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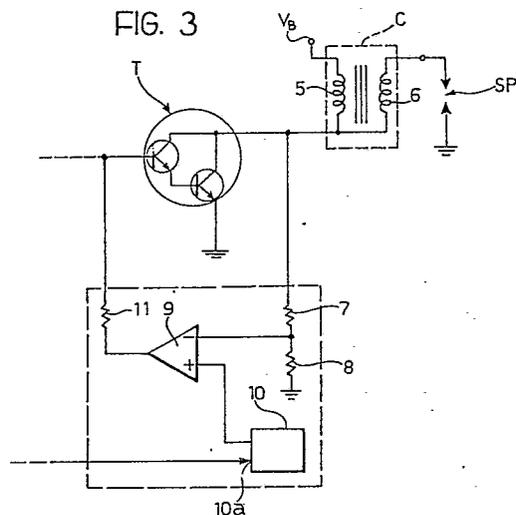
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54 **An ignition system for an internal combustion engine for motor vehicles, particularly of the static-distribution type.**

57 The invention relates to an ignition system, particularly of the static-distribution type, in which a respective ignition coil (C) with a primary winding (5) and a secondary winding (6) is coupled to the sparking plug (SP) associated with each cylinder. The system includes a respective switching transistor (T) for each ignition coil (C) and control circuit devices (4, 7-11) which, in order to generate a spark in a plug (SP), cause a first switching of the corresponding transistor (T) from the shut-off condition to the conducting condition to start the flow of current in the primary winding (5) of the associated coil (C), and a second switching to the shut-off condition to stop the flow of current in the coil (C), causing the striking of the spark. These control circuit devices (4, 7-11) are arranged to control the speed of the first switching of the transistor or transistors (T) concerned from time to time, for each ignition, so that the first switching takes place gradually at a speed less than a predetermined value. The amplitude of the voltage peak which is applied to the sparking plug (SP) in correspondence with the first switching is thus drastically reduced.



Description

An ignition system for an internal combustion engine for motor vehicles, particularly of the static-distribution type.

The present invention relates to an ignition system for an internal combustion engine, particularly of the static-distribution type, in which a respective ignition coil with a primary winding and a secondary winding is coupled to the sparking plug associated with each cylinder, the system including a switching transistor for each ignition coil and control circuit means which, in order to generate a spark in a plug, are adapted to cause a first switching of the corresponding transistor from the shut-off condition to the conducting condition to start the flow of current in the primary winding of the associated coil, and a second switching to the shut-off condition to stop the flow of current in the primary winding of the coil, causing the striking of the spark.

An ignition system of this type is schematically illustrated in Figure 1. The system illustrated includes a sensor 1 of known type for providing electrical signals indicative of the angular position and of the rate of rotation of the shaft of an internal combustion engine, not illustrated. This sensor is connected to an electronic microprocessor control unit 4 of known type, to which further sensors, such as, for example, a sensor 2 for sensing the vacuum in the intake manifold of the engine, a sensor 3 for sensing the temperature of the air taken in by the engine, etc., are also connected.

The unit 4 is arranged to cause, in a predetermined manner, the generation of sparks in sparking plugs SP through respective ignition coils C piloted by power switching transistors T, for example of the Darlington type. In particular, each coil C comprises a primary winding 5 connected in series with the collector-emitter path of a transistor T, between a direct voltage supply V_B (the battery of the motor vehicle) and earth. Each coil also includes a secondary winding, indicated 6, coupled to the respective plug SP.

In operation, the unit 4 causes the cyclical application of operating signals to the bases of the transistors T in dependence on the signals provided by the sensors 1 to 3, to cause the generation of the sparks in the various cylinders of the engine with the necessary advance.

Specifically, in order to cause the generation of a spark in a particular plug, the unit 4 applies a signal to the base of the corresponding transistor T so as to cause a first switching of the transistor from the shut-off condition to the conducting condition to start the flow of current in the primary winding 5 of the associated coil C. When a certain period of time has elapsed after the first switching, the unit 4 causes a second switching of the transistor to the shut-off condition to stop the flow of current in the primary winding of the associated coil and to cause the striking of the spark in the corresponding plug.

The trace of the voltage V_{ce} between the collector and the emitter of the transistor T correspondingly follows the trace illustrated in Figure 2, in which the times t_0 and t_1 correspond to the two switchings described above. The trace of the intensity of the

current flowing in the primary winding and in the ignition coil and the trace of the voltage applied to the plug are correspondingly indicated I_c and V_{sp} in the same drawing.

In particular, the voltage V_{sp} has a peak value P_1 which corresponds substantially with the time t_0 .

This voltage peak can in fact reach values of 2,000-3,000 V.

The voltage V_{sp} then has a second peak P_2 which corresponds substantially with the time t_1 ; this peak is the one which is actually intended to generate the spark.

In practice, however, the amplitude of the spurious peak P_1 may in some circumstances be sufficient to generate a spark which, in such a case, is decidedly out of phase.

In order to eliminate the problem represented by the voltage peak which occurs at the output of a coil in correspondence with the first switching of the associated transistor, it has been proposed that a high-tension diode be placed in series with the plug. This solution, however, has the disadvantage that, if these diodes become equivalent to an open circuit in the event of damage, they prevent the striking of sparks whilst themselves becoming equivalent to a short-circuit whereby they are unable to eliminate the spurious voltage peak V_{sp} associated with the first switching of the transistors.

The object of the present invention is to produce an ignition system of the type specified above, in which the problem relating to the spurious voltage peak associated with the first switching of the transistors piloting the coils is effectively resolved at source.

This object is achieved according to the invention by means of an ignition system whose main characteristic lies in the fact that the control circuit means are arranged to control the speed of the first switching of the transistor or transistors concerned from time to time, for each ignition, so that the first switching takes place gradually at a speed less than a predetermined value.

The reduction of the speed of switching of the transistors from shut-off to conduction causes the amplitude of the spurious voltage pulses V_{sp} related to these switchings to be reduced considerably so that they are no longer able to cause the striking of out-of-phase sparks.

In a first embodiment of the invention, the control circuit means for each switching transistor comprise a control circuit loop which is arranged to detect the voltage between the collector and the emitter during the first switching and to modify the base current of the controlled transistor so that the voltage between the collector and the emitter varies gradually in a predetermined manner.

In a different embodiment of the invention, the electronic control and operating unit of the ignition system is arranged to pilot each switching transistor so that a pulsed operating voltage is applied to the base of the transistor concerned from time to time,

with a duty cycle which increases gradually in a predetermined manner with rise and fall times which are less than the switching time of the transistor.

Further characteristics and advantages of the invention will become clear from the detailed description which follows, with reference to the appended drawings, provided purely by way of non-limiting example, in which:

Figure 1, already described, shows an ignition system for an internal combustion engine for motor vehicles, of the static-distribution type,

Figure 2, also already described, is a series of three graphs which show the time traces of three signals generated in the ignition system of Figure 1,

Figure 3 is a detailed electrical diagram of part of the ignition system of Figure 1, modified according to the invention, and

Figure 4 shows the time trace of two signals generated in an ignition system according to Figure 1, modified according to a further embodiment of the invention.

Figure 3 shows part of an ignition system according to Figure 1 which relates to the control of the striking of the spark in a plug SP. In particular, this drawing shows a switching transistor T constituted by a pair of individual transistors connected in a Darlington arrangement with their common collector connected to the primary winding 5 of the coil C and their emitter connected to earth. A resistive divider formed by two resistors 7 and 8 is connected to the collector of the transistor T. This divider is connected to the inverting input of a differential amplifier 9 to the non-inverting input of which the output of a ramp generator 10 is connected. This generator has a control input 10a connected to an output of the microprocesor unit 4.

The output of the differential amplifier 9 is connected to the base of the transistor T through a resistor 11. In operation, each time the transistor T of Figure 3 is required to operate, the microprocessor unit 4 provides a voltage to its base to cause it to switch from the shut-off condition to the conducting condition. At the same time, the ramp generator 10 is activated. The differential amplifier 9 adjusts the current provided to the base of the transistor T so that the voltage between the collector and the emitter of the transistor varies substantially according to the law of variation of the ramp signal generated by the circuit 10. Conveniently, this law of variation is sufficiently slow that the spurious pulse which appears (by differential effect) in the voltage provided at the output of the coil C has an amplitude less than a predetermined value and therefore not sufficient to enable a spark to be struck.

In another embodiment, the ignition system according to the invention retains substantially the same structure as that illustrated in Figure 1 but the electronic control and operating unit 4 is arranged, in known manner, to apply to each switching transistor (each time the first switching is to be carried out) a pulsed operating voltage with a gradually increasing duty cycle, as illustrated qualitatively by the signal indicated A in Figure 4. The rise and fall times of the

pulses of the signal A must be less than the switching time of the transistors T so that, in practice, the bases of the transistors "experience" the application of a signal having the qualitative trace indicated B in the same Figure 4. The gradual variation in the base voltage of the transistors corresponds to the gradual variation in their collector-emitter voltage and the amplitude of the corresponding spurious peaks of the voltage provided at the output of the coil C is reduced.

Claims

1. An ignition system for an internal combustion engine for motor vehicles, particularly of the static-distribution type, in which a respective ignition coil (C) with a primary winding (5) and a secondary winding (6) is coupled to the sparking plug (SP) associated with each cylinder, the system including a switching transistor (T) for each ignition coil (C) and control circuit means (4) which, in order to generate a spark in a plug (SP), are adapted to cause a first switching of the corresponding transistor (T) from the shut-off condition to the conducting condition to start the flow of current in the primary winding (5) of the associated coil (C), and a second switching to the shut-off condition to stop the flow of current in the primary winding (5), causing the striking of the spark, characterised in that the control circuit means (4; 7 to 11) are arranged to control the speed of the first switching of the transistor or transistors (T) concerned from time to time, for each ignition, so that the first switching takes place gradually at a speed less than a predetermined value.

2. An ignition system according to Claim 1, characterised in that the control circuit means for each switching transistor (T) include a control circuit loop (7 to 11) which is arranged to detect the voltage between the collector and the emitter during the first switching and to modify the base current of the controlled transistor (T) so that the voltage between the collector and the emitter of the transistor varies gradually in a predetermined manner.

3. An ignition system according to Claim 2, characterised in that the control circuit loop for each switching transistor (T) comprises a differential amplifier (9) having a first input connected to the collector of the transistor (T) and a second input connected to the output of a reference signal generator (10), and its output connected to the base of the transistor (T).

4. An ignition system according to Claim 3, characterised in that the signal generator (10) is arranged to generate a ramp signal.

5. An ignition system according to Claim 1, characterised in that the control circuit means include an electronic control and operating unit (4) arranged to pilot each switching transistor

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(T) so that, in order to cause the first switching, the unit (4) applies to the base of the transistor (T) a pulsed operating voltage (A) with a duty cycle which increases gradually in a predetermined manner, with rise and fall times which are less than the switching time of the transistor (T).

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FIG. 1

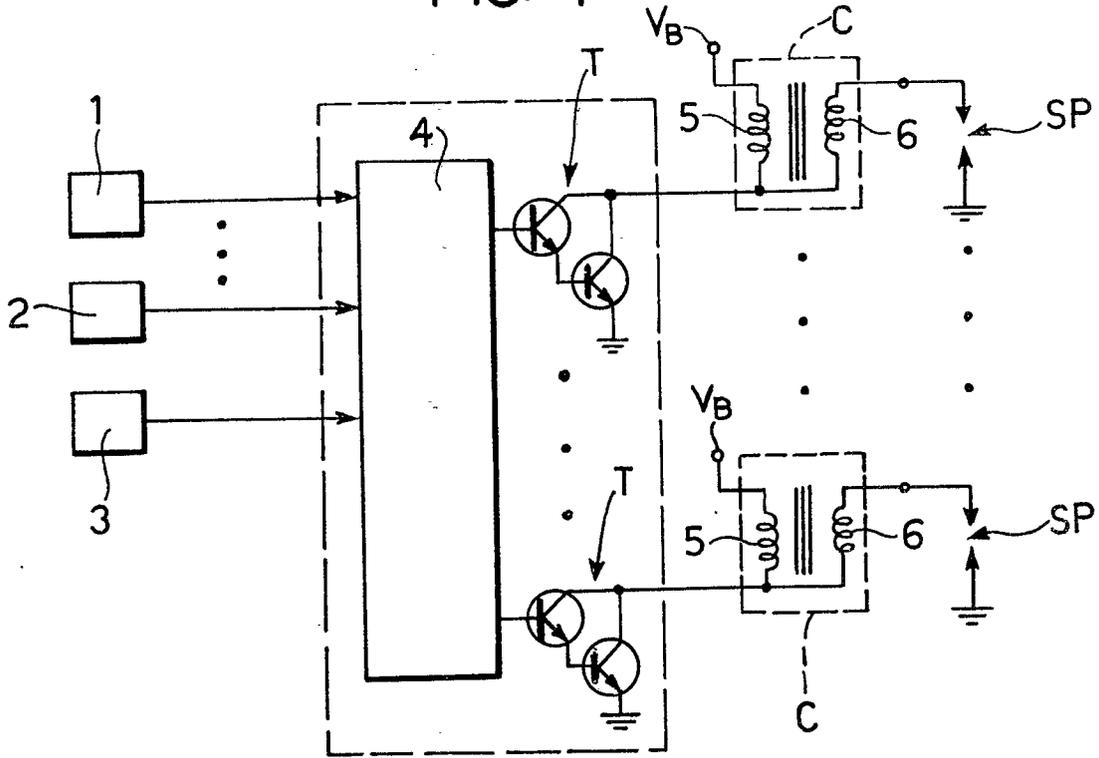


FIG. 2

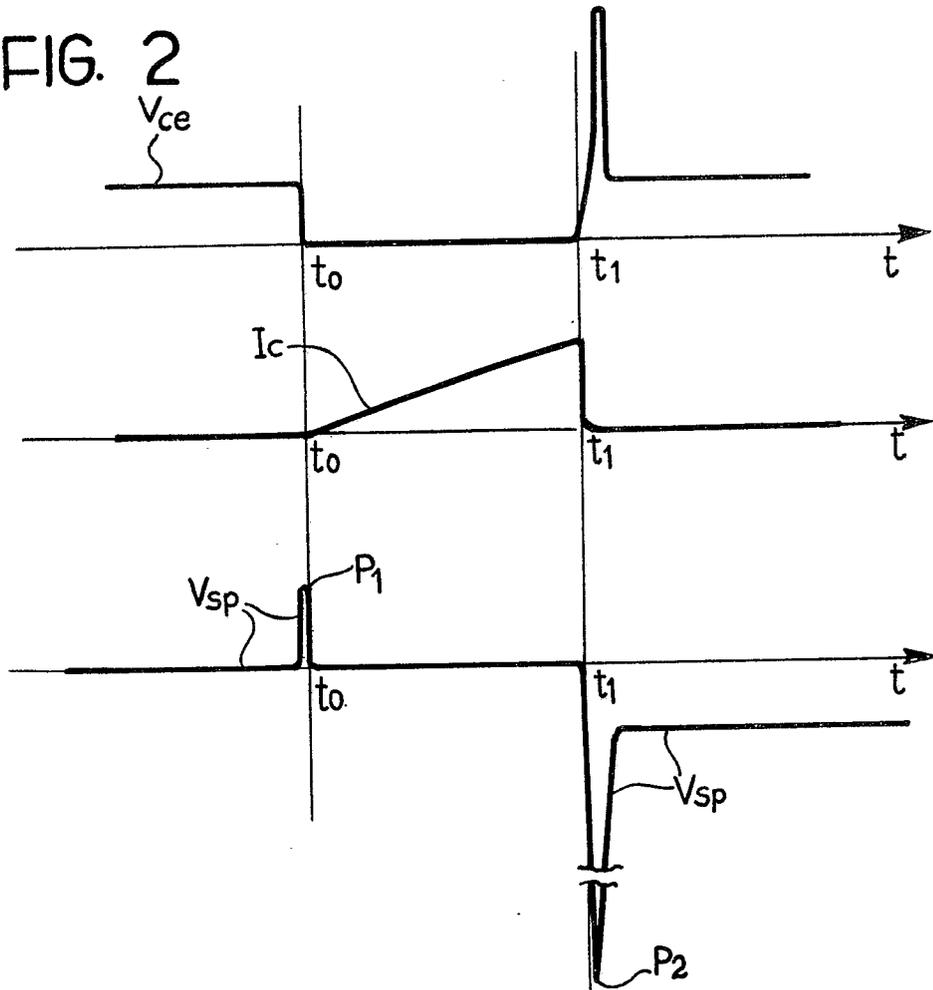


FIG. 3

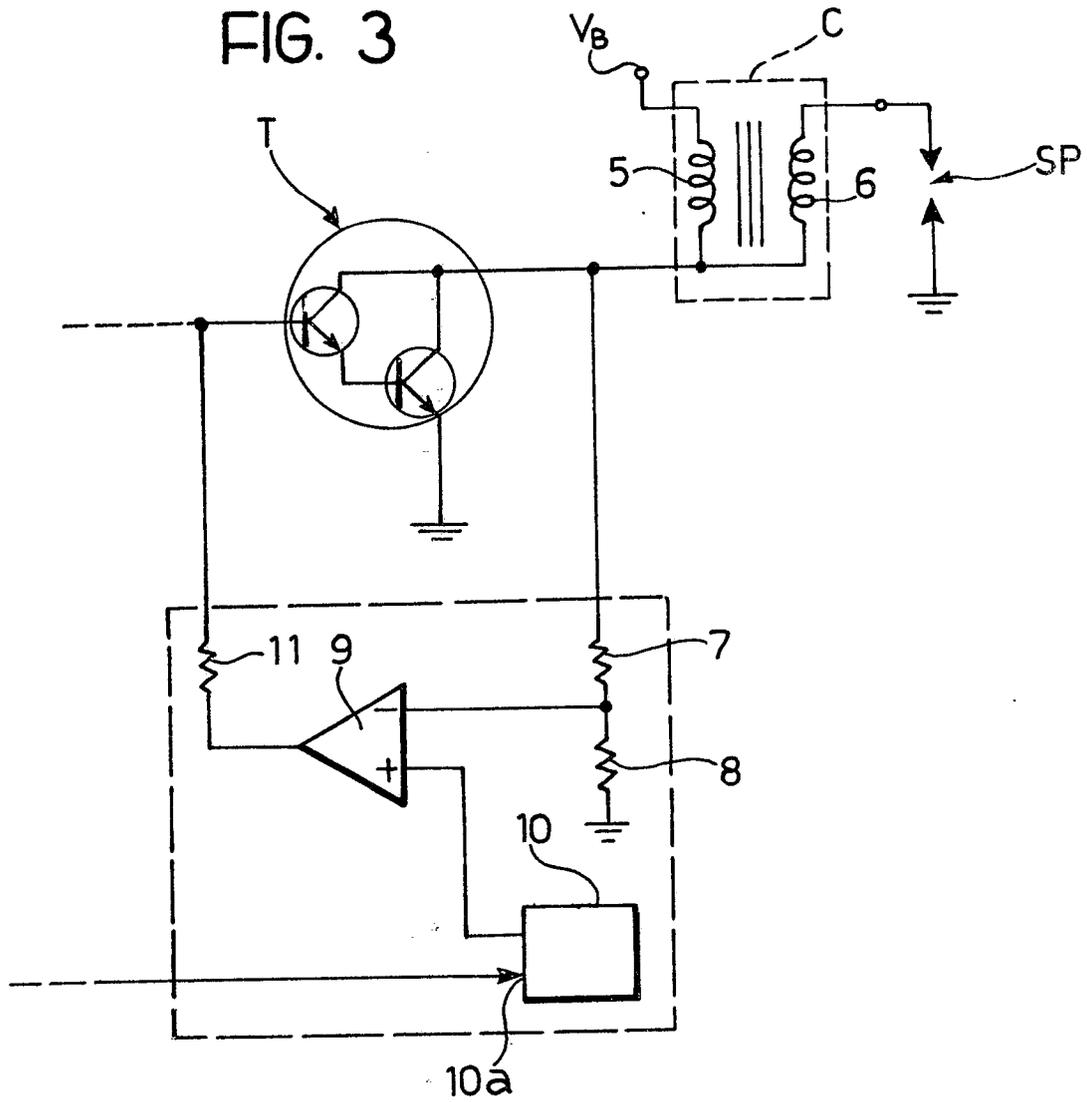


FIG. 4

