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Moriya

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[54] **ELECTRIC SPARK GENERATING DEVICE FOR IGNITORS**

[75] Inventor: **Nobuyoshi Moriya**, Omiya, Japan

[73] Assignee: **Mansei Kogyo Kabushiki Kaisha**, Saitama, Japan

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[30] **Foreign Application Priority Data**

Sept. 19, 1973 Japan ..... 45-109235[U]

[52] **U.S. Cl.** **317/96**; 315/206; 317/79; 431/266

[51] **Int. Cl.** **F23q 3/00**

[58] **Field of Search** ..... 317/79, 80, 96, 97; 431/27, 264, 266; 315/183, 206, 209 SC

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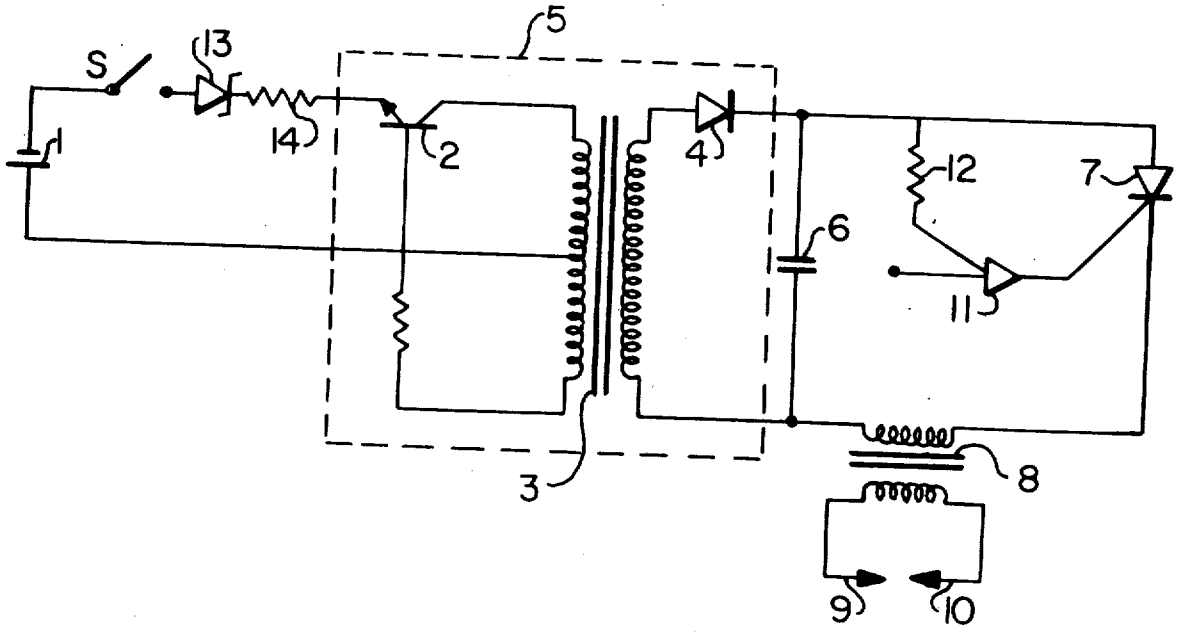
Primary Examiner—Volodymyr Y. Mayewsky
Attorney, Agent, or Firm—Armstrong, Nikaido & Wegner

[57] **ABSTRACT**

An electric spark generating device for ignitors comprising a diode connected to an inverter means, a discharge circuit including a condenser and a silicon controlled rectifier, and a step-up transformer. A programmable unijunction transistor is arranged such that the anode thereof is opened while the cathode is connected to the gate of the silicon controlled rectifier. The gate of the programmable unijunction transistor is connected to the anode of the silicon controlled rectifier.

7 Claims, 4 Drawing Figures



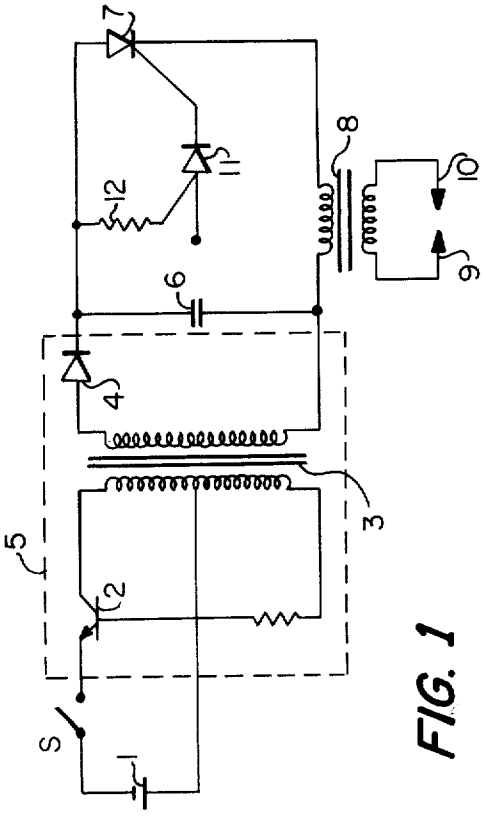


FIG. 1

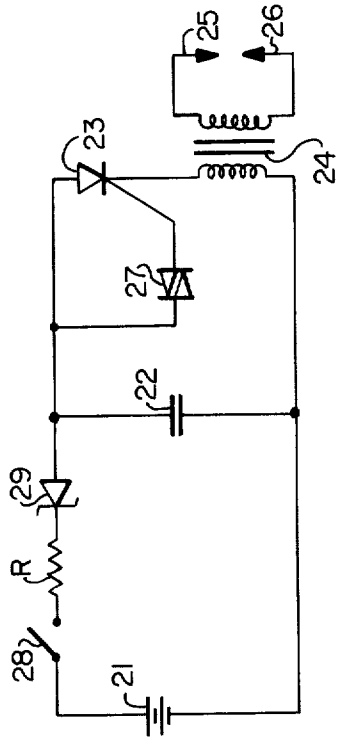


FIG. 3

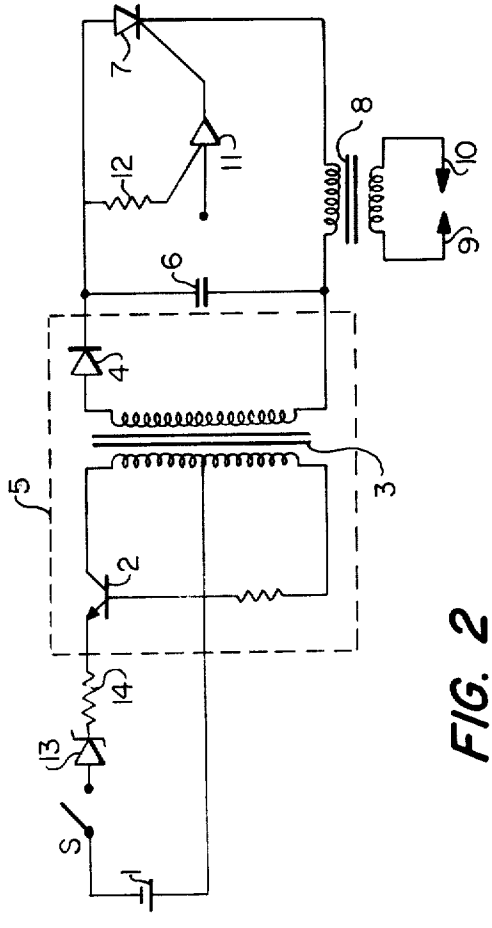


FIG. 2

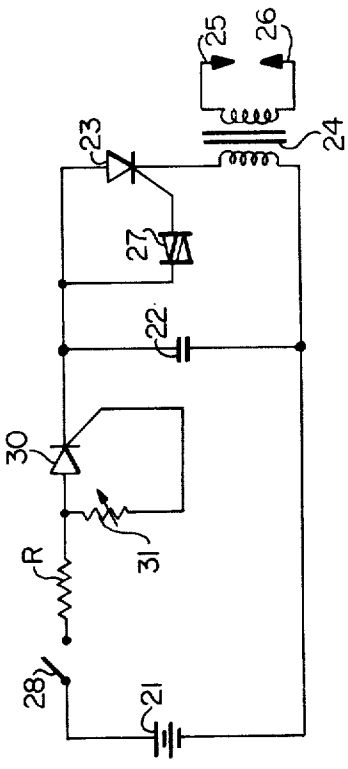


FIG. 4

ELECTRIC SPARK GENERATING DEVICE FOR IGNITORS

BACKGROUND OF THE INVENTION

The present invention relates to an electric spark generating device for ignitors such as cigarette lighters. More particularly, it relates to an electric spark generating device for ignitors, wherein the circuit includes, in combination, either a diode connected with an inverter means or a DC-DC converter connected with a direct current source, a discharge circuit including a condenser and a silicon controlled rectifier, a step-up transformer, and a spark gap. In this device, through either the diode connected with the inverter means or the DC-DC converter a half-wave voltage is obtained. The condenser is charged with the half-wave voltage and the electric charge of the condenser is transiently applied to the step-up transformer through the action of the silicon controlled rectifier. The primary side voltage of the step-up transformer induced by the above operation is stepped up to discharge sparks at the spark gap provided at the secondary side of the step-up transformer.

SUMMARY OF THE INVENTION

One object of the present invention is to improve an electric spark generating device for ignitors of the above-mentioned type.

Another object of the present invention is to provide an electric spark generating device for ignitors which has a durable and reliable circuit arrangement.

Further object of the present invention is to provide an electric spark generating device for ignitors which sequentially discharges high voltage sparks.

According to the present invention, an electric spark generating device for ignitors comprises, in combination, an inverter means, a diode connected in series with the inverter means, a discharge circuit connected with the inverter means including a condenser and a silicon controlled rectifier which are connected in parallel with the inverter means, and a step-up transformer having a primary side and a secondary side. The primary side of the step-up transformer connected in series with the discharge circuit, and a spark gap is connected across the secondary side of the step-up transformer to discharge high voltage sparks. A programmable unijunction transistor, opened at the anode, is connected at the cathode thereof to the gate of the silicon controlled rectifier, and the gate of the programmable unijunction transistor is connected to the anode of the silicon controlled rectifier. Other thyristor devices may also be used in place of the programmable unijunction transistor.

In this arrangement of the present invention, it is preferrable to arrange in series a constant-voltage controlling device such as a zener diode, a silicon controlled rectifier or the like between the power source and the condenser, so that when the energy of the source drops below a predetermined level, the constant-voltage controlling device does not apply the voltage from the source to the condenser. If desired, the constant-voltage controlling device may be connected through the DC-DC converter with the condenser.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages in accordance with the present invention will be apparent from the following description taken in connection with the accompanying drawings in which

FIG. 1 shows an ignition circuit in accordance with the present invention, wherein a programmable unijunction transistor is used for triggering a silicon controlled rectifier;

FIG. 2 shows a modified ignition circuit of FIG. 1, wherein a constant-voltage controlling device is added;

FIG. 3 shows another modified ignition circuit of the invention, wherein a DC-DC converter is not used and a zener diode is added; and

FIG. 4 shows a further modified ignition circuit of the invention, wherein a silicon controlled rectifier is substituted for the zener diode of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 and 2, the electric power source for the ignition circuit is a battery 1 which is connected with a well-known DC-DC converter 5. The DC-DC converter 5 comprises a transistor 2 for switching, a transformer 3 serving concurrently as an oscillation circuit, and a diode 4 serving as a half-wave rectifier means. An electric charge storage condenser 6 and a silicon controlled rectifier 7 (hereinafter referred to as SCR) are connected in parallel relation with the DC-DC converter 5. The primary side of a step-up transformer 8 is connected in series with the SCR 7. A spark gap which is formed with a pair of electrodes 9 and 10 is connected to the secondary side of the step-up transformer 8. A programmable unijunction transistor 11 (hereinafter referred to as PUT), which is a silicon controlled rectifier with a negative type gate, is connected to the gate of the SCR 7. The anode of the PUT 11 is open while the cathode thereof is connected with the gate of the SCR 7, and the gate of the PUT 11 is connected with the anode of the SCR 7. This arrangement of the PUT 11 is different from its conventional connection, but according to this arrangement, it is possible to change the trigger voltage of the SCR 7 from a level of a few volts to a level considerably greater (about 100 volts). Therefore the triggering voltage of the SCR 7 may be kept at high level. Good results in discharge sparks are obtained with higher voltage at the spark gap, but the life of the SCR 7 becomes shorter. In order to keep the SCR 7 more durable, a protective resistor 12 is provided between the anode of the SCR 7 and the gate of the PUT 11. For a conventional silicon controlled rectifier where low electric power is available, the resistor 12 has a value not more than certain kohms.

As seen in FIG. 2, a constant-voltage controlling device 13 such as a zener diode is connected at the anode side thereof through a switch S in series with the negative pole of the battery 1 and at the cathode side thereof through the DC-DC converter 5 in series with the condenser 6. The constant-voltage controlling device 13 may be replaced by a silicon controlled rectifier in such a method as seen in FIG. 4. As long as the battery 1 supplies a voltage above a certain level, the voltage from the battery 1 is continuously applied through the constant-voltage controlling device 13 to the condenser 6. When the energy of the battery 1 falls below the certain level, the constant-voltage controlling device 13 will not supply the voltage from the battery 1 to the condenser 6 any longer. Connected in series with the cathode of the constant-voltage controlling device

13 is a protective resistor 14 for the constant-voltage controlling device 13.

When the switch in the circuit is turned on, the voltage of the battery 1 is applied to the DC-DC converter 5 so as to be effectively stepped up. The condenser 6 is charged with the half-wave voltage obtained through the DC-DC converter 5. When the charged voltage of the condenser 6 reaches a predetermined value, the SCR 7 fires, whereby the electric charge of the condenser 6 is rapidly discharged through the SCR 7 to the primary side of the step-up transformer 8. Then, the step-up transformer 8 steps up the voltage of the primary side thereof to induce a higher voltage at the secondary side thereof. This voltage is discharged at the spark gap formed by the pair of electrodes 9 and 10. At the same time, the SCR 7 is turned off. This operation is repeated until the switch S is opened.

As described above, the PUT 11 serves as the trigger device for the SCR 7. The anode of PUT 11 is opened, the cathode is connected to the gate of the SCR 7, and the gate of PUT 11 is connected to the anode of the SCR 7. Accordingly, the normal trigger voltage of the SCR 7 of about 50 volts using a conventional trigger diode, may be increased in its value to about 100 volts by using the PUT 11 instead of the conventional trigger diode. This fact causes the higher voltage to be discharged at the spark gap so as to ignite the fuel more effectively. Further, the SCR 7 is protected by the resistor 12 arranged between the anode of the SCR 7 and the gate of the PUT 11, so that the SCR 7 may effectively and reliably operate in the ignition circuit.

Referring to FIGS. 3 and 4, a condenser 22 and a SCR 23 are connected in parallel with a battery 21. A step-up transformer 24 is connected in series with the SCR 23 at the primary side thereof. A pair of electrodes 25 and 26 to form a spark gap therebetween are connected to the secondary side of the step-up transformer 24. A trigger diode 27 is arranged in the gate circuit of the SCR 23. A switch 28 and zener diode 29 are connected in series between the positive pole of the battery 21 and the condenser 22. A resistor R, which is connected in series between the battery 21 and the switch 28, is a protective resistance for the zener diode 29.

In the circuit of FIG. 4, a SCR 30 is substituted for the zener diode 29. The gate of the SCR 30 is connected through a variable resistor 31 with the positive pole of the battery 21. In the ignition circuit of the present invention, it is possible to substitute various constant-voltage controlling devices for the zener diode 29 or the SCR 30. When the switch 28 is closed, the zener diode 29 is turned on, a predetermined voltage charges the condenser 22. As soon as the voltage on the condenser 22 reaches a predetermined value, the trigger diode 27 connected to the gate of the SCR 23 triggers the SCR 23, whereby the current transiently flows through the primary side of the step-up transformer 24. Then, the voltage is stepped up on the secondary side of the step-up transformer 24 and is discharged across the spark gap. When the current value of the SCR 23 becomes less than its holding current value, the SCR 23 turns to a non-conducting state. The operation is cyclically repeated and spark discharges continue until the switch 28 is opened.

When the voltage applied to the gate of the SCR 30 of FIG. 4 reaches a higher level than a predetermined voltage value, the SCR 30 turnes on functioning the same as the circuit of FIG. 3. When the energy of the battery 21 drops below a certain level through age or use, the voltage of the battery 21 is not supplied to the condenser 22 by the function of the constant-voltage controlling device 29 or 30. This is advantageous because the user of the ignitor will become aware that the battery 21 must be changed.

The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. An electric spark generating device for ignitors comprising:
   - a power supply;
   - a switch means connected in series with said power supply;
   - inverter means connected to said switch means;
   - a diode connected in series with said inverter means;
   - a condenser means connected to said diode to store a charge voltage supplied from said power supply;
   - a silicon controlled rectifier connected to said condenser means to discharge the charge voltage on said condenser means;
   - a trigger means connected to the gate of said silicon controlled rectifier to trigger said silicon controlled rectifier at a predetermined level of the charge voltage on said condenser means; and
   - a step-up transformer having a primary winding and a secondary winding, the primary winding of said step-up transformer being connected between the cathode electrode of said silicon controlled rectifier and said condenser means and the secondary winding of said step-up transformer being connected to ignition electrodes.

2. An electric spark generating device for ignitors as set forth in claim 1, wherein said trigger means is a programmable unijunction transistor.

3. An electric spark generating device for ignitors as set forth in claim 2, wherein said programmable unijunction transistor includes an open anode, and wherein the cathode thereof is connected to the gate of said silicon controlled rectifier and the gate thereof is connected to the anode of said silicon controlled rectifier, wherein a substantially higher trigger voltage of said silicon controlled rectifier is obtained.

4. An electric spark generating device for ignitors as set forth in claim 2, including a protective resistor connected between the gate of said programmable unijunction transistor and the anode of said silicon controlled rectifier.

5. An electric spark generating device for ignitors as set forth in claim 4, wherein said condenser means and said silicon controlled rectifier are connected in parallel to said power supply.

6. An electric spark generating device for ignitors as set forth in claim 5, wherein said power supply is a battery.

7. An electric spark generating device for ignitors comprising:
   - a power supply;

an inverter means including a transistor and a transformer forming a blocking oscillator, said inverter means being connected to said power supply to raise the level of the voltage supplied from said power supply;

a switch means connected between said power supply and said inverter means to operate said inverter means;

a diode connected in series with the output of said inverter means to rectify the output voltage of said inverter means;

a condenser connected to said diode, said condenser being charged by output voltage of said inverter means;

a silicon controlled rectifier connected to said condenser to discharge the charge voltage on said condenser;

trigger means connected to the gate electrode of said silicon controlled rectifier so as to trigger said silicon controlled rectifier at a predetermined level of the charge voltage of said condenser;

a step-up transformer having a primary winding and a secondary winding, the primary winding of said step-up transformer being connected between the cathode electrode of said silicon controlled rectifier and said condenser and the secondary winding of said step-up transformer being connected to ignition electrodes, wherein said step-up transformer is adapted to step up the voltage of the primary winding thereof to induce a higher voltage at the secondary winding thereof thereby causing a spark across the ignition electrodes.

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