United States Patent [19]

Haubner et al.

[11] **3,746,901**

[45] **July 17, 1973**

[54] MAGNETO GENERATOR FOR IGNITION SYSTEMS OF INTERNAL COMBUSTION ENGINES

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[22] Filed: **Dec. 14, 1972**

[21] Appl. No.: **314,913**

[30] **Foreign Application Priority Data**

Feb. 18, 1972 Germany .... P 22 07 639.7

[52] **U.S. Cl.** **310/70,** 123/149, 310/153

[51] **Int. Cl.** **F02p 1/00**

[58] **Field of Search** .... 310/70, 152, 153; 123/148 E, 149 A, 149 R

[56] **References Cited**

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Assistant Examiner—Robert J. Hickey
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[57] **ABSTRACT**

To provide triggering pulses to trigger a solid-state control ignition system from the same magnetic circuit which also provides power for the ignition spark itself, a control magnet is located within the physical outline of the main magnet which cooperates with the power winding to provide energy for the spark, the control magnet being reversely polarized with respect to the main magnet and having a circumferential extent which is dimensioned with respect to pole shoes of a pulse generator winding, located in magnetic circuit to the control magnet and the main magnet so that, at least once during each revolution of the magneto rotor, the pole shoes of the pulse generator winding are simultaneously located opposite the main magnet and the reversely polarized auxiliary or control magnet. Preferably, the control magnet is located internally of a cup-shaped rotor, and the armature windings are located within the rotor and stationary, on a plate, the control winding being fitted between the pole shoes of the armature and having limited circumferential extent.

12 Claims, 3 Drawing Figures

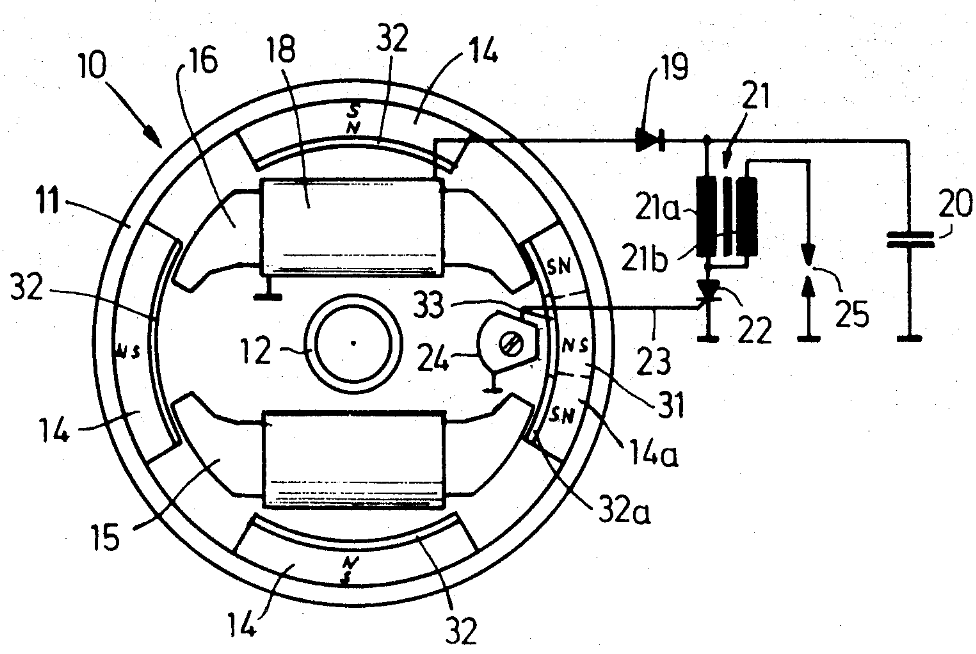


Fig.1

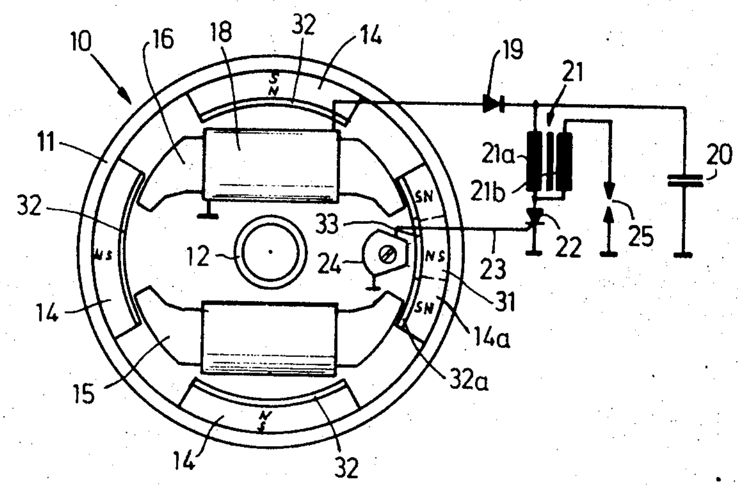


Fig.2

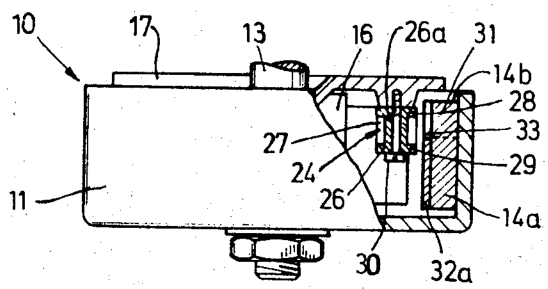
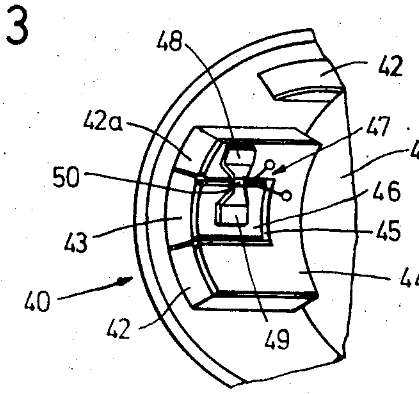


Fig.3



MAGNETO GENERATOR FOR IGNITION SYSTEMS OF INTERNAL COMBUSTION ENGINES

CROSS REFERENCE TO RELATED APPLICATION

U.S. Pat. Ser. No. 309,429 (corresp. to German Pat. No. P 22 05 722.3; Attorney Docket FF 2534; R 737)

The present invention relates to a magneto generator for ignition systems of internal combustion engines, and more particularly to magneto generators for solid-state ignition systems in which armatures are located in a magnetic circuit to provide power for ignition and, additionally, if desired for light or other utilization on an automotive vehicle, and a further pulse generator winding is located with respect to the magnetic circuit of the magneto to provide pulses for triggering of a solid-state ignition system, for example including a thyristor, and thus control ignition.

It has previously been proposed to construct magneto generators with a rotating field with permanent magnets, which cooperate with a load power winding on the one hand, to provide output power and further with a pulse winding to provide control pulses. The permanent magnets are offset with respect to each other by 180°, so that they alternately move past the power armature and the pulse armature. The ignition system includes a storage capacitor which is charged during the positive half wave induced in the power armature. The pulse coil is so located that, as soon as the charge capacitor has been charged, a control impulse is provided to a thyristor which is located in series with the primary winding of the ignition coil, to provide a discharge current therethrough. The thyristor, upon having the control pulse applied, becomes conductive, the capacitor discharges through the primary of the coil and the thyristor, and the induced voltage in the secondary of the ignition coil is conducted to the spark plug to provide an ignition discharge.

This solution has the disadvantage that only two permanent magnets can be located on the rotor, so that the capacitor of the ignition system can be charged only with one half wave of the voltage supply. Such a magnet generator thus has a low efficiency, and low output,which is particularly disadvantageous if the magneto additionally is to be so constructed that it can be connected to other utilization devices, such as head lights, signal lights, or other appliances, usually of resistive nature, which may be applied to motorcycles, or other automotive vehicles with which the magneto generator is intended to be used.

It has previously been proposed to provide four-pole magneto generators with a pulse coil which is separately controlled, that is, which has separately magnetic flux induced therein by means of a special flux guide located on the hub of the permanent field rotor. Such types of pulse sources require relatively large dimensions, are expensive and difficult to make and cannot be utilized with any magneto generator due to their poor space factor. The magnetic relationships, and the long flux paths permit only small manufacturing tolerances, thus increasing production costs.

It is an object of the present invention to provide a nagneto generator which is efficient in use, has high output with small outside dimensions, and in which a pulse generator or pulse source can be included, which is simple to manufacture and in which the pulse winding does not require any additional extra space but can be located directly within the magneto.

SUBJECT MATTER OF THE PRESENT INVENTION

Briefly, a main rotor field has main magnets thereon, and one of the magnets has a zone of reversed magnetization to provide an auxiliary, or control magnet for the pulse source. The zone of reversed magnetization, with respect to the main magnet, is so placed that any revolution of the field rotor, at least one pole face, or pole shoe of the pulse source is located in magnetic flux relationship to the control magnet, whereas another pole face or pole shoe of the pulse source is in magnetic flux relationship to the main magnet. The two pole shoes of the pulse source are, in their simplest form, the end portions of an iron core on which an induction coil is wound which, directly, produces the control voltage to control conduction of a thyristor of a solid-state controlled capacitor-type ignition system.

The invention will be described by way of example with reference to the accompanying drawings, wherein:

FIG. 1 illustrates a four-pole magneto generator having a main magnet which is partially reversely magnetized, as well as the circuit of a solid-state capacitor discharge igntion system connected to the magneto generator;

FIG. 2 illustrates a side view of the magneto generator, partly broken away to provide a sectional view in the region of the pulse source; and

FIG. 3 is a general perspective view of a different form of the magneto generator having a pulse source responsive to magnetic field.

In the example illustrated in FIGS. **1** and **2**, a one-cylinder internal combustion engine has ignition power, as well as ignition control pulses supplied from a magneto generator generally shown at **10.** The magneto generator has a rotating field **11,** which is secured with its hub **12** on a drive shaft **13** of the internal combustion engine, not shown. The rotor, that is, the rotating field is located at the inner circumference of a cup-shaped structure, and which carries four main magnets **14,** symmetrically disposed along the inner circumference thereof. The magnets **14** are radially polarized with alternately reversing polarity — see FIG. **1** — and provide magnetic flux to an accessory, or auxiliary power armature **15** and to an igntion power armature **16.** Both armatures **15, 16** are located on a fixed armature support plate **17.** The auxiliary power armature provides power to appliances and accessories not shown, for example brake light, tail light, head lights, or other loads. The ignition power armature **16** is utilized solely to supply power to the ignition system. The power winding **18** of the armature **16** is connected to chassis, or ground with one terminal; the other terminal is connected over a diode **19** with an ignition discharge capacitor **20.** The ignition coil **21** has its primary winding **21***a* connected in parallel to the discharge capacitor **20.** A thyristor **22** is connected in series with the primary winding **21***a* of the coil **21.** The control, or gate electrode of thyristor **22** is connected over a control line **23** to a pulse source **24** located on the armature plate **17** of the magneto **10.** The secondary winding **21***b* of ignition coil **21** is connected at one end to primary **21***a* and at the other to a spark plug **25.** The free terminals of the thyristor **22,** spark plug **25,** and the discharge capacitor **20** are connected to chassis.

The pulse source **24** has this construction: An iron core **26** has an induction coil **27** wound thereon, which provides the control voltage or gate voltage for the thyristor 22. Core 26 has a pair of pole shoes 28, 29 at its lateral ends, axially located with respect to the axis of the cup-shaped magnet field rotor 11. As best seen in FIG. 2, core 26 is sleeve-like, having flanged end portions which are connected to, or directly form the two pole shoes 28, 29. The central portion 26*a* of the sleeve-like element carries the induction coil 27. The pulse source 24 is secured by means of screws 30 to the armature plate 17 which, preferably, can be rocked slightly about the axis of hub 12 to provide for accurate ignition timing.

To provide a change of flux in core 26 of pulse source or generator 24, one of the main magnets 14*a* has a zone therein which is reversely magnetized to provide a reversely magnetized control portion 31. This zone, forming control magnet 31 is so located that one pole shoe 28 of pulse source 24 is briefly in magnetic flux relation to the control magnet 31 during any one rotation of the rotor, the other pole shoe 29 of the pulse source simultaneously being in flux conducting relationship to the axially adjacent zone of the main magnet 14*a*. Such an arrangement, that is, to form a control magnet 31 within the physical outline of the main magnet 14*a* can be easily made by re-magnetizing the structure of the magnet so that a control magnet zone 31 is magnetized into the structure of the main magnet 14*a*, and having reverse polarity with respect to the main magnet 14. The boundary lines of the control magnet 31 from the main magnet 14 are indicated in FIGS. 1 and 2 by dashed lines, and the directions of magnetization are shown by S (South) and N (North) in accordance with standard notation.

As best seen in FIG. 2, control magnet 31 is located in a facing axial zone of the main magnet 14*a* (with respect to the axis of rotation of the rotor). Since the main magnets 14, each, are provided with a pole shoe 32 at the side facing the power armatures 15, 16, a magnetic short circuit of the pulse source 24 by pole shoe 32*a* of the main magnet 14*a* is prevented by forming the pole shoe 32*a* in the region of the control magnet 31 with a notch 33, which is just slightly greater than the front side of the control magnet 31. Of course, a small pole shoe, separated by a gap from pole shoe 32 could be applied to the control magnet 31, for example by forming a generally circumferential pole shoe and then creating or cutting a gap aligned with the zone of control magnet 31 to prevent a magnetic short circuit, and provide a clearly defined field to the pole shoes 28, 29 of the pulse element 24.

OPERATION

Assuming that the internal combustion engine has been started, so that shaft 13 will rotate, magnets 14 of the rotor 11 will induce an alternating voltage in the power armatures 15, 16. The positive half-waves of the alternating voltage induced in the armature winding 18 of armature 16 are conducted over diode 19 to the ignition capacitor 20, thus charging capacitor 20. At the instant of ignition, the main magnet 14*a*, and the control magnet zone 31 magnetized therein will pass opposite the region of the two pole shoes 28, 29 of the pulse transducer 24. The iron core 26 of transducer 24 thus has a changing flux passing therethrough, which emanates from the north of the control magnet 31, passes to pole shoe 28, the central portion 26*a* of core 26, the second or lower pole shoe 29 of pulse source 24, and then to the south of the main magnet 14*a*. The rate of change of the magnetic flux, in increasing direction, will induce a voltage in the winding of pulse generator 24 which provides a switching or gating pulse to thyristor 22 to control the thyristor into conductive state. Capacitor 20 discharges over primary 21*a* of the ignition coil 21 and thyristor 22, and a high voltage is induced in secondary 21 of the ignition coil 21, to provide an ignition spark at spark plug 25. As the discharge current passes through zero, thyristor 22 will, automatically, block and charge capacitor 20 can again be charged by the armature 16. This cycle repeats upon each full rotation of the rotor 11, since the magnetic flux induced in pulse source 24 will build up only once at each full rotation of the rotor 11, and thereafter again decaying. The voltage peak or pulse which arises upon decay of the magnetic field in pulse source 24 is opposite the direction which causes gating of the thyristor 22, and thus has no effect on the thyristor.

Embodiment of FIG. 3: The principle of incorporating a control, or auxiliary magnet within the physical outline of the main magnet can be carried out differently, as seen in the fragmentary perspective view of FIG. 3. A cup-shaped rotor 41 has a plurality of main magnets 42, oppositely alternately poled, located around the inner circumference thereof. Only one of the main magnets 42 is completely shown, and this magnet is formed at its facing side 42a with a recess, or relief, into which a control magnet 43 is inserted. The main magnet 42 and the control magnet 43 are oppositely poled with respect to each other. A pole shoe 44 is formed with a gap 45 in the region of the control magnet 43. The pole shoe is located on the radially inwardly directed end surface of the main magnet 42. The control magnet 43 is formed with its own pole shoe 46, located within the gap 45. Pole shoe 46 is somewhat smaller than the gap 45 and is thus separated from pole shoe 44 by an air gap. The fixed armature plate, not shown in FIG. 3, has a pulse source 47 secured thereto, which includes two pole shoes 48, 49 located one behind the other in circumferential direction of the rotor 41. Both pole shoes 48, 49 are connected by a magnetically conductive element, such as a magnetic field plate 50. The pole shoes 48, 49 fit with one end against the field plate 50, and are so located and dimensioned that the other ends of pole shoes 48, 49 are located oppositely the pole shoes 44, 46 of the main magnet 42 and the control magnet 43, respectively (see FIG. 3).

Upon rotation of the rotor 41, during operation of the internal combustion engine, the main magnet 42 and control magnet 43 are moved with respect to pole shoes 48, 49 of the pulse source 47, which will cause a changing magnetic flux to occur within pulse source 47 which provides a voltage change on a coil sensitive to magnetic flux through field plate 50, for example by being twisting wound thereover. In order to ensure that only one flux change will occur at each full revolution of the rotor 41, the two pole shoes 48 and 49 of the pulse source 47 are located behind each other so closely that the distance between a pair of adjacent main magnets 42 is not bridged thereby. This can be accomplished, for example, by slightly offsetting the pole shoes internally, in radial direction, as seen in FIG. 3.

Various changes and modifications may be made within the scope of the inventive concept. Thus, various details of construction and assembly of the two examples can be interchanged with respect to each other.

Multi-cylinder motors may require magnetos in which several or all of the main magnets are formed with control magnet zones or portions, or separate control magnets (FIG. 3). In each one of them, however, the control magnet is located essentially within the outline of a main magnet such that a control pulse will be generated in the electrical coil associated with the flux through the control magnet and main magnet at the time when ignition is desired, in order to switch over a solid-state element to control, or effect ignition during operation of the internal combustion engine. More than one pulse source may be located within the magneto; thus, a pulse source similar to source **24**, and identical in all construction, can be located diametrically opposite source **24**, as shown, and connected for example through a separate coil and thyristor to a second cylinder of the internal combustion engine, to provide control pulses 180° out of phase with respect to the pulses derived from source **24**, as shown. It is also possible to provide separate discharge paths, utilizing reversely polarized thyristors, in which a thyristor, such as the one shown in FIG. **1**, is responsive to the rising flux half-wave, whereas another thyristor, operating in reverse polarity, is responsive to a decaying pulse, and occuring slightly after the rising pulse, as shown. Other rectifiers than the half-wave rectifier **19** may be used, and various circuits, including voltage doublers and the like may be employed.

The extent of the reversely polarized zone of the auxiliary or control magnet is so small that it does not materially affect the power output of power derived from the main armatures **15, 16**. The additional magnet will introduce a slight ripple in the output voltage derived from the armature, which is not usually objectionable,- particularly when a resistive load is connected to the magneto, as would be usually the case in most vehicle installations, where the loads applied to the power armature **15** would be, essentially, light sources. This ripple is negligible and if a floating battery is used, is practically entirely suppressed by the battery itself.

We claim:

1. Magneto generator for use with solid-state controlled ignition systems of internal combustion engines, comprising

a rotor having located thereon a plurality of equidistantly, circumferentially disposed permanent magnets;

at least one stationary armature winding, and a core therefor in magnetic circuit relationship to the permanent magnets of the rotor;

a stationary pulse generator winding, adapted for generation of an electrical control pulse to switch over an electronic solid-state switching element of the ignition system;

a control magnet located essentially within the physical outline of a main magnet and facing the pulse generator winding;

a magnetic circuit on which said pulse generator winding is located and having pole shoes facing the main magnets, the control magnet being reversely polarized with respect to the main magnet and having a circumferential extent which is dimensioned with respect to the pole shoes of the pulse generator winding such that one pulse generator pole shoe will be located opposite the control magnet, while another is located opposite the main magnet adjacent the control magnet at least once during each revolution of the rotor.

2. Magneto according to claim **1**, comprising an iron core on which said pulse generator winding is wound, the iron core having terminal portions forming the two pole shoes.

3. Magneto according to claim **2**, wherein the iron core comprises a sleeve-shaped element having flange-shaped ends forming said terminal portions which provide the two pole shoes, the middle sleeve-shaped portion carrying the pulse generator winding.

4. Magneto according to claim **2**, wherein the pole shoes of the pulse generator are axially staggered with respect to the direction of the rotor axis.

5. Magneto according to claim **1**, including a field plate located between the two pole shoes, the pulse generator winding being magnetically coupled to said field plate, the pole shoes being located to be affected by the magnetic field between the control magnet and the main magnet.

6. Magneto according to claim **1**, wherein the pole shoes providing flux to the stationary pulse generator winding are circumferentially aligned.

7. Magneto according to claim **1**, wherein the pole shoes providing flux to the stationary generator winding are axially aligned and axially spaced.

8. Magneto according to claim **1**, wherein the control magnet and the main magnet are a unitary element, the control magnet forming a zone of magnetization of reverse polarization with respect to the main magnet.

9. Magneto according to claim **8**, wherein the main magnet surface facing the pole shoes associated with the stationary pulse generator winding is formed with facing pole shoes, said facing pole shoes having a gap cut therein in the region of the control magnet.

10. Magneto according to claim **1**, wherein the main magnet is formed with a cut-out portion and the control magnet is accomodated in the cut-out portion of the main magnet.

11. Magneto according to claim **9**, further comprising a control magnet pole shoe located in approximate circumferential alignment with the main magnet pole shoe and spaced from the main magnet pole shoe by an air gap.

12. Magneto according to claim **1**, further comprising pole shoes attached to the main magnet and to the control magnet, respectively, and magnetically separated from each other.

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