an electrical current of extremely high voltage is induced in the fine secondary windings of the coil. This high voltage is conducted to the spark plug where it jumps the gap between the points of the plug to ignite the compressed charge of air-fuel mixture in the cylinder.

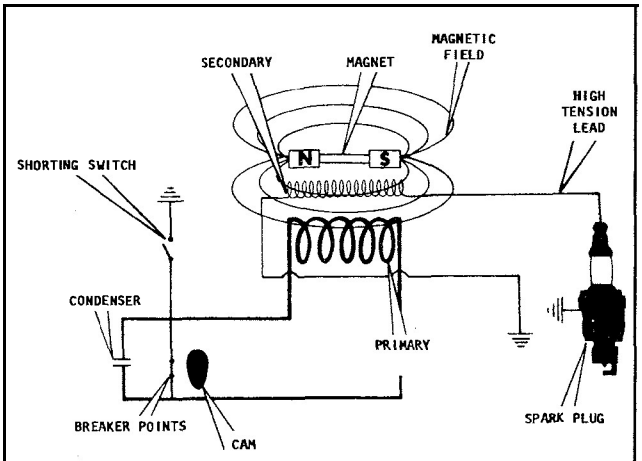

Fig. 13 Schematic of a typical magneto ignition system installed on an outboard

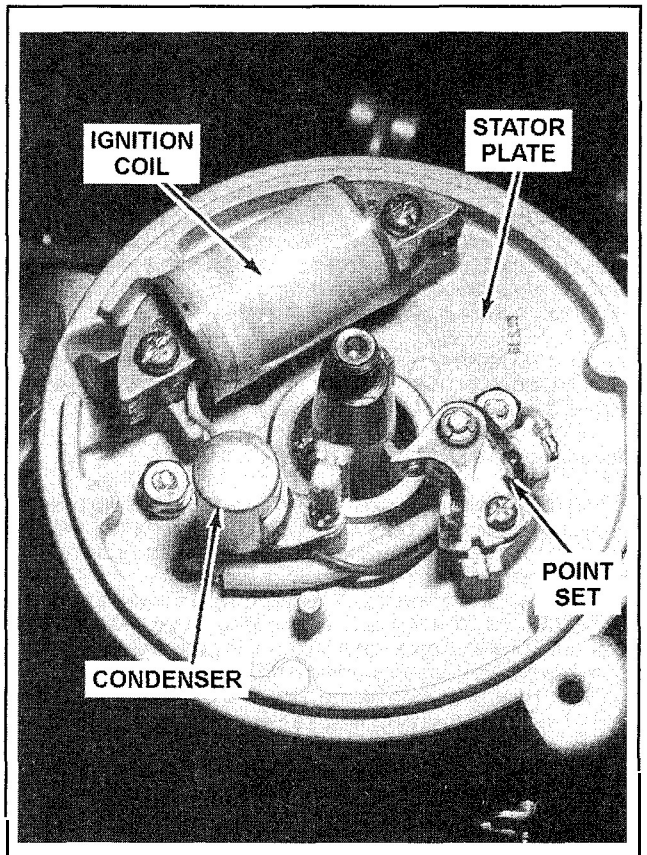

Fig. 14 After the flywheel is removed, components on the stator plate may be easily serviced

Capacitor Discharge Ignition (CDI) System

■ The Yamaha Microcomputer Ignition System (YMIS) is a version of the Capacitor Discharge Ignition (CDI) system used on most motors covered here. It uses a microcomputer to analyze signals sent from several sensors and switches to control ignition timing; yet shares many components and their related procedures with the conventional CDI system. Specific details on this system and where it differs from the conventional CDI system can be found under a separate heading for the YMIS. All other aspects of the YMIS system are included in the appropriate CDI sections.

DESCRIPTION & OPERATION

◆ See Figures 15 and 16

All Yamaha motors, other than the 2 hp model built through 1994, are equipped with a form of the Yamaha Capacitor Discharge Ignition (CDI) electronic ignition system. Some models are equipped with a micro-computer controlled version of this system, whose additional components are detailed later in this section under Yamaha Micro-Computer Ignition System (YMIS). However, the basic function of these systems are all similar.

1-Cylinder Ignition

In its simplest form, a CDI ignition is composed of the following elements:

- Magneto
- Pulser coil
- Charge, or source coil
- Igniter (CDI) box
- Ignition coil
- Spark plug

Other components such as main switches, stop switches, or computer systems may be included, though, these items are not necessary for basic CDI operation.

To understand basic CDI operation, it is important to understand the basic theory of induction. Induction theory states that if we move a magnet (magnetic field) past a coil of wire (or the coil by the magnet), AC current will be generated in the coil.

The amount of current produced depends on several factors:

- How fast the magnet moves past the coil
- The size of the magnet (strength)
- How close the magnet is to the coil
- Number of turns of wire and the size of the windings

The current produced in the charge coil goes to the CDI box. On the way in, it is converted to DC current by a diode. This DC current is stored in the capacitor located inside the box. As the charge coil produces current, the capacitor stores it.

At a specific time in the magneto's revolution, the magnets go past the pulser coil (which is usually just a smaller version of the charge coil, so it has less current output). The current from the pulser also goes into the CDI box. This current signals the CDI box when to fire the capacitor (the pulser may be called a trigger coil for obvious reasons). The current from the capacitor flows out to the ignition coil and spark plug. The pulser acts much like the points in older ignitions systems.

When the pulser signal reaches the CDI box, all the electricity stored in the capacitor is released at once. This current flows through the ignition coil's primary windings.

The ignition coil is a step-up transformer. It turns the relatively low voltage entering the primary windings into high voltage at the secondary windings. This occurs due to a phenomena known as induction.

The high voltage generated in the secondary windings leaves the ignition coil and goes to the spark plug. The spark in turn ignites the air-fuel charge in the combustion chamber.

Once the complete cycle has occurred, the spinning magneto immediately starts the process over again.

Main switches, engine stop switches, and the like are usually connected on the wire in between the CDI box and the ignition coil. When the main switch or stop switch is turned to the OFF position, the switch is closed. This closed switch short-circuits the charge coil current to ground rather than sending it through the CDI box. With no charge coil current through the CDI box, there is no spark and the engine stops or, if the engine is not running, no spark is produced.

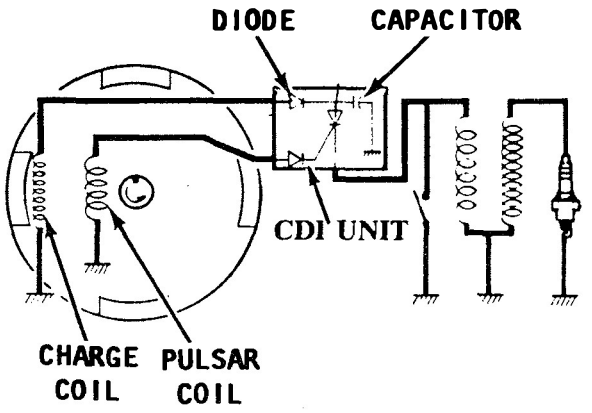

Fig. 15 Functional diagram of a CDI ignition system - except V4 and V6 powerheads

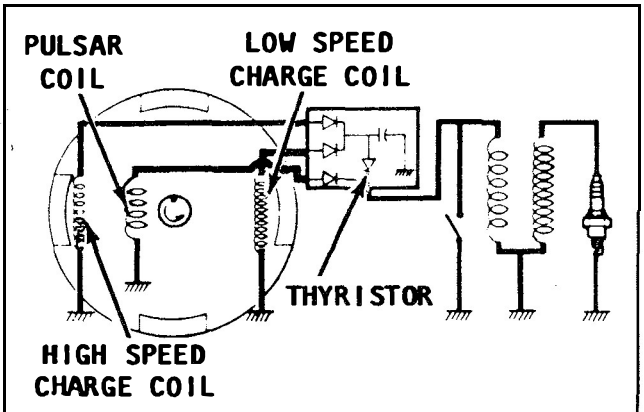

Fig. 16 Functional diagram of a CDI ignition system - V4 and V6 powerheads

2-Cylinder Ignition

Yamaha produces 2-cylinder outboards ranging from smaller 6 hp units, all the way up to larger 55 hp motors. These outboards are normally, but not always, equipped with one, dual-lead ignition coil.

In addition to the dual-lead ignition coil, the system typically uses one pulser coil (though there are a few 2-stroke motors that use dual pulser coils), one charge coil and a CDI box. When equipped with only one pulser coil, both spark plugs are fired at the same time. Although both cylinders spark at the same time, only one cylinder is actually producing power. The crankshaft is a 180 degree type which means that as piston number one is at top dead center, piston number two is at bottom dead center. The piston at TDC is compressing a fuel charge that the spark then ignites. At the same moment, the piston at BDC isn't compressing a fuel charge. Actually, there are still exhaust gases going out. The spark in this cylinder has no effect on power production. This combination of engine and ignition design is called waste spark system (which is something as a misnomer, because no efficiency is actually lost by the spark in the non-compressed cylinder).

After the crankshaft has rotated another 180 degrees, the two pistons have reversed position. The spark fires again to ignite the fuel charge compressed in cylinder number two and sparks to no effect in cylinder one.

Twin coil CDI operation up to the ignition coil is exactly like the basic CDI. The difference simply comes in the utilization of the dual-lead ignition coil

On a traditional ignition coil, the current leaves the coil, goes to the spark plug, then through the cylinder head to ground.

On a dual-lead coil, the current leaves the coil, goes through one of the spark plugs, travels through the cylinder head to the second spark plug, and returns to the coil itself. This way one coil can fire two cylinders.

This type of system requires about 30% more voltage than a standard system to fire the second spark plug. This is because more energy is required for the spark to jump from the bridge of the spark plug to the center electrode.

■ **If this system has weak spark, the first sign is the second spark plug will not having a hot enough spark. This plug will foul even though the other plug is working fine.**

A quick check to tell if the plug fouling on one cylinder is due to weak ignition is to switch the ignition coil leads. If the plug fouling goes to the other cylinder, weak ignition components are the problem.

3-Cylinder Ignition

Three-cylinder models can be divided into three groups:

- Units with 3 pulser coils
- Units with 2 pulser coils (Non-YMIS equipped)
- Units with 1 pulser coil (YMIS equipped)

Models equipped with three pulser coils use one pulser for each cylinder. The pulsers are spaced 120 apart. As each pulser produces its own signal, the CDI box fires the ignition coil for that cylinder.

The largest of the 3-cylinder engine families (the 65J-90 hp/1140cc motors) usually have two items that make them unique to other Yamaha 3-cylinder engines. One, they have 2 charge coils, one called a low-speed charge coil and the other called the high-speed charge coil. Rather than having multiple separate coils, these motors normally have both charge coils and the lighting coil combined into a single unit called a stator.

■ **The failure of any of these coils will result in the replacement of the whole stator rather than a single coil.**

The second unique feature to the 65J-90 hp (1140cc) motor family is that some models use 2 pulsers rather than three. Usually there is 1 pulser per cylinder, but in this case, 1 pulser actually controls 2 cylinders. These 2 cylinders are not firing at the same time like the earlier twin models.

In order to allow 2 cylinders to fire off 1 pulser at different times, the pulser must tell the CDI box when to ignite the appropriate cylinder. This is accomplished by taking advantage of a characteristic of the induction process.

As a magnet goes by the pulser, electricity is generated. This current flows to the igniter (CDI) box. The direction the current flows is determined by which end (north or south) of the magnet travels past the coil first. When the north end goes by the coil, current flows in one direction. When the south end of the magnet goes by, the current flows in the opposite direction. This is sometimes referred to as phase or polarity. The CDI box can differentiate the direction of current flow and direct the signal to the appropriate capacitor. The CDI box, in effect, knows which cylinder to fire by the signature of the signal.

On the YMIS equipped units, there is only 1 pulser coil in the system. It fires the 1 & 3 cylinders. The #2 cylinder firing is determined by the YMIS computer. A failure of the YMIS will extinguish the #2 spark.

Inline 4-Cylinder Ignition

The ignition system for the 45/50 hp 4-stroke motors utilizes one pulser coil, one stator mounted charge coil winding, a CDI unit and 2 dual-lead ignition coils. The system is something of a cross between the ignition used on single cylinder motors and the one used on twins.

All ignition and timing functions are controlled by the CDI based on input from the pulser coil and ignition coils are fired using voltage generated by the charge coil. The spark plugs are fired in pairs (with one cylinder at TDC of the compression stroke while the other is on TDC of the exhaust stroke) using a traditional "waste-spark" configuration. One dual-lead ignition coil is used for the #1 and #4 cylinders, while the other is used to fire the #2 and #3 cylinders.

Additional inputs from the thermo-switch and oil pressure switch are used by the ignition module to fine tune ignition function.

V4 & V6 Ignition

The V4 ignition system works like a basic CDI system with two major differences. First, 1 pulser fires 2 cylinders independently of each other. Second, there are 2 charge coils, one for low speed and one for high speed.

In the most basic CDI systems, 1 pulser coil sends the signal to fire one ignition coil. In the V4 system 2 pulser coils fire for separate ignition coils.