. Retorque after initial warm-up following assembly of these parts. General condition of hoses and oil lines should be inspected and replaced when necessary.
- 13. Exhaust stack should be covered to prevent water from entering and damaging turbine during shut down periods or when the unit is being transported.
- 14. Periodic inspection of the compressor wheel should be made to check for soft carbon deposits, damaged blading, interference, or excessive end play.
- 15. It is advisable to allow exhaust manifolds to cool before removing from engine. This will prevent warping.

3. REMOVAL

- 1. Remove the bolts and bolt locks securing the exhaust pipe elbow sleeve retainer to the turbocharger.
- 2. Remove the nuts securing the exhaust pipe elbow to the exhaust manifold and remove the elbow, sleeve and sleeve retainer.
- 3. Loosen the clamp and separate the air cleaner-to-compressor housing duct hose at the turbocharger end. Plug or cap all openings to protect against the entrance of dirt.

- 4. Loosen the clamp and separate the compressor housing-to-intake manifold duct hose at the turbocharger end. Plug or cap all openings to protect against the entrance of dirt.
- 5. Disconnect the oil inlet hose and outlet tube at the turbocharger.
- 6. Remove the nuts securing the turbocharger to the exhaust manifold and remove the turbocharger and gasket.
- 7. For information on servicing the Airesearch turbocharger refer to service manual ISS-1047 "Turbochargers for International Diesel Engines."

4. INSTALLATION

- 1. Inspect the air intake system for loose bolts, nuts or any foreign material.
- 2. Inspect the exhaust manifold for fins or projections which may become loose and for pieces of gasket or other foreign material. If any foreign material is evident, either remove the manifold and cleanor, before installing the turbocharger, run the engine to blow out any pieces left in the manifold.
- 3. Inspect the oil drain line to be sure the inside diameter has not been reduced by swelling or that the line is not clogged. Inspect the oil supply line for dirt, clogging or deterioration
- 4. Inspect the turbocharger mounting pad on the manifold for flatness. Be sure that all of the old gasket has been removed.
- 5. Check the oil change period. If the next change period is near, it is recommended that the oil and oil filter element be changed before operating the turbocharger.
- 6. Install the turbocharger onto the exhaust manifold using a new gasket. Apply "NEVER-SEEZE" or a similar compound to the turbocharger and exhaust elbow and studs and install the nuts that secure the turbocharger to the manifold.
- 7. Assemble the exhaust pipe elbow sleeve retainer and sleeve to the turbocharger outlet. Secure the retainer with the bolts and bolt locks. Position the exhaust pipe elbow on the exhaust manifold and secure to the manifold studs.
- 8. Connect the oil outlet tube to the turbocharger. Pour four or five ounces of oil into the oil inlet opening and connect the oil inlet to the turbocharger.



Page 3

NOTE: If the engine was overhauled, install a filter (Illust. 1) for the first 5 to 25 hours of operation and then remove it.

- 9. Connect the air cleaner-to-compressor housing duct hose and secure with the clamps.
- 10. Install the compressor housing-to-intake manifold duct hose and secure with the clamps.
- 11. Operate the engine observing the turbocharger for any of the following:
 - (a) Unusual turbocharger noises.
 - (b) Lubrication leaks.

- (c) Fastening to the engine not secure.
- (d) Excessive vibration.
- (e) Excessive exhaust smoke.
- (f) Air leaks in the air cleaner-to-turbocharger or turbocharger-to-intake manifold ducting.

Investigate and correct any of these conditions immediately to avoid possible turbocharger or engine failure.

12. Retighten the cap screws, hold-down nuts, air connections and oil connections to and from the turbocharger after the initial warm-up.





FUEL TRANSFER PUMP

1. DESCRIPTION

Tuthill And Viking Pumps

The transfer pump draws fuel from the main supply tank and is driven by a V-belt from a pulley attached to the front end of the crankshaft. (Illust. 6.) The following chart gives the approximate fuel pump rpm and fuel delivery.

MODEL	APPROXIMATE FUEL PUMP RPM	GAL PER HR. AT NORMAL TEMP. WITH A 4 FT. VERTICAL SUCTION LIFT
UD-14*	1090	16
UD-14A*	1138	17
UD-18*	1138	16
UD-18A*	1200	35
UD-18A*	× 1600	52

* Equipped with Tuthill or Viking Pump ** Equipped with I.H. Pump.

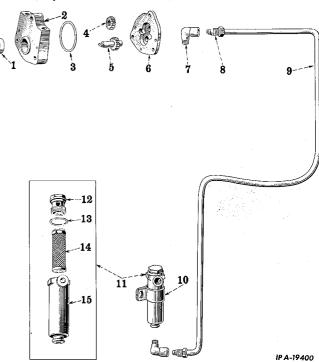
NOTE: It should be remembered that fuel delivery for a given pump speed can vary according to the fuel suction lift and the piping length of the fuel tank installations.

The direction of rotation is stamped on the round portion of the pump housing. Rotation is clockwise as viewed from the front of the engine. The pumping principle (Illust. 2) 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.

IH Transfer Pump

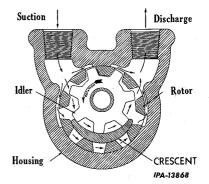
The IH transfer pump is a positive gear type fuel pump which draws fuel from the main supply tank. It is mounted to the front gear case cover. (Illusts. 3 and 5.) The pump is driven by the transfer pump drive housing drive shaft, which is slotted to fit the pump drive gear shaft. Rotation is counterclockwise as viewed from drive end of the pump. A rubber "O" ring is used to provide a tight seal.

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. (Illusts. 6 and 7.)



Illust. 1 - IH Fuel Transfer Pump, Strainer, and Connections.

- 1. Drive shaft oil seal. 9. Fuel strainer to
- 2. Pump body.
- transfer pump tube.
- 3. Gasket.
- 10. Strainer bracket.
- 4. Idler gear.
- 11. Strainer.
- 6. Cover.
- 5. Drive shaft and gear.12. Plug. 13. Gasket.
- 7. Elbow.
- 14. Strainer screen.
- 8. Coupling nut.
- 15. Strainer body.



Illust. 2 - Showing the Pumping Principle.

FUEL TRANSFER PUMP

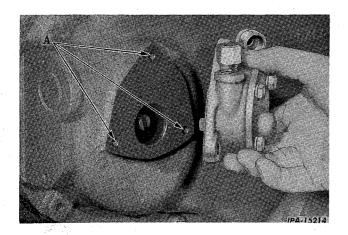
2. REMOVAL

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.
- 3. Disconnect the inlet and outlet fuel pipes from the pump housing.
- 4. Remove the cap screws, nuts, and lock washers which secure the pump support bracket (3, Illust. 4) to the front engine support. (Illusts. 6 and 7.)
- 5. Lift off the pump, complete with support bracket and pulley.
- 6. 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.
- 7. Remove the support bracket from the pump housing by removing two cap screws and lock washers.

IH Transfer Pump (Illusts. 3 and 5)

- 1. Disconnect the fuel lines from the pump housing.
- 2. Remove the cap screws securing the pump to the front gear cover.
- 3. Remove the pump and gasket.



Illust. 3 - Removing the IH Transfer Pump.

3. DISASSEMBLY

Tuthill Transfer Pump (Illust. 4)

- 1. Remove the cap screws holding the front cover (38) to the housing (32). Gasket (37) and idler gear (36) come off with the cover.
- 2. Place the complete pump in a vise with the jaws gripping across the two fuel ports and then remove cap (24) by using the spanner wrench (39). The metal gasket (25) also comes off in this operation. Hold rotor shaft (35) from rotating by placing a wrench across the flat at the drive end of the shaft, and unscrew the seal nut (26).
- 3. Remove carefully with a smoothing stone, any burrs or scratches from the rotor shaft (35) so that removal of the plug assembly (30) will not result in a grooved seat.
- 4. Remove the pump from the vise, and grip the seal nut (26) in the vise, but not too tightly. Then jerk the housing (32) so that the rotor shaft (35) will pull through the seal assembly (41).
- 5. Remove the plug assembly (30) and gasket (31). Then remove the rotor shaft from the cover end of the housing.
- 6. Disassemble the complete seal assembly (41) by unscrewing the seal unit, freeing the spring (27), metal washer (28), and metal lock ring (29).

Viking Transfer Pump (Illust. 4)

- 1. Remove the cap screws holding the front cover (22) to the housing (18). Gasket (21) and idler gear (20) usually come off with the cover (22).
- 2. Place the pump in a vise with the jaws gripping across the two fuel ports, and remove the packing nut (15) with a spanner wrench.
- 3. Remove the ball bearing (16) and the seal assembly (17) from the rotor shaft.
- 4. Remove the rotor shaft (19) from the cover end of the housing (18).

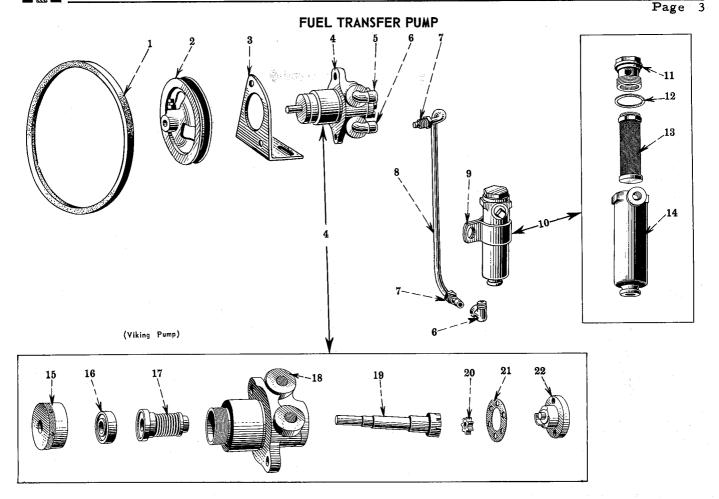
IH Transfer Pump (Illust. 1)

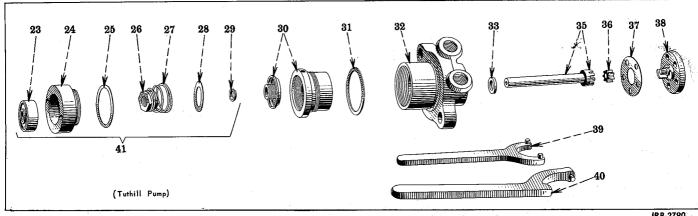
- 1. Remove the cap screws securing the cover to the pump body.
- 2. Remove the idler and drive gear from the pump. Press out the oil seal.



10.

11. Plug.





IPB-2790

Spanner wrench

Illust. 4 - Exploded View of Viking and Tuthill Transfer Pump and Strainer Assembly (UD-14A).

_	Belt. Pulley.	-	Gasket. Screen.		Bearing Cap.	35.	Wear ring. Rotor and shaft.
	Bracket.	14.	Strainer body.	25.	Gasket.		Idler gear.
	Transfer pump.			26.	Seal nut.		Cover gasket.
5.	Outlet tube elbow.	16.	Bearing.	27.	Spring.	38.	Cover and idler
6.	Inlet tube elbow.	17.	Seal assembly.	28.	Washer.		gear pin.
			Housing.	29.	Ring.	39.	Spanner wrench
	Inlet tube		Rotor shaft.	30.	Plug.		(double).

30. Plug. 19. Rotor shaft. Inlet tube. 31. Gasket. 20. Idler gear. Bracket. 32. Housing with bushing. 21. Gasket. Strainer.

(single). Seal assembly. 22. Cover and idler pin.



FUEL TRANSFER PUMP

4. INSPECTION AND REPAIR

Tuthill and Viking Pumps

- 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 should 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 packing nut 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.
- 11. Check for excessive play in the bearing itself and for pitted balls, worn races, and corresion.
- 12. Check the seal assembly. If the seal has been damaged, the complete assembly must be replaced.
- 13. Check the rotor shaft for scratches and ISS-1038. 9-58.

grooves. File or stone down any scratches, or replace the shaft.

14. Check for undue wear and grooves in the bushing. If excessive wear has caused a loose fit, it will be necessary to replace the housing.

IH Transfer Pump

- 1. Remove rust, corrosion and dirt from all parts of the pump. Remove any packed dirt from between teeth of gears. Wash all parts in dry cleaning solvent. Thoroughly clean inlet and outlet parts.
- 2. Check for excessive idler gear running clearance which must not be more than 0.001 to 0.003 inch.
- 3. Check the fit of the gears on the shaft. No perceptible play should be present between the gear and shaft. Gears must turn freely.
- 4. Replace "O" ring and oil seal with new.
- 5. Check the gear shafts for grooves and scratches. Remedy by stoning or filing the shaft. Replace if necessary.
- 6. Check for excessive backlash of gears. It must not be more than 0.004 to 0.006 inch.

5. REASSEMBLY

Tuthill Transfer Pump (Illust. 4)

- 1. Reassemble the rotor and shaft (35) into the housing (32). Install the cover (38) together with idler gear (36) and gasket (37).
- 2. Insert the plug assembly (30) with gasket (31) and pin key. Install the seal assembly as a unit.
- 3. Tighten the seal nut (26), holding the rotor and shaft (35), just enough to create a binding of lock ring (29) on the rotor shaft.
- 4. Loosen the seal nut (26) slightly and then retighten it while holding the shaft (35) and compressing the entire seal assembly forward 0.004 inch. Then remove the box wrench and again measure the distance between the outside faces of seat nut (26) and plug assembly (30) as a check to see if the seal assembly (41) has been compressed 0.004 inch.
- 5. Reassemble the cap (24) with gasket (25) and bearing (23).



FUEL TRANSFER PUMP

Viking Transfer Pump (Illust. 4)

- 1. Reassemble the rotor shaft (19) to the housing (18). The cover (22), together with idler gear (20) and gasket (21, can then be installed.
- 2. Insert the seal assembly (17), followed by bearing (16) and packing nut (15). Turn down the packing nut with a spanner wrench until it is tight.

IH Transfer Pump (Illust. 1)

- 1. Press the oil seal into the pump body. Be careful not to damage the seal.
- 2. Install the idler gear on the shaft mounted in the pump body.
- 3. Install the drive gear and shaft into the pump body.
- 4. Install a new "O" ring in the groove in the pump body, then secure the cover to the pump body with cap screws.

6. INSTALLATION

Tuthill and Viking Pumps

The installation procedure is the same for the Tuthill and the Viking pumps.

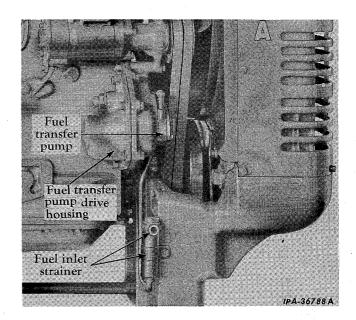
- 1. Attach the transfer pump support bracket (3, Illust. 4) to the pump body (4).
- 2. Slide pump pulley (2) onto the rotor shaft; then turn in the set screw and tighten the jam nut.
- 3. Attach the pump support bracket, complete with the pump and pulley, to the top side of the front engine support (Illust. 7).
- 4. Connect the fuel pipe from the transfer pump strainer to the lower fitting of the transfer pump, and connect the remaining fuel pipe to the upper fitting of the transfer pump. (Illusts 6 and 7.)
- 5. 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.
- 6. Pull back on the pump until the belt can be depressed three-quarters to one inch midway between the pulleys by thumb pressure. To

adjust tension, loosen mounting screws holding pump bracket to engine support. (Illusts.6 and 7.) Push in to decrease tension; pull out to increase tension.

7. Tighten the cap screws which secure the pump support bracket to the front engine support.

IH Transfer Pump

- 1. Install pump and new gasket. Engage the slot of the transfer pump drive housing drive shaft with the pump drive shaft.
- 2. Secure the pump to the front gear cover with cap screws and install fuel lines.



Illust. 5 - I.H. Fuel Transfer Pump and Strainer (Late UD-18A).

TRANSFER PUMP STRAINER

- 7. REMOVAL (See Illust. 6 and 7)
- 1. Shut off 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.

8. DISASSEMBLY

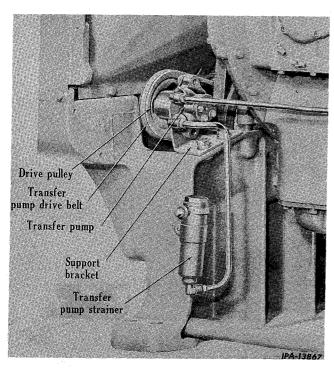
- 1. Unscrew the strainer plug and gasket.
- 2. Disconnect the screen by unscrewing the integral nut from the plug. Lift the screen from the strainer.



TRANSFER PUMP STRAINER

9. 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. Also clean out the plug and strainer screen body. If the strainer screen is cracked or broken, it should be replaced with a new strainer screen.



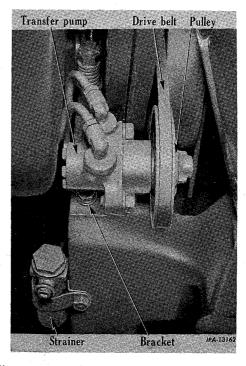
Illust. 6 - Transfer Pump and Strainer (UD-14A).

10. REASSEMBLY

Reassemble the strainer in the reverse order of disassembly.

11. INSTALLATION

Install the strainer in the reverse order of removal.



Illust. 7 - Transfer Pump and Strainer (Early UD-18A),

FUEL TRANSFER PUMP DRIVE HOUSING (LATE UD-18A)

12. DESCRIPTION

The transfer pump drive housing is mounted to the crankcase front plate on the right side of the engine (Illust. 5). It contains two gears, an idler gear and a drive gear. The camshaft gear drives the idler gear which in turn drives the drive gear and drive shaft. The drive shaft is slotted to receive the tang of the fuel transfer pump drive shaft.

13. REMOVAL

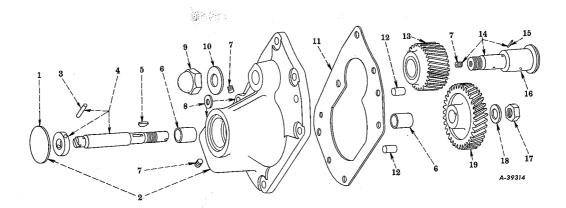
Remove the cap screws, nuts and washers securing the drive housing to the crankcase front plate. Tap the drive housing off the locating dowels.

14. DISASSEMBLY (Refer to Illust. 8)

- 1. Remove idler gear shaft nut (9) and washer (10). Drive the idler shaft (14) with gear (13) out of the housing with a babbitt hammer.
- 2. Remove the expansion plug (1). Remove nut (17) and nut lock (18). Pull the drive gear (19) off the drive shaft (4) and remove the key (5). The drive shaft will slide out of the bushings (6) in the housing.
- 3. If the collar on the end of the drive shaft is to be removed, drive out the pin (3) and pull the collar off the shaft.
- 4. Press the bushings (6) out of the housing.



FUEL TRANSFER PUMP DRIVE HOUSING (LATE UD-18A)



Illust. 8 - Exploded View of Fuel Transfer Pump Drive Housing (Late UD-18A).

- Expansion plug, 2-1/4".
 Drive housing with plug.
 Drive shaft collar pin.
 Drive shaft with collar and pin.
 Drive shaft gear key.
 Drive shaft bushing.
 Drive housing oil hole plug.
 Drive housing bolt washer.
 Idler gear shaft put

- 9. Idler gear shaft nut.
- 10. Idler gear nut lock.

15. INSPECTION AND REPAIR

- 1. Wash all parts in an oil solvent and dry thoroughly with compressed air.
- 2. Inspect all parts for wear and damage. Replace parts as needed.
- 3. After the installation of new drive shaft bushings, ream the bushing inside diameter to .874 - .875 inch.

16. REASSEMBLY (Refer to Illust. 8)

- 1. Install the collar on the end of drive shaft (4) and secure with pin (3).
- 2. Lubricate the drive shaft and install into the housing. Install key (5) and press drive gear (19) onto the shaft. Install nut lock (18) and nut (17). Torque as specified in "SPECI-FICATIONS," in Section 1.

- 11. Gasket.
- 12. Drive housing dowel.
- 13. Idler gear.
- 14. Idler gear shaft.
- 15. Idler gear pin.
- 16. Idler gear shaft.
- 17. Drive gear nut.
- 18. Drive shaft gear nut lock.
- 19. Drive gear,
- 3. Coat the expansion plug (1) and plug seat in the housing with sealer. Install the expansion plug.
- 4. Lubricate the idler gear shaft (14) and slide the gear (13) onto the shaft with the flat side of the gear facing the front of the engine.
- 5. Line up the dowel pin (15) in the idler shaft with the groove in the housing bore. This will assure correct alignment of the oil holes in the shaft and the bore. Drive the shaft into the bore with a babbitt hammer. Install nut lock (10) and nut (9). Tighten nut securely and lock with nut lock.
- 6. Check the idler gear end clearance, it should be .004 to .014 inch. Also check the backlash between the idler gear and the drive gear, it should be .003 to .006 inch.

17. INSTALLATION

Install the drive housing and secure with cap screws, nuts and lock washers.

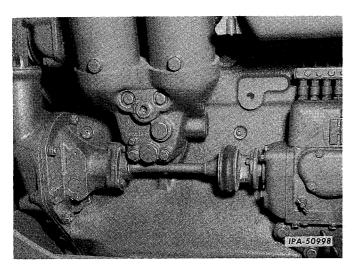




FOR ENGINES EQUIPPED WITH BASE-MOUNTED PUMPS

1. DESCRIPTION

The injection pump drive is located on the left side of the engine (Illust. 1) connecting the injection pump drive gear and the injection pump. The pump drive coupling can be assembled only one way to give the correct timing of the pump with relation to the crankshaft. The pump is driven by the injection pump drive gear which engages the idler gear in the crankcase front cover.



Illust. 1 - Injection Pump Drive.

2. REMOVAL (Refer to Illust. 2)

- 1. Slide boot (11) onto the adjuster (12).
- 2. Disconnect the fuel injection lines at the injectors. Disconnect the fuel lines from the fuel filters to the injection pump at the pump. Disconnect the governor control rod from the governor control lever.
- 3. Remove the injection pump base mounting bolts and move the injection pump back toward the rear until the spacer (10) is clear of the flange (6). Remove the spacer.

NOTE: To avoid disturbing the injection pump timing, do not separate the timing adjuster (12) from the injection pump drive flange (13) unless they are to be replaced.

- 4. Remove the lubricating oil filter base assembly.
- 5. Remove the crankcase front cover. Refer to Section 6, "TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT."

- 6. Chalk mark the matching teeth of the injection pump drive gear and the engine idler gear to assure correct reassembly.
- 7. Remove nut (26) and nut lock (15). Remove the injection pump drive gear (14) with a gear puller.

NOTE: Loosen nut (25) before removing the injection pump drive gear.

8. Remove the two bolts and bolt lock (16) securing the injection pump drive housing to the crankcase front plate, and lift out the complete injection pump drive assembly.

3. DISASSEMBLY (Refer to Illust. 2)

- 1. Remove nut (25) and washer (8). Tap flange (6) off shaft (24), and remove key (23).
- 2. Remove the three cap screws securing housing cap (2) to housing (18) and slide the cap with oil seal (3), felt (4) and retainer (5) off shaft (24).
- 3. Remove the hourmeter and hourmeter driven gear on engines so equipped.
- 4. Remove the shaft (24), with spacer (20) and bearings (19) and (21), by tapping on the gear end of the shaft with a rawhide hammer.
- 5. Remove key (22) and press off bearing (19). Slide spacer (20) off the shaft and press off bearing (21).
- 6. Press oil seal (3), felt (4) and retainer (5) out of the housing cap (2).

4. INSPECTION AND REPAIR

- 1. Clean all parts with solvent. Inspect the bearings for corrosion or wear and replace if necessary.
- 2. Inspect the shaft for damage. It is possible that the shaft may be damaged, causing a vibration which may result in the rear bearing jumping out.
- 3. Inspect the drive gear for broken teeth.
- 5. REASSEMBLY AND INSTALLATION (Refer to Illust. 2)
- 1. Press bearing (21) onto the shaft. Install spacer (20) and press on bearing (19).

NOTE: If engine is equipped with an hourmeter install the spacer (20) with the worm gear toward the front of the engine.

FOR ENGINES EQUIPPED WITH BASE-MOUNTED PUMPS

5. REASSEMBLY AND INSTALLATION - Continued

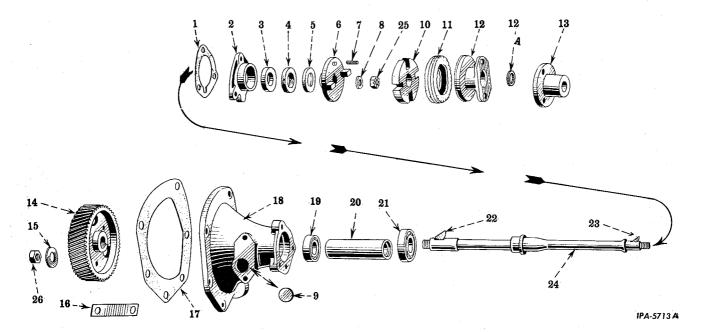
- 2. Install the shaft assembly into the housing (18). Tap on the flange end of the shaft with a rawhide hammer to seat the bearings in the housing.
- 3. Install a new oil seal (3) and felt (4) in the housing cap (2). Press retainer (5) into place. Slide the gasket (1) and housing cap over the flange end of the shaft. Be careful not to cut the lip of the oil seal on the flange shoulder of the shaft. Secure the housing cap to the housing (18) with three cap screws.
- 4. Use a new gasket (17) and mount the housing assembly (18) to the crankcase front plate. Secure the housing to the front plate with two cap screws and lock (16).
- 5. Install key (22). Start injection pump drive gear (14) onto the shaft. Line up the marks previously made on the teeth of the idler gear and injection pump drive gear. Drive the gear onto the shaft and install the nut lock (15) and nut (26). Tighten the nut to the torque specified in "SPECIFICATIONS" in Section 1. Bend nut lock (15) over the nut (25).

NOTE: If the idler gear and injection pump drive gear were not marked before disassem-

- bly the engine gear train will have to be retimed. Refer to Section 6, "TIMING GEAR TRAIN, FRONT COVER AND CAMSHAFT."
- 6. Install the crankcase front cover and fan drive pulley. Refer to Section 6, "TIMING GEAR TRAIN, FRONT COVER AND CAM-SHAFT."
- 7. Install key (23) and flange (6) on the shaft (24). Secure with washer (8), nut (25) and cotter pin. Install the hourmeter driven gear and hourmeter, if so equipped.
- 8. Coat the entire surface of the timing coupling spacer (10) with a thin film of chassis grease and install the spacer onto the flange (6).
- 9. Move the injection pump forward engaging the dowel pin (7) in flange (6) with the hole in the tang on the adjuster. Slide the boot (11) into position on the flange and adjuster.

NOTE: The coupling can be assembled only one way to give the correct timing of the pump with relation to the crankshaft.

10. Install and tighten the injection pump base mounting bolts. Reconnect the fuel lines from the fuel filters. Reconnect the fuel injection lines and the governor control rod. Install the lubricating oil filter base assembly.



Illust. 2 - Exploded View of Fuel Injection Pump Drive (18 Series Only)

- 1. Gasket.
- 2. Housing cap.
- 3. Oil seal.
- 4. Felt.
- 5. Retainer.
- 6. Flange.
- 7. Dowel.
- 8. Washer.
 - Plug. 9.
 - 10. Spacer.

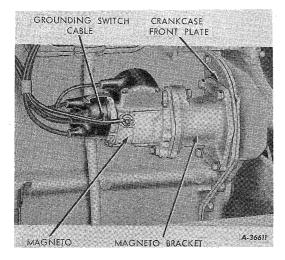
 - 11. Boot. 12. Adjuster.
 - 12A, Seal.
 - 13. Drive flange.
- 14. Drive gear.
- 21. Bearing, rear. 22. Key.
- 15. Nut lock.
- 16. Bolt lock. 23. Key.
- 17. Gasket.
- 24. Shaft. 25. Nut.
- 18. Housing. 19. Bearing, front. 26. Nut.
- 20. Spacer.

ISS-1038, 9-58,



1. DESCRIPTION

The International model H-4 magneto (14 series engines) is flange mounted to a bracket on the right side of the engine.



Illust. 1 - Magneto Installed on Engine.

The magneto is driven from a shaft and gear supported in a bracket that attaches to the right rear side of the crankcase front plate. (Illusts. 1 and 2.) The magneto mounts to the bracket and is driven by two lugs which engage in slots of the magneto drive shaft.

The magneto is grounded out during diesel operation by an automatic grounding switch in the intake manifold that shorts the primary circuit. The magneto features a completely enclosed breaker chamber, a starting impulse coupling, and an Alnico rotor magnet that should never require remagnetizing.

The magneto requires care and accuracy 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. Illust. 4 shows the complete magneto assembly.

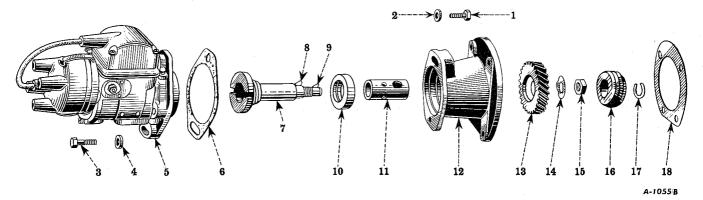
MAGNETO MOUNTING BRACKET

2. REMOVAL

Remove short-circuiting cable from the side of the magneto. (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



Illust. 2 - Magneto Mounting Bracket Components.

- 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.



MAGNETO MOUNTING BRACKET

3. DISASSEMBLY - Continued

(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 the gear can be pulled 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. If it is necessary they can be pressed out.

4. INSPECTION AND REPAIR (Refer to Illust. 2)

Wash all parts except the magneto in drycleaning solvent and dry with compressed air.

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 should be toward the front end of the 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. Particular care must be taken 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

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).

CAUTION: The gear must run true with the front face of the bracket. Install the key (9), drive gear (16) and retainer (17), if so equipped. The end clearance of the shaft should be .003 to .013 inch.

6. INSTALLATION

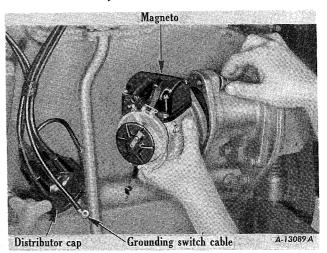
- 1. Shellac a new gasket to the bracket.
- 2. Crank the engine slowly and observe the camshaft gear through the magneto gear opening in the front plate, until the two beveled teeth on the camshaft gear appear in the opening.
- 3. Mount the bracket to the crankcase front plate, so that the magneto drive gear tooth ISS-1038. 9-58.

that has two punch marks meshes with the beveled teeth on the camshaft gear.

4. Secure the bracket with four cap screws, and install and time the magneto. (Refer to par. 8.)

7. REMOVAL (Refer to Illust. 3.)

Disconnect the grounding switch cable from the terminal on the outside of the magneto. Remove the distributor cap and the cap screws which secure the magneto mounting flange to the magneto bracket and lift off the magneto. For installation, reverse the above procedure.



Illust. 3 - Removing the Magneto.

8. TIMING THE MAGNETO TO THE ENGINE

- 1. Attach a jumper wire between the magneto terminal and the coil cover mounting bolt. This will ground the magneto and prevent accidental starting.
- 2. 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.
- 3. 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.
- 4. Assemble the magneto on the engine, being sure that the lugs on the impulse coupling en-

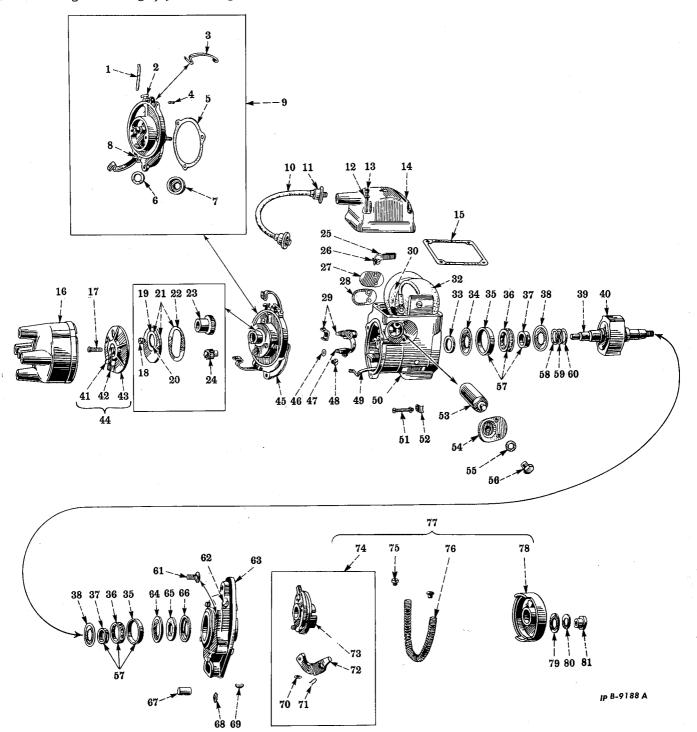


MAGNETO MOUNTING BRACKET

gage in the slots on the magneto drive gear coupling. Assemble the magneto so the top is as close to the crankcase as possible.

5. 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.



Illust. 4 - Exploded View of H-4 Magneto.

Page 4



MAGNETO MOUNTING BRACKET

8. TIMING THE MAGNETO TO THE ENGINE - Continued

Index to reference numbers shown in Illust. 4.

- 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.
- 6. 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 "l" 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 the No. 2 cylinder.
- 7. Remove the jumper wire from the magneto terminal, connect the grounding switch cable

- 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.

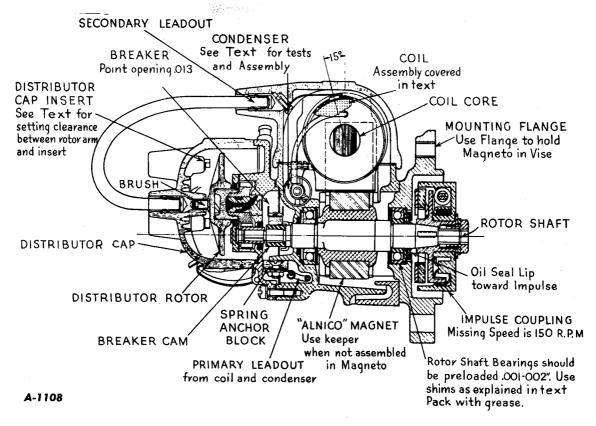
to the terminal and reconnect the jumper wire.

- 8. 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.
- 9. Remove the jumper wire from the coil cover mounting bolt to the magneto terminal.

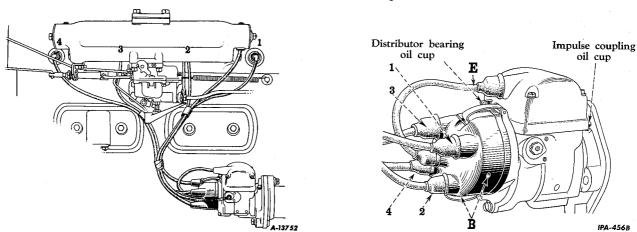
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MAGNETO MOUNTING BRACKET



Illust. 5 - Cross Section of Magneto.



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

9. 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. 4) out of the cap recesses and pull off the cap.

10. 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

DISTRIBUTOR CAP

10. INSPECTION AND REPAIR - Continued

pulled out of the socket if replacement is necessary. If the four inserts are badly worn, replace the cap. All the grease should be removed from the monel metal strip on the distributor rotor to assure good contact. The distributor cap should be free of dust or dirt, inside and out, before assembling to the magneto. The two ventilating holes (B, Illust. 7) should be open at all times.

Check thoroughly for cracks in the bakelite distributor cap around the spark plug cables and coil-to-distributor cable sockets. Very small cracks will allow a spark to go through the cap and partially short out the engine. For adjustment of the rotor arm with respect to the inserts, refer to Illust. 9 and pars. 12, 13 and 14.

11. 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

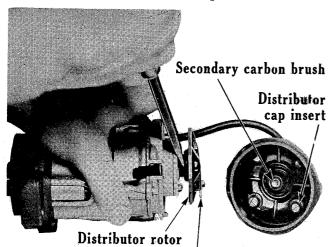
12. REMOVAL

Remove the distributor cap. Apply the end of a screwdrive 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.

13. ADJUSTMENT

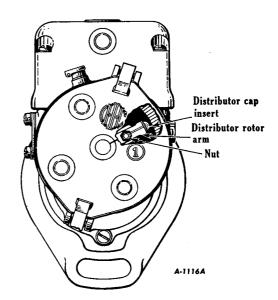
The monel metal arm on the distributor rotor is adjustable and renewable. It is removed by running out the arm nut. The arm should operate as close to the insert in the distributor cap as possible without rubbing. (Illust. 10.)

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.



Monel distributor arm *A-1114A*

Illust. 8 - Method of Removing Distributor Rotor from its Spindle.



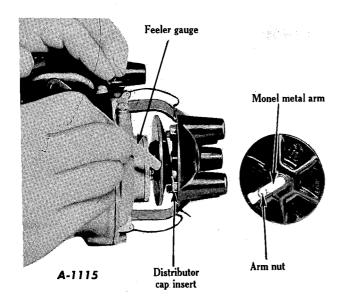
Illust. 9 - Adjusting Rotor Arm.

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.

14. INSTALLATION

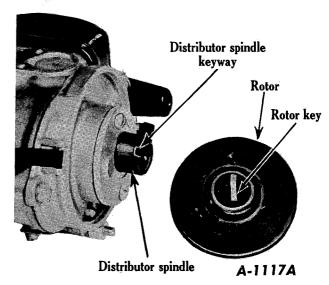
When installing the rotor, be sure that the rotor key on the inside of the rotor coincides with the slot on the end of the distributor spindle. (Illust. 11.) To assist in lining up the key with the slot, use as a guide the rib which is opposite the monel metal arm on the opposite side of the rotor, the 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 should have a heavy hand-press fit on the distributor spindle. In-

DISTRIBUTOR ROTOR



Illust. 10 - Inspecting Rotor Clearance.

stall the distributor cap and the secondary cable.

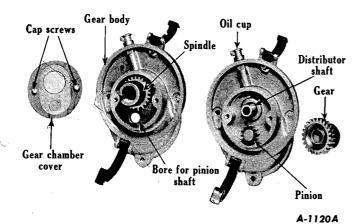


Illust. 11 - Distributor Rotor Removed.

DISTRIBUTOR GEARS

15. DESCRIPTION

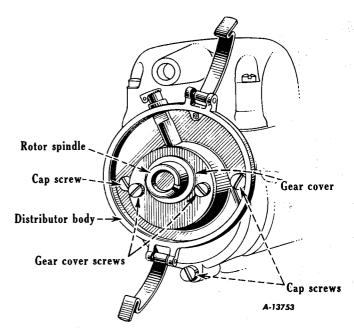
The distributor gears are contained in a chamber which is a part of the distributor body (Illust. 12). This chamber is partially filled with magneto grease and sealed with felt washers around the hub of the gear.



Illust. 12 - Distributor Gear Assembly.

16. REMOVAL

Remove three cap screws (Illust.13) from the body and remove the body with gasket.



Illust. 13 - Magneto with Distributor and Rotor Removed.

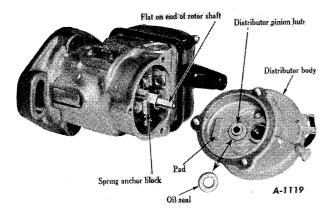
17. DISASSEMBLY

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.

DISTRIBUTOR GEARS

18. 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.

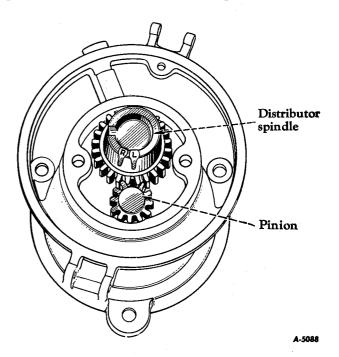


Illust. 14 - Magneto with Distributor Body Removed.

19. REASSEMBLY AND TIMING

Secure the gear body, with the gasket, to the magneto frame. The body and gasket fit in one position only. Install the distributor gear spindle on the shaft. It should turn freely on the shaft. Install the distributor pinion and check the backlash with the gear. A slight movement should be felt (approx. .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 counterclockwise magneto (this model), and the "R" mark is for a clockwise magneto. Partially fill the remaining chamber space with magneto grease. Install the cover, with the gasket, and secure with two screws. Install the distributor rotor as directed in par. 14 and secure the distributor cap.



Illust. 15 - Timing Marks on Distributor.

BREAKER MECHANISM

20. 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.

21. 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 leadout wire spring anchor terminal. The stationary point can be removed by removing one screw.

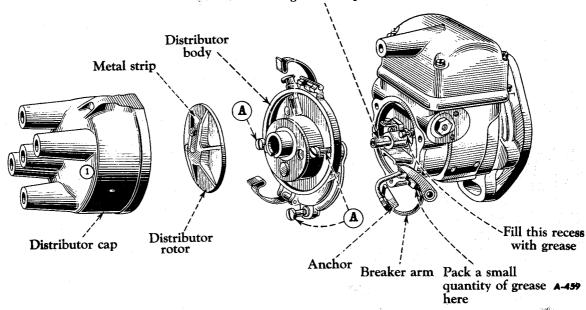
22. INSPECTION AND REPAIR (Refer to Illusts. 17 and 18.)

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.



BREAKER MECHANISM

When reassembling, be sure this shaft enters "D" shaped hole in magnet rotor pinion



Illust. 16 - Magneto Parts Removed to Gain Access to Breaker Point Chamber.

A-1122 A

23. REASSEMBLY (Refer to Illusts. 16 and 17.)

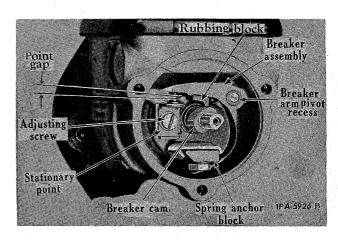
Before reassembling, thoroughly clean all parts to remove grease and oil. Apply a light coating of magneto grease to the breaker cam to prevent rusting. Reinstall the fixed breaker point, leaving the terminal screw slightly loose until the point opening has been adjusted. Secure the anchor block and 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

Stationary point Breaker cam ND" shaped end of rotor shaft Primary leadout wire Spring anchor block Breaker arm assembly

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. 19). Install the distributor rotor and distributor cap.

24. BREAKER ARM CAM (Refer to Illust. 18.)

The breaker arm cam should 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.



Illust. 18 - End View of Breaker Mechanism.

Illust. 17 - Magneto Breaker Arm Removed.



CONDENSER

25. REMOVAL (Refer to 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.

Remove the coil cover, the condenser hole cover plate and the clip and screw. Push the condenser back into the frame, 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.

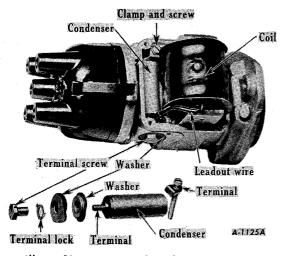
26. INSPECTION (Test)

Test the condenser. If it does not appear to be in good condition, it should be replaced.

27. INSTALLATION (Refer to Illust. 19.)

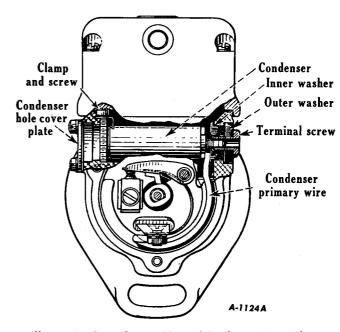
Install the inner bakelite washer. Line up the terminals of the primary wires and insert the condenser.

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 of breaking the condenser terminal. Do not apply too much pressure to the wrench when tightening the screw. Secure the condenser clamp and screw. Attach

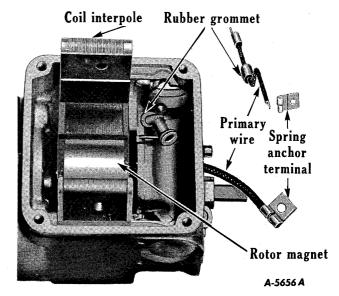


Illust. 19 - Magneto with Coil Cover Removed.

the condenser hole cover plate and gasket with cap screws and washers. Install the coil cover and gasket and secure them with four cap screws.



Illust. 20 - Cross Section View of Condenser Assembly.



Illust. 21 - Location and Assembly of Primary Wire.

PRIMARY WIRE

28. GENERAL (Refer to Illust. 21.)

The primary wire connecting the breaker arm assembly to the condenser terminal should be a tight fit in the rubber grommet, and the grommet should be a tight fit in the magneto frame. To remove the primary wire, the spring anchor terminal must first be unsol-ISS-1038. 9-58.

dered (assuming the coil cover, distributor cap, rotor, and body are removed). Then pull the terminal wire out from the top of the magneto. In reassembling the primary wires, reverse the above procedure. The primary wires to both the coil and condenser should be pulled tight when the condenser is assembled.

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COIL AND COIL COVER

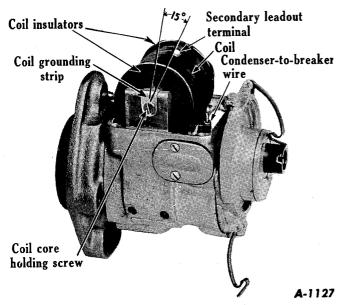
29. REMOVAL

Remove the coil cover and gasket. The screws will be retained in the cover if they are unscrewed only from the frame. Remove the primary wire from the condenser terminal. The magneto with the cover removed, and the coil grounding strip attached under the coil core holding screw are shown in 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.

30. INSPECTION AND REPAIR (Refer to Illusts. 22 and 23.)

Inspect the end insulators of the coil. If they are damaged, they should be replaced. Test the length of the coil core mounting screws by bottoming the screws lightly in the coil core and pressing the assembly into position as shown in 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

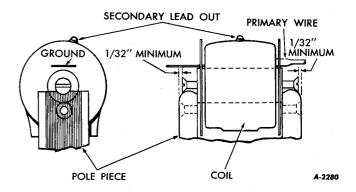


Illust. 22 - Coil Mounted on Magneto.

inch as shown, it must be removed and enough cut off the threaded end to make it fit properly. When the coil core is in place, the screws will then tighten up in the countersunk hole of the pole piece before the screws bottom in the coil core.

Test the coil. If it does not show to be in good condition, it must be replaced.

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.



Illust. 23 - Assemble Coil Core Mounting Screws to Coil Core So They Do Not Bottom in Core When Assembled in the Magneto.

31. 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. 27). Before installing the coil cover, be sure that the contact points are clean and that the secondary leadout in the coil cover bears firmly against the secondary leadout terminal. Install the coil cover, with gasket, and secure it to the magneto frame with four screws.

IMPULSE COUPLING

32. DESCRIPTION

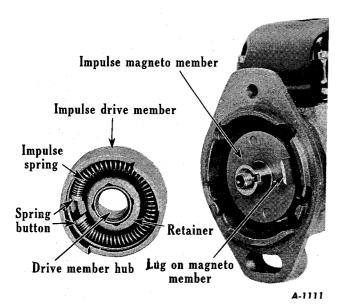
The impulse coupling, inserted between the magneto and the magneto drive, provides easy and positive starting of the engine at low starting speeds. The first purpose of the impulse coupling is to retard the spark at low engine

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

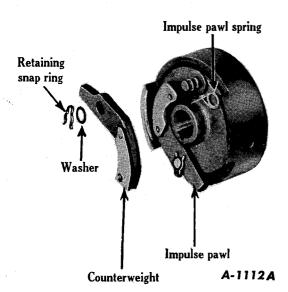
IMPULSE COUPLING

32. DESCRIPTION - Continued

pins (Illust. 28). The lug on the magneto member compresses the impulse spring. The lugs on the impulse drive member, which continutes 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 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.



Illust. 24 - Magneto Impulse Coupling Removed.

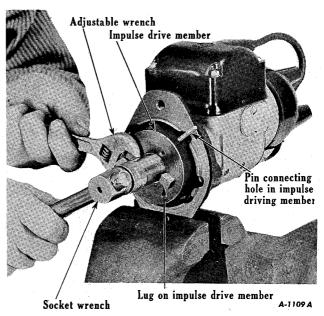


Illust. 25 - Complete Impulse Coupling Showing Rear Side of Magneto Member with Impulse Pawl Removed.

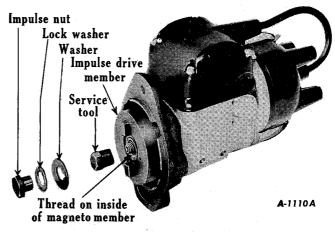
As the speed of the engine increases, the weighted ends of the pawls are thrown out by centrifugal force and their short ends no longer engage the pawl stop pins in the mounting flange. The spark is no longer retarded. The missing speed, approximately 150 rpm, is the speed at which the impulse coupling no longer continually retards the spark. At this speed it retards the spark intermittently only. Over the range of the throw-out speed, 240 to 330 rpm, the impulse coupling should cease to function completely, giving the effect of a direct drive.

33. REMOVAL

To remove the impulse coupling, insert a nail or pin through a hole (Illust. 26) in coupling



Illust. 26 - Correct Method of Removing Impulse Coupling Nut.



Illust. 27 - Removing Impulse Coupling.



IMPULSE COUPLING

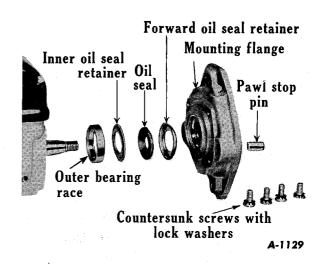
drive member, locking the two elements together. Apply a socket wrench to the nut and an adjustable wrench to one of the driving lugs to prevent shearing the nail or pin while removing the nut. The impulse coupling can now be removed with a tool (SE-912) (Illust. 27). As the tool is turned in, the inside end contacts the rotor shaft and forces the member off the shaft.

34. 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, should it be necessary, it can be pried out of place. To install this spring, just compress it sufficiently to fit into the drive member as shown. Before assembling the impulse drive member with the magneto member, soak the wick inside the impulse coupling spring with light oil. Also coat the inside drive member hub of the driving member with magneto grease. The lug of the magneto member should be a tight fit between the hardened buttons on each end of the impulse coupling spring. If the buttons become worn or grooved, install new ones.

The impulse pawl can be taken off after removing the retaining snap ring and washer. The impulse pawl spring can then be reinstalled. Use a small amount of grease on the pawl pivot and install the springs, pawls, washers and snap rings. The pawls should

move freely on the pivots. When installing the drive member, be sure the lug of the magneto member fits between the spring buttons.



Illust. 28 - Magneto with Impulse Coupling.

35. 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.

MOUNTING FLANGE

36. 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. 33). The flange is freed by taking out the four screws.

37. 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. 42).

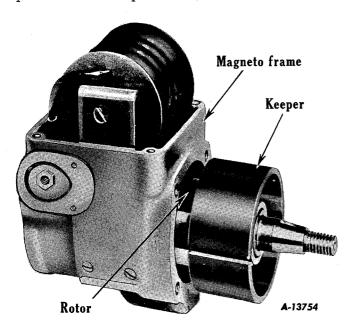
38. INSTALLATION

After the proper reassembly of the mounting flange has been made as directed in par. 37, install the flange and secure it with screws and lock washers.

ROTOR

39. REMOVAL

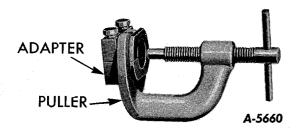
To remove the rotor and bearing, it is necessary to remove the impulse coupling (par. 33) and mounting flange (par. 36). Then slide the rotor magnet into a keeper (Illust. 29) as it is being removed from the magneto frame. Always have the rotor in the keeper while it is out of the magneto frame. Use extreme care to be sure that the rotor magnet does not pick up dirt and metal particles.



Illust. 29 - Removing Magneto Rotor.

40. DISASSEMBLY

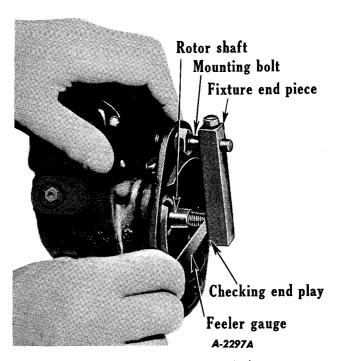
- 1. The inner bearing race can be removed readily from the rotor by using a puller and adapter as shown in Illust. 30. It is necessary to remove the inner bearing race when removing or inserting rotor shims for preloading the rotor bearings.
- 2. When the bearing inner race has been removed, the inner oil flinger and the rotor shims are free.



Illust. 30 - Inner Race Puller Tool SE-839.

41. 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.
- 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. 37).



Illust. 31 - Checking Rotor End Play.

42. ADJUSTMENT

Thoroughly clean the rotor assembly and bearing races of the old grease and grit. Lubricating the bearings should not be done until they have been checked for end play.

The old bearings and races should be assembled without disturbing the shims. Should an end play check reveal that end play is present, no attempt should be made to preload the old bearings, as this would cause rapid deterioration of the bearings. The recommended pro-



ROTOR

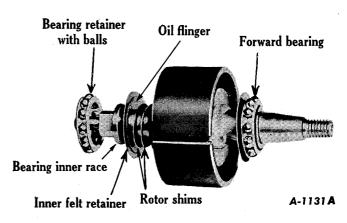
cedure, when end play exists on old bearings, is to replace them.

The distributor body assembly (Illust. 14) should 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 of end play in the rotor shaft after it is completely assembled. The end play should be checked with no grease on the bearings. Secure the mounting flange in place with the mounting screws (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 then add the required number of shims (Illust. 32) in the proper location.



Illust. 32 - Rotor Shaft with Keeper, Bearings and Shims.

Grease the ball bearings, reassemble the rotor and the mounting flange, and check the rotor for free turning. Be careful not overfill the bearing retainer with grease; just fill the spaces between the balls in the retainer with magneto grease. The preloading of the bearing should not cause binding of the rotor.

43. INSTALLATION

Install the impulse coupling, distributor body, distributor and distributor cap.

BEARING OUTER RACES AND OIL SEALS

44. REMOVAL

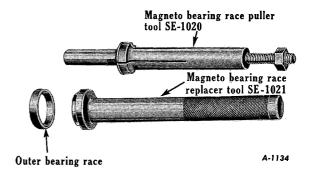
The front bearing outer race and oil seal are assembled in the mounting flange (Illust. 28). They are accessible after removing the impulse coupling and the mounting flange as directed. (Refer to pars. 33 and 36.) The purpose of the oil seal is to keep lubricating oil out of the magneto body.

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.

45. 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 a tool (SE-1021) shown in Illust. 33.

The magneto outer bearing races in both the main frame and the magneto flange can be removed readily. Loosen the expander and insert the tool into the bearing race. Manipulate the split sleeve flange through the bearing race and hold it against the felt retainer. Now draw up on the expander by applying a wrench to the flats on the threaded end of the expander and turning in a counterclockwise direction until a definite pressure is felt. Then tighten the nut and carefully drive the bearing race from place on the shaft.



Illust. 33 - Tools Used for Removing and Installing Magneto Outer Bearing Races.

Page 16



BEARING OUTER RACES AND OIL SEALS

46. REASSEMBLY AND INSTALLATION

The sequence of assembly of 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.



MAGNETO MOUNTING BRACKET

1. DESCRIPTION

The magneto is driven from a shaft and gear supported on a bracket which attaches to the right rear side of the crankcase front plate (Illust. 3). The magneto is mounted to the bracket and is driven by two lugs which engage in slots in the magneto coupling block.

2. REMOVAL

Remove the grounding switch cable from the bottom side of the magneto (Illust. 3). Remove the distributor cap and spark plug cables as a unit. Run out the cap screws holding the magneto bracket to the front plate and remove the magneto and bracket as a unit.

3. DISASSEMBLY

Remove cover (1, Illust. 1) and magneto by removing four cap screws from the bottom side of the bracket (18). Remove two cap screws from coupling (7). Remove nut (25) and key (21). Press shaft (23) out of gear (17) by removing nut (24) and washer (26). The shaft will slide out of the bushing (10) in the bracket. Idler gear (14) and shaft (15) can be removed by removing nut (11) and lock washer (12).

4. INSPECTION AND REPAIR

Wash all parts except the magneto in drycleaning solvent, and dry with compressed air.

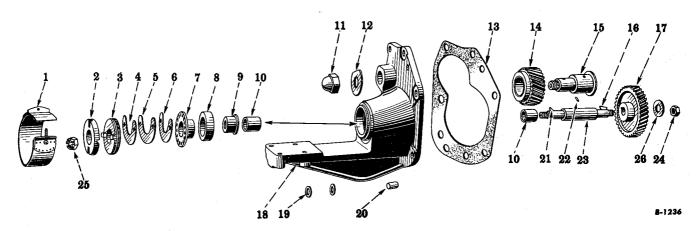
Inspect all parts for wear and damage. Replace parts if necessary. After the installation of new drive shaft bushings, ream the bushing inside diameter to .874-.875 inch.

5. REASSEMBLY

Lubricate shaft (23, Illust. 1) with engine oil. Install gear (17) on the shaft, and secure it with washer (26) and nut (24). Slide bushing (10) on the shaft, and place it in the bracket (18). Assemble spacer (9) and seal (8) in place with coupling (7) and spacer (2). Secure it with nut (25). Place shaft (15) through gear (14) and place it in the bracket. Secure with nut (11) and washer (12). The flat side of the gear must face toward the crankcase front plate. The end clearance of the shaft should be .004 to .014 inch.

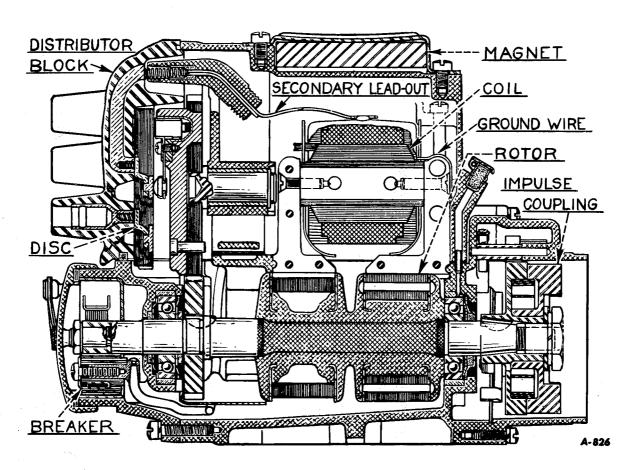
6. INSTALLATION

Shellac a new gasket to bracket (18, Illust. 1). Attach the bracket to the crankcase front plate. Install the magneto (Illust. 7) and time it to the engine. Refer to par. 8.



Illust. 1 - Magneto Mounting Bracket Components.

2. 3. 4. 5. 6.	Cover. Spacer. Coupling block. Shim, medium. Shim, heavy. Shim, light.	9. 10. 11. 12. 13.	Oil seal. Spacer. Bushing. Nut. Lock washer. Gasket.	16. 17. 18. 19.	Idler shaft. Key. Gear. Bracket. Gasket. Dowel.	22. 23. 24. 25.	Key. Pin. Shaft. Nut. Nut. Washer
	Coupling.	14.	Idler gear.				



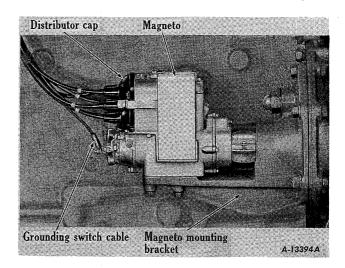
Illust. 2 - Cross Section of Magneto.

7. DESCRIPTION

The model F-6, inductor-type, high-tension magneto develops three sparks per crankshaft revolution, rotates at 3/4 engine speed, and is fully enclosed against entrance of dust, dirt and moisture. It is equipped with an automatic impulse starter coupling which makes possible the production, at cranking speed, a spark equal to that when the engine is operating.

The magneto runs continuously when the diesel engine operates either on the gasoline starting cycle or on the diesel cycle.

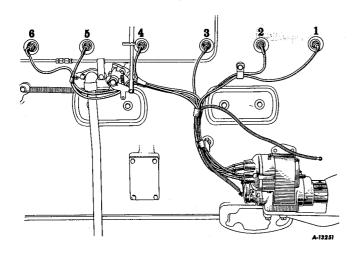
When the engine is operating on the diesel cycle, the magneto is shorted through a grounding switch which operates off the manifold butterfly valve shaft. When the magneto is grounded, it will not supply sparks to the spark plugs. The magneto is secured to a bracket by four cap screws and lock washers, and is mounted to the crankcase front plate on the right front side of the engine.



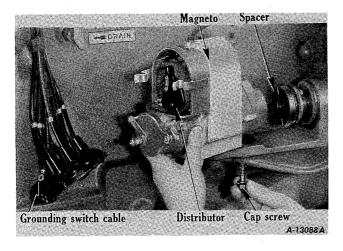
Illust. 3 - Magneto Installed on Engine.

8. REMOVAL

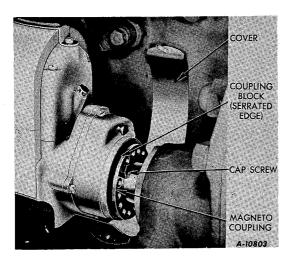
Remove the grounding switch cable from the magneto (Illust. 3). Loosen the set screw



Illust. 4 Spark plug cables in position.



Illust. 5 - Removing the Magneto.



Illust. 6 - Removing the Magneto.

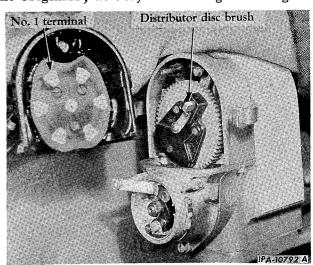
which secures the cover to the magneto drive. Remove the cap screws which secure the magneto coupling to the magneto (Illust. 6). Remove the distributor cap. Remove the cap screws which secure the magneto to the magneto bracket and lift the magneto from its position.

9. TIMING THE MAGNETO TO THE ENGINE

If the magneto has been moved for any reason, the following instructions must be followed when installing the magneto on the engine.

- 1. Pull the compression release lever into the gasoline (STARTING) position.
- 2. Remove the spark plug from No. 1 cylinder. Place your thumb over the spark plug opening and slowly crank the engine until an outward pressure can be felt. Pressure indicates that the No. 1 piston is moving toward top-dead-center of the compression stroke. Continue cranking slowly until the "DC/1-6" mark on the flywheel is in line with the pointer. (Illust. 10.)
- 3. Remove the distributor cap from the magneto and hold it close to the magneto. Rotate the magneto half of the coupling counterclockwise as viewed from the coupling end until the brush in the distributor disc is under the distributor cap terminal marked No. 1 (Illust. 7).
- 4. Place the magneto into position on the magneto bracket, engaging the lugs on the magneto coupling block with the slots in the coupling block spacer. Secure the magneto with the base cap screws and lock washers. (Illust. 8.)

NOTE: Do not use screws which are longer than the originals, as they will damage the magneto.



Illust. 7 - Showing position of distributor disc brush.



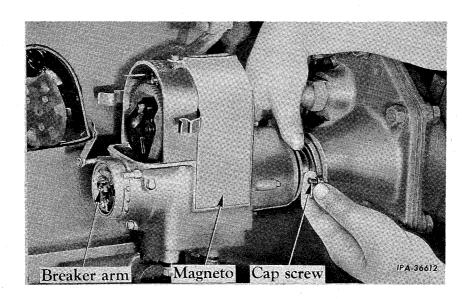
9. TIMING THE MAGNETO TO THE ENGINE - Continued

- 5. Install the distributor cap on the magneto and insert the spark plug cables into the cap according to the firing order of the engine. 1-5-3-6-2-4 as shown in Illust. 4.
- 6. Secure the magneto drive cover with the bolt.

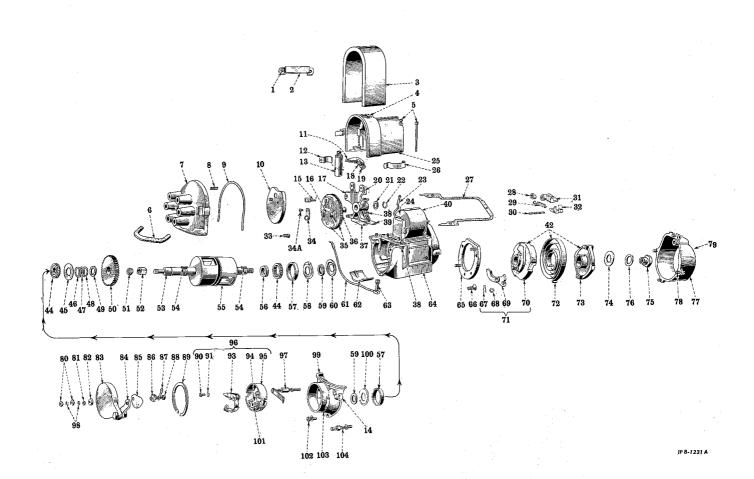
NOTE: The cover must always be assembled so the hole is on the bottom to facilitate drainage in damp or rainy weather. When operating under extremely dusty conditions, the flap over the hole in the cover must be partially closed to prevent the entrance of excessive amounts of dust.

- 7. Connect the ignition cut-out switch cable to the ground terminal with the screw and washer (Illust. 11).
- 8. Crank the engine slowly until the No. 1 piston is on the upper dead-center of the compression stroke and the impulse coupling just trips.
- 9. If timing is correct, the timing pointer on the flywheel housing will be between the "DC/ 1-6" or "MAG" mark on the flywheel. The timing pointer must never be before the "DC/

- 1-6" mark when the impulse coupling just trips. If the timing is not correct, magneto must be retimed to engine as follows:
 - a. Remove the magneto drive cover (IIlust. 6).
 - b. Remove the two cap screws (Illust. 6) in the magneto timing coupling and rotate the coupling one or two holes at a time, depending on the amount of adjustment that is necessary.
 - c. Looking from the coupling end, rotate the coupling clockwise to advance timing or counterclockwise to retard timing. turn coupling clockwise, lock the pawl out of engagement by inserting a nail into the coupling oiler and lift the main pawl so the pawl latch will hold it out of engagement. thereby allowing the rotor to rotate freely. (Illust, 12.)
 - d. Insert the cap screws into the coupling and remove the nail or wire from the oiler.
 - e. Crank the engine to be sure that the impulse coupling trips when the timing pointer is between the "DC/1-6" and "MAG" mark.
 - f. Install the magneto drive cover.



Illust. 8 - Installing Magneto on the Engine.



Illust. 9 - Exploded View of Magneto.





Index to reference numbers shown in Illust. 9.

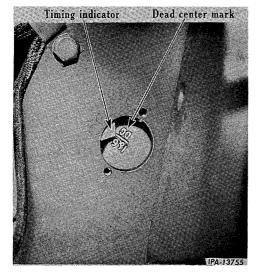
- 1. Screw.
- 2. Magneto strap.
- 3. Magnet.
- 4. Distributor bearing oiler.
- 5. Frame cover screw.
- 6. Distributor seal, lower.
- 7. Distributor block.
- 8. Distributor disc contact spring.
- 9. Distributor seal, upper.
- 10. Distributor disc.
- 11. Secondary leadout spring.
- 12. Condenser clamp.
- 13. Condenser.
- 14. Bearing oiler.
- 15. Distributor brush.
- 16. Distributor.
- 17. Distributor bearing.
- 18. Washer.
- 19. Secondary leadout.
- 20. Felt.
- 21. Washer.
- 22. Snap ring.
- 23. Primary condenser to leadout tube.
- 24. Coil end insulator.
- 25. Magneto frame cover.
- 26. Distributor block spring.
- 27. Frame cover gasket.
- 28. Pawl spacer.
- 29. Latch spring.30. Pawl latch pin.
- 31. Pawl.
 32. Pawl latch.
- 33. Distributor disc
 - screw.
- 34. Contact spring.
- 34A.Screw.

- 35. Distributor shaft with gear and distributor.
- 36. Distributor shaft and gear.
- 37. Distributor bearing shim.
- 38. Distributor bearing screw.
- 39. Distributor bearing shim.
- 40. Coil.
- 42. Magneto impulse coupling rotating member.
- 44. Bearing retainer.
- 45. Oil flinger.
- 46. Rotor shim, light.
- 47. Rotor shim, medium.
- 48. Rotor shim, heavy.
- 49. Bearing spacer.
- 50. Rotor pinion (40 teeth).
- 51. Breaker cam nut.
- 52. Breaker cam.
- 53. Breaker cam key (not seen).
- 54. Rotor shaft key.
- 55. Rotor.
- 56. Bearing inner race.
- 57. Bearing outer race.
- 58. Felt retainer, inner.
- 59. Bearing felt.
- 60. Felt retainer, outer.
- 61. Primary leadout.
- 62. Primary leadout shield.
- 63. Leadout terminal screw.
- 64. Magneto frame.
- 65. Frame ring.

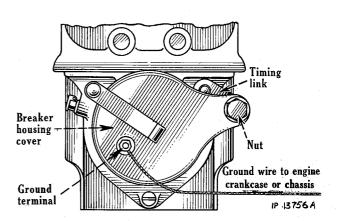
- 66. Machine screw.
 67. Pawl pin snap ring.
 68. Engaging pawl washer.

- 69. Engaging pawl.
- 70. Magneto member with pins.
- 71. Magneto member with pawls.
- 72. Drive spring.
- 73. Cam member.
- 74. Lock washer.
- 75. Impulse coupling nut.
- 76. Lock washer.
- 77. Impulse coupling cover.
- 78. Machine screw.
- 79. Impulse coupling oiler (not seen).
- 80. Nut.
- 81. Washer.
- 83. Breaker housing cover.
- 84. Magneto timing link.
- 85. Spring insulator.
- 86. Terminal insulator.
- 87. Short-circuiting spring.
- 88. Short-circuiting screw.
- 89. Breaker cover packing.
- 90. Point support screw.
- 91. Point support washer.
- 93. Breaker arm.
- 94. Cam felt.
- 95. Circuit breaker cup.
- 96. Breaker.
- 97. Breaker cover spring post.
- 98. Lock washer.
- 99. Breaker housing. 100. Felt retainer.

- 101. Spring anchor.
 102. Breaker housing screw.
 103. Breaker stop and gasket.
 104. Magneto timing link post.

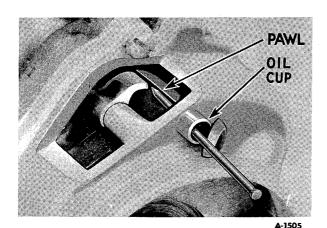


Illust. 10 - "DC" Mark on Flywheel.

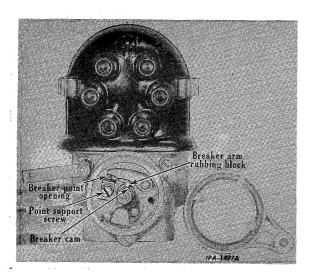


Illust. 11 - Breaker Housing Cover.





Illust. 12 - Disengaging Impulse Coupling.



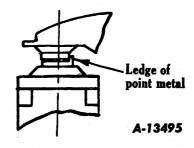
Illust. 13 - Breaker Point Adjustment.

10. CHECKING CIRCUIT BREAKER

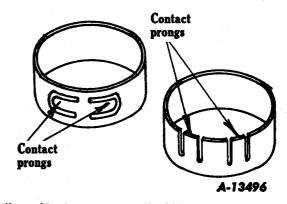
Remove the breaker housing cover and examine it for correct point performance and setting. A ledge of point medal (Illust. 14) running up the side of the companion point causes a slow break and poor performance. Breaker points should be set to .020 inch. To adjust the point opening, loosen the stationary point support screw (Illust. 13) slightly and use a screwdriver as a pry to move the stationary point support as necessary. This setting should be maintained as close as possible for maximum efficiency and checked periodically. See that the points are reasonably

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flat. File them a little if uneven point contact is formed.



Illust. 14 - Ledge of Point Metal Causes a Slow Break and Poor Performance.



Iliust. 15 - Contact Prongs Should be Bent to Make a Firm Electrical Circuit.

Examine the breaker for excess oil around the outside and at the bottom. This may interfere with the proper primary circuit from the cup member to the breaker housing. The contact prongs of the breaker cup (Illust. 15) are supposed to be bent out at the factory to make a firm electrical circuit between this cup and the housing in which it fits. The oil interferes with this contact. Likewise, a loose-fitting cup produces the same effect. Bend the prongs out if need be and reduce the oil supply.

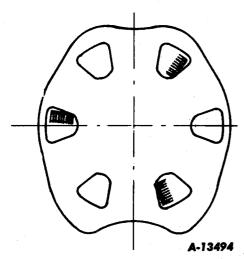
11. CHECKING DISTRIBUTOR

Remove the distributor block. Examine the brush track for black carbon, burns and for the spot on the bronze insert that tells whether the spark has been occuring at the correct place. A magneto spark is a rather long drawn out discharge. It has a tendency to burn the brush track unless the spark is started soon enough to permit a rather complete discharge before the brush runs off of the insert and onto the distributor disc surface. The distributor disc brush track can readily be cleaned of black carbon with a soft rubber eraser. DO NOT USE SANDPAPER.





All sparks from the spark spots should always come on the leading edge of the inserts (IIlust. 16), otherwise, the distributor disc will burn as the brush leaves at the other side.



Illust. 16 - Correct Timing Spots on the Distributor Disc.

12. CHECKING SAFETY GAP

If the breaker and the distributor of the magneto are both found to be in good condition, carry the examination further. Leave the distributor block off, advance the spark, disengage the impulse coupling and then turn the magneto briskly by hand. A spark should jump regularly across the safety gap. The regular safety gap setting is 7/16 inch to 15/32 inch.

Later type F-6. Magnetos will not have a safety gap because of design change.

13. CHECKING SAFETY GAP SPARKING

We will assume that the spark is unsatisfactory; intermittent and weak. The examination must then proceed still further. Remove the magnet and frame cover. Replace the condenser and test the magneto for spark once more.

The frame cover may be left off for the test; however, it is necessary to place the magnet on the magneto. The spark should jump the safety gap, with the breaker in the advance position, when the rotor is being turned briskly by hand. If performance is now satisfactory, the condenser was at fault and must be replaced. Reset the magneto safety gap (if so equipped) to 7/16 inch to 15/32 inch.

Assuming that the condenser replacement did not correct the faulty operation, it will be necessary to check the primary leadout wire for open circuit and grounding.

14. CHECKING GROUND CONNECTION

Examine the ground connection of the winding to the interpole (Illust. 18). The new type grounding strip is secured to the interpole by the coil core screw.

Earlier type coils are equipped with a grounding wire which is soldered to the hole in the interpole. On these coils, be sure that the tinning or adhesion of the ground wire is complete to the bottom of the hole in the interpole. Laying the ground wire along the interpole and making a surface joint is not secure enough. The solder will crack through in time. Be sure that this is not the case in the magneto. The coil housing should be a tight press fit between the interpoles endwise so it cannot shift and wear loose from engine vibrations. If this happens, the ground connections, or the wire to the condenser, will crack in two. A very slight amount of motion will bring this about. Be sure that this fault does not exist in the magneto being examined.

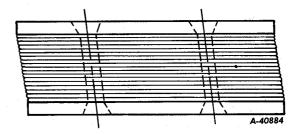
If the spark still is unsatisfactory, it will then be necessary to replace the coil. It must be faulty, as everything else has gradually been eliminated as the source of trouble.

15. COIL CORE FIT BETWEEN INTERPOLES

The smallest defect on the joining surfaces between the coil core and the interpole will permanently impair the operation of the magnet.

This joint must be a clean "sucking" fit, similar to the fit when two Johannsen gauge blocks are put together. No rust, oil or foreign matter of any kind should be on these surfaces.

Do not try to correct defects by filing the ends of the coil core. This can end only in failure. The coil core is made of laminated electrical sheet steel. It is held together by two rivets. If struck vigorously with a metal tool, it will burr and may be knocked out of line, as shown in Illust. 17.



Illust. 17 - Coil Core Knocked out of Square.

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16. COIL REMOVAL

With a coil tester make a final check for a faulty coil. Magneto coils must be detached from the magneto.

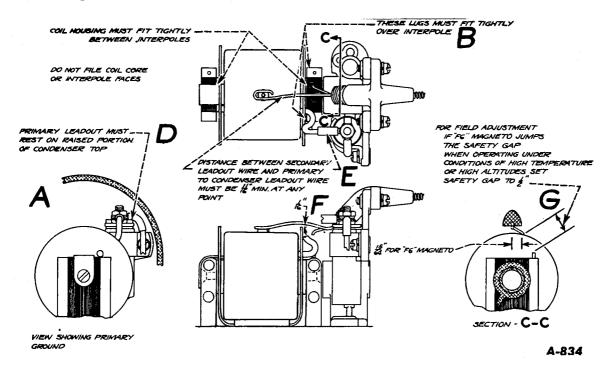
Disconnect the condenser. Then remove the distributor gear and the bearing (Illust. 19).

Next, remove the coil core screws. On coils equipped with a grounding wire, unsolder the wire from the interpole. Use a large soldering copper; have it quite hot so it can be done

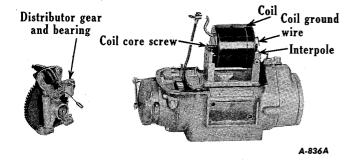
electrical testing instrument. If the core is not in place, the transformer set-up of the coil is not complete and no spark will appear at the gap. This test should not be prolonged any more than is necessary to obtain the check. Subjecting the coil to the test conditions for a prolonged period may damage it.

17. COIL DISASSEMBLY

Remove the coil core from the defective winding. Hold the coil in one hand, preferably with the coil lid up. Using a flat end hardwood or



Illust. 18 - Drawing of Magneto Coil Assembly in Place, with Service Pointers for Installing Coil Properly.



Illust. 19 - Removing Coil from Magneto.

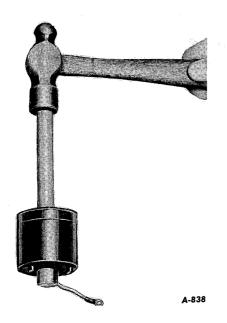
quickly. Pour out all extra solder from the countersunk hole. Finally, force the coil up-ward slowly with the aid of a screwdriver. The core should always be in position in the center of the windings when testing the coil on the

fibre punch at least 5/8 to 11/16 inch in diameter, drive the core downward between the fingers. Be sure to hold the coil firmly when driving out the core (Illust. 20). The bakelite coil case is brittle and it will break if dropped. Do not use a metal punch.

18. COIL REASSEMBLY AND INSTALLATION

The coil must be a hand-press between the interpoles and on the coil core. Otherwise, vibration will loosen it and cause failure. Also, do not attempt to file the diameter of the coil core so that it will slip into the winding easily, nor file the ends to make it fit between the interpoles easier. Paint the coil hole generously all around with a thick asphalt solution for a 3/8 inch length at each end before pressing in the core. The core should be a hand-press fit





Illust. 20 - Removing Coil Core with Hardwood or Fiber Punch.

in the winding and it may have to clear a path by removing a small amount of varnish as it is pressed in; this is permissible and will cause no damage, providing that it is started and pressed in straight. Clean the core ends thoroughly of paint. These surfaces must be absolutely clean.

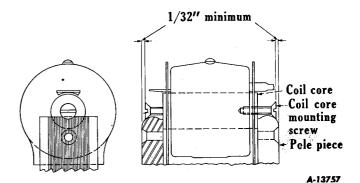
The bakelite housing will normally be a little longer than the coil core and should not be filed. The guide lugs on the coil housing should fit the interpole so that they bear against it lightly, just enough to keep the winding from moving sideways or turning around on the screws.

A check should be made on the length of the coil core screws. They should be bottomed lightly in the core, and the winding place on top of the interpoles with the screws in place. (Illust. 19). In this position it can be seen readily whether the screws bottom before they would tighten. If the guide lugs are too tight on the interpole, they may be filed until they fit properly. Be careful not to touch the end of the core with the file during this operation. Test the coil core mounting screw length by bottoming the screws lightly in the coil core and pressing the assembly into position.

If either screw head does not fall back of the face of the pole piece by 1/32 inch minimum (as in Illust, 21), it must be removed and enough cut off the end to meet this requirement. This is done so that, when coil core is in place, the screws will tighten up in the pole

piece countersunk hole before the screws bottom in the coil core.

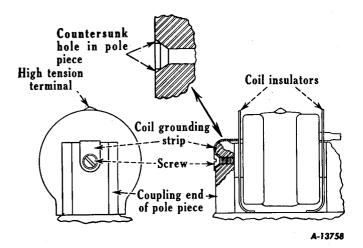
CAUTION: Do not file or in any way deface the ends of the coil core or face of pole pieces, as this will impair the magnetic circuit and the efficiency of the magneto. The coil core should be a light press fit between the pole pieces.



Illust. 21 - Testing Coil Core Screws Before Assembling Coil and Core Magneto.

19. COIL GROUND CONNECTIONS

On coils equipped with a grounding wire, this connection must be bent and inserted into the bottom of the hole to prevent the wire from breaking due to vibration. Be sure that the countersunk hole and the end of the leadout wire are clean, and that a thorough soldering job is done. Do not use acid; use a resinous flux. A resinous flux will not corrode or eat the metal.



Illust. 22 - Method of Grounding Coil With New Ground Strap.



19. COIL GROUND CONNECTIONS - Continued

Remove the old coil core and assemble the new coil on the core with a coil end insulator at each end. Locate the coil and core in the magneto so the high tension terminal is on a vertical centerline as shown in Illust. 22. On coils equipped with a grounding strip, assemble the coil grounding strip under the coil mounting screw in the pole piece as shown in Illust. 18. Tighten the screw firmly. The surface of the countersink in the pole piece and the grounding strip must be clean and bright before assembling.

If there is a shoulder in the countersunk hole in the pole piece, the shoulder must be removed.

20. HIGH TENSION LEADOUT

Do not allow this leadout to touch the bakelite coil housing at any point. Maintain a 1/16 inch space between the secondary leadout and the coil housing. (Illust. 18.) This is to prevent a drop of moisture from bridging at this place. If this wire is raised too high, the spark will jump upward to the roof of the aluminum cover.

21. CONDENSER - GENERAL

All metal surfaces contacting the condenser should be thoroughly cleaned to insure a good ground. Be sure that the condenser is pushed down as far as it will go before tightening the clamp. Refer to Illust. 18, references E and D, for instructions on the proper positioning of the lead wires to the condenser.

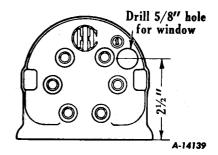
It is very important that these wires be positioned as shown in Illust. 18 to prevent shorting or grounding.

22. DISTRIBUTOR SAFETY GAP

The safety gap acts as a protection to the winding when abnormal sparking conditions are experienced. The regular safety gap setting is 7/16 inch to 15/32 inch.

High humidity, extremely high temperature, high altitude, or a combination of all three, may cause internal jumping of the spark. If a magneto spark starts jumping the safety gap, determine the cause and correct it. These gaps are amply long for almost every condition where internal combustion engines are operated, except in high altitudes.

A spark which jumps the safety gap can be readily detected by placing on the magneto a regular distributor block in which a transparent window has been provided (Illust. 23).

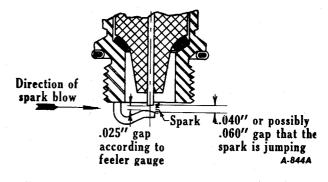


Illust. 23 - Hole for Window in Distributor Block for Observing Spark Across Safety Gap.

A window in the distributor block, rather than just an opening, must be used; otherwise, air conditions in the magneto will change and probably will prevent the spark from jumping. Drill the holes in the block as shown in Illust. 23; then, with a drill slightly larger in diameter, counterbore the same hole. A window can be made of celluloid to fit the counterbored hole. It can be held in place with shellac. Operate the engine for a sufficient time to permit the air in the magneto to attain the normal operating temperature, and observe through the window if the spark is jumping the safety gap. If the spark is jumping the safety gap, check all spark plug gap settings. It may be necessary to file off the spongy metal at the tip of the spark plug wire and close the gap to .020 inch. If the spark continues to jump the safety gap, with the engine still operating, the safety gap may be increased. Cut off and reform the spark plug leadout closer to the secondary lead. (Refer to "G." Illust. 18.)

Spark plug electrode wires burn off on one side more than on the other because the spark is blown there.

Keep the spark plug gap set close (.020 to .025 inch). In many cases even then the spark is jumping .040 to .060 inch due to turbulance in the combustion chamber. (Illust. 24.)



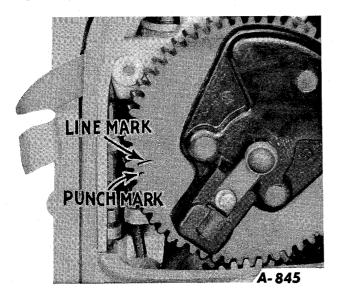
Illust. 24 - Showing How Sparks Jump Between Spark Plug Electrod Wired Which Are Burned At An Angle.



If the spark still jumps to the frame cover after reforming the safety gap, three coats of insulating varnish may be applied to the inside of the frame cover, allowing sufficient time for drying between coats. A spaghetti insulator can be slipped over the high tension leadout, or it may be coated with insulating varnish with the exception of the contact point. Another method is to place a thin sheet of bakelite under the roof of the frame cover. The information is being given, however, as an extreme emergency measure for very high altitudes, and it should not be used unless absolutely necessary.

23. DISTRIBUTOR SHAFT AND BEARING

After the distributor gear has been properly meshed with the rotor pinion (Illust. 25), be sure that the teeth have a very slight amount of clearance so that no radial pressure is exerted on the distributor shaft bearing. Use shims under the bearing bracket, if necessary, to provide this clearance.



Illust. 25 - Showing Punch Mark Used for Timing a 35-degree Spark Range Magneto, and Line Mark Used For Timing Magneto of Reduced Spark Range.

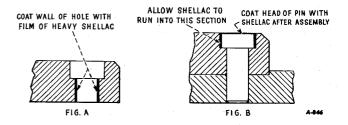
The distributor shaft end play should not be more than .014 inch or less than .004 inch. Excess end play at this point allows the distributor disc to travel back and forth, causing more or less uneven brush pressure and creating excessive wear on the disc brush track. This end play may be adjusted by placing special shim washers (number 12583 C which are .004 inch thick and number 12589 C which are .008 inch thick) between the retainer spring and the rear thrust washer.

24. DISTRIBUTOR DISC

The distributor disc and brushes should be examined periodically and the disc kept clean. The disc can be cleaned with a soft rubber eraser which is free of grit and abrasives and which will not scratch the disc surface. If the disc becomes badly worn, it can be replaced by removing three bakelite screws which hold the disc to the distributor block. When installing the bakelite screws apply a light coat of shellac to the heads. This will help to prevent them from loosening and it seals them against the possibility of changing shape from the effects of moisture.

When the brushes and disc are properly related, the brush track will wear very slowly; it will be polished and reasonably smooth. If other than this condition exists, check the gaskets for moisture or dirt and be sure that proper brushes are used.

If the magneto has been operating with the proper spark advance in relation to the distributor gear setting, a slightly blackened condition (spark spot) will exist on the insert at the leading end of the brush contact. If the magneto has been operating with the spark not properly advanced, this blackened spot will be at the center of the insert. The longest life of the distributor disc can be secured only by proper timing and the exclusion of all water.



Illust. 26 - Installing New Distributor Disc Pin.

25. DISTRIBUTOR

When installing a distributor, first push the distributor pin into place in the distributor, before final assembly to the gear. Check the clearance between the body diameter of the pin and the hole in the distributor.

If any excessive amount of clearance exists, the distributor may eventually come loose after assembly, and cause excessive disc and brush wear, and may result in faulty performance of the magneto.

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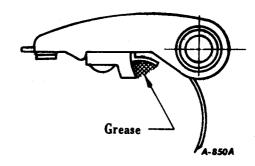
25. DISTRIBUTOR - Continued

To correct such cases where excessive clearance exists, proceed as follows:

Coat the hole in the distributor with a film of heavy shellac as shown in Fig. "A" Illust. 26. Allow the shellac to dry thoroughly. Place the distributor on the gear. Coat the pin with shellac and drive it into place through the distributor and into the gear. Be careful not to strike the distributor when doing this, since the distributor may readily be cracked. Then coat the head of the pin with shellac, allowing the shellac to run into the space between the head and the counterbore in the distributor. (Fig. "B," Illust. 26.) Wipe off any excessive shellac from the face of the distributor. Be absolutely certain that no shellac remains in the brush path. This procedure, if carefully followed, will give an assembly which will remain tight indefinitely.

26. DISTRIBUTOR BRUSHES

These brushes have to be of the proper material to match the disc they are rubbing against. This material has been worked out for each magneto by test.

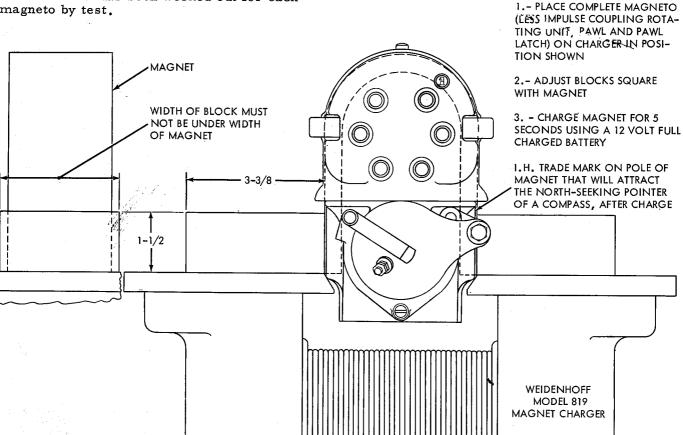


Illust. 28 - Where Magneto Grease Should be Placed on Breaker Arm to Lubricate Rubbing Fiber.

27. CHARGING THE MAGNET

Always recharge the magnet during an overhaul as it loses a little of its magnetism gradually.

The magnets can be charged while on or off the magneto. If they are charged while on the magneto, the impulse coupling, rotating unit, pawl and pawl latch must be removed. The charging blocks must then touch the sides of the magnet. Follow the manufacturers' instructions for charging the magnets, either on or off the magneto.



Illust. 27 - Recharging a Magneto Magnet on a Spool-type Charger.

A-36613



NOTE: The IH trade mark is on the pole of the magnet that will attract the north-seeking pointer of a compass after charge. If the magnet has been removed from the magneto, place a "keeper" across the base of the magnet until the magnet is installed in the magneto. Never slide the keeper up on the side of the magnet as this will result in partial demagnetization.

28. BREAKER POINTS

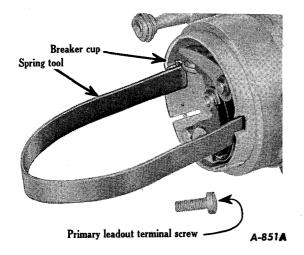
The life of the breaker points may be very materially increased by keeping the breaker arm rubbing fibre properly lubricated with magneto grease. Also keep the points set to gauge. Wide settings burn contacts rapidly.

29. BREAKER CUP

A simple tool for removing the circuit breaker cup may be made from a discarded, flat, impulse coupling spring.

Bend the spring into a "U" shape and turn a short lip at a right angle on each leg of the "U." Make the two lips long enough to hook in back of the bent-over lips on the breaker cup slots which are used to move the cup to advance or retard the spark.

To remove the breaker cup, first remove the primary leadout terminal screw. A light blow on the head of this screw, after it has been loosened about two turns, will free the leadout terminal and facilitate the breaker cup removal. The breaker cup must be positioned so the slot in the rear of the cup registers with the pin which is a stop for the advance and retard action. A light pull on the puller tool, as shown in Illust. 29, will then remove the breaker cup.



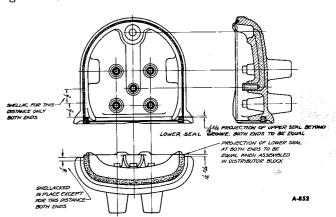
Illust. 29 - Using Tool to Remove Breaker Cup.

30. DISTRIBUTOR BLOCK AND GASKETS

For satisfactory performance of a magneto, water must not be permitted to find its way to the inside. The magneto has for some time been fitted with distributor block gaskets of waterproof construction. This is being done in two ways; one by waterproofing the felt, and the other by applying a narrow lamination of artificial rubber in the gasket to prevent seepage from working through.

In wet localities, be sure that these gaskets are used in case ignition problems are experienced. Assemble them as shown in Illust. 30.

Keep the outside of the distributor block clean of mud and water. Some soils produce a mud that is a very good conductor of electricity. With the exterior surfaces of the distributor block coated with such material, the electrical losses may easily reach values that jeopardize ignition.



Illust. 30 - Proper Method of Assembling Distributor Block Gaskets.

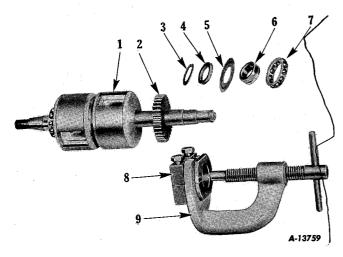
31. ROTOR REMOVAL

To remove the rotor from the magneto, first remove the impulse coupling. Use puller tool (MT-50) to avoid damage to the rear of the magneto frame. Then remove the distributor block, magnet, magneto frame cover, distributor disc, bearing assembly and breaker housing cover. Remove the primary leadout terminal screw and three breaker housing screws. The breaker housing can then be removed from the magneto frame and the rotor taken from the frame.

The inner bearing race can be readily removed from the rotor by using puller and adapter (SE-839), shown in Illust. 31. It is necessary

31. ROTOR REMOVAL - Continued

to remove the inner bearing race when removing or inserting rotor shims for preloading rotor bearings. (Refer to par. 32.)



Illust. 31 - Exploded View of Rotor Parts with Inner Race Puller Tool, SE-839.

- 1. Rotor.
- 2. Rotor pinion.
- 3. Rotor shims.
- 4. Rotor shaft bearing spacer.
- 5. Oil flinger.
- 6. Inner bearing race.
- 7. Ball bearings and separator assembly.
- 8. Bearing race adapter.
 - Puller.

32. PRELOADING ROTOR BEARINGS

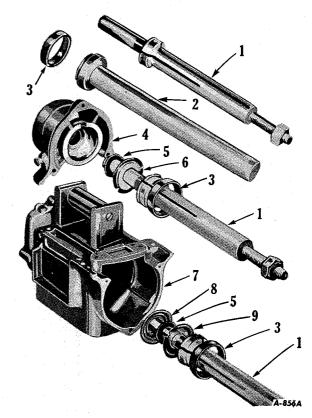
In order to maintain the high efficiency of this type of magneto, it is necessary to reduce the air gaps in the magnetic circuit to a minimum. To do this, the rotor clearance is held close. A small amount of end play would allow the rotor to rub due to the construction of the ball bearings. They are made to take a lateral as well as a radial load.

To avoid any possibility of the bearings becoming loose, they are preloaded from .000 to .002 inch lengthwise. To do this, assemble the rotor with just enough shims to obtain no end play or to a point where no perceptible play can be felt and still be free. This is to be tried with the rotor in the frame, the bearing housing in place, and all the screws in and tight. Keep the bearings free of grease and oil to get an accurate fit. Then remove the bearing housing, bearing inner race and oil flinger, and add one .002 to .0025 inch shim (Illust. 31). The washer shims must be between the inner race and the gear on the rotor shaft. After this set-up has been completed, be sure that

the shaft does not bind and that the preloading was completed with the last placed shim of .002 or .0025 inch. Too much preloading will ruin the bearing. Some relief to these bearings is provided as soon as the magneto starts to warm up on the engine. The aluminum frame expands more rapidly than the steel rotor shafts and thus relieves the preloading to a large de-

33. OUTER BEARING RACE REMOVAL AND INSTALLATION

The magneto outer bearing race in both the breaker housing and the magneto frame can be removed readily with tool (SE-1020) as shown in Illust. 29. Loosen the expander and insert the tool into the bearing race in the direction shown. Manipulate the split sleeve flange through the bearing race and hold it against the felt retainer. Now draw up on the expander by



Illust. 32 - Tools Used for Removing and Installing Magneto Outer Bearing Races.

- 1. Magneto bearing race puller tool SE-1020.
- 2. Installing tool SE-1021.
- Outer bearing race.
- Breaker housing.
- 5. Felt.
- Felt retainer, breaker housing end.
- 7. Frame.
- 8. Outer felt retainer.
- Inner felt retainer.



applying a wrench to the flats on the threaded end of the expander and turning in a counterclockwise direction until a definite pressure is felt; then tighten the hexagon nut and carefully drive the bearing race from place.

Before installing the outer bearing races, be sure the felts and retainers are correctly assembled in place. Set the bearing race on the end of tool (SE-1021). 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 into place.

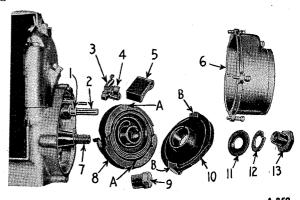
34. IMPULSE COUPLING - DESCRIPTION

A magneto is capable of delivering suitable sparks at higher speeds but, for slower speeds for starting. It is necessary to drive the rotor or armature through an impulse coupling. This impulse coupling permits the production of a strong magneto spark at the slowest cranking speeds. The impulse couplings furnished with the magnetos are completely automatic and require no adjustment and no manual engaging or disengaging. An occasional cleaning and generous lubrication with light engine oil is necessary for satisfactory impulse coupling performance.

The cam member (10, Illust. 33) is locked to the magneto drive shaft on the engine and it always rotates steadily at a definite ratio to the engine speed. The magneto member (8), with drive spring and engaging pawls, is keyed to the magneto rotor shaft driving end (7). The cam member and the magneto member are connected by a spiral drive spring, shown in magneto member (8).

As the cam member and the magneto member rotate slowly, a pawl (5, Illust. 33) which pivots on a pawl pin (2) mounted to the magneto frame, engages in the upper ratchet slot in the magneto member and prevents the magneto member from turning. The cam member continues to turn and winds up the drive spring for approximately 46 degrees. The pawl is then tripped from the ratchet slot by the cam member (10). The spiral drive spring unwinds, hurling the magneto member unit and rotor rapidly forward until the end of the milled slot (A) in magneto member strikes the lugs (B) on the cam member (Illust. 33). The complete coupling then will rotate at the same speed as a unit until the pawl catches on the following ratchet slot.

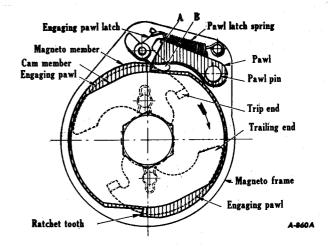
There are four equally spaced ratchet slots in the magneto member of the magneto coupling. Tripping of the pawl is timed to cause a spark to occur between the top dead center position and eight degrees after dead center, provided that the magneto is timed correctly to the engine.



Illust. 33 - Exploded View of Impulse Coupling.

- 1. Pawl spacer.
- 2. Pawl pin.
- 3. Pawl latch spring.
- 4. Engaging pawl. latch.
- 5. Pawl.
- Coupling cover.
- 7. Magneto rotor shaft
- 8. Magneto pawls with engaging pawls and drive spring.
- Impulse coupling puller tool MT-50.
- 10. Cam member.
- 11. Washer.
- 12. Lock washer.
- 13. Coupling nut.

The impulse coupling on the magneto is designed to throw out automatically at 130 to 200 rpm. As the speed of the impulse coupling increases, the cam member disengages the pawl from the ratchet teeth with greater force. When the throw-out speed is reached, the pawl is thrown high enough to catch the latch tip under pawl ledge (A, Illust. 34).



Illust. 34 - End View Drawing of Impulse Coupling.

MAGNETO

34. IMPULSE COUPLING - DESCRIPTION - Continued

In this position the pawl is supported out of engagement and the coupling rotates as a single unit, turning the magneto rotor at a steady speed with the engine. When the impulse coupling speed is reduced to between 125 to 145 rpm on the magneto, the coupling automatically comes into operation again. As the throw-in speed is reached, the trailing ends of the engaging pawls, which are the heavier, drop down on the magneto member hub when passing over the center of rotation. By so doing, the trip ends raise to a position where they will strike the lower arm of the engaging pawl latch (B, Illust. 34) releasing the latch from the pawl. The pawl then drops into working position and the impulse coupling is again in operation.

35. IMPULSE COUPLING TIMING

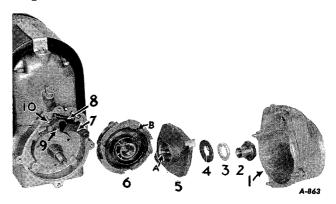
The oil cup is in a position in the impulse coupling housing where it can be used for a double purpose. First, to furnish an opening for lubricating the impulse coupling, and second, to furnish an opening through which the main pawl may be lifted to allow rotation of the magneto without the impulse action during the timing operation. By manipulating a light finishing nail through the oil cup as shown in Illust. 36, the pawl may be lifted free for rotation during timing. By placing the nail in the position shown in Illust. 36, and prying downward on the outer end, the pawl may be lifted and the latch will hold it up. It may be necessary to turn the rotor (or to rotate the magneto) to a point just past the trip of the impulse to accomplish the lifting of the pawl. If the pawl is in the low position and the impulse spring is partly wound up, it will be impossible to move it with the nail.

To return the pawl to the operating position, place the nail in the position as shown in Illust. 37, and press down on the outer end of the nail to lift the latch.

36. SERVICING IMPULSE COUPLING

To remove the coupling member (6, Illust. 35) start puller tool (MT-50) in the threads (Illust. 33), then lock the member with pawl (7, Illust. 35) and screw the puller until a considerable effort is required to turn it. If the impulse has been allowed to stand or operate without sufficient oil, the coupling member (6) may be rusted and stuck on the shaft. It may be necessary to use two screwdrivers, one on each side between the coupling and the magneto frame, and to hit the puller tool (MT-50) a rather hard blow, at the same time exerting pressure on the screwdrivers. Be careful

when this condition exists, to remove the member without damaging the threads or the magneto frame.



Illust. 35 - Impulse Coupling Disassembled From The Magneto.

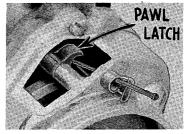
- 1. Cover.
- 2. Nut.
- Lock washer.
 Washer.
- 5. Cam member.
- 6. Coupling member.
 7. Pawl.

- 8. Latch spring.9. Pawl spacer.10. Pawl pin.



Illust. 36 - View Showing How the Main Pawl Can Be Lifted, Disengaging The Impulse Coupling for Free Rotation During Timing.

To separate the cam member from the magneto member, pull outward until the lugs clear; let it unwind about 1/2 turn, and then remove it. The drive spring can be pried out easily with a



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Illust. 37 - View Showing How the Latch is Tripped, Allowing the Pawl to Drop into the Operating Position.



screwdriver. When installing the spring, first hook it into position at "B" (Illust. 35), being sure it will wind in the counterclockwise direction shown. Wind the spring into position, using the right hand to push it down gradually and the left hand to hold the wound coils in place.

When assembling the coupling, be sure that the hub of magneto coupling member (6) is clean

and well oiled and, if the latch spring (8) is rusty, replace it with a new one. The couplings must be oiled generously with light engine oil at regular intervals. When the weather is extremely cold use kerosene.

Snap rings are used to hold the pawls in place. They must be tight on the pawl pins when in place or they will wear and fall off, causing damage to the magneto frame.





MAGNETO DRIVE

1. DESCRIPTION

The magneto drive is mounted to the rear of the hydraulic booster pump. It consists of a housing, a drive shaft, a driving shaft, an oil seal and three bushings. The magneto is mounted to the rear of the drive and is driven by the slotted drive shaft.

2. REMOVAL

1. Remove the cables from the magneto cap. Disconnect the grounding wire. Remove the two cap screws securing the magneto to the drive housing and remove the magneto. Remove the cap screws securing the magneto drive to the hydraulic booster pump and the mounting bracket. Remove the magneto drive assembly.

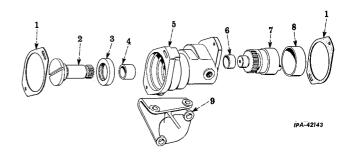
3. DISASSEMBLY (Refer to Illust. 1)

- 1. Pull the magneto drive shaft (2) and magneto driving shaft (7) out of the housing (5).
- 2. Press the oil seal (3) out of the housing.

4. INSPECTION AND REPAIR

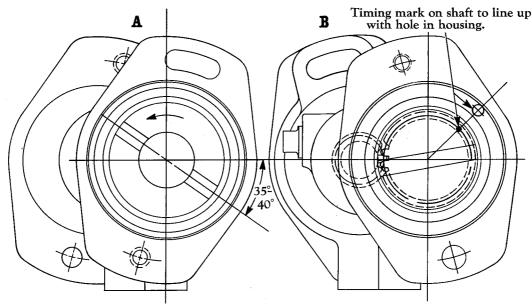
1. Wash all parts in an oil solvent and dry thoroughly with compressed air.

- 2. Inspect the shafts for signs of wear or scoring; replace if necessary.
- 3. Inspect the bushings in the housing. Remove and replace worn bushings.



Illust. 1 - Exploded View of Magneto Drive.

- 1. Gasket.
- 2. Magneto drive shaft.
- 3. Oil seal.
- 4. Drive shaft bushing.
- 5. Housing.
- 6. Drive shaft bushing (inner).
- 7. Magneto driving shaft.
- 8. Driving shaft bush-ing (outer)
- 9. Bracket.



View of magneto drive housing from magneto mounting flange with engine on cylinder No. 6 top dead center compression stroke. Driving tangs to be located by partially pulling out shaft to disengage gear teeth from mating gear and rotating to position shown.

View of magneto drive housing from hydraulic pump mounting flange with engine on cylinder No. 6 top dead center compression stroke.

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MAGNETO DRIVE

5. REASSEMBLY (Refer to Illust. 1)

- 1. Press new bushings (4, 6 and 8) into the housing (5). Also install oil seal (3).
- 2. Install driving shaft (7) so timing mark on the shaft will align with the hole in the housing (5) as shown in "B," Illust. 2.
- 3. Install the magneto drive shaft (2) in the housing so that the driving tangs are in the position shown in "A," Illust. 2.

6. INSTALLATION

- 1. Be sure that the drive and driving shafts are located in the housing as shown in Illust. 2.
- 2. Crank the engine until the number six cylinder is at top dead center of the compression stroke.

- 3. With the driving shaft in the position shown in "B," Illust. 2, mount the magneto drive to the hydraulic booster pump and bracket. Secure with cap screws.
- 4. Recheck the position of the driving slot with magneto drive shaft (A, Illust. 2). If the slot is not located properly, pull the shaft out of the housing far enough to disengage the gear and rotate the shaft to the position shown.
- 5. Fill the magneto drive housing to level of filler plug with chassis grease.
- 6. Install and time the magneto. Refer to par. 14 in this section.

MAGNETO

7. DESCRIPTION

The magneto is flange mounted to and driven by the magneto drive. It develops three sparks per crankshaft revolution, rotates at 3/4 engine speed and is fully enclosed against the entrance of dust, dirt and moisture. It is equipped with an automatic impulse coupling which makes possible the production, at cranking speed, of a spark equal to that developed when the engine is running. The coupling gives the rotor a short quick turn regardless of how slow the engine is cranked. It automatically disengages when the magneto attains a speed of approximately 180 rpm, and then acts as a positive drive only. The impulse coupling employs sliding "L" shaped weights and a coil type spring which absorbs the shock after impulsing. The cushioned action of the coupling minimizes the wear to both coupling and magneto parts. The vertical movement of the sliding "L" shaped weights is guided by the ears of the impulse member hub which engages the housing. The coupling is released by the arrester plate mounted at the shaft end of the magneto frame.

The magneto runs continuously when the engine operates either on the gasoline starting cycle or on the diesel cycle.

When the engine is operating on the diesel cycle, the magneto is grounded through a cut-out switch which operates off the intake manifold butterfly valve shaft. When the magneto is grounded through this switch, it will not supply spark to the spark plugs.

8. REMOVAL

Remove the cables from the magneto cap. Disconnect the grounding wire. Remove the two cap screws securing the magneto to the drive housing and remove the magneto.

9. DISASSEMBLY (Reference numbers refer to Illust. 3, except where indicated.)

Reassembly of the magneto will be easier if the parts are placed on a clean bench in the order in which they are removed.

- 1. Remove rotor shaft nut (1) and lock washer (2) (Illust. 4).
- 2. Remove housing (3), ball (4), spring (5), wick (6), cam (7) and the two weights (8) (Illust. 4).
- 3. Pull hub (9) from the shaft (Illust. 4). Remove key (25) (Illust. 3). Remove arrester plate (12) (Illust. 4) from the magneto housing. Note the position of the timing marks on the arrester plate, so that it can be installed in the same position.
- 4. Remove screws (73) and cover (68).
- 5. Disconnect electrical leads, attaching screws and breaker plate assembly (46).
- 6. Remove the contact points (49) and (53) from the breaker plate (46).
- 7. Remove screw (64), cam washer (63) and cam (62).



MAGNETO

- 8. Remove gear and rotor assembly (39), indicating washer (41) and condenser (43).
- 9. Pull drive gear (40) off rotor shaft and remove key (27).
- 10. Remove high-tension conductor insulation (15), four screws (30) and distributor gear bracket (33). Remove two screws (34) and high-tension conductor (35).
- 11. Remove magnet rotor (26), screws (11) and coil (16). If necessary remove bearings (23 and 37).

10. INSPECTION AND REPAIR

- 1. All metal parts except bearings should be cleaned in cleaning solvent, then thoroughly dried. Ball bearings and all insulated parts, distributor gear and distributor rotor should be wiped with a clean dry cloth.
- 2. Inspect the cables, coil and condenser for frayed or cracked insulation. Also for loose connections. Replace as necessary.
- 3. Inspect the housing ventilators and vent holes to be sure that they are open.
- 4. If the cam wick is frayed, worn or hard replace. Do not relubricate.
- 5. Check breaker lever spring tension (contact pressure should be 16 to 20 ounces). If necessary dress the contact points with a stone. DO NOT USE SANDPAPER OR A FILE.
- 6. Inspect the distributor rotor and gear for cracks, worn teeth or burrs. Replace if necessary.
- 7. Inspect the cover and distributor plate for cracks, carbon tracks and corroded brass inserts. If tracking is due to moisture, clean thoroughly and brush or spray with moisture-proof coating. Clean brass inserts.
- 8. Replace excessively worn brushes.
- 9. Inspect bearings for wear, replace if necessary.

11. REMAGNETIZING MAGNET ROTOR

- 1. Remove the magnet rotor from the magneto housing.
- 2. Determine the polarity of both the magnet rotor and magnetizer using a compass. The unlike poles of the magnet rotor and magnetizer must be placed together.

- 3. Place the magnet rotor between jaws and place on a magnetizing stand.
- 4. Width the magnetizer connected to a 12 volt D.C. power supply, allow current to flow through the magnet rotor for approximately five seconds; stop the current for about three seconds and repeat procedure three or four times.

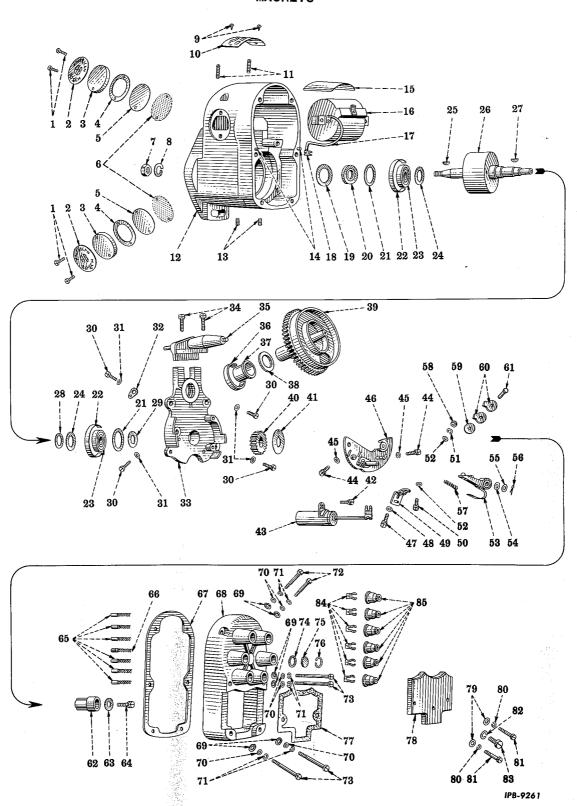
12. REASSEMBLY (Reference numbers refer to Illust. 3 except where indicated.)

- 1. Coat the lower half of the coil set screws (11) with white lead. Install the coil (16) and secure with set screws. Coat the upper protruding ends of each set screw with anti-drying black enamel.
- 2. If bearings were removed, insulation strips (22) and (36) must be placed between the outer race ring and wall of the bearing seat; any excess material can be removed with a sharp knife after the race ring has been properly seated.
- 3. Install the magnet rotor (26).
- 4. Install the high-tension conductor (35) and secure with screws (34). Install the distributor gear bracket (33) and secure with four screws (30). Install high-tension conductor insulation (15).
- NOTE: Coat the high-tension conductor and high-tension conductor insulation with ignition sealing compound to help prevent the accumulation of condensation.
- 5. Install key (27) and drive gear (40) on the rotor shaft.
- 6. Install the distributor gear and rotor assembly (39) and timing indicator disc (41). These parts must be installed simultaneously. The key slot in the center of the timing indicator disc is to engage the Woodruff key at the breaker end of the magnet rotor shaft. The slot in the outer rim of the timing disc must line up with the line under the letter "C" on the distributor rotor. The letter "C" denotes clockwise rotation. The gears must be set in accordance with the rotation of the magneto. THIS IS IMPORTANT. (Magnet rotor end play .0005-.002 inch.)
- 7. Install the condenser (43) and breaker plate assembly (46). (Select washers (55) to obtain .006 inch maximum breaker lever end play.)

(Continued on page 6.)



MAGNETO



Illust. 3 - Exploded View of Magneto (Less Impulse Coupling).



Legend for Illust, 3.

1.	Screw.
2.	Plate.
3.	Ventilator cover.
4.	Washer.
5.	Gasket.
6.	Screen.
7.	Nut.
8.	Lock washer.
9.	Screw.
1Ó.	Plate.
11.	Coil set screw.
12.	Magneto housing.
13.	Set screw.
14.	Pin.
15.	Insulation.
	Coil.
17.	Coil cable.
18.	Clip.
19.	Oil seal washer.
20.	Oil seal.
21.	Washer.
22.	Insulating strip.
23.	Ball bearing.
24.	Washer.
25.	Key.
26.	Magneto rotor.
27.	Key.
28.	Washer.
29.	Felt washer.
30.	Screw.
31.	Washer.
32.	Clip.
33.	Distributor gear bracket.
34.	Screw.
35.	High tension conductor.
36.	Insulating strip.
37.	Distributor gear shaft bearing.
38.	Washer.
39.	Gear and rotor.
40.	Magnet rotor shaft gear.
41.	Indicating washer.
42.	Screw.
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43. Condenser.
44. Screw.
45. Washer.
46. Breaker plate.
47. Screw.
48. Washer.
49. Adjustable contact point bracket.
50. Screw.
51. Washer.
52. Lock washer.
53. Breaker lever.54. Washer.
55. Washer.
56. Cotter pin.57. Brush.
58. Nut.
59. Washer.60. Felt wick.
61. Rivet.
62. Cam.
63. Cam washer.
64. Screw.
65. Brush.
66. Brush.
67. Gasket.
68. Distributor plate.
69. Washer. 70. Washer.
71. Lock washer.72. Screw.
72. Screw.
73. Screw.
74. Gasket.
75. Window.
76. Ring.
77. Gasket.
78. End Cap.
79. Washer.
80. Lock washer.
81. Screw.
82. Lock washer
83. Grounding screw.
84. Clip.
85. Nipple.
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MAGNETO

12. REASSEMBLY (Reference numbers refer to Illust. 3 except where indicated.) - Continued

NOTE: "E" gap or edge distance is .09842 inch. (Refer to par. 13 for detailed explanation.) Breaker point opening is .016 inch. (Refer to par. 15 for breaker point adjusting procedure.)

- 8. Install cam (62), washer (63) and screw (64). Note that the cam has two slots, each slot being marked with either a letter "A" (for counter-clockwise rotation) or "C" for clockwise rotation). Engage the slot marked with the letter "C" with the Woodruff key (27) at the breaker end of the magnet rotor shaft. THIS IS IMPORTANT.
- 9. Coat the recess, or pocket, in top of distributor cover (68) with ignition sealing compound to help prevent the accumulation of condensation. Install the cover and secure with screws (73).
- 10. Assemble the spring stop balls (4), spring (5) with felt wick (6) into the coupling housing (3, Illust. 4).
- 11. With the ear of coupling hub (9) facing you, engage pins of weights (8) in elongated slots of hub (9, Illust. 4).

NOTE: Letters "C" stamped on weights (8) must face up.

12. Place cam (7) on coupling hub (9) with letter "C" up. Engage ear on coupling hub between stop balls (4) in housing (3, Illust. 4) and press the two assemblies together.

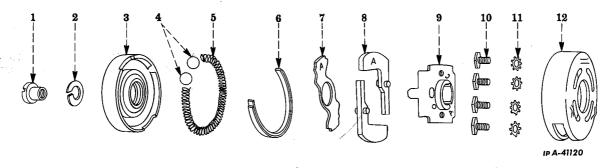
NOTE: To provide accurate setting of the impulse coupling, marks spaced 5° apart have been placed in the arrester plate (12). When the heavy center mark lines up with the fastening hole in the magneto housing, automatic retard or lag angle of impulse coupling is approximately 30°. Turning the arrester plate clockwise increases the automatic lag angle, and counterclockwise decreases the lag angle. Retards of from 10° to 50° are obtained by moving the arrester plate as outlined above.

- 13. Install the arrester plate (12, Illust. 4) to the magneto frame. Adjust the plate to the original retard setting which is 10°.
- 14. Install key (25, Illust. 3). Install the impulse coupling assembly on the magneto shaft with the keyway in the hub (9, Illust. 4) marked "C" aligned with the key in the shaft.
- 15. Secure the coupling assembly with rotor shaft nut (1) and lock washer (2, Illust. 4).

13. MAGNETO EDGE DISTANCE ("E" GAP)

Edge distance or "E" gap is the gap between the edge of the magnet rotor and the pole shoe in the magneto housing. It is important, from the standpoint of maximum efficiency, that the primary circuit in the coil winding is interrupted at the most favorable position of the rotor for maximum magnetic disturbance or change of flux. This position of the magnet rotor in relation to the pole shoe is expressed in terms of mechanical measurement called the "edge distance," or "E" gap.

The edge distance, is always determined as the magnet rotor LEAVES the pole shoe, NEVER when the magnet rotor approaches it.



Illust. 4 - Exploded View of Impulse Coupling.

- 1. Rotor shaft nut.
- 2. Lock washer.
- 3. Housing.
- 4. Ball.
- 5. Spring.
- 6. Wick.

- 7. Cam.
- 8. Weight.
- 9. Hub.
- 10. Screw.
- 11. Lock washer.
- 12. Arrester plate.



13. MAGNETO EDGE DISTANCE ("E" GAP) - Continued

With the breaker points facing you, insert a number 40 drill in the hole on the bottom right side of the magneto housing. Position the drill against the left side of the hole and position the rotor so the trailing edge of the magneto rotor is touching the drill. With the rotor in this position, the breaker contact points should be adjusted so that they have just started to open. This is very important.

The rapid change of flux, always takes place when the contact points open at the proper edge distance position of the rotor. This condition never changes. However, since both the breaker lever wear, the interruption of the primary circuit gradually occurs later and later, until it takes place after the proper edge distance is no longer maintained. This results in an improperly performing magneto. Therefore, it is always necessary when installing new contact points to adjust them in relation to the proper edge distance. It is also desirable after repeated adjustments of existing contact points to follow the same procedure.

14. INSTALLING AND TIMING THE MAGNETO TO THE ENGINE

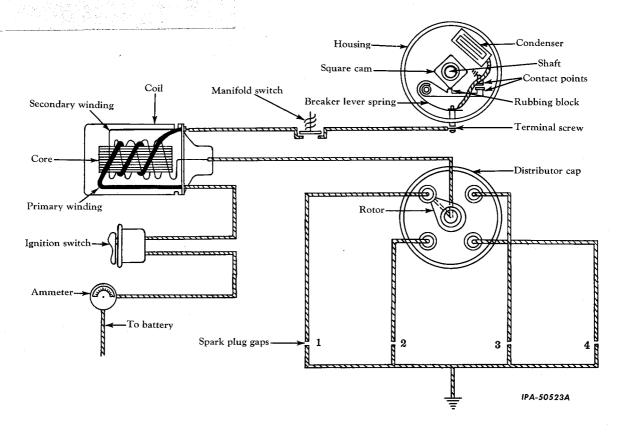
- 1. Set the compression release rod in the gasoline (starting) position. Crank the engine until the No. 1 piston (next to the radiator) is at the top dead center of the compression stroke. The compression stroke can be determined by removing the No. 1 spark plug, placing your thumb over the opening, and cranking the engine until an outward pressure can be felt.
- 2. Continue cranking until the timing mark "1 and 6 DC" on the flywheel is in line with the pointer. (To see timing mark and pointer remove the cover located just above the cranking motor.) Remove the magneto cover.
- 3. Rotate the magneto impulse coupling (counterclockwise) until the arrow on the distributor drive shaft points to the center No. 1 outlet. In performing this operation the magneto impulse coupling must be turned in the opposite direction from magneto drive, to prevent the engagement of the impulse coupling weights.

- 4. With No. 1 engine cylinder in correct firing position, (timing mark in line with pointer) flange the magneto to the drive housing and tighten the mounting screws by hand, but not so securely that the magneto cannot be moved. Rotate the top of the magneto toward the engine. APPROXIMATE timing to the engine is now obtained.
- 5. Crank the engine two complete revolutions so that No. 1 cylinder is again in firing position, (timing mark in line with pointer).
- 6. To obtain EXACT timing, the contact points should just now begin to open. Rotate the top of the magneto away from the engine until the impulse coupling trips. The magneto will be in time the instant the coupling trips. Hold the magneto in this position and tighten all mounting bolts.
- 7. Check magneto timing as follows:
 - a. Crank the engine slowly until the impulse coupling trips.
 - b. The timing marks on the flywheel should be in line with the pointer, or not more than eight degrees below. (One inch on the flywheel.) The timing mark should never be above the pointer.
 - c. Re-time the magneto if the timing mark and pointer are not properly aligned.
- 8. Replace magneto cover and install spark plug cables in cover.

15. ADJUSTING MAGNETO BREAKER POINTS

- 1. Remove the breaker housing cover. Crank the engine until the rubbing block is on the high point of the cam. Check the breaker point opening with a feeler gauge. The point opening should be .016 inch.
- 2. Adjust the moveable point so that the gauge will slip snugly into the opening. Tighten the moveable point lock screw and recheck the opening.





Illust. 1 - Schematic View of the Ignition System Using a High Tension Distributor (14 Series).

1. DESCRIPTION

The distributor has three functions: First, it opens and closes the low voltage circuit, between the source of current and the ignition coil, so that the primary winding (of the ignition coil) (Illusts. 1 and 3) 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) (Illusts. 1 and 3).

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 when 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.

2. REMOVAL

IH Model K

1. Remove the distributor cap by loosening the spring clips from the cap.



2. REMOVAL - Continued

IH Model K - Continued

- 2. Disconnect the primary (coil-to-distributor) cable from the distributor housing.
- 3. Loosen the distributor bracket set screw lock nut and remove the set screw.
- 4. Lift out the distributor and bracket.

IH Model H

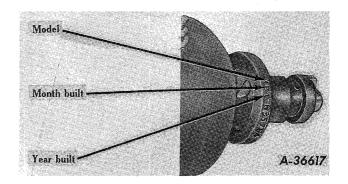
- 1. Remove the secondary (coil-to-distributor cap) cable from the ignition coil.
- 2. Remove the distributor cap by loosening the spring clips from the cap.
- 3. Remove the distributor drive housing mounting bolts.
- 4. Remove the distributor and drive housing.

3. DISASSEMBLY

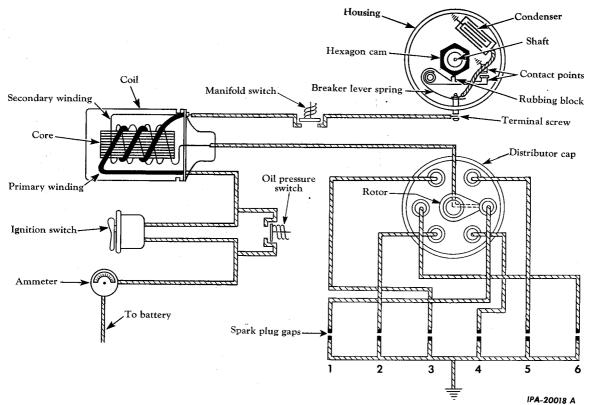
IH Model K

1. Remove the two slotted screws and mounting clamps from the bracket; remove the mounting bracket from the base of the housing.

- 2. Remove the distributor rotor (Illust. 4).
- CAUTION: The distributor rotor is made of bakelite, and will crack or break easily.
- 3. Remove the housing cover and felt seal (Illust. 5); rotating the cover will ease removal.
- 4. Remove the slotted screw from the condenser clamp; remove the primary terminal screw nut (the nut inside the housing), and remove the condenser.
- 5. Lift the breaker lever off the pivot (Illust. 8); remove the stationary point.



Illust. 2 - Model Designation.



Illust. 3 - Schematic View of the Ignition System Using a High Tension Distributor (18 Series).



2. REMOVAL - Continued

IH Model K - Continued

- 2. Disconnect the primary (coil-to-distributor) cable from the distributor housing.
- 3. Loosen the distributor bracket set screw lock nut and remove the set screw.
- 4. Lift out the distributor and bracket.

IH Model 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. Remove the distributor and drive housing.

3. DISASSEMBLY

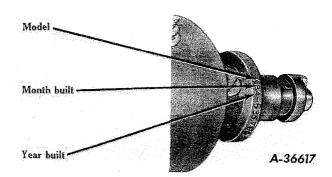
IH Model K

1. Remove the two slotted screws and mounting clamps from the bracket; remove the mounting bracket from the base of the housing.

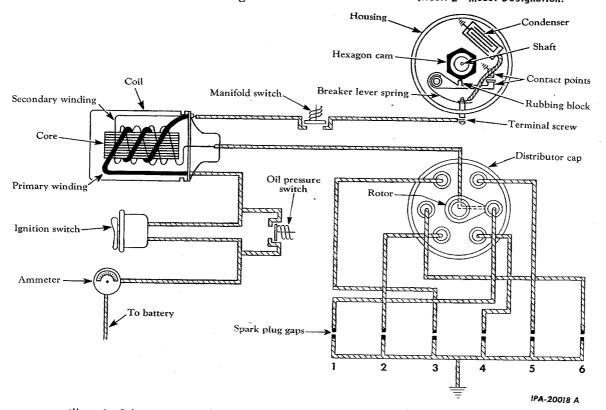
2. Remove the distributor rotor (Illust. 4).

CAUTION: The distributor rotor is made of bakelite, and will crack or break easily.

- 3. Remove the housing cover and felt seal (Illust. 5); rotating the cover will ease removal.
- 4. Remove the slotted screw from the condenser clamp; remove the primary terminal screw nut (the nut inside the housing), and remove the condenser.
- 5. Lift the breaker lever off the pivot (Illust. 8); remove the stationary point.



Illust. 2 - Model Designation.



Illust. 3 - Schematic View of the Ignition System Using a High Tension Distributor (18 Series).



- 6. Remove the terminal screw nuts (Illust. 10), lock washers, brass washers, terminal insulators, and terminal screw from the housings. (Refer to Illusts. 9 and 10.)
- 7. Remove the two slotted screws which secure the spring clips to the housings; remove the clips.
- 8. 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. 10).
- 9. Remove the pin that secures the coupling to the shaft and remove the coupling (Illust. 11).
- 10. Remove the shaft from the housing, using a twisting motion to facilitate removal (Illust. 12).
- 11. Remove the "O" ring from the retainer at the base of the housing (Illust. 13).

NOTE: The retainer does not have to be removed unless it is badly worn or scored.

12. If the bushing is badly worn or scored, the complete housing must be replaced.

IH Model H

NOTE: Due to the difference in direction or rotation, and/or amount of automatic advance, the design of parts varies from one distributor to another.

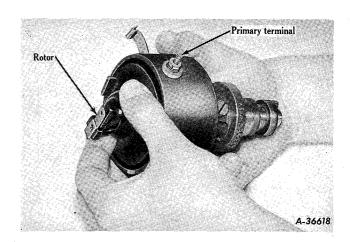
- 1. Remove the primary (coil-to-distributor) cable from the coil and distributor.
- 2. Remove the coil from the drive housing by removing two cap screws from the coil clamp and then lift off the coil.

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.

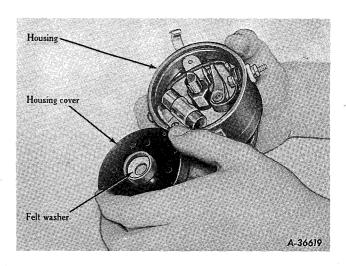
- 3. Remove the two distributor mounting clamps.
- 4. Remove the distributor from the drive housing.
- 5. Remove the distributor rotor (Illust. 4).

CAUTION: The distributor rotor is made of bakelite and will crack or break easily.

6. Remove the housing cover and felt seal; rotating the cover will ease removal. (Refer to Illust, 5.)



Illust. 4 - Removing Distributor Rotor (IH Model K Shown, Model H Similar).



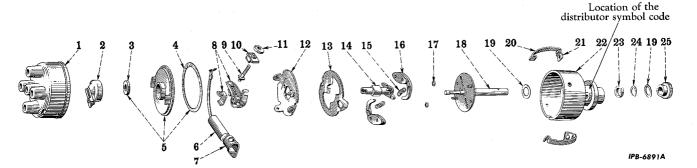
Illust. 5 - Removing Distributor Housing Cover and Felt Washer (IH Model K Shown, Model H Similar).

- 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. 7).
- 8. Lift the breaker lever off the pivot (Illust.
- 8). Remove the stationary point.
- 9. Remove the terminal screw nuts, lock washers, brass washers, terminal insulators and terminal screw from the housing. (Refer to Illusts. 9 and 10.)
- 10. Remove the two slotted screws which secure the spring clips to the housing; remove the clips.



3. DISASSEMBLY - Continued

IH Model H Continued



Illust. 6 - Battery Ignition Distributor (Type H).

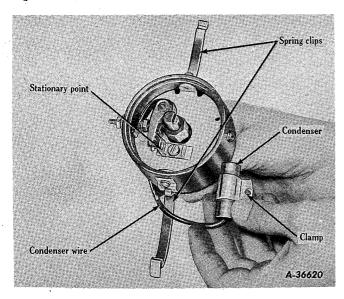
- Cap. Rotor. Felt seal.
- 4. Gasket. 5. Cover.
- 6. Condenser.
- Clamp.

- 8. Breaker points.
- 9. Screw.
- 10. Insulator.
- 11. Washer.
- 12. Plate.
- 13. Guard. *

- 14. Cam. *
- 15. Spring.*
- 16. Arm.* 17. Spacer.
- 18. Shaft.*
- 19. Washer.
- 20. Spring.21. Support.22. Housing.23. Retainer.

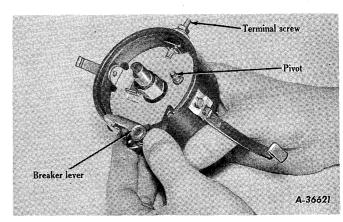
- 24. "O" ring.
- 25. Gear.

*Due to the difference in direction of rotation and/or amount of automatic advance, the design of parts varies from one distributor to another.

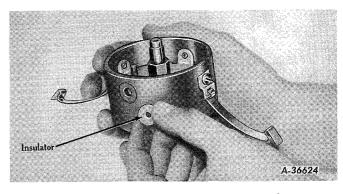


Illust. 7 - Removing Condenser (IH Model K Shown, Model H Similar).

- 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. 10).
- 12. Remove the governor weight guard by removing the two slotted screws, and lifting the guard out (Illust. 15).
- 13. Remove the governor weight springs.



Illust. 8 - Removing Breaker Lever (IH Model K Shown, Model H Similar).

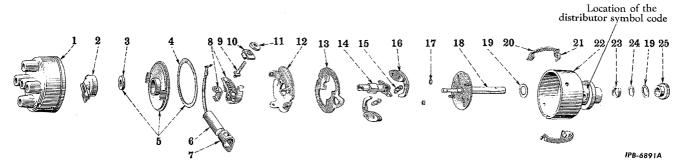


Illust. 9 - Removing Outside Terminal Insulator (IH Model K Shown, Model H Similar).



3. DISASSEMBLY - Continued

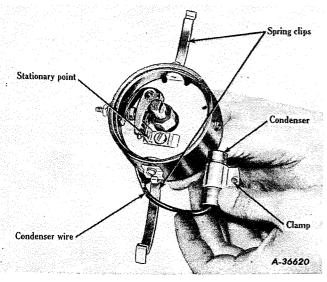
IH Model H Continued



Illust. 6 - Battery Ignition Distributor (Type H).

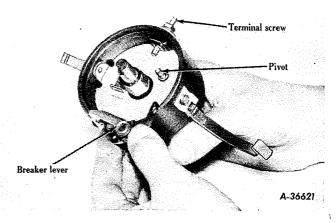
	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1					
 Cap. Rotor. Felt seal. Gasket. Cover. Condenser. Clamp. 	9. 10. 11. 12.	Breaker points. Screw. Insulator. Washer. Plate. Guard.*	15. 16. 17. 18.	Cam.* Spring.* Arm.* Spacer. Shaft.* Washer.	21. 22. 23. 24.	Spring. Support. Housing. Retainer "O" ring. Gear.

*Due to the difference in direction of rotation and/or amount of automatic advance, the design of parts varies from one distributor to another.

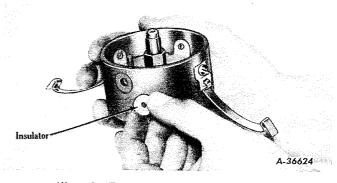


Illust. 7 - Removing Condenser (IH Model K Shown, Model H Similar).

- 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. 10).
- . Remove the governor weight guard by removing the two slotted screws, and lifting the guard out (Illust. 15).
- 13. Remove the governor weight springs.



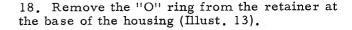
Illust. 8 - Removing Breaker Lever (IH Model K Shown, Model H Similar).



Illust. 9 - Removing Outside Terminal Insulator (IH Model K Shown, Model H Similar).

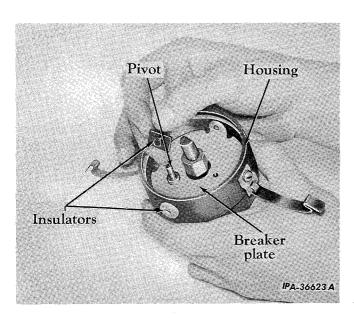


- 14. Lift out the governor weights and spacers (Illust. 16).
- 15. Lift the cam off the shaft.
- 16. Remove the pin from the drive gear and shaft. The gear can then be removed from the shaft (Illust. 17).
- 17. Remove the drive shaft through the top of the housing (Illust. 18).

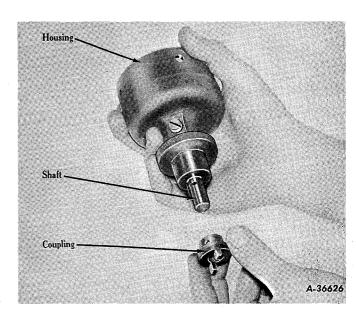


NOTE: The retainer does not have to be removed unless it is badly worn or scored.

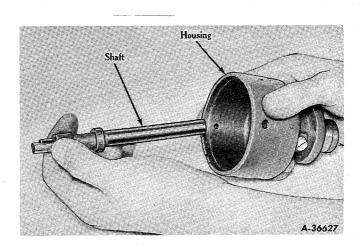
19. If the distributor shaft bushing is badly worn, scored or loose, replace the bushing as shown in Illust. 19.



Illust. 10 - Removing Inside Terminal Insulator (IH Model K Shown, Model H Similar).

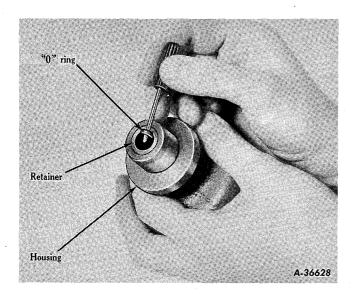


Illust. 11 - Removing IH Model K Coupling.

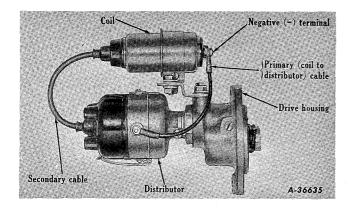


Illust. 12 - Removing IH Model K Drive Shaft.

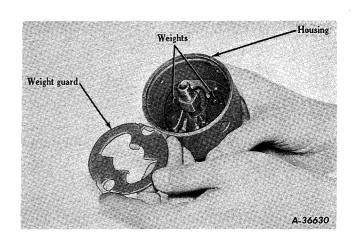




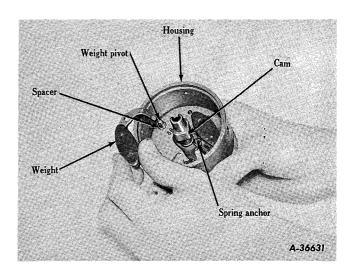
Illust. 13 - Removing Drive Shaft "O" Ring.



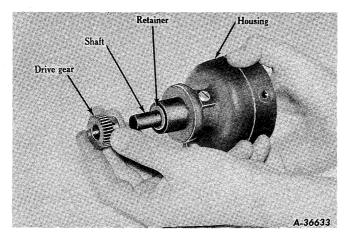
Illust. 14 - IH Model H Battery Ignition Unit.



Illust. 15 - Removing Weight Guard (IH Model H).

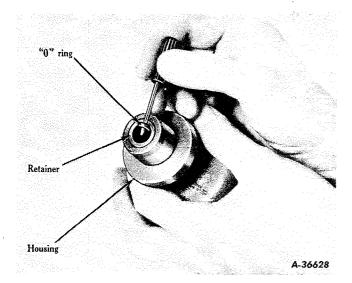


Illust. 16 - Removing Weights (IH Model H Shown).

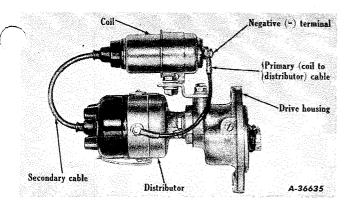


Illust. 17 - Removing Drive Gear (IH Model H).

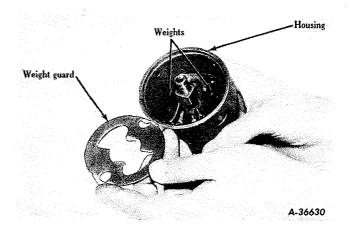




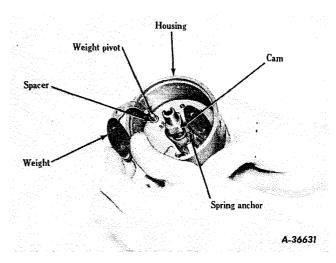
Illust. 13 - Removing Drive Shaft "O" Ring.



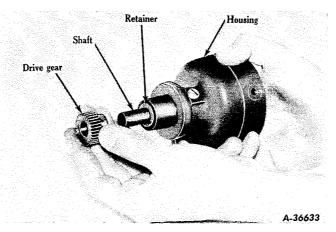
Illust. 14 - IH Model H Battery Ignition Unit.



Illust. 15 - Removing Weight Guard (IH Model H).

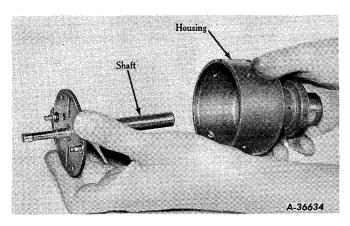


Illust. 16 - Removing Weights (IH Model H Shown).

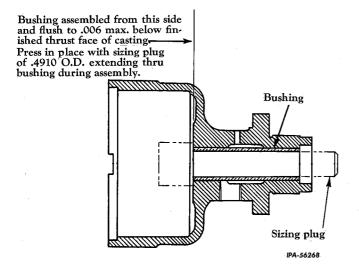


Illust. 17 - Removing Drive Gear (IH Model H).





Illust. 18 - Removing Drive Shaft (IH Model K Shown).

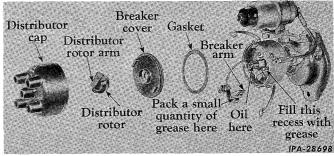


Illust. 19 - Distributor Shaft Bushing Installation.

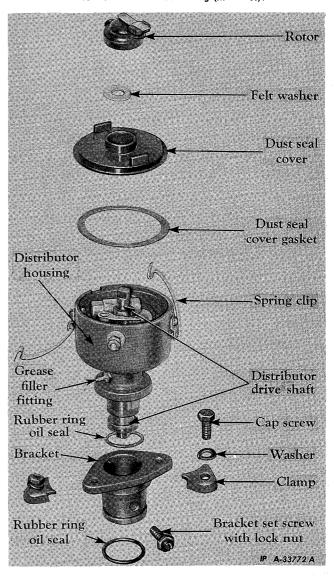
4. INSPECTION AND REPAIR

The distributor cap, rotor, insulating washers and bushings should be wiped thoroughly with a soft clean dry cloth; other parts should be cleaned with a cloth dampened with carbon tetrachloride or similar dry cleaning solvent.

CAUTION: Do not immerse distributor in a degreasing tank; to do so will ruin electrical parts.



Illust. 20 - Distributor partially
Disassembled for Servicing (Model H).



Illust. 21 - Distributor Partially
Disassembled for Servicing (Model K).



4. INSPECTION AND REPAIR - Continued

INSPECTION

- 1. Inspect the distributor cap, rotor and insulating washers for cracks, chips or burned surfaces.
- 2. Inspect distributor shaft bushings for excessive wear, damage or looseness.
- 3. Inspect contact points for pitting and burning, for oil and dirt and for correct gap setting.

- 4. Inspect for oxidized contact points.
- 5. Inspect condenser for secure connections.
- 6. Inspect condenser sealing for cracks.
- 7. Inspect condenser insulation for breakdown.
- 8. Inspect rubbing block for excessive wear.
- 9. Check breaker lever spring for correct tension.
- 10. Inspect ignition coil for secure terminals.
- 11. Inspect ignition coil for cracks and burns, or dents and punctures, in the coil insulation and containers.

REMEDY

- 1. Such damage can cause a leakage of high voltage to ground. Replace as necessary.
- 2. Replace. (Refer to Illust. 19.)
- 3. Clean points with a few strokes of a fine file or contact stone. Replace parts as necessary. Specified setting is .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.

- 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. 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 points.
- 6. Replace as necessary. Openings in condenser sealing may admit water or oil and cause a short circuit in the condenser.
- 7. Replace as necessary. Such breakdown will cause a short in the condenser.
- 8. Replace as necessary.
- 9. Weak tension on the spring may permit contacts to bounce and chatter, causing heavy burning and arcing of the points. Refer to "SPECIFICATIONS," in Section 1 for specified tension.
- 10. Tighten terminal connections.
- Replace as necessary.

5. REASSEMBLY

IH Model K

- 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 an "O" 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. 12) using a twisting motion.

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age 8



4. INSPECTION AND REPAIR - Continued

1. Inspect the distributor cap, rotor and insulating washers for cracks, chips or burned surfaces.

INSPECTION

- 2. Inspect distributor shaft bushings for excessive wear, damage or looseness.
- 3. Inspect contact points for pitting and burning, for oil and dirt and for correct gap setting.

- 4. Inspect for oxidized contact points.
- 5. Inspect condenser for secure connections.
- 6. Inspect condenser sealing for cracks.
- 7. Inspect condenser insulation for break-down.
- 8. Inspect rubbing block for excessive wear.
- 9. Check breaker lever spring for correct tension.
- 10. Inspect ignition coil for secure terminals.
- 11. Inspect ignition coil for cracks and burns, or dents and punctures, in the coil insulation and containers.

REMEDY

- 1. Such damage can cause a leakage of high voltage to ground. Replace as necessary.
- 2. Replace. (Refer to Illust. 19.)
- 3. Clean points with a few strokes of a fine file or contact stone. Replace parts as necessary. Specified setting is .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.

- 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. 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 points.
- 6. Replace as necessary. Openings in condenser sealing may admit water or oil and cause a short circuit in the condenser.
- 7. Replace as necessary. Such breakdown will cause a short in the condenser.
- 8. Replace as necessary.
- 9. Weak tension on the spring may permit contacts to bounce and chatter, causing heavy burning and arcing of the points. Refer to "SPECIFICATIONS," in Section 1 for specified tension.
- 10. Tighten terminal connections.
- 11. Replace as necessary.

5. REASSEMBLY

IH Model K

- 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 an "O" 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. 12) using a twisting motion.

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- 5. Install a second thrust washer on the coupling end of the shaft.
- 6. Install the coupling on the shaft (Illust. 11) and place a new pin through the coupling and shaft.

NOTE: Do not peen the pin.

- 7. Check the end play of the shaft between the coupling and the lower thrust washer. This end play should be .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. Install the breaker plate so that the threaded holes are facing upward (Illust. 10).
- 10. Install the spring clips and three slotted screws.
- 11. Install the two terminal screw insulators (Illusts. 9 and 10).
- 12. Install the terminal screw (Illust. 10) and secure with a brass washer, lock washer and a hex nut on the outside of the housing.
- 13. Install the breaker lever on the pivot so that the rubbing block is against the cam and the spring is on the terminal screw.
- 14. 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.
- 15. Place the brass washer and lock washer on the terminal screw. Start the hex nut, but do not tighten it.
- 16. Place the condenser on the breaker plate (Illust. 7) and secure with a slotted screw.
- 17. Connect the condenser wire to the terminal screw so that it is under the brass washer. Tighten the terminal screw hex nut.
- 18. Install the housing cover and felt washer in the housing (Illust. 5).
- 19. Install the rotor on the shaft (Illust. 4).
- 20. Install a new "O" ring in the mounting bracket.
- 21. Install the mounting bracket on the distirbutor housing, so that the long, flat side of the flange is under the terminal screw.

- 22. Install the mounting bracket clamps and secure with two slotted screws.
- 23. Install a new "O" ring in the groove at the base of the mounting bracket.

IH Model 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. 18) 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, 17) 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. The specified end play is .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. 16).
- 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. 15).
- 15. Install the breaker plate so that the threaded holes are facing upward (Illust. 10).
- 16. Install the two spring clips and three slotted screws.

5. REASSEMBLY - Continued

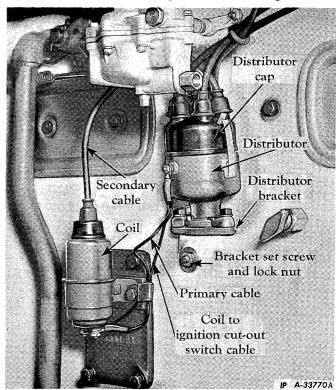
IH Model H - Continued

- 17. Install the two terminal screw insulators (Illusts. 9 and 10).
- 18. Install the terminal screw (Illust. 10) 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. 7) 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. 5).
- 25. Install the rotor on the shaft (Illust. 4).
- 26. Install the distributor in the drive housing.
- 27. Install the mounting clamps and cap screws, but do not tighten them.
- 28. On model H distributors the coil and clamps 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.

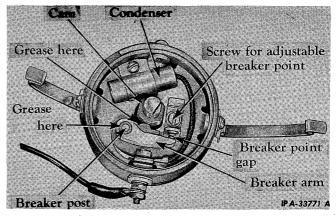
6. ADJUSTING THE DISTRIBUTOR CONTACT POINTS

Be sure the distributor cap is thoroughly clean both inside and outside and in serviceable condition. The rotor must also be clean. Unless the distributor points have been replaced, clean up the points with a few strokes of a fine cut, sharp file or an ignition file. Adjustment of the contact points can be made with the distributor mounted on the engine as follows:

- 1. Disconnect the coil-to-distributor secondary cable at the coil end. (Refer to Illust. 22.)
- 2. Remove the distributor cap, rotor and dust seal. Crank the engine slowly until the breaker arm rests on the high point of the cam lobe.
- 3. Check the opening between the breaker points, with a feeler gauge, when the rubbing block is on the high part of the cam. (Refer to Illust. 23.)
- 4. If the gap is not correct, adjust it by loosening the breaker arm locking screw with a screwdriver and turning the eccentric screw until there is the specified gap between the contact points. (Refer to Illust. 23.) Tighten the locking screw.



Illust. 22 - Battery Ignition Unit (18 Series).



Illust. 23-- Adjusting Breaker Points.



5. REASSEMBLY - Continued

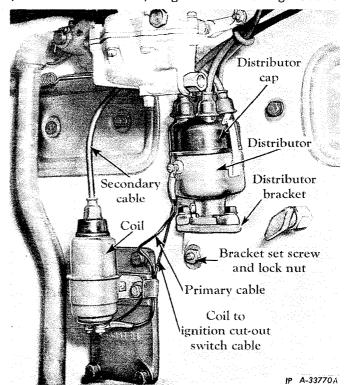
IH Model H - Continued

- 17. Install the two terminal screw insulators (Illusts. 9 and 10).
- 18. Install the terminal screw (Illust. 10) 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. 7) and secure it with a slotted screw.
- . Connect the condenser wire to the termi-A 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. 5).
- 25. Install the rotor on the shaft (Illust. 4).
- 26. Install the distributor in the drive housing.
- 27. Install the mounting clamps and cap screws, but do not tighten them.
- 28. On model H distributors the coil and clamps 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.

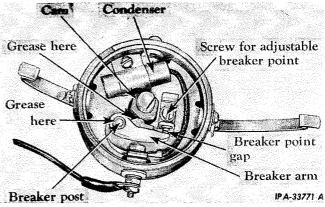
6. ADJUSTING THE DISTRIBUTOR CONTACT POINTS

Be sure the distributor cap is thoroughly clean both inside and outside and in serviceable condition. The rotor must also be clean. Unless distributor points have been replaced, clean up the points with a few strokes of a fine cut, sharp file or an ignition file. Adjustment of the contact points can be made with the distributor mounted on the engine as follows:

- 1. Disconnect the coil-to-distributor secondary cable at the coil end. (Refer to Illust. 22.)
- 2. Remove the distributor cap, rotor and dust seal. Crank the engine slowly until the breaker arm rests on the high point of the cam lobe.
- 3. Check the opening between the breaker points, with a feeler gauge, when the rubbing block is on the high part of the cam. (Refer to Illust. 23.)
- 4. If the gap is not correct, adjust it by loosening the breaker arm locking screw with a screw-driver and turning the eccentric screw until there is the specified gap between the contact points. (Refer to Illust. 23.) Tighten the locking screw.



Illust. 22 - Battery Ignition Unit (18 Series).



Illust. 23-- Adjusting Breaker Points.



INSTALLATION

IH Model K

A. CRANKSHAFT POSITION KNOWN.

NOTE: The following instructions will apply only if the engine crankshaft has not been rotated since the distributor was removed. If for any reason the engine has been rotated, refer to the instructions under "B."

- 1. If the distributor bracket was removed, inspect the condition of the rubber ring oil seal in the base of the bracket. Replace the seal if it is worn or broken.
- 2. Apply a light coat of grease to the seal ring and install the bracket. Tighten the set screw and lock nut.
- 3. Place the rotor on the distributor shaft and carefully press it into position.
- 4. Rotate the rotor so the tip is in alignment with the scribe mark made on the housing during removal.
- 5. Slide the distributor into the bracket and line up the scribe marks of the bracket and distributor housing. The tang must now be in the groove.
- 6. Install the hold-down clamps, washers and cap screws and tighten securely.
- 7. Connect the distributor-to-coil cable (primary) to the terminal on the side of the distributor housing. (Refer to Illust. 22.)
- 8. Remove the rotor and install the dust seal cover and gasket. (Refer to Illust. 21.)
- 9. Install the dust cover felt over the end of the distributor shaft. (Refer to Illust. 21.)
- 10. Install the rotor on the distributor shaft, pressing it carefully into position.
- 11. Connect the coil-to-distributor cable (secondary) to the distributor cap. (Refer to Illust. 22.)

NOTE: If the spark plug cables have been removed from the distributor cap, insert them consecutively in a counterclockwise rotation in their proper firing order. Refer to "SPECIFICATIONS" in Section 1.

12. Install the distributor cap to the housing with the tang in the cap lining up with the slot in the distributor housing.

CAUTION: If the distributor cap is incorrectly

positioned on the housing, the rotor will be damaged when attempting to start the engine.

B. CRANKSHAFT POSITION UNKNOWN.

- 1. Remove the No. 1 spark plug. Crank the engine and hold the thumb over the spark plug hole until an outward pressure is felt. Continue cranking the engine slowly until the "DC/1-6" mark on the flywheel is in line with the pointer on the flywheel housing.
- 2. If the distributor bracket was removed, inspect the rubber oil seal at the base of the bracket for excessive wear or damage. Apply a light coat of grease to the seal before installing it on the bracket.
- 3. Install the bracket in the crankcase and tighten the set screw and lock nut.
- 4. Install the rotor on the distributor shaft by carefully pressing it into position. While holding the cap approximately in the correct position, rotate the rotor with the point in the direction of the No. 1 terminal of the distributor cap.
- 5. Install the distributor in the mounting hole on the engine, lining up the scribe marks on the distributor and bracket.

NOTE: It may be necessary to move the rotor slightly to engage the tang in the slot of the drive coupling. The rotor will line up with the No. 1 terminal post when the distributor is down in place.

- 6. Seat the base of the distributor housing on the distributor bracket flange and install the distributor hold-down clamps, washers and cap screws. Tighten the cap screws enough to prevent the distributor from turning freely.
- 7. Connect the distributor-to-coil cable (primary) to the terminal on the side of the distributor housing. (Refer to Illust. 22.)
- 8. Remove the rotor and install the dust seal cover and gasket. (Refer to Illust. 21.)
- 9. Install the dust cover felt over the end of the distributor shaft. (Refer to Illust. 21.)
- 10. Install the rotor on the distributor shaft and press it carefully into position.
- 11. Connect the coil-to-distributor cable (secondary) to the distributor cap. (Refer to Illust. 22.)



7. INSTALLATION - Continued

B. CRANKSHAFT POSITION UNKNOWN - Continued

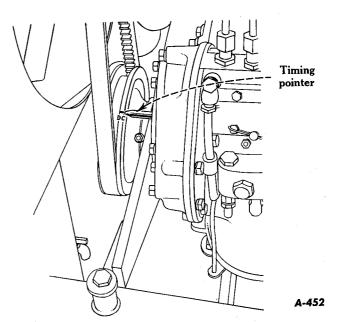
NOTE: If the spark plug cables have been removed from the distributor cap, insert them consecutively in counterclockwise rotation, according to the cylinder firing order: 1-5-3-6-2-4.

12. Install the distributor cap to the housing with the tang in the cap lining up with the slot in the distributor housing.

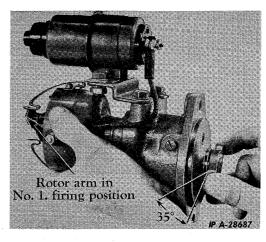
CAUTION: If the distributor cap is incorrectly positioned on the housing, the rotor will be damaged when attempting to start the engine.

IH Model H

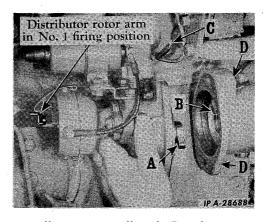
- 1. Before installing the distributor it will be necessary to crank the engine until No. 1 piston (next to radiator) is on the top dead center of the compression stroke. The compression stroke can be determined by removing the No. 1 spark plug, placing a thumb over the opening and cranking the engine 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 front cover. Refer to Illust. 24.
- 2. Hold the unit in one hand and turn the drive lugs in a counterclockwise direction until the rotor arm is approximately in the No. 1 firing position. Refer to Illust. 25. Then continue to turn slowly and lightly until a slight resistance is felt.
- 3. Pull out the drive shaft to disengage the gears; then turn the shaft counterclockwise so the drive shaft lugs "A" are approximately 35 degrees past horizontal or approximately in the same position as drive shaft slots "B." Refer to Illust. 26. Engage the gears and press the drive shaft in with the palm of the hand.
- 4. Assemble the unit and gasket. Fasten with the mounting bolts and washers, using the mounting clip in front of the lock washer on the top bolt. Assemble the distributor cap.
- 5. Connect the ignition cut-out switch cable "C" (Illust. 26) to the negative (-) terminal on the ignition coil.



Illust. 24 - Timing pointer and "DC" mark.



Illust. 25 - Adjusting Distributor Rotor and Drive Shaft Lugs for Timing Distributor.



Illust. 26 - Installing the Distributor.



7. INSTALLATION - Continued

B. CRANKSHAFT POSITION UNKNOWN - Continued

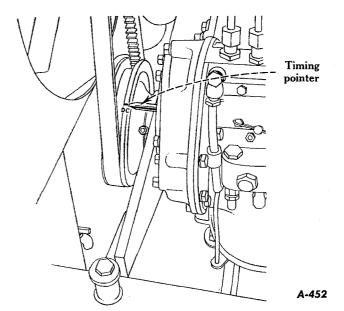
NOTE: If the spark plug cables have been removed from the distributor cap, insert them consecutively in counterclockwise rotation, according to the cylinder firing order: 1-5-3-6-2-4.

12. Install the distributor cap to the housing with the tang in the cap lining up with the slot in the distributor housing.

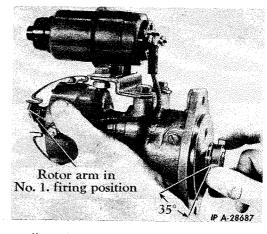
CAUTION: If the distributor cap is incorrectly positioned on the housing, the rotor will be damaged when attempting to start the engine.

IH Model H

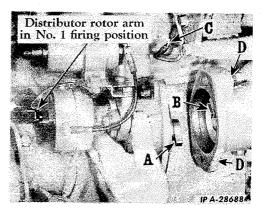
- 1. Before installing the distributor it will be necessary to crank the engine until No. 1 piston (next to radiator) is on the top dead center of he compression stroke. The compression troke can be determined by removing the No. 1 spark plug, placing a thumb over the opening and cranking the engine 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 front cover. Refer to Illust. 24.
- 2. Hold the unit in one hand and turn the drive lugs in a counterclockwise direction until the rotor arm is approximately in the No. 1 firing position. Refer to Illust. 25. Then continue to turn slowly and lightly until a slight resistance is felt.
- 3. Pull out the drive shaft to disengage the gears; then turn the shaft counterclockwise so the drive shaft lugs "A" are approximately 35 degrees past horizontal or approximately in the same position as drive shaft slots "B." Refer to Illust. 26. Engage the gears and press the drive shaft in with the palm of the hand.
- 4. Assemble the unit and gasket. Fasten with the mounting bolts and washers, using the mounting clip in front of the lock washer on the top bolt. Assemble the distributor cap.
- 5. Connect the ignition cut-out switch cable "C" (Illust. 26) to the negative (-) terminal on the ignition coil.



Illust. 24 - Timing pointer and "DC" mark.



Illust. 25 - Adjusting Distributor Rotor and Drive Shaft Lugs for Timing Distributor.



Illust. 26 - Installing the Distributor





8. IGNITION TIMING

IH Model K

- 1. Start the engine on gasoline cycle and allow a brief warm up period before continuing with the next step.
- 2. Loosen the distributor hold-down clamps and rotate the distributor to the left or right until the best performance is obtained.

NOTE: Rotating the distributor to the right (clockwise) advances the spark; to the left (counterclockwise) will retard the spark.

3. Tighten the hold-down clamps to secure the distributor in position.

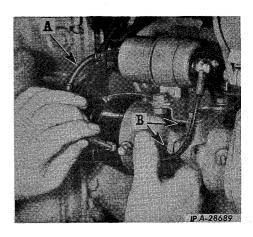
NOTE: The distributor should be timed properly when the spring clips are approximately parallel to the center line of the engine. The distributor may be rotated slightly either way for exact timing.

IH Model H

The timing operation must be performed while the engine is on the gasoline cycle.

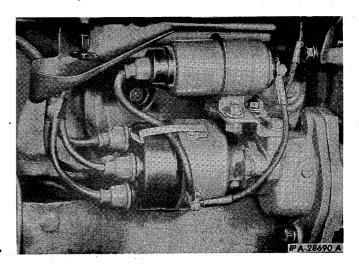
- 1. Loosen the distributor mounting bolts "B" (Illust. 27). Set the engine on the top dead center of the firing stroke of the No. 1 cylinder. Assemble the secondary cable properly in the coil terminal. Pull out the ignition switch and note if the ammeter shows discharge. If so, the points are closed 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 the cam rotation. Pull the secondary cable "A" (Illust. 27) out of the center socket on the distributor cap and hold the free end of the cable within 1/16 inch to 1/8 inch from the distributor primary terminal, as shown in IIlust. 27. Advance the distributor by turning the distributor body slowly in a direction opposite to the cam rotation until a spark occurs.
- 2. Place the secondary cable under the distributor cap spring and place the terminal within 1/16 inch to 1/8 inch of the distributor primary terminal as shown in Illust. 28. Make a final check by cranking the engine until the "DC" notch on the fan drive pulley is in line with the pointer on the crankcase front cover (refer to

Illust. 28) and continuing until the spark just occurs at the gap between the secondary cable and the primary terminal. The timing mark should be just in line or slightly past the timing pointer.



Illust. 27 - Advancing Distributor While Holding Secondary Cable 1/16 to 1/8 Inch From Primary Terminal.

NOTE: Never time before top dead center. If necessary, make the required adjustment to have the spark occur as specified. Retighten the distributor mounting bolts. Assemble the secondary cable in the distributor cap.



Illust. 28 - Secondary Cable Held Under Distributor Cap Spring for Final Check of Timing.

3. Attach the spark plug cables to the spark plugs and to the terminal sockets of the distributor cap.





1. DESCRIPTION

The types of cranking motors on the 14 and 18 series tractor and power unit engines are listed in "Chart A - Cranking Motors" in Section 1. 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 switches are of the push button type. Replace defective switches with new ones instead of attempting a repair (see 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 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 to 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 demeshes 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 that 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-andsleeve 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 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 springloaded by small plungers.

When the shift lever is operated, the clutch assembly is moved endwise along the armature shaft so that the pinion meshes with the flywheel ring gear. If the teeth should butt instead of mesh, the clutch spring compresses so that the pinion is spring-loaded against the ringgear 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-andsleeve 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 to drive the cranking motor armature, through the pinion, 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, and thus permits the pinion to overrun.

This protects the armature for the brief period in which instant 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 should be inspected periodically to determine its condition (see outline below), while it is still mounted on the engine. However, inspection should also 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.



2. MINOR REPAIRS AND ADJUSTMENTS - Continued

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 between crankings.

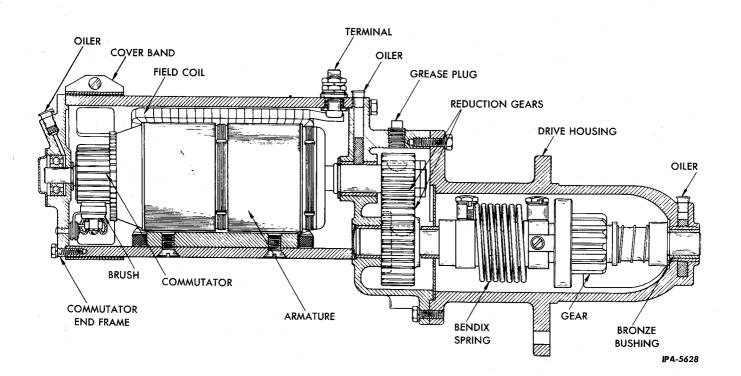
4. If the brush length is less than 1/2 inch, or if the brush leads have borken strands or are otherwise damaged, the brushes must be replaced.

New brushes should be seated with a brush seating 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. See par. 2, "SPECI-FICATIONS" in Section 1. It is important that the tension is correct, since excessive 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.



Illust. 1 - Cross Section of Cranking Motor with Bendix Drive.



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 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 "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 the 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 series) in the circuit.

5. DISASSEMBLY

Disassembly should proceed only as far is necessary to make repairs or replace defective parts.

For example, the field coils should be checked for opens or grounds and, if found to be in normal condition, should 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. DISASSEMBLY - Continued

Standard Bendix Drive - Continued

5. Unscrew the shaft spring screw to separate the drive spring from the drive pinion and shaft assembly. Discard the tang washers.

Solenoid Overrunning Clutch

- 1. Remove the starting solenoid assembly 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, field frame assembly and the drive housing.
- 4. Remove the center bearing by removing the two screws and washers.
- 5. The shift lever with attaching parts and the overrunning clutch or motor drive may be taken from the drive housing.

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 the cranking motor bushings for roughness or scoring and replace if necessary.
- 3. Inspect the armature commutator. If it is worn, dirty, out-of-round or has high mica, the armature should be put in a lathe, the commutator turned down and the mica undercut. The mica should 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 under cutting.
- 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 melting of the solder that will be thrown on the cover band. Resolder the leads in the riser bars (using resin 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 ISS-1038, 9-58.

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 the 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 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. Care must be used 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.

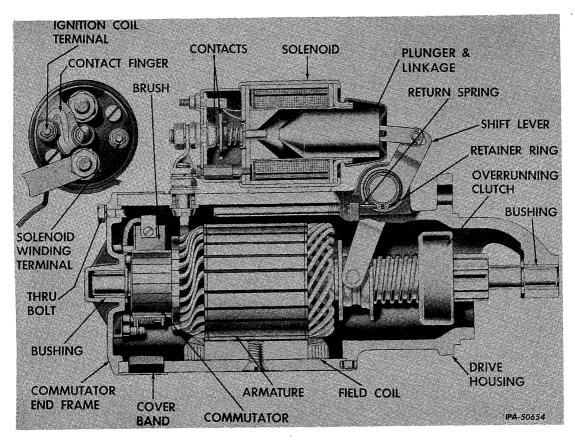
Usually, if a field coil is open or shorted internally, it will require replacement since it is difficult to repair such a defect.

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. A pole shoe spreader should 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, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe. If the varnish coating on the field coils becomes hard and interfers with assembly they may be heated in an oven to soften sufficiently for easy installation.

Grounded field coils may sometimes be repaired by removing and reinsulating them. Care must be used 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.



Illust. 2 - Sectional View of Overrunning Clutch Drive, Solenoid-Operated Cranking Motor.

8. LUBRICATION

Whenever the cranking motor is removed from the engine and disassembled, careful lubrication service should be performed depending upon the type of lubrication fittings on the motor. Grease plugs should be repacked, oil wicks should be resaturated, and oilless bushings should be given a few drops of light engine oil. Drive mechanisms should 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 and never lubricate 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.

Solenoid Overrunning Clutch

(Illust. 3)

- 1. Install the shift lever with attaching parts and the overrunning clutch or motor drive to the drive housing.
- 2. Install the center bearing using two screws and washers.



9. REASSEMBLY - Continued

Solenoid Overrunning Clutch - Continued (Refer to Illust. 2)

- 3. Assemble together the drive housing, field frame assembly, commutator end frame, and install the thru bolts.
- 4. Install the brush leads to the field leads.
- 5. Install the cover band. Install the starting solenoid assembly 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 electrical cables to the cranking motor and be sure all connections are tight.

11. ADJUSTMENT - CRANKING MOTOR PINION

Manually Operated Overrunning Clutch (Refer to Illust. 3)

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 should be 23/64 inch $\pm 1/32$ inch. Adjust by turning the lever adjusting screw in or out as necessary.

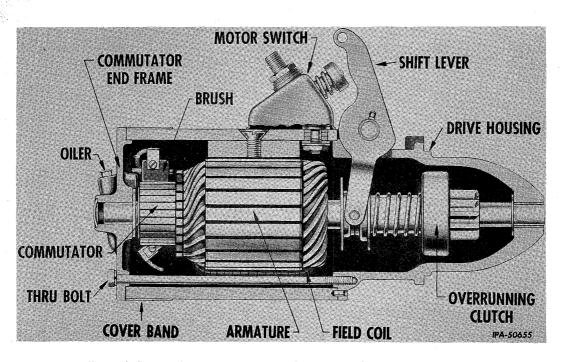
Solenoid Operated Overrunning Clutch

After the cranking motor is reassembled, the pinion clearance must be adjusted to give sufficient clearance between the end of the pinion gear and the "nose" of the housing when the gear is in mesh with the ring gear of the engine (Illust. 4).

Clamp the cranking motor in a vise and remove the cable from the 'motor' terminal of the solenoid so 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) and push the solenoid plunger in by hand.

The battery current will hold it there while the pinion clearance is being adjusted. Loosen the solenoid switch mounting screws and 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.



Illust. 3 - Sectional View - Overrunning Clutch, Manually Operated Shift Lever.

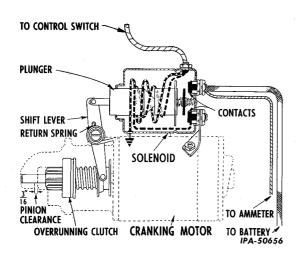


Moving the switch toward the lever increases the clearance, and moving the switch away from the lever decreases the pinion clearance. (Illust. 5.)

Tighten the solenoid switch mounting screws, and replace the connector at "motor" terminal of the solenoid.

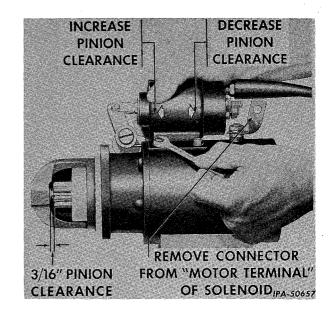
Solenoid Check

1. Connect a test lamp between the "switch" and "battery" terminals of the solenoid.



Illust. 4 - Schematic Diagram of Overrunning Clutch Type Cranking Motor - Showing Pinion Clearance.

- 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.
- * 12 volt motor 9 volts



Illust. 5 - Adjusting Pinion Clearance.



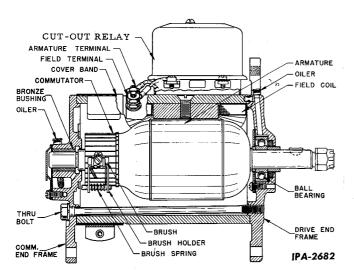


GENERATOR

1. DESCRIPTION

The purpose of the generator is to provide a source of electrical current to maintain the storage batteries in a charged condition or to recharge them when they have become discharged. Also, to supply sufficient current to carry the electrical load requirements of an engine up to the rated capacity of the generator.

The generator is sealed against the entrance of dirt and moisture. It is driven by a V-belt from the fan and water pump pulley, and mounted on the right side of the engine. The direction of rotation for all generators used is clockwise, viewed from the drive end.



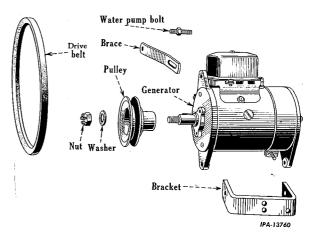
Illust. 1 - Cross Section of Generator.

The three types of generators covered in this section are:

- a. Adjustable third brush.
- b. Fixed third brush.
- c. Shunt wound (two brush).

On engines equipped with the adjustable third brush type generators, the maximum output of the generator is adjustable by moving the third brush closer to or away from the main brush.

On engines equipped with the fixed third brush or the shunt wound type generators, the output is controlled or limited by the current-voltage regulator, which prevents the output voltage from exceeding the predetermined limits. (Refer to "SPECIFICATIONS" in Section 1.)



Illust. 2 - Generator Removed (UD-14A).

2. REMOVAL

- 1. Remove the nuts, lock washers and leads from the terminals on the generator and the generator regulator unit, tagging each to facilitate replacement.
- 2. Remove the adjusting cap screw, lock washer and plain washer, which secure the generator brace to the generator housing, and 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 pulley.
- 4. Remove the mounting screws and lift the generator from the generator bracket.

3. INSPECTION AND REPAIR

1. Clean the generator externally by wiping 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 wiring 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. 13).
- 5. Keep the commutator clean and free from grease and dirt. If the commutator is dirty or burned, polish it with No. "00" sandpaper.



GENERATOR



3. INSPECTION AND REPAIR - Continued

CAUTION: Never use emery cloth or carborundum to clean the commutator or brushes. Particles of these abrasives imbed in the surfaces of the commutator and brushes where they burn, greatly reducing the life of the commutator or brush. Blow out the dust after cleaning.

4. ADJUSTMENTS

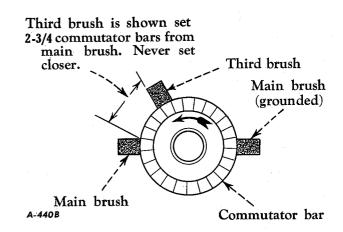
Adjusting Generator Charging Rate - Adjustable Third Brush Type

- 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 should be in accordance with "SPECIFICATIONS" in Section 1.
- 2. If the charging rate is too low, check the commutator and brushes for oil and grease deposits. Check the generator belt tension. If these checks prove satisfactory, 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. 3). When the required adjustment is made, secure the third brush and carrier by tightening the lock screw. Reassemble the cover band and recheck the charging rate.

Checking Brush Spring Tension

- 1. The generator brush tension should be as specified in "SPECIFICATIONS" in Section 1. Any brush spring 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 a generator output, cause sparking with consequent arcing, and burning of brushes and commutator.
- 2. After checking brush springs for the correct tension, inspect the brush pigtail leads



Illust. 3 - Adjustable Third Brush Setting.

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 a burned field or armature winding and a low current output.

Brush Length

Brushes should 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 generator 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, as follows:

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 light, and check as follows:





GENERATOR

- 1. Raise the grounded brush; check with test points from "A" terminal to frame. The light 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 B in "SPECIFICATIONS" in Section 1.
- 4. If the problem has not been located as yet, remove the armature, and check on a growler for short circuit.

Unsteady or Low Output

- 1. Check brush spring tension and brushes for sticking.
- 2. Inspect the commutator for roughness, grease, dirt, dirt in slots, high mica and outof-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. 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, check the field oils for opens, shorts or grounds be-

fore 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 bearing.

NOTE: The 18A series engines generator does not have a pulley, but has a coupling that is pinned to the armature. This pin must be removed before the coupling and drive end frame can be removed from the armature shaft.

Field Coil Removal

Field coils can be removed most easily from the field frame, by using 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 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 (refer to "VOLT-AGE REGULATOR" in Section 17).
- 6. Check the generator output on the ammeter.



DRIVE BELTS

9. DESCRIPTION

The generator drive belt is a single or double (type varies with engines) continuous V-belt located 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 toward the engine to relieve the belt tension. Remove the belt from the generator pulley.
- 2. On the 14 series engine, remove the fan belt, (refer to "Cooling System" in the Operator's Manual). Lift the generator belt from its groove on the fan pulley hub, and hang the belt immediately behind the fan so the lower end will hang just between the fan housing sheets. Turn the fan by hand, and pass the lower end of the belt over each blade as it passes bottom position. Remove the generator belt from between the fan and radiator core.
- 3. On other series engines, 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.

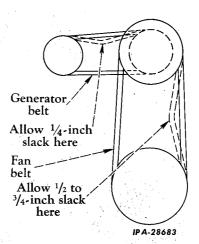
12. INSTALLATION

Reverse the procedure for removing the belts. Adjust the belt tension (par. 13).

13. ADJUSTING THE GENERATOR BELT

Check the slack of the generator belt to assure maintenance of the correct tension. The belt should never be loose enough to allow slippage and should not be so tight as to cause excessive side-thrust on the generator bearing.

Adjust the generator belt tension by loosening the generator brace bolt and generator mounting bolts, and moving the generator toward or away from the engine. Tighten the generator brace bolt and mounting bolts after the tension is taken up. The tension is correct when the belt can be depressed without effort by the thumb approximately 1/4 inch midway between the two pulleys (Illust. 4). (Refer to "SPECIFICATIONS" in Section 1.)



Illust. 5 - Correct Belt Tension (14 Series).



1. DESCRIPTION

The output of a generator is controlled or limited according to the requirements of the tractor or power unit with which it is used. This adjustment of output is accomplished by using a regulator of specific design for use with certain type generators, and described in the following paragraphs.

The combined current-voltage regulator (two-unit) consists of a cutout relay and a combination current-voltage regulator.

The standard three-unit regulator consists of a cutout relay, a voltage regulator and a current regulator unit.

CUTOUT RELAY: The cutout relay is used to close the circuit between the generator and the battery when the generator voltage is sufficient to charge the battery. It opens the circuit when the generator slows or stops, to prevent the battery from discharging through the generator.

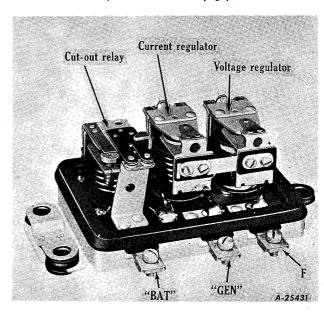
VOLTAGE REGULATOR: The voltage regulator is a voltage-limiting device, which prevents the voltage from exceeding a specified maximum and reduces the generator output to a value required for any particular condition of battery charge and electrical load.

CURRENT REGULATOR: The current regulator is a current-limiting device, which prevents the generator from overloading itself when the voltage regulator is not operating.

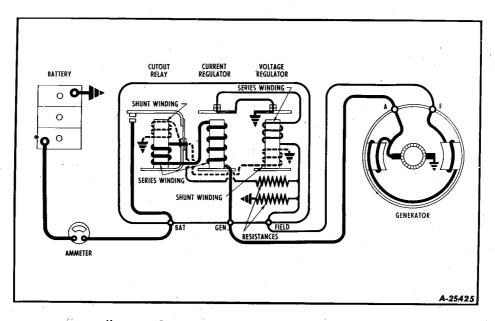
On engines equipped with adjustable third brush type generators, the cutout relay is mounted on the generator.

2. GENERAL

Before any repairs or adjustments are made refer to "CHECKING MECHANICAL PROBLEMS," in Section 1 to see if possibly the regulator, and not the generator, might be at fault.



Illust. 1 - Three Unit Regulator Cover Removed.



Illust. 2 - Circuit Wiring Diagram - Three-Unit Regulator.



2. GENERAL - Continued

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.

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 and point openings) 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 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. Refer to "SPECIFICATIONS," in Section 1.

Contact Points

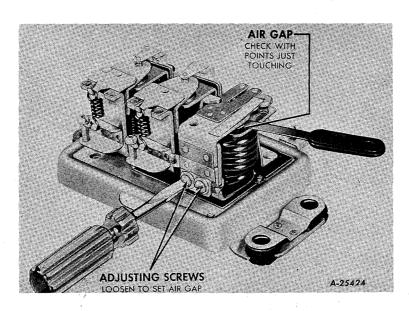
A majority of regulator problems can be eliminated by cleaning the contact points of the current and voltage regulator, plus some possible readjustments. Clean the flat points with a spoon or riffler file. On positive grounded regulators, the flat point is in the upper contact bracket, therefore the bracket must be removed for cleaning the points (II-lust. 10). 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 should not be allowed to become greasy or 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 armature and center of the core. Adjust the gap according to

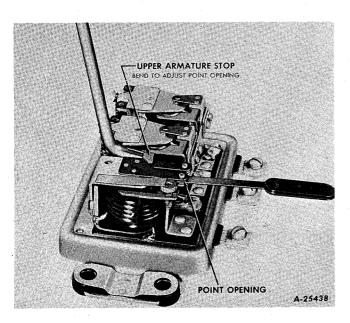


Illust. 3 - Cutout Relay Air Gap Adjustment (Three-Unit Regulator).

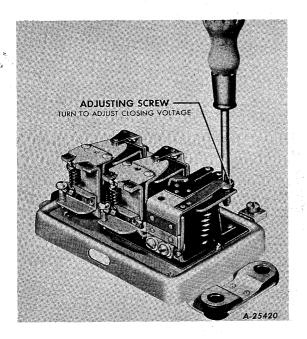


"SPECIFICATIONS," in Section 1. Tighten the screws after adjustment.

2. POINT OPENING: Check the point opening and adjust by bending the upper armature stop (Illust. 4). Refer to "SPECIFICATIONS," in Section 1.



Illust. 4 - Cutout Relay Point Opening Adjustment (Three-Unit Regulator).



Illust. 5 - Adjustment of Cutout Relay Closing Voltage (Three-Unit Regulator).

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 the closing voltage (Illust. 5). Refer to "SPECIFICATIONS," in Section 1.

Voltage Regulator Unit

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. Tighten the screws after adjustment. Refer to "SPECIFICATIONS," in Section 1.
- 2. VOLTAGE SETTING. Turn the adjusting screw clockwise to increase voltage setting or counterclockwise to decrease voltage setting. Refer to "SPECIFICATIONS," in Section 1.

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 final setting of the unit by increasing the spring tension; never by reducing it. If the setting is too high, adjust until it is below required value and then raise to exact setting by increasing the spring tension.

NOTE: The voltage regulator unit should not be set outside of the specified limits except in special cases.

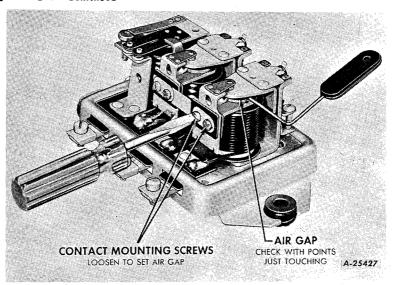
Under conditions where constant high air temperatures prevail, battery overcharge may occur; this will be indicated by excessive use of water. Ordinarily the battery should require water about every 100 hours. If water must be added more frequently than this, there is an indication of overcharge.

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



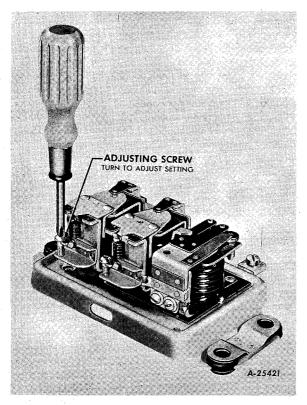
3. ADJUSTMENTS (Three Unit Regulator) - Continued

Voltage Regulator Unit - Continued



Illust. 6 - Air Gap Adjustment, Voltage Regulator Unit (Three-Unit Regulator).

setting. At the beginning of cold weather, increase the settings of the voltage regulator and cutout relay to specified limits to avoid undercharging the battery.



Illust. 7 - Voltage Setting, Voltage Regulator Unit (Three-Unit Regulator).

Current Regulator Unit

- 1. AIR GAP: Check and adjust the air gap in the same manner as for the voltage regulator (Illust. 6). Refer to "SPECIFICATIONS," in Section 1.
- 2. CURRENT SETTING: Check and adjust the current setting in the same manner as for the voltage setting. Refer to "SPECIFICA-TIONS," in Section 1.

4. REPOLARIZING THE GENERATOR

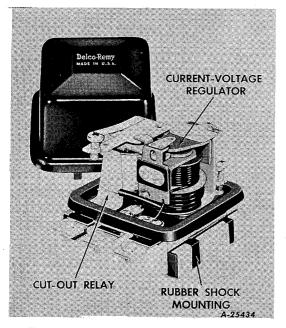
The generator must be repolarized after tests and adjustments have been completed. Connect all leads, but before the engine is started, proceed as follows: Use a jumper lead, and with one end on the "GEN" terminal (on regulator), touch the other end to the "BAT" terminal on the regulator. The resulting 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 CURRENT-VOLTAGE REGULATOR

The combined current-voltage type or two unit regulator protects the battery by providing better control when the equipment is 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 manufacturers' instructions furnished with the testing instruments.



Illust. 8 - Combined Current-Voltage Regulator.

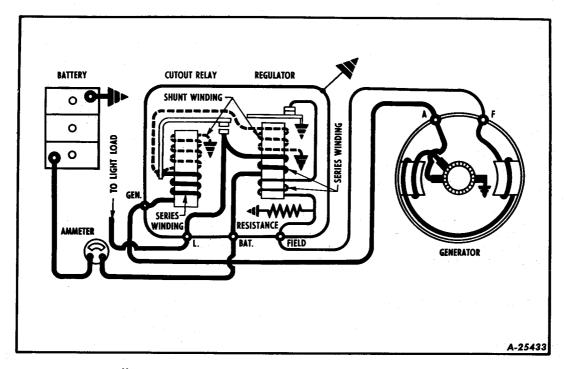
The charging circuit consists of the battery, generator and combined current-voltage regulator. (Illust. 8.) The combined current-voltage regulator consists of two units, a cut-out relay and a combination current-voltage regulator.

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 battery from discharging through the generator. When the generator begins to operate, voltage builts up in the two relay windings, the series winding and the shunt winding. 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.



Illust. 9 - Wiring Circuit of Combined Current-Voltage Regulator.



5. OPERATION OF CURRENT-VOLTAGE REGULATOR - Continued

Cutout Relay Operation - Continued

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 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.

6. ADJUSTMENT AND REPAIR OF CURRENT-VOLTAGE REGULATOR

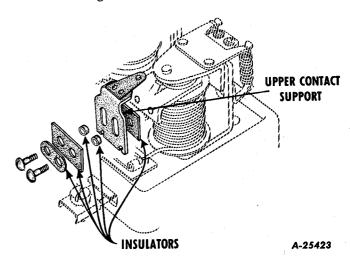
NOTE: Because of similarities in the two units and three unit regulators, the procedure for "checking" and "adjusting" are common for both.

If the regulator fails to operate or if 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."

To avoid damaging the wire-wound resistor beneath the base, extreme care must be used 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

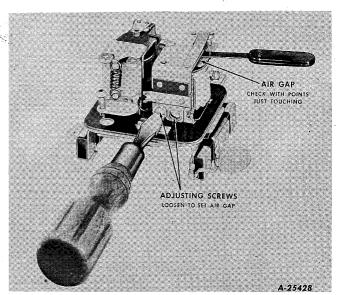
For cleaning the contact points, refer to the instructions given in Par. 3 and Illust. 10.



Illust. 10 - 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.



Illust. 11 - Cutout Relay Air Gap Check and Adjustment.

- 1. AIR GAP: (Illust. 11) Refer to "SPECI-FICATIONS," in Section 1.
- 2. POINT OPENING: (Illust. 12) Refer to "SPECIFICATIONS," in Section 1.

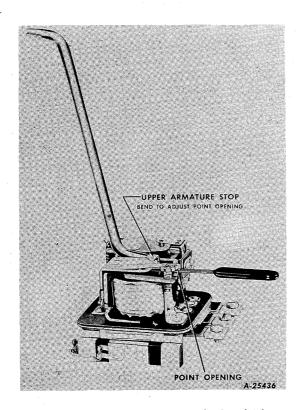


3. CLOSING VOLTAGE: (Illust. 13) Refer to "SPECIFICATIONS," in Section 1.

Current-Voltage Unit

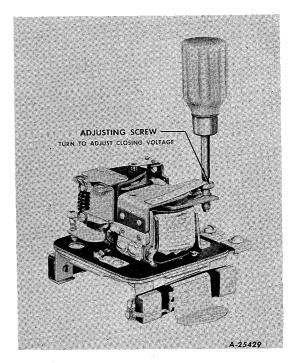
The current-voltage unit requires two checks and adjustments; air gap and voltage setting.

- 1. AIR GAP: (Illust. 14) Refer to "SPECI-FICATIONS," in Section 1.
 - 2. VOLTAGE SETTING: (Illust. 15) Refer to "SPECIFICATIONS," in Section 1.



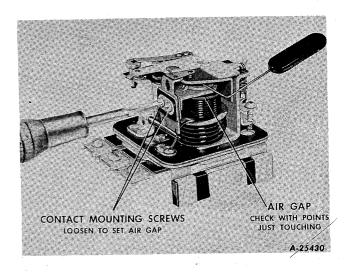
Illust. 12 - Cutout Relay Point Opening Check and Adjustment.

CAUTION: If the adjusting screw is turned down (clockwise) beyond normal range required for adjustment, 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. Final setting of the unit should always be



Illust. 13 - Adjustment of Cutout Relay Closing Voltage.

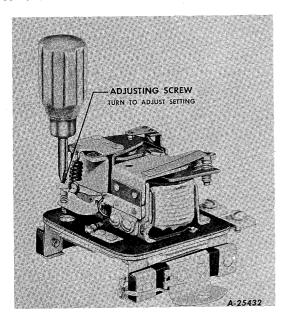
approached by increasing spring tension; never by reducing it. In other words, if the setting is found to be too high, the unit should be adjusted below the required value and then raised to the exact setting by increasing the spring tension. Be sure that the screw is exerting force on the hanger.



Illust. 14 - Current-Voltage Unit Air Gap Check and Adjustment



5. ADJUSTMENT AND REPAIR OF CURRENT-VOLTAGE REGULATOR - Continued



Illust. 15 - Adjusting Voltage Setting of Current-Voltage Regulator Unit.

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, care must be taken 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 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 the diagram shown in Illust. 10. New bushings should always be used when installing a contact support bracket since the old bushing may be distorted or damaged.



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.

A coil resistor in the manifold switch-to-ignition coil circuit on the TD-14 (142 series) and TD-20 (200 series) crawler tractors only, eliminates the possibility of the coil overheating if the engine is operated too long on the gasoline cycle.

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 en-

gine 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. Be 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.

CAUTION: Never touch the spark plugs or the spark plug high tension cables while the engine is operating.

6. REMOVAL

NOTE: Before removing the spark plugs for inspection, blow the dirt away from the base of each plug to prevent the dirt from falling into the combustion chamber.

- 1. Disconnect the spark plug cables.
- 2. Unscrew the spark plugs with a standard spark plug wrench and flex handle. Remove the spark plugs and gaskets.

7. INSPECTION AND REPAIR

NOTE: The condition of a spark plug and the color of the deposits found on the plug along with the type of deposits can be used in analyz-

ing engine performance. Refer to Illust. 2 through 7.

1. Remove oily deposits using a petroleum solvent and blow dry with compressed air. Sand

(Continued on next page.)



Illust. 1 - Checking Diesel Engine Spark Plug Gap.

SPARK PLUGS

7. INSPECTION AND REPAIR - Continued

blasting is the recommended method of cleaning spark plugs. It is recommended that spark plugs be cleaned every 250 hours of operation.

Do not use a wire brush to clean the spark plug electrodes. This will simply load the firing bore with electrically conductive metal particles from the brush and cause misfiring when the plugs are reinstalled. Before setting the gap on used plugs that have the grounded electrode located directly above the center electrode, file the center electrode flat across the end. Use a wire gauge to measure the gap.

- 2. Never use any cleaning material on the insulator that may crack or chip it. Such cracks or chips will provide a recess for carbon deposits and provide a path for leakage of high tension current to ground.
- 3. Never scrape the insulator.
- 4. Never bend the center electrode as this will cause straining or cracking of the porcelain insulator. If the electrode burns off shorter than the shell skirt, replace the plug.

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- 1. Inspect for cracked or blistered porcelain.
- 2. Inspect for dirty or burned electrodes.
- 3. Check gap between electrodes.
- 4. Inspect cables for defective insulation.

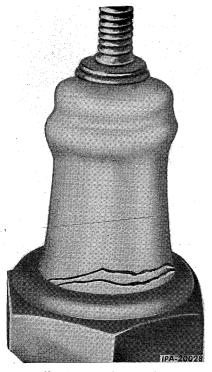
REMEDY

Replace spark plugs as necessary.

Clean dirty electrodes by scraping, brushing, or sand blasting. Replace spark plugs having excessively burned electrodes. The sparking surface should be filed flat to obtain maximum firing surface.

Adjust to .023 inch. Use a round wire gap gauge and pliers. (Illust. 1.)

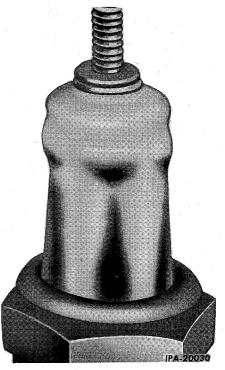
Replace oil-soaked, worn, cracked or otherwise damaged cables to eliminate the possibility of misfiring from this source.



Illust. 2 - Broken Insulator (Careless Handling).



Illust. 3 - Carbon Coating (Rich Mixture, Oil Pumping, or Cold Plug).



Illust. 4 - Streaked Insulator Top (Blow-by). PRINTED IN UNITED STATES OF AMERICA

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SPARK PLUGS

- 5. Never use graphite or other lubricants on the threads of spark plugs.
- 6. When removing or installing spark plugs, use only a correctly fitting 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 a spark plug tester.

8. INSTALLATION

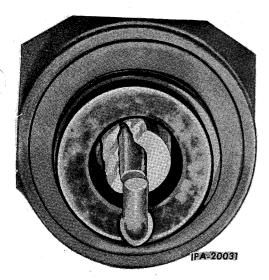
- 1. Before installing the spark plugs, clean the seat around the spark plug holes in the cylinder head.
- 2. Check the spark plug gaps. (Illust. 1.)

3. Screw the spark plugs into the cylinder head using a new copper gasket with each one.

Do not tighten more than enough to compress the gasket to seal the plug and assure a good heat transfer between the plug and the cylinder head. Torque the spark plugs to the amount shown in Section 1, "GENERAL." If a torque wrench is not available, tighten plug 1/2 to 3/4 turns past finger tight.

NOTE: If insufficient torque is applied, the plug gasket will not compress and seal properly, also heat transfer from the plug to the head will not be sufficient to keep the plug cool, possible causing pre-ignition. An excessive amount of torque could change the carefully set plug gap or break the insulator seal, or the insulator itself could be distorting the plug shell.

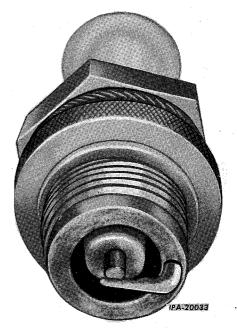
4. Connect the spark plug cables in the proper firing order.



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).

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.



9. GENERAL - Continued

The ampere hour rating of a battery is usually stamped or printed on the battery case.

A battery should be maintained at not less than 3/4 full charge in normal operation. If it is found that the battery is less than 3/4 charged, it is almost certain that some condition exists which should be corrected.

10. COMMON CAUSES OF BATTERY FAILURE

- 1. Resistance in the charging circuit.
- 2. Defective generator or slipping generator drive belt.
- 3. Improper regulator adjustment, or faulty regulator.
- 4. Overload due to defective starting system, or excessive use of accessories.
- 5. Dirt 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.

NOTE: When a battery fails, do not be satisfied to merely recharge or replace it. Find the cause of failure to prevent recurrence.

11. BATTERY VISUAL INSPECTION

The battery should always be very carefully inspected before the actual testing is done. Many undesirable conditions can be seen and corrected before they result in battery failure. Other visible indications are very important when analyzing the hydrometer readings.

PROCEDURE

- 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. This may be important when analyzing the results of the electrial tests.
- 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 test, then see battery test indications and recommendations. (Par. 15.)



STORAGE BATTERY

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 the 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.
- 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 table following.

At the top of the table find the column headed by the temperature nearest to the electrolyte temperature; find in that column the figure nearest the observed specific gravity reading and trace horizontally across to the 80°F. column. The figure in the 80°F. column is the true electrolyte specific gravity and should form the basis for any adjustment.

			_			
0°F	20°F	40°F	80°F	100°F	110°F:	120°F
1.261 1.271 1.281 1.291	1.253 1.263 1.273 1.283 1.294	1.246 1.256 1.266 1.276 1.286	1.230 1.240 1.250 1.260 1.270	1.213 1.223 1.233 1.243 1.252 1.262 1.272	1.219 1.229 1.239 1.248 1.258	1.215 1.225 1.235 1.245 1.255

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.		•	•	Freezes	at -	90°F.
1.250 sp.	gr.			Freezes		
1.200 sp.				Freezes		
1.150 sp.				Freezes		
1.100 sp.				Freezes		

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 cranking power of a fully charged battery when the temperature of the electrolyte drops from 80°F. to 32°F. and to 0°F.

80°F.			100%)	
32°F.		65%			
0°F.	40%			Terr	

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STORAGE BATTERY



5. BATTERY TEST INDICATIONS AND RECOMMENDATIONS

POSSIBLE CAUSE	RECOMMENDATIONS
SPECIFIC GRAVITY ABOVE 1.290	The battery is overcharged. See NOTE 2.
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.
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.



