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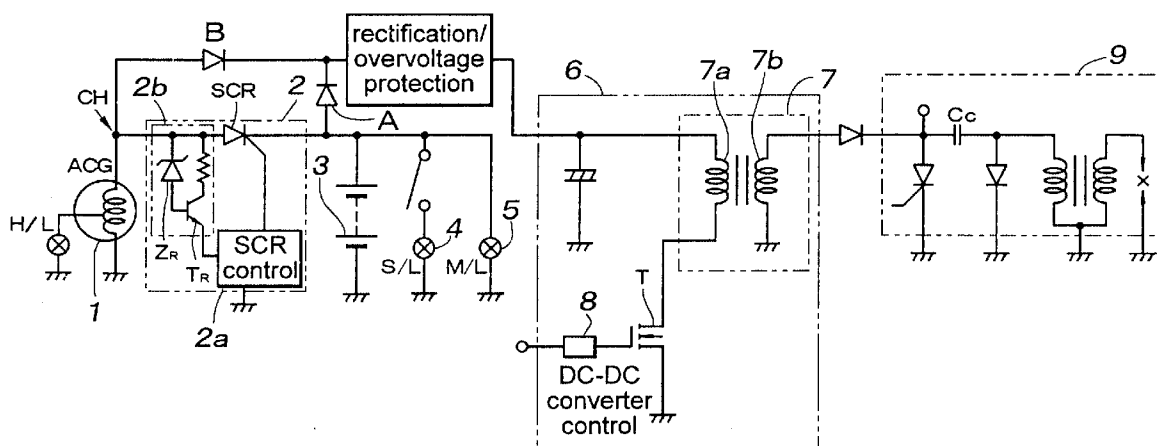
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1015 Luxembourg (LU)**(54) Ignition system with generator voltage distribution control**

(57) In an ignition system for an internal combustion engine of a motorcycle comprising an electric generator; an ignition circuit connected to the electric generator for producing a spark voltage for a spark plug; a battery having an end connected to the electric generator via switching means, and another end connected to the ground; and an electrical load connected in parallel with the battery, the switching means includes a voltage detector for detecting an output voltage of the electric generator, and a switching element for disconnecting the

battery and the electrical load from the electric generator when the output voltage detected by the voltage detector is below a prescribed value. Because the electrical load and the battery are disconnected from the generator when the output voltage of the generator is below a prescribed value, the output voltage can go up to the prescribed value or higher which is sufficient for the ignition circuit to properly operate so as to produce a spark voltage for a spark plug, with the result that the internal combustion engine can be easily started by operating a kickstarter of the motorcycle.

Fig. 3**EP 0 811 763 A2**

Description

TECHNICAL FIELD

The present invention relates to an ignition system, in particular to an ignition system comprising a CDI circuit in which a capacitor charged by a supply voltage from an electric generator is selectively discharged at an appropriate ignition timing so that ignition current is supplied to an ignition unit of an internal combustion engine.

BACKGROUND OF THE INVENTION

Various types of ignition systems are used for internal combustion engines for automobiles. For example, there are those for motorcycles known as DCCDI in which a DC-DC converter is used to raise the supply voltage so as to obtain a voltage required for a CDI-type ignition unit.

Figure 4 schematically shows a circuit configuration of a conventional DCCDI-type ignition system. An AC generator 1 is connected via a regulator circuit 12 to a battery 3, a stop lamp 4 and a lamp 5 for a meter such as a speedometer or the like, as well as to one end of a primary winding 7a of a transformer 7 in a DC-DC converter 6. The other end of the primary winding 7a is selectively connected to the ground via a switching transistor T which is controlled by a DC-DC converter control circuit 8. The secondary winding 7b of the transformer 7 in the DC-DC converter 6 is connected to an ignition unit 9.

In such conventional ignition systems, it may be difficult to start the engine in a condition where various electrical loads are connected, because the output of the AC generator is limited at such a time. For example, when the engine is started, the brake is often engaged to prevent the motorcycle from abruptly starting off, and therefore the stop lamp 4 is often turned on. Moreover, the switch for the meter lamp 5 may be closed at the starting of the engine.

In particular, when the battery 3 is disconnected or is not charged sufficiently, it may be even more difficult or sometimes impossible to start the engine by operating a kickstarter of the motorcycle. When the AC generator 1 is rotated by operating the kickstarter, the electric power generated by the AC generator 1 is consumed by the electrical loads. Further, the battery 3 may also absorb electrical current when it is undercharged. In such a case, the AC generator 1 may be unable to generate a sufficiently high voltage required for the DC-DC converter 6 to operate properly. As a result, the output voltage of the DC-DC converter 6 may be insufficiently low or sometimes the DC-DC converter 6 cannot operate at all, failing to charge the capacitor Cc in the ignition unit 9 to a sufficiently high voltage level to produce an ignition spark.

The above problem also exists in CDI systems in

which the DC-DC converter is not used and/or the AC generator is a three-phase type.

BRIEF SUMMARY OF THE INVENTION

In view of such problems of the prior art, a primary object of the present invention is to provide an ignition system which, in case the battery is not properly functioning, can distribute the power from the electric generator preferentially to the CDI circuit so that the power is prevented from being consumed by the electrical loads other than the ignition unit, to thereby ensure proper starting of the engine.

A second object of the present invention is to provide such an ignition system as a simple circuit with minimum additional cost.

To achieve the above objects, the present invention provides an ignition system for an internal combustion engine of a vehicle comprising: an electric generator; an ignition circuit connected to the electric generator for producing a spark voltage for a spark plug; a battery having an end connected to the electric generator via switching means, and another end connected to the ground; and an electrical load connected in parallel with the battery, wherein the switching means includes a voltage detector for detecting an output voltage of the electric generator, and a switching element for disconnecting the battery and the electrical load from the electric generator when the output voltage detected by the voltage detector is below a prescribed value.

The present invention is suitable for an ignition system for an internal combustion engine of a motorcycle in which a kickstarter is used to start the engine. More specifically, the present invention is particularly beneficial when the ignition circuit comprises a CDI circuit, especially when the ignition circuit comprises a DCCDI circuit in which a DC-DC converter is used to raise the output voltage from the generator so as to obtain a voltage required for a CDI-type ignition unit.

In one embodiment of the ignition system according to the present invention, the switching means comprises: a thyristor connected between the electric generator and the battery; a thyristor control circuit having an output terminal connected to a gate of the thyristor; a zener diode having a cathode connected to the anode of the thyristor; and a transistor having a base connected to an anode of the zener diode, a collector connected to the anode of the thyristor via a resistor, and an emitter connected to the thyristor control circuit.

In this manner, when the output voltage of the electric generator is below a prescribed value, the zener diode does not conduct electrical current, and the transistor is kept in the off state. This prevents the output voltage of the electric generator from being applied to the thyristor control circuit, and hence the thyristor is kept in the off state, electrically disconnecting the battery and the electrical load from the generator. Because the electric power generated by the electric generator is not con-

sumed by the battery or the electric load, the output voltage of the electric generator can go up to a sufficiently high voltage level to produce a spark from the spark plug, to thereby ensure proper starting of the engine.

Other and further objects, features and advantages of the invention will appear more fully from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Now the present invention is described in the following with reference to the appended drawings, in which:

Figure 1 is a schematic circuit diagram of an embodiment of an ignition system for a motorcycle engine to which the present invention is applied; Figure 2 is a timing chart showing voltage waveforms at essential points of the control circuit in Figure 1;

Figure 3 is a schematic circuit diagram of another embodiment of an ignition system for a motorcycle engine to which the present invention is applied; and

Figure 4 is a schematic circuit diagram of a conventional ignition system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 is a schematic circuit diagram of an embodiment of an ignition system for an internal combustion engine of a motorcycle to which the present invention is applied. As shown in the drawing, an AC generator 1 is connected via a regulator circuit 2 to one end of a battery 3, the other end of which being connected to the ground. Connected in parallel with the battery 3 are electrical loads including a stop lamp 4 and a meter lamp 5 in this embodiment. The generator 1 is also connected to one end of a primary winding 7a of a transformer 7 in a DC-DC converter 6 via a well known rectification/overvoltage protection circuit. The secondary winding 7b of the transformer 7 is connected to a CDI-type ignition unit 9. The other end of the primary winding 7a is selectively connected to the ground through a switching transistor T which is controlled by a DC-DC converter control circuit 8.

The regulator circuit 2 comprises (i) a thyristor SCR connected between the AC generator 1 and the battery 3, (ii) a thyristor control circuit 2a connected to a gate terminal of the thyristor SCR to provide a trigger signal to the gate terminal so as to turn on the thyristor SCR, and (iii) a disconnecting circuit 2b consisting of a zener diode ZR, a transistor TR and a resistor for, according to the output voltage from the AC generator 1, stopping power feed to the thyristor control circuit 2a selectively so as to electrically disconnect the battery 3 and the electrical loads including the stop lamp 4 and meter

lamp 5 in the downstream of the thyristor SCR.

Now, the operation of this circuit is described in the following. In the case where the battery 3 is properly functioning or the engine has already started properly, the AC generator 1 can generate a sufficient voltage to power the DC-DC converter. After the battery 3 has been sufficiently charged, the stop lamp 4 and meter lamp 5 can also function properly.

As shown in Figure 2, in the case where the battery 3 is not properly functioning due to some defect, the output voltage (at terminal CH) of the AC generator 1 fluctuates when the electric generator 1 is rotated by operating a kickstarter in order to start the engine. In the conventional system, as mentioned before, the output voltage of the generator 1 cannot go up to a sufficient level due to the electrical current which flows through the various electrical loads (i.e., the stop lamp 4, meter lamp 5, and the like) other than the ignition unit. Typically the voltage only goes up to as high as 4V in the conventional system as shown by the dotted line in Figure 2. Accordingly, the voltage applied to the DC-DC converter 6 may be about 3V due to a regulator circuit between the DC-DC converter 6 and the AC generator 1. At such a voltage, the DC-DC converter 6 is virtually unable to operate and cannot generate a sufficient voltage.

On the contrary, according to the present invention, when the output voltage of the AC generator 1 is below a prescribed value (e.g., 7V), the zener diode ZR does not conduct electrical current, and the transistor TR is kept in the off state. This prevents the supply voltage from being applied to the thyristor control circuit 2a, and hence the thyristor SCR is kept in the off state, electrically disconnecting the battery 3 and the electrical loads in the downstream of the thyristor SCR from the AC generator 1, with the result that the output voltage of the AC generator 1 goes up to for example 7V or higher as shown by a solid line in Figure 2. Without being transmitted via the regulator circuit 2, the output voltage from the AC generator 1 is applied to the input of the DC-DC converter 6 substantially without any loss. Such a voltage is enough to power the DC-DC converter 6 so that the capacitor Cc is charged to an adequately high voltage above a threshold level to produce a spark from the spark plug.

Figure 3 shows another embodiment of the ignition system according to the present invention. This embodiment is similar to that shown in Figure 1 except that the battery 3 is also connected to the rectification/overvoltage protection circuit via a diode A having an anode connected to the battery 3 and a cathode connected to the rectification/overvoltage protection circuit, and the electric generator 1 is connected to the rectification/overvoltage protection circuit via another diode B having an anode connected to the generator 1 and a cathode connected to the rectification/overvoltage protection circuit. In this ignition system, the DC-DC converter 6 can be supplied with power from the battery 3 via the rectification/overvoltage protection circuit when the battery 3 is

properly functioning, with the result that a more stable voltage can be applied to the DC-DC converter 6 compared with when the power is supplied from the electric generator 1 alone. In the case where the battery 3 is not properly functioning, the power is supplied from the generator 1 in a similar way to that described in the first embodiment, except that the output voltage of the electric generator 1 is decreased by a voltage drop across the diode B.

Although the present invention has been described in terms of specific embodiments thereof, it is possible to modify and alter details thereof without departing from the spirit of the present invention. For example, a single-phase AC generator was used in the above embodiments, but the present invention is also applicable to ignition systems which comprise an AC generator of a three-phase type. In such a case, a similar effect can be obtained by changing at least one diode in the regulator circuit to a thyristor and applying the present invention in a similar manner to that described above. Moreover, although a DCCDI system was used as an ignition system of an engine in the above embodiment, the present invention is also applicable to a CDI system which does not use a DC-DC converter. The electrical loads can include, besides those mentioned above, a fuel meter, a starter motor or, in some circuit configurations, a tail lamp, a head lamp or the like.

Thus according to the present invention, even when the battery is not properly functioning, it is possible to provide the ignition unit with a sufficient voltage from the electric generator by operating the kickstarter of the motorcycle, to thereby ensure proper starting of the engine.

Claims

1. An ignition system for an internal combustion engine of a vehicle comprising:

an electric generator;
 an ignition circuit connected to the electric generator for producing a spark voltage for a spark plug;
 a battery having an end connected to the electric generator via switching means, and another end connected to the ground; and
 an electrical load connected in parallel with the battery,

wherein the switching means includes a voltage detector for detecting an output voltage of the electric generator, and a switching element for disconnecting the battery and the electrical load from the electric generator when the output voltage detected by the voltage detector is below a prescribed value.

2. An ignition system according to claim 1, wherein the

vehicle consists of a motorcycle.

3. An ignition system according to claim 2, wherein the ignition circuit comprises a CDI circuit.

4. An ignition system according to claim 3, wherein the ignition circuit further comprises a DC-DC converter connected between the electric generator and the CDI circuit to raise the output voltage of the electric generator to obtain a voltage required for the CDI circuit to operate.

5. An ignition system according to claim 1, wherein the switching element consists of a thyristor.

6. An ignition system according to claim 1, wherein the switching means comprises:

a thyristor connected between the electric generator and the battery;
 a thyristor control circuit having an output terminal connected to a gate of the thyristor;
 a zener diode having a cathode connected to the anode of the thyristor; and
 a transistor having a base connected to an anode of the zener diode, a collector connected to the anode of the thyristor via a resistor, and an emitter connected to the thyristor control circuit.

7. An ignition system according to claim 1, wherein the battery is also connected to the ignition circuit via a first diode having an anode connected to the battery and a cathode connected to the ignition circuit, and a second diode is connected between the electric generator and the ignition circuit, the second diode having an anode connected to the electric generator and a cathode connected to the ignition circuit.

Fig. 1

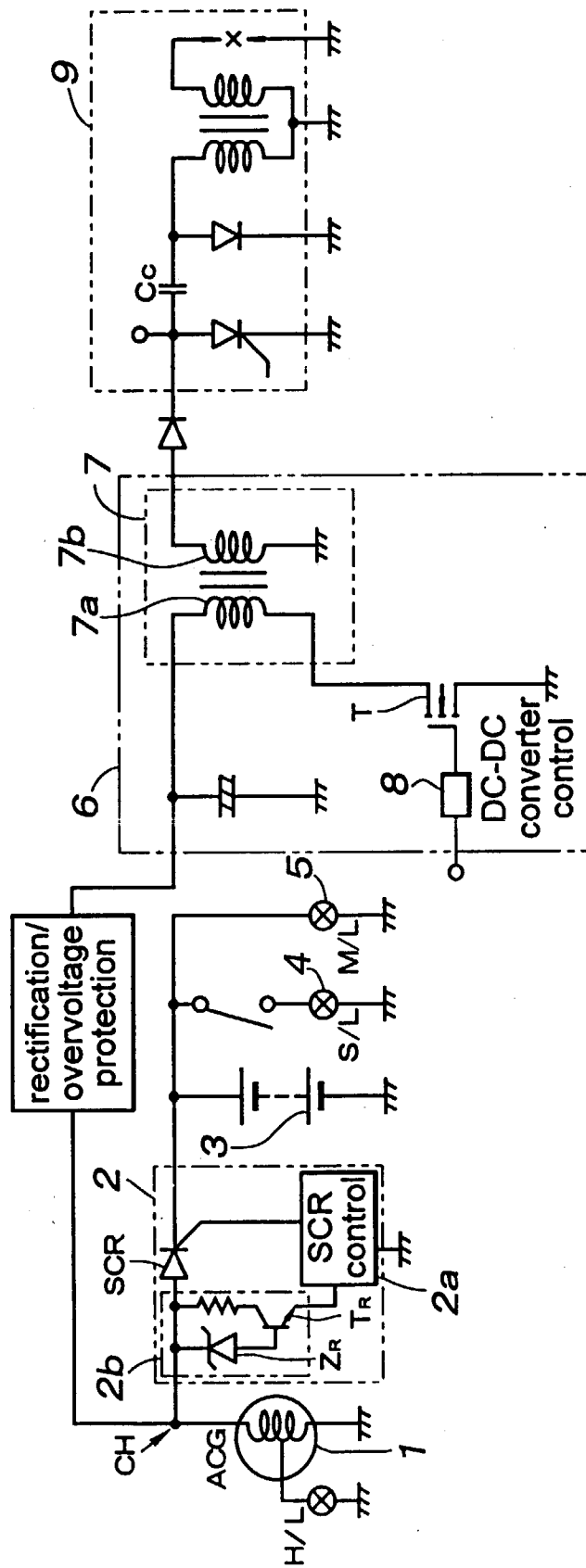


Fig. 2

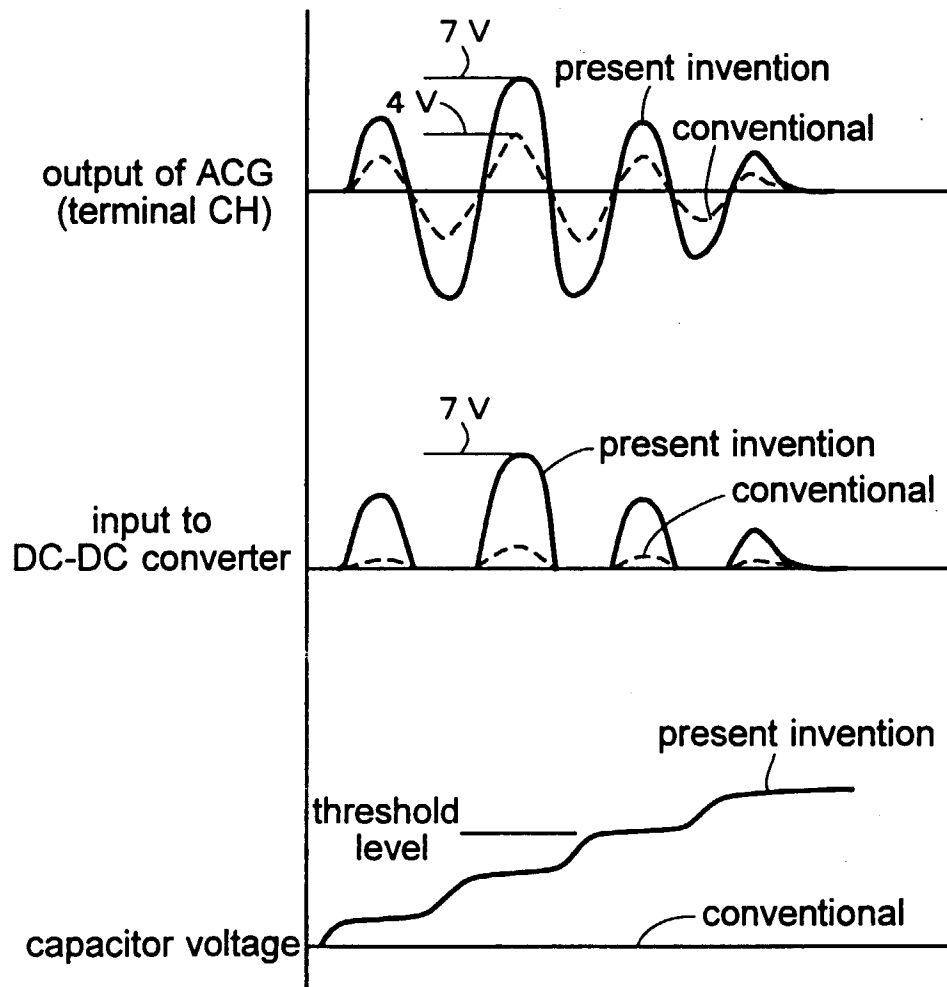


Fig. 3

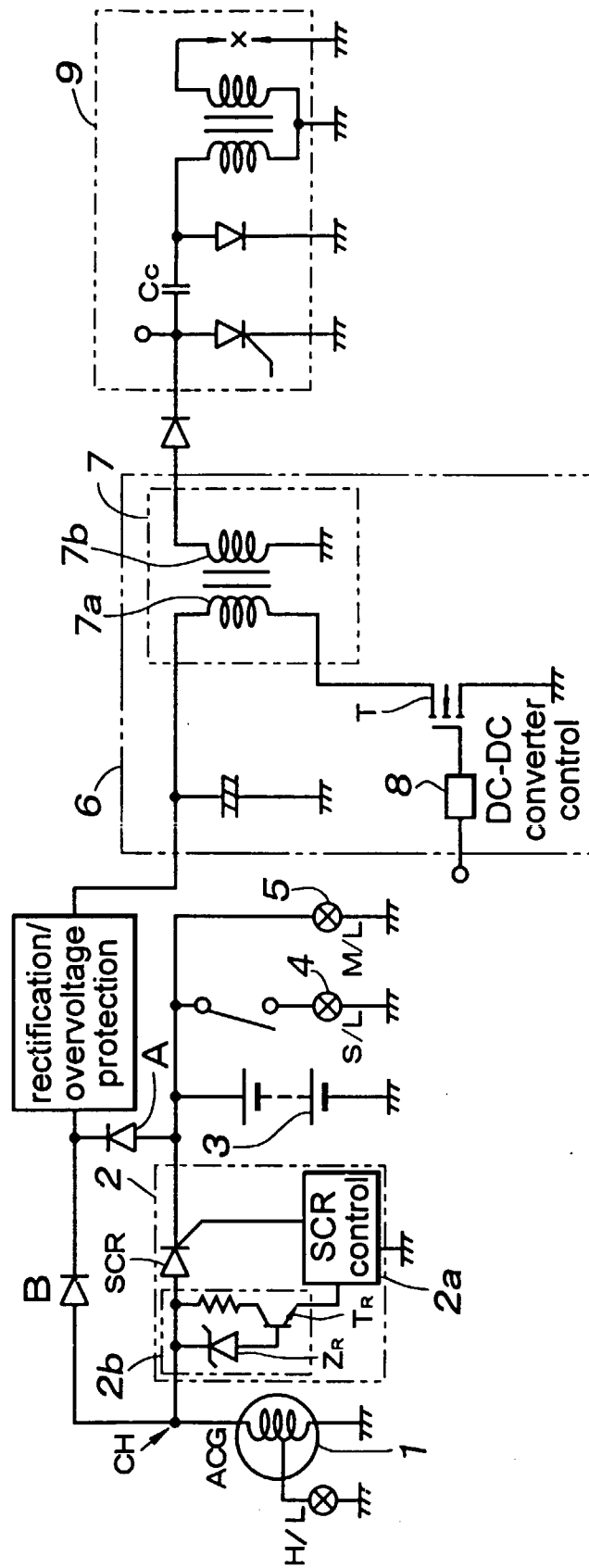


Fig. 4

