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Davalillo

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[54] **CAPACITIVE DISCHARGE IGNITION SYSTEM**

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[51] **Int. Cl.** **H05b 37/02**

[58] **Field of Search** .... 315/209 R, 209 CD, 209 SC

[56] **References Cited**

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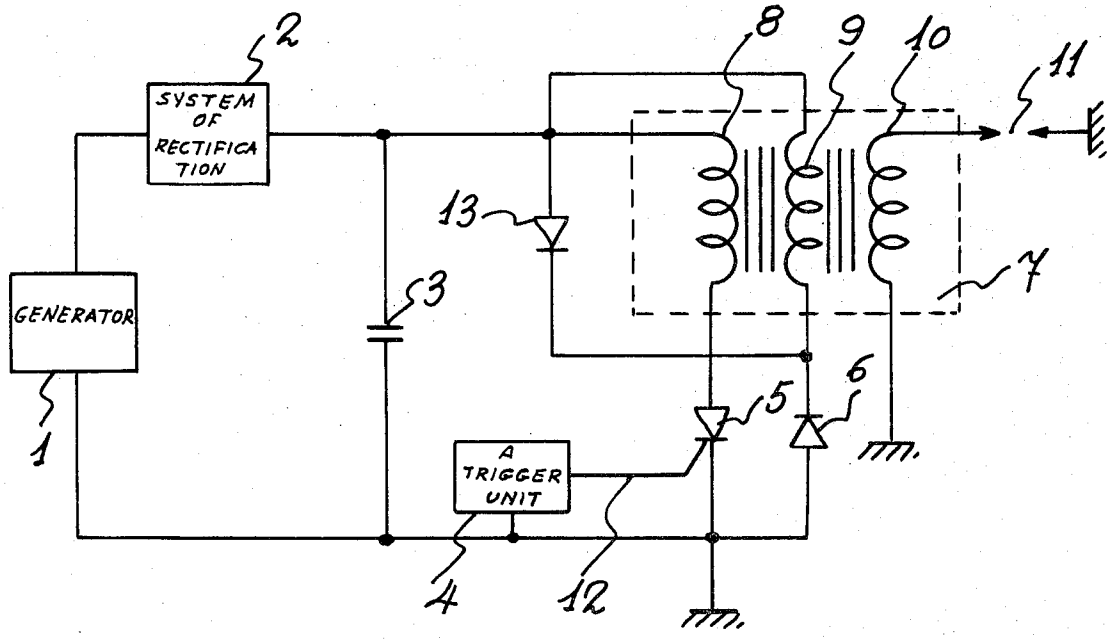
[57] **ABSTRACT**

A capacitive discharge ignition system in which a source of D.C. power charges a capacitor which is in series with the primary winding of a coil (the secondary winding being connected in series with a sparking device). The coil also includes an auxiliary primary winding magnetically connected to the secondary winding and connected in series with a diode in opposition to said primary winding and in parallel to said primary winding and said triggering device. In one embodiment another diode is also connected in parallel to said auxiliary winding to dampen current delivered thereto.

1 Claim, 2 Drawing Figures



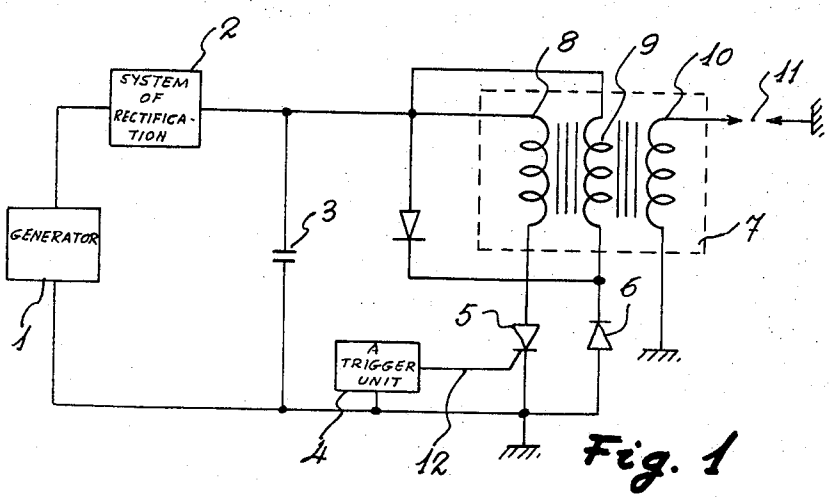

2
SYSTEM OF RECTIFICATION
GENERATOR
1
3
8
9
10
11
7
6
5
A TRIGGER UNIT
4
12

Fig. 1

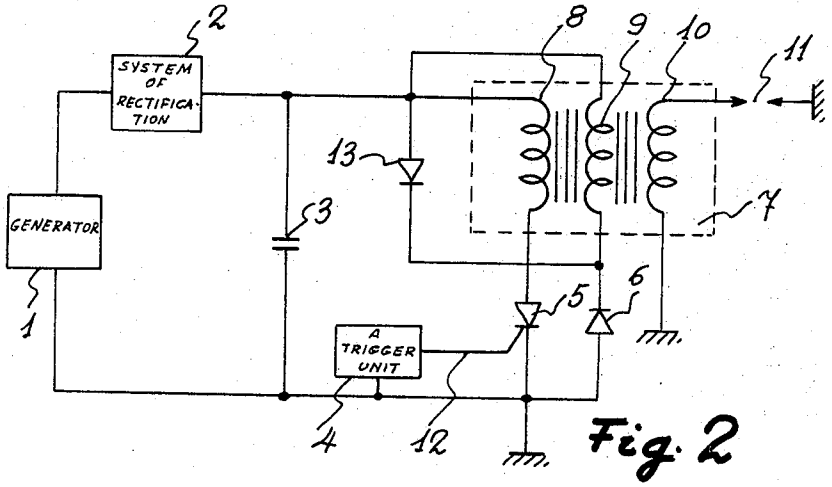

2
SYSTEM OF RECTIFICATION
GENERATOR
1
3
13
8
9
10
11
7
6
5
A TRIGGER UNIT
4
12

Fig. 2

CAPACITIVE DISCHARGE IGNITION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is concerned with a new procedure for obtaining ignition voltages with a short rise-time and a long arc duration in capacitive discharge ignition systems.

2. Description of the Prior Art

The majority of the capacitive discharge ignition systems known at the present time have the advantage of producing an ignition voltage whose rise-time is considerably shorter than that of ignition systems of the inductive type, but capacitive ignition systems have the disadvantage that the duration of the arc in the spark plug, or the time during which the arc is maintained between the electrodes of the spark plug, is not, in many cases as long as would be desirable.

There generally exists a design compromise in the two parameters mentioned above: rise-time and duration of the arc, so that if a system with a short rise-time is projected, it will necessarily have to include, within certain limits and with the techniques known, arc durations which are also short, while if the design is compelled to produce long arc durations, the rise-times obtained are great.

The advantages of having a short rise-time are known, such as permitting the engine to operate correctly with dirty or greasy spark plugs, which is translated into a longer life for said plugs. The advantages represented by having a long arc duration in the spark plugs, such as better and more complete combustion of the mixture, which, in turn, produces a better engine performance and a reduction of the atmospheric contamination produced by the said engine are also known.

Capactive ignition systems are known in which a rectified source changes a capacitor which is in series with the primary winding of a coil and a triggering device like a silicon-controlled diode, the secondary winding of said coil being connected in series with a sparking device. Further, it is known to provide an inductance and a diode in parallel with the primary winding of the coil and in series with the triggering device. As explained in the U.S. Pat. to Oishi et al., No. 3,523,211 issued Aug. 4, 1970 with respect to FIG. **1**, therein, the purpose of the branch circuit including the extra inductance is to allow continuing current circulation through the primary winding in order to extend the arc duration and the purpose of the inductance per se is to provide an impedance so that some of the back voltage produced by the primary winding charges the capacitor negatively which, in turn, produces a negative current across the silicon-controlled diode, SCR, to turn it off. The Oishi et al., patent also shows as prior art in FIG. **3** a winding and diode connected in parallel to the series lead containing both the primary winding and the SCR. This branch circuit also allows continuing current circulation through the primary winding but is not so effective as the Oishi et al. circuit at turning off the SCR.

In both of these prior art circuits, the additional winding is not magnetically coupled to the secondary winding of the coil so that their effect in prolonging arc duration is indirect, i.e., their arc duration prolonging effect depends upon their effect upon the primary rather than the secondary coil. Further, these prior art circuits do not disclose an auxiliary primary winding, wound in a direction opposite to the primary winding and connected in series with a diode across both the primary winding and the SCR. Thus, there is no provision in the prior art for causing a sharp rise time in said secondary winding while yet prolonging the arc duration therethrough.

SUMMARY OF THE INVENTION

The purpose of the present invention is to produce a better compromise between the parameters of rise-time and arc duration, which will permit a shorter rise-time and a longer arc than is possible by utilizing the techniques employed up to the present.

By providing, in a capacitive ignition system, an auxiliary primary winding, wound in opposition to the main primary winding and a properly directed diode; this series being in parallel to the primary winding and the triggering device, a short rise-time may be provided by adjusting the relative impedance values of the auxiliary and primary windings and the coil.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiment of the invention will now be described in what follows with reference to the annexed sheet of drawings in which:

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

FIG. **2** is a circuit diagram of a second embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, the first embodiment of the applicant's invention includes a source of power such as a generator **1**, a system of rectification **2**, a charging condenser **3**, a trigger unit **4**, a silicon-controlled diode **5**, having a gate terminal **12**, a normal silicon diode **6**, a coil **7** with three windings: the principal primary **8**, the auxiliary primary **9** and the secondary **10** and spark plug electrodes indicated by reference numeral **11**.

The operation of the circuit is as follows:

The generator or power source **1** supplies alternating current power which is rectified by means of the rectification system **2** to direct current thus charging the condenser **3**. The trigger unit **4** generates pulses with the synchronism required with respect to the revolution of the crankshaft of the engine and when a trigger pulse appears at the terminal **12** of the silicon-controlled diode **5**, the latter becomes a conductor producing the discharge of the condenser **3** through the principal primary **8** of the coil **7**; this discharge, because of the nature of the parameters C and L (C is the capacitance of the condenser **3** and L is the loss inductance of the said principal primary **8**) would be of the dampened oscillating type if the circuit had means for the return of current, but this is not possible since the silicon-controlled diode **5** can conduct in only one direction. Consequently, once the condenser **3** has reached the maximum negative voltage in the first hemicycle of the oscillating discharge through the principal primary **8**, this oscillating discharge continues through the diode **6** and the auxiliary primary **9**. When the condenser **3** again acquires positive voltage with respect to ground, corresponding to the second hemicycle of the oscillating discharge, this discharge now continues again

through the principal primary **8** and the silicon-controlled diode **5**, assuming that the latter still remains excited by the pulse of the trigger unit. This process is repeated until the whole of the energy stored in the condenser **3** has been exhausted. The successive discharges of the condenser through the principal **8** and auxiliary **9** primaries create in the secondary **10** of the coil **7** a voltage which in the first part of its rise will reach the breakdown value of the arc in the electrodes **11** of the spark plug, producing a first arc of short duration and determined polarity, followed by partial arcs of alternately differing polarities, corresponding to the different hemicycles of discharge of the condenser **3** into the principal **8** and auxiliary **9** primary windings. Consequently by appropriately selecting the principal primary winding **8** in such a manner that the frequency determined by the value C of the condenser **3** and the value L of the said primary is high, a short rise-time will be produced, and again, by appropriately selecting the value of the loss inductance of the auxiliary primary winding **9** in such a manner that the frequency determined by this value and the capacity C of the condenser **3** is low, there will be brought about a long duration of arc in the periods corresponding to the partial discharges of the condenser **3** through the auxiliary primary **9**.

The second embodiment of the circuit as shown in FIG. **2** is similar to the diagram of FIG. **1**, except for the inclusion of the recovery diode **13**, the remainder of the components continuing to have the same numeration as that indicated for FIG. **1**.

The functioning of the circuit is similar to that described for FIG. **1** until the first hemicycle of discharge of the condenser **3** is produced through the principal primary **8** and the silicon-controlled diode **5**; from this point onwards, the second hemicycle of the discharge of the condenser **3** takes place through the auxiliary primary winding **9** since the negative hemicycle turns off the SCR **5**, but since the recovery diode **13** is in parallel with the said primary winding **9**, the current established in the said auxiliary primary winding is damped aperiodically through the said diode **13**.

The first part of the discharge, as in the previous case, gives rise to the voltage in said secondary winding **10** with the resultant breakdown across selectrodes **11** and a first short arc, while the second part of the discharge and the corresponding damping through the recovery diode **13** gives rise to an arc of different polarity and as in the previous case the rise-time and the first partial arc are fixed by the values of the loss inductance of the principal primary winding **8**, while the duration of the secondary arc, in this case is fixed by the value of the loss inductance of the auxiliary primary winding **9** and the recovery diode **13**.

What is claimed is:

1. In a capacitive ignition circuit comprising a source of rectified power, a capacitor in series with said source which is charged thereby, a coil including a primary winding in series with said capacitor and a secondary winding magnetically coupled to said primary winding and in series with a sparking device and a triggering device in series with said primary winding for alternately connecting and disconnecting said primary winding to said capacitor whereby said capacitor is periodically discharged through said primary winding, the improvement comprising that an auxiliary winding wound in opposition to said primary winding and also magnetically coupled to said secondary winding and a diode properly connected to said auxiliary winding to allow the passage of current therethrough are connected in parallel with said primary winding and said triggering device whereby the rise-time of said sparking device is controlled by the relative impedances of said primary winding and said capacitor, while the arc duration is determined in a first hemicycle of a capacitive discharge cycle by the relative impedances of said primary winding and said capacitor and a second hemicycle of said capacitive discharge cycle by the relative impedances of said auxiliary winding and said capacitor, a diode in parallel with said auxiliary winding for damping current flow to said auxiliary winding during said second hemicycle, the rise-time of said sparking device being controlled by the relative impedances of said primary winding and said capacitor, while the arc duration is determined in a first hemicycle of a capacitive discharge cycle by the relative impedances of said primary winding and said capacitor and in a second hemicycle of said capacitive discharge cycle by the value of the loss inductance of the said auxiliary winding and diode in parallel.

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