

- [54] GENERATOR AND TRIGGERING DEVICE
-
- FOR ELECTRONIC IGNITION SYSTEM

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- [51] **Int. Cl.** H02p 9/40

- [58] **Field of Search**..... 310/70 R, 70 A, 153;
322/91, 94, 49, 50; 315/209 R, 209 T, 209
SC, 218; 123/148 AC, 148 E, 149 R, 149 C

- [56]
- References Cited**

UNITED STATES PATENTS

- | | | | |
|-----------|---------|-------------------|-----------|
| 3,186,397 | 6/1965 | Loudon | 123/148 E |
| 3,405,347 | 10/1968 | Swift et al. | 322/91 |
| 3,447,004 | 5/1969 | Falge | 310/70 |
| 3,495,579 | 2/1970 | Davalillo | 123/149 R |
| 3,619,634 | 11/1971 | Burson | 310/153 |
| 3,661,132 | 5/1972 | Farr | 123/148 E |

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|-----------|--------|----------------|---------|
| 3,663,850 | 5/1972 | Phelon..... | 310/153 |
| 3,673,490 | 6/1972 | Magrane..... | 310/70 |
| 3,732,483 | 5/1973 | Katsumata..... | 310/70 |

Primary Examiner—J. D. Miller

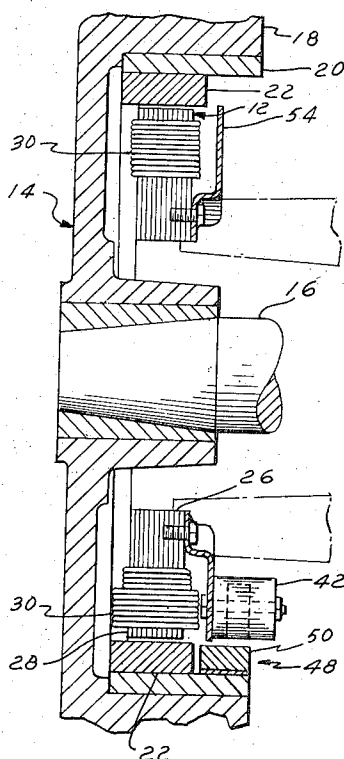
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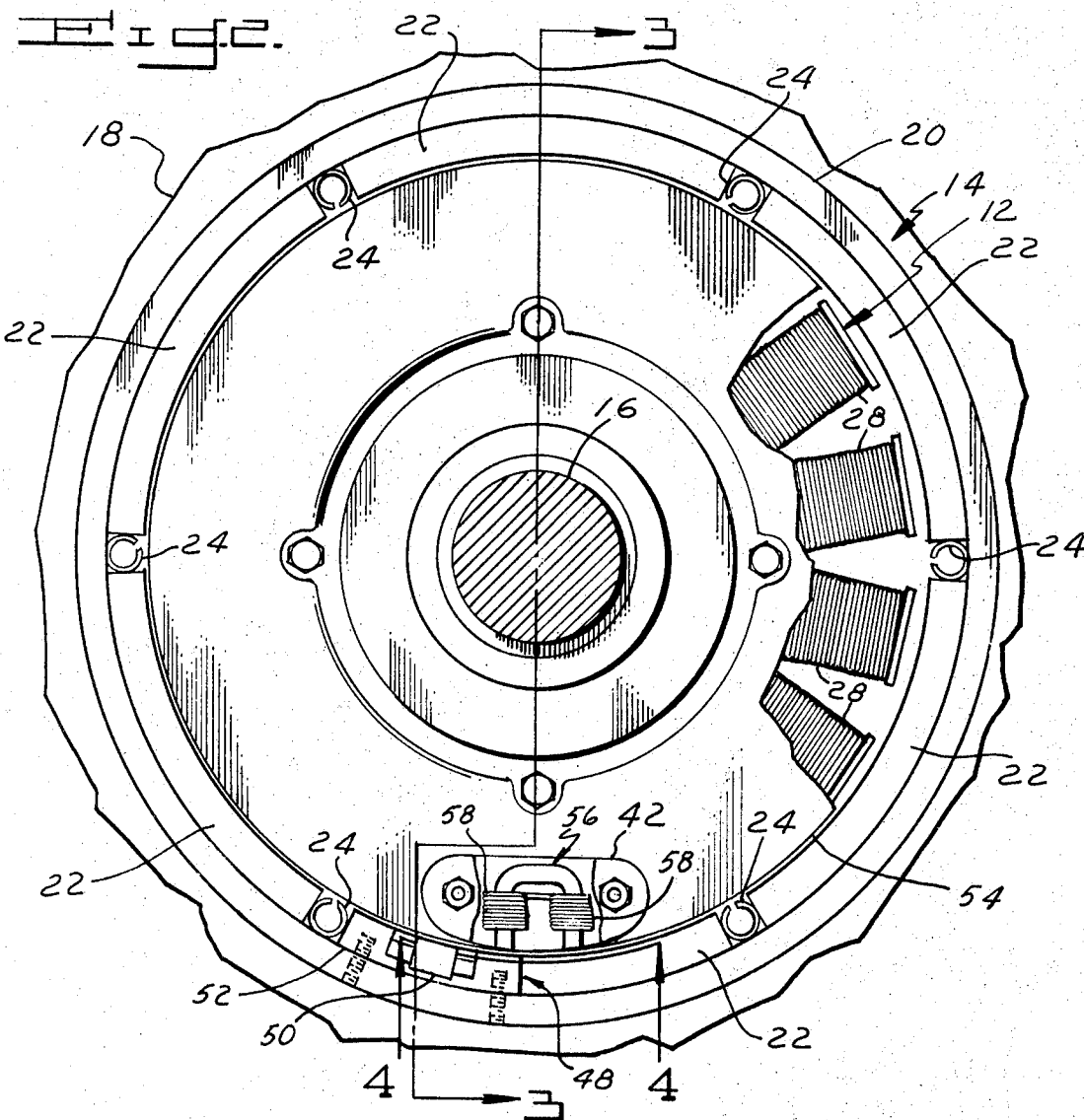
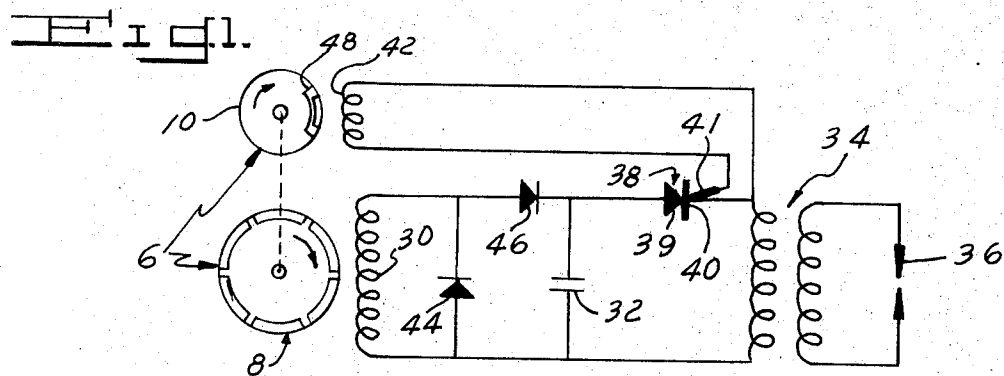
Attorney, Agent, or Firm—Chapin, Neal and Dempsey

[57] ABSTRACT

A generator and triggering mechanism for an electronic ignition system of an internal combustion engine in which the mechanism has one magnetic circuit which charges an energy storage device and which is discharged in response to periodic rotational positions of the engine shaft by which the generator is driven. Integral and relatively rotatable with the generator, the mechanism includes a second magnetic circuit comprising a triggering coil and pole piece disposed in offset axial relationship to the magnetic circuit of the generator and with a ferromagnetic disc interposed between the generator circuit and the triggering elements whereby the trigger coil is shielded from stray flux lines of the first magnetic circuit.

6 Claims, 7 Drawing Figures





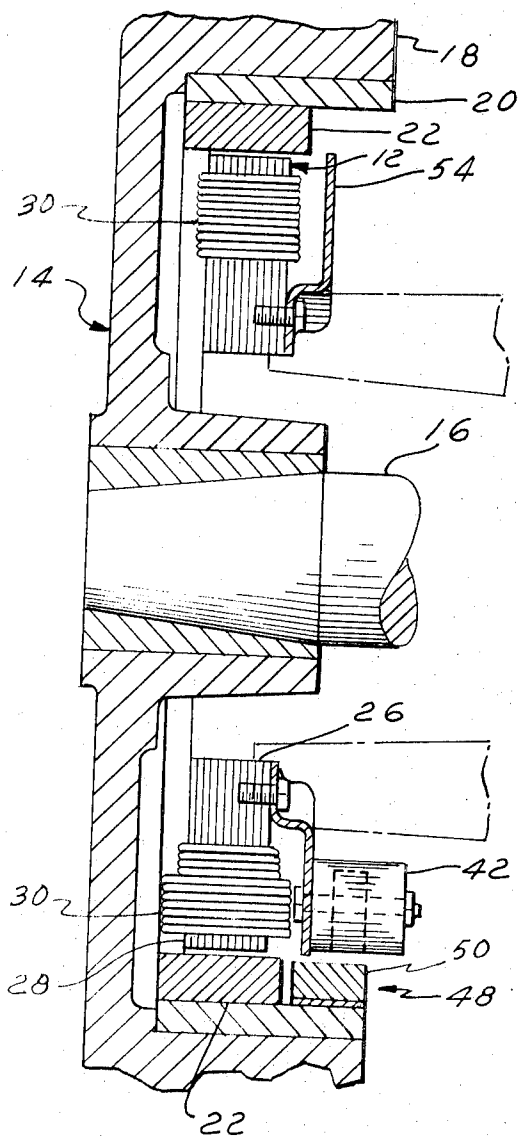


Fig. 3.

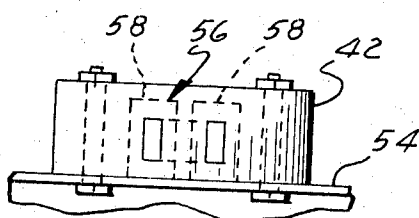


Fig. 4.

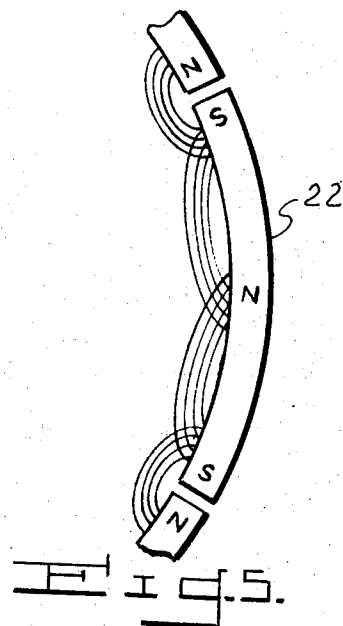
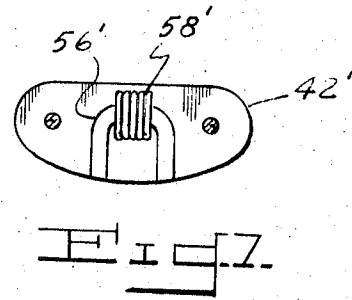
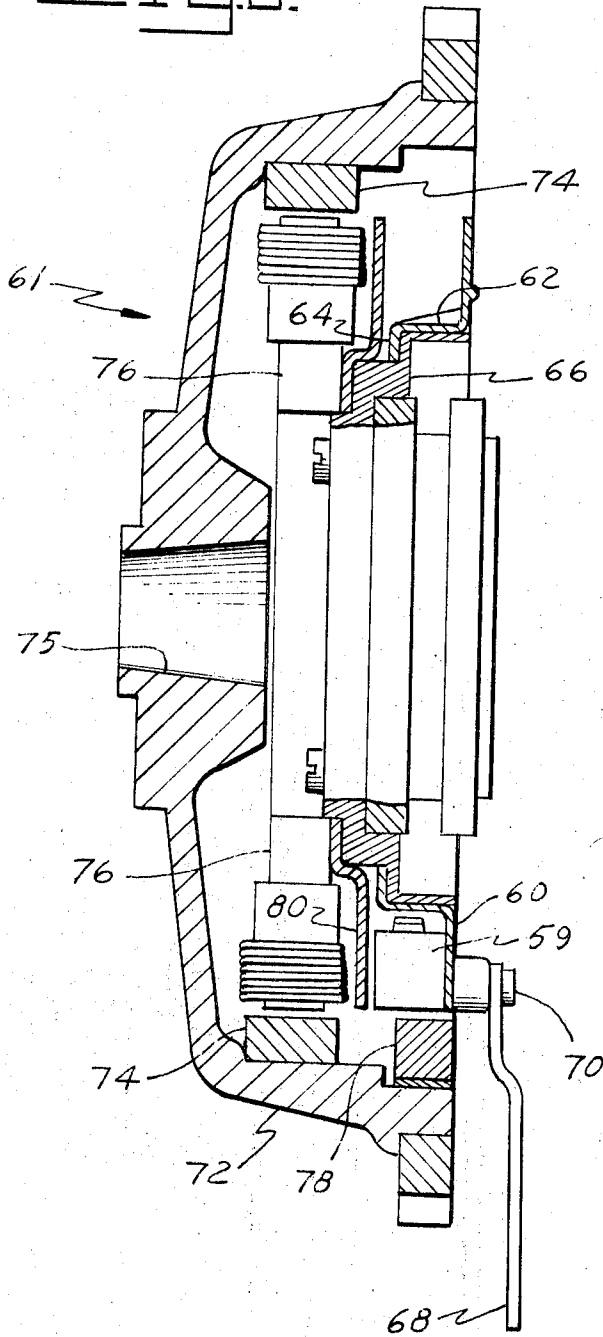


Fig. 5.

19.6.



GENERATOR AND TRIGGERING DEVICE FOR ELECTRONIC IGNITION SYSTEM

BACKGROUND

This invention relates to solid state or "breakerless" ignition systems of the type associated with an alternator in which an electrical storage device, such as a capacitor, is connected across a space discharge device and is charged by the alternator and discharged by a suitable triggering mechanism whereby the discharge device provides the ignition spark for an internal combustion engine.

During the past several years there have been a number of such breakerless ignition systems utilizing various solid state switching devices, such as a silicon controlled rectifier for controlling the discharge of an energy storage device, such as a capacitor. U.S. Pat. Nos. 3,186,397, and 3,465,739 and 3,673,490 are illustrative examples of such systems.

The principal object of this invention is to provide an improved electrical generating device, such as an alternator, with integral triggering mechanism, for use in such breakerless ignition systems.

Another important advantage is to provide an alternator-trigger coil combination of compact construction such that the operation of the one member of the combination does not reduce or modify the performance of the other member.

A further object of this invention is to provide an improved generator structure and integral triggering mechanism which is compact in size and reliable in operation.

Another object of this invention is to provide an alternator construction of the above type having one magnetic circuit and a triggering mechanism composed of another magnetic circuit disposed in closely adjacent relationship to the first circuit but wherein the magnetic lines of flux of the two magnetic circuits are kept separated. An alternator structure is thus provided with a built-in triggering mechanism which is most compact in size and configuration but has the reliability attainable where discrete magnetic mechanisms perform both functions.

Another object is to provide a compact mechanism of the above type in which the trigger coil may be mechanically moved to provide changes in ignition timing in response to throttle movement.

The above and other objects and advantages will be more readily apparent from the following description and the accompanying drawings, in which:

FIG. 1 is a schematic circuit diagram illustrative of one type of capacitor discharge ignition system with which this invention may be utilized;

FIG. 2 is a plan view, partly in section, of a flywheel alternator embodying this invention;

FIG. 3 is a section taken along line 3—3 of FIG. 2;

FIG. 4 is a section taken along line 4—4 of FIG. 2;

FIG. 5 is a diagrammatical plan view illustrating the magnetic lines of flux of the alternator shown in FIG. 2;

FIG. 6 is a cross-sectional view of an alternate embodiment of the alternator; and

FIG. 7 is a plan view of an alternate trigger coil construction.

Referring in detail to the drawings, in FIG. 1 is shown an alternator illustrated generally at 6. Although for purposes of the circuit diagram the alternator is shown as two separate rotating members, it is in fact a unitary structure as will be fully appreciated from the remainder of the figures and following description, and comprises the alternator proper illustrated at 8 and a pulse generating trigger mechanism 10 carried rotatably with the alternator and disposed in offset axial relationship therefrom. The alternator 8 may be driven by any suitable rotating portion of an internal combustion engine, such as its crankshaft 16, and in the embodiment shown takes the form of a flywheel.

The alternator includes a stator 12 (FIGS. 2 and 3) affixed to the stationary structure of the engine, and a rotor 14, the hub of which is fixed to engine shaft 16 so the rotor rotates at the same speed as the engine shaft. The rotor includes an axially extending rim portion 18 to the inner circumference of which is affixed a cylindrical support ring 20 of ferromagnetic material to which is secured a plurality of circumferentially spaced permanent bar magnets 22 shown in FIGS. 2 and 3.

In the illustrative embodiment, FIG. 2, six permanent bar magnets are spaced apart around the ring 20, each extending over an arc of about 55°. Adjacent ends of the bar magnets are separated by spacer elements 24. Small steel spring members may be used as spacers since the mass of the springs is so small as not to affect the flux pattern. Alternatively, non-magnetic spacer elements may also be used. Preferably, each bar magnet provides, with the rotor metal, a plurality of distinct flux loops or circuits, such that a radially extending magnetic flux pattern is set up by each pole, as shown in FIG. 5. Ceramic magnets without pole pieces are preferably used in this alternator structure because the lines of flux of such magnetis are highly directional so that the magnetic force approaches "one" in the axial direction while being almost entirely concentrated in the radial direction and are easier to shield than pole piece magnets having high harmonic flux content. Also, the ceramic magnets provide a uniform flux distribution, and therefore, a generated wave pattern which approaches a sine wave.

The stator 12 located within the rotor 18 of the flywheel includes a core 26 of laminated magnetic material having a plurality of radially extending circumferentially spaced poles 28 in FIG. 2. The magnets 22, support ring 20 and core 26 provide the magnetic circuit for the alternator. Each of the poles is suitably wound with insulated electrically conductive wire and the windings on each adjacent pole are connected in series one with the other to provide a source of alternating electrical power when cutting the magnetic lines of flux established by the bar magnets 22. At least one of the poles 28 is wound with an extra winding or coil 30 composed of a relatively large number of turns which is used to provide current to charge an electrical storage device, such as the capacitor 32 shown in FIG. 1 during each revolution of the rotor 14. The capacitor 32 is connected in parallel with the coil 30; the primary winding 34 of a transformer is connected across the capacitor 32 to receive the electrical discharge therefrom. A spark gap device, such as a spark plug 36, is connected across the secondary winding of the transformer 34 and is fired whenever the capacitor 32 is dis-

charged through the primary winding of the transformer 32.

Discharge of capacitor 32 is controlled by means of a silicon controlled rectifier 38. The silicon controlled rectifier includes an anode 39, a cathode 40 and a gate electrode 41. The anode and cathode electrodes are connected in series circuit with the capacitor 32 and the primary of transformer 34 and the gate electrode 41 is connected to one side of a triggering coil 42, the other side of which is connected to a common junction between the cathode circuit of the silicon rectifier and the primary of transformer 34.

Diode 44 is connected in parallel across the coil 30 and serves to rectify the current supplied to the capacitor 32 so that only positive pulses are passed thereto. Another diode 46 is connected in series with the coil 30 and serves to prevent discharge of the capacitor 32 back to the coil 30 during negative going pulses of the alternator signal. An electrical pulse is generated by triggering coil 42 when cutting the lines of flux of a pole piece magnet 48 carried by the alternator 6. As the magnetic pole 48 is carried by the rotor of the alternator past the coil 42, the electrical pulse generated in the trigger coil biases the gate 41 of the silicon controlled rectifier to its conductive or low impedance state whereby the electrical charge stored by the capacitor 32 discharges through the anode-cathode junction of the rectifier 38 and the primary winding of the transformer 34 thereby inducing a large electrical pulse in the secondary winding of the transformer and causes an ignition spark by the plug 36.

As best shown in FIGS. 2 and 3, the trigger coil 42 and the flux generating magnet 48 are disposed in closely spaced axial relationship to the poles 28 of core 26 and flux generating magnets 22 which form the magnetic circuit of the alternator. The trigger magnet 48 is axially offset in closely spaced relation outward of the outer edge of one of the magnetic bars 22 and as shown, comprises a permanent magnet 50 supported by a ferromagnetic pole piece member 52, which together provide three circumferentially magnetic poles of alternate polarity. The trigger magnet 48 is carried by rotation of the flywheel 18, while the coil unit, generally at 42, is mounted on plate or disc 54 secured to the stator 12 and includes a generally U-shaped magnetic core 56. As shown in FIG. 4 a pair of coils 58 are wound in series relationship about both leg portions of the core 56, so that any false signals generated in the coils by stray magnetic flux from the alternator magnets 22 will be in opposition and thus no trigger pulse will be generated.

The disc 54 on which coil unit 42 is mounted is formed of a ferromagnetic material such that stray magnetic flux lines generated by the bar magnets 22 which extend in an axial direction with respect to the field of rotation of the alternator core 26 will be shunted by the disc 54 back to core 26. The ferromagnetic disc or plate 54 thus serves to prevent any stray magnetic lines of flux emanating from the magnetic circuit of the alternator from interfering with the magnetically independent operation of the trigger mechanism. In effect, disc 54 serves as a shield between the magnetic circuits of the alternator and trigger mechanism whereby the coil unit 42 will be triggered only by coils 58 cutting the lines of flux generated by the triggering magnet 48.

The triggering magnet 48 in the embodiment shown has north poles at its outer ends and a south pole in between. Of course, it will be realized that these polarities could be reversed, if desired. The magnetic lines of flux therefor flow from the ends of the magnet radially outward and then back to its center. When the coil unit 42 is aligned with the triggering magnet, the flux lines flow through the U-shaped core 56 first in one direction and on continued rotation of the magnet 48 the flux in core 56 collapses and then changes to the opposite direction. This reversal of flux induces additive voltage pulses in the coils 58 which is connected at the gate 41 of the silicon controlled rectifier 38 whereby this solid state control element becomes conductive and the voltage stored in capacitor 32 discharges through the primary coils of transformer 34, thereby inducing a large surge of voltage in the secondary coil sufficient to cause the spark plug 36 to fire.

An alternate coil construction is shown at 42' in FIG. 7. In this embodiment one coil 58' is wound about the cross bar portion of the U-shaped core 56' whereby any stray flux signals picked up by the core will induce opposite-going pulses in the coil 58' which cancel each other in the same manner as the FIG. 4 construction.

The trigger coil 42 and magnet 48 are so located on the flywheel rotor and stator as to give an ignition spark in properly timed relation to the operation of the crankshaft and the piston which is reciprocally associated therewith.

In an alternate embodiment of this invention, shown in FIG. 6, a trigger coil 59 is carried by a support plate 60, rotatably mounted on the stator of an alternator, shown generally at 61. The plate 60 includes a rim on a flange portion to the upper surface of which one trigger coil 59 is affixed. The support plate further includes a cylindrical hub portion 62 which extends upwardly from the inner edge of the rim and terminates in an inwardly extending shoulder 64 which bears against an upwardly facing shoulder of stator hub 66. A the engine throttle (not shown) to a connecting pin 70 by which the linkage is pivotably connected to rotate the support plate 60 clockwise and counterclockwise through a sufficient angle to provide appropriate spark advance or retardation. In this way the plate 60 and the coil 59 carried thereby may be rotated to change the engine timing. The coil 59, which may be similar to the coils shown in either FIGS. 4 or 7, is disposed within the rim of the alternator rotor or flywheel 72. A plurality of circumferentially spaced ceramic bar magnets 74 of the type previously described in connection with FIGS. 2, 3 and 5 are carried within the rim of the flywheel 72. The flywheel 72 includes a hub 75 which is adapted to be affixed to an engine shaft so that the alternator rotor will rotate at the same speed as the engine shaft. The alternator stator located within the flywheel rim includes a core 76 of laminated magnetic material having a plurality of radially extending poles, as heretofore described in connection with FIG. 3. In the same manner as previously described, alternator coils are wound about the stator poles and at least one of the poles includes an additional coil which is adapted to charge an electrical storage device such as the capacitor 32 shown in FIG. 1.

The trigger coil 59 is supported on the plate 60 in the plane of rotation of trigger magnet 78 which may be of the same construction as the magnet 48, shown in FIG.

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2. Magnet 78 is carried by the rotation of the flywheel 72 past coil 59 which is supported by the stator whereby with each rotation of the flywheel a trigger signal is induced in coil 59. A ferromagnetic disc 80 is interposed between the magnetic field of the alternator, composed of the magnets 74 and core 76 with its associated coils and the magnetic field of the magnetic trigger circuit which includes trigger magnet 78 and trigger coil 59. The disc 80 serves as a ferromagnetic shield or shunt, as previously described in connection with the disc 54 in FIG. 3. Thus, any stray or magnetic lines of flux generated by the magnets 74 are shunted by the ferromagnetic disc 80 back into the core 76. In this embodiment of the invention as the engine throttle is moved for controlling engine speed, the angular position of the trigger coil is advanced or retarded to control engine timing in relation to the engine speed.

Having thus described this invention, what is claimed is:

1. Generator with triggering device integral therewith for a breakerless ignition system having an electrical energy storage element and control means electrically connected with said triggering device for selectively discharging the energy from said storage element to cause an ignition spark in timed relation to the rotational position of the rotor of said generator, comprising a first magnetic circuit for said generator, including at least one coil wound on a magnetic core for charging said storage element, said triggering device including a coil and a relatively movable flux generating means forming a second magnetic circuit adjacent and axially offset from the first magnetic circuit and a ferromagnetic disc disposed in a plane axially between said generator and triggering device and being engaged with the core of the generator whereby the coil of the triggering device is shielded from stray flux lines of the first magnetic circuit.

2. Generator with triggering device integral therewith as set forth in claim 1, in which said generator is an alternator and includes ceramic magnets in which the magnetic force axially of the generator approaches one.

3. Generator with triggering device integral therewith

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as set forth in claim 2, in which the coil of said triggering device comprises a pair of coils wound in series opposition about a core member whereby any false signals induced in the coils by magnetic flux from the alternator magnets are in opposition and cancel so as not to improperly trigger said control means.

4. Alternator with triggering device integral therewith for a breakerless ignition system having an electrical storage element and silicon controlled rectifier with its gate electrode in circuit with the triggering device for selectively discharging the energy from said storage element through the anode-cathode junction of the rectifier to cause an ignition spark, said alternator comprising a first magnetic circuit including a core and relatively rotatable ceramic magnets disposed concentric therewith, at least one coil on said core connected to said storage element for charging the same in response to rotation of the alternator rotor relative to the stator, said triggering device including a coil and magnet relatively rotatable with the alternator and forming a second magnetic circuit adjacent to and axially offset from the first magnetic circuit and a ferromagnetic disc disposed in a plane axially between said alternator and triggering device and being engaged with the core of said alternator for shielding said triggering coil from stray lines of flux from the first magnetic circuit.

5. Alternator with triggering device integral therewith as set forth in claim 4 in which said ferromagnetic disc comprises a generally planar ring in contact with the core of said alternator whereby axially oriented lines of flux emanating from the alternator magnets are returned by said ferromagnetic disc to the alternator core.

6. Alternator with triggering device as set forth in claim 4 for use with an engine having a throttle control and in which the coil of said triggering device is mounted by said disc, said disc being angularly movable about the axis of said stator, and means interconnecting said disc with the engine therewith for changing the angular position of the triggering coil in response to movement of said throttle.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,821,570 Dated June 28, 1974

Inventor(s) Bob O. Burson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 40, "A the engine" should read --A linkage

68 extends from the engine--.

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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