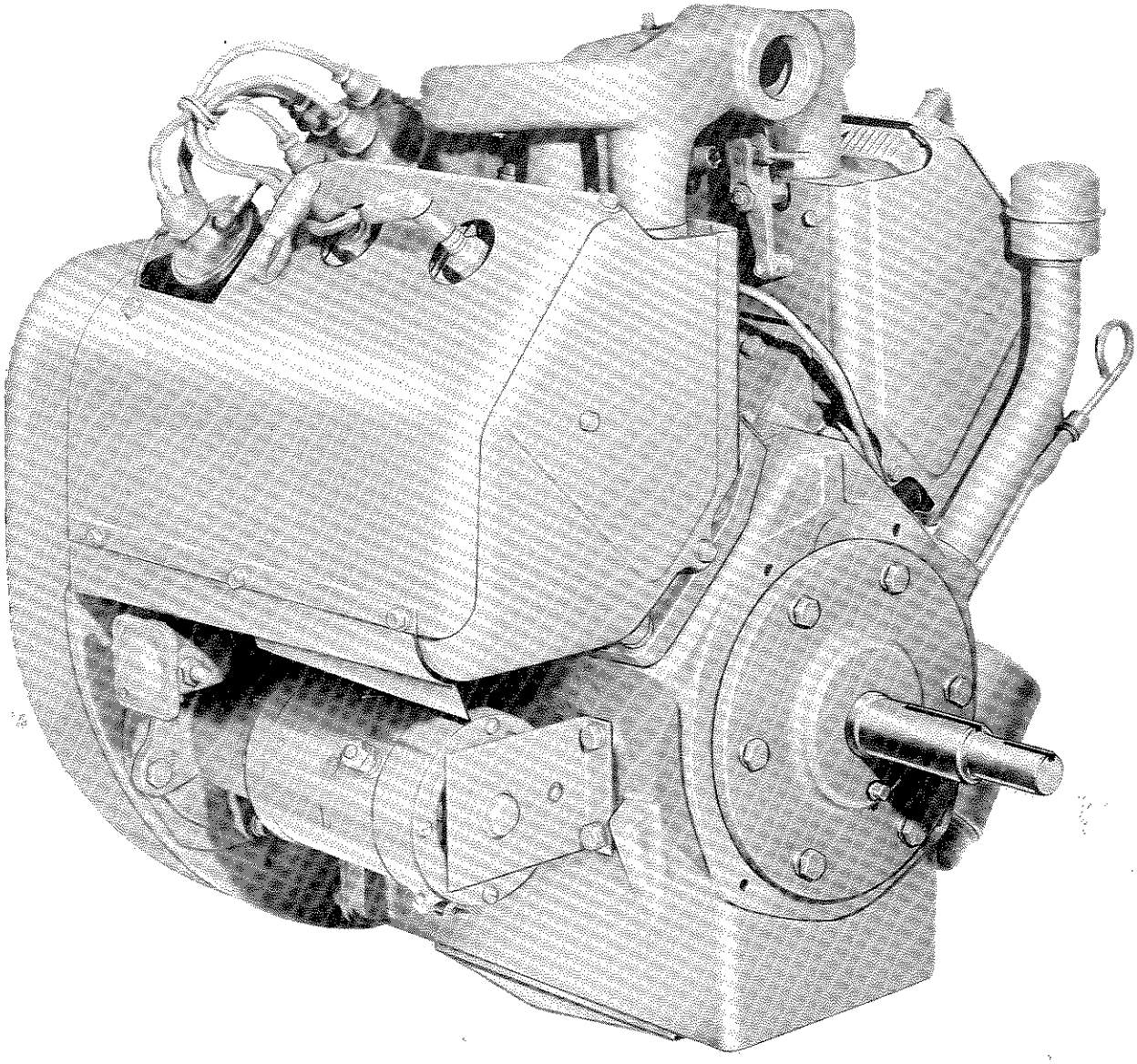


Figure IV-1 KID Engine

SECTION IV
ENGINE

• Engine Removal and Disassembly

The following procedures describe in detail the removal of the complete power train, including engine, gearbox and transmissions. Removal of the engine can only be accomplished by removing the complete power train. In describing the removal procedure, all operations such as removal of the cargo deck, drainage of transmission fluids, or removal of main drive chains (which are discussed in their respective sections) are assumed to have already been carried out.

• Compression Check

A compression check will indicate the condition of the pistons, piston rings, cylinder heads, head gasket, cylinder walls, and valves. Perform a compression check as follows:

1. Remove all four spark plugs.
2. Using a hand pressure oil can, squirt oil (10W-30) on the cylinder walls, making sure the oil runs down the walls into the piston rings.
3. Turn the engine at least one revolution to force excess oil out the spark plug holes.
4. Insert the compression tester into each spark plug hole and spin the engine. Normal compression is 95 to 104 psi. Minimum allowable operating compression is 60 psi. Any compression below 60 psi requires engine overhaul.

• Power Train Removal

1. Remove nuts, washers and U-bolt securing muffler to bracket at rear end of vehicle.
2. Using a pipe wrench, unscrew exhaust pipe and muffler and remove from inlet-exhaust manifold assembly. To avoid distorting the circumference of exhaust pipe, apply wrench on threaded end 1" from exhaust manifold.
3. Loosen screw on hose clamp at carburetor side, and disconnect air intake hose from carburetor adapter. Remove nuts, washers and screws securing air cleaner to fire wall, and remove air cleaner assembly.
4. Disconnect R.H. and L.H. transmission cables from transmission control lever by removing cotter pin and clevis. Remove nuts, washers and screws securing R.H. control cable bracket to jackshaft assembly, and L.H. control cable bracket to engine block, and remove cables and brackets from engine compartment.

   Disconnect governor control connection from carburetor throttle shaft.
5. Disconnect choke and throttle cables from the carburetor (see Engine controls) and remove nuts, washers and screws securing cable clips to cable bracket, and remove cables from engine compartment.
6. Disconnect fuel supply line from carburetor. Make sure that battery cables have been disconnected at the terminals.
7. Disconnect all electrical connections (for description see Electrical System) from motor solenoid and alternator which may interfere with the removal of the power train. Make sure to tag each connection so as to eliminate possible confusion during reassembly.
8. Disconnect and remove all hydraulic system tubing (see Hydraulic System). Disconnect the couplings in the hydraulic lines situated near the top of the oil cooler. Cap all hydraulic ports.
9. If installed, remove the power takeoff shaft as follows: Loosen set screw to free shaft retainers. The retainers are machined with eccentric centers and must be

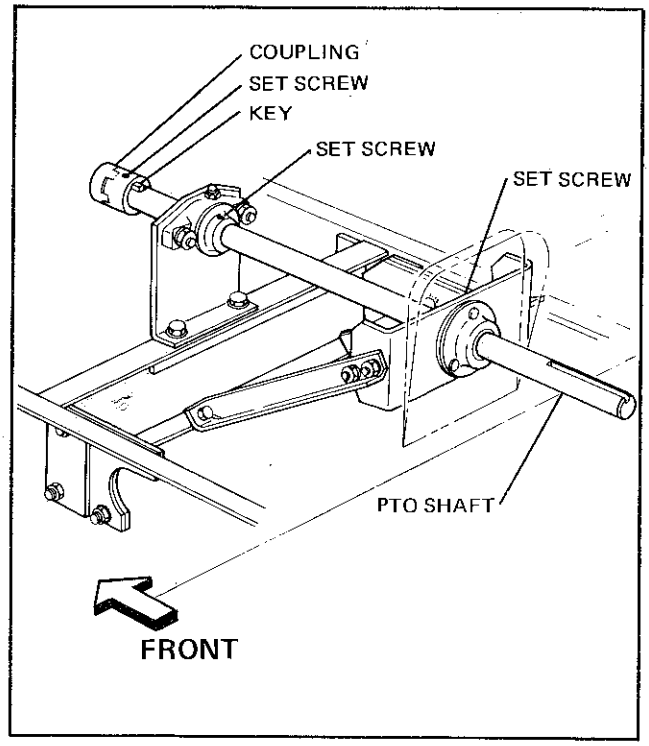


Figure IV-2 PTO Shaft Assembly

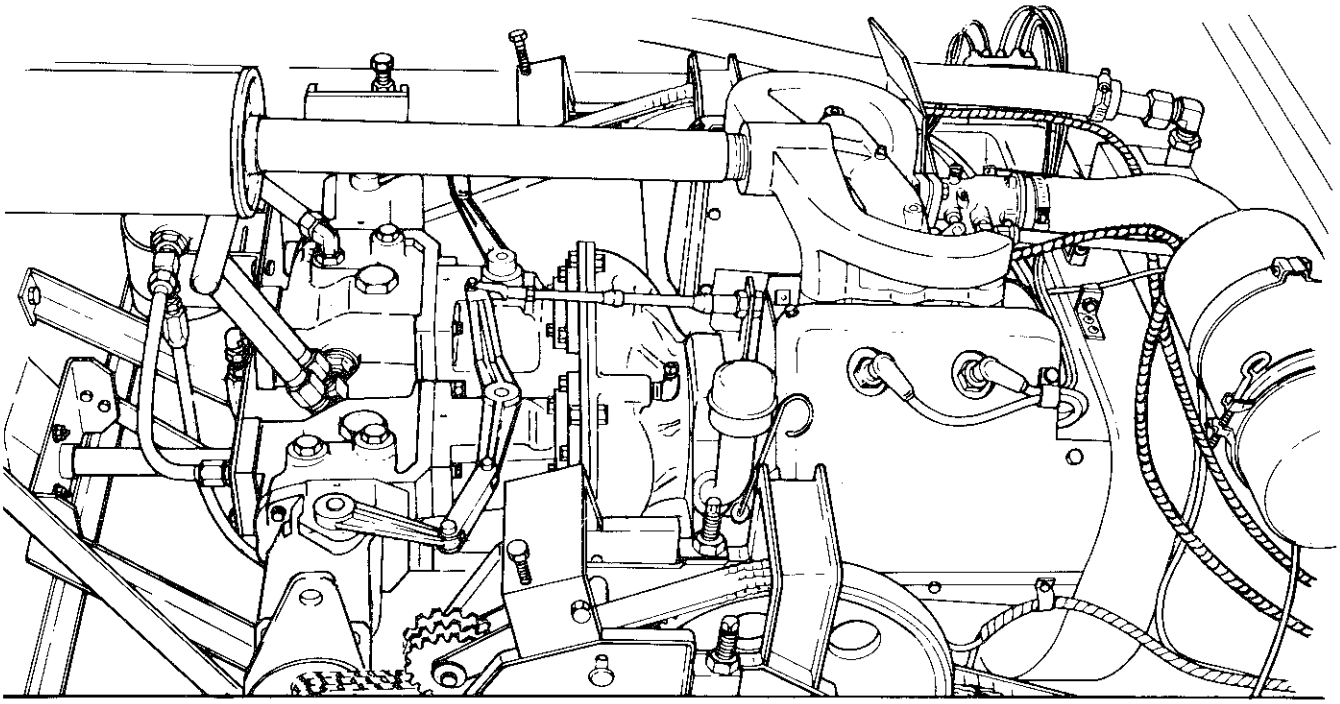


Figure IV-3 Engine Compartment

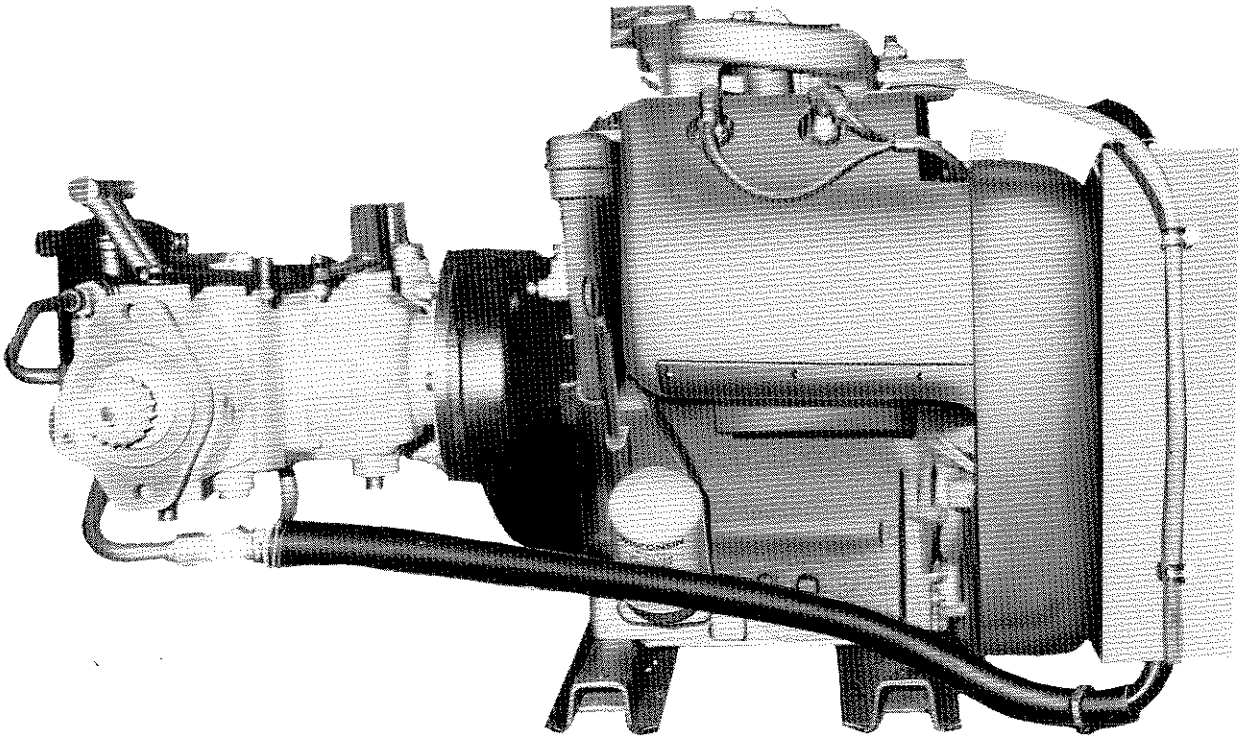


Figure IV-4 Power Train

rotated to loosen and slide them on the shaft. Disengage PTO shaft coupling by sliding shaft toward rear of the tractor. Loosen set screw on shaft portion of coupling. Slide PTO shaft out of forward shaft support bearing until shaft is free and clear of all hydraulic lines and components.

10. Remove engine mounting nuts and washers from engine mounting studs. Attach chain hoist to intake-exhaust manifold and raise power train out of the vehicle. Make sure not to damage the oil cooler when clearing the fire wall and that all drain hose is free to pull through holes in hull supports.

TRANSMISSION REMOVAL

After the Power Train has been removed from the Kid, the Transmissions can be removed. On the rear end of the two transmissions, 5 screws hold the hydraulic oil filter to the transmissions; remove these screws. The transmissions can now be removed from the Gearbox by removing the twelve (6 in each transmission) screws.

GEARBOX REMOVAL

There are 5 screws holding the Gearbox to the engine. Place a pan under the Gearbox to catch the lubricating oil. Remove the five screws, two upper and three lower. The oil will escape and the Gearbox can be removed.

(NOTE: At reassembly, be sure to use new gaskets and apply sealing compound to both sides of the gasket.)

NOTE: At reassembly, be sure to clean the gearbox surface that makes contact with the engine and the engine contact surface. Apply a liberal amount of sealing compound to both sides of the sealing gasket. This sealant prevents loss of lubricating oil.

- **Engine Disassembly**

Engine disassembly and assembly should be carried out by trained mechanics, fully familiar with such operations. Before disassembly of an engine or any part used on the engine, thoroughly steam clean the engine and inspect the overall condition. Inspect each unit removed, including electrical wires, and identify all parts to insure correct assembly during assembly operations. Remove units and parts from the engine in the sequence outlined in this manual, paying particular attention to the precautions noted. Place removed parts and units (except those parts that could be damaged) on a rack or cart for steam cleaning. Start disassembly procedures by removing oil filter, starter motor, and other engine accessories.

A. FLYWHEEL ALTERNATOR

1. Remove rim from front face of flywheel shroud. Drive out crank pin in crankshaft and remove flywheel nut and washer. The flywheel is mounted to a taper on the crankshaft and can normally be removed by pulling the flywheel forward with one hand at the same time striking the crankshaft nose with a babbit or wood hammer (see fig. IV-5). The flywheel will then slide off the tapered end of the crankshaft and can be removed.

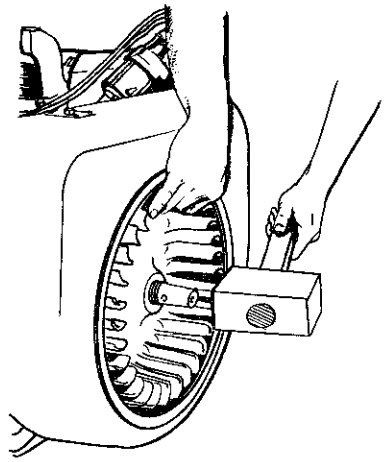


Figure IV-5 Flywheel Removal

CAUTION: Do not use a hard hammer as it will damage the crankshaft nose and the two main bearings.

2. Thoroughly clean flywheel with shop air and inspect for cracks and/or missing vanes. Inspect ring gear for missing teeth.

B. AIR SHROUDING (FIGURE IV-33).

To disassemble flywheel shroud, first disconnect the electrical wiring between alternator, rectifier, and regulator modules. Remove roll pins, screws and lockwashers securing alternator stator to the gear cover and remove stator. Remove cylinder head covers and the screws mounting the flywheel shroud to the lower cylinder shrouds, and the cylinder and distributor heat deflectors. Remove the screws holding the flywheel shroud to the gear cover.

NOTE: The two center screws are for locating the flywheel shroud on the gear cover. In order to provide the proper clearance between these screws and the flywheel, the heads are machined down to approximately half size. Use a 6 point pipe plug to remove and install.

CAUTION: Screws are installed using a locking compound.

Clean and inspect flywheel alternator stator. Use an ohmmeter with RX1 scale (minimum sensitivity of 20,000 ohms/volts.) and check continuity of stator, rectifier and regulator modules using the charts in figure IV-7.

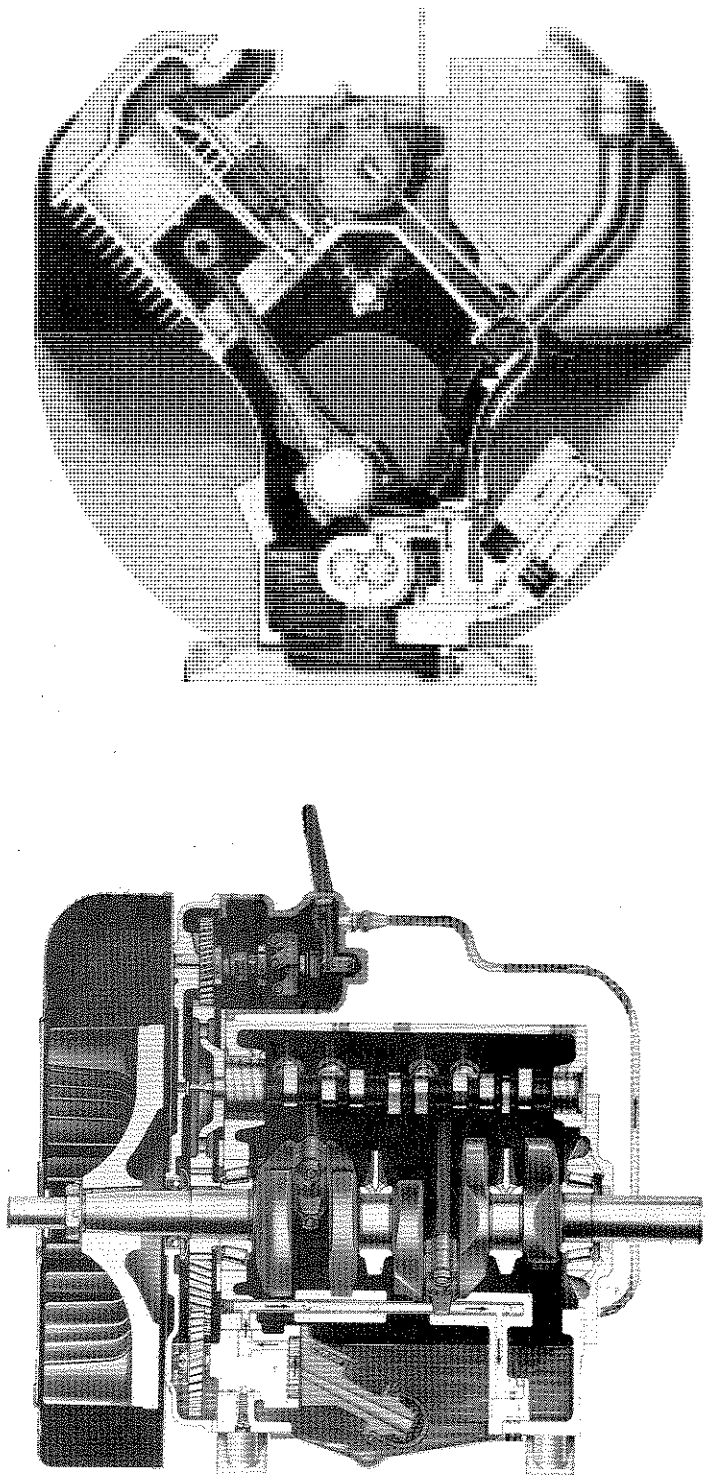
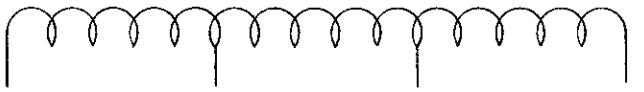


Figure IV-6 Engine Assembly

STATOR



NOTE: Wire numbers indicated for probe connections are for convenience only and are not indicated on the connectors.

METER PROBE CONNECTIONS +	–	CORRECT METER VALVE	REPLACE STATOR
Black #1 to Black #2		3.0 ohms	0 Indicates Short Circuit
Black #1 to White		1.5 ohms	
Black #2 to White		1.5 ohms	
Black #1 to Red		4.5 ohms	∞ Indicates Open Circuit.
Black #2 to Red		1.5 ohms	
Any Pin to Engine Ground		∞	Any reading indicates a short circuit.

TO CHECK RECTIFIER MODULE

The *rectifier* can be distinguished from the *regulator* being physically smaller - 7/8 inch high. Use an ohmmeter and static check continuity as follows:

METER PROBE CONNECTIONS +	–	CORRECT METER VALVE	REPLACE RECTIFIER MODULE
		R X 1 SCALE	
Eng. Gnd. to Black #1		10 to 15 ohms	
Black #1 to Eng. Gnd.		∞	Any reading indicates a short circuit.
Eng. Gnd. to Black #2		10 to 15 ohms	
Black #2 to Eng. Gnd.		∞	

TO CHECK REGULATOR MODULE

The *regulator module* can be distinguished from the *rectifier module* by the fact that it is 1/4 inch higher (1-1/8" high). and has a WHITE WIRE and a RED WIRE leading to the socket connector. Use an ohmmeter and static check continuity as follows:

METER PROBE CONNECTIONS +	–	CORRECT METER VALVE	REPLACE REGULATOR MODULE
		R X 1 SCALE	
Red to Eng. Gnd.		∞	Any reading indicates a Short Circuit.
Eng. Gnd. to Red		∞	
Red to White		∞	
White to Red		∞	
White to Eng. Gnd.		∞	

F igure IV-7 Continuity Checks Stator, Rectifier, and Regulator

C. CARBURETOR AND MANIFOLD

The carburetor and exhaust manifold can be removed as one unit. Remove nuts and washers securing manifold to the cylinder heads. After removal of the manifold, remove and discard the manifold gaskets. Remove screws, washers and nuts securing carburetor adapter to carburetor. Disconnect and discard gaskets. Remove screws, nuts and washers securing carburetor to manifold and remove carburetor, discard gaskets.

D. CYLINDER HEADS

Disconnect spark plug wires and remove spark plugs. Remove cylinder head screws securing cylinder heads to cylinders. Slightly tap the heads with a plastic hammer to break the heads loose, and lift off the heads. Discard cylinder head gaskets.

Clean cylinder heads on the outside with a wire brush and remove all carbon and lead deposits from the inside. Inspect cylinder heads for cracks, scratches, etched or worn uneven surfaces at point of contact with gasket sealing areas.

If cylinder head is warped or in any other respect is considered unusable, replace with new head.

Resurfacing of cylinder head either by filing or orbital sanding (wet) is only recommended when no more than 0.005" (.127 mm) must be removed.

E. DISTRIBUTOR (SEE FIG. IV-8)

Ensure that all electrical connections between coil and distributor are disconnected. Remove the distributor hold down screw and carefully lift the distributor from the governor housing. With the distributor removed, the screws which secure the governor housing to the gear cover plate and gear cover can be removed, and the governor housing taken off.

F. GEAR COVER (SEE FIG. IV-9)

After removing the screws securing the gear cover to the block, drive out the two dowel pins as illustrated. The cover can then be removed.

Clean and inspect the oil seal for visible damage and check the spring tension. Also check for excessive wear of camshaft button. If oil seal is damaged, replace with new seal. Make sure when installing a new oil seal that equal pressure is exerted on the total seal surface in order not to damage the seal. The use of a seal driver is recommended.

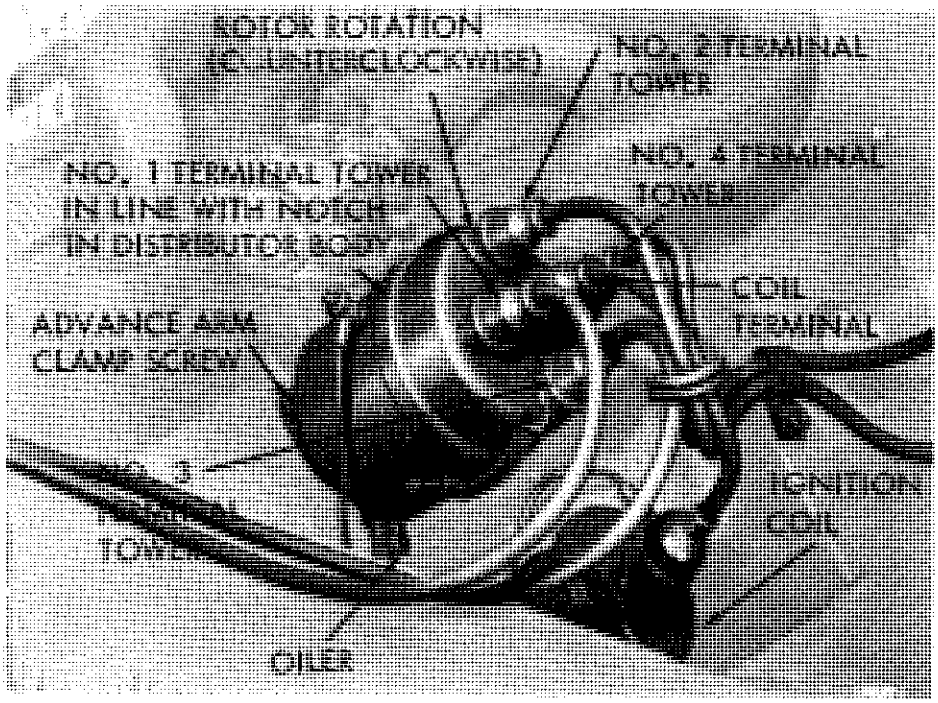


Figure IV-8 Distributor and Ignition Coil

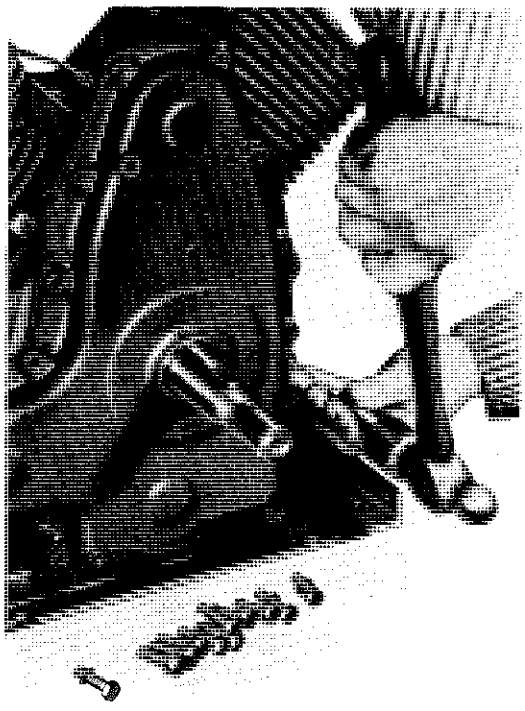


Figure IV-9 Removing Gear Cover

G. CAMSHAFT GEAR (SEE FIG. IV-25)

Only if gear teeth are damaged or broken is it necessary to remove the camshaft gear. Remove the three capscrews securing the gear to the end of the camshaft, and pry the gear off the camshaft.

NOTE: The mounting holes are staggered to eliminate incorrect installation of the gear on the camshaft, which could change the valve timing of the engine.

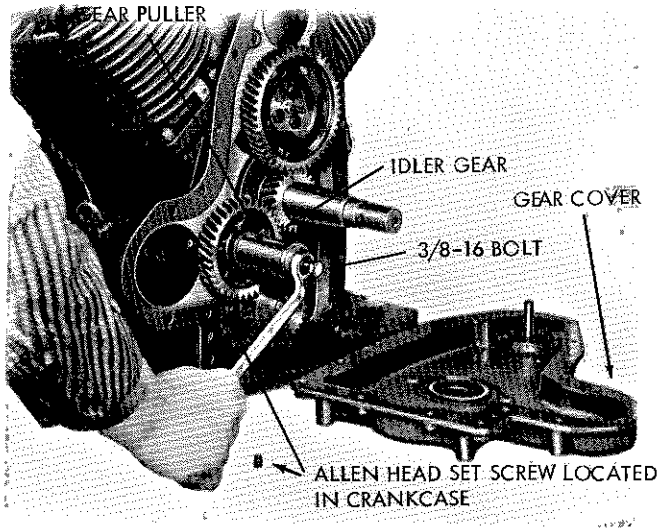
H. IDLER GEAR AND SHAFT (SEE FIG. IV-10)

Remove the Allen-head setscrew situated on the side of the crankcase (oil filter side) which locks the idler gear shaft in position. Use a gear puller to remove gear and shaft assembly from the crankcase. Inspect for wear of gear teeth and mating surfaces of gear and shaft.

I. OIL PAN (SEE FIG. IV-11)

Disconnect oil pan drain line from oil pan. Remove screws securing oil pan to crankcase and remove oil pan. Discard oil pan-to-crankcase gasket.

Before cleaning out oil pan, inspect sediment for metal



particles. The presence of metal particles can be an indication of improper lubrication or improper alignment of gears or other serious malfunction.

J. OIL PUMP (SEE FIG. IV-12)

Remove the slotted pipe plug and Allen lockscrew as illustrated. Remove locknuts securing oil pump drive gear to the shaft. With the assistance of a soft brass rod or punch, drive shaft through the gear as shown in fig. IV-30. The oil pump can then be withdrawn toward the center of the crankcase and disassembled.

K. PISTONS AND CONNECTING RODS (SEE FIG. IV-13)

Remove pal nuts and hex nuts from conrod bolts. If required, lightly tap the conrod bolts with a soft hammer in order to free the conrod cap from the bolts. The rod, with the piston, can now be pushed up through the cylinder and removed. Make sure that conrod bolts do not strike or scrape the crankshaft journals as this may cause damage to the journal surface. Replace caps on the rod to ensure proper positioning for installation. Make sure that shims between cap and rod are in place. The numbers appearing

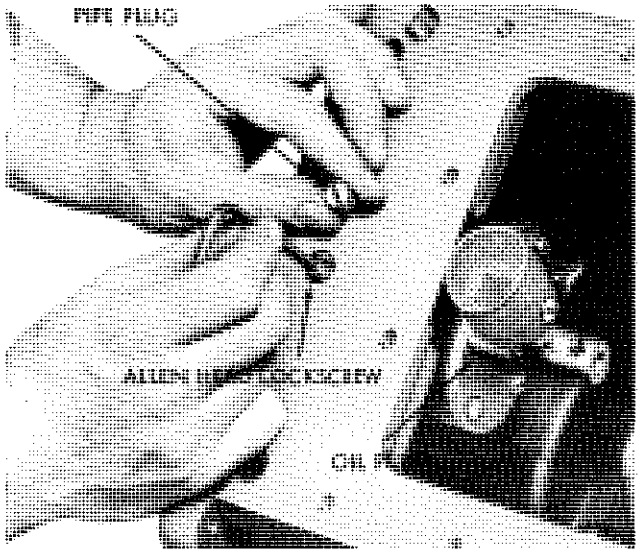


Figure IV-11 Oil Pan Removal

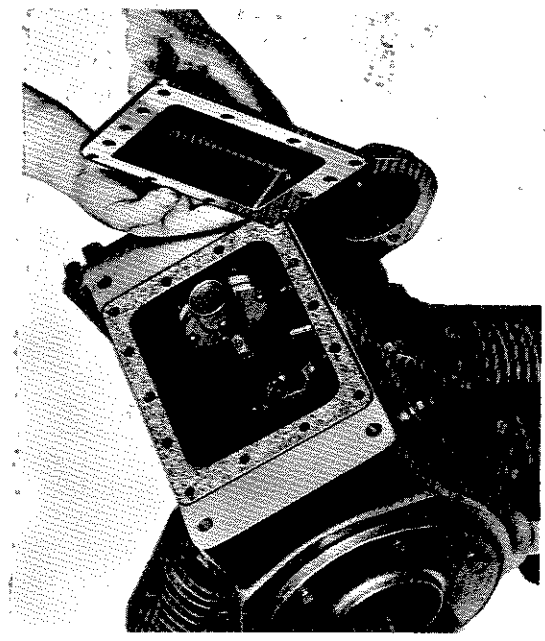


Figure IV-12. Removal of Oil Pump

on the side of the cap and the rod should be on the same side during reassembly.

Each piston and rod assembly should be marked so it will be installed in the same cylinder from which it was removed. Remove piston rings from piston, using a piston ring expansion tool in order to prevent distortion or breakage. The piston pin should be removed from the conrod assembly only if an excessive clearance is noticeable. If it is required to remove the piston pin, remove the spring clips holding the piston pin in place and press out piston pin. Clean piston (putty knife and wire brush only) of carbon and lead deposits.

Pistons are fitted to their respective bores by measuring the inside diameter of the cylinder bore and the diameter of the piston. Clearance between the piston and cylinder must be measured at the center of the thrust face of the piston skirt. The thrust faces of the piston skirt are 90° from the axis of the piston pin hole, with the wide section of the piston skirt toward the maximum thrust side (opposite side of crankshaft rotation).

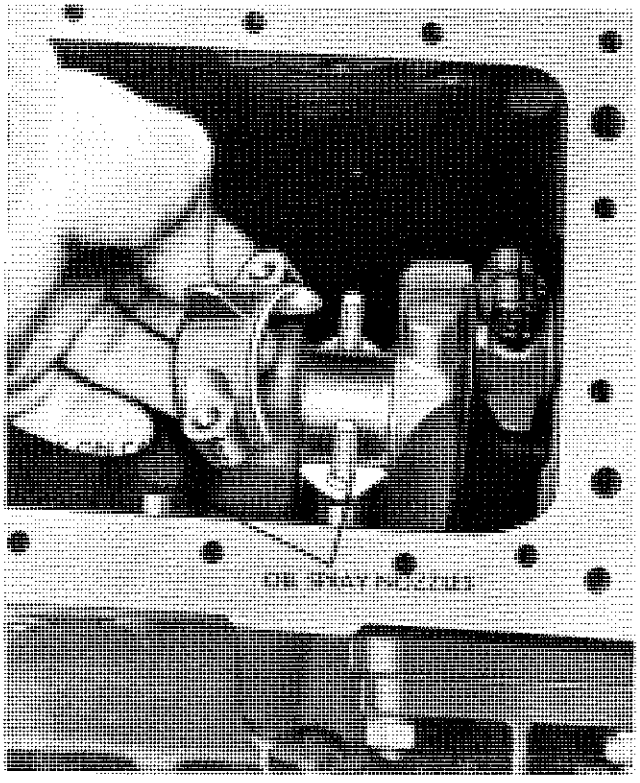


Figure IV-13 Connecting Rod Disassembly

L. CRANKCASE.

1. Crankshaft (SEE FIG. IV-14)

Remove oil slinger from crankshaft. Remove the capscrews in the main bearing plate at the take-off end of the engine. Pry off plate and remove crankshaft as illustrated. Remove capscrews securing bearing retainer plate on gear side of the engine and remove bearing cup. Make sure that gaskets and shims remain in place to ensure the correct end play for the tapered roller main bearings on the crankshaft. As there is practically no wear in these bearings, no readjustment is required after assembly when using the same gaskets and shims.

If roller bearings are severely damaged or otherwise require replacement, ensure that bearing cup and cone are replaced as a unit, never separately.

The mounting holes for the main bearing plate are offset to ensure proper reinstallation. Clean and inspect crankshaft for scored or excessively worn crankpins, and for cracks. (Check crankshaft gear for worn or cracked teeth. Use a magnetic crack detector Reynolds French & Co. or equal). If journal diameter is worn 0.005" (.127 mm), regrinding of the crankshaft journals is required. Oversized conrods in the following dimensions can be obtained 0.010" (.254 mm) and 0.020" (.508 mm).

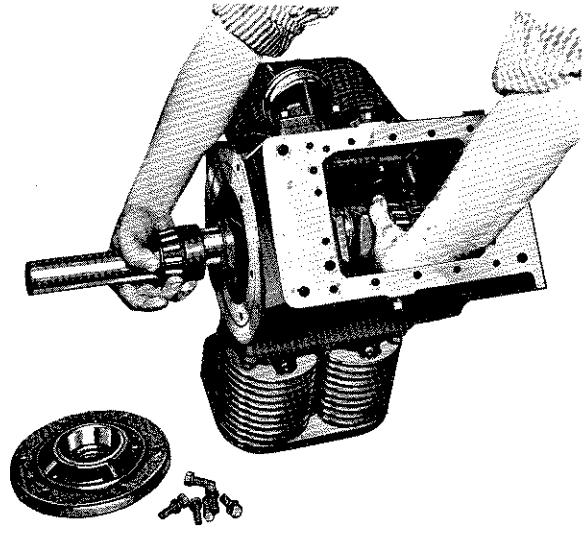


Figure IV-14 Removing Crankshaft

NOTE: Regrinding of crankshaft must be performed by a shop fully equipped to carry out such operations. Kinetics International will not be responsible for the results.

CAUTION: Check crankshaft hardness before regrinding. All crankshaft journals should check within 40 to 50 Rockwell. If journals check lower, crankshaft should be hardened to 0.090" (2.3 mm) minimum depth and 40 to 50 Rockwell before regrinding.

2. Cylinder Bore (see fig. IV-15)

In order to correctly establish piston-to-cylinder wall clearance, the cylinder measurements should be checked. Cylinder bores should be checked for scoring, taper, and out-of-round. This normally is measured with an inside micrometer or telescope gauge from the top to the bottom for taper; and from parallel to the crankpin to right angles to the crankpin for out-of-round. The standard diameter of the cylinder bore is 3.249" (82.5246 mm) to 3.250" (82.55 mm). If cylinder taper does not exceed .005" (.127 mm) and out-of-round does not exceed .005" (.127 mm) the cylinder bore may be trued by honing. Prior to fitting pistons, the trued bores must be measured for size. This diameter measurement should be taken approximately 2½" down from the top of the cylinder bore.

Cylinders should not be reused without reboring and regrinding if they exceed the worn limits (max. 0.005") (.127 mm). Pistons and rings are available in 0.010" (.254 mm), 0.020" (.508 mm) and 0.030" (.762 mm) oversize. Add oversize increments to standard dimensions to determine final oversize dimensions.

Grinding of the cylinders has the following purpose:

a. To remove the ridge at the top of worn cylinder bores to prevent damage to new rings (see fig. IV-16). This is usually accomplished with a ridge cutter.

b. To obtain next oversize dimensions.

Honing of cylinders is not only to enlarge the bore, but also to true the cylinders, and to obtain the proper finish on the cylinder walls before fitting oversize pistons and rings.

CAUTION: Always install oversize pistons in complete sets. Replace all four pistons at the same time.

When honing oversize, both roughing and finishing stones are used. Cylinder walls can be straightened with 4 or 5 passes through the bore. Visual inspection of honed cylinders will indicate the importance of using equipment and procedures which give the mechanic maximum control of operation.

Initial Set-Up

Remove cylinder block mounting nuts and remove cylinder block. Mount and secure blocks on a low work table and

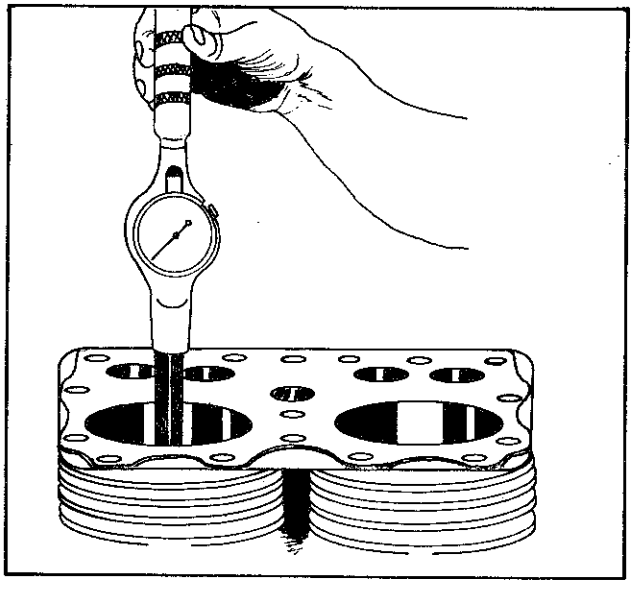


Figure IV-15 Measuring Cylinder Bore

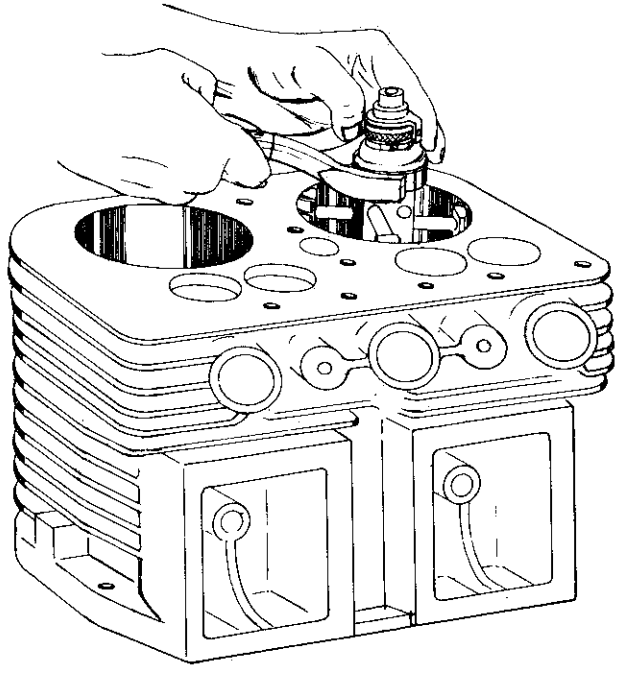


Figure IV-16 Grinding Cylinder Ridge

TABLE OF TOLERANCES						
	Minimum		Maximum		Worn Limit	
	in.	mm	in.	mm	in.	mm
Cylinder Bore. Inside Diameter	3.249	82.5246	3.250	82.55	.005	.127
Crankshaft Journals	1.875	47.65	1.876	47.675	.002	.0508
Conrod Bearing Clearance	.0007	.0178	.002	.0508	.003	.0762
Crankshaft end Clearance	.002	.0508	.004	.1016	Adj.	---
Piston Pin Bushing	.7505	19.063	.7508	19.07	.001	.0254
Conrod Length Center to Center	8.373	212.674	8.377	212.776	---	---
Piston Skirt Diameter	3.245	82.423	3.246	82.448	.005	.127
Piston Pin Bore	.7492	19.03	.7497	19.043	.0005	.0127
Piston Pin Diameter	.7497	19.043	.7500	19.05	.001	.0254
Valve Stem Diameter	.308	7.836	.309	7.86	.002	.0508
Valve Guide ID Diameter	.312	7.9375	.313	7.96	.002	.0508

Figure IV-17 Table of Tolerances

install the honing equipment. Sunnen UN-60 Universal Honing Stand or equivalent is recommended. When installing, carefully note the manufacturer's instructions concerning its assembly and the assembly of the honing stones. Before operating the honing equipment, become familiar with the honing mechanism and practice a few strokes with the stones expanded loosely in the cylinder bores.

NOTE: It is very important to obtain a 45° crosshatch pattern (see figure IV-19) to enable the piston rings to shear or peel the sharp ridge points during break in.

Honing Operation

a. Check cylinder in honing fixture to make sure it is secure.
b. Check cylinder with dial bore gauge to determine how wear pattern must be removed. In this case, assume that cylinder has a slight ring at top, 0.002 in. (0.0508 mm) wear and out-of-roundness in ring travel area. It tapers in at bottom of bore due to lack of wear in that area.
c. Assemble hone to cylinder bore. Expand stones to diameter of cylinder bore with quick-acting center pinion assembly (Knurled nut) as described under "Set-Up".
d. Expand stones and guides firmly against cylinder walls by turning winged collar clockwise on top of pinion assembly. Do not tighten too tight.

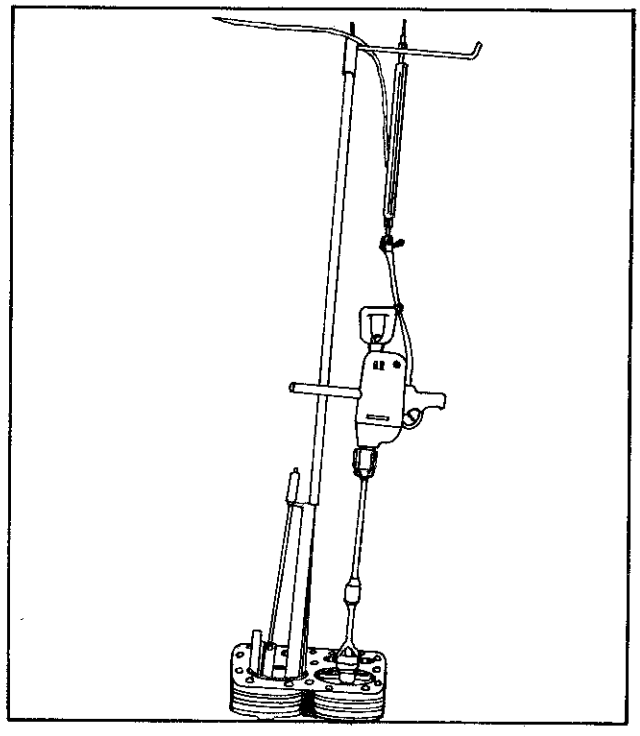


Figure IV-18 Cylinder Honing

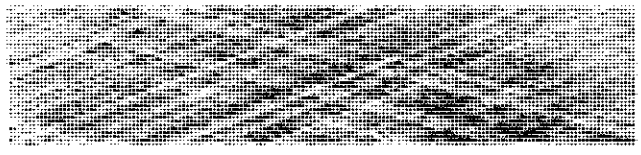


Figure IV-19 Cylinder Bore Crosshatch Pattern

e. Apply Honing Oil freely to stones, guides and cylinder walls with brush or oil can after attaching hone to Quick Coupler.

f. Grasp drill handles firmly and turn on motor. Let extension handle contact vertical stand to absorb torque of motor. Use hand on handle (with switch) to keep drill and hone over center of cylinder.

g. Stroke as follows: Move to bottom of bore and bring hone up half-way in bore. Then go back to bottom of bore. On next upstroke come all the way to top (don't let stones extend more than 1/2 to 1 in. (12 to 25 mm) out top of bore) and return to bottom repeating double stroke in bottom of bore. After 6 to 8 strokes have been made to top of bore, double stroke both top and bottom of bore. This action removes stock faster at opposite ends of bore removing tapered condition of cylinder. The first honing cycle should last only 10 to 15 seconds; then shut off drill and check for results. At first it may be wise to remove hone and check with dial bore gauge to become familiar with cutting speed of stones. Make a visual inspection of bore frequently and add oil to keep stones clean and cutting freely.

h. Apply oil and operate for another 10 to 15-second cycle, if needed, double stroking either end that is smaller in diameter than ring area. This operation is designed to straighten wall of bore and remove carbon ring at top. Keep stones cutting by adjusting pressure with winged collar. A slight reduction in drill speed will be noted when stones are cutting. Torque action felt on drill handles also is a good indicator.

i. Thirty to forty seconds honing time can remove 0.001 to 0.002 in. (0.0254 to 0.0508 mm) from bore depending upon stone pressure. Straighten bore quickly by double stroking; then full stroke bore only enough to lay a uniform finish on the walls. The total honing time will usually run about 20 to 40 seconds to perform what is commonly called a deglazing operation.

j. After pattern is uniform, stop hone; adjust stones to a frim but light pressure. Apply oil and make 4 or 5 full-length strokes and shut drill off while continuing stroke. Double stroke in bottom if necessary to time actual stopping of hone rotation when hone is at top of bore. This preserves cross-hatch pattern, and puts true stone pattern (20/30 RMS finish) on cylinder walls (fig. IV-19).

k. RMS is a convenient abbreviation for Root Mean Square, a mathematical term indicating the average irregularity of surface. This slightly irregular surface on the cylinder bores is required so new piston rings and reworked cylinders will break in (or wear in) together.

It is also necessary to have basic honed pattern in cylinders to retain some oil in valleys as piston rings scrape away oil on cylinder walls. If walls were smooth, they would quickly run dry and score.

l. Remove hone from cylinder and remove cylinder from fixture.

m. Make a final check of bore size and make sure that carbon ring at top and thrust wear pattern are removed. Note angle of cross-hatch to check stroke speed. Refer to figure IV-17 for specifications concerning maximum bore size. Out-of-roundness should not exceed 0.0015 in. (0.038 mm). If stones have been kept wet, walls will show a uniform satin finish and will be of proper finish. If a smooth shiny finish is noted, it is probably due to lack of oil, or motoring hone too long in final honing cycle. As oil disappears from walls, stones tend to load and become dull. Honing oil keeps stones sharp and promotes true cutting action.

Cleaning

a. After cylinders are honed, they must be cleaned thoroughly with solvent, steam cleaner or hot soap and water. It is recommended that cleaning operation be ended by scrubbing bore with a bristle brush to remove as much honing debris as possible. Blow cylinders dry with compressed air.

b. Coat bore of cylinders generously with clean lubricating oil. If possible, let cylinders stand 5 or 10 minutes before next step.

c. Use white paper towels to wipe lubricating oil from cylinder bores.

Note gray and even black residue that appears with oil on white towels. This is honing debris that remained on cylinder walls. Repeat application of lubricating oil and wipe off with white paper towels. If honing debris is still present, repeat lubricating oil treatment. Usually cylinders will appear clean on second application. Cylinders must be completely cleaned after honing. After soap and hot water treatment, cylinders will appear clean when a paper towel is wiped through dry bore. This is a false indication since lubricating oil treatment will remove

PISTON, RING AND ROD CLEARANCES CHART		
PISTON TO CYLINDER AT PISTON SKIRT THRUST FACE		.0035 to .004"
PISTON RING GAP		.015"
PISTON RING SIDE CLEARANCE IN GROOVES	Top Ring	.002 to .0035"
	2nd Ring	.001 to .0025"
	Scraper Ring	.001 to .0025"
	Oil Ring	.0025 to .004"
CONNECTING ROD TO CRANK PIN	Diameter	.0007 to .002"
	Side	.009 to .016"
PISTON PIN TO CONNECTING ROD BUSHING		.0005 to .001"
PISTON PIN TO PISTON		.0000 to .0008" tight

STANDARD CRANK PIN DIMENSIONS

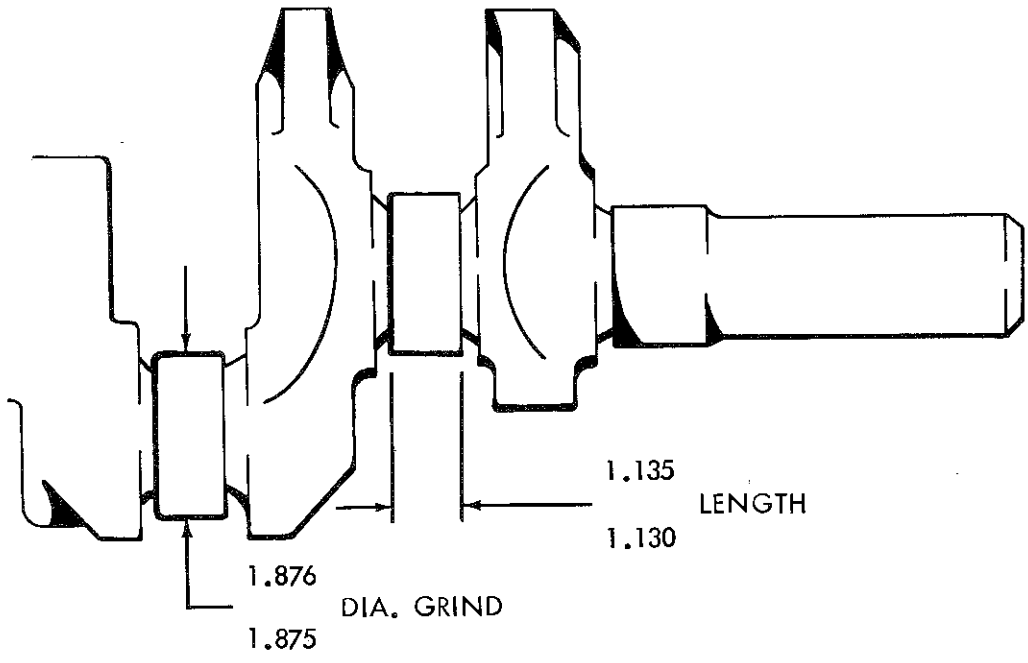


Figure IV-20 Piston, Ring and Rod Clearances Chart

additional abrasive material. We cannot be too emphatic about importance of thoroughly cleaning cylinders after honing.

3. Piston Rings

After removal of the piston rings and cleaning of the pistons, the side clearance should be checked. (see illustration figure IV-21). Also, the ring gap clearance should be checked. For this purpose install piston rings in the bottom of the cylinder near the end of the piston ring travel area using a clean inverted piston to square the ring in place. Gap clearance should not exceed 0.015".

4. Connecting Rods

Connecting rod alignment should be inspected whenever new bearings and piston pin bushings are installed. This is to insure true operation in the cylinder bore. Misaligned rods will cause uneven piston and ring wear, which will result in high oil consumption. The conrod should also be checked for a bent or twisted condition. If piston pin shows scoring or is otherwise excessively worn, replace with a new pin. Check the piston pin-to-conrod bushing clearance by measuring piston pin O.D. with a micrometer. Minimum clearance is 0.0005" (.0127 mm). Maximum clearance is 0.001" (.0254).

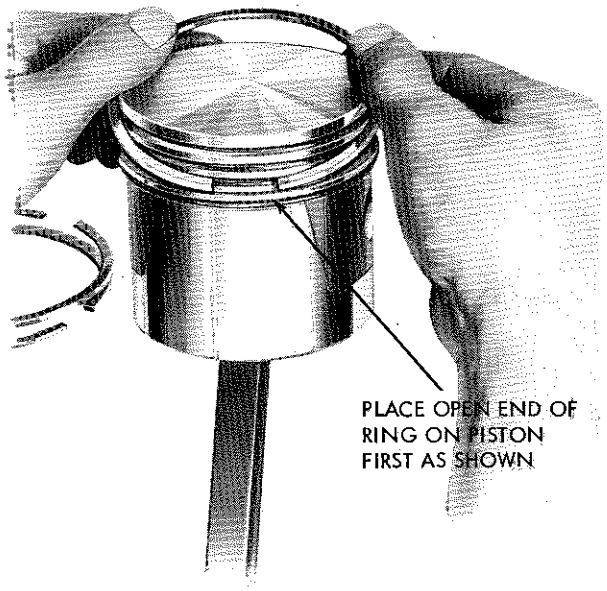


Figure IV-21 Piston and Rings

5. Conrod Bearings

Check babbit bearing surface for scoring marks, cracks, and other deficiencies. If badly worn, replace the conrod. To check clearance between the conrod and crankpin, use the following procedure. Remove crankshaft from crankcase. Install connecting rod on the crank journal from which it originally was removed. Use a feeler gauge to measure the bearing-to-pin clearance and the side clearance. A more accurate method of checking journal-to-bearing clearance is to check the journal O.D. and the conrod bearing I.D. after the cap has been torqued down to specifications on the rod. The difference between these two measurements should not be more than specified in figure IV-20.

6. Valves

After removal of the cylinders, and if required, grinding and honing of the cylinder bores, remove the valve tappet inspection plates (see fig. IV-22). Use a standard automotive type valve spring compression tool and compress the valve springs in order to remove the spring seat retaining locks. When carrying out this operation and cylinder blocks are mounted, make sure to insert a rag in the bottom opening of the valve chamber in case one of the retaining locks is dropped. Remove the valve spring seats,

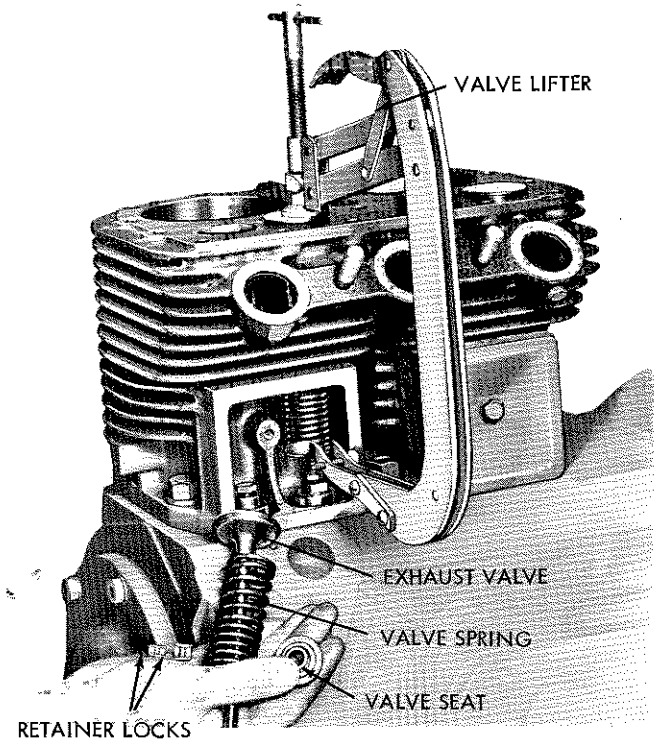


Figure IV-22 Removing Valves

springs, and valves. Clean valves, ports and guides of all carbon and gum deposits. In reassembly, ensure that valves are mounted in the same valve guide from which they were removed.

Valve Refacing

Use Kwick-Way or equivalent valve grinding equipment. Both inlet and exhaust valves are faced to a 45° angle (see figure IV-23). Valves may be refaced until remaining margin is down to 7/32", then the valve must be replaced. The valve stem tip can be refaced and rechamfered. However, never remove more than 0.010" (.254 mm) from the valve stem diameter.

After grinding the valves, the valve seats and inserts should be lapped with a suitable compound. After valve seats have been cleaned after grinding, apply lapping compound to the valve face and put the valves back in the respective valve guides. Lap the valves by rotating them back and forth with a valve lapping tool. Occasionally lift the valves and reseat them in a different position to insure a uniform seat. Check seating by putting pencil marks on the valve face and rotate valve 10°. If all pencil marks are broken, proper valve seating is accomplished.

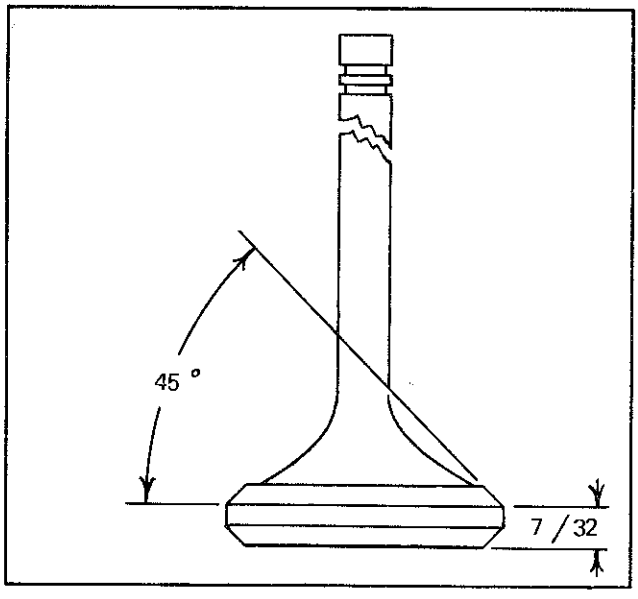


Figure IV-23 Valve Refacing

7. Valve Guides

The cylinder blocks have replaceable valve guides. Valve stems have a clearance of 0.003" (0.762 mm) to 0.005" (.127 mm) in the guides. When the clearance becomes 0.007" (.178 mm) the guides should be replaced. In order to check this clearance, measure the valve stem diameter with an outside micrometer and the valve stem guide with a small bore gauge (see fig. IV-24), with starret No. 829-D or equal.

8. Valve Rotators

The exhaust valves are equipped with valve rotators. The action of the rotocap rotates the valve slightly each time the valve opens, which prevents the valve from sticking and imparts a wiping action between the valve face and valve seat. This prevents build-up of foreign deposits. Valve rotation will also avoid prolonged exposure of any one sector of the valve face to a local hot spot on the seat. This results in lower and more uniform valve face and seat temperatures. Thoroughly clean and inspect valve rotators for proper operation.

9. Camshaft

In order to remove the camshaft, move valve tappets in outward direction, clear of cam lobes. The camshaft must be withdrawn from the flywheel end of the engine (see fig. IV-25-26). Thoroughly clean and inspect camshaft assembly. Replace camshaft if journals are badly scuffed, scored or cracked. Check by magnetic inspection for cracks, using Magnaflux (see crankshaft).

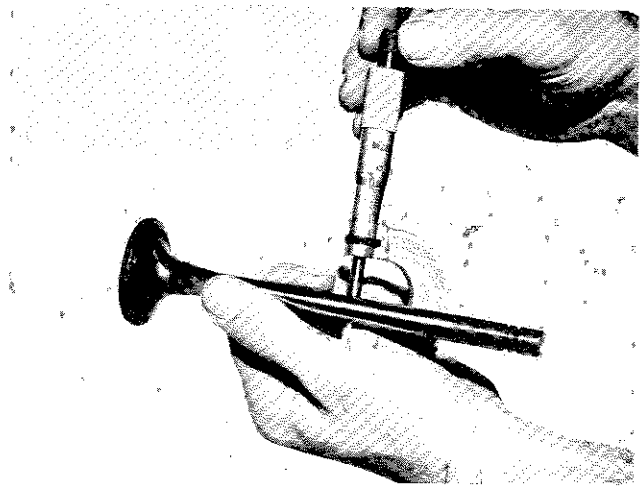


Figure IV-24 Measuring Valve Stems

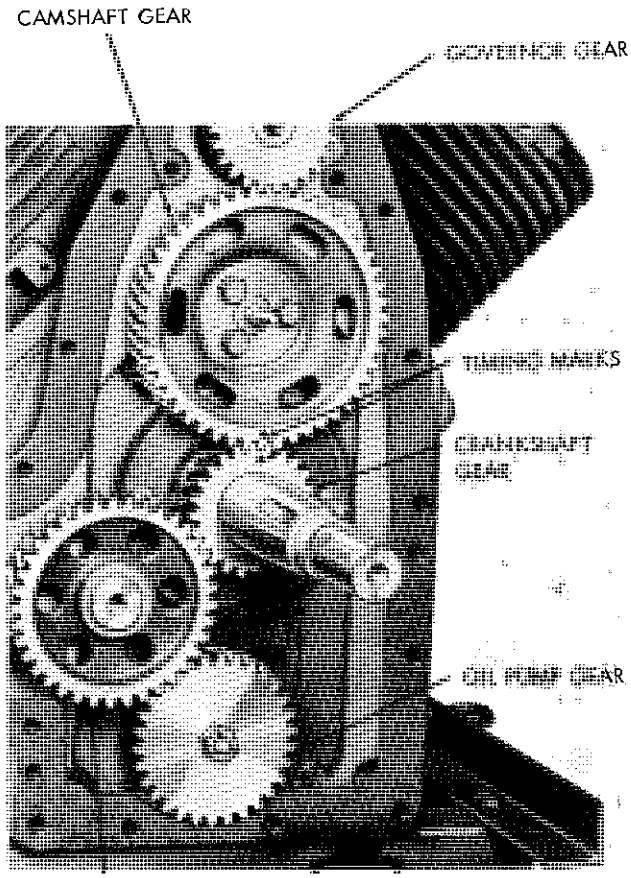


Figure IV-25. Gear Train

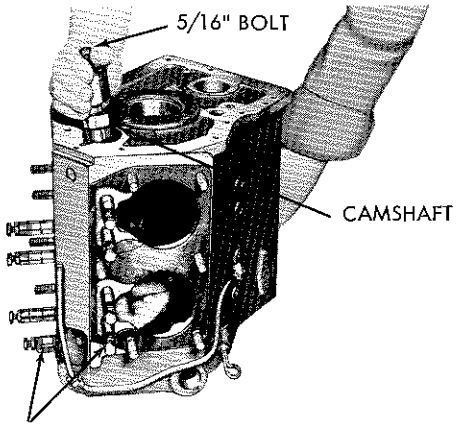


Figure IV-26 Camshaft Removal

10. Valve Tappets

The valve tappets can only be taken out after the camshaft has been removed. Check the valve tappets for excessive wear on the wear surfaces. If badly scored or scuffed, replace with new tappets. Thoroughly clean crankcase, using a steam cleaner or cleaning solvent. Blow out oil header tube, and inspect operation of oil spray nozzles and oil line from header tube to governor (figure IV-32).

• FUEL SYSTEM

The fuel system consists of a fuel tank, fuel pump (electrical), carburetor, and connecting fuel lines.

The fuel tank is located under the floor plate in the cab of the tractor. A flexible hose connects the fuel tank with the electric fuel pump. The fuel pump in turn is connected with the carburetor by means of a flexible fuel hose.

A. CARBURETOR

DISASSEMBLY OF CARBURETOR. (see fig. IV-27)

Before disassembling the carburetor, thoroughly soak the complete assembly in Bendix Metalclene or Speedclean (or equal) and rinse in cleaning solvent. Blow out all passages in both directions.

The exploded view identifies the component parts of the carburetor and shows their relationship to the complete assembly. Use the key numbers on the exploded view to identify and locate parts when assembling or disassembling the carburetor.

1. Disassembly.

a. With carburetor inverted, remove main jet (18). Remove main jet assembly washer (19) and the fuel bowl (12).

b. Stand throttle body (1) on end and press float axle (10) out of float hinges. Remove axle and float (9).

c. Hold hand under fuel inlet, and turn throttle body to horizontal position. Catch needle valve, pin and spring (parts of 20) as they fall from seat.

d. Remove idle adjusting needle (5) and spring (6) by turning counterclockwise. Remove throttle stop screw (7) and spring (8) in the same way.

e. Lay throttle body down with fuel bowl side up. Use large screwdriver to remove needle valve seat (part of 20) and washer (21) from fuel inlet port.

f. Remove bowl-to-body gasket (11).

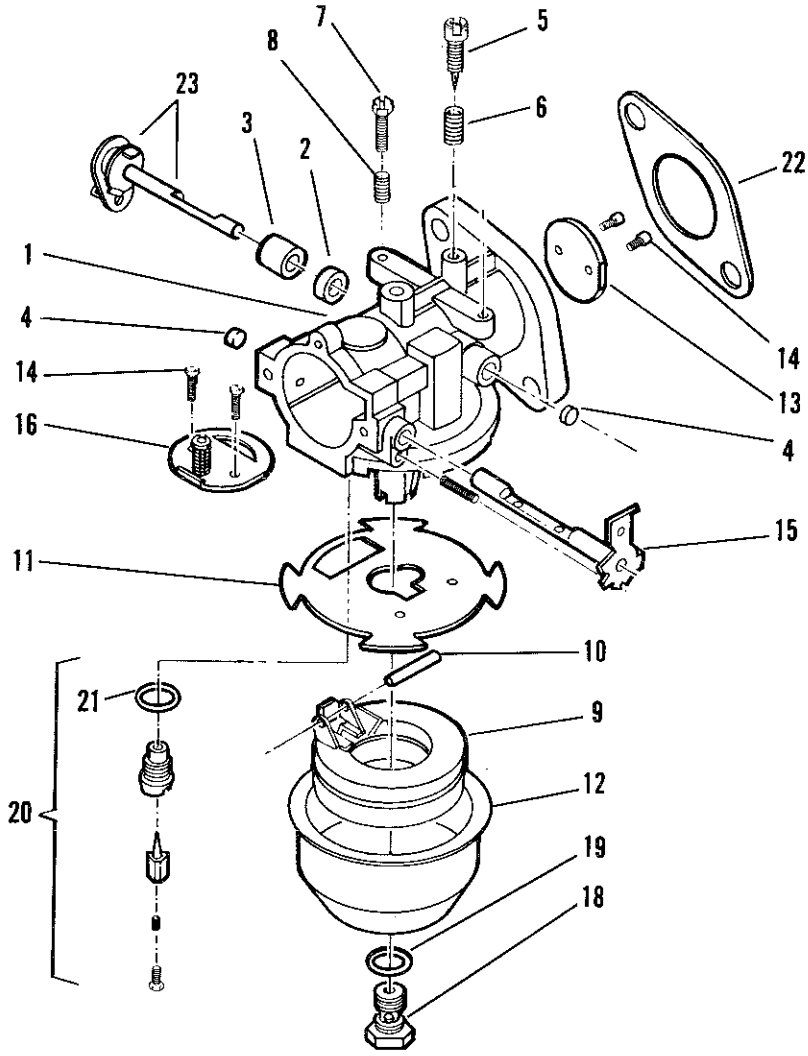


Figure IV-27 Carburetor

2. Cleaning.

Thoroughly clean all metal parts in a carburetor cleaning solvent. Blow out all passages in throttle body and fuel bowl with reduced air pressure. Be sure all carbon deposits have been removed from throttle bore and idle discharge holes. Reverse the flow of compressed air through all passages to insure the removal of all dirt. Never use a drill or wire to clean out jets or idle holes.

3. Inspection of Parts

a. Float Assembly - Replace if filled with gasoline, damaged, or if float axle bearing is worn excessively. Inspect float lever for wear at point of contact with fuel valve needle. Replace if wear is excessive.

b. Float Axle - Replace if any wear has occurred on the bearing surface.

c. Fuel Valve (Needle and Seat) Assembly - Replace as a complete unit. Wear of any of these parts can seriously affect the operation of the float.

d. Idle Adjusting Needle - Inspect tapered end of the needle to make sure it is smooth and free of grooves. Replace if pitted or grooved.

e. Gaskets - Replace all gaskets each time the carburetor is overhauled.

4. Reassembly

a. Lay throttle body down with fuel bowl side up and install bowl-to-body gasket (11).

b. Install washer (21) and fuel valve seat (part of 20). Use large screwdriver to tighten seat to 100 in-lbs. Insert valve, spring and pin (parts of 20) into seat.

c. Install float (9) and float axle (10) on support brackets of throttle body. Check operation of the float to be sure the hinge and axle do not bind and that the float moves in a perpendicular direction.

d. Install throttle stop screw (7) and spring (8). Adjust screw to open throttle slightly.

e. Install idle adjusting needle (5) and spring (6). Screw needle clockwise until it seats lightly against the idle discharge hole, then back it out 1½ turns as a preliminary idle adjustment.

5. Float Setting (SEE FIG. IV-28).

a. With fuel bowl removed, set depth gauge to dimension recommended in illustration.

b. Hold throttle body assembly in an inverted position and at the same time support float so that the tab of

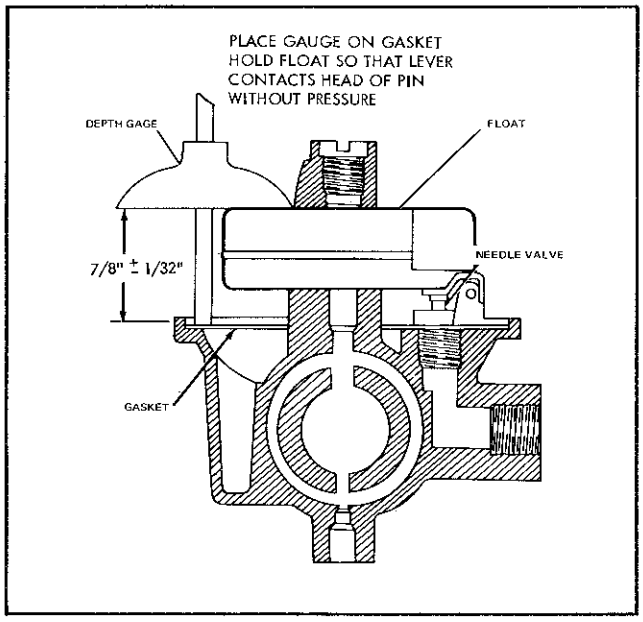


Figure IV-28 Carburetor Float Setting

the float lever just contacts the needle valve without any pressure or weight.

c. Place depth gauge in position as illustrated.

d. If float position is not to the dimension shown by depth gauge, remove float and bend tab that contacts the needle valve (use two long-nose pliers - close to the float body), until correct dimension is obtained. Reassemble float to throttle body and re-check float level position.

6. Assembly of Fuel Bowl to Throttle Body.

Assemble washer (19) on main jet (18) and install fuel bowl (12) on inverted throttle body, using care to avoid damage to the float. Screw main jet into throttle body boss, using 1/2 inch wrench. Tighten to 100 in. lbs. Install adjusting screw (part of 18). Screw clockwise until needle end seats lightly against main jet orifice, then back screw out 2¼ turns as a preliminary high speed adjustment.

7. Store carburetor in a dust-proof place or in a dust-proof plastic bag while awaiting installation (see installation, Paragraph O) and adjust when engine is running (Testing Engine).

• Air Intake System

A. GENERAL

The required function of any air induction system is to supply clean air to the engine without excessive restriction, at a temperature at which the engine will operate efficiently. Because dirt is the basic source of wear in cylinders, pistons, rings and valves, the effectiveness of the air cleaner and intake piping in preventing the entry of dirt in the engine has a considerable effect on engine life and maintenance costs. The overall design of the intake system should provide first of all minimum air intake restriction, to maintain an adequate air flow to the engine for good combustion. Air intake restriction can be measured by means of a vacuum measuring device, preferably a water-filled manometer. The air filter should at least have a filtering efficiency of 98%.

B. AIR CLEANER AND PIPING

Loosen hose clamp and remove hose from air cleaner intake. Remove dust cup from cleaner and take out element by removing wing nut holding element in position. A considerable amount of dust can be dislodged by slapping the side or bottom ring of the element with the palm of the hand. Use compressed air to blow element from clean-air side.

CAUTION: Air pressure should not be higher than 100 PSI (7.03 Kg/sq cm) to avoid rupturing element. Wash filter element with any good non-sudsing household detergent and warm water. Rinse with maximum 40 PSI (2.81 Kg/sq cm) water pressure until drain water is clean. Dry with compressed air, making sure not to concentrate air pressure in one spot.

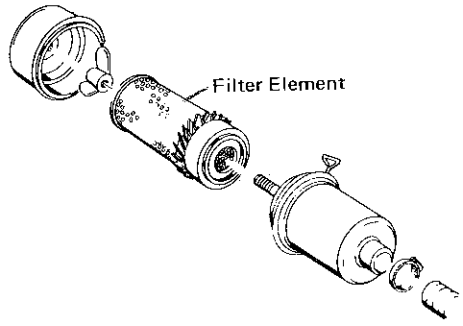


Figure IV-29 Air Cleaner

CAUTION: Never dry element in sunlight or expose it to heat. Inspect cover gasket for wear and replace if necessary.

After cleaning and drying, replace filter elements before tightening the wing nut. Install dust cup and tighten clamp securing the dust cup to the housing. Replace air cleaner hose and tighten the hose clamp.

• Lubricating Oil System

The lubricating system consists of an oil pump, filter, dipstick, oil header, oil spray nozzles, and connecting lines.

GENERAL

A gear type pump supplies oil to four nozzles, which direct oil streams against fins located on the connecting rod caps. Part of the oil enters the conrod bearings through holes in the rods, and the balance of the oil forms a spray or mist which lubricates the cylinders and other internal parts of the engine. An external oil line leading from the oil header tube in the crankcase to the governor nozzle supplies oil which lubricates the governor and gear train.

A. LUBRICATING OIL PUMP (figure IV-30)

To disassemble the pump, remove the screws and washers securing the housing cover to the housing, and pry off cover. Remove cotter pin on the outside of the cover which holds the pump relief valve spring in position, and remove spring and the relief valve (ball type). Remove shaft and gear from housing for cleaning and inspection. Inspect inside of the housing and gears for excessive wear or broken teeth. If excessive wear or scoring patches are evident on the teeth, replace with new gears. On reinstallation of the parts, make sure that gears and shafts rotate freely. Never assemble a pump dry, but lubricate rotating parts before installation. Also ensure that the correct thickness of cover gasket is used in order to obtain the correct gear to housing clearance. Pressure relief valve spring will allow a maximum oil pressure of 15 PSI (1.05 Kg/sq. cm).

B. FILTER.

Oil from the crankcase is first filtered through a screen filter before entering the pump. From the pump the oil flows to the header tube, and part of the oil is bypassed to the filter, where after being filtered through a paper element type filter, it is returned to the crankcase. The filter is of the cartridge throw-away type, and should be discarded after removal. In installing the new filter cartridge, make sure that the gasket is installed correctly. Before installation, coat gasket with clean engine oil.

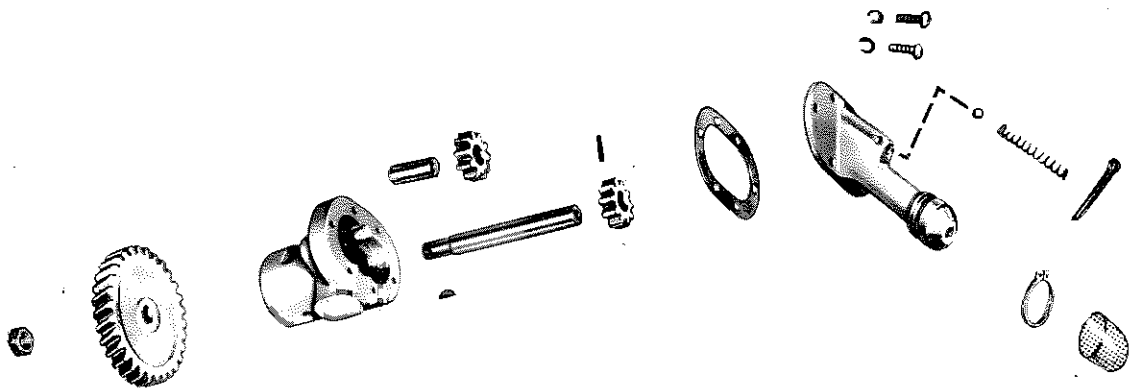


Figure IV-30 Oil Pump Disassembly

Figure IV-31 Oil Filter

C. OIL SPRAY NOZZLES (figure IV-32)
Normally spray nozzles should not have to be removed. In order to check their correct functioning, connect an air hose to the external oil line to the governor, and blow out the header tube and nozzles. An even air spray should be visible from the nozzles.

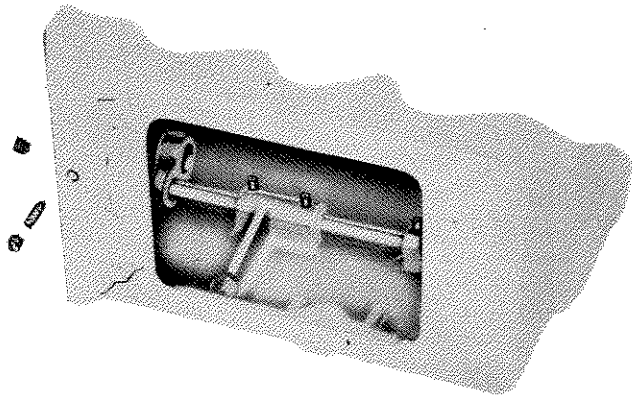


Figure IV-32 Oil Spray Nozzles

D. DIPSTICK.
The dipstick supplied on each engine to check the oil level has been calibrated to a certain operational oil level, and marked with "ADD" and "FULL". Oil levels below the "ADD" mark will result in pressure fluctuation or even loss of pressure. Oil levels above the "HIGH" mark will cause foaming and excessive oil temperatures and power loss. If dipstick should be lost or damaged always replace with a factory supplied dipstick.

• Cooling System.

A. ENGINE COOLING
Cooling of the engine is accomplished by a flow of air around the cylinders and over the cylinder heads by means of a combination fan-flywheel. In order to guide the air flow, the fan-flywheel is encased in a sheet metal shroud to insure uniform cooling of all engine parts. Also, the engine is surrounded by a sheet metal casing which, by means of ducts and baffles, guides the air flow around the engine. It is therefore of the greatest importance that the engine never be operated with any part of the shrouding removed, because this will seriously affect the air cooling.

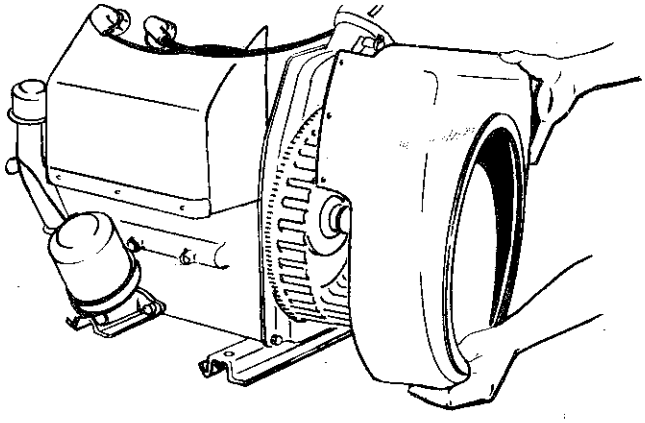


Figure IV-33. Removal of Air Shrouding

B. OIL COOLER.

Immediately in front of the flywheel shroud, and secured to it by screws, is the sheet metal casing of the radiator type hydraulic oil cooler. The oil cooler is installed in this casing by means of 4 screws on the side of the casing.

Engine cooling air is drawn through the radiator before entering the flywheel shroud, cooling the hydraulic fluid pumped through it. The radiator type oil cooler can only be removed from the vehicle as one unit with the power train, after which it can be removed by removing the 4 screws securing it to the radiator casing. Cleaning of foreign particles from the radiator can be accomplished by directing air pressure in reverse from normal operation. Internal cleaning and repair of the radiator should only be done by shops equipped with the correct machinery and staffed with trained personnel.

• Electrical System.

A. GENERAL

The electrical system is of the single wire 12-volt type, using the KID welded body construction as a conductor to complete the circuit to the battery source. Negative ground polarity is used. The charging circuit consists of the battery, flywheel mounted alternator, rectifier and regulator modules, charge circuit wiring, and the tractor body.

The flywheel alternator is of the permanent magnet type, and has no brushes, commutator, belts or adjustments. A series of coils (stator) is mounted to the engine gear cover, and the magnetic flux is provided by a permanent magnet in the flywheel which rotates around these stationary coils. Four components make up this light-weight space-saving source of energy: a flywheel with magnetic rotor, stator, rectifier module and regulator module (see figure IV-35).

The center-tap rectifier arrangement prevents damage to the alternator system, in the event of incorrect battery connection or by arc welding. One half of the load-producing winding is in series with each diode, so when the battery is connected in reverse, resistance of the winding limits the current draw and keeps it at a safe level. If the incorrect battery connection is not remedied, complete drainage of the battery occurs, but the alternator will not be damaged. In the case of arc welding, the winding acts a a choke and its inductance prevents the transient voltage from damaging the diodes.

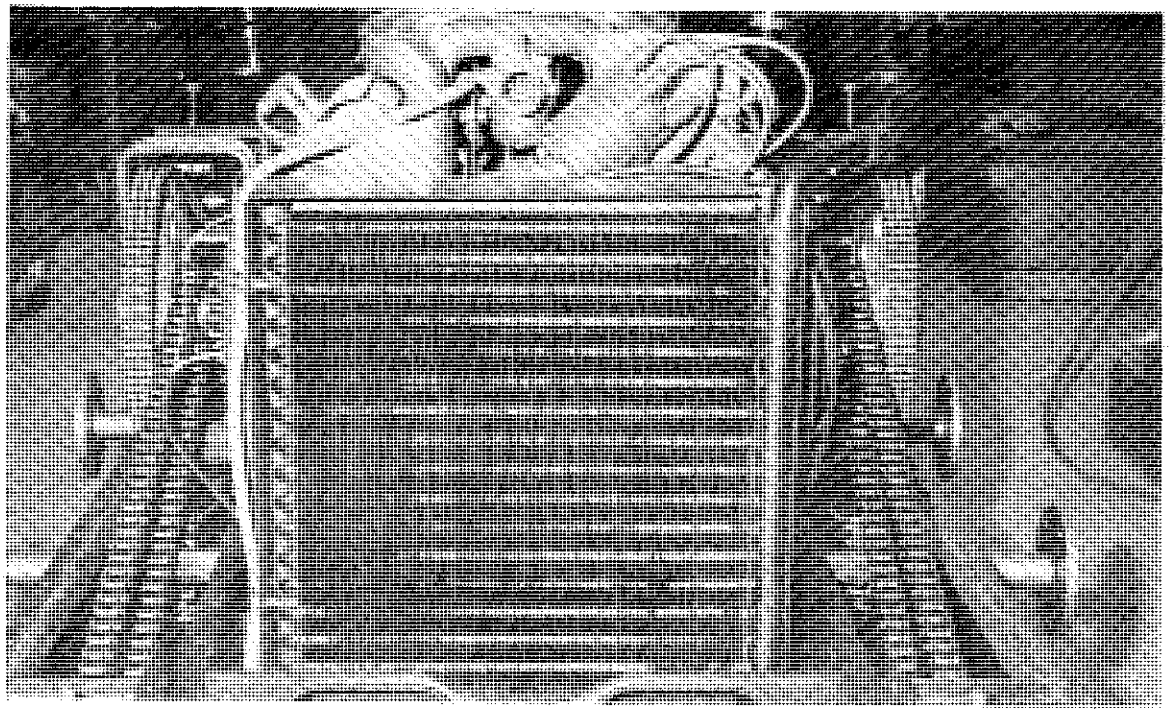


Figure IV-34 Oil Cooler

Solenoid wires to Ig. Switch Stud w/ one Rivet (DARK GREEN)

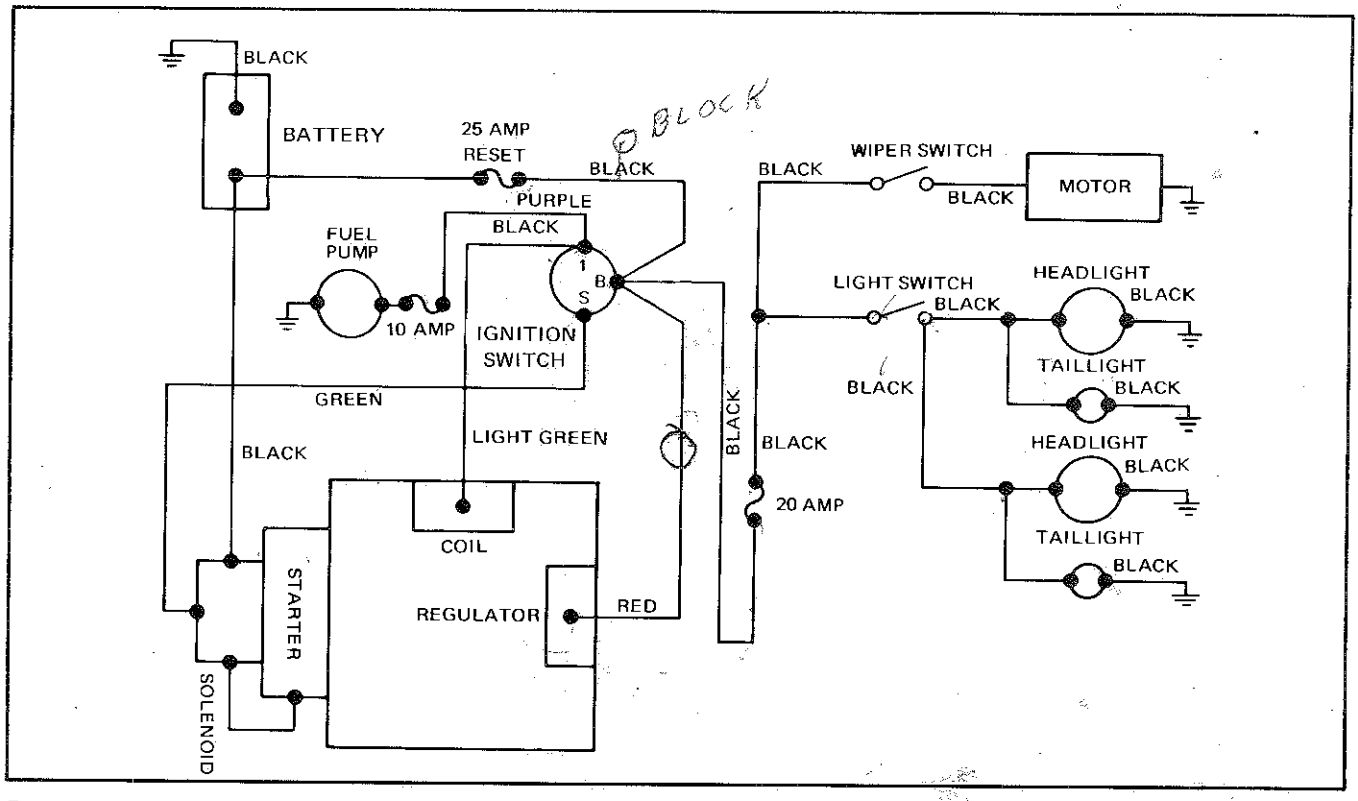


Figure IV-35 Kid Electrical Schematic

PRECAUTIONS to be exercised in the use of this flywheel alternator:

1. DO NOT reverse battery connections. This is for a negative ground system only.
2. Connect booster batteries properly - positive to positive and negative to negative.
3. DO NOT polarize the alternator.
4. DO NOT ground any wires from stator or modules which terminate at connectors.
5. DO NOT operate engine with battery disconnected from system.
6. Disconnect at least one battery lead if a fast battery charger is used.
7. Never use a fast battery charger to boost the battery output.

B. BATTERY

1. Battery Testing

a. Hydrometer Tests

Specific gravity of batteries is checked by means of a hydrometer. Hydrometer floats are calibrated to

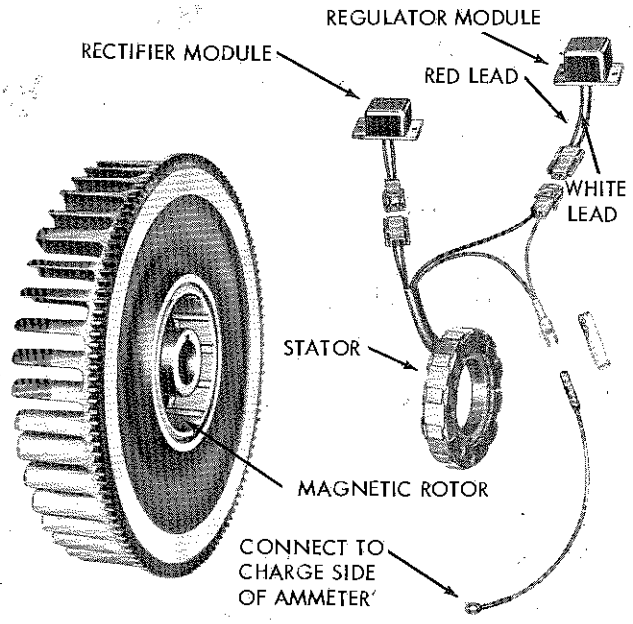


Figure IV-36 Flywheel Alternator

indicate correctly only at one fixed temperature (80° F). The temperature correction amounts to approximately .004 specific gravity referred to as 4 points of gravity for each 10° F. above 80° F. For each 10° F subtract 4 points. Always correct the specific readings for temperature variation. Measure the specific gravity of the electrolyte in each battery cell. If the specific gravity of all cells is above 1.235 but the variation between cells is more than 50 points (.050) it is an indication of an unserviceable battery. If the specific gravity of a cell or cells is less than 1.235, recharge the battery (slow charge). If the specific gravity of the cells is higher than 1.235 and variation between cells is less than 50 points, the battery may be checked under load.

b. Battery Load Tests

Light load Test

A light load test is an "in the tractor" test which quickly determines the serviceability of a lead acid battery. A light load tester or a 0-4 voltmeter with cadmium probes can be used for this purpose.

IMPORTANT: Always follow the manufacturer's operating instructions supplied with the test equipment. Add distilled water to required levels. With load or headlights on check each cell for voltage reading. If reading is lower than 1.95 volts, battery is too low to test. Differences between the highest and lowest cells should not exceed 0.05 V. If such a difference exists, the battery should be replaced.

Heavy Load Test.

Turn control knob of battery charger to "off" position. Turn voltmeter selector switch to 16-volt position. Connect test leads. Turn control knob until ammeter reading is equal to 3 times the ampere hour rating of the battery (96 Amp). Maintain this load for 15 seconds, note voltmeter reading, then turn control knob to off position. If voltmeter reading is 9.6 V. or higher with battery temperature at a minimum of 70° F, battery has correct output capacity. If less than 9.6 volts, replace battery.

2. Battery Charging

Slow Charging

a. This is the best method of recharging a battery. Ensure that the electrolyte is at the proper level before charging the battery, and that battery caps are removed. Normal charging rate is 5 Amperes for a 12 V battery. A minimum period of 24 hrs is required when using this method. A battery is fully charged when all cells are gassing freely and three corrected specific gravity readings taken at hourly intervals show no increase in specific gravity.

b. Fast Charging

When fast charging a battery always disconnect the terminal cables. The rate of charging is unrestricted as long as no excessive gassing or loss of electrolyte occurs and as long as the temperature of any one cell does not exceed 125° F.

C. WIRING CIRCUIT.

The fool-proof type connectors used prevent incorrect wiring from the stator to the rectifier and regulator modules. To disconnect plugs, squeeze outer ends of recepticle and pull apart.

The rectifier and regulator modules are grounded to the engine, and therefore should not be removed and mounted at some remote location. This is a negative ground circuit. Connect ground strap from negative post of battery to starting motor flange, or other good clean grounding surface on engine.

D. IGNITION SYSTEM (figure IV-37)

The ignition spark must occur at the correct time and with sufficient intensity to ignite the compressed fuel-air mixture. All components of the ignition system must function properly for satisfactory and economical operation. This system consists of an ignition coil, distributor, spark plugs, and ignition cables. The function of the coil is to transfer the low primary voltage to a voltage high enough to supply sufficient spark for all conditions of load and speed. The distributor has a double function. It distributes the high tension secondary voltage to the spark plugs in the proper sequence, and it opens the ignition points at the proper time to fire the spark plugs. At high speeds, the spark must occur at the spark plug earlier in the compression stroke to give the fuel-air mixture time to ignite and apply the developed energy to the piston on its power stroke. Variable spark timing in relation to engine speed is accomplished by the centrifugal advance mechanism of the distributor (figure IV-38).

E. IGNITION COIL.

The ignition coil is an oil-filled hermetically sealed unit These units do not require any service other than keep the terminals and connections clean and tight. In case of failure, the complete coil must be replaced, as no repair is possible.

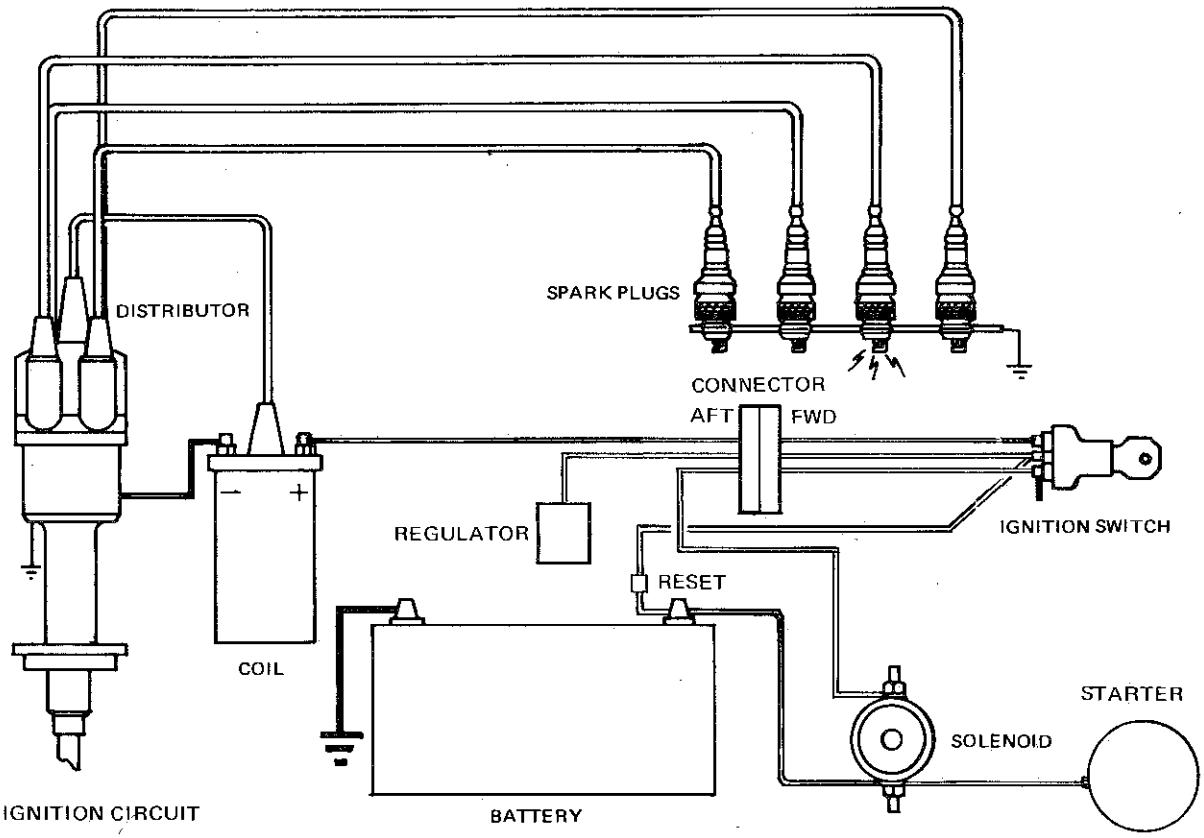


Figure IV-37 IGNITION CIRCUIT

F. DISTRIBUTOR (figure IV-38)

The distributor basically consists of the housing, drive shaft, breaker plate, breaker points, cam shaft, rotor and cap, and centrifugal advance mechanism. The centrifugal advance mechanism consists of two spring-controlled flyweights which, by means of two pins, actuate (advance or retard) the rotor shaft bottom plate. As the speed of the distributor shaft increases with the engine speed, the weights are forced outward against the spring tension. The flyweight mounted pins located in holes of the cam shaft bottom plate cause the contact points to open earlier and thus advance the spark.

Visual inspection of the distributor should be made at regular intervals. The distributor cap should be removed and wiped clean, and inspected for cracks, carbon, and corroded high tension terminals. If any of these conditions are found, the cap should be replaced. The rotor should be inspected for cracks, burning marks on the top of the metal strip, or evidence of mechanical interference with the cap.

CAUTION: Never try to correct the burning marks on the end of the metal strip by filing down. Replace the rotor.

The distributor is located on top of the governor housing, to which it is secured by means of the advance arm. The distributor drive shaft is driven by the governor shaft through a gear assembly. In order to remove the distributor, remove the screw and washer which secure the advance arm and the distributor to the governor housing.

CAUTION: Always mark the position of the advance arm on the governor housing in order to eliminate confusion during reassembly.

Carefully lift distributor from the governor housing and disassemble. Remove roll pin from drive gear on shaft. Lift out dust plate and remove screws securing breaker plate to housing and lift out the plate. Remove cam shaft and drive shaft. Clean all parts and inspect.

Condenser Test.

The purpose of the condenser in the ignition system is to prevent arcing and pitting at the breaker points and to aid in collapsing the magnetic field of the ignition coil. A capacity test, leakage, and series resistance test should be made on the condenser. As this requires special test

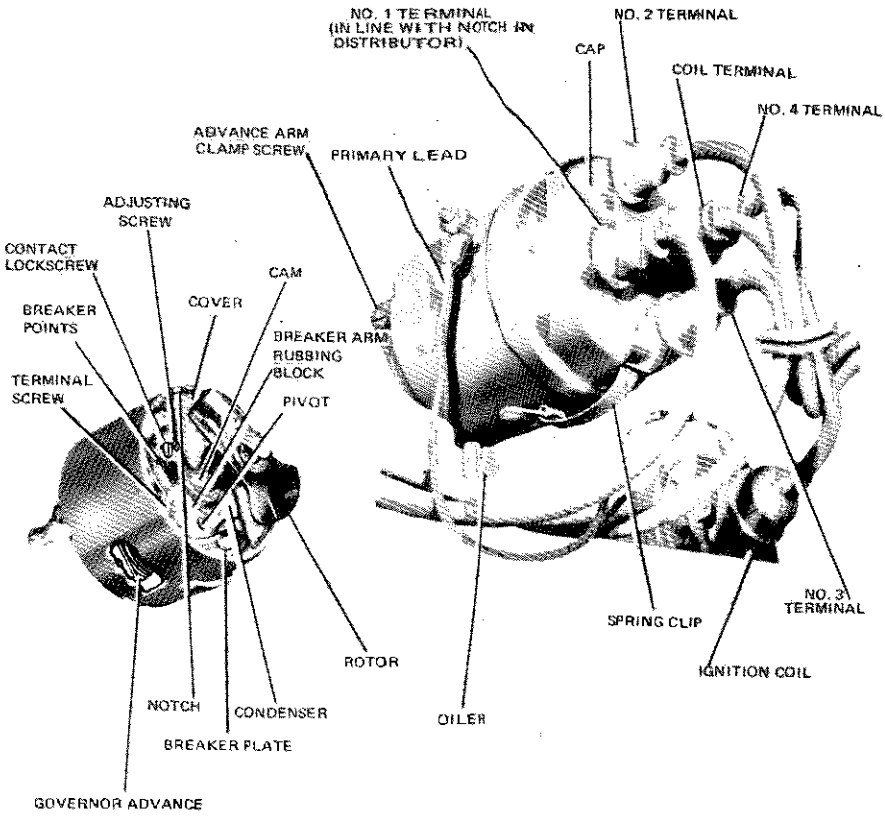


Figure IV-38 Distributor Assembly

equipment, follow the instructions of the respective manufacturer supplying the test equipment.

Breaker Points.

The breaker points should be visually inspected, and if the points are badly burned or pitted, they should be replaced.

CAUTION: Never file or use emery cloth to clean the breaker points.

The breaker points are always replaced as a complete assembly. The service replacement set has the breaker lever spring and point alignment preadjusted at the factory. Only the dwell angle (point of opening) requires adjustment after replacement.

1. Loosen the terminal screw (it is not necessary to remove this screw).
2. Lift the breaker point spring free of the terminal and release the spring tension.
3. Remove the breaker point hold-down screw, and lift the breaker point assembly free of the pivot post.
4. Install the new breaker points and hold-down screw, and set the spring in place on the terminal.
5. Remove the condenser lead from the terminal, remove the condenser hold-down screw, and remove the condenser.
6. Install the new condenser and tighten the terminal screw.

NOTE: Make sure the condenser lead is clear of the rotor and breaker points and is not touching the base.

7. Adjust the distributor points when distributor is re-installed on engine (see Engine Reassembly (N))

G. SPARK PLUGS

The spark plugs should be removed from the engine periodically and examined for burned electrodes, dirty or fouled, cracked or broken porcelain. The gaps should be checked, reset and rechecked. The recommended gap is .030" (.762 mm).

CAUTION: When installing plugs always use new gaskets. This will ensure proper compression and eliminate overheating of the plug, as gaskets assist in dissipating cylinder head heat.

When installing spark plugs always use a torque wrench, tighten spark plugs to 25 to 30 ft. lbs. (3.32 to 4.15 Kg m) torque.

H. IGNITION CABLES.

The use of secondary ignition suppression cables is recommended, as this type of cable serves the dual purpose of conducting current at the required voltages to the spark plugs and at the same time, because of sufficient resistance incorporated over its entire length, eliminates radio interference. Suppression type cable is also used in the high tension lead. When connecting the cable to the spark plugs make certain that a good connection is made, and that the protector boots fit tight on the spark plug and distributor cap. A partially seated cable creates an additional gap in the circuit and the resulting spark jump will cause terminal and cable damage. Cables should be checked for visible cracks in the insulation. Test the cables with an Ohmmeter. (Resistance value per foot is 3,000 to 7,000 ohms.) The cables can be checked for circuit continuity by removing the cable from the spark plug and holding the cable end approximately 1/4" from the engine. A good strong spark indicates good conductor continuity.

I. STARTER SOLENOID

1. Maintenance

There is no maintenance during the operational life of the starter solenoid other than to check the electrical leads and solenoid mounting bolts for tightness.

2. Removal

a. Disconnect the battery.
b. Disconnect the two high current electrical cables.
c. Disconnect the low current lead.
d. Remove two solenoid mounting bolts.
e. Remove the solenoid.

3. Repair

There is no repair recommended for the solenoid.

4. Installation

a. Hold the solenoid in place and install the two mounting bolts.
b. Connect the two high current electrical cables.
c. Connect the low current lead.
d. Connect the battery.

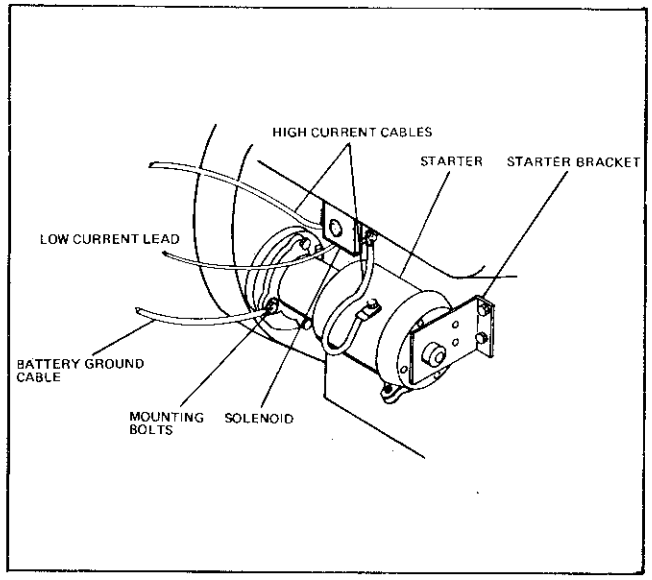


Figure IV-39 Starter and Solenoid

J. STARTING MOTOR OVERHAUL (figure IV-40).

1. Disassembly

a. Loosen screw and remove cover band.
b. Remove end plate assembly and thrust washer from starting motor frame.
c. Remove four hex cap screws and lockwashers securing the drive housing assembly to the starting motor frame.
d. Remove armature, intermediate bearing plate assembly, Bendix drive, gasket, oil seal, and drive housing assembly as a unit from the motor frame.
e. Remove the armature, bearing plate assembly, and Bendix drive as an assembly.
f. Turn the Bendix drive clockwise until the retaining pin is visible through the hole in the gear housing. Using 3/16 punch, drive the starter drive retaining pin from the armature shaft. Remove the starter drive from the armature shaft.
g. Unsolder field connections at brush and remove.
h. Remove the four countersunk head screws securing the field coil and pole shoes.
i. Remove screw and lockwasher and disconnect field wire from terminal stud.
j. Remove the four field coils and pole shoes and insulators from the motor frame.

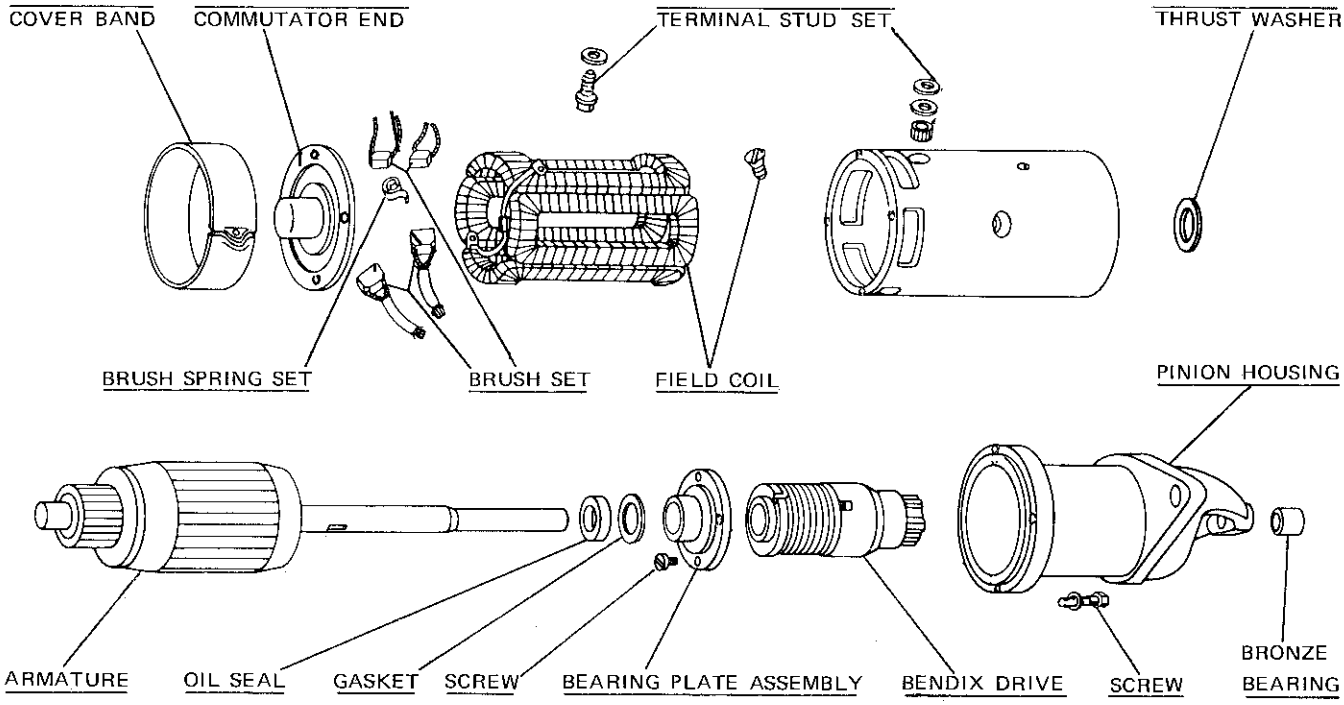


Figure IV-40 Starting Motor Assembly

k. Remove the bushing and plug from the end plate assembly.

l. Remove terminal stud package (washers, stud, bushing) from motor frame.

2. Cleaning

a. Clean the metal starting motor parts with mineral spirits, paint thinner or other suitable cleaning solvent.

NOTE: Do not clean field coils in solvent. Wipe clean with rag.

b. Air dry all parts.

3. Inspection and Repair

a. Brushes. Inspect brushes for arcing, cracks, breaks, and excessive wear.

NOTE: Always use new brushes when overhauling the starting motor.

b. Brush Holder. Check brush holder for arcing shorts, breakage, cracks and missing parts. Check the brush spring tension. Hook a brush spring scale under the bend of the spring, near the brush. Pull on the scale in a direction opposite the force exerted by the spring. Read the spring tension just as the spring leaves the brush. The tension should be between 32 and 40 oz. If the tension is too low, there will be poor brush contact. Too great a spring tension will cause excessive brush wear. To change spring tension, twist the spring at the holder with needle-nosed pliers.

c. Commutator. Check commutator for wear and discoloration. Commutator may be cleaned with 00 sandpaper using compressed air to remove all traces of sand after sanding.

NOTE: Do not use emery cloth to clean the commutator. Emery dust or metal burrs can short out the commutator.

If it is necessary to turn the commutator, use an armature lathe or its equivalent. Take off as little material from the commutator as possible. Remove the tool marks with 00 sandpaper. After cleaning, air dry and make sure all sand is removed.

NOTE: Do not undercut the mica on the starting motor armature. Undercutting the mica can result in open circuits.

d. Armature. Inspect the shaft for rough bearing surfaces, and rough or damaged splines. Visually inspect the armature for any mechanical defects before checking for shorted or grounded coils. With a set of test probes, first test the armature for grounds by touching one probe to a commutator segment and the other to the core.

CAUTION: Do not touch the test probes to either the bearing surface or the brush surface as the resulting arc will burn the finish.

If the test lamp lights, the coil connected to the commutator segment is grounded and the armature must be replaced. To test for a shorted armature coil, place the armature on a growler.

e. Field Coil. After the field coils have been installed in the motor frame, using test probes check the field coils for both ground and open circuits. To test for ground, touch one probe on the motor frame or pole piece and touch the other probe to the field coil terminals. If the test lamp lights, the field coil is grounded and must be replaced.

f. Motor Frame and End Plate. Check casting for distortions, stripped threads, cracks, breaks, and broken sections. Inspect bearing bores for out of round and oversize (worn).

g. Starter Drive. Inspect starter drive for slippage, broken spring, cracked housing, looseness or binding on armature shaft. Inspect drive gear for broken, worn or chipped teeth. Replace drive if any of the above malfunctions are present.

4. Assembly

a. Install plug and press bushing into end plate assembly.

b. Press bearing into drive housing assembly.

c. Assemble starter drive and thrust washer package on armature shaft.

d. Secure Bendix drive to armature shaft with holding pin.

e. Insert armature shaft assembly into the drive housing assembly.

f. Position the four field coil and pole shoes and insulators in the motor frame and secure in place with the four counter-sunk screws.

g. Install the brush holder in the motor frame and secure with retaining screws.

h. Install terminal and stud package (insulating bushing, terminal stud, insulating washers) in motor frame.

i. Secure field wire to terminal stud.

j Insert brushes in brush holder and solder field leads to brush holder connections.

k. Install motor frame over armature assembly, position brushes over commutator, and position motor frame to drive housing assembly and secure together.

l. Install end plate assembly on armature shaft and secure in place with screws. Install cover band.

Starting Motor and Starting Circuit Tests

1. No-Load Test

This test will uncover such faults as open or shorted windings, rubbing armature, or bent armature shaft.

Connect the starting motor in series with a 12-volt battery, an ammeter capable of reading several hundred amperes, and a variable resistance. Connect a voltmeter from the starting motor terminal to the starting motor frame. Attach an rpm indicator to measure the armature speed. Obtain the proper voltage by varying the resistance unit. When the proper voltage is attained, read the no-load current draw on the ammeter and the armature speed. Compare these readings with starting motor specifications.

2. Starting Motor Lock-Torque Tests (figure IV-41).

Remove the starting motor from the engine and mount it securely to a test bench. Connect an ammeter, voltmeter, resistance unit, and 12-volt battery. The resistance unit should be a variable resistance with a high-current capacity. Connect a brake arm to the drive pinion and attach a scale.

CAUTION: Use extreme care to ensure the end of the brake arm does not slip off the pinion when current is applied.

NOTE: When the proper amount of torque is applied, the torque can be computed from a reading on the scale. The scale can be read in foot-pounds if the brake arm is one foot long. Compare the scale reading with the specified starting motor performance.

3. Starting Motor Resistance Test

This test is conducted using the same test setup as in the lock-torque test. In this test the brake arm must be secured to prevent it from rotating. When the proper voltage is

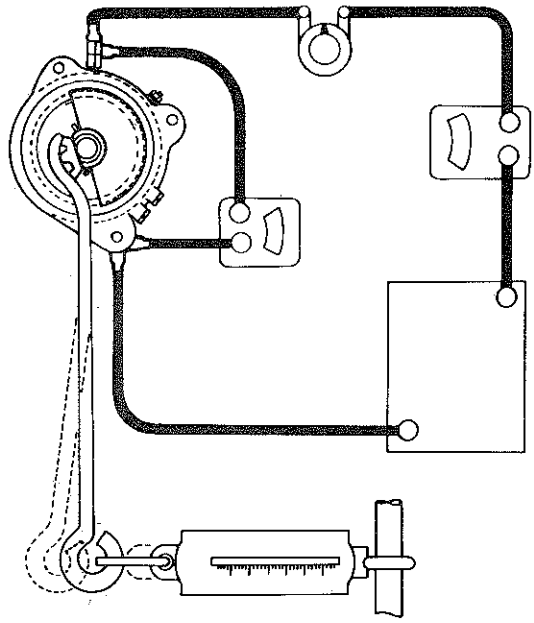


Figure IV-41. Starting Motor Lock-Torque Test

applied, the current should fall within the range specified.

Starting Motor Component Tests

1. Testing the Armature for Short Circuit

Visually examine armature for any mechanical defects before checking for shorted or grounded coils. Test the armature for shorted coils by turning it in a growler while holding a thin metal blade (hacksaw) parallel to the core and just above it. If the blade is attracted and vibrates, the armature coils are shorted and the armature must be replaced.

2. Testing Armature for Ground

Hold one test probe on the commutator and the other on the shaft. If the lamp lights, it indicates a grounded armature which must be replaced.

3. Testing Commutator Runout; Refacing and Undercut ting

Place the armature in a pair of "V" blocks and check the runout with a dial indicator. Test both the shaft and the commutator. The armature must be replaced if the shaft is bent. When the commutator runout exceeds 0.003 inch, it should be turned down in a lathe. Remove as little metal as necessary to provide a smooth, even surface.

4. Armature Open Circuit Test

An open circuit armature can sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed each time a commutator segment that is connected to an open circuit winding passes under a brush.

Exhaust System

A. EXHAUST PIPE AND MUFFLER (see fig. IV-42)

The exhaust system consists of the engine exhaust manifold, the exhaust pipe, and the muffler. The exhaust manifold and the inlet manifold form one integral casting, and it is mounted on the L.H. and R.H. cylinder blocks by means of studs and nuts.

The exhaust pipe is screwed into the exhaust manifold on one end and on the other end it is welded to the muffler to give the system the required rigidity. The muffler tail pipe leaves the vehicle at the rear and is supported by means of a bracket mounted to the tractor body. A U-bolt and nuts secure the tail pipe to the bracket. To remove the exhaust pipe/muffler assembly, remove the nuts, washers and U-bolt securing the assembly to the rear bracket, and with a pipe wrench unscrew the assembly from the exhaust manifold.

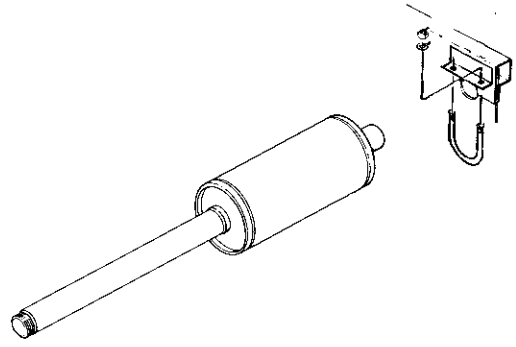


Figure IV-42 Exhaust System

CAUTION: When unscrewing the exhaust pipe make sure not to distort the pipe as this will necessitate replacement of the complete assembly.

When reinstalling the exhaust pipe always use an anti-seizure compound on the threads for ease of installation and removal. A mixture of graphite and petroleum jelly will suit the purpose.

• Engine Controls

A. GENERAL

The engine control system consists of the throttle control, choke control and governor.

The throttle control enables the operator of the tractor to regulate his engine speed (RPM) from the driver's position by means of a throttle cable. One end of the cable is attached to the carburetor throttle shaft, and the other end to the control pedestal handle.

The purpose of the choke control is to provide the operator with a means of manually adjusting the fuel-air mixture, and provide the correct mixture required for cold starting and warm up.

The choke control cable runs from the control pedestal in the cab to the engine carburetor choke shaft.

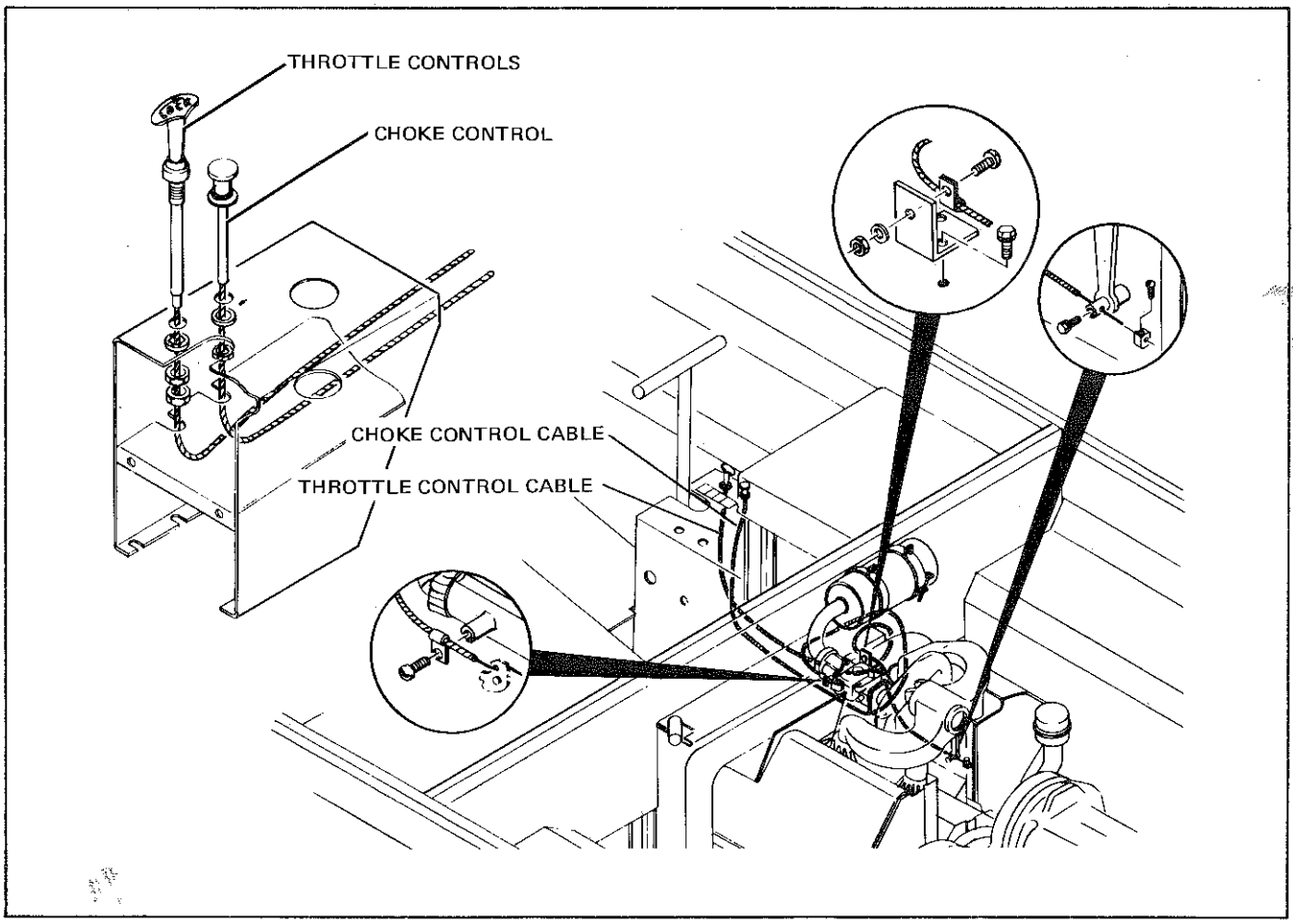


Figure IV-43 Throttle & Choke Controls

B. CHOKE CONTROL (figure IV-43)

1. Removal

a. Disconnect the choke wire from the carburetor.
b. Loosen 2 clips holding choke in position.
c. Remove locknut inside control pedestal.
d. Pull choke wire out through hole in pedestal, retaining nut when it drops off wire.

2. Inspection

Check the choke wire for sharp bends, frayed conduit, or excessive binding. If any of these conditions exist, replace the unit.

3. Installation

a. Hold the locknut in position under the hole in top of pedestal, and feed choke wire through and back to carburetor.
b. Tighten the locknut inside pedestal.
c. Tighten 2 holding clips, making sure the choke wire does not have any sharp bends and is not rubbing. Push choke handle all the way in, and set the choke butterfly full open in the carburetor.
e. Connect choke wire to carburetor, bend the wire so that the butterfly starts to close as soon as choke handle is pulled.
f. Check choke operation to make sure it has full travel and is not being held partly closed with handle in.

C. THROTTLE CONTROL (figure IV-43).

CAUTION: When removing or replacing throttle, do not change the governor setting or in any way change the relationship of the governor arm to the throttle.

1. Removal

a. Disconnect the throttle wire from the lower arm of the throttle lever.
b. Loosen clip on top of flywheel shroud, and clip in base of pedestal.
c. Remove locknut on throttle wire inside pedestal.
d. Hold the locknut and pull throttle wire out through hole in pedestal.

2. Inspection

Check the throttle wire for sharp bends, frayed conduit, or excessive binding. If any of these conditions exist, replace the unit.

3. Installation

a. Hold the locknut in position under the hole in top of pedestal and feed throttle wire through and back to carburetor.
b. Tighten locknut inside pedestal.
c. Tighten 2 holding clips making sure the throttle wire does not have any sharp bends and is not rubbing.
d. Push throttle handle all the way in, and slip the throttle wire into the screw clamp on throttle lever.
e. Make sure the throttle handle is all the way down, hold the throttle lever against the carburetor idle stop screw, and tighten the screw clamp on the wire.
f. Check throttle operation for full travel and make sure it is not binding.

D. GOVERNOR

The governor is driven by the crankshaft through a gear drive arrangement. Its function is to maintain an almost constant engine speed for a certain throttle setting, regardless of the load imposed on the engine. This is accomplished by means of a flyweight and sleeve assembly. (see fig. IV-44).

The flyweights are hinged to lugs on the gear which is driven by the camshaft gear at crankshaft speed. Hardened pins on the flyweights bear against a flanged sliding sleeve. If the engine speed increases the centrifugal force will move the flyweights outwards, which will force the sliding sleeve to move in an axial direction over the governor drive shaft. The motion of the sleeve is transmitted through a ball thrust bearing to the yoke, which is mounted on the cross shaft, which in turn is connected to the carburetor throttle shaft through a linkage arrangement. This centrifugal force works against the force of the spring, which is attached to the governor lever, and tends to hold the governor flyweights in a closed position. The spring also holds the carburetor throttle in a full open position. Increased engine speed forces the flyweights to move out against the force of the spring, and will close the throttle to a point where the engine speed will be maintained at practically a constant speed under varying load conditions.

1. Adjustment.

The control rod between the governor and carburetor must be adjusted to the proper length, otherwise the governor will not function properly.

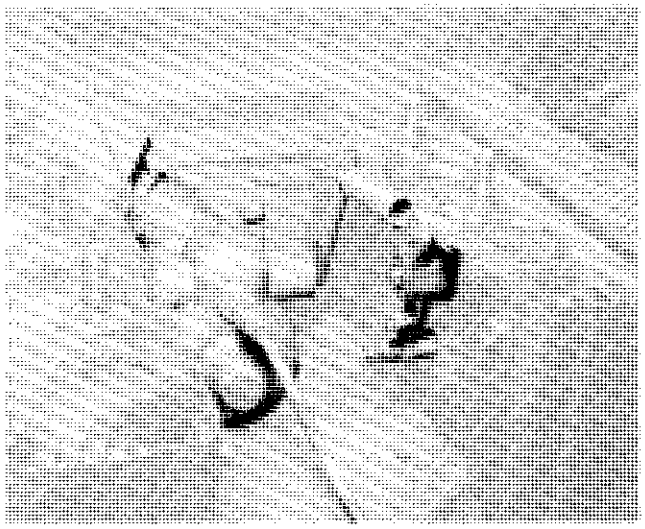


Figure IV-44. Governor Assembly

With the engine shut down, the governor spring will hold the flyweights in, and the control rod must be of such a length as to hold the carburetor throttle wide open. Before adjusting the governor, the timing of the engine must be checked. If the spark advance is not correct, adjustment of the governor is hopeless. With correct timing, proceed as follows: (See Figure IV-45)

(1) Be sure that spring is in the "B" hole of the lever.
(2) Attach a tachometer to the engine.
(3) Push throttle control lever in cab to idle position (down).
(4) Loosen the swivel block screw.
(5) Loosen the throttle cable clamping on the engine flywheel shroud.
(6) With a short length of wire, fasten point "A" of the governor lever to an item forward. Be sure the lever is pulled all the way forward.
(7) Crank engine.
(8) Adjust adjusting nut until engine is running at 2,970 RPM.
(9) Lock jamnut against adjusting nut.
(10) Remove the wire and allow the engine speed to drop.
(11) Adjust the idle speed screw on the top of the carburetor until the engine idles at 1,170 RPM.
(12) With engine running, tighten the swivel block screw on the throttle wire and tighten the throttle cable clamp on the shroud.

The engine governor is now adjusted at the same points as done in the KID factory prior to delivery of the finished unit to you. The governor requires little or no maintenance. During disassembly, inspect parts for wear, specifically the flyweight roll pins and pressure surfaces of thrust sleeve and yoke. Also the bushings in the gear cover and governor housing should be checked for excessive wear and replaced if there is evidence of scoring or if the clearance between bushing and shaft is excessive.

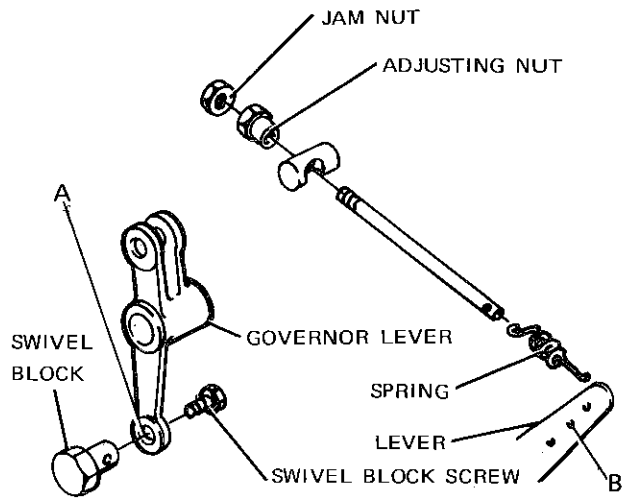


Figure IV-45 Governor Controls

• Engine Reassembly

A. TAPPETS, CAMSHAFT, AND CRANKSHAFT

After all parts and components have been cleaned, inspected, repaired or replaced, start reassembly procedures with the installation of the tappets (before installing the camshaft). Use either Lubriplate or a clean engine oil to lubricate the wear surfaces before installation. When this is accomplished, reinstall the main bearing cup on the flywheel side of the crankcase, making sure that cup is installed with the small diameter facing outward. Secure bearing cup in the crankcase by fitting the bearing retainer ring on the outside of the crankcase in such a way as to lock the bearing cup. Carefully slip crankshaft into crankcase (figure IV-14), fitting bearing cone into the bearing cup. Install main bearing plate on the take-off end of the engine and tighten main bearings. Ensure that the crankshaft end-play after tightening of the main bearing plate capscrews is approximately 0.002" to 0.004" (.0508 to .1016 mm). This can be accomplished by installing or removing shims between the main bearing plate and the crankcase.

Re-install camshaft gear on the camshaft and tighten the three screws and lockwashers which secure the gear to the shaft (figure IV-25).

NOTE: Mounting holes in the camshaft and camshaft gears are staggered in such a manner that the gear can only be assembled to the shaft one way, which automatically times the gear to the shaft.

CAUTION: Ensure that timing mark on camshaft gear corresponds with the timing mark on the crankshaft gear, otherwise engine will not operate properly or will not run at all. (see figure IV-25).

NOTE: Mounting holes in main bearing plate are offset, ensuring installation of the plate in the correct way.
Main bearing plate capscrews should be tightened to 25 to 30 ft. lbs. (3.32 to 4.15 Kg m) torque before checking endplay of the crankshaft.

B. CYLINDERS

The cylinders can be installed next. Make sure that mating surfaces are clean and flat. Use a new gasket between cylinder and crankcase, and ensure that cylinder blocks are put back on the same side from which they were removed. Tighten the cylinder block mounting nuts to 40 to 50 ft. lbs. (5.67 to 7.05 Kg m) torque. Install valves, springs and spring seats using the valve spring compressor tool. Compress the springs until the half collets can be installed. Use grease to retain half collets in place when reinstalling. Slowly release compression tool, making sure that spring retainer rings slip over the half collets, locking them in place on the valve stem.

C. PISTON AND CONNECTING ROD ASSEMBLIES (figure IV-13).

Install one piston pin snap ring in groove of piston pin bore and install piston pin through piston and connecting rod pin bore.

CAUTION: Never drive piston pins in piston. Driving may cause distortion of pistons resulting in seizure of piston in cylinder. If piston pins do not slip in easily, heat the aluminum pistons in boiling water or in an oven at or below 200° F. (98° C) and install pin before piston cools down. Secure pin with second snap ring in groove at opposite end of pin bore.

Install piston rings on piston using a piston ring expander. Always use new rings after overhaul. Ensure that piston rings are installed with the correct sides up (see fig. IV-45). Stagger the piston ring gaps so that no two gaps are adjacent.

The scraper ring must be installed with the scraper edge facing downwards, otherwise oil pumping and excessive oil comsumption will result. Compress rings with a standard ring compressor. Slide connecting rod cap from connecting

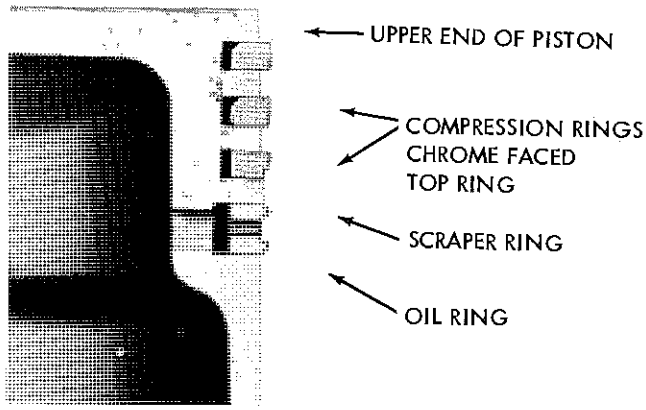


Figure IV-46 Piston Ring Installation.

rod bolts. Rod caps are not interchangeable, so keep with mating connecting rod.

Rotate crankshaft so that crank throw below the respective piston bore is in bottom center position. Lubricate piston, cylinder bore and bearing surfaces freely. With ring compressor in place, insert piston and rod assembly into cylinder. Position wide section of the piston skirt toward maximum thrust side, (opposite the crankshaft rotation). Push piston and rod assembly through ring compressor until rings are in the cylinder bore. Grasp piston and rod assembly by the rod bolts and pull down to crankshaft journal. Install rod caps over bolts in such a way that the numbers on the side of the cap and the rod are matched. Install conrod nuts and tighten to 22 to 24 ft. lbs. (2.9 to 3.3 Kg m) torque. Tightened rod should be free to move sideways on crank journal. Install pal nuts to secure the conrod nuts to the conrod bolts.

D. OIL PUMP (figure IV-12).

Install the oil pump by sliding in the pump from the center of the crankcase. Install the Allen lockscrew and tighten securely. Screw the slotted pipe plug back in place and tighten. Install gear on shaft making sure that Woodruff key is in place. Install locknut that secures gear to the shaft and tighten securely.

E. OIL PAN (figure IV-11).
Install oil pan using a new gasket, and tighten oil pan mounting screws 6 to 9 ft. lbs. (.83 to 1.4 Kg m) torque.

F. IDLER GEAR AND SHAFT (figure IV-10).
Install idler gear on shaft and insert assembly into the crankcase opening. Allow 0.003" to 0.004" (.0762 to .1016 mm) clearance between idler gear and shaft collar. Install Allen set screw from the side of the crankcase and tighten securely. This will lock the idler shaft into position and eliminates axial movement of the shaft.

G. GEAR COVER (figure IV-9).
Before replacing the gear cover and spacer, install new crankshaft seal in the gear cover. Use a seal driver and mandrell to install the seal to avoid damaging the seal. Install governor shaft bushing in the gear cover, ensuring that there is no distortion of the bushing. Install spring and plunger in camshaft. These control the axial movement of the camshaft. Install camshaft thrust button in gear cover. Install gasket between crankcase and spacer and screw spacer into place. Install oil slinger on crankshaft. Install spacer to cover gasket and secure. Install cover with two or three screws. Insert dowel pins and install remaining screws. Tighten capscrews to 14 to 18 ft. lbs. (1.9 to 2.5 Kg m) torque.

H. VALVE CLEARANCE ADJUSTMENT (figure IV-46).
1. Adjust the valve clearance as follows:
a. Turn the crankshaft until the piston is well into the compression stroke, with both valves fully closed and both tappets completely free.
b. Hold the valve lifter with a wrench, and using another wrench, turn the self-locking adjusting screw until the proper feeler gauge has a slight drag when placed in the gap. The intake valve clearance should be 0.008 inch (0.20 mm), and the exhaust valve clearance should be 0.016 inch (0.41 mm).
c. Repeat steps a and b for all 4 cylinders.

I. GOVERNOR - DISTRIBUTOR HOUSING.
Install the governor housing, making sure that gears mesh and that governor drive shaft is properly inserted into the bushing in the gear cover. Tighten screw and lock washer that secure governor to the gear cover. No timing of governor gear to camshaft gear is required.

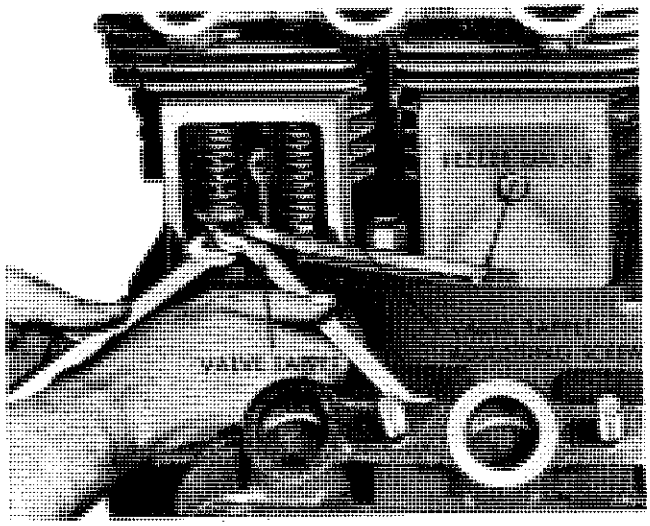


Figure IV-47 Adjusting Valves

J. CYLINDER HEADS.
Screws of different length are used to secure the cylinder heads to the blocks according to the various length of the cylinder head bosses. Always use new cylinder head gaskets when cylinder heads have been removed. Tighten cylinder head screws starting with the center screws and working

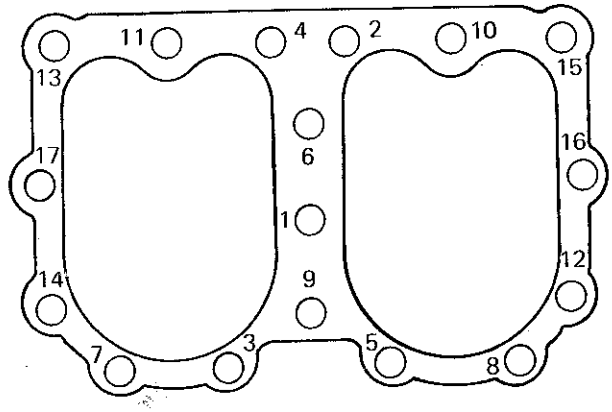


Figure IV-48 Cylinder Head Tightening Sequence

outwards hand tight (see figure 4-47). In similar sequence and using a torque wrench, tighten cylinder head screws 22 to 24 ft. lbs. (2.9 to 3.3 Kg m). Retorque screws after engine run-in and in warm condition to the same specifications.

CAUTION: Always use an anti-seizure compound or a mixture of graphite and petroleum jelly on the cylinder head screws to prevent rust forming.

K. AIR SHROUDING AND ALTERNATOR (figure IV-33).

Install cylinder shrouds and heat deflectors, tightening screws hand-tight. When all shrouds and screws are in place, secure screws firmly. Install flywheel shroud to gear cover and secure with the screws.

NOTE: Install the two flat head center screws using "locktight" to prevent loosening of the screws due to vibration during operation.

Alternator.
Install alternator stator by slipping stator over the two roll pins located in the gear cover, and secure with the 4 screws and lockwashers.

CAUTION: Make sure that alternator is installed exactly parallel with the gear cover to ensure that gap clearance between stator and flywheel-mounted rotor is the same when measured at 4 points.

NOTE: Make sure that alternator-stator wires are properly installed, leading to the rear of the shroud.

L. FLYWHEEL (figure IV-6).
Install flywheel-fan making sure that the Woodruff key is in position on the shaft and that the keyway in the flywheel is lined up accurately with the key. Secure flywheel on the crankshaft taper, ensuring that the washer is properly positioned, and tighten flywheel nut (special tool required). Install starting crank pin.

M. MODULES (figure IV-35 and IV-36).
Install regulator and rectifier modules, making sure that the modules are properly grounded to the engine flywheel shroud. The foolproof connectors used prevent incorrect wiring from the stator to the regulator and rectifier modules.

N. DISTRIBUTOR AND TIMING (Not operating)
After the distributor has been properly overhauled or is replaced and calibrated, it can be installed and timed to the engine. For this purpose locate the No. 1 piston in the firing position (by mark on flywheel or by Ignition Timing Tool, fig. IV-51). Carefully install the distributor into the governor housing, making sure that advance arm assembly and "O" ring are installed. Mesh the distributor drive gear with the mating gear on the governor drive shaft, in such a position that the distributor rotor points to the No. 1 cylinder terminal of the distributor cap.
For this purpose distributor housing is provided with a notch and the rotor center line should be in line with the center of the notch. After this has been achieved, secure advance arm to the governor housing with the hold down screw. Loosen the advance arm clamp screw and rotate distributor counter-clockwise so that breaker points are firmly closed, then rotate distributor in a clockwise direction until breaker points are just separating. At this point a slight resistance can be felt as the breaker point cam strikes the breaker point arm. Tighten advance arm clamp screw. The adjustment of the breaker point gap should be checked and adjusted to 0.018" to 0.022" (0.46 to 0.56 mm). Rotate distributor drive shaft until the breaker point

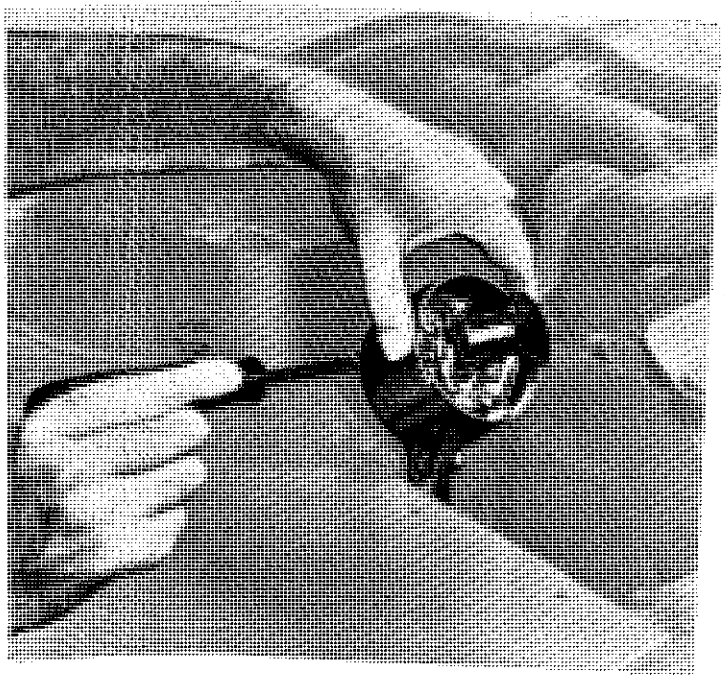


Figure IV -49 Installing Distributor

cam strikes the breaker point arm, and the breaker points start separating. Continue to rotate the drive shaft until the maximum breaker point opening is obtained. Insert feeler gauge at proper dimension and check opening. If opening is incorrect, readjust by means of the adjusting screw until proper clearance is achieved. Install the distributor cap and ignition cables. Adjust for running advance when operating (see Testing, B, 2). Secure ignition coil and connect high tension cable between distributor and coil. Install spark plugs ensuring that new gaskets are in place. Torque spark plugs down 28 to 30 ft. lbs. (3.8 to 4.1 Kg m). Install primary lead from wiring harness to ignition coil. Install inlet and exhaust manifold assembly using new gaskets between manifold and cylinder heads. Secure manifold by tightening the nuts and washers 18 to 23 ft. lbs. (2.5 to 3.1 Kg m).

CAUTION: Do not overtighten as they may cause the manifold flanges to crack.

O. CARBURETOR (figure IV-49).
Install carburetor using new gaskets between carburetor flange and inlet manifold flange. Adjust when engine is running (see Testing, C).

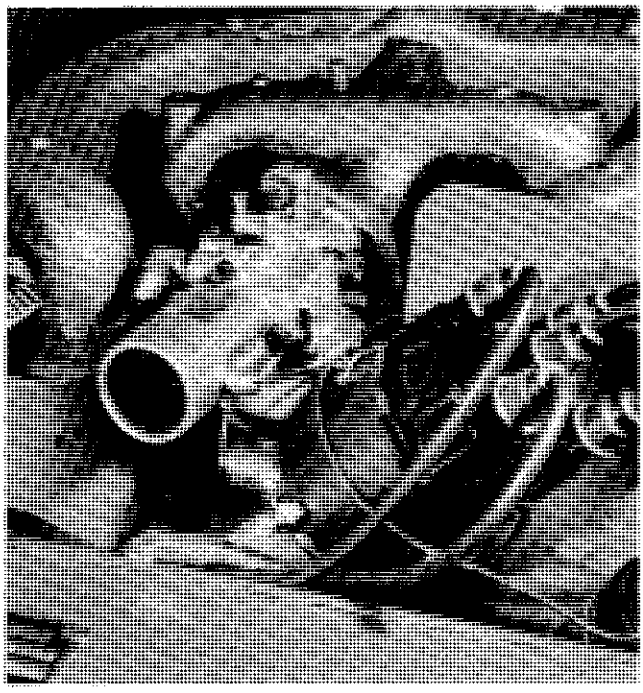


Figure IV-50 Carburetor Installed

P. FIRING ORDER
The firing order of the cylinders 1-3-4-2, and the distributor rotates at one-half engine speed, as is the case with conventional "in line" engines. The intervals between the firing of the cylinders is 180°. No. 1 cylinder is the one nearest to the flywheel in the left bank of cylinders, when viewed from the flywheel end of the engine. No. 3 cylinder is the other cylinder in this bank. No. 2 cylinder is the one nearest to the flywheel in the right bank of cylinders and No. 4 is the other cylinder in this bank, The cylinders are numbered from 1 to 4 on the air shroud near the spark plugs. The flywheel end of the engine is designated the front and the power take-off end, the rear of the engine.

• Testing Rebuilt Engine.

Every engine that is completely overhauled should be subjected to thorough break-in tests before any load is applied or before engine is reinstalled in the vehicle. The engine should be started and allowed to run for about half an hour at 1200 to 1400 RPM. Engine RPM can be checked by applying a hand-tachometer to the crankshaft. After this various tests under load/no-load conditions can be carried out.

A. IGNITION TIMING (Operating, Not Installed in KID)
Although ignition timing has been carried out with engine non-operative, this should be checked and corrected if required with the engine running and with the assistance of a neon-timing lamp. The engine should be timed to a 23° advanced position at not less than 2000 RPM. For this purpose a hole in the flywheel shroud has been provided, 23° before the TDC marks for the No. 1 and 3 piston on the flywheel shroud. Insert a small screwdriver in the No. 1 terminal tower of the distributor cap, making contact with the ignition terminal in the bottom of the tower. Connect the red terminal clip from a conventional neon timing lamp to the metal of this screwdriver. Connect the other timing lamp lead to the ground (shrouding). Chalk or paint the end of the flywheel vane white. Accellerate engine to minimum 2000 RPM (no load) and allow the flash from the neon lamp to illuminate the white vane. At the exact moment of the flash the leading edge of the white vane should line up with the 23° timing hole. If this is not the case, advance or retard distributor by rotating distributor clockwise or counterclockwise until the white flywheel vane matches up with the timing hole.

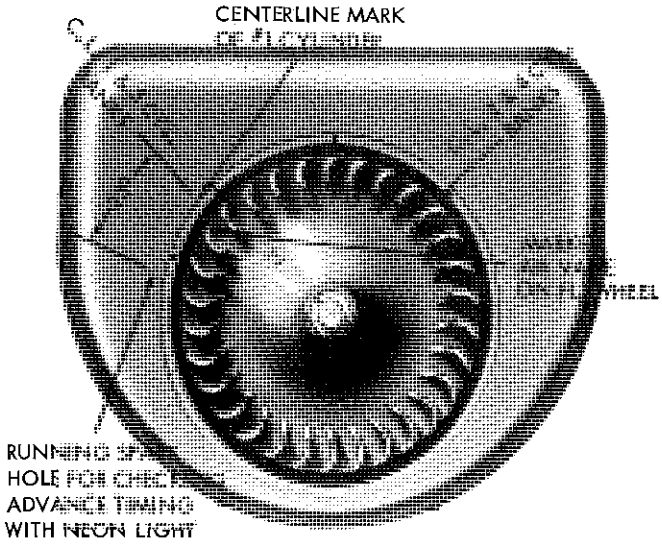


Figure IV-51 Timing Engine (Operating not Installed in KID)

B. IGNITION TIMING (INSTALLED IN KID)

1. Ignition - Timing (Not Operating)

(a) Remove the spark plug from No. 1 cylinder and place a finger over the hole.

(b) Turn the engine until air is forced out, showing that the piston is in the compression stroke.

(c) Install the timing disc on the PTO stub shaft as illustrated (figure IV-51).

(d) Turn the engine slowly until the "zero" mark on the timing disc aligns with the pointer. No. 1 piston is now at top-dead-center, and the center line of the distributor rotor should be in line with center of the notch in the distributor housing.

NOTE: If the center line of rotor does not align with mark on distributor entire distributor must be pulled out and the gears engaged so the rotor lines up.

(e) Loosen the advance arm clamp screw and turn the distributor body counterclockwise until the breaker points are fully closed. Turn distributor body clockwise until breaker points are just starting to open.

(f) Tighten advance arm clamp screw. The engine timing is set in retarded (non-operating) condition.

2. Ignition Timing (Operating - Running Advance)

(a) With the ignition timing set per (1) not operating, set running advance as follows:

(b) Make sure timing disc is installed as illustrated.

(c) Insert a small screwdriver in the No. 1 tower in the distributor cap. Clamp the timing light red lead to the screwdriver, and the other lead to ground (shrouding or engine).

(d) Start engine and illuminate timing disc with the timing light, with engine running at 2000 RPM.

(e) Loosen advance arm clamp and turn distributor until the 23° mark on the timing disc aligns with pointer. Tighten advance arm clamp.

NOTE: Do not attempt to set running advance at less than 2000 RPM because the automatic advance is not fully advanced below this speed.

C. CARBURETOR SETTING (OPERATING)

1. Idle Speed and Mixture Setting (figure IV-49)

After the carburetor is installed on the engine and the engine is in running condition, adjust the idle mixture and speed as follows:

a. Start the engine and turn the idle speed screw (throttle stop) to the point where the engine will run without holding the throttle open. Turn the mixture adjustment to the point where the engine runs smoothest. Let engine run 10 minutes to warm up.

b. Turn the idle adjustment counterclockwise until the engine speed decreases, then turn clockwise through smooth running until the engine speed decreases again. Slowly turn counterclockwise again to the point where the speed is highest and smoothest.

c. Set the idle speed screw to the desired idle speed.

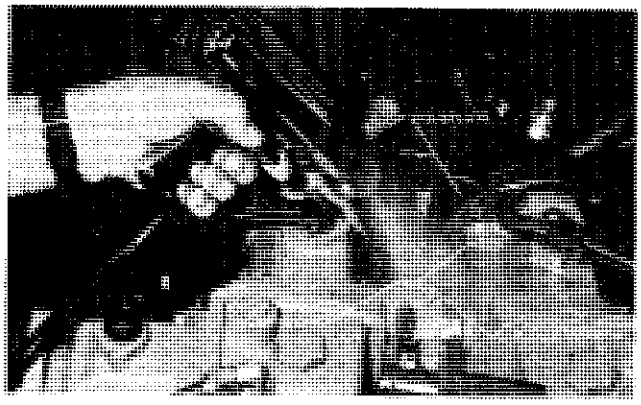


Figure IV-52 Ignition Timing Tool

TROUBLESHOOTING ENGINE

Four basic conditions must exist in order to start and run the engine:

1. A proper fuel-air mixture in the cylinder.
2. Good compression in the cylinder.
3. A good spark, at the correct time, to ignite the mixture.
4. A means of turning the crankshaft until the engine starts.

If any one of these conditions does not exist, the engine will not start.

The proper fuel-air mixture is dependent on a good fuel supply, a fuel pump; fuel lines, a carburetor, an air cleaner, and an air intake system.

The proper compression is dependent on valves, a piston; piston rings; cylinder head; and spark plug gasket.

The proper spark is dependent on a battery, a coil, breaker points, distributor, spark plugs, and wiring.

Turning the crankshaft is dependent on a battery, a switch, a solenoid, and an electric starting motor.

In isolating a trouble, it is best to work through the particular system step by step, starting with the most probable cause.

These are only suggestions to be used when the problem is not apparent at all. They are not necessarily true in all cases.

The troubleshooting chart lists the most common troubles encountered when the engine is in two conditions: starting and running.

Some of the most common malfunctions may be located or isolated as follows:

1. Dead Cylinder

Run the engine at a steady speed and disconnect and reconnect the spark plug leads, one at a time, and listen closely to the engine speed. The engine speed should drop off noticeably each time a working cylinder plug is disconnected. If this does not occur, that cylinder is weak or dead. (Check the spark plug first.)

2. Starting System

It is not an indication that the starting system is faulty if the engine will not start when the starter motor turns over at a normal rate of speed. Failure of the starting motor to spin the engine, or turning it too slow, is an indication that one or more of the starting system components is defective. To determine where the trouble is, perform the following tests.

(a) Battery Test.

Switch on the ignition and energize the starting motor. If the starting motor spins the engine at a fairly good rate of speed and then rapidly slows down, the battery is discharged. A 12-volt battery may operate the starting motor with a defective cell, but it will not spin the starting motor fast enough.

(b) Battery Cable Test

Insert the tip of a screwdriver between the battery post and the cable connector and turn the ignition switch. If the starting motor now turns, the connection is bad. Remove the cable connector and clean it and the battery post by scraping or wire brushing. Replace and secure cable connector to battery post. Repeat this procedure on the other battery terminal connection.

(c) Solenoid Starting Switch Test

Bridge the solenoid starting switch terminals with a jumper cable. If, when the system is energized, the starting motor turns, the solenoid starting switch must be replaced. If the starting motor does not function with the starter switch shorted, using a fully charged battery and having good electrical connections, the starting motor must be defective.

(d) Starting Motor Test

The size of the spark from the jumper cable clamp to the solenoid starting switch terminal in

the previous test is an indication of what kind of trouble to expect. If a strong spark occurs and the starting motor does not turn, it is possible that the starting motor has a short circuit or the starting motor drive is stuck to the flywheel.
A condition in which there is little or no spark when the jumper cable contacts the starting switch terminal can be caused by a dead battery, poor battery terminal connection or poor connections at the starting motor brushes due to a burned or oily commutator. If the starting motor spins but does not turn the engine, the starting motor drive is defective. Defective starting motor should be removed from the engine and tested to determine the cause of the malfunction.

NOTE

If the main circuit breaker in the line between the battery and the ignition switch heats enough to break the circuit, turn the ignition switch OFF and wait 30 seconds before turning it ON.

CAUTION

Never operate the starting motor more than 30 seconds at a time without pausing to allow it to cool for at least 2 minutes. Overheating caused by excessive cranking will seriously damage the motor.

TROUBLESHOOTING GUIDE

ENGINE

STARTING TROUBLE

CAUSE	REMEDY
Fuel System	
No fuel in tank.	Fill tank with a good grade of gasoline, 78 octane rating or above.
Carburetor not shoked sufficently.	Pull up manual choke control.
Flooded engine.	Push manual choke down, and pull throttle up to its full travel length. Start the engine and push throttle down gradually as engine clears and speed increases.
Vapor Lock (vaporized fuel in system blocks flow of fuel).	Allow fuel system components (usually fuel line) to cool. This allows vapor to condense to a liquid.
Ice in fuel line.	Allow ice to thaw.
Non-volatile gasoline (poor quality, old, or low octane gasoline).	Drain fuel tank and replace with a good grade of gasoline.
Dirt, water, or foreign matter in gasoline.	Clean or replace fuel filter in fuel pump. Drain fuel tank and replace with clean ffuel.
Broken or binding choke linkage.	Replace or repair linkage.
Broken or binding throttle linkage.	Replace or repair linkage.
Fuel pump inoperative.	Check for poor electrical connection and fuse in fuel pump line.
Fuel pump operating but not pumping fuel.	Check for clogged fuel filter or fuel line, and clean.
Incorrect carburetor idle adjustment.	Adjust carburetor idle adjustment needle.
Tank vent plugged. Engine will start with fuel tank cap off.	Remove obstruction from vent hole and replace cap.
Compression	
Oil drained from cylinder walls (engine not used for a considerable lenght of ttime).	Restore oil in cylinder walls and pistons. Pour in spark plug holes.
Fuel Pump	
Fuel pump motor does not run when ignition switch is in ON position.	Check for poor electrical connections at switch, battery, and fuel pump. Check fuse.

STARTING TROUBLE	
CAUSE	**REMEDY**
Unsatisfactory pump operation after pump is installed.	Replace pump. Check for the following: a. Proper pump voltage and polarity. b. Loose pump electrical connections. c. Bad pump ground connections. d. Collapsed or clogged filter screen.
Starter System	
Starter will not crank engine; solenoid starting switch does not click.	Charge or replace battery.
	Check for loose connections or defective wiring between ignition switch and starter switch. Tighten connections or replace wiring.
Starter will not crank engine; solenoid starting switch clicks.	Inspect battery cables and check battery ground connection. Clean and tighten cables and connections.
Engine turns over too slowly to start.	Charge or replace battery.
	Engine low on oil, or wrong oil viscosity grade for ambient temperature. Change engine oil and engine oil filter.
Slow starter speed:	
Discharged battery or shorted battery cell.	Recharge or repair.
Engine ground loose.	Clean terminal and tighten (both ends.).
Loose or dirty terminals.	Clean and tighten.
Dirty commutator.	Clean with No. 00 sandpaper.
Worn out brushes.	Install new brushes.
Weak brush spring tension.	Replace.
Worn bearings.	Replace.
Burned starter switch contacts.	Replace switch.
Starter will not turn engine:	
Open circuit at starter.	Correct.

STARTING TROUBLE	
CAUSE	**REMEDY**
Starter switch defective.	Replace switch.
Starter drive broken or stuck.	Repair or replace.
Battery discharged.	Recharge battery.
Ignition System	
Ignition cable disconnected from distributor or spark plugs.	Ensure that all cables are tightly in place on distributor cap or plugs.
Broken or frayed ignition cables.	Replace cables.
Ignition cables wet.	Allow cables to dry thoroughly.
Spark plugs wet or dirty.	Remove and clean plugs.
Spark plug gap incorrect.	Check, clean, and re-gap plugs.
Spark plug insulators broken.	Replace plug or plugs.
Distributor breaker points pitted or badly burned.	Remove distributor cap, rotor and dust cover. Re-gap or replace distributor points.
Distributor breaker arm sticking.	Apply one or two drops of SAE 10W oil to breaker arm pivot.
Distributor cap cracked or terminals badly corroded.	Replace cap. Ensure that spark plug cables are replaced in proper towers.
Distributor rotor cracked or contact strip excessively burned.	Replace rotor. Do not attempt to repair strip.
Breaker points burned or pitted.	Replace and adjust.
Breaker arm stuck on pivot pin.	Clean and lubricate.
Breaker arm spring weak.	Replace.
Points improperly adjusted.	Adjust .018 to .022 in. (.46 to .56 mm)
Spark plug points improperly set.	Adjust .030" (.762 mm)
Spark plug wire terminals in distributor cap corroded.	Clean.

STARTING TROUBLE	
CAUSE	**REMEDY**
Alternator not charging.	Inspect alternator regulator and rectifier ground.
Loose or dirty terminals.	Clean and tighten.
Insufficient driving.	Recharge battery.
Low electrolyte level in cells.	Add distilled water.
Alternator	
Fails to charge:	
Open or high resistance in charging circuit, ground return circuit, or battery connections.	Test and correct.
Battery Discharged:	
Shorted cell in battery.	Replace battery.
Short in wiring.	Check wiring circuit and repair.

RUNNING TROUBLE	
CAUSE	**REMEDY**
Open rotor (field coil).	Test and replace if necessary.
Low or unsteady charging rate:	
Intermittent or high resistance charging or ground return circuit or battery connections.	Test and correct.
Shorted or open rectifier diode.	Test and replace if necessary.
Grounded or shorted turns in rotor (field coil).	Test and replace if necessary.
Open, grounded, or shorted turns in stator.	Test and replace if necessary.
Excessive charge rate:	
Faulty regulator.	Check and repair as necessary.
Engine Misses:	
Spark plug gap incorrect.	Check and re-gap spark plugs.
Broken or frayed ignition cable.	Test by checking spark at distributor and at spark plug end of cable. Replace cable if necessary.
Weak spark or intermittent spark.	Check ignition cables for loose connections.
Dirt in carburetor or contaminated fuel.	Clean carburetor air cleaner and air filter. Drain fuel tank and replace with good grade of gasoline. Clean fuel pump.
Engine Overheats:	
Oil low in engine crankcase.	Add proper oil to crankcase.
Incorrect grade or dirty oil in crankcase.	Drain engine oil, replace engine oil filter, and add proper grade of oil.
Engine overloaded.	Observe the recommended load limits when pulling or towing a load.
Poor quality gasoline	Drain fuel tank and replace with a good grade of gasoline.

RUNNING TROUBLE	
CAUSE	**REMEDY**
Engine Suddenly Stops:	
Tank vent plugged. Engine will run with fuel tank cap off.	Remove obstruction from vent.
Fuel Tank empty.	Fill.
Coil Secondary Lead Disconnected (to center tower of distributor).	Replace.
Restricted air circulation over transmission oil cooler radiator vanes.	Do not obstruct transmission oil cooler radiator vanes. Radiator vanes must be kept clean of all foreign matter.
Part of air shroud missing from engine.	Engine must be properly shrouded to direct air over cylinders.
Dirt or foreign matter on engine cooling fins.	Remove engine shrouding, and clean fins. Straighten fins if bent or damaged.
Restricted engine exhaust.	Inspect exhaust outlet pipe for any obstruction.
Engine Knocks:	
Poor quality or low octane gasoline.	Use a good grade of gasoline.
Engine operating under heavy load at low speed.	Observe vehicle load restrictions.
Spark advanced too much.	Reset distributor timing.
Engine Backfires Through Carburetor:	
Water or dirt in gasoline or poor grade of gasoline.	Clean or replace fuel filter if contaminated. Drain fuel tank and replace with a good grade of gasoline.
Engine cold.	Allow engine to reach normal operating temperature.
Incorrect valve clearance.	Set valves.