MAGNETO — ALTERNATOR TYPE

An alternator system may be used to supply electrical energy to charge the 12 volt battery which in turn furnishes energy for ignition, cranking and also for lighting circuits on some applications.

While the motor-generator functions with stationary flux and a moving conductor, the alternator uses a stationary conductor (stator) and a moving flux (magnet ring). The alternator system consists of the following basic components:

1. Permanent field magnet ring.
2. Alternator stator assembly.
3. Rectifier-regulator assembly.

Operation: The magnet ring has a specific number of permanent magnets imbedded in a cast ring. These high strength ceramic magnets are arranged between pole pieces, so that there is an equal number of north and south magnetic poles as illustrated in Figure 11. The magnet ring is permanently fitted to the inside rim of the engine flywheel so that it can be rotated around the alternator stator which is assembled in stationary position.

The alternator stator assembly consists of soft iron laminations which are stacked to form a core for the conductor or the coil windings. The ends of this primary (load) conductor are connected to terminals on the Rectifier-Regulator assembly.

Whenever magnetic lines of force cut a conductor which is part of a complete electrical circuit, an electrical current will be induced in the conductor. To explain how alternating current is induced in the primary windings, refer to the coil shown in the 12 o'clock position in Figure 11. In this illustration, a south magnetic pole piece is just above the reference coil. When in this position, the magnetic lines of force move out of the adjacent north pole pieces, downward through the adjacent core posts, then upward through our reference coil to return to the magnets through the south magnetic pole piece. The direction of flux is important as it also determines the direction that the current flows through the windings. For example, when a north magnetic pole piece rotates above our reference coil, the flux direction is opposite of what it was when the south pole was in the same position. Since the flux direction is reversed, the direction of current through the primary windings is also reversed. This current continually changes direction, since the pole pieces are alternately north and south. The Alternating Current (AC) thus produced must be changed into Direct Current (DC) to be used in the battery and ignition system.

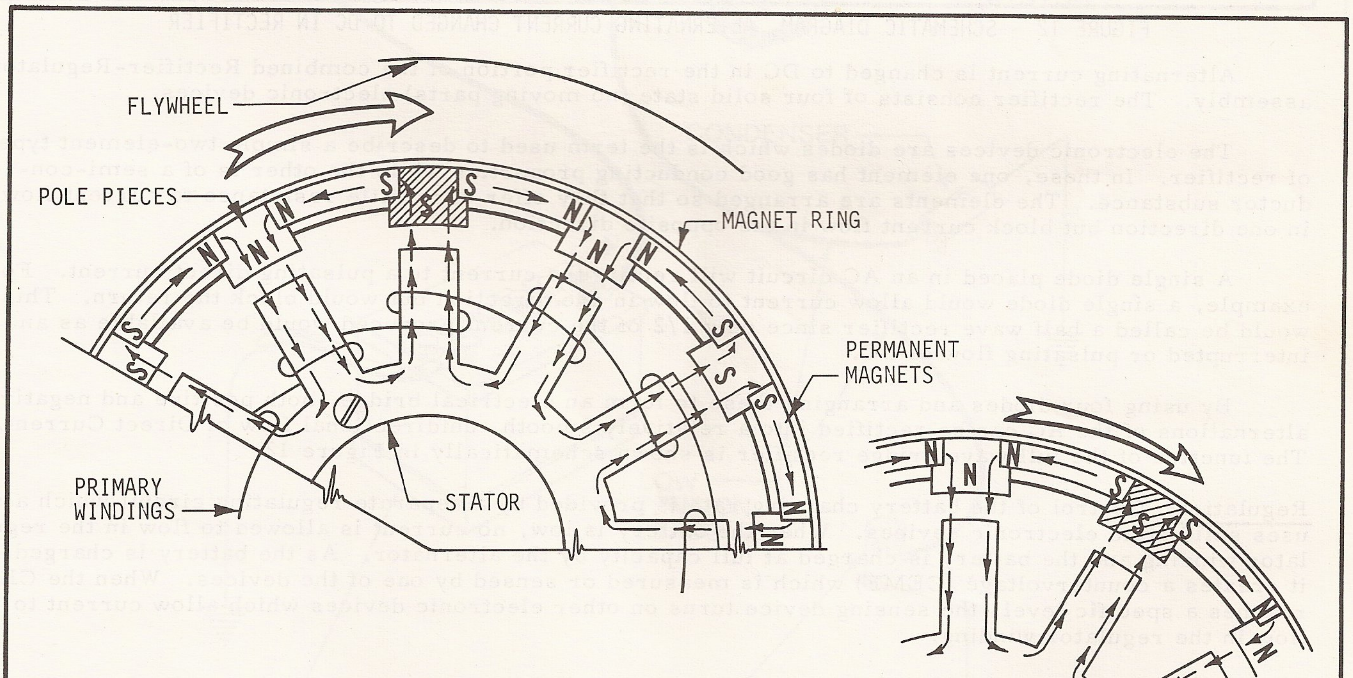

FIGURE 11 - SCHEMATIC DIAGRAM, ALTERNATING CURRENT PRODUCED IN STATOR WINDINGS

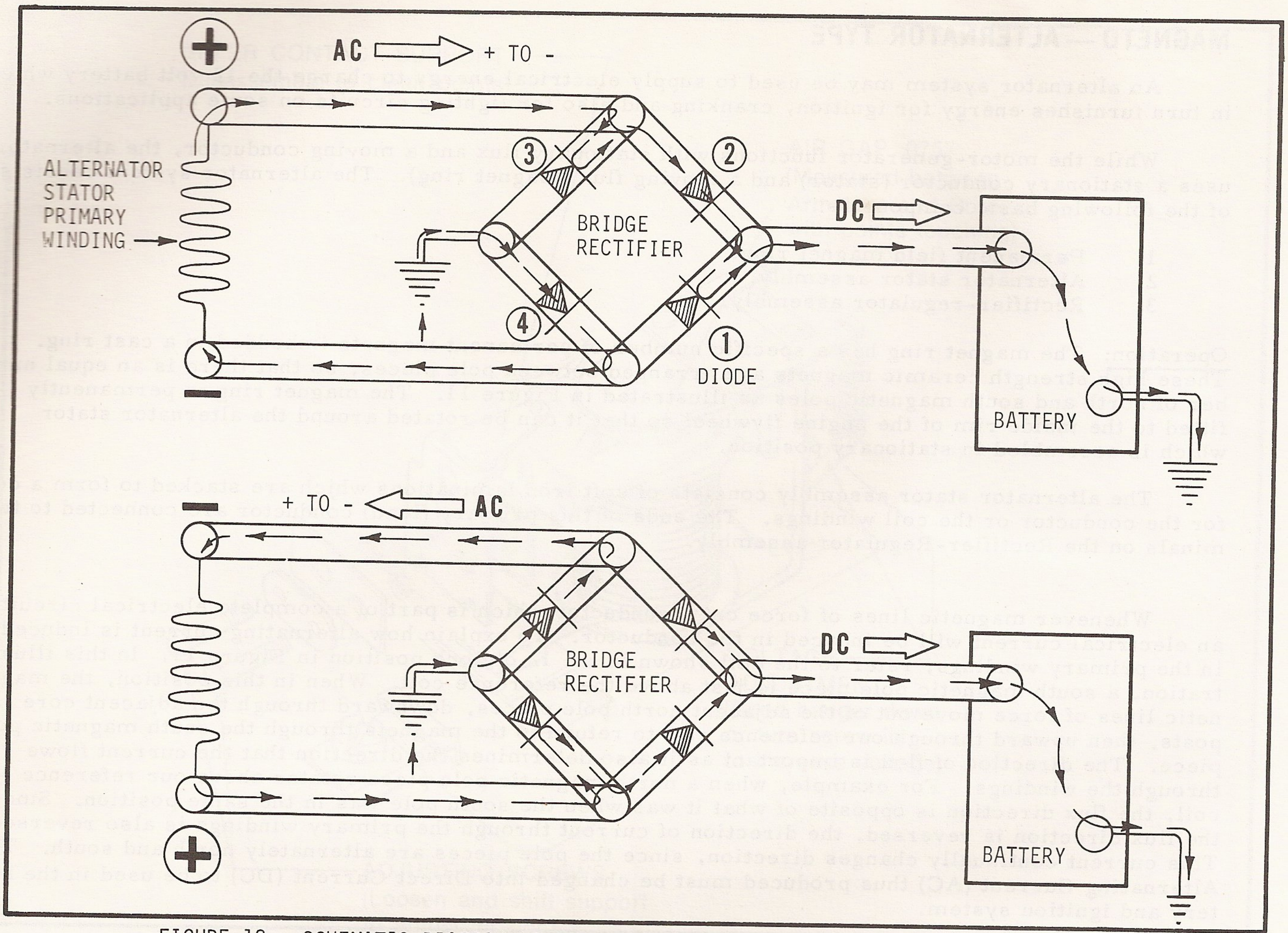

FIGURE 12 - SCHEMATIC DIAGRAM, ALTERNATING CURRENT CHANGED TO DC IN RECTIFIER

Alternating current is changed to DC in the rectifier portion of the combined Rectifier-Regulator assembly. The rectifier consists of four solid state (no moving parts) electronic devices.

The electronic devices are diodes which is the term used to describe a simple two-element type of rectifier. In these, one element has good conducting properties while the other is of a semi-conductor substance. The elements are arranged so that they offer very little resistance to current flow in one direction but block current flow in the opposite direction.

A single diode placed in an AC circuit will rectify the current to a pulsating direct current. For example, a single diode would allow current to flow in one direction but would block the return. This would be called a half wave rectifier since only 1/2 of the current produced would be available as an interrupted or pulsating flow of DC.

By using four diodes and arranging these to form an electrical bridge, both positive and negative alternations of the AC can be rectified into a relatively smooth, unidirectional flow of Direct Current. The function of the full wave bridge rectifier is shown schematically in Figure 12.

Regulation: Control of the battery charging rate is provided by a separate regulating circuit which also uses solid state electronic devices. When the battery is low, no current is allowed to flow in the regulator winding and the battery is charged at full capacity by the alternator. As the battery is charged, it creates a countervoltage (CEMF) which is measured or sensed by one of the devices. When the CEMF reaches a specific level, the sensing device turns on other electronic devices which allow current to flow in the regulator winding.

10 AMP ALTERNATOR

The 10 Amp Alternator System consists of three major components: a permanent magnet ring bolted to the inside rim of the flywheel, an alternator stator assembly which is affixed to the engine bearing plate and a rectifier-regulator unit which is externally mounted on the engine or the equipment powered by the engine. Identification of engines with this system can be made through the externally mounted rectifier-regulator unit as shown on the accompanying illustration.

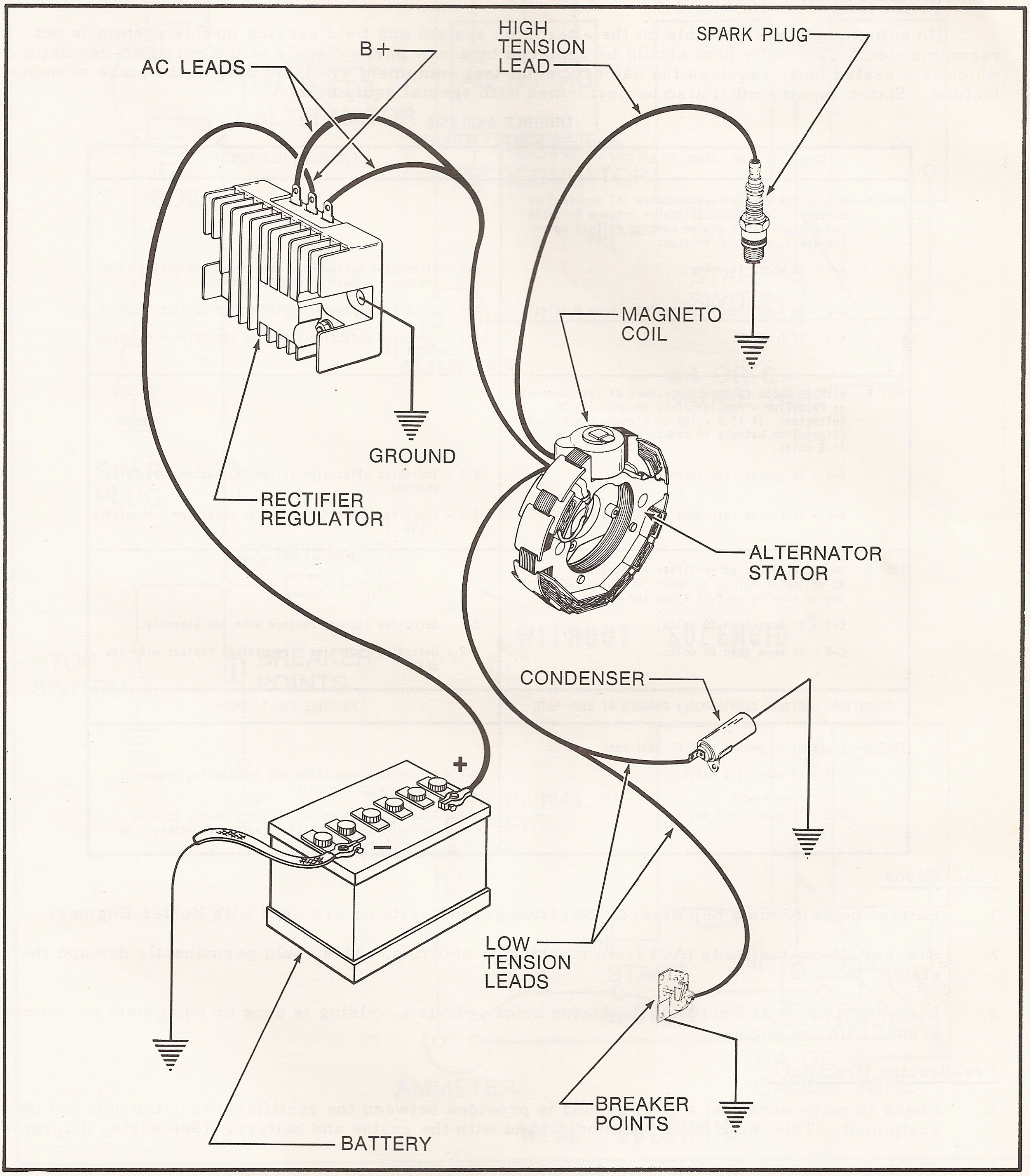

FIGURE 13 - SCHEMATIC, 10 AMP MAGNETO-ALTERNATOR SYSTEM

Operation: As the magnet ring is rotated around the stator, an Alternating Current is generated in the stator winding. The AC thus produced is rectified to Direct Current in the rectifier-regulator unit. This is accomplished through the use of solid state electronic devices which are arranged to form a full wave bridge rectifier. Regulation is also provided by electronic devices which "sense" the counter-voltage created by the battery to control or limit the charging rate. Since heat is generated in operation of certain of these electronic devices, cooling fins are provided on the rectifier-regulator to help dissipate the heat. The unit should be mounted with the fins in a vertical position and preferably in a well ventilated area.

No adjustments are possible on the alternator system and field service on this system is not recommended. The faulty part should be replaced by a new part. Repair of the rectifier-regulator, which is a sealed unit, requires the use of special test equipment available only at the place of manufacture. Stator repairs must also be performed with special equipment.

TROUBLE ANALYSIS
10 AMP MAGNETO - ALTERNATOR

CONDITION: NO CHARGE TO BATTERY	POSSIBLE FAULT/REMEDY
TEST A - Disconnect B+ cable at positive (+) terminal of battery. Connect DC Voltmeter between B+ cable and ground. With engine running at full speed (no load), check DC voltage:	
A-1 - If above 14 volts.	A-1 - Alternator system OK - ammeter may be giving false reading. Repair or replace ammeter.
A-2 - If less than 14 volts (but above 0 volts).	A-2 - Check for defective rectifier - regulator (TEST C)
A-3 - If 0 volts.	A-3 - Check for defective stator or rectifier - regulator (TEST C).
TEST B - With B+ cable reconnected, check B+ (at terminal on rectifier - regulator) to ground with DC Voltmeter. If 13.8 volts or higher, place load (lights) on battery to reduce voltage below 13.6 volts:	
B-1 - If charge rate increases.	B-1 - Indicates alternator system OK, battery was fully charged.
B-2 - If charge rate does not increase.	B-1 - Check for defective stator or rectifier - regulator (TEST C).
TEST C - Unplug AC leads at rectifier - regulator, connect AC Voltmeter across AC leads, check voltage with engine running at full speed (no load):	
C-1 - If less than 20 volts.	C-1 - Defective stator, replace with new assembly.
C-2 - If more than 20 volts.	C-2 - Defective rectifier - regulator, replace with new unit.
CONDITION: BATTERY CONTINUOUSLY CHARGES AT HIGH RATE	**POSSIBLE FAULT/REMEDY**
TEST D - Check B+ to ground with DC Voltmeter:	
D-1 - If over 14.7 volts.	D-1 - Rectifier - regulator not functioning properly. Replace with new unit.
D-2 - If under 14.7 volts.	D-2 - Alternator system OK. Battery unable to hold charge. Check specific gravity of battery. Replace if necessary.

Precautions

1. Battery polarity must be correct. Negative ground systems are used with Kohler Engines.

2. Prevent alternator leads (AC) from touching or shorting. This could permanently damage the stator.

3. Disconnect leads at Rectifier-Regulator before electric welding is done on equipment in common ground with the engine.

Pre-Service Procedure

1. Check to make sure that a good ground is provided between the rectifier-regulator unit and the equipment. This must be in common ground with the engine and battery. (See wiring diagrams)

2. Check for and correct poor connections or broken wires.

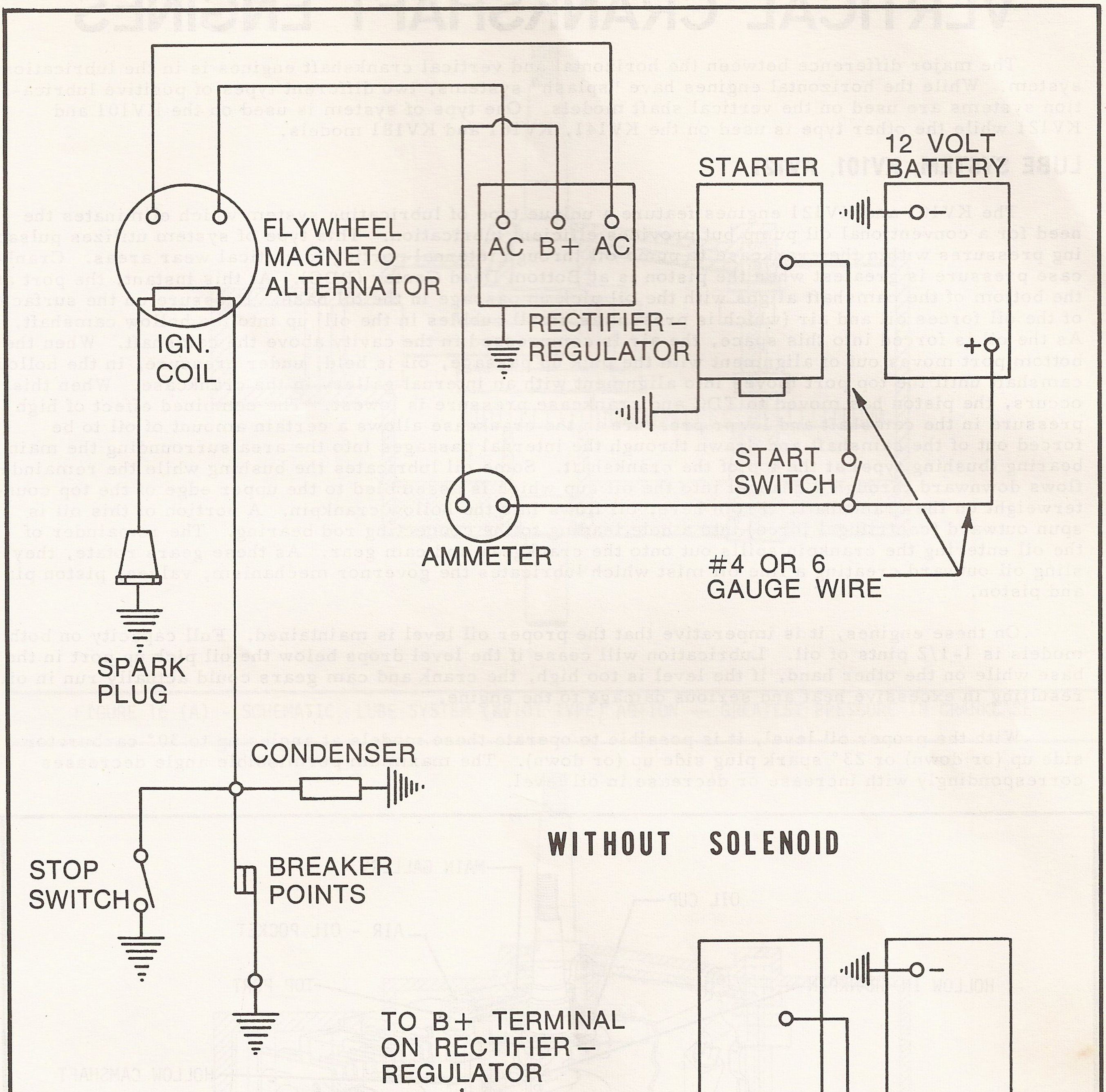

FIGURE 14 - WIRING DIAGRAMS, 10 AMP MAGNETO-ALTERNATOR SYSTEMS

VERTICAL CRANKSHAFT ENGINES

The major difference between the horizontal and vertical crankshaft engines is in the lubrication system. While the horizontal engines have "splash" systems, two different types of positive lubrication systems are used on the vertical shaft models. One type of system is used on the KV101 and KV121 while the other type is used on the KV141, KV161 and KV181 models.

LUBE SYSTEM; KV101, KV121

The KV101 and KV121 engines feature a unique type of lubricating system which eliminates the need for a conventional oil pump but provides efficient lubrication. This type of system utilizes pulsating pressures within the crankcase to pump oil through internal porting to critical wear areas. Crankcase pressure is greatest when the piston is at Bottom Dead Center (BDC). At this instant, the port at the bottom of the camshaft aligns with the oil pick up passage in the oil base. Pressure on the surface of the oil forces oil and air (which is present as small bubbles in the oil) up into the hollow camshaft. As the oil is forced into this space, the air is compressed in the cavity above the camshaft. When the bottom port moves out of alignment with the pick up passage, oil is held, under pressure, in the hollow camshaft until the top port moves into alignment with an internal gallery in the crankcase. When this occurs, the piston has moved to TDC and crankcase pressure is lowest. The combined effect of high pressure in the camshaft and lower pressure in the crankcase allows a certain amount of oil to be forced out of the camshaft and drawn through the internal passages into the area surrounding the main bearing (bushing type) at the top of the crankshaft. Some oil lubricates the bushing while the remainder flows downward through a channel into the oil cup which is assembled to the upper edge of the top counterweight on the crankshaft. From here, oil flows into the hollow crankpin. A portion of this oil is spun outward (centrifugal force) into a hole leading to the connecting rod bearing. The remainder of the oil entering the crankpin spills out onto the crankgear and cam gear. As these gears rotate, they sling oil outward creating a fine oil mist which lubricates the governor mechanism, valves, piston pin and piston.

On these engines, it is imperative that the proper oil level is maintained. Full capacity on both models is 1-1/2 pints of oil. Lubrication will cease if the level drops below the oil pick up port in the base while on the other hand, if the level is too high, the crank and cam gears could actually run in oil resulting in excessive heat and serious damage to the engine.

With the proper oil level, it is possible to operate these models at angles up to 30° carburetor side up (or down) or 23° spark plug side up (or down). The maximum permissible angle decreases correspondingly with increase or decrease in oil level.

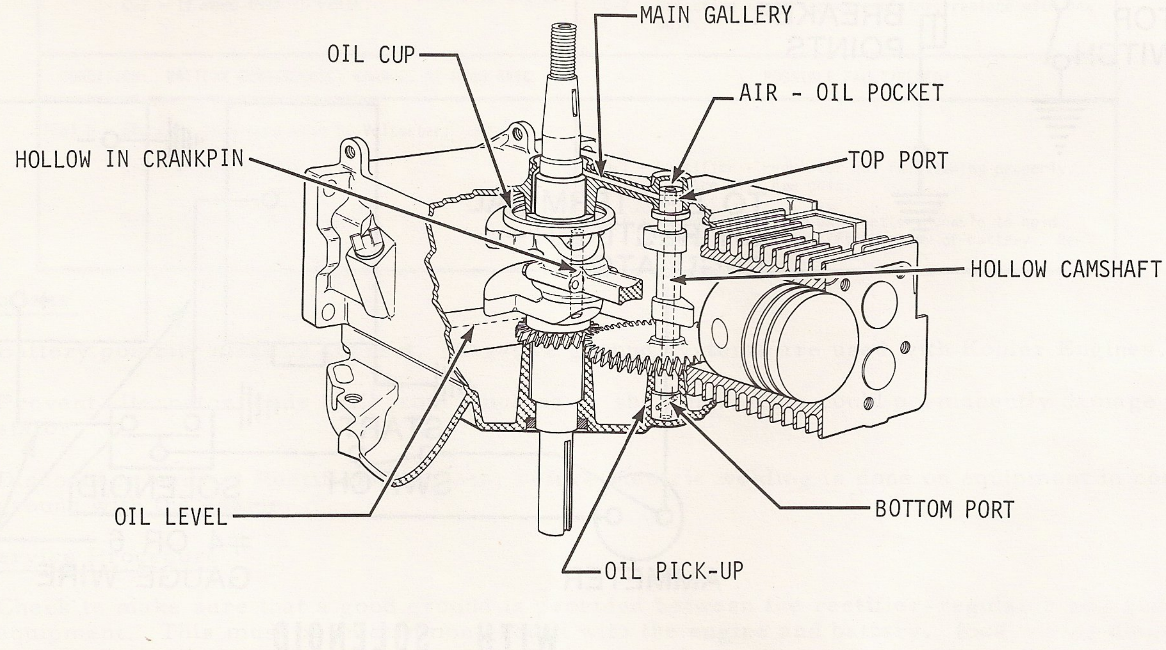

FIGURE 15 - CUTAWAY VIEW, KV101 ENGINE

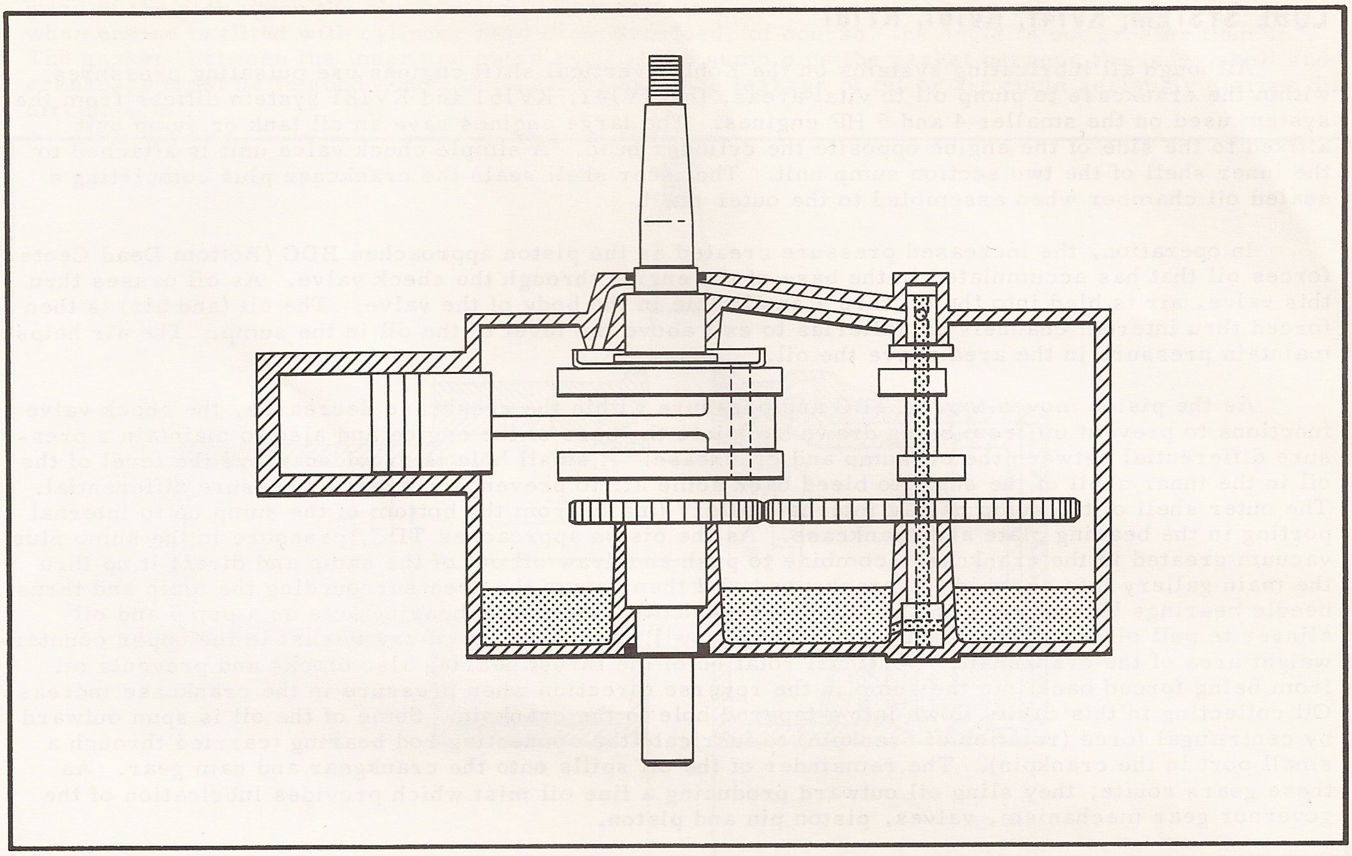

FIGURE 16 (A) - SCHEMATIC, LUBE SYSTEM (KV101 TYPE) ACTION -- GREATEST PRESSURE IN CRANKCASE

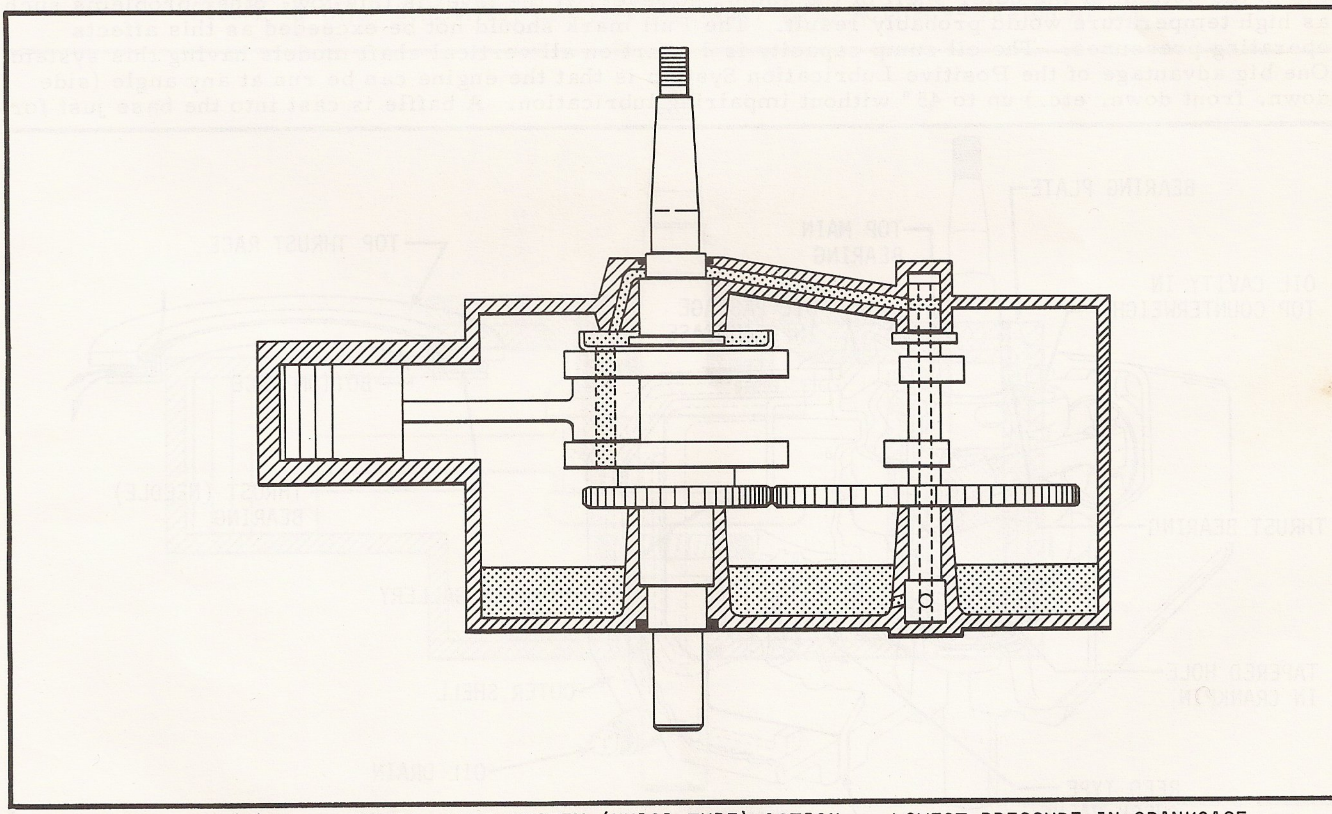

FIGURE 16 (B) - SCHEMATIC, LUBE SYSTEM (KV101 TYPE) ACTION -- LOWEST PRESSURE IN CRANKCASE

LUBE SYSTEM; KV141, KV161, KV181

Although all lubricating systems on the Kohler vertical shaft engines use pulsating pressures within the crankcase to pump oil to vital areas, the KV141, KV161 and KV181 system differs from the system used on the smaller 4 and 5 HP engines. The large engines have an oil tank or sump unit affixed to the side of the engine opposite the cylinder head. A simple check valve unit is attached to the inner shell of the two section sump unit. The inner shell seals the crankcase plus completing a sealed oil chamber when assembled to the outer shell.

In operation, the increased pressure created as the piston approaches BDC (Bottom Dead Center) forces oil that has accumulated in the base of the engine through the check valve. As oil passes thru this valve, air is bled into the oil thru a small hole in the body of the valve. The oil (and air) is then forced thru internal channels or galleries to exit above the level of the oil in the sump. The air helps maintain pressure in the area above the oil.

As the piston moves toward TDC and pressure within the crankcase decreases, the check valve functions to prevent oil from being drawn back into the base of the engine and also to maintain a pressure differential between the oil sump and crankcase. A small hole is provided above the level of the oil in the inner shell of the sump to bleed back some air to prevent too great a pressure differential. The outer shell of the sump has an internal gallery (main) from the bottom of the sump up to internal porting in the bearing plate and crankcase. As the piston approaches TDC, pressure in the sump plus vacuum created in the crankcase, combine to push and draw oil out of the sump and direct it up thru the main gallery into ports in the crankcase. Oil then enters the area surrounding the main and thrust needle bearings located near the top of the crankshaft. The thrust bearing acts as a pump and oil slinger to pull oil out of the main gallery and throw it downward into a cavity cast in the upper counterweight area of the crankshaft. Continual rotation of the thrust bearing also blocks and prevents oil from being forced back into the sump in the reverse direction when pressure in the crankcase increases. Oil collecting in this cavity flows into a tapered hole in the crankpin. Some of the oil is spun outward by centrifugal force (rotation of crankpin) to lubricate the connecting rod bearing (carried through a small port in the crankpin). The remainder of the oil spills onto the crankgear and cam gear. As these gears rotate, they sling oil outward producing a fine oil mist which provides lubrication of the governor gear mechanism, valves, piston pin and piston.

This system will continue to lubricate as long as there is sufficient oil to cover the channel opening in the bottom of the outer shell of the sump, however, if the level is this low, other problems such as high temperature would probably result. The Full mark should not be exceeded as this affects operating pressures. The oil sump capacity is 1 quart on all vertical shaft models having this system. One big advantage of the Positive Lubrication System is that the engine can be run at any angle (side down, front down, etc.) up to 45° without impairing lubrication. A baffle is cast into the base just for-

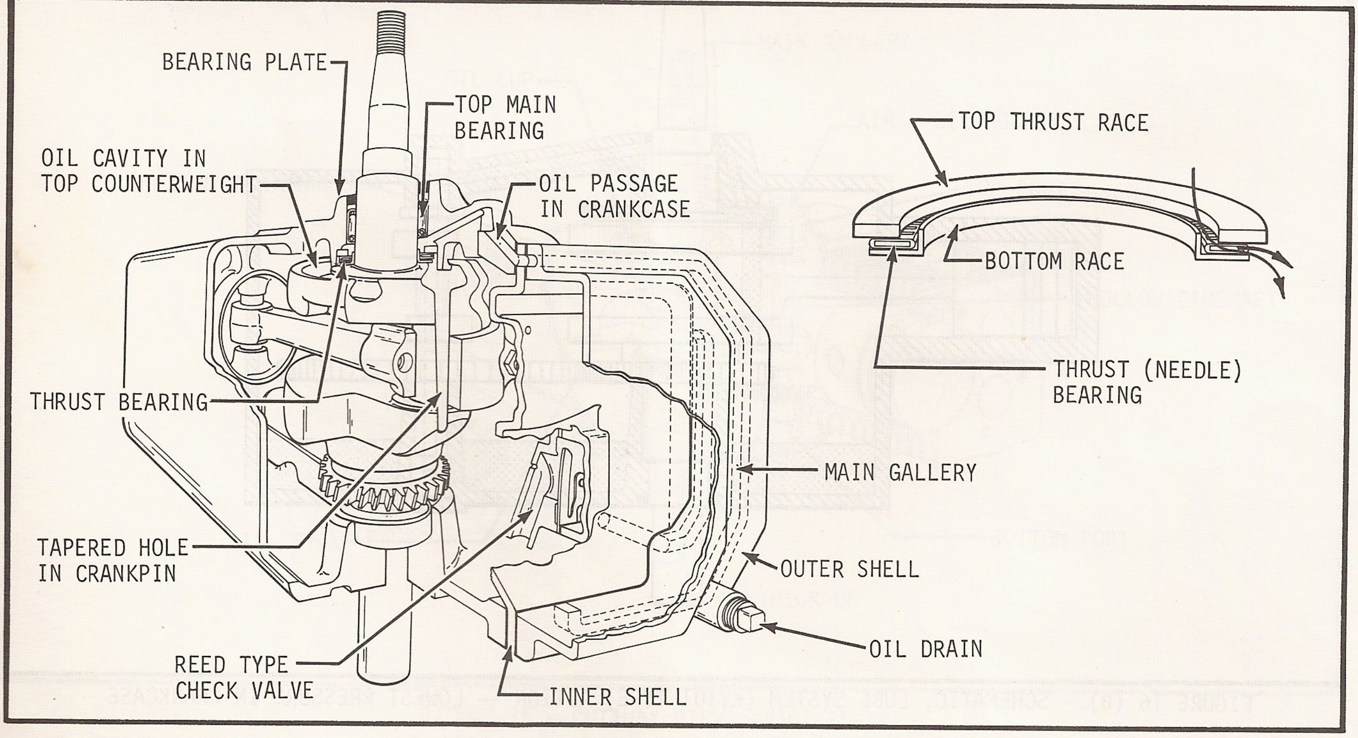

FIGURE 17 - CUTAWAY VIEW, KV141 TYPE ENGINE

ward of the pick up on the check valve. This retains a sufficient quantity of oil to maintain flow even when engine is tilted with cylinder head down provided, of course, the angle is not greater than 45°. The gaskets between the inner and outer shell of the sump plus the gasket between the inner shell and crankcase must be in good condition at all times since leakage of oil or air could seriously disrupt oil circulation.

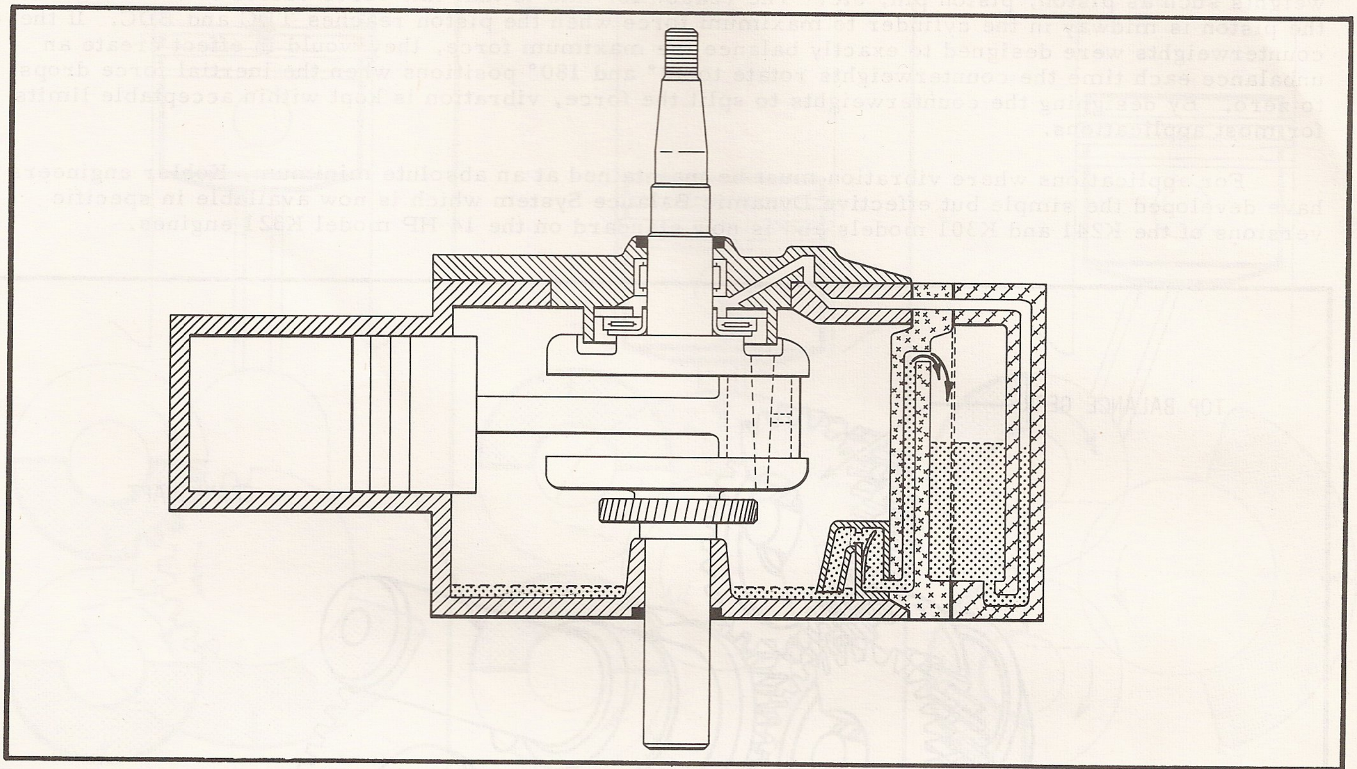

FIGURE 18 (A) - SCHEMATIC, LUBE SYSTEM (KV141 TYPE) ACTION -- PISTON AT BDC

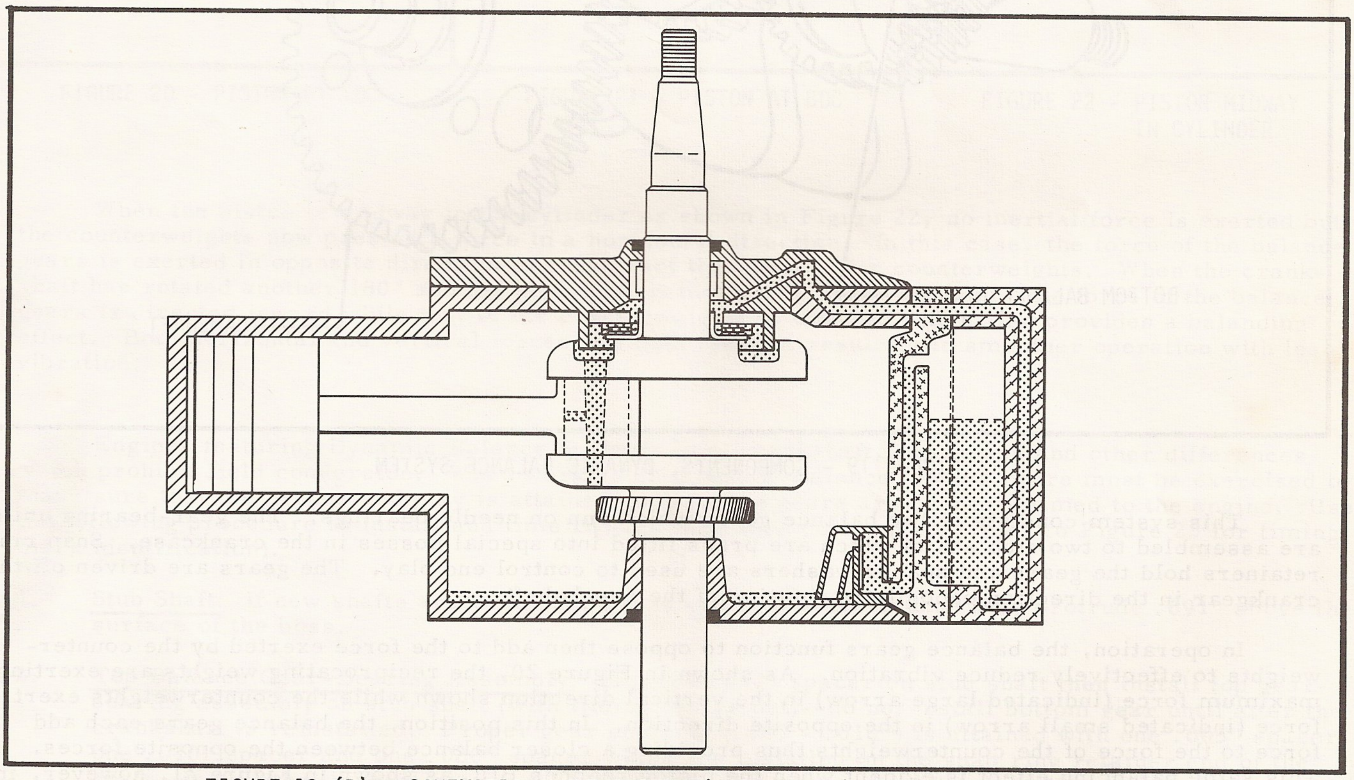

FIGURE 18 (B) - SCHEMATIC, LUBE SYSTEM (KV141 TYPE) ACTION -- PISTON AT TDC

DYNAMIC BALANCE SYSTEM

On conventional single cylinder engines, counterbalancing is by necessity a compromise. The counterweights are designed to balance only about 1/2 of the inertial force created by the reciprocating weights such as piston, piston pin, etc. The reason for this is that this force varies from 0 value when the piston is midway in the cylinder to maximum force when the piston reaches TDC and BDC. If the counterweights were designed to exactly balance the maximum force, they would in effect create an unbalance each time the counterweights rotate to 90° and 180° positions when the inertial force drops to zero. By designing the counterweights to split the force, vibration is kept within acceptable limits for most applications.

For applications where vibration must be maintained at an absolute minimum, Kohler engineers have developed the simple but effective Dynamic Balance System which is now available in specific versions of the K241 and K301 models and is now standard on the 14 HP model K321 engines.

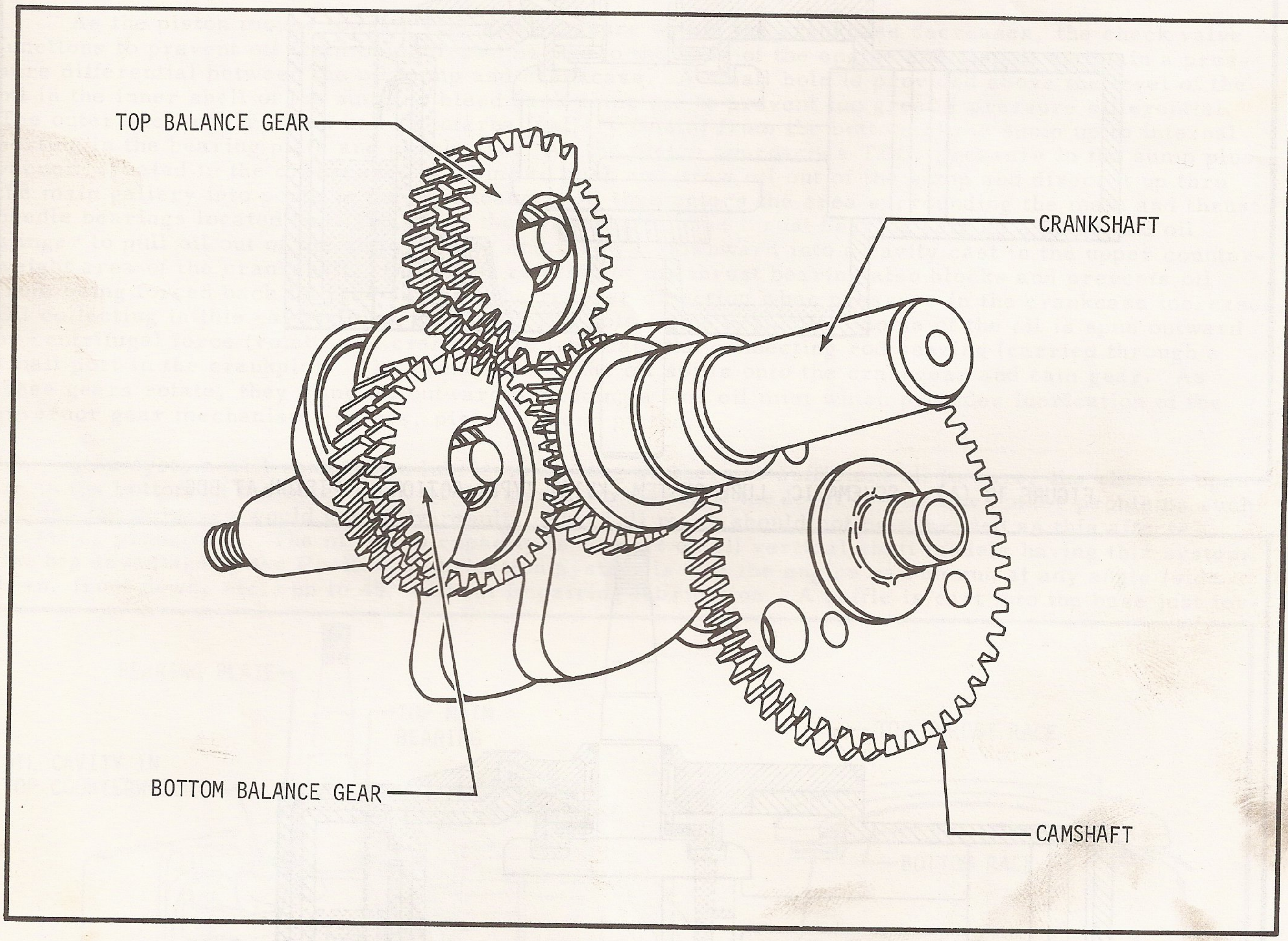

FIGURE 19 - COMPONENTS, DYNAMIC BALANCE SYSTEM

This system consists of two balance gears which run on needle bearings. The gear-bearing units are assembled to two stub shafts which are press fitted into special bosses in the crankcase. Snap ring retainers hold the gears and spacer washers are used to control end play. The gears are driven off the crankgear in the direction opposite to rotation of the crankshaft.

In operation, the balance gears function to oppose then add to the force exerted by the counterweights to effectively reduce vibration. As shown in Figure 20, the reciprocating weights are exerting maximum force (indicated large arrow) in the vertical direction shown while the counterweights exert force (indicated small arrow) in the opposite direction. In this position, the balance gears each add force to the force of the counterweights thus providing a closer balance between the opposite forces. This same balancing effect is evident when the piston reaches BDC as shown in Figure 21, however, in this case the direction of the two forces is toward each other.

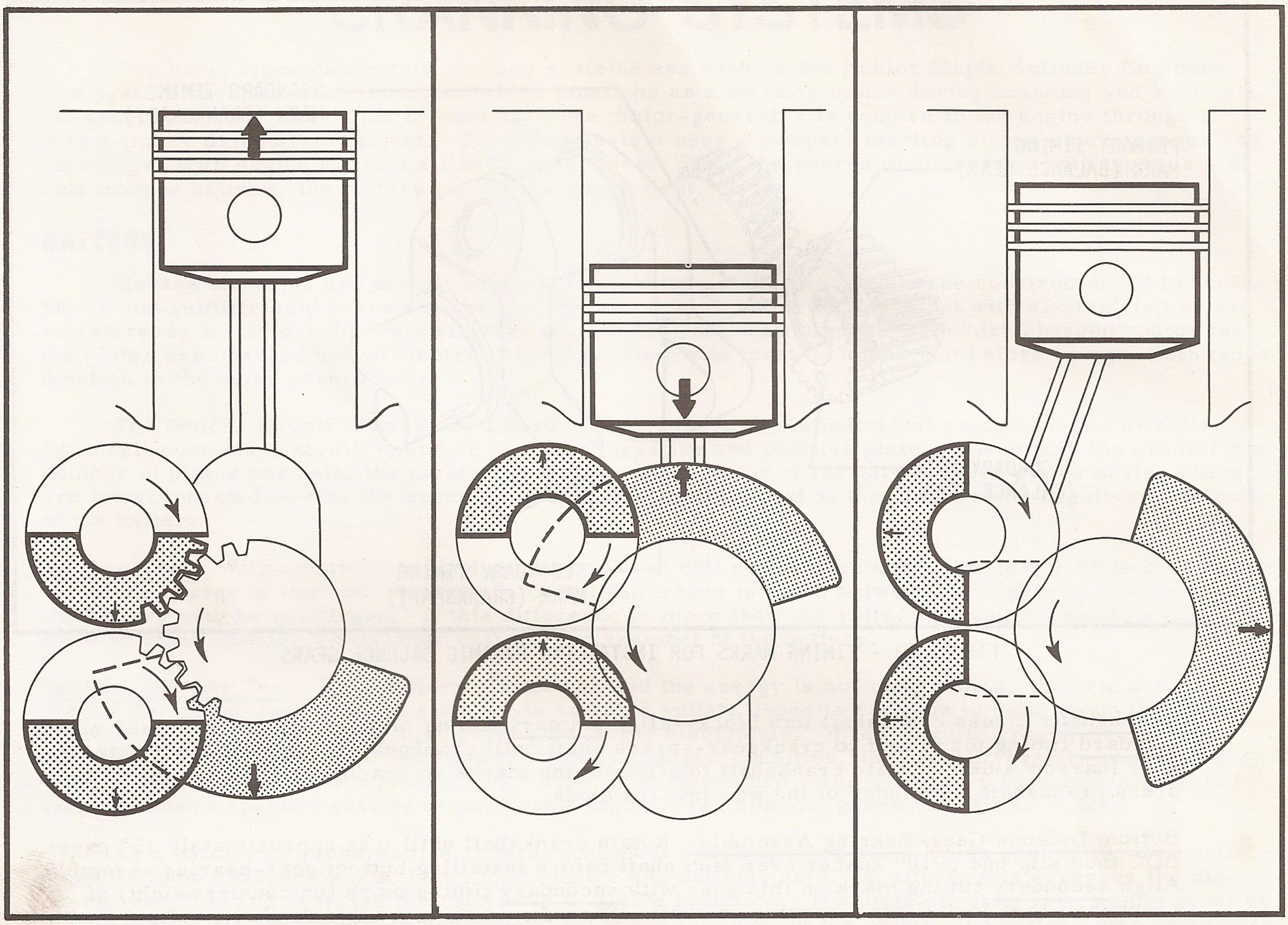

FIGURE 20 - PISTON AT TDC FIGURE 21 - PISTON AT BDC FIGURE 22 - PISTON MIDWAY IN CYLINDER

When the piston is midway in the cylinder as shown in Figure 22, no inertial force is exerted but the counterweights now present a force in a horizontal direction. In this case, the force of the balance gears is exerted in opposite direction to counteract the force of the counterweights. When the crankshaft has rotated another 180° and the piston is again midway in the cylinder, the force of the balance gears is directed inward while that of the counterweights is outward which also provides a balancing effect. Both horizontal and vertical forces are thus reduced resulting in smoother operation with less vibration.

Engines featuring Dynamic Balance Systems have crankshaft, crankcase and other differences which prohibit field conversion. When working on Dynamic Balance models, care must be exercised to make sure that the proper end play is attained and that the gears are properly timed to the engine. Use the following procedure to install and time Dynamic Balance components (refer to Figure 23 for timing mark identification).

1. Stub Shaft: If new shafts are required, press shafts into block until they protrude .691" above the surface of the boss.

2. Top Balance Gear-Bearing Assembly: Slip one .010" spacer on stub shaft then install top gear-bearing assembly on stub shaft (with timing marks out)--do not install bottom gear until after the crankshaft is reinstalled. Proper gear end play (.005 - .010") is attained with one .005" spacer, one .010" spacer and one .020" spacer which are installed on the snap ring retainer end of the shaft--install the thickest spacer (.020") next to the retainer. After installing retainer, recheck end play and adjust (add or subtract .005" spacers) if needed.

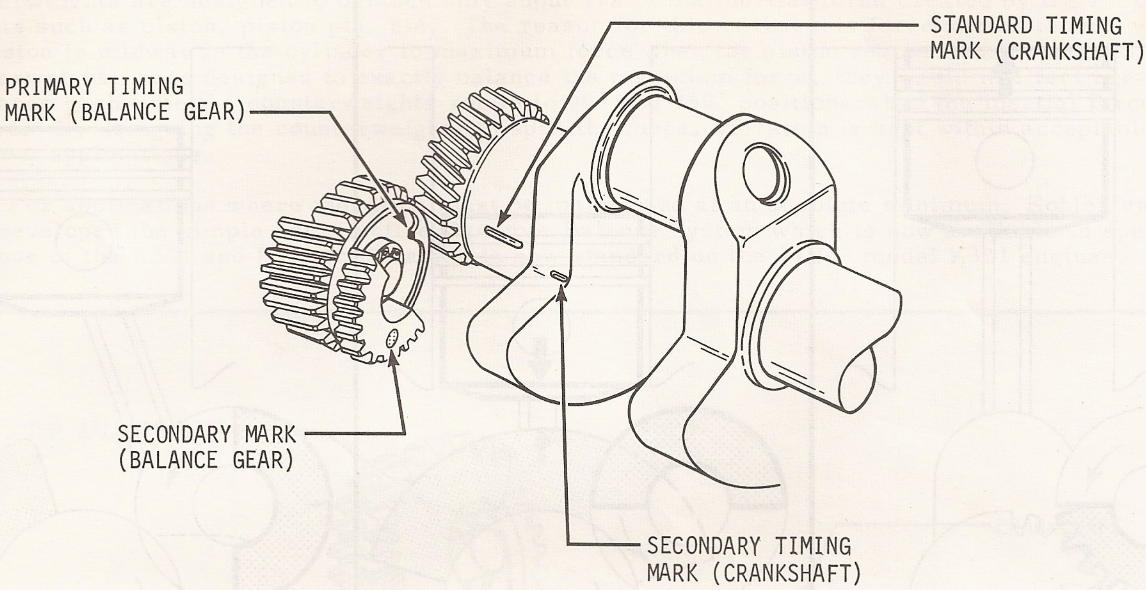

FIGURE 23 - TIMING MARKS FOR INSTALLING DYNAMIC BALANCE GEARS

3. Crankshaft: Press crankshaft into block--align primary timing mark on top balance gear with standard timing mark next to crankgear--press shaft until crankgear is engaged 1/16" into top gear (narrow side). Rotate crankshaft to align timing marks on crankgear and cam gear, then press crankshaft remainder of the way into the block.

4. Bottom Balance Gear-Bearing Assembly: Rotate crankshaft until it is approximately 15° past BDC then slip one .010" spacer over stub shaft before installing bottom gear-bearing assembly. Align secondary timing mark on this gear with secondary timing mark (on counterweight) of crankshaft then install gear-bearing on shaft. Secondary timing mark will also be aligned with standard timing mark on crankshaft after installation if properly timed. Use one .005" spacer and one .020" spacer (largest next to retainer) to obtain proper end play of .005 to .010". Install snap ring retainer then recheck and adjust end play as needed.

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