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SPARK IGNITION SYSTEMS FOR INTERNAL COMBUSTION ENGINES

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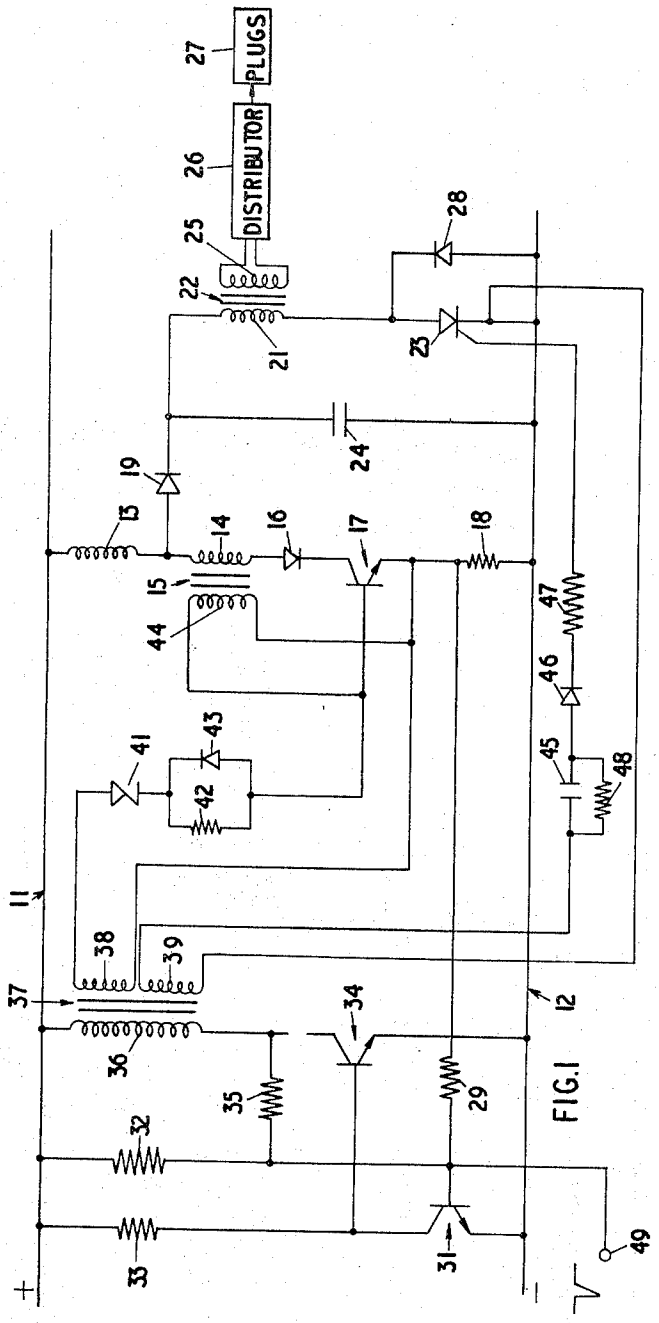

FIG. 1

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SPARK IGNITION SYSTEMS FOR INTERNAL COMBUSTION ENGINES

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ABSTRACT OF THE DISCLOSURE

In a spark ignition system, a transistor is turned on by means driven by the engine, and when it is turned on energy is stored in an inductor in series with the transistor. The transistor is turned off when the current flowing in the inductor reaches a predetermined value, and the energy is then transferred to a capacitor, which when the transistor is turned on again is discharged to produce the spark. In series with the transistor is a transformer, and the arrangement is such that as the current through the transistor increases, the transformer applies an increasing base drive to the transistor so as to ensure adequate base current in the transistor as the current in the inductor increases.

This invention relates to spark ignitions systems for internal combustion engines of the kind in which current flow through inductor is controlled by a transistor, the energy stored in the inductor later being used to produce a spark.

According to the invention a drive circuit for the transistor of a system of the kind specified includes means for initiating conduction of the transistor so that current flows through the transistor, and a feedback transformer for increasing the drive current applied to the base of the transistor as the current flowing through the transistor increases.

In the accompanying drawings, FIGURE 1 is a circuit diagram illustrating an example of the invention.

Referring first to the drawing, there are provided positive and negative lines **11**, **12** which in use are connected to the battery of a vehicle. Connected in a series circuit across the lines **11**, **12** are a storage inductor **13**, the primary winding **14** of a transformer **15**, a diode **16**, a transistor **17** and a resistor **18**. A point intermediate the inductor **13** and winding **14** is connected through a diode **19** to one end of the primary winding **21** of an ignition transformer **22**, the other end of the winding **21** being connected to the line **12** through a controlled rectifier **23**. The winding **21** and rectifier **23** are bridged by a capacitor **24**, and the secondary winding **25** of the transformer **22** is connected through a distributor **26** to the plugs **27** of the engine in turn. The anode and cathode of the rectifier **23** are interconnected through the cathode and anode of the diode **28**.

The emitter of the transistor **17** is connected through a resistor **29** to the base of a transistor **31** having its emitter connected to the line **12** and its base and collector connected to the line **11** through resistors **32**, **33** respectively. The collector of the transistor **31** is further connected to the base of a transistor **34**, the emitter of which is connected to the line **12**, and the collector of which is connected to the base of the transistor **31** through a resistor **35**, and to the line **11** through the primary winding **36** of a transformer **37** having secondary windings **38**, **39**. One end of the winding **38** is connected to the emitter of the transistor **17**, and its other end is connected to the anode of a Zener diode **41** the cathode of which is connected to the base of the transistor **17** through a resistor **42** and a diode **43** in parallel. Moreover, the base and emitter of the transistor **17** are interconnected through the

secondary winding **44** of the transformer **15**. One end of the winding **39** is connected to the cathode of the rectifier **23**, and its other end is connected to the gate of the rectifier **23** through a capacitor **45**, a diode **46** and a resistor **47** in series, the capacitor **45** being bridged by a resistor **48**.

In order to understand the operation of the ignition circuit, consider a point in a cycle of operation in which the capacitor **24** is charged. At this point, the transistors **17**, **34** are off but the transistor **31** is on. At the instant when a spark is required, a pulse is applied to a terminal **49** by any convenient means driven by the engine in timed relationship thereto. The terminal **49** is connected to the base of the transistor **31**, and the pulse acts to turn the transistor **31** off, so that the transistor **34** is turned on. Current now flows in the winding **36**, and so currents are induced in the windings **38**, **39**. The current induced in the winding **39** is fed through the series circuit **45**, **46**, **47** to the gate and cathode of the rectifier **23** to turn it on, and consequently the capacitor **24** discharges through the winding **21** and the rectifier **23**. Discharge of the capacitor causes a high E.M.F. to be induced in the secondary winding **25** of the transformer **22**, thereby producing the required spark. The resonance of the discharge circuit of the capacitor **24** switches the rectifier **23** off by reverse biasing it.

At the same time as the rectifier **23** is switched on, the current induced in the winding **38** is passed through the resistor **42** to the base and emitter of the transistor **17**. The current flowing through resistance **42** is small, but is sufficient to start the transistor **17** conducting. As soon as the transistor **17** conducts, its collector-emitter current begins to rise, and the current supplied from the winding **38** would not be sufficient to maintain the transistor **17** saturated. However, as current flowing through the transistor **17** increases, feedback is provided by way of the transformer **15** to increase the base drive, and so the transistor **17** is maintained in its saturated condition.

Current flowing through the transistor **17** causes energy to be stored in the inductor **13**, and when the voltage across the resistor **18** reaches a predetermined value, the transistor **31** is switched on again and consequently the transistor **34** is switched off. An E.M.F. is again generated in the winding **39**, but this has no effect on the rectifier **23** because of the diode **46**. At the same time, the current is induced in the winding **38** which passes through the diodes **41**, **43** to reverse bias the transistor **17** so that it is switched off. The transformer **15** can also assist turn-off. It will be understood that the transistor **17** will be switched off if its base-emitter current is merely removed, but it is preferred to reverse bias the base-emitter junction in order that the switch-off is rapid. As soon as the transistor **17** ceases to conduct, the energy stored in the inductor **13** is transferred to the capacitor **24** by way of the diode **19**, so completing one complete cycle of operation. The voltage to which the capacitor **24** is charged is considerably in excess of the battery voltage.

Because the series circuit including inductor **13** remains completed until the voltage across the resistor **18** reaches a predetermined value, the current flowing through the inductor **13** at the moment when the transistor **17** is switched off will be independent of battery voltage, and so the energy transferred to the capacitor **24** will be constant. Moreover, since the base drive for the transistor **17** is provided by the transformer **15** after the initial drive is received from the transformer, **37**, this base drive will also be independent of battery voltage. These two features render the circuit particularly useful in cases where the battery voltage can fall to a very low level.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. A spark ignition systems for an internal combustion engine, comprising in combination

(a) a D.C. source

(b) a transformer having a primary winding and a secondary winding, the transformer having the characistic that as the current flow through its primary winding increases, the current flow through its secondary winding increases proportionately

(c) a series circuit connected across said D.C. source and including an inductor, the primary winding of said transformer and the collector-emitter path of a transistor

(d) a feedback path coupling the secondary winding of said transformer with the base of said transistor

(e) means operable in timed relationship with the engine for initiating conduction of said transistor at instants when a spark is required, current then building up in said inductor and said transformer providing increasing base drive to said transistor as said current builds up in said inductor

(f) means sensitive to current flow in said inductor for turning said transistor off when the current flowing in said inductor reaches a predetermined value

(g) a capacitor coupled with said inductor where energy stored in said inductor is transferred to said capacitor when said transistor is turned off

(h) means for discharging said capacitor when the transistor conducts

(i) means operable by discharge of the capacitor for producing a spark.

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