United States Patent

[11] **3,565,048**

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[33] **France**
[31] **123611**

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[54] **ARRANGEMENT FOR THE CONTROLLED ELECTRONIC IGNITION OF INTERNAL COMBUSTION ENGINES**
6 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **123/148,** 123/32
[51] **Int. Cl.** **F02p 3/06**
[50] **Field of Search** ..... 123/32, 32 (F), 32 (E-1), 148 (DC), 148(E)

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ABSTRACT: In an internal combustion engine, an electronic system comprising an ignition coil adapted to energize the sparking plugs upon application of an electric pulse on a semiconductive member, said system including an oscillating system controlled by said semiconductive member and constituted by an induction coil and a condenser together with two diodes adapted to prevent the discharge of the latter. The semiconductive member is constituted by a transistor or a thyristor incorporated with said circuit so that the ignition-controlling pulses reaching said transistor or thyristor allow the condenser to discharge into the primary of the ignition coil and to thereby release the ignition. The induction coil can possibly control the injection of fuel in which case two semiconductive members are used which control respectively injection and ignition.

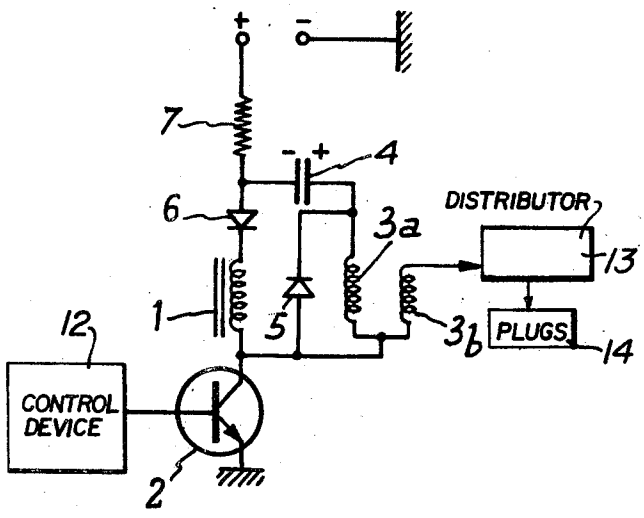


Fig: 1

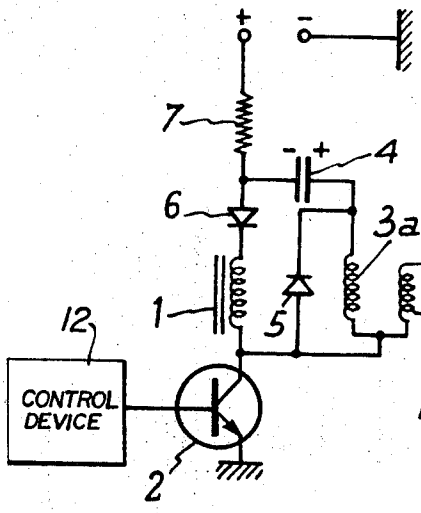


Fig: 2

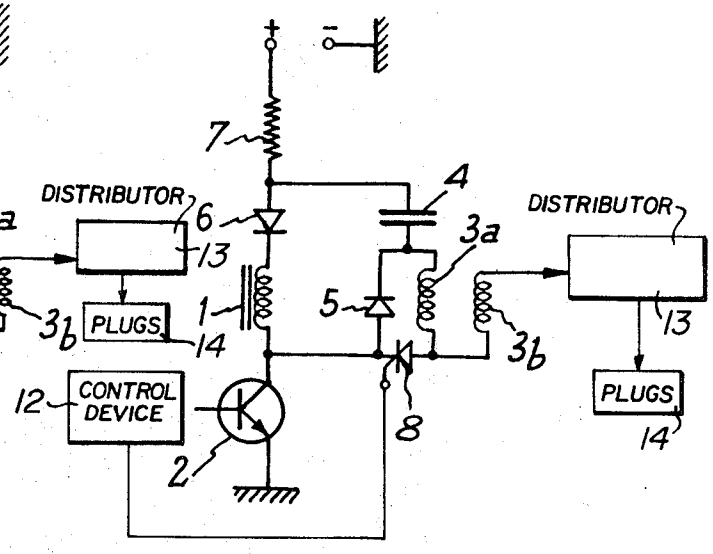


Fig: 3

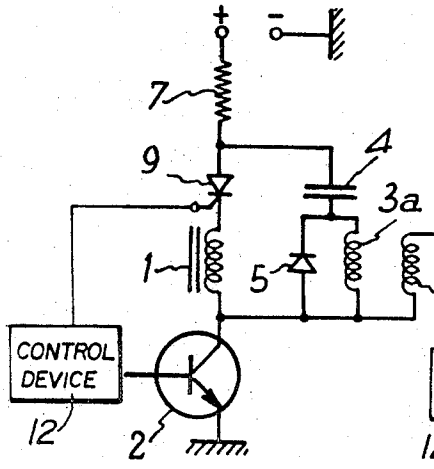
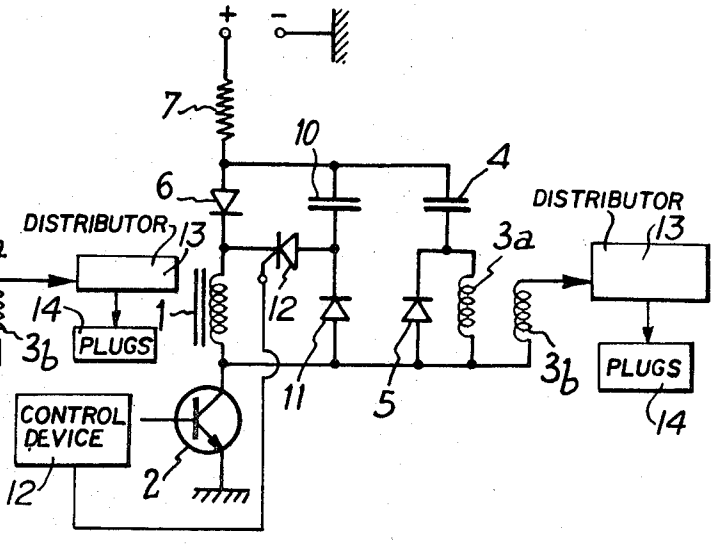


Fig: 4



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ARRANGEMENT FOR THE CONTROLLED ELECTRONIC IGNITION OF INTERNAL COMBUSTION ENGINES

The present invention relates to an electronic ignition system for internal combustion engines, the ignition of which is to be controlled, said arrangement including an ignition coil provided with a primary and with a secondary winding, a distributor feeding the high voltage from the secondary winding, into the sparking plugs according to the desired sequence of the cylinders to be subjected to ignition and lastly a semiconductive member receiving the electric pulses adapted to trigger the ignition procedure.

It is also known to produce such an arrangement resorting to a semiconductive member such as a transistor adapted to switch off the current in the primary of the ignition coil, the switching off pulses being produced by the periodical opening of a switch by a cam operatively connected with the camshaft of the engine for instance. In this case, it is possible to considerably increase the current in the primary of the ignition coil and to obtain through its sudden cutoff a high voltage in the secondary winding without any risk of damaging the contact-pieces. The drawback of such a prior arrangement resides in the fact that the ignition coil draws a current of a large intensity which is objectionable chiefly when the engine runs at a low speed and the generator or the alternator does not yet produce the maximum loading current since the current passes through the ignition coil almost constantly, except during the very short duration of the interruption required for inducing a high voltage in the secondary winding. In addition, the ignition coil must be of a special structure by reason of the intense primary current causing considerable heating of the windings.

It has also been proposed to resort to the discharge of a condenser into the primary of the ignition coil, which discharge is also controlled by a semiconductive member. In such a case, current passes through said primary only during the discharge periods. However, in order to obtain a sufficiently large pulse capable of inducing a high voltage in the secondary, it is necessary to provide a condenser of a very high capacity if it is desired to load it only under the voltage provided by the electric circuit of an automobile, for instance. It is then necessary to resort again to a special ignition coil adapted to resist the large intensities of the current in the primary or else a special generator is used, so as to load the condenser under a voltage which is higher than that supplied by the electric circuit of the automobile, such a generator leading to the incorporation of special and expensive arrangements.

The present invention has for its object to cut out such drawbacks of prior arrangements and it covers an ignition system for internal combustion engines the ignition of which is controlled, said arrangement including conventionally an ignition coil provided with a primary and with a secondary winding, a distributor feeding the high voltage from the secondary of the ignition coil into the sparking plug or plugs in the prescribed sequence and a semiconductive member adapted to receive an electric pulse wherethrough the ignition procedure is triggered. According to our invention the energy for the ignition coil is stored in at least one condenser inserted in parallel with an induction coil and forming with said induction coil an oscillating circuit. The discharge of said condenser through the induction coil is prevented by two diodes. The flow of current through the induction coil is controlled by a transistor the base of which is subjected to a switching pulse while the ignition coil is connected in a manner such that for each pulse applied to the semiconductive member controlling the ignition, said condenser discharges into the primary of said ignition coil.

A few further optional features of the invention are disclosed hereinafter, to wit: The induction coil is constituted by the winding controlling an electromagnetic fuel injector inserted in series with a resistance, a diode and an injection-controlling transistor, the condenser being connected through one of its terminals with a point of the lead connecting the resistance with said diode and through its other terminal through another diode with a point of the lead connecting the induction coil with the collector of the transistor while the primary of the ignition coil is connected across the terminals of said other diode and the semiconductive member controlling the ignition is constituted by the transistor controlling the injection of fuel, whereby each pulse applied to said transistor triggers simultaneously an injection of fuel and an ignition of a spark plug.

The semiconductive member controlling the ignition is constituted by a thyristor inserted between the primary of the ignition coil and the transistor, a signal applied on the electrode controlling said thyristor causing the discharge of the condenser through the primary of the ignition coil after a pulse applied to the transistor controlling the injection has initiated the latter in accordance with the disclosure in the preceding paragraph.

The induction coil is constituted by the winding of an electromagnetic fuel injector inserted in series with a resistance, a thyristor controlling the injection and a transistor adapted to control the flow of current through the induction coil, the condenser being connected through one of its terminals with a point of the lead connecting the resistance with the thyristor and through its other terminal with a diode connected with a point of the lead connecting the induction coil with the collector of said transistor, the primary of the ignition coil being connected across the terminals of the last-mentioned diode. The semiconductive member controlling the ignition in this embodiment is the transistor controlling current flow through the induction coil, whereby each pulse applied to said transistor triggers an ignition through a discharge of the condenser across the primary of the ignition coil and each pulse applied to said thyristor triggers an injection after the pulse applied to the transistor has triggered the ignition procedure.

A second condenser and a further diode in series therewith form a shunt across the first condenser and its diode, while a point of the lead connecting said second condenser with its diode is connected with one terminal of the induction coil through the agency of a thyristor, the semiconductive member controlling the ignition being in one with the transistor adapted to control of the current flow through the induction coil, so that each pulse applied to said transistor triggers an ignition through a discharge of said first condenser across the primary of the ignition coil and each pulse applied to said thyristor triggers an injection through the discharge of said second condenser across the winding of the electromagnetic injector after the pulse applied to the transistor has triggered the ignition procedure.

By way of example and with a view to furthering the understanding of the following description, the accompanying drawings illustrate various embodiments thereof. In said drawings:

FIG. 1 illustrates a first embodiment of the invention.

FIG. 2 illustrates a second embodiment of the invention.

FIG. 3 illustrates a third embodiment of the invention.

FIG. 4 illustrates a fourth embodiment of the invention.

Turning to FIG. 1, it is apparent that the induction coil 1 is inserted in series with a diode 6, a resistance 7 and a transistor 2 between the terminals of a supply of voltage. A condenser 4 inserted in series with a further diode 5 forms with said induction coil an oscillating circuit.

The primary 3*a* of the ignition coil is connected in parallel with the diode 5 and its secondary 3*b* is connected either directly with the spark plug in case of a single cylinder engine or else with a conventional distributor 13, which feeds the high voltage from 3*b* to the different spark plug 14 plugs in the desired sequence required for ignition.

The operation of the arrangement is as follows:

When the semiconductive member controlling the ignition procedure which is constituted in the case illustrated in FIG. 1 by the transistor 2 is conductive, some current passes through the resistance 7, diode 6, induction coil 1 and transistor 2 which is then saturated by a voltage fed to its base by control device 12, which is driven through the rotation of the engine.

The transistor 2 is thus suddenly cutoff and the oscillating circuit constituted by the induction coil 1 and condenser 4 begins oscillating during one quarter of a period, so as to charge the condenser through the diodes 5 and 6; the oscillations are however locked thereafter by said diodes and the kinetic energy in the induction coil is stored as a voltage between the plates of the condenser 4.

When transistor 2 once again becomes conductive through the action of control device 12 so as to allow the following ignition, the primary 3*a* is fed with a voltage equal to the voltage stored in the condenser increased by the voltage feeding the circuit. At the same time, current flows again through the induction coil 1.

It should be remarked that the induction coil 1 may be constituted by the winding controlling an electromagnetic injector. In this case, the signal initiating the injection of fuel is applied to the base of the transistor 2 so as to energize the induction coil 1 and commence the injection corresponding for instance to the cylinder No. 1 of a four-cylinder engine and the ignition of the cylinder No. 4 of the same engine since in this case said cylinder No. 1 is at the beginning of its suction stroke while the cylinder No. 4 is at the same moment at the stage corresponding to ignition. Obviously in this case the duration of the pulse to which the base of the transistor is subjected should correspond to the duration of the injection to be produced by the energization of the winding constituted by the corresponding injection coil 1.

Turning now to FIG. 2, a thyristor 8 inserted in the circuit of the primary 3*a* of the ignition coil constitutes the semiconductive member controlling the ignition. In this case, the initiation of the ignition is not obtained simultaneously with the energization of the induction coil controlling the electromagnetic injector. The ignition is initiated only a short time afterwards by an ignition signal applied to the control electrode of said thyristor 8 which last signal is produced by control device 12 as disclosed above in connection with the embodiment of FIG. 1.

The embodiment illustrated in FIG. 3 includes a thyristor 9 as a substitute for the diode 6 in FIGS. 1 and 2. The semiconductive member controlling the ignition is constituted by the transistor 2. In this case, the ignition is initiated by the saturation of the transistor 2, while the injection is initiated only a short time afterwards by a pulse fed into the electrode-controlling thyristor 9 and produced by control device 23, as described above. The duration of the injection corresponds therefore to the period elapsed between conduction of the thyristor 9 and the cutoff of the transistor 2.

Under certain conditions, it is possible to use only a part of the energy stored for ignition and to feed the remainder of said energy into the induction coil 1 controlling an electromagnetic injector. To this end and as illustrated in FIG. 4, a second condenser 10 inserted in series with a diode 11 shunts the first condenser 4 in series with the diode 5. The kinetic energy in the induction coil 1 is then stored in both condensers 4 and 10 when the transistor 2 has been switched off after one quarter of a period of oscillation has elapsed. In the case of FIG. 4 a thyristor 12 is connected through one of its terminals with condenser 10 and through its other terminal with a point between the induction coil 1 and diode 6. Consequently, when transistor 2 is made conductive by control device 12, the ignition is started by a discharge of the condenser 4 through the primary 3*a* of the ignition coil. At the same time, a holding current is then obtained in the injection coil 1 controlling an electromagnetic injector but in this case the holding current is insufficient for initiative of the injection. A certain time afterwards when thyristor 12 has been energized by control device 12 the pulse produced by the discharge of the condenser 10 is superimposed over the holding current in injection coil 1 and starts the injection. The holding current is then sufficient for maintaining the injector in its operative condition until the transistor 2 is cutoff.

I claim:

1. An improved ignition system for a fuel injection engine comprising: an ignition coil; an inductance through which current normally flows during fuel injection; energy storage means connected in parallel with said inductance; switching means for causing the electrical energy generated upon cutoff of current flow through said inductance to be stored in said energy storage means; and means for transferring the energy stored in said energy storage means to the ignition coil at the commencement of ignition.

2. The improved ignition system of claim 1 including means connected between said energy storage means and said inductance to prevent the transfer of energy stored in said energy storage means to said inductance.

3. The improved ignition system of claim 1 wherein said switching means and said means for transferring the energy stored in said energy storage means comprises a transistor.

4. The improved ignition system of claim 1 wherein said switching means comprises a transistor connected in series with said inductance and said means for transferring comprises a thyristor connected between an electrode of said transistor and said ignition coil.

5. The improved ignition system of claim 1 wherein said switching means comprises a thyristor connected in series with said inductance and said means for transferring comprises a transistor connected in series with said ignition coil and said energy storage means.

6. The improved ignition system of claim 1 including second energy storage means connected in parallel with said energy storage means; a thyristor connected between said energy storage means and said inductance and wherein said switching means and said means for transferring comprise a transistor connected in series with said inductance.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,565,048 Dated February 23, 1971

Inventor(s) Louis A. Monpetit

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 3, line 45 Control device 23 should be Control device

Col. 4, line 13 iniative should be initiation

Signed and sealed this 9th day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of P