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Gemander

[54] **IGNITION ARRANGEMENTS FOR INTERNAL COMBUSTION ENGINES**

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

[58] **Field of Search**.................123/148 E, 149 A, 149 D, 41, 123/146.5 A; 315/209

[56] **References Cited**

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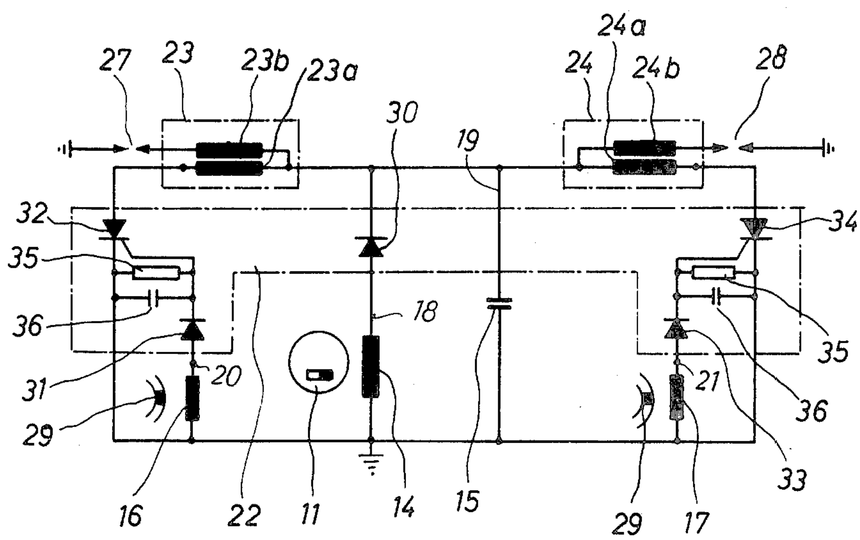
[57] **ABSTRACT**

An arrangement for providing ignition pulses for an internal combustion engine while at the same time inhibiting ignition pulses from being applied when said engine is operated in the improper direction. Ignition pulses are produced through an ignition coil which has its primary winding connected to a capacitor charged through a magneto generator. Discharging of the capacitor is controlled through a thyristor which, in turn, is fired through the application of pulses derived from pulse emitters. The thyristor is switched to the conducting state, during improper operating direction of the engine, by the voltage pulse which causes charging of the capacitor when the thyristor is in the nonconducting state.

10 Claims, 8 Drawing Figures



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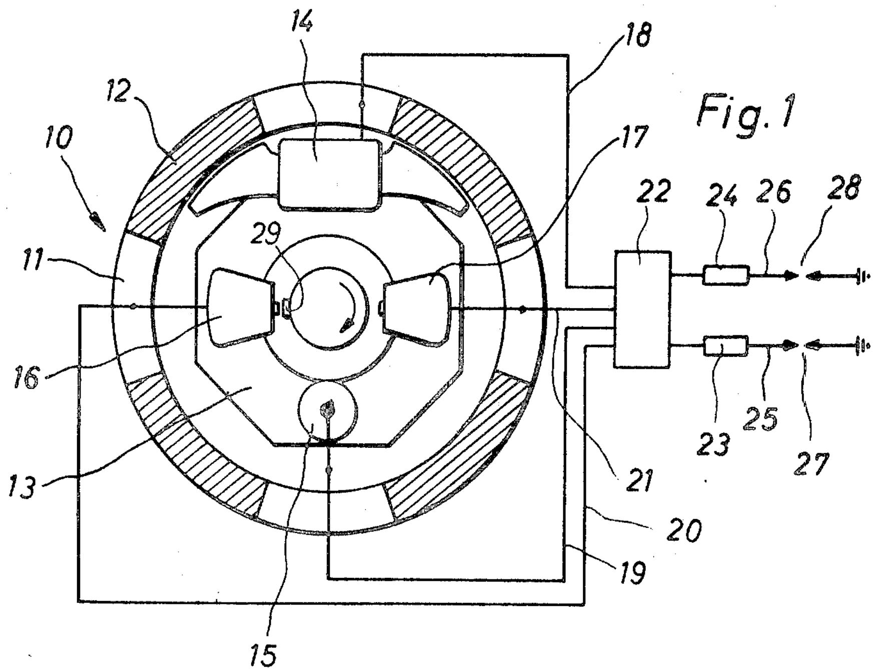

Fig. 1

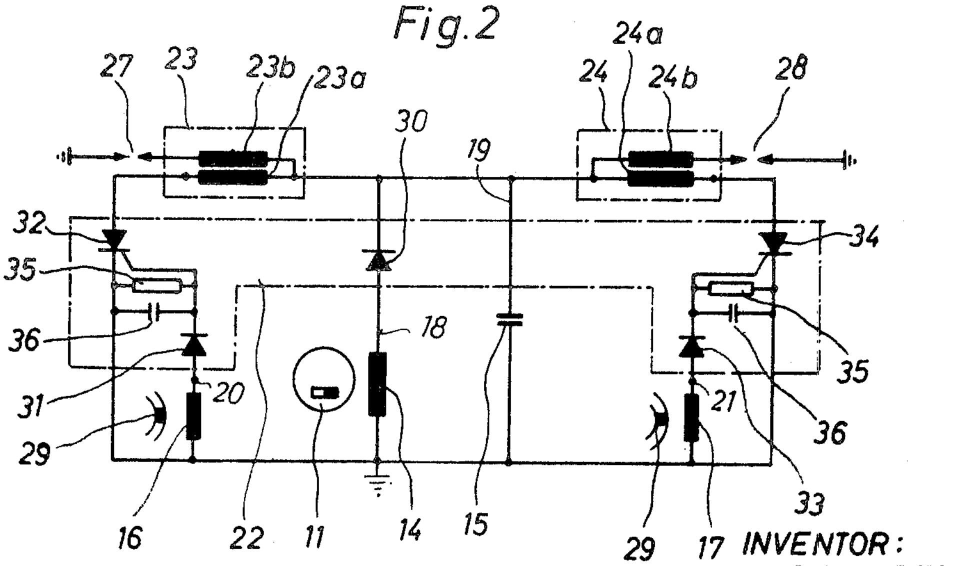

Fig. 2

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Fig.4a

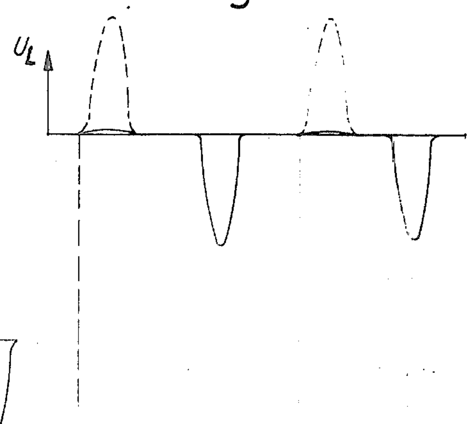


Fig.3a

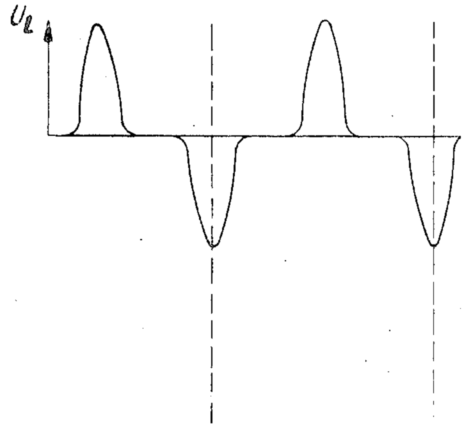


Fig.4b

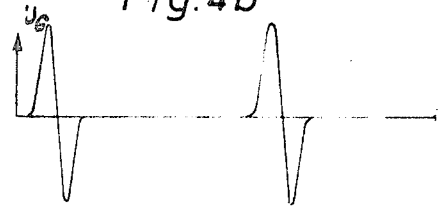


Fig.3b

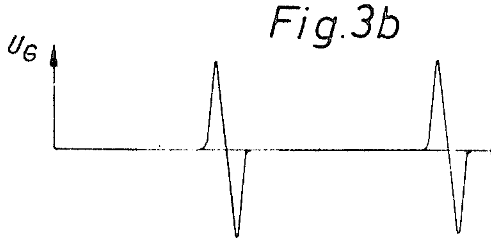


Fig.4c

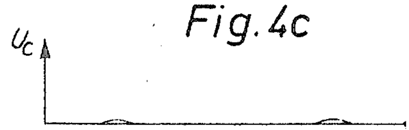
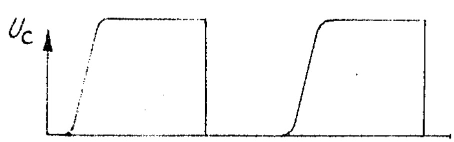


Fig.3c



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IGNITION ARRANGEMENTS FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The present invention resides in an ignition arrangement for internal combustion engines in which a capacitor becomes charged from a magneto generator, and then becomes discharged at the instant of ignition through the primary winding of an ignition coil, upon actuation of an electronic circuit. The secondary winding of the ignition coil is connected to the spark plug of the engine.

It is known in the art to provide a thyristor in such electronically controlled capacitor type of ignition arrangements, and to fire the thyristor at the instant of ignition through a voltage pulse. The voltage pulse for firing the thyristor is generated through a magnetic type of generator or emitter which operates in conjunction with a moving element that passes or conducts flux lines. As soon as this element which passes or conducts flux lines, moves beneath the pole pieces of the pulse emitters or generators, in operation of the engine, the magnetic circuit of the pulse generator becomes briefly closed. As a result of the closure, and the change of the magnetic flux within the induction coil of the generator, thereby, a positive voltage pulse with a subsequently following negative pulse become induced. Whereas the positive pulse is used for ignition purposes, the negative pulses are blocked through a diode, and thereby remain ineffective. Such ignition arrangements have, however, the disadvantage that when operating in reverse as, for example, at the start, the previous negative pulse derived from the pulse generator, becomes a positive pulse due to the changed direction of motion. The resulting positive pulse causes the thyristor to be switched to the conducting state, and accordingly the capacitor becomes discharged through the ignition coil and a spark is thereby applied at the spark plug. With such operation of the spark plug, the engine is aided in running in the wrong direction.

Accordingly, it is an object of the present invention for providing, in an ignition combustion engine, means for inhibiting the generation of sparks or sparking of the plugs within the engine, when the latter operates in the reverse direction. It is particularly an object of the present invention to provide such an arrangement for engines having one or more cylinders.

The objects of the present invention are achieved by providing for switching the thyristor to the conducting state, as soon as the half wave of a voltage is produced during the wrong direction of motion of the magneto generator. Such halfwave would, otherwise, cause charging of the capacitor which is connected to the magneto generator, should the electronic switching element in the form of the thyristor be turned off. The switching of the thyristor, thereby, takes place in the simplest manner when the engine operates in the wrong direction, and such switching of the thyristor is accomplished by the voltage pulse of a magnetic generator or pulse emitter which switches the thyristor to the conducting state. When the engine is operated in the proper direction, the pulse emitter provides the pulse for switching the thyristor to the conducting state at the instant of ignition.

SUMMARY OF THE INVENTION

An ignition arrangement for internal combustion engines in which a capacitor charged by a magneto generator discharges through the primary winding of an ignition coil upon firing of a thyristor. The anode-cathode path of the thyristor is connected in series with the primary winding of the ignition coil. The gate of the thyristor has a voltage pulse applied to it through a pulse emitter. The thyristor is switched to the conducting state upon generation of a voltage pulse which would charge the capacitor through the magneto generator, at the instant of ignition, and when the thyristor is in the non-conducting state. When the engine is operating in the improper direction, the thyristor is switched to the conducting state and inhibits, thereby, the charging of the capacitor.

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 functional schematic diagram of an internal combustion engine with two cylinders and a magneto generator for charging an ignition capacitor, in accordance with the present invention;

FIG. 2 is a circuit diagram of the arrangement of FIG. 1;

FIGS. 3*a*, 3*b* and 3*c* are voltage waveforms of the armature winding induced pulses of the ignition generator arrangement when operated in the proper direction of motion; and

FIGS. 4*a*, 4*b* and 4*c* are voltage waveforms prevailing in the ignition arrangement when the engine is operated in the improper direction.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing, and in particular to FIG. 1, an internal combustion engine with two cylinders and of two cycle design, is provided with a magneto generator **10**. This generator consists of a pole wheel **11** provided with four symmetrically arranged permanent magnets **12**. These permanent magnets **12** are arranged so that they are situated with alternating polarity. The generator, furthermore, has an armature plate **13** upon which are mounted a charging armature **14** for producing the ignition energy, and ignition capacitor **15** for storing the ignition energy, as well as two oppositely lying magnetic pulse emitters **16** and **17**. The elements mounted upon the armature 13, are connected to a circuit **22** situated outside of the generator **10**, through interconnecting lines **18,19,20** and **21**. Two ignition coils **23** and **24**, are, furthermore, connected to the ignition circuit **22**. The high voltage portions of these ignition coils have terminal lines **25** and **26** connected to both spark plugs **27** and **28** which are arranged in the combustion chamber of the engine.

The functional operation of the ignition arrangement may be obtained from FIGS. 2, 3 and 4. FIG. 2 shows precisely the circuit construction of the ignition arrangement shown in FIG. 1. With normal rotation in the normal direction, an alternating voltage U_L is generated within the charging armature **14** of the generator **10**, through the rotating pole wheel **11**. This voltage U_L is shown in FIG. 3*a*. The next positive halfwave which appears as a result of the electrical energy produced in the magnetic generator **10**, is applied to the ignition capacitor **15**, through a diode **30**. As a result, the ignition capacitor **15** becomes charged. Since the diode **30** prevents discharging of the ignition capacitor **15** through the charging armature **14**, the capacitor voltage U_c appears as shown in FIG. 3*c*. In this latter diagram, the capacitor voltage has a maximum value for the positive voltage halfwave of substantially **120** volts.

With further rotation, the element **29** which is connected to the motor shaft and which serves to pass the flux lines, is moved beneath the magnetic generator **16** at the instant at which the negative halfwave within the charging armature **14** has attained its maximum value. Through the element **29**, variation in the magnetic flux takes place within the generator **16**. As shown in FIG. 3*b*, first a positive and then a negatively following voltage pulse U_G of approximately 1.8 volts is induced. The positive voltage pulse is applied to the control gate of a thyristor **32**, through a diode **31**. With the application of this positive voltage pulse to this thyristor, the latter is switched to the conducting state. The ignition capacitor **15** becomes thereby suddenly discharged, as shown in FIG. 3*c*, since the circuit through the primary winding **23*a*** of the ignition coil **23** and the thyristor **32**, is close to ground. As a result, an ignition voltage is induced within the secondary winding **23*b*** of the ignition coil **23**. This ignition voltage is then applied to the spark plug **27** for the purpose of producing a spark across the electrodes of the plug.

With further rotation of the magnetic pole wheel **11**, a second positive halfwave voltage is induced within the charging armature or charging coil **14**, and this voltage halfwave serves to charge again the ignition capacitor **15** through the diode **30**. Since the two magnetic generators **16** and **17** lie opposite to each other as shown in FIG. **1**, the element **29** is moved beneath the second generator **17** with further rotation of 180°. As a result, a positive and subsequently following negative voltage pulse are also here generated. The positive voltage pulse is applied to the control gate of a second thyristor **34** through a further diode **33**, and switches the thyristor, thereby, to the conducting state. In this manner, the ignition capacitor **15** becomes discharged through the primary winding **24*a*** of the second ignition coil **24**, and through the thyristor **34**. In this manner, a high voltage results also in the secondary winding **24*b*** of the ignition coil **24**, and this high voltage is applied to the spark plug **28** for producing a further spark. The negative voltage pulse appearing at both magnetic generators **16** and **17** have no effect upon the associated thyristors **32** and **34**, since the diodes **31** and **33** will not conduct. To protect the thyristors **32** and **34** against excess voltages, the control gates are connected to ground potential through a resistor **35** and a capacitor **36** connected in parallel therewith.

When the internal combustion engine is operated in the wrong rotational direction, the voltage halfwaves induced within the charging coil or armature **14** have the reversed sequence and reverse direction. The last negative halfwave shown in FIG. **3*a***, becomes thereby the first positive halfwave, as shown in broken lines in FIG. **4*a***, during incorrect rotational direction. This also applies to the voltage pulses of the magnetic generator **17** whose negative pulses now become positive ones, as shown in FIG. **4*b***. These positive pulses are applied to the control gate of the thyristor **34** and switch the latter to the conducting state at the instant that the positive halfwave at the charging coil **14** begins. The circuit through the charging coil **14**, diode **30**, as well as through the primary winding **24*a*** of the ignition coil **24**, becomes closed. As a result, the charging of the ignition capacitor **15** is prevented.

Since the primary winding **24*a*** of the ignition coil **24** has a relatively low resistance value, the actual voltage at the charging armature or charging coil **14** is very small, and consequently the voltage at the ignition capacitor **15** is also small. This may be seen from the extended line in FIGS. **4*a*** and **4*c***. Through such action, therefore, no spark appears at the spark plug **28**.

Since the thyristor **34** remains in the conducting state as long as current flows in the circuit, the thyristor becomes turned off first after the end of the positive halfwave from the charging armature or coil **14**. With further rotation of the pole wheel **11**, a negative halfwave becomes now induced within the charging armature or coil **14**, and this negative halfwave remains ineffective for the ignition arrangement, because the diode **30** remains in the non-conducting state. First after the positive halfwave at the charging armature or coil **14**, can the ignition capacitor **15** become charged through the diode **30**. Since, however, at that instant of time the element **29** becomes moved beneath the other generator **16**, and a positive and negative voltage pulse becomes generated therein, the thyristor **32** becomes switched to the conducting state through the diode **31**. As a result, the same procedure as before is repeated with respect to the thyristor **34**. As shown in FIG. **4*c***, an insignificant voltage U_C appears at the capacitor **15** during the positive halfwave in the charging armature **14** upon resetting, but charging of the capacitor does not take place.

The cooperative arrangement of the generator **16** and **17** with the element **29** is essential for assurance of proper resetting of the ignition arrangement. It is necessary to arrange the element **29** so that its rear end produces a positive pulse for the thyristors **32** and **34** at the instant of time when it is moved beneath the magnetic generator **16** and **17**, when the engine is rotated in the wrong direction. Through such conditions, a positive halfwave begins within the charging armature or coil **14**, and charging of the ignition capacitor **15** is thereby avoided with safety.

The element **29**, in an embodiment, extends preferably over an arc of 0.21 radians, or approximately 12°. Accordingly, when the engine is rotated in the proper direction, the pulse produced with its front end within the generator **16** or **17**, appears within the region of the maximum value of the negative halfwave of the charging armature **14**. This pulse determines the ignition instant and is used as the control pulse for the thyristors. Due to the narrow element **29**, the magnetic circuit of the generator is directly closed and opened again in sequence. It has been found, thereby, that the positive and the negative generator pulse which follows directly, is larger than what would occur for a longer element **29**, in which case the two generated pulses do not follow each other directly. The arrangement, therefore, also operates safely with small backup speeds.

The present invention is not limited for these particular embodiments illustrated. The present invention is, instead, applicable to single cylinder as well as multicylinder engines. In the latter case, the ignition arrangement is provided with a plurality of poles in the magneto generator, and a magnetic generator, furthermore, is provided for each thyristor control and cooperates with the rotating element **29**, for example.

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 constructions differing from the types described above.

While the invention has been illustrated and described as embodied in ignition arrangements for internal combustion engines, 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. An ignition arrangement for internal combustion engines comprising, in combination, ignition coil means with primary and secondary windings for producing an ignition pulse in said secondary winding; charging capacitor means connected to said primary winding means for storing the ignition energy; connection means between said charging capacitor means and said primary winding means for discharging said ignition energy through said primary winding means; magneto generator means connected to said capacitor means for charging said capacitor means, said capacitor means discharging through said connection means and through said primary winding for producing said ignition pulse in said secondary winding; electronic switching means connected in series with said primary winding; means for connecting the series combination of said switching means and said primary winding in parallel with said capacitor means, said switching means and said primary winding being a conductive path across said capacitor means when said switching means is in the conducting state; pulse emitting means coupled to said engine and emitting pulses at spaced intervals; means for connecting said pulse emitting means to said switching means for controlling the state of said switching means, said switching means being switched to the conducting state by said pulse emitting means during a first operating direction of said engine whereby said capacitor means is inhibited from being charged by said generator means so that said ignition pulse is not produced in said secondary winding,

said switching means being switched to the non-conducting state when said engine is operating in a second direction whereby said capacitor means is charged by said generator means to produce said ignition pulse only when said engine is operating in said second direction.

2. The ignition arrangement as defined in claim 1, wherein said electronic switching means comprises thyristor means.

3. The ignition arrangement as defined in claim 1 including spark plug means connected to said secondary winding of said ignition coil means.

4. The ignition arrangement as defined in claim 2, wherein said pulses from said pulse emitting means switch said thyristor means to the conducting state at the instant of ignition when said engine operates in the second direction.

5. The ignition arrangement as defined in claim 4, wherein said pulse emitting means comprises electromagnetic means.

6. The ignition arrangement as defined in claim 1 including diode means connected to said capacitor means for charging said capacitor means with positive voltage from said magneto generator means, said electronic switching means being a thyristor switched to the conducting state through positive voltage pulses from said pulse emitting means.

7. The ignition arrangement as defined in claim 1, wherein said pulse emitting means comprises induction coil means; ferromagnetic means movable in proximity of said induction coil means so that a voltage is induced within said induction coil means for switching said electronic switching means to conducting state within substantially the maximum negative region of the voltage from said magneto generator means during said operating direction of said engine.

8. The ignition arrangement as defined in claim 7, wherein said ferromagnetic means comprises a substantially elongated ferromagnetic element extending over an arc of 0.21 radians.

9. The ignition arrangement as defined in claim 1, wherein said engine has a plurality of cylinders, each of said cylinders being associated with one electronic switching means and one pulse emitting means, all of said pulse emitting means being operated with one ferromagnetic element movable relative to said pulse emitting means.

10. The ignition arrangement as defined in claim 9, wherein said electronic switching means comprises a thyristor.

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