

[54] IGNITION DEVICE FOR AN INTERNAL COMBUSTION ENGINE

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[58] **Field of Search** 123/148 E; 315/209 CD

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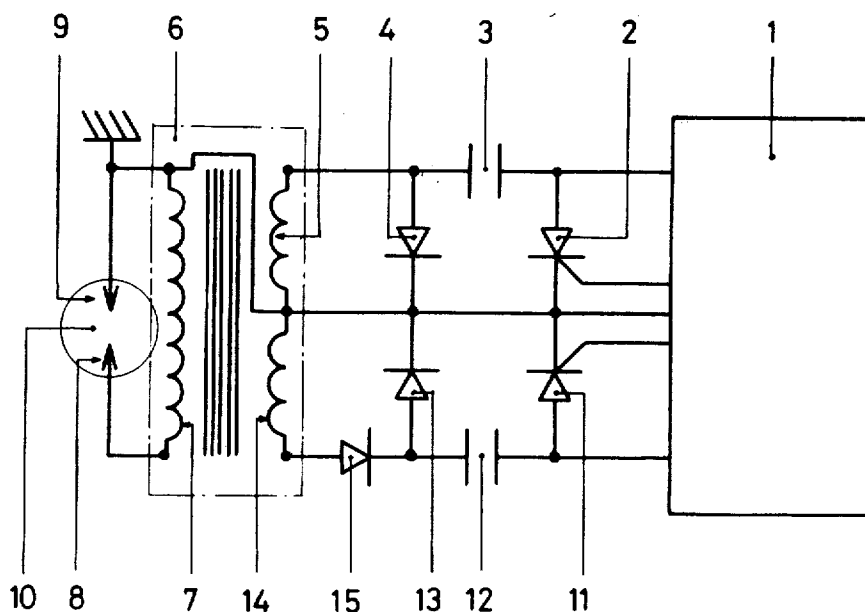
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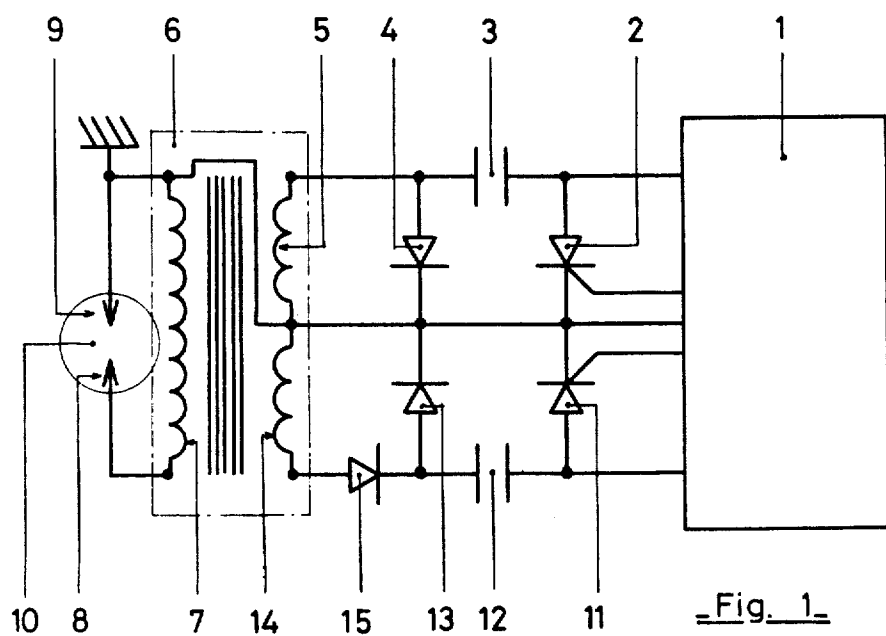
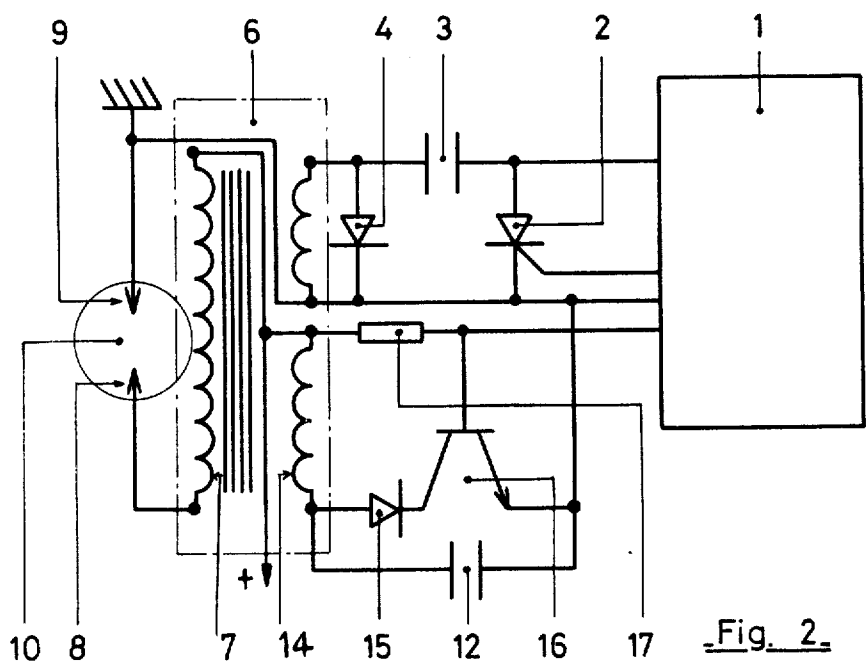
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[57] **ABSTRACT**

An ignition device for an internal combustion engine, comprises a capacitor, a diode through which said capacitor is charged, and a thyristor for discharging said capacitor through a first primary winding of an ignition coil. The secondary winding of the ignition coil has induced therein a high voltage each time the capacitor discharges through the primary winding. The high voltage is arranged in use to create an electric spark between electrodes of a spark plug and the thyristor is triggered by a timing circuit in synchronism with rotation of the internal combustion engine. Auxiliary means are also provided for prolonging the arc created between the electrodes of the spark plug.

2 Claims, 2 Drawing Figures





IGNITION DEVICE FOR AN INTERNAL COMBUSTION ENGINE

The present invention relates to an ignition device for an internal combustion engine and more particularly to an ignition device of the capacitor discharge type, that is to say of the type comprising a reservoir capacitor discharged in an intermittent manner in order to pass a current through an ignition coil.

The capacitor is charged at a mean voltage (200 to 1,000V) either by means of a converter or a saturable transformer, or by transferring energy previously stored by self-induction. The energy stored in the capacitor is liberated into the primary winding of the ignition coil by means of a mechanical switch (contact breaker assembly) or an electronic switch (thyristor, thyatron, etc.,) actuated in synchronism with the rotation of the internal combustion engine. An output voltage results which is available to the secondary winding of the coil, the rise time of which is dependent on the associated primary components (self-induction of the primary winding and reservoir capacitor). Such devices have been designed particularly in order to obtain high voltages at the output of the secondary winding, under a high charge in the coil (clogged up or flooded plug, etc.,)

It is known that the functioning ability of the capacitor discharging devices under a high charge in the coil is obtained to the prejudice of a very important parameter, namely the arc duration, for the functioning of the engine under a certain condition (cold start-functioning at low charge), in other words the amplitude of the voltage obtained in the secondary winding of a charged coil is an inverse function of the rise of time of the high tension wave while the arc duration is a direct function of this rise time.

The object of the present invention is to provide an ignition device of capacitor discharge type which prolongs the duration of the arc.

In accordance with the present invention there is provided an ignition device for an internal combustion engine, comprising a capacitor; a diode through which said capacitor is charged, in use a thyristor for discharging said capacitor through a first primary winding of an ignition coil the secondary winding of which has induced therein a high voltage each time said capacitor discharges through said primary winding, said high voltage being arranged in use to create an electric spark between electrodes of a spark plug, said thyristor being triggered in use by a timing circuit, in synchronism with rotation of the internal combustion engine; and auxiliary means for in use prolonging the arc created between the electrodes of said spark plug.

Preferably, said auxiliary means comprises a second primary winding of the ignition coil which winding has a greater impedance than that of the first primary winding and is associated with a second capacitor dischargeable by a second thyristor which is triggered in use simultaneously or with a slight dephasing in relation to the first thyristor, by the timing circuit, in synchronism with the rotation of the engine.

Alternatively, said auxiliary means comprises a second primary winding of the ignition coil which has a greater impedance than that of the first primary winding and is associated with a second capacitor controlled by a transistor, which is operated simultaneously or with a slight dephasing in relation to the first thyristor,

by a signal in synchronism with the rotation of the engine.

The invention will now be more particularly described with reference to the accompanying drawing wherein:

FIG. 1 is a circuit diagram of one embodiment of an ignition device constructed in accordance with the present invention, and

FIG. 2 is a circuit diagram of a further embodiment of an ignition device constructed in accordance with the present invention.

Referring more particularly to FIG. 1 of the accompanying drawing, there is shown therein an ignition device including a unit 1 comprising a mean voltage generator for charging capacitors 3 and 12 referred to hereinafter and a timing circuit for triggering thyristors 2 and 11 also referred to hereinafter. The mean voltage generator and timing circuit are well known and will therefore not be described in detail.

The thyristor 2 serves to discharge a reservoir capacitor 3 which is connected in series with a primary winding 5 of an ignition coil 6 and which is charged through a diode 4 connected in parallel with said winding 5. The secondary winding 7 of the ignition coil 6, in which a high voltage is induced in use, provides a spark having a certain arc duration, between the electrodes 8 and 9 of a spark plug 10. The primary winding 5 associated with the capacitor 3 has a very small impedance so as to provide an impulse having a very steep wave front. The diode 4, as will be described hereinafter also enables the arc to be prolonged during the whole duration of a suitable period of oscillation of the circuit L1-C1 (winding 5 - capacitor 3).

Moreover, the ignition device comprises auxiliary means constituted by a second thyristor 11, the triggering of which is controlled, simultaneously with, or with a slight dephasing in relation to the thyristor 2, by a signal emitted by the unit 1. This signal can be common for both thyristors. A capacitor 12, controlled by the thyristor 11, and charged through a charging diode 13, is connected in series, by means of a protection diode 15, with a second primary winding 14 housed inside the ignition coil 6. The circuit L1-C2 (primary winding 14 - capacitor 12) must have a higher impedance than the circuit L1-C1, whence a number of turns of the winding 5 such that: the product

$$\frac{U_c \times NS}{NP2}$$

is always at least equal to the maintaining voltage of the arc,

U_c = charging voltage of the capacitor 12,

NS = number of turns in the secondary winding 7,

$NP2$ = number of turns of the primary winding 14, the rise time of U to the terminals of the winding 14 is less than the duration of a suitable period of the circuit L1-C1 so that the initial arc is not extinguished but is relayed by the circuit L2-C2.

The above described device functions in the following manner. Initially the capacitors 3 and 12 are charged by the voltage generator contained in the unit 1, through the diodes 4 and 13 respectively. Subsequently, in synchronism with the engine, impulses or trigger signals are applied simultaneously or with a slight dephasing to the gates of the thyristors 2 and 11

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by said timing circuit, thus causing the capacitors 3 and 12 to discharge through the primary windings 5 and 14 respectively.

The winding 5, which has a low impedance, is traversed by a primary current with a high crest generating a high-voltage impulse with a very steep rise front in the secondary winding 7, the effect of this impulse being to strike the arc between the electrodes 8 and 9 of the plug 10 during the first half-period of the circuit L1-C1. At the end of this half-period the self-inductance L1 of the winding 5 is charged and discharges itself through the diode 4 during the following half-period. The arc created by the discharge of the capacitor 3 is therefore maintained during a complete period of the circuit L1-C1.

Either simultaneously or with a slight dephasing, the conduction of the thyristor 11 causes the capacitor 12 to discharge through the winding 14. The winding 14 has a relatively higher impedance than the winding 5 and this results in a rise in voltage at the terminals of the secondary winding 7, with a rise front which is less steep than that resulting from the discharge of the capacitor 3 and with a smaller amplitude which is however sufficient to maintain the arc already struck by the discharge of said capacitor 3. Because of the higher impedance of the winding 14, the suitable period of the circuit L2-C2 will be greater than that of the circuit L1-C1, and the duration of the arc will be able to be prolonged to a maximum time, equal to the proper period of the circuit L2-C2.

As an example, through the discharge of the capacitor 3 in the primary winding 5, it will be possible to obtain a high initial voltage with a rise front of 10μ striking an arc maintained during $80\mu s$. The discharge of the capacitor 12 through the primary winding 14 will be able to create in the secondary winding $7.60\mu s$ later, a voltage which is at least equal to the maintaining voltage of the initial arc and the exchange of energy between the winding 14 and the capacitor 12 will be able to last $240\mu s$.

A total passage time of the arc to the terminals of the electrodes of the plug results which has a total duration of $240 + 60 = 300\mu s$, being about $200\mu s$ greater than the passage time of the arc which is produced by the known ignition devices.

The embodiment shown in FIG. 2 differs essentially from the previous one in that the primary winding 14 is controlled by a system termed "transistorised."

The primary winding 14 is connected in series with the collector and the emitter of a transistor 16 through the diode 15. The transistor 16 which is of the NPN type is polarised by a resistor 17. The capacitor 12 in series with the primary winding 14 is connected to the terminals of the series circuit constituted by the diode 15 and the transistor 16.

I claim:

1. An ignition system for an internal combustion engine comprising a voltage generator, a capacitor, a

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charging circuit for said capacitor connecting said voltage generator to said capacitor and including a diode through which said capacitor is charged in use, an ignition coil having first and second primary windings on which the second primary winding has a greater impedance than the first primary winding, and a secondary winding, a spark plug having its electrodes connected across the secondary winding, a thyristor connecting said capacitor to the first primary winding so that the secondary winding has induced therein a high voltage signal each time said thyristor is triggered, said high voltage signal being of short duration and having a rapid rise front and creating an electric spark between the electrodes of the spark plug, a timing circuit operating in synchronism with rotation of the internal combustion engine to trigger said thyristor, and an auxiliary circuit connected across said second primary winding and including a further capacitor, a charging circuit for said further capacitor and means controlling discharge of said further capacitor through the second primary winding for prolonging the arc created between the electrodes of said spark plug on triggering of the thyristor, and wherein said means for controlling the discharge of the capacitor through the second primary winding comprises a further thyristor connected for triggering by said timing circuit simultaneously with the triggering of the first mentioned thyristor.

2. An ignition system for an internal combustion engine comprising a voltage generator, a capacitor, a charging circuit for said capacitor connecting said voltage generator to said capacitor and including a diode through which said capacitor is charged in use, an ignition coil having first and second primary windings on which the second primary winding has a greater impedance than the first primary winding, and a secondary winding, a spark plug having its electrodes connected across the secondary winding, a thyristor connecting said capacitor to the first primary winding so that the secondary winding has induced therein a high voltage signal each time said thyristor is triggered, said high voltage signal being of short duration and having a rapid rise front and creating an electric spark between the electrodes of the spark plug, a timing circuit operating in synchronism with rotation of the internal combustion engine to trigger said thyristor, and an auxiliary circuit connected across said second primary winding including a further capacitor, a charging circuit for said further capacitor and means controlling discharge of said further capacitor through the second primary winding for prolonging the arc created between the electrodes of said spark plug on triggering of the thyristor, and wherein said means for controlling the discharge of the further capacitor through the second primary winding is a transistor connected to the triggering means so as to be operated simultaneously with the first mentioned thyristor.

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