Illustration No. 75 shows a gas fouled spark plug. This condition is usually identified by a black, dry fluffy deposit which results from:

1. Heat range of spark plug too cold for particular service.
2. Prolonged periods of engine idling.
3. Excessive use of choke or improper adjustment of automatic choke.
4. Too rich an air-fuel mixture.
5. Spark plug gaps set too close.

Illustration No. 76 shows an oil fouled plug. This condition is usually identified by the wet, black shiny deposit. This may be caused by:

1. Heat range of spark plug too cold for particular type of service.
2. Distributor trouble or faulty ignition cables.
3. Weak coil or battery.
4. Spark plug gaps too close.
5. Worn piston rings or pistons.

Illustration No. 77 shows how the spark plug points wear or corrode with service. The amount of wear indicates the extent of service to which the plug has been subjected. When plugs become worn to this extent, they should be discarded and replaced.

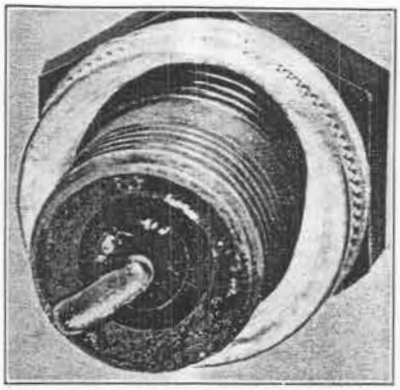

Illustration No. 75

Before reinstalling the spark plugs they should be cleaned and have the point gap adjusted. Always adjust the points by bending the ground electrode. Never attempt to bend the center electrode as this may chip or crack the insulator and render the plug inoperative.

When installing spark plugs, use a new gasket, if available.

The plug is properly tightened when the gasket is compressed to approximately one-half its original thickness when new. If a spark plug is tightened too tight the body may become distorted and crack the insulator.

If the plug is too loose it may allow exhaust gases to escape around the threads and at the same time the heat will not be carried away from the plug fast enough to prevent the plug from becoming damaged from excessive heat.

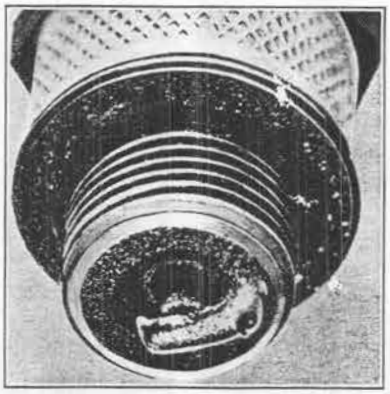

Illustration No. 76

STARTING MOTOR

The starting motor is designed to crank the engine when the switch closes the circuit between the storage battery and the motor. It consists of five main sub-assemblies. the frame and field. the armature, the commutator end head, the pinion housing and the Bendix drive. The frame and field consists of the frame, which supports the components of the starting motor, the pole pieces and the field coils. The coils supply the magnetic field which is needed to produce torque; the pole pieces and frame supply the path for the magnetic field. Illustration No. 78 is an assembly drawing of the starting motor.

The armature consists of a soft iron core, a commutator and the windings which are wound in slots in the core and are connected to the commutator. The commutator consists of a number of copper segments insulated from each other and from the armature shaft.

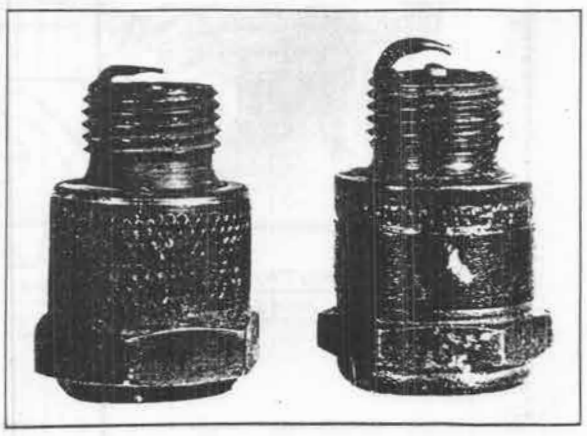

Illustration No. 77

The commutator end head supports a bearing, brush holders and brushes. The pinion housing is a cast iron housing for the Bendix drive and also provides the motor mounting lugs. The Bendix drive is an automatic clutch that engages the starting motor with the engine flywheel when the motor cranks the engine and disengages when the engine starts. It consists of a threaded sleeve fastened to the armature shaft thru a drive spring and a pinion mounted on the threads of the sleeve. When the starting circuit is closed the armature revolves, turning the sleeve within the pinion and forces the gear forward, meshing it with the flywheel gear. The sudden shock of meshing is absorbed by the spring. When the engine starts the pinion is driven faster than the sleeve and is forced back along the threads, automatically demeshing it from the flywheel.

LUBRICATION

Some starters are provided with an oil cup which should be filled with lubricating oil when unit is lubricated.

Other starters have no provision for oiling and these are lubricated at time of overhaul.

After the starting motor has been in service for an extended period it should be removed, dismantled and cleaned. Clean the Bendix drive thoroughly and lubricate sparingly with light oil. Inspect the wiring for loose or corroded connections and for broken leads. Make sure the insulation on the wiring has not become frayed.

THERMOSTAT AND BYPASS

Some engines are equipped with a thermostat so designed that it will not allow water from the radiator to circulate through the engine until the water in the engine is at operating temperature but does bypass a certain amount of water from the cylinder block which is carried through the bypass tube to the inlet side

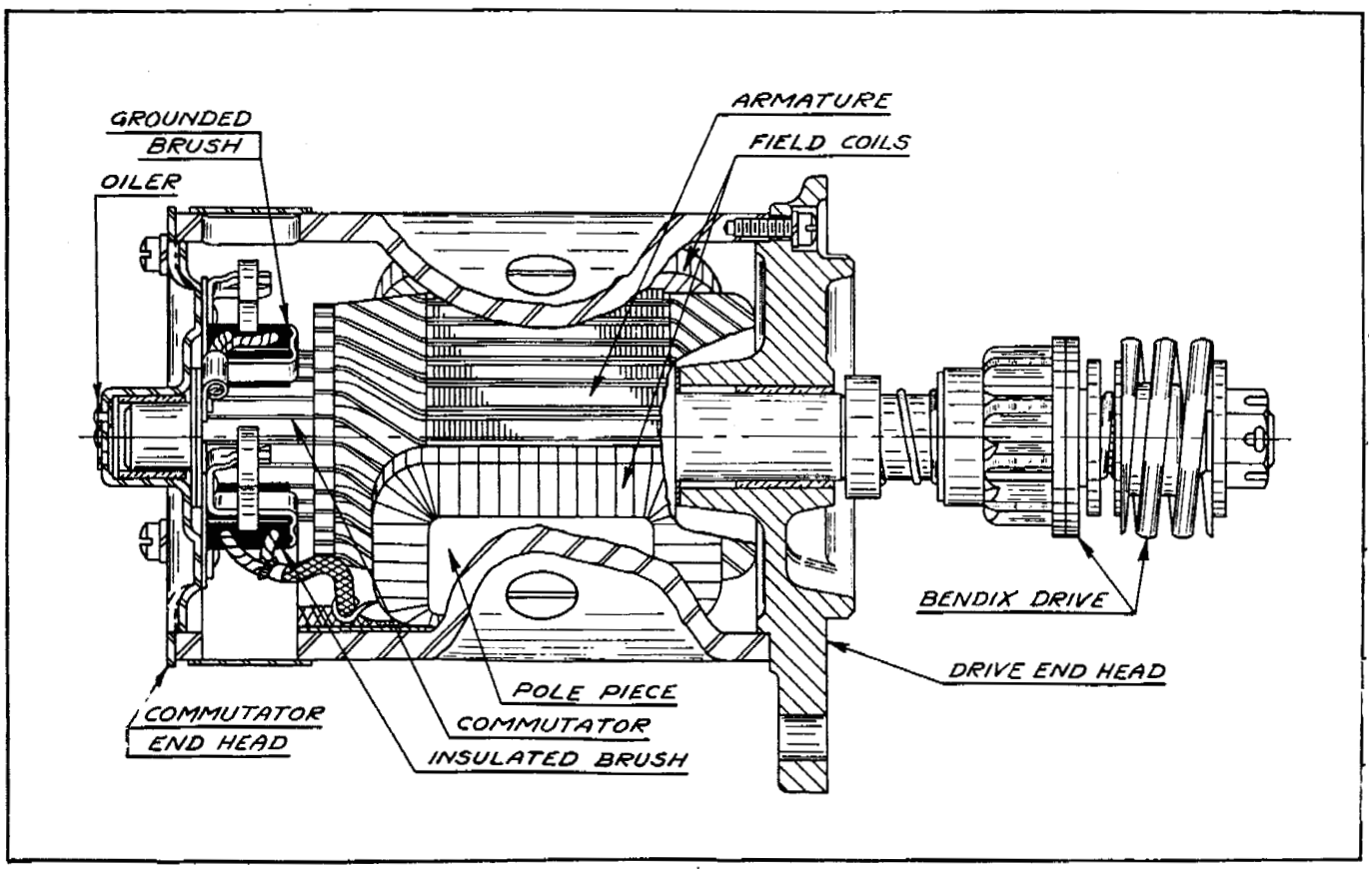

Illustration No. 78

of the water pump where it is again circulated through the engine. This is repeated until the water in the engine is heated to operating temperature, when the thermostat begins to open and permit the water from the engine to enter the radiator. This water is at the same time replaced in the engine by the water pump drawing from the bottom of the radiator. Thus the water temperature is constantly maintained in the proper heat range.

A defective thermostat of this type must be replaced as it cannot be repaired. The thermostat should start opening at 150° ± 2½° F. and be completely open at 175° in still water test.

The still water test is as follows:

Place approximately 4" of water in a pan or pail. Insert a thermometer of this heat range in the water and set the thermostat in the water with the bellows submerged. Heat the water slowly and carefully observe when the thermostat valve starts to open and note the water temperature as indicated by the thermometer; continue to heat the water until the thermostat is fully open and again note the water temperature and then compare these temperatures with those given above.

Five degrees above or under those given are permissible.

VALVES

The intake and exhaust valves are made of special steel and operate in valve guides pressed into the cylinder block. They are held on their seats by strong steel springs which are fastened to the valve stem by a suitable spring seat and valve lock arrangement. These valves are operated by the camshaft cams through mushroom type tappets. The replacement of valves and valve guides will be found under the subject of Valve Grinding, see below. The replacement of valve tappets is discussed under the subject of Valve Tappets, starting on Page 71.

VALVE GRINDING

In order to continue to get good performance from an engine it may be necessary to grind or reseat the valves at varying intervals. The frequency for doing this depends on the care in the operation of the engine, but if the instructions in this book are carefully followed the necessity for doing this as well as other service operations will be reduced to a minimum.

The necessity of removing the cylinder head is sometimes due to excessive carbon which makes its presence known by knocking. As this knocking is due to the carbon having partly filled up the combustion space and made the compression too high for the fuel being used, the knocking can be reduced by using a fuel of higher anti-knock qualities. Eventually, though, it will be necessary to remove the cylinder heads and clean out the carbon and it is a good policy to examine and reseat the valves while the head is removed.

At other times the necessity for removing the cylinder head may be due to one or more leaking valves which will cause an engine to miss fire while pulling a load at low speeds and also may be detected by rocking the engine against compression on each cylinder in turn with the starting crank. When testing the compression in this manner have the ignition off and the throttle wide open to allow a full charge of air to enter the cylinders.

Assuming that the carbon is to be cleaned out and the valves ground, we suggest several important steps in the general procedure.

1. Remove cylinder head, see Page 38.
2. Remove crankcase ventilation tubes, if used.
3. Remove tappet covers.
4. With a conventional type valve spring lifter, compress the valve springs and remove the valve seat locks. Pack the holes in the lower part of valve tappet chamber with rags to prevent locks from falling into oil pan. See Illustration No. 16.
5. Lift out valves and place them in a cardboard or wood block drilled and numbered so that valves may be reinstalled in their respective places when grinding or reassembling. (Do not mark valves with file or punch.)

6. Clean all carbon from cyinder head, piston heads, valve seats, valve guides and valves with suitable scraping or buffing tools.

7. Inspect the valve guides for excessive wear. If the valve guides are to be renewed, this should be done before any work is done on the valve seats. This will insure the seat being finished square with respect to the new guide. The exhaust valve guides will usually show the most wear. If necessary to remove the guides, they should be pulled from the cylinder block. However, if no puller is available, they may be driven down through the block after the valve springs and seats have been removed, the tappet adjusting screw should be screwed all the way down and the engine turned so that the tappet is on the low part of the cam. After the guides are driven down, so that they almost touch the tappet screw, it may be necessary to break off the low part of the valve guide. To drive out valve guides, use a drift $^{15}/_{32}$" diameter with a $^{5}/_{16}$" diameter pilot. Drive in new guides to the same depth location as old guides. After new guides are driven in, they must be reamed to size on the inside diameter to correct any squeezing in or possible distortion due to being driven into place. This is important in order to get a proper fit and the proper clearance. See Table of Clearances, Page 77.

8. Inspect valve seats and if they are pitted or if new guides have been installed the seats should be refinished. Valve seat tools with $^{5}/_{16}$" diameter pilots are required. The exhaust valve seats are finished on a 30° angle and should have an even width all the way around. The intake valve seats are usually finished on a 30° angle.

9. Inspect valves carefully and if the stems are badly worn or are not straight, the valves should be replaced by new ones. However, valves that are only slightly pitted can be used by refacing them on a valve face grinder. Valves must have an accurately finished face of the correct angle. See table on Page 77 for seat face width.

10. Grind or lap each valve to its seat. Be sure the tappet is in such a position that it does not hold the valve off its seat. Use a light coil spring under each valve as it is being lapped in, to raise the valve off its seat during the process. Use a medium grade compound and using only a light pressure rotate the valve only part of turn with a screw driver or other suitable tool before raising it off its seat and rotating while off to a new position before again lightly bringing it against the seat for another part of a turn. Avoid continuous round and round motion that would cut grooves in the valve or seat. Repeat this process of lapping, until a bright silver-like band of uniform width is produced on valve and seat, then clean off all traces of the compound and test each valve for a tight seat by making pencil marks across the face of the valve at short intervals and then rotate the valve against its seat for part of a turn with a firm pressure and again lift out and observe if the pencil marks are all rubbed out on the contact surface; if not, regrind until this test shows a gas tight mating of valve to seat. It is imperative that the valves be assembled in the same seats to which they were ground.

TC REASSEMBLE THE VALVES

1. Clean all traces of grinding compound off of valves, stems and guides; put a few drops of oil on the valve stems and insert valves.

2. Pack the holes in the lower part of valve tappet chamber with rags to prevent any locks from falling into the crankcase. See Illustration No. 16.

3. Use lifter as in Item 4, Page 69, to compress valve springs and insert valve locks.

4. Remove the rags that were used for packing.

5. Adjust tappets as shown in Illustration No. 79 to approximate setting, refer to Section on "Valve Tappets," Page 71.

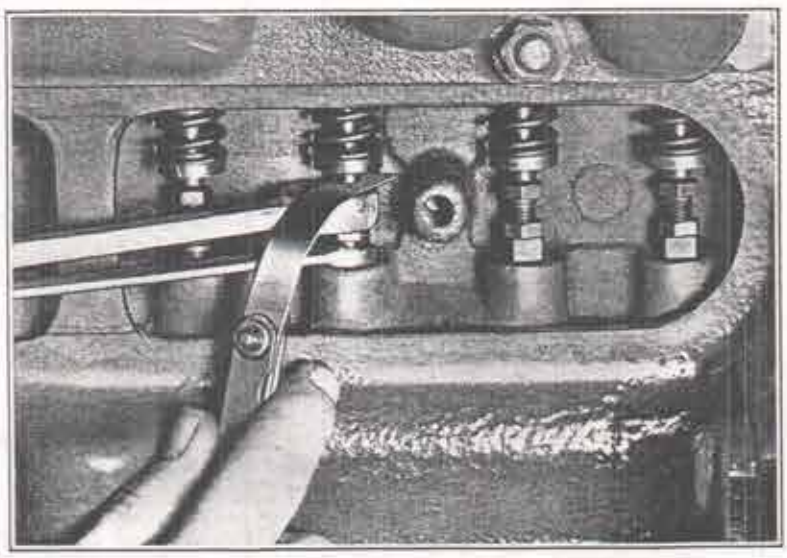

Illustration No. 79

6. Install cylinder head and other parts, see Page 38.
7. Fill cooling system with water or cooling solution.
8. Start and warm engine to operating temperature.
9. With the engine idling slowly, adjust tappets to correct clearance, see Page 77.
10. Assemble the valve covers (use new gaskets) and crankcase ventilating tube.

VALVE TAPPETS

The valve tappet assembly is the mushroom type and consists of three pieces: the valve tappet or push rod, valve tappet screw and valve tappet screw lock nut. When these three parts are assembled together they form the complete tappet with the mushroom riding the cam on the camshaft and the head of the tappet screw in contact with the valve stem.

TO REPLACE VALVE TAPPETS

1. Remove camshaft. See Page 30.
2. Remove tappet from cylinder block.
3. Check the tappet screws for wear and replace any which have started to cut or hammer out.
4. Check tappet clearance in cylinder block. This should be approximately .001". However, it will not be necessary to change tappets if this clearance is slightly greater.
5. If necessary to replace tappet, try a new tappet for clearance and if the clearance is still too great it will be necessary to procure oversize tappets.

TO REINSTALL TAPPETS

1. Assemble tappet screws and nuts, and insert tappets in cylinder block.
2. Reassemble the camshaft. See Page 32.
3. Adjust tappets for each of the cylinders, setting them for at least .007" clearance on the intake and .010" clearance on the exhaust. After the engine has warmed up and while running at idle speed check and reset tappet clearance, Illustration No. 79, to clearance as shown on Serial Number Plate on crankcase.
4. Replace tappet covers.

WATER PUMP (IX - 5)

Illustration No. 80 shows longitudinal section of the water pump commonly used on the IX-5 Series Engines. This pump is used with either distributor or magneto ignition. The pump may be readily removed from the engine after the cooling system is drained.

Remove water pump and inlet discharge pipe, disconnect distributor, primary wire and remove distributor cap. Then remove three cap screws, holding water pump to cylinder block. The water pump can now be pulled back out of the cylinder block.

DISASSEMBLE THE PUMP

1. Depress rear seal spring cup Y, remove pin AA, pull seal assembly from shaft.
2. Remove screws AB, lockwashers AC, then pull cover V from pump.
3. Remove front seal pin in same manner as rear pin was removed.
4. Remove impeller pin T, then place suitable support under pump at cylinder block attaching flange and press shaft B out of impeller R and body G.
5. Press shaft B out of gear D.
6. If seal K is to be replaced, use small pin punch to remove seal retainer J.
7. Use special bushing driver (Hercules 13234-A) to remove bushing F.

8. It is seldom necessary to remove bushings O and U; however, if these are worn or damaged, they may be pressed out of the body and cover.

9. The distributor drive gear I should not be removed unless it is to be replaced as this gear is a very tight press fit on the shaft.

10. After the pump is disassembled, wash and clean all parts thoroughly and examine for excessive wear, cracks or other damage.

TO REASSEMBLE THE PUMP

1. Insert Woodruff Key C in shaft B, then press shaft into the gear D.

2. If distributor drive gear has been removed, insert Woodruff Key H and press gear I on to shaft. Assemble seal K and seal retainer J in pump body, then press bushing F into body.

3. Try shaft in body bushing for running clearance. This should be .0015" to 002".

4. After shaft is fit to proper clearance, assemble washer E on shaft and oil bushing, then place seal assembly L, M and N in place and insert shaft in body. Install seal pin in front seal.

5. Assemble thrust washer Q on shaft, insert Woodruff Key S and press impeller R on shaft. The shaft should have .002" to .005" end thrust. After the impeller is properly spaced to obtain this clearance, insert impeller pin T.

6. Place new gasket P on body and assemble cover V with cap screws and lock washers as removed.

7. Assemble seal W, X, Y and Z and insert seal pin AA.

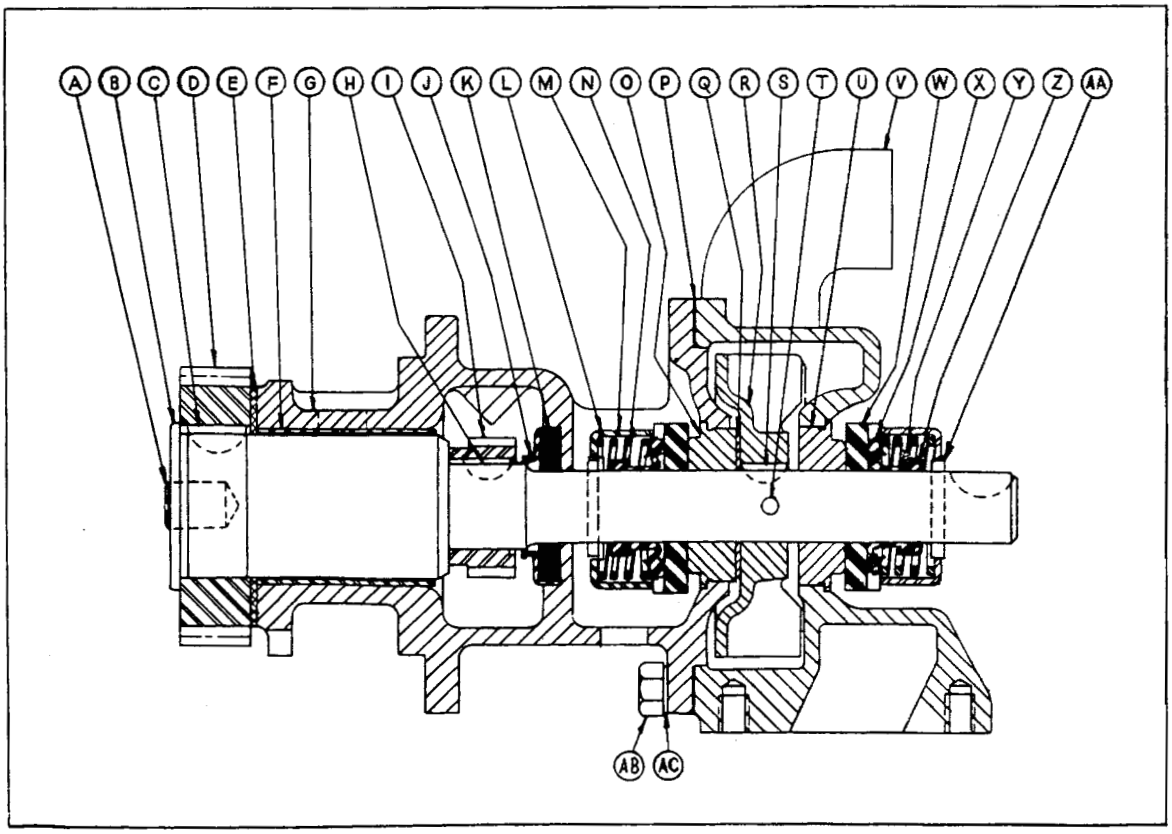

Illustration No. 80

WATER PUMP AND FAN ASSEMBLY (IX - 3)

Illustration No. 81 shows a sectional view of the water pump and fan housing (blade is not shown) used on the IX-3 Series Engines. This pump may be readily removed from the engine after removal of water inlet hose and fan blade. It is necessary to remove the water pump to cylinder block attaching screws and lift pump away from engine.

TO DISASSEMBLE THE PUMP

1. Pull fan drive pulley hub from water pump shaft.
2. Remove lock wire indicated at A. Remove back cover plate.
3. Support the pump body at suitable points and press the shaft and bearing assembly out of the impeller, at the same time removing the shaft and bearing assembly from the water pump body.
4. Press seal assembly out of pump body.

   Wash and clean all parts thoroughly, inspect for wear and damage. Do not attempt to remove the bearing from the shaft as this shaft and bearing can only be purchased as an assembly. It is advisable to reface the seal surface on the pump body with a special refacing tool. Apply a coating of grease on the seal surface before starting reassembly of pump.

TO ASSEMBLE PUMP

1. Press new seal assembly into pump body.

   CAUTION: Press on the outer flange of the seal to avoid damaging the seal.

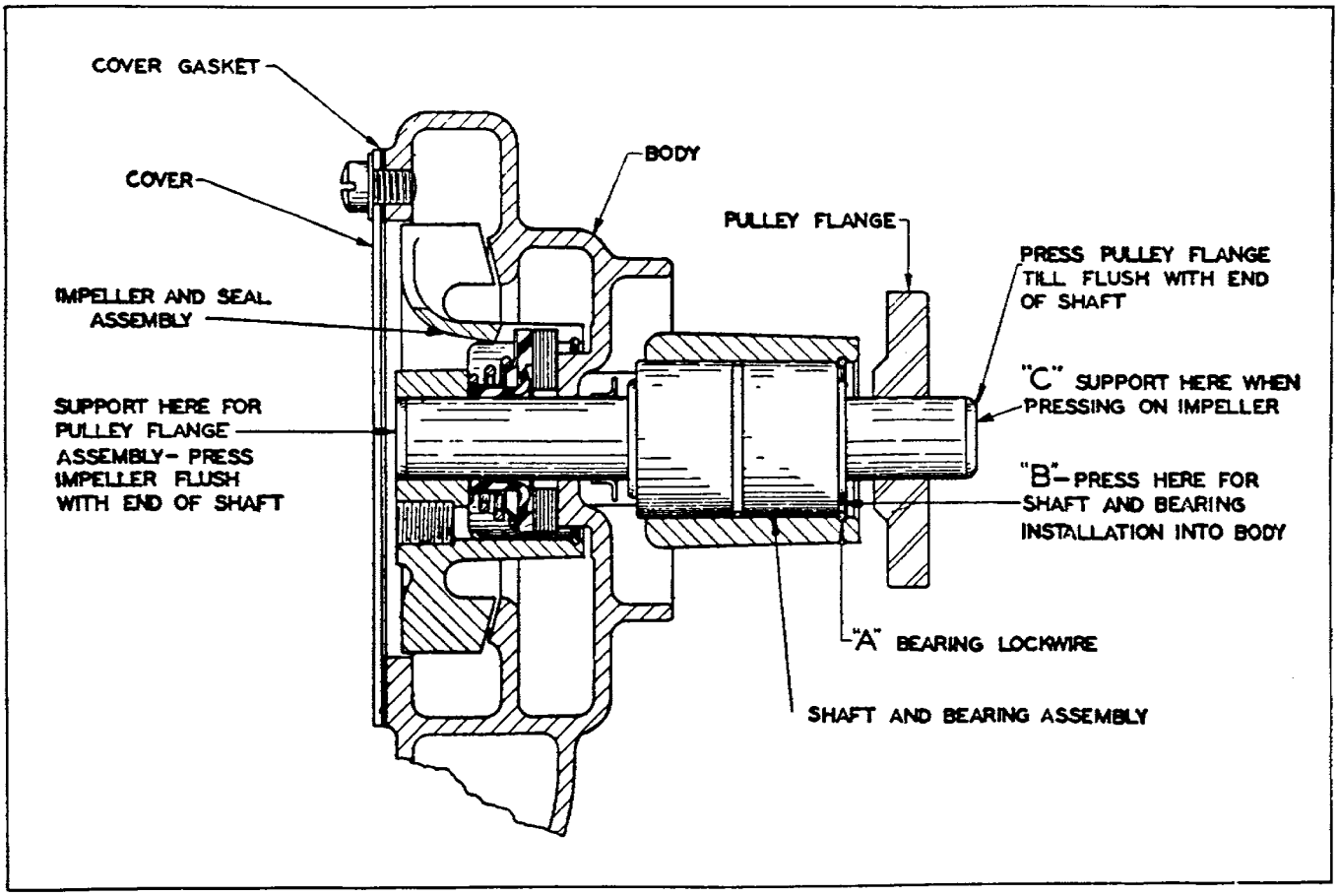

Illustration No. 81

2. Press the shaft and bearing assembly into the body.

   CAUTION: Press only on the outer bearing face of the bearing and not on the end of the shaft.

3. Replace bearing lock wire A. Press impeller and seal assembly on the shaft.

   CAUTION: Apply coating of grease or oil on the shaft before pressing on impeller. Support the pump shaft and not on the pump body. See C.

4. Press on impeller flange as described for the impeller.

5. Install new cover gasket and pump cover.

6. Replace drive pulley and plate assembly.

WIRING DIAGRAM

The wiring diagram shown in Illustration No. 82 is applicable to most installations. However, there are some special installations where this diagram cannot be used. If in doubt, write to the Service Department of the Hercules Motors Corporation, Canton, Ohio giving full particulars, including engine serial number and model designations of starter, generator and voltage regulator.

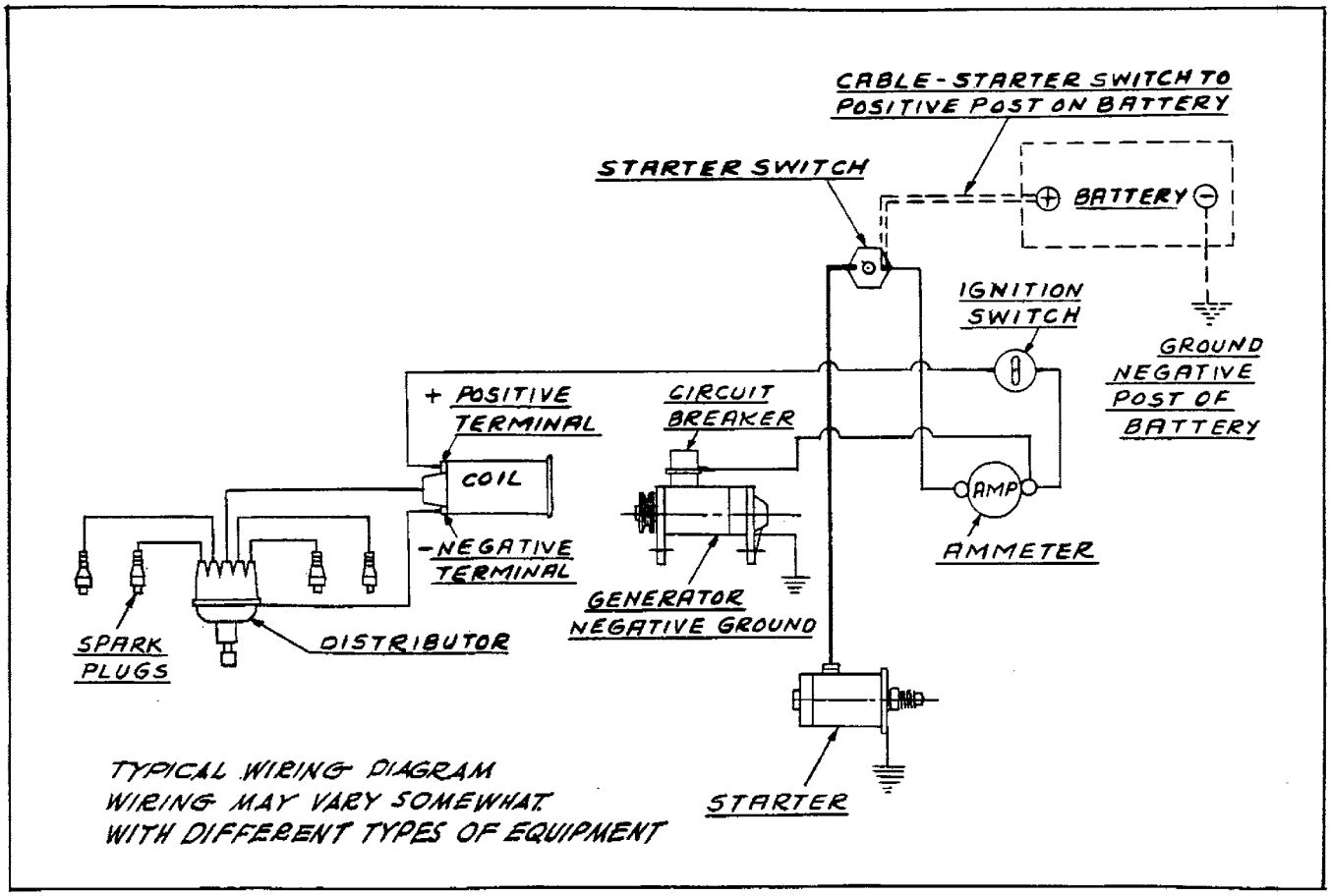

Illustration No. 82

IX TOOLS

PART NO.	PART NAME	WHERE USED
3170-A	9/16" Socket	Bellhousing
		Cylinder Head
		Water Pump
		Connecting Rods
		Gear Cover
		Valve Cover
3171-A	5/8" Socket	Manifold
		Flywheel
3172-A	7/8" Socket	Main Bearings
11462-A	1/2" Socket	Oil Pan
		Water Pump
		Piston Pin Lock
		Oil Pump
		Connecting Rod
		Fuel Pump
2245-B	1/2" Square Speeder Handle	To be used with the above sockets
3168-A	Socket Extension 6"	To be used with the above sockets
2252-A	Speed Wrench Universal	To be used with the above sockets
13078-A	9/16" x 5/8" Open End Wrench	Water Pump
		Water Inlet & Outlet Flanges
		Oil Pan
		Gear Cover
		Manifolds (Intake & Exhaust)
		Carburetor
		Fuel Lines
14897-A	3/8" Open End Tappet Wrench	Tappets
3777-A	1/2" Open End Tappet Wrench	Tappets
3256-A	1/2" Open End Wrench	Water Pump
		Fuel Pump
		Oil Pump
359-A	5/8" x 5/8" Angle Wrench	Manifolds
	1/2" Service Ratchet	To be used with sockets

PART NO.	PART NAME	WHERE USED
11927-A	Flex Handle	To be used with sockets
2253-A	Connecting Rod Spreader	To install Piston Pins
13171-A	Piston Ring Compressor	Used in installing pistons
13341-A	Valve Spring Lifter	
6362-A	Valve Guide Driver	To remove or install valve guides
13566-A	Cam Bearing Driver	Removing and installing camshaft bearings.
13098-A	Piston Ring Expander	
11925-A	Screw Driver 3/16" x 5" blade.	
13175-A	Screw Driver 1/4" x 6" blade	
13095-A	Pliers—9" Heavy Duty	
13278-A	Adjustable Wrench—8"	
11919-A	Feeler Gauge Set—9" Blades	
11920-A	Lady Foot Pry Bar	
11921-A	Ball Pein Hammer 12 oz.	
3444-A	Torque Wrench	
6335-A	Tool Box	

REMEMBER

Good Oil changed frequently . . . . Oil Filter Elements replaced often . . . . Breather and Air Cleaner kept clean and functioning properly . . . . and Engine in good adjustment . . . . . .

Mean Longer Life to the Engine and Trouble-Free Operation

TABLE OF CLEARANCES

(All Dimensions In Inches)

	Min.	Max.
Valve tappet clearance, intake (Hot)	.006	
Valve tappet clearance, exhaust (Hot)	.008	
Valve seat width, intake	.125	
Valve seat width, exhaust	.125	
Valve stem clearance in guide, exh. & int.	.001	.0015
Valve stem clearance in guide, fire and marine, exhaust	.0025	.003
Push rod or tappet clearance in guide	.00075	.001
Idler bearing clearance	.001	.0015
Cam bearing clearance	.0015	.0025
Crankshaft main bearing clearance	.002	.0025
Crankshaft end thrust	.002	.004
Bellhousing on chamfer	.014	.020
Connecting rod bearing	.001	.0015
Connecting rod side clearance	.005	.010
Accessory drive bearing clearance	.0015	.002
Accessory drive shaft end clearance	.002	.003
Water pump bearing clearance	.0015	.002
Water pump shaft end clearance	.002	.005
Gear cover clearance around crankshaft	.008	.015
Oil pan clearance around crankshaft	.008	.015
Accessory drive gear back lash	.002	.004
Crankshaft gear back lash	.000	.002
Idler gear back lash	.002	.004
Oil pump gear back lash	.008	.010
Piston clearance, C.I. or Alum.—"IX & IXF"	.002	.0025
Piston clearance, C.I. or Alum.—"IXA"	.0025	.003
Piston clearance, Cast Iron—"IXB"	.003	.0035
Piston clearance, Aluminum—"IXB"	.0025	.003
Piston ring clearance in groove (Alum.)	.0015	.0035
Piston ring clearance in groove (Cast Iron)	.0015	.0025
Piston ring gap	.015	.020
Piston pin clearance (Cast Iron piston)	.0005	
Piston pin clearance (Aluminum piston)	.0001	.0002

WRENCH TENSION

	Inch Pounds
Cylinder Head	420
Connecting Rod	504
Main Bearings	924

Section and Group Index

Sectional and Group Index (Continued)

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