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Haubner et al.

[11] 3,885,542

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[54] **ENGINE IGNITION SYSTEM ADAPTED TO PREVENT ENGINE ROTATION IN THE WRONG DIRECTION**

[75] Inventors: **Georg Haubner**, Berg; **Walter Hofer**, Schwabach; **Peter Schmaldienst**, Nurnberg, all of Germany

[73] Assignee: **Robert Bosch G.m.b.H.**, Stuttgart, Germany

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Oct. 2, 1972 Germany 2248293

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[51] **Int. Cl.** **F02p 1/17**

[58] **Field of Search** .... 123/148 E, 148 MCD

[56] **References Cited**

UNITED STATES PATENTS

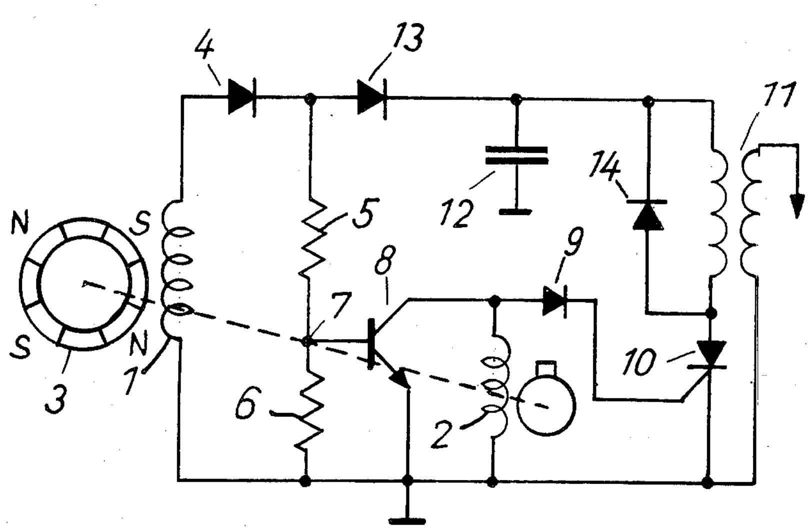
3,554,179	1/1971	Burson	123/149
3,598,098	8/1971	Sohner et al.	123/148 E
3,722,488	3/1973	Swift et al.	123/149 D
3,791,363	2/1974	Schmaldienst et al.	123/148 E

Primary Examiner—Manuel A. Antonakas
Assistant Examiner—James W. Cranson
Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

The ignition system of an internal combustion engine having a crankshaft includes a charging generator having a mechanical input coupled to the engine crankshaft and having an electrical output winding, the charging generator being operative for generating an A.C. output voltage. The system furthermore includes an ignition capacitor. A rectifying stage connects the output winding of the charging generator to the ignition capacitor, and is operative for applying across the ignition capacitor voltage half-cycles of only one predetermined polarity. An ignition transformer has a primary winding and a secondary winding. A fuel igniting unit is connected across the secondary winding of the ignition transformer. A discharge circuit connects the ignition capacitor to the primary winding of the ignition transformer and includes an electronic discharge switch having a control input. The discharge circuit is operative when the electronic discharge switch is conductive for discharging the ignition capacitor through the electronic discharge switch and through the primary winding of the ignition transformer. A triggering signal generator has a mechanical input coupled to the engine crankshaft and has an electrical output connected to the control input of the electronic discharge switch for controlling the conductivity of the latter, and is operative for producing triggering signals synchronized with voltage half-cycles produced by said charging generator. A control circuit is connected to the triggering signal generator and is connected to the charging generator and is operative for preventing the triggering signal generator from rendering the discharge switch conductive when the voltage half-cycle being generated by the charging generator is of a predetermined first polarity and is operative for permitting the triggering signal generator to render the discharge switch conductive when the voltage half-cycle being generated by the charging generator is of opposite second polarity.

6 Claims, 6 Drawing Figures



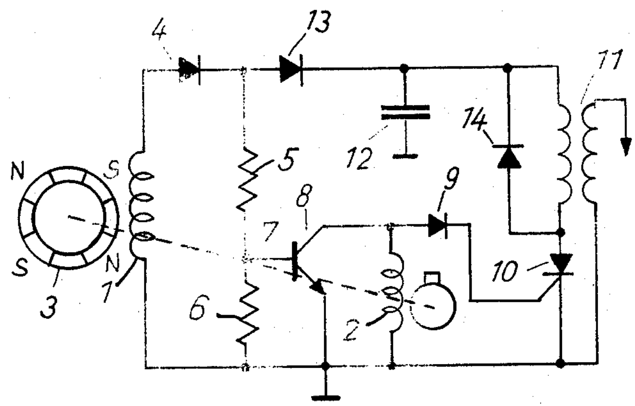


Fig.1

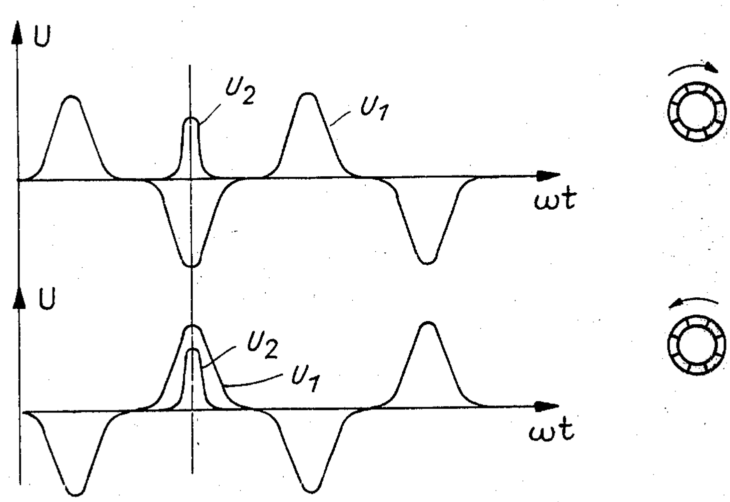


Fig.2

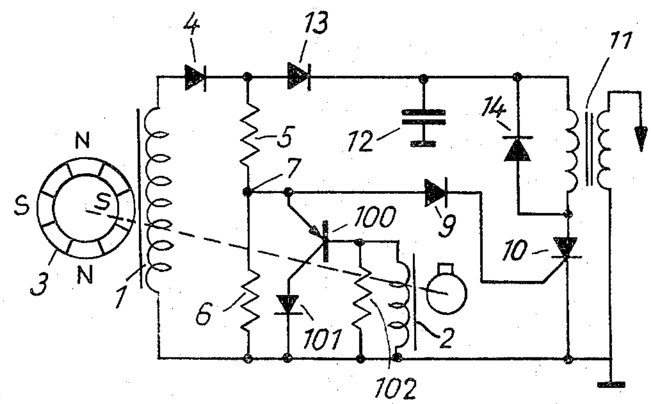


Fig.3

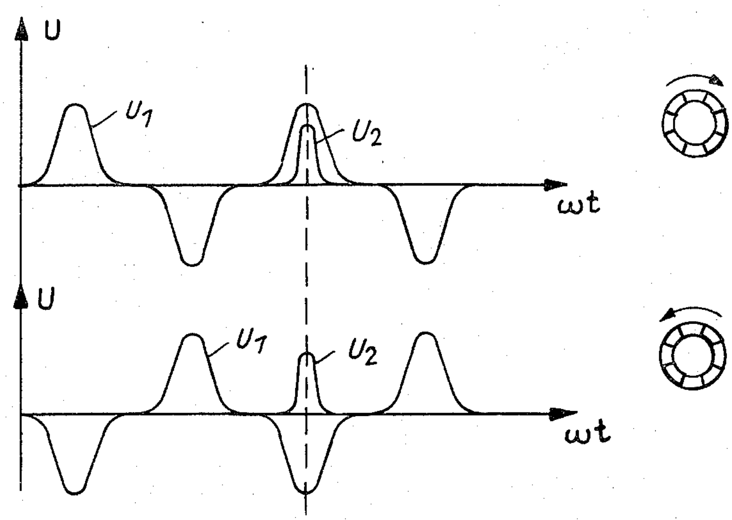


Fig.4

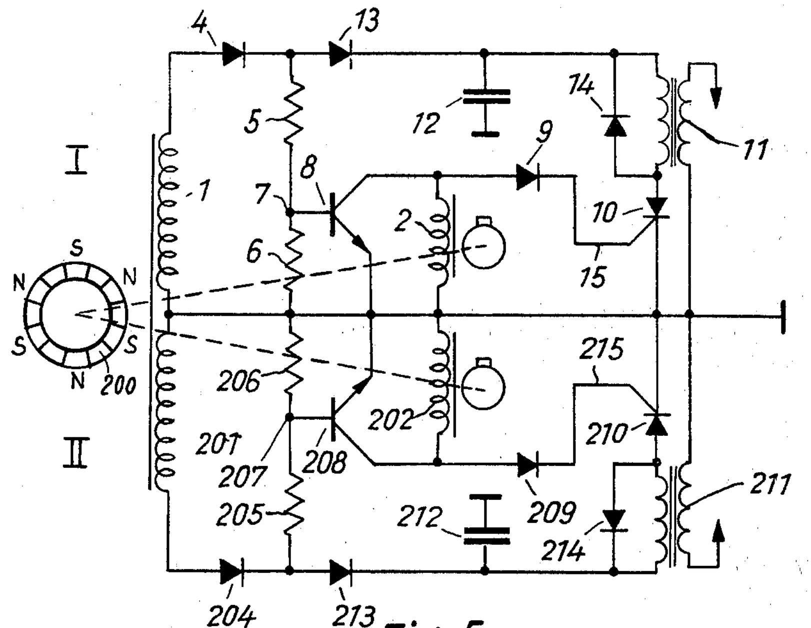

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Fig.5

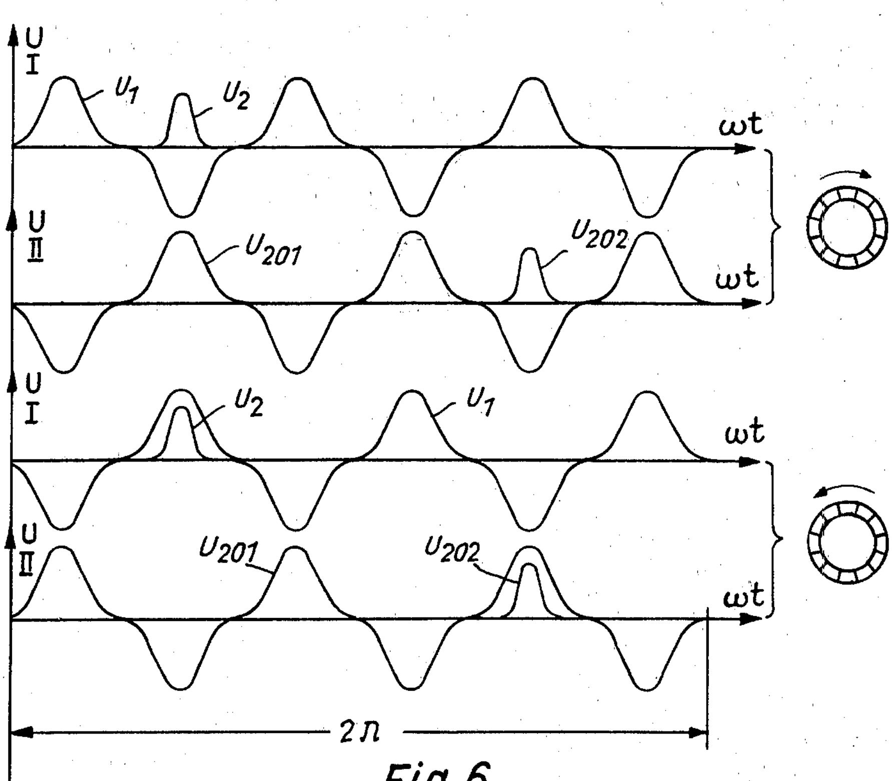
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Fig.6

ENGINE IGNITION SYSTEM ADAPTED TO PREVENT ENGINE ROTATION IN THE WRONG DIRECTION

BACKGROUND OF THE INVENTION

The invention relates to ignition systems for internal combustion engines, and more particularly to ignition systems for engines of the type where each spark plug, or other ignition unit, of the ignition system is provided with a separate respective charging capacitor connected via a respective charging diode to the charging winding of a generator coupled with a rotating shaft of the engine, such as the engine crankshaft, and furthermore provided with a discharge current path connected to the ignition capacitor, the discharge current path including the primary winding of a charging transformer whose secondary winding is connected across the spark plug, and furthermore an electronic switch connected in the ignition capacitor discharge path, for releasing the flow of ignition capacitor discharge current through the primary winding of the ignition transformer at the appropriate time.

With one known ignition system of this type, the A.C. voltage furnished by the charging generator is applied to a rectifying stage and then to a low-pass filter stage, so as to be applied to the ignition capacitor as a flat D.C. voltage. For the electronic discharge switch connected to the ignition capacitor discharge path, this prior-art system made use of a thyristor. The anode of the thyristor was connected to the tap of a voltage divider, the voltage divider being supplied with the aforementioned flat D.c. voltage. At the moment at which ignition should occur, the thyristor was rendered conductive by suitably designed means for applying a triggering signal thereto, whereupon the voltage available at the aforementioned voltage-divider tap was applied to the gate electrode of a further thyristor actually connected in the ignition capacitor discharge current path, in order to render the latter conductive. As soon as the thyristor in the ignition capacitor discharge current path becomes conductive, the ignition capacitor discharges through the primary winding of the ignition transformer, thereby inducing a very high magnitude voltage spike across the secondary winding of the ignition transformer, resulting in the generation of an igniting spark by the spark plug connected across the secondary winding of the ignition transformer.

This known arrangement has the disadvantage that it operates in a manner which prevents an engine from operating in the wrong or undesired direction, only if it is used in conjunction with a multiple-cylinder engine provided with a suitable ignition distributor. In such a context, the proper sequence of ignition in the several engine cylinders is established by the ignition distributor device, so that rotation of the engine crankshaft in the wrong or undesired direction is prevented. However, with one- or two-cylinder engines not provided with ignition distributors, the ignition system will not be capable of preventing the engine from being started up and continuing to operate in the wrong direction.

It is for this reason known to employ a magnetic device for applying triggering signals directly to the discharge thyristor connected in the ignition capacitor discharge current path. With the construction in question, the means for generating the triggering signals is provided in the form of a magnetic generator having a magnetically conductive rotor configurated to have circumferentially successive steep edges separated from each other by gradually sloping portions, so that such rotor has a generally sawtooth-type configuration, with one side of each tooth being extremely steep and the other side of each such tooth having a very gradual slope. The inductive pick-up associated with the thusly configurated rotor will apply to the discharge thyristor a triggering signal when the engine turns in the correct direction in response to the passage by such pickup of the steep flank of the rotor tooth, but in response to the passage by the pick-up of the gradually sloping flank the voltage induced in the pick-up will be too low to trigger the thyristor when the engine turns in the incorrect direction.

A difficulty with this known construction is the development of interference signals such as are capable of improperly rendering the discharge thyristor conductive, to permit ignition, even with the engine turning in the wrong direction. This can happen at high speeds, for instance when an engine is started up by pulling with great force an engine-starting cable or rope, such as used on the outboard motors of small boats. The voltages associated with the steep flanks of the rotor will still be higher than those associated with the gradually sloping flanks thereof. However, at these higher speeds, the voltages associated with the gradually sloping flanks will be of considerable magnitude, and may reach magnitudes sufficient to render the discharge thyristor conductive with the engine turning in the wrong direction. It is possible to so configurate such rotor as to reduce or weaken the voltage which will be associated with the gradually sloping flanks at high engine speeds. However, this necessarily results in a decrease of the voltage associated with the steep flanks, with the disadvantageous consequence that high idling speeds will be required for the steep flanks of the rotor to produce triggering voltages of the sufficient magnitude.

SUMMARY OF THE INVENTION

It is therefore the general object of the invention to provide an ignition system which prevents the start-up and continued operation of the engine in the wrong direction.

It is a more specific object to provide such a system wherein the idling speeds required for normal operation of the ignition system are low.

It is a further object to provide such a system which is operative for preventing operation of the engine in the wrong direction over the entire range of engine speeds.

These objects, and others which will become more understandable from the following description of specific embodiments, can be achieved, according to one advantageous concept of the invention, by providing an ignition system of an internal combustion engine having a crankshaft which includes a charging generator having a mechanical input coupled to the engine crankshaft and having an electrical output winding, the charging generator being operative for generating an A.C. output voltage. The system furthermore includes an ignition capacitor. A rectifying stage connects the output winding of the charging generator to the ignition capacitor, and is operative for applying across the ignition capacitor voltage half-cycles of only one predetermined polarity. An ignition transformer has a primary winding and a secondary winding. A fuel igniting unit is connected across the secondary winding of the ignition transformer. A discharge circuit connects the ignition capacitor to the primary winding of the ignition transformer and includes an electronic discharge switch having a control input. The discharge circuit is operative when the electronic discharge switch is conductive for discharging the ignition capacitor through the electronic discharge switch and through the primary winding of the ignition transformer. A triggering signal generator has a mechanical input coupled to the engine crankshaft and has an electrical output connected to the control input of the electronic discharge switch for controlling the conductivity of the latter, and is operative for producing triggering signals synchronized with voltage half-cycles produced by said charging generator. A control circuit is connected to the triggering signal generator and is connected to the charging generator and is operative for preventing the triggering signal generator from rendering the discharge switch conductive when the voltage half-cycle being generated by the charging generator is of a predetermined first polarity and is operative for permitting the triggering signal generator to render the discharge switch conductive when the voltage half-cycle being generated by the charging generator is of opposite second polarity.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a circuit diagram of a first embodiment of the invention;

FIG. 2 is a graphical depiction of certain aspects of the operation of the embodiment shown in FIG. 1;

FIG. 3 is a circuit diagram of a second embodiment of the invention;

FIG. 4 is a graphical depiction of certain aspects of the operation of the embodiment shown in FIG. 3;

FIG. 5 is a circuit diagram of a third embodiment of the invention; and

FIG. 6 is a graphical depiction of certain aspects of the operation of the embodiment shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The magnetic generator shown in FIG. 1 is comprised of a stationary charging winding **1**, a stationary triggering signal generator including a triggering signal generator output winding **2**, and a rotating permanently magnetic pole wheel **3**. The charging winding **1** is connected via a diode **4** with a voltage divider composed of resistors **5** and **6**. The voltage-divider tap **7** is connected to the base of an npn transistor **8** with the emitter of transistor **8** being connected to ground. The collector of transistor **8** is connected via a second diode **9** with the gate electrode of a thyristor or SCR **10**. The triggering signal generator winding **2** is connected across the collector-emitter path of transistor **8**. The cathode of thyristor **10** is connected to ground. The anode is connected ground, via the primary winding of the ignition transformer **11** and via an ignition capacitor **12**. The terminal of capacitor **12** not connected directly to ground is connected, via a third diode **13** and the first diode **4**, with the charging widing **1**. A fourth diode **14** shunts the primary winding of the ignition transformer **11**. The secondary winding of the ignition transformer **11** has one terminal connected to ground and an other terminal connected to a (non-illustrated) spark plug.

The triggering signal generator including the winding **2** is more fully described in the U.S. Pat. No. 3648675 or in the copending U.S. application Ser. No. 309429, filing date Nov. 24, 1972.

The operation of the circuit of FIG. **1** will be described with reference to FIG. **2**. The desired correct direction of rotation for the pole wheel **3** is clockwise, as viewed in FIGS. **1** and **2**. The undesired or incorrect direction of rotation for pole wheel **3** is counterclockwise. When the pole wheel **3** is turning in the correct direction, the first positive voltage half-cycle of the voltage generated across charging winding **1** is applied via charging diodes **4** and **13** to the ignition capacitor **12**. Charge accumulates on the ignition capacitor **12**, because its discharge path is non-conductive due to the fact that discharge thyristor **10** is non-conductive. The succeeding negative voltage half-cycle of the voltage generated across charging winding **1** renders charging diode **4** non-conductive, so that ignition capacitor **12** receives no more charging current. The voltage-divider resistors **5** and **6** carry no current, the base-emitter junction of transistor **8** will not be forward-biased, and the collector-emitter path of transistor **8** will be non-conductive. At this time, i.e., contemporaneously with the generation of the negative voltage half-cycle across charging winding **1**, the triggering signal generating means **2** applies a triggering voltage via capacitor **9** to the gate electrode of thyristor **10**, rendering thyristor **10** conductive. The capacitor **12** discharges through the primary winding of the ignition transformer **11** and through the now-conductive thyristor **10**. The resulting high-magnitude voltage spike induced across the secondary winding of ignition transformer **11** is applied to the spark plug or other igniting element of the internal combustion engine. If the engine and accordingly the pole wheel **3** are turning in the wrong direction—i.e., if pole wheel **3** is turning counterclockwise as viewed in FIGS. **1** and **2**—then the output voltage generated across charging winding **1** will be phase-shifted by 180° relative to what it is when the pole wheel **3** is turning clockwise. As a result, the triggering signals generated across triggering signal generator output winding **2** are generated contemporaneously with the positive voltage half-cycle of the voltage generated across the charging winding **1**. During the positive voltage half-cycle of the voltage generated across charging winding **1**, a voltage is evidently applied across voltage divider **5**, **6** and accordingly a positive voltage is applied to the base of transistor **8** which is therefore conductive. The conductive collector-emitter path of transistor **8** diverts the triggering signal generated across the winding **2** to ground, since the threshold voltage of the second diode **9** and of the gate-cathode path of thyristor **19** is higher than the voltage across the collector-emitter path of transistor **8**, under these conditions. Thyristor **10** accordingly is not rendered conductive and therefore no ignition impulse is generated.

If a pnp transistor is used instead of the npn transistor **8**, then an ignition pulse will be generated upon the coincidence of a positive voltage half-cycle of the voltage generated across charging winding **1** and a triggering signal generated across winding **2.** The geometric and circuit arrangement of the armature of the triggering signal generating means and of the charging means must be changed accordingly.

The circuit shown in FIG. **3** corresponds to that shown in FIG. **1** with the following differences: The voltage divider tap **7** is connected directly to the gate electrode of thyristor **10,** via the second diode **9.** The voltage-divider tap **7** is furthermore connected to ground, via the emitter-collector path of a pnp transistor **100** and fifth diode **101.** The base of transistor **100** is connected to ground, via the output winding **2** of the triggering signal generating means and a resistor **102** connected in parallel to winding **2.**

The operation of the circuit shown in FIG. **3** will be described with reference to FIG. **4.** If pole wheel **3** is turning in the correct direction, then the first positive voltage half-cycle of the voltage generated across charging winding **1** will be applied via charging diodes **4** and **13** to ignition capacitor **12,** to charge the same. The voltage-divider tap **7** establishes at the emitter of transistor **100** a potential more positive than the base potential of transistor **100,** and transistor **100** becomes conductive. The voltage at voltage-divider tap **7** is now dependent upon the collector-emitter voltage of transistor **100** and the anode-cathode voltage of diode **101.** Inasmuch as the threshold value of the anode-cathode voltage of diode **9** and of the gate-cathode voltage of thyristor **10** is higher than the voltage on voltage-divider tap **7,** thyristor **10** remains non-conductive. The first negative voltage half-cycle of the voltage generated across charging winding **1** renders diode **4** non-conductive, and no current appears. A triggering signal appears across the winding **2** of the triggering signal generating means during the second positive voltage half-cycle of the voltage generated across charging winding **1.** Current flows through resistor **102,** raising the base voltage of transistor **100,** and thereby rendering transistor **100** non-conductive. As a result, the potential at voltage-divider tap **7** rises, and thyristor **10** becomes conductive. The ignition spark is produced in the manner described with reference to FIG. **1.** If the engine is turning in the wrong direction, then, during the times of generation of the triggering signal, the voltage across the charging winding **1** will be negative. The diode will be non-conductive and current will not be able to reach thyristor **10.** Thyristor **10** will remain non-conductive, and no ignition spark will be generated.

In the embodiment of FIG. **5** the illustrated circuit is comprised of two mirror-symmetrical portions I and II. Circuit portion I is identical to the circuit shown in FIG. **1,** and circuit portion II is the mirror image thereof. The charging winding **1** of circuit portion I and the charging winding **201** of circuit portion II share a common core. The circuit components in circuit portion II are designated by numerals **200** greater than the numerals designating the corresponding circuit components of circuit portion I.

Inasmuch as the circuit of FIG. **5** constitutes a doubling of the circuit of FIG. **1,** the circuit operation is correspondingly different from that of FIG. **1.** The voltage appearing on the triggering signal output windings **1** and **201** are phase-shifted relative to each other by 180°. The respective voltage waveforms are depicted in FIG. **6** and correspond to those shown in FIG. **2.** The two upper voltage waveforms represent the voltage waveforms generated in both the circuit portions I and II when the engine is rotating in the correct direction, whereas the two lower voltage waveforms correspond to engine rotation in the wrong direction. Per rotation of the pole wheel an ignition spark is generated for each of the two spark plugs.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of circuits and constructions differing from the types described above.

While the invention has been illustrated and described as embodied in an engine ignition system adapted to prevent the engine from rotating in the wrong direction, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In the ignition system of an internal combustion engine having an engine crankshaft, in combination, charging generator means having a mechanical input coupled to the engine crankshaft and having an electrical output winding and operative for generating an AC output voltage; ignition capacitor means; rectifying means connecting said output winding of said charging generator means to said ignition capacitor means and operative for applying across said ignition capacitor means voltage half-cycles of only one predetermined polarity; an ignition transformer having a primary winding and a secondary winding; a fuel igniting unit connected across said secondary winding; circuit means connecting said ignition capacitor means to said primary winding and including an electronic discharge switch having a control input and operative when said discharge switch is conductive for discharging said ignition capacitor means through said electronic discharge switch and through said primary winding of said ignition transformer; triggering signal generating means having a mechanical input coupled to said engine crankshaft and having an electrical output connected to said control input of said electronic discharge switch for controlling the conductivity of the latter and operative for producing triggering signals synchronized with voltage half-cycles produced by said charging generator means; and control means connected to said triggering signal generating means and connected to said charging generator means and operative for preventing said triggering signal generating means from rendering said discharge switch conductive when the voltage half-cycle being generated by said charging generator means is of predetermined first polarity and operative for permitting said triggering signal generating means to render said discharge switch conductive when the voltage half-cycle being generated by said charging generator means is of opposite second polarity, wherein said triggering signal generating means comprises an electromechanical triggering signal generator having an output winding connected to said control input of said discharging switch and operative for periodically generating triggering signals in synchronism with the generation of voltage half-cycles by said charging generator means, and wherein said control means comprises diverting means connected to said output winding of said charging generator means and connected to said output winding of said triggering signal generator and operative for diverting triggering signals produced by said triggering signal generator away from said control input of said electronic switch when the voltage half-cycle being generated across said output winding of said charging generator means is of said predetermined first polarity, wherein said diverting means comprises a semiconductor switch circuit having an input connected to said output winding of said charging generator means and having an output current path connected across said output winding of said triggering signal generator and operative when the voltage half-cycle being generated across said output winding of said charging generator means is of said predetermined first polarity for substantially short-circuiting said output winding of said triggering signal generator.

2. The system defined in claim **1** wherein said semiconductor switch circuit is comprised of a transistor having an emitter-collector path connected across said output winding of said triggering signal generator, connecting means connecting the base of said transistor to the output winding of said charging generator means and operative when the voltage half-cycle being generated across said output winding of said charging generator means is of said first polarity for applying to the base of said transistor a voltage such as to render said transistor conductive.

3. A system defined in claim **2,** wherein said connecting means comprises a voltage divider having two end terminals and a voltage-divider tap, one of said end terminals being connected to one terminal of said output winding of said charging generator means, and a diode having one electrode connected to the other terminal of said output winding of said charging generator means and having an other electrode connected to the other end terminal of said voltage divider, and said voltage-divider tap being connected to the base of said transistor, and said diode having such a polarity as to render said transistor conductive when the voltage being generated across said output winding of said charging current generator means is of said first polarity.

4. In the ignition system of an internal combustion engine having an engine crankshaft, in combination, charging generator means having a mechanical input coupled to the engine crankshaft and having an electrical output winding and operative for generating an AC output voltage; ignition capacitor means; rectifying means connecting said output winding of said charging generator means to said ignition capacitor means and operative for applying across said ignition capacitor means voltage half-cycles of only one predetermined polarity; an ignition transformer having a primary winding and a secondary winding; a fuel igniting unit connected across said secondary winding; circuit means connecting said ignition capacitor means to said primary winding and including an electronic discharge switch having a control input and operative when said discharge switch is conductive for discharging said ignition capacitor means through said electronic discharge switch and through said primary winding of said ignition transformer; triggering signal generating means having a mechanical input coupled to said engine crankshaft and having an electrical output connected to said control input of said electronic discharge switch for controlling the conductivity of the latter and operative for producing triggering signals synchronized with voltage half-cycles produced by said charging generator means; and control means connected to said triggering signal generating means and connected to said charging generator means and operative for preventing said triggering signal generating means from rendering said discharge switch conductive when the voltage half-cycle being generated by said charging generator means is of predetermined first polarity and operative for permitting said triggering signal generating means to render said discharge switch conductive when the voltage half-cycle being generated by said charging generator means is of opposite second polarity, wherein said triggering signal generating means comprises an electromechanical triggering signal generator having an output winding and operative for generating across its output winding triggering signals in synchronism with the generation of voltage half-cycles by said charging generator means, and wherein said control circuit comprises a voltage divider having two end terminals and a voltage-divider tap, and wherein one of said end terminals is connected to one terminal of said output winding of said charging generator means, and a diode connecting the other end terminal of said voltage divider to the other terminal of said output winding of said charging generator means, and means connecting said voltage divider tap to said control input of said electronic discharge switch, a semiconductor switch having an output current path connected across said voltage-divider tap and one end terminal of said voltage divider, and means connecting said output winding of said triggering signal generator to the control electrode of said semiconductor switch and operative for controlling the conductivity of said semiconductor switch in dependence upon the triggering signals generated across said output winding of said triggering signal generator.

5. In the ignition system of an internal combustion engine having an engine crankshaft, in combination, charging generator means having a mechanical input coupled to the engine crankshaft and having an electrical output winding and operative for generating an AC output voltage; ignition capacitor means; rectifying means connecting said output winding of said charging generator means to said ignition capacitor means and operative for applying across said ignition capacitor means voltage half-cycles of only one predetermined polarity; an ignition transformer having a primary winding and a secondary winding; a fuel igniting unit connected across said secondary winding; circuit means connecting said ignition capacitor means to said primary winding and including an electronic discharge switch having a control input and operative when said discharge switch is conductive for discharging said ignition capacitor means through said electronic discharge switch and through said primary winding of said ignition transformer; triggering signal generating means having a mechanical input coupled to said engine crankshaft and having an electrical output connected to said control input of said electronic discharge switch for controlling the conductivity of the latter and operative for producing triggering signals synchronized with voltage half-cycles produced by said charging generator means; and control means connected to said triggering signal generating means and connected to said charging generator means and operative for preventing said triggering signal generating means from rendering said discharge switch conductive when the voltage half-cycle being generated by said charging generator means is of predetermined first polarity and operative for permitting said triggering signal generating means to render said discharge switch conductive when the voltage half-cycle being generated by said charging generator means is of opposite second polarity, wherein said charging generator means comprises an additional electrical output winding and is operative for generating across each of the two output windings thereof an AC voltage, the AC voltages being phase-shifted relative to each other, and further comprising an additional ignition capacitor means; additional rectifying means connecting said additional output winding to said additional ignition capacitor means and operative for applying across said additional ignition capacitor means voltage half-cycles of only one predetermined polarity; an additional ignition transformer having a primary winding and a secondary winding; an additional fuel igniting unit connected across the secondary winding of said additional transformer; additional circuit means connecting said additional ignition capacitor means to said primary winding of said additional transformer and including an additional electronic discharge switch having a control input and operative when said additional electronic discharge switch is conductive for discharging said additional ignition capacitor means through said additional electronic discharge switch and through said primary winding of said additional ignition transformer; additional triggering signal generating means having a mechanical input coupled to said engine crankshaft and having an electrical output connected to said control input of said additional discharge switch for controlling the conductivity of the latter and operative for producing triggering signals synchronized with voltage half-cycles produced across said additional output winding of said charging generator means; and additional control means connected to said additional triggering signal generating means and connected to said additional output winding of said charging generator means and operative for preventing said additional triggering signal generating means from rendering said additional discharge switch conductive when the voltage half-cycle being generated across said additional output winding of said charging generator means is of predetermined first polarity and operative for permitting said additional triggering signal generating means to render said additional discharge switch conductive when the voltage half-cycle being generated across said additional output winding of said charging generator means is of opposite second polarity.

6. The system defined in claim **5**, wherein said two output windings of said charging generator means are wound around a common iron core.

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