FLYWHEEL MAGNETO IGNITION SYSTEM

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ABSTRACT
A flywheel magneto ignition system of the breakerless type using solid state devices to control the firing of the spark plugs.

3 Claims, 8 Drawing Figures
FLYWHEEL MAGNETO IGNITION SYSTEM

This is a continuation, of application Ser. No. 83,363, filed Oct. 23, 1970 now abandoned.

In many applications it is desirable to provide a compact ignition system for use with light, portable engine devices, such as in engines for boats. Such systems are preferably designed without a battery in order to make the device light and compact and to eliminate the need for a separate battery system. The present invention relates to the foregoing type ignition system and employs a simple magneto arrangement and a few simple circuit elements in its preferred embodiments.

The present invention preferably employs the flywheel as part of the magneto with permanent magnet flux generating means attached to the flywheel. Thus, the flux generating portion of the magneto is synchronously operated with the engine at all engine speeds and can be utilized to actuate one or more components of the ignition system.

Accordingly, it is a principal object of this invention to provide a flywheel magneto ignition system for efficiently providing trigger impulses to energize an associated spark plug.

Another object of the invention is to provide a low cost flywheel magneto ignition system for use on two-cylinder, two-cycle combustion engines.

It is a further object of the present invention to provide a breakerless type ignition system using solid state devices to control the firing of associated spark plugs.

The foregoing and other features and advantages of the invention will be apparent from the following more particular description as illustrated in the accompanying drawings wherein:

FIG. 1 is a sketch of a flywheel for mounting on a crankshaft of an engine in a conventional manner;

FIGS. 2a, 2b, 2c and 2d are waveforms useful in explaining the operation of the apparatus shown in FIG. 1;

FIG. 3 is a schematic diagram of an ignition system circuit in accordance with the invention for providing a D.C. spark;

FIG. 4 is a modification of the circuit of FIG. 3 utilizing a center connected trigger coil.

FIG. 5 is another modification of the circuit of FIG. 3 for providing an A.C. spark.

Referring to the drawings, in FIG. 1 permanent magnets M1 and M2 are affixed to a conventional flywheel 12 and are positioned diametrically opposite to each other. Flywheel 12 normally rotates in counterclockwise direction as indicated by the arrow, and the south pole (S) of magnet M1 is positioned to be the relatively leading pole; and the north pole (N) of magnet M2 is positioned to be the leading pole.

An energy coil P having terminals A and B is wound around either the center leg of an E-shaped magnetic steel laminated assembly 14 or one leg of a U-shaped laminated. A trigger coil T having terminals a and b is wound around the center leg of a second E-shaped magnetic steel laminated assembly 16. Energy coil P and trigger coil T and their associated assemblies 14 and 16 are coplanarily positioned in fixed angular relationship to each other and are stationary with respect to the flywheel 12. In the embodiment shown, coils P and T are positioned in approximately 90° angular relationship.

The electronic circuit 11 used in conjunction with the apparatus of FIG. 1 is shown in FIG. 3. In the circuit 11, the terminal points A and B of coil P are connected to a single phase full wave rectifier bridge 15 to provide a D.C. voltage which charges capacitor 17 connected across conductive leads 20 and 22. Lead 20 is connected to ground reference.

Circuit 11 includes a pair of known silicon-controlled rectifiers 21 and 23 (hereinafter referred to by the abbreviation SCR). The first SCR 21 has its anode connected to one terminal of the primary winding 25 of an ignition coil S1 which has its other terminal connected to lead 20. One terminal of the secondary winding 27 of ignition coil S1 is connected to lead 20 and its other terminal is connected to its associated spark plug, not shown. The cathode of SCR 21 is connected to lead 22, and its gate electrode is connected to the cathode of a diode 31 and to the plate of capacitor 33. The anode of diode 31 and the other plate of capacitor 33 are connected to lead 22. Capacitor 33 filters high frequency noise to prevent false triggering of SCR 21 and diode 31 functions to reduce the reverse biasing on the gate to cathode of SCR 21. A capacitor 29 is connected across the anode to cathode of SCR 21 to function as a bypass capacitor to enhance the rate of change of voltage versus time characteristic of SCR 21. The gate electrode of SCR 21 is also connected to terminal a of the trigger coil T. The other terminal b of trigger coil T is connected to the gate electrode of SCR 23.

SCR 23 is connected in the same manner in the circuit as SCR 21 and is connected in parallel to SCR 21. The anode of SCR 21 is connected through the primary winding 35 of ignition coil S2 to lead 20; and its cathode is connected to lead 22. The secondary winding 36 of ignition coil S2 is connected to its associated spark plug. A diode 37 is connected from the gate of SCR 23 to lead 22 and a capacitor 39 is connected in parallel with diode 37. Diode 37 and capacitor 39 function similarly as diode 31 and capacitor 33. Capacitor 41 is connected across the anode to cathode of SCR 23 and functions similarly as capacitor 29.

The operation of the apparatus of FIG. 1 and the circuit of FIG. 3 will now be explained. Assume a steady state condition exists when magnets M1 and M2 are positioned relative to energy coil P and trigger coil T (as shown in FIG. 1). SCR 21 and SCR 23 are OFF or non-conducting and capacitor 17 has no charge. When flywheel 12 is caused to rotate in a counterclockwise direction, magnet M1 passes by energy coil P and the motion of the magnet relative to the coil produces a voltage having a waveform as shown in FIG. 2a. The voltage is rectified by bridge 15. Capacitor 17 which is connected across bridge 15 is thus charged. Note that the upper plate of capacitor 17 is connected to lead 20 and ground reference.

As flywheel 12 continues to rotate, magnet M2 next passes trigger coil T producing voltage having a waveform as shown in FIG. 2b. Note that terminal a of trigger coil T is connected to the gate of SCR 21 and the other terminal b of trigger coil T is connected to the gate of SCR 23. The voltages developed at terminals a and b are of opposite polarity, hence the first pulse reverse biases SCR 21 and turns ON SCR 23. This assures that SCR 21 is maintained in the OFF condition while SCR 23 is conducting.

With SCR 23 turned ON the charge stored in capacitor 17 causes current to flow through the primary wind-
ing 35 of ignition coil S2 producing a voltage across the secondary winding 36. The output of winding 36 is coupled in conventional manner to the spark plug associated with one cylinder of the engine. As is known, the energy stored in capacitor 17 is discharged through ignition coil S2 and SCR 23 to produce a spark across the electrodes of the spark plug and fire the cylinder.

The second pulse in the waveform of FIG. 2a turns ON SCR 21 and at the same time reverse biases SCR 23. However, at this point in time, and in the position of the rotation of flywheel 12, the capacitor 17 has been fully discharged and no energy is available to be discharged through the primary winding 35 of ignition coil S1. Thus, no spark is produced at the spark plug connected to coil S1.

The third pulse in the waveform of FIG. 2a is similar to the first pulse and produces the same gate biasing conditions to SCR 23 and SCR 21 as the first pulse. However, since capacitor 17 is discharged, no energy is available at this point in time to affect the spark plug connected to ignition coil S2.

After magnet M2 has passed trigger coil T, both SCR 21 and SCR 23 are returned to an OFF condition and there is no energy stored in capacitor 17. Further rotation counterclockwise of the flywheel 12 causes magnet M2 to pass energy coil P producing a voltage having a waveform as shown in FIG. 2c. As mentioned, magnet M2 is essentially a duplicate of magnet M1 except that the north pole (N) of M2 is the leading pole; and, accordingly, the waveform of FIG. 2b is of the same shape as in FIG. 2a but relative reversed in polarity. The voltage produced in energy coil P by magnet M2 is rectified by bridge 15 to charge capacitor 17. Further rotation of the flywheel 12 next causes magnet M1 to pass trigger coil T producing a voltage having a waveform as shown by FIG. 2d.

The first pulse in the waveform of FIG. 2d turns ON SCR 21 and reverse biases SCR 23. When SCR 21 turns ON, the charge stored in capacitor 17 causes current to flow through the primary winding 25 of ignition coil S1 producing a voltage at the output of the secondary winding 27 to cause a spark across the gap of the spark plug associated with coil S1. The energy stored in capacitor 17 is thus dissipated, hence as discussed above, the second and third pulses in the waveform of FIG. 2d are essentially ineffective.

Thus, on one rotation of the flywheel 12, the spark plugs associated with both coils S1 and S2 are fired, and each succeeding revolution of the flywheel repeats the sequence.

The angular relationship of coils T and P in the embodiment shown is 90°; however, this angular relationship may be varied. The angular relationship and the related speed of rotation of flywheel 12 should be such that capacitor 17 is fully charged before any voltage is produced in the trigger coil T by the leading magnet to bias an SCR to conduct and discharge the capacitor 17.

FIG. 4 is a schematic diagram of the circuit employed with the trigger coil consisting of two windings labeled as T1 and T2. The circuit of FIG. 4 is essentially similar to the circuit of FIG. 1 with the exception that in FIG. 4 the trigger coil T is formed of two distinct windings T1 and T2. Windings T1 and T2 have terminals a, b, and c, d, respectively, with terminals b and d being connected to one another and to lead 22. Coil T1 is wound in opposite direction to coil T2. The circuit of FIG. 4 operates essentially the same as the circuit of FIG. 3 but has the advantage of reducing current flow through the SCRs, thus promoting lower operating temperature for these devices.

The circuit of FIG. 5 is a modification of the circuits of FIGS. 3 and 4 to provide an alternating current or A.C. spark for firing the spark plugs. Note that like reference characters in FIGS. 3, 4 and 5 refer to essentially identical components.

In FIG. 5 a principal modification consists in providing triacs 61 and 63 in lieu of the SCRs 21 and 23 shown in FIGS. 3 and 4. Triac 61 has its main terminal 2 connected to winding 25 of coil S1 and its main terminal 1 connected to lead 22. The gate electrode g of triac 61 is connected through a diode 66 and resistor 65 to terminal a of coil T1. The other terminal b of coil T1 is connected to lead 22. A resistor 67 connects triac 61 to lead 22, and a capacitor 69 is connected in parallel with resistor 67.

Similarly, main terminal 2 of triac 63 is connected to winding 35 of coil S2. The gate electrode g of triac 63 is connected through a diode 73 and resistor 71 to terminal c of coil T2. Terminal 1 of coil T2 is connected to lead 22. A resistor 77 connects triac 63 to lead 22, and a capacitor 75 is connected in parallel with resistor 77.

As is known, the triacs 61 and 63 are capable of conducting in both directions thus enabling current to flow through the respective coils 25 and 35 in both directions to provide alternating current pulses. It has been found that alternating pulses provided to the spark plugs are effective to maintain the plugs clean.

In operation, the rectified output from bridge 15 is connected across a resistor 26 and capacitor 17. The potential at the junction 24 of resistor 26 and capacitor 17 varies about a zero reference potential. Resistor 26 thus enables capacitor 17 to be charged in both a positive and negative direction in order to provide energy of the proper polarity to flow through triacs 61 and 63 to provide the above-mentioned alternating current.

The trigger coils T1 and T2 are center tapped with their terminals b and d connected in common and to lead 22. Diodes 66 and 73 eliminate any reverse voltage being effective at the gate g of the triacs 61 and 63. For example, diode 66 blocks the current flow path in the direction from terminal b of coil T1 through lead 22, resistor 67, capacitor 69, resistor 65, and back to terminal a of coil T1. Since there is no current flow, resistor 67 will be prevented from having a voltage which is negative at its terminal which is connected to the gate g of triac 61 and positive at its terminal which is connected to lead 22. Accordingly, triac 61 is prevented from turning ON when a negative pulse is developed across terminals a b of coil T1. Diode 73 functions in a like manner to prevent triac 63 from turning ON when a negative pulse is developed across terminals c d of coil T2. Trigger coils T1 and T2 and the diodes 66 and 73 together make it possible to maintain one triac in an OFF or non-conducting condition while the other triac is in an ON condition.

While only a limited number of embodiments of the present invention are specifically disclosed herein, it will be apparent that other variations may be made therein, all within the scope of the invention as claimed in the following claims.

I claim:

1. An ignition system for an engine having a flywheel and employing at least two spark plugs comprising in
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combination: a pair of magnets mounted in respective angular spaced relation on the flywheel for rotating therewith; said magnets being positioned such that the north pole of one magnet is the relatively leading pole as said flywheel is rotated and the other magnet being positioned such that its south pole is the relatively leading pole as said flywheel is rotated; first and second magnetic assemblies each having at least one winding, said assemblies being relatively stationary and in angular spaced relation to one another, said magnets rotating in a path adjacent said magnetic assemblies whereby rotation of said magnets past said magnetic assemblies develops an alternating current energy in said windings, rectifier means connecting to a first winding in said assembly for rectifying said current energy, capacitive means connected to said rectifier means for storing energy developed in said first winding, switch means connected to a winding in said second assembly, said switch means being activated by the energy developed in the winding in said second assembly for initiating discharge of said capacitive means to provide a pulse of energy to said spark plugs, said switch means comprising a pair of triac means, each triac means having two main terminal electrodes and a gate electrode, respective transformer means associated with a respective spark plug connected to one of said main terminal electrodes of each triac means, said winding in said second assembly being center tapped, and respective diode means connecting each gate electrode to the opposite end terminals of said winding in said second assembly, whereby when current flows in said triac means an energy pulse is provided to the associated spark plug, a first portion of said winding in said second assembly connecting to said triac means to permit an energy pulse in the winding to turn ON only one triac means and bias the other triac means OFF during a given period to enable said triac means to provide alternating current pulses to said spark plugs.

2. An ignition system as in claim 1 wherein the center tapped winding is connected to provide unidirectional pulses only to the gating electrode of the triacs.

3. An ignition system as in claim 1 wherein the diode means are connected to have their respective anodes connected toward the winding in said second assembly and their cathodes connected to the junction of the respective gate and resistive means to prevent the respective triacs to be turned ON by a negative pulse produced in said winding.

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